J. Mar. Biol. Ass. U.K. (2007), **87**, 109–112
Printed in the United Kingdom
doi: 10.1017/S0025315407054148

Hawaiian spinner dolphins and the growing dolphin watching activity in Oahu

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Hawaiian spinner dolphins (*Stenella longirostris*) feed offshore at night on mesopelagic prey and move to protected shallow waters in early morning to rest. We hypothesized that this behaviour would make them particularly sensitive to anthropogenic factors in these rest areas and would affect their overall behaviour and their population frequency. To test our hypothesis we collected data in a known rest area along the north-west coast of the island of Oahu during August of 2001, 2002 and 2003. Using land- and water-based surveys, we evaluated dolphin group size, counted boats, kayaks and swimmers in the vicinity of the dolphins (<40 m) and reported any changes in dolphin behaviour. Our results demonstrated a stable dolphin habitat frequency over the three summers, which emphasizes the critical value of this rest area for this spinner dolphin population. The results also showed an increase in dolphin-oriented activities, but we could not draw any definitive conclusion on their real impacts on spinner dolphin ecology and ethology.

INTRODUCTION

Studies on Hawaiian spinner dolphins (*Stenella longirostris*) started in the 1970s and mainly focused on the population around the Big Island of Hawaii (Norris & Dohl, 1980). This species frequents both deep and shallow waters: the animals usually feed offshore at night on mesopelagic prey (Benoit-Bird & Au, 2003) and typically enter protected, sandy-bottom bays in early morning to rest before going back to deep waters in the afternoon (Norris et al., 1994).

In recent years, ecotourism has been increasing worldwide at an annual rate of more than 10% (Travel Industry Management, 1998); similarly, marine-based tourism activities in Hawaii have grown tremendously, offering people the opportunity to experience marine mammals in their natural habitat.

We evaluated the impacts of three specific human activities on spinner dolphin population frequency and behaviour over three summers in a given area and we discuss the results within the framework of general animal welfare.

MATERIALS AND METHODS

This study took place on the island of Oahu during August 2001, 2002 and 2003. We arbitrarily chose one spinner dolphin resting spot on the north-west coast of the island (21°32'N 158°14'W). The ethological data were collected mainly using scan and *ad libitum* sampling methods (Altmann, 1974) from shore (>10 m above sea level) and underwater from 0700 to 1200–1300 h. Trained observers were on site (Table1): (1) to estimate dolphin group size from shore and underwater and identify the age-class of present animals from underwater (adults, subadults, juveniles and newborns) in order to have the composition of the present groups (data not relevant here); (2) to complete a simple non-exhaustive ethogram including swimming direction, activity level, aerial and social behaviours; and (3) to record the number and activities of boats, kayaks and swimmers in the vicinity of the dolphins (distance <40 m). One pair of observers was in the water, at distance from the dolphins (>20 m), using scan and *ad libitum* sampling methods and the other observers were on the beach. They regularly alternated roles. We gathered and analysed a total of 323 h of observation.

We also documented (*ad libitum* sampling method) human–dolphin encounters that showed disruption in the animals' behavioural patterns as expressed by changes in swimming direction, in general activity level or in aerial behaviours (tail or head slaps) when dolphins were in the vicinity (1–5 m) of a potential source of disturbance. Only incidents simultaneously recorded and noted as disruptive by at least 80% of the observers, without preliminary consultation (inter-observer reliabilities ranged between 0.86 and 0.94), were considered relevant and categorized.

RESULTS

Dolphins' presence over the three summers
(Figures 1–3)

The absence of dolphins from 0700 to 1300 h was recorded. A session started when dolphins had been sighted, their number and the time spent in the area were recorded, and it ended when all dolphins had left the area. We cumulated the numbers of dolphins present (sum of all dolphins for each session) and we counterbalanced that number by the hours of presence in the area to get their frequency.

There was a slight difference in numbers of dolphins present over the three summers (Kruskal–Wallis test: KW=4.924, P=0.085) in the study area. The only significant difference in numbers of dolphins present appeared in

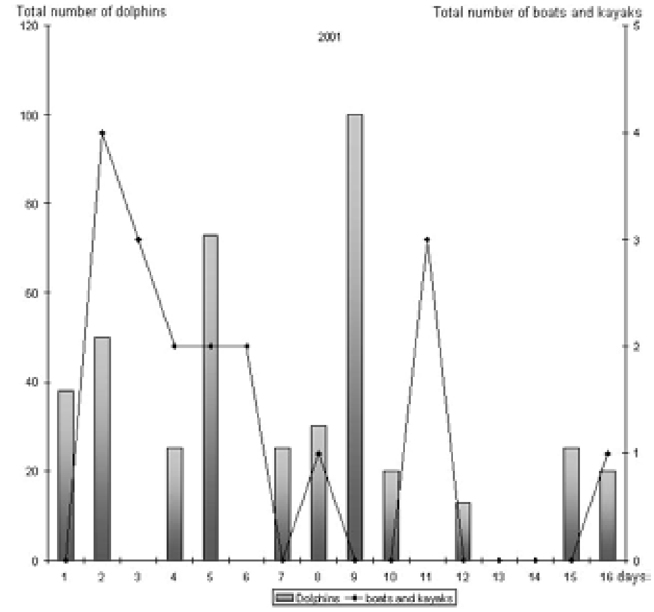

Figure 1. Total number of dolphins and total number of boats and kayaks over 16 d in August 2001.

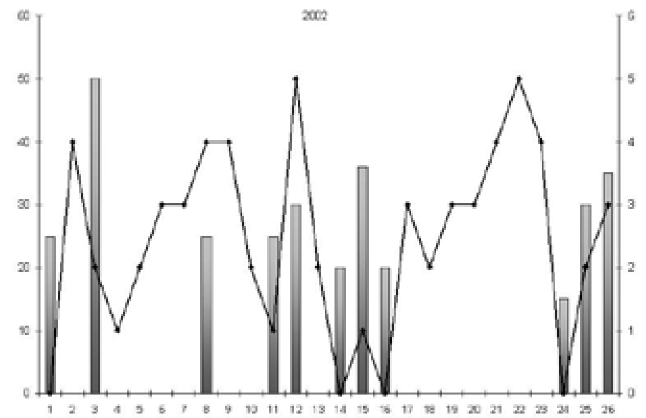

Figure 2. Total number of dolphins and total number of boats and kayaks over 26 d in August 2002. Key as in Figure 1.

2002: the animals came less frequently than in August 2003 (Kruskal–Wallis test: KW=−14.197, $P<0.05$); no difference appeared compared to August 2001.

Evolution of human activity over three summers

If we examine the three major anthropogenic parameters (numbers of boats, kayaks and swimmers) pooled together, the three summers demonstrate differences (Kruskal–Wallis test:

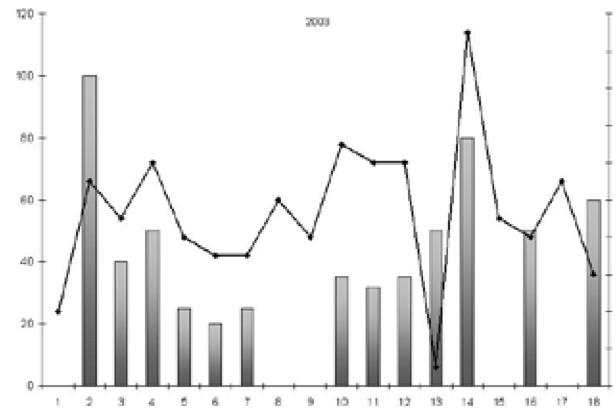

Figure 3. Total number of dolphins and total number of boats and kayaks over 18 d in 2003. Key as in Figure 1.

Table 1. *Observers, observations and dolphin sightings.*

	August 2001	August 2002	August 2003
Number of observers	11	6	5
Total days of observation	16	26	18
Total hours of observation	96	130	97
Number of dolphin sightings	11	11	13
Dolphin group size (mean)	38.1	31.1	46.3
Dolphin group size (SD)	20	15.5	28.4

SD, standard deviation.

KW=17.799, df=2, $P<0.0001$): in August 2003 human activity significantly increased as compared to August 2002 (Dunn's multiple comparisons test:−29.971, $P<0.01$) and August 2001 (Dunn's multiple comparisons test: −39.109, $P<0.001$). Boats frequented the study area more often in August 2003 than in August 2001 (Dunn's multiple comparisons test:−15.146, $P<0.05$) and August 2002 (Dunn's multiple comparisons test:−11.641, $P<0.05$). The number of kayaks increased in August 2003 as compared to August 2001 (Dunn's multiple comparisons test:−33.174, $P<0.001$) and August 2002 (Dunn's multiple comparisons test:−23.871, $P<0.001$). The number of people coming to this area to swim with the dolphins did not show any variation over the three years (statistical test not significant).

In conclusion, the two human activities that increased from August 2001 to August 2003 were the number of boats and kayaks.

Table 2. *Correlations between numbers of dolphins present and human activities (Spearman rank correlation).*

	Over three summers	August 2001	August 2002	August 2003
Dolphins/swimmers	N=60, r=0.427, P=0.0007	N=16, r=0.502, P=0.047	nc	N=18, r=0.069, P=0.002
Dolphins/kayaks	nc	nc	N=26, r= −0.556, P=0.003	nc
Dolphins/boats	nc	nc	nc	N=18, r=0.52, P=0.027
Kayaks/boats	N=60, r=0.413, P=0.001	nc	nc	nc

nc, not correlated.

Table 3. *Number of sightings when dolphins displayed behavioural changes following an encounter with humans.*

	August 2001	August 2002	August 2003
Number of dolphin sightings	11	11	13
Increased aerial behaviours (% of sightings)	3 (27%)	5 (45%)	6 (46%)
Changing swimming direction (% of sightings)	2 (18%)	4 (36%)	8 (61%)

Correlations between numbers of dolphins present and human activities (Table 2)

An effective general positive correlation between numbers of dolphins present and swimmers appeared when we pooled the collected data over the three summers (Spearman rank correlation test: N=60, r=0.427, *P*=0.0007). The presence of kayaks appeared to be negatively correlated with the presence of dolphins in August 2002 (Spearman rank correlation test: N=26, r=–0.556, *P*=0.003). In August 2003 the presence of boats was positively correlated with the presence of dolphins (Spearman rank correlation test: N=18, r=0.52, *P*=0.027). Moreover, the presence of kayaks and boats appeared positively correlated over the three summers (Spearman rank correlation test: N=60, r=0.413, *P*=0.001).

Incidents of changes in dolphin behavioural patterns (Table 3)

Observers witnessed a change in dolphin swimming direction following an encounter with humans for 18% of sightings in August 2001, 36% of sightings in August 2002 and 61% of sightings in August 2003. They also reported an increase in dolphin aerial behaviour following an encounter with humans for 27% of sightings in August 2001, 45% of sightings in August 2002 and 46% of sightings in August 2003.

DISCUSSION

The dolphins frequented the study area equally in August 2001 and 2002, showing a slight increase in August 2003 as compared to August 2001. Marten & Psarakos (1999) demonstrated 'long-term site fidelity' for this dolphin population; our findings corroborate the idea that this area is of great interest for longitudinal works and could be a critical parameter in any future study on this population. However, to draw any conclusion on dolphin frequency in this particular rest area we should extend our observational work over months and years in order to detect any significant changes in the occupancy pattern.

Spinner dolphins can be found in both deep and shallow waters. They feed at night on mesopelagic prey (Benoit-Bird & Au, 2003) and enter shallow protected bays in early morning to rest and socialize (Norris & Dohl, 1980). However, a recent study on odontocete populations in Hawaiian waters reported that spinner dolphins showed the shallowest depth distribution as compared to other cetacean species such as bottlenose dolphins and pantropical spotted dolphins (*Stenella attenuata*) (Baird et al., 2003). We suggest that this behaviour will make them particularly sensitive to coastal human activities.

If we consider the three identified anthropogenic factors, our results showed growth in marine-based tourism activities on the north-west coast of Oahu, and specifically in our study area, a small protected bay mainly frequented by local fishermen and by people running 'swim-with-dolphins' programmes. This particular activity, which began around 1991 (S. Psarakos, personal communication), increased during 2001 to 2003 and brought more kayaks and more people to approach the dolphins. We saw the same tendency with the ecotour boats: in August 2003 dolphin presence was correlated with the presence of kayaks. This could be explained by the fact that spinner dolphins are not generally observed in other places around Oahu, and thus ecotourism activity is focused on this easily accessed area where dolphins can be seen. Kayaks are usually the first to arrive (0730–0800 h) on site and the boats come later on (after 1000 h); we suggest that boats use kayaks to signal the presence of dolphins. The positive correlation between the two tends to confirm this hypothesis.

Does the presence of boats and kayaks have an impact on spinner dolphin behaviour, and if so, to what extent? Samuels et al. (2003), who observed spinner dolphins and humans in Kealakekua Bay on the Big Island of Hawaii, reported up to 30–40 kayakers, as well as commercial tour boats and inflatable dinghies, coming to watch dolphins, and demonstrated a decrease in dolphin presence over time which may be related to tourist activity. This finding raises the issue of animals' tolerance for and habituation to humans (and their activities), and the vital biological and ecological needs that determine their welfare. This also points out the necessity of finding pertinent criteria to measure and control these parameters.

Reviewing the recent literature, we find some emerging relevant parameters for both wild (1) and captive cetaceans (2). For (1): breathing synchrony (Hastie et al., 2003), resting and milling behaviours (Constantine et al., 2004) in bottlenose dolphins (*Tursiops truncatus*), dive duration and changing activities for humpback dolphins (*Sousa chinensis*) (Leung Ng & Leung, 2003), velocity and time spent at the surface in fin whales (*Balaenoptera physalus*) (Jahoda et al., 2003), changes in speed and aerial displays in sperm whales (*Physeter macrocephalus*) (Malgalhães et al., 2002), and changes in direction and travelling speed in spinner dolphins (Driscoll-Lind & Ostman-Lind, 1999); and for (2): use of a refuge area and surfacing behaviour in captive common dolphins (*Delphinus delphis*) (Kyngdon et al., 2003). All these parameters should be carefully monitored over extended periods of time in order to get a more accurate picture of the real impact of anthropogenic factors on dolphin ecology and ethology.

The effect of kayaks and boats can be accentuated by people intending to approach the dolphins in the water (Driscoll-Lind & Ostmand-Lind, 1999). However, in our study area the number of swimmers stayed stable over the three summers: although boats and kayaks brought more people to swim with the dolphins, the number of swimmers approaching the dolphins surprisingly did not go up. This could be explained by a change in the general public attitude: more people are going through tour operators and less individual groups of people come by themselves.

We report here several instances where human activities provoked evident disruptions in the dolphins' behavioural patterns. Hawaiian marine mammal viewing guidelines state that a distance of 50 yards (≈46 m) should be respected while watching dolphins and observation time should not exceed half an hour for an animal (US National Oceanographic and Atmospheric Administration and US National Marine Fisheries Service websites). Boat operators also have rules to follow concerning their approach speed, direction and movements while close to these animals. According to the 1994 amendments to the US Marine Mammal Protection Act, incidents breaking these rules fall into Level B harassment. It is difficult to fully understand what the short- and long-term effects of the increase of these acts are, and to what extent they are harmful for the animals. We must ask: what are the benefits for the dolphins? This spinner dolphin population enters on an almost daily basis this shallow protected area to rest and socialize (Norris & Dohl, 1980). Moreover, summer is the peak of their reproductive behaviour (Norris et al., 1994). We can wonder what the impact is of disruptive human behaviours on the overall reproductive status (i.e. mating and nursing behaviours, calf survival rate) of this population? In a recent study, Lusseau (2003) showed that male and female bottlenose dolphins have different strategies to avoid interactions with tour boats in New Zealand. This author demonstrated that males avoided boats as soon as they were present while females dived when interactions became intrusive; according to Lusseau this different strategy could be related to the sex metabolic regime. This hypothesis is interesting and should be tested on our population.

Finally, we would like to comment on the general lack of knowledge of dolphin biology and ethology of people interested in observing marine wildlife in their natural habitat. We agree with Samuels et al. (2003), and think that it is difficult for naive, inexperienced or non-educated swimmers to identify and to recognize crucial dolphin behaviours (resting, reproductive, feeding, social behaviour) and to evaluate the impact their actions might have on the dolphins and their welfare. After several informal discussions with swimmers throughout the three summers (not documented in this study), we think that it would be beneficial for the public (and the dolphins) to participate in marine education and conservation programmes.

CONCLUSION

This study showed a general increase in dolphin-watch tours and swim-with-dolphin programmes based from boats and kayaks on the north-west coast of the island of Oahu. We also demonstrated a stable dolphin habitat frequency over three summers, which emphasizes the critical value of this area for this spinner dolphin population. This study demonstrates the vulnerability of these animals to coastal human activities in this rest area. Moreover, we consider this area of major value for future longitudinal studies on this population.

In accord with similar studies, we suggest that regulation of commercial ecotour operations and swim-with-dolphin programmes should be enforced and should be accompanied by actions to educate the general public interested in experiencing marine wildlife in its natural environment.

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Submitted 2 May 2006. Accepted 10 August 2006.