

FINAL REPORT

to the Great Barrier Reef Marine Park Authority

Seasonal distribution of the dugong in the southern Great Barrier Reef Marine Park.



Helene Marsh and Helen Penrose

Table of Contents

Executive Summary	1
Introduction	2
Methods	3
Results and Discussion	3
Options for further research	3
Acknowledgements	4
References	5
Personal Communications	7
List of Figures	
Figure A: Position of DPAs in the southern GBR	8
Figure 1: Position of dugong sightings relative to the Hinchinbrook DPAs and region zoning.	9
Figure 2: Position of dugong sightings relative to the Cleveland Bay and Bowling Green Bay DPAs and region zoning.	10
Figure 3: Position of dugong sightings relative to the Upstart Bay and Edgumbe Bay DPAs and region zoning.	11
Figure 4: Position of dugong sightings relative to the Repulse Bay and Newry region DPAs and region zoning.	12
Figure 5: Position of dugong sightings relative to the Ince/Llewellyn Bay and Clairview region DPAs and region zoning.	13
Figure 6: Position of dugong sightings relative to the Shoalwater Bay/Port Clinton DPA and region zoning.	14
Figure 7: Position of dugong sightings relative to the Rodds Bay DPAs and region zoning.	15
Figure 8: Position of dugong sightings relative to the Hervey Bay/Great Sandy Strait DPA and region zoning.	16
List of Tables	
Table 1: Summary of information available on dugong distribution and abundance for the DPA A zones.	17
Table 2: Summary of information available on dugong distribution and abundance for the DPA B zones.	18
Appendices	
Appendix 1(a): Details of the information available on dugong distribution for the Hinchinbrook DPA.	20
Appendix 1(b): Details of the information available on dugong distribution for the Cleveland Bay, Bowling Green Bay and Upstart DPAs.	23
Appendix 1(c): Details of the information available on dugong distribution for the Edgumbe Bay DPA.	28
Appendix 1(d): Details of the information available on dugong distribution for the Repulse Bay DPA.	29
Appendix 1(e): Details of the information available on dugong distribution for the Newry region DPA.	30
Appendix 1(f): Details of the information available on dugong distribution for the Llewellyn/Ince Bay DPA.	31
Appendix 1(g): Details of the information available on dugong distribution for the Clairview DPA.	32
Appendix 1(h): Details of the information available on dugong distribution for the Shoalwater Bay/Port Clinton DPA.	33
Appendix 1(i): Details of the information available on dugong distribution for the Rodds Bay DPA.	38
Appendix 1(j): Details of the information available on dugong distribution for the Hervey Bay/Great Sandy Strait DPA.	39

Seasonal distribution of the dugong in the southern Great Barrier Reef Marine Park.

Helene Marsh and Helen Penrose

School of Tropical Environment Studies and Geography,
James Cook University, Townsville, 4811.

Executive Summary

- The Australian and Queensland governments established a two-tiered system of Dugong Protection Areas (DPAs) in 1997. Gill and mesh netting are greatly restricted or banned in seven Zone A DPAs totalling 2,407km², and subject to lesser modifications in eight Zone B DPAs totalling 2,243km². An additional DPA A of 1703km², in which gill and mesh netting practices were modified, was established in Hervey Bay immediately south of the region.
- A rationale for these DPAs is that they support a significant proportion of dugongs in the southern Great Barrier Reef region throughout the year. This selection of the DPAs and their boundaries were based on the analysis of all available dugong distribution data. However, the analysis did not consider the time of year that the data were collected. Thus the ecological robustness of the rationale for the establishment of the DPAs is untested.
- We conducted this desk-top study compiling information on the distribution and abundance of dugongs in the inshore waters of the southern Great Barrier Reef region from a range of sources, including both dedicated shoreline and quantitative surveys, and incidental sightings.
- We conclude that the available data are generally inadequate to evaluate the seasonality of the distribution and abundance of dugongs in six of the DPA As (including Hervey Bay), and all eight of the DPA Bs. Nonetheless, we find no evidence of seasonal use of the Hinchinbrook and Cleveland Bay DPA A's where the information is more comprehensive.
- We suggest that conducting aerial surveys to determine whether there is seasonal variation in the use of DPAs by dugong be considered as part of a review of future arrangements for dugong aerial surveys in the Great Barrier Reef in mid 2001.

Introduction

A temporal series of aerial surveys (Marsh *et al.* 1996) indicated that the numbers of dugongs, *Dugong dugon*, in the southern Great Barrier Reef declined significantly between the mid 1980s and 1992-1994. This decline was observed over more than one thousand kilometres of coastline in the Great Barrier Reef World Heritage Area, from Innisfail to the southern border near Bundaberg. Anecdotal evidence suggests that this decline had been occurring for decades (Marsh *et al.* 1996). The reasons for this decline are complex and could include habitat loss and change, incidental drowning in both commercial and illegal gill nets and shark nets set for bather protection, and traditional hunting (Marsh *et al.* 1996). The relative importance of these impacts has not been quantified.

This decline threatened the World Heritage values of the Great Barrier Reef region. An explicit justification for the region's inclusion on the World Heritage List was the fact that it 'provides major feeding grounds for large populations of the endangered species, *Dugong dugon*', (GBRMPA 1981). In 1997, the Australian and Queensland governments agreed to several measures aimed at arresting this decline, including a resolution not to issue permits for the indigenous hunting of dugongs in the region south of Cooktown. The most controversial measure was to establish a two-tiered system of Dugong Protection Areas (DPAs). Gill and mesh netting are greatly restricted or banned in seven Zone A DPAs totalling 2,407km², and subject to lesser modifications in eight Zone B DPAs totalling 2,243km² (*Fisheries Regulation [No. 11] 1997 [Queensland]*). An additional DPA A of 1703km², in which gill and mesh netting practices were modified, was established in Hervey Bay, immediately south of the region (Marsh 2000).

Satellite tracking studies show that individual dugongs are very variable in their movements. Some individuals are relatively sedentary while others move hundreds of kilometres in a few days (Marsh *et al.* 1999). Recent analysis of Dr Tony Preen's data, shows that more than half of all tagged dugongs moved over 80km in a couple of months, with one moving over a total of more than 800km of coastline (Preen 1999, 2001). Thus individual dugongs will generally not remain in single DPAs. Rather, the rationale for these Areas is that they support a significant proportion of dugongs in the southern Great Barrier Reef region throughout the year. The selection of the DPAs and their boundaries were based on the analysis of all available dugong distribution data presented by Preen & Morissette (1997). However, their analysis did not consider the time of year that the data were collected. Thus the ecological robustness of the rationale for the establishment of the DPAs is untested.

Methods to estimate the distribution and relative abundance of dugongs at regional scales using aerial survey techniques are well-established (Marsh & Saalfeld 1989; Marsh & Sinclair 1989). It would be possible to study the seasonal distribution of dugongs by conducting dedicated aerial surveys of each DPA several times per year. This approach has several disadvantages:

- expense
- difficulty in finding the necessary weather window at most times of the year
- resultant information providing only one or two snapshots of the seasonal distribution of dugongs in the southern Great Barrier Reef region.

The Great Barrier Reef Marine Park Authority (GBRMPA) commissioned this desk-top study as an alternative. We compiled information on the distribution and abundance of dugongs in the inshore waters of the southern Great Barrier Reef region from a range of sources including both dedicated surveys and incidental sightings.

We conclude that the available data are generally inadequate to evaluate the seasonality of the distribution and abundance of dugongs in six of the DPA As (including Hervey Bay) and all eight of the DPA Bs. Nonetheless, we find no evidence of seasonal use for the Hinchinbrook and Cleveland Bay DPA As, where the information is more comprehensive.

Methods

As summarised in Tables 1 and 2 and Appendices 1(a) to (j), information on dugong distribution and abundance was compiled from the following sources:

- regional-scale quantitative aerial surveys conducted since the mid 1980s
- qualitative (shoreline) surveys conducted in the 1970s
- several series of local scale surveys conducted at intervals of weeks/months in the Shoalwater Bay and Cleveland Bay, Bowling Green Bay and Hinchinbrook regions
- incidental sightings.

The survey data were coded by season as follows:

Wet:	December through to February
Post-Wet	March through to May
Dry	June through to August
Pre-Wet	September through to November.

Results and Discussion

The data available for the various DPAs were extremely variable in extent and quality (see Tables 1 and 2) and reflected the influence of north Queensland weather on the timing of marine mammal surveys (resulting from the impact of weather conditions on sight-ability). The data are in several forms that are not comparable. Data from shoreline surveys and incidental sightings are uncorrected counts. The shoreline survey data result from a comprehensive coverage of the inshore waters of each DPA (generally from the shoreline out to about 1km). The incidental data are reports of actual sightings only; negative sightings are not reported. Thus the capacity of incidental data to indicate seasonal trends in distribution and abundance is questionable. The data from the quantitative surveys are the least biased, resulting from systematic transect surveys of the entire area of each DPA. However, the aerial survey blocks for which the resultant population estimates were calculated generally do not correspond exactly with the DPA boundaries (Figure A), making the data for the small sized DPAs difficult to extract. *Available* dugong distribution data within DPAs is illustrated in Figures 1 to 8. These maps have not been corrected for survey effort.

Wet season data were unavailable for one DPA A zone and three DPA B zones and were limited to incidental sightings in one DPA B. Post-Wet season data were available for all DPA As but only four DPA Bs, and limited to incidental sightings for two DPA As and three DPA Bs. Dry season data were available for seven DPA As and six DPA Bs but limited to incidental sightings for one DPA A and two DPA Bs. The best data were available for the Pre-Wet season when most of the dedicated dugong surveys have been conducted.

Reasonably comprehensive seasonal data were available only for the Hinchinbrook and Cleveland DPAs (Table 1). There was no evidence of seasonal patterns in the occurrence of dugongs in either of these Areas.

Options for Further Research

We conclude that the only way to confirm whether or not the use of DPAs by dugongs is seasonally-biased would be to conduct a dedicated series of surveys in each season over several years. This option would be extremely expensive and operationally difficult given the

strict weather conditions required for dugong aerial surveys (Beaufort Sea State ≤ 3 , cloud cover ≤ 4 (Marsh & Sinclair 1989)).

Recent data from Western Australia (Gales *pers comm.* 2000), Torres Strait (Marsh *et al.* 1997), the southern Great Barrier Reef (Marsh & Lawler 2001) and Hervey Bay (Preen & Marsh 1995; Marsh & Lawler 2001) suggest that variations in the patterns of dugong distribution reflect movements of dugongs over large spatial scales. The reasons for such movements are poorly understood. We hypothesise that they are responses to the destruction and development of seagrass beds caused by extreme weather events. *Halophila*, a genus that is a preferred food of dugongs, appears to be particularly sensitive to light reduction. The duration and frequency (and probably timing) of light-deprivation events such as plumes of muddy freshwater appear to be the primary factors affecting the survival of seagrasses of this genus in environments that experience transient light deprivation (Longstaff *et al.* 1999). Members of the genus *Halophila* occur at greater depths than other species of tropical seagrasses and this sensitivity to light reduction is a plausible explanation of the large-scale loss of deep-water seagrasses in Torres Strait (Poiner & Peterken 1996) and Hervey Bay (Preen *et al.* 1995). In contrast, inputs of freshwater apparently stimulate germination in shallow water meadows of *Halodule uninervis* (Inglis *pers comm.* 2000). We conclude that the responses of seagrass beds to extreme weather events is complex and probably a much more important influence on dugong distribution than seasonal environmental changes *per se*.

Given this unpredictability, the present strategy of having a comprehensive series of DPAs is justified. However, we suggest that the likely temporal variation in the distribution and abundance of seagrass meadows in the inshore waters of the Great Barrier Reef region should be taken into account in developing strategies for dugong conservation. The activities of 'Seagrass Watch', the community-based seagrass monitoring program coordinated by the Queensland Department of Primary Industries, will be central to providing information on changes in the distribution and abundance of seagrasses. The efficacy of the DPA Bs in reducing dugong mortality in commercial gill nets is uncertain (Marsh 2000). Given this uncertainty, it would be prudent for the GBRMPA to have the capacity to alter the zoning status of selected DPA Bs quickly in the event of widespread destruction of the seagrass in the two key DPA As- Hinchinbrook and Shoalwater Bay/Port Clinton (Marsh 2000).

The quantitative aerial survey that covered both the northern and southern regions of the Great Barrier Reef simultaneously in late 2000, has provided further insights into the changing pattern of dugong distribution in the Great Barrier Reef Marine Park (see Marsh & Lawler 2001). We therefore suggest that future arrangements for aerial surveys of dugongs in the Great Barrier Reef region be formally reviewed in mid 2001.

Acknowledgements

Most of the surveys on which this report is based were funded by the Great Barrier Reef Marine Park Authority, who also funded this desk-top study. Staff from the Environmental Protection Agency, Queensland Parks and Wildlife Service, Queensland Department of Primary Industries and the Capricorn Community Dugong Watch provided access to their incidental sightings data. Maps were created by James Moloney of the School of Tropical Environment Studies and Geography, James Cook University.

References

- Anderson, P.K. and Birtles, A. 1978. Behaviour and ecology of the dugong, *Dugong dugon* (Sirenia): observations in Shoalwater and Cleveland Bays, Queensland. *Australian Wildlife Research* 5: 1-23.
- GBRMPA (Great Barrier Reef Marine Park Authority). 1981. Nomination of the Great Barrier Reef by the Commonwealth for Inclusion in the World Heritage List. Great Barrier Reef Marine Park Authority, Townsville, Australia.
- Heinsohn, G.E. 1975. Aerial surveys of northern Australian waters. 1975 and 1976 Reports to Department of the Environment, Canberra, Australia.
- Heinsohn, G.E. 1976. Ecology and conservation of the dugong, (*Dugong dugon*) in Australia. Report on Project supported by Department of Environment, Housing and Community Development, Canberra, Australia. December 1976.
- Heinsohn, G.E. and Marsh, H. 1980. Ecology and conservation of the dugong, (*Dugong dugon*) in Australia. Unpublished Report to Australian National Parks and Wildlife Service.
- Ligon, S.H. 1975. A survey of dugongs (*Dugong dugon*) in Queensland. *Journal of Mammalogy* 75(3): 580-582.
- Longstaff, B.J., Loneragan, N.R., O'Donohue, M.J. and Dennison, W.C. 1999. Effects of light deprivation on the survival and recovery of the seagrass *Halophila ovalis* (R.Br.) Hook. *Journal of Experimental Marine Biology and Ecology* 234: 1-27.
- Marsh, H. 1987. Development and application of VHF and satellite tracking methodology for dugongs and results of aerial surveys for dugongs and sea turtles in the Great Barrier Reef Marine Park. Unpublished Report to the Great Barrier Reef Marine Park Authority, Townsville, Australia.
- Marsh, H. 1989. Biological basis for managing dugongs and other large vertebrates in the Great Barrier Reef Marine Park. Vol. 3: Papers on movements and habitat usage, traditional hunting and incidental sightings. Unpublished Report to the Great Barrier Reef Marine Park Authority, Townsville, Australia.
- Marsh, H. 2000. Evaluating management initiatives aimed at reducing the mortality of dugongs in gill and mesh nets in the Great Barrier Reef World Heritage Area. *Marine Mammal Science* 16(2): 684-694.
- Marsh, H. & Heinsohn, G.E. 1979. Report of the Aerial Survey Workshop on Dugongs. James Cook University, Townsville, Australia.
- Marsh, H. and Saalfeld, W.K. 1989. The distribution and abundance of dugongs in the northern Great Barrier Reef Marine Park. *Australian Wildlife Research* 17: 83-100.
- Marsh, H. and Sinclair, D.F. 1989. An experimental evaluation of dugong and sea turtle aerial survey techniques. *Australian Wildlife Research* 16: 639-50.
- Marsh, H. and Lawler, I. 2001. Dugong distribution and abundance in the southern Great Barrier Reef Marine Park and Hervey Bay: results of an aerial survey in October-December 1999. Report to the Great Barrier Reef Marine Park Authority, Townsville, Australia.
- Marsh, H., Corkeron, P., Lawler, I.R., Lanyon, J. and Preen, A.R. 1996. *The status of the dugong in the southern Great Barrier Reef Marine Park*. Great Barrier Reef Marine Park Authority Research Publication No.41.

- Marsh, H., Harris, A.N.M. and Lawler, I.R. 1997. The sustainability of the indigenous dugong fishery in Torres Strait, Australia/Papua New Guinea. *Conservation Biology* 11: 1375-86.
- Marsh, H., Eros, C., Corkeron, P. and Breen, B. 1999. A conservation strategy for dugongs: implications of Australian research. *Marine and Freshwater Research* 50: 979-90.
- Poiner, I.R. and Peterken, C. 1996. Seagrasses. In: *The State of the Marine Environment Report for Australia. Technical Annex: 1* (Eds L.P. Zann & P. Kailola). Great Barrier Reef Marine Park Authority, Townsville, Australia.
- Preen, A.R. 1999. Dugongs in the Shoalwater Bay area. Draft Report to the Great Barrier Reef Marine Park Authority, Townsville, Australia.
- Preen, A.R. 2001. Dugongs, boats, dolphins and turtles in the Townsville-Cardwell Region and recommendations for a boat traffic management plan for the Hinchinbrook Dugong Protection Area. Report to the Great Barrier Reef Marine Park Authority, Townsville, Australia.
- Preen, A.R. and Marsh, H. 1995. Response of dugongs to large-scale loss of seagrass from Hervey Bay, Queensland. *Wildlife Research* 22: 507-19.
- Preen, A.R., Lee Long, W.J. and Coles, R.G. 1995. Flood and cyclone-related loss and partial recovery of more than 1000km² of seagrass in Hervey Bay, Queensland, Australia. *Aquatic Botany* 52: 3-17.
- Preen, A. and Morissette, N. 1997. A system of dugong sanctuaries for the recovery and conservation of dugong populations in the Great Barrier Reef World Heritage Area and adjacent southern waters. Report to the Great Barrier Reef Marine Park Authority, Townsville, Australia.
- Wake, J.A. 1975. A study of the habitat requirements and feeding biology of the dugong (*Dugong dugon*). BSc. Thesis, James Cook University, Australia.

Personal Communications

Chapman, Felicity
Technical Officer
Environmental Protection Agency
Cardwell (Northern region)
Australia

Gales, Nick
Principle Research Scientist
Department of Conservation and Land Management (CALM)
Western Australia

Griffiths, Andrew
Conservation Officer
Queensland Parks and Wildlife Service
Airlie Beach (Central region)
Australia

Inglis, Graeme
Formerly of the School of Tropical Environment Studies and Geography
James Cook University
Townsville, Australia

McKenzie, Len
Senior Research Scientist
Department of Primary Industries
Cairns, Australia

Mulville, Cameron
Shipmaster
Queensland Parks and Wildlife
Marine Parks Section (Central Coastal Region)
Australia

O'Brien, Pat
Wildlife Preservation Society of Queensland (Central Region)
"Capricorn Community Dugong Watch"

Preen, Tony
Formerly of the School of Tropical Environment Studies and Geography
James Cook University
Townsville, Australia

Savage, David
Senior Conservation Officer
Marine Parks Section
Queensland Parks and Wildlife Service
Townsville, Australia

Figure A:

Position of Dugong Protection Areas in the southern Great Barrier Reef.

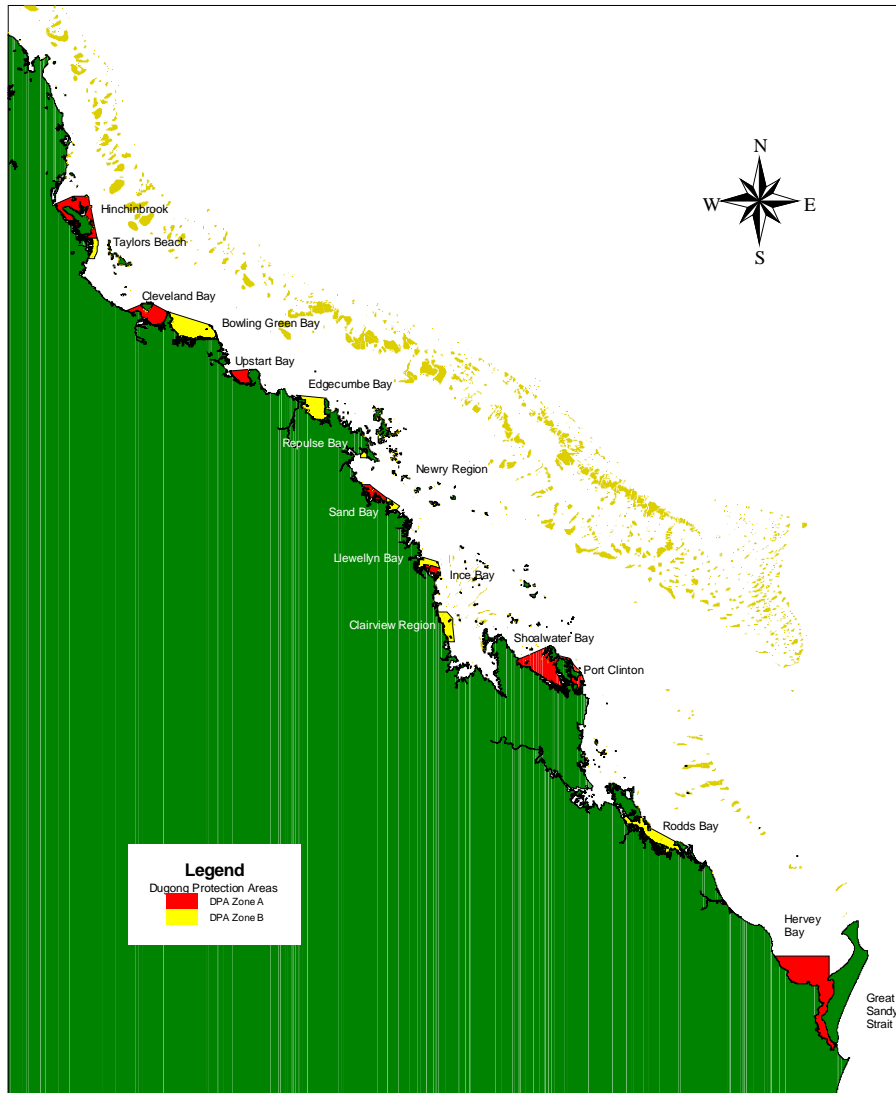


Figure 1: Positions of dugong sightings relative to the Hinchinbrook Dugong Protection Areas and region zoning.

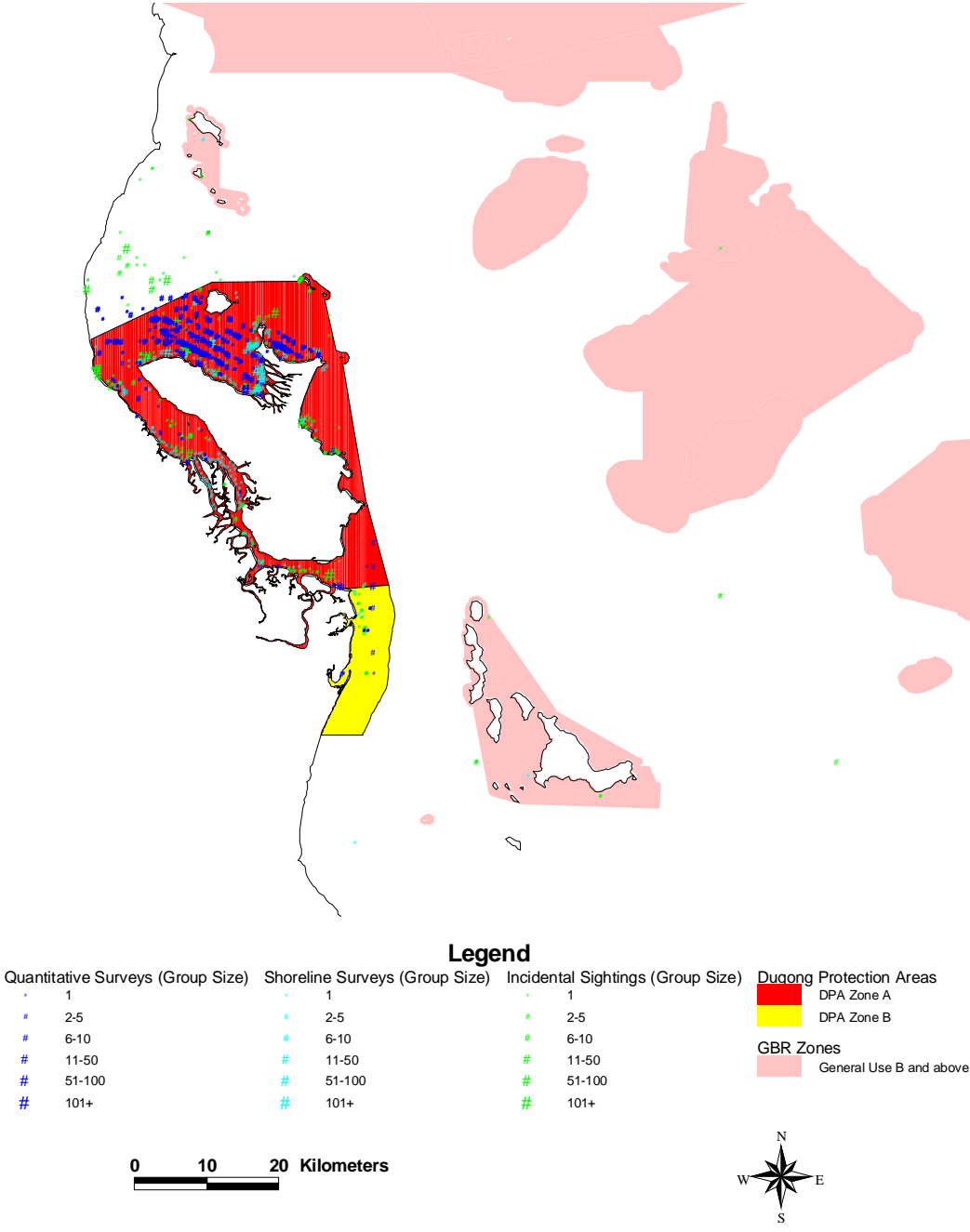


Figure 2: Positions of dugong sightings relative to the Cleveland Bay and Bowling Green Bay Dugong Protection Areas and region zoning.

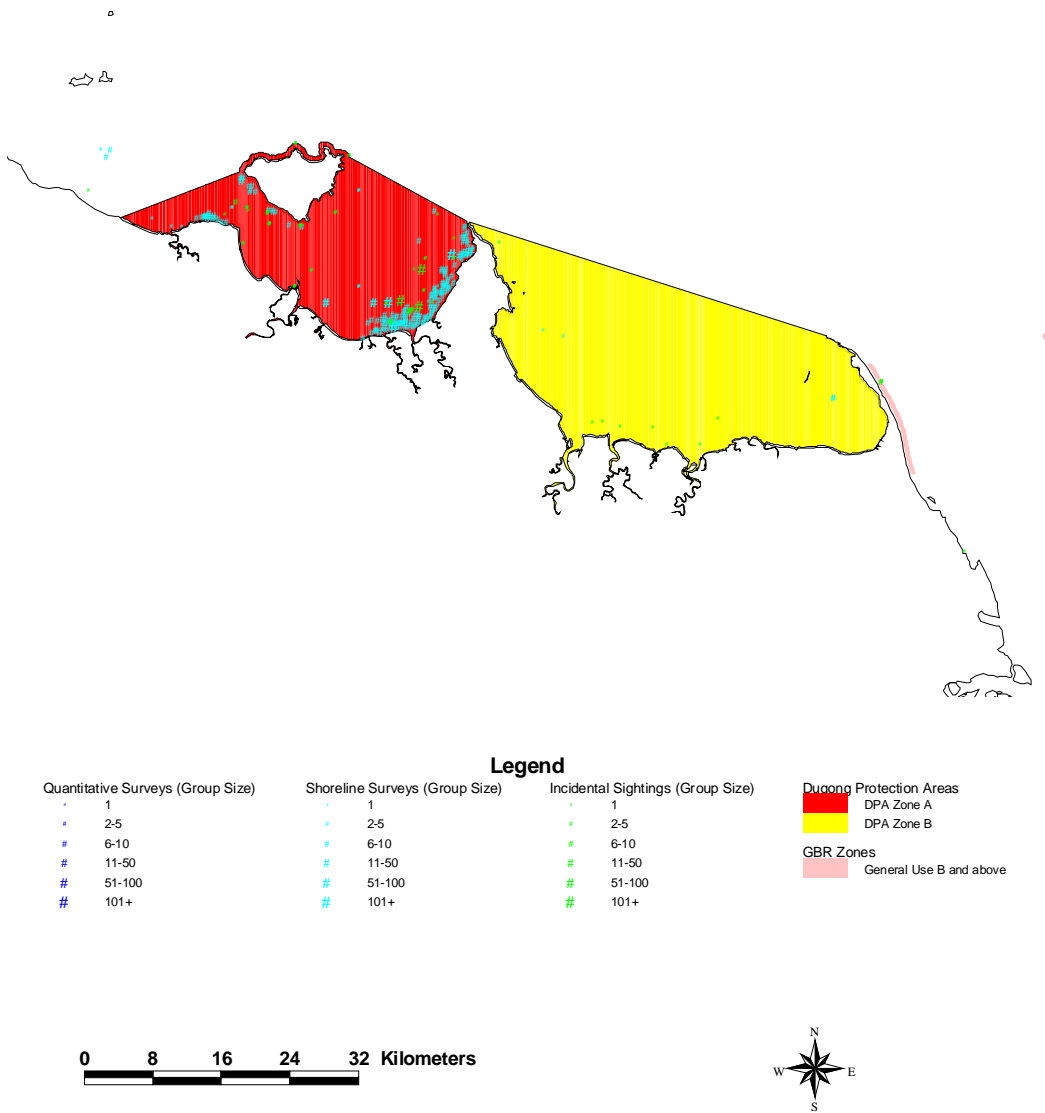
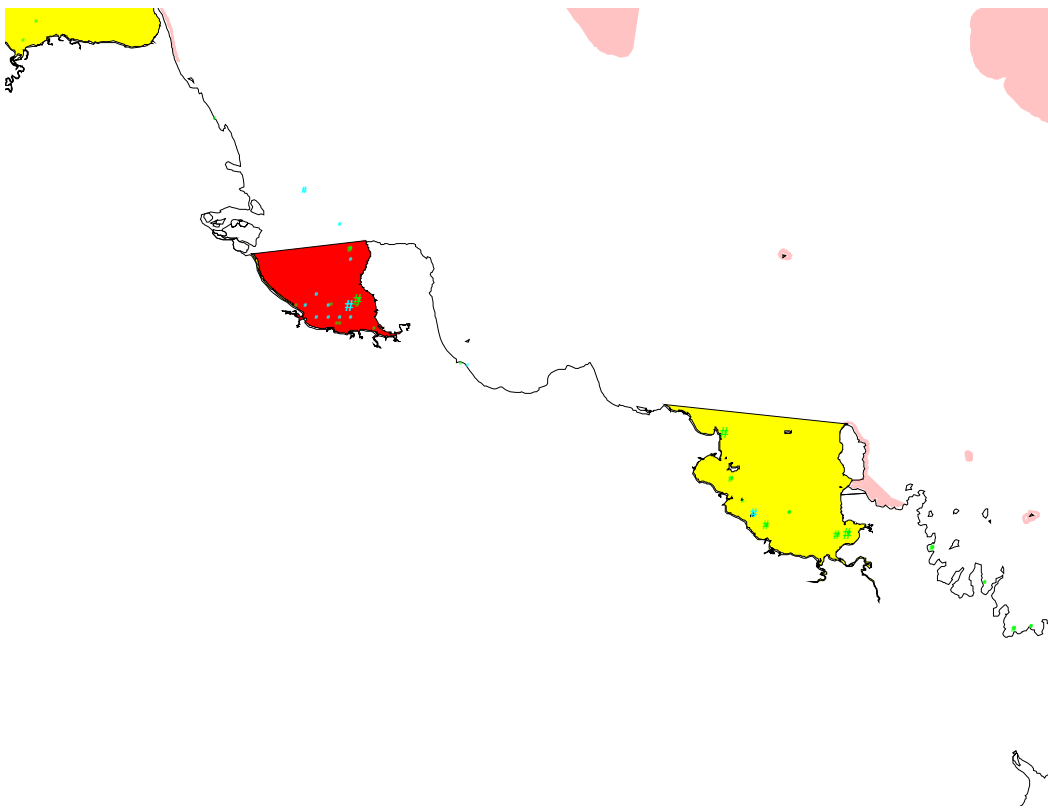


Figure 3: Positions of dugong sightings relative to the Upstart Bay and Edgecumbe Bay Dugong Protection Areas and region zoning.



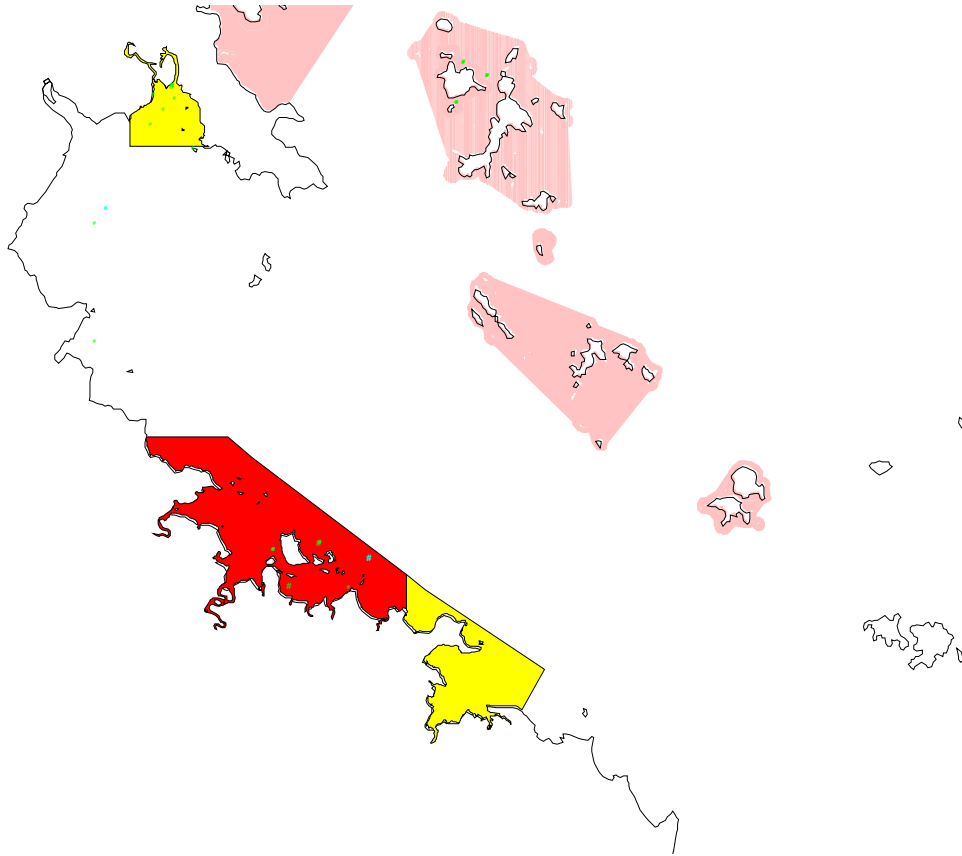
Legend

Quantitative Surveys (Group Size)	Shoreline Surveys (Group Size)	Incidental Sightings (Group Size)	Dugong Protection Areas
• 1	• 1	• 1	■ DPA Zone A
• 2-5	• 2-5	• 2-5	■ DPA Zone B
# 6-10	# 6-10	# 6-10	■ GBR Zones
# 11-50	# 11-50	# 11-50	■ General Use B and above
# 51-100	# 51-100	# 51-100	
# 101+	# 101+	# 101+	

0 10 20 Kilometers



Figure 4: Positions of dugong sightings relative to the Repulse Bay and Newry region Dugong Protection Areas and region zoning.



Legend

Quantitative Surveys (Group Size)	Shoreline Surveys (Group Size)	Incidental Sightings (Group Size)	Dugong Protection Areas
• 1	• 1	• 1	 DPA Zone A
# 2-5	# 2-5	# 2-5	 DPA Zone B
# 6-10	# 6-10	# 6-10	GBR Zones
# 11-50	# 11-50	# 11-50	 General Use B and above
# 51-100	# 51-100	# 51-100	
# 101+	# 101+	# 101+	

0 8 16 Kilometers



Figure 5: Positions of dugong sightings relative to the Ince /Llewellyn Bays and Clairview region Dugong Protection Areas, and region zoning.

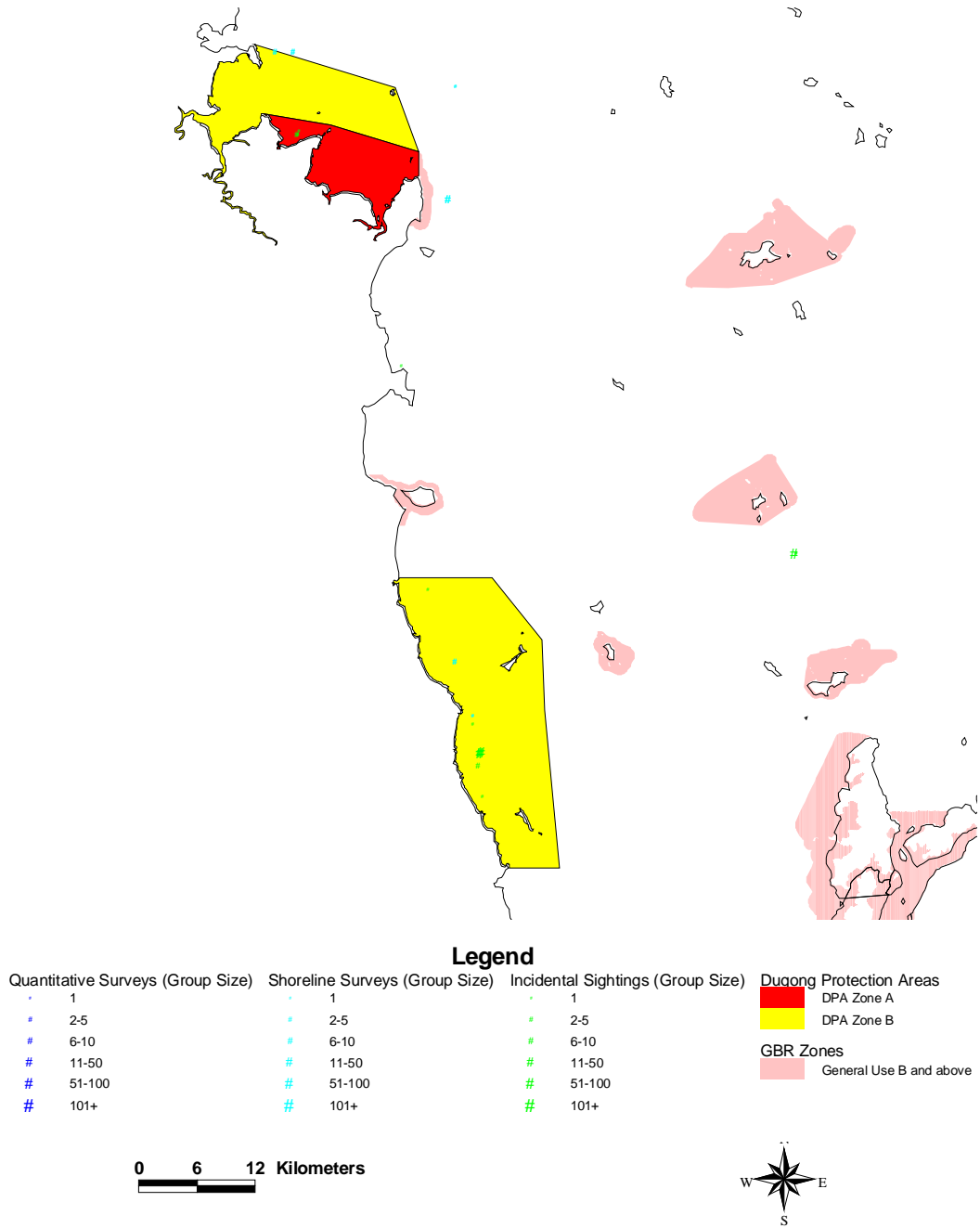


Figure 6: Positions of dugong sightings relative to the Shoalwater Bay/Port Clinton Dugong Protection Area and region zoning.

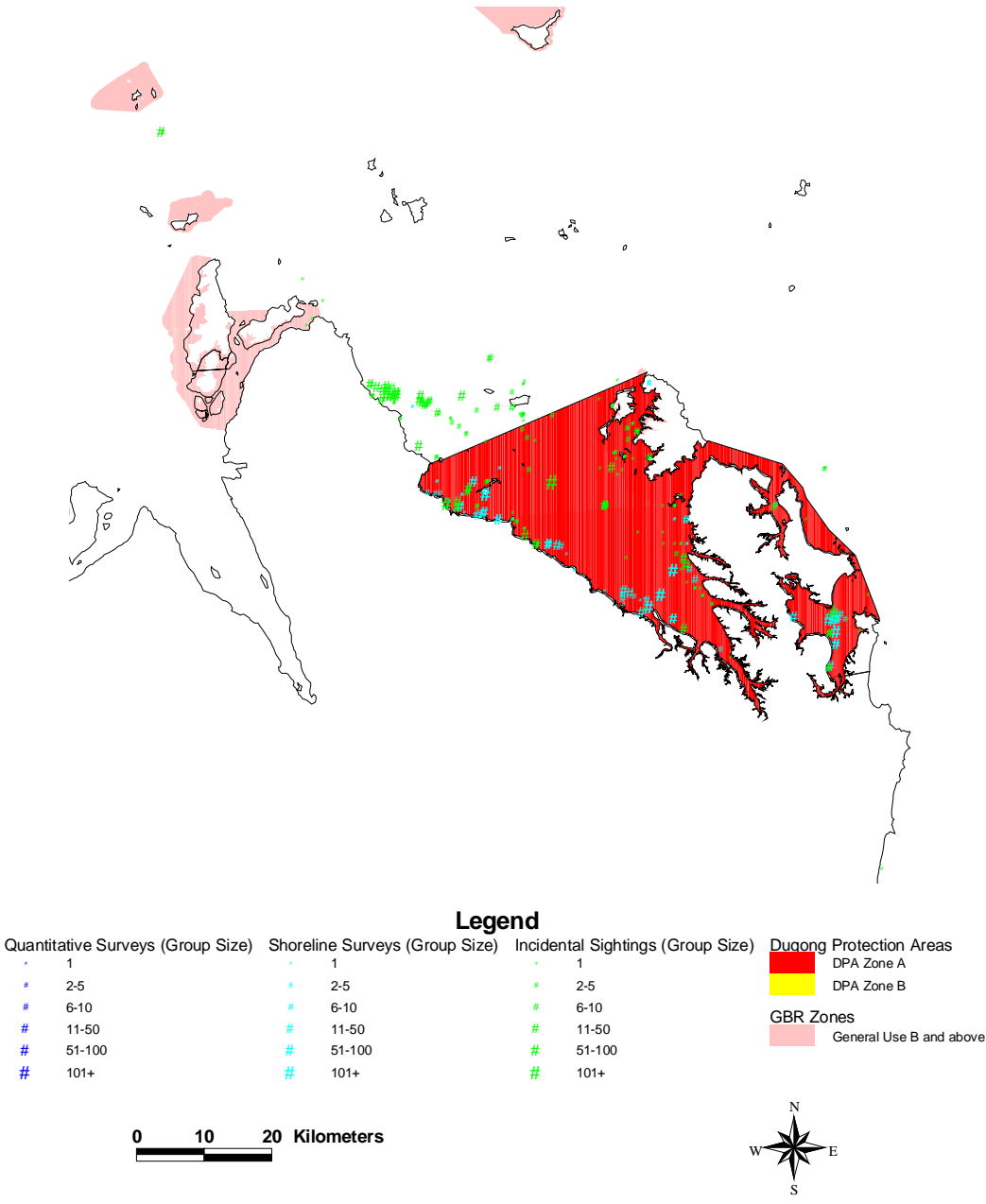
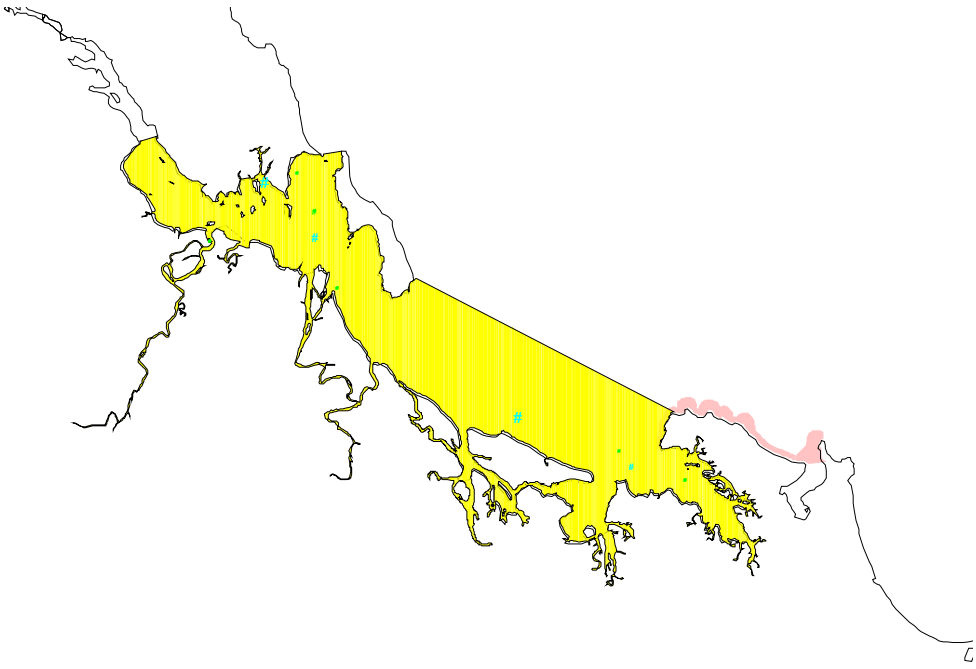


Figure 7: Positions of dugong sightings relative to the Rodds Bay Dugong Protection Area and region zoning.

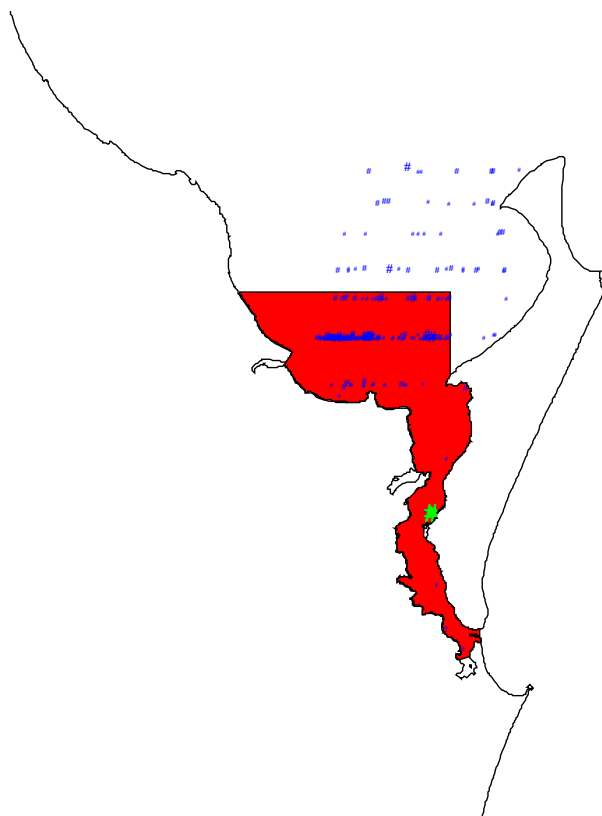


Legend

Quantitative Surveys (Group Size)	Shoreline Surveys (Group Size)	Incidental Sightings (Group Size)	Dugong Protection Areas
• 1	• 1	• 1	■ DPA Zone A
• 2-5	• 2-5	• 2-5	■ DPA Zone B
# 6-10	# 6-10	# 6-10	
# 11-50	# 11-50	# 11-50	GBR Zones
# 51-100	# 51-100	# 51-100	■ General Use B and above
# 101+	# 101+	# 101+	



Figure 8: Positions of dugong sightings relative to the Hervey Bay/Great Sandy Strait Dugong Protection Area and region zoning.



Legend

Quantitative Surveys (Group Size)	Shoreline Surveys (Group Size)	Incidental Sightings (Group Size)	Dugong Protection Areas
• 1	• 1	• 1	■ DPA Zone A
# 2-5	# 2-5	# 2-5	■ DPA Zone B
# 6-10	# 6-10	# 6-10	GBR Zones
# 11-50	# 11-50	# 11-50	■ General Use B and above
# 51-100	# 51-100	# 51-100	
# 101+	# 101+	# 101+	

0 20 40 Kilometers



Table 1: Summary of information available on dugong distribution and abundance for the Dugong Protection Areas A, and evaluations of (a) the capacity of this data to assess the seasonality of dugong distribution and abundance and (b) evidence for such seasonality.

DPA Type	A	A	A	A	A	A	A	A
Location	Hinchinbrook	Cleveland Bay	Upstart Bay	Newry region	Ince Bay	Shoalwater Bay	Port Clinton	Hervey Bay/Great Sandy Strait
Season 1 (WET: Dec-Feb)								
# Shoreline surveys	2	4	0	0	0	0	1	0
# Quantitative surveys	2	2	0	1	0	0	0	1
# Incidental sighting occasions	13	1	2	0	0	27	2	6
Season 2 (POST WET: Mar-May)								
# Shoreline surveys	1	5	1	0	0	2	2	3
# Quantitative surveys	3	3	0	0	0	0	0	0
# Incidental sighting occasions	6	10	4	1	1	10	4	0
Season 3 (DRY: June-Aug)								
# Shoreline surveys	0	5	0	0	1	6	5	4
# Quantitative surveys	1	1	0	0	0	1	1	1
# Incidental sighting occasions	6	19	1	0	1	16	5	1
Season 4 (PRE-WET: Sept-Nov)								
# Shoreline surveys	2	7	0	0	0	4	1	0
# Quantitative surveys	7	6	4	3	5	4	0	3
# Incidental sighting occasions	10	5	3	4	0	21	7	0
Capacity to assess seasonality								
<i>Shoreline surveys</i>	nil	moderate	nil	nil	nil	poor	nil	nil
<i>Quantitative surveys</i>	some	some	nil	nil	nil	nil	nil	nil
Evidence of seasonality								
<i>Shoreline surveys</i>	n/a	nil	n/a	n/a	n/a	nil	n/a	n/a
<i>Quantitative surveys</i>	nil	nil	n/a	n/a	n/a	n/a	n/a	n/a
Capacity to assess seasonality:								
	Shoreline surveys		Quantitative surveys					
<i>Nil</i>	0 or 1 survey in > 2 seasons		0 or 1 survey in > 2 seasons					
<i>Poor</i>	> nil < some		> nil < some					
<i>Some</i>	>= 2 surveys per season		>= 1 survey per season					
<i>Moderate</i>	> some < excellent		> some < excellent					
<i>Excellent</i>	> 2 surveys per season in a single year		> 2 surveys per season in a single year					
Evidence to assess seasonality:								
	If capacity = nil, evidence is n/a							
	If capacity > nil, evidence is evaluated							

Table 2: Summary of information available on dugong distribution and abundance for the Dugong Protection Areas B, and evaluation of (a) the capacity of this data to assess the seasonality of dugong distribution and abundance, and (b) evidence for such seasonality.

DPA Type	B	B	B	B	B	B
Location	Bowling Green Bay	Edgecumbe Bay	Repulse Bay	Llewellyn	Clairview	Rodds Bay
Season 1 (WET: Dec-Feb)						
# Shoreline surveys	1	0	0	0	0	0
# Quantitative surveys	0	1	0	0	0	0
# Incidental sighting occasions	0	1	2	0	0	0
Season 2 (POST WET: Mar-May)						
# Shoreline surveys	2	0	0	0	0	0
# Quantitative surveys	0	0	0	0	0	0
# Incidental sighting occasions	3	0	1	1	4	0
Season 3 (DRY: June-Aug)						
# Shoreline surveys	2	0	1	1	0	2
# Quantitative surveys	0	0	0	0	0	0
# Incidental sighting occasions	3	2	1	1	2	0
Season 4 (PRE-WET: Sept-Nov)						
# Shoreline surveys	0	0	0	0	0	0
# Quantitative surveys	5	3	5	5	3	4
# Incidental sighting occasions	1	0	4	0	1	2
Capacity to assess seasonality						
<i>Shoreline surveys</i>	nil	nil	nil	nil	nil	nil
<i>Quantitative surveys</i>	nil	nil	nil	nil	nil	nil
Evidence of seasonality						
<i>Shoreline surveys</i>	n/a	n/a	n/a	n/a	n/a	n/a
<i>Quantitative surveys</i>	n/a	n/a	n/a	n/a	n/a	n/a

Table 2 (continued): Summary of information available on dugong distribution and abundance for the Dugong Protection Areas B, and evaluation of (a) the capacity of this data to assess the seasonality of dugong distribution and abundance, and (b) evidence for such seasonality.

<u>Capacity to assess seasonality:</u>					
	Shoreline surveys	Quantitative surveys			
<i>Nil</i>	0 or 1 survey in > 2 seasons	0 or 1 survey in > 2 seasons			
<i>Poor</i>	> nil < some	> nil < some			
<i>Some</i>	>/= 2 surveys per season	>/= 1 survey per season			
<i>Moderate</i>	> some < excellent	> some < excellent			
<i>Excellent</i>	> 2 surveys per season in a single year	> 2 surveys per season in a single year			
<u>Evidence to assess seasonality:</u>					
	If capacity = nil, evidence is n/a				
	If capacity > nil, evidence is evaluated				

Appendix 1 (a): Details of the information available on dugong distribution and abundance for the Hinchinbrook Dugong Protection Area.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
23.02.76	1	Hinchinbrook	A	Shoreline survey	2		Heinsohn (1976)
09.02.99	1	Hinchinbrook		Shoreline survey	40		Savage (<i>pers comm.</i> 2000)
Dec. 1997	1	Hinchinbrook	A	Quantitative		448 \pm 175	Preen (1999)
Feb. 1998	1	Hinchinbrook	A	Quantitative		306 \pm 108	Preen (1999)
25.01.78	1	Hinchinbrook	A	Incidental/unknown	4		Marsh (1989)
05.01.89	1	Hinchinbrook	A	Incidental/shore	1		Chapman & Savage (<i>pers comm.</i> 2000)
11.12.89	1	Hinchinbrook	A	Incidental/shore	1		Chapman & Savage (<i>pers comm.</i> 2000)
04.01.90	1	Hinchinbrook	A	Incidental/shore	1		Chapman & Savage (<i>pers comm.</i> 2000)
02.01.91	1	Hinchinbrook	A	Incidental/shore	1		Chapman & Savage (<i>pers comm.</i> 2000)
02.12.91	1	Hinchinbrook	A	Incidental/shore	1		Chapman & Savage (<i>pers comm.</i> 2000)
30.12.91	1	Hinchinbrook	A	Incidental/shore	3		Chapman & Savage (<i>pers comm.</i> 2000)
28.12.95	1	Hinchinbrook	A	Incidental/shore	1		Chapman & Savage (<i>pers comm.</i> 2000)
11.12.96	1	Hinchinbrook	A	Incidental/boat	2		Chapman & Savage (<i>pers comm.</i> 2000)
12.12.96	1	Hinchinbrook	A	Incidental/boat	3		Chapman & Savage (<i>pers comm.</i> 2000)
04.12.97	1	Hinchinbrook	A	Incidental/boat	1		Chapman & Savage (<i>pers comm.</i> 2000)
19.12.97	1	Hinchinbrook	A	Incidental/unknown	1		McKenzie (<i>pers comm.</i> 2000)
09.02.99	1	Hinchinbrook		Incidental/boat	19		Chapman & Savage (<i>pers comm.</i> 2000)
11-13.04.75	2	Hinchinbrook	A	Shoreline survey	1		Wake (1975)
Apr. 1997	2	Hinchinbrook	A	Quantitative		483 \pm 164	Preen (1999)
May-97	2	Hinchinbrook	A	Quantitative		312 \pm 154	Preen (1999)
Apr. 1998	2	Hinchinbrook	A	Quantitative		327 \pm 132	Preen (1999)
11.04.74	2	Hinchinbrook	A	Incidental/unknown	31		Marsh (1989)
09.04.89	2	Hinchinbrook	A	Incidental/shore	3		Chapman & Savage (<i>pers comm.</i> 2000)
25.05.89	2	Hinchinbrook	A	Incidental/boat	1		Chapman & Savage (<i>pers comm.</i> 2000)

Appendix 1 (a) continued: Details of the information available on dugong distribution and abundance for the Hinchinbrook Dugong Protection Area.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
02.03.99	2	Hinchinbrook	A	Incidental/boat	2		Chapman & Savage (<i>pers comm. 2000</i>)
29.04.99	2	Hinchinbrook	A	Incidental/boat	1		Chapman & Savage (<i>pers comm. 2000</i>)
05.03.00	2	Hinchinbrook	A	Incidental/shore	1		Chapman & Savage (<i>pers comm. 2000</i>)
Aug. 1997	3	Hinchinbrook	A	Quantitative		1186 \pm 458	Preen (1999)
20.08.78	3	Hinchinbrook	A	Incidental/unknown	3		Marsh (1989)
29.08.89	3	Hinchinbrook	A	Incidental/shore	1		Chapman & Savage (<i>pers comm. 2000</i>)
07.07.98	3	Hinchinbrook	A	Incidental/boat	21		Chapman & Savage (<i>pers comm. 2000</i>)
01.07.99	3	Hinchinbrook	A	Incidental/aircraft	2		Chapman & Savage (<i>pers comm. 2000</i>)
07.07.99	3	Hinchinbrook	A	Incidental/shore	1		Chapman & Savage (<i>pers comm. 2000</i>)
24.07.99	3	Hinchinbrook	A	Incidental/shore	4		Chapman & Savage (<i>pers comm. 2000</i>)
03.11.74	4	Hinchinbrook	A	Shoreline survey	34		Heinsohn (1975)
05.09.79	4	Hinchinbrook	A	Shoreline survey	8		Heinsohn & Marsh (1980)
Sept. 1986	4	Hinchinbrook	A	Quantitative	23	340 \pm 74	Marsh (1989)
Nov. 1987	4	Hinchinbrook	A	Quantitative	17	184 \pm 110	Marsh <i>et al.</i> (1996)
Nov. 1992	4	Hinchinbrook	A	Quantitative		114 \pm 89	Marsh <i>et al.</i> (1996)
Nov. 1994	4	Hinchinbrook	A	Quantitative		377 \pm 154	Marsh <i>et al.</i> (1996)
Oct. 1997	4	Hinchinbrook	A	Quantitative		650 \pm 248	Preen (1999)
Oct. 1997	4	Hinchinbrook	A	Quantitative		653 \pm 211	Preen (1999)
Nov. 1999	4	Hinchinbrook	A	Quantitative	86	725 \pm 436	Marsh & Lawler (2001)
17.11.78	4	Hinchinbrook	A	Incidental/unknown	2		Marsh (1989)
12.11.87	4	Hinchinbrook	A	Incidental/unknown	45		Marsh (1989)
07.10.95	4	Hinchinbrook	A	Incidental/shore	1		Chapman & Savage (<i>pers comm. 2000</i>)
11.11.96	4	Hinchinbrook	A	Incidental/boat	1		Chapman & Savage (<i>pers comm. 2000</i>)
02.09.97	4	Hinchinbrook	A	Incidental/boat	1		Chapman & Savage (<i>pers comm. 2000</i>)
02.09.97	4	Hinchinbrook	A	Incidental/boat	1		Chapman & Savage (<i>pers comm. 2000</i>)
26.11.98	4	Hinchinbrook	A	Incidental/unknown	2		McKenzie (<i>pers comm. 2000</i>)

Appendix 1 (a) continued: Details of the information available on dugong distribution and abundance for the Hinchinbrook Dugong Protection Area.

Date	Sea son	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
01.09.99	4	Hinchinbrook	A	Incidental/jetty	20		Chapman & Savage (<i>pers comm. 2000</i>)
13.10.99	4	Hinchinbrook	A	Incidental/boat	2		Chapman & Savage (<i>pers comm. 2000</i>)
14.10.99	4	Hinchinbrook	A	Incidental/boat	15		Chapman & Savage (<i>pers comm. 2000</i>)

Appendix 1 (b): Details of the information available on dugong distribution and abundance for the Cleveland Bay, Bowling Green Bay and Upstart Dugong Protection Areas.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
19.12.74	1	Cleveland Bay	A	Shoreline survey	21		Heinsohn (1975)
20.01.75	1	Cleveland Bay	A	Shoreline survey	19		Heinsohn (1975)
17.02.75	1	Cleveland Bay	A	Shoreline survey	11		Heinsohn (1975)
25.01.78	1	Cleveland Bay	A	Shoreline survey	4		Marsh (1989)
Dec-97	1	Cleveland Bay	A	Quantitative		300 \pm 131	Preen (1999)
Feb. 1998	1	Cleveland Bay	A	Quantitative		381 \pm 90	Preen (1999)
25.01.78	1	Cleveland Bay	A	Incidental/unknown	2		Marsh (1989)
12.03.75	2	Cleveland Bay	A	Shoreline survey	22		Heinsohn (1975)
22.03.75	2	Cleveland Bay	A	Shoreline survey	4		Heinsohn (1975)
18.04.75	2	Cleveland Bay	A	Shoreline survey	3		Heinsohn (1975)
23.05.75	2	Cleveland Bay	A	Shoreline survey	1		Heinsohn (1975)
17.05.99	2	Cleveland Bay	A	Shoreline survey	15		Savage (<i>pers comm.</i> 2000)
Apr-97	2	Cleveland Bay	A	Quantitative		248 \pm 58	Preen (1999)
Mar. 1998	2	Cleveland Bay	A	Quantitative		177 \pm 60	Preen (1999)
Apr. 1998	2	Cleveland Bay	A	Quantitative		177 \pm 52	Preen (1999)
08.05.79	2	Cleveland Bay	A	Incidental/unknown	20		Marsh (1989)
03.03.99	2	Cleveland Bay	A	Incidental/boat	1		Parra (unpublished data)
03.03.99	2	Cleveland Bay	A	Incidental/boat	1		Parra (unpublished data)
04.03.99	2	Cleveland Bay	A	Incidental/boat	1		Parra (unpublished data)
04.03.99	2	Cleveland Bay	A	Incidental/boat	1		Parra (unpublished data)
04.03.99	2	Cleveland Bay	A	Incidental/boat	1		Parra (unpublished data)

Appendix 1 (b) continued: Details of the information available on dugong distribution and abundance for the Cleveland Bay, Bowling Green Bay and Upstart Dugong Protection Areas.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate ± S.E	Reference
04.03.99	2	Cleveland Bay	A	Incidental/boat	1		Parra (unpublished data)
15.05.99	2	Cleveland Bay	A	Incidental/aircraft	30		Chapman & Savage (<i>pers comm. 2000</i>)
15.05.99	2	Cleveland Bay	A	Incidental/boat	18		Chapman & Savage (<i>pers comm. 2000</i>)
27.05.99	2	Cleveland Bay	A	Incidental/boat	5		Parra (unpublished data)
30.06.75	3	Cleveland Bay	A	Shoreline survey	22		Heinsohn (1975)
24.07.75	3	Cleveland Bay	A	Shoreline survey	16		Heinsohn (1975)
20.08.75	3	Cleveland Bay	A	Shoreline survey	89		Heinsohn (1975)
28.06.77	3	Cleveland Bay	A	Shoreline survey	97		Heinsohn (1976)
25.08.99	3	Cleveland Bay	A	Shoreline survey	24		Savage (<i>pers comm. 2000</i>)
Jul-97	3	Cleveland Bay	A	Quantitative		400 ± 97	Preen (1999)
20.08.78	3	Cleveland Bay	A	Incidental/unknown	19		Marsh (1989)
09.06.99	3	Cleveland Bay	A	Incidental/aircraft	1		Chapman & Savage (<i>pers comm. 2000</i>)
15.06.99	3	Cleveland Bay	A	Incidental/boat	1		Parra (unpublished data)
29.06.99	3	Cleveland Bay	A	Incidental/boat	2		Parra (unpublished data)
29.06.99	3	Cleveland Bay	A	Incidental/boat	1		Parra (unpublished data)
29.06.99	3	Cleveland Bay	A	Incidental/boat	1		Parra (unpublished data)
30.06.99	3	Cleveland Bay	A	Incidental/boat	1		Parra (unpublished data)
01.07.99	3	Cleveland Bay	A	Incidental/aircraft	3		Chapman & Savage (<i>pers comm. 2000</i>)
01.07.99	3	Cleveland Bay	A	Incidental/aircraft	2		Chapman & Savage (<i>pers comm. 2000</i>)
01.07.99	3	Cleveland Bay	A	Incidental/aircraft	1		Chapman & Savage (<i>pers comm. 2000</i>)
12.07.99	3	Cleveland Bay	A	Incidental/boat	1		Parra (unpublished data)
12.07.99	3	Cleveland Bay	A	Incidental/boat	1		Parra (unpublished data)
12.07.99	3	Cleveland Bay	A	Incidental/aircraft	1		Chapman & Savage (<i>pers comm. 2000</i>)
17.07.99	3	Cleveland Bay	A	Incidental/boat	1		Chapman & Savage (<i>pers comm. 2000</i>)
02.08.99	3	Cleveland Bay	A	Incidental/aircraft	4		Chapman & Savage (<i>pers comm. 2000</i>)

Appendix 1 (b) continued: Details of the information available on dugong distribution and abundance for the Cleveland Bay, Bowling Green Bay and Upstart Dugong Protection Areas.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate ± S.E	Reference
20.08.99	3	Cleveland Bay	A	Incidental/boat	1		Chapman & Savage (<i>pers comm. 2000</i>)
22.08.99	3	Cleveland Bay	A	Incidental/boat	3		Chapman & Savage (<i>pers comm. 2000</i>)
27.08.99	3	Cleveland Bay	A	Incidental/boat	3		Parra (unpublished data)
29.08.99	3	Cleveland Bay	A	Incidental/shore	3		Chapman & Savage (<i>pers comm. 2000</i>)
19-27.09.74	4	Cleveland Bay	A	Shoreline survey	48		Heinsohn (1975)
09/10.74	4	Cleveland Bay	A	Shoreline survey	regularly to rarely seen		Wake (1975)
25.10.74	4	Cleveland Bay	A	Shoreline survey	18		Heinsohn (1975)
18.11.74	4	Cleveland Bay	A	Shoreline survey	74		Heinsohn (1975)
19.09.75	4	Cleveland Bay	A	Shoreline survey	15		Heinsohn (1975)
18.11.78	4	Cleveland Bay	A	Shoreline survey	15		Heinsohn & Marsh (1980)
05.09.79	4	Cleveland Bay	A	Shoreline survey	20		Heinsohn & Marsh (1980)
22.09.86	4	Cleveland Bay	A	Quantitative	25	375 ± 118	Marsh (1987)
Oct. 1987	4	Cleveland Bay	A	Quantitative		360 ± 92	Marsh <i>et al.</i> (1996)
Nov. 1992	4	Cleveland Bay	A	Quantitative		106 ± 56	Marsh <i>et al.</i> (1996)
Nov. 1994	4	Cleveland Bay	A	Quantitative		183 ± 29	Marsh <i>et al.</i> (1996)
Oct-97	4	Cleveland Bay	A	Quantitative		180 ± 39	Preen (1999)
Nov. 1999	4	Cleveland Bay	A	Quantitative	23	362 ± 157	Marsh & Lawler (2001)
17.11.78	4	Cleveland Bay	A	Incidental/unknown	14		Marsh (1989)
07.11.86	4	Cleveland Bay	A	Incidental/diving	3		Marsh (1989)
23.09.99	4	Cleveland Bay	A	Incidental/aircraft	18		Chapman & Savage (<i>pers comm. 2000</i>)
21.10.99	4	Cleveland Bay	A	Incidental/shore	2		Chapman & Savage (<i>pers comm. 2000</i>)
28.10.99	4	Cleveland Bay	A	Incidental/boat	1		Chapman & Savage (<i>pers comm. 2000</i>)
Dec. 1996	1	Bowling Green Bay	B	Shoreline survey	31		Preen & Morissette (1997)

Appendix 1 (b) continued: Details of the information available on dugong distribution and abundance for the Cleveland Bay, Bowling Green Bay and Upstart Dugong Protection Areas.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
22.03.75	2	Bowling Green Bay	A	Shoreline survey	2		Heinsohn (1975)
18.04.75	2	Bowling Green Bay	B	Shoreline survey	1		Heinsohn (1975)
08.05.79	2	Bowling Green Bay	B	Incidental/unknown	6		Marsh (1989)
08.05.79	2	Bowling Green Bay	B	Incidental/unknown	9		Marsh (1989)
08.05.79	2	Bowling Green Bay	B	Incidental/unknown	27		Marsh (1989)
28.06.77	3	Bowling Green Bay	B	Shoreline survey	13		Heinsohn (1976)
09.06.78	3	Bowling Green Bay	B	Shoreline survey	3		Marsh & Heinsohn (1979)
09.07.78	3	Bowling Green Bay	B	Incidental/unknown	3		Marsh (1989)
29.06.99	3	Bowling Green Bay	B	Incidental/aircraft	30		Chapman & Savage (<i>pers comm. 2000</i>)
01.07.99	3	Bowling Green Bay	B	Incidental/aircraft	3		Chapman & Savage (<i>pers comm. 2000</i>)
Oct. 1987	4	Bowling Green Bay	B	Quantitative		31 \pm 35	Marsh <i>et al.</i> (1996)
Oct. 1987	4	Bowling Green Bay	B	Quantitative		136 \pm 120	Marsh <i>et al.</i> (1996)
Nov. 1992	4	Bowling Green Bay	B	Quantitative		58 \pm 50	Marsh <i>et al.</i> (1996)
Nov. 1994	4	Bowling Green Bay	B	Quantitative		54 \pm 38	Marsh <i>et al.</i> (1996)
Nov. 1999	4	Bowling Green Bay	B	Quantitative	16		Marsh & Lawler (2001)
09.11.86	4	Bowling Green Bay	B	Incidental/shore	3		Marsh (1989)
25.12.98	1	Upstart Bay	A	Incidental/public	6		Griffiths (<i>pers comm. 2000</i>)
25.12.98	1	Upstart Bay	A	Incidental/public	5		Griffiths (<i>pers comm. 2000</i>)
22.03.75	2	Upstart Bay	A	Shoreline survey	28		Heinsohn (1975)
22.03.75	2	Upstart Bay	A	Incidental	11		Marsh (1989)
15.05.87	2	Upstart Bay	A	Incidental/research vessel	3		Marsh (1989)
26.03.99	2	Upstart Bay	A	Incidental/public	1		McKenzie (<i>pers comm. 2000</i>)
12.05.99	2	Upstart Bay	A	Incidental/QPWS	1		McKenzie (<i>pers comm. 2000</i>)

Appendix 1 (b) continued:		Details of the information available on dugong distribution and abundance for the Cleveland Bay, Bowling Green Bay and Upstart Dugong Protection Areas.					
23.07.87	3	Upstart Bay	A	Incidental/boat	3		Marsh (1989)
Oct. 1987	4	Upstart Bay	A	Quantitative		171 ± 87	Marsh <i>et al.</i> (1996)
Nov. 1992	4	Upstart Bay	A	Quantitative		91 ± 46	Marsh <i>et al.</i> (1996)
Nov. 1994	4	Upstart Bay	A	Quantitative		19 ± 19	Marsh <i>et al.</i> (1996)
Nov. 1999	4	Upstart Bay	A	Quantitative		25 ± 26	Marsh & Lawler (2001)
10.11.89	4	Upstart Bay	A	Incidental/unknown	1		Griffiths (<i>pers comm.</i> 2000)
10.11.89	4	Upstart Bay	A	Incidental/unknown	1		McKenzie (<i>pers comm.</i> 2000)
07.11.99	4	Upstart Bay	A	Incidental/QPWS	2		Griffiths (<i>pers comm.</i> 2000)

Appendix 1 (c): Details of the information available on dugong distribution and abundance for the Edgecumbe Bay Dugong Protection Area.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
Dec. 1999	1	Edgecumbe Bay	B	Quantitative	19	205 \pm 90	Marsh & Lawler (2001)
25.01.99	1	Edgecumbe Bay	B	Incidental/aircraft	1		Chapman & Savage (<i>pers comm. 2000</i>)
09.07.78	3	Edgecumbe Bay	B	Incidental/unknown	8		Marsh (1989)
20.07.85	3	Edgecumbe Bay	B	Incidental/unknown	3		Marsh (1989)
Oct. 1987	4	Edgecumbe Bay	B	Quantitative		173 \pm 77	Marsh <i>et al.</i> (1996)
Nov. 1992	4	Edgecumbe Bay	B	Quantitative		40 \pm 24	Marsh <i>et al.</i> (1996)
Nov. 1994	4	Edgecumbe Bay	B	Quantitative		20 \pm 17	Marsh <i>et al.</i> (1996)

Appendix 1 (d): Details of the information available on dugong distribution and abundance for the Repulse Bay Dugong Protection Area.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
16.12.98	1	Repulse Bay	B	Incidental/QPWS	3		Griffiths (<i>pers comm. 2000</i>)
25.01.99	1	Repulse Bay	B	Incidental/aircraft	2		Chapman & Savage (<i>pers comm. 2000</i>)
11.05.99	2	Repulse Bay	B	Incidental/QPWS	1		Griffiths (<i>pers comm. 2000</i>)
11.07.78	3	Repulse Bay	B	Shoreline survey	1		Heinsohn & Marsh (1979)
21.08.84	3	Repulse Bay	B	Incidental/shore	3		Marsh (1989)
Nov. 1986	4	Repulse Bay	B	Quantitative		240 \pm 104	Marsh <i>et al.</i> (1996)
Sept-Oct 1987	4	Repulse Bay	B	Quantitative		31 \pm 35	Marsh <i>et al.</i> (1996)
Nov. 1992	4	Repulse Bay	B	Quantitative		70 \pm 59	Marsh <i>et al.</i> (1996)
Nov. 1994	4	Repulse Bay	B	Quantitative			Marsh <i>et al.</i> (1996)
Nov. 1999	4	Repulse Bay	B	Quantitative		90 \pm 57	Marsh & Lawler (2001)
18.11.84	4	Repulse Bay	B	Incidental/shore	6		Marsh (1989)
24.11.84	4	Repulse Bay	B	Incidental/shore	2		Marsh (1989)
18.10.98	4	Repulse Bay	B	Incidental/Helireef	5		Griffiths (<i>pers comm. 2000</i>)
18.10.98	4	Repulse Bay	B	Incidental/Helireef	1		Griffiths (<i>pers comm. 2000</i>)

Appendix 1 (e): Details of the information available on dugong distribution and abundance for the Newry region Dugong Protection Area.							
Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
Dec.1999	1	Newry region*	A	Quantitative	1		Marsh & Lawler (2001)
19.05.99	2	Newry region*	A	Incidental/unknown	4		McKenzie (<i>pers comm. 2000</i>)
Oct. 1987	4	Newry region*	A	Quantitative		240 \pm 104	Marsh <i>et al.</i> (1996)
Nov. 1992	4	Newry region*	A	Quantitative		24 \pm 22	Marsh <i>et al.</i> (1996)
Nov. 1994	4	Newry region*	A	Quantitative	2	38 \pm 37	Marsh <i>et al.</i> (1996)
10.10.97	4	Newry region*	A	Incidental/boat	8		O'Brien (<i>pers comm. 2000</i>)
14.10.97	4	Newry region*	A	Incidental/boat	8		O'Brien (<i>pers comm. 2000</i>)
19.10.97	4	Newry region*	A	Incidental/boat	4		O'Brien (<i>pers comm. 2000</i>)
26.10.97	4	Newry region*	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)

* refer to Block 8 (Marsh *et al.* 1996). Note non-coincidence of block and DPA boundaries.

Appendix 1 (f): Details of the information available on dugong distribution and abundance for the Llewellyn/Ince Bay Dugong Protection Area.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
24.05.99	2	Ince Bay**	A	Incidental/unknown	1		McKenzie (<i>pers comm.</i> 2000)
09-11.07.78	3	Llewellyn/Ince Bay**	B/A	Shoreline survey	8		Heinsohn (1986)
09.07.78	3	Llewellyn**	B	Incidental/unknown	7		Marsh (1989)
Oct. 1987	4	Llewellyn/Ince Bay**	A	Quantitative		542 \pm 293	Marsh <i>et al.</i> (1996)
Nov. 1986	4	Llewellyn/Ince Bay**	B/A	Quantitative	6		(Marsh 1987)
Nov. 1992	4	Llewellyn/Ince Bay**	A	Quantitative		34 \pm 33	Marsh <i>et al.</i> (1996)
Nov. 1994	4	Llewellyn/Ince Bay**	A	Quantitative		82 \pm 60	Marsh <i>et al.</i> (1996)
Nov. 1999	4	Llewellyn**	B	Quantitative	20		Marsh & Lawler (2001)

** based on Block 6 (Marsh *et al.* 1996). Note non-coincidence of block and DPA boundaries. Includes Clairview DPA.

Appendix 1 (g): Details of the information available on dugong distribution and abundance for the Clairview region Dugong Protection Area.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
27.03.99	2	Clairview region*	B	Incidental/unknown	2		Mulville (<i>pers comm. 2000</i>)
12.05.99	2	Clairview region*	B	Incidental/unknown	35		Mulville (<i>pers comm. 2000</i>)
12.05.99	2	Clairview region*	B	Incidental/unknown	9		Mulville (<i>pers comm. 2000</i>)
12.05.99	2	Clairview region*	B	Incidental/unknown	1		Mulville (<i>pers comm. 2000</i>)
							Mulville (<i>pers comm. 2000</i>)
29.06.99	3	Clairview region*	B	Incidental/unknown	12		Mulville (<i>pers comm. 2000</i>)
20.08.99	3	Clairview region*	B	Incidental/unknown	4		Mulville (<i>pers comm. 2000</i>)
Oct. 1987	4	Clairview region*	A	Quantitative		542 \pm 293	Marsh <i>et al.</i> (1996)
Nov. 1992	4	Clairview region*	A	Quantitative		34 \pm 33	Marsh <i>et al.</i> (1996)
Nov. 1994	4	Clairview region*	A	Quantitative		82 \pm 60	Marsh <i>et al.</i> (1996)
10.11.99	4	Clairview region*	B	Incidental/unknown	1		Mulville (<i>pers comm. 2000</i>)

* block 6 includes Llewellyn/Ince Bay DPAs.

Appendix 1 (h): Details of the information available on dugong distribution and abundance for the Shoalwater Bay/Port Clinton Dugong Protection Area.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
24.12.96	1	Shoalwater Bay	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)
30.12.96	1	Shoalwater Bay	A	Incidental/boat	8		O'Brien (<i>pers comm. 2000</i>)
06.01.97	1	Shoalwater Bay	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)
18.01.97	1	Shoalwater Bay	A	Incidental/boat	2		O'Brien (<i>pers comm. 2000</i>)
22.01.97	1	Shoalwater Bay	A	Incidental/shore	3		O'Brien (<i>pers comm. 2000</i>)
22.02.97	1	Shoalwater Bay	A	Incidental/boat	31		O'Brien (<i>pers comm. 2000</i>)
28.01.97	1	Shoalwater Bay	A	Incidental/boat	2		O'Brien (<i>pers comm. 2000</i>)
30.01.97	1	Shoalwater Bay	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)
17.02.97	1	Shoalwater Bay	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)
18.02.97	1	Shoalwater Bay	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)
20.02.97	1	Shoalwater Bay	A	Incidental/boat	2		O'Brien (<i>pers comm. 2000</i>)
22.02.97	1	Shoalwater Bay	A	Incidental/boat	2		O'Brien (<i>pers comm. 2000</i>)
21.12.98	1	Shoalwater Bay	A	Incidental/unknown	2		Mulville (<i>pers comm. 2000</i>)
12.01.99	1	Shoalwater Bay	A	Incidental/unknown	15		Mulville (<i>pers comm. 2000</i>)
12.01.99	1	Shoalwater Bay	A	Incidental/unknown	4		Mulville (<i>pers comm. 2000</i>)
12.01.99	1	Shoalwater Bay	A	Incidental/unknown	15		Mulville (<i>pers comm. 2000</i>)
12.01.99	1	Shoalwater Bay	A	Incidental/unknown	40		Mulville (<i>pers comm. 2000</i>)
12.01.99	1	Shoalwater Bay	A	Incidental/unknown	2		Mulville (<i>pers comm. 2000</i>)
24.02.99	1	Shoalwater Bay	A	Incidental/unknown	10		Mulville (<i>pers comm. 2000</i>)
24.02.99	1	Shoalwater Bay	A	Incidental/unknown	2		Mulville (<i>pers comm. 2000</i>)
25.02.99	1	Shoalwater Bay	A	Incidental/unknown	1		Mulville (<i>pers comm. 2000</i>)
25.02.99	1	Shoalwater Bay	A	Incidental/unknown	4		Mulville (<i>pers comm. 2000</i>)
25.02.99	1	Shoalwater Bay	A	Incidental/unknown	2		Mulville (<i>pers comm. 2000</i>)
26.02.99	1	Shoalwater Bay	A	Incidental/unknown	40		Mulville (<i>pers comm. 2000</i>)
26.02.99	1	Shoalwater Bay	A	Incidental/unknown	3		Mulville (<i>pers comm. 2000</i>)
26.02.99	1	Shoalwater Bay	A	Incidental/unknown	8		Mulville (<i>pers comm. 2000</i>)
18.03.99	1	Shoalwater Bay	A	Incidental/unknown	2		Mulville (<i>pers comm. 2000</i>)
09.05.75	2	Shoalwater Bay	A	Shoreline survey	37		Anderson & Birtles (1978)

Appendix 1 (h) continued: Details of the information available on dugong distribution and abundance for the Shoalwater Bay/Port Clinton Dugong Protection Area.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
04.04.96	2	Shoalwater Bay	A	Shoreline survey	66		Preen (1999)
04.03.96	2	Shoalwater Bay	A	Incidental/unknown	1		McKenzie (<i>pers comm. 2000</i>)
28.03.97	2	Shoalwater Bay	A	Incidental/boat	2		O'Brien (<i>pers comm. 2000</i>)
09.04.97	2	Shoalwater Bay	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)
24.04.99	2	Shoalwater Bay	A	Incidental/unknown	20		Mulville (<i>pers comm. 2000</i>)
24.04.99	2	Shoalwater Bay	A	Incidental/unknown	7		Mulville (<i>pers comm. 2000</i>)
21.05.99	2	Shoalwater Bay	A	Incidental/unknown	1		Mulville (<i>pers comm. 2000</i>)
21.05.99	2	Shoalwater Bay	A	Incidental/unknown	7		Mulville (<i>pers comm. 2000</i>)
21.05.99	2	Shoalwater Bay	A	Incidental/unknown	3		Mulville (<i>pers comm. 2000</i>)
21.05.99	2	Shoalwater Bay	A	Incidental/unknown	1		Mulville (<i>pers comm. 2000</i>)
21.05.99	2	Shoalwater Bay	A	Incidental/unknown	2		Mulville (<i>pers comm. 2000</i>)
07.06.75	3	Shoalwater Bay	A	Shoreline survey	86		Anderson & Birtles (1978)
17.06.75	3	Shoalwater Bay	A	Shoreline survey	117		Heinsohn (1975)
19.06.75	3	Shoalwater Bay	A	Shoreline survey	96		Anderson & Birtles (1978)
8-13.08.79	3	Shoalwater Bay	A	Shoreline survey	143		Marsh & Heinsohn (1979)
29.05.96	3	Shoalwater Bay	A	Shoreline survey	67		Preen (1999)
21.07.96	3	Shoalwater Bay	A	Shoreline survey	213		Preen (1999)
Aug. 1997	3	Shoalwater Bay	A	Quantitative		356 \pm 82	Preen (1999)
19.06.75	3	Shoalwater Bay	A	Incidental/unknown	11		Marsh (1989)
19.06.75	3	Shoalwater Bay	A	Incidental/unknown	42		Marsh (1989)
08.08.79	3	Shoalwater Bay	A	Incidental/unknown	17		Marsh (1989)
08.08.79	3	Shoalwater Bay	A	Incidental/unknown	58		Marsh (1989)

Appendix 1 (h) continued: Details of the information available on dugong distribution and abundance for the Shoalwater Bay/Port Clinton Dugong Protection Area.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
30.06.96	3	Shoalwater Bay	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)
15.06.97	3	Shoalwater Bay	A	Incidental/unknown	99		O'Brien (<i>pers comm. 2000</i>)
28.08.97	3	Shoalwater Bay	A	Incidental/boat	12		O'Brien (<i>pers comm. 2000</i>)
29.08.97	3	Shoalwater Bay	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)
07.07.99	3	Shoalwater Bay	A	Incidental/unknown	10		Mulville (<i>pers comm. 2000</i>)
08.07.99	3	Shoalwater Bay	A	Incidental/unknown	14		Mulville (<i>pers comm. 2000</i>)
09.07.99	3	Shoalwater Bay	A	Incidental/unknown	15		Mulville (<i>pers comm. 2000</i>)
09.07.99	3	Shoalwater Bay	A	Incidental/unknown	3		Mulville (<i>pers comm. 2000</i>)
20.08.99	3	Shoalwater Bay	A	Incidental/unknown	10		Mulville (<i>pers comm. 2000</i>)
26.08.99	3	Shoalwater Bay	A	Incidental/unknown	50		Mulville (<i>pers comm. 2000</i>)
26.08.99	3	Shoalwater Bay	A	Incidental/unknown	20		Mulville (<i>pers comm. 2000</i>)
26.08.99	3	Shoalwater Bay	A	Incidental/unknown	10		Mulville (<i>pers comm. 2000</i>)
01.10.75	4	Shoalwater Bay	A	Shoreline survey	213		Heinsohn (1976)
07-09.11.79	4	Shoalwater Bay	A	Shoreline survey	41		Heinsohn & Marsh (1980)
06.09.96	4	Shoalwater Bay	A	Shoreline survey	129		Preen (1999)
06.09.96	4	Shoalwater Bay	A	Shoreline survey	147		Preen (1999)
Nov. 1986	4	Shoalwater Bay	A	Quantitative		765 \pm 161	Marsh (1989)
Nov. 1992	4	Shoalwater Bay	A	Quantitative		566 \pm 185	Marsh <i>et al.</i> (1996)
Nov. 1994	4	Shoalwater Bay	A	Quantitative		406 \pm 78	Marsh <i>et al.</i> (1996)
Oct. 1999	4	Shoalwater Bay	A	Quantitative		452 \pm 132	Marsh & Lawler (2001)
01.10.75	4	Shoalwater Bay	A	Incidental/unknown	11		Marsh (1989)
07.11.79	4	Shoalwater Bay	A	Incidental/unknown	2		Marsh (1989)
07.11.79	4	Shoalwater Bay	A	Incidental/unknown	63		Marsh (1989)
07.11.79	4	Shoalwater Bay	A	Incidental/unknown	8		Marsh (1989)

Appendix 1 (h) continued: Details of the information available on dugong distribution and abundance for the Shoalwater Bay/Port Clinton Dugong Protection Area.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
07.11.79	4	Shoalwater Bay	A	Incidental/unknown	6		Marsh (1989)
07.11.79	4	Shoalwater Bay	A	Incidental/unknown	15		Marsh (1989)
16.09.95	4	Shoalwater Bay	A	Incidental/unknown	2		McKenzie (<i>pers comm. 2000</i>)
18.09.95	4	Shoalwater Bay	A	Incidental/unknown	2		McKenzie (<i>pers comm. 2000</i>)
12.11.97	4	Shoalwater Bay	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)
29.10.98	4	Shoalwater Bay	A	Incidental/unknown	45		Mulville (<i>pers comm. 2000</i>)
29.10.98	4	Shoalwater Bay	A	Incidental/unknown	6		Mulville (<i>pers comm. 2000</i>)
08.11.98	4	Shoalwater Bay	A	Incidental/unknown	2		Mulville (<i>pers comm. 2000</i>)
08.11.98	4	Shoalwater Bay	A	Incidental/unknown	1		Mulville (<i>pers comm. 2000</i>)
09.11.98	4	Shoalwater Bay	A	Incidental/unknown	40		Mulville (<i>pers comm. 2000</i>)
09.11.98	4	Shoalwater Bay	A	Incidental/unknown	4		Mulville (<i>pers comm. 2000</i>)
07.09.99	4	Shoalwater Bay	A	Incidental/unknown	50		Mulville (<i>pers comm. 2000</i>)
07.09.99	4	Shoalwater Bay	A	Incidental/unknown	30		Mulville (<i>pers comm. 2000</i>)
07.09.99	4	Shoalwater Bay	A	Incidental/unknown	6		Mulville (<i>pers comm. 2000</i>)
08.09.99	4	Shoalwater Bay	A	Incidental/unknown	1		Mulville (<i>pers comm. 2000</i>)
08.09.99	4	Shoalwater Bay	A	Incidental/unknown	24		Mulville (<i>pers comm. 2000</i>)
23.10.99	4	Shoalwater Bay	A	Incidental/unknown	1		Mulville (<i>pers comm. 2000</i>)
07.12.96	1	Port Clinton	A	Shoreline Survey	28		Preen (1999)
07.12.96	1	Port Clinton	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)
07.12.96	1	Port Clinton	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)
04.04.96	2	Port Clinton	A	Shoreline Survey	2		Preen (1999)
29.05.96	2	Port Clinton	A	Shoreline Survey	154		Preen (1999)
28.04.98	2	Port Clinton	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)

Appendix 1 (h) continued: Details of the information available on dugong distribution and abundance for the Shoalwater Bay/Port Clinton Dugong Protection Area.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
10.03.99	2	Port Clinton	A	Incidental/unknown	1		Mulville (<i>pers comm. 2000</i>)
20.05.99	2	Port Clinton	A	Incidental/unknown	1		Mulville (<i>pers comm. 2000</i>)
20.05.99	2	Port Clinton	A	Incidental/unknown	1		Mulville (<i>pers comm. 2000</i>)
17.06.75	3	Port Clinton	A	Shoreline Survey	7		Heinsohn (1975)
19.06.75	3	Port Clinton	A	Shoreline Survey	21		Wake (1975)
19.06.75	3	Port Clinton	A	Shoreline Survey	7		Heinsohn (1975)
13.08.79	3	Port Clinton	A	Shoreline Survey	80		Heinsohn & Marsh (1980)
21.07.96	3	Port Clinton	A	Shoreline Survey	80		Preen (1999)
Aug. 1997	3	Port Clinton	A	Quantitative		82 \pm 29	Preen (1999)
19.06.75	3	Port Clinton	A	Incidental/unknown	42		Marsh (1989)
08.08.79	3	Port Clinton	A	Incidental/unknown	80		Marsh (1989)
08.08.79	3	Port Clinton	A	Incidental/unknown	14		Marsh (1989)
14.06.97	3	Port Clinton	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)
06.07.97	3	Port Clinton	A	Incidental/boat	1		O'Brien (<i>pers comm. 2000</i>)
07-09.11.79	4	Port Clinton	A	Shoreline Survey	23		Heinsohn & Marsh (1980)
01.10.75	4	Port Clinton	A	Incidental/unknown	3		Marsh (1989)
07.11.79	4	Port Clinton	A	Incidental/unknown	15		Marsh (1989)
07.11.79	4	Port Clinton	A	Incidental/unknown	19		Marsh (1989)
07.11.79	4	Port Clinton	A	Incidental/unknown	7		Marsh (1989)
14.11.84	4	Port Clinton	A	Incidental/boat	8		Marsh (1989)
22.10.99	4	Port Clinton	A	Incidental/unknown	3		Mulville (<i>pers comm. 2000</i>)
22.10.99	4	Port Clinton	A	Incidental/unknown	1		Mulville (<i>pers comm. 2000</i>)

Appendix 1 (i): Details of the information available on dugong distribution and abundance for the Rodds Bay Dugong Protection Area.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
17.06.75	3	Rodds Bay	B	Shoreline Survey	2		Heinsohn (1975)
12.08.79	3	Rodds Bay	B	Shoreline Survey	17		Marsh & Heinsohn (1979)
Nov. 1986	4	Rodds Bay	B	Quantitative	5	301 \pm 95	Marsh (1989)
Nov. 1992	4	Rodds Bay	B	Quantitative		91 \pm 60	Marsh <i>et al.</i> (1996)
Nov. 1994	4	Rodds Bay	B	Quantitative		104 \pm 56	Marsh <i>et al.</i> (1996)
Nov. 1999	4	Rodds Bay	B	Quantitative	5	55 \pm 37	Marsh & Lawler (2001)
01.09.96	4	Rodds Bay	B	Incidental/unknown	15		O'Brien (<i>pers comm.</i> 2000)
06.09.99	4	Rodds Bay	B	Incidental/boat	10		Chapman & Savage (<i>pers comm.</i> 2000)

Appendix 1 (j): Details of the information available on dugong distribution and abundance for the Hervey Bay/Great Sandy Strait Dugong Protection Area.

Date	Season	Location	DPA Type	Data Type	# Dugongs counted	Population Estimate \pm S.E	Reference
Dec. 1993	1	Hervey Bay/Great Sandy Strait	A	Quantitative		579-629 \pm 126	Preen & Marsh (1995)
07.12.98	1	Hervey Bay/Great Sandy Strait	A	Incidental/unknown	1		McKenzie (<i>pers comm.</i> 2000)
11.12.98	1	Hervey Bay/Great Sandy Strait	A	Incidental/unknown	1		McKenzie (<i>pers comm.</i> 2000)
12.12.98	1	Hervey Bay/Great Sandy Strait	A	Incidental/unknown	1		McKenzie (<i>pers comm.</i> 2000)
13.12.98	1	Hervey Bay/Great Sandy Strait	A	Incidental/unknown	1		McKenzie (<i>pers comm.</i> 2000)
13.12.98	1	Hervey Bay/Great Sandy Strait	A	Incidental/unknown	1		McKenzie (<i>pers comm.</i> 2000)
13.12.98	1	Hervey Bay/Great Sandy Strait	A	Incidental/unknown	1		McKenzie (<i>pers comm.</i> 2000)
Mar. 1974	2	Hervey Bay to Rodds Bay area	A/B	Shoreline survey	61		Ligon (1975)
23.03.75	2	Hervey Bay/Great Sandy Strait	A	Shoreline survey	2		Heinsohn (1975)
23.03.75	2	Hervey Bay/Great Sandy Strait	A	Shoreline survey	59		Heinsohn (1975)
17.06.75	3	Hervey Bay/Great Sandy Strait	A	Shoreline survey	10		Heinsohn, (1975)
10-11.08.79	3	Great Sandy Strait	A	Shoreline survey	46		Marsh & Heinsohn (1979)
10-12.08.79	3	Hervey Bay	A	Shoreline survey	97		Marsh & Heinsohn (1979)
17.06.75	3	Hervey Bay/Great Sandy Strait	A	Shoreline survey	6		Heinsohn (1975)
Aug. 1988	3	Hervey Bay/Great Sandy Strait	A	Quantitative		1971 \pm 359	Preen & Marsh (1995)
24.06.97	3	Hervey Bay/Great Sandy Strait	A	Incidental/boat	2		O'Brien (<i>pers comm.</i> 2000)
Nov. 1992	4	Hervey Bay/Great Sandy Strait	A	Quantitative		1109 \pm 383	Preen & Marsh (1995)
Nov. 1994	4	Hervey Bay/Great Sandy Strait	A	Quantitative		807 \pm 151	Heinsohn & Marsh (1980)
Nov. 1999	4	Hervey Bay/Great Sandy Strait	A	Quantitative	160	1673 \pm 521	Marsh & Lawler (2001)