Behaviour and ecology of common dolphins (*Delphinus delphis*) and the impact of tourism in Mercury Bay, North Island, New Zealand

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Cover: common dolphin in the Hauraki Gulf. *Photo: Karen Stockin*

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ABSTRACT

This report provides insights into the behavioural ecology of short-beaked common dolphins (*Delphinus delphis*) in Mercury Bay, on the east coast of the Coromandel Peninsula, North Island, New Zealand. The report also includes a preliminary assessment of the influence of tourism activity on common dolphins in the area. From 1998 to 2001 (excluding the austral winter months May to September) we conducted 166 boat-based surveys, resulting in 102 'focal group follows', with 118.2 hours spent observing common dolphins. In Mercury Bay common dolphins showed a geographical movement associated with seasonal changes. The dolphins were found further inshore in spring and increasingly offshore through summer and during autumn. Anecdotal reports suggest continued offshore movement over winter. However, re-sightings of identifiable dolphins indicate movement of individuals between Mercury Bay and the Hauraki Gulf to the north and west (by sea) and between Mercury Bay and the waters off Whakatane to the south. Data revealed that common dolphins spent 57% of their daylight time traveling, 21.5% milling, 13% feeding, 8% socialising, and 0.5% resting. Common dolphins were observed to prey on at least six different species of fish. Boat traffic altered the behaviour of some dolphin groups, especially those containing few individuals; however, low-level commercial tourism appeared to have little impact on the dolphins. Few attempts at swimming with common dolphins resulted in a sustained interaction. This information about Mercury Bay common dolphins will be useful for comparative purposes as recreational and tourism activity increases in the future.

Keywords: Common dolphins, *Delphinus delphis*, Mercury Bay, behaviour, ecology, activity budget, dolphin-human interactions, tourism, boating.

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1. Introduction

The common dolphin was first described by Linnaeus in 1758. Over the past 50 years, our understanding of common dolphins and other cetaceans has grown exponentially (Samuels & Tyack 2000). Two separate species of common dolphin are now widely recognised, based on genetic and morphological differences. The term *Delphinus delphis* is used for the short-beaked common dolphin, while the long-beaked common dolphin is known as *Delphinus capensis* (refer Heyning & Perrin 1994; Rosel et al. 1994). To date, only the short-beaked species has been reliably documented for New Zealand (Bell et al. 2001).

Although the common dolphin is the most prevalent species of dolphin found off the east coast of the North Island of New Zealand, there has been no empirical investigation of the species in this area. In order to redress this, a 3-year study on the ecology and behaviour of common dolphins was conducted in Mercury Bay, on the

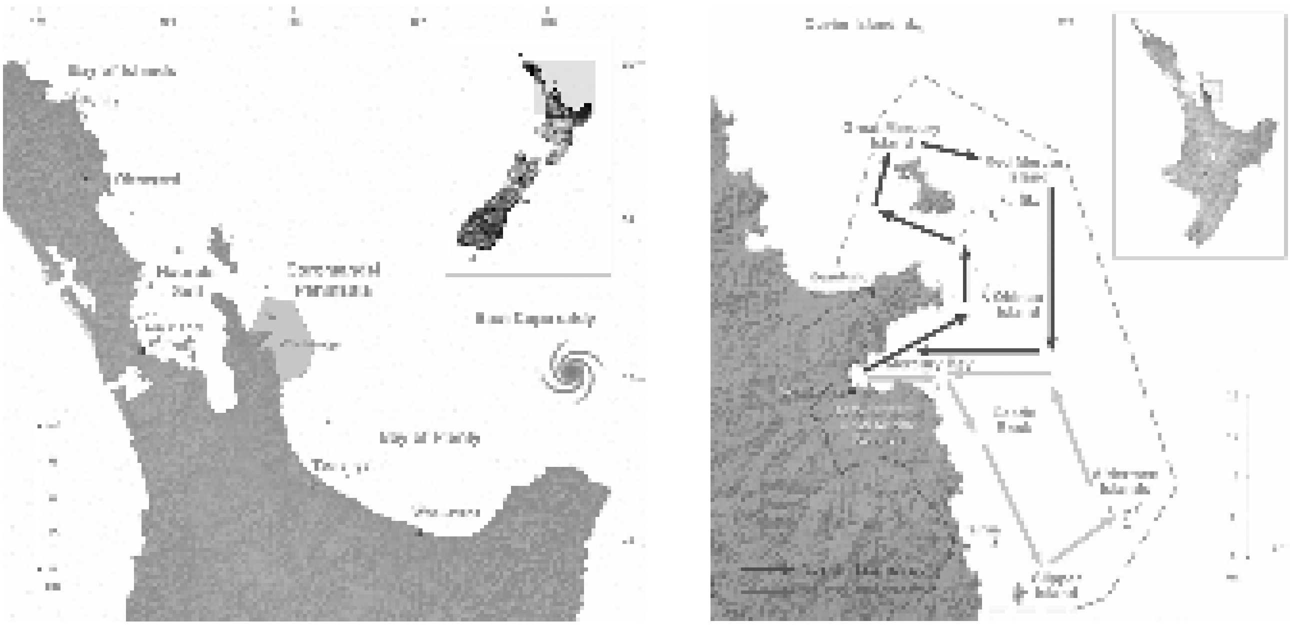

Figure 1. A, Map of northern North Island, New Zealand. Study area near Whitianga is shaded light grey. B, Mercury Bay study area, with arrows indicating typical survey routes.

east coast of the Coromandel Peninsula (Fig. 1). The main aim of the study was to contribute to an improved understanding of the basic behavioural ecology of this species in this area and to assess the impact of the present level of tourism.

Although there are three reported studies in New Zealand that include data on free-ranging common dolphins (Gaskin 1968; Constantine 1995; Slooten & Dawson 1995), the study reported here is the first to focus exclusively on common dolphins in Mercury Bay. This information is important because, although common dolphins are still abundant both worldwide and in New Zealand and are not listed as a threatened species, they do face a number of anthropogenic threats. For example, large numbers have been killed in bycatch associated with the yellow-fin tuna (*Thunnus albacares*) fishery in the eastern tropical Pacific (Evans 1994). Furthermore, bycatch of common dolphins associated with the jack mackerel (*Trachurus novaezelandiae*) fishery around New Zealand has also been reported (Slooten & Dawson 1995). Deliberate killing of this species has occasionally occurred in Australia (Gibbs & Long 2001; Kemper et al. 2001). Although there is no suggestion that such mortality is an issue for Mercury Bay, there is concern over the potential impact from 'dolphin-watch' and 'swim-with-dolphin' tours. Common dolphins are targets for a number of swim-with-dolphin operations around New Zealand (Constantine 1999a) including in Mercury Bay and the wider Bay of Plenty. There is evidence that other cetacean species are negatively affected by such tourism operations (Kruse 1991; Constantine 1995; Corkeron 1995; Barr 1997; Bejder et al. 1999). There has, however, been no specific consideration of the impact of such operations on *D. delphis* (but see Constantine 1995 for information on Bay of Islands common dolphins and tourism).

Identifying potentially harmful impacts will be valuable in addressing and mitigating them (Valentine 1990). This can contribute not only to the welfare of the dolphins, but also to the viability of tourism operators, who rely on a healthy and abundant population of dolphins for their livelihood. The importance of baseline information for such an assessment was pointed out by Constantine (1999a, p. 5); 'One of the most important aspects of evaluating the effects of tourism on marine mammals is the presence of pre-disturbance baseline data on the population size, habitat use, home range, and behavioural ecology of the target species.'

There is currently some cetacean-based tourism activity in the Mercury Bay area, but it is very small in scale, with fewer than 20 trips per summer season. This study is, therefore, an approximation of a 'pre-impact' situation. This is particularly relevant for Mercury Bay because of the substantial plans for commercial development in nearby Whitianga (Auckland City Council 2001) and the continued rapid growth of the New Zealand tourism industry (Tourism Strategy Group 2001).

This report looks first at group composition and movement of common dolphins in Mercury Bay and then considers behaviour and sexual dimorphism. The potential effects of common dolphin interactions with humans are considered and suggested guidelines for managing these interactions in Mercury Bay are provided.

2. Group composition and movement

2.1 INTRODUCTION

Common dolphins are generally considered to be pelagic, with most groups occurring over the continental shelf and beyond (Gaskin 1992). There, they form large groups, sometimes numbering in the thousands (Reilly & Fiedler 1994). Overall, their behavioural ecology appears to resemble that of other pelagic dolphins, particularly some populations of spotted dolphins (*Stenella attenuata*) and spinner dolphins (*Stenella longirostris*) (Norris & Dohl 1980).

The social organisation of common dolphin groups is largely unknown. Some delphinids, such as the killer whale, *Orcinus orca*, show a high degree of natal philopatry[1] (Baird 2000), while others live in very fluid fission-fusion societies (Wells 1991). Similarities with spotted and spinner dolphins' behaviour suggest that common dolphins could tend towards the latter (Norris & Dohl 1980).

Common dolphins have a worldwide distribution and are found in all tropical, subtropical, and temperate seas. They appear to be particularly abundant in the eastern tropical Pacific (Au & Perryman 1982; Evans 1994). In New Zealand, common dolphins are seen regularly from the Bay of Islands in the north (Constantine & Baker 1997) to Kaikoura in the south (Würsig et al. 1997).

The distribution and movements of delphinids are reported to be influenced by a great number of variables. These include prey availability (Cockcroft & Peddemors 1990), sea floor profile (Hui 1979; Selzer & Payne 1988; Gaskin 1992; Gowans & Whitehead 1995; Davis et al. 1998), thermocline (Reilly 1990), oxygen minimum layer (Polachek 1987), and sea surface temperature (Gaskin 1968; Dohl et al. 1986; Shane 1994). The time of year (Bräger 1993; Barlow 1995; Waples 1995), the time of day (Saayman et al. 1973; Shane 1990a; Bräger 1993; Waples 1995), and tidal state (Würsig & Würsig 1979; Hanson & Defran 1993) have also been shown to have an effect on dolphin movements.

Common dolphins are believed to reach sexual maturity around 6 years of age, have a 10-month gestation period, and nurse their young for at least 10 months (Collet 1981). Seasonal parturition would result in higher numbers of newborn calves in common dolphin groups at a particular time of year. The peak breeding period appears to be in the middle of summer (Collet 1981; Ferrero & Walker 1995), and Constantine (1995) observed a peak in the number of newborn calves in mid-summer (January) in the Bay of Islands.

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[1] Natal philopatry refers to the tendency of offspring to remain in socially structured groups based around the mother.

2.2 OBJECTIVES

1. To determine the size of common dolphin groups in Mercury Bay.
2. To investigate the influence of season on group size in Mercury Bay.
3. To investigate the influence of season on the presence of calves and newborns in Mercury Bay.
4. To consider the influence of season on geographical movement in Mercury Bay.
5. To consider the possibility of residence of common dolphins in Mercury Bay.

2.3 METHODS

2.3.1 Study area

Over three study seasons, from December 1998 to March 2001 (with the exception of the winter months May – September each year), observations were conducted in the greater Mercury Bay area, based from Whitianga (36°50'S, 175°42'E), on the east coast of the Coromandel Peninsula, North Island, New Zealand.

2.3.2 Observation platform

Observations were conducted by three trained observers from on board a 5.5 m centre-console, rigid-hull inflatable boat with a 90 hp outboard engine. To increase the likelihood of observing natural, unaffected dolphin behaviour, 'focal group follows' were conducted in strict adherence to the Marine Mammals Protection Regulations (see Appendix 1 on p. 39) and to widely accepted protocols for field studies of small cetaceans (Mann 2000). More specifically, a 'focal group follow' protocol was utilised (see Mann 2000 and section 3.3.1 of the present publication for a more detailed description).

2.3.3 Surveys

The search for dolphins was conducted along two standardised routes, a northern and a southern (Fig. 1). During searches the waters were visually scanned for signs of dolphins, particularly dorsal fins and splashes, but also feeding gannets because of their known association with feeding common dolphins (Gallo Reynoso 1991). Surveys were conducted only in sea conditions of Beaufort 2 or less. When dolphins were sighted, their location was recorded using a hand-held Garmin 35 GPS. The number of animals in the group was counted or estimated, and the predominant group activity at the first sighting—typically from a distance of between 200 and 400 metres—was recorded. The vessel then approached closer for 'group follow' and photo-identification purposes. All information was logged by hand on to a standardised data sheet (see Appendix 2 on p. 40). Data on sea state, wind direction and speed, and sea surface temperature were also recorded for each sighting.

2.3.4 Photo-identification of individuals

Common dolphins, like many other small cetaceans, can be identified by unique shapes and markings of their dorsal fins and / or other body parts (Würsig & Würsig 1977; Würsig & Jefferson 1990). Photographs of individuals were obtained by opportunistically photographing animals that came close to the boat during group follows. Photos were taken with a Canon EOS 300 camera and a Tamron 35–200 mm zoom lens on Fujichrome 100 ASA slide film. Only crisp pictures that were completely in focus and allowed the examination of one or more distinct characteristics were used in the analysis. To determine whether identifiable individuals had been sighted more than once, the photographs were systematically checked against each other by simultaneous projection using two slide projectors side by side. Any potential matches were rechecked by an independent trained examiner.

Once the photo catalogue was complete, it was also checked for potential matches against existing photo catalogues[2].

2.3.5 Group size and composition

Following Reynolds et al. (2000), a combination of proximity-measure and the direction of movement was used to define a group. A group was defined as an aggregation of all the dolphins within visual range (naked eye, 2 metres above sea surface), as long as they were simultaneously moving in the same direction when traveling.

A visual count or estimate of the number of animals in the focal group was one of the variables recorded. Estimates were always based on the minimum number of animals positively identified as different individuals, and can therefore be considered conservative. When estimated numbers exceeded 50 individuals, a subsection of the group was focused on. The animals in this subgroup were counted, and an estimate of total group size was extrapolated from this figure. Thus, group sizes greater than 50 were recorded as an estimated range.

In order to judge the age composition of each group, numbers of dolphins in three size-based categories were estimated. These categories were:

- *Newborns:* young calves that still showed fetal folds, or animals that were of typical newborn size, 80–120 cm (Evans 1994), without the folds being apparent.
- *Calves:* animals ranging in size from 130 to 160 cm, as long as they were still traveling in the typical calf position alongside an adult individual.
- *Adults / Sub-Adults:* any animal not belonging to one of the two categories above. These were apparently fully grown individuals (180–220 cm in length), physically mature, but not necessarily sexually mature (Collet & St Girons 1984). Sub-adults—immature animals that were not yet fully grown but were larger than calves and did not travel in the typical calf position alongside an adult individual—were also included in this category.

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[2] Catalogues were created by Nicolle Van Groningen, Zee Aquarium, Bergen aan Zee, The Netherlands (Whakatane area, January – July 1998, 108 individuals) and Alexandra Leitenberger, University of Vienna, Austria (Hauraki Gulf, November 2000 – March 2001, 500 individuals). Both unpublished.

2.3.6 Statistical methods used

To avoid pseudoreplication each focal group follow, not each data point, was treated as an independent sample. In the majority of cases, data were not normally distributed and had high variance; therefore non-parametric tests were used for analysis. Following widely accepted convention, alpha = 0.05 was used to determine significance or non-significance of relationships between variables. Because in most cases data were categorical or ranked, the non-parametric Kruskal-Wallis test was used to compare groups of data. However, in considering the relationship between distance from shore and season, the larger data set allowed the use of a simple *t*-test. This test is relatively robust with regard to departures from normality, particularly when sample sizes are not small (Berenson & Devine 1992) as was the case here. In addition, in some cases a simple comparison of proportions (*z*-test) was used to assess the significance or otherwise of relationships. Statistical tests were conducted using Minitab 14.0.

2.4 RESULTS

2.4.1 Field effort

We conducted 166 trips, producing 102 focal group follows. Of the 641 hours spent surveying for dolphins, 118.2 hours were spent following common dolphins. The mean time spent conducting focal group follows was 67.5 minutes (SD = 39.5, range 15–195). Sixty-nine follows were conducted from the research vessel with no other vessel present, and a further 33 were conducted from the research vessel when the tour boat *Seafaris* was also present. The entire data set was used to calculate the results for this section.

2.4.2 Group sizes and the influence of season

Over the 3-year study, the number of individuals in each encountered group ranged from 2 to approximately 400, with a median of 32.5 (mean = 59.36, SD = 75, n = 102). Group size varied seasonally, with the largest groups encountered in early spring (300) and late summer (400). However, there was no significant relationship between group size and season (H = 1.48, d.f. = 2, p = 0.477).

2.4.3 Influence of season on the presence of calves and newborns

The number of calves in each group ranged from 0 to 15 with a median of 2 calves per sighting (mean = 2.32, SD = 2.48, n = 102). However, there was no significant relationship between the number of calves sighted and season (H = 1.54, df = 2, p = 0.464).

The number of newborns in each group ranged from 0 to 12 with a median of 1 newborn per sighting (mean = 1.95, SD = 2.15, n = 102). Increasing numbers of newborns were observed from October throughout the spring and summer, peaking in February and March. However, this increase was not significant (H = 2.36, d.f. = 2, p = 0.307).

2.4.4 Seasonal movements in Mercury Bay

Dolphins were found at a mean distance of 11.2 km from shore in spring (October – November) (SD = 4.82, n = 36), 15.2 km from shore in summer (December – February) (SD = 12.8, n = 163), and 16.35 km from shore in autumn (March – April) (SD = 5.66, n = 57) (Fig. 2). While the change from summer to autumn was not significant (t = –0.92, d.f. = 206, p = 0.359) the increased distance from shore from spring to summer (t = 3.14, d.f. = 149, p = 0.002) and spring to autumn (t = 4.7, d.f. = 83, p = 0.000) was significant.

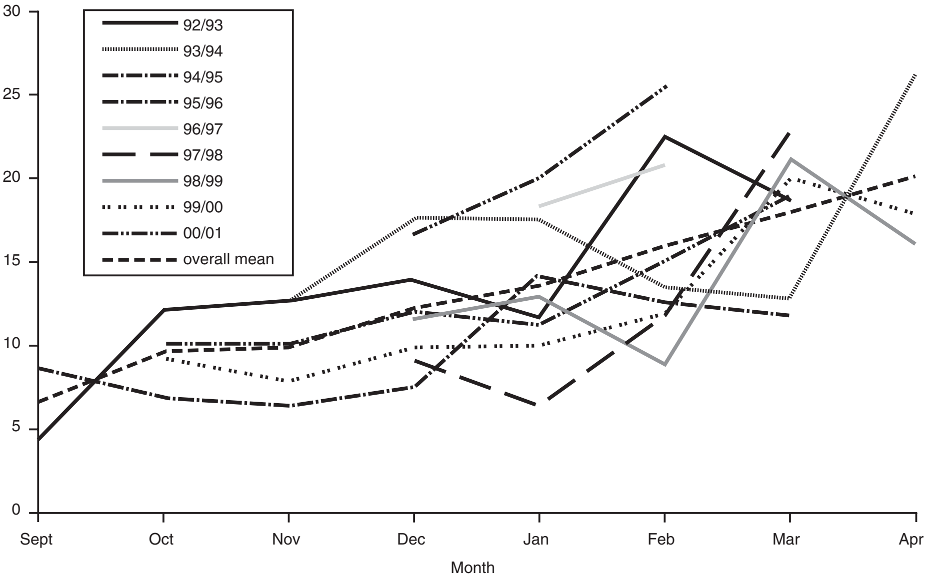

Figure 2. Mean distance from shore for common dolphin groups (excludes winter) from 1992 to 2001. Data from 1992 to 1997 were collected by Rod and Elizabeth Rae, commercial tour operators of 'Mercury Bay Seafaris'.

2.4.5 Common dolphin site fidelity in Mercury Bay

Because of the size of each group, obtaining a photograph of every individual was not possible. This precluded an assessment of the proportion of animals in each group that could be reliably identified versus those that could not. Therefore, although photo-identification is often used for mark-recapture analyses in estimating cetacean abundance (Wells & Scott 1990), such an estimate would have been unreliable for this study. However, the number of common dolphins seen in the study area must be in excess of 408 (the number of uniquely identified individuals) and could be as high as 6000 (the cumulative total number of animals observed in focal groups). The low rate of re-sightings (4.4%), and the fact that the number of identified individuals did not plateau, suggest that the actual abundance probably tended towards the higher end of this range. The rate of identifying new individuals in each focal group did not decrease over the study period.

Eighteen identified dolphins were seen more than once. Fifteen of these were seen only twice but BC 208 was identified on five separate occasions, BC 209 on four occasions, and BC 91 three times. Eleven re-sightings occurred over consecutive seasons off Whitianga. The interval between the first sighting and the next re-sighting ranged from one day (for C 374) to 983 days (for BC 91).

Four individuals were matched between Mercury Bay and the waters off Whakatane and two were matched between Mercury Bay and the Hauraki Gulf.

2.5 DISCUSSION

2.5.1 Group size and presence of newborns

The size of the groups observed in Mercury Bay closely corresponded with the findings of Leitenberger (2001), who observed a mean group size for common dolphins in the Hauraki Gulf of 54 individuals, ranging from 2 to 400 animals per group. These numbers are, however, considerably smaller than group sizes of many thousands reported for common dolphins in open ocean habitats (see Polachek 1987; Reilly 1990).

Constantine (1995) found the occurrence of newborn common dolphins in the Bay of Islands to peak in January. The numbers of newborns peaked in February–March in this study, which is consistent with the reported Eastern Atlantic pattern of most common dolphin births taking place in mid-summer (Collet 1981).

2.5.2 Seasonal movements

While common dolphins were encountered in the 500 km^2 study area on a regular basis over several months, this does not necessarily indicate that these dolphins are resident within the study area. The low frequency of individual re-sightings suggests that the common dolphins observed in the study area could represent a succession of transient dolphin groups.

Defran et al. (1999) found that bottlenose dolphins in the Southern California Bight range along the coast for distances of up to 470 km. They tend to frequent a very narrow corridor less than 1 km from shore and do not appear to mingle with bottlenose dolphins around the Channel Islands, 42 km from shore (Defran & Weller 1999). Defran et al. (1999) attributed the need to cover large distances in this area to low food abundance and patchy distribution of prey.

Studies on dusky dolphins (Würsig & Würsig 1980) and common dolphins (Cockcroft & Peddemors 1990) have related local seasonal fluctuations in the abundance of these species to the availability of their preferred prey. The distribution and abundance of small schooling fishes is strongly tied to a number of environmental variables, water temperature being one of the most important. While data on the abundance and distribution of dolphin prey for this study were not available, the dolphins' movements in this study appear closely linked to sea surface temperature (SST). When the waters were warm in spring and summer (18°–23°C), dolphins were found relatively close to shore in Mercury Bay. As SST dropped in autumn (16°–18°C), the dolphins were found increasingly further from shore. Information from the local tour operator suggested that common dolphins were absent from Mercury Bay in winter and independent surveys by the first author during the winter months (May to September) resulted in no sightings of common dolphins.

A similar movement pattern was reported in the Irish Sea where common dolphins also moved further offshore in autumn as SST dropped (Goold 1998). Barco et al. (1999) encountered five times as many bottlenose dolphins in their Virginia Beach study area in mid-summer, when SST was highest, as they encountered in spring and autumn. Constantine & Baker (1997) also found a correlation between common dolphin distribution and SST in the Bay of Islands. However, there, the trend was reversed. Common dolphins were found more often in shallow water in the winter months, when SST was lowest. In summer, when SST was highest, they were seen more often in deep water outside the Bay. It is possible that the oceanographic patterns in the Bay of Islands create a nutrient and prey distribution very different from that in the Mercury Bay area.

While these data suggest a seasonal offshore migration from Mercury Bay, there may be an alternative explanation. Dolphins previously observed near shore in the study area may have travelled north or south of the study area over winter. Thus, there could be seasonal coastal migration as opposed to an inshore–offshore migration. The matching of photo-identification records from Mercury Bay and the waters off Whakatane demonstrated that at least some common dolphins move from one coastal location to another. However, commercial fishermen based in Whitianga have reported large numbers of common dolphins over the continental shelf 50+ km offshore (A. Hansford, pers. comm., 15 October 1998). It is not known whether these dolphins are ecologically separate from the animals observed in this study or if their sighting is a result of an inshore–offshore migration. Future satellite tracking, genetic sampling, or increased photo-identification efforts could help clarify this issue.

2.5.3 Group formation and composition

There was no indication that the number of photo-identified animals was approaching a plateau over the period of this study. This suggests that the common dolphins observed in Mercury Bay form part of a large population of dolphins. The fact that only 4.4% of catalogued individuals were seen more than once during the study may indicate the movement of a succession of common dolphins through the area. These animals may utilise the Mercury Bay habitat at different times, rather than residing in the area for extended periods. Re-sightings between years indicate that at least some common dolphins in the greater Bay of Plenty may be following some kind of annual cycle that brings them to Mercury Bay for at least a few days every year.

Re-sightings of four individuals off Whakatane (additional surveys conducted by first author not reported here) that were previously identified in Mercury Bay (200 km to the north) suggest that common dolphins can be very mobile in the greater Bay of Plenty area. Two Mercury Bay dolphins were matched for the Hauraki Gulf; at a distance of more than 100 km to the north and west of Mercury Bay by sea, this indicates that at least some common dolphins do not restrict their movements to within the Bay of Plenty.

3. Common dolphin behaviour and sexual dimorphism

3.1 INTRODUCTION

There is a conspicuous lack of scientific literature on the behaviour of common dolphins. Where their behaviour has been investigated, it has primarily focused on animals in captivity, describing their social interactions and vocalisations (Evans 1994).

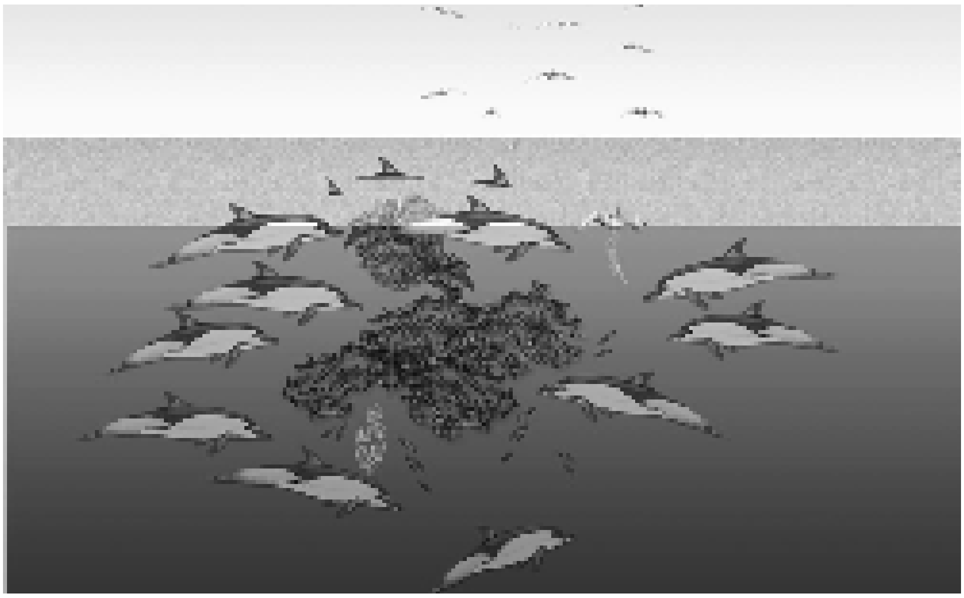

Figure 3. Carouselling: Dolphins cooperatively encircle a school of fish and trap them against the surface.

Image by Brett Orams, Orbyt Graphics.

What is relatively well known about common dolphins are their feeding habits. Stomach content analyses from various locations have shown that common dolphins appear to live on three major food groups (Pascoe 1986; Evans 1994; Young & Cockcroft 1994, 1995; Walker & Macko 1999):

- small schooling fishes, such as anchovies and mackerel.
- fishes from the deep-scattering layer, such as deep sea smelt and lanternfish.
- squid species, also often associated with the deep-scattering layer.

The deep-scattering layer organisms are normally available to dolphins only during their nocturnal migrations towards the surface. This suggests a great deal of night-time feeding in common dolphins. This has also been inferred from acoustic data (Goold 2000).

Little is known about how common dolphins capture their prey. The feeding strategies of Delphinidae are known to be highly variable. Habitat, the nature of the targeted prey, and the learning of specialised hunting techniques lead to the use of many different foraging methods. Direct observations of common dolphin feeding behaviour are scarce, but Würsig (1986), Belíkovich et al. (1991), and Gallo Reynoso (1991) have all described dolphins cooperatively rounding up small schooling fish and driving them to the surface in a tight ball, a behaviour known as 'carouselling' (Fig. 3). This type of cooperative feeding often attracts other predators, such as diving birds or pinnipeds, which will feed on the same school (Würsig & Würsig, 1980; Gallo Reynoso 1991; Wells et al. 1999).

Aspects of the behavioural repertoire of common dolphins may be comparable to that of other delphinids. For example, most 'behaviours' that are frequently performed by bottlenose dolphins in captive displays have also been taught successfully to captive common dolphins (Evans 1994). Like most odontocetes, common dolphins can be presumed to use acoustic signals, both for communication (whistles) and for hunting and orientation in their environment (echolocation clicks) (Norris et al. 1994). Various aerial behaviours, such as leaps, breaches and tail-slaps, that have been described for other delphinids (see, for example, Shane 1990a) are also performed by common dolphins. These behaviours have been attributed variously to coordination of group activity (Norris et al. 1994), shows of excitement, or agonistic displays (Connor et al. 2000).

To fully comprehend the behaviour and social organisation of a species, it is necessary to distinguish between males and females. However, common dolphins are generally accepted to show very little sexual dimorphism, although Evans (1994) believes that differences in the colouration of the area adjacent to the genitals in common dolphins from the northeastern Pacific show sexual dimorphism.

3.2 OBJECTIVES

1. To compile an activity budget for common dolphins.
2. To consider the influence of season on common dolphins' behaviour.
3. To identify prey items.
4. To investigate the existence of sexual dimorphism in common dolphins.

3.3 METHODS

3.3.1 Sampling regime

The observational sampling of cetacean behaviour can be extremely difficult and all sampling methods have some shortcomings. To obtain adequate data, 'it is practical and advisable to use more than one sampling method' (Mann 2000, p. 63). In this study, visual observations were aided by documenting some behaviour on video using a Sony 900 E digital handycam. A custom-built underwater housing on a 2 m stainless steel pole also allowed for underwater filming while the observers remained on board the research vessel. The original descriptions of the behavioural sampling techniques discussed here can be found in Altmann (1974) and Martin & Bateson (1993) while the terminology used below follows Mann (2000).

Focal animal sampling was not an appropriate option for this study because groups were often large (> 50 individuals), individuals were rarely recognisable in the field from natural markings, and individuals frequently changed their position within the group. It would not have been possible to follow one individual consistently without driving the boat through the group, potentially causing considerable disturbance. As a consequence, 'a focal group follow', protocol was chosen for data collection. To minimise potential bias, it followed Mann's (2000, p. 110) recommendations: 'When conducting a focal group follow' an estimate of predominant group activity can be achieved by explicitly scan-sampling over 50 percent of the individuals, rather than by "watching" the group.' This was accomplished by instantaneous scan-sampling at 3-minute intervals. Mann (p. 105) also states: 'The sampling protocol must include a "decision rule" for when one or more animals leave the group'. This was addressed by creating the following *a priori* rule: When the focal group split into two or more separate groups, the follow was continued with the group that stayed on a course parallel to the research vessel, regardless of whether it was the larger or the smaller group. This was possible because the two groups never simultaneously deviated from their previous course. This rule was employed to avoid harassment of the dolphins. Following the 'breakaway' group would have necessitated piloting the research vessel through the parallel group.

3.3.2 Behavioural states

To establish how much time common dolphins spent on various activities, the focal group was scanned every 3 minutes and data on 'activity states' were recorded. Following Mann (2000), activity state was defined as the behaviour that more than 50% of the animals in the focal group were involved in at each time point. Five categories of activity state were used. These categories were derived from the definitions used by Shane (1990a), Hanson & Defran (1993), and Waples (1995) for bottlenose dolphins.

Resting: The dolphins stayed close to the surface and close to each other. They surfaced at regular intervals in a coordinated fashion, either not propelling themselves at all, or moving very slowly forward.

Milling: The dolphins were swimming but frequent changes in direction prevented them from making noticeable headway in any one direction and they remained in the same general area. Often different individuals in the group were swimming in different directions at a given time point, but their frequent directional changes kept them together.

Traveling: The dolphins propelled themselves along at a sustained speed, all were headed in the same direction, and they made noticeable headway along a consistent compass bearing.

Feeding: The dolphins were seen either capturing fish or pursuing fish. The herding of fish was also included in this category as it was invariably followed by at least some fish captures.

Socialising: Any physical interactions that took place among the members of a group (except mothers and calves). These varied from chasing each other, to body contact and copulation. This was often accompanied by aerial behaviour.

3.3.3 Genetic sampling and gender determination

In an attempt to test for the possibility of sexual dimorphism in common dolphins, exfoliated skin was collected from bow-riding common dolphins during March and April 2001. DNA was then isolated from these skin samples[3]. Samples were obtained by using a slightly modified skin-swabbing technique which has been applied

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[3] Necessary permits were granted via the DOC Conservancy.

successfully to genetic sampling of other small cetaceans, for example, Hector's dolphins (Pichler et al. 1998) and dusky dolphins (Harlin et al. 1999). A 5 cm piece of velcro was glued to the tip of a 1.5 m wooden broomstick (latex gloves were worn while handling velcro to avoid contamination). This apparatus was then scraped firmly across the backs of bow-riding dolphins. When pieces of skin remained attached to the velcro, these were transferred immediately to a Falcon tube containing 70% ethanol, for preservation. DNA was then extracted from these samples[4] using a simple chelex extraction method, followed by polymerase chain reaction using X–Y related primers (Gilson et al. 1998). The results were then interpreted visually, based on the banding patterns on an electrophoresis gel. The presence or absence of a post-anal hump in these animals was determined visually during sampling for each of these individuals.

In all instances when bow-riding dolphins were sampled, an evasive reaction resulted. The dolphins immediately stopped bow-riding and separated from the research vessel. Therefore it was decided to abandon attempts to obtain further samples in this manner. Only nine samples were collected.

3.4 RESULTS

3.4.1 Activity states

During focal group follows with only the research boat present (n = 47), common dolphins spent 56.7% of their time traveling, 21.6% milling, 13.1% feeding, 8.1% socialising and 0.5% resting. The percentage of time spent by dolphins engaged in each activity category did vary between seasons, but only the percentage of time spent feeding (spring 5.5%, summer 17%, autumn 20.8%) varied significantly (H = 8.81, d.f. = 2, p = 0.012).

3.4.2 Prey

Underwater video footage allowed prey to be identified in 11 sightings of feeding behaviour. Schools of jack mackerel (*Trachurus novaezelandiae*) were preyed upon on four different occasions, juvenile (< 30 cm in length) kahawai (*Arripis trutta*) on two occasions, and yellow-eyed mullet (*Aldrichetta forsteri*) were taken on two separate occasions. On three occasions dolphins were seen chasing flying fish (*Cypselurus lineatus*) and at least once there was a successful capture. On one occasion dolphins rounded up a school of parore (*Girella tricuspidata*).

3.4.3 Sexual dimorphism

Observations of adult common dolphins during this study revealed that some individuals possessed a pronounced ventral peduncle keel or post-anal hump whereas others did not. The presence or absence of this post-anal hump was recorded for all individuals and genetically sampled. Analysis of nine samples (as collected from adult common dolphins) revealed that all post-anal hump carriers were male (n = 3). The immediate and evasive reaction to the skin swabbing technique precluded the gathering of a large sample for this analysis. However, despite the small sample, these

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[4] By K. Russell at the University of Auckland.

results are suggestive of sexual dimorphism in adult common dolphins in this location. This hypothesis is supported by the observation that calves and juveniles did not carry a post-anal hump and dolphins that were consistently accompanied by calves (i.e. presumed females) never showed a post-anal hump. In addition, an adult common dolphin found dead on 29 December 2000 in the Whitianga estuary had a post-anal hump, and direct examination revealed that it was a male.

3.5 DISCUSSION

3.5.1 Activity states

Traveling and feeding: Because there is a strong connection between traveling and feeding, the two activities will be discussed together.

Food availability is the most important factor in determining an animal's activity budget (Goodson et al. 1991; Shepherdson et al. 1993; Westerterp et al. 1995; Stock & Hofeditz 1996; Adeyemo 1997; Baldellou & Adan 1997). Other activities are usually secondary to this 'driver' (Doenier et al. 1997).

The dolphins spent most of their time traveling (56.7%). This was expected because daily and seasonal movements are likely to be governed by the distribution and availability of prey. Food resources are rarely uniformly distributed throughout the environment, which necessitates travel between foraging locations.

The daily food intake requirements of bottlenose dolphins range between 4% and 6% of body weight (Shapunov 1971; Shane 1990b). Assuming a similar range for common dolphins and a typical adult weight of 100 kg (Collet & St Girons 1984), common dolphins would consume around 5 kg of prey per day. In this study, common dolphins spent 13.1% of their time feeding. This lies within the 13–17% of time spent feeding reported for bottlenose dolphins in Florida (Waples 1995; Shane 1990a). Pacific coast bottlenose dolphins spent 19% of their time feeding (Hanson & Defran 1993), whereas Atlantic white-sided dolphins off New England spent only 9.5% of their time feeding (Weinrich et al. 2001). Such variations may partly be a result of varying diurnal activity patterns. All these activity budgets, including those in this study, are based on data collected during daylight hours. The amount of time devoted to various activities at night still remains to be determined.

Milling: The amount of time spent milling (21.6%) is comparable to the 14% reported by Waples (1995) for bottlenose dolphins. Milling has been widely used as a behavioural category in studies of dolphin behaviour (Shane et al. 1986; Reynolds et al. 2000) but few attempts have been made to explain its biological significance. Milling could mark a stage of foraging, when dolphins have reached a promising location and are investigating a given area more closely for prey. Conversely, milling could be a brief rest stop between bouts of traveling, or it could represent a transitional stage between traveling and resting / socialising / feeding. This idea is supported by studies that associate milling with other behaviours, such as feeding, socialising, or playing (Shane et al. 1986). It seems likely that milling is a transitory behaviour related to all of the above.

Socialising: Most socialising observed in this study involved interactions related to sexual behaviour, signalled by belly-to-belly contact (with or without actual intromission). Chasing one another (which in rare cases included bites directed at the tail-flukes, pectoral flippers or dorsal fin) was also scored as a social activity. The time available for socialising probably depends on how easily other more immediate requirements, such as food, can be satisfied. One might expect socialising to increase when prey is particularly abundant, and / or when females are receptive. Time devoted to socialising varied seasonally in this study, but did not show a consistent trend. Since data were not available on dolphin prey abundance or the reproductive state of female individuals, it was not possible to establish any correlations between these factors and the frequency of socialising.

Resting: In studies on bottlenose dolphins, resting ranged between 2% and 3% of time observed (Waples 1995; Hanson & Defran 1993), whereas it was not observed at all in a study on Atlantic white-sided dolphins (Weinrich et al. 2001). The low frequency of resting observed in this study (0.5%) could be a sampling artifact. When resting, common dolphins show virtually no conspicuous surface activity, which makes it very difficult for an observer to locate resting groups. Common dolphins could also generally rest in smaller groups, which would compound the problem, because smaller groups are more difficult to sight over long distances than are larger groups. The group sizes for the limited number of sightings of resting in this study were smaller, ranging from 12 to 40 individuals. Alternatively, common dolphins may rest primarily at night, when no surveys were conducted.

An alternative possibility is that the dolphins' resting behaviour was disturbed by the research vessel. The dolphins may have detected the approach of the vessel before observers on board detected the dolphins and, as a consequence, by the time data collection began the dolphins' behaviour may have changed to an activity other than resting.

3.5.2 Prey

The six different prey species identified in 11 sightings of common dolphins in Mercury Bay suggest a rather opportunistic feeding pattern. Studies of the stomach contents of dead common dolphins from elsewhere also reveal a relatively opportunistic diet, consisting of small scombrids (e.g., mackerel), anchovies, and mullet, but also squid, lanternfish, and other species typical of the deep-scattering layer (Young & Cockcroft 1994, 1995; Walker & Macko 1999).

Unfortunately, it was not possible to conduct night-time observations during this study and therefore the potential importance of various species of nocturnal fishes and cephalapods in the diet of Mercury Bay common dolphins could not be determined. However, squid is commercially harvested in the outer Bay area and common dolphins have been observed by crew members during night-time fishing activities (S. Morrison, pers. comm., 12 April 2000). Squid and myctophid lanternfish are known to undertake diurnal vertical migrations, rising closer to the surface at night, where they become available to the dolphins. This suggests that squid may also play a role in the diet of Mercury Bay common dolphins.

The two locations where common dolphins were found most often in this study—around Castle Rock, and south of Ohinau Island (Fig. 1)—are areas of high sea floor relief. Common dolphins have been shown to prefer these areas, probably because fish tend to concentrate there (Hui 1979; Selzer & Payne 1988). The dolphins' apparent offshore movement in autumn may be linked to seasonal movements of their prey, which are governed by changes in sea surface temperature.

3.5.3 Sexual dimorphism

Genetic analysis of the small sample obtained in this study suggests that sexually mature male common dolphins carry a visible post-anal hump. While this result provides little quantifiable evidence of sexual dimorphism in adult common dolphins, it is worthy of further consideration. Post-anal humps are present in other delphinids (Jefferson 1990; Jefferson et al. 1997; Norris et al. 1994). Evans (1994) describes sexually dimorphic differences in the colouration of the area adjacent to the genitals for common dolphins from the northeastern Pacific. This 'genital blaze' was only apparent in a handful of individuals seen in this study, and could not be used as a reliable characteristic to distinguish between males and females. However, some individuals clearly showed a post-anal hump. In addition, photographs of dead common dolphins of known sex (Heyning & Perrin 1994, pp. 8–9) clearly show a post-anal hump in all adult males while it is absent in the adult females. These pictures also illustrate that a post-anal hump is present in both the short-beaked (*D. delphis*) and the long-beaked (*D. capensis)* common dolphin species.

Further evidence supporting the post-anal hump hypothesis is provided in records (1992–2004) kept of necropsies of beach-cast and by-caught marine mammals from around New Zealand undertaken by staff at Massey University (P. Duignan pers. comm.). These records confirm the presence of a post-anal hump only in adult males (n = 7), while it was absent in adult females (n = 13) and also absent in sub-adults, juveniles and neonates (n = 19).

This hypothesis is worthy of further investigation for common dolphins, both in New Zealand and elsewhere. If the presence of a post-anal hump can be used as a means of identifying sexually mature male common dolphins in the field, this will be a valuable new tool that will allow researchers to improve their understanding of common dolphin social structure.

4. Common dolphins and tourism in Mercury Bay

4.1 INTRODUCTION

Many humans appear to harbour a great desire to get close to dolphins (Doak 1981, 1988). This desire has been, and still is, commercially exploited on a great number of levels, the most direct being the exhibition of cetaceans in captivity (Yale 1991; Samuels & Spradlin 1995). As public awareness about issues regarding the well-being of captive cetaceans has increased, a new trend towards 'making contact' with dolphins in their natural environment has emerged (Amante-Helweg 1996). This has contributed to the creation of a rapidly growing whale and dolphin-watching industry around the world (Orams 1999).

Cetacean tourism has great potential to increase people's awareness of a need for nature conservation, by using whales or dolphins as an iconic 'ambassador' species. A greater appreciation of the threats human activities pose to dolphins, combined with sound environmental education strategies, can benefit conservation (Orams 1995, 1997). Dolphin and whale-based tourism can also provide a non-lethal economic value for cetaceans as a commercial resource (Orams 1999). The profitability of such ventures may even help alter attitudes in nations that still conduct whaling activities, including the killing of small cetaceans. In Iceland and Norway, for example, ex-whaling boats have been re-commissioned as whale-watching boats with whales still providing the income for former whalers (pers. obs., D. Neumann). In Tonga the economic benefit of whale-watching, compared to whale-hunting, has been used to argue for the continued protection of humpback whales (*Megaptera novaeangliae*) (Orams 2001).

Adverse reactions to boat traffic have been observed for whales (Beach & Weinrich 1989; Corkeron 1995) as well as dolphins (Au & Perryman 1982; Janik & Thompson 1996; Nowacek 1999). These include longer dives, heading away from boats, and disruption of normal behaviour patterns. This may lead to short-term effects such as decreased foraging, resting or socialising opportunities (Kruse 1991; Constantine & Baker 1997; Nowacek 1999). The resulting long-term effects may be more detrimental and could include decreased survival rates, lower reproductive success, or permanent emigration (Constantine 1999a).

Because cetacean tourism is predominantly boat-based, there are legitimate concerns that such ventures could be detrimental to cetaceans' health and survival (Curran et al. 1996). For example, the majority of approaches by tour boats to dusky dolphins in Kaikoura caused changes in behaviour and, in some cases, disrupted feeding and resting activities (Würsig et al. 1997).

The potential for injury by boats is also of concern and has been reported elsewhere. During times of very high pleasureboat density in Florida, for example, bottlenose dolphins were injured in boat collisions (Wells & Scott 1997).

Swim-with-dolphins tourism, popular in New Zealand, adds another potential stressor to tourism-cetacean interactions. Both bottlenose and common dolphins have shown avoidance behaviour in reaction to swimmers (Constantine 1995, 1999b; Samuels et al. 2000).

In New Zealand, four species of dolphins are targets of commercial dolphin-watching and swim-with-dolphin operations. In the Bay of Islands, the primary target species is the bottlenose dolphin (Constantine 1995; Constantine & Baker 1997). In Kaikoura, dusky dolphins are sought out by tourists (Barr 1997), while Hector's dolphins (*Cephalorhynchus hectori*) draw tourists to Banks Peninsula and Porpoise Bay (Bejder 1997; Bejder et al. 1999). In the Bay of Plenty / Coromandel area common dolphins are the most abundant cetaceans and are the prime target for dolphin tours.

Under the Marine Mammals Protection Act (1978) and the Marine Mammals Protection Regulations (1992), the Department of Conservation (DOC) is charged with ensuring that tourism operations do not have a detrimental impact on these animals. A licensing system administered by DOC has been established. In the greater Bay of Plenty area in June 2001 there were six licensed dolphin-tour operators who primarily targeted common dolphins: one in Mercury Bay off

Whitianga, one offshore from Whangamata, two off Tauranga and two off Whakatane (DOC unpublished data). To date no study has examined the effects of this tourism activity on this species.

4.2 OBJECTIVES

1. To consider the influence of the research vessel's approach on common dolphin behaviour.
2. To consider the influence of the tour vessel on common dolphin behaviour.
3. To examine the effects of tourists swimming on common dolphin behaviour.

4.3 METHODS

4.3.1 Assessing vessel and swim impact

Data were collected from whenever the dolphin group was first sighted. Observations were made at distances that varied between 200 and 500 m from the group. While it is possible that the dolphins' behaviour was already affected by the presence of the research vessel at this distance (Au & Perryman 1982), it is difficult for a small research vessel to assess the behavioural state of small cetaceans at any greater distance (Constantine 1995; Constantine & Baker 1997). Thus, it is assumed that the effect of the research vessel was negligible at this first data collection point. The research vessel then proceeded at 'no wake speed' (< 5 knots) to within 100 m of the nearest dolphin for further recording of behaviour and photo-identification. This slow and steady approach typically took 30–90 seconds. By the time of the second data point (3-minute sampling regime), the vessel was approximately 100 m from the dolphins. Thus, behaviour change in response to the approach of the research vessel was tested by comparing the first and second data points for each 'focal group follow'. Similarly, data were collected from arrival of the tour boat (distance approx. 500 m) and during the approach of the tour boat (every 3 minutes). Data on swim attempts were collected from the moment the first swimmer entered the water.

The following variables were used to consider the influence of boats and swimmers on dolphins for this study:

Boat encounter: A vessel (either the research vessel or the tour boat) was within 500 m of dolphins. Additional vessels were encountered so rarely that their presence was not included for analysis.

Attraction: At least one dolphin changed its direction of travel and actively swam towards the boat reducing the distance to less than 5 m.

Avoidance: More than half the group changed direction and actively swam away from the following vessel more than three times in succession, thus increasing the distance between the dolphins and the vessel.

Group size: The number of individuals within a focal group was counted. When the group was larger than 50 individuals, group size was approximated.

Group composition: An assessment of the age classes contained within the focal group. Three classes were designated: adults / sub-adults only; adults / sub-adults and calves; adults / sub-adults, calves and newborns.

Duration of boat encounter: The amount of time (in minutes) that a boat was located less than 500 m distance from the focal group.

Swim interaction: Dolphins actively approached swimmers in the water to a distance less than 5 m.

Activity state: The predominant (> 50%) group activity, categorised as traveling, feeding, milling, socialising or resting.

Data on these variables were recorded at every 3-minute sampling time point and tested for association with research boat approaches, tour vessel approaches and presence, and swim attempts from the tour boat. Changes in dolphin activity state were recorded in relation to the absence, approach and presence of the tour boat and for each swim attempt.

4.4 RESULTS

4.4.1 Impact of boat traffic

Data were collected from 69 independent approaches by the research boat (no other vessels present) and also from 33 independent approaches from the tour boat (with the research boat already present). Dolphins changed their initial activity state 19 times (26.3% of observations) in response to an approach by the research vessel and 7 times (21.2% of observations) in response to an approach by the tour boat, most frequently from feeding to traveling. Overall these changes in activity state were not statistically significant ($z = 0.59$, $p = 0.557$).

Attraction and avoidance: In 31 cases (43.1% of observations) at least one dolphin was attracted to the research boat for bow-riding and in 17 cases (51.5%) at least one dolphin was attracted to the tour boat and started bow-riding. However, this difference is not statistically significant ($z = -0.81$, p = 0.419).

Avoidance of the research boat occurred in 34.7% of observations ($n = 72$) while avoidance of the tour boat occurred in 24.2% of observations ($n = 33$). This difference is not statistically significant ($z = 1.12$, $p = 0.262$). For both vessels combined, boat avoidance behaviour occurred at a mean duration of 48.6 minutes into the encounter (SD = 22.6, range = 12–110 minutes).

Group size: Mean group size was 59.36 (SD = 75.0, range = 2–400). Groups of dolphins with fewer members than the mean were not significantly more likely to exhibit boat avoidance than groups containing larger numbers than the mean (chi-square = 1.134, d.f. = 1, $p = 0.287$). For all groups that showed boat avoidance, the mean size was 44.1 (SD = 46.3, range = 3–250), whereas groups that showed no boat avoidance had a median size of 63.3 (SD = 50.6, range = 5–400).

Group composition: Calves and newborns were present in similar numbers (mean = 2) in both groups that showed avoidance and groups that showed none. Their presence or absence did not appear to influence boat avoidance (chi-square = 2.45, d.f. = 1, $p = 0.117$).

4.4.2 Swim impact

Swimming with dolphins: Swimming with dolphins was attempted on only 15 of the 33 tour boat trips. Because of this small number of observations, statistical analysis of these data was not undertaken. Observations are nevertheless reported here. Thirty-nine separate swim attempts were undertaken during those 15 trips, resulting in a mean of 2.6 swim attempts per trip (SD = 1.4, range = 1–5). Dolphins were interactive during 8 swim attempts (20.5%). The mean duration of these interactions was 3 minutes (SD = 1.6, range = 1–10 minutes).

Three swim attempts with small groups (fewer than 15 dolphins) resulted in no interactions and only 1 interaction occurred from 7 attempts with groups containing between 15 and 30 dolphins. Groups comprising more than 30 dolphins did result in increased rates of interaction (7 from 29 attempts). Swim attempts that did not result in an interaction followed a consistent pattern: the dolphins continued with their existing activity, but slowly increased their distance from swimmers. On no occasion did dolphins show active avoidance by abruptly changing direction to actively move away from the swimmers. Similarly, dolphins were not observed changing their behavioural state when swimmers entered the water.

Calves or newborns were not present during swim attempts because it is a violation of existing regulations to swim with them. The tour operator adhered to this requirement on all occasions observed in this study.

On no occasion did dolphins approach swimmers to a distance closer than 3 m nor did swimmers manage to reduce their distance from the dolphins to less than 5 m. It was also noted that a fast approach by swimmers toward dolphins resulted in dolphins gradually increasing their separation from swimmers.

4.5 DISCUSSION

4.5.1 Impact of boat traffic

The frequency of changes in behaviour from feeding to traveling in response to an approaching vessel suggests that, on certain occasions, boat traffic can interfere with common dolphins' feeding behaviour. Constantine (1995) reported that common dolphins changed their behaviour during 52% of boat approaches, while only 32% of bottlenose dolphin groups changed their activity. However, these figures cannot be compared directly with this study, because she added 'bow-ride' to the five activity categories used here. 'Bow-riding' was not scored as a separate activity category in the current study because it did not fulfil the definition of a predominant group activity, at any time (i.e. > 50% of the group being involved in a certain activity).

While it is tempting to interpret a dolphin's approach to vessels to bow-ride as a positive response to vessel activity, it is important to recognise that this could still have negative long-term effects, for example, by reducing the amount of time spent feeding or resting (Janik & Thompson 1996). If the close proximity of vessels is a source of stress for dolphins this could have a negative impact on their physical fitness (Bejder et al. 1999; Orams 2004). Because of the implications for cetacean conservation an increasing number of studies are now addressing this issue (e.g. Nowacek 1999). Observed reactions reported in the literature range from an initial attraction to boats for Hector's dolphins (Bejder et al. 1999) to changing direction and avoiding boats as far as 6 miles away for spinner and spotted dolphins (Au & Perryman 1982). Kruse (1991) reported that killer whales increased their travel speed when boats were present but maintained their heading, and Acevedo (1991) showed that bottlenose dolphins in a busy shipping channel showed changes in their behaviour when boats started to follow rather than bypass them. In Sarasota Bay, bottlenose dolphins dived longer as boats passed near them (Nowacek 1999), and bottlenose dolphins in the Moray Firth appeared to take longer dives and / or move away from approaching boats (Janik & Thompson 1996).

The reactions by common dolphins observed in this study appear to correspond closely to those found by Bejder et al. (1999) for Hector's dolphins. Hector's dolphins showed an initial attraction to boats for 'bow-riding' lasting up to 50 minutes. After 70 minutes the dolphins were no longer attracted to the boat and eventually began avoiding it. The period of initial attraction found in this study for common dolphins was much shorter, and boat avoidance appeared to occur earlier (mean duration = 48.6 minutes). However, the overall pattern of an attraction-neutral-avoidance behavioural sequence is the same.

Boat avoidance appeared to be influenced by the size of the group. Large groups form partly to provide better protection from predation or other threats. This is achieved by increased group vigilance and also by a decreased likelihood of any one individual being taken (dilution effect). Thus, species of dolphins that tend towards 'schooling' behaviour, such as common dolphins, are less likely to be disturbed by an unfamiliar entity or potential threat, such as a boat, when in large groups than when they are in smaller groups. Results from this study, while not statistically significant, provide indications that group size may be an important factor influencing the likelihood of disturbance of common dolphins by human activities such as tourism.

4.5.2 Behavioural states

The behaviour of dolphins did not appear to be significantly affected by the presence of either the research vessel or the tour boat. This could be the result of:

- The skippers' experienced and responsible handling of the vessels and their adherence to the Marine Mammals Protection Regulations. This indicates that these regulations can be effective, if adhered to.
- The frequency of dolphin-watching trips being too low to have an effect in this area. Typically, around 20 trips were conducted over an entire summer. Furthermore, this study indicates that any one common dolphin group does not spend extended periods of time in Mercury Bay. Therefore it is unlikely that individual dolphins experience multiple occasions with the tourist vessel in close proximity. This decreases the likelihood of either sensitisation or habituation to these trips.

While tourism impact in Mercury Bay is diluted by being spread over various groups during consecutive sightings, this could be counteracted by the cumulative effects of tourism exposure in different places. Movements by individual dolphins from Mercury Bay to the Hauraki Gulf and from Mercury Bay to Whakatane were documented. Both locations feature a greater level of dolphin-tourism than Mercury Bay. This means that while individual dolphins may be exposed to tourism only briefly in one location, they could be subject to additional tourism activity in another location.

4.5.3 Potential impact of swimmers

Constantine & Baker (1997) reported a slightly higher rate of sustained interactions per swim attempt for common dolphins in the Bay of Islands (24% compared with 20.5% for our study) and the mean duration of these interactions was longer (5.3 minutes compared with 3 minutes for our study). However, Constantine & Baker (1997) observed an 86% avoidance rate when swimmers were placed in the path of the dolphins' direction of travel (Fig. 4A) rather than if they entered the water when dolphins were milling around the boat (Fig. 4B), a strategy that produced a 75% interaction rate. This finding resulted in a recommendation that 'in-path' placement techniques not be used by tour operators offering swim-with-dolphins opportunities. Hence the 'in-path' swimmer placement strategy was not used in Mercury Bay; this could explain the fact that no active avoidance of swimmers was observed in this study.

Constantine & Baker (1997) reported a high rate of interaction between common dolphins and swimmers when dolphins were milling around the tour boat (75% of swim attempts), but Leitenberger (2001) observed very low rates of interaction between common dolphins and swimmers in the Hauraki Gulf. Similarly, results from this study suggest that common dolphins are not particularly interactive with swimmers. However, this lack of interaction should not be interpreted as lack of impact. Cumulative effects of swim attempts have been shown for bottlenose dolphins in the Bay of Islands, where they have become more sensitive to swim attempts over 6 years of increasing tourism exposure (Constantine 1999b). These bottlenose dolphins are members of a relatively closed population showing a high degree of site fidelity (Constantine 1999b) and are therefore subject to repeated swim attempts. Such a sensitisation seems less likely to occur in the much more transient common dolphins unless the cumulative effects of tourism in different locations are significant. However, it is important to note that while it was only a short-term (6-month) observation, Leitenberger (2001) found an increase in boat and swimmer avoidance by common dolphins in the Hauraki Gulf.

The Hauraki Gulf common dolphin population may show greater site fidelity than the common dolphins observed in Mercury Bay. Leitenberger's (2001) photo-identification effort in the Hauraki Gulf had a much higher re-sighting rate than our study. In Leitenberger's study 40% of 500 catalogued individuals were seen more than once and 13.8% were seen three times or more. Frequently sighted individuals were observed throughout the entire study period in the Hauraki Gulf which suggests that at least some individuals may be present in the Gulf for extended periods of time. Their encounter rate with the tour boat—which operates far more frequently than the operator in Mercury Bay—would therefore be much higher than that for dolphins in Mercury Bay, making them more susceptible to potential habituation or sensitisation.

However, the increased avoidance rates observed towards the end of Leitenberger's November 2000 to April 2001 study coincided with a decrease in mean group size. As in this study, Leitenberger also found larger groups of common dolphins to be more tolerant, showing less avoidance behaviour of both boats and swimmers than smaller groups. She therefore argued that the increase in avoidance rates was a function of the smaller group sizes she observed in her autumn sample. Her conclusion is supported by our finding that common dolphins are less likely to be disturbed when they are in large groups.

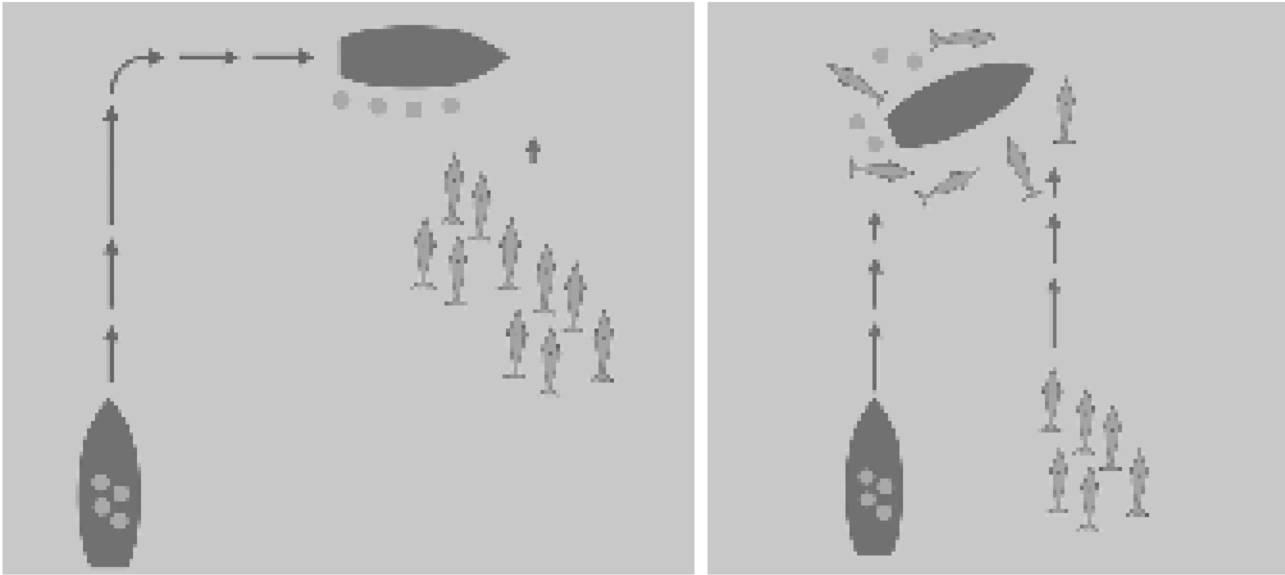

Figure 4. A, In-path placement of swimmers (represented by dots). B, Around-boat strategy for placement of swimmers.

Overall, common dolphins appear to be much less ‘receptive’ to make contact with human swimmers than the other species targeted by swim-with-dolphin tourism operators in New Zealand. This is illustrated by the brevity of interactions, the separation distance from swimmers that common dolphins seem to maintain, and the low proportion of swim attempts that result in a sustained interaction. The rates of interaction between swimmers and common dolphins reported here for Mercury Bay (20.5%) are much lower than those reported for Hector’s, dusky, and bottlenose dolphins, all of which were over 50% (Barr 1997; Bejder 1997; Constantine 1995).

The small sample size for this study and the short-term nature of Leitenberger’s study do not allow for a conclusive assessment of the impact of swimming on common dolphins. However, it is important that the sensitisation versus habituation issue be considered and studied more closely for this species. Bottlenose dolphins in the Bay of Islands are subject to intense tourism activities, and Constantine (1999b) found evidence for sensitisation of these dolphins to boats and swimmers over several years. Compared to the Bay of Islands, dolphin tourism along the coast of the Coromandel Peninsula and in the Hauraki Gulf is still in its infancy. However, human use of these areas is bound to increase, with continued growth in the New Zealand tourism industry (Tourism Strategy Group 2001), and multi-million dollar residential developments such as those in Whitianga (Auckland City Council 2001). Therefore, long-term monitoring of common dolphin populations is needed to further examine the effects of tourism on this species.

5. Conclusions

5.1 SUMMARY OF FINDINGS

The main objective of our study was to improve knowledge regarding common dolphin behavioural ecology in Mercury Bay. The study has provided new insights into this species, including the relatively small size of common dolphin groups in comparison to those reported for this species elsewhere; the suggestion that summer appears to be an important time for calving; evidence to support an offshore movement over the winter months; re-sightings confirming coastal movements for at least some individuals; a predominance of time spent traveling, at least during daylight hours; the confirmation of six prey species; and the post-anal hump as a potential visual indicator of gender in adults.

In addition, preliminary observations of low-scale tourism activity suggest that there are few impacts from tourism on dolphins in Mercury Bay. However, while common dolphins in the Bay may have a 'tolerance' of vessels in close proximity, this tolerance appears to be influenced by time duration. Results also suggest that common dolphins are less likely to be disturbed by vessel activity when they are aggregated in large groups of 50 or more individuals. Common dolphins proved, from a limited number of observations, not to be particularly interactive with swimmers. While active avoidance of swimmers was not detected, it appeared that the dolphins maintained a distance from swimmers that could be described as 'passive avoidance'.

5.2 FUTURE IMPACTS

Although this study addressed some of the issues associated with tourism-related boating and swimming activity, it is essentially a study that provides baseline information on how common dolphins behave in the presence of comparatively little human impact. It is the kind of pre-impact study that many authors have called for (e.g. Bejder & Dawson 1998; Constantine 1999a). This will be important in assessing future impacts of recreational activity on common dolphins in the Mercury Bay area. From 26 December to the end of January each summer, the population of Whitianga increases from approximately 4,000 to 35,000 (Whitianga Tourist Information Centre, pers. comm. 28 April 2001). This is due to an influx of people, chiefly from the Hamilton and Auckland areas, who own holiday homes in Whitianga and routinely spend their summer holiday there. A large number of these visitors bring their own pleasure boats to Whitianga. On a typical off-season day, between 5 and 10 private boats are launched from the Whitianga harbour boat ramp, but this figure rises to between 80 and 100 per day during the main holiday season (Whitianga harbourmaster, pers. comm. 30 April 2001).

The amount of boat traffic is set to increase even further as a result of the new 'Whitianga Waterways' development, which is specifically targeted at recreational 'boaties'. A series of canals is being constructed to create new waterfront properties with direct access to the harbour (Auckland City Council 2001). The development will provide 1600 sections, 500 of which will have direct private access to a canal. A new public boat ramp will also be built, creating a launching facility for the owners of the remaining sections (Hopper Developments, pers. comm., 3 May 2001). The Waterways development will substantially increase the volume of boat traffic in Mercury Bay and this will have an impact on the local marine environment.

Although our study shows little impact from boating activity at present, it is clear from studies undertaken elsewhere that dolphins can be adversely affected by boat traffic and they are susceptible to injury from recreational fishing activity.

Recreational fishing is a major activity in Mercury Bay. Any increase in recreational fishing could result in a decline in local fish abundance, which would have significant consequences for common dolphins in the area. It is claimed that there has been a major reduction of kelp forests in the area as a result of a population explosion of sea urchins, possibly a result of overfishing snapper *(Pagrus auratus)*, a major sea-urchin predator (R. Rae, pers. comm., 6 February 2000).

5.3 FUTURE RESEARCH

It will be important to conduct further studies on common dolphins in the greater Mercury Bay area to assess the impacts of the increased use of the Bay by recreational vessels. Our study has provided some data which could be helpful in considering those impacts in the future. In addition, the study has raised a number of other important questions regarding this species. These include:

1. Are common dolphin adults sexually dimorphic? Our study showed that only adult male common dolphins have a post-natal hump. Further empirical work could confirm this feature as a visual indicator of gender for this species.
2. Why are common dolphins found in smaller groups in Mercury Bay than reported for this species elsewhere?
3. Why are common dolphins seen so seldom in Mercury Bay in winter? Our study has suggested an offshore movement, and anecdotal reports from fishers claim sightings of common dolphins offshore over the continental shelf. Empirical work could confirm this.
4. What is the significance of coastal movement of common dolphins in the north-eastern coast of the North Island? Matches of individuals in catalogues from this study and others for the Hauraki Gulf and off Whakatane show at least some coastal movement for this species.
5. What do common dolphins do at night? This study observed very low levels of resting behaviour—is this finding an artifact of the boat-based research platform or do they rest at night?
6. Are smaller groups of common dolphins more easily disturbed by vessels than large groups? This study suggests that common dolphins exhibit ‘schooling’ behaviour and that this may influence the effects of vessel traffic, including that created by tourism.
7. Are common dolphins more susceptible to disturbance from swimmers than are other species? Results from a limited number of observations in this study suggest that common dolphins are not interactive with swimmers. There may be more active pursuit of this species by tour operators who wish to provide a close proximity swim experience for their clients.

8. What are the long-term consequences of vessels following common dolphins in close proximity? Is habituation or sensitisation a likely result?
9. What are the long-term consequences of people swimming with common dolphins and attempting to approach the dolphins in the water? Is habituation or sensitisation a likely result?

5.4 MANAGEMENT RECOMMENDATIONS

Our study has provided evidence that supports the effectiveness of the New Zealand Marine Mammals Protection Regulations (1992) in minimising disturbance to common dolphins. However, while they have been shown to be effective for Mercury Bay with regard to the currently low levels of tourism activity based on common dolphins in the area, further refinements should still be considered. The Marine Mammals Protection Regulations are generic and not specific to species or location. This study has added to a growing understanding that different species of dolphins found in New Zealand waters behave in different ways and react to human activities differently. It is also worth noting that individuals of the same species of dolphins found in differing locations have also been shown to behave differently. It is important to consider the behavioural ecology, needs and potential disturbance for differing locations and for different species even if found in the same location.

The Marine Mammals Protection Regulations allow the Department of Conservation to set specific conditions attached to a Marine Mammal Tourism Permit. Thus, a mechanism exists to 'tailor-make' management regimes for the specific needs of a species and / or location. This flexibility is important and should continue to be utilised by the Department when considering applications for the issuing or renewal of Marine Mammal Tourism Permits.

With regard to common dolphins in Mercury Bay, the authors recommend the following:

1. Common dolphins should always be approached in a cautious manner consistent with the Marine Mammals Protection Regulations (1992). To minimise disturbance, a slow and gradual approach from behind and slightly off to one side of the group is recommended. The group can then be followed by cruising at the same speed, parallel to the dolphins, off to one side and towards the rear of the group.
2. If common dolphins begin to exhibit avoidance behaviour, such as continually changing their heading away from the following boat, follows should be discontinued.
3. The amount of time spent with any group of common dolphins should be limited to a maximum of 50 minutes, to avoid reaching the average boat avoidance threshold.
4. Vessels should be discouraged from close approaches to groups of fewer than 20 dolphins.
5. A code of conduct that outlines the above recommendations should be developed to educate the recreational boating community in Mercury Bay. Posters, pamphlets and signage at boat ramps should communicate these messages to the wider community in Whitianga.

Common dolphins in Mercury Bay are facing new challenges. Increased recreational boating in the Bay is likely to increase disturbance of the dolphins. If the natural attraction and curiosity that people seem to have towards dolphins can be extended to a level of knowledge, respect and care for their welfare, then there is no reason why dolphins and people cannot co-exist with success in Mercury Bay. However, without that *kaitiaki* (guardianship) for *aihe* (the common dolphin) the privilege and joy of seeing common dolphins in the Bay could be lost.

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Appendix 1

A synopsis of those Marine Mammal Protection Regulations (1992) that are relevant to this study:

R.18. CONDITIONS GOVERNING COMMERCIAL OPERATIONS AND BEHAVIOUR OF ALL PERSONS AROUND ANY MARINE MAMMAL –

Every commercial operation, and every person coming into contact with any class of marine mammal, shall comply with the following conditions:

(a) Persons shall use their best endeavours to operate vessels, vehicles, and aircraft so as not to disrupt the normal movement or behaviour of any marine mammal:

(b) Contact with any marine mammal shall be abandoned at any stage if it becomes or shows signs of becoming disturbed or alarmed:

(c) No person shall cause any marine mammal to be separated from a group of marine mammals or cause any members of such a group to be scattered:

(d) No rubbish or food shall be thrown near or around any marine mammal:

(e) No sudden or repeated change in the speed or direction of any vessel or aircraft shall be made except in the case of emergency:

(f) Where a vessel stops to enable the passengers to watch any marine mammal, the engines shall be either placed in neutral or be switched off within a minute of the vessel stopping:

(i) No person shall disturb or harass any marine mammal:

(k) No person, vehicle, or vessel shall cut off the path of a marine mammal or prevent a marine mammal from leaving the vicinity of any person, vehicle, or vessel:

(l) The master of any vessel less than 300 meters from any marine mammal shall use his or her best endeavours to move the vessel at a constant slow speed no faster than the slowest marine mammal in the vicinity, or at idle or “no wake” speed:

R. 20. SPECIAL CONDITIONS APPLYING TO DOLPHINS OR SEALS –

(a) No vessel shall proceed through a pod of dolphins

(b) A vessel shall approach a dolphin from a direction that is parallel to the dolphin and slightly to the rear of the dolphin.

Appendix 2

The data sheet used to record the information presented in this study, and an example of how it was filled in.

DATE : 17.10.2000 LOW TIDE : 4:33 a.m. WEATHER : 10 kn SW, 1 m swell ID-FILE : Film 72: 1-15

Time	Location	Depth	Temp.	Adults	Calves	Babies	Activity	Spread	Heading	Speed	Boats	Distance	Notes
12:55	36-47-29/ 175-47-42	50 m	19 C	40	3	6	TR	150	120	7 kph	Aihe	0	
12:58				40	3	6	TR	200	180	7	Aihe	10	
13:01				40	3	6	FE	100	var.	var.	Aihe	20	gannets also FE
13:04	36-47-34/ 175-47-22	50 m	19 C	40	3	6	FE	100	var.	var.	Aihe	20	
13:07				40	3	6	FE	100	var.	var.	Aihe	30	
13:10				40	3	6	TR	100	90	5	Aihe	5	
13:13	36-47-40/ 175-47-20	50 m	19 C	40	3	6	TR	150	90	5	Aihe	5	
13:16				40	3	6	TR	100	150	5	Aihe	10	
13:19				40	3	6	MI	70	var.	slow	Aihe	10	