



# Wild Dolphin Provisioning at Tangalooma, Moreton Island: An Evaluation



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## Abstract

Wild bottlenose dolphins (*Tursiops truncatus*) have been provisioned at Tangalooma, Moreton Island since 1992. This paper provides a brief summary of the history of human - dolphin interactions in Moreton Bay and an overview of the management regime established by the Tangalooma Resort. The outcomes of the Tangalooma provisioning program are contrasted with those reported from a similar program at Monkey Mia in Western Australia.

## Introduction

Wild bottlenose dolphins (*Tursiops truncatus*) have been hand-fed at Monkey Mia, Shark Bay, Western Australia for more than 30 years (Connor & Smolker, 1985). Habituation of these dolphins has occurred progressively since the 1950s (Ross & Cockroft, 1990). More recently, in 1992 (Orams, 1995; 1996), a dolphin hand-feeding (provisioning) program commenced at Tangalooma Resort, Moreton Island, Australia (Figure 1). Opinions vary as to whether the Tangalooma program is ethical and/or should be allowed to continue. This diversity of opinion on the ethics and outcomes of the provisioning occurs within a more wide-ranging debate on the issue of human interactions with both captive and free-ranging dolphins throughout the world (Capaldo, 1989; Inuzi & Rowan, 1991; Frohoff & Packard, 1995).

The negative outcomes of the Monkey Mia program (e.g. relatively high calf mortality, Connor *et al.*, 1992; Richards, 1993) are often seen as evidence of the intractability of managing wild dolphin provisioning programs, resulting in criticism and adverse publicity (e.g. van Tiggelen, 1995). In this paper, the wild dolphin provisioning program at Tangalooma is described and its outcomes contrasted with those reported from Monkey Mia.

Features of the Tangalooma program which differ from Monkey Mia include dolphins spending only a limited time at the beach (< one hour daily, one feeding session only per day, with provisioning time restricted to 20-30 min), provisioning only at night, no touching and no swimming with the dolphins permitted (Anon., 1994; Hassard, pers. comm.; pers. obs.). Environmental conditions at Tangalooma (e.g. excellent circulation of oceanic waters) result in relatively low pollution risks to the dolphins compared with most mainland beaches adjacent to semi-enclosed waters.

## Human - Dolphin Interactions in Moreton Bay

Interactions between humans and dolphins have a long history, both globally (Orams, 1997) and in the Moreton Bay area. Eye-witness accounts of cooperative hunting between bottlenose dolphins and Aboriginals living on offshore islands in Moreton Bay were given by several writers in the last century (e.g. Backhouse, 1843; MacGillivray, 1852; Fairholme, 1856; Campbell, 1875; Russell, 1888; Petrie, 1904, reviewed in Longman, 1926; Bryden, 1978;

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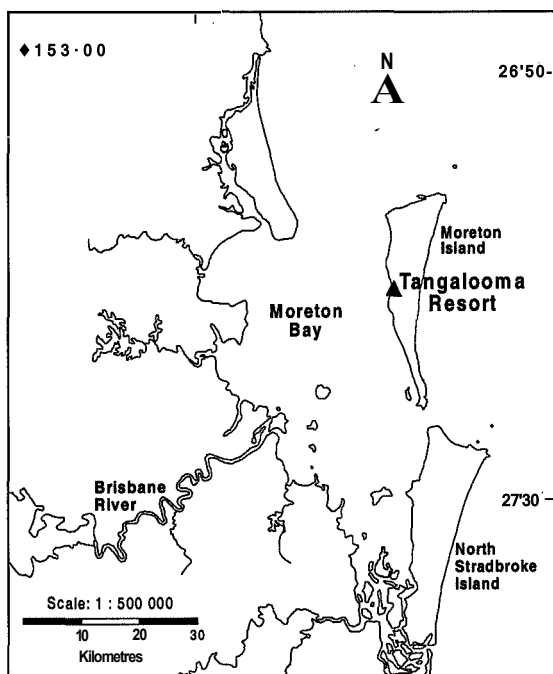


Figure 1. Map of Moreton Bay, Queensland, Australia showing Tangalooma Resort.

Hall, 1984). These accounts relate to fishing for mullet and tailor in shallow waters on the coast of Moreton Island (Petrie, 1904) and on Stradbroke Island north of Dunwich (Hall, 1984). The interaction at Amity Point is described by Fairholme (1856):

".. On seeing a shoal ..[of mullet] .. several of the men run down, and with their spears make a peculiar splashing in the water.. they .. [the dolphins] .. at once come in towards the shore, driving the mullet before them. As they near the edge, a number of the blacks with spears and hand-nets .. dash into the water. The porpoises [viz. dolphins] being outside the shoal, numbers of fish are secured before they can break away... So fearless are .. [the dolphins] .. that they will take a fish from the end of a spear when held to them...".

Petrie (1904) reported that tailor fishing on Moreton Island was assisted by dolphins, apparently summoned by

".. jobbing with their spears into the sand under the water, making a queer noise, also beating the water with spears... ", "...driving the fish towards land. When they came near, the blacks would run out into the surf, and with their spears would job down here and there at the fish, often getting two on one spear, they were so plentiful... The porpoises would actually be swimming in and out amongst all this, apparently quite unafraid of the darkies. Indeed, they seemed all to be on quite good terms, and I have more than once seen a blackfellow hold out a fish on a spear to a porpoise, and the creature take and eat it"

These historical accounts also indicate that the human - dolphin relationship was deeper than simply cooperative fishing. For example, Petrie (1904) said that on Moreton Island:

"one old porpoise was well known and spoken of fondly. He had a .. stick of some sort stuck in his back.. and by this he was recognised.. I have seen this creature take a fish from a spear, and the white men working on the island told me they often saw him knocking about with the blacks. At all times porpoise would be spoken of with affection by these blacks.. who said they never failed when called to drive in fish to them".





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A similar relationship is reported from Amity Point, with "one old fellow, . [identified by] . a large patch of barnacles or some fungus on his head, . as tame -with those blacks - as a pussy cat, . [with] . a name which they believed he knew and answered to" (Russell, 1888). "The blacks will even pretend to own particular porpoises, and nothing will offend them more than to attempt to injure one of their porpoises" (Campbell, 1875). Welsby (1917) reports that ". at Amity Point porpoises were so tame as to allow themselves to be handled by the blacks in the shallower waters ..".

Reports from Fraser Island and the Gold Coast area (e.g. Curtis, 1838; Gresty, 1947; Alexander, 1971) suggest that Aboriginal human - dolphin fishing cooperatives are not unique to Moreton and Stradbroke Islands and were probably quite widespread in southeast Queensland. Human - dolphin fishing cooperatives have also been reported from several other parts of the world including Africa (Busnel, 1973), South America (Lamb, 1954) and India (Lockley, 1979).

The human - dolphin interaction has been continued in Moreton Bay in more recent times with dolphins utilising trawler by-catch (Corkeron *et al.*, 1990). Again, this practice is not unique to the Bay and has been reported from North America (Leatherwood, 1975; Fertl, 1994), northern Australia (Hill & Wassenberg, 1990) and South Australia (Allen, 1996). Human - dolphin interactions at Tangalooma commenced with dolphins observed from the resort jetty and being thrown fish. Subsequently, the resort funded a research project with the objective of establishing a provisioning program. This involved attempts to attract dolphins into the resort area by feeding them by-catch from a trawler, feeding them from a small boat, and feeding them from the jetty at night (Green & Corkeron, 1991). Although these attempts were unsuccessful, it was concluded that, with more effort, dolphin feeding could be established (Green & Corkeron, 1991).

The human - dolphin interaction at Tangalooma should be considered in the context of the historical and contemporary examples of these associations, both locally and elsewhere, and of the diversity of types of human - dolphin interactions.

***Regulatory context of the Tangalooma dolphin provisioning program***

In Queensland the conservation and management of cetaceans and management of human - cetacean interactions are regulated under the Nature Conservation Act 1992 and the subordinate legislation of the Nature Conservation Regulation 1992, the Nature Conservation (Wildlife) Regulation 1994 and the Nature Conservation (Whales and Dolphins) Conservation Plan 1997 (Queensland Department of Environment (DoE), 1997).

Dolphin provisioning at Tangalooma is carried out under permit from the Queensland Department of Environment. The Department intends that there be no expansion of wild dolphin provisioning in Queensland and, under the proximity restrictions of the Conservation Plan, there will be no 'swim with dolphins' programs (DoE, 1997), however, human - dolphin interactions in breach of these regulations occur in several locations in southeast Queensland. Provisioning of Indo-Pacific humpback dolphins (a mother and calf) occurs at Tin Can Bay in the absence of either a permit or satisfactory management of the provisioning (Garbett & Garbett, 1995). Specific problems associated with this activity include poor control of fish quality and the condition of fish containers, large numbers of people in the water with the dolphins (as many as 43 at one time have been observed), people increasing their risk of injury by moving into deeper water to get closer to the dolphins, poor control of food quantity (feeding dolphins until satiation), feeding the calf, touching the dolphins and attempts to ride on the calf by holding onto its dorsal fin (Garbett & Garbett, 1995; 1996).





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In Moreton Bay there are anecdotal reports of boat operators attracting dolphins to their boats and feeding them at locations in both the eastern and western Bay. Reports to date suggest that the dolphins provisioned at Tangalooma are not involved in these interactions. Casual boat-based provisioning may be detrimental to dolphins, particularly as it is difficult to monitor and control, and is an activity which may arise in the vicinity of provisioning programs. For example, Wilson (1994) observed that "...the frequency of dolphins begging from fishing boats and stealing baits from fishing lines and crab nets increased markedly following the introduction of regular provisioning ..." at Bunbury in southwest Western Australia. Boat-based provisioning is beyond the scope of the management of provisioning at Tangalooma and beyond the scope of this discussion. Nevertheless, the existence of these casual dolphin provisioning activities in southeast Queensland highlights the need for implementation, enforcement and public education in respect of the Conservation Plan.

### ***The dolphins of Tangalooma***

A brief description of each of the dolphins provisioned at Tangalooma, largely based on Orams (1996), is provided here (summarised in Table 1):

The first dolphin to be provisioned at Tangalooma was *Beauty*, an adult female. *Beauty* took fish thrown to her from the jetty in March 1992 and was taking hand-held fish in April 1992. *Beauty* was the only dolphin accepting hand-held fish until August 1992, although several other dolphins attended the provisioning without participating. At the time hand-feeding commenced, *Beauty* was accompanied by a calf (*Tinkerbelle*). *Beauty* ceased participation in the provisioning in December 1995 and is believed to have died (further discussed below).

Beauty's calf at the time provisioning commenced was *Tinkerbelle*, a female now (early 1998) estimated to be about seven years of age. In early 1992, *Tinkerbelle* would occasionally take fish thrown to her, but generally played with them, rather than eating them. *Tinkerbelle* accepted hand-feeding in October 1992.

*Shadow* was born to *Beauty* in October 1994. Although still very young (about 14 months), *Shadow* was included in the provisioning program following Beauty's death.

An adult female, *Bess*, attended the provisioning with her calf *Rani* from June 1992, but did not accept hand-feeding until December 1992. In January 1997, *Bess* gave birth to another calf, *Nari*.

*Bobo* is a male estimated to be about ten years old. Bobo's familial relationships are uncertain, Orams (1996) suggesting that he is a son of *Beauty*. *Bobo* attended provisioning sessions from early 1992 and participated in them from October 1992.

*Rani* is a female calf of *Bess* with an estimated age of six. After six months attendance, *Rani* commenced hand-feeding in January 1993.

*Nari* was born to *Bess* in late January 1997. Although *Nari* attends the provisioning sessions with *Bess*, resort staff do not permit provisioning of *Nari*.

*Fred*, an adult male, has attended and participated in provisioning since February 1993. Unlike the other dolphins, he underwent no lengthy acclimatisation period, accepting hand-held fish soon after his first arrival in February 1993. It is not known whether *Fred* is related to any of the other provisioned dolphins.

*Nick* is estimated to be eight years old. His maternal lineage is uncertain because he was weaned at the time he commenced attendance at the provisioning (May 1994). *Nick* is an irregular and often indifferent participant.





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In June, 1993, *Echo* arrived at Tangalooma and commenced hand-feeding about one month later. *Echo* arrived unaccompanied at an estimated age of one year and it is therefore assumed that *Echo* is an orphan. *Echo* is now about five years old.

Other dolphins have attended the provisioning on one or just a few occasions, but no longer do so. Over 300 individual bottlenose dolphins have been identified in Moreton Bay (Preen *et al.*, 1992) which suggests that the nine dolphins attending the provisioning at Tangalooma represent less than 3% of the population.

Table 1. Characteristics of the dolphins provisioned at Tangalooma, Moreton Island (in order of first attendance).

Dolphin	Sex	Est. age (January 1998)	Familial relationships	First attendance	First acceptance of fish
<i>Beauty</i>	F	Adult (Deceased)	Mother of <i>Bobo</i> , <i>Shadow</i> and <i>Tinkerbe/1</i>	early 1992	April 1992
<i>Tinkerbe/1</i>	F	7	Daughter of <i>Beauty</i>	early 1992	October 1992
<i>Bess</i>	F	Adult	Mother of <i>Rani</i> & <i>Nari</i>	June 1992	December 1992
<i>Bobo</i>	M	10	Son of <i>Beauty</i>	July 1992	October 1992
<i>Rani</i>	F	6	Daughter of <i>Bess</i>	July 1992	January 1993
<i>Fred</i>	M	Adult	Unknown	February 1993	February 1993
<i>Echo</i>	M	5	Unknown	June 1993	July 1993
<i>Nick</i>	M	8	Unknown, believed orphaned	May 1994	September 1994
<i>Shadow</i>	F?	3	Daughter of <i>Beauty</i>	October 1994	January 1996
<i>Nari</i>	M?	1	Son of <i>Bess</i>	January 1997	Not provisioned

**Management of Dolphin Provisioning at Tangalooma**

The Tangalooma program consists of two components.

- (i) **The Dolphin Education Centre** (now known as the Marine Education and Research Centre) was established by the resort with the assistance of Mark Orams. This facility, open to the public daily, comprises a small library of publications relevant to marine mammals, displays about marine mammals in general and about the "Tangalooma Dolphins" in particular, various brochures, petitions etc. relevant to marine mammals and their conservation, a 30 seat theatre, children's activities room, offices, and toilet facilities. People intending to feed the dolphins must book at the Dolphin Education Centre on the afternoon preceding the night on which they wish to participate in the provisioning. They are issued with one provisioning token per person, without which they will not be permitted to participate. Orams (1996) has shown that this education program significantly improved the experience of participants in the dolphin provisioning, as well as resulting in more positive environmental attitudes.
- (ii) **Dolphin provisioning** (described by Orams, 1994; 1995; 1996) occurs at a dedicated area of the beach adjacent to the resort jetty. This area is marked by buoys. Landward and seaward signs state that the area is off-limits to activities such as swimming, fishing and boating at all times. Participants are required to be at the jetty 30 min. prior to the scheduled feed time, normally at sunset. Participants are given a briefing which explains:
  - how to conduct themselves around the dolphins;





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- what to expect of the dolphins;
- the need to disinfect their hands prior to the provisioning (disinfectant is provided for the purpose);
- a prohibition on provisioning the dolphins if the participants are suffering from colds or flu;
- prohibition on insect repellants and suntan lotions;
- prohibition on smoking in the provisioning area;
- the need to remove any sharp hand jewellery, etc. to avoid any injury to the dolphins;
- the prohibition on touching, stroking, or patting the dolphins; and
- the reasons for the short duration of their time in the water.

Following the briefing, participants are formed into several queues, the number depending on both the number of people and the number of dolphins participating on the night. From each queue, groups of participants (generally two), accompanied by a trained resort staff member, walk into the water (between knee and thigh deep) holding the fish provided. At a signal from the staff members, participants place the fish (generally two, offered one at a time) below the water surface in front of the dolphin. After a brief interval (ea. 30 sec.) all participants and staff leave the water. This procedure is repeated until all of those holding feeding tokens have fed a dolphin. The number of participants varies, generally in the range 80-100 in summer, and 20-80 in winter. Staff members are present to assist and advise the participants, and to ensure that no breaches of the provisioning guidelines occur.

Resort staff keep records of the dolphin provisioning, including the number and identity of dolphins present, the quantity of fish fed, the arrival and departure times of the dolphins as well as a video record of the provisioning sessions. Researchers from the University of Queensland also monitor specific aspects of the program.

Planning for management of the program at Tangalooma was carried out with the benefit of information from similar programs elsewhere, and was intended to minimise adverse effects on the dolphins. A full description is given in Orams (1994; 1995; 1996).

**Contrasting Dolphin Provisioning at Monkey Mia with Tangalooma**

Wilson (1994) identified the following areas of concern regarding the provisioning of wild dolphins at Monkey Mia:

- high infant mortality;
- low juvenile (post-weaning) survival; and
- changes in behaviour resulting from provisioning.

The main points of Wilson's (1994) report are outlined below, and are then evaluated in the context of the Tangalooma program. Whilst Wilson's (1994) findings should be treated with some caution as they were not formally published, they do provide a good summary of the relevant issues.

***High infant mortality***

Calf survival at Tangalooma is difficult to assess because only two have been born to provisioned dolphins since provisioning commenced. However, given the importance of calf health and survival, its discussion is warranted here. Wilson's (1994) report suggested that high mortality





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of calves born to provisioned dolphins at Monkey Mia may have been due to:

- prolonged exposure to polluted near-shore waters;
- exposure to human pathogens;
- provisioning distracting the mothers and offspring from attending to potential threats, especially shark attack;
- concentration of fish offal in the area which may have attracted sharks;
- provisioned dolphins accepting poor quality food items (or non-food items) from boats, causing illness; and
- nutritionally inappropriate provisions.

#### ***Prolonged exposure to polluted near-shore waters***

The disappearance of seven provisioned dolphins, including three calves, at Monkey Mia during a period of 18 days in early 1989 has been attributed to pollution from sewage contamination at Monkey Mia beach (Wilson, 1994). The calves are assumed to have died because they were still nursing from their mothers at the time of their disappearance and the adults were presumed dead because they were never again seen by the researchers who were involved in ongoing studies of the Monkey Mia dolphins (Wilson, 1994). Wilson (1994) suggests that emigration is an unlikely explanation of these disappearances because it is an uncommon occurrence in dolphin communities. For example, Wells & Scott (1990) report a mean annual immigration rate of 0.021 and a maximum emigration estimate of 0.029 for a population of 156 dolphins in Sarasota Bay, Florida.

Dolphins at Tangalooma are likely to be at much lower risk from pollution than those at Monkey Mia or even those in western Moreton Bay where dolphins are commonly seen (Corkeron, 1990; Preen *et al.*, 1992). This is due to the physical conditions at Tangalooma where, by comparison with western Moreton Bay, there is: better water circulation (Milford & Church, 1977; Patterson & Witt, 1992); oceanic water (Islam *et al.* 1994; 1995); and little risk of pollution from sewage, industrial and port discharges, and urban runoff, all of which are concentrated in western Moreton Bay (Moss *et al.*, 1992). Tangalooma sewage is secondary-treated and effluent is used for irrigation on land, and not discharged to the Bay. The limited time dolphins spend in the provisioning area (generally < one hour per day) also decreases their risk of exposure to pollution. This is in marked contrast to the situation at Monkey Mia where dolphins are provisioned up to three times daily over a five hour period between 8 a.m. and 1 p.m. (Wilson, 1996).

#### ***Pathogen induced disease***

Wilson (1994) also suggested that infectious disease may have caused the 1989 mortality event at Monkey Mia, and that contact with humans at the beach may have been implicated, because no comparable mortality occurred in nearby non-provisioned dolphins.

The risk to dolphins from pathogen-induced disease is likely to be far lower at Tangalooma than at Monkey Mia for several reasons:

- close proximity between any individual human and the dolphins is of very limited duration;
- physical contact between humans and dolphins, initiated by humans, is prohibited;
- provisioning by people with colds and influenza is discouraged;





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- disinfection of hands is required prior to provisioning; and
- the oceanic waters at Tangalooma are not conducive to pathogen survival and transmission.

Observations by resort staff and independent observers suggest that most people readily accept the limitations imposed in the best interest of the dolphins.

#### High predation

Bottlenose dolphins typically increase group cohesion in the presence of predators (e.g. sharks; Shane *et al.*, 1986). Mothers and calves may maintain close association until the calf reaches three to six years of age (Navarro, 1990; Wells, 1991) and mothers have been reported to become aggressive toward calves that stray either too far or for too long (Chirighin, 1987). Consequently, dolphin calves are probably afforded some protection from predation through close association with their mother and with other adults in their group. Wilson (1994) suggests that the vulnerability of calves to shark attack is increased if they stray from their group and are not attended to by the adults, which was apparently the situation when one of the Monkey Mia calves was killed by a shark. According to witnesses, the lone calf was approximately 70 m from the beach where its mother and other adult females were interacting with people (Wilson, 1994).

The risk of predation at Tangalooma is likely to be much lower than at Monkey Mia. Reasons for this include:

- dolphins spending less than one hour daily in the provisioning area, rather than "hanging around" during the day as occurred at Monkey Mia;
- during provisioning, the dolphins spend less than half of the time actually being fed. For the rest of the time they interact or swim with each other. Observations of a calf born in October 1994 (*Shadow*) indicate that, during the time other dolphins were feeding, *Shadow* generally remained within approximately 20 m of the rest of the group. Another calf, born in January 1997 (*Nari*), exhibits similar behaviour; and
- some protection may be given to dolphins in the provisioning area by a shallow bank offshore from the provisioning area (the risk of shark attack, and the need for vigilance against attack, increases in deeper waters (Johnson & Norris, 1986)), although attacks on marine mammals, notably seals, do occur in shallow water (Corkeron, 1997; see also Wood *et al.*, 1970).

#### Inadequate nutrition

Wilson (1994) points out that no information is available on which fish species dolphins select under differing conditions or on the relative nutritional values of fish species eaten. He suggests it is possible that the fish given to Monkey Mia dolphins was nutritionally inadequate or inappropriate and that accepting a significant proportion of their food from hand-outs may result in malnutrition, leaving the dolphins vulnerable to disease and predation.

No data are yet available from Tangalooma regarding the nutritional status of the fish used in provisioning, although the choice of species used was based on the apparent dietary preference of the dolphins. Comparisons of the diet of the Tangalooma dolphins with that of dolphins elsewhere is made difficult by the marked spatial and temporal variability in both the quantity of prey consumed (Ross & Cockroft, 1990) and the relative importance of the various prey species in the bottlenose dolphin diet (Cockroft & Ross, 1990).







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The provisioning regime adhered to at Tangalooma means that most dolphins consistently receive one-third or less of their estimated average daily food requirement (Orams, 1996) and the absence of the dolphins from the beach, except during the regulated provisioning periods, eliminates the problem of casual provisioning at the resort. Some of the potential for malnutrition at Monkey Mia is associated with *ad hoc* provisioning of dolphins from boats. There is likely to be a lower risk of this at Tangalooma because the relatively exposed waters of Moreton Bay limit access. Furthermore, this type of provisioning is prohibited under the Conservation Plan. Following the recommendations of Wilson's (1994) report, a regulation under the Wildlife Conservation Act (Western Australia) was introduced prohibiting dolphin provisioning in the Shark Bay Marine Park, with the exception of the designated area. Wilson (1996) suggests that this has virtually eliminated boat-based feeding.

Deliberate boat-based provisioning of dolphins by recreational boaters also occurs in Moreton Bay, and it is important that this practice cease as the freshness and nutritional suitability of fish supplied in this way is uncertain and would be difficult to regulate.

In Moreton Bay, dolphins are provisioned inadvertently from bycatch generated by commercial fishing operations (Corkeron *et al.*, 1990). Possibly, this source of food partially compensates for loss of food resources as a result of commercial and recreational fishing (Corkeron, 1990) which, collectively, remove between 1 300 t (data from QFMA, 1996) and 2 000 t (Quinn, 1993) of finfish from Moreton Bay annually. The use of trawler bycatch by dolphins in Moreton Bay suggests that the fishery is removing food which is attractive to the dolphins. This utilisation of trawler bycatch may also have disadvantages for the dolphins, given the attraction of sharks to the trawler bycatch and the association between the seasonal peak in trawler operations and in shark wounds on dolphins (Corkeron *et al.*, 1987; 1990; Preen *et al.*, 1992).

An indication of the probable nutritional adequacy of the fish provided at Tangalooma, in combination with other food sources, is suggested by two characteristics of the group. Firstly, calves born to and reared by provisioned mothers have survived to date. For example, *Tinkerbell* (calf of *Beauty*) is estimated to have been two years old at the time *Beauty* commenced her participation in the provisioning program. Similarly, *Shadow*, a calf of *Beauty*, was born in October 1994 while *Beauty* was a participant in the provisioning. *Nari*, born to *Bess* in January 1997, has survived with no apparent signs of ill health. More compelling evidence of nutritional adequacy is the survival of orphaned dolphins. *Echo*, now approximately five years old, arrived at Tangalooma unaccompanied, at an estimated age of one year, suggesting he was an orphan. *Shadow* was orphaned at 14 months of age by *Beauty's* death in December 1995, and has also survived with no apparent signs of ill health.

One of the most telling criticisms of dolphin provisioning at Monkey Mia is the observation that survivorship of calves of provisioned dolphins is significantly lower than that for calves of non-provisioned dolphins. Wilson (1994) cites data which indicate that survivorship of calves of provisioned dolphins was < 30 % in the period from 1975, and < 20 % since 1986, compared with one estimate (from another location) for natural populations of 80% survivorship. Similarly, survival of calves through the first year of life, over the 1985-1993 period at Monkey Mia was 67 % for calves of non-provisioned dolphins, and 36 % for calves of provisioned dolphins.

Only two calves have been born since the commencement of the Tangalooma program - *Shadow*, now over three years, and *Nari*, now over one year old. One calf, *Tinkerbell*, has survived to seven years, despite being involved with the provisioning program for five of those years. Another apparently orphaned calf, *Echo*, has survived to about five years with no maternal support and despite four years participation in provisioning and *Rani*, now about six years old, has been a participant in the provisioning at Tangalooma for five of those years. Whilst a





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conclusive statement regarding the long term effect of provisioning at Tangalooma on calf mortality is not yet possible, all of the calves associated with the provisioning have survived to date.

Low juvenile (post-weaning) survival

Wilson (1994) states that:

"there are few data on survival of juvenile dolphins after weaning but available information suggests that there may be a problem here also ... Four juveniles born to provisioned Monkey Mia females since research began have survived past weaning (that is about two years of age). Two of these were provisioned but died within two years of weaning. The two that still survive have never accepted handouts and, since leaving their mothers, have never been regular beach visitors."

The survival of all four juveniles, *Tinkerbelle*, *Rani*, *Echo*, and *Shadow*, at Tangalooma shows that post-weaning mortality has not occurred at Tangalooma. Again, this may, at least in part, be attributed to the limited duration of provisioning times, restrictions on the amount of food given and the other management provisions applied.

Changes in behaviour resulting from provisioning

Wilson (1994) states that:

"Researchers ... have documented significant differences in the behaviour of provisioned dolphins compared with non-provisioned dolphins at Monkey Mia. Their study included data on 32 infants, nine of which were born to provisioned females. They showed that infants of provisioned females spend less time in contact with their mothers overall. This appears to be due to the fact that provisioned infants spend less time in contact with their mothers when near the provisioning area than when they are away from the beach."

It seems that the short duration of provisioning at Tangalooma minimises the likelihood of significant alterations to behaviour. For example, a dolphin attending all feeds for the maximum duration would spend > 95 % of its time elsewhere. A dolphin attending 80% of feeds and arriving only as provisioning commenced would spend > 98 % of its time elsewhere. It follows that the provisioned dolphins spend the majority of their time away from the provisioning area, in "natural" conditions. However, insufficient observational data are yet available to determine whether, when they are away from the provisioning area, their behaviour differs significantly from that of other dolphins in Moreton Bay.

In the case of the mother-calf pair currently attending the provisioning (*Bess and Nari*), although they spend little time in contact during the provisioning period, these periods are of short duration. They generally maintain close association both before and after the provisioning, and in intervals during provisioning when groups of people are not in the water. At 11 months of age (observations over 14 nights during December 1997 - January 1998), *Nari* was alone (defined as > 3 m from any other dolphin) 29 % of the time, with *Bess* or in groups including *Bess* 47 % of the time, and in other groups without *Bess* for 24 % of the time. *Nari* was alone outside the illuminated provisioning area 1.2 % of the time (Takei & Neil, 1998). The net effect of this pattern is that mother - calf separation, as a consequence of provisioning, is limited in total to about 15 minutes daily, in 15-20 short increments.





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It should be noted that behavioural comparisons between the Tangalooma dolphins and those from other locations are difficult as any differences which do occur may be due to geographical differences rather than the effects of provisioning.

**The Illness and Death of *Beauty***

Given that *Beauty* developed an illness and died while a participant in the provisioning program, some discussion of the cause of death is warranted. The following comments on *Beauty*'s illness are from Wendy Blanshard, the Sea World veterinarian who monitored *Beauty* during the latter half of her illness. There is no definitive diagnosis of the illness which consisted of a destructive lesion on the rostrum. The most likely cause is considered to be neoplasia (a tumour), although the other possibility, osteomyelitis (an infection of the bone), cannot be ruled out. It is likely that these illnesses occur in nature, although there are insufficient data to determine their natural rates of occurrence.

Neoplasms in marine mammals were considered a rare or uncommon event and it was speculated that marine mammals may have had some resistance to neoplasm development. More careful observation on larger numbers of animals has revealed a larger number of neoplasms than previously thought (Howard *et al.*, 1983). However, Geraci *et al.* (1987) caution that many of the reported neoplasms are not well documented. Of 41 confirmable tumours on cetaceans, Geraci *et al.* (1987) report that most were from either the gastro-intestinal tract (31 %) or the skin (24%). Although there are numerous factors which may induce tumours (e.g. hormones, viruses, congenital defects, and physical and chemical agents) and cetacean tumours have been linked to environmental pollutants (e.g. Martineau *et al.*, 1985; Bossart *et al.*, 1997). "...so little is known about cetacean tumours that it hardly seems necessary to propose causes, however tempting..." (Geraci *et al.*, 1987). Bossart *et al.* (1997) suggest that the presence of tumours may predispose affected cetaceans to other terminal events, such as net entanglement and shark attack.

Osteomyelitis in a dolphin maxillary bone could be caused by a puncture wound in the mouth from a fish spine. However, such injuries are likely to be a normal hazard of eating spiny fish. Blanshard (pers. comm.) suggests that it is most likely that *Beauty*'s condition was a random accident of nature and that there is no direct evidence to link it with participation in the provisioning. Rather, provisioning allowed the observation of a condition which is likely to occur naturally. *Beauty* ceased attendance at the provisioning in December 1995, although her fourteen month old calf *Shadow* continued to attend. It is therefore assumed that *Beauty* died at this time. In the absence of a body, no necropsy was conducted.

**Conclusion**

In general, the Tangalooma program appears to comply with the management recommendations of Wilson (1994) and, to date, appears to have avoided many of the problems reported at Monkey Mia.

This outcome appears to be largely related to two main factors. Firstly, the physical setting assists in minimising adverse impacts on the dolphins as a result of both high water quality and limited public access. Secondly, the management regime of fixed feeding times of short duration, food rationing and no physical contact with humans limits the risks associated with dependency, malnutrition, predation and pollution. Given that provisioning at Tangalooma commenced only five years ago (cf. 30 years at Monkey Mia) chronic problems associated with provisioning may not yet be apparent, thus continued monitoring and assessment of the program is essential.





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