VESSEL ACTIVITY, DOLPHINS AND DUGONGS IN RED CLIFF BAY, MONKEY MIA:

AN OVERVIEW OF ACCOMPLISHMENTS AND PRELIMINARY RESULTS OF THE FIRST FIELD SEASON (APRIL – AUGUST 2000)

A REPORT TO THE DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT, WESTERN AUSTRALIA

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BACKGROUND

The general public is becoming increasingly interested in marine mammals and seeks out close encounters with cetaceans at an ever-increasing rate. Commercial cetacean-watching[1] has grown almost exponentially in the last 45 years. Hoyt (2000) reported that the global cetacean-focused tourism is a $1 billion USD industry attracting more than nine million people annually in 87 countries and territories.

In Australia, tourism is the largest single earner of foreign exchange (Hoyt 2000). Wildlife tourist activities, such as cetacean-watching, are at the top of the visitor attraction list. In 1998, 46 communities, involving 223 commercial operators, offered cetacean-watching tours. More than 730,000 tourists engaged in cetacean-watching producing a total revenue of $56 million USD. In Western Australia, in 1998, there were 87 commercially licensed cetacean-watching operators and two "swim-with-dolphin" operators in 13 communities with an additional 23 operators offering dolphin-watching as part of other activities, e.g. fishing and sightseeing (Hoyt 2000).

The cetacean-watching industry holds considerable economic and educational potential, but the impacts of uncontrolled tourism could have serious consequences for target animals. Although single encounters with boats seldom cause long-term complications for cetaceans (exceptions include incidents of direct collisions), repeated encounters have the potential for detrimental effects. While whale- and dolphin-watching vessels are less numerous and less noisy than those involved in most other shipping activities, they repeatedly target close-encounters with cetaceans for prolonged periods of time.

To address the potential effects of the global cetacean-watching industry, and with the concurrent need for management, some research has been conducted to evaluate impacts on target animals. Reported short term behavioural reactions to approaches of tourist vessels include changes in: travelling directions, travelling speeds, group composition, surface intervals, submergence times, displacements from the area and acoustic vocalisations (e.g. Baker and MacGibbon, 1991; Kruse, 1991; Gordon et al., 1992; Blane and Jaakson, 1994; Bejder et al., 1999). In some places the number of recreational and commercial-tour vessels approaching cetaceans is cause for serious concern (Constantine, 1995; Nowacek, 1999). Dolphins that are forced to spend considerable time and energy avoiding boats (and/or boat noise) may be displaced from preferred feeding and breeding habitats with detrimental consequences. Cumulative impacts may reduce the biological fitness of an animal and population by disruption of critical energy budgets, breeding success, feeding activity and resting opportunities.

Shark Bay, Western Australia

The dolphins of Red Cliff Bay, and particularly those who visit Monkey Mia, are of extreme economic significance to the local community. Monkey Mia receives over 100,000 visitors annually - 69% of which come primarily to see dolphins (Reark Research 1995). One commercial dolphin-watching tour vessel (Shotover) has been operating within Red Cliff Bay since 1993. A second license application was approved in 1997 by the Marine Parks and Reserve Authority and by the Minister for the Environment. In 1998, the Department of Conservation and Land Management (CALM) made the license available to the commercial tour-vessel operator (Aristocat 2). The latter has been operating in Red Cliff Bay since August 1998.

Stated in the Monkey Mia Reserve - Draft Management Plan (1993), "since dolphins are the major reason people visit Monkey Mia, continued visits depend on the presence and health of the dolphins." The overall management goals within the Monkey Mia Reserve, as outlined by the CALM and the Shire of Shark Bay, include: to protect the Monkey Mia dolphin population and habitat from adverse impacts.

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[1] "Cetacean-watching" includes tours by boat, air or from land, with at least some commercial aspect, to see, swim-with or feed one or more cetacean species.

To promote management plans for dolphin-focused tourism that are informed by scientific study, the Marine Parks and Reserve Authority proposed that CALM carry out a monitoring plan to assess the potential impacts of the commercial and recreational dolphin-watching vessels on dolphins in Red Cliff Bay. In response, a one-month pilot study was carried out in August 1998 (Donaldson 1998). Preliminary findings included dolphin behavioural changes during vessel approaches (or within minutes of vessel arrival), including changes in activity states, splitting of dolphin groups and an increased rate of synchronous surfacing behaviour. Following recommendations from the pilot study, a three-four year research program, funded by CALM, commenced in April 2000. The research is being carried out by myself, Lars Bejder (PhD candidate) under the supervision of Dr Nick Gales (CALM), Dr. Amy Samuels (Chicago Zoological Society and Woods Hole Oceanographic Institution, USA), Dr. Peter Tyack (Woods Hole Oceanographic Institution, USA) and Prof. Hal Whitehead (University of Dalhousie, Canada).

The main aims of the study are to:

- **develop complementary research methodologies to assess potential disturbance of vessel activity on dolphins, which, in turn, can the used to assess strengths and weaknesses of specific methods.**

- **identify potential effects of vessel activity (commercial and recreational) on dolphins (and dugongs) in the Red Cliff Bay area.**

- **develop recommendations, pertaining to vessel activity, to minimise impacts on targeted animals that, in turn, will help ensure the sustainability of the industry.**

This report summarises the accomplishments of the first season including development of methodologies and preliminary findings. It does not include a comprehensive analysis of the complete data set from the initial field season. Rather, the material presented represent preliminary findings and trends. The aim of the report is to provide CALM with information pertaining to the initial season, including:

a. development of methodologies
b. type of data collected
c. sample sizes obtained
d. preliminary trends
e. matters of potential concern

SCOPE OF FIRST SEASON

The research will be carried out over three-four field seasons - each approximately six months in duration. The aims of the first field season, April – August 2000, were to:

1. establish good working relationships between the local community, tour operators and the project
2. evaluate the feasibility of data collection on impacts of vessel activity on dolphin behavior from four different observation platforms:
   a. land-based theodolite station
   b. commercial tour vessels
   c. independent research vessel
   d. acoustic recordings
3. devise appropriate sampling protocols for the four different observation platforms
4. collect preliminary data on potential impacts of vessel activity on dolphins in Red Cliff Bay.

ACCOMPLISHMENTS OF THE FIRST SEASON

Working relationships

At the start of the season an informal meeting was initiated by CALM, and held between CALM employees, tour operators and staff, Monkey Mia Dolphin Resort staff, other researchers and myself. The aim was to inform all parties about the research program, i.e. aims, methods and proposed outcomes, to address questions and matters of concerns that any parties had, and to initiate a good working relationship between parties and the research project.

Twice a week, throughout the field season, I gave presentations to local residents and tourists staying at the Monkey Mia Dolphin Resort outlining the focus of the research program and about bottlenose dolphin ecology and history life.

Development of methodology and protocols

To effectively evaluate potential impacts of vessel activity on the bottlenose dolphins in Red Cliff Bay, I have designed a study that incorporates land-based observations, acoustic recordings together with behavioural observations from two different vessel platforms, commercial dolphin-watching vessels and an independent research vessel (see Appendix A for observation platform details). Comparison, and linkage, of data simultaneously obtained from these platforms will identify appropriate measures of the effects of boating on important aspects of the lives of these animals. Existing demographic- and baseline behavioural data on the Shark Bay bottlenose dolphin population allow for post-stratification of dolphin responses in relation to age, sex, group composition and present level of habituation to vessels and humans. The complementary research methodologies can also identify how data collection methods may affect conclusions about boating effects on cetaceans and hence be used to assess methodologically induced biases in other studies. Results will allow for recommendations on methodologies appropriate to specific research questions pertaining to human-dolphin encounters.

During the course of the season, protocols for three of the four observation platforms were developed (land-based theodolite station, commercial tour vessels and independent research vessel). Feasibility of acoustic recordings of dolphin vocalizations and vessel noise were tested. The geographic placement of sonobouys was determined for future seasons. Acoustic data collection and behavioral data collection from the independent research vessel will commence in the second field season (March 2001). The preliminary analyses presented in this report are based on data collected from the commercial tour vessels and from the theodolite station.

PRELIMINARY RESULTS AND DISCUSSION

It is of paramount importance that the results presented be treated and interpreted carefully and only as preliminary findings. The aim of the first field season was to devise systematic protocols for recording dolphin encounters with vessels from various observation platforms, therefore, protocols were continuously revised and some behavioural measures were added over the course of the season. Skills to observe and identify individual dolphins also changed during the course of the season. As a result, observations were standardised and improved as the field season progressed. Results reported here may therefore be based on different sample sizes and on continuously changing sampling protocols. Results presented are to be seen as trends – trends that could turn out either biologically and statistically significant or insignificant.

Analyses have been carried out on a subset of the collected data. In the following, preliminary results are presented from data collected a) aboard the commercial tour-vessels and b) from the land-based theodolite station. The data have not been analyzed in its entirety and many analyses are still pending.

Overview:
A). Preliminary analyses of data collected from commercial tour-vessels include:

Dolphin observations:
- Number of encounters between commercial tour-vessels and dolphin groups
- Location of encounters between commercial-tour vessels and dolphin groups
- Encounter rates with dolphin groups (per trip and per hour)
- Duration of encounters between commercial tour-vessels and dolphin groups
- Number of encounters each identifiable dolphin had with commercial tour-vessels

Dugong observations:
- Number of encounters between commercial tour-vessels and dugongs
- Location of encounters between commercial-tour vessels and dugongs
- Encounter rates with dugongs (per trip)
- Duration of encounters between commercial tour-vessels and dugongs

Turtle observations:
- Number of turtle sightings from commercial-tour vessels
- Location of turtle sightings;

Commercial tour-vessel motor activity observations:
- Motor activity throughout commercial tour;
- Motor activity during encounters with dolphin groups;
- Motor activity during encounters with dugongs;

B). Preliminary analyses of data collected from the land-based theodolite station include:

Dolphin observations:
- Number of dolphin groups tracked
- Duration of all the dolphin groups tracked
- Overall number of fission and fusion events when no vessels (commercial or recreational) present
- Overall number of fission and fusion events when commercial vessels present

COMMERCIAL TOUR-VESSEL OBSERVATIONS

The two tour-operators offer a total of eight trips per day combined – both running two tours in the morning and two in the afternoon. All tours run for 2-2.5 hours duration except for the first morning tour, which lasts for one hour. Tours primarily target encounters with dolphins but encounters with dugongs are specifically targeted during two tours daily.

Observations were carried out during 188 trips (336hrs 37min) aboard the commercial tour-vessels operating out of Monkey Mia (Aristocat: n=91 trips; 176hrs 19 min; Shotover: n=97 trips, 160hrs 18min) (Table 1).

DOLPHIN OBSERVATIONS

A dolphin "group" is defined using a 10 m chain rule: when A is within 10 m of B and B is within 10 m of C but A and C are more than 10 m apart, A and C are considered in the same group (Smolker et al., 1992). An "encounter" is defined to be when a vessel is within 50 m of the closest dolphin in a group for more than one minute. Situations where a vessel bypassed a dolphin group without stopping were not considered to be encounters. In cases where more than one group was within 50 m of a vessel and the groups were more than 10 m apart, it was counted as one encounter. The number of groups per encounter was noted.

A total of 349 encounters with dolphin groups were observed (see Figure 1 for geographic locations of encounters). The average number of encounters per tour was 1.86 (s.d. = 1.07) dolphin groups (Table 2). Morning tours had the highest number of encounters per trip (2.14; s.d. =1.2). On days when both tour-vessels operated at full capacity, i.e. eight tours per day, extrapolation indicates that dolphins were encountered 14.97 times per day.

Table 1. Number of monitored trips (and number of dolphin encounters).

	TOTAL
Morning trips (9:00,10:30/11:00)	97 (208)
Afternoon trip (13:00/13:30)	58 (92)
Late afternoon trips (16:30/17:00)	33 (49)
Total no. trips and encounters monitored	188 (349)

Table 2. Mean number of dolphin encounters per trip (and per hour).

	Mean no. of encounters per trip (and per hour)
Mean no. of encounters per morning trips	2.14 (1.41)
Mean no. of encounters per afternoon trips	1.59 (0.65)
Mean no. of encounters per late afternoon trips	1.48 (1.01)
Mean no. of encounters per trip (all trips combined)	1.86 (1.04)

Three hundred thirty eight encounters between dolphin groups and commercial tour-vessels were of know duration. Duration of encounters varied from one minute to 46 min 35 sec (mean = 10 min 38 sec; s.d. = 7 min 20 sec) (Figure 2 and Table 3). Approximately twenty percent of encounters exceeded the maximum 15-minute limit specified in the commercial tour-vessel license conditions and in the Code of Conduct (1998).

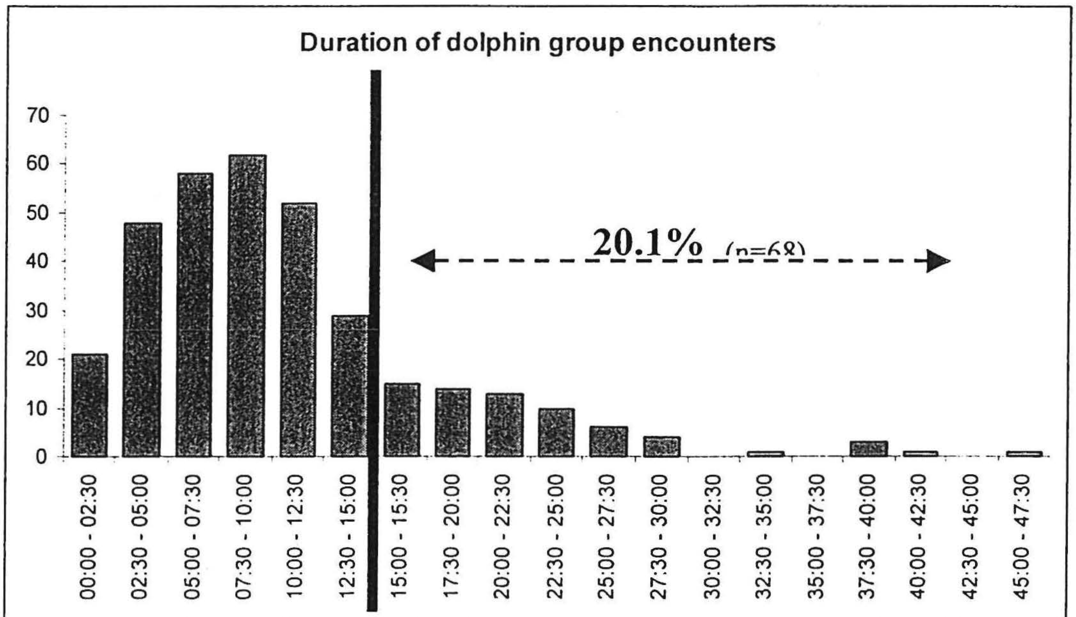

Figure 2. Duration of encounters between commercial tour-vessels and dolphin groups.

Table 3. Duration and percent of encounters exceeding 15 minutes.

	Both CVs
Mean encounter duration (s.d.)	10:38 (07:20)
Percent of encounters exceeding 15 minute duration	20.12%

A total of 1462 dolphins (includes multiple counts of same individuals) were encountered during the 349 interactions (of which 1005 were identified). Fifty-two dolphins were individually identified. Each identifiable dolphin was, on average, interacted with on 19.33 occasions (s.d. = 20.33) during 188 tours. The most often identified dolphins, that the commercial-tour vessels interacted with, were the female dolphin (Joy's Friend) and her dependent calf (Jambo) - both of whom were interacted with on 75 occasions (Figure 3).

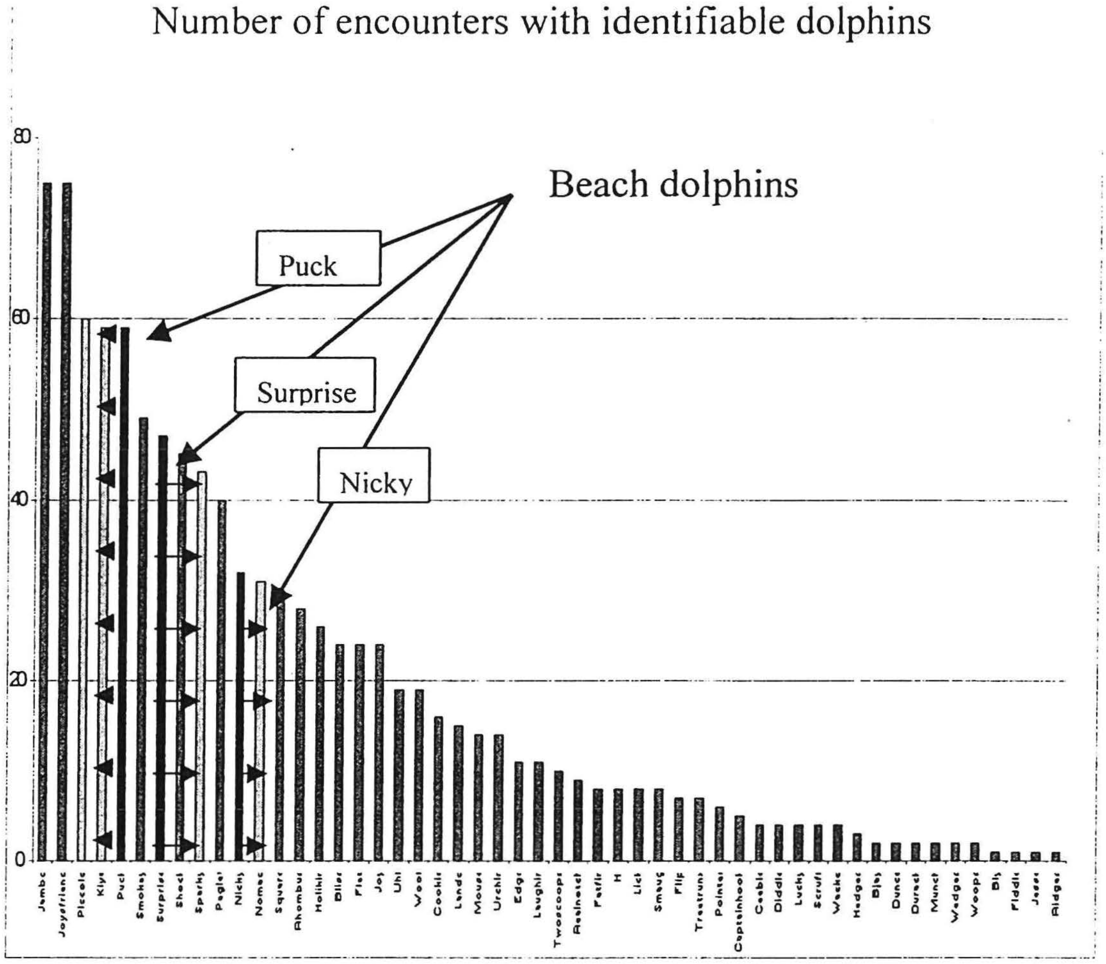

Figure 3. Identity and frequency of encounters with identified dolphins during 188 tours. The long arrows point to the three "beach dolphin" that are food provisioned at Monkey Mia. The smaller arrows point to their dependent offspring.

Beach dolphins

Of particular interest are the encounters between vessels and the three female "beach dolphins" who are provisioned at Monkey Mia beach and their offspring. Seven of the twelve most often identified dolphins during encounters, during the 188 tours monitored, were the three beach dolphins (Puck (n=59), Surprise (n=47) and Nicky (n=32)), their three dependent calves (Kiya (n=59), Sparky (n=43) and Nomad (n=31)) and one juvenile offspring (Piccolo (n=60)).

During encounters where all dolphins were identified (n=151 encounters) Puck, Surprise and Nicky were encountered during 27.2%, 19.2% and 16.6% of these encounters, respectively. Preliminary analyses indicate, at the daily rate of 14.97 encounters between commercial tour-vessels and dolphin groups, an encounter rate for Puck, Surprise and Nicky of 4.06, 2.88 and 2.47 per day. These encounter rates are roughly equal to or below the permitted number of encounters per vessel per day under the license regulations, i.e. two encounters with each of the beach dolphins per commercial tour-vessel per day.

DUGONG OBSERVATIONS

An "encounter" is defined to be when a vessel is within 50 m of a dugong for more than one minute. Situations where a vessel bypassed a dugong without stopping were not considered to be encounters. In cases where more than one dugong was within 50 m of the commercial vessel, it was counted as one encounter. The number of dugongs per encounter was noted.

One hundred sixty seven encounters between commercial-tour vessels and dugongs were observed (Table 5). Encounter locations were mainly concentrated at Which Bank and on one other bank extending from the NW to SE through the 3rd channel marker (Figure 4).

On average, dugongs were interacted with 0.89 times per trip. The overall average encounter duration was 12 min 25 sec (Figure 5 and Table 5). More than 27% of encounters exceeded the maximum 15-minute encounter limit specified in the commercial tour-vessel license conditions and in the Code of Conduct (1998).

Table 5. Number and duration of encounters between commercial tour-vessels and dugongs.

	Both CVs
No. of encounters with dugongs	167
Average no. of dugong encounters per trip	0.89
Average encounter duration (s.d.)	12:25 (07:24)
No. of encounters >15 min duration	46
Percent of encounters with dugongs exceeding 15 min. in duration	27.54%

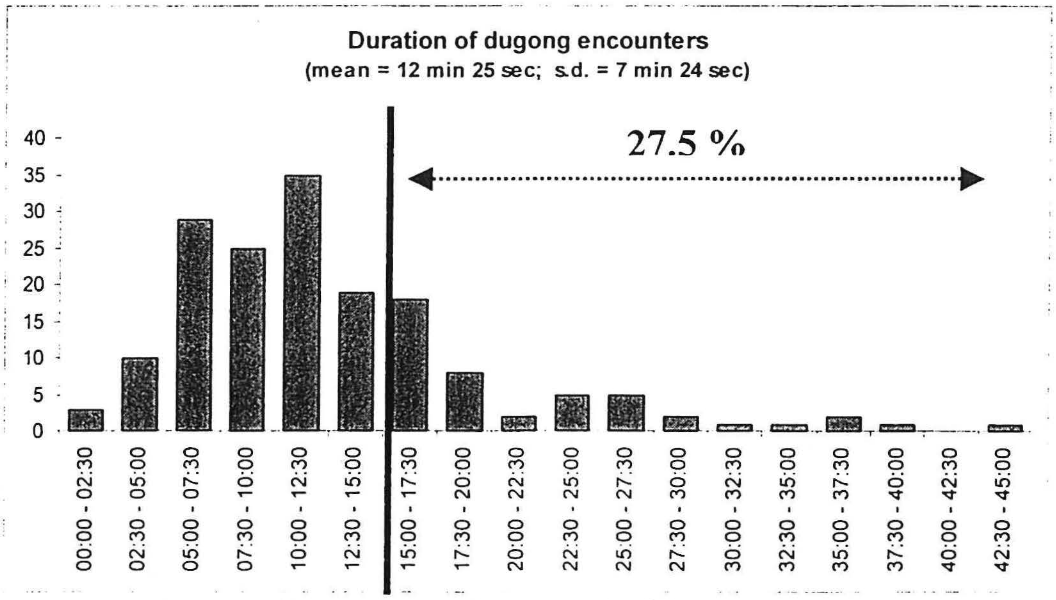

Figure 5. Duration of encounters between commercial tour-vessels and dugongs.

TURTLE OBSERVATIONS

Two hundred ninety four turtles were sighted during the 188 commercial tours monitored resulting in a turtle sighting rate of 1.56 turtles per trip (Figures 6 and 7).

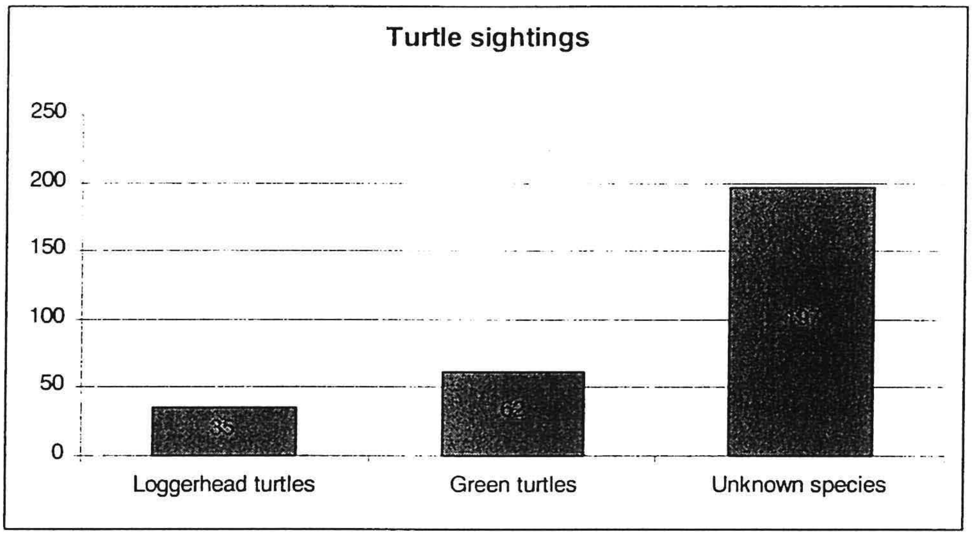

Figure 7. Number of turtle sightings from commercial tour vessel

MOTOR ACTIVITY OBSERVATIONS

It is important to also investigate potential effects of noise produced by vessels on the behaviour (vocal and non-vocal) of dolphins given that they rely so heavily on acoustic vocalisations for communication and orientation, and for detecting conspecifics, predators and prey (Payne and Webb, 1971; Myberg, 1990; Richardson et al., 1995). Vessel motor noise can overlap with frequencies used by dolphins, and lead to masking of their vocalisations or a modification in their use of vocalisations (Payne and Webb, 1971; Reeves, 1992). Forcing animals to modify their acoustic behaviour or reducing their hearing capabilities could have detrimental consequences. Vessel motor activity and changes in motor activity, e.g. changing into and out of gear are likely to bring about excess noise.

Therefore, motor activities of the commercial-tour vessels were monitored, during 188 tours, in two different ways; a) throughout each trip, point samples were taken, at 2.5-minute intervals, of the commercial tour-vessel's motor activity. Motor activity was categorized as either on (in propulsion), off or neutral; b) changes in motor activity were *continuously* monitored during encounters with dolphins and dugongs (<50m). Noted changes included shifting motors into forward, reverse, neutral, or off and revving up or revving down.

The popularity of cetacean-watching has prompted some countries to formulate legislative regulations to manage the industry (e.g. United States, Australia and New Zealand) while others have set-up voluntary "Code of conduct guidelines" to minimise potential impacts (Carlson, 1998). Regulations and guidelines usually dictate vessel and vessel engine conduct in the vicinity of marine mammals. For example, New Zealand regulations state that "where a vessel stops to enable the passengers to watch any marine mammal, the engines shall be either placed in neutral or be switched off within a minute of the vessel stopping". In Argentina, engines are to be "stopped near animals". Commercial operators at Monkey Mia work under permit regulations that state the "licensee shall approach a dolphin by maneuvering their vessel so as to be able to drift downwind from a distance of 100 meters, and their vessel's engines are not placed into drive or engaged until 100 meters beyond the closest dolphin". A common theme in all the above mentioned regulations and guidelines put forth advice against sudden changes in vessel direction, speed and noise and to minimize noise from all sources.

Results from the first season indicate that when dolphins and/or dugongs were present within 50 m of commercial tour-vessels in Red Cliff Bay, motors were in propulsion during 37.8% of the time (Figure 8). Furthermore, during interactions with dolphins and dugongs, motor activities were, on average, changed roughly three times per minute and every two minutes, respectively (Table 6).

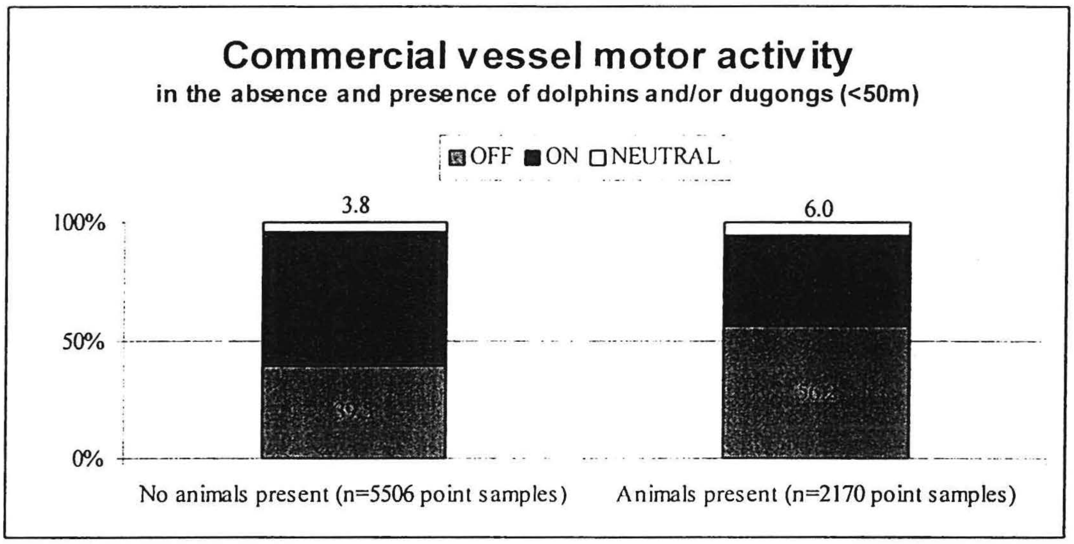

Figure 8. Motor activity of commercial tour-vessels.

Table 6. Rates of changes in motor activity during encounter with dugongs and dolphin groups (<50m).

	Dolphins	Dugongs
No. of changes in motor activity (per minute) during encounter	2.83	0.51
Time interval between a change in motor activity during encounter	21.2 sec	1 min 58 sec

Different engines produce different amounts of noise and these noises are likely to have different characteristics. Future field seasons will serve to document the noises produced by the commercial vessels and to record dolphin vocalizations in reaction to vessel approaches. Analyses will explore dolphin vocal reactions to the physical and acoustical presence of vessels.

LAND-BASED THEODOLITE OBSERVATIONS

Theodolite data is awaiting analysis on dolphin group speed, group movement patterns, group behaviour and group dispersion. Comparisons will be made of behaviour before, during and after vessel approaches. Here, information is presented pertaining to the obtained sample sizes, examples of dolphin tracks obtained during observations and preliminary analyses on dolphin group fission-fusion events in the presence and absence of commercial-tour vessels.

For theodolite observations a dolphin "group" is defined using a 50-m chain rule: when A is within 50 m of B and B is within 50 m of C but A and C are more than 50 m apart, A and C are considered in the same group.

Changes in group dispersion and events of group fission (splitting) and group fusion (joining) in reaction to vessel approaches are used as indicators of disturbance. Dolphin groups reportedly form tighter groups in situations of surprise, threat or danger (Johnson 1986). It is presumed that the physical proximity of other dolphins provides greater protection for the individual dolphin. Fusion events in reaction to disturbance could possibly serve to provide greater protection for individual dolphins. Fission events could possibly be a fleeing reaction by some members of a group. Animals that are less tolerant to a potentially threatening situation are most likely to elicit a fission response. Group composition changes were continuously recorded from the theodolite station as fission-fusion events. A fission occurs when an individual or part of a group leaves the remainder of the focal group *i.e.*, moves beyond the 50-m chain. A fusion occurs when an individual(s) joins a focal group.

Theodolite observations were carried out on 35 days (182 hrs; 127 hrs following dolphin groups) from two different theodolite station locations. A total of 80 dolphin group follows were a minimum of 30 minutes in duration (mean = 57 min 08 sec; s.d.= 50 min 59 sec).

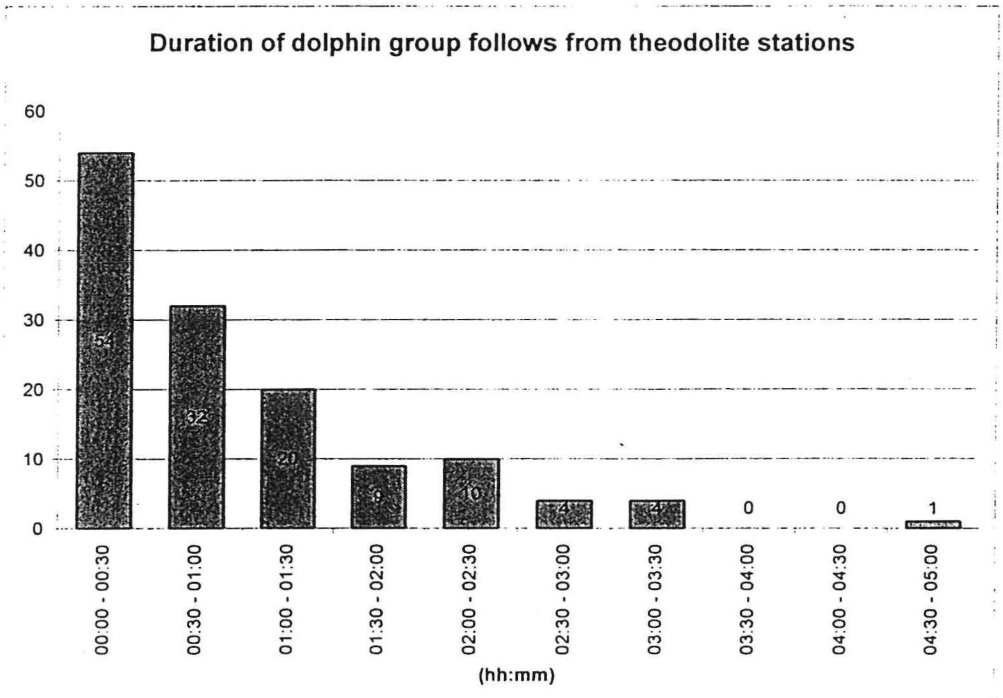

Figure 9. Duration of dolphin group follows carried out from the land-based theodolite stations.

Sixty-three group follows of greater than 30 minutes duration were collected from the Cherry Picker theodolite station (Table 8). Commercial-tour vessels were present within 50 m of these focal groups during approximately 27% of the total tracking time during which 55 fission/fusion events were observed. A total of 117 fission/fusion events were observed when vessels were absent within a 50 m radius of the focal groups. A chi-square test was carried out to test whether fission/fusion events were more likely to occur during encounters with commercial-tour vessels compared to when vessels were absent. There was a tendency for fission/fusion events to occur less often during encounters, but not at a statistically significant level (p. = 0.168).

Table 8. Dolphin group-follows of greater than 30 minutes duration collected from Cherry Picker theodolite station.

N=63 group follows	Vessels absent	During Encounter
Tracking time	65:40:00	24:20:00
No. of fission/fusion events	117	55

The preliminary analysis on fission/fusion events does not discriminate between fission events and fusion events nor does it take into account when fission or fusion events occurred during vessels approaches and departures. A more thorough and vigorous analysis is needed (and a larger sample size) to test whether groups split up as a reaction to vessel approaches or whether there is a tendency for animals to join a group upon termination of an interaction. Further analyses will also stratify fission/fusion reactions by age and gender of animals.

OTHER MATTERS

License regulations dictate that vessels shall not approach a dugong closer than 100 meters at a speed greater than 5 knots. Upon departure vessel speed shall not exceed 5 knots until at least 300 meters distance from the closest animal. In general, this was well complied with by both operators during *intended* approaches and departures. However, in three separate instances, a commercial tour-vessel nearly hit or actually hit a dugong at an excess speed (>10 knots). All near-collisions (or collisions) took place under circumstances in which the commercial tour-vessel was late in returning to the Monkey Mia jetty to pick up tourists for their next tour and hence operating at high speeds. Three near-collisions (or collisions) during 188 monitored tours indicate a collision rate of one every 63 tours. At this rate, if commercial vessels operate at, say, 75% of their maximum capacity, i.e. a total of 6 tours per day, 34 dugongs are hit or nearly hit per year (2.87 per month). In my mind, the only way these collisions can be avoided is by reducing the speed at which vessels are allowed to operate – not only during encounters with animals but also during no-encounter periods.

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APPENDIX A:

Land-based theodolite tracking

Land-based theodolite tracking offers reliable position-fixing without disturbance to the study animals. Theodolites have been widely used to document responses to various stimuli, including acoustic alarm devices (Todd et al., 1992; Goodson and Mayo, 1995) and vessels (Baker and Herman, 1989; Polacheck and Thorpe, 1990; Acevedo, 1991; Baker and MacGibbon, 1991; Kruse, 1991; Barr, 1997; Bejder et al., 1999; Yin, 1999).

Research using a theodolite is a zero-disturbance technique that allows accurate measurements of vessel speed and direction; dolphin group speed, direction and dispersion; and of distances between study animals and vessels. Theodolite observations can be collected during "no impact" situations, i.e. no vessels present, and during experimental and opportunistic vessel approaches to study animals. Theodolite observations allow measurement of group avoidance reactions to vessels at distances and for comparisons of behaviour before-, during and after a potential impact situation.

Boat-based research assessing vessel impacts

Vessel-based studies evaluating the effects of dolphin-watching vessels on dolphin behaviour can be conducted either aboard the tour vessel itself or aboard an independent research vessel. These platforms allow for observations of study animals at short distances, but there are limitations to both approaches that may complicate detection of impacts caused by the commercial vessels.

Commercial tour vessel as data collection platform

Commercial vessels are appropriate platforms from which to document dolphin group behaviours *during* close vessel/boat encounters and to document identification of individual animals that engage in encounters with vessels (e.g. Ritter, 1996; Donaldson, 1998). But, for a complete assessment of potential impacts of vessel/cetacean encounters, baseline information on behaviour during "no impact" situations is vital, as is information on behaviour before, during, and after vessel arrival. Obviously, data collection aboard whale- and dolphin-watching vessels can not be collected in the absence of the vessel. Furthermore, this platform does not allow for measurement of avoidance reactions to vessels at distance or of documentation of possible group splitting/joining in response to vessel approaches. Also, data collection aboard a tour vessel imposes several limitations to sampling protocols as the researcher is restricted in time and manoeuvrability, both of which are dictated by the tour operator.

Independent research vessel as data collection platform

Data collection from an independent vessel has been used to investigate impacts of vessels on cetaceans (e.g. Blane and Jaakson, 1994; Corkeron, 1995; Constantine and Baker, 1997; Nowacek, 1999). This platform allows researchers to design sampling protocols to record group behaviour before, during and after arrival of commercial tour vessels. In contrast to the commercial vessel platform, it allows for measurement of avoidance reactions to vessels at distances and of documentation of possible group splitting/joining in response to commercial vessel approaches. Identification of individual animals engaging in encounters with vessels can also be documented. However, the physical and acoustic presence of the research vessel *has the potential* to cause disturbance that may compromise detection of commercial vessel impacts.

Acoustic research assessing vessel impacts

It is important to investigate vessel effects (physical or acoustic) on the vocal behaviour of cetaceans given that marine mammals make use of acoustics for communication and orientation, and for detecting, recognising and localising companions, competitors, mates, predators and prey (Payne and Webb, 1971; Myberg, 1990; Richardson et al., 1995). Anthropogenic noise pollution can overlap with frequencies used by dolphins, and lead to masking of their vocalisations (Payne and Webb, 1971; Reeves, 1992). Documented vocal responses to vessels include reductions in calling rate, increase in the repetition of calls, cessation of vocalisations and shifts in frequency bands (Dalhlheim, 1987; Finley et al., 1990; Lesage et al., 1999).

Acoustic recordings can help assess impacts by giving insight into whether dolphin communication is compromised by vessels, either by acoustic masking or by a change in vocal behaviour. Vocalisation rates, frequencies and intensities are some of the possible measures that can be collected during acoustic recordings. Recordings are being carried out from remote recordings via sonobuoys (e.g. Frankel et al., 1995). Sonobuoys receive acoustic signals, via hydrophones, which are subsequently transmitted, via radio signals, to shore stations where recordings are made. Hence, after initial deployment of a buoy, recordings can be carried out without physical or acoustic disturbance to study animals, thus strengthening the credibility of results.

Fig 1.

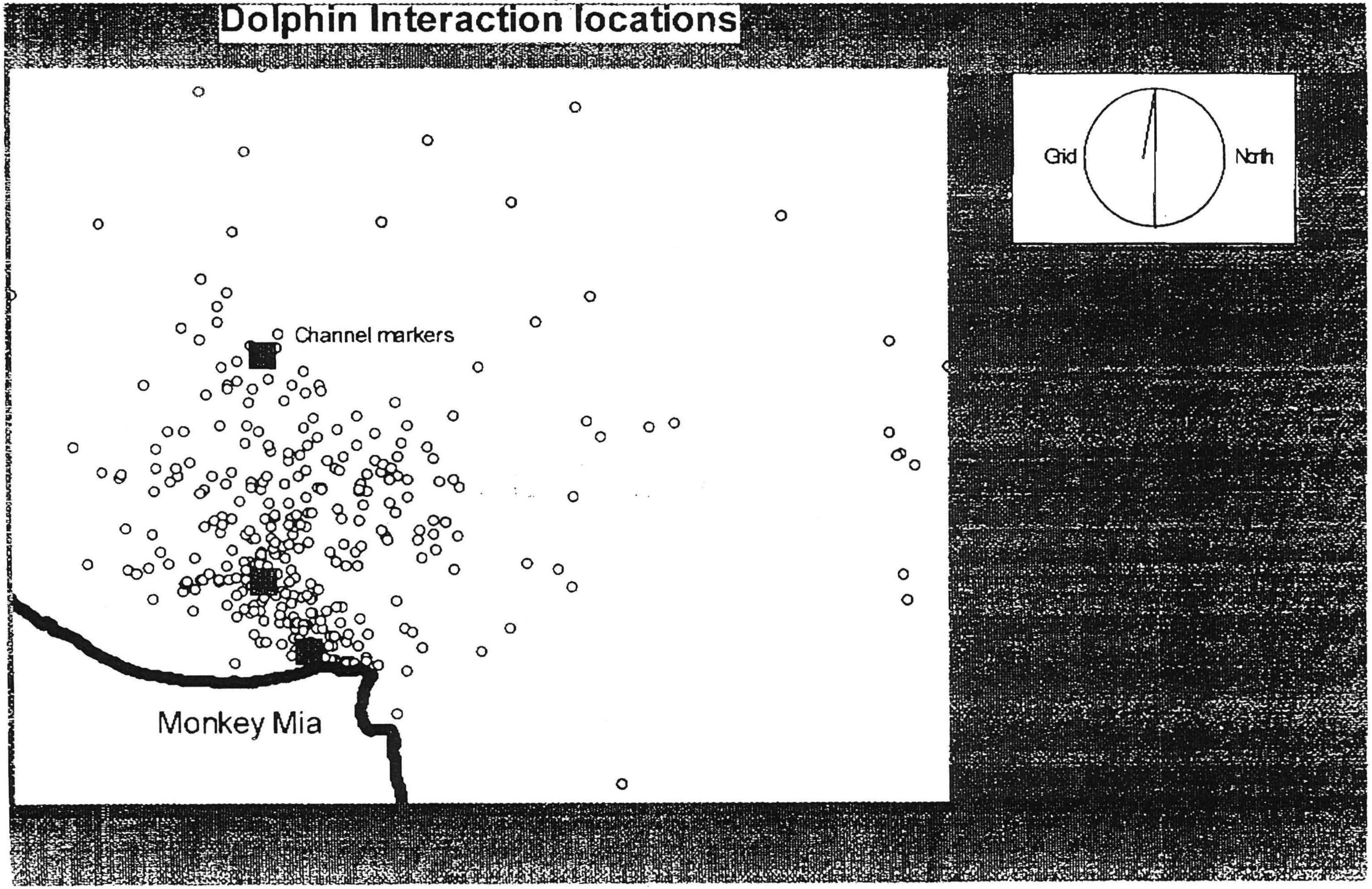

Dolphin Interaction locations
Channel markers
Monkey Mia
Grid
North

Fig. 4.

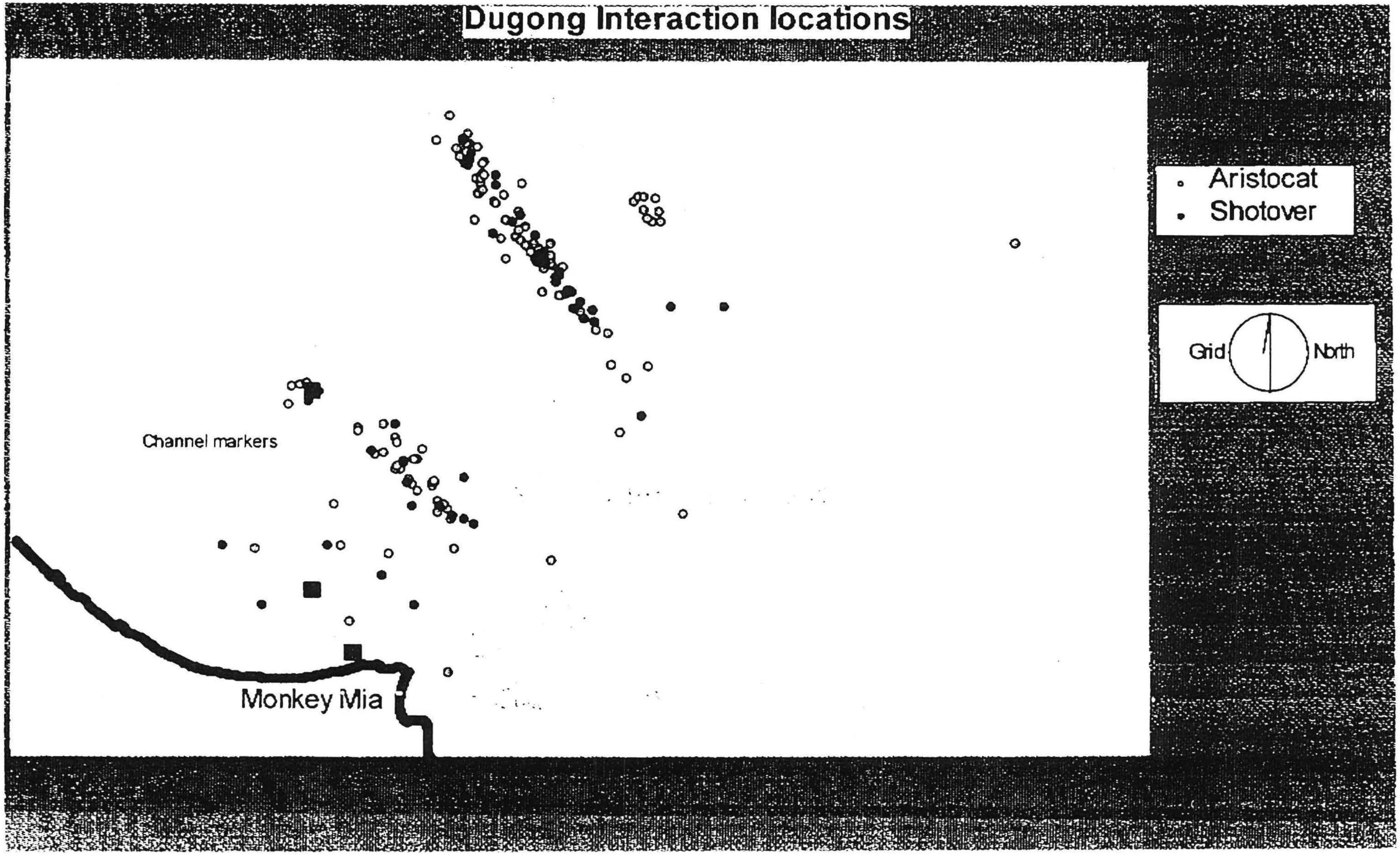
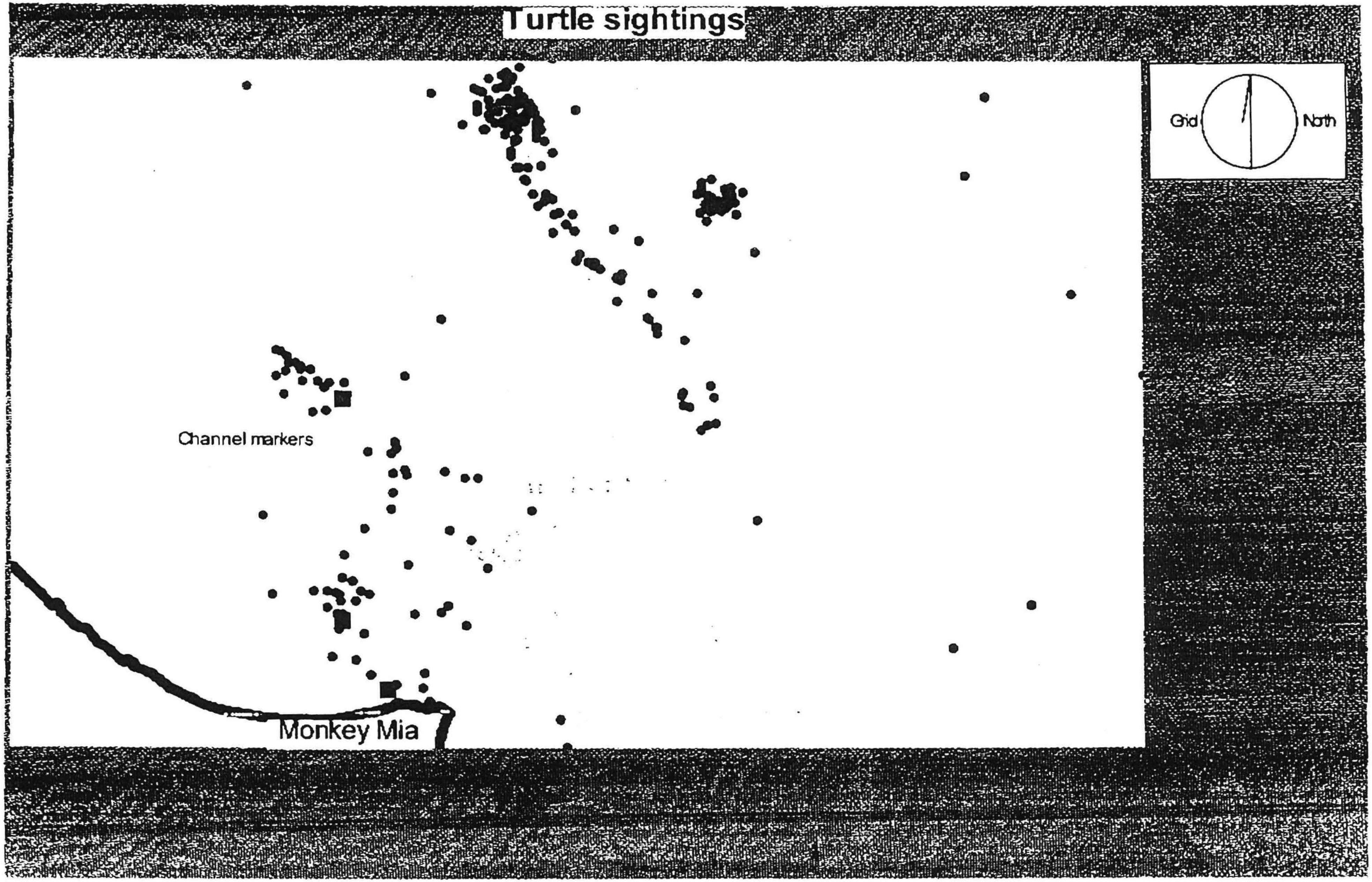

Dugong Interaction locations
Aristocat
Shotover
Grid North
Channel markers
Monkey Mia

Fig. 6.



~~2/ Nick D'Adamo.~~ 1: ~~Dave M~~ –
For referral to MPRA ~~Refer to Nick D'Adamo~~
[illegible]. [initials] 4/1/01. for copying to MPRA
[initials].

Hi Gordon,

I have just received the attached report from Lars Bejder. As I am off today I cannot afford much time to review it. However, I believe he has done an excelent job and identified a couple of important issue.

→ VERY high rate of interaction with beach dolphin.

→ extended duration of dugong interaction (above licence rules)

The MPRA should get this report for their next meeting when they consider licence re-newals. There is nothing in this report to suggest we should not licence both operators, but we should review the ways they operate.

Nick 22-11-00