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DISAPPEARANCE OF DOLPHINS AT MONKEY MIA

FINDINGS OF A PRELIMINARY INVESTIGATION

REPORT AND RECOMMENDATIONS
OF THE
ENVIRONMENTAL PROTECTION AUTHORITY

Environmental Protection Authority
Perth, Western Australia
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SUMMARY

The death of a six week old dolphin calf on January 23, 1989 was closely followed, over the next 18 days, by the disappearance of the two remaining calves, the three adult males and a juvenile female from the 'regular' group of dolphins that visit Monkey Mia. These dolphins have not been seen since early February and, apart fom the juvenile female, represents a drastic departure from their normal behaviour over recent times. The mothers of the dead calf and the two missing calves were absent from Monkey Mia for varying periods in February. However all three were observed offshore being herded by male dolphins, and all have resumed visiting Monkey Mia again without their calves. The separation of the calves from their mothers suggests these calves are unlikely to be alive.

The three male dolphins have not been seen at Monkey Mia since early February and have not been observed in the 'coalitions' or groups of offshore dolphins that they normally associate with when they are not at Monkey Mia. These three dolphins each visited Monkey Mia on over 320 occasions in 1987 and on over 345 days in 1988 and they were never absent for more than 4 days at any time. As such their prolonged absence in early 1989, coinciding with the death and disappearance of the calves, warrants some concern. The juvenile female dolphin, Holly has not been seen for four weeks. In 1988 she was often absent for long periods, including one period of 22 days and, as such, there is no reason to be overly concerned for her welfare at the present time. No apparent changes have been observed in the offshore dolphin population at Monkey Mia, and all the calves of the offshore females that have been observed recently appear healthy.

These observations indicate that the death and disappearance of dolphins is confined to the 'regular' population that visit Monkey Mia and is unlikely to be a series of unrelated natural events, but rather be related to some factor in the inshore areas at Monkey Mia.

The possibility that fish fed to the dolphins are implicated in the death and subsequent disappearance of the dolphins at Monkey Mia is unlikely.

During the present survey the interstitial water (soil water) and the seawater immediately off the beach at Monkey Mia contained elevated (above controls) levels of faecal bacteria and extremely high concentrations of nitrate+nitrite-N. These data indicate that the interstitial waters and the nearshore marine waters of Monkey Mia were significantly contaminated. This pollution is likely to be coming from septic systems from the Monkey Mia Caravan Park and the Visitor Centre. However it should be stressed that although sewage wastewater is the most obvious source of contamination of the local marine environment at Monkey Mia, it does not necessarily imply there is a causal link to the death and disappearance of the dolphins.

RECOMMENDATIONS

IMMEDIATE PRECAUTIONARY MEASURES

1. It is recommended that the use of the toilet facilities at the Monkey Mia Caravan Park and the Visitor Centre should be suspended during the Easter and April school holidays, the next periods expected to attract high visitor numbers to Monkey Mia. Temporary facilities should be installed or suitable alternative arrangements should be made as interim measures to avoid contamination of the marine environment during these periods.

MANAGEMENT PLAN FOR MONKEY MIA

2. It is recommended that a detailed management plan be established to ensure a high environmental quality for the Monkey Mia area with particular reference to the marine environment.

Issues to be addressed in the plan should include:

a. The suitability of the present location of the caravan park in relation to its close proximity to the waters edge.

b. Alternatives for a more suitable form of wastewater treatment for the Monkey Mia Caravan Park and the Visitor Centre should be reviewed immediately by the relevant authorities.

c. Visitor access to the dolphins should be reviewed immediately in relation to crowd-related stress to the dolphins, the introduction of possibly toxic materials such as sun screen lotions to the waters of Monkey Mia and the possibility of the transfer of infection from humans to dolphins as a result of physical contact.

d. The practice of feeding of fish to the dolphins by tourists should be reviewed especially in regard to preventing the introduction of unhealthy fish.

e. The spraying of toxic chemicals for pest control in the vicinity of the Visitor Centre should be reviewed and alternatives considered.

f. Consideration should be given to the possibility of hydrocarbon spills in relation to the proximity of the boat launching ramp to the dolphin visiting area.

MONITORING PROGRAMME

3. It is recommended that after suitable programmes to determine the flushing and ambient water quality characteristics of the waters in the vicinity of Monkey Mia, an on-going monitoring programme be established to ensure that high water quality is maintained in this area.

The monitoring programme should address the following issues:

a. The flushing characteristics of the waters in the vicinity of Monkey Mia should be determined under a complete range of conditions.

b. The ambient water quality characteristics of Monkey Mia should be determined for one year to provide baseline data for future reference. This survey should include the bacteriological, nutrient and biological status of the water as well as the physical characteristics of the water column.

c. An on-going monitoring programme of the physical, chemical, biological and bacteriological characteristics of the waters of Monkey Mia should be established following the completion of (a) and (b).

d. The current daily collection of information concerning dolphin and tourist visits to Monkey Mia should be continued.

e. Provision should be made to continue monitoring the offshore population of dolphins in the Monkey Mia area following the departure of Richard Conner to the United States of America in July of 1989.

f. Implementation of (c) and (e) should be carried out by the rangers at the Visitor Centre after a period of training.

g. A contingency plan for future dolphin deaths in the area should be formulated. In particular, a procedure for the recovery and storage of dead dolphins should be established.

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1. INTRODUCTION

The bottlenose dolphins (*Tursiops* sp.) of Monkey Mia (Fig. 1) are unique in that they allow close contact with humans on a regular basis. As a result of this association, these dolphins have developed into an important international and domestic tourist attraction. The number of tourists that visit the Shire of Shark Bay to see these animals has increased markedly in recent years and tourism is now a significant and growing part of the local economy. A Visitor Centre was established by the Western Australian Tourism Commission in 1986 and rangers were employed by the Shire of Shark Bay to manage the visitors to Monkey Mia. The centre is managed by the Shire of Shark Bay, while the land is jointly vested with the Department of Conservation and Land Management.

In addition to the economic benefits brought by tourism, the dolphins of Monkey Mia are also of immense scientific importance. As the only population of wild dolphins that permit regular physical contact with humans, these animals provide an excellent opportunity to study dolphin sociality in the wild. Their scientific importance has been recognised worldwide and researchers from the University of Michigan have conducted an extensive dolphin research programme since 1982. Currently five researchers from this university and one from Harvard University are studying the behavioural biology of these animals. One researcher in particular, Richard Conner, has studied the Monkey Mia dolphins almost continuously since 1982. This research is funded by National Geographic, the National Science Foundation and private contributions to the Dolphins of Shark Bay Research Foundation, Inc. and is part of an on-going programme to be conducted over the next 20 or so years.

Over 200 dolphins in Shark Bay can now be individually recognised using the standard technique of identifying individuals by the shapes and markings of their dorsal fins. Over the past five years about 70 of these have appeared regularly in a study area (about 100 km^2) located in the waters surrounding Monkey Mia. The interactions between dolphins and humans have occurred here for at least 25 years and informal records of dolphin visits at Monkey Mia were begun in 1975 by Wilf and Hazel Mason, the former proprietors of the Monkey Mia Caravan Park.

Two groups of dolphins visit the nearshore areas at Monkey Mia: a group of 'regulars' and a group of 'occasionals'. Until recently the 'regulars' consisted of 3 adult females, each with a calf, 1 juvenile female and 3 adult males. These dolphins allowed humans to touch them and, apart from the calves which were still suckling, took fish that were offered to them. The 'occasionals' represent part of the 'offshore' dolphin population, and individuals visit Monkey Mia on an intermittent basis. In contrast to the 'regulars' these dolphins avoid physical contact with humans and generally do not take fish offered to them.

On the morning of January 23, 1989 Koorda, a six week old dolphin calf of Holey Fin, one of the oldest of the 'regular' dolphins that visit Monkey Mia, was found dead in the shallows in front of the Visitor Centre. The calf appeared to be healthy the previous evening and was still warm when it was found by the rangers. Over the next seventeen days the two remaining calves and the three males from the 'regular' population disappeared.

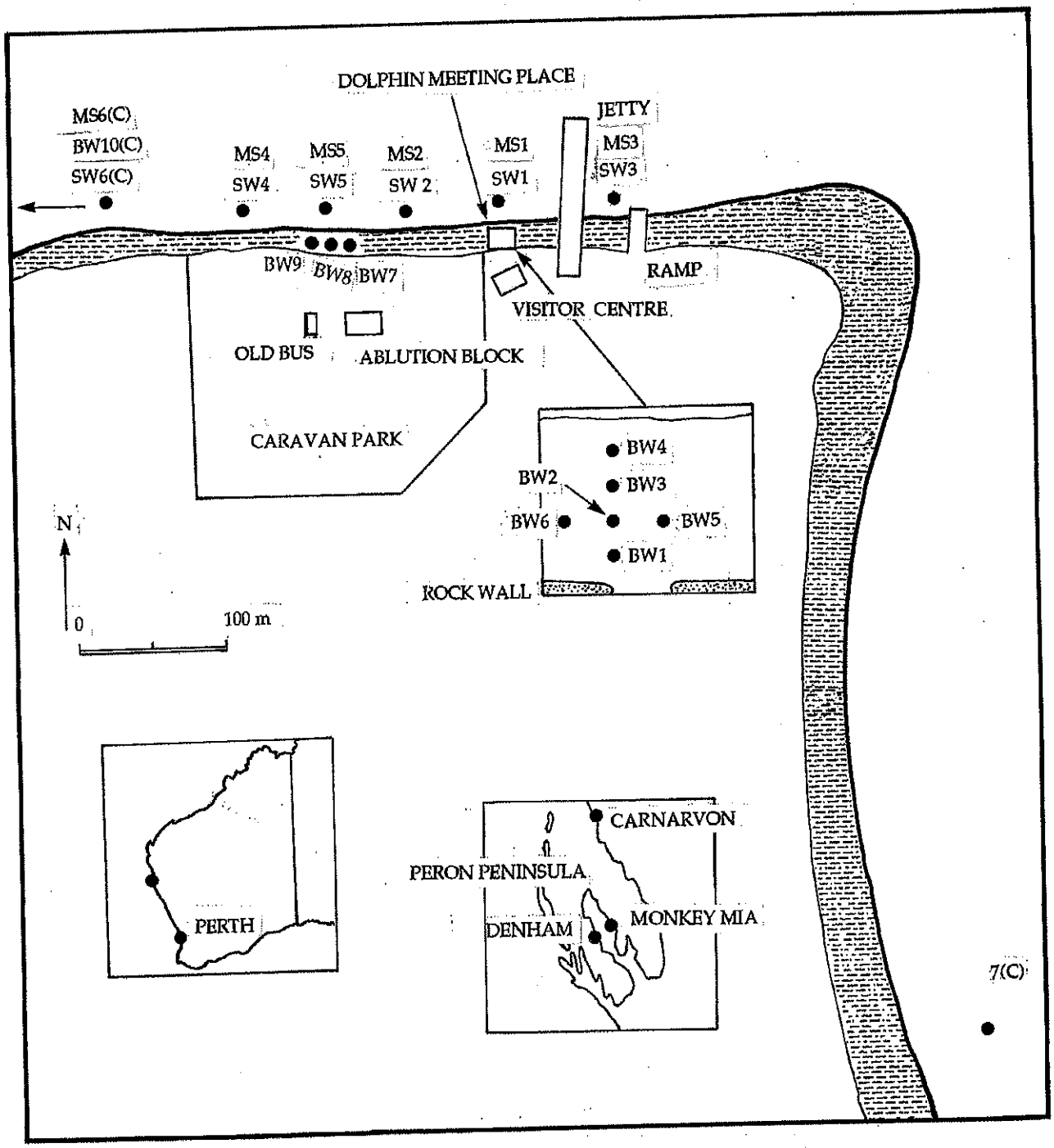

Figure 1. Location map of Monkey Mia showing sampling sites.

The disappearance of these 'regular' dolphins was unusual and provoked some concern for their safety. In response to a request for assistance from the Department of Conservation and Land Management (CALM) on February 24, the Environmental Protection Authority (EPA) conducted a brief investigation on March 1-2 in relation to possible contamination of the waters surrounding Monkey Mia. This report outlines the findings of that study.

2. SAMPLING PROCEDURE

The sampling procedure was designed to assess whether sewage was leaching from the Visitor Centre and the Monkey Mia Caravan Park septic systems into the local marine environment. Single surface seawater samples (SW sites, Fig. 1) and duplicate marine sediment (MS sites) cores (ie top 70 mm) were taken from 5 test sites located about 5 m offshore in the immediate vicinity of Monkey Mia. Two control sites (C sites), about 1 km either side of the Visitor Centre were also sampled. In addition, samples of interstitial water (soil water) were taken at 10 beach sites (BW sites) located in front of the Visitor Centre and the main ablution block of the caravan park and at one control site about 1 km west of Monkey Mia (Fig. 1). The salinity of the beach interstitial water was measured along a transect perpendicular to the shoreline in front of the Visitor Centre to determine the extent of seawater intrusion. As a result additional sampling sites were located parallel to the shoreline to coincide with salinities of about 16-20 $^{o}/_{oo}$.

At each site approximately 300 ml of water was taken for bacteriological analyses using sterile 500 ml bottles. These samples were placed in a refrigerator within 5 minutes of collection. Water samples of approximately 150 ml were taken for each nutrient analysis. Samples for total phosphorus (TP) and total nitrogen (TN) were not filtered. Samples for orthophosphate (PO_4), ammonium-N (NH_4-N) and nitrate+nitrite-N (NO_3+NO_2-N) were filtered through a 0.8-1.2 µm Millipore GFC filter. These samples were stored in Whirl-paks and placed in a freezer immediately following collection. Sediment cores were also placed in the freezer immediately following collection. Bacteriological analyses were carried out by the Environmental Laboratory of the State Health Laboratory Services and nutrient analyses of the water and the sediment samples were carried out by the Nutrient Analysis Laboratory at the Botany Department of the University of Western Australia. Seawater temperature was measured with a thermometer ($\pm$ 1° C) and the salinity of the water samples was measured with a refractometer ($\pm$ 1 $^{o}/_{oo}$).

3. PATTERN OF DOLPHIN VISITS

A preliminary analyses of dolphin visits to Monkey Mia indicate that a marked change in visitation rates of the 'regular' dolphins occurred following the death of the six week old calf on January 23, 1989 (Fig. 2). The number of 'regular' dolphins visiting Monkey Mia throughout 1988 was relatively constant with a monthly mean of over 6 dolphins per day. By February 1989 this had decreased to about 1. By the middle of February one calf was confirmed dead, 2 other calves and three males were missing. During the last two weeks of February only Holey Fin, an adult female, was visiting Monkey Mia although the other adult females, Puck and Nicky, had been seen offshore

being herded by males. In the first week of March Nicky returned followed by Puck a week later. The juvenile female Holly, last seen on February 15, has not yet returned to Monkey Mia.

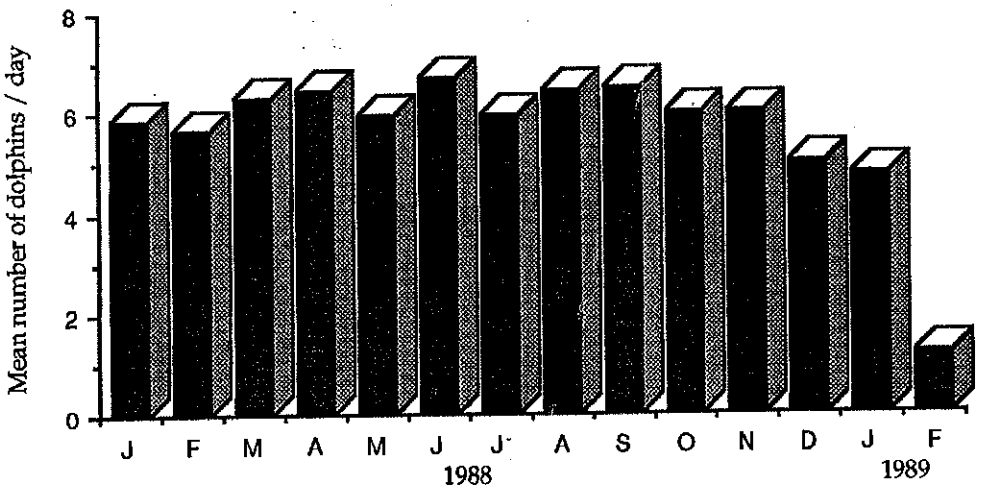

Figure 2. Monthly mean dolphin visits per day for the 'regular' dolphins that visit Monkey Mia. There were 8 'regulars' for most of 1988. Two calves were born recently: on December 11, 1988 and on January 21, 1989. Dolphin visitation patterns for 1987 were similar to 1988.

4. PATTERN OF HUMAN VISITS

From April 1987 to June 1988 a traffic counter was established to record the number of vehicles using the road from Monkey Mia to Denham. Estimates of visitors to Monkey Mia were determined during this period by assuming 3 occupants per car. Since the road was diverted through the Visitor Centre in June 1988, accurate records of visitors have been kept (Fig. 3).

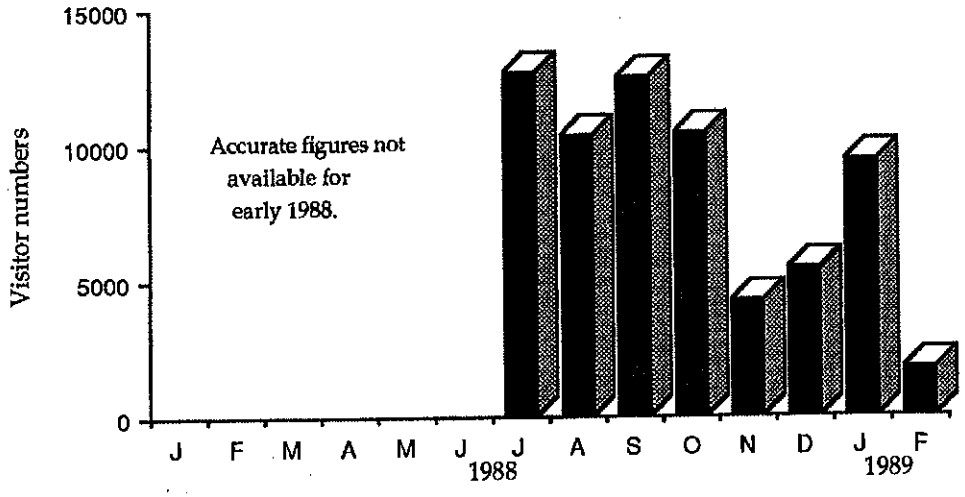

Figure 3. Visitor numbers to Monkey Mia.

In general more tourists visit Monkey Mia in the winter months (April to October) than in the summer (December to March). Numbers in winter often exceed 10000 per month and but generally less than 5000 per month in summer. The maximum of visitors recorded in one day during 1988

occurred on July 6 with 935 people arriving at the Visitor Centre. In January 1989, 9433 people were recorded which was over twice as many as the previous January. This number was unusually high for summer and was the first time that so many people had visited Monkey Mia at this time of the year.

5. POTENTIAL SOURCES OF POLLUTION

The most obvious potential source of pollution at Monkey Mia is the leaching of sewage wastewater from the toilet blocks of the Visitor Centre and the adjacent Monkey Mia Caravan Park. Both facilities operate on septic systems involving holding tanks for solid wastes connected to leach drains to take the liquid overflow. The Visitor Centre is located directly in front of where the dolphins come into the beach, and the distance from the Centre to the high water mark is about 30 m. The septic tanks and leach drain are located between the Centre and the ocean, the leach drain being about 15-20 m from the high water mark. The main septics and leach drains for the caravan park are set back about 45 m from the high water mark and located about 70 m west of the Visitor Centre. With peak visitor numbers over 900 people a day and peak monthly figures in winter of over 12000 (Fig. 3), both facilities may be inadequate to cope with peak demand. Evidence of sewage overflow was present at both facilities. It is therefore possible that significant bacterial contamination of the nearby waters may occur during these periods.

Table 1. Results of analyses on samples collected at Monkey Mia on March 1-2, 1989 (BW-beach water; SW-seawater; MS-marine sediments; (C)-control). Blanks indicate that analyses are not complete.

SITE	NUTRIENTS					BACTERIA			
	TP	PO_4	NO_3+NO_2-N (µg/L)	NH_4-N	TN	Total	F. coliforms (Bacteria/100 ml)	F. streptococci	Salmonella
BW1	578	99	110000	38	111381	0	0	20	0
BW2	409	235	105000	203	105904	100	40	40	0
BW3	351	180	50000	19	50382	20	20	0	0
BW4	739	94	2000	33	3231	0	0	0	0
BW5	-	-	-	-	-	0	0	10	0
BW6	-	-	-	-	-	20	0	60	0
BW7	561	108	35000	41	36638	60	60	20	0
BW8	451	74	18000	30	19452	0	0	0	0
BW9	440	118	19250	28	19835	30	30	80	0
BW10(C)	1130	83	263	118	4333	0	0	0	0
SW1	35	12	250	9	482	2	0	0	0
SW2	22	6	250	9	482	2	0	0	0
SW3	21	6	2125	8	2312	0	0	0	0
SW4						24	24	16	0
SW5						0	0	4	0
SW6(C)	26	13	55	24	331	0	0	0	0
SW7(C)	19	7	18	6	267	0	0	0	0
MS1		-	-	-		-	-	-	-
MS2		-	-	-		-	-	-	-
MS3		-	-	-		-	-	-	-
MS4		-	-	-		-	-	-	-
MS5		-	-	-		-	-	-	-
MS6(C)		-	-	-		-	-	-	-
MS7(C)		-	-	-		-	-	-	-

The results of the survey indicate that at most sites both nutrients and faecal bacteria were elevated above the controls (Table 1). Nitrate+nitrite-N concentrations in the interstitial water and the seawater at some sites were up to 400 times and about 60 times, respectively, the mean concentrations at the control sites. At sites BW7-9, about 45 m away from the nearest leach drain, mean nitrate+nitrite-N concentrations were approximately 90 times higher than at the control site. One ocean site had faecal bacteria counts considerably higher than the control sites. Of the 9 test samples of interstitial water, seven were contaminated with faecal bacteria. These results suggest that considerable amounts of sewage is leaching into the marine environment of Monkey Mia from both facilities. The survey on March 1-2 followed a period when visitor numbers were low (Fig.3). As a result this survey is unlikely to reflect the degree of contamination under high usage. Furthermore it was assumed that effluent in the groundwater flowed directly to the ocean. As such the sample sites may not have intercepted the main effluent streams into the ocean.

The water level in the sampling holes dropped when the tide ebbed indicating that considerable exchange does occur between the ocean and interstitial water under this beach further suggesting that contaminants released near the beach will be transported rapidly to the ocean. Any contamination of the interstitial water at all, especially as far away as 45 m from the source, is likely to be a reflection of significant groundwater contamination. The water level in a disused well, about 100 m from the beach, also oscillates with the tide, according to Wilf Mason, the former proprietor of the Monkey Mia Caravan Park, suggesting that tidally forced exchange between the groundwater and the ocean extends a considerable distance inland. This has important implications in relation to effluent disposal in the Monkey Mia area and the resultant transfer of pollutants from the land to the ocean. The disused well was full of oily water and rubbish at the time of this visit and could be a possible further source of pollution.

Other sources of pollution that may be significant include sun screen lotion and pesticides. During the present visit oil slicks, presumably sun screen lotion, were observed emanating from people who were wading into the shallows to touch and feed the one dolphin that was present at the time. If the observed situation was typical, then from the numbers of people that visit Monkey Mia and the extent of the observed slicks, it is highly likely a considerable quantity of this material is entering the marine environment. Whether or not this material is harmful to dolphins is unknown. However sun screen lotion is a severe irritant to human eyes and, at the very least, may be the same for dolphins.

During the present visit a contractor arrived at the Visitor Centre and sprayed the external parts of the building in contact with the ground, with a pesticide for treatment against white ants. Given the close proximity of the dolphins to the Visitor Centre this practice should be reviewed.

6. POSSIBLE NATURAL CAUSES AND EXPLANATIONS FOR THE SUDDEN DEATH AND DISAPPEARANCE OF DOLPHINS AT MONKEY MIA

Dolphin calves have died at Monkey Mia in the past therefore the sudden death of the calf may have been due to natural causes. However, if this were the case it would be highly unlikely that all three calves at Monkey Mia would die or disappear within about 18 days of each other,

especially since all the calves of the offshore population, that have been observed in February 1989, were with their mothers and appeared to be healthy.

The most simple possible explanation for the sudden disappearance of some of the other dolphins at Monkey Mia is that they became disenchanted and left. This seems unlikely as they visited Monkey Mia very regularly throughout 1987 and 1988 when visitor numbers in winter were often higher than in January 1989. Another possible explanation is that they have resumed their summer visiting pattern of several years ago when they were often absent for several weeks at a time. However, when the hand feeding of fish to the dolphins was extended to all year round about 3 years ago, the dolphins promptly responded by visiting year round. Based on the number of 'regular' dolphins that visited Monkey Mia in January to March 1987 and 1988, the marked decrease observed in February and the first half of March in 1989 is very unusual.

The two missing calves were both suckling at the time of their disappearance and, as their mothers have since been observed being herded by males offshore and were obviously in oestrus, then it is reasonable to assume that these 2 calves are dead. The normally close association between dolphin mother and calf can been seen in the visitation patterns of Nicky and her 14 month old calf Nipper during 1988 (Fig. 4). On the 10 occasions Nicky was absent from Monkey Mia so was Nipper. Both dolphins visited Monkey Mia on February 7. On February 8 all of the dolphins were absent, and when Nicky returned on February 9 without Nipper the rangers at Monkey Mia immediately became very concerned.

Dolphins normally have a calf every 4-5 years and calves in the wild are weaned at age 3-4 years in contrast to about 18 months in captivity. In addition weaning normally takes place over several months and usually results in considerable friction between mother and calf; a behaviour not observed between Nicky and Nipper prior to Nipper's disappearance. Thus successful weaning as an explanation for the two calves disappearance is extremely unlikely in 14 month old Nipper's case and impossible in the case of the almost week old calf of Puck. The possibility that these calves were fostered to other females is also very unlikely.

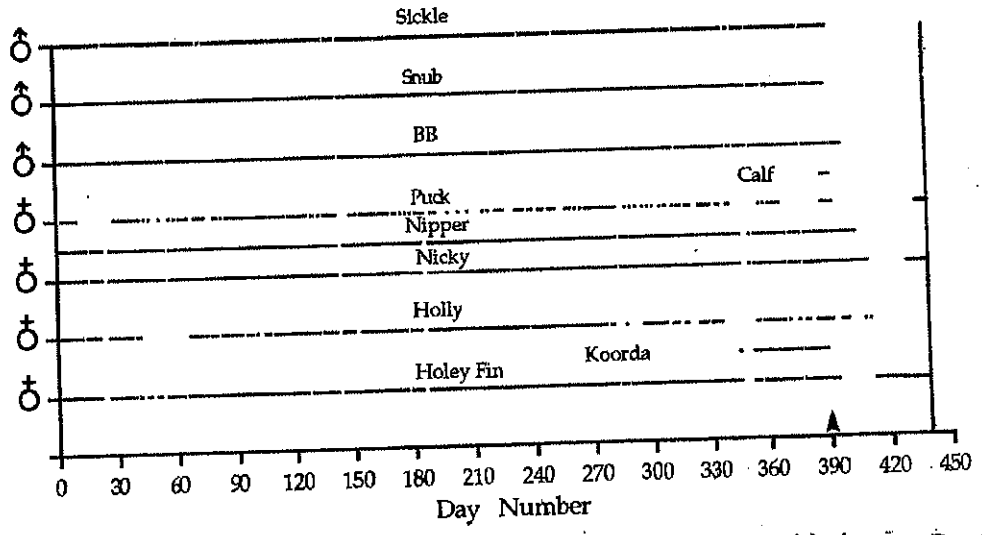

Figure 4. Daily visitation records for each of the 'regular' dolphins that visit Monkey Mia. Day 1 is January 1, 1988.. Last record is March 15, 1989 which is day 440. (▲) Dead calf found in the shallows.

The three missing male dolphins (Sickle, Snub, BB) disappeared between January 23 to 30 and have not been seen since (Fig. 4). When not visiting Monkey Mia, these dolphins are normally part of established coalitions or groups of males of the offshore dolphin population in the Monkey Mia study area. These coalitions have been monitored for several years and 'membership' is generally stable although a dolphin may belong to several coalitions simultaneously. Observations during February 1989 indicate that the offshore population of male dolphins has remained stable with 20 of the 21 males being observed so far. In the past, the one missing male from the offshore population has often been recorded absent. The three missing males from the Monkey Mia 'regulars' have not been observed with any of the offshore males that they normally associate with, and considering that each of these three males visited Monkey Mia over 320 times in 1987 and 345 times in 1988, their continued absence since the last week in January 1989 is highly unusual and provokes some concern for their well being. Two possible explanations may account for their disappearance. Either they have left the study area, something they have not done in the last few years, or they have died. In relation to the second possibility, an extensive search was conducted by a dolphin researcher along parts of the coastline of Shark Bay between February 22-29, 1989 and no recently dead dolphin bodies were found. The remaining 'regular' is a juvenile female called Holly, and was last seen on February 15. She has often been absent in the past for several weeks (Fig. 4) so her continued absence at this stage is not reason to be overly concerned.

At present only the three adult females of the 10 'regular' dolphins are visiting Monkey Mia. One calf is confirmed dead and circumstantial evidence suggests the other two calves are also dead. The three males have now been missing for over 6 weeks, a period of absence unprecedented in the last few years and highly out of character for these three dolphins who were the most regular visitors to Monkey Mia. The juvenile female, Holly, has also been absent for over 4 weeks. The death of a calf and the subsequent disappearance of 5 other 'regular' dolphins within a short period at Monkey Mia, in contrast to the apparent stability and health of the offshore population of dolphins, suggest that some localised event occurred in the vicinity of Monkey Mia causing a major disruption in the behaviour of the 'regular' dolphins.

7. POSSIBLE UNNATURAL CAUSES FOR THE SUDDEN DEATH AND DISAPPEARANCE OF DOLPHINS AT MONKEY MIA

On January 21, 1989, two days before the sudden death of the calf Koorda, the type of fish that were being routinely fed to the dolphins were changed from Shark Bay herring to garfish. These garfish were caught locally, on the western side of Peron Peninsula (Fig.1). This apparent coincidence led to suggestions that these garfish were implicated in the death and subsequent disappearance of the dolphins. A superficial examination of frozen specimens of garfish that were part of the 'batch' being fed to the dolphins at the time of the calf's death, revealed that these fish had clear eyes and shiny scales ie signs that these fish were in a healthy condition when they were snap frozen. Advice from the Fisheries Department and from a veterinary toxicologist at Murdoch University indicated that little could be gained from conducting tests on these fish. Furthermore it is considered unlikely that these fish are implicated because the adult females with

the three calves ate the fish and are alive, while their calves which were suckling at the time are either dead or presumed to be dead.

The presence of faecal bacteria levels and nutrient concentrations above controls in the interstitial water of the beach and in the nearby seawater indicate that leaching of sewage wastewater into the local marine environment of Monkey Mia does occur. Whether this contamination ever reaches levels that would constitute a serious threat to the dolphins' health is unknown. However it is possible that, at certain times of the year, the flushing of the waters in the immediate vicinity of Monkey Mia may be severely restricted during particular conditions of wind and tide. If these periods coincided with high water temperatures and high visitor numbers (and presumably high usage of the toilet facilities) then it is possible that bacteria or viruses may survive in sufficient concentrations to pose a threat to the dolphins' health. The number of visitors in January 1989 was unprecedented, being over twice the number of the previous January and water temperatures were probably between 26-28° C. In addition it was unusually calm. Whether these conditions resulted in a significant deterioration in the water quality around Monkey Mia, just prior to the death and subsequent disappearance of the dolphins, is unknown.

The potential effects on the dolphins of a temporary decline in water quality during summer would possibly be exacerbated by the behavioural characteristics of the calves and the males at this time of the year. Other mammals such as pigs are particularly vulnerable to bacterial infections when they are suckling and this may also apply to dolphins. Furthermore the breeding season of dolphins at Shark Bay extends mainly from September to March and is characterised by fighting between the males resulting in open wounds being common throughout this period. In addition the high testosterone levels that occur in the males during the breeding season depress their immune system. Thus exposure to high levels of bacteria or viruses from sewage leachate, even for a short period, would increase the chance of infection through the open wounds at a time when they were more vulnerable to infection than usual.

8. CONCLUSIONS

The sudden death of a six week old dolphin calf on January 23, 1989 was closely followed, over the next 17 days, by the disappearance of the two remaining calves, the three adult males and a juvenile female from the 'regular' group of dolphins that visit Monkey Mia. These dolphins have not been seen since early February and, apart from the juvenile female, represents a drastic departure from their normal behaviour over recent times. The mothers of the dead calf and the two missing calves were absent from Monkey Mia for varying periods in February. However all three were observed offshore being herded by male dolphins and all have resumed visiting Monkey Mia again without their calves. The separation of the calves from their mothers suggests these calves are unlikely to be alive.

The three male dolphins have not been seen at Monkey Mia since early February and have not been observed in the 'coalitions' or groups of offshore dolphins that they normally associate with when they are not at Monkey Mia. These three dolphins each visited Monkey Mia on over 320 days in 1987 and on over 345 days in 1988. As a result their prolonged absence in early 1989, coinciding

with the death and disappearance of the calves, warrants concern. No apparent changes have been observed in the male offshore dolphin population at Monkey Mia and all the calves of the offshore females that have been observed recently appear healthy.

These observations indicate that the death and disappearance of dolphins is confined to the 'regular' population that visit Monkey Mia and is unlikely to be a series of unrelated natural events, but rather be related to some factor in the inshore areas at Monkey Mia.

The possibility that fish fed to the dolphins are implicated in the death and subsequent disappearance of the dolphins at Monkey Mia is unlikely.

During the present survey the interstitial water (soil water) and the seawater at some sites immediately off the beach at Monkey Mia contained elevated (above controls) levels of faecal bacteria and extremely high concentrations of nitrate+nitrite-N. These data indicate that the interstitial waters and the nearshore marine waters of Monkey Mia were highly contaminated. This pollution is likely to be coming from septic systems from the Monkey Mia Caravan Park and the Visitor Centre. However it should be stressed that although sewage wastewater is the most obvious source of contamination of the local marine environment at Monkey Mia, it does not necessarily imply there is a causal link to the death and disappearance of the dolphins.

9. ACKNOWLEDGEMENTS

Considerable information on dolphin behaviour, biology and ecology was supplied by Richard Conner, a University of Michigan researcher living at Monkey Mia and Dr. Nick Gales of Atlantis Marine Park. Statistical data on dolphin and tourist visits was supplied by Sharon Gosper, the head ranger of the Monkey Mia Visitor Centre. This assistance is gratefully acknowledged.