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Assessment of bottlenose dolphin (Tursiops aduncus) habitat characteristics in the estuarine waters of the Adelaide Dolphin Sanctuary, South Australia.

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Abstract
The distribution and behaviour of bottlenose dolphins (*Tursiops aduncus*) in the Adelaide Dolphin Sanctuary (ADS), South Australia, was investigated in relation to habitat type and environmental water properties from boat based surveys between May and August 2006. Although the distribution and behaviour of bottlenose dolphins were not related to the physico-chemical properties of the water column or habitat type, this study gives a quantitative assessment of the distribution and behaviour, which is essential when implementing management strategies. [JMATE. 2008;1(1):6-8]

Keywords: Bottlenose dolphin, habitat, conservation, South Australia

Introduction

Bottlenose dolphin (*Tursiops* spp.) habitat has previously been investigated by relating their distribution patterns to a number of environmental factors (4,3,13). However, few studies have quantitatively measured more than one environmental factor, which therefore places some limits on understanding cetacean habitat. Bottlenose dolphins (*Tursiops aduncus)* are found in South Australian coastal waters and Gulfs (8), in particular the Port Adelaide River-Barker Inlet estuary, which supports a population of resident individuals (1). However, this estuary is increasingly impacted and threatened by a variety of anthropogenic activities. As a result, this area has recently been proclaimed the Adelaide Dolphin Sanctuary (ADS), seeking to protect both the resident dolphins and their habitat (16). This stresses the need to develop and implement conservation strategies. Therefore, the objective of the present study was to provide baseline information on the potential relationship between bottlenose dolphins and the space-time structure of their habitat.

The ADS, covering 118km^2 (34°39'S - 138°25'E, 34°51'S - 138°30'E), and ranging in depths from 2 to 16m, is situated on the eastern side of Gulf St. Vincent, South Australia. The northern area of the ADS extends out into the open waters of the gulf and is characterised by the presence of seagrass. In contrast, the southern area of the ADS, consists of sheltered channels that are essentially devoid of vegetation such as seagrass and attached algae and consist predominantly of a bare sandy bottom (7). The potential relationships between *T. aduncus* and the biotic and abiotic properties of their environment were investigated through standard boat based surveys (18), conducted under daylight conditions (07:00 to 15:00) in the austral winter (May - August 2006). This provided even and representative coverage in which to examine the space-time structure of bottlenose dolphin habitat. Group size (defined as being the total number of animals counted within a 100 m radius of each other; (5), behavioural activity (categorized as travelling, milling, resting, feeding and socialising; (15), habitat type (seagrass, bare sand) and GPS location were recorded at the time of a dolphin sighting. Depth, temperature, dissolved oxygen, salinity, turbidity and pH were recorded using a depth sounder and a TPS 90FL-T at 30 minute intervals until the completion of a survey and at the time of a dolphin encounter.

As the environmental parameters were not normally distributed (Kolmogorov-Smirnov test, $p<0.05$), the potential differences in environmental water properties between dates and locations used and not used by dolphins were inferred using the Wilcoxon-Mann-Whitney U-test (19). The space-time structure of the environment used by dolphins was investigated through a principal components analysis (PCA) performed on the observations and the variables (13). These variables were date (julian days), latitude, longitude, depth (m), temperature (°C), dissolved oxygen (mg/L), salinity (ppm), turbidity (NTU), pH and habitat type (seagrass or bare sand). The identification of the components of the multivariate analysis was carried out using the factor loadings of the variable in the PCA analysis since the factor loadings of a given factor could be related to the variance explained by such a factor (11). A subsequent analysis was done introducing in the original PCA additional variables related to the number of dolphins observed at each date and location, together with their behavioural activity.

No statistically significant differences were observed between the environmental water properties measured at dolphin and non-dolphin sites (Table 1; U-test, $p>0.05$). While environmental water properties, in particular temperature and depth (6,18,5) have commonly been identified as factors which influence bottlenose dolphin distribution, this indicates that distribution of *T. aduncus* within the ADS was not related to the physico-chemical properties of the water column. Field observations also suggested a preference in the utilization of

Environmental Property	Dolphin Sites		Non-Dolphin Sites	
	Min	Max	Min	Max
Temperature (C°)	13.4	24.1	13.4	24.1
Depth (m)	1.8	15.4	1.9	14.3
Salinity (ppm)	24.8	44.8	24.3	47
Dissolved Oxygen (mg/L)	8.78	30.14	7.1	20.14
Turbidity (NTU)	1.0	7.4	0.3	4.5
pH	5.49	5.91	5.27	5.64

Table 1: Minimum and maximum values of environmental water properties measured at dolphin and non-dolphin sites.

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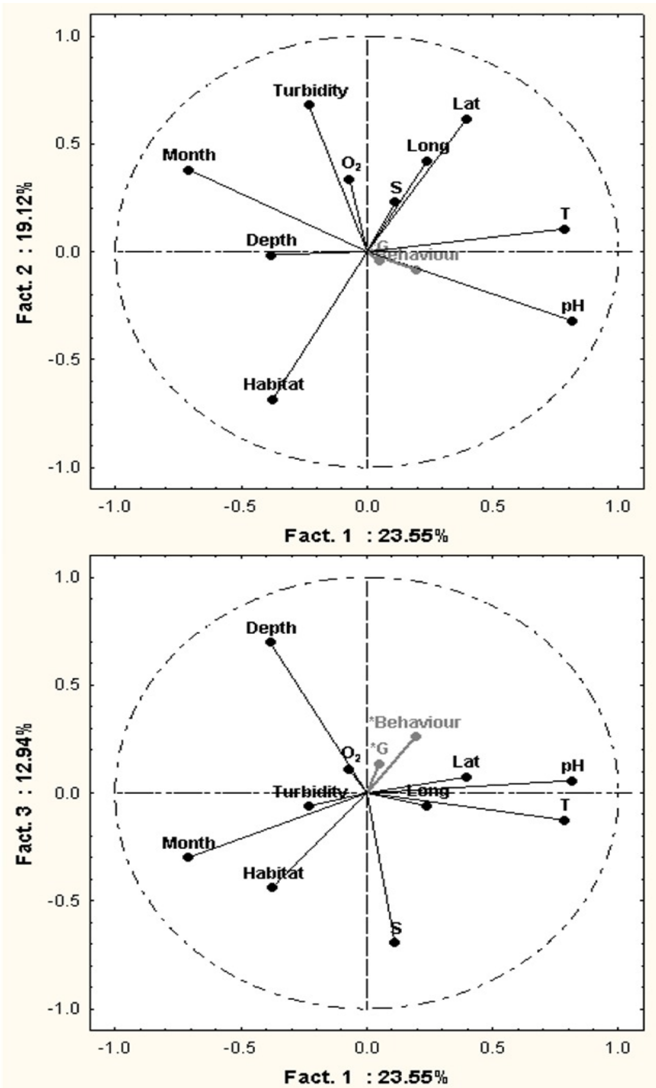

Figure 1.
Principal Component Analysis. Correlation circle showing the position of the initial variables (black dots) and additional variables (grey dots) in the two-dimensional spaces of the three principal components Fact. 1, Fact. 2 and Fact. 3. (G: Group Size; Lat: Latitude; Long: Longitude; T: Temperature; S: Salinity, O2: Oxygen).

one habitat type as all behavioural activities, except resting, were observed over the bare sand habitat within the estuary, whilst only travelling and feeding were observed over seagrass. These observations were specified by the PCA analysis. The first three principal components of the PCA (Fig. 1) explained 55.61% of the total variance. The first component (Fact. 1; 23.55% of the variance), was significantly positively correlated with latitude, longitude, temperature and pH and negatively correlated with depth, habitat type and sampling date (Fig 1). The second component (Fact. 2; 19.12% of the variance), was significantly negatively correlated with habitat type and pH, and positively with sampling date, latitude, longitude, oxygen concentration and turbidity. Finally, the third component (Fact. 3; 12.94% of the variance) was only significantly positively correlated with depth and negatively with salinity. The additional variables relative to the group size and behaviour of the dolphins exhibited patterns in the spatio-temporal space defined by the PCA. Bottlenose dolphins did not exhibit any specific habitat choice (i.e. seagrass or bare sand) in terms of group size (Fig 1.). In contrast, the positive correlation between the behaviour index and the third component suggests that socialising occurs more frequently in deeper water whatever the habitat type. While this may contradict previous studies showing correlations between dolphin behavioural activity and the physical and spatial components of habitat (14), our observation of an increased utilization of deeper waters for socialising may be considered as a first step to identify areas of particular relevance for the ecology, hence, the conservation of local populations of *T. aduncus* (17).

Despite this lack of clear relationships between dolphins and habitat, it is likely that they are responding to other environmental factors. In particular, prey distribution is more likely to affect cetacean distribution than properties of the physical and chemical environment (10,9,2). It is intrinsically difficult to obtain reliable estimates of fish stocks in shallow environments. In particular, in the ADS this limits the ability to make direct links between predator and prey distributions. Further studies should incorporate investigations of dolphin prey space-time dynamics to objectively infer the potential link between dolphins and their habitat. In conclusion, the approach used in this work to quantitatively measure dolphin habitat within an estuarine environment may provide an objective, statistically-sound basis to uncover the complexity of dolphin-habitat interactions in coastal waters. This may also provide assistance to the implementation of further management and conservation plans.

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