An Update on Captive Cetacean Welfare

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Abstract: The welfare of captive cetaceans (i.e., dolphins, whales, and porpoises) has garnered increasing attention over the years as captivity presents significant challenges for these long-lived, highly intelligent, wide-ranging, and socially complex animals. This paper provides an overview of the current state of captive cetacean welfare, examining captive facilities, recent improvements, persistent problems, and the clinical/behavioral/neural consequences of confinement. We specifically address both quantitative and qualitative aspects of captive space, sociocognitive factors, feeding, and welfare concerns such as stereotypies, physical health, reproduction, and lifespan. The contrast between the restrictive nature of captive environments and the dynamic, multifaceted characteristics of the natural environment highlights the difficulties faced by cetaceans in captivity. Despite efforts by some facilities to improve conditions, serious welfare challenges persist, raising critical ethical concerns about the well-being of captive cetaceans.

1. Introduction

Cetaceans (i.e., dolphins, whales, and porpoises) have long been considered challenging and ethically problematic candidates for captivity (Carter, 1982; Goldblatt, 1993; Lott & Williamson, 2017; Rose et al., 2017 Hosey et al., 2020; Marino, 2020; Marino et al., 2020; Marino & White, 2022; McGillian, 2023). Typically, only odontocetes (i.e., toothed whales) are held in captivity because mysticetes (i.e., baleen whales) are too large and have feeding habits that make captivity particularly challenging. The 2013 film *Blackfish,* directed by Gabriela Cowperthwaite, played a key role in changing public sentiment about captive cetaceans, particularly orcas ("killer whales") by focusing on the disturbing personal history of the orca Tilikum (Parsons & Rose, 2018; Boissat et al., 2021). Increasingly, the public in many parts of the world has become more concerned about the welfare of captive cetaceans and less favorable towards captivity itself (Giovos et al., 2019; Naylor & Parsons, 2019). Wasserman et al. (2018) found that, when accounting for some biases in previous surveys of visitor attitudes, support for orca shows and swim-with-dolphins (SWD) programs in their survey was well below what had been reported in previous studies conducted on behalf of captive cetacean attraction operators. Clegg (2021) argued that captive cetacean facilities will need to respond to these changing social ethics to survive into the future.

This increase in public concern has led to several legislative efforts around the world to limit or eliminate keeping cetaceans for entertainment. Canadian Bill S-203 (Parliament of Canada, 2025), passed in 2019, bans the breeding and use of captive cetaceans for pure entertainment. In 2021, the French government decreed a trading and breeding ban, which will end whale and dolphin captivity by 2026 (Berry, 2021). More recently, Belgium has officially become the seventh country worldwide and the fourth in Europe to enact a permanent ban on dolphinariums (The Brussels Times, 2024). The above mentioned legislation requires alternative housing options be in place that would improve the animals' welfare (see discussion of authentic sanctuaries in Section 6). The U.S.-based SWIMS Act (2024), a federal bill to phase out captive cetacean entertainment in the United States, was last reintroduced in 2024.

Nevertheless, captive cetacean entertainment persists across 50 countries in the world, with most facilities found in China, the U.S., Mexico, Japan, and Russia (Cetabase, 2024). The scope of the issue of captive cetacean welfare is broad. In China, the captive cetacean entertainment industry

Commented [A1]: This start is very much framed as a "some people say" argument. I would recommend a more balanced approach where objective measures are considered. Where the authors must rely on "some people say" arguments more effort should be put into discussing the peer reviewed rebuttals to these papers and arguments.

Commented [redacted] Be specific here.

Commented [redacted] Both studies were based on limited social media samples that were not global. I would be cautious to frame this appropriately.

Commented [A4]: As the authors are trying to frame this paper as an update on the state of captive animal welfare, it is incomplete to just mention this legislation without discussing some of the impacts of it. Including the failure to establish potential relocation plans before some of these laws went into effect, leading to dire welfare conditions for animals in both Canada and France.

Commented [redacted] Can you point to any data that shows animals in GFAS sanctuaries have better welfare than pool counterparts? Is there perhaps data from a C-well assessment that can be used to compare the welfare of little white and little grey when in the sea pen and when in their pool? An assumption of better welfare is not sufficient, data are necessary before any other animals move into these GFAS accredited sea pens.

has been growing precipitously over recent years (Ong, 2017). Globally, more than 3,500 cetaceans are housed in concrete tanks or small pens in ~350 marine parks, zoos, and military facilities (Cetabase, 2024). The most abundant cetacean species in captivity are common bottlenose dolphins (*Tursiops truncatus,* ~87% of all cetaceans; Brando et al., 2018), beluga whales (*Delphinapterus leucas*), and orcas (*Orcinus orca*), but also includes pilot whales (*Globicephala macrorhynchus*), Commerson's dolphins (*Cephalorhynchus commersonii*), white-sided dolphins (*Lagenorhynchus obliquidens*), and several other species and hybrids (Cetabase, 2025). In North America alone, there are ~480 bottlenose dolphins, ~60 belugas, and 18 orcas in captivity (Cetabase, 2025).

Animals in zoos and marine parks in the U.S. are covered by minimal regulations set forth under the Animal Welfare Act (2025), which are often under-enforced (Winders & Chilakamarri, 2018). Accrediting organizations (e.g., Association of Zoos and Aquariums, AZA; ~40 members/facilities housing cetaceans) set welfare standards for their members. More broadly, some associations specifically focus on aquatic animals (e.g., Alliance of the Marine Mammal Parks and Aquariums, AMMPA; ~50 members; European Association for Aquatic Mammals, EAAM). In addition, the World Association of Zoos and Aquariums (WAZA; ~400 members) provides a platform for collaboration among institutions and sets ethical guidelines but does not serve as an accrediting body. However, even under the highest standards, there remain unique challenges in meeting the essential needs of the animals (Morgan & Tromborg, 2007; Shepherdson & Carlstead, 2020). Moreover, only a relatively small number of existing zoos and aquatic parks around the world are accredited, potentially indicating widespread problems in welfare for the majority of captive entertainment facilities.

Recently, a series of nine articles known as the Cetacean Welfare Study examined captive cetacean welfare measurements across 43 accredited zoos and aquariums in seven countries (Lauderdale et al., 2021a-e; Miller et al., 2021a-d). It was designed to identify factors related to the welfare of bottlenose dolphins (*Tursiops truncatus*), Indo-Pacific bottlenose dolphins (*Tursiops aduncus*), beluga whales (*Delphinapterus leucas*), and Pacific white-sided dolphins (*Lagenorhynchus obliquidens*). This project did not examine unaccredited facilities or those housing other cetaceans. These studies focused on which welfare factors of captive dolphins

Commented [redacted] What do you mean by small? Do you have data that size of sea pen positively correlates with welfare?

Commented [A7]: This language seems biased and fairly subjective.

Commented [A8]: Yes. But there are other accreditation groups such as the American Humane Society, EAZA, The Alliance of Marine Mammal Parks and Aquariums and the International Marine Animal Trainers Association (which accredits facilities based on their use of positive reinforcement techniques). As in the previous paragraphs the authors would be best served going into detail the number of facilities accredited and the nature of those accreditations quantitatively by region (given the proposed scope of this paper). After all, one wouldn't necessarily expect that facilities all over the world are accredited by organizations who mostly operate within the US. https://www.ammpa.org/membership/standards-guidelines, https://www.aza.org/assets/2332/aza-accreditation-standards.pdf, https://eaam.org/wp-content/uploads/2019/06/EAAM-Standards-and-guidelines-2019.pdf, https://www.eaza.net/assets/Uploads/Standards-and-policies/2020-10-EAZA-Standards-for-Accomodation-and-Care.pdf. There are also guidelines present from groups like WAZA. https://www.waza.org/wp-content/uploads/2020/05/ENG_WAZA-Guidelines-for-AVI_FINAL_-April-2020.pdf

Commented [redacted] Do the authors have a sense of this? How many cetacean housing facilities are accredited? I do not believe it is a "small" number. It would be better to be precise on issues like this to give a good update on the state of captive welfare in cetaceans.

were determined to be most important, and which ones could be implemented in the future. Identified factors included habitat characteristics and management practices (Lauderdale et al. 2021c,d; Miller et al., 2021b), environmental enrichment (Lauderdale et al., 2021e), health reference intervals (Lauderdale et al. 2021a), biomedical markers (Lauderdale 2021a; Miller et al., 2021d) social behavior (Miller et al., 2021b), and behavioral diversity (Miller et al., 2021a). The findings of these studies are integrated in the present review where relevant.

The science of captive wild animal well-being thus continues to be informative about the needs of various species held in zoos, marine parks and aquaria (Whitham & Wielebnowski, 2013; Clegg & Delfour, 2018; Shepherdson & Carlstead, 2020). Yet, several species, including cetaceans, still face significant challenges in captive settings (Clubb & Mason, 2003; Morgan & Tromborg, 2007; Mason, 2010; Fischer & Romero, 2018; Limin et al., 2025). There are numerous markers of poor welfare (e.g., stereotypies, defined as unchanging repetitive actions; Mason, 1991; Jacobs et al., 2021) and, too, ways to determine positive welfare (Lauderdale et al., 2021b). The Cetacean Welfare Study, for example, found that environmental enrichment programs and social management factors were positively associated with positive welfare (Lauderdale et al., 2021b). Importantly, good welfare is not simply equivalent to the absence of negative welfare markers (Miller et al., 2020). There are several factors such as diet, shelter, health, ability to express species-specific behaviors, and choice, that provide positive well-being (Vicino & Miller, 2015).

The objective of the present review is to examine the current well-being of captive cetaceans. To that end, we review the literature to examine how well the care of captive cetaceans around the world aligns with their needs, aiming to identify remaining challenges. This includes an overview of behavioral and clinical factors in cetacean captivity, particularly in managed settings. Our focus is on the most recent research and representative facilities, many (but not all) of which hold accreditation from one or more professional organizations, presumably indicating higher welfare standards. Finally, we discuss the ethical implications of our findings. And we are concerned with several species held in captivity, not just bottlenose dolphins.

2. Literature review methodology

Commented [A10]: I can understand the citations for Whitham and Wielebnowski and Shepherdson and Carlstead as they make arguments for new paradigms in how to study zoo animal welfare. But Jacobs et al is speculative with convincing rebuttals in the press (**https://doi.org/10.3390/ani13172707**). I recommend removing Jacobs et al here.

Commented [A11]: This again seems very one sided. There are a series of articles now discussing enhanced welfare in captive cetaceans both in measures of behavior and in terms of longevity. A more even discussion of the literature would provide readers with a better sense of the state of captive cetacean welfare. See: https://doi.org/10.1371/journal.pone.0255506, https://doi.org/10.1371/journal.pone.0250687, https://doi.org/10.1371/journal.pone.0252010, https://doi.org/10.1371/journal.pone.0253688, 10.1098/rspb.2023.1895, https://doi.org/10.1111/mms.12601

Commented [A13]: I would also cite 10.3390/ani13172707 here as this paper specifically addresses the complexity of how to consider an animal in good welfare in a way these authors seem to want to focus on.

Our methodology involved conducting a scoping review of the literature (Munn et al., 2018) on captive cetacean welfare and related topics such as: body condition, dietary preferences, health, stereotypies, disease, maturation, sociality, reproduction, housing, management, enrichment, performance, space, complexity, and behavioral diversity. After a review of that literature we organized the review into dimensions of the captive setting important to cetacean welfare: a) enclosures, space and exercise, b) complexity and sensory-perceptual experience, c) sociality, d) feeding and cognitive demands, and e) performances and interactions with humans, as well as specific welfare topics: brain and behavior (e.g., stereotypies, aggression) and physical health (e.g., nutrition and metabolism, skin health, dental disease, digestive and gastrointestinal disease, infections, reproduction, longevity, survival rates, and mortality rates). We examined and included data on free-living and captive cetaceans.

We conducted our primary searches using Google Scholar. We used our own papers and referencesd from published scientific papers as well. We selected only publications for which we could obtain the complete article/chapter (as opposed to just an online abstract). Given that the field of cetacean welfare advances rapidly, we focused on articles published since 2000 with only a few exceptions.

We used 282 substantiated sources of information in this review. These included 215 peer-reviewed papers, 27 chapters in edited books, and six scientific books. We used 34 sources of gray literature (*e.g.*, conference proceedings, white papers, government documents, accrediting organization websites). We gave priority to the most recently dated findings. Eighteen citations were for publications prior to the year 2000, 176 published between 2000-2019, and 88 between 2020-2025. We obtained information about standards and recommended practices published by professional organizations from their websites. Moreover, we did not omit findings that demonstrated improvements in welfare or positive views of captive cetacean welfare because our aim was to generate an accurate, comprehensive and current picture of the status of captive cetaceans. To confirm that our search was comprehensive and inclusive, we examined reference lists of all articles we used. Finally, findings from secondary sources (e.g., review articles, online web pages) were confirmed in primary sources whenever possible.

Commented [A14]: Do the authors mean to imply that if a paper was behind a paywall they did not utilize it? That would be unacceptable. Also many of the papers that are omitted here are open access.

Commented [A15]: I think there is an effort here to imply that this is a comprehensive review. I would argue it is not and that these methods were not robust toward achieving a comprehensive review for the purposes of determining the objective state of captive cetacean welfare (if such a thing is even possible given the variety of housing conditions current cetaceans in captivity find themselves).

3. The captive environment

Captivity in the present context is the state of being confined to an artificial environment (usually designed for human benefit), which is typified by zoos, aquaria, and marine parks but also includes research laboratories and military facilities (Hancocks, 2002; Marino, 2018; Marino & White, 2022). Authentic sanctuaries (discussed in Section 6) are also a form of captivity, designed for animals who cannot be released or returned to the wild (Doyle, 2017). They differ in that an authentic sanctuary prioritizes the well-being of each resident over human interests in an entirely non-exploitive setting more consistent with their evolutionary history and needs (Marino et al., 2025).

Across these managed establishments, there are significant differences in terms of space allotted, quality of veterinary care, level of visitor interactions, inclusion of demonstrations/performances, and several other factors (Shepherdson & Carlstead, 2020). The captive environment is multifaceted, influencing both physical and behavioral aspects of welfare. Key factors include space and complexity, movement, sensory experiences and mental stimulation, diet, and social interactions.

3.1a Enclosures, Space, Exercise

Although some cetaceans are kept in sea pens and netted off areas in a lagoon or bay adjoining the ocean, most are kept in land-based concrete tanks. Individuals housed in enclosures continuous with the ocean tend to fare somewhat better than those in tanks (see below; Ugaz et al., 2009, 2013). In the Cetacean Welfare Study, ~58% of dolphins lived in zoo/aquarium habitats and ~42% lived in habitats connected to ocean water (Lauderdale et al., 2021e). Cetaceans are also often managed by holding them in various pools for training, medical procedures, and to separate aggressive individuals. There are also quarantine pools and maternity pools that allow for separation and enhanced control over the animals. Moreover, some tanks have lifting floors that allow the animal to be lifted out of the water to be physically restrained by trainers and veterinarians (Couquiaud, 2005). The Cetacean Welfare Study found that most facilities had five or fewer areas that were separated by gates (Lauderdale et al., 2021e).

Commented [redacted] These terms are subjective and are being used to hide the fact that a GFAS sanctuary is another form of captivity that must be evaluated solely on its welfare implications for the captive animals who live within it. This whole section needs to be reframed with far less bias.

Commented [A19]: This definition needs a citation. Captivity is the condition of being confined. Whether the environment is artificial or not. The rest of this definition seems to imply that only zoos are captive environments when, even by the authors' own admission, a large sea pen sanctuary is still captivity (which is defined as a naturalistic environment).

Commented [redacted] These criteria are not exclusive to sanctuaries. Marine parks, zoos and aquariums also house animals that cannot be returned to the wild.

Commented [redacted] So citing Marino 2025 is like citing "because I said so". Marino 2025 is a commentary. While it may be peer-reviewed it's a peer-reviewed opinion. It is NOT sufficient to cite your opinion as evidence that accredited zoos and aquariums do not prioritize the welfare of their animals over the needs of guests.

Commented [A20]: How are these determined? The Cetacean Welfare study argues space is not a significant factor relative to trainer and conspecific social interactions.

Commented [A21]: These statements need to be contextualized with The Cetacean Welfare Study https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0250687

Commented [redacted] This is not what was meant by contextualizing this with the CWS. One should contextualize this finding with the contrasting findings of the CWS.

In this context, it is important to acknowledge that cetaceans have evolved for efficient, long-distance swimming (Buchholtz, 2001; Gillet et al., 2019), with certain species specialized for deep diving (Piscitelli et al., 2013; Hindle 2020), activities that are severely curtailed in captivity. There is considerable variation in tank size across captive facilities. Many tanks are too small or shallow to allow natural swimming behaviors, especially for larger cetaceans (Corkeron, 2009; Lott & Williamson, 2017). For instance, orcas are the largest odontocetes held in captivity, with adult males ranging up to 9 meters in length and weighing close to 7,000 kg (Baird, 2002). Despite this, under the federal Animal Welfare Act (2025), which is enforced by the United States Department of Agriculture, the minimum size standard for orca enclosures is 15 m for minimum horizontal distance (i.e., length and width) and 4 m for minimum depth, which would limit animal movement if facilities of that size existed for orcas (Joseph & Antrim, 2010; Rose et al., 2017). Thankfully no facility exists with such dimensions. One of the largest pools in the world housing orcas is the Port of Nagoya Public Aquarium in Japan. It is 12 m deep, 60 m long and 30 m wide, resulting in an overall water volume of ~13,499 m^3. By comparison, the Salish sea, the primary home range to J Pod orcas, is ~18,000 km^2 in area and contains ~2 x 10^{12} m^3 of water (MacCready et al., 2021). Within these large home ranges, orcas "routinely swim multiple kilometers in straight lines and are capable of travelling as many as 225 km a day for up to 30–40 days without rest" (p. 46, Rose et al., 2017) reaching up to 9,400 km in 42 consecutive days (Durban & Pitman, 2012). To put this in perspective, a distance of 225 km would require ~1,518 laps of the Nagoya Public Aquarium. In terms of depth, the deepest recorded dive for an orca is 1,087 m (Towers et al., 2019), although they typically dive much shallower (~200-400 m; Miller et al., 2010; Wright et al., 2017; Tennessean et al., 2019).

Similar ranges and depths have been documented for beluga whales as well. For example, the summer core range for the Eastern Beaufort Sea population has been estimated to be 36,349 km^2; the actual home range is much larger, consisting of the Amundsen Gulf, the eastern Beaufort Sea shelf, shelf and slope regions west and north of Banks Island into M'Clure Strait and Viscount Melville Sound (Hauser et al., 2014). These whales are also known to swim >50 km/day (Hauser et al., 2014)., and dive as deep as ~900 m (Hauser et al., 2015).

Commented [redacted] Yes. But it seems that belugas (n=2) stress out when put in large sea pens after living in pools for a long time. Consequently it may not matter what the animals "evolved" to do. This is why it was important to take seriously the comments about explaining the concerns with the GFAS sanctuary model.

Commented [redacted] Do you have any data that shows that captive animals from pools would want to engage in these behaviors? Are you assuming they would?

Commented [redacted] But you are comparing starving orcas who waste away searching for food burning untold calories to provisioned and monitored animals. I just don't think this is a great comparison in context. Are you arguing that J-pod is experiencing better welfare than orcas at Sea World? I think that is probably wrong and in this case highly speculative. I ge that you are trying to avoid having to discuss that the sizes for pools actually exceed the USDA standards, but I don't think this is an effective way to do that.

Commented [redacted] Same problem as above. You assume the animals want that kind of space when there is at least some data suggesting that they don't. I would recommend a discussion of how we don't know how animals who have lived in pools would react to super enlarged enclosures, and that those reactions could be negative. If not, it's the naturism fallacy.

Commented [A28]: Are any American facilities housing orcas at those dimensions? Perhaps discuss what the current digestions are for orcas under captive conditions in the US relative to these standards.

Commented [redacted] See recommended highlighted changes.

For captive dolphins in the Cetacean Welfare Study, Lauderale et al. (2021e) found that mean habitat length was 41.28 m (width was not reported) and the mean maximum habitat depth was 7.66 m, allowing access to 2,610 m^3 at night, and 2,540 m^3 during the day. Bottlenose dolphin home ranges vary considerably, from 20 km^2 to 344 km^2 (Nekolny et al., 2017), and they are known to travel 33-89 km a day while making journeys of up to 4,200 km (Wells et al., 1999; Wells & Scott, 2009). Although coastal bottlenose dolphins (e.g., in Sarasota Bay) remain in relatively shallow waters (<4 m; Wells et al., 2013), offshore bottlenose dolphins regularly dive deeper than 500 m and sometimes as deep as 1,000 m (Fahlman et al., 2022). There does not appear to be any research on the daily distances covered by dolphins in captivity, although Lauderdale et al. (2021d) measured average distance traveled per hour (ADT). They found that captive dolphins traveled an average of 2.32 km/hr during the day, slightly above the rates of wild bottlenose dolphins on the Pacific Coast of the United States (Irvine et al., 1981). However, Lauderdale et al. (2021d) did not track movement at night, noting that captive dolphins, unlike their wild counterparts (Shorter et al., 2017), exhibit reduced activity at night. Using a 3D video-tracking system, Rachinas-Lopes et al. (2018) found that captive bottlenose dolphins spent most of their time at the surface in the deep area of their pool, presumably because they have more stimuli (e.g., trainers, objects, food) at the surface. They also suggested that wild dolphins in their natural habitat might have more incentive than captive dolphins to explore deeper waters (Rachinas-Lopes et al., 2018). This would seem to be confirmed by Cetacean Welfare Study, which found that dolphins in managed ocean habitats swam in the top third of the water column less often than dolphins in managed zoo/aquarium habitats, presumably because they were exploring the more natural ocean environment (Lauderdale et al., 2021b; Miller et al. 2021b).

Factors other than the amount of space can also affect cetacean welfare. Miller et al. (2021b, 2021c) found that type and timing of enrichment can sometimes be more important than tank size for captive bottlenose dolphins. Specifically, captive dolphins on a more predictable schedule of enrichment activities were more socially interactive than those on a random schedule. Similarly, Lauderdale et al. (2021c, d) found that environmental enrichment and predictable training schedules were more strongly associated with how dolphins used their habitat (e.g., time in bottom third of enclosure) and with distance traveled (as measured by ADT) than were habitat characteristics (e.g., tank size, water volume availability). Moreover, given orders of magnitude difference between

Commented [redacted] How many offshore dolphins are in captivity?

Commented [redacted] I think this entire section is predicated on this idea that swimming great distances is preferable to not. I'm not sure there is an established welfare benefit to swimming in this way for captive cetaceans. I think there is a romanticized view of freedom typified in swimming great distances, but one would need to assess the willingness captive animals would have for this if placed in large sea pens as the authors prescribe. I reject this assumption of increased welfare benefit to vast swim distances without data to support it. I also think it is very difficult to make these comparisons in general given the differences in movement and activity patterns across numerous populations and species of cetaceans. It can very easily lead to cherry picking populations (knowing that most captive dolphins in the US are near shore coastal vs. open ocean, for example).

Commented [redacted] This is what the paper actually said: "Results showed that both animals spent about 85% of the time in the Deep Area of the pool, but mostly at the surface, and only 7% in the Bottom, near the 5 meters maximum depth. This is not surprising since these animals have more stimuli at the surface, e.g. the trainers, food and toys. In the Bottom, on the contrary, the animals find only a canvas surface. While in natural environments dolphins may feel motivated to explore deeper, in captivity the animals may prefer to spend less time near the bottom, and that kind of information could be relevant when planning new habitats." I would reword this to make it clear that there is no assumption on Rachinas-Lopes et al.,'s part that pool dolphins would behave like wild dolphins if put in that environment. Suggested edits made to document.

Commented [A33]: Can you discuss under what conditions this is true? If it is the conclusion of Miller et al., 2021 that this is always the case consider removing the qualifier.

Commented [redacted] Authors should also discus findings related to ocean vs. pool housing.

captive pools and the extensive natural home ranges for which many cetaceans have evolved, there is potential confound (i.e., a floor effect) with conclusions about how tank size affects movement and social behavior. In the Cetacean Research Study, for example, the magnitude of habitat change in length from the smallest measure to the largest is 13.13; in depth, it is 6.4 (Lauderdale et al., 2021e, Table 5). These are miniscule changes compared to the change from the captive to the natural habitat. Not only the size of a species' native habitat for which it evolved, but also the actual size of a species (e.g., a goldfish vs. an orca) may affect its perception of enclosure size/complexity (de Azevedo et al., 2023). As such, it could be that the different sizes and complexities of captive enclosures do not constitute a meaningful difference for cetaceans. Studies incorporating significantly larger areas could potentially find associations between enclosure size/complexity and welfare outcomes. In conclusion, the strong mismatch between their natural aquatic behavior and captive enclosures, along with the complexities of habitat issues themselves, indicate that welfare in captive cetaceans is impacted by an array of interwoven factors.

Commented [redacted] Which for those animals is a doubling of size.

Commented [redacted] Right. Which could be, and may already have been in Iceland, too overwhelming. Hence why authors of this paper have talked about different techniques for staging animals in increasing sized sea pens.

Commented [redacted] They may have evolved there, but they didn't grow up there. I think if you are going to make welfare prescriptions you should have data to support the idea that nature wins this battle.

Commented [redacted] That is pretty speculative. Again, if space is a pancia, why are Little White and Little Grey in a staging pool instead of their sea pen after over 5 years of being in Iceland?

Commented [redacted] And one should not assume the directionality of those.

Commented [redacted] At no point did the authors provide any evidence that increased space is tantamount to improved welfare (or any welfare consequence).

3.1.b Complexity and sensory-perceptual experience

Sensory-perceptual experiences are largely determined by the physical features of captive enclosures, which are relatively limited and unchanging. Remarking on the lack of complexity in captive environments, Jaakkola (2024, p.2) stated: "in contrast to the situation in the wild, these animals live in highly predictable and structured environments." Most captive cetacean tanks are painted light or bright blue and designed to maximize the ability of visitors to observe them. Underwater windows, if present, may further decrease the opportunity for captive animals to find refuge from visitor gaze. To ensure ease of maintenance and cleaning, tanks have smooth concrete surfaces and substrates and are relatively featureless as opposed to naturalistic textures (Couquiaud, 2005; Rose et al., 2023). Water clarity and cleanliness is typically achieved through filtration, ozonation, and chlorination (Couquiad, 2005).

Commented [A44]: The authors spend some time stating that there are a variety of enclosures, yet refer to them as immutable limited and unchanging. This dissonance weakens the paper.

Commented [A45]: What are the benefits of naturalistic textures? I would imagine fake rock work would also be for the guests rather than the animals.

Commented [redacted] I am seeing a lot of assumptions around the benefits of environmental complexity in cetacean welfare, but I see no data. Can the authors please present data or studies that use data that discuss how welfare in a pool differs than that of a lagoon or sea pen as a function of environmental complexity? The CWS has such data.

The acoustic properties of concrete tanks, which are affected by tank size, depth, surfaces, and configuration, can be problematic for cetaceans, who are highly reliant on sound to perceive/navigate their environment (Au, 1993; Pack et al., 2002; Branstetter & Mercado, 2006), and

Commented [A47]: Can you please highlight where this is a problem? Is excessive chlorination common in modern cetacean holding facilities? What would be excessive chlorination?

for socialization/communication (Janik et al., 2006; Janik, 2014). Anthropocentric noise in captive settings, for example, has been shown to alter acoustic behavior in bottlenose dolphins (Therrien et al., 2012) and to disrupt communication involved in performing a cooperative task (Sørensen et al., 2023). Persistent, anthropogenic noise from nearby construction, traffic or amusement park rides, if not dampened sufficiently, can increase stress and negatively impact welfare (i.e., increase levels of cortisol, a stress hormone; Monreal-Pawlowsky et al., 2017; Yang et al., 2021) but more research is needed to determine how prevalent this issue is for captive cetaceans. Acoustic noise is also exacerbated by the shallowness of the tank due to "...greater reflection off substrate and the shallow longitudinal wavelengths of low-frequency sounds" (p. 6, Stevens et al., 2021). Moreover, any sharp angles in a tank can cause potentially stressful reverberations (Wright et al., 2007; Huettner et al., 2021). In this regard, it has been suggested that smooth tank surfaces may result in reverberations that lead to reduced rates of echolocation (Rose et al., 2023). In addition, several alterations in cetacean vocal patterns have been noted in captivity. Irrawaddy dolphins exhibited a reduction in whistles after years in captivity (Svarachorn et al., 2016). Following transportation to a new facility, beluga whales exhibited a significant and prolonged reduction in vocalizations, suggesting stress-related suppression in acoustic activity (Castellote & Fossa, 2006). Bottlenose dolphins exhibited changes in the structural characteristics of signature whistles in association with staff presence and food-anticipatory activity, indicating increased arousal (Probert et al., 2021). The effects of a captive environment on cetacean acoustic behavior is an area where additional research is needed (Stevens et al., 2021), with some researchers suggesting that acoustic behavior could be used to evaluate cetacean welfare (Jones et al., 2021; Winship & Jones, 2023).

3.1.c Sociality

Although there is variability across cetacean species in terms of level and type of sociality (i.e., the ways in which groups are structured and held together), the species usually kept in captivity (e.g., common bottlenose dolphins, orcas, beluga whales) are highly social. They have extensive juvenile periods during which they learn cultural practices within a complex social network that is maintained throughout their lives in the wild (Williams & Lusseau, 2006; O'Corry-Crowe et al., 2020; Whitehead & Rendell, 2021). Bottlenose dolphins can form nested alliances within complex social networks (King et al., 2018). Free-living orcas live in nested pods within clans that are bonded by dialect and other behavioral traditions (Williams & Lusseau, 2006; He, 2023). In the wild, beluga whales live in small groups that join, from time to time, with larger

Commented [redacted] Yeah. But that was not noise common to facilities. It basically took a power washer almost on top of them before they made significant mistakes.

Commented [redacted] I choose to interpret the author's misrepresentation of our words charitably. Stevens et al., 2021 does not imply anything about tank noise with this statement taken out of context. The actual paragraph that this comes from says. "*The propagation of anthropogenic noise varies by the depth of water, and the intensity of sound depends on the geophysical constitution of the location that it is produced in, as well as its source.* ***In shallow water, there is greater noise pollution due to greater reflection off substrate and the shallow longitudinal wavelengths of low-frequency sounds.*** *In noisy areas of the Ganges River, vessel sound pollution increased the ambient noise levels by 14 dB, with an average water column height decrease of 1.5 m during the dry season [45]. Although deeper natural river channels may act as a buffer to some of the increased vessel noise during times with low water levels, river dolphins require full use of shallow and deep areas for resting and foraging [45]. During louder times, marine cetaceans may retreat into deeper waters, but river dolphins and cetaceans restricted to shallow waters in sea-side lagoons or sea pens may not have such opportunities.* The quote you have taken applies to wild or natural soundscapes with massive acute vessel noise. Kindly remove.

Commented [redacted] I can't determine why this paper is cited here. This was in no way the thrust or data associated with Tim's study.

Commented [redacted] This is speculation and is discussed in Bruck, 2024 with a way of studying this.

Commented [redacted] That is correct. This paper did say that. And sanctuaries are also part of what we were talking about here...

Commented [redacted] To help contextualize this section with a paper you must have read because you cited it here. Here are some aspects you should include here on how some concerns with noise are likely not as dire as they are highlighted in this section. From Stevens et al., 2021 "*In human care facilities, anthropogenic noise composition depends on multiple factors including, but not limited to, facility type, amount of exposure to the ocean, life support machinery, presence of shows, and location. Facilities that house marine mammals in pools do not have additional oceanic anthropogenic noise, but their enrichment devices* ... [1]

Commented [A54]: This is all very speculative. This is supposed to be a state of the current captive situation for these animals. Are there any data the authors can utilize to contribute to this? If those data are not available perhaps the authors can highlight where opportunities exist for further study. See 10.3390/ani11113312. The authors will later endorse the use of sea pen sanctuaries (defined ... [2]

aggregations of hundreds or thousands of individuals (O'Correy-Crowe et al., 2020). Adult females are strongly bonded with their newborns as well as with older offspring. These triads stay together and join with others to form large nursery groups. Generally, group composition is fluid and underwritten by complex vocalizations and a variety of other characteristics (O'Corry-Crowe, 2009).

In captivity, by contrast, cetaceans live in managed collections that largely forgo opportunities for choice in relationships (Waples & Gales, 2002). Clegg & Butterworth (2017) noted that social group composition in captive facilities is largely artificial and under the control of zoo management rather than the animals themselves. Animal welfare scientists have stated that "keeping animals in appropriate social groupings, and with the required space and complexity to allow individuals to choose to spend time together or apart, is likely to be the most important welfare consideration" (Brando & Buchanan-Smith, 2018, p 85). After the minimum weaning age, captive cetacean mothers and offspring living in marine parks may be separated, as are other socially bonded individuals (Rose et al., 2023). Because captive cetacean groups do not resemble social groups in the wild there may be long-standing repercussions for the psychosocial well-being of calves. Lott and Williamson (2017, p. 166) state: "In captivity, because of the artificial nature of the environment and the fact that calves of a number of cetacean species held in captivity are often separated from their mothers at a young age, whales and dolphins cannot learn the skills important to survival or essential nursing skills necessary to care for their own young (Rose et al. 2009). High rates of neonatal mortality are considered a major problem in captivity (Van Lint et al., 2006)." The limited space available to groups of captive cetaceans may also impact their ability to use dispersal to keep intra-group aggression to a minimum, but this possibility has not been systematically studied.

3.1.d Feeding and cognitive demands

Feeding is not just about fulfilling dietary requirements; it also encompasses vital cognitive and physical challenges that are essential to well-being. Consistent with the notion that the cognitive demands of feeding are integral parts of welfare, Clegg et al. (2023b) found that when captive bottlenose dolphins are presented with cognitively enriched foraging opportunities, they exhibit

Commented [A55]: And yet the Cetacean Welfare Study qualitatively showed something different with regard to space. A discussion of the differences here in conclusions would be helpful to the readers.

Commented [A56]: This again is vague. How often is this practice enacted currently. I know of no facility that regularly separates pre-weaned animals from their mothers. In fact one might argue that cetacean's today remain in the presence of their mother's too long given a cursory evaluation of CetaBase and inferences from Sarasota and Shark Bay.

Commented [A57]: Multi-generational populations are not a rule. Nor are preferences for kin associations (see https://www.sciencedirect.com/science/article/pii/S0376635715300930?casa_token=qqfX_wvvHzkAAAAA:g7JA198MRbRNRj5czc4Y9tNOjTtluM7cSIWkOVymp9Z9Kn3IMPyA19ZjBwwe2JALdY2WqOibOJA, https://q.bstatic.com/data/bsuitewf/f277d42400017e09095fed934aab6b6d86fabf49.pdf) Especially in bottlenose dolphins which are now to have social units termed as "groups" rather than "pods" given their social fluidity. That being said there are many instances of alloparenting in zoological populations. Perhaps a discussion of these examples would strengthen the paper. https://www.aquaticmammalsjournal.org/wp-content/uploads/2022/11/48-6-dudzinski.pdf,

Commented [redacted] Please let me know what modern accredited zoo separates calves at a young age.

Commented [A59]: This citation is a general review article speaking about social integration and wild survival rates (with implications for humans). It says nothing about the status of captive cetacean groups and the only intent reference to dolphins is: "*In some species, juvenile survival may also be linked to the ability to socially integrate into mixed-age social groups (49, 50).*" Whereas 49 is a reference to a dolphin paper. The only other reference in the paper is in figures where comparisons are used to discuss comparative network centrality with the dolphin data based on that same one wild study. This sentence implies that Snyder-Mackler et al makes claims about dolphins that frankly aren't made. This must be reworded to more accurately reflect the citation so it is not assumed the citation here is evidence for the authors' claims about dolphins.

Commented [redacted] Do you have a source for this that isn't about 20 years old? Given the increases in captive lifespans over the years I would argue you really don't want to cite anything on this older than 5 or 10 years.

more positive (e.g., greater engagement and healthy appetite) and fewer negative (e.g., stereotypies, excessive logging) welfare behaviors.

Dietary preferences and needs vary widely across cetacean species and across communities within species. For instance, southern resident orcas in the Pacific Northwest have a diet that consists of nearly 80% chinook salmon, depending on the season. The emphasis on chinook is not just a preference; it is a vital aspect of their culture (Hanson et al., 2021). Orcas off the coast of New Zealand, on the other hand, specialize in eating stingrays, requiring a high level of skill in processing before they are ingested because of the danger of stingray spine penetrations (Duignan et al., 2000). Orcas can also eat highly varied diets, sometimes including mammals, sea birds, and fish (Samarra et al., 2018). Other species, like common bottlenose dolphins, also have quite diverse diets (Gannon & Waples, 2004). Captive cetaceans are fed a narrower selection of commercially available dead fish and occasional invertebrates (Rosen & Worthy, 2018). Rosen and Worthy (2018, p. 719) note "both a lack of diet diversity and the reliance on frozen foods present potential nutritional challenges." Although the fish are generally of high quality (i.e., freshly frozen and thawed, free from contaminants, regularly tested, and meeting balanced nutritional requirements), they are delivered to them in a manner (i.e., thrown directly into their mouths above water) that requires little to none of the cognitive activity relevant in natural hunting and feeding. In addition, the freezing and thawing of fish results in significant nutrient loss; for this reason supplements are often supplied (Brando et al., 2018). The lack of stimulation from the way food is delivered must be countered by the implementation of other methods of cognitive enrichment. One reason for providing a limited selection and uniform delivery is to maintain records of how much each individual is eating, as appetite is an important indicator of health.

It must be understood that animals are evolutionarily driven to seek the most accessible and abundant food resources for survival. However, the routine consumption of readily available food sources, such as occurs in fish provisioning, ecotourism, or in the captive setting, does not satisfy the biological drive to engage complex cognitive and physical faculties inherent in foraging, which involves travelling to locate food along with capturing and consuming the prey. These activities present opportunities and challenges that are collectively enriching and consume a

Commented [A62]: This is a good addition. The authors should also consider discussing Jaakkola, 2024 here as it also speaks to opportunities for cognitive enrichment.

Commented [A65]: Animals frequently defy this pattern. Even cetaceans like wild orcas will engage in arduous hunts of large baleen whales only to eat tongues and livers. Many animals will forgo easy food sources to pursue preferred food sources. GUDs are a rich literature in this regard.

Commented [redacted] This is still a really bad way to argue about something from an evolutionary perspective. If you absolutely need this statement argue it from an energetics perspective.

Commented [redacted] How do those references make this point in cetaceans?

large percentage of cetaceans' time budget in the wild (Neumann, 2001; Stockin et al., 2009; Noren & Hauser, 2016).

3.1.e Interactions with Humans

Captive cetaceans are often required to interact with humans in different ways, for husbandry, training, and entertainment of the public – all of which have an effect on welfare. Standards that safeguard animal well-being in interactions with visitors (e.g., dolphin assisted therapy and other swim programs, petting pools, and public feeding activities; Stewart & Marino, 2009) vary. In many respects, standards implemented by the U.S. Animal Welfare Act (2025), AMMPA (2020), AZA (2025), and EAAM (2019) mirror one another. However, an important difference is found in standards for interaction time. The Animal Welfare Act (2025) requires that interaction time (i.e., designated interactive swim sessions) for each cetacean cannot exceed two hours per day, with at least one period of at least 10 continuous hours without public interaction within a 24-hour period. AMMPA, EAAM and AZA standards do not require a similar 2-hour cap. The AMMPA (2020) requires that each cetacean have at least one period of at least 10 continuous hours without public interaction in each 24 hour period, and EAAM (2019) standards require one period of at least 12 continuous hours without public interaction within a 24-hour period. Under AMMPA and EAAM standards, a cetacean can be exposed to extended hours of interaction time. The AZA (2025) standards require that certain staff determine interaction time based on various factors. Another difference is in the ratio of human participants to cetaceans. The Animal Welfare Act (2025) states that the ratio of human participants to cetaceans shall not exceed 3:1. The AMMPA (2020), AZA (2025), and EAAM (2019) do not provide a specific ratio; their standards require that the ratio of human participants to cetaceans should be appropriate to the type of interactive activity offered, although they require approval of the ratio by certain staff.

Training for interactions with the public (as well as husbandry and veterinary care) is conducted through positive reinforcement methods in which the animals are rewarded with something they like, typically food, for performing a requested behavior. Trainers may also use a secondary reinforcer known as a "bridge", usually a whistle, that indicates correct responses to a trainer's commands (Feng et al., 2016). It has been suggested that training and performance are a form of environmental enrichment for captive cetaceans (Westlund, 2014; Jaakkola et al., 2023; Melfi &

Commented [A68]: These statements need citations or data.

Commented [A69]: It would be beneficial to the stated goals of the authors to provide more detail here. What specifically are the arguments here. Again, I would discuss Jaakkola, 2023 and 2024- but there is a rich literature in cetaceans and other species that the authors should consider. https://pmc.ncbi.nlm.nih.gov/articles/PMC2859718/, https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0253688, https://doi.org/10.1016/j.applanim.2013.04.011, Ramirez K. Animal training: successful animal management through positive reinforcement. Chicago, IL: Shedd Aquarium Press; 1999., https://www.researchgate.net/profile/Sabrina-Brando/publication/250020474_Decrease_Stress_Train_Your_Animals_The_Effect_of_Handling_Methods_on_Cortisol_Levels_in_Harbour_Porpoises_Phocoena_phocoena_Under_Human_Care/links/00b7d52bb6399b70e9000000/Decrease-Stress-Train-Your-Animals-The-Effect-of-Handling-, https://doi.org/10.1016/j.applanim.2018.01.015

Ward, 2020). There is some evidence to suggest that positive reinforcement training can help to decrease stereotypic behavior and the stress of husbandry and medical procedures in other species in captivity (Desportes et al., 2007; Coleman & Maier, 2010); however, it is unclear how and when various forms of training correlate with overall enhanced enrichment and well-being for captive wildlife (Melfi, 2013; Fernandez, 2022). Thus, it is clear that more research is required to understand which components of training and performance are indeed enriching rather than just providing temporary relief from boredom, creating a distraction, or otherwise occupying the time budget of captive cetaceans.

Several factors may play an important role in stress levels during interactive programs and therefore the issue is very complicated. Matsushiro et al. (2021) studied only five dolphins, showing that the average cortisol level of the group decreased significantly after an interaction session. But average cortisol levels were significantly higher in the busy visitor season than in low visitor season in two out of three dolphins. They concluded that there was little evidence that interactions caused acute stress but kept open the possibility of chronic stress in dolphins participating in interactive programs during the high visitor season. It should also be noted that cortisol is not necessarily harmful unless it becomes dysregulated during periods of chronic stress (Sapolsky et al., 2000; Jacobs et al., 2021). One study in New Zealand, with a small sample size of three dolphins, found that common dolphins significantly increased their use of refuge areas when exposed to the public in SWD attractions (Kyngdon et al., 2003), suggesting these sessions may be aversive or stressful. However, they found no overall decrease in welfare due to SWD activities. Miller et al. (2011), however, found higher rates of behavioral diversity following swim programs, which may be interpreted as a positive welfare indicator (Miller et al., 2020; Brereton & Fernandez, 2022), although this has yet to be validated.

More changes in behavior have been reported during unstructured or free-style SWD sessions compared to structured (staged) sessions in which there is explicit trainer regulation of interactions between dolphins and human swimmers. (Brensing et al. 2005). Brando et al. (2019) found that some dolphin behaviors change during swim sessions but that these changes may be due to the presence or absence of trainers or disturbances in the pool rather than due to the swim session itself. Therefore, although there are reasons to view interactions with humans – and in particular the public – as negative for captive dolphins, it is yet to be determined which specific components of those activities (and those before or after) are important factors in how dolphins

Commented [A73]: Again. And this is a theme. This is a very selective reading of this study. The authors should attempt to provide as full a depiction of this research as possible to give their readers the best information if the authors goal is to provide a comprehensive review of what is currently known about the welfare of captive cetaceans. For example, the last line of the abstract for this study reads "The SWD sessions did not appear to have a detrimental effect on the dolphins."

Commented [redacted] I would delete. Unless the authors would like to tack this qualifier on studies that support their views?

Commented [A76]: As this is meant to be a current state of captive dolphin welfare I wouldn't focus on unstructured SWD as it isn't practiced commonly in accredited facilities. The facility in question in this study is Dolphins Plus and they do not engage in this currently.

react. Delfour et al. (2020) developed a method of analyzing dolphin-trainer interactions during training sessions that may have promising applicability to SWD sessions but is not yet fully validated as a direct measure of welfare. More research on important physiological and behavioral factors (i.e., oxytocin levels, more precise cortisol levels) may elucidate the nature of the dolphin-trainer relationship and how it impacts dolphin welfare.

3.1.f Summary

Above, we discuss some of the most relevant and substantive aspects of captive environments for cetaceans. These include the amount of space (both horizontal and depth) provided but also the complexity of the environment. Recent studies suggest that the complexity of a captive environment, and not just the size, is important. The nature of sensory-perceptual experience in captivity is also important for welfare and, as cetaceans are highly acoustically sensitive animals, more research is needed to understand how tank size and shape affects them in terms of acoustic behavior. Other relevant factors are sociality and how groupings in captivity do or do not resemble natural social groups. Finally, feeding, cognitive demands, and interactions with humans are discussed in terms of whether food is not only balanced and nutritional but also is presented in a stimulating way.

4. Current Welfare Issues

The welfare of cetaceans, as with any animal, is multidimensional; each factor involved in their overall well-being is intricately linked to several others. A deep understanding of captive cetacean welfare requires appreciating that many welfare problems, particularly health challenges that present a risk to welfare (e.g., infections, parasites, etc.) occur both in captivity and in the wild. But the critical point is that there are numerous known reasons for illness, injury, and mortality in the wild, including pollution, pathogens, predators, ships, noise, nets, and so on (Bossart et al., 2003; Fair et al., 2017; Avila et al., 2018; Bossart et al., 2019; Sanganyado & Liu, 2022). None of these have any relevance to the captive situation and, therefore, leave open the possibility that there are other factors (e.g., stress, novel pathogen and chemical exposure, neurobiological harm) unique to or exacerbated by captivity that contribute to poor welfare and death in captive cetaceans. For example, below we present evidence suggesting that at least some common diseases of captive cetaceans are directly linked to husbandry or environmental

Commented [A77]: I think it is fairly clear, even from the studies cited here, that the relationship between the trainer and the dolphin plays a large role in facilitating a successful SWD program. The authors should consider calling for oxytocin studies with dolphins in relation to their interactions with trainers as a potential method for assessing this.

Commented [redacted] Define what full validation would look like here.

Commented [redacted] These are not current welfare issues at least in accredited facilities. Again. You need a zoo-based co-author.

Commented [redacted] They do if your captive environment has a net surrounding 100 acres of ocean.

Commented [redacted] This just ignores all of the survival improvement literature you were asked to cite. Again. Not only can you not assume this, there are data specifically countering this.

conditions. Despite decades of housing cetaceans in captivity and efforts by accredited zoos and aquaria to modify their facilities, husbandry, and preventative medical programs to reduce these diseases, many of them persist.

Although sufficient evidence exists to raise concerns about the health and welfare of captive cetaceans, as is detailed in the present paper, it is important to note that a great deal of data on captive cetacean disease and illness is absent from the literature and is publicly inaccessible. The reason for this is that the medical and behavioral records of these animals are routinely withheld by the institutions housing them, including the cause of death data and necropsy reports of deceased captive cetaceans. Despite the value of such records for advancing captive cetacean health, husbandry, and welfare, as well as wildlife conservation efforts, federal agencies with jurisdiction over these animals and facilities have routinely failed to enforce their authority to obtain such records (Rally et al., 2018). Therefore, it can be expected that the information available and presented herein is likely an under-representation of the true rates and etiologies of morbidity in captive populations.

In this section, we describe the current well-being (mental and physical health) of captive cetaceans, starting with brain and behavioral issues, various dimensions of physical health, and concluding with longevity, survival, and mortality statistics. The chronic stress of coping with the various dimensions of captivity over time has an impact on mental and physical health in cetaceans, as it does in every other species (Marino et al., 2020). All these factors, described more fully below, contribute to a generally problematic picture of captive cetacean welfare.

4.1. Brain and Behavior

4.1.a. Stereotypies

One of the more prevalent behavioral abnormalities found in captive animals is stereotypic behavior (Mason & Latham, 2004; Mason & Rushen, 2008; Bacon, 2018). When present, stereotypies reflect changes in the brain. The circuitry involved in motor control and stereotypies is complex but, at the neural center of this circuitry, is the basal ganglia (or corpus striatum), which are highly conserved across mammals, including cetaceans (Grillner & Robertson, 2016; Marino,

Commented [redacted] Not publicly inaccessible. Just not accessible to someone who actively antagonizes zoos and aquariums. A fair minded scientist interested in working to solve any zoo-born illness would be able to access said data. So this is not accurate.

Commented [redacted] Is your goal in obtaining the records to improve welfare by actively working to cure a disease of interest? Or is your goal to attack zoos and aquariums? If it is the latter are you surprised they aren't sharing these things with you? Eitherway, the absence of data are not data in this case. It is not sufficient to say, "the zoos won't give us these data so they must be hiding something". The onus is on the authors to substantiate their claims with data/facts or to not make the claims.

Commented [A85]: There have been two substitutive critiques of this paper by two different sets of authors. This paper should not be cited outside of the context of those critiques. https://pmc.ncbi.nlm.nih.gov/articles/PMC7401611/, https://escholarship.org/uc/item/6cj9473p

Commented [redacted] Still true

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2022). Therefore, cetacean stereotypies, like stereotypies in other mammals, are not just behavioral issues, but also represent brain function abnormalities (Jacobs et al., 2021).

Captive cetaceans exhibit a range of stereotypies that are also found in other captive species (Clubb & Mason, 2003; Morgan & Tromborg, 2007; Mason, 2010) but not found in free-living cetaceans. Although much more in-depth research is needed on the frequency and nature of stereotypies in captive cetaceans (Gygax, 1993; Clark, 2013), oral stereotypies appear to be relatively common (Jett et al., 2017). These are observed most frequently, but not exclusively, in captive orcas and include biting, chewing, and jaw-popping on hard tank surfaces (Ventre & Jett, 2015; Visser & Lisker, 2016; Jett et al., 2017; Figure 2) Also found in captive cetaceans are circling and repetitive swimming patterns (Jett & Ventre, 2011; Ugaz et al., 2013). However, Miller et al. (2021a) did not find route tracing behavior (a form of stereotypical swimming) in the captive bottlenose dolphins they studied but rather a high rate of behavioral diversity (amount of species typical behavior), suggesting an inverse relationship between behavioral diversity and stereotypies. Continued research is necessary to validate behavioral diversity as an indicator of positive welfare for bottlenose dolphins and other captive cetaceans (Miller et al., 2020; Brereton & Fernandez, 2022).

Self-harm, whether deliberate or incidental to other abnormal behaviors like stereotypies, also occurs in captive cetaceans but, again, is largely unobserved in free-living cetaceans (although these kinds of behaviors are more difficult to observe in the wild). Examples include constantly rubbing their skin on hard objects, resulting in excessive abrasions (Lipman, 2016), or continually hitting against the side of the tank (Dima & Gache, 2004). In one well-known case, a captive orca continually hit his head against the sides of the tank until he died of a brain aneurysm in 1980 (Ringelstein, 2021). Repetitive regurgitation and reingestion is another stereotypic behavior that develops in response to boredom, illness, social isolation/instability, and/or stressful training interactions (Walsh et al., 1996; Calle, 2005). On the other end of the activity spectrum are symptoms which may indicate depression (e.g., spending more time logging or lying motionless on the surface of the water for extended periods, resting motionless on the bottom of the tank, and loss of appetite in the absence of physical illness; Dima & Gache, 2004; Jett & Ventre, 2012; Worthy et al., 2013). It should be noted that lying on the bottom of the tank is sometimes observed in

Commented [A88]: This paper has a significant rebuttal from Jaakkola. Not discussing it is problematic as that rebuttal pretty much addresses much of what is in 4.1 https://www.mdpi.com/2076-2615/13/17/2707

Commented [A89]: I would be much more specific here, especially when arguments from other species are used to justify conclusions in cetaceans.

Commented [A90]: I think the cetacean welfare study has addressed some of these issues from the 1993 paper if the authors want to incorporate that into this section.

Commented [A91]: There are a lot of things that aren't observed in wild cetaceans. They are hard to watch 24/7.

Commented [A93]: I would not consider a 30 year old abstract to a veterinary conference a "foundational paper". Especially when the rates of regurgitation in current populations are not properly assessed by the authors.

resting individuals who are not necessarily depressed. These various factors are best interpreted in a more holistic way, such as assessing whether many different indicators of depression are present rather than just one. Captive facilities attempt to control or diminish stereotypies primarily through reinforcement of alternative behaviors, pharmacological treatment, or environmental enrichment, but none are completely successful (Mason et al., 2007). However, one study found that cognitive foraging enrichment led to reduced stereotypies and other abnormal behaviors (Clegg et al., 2023b), suggesting that more complex enrichment formats anchored in more naturalistic behaviors may be more helpful than non-cognitive forms.

4.1.b. Aggression

Although aggression towards members of one's family or social group does occur in free-living cetaceans (Scott et al., 2005; Marley et al., 2013; Robinson, 2014), it is often kept from escalating by dispersal and other factors (Bisther, 2002; Towers et al., 2018). But conspecific aggression can sometimes be exacerbated in tanks, where space is inadequate for dispersal, is shared by individuals who are not necessarily compatible, and where separation or isolation might be the only recourse – all of which have welfare ramifications (Frohoff, 2004; Evans, 2015; Ventre & Jett, 2015). Miller et al. (2021c) suggest that for species with dominance hierarchies, such as bottlenose dolphins, the ability to have the space to separate themselves physically from other individuals may be important for welfare. Likewise, direct attacks on humans by orcas and belugas in the wild are unknown (Pagel et al., 2017) and there is only one record of a free-living bottlenose dolphin killing a human (who was abusing him; Santos, 1997). Nevertheless, there have been hundreds of aggressive acts by captive cetaceans towards humans (Lott & Williamson, 2017) and four human deaths by captive orcas (Parsons, 2012). Moreover, captive bottlenose dolphins and other cetaceans, especially those in interaction and feeding sessions with the public and SWD programs, also have a long record of aggression towards humans, often resulting in severe human injuries (Anderson et al., 2016). Maternal rejection and aggression towards calves is also not uncommon in captive cetaceans (Rose et al., 2023; Marino et al., 2020). In the wild, infanticide has been observed in six odontocete species and has been theorized to be motivated by sexual access to females or removal of genetic competition (orcas: Towers et al., 2018; bottlenose dolphins: McEntee et al., 2023).

Commented [A94]: This is not a good representation of this paper. Mason et al argues that their 2007 paper that ARBs can and should be reduced to zero.

Commented [A95]: That is a sampling bias given the proximity of dolphins in captivity to humans. These should not be evaluated as apples to apples comparisons.

Commented [A96]: I am not aware of any dolphin petting programs.

Commented [A97]: Anderson et al is an opinion piece about killer whales. Nothing to do with SWD programs. This article also argues that the reasons for increased aggression is because whales do not get unstructured time with guests and that's why they are aggressive. This is hardly an objective or well reasoned paper. https://www.mdpi.com/2076-2615/6/8/49, https://www.kintocetaceans.org/robert-anderson.html

Commented [A98]: cf Jaakkola et al 2020 and Dudzinski, et al., 2021)

Commented [A99]: In the wild infanticide motivated by increased sexual access to females with calves, or the elimination of potential genetic competition has also been proposed for delphinids. Examples include killer whales (Towers et al. 2018), Indo—Pacific humpback dolphins (Zheng et al. 2016), Guiana dolphins (Nery and Simao 2009), and bottlenose dolphins (Dunn et al. 2002, Scott et al. 2005, Kaplan et al. 2009, Robinson 2014, Perrtree et al. 2016). And maternal failure in first born calves is VERY common but it is unclear if that's a feature of maternal rejection or built up organic pollutants passed to the offspring.

4.2 Physical health

4.2.a. Nutrition and metabolism

Many diseases in captive cetaceans are associated with metabolic syndromes believed to be linked to the captive diet (Rosen & Worthy, 2018). Captive bottlenose dolphins, for example, are prone to developing insulin resistance and fatty liver disease, similar to type-2 diabetes in humans (Colegrove, 2018). Free-living bottlenose dolphins have been found to be 15 times more likely to express lower iron levels than captive dolphins (Mazzaro et al., 2012). Elevated iron found in captive bottlenose dolphins as they age is a precursor to developing a disease called hemochromatosis, which is known to occur in managed care populations. This suggests that captive dolphins are more susceptible to non-hereditary hemochromatosis than free-living populations, which can lead to liver, heart, and reproductive problems, as well as joint pain, increased cancer risks, and death (Mazzaro et al., 2012; Venn-Watson et al., 2012a, 2013). Another condition likely related to the captive diet is hypocitraturia, which is characterized by low levels of citrate urinary excretion (Zuckerman & Assimos, 2009). This disease is four times more common in captive than in free-living bottlenose dolphins and promotes the formation of kidney stones, which can lead to serious complications such as renal failure and death (Venn-Watson et al., 2010). Despite

4.2.b. Skin Health

Skin disease is common in captive dolphins, with the most prevalent being tattoo skin disease (TSD; black or grey stippling discoloration of the skin), caused by poxvirus, and diamond skin disease (slightly raised, rhomboidal grey patches), caused by the bacterium *Erysipelothrix rhusiopathia*. Skin diseases are also found in dolphins in the wild; for example TSD is associated with poor population health (van Bressem et al., 2008). Although poxvirus is associated with TSD lesions in bottlenose dolphins, the virus typically is expressed in individuals who are immunocompromised from stress or concurrent illness. Van Bressem et al. (2008) reported that 20.6% of the 257 bottlenose dolphins held in 31 U.S. and European facilities had tattoo lesions. When left untreated, active diamond skin disease lesions can progress to a serious and life-threatening zoonotic bacterial infection (Tryland, 2018; Lacave et al., 2019). However, it is also possible for cetaceans to develop sudden illness and death in the absence of obvious skin lesions. The causative organism is found on dead fish products, the main source of infection for captive

Commented [A100]: Mazzaro et al., did not say what these authors imply here. What they said was"Compared with those in managed collections, wild dolphins were 15 times more likely to have low serum iron (100 µg/dL or less), and this measure was associated with lower haptoglobin." High serum iron was defined as levels exceeding 300 µg/dL. The Average for the study was 184 ± 132 µg/dL.In the captive data all populations are under the 300 µg/dL level considered normal. In the wild populations some are below the 100 µg/dL. https://pmc.ncbi.nlm.nih.gov/articles/PMC3527756/table/tbl4/.

If one goes through just about all of these references there is a good chance similar discrepancies will be found.

Commented [A101]: And that is possible in the wild. What are the authors trying to claim here about cetacean welfare in captivity?

cetaceans (Lacave et al., 2019). For this reason, Erysipelas is primarily a disease of captive cetaceans (Rosen & Worthy, 2018) and numerous deaths have been reported due to peracute septicemic *Erysipelothrix* infection (Van Bonn et al., 2007).

4.2.c. Dental Disease

Tooth injury resulting from stereotypical behavior is a major problem for many animals across a range of species in zoo settings (Glatt et al., 2008). Mason and Latham (2004) estimated that 82% of wild carnivores held in zoos express stereotypical behavior, with oral stereotypies being most prevalent (Bergeron et al., 2006). Tooth wear from oral stereotypies is also commonly reported in captive orcas (Graham & Dow,1990; Jett & Ventre, 2012; Ventre & Jett, 2015; Almunia, 2017). Even though they are fed in a way that does not involve using their teeth (by throwing fish into the back of the throat), captive orca teeth commonly exhibit extensive wear and other dental pathologies such as fractures and exposed pulp cavities (Jett & Ventre, 2012; Ventre & Jett, 2015; Visser & Lisker, 2016; Jett et al., 2017). The main reason for the extensive dental wear and trauma in captive orcas is frequent biting and grating of the teeth against hard surfaces in the tank. This stress-related stereotypy does not appear to be as problematic in captive belugas and bottlenose dolphins as in orcas. In one large survey, approximately 69% of captive orcas in the U.S. and Spain had fractured mandibular teeth and 24% exhibited "major" to "extreme" mandibular coronal tooth wear down to the gingiva (Jett et al., 2017).

Natural tooth wear is associated with increasing age in free-living odontocetes (Perrin & Myrick, 1980; Ramos et al., 2000; Foote et al., 2009; Loch & Simões-Lopes, 2013, Loch et al. 2025); however, advanced tooth damage from traumatic crown injury is rare in free-living orcas (Loch et al., 2025). Moreover, tooth wear in orcas in the wild is related to specific ways some orca subtypes feed. For example, when evaluating the dentition of three orca ecotypes (i.e., Offshore, Transient, and Resident), Ford et al. (2011) suggested that the abrasive skin of sleeper sharks (*Somniosus pacificus*), a frequent prey of Offshore orcas but not the other two subtypes, was implicated in their pronounced dental wear.

When teeth are gradually traumatized over the lifetime of an animal, such as on the rough skin of prey or from water and tongue movements during suction feeding (Marx et al., 2023), internal

Commented [A102]: I would recommend having Dave Rosen and Geraldine Lacave look at this section.

Commented [A103]: To give a sense of the selective interpretation of these studies, and the heavy lift that the word "May" is doing here, this is the abstract from Loch and Simoes-Lopez, 2013. Abstract
(1) Dental wear is a common phenomenon in mammals. Its occurrence is influenced by tooth anatomy, animal physiology, biomechanics and behaviour. So far, investigations of dental wear in cetaceans have been scanty and superficial. We compare the frequencies of occurrence, location and intensity of dental wear in some species of dolphins from southern Brazil, South Atlantic Ocean. (2) Teeth of ten species were evaluated using a stereoscopic microscope to identify wear facets, which were classified according to location, anatomical position and wear intensity. (**3) Frequencies of dental wear were high for all species with exception of Delphinus capensis, with less than 50% of teeth worn.** Simultaneous wear facets in the apex and lateral of teeth were more common than facets restricted to the apex or lateral faces. Wear on the dental crown was more common, but some species showed less frequent wear down to the cingulum or root level. Superficial wear seems to be the general trend for dolphins, but Stenella coeruleoalba and Pseudorca crassidens showed a higher frequency of severe wear. Only for Tursiops truncatus the frequencies of wear were significantly different between males and females. When considering the ontogeny of dental wear, only for T. truncatus and Stenella frontalis indexes of dental wear were correlated with body length. (4) Whether dental wear has implications or not in fitness and feeding behaviour, severely worn teeth may expose the pulp cavity and increase the susceptibility to local infections.

Commented [A104]: This is not true from even the study the authors cited. https://pdf.sciencedirectassets.com/271218/1-s2.0-S0003996912X00141/1-s2.0-S0003996912002610/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEHYaCXVzLWVhc3QtMSJHMEUCIEfbKMuRwp0ttYyvHay7EpaQjCBW9dk7%2F5q5dkSnWbzxAiEAh79Hrt7UYP5xsbeXovPM3%2FILS%2BlJlOZ9yd84vd3mXXwqvAUI%2Fv%2F%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FARAFGgwwNTkwMDM1NDY4NjUiDHki3P1AqWKVPtf05iqQBR1QxzPBW8WcSVbrviRhCZU0%2FexE%2BJlWJbyr%2F74ZCpf8UFQSIsBP6b8MH9bdh4v7oSxME6RBhMxkgLUOXlu955cLaVCbr3mFDuDzoI9hhQl4XSW72iYRrSH3HO3tKm7c5pDi2DcrizjDDhu1qi2IPyH0QIn3JKrmnclIB9gGO0nIpenTDOlPAOhMNooblLIpjinkvo28f%2BiYDLhPYTfNzzzIFEDz1HGW9B4d7KeU9shIDmQgx1mSL8kuH0RhSBRZNi9Eza7KwMzxj%2F17eMcyoapmD6GdOzs93puQ3[3]

Commented [A105]: These studies did not suggest that tooth wear in wild orcas is rare. In fact, new studies come out frequently highlighting new forms of tooth wear- even in orcas. https://link.springer.com/article/10.1007/s10914-022-09645-1

healing mechanisms are initiated to protect the integrity of the pulp chamber, such as tertiary dentin formation (Loch et al., 2025). The superficial forms of dental wear commonly seen in free-ranging orca (e.g., attrition, abrasion, abfraction, and erosion) are gradual enough to allow for concurrent healing processes and do not result in pulp exposure and subsequent infection (Loch et al., 2025). However, in captivity, cetaceans experience different types of dental injury such as acute onset of traumatic complicated crown fractures that do pose a significant health threat, including pulp infection, tooth root abscess formation, and bacteremia (Holmstrom, 2018).

In an effort to avoid infection and health complications, captive orcas with damaged teeth are often forced to undergo a modified pulpotomy procedure whereby the teeth are drilled, and pulp and debris are removed (Ventre & Jett, 2015). To mitigate the risk of systemic infection, damaged teeth are thereafter flushed with antiseptic solutions daily and the animals are often routinely treated with antibiotics, which may result in drug-resistant pathogens (Davies & Davies, 2010; Dold, 2015) and altered immune system function (Yang et al., 2017).

4.2.d. Digestive and Gastrointestinal Disease

Diseases of the gastrointestinal tract, such as gastritis and gastric ulceration, have been seen in both wild and captive cetaceans. Gastric ulcers are one of the most common gastrointestinal diseases in captive cetaceans (Colegrove, 2018). In many cases, their etiology remains unclear; however, ulcers in captive cetaceans have been linked (or suspected to be linked) to social stress (Joseph et al., 2019), dietary factors and food quality (Geraci & Gerstmann 1966; Rosen & Worthy, 2018), foreign body ingestion (Buhrmann et al., 2023), the administration of non-steroidal anti-inflammatory drugs (Simeone et al., 2014), as well as the bacteria *Helicobacter delphinicola* (Segawa et al., 2023). A recent study of this bacterial organism in dolphinaria in Japan found a statistically significant relationship between the presence of this organism and chronic gastrointestinal disease in captive bottlenose dolphins and found evidence to suggest that transmission occurred rapidly between individuals sharing the same pool enclosure (Segawa et al., 2023). *Helicobacter* gastritis and ulceration can lead to perforation of the stomach lining (Stoskopf, 2015) and has been associated with deadly cases of stomach torsion (Begeman et al., 2013).

Also, repetitive regurgitation and reingestion can result in chronic irritation of the delicate mucosal surfaces of the esophagus from routine exposure to acidic stomach contents, leading to inflammation, corrosion, and even death (Walsh et al., 1996). This behavior, as opposed to simple regurgitation or vomiting, has not been reported in wild cetaceans. Intestinal volvulus (an abnormal rotation of the intestine), another deadly gastrointestinal disease found in free-living and captive cetaceans, is a common cause of mortality in both (Begerman et al., 2013). Although the etiology of this condition remains unclear in most reported cetacean deaths, a significant factor known to influence the development of intestinal torsion and volvulus in a wide array of other mammalian species is dysbiosis, or an imbalance in the natural gut microbiota (Weese et al., 2015; Hullar, 2018; Oliveira, 2024). In a variety of non-human animals, and in humans, there appears to be a strong relationship between disturbances in the gut microbiota and chronic stress and depression (Kelly et al., 2016; Peirce & Alviña, 2019; Yang et al., 2020). Additional studies are necessary to understand the impact of the various social, environmental, and husbandry factors influencing the cetacean intestinal microbiome and how these might also affect mental health. However, numerous studies have shown a clear and significant impact of captivity on the fecal microflora of captive cetaceans (Bai et al., 2021; Suzuki et al., 2021; Shah et al., 2024), which consequently impacts both gastrointestinal health and the systemic immune system (Linnehan et al., 2024.

4.2.e. Infectious Disease

Viral, bacterial, and fungal infections are found in both captive and free-living cetaceans with viral and bacterial pneumonia the most common causes of fatality in captive cetaceans (Kielty, 2011; Jett & Ventre, 2012; Nelson et al., 2019). Pulmonary mycotic infection (fungal pneumonia) is also a frequent cause of death in captive and free-living cetaceans (Brando et al., 2018; Reidarson et al., 2018). At least 15 of the 22 orcas who died in U.S. marine parks between 1990 and 2010 succumbed to infectious and inflammatory diseases, including pneumonia, encephalitis, bacteremia, and leptomeningitis (Kielty, 2011). In a retrospective study of the US Navy Marine Mammal Program from 1980-2010, 50% of the dolphins had histopathologically confirmed pneumonia (Venn-Watson et al., 2012b). Other infectious diseases in captive cetaceans are related to behavioural dysfunctions. For instance, it has been suggested that the increased time orcas spend floating on the tank surface increases vulnerability to mosquito-borne infections, such as St.

Commented [A106]: This is a very selective presentation of the literature and is very speculative. Are the authors aware of current rates and prevalences of digestive and gastrointestinal disease in cetaceans today? If not this would be a great opportunity to investigate that or, if necessary, call for that work. Unless you have modern papers that suggest that ulcers are common in zoos then I think this section needs to be removed or revised to suggest that work is needed here (if it's actually needed). To be fair the authors are also selectively discussing ulcers. Belugas in the Sea Life Beluga Sanctuary were found to have ulcers that correlated to their time in the sea pen and away from their tanks. This has resulted in the whales not being able to go to their sanctuary. As the authors advocate sanctuaries an even discussion of this phenomenon would be more balanced. https://www.mdpi.com/2076-2615/14/2/335, https://www.mdpi.com/2673-5636/6/1/4

Louis encephalitis (Jett & Ventre, 2012). At least two captive orcas deaths from this disease have been documented (St. Leger et al., 2011; Jett & Ventre, 2012).

Routine preventative administration of antibiotics and antifungals often causes an imbalance of microflora and resistance to the medicines themselves (Dold, 2015; Reidarson et al., 2018; Park et al., 2020). For instance, meticillin-resistant *Staphylococcus aureus* (MRSA) was reported in captive dolphins in two Italian facilities, with one dolphin in each facility dying from MRSA-linked septicemia (Gili et al., 2017). Another recent case demonstrated the presence of resistant *Morganella morganii*, a bacterium associated with fatal sepsis in human beings, in a captive bottlenose dolphin in South Korea (Park et al., 2020). *Candidiasis*, often observed in immunocompromised individuals, is increasingly prevalent in captive cetaceans (Reidarson et al., 2018; Ohno et al., 2019). Several other opportunistic infections (e.g., *Giardia* sp. and *Cryptosporidium* spp.) have also been linked to the captive environment (Koch et al., 2018).

4.2.f. Reproduction

Most cases of neonatal death in captive facilities occur in young females giving birth for the first time (Owen, 1990; Sweeney et al., 2010), which may be due to immaturity and lack of exposure to natural mother-calf relationships (i.e., factors particularly relevant to the captive situation). The same pattern is true in the wild (Henderson et al., 2014; Robinson et al., 2017; Wells et al., 2025). However, the fact that these infant mortality statistics are the same in the wild and in captivity – where none of the dangers or risks inherent in the wild are present – leaves open the critical question of why neonatal deaths in captivity are not lower than in the wild.

Female dolphins at SeaWorld facilities are often impregnated through artificial insemination (AI), an invasive procedure that requires mild sedation so that semen can be deposited inside the reproductive tract through a catheter (Robeck et al., 2005; O'Brien & Robeck, 2006). AI often involves multiple attempts. In the common bottlenose dolphin, the conception rate after AI using frozen–thawed semen is 65–70% (Robeck et al., 2009). SeaWorld also employs AI to control the sex ratio of its captive dolphin population in favor of breeding females. Out of 30 such inseminations, 28 have resulted in females (Robeck & O'Brien, 2018).

Commented [A107]: The authors fail to contextualize this limited literature with studies that utilize captive cetaceans as the control for sick wild populations. See the body of research from Greg Bossart. The authors state in the longevity portion of this paper that meaningful comparisons cannot be made regarding captive and wild animal life spans when lifespan data is usually incomplete for wild populations. Yet the authors have no problem making that implied comparison here, without much recognition of the fact that wild cetaceans also get sick. As this paper is supposed otherwise be an update to the current state of cetacean welfare in captivity a lot of these data are also really old.

Commented [A108]: A comprehensive review of birth control is missing here. Especially given the authors' preferences for authentic/GFAS sanctuaries where that tool would be deployed. See https://www.mdpi.com/2076-2615/14/2/335

Orca females reach sexual maturity between 11 and 13 years of age in the wild (Ford, 2018) but reach peak fertility at around 20 years of age (Ward et al., 2009). Females typically give birth to their first viable calf at 12–14 years of age (Olesiuk et al., 2005). Calves nurse exclusively for at least a year but remain in close association with their mother for at least the first two years or longer (NOAA, 2025). Males sexually mature at the age of 15, but do not typically reproduce until age 21 (Ford, 2009). AI is used to breed captive orcas as well and several have been conceived at SeaWorld parks this way (Robeck et al., 2004, 2017).

Female beluga whales in the wild become sexually mature at age 8–12 years, males between 9-15 years–although there is still considerable variability in estimates (O'Corry Crowe, 2009; Suydam, 2009). Most calves continue nursing until they are 20 months old, although nursing is often available to calves for more than two years (O'Corry Crowe, 2009). Captive beluga reproduction has been a longstanding problem because of physiological and behavioral factors (e.g., they are facultative induced ovulators and seasonal breeders; Steinman et al., 2012). That is, they are not always ready to breed. Therefore, AI has been used, with uneven success, in captive beluga whales (O'Brien et al., 2008; Robeck et al., 2010).

4.2.g. Longevity, survival, and mortality rates

Although more data are needed, captive cetaceans continue to experience an equivalent or higher risk of dying compared to conspecifics from healthy, free-living populations (Montano, 2017; Jaakkola & Willis, 2019; Rose et al., 2023). These findings are difficult to explain given that cetaceans in captivity are afforded full-time veterinary care and are protected from food shortages, predators, pollution, and parasites. This situation begs the question of why illness and mortality are so high in captivity.

Estimates for free-living bottlenose dolphins suggest a maximum lifespan of ~25 years (Sergeant et al., 1973) whereas Wells et al. (2013) suggest an average age at death of 19.9 years. Wells & Scott (2009) suggest that female free-living bottlenose dolphins can live to more than 56 years and males to 48 years. Therefore, there is variation in estimates of maximum lifespan for free-living bottlenose dolphins. One recent study suggested that mean life expectancy for captive bottlenose dolphins is not significantly different from that in some free-living populations (Jaakkola & Willis; 2019). The

most recent study of longevity also indicates improvements in life expectancy and first year survival rates for captive bottlenose dolphins (Tidière et al., 2023). These increases were attributed to improvements in captive environments and to the fact that there were fewer wild-caught dolphins, who have higher mortality rates, in the more recent time periods examined. One crucial point remains: the authors acknowledge that the study "does not assess individual-level welfare or quality of life, which is essential to advance animal care and develop a holistic understanding of animal welfare" (p. 7, Tidière et al., 2023). Longevity for common bottlenose dolphins thus appears to have increased over time in captive settings. It remains important to remember, however, that although longevity may be related to quality of life, it is not the same.

For orcas, the mean life expectancy for females in the Pacific Northwest is ~46-50 years, with a maximum of ~80 years (Olesiuk et al., 2005; Ford, 2018). Mean life expectancy for males is ~30 years but they may live to ~60 years (Ford, 2018). In contrast, of the more than 200 wild-caught or captive-born orcas held since the 1960s, fewer than 15% have lived to age 30 (Rose et al., 2023). Jett and Ventre (2015) found that orcas in U.S. facilities (12.0 years) demonstrated a significantly higher median survival time than those in non-U.S. facilities (4.4 years), as did whales entering captivity after January 1985 (11.8 years) versus those entering prior to January 1985 (3.9 years). Therefore, survival of captive orca cohorts has generally increased in the last four decades, although survival to age milestones remain poor in captive animals in comparison to free-living orcas.

For free-living beluga whales, mean life expectancy is ~20-30 years and maximum ~60 years (Lockyer et al., 2007; Wells & Scott, 2009; Willis, 2012). Although definitive life expectancy statistics for captive beluga whales have not yet been established, there is evidence that lifespan is compromised (Woodley et al., 1997). The best estimation for maximum longevity in captive beluga whales is 35 years of age (Montano et al., 2017). Survival rates in captive belugas also appear to be lower than in nature (Small & DeMaster, 1995; Woodley et al., 1997). However, updated research on these statistics for captive belugas is critically needed.

4.2.h Summary

Commented [A111]: The authors say these groups can't be compared and then proceeds to compare them. Truth is we have really good data in zoos and we have some good data for some populations in wild dolphins. The clear pattern is that male and female dolphins outlive their wild counterparts. https://royalsocietypublishing.org/doi/10.1098/rspb.2023.1895. The authors should cite from peer reviewed sources rather than blogs (this is Long, 2018, https://us.whales.org/2018/08/23/how-long-do-bottlenose-dolphins-survive-in-captivity/).

Commented [A112]: Again we are told we can't compare spotty wild data to complete captive data. The authors need a consistent view on this.

Commented [A113]: So this way of analyzing the data forgets that there are quite a few whales that may survive past those ages. The only way this analysis is useful is if the population is extinguished and you can look back at each animal's total lifespan.

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Commented [A115]: Pre 2000

Commented [A116]: This is the only sentence in this paragraph that objectively true and useful. Cook Inlet belugas against captive belugas is probably a different story than it would be for Black Sea belugas. But we just don't know.

In the above sections, we described the mental and physical health of captive cetaceans, starting with brain and behavioral issues, various dimensions of physical health, and concluding with longevity, survival, and mortality statistics. Captive cetaceans, and especially orcas, exhibit several abnormal behaviors in captivity, including oral stereotypies, self harm, and hyperaggression towards tankmates and humans. In terms of physical health, captive cetaceans suffer from all of the systemic, skin, and digestive diseases known to occur in cetaceans in the wild. This finding begs the question of why they are exhibiting these diseases in a clean, controlled environment. Moreover, reproduction and births remain problematic in captivity. Finally, with the exception of the bottlenose dolphin, no other cetacean species lives as long in captivity as in the wild.

5. Environmental Enrichment

Whether zoos and marine parks can, in principle, provide for the needs of cetaceans is a question that has received increasing attention in the domain of environmental enrichment (Brando et al., 2018; Jacobs et al., 2021). The marine park industry was the first to recognize the difficulties cetaceans have in coping with the incongruity between artificial and natural environments (Swaisgood & Shepherdson, 2005; Morgan & Tromborg, 2007). As a result, accrediting agencies require various forms of enrichment, which are implemented to "maximize psychological health" (WAZA, 2025), to stimulate "natural behavior" (AZA, 2025), to allow the animal "variety and choices" in the animal's environment (AMMPA, 2025), and to provide the animal with "behavioural choices" and "control over its environment" (EAAM, 2025). The requirement of such ad hoc enrichment constitutes a de facto recognition that the captive environment is inherently impoverished, as has been suggested by several researchers (Hancocks, 2002; Mason & Burn, 2018; Jacobs et al., 2021). This claim has been refuted for accredited dolphin enclosures by Jaakkola (2023), but Jaakkola does not consider facilities for larger cetaceans or those that are unaccredited. Nevertheless, it should be noted that this refutation is based on an oversimplified interpretation of the impoverishment-enrichment continuum used in laboratory studies whereby Jaakkola isomorphically maps the laboratory paradigm onto captive dolphin enclosures. Simply adding enrichment to an enclosure does not necessarily transition an impoverished environment to an enriched environment (Jacobs et al., 2021).

Commented [A117]: Can enrichment take other forms? See Heather Browning argument. Also Lauderdale LK, Miller LJ. Common bottlenose dolphin (*Tursiops truncatus*) problem solving strategies in response to a novel interactive apparatus. Behav processes. 2019 Dec 1;169:103990. pmid:31678324

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Commented [A119]: This study implied that captive dolphins live in impoverished environments. That just isn't quantitively or qualitatively true. See Jaakkola, 2023.

Traditionally, much of the enrichment for captive cetaceans has involved the presentation of plastic or rubber floating objects (i.e., toys) with which the animals can interact (Brando et al., 2018; Lauderdale et al., 2021e; Jaakkola, 2024). Although such objects may initially arouse interest, habituation occurs relatively quickly (Clark, 2013), which is why variable enrichment schedules and novel items are recommended (Kuczaj et al., 2002). It nevertheless remains unclear to what extent such objects are actually enriching (Delfour & Beyer, 2011). Other types of enrichment may include submerged objects, human interaction/training, as well as food-based, structural, and sensory enrichment (Brando et al., 2018), including classical music (Guérineau et al., 2022). More recent efforts have focused on cognitive challenges (e.g., physical or virtual puzzles and games) to the enrichment repertoire (Clark, 2013; Jaakkola, 2024). As summarized by Jaakkola (2024), cognitive stimulation appears to be intrinsically rewarding and has been associated with a variety of positive welfare indicators (e.g., increases in activity, decreased stereotypies, increased exploratory behavior). Yeater et al. (2024) taught dolphins the concept of innovation and found that the activity was intrinsically rewarding and cognitively engaging. Clegg et al. (2023a) found that cognitive foraging enrichment improved welfare by increasing dolphin engagement and motivation in training sessions and led to fewer stereotypic behaviors. Such cognitive challenges need to account for both species and individual differences and need to be at an appropriate level of difficulty to avoid negative welfare outcomes (e.g., unresolved frustration; Jaakkola, 2024). Unfortunately, as of 2017, cognitive enrichment appeared to be the least-used type of enrichment in captive settings (Clark, 2017). However, cognitive-focused enrichment practices have grown in recent years and appear to to be more effective in diminishing abnormal stress-related behaviors, at least for smaller cetaceans (Perlado-Campos, 2017; Matrai et al., 2020).

Neuroscience research suggests that a more natural environment is better for the brain and for the emotional health of the animal than are artificially enriched environments (Rosenzweig et al., 1972; Lambert et al., 2015, 2016). Consistent with this notion are studies that suggest that dolphins in captive environments with more natural elements (e.g., sea pens or netted off areas continuous with the ocean) are less stressed and display fewer behavioral abnormalities than those living in tanks. For instance, Ugaz et al. (2009) found that the same group of bottlenose dolphins engaged in more active swimming and less logging in open sea pens (with access to ocean and a more

Commented [A120]: These arguments should be contextualized with Proie, 2013 which showed no differences in cortisol between captive and wild animals (with captive animals showing even less stress than wild animals under SD). I know the lead author is familiar with this work because she is in Proie's acknowledgements.

complex environment) than when they were in closed facilities with no ocean access. As noted previously, dolphins in closed artificial environments were also found to have higher salivary cortisol levels than those in open sea pens (Ugaz et al., 2013). Moreover, dolphins transferred from concrete tanks to captive ocean environments spent less time in social interactions (Ruiz et al., 2009). The authors suggested this finding could be due to the significant increase in space available (the ocean habitat was approximately five times the size of the tanks) as well as the opportunity to explore other features of the natural environment, such as fish and other organisms who may be present (Ruiz et al., 2009). In a review of several studies of cortisol levels in and out of captivity, Proie (2013) found evidence for higher levels in free-ranging cetaceans than in captive cetaceans. However, as Proie noted, cortisol assays in the wild are done by chase and capture whereas, in captivity, they are done as part of routine husbandry procedures, thus making comparisons problematic: "...sampling methodology is such a pronounced confounding variable it would be inaccurate to conclude that captive cetaceans have a lower resting cortisol level than wild cetaceans or to assume that captive cetaceans are 'less stressed' than their wild counterparts" (Proie, 2013, p. 138).

Lauderdale et al. (2021b) found that dolphins in natural ocean facilities (netted off areas continuous with the ocean) spent less time swimming in the top third of the water column than those in tanks. The authors suggested that, among other reasons, dolphins in ocean facilities may spend more time deeper in the water column because of the presence of natural flora and fauna, especially fish, who enter and exit the area (Lauderdale et al., 2021b). The above studies, while far from conclusive, strongly suggest that there are welfare benefits to dolphins (and likely other cetaceans) of living in a more natural ocean environment – even when captive. The current literature on environmental enrichment and welfare in cetaceans indicates that much more research is needed to determine if and how specific enrichment efforts can improve welfare with the caveat that certain aspects of enrichment (e.g., space) often cannot reasonably be addressed in traditional captive facilities. The effects of environmental enrichment can only be fully understood by employing well-confirmed welfare tests (Brereton & Rose, 2023).

6. Discussion and Conclusion

Commented [A121]: But for a dolphin moving from a pool to a sea pen the experience may be very different.

Commented [A122]: This needs to be contextualized with the overall findings of the Cetacean Welfare Study that showed that space and whether or not the animals were in a pool or a sea pen were the weakest welfare predictors.

Commented [A123]: Well this Is not true at all. One could treat this in lagoon facilities where dolphins have open ocean access and the amount of primary reinforcement it takes to get the animals to swim into the open ocean could be used as the dependent measurement to determine the effectiveness of space in improving welfare. But again. The Cetacean Welfare Study looked at this. See the numerous calls to incorporate that better into this paper. The authors are hampered here by not having a complete understanding of the diversity of captive facilities in the world.

In the present review, we have underscored concerns that are vital to captive cetacean welfare. For cetaceans, there is a significant mismatch in amount and complexity of space available, socio-cultural opportunities, and cognitive stimulation between the captive and natural environments, which contributes to their difficulties coping with life confined to concrete tanks (Mason, 2010; Hosey et al., 2020). Additionally, the natural characteristics of cetaceans (e.g., their need for space, cognitive and social complexity) predict the welfare challenges outlined above (Clubb & Mason, 2007; Pomerantz et al., 2013; Hosey et al., 2020; Mellor et al., 2021). These outcomes are in keeping with Mason's (2010) study of how different species respond to captivity.

Much of the literature we have cited acknowledges areas where further study is needed. For instance, important questions remain about how amount of space and complexity interact as factors in well-being, how to provide more supportive environments for nursing and rearing calves, and which enrichment methods are long-lasting and the most effective, and why, among others. In addition, the bulk of the cetacean welfare literature appears to be focused on dolphins and less so on the larger odontocetes like orcas and beluga whales. There remain significant (practical) limits to the extent to which land-based entertainment parks can provide larger, more complex, and variable environments that would allow cetaceans to engage in a greater range of natural behaviors. Pierce and Bekoff (2018) point out that discussions of animal welfare in zoos and marine parks often center on incremental improvements while overlooking the fundamental issue of captivity itself, namely the underlying incompatibility between captivity and life in the wild.

Welfare measures and assessments make up the bulk of the literature on captive animal welfare because one can collect scientific, quantifiable data. Such studies, however, do not address an important factor: quality of life. Presumably, this is because quality of life is a subjective evaluation made by the non-human animal and is not something one can scientifically measure in the absence of self-reporting. One can conduct choice and preference testing to help determine what is important to an animal (Dawkins, 2003), but the choices provided may not discern what the animal truly prefers, that is, what is actually optimal for the animal. For example, a researcher may give an animal a choice between Food A and Food Z, but what the animal prefers might actually be Food B at Time F, and food J at Time Y. The former option provides the animal with a choice; the latter option is more reflective of true autonomy. In the Cetacean

Commented [redacted] This is correct. It should be applied what is known and unknown about the GFAS sanctuary model at the end of this paper.

Commented [redacted] Orcas are dolphins. I think you mean to change "dolphins" to "bottlenose dolphins"

Commented [redacted] Yes. There is an incompatibility to life in captivity and in the wild, which I think explains why releasing cetaceans doesn't work and why GFAS cetacean sanctuaries as a concept are flawed. Animals that have no experience with the wild may not be compatible with even limited amounts of it, as anyone who has watched zoo-dolphins flee from a swimming fish will attest. This is a philosophical critique because the authors make philosophical arguments. Not sure that belongs in a paper that is ostensibly about the state of cetacean welfare in zoos.

Welfare Study, “quality of life” is mentioned only one time: “There is a strong commitment among zoos and aquariums to continuously advance an understanding of welfare across facilities using scientific methods to positively impact the quality of life for the animal” (p. 2, Lauderdale et al., 2021b). As such, there is an assumption or belief that improved welfare measures will lead to a better quality of life (Pierce & Bekoff, 2018). However, the studies did not evaluate the actual well-being of the dolphins; in fact, of the nine articles, there is only one mention of the term “well-being” (Miller et al., 2021c), and then only in a quote from Shepherdson (1998). The question thus remains: how can one definitively determine which welfare assessments actually provide quality of life? For example, researchers would probably agree that having autonomy (i.e., choice and control over the environment) should improve well-being (Jaakkola, 2023) by providing captive animals with the opportunity to thrive (Vincino & Miller, 2015; Miller et al., 2020). But the relationship between autonomy and quality of life in a captive setting is not something one can easily quantify. As noted previously, although Tidière et al. (2023) found that their data on captive animals demonstrated increased longevity in recent decades (a finding typically interpreted as indicating positive welfare), the study did not address quality of life itself. This issue would seem to go beyond the quantifiable bounds of science.

Commented [redacted] I’m not sure what the purpose of this section is. Do the authors wish to imply that animals under human care have a poor quality of life? If the authors agree that no claim can be made on that through science why bring it up in this context?

Moreover, as often appears to be the case with such welfare measurement studies, it is not clear if any of the welfare measures have actually been implemented. For the Cetacean Welfare Study, for example, apart from providing baseline reference measures through an iOS application (e.g., blood variables, fecal hormone metabolites; Lauderdale et al., 2021b), it remains unclear if, to what extent, how, or where the welfare measures determined to be important will be incorporated by captive facilities. In recent years, there have been attempts to apply comprehensive assessment programs for dolphins (e.g., the C-Well Assessment for bottlenose dolphins, Clegg et al., 2023a; Dolphin-WET, Baumgartner et al., 2024). These efforts reflect growing progress toward embedding welfare assessments into the daily care of captive cetaceans, but concerns remain regarding the quality of life for these animals (Hoy et al., 2010; Clegg & Delfour, 2018; Clegg et al., 2023b).

Commented [redacted] So you say that one cannot scientifically know quality of life but you assume it to be bad? This treads dangerously into the “because I said so” territory. This all really should go. I also would make sure that the authors cited would subscribe to your framing of this.

Thus, from an ethical standpoint, the deeper question is whether cetaceans can truly thrive in captivity, rather than merely survive. Thriving goes beyond physical health or lifespan – it

encompasses overall *quality* of life and well-being. This includes factors such as the ability to exercise autonomy (as highlighted in Vicino and Miller's, 2015, emphasis on choice and control) and engage in meaningful environmental challenges. Partoon et al. (2025) suggest that a positive mental state is crucial to an animal thriving, and this involves promoting positive experiences for the animal through a species appropriate diet, naturally occurring social groupings, preventative healthcare, and a species appropriate habitat. Current evidence indicates that, although marine parks and aquariums can upgrade enclosures to offer some physical and behavioral benefit, they remain limited by available space and the artificial conditions required to keep cetaceans in captivity. Certainly, they cannot replicate the conditions of a free-living life necessary for cetaceans to truly thrive. With few exceptions (i.e., when individuals are captured from the wild or rescued and held in captivity for a short while), captive cetaceans cannot be released into the wild because they lack basic survival skills. Therefore, there are limited ethical alternatives. One of the most feasible options is a sanctuary, that is, ocean–based captive enclosures where cetaceans can receive human care while experiencing more space, autonomy, and choice in a natural environment. There are currently three cetacean sanctuaries being created by the Whale Sanctuary Project, the National Aquarium, and SEALIFE TRUST (Marino et al., 2025). Authentic sanctuaries, as opposed to greenwashed or temporary sea pen facilities (Speiran, 2025), are still captive environments and therefore will share many management challenges with other captive facilities (e.g., feeding, veterinary care, funding; Bruck, 2024). However, a sanctuary has different tools to mitigate the challenges of captivity such as a larger, more natural environment that offers greater complexity and enhanced sensory-perceptual experiences. As opposed to zoos, marine parks, and other entertainment venues (as well as military and scientific settings) authentic sanctuaries are not driven by objectives that often compete with animal well-being and autonomy (e.g., visitor experiences, scientific studies, breeding through AI). Accreditation standards for cetacean sanctuaries have been adopted by the Global Federation of Animal Sanctuaries (GFAS, 2025; Marino et al., 2025). Authentic sanctuaries for other wild animals, such as elephants and great apes, face many of the same challenges as cetacean sanctuaries but report improved physical and psychological health in their residents after they acclimate to their new environment (Buckley, 2009; Derby, 2009; Grow, 2020).

Although concerns about sanctuaries have been expressed by those who currently work with both wild and captive cetaceans (Bruck, 2024; Almunia & Canchal, 2025), it remains one of the only options available for those animals currently held in managed land-based tanks. Clearly,

Commented [redacted] Does a cetacean have autonomy if you put it in a stretcher haul it to Nova Scota and put it in a 100 acre sea pen? Does it have a choice in that move? If you are interested in choice perhaps you could go to Dolphin Quest Bermuda where their pools are connected to the open ocean or Dolphin Research Center where the animals have open ocean experience and start testing habitat preferences. One could even use the amount of primary reinforcer is a dependent measurement when examining how willing animals are to go from place to place in these different habitats. I think the answer would surprise you. You talk later about "species appropriate habitat". I think you should consider "individual appropriate habitat". What is the habitat appropriate for this individual with this l… [4]

Commented [A131]: The authors should be very specific as to what environmental challenges they expect for the animals. And they should meaningfully contrast these enrichment experiences with speci… [5]

Commented [redacted] Can you please present data from cetaceans that shows that a free living life is necessary for cetaceans under human care to thrive? To my knowle… [6]

Commented [A133]: There are at least two publications that I am aware of that highlight serious concerns with sanctuaries proposed under the model of the Global Federation of Animal Sanctuaries. Detail is given … [7]

Commented [redacted] There is no such thing as an authentic sanctuary. Until such a thing exists with animals living in the intended sea pen environment it is not for you to say what is greenwashing and what is legitimate. G… [8]

Commented [redacted] The point of this paper was to highlight the increased challenges associated with vast sea pens where folks try to skate a line between wild and captive. A facility with a 100 acre sea pen has MORE … [9]

Commented [redacted] This sounds like a statement that has little informing it from actual accredited facilities. I don't know any facility where animal welfare takes a back … [10]

Commented [A139]: The authors seem to have a view of current zoological models that assumes research with the animals or visitor interactions are implicitly negative experiences for the animals. I think rese… [11]

Commented [A140]: If you are going to discus sanctuaries it would be appropriate to discuss the challenges associated with them. Animals not responding well to them, noise, veterinary acces… [12]

Commented [redacted] It would be necessary at this point to discuss critiques of the standards. There are a lot. It would also be important to highlight what informs these standards. I'm sorry but your readers should not hav… [13]

Commented [redacted] It is important to properly characterize the work of those you cite.

Commented [redacted] There is also the option not to move the animals into massive sea pens. At least not until compelling data suggests that they will uniformly experience improved welfare. The authors should no… [14]

transitioning cetaceans to an authentic sanctuary requires careful planning (e.g., priming the microbiota to buffer against novel pathogens; Dallas & Warne, 2023) and will require continued research to evaluate the welfare of transferred animals. Welfare assessments in sanctuaries will, in some ways, differ from those in zoos and aquariums as the animals will have access to and interact with more natural environments. The goal would be for animals to exhibit (1) greatly reduced or an absence of stereotypies, (2) greater engagement in natural behaviors, including those that were previously unavailable to them (e.g., exploring/interacting with natural features of the environment, foraging), (3) increased time spent in play and other positive behaviors illustrating greater behavioral diversity, (4) time budgets closer to what exists in nature, (5) decreased time spent in human-animal interactions, (6) increased autonomy and the ability to make meaningful choices, and (7) a decrease in physiological indicators of stress. These goals are consistent with the five domains model of animal welfare (Hampton et al., 2023; Partoon et al., 2025). Although none of these, in isolation, indicates that an animal is thriving, the broad confluence of all these factors would indicate more natural behavior and would help attain the goals set by accrediting agencies mentioned previously, namely: "maximize psychological health" (WAZA, 2025), stimulate "natural behavior" (AZA, 2025), allow the animal "variety and choices" in the animal's environment (AMMPA, 2025), and to provide the animal with "behavioural choices" and "control over its environment" (EAAM, 2025).

In conclusion, the evidence clearly shows that ongoing health and welfare challenges remain for captive cetaceans, indicating that they are generally unsuited for captivity from both practical and ethical standpoints. Marine parks, particularly those that are accredited and have environmental enrichment programs, have improved in their ability to provide better welfare for captive cetaceans. Nevertheless, they still cannot fully meet the complex needs of these animals. As interest and experience in captive animal well-being grows, it is essential to acknowledge when certain environments fail to provide what a species needs to thrive. Moving forward, science-based policies should be considered to determine which species should no longer be housed or bred in zoos, aquariums, and entertainment parks.

Commented [redacted] Perhaps one would assess the potential welfare outcomes before animals are irrevocably moved to these environments? Which I remind the authors the two belugas in Iceland were moved to and had to move back into the pool. Hence why you should properly read and discuss Bruck, 2024 and Almunia and Canchal, 2025 in this section to give a fair minded discussion of the GFAS Standards and how they relate to the animals, in theory, that should be experiencing them right now.

Commented [redacted] Even the study you mentioned on animal tracking showed little evidence for steryotypies. Where is your evidence that this is a pervasive problem that requires all cetaceans to be put in GFAS sanctuaries? From Rachinas-Lopes 2019 "The subjects showed specific movement routines that involved circular swimming over the Deep Area of the pool and used most of their habitat, performing rings with different durations and sizes. These rings presented differences between individuals and were variable across sessions, indicating that these patterns of movement are not highly stereotyped. In any case, having a baseline of the normal movements of captive dolphins facilitates the detection of bizarre behaviours that m ... [15]

Commented [redacted] Again. This is the naturism fallacy. Where in the cetacean welfare study did it show that cetaceans in ocean environments had better welfare than those in pools? Will the animals stop stress swimming at any point to engage in these behaviors? Little White and Little Grey didn't and that's why they are back in their stag ... [16]

Commented [redacted] This is the naturism fallacy. Why is a time budget closer to nature better for welfare? To me it seems your best case scenario is that these whales go somewhat back to wild. How would you be able to do medical care with them when their medical training collapses? The frustration is that it doesn't take muc ... [17]

Commented [redacted] Increased autonomy can lead to decreased training, decreased medical care, decreased welfare. Micheal Moore speaks eloquently about the welfare of wild animals. He does not paint the rosy picture the authors do here. Any fair-minded discussion of the state of welfare in captive cetaceans should honestly cons ... [18]

Commented [redacted] That assumes, probably erroneously, that the animals have heightened stress in human care- which was a surprise, I'm sure, for Proie and the folks from this paper who helped them. The more pressing problem is assuming that there won't be a stress response to the noise, activity and sheer space afforded by a GFAS sanctuar ... [19]

Commented [A150]: incredibilly biased language.

Commented [redacted] I'm not seeing data that shows this. In the studies cited I see opinions, but I don't see data. The CWS, for whatever criticisms you have of it, has data and it does not show this. I would recommend softening this language to use words like "may" or "might".

Commented [A152]: That is not a consensus opinion and has not been demonstrated from the selective use of primary materials present in this paper.

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Commented [A153]: This is an opinion article with a retired Space Dynamics Laboratory member as the lead author

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Comments:

As a review paper, despite its heavy revisions, it still fails at its two ultimate goals of A) convincing the reader that, as a population, animals under managed care are experiencing uniformly poorer welfare than their wild counterparts, B) that the welfare of cetaceans in zoos and aquariums would be uniformly improved by movement into GFAS accredited sanctuaries. I fear no amount of revision can make this article successful in these endeavors. As an exercise, the authors should consider attempting to make the argument that cetaceans experience, poorer welfare in zoos and aquariums without widespread self-citation, misrepresentation of other authors, or omission from other authors. Taking Marino et al.,'s referencing of my own paper as an example, Marino et al., misleadingly implies that Bruck, 2024 believes the challenges associated with feeding, veterinary care and funding are shared equally by GFAS sanctuaries and Alliance accredited marine mammal facilitates. The entire thrust of that paper highlights why those issues are exacerbated by the prescriptions of GFAS accreditation. There are issues like this throughout that render the paper unfit for publication under any pretense that these are neutral observers just calling balls and strikes. If this were a an opinion commentary or philosophy paper in another journal I would be less inclined to protest; however, these authors are attempting to pass this off as a neutral and even handed evaluation of the current state of captivity for cetaceans and after reading both its original version and now this revised one I can't help but get the impression that none of these authors have set foot or much less worked with a modern accredited zoo or aquarium or their animals. Furthermore, there is a serious lack of data supporting the position that the population of animals in zoos and aquariums are in dire need of intervention and that that intervention should be sea pen sanctuaries. The authors expressed some disagreements with the cetacean welfare study's methodology but offer no competing data of their own that improves on those perceived limitations (which I explain below do not actually undercut the main theses of those papers). Surely if the animals are experiencing uniformly, poor welfare there should be a convincing case in the literature. These animals represent significant investments for the facilities that house them. One should expect at least some literature examining those issues. Rather, these authors have built a house of publications criticizing the welfare of animals in zoos and aquariums, without a foundation of data to support their conclusions. This has led to a perpetual ring of self-citations with the goal of achieving a false consensus to their conclusions. Meanwhile sleight of hand is used to both emphasize the scientific immeasurability of "quality of life" only to imply that the animals in zoos either have a poor quality of life or would have their quality of life improved by living in a GFAS sanctuary. Meanwhile no data are present to support those

conclusions because quality of life is subjective and even if you could base it on good welfare data, the authors do not present any of it to at least imply that GFAS sanctuaries would lead to at least something most cetacean welfare experts might subjectively assess to be a "quality of life" improvement. In this case the authors should identify any data they can manage from the Beluga Sea Life Sanctuary that might explain why, after 5+ years of living in a pool instead of their sea pen, Little Grey and Little White would still benefit from living in that sea pen sanctuary, despite multiple attempts to put them out there and multiple trips back to the pool. Perhaps there is a C-Well assessment that shows, despite all appearances, the belugas did have better welfare in the sea pen than the pool, and that would be a great thing to have in a paper ostensibly about the current state of captive cetacean welfare. Do the authors know how well the animals were stationing in the sanctuary? Or if they showed any signs of stress in the sanctuary like ulcers for example? Those would be good things to discuss with readers, if this paper is about the current state of captivity and why it is bad and these animals need to be in sanctuaries. While I cast no aspersions on the authors, such data would also go a long way toward showing that the lead author who happens to be president of the Whale Sanctuary Project (and, to my knowledge, still draws salary from that) is fully aware of the issues she may confront when housing her own animals in the way she elected to when writing the GFAS standards.

As far as my review, again I have chosen to directly edit the manuscript and put comments upon it as they are extensive. New comments have my name on them (old comments that weren't addressed satisfactorily or are needed for context remain with the name 'author' on them). Some of the author responses to my comments are replied to here, however, for the sake of time, I have chosen to respond to only those comments that I think the authors struggled most with or would lead to some improvement.

That being said, I must again offer that this is not the format or journal for this work. The authors do not have sufficient data, nor do they reference studies with sufficient data to make the points they are making convincingly. Much of this is opinion, and not fact. If this were to be published, I would recommend focusing not on speculation, but what is not known about cetacean welfare in zoos and how we could get at those questions honestly. To do this and to provide more captive cetacean experience to the paper, the authors should seriously consider adding an additional author or two who does not share blanket anti-captivity views to help balance out the paper. I would recommend finding a current zoo professional (someone like Lance Miller or Jessica Whitham) who works with animals/welfare and a welfare specialist (like Fabienne Delfour or Kathleen Dudzinski) to round out the author list and provide deeply needed perspective.

Reviewer 2

Basic reporting

BASIC REPORTING:
Note: Given the volume of necessary edits, I have made an editable version of this manuscript and placed comments within. Comments for how to improve a potential revision are included in that attachment.

Is the review of broad and cross-disciplinary interest and within the scope of the journal?
It seems the topic of cetacean captivity is within the scope of the journal.

I do not know exactly how broad the cross-disciplinary interest will be given cetacean captivity issues are fairly niche in scientific community. Online and in social media articles like this are used frequently to advocate for anti-captivity positions so it may have legs there.

Has the field been reviewed recently? If so, is there a good reason for this review (different point of view, accessible to a different audience, etc.)?

I think the best review of cetacean captivity (with data) is The Cetacean Welfare Study led by Lance Miller. This is a nine-paper series using the latest technology and tools to assess captive cetacean welfare across almost every accredited facility in the US and Europe. https://collections.plos.org/collection/cetacean-welfare/ This review barely mentions this comprehensive series of studies and seems more focused on presenting a narrative favorable to cetacean sanctuary projects. That would be fine if this took an even and comprehensive position relative to the literature. Unfortunately, this manuscript fails to do that in a meaningful way (see Attachments for line-by-line examples of these shortcomings). As such this reads very much like previous articles from these authors (Marino et al 2020 and Jacobs et al 2021) that each have comprehensive rebuttals from many groups of authors. I don't honestly know what the purpose of this paper is in terms of the scientific literature.

> Although we did not originally use the term “Cetacean Welfare Study,” we did, in fact, cite four of the nine articles. In accordance with the reviewer’s comments, we have now mentioned the study and all of the articles in the introduction and incorporated more of the articles throughout the paper.
>
> The articles may have been cited, but the information in the articles was not appropriately incorporated. For example, in the advocacy for sea pen sanctuaries no reference was made to how space and net pen vs. pool housing are the weakest predictors of welfare across that study.

Does the Introduction adequately introduce the subject and make it clear who the audience is/what the motivation is?

The Introduction does not adequately introduce the subject as the authors present a fairly biased interpretation of current captive situations (see Additional Documents for specific examples). Frankly, given the seminal nature of The Cetacean Welfare Study on this topic if the authors aren't going to frame this paper as either a rebuttal or comprehensive assessment of those conclusions then I don't know how this can either provide a reasoned different view of the state

of information for captive cetaceans or even inform a different audience about the current state of information in captive cetaceans. I don't know what the motivation for this paper is considering the author's stated goals relative to their execution of said goals though their limited evaluation of the scientific data on cetacean welfare (specifically studies that show positive welfare gains- see attachments).

We appreciate that this reviewer holds the opinion that the Cetacean Welfare Study was definitive and all-encompassing. We do not share this view. However, we do acknowledge that these were important studies that are good examples of systematic assessment of captive cetacean welfare and applaud their publication. However, our paper is intended to have a larger scope than these nine papers and, thus, we do not think it is appropriate to frame our entire paper as a direct response to the Cetacean Welfare Study. Nevertheless, as we said before, we have included and mentioned these studies throughout the paper when relevant.

The Cetacean Welfare Study (CWS) was a comprehensive data-based assessment of cetacean welfare in captive settings, but the reviewer did not hold that it was definitive and all encompassing. The reviewer only aimed to point out that aspects of that study were not mentioned in this review, especially where the findings contrasted with the authors' stated opinions on cetacean captivity. This is a review paper called "An Update on Cetacean Captive Welfare" written by a series of authors who seem not to have current direct experience working with captive cetaceans. If the authors have contrasting data, they wish to present to refute the Cetacean Welfare Study, they should present that. If the authors have methodological concerns with the CWS they should discuss those. While the authors now highlight that the CWS did not address unaccredited facilities or rough-toothed dolphins (for example), that is not a reason to omit a fulsome discussion of the welfare study. Simply, one cannot write a paper called "An Update on Cetacean Captive Welfare" and not fulsomely discuss the largest captive cetacean welfare study in history published only a few years ago. Especially where that series of studies contrasts with the author's opinions.

In our Introduction, we added:

> Recently, a series of nine articles known as the Cetacean Welfare Study examined captive cetacean welfare measurements across 43 accredited zoos and aquariums in seven countries (Lauderdale et al., 2021a-e; Miller et al., 2021a-d). It was designed to identify factors related to the welfare of bottlenose dolphins (*Tursiops truncatus*), Indo-Pacific bottlenose dolphins (*Tursiops aduncus*), beluga whales (*Delphinapterus leucas*), and Pacific white-sided dolphins (*Lagenorhynchus obliquidens*). This project did not examine unaccredited facilities or those housing other cetaceans. Identified factors included habitat characteristics and management practices (Lauderdale et al. 2021c,d; Miller et al., 2021b), environmental enrichment (Lauderdale et al., 2021e), health reference intervals (Lauderdale et al. 2021a), biomedical markers (Lauderdale 2021a; Miller et al., 2021d) social behavior (Miller et al., 2021b), and behavioral diversity (Miller et

al., 2021a). The findings of these studies are integrated in the present review where relevant. These studies focused on which welfare factors of captive dolphins were determined to be most important, and which ones could be implemented in the future.

That being said, there are considerable methodological issues with this study. In Lauderdale et al. (2021e), for example, they say “a different individual was substituted for the second data collection”--this methodology assumes all dolphins in any given environment are interchangeable on all the selected variables. We don't know if that is true. It would not be if this study were about humans. This is a source of additional error variance. We understand why this was done, but ideally those facilities would have been excluded from the study.

Second, while the dolphins are measured, the humans who administer dolphin care, training, and enrichment are not. It seems reasonable to suspect that different humans and human teams are variable in their administration of care, training, and enrichment. Some measures of human skill, and motivation, would best be included since these would be expected to have an impact on dolphin characteristics.

Third, the paper states: "Enrichment program index. Respondents rated the frequency with which they engaged in several evaluative aspects of their enrichment programs. These included how often a team set enrichment goals, how frequently a team recorded when enrichment was provided, how often enrichment was evaluated, and how often the team adjusted the enrichment. Creating goals and setting goals were highly correlated so the creating goals question was dropped from the analysis. A principle [sic] components analysis using polychoric correlations was used to reduce the four variables into a single component that explained 56.84% of the variance." First, it’s “principal” not “principle.” Second, these attributes are not completely operationalized in text. Over what periods of time? Are all the durations of surveyed attributes the same? If not, this confounds any analysis. Third, the use of PCA with only 56.84% of the variance captured literally means that 43.16% of the variability is missed, either showing up in the error term(s) or just being ignored. Some measure of interrater reliability could be used as a stand-in for variance in measurement at those facilities with more than one staffer. An average of some such measure would buttress the implicit assumption that all raters are identically accurate.

Thus, although the Cetacean Welfare Study represents an impressive undertaking, some fundamental questions such as rater reliability and motivations for positive care of dolphins are not addressed. An alternate and more revealing study design would have preliminary analyses that address these issues. Then utilize a variable reduction if necessary for further analysis. In the Cetacean Welfare Study, there are concerns over the

variable reduction method, but we appreciate that the goal is to support other analyses. We do not feel that the current manuscript is the place to discuss such issues.

These are not “considerable” methodological issues. None of what the authors present here justifies the exclusion of these studies. Perhaps the authors would like to explain exactly how these issues affect the interpretation of the data with regard to specifically what factors of socialization and housing are not represented correctly in the CWS? Your points about PCA do not consider the massive size and scope of the undertaking. Of course there will be variability on some of those dimensions, however, the question that needs to be asked is whether that affects the conclusions. On the variables of space, ocean vs. pool, socialization, training the size of the study washes away those interobserver effects.

Experimental design

Is the Survey Methodology consistent with a comprehensive, unbiased coverage of the subject? If not, what is missing?

No. For example. The Survey Methodology describes an arbitrary process where the authors state that papers published before 2000 would not be considered unless they were foundational papers. However, I would argue that not only are many of the pre-2000 papers not foundational, but they all seem to lean toward an anticaptivity bent. I can see Mason, 1991 but most of the others seem not to be foundational papers. The reliance on biased non-peer reviewed sources like Vail (which is not accessible) or Long 2018 https://us.whales.org/2018/08/23/how-long-do-bottlenose-dolphins-survive-in-captivity/) is problematic because while these poorer blog sources support anti-zoo narratives they are used in place of quality peer reviewed work that shows zoos more positively. sources. Like this for lifespan data https://royalsocietypublishing.org/doi/10.1098/rspb.2023.1895.

We have removed the word “foundational” and now state: “Given that the field of cetacean welfare advances rapidly, we focused on articles published since 2000 with only a few exceptions.” Note that reviewer #1 requested some earlier articles to set historical markers (see above). See also response to A36, A51. We have removed the Vail citations and the Long (2018) citation. And we have already mentioned that we’ve included a very small number of non peer-reviewed papers, including at least one recommended by this reviewer.

Proie is only recommended because no peer-reviewed study has yet looked at comparative physiological markers of stress as she did it, and she specifically thanked one of the authors of this paper indicating that it is likely you all are aware of it. That being said I too wish those data were published, but I would not compare that effort to the Long or Vail references. Frankly, there is a big difference between the author's intended citations and the citation of a MSc

However, we thank the reviewer for calling our attention to Tidiere et al (2023) and we have incorporated their results in our paper, along with others suggested by all four reviewers.

There have also been several articles that have been published since the original manuscript was written–those have now been incorporated.

Note in this regard, the reviewer asked us in A78 to include a non-peer-reviewed master's thesis (Proei, 2013), which we have done.

Are sources adequately cited? Quoted or paraphrased as appropriate?

No. Please see the attachments. Many examples of misrepresented research. This work is not in keeping with the standards of PeerJ.

We have addressed these issues in responding to all of the reviewers' comments.

Is the review organized logically into coherent paragraphs/subsections?

There is a great deal of repetition where concepts like stereotypical behaviors are brought up throughout with little organization.

Stereotypies are introduced and defined in the introduction, mentioned as a key word in methodologies. Apart from section 4.1.a on stereotypies, they are again mentioned (1) with regard to dental issues, which seem appropriate because oral stereotypies result in dental problems, and (2) with regards to enrichment, as stereotypies are a welfare issue that enrichment is supposed to alleviate. As such, this does not seem repetitive or disorganized to us. Note also that Reviewer #1 stated: "... the way the author structured the review is good." Moreover, Reviewer #3 notes: "This review is incredibly well written and conceived."

I appreciate the perspectives of Reviewers 1 and 3 and I'm glad they had a better time with the paper than I did, however, I disagree.

Validity of the findings

Is there a well developed and supported argument that meets the goals set out in the Introduction?

Not with this level of bias, no. This is not an assessment of the current state of cetacean captivity (that would be The Cetacean Welfare Study). This is a remix of Marino et al, 2020 and Jacobs, et al,. 2021 and it lacks a fulsome review of the literature, both in terms of challenges for zoos as well as the challenges zoos have overcome.

As we have explained elsewhere, this paper goes beyond Marino et al. (2020) and Jacobs et al. (2021). We incorporated 191 substantiated sources of information in the initially submitted review– and have incorporated ~90 new articles in the revision to address the

concerns of the four reviewers–most of these, as was the case in the original manuscript, point out problems that exist for captive cetaceans. We thus believe we have provided a comprehensive overview regarding the well-being of cetaceans. We believe the bulk of the literature does indeed suggest that there continue to be significant issues with regard to housing cetaceans in captivity, particularly for larger cetaceans such as orcas. We note that the Cetacean Welfare Study provides an assessment of certain welfare factors, but it does so only for dolphins and only in accredited facilities. Moreover, it does not really address the overall **well-being** of captive cetaceans. As we note in our conclusion now, the nine papers in question only use the word "well-being" one time, and then only in a direct quote.

In terms of bias, we realize there are arguments both for and against housing cetaceans in captivity (as partially outlined, for example, in Corkeron, Marine Mammal Captivity, an Evolving Issue, 2022). There is also a wealth of research on welfare measures in cetaceans, and some evidence of positive benefits (e.g., longer lifespans of dolphins in captivity). However, the accusation of bias would suggest we have ignored literature demonstrating that cetaceans are thriving in captivity. If we have missed papers that, in fact, demonstrate that cetaceans are **thriving** in captivity (not just that there are welfare measures that have been explored, or perceived incremental improvements), we would certainly be open to including those.

Does the Conclusion identify unresolved questions / gaps / future directions?

The conclusions and ideas for moving forward are also not well organized and seem muddled in focus. There should be specifically a section that considers paths moving forward, especially in the assessment of if sanctuaries would be effective for improving welfare. instead of discussing the challenges associated with a sanctuary, something the lead author should be familiar with, sanctuaries are offered as a panacea, unchallenged. It gives the appearance of self-interested bias, and is a missed opportunity to highlight the sober knowledge the WSP has gained since it began its efforts in 2016.

In contrast to this, we note that reviewer #1 says the following: "Additionally, I would like to point out that I personally appreciate that the authors end the paper with statements that highlight the direction for improving cetacean welfare, which questions the need for continuing to hold captive cetaceans, the consideration of moving towards the development of sanctuaries, and the need for building a list of species that are for sure should not be held captive anymore." We have expanded the conclusion to provide a broader perspective regarding sanctuaries, including possible welfare issues that will require continued monitoring. We have stated from the beginning that sanctuaries are indeed a form of captivity. We never claimed they were a panacea. This is now spelled out more clearly in the conclusion.

Regarding bias and the Whale Sanctuary Project, we fail to see how this is a bias or a conflict of interest insofar as the ultimate goal of any sanctuary is to become unnecessary (because there are no longer any animals requiring sanctuary). Sanctuaries are non-profit; as such none of the authors of this manuscript benefit if the paper is published. We would like to point out that conflict of interest is also a two-way street. If an author or reviewer works with captive cetaceans, that should also be disclosed as anyone who works with captive cetaceans is, in fact, directly affected by decisions about captivity as their career depends on having captive cetaceans. Several of the articles suggested by this reviewer are written by individuals in such a situation. We ask that the editor keep this in mind when considering reviewer comments.

note The reviewer has attached an annotated manuscript to this review.

COMMENTS ON LINE EDITS IN ATTACHMENT

Section 1.

A1. This does not seem like a controversial statement. Moreover, we are simply opening the paper with a general framing statement here. This is an appropriate way in which to bring the reader into the issue, which is then treated more deeply later on in the paper.

The comment stands. The framing is controversial, however, not seemingly to the authors who rely mostly on self-citation to make said argument. Truth is there is not a strong body of evidence outside of the non-data/review papers of a select few authors (mostly the authors of this paper) that claim that the current conditions/welfare of cetaceans in accredited zoos and aquariums is poor. The online and popular press dialogue on this issue does not match the actual science discourse of this topic.

A2 We thank the reviewer for his or her point and have added: The changes mentioned above all require there to be an alternative for the animals in these facilities that improve their welfare (see our discussion of sanctuaries).

A3. We have changed “confined to” to “housed in”.

A4. We have added other accredited agencies in this section, and have rewritten the section.

A5. We have removed the Jacobs citation here. Note, however, there is only one rebuttal that we know of, not multiple in the literature, and the one is questionable at best (see Section 5 comments). The rebuttal simply states that dolphin captive environments are not impoverished, but says nothing about captive environments for larger cetacea. Moreover, the rebuttal does not question the basic tenet of

Jacobs et al. (2021), namely that impoverished environments are neurobiologically harmful, which has been established with decades of experimental work on a wide range of species.

A6 We have incorporated the general findings of the Cetacean Welfare Study in this introductory section, and explore it further in the appropriate subsections of the paper.

A7. We have now cited the Lauderdale et al. (2021) paper.

A8. We don't think the recommended paper fits here; but we have cited it elsewhere. See our comment on A75-78.

Section 2.

A9. We have rephrased this to be clearer. Note, we have removed the word "foundational" and now state: "Given that the field of cetacean welfare advances rapidly we focused on articles published since 2000 with only a few exceptions." See response to A36, A51.

A10. We believe the revised paper is more comprehensive than the original paper with the inclusion of additional articles, as suggested by the reviewers.

Section 3.

A11. We have provided citations for the term captivity, and, later on in the paper, we have noted that authentic sanctuaries are a form of captivity and provided a definition.

A12. We appreciate that the Cetacean Welfare Study argues that amount of space is not as important as other factors for bottlenose dolphins and smaller cetaceans, but it would be problematic to use the conclusions of one study on a limited range of species (within a limited range of enclosure spaces and no consideration of a possible floor effect in data interpretation) to omit an important factor that continues to be a focus of discussion about the welfare of larger animals who swim long distances and dive deep, such as orcas. The Cetacean Welfare Study did not include orcas, nor did it consider non-accredited facilities. Therefore, it is limited in scope.

It is more problematic to use no data and speculation to argue against data. What you call a floor effect is still a twofold difference in maximum depth across the study. None of the criticisms here preclude a discussion of the contrasting findings of that study. You are bringing "no data" to a "data" fight. I don't know how you can adequately discuss the current state of captive welfare without citing these nine papers more fulsomely,

including when they contrast with your beliefs or assumptions. While you may want to compare greater depths and think the CWS would be improved by such data, right now your discounting of their findings is speculative. You need data to confront data.

A13. We have significantly revised this section of the paper to incorporate more findings from the Cetacean Welfare Study

A14. We have removed this statement.

A15. We have expanded Section 3.1a considerably, as requested by Reviewer#4 to provide more context, including the sizes of actual enclosures (vis-a-vis the size of natural habitats).

A16-18. As noted above, we have significantly expanded this section and include research from the Cetacean Welfare Study.

A19. We have removed this section, as it was confusing and not critical to our analysis.

A20. Although there is some variation in tank size across facilities, the point is that they are all very similar in one respect - that they are not very complex or interesting environments nor do they change much. So we contend that our statement still stands.

OK. but what are the welfare consequences of a stable vs. unstable environment? As you know predictability tends to lead to better welfare outcomes in managed populations. It should be your goal to have a paper that makes its points whether people believe you or not. Too often you are asking me to just believe you about what is good welfare with no data to support it.

A21. The reviewer asks an interesting question about whether naturalistic objects in the tanks are beneficial. Certainly, it is the case that, in zoos and aquariums, these features can be more important for visitors than the animals on display. However, Miller et al. (2021) found that the total number of habitats available to captive dolphins is positively related to behavioral diversity (an indicator of positive welfare). Although "number of habitats" is not the same as "tank features" per se, this finding suggests that access to a wider range of physical environments (and features) are important for dolphin welfare. Moreover, dolphins in natural settings (e.g., lagoons) tend to have less stress than those in tanks (Ugaz, 2013).

Given some facilities have recently added rockwork to their pools I asked a relevant party what the thought behind that was, they said it is for the guests, not for the dolphins. So these transitive leaps are a bit too speculative given there are actual assessments out there on these features. While the dolphins do not care much about the rockwork, facilities have started adding things like sand pits in the bottom of their enclosures for the dolphins to root around in and find stuff. Brookfield Zoo has just done this for example. The dolphins do respond very well to that. I would consider asking Lance Miller about it and cite the personal communication, better yet maybe entice some folks who work with these animals to co-author with you so you can be brought up to date on modern welfare practices.

A22. We have removed this statement about excessive chlorination.

A23. We have expanded this section to address acoustical issues in more depth, and have cited Stevens et al. (2021) along with several additional sources.

Please reread Stevens et al., to more accurately cite what that paper is saying.

A24. We are encouraged by the reviewer's statements about zoos moving towards using playback and other methods to assess social preferences in captive cetaceans. However, we would ask how those preferences, once ascertained, would be honored given that there is a very limited amount of space in marine parks. We are not implying that a captive managed dolphin does not have social preferences within the constraints of the opportunities available. We are saying that the breadth of opportunity for social preference and association is highly restricted, which we can expect to have an undeniable negative welfare impact in a species with a highly dynamic social life.

In bottlenose, the animals are moved to their preferred social partner (we are working to identify the signature signals in belugas so once could perform the same assessment with them). I'm not sure why you think this is as restrictive as it is. Bottlenose are moved quite frequently with an eye toward social partner preference. I would not have been able to do the memory study if they weren't. And on that topic, they aren't moving young animals anymore as implied in your paper. The standard is toward keeping calves with mom until she rejects them. For females that likely means they stay with mom, while males are identified based on compatible male pair bonds. In all of my playbacks the strongest responses were for MPB, dolphins rarely show strong responses to mothers or calves. Laela may have published data on this in the wild and we will have a paper out on this soon.

A25. The reviewer is correct in pointing out that the Cetacean Welfare Study found that space may not be the most important welfare factor for dolphins and belugas (although there is a potential floor effect as a confound). However, the statement by Brando & Buchanan-Smith mentions other factors, such as complexity, choice, and appropriate social groupings, which are still issues. These remain important factors and are not completely unrelated to space.

A26. The reviewer takes issue with the claim that "pre-weaned animals" are separated from their mothers. But we never said this. We actually say: "After the minimum weaning age, captive cetacean mothers and offspring living in marine parks may be separated." We do not claim that mothers and calves are routinely separated but only that it does happen.

See above. I will caveat that I am talking about the standards for accredited facilities. If you have examples of bad actors elsewhere feel free to name and shame as appropriate.

A27. We thank the reviewer for the information on social groups and have replaced the original statement with: Because captive cetacean groups do not resemble social groups in the wild there may be longstanding repercussions for the psychosocial well-being of calves.

That's an open question isn't it? Does the amount of movement between facilities in the Atlantic Bottlenose Dolphin Breeding Consortium, for example, sufficiently simulate fission fusion dynamics? That could be a great area for future study.

A28. We have added more information about Clegg et al (2023).

A29. The reviewer's point is well-taken and we have removed this statement from our paper.

A30. We added Jaakkola (2024) in Section 5, which we expanded to say more about cognitive enrichment. We have also added: Remarking on the lack of complexity in captive environments Jaakkola (2024, p.2) stated: "in contrast to the situation in the wild, these animals live in highly predictable and structured environments."

See comments above.

A31. We have replaced (Couquiaud, 2005) with a more recent paper on captive cetacean diets. We have replaced the word "narrow" with "narrower". We have also added: Rosen and Worthy (2018, p. 719) note, "both a lack of diet diversity and the reliance on frozen foods present potential nutritional challenges."

But the facilities have mitigations for these issues which you should highlight. As an example, for frozen fish and water loss, hydration is applied.

We do not necessarily claim that a narrower diet is detrimental from the cognitive viewpoint as we focus more on the delivery method. We refer to the manner of food delivery as potentially problematic in the statement: "they are delivered to them in a manner (i.e., thrown directly into their mouths above water) that requires little to none of the cognitive activity relevant in natural hunting and feeding." And, in accordance with the reviewer's request, we have added that: "the lack of stimulation from the way food is delivered must be countered by the implementation of other methods of cognitive enrichment."

Better yet you could also discuss the use of food puzzles where managed animals must work though enrichment devices to access food. I'm pretty sure these are highlighted in Isabella Clegg's enrichment catalogue.

A32. We thank the reviewer for his/her remarks and added: It should be noted that dolphins kept in lagoons will sometimes chase wild fish but they rarely catch them, presumably due to their lack of hunting skills.

Even in the wild dolphins rarely catch fish one on one. This is much of the basis of dolphin sociality. Fish are very well tuned to avoid being eaten and can turn on a dime. Dolphins are like a semi-truck with almost none of the turning radius of a high bodied fish. Hence you see cooperation around the formation of bait balls, strand feeding, lob feeding, etc. It has little to do with captivity except that motivation is much reduced when one is provisioned and schooling fish in sufficient quantities for a bait ball likely do not exist in lagoons. Although I would agree that advanced hunting tactics are not part of the repertoire of behaviors passed from mom to calf in managed facilities. There should be plenty of papers to cite on hunting strategies.

A33. We also thank the reviewer for mentioning the many highly specific ways in which free-living cetaceans engage in feeding.

A34. We have included three references regarding time budgets: Neumann, 2001; Stockin et al., 2009; Noren & Hauser, 2016.

See comment on paper itself. I was referring to a citation demonstrating that, for example, provisioning does not satisfy biological drives, etc. I can see a scenario where dolphins master the art of getting people to give them fish and they find that cognitively enriching (both in the wild and in zoos). Watch the diversity of attention seeking behaviors from dolphins before a feed session. These are engaged animals. A question worthy of study, but it is important not to make assumptions here.

A35. We have incorporated three of the suggested papers from the reviewer in this section. Ramirez (1999) is a dated reference and, while training undoubtedly increases compliance of the animals and facilitates the captive management of wildlife, this is an alternate purpose to enhancing welfare. Enhanced compliance cannot be assumed to automatically correlate with enhanced welfare. Thus, we do not feel that this reference fits within the scope of the paper.

I think anyone who has a pet whom they train can easily understand what benefits training and engagement have on welfare. Training by itself does not lead to compliance, and Ken has never said that it did. Training is about the formation of a relationship between the trained and the trainer. I encourage you to study this more closely, in person, because you are missing a lot here. The only thing that can guarantee "compliance" is the nature of the relationship that trainer has with that animal. In your parlance enhanced compliance is indicative of a positive relationship which is indicative of good welfare (in a positive reinforcement model of training).

A36. We have previously addressed this issue in our responses.

Section 4.

A37. We thank the reviewer for pointing out that cortisol is not always a bad thing. It becomes harmful when it becomes dysregulated during chronic stress. We have added this point to our paper.

A38. We added: Much more research is needed in this area as the study conducted by Matsushiro et al. (2021) involved only five dolphins and revealed the possibility of - but not the definitive presence of - chronic stress with SWD programs during seasons when the number of visitors to the park was high.

A39. We added: "...with a small sample size of three dolphins…" and "However, they found no overall decrease in welfare due to SWD activities."

A40. The reviewer points out that Samuels and Spradlin (1995) is an old paper. In order to comply with the reviewer's views we have omitted that paper. However, the reviewer goes on to say that there are virtually no uncontrolled swim programs at accredited facilities. That may be true but in this paper we are considering both accredited and unaccredited facilities.

That wasn't my view. That was you selectively enforcing your own criteria for the benefit of your anti-zoo position. I think the age of the publication is less important as a specific number or date than having a handle on the way the topic is evolving over the years. For example, I think 2006 is too old a citation for talking about captive lifespans because that has so materially evolved over the last twenty years, whereas mirrored affiliative behavior in zoos and the wild is less likely to have such profound shifts (or at least indicate worse welfare in 2025 than in 1995). As for your distinction on accredited and unaccredited facilities make that distinction in the paper. Stop painting with this overtly broad brush. Not all facilitates are the same, but too often in this paper you seem to want to make the worst of them the example for all of them. That doesn't paint an honest assessment of current practices.

A41. The reviewer suggests: "I wouldn't focus on unstructured SWD as it isn't practiced commonly in accredited facilities." That is the case, but we did not exclude unaccredited facilities in our review, therefore the same cannot be said of them.

See above.

A42. We thank the reviewer for this suggestion and have added: More research on important physiological and behavioral factors, i.e., oxytocin levels, more precise cortisol levels, etc. may elucidate the nature of the dolphin-trainer relationship and how it impacts dolphin welfare.

A43. We are familiar with Dr. Bossart's work since one of us has worked alongside him in the field on health assessments of the IRL dolphins. Dr. Bossart's research referenced by the reviewer includes studies in which captive dolphins with no sign of recent illness (healthy individuals) are compared to wild populations, especially those in the Indian River Lagoon in Florida, whose population health is compromised, primarily by heavy pollution and human interaction. We have never claimed that there are no healthy individuals in captivity who can reliably be used as controls for sick individuals in the wild, as the reviewer seems to be suggesting. The increased rate and/or differential etiology of disease in captive populations, as our research suggests, does not preclude the existence of a good number of healthy individuals at any given period of time. We have included the work of Bossart et al. (2003, 2017) and of Fair et al. (2017) into the paper.

A44. Marino et al (2020) is a peer-reviewed scientific paper which has not been substantively critiqued. The reviewer is referring to two biased opinion pieces. The problems with these critiques are extensive. To cite just one example, ~~Dudsinski~~Dudzinski et al. (2020) tri~~edy~~ to dismiss Marino's et al's argument that

orcas under human care suffer from chronic stress by saying Marino et al., misrepresented the conclusions of Atkinson et al. (2015), who found physiological mediator differences between terrestrial mammals and marine mammals. And yet, they failed to see that Atkinson et al. (2015) states the following; "Overall, the neuroendocrine system in marine mammals appears to respond largely in a manner similar to that of terrestrial mammals" (p. 469); "In response to a challenge or stimulation with ACTH, marine mammals appear to respond similarly to terrestrial mammals…" (p. 469); "...diurnal variations of GCs exist in marine mammals, similar to that observed in terrestrial mammals" (p. 470); "...the expression of glucocorticoids, particularly cortisol, appears to be a maintained characteristic of the stress response across marine and terrestrial mammals" (p. 476); and, in the conclusion: "Physiological indices of stress commonly measured in terrestrial mammals, such as GC or ACTH, have been measured in many marine mammal species and in general indicate that the HPA axis functions similarly to terrestrial mammals" (p. 477). In other words, despite some variations in marine mammals when compared to terrestrial mammals, the stress mechanisms are remarkably similar. The other article, Jaakkola et al. (2020), makes the same mistake, and is written by individuals with a conflict of interest insofar as they work with captive dolphins and thus have an inherent interest in maintaining the status quo when it comes to cetacean captivity (despite them claiming no conflict of interest). In this, and in other ways, the critiques offered by the opinion papers cited by this reviewer are problematic. The current manuscript does not seem to be the place to debate these issues.

Commented [redacted] Which you should have discussed in your 2020 paper fulsomely. With implications for what these differences mean both for absolute cortisol measurements and the effects of elevated blood cortisol on bodies that can mitigate that effect at the tissue level. You did not adequately discuss these crucial differences and a lot of authors pointed that out.

Commented [redacted] LIKE?

Commented [redacted] Perhaps their work with captive dolphins have given them a perspective you would benefit from. Unless you are impugning their integrity. I know you are sensitive to the idea that you are doing this because of your salary from the WSP. Do you think that people who disagree with you only do so for money while when you disagree with other's it is principled? That would be a problematic viewpoint.

It's not a conflict of interest when people disagree with you. You can be wrong, and in this case, you can be wrong because of bias and misrepresentation. Because we are literally confronting the same issues now, I only have to point to how you have misrepresented my work here to highlight that this is a pattern. What I am referring to two are also peer-reviewed papers (not opinion pieces- another misrepresentation) some of whom had authors with anti-captivity views who were so offended by the misrepresentation and bias that they chose to respond in the literature to maintain the integrity of scientific discourse on this issue. This is the problem with using an activist approach of advocacy, but from the framing of a neutral scientist. Even in your response you are highlighting the problem that got two sets of authors to both write peer-reviewed papers responding to that paper. Using your example, you selectively cited Atkinson where on top level things he argued that there were some similarities, but you glazed over the differences. Selective citing and interpretation of citations are not appropriate in scientific discourse. Period.

Just so we are all clear, while many of the basic systems of cetacean stress like the HPA axis for example are conserved, marine mammals tend to have higher basal cortisol levels and more variability than their terrestrial counterparts. Furthermore, marine mammals generally are thought to modulate their sensitivity to glucocorticoids at the tissue level to avoid chronic damage from persistently elevated levels. These would have been important differences I would have recommended you add had I peer reviewed that paper, and it highlights the importance of a good peer review process so we can eliminate this ugliness.

A45. This paper is discussed in Section 5 with regards to cognitive enrichment.

A46. Again, the mentioned rebuttal has significant flaws, including a severe conflict of interest. Moreover, the article does not dispute that stereotypies represent neural issues, which is the claim of this sentence.

I'm sorry. you can be criticized and be magnanimous about it. That's how science is supposed to work. Marino, 2020 should read (Marino 2020, c.f. Jaakkola et. al., 2021; Dudzinski et al, 2021) and Jacobs et al., 2021 should read (Jacobs et al., 2021, c.f. Jaakkola, 2023). Two reasons: 1) if you think these critiques are unfair you have had plenty of time to respond in peer review. 2) Your job in this paper is to present a state of the art in cetacean captivity, denying the acknowledgement of these papers denies your readers the chance to make up their minds for themselves. Which is exactly the problem.

Section 5.

A47. We are not sure what the issue is here: we say that stereotypies are found in other captive species, and then provide citations for that statement. We subsequently provide citations specific to cetaceans, and go into more detail on this issue.

A48. None of the Cetacean Welfare Study papers mention Gygax (1993); note that we did mention Miller et al. (2021) later in the paragraph, and their finding of an inverse relationship between behavioral diversity and route tracing.

A49. We have added the caveat that it is difficult to make definitive observations of free-living cetaceans.

A50. We have removed the current reference and replaced it with Ringelstein (2021).

A51. Again, we have removed the term foundational; we have kept Walsh et al. (1996) and have added Calle (2005).

A52. The central point of Mason et al. (2007) is to show that, to date, there are no ways to completely eliminate ARBs in captive wild animals. That is also the point we are making. It may be that, in the future, more successful methods will be devised and used.

A53. The reviewer makes a good point about the fact that there may be many more recorded attacks of cetaceans on humans in captivity than in the wild because of sampling. Nevertheless, we searched for reports of cetacean attacks on humans in the wild and found only the one dolphin case. While orcas, belugas, and other cetaceans do not come into contact with humans in the wild as much as in captivity, there is certainly some opportunity for interaction and one would think there would be more cases if the aggression issue occurred in the wild.

A54. We have replaced the word "petting" with "interaction".

A55. The reviewer provides two links in this comment. The first is Anderson et al. (2016), which is a peer-reviewed paper, and the one we cite in the manuscript. We have kept this citation. The second is the opinion piece (i.e., Anderson, 2016), which is not the one we cited. As such, we're not sure what the objection is about.

A56. We addressed this in A44.

A57. We have added references to the fact that infanticide does occur in the wild. We have already addressed the fact that there is high first-time infant mortality in the wild in our section on Reproduction.

A58. We have adjusted the language to address the reviewer's concern about phrasing of the statistics related to iron levels between captive managed and free-ranging populations.

A59. The reviewer's comment here is answered in the sentence following: "The causative organism is found on dead fish products, the main source of infection for captive cetaceans (Laacave et al., 2019). For this reason, Erysipelas is primarily a disease of captive cetaceans…"

A60. This comment does not require any edits.

A61. We see no need for edits here. If the reviewer had looked beyond the cited paper's abstract, they would have found the following content: " Dental wear is a consequence of a multifactorial process involving three synergistic components…and normally is related to age progression… More recently, Foote et al. (2025) observed distinct dental wear rates in different haplotypes of killer whales from the North Atlantic, suggesting that genetic and ecological divergence of populations may be reflected in dietary specializations and dental wear. The same idea was corroborated by Ford et al. (2011) relating the extreme wear of offshore killer whales with a diet based on sharks, prey that can be extremely abrasive on teeth… For most of the species analysed, although general prevalence of wear was high, wear was mostly superficial and affected enamel and outer dentine…superficial wear would have limited or negligible implications for the fitness of individuals, moderate and severe wear could have the potential to expose the pulp cavity and lead to tissue necrosis and increase the susceptibility to infections… **In general, the occurrence of dental wear is related to progression of age."** Although the paper finds that the frequency of dental wear in free-ranging cetaceans is high (something that we have never disputed) it specifically qualifies that wear as superficial and age-related for the vast majority of species other than those with specific life history characteristics that precipitate more aggressive patterns of dental wear.

A62. The link provided by the reviewer in this comment is not accessible in the pdf format we received. However, we believe the reviewer's concern is addressed in response to comment A61 above.

A63. The paper the reviewer is citing is not in contradiction to our statements. We have never stated that superficial and slowly progressive forms of wear are rare in orcas. However, we do specifically refer to "advanced" tooth damage as rare in

orca. We have added the term “traumatic” to the text to further characterize the type of tooth damage we are referring to in captive cetaceans. The two new forms of dental wear being described in the referenced paper are both superficial in nature, gradual in process, and do not precipitate dental injuries that can be characterized as “advanced” and “traumatic”. The point of this section is not to debate whether or not free-ranging cetaceans experience dental wear; of course they do. The purpose is to highlight the differential processes that lead to tooth wear and damage in captive vs. free ranging populations. As with other tissues in the body, the teeth have healing mechanisms designed to protect the sensitive pulp chamber from infection, a condition which can be life-threatening. However, these mechanisms (i.e. tertiary dentin formation) can only occur in situations where damage to the integrity of the tooth is gradual and subtle, such as with progressive age-related wear. By contrast, in captive situations, cetaceans are prone to sudden traumatic injuries, such as complex crown fractures. Such fractures by definition extend into the pulp chamber and often fail to heal, leaving the tooth vulnerable to infection without invasive pulpotomy procedures and routine, daily antiseptic flushing. Thus, these differences in the cause and nature of dental injuries are the reason why there is a greater health risk associated with dental disease in captive populations. Content and references have been added to clarify this point.

A64. Citation and elaboration has been added to address reviewer’s concern about a lack of recent literature supporting the presence of gastric ulceration in captive cetaceans. As with dental disease, the purpose of this section is not to suggest that this disease is not also a problem for free-ranging cetaceans, but simply to highlight that it exists as a common challenge for captive populations and that, in some cases, factors associated with the captive environment or husbandry have contributed to the development of the disease.

A65. The reviewer correctly points out that this is intended to be a review of literature related to the state of captive cetacean health and welfare. Nowhere in this paragraph does it state that free-ranging cetaceans fail to succumb to illness, nor do we feel this is relevant to the discussion. In fact, there are several places within the text of this paragraph that explicitly acknowledge that the diseases discussed do in fact also affect free-ranging cetaceans. Dr. Bossart’s research referenced by the reviewer includes studies in which captive dolphins with no sign of recent illness (healthy individuals) are compared to wild populations in the Indian River Lagoon in Florida whose population health is understood to be compromised, primarily by heavy pollution and human interactions. We have never claimed that there are no healthy individuals in captivity who can reliably be used as controlled for sick individuals in the wild, as the reviewer seems to be suggesting. We fail to see the relevance of this to our arguments and therefore have chosen not to contextualize it, as the reviewer has requested. Finally, publications detailing the cause of morbidity and mortality of captive cetaceans are limited due to the paucity of literature that emerges from the industry that holds these data (see Rally et al., 2018. Looking behind the Curtain: Achieving Disclosure of Medical

and Scientific Information for Cetaceans in Captivity through Voluntary Compliance and Federal Enforcement).

A66. We do not believe that a "comprehensive review of birth control" in captive cetaceans is relevant to this section, which is intended to discuss the reproductive health consequences of captive environments on cetaceans.

A67. We have deleted the word "uncomfortable".

A68. We have deleted this sentence altogether.

A69. In the interest of clarity, we deleted that statement.

A70. Same.

A71. Yes, before 2000–we address this above noting that we removed the term "foundational" in our methodology and that we did include some citations that were before 2000.

A72. Yes, but see our comments on this issue and in A73 below.

A73. Yes, before 2000–we address this above noting that we removed the term "foundational" in our methodology and that we did include some citations that were before 2000.

A74. In agreement with the reviewer, we explicitly state that much more research on different populations of belugas is necessary at this point.

A75 Of course, enrichment can take a variety of forms, and this should be clear from the revision of Section 5. Environmental Enrichment.

A76 - 77. This reviewer says that we should include a study by Jaakkola (2023), which claims that accredited captive environments for dolphins are not impoverished. We have now cited this publication, but we note briefly there are problems with its conclusions because of an oversimplified understanding of the environmental enrichment paradigm. Moreover, the paper does not discuss facilities that are not accredited, nor does it discuss facilities housing larger cetaceans. There are other issues with the study that we do not mention in the manuscript. Specifically, there appears to be bias and conflict of interest insofar as the author's career relies on captive dolphins (she is the director of the Dolphin Research Center) and this piece was published in a special issue of *Animals* that was sponsored by Dolphin Quest, SeaWorld, and Loro Parque—all facilities that support dolphin captivity. The same is true for another article recommended by this reviewer, namely Bruck (2024).

A78. We have added Proie (2013), although it should be noted this is not a peer-reviewed article but rather a master's thesis.

A79. Referring to Ugaz (2009), the reviewer states: But for a dolphin moving from a pool to a sea pen the experience may be very different. We agree that it may be or, perhaps not. We don't know at this point and the reviewer's statement is conjecture.

A80. This issue is discussed above with regards to space.

A81. The reviewer is implying that the fact that captive dolphins are known to require encouragement to leave lagoon-based captive facilities and enter the ocean may be an indication that larger spaces are not inherently enriching. It is well known that captive wild animals have enhanced fear-responses to changes in their daily routines or environments. Introduction to a new environment is inherently stressful for any animal. For this reason, it is not uncommon for captive animals to seek familiar spaces and display behavioral indications of stress when asked to enter an unfamiliar space and require encouragement to do so. However, offering an occasional opportunity to explore a vast and unknown environment is quite a different situation to providing a primary enclosure that is spatially enriching. In no way would we consider any studies involving the former scenario to be an accurate reflection of the "effectiveness of space in improving welfare."

A82. We have deleted this statement.

Section 6.

A83. We have significantly expanded this section, including information about sanctuaries. Although Browning (2020) makes some interesting points regarding natural behavior, we do not accept many of the arguments put forth, especially when it comes to ignoring the fundamental evolutionary history of a species. Captivity inherently constrains any animal, and our contention all along is that some species (including cetaceans) are more negatively affected by captivity than others. One goal of the AZA and other accrediting agencies is, in fact, to stimulate "natural behavior." Numerous studies over the years by Georgia Mason and others have shown that the effects of captivity are largely dependent upon how well the captive situation fits with the natural adaptive characteristics of a given species. Moreover, the reviewer has an inaccurate view of the "naturalistic fallacy". He or she implies that it has to do with the appropriateness of an environment for a given species. In fact, the fallacy has more to do with assuming a positive moral or ethical valence to nature. Our stance is about the evidence for how well cetacean evolved characteristics fit with the captive environment and not whether nature - in and of itself - is "good or bad."

The definition I am operating under is: The naturalistic fallacy is an informal logical fallacy which argues that if something is 'natural' it must be good (which is a very common definition- the authors are free to look it up). In this case sanctuaries would fall under that because the assumption is it is more natural than a concrete tank, therefore it is better. The mistake here is assuming that the animal, who maybe has never known nature, will somehow react positively to it because they evolved for it. The more likely scenario is that the animal, who is argued by these authors to be cognitively complex, will not see real nature as natural because it has no experience with it, and potentially react to nature as if it is unnatural (i.e. stress responses, etc.). One of many differences between

terrestrial sanctuaries and cetacean sanctuaries is the animal's perception of its world. An elephant can see over its zoo exhibit and know there is a world out there he/she might inhabit. For a dolphin in a pool who has never lived elsewhere (although it would be interesting to see how zoo to zoo movement over lifespan affects this) the only world it knows is the pool it's in. So if you put it in a 100-acre sanctuary I think you have to ask is that really fundamentally the same thing for the dolphin as it would be for the elephant released to a 100-acre preserve? Given how many fish it takes to get dolphins to swim out of their pools into connected outer ocean habitats I question that it is. I definitely do not think it can be assumed that it is (see Little White and Little Grey).

A84. We have included two references here that raise questions about sanctuaries (e.g., Bruck, 2024; Almunia & Canchal, 2025). It should be noted that both of these have severe conflicts of interest insofar as the authors of both articles work with captive cetaceans in traditional settings and thus are critical of sanctuaries, which offer more natural environments. We do not feel it is appropriate in the conclusion to have an in depth discussion on the issue of sanctuaries. Moreover, many of the objections in Bruck (2024) have already been addressed elsewhere (Marino et al., 2025). We also now note in this section that accreditation standards for cetacean sanctuaries have been adopted by the Global Federation of Animal Sanctuaries.

I'm critical of sanctuaries because they are an untested idea that has seen two belugas stress out in Iceland (over 5 years of repeated attempts to put them in that sea pen) and has seen no progress from the WSP side since inception in 2016 (with a similar timeline for Baltimore Aquarium). If you are going to present sanctuaries as the panica for the issues you have highlighted then you better have a discussion about their potential issues. The authors cannot just fundamentally ignore any papers that are critical of their views or opinions, especially when these authors come to the debate with so little data.

Bruck, 2024 went through a peer review process with a pro-sanctuary reviewer who made the paper better for their thoughts and suggestions. The same is true here. Not everyone who disagrees with you is doing so because they are on the take. People legitimately disagree with your ideas because you have failed to support them and have used "trust me" arguments where they are not warranted. Go collect data as described in my comments on the paper and assess whether cetaceans would prefer this form of captivity, but do not assume that sanctuaries are a welfare improvement without meaningful data to support it.

As for Marino, 2025. Here is comprehensive list of omitted materials from that paper (which was a commentary). Note there is no reference to Bruck, 2024 or Almuna,& Canchal, 2025 in that paper. If you are going to write a rebuttal to the points made in those papers then you probably would have cited them.

A85. We have removed the term "ticket sales" from this sentence.

A86. The reviewer may be correct in stating that choice and control "...could be implemented in current existing zoos" and we do cite this paper in the following statement:

> The question thus remains: how can one definitively determine which welfare assessments actually provide quality of life? For example, researchers would probably agree that having autonomy (i.e., choice and control over the environment) should improve well-being (Jaakkola, 2023) by providing captive animals with the opportunity to thrive (Vincino & Miller, 2015; Miller et al., 2020).

However, we contend that significant questions remain about autonomy for captive cetaceans–choice issues mentioned in the conclusion section. Moreover, the reviewer again points to Jaakkola (2023) but we already noted the problems in this paper and in the author's conclusion.

A87. We have made this same point in our section on Interactions with humans. And we have added another citation.

A88. Please see A84 above.

A89. We have rephrased this sentence.

A90. The reviewer states that this is not a consensus opinion. We do not claim it to be. It is our conclusion based on the evidence we have presented.

A91. It is unclear what the issue is with regards to the author's affiliation (there is no stated basis for conflict of interest). The article was published in a peer-reviewed journal, the same journal containing other articles that this reviewer has repeatedly suggested we cite, namely, *Animals*. It is unclear how this article is any different than, say, Bruck (2024–where there is a stated conflict of interest). Why is this article an "opinion" piece, but Bruck (2024) is not?

It's not a conflict of interest issue it's a qualifications and quality of the information issue. Forget the fact that you agree with the author and ask yourself to what standard do you hold this information if you were neutral on it. Its not a proper review paper, its not a data paper, it's just a narrative more appropriate for some short personal book. It is by no means a causal study as the name implies. I don't care what journal published it; I wouldn't cite it as a matter of professionalism. It is up the authors to evaluate sources of evidence beyond what journal they come from. I invite the editor to read Bruck 2024 and Anderson 2016 as it is fairly obvious the difference in scope and support for each papers conclusions.