Darwin Harbour Coastal Dolphin Project

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Interim report

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Executive Summary

The coastal dolphin project has been operating in Darwin Harbour for a 24 period (March 2008 to February 2010). The project is expected to continue for another 12 to 24 months. Prior to this, no systematic long-term studies had been conducted on the ecology, habitat use, abundance or seasonality of three species of coastal dolphins in the Northern Territory. This project is still underway, and this report presents only a summary of information collected to date on the most relevant to conservation issues in the Darwin Harbour area.

Three species of coastal dolphins are regularly recorded in Darwin Harbour, the Australian snubfin *Orcaella heinsohni*, Indo-Pacific humpback *Sousa chinensis* and the Indo-Pacific bottlenose *Tursiops aduncus*. Preliminary results suggest i) populations of the 3 species appear resident; (ii) all 3 species use the area for breeding; (iii) there is some degree of spatial preference, and this varies between different species - but most areas are used by most species; and (iv) numbers appear to be sizable, particularly for *Sousa* and *Tursiops* though a proportion of these sightings (for all three species) will be the same individuals. However, at the time of writing of this report, the residency patterns using photo-identification have not been analysed.

Background

As a result of mainly human activities, coastal and river dolphins are among the world's most threatened mammal species (Thompson *et al.* 2000, Kreb and Budiono 2005). In Australia, populations of snubfin (*Orcaella*), Indo-Pacific humpback (*Sousa chinensis*) and Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) are found in coastal waters of Queensland, Northern Territory and Western Australia and are the only truly coastal dolphins found in northern Australia. The Australian snubfin was recently described as a new species, *Orcaella heinsohni*, and is endemic to Australian waters (Beasley *et al*. 2005).

Humpback dolphins (*Sousa* spp.) have a wide distribution in the tropical Atlantic and Indo-Pacific Oceans and a confused taxonomy. Morphological assessments have suggested three putative species groupings - *S. teuszii* in the eastern Atlantic, *S. plumbea* in the western Indo-Pacific and *S. chinensis* in the eastern Indo-Pacific - but most taxonomies recognise only a single Indo-Pacific species (*S. chinensis*). However, recent genetic analysis showed that the mtDNA lineages from South Africa, China (Hong Kong), and Australia each represent distinct, reciprocally-monophyletic clades which differ from one another by at least 5%, suggesting that a single-species taxonomy for *Sousa* in the Indo-Pacific (*S. chinensis*) is overly simplistic (Frere *et al*. 2008). A similar conclusion was reached by Jefferson and Van Waerebeek (2004) based on their cranial morphometric analyses. Frere *et al*. (2008) provided further evidence that three Indo-Pacific populations sampled (South Africa, China, and Australia) clearly represent distinct evolutionary entities, with those in South Africa and Hong Kong more closely related to one another, and to the Atlantic *S. teuszii*, than to *Sousa* in Australia. Australian humpback dolphins are highly divergent from those in nearby SE Asia, and are likely to represent a distinct species (Frere *et al.* 2008). The recognition of the Australian *Sousa* as an evolutionarily significant unit (ESU; Moritz 1994), and potentially as a distinct species, has important implications for conservation and management. Although the current Australian Cetacean Action Plan lists *Sousa* as 'insufficiently known' (Bannister *et al*. 1996), Australia is recognised as a stronghold for the humpback dolphins owing to its sparsely developed northern coastline, in contrast to many other nations in the Indo-Pacific (Perrin *et al*. 2005).

Population estimates for *Sousa* and *Orcaella* in localised sites along the Queensland coast suggest that populations are small, making them particularly susceptible to anthropogenic disturbances on coastal ecosystems (Corkeron *et al.* 1997, Parra 2006, Parra *et al.* 2006a, b). A 4 year photo-identification study on *Orcaella* and *Sousa* from Queensland also suggest reasonable levels of site fidelity and when combined with a restricted coastal distribution makes these species particularly vulnerable to coastal habitat degradation (Parra *et al*. 2006). Recent studies of *Orcaella* and *Sousa*, have shown a heterogeneity in distribution and varied use of patches within a habitat (Stensland *et al*. 2006, Parra 2006) and a few important key habitats (hotspot areas). Such fine-scale habitat selection and spatial heterogeneity is important for the coexistence of sympatric species like the Australian Snubfin, Indo-Pacific Humpback dolphins (Parra 2006) and *Tursiops*.

Cetaceans can be particularly difficult and time consuming to study because most of their lives are spent underwater. Moreover, the coastal dolphins (particularly *Sousa* and *Orcaella*) found in northern Australia are shy and elusive, making them one of the harder cetaceans to study.

In 2008, I started the coastal dolphin project, with funding from WWF and ING Direct. Prior to this, no systematic long-term studies had been conducted on the ecology, habitat use, abundance or seasonality of these three species in the Northern Territory. This project is still underway, and this report presents only a summary of information collected to date, and the most relevant to conservation issues in the Darwin Harbour area.

Underlying this study is the assumption that the relatively pristine and undeveloped NT coastline could hold secure populations and be critically important for the long-term conservation of the three species.

The overall project aims for the coastal dolphin project in Darwin Harbour include to:

- Assess the taxonomic identity of Northern Territory populations of *Sousa, Orcaella* and *Tursiops*
- Examine residency and movement patterns
- Assess the habitat use patterns
- Estimate population sizes
- Investigate the spatial distribution of *Sousa*, *Orcaella* and *Tursiops* in Northern Territory waters
- Develop recommendations regarding the conservation and management of the three species in NT waters

Methods

Darwin Harbour (Figure 1) is defined as an area extending from Charles Point in the west to Gunn Point in the east. This region includes Darwin Harbour and Shoal Bay (Padovan 2003). The harbour experiences a macro-tidal regime with a tidal range up to 7.8 meters. The major waterways discharging into the harbour are the Blackmore River and Berry Creek that flow to Middle Arm, and the Elizabeth River that flows to East Arm. The main waterway discharging into Shoal Bay is the Howard River. Major flows occur between December and February, but typically commence in December and cease in June. This pattern corresponds with rainfall, which averages 1,700 mm (BOM 2003).

Coastal dolphin data collection is primarily undertaken via boat-based systematic transects, opportunistic sightings and photo-identification methods. To this end, Darwin Harbour has been divided into a number of transects encompassing a range of environments (Figure 1; Table 1). Weather permitting, transects are undertaken over a 5 day period per month. Opportunistic sighting of dolphins are recorded whenever a school is sighted whilst off transect (including travel to and from the boat ramp).

Transects are conducted at a speed of 12 – 20 km/h with one to two observers and the coxswain searching for dolphins with the naked eye and 7 x 50 binoculars. All surveys are undertaken during daylight hours and in calm sea conditions (Beaufort

scale <2 and swell <0.5 m). Once an individual or school is spotted (on transect or off transect), the school is approached slowly to within 10 m. A number of parameters are recorded including: location, time, species identification, cohesiveness, estimation of school size and age composition (adults = 2 to 3 m; juveniles = approximately 2/3 the length of the adult and usually swimming in close proximity to an adult and sometimes independently; calves = ≤1/2 adult length and swimming regularly besides adult or sometimes just behind the adult), depth, tide, tide state, salinity, conductivity, water temperature, swell height, Beaufort scale, visibility and behavioral activities.

Dolphin schools are defined by relatively close cohesion (cohesiveness) (each dolphin within 100 m of each other) and undertaking similar behavioral activities (Parra *et al.* 2006a). Behavioral activity classification (modified from Parra *et al.* 2006a) includes:

- *Foraging* - individual dolphins move in various directions but with no obvious pattern, dive frequently and sometimes steeply, fast acceleration and unpredictable movements at surface (usually indicates chasing fish).

- *Socialising* - dolphins in close proximity to one another with localized movements. High level of interactions (touching each other and rubbing bodies). Fins and flukes break the water often and frequent leaps and somersaults.

- *Milling* - dolphins in close proximity but no interaction, activity levels are low, no aerial behaviors, animals surface in a uniform manner and most of the time is spent at the water's surface.

- *Slow travel* - moving in slow and persistent directional pattern. Regular surfacing and diving pattern and animals are not underwater for great lengths of time.

- *Fast travel* - moving fast but in a persistent and directional pattern. Regular surfacing and diving patterns and animals are not underwater for great lengths of time.

Photo-identification
Photographic techniques are used to study the movement patterns (including site ranging patterns, site fidelity and residency patterns) of both individually recognizable dolphins and dolphin group locations, following the methods outline in Parra *et al.* (2006a), Wilson *et al.* (1997) and Stensland *et al*. (2006).

Digital images of individuals are taken as perpendicular to the dolphin's body as possible and concentrating on the dorsal fin. All photographs are classified and graded into 3 grades (excellent, good, poor) based on focus, relative angle to the dolphin and contrast. Only digital images graded as excellent and good are used to identify animals and develop catalogues for each species (Würsig and Jefferson 1990, Parra *et al.* 2006a).

Genetics
NRETAS is a partner in a collaborative genetics project operating across northern Australia collecting tissue samples from all three coastal dolphin species for various genetic analyses.

Tissue sampling is undertaken during boat-based surveys and is carried out using the PAXARMS biopsy system (Krützen *et al.* 2002). Dolphins are darted only in good sea conditions (Beaufort scale <1, no rain, and no swell). Photos of biopsied individuals are taken to avoid re-sampling the same individuals. Wherever possible, tissue samples from stranded or incidental by-catch dolphins are also collected.

DNA is extracted from tissue samples using standard procedures and nucleotide sequences from the mitochondrial control region. Molecular genetic variation analysis includes: phylogeography of mitochondrial DNA (mtDNA) control region sequences, variation in mtDNA haplotype frequencies, and variation in microsatellite allele frequencies.

Preliminary results

Sighting data

Three species of coastal dolphin have been regularly recorded in Darwin Harbour, the Australian snubfin *Orcaella heinsohni*, the Indo-Pacific humpback *Sousa chinensis* and the Indo-Pacific bottlenose *Tursiops aduncus*. Two other marine mammals have also been regularly recorded, the false-killer whale *Pseudorca crassidens* (Palmer *et al.* 2009), and the dugong *Dugong dugon* (Figure 2).

The most commonly sighted dolphin was the Indo-Pacific Humpback *Sousa chinensis* (354 records) followed by the Indo-Pacific Bottlenose *Tursiops aduncus* (252) and the Australian Snubfin *Orcaella heinsohni* (33). Average school sizes for both *Sousa* and *Orcaella* were three and for *Tursiops* six. Depths ranged from 0.7 m to 25 m. (Table 2).

Transects – survey effort

During the 24 month period (March 2008 to February 2010), 2,347.3 km of systematic transects have been completed. Two hundred and eighty four *Sousa* were recorded in 88 schools (0.12 *Sousa* per km), 31 *Orcaella* were recorded in 10 schools (0.01 *Orcaella* per km) and 188 *Tursiops* were recorded in 27 schools (0.08 *Tursiops* per km). Survey effort was not uniformly distributed due to environmental constraints and /or tides (particularly for transects in Shoal Bay). The number of times transects were surveyed was similar for transects 1, 2, 3, 4 (38 to 42 times) and 5, 6, 7, 8, 9, 10 (27 to 32 times) (Table 3, Figure 3).

Sousa were recorded predominantly in transects 3, 4, 7, 8, 9, and 10 and foraging was the dominant behavior (Figure 4). *Orcaella* were recorded predominantly in transect 6 and foraging was the dominant behavior (Figure 5). *Tursiops* were recorded predominantly in transect 1 and foraging was the dominant behavior. *Tursiops* were never recoded on the western side of the harbour (transect 5 & 6) or in transects 8, 9, or 10 (Shoal Bay) (Figure 6).

Generally, total numbers for the three species remained the same during the wet and dry seasons (Figure 7), though when broken down by transects, data suggest there are wet and dry season peaks (Figures 8, 9, 10). Sousa remains the constant species across transects throughout the wet and dry seasons (Figure 7). There appears to be a wet season peak in calving (October to April) for all 3 species (Figure 11 and 12).

Photo-id
Photo-identification of all three species of coastal dolphins is on-going. However, a proportion of the observations for all three species recorded in the harbour (and presented in this report) (particularly for *Sousa* and *Tursiops*) will be the same individuals (Palmer pers. comm.). Analysis of residency patterns (during the last 24 months) using photo-identification of individuals will be undertaken in the next 2 months.

Genetics
Orcaella
Due to sampling deficiencies, the genetic affinities of the geographically intermediate populations in the Northern Territory (NT) and Western Australia (WA) have remained unclear. Three tissue samples from the NT and two from Western Australia were analysed recently (2009) at Charles Darwin University. We sequenced 403 base pairs of the mtDNA control region from five free ranging *Orcaella* individuals from these geographically intermediate populations. Our results confirm that *Orcaella* occurring in the NT and WA is the Australian snubfin (*O. heinsohni*) and our data suggest there are no subspecies. Obtaining genetic material from *Orcaella* is inherently difficult. Darting *Orcaella* proved to be challenging, time consuming and required a different approach to what has been used on other small cetaceans (Palmer *et al*. in prep).

Sousa
Samples from *Sousa* have been collected in Darwin Harbour. These will be analysed with other Australian and Indonesian samples which will allow us to assess whether Australia and South-East Asia *Sousa* form two distinctive phylogenetic groups or not.

Tursiops
Tissue samples from both Darwin Harbour and Cobourg have been collected and will be analysed to assess population structure between two areas.

Discussion
The project has been operating in Darwin Harbour for 24 months and the field component is expected to continue for another 12 to 24 months. Preliminary results show that the three species of coastal dolphins (in varying combinations) have some degree of spatial and space use overlap, are undertaking similar behavioral activities and appear to occur year round in Darwin Harbour. In particular, the Howard River and Hope Inlet are important areas for *Sousa* and are not accessed by the other two species. *Tursiops* appears to prefer the open bay (transect 1) but has also been recorded foraging along transect 3 (estuarine environment) Intriguingly, *Orcaella* occurs in low numbers when compared to sighting data from Cobourg and Alligator Rivers Region (Palmer *et al.* 2009 and Palmer 2009). However, the relative significance of Darwin Harbour to that from other sites in NT or elsewhere, at this stage of the project is difficult to assess.

Over the last 15 years, Darwin and its harbour has experienced rapid development including a 50% increase in population, and the completion of several large

infrastructure projects, with more planned (Williams 2008). Characteristic of many remote regions, the Northern Territory lacks baseline information with which to support marine planning and develop conservation plans. This study on coastal dolphins is improving and expanding on our understanding of these species in remote Northern Australia and will underpin conservation management strategies for the species.

Acknowledgments
The project was initially funded by WWF (Australia) and their corporate sponsor ING Direct and more recently partly funded by the Australian Marine Mammal Centre. I thank all the NRETAS staff and volunteers that have participated in the boat-based surveys. Many thanks to John Woinarski, Alaric Fisher and Tony Griffiths for help with the overall project. I thank John Woinarski for valuable comments and advice on the report. Fieldwork is carried out under permit from Parks and Wildlife Service of the NT and ethics approval from Charles Darwin University.

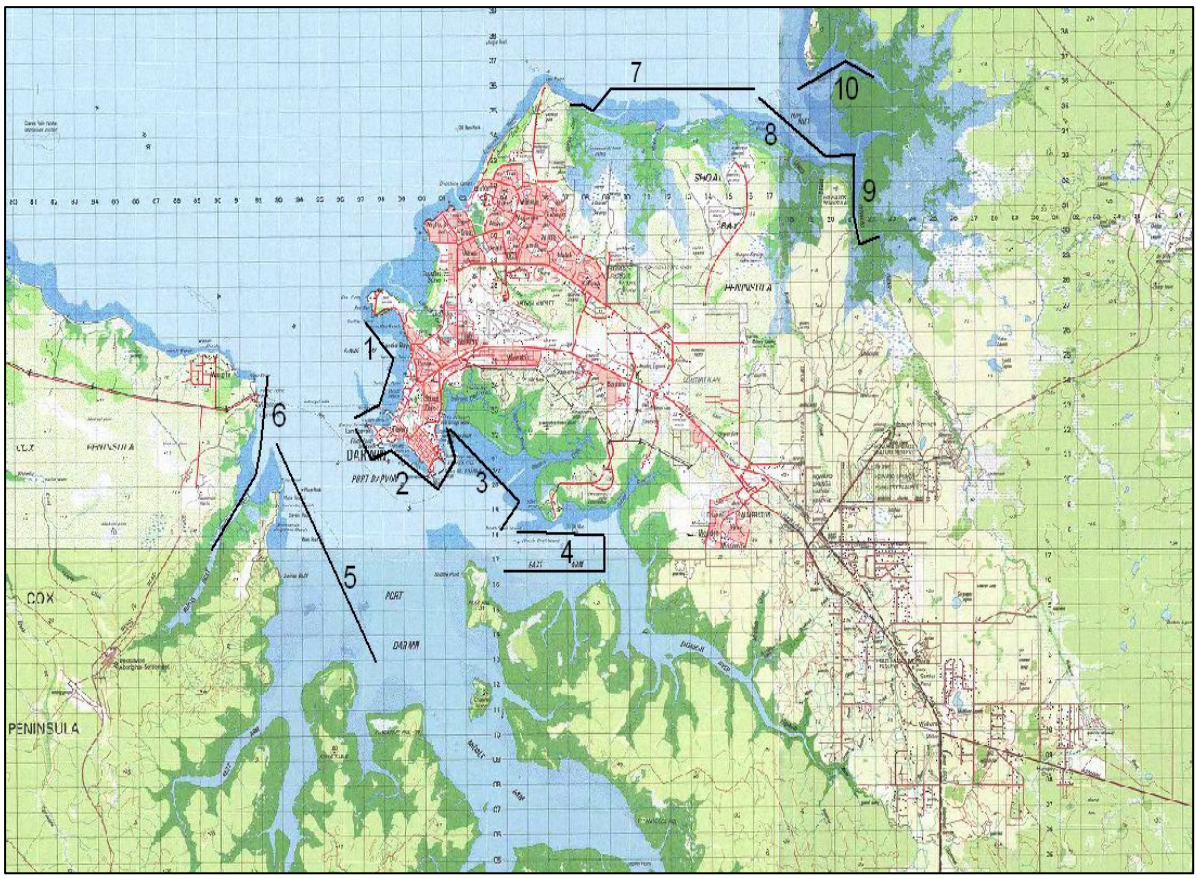

Figure 1. Darwin Harbour (showing transect placement)

Table 1. Transect lengths and general environment

Transect no.	Length (km)	Habitat
1	5.0	open bay, sea-grass, sandbars
2	8.5	mud
3	6.0	mud, mangroves, estuary, mouth of Sadgroves, Reichardt, Blessers Creeks
4	10.0	sand bars, estuary, mouth of Elizabeth River, Hudson Creek
5	10.0	rocky reef
6	7.5	estuary, sand, rocky reef,
7	9.5	estuary (Buffalo Creek), sand bars, sea-grass, open coastline
8	5.5	sandbars, inter-tidal zone, mangroves, mouth of Howard River
9	4.5	sand bars, inter-tidal zone, mangroves, Howard River
10	4.0	sand bars, inter-tidal zone, mangroves, estuary

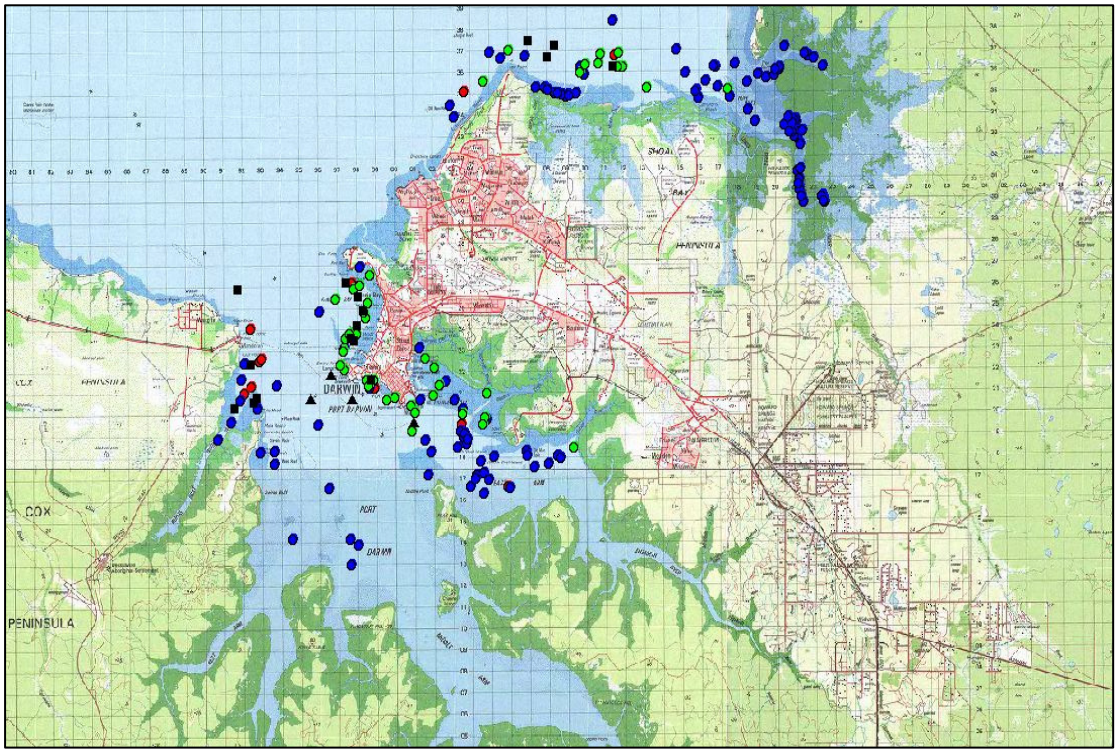

Figure 2. All observation (transect and opportunistic sightings) of marine mammals in Darwin Harbour (March 2007 to February 2010) (blue circles = *Sousa*, red circles= *Orcaella*, green circles = *Tursiops*, black square = Dugong, black triangle = false killer whale.

Table 2. Summary sighting data (transect and opportunistic sightings) for three species of coastal dolphins in Darwin Harbour

Species	**Total no. observed**	**Total no. adults**	**Total no. juveniles**	**Total no. calves**	**Mean school size (range)**	**Mean depth (m)(range)**
Sousa	354	260	60	34	3 (1 to 6)	5.5 (0.7 to 22)
Tursiops	252	171	62	19	6 (1 to 15)	6.3 (2.3 to 25)
Orcaella	31	23	4	4	3 (1 to 7)	8.1 (3.3 to 20)

Table 3. Total effort for each transect (March 2008 to February 2010).

Transect	Transect length km	No. times surveyed	Total km	No. of *Sousa*	No. of *Orcaella*	No. of *Tursiops*
1	5.0	38	190.0	8	7	87
2	8.5	38	319.5	5	0	23
3	6.0	42	252.0	38	1	45
4	10.0	38	380.0	45	1	6
5	10.0	31	299.0	19	7	0
6	7.5	29	211.8	12	12	0
7	9.5	32	292.5	33	2	27
8	5.5	30	169.5	47	0	0
9	4.5	27	117.5	38	0	0
10	4.0	27	115.5	39	0	0

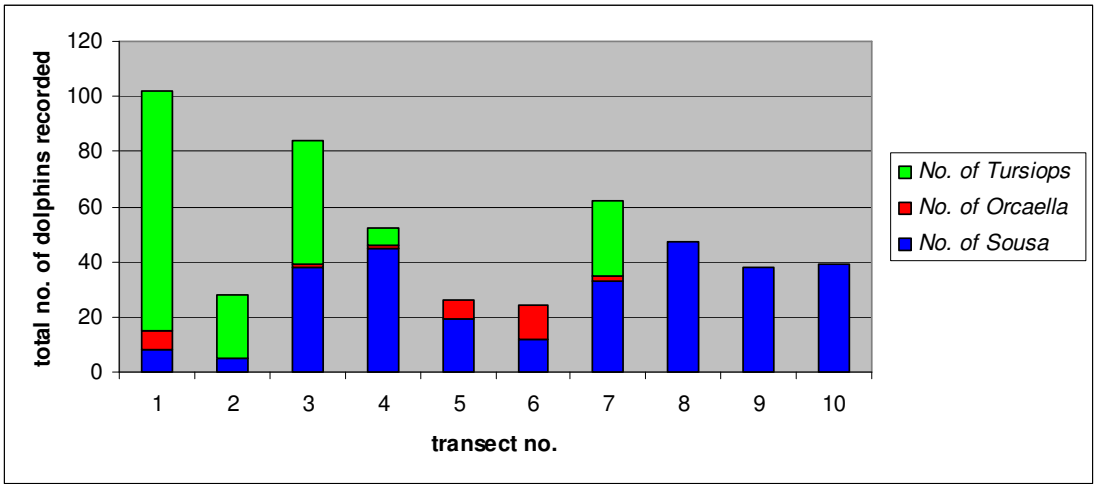

Figure 3. Total number of dolphin species recorded during systematic transects (March 2008 to Feb 2010) in Darwin Harbour.

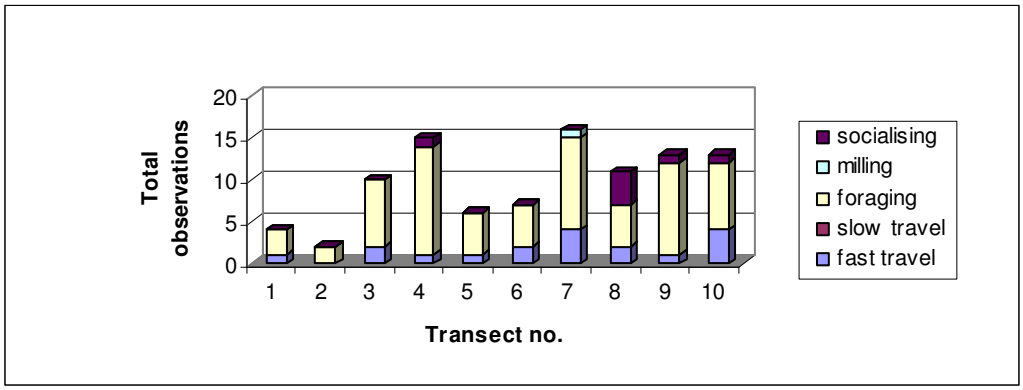

Figure 4. *Sousa* behaviours recorded on systematic transects (March 2008 to February 2010).

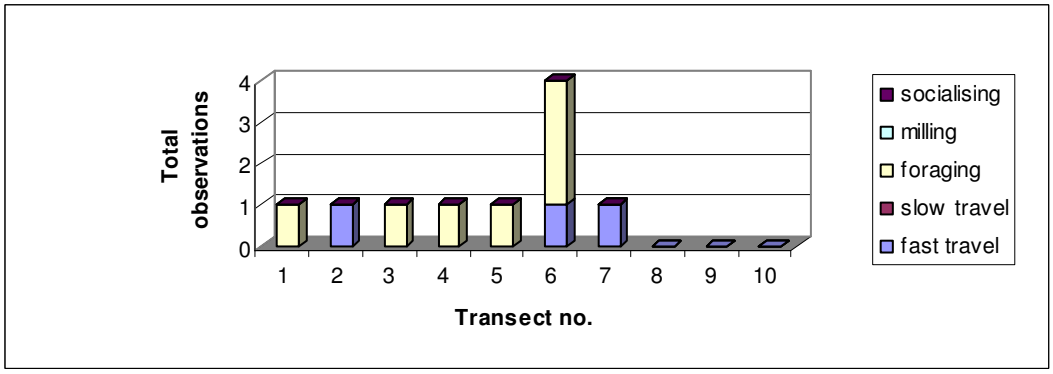

Figure 5. *Orcaella* behaviours recorded on systematic transects (March 2008 to February 2010)**.**

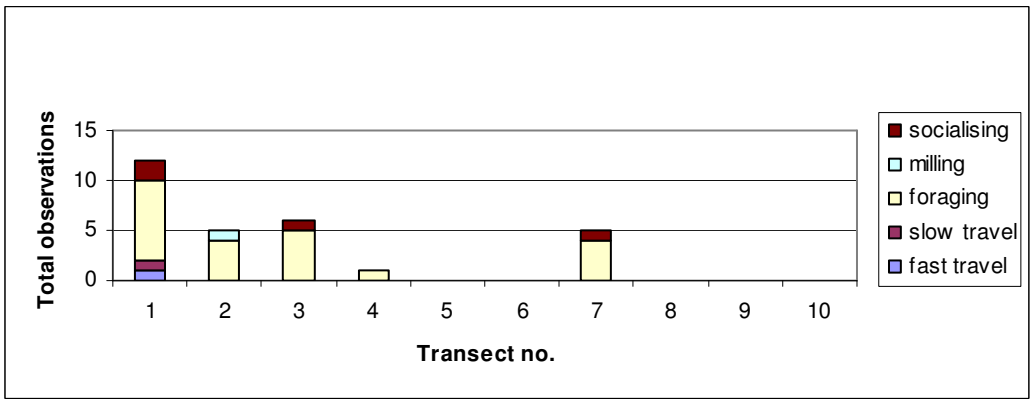

Figure 6. *Tursiops* behaviour recorded on systematic transects (March 2008 to February 2010).

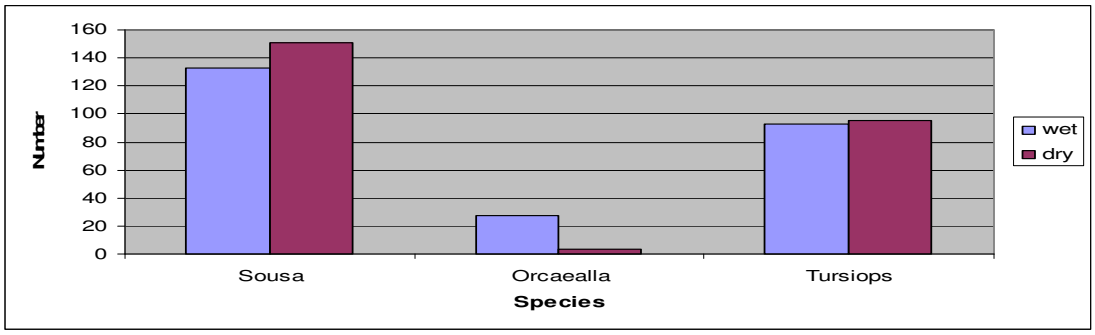

Figure 7. Total number of coastal dolphins recorded during the wet and dry seasons (March 2008 to February 2010) (transect sightings only).

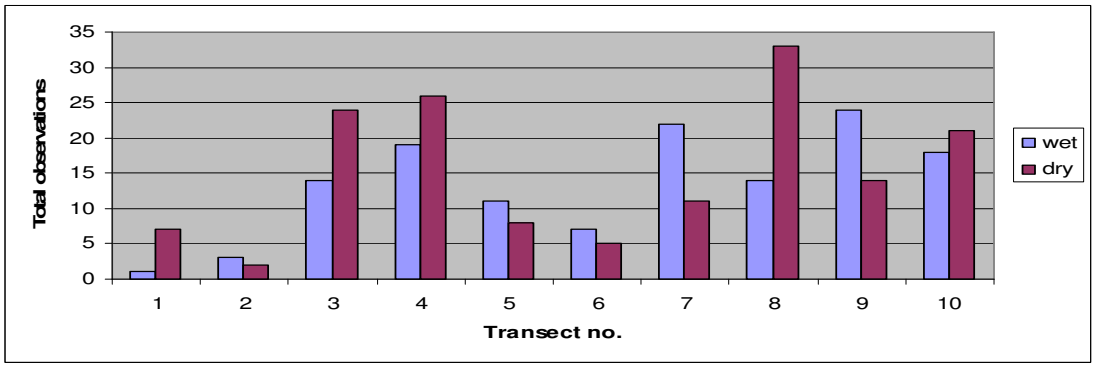

Figure 8. Wet and dry season transect sightings of *Sousa* (March 2008 to February 2010).

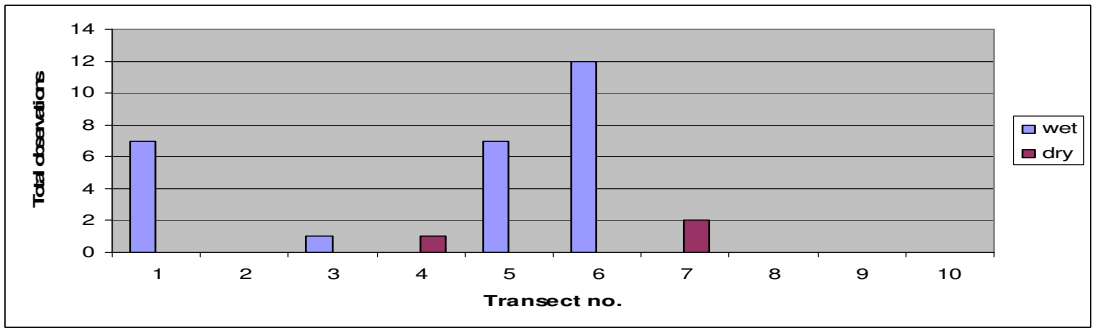

Figure 9. Wet and dry season transect sightings of *Orcaella* (March 2008 to February 2010).

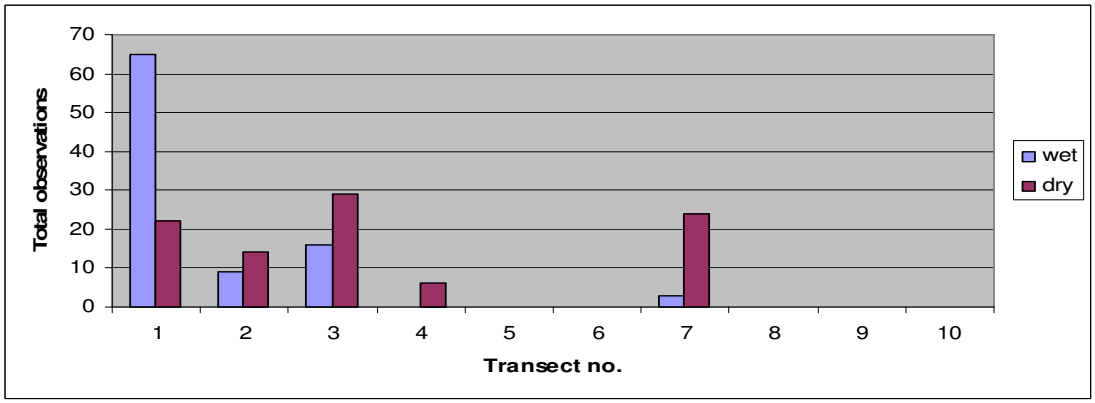

Figure 10. Wet and dry season transect sightings of *Tursiops* (March 2008 to February 2010).

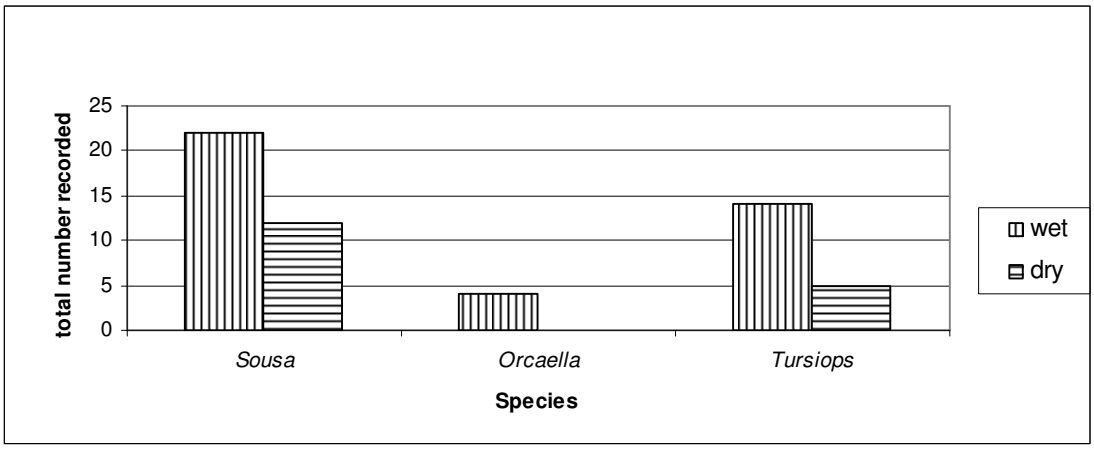

Figure 11. Number of calves recorded during the wet and dry seasons (transect sightings) March 2008 to February 2010.

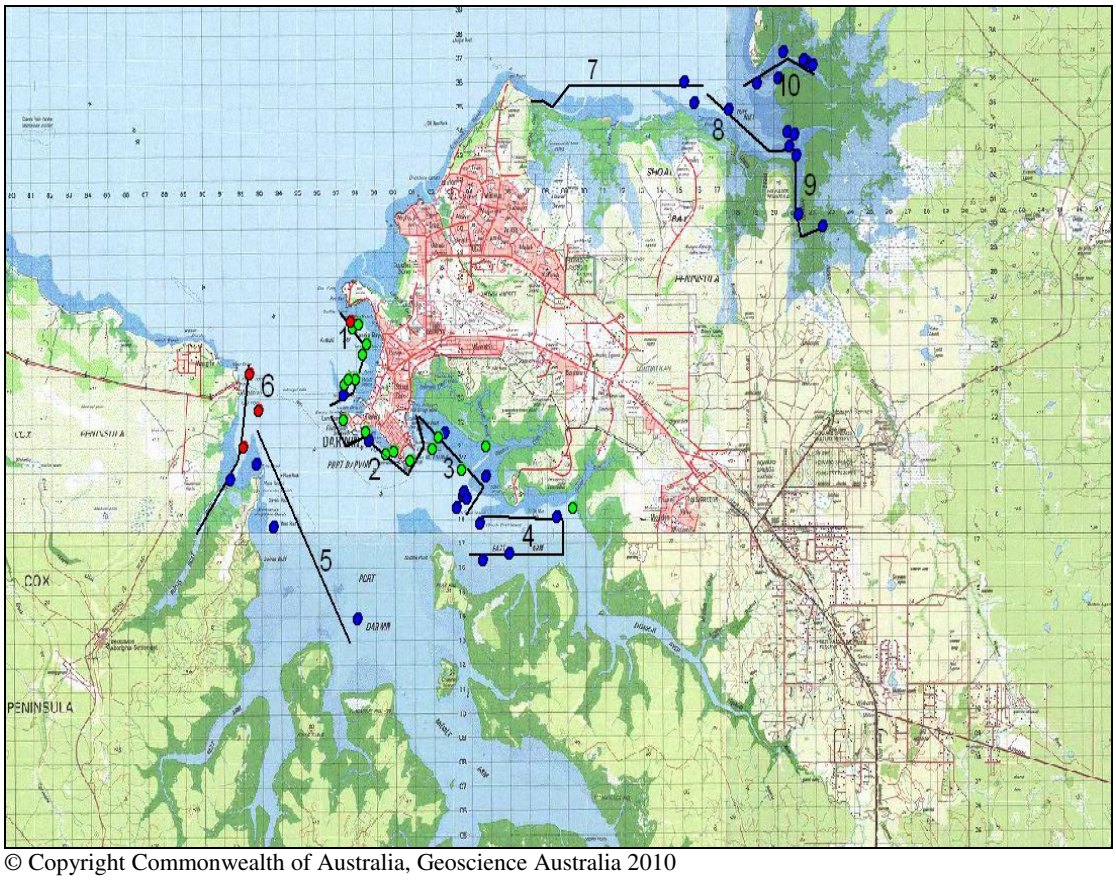

Figure 12. Locations of calves recorded during transect surveys: blue circle = *Sousa*; red circle = *Orcaella*; green circle = *Tursiops*.

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