

Topic Summary: Relationship Between Captivity and Killer whale (*Orcinus orca*) Behaviour

Killer whales are highly complex, vast-ranging marine mammals that have shown poor adaptability to a captive lifestyle (Marino et al., 2020). Human-controlled environment highly influences these behaviours, resulting in the prevalence of abnormal behaviours in captivity and research focused on enrichment strategies and understanding Killer whale personality (Ubeda et al., 2019; Law & Kitchener, 2017). A significant behavioural change observed in captivity is the social behaviours conspecifics will display when interacting (Sánchez-Hernandez et al., 2019). Abnormal social behaviours include changes in vocalizations, learning, pod structure, and aggressive interactions (Marino et al., 2020). Other abnormal behaviours have been observed and associated with stress, such as "learned helplessness," (Marino et al., 2020).

The formation of artificial pods in captivity is a cause of several behavioural changes (Marino et al., 2020). Traditionally, free-ranging Killer whales have highly sophisticated social groupings (pods) and long maternal relationships (Marino et al., 2020; Law & Kitchener, 2017). In captivity, social groupings are formed artificially with whales from various locations (Kremers et al., 2012). Captive Killer whale pods exhibit several abnormal behaviours including, vocalizations, aggression, and changes to social structures. Social behaviours and interaction were observed, and quantified revealing Killer whales have distinct personalities and varying compatibilities (Sánchez-Hernandez et al., 2019; Ubeda et al., 2021). Conspecifics with low compatibility exhibited an increase in aggressive behaviours (biting, chasing, and aggressive calls) between conspecifics (Sánchez-Hernandez et al., 2019). Physically confining pods also creates unnatural situations where conspecific aggression cannot be avoided spatially, subsequently increasing conspecific aggression (Sánchez-Hernandez et al., 2019; Marino et al., 2020). Poor compatibility, stress, and physical restrictions are all causes of the increased conspecific aggression and abnormal behaviours observed in captive Killer whales (Sánchez-Hernandez et al., 2019; Marino et al., 2020).

Artificial pod formation significantly affects captive Killer whales' communication behaviors (Kremers et al., 2012). Wild populations of killer whales have distinct dialects, much like

humans have different languages (Kremers et al., 2012). Observations of vocalizations between conspecifics suggest that captivity has given rise to new call-types and unique pod languages (Graham & Noonan, 2010; Kremers et al., 2012). The findings suggest artificial pod formations can provide vocal language learning opportunities between conspecifics (Kremers et al., 2012). However, the findings also suggest that captive killer whales have developed distinct aggressive call-types which have not been observed in the wild (Graham & Noonan, 2010).

Abnormal behaviours are prevalent throughout the literature, such as depression or "learned helplessness" (Marino et al., 2020; Jett et al., 2017; Anderson et al., 2016). "Learned helplessness" was observed as Killer whales became sedentary and detached from their surroundings, mirroring depression and is likely a product of stress (Marino et al., 2020). Killer whales are highly complex, both emotionally and cognitively; researchers suggest anthropomorphism as a valid method for assessing behaviours and researching them holistically (Anderson et al., 2016). Finally, Killer whales have a high encephalization quotient (brain-body ratio) and are highly sensitive to their environments, often leading to stress (Marino et al., 2020; Law & Kitchener, 2017). Stress has been observed to be a potent cause of abnormalities (Marino et al., 2020). Stressors are still being researched, but some are broadly recognized, unnatural social settings, poor well-being, boredom, and a lack of control (Marino et al., 2020). The well-being of captive Killer whales has correlated positively with normal behaviors; this suggests abnormal behaviours are likely an indicator of poor well-being (Ubeda et al., 2021).

Stereotypies for Killer whales have not been observed in free-ranging populations (Jett et al., 2017). However, in captivity, Killer whales exhibit self-harming stereotypies such as biting metal bars and slamming their heads into enclosure walls populations (Jett et al., 2017). Killer whales express both vocal learning and mimicry, the transmission of these stereotypies was observed to be a product of mimicry (Jett et al., 2017). The occurrence of such a stereotypy illustrates that captivity gives rise to newly learned behaviours that are consistent with poor well-being (Ubeda et al., 2021; Marino et al., 2020).

Killer whales have illustrated poor adaptability to captivity in many facets. Killer whales are highly complex and require a stimulating environment, both physically and socially (Marino et al., 2020). Therefore, future research should be focused on social and environmental enrichment strategies (Marino et al., 2020).

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