



Letter to the Editor

Distinguishing Personal Belief from Scientific Knowledge for the Betterment of Killer Whale Welfare – A Commentary

Appendix – Supplemental Material

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*Please note that all references in this table are included in the main article.

Submitted: March 5th, 2020

Accepted: March 30th, 2020

Page Cited in Marino et al.	Topic	Brief Citation (full in literature cited section)	Year	Original killer whale data	Killer whale mention in Marino et al.	original data (O), review (R), editorial (E), popular press (P)	Actual topic of citation	Comments
1	Paper Title							
1	abstract; chronic stress	na	no reference provided					
1	abstract; chronic stress	na	no reference provided					
2	captive cetaceans consistently display behavioral and physiological signs of stress	na	no reference provided					
2	captivity, stress, morbidity, mortality all linked in killer whales	na	no reference provided					
6	distress and epimeletic behavior (attending to dead)	Bearzi et al.	2018	no	yes	R	A "comprehensive literature review" of cetacean responses to dead conspecifics	This reference is accurately represented in Marino et al. However, as acknowledged in the reference, other non-cetecean species also demonstrate behavior that could be considered grieving or "compassionate behavior". This reference also considers alternate interpretations of responses to dead conspecifics, including cannibalism.
8	effects of stress on immune sysem, chemical irritants, improper antimicrobial use, microbiota imbalance	Reidarson et al.	2018	yes	yes	R	This reference for veterinary clinicians discusses the causes, diagnostics, treatment, and prevention of mycotic infections in marine mammals.	The key point that Marino fails to acknowledge is that vertebrate species, in general, including humans, are susceptible to mycotic infections. As is common for general veterinary and human medical texts that consider infectious diseases, this reference addresses causes and potential interventions for mycotic infections. Failure to place the occurrence of disease and veterinary considerations in context is a misrepresentation of the reference that should not be accepted by a peer-reviewed veterinary journal.

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8	gastric ulceration caused by prolonged stress	Nomura et al.	1994	no	no	O	This reference addresses the risk of duodenal and gastric ulceration of <i>Helicobacter pylori</i> infection in humans.	Marino cited this outdated reference on humans without acknowledging that <i>Helicobacter</i> spp. can be found in many individuals without disease, or acknowledgement of the many studies of <i>Helicobacter</i> spp in cetaceans and other species in the past quarter of a century .
10	stereotypies associated with psychological stress and poor well-being	Mason & Latham	2004	no	no	R	This reference reviews the value of stereotypies as indicators of poor animal welfare in multiple taxa.	While this reference indicates that stereotypies can be associated with poor animal welfare, it is important to note that the authors state that stereotypies should "never (be) used as the sole index of welfare", thereby undermining Marino's approach to dental disease (along with failure to acknowledge dental disease in free-ranging killer whale). This point is reiterated in a more recent review of welfare research by Walker et al. (2014) with a discussion of the complexity of understanding stereotypies, including when they reflect compromised animal welfare.
12	HEADER							
12	HEADER							
12	"Most definitions of stress are rooted in the foundational concept of homeostasis and the ability of an organism to adapt to various circumstances"	Selye	1976	no	no	R	This book is a summary of Selye's pioneering work about the body's physiological responses to stressors.	Marino briefly acknowledges that "stress" (stressors) is (are) not invariably negative, and that eustress is a normal and beneficial part of animal's existence. However, Selye's concept is not fully and transparently considered throughout the manuscript, as is key to appropriately assessing and optimizing animal welfare objectively.
		McEwen & Wingfield	2007	no	no	R	This reference reviews the concept of allostasis, the process of maintaining physiological homeostasis in response to the environment.	Allotaxis and allostatic load are valid concepts to consider as a part of animal welfare assessments. However, Marino et al. do not present data that links killer whales to the human, bird, rodent, and nonhuman primate pathologies that represent the primary basis of this reference. Given that Marino et al. do not indicate what data in killer whales would support McEwen et al.'s concepts, the presentation of this material is speculative at best.

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12	stress contribution to allostatic load	McEwen & Rasgon	2018	no	no	R	This reference reviews the concept of allostasis, the process of maintaining physiological homeostasis in response to the environment, as a contributing factor to depression and dementia in humans.	Allostatic loads and animal's affective states are valid concepts to consider as a part of animal welfare assessments. However, Marino et al. do not present data that links killer whales to the human, bird, rodent, and nonhuman primate data that represent the primary basis of this reference. Given that Marino et al. do not indicate what data in killer whales would support McEwen et al.'s concepts, the presentation of this material is speculative at best.
12	short-lived stressor adaptation	na	no reference provided					
12	beneficial stress response to acute stressors	na	no reference provided					
12	response to stressor	na	no reference provided					
12	return to homeostasis	na	no reference provided					
12	severe stressors	na	no reference provided					
12	stress contribution to allostatic load and severe health consequences	Juster & McEwen	2010	no	no	R	This reference reviews the concept of allostasis, the process of maintaining physiological homeostasis in response to the environment, and its potential value for predicting human morbidity and mortality.	Allostatic loads and their potential impact on killer whale morbidity and mortality are valid hypotheses to consider as a part of animal welfare assessments. However, Marino et al. do not present data that links killer whale to the human data that this reference is largely based upon, and does not indicate what data in which killer whales would support Jusster and McEwen et al.'s concepts.

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		McEwen	2017	no	no	R	This reference reviews the concepts of allostasis and chronic stress and their impact on the brain and behavioral states for humans and various animal models.	Allostatic loads and the adverse impacts of chronic stress are valid concepts to consider as a part of animal welfare assessments. However, Marino et al. do not present data that links killer whale to the human and rodent data that this reference is largely based upon, and do not indicate what data in killer whales would support McEwen et al.'s concepts.
12	non-HPA-dependent stress responses	na	no reference provided					
12	mineralocorticoid release during stress response	na	no reference provided					
12	chronic stress	na	no reference provided					
12	acute stressors	na	no reference provided					
12	stressor desensitization	na	no reference provided					
13	cost of stress response to animals	Atkinson et al.	2015	no	yes	R	This quotation is accurately reproduced but does not give attribution to the original citations.	This is a general comment on other author's publications that is consistent with Marino et al.'s hypothesis. This reference's mention of killer whales included the conclusion that there are species-specific circadian patterns for cortisol secretion, as is typical for many species. This circadian rhythm must be accounted for in assessments of killer whale welfare, and likely confounds simple interpretations of cortisol secretion. Marino et al. did not acknowledge these caveats.
13	chronic stress has profound effects on brain structures	na	no reference provided					

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13	general stress response	na	no reference provided					
13	stressful responses	McEwen	2017, quote p 2-3	no	no	R	This reference reviews the concepts of allostasis and chronic stress and their impact on the brain and behavioral states. The quotation is accurately reproduced.	This quotation's general review of the negative impacts of distress is part of a general discussion of chronic stress. These are valid concepts to consider as a part of animal welfare assessments. However, Marino et al. do not present data that links killer whale to the human and rodent data that this reference is largely based upon, and do not indicate what data in killer whale would support McEwen et al.'s concepts.
	stress neurochemistry	McEwen	2017, quote p 2-3	no	no	R	This reference reviews the concepts of allostasis and chronic stress and their impact on the brain and behavioral states.	Allostatic loads and the adverse impacts of chronic stress are valid concepts to consider as a part of animal welfare assessments. However, Marino et al. do not present data that links killer whale to the human and rodent data that this reference is largely based upon, and do not indicate what data in killer whales would support McEwen et al.'s concepts.
	stressed out	McEwen	2017, quote p 2-3	no	no	R	This reference reviews the concepts of allostasis and chronic stress and their impact on the brain and behavioral states.	Allostatic loads and the adverse impacts of chronic stress are valid concepts to consider as a part of animal welfare assessments. However, Marino et al. do not present data that links killer whales to the human and rodent data that this reference is largely based upon, and do not indicate what data in killer whales would support McEwen et al.'s concepts.
13	shrinkage of hippocampal neurons and loss of dendritic spines in response to stressors	McEwen	2016	no	no	R	This reference reviews stress-induced effects on hippocampal neurons and the resulting impact on behavior and behavioral states.	Chronic stress and its impacts on behavior and affective states are valid concepts to consider as a part of animal welfare assessments. However, Marino et al. do not present data that links neuroanatomical changes in killer whales or other cetaceans to the human and animal data that this reference is largely based upon, and do not indicate what data in killer whales would support McEwen et al.'s concepts.

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13	fear response, chronic stress and increase in basolateral amygdala dendrites	Vyas et al.	2002	no	no	O	This reference compared the stress responses of rats completely immobilized for 2 hr/d without food and water with rats randomly exposed to eight different stressors	This reference demonstrated different types of brain remodeling with different types of stressors, and speculated how this might have behavioral implications. Marino et al.'s narrative fails to acknowledge that Vyas's Abstract addresses "contrasting patterns of dendritic remodeling in neurons of the amygdala and hippocampus", and do not link to adverse welfare states in killer whales. Overgeneralization from specific stressors of a rodent model is used to only speculate on a large aquatic mammal with no empirical evidence.
		Bennur et al.	2007	no	no	O	This reference documents a biochemical mechanism for remodeling of the amygdala as a part of the stress response of mice.	Marino et al.'s use of the biochemical mechanisms of brain remodeling in laboratory mice subjected to 6 hr of restraint has uncertain practical relevance to animal welfare assessments in general, and no linkage to assessment of killer whale welfare concerns was provided.
		Lau et al.	2017	no	no	O	This reference documents the use of a candidate antidepressant to address amygdala remodeling in response to experiencing chronic restraint stress.	This reference's investigation of brain structural plasticity and its response to an antidepressant is of potential clinical significance "as a model for increasing the resilience to stressors in at risk populations", but Marino did not provide a linkage to practical assessments of killer whale welfare.
	anxiety, posttraumatic	Buwalda et al.	2005	no	no	R	This reference reviews the long-term effects of social stress on the hippocampus and behavior.	This reference primarily explores the chronic physiology, behavior, and neuroanatomy of rats that experience social defeat. Given social management of killer whales to minimize agonistic interactions in captivity, the linkage of this reference to compromised killer whale welfare was not indicated.
		McEwen	2006	no	no	R	This reference reviews stress-induced effects on the brain and the resulting impact on behavior, behavioral states, and overall health.	Chronic stress and its impacts on behavior, affective states, and overall health are valid concepts to consider as a part of animal welfare assessments. However, Marino et al. does not present data that links killer whales to the human and animal data that this reference is largely based upon, and do not indicate what data in killer whales would support McEwen et al.'s concepts.

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13	stress, cognitive impairment, depression, mood dysregulation	McEwen	2017	no	no	R	This reference reviews the concepts of allostasis and chronic stress and their impact on the brain and behavioral states.	Allostatic loads and the adverse impacts of chronic stress are valid concepts to consider as a part of animal welfare assessments. It is notable that this reference distinguishes between "good stress", "tolerable stress", and "toxic stress". However, Marino et al. do not present data that links killer whales to the human and rodent data that this reference is largely based upon, and do not indicate what data in killer whale would support McEwen et al.'s concepts.
		Lupien et al.	2009	no	no	R	This reference presents a model that stressor exposure at different lifestages results in different disorders.	This reference presents insights into stress-responses that are valuable for general discussions of chronic distress, particularly where genetic and family environment factors are considered. These authors state that "stress is not and should not be considered as a negative concept only." Marino et al. did not provide linkage as to how the psychological concerns listed are relevant to killer whale welfare.
13	chronic stress and neuroanatomical correlates with 'cognitive rigidity' and attention control	Liston et al.	2006	no	no	O	This reference documented remodeling of the prefrontal cortex in rats experiencing restraint stress as a possible mechanism for explaining stress-related mental illnesses.	"Cognitive rigidity" is not a term used in this reference, and the two times "cognitive" is used in the text refer to mediation or modulation of cognitive functions. Regardless, the linkage to killer whale welfare was not presented by Marino.
13	stressor exposure early in life can potentially affect coping strategies later in life	McEwen	2017	no	no	R	This reference reviews the potential impact of chronic stress at different life stages and for different sexes, as well as the concepts of allostasis, epigenetics, and impacts on the brain and behavioral states.	Allostatic loads and the adverse impacts of chronic stress at different lifestages are valid concepts to consider as a part of animal welfare assessments. However, Marino et al. do not present data that links killer whales to the human and rodent data that this reference is largely based upon, and do not indicate what data in killer whales would support McEwen et al.'s concepts.

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13	stress response and cetacean adherence to classic HPA model	Atkinson et al.	2015	no	yes	R	This review considers marine mammal stress physiology and the degree of consistency with terrestrial mammals.	While this review discusses similarities between marine and terrestrial mammals, Marino et al. overstate this review's conclusions and fail to acknowledge this citation's statements regarding limited data and uncertainty, as well as where marine mammal's "mediator activity ... diverges from generalized terrestrial models" (Atkinson Abstract). Marino et al. also fail to acknowledge Table 2 in this reference that highlights differences in the stress response between marine and terrestrial mammals.
		Atkinson & Dierauf	2018	no	no	R	This book chapter is a review of the stress response in marine mammals.	Marino selectively interprets this citation, and ignore's the citation's statements that stress-related terminology is "often applied indiscriminately as a convenient "catchall", that there are "sometimes beneficial acute stress response(s) to the potentially lethal chronic response", and that there is a need to "develop a broad database of bioindicators that will improve the ability to recognize and manage stress (in) managed care setting(s) and in the wild".
		Thomson & Geraci	1986	no	no	O	This reference documents the acute stress response of bottlenose dolphins (<i>Tursiops truncatus</i>) capture and handling stressors.	Marino et al. confuse acute stress responses documented in this reference with the chronic stress response concerns that are the basis of Marino et al.'s manuscript.
		Romano et al.	2002	no	no	R	This review chapter discusses linkage between the nervous and immune systems of cetaceans using beluga whale lymphoid organ morphology, innervation, and immunology as a model.	While this reference does refer to norepinephrine (part of the acute stress response, in contrast to Marino et al.'s discussion of chronic stress concerns), this reference's absence of reference to the hypothalamus, pituitary gland, corticotropin releasing hormone, adrenocorticotrophic hormone (ACTH), corticosteroids, serotonin, or vasopressin does not provide credible support for Marino's general assertions regarding the HPA axis in cetaceans.

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		Houser et al.	2011	no	no	O	This reference documented cortisol and aldosterone levels in two cold-stressed bottlenose dolphin (<i>Tursiops truncatus</i>), in comparison to two controls, with reference to the physiologic response of free-living dolphins inhabiting cold water.	Marino et al. do not acknowledge the reference's caution about the degree to which the study's results were a part of the general adaptive stress response (in Abstract and concluding paragraph), which provides an inaccurate representation of the results.
		Fair et al.	2014	no	no	O	This reference documented the acute stress response of wild bottlenose dolphin (<i>Tursiops truncatus</i>) during field capture and handling research.	Marino et al., confuses acute stress responses documented in this reference with the chronic stress response concerns that are the basis of Marino et al.'s paper.
		Levin	2018	no	yes	R	This chapter reviews marine mammal immunology, diagnostics, and future needs.	This reference's absence of discussion of the hypothalamus, pituitary gland, corticotropin releasing hormone, adrenocorticotrophic hormone (ACTH), corticosteroids, norepinephrine, serotonin, chronic stress, or vasopressin does not support Marino et al.'s general assertions regarding the HPA axis in cetaceans.
13	maladaptive stressors	na	no reference provided					NOTE THAT THERE IS NO SUCH THING; POTENTIALLY MEAN MALADAPTIVE STRESS RESPONSE
14	chronic stress of killer whales in concrete tanks	na	no reference provided					
12	HEADER SOCIAL STRESS							

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15	Loro Parqu dysfunctional grouping	Visser & Lisker	2016	yes	yes	O	This unpublished and non-peer reviewed document addresses animal welfare concerns of killer whale at the Loro Parqu facility.	This self-citation of a non-published, non-peer reviewed document is not based on scientific evidence, but represents an opinion based on personal, anecdotal evidence acquired during public visits using information from a different killer whale. This is misleading and an inappropriate conflation of information.
15	social stressors	na	no reference provided					
15	chronic social stress and depression in humans and other species associated with social isolation	Sandi & Haller	2015	no	no	R	This review discusses "structural, functional and molecular changes in the brain that underlie the effects of stress on social behaviour" in humans and other animals.	With relevance to killer whales, Marino et al.'s statement ignores current best practices to manage cetaceans in compatible social groups, as well as the practical challenges of socially integrating killer whales that have long been singly held. The subsequent sentence's attempt to support Marino et al.'s misrepresentation were based on a highly speculative citation (Waples & Gales, 2002) concerned with dolphin (not killer whale) deaths where there was a lack of consistent data collection.
16	HEADER STRESS OF CONFINEMENT							
		Başoğlu	2009	no	no	O	This reference of human survivors of war-related captivity evaluated data to determine what constitutes torture.	This choice of reference appears to be a strategy for conflating torture of human prisoner's of war with captive killer whale management. This reference included consideration of sexual torture, physical torture, deprivation of sleep, food and hygiene, and other stressors, and similar, published or otherwise, examples in killer whale management were not presented by Marino et al.

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16	PTSD and depression in confined humans and primate	Ferdowsian et al.	2011	no	no	O	This reference assessed whether chimpanzees that experienced traumatic events have evidence of PTSD or depression using human clinical standards.	Although this reference has not been validated by other research teams, a limited amount of converging evidence suggests that primates can display symptomology that aligns with specific psychological disorders. Thus, the possibility that other animals may experience similar psychological issues provides an interesting direction for future research on myriad animals, including killer whales and other cetaceans. However, the absence of similar evaluations in killer whales creates uncertainty as to the relevance. of this reference and represents another attempt to conflate an idea with no direct evidence.
		Aloni et al.	2018	no	no	O	This reference investigated PTSD in former prisoners of war	This choice of reference appears to be a strategy for conflating torture of human prisoner's of war (POW) with captive killer whale management. This reference emphasized cognitive impairment in ex-POWs, and no empirical evidence or suggestions of captive killer whale cognitive impairment were presented by Marino et al.
16	killer whale vulnerability to stress of confinement	Mason	2010	no	yes	R	This reference proposes use of a comparative approach as a strategy to identify species that "have requirements that are either particularly difficult to accommodate in captivity or are simply not yet understood".	This reference does not state that "killer whales are vulnerable to stress from confinement" (Marino et al., 2019). This reference does cite outdated annual mortality rates, relative to wild populations, that have been contradicted by recent publications (Robeck et al., 2015, 2016). A second point of concern was that captive breeding was limited. However, the review indicates that the original sources of this material are an IUCN document concerned with cetacean conservation that does not explain the meaning of "limited" captive breeding success as a part of reduced capture of wild killer whales for oceanaria (this is not an established IUCN criteria or assessment) (Reeves, 2003) and a second reference (Couquiaud, 2005) states that killer whales have been "successfully kept and bred in captivity around the world". A third concern listed by this citation cites attacks on trainers, yet does not explain how this represents an animal welfare issue.

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16	Confinement of naturally wide-ranging mammals causes chronic stress, impairs brain development, and decreases behavioral flexibility	Dawkins	1998	no	no	R	This reference proposes that animal welfare studies are a relevant discipline for understanding biological phenomena.	The paragraph on migration indicates that migration has costs and benefits, and that animals in captive environments may "make inappropriate choices", such as selection of foods with a sweet taste. Moreover, the terms "chronic stress" or "long(-term) stress" are not in the reference. Thus, this reference does not state what Marino asserts.
		Robbins et al.	1996	no	no	R	This reference reviews the behavioral and neurochemical effects on rats isolated from peers at an age of approximately 20 days.	This reference has no mention of migration or travel, and Marino appears to be inappropriately conflating social isolation in juvenile rats with captive environments where killer whales have social interactions with other killer whales and/or humans throughout their lives.
		Lewis et al.	2006	no	no	R	The chapter cited discusses the role of environmental complexity in influencing abnormal behavior.	This chapter has no mention of migration or travel.
16	confinement stress due to prevention of species-typical behavior	Clubb & Mason	2003	no	no	O	This reference suggests that Carnivora species that naturally have large home ranges are more likely to experience compromised welfare when held under human care.	This abbreviated (one page) presentation provides a coarse scale hypothesis to address the question as to why some species do better in captivity than others. This reference does not define stereotypy or pacing, particularly with respect to more recent understandings of stereotypies (reviewed by Walker et al., 2014), or recognize that management strategies related to staff (Cole & Fraser, 2018), enrichment (Chudeau et al., 2019; Makecha & Highfill, 2018; Wagman et al., 2018; Wolfensohn et al., 2018), or the environment (Liu et al., 2018; Wolfensohn et al., 2018) are key to ensuring animal welfare under human care. In addition, Marino et al.'s point does not link killer whale and Carnivora needs or acknowledge how human care meets animal's physical and cognitive needs.

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		Clubb & Mason	2007	no	no	O	This reference suggests that Carnivora species that naturally have large home ranges are more likely to experience compromised welfare when held under human care, and that this information can be used to improve zoo enclosure design.	While this reference provides more information regarding Methods and other details beyond Clubb, 2003, and acknowledges the study's limitations, it remains a coarse scale assessment that is relevant to the author's intent of how zoos can improve enclosure design for some Carnivora species. Nevertheless, the absence of linkage to killer whale welfare exists in Marino et al.'s reference.
16	adrenal hypertrophy associated with carnivores in captivity	Terio et al.	2004	no	no	O	This reference explores chronic stress as a limitation to captive cheetah's (<i>Acinonyx jubatus</i>) reproductive success and contributor to morbidity and mortality.	Marino generalizes cheetah biology to all <i>Carnivora</i> . Not only does this generalization not hold for other nondomestic felids and <i>Carnivora</i> (including those with larger home than cheetah, per Marino et al.'s 2007 Clubb reference), there is no linkage to captive killer whales aside from speculation.
16	HEADER SENSORY DEPRIVATION AND STRESS							

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16	"Studies have shown that these factors (associated with "concrete tanks") affect animal behavior, psychological well-being, and stress levels.	Couquiaud	2005	no	yes	R	The reference is a paper from a special edition of Aquatic Mammals that reviews captive cetacean environments.	This review was "about how to contribute to make the environment of cetaceans in human care as suitable and as good as possible," and Marino et al. misrepresented this reference by using it to support the negative implication that concrete tanks are sensory depriving. A search of the text for the terms "sense," "senses," "sensory," "stress," "stressful," and "stressed" did not identify passages that could be interpreted as Marino et al. did. A search of the text for "orca" resulted in sections where killer whales were part of a list, and a single passage (p. 302) where killer whales were identified as naturally inhabiting "shallow to deep water," as well as being "playful, easily trainable in captivity...successfully kept and bred in captivity around the world," along with acknowledgement of attacks on humans while under human care.
		Parsons	2013	no	yes	R	This is a textbook on marine mammal biology and conservation.	The section in this reference that this statement appears to refer to are pages 298-299 where there is an unreferenced presentation of the pros and cons of dolphinarium. Of relevance is this book's discussion of stress on page 237, where both adaptive and maladaptive stress are discussed.

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	as well as sensory capacities"	Clegg & Butterworth	2017	no	yes	R	This reference acknowledges cetacean welfare assessments as needing to balance positive and negative affective states.	This reference does not appear to support Marino et al.'s assertion, given that "concrete", "sensory", and "psychological well-being" were not terms found in the reference, and the word "stress" was associated with discussions of social stress and physiological indicators of stress. In addition, discussion of captive killer whales did not discuss Marino et al.'s points, and included mention of studies with findings on killer whale longevity that contrast with Marino et al.'s assertion (Jett and Ventre, 2015; Robeck et al 2015) and mentioned that another study (Jett and Ventre, 2012) proposed that captive killer whale are at risk of mosquito-borne diseases without supportive data. Furthermore, this reference indicated that terrestrial animal stress models may not always be applicable to marine mammals, from a reference (Atkinson, 2015) that Marino et al. miscites and states that killer whales have an HPA axis that conforms to terrestrial models.
17	Miami Seaquarium "regularly" administered the killer whale prophylactic antibiotics prior to stadium repairs	Visser	2016	yes	yes	O/R	This document was developed as part of a PETA v. Miami Seaquarium Civil Procedure. This document presents non-peer reviewed data and interpretations on a single killer whale under human care at a single facility.	Search of this self-reference did not identify antibiotics and there was brief mention of stadium, repair. Given the document's overall misunderstanding/misrepresentation of diagnostic test results and infectious diseases, Visser's clinical assessments are not credible. Moreover, Visser does not explain why provision of treatment is a concern, as the veterinary care provided is consistent with standards for cetaceans and is similar or superior to those for other species, including humans.
17	captive killer whale exposure to sounds affecting health	Visser	2016	yes	yes	O/R	This document was developed as part of a PETA v. Miami Seaquarium Civil Procedure. This document presents non-peer reviewed data and interpretations on a single killer whale under human care at a single facility.	Verification of Marino et al.'s claim is absent, as an electronic search of this self-reference did not identify the following words in the electronic version of this text: pump, firework, construction, sound, noise, or acoustic. Review of the self-reference did not indicate details of the "noise" or volume that would support Marino et al.'s claim.

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17	"Concern about acoustic stress tends to focus on underwater sound sources"	Scheifele et al.	2012	no	no	O	"Underwater and in-air noise evaluations were completed in performance pool systems at Georgia Aquarium under normal operating conditions"	The first line of the abstract of this reference contradicts Marino et al.'s assertion by stating that in-air noise evaluations were conducted at this single facility.
17	HEADER STRESS LACK OF CONTROL							
17	one of greatest stressors is lack of control	Goldblatt	1993	no	no	R	This reference discusses environmental enrichment, behavioral engineering and training as strategies that have been demonstrated to improve animal welfare "by increasing the animal's stimulation and/or control of its environment".	This 1993 reference discusses a range of concepts where animal welfare can be compromised, and strategies for mitigating stressors. These strategies are a part of conventional killer whale and marine mammal management that Marino et al. fail to acknowledge in their paper.
		Sambrook et al.	1997	no	no	R	This reference reviews control and complexity of novel objects used for enrichment.	In contrast to Marino et al.'s central thesis of chronic stress in killer whale, this reference lists criteria for use of novel enrichment objects to optimize animal welfare that are consistent with conventional killer whale management. Namely, conventional killer whale management uses objects with a diverse number of controllable features, predictability of these objects varies, and a variety of controllability grades (per the reference) are evident in the enrichment objects provided.
		Morgan et al.	2007	no	yes	R	This reference discusses sources of stress for animals under human care.	This reference is correctly cited and there is a single listing of killer whale in a list of species that produce and detect ultrasonic sound. However, unlike Marino et al., this reference recognizes the difference between adaptive and maladaptive stress, recognized the imprecise use of the term "stress" by one of Marino et al.'s frequent sources (McEwan, 2000), and required substantiation of positions regarding chronic stress. Marino et al. do not link this reference to evidence indicating chronic stress in killer whale.

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18	"...“learned helplessness,” which results in a range of outcomes associated with chronic stress, including depression, “giving up” or lack of motivation to learn or explore, anorexia, and immune system dysfunction"	Seligman	1975	no	yes	R	This reference is entitled: Helplessness: on depression, development and death	Marino et al. did not provide documentation of depression or learned helplessness in killer whales. The activity of killer whales under human care and their engagement with humans, other killer whale, hunting of birds that land in their enclosure, and other documented activities appear to be inconsistent with depression or helplessness (Guarino et al., 2017; Hill et al., 2017; Sánchez–Hernández et al., 2019).
		Maier & Seligman	2016	no	no	R	This reference reviews the concept of "learned helplessness", which was defined as the "escape shock induced by uncontrollable aversive events".	This reference is concerned with passive behavior where an organism has a lack of control over events. Ignoring the fact that killer whale and other animals have finite control over events and the environment in natural settings, the behavior of killer whale under human care and management strategies that provide killer whale with opportunities to control the environment and other enrichment do not support Marino’s assertions (Melfi & Ward, 2020)
	chronic stress ... lack of control ... effects on	Couquiaud	2005	no	yes	R	The reference is a paper from a multipaper special edition of Aquatic Mammals that reviews captive cetacean environments.	This review was “about how to contribute to make the environment of cetaceans in human care as suitable and as good as possible”. A search of the text for the terms "sense," "senses," "sensory," “stress,” “stressful,” and “stressed” did not identify passages that could be interpreted as Marino et al. did. A search of the text for “ <i>orca</i> ” resulted in sections where killer whale were part of a list, and a single passage (p 302) where killer whales were identified as naturally inhabiting “shallow to deep water”, as well as being “playful, easily trainable in captivity...successfully kept and bred in captivity around the world,” along with acknowledgement of attacks on humans while under human care. Thus, this reference does not support this passage in Marino et al.

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18	health and well-being ... consistent with the symptoms of learned helplessness	Atkinson, et al,	2018	no	no	R	This book chapter is a review of the stress response in marine mammals.	As the presumptive stress response bioindicators listed in this reference largely do not appear to be addressed in the “learned helplessness” references (Seligman, 1975; Maier, 2016), there is an absence of evidence supporting Marino et al.’s assertions. The lone exception is the reference to corticosteroids, and learned helplessness is not defined/diagnosed by corticosteroids (Seligman, 1975; Maier, 2016), and appears to be more of a psychological diagnosis for which the symptoms (e.g., sad mood, loss of interest, weight loss, sleep problems, psychomotor problems, fatigue, indecisiveness). None of these indicators were documented in Marino et al.’s references, other than the exception of release of a killer whale (Keiko) from human care into North Atlantic waters where there was weight loss (N.Rose, p. 300 in Parsons, 2013).
18	HEADER STRESS OF BOREDOM - note that this discussion is solely on boredom with the exception of one mention of "stressed"							
19	“captive dolphins in open facilities...are less stressed, have lower salivary cortisol	Ugaz et al.	2009	no	no	O	This reference compares the behavior of 10 dolphin (Tursiops truncatus) before and after their transfer from a "closed" facility to an "open" facility (in contrast to Ugaz, 2013, where different dolphins in different types of facilities were compared).	This reference presents some interesting behavioral observations comparing the same animals in two different facilities. Inconsistent and incomplete documentation limits inferences possible. There is some uncertainty about the first facility, described as "open facilities conformed by a dock", and new facilities "conformed by five lagoons or natural pools". There is also uncertainty as to whether interactive swimming with people occurred similarly in both pools. Regardless, the key question is what differences in management occurred in each setting, as the baseline welfare and management is uncertain and management is a key component of animal welfare (Cole & Fraser, 2018). Nevertheless, this reference highlights the need to clarify environmental and management factors that optimize animal welfare.

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	levels, and are more behaviorally engaged"	Ugaz et al.	2013	no	no	O	This reference compares the behavior and salivary cortisol of 23 dolphin (<i>Tursiops truncatus</i>) in "open" and "closed" facilities (in contrast to Ugaz, 2009, where dolphins were observed (no cortisol measurements) before and after moved to "open" facilities.	This reference presents some interesting cortisol and behavioral data comparing different animals in two "open" and two "closed" facilities, although documentation is incomplete and inconsistent. It appears that the cortisol measurements were likely conducted using validated methods. However, as with Ugaz, 2009, a simple comparison of facility type without consideration of management misses a key component of animal welfare (Cole & Fraser, 2018). The reference's authors also note in their summary that "open" and "closed" facilities each have facility-specific challenges. Nevertheless, this reference highlights the need to clarify environmental and management factors that optimize animal welfare.
19	captivity = stress associated with immune dysfunction, disease, and disorder (DSM "disorder"	na						
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	<i>Notes: 87 including 8 headers and 1st column of table leads to 79 uses of the word "Stress" in the main document.</i>							
	<i>48 references cited when Marino et al. mention stress or stressor.</i>							
	<i>Marino et al. have 21 mentions of "stress" without a reference.</i>							