Aquatic Mammals 1998, **24.2**, 93–104

Range and sociability of a solitary bottlenose dolphin *Tursiops truncatus* in New Zealand

M. Müller[1], M. Z. Battersby[2], D. Buurman[3], M. Bossley[4] and W. Doak[5]

[1]*Observatoire Océanologique, Laboratoire Arago, BP 44, 66651 Banyuls-sur-Mer, France*
[2]*Dolphin Watch Marlborough, P.O. Box 197, Picton, New Zealand*
[3]*Dolphin Encounter, 58 West End, Kaikoura, New Zealand*
[4]*The Marine Environment Institute, P.O. Box 46, Uraidla, South Australia 5142*
[5]*P.O. Box 20, Whangarei, New Zealand*

Abstract

The movements and social behaviour of a solitary and sociable bottlenose dolphin (*Tursiops truncatus*) in New Zealand waters were documented between 1992 and 1997. Both the movement patterns and social behaviour observed showed substantial differences to that described for other such dolphins. The dolphin moved regularly between two ranges separated by 160 kilometres. The character of this animal's social behaviour changed during the six years of observation from being human-oriented to being more focused on other dolphin species (Dusky dolphins, *Lagenorhynchus obscurus* and Hector's dolphins, *Cephalorhynchus hectori*) and finally moving more towards socialising with other bottlenose dolphins. In March 1997, the dolphin gave birth and focused her social behaviour on her calf and also on humans again. This dolphin's behaviour indicates that at least some 'solitary' dolphins may engage in a spectrum of social contacts.

Introduction

The occurrence of wild, solitary and sociable dolphins world-wide is well documented (Lockyer, 1990) in particular for several individuals in Europe (Lockyer, 1978; Webb, 1978; Hussenot, 1980; Lockyer & Morris, 1985*a*, 1986, 1987; Pelletier, 1985; Goodson *et al.*, 1988; Morris & Lockyer, 1988; Augier, 1991; Bloom, 1991, 1993; Bloom *et al.*, 1995; Müller & Ferrey, 1995). The appearance and prolonged residence of these dolphins in coastal areas close to human activities seems both more frequent in modern times and a global phenomenon (Doak, 1995).

Lockyer (1978) noted a limited home range, often only a few bays and harbours, as a common feature of sociable wild bottlenose dolphins (*Tursiops truncatus*). 'Freddy' on the east coast of England stayed within a range of not more than 0.5 km^2 (Bloom, 1993; Bloom *et al.*, 1995); 'Simo' off the coast of Wales used a range of 25 km^2 (Morris & Lockyer, 1988); 'Percy' in Cornwall inhabited a range of around 77 km^2 (Lockyer & Morris, 1986); and the old male 'Fungie', still resident off the coast of south-west Ireland, lives in an area of less than 20 km^2 (Fitzgibbon, 1989).

Some dolphins move between what might be called 'nodal home ranges'; their behaviour is concentrated around a series of geographically separated nodes. Two are known to have shifted their ranges over long distances: the male dolphin 'Beaky' (Lockyer, 1978) around the Isle of Man, Wales and Cornwall and the female 'Dolphy' (Müller & Ferrey, 1995) around the French-Spanish Mediterranean border. Both animals were resident in small areas for several years before starting longer excursions and travels outside their home ranges. Long residency in limited home ranges as well as long distance travels between ranges have also been well documented in a few long term studies of dolphin populations (Shane *et al.*, 1986; Wells *et al.*, 1980, 1990).

This paper describes observations of a lone sociable female bottlenose dolphin around New Zealand whose travel patterns and social behaviours differ substantially from those previously described for this category of dolphin.

Correspondence should be sent to: Monica Müller Observatoire Océanologique, Laboratoire Arago, BP 44, 66651 Banyuls-sur-Mer, France. Tel.: 33-4-68.88.73.73. Fax: 33-4-68.88.73.95. E-mail: monica@arago.obs-banyuls.fr

Methods

Study animal

Observations of a female bottlenose dolphin known as 'Maui', or 'Woody' started in 1992. At this time she had relatively few scars and was approximately two metres long. Adult bottlenose dolphins in New Zealand waters are about 3.8 m long with old animals characterised by extensive scarring (Baker, 1983). Wells *et al.* (1987) classified independent young females as subadult, typically less than 2.3 m long and less than 7 years old. 'Maui' was estimated to be a subadult dolphin of about six years. She was often observed approaching boats and sustained two propeller wounds in 1992 which left distinctive scars on her left flank, just below the dorsal fin. During subsequent years, the number of scars and tooth rakes increased significantly as a result of her interactions with other dolphins.

Study area

The study area covers the Marlborough Sounds and parts of the east coast of the South Island including the Kaikoura Peninsula and the Motunau Coast of New Zealand.

Motunau Coast/Kaikoura Peninsula

Between Motunau Beach and Kaikoura Peninsula (Fig. 1) the coast is characterised by rocky headlands interspersed with coarse sandy beaches, all very exposed to the sea. Large intertidal limestone platforms are very common. The Kaikoura Peninsula is close to the deep water of the Kaikoura Canyon nutrient-rich upwellings (South & Adams, 1976). The Kaikoura range offers shelter from rough seas. The Kaikoura Peninsula has been a popular tourist destination for several years, offering whale-watching and 'Swim-with-dolphins' tours (Donoghue, 1996).

The coast between the Marlborough Sounds and Kaikoura Peninsula

This region, from Cloudy Bay to the Kaikoura Peninsula (Fig. 2), consists of several extensive sandy bays with heavy surf from storms and a pronounced swell from the south (South & Adams, 1976).

The Marlborough Sounds

Diverse habitats are found within this area encompassing about 5200 km^2 (Figs 1, 2). They range from exposed, rugged coastlines, headlands and numerous islands to a range of harbours and little bays that extend in some cases into sheltered environments and estuaries. The main rivers flowing into the area are the Wairau and Pelorous. The two important sounds in this range are Queen Charlotte Sound, 50 km long and Pelorus Sound,

Figure 1. The study area showing the three nodal home ranges: Motunau beach (1), Kaikoura Peninsula (2) and Marlborough Sounds (3).

50 km long (Nelson *et al.*, 1992). Because of mixing of subtropical and subantantarctic coastal currents of the Cook Strait (Gaskin, 1968; Hearth, 1985), the area is extremely nutrient rich with a great diversity of marine wildlife. The Marlborough Sounds are used for aquaculture farms and also for recreation.

Data collection

Movements and behaviour of the dolphin were documented by several individuals, starting in 1992. Observations continue. Regular surveys and

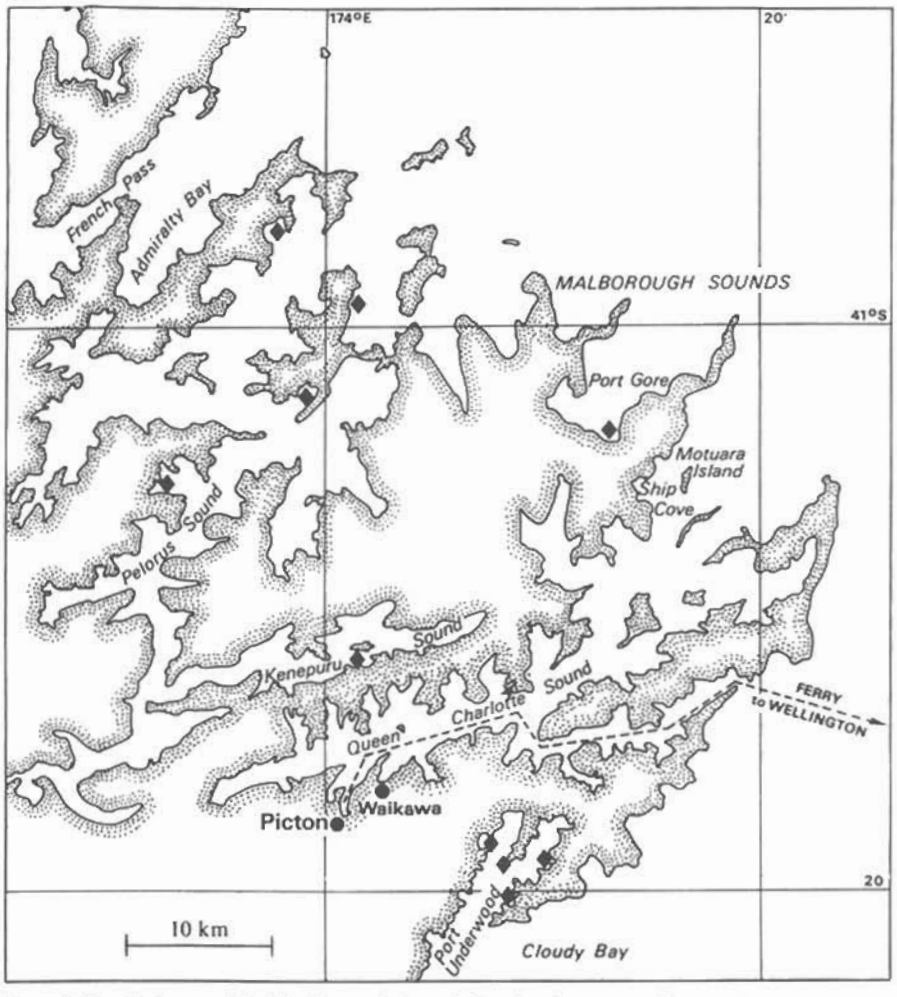

Figure 2. Detailed map of the Marlborough Sounds showing the two specific sounds mostly used by the dolphin (Queen Charlotte and Pelorous Sounds). The diamond marks frequented areas; the star indicates a salmon farm visited by the dolphin.

opportunistic observations have been made by two dolphin-tour operators, the 'Dolphin Encounter' from Kaikoura for the northern range of the east coast of the Kaikoura Peninsula and 'Dolphin Watch Marlborough' from Picton for the range including the Marlborough Sounds. Both operators have built a well-organised information network to ascertain the presence of different dolphin species and individuals in their area including sightings of 'Maui', who was well-known in both ranges and regularly joined the dolphin-boats. From 1992 till mid-1994, swim-with-dolphin tours were organised around the Kaikoura Peninsula to meet 'Maui'. The dolphin was sought with motorboats and two to four swimmers were allowed to enter the water at a time. Video recordings of these encounters were made and have been analysed to examine the surface behaviour patterns of the dolphin when interacting with humans. Several videos of interactions between 'Maui' and dusky dolphins (*Lagenorhynchus obscurus*) were also analysed to document interspecific behaviour. Dolphin behaviour was noted and analysed, using the method of 'all-occurrence-recording' (Altmann, 1974).

Definitions

The following definitions have been used for the analyses of the data concerning the range use of the dolphin:

Range. Any geographic area where the dolphin was observed regularly during a period of at least two

weeks while engaged in routine daily activities (e.g. foraging, socialising). Two different movement patterns of 'Maui' were distinguished:

Travels. Movements of more than 50 km with a shift to another coastal area for at least two weeks.

Local movements. Shorter movements of five to 50 km within a given range, during which the dolphin rested several days at different places. Some longer movements of up to 100 km in one direction were also observed within the range. Lockyer (1990) described different degrees in sociability of solitary and sociable dolphins. For most individuals, Lockyer found increasing sociability in solitary dolphins along the following order: from interacting with boats to interacting with swimmers without physical contact to behaviour towards swimmers allowing body contact. For 'Maui', six different behavioural categories were distinguished:

1. interactive only with boats;
2. interactive with boats and swimmers without physical contact;
3. familiar with humans: allowing close body contact, interactive with boats;
4. rarely interactive with humans, occasionally interactive with boats;
5. interactive with other dolphin species;
6. contact with dolphins of her own species.

Results

Movement patterns

The first confirmed sighting of 'Maui' was in February, 1992, at Motunau, 78 km south of the Kaikoura Peninsula. Following a large storm in early August of the same year, she relocated to Kaikoura which became her southern nodal home range. The size of this nodal home range gradually increased between 1992 and 1994, and then stabilised (Fig. 3). In 1994, she was sighted 150 km to the north of Kaikoura in the Marlborough Sounds. This area became her northern nodal home range. The size of this home range also increased over time and then stabilised (Fig. 4). From 1994 to 1996, 'Maui' moved between the two nodal home ranges on a regular and predictable basis: in the period between May and September, she moved to the Marlborough Sound area and back in February to the range around Kaikoura Peninsula. 'Maui's movements within the northern home range were much reduced following the birth of her calf in March, 1997, but her movements are now slowly increasing. Figure 4 displays 'Maui's total home range during the duration of the study period. The area between the two nodal home ranges appeared to be little used other than as a transit route.

Development of sociability with humans

'Maui's' behaviour towards humans changed during the course of the study. She showed a strong orientation towards humans from the beginning of the study, including allowing herself to be touched and frequently seeking close body contact. However, her response to humans was inconsistent, sometimes initiating contact and sometimes seeming indifferent or even avoiding humans. The form and vigour of her interactions often varied with the attitude of the swimmers and could include dorsal fin tows; swimming in tight circles around people and sometimes leaping over them, and an interaction pattern involving seaweed. The latter included carrying it on her fins or flukes and allowing humans to rub it over her body and even in her mouth.

'Maui' was at the peak of her human orientation in the summer of 1992/93. During this period she became increasingly boisterous with familiar humans and, following some extended interactions, attempted to prevent them leaving the water. Her interest in humans gradually declined but she remained strongly associated with boats.

In early 1997 (in the latter stages of her pregnancy), she displayed a clear intolerance to humans, including pushing them roughly with her rostrum. Following the birth of her calf she actively avoided human contact and approaching boats (note also that swimming with mother calf pairs is illegal in New Zealand).

A summary of 'Maui's' social behaviour with humans is presented in Table 1.

Sociability with other dolphins

Three species of dolphins are found in the areas frequented by 'Maui': bottlenose dolphins, dusky dolphins and the small endemic species Hector's dolphin (*Cephalorhynchus hectori*). Dusky dolphins are present in large numbers in the Kaikoura region. Hector's are found over the whole area but are not abundant. Bottlenose dolphins are mainly seen in the Marlborough area.

In the Kaikoura area, 'Maui' spent much of her time swimming with dusky dolphins (Fig. 6). Her annual departure north to Marlborough coincided with the departure of most of the duskies from Kaikoura. The dusky dolphins displayed strong avoidance reactions to her presence in the early stages of her residency in Kaikoura but gradually habituated to her. There were several observations of her attempting to mate with duskies but her efforts were not reciprocated.

In August 1995, 'Maui' spent an entire morning playing with a subadult Hector's dolphin in Picton Harbour (in her northern home range). She frequently tossed the small dolphin with her rostrum and also reared over it and pushed it under the

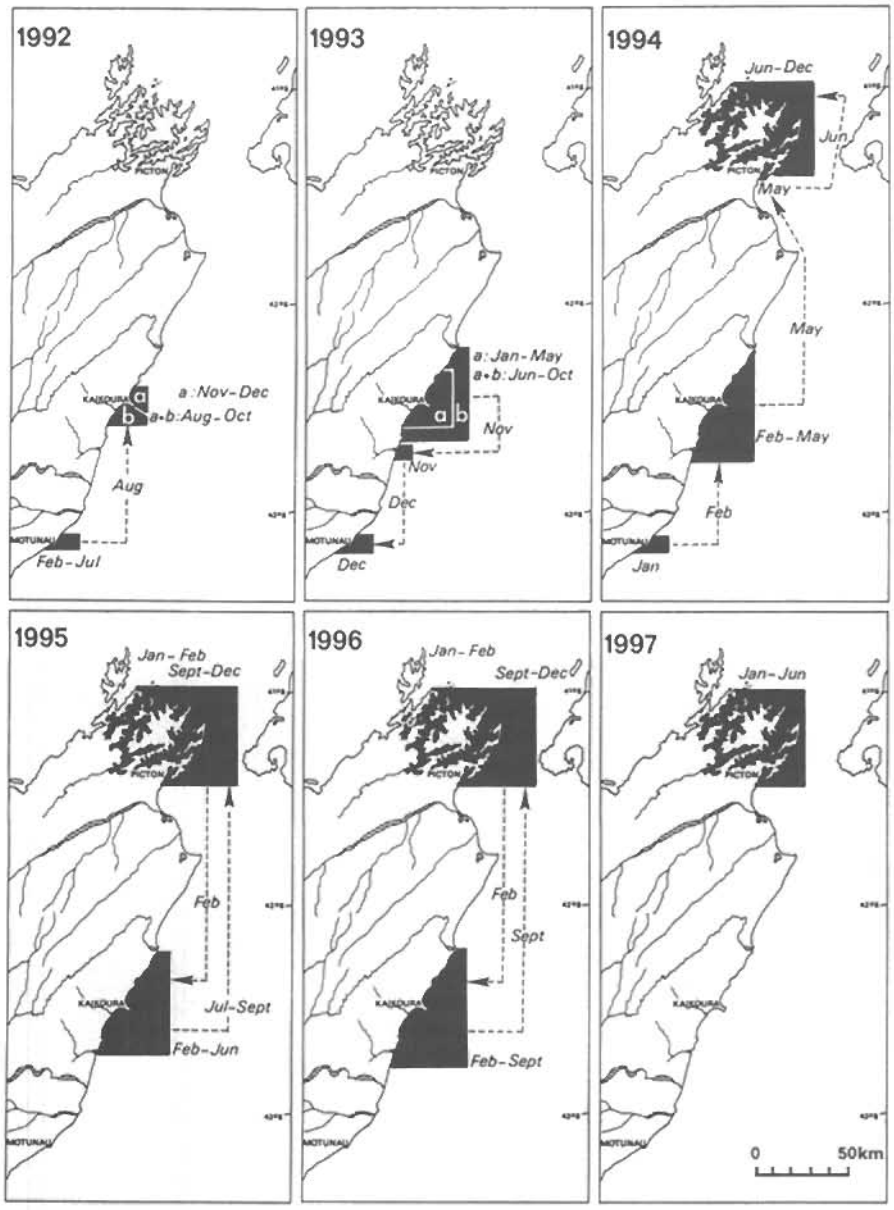

Figure 3. Home range extension from 1992 to 1997. The black areas indicate the real sizes along the coastline but not the actual extension seawards that has been estimated at 5 km from the coast. In the figures for 1992 and 1993, the signs 'a' 'b' 'a+b' at the Kaikoura range designate the different range sizes during different periods of the same year. The arrows indicate the travels.

water as if to prevent it from breathing. The Hector's dolphin was not seen again and may have died as a result of 'Maui's' behaviour.

She was seen avoiding bottlenose dolphins several times in the Marlborough area in 1994 and 1995 but in 1996 was seen with rake marks which were almost certainly (from the characteristic distance between the marks) those of a conspecific. The birth of her calf in March indicates contact with conspecifics in March of the previous year.

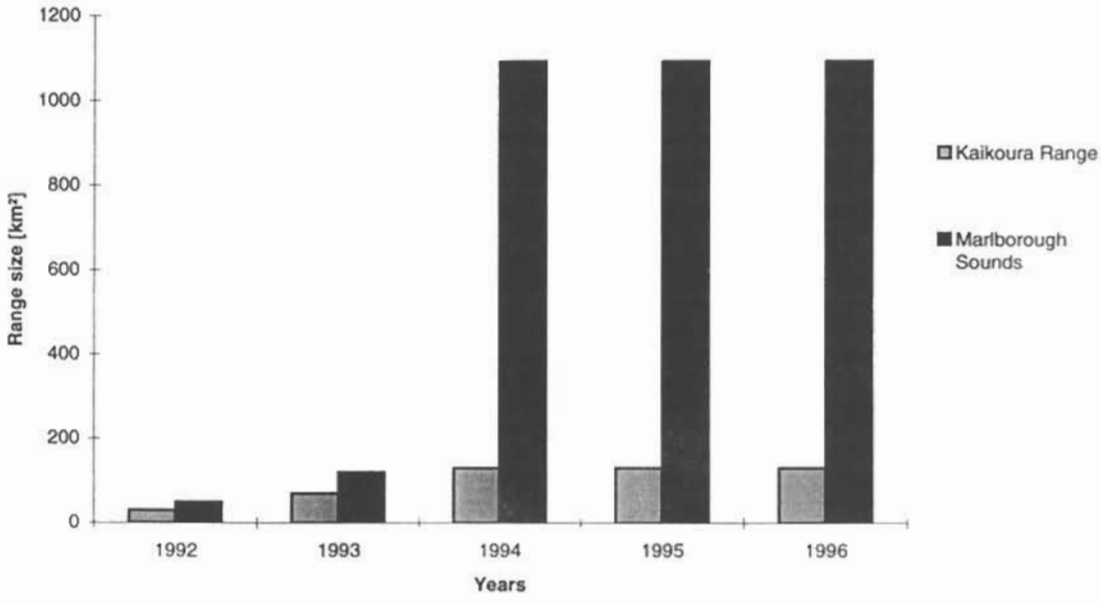

Figure 4. Extension of the sizes of the Kaikoura and Marlborough Sounds ranges from August 1992 to June 1997.

Figure 5. 'Maui' during a close interaction with a swimmer in 1994 (photo: D. Buurman).

Maternal behaviour

Since giving birth in March 1997, 'Maui' has stayed with her calf in the Picton area. When the two animals were sighted for the first time by the tour operator she was swimming calmly around different boats and followed the dolphin boat together with her calf right into the harbour of Picton. During the following months, 'Maui' and her calf 'Woodchip' (Fig. 7), were regularly observed swimming around Picton harbour and the marina at Waikawa with

Table 1. Different categories of sociability during the period from 1992 to June 1997. The six categories are: (1) Interactive with boats; (2) Interactive with boats and swimmers without physical contact; (3) Familiar with humans, allowing close body contact; (4) Less interactive with humans; (5) Interactive with other dolphin species; (6) Contact with dolphins of their own species. The three letters indicate the ranges where the dolphin was observed: M=Motunau, K=Kaikoura, S=Marlborough Sounds

Date	Sociability	Range	Behaviour
1992			
Feb–Jul	1–2	M	First appearance: accompanying fishing boats during Cray fish season, showing the inquisitive behaviour of a young animal.
Aug–Oct	2	K	First appearance in the Kaikoura region: preferred interaction with fishing boats but also interested in interacting with swimmers, quickly allowing body-contact.
Nov–Dec	3	K	More interactive and boisterous with swimmers, allowing also very close body contact during long periods of stationary behaviour.
1993			
Jan–Oct	3, 5	K	Increasingly intensive interactions with swimmers and regular swims with several people; several short observations with dusky dolphins and a few interactions with Hector's dolphins.
1994			
Jan–Feb	3–4	M	Following fishing boats, feeding in river estuaries.
Feb–May	4, 5	K	Rarely interactive with swimmers, associating frequently with dusky dolphins of local population, attempts to mate with dusky dolphins.
May–Jul	2, 3	S	First appearance in the Marlborough Sounds, familiar behaviour towards humans, allowing close contact with swimmers.
Jul–Dec	4	S	Interacting with fishing boats and sometimes also very interactive with swimmers and divers.
1995			
Jan–Feb	4	S	Interacting with boats and sometimes with swimmers.
Feb–Jun	4, 5	K	Often associating with dusky dolphins, avoiding close contact with swimmers.
Sep–Dec	4	S	Ignored several pods of bottlenose dolphins.
1996			
Jan–Feb	4	S	Interactive with boats, few contacts with swimmers.
Feb–Sept	5, 4	K	Associating much with dusky dolphins, occasionally interacting with swimmers as well.
Sept–Dec	4, 6	S	First tooth rakes of bottlenose dolphins identified on the skin, less interactive with humans, sometimes avoiding boats.
1997			
Jan–Mar	4, 6	S	Intolerant with swimmers.
Mar–Jun	4, 6	S	Accompanied by a calf. Interactive with calf and boats, no contact with swimmers.

regular excursions to the Ruakaka Salmon Farm (Fig. 2). As swimming with dolphins accompanied by calves is forbidden by law in New Zealand (Donoghue, 1996), no interactions with humans in the water were observed. However, 'Maui' was still interacting with boats with the calf mimicking its mother. Sometimes 'Maui' was 'frisky', showing slightly aggressive behaviour in the form of bumping dinghies and performing regular tail slaps in proximity of approaching boats. During the first months the mother and her calf were always observed swimming close together.

Discussion

Home range use and movements

In the present study, the New Zealand bottlenose dolphin 'Maui' occupied two separated ranges and proved to be highly mobile, covering not only the distance of around 160 km between the two areas but also frequently showing local movements over large distances inside each range. The small home range of around 50–80 km^2 that this dolphin occupied during the first year documented around Kaikoura Peninsula was similar in extent to the

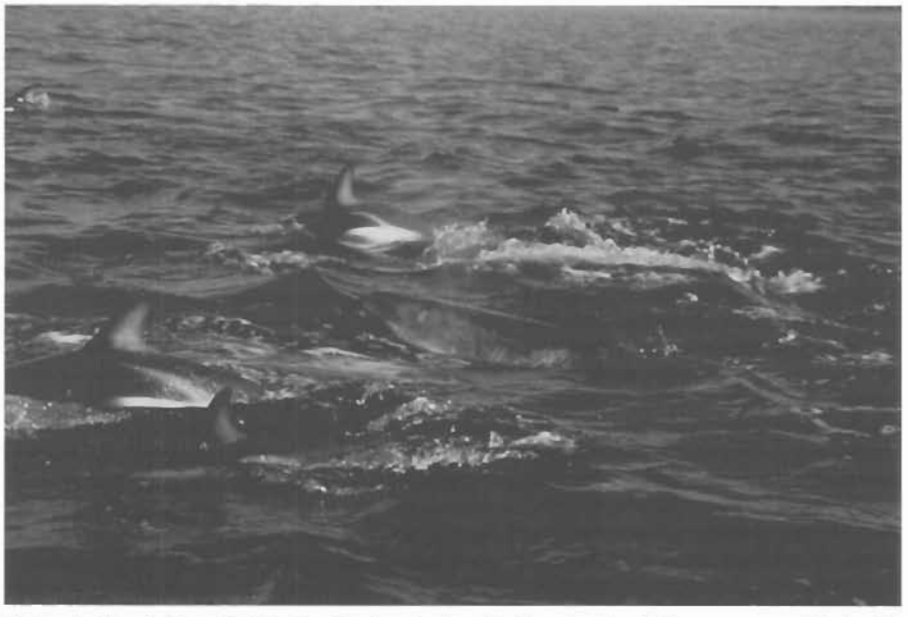

Figure 6. Association of 'Maui' with the dusky dolphins in the Kaikoura range (photo: D. Buurman).

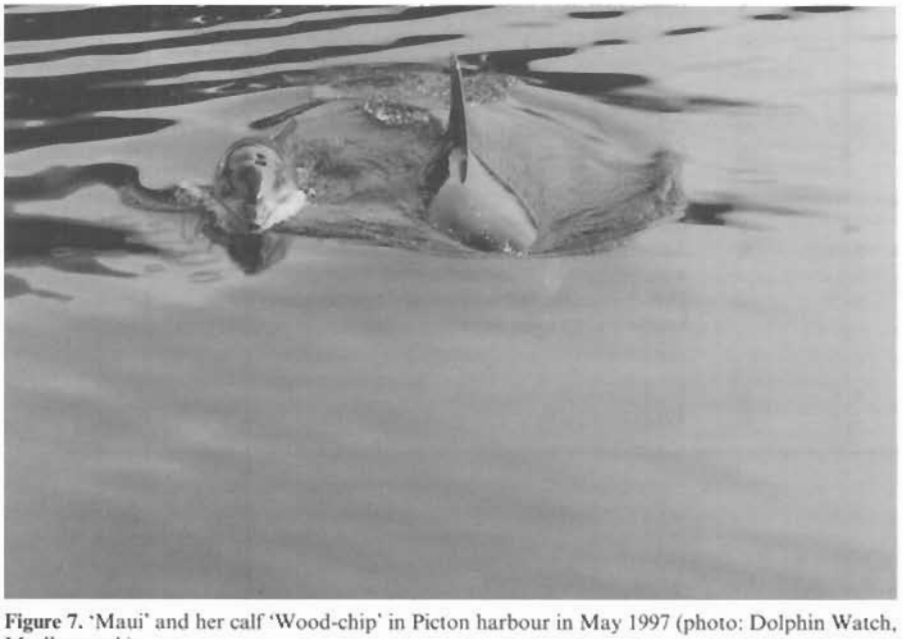

Figure 7. 'Maui' and her calf 'Wood-chip' in Picton harbour in May 1997 (photo: Dolphin Watch, Marlborough)

estimated ranges of the British and Irish solitary and sociable dolphins whose reported ranges were 0.5 km^2 for 'Freddy' (Bloom, 1993); 10 to 25 km^2 for 'Simo' (Morris & Lockyer, 1988), 25 km^2 for 'Fungie' (Fitzgibbon, 1989); and 77 km^2 for 'Percy' (Lockyer & Morris, 1986). Similar sizes in home ranges have been reported for two adult female bottlenose dolphins along the French Coast (Hussenot, 1980; Augier, 1991).

Individual and group home ranges as well as variability in home range size are reported in the literature (Caldwell, 1955; Shane *et al.*, 1986).

Range sizes between 50 and 130 km^2 for 'Maui' in the Kaikoura region are similar to those reported in the literature. Ballance (1992) found home ranges of several individuals spanned a minimum of 65 km of coastline in the Gulf of California. Irvine *et al.* (1979) reported a mean home range of 85 km^2 for a group of bottlenose dolphins in the western North Atlantic, close to the ranges size reported for 'Percy'. However, the huge size of more than 1500 km^2 that 'Maui' has used since late 1994 in the Marlborough Sounds is much bigger than any other known range for solitary and sociable dolphins (Fig. 4).

Regular local movements as observed for 'Maui' have been reported for most of the known solitary and sociable dolphins inside their ranges (Lockyer, 1990). However, only very few or no small excursions outside their chosen range during the period of their residency were documented for these individuals. Some solitary dolphins, however, performed longer travels and made similar shifts in their home range as did 'Maui' (Fig. 3). 'Beaky', an adult male solitary dolphin around Cornwall, moved distances of over 300 km to the south from his first known range (Lockyer, 1978). The female bottlenose dolphin, 'Dolphy', at the French–Spanish Mediterranean coast made two excursions of several hundred kilometres and travelled more than 600 km to the south before disappearing (Müller & Ferrey, 1995). A second New Zealand dolphin, an adult female, 'Aihe', in Golden Bay, South Island, remained for several years in a limited home range of several kilometres of coastline like 'Dolphy' and 'Maui', and then began to move gradually east, covering more than 130 km (Doak, 1995). Long distance travels of bottlenose dolphins to new areas are known from several other studies of dolphin populations. The travel of 670 km, described by Wells *et al.* (1990) for a dolphin group off the Californian Coast figures among the longest movements reported for this species.

The movements of 'Maui' within her nodal home ranges are very similar to those reported for other solitary and sociable dolphins. There are also many similarities in 'Maui's' ranges such as rocky coasts, river mouths, harbours, great fish abundance, and boat and swimmer activity (Lockyer & Morris, 1985*a*). Several factors may influence the use of different areas within a given home range by a dolphin. The most basic need is food and therefore, dolphins choose nutrient rich areas with easy accessibility to food (Bloom, 1993). Several solitary dolphins, including 'Maui', have been observed frequently close to aquaculture farms which attract many wild fish. Environmental factors like seasonal weather and sea conditions as well as tidal changes often influence the local movements of fish and therefore prey-related local movements of dolphins (Shane *et al.*, 1986). Boat traffic and other human activities are certainly factors that strongly influence the activities and movements of solitary and sociable dolphins (Lockyer, 1990). Like other friendly dolphins 'Maui' interacted with boats and this interest probably plays an important role in solitary dolphin's introduction to humans (Lockyer, 1990). Bloom (1993) reports that 62% of the movements of 'Freddy' were related to boat escorting.

Although there are many similarities in home range use and movements of the described solitary and sociable dolphins, the case of 'Maui' is unusual for several reasons. There is no report of any other wild and sociable dolphin shifting its range as frequently as 'Maui' did from 1994 to 1996. The fact that 'Maui' moved, in the period between May and September in three successive years, to the Marlborough Sound area and back in February to the range around Kaikoura Peninsula could indicate seasonality of movements; however, in the following year in February and March, 'Maui' remained in the Marlborough Sounds, possibly because of her pregnancy. There is also no report of any other solitary and sociable dolphin that associated frequently with dolphins of another species, as 'Maui' did with the dusky dolphins. She also clearly followed some of their local movements. Dusky dolphins in New Zealand often form interspecific associations with short-beaked common dolphins (*Delphinus delphis*) and are also observed with Hector's dolphins and southern rightwhale dolphins (*Lissodelphis australis*, Würsig *et al*, 1996). They are however, apart from the unusual association with 'Maui', rarely observed with other bottlenose dolphins. Würsig and Würsig (1980) observed that dusky dolphins of Golfo San José, Argentina, were rarely seen close to bottlenose dolphin groups in overlapping areas. The two species even seemed to avoid each other. Although dusky dolphins occur regularly in the Marlborough Sounds (Webb, 1973; Constantine, 1996), 'Maui' has only been seen with them in the Kaikoura region. Recent field studies indicate seasonal changes in distribution of dusky dolphins in the coastal waters of South Island (Würsig *et al.*, 1996), but there is no evidence that 'Maui's movements are related to these.

Wiley *et al.* (1994) suggest that the appearance of animals in new areas may be the result of individuals adjusting to new environmental conditions, 'ecological plasticity' or to changes in ecological conditions, e.g. water temperature, prey species distribution or abundance. It is usually difficult to decide with certainty which factor induces one particular movement.

Movements can be induced not only by external factors such as environmental changes but also by

internal factors such as the animal's condition, age and maturity and the inquisitive nature and curiosity observed within the species *Tursiops truncatus*. As 'Maui' was a subadult female in the first years of her residency around Kaikoura, the gradual extension of her home range size could possibly be related to her age. Sexual maturity for female bottlenose dolphins is believed to occur between the ages of five and twelve years (Sergeant *et al.*, 1973; Wells *et al.*, 1987). The juvenile dolphin 'Simo' off the coast of Wales initially used a range of only 10 km^2. Lockyer & Morris (1987) believed his young age to be the reason for the small range that extended to 25 km^2 as he aged. An increasing need for social contact with conspecifics is probably another factor that may become more important with the gradual maturation of a young solitary and sociable dolphin.

General behaviour patterns

The general behavioural characteristics of 'sociability' with humans are very similar among the different sociable individuals. 'Maui's fascination for escorting and interacting with boats and for approaching propellers is documented for most sociable and solitary dolphins. Her interactions with humans were also similar to 'Percy', 'Beaky', 'Simo' and others, including her interest in anything new, engaging in fast swimming games, seeking a great amount of tactile contact, and her development of different games with and without objects (Lockyer, 1990). 'Maui' displayed minimal aggressive behaviour although she could sometimes interact quite roughly. There are many reports of aggressive and sexual behaviour by other solitary Bottlenose dolphins, in particular in male dolphins (Webb, 1978; Bloom, 1993), but also in at least one female (Dudzinski *et al.*, 1995). The few incidents of aggressive behaviour by 'Maui' before giving birth to her calf were probably related to her pregnancy. There is a similar report of unusual aggressive behaviour shortly before giving birth by a second sociable female, 'Oleen', in the Red Sea in December 1996 (Goffman, pers. comm. 1996).

Developmental changes in sociability

Recently, researchers have described dolphins who appear alone in coastal areas and become familiar with humans and seek their company as 'wild solitary and sociable dolphins' or 'lone sociable dolphins' (Dudzinski *et al.*, 1995). Lockyer (1990) and Dudzinski *et al.* (1995) define the term 'sociable' as implying 'friendliness and seeking company'. This definition also involves a range of interactive behaviours with different individuals which may include aggressive and affiliative behaviour. The emergence of sociability with humans by gradual habituation is easier to explain than its ending, when an animal disappears for reasons that are mostly unknown, or becomes, like 'Maui', less interested in contact with humans. In most wild sociable dolphins the acceptance of close body contact with humans takes several months or years of gradually increasing confidence (Lockyer, 1990). Like most other solitary and sociable dolphins, 'Maui' shifted gradually from being very interactive with boats to interactions with swimmers at first without and then with physical contact (Table 1: categories 1, 2, 3). Similarly to 'Beaky' (Lockyer, 1978), 'Maui' was observed in the Kaikoura region to accept touch after a very short time of residency. This could be due to the fact that she had already become habituated to interactions with humans in her first range at the Motunaru beach (Fig. 3). Other individuals, like 'Percy' (Lockyer & Morris, 1986) and 'Jean-Louis' (Pelletier, 1985), did not accept close encounters or body contact for several years.

Although there are a few records of dolphin groups interacting with humans (Doak, 1994), most records of dolphin sociability with humans describe the behaviour of apparently solitary individuals (Lockyer, 1990). These individuals seek contact with humans although conspecifics have been present in the same range in some cases. The general opinion has been that 'solitary and sociable' dolphins have probably been excluded from their original group and are not able to rejoin conspecifics (Cousteau & Diole, 1975). These dolphins are therefore considered 'solitary' in the sense of being completely isolated from social contact with other bottlenose dolphins. The association with humans is considered by Doak (1995) and Lockyer (1990) as a possible substitute for their need to socialise and for tactile stimulation. In 'Maui's' case however, this is far less distinct, with a clear preference for human company and close body contact only during the first two years of her residency (Table 1: category 3). Her obvious alteration from sociability with humans to regular interspecific association with pods of the much smaller dusky dolphins in 1994 is very unusual for all known solitary and sociable dolphins (Table 1: categories 4, 5). Several other sociable individuals were reported to ignore available humans when playing with seals or dogs (Doak, 1995), but this has only been for short periods of several hours.

There is also much evidence that the 'solitary' state does not necessarily mean that the sociable dolphin has no social contact with conspecifics. 'Beaky' was observed with a conspecific during one week in which he avoided human contact (Lockyer, 1978). 'Pita', off the coast of Belize, had regular contact with other bottlenose dolphins (Dudzinsky *et al.*, 1995). 'Maui' seemed to avoid close contact with conspecifics several times during the first years,

but was found with tooth rake marks, probably from other *Tursiops* in 1996, suggesting regular and intimate contact with conspecifics (Table 1: category 6). She was also observed at least once with another adult bottlenose dolphin that accompanied her and her young calf. Tooth rakes were also observed on 'Percy' in the year before he disappeared (Lockyer & Morris, 1985*b*) and on 'Simo' (Morris & Lockyer, 1988). Lockyer & Morris (1985*b*) concluded from the regular observations of fresh skin marks that 'Percy' did not appear to be truly solitary, 'being rather an animal which has established a permanent home range and which either makes social contact with passing groups or has a regular group of his own in another area which he regularly visits'.

'Maui' and 'Oleen' in the Red Sea give further proof of 'solitary' dolphins having intimate contact with other *Tursiops* by the fact that each gave birth to a calf. Both females remained with their calves in their previous range while continuing to interact with humans. Many wild sociable dolphins remain as 'residents' in their home range for several years, with 'Fungie', off the Coast of Dingle in southern Ireland, residing longest with 14 years of residency (Fitzgibbon, 1989). Most solitary and sociable dolphins disappeared completely or died (Lockyer, 1990). Some of them, like 'Beaky' (Lockyer, 1978), 'Aihe' (Doak, 1995) and 'Dolphy' (Müller & Ferrey, 1995), left their original range and moved gradually along the coast before disappearing. Thus, there is some evidence that the solitary state may be temporary. 'Dolphy' and 'Aihe' have both been observed with other bottlenose dolphins during their last sightings and may have joined a group of conspecifics. 'Georgy Girl', a female bottlenose dolphin with social contact with a family in Florida was reported to have joined a male and ceased making close contact with humans (Lund, 1970). There is no documented case of a solitary dolphin definitely rejoining its kin apart from an Australian bottlenose dolphin who died accidentally a short time after having mixed with bottlenose dolphins in his range (Doak, 1995).

'Maui's' movement patterns and social behaviour are substantially different from that described for solitary, human-oriented, bottlenose dolphins, nor do they correspond to the behaviour of group-living dolphins. We suspect the behaviour of both categories of animal to be more subtle and complex than has so far been described. Long term studies of single animals may provide insights into behaviour not possible with more broadly focused studies.

Acknowledgements

This work was supported by grants from the European Union, from the French Embassy in Germany, and from Jade Production. We acknowledge gratefully the assistance of all the voluntary observers in the Kaikoura region and the Marlborough Sounds who supplied us with information regarding dolphin sightings. The first author acknowledges the Observatoire Océanologique of Banyuls-sur-Mer for continued support. Thanks also to Marie-Josée Bodiou for drafting several figures and to Nick Tregenza for his constructive comments during the preparation of this paper.

Postscipt

In the autumn of 1997 some people were seen throwing tuna bombs from the shore at Maui and her calf. The calf disappeared immediately and Maui did so a few days later. No sightings of either have been reported since.

References

Altmann, J. (1974) Observational study of behaviour: Sampling methods. *Behaviour* **49,** 227–267.

Augier, H. (1991) Les dauphins, un statut national de protection peu efficace. *Coll. Intern. 'Les espèces marines à protéger en Méditerranée'.* Marseille, France, G.I.S. Posidonie, 307–315.

Baker, A. N. (1983) Whales & Dolphins of New Zealand and Australia. Victoria University Press, New Zealand.

Ballance, L. T. (1992) Habitat use patterns and ranges of the bottlenose dolphin in the gulf of California, Mexico. *Mar. Mamm. Sci.* **8,** 262–274.

Bloom, P. (1991) The diary of a wild, solitary, bottlenose dolphin *Tursiops truncatus*, resident off Amble on the north Northumberland coast of England, from April 1987 to January 1991. *Aquatic Mammals* **7,** 103–119.

Bloom, P. R. S. (1993) The movements and activity time budget of a wild, solitary, bottle-nosed dolphin *Tursiops truncatus*. Monitored through complete 24 hour cycles. *Proc. of the 11th Conf. of the European Cetacean Society*, 67–71.

Bloom, P. R. S., Goodson, A. D., Klinowska, M. & Sturtivant, C. R. (1995) The activities of a wild, solitary bottlenose dolphin *Tursiops truncatus*. *Aquatic Mammals* **21,** 19–42.

Caldwell, D. K. (1955) Evidence of home range of an Atlantic bottlenose dolphin. *J. Mammal.* **36,** 304–305.

Constantine, R. (1996) Distribution of dusky dolphins *Lagenorhynchus obscurus* in New Zealand waters. Unpublished report for the Department of Conservation, Auckland, New Zealand.

Cousteau, J. Y. & Diole, P. (1975) Dolphins. Cassell, London, United Kingdom.

Doak, W. (1994) Swimming with dolphins in New Zealand. Hodder & Stoughton, Singapore.

Doak, W. (1995) Friends in the Sea. Solo dolphins in New Zealand and Australia. Hodder Moa Beckett Publishers Limited, Auckland, New Zealand.

Donoghue, M. (1996) The New Zealand Experience—One Country's Response to Cetacean Conservation. In: M. P. Simmonds & J. D. Hutchinson (eds) *The*

Conservation of Whales and Dolphins. pp. 423–447, John Wiley & Son, New York, USA.

Dudzinski, K. M., Frohoff, T. G. & Crane, N. L. (1995) Behaviour of a lone female bottlenose dolphin *Tursiops truncatus* with humans off the coast of Belize. *Aquatic Mammals* **21**, 149–153.

Fitzgibbon, R. (1989) The Dingle Dolphin. Temple Printing Co., Athlone, Ireland.

Gaskin, D. E. (1968) Distribution of *Delphinidae cetacea* in relation to sea surface temperatures off eastern and southern New Zealand. *New Z. J. Mar. Freshwater Res.* **2**, 527–534.

Goodson, A. D., Klinowska, M. & Morris, R. (1988) Interpreting the acoutic pulse emission of a wild bottlenose dolphin (*Tursiops truncatus*). *Aquatic Mammals* **14**, 7–12.

Hearth, R. A. (1985) A review of the physical oceanography of the seas around New Zealand—1982. *New Z. J. Mar. Freshwater Res.* **19**, 79–124.

Hussenot, E. (1980) Le grand dauphin *Tursiops truncatus* en Bretagne. Types de fréquentation. *PENN BED (Brest)* **12**, 355–380.

Irvine, A. B., Scott, M. D., Wells, R. S., Kaufmann, J. H. & Evans, W. R. (1979) A study of the activities and movements of the Atlantic bottlenosed dolphin, *Tursiops truncatus*. *Cetology* **13**, 1–5.

Lockyer, C. (1978) The history and behaviour of a solitary wild, but sociable, bottlenose dolphin *Tursiops truncatus* on the west coast of England and Wales. *J. Nat. Hist.* **12**, 513–528.

Lockyer, C. (1990) Review of incidents wild, sociable dolphins, world-wide. In: S. Leatherwood & R. R. Reeves (eds) *The Bottlenose Dolphin*. pp. 337–353, Academic Press, London, United Kingdom.

Lockyer, C. & Morris, R. J. (1985*a*) A wild but sociable dolphin off Portreath, north Cornwall. *J. Zool. Lond. A* **207**, 605–607.

Lockyer, C. & Morris, R. J. (1985*b*) Body scars of a resident, wild bottlenosed dolphin *Tursiops truncatus*, information on certain aspects of his behaviour. *Aquatic Mammals* **11**, 42–45.

Lockyer, C. & Morris, R. J. (1986) The history and behaviour of a wild, sociable bottlenose dolphin *Tursiops truncatus* off the north coast of Cornwall. *Aquatic Mammals* **12**, 3–6.

Lockyer, C. & Morris, R. (1987) Observed growth rate in a wild juvenile *Tursiops truncatus*. *Aquatic Mammals* **13**, 27–30.

Lund, V. (1970) Georgy Girl. *J. Underw. Nation* **6**, 12–15.

Morris, R. J. & Lockyer, C. (1988) Twenty months in the life of a juvenile wild bottlenose dolphin. *Aquatic Mammals* **14**, 49–62.

Müller, M. & Ferrey, M. (1995) Dolphy, vagabonde des mers, ou le déplacement des dauphins familiers et solitaires. *Stenella* **8**, 2–3.

Nelson, W. A., Adams, N. M. & Fox, J. F. (1992) Marine algae of the northern South Island. *Natl. Mus. N. Z. Misc. Ser.* **26**.

Pelletier, F. X. (1985) Jean-Louis, le gentil dauphin breton. *30 millions d'amis* **83**, 22–27.

Sergeant, D. E., Caldwell, D. K. & Caldwell, M. C. (1973) Age, growth, and maturity of bottlenosed dolphin (*Tursiops truncatus*) from Northeast Florida. *J. Fish Res.* **30**, 1009–1011.

Shane, H. S., Wells, R. S. & Würsig, B. (1986) Ecology, behaviour and social organisation of the bottlenose dolphin: A review. *Mar. Mamm. Sci.* **2**, 34–63.

South, G. R. & Adams, N. M. (1976) Marine algae of the Kaikoura Coast. *Natl. Mus. N. Z. Misc. Ser.* **1**, 1–43.

Tayler, C. K. & Saayman, G. S. (1972) The social organisation and behaviour of dolphins *Tursiops truncatus* and baboons *Papio ursinus*: some comparisons and assessments. *Ann. Cape Prov. Mus. Nat. His.* **9**, 11–49.

Webb, B. F. (1973) Dolphin sightings, Tasman Bay to Cook Strait, New Zealand, September 1968–June 1969. *New Z. J. Mar. Freshwater Res.* **7**, 399–405.

Webb, N. G. (1978) Women and children abducted by a wild, but sociable adult male bottlenosed dolphin. *Carnivore* **1**, 89–94.

Wells, R. S., Hansen, L. J., Balbridge, A., Dohl, T. P., Kelly, D. L. & Defran, R. H. (1990) Northward extension of the range of bottlenose dolphins along the California Coast. In: S. Leatherwood & R. R. Reeves (eds) *The Bottlenose Dolphin*. pp. 421–431, Academic Press, London, UK.

Wells, R. S., Irvine, A. B. & Scott, M. D. (1980) The social ecology of inshore odontocetes. In: L. M. Herman (ed) *Cetacean Behaviour: Mechanisms and Functions*. pp. 263–317, John Wiley & Sons, New York, USA.

Wells, R. S., Scott, M. D. & Irvine, A. B. (1987) The social structure of free-ranging bottlenose dolphins. In: H. H. Genoways (ed) *Current Mammalogy, vol. 1*, pp. 247–305, Plenum Press, New York, USA.

Wiley, D. N., Wenzel, F. W. & Young, S. B. (1994) Extralimital residency of bottlenose dolphins in the western North Atlantic. *Mar. Mamm. Sci.* **10**, 223–226.

Würsig, B., Cipriano, F., Slooten, E., Constantine, R., Barr, K. & Yin, S. (1996) Dusky dolphins *Lagenorhynchus obsurus* off New Zealand: Status of present knowledge. *Rep. Int. Whal. Commn.* in press.

Würsig, B. & Würsig, M. (1980) Behavior and ecology of the dusky dolphin, *Lagenorhynchus obscurus* in the South Atlantic. *Fish Bull. (U.S.)* **77**, 871–890.