

## Interactions between boats and bottlenose dolphins, *Tursiops truncatus*, in the entrance to Ensenada De La Paz, Mexico

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The presence of bottlenose dolphins, *Tursiops truncatus*, in areas frequently used by humans has been widely documented (reviews by Leatherwood and Reeves 1982, Shane *et al.* 1986); however, no detailed study on the effect of boat traffic on bottlenose dolphin behavioural states (from now on referred as behaviours) has been conducted. Bottlenose dolphins occur regularly in the entrance to Ensenada de La Paz, México (Michel 1986), apparently in relation to availability of prey (Acevedo 1989). Since La Paz is both a fishing and a tourist city, boats recurrently drive through the entrance to Ensenada de La Paz. As part of a larger study on behaviour and movements of bottlenose dolphins, I recorded interactions between boats and dolphins in the entrance to Ensenada de La Paz.

The entrance to Ensenada de La Paz connects Ensenada de La Paz, a mangrove-based coastal lagoon, with the southeast end of La Paz Bay (Fig. 1). It is located near the southeast tip of the Baja California Peninsula, México. The study area is shallow, mostly less than 5 m deep, with a dredged ship channel in a north-south direction. Observations were performed from May through September 1987. I searched for dolphins from a point 15 m above mean low water at the Centro Regional de Investigaciones Pesqueras (CRIP) (Fig. 1). While searching for dolphins, I recorded boat traffic every 10 min with a sampling duration of 15 min. When dolphins were sighted, I continuously observed them with 7 × 50 binoculars using focal group sampling (Martin and Bateson 1986). I continuously recorded dolphin behaviour and their reaction to boats. I recorded the nearest position of both the boat and the centre of the dolphin group with a surveyor's theodolite (20 s of arch precision, 30-power monocular). Since observations were based on the same groups more than once, data were not independent. Therefore, I analyzed dolphin reactions to boats using the concept of

conditional probabilities (Bakeman and Gottman 1986). Other statistical analyses were based on Zar (1984).

I defined three categories of vessels: 1) pangas (<8 m), fibreglass or wooden boats used by fishermen; 2) small vessels (8–15 m), recreational boats used by tourists; and 3) large vessels (>15 m), including yachts and coast guard vessels. Boat movement was defined as: 1) in the Ship Channel, 2) near the shore of the City of La Paz, and 3) near the shore of El Mogote sand bar (Fig. 1). Four different types of boat approach to dolphins were defined: 1) boats cruising more than 25 m away from dolphins (not included in the analyses, 2) boats cruising between 5 to 25 m of dolphins, 3) boats cruising within 5 m of dolphins, and 4) boats following dolphins at distances 2 to 10 m.

Boat traffic occurred at a median of 7.3 boats/effort hour (Interquartile Range = 5.6–10.0,  $n = 55$ ). I observed 1,599 boats moving in the study area. Pangas comprised 66.5% of the total, followed by small vessels (30.8%) and large vessels (2.7%). Overall, boats travelled more frequently in the Ship Channel than near the shores of La Paz or El Mogote ( $G_2 = 1174.23$ ,  $p < 0.0001$ ,  $n = 1599$ ). However, pangas travelled with the same frequency in each of the three areas ( $G_2 = 2.65$ ,  $p > 0.05$ ,  $n = 1063$ ).

I observed 71 dolphin groups during the study. I recorded 87 interactions between dolphins and boats, including 8 with my research vessel. Three different types of dolphin behaviour in relation to boats were observed: 1) dolphins did not alter their behaviour, 2) dolphins dove and resumed their previous behaviour, and 3) dolphins modified their behaviour, by moving in an erratic manner, before resuming it after boat departed (Fig. 2). Dolphin reaction was related to boat approach. Dolphins did not modify their behaviour when boats cruised between 5 to 25 m of them. They dived and resumed their previous behaviour when boats cruised within 5 m of them. Dolphins modified their behaviour when boats followed them (Fig. 3).

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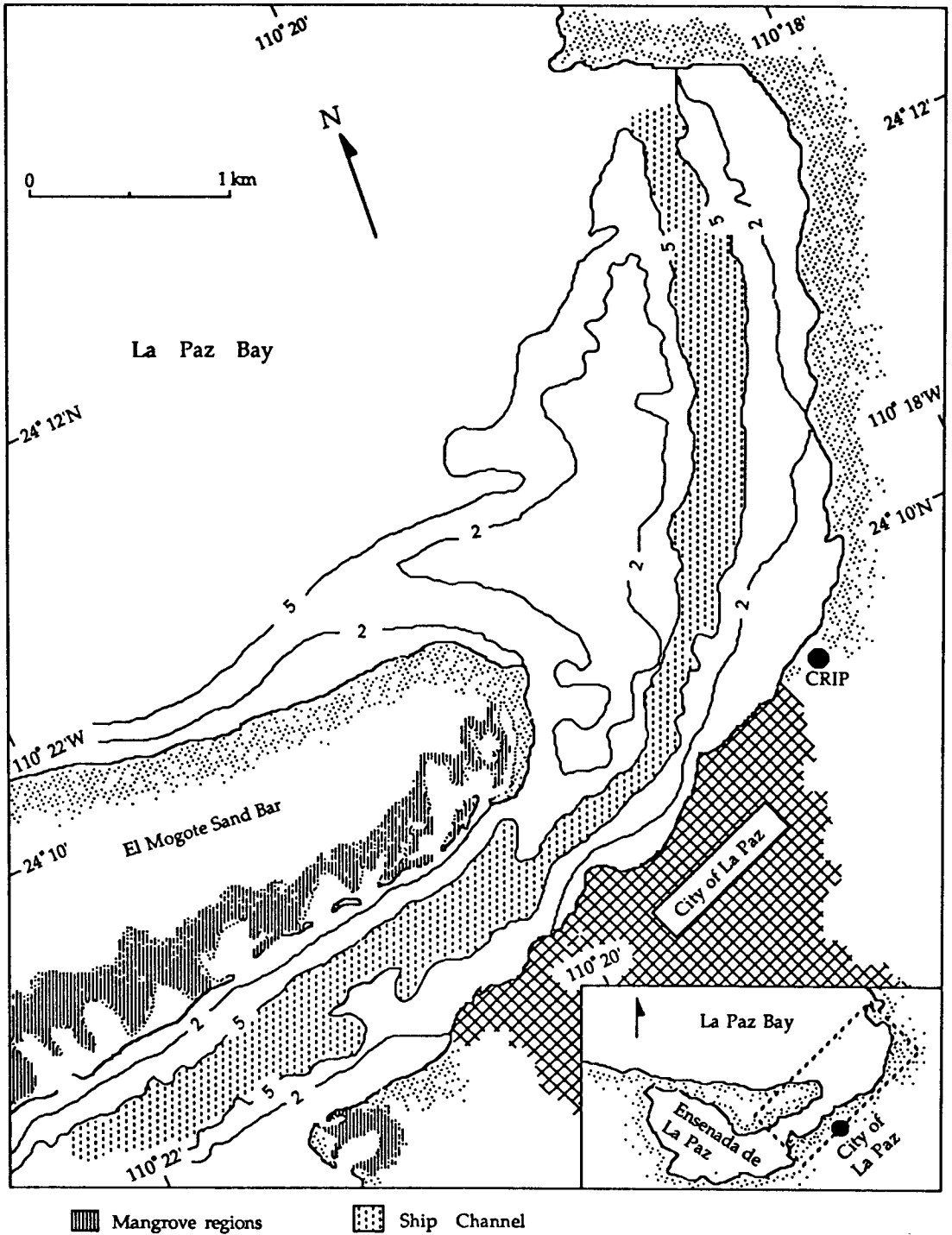


Figure 1. Location and bathymetry (in metres) of the study area, the entrance to Ensenada de La Paz.

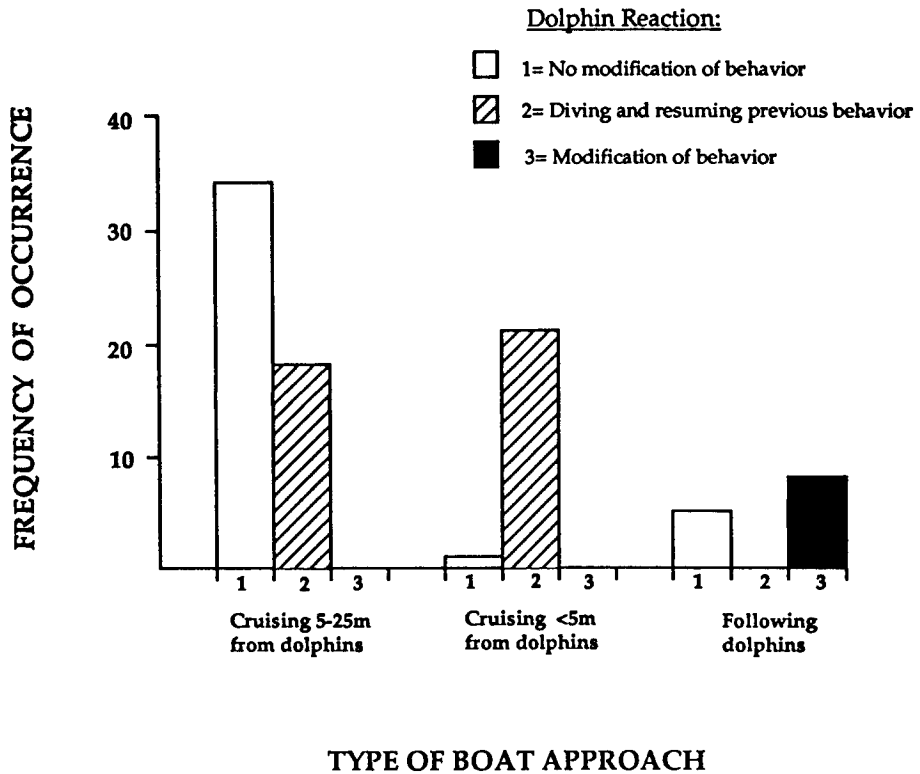


Figure 2. Frequency of dolphin reactions to boat approach.

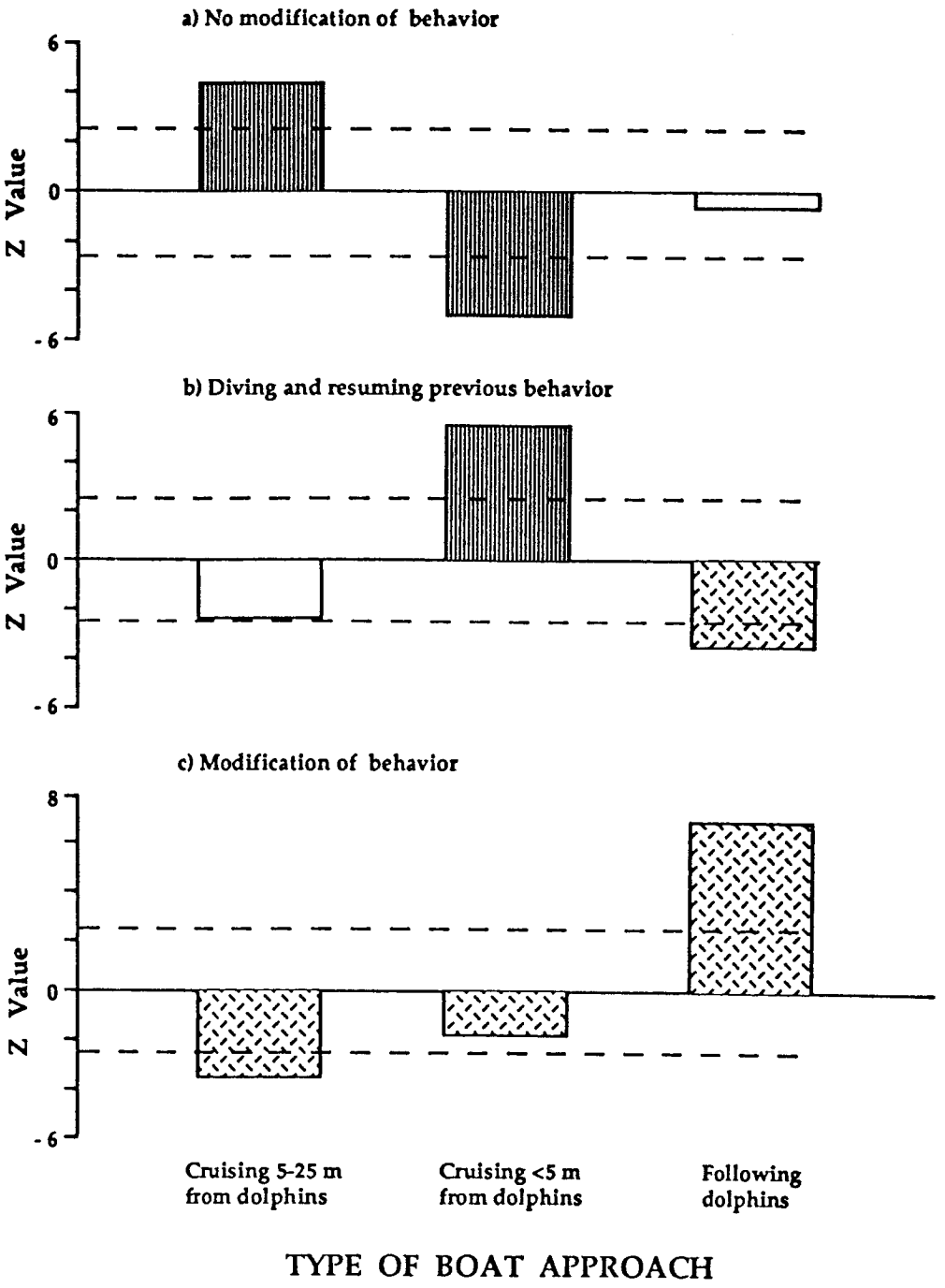
Boats driving through the area did not alter dolphin behaviour. Boat traffic also did not alter the frequency of occurrence, location, behaviour, and movements of dolphins thereafter; apparently, these were related to prey availability and movements (Acevedo 1989). Dolphins maybe were unaffected by boats driving through the area because they have been constantly exposed to boats since 1) dolphin presence in the study area has been well-known for a long time, 2) boats continually drive through the study area, and 3) size and shape of the area do not provide regions free of boats. Dolphin reaction to boat traffic should also be investigated in areas where these conditions differ.

Although small sample size does not allow a conclusive statement, boats that followed dolphins affected their behaviour, at least during the time that dolphins were being followed. It is unclear whether dolphin reaction to following boats was related to the behaviour that they were exhibiting at the time of approach. Both feeding and non-feeding dolphins were equally affected by a following boat. Würsig (per. comm.) observed that bottlenose and dusky dolphins, *Lagenorhynchus obscurus*, in Argentina at

times altered their travel routes when followed by the research vessel; dolphins also appeared to be more approachable after they fed. Kruse (in press) established that killer whales, *Orcinus orca*, in Johnstone Strait, British Columbia, swam more rapidly when approached by boats to within 400 m than whales unaccompanied by boats. This was related to size and engine-type of boat. Observations from the entrance to Ensenada de La Paz suggest that behavioural data taken from boats should be carefully analyzed; ideally, it should be compared with non-intrusive data taken when no boats are present.

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TYPE OF DOLPHIN REACTION



- Significant values ( $p < 0.05$ )
- Small sample size, Z scores presented as indexes

**Figure 3.** Dolphin reactions in relation to boat approach. For Z values larger than zero, dolphin reaction to boat approach had a frequency higher than expected. For Z values smaller than zero, dolphin reaction to boat approach had a frequency lower than expected. Dashed lines indicate critical values of Z ( $p < 0.05$ ).

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