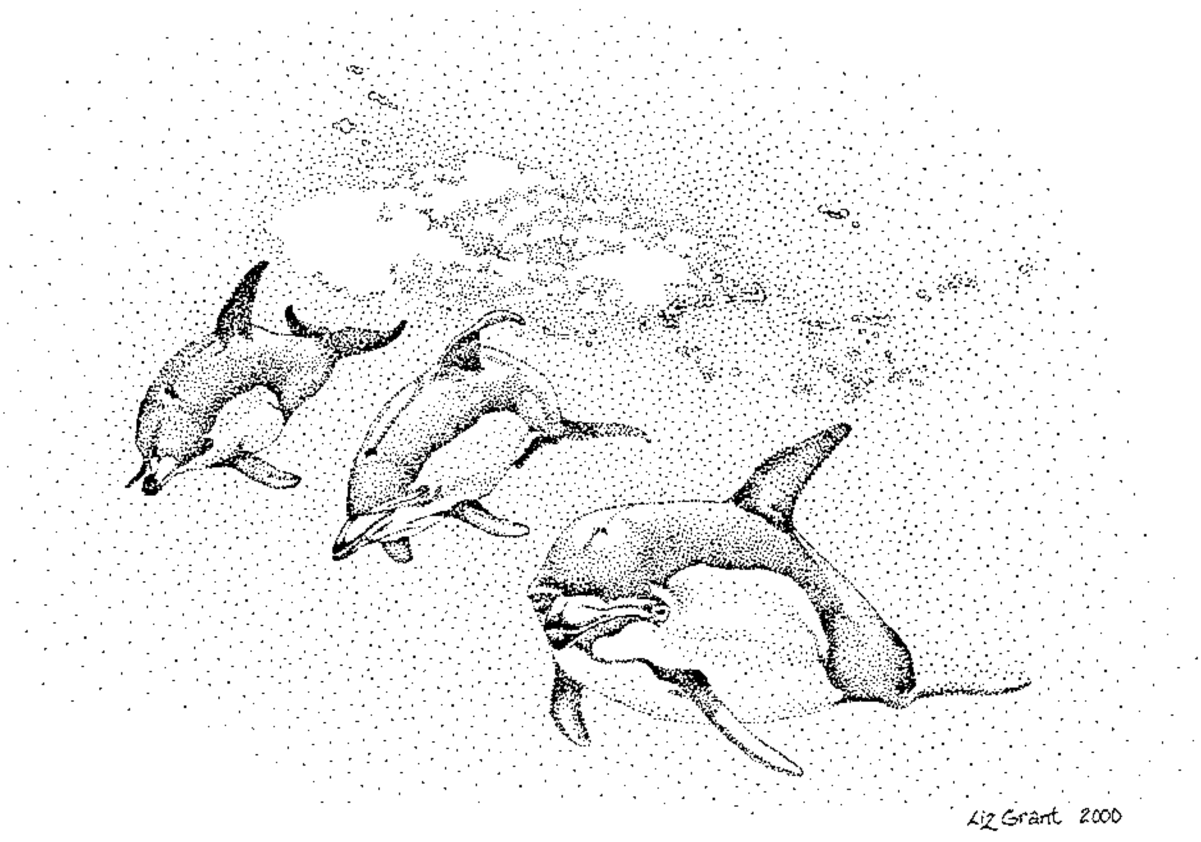
The behaviour and vocalisations of common dolphins *Delphinus delphis* at Marineland, Napier, New Zealand



Deborah Jane Kyngdon

2000

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THESIS ABSTRACT

Three female common dolphins *Delphinus delphis* at Marineland, Napier were studied from November 1998, through to October 1999. The first step was to construct an ethogram. Following that, I examined the behavioural and vocal responses of the dolphins to the Swim-with-Dolphin (SWD) programme.

An ethogram was constructed for common dolphin behaviour by collating notes and video footage. The ethogram consists of 16 categories of behaviour that were sub-divided into different aspects of those behaviours. Each behaviour is described and some are illustrated. The effect of the SWD programme was assessed by monitoring changes in the dolphins use of a refuge area, changes in six behavioural categories (Aggressive, Touch, Other, Abrupt, Submissive and Play), and changes in surfacing frequency and location before, during and after SWD sessions. There was a significant increase in refuge area use during a SWD session, but this returned to pre-swim levels immediately afterwards. There were small changes in behaviour during SWD sessions, with an increase in Other and Touch behaviours. These changes are not like the documented stress response of bottlenose dolphins *Tursiops truncatus* which include an increase in aggression. During sessions with swimmers the frequency of surfacing increased slightly and a greater percentage of surfacing occurred in the refuge area. The difference in the proportion of five types of dolphin vocalisations (Whistles, Clicks, Chirps, Squeaks and Whines) before, during and after SWD sessions was not significant. There was a slight increase in the frequency of all calls during SWD sessions. The behaviour that occurred during 521 vocalisations was also analyzed. Clicks were commonly heard when the dolphins were approaching people, another dolphin or the bell. Chirps indicated the departure of one dolphin from the other.

The common dolphins at Marineland show no significant behaviours indicative of distress in response to the SWD programme. The behaviour changes that occurred were not associated with a distress response and the changes in vocalisations were not significant.

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Chapter One

General introduction

Early morning training, the dolphins practicing their bow.

1.1 INTRODUCTION

Managers of zoos and aquariums have to ensure that the welfare of the animals held in their facilities is not compromised. There is, however, often a conflict between animal welfare and financial return. Managers may want to change an animal's environment to improve its welfare but lack the funds to do so.

When animals lose control of their environment, especially for those in captivity, stress symptoms may appear and their welfare may become compromised (Weipkema and Koolhaas 1993). If animals have no control over important events in their environment, disturbed behaviour may develop (Ödberg 1987). There are two major types of disturbed behaviour, injurious behaviour and stereotypies (Fraser and Broom 1990).

Stereotypic behaviour is often seen in captive animals. Stereotypies are repetitive, unvarying and apparently functionless behaviour patterns (Fox 1965). This behaviour is associated with stress and indicates poor 'well-being' (Mason 1991). Goldblatt (1993) suggested that the appearance of a stereotypy indicates that an animals behavioural needs are not being met and they serve to help the animal cope with its environment (Barnett and Hemsworth 1990). Wiepkema and Koolhaas (1993) suggest that it is important to have some unpredictability in an environment to reduce the development of stereotypies.

The effect of management practices on animals may be monitored by looking for abnormal behaviour and changes in behaviour. Behaviour changes may be subtle and it is important to note that no two individuals are the same. Behavioural responses to stressors by individuals can range from increased aggression to increased submission (Frohoff 1993). Thus, for managers, knowledge of an individual animal's behaviour is important. This is where an ethogram is useful. A typical stress response is a loss of appetite, reduced reproductive success, poor health (Kleiman *et al.* 1996) or decreased social interaction, as seen in Siberian dwarf hamsters *Phodopus sungorus pallas* (Crawley 1984). Another method to assess stress is to monitor changes in vocalisations and the presence of alarm or distress calls (Caldwell *et al.* 1962; Lilly 1963; Seyfarth *et al.* 1980). For example, when young squirrel monkey *Saimiri sciureus* are separated from their mothers they exhibit signs of distress such as heightened vocalisations and activity and increase plasma cortisol levels (Levine 1983).

The tourist demand for wildlife experiences has encouraged the development of whale and dolphin watch ventures and Swim-with-Dolphin (SWD) programmes. There are whale or dolphin watching industries in over 65 countries and island territories (Hoyt 1995). Programmes in aquariums are also in high demand and in the USA, there are 6 registered captive 'Swim-With-Dolphin' programmes (Constantine and Baker 1997).

New Zealand has responded to this global demand by establishing whale and dolphin watching enterprises and 'Swim-with-Dolphin' (SWD) programmes around its coast. Marineland of New Zealand, in Napier, holds captive common dolphins *Delphinus delphis* and has a popular SWD programme. It caters for those unable to swim with dolphins in the open ocean and gives the public an opportunity to swim with the dolphins in a confined and controlled environment. The programme also gives people with disabilities a chance to get close to a dolphin in safety.

SWD programmes in the USA have come under scrutiny recently and were temporarily stopped while research was conducted to see if the bottlenose dolphins *Tursiops truncatus* or people are at any unnecessary risk while participating in the SWD sessions. This encouraged the Department of Conservation (NZ) to initiate research on the effects of the SWD programme on the common dolphins at Marineland. Results from that research are detailed in this thesis.

1.2 BACKGROUND

Dolphins and man:

The ancient Greeks held the dolphin in very high regard as illustrated in the roles they played in Greek legends. In these legends dolphins help humans to safety (Montagu and Lilly 1963).

Historically, marine mammals, especially cetaceans and seals, have been exploited by hunters. No one knows exactly when whaling began but the Norwegians were whaling in 890 A.D. (Slijper 1979). Cetaceans were a valuable source of meat and blubber for food, skins for clothing and oil for heat and light (Hofman and Bonner 1985). Whale skeletons, probably from stranded animals, have been found in Stone Age diggings. Whale bone was often used by Maori as tattooing tools, fishing hooks, and as body ornaments (Hamilton 1896).

The improved whaling techniques of the nineteenth and twentieth centuries resulted in a devastating reduction of cetacean numbers (McBain 1999). In New Zealand the population of Hector's dolphin *Cephalorhynchus hectori* declined and currently it is a threatened species. Hunting caused the initial decline in Hector's dolphin numbers but now they are killed accidentally in drift nets (Dawson 1991).

There are numerous accounts of interactions between humans and dolphins. Most of these report on the friendliness of dolphins to humans, especially children (Montagu and Lilly 1963). There are anecdotes of dolphins rescuing swimmers and warning swimmers of danger (Doak 1981). Bottlenose dolphins *Tursiops truncatus* and common dolphins *Delphinus delphis* are characterised by playfulness and friendliness towards man. Many superstitions predict that the presence of dolphins means good luck for fisherman (Robson 1976).

It is an amazing experience to be surrounded by thousands of dolphins feeding, playing or travelling. But for many, this is a dream. One of the reasons for keeping animals in captivity is to provide specimens for the public to observe. Zoos and aquariums are important educational tools. They allow the public to see endangered species and help them observe the diversity of species and understand why it's so important to protect them.

Zoological parks originated as private menageries that were symbols of wealth and power. Zoos celebrated the domination of nature by man (Jamieson 1995). By the late Middle Ages, menageries had become a popular form of public entertainment in Europe. The first true zoological park was established at Jardin des Plantes in Paris in the late eighteenth century (Mench and Kreger 1996). However, only a few zoos historically, had the goals of the best modern zoos, i.e. research, conservation, education and recreation.

Carl Hagenbeck (1910) developed new ideas about the relationship between animals and humans in the zoo environment. He pioneered the use of positive training techniques and owned a revolutionary type of zoo at Stellingen, outside Hamburg, that presented animals as he had seen them in the wild.

In the 21st Century, zoos have become centres for conservation research, conservation action and education. In the past, zoos housed charismatic mega-vertebrates (CMV), taking advantage of human interest in these animals. Protesters have contended that the human interest in CMV has led to a decrease in the numbers of these species in the wild. However, Conway (1968) found no instance where zoo collecting had been a significant cause of decline for any species.

Marineland Background:

Marineland is a marine park situated on Marine Parade, Napier, New Zealand. It is the only zoo in New Zealand to hold dolphins and the only one in the world to have female common dolphins *Delphinus delphis*. Marineland has been open for 35 years. It is an important education centre and is a hospital for marine animals such as seals and birds. Marineland offers a wide range of activities to the public, including behind the scenes tours, penguin recovery workshops, animal shows, and swims with the dolphins. The tours and workshops give members of the public an opportunity to see the animals close up, to feed them and to learn how the animals are looked after.

The animals kept at Marineland include common dolphins *Delphinus delphis*, California sea lions *Zalophus californiaus*, New Zealand fur seals *Arctocephalus forsteri*, leopard seal *Hydruga leptonyx*, little blue penguins *Eudyptula minor*, Australasian gannets *Sula serrator* and two Asian short clawed otters *Aonyx cinerea*.

Marineland's main attraction is the common dolphins. There are two female common dolphins at Marineland named Shona and Kelly. These dolphins perform in shows two or three times each day during the peak season. The dolphin show lasts for 20 minutes. After the shows they may take part in a photo session with the public. The dolphins are involved in the behind the scenes tours twice daily, when the public are allowed to feed and touch a dolphin and learn about looking after dolphins. Members of the public may also swim with the dolphins. The Swim-with-Dolphin (SWD) programme offered at Marineland is primarily an observational swim and is not at all interactive. This study investigates the effects swimmers have on the dolphins' welfare.

1.3 'SWIM-WITH-DOLPHIN' PROGRAMME.

History:

An informal Swim-with-Dolphin (SWD) programme began in the 1970's when people could swim with the dolphins for free. In the 1980's, the swim programme became more structured but there were not any rules. The SWD programme officially started on the 1st of December 1992. At this time the first rules were developed. These included using the holding pool as a refuge area. In September 1997, the SWD programme had its rules updated to help the dolphins cope with the increasing demand for the programme.

By 1998, the Department of Conservation (DoC) had established new guidelines for housing marine mammals. DoC required Marineland to fund a behavioural and physiological study on the effects of the SWD programme on the common dolphins.

Study animals:

The dolphins at Marineland were caught in Hawke Bay to be displayed at Marineland (Figure 1.1). In 1998, three female common dolphins *Delphinus delphis* participated in the SWD programme at Marineland (Table 1.1). They are the only reported captive female common dolphins in the world. Shona and Kelly were caught on the same day and were most likely from the same school.

The three dolphins were observed during November 1998 – June 1999. However, Selina, the youngest dolphin died in June 1999 and wasn't alive for the vocalisation study (Chapter 4). Sound recordings were made in September 1999, over 9 SWD sessions and during feeding.

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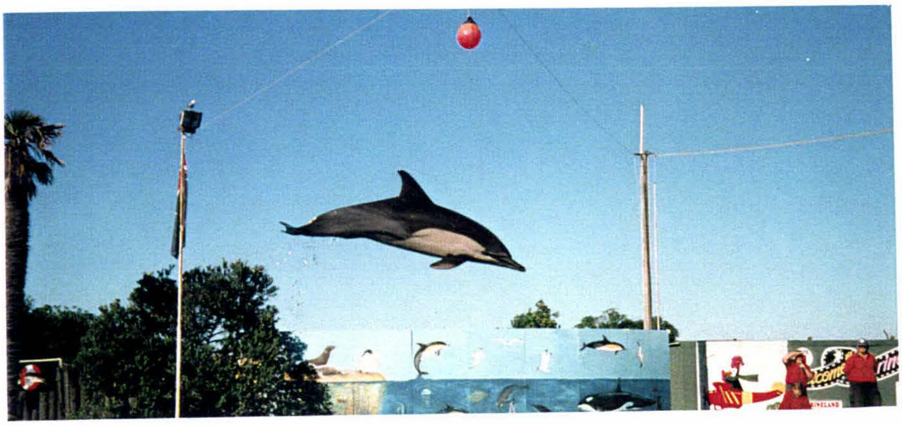

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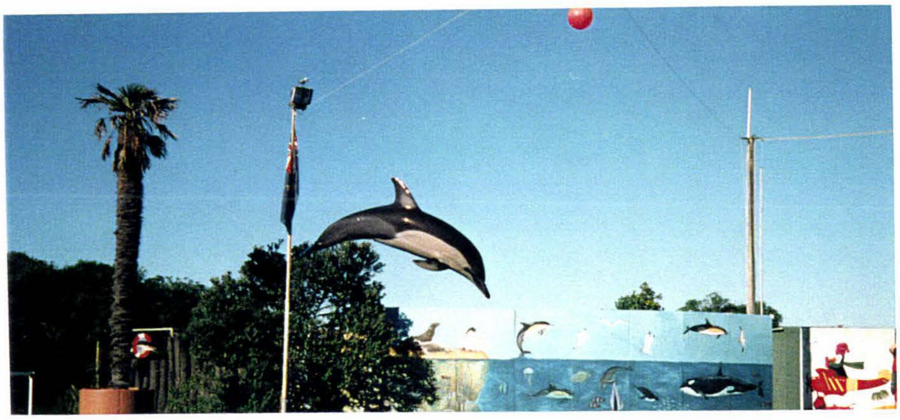

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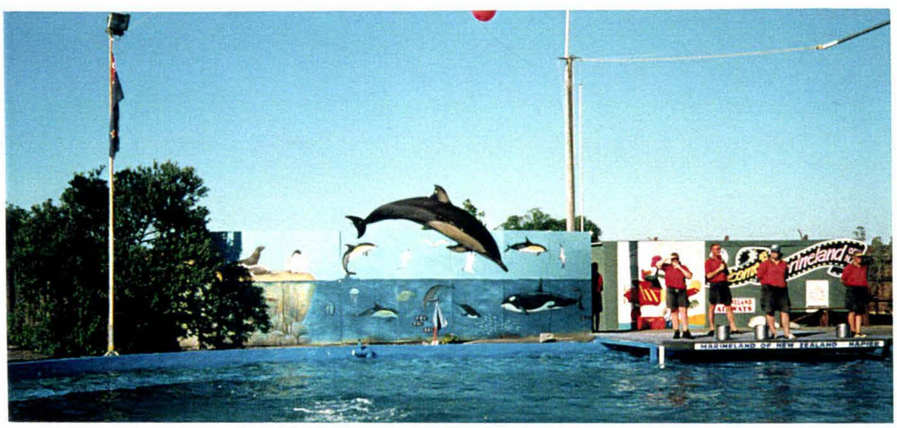


Figure 1.1 The three dolphins performing a 'Bow' during a show. A) Shona, B) Kelly and C) Selina.

Table 1.1 Date of capture, age and physical characteristics of the three common dolphins *Delphinus delphis* at Marineland during the study in 1998-1999.

Dolphin	Date of Capture	Approximate age at capture	Physical Characteristics
Shona	13 December 1974	7	Dorsal fin is dark and has a V-shaped notch.
Kelly	13 December 1974	5	A large dolphin, tall dorsal fin with white patches on either side.
Selina	26 February 1987	3	A very small dolphin. Her dorsal fin is bent to the left.

Study site:

The dolphins are kept in the main pool of Marineland that is situated in front of the Grandstand (Figure 1.2). The dimensions of the pool are 30m x 15m x 4.1m deep. It has a capacity of 1.5 million litres. In addition, there is a holding pool with a diameter of 9.2m, a depth of 2.3m and a capacity of 120 000 litres. There is a shallow area around the front of the main pool that continues under the stage. A bell, which is frequently used by the dolphins, is situated at the end of the pool opposite to the holding pool (Figure 1.2).

The salt water in the pool is drawn continuously from Hawke Bay, via submersible pumps set in wells along the beachfront and situated below the sea level. Sand and shingle on the beach act as a filtering system. The pool is cleaned twice a week during the summer months. In winter, there is less algal growth so the pool is cleaned only once a week.

During the SWD sessions, one third of the pool is flagged off as a refuge area to be used only by the dolphins. The refuge area includes the holding pool.

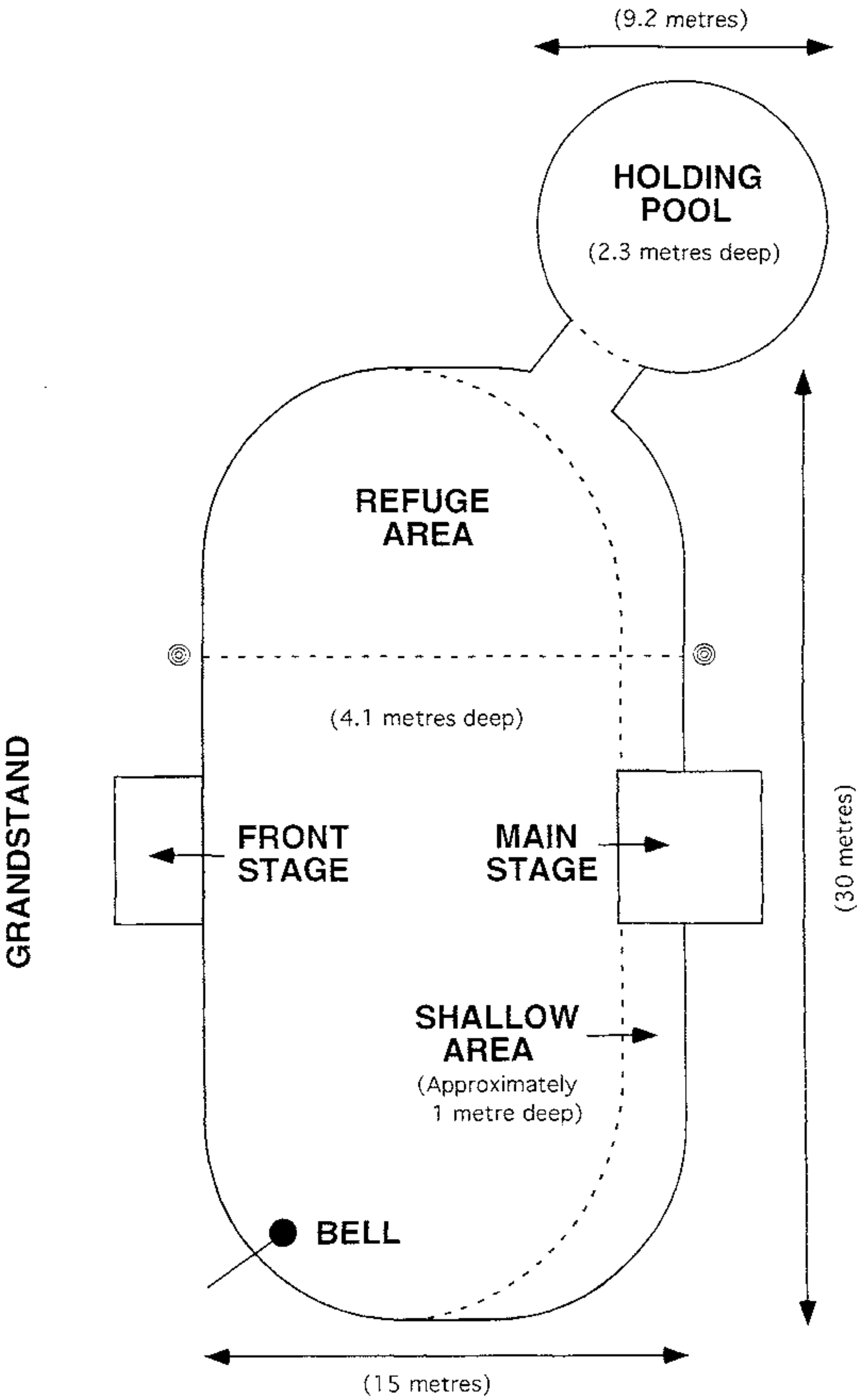


Figure 1.2 The main pool at Marineland, and study site for this thesis.

SWD session times:

SWD sessions are held up to eight times a day depending on the season and demand. The session times are held at: 0800 h, 1200 h, 1500 h, 1530 h, 1600 h, 1645 h, 1715 h and 1745 h. SWD sessions at 0800 h, 1200 h and 1500 h were monitored. It was difficult to observe the dolphins during the sessions after 1530 h because the pool became shaded, making it difficult to see the bottom. The dolphins become highly active at 1600 h probably in anticipation of their feed at 1630 h. After the feed, the dolphins became very lethargic and appear to rest.

SWD session:

In 1998, the SWD sessions were 45 minutes long and three swimmers were allowed in the pool per session. However, after Selina died, the sessions were shortened to 30 minutes and the number of swimmers was reduced to two.

The swimmers arrive at Marineland 15 minutes before the start of the SWD session. They are provided with a wetsuit, mask, snorkel and flippers. The swimmers are given a list of the SWD rules (Appendix 1) and wait by the pool till the trainer has reiterated the rules. Many swimmers leave the pool before their time is up because the water is too cold. If swimmers do not obey the rules they are given a warning and if they break them a second time they are asked to leave the pool (however, if they restrain, pull, or grab a dolphin, they are removed immediately from the pool). A trainer is always present during a SWD session to ensure that swimmers follow the rules. The trainer does not control the dolphins.

1.4 COMMON DOLPHIN *Delphinus delphis*

The exact number of species in the genus *Delphinus* has not been agreed upon. Many scholars recognise only a single species, *Delphinus delphis* Linneaus, 1758, and divide it into three sub-species, *Delphinus delphis delphis* Linneaus, 1758, *Delphinus delphis bairdi* Dall, 1873, *and Delphinus delphis ponticus* Barabash-Nikoforov, 1935 (Tinker

1988). However, there are many other sub-species not mentioned here. The species *D. delphis* is distributed widely around the world (Figure 1.3) and has many different local common names. English names include common dolphin, saddleback porpoise, white-bellied porpoise and the cape dolphin (Evans 1994). It is one of the commonest of all marine mammals, and is familiar to many because of its habit of following ships at sea (Bonner 1980).

Distribution:

The common dolphin is the most numerous cetacean found in New Zealand waters. It is found worldwide in temperate, tropical and subtropical seas (Evans 1994). Common dolphins are sighted in areas of high sea floor relief and in warmer, more saline waters.

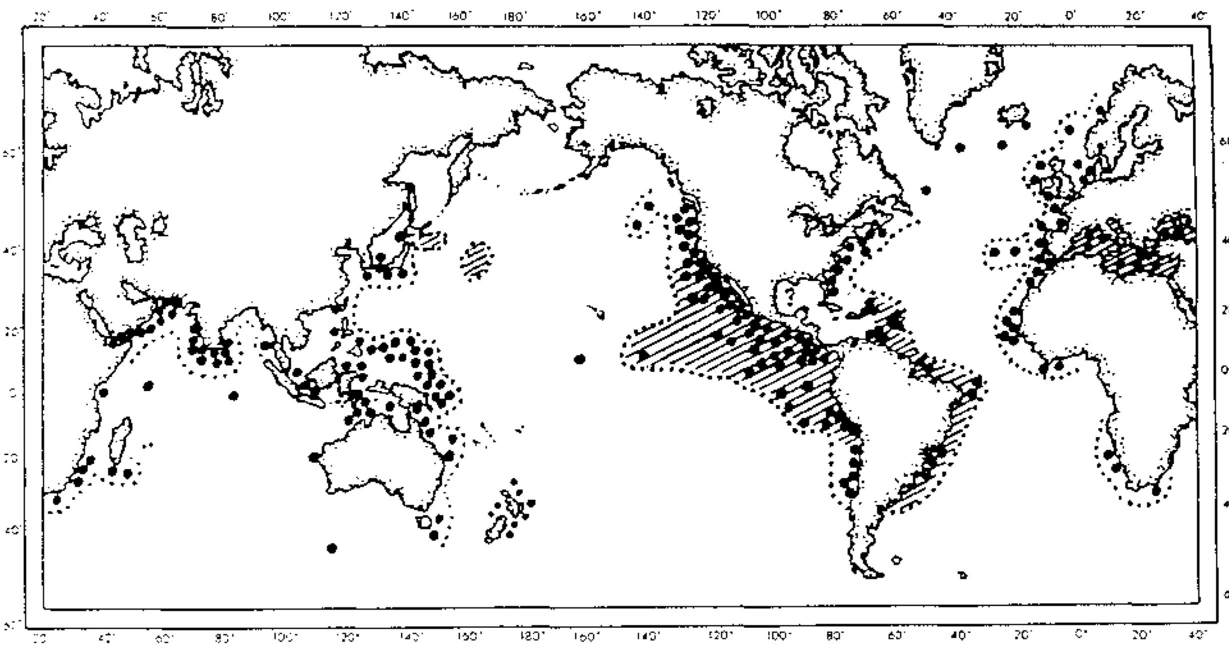


Figure 1.3 The Global distribution of *Delphinus* based on specimens and sightings at sea. Dots represent sightings and specimens, and shading represents known distributions (from Evans 1994).

Characteristics:

The most distinctive and variable external characteristic of the common dolphin is its criss-cross colour patterning (Mitchell 1970). The V-shaped saddle and the dorsal fin serve as useful markings in the case of sightings and recordings for research (Evans 1994) because all are variable and easy to photograph for records. Their colouring is striking, the dorsal surface is usually black/brown from head to tail and the sides are yellowish brown and gray. They have a dark line extending from the eye forward to the base of the forehead and another dark line extending forward from the base of the flipper to the corner of the mouth. The flippers and flukes are dark in colour (Tinker 1988).

The estimated life-span of common dolphins in the wild is 20 years (Dawson 1985).

Behaviour:

The common dolphin is a highly active and sociable cetacean. They jump often, usually making long, smoothly arcing leaps, especially when moving at speed (Dawson 1985). Common dolphins can occur in schools consisting of hundreds or thousands of individuals (Dohl *et al.* 1986) but their basic social unit may be less than 30 (Evans 1994). The large schools may be mixed, or in some localities, age and sex-segregated (Bonner 1980). *D. delphis* mixes frequently with other species such as Pacific white-sided dolphins *D. lagenorhynchus* and pilot whales *Globicephala melaena* (Evans 1994).

Common dolphins are attracted to large vessels and they like to ride in their bow-waves. This makes them easy to catch. In the past, they have been maintained in many oceanaria but they cannot be trained as easily as some other dolphin species (Bonner, 1980). This is why bottlenose dolphins are far more common in captivity.

Common dolphins are very vocal mammals. They click, squeak, whistle, whine, scream and creak. During the daylight hours, whistles and screams, rich in harmonics, are common, but at night the dolphins' whistles are of a higher frequency and a narrower bandwidth, and are probably associated to feeding (Evans and Awbrey 1988).

The maximum dive depth recorded for a common dolphin is more than 200m. Most dives, however, are in the range of 9 - 50 m. Like other small dolphins they cannot make prolonged dives and generally surface every few minutes, breathing rapidly and efficiently (Evans 1988).

Common dolphins appear to feed co-operatively by rounding up fish and taking turns to race through and feed (Baker 1987). The *D. delphis* off southern California start feeding at dusk and continue to feed throughout the night. The diet of common dolphins varies with location and season.

1.5 MEASURING ANIMAL WELFARE

When housing captive animals or starting a programme such as a 'Swim-with-Dolphin programme', it is important to ensure that the welfare of the participating animals is not compromised. Morberg (1985) suggests that one approach to assessing an animal's 'well being' is to monitor its stress response.

Stress has many definitions but in this discussion it is the response of an individual when challenged physically or psychologically. The physiological and/or behavioural response to cope with the challenge may be a small or large deviation from the normal values.

A stress response is not only the result of a negative stressor. Selye (1973) showed that a sudden pleasant stimulus, such as a passionate kiss, can stimulate a greater corticosteriod secretion than an electric shock. Expectations and fears (psychological factors) also cause a stress response (Mason 1971).

The effects of stressors on animals include impaired immune function, gastric ulcers, impaired growth and reproduction, abnormal behaviour and disease (Lay 2000). If an animal cannot escape from a stressor, symptoms of stress, such as increased heart rate and respiration and piloerection occur. It is often implied that any stress is unacceptable and that stress must be avoided at all costs (Moberg 2000). Not only is this impossible but as Selye (1973) observed, 'the absence of stress is death'. Thus, the goal is not to eliminate stress but to manage it.

Selye (1974) identified two types of stress, distress and eustress. Distress occurs when the stressor causes harm and decreases the fitness of the organism (Lay 2000). Distress is harmful to the individual because it may lower its resistance to infection by inhibiting certain components of the immune system (Tortora and Grabowski 1996). Eustress occurs when a stressor is pleasurable, such as animals running during play or the act of copulation (Lay 2000). Eustress may help an individual cope with some challenges (Tortora and Grabowski 1996).

Stress response:

The stress response is a combination of physiological and behavioural responses. Ideally, both behavioural and physiological responses should be monitored to determine whether an individual is distressed.

Selye (1973) introduced the 'General Adaptation Syndrome' (GAS) which acts to prepare the body to meet any emergency (Tortora and Grabowski 1996). It is a non-specific response, because a wide range of stressors are able to trigger this physiological response.

In the GAS there are three stages after exposure to a stressor:

1. Alarm reaction – fight, fright, and flight response involving the sympathetic adrenomedullary system (Cannon 1935).

2. Stage of resistance – the resistance phase is a reaction initiated mainly by hypothalamic hormones and is a long-term reaction (Torand Grabowski 1996) that allows the body to fight a stressor long after the initial alarm reaction has stopped.

3. Stage of exhaustion – this occurs if the stressor continues. The body's resources become depleted and the resistance stage can no longer be sustained. Once an individual enters this stage it may be at risk of infection if exposed to pathogens.

Measuring a stress response:

One way to determine the presence of stress in an animal is to monitor the physiological and behavioural responses commonly associated with stress.

Physiological stress response

The physiological stress (distress) response is complex and there are a number of features that may be used to measure it. These include:

- Increase in heart rate and blood pressure
- Increased plasma glucocorticoid levels e.g. cortisol
- Raised body temperature and perspiration
- Increase breathing rate
- Piloerection
- Increased number of red blood cells
- Reduced immune response

(Guyton 1991; Tortora and Grabowski 1996)

Behavioural stress response

Behavioural studies are complex and require extensive fieldwork. Nevertheless, when dealing with wild/free-living animals, behavioural observations are best as they are not invasive, unlike the monitoring of physiological variables (Hediger 1950). The following is a summary of possible behavioural responses to different stressors:

- Displacement – the individual moves as a direct result of the stressor to avoid or escape it (Recarte *et al.* 1998).
- Immobility (Carlstead 1996).
- Protective responses or fight response – this is usually behaviour that is not related to any normal territorial response but as a reaction to a dangerous situation (Carlstead 1996).

- Abnormal behaviours – the individual displays behaviour that doesn't usually occur at that time (Meyer-Holzapfel 1968).
- Specific vocalisations and startle responses (Caldwell *et al.* 1962; Lilly 1963; Seyfarth *et al.* 1980).
- Stereotyped behaviour – these are repeated sequences of movements that have no obvious function (Ödberg 1987). They may develop as a coping strategy by the individual. Recent research indicated that stereotypies are not primarily related to stress as they continue when the animal has been removed from the stressor (Mason 1991). Some stereotypic behaviour produces endogenous opoid peptides that have an analgesic action (Huges *et al.* 1975) and a self-narcotization effect (Cronin *et al.* 1985).

Other stress responses

There are also other measures of stress (distress). These include reduced reproductive success, poor health and reduced appetite. These are good measures of animal welfare but, because of management restraints, they could not be used on the dolphins at Marineland.

Ongoing exposure to stress (distress) may compromise an animal's health in the following ways (Broom and Johnson 1993):

- Reduced reproductive success
- Weight loss
- Muscle wasting and weakness
- Immunosuppression.
- Ulcerations in the gastrointestinal tract (Guyton 1991).

Measuring dolphin welfare:

Many cetacean studies have focused on behavioural responses of individuals and populations to stressors (Samuels and Spradlin 1995; Constantine and Baker 1997; Barr 1997; Richardson and Würsig 1997). These studies looked at short-term displacement of a population, surfacing frequencies and general behavioural changes in response to different stressors. Studies of wild cetaceans generally look at population responses rather than individual responses due to the difficulty of continuous observations of one individual and identification of individual animals. Samuels and Spradlin (1995) and Frohoff (1993) studied the behavioural responses of individual bottlenose dolphins to swimmers. They looked at the changes in specific types of behaviour namely, Aggression, Submission, Abrupt, Sexual and Play behaviours, during different SWD programmes. Samuels and Spradlin (1995) observed an increase in aggressive behaviour by the dolphins in the presence of swimmers.

One method of assessing the psychological state of a dolphin is to monitor its vocalisations. Bottlenose dolphins have been found to elicit alarm and distress calls in stressful circumstances (Lilly 1963; Herman and Tavolga 1980). Caldwell *et al.* (1962) described a sound produced by bottlenose dolphins that was apparently a context-specific sound produced during fright. These calls may startle or frighten a predator and alert neighbouring dolphins to the predator's presence (Dawson 1991).

Stereotypies may be used to determine whether a captive animal's welfare has been compromised. Wild animals frequently develop stereotypic behaviour patterns in captivity, especially in monotonous environments (Hediger 1950; Meyer-Holzapfel 1968). Stereotypic behaviours in cetaceans, specifically in dolphins, are very difficult to identify (Greenwood 1977). A stereotypic head-pressing movement was exhibited by three captive bottlenose dolphins *Tursiops truncatus* as a reaction to a restricted and monotonous environment (Greenwood 1977).

Wild marine mammals are often under threat from human activities such as, whaling, drift net fishing, trawling, shipping, noise and tourist boats. Their response to stressors include alarm calls (Lilly 1963), tight schooling and in some cases pheromone release as in beluga whales *Delphinapterus leucas* (Yablokov *et al.* 1972).

The sound produced by bottlenose dolphins in response to fright corresponded to behaviours that were typified by flight, tight schooling and hyper-excitability (Caldwell *et al.* 1962). Schooling is very important in predator avoidance and in fishes it is a form of cover seeking and protection from predation (Williams 1964). Schooling is commonly seen in smaller cetaceans especially when they are attacked by larger cetaceans and sharks (Norris 1994). Schooling in large groups helps in the quick detection of predators and the group can act together to scare a predator off by mobbing it. The group may also scatter thus confusing the predator, as in sticklebacks (Milinski 1984).

Man-made activities such as seismic surveying, marine industrial activities, tourism, boats and aircraft noise have many effects on the movements and behaviour of cetaceans and other marine mammals, although only short term responses have been examined (Richardson and Würsig 1997). These responses include displacement, loss of contact between individuals, masking of sounds of surf predators, temporary or permanent hearing damage and noise induced physiological stress.

Disturbances, such as aircraft overflights, elicited sudden dives or turns and tail or flipper slaps in both baleen and toothed whales (Richardson and Würsig 1997). They may also cause subtle changes in surfacing and respiration patterns. Other factors may affect a dolphin's behaviour and it is important to know what behavioural state they are in at the time of observations. If they are feeding, socialising or mating they may be less responsive to disturbances than when they're resting. A number of cetaceans change their initial response to specific stressors over time. Humpback whales *Megaptera novaeangliae* were shy of vessels but now often approach them without obvious concern (Watkins 1986). Conversely, Minke whales *Balaenoptera acutorostrata* used to be curious and follow boats, but now they often ignore them (Richardson and Würsig 1997).

The dolphins at Marineland have become habituated to people but have not been trained to present a pectoral fin or fluke for blood sampling. Blood samples have been taken from the dolphins at Marineland but it involved getting the dolphins into the holding pool and then lowering the water level. The trainers can then stand on the bottom and catch a dolphin and put it on a stretcher and raise it to the lip of the pool (Figure 1.2). The dolphin is then restrained and blood is taken and it is weighed. Taking blood to monitor cortisol or glucose levels in response to the SWD session would therefore be inappropriate because if there was a response it would be masked by the response to the blood sampling procedure.

Studying the behaviour and vocalisations is the best method to assess the effects of the SWD programme on common dolphins. It is a non-interactive sampling method and it reveals the entire picture without causing added stress. The dolphins have been in captivity for over 25 years and have most probably become habituated to human presence. Habituation reduces the stress response by individuals to. For example regularly handled kiwi produced a lower cortisol response than un-handled kiwi (Dominic Adams *pers. comm.* 2000). Despite the claims that physiological responses provide the best method to measure a stress response they still require validation by behavioural observations to ensure a physiological response is associated to the stressor being examined.

1.6 REFERENCES

Baker, M. L. 1987. *Whales, dolphins and porpoises of the world.* Doubleday and Co., New York.

Barnett, J. L. and P. H. Hemsworth. 1990. The validity of physiological and behavioural measures of animal welfare. *Applied Animal Behaviour Science* **25:** 177-187.

Barr, K. 1997. *The impacts of marine tourism on the behaviour and movement patterns of dusky dolphins* (Lagenorhynchus obscurus) *at Kaikoura, New Zealand.* Unpublished thesis, University of Otago, Dunedin.

Bonner, W. N. 1980. *Whales.* Blandford Press, Poole.

Broom, D. M. and K. G. Johnson. 1993. *Stress and animal welfare.* Chapman and Hall, London.

Caldwell, M. C., R. M. Haugen and D. K. Caldwell. 1962. High-Energy sound associated with fright in the dolphin. *Science* **138:** 907-908.

Cannon, W. 1935. Stresses and strains of homeostasis. *American Journal of Medical Science* **189:** 1-14. [Original not seen, cited in Carlstead 1996]

Carlstead, K. 1996. Effects of captivity on the behaviour of wild mammals. In: *Wild mammals in captivity: principles and techniques.* Kleiman, D. G., M. E. Allen, K. V. Thompson, and S. Lumpkin (eds.). The University of Chicago Press, Chicago p.317-333

Constantine, R. and S. Baker. 1997. *Monitoring the commercial swim-with-dolphin operations in the Bay of Islands.* Report Number 56. Department of Conservation, Wellington.

Conway, W. 1968. The consumption of wildlife by man. *Animal Kingdom* **7:** 18-23.

Crawley, J. W. 1984. Evaluation of a proposed hamster separation model of depression, *Psychiatry Research* **11:** 35-47

Cronin, G. M., P. R. Wiepkema and J. M. van Ree. 1985. Endogenous opioids are involved in abnormal stereotyped behaviours of tethered sows. *Neuropeptides* **6:** 1776-1786.

Dawson, S. 1985. *The New Zealand whale and dolphin digest: the official Project Jonah guidebook.* Brick Row Publishing, Auckland.

Dawson, S. M. 1991. Modifying gillnets to reduce entanglement of cetaceans. *Marine Mammal Science* **7:** 274-282.

Doak, W. 1981. *Dolphin, dolphin.* Hodder and Stoughton, Auckland, N.Z.

Dohl, T. P., M. L. Bonnell, and R. G. Ford. 1986. Distribution and abundance of common dolphin, *Delphinus delphis*, in the southern California Bight: a quantitative assessment based upon aerial transect data. *Fisheries Bulletin, US.* **84:** 333-343

Evans, W. E. and F. T. Awbrey. 1988. Natural history aspects of marine mammal echolocation: feeding strategies and habitat. In: *Animal sonar: processes and performance.* P. E. Nachtigall and P. W. B. Moore (eds.). Plenum Press, New York. p. 521-534.

Evans, W. E. 1994. Common dolphin, White-bellies porpoise, *Delphinus delphis* Linnaeus, 1758. In: *Handbook of Marine Mammals.* S. H. Ridgeway and R. J. Harrison (eds.). Academic Press Ltd, Cambridge. p. 191-224.

Fox, M. W. 1965. Environmental factors influencing stereotyped and allelomimetic behaviour in animals. *Laboratory Animal Care.* **15**: 63-370

Fraser, A. F. and D. M. Broom. 1990. *Farm animal behaviour and welfare.* Baillière Tindall, London.

Frohoff, T. G. 1993. *Behavior of captive bottlenose dolphins* (Tursiops truncatus) *and humans during in-water interactions*. Unpublished thesis, Texas A and M University, Texas.

Goldblatt, A. 1993. Behavioural needs of captive marine mammals. *Aquatic Mammals* **19:** 149-157.

Greenwood, A. G. 1977. A stereotyped behaviour pattern in dolphins. *Aquatic Mammals* **5:** 15-17.

Guyton, A. C. 1991. *Textbook of medical physiology*. W.B. Saunders Company, Philadelphia.

Hagenbeck, C. 1910. *Beasts and men*. Longmans and Green, London.

Hamilton, A. 1896. *The art workmanship of the Maori race in New Zealand : a series of illustrations from specially taken photographs, with descriptive notes and essays on the canoes, habitations, weapons, ornaments and dress of the Maoris, together with lists of the words in the Maori language used in relation to the subjects.* Fergusson & Mitchell, Dunedin.

Hediger, H. 1950. *Wild animals in captivity*. Dover Publications, New York.

Herman, L. M. and W. N. Tavolga. 1980. The communication systems of cetaceans. In: *Cetacean behaviour: mechanisms and functions.* Wiley, New York. p. 149-210.

Hofman, R. J. and W. N. Bonner. 1985. Conservation and protection of marine mammals: past, present and future. *Marine Mammal Science* **1:** 109-127.

Hoyt, E. 1995. *The worldwide value and extent of whale watching*. Report Number 140. Whale and Dolphin Conservation Society, Bath. [Original not seen, cited in Constantine and Baker 1997]

Huges, J., T. Smith, H. Kosterlitz, L. Fothergill, B. Morgan and H. Morris. 1975. Identification of two related pentapepides from the brain with potent opiate agonist activity. *Nature* **258:** 577-579.

Jamieson, D. 1995. Zoos revisited. In: *Ethics of the ark: zoos, animal welfare and wildlife conservation.* B. G. Norton, M. Hutchins, E. F. Stevens and T. L. Maple (eds.). Smithsonian Institution Press, Washington. p. 52-68.

Kleiman, D. G., M. E. Allen, K. V. Thompson and S. Lumpkin. 1996. *Wild mammals in captivity: principles and techniques.* The University of Chicago Press, Chicago.

Lay Jr, D. C. 2000. Consequences of stress during development. In: *The biology of animal stress: basic principles and implications for animal welfare.* G. P. Morberg and J. A. Mench (eds.). CABI Publishing, Wallingford. p. 249-267.

Levine, S. 1983. Coping: an overview. In: *Biological and psychological basis of psychosomatic disease.* H. Ursin, and R. Murison (eds.). Pergamon Press, Oxford. p.15-26

Lilly, J. C. 1963. Distress call of the bottlenose dolphin: stimuli and evoked behavioral responses. *Science* **139:** 116-118.

Mason, J. W. 1971. A re-evaluation of the concept of non-specificity in stress theory. *Journal of Psychiatric Research* **8:** 323-333.

Mason, G. J. 1991. Stereotypies: a critical review. *Animal Behaviour* **41:** 1015 - 1037.

McBain, J. F. 1999. Cetaceans in captivity: a discussion of welfare. *Journal of the American Veterinary Medical Association* **214:** 1170-1174.

Mench, J. A. and M. D. Kreger. 1996. Ethical and welfare issues associated with keeping wild mammals in captivity. In: *Wild mammals in captivity: principles and techniques.* D. G. Kleiman, M. E. Allen, K. V. Thompsom, S. Lumpkin and H. Harris (eds.). The University of Chicago Press, Chicago. p. 5-15.

Meyer-Holzapfel, M. 1968. Abnormal behavior in zoo animals. In: *Abnormal behavior in animals.* M. W. Fox (ed.). W. B. Saunders. Philadelphia. p. 476-503.

Milinski, M. 1984. A predator's cost of overcoming the confusion effect of swarming prey. *Animal Behaviour* **32:** 1157-1162.

Mitchell, E. 1970. Pigmentation pattern evolution in delphinid cetaceans: an essay in adaptive coloration. *Canadian Journal of Zoology* **48:** 717-740.

Moberg, G. P. 1985. *Animal stress.* American Physiological Society, Bethesda.

Moberg, G. P. 2000. Biological response to stress. In: *The biology of animal stress: basic principles and implications for animal welfare.* G. P. Morberg and J. A. Mench (eds.). CABI Publishing, Wallingford. p. 1-21.

Montagu, A. and J. C. Lilly. 1963. *The dolphin in history.* Willian Andrews Clark Memoral Library, University of California, Los Angeles.

Norris, K. S. 1994. Beluga: white whale of the North. *National Geographic* **185:** 2-31.

Ödberg, F. O. 1987. Behavioural responses to stress in farm animals. In: *Biology of stress in farm animals: An integrative approach.* P. R. Wiepkema and P. W. M. van Adrichem (eds.). Martinus Nijhoff, Dordrecht. p. 135-150.

Recarte, J. M., J. P. Vincent, and A. J. M. Hewison. 1998. Flight responses of park fallow deer to the human observer. *Behavioural Processes* **44:** 65-72

Richardson, W. J. and B. Würsig. 1997. Influences of man-made noise and other human actions on cetacean behaviour. *Marine and Freshwater Behavioural Physiology* **29:** 183-209.

Robson, F. D. 1976. *Thinking dolphins, talking whales.* A. H. and A. W. Reed Ltd., Wellington.

Samuels, A. and T. Spradlin. 1995. Quantitative behavioral study of bottlenose dolphins in the Swim-with-Dolphin programs in the United States. *Marine Mammal Science* **11:** 520-544.

Selye, H. 1973. *Stress without distress.* Hodder and Stoughton, London. [Original not seen, cited in Carlstead 1996].

Seyfarth, R. M., D. L. Cheney and P. Marler. 1980. Monkey responses to three different alarm calls: evidence of predator classification and semantic communications. *Science* **210:** 801-803

Slijper, E. J. 1979. Historical introduction. In: *Whales.* W. N. Bonner (ed.). Hutchinson, London. p. 11-57.

Tinker, S. W. 1988. *Whales of the world.* E. J. Brill Publishing Company, Leiden, The Netherlands.

Tortora, G. J. and S. R. Grabowski. 1996. *Principles of anatomy and physiology.* Harper Collins College Publishers, Menlo Park, California.

Watkins, W. A. 1986. Whale reactions to human activities in Cape Cod waters. *Marine Mammal Science* **2:** 251-262.

Wiepkema, P. R. and J. M. Koolhaas. 1993. Stress and animal welfare. *Animal Welfare* **2:** 185-218.

Williams, G. C. 1964. Measurements of consociation among fishes and comments on the evolution of schooling. *Biological Science* **2:** 488-497.

Yablokov, A. V., V. M. Bel'Kovish and V. I. Borisov. 1972. *Whales and dolphins.* Israel Programme for Scientific Translations, Jerusalem. [Original not seen, cited in Carlstead 1996]

Chapter Two

Common dolphin ethogram

Kelly, Shona and Selina are checking me out while I am SCUBA diving.

ABSTRACT

The three female common dolphins *Delphinus delphis* held at Marineland, Napier were observed in order to begin development of an ethogram. Observations were made from November 1998 to July 1999 during daylight hours from 0745 h to 1815 h. Notes, sketches and video recordings were made over this period. The behaviours of the dolphins were classified into fifteen categories and then divided into different aspects of those behaviours. This ethogram follows a format similar to that produced for bottlenose dolphins *Tursiops truncatus* by Müller *et al.* (1998). Two categories of behaviour were included that would not be seen normally by dolphins in the wild; stereotypic and trained behaviour. The aim of this ethogram is to list and describe as many common dolphin behaviours as possible.

2.1 INTRODUCTION

The categorisation of behaviour patterns into separate classes is crucial to the study of animal behaviour (Janik 1999). One method of categorising behaviour is to construct an ethogram.

An ethogram is a catalogue of the natural behaviours performed by an animal and the context in which they occur (Lawrence 1995). It includes discrete, species typical behaviour patterns that form the basic behavioural repertoire of the species (Lehner 1987). Published ethograms vary enormously in the number of behavioural categories included and the detail with which they are described (Martin and Bateson 1993). An ethogram may be a simple alphabetical listing of the behaviours performed by the animal or may include detailed descriptive text. Line drawings and/or photographs of behavioural sequences (McDonnell and Haviland 1994) may illustrate the behaviour. Ethograms may be very detailed, describing every single aspect of a behaviour, or they may be simplified by describing a whole behavioural action rather than breaking it down into its component parts.

Ethograms help to identify a behaviour quickly and they reduce observer bias because all observers use the same template when identifying behaviours. A complete ethogram for any species may require years of observation and the species may have to be studied in different environmental situations and during all its life stages. It might entail co-operation between researchers to agree on the description of the specific behaviours and to develop a complete list of the species' behaviours.

An ethogram may follow the proposed format of Schleidt *et al.* (1984) who identified the need to standardise reporting of behavioural observations and presented as a model their ethogram of blue-breasted quail *Coturnix chinesis*. They constructed a chart showing behaviours broken down into particular phases (orientations and states) of the animal's body parts. It is a simplified table with codings of body spatial relations. This type of ethogram requires a lot more knowledge of the species' behaviour in different circumstances, including the wild, and a more extensive observation period than was possible in this study.

This ethogram of the common dolphin lists groups of behaviours and includes descriptions of them. Some have either a photographic image or a simple line drawing to aid in the description of the behaviour.

The context in which a behaviour is performed is an important key to understanding its function and a possible help in understanding the emotional state of the animal. Many behavioural responses to stressors may not be a true indication of the animal's physiological state. For example, the behavioural reaction of nesting penguins to a threat does not reflect their physiological stress response. The penguins' heart rate increases rapidly in response to a threat but the adult remains quietly on its nest until the point at which it flees, exposing eggs and chicks to predators (Nimon *et al.* 1996).

There is no published ethogram for the common dolphin. The common dolphin has a wide global distribution but it is difficult to carry out extended observations. This is because they are continuously moving and diving and because their schools are so large, from a dozen to ten thousand individuals, making it difficult to continuously observe one dolphin.

The increasing interest in tourist ventures, such as the whale and dolphin watching programmes, wild 'Swim-with-Dolphin' (SWD) programmes and captive 'SWD' programmes, makes it important to monitor the impacts on the dolphins and whales involved. Ethograms are needed for the species involved in these ventures to help researches quickly identify normal behaviours and to recognise abnormal behaviours.

The last section of this ethogram describes behaviours that occur in response to signals given by trainers at Marineland. The dolphins have been trained to perform in shows. Training captive animals to perform behaviours on command is an important aspect of zoo keeping in order to tame the animals and to improve relations between the animals and zoo keepers (Hediger 1950). The dolphins are trained using a 'bridging' technique in which the animal receives reinforcement when it performs a target behaviour. Reinforcement may be vocal praise, a whistle or food reward. The animal soon learns that if it performs a specific behaviour after a signal, it will be given a reinforcement.

This ethogram is for common dolphins in captivity. Two of the dolphins have been living at Marineland since 1974. They participate in daily Swim-with-dolphin (SWD) programmes and there is a need to determine the impacts of this programme on them. This may be done by recording the dolphin's behaviour before, during and after the SWD sessions and comparing those behaviours. The ethogram will be used as a reference in subsequent chapters.

2.2 METHODS

Three female common dolphins *Delphinus delphis* were studied at Marineland, Napier from November 1998 to July in 1999. The dolphins used were called Shona, Kelly and Selina (Table 1.1). They were held in the main pool situated in front of the Grandstand (Figure 1.2).

Study site:

A detailed description of the study site is in section 1.3.

Data collection:

The data collection took place from four observation sites: the main stage, the stage in front of the grandstand, the grandstand and the underwater viewing windows (Figure 1.2). I made notes and took video recordings of the dolphins. These were analyzed later and became the basis of the descriptions of individual dolphin behaviours in the ethogram.

Photographs and video footage were used to help in the construction of the abstract sketches that aid in the description of the behaviours.

Terminology:

This ethogram follows a format similar to that of Müller *et al.* (1998) constructed for bottlenose dolphins and, where possible, the terminology is the same.

Throughout the Ethogram, descriptions of the behaviours may include reference to external features of the dolphins shown in Figure 2.1.

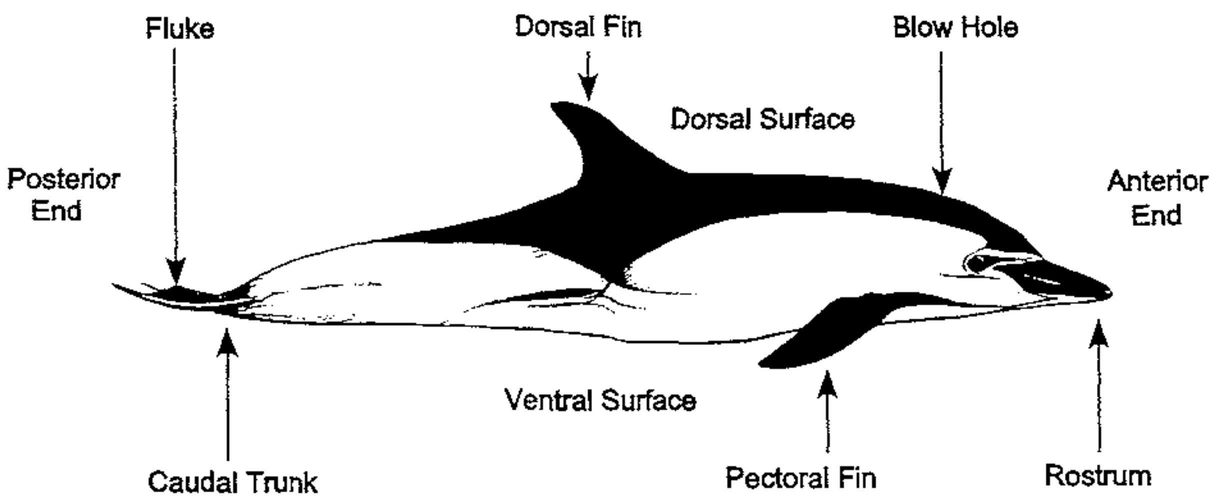


Figure 2.1 External features of the common dolphin *Delphinus delphis*.

2.3 RESULTS

The following is a repertoire of behaviours performed by captive female common dolphins *Delphinus delphis*. The presence of figures is indicated by '*' for a line sketch and '**' for a photograph.

A. Swimming positions:

1. Normal swim – the dolphin swims in a horizontal position parallel to the surface of the water. *
2. Inverted swim – the dolphin swims in a horizontal position parallel to the surface of the water with its ventral surface exposed/out of the water. (see G2, L6) *
3. Lateral swim – the dolphin swims in a horizontal position on its side with one pectoral fin out of the water. (see L7) *

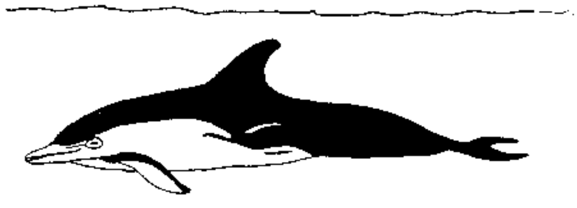
B. Swimming speeds:

1. Slow – the dolphin swims at a speed less than 2 km/hr
2. Medium – the dolphin swims at a speed between 2 and 10 km/hr
4. Fast – the dolphin swims at a speed greater than 10 km/hr

C. Swimming depth:

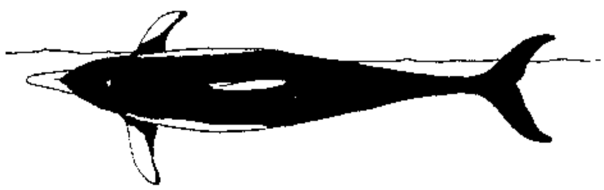
1. On surface – the dolphin swims at the surface of the water with its dorsal surface exposed.
2. Sub-surface – the dolphin swims just below the surface of the water with body completely submerged in the top third of the pool.
3. Middle – the dolphin swims in the middle third of the pool.
4. Deep – the dolphin swims in the bottom third of the pool.

A1

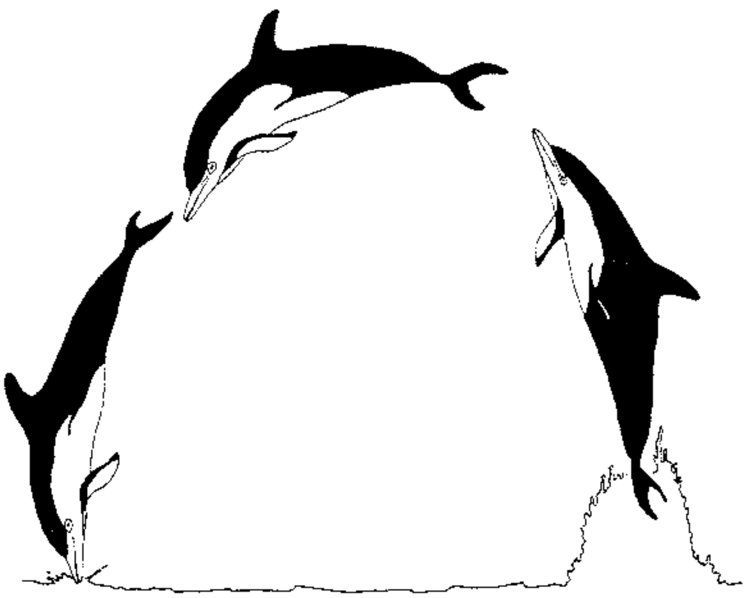


A2, G2, L6

A3, L7



D1, P1



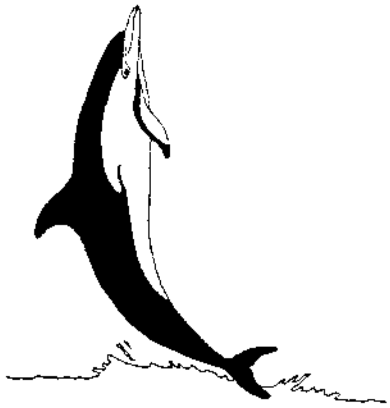
D. Aerial Behaviour:

1. Bow – the dolphin leaps out of the water, at the peak of the leap the body pivots so the head enters the water first. (see P1)*
2. Head up – the front part of the body is out of the water in an oblique position, the body remains arched.
3. Lateral bow – the dolphin leaps out of the water twists then pivots at the peak of the jump and enters the water head first with its body twisted. Alternatively, the dolphin may leave the water twisted and pivot at the peak remaining twisted as it enters the water.
4. Breaching – the dolphin lifts itself partly out of the water and lets itself fall flat on its side.
5. Back breaching – the dolphin lifts itself partly out of the water pivots and lets itself fall backwards slapping its dorsal surface on the water (back slaps). (see I2, P7)*
6. Leap – the dolphin leaps out of the water in a normal position over a distance not greater than its body length. *
7. Inverted leap – the dolphin leaps out of the water in an inverted position, the dorsal surface underneath.
8. Lateral leap – the dolphin leaps out of the water and lands on its side.
9. Lateral lurch – the dolphin surfaces slowly on its side exposing its ventral surface.

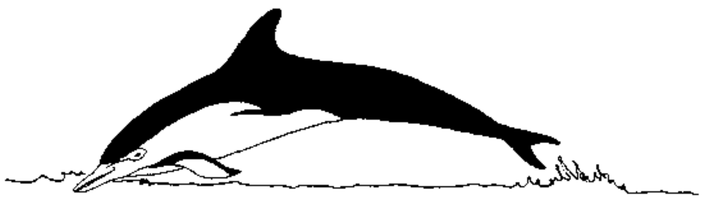
E. Contact Behaviour:

1. Kelp dragging – the dolphin drags a piece of kelp (seaweed) on some part of its body (rostrum, pectoral fins, dorsal fin, fluke or in its mouth). **
2. Rostral nudge – the tip of the rostrum touches an object, person or another dolphin briefly or repeatedly. (see N8) *
3. Beak over – the dolphin places its rostrum over an object or on top of a trainer's hand.
4. Object toss – the dolphin tosses an object with its rostrum so the object exits the water and moves in front of the dolphin.
5. Bite object – the dolphin puts an object or part of an object in its rostrum and exerts pressure on it.

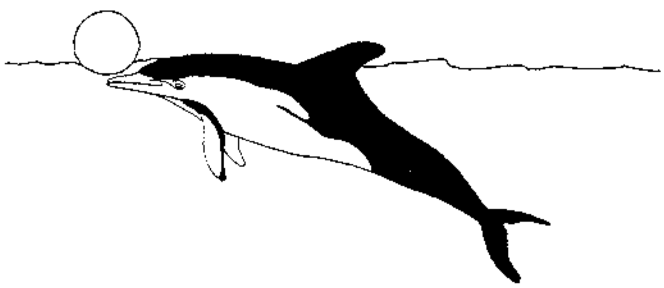
D5, I2, P7



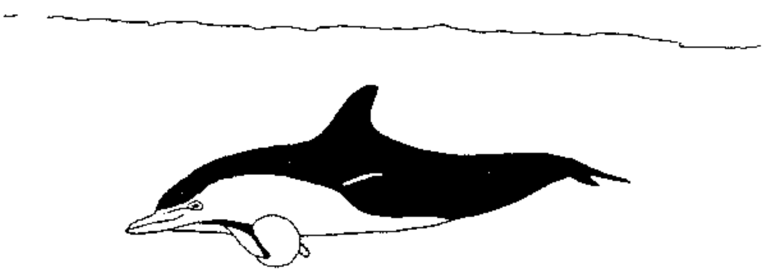
D6



E2, N8

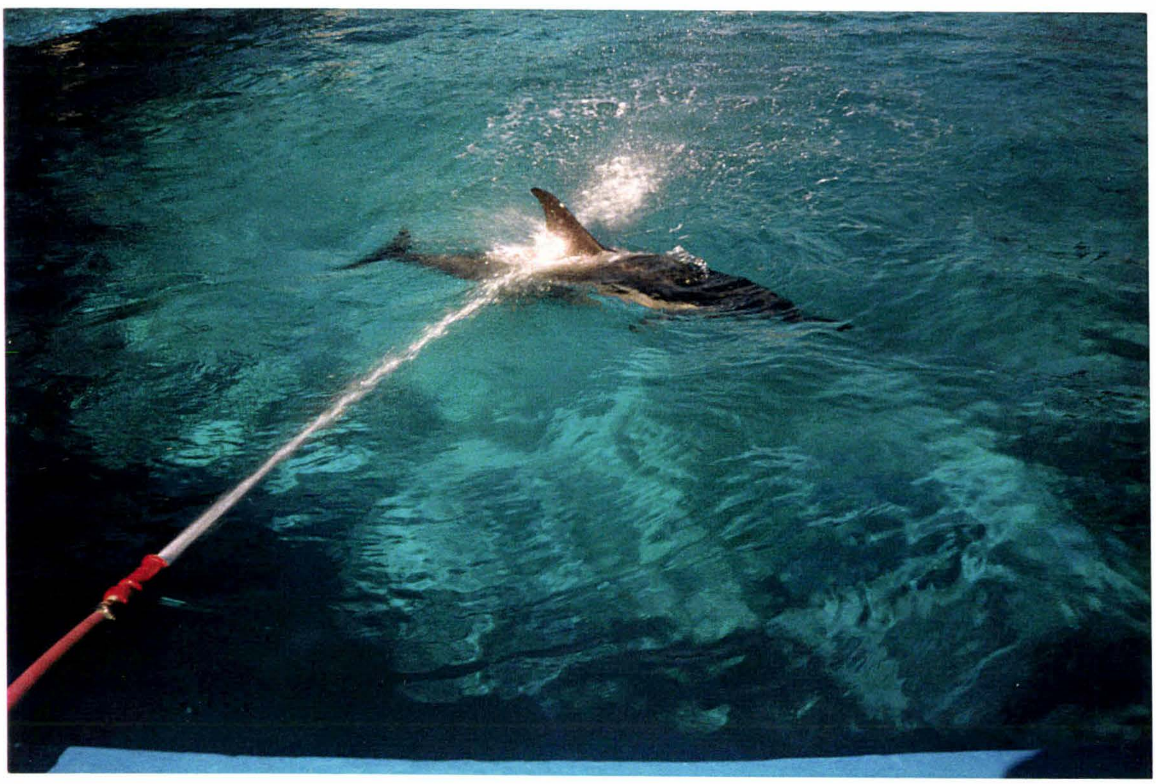


E7



E1

E8



6. Playing with the bell – the dolphin holds the bell cord in its rostrum and nods its head making the bell ring.
7. Playing with the ball – the dolphin pushes the ball ahead with its rostrum, balances the ball on its rostrum, or bites the ball. The ball may also be carried under the dolphin's pectoral fin or stomach. The dolphin may roll over the ball, causing it to pop out from under the dorsal fin. *
8. Playing under a hose or water outlet – the dolphin swims under the high-pressure hose or water outlet, which appears to massage the dolphin. **
9. Pull – the dolphin tows a person who remains parallel to the dolphin holding on to the dorsal fin.

F. Head Movements:

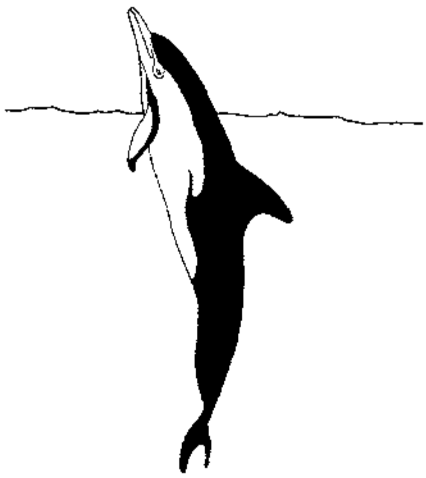
1. Chin-up – a brief exposure of the rostrum above the water surface on variable angles caused by an elevation of the head.
2. Glance – the dolphin rotates its head and its eye is exposed at the surface.
3. Head nod – the dolphins head moves up and down while in a normal swimming position. (see A1)
4. Head up – slow movement of the head to help the dolphins blow hole emerge to breathe. *
5. Head shake – alternate movement of the head to the right and left.
6. Spyhop – a brief vertical elevation of the front part of the body. *
7. Mouth open – the dolphin opens its mouth wide.

G. Pectoral Fin Movements:

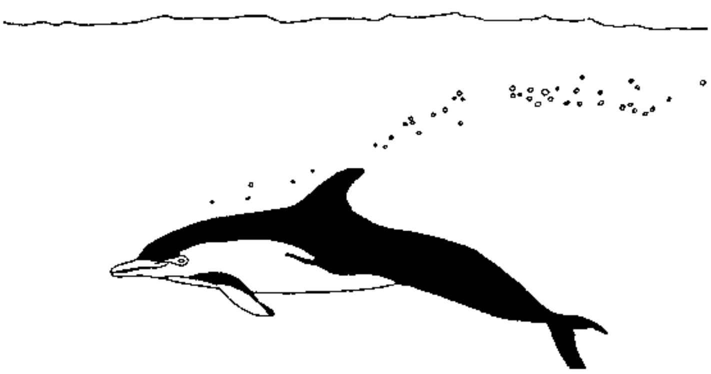
1. Pectoral extension – the dolphin is at the surface on its side exposing a pectoral fin.
2. Pectoral parallel extensions – the dolphin is on its back exposing both pectoral fins parallel to each other above the surface (similar to A2, L6). *
3. Pectoral flex – rapid movements of the pectoral fins up and down or side to side while exposed at the surface.

F4

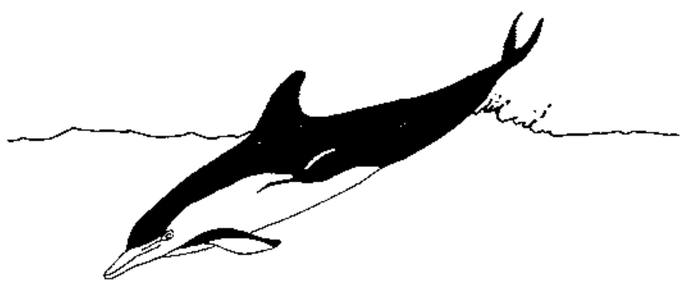
F6



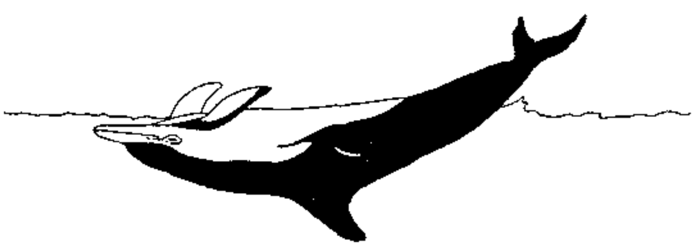
H3



I4, P4



I5



H. Respiration:

1. Squeeze breath – quick, noisy exhalation of air from the blowhole.
2. One large bubble – exhalation of a large bubble underwater from the blow hole.
3. Bubble stream – exhalation of a stream of small bubbles. *
4. Vapourous breath – audible exhalation taking place at the surface producing a cloud of vapour.
5. Silent vapourous breath – silent exhalation producing a cloud of vapour.
6. Coughing – on surface rotating to the side and coughing to expel water.

I. Slaps:

1. Head slap – the dolphin raises its head and hits/slaps the water loudly as it re-enters the water.
2. Back breaching – (back slaps). (see D5, P7) *
3. Chest slap – the dolphin partially exits the water and forcefully re-enters the water slapping the surface with its chest. **
4. Fluke slap – the dolphin surfaces, raises the fluke vertically and slaps loudly on the surface of the water. (see P4)*
5. Inverted fluke slap – the dolphin is in an inverted position and slaps the dorsal surface of its fluke loudly on the water. *
6. Motorboating – a series of fast repeated fluke slaps during movement in a normal position or an inverted position.

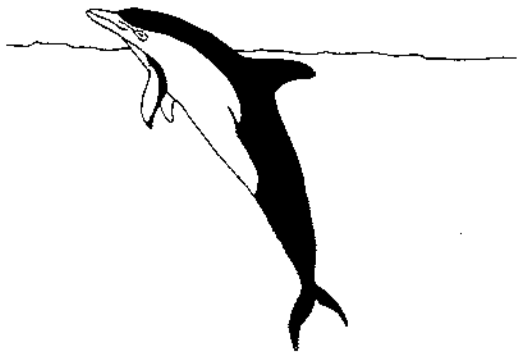
J. Stationary Behaviour:

1. Floating – the dolphin glides along the surface without any movement of its fluke.
2. Lean – the dolphin is floating (see J1) and rotates letting one eye emerge above the water.
3. Hanging – the dolphin is in an almost vertical position floating and balancing with its pectoral fins. Its head and blow hole are above the surface. *

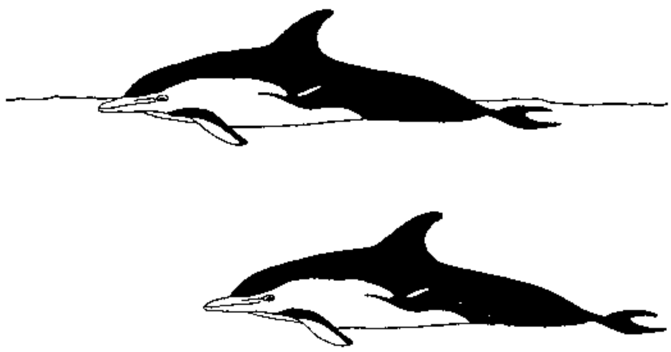
I3

K10

J3

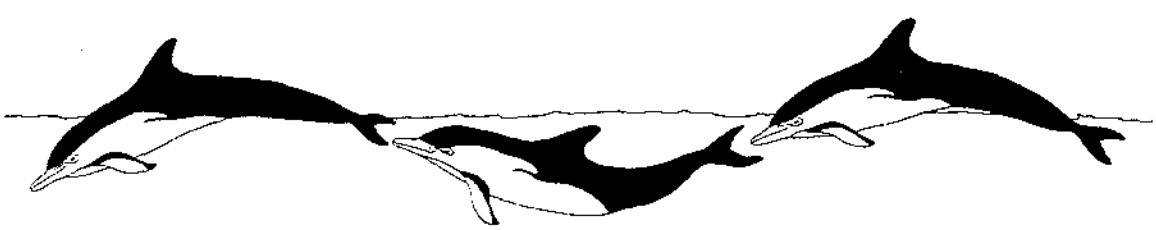


K6



L1

L8



K. Surfacing and submerging

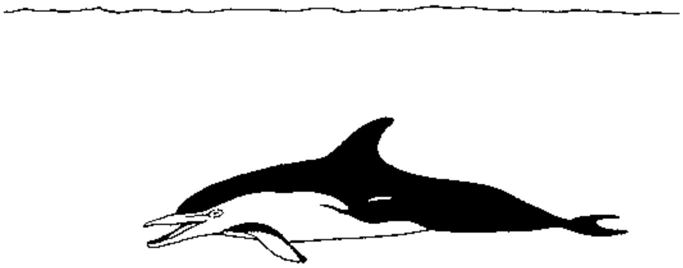
1. Arched dive – a single brisk movement by a dolphin in a normal position, arched on the surface the fluke stays in contact with the water and seems to be the pivot point. The head submerges first.
2. Slow rising – the dorsal fin slowly rises followed by the rest of the body with the fluke remaining parallel with the surface of the water.
3. Slow progressive surface – the dolphin progressively surfaces with part of its body always submerged.
4. Lateral dive – the dolphin surfaces in a normal position and suddenly pivots onto its side and dives laterally.
5. Leveling off surface – extension of the fluke once the dolphin is on the surface elongating its entire body.
6. Parallel surfacing – the dolphin emerges parallel to the surface, the entire dorsal surface emerges simultaneously. *
7. Pivot dive – the dolphin leaves the water almost vertically, and rapidly dives at the peak. The dolphin's body shows significant flexion.
8. Paused surface – the dolphin surfaces and makes a brief halt at the surface exposing the blowhole and inhales.
9. Slow surface/abrupt dive – a slow surface in a normal position then a rapid vertical dive.
10. Long surface – the dolphin surfaces in a normal position and remains on the surface for more than three seconds (resting). **

L. Swims

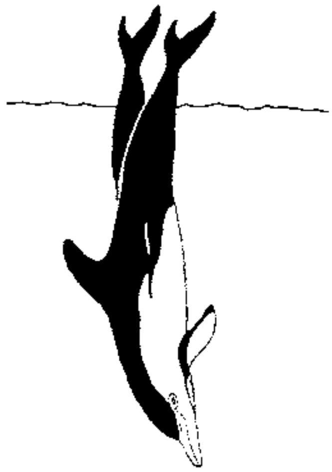
1. Corkscrew swim – the dolphin executes a series of rotations around the longitudinal axis parallel to the surface. *
2. Glide – the dolphin glides forward in a normal position without fluke movement.
3. Half-circle turn – the dolphin quickly performs a half circle in a normal position.
4. Veering turn – the dolphin slowly changes the trajectory of the swim without losing speed.

L10

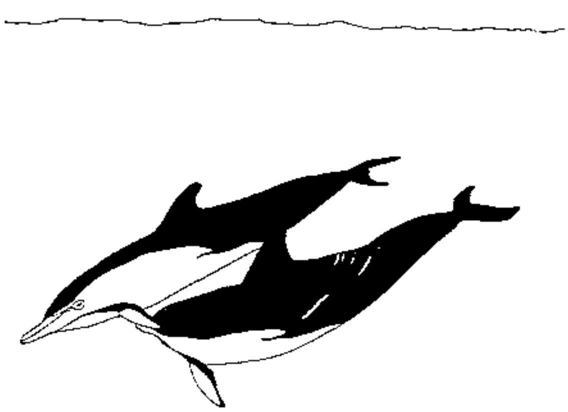
L13, N11



M1, P2



N7



5. Turn at oblique angle – swimming towards an object, dolphin or person, followed by a brisk change in trajectory at 2m or less away from the object, dolphin or person.
6. Inverted swim – the dolphin swims on its back. (see A2, G2) *
7. Lateral swim – the dolphin swims on its side. (see A3) *
8. Porpoising – the dolphin performs a series of leaps without fully leaving the water. *
9. Subsurface swim – the dolphin swims just under the water without emerging. (see C2)
10. Surface finning/shark – the dolphin swims just under the water with only the dorsal fin emerging, resembling a shark surfacing. *
11. Ventral/ventral swim – the brief contact of the ventral surfaces of two dolphins. (see N10)
12. Ventral/dorsal swim – the brief contact of the ventral and dorsal surfaces of two dolphins. (see N11)
13. Charge – the dolphin swims rapidly towards another dolphin or a swimmer with its mouth partly or fully open. (see N11) *
14. Fast circling – the dolphin swims in small rapid circles on or below the surface of the water around a swimmer. (see N13)

M. Fluke Movements:

1. Fluke wave – the dolphin is vertical with its head down and the fluke is out of the water, moving backwards, forwards or sideways for balance. (see P2) *
2. Fluke wipe – the fluke swipes past and is put in contact with another dolphin. (see N4)
3. Caudal trunk snap – the movement following a tail slap down that gives the dolphin a strong forward acceleration.

N. Group Behaviour

1. Close swim – a dolphin swims close to another dolphin, within a metre of each other.

2. Pectoral fin touch – a dolphin swims over, under or beside another dolphin and rubs another dolphin with its pectoral fin.
3. Dorsal fin touch – the dolphin swims under another dolphin touching the other dolphin's ventral surface with its dorsal fin.
4. Fluke touch – a dolphin swims past another dolphin and touches it with its fluke. (see M2
5. Ventral surface touch – the dolphin swims over another dolphin rubbing its ventral surface on another dolphin.
6. Cross over – a dolphin swims crossing over or under another dolphin possibly to change direction or to surface.
7. Sexual behaviour – a dolphin rubs the genital slit of another dolphin using its rostrum, pectoral fin, dorsal fin or tail fluke. *
8. Rostral nudge – (see E2). *
9. Ventral/ventral swim – (see L11).
10. Ventral/dorsal swim – (see L2).
11. Charge – (see L13). *
12. Fast circling – (see L14).

O. Possible stereotypical behaviours:

Mason (1991) defined stereotypy as a behaviour pattern that is repetitive, invariant and has no obvious goal. Wild animals frequently develop stereotypic behaviour patterns in captivity, especially in confined and monotonous environments (Hediger 1950; Meyer-Holzapfel 1968).

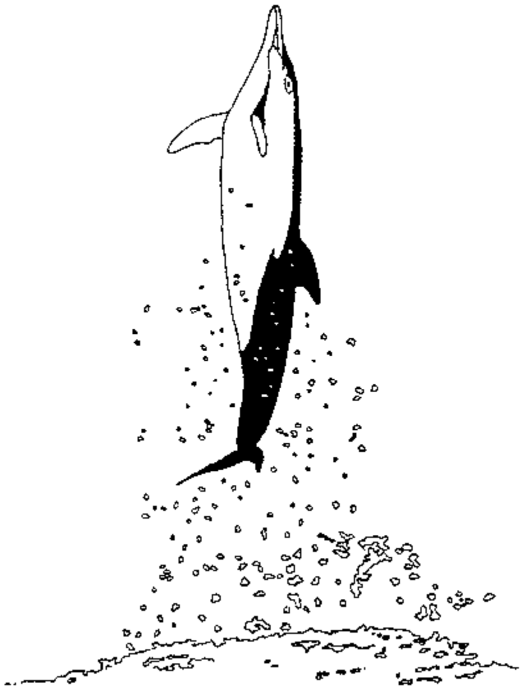
1. Bell ringing – the dolphin rings the bell in a repeated pattern, pull and ring, pull and not ring, pull and ring, pull and not ring. Sometimes there is no obvious pattern. **
2. Regurgitation – the dolphin is in a vertical position with its head down and tail up. The dolphin repetitively spits its food and re–ingests it immediately after a feed. *
3. Circling – the dolphin circles at a medium speed over exactly the same path at any depth for long periods.

O1

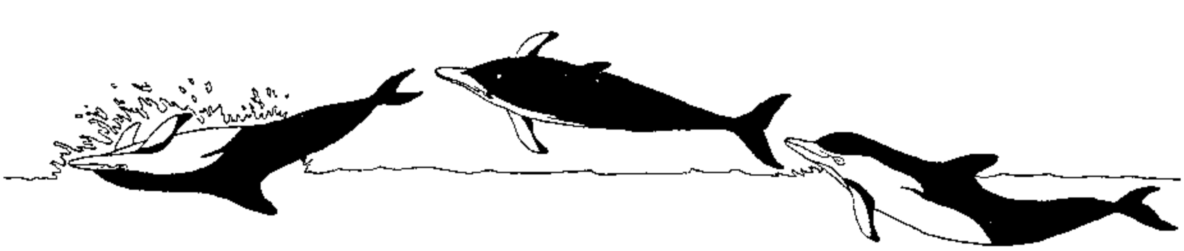
P5

02

P10



P11



P18

P. Trained behaviours:

Trained behaviours are those that occur in response to a signal or command. The animals have been trained to perform these behaviours using food, vocal praise or a whistle blow as reinforcements.

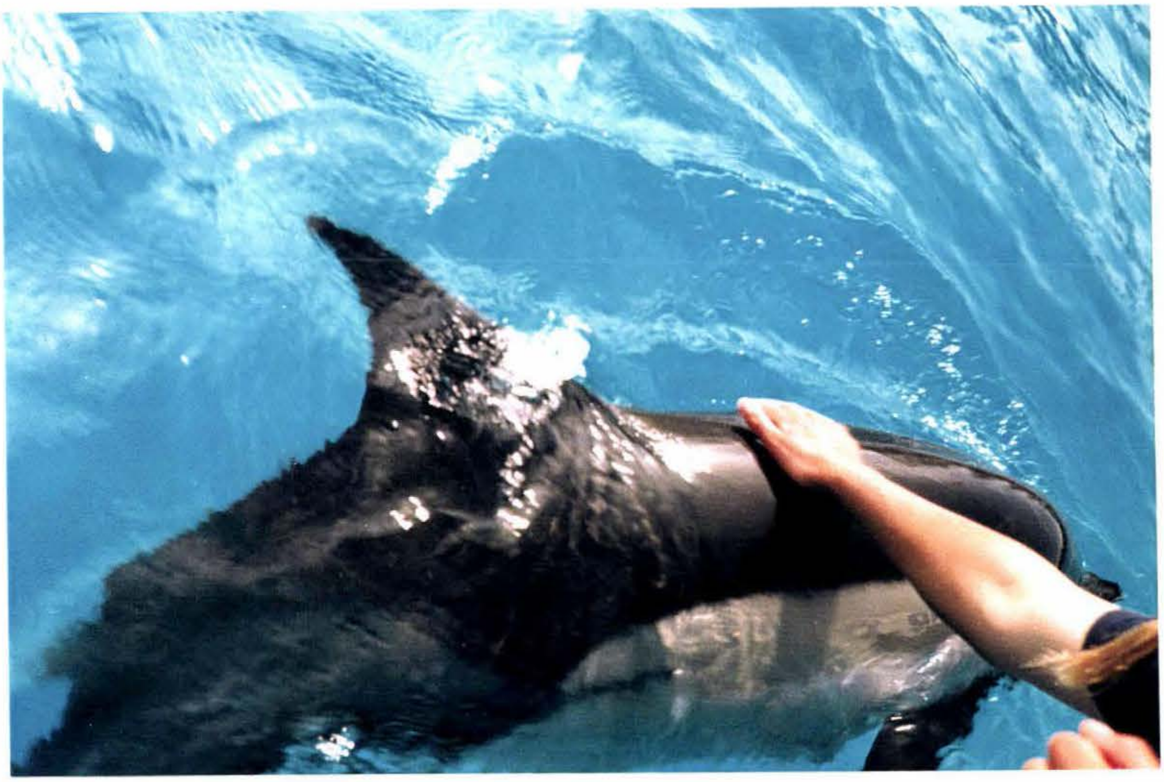
1. Bow – the dolphin leaves the water, at the top of the leap the body pivots and the head enters the water first. (see D1) *
2. Fluke wave – the dolphin is vertical, head down fluke up, and moves its fluke backwards and forwards as if it is waving. *
3. Pectoral wave – the dolphin swims in an inverted position and its pectoral fins are above the water.
4. Fluke slap – (see I4) *
5. Fluke walk – the dolphin propels itself out of the water with its fluke moving backwards in a vertical position. Only the posterior end of the dolphin remains in the water. **
6. Corkscrew – (see L1).
7. Back breaching – Back slaps. (see D5, I2).
8. Bar jumps – the dolphin leaps over a suspended bar at varying heights. The head is the first to exit and enter the water. **
9. Ball jumps – the dolphin leaps and touches a suspended ball with its rostrum pivots and re-enters the water headfirst.
10. Vertical spirals – the dolphin exits the water remaining vertical and spins around the vertical axis and re-enters fluke first. *
11. Horizontal spirals – the dolphin jumps and remains horizontal and spins around the horizontal axis. *
12. Back flips – the dolphin exits the water and pivots backwards remaining elongated and entering the water head first.
13. Ball balance – the dolphin holds the ball on the tip of its rostrum for an extended time. **
14. Fluke grab – the dolphin allows the trainer to hold onto is fluke and tip it vertical, head down, for a few seconds.

P8

P13

15. Flipper shake – the dolphin propels itself out of the water with its tail and remains vertical allowing the trainer to hold onto its pectoral fin, as if shaking its hand.
16. Beaching – the dolphin swims up and strands itself onto the side of the pool.
17. Kiss – the dolphin lifts itself up and touches the trainer on the cheek with its rostrum.
18. Rostrum hold hand – the dolphin allows the trainer to hold a hand in the dolphin's rostrum. *
19. Pat – the dolphin swims slowly past the stage so the trainer can stroke and rub the dolphin. **
20. Spyhop look - the dolphin spyhops and twists in a 360° circle on the spot.

P19



2.4 DISCUSSION

In this chapter the behavioural repertoire of the only captive female common dolphins *D. delphis* in the world is described. It is an attempt to describe all the behaviours performed by the dolphins. Despite the obvious limitations of this ethogram, in that it deals with only female captive dolphins, basic common dolphin behaviour has been described.

Ethograms have been constructed for many other marine mammals and one species, the bottlenose dolphin *Tursiops truncatus*, has been used on many occasions for behavioural studies. It has served as the 'white rat' of cetology with a great deal now known about its behaviour (Würsig and Würsig 1979).

Bottlenose and common dolphins behave in similar ways. There are differences in the behaviours of the two species especially in their aerial behaviour capabilities. Bottlenose dolphins are very social animals (Galhardo *et al.* 1996) and in captivity have established themselves as highly intelligent, playful and friendly performers. Bottlenose dolphins can perform more acrobatic surface behaviour than common dolphins due to their greater strength. The common dolphin tends to be timid and not very playful in captivity (Montagu and Lilly 1963). This is one of the reasons why bottlenose dolphins are the most widely kept cetacean in captivity (Galhardo *et al.* 1996). The common dolphin naturally occurs in oceanic waters and has been reported on many occasions to bow ride ships and play in the wakes produced (Doak 1981). Botttlenose dolphins are much larger and more aggressive cetaceans. They are also coastal dolphins who feed and interact with other dolphins on reefs and close to shore.

Another difference between bottlenose and common dolphin behaviour is that the common dolphin very rarely stops to spyhop or interact/rub another individual. It is always done on the move. Common dolphins rarely stop to rest or sleep, and recent observations indicate that sleep is accomplished through the resting of one hemisphere of the brain at a time (Goley 1999). At these times, the dolphin's activity and vocalisations steadily decline, indicating rest but they remain swimming on the surface.

I observed an unusual behaviour performed by a sick dolphin (Selina) where she hung in the water and spyhopped in one corner throughout the last few days of her life. She spent many extended periods lying on the surface remaining very still. During my study no other dolphin exhibited this type of behaviour. This behaviour may be performed when a dolphin is in a lot of pain or is terminally ill.

This ethogram is based on the behaviours performed by female captive common dolphins that have become settled and acclimatised to the captive environment, and adapt many of their behaviours to suit the smaller and regular shaped pool. It is known that when animals are placed in captivity some of their behaviours tend to become modified or lost (Carlstead 1996). The captive environment may change the frequency of natural behaviours, exclude some (cooperative foraging) and amplify the occurrence of specific behavioural categories and social structure (Galhardo *et al.* 1996). This ethogram has behaviours performed by female dolphins, which means that behaviours that are performed exclusively by males or interactive behaviours between male and female or an adult and juvenile have not been described.

Two papers have documented captive dolphins performing stereotypic behaviour. Greenwood (1977) observed head pressing in three Atlantic bottlenose dolphins when they were placed in close confinement. Gygax (1993) reported that two captive bottlenose dolphins performed a spatial stereotyped behaviour pattern, where the dolphins circled in a pattern that was repetitive, invariant and had no obvious goal, especially in anticipation of the training/feeding session. Stereotypies have been found to elicit a release of endogenous opioids that have an analgesic action (Huges *et al.* 1975) and self-narcotization effect (Cronin *et al.* 1985). These factor may make developed stereotypies very difficult to stop, although changing the external environment has been known to reduce stereotypic behaviour. Head pressing by dolphins disappeared when the dolphins were placed in a larger pool (Greenwood 1977).

A few behaviours performed by the three common dolphins may be interpreted as stereotypic behaviours. However, as noted by Greenwood (1977) defining stereotypies in dolphins is very difficult. The dolphins repetitively ring the bell placed at one end of their pool (Figure 1.2). This has no apparent purpose other than to produce a ring.

Kelly has developed a ring pattern where she will ring the bell then pull and not make the bell ring then pull and make it ring, repeating this pattern. The other dolphins didn't appear to have developed such a pattern. The dolphins exhibited a similar stereotypic pre-feeding/training behaviour as that observed by Gygax (1993). The dolphins increased speed and had a set path occasionally porpoising but nearly always in the same location. They occasionally swam slower circles at the end closest to where the trainers enter the pool compound with the food, always looking out at the same position of the loop. The three dolphins appeared to show similar anticipation behaviour.

To construct a complete ethogram for the common dolphin it is necessary to observe them in the wild to see how they interact in a group and to observe behaviour performed by individuals of a different sex, age and social rank. Behavioural observations of wild dolphins have limiting factors. There is a limited depth at which the dolphins can be observed. Many behaviours are performed under water and it is difficult to make continuous sampling of one dolphin. This is where studying captive animals is an advantage. I was able to observe the dolphins during many different behavioural states without ever losing sight of them, and to perform continuous sampling on one dolphin.

This ethogram is a comprehensive list of behaviours performed by three captive female common dolphins. It is a result of nine months of observations. It describes what each behaviour looks like, without trying to explain what the behaviours mean. This is because the behaviours may mean different things under different circumstances. For example, bubble blow may be a form of play behaviour or a sign of aggression (Dawson and Slooten 1996). It was necessary to construct this ethogram for the data collection in the next chapter. The ethogram gives definitions of the behaviours I describe in Chapter Three, and it is in that chapter I try to understand the meaning of some behaviours.

2.5 REFERENCES

Carlstead, K. 1996. Effects of captivity on the behaviour of wild mammals. In: *Wild mammals in captivity: Principles and techniques*. D. G. Kleiman, M. E. Allen, K. V. Thompson and S. Lumpkin (eds.). The University of Chicago Press, Chicago. p.317-333

Cronin, G. M., P. R. Wiepkema and J. M. van Ree. 1985. Endogenous opioids are involved in abnormal stereotyped behaviours of tethered sows. *Neuropeptides* **6:** 1776-1786.

Dawson, S. and E. Slooten. 1996. *Understanding behaviour*. Canterbury University Press, Christchurch.

Doak, W. 1981. *Dolphin, dolphin*. Hodder and Stoughton, Auckland, N.Z.

Galhardo, L., M. C. Appleby, N. K. Waran and M. E. dos Santos. 1996. Spontaneous activities of captive performing bottlenose dolphns (*Tursiops truncatus*). *Animal Welfare* **5:** 373-389.

Goley, P. D. 1999. Behavioral aspects of sleep in Pacific white-sided dolphins (*Lagenorhynchus obliquidens*). *Marine Mammal Science* **15:** 1054-1064.

Greenwood, A. G. 1977. A stereotyped behaviour pattern in dolphins. *Aquatic Mammals* **5:**15-17.

Gygax, L. 1993. Spatial movement patterns and behaviour of two captive bottlenose dolphins (*Tursiops truncatus*): absence of stereotyped behaviour of lack of definition? *Applied Animal Behaviour Science* **38:** 337-344.

Hediger, H. 1950. *Wild animals in captivity*. Dover Publications, Inc., New York.

Huges, J., T. Smith, H. Kosterlitz, L. Fothergill, B. Morgan and H. Morris. 1975. Identification of two related pentapepides from the brain with potent opiate agonist activity. *Nature* **258:** 577-579.

Janik, V. M. 1999. Pitfalls in the categorization of behaviour: a comparison of dolphin whistle classification methods. *Animal Behaviour* **57:** 133-143.

Lawrence, E. 1995. Hendersons dictionary of biological terms. Longman Group Ltd, Essex, England.

Lehner, P. N. 1987. Design and execution of animal behavior research: an overview. *Journal of Animal Science* **65:** 1213-1219.

Martin, P. and P. Bateson. 1993. *Measuring behaviour: an introductory guide*. Cambridge University Press, Cambridge.

Mason, G. J. 1991. Stereotypies: a critical review. *Animal Behaviour* **41:** 1015 - 1037.

Meyer-Holzapfel, M. 1968. Abnormal behavior in zoo animals. In: *Abnormal behavior in animals.* M. W. Fox (ed.). W. B. Saunders. Philadelphia. p. 476-503.

McDonnell, S. M. and J. C. S. Haviland. 1994. Agonistic ethogram of the equid bachelor band. *Applied Animal Behaviour Science* **43:** 147-188.

Montagu, A. and J. C. Lilly. 1963. *The dolphin in history.* Willian Andrews Clark Memoral Library, University of California, Los Angeles.

Müller, M., H. Boutiere, A. C. F. Weaver and N. Candelon. 1998. Nouvel inventaire du comportement du grand daupin (*Tursiops truncatus*). *Vie Milieu* **48:** 89-104.

Nimon, A. J., R. C. Schroter and R. K. C. Oxenham. 1996. Artificial eggs: measuring heart rate and effects of disturbance in nesting penguins. *Physiology and Behavior* **60:** 1019-1022.

Schleidt, W. M., G. Yarkalis, M. Donnelly and M. G. J. 1984. A proposal for a standard ethogram, exemplified by an ethogram of the bluebreasted quail (*Coturnix chinesis*). *Ethology* **64:** 193-220.

Würsig, B. and M. Würsig. 1979. Behavior and ecology of the bottlenose dolphin, *Tursiops truncatus*, in the south Atlantic. *Fishery Bulletin* **77:** 399-412

Chapter Three

Behavioural responses to SWD sessions

A typical 0800 hour Swim-with-Dolphin session

ABSTRACT

The effects of 'Swim-With-Dolphin' (SWD) sessions on the behaviour of three female common dolphins at Marineland, Napier, New Zealand were studied from January 1999 through to July 1999. Dolphin behaviour during 165 SWD sessions were monitored. Three activities were recorded before, during and after SWD sessions, (1) the use of the refuge area, (2) surfacing frequencies and location and, (3) the behaviour changes of the dolphins. Refuge use increased significantly during SWD sessions and returned to pre-SWD levels immediately after the sessions. The dolphins surfaced more in the refuge area during SWD sessions. The presence or absence of swimmers made no significant difference to the frequency of dolphin surfacing. SWD sessions had little effect on the behaviour of the dolphins. There was a slight increase in Touch and Other behaviours but contrary to expectation the dolphins decreased Aggressive, Submissive, Abrupt and Play behaviour during SWD sessions. The three dolphins had similar reactions to swimmers. The SWD sessions do not appear to cause distress to the dolphins.

3.1 INTRODUCTION

Free-ranging dolphins, especially bottlenose dolphins *Tursiops truncatus*, often initiate sociable contact with humans (Doak 1981; Lockyer 1985; Orams *et al.* 1996; Orams 1997; Frohoff and Packard 1995). These encounters vary in the degree of interaction and include dolphins swimming close to boats, assisting distressed humans, fishing co-operatively with humans and interacting with waders, swimmers and divers. However, after a series of encounters, dolphins may become aggressive and dangerous (Frohoff and Packard 1995). Wild bottlenose dolphins that have been fed at Monkey Mia and Tangalooma bays in Australia become aggressive over time (Wood 1999; Conner and Smolker 1985; Orams 1997; Frohoff 1993). There is no documented close shore encounter between humans and common dolphins *Delphinus delphis* (Orams 1997).

'Swim-with-Dolphin' (SWD) programmes operate world-wide, taking advantage of the natural affiliation between bottlenose dolphins and humans. In 1994, New Zealand had 12 dolphin swim/watching operations in the wild and one SWD programme at

Marineland, Napier. These swim operations give members of the public an opportunity to get close to dolphins and are popular eco-tourist attractions. The SWD programmes have also increased in popularity because of anecdotal reports of the benefits to humans when swimming with dolphins. SWD programmes are said to help autistic and handicapped children relax by providing a suitable environment for learning and improving learning abilities (Nathanson and de Faria 1992).

The effects of human interactions on the behaviour of common dolphins has not received much attention. Constantine and Baker (1997) investigated the effects of swimmers on dolphins in the Bay of Islands, New Zealand. Two dolphin species, the bottlenose dolphins and the common dolphin featured in that swim venture. Bottlenose dolphins remained within five metres of the swimmers in 48% of the encounters, showed no apparent response to swimmers in 30% of the encounters, and avoided swimmers in 22% of the encounters. The common dolphins' response was unlike that of the bottlenose dolphin. The common dolphins sustained interactions (remaining within 5 metres) with swimmers in only 24% of the encounters, in 38% of the encounters they showed no apparent response, and in 38% of the encounters they avoided swimmers. Thus, the two species responded to swimmers in different ways, with the common dolphins showing less interest in humans.

Hector's dolphins *Cephalorhynchus hectori* are involved in tourist swim and watching ventures in Porpoise Bay, Otago, New Zealand (Bejder *et al.* 1999). In 57% of observed swims, Hector's dolphins remained nearby and were not disturbed by swimmers, but in 30% of the encounters the dolphins left within a few minutes. Bejder *et al.* (1999) suggests that because the dolphins could easily avoid the swimmers, they may not perceive them as a threat and therefore do not flee. The behaviour of dusky dolphins *Lagenorhynchus obscurus* (Barr 1997), off the Kaikoura coast, New Zealand, was also assessed to determine if it was affected by swimmer presence. Barr (1997) found that the general behaviour did not change in the presence of swimmers, but individual dolphin responses were not observed. Although the effect of swimmers on dusky dolphin behaviour was thought to be insignificant, the dolphin schools became more compact during morning and early afternoon interactions with swimmers (Barr and Slooten 1999). This behaviour has been observed when dolphins are in situations of surprise, threat or danger and may be a form of protection (Johnson and Norris 1986).

Wild dolphins participating in SWD programmes are not restricted by space and are able to leave the vicinity of the swimmers when they choose. Dolphins in captive situations are unable to do this. Therefore, SWD programmes involving captive dolphins must be designed to ensure that the welfare of the dolphins is not compromised. Public interest in captive animal welfare, in particular dolphin welfare, has prompted the need to investigate the impacts of captive SWD programmes on participating dolphins. With so many captive SWD programmes world wide, there is a need to understand the welfare implications of them.

Bottlenose dolphins are the most common captive cetacean due to their friendliness towards people and their perceived intelligence (Montagu and Lilly 1963; Robson 1976). It is also the most common species to participate in SWD programmes. The impact of these programmes on captive bottlenose dolphins has been investigated by Samuels and Spradlin (1995) and Frohoff (1993). Two types of swim session were studied, one type where the dolphins' behaviour was controlled by a trainer, i.e. made to go over and touch a swimmer, and the other where the trainers didn't control the dolphins. Samuels and Spradlin (1995) found that bottlenose dolphins at Dolphin Plus, Key Largo, Florida, exhibited more (61%) high-risk (Agonistic or Sexual) behaviour during non-controlled swims and high-risk behaviours were rarely (< 1%) seen during controlled swims. Samuels and Spradlin (1995) also investigated the effects of swimmer type (adult female, adult male and child), and found that adult men were involved in disproportionately more swimmer-at-risk interactions with dolphins than women and children. It was also recorded that male dolphins were implicated in more high-risk activities and female dolphins were the preferred sex for human-dolphin interactions.

The bottlenose dolphins at Dolphin Plus, Key Largo, Florida who participate in the SWD programme did not use their refuge area effectively, perhaps because the area was not an adequate size to provide sanctuary from swimmers during swims (Samuels and Spradlin 1995). The bottlenose dolphins at Dolphin Quest, Waikoloa, Dolphin Research Center, Marathon Shores, and Theatre of the Sea, Islamorada used the refuge area significantly more during free time than during SWD sessions. However, the dolphins at these facilities were recalled from the refuge areas by trainers during SWD sessions (Samuels and Spradlin 1994).

Frohoff (1993) investigated the behaviour of bottlenose dolphins in SWD programmes in the United States. SWD sessions were monitored to identify behaviours that indicate dolphin stress or disturbance. Side slaps, body slaps, fluke slap and abrupt turns and general slaps are believed to indicate stress. Dolphins exhibit these behaviours when they are "annoyed" and may not do so when they feel threatened or are distressed (Frohoff 1993). Rushen (2000) suggests that it is not possible to use behavioural responses as indicators of stress, until the underlying causes of the behaviours are understood. This understanding can only come from investigating the motivation and the neurophysiological basis of the behaviour.

There have been a few attempts at relating dolphins' behaviours to specific emotional states (Frohoff 1993; Slooten 1994). Dolphins have a large behavioural repertoire and the context of these behaviours has been examined in many studies. One method used to assess the meanings of behaviours is to look at the context in which they are performed. This requires analysis of behavioural sequences.

Slooten (1994) looked at behavioural sequences of free-living Hector's dolphins. She identified many relationships between specific behaviours. A bite was closely associated with other apparently aggressive behaviours such as tailslap and chase and aerial behaviours were most strongly associated with sexual and aggressive behaviours.

Bubble blow and Active/Abrupt behaviour are two behaviours that have been examined in great detail (Salden 1979; Frohoff 1993; Norris 1994; Slooten 1994; Marten *et al.* 1996; Delfour and Aulagnier 1997). Bubbleblow has been reported in many cetacean ethograms (Salden 1979; Norris 1994) and appears in many different contexts. In general, dolphins emit streams of small bubbles when they make sounds. In humpback whales *Megaptera novaeangliae* and many dolphin species bubbleblow is associated with feeding (Dawson 1985). Delfour and Aulagnier (1997) suggested that bubbleblow in Beluga whales *Delphinaperaus leucas* is a non-interactive behaviour associated with solitary play. Bubbleblow has also been associated with excitement, surprise or alarm.

When large amorphous bubbles are expelled and rise quickly to the surface it may frighten predators. Bottlenose dolphins also create more exotic types of bubbles, such as rings and helices, in association with play (Marten *et al.* 1996).

Many studies have looked at the surfacing frequencies of whales in response to stressors (Richardson and Würsig 1997). The river dolphin *Lipotes vexillifer* is shy of humans and when a ship approaches them they make long dives and change direction. Evidence of propeller damage, scarring on their heads, suggests these dolphins may have initially been attracted to the boats (Renjun *et al.* 1986). Small odontocetes decrease the "frequency" of surfacing after being approached by dolphin-watching and other types of boats (Janik 1996). This may be a direct avoidance of the boats or a secondary response if the boat frightened away the dolphins' prey.

In captivity, dolphins are not able to avoid swimmers and they may adapt to swimmers in other ways. The respiration rate of an animal may be a possible indicator of stress (Toates 1995; Tortora and Grabowski 1996). The surfacings by dolphins may be correlated to the respiration rate. Therefore, recording the frequency of surfacings during SWD sessions, and comparing that to the frequency before and after the session may be an indicator of respiration rate.

A comparison of dolphin behaviour during SWD sessions to the behaviour of dolphins in known benign conditions or adverse circumstances may be used to determine the effects of the SWD programme. Skin biopsy sampling, loud sounds underwater and whale-watching ventures may be stressful situations. Clapham and Mattila (1993) noted the responses of humpback whales to a skin biopsy procedure. Changes in behaviours included tail flicks, lateral tail thrashes, long dives, changes from being curious to not being curious and from travelling to not travelling.

Marineland in Napier is the only institution that houses female common dolphins and is the only one to use common dolphins in SWD programmes. The SWD programme at Marineland is particularly popular with tourists as it provides a safe controlled environment while swimming with dolphins. It guarantees that the swimming participant will get quite close to the dolphins.

Increasing participation in the SWD programme at Marineland and recent investigations of the SWD programmes in the United States prompted the Department of Conservation (DoC) to investigate the impacts SWD programmes have on the dolphins at Marineland. In 1997, Marineland established guidelines for the SWD programme to help the dolphins cope with the increasing number of swimmers (Appendix 1).

Determining the effects of the SWD programme on an individual dolphin is difficult. Two common approaches were used to assess the impacts of management practices on animals, namely monitoring either physiological and/or behavioural responses. It is better to evaluate the impacts of potential stressful situations on animals by using combined behavioural and physiological data than using only one (Barnett and Hemsworth 1990). Physiological data, such as changes in plasma cortisol levels, would complement the behavioural responses, but it was not possible to take blood samples from the dolphins, as they were not trained to allow it.

In the wild, common dolphins do not actively seek out humans. This is the first study assessing the response of individual common dolphins to a SWD programme. The effect of the SWD programme was examined by observing the use of the refuge area, monitoring surfacing frequencies of the dolphins and changes in behaviour, and comparing the surfacing frequencies of the dolphins in the refuge area and the swimmer area.

This chapter addresses the following questions:

- Is the dolphins' use of the refuge area affected by swimmers?
- Are specific dolphin behaviours changed as a result of the SWD programme?
- Is the surfacing location of the dolphins affected by swimmers?
- Does the surfacing frequency of the dolphins change when swimmers are present?

3.2 METHODS

The behaviour of three female common dolphins (Table 1.1) at Marineland, Napier was studied while they participated in the SWD programme (Section 1: 3). Three SWD session times at 0800 h, 1200 h and 1500 h were observed. The dolphins were held in the main pool (Figure 1.2) situated in front of the grandstand.

Data Collection and Analysis:

Focal animal sampling (Altmann 1974) was used during SWD programmes. One dolphin was observed for a whole swim session. The three dolphins were chosen randomly to be the focal animal. Each dolphin was watched once a day. Some sessions finished early because of interruptions, which prevented the full 15 minutes sampling time after the swim sessions. The afternoon sessions often ran on one after the other, without breaks between sessions, so that sometimes there was no period without swimmers after the 1500 h session.

Two methods of collecting data were used in this chapter.

- **Method One**

Data were collected between January 1999 and March 1999. Only sessions (n = 83) with three swimmers were included in the data analysis. The focal dolphin was observed continuously, starting 15 minutes before a swim session and ending 15 minutes after a swim session. Thus, with a 45-minute SWD session the total observation time was 75 minutes. Recordings were taken at 30 second intervals of the dolphins position in the pool and of their exact behaviour

- **Method Two**

The data were collected between April 1999 and June 1999. A total of 82 sessions were recorded. The total number and position of surfacings by the focal dolphin was noted. Two session types were observed, i.e. sessions with swimmers and sessions without swimmers. The sessions were 45 minutes long. During winter the SWD programme was less popular giving an opportunity to observe sessions with swimmers and sessions without swimmers.

- **Data Analysis:**

The statistical package SAS (SAS Institute Inc. 1989) was used to fit a general linear model (ANOVA) and to examine the significance of different factors on dolphin responses to swimmers. Because of the small sample size (3) a number of sessions were observed for each dolphin. The responses of each dolphin were then treated as coming from different populations. Thus, the results of statistical hypothesis tests presented in this chapter apply only to these three captive female common dolphins. The results presented here are, at best, only indicators of what is expected in other common dolphins. The tables of SAS output are included in the Appendix 2, Tables 1-4.

3.2.1 Is the dolphins' use of the refuge area affected by swimmers?

The position of the focal dolphin was noted every 30 seconds as being in the refuge area or in the main swimming area. The proportion of refuge area use by the focal dolphin was calculated for the three periods (before, during and after) of each swim session. The proportion of refuge use was calculated by adding the number of times the dolphin was in the refuge area during those three periods and dividing it by the total number of observations. These results can be further divided into session time (0800 h, 1200 h and 1500 h). The proportion of refuge area use for each dolphin at the three session times was then analysed to see if refuge use was affected by swimmer presence. The proportion of refuge area use was also determined at five-minute intervals to see if there was a change in refuge area use over time.

3.2.2 Are specific dolphin behaviours changed as a result of the SWD programme?

The data on behavioural changes were collected simultaneously with refuge use. The behaviour of the focal dolphin was recorded at thirty-second intervals. Behaviours were assigned to appropriate categories (Table 3.1). The categories were identified from the literature on dolphin behaviour. (Samuels and Spradlin 1994; Frohoff 1993; Chrousos *et al.* 1988):

Table 3.1 Description of the six behaviour categories analysed.

Behaviour Category	**Description of the behaviour**
Touch	A dolphin touches another dolphin in a non-aggressive manner.
Aggressive	Tail slap, displace from bell, chase
Submissive	Flee, displaced, receiving an aggressive encounter
Abrupt	Sudden behaviours: direction change, aerial behaviour, fast swim, body slap
Play	Interacting with props: the bell, balls and kelp
Other	Any behaviour not listed above, usually continual cruising

The frequency of the six behaviours was determined for each period (before, during and after) of all swim sessions. These results were split into session time (0800h, 1200 h and 1500 h) and the three dolphins (Shona, Kelly and Selina). The frequencies of different behaviours were then analysed to see it there was an effect of session time and to determine any individual dolphin responses. The general behavioural response of the dolphins to swimmer presence was also assessed.

3.2.3 Is the surfacing location of the dolphins affected by swimmers?

Data were collected from April 1999 to July 1999 during the off season when the conditions were not as favourable for swims. This provided an opportunity to gather information on the surfacing locations of the dolphins during sessions with swimmers and sessions without swimmers. The focal dolphins' location during all surfacings was recorded, specifically whether the dolphin surfaced in the refuge area or in the main swimming area.

The frequency of use of the two surface locations, refuge area or main swimmer area, was calculated for the focal dolphin. The two session types, sessions with and without swimmers, were compared. The results were divided according to session time and dolphin identity to determine if there is a time of day preference for surface location and to see if the three dolphins have individual surface location preferences. The data were averaged to examine the preferred surface location in the presence and absence of swimmers.

3.2.4 Does the surfacing frequency of the dolphins change when swimmers are present?

The data collected in section 3.2.3 were used to answer this question. The frequency of surfacings of the dolphins during the two session types (with and without swimmers) was calculated. The surfacing frequency of the dolphins during the two session types was then tested for significant differences. The surfacing frequencies at different session times (0800h, 1200 h and 1500 h) and for the three dolphins (Shona, Kelly and Selina) were also examined.

3.3 RESULTS

3.3.1 Is the dolphins' use of refuge area affected by swimmers?

3.3.1.1 Average of all sessions

A significant difference was found between refuge use by the dolphins during different stages of the swim session ($F_{2,140} = 64.5$, $P < 0.0001$). Logit Means identified that refuge area use by the dolphins was much higher during (D) the swim session than before (B) and after (A) a session (Figure 3.1).

3.3.1.2 Dolphins

A significant difference was found between dolphins in their use of the refuge area ($F_{2,140} = 5.1$, $P = 0.008$). Shona used the refuge area more often than Selina and Kelly (Figure 3.2). The three dolphins has similar patterns of refuge use across the three stages of the swim, that is, the session (BDA) * Dolphin interaction was insignificant ($F_{4,140} = 0.6$, $P = 0.7$). The three dolphins showed the same trend, using the refuge area more during the SWD programme and returning to pre-swim levels immediately after the swimmers left the pool (Figure 3.2).

3.3.1.3 Time of Day

There was an insignificant difference in refuge area use during the three sessions times ($F_{2,140}$ = 2.4, P = 0.09) (Figure 3.3). The use of the refuge area during the three stages of SWD sessions was not significantly affected by time of day ($F_{4,140}$ = 0.7, P = 0.6). The use of refuge area increased slightly before SWD sessions and decreased slightly after the SWD sessions. As soon as swimmers entered the pool, refuge area use by the dolphins increased by approximately 30% and remained at that level throughout the SWD sessions, dropping immediately to pre-swim levels when swimmers exited the pool (Figure 3.4).

The SAS output for this section is in Table 1 in Appendix 2.

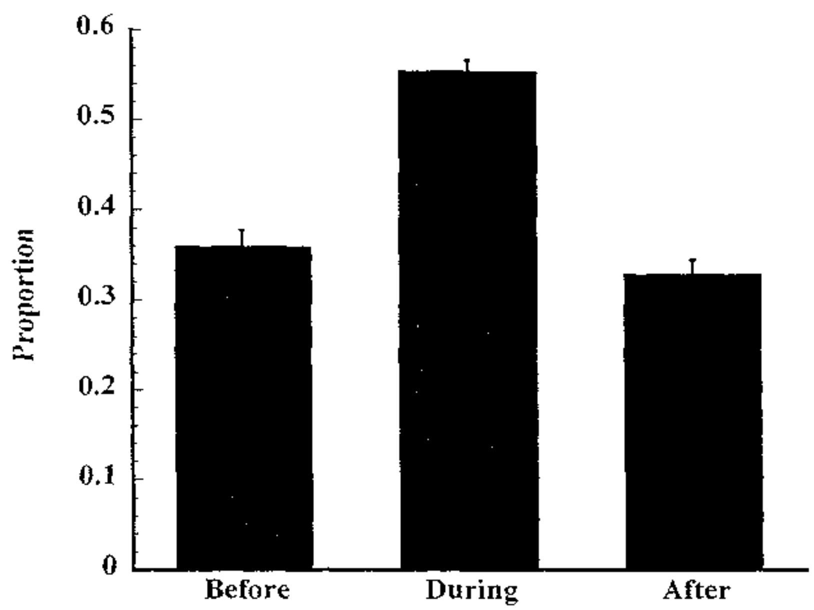


Figure 3.1 The average proportion of refuge area use by the dolphins during the three stages of SWD sessions (Before, During and After) (Bars = SE).

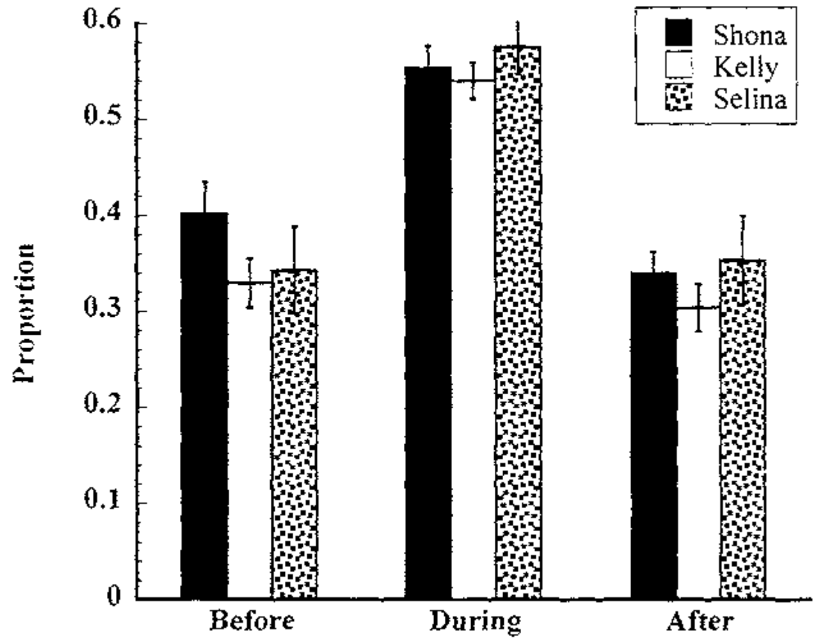


Figure 3.2 The average proportion of refuge area use by the dolphins (Shona, Kelly, Selina) during the three stages of the SWD programme (Before, During and After) (Bars = SE).

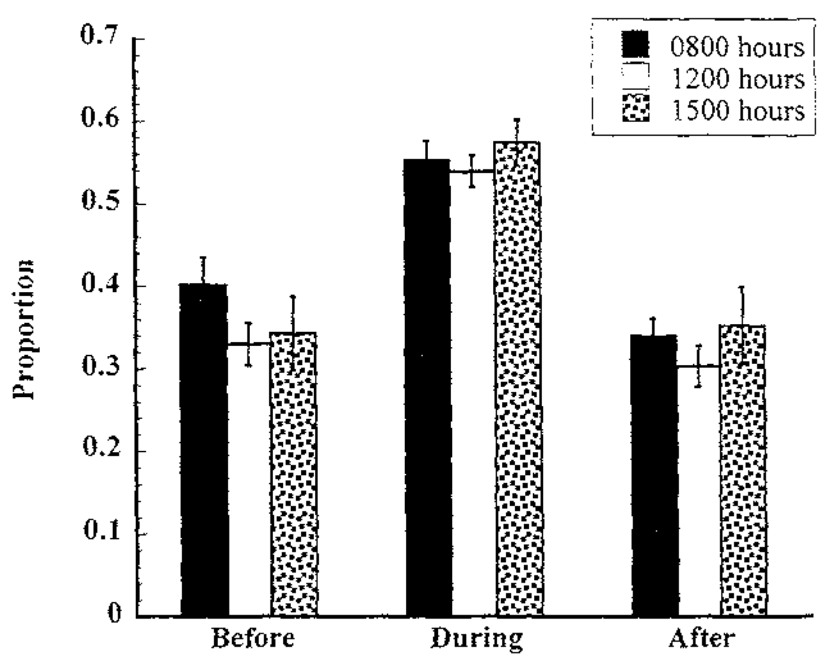


Figure 3.3 The average proportion of refuge area use by the dolphins during the three stages of SWD sessions (Before, During After) at three session times (0800h, 1200h and 1500h) (Bars = SE).

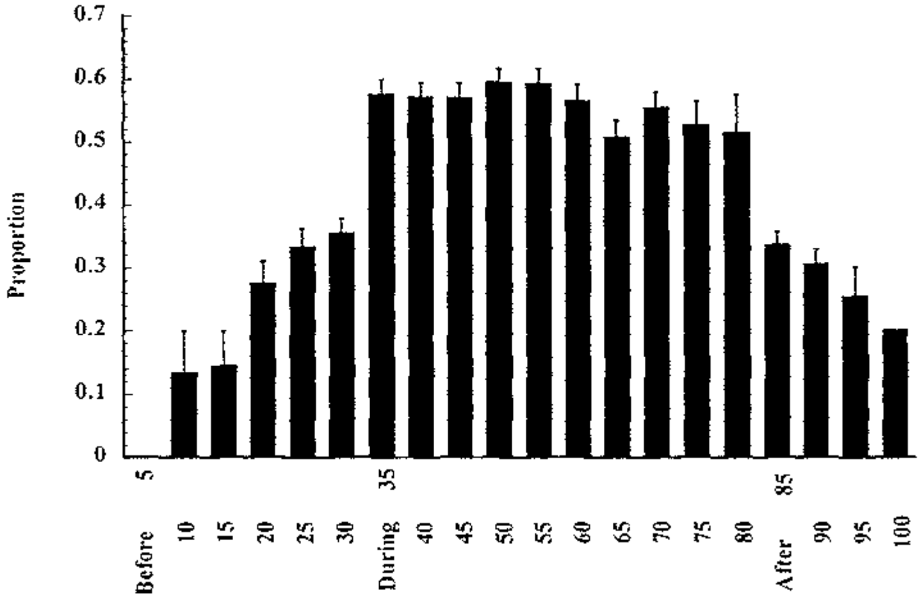


Figure 3.4 The average proportion of refuge area use by the dolphins at five minute intervals, starting 15 minutes before a SWD session and finishing 15 minutes after a SWD session (Bars = SE).

3.3.2 Are specific dolphin behaviours changed as a result of the SWD programme?

3.3.2.1 Average of all sessions

There was a significant difference in the dolphins' behavioural responses to swimmers during SWD sessions ($F_{5, 898} = 495.2$, $P = 0.0001$). There was an increase in Touch and Other behaviours and a decrease in Aggressive, Submissive, Abrupt and Play behaviours during SWD sessions. Aggressive, Submissive, and Play behaviour returned to pre-swim levels immediately after the swim session. Touch behaviour continued to increase after the swim session and Abrupt behaviour increased after a swim session (Figure 3.5). The behaviours performed by the dolphins were significantly different during the three stages of SWD sessions (Before, During and After) ($F_{2,140} = 2.7$, $P = 0.02$).

3.3.2.2 Dolphins

The three dolphins performed similar ratios of the six behaviours, e.g. all exhibiting Other behaviour most often ($F_{2, 898} = 1.1$, $P = 0.3$). The behaviour of individual dolphins (Dolphin * Behaviour interaction) differed significantly before, during and after SWD sessions ($F_{10, 898} = 4.1$, $P < 0.0001$).

During a swim session Kelly exhibited a decrease in Aggression, Abrupt and Play behaviour and an increase in Other and Touch behaviour (Figure 3.8). Selina behaved differently to Kelly and Shona. She increased Play, Touch and Submissive behaviour significantly during a swim session. The other behaviours all decreased (figure 3.8). Shona increased Aggressive, Abrupt and Play behaviours and decreased Other behaviour during SWD sessions (Figure 3.8).

Overall, Shona exhibited Touch and Abrupt behaviours significantly more often that the others. Selina was more Submissive and Played lot more than Shona and Kelly. Kelly's behaviour was intermediate between that of Shona and Selina on all occasions (Figure 3.6).

3.3.2.3 Time of Day

There was a significant difference in behaviours performed at different times of the day ($F_{2,140} = 12.3$, $P = 0.0001$) (Figure 3.7). The time of day appeared to have a significant effect on the behaviours performed by the dolphins (Time of Day * Behaviour interaction) ($F_{10, 898} = 3.5$, $P < 0.0001$) (Figure 3.9). There was a significant difference in behaviour changes over the three stages during three SWD session times ($F_{2, 898} = 6.4$, $P = 0.002$). All behaviours were roughly the same except for Abrupt, Touch and Play (Figure 3.9). There was a decrease in Aggressive, Submissive and Abrupt (except in the 1200 h session) behaviour during a SWD session (Figure 3.9). Touch behaviour increased during the SWD session and continued to increase during the 0800 h and 1200 h sessions but returned to pre-swim levels after the 1500 h sessions (Figure 3.9). On average, the dolphins exhibited more Play behaviour during the 1200 h session than during sessions at 0800 h and 1500 h. Abrupt behaviour increased significantly after SWD sessions at 1500 h (Figure 3.9).

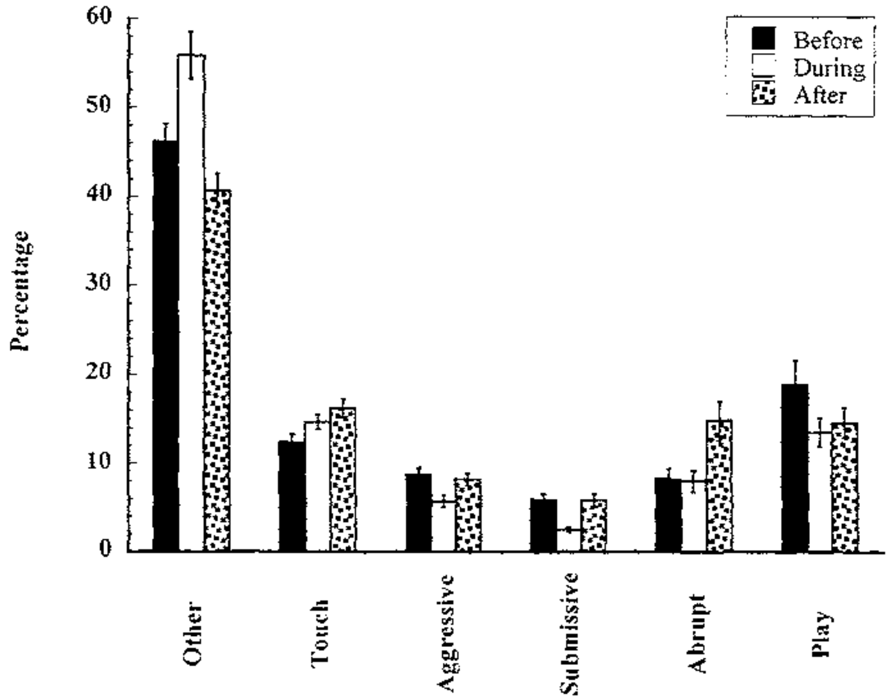


Figure 3.5 The average of percentage of 6 behaviour categories performed during three stages (Before, During and After) of SWD sessions (Bars = SE).

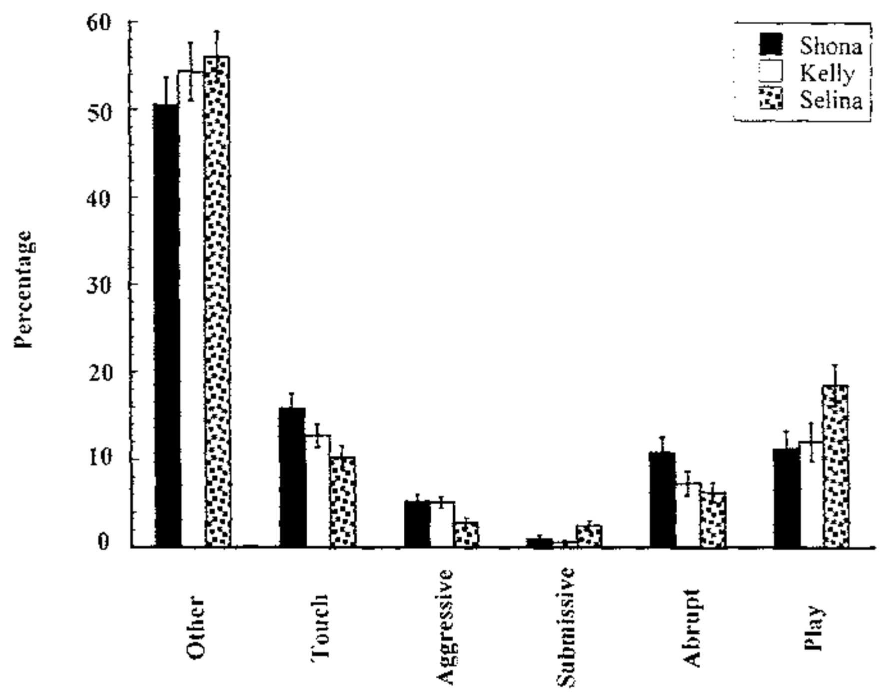


Figure 3.6 The average percentage for the three SWD periods of the 6 behaviours performed by each dolphin (Shona, Kelly and Selina) during SWD sessions (Bars = SE).

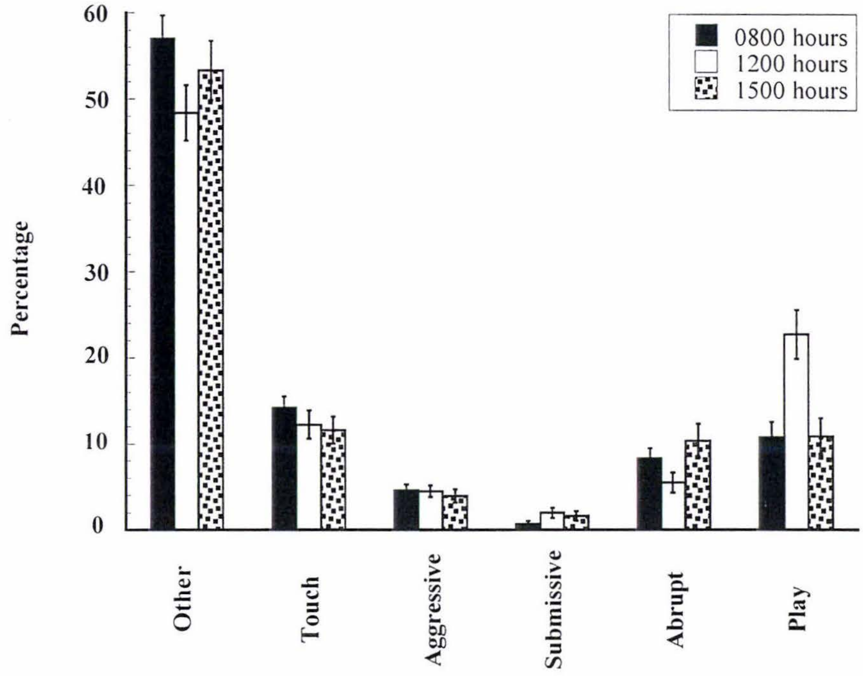
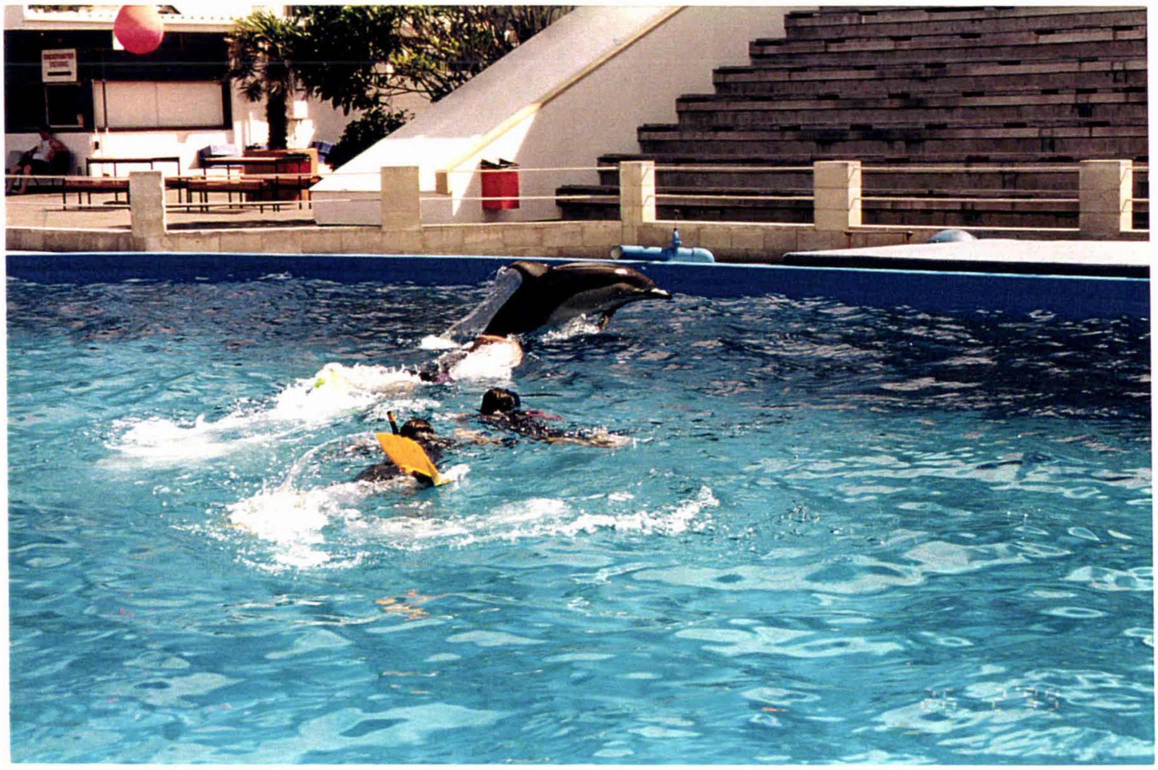


Figure 3.7 The average percentage for the three SWD periods of the behaviours performed by the dolphins at different SWD session times (0800 h, 1200 h and 1500 h) (Bars = SE).



Three swimmers and Selina porpoising beside them ….. 'you can't catch me'

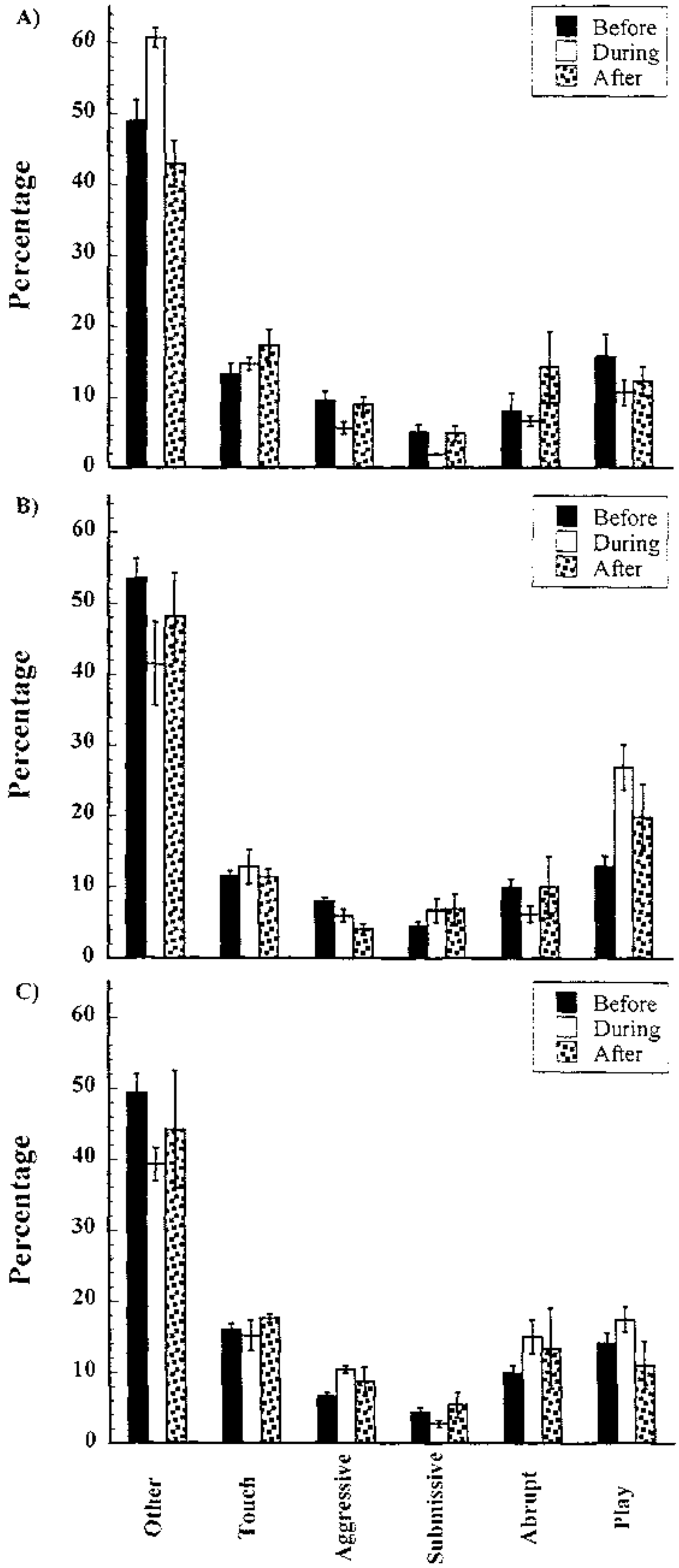


Figure 3.8 The average percentage of 6 behaviour categories performed by the three dolphins, Kelly (A), Selina (B) and Shona (C) during the three stages (Before, During and After) of SWD sessions (Bars = SE).

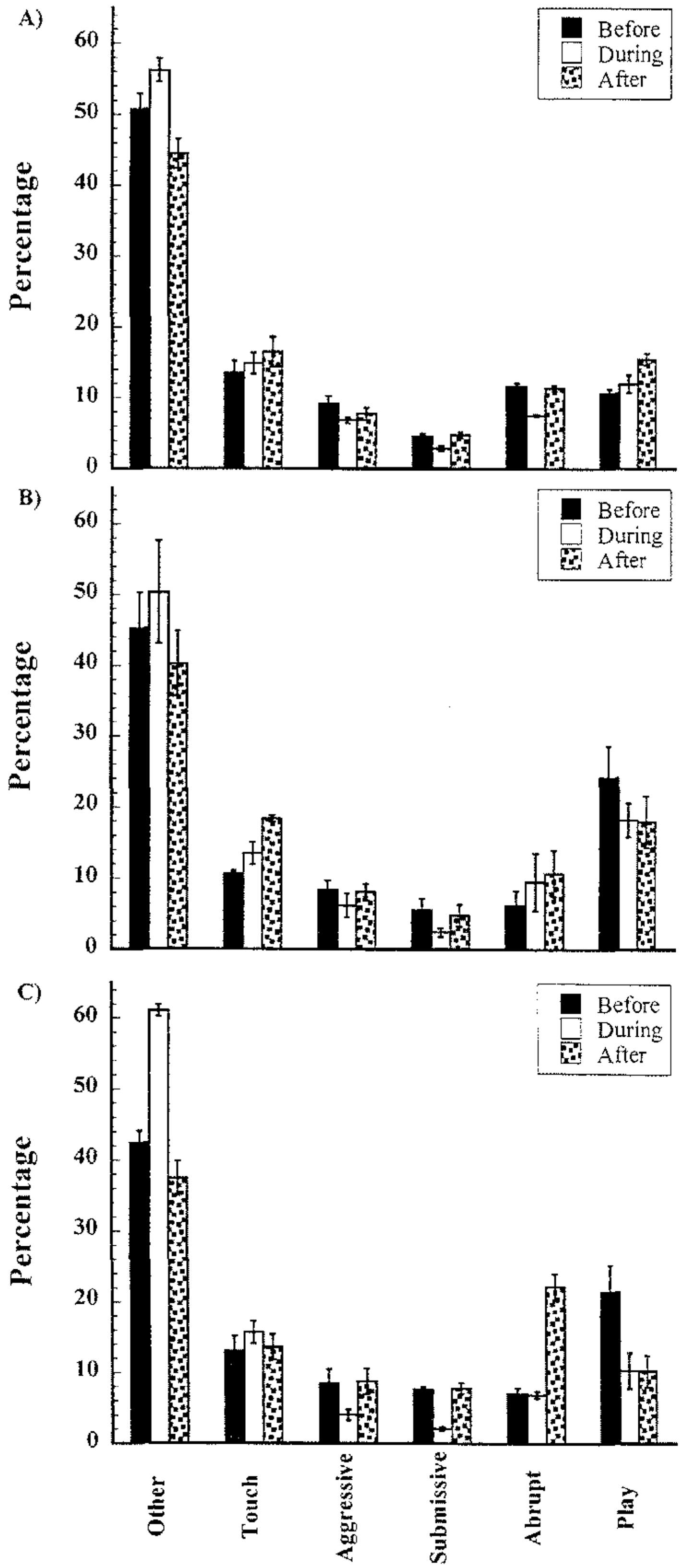


Figure 3.9 The average percentage of 6 behaviour categories performed by the dolphins during the three stages (Before, During and After) of SWD sessions at different session times 0800 h (A), 1200 h (B) and 1500 h (C) (Bars = SE).

3.3.3 Is the surfacing location of the dolphins affected by swimmers?

3.3.3.1 Average of all sessions

The dolphins surfaced significantly more often in the refuge area with swimmers present ($F_{1,144} = 88.7$, $P < 0.0001$), the number increasing from 20 to 65 surfacings in the refuge area with swimmers present (Figure 3.10). The type of session, with or without swimmers had a significant effect on surface location of the dolphins ($F_{1,144} = 150.5$, $P = 0.0001$) .

3.3.3.2 Dolphins

All the dolphins showed similar surfacing patterns, surfacing more often in the refuge area with swimmers present ($F_{2,144} = 2.7$, $P = 0.07$) (Figure 3.11). Overall, Selina surfaced more often than the other two in the refuge area and Kelly did not surface in the refuge area quite as often as Shona. There was an insignificant difference between dolphin surfacings during sessions with and without swimmers ($F_{2,144} = 0.6$, $P = 0.6$) and at different times of the day ($F_{4,144} = 0.9$, $P = 0.5$).

3.3.3.3 Time of Day

The number of surfacings was affected by time of day ($F_{2,144} = 8.2$, $P = 0.0004$). The dolphins do not appear to surface as often in the 0800 h session. In the 1500 h sessions without swimmers the dolphins appear to surface significantly more in the main area. The sessions that had swimmers present had the same surfacing pattern during the three session times ($F_{2,144} = 1.2$, $P = 0.3$) (Figure 3.12).

3.3.4 Does the surfacing frequency of the dolphins change when swimmers are present?

3.3.3.1 Average

The dolphins surfaced significantly more often in SWD sessions with swimmers present ($F_{1,64}$ = 6.1, P = 0.02) (Figure 3.13).

3.3.4.2 Dolphins

The three dolphins exhibited the same pattern, surfacing significantly more often in sessions with swimmers ($F_{2,64}$ = 0.4, P = 0.6) than without swimmers (Figure 3.14).

3.3.4.3 Time of day

The time of day did affect the surfacing frequencies of the dolphins ($F_{2,64}$ = 5.0, P = 0.001) (Figure 3.12). There were more surfacings with swimmers present in the 0800 h and 1200 h sessions but averaged there were more surfacings in the 1500 h sessions without swimmers (Figure 3.15).

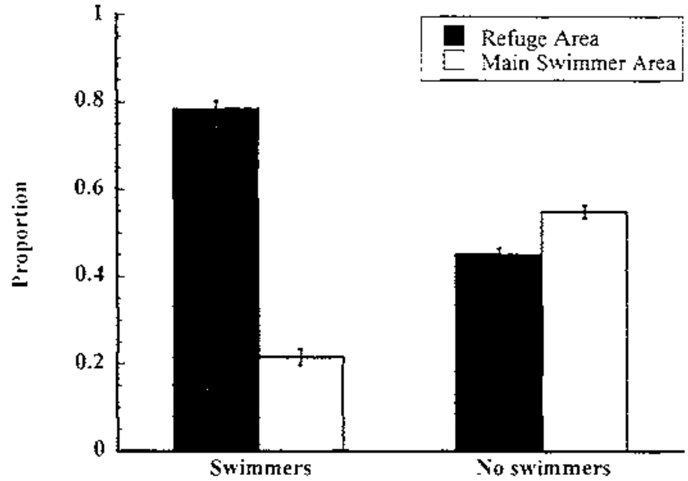


Figure 3.10 The average proportion of surfacings in the two areas of the pool (refuge area or swimmer area) during different types of sessions (swimmers and no swimmers) (Bars = SE).

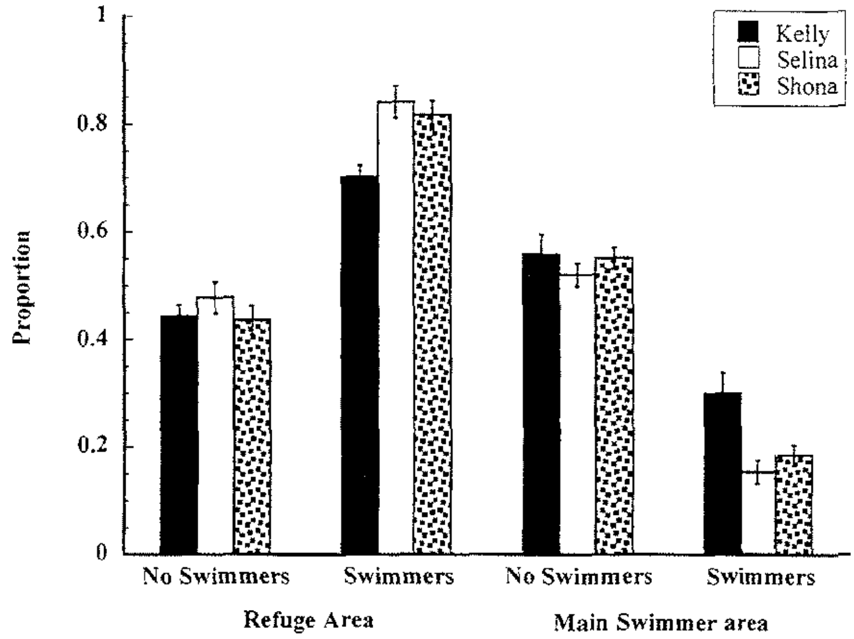


Figure 3.11 The average proportion of surfacings by the three dolphins (Shona, Kelly and Selina) in the two areas of the pool (refuge area or swimmer area) during different types of sessions (swimmers and no swimmers) (Bars = SE).

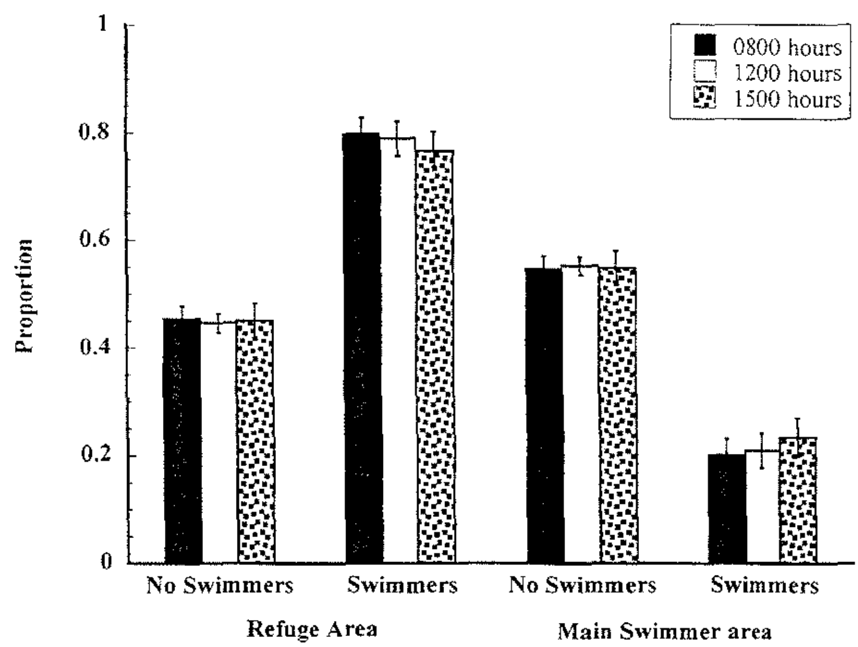


Figure 3.12 Average proportion of surfacings by the dolphins at three SWD session times (0800 h, 1200 h and 1500 h) during sessions with and without swimmers (Bars = SE).

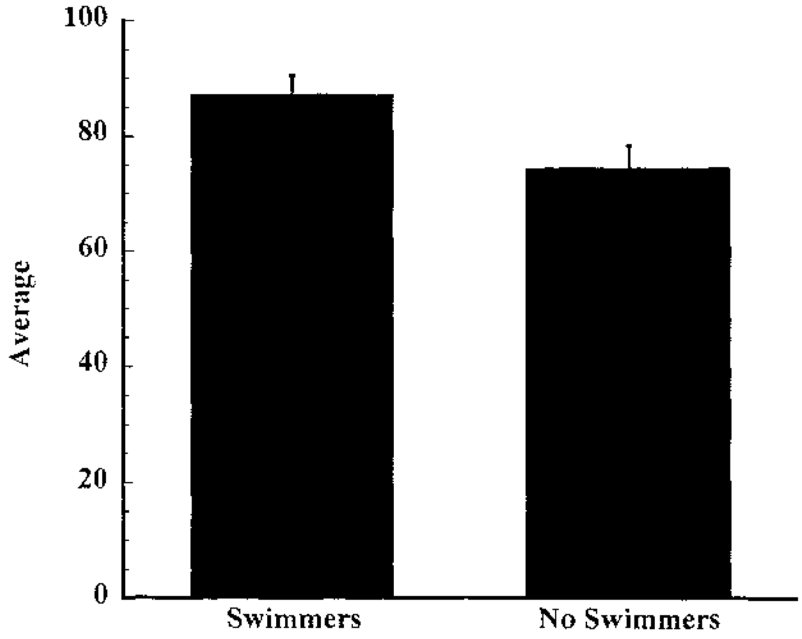


Figure 3.13 Average surfacing frequency of the dolphins during two types of sessions (swimmers and no swimmers) (Bars = SE).

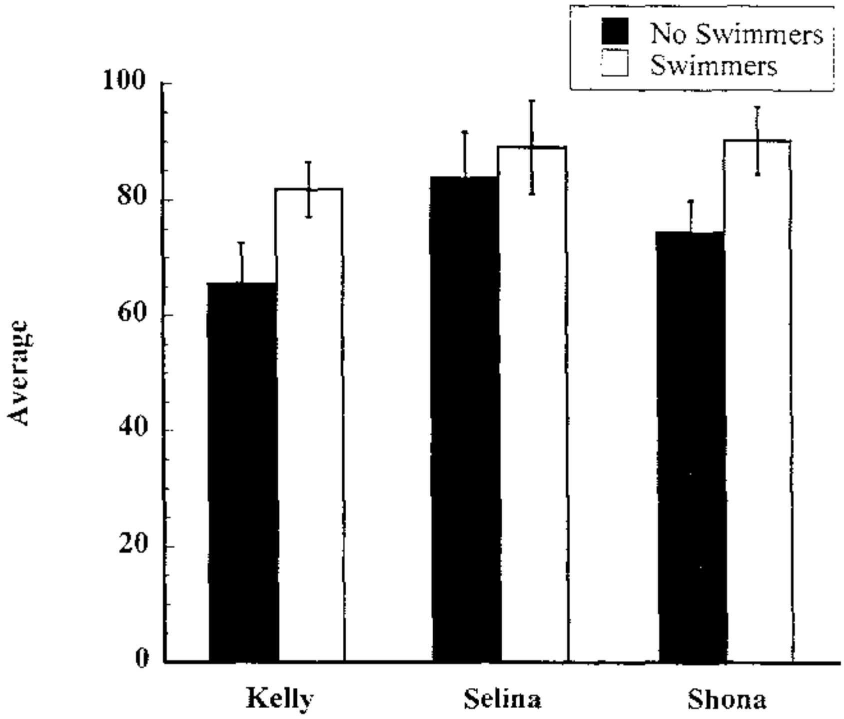


Figure 3.14 Average surfacing frequency of the three dolphins (Shona, Kelly and Selina) during two types of SWD sessions (swimmers and no swimmers) (Bars = SE).

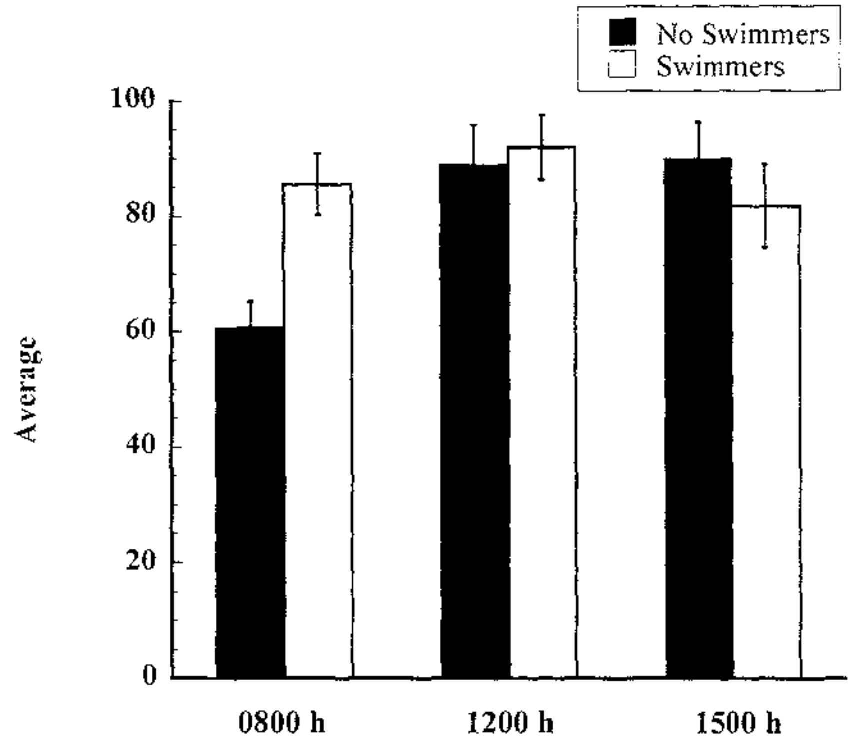


Figure 3.15 Average surfacing frequency of the dolphins during three SWD session times (0800 h, 1200 h and 1500 h) during two types of sessions (swimmers and no swimmers) (Bars = SE).

3.4 DISCUSSION

Swimming with the dolphins is an increasingly popular activity. Many tourist ventures worldwide have been initiated as a response to this interest. Although these programmes have been running at captive institutions for years, it is only in the last decade that permits have been needed to run them. Recent research in the United States has revealed that the rules set out for the in-water interactions are not sufficient to reduce bottlenose dolphin stress and high-risk behaviour towards swimmers (Samuels and Spradlin 1995). Therefore, the rules for swim sessions in United States are currently under review. This prompted the need to assess what effects the SWD programme has on the dolphins at Marineland. This study looks at the behaviour of the dolphins in order to assess the impacts of the SWD programme on them.

A behavioural response to a stressor may be the fright/flight response part of the general adaptation syndrome (Selye 1973). However, the reaction of animals to disturbing events will differ depending on the experience of the individual and the security of its immediate environment (Recarte *et al.* 1998). Habituation is most likely to occur when avoidance is not possible due to lack of space and with continued exposure to a non-harmful stressor the animal learns that the stressor will not harm it (Recarte *et al.* 1998; Geist *et al.* 1985).

In the wild, common dolphins in the Bay of Islands, New Zealand, avoid swimmer interactions (Constantine and Baker 1997). The dolphins at Marineland are unable to avoid swimmers. Therefore, they may have become habituated to human presence. Marineland's SWD programme has given the dolphins the opportunity to avoid swimmers by creating a refuge area that is a third of the pool and clearly flagged for the dolphins' use only. The dolphins at Marineland were found to increase refuge area use from 1/3 of the time with no swimmers to 2/3 of the time with swimmers. The three dolphins showed similar responses but Shona used the refuge area significantly more than the other two dolphins. The bottlenose dolphins *Tursiops truncatus* at Dolphin Plus, Key Largo, Florida, very rarely chose to enter the refuge area in a free swim or with swimmers (Samuels and Spradlin 1995).

There are two obvious explanations for increased refuge area use during a SWD session. Firstly, the dolphins may be actively avoiding swimmers and fleeing into the refuge area. Secondly, they may find the main swimming area too full of bodies and use the refuge area because there is not enough space elsewhere. The dolphins use of the refuge area increased as soon as the SWD session started and did not decline throughout the session. Refuge use returned to pre-swim levels immediately after the swimmers exited the pool.

The dolphins do not use the refuge area 100% of the time when swimmers are present. The dolphins have been in captivity for over 20 years. Throughout the dolphins' captivity they have had swims with Marineland staff and for at least eight years with members of the public. They have never been harmed or injured as a result of human interaction. Even though the dolphins habituate to the swimmers they do not spend more time with them as the SWD session progresses. These results suggest that the dolphins' don't actively avoid swimmers. They may increase their use of the refuge area simply because there is more space there for them to manoeuvre.

The behavioural response of common dolphins to the SWD programme was contrary to expectation. The behavioural response of bottlenose dolphins to swimmers in the United States SWD programmes is an increase in high-risk activity in non-controlled sessions. That is, an increase in Aggressive and Sexual behaviour (Samuels and Spradlin 1995). The three common dolphins at Marineland decreased Aggression, Submission and Abrupt behaviour and increased Touch and Other behaviours. The dolphins performed the same proportion of behaviours but the response to the swim sessions differed. Shona, the eldest dolphin of the three, increased Aggression, Abrupt and Play behaviour during SWD programmes. Thus, she appeared not to be happy with swimmers presence. Shona's personality may have influenced this. She did not have much patience during interactions with people, including trainers, preferring to spend time alone. Selina was the opposite to this. She appeared to be intrigued with swimmers and her behaviour supported this as she was often seen circling the swimmers, as if checking them out. She was the youngest dolphin, and spent a lot of her time playing and seeking out interactions with the other dolphins. Kelly was the dominant dolphin and her behaviour did not indicate she was disturbed. She was markedly different from bottlenose dolphins in that her behaviour remained unaffected by swimmer presence.

The behaviour of the dolphins in captivity changes to suit the environment. There were limitations to movement and the dolphins were unable to perform some natural behaviours such as deep diving. This means some behaviours were no longer expressed and some have developed that are unusual, such as bell ringing. These dolphins were old and probably tired easily. This was particularly true for Shona. She spent more time in the refuge area and performed aggressive behaviours such as fluke slaps more. Although Kelly was of a similar age, she seems to be a little more tolerant, even a little indifferent, towards swimmers. Common dolphins are oceanic and not normally thought of as sociable towards humans. Therefore, spending more time in the refuge area was expected.

Animals in stressful situations tend to have increased respiration (Totora & Grabowski 1996). The dolphins surfaced a lot during the sessions with swimmers and they surfaced more often in the refuge area away from the swimmers. There may be two reasons why this pattern emerged. The dolphins may have surfaced in the refuge area more often than the main swimmer area because of the dolphins increased use of refuge area anyway. They may also be actively choosing to surface in the refuge area because when they surface they may feel vulnerable to attack and therefore they surface where there aren't any swimmers acting as potential threats.

The dolphins at Marineland significantly increased surfacing frequencies in sessions with swimmers. This suggests that respiration rate increased and the dolphins may be slightly stressed. However, surfacings are not just respiratory in function as dolphins may be surveying the surroundings or resting, for example when killer whales *Orcinus orca* spyhop (Dawson and Slooten 1996). These types of surfacings could not be separated from surfacings that may be for respiration.

There are many problems involved when interpreting behaviour. Categorising behaviours broadly helps reduce possible bias. Abrupt behaviour gives the impression of being a negative behaviour as a result of frustration but it included play behaviour between the dolphins. Categorising behaviours into specific groups is difficult. Some behaviours may be classified in a number of groups as they have two or three possible meanings when performed in different contexts. Bubble blow and aerial behaviour are such behaviours. The behaviours were categorised into six groups and in some cases educated guesses were used to group them by looking at the context in which they were performed. To simplify the results, Play behaviour was that behaviour which involved interacting with props, such as a bell and ball.

Bottlenose dolphins are much larger than common dolphins and in captivity sometimes direct aggression towards humans. This may be explained by the 'assimilation tendency' as described by Hediger (1950). Assimilation tendency is " a characteristic of men as well as animals where they regard animals of different species as if they belonged to the same species". Common dolphins are almost half the size of bottlenose dolphins and similar in size to humans. These dolphins may feel vulnerable in the presence of humans because they may perceive them as a threat.

These results show that the dolphins' behaviour is not consistent with a stress response, there were, however, occasional signals that may indicate the dolphins didn't want swimmers in their pool. The dolphins occasionally exhibited behaviours such as body slaps, charges and abrupt behaviours indicating frustration (Frohoff 1993). Dolphin charges, when the dolphin swims quickly towards a swimmer with its rostrum open, then, at about one metre away, it abruptly changed directions were rarely seen. This behaviour sparked an immediate response from the swimmers who quickly moved to the side of the pool or looked up and screeched.

A 'flight distance' was observed in the dolphins' response towards swimmers. Flight distance is that distance maintained by an animal that, when encroached upon, results in the withdrawal of the animal (Wallace 1979). The dolphins used the bell frequently and it gave swimmers an opportunity to get quite close to the dolphins. However, when a swimmer got nearer than one metre from the dolphins they left the bell. When the swimmers retreated the dolphins came back to the bell. Occasionally, if the swimmers stood in the shallow area (Figure 1.2) of the pool the dolphins would speed around them in fast small circles, but not close enough for the swimmers to touch them. This behaviour appeared quite intimidating for the swimmers. The dolphins at times appeared to focus their slaps towards swimmers.

The welfare of captive animals is very important and assessing this can be difficult. The dolphins at Marineland do not appear to be seriously affected by the SWD programme. Although there was a displacement to the refuge area, there were not any significant behaviour changes that indicate distress, nor very many aggressive behaviours as seen in bottlenose dolphins by Samuels and Spradlin (1994). It is unlikely that the common dolphins at Marineland will inflict injury on swimmers. The dolphins appear to have habituated to swimmers and have adapted their use of the refuge area to cope with swimmer presence. There is no behavioural evidence of distress in the dolphins' response to swimmers.

3.5 REFERENCES

Altmann, J. 1974. Observational study of behavior: sampling methods. *Behavior* **49:** 227-265.

Barnett, J. L. and P. H. Hemsworth. 1990. The validity of physiological and behavioural measures of animal welfare. *Applied Animal Behaviour Science* **25:** 177-187.

Barr, K. 1997. *The impacts of marine tourism on the behaviour and movement patterns of dusky dolphins (Lagenorhynchus obscurus) at Kaikoura, New Zealand.* Unpublished thesis, University of Otago, Dunedin.

Barr, K. and E. Slooten. 1999. *Effects of tourism on dusky dolphins at Kaikoura*. Report Number 229. Department of Conservation, Wellington.

Bejder, L., S. M. Dawson and J. A. Harraway. 1999. Responses by Hector's dolphins to boats and swimmers in Porpoise Bay, New Zealand. *Marine Mammal Science* **15:** 738-750.

Carlstead, K. 1996. Effects of captivity on the behaviour of wild mammals. In: *Wild mammals in captivity: Principles and techniques.* D. G. Kleiman, M. E. Allen, K. V. Thompson and S. Lumpkin (eds.). The University of Chicago Press, Chicago. p.317-333

Chrousos, G. P., D. L. Loriaux and P. W. Gold. 1988. The concept of stress and its historical development. In: *Mechanisms of physical and emotional stress.* Plenum Press, New York. p. 3-7.

Clapham, P. J. and D. K. Mattila. 1993. Reactions of humpback whales to skin biopsy sampling on a West Indies breeding ground. *Marine Mammal Science* **9:** 382-391.

Connor, R. C. and R. S. Smolker. 1985. Habituated dolphins (*Tursiops* spp.) in Western Australia. *Journal of Mammalogy* **66:** 398-400.

Constantine, R. and S. Baker. 1997. *Monitoring the commercial swim-with-dolphin operations in the Bay of Islands*. Report Number 56. Department of Conservation, Wellington.

Dawson, S. 1985. *The New Zealand whale & dolphin digest: the official Project Jonah guidebook*. Brick Row: Project Jonah (N.Z.) Inc., Auckland, N.Z.

Dawson, S. and E. Slooten. 1996. *Understanding behaviour.* Canterbury University Press, Christchurch.

Delfour, F. and S. Aulagnier. 1997. Bubbleblow in beluga whales (*Delphinapterus leucas*): a play activity? *Behavioural Processes* **40:** 183-186.

Doak, W. 1981. *Dolphin, dolphin.* Hodder and Stoughton, Auckland, N.Z.

Frohoff, T. G. 1993. *Behavior of captive bottlenose dolphins* (Tursiops truncatus) *and humans during in-water interactions.* Unpublished thesis, Texas A and M University, Texas.

Frohoff, T. G. and J. M. Packard. 1995. Human interactions with free-ranging and captive bottlenose dolphins. *Anthrozoos* **8:** 44-57.

Geist, V., R. E. Stemp and R. H. Johnston. 1985. Heart-rate telemetry of bighorn sheep as a means to investigate disturbances. In: *The ecological impacts of outdoor recreation on mountain areas in Europe and North America.* N. G. Bayfield and G. C. Barrow (eds.). Recreational ecology research group report, Wye College, Wye. p. 92-99.

Hediger, H. 1950. *Wild animals in captivity.* Dover Publications, Inc., New York.

Janik, V. M. 1996. Changes in surfacing patterns of bottlenose dolphins in response to boat traffic. *Marine Mammal Science* **12:** 597-602.

Johnson, M. C. and K. S. Norris. 1986. Delphinid social organization and social behavior. In: *Dolphin cognition and behavior: a comparative approach.* J. A. Thomas and F. G. Wood (eds.). Lawrence Erlbaum Associates, Hillsdale. p. 335-346.

Lockyer, C. 1985. A wild but sociable dolphin off Portreath, North Cornwall. *Journal of Zoology. (Series A)* **207:** 605-607.

Marten, K., K. Shariff, P. S. and D. J. White. 1996. Ring bubbles of dolphins. *Scientific American* 84-87.

Montagu, A. and J. C. Lilly. 1963. *The dolphin in history.* Willian Andrews Clark Memoral Library, University of California, Los Angeles.

Nathanson, D. E. and S. de Faria. 1992. Cognitive improvement of children in water with and without dolphins. *Anthrozoos* **6:** 17-29.

Norris, K. S. 1994. Beluga: white whale of the North. *National Geographic* **185:** 2-31.

Orams, M. B., G. J. E. Hill and J. A. J. Baglioni. 1996. "Pushy" behaviour in a wild dolphin feeding program at Tangalooma, Australia. *Marine Mammal Science* **12:** 107-117.

Orams, M. B. 1997. Historical accounts of human-dolphin interaction and recent developments in wild dolphin based tourism in Australasia. *Tourism Management* **18:** 317-326.

Recarte, J. M., J. P. Vincent, and A. J. M. Hewison. 1998. Flight responses of park fallow deer to the human observer. *Behavioural Processes* **44:** 65-72

Renjun, L., M. Klinowska and R. J. Harrison. 1986. The behaviour of *Lipotes vexillifer* and *Neophocaea phocaenoides* in the Changjiang River and in captivity in China. In: *Research on Dolphins.* M. M. Bryden and R. Harrison (eds.). Oxford University Press, New York. p. 433-439

Richardson, W.J. and B. Würsig. 1997. Influences of man-made noise and other human actions on cetacean behaviour. *Marine and Freshwater Behavioural Physiology* **29:** 183-209

Robson, F. D. 1976. *Thinking dolphins, talking whales*. A. H. and A. W. Reed Ltd., Wellington.

Rushen, J. 2000. Some issues in the interpretation of behavioural responses to stress. In: *The biology of animal stress: basic principles and implications for animal welfare*. G. P. Morberg and J. A. Mench (eds.). CABI Publishing, Wallingford. p. 23-42.

Salden, S. 1979. Supplementary observations concerning an ethogram of the killer whale. *Carnivore* **2:** 17-18.

Samuels, A., and Spradlin, T. 1995. Quantitative behavioral study of bottlenose dolphins in the Swim-with-Dolphin programs in the United States. *Marine Mammal Science* **11:** 520-544.

SAS Institute Inc. 1989. *SAS/STAT User's guide*. Version 6, Fourth Edition, Volume 2, SAS Institute Inc., Cary, NC.

Selye, H. 1973. *Stress without distress*. Hodder and Stoughton, London. [Original not seen, cited in Carlstead 1996]

Slooten, E. 1994. Behavior of Hector's dolphin: classifying behavior by sequence analysis. *Journal of Mammalogy* **75:** 956-964.

Toates, F. 1995. *Stress: conceptual and biological aspects*. John Wiley and Sons Ltd, Sussex.

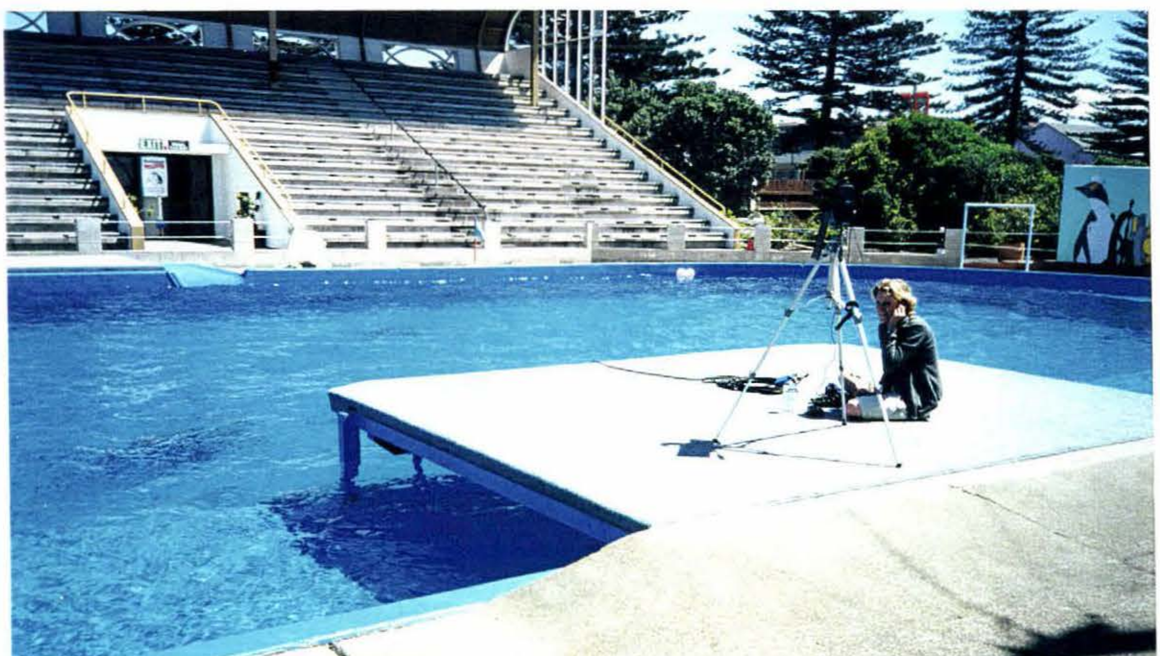
Tortora, G. J. and S. R. Grabowski. 1996. *Principles of anatomy and physiology*. HarperCollins College Publishers, Menlo Park, California.

Wallace, R. A. 1979. *Animal behavior: its development, ecology, and evolution.* Goodyear Publishing Company, Inc., Santa Monica, California.

Wood, C. J. 1999. A period of human contact by two free-ranging bottlenose dolphins (*Tursiops truncatus*). *Marine Mammal Science* **15:** 863-871.

Chapter Four

Vocalisations of common dolphins



Nicky on the main stage listening to the dolphins vocalisations.

ABSTRACT

The vocalisations and behaviour of two female common dolphins at Marineland, Napier were recorded simultaneously during nine 'Swim-with-Dolphin' (SWD) sessions. The frequency of occurrences of five types of vocalisations (Whistles, Clicks, Squeaks, Whines and Chirps) was examined before, during and after the SWD sessions. None of the five vocalisations changed in proportion during the three stages of the SWD sessions. The rate of calling, however, increased significantly throughout the SWD sessions, indicating a heightened state of activity. During two SWD sessions, 521 vocalisations and their accompanying behaviours were noted. Whistles occurred most often when a dolphin was approaching another and Clicks were associated with dolphins approaching objects, other dolphins and people. Squeaks were heard when a dolphin was leaving another or a swimmer. The most common vocalisation for dolphins more than two metres away from another dolphin was a Whine.

4.1 INTRODUCTION

Marine mammals rely on sound production for communication between members of a school. It is especially important in oceanic cetaceans such as the common dolphin *Delphinus delphis* because visual contact is not a reliable form of communication for them. It is also an effective method of communication within a school of dolphins, which can comprise over 10000 individuals (Dohl *et al.* 1986). Sounds are produced by all toothed cetaceans and vary from loud echolocation clicks, used to examine objects and find food (Goold 1996), to high pitched whistles, used to co-ordinate prey capture between members of the herd. Dolphins are thought to be intelligent because of their large brain (Morgane *et al.* 1986) and complex behaviour (Conner and Norris 1982; Würsig and Würsig 1979). Thus, studying dolphins will help in understanding cognition, social behaviour and welfare issues.

Vocalisations can be used as an indicator of an animal's behavioural state. Weary and Fraser (1995) demonstrated that certain animal signals reflect the signaller's condition, and thus can be useful in the assessment of its welfare. Two types of calls, 'Distress calls' and 'Alarm calls', have been well studied. Monitoring the frequency of these calls could therefore be a good measure of animal welfare.

When animals are in pain or distress their calling rate increases. These calls are termed 'Distress calls'. They are heard when piglets are castrated (Weary *et al.* 1998), during frustration in hens (Zimmerman and Koene 1998), while bottlenose dolphins *Tursiops truncatus* are ill (Lilly1963), and when bats *Pipistrellus pipistrellus* are restrained (Russ *et al.* 1998). 'Distress calls' may serve to initiate help from conspecifics.

The calls of animals that communicate the presence of danger are termed 'Alarm calls' (Macedonia and Evans 1993). Theses calls occur in vervet monkeys *Cercopithecus aethiops* to warn kin of immediate danger (Seyfarth *et al.* 1980) and bottlenose dolphins when exposed to a threatening stimulus (Caldwell *et al.* 1962). In Hector's dolphins *Cephalorhynchus hectori* these calls serve two purposes. They may startle or frighten the predator and they may alert any neighbour of the predators' presence (Dawson 1991).

The sounds produced by toothed whales have been divided into three main groups: pure-tone whistles, complex sounds and impulsive clicks (Popper 1980). Dolphin sounds have been described as blats, bleats, chirps, clicks, creaks, pulses, quacks, racs, rasps, squeals, squeaks, squawks, wails, groans, whines and whistles (MacKay and Liaw 1981). Most studies of cetacean acoustic communication have been done using captive dolphins and have concentrated on sounds in the range of human hearing.

The vocal activity of cetaceans changes with time of the day and behaviour. The overall mean vocalisation rate of the white whale *Delphinapterus leucas* was influenced by its behaviour. Vocalisation rate was higher during periods of social interaction than during directive swimming, resting or alarm situations. The total number of pulsed tones (including noisy vocalisations) emitted per whale/min varied with changes in behaviour. Fewer pulsed tones were emitted during alarm situations than during social interaction (Sjare and Smith, 1986).

The common dolphin *Delphinus delphis* communicates with high frequency modulated whistles (Caldwell and Caldwell 1968). The vocalisations of common dolphins have been classified into five whistle types; clicks and whistles paired with clicks (Evans 1987), squeaks, whines, beeps and barks. Busnel and Dziedzic (1966) established five whistle-types in their analysis of 80 signals recorded from common dolphins in the Mediterranean Sea. Moore and Ridgway (1995) categorised spectrograms of common dolphin vocalisations into eight whistle-types and four of those comprised 97% of any sample. These were four of the five whistle-types previously described by Caldwell and Caldwell (1968) and Busnel and Dziedzic (1966)

Acoustic communication of short-beaked common dolphins predominated during the early morning and late evening with minimum activity recorded during the midday period (Goold 2000). The predominant vocalisations produced by common dolphins in the wild were whistles. Goold (2000) suggests that common dolphins increase vocal communication at night either because they lack visual cues in the absence of sunlight or because the dolphins forage co-operatively at this time. Ohizumi (1998) noted diel patterns of prey abundance and feeding in the common dolphin. This supports Goold's (2000) idea that whistle production may increase during co-operative feeding activity. Clicks are important in prey capture. The repetition rate of dolphin clicks increases when they are hunting and capturing their quarry. The rhythm of clicks is also not steady, but is liable to be accelerated, especially while the animal is feeding (Vincent 1963).

Alarm calls have been reported in the bottlenose dolphin *Tursiops truncatus* as a fright response. Caldwell *et al.* (1962) describes a sound produced by bottlenose dolphins that was apparently a context-specific sound produced during fright. The sound consists of a loud, sharp 'crack' with a jarring impact on the listener's ear. The behaviour associated with this sound is typified by flight, tight schooling and hyper-excitability. The sound has a high (energy) volume at a low frequency and has a startling effect. An analysis of this vocalisation by bottlenose dolphins *Tursiops truncatus* has identified one pair of specific short (0.2 to 0.6 second) whistles that was consistently stimulated by physical distress (Lilly 1963).

The aim of this chapter is to investigate whether the vocalisations produced by the dolphins' changes during a Swim-with-Dolphin (SWD) programme. This will be determined by looking at the frequency of different vocalisation types, focusing on sounds audible to the human, and determining whether the dolphins produce the distress or alarm calls found in bottlenose dolphins (Lilly and Miller 1961; Caldwell *et al.* 1962). Specific vocalisations will also be investigated to see if there is a correlation between particular behaviours and vocalisations.

4.2 METHODS

Recordings of dolphin vocalisations took place at Marineland, Napier, New Zealand, during nine 'Swim-with-Dolphin' (SWD) sessions. The dolphins were held in the large main pool in front of the Grandstand (Figure 1.2).

Study Animals:

Two female common dolphins were recorded, Shona and Kelly (Table 1.1). It was not possible to identity which dolphin produced what vocalisation. Thus, one dolphin may have been more vocal than the other or there may have been differences in individuals vocal repertoire. However, it was technically too difficult to separate the sounds produced by each dolphin. It was also difficult to associate caller with behaviour in the videos. Therefore, associations were recorded only when the actual dolphin could be accurately identified. This was possible when one of the dolphins was playing on the bell as then, her head was out of the water, and the other dolphin was making the sound.

Data Collection:

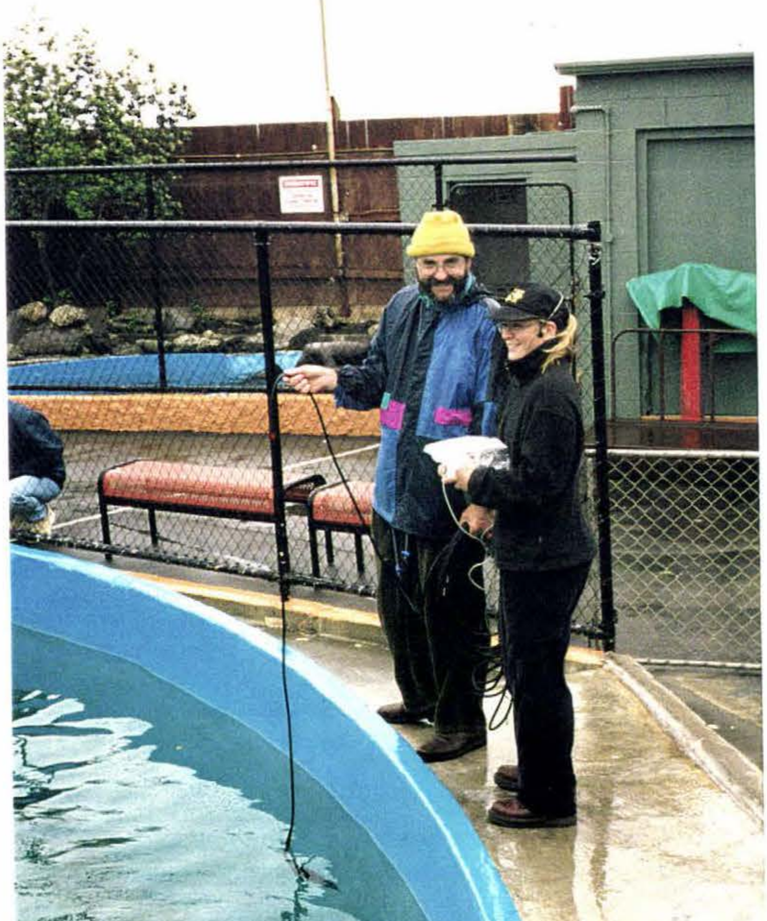
Vocalisations and behaviour were recorded sonically and visually using a Sonatech 8178 hydrophone linked to a Sony TCD D8 DAT walkman and a Panasonic S-VHS Movie video camera. The hydrophone and DAT recorder had sensitivity to frequencies in the range of 0.01 to 22 kHz. The dolphins were recorded before, during and after the 0800 h, 1200 h, 1500 h and 1545 h SWD sessions.

The SWD programme was the same as described in previous chapters (Section 1.3), but there were only two swimmers in a SWD session at one time (Appendix 1). The SWD sessions were half an hour in duration.

Dolphin vocalisations and behaviour were recorded for 10 minutes before a SWD session started, throughout the 30 minute SWD session and for 10 minutes after the SWD session.

Data Analysis:

The occurrence of five types of vocalisations (Whistles, Clicks, Squeaks, Chirps and Whines) was analysed. The vocalisations were examined using a computer based sound analysis programme, Canary (Charif *et al.* 1995). Sample spectrograms for each type of vocalisation are shown in Figures 4.1 - 4.5.



Kevin Stafford and myself testing the hydrophone. Photo taken by Ed Minot.

Figure 4.1 Spectrograms of 8 examples of Whistles:

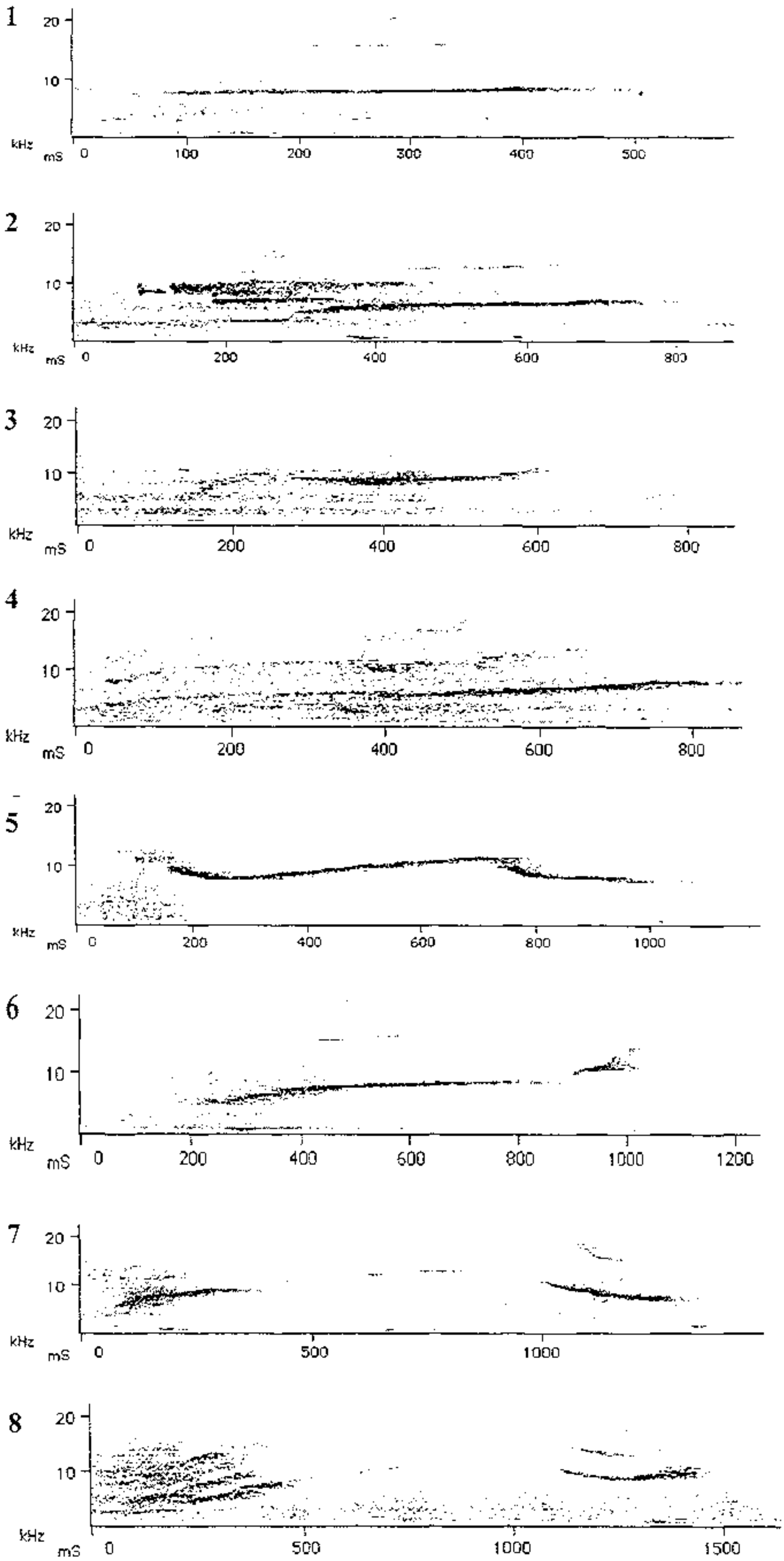


Figure 4.2 Spectrograms of 5 examples of Clicks:

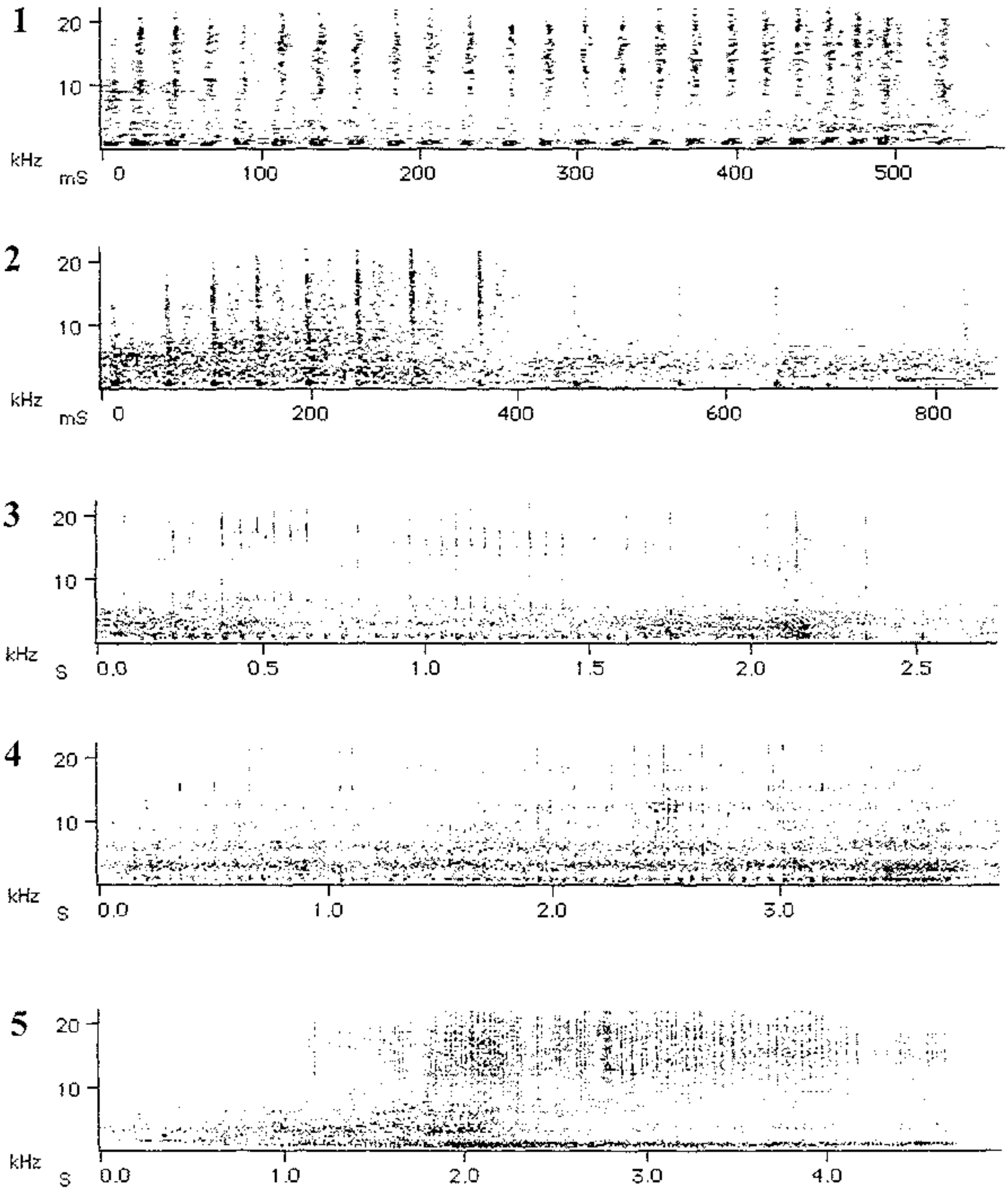


Figure 4.3 Spectrograms of 6 examples of Squeaks:

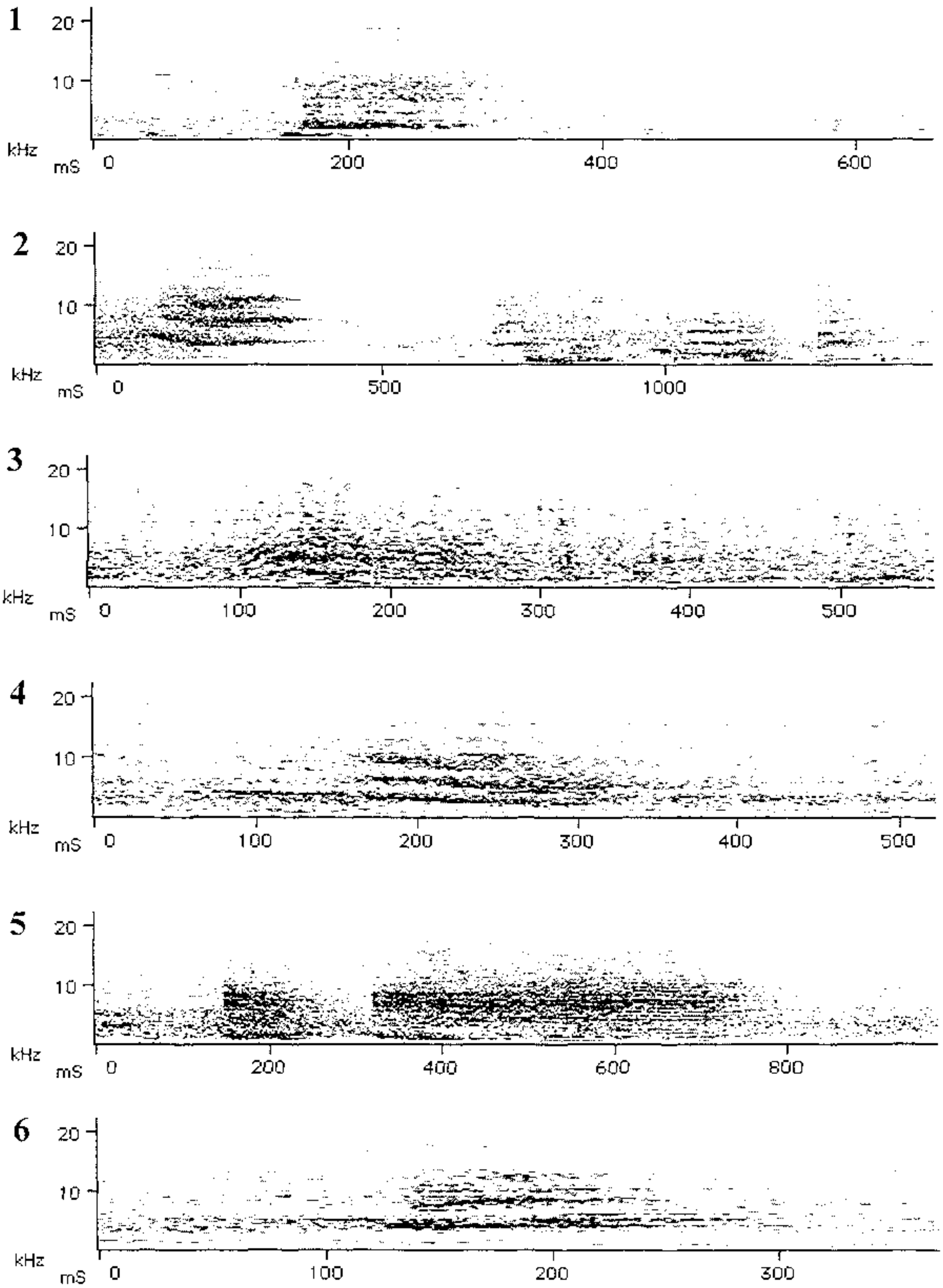


Figure 4.4 Spectrograms of 5 examples of Chirps:

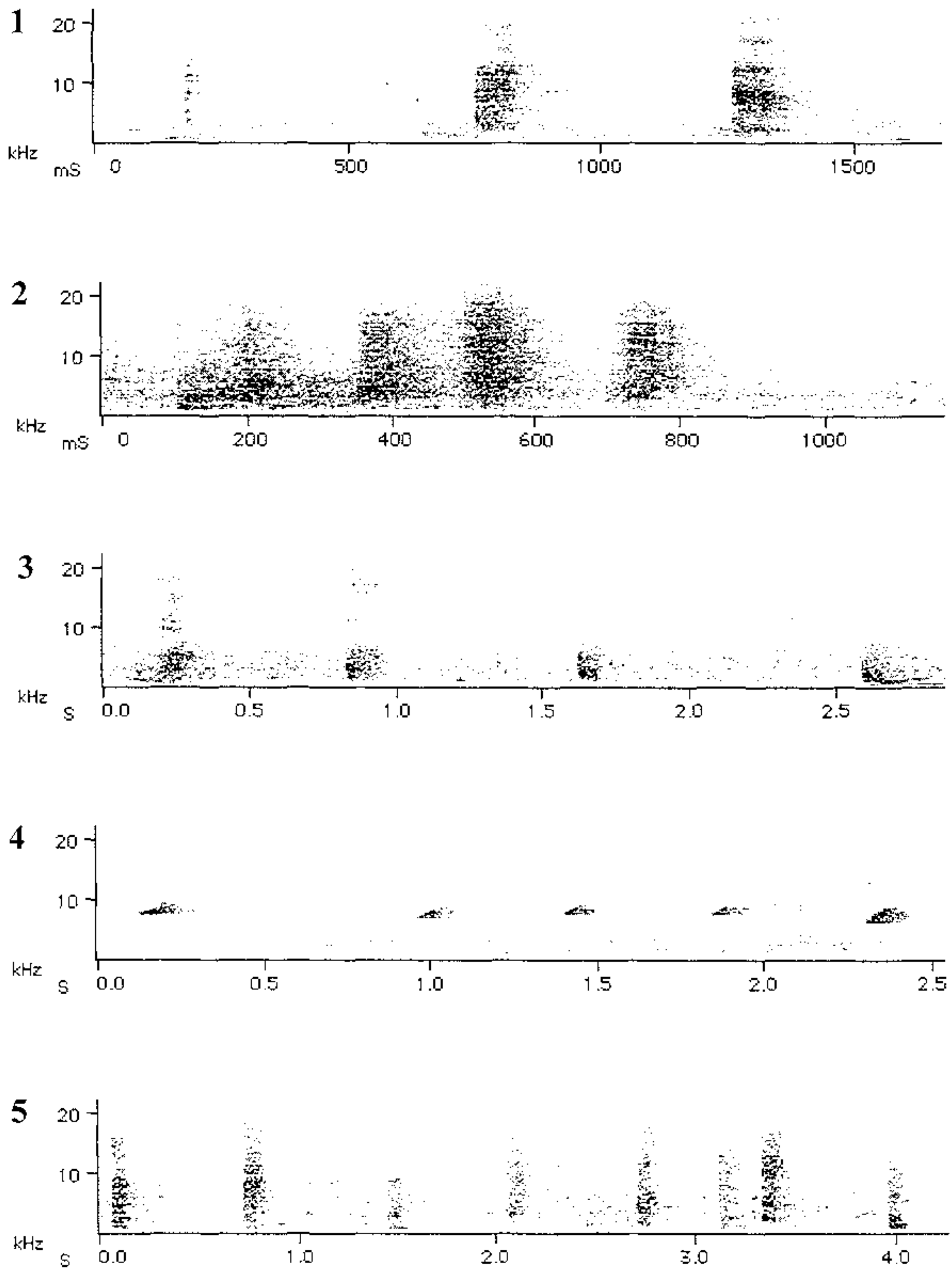
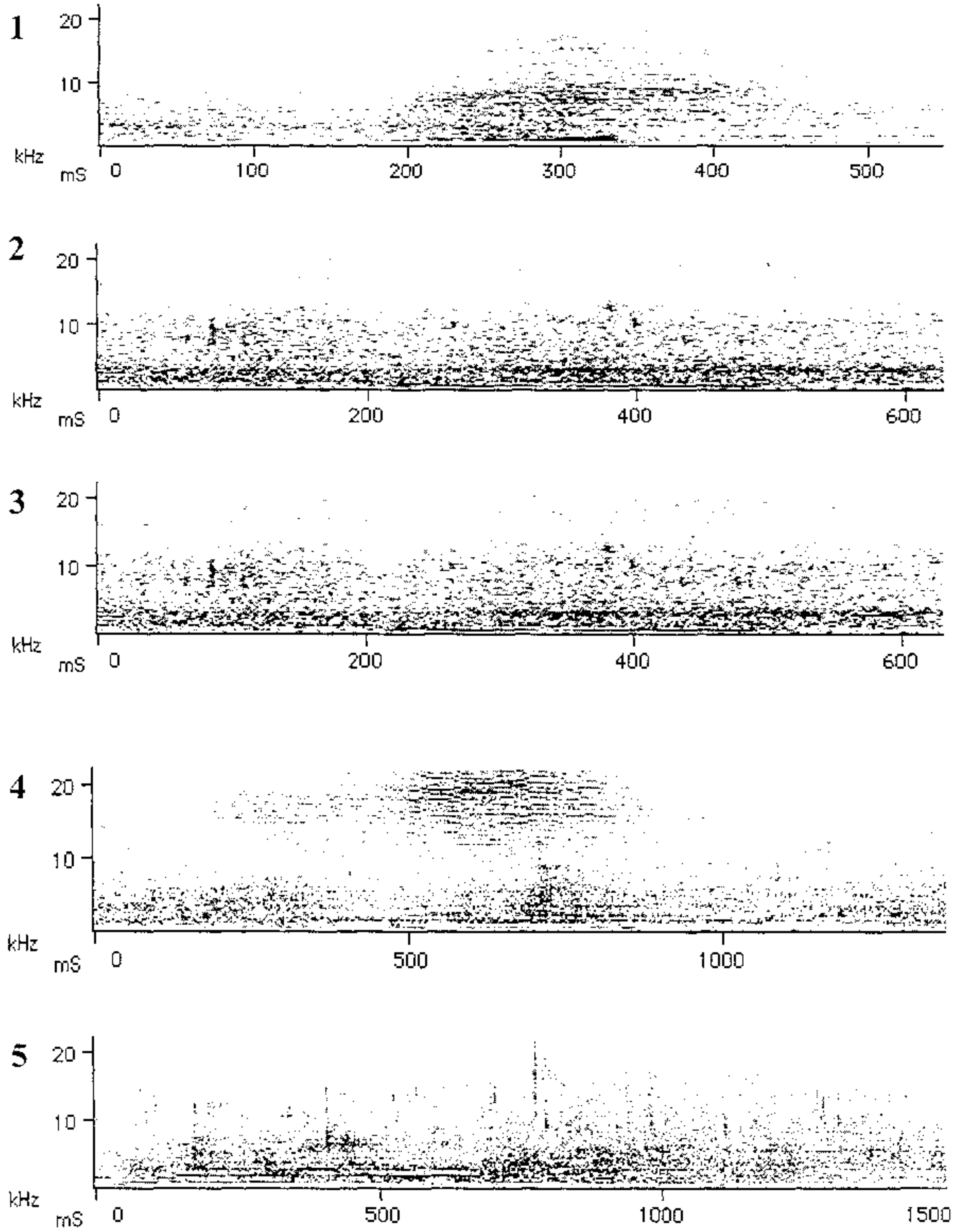


Figure 4.5 Spectrograms of 5 examples of Whines:



4.2.1 Vocalisations performed during different stages of SWD programmes.

Categorising the dolphins' vocalisations was difficult. Therefore, they were grouped into five broad types of vocalisation to reduce error, Whistles, Clicks, Chirps, Squeaks and Whines (Figures 4.1- 4.5).

The tapes for nine SWD sessions were examined and the frequency of occurrence of the five types of vocalisations were noted for the three stages of each SWD session. The stages were ten minutes before (B) a SWD session, 30 minutes during (D) a session and ten minutes after (A) a session.

The average frequency of occurrence of the five types of vocalisations were calculated for the three stages (BDA) of the SWD sessions. The frequency of the five vocalisation types was calculated during SWD sessions at 0800 h (three times), 1200 h (four times), 1500 h (once) and 1545 h (once). This was to determine if the dolphins had a period during the day when they were more vocal.

Logistic regression was used to examine whether the dolphins produced different vocalisations at different stages of SWD sessions and to identify whether the dolphins were more vocal at different times of the day.

4.2.2 Vocalisations performed and the associated behaviour.

Video footage for three SWD sessions was used to determine whether there was any association between specific behaviours and vocalisation. In all, 521 vocalisations were recorded. Vocalisations were only analysed if the dolphins' behaviour could also be examined concurrently. If the dolphins' behaviour could not be identified, the vocalisation was ignored. Four of the five types of vocalisations were analysed in this section, i.e. Clicks, Whistles, Squeaks, and Whines. The number of Chirps was insignificant and therefore was not included. The specific behaviours observed were categorised into 9 contexts: 1. Approaching swimmer, 2. Approaching a dolphin, 3. Approaching a dolphin at the bell, 4. Displace dolphin on the bell, 5. Approach hydrophone, 6. Leaving a dolphin, 7. Leaving a swimmer, 8. One metre of another dolphin, and 9. Dolphin by itself (more than two metres away from another dolphin).

The percentage of the four vocalisation types was determined for each of the behavioural contexts. The data were then tested using a logistic regression to examine if specific behaviours were associated with any vocalisation. The statistical package SAS was used (SAS Institute Inc. 1989). A correspondence analysis was used to examine the extent to which specific vocalisations occurred with specific behaviours.

4.3 RESULTS

4.3.1 Vocalisations performed during different stages of SWD programmes:

Clicking was the predominant dolphin vocalisation during all stages of a SWD programme (Figure 4.6). The number of clicks was twice the number of other vocalisation types ($F_{4,105} = 27.3$, $P < 0.0001$). The total number of vocalisations was greater After than Before a SWD session ($F_{1,105} = 4.4$, $P = 0.04$). The relative proportions of the five vocalisation types did not change throughout a SWD session (Figure 4.1, $F_{8,105} = 0.3$, $P = 1.0$). Vocal activity appeared to heighten, i.e. increase in number as a SWD session progressed and continued to increase after a SWD session. ($F_{1,105} = 4.9$, $P = 0.03$).

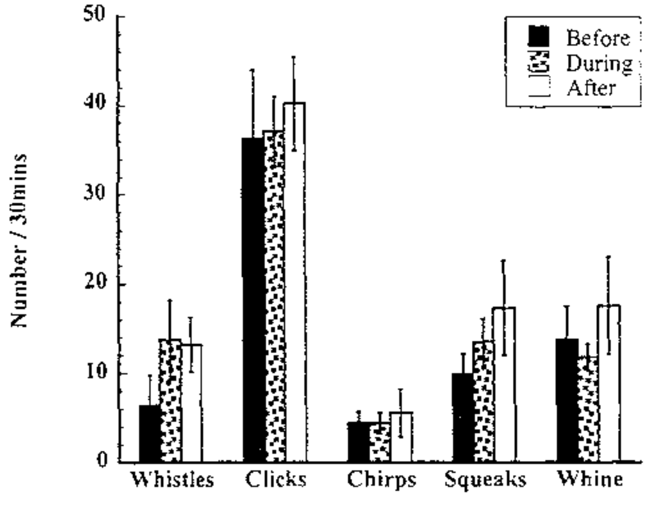


Figure 4.6 Average number of the five types of vocalisations for the three stages in SWD sessions (Bars = SE).

4.3.2 Vocalisations performed during sessions at different times of the day:

The frequency of whistles and chirps was highest in the 1545 h session. However, without replication, it is impossible to test the significance of this observation. There was only a weak tendency for a change in the distribution of vocalisation types between different SWD session times (Figure 4.7, $F_{12,105} = 1.6$, $P = 0.1$).

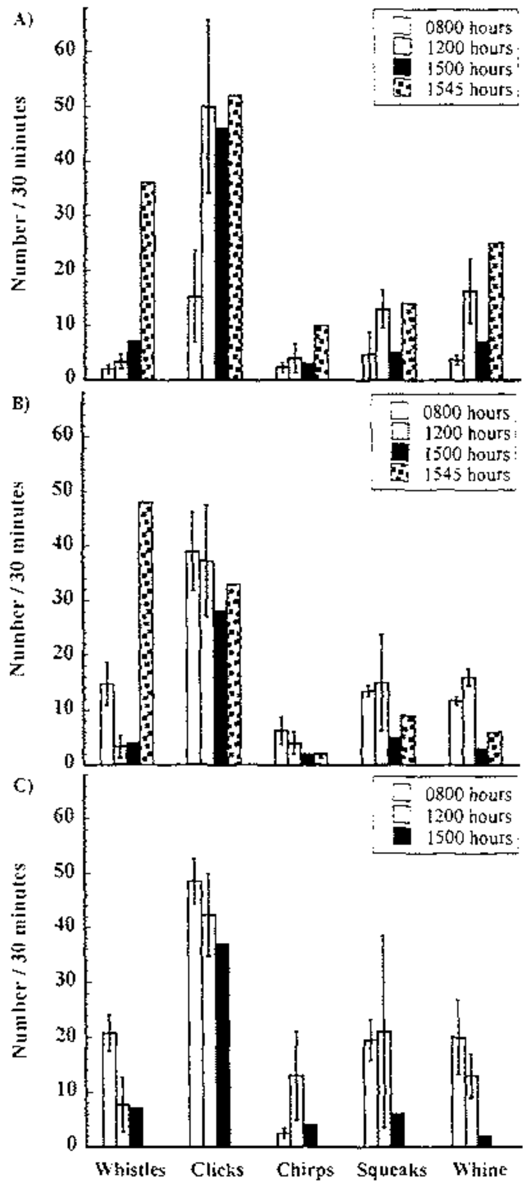


Figure 4.7 Frequency of occurrence of each type of vocalisation by the dolphins Before (A), During (B) and After (C) SWD sessions at different times of the day 0800 h, 1200 h, 1500 h and 1545 h (Bars = SE).

4.3.3 Vocalisations performed and the associated behaviour.

Four types of vocalisations were recorded during the video taping sessions. Of the four types of vocalisations, Clicks was the most common, occurring while dolphins performed all nine behaviour groups. A dolphin produced a lot more of all four types of vocalisation when it was by itself (more than 2 metres away from another dolphin).

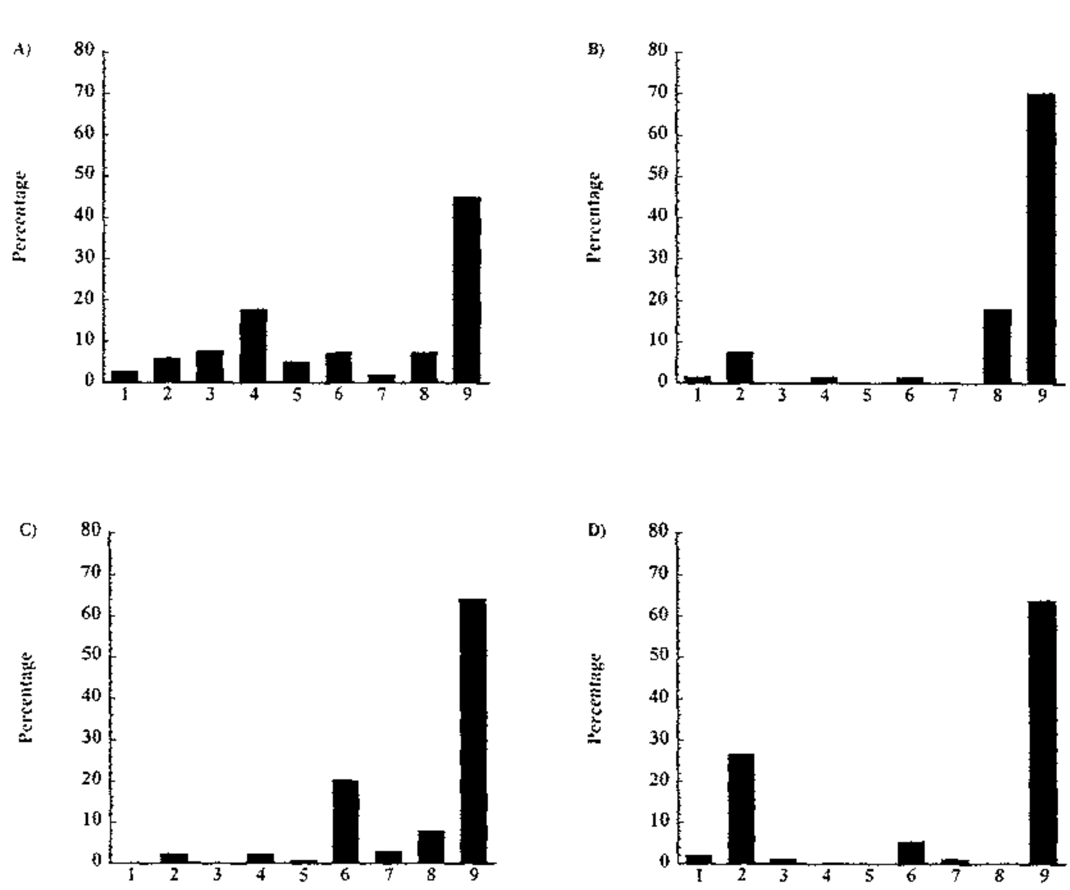


Figure 4.8 Percentage of the nine behaviours performed in association to four types of vocalisations. The behaviours are: 1. Approaching swimmer, 2. Approaching a dolphin, 3. Approaching a dolphin at the bell, 4. Displace dolphin on the bell, 5. Approach hydrophone, 6. Leaving a dolphin, 7. Leaving a swimmer, 8. One metre from another dolphin, and 9. Dolphin by itself. The vocalisations are: A) Clicks, B) Whines, C) Squeaks, and D) Whistles.

Certain vocalisations were closely associated with specific behaviours (Appendix 3, Table 4.2; Figure 4.8). Correspondence analysis shows that when dolphins approached one another they Whistled and when they left the other dolphin they Squeaked (Figure

4.9). Clicks were most likely to be heard when a dolphin approached an object, be it a dolphin, swimmer or the hydrophone. A dolphin swimming by itself produced all vocalisations but it was most likely to whine (Figure 4.9).

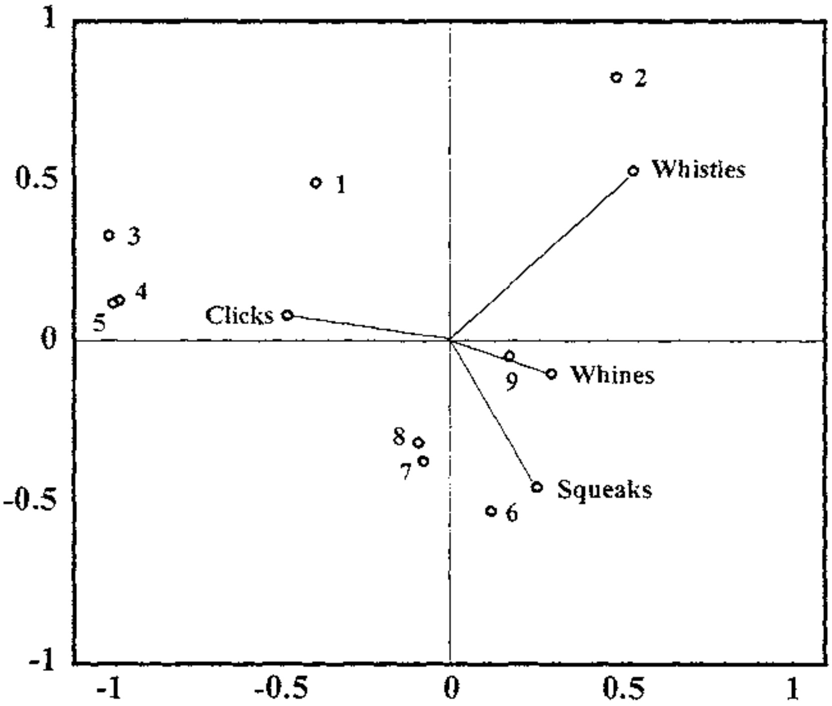


Figure 4.9 A correspondence analysis of behaviours and their associated vocalisations. The behaviours observed were 1. Approaching swimmer, 2. Approaching a dolphin, 3. Approaching a dolphin at the bell, 4. Displace dolphin on the bell, 5. Approach hydrophone, 6. Leaving a dolphin, 7. Leaving a swimmer, 8. One metre from another dolphin, and 9. Dolphin by itself (more than two metres away from another dolphin).

4.3 DISCUSSION

In stressful situations many animals have been reported to perform 'alarm' or 'distress' calls (Seyfarth *et al.* 1980; Kiley 1972). Caldwell *et al.* (1962) first documented alarm calls in captive bottlenose dolphins *Tursiops truncatus*. The sound was apparently inaudible out of the water, but it was heard clearly on underwater listening equipment.

Lilly (1963) reports another specific vocalisation that was associated with physical distress. Neither of these sounds was heard while examining the vocalisations of the common dolphins at Marineland during SWD sessions.

As discussed earlier, vocalisations are possible indicators of distress. This is seen in the response of piglets' to castration (Weary *et al.* 1998), the response of cattle to branding (Schwartzkopf-Genswein *et al.* 1998), and the response of sheep to castration and docking (Mellor and Murray 1989). The dolphins did not appear to perform any alarm or distress calls as seen in bottlenose dolphins, indicating they were not alarmed or in distress during SWD sessions.

The examination of the changes dolphin vocalisations during SWD sessions may indicate what physiological state the dolphins are in, for example, young squirrel monkeys *Saumiri sciureus* in distress exhibit heightened vocalisations, activity and increases cortisol levels (Levine 1983). However, no significant difference was found between types of vocalisations performed by the dolphins at different stages of SWD sessions. This suggests the dolphins are not distressed by the presence of swimmers. However, the overall frequency of all types of calls increased slightly thoughout the sessions. This is indicative of a heightened mental state.

The vocalisations performed by the common dolphins at Marineland have the same diel vocal pattern as common dolphins in the wild (Ohizumi 1998). The dolphins increased whistle production in anticipation of feeding as documented in many dolphin species, including dusky dolphin *Lagenorhynchus obscurus* (Barr 1997) and short-beaked common dolphin *Delphinus delphis* (Goold 2000).

The vocalisations of the dolphins at Marineland were predominantly Clicks. Dawson (1991) found a significant difference in the usage of Click types, with more complex sounds being used in larger groups of Hector's dolphins *Cephalorhynchus hectori*, suggesting that these sounds have social significance. The common dolphins in this study were found to produce Clicks in all behaviour contexts, but they appeared to have the greatest importance during dolphin interactions. Whistles were heard most often when one dolphin approached another. Squeaks and Whines were commonly heard when one dolphin left another dolphin, a swimmer, or the hydrophone or when it was by itself.

Free-ranging Atlantic spotted dolphins *Stenella frontalis* in Bahamian waters vary their vocalisation type significantly with behavioural activity, group type, and age group. Whistles and Chirps were observed mostly during social and play activity, and Click trains during foraging and searching the environment. Spotted dolphins use vocal, visual, and tactile pathways for signal exchange. Behaviours and vocal signals are used concurrently, apparently to maximize or enhance a message (Dudzinski 1998).

The structure of dolphin vocalisations may explain their purpose and their association to specific behaviours. These results suggest that Clicks are the most important vocalisation as they are a form of echolocation. They occur in many situations and may be the basis of a complex language. Clicks are used to assess the environment and search for food. Clicks were the most predominant vocalisation. They are especially intense during displacement interactions, e.g. displacing a dolphin from the bell, and may serve as a form of aggression.

In common dolphins, there is a large number of different whistle types with significantly different structures. Whistles appear to be a form of complex communication and are especially prevalent during states of excitement. Whistles were rarely heard during 0800 h sessions and 1200 h sessions. The frequency of Whistles increased significantly in anticipation of feeding, becoming the predominant vocalisation immediately before and during feeding. Whistles were heard when dolphins approached one another and ceased once they joined up, with the dolphins either becoming quiet or producing Click trains subsequently. As with Hector's dolphins (Dawson 1991), there was no evidence of a specific vocalisation occurring with only one behaviour.

The most common vocalisation after a click, was the Whine. A dolphin swimming at a distance from the other dolphin, who was at the bell, quite often produced a Whine. It was a quiet sound that appeared to have no structure to it and was very repetitive. This sound did not initiate any behaviour change by the other dolphin and wasn't caused by an interaction or as a response to the other dolphins' behaviour.

The dolphins at Marineland don't exhibit any significant changes in vocalisations in response to the SWD programme. Throughout the duration of the study no 'distress' or 'alarm' calls were heard. The correspondence analysis suggests that some vocalisations are most likely to occur during specific behavioural activities. Vocalisation responses suggest no distress is experienced by the dolphins during SWD sessions.

4.4 REFERENCES

Barr, K. 1997. *The impacts of marine tourism on the behaviour and movement patterns of dusky dolphins* (Lagenorhynchus obscurus) *at Kaikoura, New Zealand.* Unpublished thesis, University of Otago, Dunedin.

Busnel, R. G. and A. Dziedzic. 1966. Acoustic signals of the pilot whale, *Globicephala melaena* and of the porpoises *Delphinus delphis* and *Phocoena phocoena.* In: *Whales, dolphins and porpoises.* K. S. Norris (ed.). University of California Press, Los Angeles. p. 607-646.

Caldwell, M. C., R. M. Haugen and D. K. Caldwell. 1962. High-Energy sound associated with fright in the dolphin. *Science* **138:** 907-908.

Caldwell, M. C. and D. K. Caldwell. 1968. Vocalisation of naive captive dolphins in small groups. *Science* **159:** 1121-1123.

Charif, R. A., S. Mitchell, and C. W. Clark. 1995. *Canary 1.2 user's manual.* Cornell Laboratory of Ornithology, Ithaca, New York.

Connor, R. C. and K. S. Norris. 1982. Are dolphins reciprocal altruists? *The American Naturalist.* **119:** 358-374.

Dawson, S. M. 1991. Clicks and communication: the behavioural and social contexts of Hector's dolphin vocalisations. *Marine Mammal Science* **88:** 265-276.

Dohl, T. P., M. L. Bonnell, and R. G. Ford. 1986. Distribution and abundance of common dolphin, *Delphinus delphis,* in the southern California Bight: a quantitative assessment based upon aerial transect data. *Fisheries Bulletin, US.* **84:** 333-343

Duszinski, K. M. 1998. Contact behavior and signal exchange in Atlantic spotted dolphins (*Stenella frontalis*). *Aquatic Mammals* **23:** 129-142.

Evans, P. G. H. 1987. *The natural history of whales and dolphins.* Christopher Helm, London.

Goold, J. C. 1996. Acoustic assessment of populations of common dolphin *Delphinus delphis* in conjunction with seismic surveying. *Journal of Marine Biological Association U. K.* **76:** 821-824.

Goold, J. C. 2000. A diel pattern in vocal activity of short-beaked common dolphins, *Delphinus delphis*. *Marine Mammal Science* **16:** 240-244.

Kiley, M. 1972. The vocalisations of ungulates, their causation and function. *Zeitschrift für Tierpsychologie* **31:** 171-222.

Levine, S. 1983. Coping: an overview. In: *Biological and psychological basis of psychosomatic disease.* H. Ursin and R. Murison (eds.). Pergamon Press, Oxford. p.15-26

Lilly, J. C. and M. A. Miller. 1961. Sounds emitted by the bottlenose dolphin. *Science* **213:** 1689-1692.

Lilly, J. C. 1963. Distress call of the bottlenose dolphin: stimuli and evoked behavioral responses. *Science* **139:** 116-118.

MacKay, R. S. and H. M. Liaw. 1981. Dolphin vocalization mechanisms. *Science* **212:** 676-678.

Macedonia, J. M. and C. S. Evans. 1993. Variation among mammalian alarm call systems and the problem of meaning in animal signals. *Ethology* **93:** 177-197.

Mellor, D. J. and L. Murray. 1989. Effects of tail docking and castration on behaviour and plasma cortisol concentrations in young lambs. *Research in Veterinary Science* **46:** 387-391.

Moore, S. E. and S. H. Ridgway. 1995. Whistles produced by common dolphins. *Aquatic Mammals* **21:** 55-63.

Morgane, P. J., M. S. Jacobs and A. Galaburda. 1986. Evolutionary morphology of the dolphin brain. In: *Dolphin cognition and behaviour*. R. J. Schusterman, J. A. Thomas and F. G. Wood (eds.). Lawrence Erlbaum Assoc., Hillsdale. p. 5-29.

Ohizumi, H. 1998. Stomach contents of common dolphins (*Delphinus delphis*) in the pelagic Western North Pacific. *Marine Mammal Science* **14:** 835-844.

Popper, A. N. 1980. Sound emission and detection by Delphinids. In: *Cetacean Behavior*. L. M. Herman (ed.). John Wiley and Sons Inc., New York. p. Chapter One.

Russ, J. M., P. A. Racey and G. Jones. 1998. Intraspecific responses to distress calls of the pipistrelle bat, *Pipistresllus pipistrellus*. *Animal Behaviour* **55:** 705-713.

SAS Institute Inc. 1989. *SAS/STAT User's guide*. Version 6, Fourth Edition, Volume 2, SAS Institute Inc., Cary, NC.

Schwartzkopf-Genswein, K. S., J. M. Stookey, T. G. Crowe and B. M. Genswein. 1998. Comparison of image analysis, exertion force, and behavior measurements for use in the assessment of beef cattle responses to hot-iron and freeze branding. *Journal of Animal Science* **76:** 972-979.

Seyfarth, R. M., D. L. Cheney and P. Marler. 1980. Monkey responses to three different alarm calls: Evidence of predator classification and semantic communications. *Science* **210:** 801-803.

Sjare, B. L. and T. G. Smith. 1986. The relationship between behavioural activity and underwater vocalizations of the white whale, *Delphinapterus leucas*. *Canadian Journal of Zoology* **64:** 2824-2831.

Vincent, F. 1963. Signals for auto-information or echolocation. In: *Acoustic Behaviour of Animals*. R. G. Busnel (ed.). Elsevier Publishing Company, Amsterdam. p. 183-225.

Weary, D. M. and D. Fraser. 1995. Signalling need: costly signals and animal welfare. *Applied Animal Behaviour Science* **44:** 159-169.

Weary, D. W., L. A. Braithwaite and D. Fraser. 1998. Vocal response to pain in piglets. *Applied Animal Behaviour Science* **56:** 161-172.

Würsig, B. and M. Würsig. 1979. Behavior and ecology of the bottlenose dolphin, *Tursiops truncatus*, in the south Atlantic. *Fishery Bulletin* **77:** 399-412.

Zimmerman, P. H. and P. Koene. 1998. The effect of frustrative non-reward on vocalisations and behaviour in the laying hen, *Gallus gallus domesticus*. *Behavioural Processes* **44:** 73-79.

Chapter Five

Thesis summary

Shona and Selina……..enjoying an intimate moment

5.1 CONCLUSIONS

The least invasive method of assessing dolphin welfare is to study their behaviour. Previous studies examining the impacts of Swim-with-Dolphin (SWD) programmes on the bottlenose dolphins *Tursiops truncatus* have all looked at behavioural responses. This study examines both behavioural and vocal responses of common dolphins *Delphinus delphis* to the SWD programme. The use of a refuge, behavioural changes, surfacing frequency, surfacing location and changes in types of vocalisation produced by the dolphins were monitored to assess effects of the SWD programme on the common dolphins.

The use of the 'Refuge area' by the common dolphins at Marineland was quite different from that observed for bottlenose dolphins in SWD programmes in the USA. Four SWD programmes, at Dolphin Plus (DP), Dolphin Quest (DQ), Dolphin Research Centre (DRC) and Theatre of the Seas (TOTS) were examined by Samuels and Spradlin (1995). Bottlenose dolphins used the refuge area significantly more during free time than during SWD sessions (Samuels and Spradlin 1995) whereas, the common dolphins at Marineland increased their use of the 'Refuge area' significantly during the SWD sessions. This suggests that the dolphins at Marineland have learnt that this area is safe and use it to avoid the swimmers. However, because the common dolphins continue to use the whole pool during SWD sessions, it indicates they may not be using the refuge area in a 'flight' response but because it gives them more space. The common dolphins appeared to be uninterested in the swimmers during SWD sessions.

The behaviours and vocalisations of the common dolphins changed little during the SWD sessions, giving no indication of distress. The typical behavioural stress responses are fight, flight or freeze response (Cannon 1935) and an increase in aggressive and submissive behaviour and avoidance (Frohoff 1993). The dolphins at Marineland increased Touch and Other behaviour during SWD sessions and decreased Aggressive, Submissive and Play behaviour. In contrast the bottlenose dolphins in the SWD programme at Dolphin Plus (Florida, United States), increased Agonistic (Aggressive) and Sexual (Touch) behaviour. However, in other SWD programmes in the USA, there were no significant differences in behaviour except an increase in Submissive behaviour during SWD sessions.

The dolphins at Marineland increased Touch behaviour (Sexual behaviour) during SWD sessions. Sweeny (1990) maintains that excess sexual activity found in captive dolphins is due to understimulation. Therefore, it is possible the swim programme did not provide adequate stimulation.

The common dolphins' surfacing frequency increased slightly and they surfaced more in the 'Refuge area' than in the 'Main swimmer area' during SWD sessions. Surfacing frequency has not been studied in bottlenose dolphins during SWD programmes. However, it has been examined in whales responding to ship traffic and their surfacing frequencies decreased during those disturbances indicating avoidance (Richardson and Würsig 1997). The common dolphins may have increased surfacing frequency to keep an eye on the swimmers who spent the majority of the time on the surface. Surfacing may be an indication of respiration rate, and increased respiration is an indicator of stress. Therefore, increased surfacing frequency may be an indicator of stress.

The vocalisations of Marineland common dolphins gave no indication of distress. The proportion of specific vocalisation types did not change significantly before, during and after the SWD sessions. However, the time of day had an effect on vocalisations. Whistles were most often heard during the 1500 h session, before feeding.

Many vocalisations were closely associated with specific behaviours. Clicks were associated with nearly all behaviour groups, but were heard most often when dolphins approached objects. Whistles stimulated an interaction between individuals and Chirps occurred when one dolphin left another dolphin. These findings are similar to those reported for free-ranging Atlantic spotted dolphins *Stenella frontalis* in Bahamian waters (Dudzinski 1998).

There was no evidence of distress caused by the SWD programme. The dolphins did not exhibit any behavioural or vocal changes that indicate distress. Other activities at Marineland, such as pool cleaning, feeding and veterinary checks have had a far greater effect on dolphin behaviour than the SWD sessions. By comparing the behaviour of the dolphins during these activities, to SWD sessions, the effects of the programme can be put into perspective. The dolphins' behavioural responses to SWD sessions were very subtle. In contrast, the dolphins response to veterinary visits and to feeding is very obvious. The typical response of the dolphins to veterinary visits is avoidance and aggressive tail slaps, accompanied by harder, more frequent breathing (Gary MacDonald *pers. comm.* 2000).

The common dolphins at Marineland have probably habituated to swimmer interactions as a result of spending the last 25 years in captivity. Repeated human interactions and handling has been shown to cause habituation and to reduce the physiological stress response in many species, such as kiwi (Dominic Adams *pers. comm.* 2000) and penguins (Fowler 1999).

5.2 LIMITATIONS

This study was an observational study of dolphins' behavioural responses to the SWD programme and an examination of behavioural indicators of stress. There are other methods for assessing animal welfare, such as monitoring physiological responses, reproductive success and health. Physiological measures require invasive procedures that are not always feasible. These procedures themselves may cause distress that alters the physiological response and thereby interfere with the true stress response. Interpretation of corticosteroid levels and heart rate as indicators of stress in the dolphins may be difficult.

Several features of this study make it difficult to generalise about the welfare of other dolphins in a SWD programme. The study animals are old and have been in captivity for most of their lives. They are all female and the sample size is only three. To reach conclusions about common dolphins in general I would require more animals of different sex and ages.

A comparison of wild and captive common dolphin behaviour may also be beneficial. This is because the captive dolphins may be exhibiting behaviours that are not normally seen at that time or at all. The behaviour of wild animals is often used as a bench-mark by which the welfare of captive animals can be assessed (Heidiger 1950; Chamove and Anderson 1989; Fraser and Broom 1990). It has been commonly assumed that if animals don't perform behaviours that are seen in wild animals, their welfare has been compromised (Carlstead 1996; Mench and Kreger 1996). However, homeostatic models of motivation suggest that many behaviours are stimulus driven rather than internally generated (Veasey *et al.* 1996). That is, behaviours that occur in wild animals occur because of an external stimulus and without that stimulus they would not be naturally exhibited.

The presence of stereotypies is thought to be an accurate indicator of poor animal welfare. In dolphins it is difficult to define stereotypies. Gygax (1993) describes how difficult it was to class particular behaviours in dolphins as stereotypic. Some behaviours performed by the dolphins could be interpreted as stereotypies. For example, one common stereotypic behaviour is the repetitive use of a line or path. However, defining a line or path for dolphins is very difficult because a path or line is not physically etched into the ground. Nevertheless, some behaviours, such as head pressing by dolphins when placed in small pools, are quite easily defined as stereotypic (Greenwood 1977).

Another possible stereotypy seen in dolphins, and one common to many captive animals, is an anticipatory, appetitive behaviour as seen in pigs (Rushen 1984) and carnivores (Kleiman *et al.* 1996). Dolphins rapidly increase their swimming speed, porpoising and constructing large oblong circles before feeding. Marineland reduced the chances of the development of stereotypies by introducing a variety of interesting and stimulating devices to the dolphins' pool and by having training sessions. These include beach balls and seaweed. Little herrings are also often released into the pool, water jets are squirted into the pool creating bubbles for the dolphins to play in, and play/feeding times are extended.

The findings in this behavioural study suggest the dolphins are not distressed by the SWD programme. However, the research protocols were restricted by unavoidable management practices. Future research should focus on expanding the protocols to test a few hypotheses revealed in this study. Future studies should control the number of swimmers, behaviour of swimmers, location, size and shape of the refuge area, length of the sessions and location of the bell to reveal the actual dolphin response to swimmers. It may answer the following question: are the dolphins using the refuge area during SWD sessions because there is more space or to avoid swimmers?

Pending further research, the most reasonable conclusions from this study is that the current SWD programme at Marineland, Napier, causes no, or very little, distress to the common dolphins participating in it.

5.3 REFERENCES

Cannon, W. 1935. Stresses and strains of homeostasis. *American Journal of Medical Science* **189:** 1-14. [Original not seen, cited in Carlstead 1996]

Carlstead, K. 1996. Effects of captivity on the behaviour of wild mammals. In: *Wild mammals in captivity: Principles and techniques.* D. G. Kleiman, M. E. Allen, K. V. Thompson and S. Lumpkin (eds.). The University of Chicago Press, Chicago. p.317-333

Chamove, A. S. and J. R. Anderson. 1989. Examining environmental enrichment. In: *Housing, care and psychological well-being of captive and laboratory primates.* E. F. Segal (ed.) E F Noyes Publications, Park Ridge, USA.

Duszinski, K. M. 1998. Contact behavior and signal exchange in Atlantic spotted dolphins (*Stenella frontalis*). *Aquatic Mammals* **23:** 129-142.

Fowler, G. S. 1999. Behavioral and hormonal responses of Magellanic penguins *Spheniscus magellanicus* to tourism and nest site visitation. *Biological Conservation* **90:** 143-149.

Fraser, A. F. and D. M. Broom. 1990. Farm animal behaviour and welfare. Baillière Tindall, London.

Frohoff, T. G. 1993. *Behavior of captive bottlenose dolphins* (Tursiops truncatus) *and humans during in-water interactions*. Unpublished thesis, Texas A and M University, Texas.

Greenwood, A. G. 1977. A stereotyped behaviour pattern in dolphins. *Aquatic Mammals* **5:** 15-17.

Gygax, L. 1993. Spatial movement patterns and behaviour of two captive bottlenose dolphins (*Tursiops truncatus*): absence of stereotyped behaviour of lack of definition? *Applied Animal Behaviour Science* **38:** 337-344.

Hediger, H. 1950. *Wild animals in captivity.* Dover Publications, Inc., New York.

Kleiman, D. G., M. E. Allen, K. V. Thompson and S. Lumpkin. 1996. *Wild mammals in captivity: principles and techniques.* The University of Chicago Press, Chicago.

Mench, J. A. and M. D. Kreger. 1996. Ethical and welfare issues associated with keeping wild mammals in captivity. In: *Wild mammals in captivity: principles and techniques.* D. G. Kleiman, M. E. Allen, K. V. Thompsom, S. Lumpkin and H. Harris (eds.). The University of Chicago Press, Chicago. p. 5-15.

Richardson, W. J. and B. Würsig. 1997. Influences of man-made noise and other human actions on cetacean behaviour. *Marine and Freshwater Behavioural Physiology* **29:** 183-209.

Rushen, J. 1984. Stereotyped behaviour, adjunctive drinking and the feeding periods of tethered sows. *Animal Behaviour* **32:** 1059-1067.

Samuels, A. and T. Spradlin. 1995. Quantitative behavioral study of bottlenose dolphins in the Swim-With-Dolphin programs in the United States. *Marine Mammal Science* **11:** 520-544.

Sweeny, J. C. 1990. Marine mammal behavioral diagnostics. In: *CRC Handbook of marine mammal medicine: health, disease and rehabilitation.* L. A. Dierauf (ed.). CRC Press, Boca Raton, Florida.

Veasey, J. S., N. K. Waran and R. J. Young. 1996. On comparing the behaviour of zoo housed animals with wild conspecifics as a welfare indicator. *Animal Welfare* **5:** 13-24.

Appendices

APPENDIX 1

Rules of the 'Swim-With-Dolphin' programme:

Marinelands rules for the 'Swim-With-Dolphin' programme, established with the help of the Department of Conservation (DoC):

1. No one may swim with the dolphins who has:
   - A) A respiratory disease, or on medication that suppresses immune function.
   - B) Open sores or other outward signs of illness.
2. Any swim participant who restrains, pulls, or grabs at the dolphins will immediately be removed from the swim session.
3. Participants must be advised that there is some potential risk of injury or disease transmission.
4. Shower facilities must be provided - DoC recommend showering with soap and water prior to and after the swim.
5. No more than one swimmer per dolphin in the pool at any time.
6. No one under the age of five years may participate in the swim programme.
7. No smoking and /or drinking alcohol in the pool area.
8. No jumping or diving into the pool.
9. No unaccompanied children are permitted into the swim area.
10. No hair ties or clips to be worn in the pool.
11. The northern end of the pool (marked by flags) is out of bounds to all swim participants: it is a dolphin only zone (Refuge area).
12. SCUBA divers: must be fully certified to use their equipment at Marineland.
13. Balls are not to be thrown directly at the dolphins or played with outside of the pool.
14. The swimmers must not touch or ring the bell.

OHS warning: do not run around the perimeter of the dolphin pool.

There can be up to eight people booked into a swim session, as long as rule 5 is obeyed.

APPENDIX 2

Chapter Three – Tables with SAS output

Table 3.1 General Linear Model, SAS output, on the use of the 'Refuge Area' by the common dolphins at Marineland.

Source * = interaction	**NDF**	**DDF**	**F Value**	**Pr > F**
Dolphin	2	140	5.1	0.008
Time of Day (TD)	2	140	2.4	0.09
Before, During, After (BDA)	2	140	64.5	0.0001
BDA * Dolphin	4	140	0.6	0.7
TD * BDA	4	140	0.7	0.6

Table 3.2 General Linear Model, SAS output, on the behaviour changes of the common dolphins at Marineland during three stages of the SWD sessions at different times of the day.

Source * = interaction	**NDF**	**DDF**	**F Value**	**Pr > F**
Dolphin	2	898	1.1	0.3
Before, After Vs During (BAvsD)	1	898	1288.9	0.0001
Before, After, During (BDA)	1	898	23.2	0.0001
Time of Day (TD)	2	898	12.3	0.0001
Behaviour	5	898	495.2	0.0001
Behaviour * BAvsD	5	898	12.4	0.0001
Behaviour * BDA	5	898	2.7	0.02
TD * Behaviour	10	898	3.5	0.0001
TD * BAvsD	2	898	6.4	0.002
Dolphin * Behaviour	10	898	4.1	0.0001
Dolphin * BAvsD	2	898	6.3	0.002
Dolphin * Behaviour * BAvsD	10	898	0.5	0.9

Table 3.3 General Linear Model, SAS output, on the use of the surfacing location of the common dolphins at Marineland during two types of SWD sessions.

Source * = interaction	**NDF**	**DDF**	**F Value**	**Pr > F**
Dolphin	2	144	2.6	0.08
Time of Day (TD)	2	144	8.2	0.0004
Type of Session (ToS)	1	144	3.7	0.06
Surface Location (SL)	1	144	88.7	0.0001
Dolphin * ToS	2	144	0.6	0.6
Dolphin * SL	2	144	2.7	0.07
Dolphin * TD	4	144	0.9	0.5
TD * ToS	2	144	3.7	0.03
TD * SL	2	144	1.2	0.3
ToS * SL	1	144	150.5	0.0001

Table 3.4 General Linear Model, SAS output, on the surfacing frequency of the common dolphins at Marineland during two types of SWD sessions

Source * = interaction	**NDF**	**DDF**	**F Value**	**Pr > F**
Dolphin	2	64	2.1	0.1
Time of Day (TD)	2	64	5.0	0.001
Type of Session (ToS)	1	64	6.1	0.02
Dolphin * ToS	2	64	0.4	0.6
Dolphin * TD	4	64	0.6	0.7
Dolphin * ToS * TD	6	64	1.2	0.3

APPENDIX 3

Chapter Four – Tables with SAS output

Table 4.1 Logistic regression to determine the significance of the listed sources on the vocalisations of the common dolphins *D. delphis* at Marineland during the SWD programme.

Source	NDF	DDF	F Value	Pr > F
Time of Day	3	105	1.2	0.3
Before, After vs During (BAvsD)	1	105	0.09	0.8
BDA	1	105	4.4	0.04
Type of Sound (sound)	4	105	27.3	<0.0001
TD*sound	12	105	1.6	0.1
sound*BAvsD	4	105	0.9	0.8
BDA*sound	8	105	0.3	1.0

Table 4.2 Contrast Results of vocalisations performed during the three stages (Before, During and After) of the SWD sessions.

Contrast Type	NDF	DDF	F Value	Pr > F
Before vs During	1	105	2.2	0.1
After vs During	1	105	0.5	0.5
Before vs After	1	105	4.9	0.03

Table 4.3 Chi-squared test to determine if there is an interaction between behaviours and vocalisations performed during SWD sessions.

Source	DF	Chi Square	Pr > ChiSq
Behaviours (Behav)	8	721.8	<0.0001
Vocalisation (Vocal)	3	101.4	<0.0001
Behav*Vocal	24	185.2	<0.0001