Differences and Similarities Observed in Dolphins Raised in Captivity vs Dolphins Raised in the Wild (Különbségek és Hasonlóságok Fogságban Nevelt és Szabadon Nevelkedett Delfinek Között)

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Literature Review

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1. List of Abbreviations

AI- Artificial Insemination

SW- Signature Whistles

NSW- Non-Signature Whistles

SIGID- Signature Identification

PVs- Papilloma Viruses

CBC- Complete Blood Count

ALT- Alanine Transaminase

MPN- Most Probable Number

2. Abstract

In English

Dolphins are remarkable animals. They are considered to be one of the smartest animals, secondary to humans. They have highly advanced cognitive abilities. Not only can they communicate with one another, but they can also solve problems, identify themselves in mirrors and use echolocation to identify their surroundings. This dissertation explores the differences and similarities between dolphins found in the wild and dolphins born and bred in captivity or taken into captivity. We will mainly be discussing the bottlenose dolphin as these are one of the most popular breeds of dolphin found in captivity and used for entertainment.

Section 5.1 focuses on play in these dolphins, play is important for the cognitive development and stimulation of these animals. Section 5.2 delves into the different modes of breeding of these dolphins and the different ways with which they nurse their young. Section 5.3 investigates the complexities of human and dolphin relationships and how this affects their development and how they impact one another. Section 5.4 highlights the different ways with which dolphins communicate and how they develop their signature clicks and whistles. Section 5.5 names many different diseases that affect dolphins, such as skin diseases and urogenital diseases, and analyses the different treatments, if any, that are available to these animals. In Section 5.6 the ages of death in dolphins found in the wild versus those in captivity are compared and contrasted. This section explores the reasons for any differences. Section 5.7 examines the differences in dolphin nutrition when they are made to find their own food in the wild versus when it is provided for them. Section 5.8 compares the conditions of the pools versus that of the sea and how these conditions aid or hinder the quality of life of these animals. Section 5.9 emphasises the importance of the safe capture andtransport of dolphins and how this can be detrimental to their future.

Through these analyses, this dissertation aims to shed light on the ways in which dolphins are treated in captivity and how this affects their physical and cognitive development and their quality of life and how this differentiates from the development of dolphins living in their natural habitat.

In Hungarian

A delfinek figyelemre méltó állatok. Az ember után őket tartjuk a legokosabbnak az állatok közül: nagyon fejlett kognitív képességekkel rendelkeznek. Nem csak kommunikálnak egymással, de képesek megoldani problémákat, felismerni magukat a tükörben (saját identitás tudattal rendelkeznek). Környezetük feltérképezésére echolokációt alkalmaznak. Ez a dolgozat feltárja a különbségeket és hasonlóságokat a vadon élő delfinek és az a fogságban született és felneveltdelfinek között. A munka alapját a palackorrú delfinről olvasott publikációk alkotják, amely egyik legnépszerűbb delfinfajta. Fogságban számos helyen találkozunk velük és akár szórakoztatásra is kiképezettek.

Az 5.1. szakasz a delfinek játékára összpontosít, mivel a játék fontos a kognitív képességek szempontjából és serkenti, fejleszti ezeket az állatokat. Az 5.2. szakasz a különböző módokat tárgyalja a delfinek tenyésztése és borjaik gondozása szempontjából. A 5.3. szakasz vizsgálja az emberek és a delfinek közötti kapcsolatok bonyolultságát és ennek hatását fejlődésükre. Az 5.4. szakasz kiemeli a különböző módokat, amellyel a delfinek kommunikálnak. Elemzi, hogyan alakítják ki jellegzetes kattintásaikat és sípoló hangjaikat. Az 5.5 szakasz számos különféle betegséget nevez meg, amelyek a delfineket érintik, mint például a bőrbetegségek és urogenitális betegségeket. A szakasz elemzi a különböző kezeléseket, ha vannak ilyenek, amelyek elérhetőek állatokat. Az 5.6. szakaszban a vadon élő delfinek halálozási korát mutatjuk be, összehasonlítva a vadon élő delfinek halálozási korával. Ez a rész az eltérések okait vizsgálja. Az 5.7. szakasz azt elemzi, hogy milyen különbségek vannak a delfinek táplálkozásában, a vadászat és a biztosított élelem megszerzésében. Az 5.8. szakasz összehasonlítja a medencék állapota a tengerhez képest, és hogy ezek a körülmények hogyan segítik vagy akadályozzák ezeknek az állatoknak az életminőségét. Az 5.9. szakasz hangsúlyozza a biztonságos rögzítését a fogságban élő delfinek mozgatása, szállítása közben.

Ezen elemzéseken keresztül a disszertáció célja, hogy rávilágítson arra, hogyan kezelik a delfineket fogságban, és ez hogyan befolyásolja fizikai és kognitív képességeiket fejlődésüket és életminőségüket, és miben különbözik mindez természetes élőhelyükön élő delfinektől.

3. Introduction

The captivation of marine mammals dates back to the 1860s, where two beluga whales, coming from the Labrador Coast, were transported to New York and displayed in Barnum's American Museum [1]. Overtime this practice only increased with these animals not only being used in circuses and museums but also on movie sets in order to film particular scenes [1]. In the 1930s the bottlenose dolphin rose to popularity due to its appearance in popular entertainment and the filmmakers capitalised on this by displaying these dolphins for the public [2]. Through the increased study of these dolphins we observed that they seemed to be capable of learning simple commands and communicating between themselves [3]. We came to realise how intelligent they are and how they are capable of learning tricks and areable to be trained [3]. This led to further capitalisation when in the 1960s these animals were trained and used in performance rather than just for observation as they had been in the past [3]. This is what began the business model we see nowadays of using dolphins for entertainment value [3].

Dolphins are said to be found in oceans and seas worldwide in both cold andtropical areas [4]. There are 2 main types of dolphins found those which are short and those which are long beaked [4]. The most common dolphin found in the Mediterranean is the *Delphinus delphis* known as the common dolphin which have now been listed as an endangered species due to falling victim to prey, fisheries, pollution, climate change amongst other risks [5]. In this report we will be discussing dolphins, mainly bottlenose dolphins (*Tursiops truncatus*), as these are the main dolphins found in waterparks and zoos. In enclosed basins, such as the Mediterranean Sea, the pressure of human activities has had a significant effect on the marine environment, especially in coastal areas [6].

Several issues have arisen due to the popularity of entrapping these animals;many behavioural changes have been observed for example dolphins start to fight for dominance due to being in an enclosed space [7]. In the wild, on the other hand,

dolphins are found in pods which could reach numbers greater than a 100 and due totheir high intellect they are able to communicate within their pods. Dolphins can use verbal communication, which is also combined with non-verbalcommunication such as, body postures, bubble blowing and fin caresses [8]. Whenhaving dolphins from different pods in one pool problems can arise as they are unable to communicate with one another [8].

This study is going to be focused on the differences we observe in dolphins found in their natural habitat and those in captivity. We will assess the pros and cons for both and look at the benefits of the conservation of these animals while also observing behavioural changes. In addition to this we will also focus on the veterinary side of the captivation of these animals as it can be beneficial, such as insituations of illness since the animals can be identified and treated more quickly.

4. Aims

The main aim of this study is to discuss and assess the main differences found between dolphins which were bred or taken into captivity and those found in their natural habitats.

The topics that we will be discussing are;

Inter and intra-specific relationships:

- The different ways of brain stimulation and entertainment available to the dolphins in thewild versus in captivity.
- The different methods of breeding (e.g. artificial insemination, sexual intercourse)
- The differences between the human relationships developed by both groups
- The different methods of communication employed by both groups.
- Common disease amongst dolphins and the veterinary influence

Physico- chemical differences of the living environment:

- The life spans of both groups.
- The different foods eaten and feeding methods employed by both groups.
- The different pH levels and salinities of the water in the pools versus those of the Mediterranean Sea.
- The different temperatures of the pools versus the natural environment.
- The methods of capture and transport of these dolphins.

By the end of this study, I aim to have highlighted the differences and similarities between these

two distinct groups of dolphins. Through unbiased research I aim to emphasize how captivity can be both beneficial and harmful to these species and the veterinaryrelevance of these results.

5. Literature review

During the write up we will be comparing and contrasting the main differences seen between wild vs captive dolphins. We will discuss different ways to improve upon certain threats and also highlight how we can protect and benefit these animals. Additionally, we will speak about the benefits and humane ways we these animals should be treated in captivity.

5.1.Play in Wild Dolphins vs Play in Captive Dolphins

Play is defined as a spontaneous action where an animal is able to learn new behaviours and modify old ones in the absence of stressful situations [9]. It is said that play isan important activity which provides socialisation, but it also can be a solitary action [10]. Juvenile play in dolphins seems to be more complicated than that of adults such as chasing, wrestling and jumping. Play is said to be highly important in young dolphins as it will help to teach them survival practices as adults [10]. It helps young dolphinsdevelop their locomotor skills such as foraging and mating strategies [11]. Dolphins' play is further enhanced when calves find themselves in bigger groups which in turn enriches the development of their problem-solving skills. Through this these dolphins can also gain better social behaviours and increase effective communication within the group [11]. As a result of this we will see an improvement in the reproducing nature of the animal and also increases in its chances of survival [11]. Play at the beginning of life is mostly seen as solitary, whilst in juveniles andsubadults play becomes more of a social experience and the young will start trying to play with older members of the pod [9]. As dolphins age play will start to be less frequent butmore complex [9].

5.1.1. Play in Wild Dolphins

Play in dolphins is used for learning, for example, observing older dolphins and examining their behaviours. It is also used to allow the dolphins to learn about their environment, for example, young dolphins will follow their mothers and learn where to find fish for feed . Additionally, through object manipulation, dolphins can learn, through trial and error, the proper skill which need to be developed and the appropriate behaviour [12]. Dolphins in the wild ten to play with everything they find, and human influence is rarely seen [11]. We can observe wild dolphins playing with the bubbles they create with their mouths or playing with their food before consumption, for example, using fish. Sometimes they use animals which should not be used as playful objects such as sharks, sea stars, turtle, jellyfish [11].

In a study it was seen that adult dolphins participate more in solo play rather than group

play whilst the younger dolphins seemed to participate in both solo and group play equally (notably, this was done almost twice more than any other age group) [10]. This iswhy it is important that dolphins kept in pools, especially young dolphins, are given objects and enough enrichment to stimulate their need to release energy and foster survival skills along with the other benefits mentioned above. This study also examined whether the sex of the animal had any significance on the type of play and the frequency of play in wilddolphins and it was in fact not significant [10].

5.1.2. Enrichment for Captive Dolphins

Nowadays cognitive enrichment has become an important tool for the well being of captive animals [13]. Interestingly, dolphins are quite specific and they do not consider all objects as toys [14]. When giving objects for the enrichment of these animals we need to observe their behaviour towards the particular object in order to determine if it is providing enrichment [14]. Environmental enrichment is needed in order to reduce unwanted behaviours of violence [15]. It is said that there are 3 main types of enrichment for dolphins, those being of object play, human interaction and food motivation and this is done to improvethe well-being of the dolphins in captivity [15]. Food can be used in order for brainstimulation for the dolphins this can be done by for example hiding the food in the enclosure and thus forcing the animal to look for it so this can trigger the hunting instinct in the dolphins, or for example freezing the food or using a feeding device in order to allow the dolphins to exert their energy by having to work to receive the food [15]. Pools mostcommonly use bath mitts in order to allow dolphins to rub their backs on it, and they also provide dolphins with toys such as balls, buoys, hula hoops, feeder pipes, mirrors, target poles amongst other objects. These are used in order to promote natural behaviours in dolphins and also to help build relationships between the human trainers and the dolphins [16].

5.1.3. Play in Captive Dolphins

Captive dolphins were observed to perform both solo and group play in captivity, this is important for the development of locomotor skills and to develop relationships withhumans [17]. Captive dolphins not only play with objects but also with water bubbles [17]. Play is also important to teach calves how to stimulate themselves for example mother dolphins will be observed producing bubbles and them popping them with her mouth and the young will see this and attempt to imitate the mother dolphin, this is important in order to teach the young

different ways to exhaust their energy [18]. Play is said to be an important tool in observational learning [18]. It is also easier to evaluate observational learning in captive dolphins rather than wild ones and we can see the extensive thinking the dolphins are capable of. Additionally, we may also study the different relationships and ways that dolphins communicate with one another through play [18].

5.1.4. Conclusion

In summary, wild dolphins engage in more spontaneous and diverse play behaviours that reflect their natural habitat, while captive dolphins benefit from structured enrichment activities. Both environments highlight the impact of play and studies show that play is critical for the physical and mental development of dolphins no matter where they are found. This emphasises the importance of promoting play when tending to dolphins in captivity.

5.2. The Different Modes of Breeding of Dolphins and Nursing their Calves

Upon studying these animals reproductive seasonality was found to not be influential. Locality was also determined not to be a factor. It was discovered that dolphin breeding is most likely to be influenced by the local environmental conditions [19]. Their reproduction is said to be moderately seasonal taking place mostly between September- January [20]. Averagely a dolphin pregnancy lasts around 12 months [21]. It is said that dolphins tend to ovulate between 2 to 7 times a year and their cycle lasts 30 days [22]. Therefore, dolphins are considered to be seasonally polyestrous and both male and females have multiple partners during their mating period [22]. During the sexual intercourse the dolphins will participate in head butting and tail scratching [22]. Signs of menopause are doubtful in dolphins as geriatric dolphins have been seen to become pregnant as well [22]. Females reach their sexual maturity between the ages of 5-10 years old on the other hand males are considered sexually mature later between the ages of 8-12 years old [21]. Female dolphins are able to bear a calf every 2 years and per pregnancy they usually have one calf [23]. Calves are normally 111-116.3 cm and they weigh are 10-20kg [23]

5.2.1. Natural Intercourse

The male's reproductive equipment are found inside the body which is not ordinary as normally in mammals testicles are found outside the body as the body temperature is to warm for the sperm [21]. In dolphins this is regulated by the fact that they have blood vessels which go from the testicles to the dorsal fin and flukes in order to transmit the heat away from the testicles in order to keep them below the body temperature [21]. The testes are found in the abdominal cavity and are kept attached within the body by the mesorchium [24]. Interestingly the only accessory gland found in dolphins is the prostate which is lined with fibroelastic tissue [24]. The penis is a fibroeleastic type muscle in dolphins [24]. Maledolphins are able to get erections almost instantaneously and ejaculation seems to be a voluntary response [21]. This function has been developed as to just in case a predator appears the dolphins are able to ejaculate quickly and leave [21].

The female reproductive system is composed of the ovary, oviduct, uterus, cervix, vagina, clitoris and the vestibule and is said to be similar to that of a horse [25]. Dolphins have a bicornate uterus [21]. Both the horns found in females act as uteri [21]. In the vagina unusual folds can be seen [26]. The function of these are not clear but it has been hypothesised

that these folds are present in order to be able to mate in the water or in order toprevent seawater from entering the upper reproductive tract once the penis is removed [26]. The reason for this could be because sea water may kill sperm of the dolphins [26]. Maybe these vaginal folds are present in order to retain the semen within the uterus and this can be very important since dolphins lack specific glands such as the seminal vesicles and bulb- urethral glands that in many mammals are present in order to mix the semen [26]. On the other hand these folds rather than being present for mating purposes they might also be there in order to prevent miscarriages when there are pressure changes or else in order to allow for stretching during the time of birth [26]. Female dolphins tend to only use one of the ovaries but they might change which one they use as they age [21].

Just like humans, female dolphins have a clitoris which needs to be stimulated in order to reach sexual pleasure [27]. This seems to play an important role during female-female sexual intercourse which during this they rub each other's clitorises with their snouts, flippers and flukes [27].

In the wild dolphin's copulation appears to be ritualistic [28]. There will be one female which becomes surrounded by a group of males and they violently attempt to copulate with the female [28]. The female dolphin will start to be pushed out of the water by the male dolphins and the males will lie their tails and slap them around [28]. After this we can assume that multiple male dolphins would have copulated successfully with the female dolphin [28]. Interestingly in bottlenose dolphins the males of the group will trap the female not allowing her to escape in order for outside members from the group will not be able to copulate with her [28]. Males seem to only be around the female dolphins during the copulation other than this time male dolphins seem to stay together away from the females, and they play no role in the raising of the baby [21]. In fact, male dolphins are said to be a threat towards their offspring [21].

5.2.2. Artificial Insemination (AI) in Captive Bottlenose Dolphins

This practice has been adopted by marine parks in order to reduce stress on the animals as prior to this the dolphins would have to be moved from one facility to another in order to perform the insemination [29]. This is also important to improve the gene pool and allow for a wider range of genetic variation [29]. The most efficient way of artificialinsemination in dolphins is by performing intrauterine insemination with semen which has been chilled and was stored for less than 3 days and used within 24 hours after the estradiol has peaked [29]. In

the past AI used to be done using an endoscope and depositing the sperm in the vaginal fold close to the cervix but with this method there was a lack of successful pregnancies hence why the idea of intrauterine insemination became more popular and in factmore success was seen using this method [29]. In order to detect the ovulation in dolphins the luteal hormone (LH) peak needs to be detected by doing a urinary analysis [29]. Another way how ovulation could be detected is by measuring the the follicular sizes by performingan ultrasound (US) [29]. The use of a US is not as accurate as measuring the LH so when the US was being used a lot more dolphins were being inseminated without them actually being in their ovulation period [29]. Throughout the improvement of AI by correctly identifying theproper timing of ovulation has helped in the reduction of the amount of times the insemination is needed in order to gain a successful pregnancy [29].

5.2.3. Nursing in Dolphins

Calves are born with fringes on their tongue which helps them with nursing from the mother dolphins mammary [21]. These fringes help create a suction which allows for the milk to flow out relatively easily and the mothers also help by actively forcing the milk to flow out [21]. Calves are said to nurse every 20 minutes and they are nursed for around 2 years up until 4 and a half years [21]. For successful nursing the calve needs to reach the rostrum of the mothers mammary [30]. The first 30 days of age are the most crucial as the death of the calves is very common during this time period [30]. The mother during rearing arches her back in order for better accessibility for the calves to suckle from the mother as they are still not the best swimmer and their lungs have not fully developed [31]. Unsuccessful nursing can lead to multiple problems such as malnutrition, aspiration pneumonia, bronchopneumonia amongst other diseases [31]. Normally in captivity calves which are not nursing properly all be moved to a nursing pool temporarily in order to care forthem and monitor them closely [32]. They will be tube fed every couple of hours in the first 24 hours [32]. They are fed from the milk of the mother and then they will be transferred ontoformula [32]. It is important that the formula mimics the milk of the mother which is high in

fat and high in colostrum [21]. The caloric intake when giving formula needs to be adjusted in a way as to reach the target amount that the calf requires, normally this ranges around 150-200kcal/kg/day [32]. This isolation should be done as quick as possible if it is noticed that the calf is not rearing properly the earlier this is identified the faster the intervention can be done and this will increase the calf's chance of survival.

5.3.Human and Dolphin Relationships

Humans build relationships with dolphins in order to fulfil some kind of need of connection and in turn this helps to increase the well-being of the animals [33]. Humans with regards to wild dolphins seem gain a lot more than them from this connection. In turn this helps to promote protection, care and appreciation for these animals [34].

5.3.1. Human-Dolphin Relationships in the Wild

In the past thirty years the interest and popularity of dolphin tours has increased [35]. These dolphin watching tours can be looked at as somewhat beneficial as people get the opportunity not only to observe the beauty of these animals but also see how intelligent these animals are and in turn this will promote the urge to protect these species [36]. However, boats seem to have a negative impact on dolphin activity [37]. This is why it is very important to study the effects that tourism has on these animals [37]. Both short-term and long-term effects can be observed, and these will affect the animals feeding tactics, itsresponse to predators, breeding, respiration and thus the energy will find itself wasting more energy than it normally does [37]. Bottlenose dolphins are of high demand to tourists due to the fact that they do not move much and live close to the shore and thus are easily accessible [37]. A study conducted on dolphins in Dolphin Bay, Bocas Del Toro, Panama proved that there has been a change in the behaviour of bottlenose dolphins due to the increase in tourism[37]. It was found that the time dolphins spent foraging and the time spent socialising was reduced because of this added stress [37]. In the long run this can greatly affect the animals asthey will not be taking up enough nutrients and eventually this can reduce the chance of the animal's survival [37]. Interestingly, an increase in traveling has been observed in these dolphins which could be because of the increase in the number of boats in the area forcing thedolphins to emigrate to other places [37]. The above-mentioned points should play a considerable factor in the conservation of these animals and should be put into consideration when discussing the effects of tourism [38]. In my opinion, boat watching needs to be more closely monitored and we must work harder on reducing the number of tourists in order to putthe well-being of the animal above the curiosity of human beings.

Humans are one of the biggest threats towards dolphins due to the large fishing industry. It has become a common problem for people to accidentally capture these animals, this is known as bycatch [39]. Not only can these fishing lines remain attached to the animal and cause physical harm but they may also kill the animal as it will not be able to go above the

surface to get air [39]. It is thought that young dolphins are more susceptible to these fishing nets rather than adults [40]. A study done in Galicia found that the majority of dolphins accidentally captured were males and were younger than previously anticipated[40]. It can be assumed that males are normally caught due to the way they breed and most ofthe time they would be captured during their breeding season [40]. The majority of dolphins captured are also said to be short-beaked type as these tend to be in shallower waters where they fishing nets are placed [40]. It is a human's responsibility to reduce these threats towardsdolphins and do their outmost to reduce any harm towards these animals. In fact, it has become European law to outlaw the use of driftnets and promote the use of pair trawlers in order to reduce capturing these mammals accidentally [40].

5.3.2. Human and Captive Dolphins' Relationship

In captivity dolphins appear to rely on the humans signal in order to perform an action [41]. Dolphins, being so intelligent, are highly capable of learning new tricks and solving complex problems which is why humans found these animals the perfect animal to mould into performers [42]. This can be looked at as abusive because enclosing them in such a small space, especially when compared to the ocean, can be looked at as cruel as these animals might not be getting enough brain stimulation because of this [42].

Dolphins along the years have become somewhat weaponised, they have been used by the military for defence manoeuvres, for example, to find mines and for the development of solar weapons [42]. Although a lot of this information is kept private, therefore not much data can be found regarding this topic [42].

Dolphins have now come to be used as therapy animals [42]. They have begun to be used for sick patients, and it was seen that this therapy helped these patients to improve on their behaviours, communications and served as brain stimulation [43]. In these patients therewas an improvement in their attitude and physical health, thus speeding along their recovery [43]. This therapy was also found to be beneficial in children who struggle with communication [43]. The dolphins together with their trainer and professional therapistsbuild a relationship with the child in order to help them to become more socially responsive [43]. The dolphins will be trained beforehand to listen to certain commands and they will be taught tricks in order to play with the children [43]. The trainers will manoeuvre the dolphins in such a way as to play with the children [43]. During the sessions the interactions become more complex as the previous action would be repeated and new ones will be added on each time [43]. Criticisms

have arose from this treatment as it can considered abusive towards the animals [43]. This treatment threatens the welfare of the animals and has been linked to manydifferent diseases such as respiratory problems, vision issues and other stress disorders and it has also been associated with behavioural stresses such as hyper-sexuality, and because ofthis the animals can become dissociated and aggressive [43]. This may also lead to certain social stresses, because of this there will be a lack of sexual parties, no hierarchy will be present and there will be a lack of socialisation which can be seen as quite a traumatic experience for these animals, which are social animals and highly intellectual creatures [43]. Although, this can be a highly beneficial procedure for humans we need to ask ourselves if this is dignified for these animals which are being trapped in pools for our own benefit [43].

The most popular use of captivity is most definitely that for entertainment value but the idea of keeping these animals captive can be looked at as beneficial in order to promote conservation [42]. The public nowadays are able to pay to swim, play or pet these animals [42]. A study was carried out to evaluate and examine the effects of these shows [44]. This study showed that there was an increase in humans wants to protectthese animals [44]. However, this can be seen as an exploitation of these dolphins and using them as a money pumping business [45]. Dolphins quickly learn that in order to get food theymust perform certain tricks for the audience [45]. This by many may be viewed as abusive and goes against animal rights [45]. On the other hand, keeping these animals captive have also broadened the veterinary field and allowed further study on the medical care of these animals [46]. Keeping dolphins captive in these institutions can also be beneficial for detecting a pregnancy and also to help manage the pregnancy and help the animal carry the calf to term [45]. Nowadays, there is access to full body ultrasounds for these animals inorder to perform a complete health assessment [46]. Captivity makes it easier to take samples such as blood, urinalysis, and blubber samples in order to find any abnormalities in theanimal [46]. The increasing interest that humans have developed for dolphins has also helped in prioritising the health and well-being of these animals, especially those in captivity, by keeping them as well kept as possible and increase in more scientific research on how to improve the health of these animals [46]. In my opinion, this can also be a good thing asthese studies will give us more knowledge on these species and show us different ways on improving the health of these animals and this can eventually be used to aid both captive and wild living dolphins. In fact the capture- release method can start to be used in order to assessthe health of wild dolphins and attempt to cure them and once they are cured they can be sent back out into the wild [46].

Procedure	Description	Use	References
Blood sample (**Figure 4**)	Obtained from the periarterial rete on the ventral aspect of the tail fluke	Biochemistry Hematology Blood gas analysis Endocrinology Immunology Serology Genetics	(23, 29, 30, 74, 91–93)
Surgical biopsy	Full thickness wedge biopsies of skin and blubber are routinely taken via an inverted "L" block under local anesthesia from the left lateral body wall caudal to the dorsal fin	Genetic population structure (skin) Foraging ecology (skin) Chemical contaminants (blubber) Hormone levels (blubber) Microbiome	(31, 33, 49, 57, 94–96)
Urinalysis	Bladder catheterization	Renal function assessment Dietary analysis	(91, 97–99)
Tooth extraction	Single tooth extracted under local anesthesia	Age determination	(17, 100)
Ultrasonography (**Figure 3**)	Thoracic and abdominal internal assessment	Lung pathology Reproductive Assessment Full abdominal exam including renal assessment Blubber thickness	(77, 97, 101–103)
Electrocardiography (**Figure 6**)	Adapted field use in and out of water	Cardiac assessment	(104)
Morphometrics (**Figure 7**)	Standardized full body measurements: lengths, girths, weight	Assess body condition and growth rates	(105)
Auditory evoked potential	Portable unit adapted for field assessment audiograms	Assess hearing range and sensitivity	(106)
Lesion biopsy	Sample of abnormal skin lesions e.g., pox or freshwater lesions	Histopathology	(57, 93)
Blow analysis (**Figure 5**)	Exhaled breath vapor	Pathogen and hormonal analysis Metabolites Respiratory function testing	(107, 108)
Microbiology	Swabs/culture plates from oral respiratory or genital orifices	Bacteriology Virology	(109)
Freeze brand	Dorsal Fin	Identification	(110)
Feces and urine collection	Swabs or catheter	Biotoxin analysis	(46)
Skin biopsy Electronic and/or roto tagging	Skin sample from biopsy or during dorsal fin tagging	Genetics, sex, stable isotopes identification Ranging patterns reproductive status Survival	(70, 111, 112)

Figure 1*: Listing of veterinary samples collected to study the health of the bottlenose dolphins* [45]

5.3.3. Conclusion

Dolphins in the wild seem to be negatively impacted by humans as, due to the rise of tourism, they are caused stress and are forced to move out of their natural habitats. On the other hand, tourism can help show people how mesmerising dolphins are and help promote their conservation. With regards to captive dolphins however, it might be looked at as cruel to keep these animals in an enclosed space, although human intervention has helped promote veterinary care for them and also helps promote new scientific discoveries on how to keep these animals well maintained.

5.4. Communication Amongst Dolphins

The fact that dolphins are vocal animals has been known for a long time [47]. Upon recent research done by David Caldwell he discovered that, just like humans, each individual dolphin has their own distinct type of whistle [47]. It was found that bottlenose dolphins are able to imitate certain sounds and can use them to make reference towards certain objects [47]. The act of communication amongst dolphins is said to be one of the most complex and highly developed when compared the majority of animals [47].

Dolphins have the capability of recognising each other, which is what allows them to form social groups and to form their pods [48]. Due to the fact that these animals are capable of recognising each other via communication they are able to form alliances and will begin to hunt together [48]. Dolphins, being a complex animal with an intricate cognition, are capable of performing different vocalisation for certain behaviours, for example, clicks are used for sonar activities, burst-pulse sounds are used to socialise with each other and during feeding and narrow frequencies will be used for many other tasks [48].

5.4.1. Dolphin Whistles

Whistles differ from dolphin to dolphin [47]. Dolphins undergo vocal production learning and whilst they can develop these whistles by mimicking each other they are more likely to be developed because of the auditory experience of the dolphin [47]. There are a variation of whistle types and every whistle has a particular frequency pattern [47]. Similar whistles can be developed from each animal with the same pattern and thus, in order to identify the animal we look at the voice cues which are different in morphology in every individual [47]. These whistles were found to differ in every individual by isolating the animal but more recently bout analyses are performed [49]. Upon a study where theacoustical analyses were recorded only those recordings within 500m radius from the pod of dolphins within vessels present [48]. There were twotypes of whistles which were categorised, these being signature whistles (SW) and non- signature whistles (NSW) [48]. SW was then compared to a template of past categories and if it was the same it would be assigned to that category but if the whistle could not be assigned to any category a new one would be created [48]. The Signature Identification (SIGID) method is used to identify the SW in free swimming bottlenose dolphins [49]. Using a bout analysis it was found that 12 SW can be positively identified using the SIGID method [49]. In this method a hydrophone is used to make these recordings [49]. The

emission rate of these whistles for SW is 0.15 whistles/min/dolphin and NSW were found to be 0.41 whistles/min/dolphin [49]. For both

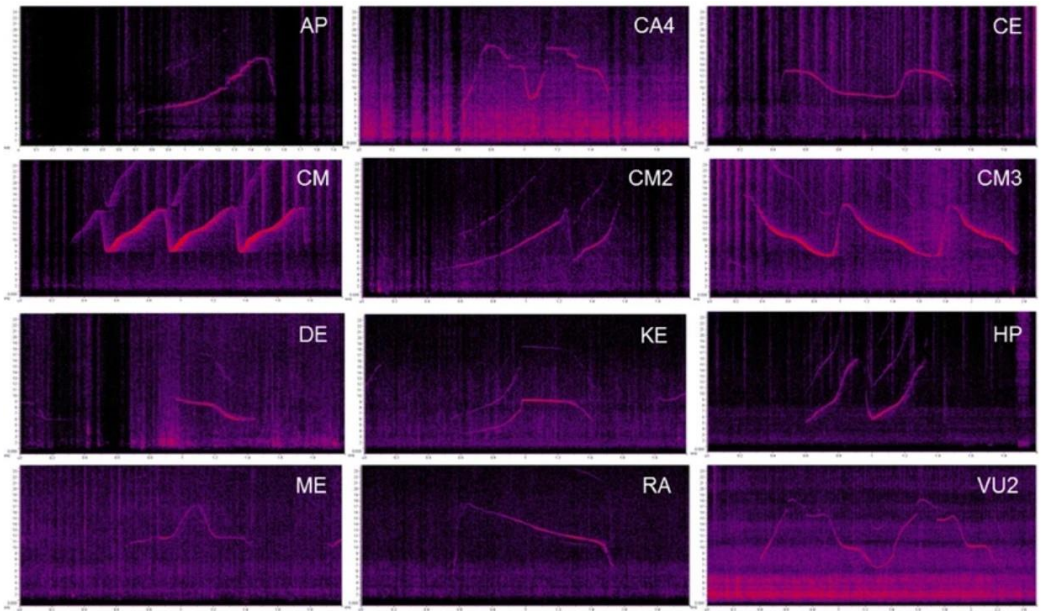

Figure 2*: positively identified 12 SW using the SIGID Method* [49]

these categories the lowest emission rate was found to be during travel[49]. The SW has the highest emission rate during socialisation and for the NSW the highest emission rate was during surface feeding [49]. These emission rates can be increased becauseof a disturbance in the environment such as increases tourism which will add extra stress to the dolphins [49]. In collusion SW is significantly important for long term recognition ofeach individual [49]. On the other hand the SIGID method is not entirely accurate and it can be assumed that around half of the SW can go unrecorded so the results at present can be considered strongly underestimated [49].

It was found that the whistles of captive animals seemed to be shorter than that of wild dolphins and the captive animals frequency seemed to be less frequency motivated but rather seemed to sound more like the whistles of trainers [50]. When comparing the total flatness ratio it was found that captive dolphins have a higher contiguous flatness ratio when compared to the wild dolphins, this can be because the dolphins born in captivity have more artificial sounds and they try to imitate the sounds produced by humans such as that of the training whistle [50]. This will then be incorporated into their final sounds [50].

Studying whistles in captive dolphins can help in understanding why these sounds are used in the wild and what they mean [51]. This can help in understanding the activity of wild

dolphins [51].

5.4.2. How Signature Whistles are Produced

Signature whistles start to be produced very early on in life and by the time they are 3 months old the signature whistles are said to be developed [47]. Calves which have been fostered by another dolphin tend to change their whistle in order to imitate the foster mother [47]. It is found that captive dolphins have less adjustments in their signature whistles than wild dolphins [47]. These signature sounds are not influenced by genetics but rather by sounds in their environment and them trying to imitate these sounds [47]. It is very rare for these animals to change their whistles once they are developed, females tend to never change but males can change their whistles according to the alliances they form [47]. It has been discovered that these signature whistles are used for identification amongst individuals, especially when they are out of sight of each other [47].

5.4.3. Conclusion

Signature whistling has been found to be the most important way that dolphins recognise each other [47]. This evolutionary development is important for these animals to be able to locate each other in an environment where there is a lot of differer sounds [47]. This is why it is important that each individual dolphin has their own specific whistle in order to be able to tell them apart as these animals have high cognitive intellect and are capable of identifying each other.

5.5. Common Diseases in Bottlenose Dolphins

In the wild there is a 10% mortality rate per year in the dolphin population whilst in captive dolphins the mortality rate ranges between 2.5-15% per year [52]. Here we can argue that captivity may be more beneficial as here the nutrition can be kept optimal, there are no threats from prey and medical intervention is at the animal's beck and call [52]. Diseases cause the biggest threat to these animals when they are less than 2 years old and over 14 years old, this is when they have a higher chance of death [52].

5.5.1. Respiratory Diseases

Starting with the nasal cavity, inflammation can be found which is usuallinked to secondary diseases [52]. A very common infection in the nasal cavity is that of*Candida spp* [52]. Through the continuously developing veterinary field anti-fungals havebeen developed against this but if it progresses it can worsen into a respiratory infection [52]. Sometimes we can find parasites in the sinuses of bottlenose dolphins such as *Naistrema spp* which will cause a bad odour to come out from the blow-hole [52]. Thisparasite can also predispose the dolphin to respiratory infections and is often accompanied by bacterial infections [52].

Upper respiratory infections are quite uncommon in bottlenose dolphins and normally this is a secondary result to a bigger problem [52].

One of the most common diseases of the lungs in bottlenose dolphins is pneumonia which has a high morbidity [53]. Commonly both bacterial and fungal infections are found to cause pneumonia in bottlenose dolphins [53]. Most commonly Staphylococcus aureus is thought to be the primary cause but it can also be caused by *Cryptococcus neoformans*, *Erysipelothrix rhusiopathiae*, *Histoplasma capsulatum*, parainfluenza virus, *Proteus* species, *Pseudomonas aeruginosa*, or *Streptococcus zooepidemicus* [53]. In acute cases we can expect to see foul breath, coughing, rattling sounds coming from the lungs, and depression amongst other symptoms [52]. Antibiotics are most commonly used against this and in order to use the correct medication a swab from the blowhole should be done in order to see what medicines to use [52]. The drugs are normally administered via the intratracheal route [52]. Sometimes pneumonia can be caused by parasites such *as Halocercus lagenorhynchus* which will cause calcified nodules on the lungs [52].

5.5.2. Cardiovascular Diseases

Cardiovascular diseases are extremely rare in dolphins and is almost unheard of in bottlenose dolphins [54]. They have very good arterial ageing which can withstand a lot [54]. They are said to have excellent endothelial function even at geriatric age [54]. Nowadays, it is also hard to diagnose problems with the heart and vessels of these animals as we do not have the proper equipment to do so [52]. It was found that some of these species had an infraction in their myocardium but these seemed to cause no functional problem in the heart [52]. Some of these animals may suffer from mitral valve insufficiency but this very rare[52].

In regard to the peripheral arteries, thromboses can be seen in some cases [52]. These typically occur after an infection with *Erysipelothrix rhusiopathiae* [52].

5.5.3. Skin Diseases

Some skin diseases are considered to be primary diseases in dolphins such as, *Erysipelothrix rhusiopathiae* which form lesions all over the body and *Streptococcus* which typically form lesions on the head [52]. Antibiotic treatment seems to be beneficial for these bacteria [55]. *Aeromonas spp* is said to cause both pneumonia and ulcerative dermatitis [55]. *Pseudomonas aeruginosa* is one of the most invasive pathogens and can cause bronchopneumonia but also extensive dermatitis [55]. Symptoms can include anorexia, and dyspnea necrotic nodules [55]. The bacteria *Vibrio spp.*causes ulcers and abscesses all over the body of the dolphin [55]. Antibiotics are used against these but there is a growing problem of antibiotic resistance due to the overuse of antibiotics in aquaculture [55].

Viruses may also be responsible for certain skin diseases in bottlenose dolphins [55]. Calcivirus, which is responsible for vesicular exanthema in swine, can also affect these dolphins [55]. Vesicles first form and these eventually become ulcers and heal with scars [55]. These usually resolve by their proper functioning immune system and there is no need for treatment [56]. It is said to be a self-limiting infection [56]. *Alphaherpesvirinae* has also been detected in skin lesions of bottlenose dolphins [55]. This can cause both a cutaneous and systemic infection [55]. There is a trivalent poliovirus vaccine which can be given if herpes is suspected [56]. Stress and immunosuppression tend to worsen the effects of the herpesvirus [56]. There is not enough information yet on how this virus affects the survival ofthese animals [55]. Papillomavirus (PVs) has also been diagnosed in bottlenose dolphins using immunohistochemistry [55]. Dolphins have high prevalence for this tumor forming virus [57]. PVs are said to be self-limiting [56]. Another virus which can cause skin lesions are poxviruses, which cause irregularly shaped, greyish-yellow lesions [55]. To diagnose this the presence of eosinophilic, intracytoplasmic inclusion bodies should be found using an electron microscope

[56]. This virus will only cause skin lesions but preventative methods should be used in order to prevent a secondary bacterial infection [56]. Morbillivirus is a viraldisorder seen in dolphins [56]. It causes a diseases known as distemper in these animals [56]. This virus does not appear to kill the animal, but will cause immunosuppression [56].Vaccination preventative methods are being practiced in Europe [56]. Currently the treatmentfor this virus is supportive treatment [56].

Fungi can also be the culprit for causing skin lesions [52]. *Candida app* is said to be the most common fungal disease [52]. It is very common in the captive animals because of stress, insufficient disinfection of the pools, or misuse of antibiotics [55]. The lesions are normally seen around the openings of the body [55]. No treatment has been found useful to cure this [52]. *Lacazia loboi* is another fungal species which can effect the bottlenose dolphin [55]. This fungus is normally seen in humans but it can also effect these animals and cause small greyish-pink lesions that may in time become ulcers [55]. Another fungi that has been seen in in captive bottlenose dolphins is *Tricophyton spp* [55].

Ciliated protozoa can commonly be found in dolphins [55]. Epithelia damage is said to be caused by copepods or barnacles [52]. When these animals are caught for captivity the barnacles are removed from the dolphin [52]. In order to remove these things from the animal fresh water is used or CuSO4 bath can be done [52].

Sometimes exposure to water which has less than 2% NaCl can cause swelling and degradation of the skin of the bottlenose dolphin [52]. The maximum time a bottlenose dolphin can spend in fresh water is 10 days [52]. Fresh water has been used both for curing diseases caused by ciliated protozoa but also for when the animal finds itself in kidney failure[52]. So therefore the concentration of the water should be closely monitored [52]. Skin lesions can also be caused by bite wounds, especially from other dolphins kept in captivity [52]. If there are multiple bite wounds it can be assumed that there is a struggle for dominance among the dolphins [52]. These will normally heal on their own but sometimes they can become infected when any above mentioned pathogen and cause the animal to become unwell [52]. Another reasons lesions can occur in captivity is due to the animals knocking into the walls of the pools or inappropriate handling when the animal is being restrained [52]. These should be handled with care and disinfected in order to prevent a moreserious infection from taking place [52].

Sometimes the skin of the dolphin can dry out [52]. This can happen because of the sun, wind or lack of water [52]. The skin will eventually crack and start to blister and expose the animal to other pathogens [52]. In order to prevent the skin from drying out one must keep the skin wet, especially during the transportation of the animal when animal is out of the

water [52]. Water sprays are used in order to keep the moisture of the animal when not in the pool [52].

Veterinary mishandling can also cause skin conditions in dolphins [52]. For example, when giving an intravenous injection infarcts can form [52]. Trauma can be seen in arteries when giving injections and can result in thrombosis and infarcts in the tissue [52]. Necrosis will then take place and the skin is then sloughed off [52]. Veterinary intervention is needed here in order to prevent premature closing of the wound, which can result in an abscess to form [52].

5.5.4. Digestive Tract Diseases

In order to diagnose common digestive microorganisms in bottlenose dolphins one must take a fecal specimen and examining it [52]. Nematodes are said to be found in almost all dolphins but they rarely ever cause any serious symptoms [52]. Anthelmintics should be given to newly captured dolphins just as a preventative method and not to put other dolphins in captivity at risk [52]. Nematodes are rarely seen in dolphins which have been in captivity for a while as they are fed frozen fish and so hardly ever develop new infections [52]. Trematodes such as the *Braunina cordiformis* (stomach fluke) may be found in the stomach and can cause symptoms for over 3 years if not treated [52].

Bottlenose Dolphins have commonly been found with gastric ulcers in both wild and captive scenarios [58]. The bacteria *Helicobacter sp,* parasites, high histamine from fish in the diet, and accidental ingestion of a foreign object can all cause gastric ulcers [58]. If the cause isnot clear it could also be due to stress [52]. Gastroscopy nowadays is the main tool used to diagnose these ulcers as it is considered to be the most accurate [58]. Radiography or examination of the gastric content can be used as an alternative to diagnose the ulcers [52]. The main symptom observed would be the dolphin refusing feed very early on even though they would still be hungry. This will then result in anorexia because the animal will be in severe pain [52]. As a treatment magnesium hydroxide can be used as an antacid [52]. Tube feeding is also suggested using homogenous fish, water and medicine mixed together [52]. If ulcers are caused by a forge in object these can either be vomited up or if the object is sharp itcan cause trauma to the gut [52]. These objects will need to be removed by using a gastroscope, stomach tube and a magnet or else the object is palpated and then removed [52].

Enteritis is also an illness which may be seen in dolphins and is known as transient enteritis [52]. Common symptoms would be anorexia, diarrhoea, and an increase in peristaltic movements [52]. In order to diagnose the cause of enteritis would be to take fecal samples

and observing the clinical signs [52]. The most common reason for infectious enteritis would be *Pasteurella multocida* [52]. This can result in hemorrhages in the intestines [52]. Here we can also see obstructions by foreign objects but this is more common in the stomach [52].

Hepatitis can also be seen in some *T. truncatus* and can lead to chronic fibrosis and fatty liver disease [52]. It mostly seen in older dolphins [52]. Hepatitis can be linked to being caused by ingesting toxins such as bacterial toxins, heavy metals and pesticides or due to lack of nutrients in their diet [52]. Eventually, hepatitis will lead to secondary diseases which will cause even worse problems and could eventually lead to death [52]. In order to diagnose hepatitis a biopsy should be taken and a histological examination should be performed or else an indocyanine green retention test [52]. Indocyanine green retention test is a liver function test which is used to observe the portal hypertension [59]. Normally, when hepatitis is present the liver would be orange in colour, enlareged, friable and the parenchyma will become non-homogenous [52].

Pancreatitis is another disease which can be seen in bottlenose dolphins [52]. Like hepatitis it is seen in elder animals [52]. During chronic pancreatitis the pancreas would usually be enlarged, white in colour and firm [52]. In order to diagnose this normally blood samples would be taken and the enzymes would not be being produced during chronic pancreatitis as the acing cells will be replaced by fibrin [64]. The feaces of the animal would be white and slimy [52]. In order to treat this pancreatic enzyme supplements are given [52].

5.5.5. Musculoskeletal Diseases

A lot of these diseases can be due to trauma which can be induced by humans [52]. For example, when humans entrap the animals due to bad restraint methods it can result in dislocation of flippers [52]. Sometimes, when the dolphins perform tricks in their pools they can jump out of enclosure and this causes injuries [52]. Another reason musculoskeletal injuries could take place is because of fighting between the animals for dominance [52]. If this is happening in the pools as a preventative method the animals should be separated [52]. Fishing line entanglements can also cause trauma to the musculoskeletal system of these animals [61].

Another issue which has been observed in cetaceans is that their bodies would be twisted in abnormal directions and this could be a sign that the animal is suffering from scoliosis, kyphosis or lordosis [60, 61]. This can be a congenital disorder because of the abnormal embryonic development [60]. These can be diagnosed using X-rays or by a visual examination [61]. It is said that these conditions do not shorten the lifespan of dolphins and rather they adapt to their disability and live relatively normal lives [61].

A blackleg like illness can be seen in the dolphins' iliopsoas muscles and will cause myositis where gas bubbles are produced [52]. *Clostridium sp* was found to cause this [52].

Dolphins also seem to suffer from osteomyelitis mainly in the mandibular region and in these cases it is recommended to perform teeth extraction and to give antibiotics to prevent secondary illnesses [52, 62].

5.5.6. Urogenital Diseases

The most common urinary disease found in bottlenose dolphins is that of pre renal azotemia [52]. Eventually, this can result in renal failure which will then lead to lethargy, anorexia and depression [52]. In order to diagnose this urinary tests and blood tests are done [52]. In the urinary test it would be expected to see a Hugh specific gravity and protein would be seen in the urine [52]. In the blood tests there would be high levels of creatinine andin increased blood urea nitrogen [52]. It is important that in these cases that animals are kept hydrated in by force feeding on using a fluid infusion [52].

Through the use of ultrasound throughout the years it has been determined thatproblems during pregnancies and birth are rare [63]. Rarely dystocia can be seen which can result in intrauterine fatal death which is the result of incorrect positioning of the foetus [52]. Nowadays, because of the tools that are available, it is possible to diagnose this prior to the death of the foetus in order for the vet to get involved in time [52].

Orchitis can be observed in male dolphins and this can be identified with granulomatous lesions during the pathological examination [64]. Ovarian cysts have also been documented as well as metritis in female dolphins [52]. Mastitis has also been documentis bottlenose dolphins and is said that it can be caused by *Edwardsiella tarda* [52].

5.5.7. Neurological Diseases

Abscesses have been found in the brain of *T. truncatus* and these will cause uncoordinated movements and abnormal positioning in the dolphins [52]. Neurological problems have also been found to be caused by nasal flukes which migrated from the nares into the brain of the animal [52].

5.5.8. Ophthalmic Diseases

The most common eye disease in dolphins are conjunctivitis and keratitis [52]. Most cases of keratitis will not require any treatment and will fix itself. In a more persistent case

changing the pool water and making sure it remains clean and providing proper nutrition to the animals can help resolve this [52].

5.5.9. Metabolic Diseases

Anemia happens mainly due to the improper bone marrow function [52]. The biopsy of bone marrow has become a leading examination in the diagnosis of anemia [52]. The study of reticulocytes, spherocytes and neutrophilias can help with the diagnosis of anemia[65]. Iron deficiency anemia can be diagnosed when doing a complete blood cell count(CBC) which will show an insufficient amount of reticulocytes [52]. Anemia more often than not is caused by gastrointestinal bleeding and this is said to be determined because of reticulocytosis [52]. If anemia is diagnosed it is important that immediate intervention takes place and immunosuppressive drugs are given and CBC should continuously be carried out in order to make sure the blood parameters return to normal and that is when therapy can be stopped [65].

5.5.10. Conclusion

In my opinion this is why maintaining captive animals can be looked at as beneficial, since these animals are in close proximity to the vet they can be treated quickly and properly. It is also easier to observe these animals and become aware of any abnormal behaviour. It is also much easier to perform diagnostic examinations in these animals in order to find out what is causing the problems in the animals.

5.6. Comparing the Ages of Death of Animals in the Wild vs in Captivity

The ages of death of dolphins can be considered an indication of the health of the animals both in captivity and the wild [66]. Comparing the lifespan of wild bottlenose dolphins and captive ones can be used in order to assess if keeping these animals in captivity is a humane thing to do [66].

5.6.1. How to Predict the Age of a Dolphin

There are many different methods to assess the age of a dolphin, one way of doing this is by studying the teeth [67]. To be able to do this a tooth must be extracted and then sectioned and the layers of growth should be counted [67]. In accordance to the number of layers we can assume the age of the dolphin [67]. However, this can be inaccurate as teeth can be worn out and it would not be possible to properly assess the teeth [67].

Alternatively, we can take blood samples to estimate the ages [68]. Older dolphins were found to have high globulin and an increased level in autoantibodies in their results [68]. Also dolphins over 36 years of age werefound to have neutrophilic leukocytosis [68]. Oftentimes, older dolphins will have an elevated T- cell count [68]. Triglycerides and cholesterols were found to increase with age so we can state that there are more free fatty acids amongst older animals [68]. Additionally, creatinine was found in some older dolphins and this can linked to the decreasing muscle mass which comes with age [68]. ALT (alanine transaminase, a liver enzyme) also seemed to increase in age due tothe decrease in liver health [68]. Hematocrits and haemoglobin were also found to be lowerin dolphins over 35 years of age [68].

5.6.2. How Long do Wild and Captive Dolphins Live for?

The average bottlenose dolphins may live for around 40 years if not longer in the wild [69]. On average, captive dolphins live for around 29 years but it was found that those dolphins who where born in captivity died much earlier than those who were born in the wild and eventually moved into captivity [70, 71]. Since pools are much smaller than the environmental waters and in most cases many dolphins are brought in from different podsinto the same pools there would be struggle amongst these dolphins for communication as

different pods have different methods of communicating with one another [72]. This can be quite a stressful environment for such social and pod-dependent animals which is why we can consider this an option as to why the lifespan is shorter in captivity [72]. Dolphins may eventually get bored as they would be swimming around in circles in these small tanks and as well they could be suffering from food deprivations some facilities would withhold food in till the animal performs the trick and this can increase the animals stress levels and thus reduce its immune system [72]. Another study done using annual survival rate, age-at-death, and Kaplan-Meier methods suggested that captive dolphins are able to flourish and live as long as wild dolphins if not longer but this has only come to be in the past couple of years [73]. It is suggested for more studies to be carried out in order to further improve the captive life of dolphins and to further lengthen the lifespans [73].

5.6.3. Conclusion

In my opinion even though treatment is quicker for dolphins in captivity, it can also be argued that these animals are not living up to their full potential and not thriving in captivity as they would be in the wild. In my opinion its quite a stressful transition for these animals since they are in such a confined space. These are unnatural conditions for these animus and some of these places may give a false representation on how animal friendlythese pools are. Researches must continue studying the environment of the pools in order make the best possible living space and improve the lifespan of the dolphins.

5.7. Dolphin Nutrition

Dolphins both in zoos and in the wild primarily feed on a number of different species of fish, the main difference being that those found in a zoo are fed with fish that have been frozen, stored and thawed whilst wild dolphins feed on a number of live fish [74]. Dolphins found in the wild have also been known not to just hunt fish but also octopus, squids, jellyfish, and other crustaceans amongst a number of other species [75]. This makes the skill of being able hunt in the wild highly important for free-range dolphins [76]. Pooled dolphins are used to a life which is more barren in an enclosed area where hunting isnot a necessity thus these dolphins never develop this skill [76]. Eventually, this may become a problem if there was interest to return these dolphins back to their natural habitat [76]. Interestingly, pooled dolphins spend a lot more time at the surface level of the water whilst wild dolphins spend more of their lives a lot deeper than the surface level of water [76]. This could be because the dolphins anticipate that the food is coming from above in the zoos rather than needing to be hunted like in the wild, where the prey can be found in all different areas.

5.7.1. Dolphins Hunting for Prey in the Wild

It is said that little is known on how dolphins use sounds to communicate to one another in order to hunt for prey [77]. There may be two explanations which may explainwhy dolphins hunt in large groups, those being: that dolphins hunting in large groups may strengthen their bond either before or after a hunt or it may be to help capturing prey [78]. A study was carried out assessing the occurrence and frequency of aerial behaviour in each dolphin, describing the types of aerial behaviours (such as lunging, tail slaps, flipper slaps, head slaps, spins, head leaps, etc...) and the study related these variables to group sizes andthe different behavioural scenarios. The assessment of these dolphins took place before feeding, during feeding, after feeding and non-feeding. It was found that dolphins moved more quickly and exhibited aerial behaviour mostly during feeding thus this study supported mostly the aid-in-capture-of-prey hypothesis [78].

Recent advances have allowed us to study in further depth the connection between passive acoustic systems to surface behaviour in individual dolphins [77]. Bottlenose dolphins were found to have a low- frequency call when feeding and this call seemed to be followed by other dolphins quickly approaching [77]. This call is thought to be done in order to take advantage of prey in order to make it easier for the dolphins to approach and capture their prey [77]. This further supports the hypothesis mentioned previously.

On the other hand, dolphins which find themselves captivated do not develop the skill to hunt for their prey. Most of the time positive reinforcement is used in order to get the dolphins to learn and perform tricks and obey commands and if this is done they are gifted with food [79]. Captured dolphins over a period of time will lose their ability to hunt for prey and those born in captivity will never learn this skill as this is normally brought to them by their mothers [79]. This is a major problem as it is close to impossible to put a captivedolphin back into the wild [79]. Many people hold the opinion this would be cruel as it is believed that their chances of survival are minimal [79]. This is especially true since dolphinsare social animals and so moving them from captivity to an area they don't know would be highly stressful for these animals who have not developed the tools to be put there [79].

5.7.2. Nutrition of Captive Dolphins

It is of utmost importance for dolphins kept in captivity to be fed a proper diet and one which is similar to those of dolphins found in the wild. A study carried out by Hartmann, personal communication, 2015 stated that within Europe there were 255 *Tursiops truncatus* housed in 26 European countries. Blood measurements of captive dolphins were taken to ensure that the dolphins maintained a well-balanced diet in captivity; the levels of fat soluble vitamins were taken such as retinol (vitamin A), calcidiol (vitamin D3) and tocopherol(vitamin E) [80]. Captive dolphins have a much smaller pool of species of fish given to them hence there will be a decrease in the nutrient concentration [81]. Since fish is a food which spoils easily it is of utmost importance that the food is properly stored in order to maximise the nutritional quality [82].

Tocopherol is an antioxidant and this gets depleted during the oxidative degradation of lipids thus the more long-chain polyunsaturated fatty acids are found the faster the vitamin E will get depleted along with other nutrients such as vitamin C and selenium [82]. This can also be seen when the fish is stored and the vitamin E will also get depleted [82]. It is suggested to supplement each fish with around 100 IU/Kg per fish per day to the dolphins to avoid problems which may arise due to lack of vitamin E such as liver necrosis, anaemia, steatitis and muscular degeneration [80].

Another important vitamin is vitamin B1 (thiamine) which is broken down in fish by thiaminase in frozen fish this breakdown is slowed down but alternatively the longer the fish is stored the more the thiamine is being diminished thus resulting in a lack of this vitamin in dolphins [80]. The lack of thiamine will result in neurological problems and can eventually

lead to death which is why the loss of this vitamin needs to be supplemented when feeding frozen fish [80].

Sometimes we can see the opposite effect in regards to other vitamins. For example, fat soluble vitamins which are found in large amounts in fish such as vitamin A and vitamin D3 and thus these should not be supplement because if vitamin A is given in excess to the dolphin this will in turn reduce the vitamin E in the body resulting in problems that have beenpreviously mentioned above [83].

On the other hand, water soluble vitamins in frozen fish are reduced because of the process of thawing and also during the cutting of the fish because water is lost and this will in turn reduce the amount of water-soluble vitamins taken in by the dolphins, which is why they need to be supplemented [81]. In dolphins the baseline value of retinol and tocopherol is known but for other water-soluble vitamins the baseline is not yet noted and more studies need to be done with regards to this topic [84]. In pets blood samples are taken regularly to figure out the vitamin baseline for these animals so maybe in the future this practice will become common for bottlenose dolphins. Many places housing bottlenose dolphins are saidto use a multi-vitamin tablet in order to supplement the vitamins [82]. The main issue with the supplementation using a multi- vitamin tablet is that of over supplementation of fat soluble vitamins [82].

A study was carried out to observe the level of different vitamin values found in captive dolphins in comparison to levels measured in free- ranging dolphins, this was done bytaking one blood sample from each dolphin from the tail fluke [82]. It was important that the samples were taken in the morning before the animals were fed in order to get the most accurate result possible [82]. These samples tested the levels of retinol, tocopherol, calcidiol, cobalamin and thiamine pyrophosphate [82].

This study concluded that vitamin A is higher in dolphins under human care compared to wild dolphin therefore this further supported the fact that fat soluble vitamins accumulate and it is stored in the blubber of the dolphins [82]. Thus, we can assume from this result that supplementation is not necessary. Not enough study has been done on the effect of retinol on dolphins to fully understand the impact the excess of this vitamin has on the bottlenose dolphin [82].

Upon research done on vitamin B12 (cobalamin) it was found to not be influenced by the thawing [82]. This again proves that more research and testing needs to be carried out inorder to obtain a clearer understanding on this. When it comes to cobalamin, there have been no referenced concentrations for bottlenose dolphins, but we know that cobalamin is needed

for the proper development of the brain, nervous system and for blood formation [82].

With regards to the vitamin B1 the study found that there was a deficiency of this in housed bottlenose dolphins [85]. This decrease as mentioned above is believed to be due to thawing [82]. Interestingly, on further study of the vitamin B1 a lower amountwas found in female dolphins during lactation and therefore this could bring about theassumption that both pregnant and lactating dolphins should be supplemented more that thosethat are non-breeding [82].

In the case of vitamin D3, captive dolphins are found to have lower levels than the free-ranging ones. According to the study this was not expected as fish tend to contain a highamount of vitamin D3, which is not known to decrease during the freezing storage [81]. A further study on this was carried out using hooded seals and the results supported the fact that low concentrations of this vitamin were observed. This was found to be because the excess can be stored in the blubber or excreted [86]. A study on mice was also performed with regards to this and it was found that if there is an excess of both vitamin E and vitamin A the ability to take in vitamin D3 was lessened. This is why it is important to supplement these vitamins, and testing should be carried out to determine the D3 levels found in dolphins but,

there seems to be no threat to the health of these dolphins from low concentrations of vitamin D3 [82].

Upon a study carried out in Sarasota Bay, Florida it was found that in, the majority of animals tested, there was a higher level of vitamin E then in those found in the wild [84]. It was observed that if vitamin E given in excess to seals is stored in their blubber [87]. Because of this we can assume that it is stored this way in bottlenose dolphins as well as they are also marine mammals [82]. As mentioned previously, we need to be very careful when supplementing vitamin E in order to prevent excess concentrations due to the reasons mentioned above [82]. Nevertheless, this still needs to be supplemented as we know that when thawing and freezing fish this vitamin E can be lost [81].

5.7.3. Conclusion

From this research I have concluded that more studies need to be done, and further testing is necessary in order to further understand the effects of the nutrition mentioned above. This should be done in order to improve the lifestyle of captive dolphins with regards to their basic needs and in order to help them develop the best life they can under the circumstance that they are in and be at their utmost healthiest.

5.8. The Condition of the Pools in Comparison to the Wild

It is important that if a facility is going to keep bottlenose dolphins it meets the legal requirements [88]. These state that the pool should be made of tough material that does not allow water leakage and should not be made of a toxic material [88]. The pool should be able to cleaned without any difficulty [88]. All objects found in the pool should be non-hazardous and will not cause any harm towards the animal [88]. A proper drainage system should also be present in the pool in order to be able to clean and renew the water [88]. All pools require a shaded area to avoid the animal being in direct sunlight and to avoid over heating [88]. To avoid additional stress to the bottlenose dolphins it is important that the facility provides boundaries to reduce harassment coming from the public viewers [88]. The area should be equipped with gates, partitions, walls or distance from the crowd of people [88]. Pools should also be built in such a way as to avoid noise disturbance to the dolphins and pools should be checked on the daily to make sure that there are no harmful objects which have been thrown into the pool [88]. Veterinarians must also be present in the facility especially when the public are allowed to swim with the dolphins as to make sure that the activity is fully insured [88].

5.8.1. Dimensions of the Pools

It is mandatory that the enclosure gives enough space to each animal both horizontally and vertically to allow proper movement for the dolphins [88]. If the enclosure is too small this can result in aggression between the animals for hierarchy [88]. The main enclosure should be at least 14m narrow and more than 2.5m deep [88]. For each animal 49 square metres needs to be provided [88]. The secondary pool needs to be at least 12m narrow and more shallow than 1.8m [88]. It is ideal that these 2 pools are connected in order to allow more movement for the animals to further mimic their natural environment but this secondarypool can also be used for the breeding of calves [88]. Facilities should also have holdingpools which should only keep the dolphins for a maximum of 24 hours and isolation pools should also be equipped in the facility. These should have a separate water system to theother pools and this is present to isolate animals before introducing them to the other animals or in order to separate the sick animals to prevent them from infecting the other animals [88].

The isolation pools should be at least 7m narrow and at least 2m deep and the water levels can be manually lowered to allow for more accessibility to the animal in order to be able to treat the animal more easily [88].

5.8.2. The Quality of the Water

Water should regularly tested in order make sure there are no contaminant which can harm the animals [88]. They need to be equipped with proper water filters and should be treated with disinfectants which will not cause harm to the dolphins [88]. Ozone has been used for disinfection in pools and it has been found to be more effective than chlorine even though chlorine is also being used in other facilities [89]. There is no specified amount of chlorine that must be used and so this amount depends on the facility [89]. Chlorine was found to be non-toxic to dolphins and also has no odour nor taste [88]. Ozone is said to be better because it does not leave any residue after use [89].

Water temperature should vary between 10°C and 28°C in order imitate the waters wild dolphins live in [88]. The pH of the water should be between 7.5-8.4 [88]. Dolphins usually live in seas which have a salinity value between 15-35 ppt [90]. If the value ofsalinity is below this rage they may suffer from freshwater intoxication which can result in ulcers and erosions on the skin [90]. The salinity in captivity should be around 20 ppt in orderto mimic the salinity of the wild with a specific gravity of 1.022-1.024 [88]. Water is said to be tested at least 3 times a day in order to evaluate the pH, salinity and temperature in orderto make sure they stay within the proper ranges and for intervention to be done if this is not the case [88]. The bacteria in the water should be less than 500MPN (most probable number) per 100ml water and chemicals are used to make sure the bacterial growth does not exceed this limit [88]. The water flow should continuously be flowing in order to properly filter and remove the waste of the animals [88]. It is important to continuously clean the pool and the areas around the pool in order to prevent contamination [88]. A lot of these facilities are also said to use pesticides and rodenticides and it is important that measures are taken in order to prevent these chemicals from contaminating the pool as these can be a threat to the dolphins [88].

5.8.3. Conclusion

I think it’s important for the pools to imitate the natural environment as much as possible in order to minimise stresses and optimise the health of the animal. They shouldhave the appropriate space to move around and release their energy when kept in captivity as these animals are so intelligent it is very easy for them to become depressed, and the lack of brain stimulation may diminish their health.

5.9. Capture and Transport of Dolphins

The most commonly used method to capture wild dolphins is using a seine net which is placed into the water vertically, weights which pull the net to the bottom and buoys which will allow the top of the net to float at the top [91]. The net is attached to a speed boat and will enclose the animals, trapping them and they will be placed on the vessel [91]. Another method is the hoop net method which is hand held and traps the animals and they are then pulled onto the boat [91]. The drive hunt method can also be used but is is said to be the most brutal as this method entails chasing the animals to the shore where the nest will be found [91]. The animals are then held whilst being transported to the facility centre [91]. For short journeys the animals are placed in wet slings and are transported on a truck but for long distances they are again put in slings and placed into a tank and are transported [91].

5.9.1. Transporting Animals from the Facility

Transporting animals can only be done by approval from the veterinary doctor [88]. The animals need to be placed in a tank which has proper ventilation and will not cause injury towards the animal [88]. The tanks need to be have soft cushioning to prevent injury, should be an appropriate size, able to withstand the weight of the animal and the animal needs to be properly secured to avoid injuries and abnormal movements during the journey [88]. The animals during the transportation need to be easily accessible in case any injuries take place [88]. These containers need to be built in such a way as to not have any leakages during the journey [88]. The proper paperwork needs to accompany the animals, the tank needs to be labelled with a live cargo sticker, the type and amount of the animals being transported, the proper temperature needs to be kept, the reason for travel, the date of when the animal was placed in the crate, how long the animal has been out of the water and how long the journey is needs to be documented [88]. It is important that proper documentation is kept during these processes [88]. The animals heart rate and rectal temperature should be taken throughout the transport to make sure the animal is not under duress [92].

5.9.2. Conclusion

Transportation is a stressful time for these animals and can affect their immune system as during stress cortisol is produced and this is a steroid hormone it will cause

immunosuppression [93, 94]. This is why, in my opinion, we should handle the animals with proper care and make the journey as easy as possible by eliminating as many stresses as we can and avoid any injuries which can take place to the animals. I think that animals should be transported only when it is necessary and it is for the greater good of the animals and will improve their overall health in the long run.

6. Conclusion

This comparative analysis between wild and captive bottlenose dolphins emphasises the dual nature of human interaction with these mammals and the complexities of human involvement in their lives. While captive environments are positive in that they facilitate advanced veterinary care (both in terms of treatment and diagnosis) controlled nutrition and detailed behavioural studies, they often fall short when it comes to replicating the stimulation and independence found in the wild. Captive dolphins benefit from immediate medical intervention and structured play activities however, living in captivity can limit their social structures and lead to stress because of space restrictions and forced behaviour.

On the other hand, wild dolphins are able to enjoy a more enriching life that supports natural behaviour, group dynamics, and survival skills honed through hunting and communication. Yet, they face environmental challenges, including human-related threats. The mortality rates and quality of life between the two groups are complicated as although captivity can extend the lives of dolphins it can at the same time suppress their natural instincts and affect their overall well-being.

This thesis highlights the importance of improve the conditions of captive dolphins to more closely resemble their natural habitats. Future research should continue to work on improving the best practices, balance the educational and conservational benefits of captivity and consider more ethical practices. Enhancing the quality of life for dolphins, whether in the wild or in human care, remains a vital objective and requires thoughtful action and continuous advancement in conservation strategies.

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Consultation – 1st semester

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The thesis meets the requirements of the Study and Examination Rules of the University and the Guide to Thesis Writing.

I accept the thesis and found suitable to defence,

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