Monitoring the commercial swim-with-dolphin operations in the Bay of Islands

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CONTENTS

Abstract

Bottlenose (*Tursiops truncatus)* and common dolphins *(Delphinus delphis)* were observed and photographed during their encounters with swim-with-dolphin operations in the Bay of Islands from March, 1994 to March, 1995. From observation of 156 commercial trips, lasting an average of 3.1 hours, there was an 86% success rate in encountering one or both species of dolphins. Bottlenose dolphins changed their behaviour on 32% of approaches by the operator's boat, and common dolphins changed their behaviour on 52% of approaches. Of all groups of dolphins encountered, 37% were exposed to at least one swim attempt. A total of 163 swim attempts were observed, including multiple attempts with the same pod. Bottlenose dolphins had a sustained interaction with swimmers on 25% (n = 33) of encounters involving swims, and common dolphins had a sustained interaction on 21% (n = 6). The remaining swims resulted in neutral or avoidance behaviour. Dolphin responses to swimmers were dependent to some degree on swimmer placement, with in-line placement eliciting the highest risk of avoidance. A total of 265 bottlenose dolphins were individually identified by photographs of nicks and scars on their dorsal fins. The majority (76%) were re-sighted on more than one occasion, but the Bay of Islands does not seem to be the exclusive home range of any individuals. Future research should attempt to determine the dolphins' home range, habitat use, and the impact of changes in their environment. In the long-term, it is possible that dolphins will become. familiar with the boats and swimmers and increase their approaches or, conversely, develop a cumulative aversion towards them.

1. Introduction

Bottlenose dolphins (*Tursiops truncatus)* and common dolphins *(Delphinus delphis)* are abundant throughout the world's oceans (Evans 1987). Common dolphins tend to be a pelagic or continental shelf species (Leatherwood & Reeves 1983) whereas bottlenose dolphins are most common in coastal temperate waters, although an offshore pelagic form is observed in some areas. Both species are distributed throughout New Zealand's coastal waters (Baker 1983).

1.1 BOTTLENOSE DOLPHINS

Although bottlenose dolphins are found throughout the world's oceans, they are more common in temperate or tropical waters. There appear to be two ecotypes: i.e., a coastal form that is frequently found in bays, estuaries and river mouths, and an offshore form found particularly in the tropics (Klinowska 1991, Leatherwood & Reeves 1983). Inshore bottlenose dolphin populations have been studied throughout the world with the most established, long-term research project based in Sarasota Bay, Florida (Scott *et al.* 1990). The highest

latitude study so far (45°28'S, 167°0.0'E) has been conducted by Williams (1992) who believes that the deep, cool, temperate waters of New Zealand's Doubtful Sound provide the possible limits of the animal's range.

Studies of coastal bottlenose dolphins have found that some areas have a closed, resident population with a well defined home range e.g., Sarasota Bay, Florida (Wells *et al.* 1980, Wells 1991); Moray Firth, Scotland (Hammond & Thompson 1991) and Doubtful Sound, New Zealand (Williams *et al.* 1993). Researchers in other areas have found that bottlenose dolphins utilise a large undefined range area without obvious boundaries e.g., Gulf of California (Ballance 1992) and Galveston Bay (Henningsen & Wursig 1991).

Most research on coastal dolphins has used shore-based or small boat operations to monitor group behaviours and to identify individuals (Wiirsig & Wursig 1979, Irvine *et al.* 1981, Shane 1990a). An important technique of this research is photo-identification. This involves identifying individuals from photographs of natural markings (Wursig & Jefferson 1990). Photo-identification of dolphin populations has allowed long term studies to assess population size (Bigg 1982), survival rates (Slooten & Ladd 1990) and social associations (Brager *et al.* 1994, Ostman 1994) with relatively little interference to the animals. Individually identifying dolphins typically involves taking photographs showing a lateral view of the animals' dorsal fin and back. Lockyer and Morris (1990) ,found that certain wound types are more persistent than others. The outline of nicks on the dorsal fins have been used in long term identification of individual bottlenose dolphins in Sarasota Bay, Florida by Scott *et al.* (1990) who recognised individuals 17 years after they were first sighted. Wursig and Harris (1990) identified animals in Argentina 8-12 years after they were first sighted.

1.2 COMMON DOLPHINS

Common dolphins are distributed throughout the world's oceans but are restricted to temperate and tropical latitudes (Gaskin 1968). Jefferson *et al.* (1993) estimated their absolute geographical limits to be 60°N and 50°S. There are two genetically distinct populations of common dolphins in the northeast Pacific Ocean: a larger, more coastal long-beaked form and a smaller, more oceanic short-beaked form (Rosel *et al.* 1994). Similar populations are known to occur in other oceans but work is yet to be conducted to genetically differentiate the two.

Common dolphins are known to frequent continental shelf regions and feed on the deep scattering layer of organisms associated with these areas (Evans 1971, Gaskin 1992). They are known to occur more frequently in areas of high sea floor relief and their distribution is affected by environmental factors such as water temperature and salinity which may affect prey distribution (Hui 1979; Selzer & Payne 1988). Little is known about the habits of either bottlenose or common dolphins in the coastal waters of Northland, New Zealand.

1.3 HUMAN/DOLPHIN INTERACTIONS

The coastal or continental shelf habitats of bottlenose and common dolphins bring them into frequent contact with humans, making them vulnerable to habitat degradation, disturbance, pollution and incidental takes in fisheries (Klinowska 1991, Moscrop & Simmonds 1994). Bottlenose dolphins are often encountered by recreational vessels (Acevedo 1991) and coastal fishing (Corkeron 1990, Fertl 1994a). Commercial swim-with-dolphin and dolphin-watching operations now add to the number of boats encountering dolphins each day.

Interaction between cetaceans and humans is not a new event. Most ships have had dolphins bowriding at some stage of their journey and many recreational boaties have encountered dolphins (Lockyer 1990). In some cases, dolphins exhibit characteristic behavioural patterns associated with vessels. For 24 years, from 1888 to 1912, a Risso's dolphin (Grampus griseus) - `Pelorus Jack' - frequently rode the bow wave of steamboats coming into the Marlborough Sounds, New Zealand (Szabo 1992).

There are many reports of wild, untrained dolphins actively seeking human contact, sometimes with no obvious immediate reward or advantage (Lockyer 1990). Doak (1981) reported many encounters with bottlenose and common dolphins bowriding his yacht and then interacting with swimmers as they entered the water. In 1955, the Hokianga Harbour was home to a lone female bottlenose dolphin `Opo'. She would allow people to touch her and would swim between the legs of children and take them for rides on her back (Lee Johnson & Lee-Johnson 1994). Similar reports of wild, sociable dolphins have come from a number of countries including England and Wales e.g., `Donald' and `Simo'; Ireland, `Dorad or Funghi'; Florida, `Georgy Girl'; and Spain `Nina' (Donoghue & Wheeler 1990, Lockyer 1990). No-one knows why these dolphins choose to leave their conspecific social group to interact with humans so closely.

Some human/dolphin interactions involve a direct benefit to the dolphins, usually in the form of food. In Laguna, Brazil, fishermen have been assisted by bottlenose dolphins in catching fish for almost 150 years. This involves bottlenose dolphins herding fish into their nets and then catching any fish which try to escape (Pryor & Lindbergh 1990).

1.4 FEEDING WILD DOLPHINS

There are a number of commercial operations which allow people to feed wild dolphins. The dolphins' approaches to humans have been reinforced by handouts of fish and these dolphins can be encountered on a regular and predictable basis. In Shark Bay, Western Australia there is a resident population of bottlenose dolphins that accepts dead fish from humans. It is believed that some of these dolphins have been coming to the area for at least 20 years and over this time have become habituated to accepting handouts from people (Connor & Smolker 1985). The dolphins that come into Monkey Mia to be fed are part of a larger population that inhabit the waters of Shark Bay. This dolphin feeding venture has developed into a popular tourist attraction and provided the incentive to initiate a bottlenose dolphin feeding programme on Moreton

Island, Australia. Here an unsuccessful attempt was made to train the wild dolphins to take handouts from fishing trawlers and a small boat (Green & Corkeron 1991). In 1992, a female bottlenose dolphin and her calf started to feed on fish thrown to them by people on the wharf at Tangalooma Moreton Island Resort and now a total of nine dolphins are coming to the feeding (Orams 1994). Recently the potential long-term impact of these activities have become apparent in Monkey Mia. Researchers have found there is an increased mortality rate of juvenile dolphins born to provisioned mothers (IFAW 1995). It is thought that the young dolphins did not learn to forage properly and the provisioned mothers invested less time in their offspring to protect them from predators. This made the offspring with provisioned mothers more vulnerable than the offspring of non-provisioned dolphins.

In 1992, there were at least 20 commercial cruise and 50 charter vessels operating feed-the-dolphin tours in the southeastern United States of America. These operations were found to alter the animals' behaviour patterns i.e., dolphins surrounding small fishing boats in anticipation of fish handouts and dolphins biting swimmers. Since this time the U.S. Marine Mammal Protection Act (1972) has been amended to include feeding as a form of harassment as it disturbs the dolphins normal behaviour and may make them less able to search for food on their own (Marine Mammal Commission 1994).

Such close contact between dolphins and humans can result in the dolphins being reliant on humans for some of their needs. As this is controlled by the humans, dolphins may become aggressive in order to get what they want. In Monkey Mia there has been an increase in aggressive behaviour by the dolphins towards the people feeding them (IFAW 1995). The Marine Mammal Commission (1994) reports incidents of aggression and there were occurrences of dolphins biting swimmers.

1.5 CAPTIVE SWIM-WITH-DOLPHIN PROGRAMMES

In the United States of America, four marine mammal facilities have been permitted to conduct swim-with-dolphin programs in a captive situation (Marine Mammal Commission 1994). Research involving 107 hours of observations on the captive bottlenose dolphins responses to swimmers showed a high level of agonistic and sexual behaviour toward the swimmers when the dolphins were not controlled by their trainer (Samuels & Spradlin 1994). High-risk activities such as aggression towards swimmers or submissive behaviour by the dolphins were observed in up to 61% of the dolphins' social time with swimmers. The researchers concluded that the level of high risk activity could be reduced when the swim was directly controlled by a trainer. This minimised the risk to the dolphins and the swimmers.

In New Zealand there is one captive swim-with-dolphin operation at Napier Marineland involving four female common dolphins. To date there has been no published research on the common dolphins' responses to swimmers.

In Freeport, Bahamas, bottlenose dolphins are held in pens and released into the sea as part of a commercial venture for tourists. These dolphins have been conditioned to interact with the divers and are rewarded with fish upon doing so. At the conclusion of the encounter the dolphins then return to their pens (Doak 1994).

1.6 ECONOMICS OF WHALE-WATCHING

Dolphin and whale-watching are rapidly growing industries providing employment in many communities around the world (Hoyt 1995). In New Zealand, the swim-with-dolphin and whale-watching industry is expected to earn in excess of $15 million in direct income by the year 2000 (Donoghue 1994). Additional input into the New Zealand economy as an indirect result of dolphin and whale watching is expected to reach $45-50 million. This level of growth is expected in the whale-watching industry worldwide, with already more than 4 million participants per year in approximately 50 countries and overseas territories (IFAW 1995). The economic benefits to the mostly smaller communities from which these businesses operate is often considerable. Duffus and Dearden (1993) calculated that the economic value of whale-watching at Johnstone Strait, Canada was at least $4,000,000 in 1989. This was based on 10,000 whale-watching tourists spending an average of $400 each.

There are also non-economic benefits from interacting with cetaceans in the wild (Amante-Helweg 1995). These include potential benefits to conservation from the long-term effect of changing peoples' attitudes towards wild cetaceans and the habitat in which they live (Duffus & Dearden 1990). Nations which have a history of killing whales and dolphins are the target of campaigns aimed at not killing whales in an effort to conserve the species. This concept of non-consumptive utilisation of whales has led to conflict in Andenes, northern Norway. A commercial whale-watching venture aimed at increasing the appreciation of living whales is perceived as being in direct conflict with the coastal whaling communities who see commercial whale-watching as an attack on their cultural values (Ris 1993).

1.7 COMMERCIAL SWIM-WITH-DOLPHIN OPERATIONS IN NEW ZEALAND

New Zealand is fortunate to have several species of coastal dolphins that are receptive to swim/watching operations in the wild. In early 1995, when this report was prepared, there were twelve operations permitted by the Department of Conservation (DoC) to run commercial swim-with-dolphin tours (R. Suisted, DoC, pers.comm.). These operations are found in the Bay of Islands, Coromandel, Bay of Plenty, Marlborough Sounds, Kaikoura, Banks Peninsula and Porpoise Bay, Southland. There are many more permit applications currently on file at the Department of Conservation (R. Suisted, pers. comm.).

Commercial operations in New Zealand offer a mixture of swimming with or just watching a number of different species of dolphins, primarily bottlenose *(Tursiops truncatus),* dusky *(Lagenorhynchus obscurus),* common *(Delpbinus delphis)* and Hector's dolphins *(Cephalorhynchus hectori).* There is research currently underway on the impact of boat traffic on the dusky dolphins in Kaikoura and the Hector's dolphins in Porpoise Bay using both land and boat based techniques.

1.8 IMPACTS OF BOAT TRAFFIC

With increased growth in the commercial swim-with-dolphin and whale-watching industry comes the need for effective management to minimise the risks of harassment of the animals. It is generally in the interests of the operators to have as little impact as possible on the dolphins or whales in order to maximise the human experience (Beach & Weinrich 1989). Many countries have regulations to control the activities of commercial and recreational boats around. cetaceans but these are often lacking the support of scientific research (IFAW 1995). New Zealand regulates all commercial and private vessels and aircraft operating around marine mammals under the 1978 Marine Mammals Protection Act.

Boat traffic has the potential to disturb dolphins and whales and change their natural behavioural patterns. In some areas this has resulted in recommendations to restrict the number of permits issued, e.g., the St. Lawrence River beluga operations (Prescott 1991).

Research into cetacean responses to boat traffic is relatively new and covers a limited number of species such as humpback whales *(Megaptera novaeangliae* – Baker & Herman 1989), bowhead whales *(Balaena mysticetus* - Richardson *et al.* 1995), killer whales *(Orcinus orca* - Kruse 1991) and bottlenose dolphins (Acevedo 1991). Not all associations appear to be detrimental in the short-term. In Texas, Fertl (1994a) found bottlenose dolphins closely associated with shrimp trawlers and similar findings were made by Corkeron (1990) in Australia. These activities appear to be of benefit to the dolphins who feed off the discarded fish and fish stirred up by the trawler's fishing operations.

Other cetacean species do not respond so favourably to the presence of boat traffic. Au and Perryman (1981) found during their fieldwork in the eastern tropical Pacific Ocean that all schools of spotted *(Stenella attenuata)* and spinner dolphins *(Stenella longirostris)* swam away from an approaching purse seine fishing vessel. This may be in response to their having previously encountered these vessels and been trapped in their nets. Belugas *(Delphinapterus leucas)* also showed strong avoidance reactions to ships up to 50 km away (Finley *et al.* 1990).

1.9 OBJECTIVES

This is a report of the first monitoring of the Bay of Islands bottlenose and common dolphin populations and documents the exposure and behavioural responses of the animals to commercial swim-with-dolphin operations. Baseline data is presented here including basic biological information on bottlenose and common dolphins in the Bay of Islands. An estimate of local abundance is made by compiling a catalogue of photographically identified individuals. This is important so that the extent of the resource can be assessed and any future changes in numbers of dolphins in the area can be evaluated. Photo-identification will also allow documentation of possible changes in behaviour of individual dolphins (i.e., habituation or aversion) as a result of swim/watching encounters.

The goals of the research were to:

1. Document the exposure (i.e., number of encounters and length of encounters) of bottlenose and common dolphins to commercial swim-with-dolphin operations and the success of operators in finding and swimming with dolphins.
2. Assess the short-term response (e.g., approach or avoidance) of bottlenose and common dolphins to commercial swim-with-dolphin vessels and swimmers.
3. Photo-identify the bottlenose dolphins exposed to commercial operations and estimate the population size.
4. Collect basic demographic information on bottlenose and common dolphins in the Bay of Islands, including pod size, pod structure, habitat use and inter-species associations e.g., sea birds.

2. Human/dolphin interactions

2.1 INTRODUCTION

An assessment of the commercial swim-with-dolphin operations in the Bay of Islands forms the basis of this chapter; which focuses on the following aspects associated with these operations:

1. The catch per unit effort of commercial operators and the success of the swims.
2. The change in bottlenose and common dolphin behaviours as the boats approach the dolphins.
3. The responses of the dolphins to swimmers entering the water and the influence that swimmer entry type has on their response.
4. Case histories of disturbance responses by dolphins to boats and swimmers.

The responses of bottlenose and common dolphins to the presence of commercial swim-with-dolphin boats and swimmers were studied in the Bay of Islands from March, 1994 until March, 1995. All data were collected from the commercial boats during normal operations.

2.2 METHOD

The primary platform for collecting data was the commercial operators' boats. The use of the operators' boats allowed limited data collection on dolphin responses to the boats. Ideally, the most effective method would have been theodolite tracking from land. However, as the Bay of Islands did not offer any site with an unobstructed view over the bay to allow this research tool, we had to use the operators' boats as the primary platform for research. On the other hand, for assessment of the dolphins' responses to swimmers, the operators'

boats provided a good platform from which to closely view the swimmers and dolphins and therefore collect accurate data.
The aim was to accompany the commercial swim-with-dolphin operators on as many of their 3-4 hour trips (maximum two per day) as possible for the 12 month research period.

2.2.1 Study area

The Bay of Islands is situated on the east coast of the North Island of New Zealand (35°14'8, 174°06'E). The mouth of the bay from the Ninepin (Tikitiki Island) to Piercy Island (Motukokako Island) is approximately nine nautical miles wide. There are 144 islands within the Bay (Department of Conservation 1989). The area permitted by the Department of Conservation for commercial swim-with-dolphin operations also includes area outside the actual bay, with the northern limit being the Takou River and southern limit Whangamumu Harbour. The Waikare Inlet, Te Puna Inlet and half of the Kerikeri Inlet were closed areas for the commercial operators (Fig. 1).

2.2.2 Data recording

All data were collected by voice on a Sony micro-cassette recorder and the notes were transcribed each evening onto a coded data sheet. Environmental data, demographics regarding the dolphin pod encountered and data on responses to the boat and swimmers were recorded. All times were recorded accurate to the second from a stopwatch.

2.2.3 Dolphin behaviour

Responses to boats A focal pod approach was used (Altmann 1974, Martin & Bateson 1986). Once a pod of dolphins was encountered by the boat, this became the focal pod. A pod was defined as any number of dolphins moving in a similar direction or engaged in similar behaviours and within five dolphin lengths of any other member of the pod (Fertl 1994a).

To assess the dolphins' response to the approaching commercial operators boat, observations made at 400 m or less were classified as potentially disturbed conditions for the dolphins (Baker & Herman 1989). This distance was also the maximum distance at which an accurate visual assessment of the dolphins behaviour could be made. The time at which the dolphins were first seen was recorded and as the boat approached the dolphins, an assessment of the pod's general behavioural state and the total number of boats within 400 metres of the pod was made. The behavioural state was reassessed as the boat approached to within 100 metres of the dolphins and any change in the pod's behaviour was noted.

Behavioural states were assigned to one of seven categories (Table 1) modelled on the definitions used by Shane et al. (1986). If the dolphins dived and surfaced away from the boat and resumed their behavioural state prior to the boat's approach, this was interpreted as an avoidance response.

Responses to swimmers Upon encountering a pod of dolphins, the operator would decide whether the passengers would be able to swim. Factors such as the presence of calves, the dolphins' behavioural state and weather conditions

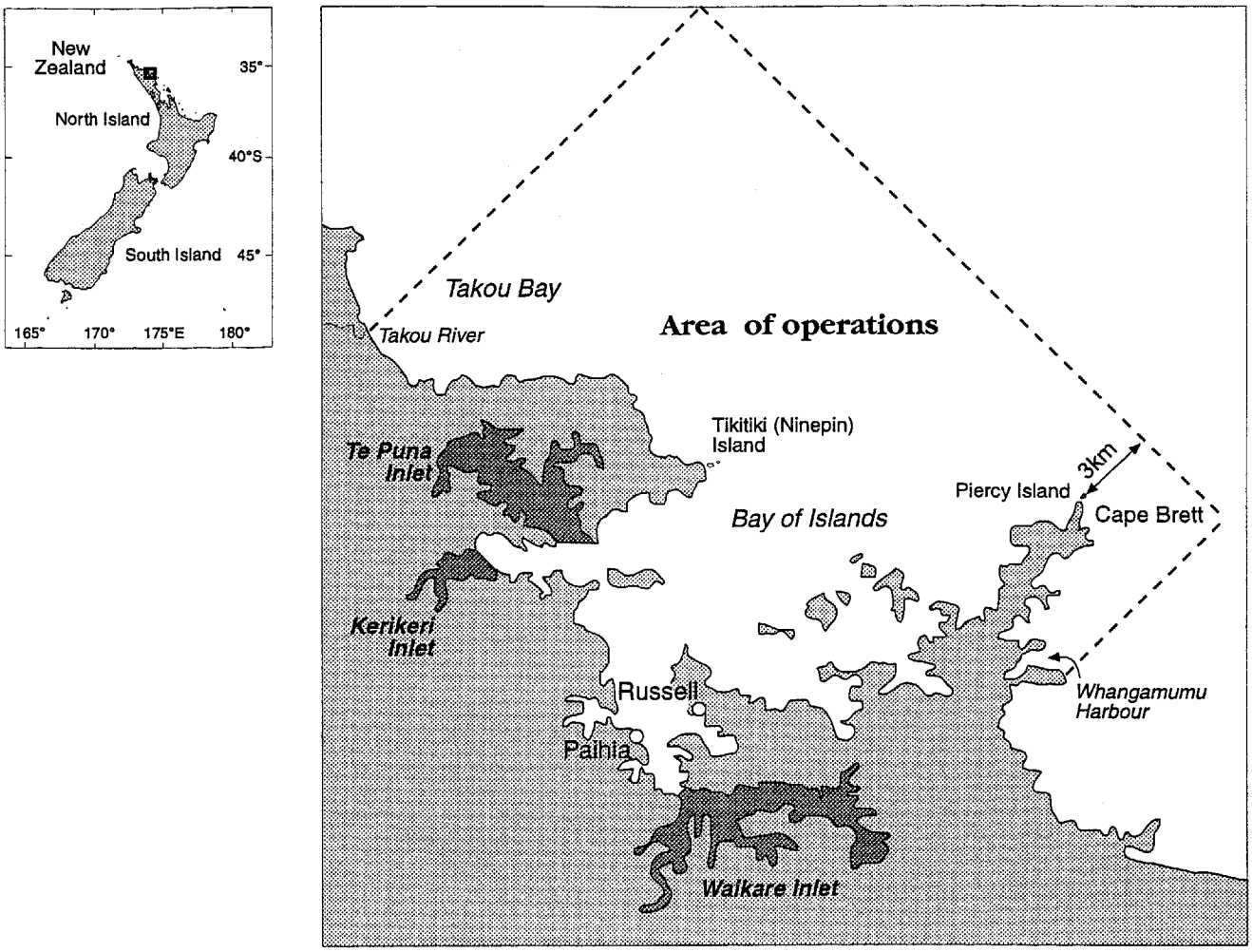

FIGURE 1. AREA PERMITTED FOR COMMERCIAL SWIM-WITH-DOLPHIN OPERATIONS IN THE BAY OF ISLANDS. THE DARK SHADED AREAS ARE OFF-LIMITS TO THE COMMERCIAL OPERATORS.

influenced this decision. If the decision was made to swim, data were collected on the boat strategy used by the operator to place swimmers in the water. The time the first swimmer entered the water, the number of swimmers, and the time the last swimmer exited the water were also recorded. If there was a decision not to swim, the reason given by the operator as to why no swim attempt would occur was noted.

The response of the dolphins to the swimmers was assessed during each swim attempt and this response fell into one of three categories. An `approach' was defined as at least one of the dolphins in the pod swimming within five metres of one of the swimmers. The dolphins `sustained' an interaction with the swimmers by repeatedly swimming (milling) within five metres of them. This was considered an approach response. `Avoidance' was assessed by the dolphins either changing their path of travel (as determined prior to the swimmers entering the water) away from the swimmers or by diving and surfacing away from the swimmers. A neutral response was defined as no apparent change in behaviour by the dolphins. This sometimes resulted in the dolphins coming within five metres of the swimmers but they continued swimming and did not appear to interact with the swimmers in any way.

TABLE 1. DEFINITIONS OF THE DOLPHIN BEHAVIOURAL STATES.

BEHAVIOURAL STATE	DEFINITION
Socialising	Dolphins observed leaping, chasing and engaged in body contact with each other. Involves aspects of play and mating with other dolphins. Serves a social and sexual role.
Feeding	Dolphins involved in any effort to capture and consume prey as evidenced by chasing on the surface, deep diving and circle swimming. Prey is sometimes observed.
Resting	Dolphins engaged in slow movements as a tight group, generally lacking the active components of the other behaviours described.
Travelling	Dolphins involved in persistent, directional movement.
Milling (Idling)	Dolphins show frequent changes in heading and may be associated with feeding, socialising or play.
Bowriding	Dolphins approach the boats bow and orient themselves to swim in the boats bow wave.
Diving	Dolphins involved in surface behaviours such as those listed above suddenly stop and dive below the surface only to resurface at a distance from the boat usually to resume the prior behaviour.

The total interaction time of the dolphins with the swimmers was calculated by recording the time at which one or more dolphins from the focal pod approached within five metres of any of the swimmers. Then the time at which there was no longer any dolphin within five meters of any swimmer was recorded. If no interaction between dolphins and swimmers occurred, i.e., no dolphin approached to within five metres of a swimmer, then this was scored as zero time. When the boat left the focal pod, the time of departure as well as the number of dolphins and their general behavioural state was recorded.

2.3 RESULTS

2.3.1 Effort and success

During the 12 month research period there were a total of 179 groups of either bottlenose (Tursiops truncatus) or common dolphins *(Delphinus delphis)* encountered (Table 2). One or more pods of dolphins were encountered on 134 of these trips for an 86% success rate in finding dolphins. Bottlenose dolphins were encountered on 123 occasions and common dolphins were encountered on 56 occasions.

A total of 616 hours were spent searching the permitted area for dolphins. The operators spent an average time of 3 hours 6 minutes on the water per trip (range = 41 minutes to 4 hours 16 minutes). The time which elapsed between leaving port and encountering the first pod of dolphins ranged from 2 minutes to 2 hours 58 minutes. The time it took to find the dolphins varied seasonally (Fig. 2). Dolphins were found with least effort during late winter and early

TABLE 2. SUMMARY OF THE COMMERCIAL SWIM-WITH-DOLPHIN OPERATORS EFFORT AND SUCCESS OF THEIR ENCOUNTERS AND SWIMS WITH BOTTLENOSE AND COMMON DOLPHINS.

	SPECIES	n	TOTAL	
Total number of trips accompanied.			156	
Number of trips in which dolphins were encountered.			134	86%
Mean number of dolphin encounters per trip.		156	1.15	
Average time on water per trip.			3.1 hours	
Average time spent with dolphins per encounter.	Bottlenose Common	123 56	54 mins 44 mins	
Number of pods encountered.	Bottlenose Common	123 56	179	
Encounters with swims.	Bottlenose Common	51 15	66	37%
Number of swims.	Bottlenose Common	134 29	163	
Number of sustained interactions per swim encounter.	Bottlenose Common	33 6		25% 21%

spring. During late summer and autumn the operators had to search for twice as long as in winter and spring to find dolphins.

There were 153 hours of contact with the dolphins during the 134 trips. The time spent with each dolphin pod ranged from 4 minutes to 2 hours 17 minutes for bottlenose dolphins ($\bar{x}$ = 54 minutes) and from 8 minutes to 1 hour 47 minutes ($\bar{x}$ = 44 minutes) for common dolphins. The average amount of time spent with the dolphins per trip (n = 156) was 59 minutes and 48 seconds, almost one third of the total time on the water.

2.3.2 Responses to commercial swim-with-dolphin boats

Bottlenose dolphins On initial encounter, the most common behavioural state of bottlenose dolphins was travelling (38%, n = 42). When the behavioural state was reassessed as the boat approached to within 100 m, 69% (n = 29) of travelling groups remained travelling, 22% (n = 9) changed their behaviour to bowriding, 2% (n = 1) changed their behaviour to milling and 7% (n = 3) changed their behaviour to diving and avoiding the boat (Table 3). Feeding behaviour by bottlenose dolphins was least likely to change. In this situation there was no apparent behavioural change on 89% (n = 16) of approaches to feeding dolphins. Socialising behaviour was most likely to result in a behavioural change. Dolphins approached the boat to bowride on 50% (n = 6) of approaches to socialising pods.

Boat approaches to bottlenose dolphins resulted in a behavioural change on 32% (n = 36) of encounters (Fig. 3a). The behavioural changes were categorised as approach i.e., bowriding the operators' boat or avoidance i.e., the dolphins dived and surfaced away from the boat. For bottlenose dolphins, 23% (n = 26) of boat approaches resulted in an approach i.e., the dolphins were bowriding

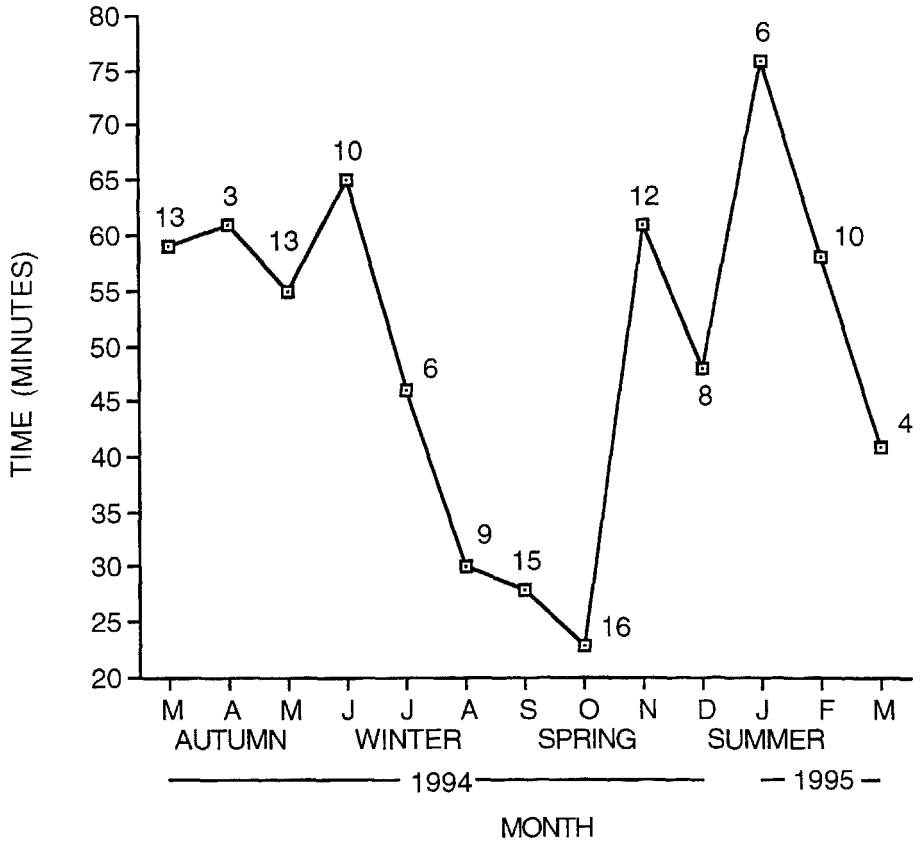

FIGURE 2. MEAN TIME ELAPSED BETWEEN LEAVING PORT AND ENCOUNTERING THE FIRST POD OF DOLPHINS; n = 125. NUMBER OF GROUPS OBSERVED PER MONTH APPEAR BY THE DATA POINTS.

TABLE 3. CHANGES IN BEHAVIOURAL STATE OF THE BOTTLENOSE DOLPHINS AS THE BOAT APPROACHED FROM A DISTANCE OF 400 m TO 100 m (n = 111). UNDERLINED NUMBERS SHOW THE NUMBER OF TIMES THE BEHAVIOURAL STATE DID NOT CHANGE.

BEHAVIOUR AT 400 m

BEHAVIOUR AT 100m	BOWRIDE	TRAVEL	MILL	SOCIAL	REST	FEED	SWIM	DIVED	TOTAL
Bowride	1'	9	6	5	0	1	2	0	26
Travel	0	2	1	1	2	1	0	0	34
Mill	0	1	j5-	0	0	0	0	0	16
Social	0	0	0	_	0	0	0	0	6
Rest	0	0	0	0	_	0	0	0	8
Feed	0	0	0	0	0	16_	0	0	16
Swim	0	0	0	0	0	0	1	0	1
Dived	0	3	1	0	0	0	0	_	4
Total	3	42	23	12	10	18	3	0	111

N.B. "The dolphins changed from bowriding another boat to approach the operator's boat to bowride. This was considered a behavioural change.

the operators boat, 4% (n = 4) resulted in an avoidance i.e., the dolphins dived and surfaced away from the boat, and 5% (n = 6) resulted in milling or travelling behaviour.

Common dolphins On initial encounter the most common behavioural state was feeding (40%, n = 17). When the common dolphins' behavioural state was reassessed as the boat approached to within 100 m, feeding was most likely to change to bowriding (47%, n = 8). Resting was the behavioural state least likely to change. On 100% (n = 4) of approaches the dolphins remained resting. Socialising behaviour was most likely to result in a behavioural change. Dolphins approached the boat to bowride on 67% (n = 2) of approaches to socialising pods (Table 4).

TABLE 4. CHANGES IN BEHAVIOURAL STATE OF THE COMMON DOLPHINS AS THE BOAT APPROACHED FROM A DISTANCE OF 400 m TO 100 m (n = 42). UNDERLINED NUMBERS SHOW THE NUMBER OF TIMES THE BEHAVIOURAL STATE DID NOT CHANGE.

BEHAVIOUR AT 100rn	BEHAVIOUR AT 400 m						
	BOWRIDE	TRAVEL	MILL	SOCIAL	REST	FEED	TOTAL
Bowride	0	7	1	2	0	8	18
Travel	0	_	2	0	0	0	8
Mill	0	0	_	0	0	2	4
Social	0	0	0	_	0	0	1
Rest	0	0	0	0		0	4
Feed	0	0	0	0	0	Z	7
TOTAL	0	13	5	3	4	17	42

Of all approaches to common dolphins 52% (n = 22) resulted in a behavioural change (Fig. 3b). There was a significant difference in behavioural change between the bottlenose and common dolphins (Chit = 4.502 [1], p = 0.0339). Common dolphins approached to bowride on 43% (n = 18) of boat approaches and changed to milling or travelling behaviour on 10% (n = 4) of boat approaches. There were no recorded avoidance responses by common dolphins to the operators boats on initial approach.

2.3.3 Swimming with the dolphins

Upon encountering a pod of dolphins, the operator chose whether to allow passengers in the water. Out of the 156 trips to see the dolphins there was a 42% chance that at least one swim would be attempted. Table 5 summarises the reasons given by the operator as to why no swim was attempted. The dolphins'

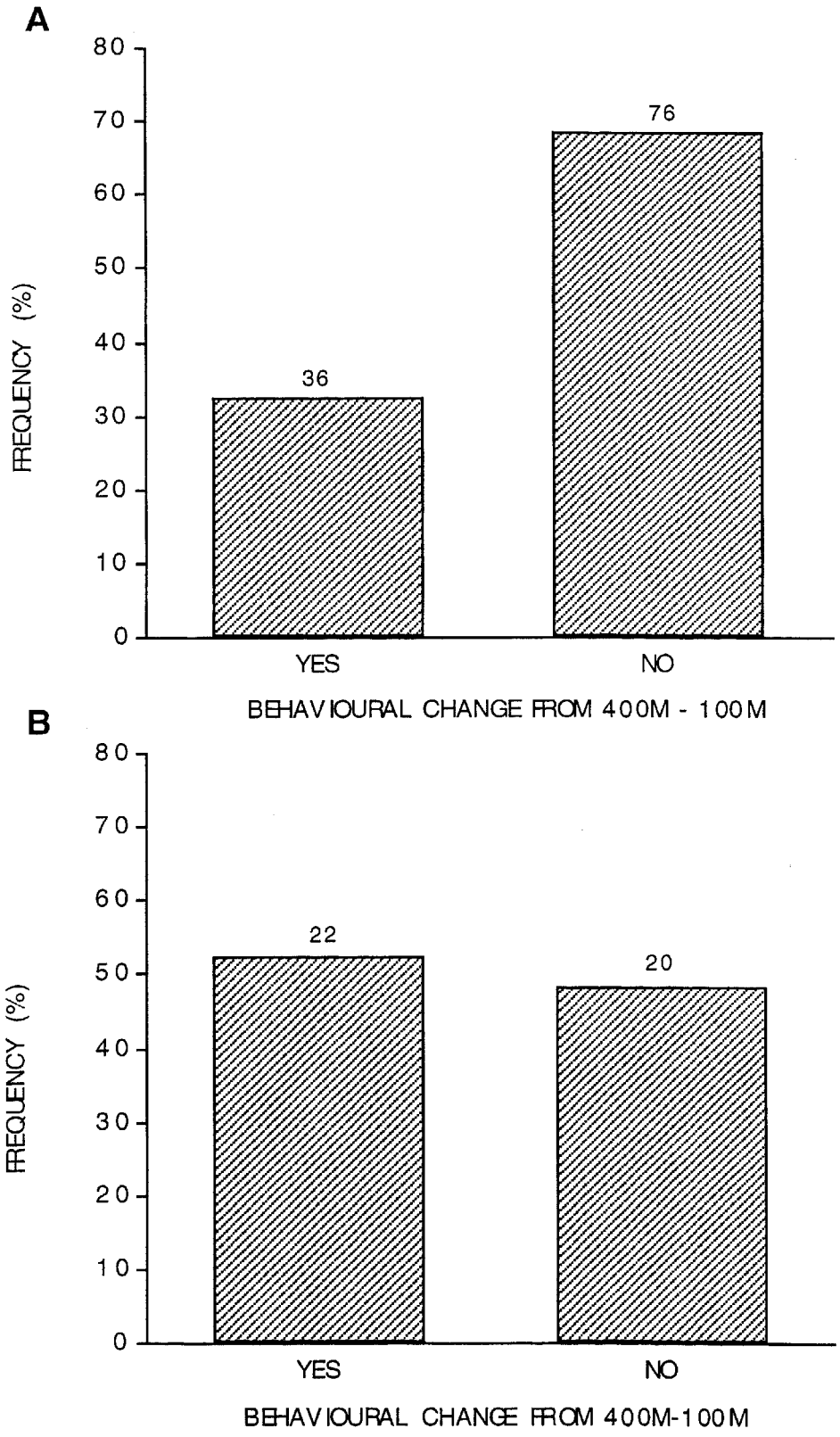

FIGURE 3. CHANGES IN DOLPHIN BEHAVIOUR AS THE COMMERCIAL OPERATOR'S BOAT APPROACHED FROM A DISTANCE OF 400 m TO 100 m.

A: BOTTLENOSE DOLPHINS; n = 112.

B: COMMON DOLPHINS; n = 42.

TABLE 5. REASON GIVEN BY THE OPERATOR FOR NOT SWIMMING WITH THE DOLPHINS. TOTAL n = 113.

REASON	BOTTLENOSE	COMMON	TOTAL
Behavioural state	36 (50%)	19(46%)	55 (49%)
Calves present	24 (33%)	10 (24%)	34 (30%)
Weather i.e., rough sea	8 (11%)	6 (15%)	14(12%)
Out of permitted area	1 (1%)	0 (0%)	1 (1%)
Unknown	3(4%)	6 (15%)	9 (8%)
TOTAL	72	41	113

behavioural state, e.g., feeding, travelling or resting (n = 55), was the most common reason given to the passengers as to why no swim would be attempted. The presence of calves (n = 34) was also frequently used as a reason not to swim.

There were 66 encounters with pods of dolphins (bottlenose n = 51; common n = 15) where at least one swim was attempted (range: 1-7 swim attempts). The total number of swims observed was 163, including multiple swim attempts during a single encounter. Of these, 134 were with bottlenose dolphins and 29 with common dolphins.

The likelihood of swimming with bottlenose dolphins per encounter (41%) was greater than swimming with common dolphins (27%). If the decision to swim was made, there was an average of 2.5 swim attempts per encounter (bottlenose dolphins x = 2.9; common dolphins x = 1.9).

2.3.4 Operator success and dolphin responses to swimmers

A successful swim for the operators was defined as at least one dolphin approaching within less than five meters of a swimmer (see methods). Based on this criterion the success rate of swims with bottlenose dolphins (n = 134) was 60% (Fig. 4a), significantly greater than the 31% success rate with common dolphins (n = 29) (Chi t = 6.8 [1], p = 0.009) (Fig. 4b).

The dolphins' response to swimmers was evaluated according to three categories: 1) dolphins remained within five metres of the swimmers (sustained); 2) dolphins actively avoiding the swimmers (avoidance); or 3) dolphins showed no apparent response to swimmers (neutral) (Figs. 5a & b). The cases when dolphins swam within five meters of the swimmers but did not sustain any form of interaction have been placed in the neutral category. Based on this criterion, 48% (n = 64) of bottlenose dolphin swims involved a sustained interaction, 30% (n = 40) were neutral and 22% (n = 30) involved active avoidance by the dolphins. The common dolphins showed a sustained interaction with the swimmers on 24% (n = 7) of the swims, remained neutral on 38% (n = 11) of swims and avoided the swimmers on 38% (n = 11) of the swims.

When the dolphins did have a sustained interaction with swimmers, bottlenose dolphins spent an-average time of 4.2 minutes (range 14 seconds to 20 minutes)

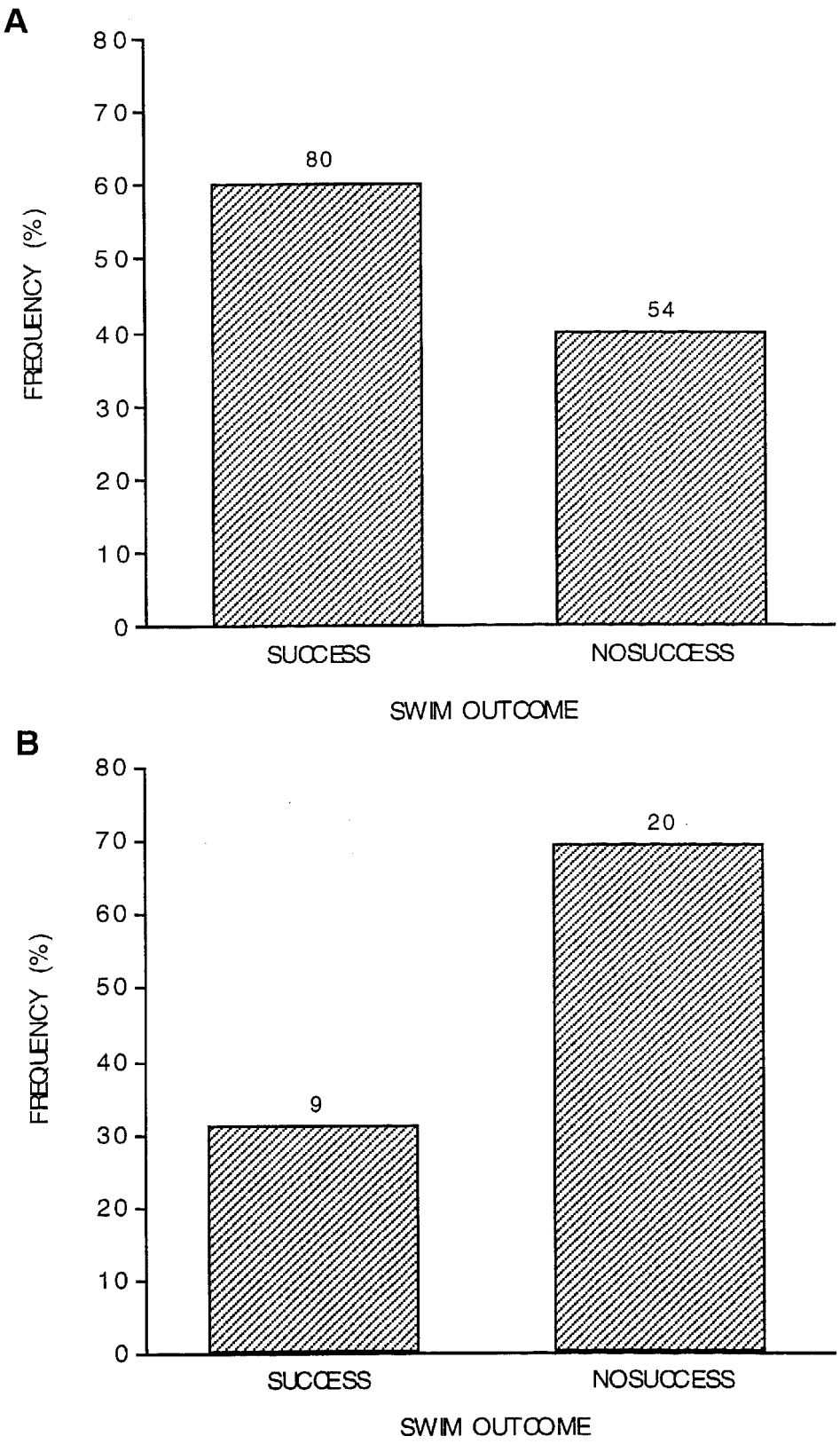

FIGURE 4. OPERATORS' SWIM SUCCESS WITH THE DOLPHINS.
A: BOTTLENOSE DOLPHINS; n = 134.
B: COMMON DOLPHINS; n = 29.

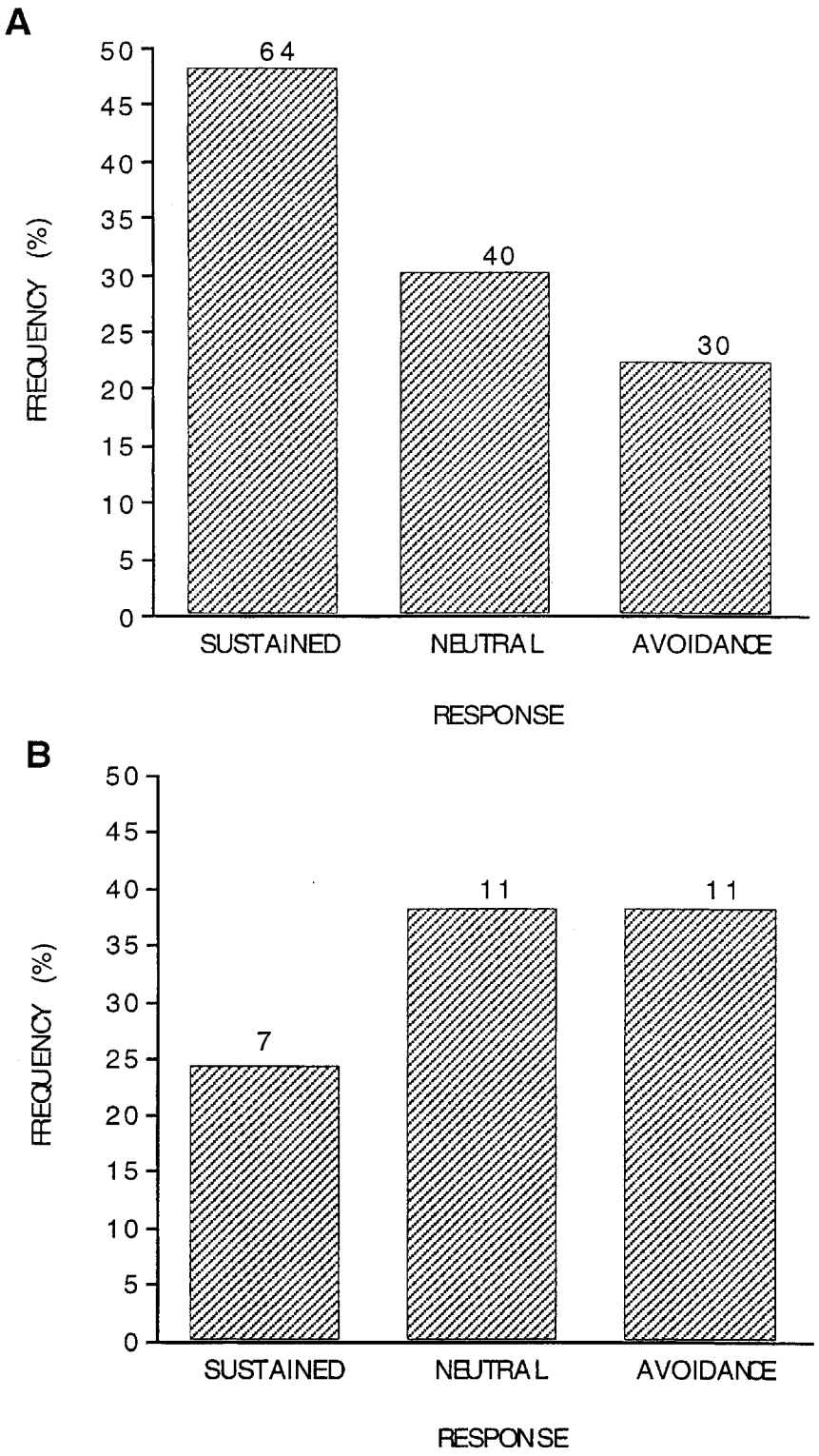

FIGURE 5. DOLPHIN RESPONSE TO SWIMMERS. THE DOLPHINS RESPONDED TO THE SWIMMERS IN ONE OF THREE WAYS: 1) THEY REMAINED WITHIN 5 m OF THE SWIMMERS (SUSTAINED); 2) THEY MADE NO APPARENT RESPONSE (NEUTRAL); OR 3) THEY ACTIVELY AVOIDED THE SWIMMERS (AVOIDANCE).

A: BOTTLENOSE DOLPHINS; n = 134.

B ; COMMON DOLPHINS; n = 29.

with the swimmers. This length of interaction was 1.1 minutes shorter than the average time with common dolphins which spent an average of 5.3 minutes (range 22 seconds to 14 minutes 45 seconds) with the swimmers.

2.3.5 Response to operator strategy

To evaluate operator strategy for placing swimmers in the water and the dolphins' subsequent response to these strategies, all swim attempts were placed in one of three categories based on these strategies (Fig. 6):

1. Line abreast - i.e., the swimmers were placed to the side and slightly ahead of the dolphins' path of travel.
2. In the path of travel - i.e., the swimmers entered the water directly in front of the dolphins path of travel.
3. Around the boat - i.e., the boat was stationary and dolphins were milling around the boat when the swimmers entered the water.

Operator strategy significantly affected bottlenose dolphin responses to swimmers (Chi^t = 26.887 [4]; p = 0.0001). During the `line abreast' strategy, bottlenose dolphins approached the swimmers on 43% of the entries, remained neutral on 47% and avoided the swimmers 10% of the time (Fig. 7a). For common dolphins, there were no sustained approaches to swimmers when placed in this way, only neutral (79%) and avoidance responses (21%) (Fig. 7b).

During the `in path' strategy, bottlenose dolphins approached the swimmers on 32% of the entries, remained neutral on 18% and avoided the swimmers on 50% of the entries. The common dolphins approached swimmers in their path of travel 14% of the time and avoided them 86% of the time. This was the greatest rate of avoidance by common dolphins in all three categories. There were no neutral responses in this category.

During the `around boat' strategy, bottlenose dolphins approached the swimmers on 63% of the entries, remained neutral on 17% and avoided the swimmers on 20% of the entries. Common dolphins had a 75% approach rate and 25% rate of avoidance. There were no neutral responses by common dolphins to this entry type.

2.3.6 Seasonal habitat use and numbers of boats

To evaluate the possible influence of commercial and recreational boat numbers and dolphin habitat use, data were collected on the number of boats within 400 metres of the focal pod and position and water depth of initial encounter. We hypothesised that the displacement of dolphins from the bay into deeper water due to seasonal increases in vessel use would be indicated by a correlation between these variables. An alternative hypothesis that seasonal changes in water temperature influences the preferred water depth of dolphins is tested in Section 3 (Demographics).

Boulenose dolphins There was a peak in the number of boats within 400 metres of the dolphins during the May school holiday period and also during the summer holiday period over Christmas and New Year as shown in Fig. 8a. The mean number of boats was highest in December, 1994 with an average of two boats within 400 metres of the pod and lowest in September with a mean of

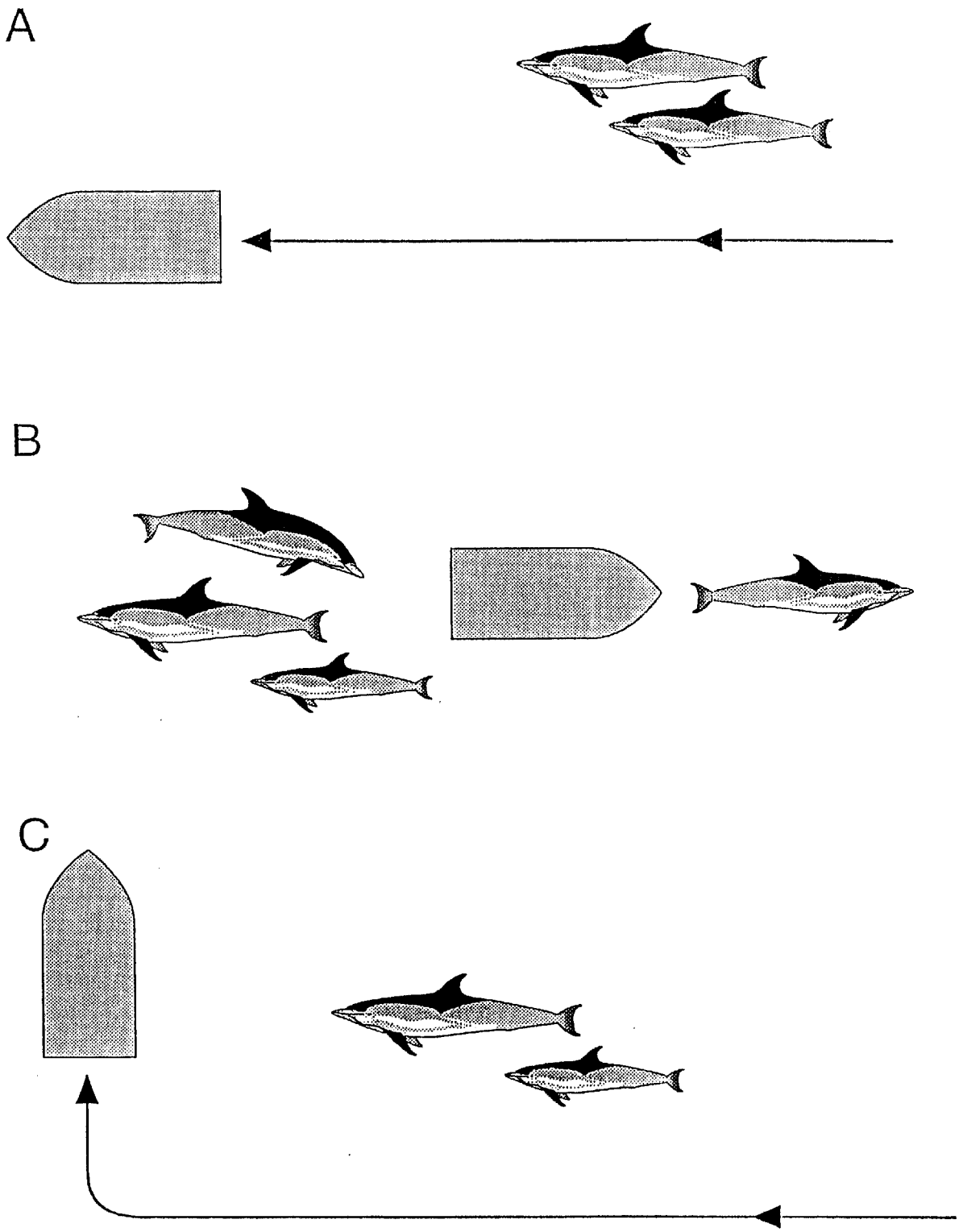

FIGURE 6. BOAT STRATEGIES USED FOR PLACING SWIMMERS IN THE WATER.
A. 'LINE ABREAST' STRATEGY. SWIMMERS PLACED TO THE SIDE AND SLIGHTLY AHEAD OF THE DOLPHINS' PATH OF TRAVEL.
B. 'AROUND BOAT' STRATEGY. THE BOAT WAS STATIONARY AND DOLPHINS WERE MILLING AROUND THE BOAT WHEN SWIMMERS ENTERED THE WATER.
C, 'IN PATH' STRATEGY. SWIMMERS ENTERED THE WATER DIRECTLY IN THE DOLPHINS' PATH OF TRAVEL.

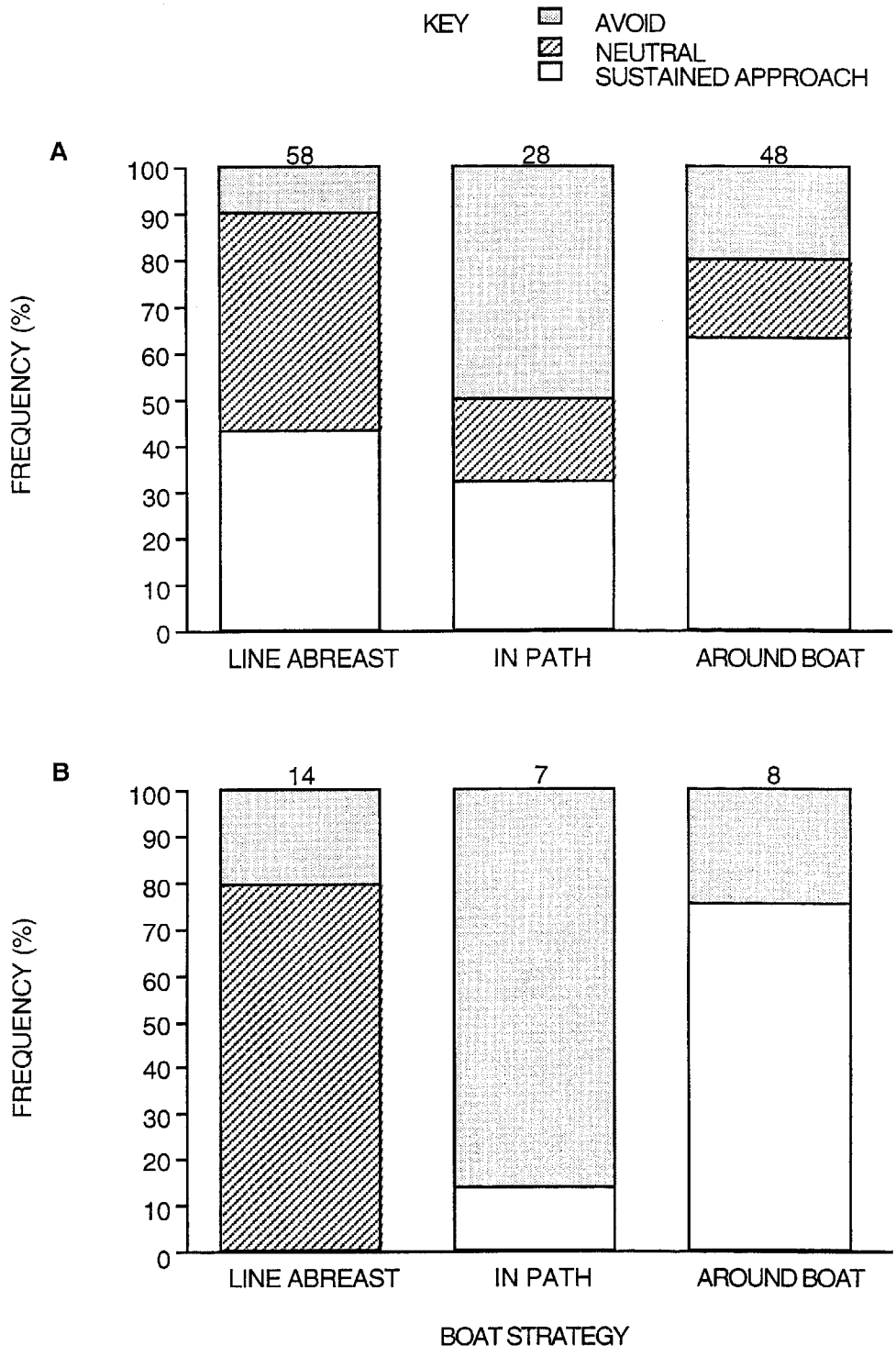

FIGURE 7. DOLPHIN RESPONSES TO SWIMMERS DEPENDENT ON BOAT STRATEGY.
A: BOTTLENOSE DOLPHINS; n = 134.
B. COMMON DOLPHINS; n = 29.

0.29 boats. Although dolphins were found in deeper waters during periods of increased vessel numbers in summer months, the correlation between water depth and the mean number of boats within 400 metres of the dolphins was not significant (R^2 = 0.13 [1]; p = 0.229).

Common dolphins The mean number of boats within 400 metres of the common dolphins showed a peak of 0.67 during September (Fig. 8b). This was when the dolphins were found in shallower waters inside the limits of the Bay of Islands. During the summer months the dolphins were found in water depths of approximately 100 metres. This was beyond the limits of the bay and generally out of reach for small, recreational boat traffic. There was no correlation between water depth and boat numbers for common dolphins (R^2 = 0.27 [1]; p = 0.996).

2.3.7 Case histories of disturbance

Not all observations of dolphins' responses to swimmers and boats could be placed into general categories determined by the methods of data collection. On infrequent occasions, dolphins' responded to swimmers or boats in a notably disturbed manner which seemed directly to be human induced. Both bottlenose and common dolphins are represented in these case studies and both commercial swim-with-dolphin operators and private boats were involved.

These case histories are not representative of average or typical responses by the dolphins but instead document dramatic responses. The average dolphin responses to swimmers and boats are discussed earlier in the results section.

Responses to boats

CASE 1- Encounter #2-1 On the morning of 3 March 1994, an approach was made to a mixed age pod of 12 bottlenose dolphins resting in a bay near Tapeka Point. The bay was small with a sandy bottom and rocks bordering each side. When at a distance of ten meters from the dolphins the operator turned the 6.6 metre boat side on to the dolphins. This occurred when the dolphins were 20 metres from shore. When the boat turned side on, a large adult dolphin did 11 tailslaps in a row and the pod immediately came together as a tight group. The dolphins then swam one or two dolphins wide through a 15 metre gap between the boat and the rocks. The gap on the other side of the boat was of similar size. They then proceeded to spread out and travel as a group for the rest of the encounter.

CASE 2 - Encounter #103-1 On 9 September 1994, a group of approximately 150 common dolphins was encountered while they were feeding. At 10:04 the operator proceeded to drive the boat at a speed of 5-10 knots in circles around a sub-pod of 30 dolphins. Over half the dolphins then porpoised away from the boat. Three or four dolphins were either bowriding the boat or leaping in its wake and a group of ten dolphins were milling as a tight group in the middle of the circle formed by the wake of the boat. Less than 30 seconds after beginning this activity the skipper stopped and the dolphins milling in the circle created by the wake swam away at speed and rejoined the rest of the pod who had slowly moved away.

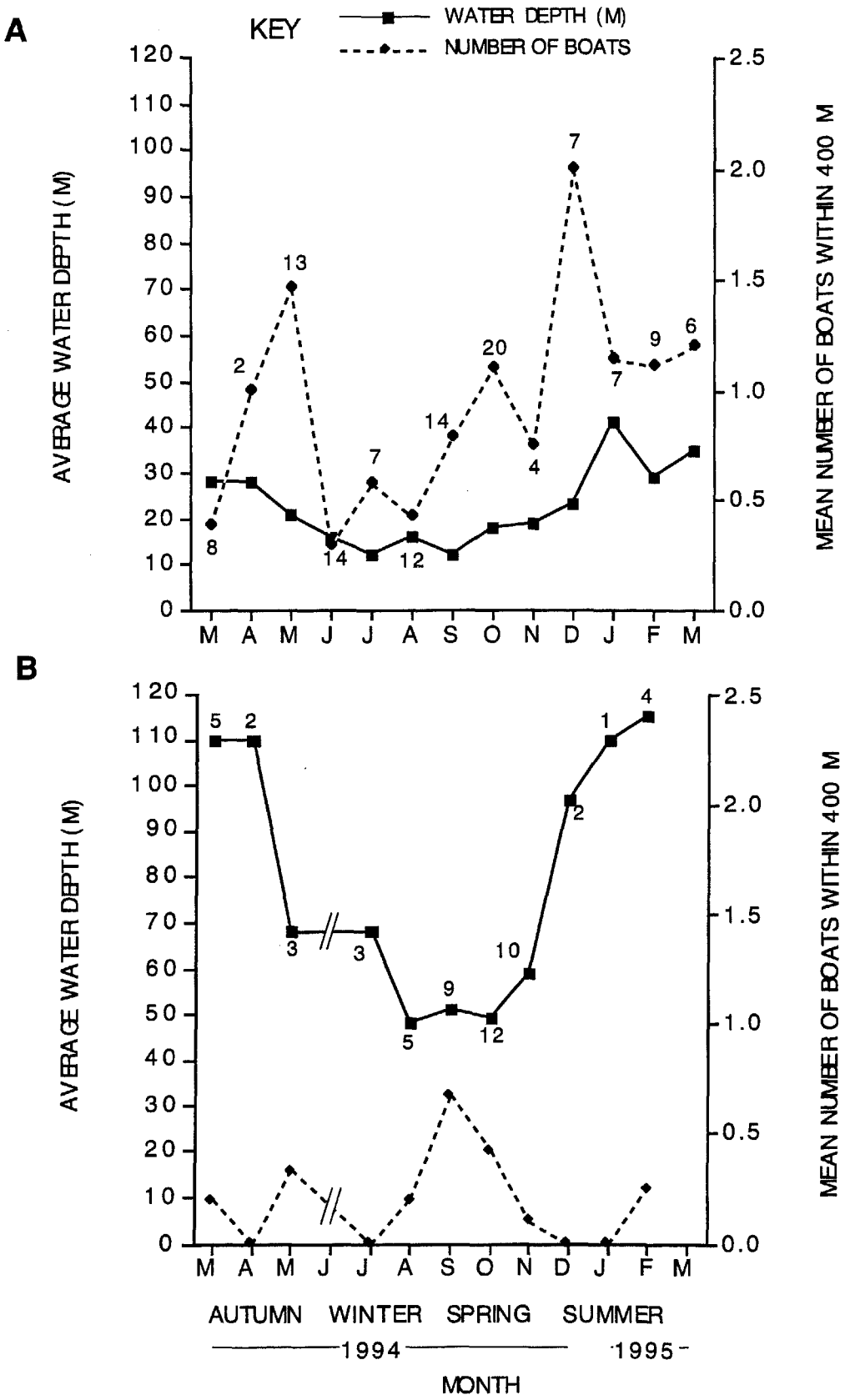

FIGURE 8. MEAN MONTHLY WATER DEPTH AND NUMBER OF BOATS WITHIN 400 m OF THE DOLPHINS. NUMBER OF GROUPS OBSERVED PER MONTH (n VALUE) APPEAR BY THE DATA POINTS.

A: BOTTLENOSE DOLPHINS; n = 123.

B: COMMON DOLPHINS; n = 56.

CASE 3 - Encounter #135-4 On 8 October 1994, 15 adult bottlenose dolphins were milling/feeding by Poroporo Island. A ten metre private motor launch proceeded to drive in circles at a speed of 5-10 knots around the dolphins, and swimmers from the commercial swim-with-dolphin boats who were in the water at the time. Two of the dolphins were bowriding the launch but the rest of the dolphins remained as a tight milling group away from the swimmers but inside the circle of wake formed by the launch. When the boat stopped circling, the dolphins passed outside the circle of wake and resumed milling as a scattered pod.

CASE 4 - Encounter #4-1 On 4 March 1994, a pod of 20 common dolphins was encountered 2.25 nautical miles north of Piercy Island (Motukokako Island). These dolphins joined with a larger pod of 60 dolphins and proceeded to porpoise travel at a speed of 5-7 knots in a southerly direction. There were four boats present and some of the dolphins were bowriding these boats. There was a six metre boat travelling behind the dolphins but at the same speed, a 12 metre boat travelling parallel to the dolphins and a 6.6 metre boat which accelerated past the dolphins and stopped 150 metres ahead of the dolphins but directly in their path of travel. Swimmers immediately entered the water from this boat. All dolphins in the pod immediately stopped their porpoise travel and milled for five to ten seconds as a tight group. They then changed their travel direction to an easterly course as there were boats to the north, south and west, and the pod continued travelling.

CASE 5 - Encounter #31-3 On 10 May 1994, twelve adult bottlenose dolphins were encountered socialising and travelling slowly off Te Hue Point. There were four to six boats present for most of the encounter. As the dolphins slowly travelled past the stationary boats at a distance of 50 metres, a six metre outboard-powered fishing boat accelerated from being stationary and parallel to the dolphins and turned sharply to stop five to ten metres directly in front of the dolphins. The dolphins stopped their travel immediately and changed direction away from the boat.

Responses to swimmers

CASE 1 - Encounter #15-1 On 28 March 1994, a mixed age pod of ten bottlenose dolphins were scattered near the Black Rocks. There were seven swimmers in the water, all from the commercial swim-with-dolphin operator's boat. In an attempt to attract the dolphins, one of the swimmers slapped his fins hard on the surface of the water. Immediately following the two loud slaps the ten dolphins came together as a tight group, having previously been scattered over a distance of100 metres, and dived, surfacing 150 metres away from the swimmers. They then became a scattered group again.

CASE 2 - Encounter #109-1 On 17 September 1994, a pod of approximately 100 resting common dolphins were encountered. At 10:16 three swimmers entered the water from the commercial operator's boat. One of the swimmers jumped into the water making a loud slap sound with her fins upon entry. At this point there were three dolphins approximately 15 metres from the boat and swimming towards the two other swimmers who had already made quiet entries into the water. As the swimmer hit the water the dolphins immediately changed direction and swam away from the swimmers.

CASE 3 - Encounter #175-1 On 8 December 1994, a mixed age pod of 30 bottlenose dolphins was encountered on the seaward side of Waewaetoria Island. At 13:05 they were a tight resting group and had been resting for approximately 30 minutes and had remained on the same course for this period of time. The commercial operator placed swimmers in the water at this time to the side of the dolphins. The whole pod abruptly turned 180° and increased their speed slightly. After moving 50 metres from the swimmers, they then resumed their slow resting behaviour.

2.4 DISCUSSION

2.4.1 Effort and success

The commercial swim-with-dolphin operators in the Bay of Islands had an 86% success rate in encountering either bottlenose or common dolphins on a given trip during the twelve month research period. The chance of encountering bottlenose dolphins was more than twice as high as the chance of encountering common dolphins. This difference reflects both the distribution of the two species and the strategy of the operators. It was typical that the more sheltered inner islands area was searched first before the operators moved out to deeper waters. This occurred particularly in winter when the chance of bad weather and therefore a less pleasant trip for the customers was higher.

Dolphins were more easily found during late winter and early spring. This was related to the seasonal difference in habitat use by both bottlenose and common dolphins who were generally found in deeper waters further from port during summer (see Section 3.3.4).

2.4.2 Responses to swim-with-dolphin boats

Responses to approaching commercial swim-with-dolphin boats in the Bay of Islands differed significantly between bottlenose and common dolphins. Bottlenose dolphins were less responsive to the approaching boats than were common dolphins. When either species did respond to the presence of the boat, then it was predominantly an approach response in the form of bowriding, although in the case of bottlenose dolphins 4% of approaches resulted in the dolphins diving to avoid the boat. This avoidance behaviour was not observed with the common dolphins.

It is possible that pods of dolphins in the Bay of Islands are avoiding boats before they are sighted by the operators. If so, the pods that were encountered during this research period could be pods that are tolerant of, or attracted to boats. Baker and Herman (1989) found that humpback whales responded to the presence of vessels up to 4000 metres away. Au and Perryman (1981) found that spotted *(Stenella attenuata)* and spinner dolphins *(Stenella longirostris)* made evasive direction changes away from a purse seine trawler often at distances approaching the horizon.

Bottlenose dolphins were most frequently encountered travelling and common dolphins were most frequently encountered feeding. The behaviours least likely to change as the boat approached to within 100 metres were feeding for

bottlenose dolphins and resting for common dolphins. As these are important life functions for the dolphins, it is encouraging that they were rarely disturbed by the approaching boats. In 25% of approaches to resting bottlenose dolphin pods, a behavioural change to travelling was observed. It is possible that the dolphins were disturbed from their resting state by the approaching boat. It is also possible that they may have been ready to move out of their resting phase naturally. In order to minimise the risk of boats disturbing the dolphins, resting pods should be approached with caution.

Almost half the common dolphin pods engaged in feeding had individuals approach the boat to bowride. This may be explained by the large feeding aggregations that form when common dolphins feed, allowing only a certain number of individuals to feed on the ball of fish. It is possible that the dolphins that approached the boat may have already fed to saturation or were not ¡mmediately involved in the cooperative feeding process.

2.4.3 Swim success and behavioural responses

An encounter with a pod of dolphins did not necessarily imply that a swim would be attempted. Reasons for not swimming with dolphins were dictated by conditions of the operator's permits, passenger safety and the operator's prediction of success of the swim. Swimming with juveniles is not permitted under the Marine Mammal Regulations (1989) and the operators are bound by these regulations, although there were instances where the operators allowed swimming with juvenile dolphins due to ambiguity in defining the term `juvenile'. Also, swimming was not allowed when the sea conditions were too rough. This was a safety measure by the operators as rough seas made retrieval of the swimmers potentially dangerous.

A swim was attempted with only 37% of all pods of dolphins encountered and of those, there was twice the chance of swimming with a pod of bottlenose dolphins than with common dolphins. This difference could be explained by the commercial operators' perception of bottlenose dolphins as a friendlier, more interactive species and therefore a greater willingness on their part to place swimmers in the water. Another contributing factor could be the different species' behaviours and habitat use. The common dolphins were frequently found feeding or travelling, and these behaviours were generally not conducive to a good swim as the dolphins would usually not interact with the swimmers. Bottlenose dolphins tended to interact with the boat more often than common dolphins if the boat was stationary, and swimmers would then be placed in the water. Also, if the dolphins were socialising they would often come to observe the swimmers.

Swim response

The response of dolphins to swimmers was somewhat independent of operator ¸success' as defined above. Sometimes swimmers would see the dolphin but only briefly as it swam by without changing course. Only a sustained interaction i.e., one where the dolphin repeatedly swam within five metres of the swimmers, is evidence that the dolphins were attracted to the swimmers. Sustained interactions occurred on 48% of all swims with bottlenose dolphins.

Bottlenose dolphins made no apparent response to the swimmers (neutral) on 30% of all swims and actively avoided swimmers on 22% of all swim attempts.

For common dolphins, there was only a 24% chance of a sustained interaction with the swimmers. The common dolphins were as likely to ignore the swimmers (38%) as they were to avoid them (38%).

2.4.4 Effects of swimmer entry strategy on dolphin response: ,success' v. `risk'

There were three boat strategies employed by the operators in order to place swimmers in the water: `line abreast', `in path' and `around boat'. These strategies influenced the dolphins' response to swimmers and were influenced by the dolphins' pre-swim behaviour. Each strategy had the potential to result in a successful swim as defined by the operators criterion, but it also carried the risk of the dolphins avoiding the swimmers. Each of these strategies are discussed below.

The `line abreast' strategy offered the dolphins the most options to respond. This provided the best opportunities for studying the dolphins' attraction to humans in the water. In the `line abreast' strategy, the dolphins had three choices: 1) to actively change course in order to interact with the swimmers, 2) to remain with their behaviour prior to the swimmers entering the water, or 3) to change course away from the source of disturbance, and thereby avoid the swimmers even though they would not have encountered them had they stayed on course. For bottlenose dolphins this method resulted in the lowest rate of avoidance (10%) for all swimmer strategies and it provided the highest rate of neutral responses (47%). There was an almost equal chance that the dolphins would engage in a sustained interaction (43%) or ignore the swimmers. For the `line abreast' strategy there was a 4:1 ratio of approach v. avoidance for bottlenose dolphins.

The `around boat' strategy was used when the dolphins were already attracted to the boat to bowride. The operator then slowed the boat to enable the swimmers to be placed in the water. The dolphins had the same two choices with the `around boat' strategy as they did with the `in path' strategy. They could continue their behaviour prior to the swimmers' entry and thereby inevitably encounter the swimmers, or they could actively avoid the swimmers by swimming away. With the `around boat' strategy, the bottlenose dolphins had an approach v. avoidance ratio of 3:1. This was the highest rate of sustained interaction by the dolphins (63%), but the risk of avoidance (20%) was greater than that of the `line abreast' option. The common dolphins had an approach v. avoidance ratio of 4:1 for the `around boat' strategy. This was a five fold increase in approaches (75%) from the `in path' strategy.

The `in path' strategy provided the dolphins with two choices: 1) to continue their behaviour prior to the swimmers entry and thereby inevitably encounter the swimmers, or 2) to actively avoid the swimmers. With the first option the dolphins could sustain the interaction by swimming repeatedly (milling) within five meters of the swimmers. Alternately, they could continue to swim through the swimmers but not hesitate to interact with them (neutral response). To

avoid the swimmers, the dolphins had to either dive or change their path of travel.

For bottlenose dolphins, the `in path' swimmer strategy had an approach v. avoid ratio of 3:5. This resulted in the highest rate of avoidance (50%) by bottlenose dolphins in all three categories, resulting in a five fold greater risk of avoidance compared to the `line abreast' strategy. For common dolphins, the risk of approach v. avoidance for the `in path' swimmer strategy had a ratio of 1:6. Like the bottlenose dolphins, this strategy provided the highest level of avoidance by the common dolphins (86%).

The `in path' strategy appears to conflict with current New Zealand law. Under the Marine Mammals Regulations (1989) it is illegal to cut a dolphin off its path of travel. There is an obvious conflict between the operators' desire to provide an optimal experience for the customers and the current regulations.

In summary, the risk of bottlenose and common dolphins avoiding swimmers was greatest for the `in path' swimmer strategy. `Around boat' entry resulted in a higher risk of avoidance than `line abreast' even though the chance of a sustained approach was greater for both species. This level of risk must be accounted for when balancing minimum disturbance to the dolphins with the optimal success rate for the operators. What results in the highest chance of a sustained interaction may also be resulting in a higher avoidance rate by the dolphins such as that observed for the `around boat' entry type.

2.4.5 Seasonal habitat use and boat numbers

The Bay of Islands experiences dramatic increases in boat traffic during summer and holiday seasons. During the New Year holidays, for example, an estimated 800 to 1000 boats may be operating on any given day (T. Jones, Department of Conservation, pers. comm.). Although it is cause for concern, the long-term ¡mpact of boat numbers on dolphins could not be addressed adequately within this 12 month research study. In an attempt to evaluate possible impacts, we examined the relationship between the number of boats within 400 metres of the dolphins, as an indicator of vessel density, and the initial water depth of the dolphins, as an indicator of habitat use. Although both species of dolphins tended to move out of the inner bay into deeper waters during summer and holiday seasons, we found no significant correlation between habitat use and boat numbers during the course of the study.

3. Demographics

3.1 I NTRODUCTION

This chapter summarises data from 12 months of boat-based research on bottlenose and common dolphins encountered during the commercial swim-with-dolphin tours in the Bay of Islands region. The commercial swim-with-dolphin boats provided a useful and economical platform from which to observe and collect demographic data on dolphins pod size, habitat use and

inter-species associations. The results of the photo-identification study on the bottlenose dolphins which use the Bay of Islands are shown and a minimum population estimate is given. Data on pod composition and age structure of the common and bottlenose dolphins is summarised. The water depths in which bottlenose and common dolphins are found are shown, along with seasonal differences in the use of the area. Finally any interspecies associations. are outlined.

3.2 METHODS

Bottlenose and common dolphins were observed and photo-identified from March, 1994 to March, 1995 in the Bay of Islands. The description of study site and general field methods follow those described in Section 2.

3.2.1 Individually identifying dolphins

Dolphins were individually identified from photographs of natural markings, a technique referred to as photo-identification (Wursig & Wursig 1977). The trailing edge of a dolphin's dorsal fin is thin and easily tattered and the nicks in their dorsal fins can persist over a number of years (Wiirsig & Harris 1990). The tooth rakes caused by one dolphin biting another are useful over shorter periods but can fade after periods of six months to one year (Lockyer & Morris 1990).

A Canon AE-1 camera equipped with a Tamron 80-210 mm zoom lens was used for the first three months of the study then a Canon EOS630 autofocus camera with a 100-300 mm zoom lens was used for the remainder of the research period. Both cameras were equipped with a motor drive. Ilford XP2 400 ASA black and white film was used to photograph the dolphins. All photographs were catalogued according to the date, time and the corresponding data sheet completed at the end of each encounter. The best photograph of each individually recognised dolphin was catalogued for comparison with future photographs.

Over 4500 photographs were taken of bottlenose dolphins but only those which were in focus and showed a lateral view of the dolphin's entire dorsal fin were matched to the catalogue. I was unable to photograph both sides of the dolphin's dorsal fin due to the operator's boat handling which I tried not to influence (see Chapter 2).

Two sources of error are possible with photo-identification (Perry et al. 1990). Photographs of the same individual may be considered different (a missed match), giving a false negative result. Alternately, photographs of different individuals may be considered the same (a mismatch), giving a false positive result. In order to minimise these errors, the photo-identification catalogue was checked by an independent observer experienced with photo-identification (A. Perry).

3.2.2 Social group composition

Pod A pod was defined as any number of dolphins moving in a similar direction or engaged in similar behaviours and each of them within five dolphin lengths of any other member of the pod (Fertl 1994a).

Newborn calf A newborn calf was defined by noticeable white dorso-ventral folds along their sides. These are thought to be the result of a recent foetal position. The foetal folds persist for four to eight weeks (Cockcroft & Ross 1990, Shane 1990a). Newborn calves also showed poor motor skills and appeared uncoordinated when surfacing.

Calf A calf was an individual that was distinctly smaller (usually half the size) than a closely associated accompanying adult (Wells et al. 1980). The calf was usually found swimming beside an adult but slightly behind it (Shane 1990a).

Juvenile Juvenile dolphins were about two meters long and often swam independently of other members of the pod (Shane 1990a).

Mother An individual was identified as a mother when sighted in close association with her calf on more than one occasion.

3.2.3 Environmental parameters

Position and water depth Upon initially encountering a pod of dolphins' the position of the pod was recorded with a Magellan handheld GPS. The position was later transcribed onto a nautical chart (Navy Chart N.Z. 5122) of the Bay of Islands area. The corresponding depth shown when the GPS position was plotted was recorded as the depth of the sighting.

Water temperature Water temperature readings were not taken in the Bay of Islands but a standardised, inshore, daily sea surface temperature reading is taken at the University of Auckland's Leigh Marine Laboratory situated 150 km south of the Bay of Islands. After consultation with Dr. Bill Ballantine and Dr. Russell Babcock from Leigh Marine Laboratory, it was decided that even though the actual temperatures from Leigh would not be the same as for the Bay of Islands, the trends in monthly water temperature changes would be comparable.

Presence of boats When the dolphins were approached by the commercial swim-with-dolphin operator to within 400 metres a count was made of the number of boats within 400 metres of the focal pod. This count included the operator's boat.

Seasons The seasons were defined as follows: 1) Autumn, March - May, 2) Winter, June - August, 3) Spring, September - November, 4) Summer, December - February. As the research covered March of 1994 and 1995, both months have been included in analyses for autumn along with April and May 1994.

3.3 RESULTS

3.3.1 Survey effort

Between March 1994 and March 1995, a total of 179 pods of dolphins were encountered on 156 trips by the commercial swim-with-dolphin operators in the Bay of Islands. This yields an average of 1.15 pods of dolphins encountered per trip. Of this total, 123 encounters (69%) were with bottlenose dolphins. In addition to these trips, surveys were conducted from an independent vessel on 14 occasions during the research period.

3.3.2 Photo-identification survey

A photo-identification survey was conducted on the bottlenose dolphins of the Bay of Islands region for 16 months from December 1993 to March 1995. During the pilot study for the research, one of us (CSB) conducted four independent boat surveys during the three months from December 1993 to February 1994. Research from March 1994 to March 1995 was conducted by Rochelle Constantine and all photographs of the bottlenose dolphins taken during this time are included in the results. Because of the large numbers in most groups of common dolphins and the relatively small number of identifiable individuals, it was decided that a photo-identification survey was not practical for the common dolphins.

Between December 1993 and March 1995, a total of 949 high-quality photographs were taken. From these photographs, 265 bottlenose dolphins were individually identified from nicks and scars on their dorsal fins. Three of these dolphins were determined to be female; two from a consistently close association with a calf (#148 and #182) and one from direct observation of her genital and mammary slits (#131). One dolphin was identified as a male from direct observation of his genital slits (#130).

The majority of dolphins were identified by small nicks and cuts on their dorsal fins which were consistent over time (Fig. 9), but four individuals had unusual markings. `Quasi' (# 272) had a spinal deformity which resulted in its tail stock being `s-shaped'. Dolphin #70 had a crescent shaped gouge across its back behind its dorsal fin. This wound was fully healed but had left a scar approximately 3 cm deep and 3 cm wide which extended well around the girth of the dolphin. This was similar to a wound caused by a rope as described by Fertl (1994a). One dolphin, `Stimpy' (#124), had the top half of its dorsal fin missing entirely. A similar wound was described by Green *et al.* (1991) for a spinner dolphin *(Stenella longirostris)* and was known to have occurred through entanglement with fishing line. A calf (`Little Timmy') was identified through its close association with its mother (#148) but also from a tumour-like lump on its right hand side at the base of its dorsal fin. This seemed to have caused the dorsal fin to bend at a 90° angle to the left. Between August, when this mother/calf pair were first identified, and late December, when the pair was last sighted, no increase in the size of the lump was noted.

An independent assessment of the photo-identification catalogue to check for matching error involved randomly selecting 15 unique photographs (i.e., individuals photographed only once) and comparing them to the catalogue. Of

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