

# **THE RISK TO DUGONGS OF VESSEL STRIKE IN THE SOUTHERN BAY ISLANDS AREA OF MORETON BAY**



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## CONTENTS

Executive Summary.....	3
Recommendations .....	4
Management .....	4
Research .....	4
Introduction .....	5
Methods.....	8
Survey of dugong distribution .....	8
Anecdotal dugong distribution .....	9
Survey of seagrass distribution.....	9
Results .....	10
Dugong distribution and abundance .....	10
Dugong mortality during the study period .....	11
Seagrass and feeding trail distribution .....	12
Information from dugong carcasses .....	13
Discussion .....	15
Dugong mortality, behaviour and movements .....	15
Seagrass distribution in relation to dugong distribution .....	17
Research .....	19
Acknowledgements .....	20
Literature Cited.....	21

## EXECUTIVE SUMMARY

- The Southern Bay Island area of Moreton Bay is a 'hot-spot' for the mortality of dugongs caused by vessel-strike. However, little was known of how many dugongs use this area, nor how they are distributed.
- This study assessed the distribution and abundance of dugongs within the Southern Bay Islands with a view to assessing the sustainability of the level of mortality caused by boat-strike and identifying ways to reduce mortality.
- We recorded low numbers of dugongs in the area, seeing only 10 dugongs in nine separate sightings over 25 days of fieldwork. These data were supplemented by anecdotal data on dugong sightings by members of the public frequenting the area.
- Dugongs were distributed throughout the northern part of the study area, but most sightings were centred around the region between Macleay Island to the north, Russel Island to the south, Karragarra Island to the east and Garden Island to the west.
- This core area of dugong mortality is intersected by the path of the ferry to the surrounding Bay Islands. The ferry passes through the area 60 times per day.
- The bathymetry of the area means that continuing boat-strike appears inevitable. The area is shallow with few deeper channels running through it. At low tide in particular both dugongs and boats must use the same channels.
- There was an incident of dugong mortality caused by boat-strike during our study. A mother and calf pair, presumably the pair that had been seen alive in the boating channel on 16<sup>th</sup> May 2004, were found dead on 18<sup>th</sup> of May. Both bore cuts from a boat propeller.
- It is difficult to assess the relationship between the Southern Bay Island dugong population and that of the larger population on the eastern banks of Moreton Bay. However, several carcasses found in the Southern Bay Islands area had tags from the mark-recapture program of Dr Janet Lanyon (UQ) indicating that some animals use both areas.
- Irrespective of the level of connectedness between the two dugong populations, the mortality occurring in the Southern Bay Islands is of significant conservation concern.

## **RECOMMENDATIONS**

### **Management**

1. The Queensland Parks and Wildlife Service work with the Queensland Department of Transport to introduce a go-slow area with a speed limit of 4-5 knots for all vessels in the area bounded by 153<sup>0</sup>20.75'E to 153<sup>0</sup>22.22'E and 27<sup>0</sup>37.97'S to 27<sup>0</sup>39.49'S.
2. The Queensland Parks and Wildlife Service introduce on the spot fines for offenders who breach the go-slow restrictions.
3. The Queensland Parks and Wildlife Service employ an expert in Operations Research to work with the ferry company to optimise ferry services to minimise the cost of the 'go-slow' zone on the ferry company.
4. The Queensland Parks and Wildlife Service develop a public education campaign to educate the public about the risk to dugongs of vessel strikes and the need for go-slow areas.
5. The Queensland Parks and Wildlife Service work with the Queensland Department of Transport to introduce compulsory vessel transit lanes in association with a go-slow area.
6. The Queensland Parks and Wildlife Service work with the Queensland Department of Transport to introduce compulsory propeller guards for the passenger ferries in association with a go-slow area.
7. The Queensland Parks and Wildlife Service work with the Queensland Department of Transport to investigate the efficacy of using hovercraft on the ferry routes traversing the area of interest
8. That if it is cost-effective to use hovercraft on these routes, the ferry company be required to replace their vessels with hovercraft over an agreed time-frame.

### **Research**

1. This study be repeated in the second half of 2004 with some modification to the survey design to make it more cost-effective.
2. The revised study include a study of currents in the study area to allow more effective determination of the likely site of a boat strike incident once a carcass is recovered.
3. Dr Janet Lanyon be asked to provide the Queensland Parks and Wildlife Service with the capture-history of the dugongs she captures and tags in Moreton Bay as a condition of her research permit to facilitate understanding of the movements of dugongs between the eastern banks and the 'Area of Interest'.

## INTRODUCTION

The dugong (*Dugong dugon*) is the only herbivorous mammal that is strictly marine. Dugongs are obligate benthic feeders specialising on sub-tropical and tropical seagrasses (Marsh et al. 1982). Consequently, their distribution and abundance is highly correlated with seagrass distribution and abundance, and seawater temperature. The dugong's range extends through the coastal and island waters of the Indo-Pacific between approximately 26° and 27°N and S of the Equator (Marsh et al. 2002). In Australian waters, their distribution is primarily along the northern tropical coasts, extending as far south as Shark Bay (25° 45'S, 113° 44'E) on the west coast, and to Moreton Bay (27°20'S, 153°20'E) on the east coast (Marsh et al., 2002). IUCN- the World Conservation Union (Hilton-Taylor 2000) and the *Queensland Nature Conservation (Wildlife) Regulation 1994*, both classify dugongs as "Vulnerable".

Moreton Bay is the highest latitude at which dugongs are found year round on the east coast of Australia. The dugong population of Moreton Bay is significant in being the largest population adjacent to a major metropolitan area (Heinsohn et al. 1978). The number of dugongs in Moreton Bay has fluctuated substantially since European settlement, apparently as a result of a combination of natural and anthropogenic processes.

Before the arrival of Europeans in 1824, Aborigines in Moreton Bay caught dugongs in large nets, as described by Flinders in 1799 (Mackanness 1979). The earliest mention of dugong fishing by Europeans was in 1847 (MacGillivray 1852), but there may have been Europeans based at Amity and fishing for dugongs in the 1830s (Welsby 1907). Championed by a Dr Hobbs (1857), a cottage industry for dugong oil developed from the 1850s and persisted intermittently until about 1920 (Johnson 2002). On the basis of his informal boating activities, Welsby (1905) estimated that Moreton Bay typically supported 300-400 dugongs at the end of the 19<sup>th</sup> century, close to current estimates (Lawler 2002). Nonetheless, Welsby observed a herd that he estimated to be three miles long and about 300 yards wide in July 1893 near the Black Beacon at the western entrance of Rous Channel. Dugong numbers in Moreton Bay were believed to have been depleted between the late 1800s and the early 1900s (Petrie 1932). However, when supplies of cod-liver oil from the Atlantic were disrupted during the Second World War, dugong oil was once again in demand and there were reports of large herds of dugongs in eastern Moreton Bay (Harbours and Marine 1943).

Bertram and Bertram (1973) reported that there were only a few dugongs remaining in Moreton Bay in the 1960s, although there was some suggestion that numbers were increasing again. By the mid-1970s, aerial surveys established that there was a population of at least 300 dugongs (Heinsohn et al. 1978). The standardised population estimates of the Moreton Bay dugong population resulting from aerial surveys conducted since 1988 range between 344 ( $\pm$  s.e. 88) and 1019 ( $\pm$  s.e.166) (Lear 1977; Heinsohn et al. 1978; Preen 1993; Preen and Marsh 1995; Lawler 2002; Lanyon 2003). The most recent estimate was 493( $\pm$  s.e.45) in November 2001 (Lawler 2002).

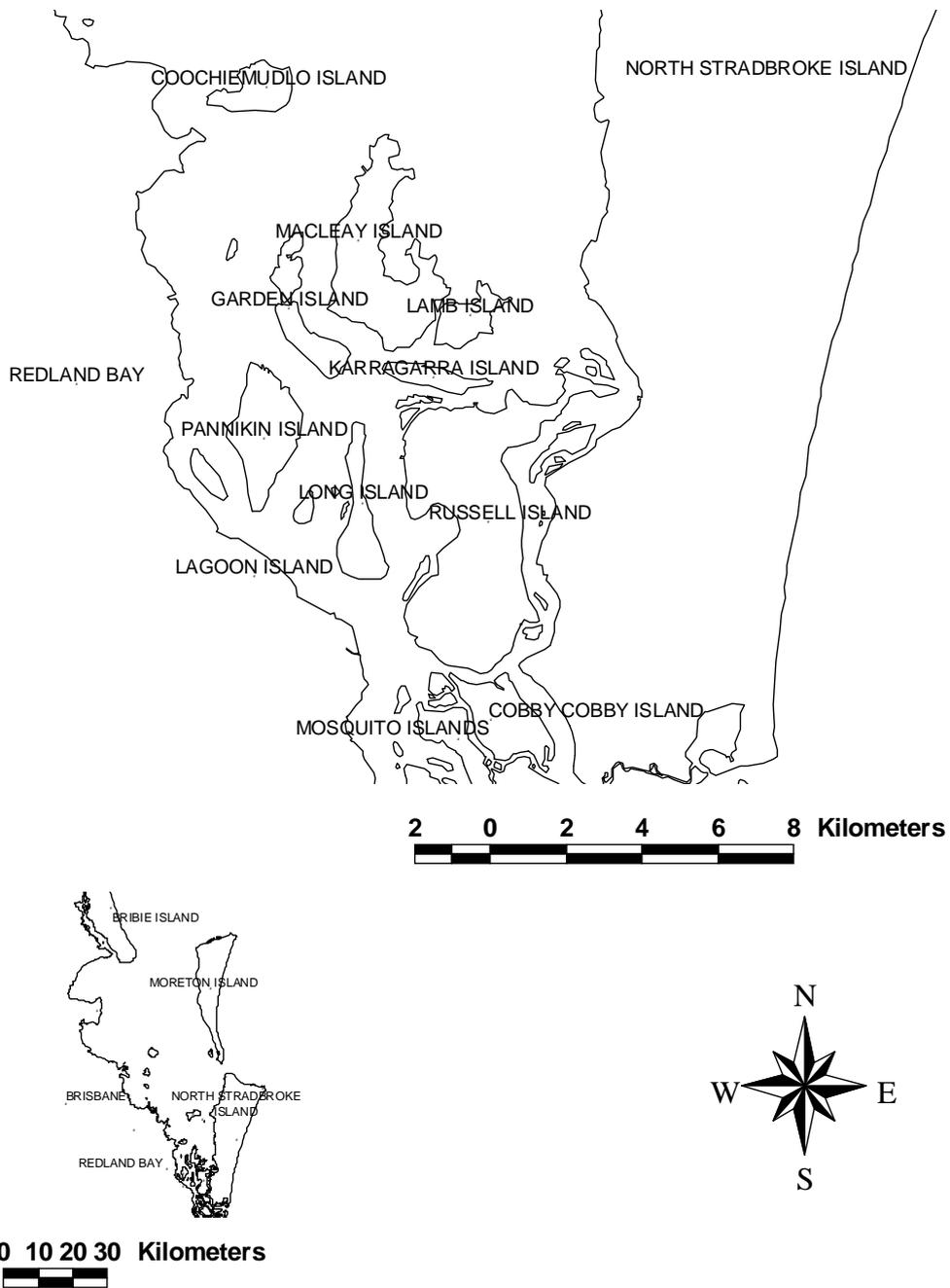
Evidence from other parts of the dugong's range in Australia (Marsh et al. 2001; Marsh and Lawler 2002; Marsh et al. 2003; Gales et al. 2004) indicates that dugongs undergo large-scale movements. Thus the variation reported in the historical accounts above and since the 1970s is likely to be the result of several confounding influences including: (1) anthropogenic mortality, especially as a result of the dugong oil industry, (2) dugongs moving in and out of Moreton Bay in response to habitat change, and (3) differences in the survey techniques used since the 1970s.

There is some evidence that the distribution of dugongs within Moreton Bay has constricted since European settlement. The establishment of dugong oil activities around Green Island and Saint Helena Island suggests that dugongs were once abundant in the western bay

(Cilento and Lack 1959). In contrast, the great majority of dugongs are currently found on the eastern banks. In fact, in recent aerial surveys so few individuals were seen elsewhere that population estimates for other parts of the bay were not possible (Lawler 2002). There are several possible explanations for this range reduction: (1) dugongs were depleted in the western bay by the oil industry and have not reoccupied this region; (2) animals have been displaced from the western bay by vessel traffic (Preen 1993), and (3) an estimated 20% of seagrass has been lost from Moreton Bay since European settlement, mostly from the western bay (Abal et al. 1998). There is no evidence to support or reject the first two of these explanations.

However, despite the relatively low numbers of dugongs in Moreton Bay outside the eastern banks which are relatively pristine (Dennison and Abal 1999), the Southern Bay Islands region has recently been identified as a 'hot spot' for recovering carcasses killed by vessel strike (Yeates and Limpus 2003). Prior to 2004, nine dugong deaths were attributed to boat strike within a few kilometres of a focal area between the southern end of Macleay Island and the northern end of Russel Island (Figure 1). This level of mortality raises concerns about the sustainability of the dugong population of that area, in the absence of reliable information on its size or connectivity to the larger population of the eastern banks 25km to the north.

We report here on a study undertaken to provide baseline information on the distribution and abundance of dugongs and their seagrass food resource in the Southern Bay Island region. We show that there are relatively few dugongs within the region, but that their distribution and the physical nature of the area are such that there is a very high probability of boat strike. We discuss the sustainability of the situation, the relationship of this population to the larger population of the eastern banks and consider potential management actions to reduce mortality levels.



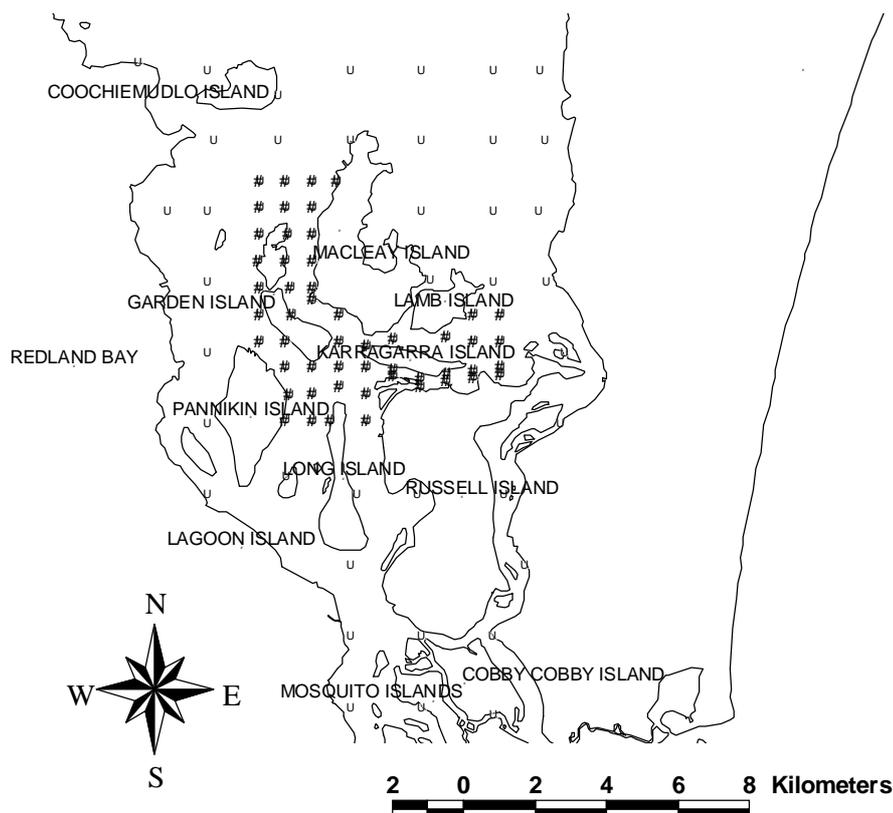
**Figure 1:** Map of the study area, with larger map of Moreton Bay below left.

## METHODS

### Survey of dugong distribution

We used a point-sampling technique to survey dugongs in the region. Our rationale for this approach was the relatively small size of the region, the need for information at a fine spatial scale, the turbidity of the water and knowledge of the diving behaviour of dugongs (Chilvers et al. 2004; Amanda Hodgson unpublished data). Dugongs spend less than 2% of their time at the surface of the water and often surface cryptically (Anderson 1985; Churchward 2001; Amanda Hodgson unpublished data). We decided that methods using moving platforms, such as line transect surveys with vessels, or strip transect aerial surveys would be unlikely to be cost-effective.

We adopted a sampling design based on a grid overlaid over the study area and adjusted so that no sites were over land. The design was stratified so that over the full extent of the study region (from 27° 34'S to 27° 43'S), 39 grid points were spaced approximately 2km apart, but grid spacings were decreased to 750m (52 grid points) within a smaller "Area of Interest" based on the concentration of boating activities and recovered carcasses of dugongs killed by boat strike (Figure 2).



**Figure 2.** Distribution of grid points surveyed. Note the open squares at lower density in the overall study area relative to the higher density of sampling in the 'Area of Interest' (closed circles).

Because of the high proportion of time that dugongs spend underwater, we increased the height of the viewing platform to provide a more vertical line of view and thus greater penetration below the water. We used a video camera mounted on a helium-filled balloon tethered to the boat (hereafter referred to as “blimp-cam”, Hodgson in review). The camera was controlled remotely from the boat allowing the area to be panned up and down and to zoom in and out. Video output was monitored in real time and simultaneously recorded for later analysis. This allowed us to gain a vantage point approximately 40-50m above the water and to scan from 150-250m from the boat, depending on glare and wind conditions. As a result of equipment malfunction and associated delays in conducting the field work, the blimp-cam was used only in the ‘Area of Interest’ (Figure 2). A minimum of two, and usually three, observers were used throughout the remainder of the study area as outlined below.

Using the blimp-cam, we did an initial 360° scan for 1 minute at the beginning and end of each 12 minute observation period. We then held the blimp-cam stationary for 10 minutes at a position determined by glare, water depth and proximity to land. The camera lens was kept fully zoomed out at each site and was tethered by 50m of rope above the vessel. The survey distance was delineated by the use of reference points such as navigational markers, landmarks and buoys. During this 10 minute period, two additional observers were positioned on either side of the roof of the research vessel and scanned to 45° on either side up to 200m from the boat, a combined search area of approximately 0.112km<sup>2</sup>. This provided a sampling fraction of approximately 20% in the ‘Area of Interest’ and 2.8% in the remainder of the survey area. The presence/absence of dugongs and turtles was recorded based on the blimp-cam and visual observations. The 10 minute period was chosen because 90% of dugong dives are less than five minutes duration and dives greater than 10 minutes are very uncommon (Chilvers et al. 2004).

### **Anecdotal dugong distribution**

We supplemented the survey data by collecting anecdotal information from people who regularly use the waterways in the area. Each person was shown a map of the area and asked to mark where they had recently seen dugongs. People surveyed included:

- 6 car and 6 passenger ferry operators
- 3 local crab fishermen
- 10 boaters and fishermen

### **Survey of seagrass distribution**

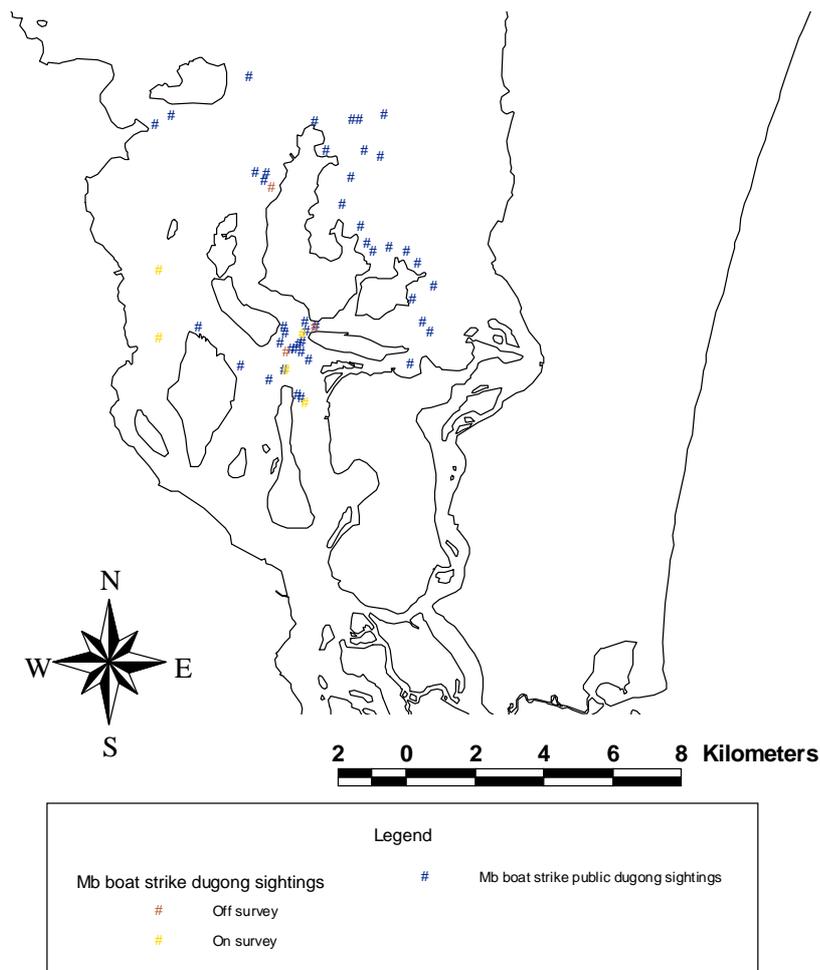
The same survey design (Figure 2) was used to survey seagrass. Seagrass presence or absence was determined using a cable-mounted video camera to survey two haphazardly placed 0.25m<sup>2</sup> quadrats at each sampling location. Species identification was confirmed by collecting two grab samples. Where seagrass was present, the site was then surveyed by snorkelling for the presence of dugong feeding trails. The age of the feeding trails was determined based on the distinctiveness of the furrow and whether or not seagrass was starting to grow back into it again.

## RESULTS

### Dugong distribution and abundance

#### *Survey data*

Dugongs were uncommon in the study area. Despite spending in excess of 25 days on the water, there was a total of only nine sightings of 10 live dugongs (Figure 3). Some of these may have been repeat sightings. Three of the nine sightings, including a mother and calf pair were seen opportunistically outside of the formal survey program. Five sightings, of six dugongs, were in the region bounded by the northern end of Russel Island and the southern end of Macleay Island and the western end of Karragarra Island. The mother and calf pair were within the channel known as the “Ws” through which the ferry to Russel and Macleay Islands passes 60 times daily. A photo was taken of a recreational boat travelling at planing speed passing within approximately 20m of the surfacing pair (Figure 4) on 16<sup>th</sup> May 2004. Soon afterwards, the ferry was observed to pass directly over a position where the pair had surfaced.



**Figure 3.** Locations of dugongs sightings



**Figure 4.** Recreational boat passing dugong mother and calf in boat channel west of Karragarra Island at low tide on 16<sup>th</sup> May 2004.

### ***Anecdotal data***

Sightings recorded by members of the public showed a wider distribution than we observed, extending north to Coochiemudlo Island and along the eastern side of Macleay Island (Figure 3). We have no information to evaluate whether these sightings are a random sample of the dugongs' use of the area. However, these sightings support our observations that the area around the western end of Karragarra Island is relatively important for dugongs in the Southern Bay Islands region. The mother and calf dugongs had been seen several times near the yellow navigation marker at the western end of Karragarra around the time of the survey.

### **Dugong mortality during the study period**

During our survey period, there was an unambiguous incident of boat strike mortality (Figure 5). A mother and calf dugong (given the low numbers of animals seen and the location, we consider that it is highly likely that they were the same pair we photographed) were struck by a vessel on May 18<sup>th</sup> 2004. The mother had fatal propeller cuts across her head and back. She was found at 2:45pm approximately opposite the jetty at the southern end of Macleay Island. She was struck while still alive as indicated by the fact that her wounds were bleeding when she was recovered. She was lactating. The 1.6 m calf which also had fresh propeller wounds was found two hours later two kilometres west-southwest at the southern end of Garden Island.

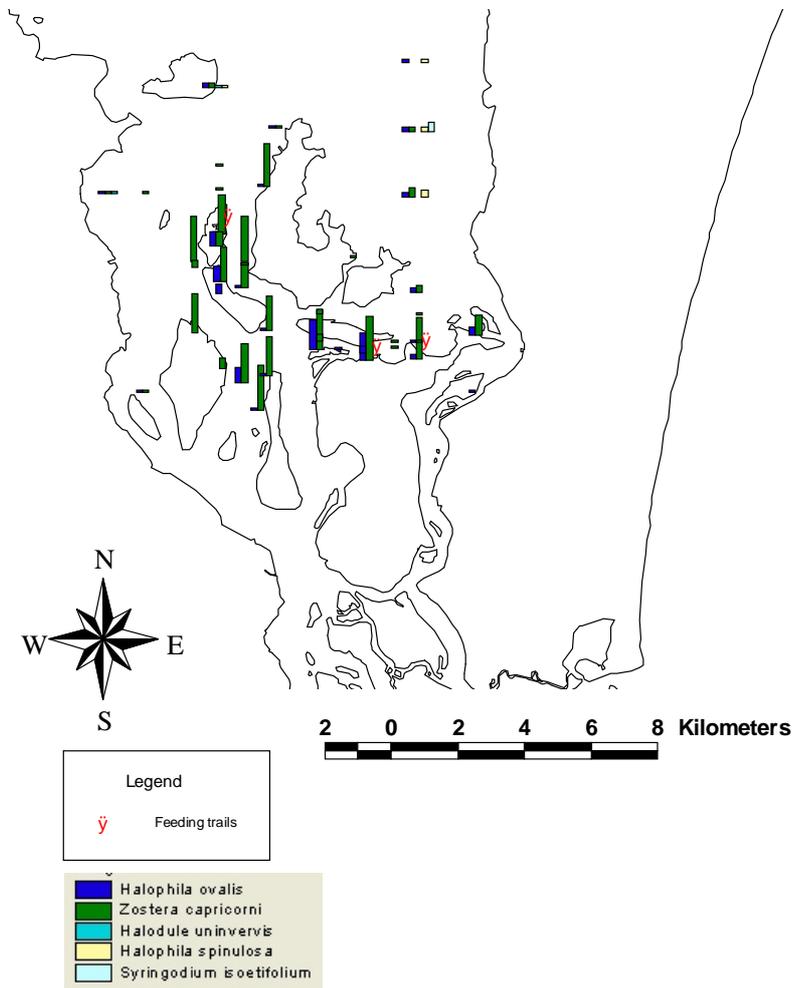


**Figure 5.** Mother and calf dugongs killed by boat strike on 18<sup>th</sup> May 2004.

### **Seagrass and feeding trail distribution**

Within the broader study area we recorded five species of seagrass: *Halophila ovalis*; *Zostera capricorni*; *Halodule uninervis*; *Halophila spinulosa*, and; *Syringodium isoetifolium*. The last three species were uncommon, found in only two, four and one sampling sites respectively. Only *H. ovalis* and *Z. capricorni*, were found in the 'Area of Interest'. *Z. capricorni* was present at up to 90% percentage cover while *H. ovalis* reached up to 60% percent cover but was more usually 5-15%. Interestingly, little seagrass of any type was found around the areas where most dugongs were recorded (Figure 6). There was no seagrass found in the southern end of the study area.

Feeding trails were identified in only three places. Two were at the northern end of Russel Island at the eastern end of Karragarra Island. The other was on the north eastern side of Garden Island. The distribution of feeding trails did not coincide with the distribution of dugong sightings. None of the feeding trails seen was recent.



**Figure 6.** Distribution of seagrasses and dugong feeding trails

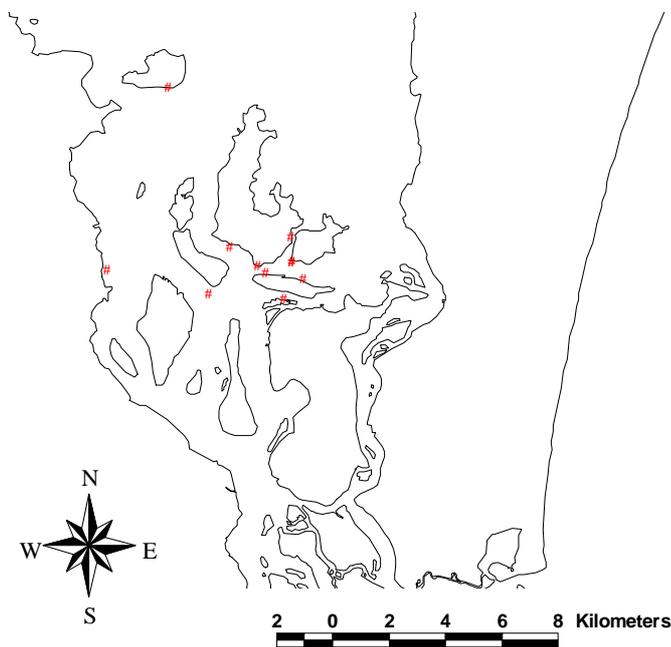
### Information from dugong carcasses

The mortalities recorded during this study bring the total boat strike mortality of dugongs for the Southern Bay Islands to 10 since 2001. This distribution of carcass locations suggests that the area of risk from vessel strike is focussed around the area between Macleay, Karragarra and Russel Islands (Figure 7). The calf that died from vessel strike on May 18<sup>th</sup> 2004 was recovered two hours after its mother was seen dead, and two kilometres away, confirming that the location of recovery is not necessarily an accurate indication of the location of the vessel collision.

Examination of the dates of the deaths shows no clear seasonal trend, with mortalities recorded in summer, spring and autumn. There have been no mortalities recorded in winter (June through August), which may reflect an absence of dugongs from the area during winter, but there are no data to support or refute this possibility. It is not possible to determine patterns in the times of day or tidal height when dugongs were struck because of the indeterminate amounts of time between each incident and recovery of the associated carcass(es).

Six of the carcasses had tags in their tails, presumably from the mark-recapture program run by Dr Janet Lanyon of University of Queensland (Lanyon et al. 2002). This result indicates that a significant proportion of the dugongs in the Southern Bay Islands area range between this area and the eastern banks.

The calf of the pair of dugongs recorded killed in this study showed evidence of having been struck previously. Its tail had been severely cut, but healed, and there were scars on its back consistent with propeller marks. Given that the calf was 1.6m long and that its assumed mother was still lactating, it is estimated to be less than 18 months old, probably about 6 months old (Marsh 1980). This result suggests that: (1) the risk of boat strike is high and (2) the calf had not learned from the first incident.



**Figure 7. Locations of dugong carcasses**

## DISCUSSION

### Dugong mortality, behaviour and movements

The region between Macleay, Russel, Karragarra and Garden Islands is clearly an area where the risk of dugongs being struck by vessels is high. While dugongs were seen throughout the study area, the majority of sightings and retrieved carcasses have been found in this area. This is a particular concern because the area is also traversed about 60 times each day by the passenger ferry servicing Macleay and Russel Islands in addition to high recreational boater traffic.

This area is shallow, with significant intertidal areas leaving both boats and dugongs constrained to narrow channels (<100m wide in places) during the low part of the tidal cycle. The resultant interaction between dugong behaviour and bathymetry is likely to be a major factor in the high probability of boat strike in the Southern Bay Islands.

Amanda Hodgson (Hodgson unpublished data 2004) used the blimp-cam in the clear waters on the eastern banks of Moreton Bay to study the responses of dugongs to approaching boats. One of the primary responses of dugongs to the sound of an approaching boat is to move towards deeper water. In the Southern Bay Islands area, such a response may be maladaptive, leading dugongs to seek refuge in the narrow channels to which the boats are constrained, particularly at low tide. Additionally, Hodgson's review of the motor vehicle accident literature suggests that the point at which dugongs initiate their response to an approaching vessel is more likely to be a function of the distance of the vessel rather than its speed. The practical consequence of this behaviour is that when a vessel is approaching quickly, dugongs may fail to attempt to evade it until it is such time as impact is unavoidable. Hodgson's opportunistic blimp-cam footage of (non-research) vessel passes shows that at times dugongs do not exhibit a detectable avoidance response until after a vessel has passed by, or directly over, the dugongs. Hodgson's opportunistic records of vessel passes also showed that the likelihood of a dugong passing in front of a moving vessel increased when vessels were travelling above planing speed.

Approximately 25-30% of manatee deaths in Florida are attributed to watercraft injuries (Florida Fish and Wildlife Conservation Commission <http://www.floridaconservation.org/psm/manatee/boaters.htm>). Almost 50% of these injuries are from the impact of blunt trauma, nearly equal to those of injuries caused by propellers. Because force equals mass by acceleration, the faster a boat goes, the more force is applied to a "strike." For instance, the difference between the force of a strike at 60 km per hour is exactly twice that of a 30 km an hour, all other factors being equal. Based on the same logic, the impacts of large, heavy vessels such as ferries will be relatively greater than the impact of smaller boats travelling at the same speed.

The concept of risk is seen as having two elements: (1) the likelihood of something happening, and; (2) the consequences if it happens. Using this definition, risk is evaluated as the product of the probability of an event and the magnitude of the consequences of that event (Norton et al. 1996). Given that ferries traverse the 'Area of Interest' at least 60 times per day, the probability of their striking a dugong is higher than for other boats which traverse the area less frequently. In addition as their mass is much greater than that of most other vessels using the area, the consequence of their hitting a dugong is likely to be more serious. Thus the risk posed by the ferries to dugongs in this area is significant.

It would appear inevitable that without management intervention or a major change in their behaviour, dugongs will continue to be struck by vessels in the 'Area of Interest', and that the risk of their being killed by ferries is likely to be greater than other boats. This in turn raises

the question of whether dugongs will continue to use the area, and if so, whether they will continue to use it in the same manner or modify their behaviour. Our understanding of the nature of dugong movements is insufficient to answer these questions. We do know that dugongs will repeatedly use the same areas for periods of weeks to months, feeding on available seagrasses (Marsh and Rathbun 1990; Preen 2001). However, the behaviour of individual dugongs is very variable, as are the nature and location of seagrass patches. The precautionary principle demands that we assume that dugongs will continue to frequent the high risk 'Area of Interest' in the same manner as in the past until the animals using this area are exterminated.

If the dugongs of the Southern Bay Islands belonged to a small, closed population the most likely scenario would be extinction. The present mortality rate is clearly unsustainable for a population that is so small that it cannot be estimated by normal means. However, the fact that six of the dugong carcasses were tagged, presumably under the mark-recapture programme of Dr Janet Lanyon (School of Life Sciences, University of Queensland) clearly shows that the population includes individuals which range at least as far as the Eastern banks of Moreton Bay. The significance of this connection is difficult to assess. We do not know, for example, how many dugongs have been tagged under Dr Lanyon's program so it is not possible to judge whether the proportions of tagged dugongs on the Eastern banks is similar to the proportion in the sample of located carcasses from the Southern Bay Islands. Neither do we know anything of the frequency of movements between the two areas or the residence time of individuals within the 'Area of Interest'. The only data on this latter point come from the calf killed on 18<sup>th</sup> May 2004, which showed evidence of previous boat strike injury, most likely incurred in the general same area weeks or months earlier.

Irrespective of whether there are many individuals using the Southern Bay Islands area, or only a few, the potential scenarios are of conservation concern. If most or all of the population of the Eastern banks visits the area then high boat strike mortality will most likely continue, potentially leading, or at least contributing, to unsustainable anthropogenic mortality at the scale of the whole Moreton Bay population.

Alternatively, if a much smaller proportion of the overall bay population use the Southern Bay Islands, we may see the loss of "cultural knowledge" of the area by some dugongs, leading effectively to localised extinction of dugongs in the Southern Bay Islands. As there is no relevant data with which to determine how dugongs acquire their larger scale geographic knowledge of habitats, we must rely on parallel information from studies Florida manatees which are both phylogenetically and ecologically closely related to dugongs.

Like dugongs, manatees show large scale movement patterns that are highly variable between individuals (Deutsch et al. 2001; Weigle et al. 2001). A common feature of both dugongs and manatees is that individuals that occupy large ranges will move in an apparently purposeful and directed manner to distant sub-ranges, often bypassing suitable habitats that are much closer. Long term studies of manatees provide insights into this behaviour because in several cases female manatees have been tracked and subsequently their calves have also been tracked after becoming independent. These studies show a strong tendency for calves to exhibit the same larger-scale movement patterns as their mothers, rarely visiting areas to which they did not travel as calves (Deutsch et al. 2001; Weigle et al. 2001). Therefore, if the majority of dugongs using the Southern Bay Islands are killed by boats it is unlikely that the dugong population there will be re-established except over the very long term. An analogous situation has occurred in Picnic Bay on Magnetic Island adjacent to Townsville in North Queensland. In that case, the source of mortality was the introduction of the shark meshing program for bather protection in 1962. In the first five years of shark meshing, at least 94 dugongs were killed (Heinsohn 1972). Only a very few individuals were caught in subsequent years. The shark nets have since been removed from Picnic Bay. However, despite there

being a resident population of several hundred animals in eastern Cleveland Bay, less than 20km away, dugongs are now seen in Picnic Bay only rarely.

### **Seagrass distribution in relation to dugong distribution**

Our dugong sightings were not highly correlated with the areas where seagrasses or feeding trails were found (see Figures 3 and 6). There are a number of possible reasons for these results.

(1) The distribution of seagrasses is highly variable, both spatially and temporally. We may have used a sampling design that was too coarse to reliably map the spatial distribution of patches within the core area. That is, while we did not find seagrass at a particular grid point does not necessarily mean that there was no seagrass between grid points or that there may not have been seagrass at the grid point on another occasion.

(2) The current seagrass distribution and abundance within the 'Area of Interest' may have been reduced by the feeding activities of the resident dugongs and approaching the point at which dugongs move to another patch.

### **Options for Management**

The region between Macleay, Russel, Karragarra and Garden Islands is clearly an area where the risk of dugongs being struck and killed by vessels is high. Indeed, it is currently the hotspot for dugong –vessel strikes in both Queensland and Australia. Our risk assessment suggests that the risk of dugongs being killed by the ferries that traverse this area is likely to be greater than that for other vessels using the area at the same speed because of: (1) the frequency with which ferries traverse the area and (2) the greater mass of ferries relative to other boats. Although the probability of dugongs being killed by other vessels using the area is not zero, actions to reduce the risk of dugongs being killed by ferries is likely to result in the greatest reduction in risk. However, actions should also address the risks of dugongs being hit by other vessels.

We discuss several options for management of this problem.

#### 1. Close the area of Interest to vessel traffic

Services by both commercial ferries and private boats are essential for people to continue to live on the Southern Bay Islands. It is clearly not feasible to close the 'Area of Interest' to boat traffic, so this option is not considered further.

#### 2. Do nothing

The dugong is classified as vulnerable under the Queensland *Nature Conservation Act 1992*. Australia has obligations under the Convention on Migratory Species to take "appropriate and necessary steps to conserve migratory species the conservation status of which is unfavourable". The Commonwealth Environment Protection and Biodiversity Conservation Act (1999) includes dugongs as "listed migratory species" and "listed marine species", both of which are considered matters of national environmental significance under the act. The conservation and management plan for the dugong (Environmental Protection Agency Queensland 1999) states that it will "introduce controls in marine parks or liaise with the Department of Transport to restrict speed limits where necessary outside marine parks". If nothing is done by the Queensland Government to address the problem of dugong mortality from vessel strike, experience in the United States suggests that nature conservation and animal rights NGOs will resort to litigation in an attempt to force the government to address the issue. In addition, it will be difficult for the Queensland Government to convince other stakeholders such as

Indigenous peoples and commercial fishers to reduce the number of dugongs they kill, if they perceive that nothing is being done to address mortality caused by the vessel strike. We reject the 'do nothing' option for these reasons.

### 3. Introduce go-slow zones

The risk of vessel strikes to dugongs may be reduced significantly by the introduction of relatively small areas where vessel speeds are reduced. At a recent workshop on Dugong and Turtle Tourism in Townsville on May 22 and 23 2004, the operators of vessels involved in dugong tourism in Queensland and Western Australia advised that they considered that an appropriate speed to reduce the risk of vessel strike on dugongs was 4-5 knots.

We consider that if this speed restriction were imposed on all vessels using the area from the southern end of Garden Island to 2km eastward and to slightly south of the northern end of Long Island, the risk of dugong mortality from vessel strike would be substantially reduced.

Clearly the stakeholder most affected by such a measure would be the ferry company. A rudimentary examination shows that imposing such a go-slow zone would result in an increase of approximately 10 minutes in the travel time each way. Given the likely increase in cost of this impost, we suggest that the QPWS should consider employing an expert in Operations Research to work with the ferry company to optimise ferry services to minimise the cost of the 'go-slow' zone on the ferry company. Dr John Belward, Honorary Reader in the Mathematics at the University of Queensland has indicated to us that he would be unable to undertake this work but could provide the names of mathematicians with the required expertise. The introduction of such a go-slow zone should be accompanied by an appropriate public education campaign.

#### **We recommend that:**

- (1) The Queensland Parks and Wildlife Service work negotiate with the Queensland Department of Transport to introduce a go-slow area with a speed limit of 4-5 knots for all vessels in the area bounded by 153<sup>o</sup>20.75'E to 153<sup>o</sup>22.22'E and 27<sup>o</sup>37.97'S to 27<sup>o</sup>39.49'S**
- (2) The Queensland Parks and Wildlife Service introduce on the spot fines for offenders who breach the go-slow restrictions.**
- (3) The Queensland Parks and Wildlife Service employ an expert in Operations Research to work with the ferry company to optimise ferry services to minimise the cost of the 'go-slow' zone on the ferry company.**
- (4) The Queensland Parks and Wildlife Service develop a public education campaign to educate the public about the risk to dugongs of vessel strikes and the need for go-slow areas.**

### 4. Introduce compulsory vessel lanes

The Great Barrier Reef Marine Park Authority has introduced voluntary vessel lanes in the Hinchinbrook region in an attempt to reduce the risk of vessel strike. There is no evidence that these lanes work and compliance, particularly the compliance of recreational boaters, is low (Groom 2003). However, if vessel lanes can be made compulsory they may have some positive effect in this particular instance. We, and QPWS staff, have observed the passenger ferries cutting the channels at high tide and have found keel marks through seagrass beds, including seagrass beds where dugong feeding trails were sighted. Thus, risk of boat strike to dugongs at high tide may be

reduced by such a measure. However, they will not reduce boat strike risk in the lower parts of the tide because both dugongs and boats are physically constrained to the channels at these times, regardless of any regulation. Compulsory vessel lanes in the 'Area of Interest' should therefore be considered, but they are unlikely to be sufficient in isolation of other measures.

**We recommend that:**

- (5) The Queensland Parks and Wildlife Service negotiate with the Queensland Department of Transport to introduce compulsory vessel transit lanes in the 'Area of interest' in association with a go-slow area.**

5. Make propeller guards compulsory

Propeller guards should reduce deaths from propeller cuts and may reduce the risk of dugongs being killed by ferries. However, given that the Florida experience suggests that a significant proportion of injuries will be from blunt trauma, making propeller guards mandatory for all vessels using the area may introduce a sense of complacency and reduce compliance with speed restrictions. If compulsory propeller guards are introduced, we recommend that they be restricted to the ferries and be accompanied by mandatory speed restrictions.

**We recommend that:**

- (6) The Queensland Parks and Wildlife Service negotiate with the Queensland Department of Transport to introduce compulsory propeller guards for the ferries in association with a go-slow area.**

6. Replace the ferries with vessels such as hovercraft which do not project into the water.

Manufacturers claim that a 'well-designed hovercraft is superior to a boat because it has less drag and requires less horsepower and fuel to operate'. Rising fuel prices may increase the financial viability of hovercraft which travel above the surface of the water with no concern for depth or hidden obstacles. Replacing the ferries with hovercraft is a long-term option that should greatly reduce the risk of dugong mortality from vessel-strike in the area of interest.

**We recommend that:**

- (7) The Queensland Parks and Wildlife Service negotiate with the Queensland Department of Transport to investigate the efficacy of using hovercraft on the ferry routes traversing the area of interest**
- (8) That if it is cost-effective to use hovercraft on these routes, the ferry company be required to replace their vessels with hovercraft over an agreed time-frame.**

## Research

While the data presented here are sufficient to demonstrate the clear need for management action to be implemented as a matter of urgency, they do not provide a complete understanding of the situation. The single field season does not provide any information on

the potential for seasonal or periodic shifts in distribution of dugong activity. We recommend that this study be repeated, with some modification, in late 2004.

In particular, we suggest it be modified as follows:

- Coverage of the broader study area should be reduced or abandoned to focus on the area of interest only, and perhaps only the subset of the region intersected by the path of the ferries. Increased resolution in this area may help to define the minimum effective area to implement go-slow zones.
- In practice we found the blimp-cam to be less effective than we had expected because of the high water turbidity in the study area. All dugongs seen were spotted without the blimp-cam. We would advise abandoning the use of the blimp-cam to reduce sampling times and associated costs, enabling us to intensify sampling without increasing expenditure.
- The increased coverage would also apply to seagrass mapping, to better describe the small-scale spatial variability in patches.

We do not recommend attempting to satellite track dugongs as we do not consider that it will add to the data obtained from the tagging study of Dr Lanyon. Dr Lanyon should be required to provide capture histories of the dugongs she tags to Queensland Parks and Wildlife Service in order to maximise the information obtained from tagged carcasses. It will be extremely difficult to catch dugongs in the 'Area of Interest'. The rodeo capture method that we employ would not work in this area because of the high turbidity. Thus the animals will have to be caught on the eastern banks with no guarantee that they will travel down to the 'Area of Interest'.

**We recommend that:**

- 1. This study be repeated in the second half of 2004 with some modification to the survey design to make it more cost-effective.**
- 2. The revised study include a study of currents in the study area to allow more effective determination of the likely site of a boat strike incident once a carcass is recovered.**
- 3. Dr Janet Lanyon be required to provide the Queensland Parks and Wildlife Service with the capture-history of the animals she captures and tags in Moreton Bay as a condition of her research permit to facilitate understanding of the movements of animals between the Eastern banks and the 'Area of Interest'.**

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