City Pacific Project Management Pty Ltd
HSBC Building
Level 12
300 Queen Street
BRISBANE QLD 4000

UniQuest Pty Limited
Consulting & Research
(A.B.N. 19 010 529 898)

Level 7, GP South Bldg
Staff House Road
The University of Queensland
Queensland 4072

Postal Address:
PO Box 6069
St. Lucia
Queensland 4067

Telephone: (61-7) 3365 4037
Facsimile: (61-7) 3365 7115

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Report Prepared for:	**Mr Peter Trathen**
Subject:	**Interim Report – Section 1: Review of the current knowledge of the biology of Australian snubfin and Indo-Pacific humpback dolphins and dugongs in Cleveland Bay.** **Consultancy on mitigation and monitoring strategies for dolphins and dugongs in Cleveland Bay with respect to the Townsville Ocean Terminal project.**
Date:	**16 May 2008**
Report Prepared By:	**Dr Guido Parra and Dr Amanda Hodgson**

Signed for and on behalf of UniQuest Pty Limited

Gary Heyden

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1. DUGONGS

1.1 Overview

The *IUCN Red List of Threatened Species* classifies dugongs as “vulnerable to extinction” at a global scale based on an inferred significant population reduction (IUCN 2007). The range of the dugong extends from east Africa to Vanuatu between the latitudes of about 27^{o} north and south of the equator. Numbers have declined in most countries and territories where dugongs occur such that only relict populations remain, which are separated by large distances (Marsh et al. 2002). Australian waters are considered the dugong’s stronghold. The presence of significant populations of the dugongs in the Great Barrier Reef region is an explicit reason for its World Heritage listing (Marsh et al. 2003). Under Australia’s *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*, dugongs are a listed migratory and marine species. Queensland’s *Nature Conservation (Wildlife) Regulation 1994* lists dugongs as “vulnerable” The regulation notes that *the conservation of the habitat of vulnerable wildlife is critical to ensuring the survival of the wildlife* (*Queensland Nature Conservation (Wildlife) Regulation 1994*, p. 48).

Dugongs are primarily dependent on seagrass, and as a result are mainly confined to shallow and protected areas of high seagrass productivity (Heinsohn et al. 1977; Anderson 1981). Along the urban coast of Queensland this is reflected by the fact that dugongs mostly occur in large, northward facing bays (including Cleveland Bay) that are sheltered from the prevailing southeast winds, as these bays support the most seagrass along this coastline (Marsh et al. 2002). Although dugongs appear to spend most of their time at water depths of less than 3 m (Chilvers et al. 2004; Hodgson 2004), they are also reported to occur in waters up to 58 km from the coast where water depths are up to 37 m (Marsh and Saalfeld 1989; Sheppard et al. 2006), and feeding trails have been recorded at depths up to 33 m (Lee Long and Coles 1997).

Dugongs are long-lived with the maximum age estimated from counts of growth layer groups in their tusks being 73 years (Marsh 1980; Marsh 1995; Marsh 1999). They are slow to reach sexual maturity with females having their first calf at 6 to 17 years of age, and have long calving intervals of 2.4 to 7 years (Marsh 1995; Kwan 2002). This life history results in a slow rate of maximum population increase of less than about five percent per year (Marsh 1995). As population increase is most sensitive to changes in the survival probability of adults, dugong populations are vulnerable to even small levels of anthropogenic mortality. This effect is multiplied when habitat quality (i.e., available forage) is reduced and dugongs respond by reducing fecundity (Marsh and Kwan in press). This effect emphasises the critical importance of habitat conservation.

1.2 Distribution and abundance

Trends in dugong distribution and abundance along the urban coast of Queensland (also termed the "Southern Great Barrier Reef Region" and including the coastline between Cooktown and the Queensland – New South Wales border) have been determined using two methods: (1) for the 1960s onwards using anecdotal information and records of dugong by-catch from a government shark control program, and (2) for the 1980s onwards by conducting a series standardised aerial surveys. The former method provides evidence of a long-term decline in dugong numbers along the urban coast since the 1960s (Marsh et al. 2005). By-catch of dugongs in shark control set nets at six locations along the urban coastline (including Cleveland Bay) were used to provide an index of the decline in dugong numbers from all causes in this area. Between 1962 and 1999, the catch rate of dugongs declined by 8.7% per year. If the catch rates are a reliable index of the dugong population, they suggest that by the 1990s the dugong population had declined to 3.1% of the 1960s urban coast population (Marsh et al. 2005). Most of this decline occurred in the 1960s and 1970s.

Aerial surveys for dugongs along the urban coast have been conducted regularly since the 1980s. Numbers within this region have fluctuated between aerial surveys, having declined dramatically in the mid-1990s (probably due to animals moving out of the area as a result of seagrass dieback) and then increased in more recent surveys. The surveys suggest that numbers along this part of the coast are now stable over the last two decades but have not recovered to the levels projected for the mid 1960s. At a finer local scale such as Cleveland Bay, dugong populations fluctuate due to movements between individual bays (Marsh and Lawler 2006).

1.2.1. Movements

Aerial surveys and satellite tracking of dugongs have shown that their movements occur at several spatial scales. Large scale movements likely occur as a result of episodic loss of seagrass from events such as cyclones, floods and sedimentation (Preen and Marsh 1995; Marsh et al. 2003; Gales et al. 2004; Marsh et al. 2004). There is considerable individual variation in dugong movement patterns, with the home ranges of individuals varying from 0.5 to 733 km^2 (Marsh and Rathbun 1990; Preen 1992; de Iongh et al. 1998; Sheppard et al. 2006). Of 70 animals satellite tracked, a large amount of individualistic variation was exhibited in movement patterns (Sheppard et al. 2006). While some animals moved no more than 15 km of where they were caught and tagged, others exhibited "mesoscale" local movements between seagrass patches (15 – 100 km) or “macroscale” ranging movements (> 100 km) (Sheppard et al. 2006). These macroscale movements are between habitat areas and sometimes “return trips” suggesting spatial memory of known habitat areas. The movement heterogeneity described correlates with, and may occur in response to, changes in seagrass quality, where animals respond to large scale seagrass loss by either remaining in the area or moving to find seagrass elsewhere (Preen and Marsh 1995; Marsh et al. 2004). Aerial surveys conducted over a series of years provide further evidence of large scale movements as numbers fluctuate throughout the Torres Strait, Queensland, Northern Territory and Western Australia (Marsh et al. 1996; Marsh et al. 1997; Marsh and Lawler 2001; Marsh et al. 2003; Gales et al. 2004; Marsh et al. 2004; Marsh and Lawler 2006; Marsh et al. 2007).

Movements also occur in response to water temperatures at the limits of the dugongs’ range. In Shark Bay (Western Australia), dugongs move from shallow inshore summer feeding areas to deeper water in winter where the temperature remains higher (Anderson 1986; Marsh et al. 1994; Gales et al. 2004; Holley et al. 2006). In Moreton Bay dugongs are often found up to 15 km outside the bay during winter, where water temperature can be up to 5˚C higher than inside the bay (Preen 1992). Similarly in Hervey Bay, some satellite tagged individuals made return trips across the Bay during winter to warm oceanic waters despite a lack of seagrass and presence of large numbers of sharks in these waters (Sheppard et al. 2006). Local scale movements of dugongs generally coincide with tidal movements where dugongs are dependent on seagrass growing in intertidal and shallow sub-tidal areas (Heinsohn et al. 1977; Anderson and Birtles 1978; Marsh and Rathbun 1990; Sheppard et al. 2006).

1.2.2. Cleveland Bay and the FDA site (“duckpond”)

Aerial surveys of the Southern Great Barrier Reef region since the 1980’s have shown that Cleveland Bay is one of the most important habitat areas for dugongs along the urban coast of Queensland (Marsh et al. 2002; Grech and Marsh 2007). The importance was reflected in the establishment of a Cleveland Bay Dugong Protection Area Type A in 1997 in efforts to conserve the dugong in the Great Barrier Reef Marine Park (Marsh et al. 1999; Marsh 2000; Marsh et al. 2002; Marsh et al. 2003). More recently, Grech and Marsh (2007) developed a spatial model of the dugong population along the Queensland coast and used relative density and distribution to identify areas of zero, low, medium and high conservation values to dugongs. Cleveland Bay was a hotspot along the Queensland urban coast containing a significant proportion of high conservation value habitat. Dugongs in the Bay spend most of their time in the vicinity of seagrass beds but use much of the bay (Figure 1) with the whole bay being of low conservation value or greater (Grech and Marsh 2007). The local scale movements in response to water temperatures and accessibility to seagrass that are described above are not characteristic of dugong behaviour in Cleveland Bay. Warm water temperatures persist throughout the year and seagrass grows subtidally, so dugongs' daily movements are not dictated by the tides.

There is no detailed information about dugong distribution and abundance within the FDA (also referred to as the "duckpond"). None of the aerial survey transects pass directly over the top of this area (Figure 2). However, the spatial model developed by interpolating the aerial survey data suggests that the duckpond contains medium dugong densities (Figure 1) and habitat of low rather than zero conservation value (Grech and Marsh 2007). Thus the potential impact of developments within this area on dugongs cannot be ignored. The potential loss or reduction in quality of the environment surrounding will likely have a negative impact on the populations of dugongs in Cleveland Bay.

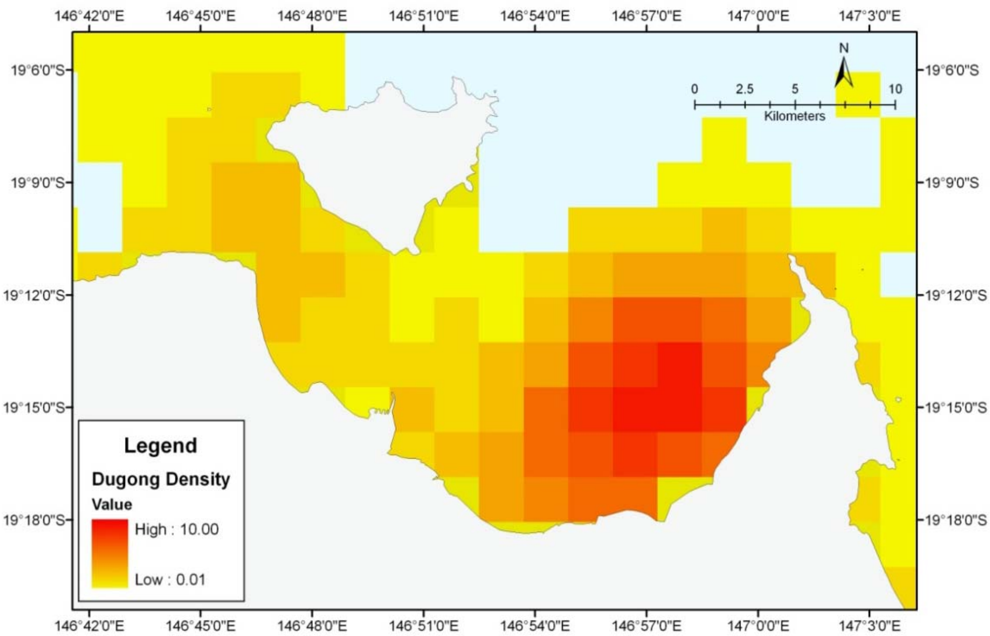

Figure 1. Model of dugong relative density and distribution in Cleveland Bay, Queensland (source: Alana Grech, see Grech and Marsh in press). All of Cleveland Bay is of some conservation significance to dugongs.

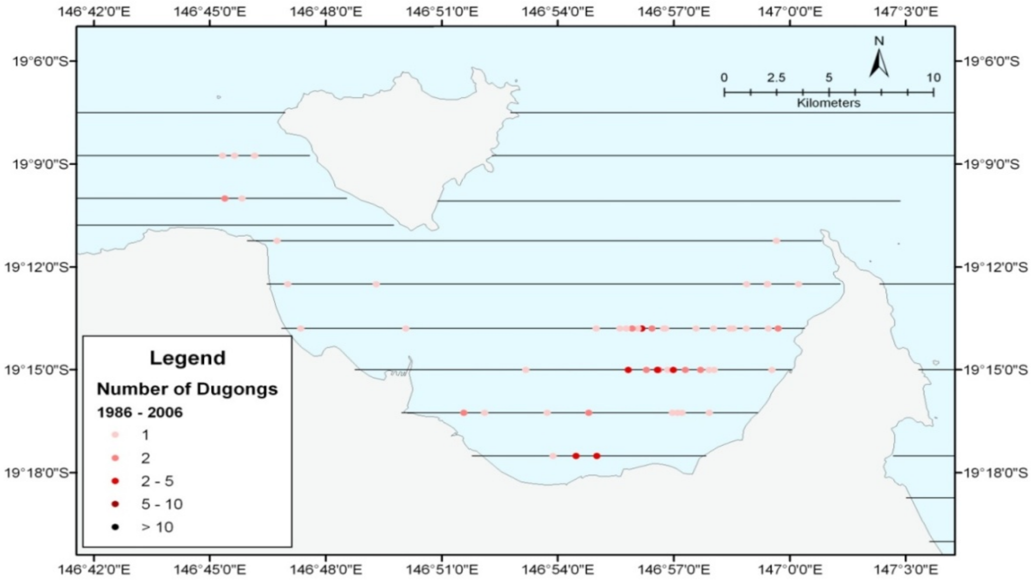

Figure 2. Line transects flown during aerial surveys for dugongs in Cleveland Bay, and numbers of dugongs sighted along the lines during six surveys between 1986 and 2006 (source: Helene Marsh, see Marsh and Lawler 2006).

1.3 Conservation threats

1.3.1. Habitat degradation

As herbivores feeding almost exclusively on seagrass, dugongs rely on a food source which is very sensitive to human impact (Marsh et al. 1999). Seagrass die-off is commonly caused by smothering and lack of light as a result of high levels of suspended sediments. Sedimentation can occur naturally, particularly as a result of cyclones and extreme rainfall events, but has been enhanced by clearing of inland and coastal vegetation, which has increased erosion (Green and Short 2003). The increase in sedimentation and nutrient loading caused by land clearing also affects the ability of the seagrass to recover from flooding events (Wachenfeld et al. 1998). Other impacts on seagrass include direct disturbance from dredging, land reclamation, mining or trawling, as well as pollution from agriculture and sewage (Marsh et al. 1999; Marsh et al. 2002; Hodgson 2006). Both these direct and indirect impacts have occurred in much of the dugongs range. As stated by Marsh et al. (2002), typically the areas that provide the ideal water conditions and shelter for seagrass growth are also the ideal sites for port development and/or are downstream from heavily disturbed catchments.

1.3.2. Indigenous hunting

Dugong populations have also declined as a result of direct and incidental or indirect takes. Although dugongs have been officially protected since 1969 (Heinsohn et al. 1977), Indigenous Australians are allowed to hunt them as a Native Title Right. Recent surveys of the Torres Strait and hunting records suggest that the current rate of hunting in Torres Strait and northern GBRMP is too high to be sustainable (Heinsohn et al. 2004; Marsh et al. 2004). Most management intervention to control and monitor hunting levels has not been effective to date although current initiatives by Traditional Owners are substantial. Dugong hunting is not currently permitted in Cleveland Bay.

1.3.3. Fisheries

Incidental takes include dugongs caught in commercial gill and mesh nets, as well as shark nets set for bather protection. Shark nets killed over 800 dugongs between 1962 and 1995 (Marsh et al. 1999). The take in Cleveland Bay was substantial before they were removed e.g. the Picnic Bay Shark nets caught 94 dugongs in the first five years (Heinsohn 1972). Shark nets have been replaced with drumlines in most areas, including Cleveland Bay (Gribble et al. 1998). Although not quantified, commercial set nets are known to have caught significant numbers of dugongs in Cleveland Bay (Marsh et al. 1999; Helene Marsh pers. comm.). Dugong Protection Areas (DPAs) implemented in 1997, were designed to reduce dugong bycatch mortalities in areas that are most heavily used by dugongs.

Rapid increases in boat traffic along the urban coastline in Australia emphasise the importance of considering the potential for dugongs to be disturbed and/or displaced by boats. In Queensland, the number of registered boats is currently increasing at 5% per year, and proportionally, vessel ownership and the level of on-water vessel boating is also increasing (Queensland Transport 2007). Boats can interrupt dugongs' feeding when they pass close by dugong herds (Hodgson and Marsh 2007). Boat strikes are a significant cause of dugong mortality in Australia (Greenland and Limpus 2006), and the delayed response of dugongs to boats makes them particularly vulnerable to large, high speed vessels (Groom et al. 2004; Hodgson 2004).

1.3.4. Potential Biological Removal

The large variability in population estimates resulting from large-scale movements (e.g., Marsh and Lawler 2001; Gales et al. 2004; Marsh et al. 2004), along with the slow rate of population increase for dugongs (Marsh 1995; Marsh 1999), means that aerial surveys need to be conducted over many years to detect an increase or decline in population size. A declining population may, by that time, have reached a critically low level (Marsh 1995). Regular aerial surveys along the Queensland urban coast have provided critical information about dugong distribution, abundance and trends. However this information is even more valuable when assessed in combination with known mortality rates from human impacts. Abundance estimates can be used to determine the Potential Biological Removal (PBR), which is the maximum level of human-caused mortality that can occur in a population from all causes (e.g. accidental entanglement in fishing nets or vessel strikes), while allowing the population to reach or maintain an optimal sustainable size (Wade 1998). The PBR is the product of a minimum population estimate, half the maximum rate of increase, and a recovery factor that allows for population growth and compensates for uncertainties in population estimates or responses to human impacts (Wade 1998). Marsh et al. (2005) estimate that if dugongs are to recover along the urban coast of Queensland including Cleveland Bay then management should aim to reduce human related mortality to zero. This includes mortalities from all causes, including those from boat strikes.

1.3.5. Cumulative impacts

The Cleveland Bay dugong population can be regarded as significantly depleted compared with the situation in the middle of the 20th century. The significant interventions to protect dugongs in the area have made the wider community very sensitive to further human impacts. In particular, fishers and Traditional Owners express concern that other human impacts on dugongs in Cleveland Bay are also minimised. Therefore the potential impacts of further development in the area, such as the TOT, need to be considered in relation to the potential cumulative effects of all impacts and the ultimate aim of reducing the overall effects of human activities on dugong populations.

2. AUSTRALIAN SNUBFIN AND INDO-PACIFIC HUMPBACK DOLPHINS

2.1 Overview

Coastal dolphins are among the most threatened species of cetaceans because of their close proximity to anthropogenic activities (DeMaster et al. 2001; Thompson et al. 2000). The Townsville Ocean Terminal (TOT) and the FDA site ("duckpond") are in the Great Barrier Reef World Heritage Area (GBRWHA). The GBRWHA supports critical habitats for listed and threatened marine species as well as soft-sediment benthic communities, seagrass beds and coral reefs of global significance. The waters adjacent to the TOT and FDA site (i.e. Cleveland Bay) have been recognized as an important habitat for Australian snubfin (*Orcaella brevirostris*) and Indo-Pacific humpback (*Sousa chinensis*) dolphins (Parra et al. 2006). Snubfin and Indo-Pacific humpback dolphins are listed as *Rare* under the Queensland Nature Conservation Act 1992 and are classified as *Data Deficient* by the IUCN. The Australian snubfin dolphin was only recently described as a new species and is the only cetacean endemic to Australian waters and possibly Papua New Guinea (Beasley et al. 2005) . Recent genetic studies on Indo-Pacific humpback dolphins indicate Australian populations may also represent a different species only found in Australia (Frère et al. 2003; Frère et al. *in press*). Thus, Australian snubfin and humpback dolphins have extremely high biodiversity and conservation value at a national and international level.

Dolphins have long life spans, late maturity, low reproduction rates, low fecundity, and long parental care. These characteristics result in slow rates of population growth and vulnerability to rapid population declines (Taylor 2002). Recent studies have identified Cleveland Bay in North Queensland as an important habitat for snubfin and Indo-Pacific humpback dolphins (Parra et al. 2006). The shallow waters, seagrass beds, coral reefs and the mouth of the Ross River are important habitats for these species. The potential loss or reduction in quality of these environments will likely have a negative impact on local populations of these species. The Townsville region is one of the largest growing coastal areas in northeast Queensland with an average annual growth rate of 2-3% over the past 30 years (King 2003). Given the high biodiversity value of these dolphin species, Australia has an international responsibility to protect them and ensure their long-term survival. Any activity that has the potential to adversely impact local populations of these marine mammals must be evaluated carefully.

In Cleveland Bay, snubfin and humpback dolphins are already exposed to a heavily modified habitat due to the proximity of the relatively large coastal city of Townsville. Current threats include: habitat degradation and loss due to coastal zone development, pollution, vessel traffic, overfishing of prey resources, and an increase in pathogen pollution (Parra et al. 2002; Parra et al. 2004; Parra et al. 2006). The magnitude of the TOT development will add to the cumulative impacts already at work in Cleveland Bay and must therefore not be assessed as a discrete impact of low significance.

2.2 Distribution and abundance

The distribution of Australian snubfin and humpback dolphins has been poorly documented at a national level. Strandings and sighting data indicate both species are found throughout coastal waters of Queensland, Northern Territory and Western Australia (Fig. 3). Snubfin dolphins have been recorded from Broome in Western Australia, along the northern coastline near Darwin and the Gulf of Carpentaria, and off the eastern coast as far south as the Brisbane River (27º 32'S, 152º 49'E) (Stacey and Arnold 1999). Indo-Pacific humpback dolphins have a similar range extending from approximately the Queensland - New South Wales border in the east to Shark Bay in the west (Preen 1995) (Corkeron, Morissette et al. 1997). Off the east and northern coast of Queensland the distribution of both species appears to be continuous, with the range of Indo-Pacific humpback dolphins extending further southeast into Moreton Bay. Snubfin dolphins have rarely been sighted further south than Gladstone.

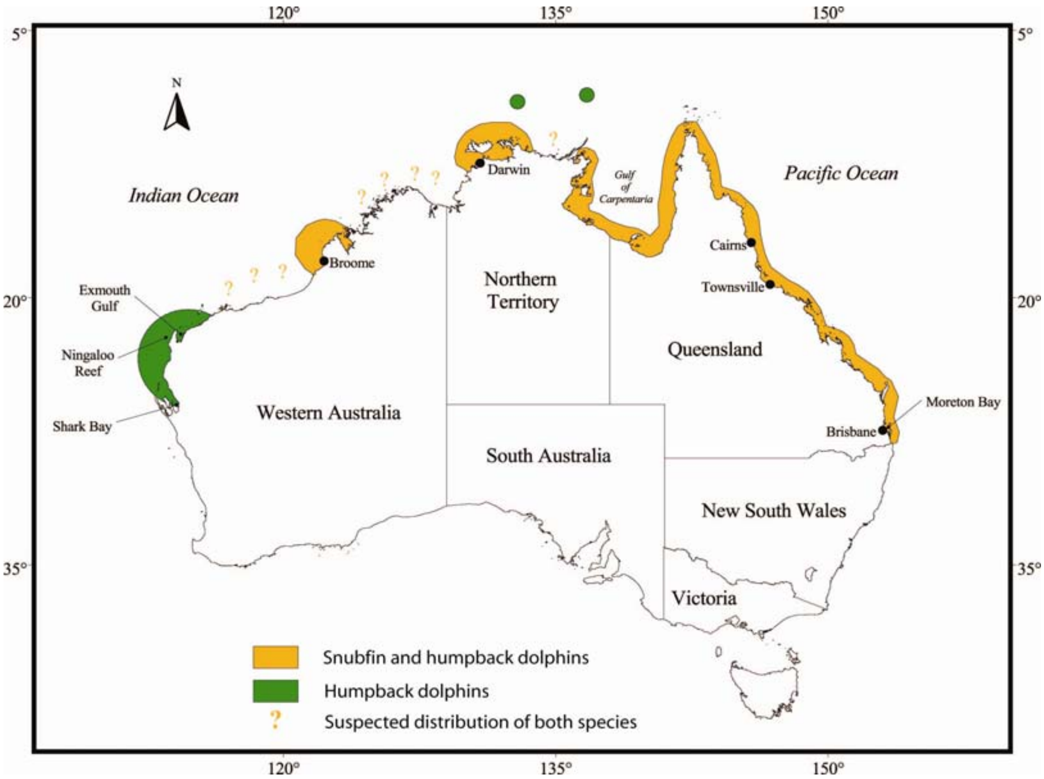

Figure 3. Distribution of Snubfin and humpback dolphins in Australian waters. The known distribution of both species is based on information reviewed in Parra et al. (2002 and 2004). Question marks indicate areas of probable, but unconfirmed, distribution.

There are no current estimates of population sizes or trends for Australian snubfin and humpback dolphins at a national level. Estimates of population size are only available for Cleveland Bay, and Moreton Bay, Queensland. Estimates of population size for both species in Cleveland Bay are worryingly small (Table 1), numbering 67 (95% CI= 51-88) snubfin dolphins and 54 (95% CI= 38-77) humpback dolphins in 2002 (Parra et al. 2006). This information suggests that populations of both species are vulnerable to anthropogenic mortality and potentially rapid population declines. Such small populations are more prone to local extinction than large stable populations because of loss of genetic variability and environmental and demographic stochasticity (Caughley and Gunn 1996). Population viability analysis of well known coastal dolphin species (i.e. bottlenose dolphin, *Tursiops truncatus*, and Hector's dolphin, *Cephalorhynchus hectori*) indicates that populations of less than a hundred animals face very high extinction probabilities (Thompson et al. 2000; Burkhart and Slooten 2003). Even small decreases in population size (e.g. 5% decline per year) have the potential to lead to local extinction of snubfin and humpback dolphins (Parra et al. 2006).

Table 1. Abundance estimates (N_{total}) of (a) snubfin and (b) humpback dolphins in Cleveland Bay between January 1999-October 2002 (Parra, Corkeron et al. 2006).

a) Australian snubfin dolphins

Year	N_{total}	SE	CV	95% CI
2000	**76**	6.0	0.08	65-88
2001	**64**	7.4	0.11	51-80
2002	**67**	9.4	0.14	51-88

b) Indo-Pacific humpback dolphins

Year	N_{total}	SE	CV	95% CI
2000	**52**	7.1	0.14	40-68
2001	**34**	6.3	0.19	24-49
2002	**54**	9.6	0.18	38-77

Population size estimates of humpback dolphins for Moreton Bay in the mid 1980s, covering two different time periods, were 163 (1984-1986, 95% confidence intervals = 108-251) and 119 individuals (1985-1987, 95% confidence intervals = 81-166) (Corkeron et al. 1997). Based on the small and declining number of sightings of humpback dolphins during aerial surveys of the

Great Barrier Reef region between 1987 and 1995, Corkeron et al. (1997) suggested humpback dolphins are probably declining in Australian waters.

Population sizes of the coastal dolphins at a State level (e.g. Queensland) are likely to be in the order of thousands rather than tens of thousands. This conclusion is substantiated by: 1) the low numbers of snubfin and humpback dolphins sighted during aerial surveys covering most of the east Queensland Coast between 1987 and 1995 (i.e. 29 sightings of snubfin dolphins and 54 sightings of humpback dolphins (Corkeron et al. 1997; Parra et al. 2002); 2) the low number of sightings during boat-based line transect surveys in selected areas of northeast Queensland (22 sightings of snubfin dolphins and 14 sightings of humpback dolphins, Parra 2005); and 3) the low estimates of abundance for humpback dolphins in Moreton Bay, an area approximately four times the size of Cleveland Bay. Against this background, the first priority of managers should be to reduce and control all direct threats to local populations while minimising the impacts of management decisions on different stakeholder groups (Parra et al. 2006).

2.3 Habitat use

Australian snubfin and humpback dolphins are typically associated with shallow, coastal and estuarine waters. Most schools of snubfin seen during opportunistic aerial surveys of Dugongs (*Dugong dugon*) along the Great Barrier Reef Region east coast of Queensland were seen within 10 km from the nearest point of land, in waters less than 10 meters deep, and within 10 km from the nearest river mouth (Parra et al. 2002). Similarly, sightings of Indo-Pacific humpback dolphins in the same region occurred mainly in waters within 10 km from the nearest coast and shallow areas (i.e., areas less than 2 m deep at low tide, Corkeron et al. 1997).

Snubfin and humpback dolphins are present year round in Cleveland Bay, with no significant seasonal differences (Figure 4). Schools with calves and/or juveniles are seen year round within the bay. Both species range within the bay extends from Crocodile Creek in the southeast to Black River in the northwest (Figure 5). Most individual dolphins do not reside permanently in Cleveland Bay, but use the coastal waters of the bay regularly from year to year following a model of emigration and reimmigration (Parra et al. 2006). Both species are seen throughout the bay, particularly close to river mouths (Ross River, Black River and Bohle River) and dredged channels and breakwaters close to the Port of Townsville, including the the FDA site and areas immediately surrounding it (Parra 2006).

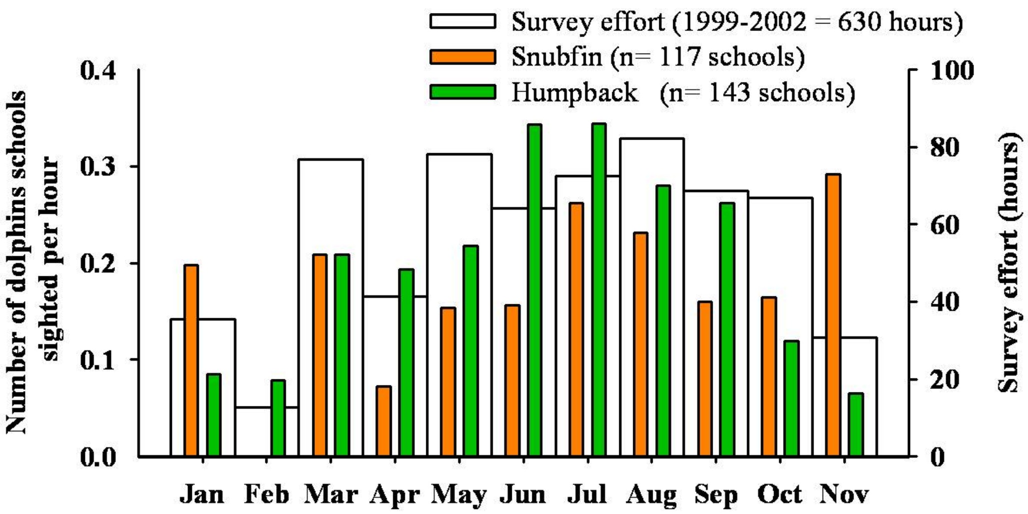

Figure 4. Number of snubfin and humpback dolphin schools sighted per hour in Cleveland Bay between 1999 and 2002.

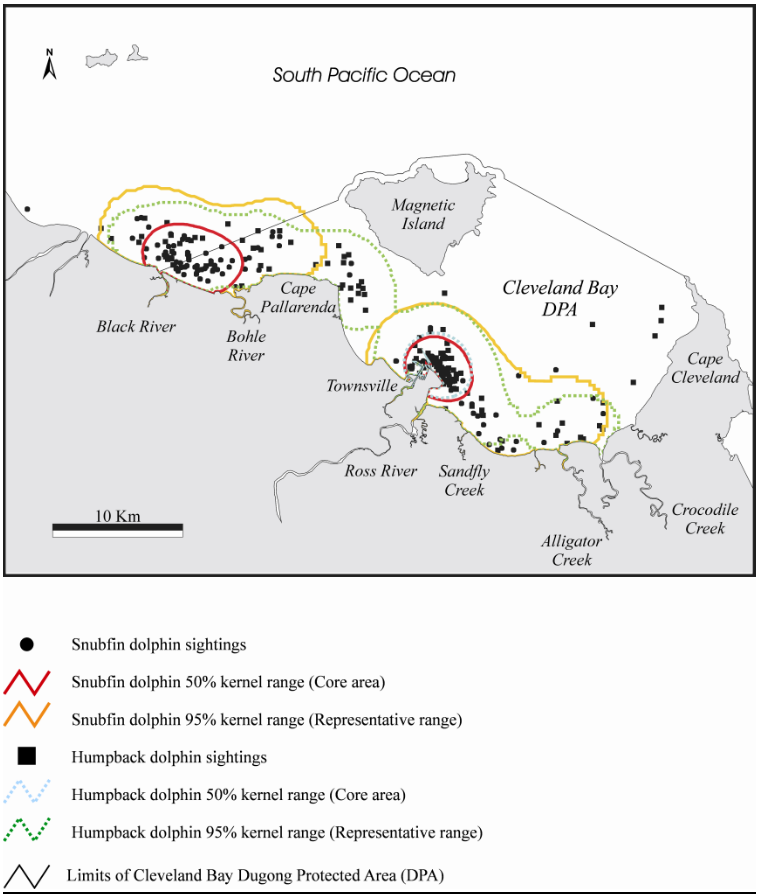

Figure 5. High use areas (50% kernel range) and representative ranges (95% kernel range) of snubfin and humpback dolphins in Cleveland Bay in 1999-2002 (Parra 2006).

Within these areas Snubfin and humpback dolphins are mainly seen foraging, travelling, and socializing (Parra 2006). Snubfin dolphins concentrate their activities around two areas: 1) northwest of Cape Pallarenda, and 2) south around Townsville's Port and Ross river mouth. Humpback dolphins show a similar space use pattern concentrating their activities mainly around the dredged channels and breakwaters close to the Port of Townsville (Figure 5) (Parra 2006).

The recurrent use of coastal waters of Cleveland Bay by both species, the predominance of foraging activity, and the presence of calves and juveniles of both species indicates that coastal waters of Cleveland Bay represent an important feeding and nursing area for local snubfin and humpback dolphins (Parra 2005; Parra 2006; Parra et al. 2006).

2.4 Conservation threats

2.4.1. Habitat degradation and loss

Species with high levels of site fidelity are vulnerable to population declines as a result of habitat degradation and loss, particularly when those species occupy relatively restricted habitats (Warkentin and Hernandez 1996). Snubfin and humpback dolphins use the coastal waters of Cleveland Bay regularly from year to year (Parra et al. 2006). Such site fidelity potentially conveys several ecological benefits including reduction in the costs and risks involved in relocating to new sites, and familiarity with resources and predators (Greenwood 1980).

The various habitats within the home range of snubfin and humpback dolphins are unlikely to be of the same quality. Consequently, degradation and loss of coastal habitats can lead to an increase in distance among habitable patches and/or reduction in number of remnant habitats (i.e., habitat fragmentation, Andrén 1994). The modification of highly used areas (e.g. area around the port of Townsville and Ross river mouth) may cause shifts in prey and predator distribution and abundance, resulting in species regularly using the area not finding suitable habitats and having lower survival probability. For example, a large scale loss of seagrass habitat in Hervey Bay, immediately south of the Great Barrier Reef Marine Park, following a cyclone and two floods resulted in unprecedented deaths and decline of local dugongs (Preen and Marsh 1995).

In the case of Cleveland Bay it is clear that coastal waters of the bay, including the area around the Port of Townsville, Ross river mouth, FDA site, and adjacent areas represent an important habitat for both species and efforts to maintain or improve current levels of protection inside and in adjacent areas will play a key role in the persistence of local populations in this area.

2.4.2. Pathogen pollution

Recent studies have shown that pathogen pollution may have considerable negative effects on populations of coastal marine mammals (Kreuder et al. 2003). The carcasses of three humpback dolphins recovered in the Townsville region between 2000 and 2001 were infected with *Toxoplasmosis gondii* (Bowater et al. 2003), a terrestrial parasite that can be fatal or have deleterious effects to the health of marine mammals (e.g., infection with *T. gondii* is one of the leading causes of mortality of southern sea otters along the California coast (Kreuder et al. 2003)). Given the small number of Snubfin and humpback dolphins in Cleveland Bay, the incidence of this pathogen is of serious concern. The introduction of this parasite to the coastal ecosystem appears to be linked to runoff of contaminated water with cat faeces or litter carrying oocyst of *T. gondii* (Miller et al. 2002). Thus controls on the disposal of cat faeces, and improvements of the treatment of stormwater and sewage discharges will be fundamental as a precautionary measure. Monitoring of the incidence of this pathogen in stranded animals and studies on its potential sources are also needed to determine areas of high risks associated with *T. gondii* infection.

2.4.3. High vessel traffic

In Cleveland Bay, areas highly used by snubfin and humpback dolphins (i.e., the Port of Townsville, river mouths) overlap with areas of high vessel traffic. High vessel traffic in shallow coastal areas can cause serious injuries and mortalities to coastal dolphins (Wells and Scott 1997), reduce their access to particular areas within their home range (Allen and Read 2000), affect their acoustic communication (Van Parijs and Corkeron 2001), and alter their behaviour (Lusseau 2003; Constantine et al. 2004). All of these effects can be potentially detrimental to the small populations of snubfin and humpback dolphins inhabiting Cleveland Bay.

Boat traffic is likely to increase as a result of the TOT development and has the potential to displace dolphins and disrupt their behaviour (Van Parijs and Corkeron 2001; Bejder et al. 2006a; Bejder et al. 2006b; Lemon et al. 2006; Hodgson and Marsh 2007). The acoustic communication and group cohesion of humpback dolphins is affected by boat traffic and noise (Van Parijs and Corkeron 2001). Post mortem investigation on stranded humpback dolphins in Hong Kong suggests that some deaths may have been caused by boat strikes (Parsons and Jefferson, 2000). Voluntary transit lanes and speed limits set in other areas along the Queensland coast for protection of dugongs have low levels of compliance (Groom 2003; Hodgson and Marsh 2007). Thus enforced vessel lanes and/or speed restrictions to protect snubfin and humpback dolphins from vessel strike or disturbance should be considered as a precautionary measure in areas of high vessel traffic.

2.4.4. Gillnets

Entanglements in gillnets and shark nets set for bather protection have long been recognized as a major threat for snubfin and humpback dolphins (Cockcroft 1990; Paterson 1990; Hale 1997).

Commercial gillnetting in Cleveland Bay is prohibited due to its status as a Dugong Protected Area type A, however the coastal waters of DPA do not include the full home range of snubfin and humpback dolphins using this area. The areas adjacent to Cleveland Bay DPA offer different levels of protection from entanglement in gillnets. Bowling Green Bay to the south is a Dugong Protected Area Type B, where gillnetting activities are allowed with safeguards and restrictions. However, Halifax Bay to the north, is a “General Use” zone and there are no area–specific regulations regarding netting practices. Thus, entanglement in gillnets still poses a risk to the maintenance of local populations when individuals are outside the study area, a potentially serious threat to populations occurring in low numbers. Although the threats from incidental drowning in gillnets have been reduced by the establishment of the Dugong Protection Areas in some of the region and the re-zoning of the Great Barrier Reef Marine Park in 2003, the draft East Coast Finfish Management Plan proposes to allow increased gill netting in the area which increases the risk of mortality to coastal dolphins.

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