RSPCA
for all creatures **great** & **small**

RESEARCH REPORT:
The welfare of dolphins in captivity

FEBRUARY 2019

The RSPCA is Australia's leading animal welfare organisation and one of Australia's most trusted charities.

CONTENTS

1. INTRODUCTION

As a species, dolphins are extremely popular and have been the focus of intense human interest for the past century. They have attracted attention for many reasons including their behaviour in the wild, in performances at marine parks, direct interactions with humans and use in research, especially regarding echolocation capabilities. Humans also find their appearance attractive and intriguing. Therefore, the opportunity to closely interact with them is very appealing and keenly pursued by some people.

Dolphins belong to the order *Cetacea* which includes two sub-orders *Mysticeti* (baleen whales) and *Odontoceti* (toothed whales). Dolphins and orcas are toothed whales within the most diverse and largest group of cetaceans, the *Delphinidea* family, which has about 37 species.

The bottlenose dolphin (*Tursiops* sp.) is believed to be the most commonly displayed cetacean on all continents, held in 89% of marine mammal facilities in 42 countries around the world according to the most recent and comprehensive survey undertaken (Couquiaud 2005). In Australia, the number of marine parks housing dolphins has declined over the past 20 years from about eight to now only two, one in Queensland and one in New South Wales. The reason for this decrease is unclear but is likely to be a combination of financial constraints, declining audiences and pressure from animal advocacy groups.

From the 1960s, dolphinariums have based their business model on captive dolphins performing shows for audiences for entertainment. In addition to performances, since the 1990s, there has been an increased focus on interactive programs including swimming with dolphins and assisted therapy, where people have direct contact with dolphins.

Dolphins may also be brought into captivity following rescue due to injury or illness. Rescued dolphins may be retained temporarily for rehabilitation before being returned to the wild, or can continue to remain in captivity. Dolphins have also been used for research and potential detection work by the military but little information is available on this.

Consistent with an expanding awareness and concern about the welfare of animals, there are heightened community expectations regarding the needs of animals used in entertainment. Given that dolphins are highly intelligent animals with complex social structures who swim vast distances in open oceans, the state of their welfare in a captive environment, where they are used for performances and interactions, is being increasingly questioned. This is gaining greater attention due to the expanding recognition of animal sentience, which emphasises that animals are aware of their surroundings (perception), have the capacity to experience feelings (emotions) and to process information to help meet their needs (cognition) (Broom 2016). The challenges of meeting species-specific needs of some animals retained in captivity, including bears, great apes, canids, marine mammals and elephants, is also increasingly being recognised (Gray 2017).

When assessing animal welfare, several different models or frameworks can be used. The framework chosen as the basis for this report is the three dimensions model (Fraser et al. 1997; Fraser 2009). In this model, the three areas considered are function, feeling and natural life. The function dimension focuses on physical aspects such as health, longevity, reproductive success and physiological responses to the environment (e.g. stress indicators). The feeling dimension considers the mental state of animals, both positive (e.g. contentment, joy, satiety) and negative (fear, frustration, depression) and can be evaluated using various methods including behavioural assessments. Finally, the natural life dimension considers the impact of imposed restrictions on opportunities that would be encountered by the same species in their natural environment.

2. DOLPHINS IN THE WILD

To understand the full impact of confining dolphins in captivity, it is essential to consider the full range of observed normal behaviours in their natural environment. Numerous studies have been done, particularly in relation to biology and behaviour. Up until 2009, over two thirds of the publications on cetaceans involved wild populations with the remainder focused on captive dolphins and a few comparing captive and wild dolphins (Hill & Lackups 2010). Studies undertaken on wild dolphins may assist in improving conditions that dolphins are kept in captivity to help meet their behavioural needs. However, there are unlikely to be many direct benefits to wild populations from research involving captive dolphins.

2.1 Longevity

In the wild, dolphins can live for 45-50 years with predation and human impacts, including pollution, food scarcity due to overfishing and injury from boats and fishing nets, posing the greatest threats to survival in adulthood. Preventing and minimising further impacts of human interference on wild dolphins should be a global priority.

2.2 Travelling

A study of dolphins in coastal waters off northern New South Wales found dolphins spent 38% of their time travelling compared to socialising, milling and feeding/foraging (Hawkins & Gartside 2008). Consistent with other studies, travelling was found to be a significant activity and one which would be severely thwarted by captivity, irrespective of the reason for captivity. The home ranges for the two groups studied were 177km^2 and 320km^2, with the authors commenting that the actual home ranges were likely to be larger than reported.

Limited data are available on the swim speed of bottlenose dolphins. One study recorded maximum speeds of 24 km/hour in the wild compared with trained captive dolphins attaining 29 km/hour in a restricted pool (Rohr et al. 2002). These are considered 'burst' speeds, which are faster than normal swimming and occur for short periods to catch prey or evade predators and are an important part of normal swimming behaviour.

2.3 Foraging and feeding

Foraging, or the search for food, is an important day-to-day activity which is both stimulating and rewarding. Depending on local availability and preference, dolphins may travel long distances, in excess of 100km, in search of food. Their diet varies but generally mainly consists of fish, octopus, and squid. Hunting for food in the wild is a strongly motivated behaviour and may involve establishing alliances with other dolphins to capture prey. Hawkins and Gartside (2008) found that feeding accounted for 19% of time with associated behaviours including deep diving, fast swimming and porpoising. Expression of all these behaviours is virtually impossible in a captive environment as well as the ability to choose different food sources. It is questionable as to whether feeding thawed frozen fish to captive dolphins can fulfil these innate behaviours.

2.4 Diving and surfing

Diving and porpoising are common behaviours in the wild, with some dolphins also actively seeking the opportunity to wave surf, particularly on pressure waves produced by boats, or even whales (Paulos et al. 2010), suggesting that this is a pleasurable activity.

2.5 Social interactions

An Australian study of wild coastal dolphins found that the mean pod size was 13 individuals, with the mean size of mother and calf pods comprising 21 individuals (Hawkins & Gartside 2008). This study also reported that social interactions are dynamic and flexible with some individuals having only loose associations within their group whilst others interacted with a number of individuals in several social groups. It appears that bottlenose dolphins live in complex fission-fusion societies where the composition of groups or pods may change within an hour or over a number of days, and may depend on the abundance and distribution of prey, foraging techniques, habitat type, behaviour, reproductive state, time of day and season, and complexities which are unable to be expressed in a captive environment.

A three-year study observing over 2,100 encounters of 52 free-living dolphins in the Shark Bay area of Western Australia revealed that the majority of associations across different behavioural states (e.g. rest, travel, social, foraging) were of an acquaintance type where preferred associations are not formed (Gero et al. 2005). However, nearly 30% of interactions, mainly between juveniles, did involve preferred associations in several behavioural states. Out of the possible 51 dolphins, the average individual was observed to associate with 34.7 (SD = 9.68) individuals, of which 17.7 (SD = 7.52) were preferred. On average, each dolphin had approximately six behavioural associates in all behavioural states. The remaining dolphin formed only an affiliate-type association. The study concluded that a large number of individuals have different preferred partners in different behavioural states. This study adds to the body of evidence that demonstrates the complexity and fluid nature of dolphin associations in a wild state, where they can choose to interact with different individuals depending on the context.

3. ASSESSING INTELLIGENCE AND COGNITION

As has been identified by many studies, dolphins are recognised as being extremely intelligent with significant cognitive abilities.

3.1 Brain size and complexity

Anatomical research has identified that the structure of the cetacean brain is very complex, allowing advanced information processing enabling intelligent, rational behaviour (Marino et al. 2007). Furthermore, dolphins have a very complex neocortex, a neurological feature associated with problem solving, self-awareness and processing emotions in humans.

Interestingly, a comparison of brain mass, body mass and encephalisation quotient (a value which describes relative brain mass across species with varying body mass) of 630 mammalian species, showed that the relationship between brain and body mass in odontocete cetaceans is not consistent with the evolutionary pattern (Boddy et al. 2012). In other words, in dolphins, the brain size is relatively larger than would be expected for body size and this is considered to indicate increased cognitive ability.

3.2 Self awareness

Many studies have demonstrated that, in addition to general intelligence and emotional complexity, dolphins are self-aware. One such study showed that dolphins display a similar capacity for self-recognition as great apes and humans, through observing two captive bottlenose dolphins in a ‘mirror’ study (Reiss & Marino 2001). Despite dolphins being unable to use a hand to touch a marked part of the body, both dolphins spent a significant amount of time engaging in self-directed behaviours at reflective surfaces in order to view parts of their body that had been marked with non-toxic temporary black ink compared to being sham-marked, where the action of applying a mark was made but no mark was left. Both dolphins also swam quicker to the mirror to view the marked or sham-marked area compared to when they were not marked. These results provided the first clear evidence of mirror self-recognition in dolphins. This suggests that dolphins are likely to be very aware of their surroundings, including perhaps the limitations posed by a captive environment.

A study by Hermann (2010) demonstrated self-awareness in relation to the dolphin’s conscious awareness of their own recent behaviour, and conscious awareness of their own body parts when symbolically referenced. These findings add further evidence to the flexibility and extensibility of dolphin cognition needed to function within complex social dynamics.

3.3 Learning, language and play

Tool use by animals is of inherent interest given its relationship to intelligence, innovation and cultural behaviour. Like humans who preferentially associate with others who share their subculture, tool-using dolphins prefer others like themselves, strongly suggesting that sponge tool-use is a cultural behaviour (Mann et al. 2012).

One particular study showed evidence that a dolphin’s learned identity signal (the signature whistle) is used as a label when communicating with conspecifics (King & Janik 2013). The ability of bottlenose dolphins to use

learned signals to identify different social companions appears to be unique amongst nonhuman mammals.. This suggests that dolphins have a high level of cognition, vocal matching and individual recognition.

There is abundant evidence that play is an important behaviour for both captive and wild dolphins, and that dolphins play in many different ways (Paulos et al. 2010). A five-year study categorised captive dolphin play behaviours as follows: motor play, bubble play, human play, ball play and object play (with objects other than balls) (Kuczaj et al. 2006). During the course of this study 270 novel play behaviours were documented.

Another study of cognitive capacity in one dolphin revealed that this dolphin was able to discriminate in relation to the 'more' or 'less' magnitude for numerical competence (Yaman et al. 2012). Not only was numerosity represented as an abstract category but the dolphin in question was required to complete single reversal learning (original training involved selecting 'more' but with single reversal learning, the dolphin had to select 'less') to participate in the experiment, thus providing evidence of high cognitive capacity. Other research has also demonstrated the high level of intelligence of dolphins by revealing their ability to mimic sounds and behaviours as well as understand specific aspects of human-made symbolic language (Marino et al. 2008).

4. DOLPHINS IN A CAPTIVE ENVIRONMENT – WELFARE CONCERNS

During the 1960s and 70s, the number of dolphinariums and marine parks where dolphins performed for entertainment on a daily basis increased dramatically, particularly in the United States. The vast majority of these dolphins were taken from their natural marine environment. Attempts to breed captive dolphins soon followed with marine parks in Australia, the USA and Europe now largely maintaining their numbers this way. However, many marine parks in other parts of the world, particularly Asia, continue to source dolphins from the wild.

There are two main types of captive environments in which dolphins are kept: semi-natural environments comprising sea enclosures, or artificial environments, where pools, tanks or enclosures with natural elements such as lagoons are used. Most marine parks which retain dolphins have pools or tanks made from concrete, plastic or fibreglass. Where pools are used, there may be several available which provide different functions. The largest pool is generally used for performances, while smaller pools are used for holding, training and temporary separation of individuals. Ideally, there should be two holding pools to allow individuals to be isolated where behavioural problems are recognised and a quarantine and/or treatment pool where new animals and sick animals can be isolated. Where breeding is undertaken, there should be an additional 'maternity' pool where birthing and nursing females can be segregated, if required.

When comparing a dolphin's natural environment to this captive situation, there are a number of obvious differences which are likely to have an impact on dolphin welfare. These include the available space, the complexity of the environment, the number of dolphins with which an individual can interact, and the impact of human activity on dolphins. Rose (2004) states that the rationale for retaining dolphins in captivity is based on educational benefits for people and not welfare benefits for dolphins.

4.1 Restricted space

Where dolphins are maintained in an artificial environment, space will always be limited due to the cost of constructing and maintaining such facilities. Captive dolphins endure severe space restrictions compared to the open ocean or even an estuarine environment.

A review of stressors posed by captivity, especially those which are uncontrollable, helps to identify areas that may have adverse effects on captive populations of different species (Morgan & Tromberg 2007). Stressors include loud or aversive sounds, uncomfortable temperatures, lighting variation, and forced restrictions on movement and behavioural expression. Further, space restrictions may limit escape from aggressive encounters with conspecifics, which could lead to stress or injury.

A study of seven dolphins at a US zoo facility where dolphins could choose their location, showed that most time was spent in the moderate depth pool compared to the deeper performance pool which had a larger surface area and volume (Shyan et al. 2010). However, although interesting, this study had a number of

limitations including the inability to control factors such as underwater noise differences, ambient light and conditioned associations with the pools that may have influenced the dolphins' choices. A more definitive study comparing closed and open captive environments showed that dolphins maintained in an open facility which had the greatest length compared to the other facilities had salivary cortisol levels (0.09 nmol/L) at least 15 times lower than dolphins kept in the smallest closed facility (1.40 nmol/L) (Ugaz et al. 2013). However, these cortisol levels must be viewed with caution given they are very low. Further research is required to determine the usefulness of cortisol measures to assess stress levels in dolphins.

The need to address issues such as circular (repetitive) swimming and the limited time spent underwater of captive dolphins has also been identified, with further research needed on appropriate environmental enrichment (Clark et al. 2013). Ugaz et al. (2013) found that dolphins in open facilities spent more time swimming (overall and in a linear rather than a circular orientation) and less time floating compared to dolphins in closed facilities, with the conclusion that this may be due to open facilities providing more space and diverse stimuli.

Gubbins (2002) reported the smallest core range for a bottlenose dolphin in an estuarine environment as 600,000 m^2 (0.6km^2), whereas a global survey of marine mammal facilities by Couquiaud (2005) found the minimum surface area was just 14m^2. Furthermore, a recent review of the US marine mammal care regulations suggests a minimum standard should be for 10-12 tail strokes or a minimum horizontal dimension of 35 metres to address space requirements, despite acknowledging that dolphins in the wild travel tens of kilometres daily (Rose et al. 2017). This means that a captive dolphin would need to swim the 35 metres over 500 times a day to cover a similar distance as their wild counterparts.

It is unclear how important the depth of a pool or tank is for captive dolphins, especially as some populations inhabit relatively shallow areas. Where dolphins have access to deep water, diving is a common behaviour, so keeping dolphins in pools less than 10 metres deep may not be in their best interests. One researcher has stated that it is important to provide animals with habitats as large and deep as possible to encourage diving and rapid swimming (Couquiaud 2005).

4.2 Barren environment

Most dolphin facilities have little variety or complexity in the underwater environment. This type of design is driven in part by the need for facilities to filter and circulate the tank water and maintain water hygiene. However, in recent times there has been an increased recognition of the importance of providing environmental enrichment to captive dolphins. Some newer facilities are designed with more natural and varied features including coves and islands as well as sandy bottoms and boulders. However, whilst making some progress to provide a less sterile environment, these facilities are still limited in their capacity to reflect the natural marine landscape.

Training for performances and human interaction have been shown to help alleviate the boredom of captivity but it is recognised that considerable and ongoing effort is required to provide sufficient mental stimulation for such intelligent animals. A recent study of anticipatory behaviour of seven captive dolphins suggested that toys and human interaction were rewarding for some dolphins and that non-food human interactions could play an important role in the life of a captive dolphin (Clegg et al. 2018). However, the results showed that the proportion of time anticipatory behaviour was displayed for some individuals was very low, i.e. only 2-3% for toys and 3-4% for human interaction. The overall average was boosted by two dolphins who displayed significantly more anticipatory behaviour compared to the remaining five. Therefore, the results need to be considered with caution in terms of individual behaviour.

A review of cognition and current marine mammal enrichment has identified that captive dolphins need appropriate cognitive challenges which are relevant, motivating, controllable and possible to master (Clark 2013). Most dolphinariums only provide floating toys for environmental enrichment and this is insufficient to meet cognitive needs. A study involving six dolphins to assess 21 familiar objects found that only 50% of the objects elicited manipulative behaviours, thus indicating that not all objects are considered toys (Delfour & Beyer 2012). Behavioural changes subsequent to the introduction of objects does not necessarily indicate an enrichment effect. Research by Neto et al. (2016) highlights the difficult challenges posed by the variable response of individuals to novel objects in terms of being positive, neutral or negative. This work shows that

some dolphins need to be trained to use novel objects but it is unclear as to how long the level of interest might remain.

A study by Clark et al. (2013) revealed different responses by dolphins to an underwater maze with none of the females approaching the maze, whilst two of the six male dolphins navigated the maze successfully. Further, although the maze did not decrease repetitive swimming patterns, the males spent more time underwater when the maze was in the pool.

Descriptions and data on the prevalence of stereotypical behaviours displayed by captive dolphins are limited. However, these behaviours have been reported as being indicative of stress or abnormal mental states in some animals due to frustration, coping attempts or brain dysfunction (Miller et al. 2011a). Causative factors may include restrictions on expressing species-specific behaviours, limited sensory stimulation and lack of choice to perform certain functions and behaviours. Potentially damaging stereotypies described in the C-Well® Index include repetitive head/genital scraping, tooth rubbing, and intentional and repeated collisions with enclosure structures (Clegg et al. 2015). Other reported stereotypies include pattern swimming (direction and speed) and repetitive vocalisations. However, the prevalence and severity of these behaviours is not available publicly so it is difficult to determine their significance. It is also noted that echolocation is an important behaviour with low use indicating a barren environment.

Preventing and/or minimising the expression of stereotypic behaviour in captive animals is very challenging. Miller et al. (2011a) questions whether environmental enrichment has been shown to completely eliminate stereotypic behaviours in an entire group of animals within a zoological setting. Providing appropriate mental stimulation for captive dolphins requires a commitment to vary cognitive challenges on a regular basis and so enrichment objects need to be designed to allow changes to maintain motivation and interest. Once mastered, the challenge and therefore motivation to continue to engage with a specific environmental enrichment tool is likely to decline. Stereotypical behaviours, such as circular swimming, could be reduced by providing varied shapes and an enriched environment to allow forage, play and socialising with conspecifics (Couquiaud 2005).

4.3 Impact on social behaviour

Social grouping has been recognised as one of the most important issues affecting health and welfare of captive cetaceans. Although in some cases an effort is made to mimic the nature of social groupings in captivity, it is impossible to provide for the varied and complex interactions that occur in the wild due to the limit on the number of individuals maintained in captive groups and the restricted physical environment.

Research conducted in the 1980s and 1990s identified that in a controlled environment certain aspects of normal social dynamics may be impeded causing disruptions to social groupings as well as risking harm to some individuals. Male dominance was cited as a common source of social and behavioural problems which has been reported to lead to hostility resulting in stress, and psychological and physical trauma. Since 2000, very few scientific articles have been published relating to aggression in captive dolphins, suggesting that research in this area is not being conducted. However, three cases of illness and mortality attributed to stress resulting from social instability and subsequent aggressive interactions indicate this is an important health and welfare consideration for captive dolphins (Waples & Gales 2002). Miller et al (2018) also identify the conflict between achieving species-typical social groupings to optimise group welfare with the potential welfare impact on individuals who may be at the bottom of the social hierarchy and unable to escape aggressive encounters.

A recent study using synchronous swimming as an indicator of affiliative behaviour (therefore suggesting a positive mental state) found that three of the eight dolphins studied clearly showed a low proportion of their time engaged in synchronous swimming and slow latency response to a cue to target in positions in between those where a reward had been given (Clegg et al. 2017). Although the authors noted that two dolphins showed behaviour that indicates optimism and therefore potentially positive affective states, at least three showed pessimism, with the remaining three dolphins displaying responses tending towards pessimism rather than optimism. Thus on balance, this study suggests that fewer captive dolphins engaged in affiliative behaviour (i.e. synchronous swimming) and displayed optimistic behaviour compared to others who showed limited affiliative behaviour and some pessimistic behaviour. This raises questions regarding the affective state of the majority of these dolphins in the study. As mentioned previously, studies in the wild show that social

interactions are complex, flexible, may involve many different individuals, and may change very quickly. Where small numbers of dolphins are kept in a limited space, there is little or no opportunity to experience such dynamic interactions.

4.4 Impact of sound

It is difficult to assess the impact of sound on captive dolphins, although it is recognised as being potentially aversive in wild populations, mainly in relation to sonar and shipping movements (Mooney et al. 2012). Despite the possibility that dolphins have mechanisms to protect their sensitive ears from their own loud echolocation clicks, these may not be sufficient to avoid negative effects of human-made sound. Life in a dolphinarium will expose dolphins to a range of different sounds both above and below water, including the human voice, loudspeaker music, crowd noise, traffic noise and construction sound. Wright et al. (2007) have reported the likelihood of loud, intermittent, impulsive sounds evoking stress responses in captive marine mammals. Dolphins spend a significant amount of time with their heads above water in anticipation of trainer commands and food delivery thus exposing them to in-air noise. Further studies on the impact of sound on dolphin behaviour are warranted.

4.5 Health

Studies have shown that dolphins in captivity can suffer stress resulting in appetite loss, ulcers, and increased susceptibility to disease due to changes in their social grouping, competition for resources and unstable social structures (Waples & Gales 2002). However, there is very limited information in the public domain on disease conditions in captive dolphins, or the measures to prevent and treat them. Details on administration of drugs to limit bacterial infection or modify behaviour are not available. Health records including clinical assessments and outcomes as well as treatment details would provide essential information to assist with determining the health status of dolphins held in captivity. The key issue is whether captivity initiates or exacerbates particular diseases.

Some disease conditions have been reported including eye problems, respiratory disease, fatty liver disease and metabolic syndrome. Colitz et al. (2016) found that over 10% of dolphins studied had medial keratopathy (damage to the cornea of the eye) and cataracts with possible predisposing factors being excess exposure to sunlight through feeding and training regimes, swim patterns close to walls and cohort trauma. Eye conditions are also included in the C-Well® Index (Clegg et al. 2015).

Delaney et al. (2012) reported that respiratory diseases are common in dolphins and describes four individual cases where all captive dolphins had a similar prolonged (months to years) clinical history, including episodic lethargy, inappetence, respiratory ‘‘wheezes,’’ and abnormal ‘‘honking’’ behaviour. This suggests that even with veterinary support and therapeutic agents, individual captive dolphins with chronic infections can suffer prolonged disease and possibly compromised affective states including anxiety, breathlessness and depression.

Metabolic disease has been reported in captive dolphins. Venn-Watson et al. (2012) found that of 18 captive dolphins who had acute or chronic disease preceding death, nearly 39% had mild to severe fatty liver disease and 66% had mild to moderate haemosiderosis (iron overload in the body). Wells et al. (2013) found that free ranging dolphins in Florida had a lower risk of developing insulin resistance and metabolic syndrome compared to captive dolphins with differences in diet and activity cycles considered to be important factors.

4.6 Longevity and neonatal mortality

Some individual dolphins have lived for over 50 years in captivity but given they have a constant food supply, veterinary support and no predators, pollution, nets or boats, this would be expected. Thus, it is difficult to compare longevity for captive and wild dolphins in a purely natural environment without removing the negative impact of human influence on wild populations. In addition, the question has been raised as to what the true impact of stress is on the average longevity of dolphins in captivity, especially as stress can increase susceptibility to disease (Rose 2004).

Dolphinariums often promote the age of individuals in their care who live beyond 40 years as being an indication that captivity is not harmful but virtually no data is released regarding sickness and mortalities, so

the average life span of captive dolphins is difficult to determine. However, one study of 103 captive dolphins in the US Naval Marine Mammal Program found the median age at death was 32 years, reportedly 10 years older than a study on wild dolphins (Venn-Watson et al. 2015). Further, the oldest age reached was 53 years in captivity and 63 years in the wild. One might expect a much higher longevity in captivity given the regular food supply and no predators or pollution.

Unfortunately, limited data are publicly available regarding the nature or prevalence of stillbirths and neonatal deaths for dolphins bred in captivity. One study highlights that stillbirth and mortality in the first three months after birth are significant issues in captive breeding programs for bottlenose dolphins (van Elk et al. 2007). Sweeney et al. (2010) collated birthing records from three major marine mammal facilities from 1999 to 2009. The reported mortality of young until one year of age was 19.3%, so nearly one in five births resulted in death within the first year of life. However, with improved management, a reduction in mortality rate to 13.7% for the period 2000-2009 was shown. Despite this, mortality of young captive bred dolphins remains a significant issue, with more than one in ten dolphins born dying before the age of one year. Another concern is that these data are from the better managed facilities including the US Navy Marine Mammal Program facility. Mortality rates in lower standard facilities is expected to be much higher. Although valuable information has been collected through this study, concerns remain regarding the consequences of a captive environment such as restriction of natural behaviour. For example, in the wild, mothers dive with their newborn calves as deep as possible and as early as possible to help strengthen respiratory function – this critical behaviour may be restricted in a captive environment. Secondly, in the wild, mothers remain close to their newborn due to the predatory threat but captive mothers generally do not display this. Furthermore, aggression towards neonates, especially by first time mothers, is a significant cause of trauma in captivity leading to death within the first 24 hours of birth. Aggression by conspecifics may also injure neonates leading to death.

Other studies have revealed that protecting young can be problematic due to attacks by males and stealing by other females (Lacave et al. 2004). In the study by Sweeney et al (2010), details of conditions or illness where young dolphins recovered but which would likely have caused some stress and/or suffering to affected individuals were not reported. Until captive breeding is prohibited, adverse outcomes could be minimised through mandatory standards which would only allow those facilities which have the expertise, infrastructure and resources to monitor and provide appropriate interventions to undertake captive breeding. For example, Lacave et al. (2004) believe that regular ultrasound examination combined with a birth prediction program would greatly assist in providing accurate dates for parturition which would allow time for support staff to make appropriate provisions for imminent birthing. Unfortunately, most facilities have neither the equipment nor expertise to conduct ultrasound examinations, thus denying opportunities to adequately prepare birth delivery to help minimise neonatal deaths.

Captive breeding poses a number of other welfare risks including trauma, infection and ill-thrift leading to suffering and death of young dolphins. However, the impact on mothers who lose their newborn calf including physiological risks (e.g. inappetence, infection and lactation complications), as well as potential psychological impacts (anxiety, frustration, fear, depression) has not been reported. Research in this area is warranted to fully understand the welfare impacts of captive breeding on both mothers and calves.

4.7 Effect of human-dolphin interactions

Direct human-dolphin interactions are a common activity in many dolphinariums and include swim-with-dolphin programs, fin-riding, and animal-assisted therapy sessions for people with special needs such as autism and developmental disabilities.

A number of studies have reported conflicting findings for the effects of human-dolphin interactions. For example, a New Zealand study of captive dolphins found some behaviour changes after swim-with-dolphin programs, including increased use of the refuge area, and relatively more time spent on the surface, with some slaps, charges and abrupt behaviours being observed (Kyngdon et al. 2003). Constantine (2001) also reported that wild dolphin interactions in New Zealand decreased from 48% to 34% and swimmer avoidance increased from 22% to 31% over a three year period. However, other studies have reported increased play after such interactions, which is deemed to indicate positive welfare (Miller et al. 2011b). Another study of three dolphins before and after interactive programs found no adverse effects, with some dolphins displaying increased locomotory behaviour following interactions (Sew & Todd 2013).

Facilities which conduct dolphin interactions promote the benefits to the human participants derived from such encounters to justify the programs. However, a review of five published papers espousing these human health improvements in dolphin assisted therapy programs described the methodologies and the conclusions as flawed (Marino & Lilienfeld 2007). The key flaws identified include inadequate experimental controls and non-specific effects (e.g. placebo and novelty effects) as well as small sample sizes. It is essential that any claims about the purported benefits of human-dolphin interactions are based on rigorous scientific methodology to ensure the data are robust and the interpretation and conclusions valid.

Furthermore, a comparative study which examined the impact on behaviour of human-dolphin interactions in a small marine enclosure and a larger marine park, with the latter being deeper, more than 20 times the surface area (600 m^2 versus 14,000 m^2) and with a refuge area, revealed that dolphins in the larger enclosure did not display avoidance behaviours whereas those in the smaller enclosure did (Brensing et al. 2005).

Another overseas study of tourists participating in a swim-with-dolphins program reported that, despite initially reporting being in awe of the grace, size and power of dolphins, participants subsequently had concerns about the size of enclosures and that too many tricks were performed (Curtin & Wilkes 2007). Interestingly, a survey of 244 visitors interacting with wild dolphins at Monkey Mia in Western Australia showed that over 80% would accept restrictions including reduced interaction time and proximity to dolphins if the welfare benefits to the dolphins were clearly communicated (Bach & Burton 2017). This suggests that welfare concerns are being increasingly recognised. with patrons willing to prioritise the needs of dolphins above tourism expectations.

Another concern is injury or potential disease transfer from dolphins to humans due to close interactions, particularly 'dolphin kisses'. Dolphins are known to be carriers of many organisms which cause disease in humans including bacteria, viruses, fungi and protozoa. A study of marine mammal workers reported half of those surveyed received an injury caused by a marine mammal, whilst 23% had a skin rash or reaction (Hunt et al. 2008). Infectious diseases reported included erysipelas, candidiasis, salmonellosis, leptospirosis and tuberculosis. The authors also acknowledged the potential for the transfer of pathogens between dolphins and people participating in interactive activities such as 'swim-with-the-dolphins' programs. *Bartonella*, bacteria which can cause fever like symptoms in humans, have been confirmed in captive dolphins (Harms et al. 2008) and Goldman et al. (2002) identified another bacteria, *Helicobacter* in the dental plaque of dolphins, which is implicated in gastric disease in humans. Similarly, dolphins interacting closely with humans are also at risk of contracting an infectious disease. Therefore, participants in interactive programs should be screened for respiratory infections, open wounds or other infectious disease as a precaution.

In the UK there has been a notable shift from tourist-based businesses promoting captive dolphins to those promoting wild dolphin experiences, primarily as a result of advocacy from animal welfare and animal rights groups (Hughes 2001). One study highlights the need for the tourism industry and researchers to consider the ethical implications where animals are involved in tourist-based activities (Hughes 2001). Given the growing popularity of these programs, but the apparent lack of operating guidelines and conflicting research findings, the development of consistent mandatory guidelines to safeguard the welfare of dolphins and humans in these situations is warranted.

4.8 Assessing the welfare of captive dolphins

Over the last decade there has been an increasing focus on objectively assessing the welfare of dolphins retained in captivity. The C-Well® (Cetacean Welfare Assessment) Index developed by Clegg et al. (2015) provides a useful framework by considering four key areas – food, health, housing and behaviour. Although it includes 11 criteria and 36 species-specific measures, C-Well® does not incorporate the assessment of emotional state, which is one of the most critical aspects. Although recognised as being a significant parameter, there is a paucity of scientific information regarding the emotional state of captive dolphins. C-well® is a good step forward despite only being 58% animal based and limited in terms of assessing restrictions on expression of natural behaviours, i.e. omission of foraging/hunting, travelling and complex social interactions.

5. LEGAL PROTECTION

There are significant international differences between jurisdictions regarding the capture and keeping of dolphins. Some countries prohibit the taking of wild dolphins for commercial purposes, whilst others freely permit this. Bottlenose dolphins are internationally listed as a CITES Appendix II animal, that is, they are not considered threatened with extinction but trade needs to be closely controlled. However, there are isolated populations of some dolphin species which are threatened, including the Australian snubfin dolphin. In 2007, the Australian government declared that all cetaceans would be listed as CITES Appendix 1 animals which prohibits the import or export of cetaceans or cetacean products. It is believed that this declaration was introduced to restrict trade rather than dolphins being considered a threatened species.

Over the past decade there has been a call from a number of cetacean scientists for greater global legal protection for dolphins. In 2010, a group of cetacean scientists, philosophers and advocates published a *Declaration of Rights for Cetaceans – Whales and Dolphins* which states that 'no cetaceans should be held in captivity or removed from their natural environment'. The aim is to present the declaration to the United Nations.

In the USA, much criticism has been directed at the recently reviewed US marine mammal care regulations as not referring to current scientific findings and industry best practice as well as being inadequate in many areas (Rose et al. 2017). This includes a lack of standards regarding appropriate environmental enrichment, noise limits and retreat space.

In the UK, following the findings of a parliamentary inquiry, stringent laws were introduced regarding the keeping of dolphins in captivity. Essentially, these tough laws combined with lobbying from animal welfare groups, led to all dolphinariums closing down in the UK by the 1990s. As with the UK, other countries have introduced tough requirements resulting in venues closing down, including Brazil, Luxembourg, Nicaragua and Norway. In 2009, Bolivia became the first country to ban dolphinariums (along with circuses and other venues using animals for public performances) with similar bans established in Chile, Costa Rica, Croatia, Cyprus, Hungary, India, Nicaragua, Slovenia, Switzerland, Mexico City and City of Barcelona.

In Australia, dolphins are recognised under state-based animal welfare legislation and any cruelty, ill-treatment or neglect of captive dolphins would be prosecutable. In addition, some states have welfare standards or a code of practice relating to animals used for display or exhibition which would apply to captive dolphins.

In 1988, Victoria prohibited the keeping of cetaceans, including dolphins, under the *Wildlife Act 1975*. Prior to this, the capture of live cetaceans for commercial purposes was also prohibited in Victoria but this has now been superseded by commonwealth legislation. Queensland and New South Wales are the only two states that currently have a facility with captive dolphins for entertainment purposes.

In New South Wales, the dolphin facility at Coffs Harbour is licensed by the NSW government and must comply with the provisions of the General Standards for Exhibiting Animals in NSW (2015) and the Standards for Exhibiting Bottle-nosed Dolphins (1994). However, these standards are now over 23 years old and no longer reflect current knowledge of dolphin behaviour and social structures.

In Queensland there are no specific welfare standards for dolphins, however, the dolphin facility on the Gold Coast must be granted a wildlife exhibitors licence from the Queensland Department of National Parks, Sport and Racing to operate. In addition, the facility must also retain a wildlife rehabilitation licence to be able to rescue, treat and retain injured dolphins from the wild.

Currently, there is no legal prohibition on breeding dolphins in captivity in either New South Wales or Queensland.

6. COMMUNITY ATTITUDES

As we continue into an era where the community is increasingly questioning our treatment of animals in general, the breeding and use of captive cetaceans for entertainment is of particular interest. While some of this attention has focused on orcas, such as with the documentary film *Blackfish* which raised questions about the keeping and treatment of orcas by SeaWorld in the USA, concern over the welfare of captive dolphins has also increased. Another documentary by US filmmaker Stan Minasian, *By All Rights*, released in early 2016, is the first film to focus on the issue of the rights of whales and dolphins, including the right to freedom from captivity. Over the past decade, animal welfare groups have campaigned strongly to raise concerns regarding the keeping of cetaceans in captivity, as understanding of the needs of these complex animals and the difficulty to adequately provide for them in captivity has grown. Interestingly, a survey of marine park visitors revealed that 47% did not believe that dolphins and whales enjoy their life at aquariums compared to 24% who thought they did (Jiang et al. 2008).

With concern mounting, audience attendances at marine shows in some parts of the world have declined significantly with associated business enterprises suffering financially. In 2016, the US National Aquarium announced it would transfer their remaining eight dolphins to an ocean refuge by 2020 which will provide a much more natural environment and stated "*In appreciation of their intellect and resilience, we continue to evolve our care to best suit their needs. Our future goal for these animals is to maintain the highest standards of health and welfare, while creating a more natural, ocean water sanctuary in which they can thrive."*

This follows a commitment by SeaWorld in early 2016 to cease breeding orcas in captivity. Pressure continues to release captive orcas into sea sanctuaries.

This change in community attitude is also reflected in the announcement that a proposed $100 million aquarium to be built in Queensland will not house dolphins, a decision welcomed by animal advocacy groups.

In 2018, Dolphin Marine Magic, based in Coffs Harbour, New South Wales, announced a collaborative partnership with advocacy groups, Action for Dolphins and World Animal Protection (funding providers), to undertake a feasibility study to relocate their five resident dolphins to a sea pen sanctuary.

Recently, there has been a greater focus on the welfare of animals used in tourism, in particular captive wild animal 'selfies' and elephant rides. In response, some travel agents (e.g. Trip Advisor, Responsible Travel) have developed animal welfare policies, and Instagram now provides warnings regarding animal welfare when certain hash tags are used, e.g. dolphin kisses and swim-with-dolphins.

The shift in how people view the use of captive dolphins has arisen in part due to the greater recognition of the intrinsic value of animals. For some people, performing dolphins demonstrate human use of an intelligent animal for profit which only recognises their utility rather than their intrinsic value. This is inconsistent with a philosophical view that animals have inherent value and are not to be treated as a means to an end (Regan 1983).

Yerbury et al. (2017) acknowledges that, although leisure interactions with animals may be viewed to satisfy fundamental human needs, the rights of other beings and nature must also be considered and that on this basis, challenges the justification for retaining dolphins in captivity for leisure.

7. JUSTIFICATIONS FOR THE KEEPING AND BREEDING OF DOLPHINS

Proponents of retaining, breeding and using dolphins in captivity rebuke criticisms and calls to cease such practices. In response, many animal advocates challenge claims that the keeping of dolphins in captivity is justified on the grounds of conservation and research benefits (Rose et al. 2009).

7.1 Conservation

Bottlenose dolphins, the most common species held in captivity, are not threatened in the wild and are listed as of least concern on IUCN's Red List, with an estimated wild population of at least 600,000. There is no evidence of a global populations decline that would justify the keeping and breeding of dolphins in captivity. This is in contrast to the conservation purposes that some zoos undertake to breed and release endangered species.

Some scientists see benefits in collating findings from both captive and wild population studies to further conservation efforts. However, until 2009, of the 50 papers published relating to conservation of cetaceans, only four involved captive populations with dolphins being the main species studied (Hill & Lackups 2010).

In order to justify the keeping of a highly intelligent animal with complex social structures and long natural range, for conservation, the species would need to be severely threatened. In addition, active rescue, breeding and release programs would need to be undertaken to help re-establish natural populations. None of these activities are being undertaken in relation to dolphins. It appears that the only reason dolphins are being bred in captivity in Australia is to perpetuate their use for entertainment.

Where zoos or aquariums engage in significant conservation work with the aim to return captive bred animals to a natural environment and support habitat restoration, they lay claim to a conservation-based ethic. Such claims by marine parks as to their contribution to conservation is being increasingly challenged. Gray (2017) states that, although marine parks with performing animals are considered part of the zoo industry, it is a questionable fit given that the modern zoo focuses heavily on welfare, conservation and education. According to Gray, *'There is no evidence that dolphin shows in any way promote the health and conservation of wild dolphins.'*

This is supported to some extent by a study by Jiang et al. (2008) which found that 46% of marine park visitors disagreed that such parks provide lots of information on conservation compared to 27% who agreed with this statement.

Where injured dolphins are rescued and rehabilitated, as with other species, if animals are unable to be returned to the wild, appropriate open enclosures should be established for their long-term care and management, rather than retaining them for entertainment performances or interactions.

7.2 Education

Some dolphinariums claim that dolphin performances are framed to educate audiences about marine conservation and dolphin behaviour. However, there is no evidence that live dolphin shows are necessary to achieve this outcome. People can experience and appreciate the natural environment as well as the animals who live within it by patronising ecologically sensitive and sustainable charter tours to observe dolphins in the wild. Messages about marine conservation can also be successfully extended through community education programs as well as beach walks and other activities to promote all sea life, not just through viewing performances of or interaction with captive animals.

7.3 Research

The keeping of dolphins in captivity is supported by some scientists who argue that experimental subjects are needed to continue research into dolphin behaviour and physiology. However, there are no formal scientific research programs associated with dolphinariums in Australia.

Research on captive dolphins has a number of serious limitations including restricted social groupings, confined space, small sample sizes, the impact of passive feeding and medical treatments (hormones) on behaviour and questionable capacity of captive dolphins to represent wild populations (Perelberg et al. 2010).

There are challenges with studying dolphins in the wild as well as in captivity. One of the major impediments with 'wild' studies is that controlled experiments are difficult; other challenges include varying and unsuitable sea conditions, poor visibility and unpredictability in being able to observe subjects. However, these problems are common to field research on other marine species and scientists are achieving increasing success studying free-living populations of cetaceans in their natural environment with the use of technological advances including DNA analysis (Nowacek et al. 2016).

Studying synchrony and alliances in male dolphin behaviour has been an important area of research on wild populations and is virtually impossible in captive environments. Caution must be taken when interpreting social relationships of captive, artificially grouped animals, and validation via comparisons to wild populations (Connor et al. 2006). One study supporting continued research on both captive and wild dolphins claims that there are advantages to pooling findings from wild and captive dolphin studies (Dudzinski 2010). However, the report is somewhat contradictory in that there is extensive overlap between observed behaviours of both populations, raising the question of the need for captive studies to be conducted at all. These findings were derived from surveys conducted on trainers who watched underwater footage of wild dolphins, with many confirming similar behaviours seen in captive dolphins.

Large whales cannot be studied in captivity due to the physical limitations of retaining them in a restrictive environment. Unfortunately, human curiosity and our ability to breed dolphins in captivity have taken precedence over fulfilling the needs of these individual animals. While in some countries, predominantly the USA, studies continue on captive dolphins, other researchers are focusing efforts on wild population studies to demonstrate that the former are neither necessary nor ethically sound (Grimes 2011).

Marino and Frohoff (2011) promote an innovative approach referred to as 'interspecies collaborative research' which involves researchers working with free-ranging cetaceans who have initiated or chosen to participate in sociable interactions in the wild. It is anticipated that this approach will avoid the ethical and scientific challenges that are inherent with research on captive animals. Furthermore, an important element is that studies are designed so that the participating cetaceans are the direct recipients of the benefits gained from the research.

If wild dolphins were at risk of extinction, and there was no other option but to retain individuals for scientific purposes, then this could be the only acceptable grounds for dolphins to be kept in captivity. However this is not the case. The argument to maintain captive dolphins on the basis that some aspects cannot be obtained from wild studies, is difficult to defend.

7.4 Breeding

The exact number of dolphins bred in captivity in Australia is not available; however, both facilities holding dolphins rely on breeding to ensure ongoing performances, as it is illegal to capture dolphins from the wild in Australian waters. Young dolphins are born and raised in an artificial environment, destined to live in pools and tanks where space is limited and the opportunity to express many natural behaviours is denied.

The only potential justification to breed dolphins in captivity is for conservation purposes, where the ultimate goal is for release into the wild to replenish diminishing populations. As discussed above, bottlenose dolphins are not endangered, therefore captive breeding on this basis is ethically questionable.

Some proponents of dolphinariums claim that keeping dolphins in captivity can be justified on the basis that it is also deemed acceptable to retain other species with high levels of intelligence, large natural range and complex social relationships in zoos. The capacity for any confined environment to meet all needs of these types of animals is also questionable. Preventing natural behaviour patterns for some species with a large natural home range can give rise to stress and frustration, and the only option to address this is to either expand captive space considerably or cease maintaining these species in zoos (Clubb & Mason 2003). Other studies have also identified numerous stressors associated with confinement (Morgan & Tromborg 2007).

8. CONCLUSIONS

Dolphins are extremely intelligent, self-aware marine mammals with complex cognitive capacities. They have a large brain relative to their body mass, and a highly developed neocortex, associated with problem solving and processing emotions, and a sense of self. They are highly social, with dynamic group structures and affiliations where they choose to interact with different individuals, depending on the context. In the wild they swim vast distances in open oceans, spend a significant amount of their time foraging and hunting, seek out pleasurable activities and enjoy several forms of play.

Our ability to meet these needs in a captive environment is compounded by a range of factors. Captive dolphins endure severe space restrictions compared to their wild counterparts, which can lead to stress and behaviours associated with boredom and lack of stimulation. Dolphin facilities have little variety or complexity in the underwater environment. Training and human interaction can help alleviate the boredom of captivity but providing sufficient mental stimulation for captive dolphins requires considerable and ongoing effort to vary cognitive challenges on a regular basis. There is conflicting evidence on whether human-dolphin interactions have an overall positive impact on dolphin welfare, indicating that such programs should be implemented with caution and carefully monitored and evaluated. Captive dolphins are also restricted in terms of social interactions, both in terms of the number of individuals they can interact with, and the flexibility and choice of who they interact with. There is little or no opportunity for the type of dynamic interactions they would experience in the wild. Cumulatively, these restrictions can lead to health issues associated with chronic stress, including increased susceptibility to disease.

It is no longer possible for dolphinariums in Australia to capture dolphins from the wild, however, where such facilities are licensed for dolphin rescue and rehabilitation they can retain wild dolphins who are unable to be released. Legal protection for captive dolphins in Australia varies from state to state, with Victoria being the only state that has prohibited the keeping of dolphins and other cetaceans in captivity. NSW is the only jurisdiction with specific standards for the exhibition of dolphins, but these do not reflect current knowledge of dolphin biology.

Community concerns over the keeping of cetaceans in captivity appear to be increasing, with leading scientists, philosophers and animal welfare organisations supporting the concept of a Declaration of rights for cetaceans including the right to freedom from captivity. In addition, twenty scientists from around the world have signed a statement that based on the current evidence, dolphins should not be maintained in captivity for entertainment. As a result, some institutions have disassociated themselves from keeping cetaceans.

There appears to be little evidence to support the main claims made by proponents of dolphin captivity. Bottlenose dolphins, the most commonly held species in captivity, are not threatened in the wild and there are no active conservation programs being undertaken in association with Australian dolphinariums. Furthermore, there is no evidence that the keeping or breeding of dolphins in Australia has educational or scientific benefits. The only reason dolphins are being bred and kept in captivity in Australia is to perpetuate their use for entertainment.

The RSPCA is opposed to the keeping of animals for exhibition or entertainment where scientific evidence indicates that their needs cannot be adequately met in a captive environment. The evidence presented here strongly indicates that the keeping of dolphins in captivity has the potential to cause adverse effects on health and welfare. In our view, legislation should be enacted in all states and territories to end the breeding and keeping of dolphins and other cetaceans in Australia.

REFERENCES

Bach L & Burton M (2017) Proximity and animal welfare in the context of tourist interactions with habituated dolphins. Journal of Sustainable Tourism, 25(2):181-197

Boddy AM, McGowan MR, Sherwood CC et al. (2012) Comparative analysis of encephalization in mammals reveals relaxed constraints on anthropoid mammals and cetacean brain scaling. Journal of Evolutionary Biology, 25:981-994

Brensing K, Linke K, Busch M et al. (2005) Impact of different groups of swimmers on dolphins in swim-with-the-dolphin programs in two settings. Anthrozoos, 18:409-429

Broom DM (2016) Considering animals' feelings. Animal Sentience, 005

Clark FE (2013) Marine mammal cognition and captive care: a proposal for cognitive enrichment in zoos and aquariums. Journal of Zoo and Aquarium Research, 1(11):1-6

Clark FE, Davies SL, Madigan AW et al. (2013) Cognitive enrichment for bottlenose dolphins (*Tursiops truncatus*): Evaluation of a novel underwater maze device. Zoo Biology, 32:608-619

Clegg ILK, Borger-Turner JL & Eskelinen HC (2015) C-Well: The development of a welfare assessment index for captive bottlenose dolphins (*Tursiops truncatus*). Animal Welfare, 24:267-282.

Clegg, ILK, Rödel HG & Delfour F (2017) Bottlenose dolphins engaging in more social affiliative behaviour judge ambiguous cues more optimistically. Behavioural Brain Research, 322:115-122

Clegg ILK, Rödel HG, Boivin X & Delfour F (2018) Looking forward to interacting with their caretakers: dolphins' anticipatory behaviour indicates motivation to participate in specific events. Applied Animal Behaviour Science, 202:85-93

Clubb R & Mason G (2003) Captivity effects on wide-ranging carnivores. Nature, 425:473-474

Colitz CM, Walsh MT & McCulloch SD (2016) Characterisation of anterior segment ophthalmologic lesions identified in free-ranging dolphins and those under human care. Journal of Zoo and Wildlife Medicine, 47(1): 56-75

Connor RC, Smolker, R & Bejder L (2006) Synchrony, social behaviour and alliance affiliation in Indian Ocean bottlenose dolphins, *Tursiops aduncus*. Animal Behaviour, 72:1371-1378

Constantine R (2001) Increased avoidance by wild bottlenosed dolphins (*Tursiops truncatus*) due to long term exposure to swim-with-dolphin tourism. Marine Mammal Science, 17(4): 689-702

Couquiaud L (2005) A survey of the environments of cetaceans in human care. Aquatic Mammals, 31:3

Curtin S & Wilkes K (2007) Swimming with captive dolphins: current debates and post-experience dissonance. International Journal of Tourism Research, 9:131-146

Delaney MA, Terio KA, Colegrove KM et al. (2012) Occlusive fungal tracheitis in four captive bottlenose dolphins (*Tursiops truncatus*). Veterinary Pathology, 50(1):172-176

Delfour F & Beyer H (2012) Assessing the effectiveness of environmental enrichment in bottlenose dolphins (*Tursiops truncatus*). Zoo Biology, 31:137-150

Dudzinski K (2010) Overlap between information gained from complementary and comparative studies of captive and wild dolphins. International Journal of Comparative Psychology, 23:566-586

Fraser D, Weary D, Pajor E & Milligan B (1997) A scientific conception of animal welfare that reflects ethical concerns. Animal Welfare, 6:187-205

Fraser D (2009) Assessing animal welfare: Different philosophies, different scientific approaches. Zoo Biology, 28(6):507-518

Gero, S, Bejder L, Whitehead H et al. (2005) Behaviorally specific preferred associations in bottlenose dolphins (*Tursiops spp*). Canadian Journal of Zoology, 83:1566-1573

Goldman CG, Loureiro JD, Quse V et al. (2002) *Helicobacter sp*. in dental plaque of captive dolphins (*Tursiops gephyreus*). Journal of Wildlife Diseases, 38(3):644-648

Gray J (2017) Zoo ethics – The challenges of compassionate conservation. The University of Chicago Press.

Grimes D (2011) Are dolphins too smart for captivity? Science, 332:526-529

Gubbins C (2002) Use of home ranges by resident bottlenose dolphins (*Tursiops truncatus*) in a south Carolina estuary. Journal of Mammalogy, 83(1):178-187

Harms CA, Maggi RG, Breitschwerdt EB et al. (2008) *Bartonella* species detection in captive, stranded and free-ranging cetaceans. Veterinary Research 39:59 doi:10.1051/vetres:2008036. Accessed 2nd February 2019.

Hawkins E & Gartside D (2008) Social and behavioural characteristics of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in northern New South Wales, Australia. Australian Mammalogy, 30:71-82

Hermann LM (2010) What laboratory research has told us about dolphin cognition. International Journal of Comparative Psychology, 23:310-330

Hill H & Lackups M (2010) Journal publication trends regarding cetaceans found in both wild and captive environments: What do we study and where do we publish? International Journal of Comparative Psychology, 23:414-534

Hughes P (2001) Animals, values and tourism – structural shifts in UK dolphin tourism provision. Tourism Management, 22:321-329

Hunt TD, Ziccardi MH, Gulland FMD et al. (2008) Health risks for marine mammal workers. Diseases of Aquatic Organisms, 81:81-92

Jiang Y, Luck M & Parsons ECM (2008) Public awareness, education and marine mammals in captivity. Tourism Review International, 11:237-249

King S & Janik V (2013) Bottlenose dolphins can use learned vocal labels to address each other. Psychological and Cognitive Sciences, 110(32):13216-13221

Kuczaj SA, Makecha R, Trone M et al. (2006) Role of peers in cultural innovation and cultural transmission: Evidence from the play of dolphin calves. International Journal of Comparative Psychology, 19:223-240

Kyngdon DJ, Minot EO & Stafford KJ (2003) Behavioural responses of captive common dolphins *Delpninus delphis* to a 'swim-with-dolphin' programme. Applied Animal Behaviour Science, 81:163-170

Lacave G, Eggermont M, Verslycke T et al. (2004) Prediction from ultrasonographic measurements of the expected delivery date in two species of bottlenosed dolphin (*Tursiops truncatus* and *Tursiops aduncus*). Veterinary Record, 154:228-233

Mann J, Stanton MA, Patterson EM et al. (2012) Social networks reveal cultural behaviour in tool-using dolphins. Nature Communications, 3:980

Marino L & Frohoff T (2011) Towards a new paradigm of non-captive research on cetacean cognition. PloS ONE, 6(9): e24121. doi.org/10.1371/journal.pone.0024121. Accessed 15th October 2018.

Marino L, Butti C, Connor RC et al. (2008) A claim in search of evidence: reply to Manger's thermogenesis hypothesis of cetacean brain structure. Biological Reviews, 83(4):417-440

Marino L, Connor RC, Fordyce RE et al. (2007) Cetaceans have complex brains for complex cognition. PLoS Biol, 5(5):e139. doi:10.1371/journal.pbio.0050139.. Accessed 10th November 2018.

Marino L & Lilienfeld SO (2007) Dolphin assisted therapy: More flawed data and more flawed conclusions. Anthrozoos, 20(3):239-249

Miller LJ, Kuczaj SA & Herzing D (2011a) Stereotypic behaviour in wild marine carnivores? Zoo Biology, 30(4):365-370

Miller LJ, Mellen J, Greer T & Kuczaj SA (2011b) The effects of education programmes on Atlantic bottlenose dolphin (*Tursiops truncatus*) behaviour. Animal Welfare, 20(2):159-172

Miller DS, Anthony R & Golab G (2018) Assessing aquatic mammal welfare while assessing differing values and imperfect tradeoffs. Aquatic Mammals, 44(2):116-141

Mooney TA, Yamato M & Branstetter BK (2012) Hearing in cetaceans: From natural history to experimental biology. Advances in Marine Biology, 63:197-246

Morgan, KN & Tromborg CT (2007) Sources of stress in captivity. Applied Animal Behaviour Science, 102:262-302

Neto MP, Silveira M & dos Santos ME (2016) Training bottlenose dolphins to overcome avoidance of environmental enrichment objects in order to stimulate play activities. Zoo Biology, 35:210-215

Nowacek DP, Christiansen F, Bejder L et al. (2016) Studying cetacean behaviour: new technological approaches and conservation applications. Animal Behaviour, 120:235-244

Paulos RD, Trone M & Kuczaj II SA (2010) Play in wild and captive dolphins. International Journal of Comparative Psychology, 23(4):701-722

Perelberg A, Veit F, van der Woude SE et al. (2010) Studying dolphin behaviour in a semi-natural marine enclosure: Couldn't we do it all in the wild? International Journal of Comparative Psychology, 23:625-643

Regan T (1983) The case for animal rights. University of California Press

Reiss D & Marino L (2001) Mirror self-recognition in the bottlenose dolphin: A case of cognitive convergence. Proceedings of the National Academy of Sciences, 98(10):5937-5942

Rohr JJ, Fish FE & Gilpatrick Jr. JW (2002) Maximum swim speeds of captive and free-ranging delphinids: critical analysis of extraordinary performance. Marine Mammal Science, 18(1):1-19

Rose NA (2004) Captive cetaceans: The science behind the ethics. Proceedings of European Cetacean Society 18th Annual Conference, Kolmarden, Sweden

Rose N, Hancock Snusz G, Brown DM & Parsons ECM (2017) Improving captive marine mammal welfare in the United States: science based recommendations for improved regulatory requirements for captive marine mammal care. Journal of International Wildlife Law & Policy, 20(1):38-72

Rose N, Parsons E & Farinato R (2009) The case against marine mammals in captivity. The Humane Society of the United States and the World Society for the Protection of Animals

Sew G & Todd PA (2013) The effects of human dolphin interaction programmes on the behaviour of three captive Indo-Pacific humpback dolphins. The Raffles Bulletin of Zoology, 61:435–442

Shyan MR, Merritt D, Kohlmeier NM et al. (2010) Effects of pool size on free-choice selections by Atlantic bottlenose dolphins at one zoo facility. Journal of Applied Animal Welfare Science, 5(3):215-225

Sweeney JC, Stone R, Campbell M et al. (2010) Comparative survivability of *Tursiops* neonates from three US institutions for the decades 1990-1999 and 2000-2009. Aquatic Mammals, 36(3):248-261

Ugaz C, Valdez RA, Romano MC & Galindo F (2013) Behavior and salivary cortisol of captive dolphins (*Tursiops truncatus*) kept in open and closed facilities. Journal of Veterinary Behaviour, 8:285-290

van Elk CE, van dep Bildt MWG, Martina BEE et al. (2007) *Escherichia coli* septicaemia associated with lack of maternally acquired immunity in a bottlenose dolphin calf. Veterinary Pathology, 44:88-92

Venn-Watson S, Benham C, Karlin K et al. (2012) Hemochromatosis and fatty liver disease: building evidence for insulin resistance in bottlenose dolphins (*Tursiops truncatus*). Journal of Zoo and Wildlife Medicine, 43(3):S35-S47

Venn-Watson SK, Jensen ED, Smith CR et al. (2015) Evaluation of annual survival & mortality rates and longevity of bottlenose dolphins (*Tursiops truncatus*) at the United States Navy Marine Mammal Program from 2004 through 2013. Journal of American Veterinary Medical Association, 246(8):893-898

Waples KA & Gales NJ (2002) Evaluating and minimising social stress in the care of captive bottlenose dolphins (*Tursiops aduncus*). Zoo Biology, 21:5-26

Wells RS, McHugh KA, Douglas DC et al. (2013) Evaluation of potential protective factors against metabolic syndrome in bottlenose dolphins: feeding and activity patterns of dolphins in Sarasota Bay, Florida. Frontiers in Endocrinology, 4: Article 139

Wright AJ, Soto NA, Baldwin AL et al. (2007) Do marine mammals experience stress related to anthropogenic noise? International Journal of Comparative Psychology, 20:274-316

Yaman S, Kilian A, von Ferson L & Gunturkun O (2012) Evidence for a numerosity category that is based on abstract qualities of "few" vs. "many" in the bottlenose dolphin (*Tursiops truncatus*). Frontiers of Psychology, 3: Article 473

Yerbury R, Boyd W, Lloyd D & Brooks A (2017) Right to leisure? Refocusing on the dolphin. Annals of Leisure Research, 20(3):368-385

RSPCA

for all creatures **great** & **small**

The RSPCA is Australia's leading animal welfare organisation and one of Australia's most trusted charities. The RSPCA works to prevent cruelty to animals by actively promoting their care and protection.

RSPCA Australia
PO Box 265 Deakin West ACT 2600