

# Interpreting short-term behavioral responses to disturbance within a longitudinal perspective\*

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## INTRODUCTION

In assessing effects of anthropogenic activity on wildlife, it is seldom possible to identify the biological significance of short-term behavioral responses. We address this problem by interpreting behavioral responses of Indo-Pacific bottlenose dolphins (*Tursiops* sp.) in Shark Bay, Australia, to experimental vessel approaches within the context of long-term data. Here, ca. 800 individual dolphins have been identified and their distribution mapped through photo-identification surveys. We show that the long-term data are critical for correct interpretation of the significance of short-term behavioural responses.

## EXPERIMENTAL DESIGN

### EXPERIMENTAL VESSEL APPROACHES AT CONTROL AND TOURISM SITES

- BDA experimental design. Three 15-min experimental periods: B (before), D (during) approach, A (after)
- Two experimental sites:
  - Tourism site: defined via GPS logs from 372 commercial dolphin watch trips (Fig 1).
  - Control site: virtually no vessel traffic



Photo-identification records obtained during experimental approaches documented complete segregation of individual dolphins between sites.

FIGURE 1

## RESULTS

### DIFFERENCES IN DOLPHIN RESPONSES BETWEEN BDA PERIODS

Canonical variate analyses were used to identify which behavioral measures were most useful to discriminate between BDA experimental periods (Table 1).

High loadings indicate greatest influences on 1<sup>st</sup> canonical variate (CV1) fall into 2 groups.

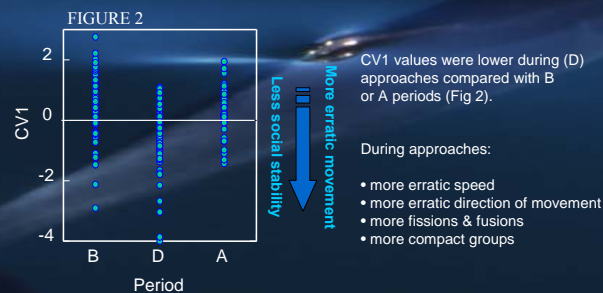
**Movement & Sociality** response variables were best discriminators among periods.

### MOVEMENT

### SOCIALITY

Response variables	CV1 loadings
Distance traveled	0.051
Avg. speed	-0.064
<b>SD of speed</b>	<b>-0.372</b>
<b>Avg. change in dir.</b>	<b>-0.342</b>
No. of fissions	-0.365
No. of fusions	-0.398
<b>Within-group spacing</b>	<b>0.725</b>

TABLE 1



### DIFFERENCES BETWEEN TOURISM & CONTROL SITES

Changes in CV1 scores ( $\Delta$  CV1) in D and A periods relative to B were calculated to compare dolphin responses between TOURISM and CONTROL sites (Fig. 3).

Behavioral responses by dolphins at the CONTROL site were more intense relative to those at TOURISM site.

Dolphin responses at the CONTROL site did not return to "before" levels within 15 min.

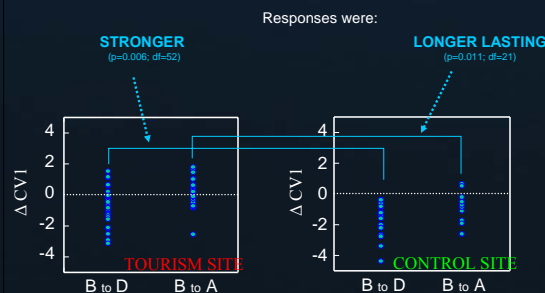


FIGURE 3

## LONGITUDINAL PERSPECTIVE

In absence of additional information, the moderate short-term responses within the tourism site could be misconstrued as habituation to vessels. However, the long-term dolphin research provided an opportunity to interpret these short-term responses within a longitudinal perspective, resulting in a different conclusion.

Bejder *et al.*, (in review in Conservation Biology; oral presentation 16<sup>th</sup> Biennial Conference on the Biology of Marine Mammals)

Long-term impacts of vessel-based tourism were compared within adjacent 36 km<sup>2</sup> sites (Tourism and Control site #2), over three consecutive 4.5-year periods wherein tourism levels increased from zero (T0), to one (T1), to two (T2) dolphin watch operators. (Fig. 4b).

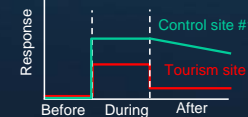
When comparing periods of no-tourism and one-operator within the tourism site, there was no change in dolphin numbers.

As four operators increased to two, there was a significant average decline of 14.9% in relative dolphin abundance. This approximates a decline of one per seven individuals.

Concurrently, within control site #2, there was a non-significant average increase of 8.5% in dolphins per km<sup>2</sup>.

## CONCLUSIONS

**A. Short-term** behavioral responses to controlled vessel approaches



Responses were significant at both sites, but more moderate and of shorter duration at tourism site

**B. Long-term** community-level effect of increasing boat-based tourism



At tourism site: 15% reduction in dolphin numbers with increasing tourism

FIGURE 4

## TAKE HOME MESSAGE

Do the more moderate short-term responses of dolphins at tourism site indicate habituation to vessel activity? **NO !!**

Long-term analyses indicate alternative hypotheses, e.g., displacement of less tolerant animals prior to assessment.

Thus, short-term impact assessment was likely based on a biased sample of more tolerant individuals.

These findings challenge the traditional assumption that short-term responses are sufficient indicators of disturbance. Nonetheless, short-term responses documented at periodic intervals can be valuable indicators of long-term impacts of disturbance.

\* In review, Animal Behaviour