Status of seagrasses in the Great Barrier Reef region

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Abstract

Broad-scale surveys of the Great Barrier Reef (GBR) province have found seagrasses in estuaries, shallow coastal bays and inlets, on fringing and barrier reef platforms and in deep, inter-reef waters. Coastal and island waters have been mapped for all of Queensland, but knowledge of seagrasses on reef platforms and in deep water (> 15 m) is limited. Large areas of seagrass at depths between 10 and 30 m in the Cairns and Far Northern Sections and in Hervey Bay, have been associated with large dugong populations.

Approximately 3000 km^2 of coastal seagrass habitat has been mapped in the GBR region to date, and at least 2000 km^2 of deepwater seagrass habitat has been estimated so far. Fourteen known seagrass species were recorded from surveys of Queensland coastal, island and reef waters, but increases in the species list for the Genus *Halophila* are likely with surveys of new habitats. Some species reach the latitudinal limits of their distribution in Queensland and at least two *Halophila* species may be endemic to either the GBR region or northeastern Australia.

Estuarine and shallow coastal seagrass meadows appear to be much more important than deepwater seagrasses as nursery habitat for juvenile prawns and fish. Seagrasses in the GBR are also sources of food to dugong and green sea turtles - species listed as threatened or endangered. The distribution and ecological importance of seagrasses on reef platforms and in deep water (> 10 m) requires attention.

Natural events such as cyclones and floods can cause widespread loss of seagrasses in shallow and deep water. Current agricultural land-use practices may exacerbate the effects of these natural events, as well as slow recovery processes. Localities which provide shelter and water conditions ideal for productive seagrass habitat are often targets for port development, and at the downstream end of heavily impacted catchments. Far Northern Section seagrasses do not yet face the same immediate threats from urban and agricultural runoff, or coastal and Barrier Reef development, that occur in southern, more populated regions.

We have little understanding of the scale and ecological consequences of natural year-to-year change in most of these seagrasses. Anthropogenic impacts on seagrasses in the GBR currently appear low to moderate, but land-use practices and coastal management need careful attention to minimise adverse impacts of increasing population and development. Integrated catchment management may be one of the most important programs to help ensure survival of seagrass systems in the GBR region. Marine Parks and fishing industry closures help protect valuable inshore seagrass prawn nursery and dugong feeding habitat, but recently discovered deepwater seagrasses do not yet receive such formal protection measures. There is a need for research to describe the responses of seagrass to natural and human impacts and to establish acceptable levels of changes to seagrass meadows and the acceptable levels of water quality conditions which cause those changes.

Overview

Seagrasses in the coastal waters of the GBR province were mapped from broad-scale surveys of separate regions from 1984 to 1989 (Coles et al. 1985; Coles et al. 1987a,b; Coles et al. 1992; Lee long et al. 1992). Seagrasses have been found in estuaries, shallow coastal bays and inlets, on fringing and barrier reef platforms and in deep water. Coastal and island waters have been mapped for all of Queensland, but surveys of deeper water (more than 15 m), inter-reef and barrier reef platform areas have only recently begun. Seagrasses have been found to depths of 58 m in the Cairns and Far Northern Sections (Lee Long, McKenzie and Coles 1996), and large areas of *Halophila* species at depths between 15 and 30 m (Lee Long et al. 1989), have been associated with large dugong populations (Marsh and Saalfeld 1989). Major areas of seagrass habitat identified from initial broadscale surveys in the 1980s are shown in Fig. 1 and Table 1 (from Lee Long et al. 1993).

Approximately 3000 km^2 of coastal (< 15 m depths) seagrass habitat has been mapped in the GBR region to date (Lee Long, Mellors and Coles 1993), and at least an additional 2000 km^2 of deepwater seagrass habitat has been estimated so far (Lee Long et al. 1996). Fourteen known seagrass species were recorded from surveys of Queensland coastal, island and reef waters between 1984 and 1989 (Lee Long, Mellors and Coles 1993). Most of these species are common to the Indo-West Pacific region, but some reach the latitudinal limits of their distribution in Queensland (Lee Long, Mellors and Coles 1993) and at least two species (*Halophila tricostata* and *Halophila* sp.) may be endemic to the GBR. One new species (*Halophila capricorni*, Larkum 1996) has since been described and taxonomic studies of additional undescribed plants in the Genus *Halophila* will likely lead to further increases in the species list for the GBR (Kuo, pers. comm.).

All seagrasses are important in primary production and therefore in supporting complex marine food webs. They are often valuable nursery grounds for commercially and recreationally important species of prawns and fish. Estuarine and shallow coastal seagrass meadows appear to be much more important as nursery habitat for juvenile prawns and fish (Derbyshire et al. 1995). Seagrasses in the GBR are also sources of food to dugong and green sea turtles - species listed as threatened or endangered. Meadows dominated by *Halophila* and *Halodule* species are preferred dugong feeding areas. Seagrasses in coastal regions play important roles in maintaining sediment stability and water clarity. Their physical role in deep water (> 10 m) is less understood.

Pressures on seagrasses in the Great Barrier Reef

Natural events such as cyclones and floods can cause widespread loss of seagrasses in shallow and deep water, with devastating effects on dugong populations and some fisheries (Preen et al. 1995; Preen and Marsh 1995). Current land-use practices may exacerbate the effects of these natural events through increased soil erosion and nutrient run-off. Continued urban and agricultural expansions present a chronic threat and land run-off impacts may also affect the recovery of seagrasses after loss. Integrated Catchment Management programs seek to address these issues and are seen as an important part of good management for continued survival of seagrasses in the GBR.

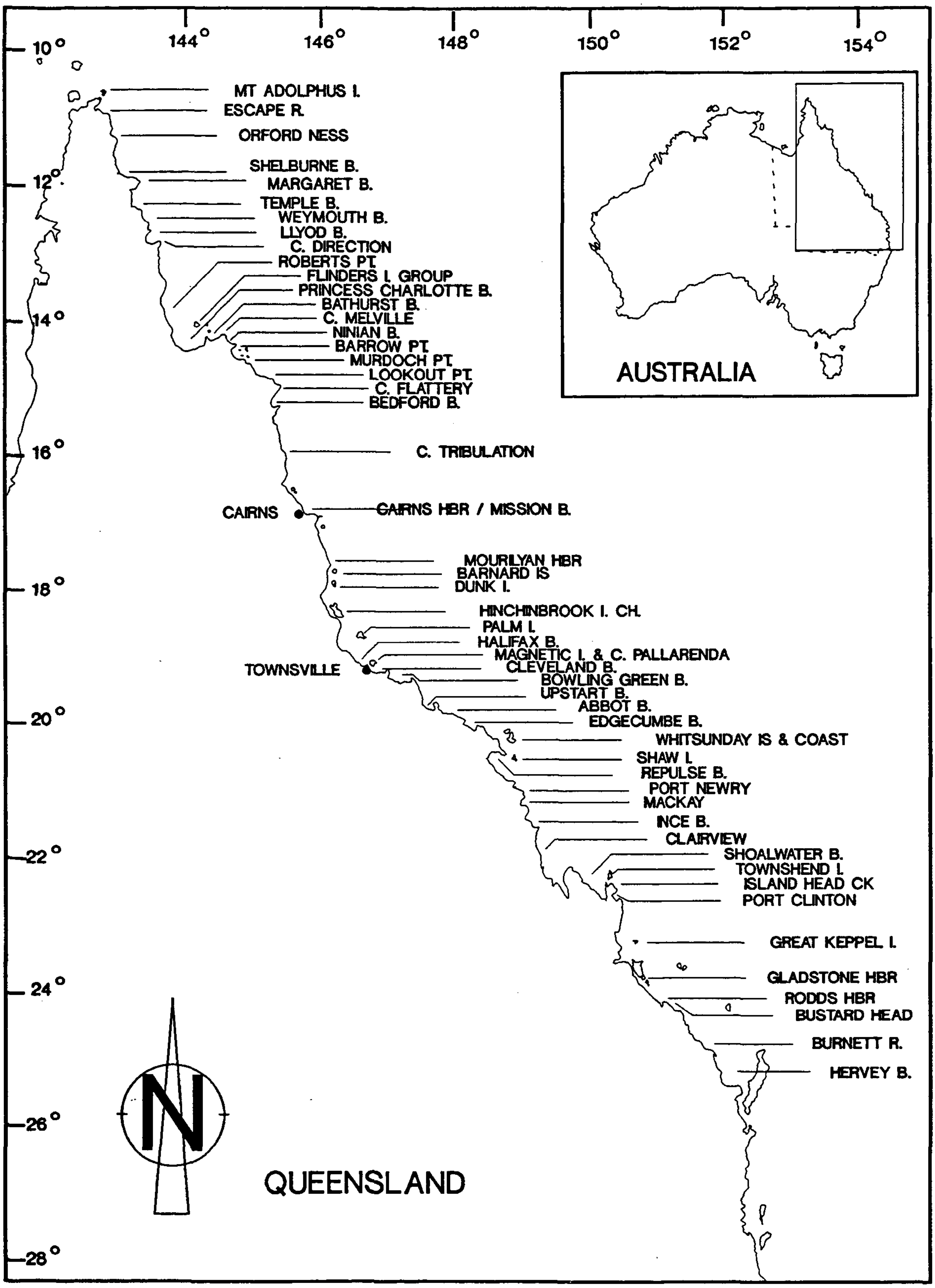

Figure 1. Major areas of seagrass habitat identified from initial broadscale surveys in the 1980s

Table 1. Summary of seagrass areal cover for major habitats along the Queensland coast

Geographical Location	Area of seagrass cover (km^2) <10%	10-50%	>50%	Total	Halophila ovalis	Halodule uninervis-wide	Halophila spinulosa	Halodule uninervis-thin	Halophila decipiens	Halophila ovata	Cymodocea serrulata	Halodule pinifolia	Zostera capricorni	Syringodium isoetifolium	Halophila tricostata	Thalassia hemprichii	Cymodocea rotundata	Enhalus acoroides
MT ADOLPHUS I.			0.98	0.98	■		■				■			■				
ESCAPE R.		4.18		4.18	■	■	■			■	■					■		■
ORFORD NESS	2.12	4.95		7.07	■	■	■	■	■									
SHELBURNE B.		1.50	11.10	16.70	■	■	■	■	■		■							
MARGARET B.	4.02	5.81	6.08	15.91	■	■	■		■	■	■			■				
TEMPLE B.	24.64			24.64	■	■	■		■	■		■						
WEYMOUTH B.			4.14	4.14	■	■	■			■	■	■		■		■		
LLOYD B.	3.92	8.08		12.00	■	■	■	■	■	■								
C. DIRECTION	48.07	71.32		119.39	■	■	■	■	■	■	■	■						
ROBERTS PT.			159.00	159.00	■	■	■				■			■				
FLINDERS I. GROUP	5.68		10.15	15.83	■	■	■		■	■	■			■	■			■
PRINCESS CHARLOTTE B.		51.04	16.08	67.12	■	■	■	■	■	■	■	■		■				
BATHURST B.	68.75		118.28	187.03	■	■	■		■	■	■			■				
C. MELVILLE		13.41		13.41		■			■		■			■				
NINIAN B.			28.24	28.24	■	■	■		■		■	■		■				
BARROW PT. - MURDOCH PT.	107.07	211.51	43.17	361.75	■	■	■	■	■	■	■	■		■	■	■	■	
MURDOCH PT. - LOOKOUT PT.	534.29	502.22	167.52	1204.03	■	■	■		■	■	■			■	■			
C. FLATTERY	2.16	8.51		10.67	■	■	■		■	■	■					■		
BEDFORD B. - C. TRIBULATION	2.16	1.07	2.53	5.76	■	■	■	■	■	■	■			■				
CAIRNS HBR.	1.37	7.79	11.85	21.01	■	■		■	■		■	■	■		■	■	■	
MOURILYAN HBR.	0.19	1.12		1.31		■			■	■								
BARNARD IS.	3.74	4.60		8.34	■	■			■	■					■			
DUNK I. & COAST	1.39	3.93		5.32	■	■	■	■	■	■	■	■		■	■	■	■	
NTH HINCHINBROOK I.	19.19	9.05		28.24	■	■		■	■	■		■						
HINCHINBROOK I. & CH.	19.70	5.53	5.15	30.38	■	■	■		■	■		■		■	■			
PALM I.	1.43	2.05		3.48	■	■	■	■		■	■	■						
HALIFAX B.	16.95	3.44		20.39	■		■	■	■			■				■		
C. PALLARENDA	5.92	9.12		15.04	■		■	■	■	■	■	■						
MAGNETIC I.	6.54	4.78	1.56	12.88	■	■	■	■	■	■	■	■			■	■	■	
CLEVELAND B.	3.22	56.95		60.17	■	■	■	■	■	■	■	■						
BOWLING GREEN B.	7.15			7.15				■				■	■					
UPSTART B.	6.20	20.64	32.33	59.17	■	■	■	■	■	■	■	■	■		■			
ABBOT B.	14.44	15.91	3.00	33.35	■	■	■	■	■	■		■						
EDGECUMBE B.	7.16	3.66	13.35	24.17	■	■		■	■	■		■	■	■		■	■	
WHITSUNDAY COAST	12.41	4.11		16.52	■	■	■	■			■			■		■	■	
WHITSUNDAY ISLANDS	9.74	7.17	13.06	29.97	■	■	■	■		■	■		■	■	■			
SHAW I.	1.22	2.53		3.75	■	■	■	■		■	■			■			■	
REPULSE B.	4.47	2.28		6.75	■	■	■	■		■			■	■				
PORT NEWRY	4.88	2.53		6.74	■	■		■		■	■		■	■				
MACKAY	5.47	1.64		7.11		■	■	■										
INCE B.	5.75	5.49		11.24	■		■					■						
CLAIRVIEW	12.93	7.39		20.32	■			■				■	■					
SHOALWATER B.	15.93	21.25		37.18	■	■	■	■	■	■	■	■	■	■				
TOWNSHEND I.	9.96	4.15		14.11	■	■	■			■								
ISLAND HEAD CK	0.60	4.14	0.45	5.19	■				■	■			■					
PORT CLINTON	0.61	3.64	9.68	13.93	■		■			■			■					
GREAT KEPPEL I.	4.44	1.25	0.45	6.14	■	■	■			■								
GLADSTONE HBR	2.85	10.27	4.04	17.16	■	■	■	■	■	■			■		■			
RODDS HBR	4.29	2.89	0.27	7.45	■	■	■	■					■					
BUSTARD HEAD		3.07		3.07	■	■		■					■					
BURNETT R.		2.07		2.07	■				■									
HERVEY B.	21.16	225.50	779.68	1026.34	■	■	■	■	■	■		■	■					
TOTALS	1034.18	1343.54	1442.14	3819.86														

Seagrasses are common in sheltered areas where coastal developments are concentrated and bring increased threats of urban and industrial runoff, dredging or burial. Impacts which increase water column sediments and nutrients, or phytoplankton or epiphyte density can lead to greater attenuation of light and reduced seagrass survival at the deep end of its distribution (Dennison et al. 1993). These threats are greatest in semi-enclosed bays and ports where water exchange rates are low. Far Northern Section seagrasses do not yet face the same immediate threats from urban and agricultural runoff, or coastal and Barrier Reef development that occur in southern populated regions.

Damage to inshore seagrass meadows by trawling activity should be minimal under the fishery management policy of strip closures, and dense meadows in deep water are usually avoided by trawlers when possible. Low density seagrass meadows in deep water, which are dugong feeding habitat, receive no special zoning or protection from trawling and may be at risk of damage.

Increases in shipping traffic along eastern Queensland will lead to increased threats from oil spills. Oil spills may cause severe and immediate damage to intertidal seagrass meadows but subtidal seagrasses may be at lesser risk (Jackson et al. 1989; Kenworthy et al. 1993). Impacts on the invertebrate and fish communities which seagrasses support can be severe, but may respond positively to subsequent regeneration of seagrasses.

Status of seagrasses in the Great Barrier Reef region

Seagrass habitat information was not available when most initial Marine Park zone plans were drawn. Limited information from Queensland Department of Primary Industries (QDPI) initial broad-scale surveys was the only seagrass data available for use in formulating the original Far Northern Section (FNS) zoning plan. Data from these surveys are now very dated and distribution patterns are likely to have changed since the time of surveys. In 1989, for example (four years after the original FNS zoning plan), approximately 1500 km^2 of predominantly deep water seagrass habitat were mapped between Lookout Point and Barrow Point (Lee Long et al. 1989). This area coincides with one of the largest populations of dugongs on the eastern Queensland coast (Marsh and Saalfeld 1989), and improved the evidence for a correlation between dugong population size and seagrass habitat area. It so far receives no formal protection from trawling activity. Further seagrass habitats have been recently discovered at 15-60 m depths, including trawl-fishing areas of the Far Northern, Cairns and Central Marine Park Sections (Coles et al. 1995). The seagrasses (*Halophila tricostata* and *H. decipiens*) in trawl areas appear to be mostly ephemeral (spring/ summer) species, and their ecological importance is not understood. Management of these areas needs further information on their importance to dugong and turtles, and to prawn fisheries.

Recent discoveries of large areas of deepwater seagrasses provide evidence for a more complex inter-reef soft-bottom habitat than previously assumed (Lee Long, McKenzie and Coles 1996). Additional *Halophila* species (cf. *H. capricorni*) plants have been found associated with reef habitats to 35 m depths in the Far Northern and Cairns Sections (QDPI, unpublished information) and in the Mackay/Capricorn Section (Larkum 1996). The importance of these small meadows on reef slopes is not yet clear, but not likely to be great.

There is very little information regarding seagrasses on reef platforms (of barrier and fringing reefs), but ad hoc surveys have found these habitats to be valuable as prawn nursery habitat and for dugong and turtle feeding. They may also play a part in reducing the sediment and nutrient impacts on the adjacent coral reef habitat. Formal surveys and studies will help to establish the value of these seagrasses to coral reef ecology.

Very few studies have examined impacts of sediments or nutrients on seagrasses of the GBR region. Preliminary studies indicate seagrasses in many coastal and reef localities are still nutrient limited and respond positively to additions of nutrients (Mellors and Udy, pers. comm.). The few monitoring programs at specific ports and bays (e.g. QDPI surveys), also indicate only low-to-moderate levels of human impacts (e.g. industry, mining and agricultural land runoff) on most coastal and deep water seagrasses, but these should be carefully examined as development (particularly urban and agricultural expansion) in catchments and on the coast proceeds. Port developments and coastal mariculture (e.g. prawn, fish and pearl shell) operations require planning to minimise adverse impacts on nearby seagrasses, particularly where important prawn nursery or dugong/turtle feeding areas are threatened. Individual operations and developments can appear insignificant in potential impact, but the total impact of incremental increases in pressure needs overall planning and management. Some localised planning programs are in place but need to be monitored for effectiveness.

The paucity of information on year-to-year or long term change in seagrass distribution and abundance for most of the GBR region has left zoning plans and management programs potentially incomplete. Seagrasses are the main food source for dugong, so information on long term change in seagrass abundance is paramount to refinement of management plans for dugong conservation. The influence of seagrass losses to annual prawn production is also poorly understood.

Management and responses

Management plans, and responses to impacts, for GBR region seagrasses are designed primarily around the maintenance of seagrasses for commercial prawn fisheries and for dugong and turtle populations. The Great Barrier Reef Marine Park Authority (GBRMPA) and Port Authorities at Cairns, Mourilyan, Gladstone and other areas, support seagrass management measures which also consider the broader ecological importance of seagrasses in maintaining coastal water quality, sediment stability, and as the basis for other marine fisheries and food-webs.

Relevant existing zoning provisions and policies

In 1990, the Queensland Fish Management Authority (QFMA), in consultation with fishing industry, acknowledged the value of seagrasses to tiger and endeavour prawn stocks, and added to the seasonal prawn closures with a coastal strip closure system to protect juvenile prawns and their seagrass habitat. Almost all shallow, coastal seagrass habitat in the Far Northern and Cairns Sections north of Cape Tribulation, is thus currently in areas zoned as free from trawling activity, either within the QFMA policy of coastal strip closures or within GBRMPA zoning. An extension of this reasonably effective strip closure system to coastal seagrasses south of Cape Tribulation is also being considered for evaluation by Queensland trawl fisheries management.

Important dugong feeding areas inshore between the Starcke River and Barrow Point receive special protection through scientific and preservation zones. Deep water seagrasses in this area are important dugong feeding habitat (e.g. Lee Long et al. 1989), but are not afforded complete protection through zoning. There may be other unsurveyed areas of deep water seagrasses in the GBR important to dugongs and green sea turtles, but which receive no special protection. Seagrasses are listed as protected marine plants under Section 51 of the Queensland Fisheries Act 1994, to enable prosecutions for wilful and irresponsible damage to seagrass habitat.

Integrated catchment management programs are gaining wider acceptance across Queensland and should be encouraged from a seagrass conservation perspective, since seagrasses are at the

'downstream end' of catchment run-off. This may be one of the most reliable management measures for successful seagrass conservation. Point-source discharges are also being addressed and effluent controls are being slowly introduced at reef locations to help minimise impacts on seagrasses and corals. We strongly recommend greater community education, awareness and involvement in land-use practices which minimise downstream impacts on seagrasses. The incremental increases in all of the above impacts, associated with an expanding population, are the most serious threat to long term survival of seagrasses in the GBR region. Planning and management of these increasing pressures must be acknowledged by the whole community. This would help speed the implementation of programs to minimise and limit land run-off impacts.

Existing consultative mechanisms for seagrass research and management

Mechanisms or structures for directing research and management of seagrasses in the GBR region include the interchange of information at annual GBR and CRC researcher conferences, and at ad hoc workshops and meetings. The GBRMPA, the QFMA, the Queensland Department of Environment (QDoE), and the QDPI are the major organisations responsible for seagrass management in marine park and fisheries areas. The Cooperative Research Centre for Sustainable Development of the Great Barrier Reef (CRC Reef Research Centre) supports new initiatives in seagrass studies for obtaining information of direct use toward management of the GBR. Research on GBR region seagrasses is conducted primarily by the QDPI, the James Cook University's Tropical Environment Studies and Geography group and the University of Queensland's Marine Botany group. Requests from the above organisations, and initiatives from scientists, are currently the major avenue for generation of research and monitoring, and information gained on seagrass habitat distribution and ecology is distributed to these organisations and extended for public consumption.

The GBRMPA holds an archival GIS database using Arc-Info to store QDPI data on survey sites and seagrass distribution for research and management use. The QDPI's MapInfo GIS databases include full sets of the raw data generated from a series of fine- and broad-scale mapping and monitoring programs.

Research and monitoring in progress

Initial QDPI surveys conducted in the 1980s and 1990s provided information on seagrass distribution and abundance for large parts, but not all, of the GBR region. Collection of preliminary information on deep water and reef platform seagrass distributions is an immediate priority and ongoing surveys will eventually cover most of the GBR.

This information is now very dated and should be used with some caution in future zone planning. There is also a paucity of information on year-to-year change in seagrass distribution and abundance for most areas of the GBR. The CRC Reef Research Centre is now conducting studies on a) growth responses to natural and human impacts, and b) mechanisms of seagrass recovery after loss.

There is no formal strategy or program in place for monitoring seasonal or long term change in seagrass distribution and abundance in any part of the GBR. Measures of long term changes in seagrass distribution and abundance since the original seagrass surveys will require a large resource base. Studies of year-to-year change at specific coastal and deep water sites in the Cairns Section are currently supported by some port authorities and by the CRC Reef Research Centre.

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