

Seagrass-Watch: Community-based monitoring of seagrass meadows in Hervey Bay and Whitsunday Regions: 1998-2001

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EXECUTIVE SUMMARY

Community-based monitoring provides members of the community with the ability to contribute to the preservation of their local environment. The hands-on and participatory nature of Seagrass-Watch has proved to be a cost-effective method of collecting data on and engaging local interest and ownership in coastal seagrass habitats. The most powerful aspect of Seagrass-Watch is its use as an educational tool to raise community awareness. It has generated local support and invaluable networks between community groups and government for seagrass conservation and management.

Maintaining momentum and positive outcomes from the Seagrass-Watch program has required regular quality feedback to community groups. A quarterly Seagrass-Watch Newsletter, regular reports and presentations helped achieve this. Data assurance and quality has been an important focus with training programs and calibration tools used to ensure accurate and precise data collection.

A Seagrass-Watch calendar/diary was established to capture regular anecdotal information of seagrass related events and of activities which affect seagrass. Information recorded on the calendar is not statistical in nature but is used to interpret the monitoring data. The calendar also entices participation in the Seagrass-Watch program from a wider sector of the community.

Current levels of interest in Seagrass-Watch are high, but maintaining community participation in, and effectiveness of, the program will require continued government support to coordinate community volunteers and stakeholders. Further expansion of the program is expected as Aboriginal and Islander communities, and volunteer groups in other areas become involved in the management of their local seagrass and coastal resources.

Major findings

Community groups and volunteers are assisting fisheries scientists to establish a reliable early warning system on the status of seagrass resources, and a broad measure of coastal changes. The program, called Seagrass-Watch, includes community volunteers and/or groups trained to map and monitor intertidal seagrass habitats in Queensland. Community volunteers collect quality information for coastal management on changes in seagrass meadow characteristics, such as the extent of coverage, position and depth of habitat, species composition, estimates of seagrass and algal abundance, presence of dugong feeding trails and possible human impacts. Seagrass-Watch is currently underway with communities in southern-, central-, and northern-Queensland regions.

Recommendations:

- ☞ Additional research to address issues (eg nutrient inputs) influencing the growth of filamentous algae in Pigeon Island and its possible impact on seagrasses.
- ☞ Develop strategies to reduce impacts associated with anchor damage on seagrass beds at Whitehaven Beach and at other sites where potential damage is occurring.
- ☞ Investigate the impact of catchment inputs on the seagrass ecosystems in the Sandy Straits.
- ☞ Develop strategies to reduce pollutant (nutrients, herbicides, sediment, metals) runoff from catchments into Hervey Bay and Sandy Straits.
- ☞ Additional funding to ensure the continuation of the Seagrass-Watch program to engage local communities in on-ground monitoring of seagrass habitats in Hervey Bay, Sandy Straits and Whitsundays.

INTRODUCTION

Background

The successful management of the marine environment is dependent upon comprehensive long-term monitoring programs that provide: *i*) information on natural variability and long-term trends in key biological communities; *ii*) data on the status of important natural attributes at regular intervals; and *iii*) identification of undesirable trends resulting from human activities in time for remedial management action to be implemented.

Monitoring programs generally comprise one or more of the following complementary objectives: *i*). local scale impact and/or *compliance monitoring* that examines the effects of human activities in a localised area(s); *ii*) temporally-constrained, broadscale *surveillance monitoring* to assess the impact of episodic regional physical and biological processes (eg. the effect of floods); and *iii*) spatially-constrained, long term monitoring of key biological parameters to determine the extent and cause of *natural variation* (eg seasonal and inter-annual variability) of key ecosystem attributes.

The Seagrass-Watch long-term monitoring program was established in 1998 as an initiative of the Queensland Department of Primary Industries (QDPI) to harness local knowledge and allow local community groups to help in mapping and monitoring seagrass habitats vital for fisheries, turtles and dugongs.

Local community volunteers were trained, at workshops organised by QDPI, in the methods required for scientifically rigorous assessment of seagrass resources. These volunteers were able to collect data from their region to give environmental managers an indication of the extent of seagrass resources. They also conduct ongoing monitoring and identify any areas of loss which may need particular attention.

The program was designed to provide an early warning of change in the seagrasses of each region and was established at specific sites identified using the results of mapping surveys. The sampling design and the parameters to be measured depend on the specific question to be answered and were decided in collaboration with the community and research scientists. The purpose of monitoring is to provide an early warning of change to alert management agencies.

Community participation

This monitoring program is designed to depend on considerable input and feedback from community volunteers. It is user-friendly with simple field sampling methods, uncomplicated data recording and handling, and has prompt follow-up from a coordinator. This ensures information is fully used in coastal zone management for continuous good health of fisheries and dugong populations.

Three main community groups monitor seagrasses throughout Queensland, The Hervey Bay Dugong and Seagrass Monitoring Program, based in Hervey Bay, and the Whitsunday Volunteers and the Order of Underwater Coral Heroes (OUCH) based in the Whitsundays.

More than 100 people have been involved in on-ground monitoring of seagrasses, as part of Seagrass-Watch, over the past 2 years. The people involved are from a variety of backgrounds including retirees, school teachers, past servicemen and women, farmers, secondary and tertiary students, local fishermen, conservation groups, indigenous TAFE students, local government people, coastal managers and rangers.

Seagrass-Watch monitoring involves the community in the collection of important information and scientific data on the health of seagrass meadows. Community members are carrying out methods such as laying out transect lines and reporting seagrass abundance information onto datasheets for analysis by scientists.

Information from Seagrass-Watch has provided information for zoning plans for marine and coastal management plans, the declaration of marine and coastal protected areas, maps for coastal planners and information for coastal development projects. The data can also be used to assess the success of catchment management strategies that aim to reduce inputs of nutrient and sediments into inshore marine waters.

Monitoring seagrass ecosystems

Seagrass meadows in sheltered nearshore regions of Hervey Bay, the Great Sandy Strait and Whitsundays are some of the largest single areas of seagrass habitats on the eastern Australian coastline (McKenzie *et al.* 2000). Their contribution to primary carbon production in these regions underpins marine and estuarine food webs and provide extensive habitat for dugong *Dugong dugon* (Miller) (Preen and Marsh 1995), green sea turtles, *Chelonia mydas* (Linnaeus) (Lanyon *et al.* 1989), fish populations, species of penaeid prawns and wading birds (Coles and Lee Long 1985; Coles *et al.* 1993; Watson *et al.* 1993). The management of tropical seagrass meadows has received much attention over the past decade following losses due to cyclones, floods (Preen *et al.* 1995, Short and Wyllie Echeverria 1996) and human induced changes (Durako 1994, Hall *et al.* 1999). Management of seagrass habitats involves the mapping and monitoring of seagrass abundance and distribution so that decisions on habitat protection can be based on pertinent information relevant to a specific area of concern.

The monitoring of seagrass meadows to identify causes of change is intrinsically linked with issues of scale. Mapping of seagrasses over landscape scales provides information on the areal coverage of seagrasses in a region, changes to depth related distributions and long-term changes in seagrass abundance and distribution (Lee Long *et al.* 1998, Virnstein 2000). At smaller geographic scales the monitoring of seagrass meadows can detect disturbance at an early stage (Kirkman 1996) and distinguish changes due to anthropogenic or natural causes from natural variation. Monitoring may also allow seasonal differences in seagrass abundance to be described at various spatial scales. At small geographic scales monitoring programs can be designed to detect changes in the depth distribution of seagrasses (Abal and Dennison 1996), seagrass abundance (Kirkman and Kirkman 2000) and species composition. Repeated monitoring of fixed transects within seagrass meadows can detect short term fluctuations in seagrass and algal coverage, canopy height, patchiness and composition. The use of multiple transects and replicated sampling units within seagrass beds allows comparisons to be made between seagrass beds (Virnstein 1995, 2000).

Few studies have examined the seasonal variation of tropical seagrasses in Australia (Birch and Birch 1984, Mellors *et al.* 1993, McKenzie 1994) or examined the seasonal and inter-annual trends in seagrass abundance of seagrass meadows at different levels of geographic scale, across regional landscapes and at site specific meadows. Further, the time it takes for seagrass seeds to germinate and recolonise in areas following disturbance is not well documented and poorly understood. Seagrasses growing in subtidal regions have been found to re-colonise disturbed areas within two years of the initial loss (Preen *et al.* 1995), but there is a paucity of information on the recovery of intertidal seagrasses following disturbance and loss (Anon. 1995, J. Comans, HBDSMP, Pers Comm).

This study examined the seasonality and inter-annual trends in seagrass abundance and epiphyte/algal abundance at specific local sites and across regional landscape scales. The two main parameters measured to assess changes in seagrass abundance were based upon our conceptual understanding of seagrass growth dynamics in tropical and subtropical regions.

Percentage cover estimates provide a surrogate measure of increased biomass and shoot density because growth is primarily through rhizome extension and shoot growth. The measure of shoot or canopy height can indicate influences associated with nutrient enrichment and catchment inputs (Udy and Dennison 1997). The study was unique in that it implemented a community based monitoring program to train community members in the use of scientifically rigorous monitoring techniques. Changes in seagrass abundance and distribution were recorded at a number of selected sites in Hervey Bay and Whitsundays regions in Queensland, Australia. This report summarises findings of the first 12 month period of the Seagrass-Watch program from September 1999 to September 2000.

Regional descriptions

Hervey Bay is a large embayment (3,940 km²) situated on Queensland's southern coast. Extensive intertidal banks (2,307 km²) consisting of fine to medium grained sands fringe the landward component of the bay supporting extensive yet sparse seagrass meadows. The tidal range in this region is up to 4.1m. The Mary River flows into the northern region of the Great Sandy Strait before entering Hervey Bay from the south. The Mary River Catchment consists of both sewered and unsewered residential and urban areas fringing the coastline. Leakage from septic tanks into nearby drains and creeks and stormwater run-off threaten the viability of near-shore seagrass ecosystems. Extensive land clearing for cane production and dryland grazing has also altered the catchment contributing to erosion and increased freshwater run-off into near-shore ecosystems.

The Great Sandy Strait is a sand passage estuary between the mainland and Fraser Island and encompasses 93,160 hectares (McKenzie *et al.* 2000). The area contains 5,554 hectares of seagrass meadows growing on intertidal sand and mud flats. The tidal range in the strait is up to 4.1m. The catchment to the south and west of the strait consists of two major drainage basins; the Tin Can and Boonooroo watersheds. The Tin Can watershed includes three major creeks (Teebar, Snapper and Kauri Creeks). The catchment encompasses the Cooloola National Park comprising native woodlands, heath and coastal dune vegetation. By comparison, much of the Boonooroo catchment consists of woodlands, extensive mangrove wetlands and modified agricultural lands. Two major watercourses, the Tuan and Poona Creeks drain the Boonooroo watershed from extensive pine plantations, cane farms and grazing lands. More detailed description of these catchments are described in McKenzie *et al.* (2000).

The Whitsunday region has extensive seagrass meadows occurring both on intertidal mudflats and in nearshore and offshore subtidal regions. The region contains 5,554 hectares of seagrass from Midge Point in the south to Hydeaway Bay in the north. The tidal range is up to 4.1m. The catchment encompasses extensive urbanised residential areas fringing the coastline. Treated sewage effluent from the townships of Airlie Beach and Cannonvale is discharged into Pioneer Bay. Other townships in the region are unsewered and rely of septic tanks. Agricultural useage in the catchment includes cane production and lowland grazing. Cape Conway National Park is situated in the centre of the region. Two major rivers enter Repulse Bay: the Proserpine River and the O'Connell Rivers.

METHODOLOGY

Program Structure

The Seagrass-Watch program involves collaboration between Government and the Community by using: community resources; local coordination; local support; available capital, and scientific expertise.

Regional Steering Committees were formed within each project region with various stakeholders of the community to ensure that project goals and milestones were being met and to highlight any difficulties. A government funded Seagrass-Watch Coordinator was employed to manage/validate the data, coordinate between communities and scientists, establish networks and to develop the program state/nation-wide.

The main contact in each region is a Local Community Coordinator who was a link in the information and data chain between local communities and the Seagrass-Watch Coordinator. Community groups are encouraged to meet periodically (such as monthly) to update members on the project status and coordinate volunteers to monitor sites and conduct extension activities to raise public awareness (eg local festivals and displays).

Training

Training of volunteers was usually comprised of three components – formal lectures, field training exercise, and laboratory exercise. Training also included hands on experience with standard methodologies used for seagrass mapping and monitoring (Coles *et al.* 1995). Methods used in the program however were modified based on feedback from participants during the training exercises.

Participants were trained to identify local seagrass species, undertake rapid visual assessment methods (% cover), preserve seagrass samples for a herbarium, use a GPS, photograph quadrats, identify presence of dugong feeding trails or other impacts, and the use, analysis and interpretation (including Geographic Information Systems) of the data collected.

Follow up training (“refresher”) was an important component of the program to ensure that data collection is rigorous. Training aids were developed in consultation with the community and included a manual, field data books, and photographic reference sheets.

Seagrass resource mapping (refer Seagrass-Watch manual)

Seagrass-Watch activities initially assisted in the mapping of the distribution of seagrass meadows in each region. Community volunteers were limited to mapping the accessible intertidal seagrasses, although in some cases subtidal seagrass meadows were included. Mapping activities were coordinated through the Local Community Coordinator to ensure that as much of the region is covered as possible within the shortest period of time. Mapping strategies were also checked with the Seagrass-Watch Coordinator to ensure rigour. Once field mapping was completed, the data sheets were returned to the Seagrass-Watch Coordinator, via the Local Community Coordinator (who checks for any discrepancies). After the data from the mapping activities was validated and analysed, GIS maps were prepared for the region and fed back to the community groups.

Seagrass resource monitoring (refer Seagrass-Watch manual)

Using these maps of seagrass distribution, a community consultation meeting with the Seagrass-Watch volunteers was held to select the locations for long-term monitoring. The

program initially targeted inshore, intertidal seagrasses. In some cases subtidal seagrass meadows were included. Site selection was assisted by consultation with environment management agencies, local government, and seagrass researchers. The position of sites was also dependent on volunteers, as often volunteers elected to adopt a site which was close to their place of residence. Seagrass-Watch ongoing monitoring was coupled where possible with existing environmental monitoring programs (eg. seagrass depth range, water quality and beach profile) to complement other datasets used to predict threats and identify impacts on coastal seagrass habitats.

The monitoring strategy employed a nested design conducted at three spatial scales: transect (metres), site (kilometres) and location (10s kilometres). Long term monitoring sites were established in areas of **a.** relatively high usage, **b.** where usage may be high in the near future and **c.** in comparable ‘control’ sites where current and predicted usage is low and likely to remain low. Generally, two to four sites are established within each location.

At each site, three parallel 50m transects (each 25m apart) were established, with only the middle transect permanently marked. The location of sites was recorded using GPS. The seagrass habitats along each transect were sampled by visual observation. At each transect, eleven quadrats were sampled (1 quadrat every 5m), every three months, depending on site access and availability of volunteers. Quadrats were photographed at 5, 25 and 45m to ensure standardisation/calibration of observers and to provide a permanent record.

Site selection

From December 1998 to January 2000 the seagrass abundance and distribution throughout the Hervey Bay (Map 1). and Whitsunday regions (Map 2) were mapped. Twelve localities within Hervey Bay/Great Sandy Straits and 8 within the Whitsundays were selected to represent the geographic extent of seagrass communities and the complexity of threats to their survival. Threats were associated with disturbances from dredging, anchor damage, stormwater inputs, sewage, and septic inputs and catchment runoff. Areas were also chosen to encompass the range of habitats utilised by fauna, such as dugong, turtles, fish and prawns.

Site localities

A total of 20 localities consisting of 53 sites were monitored by community groups across the Hervey Bay (9 sites), Great Sandy Straits (23 sites) (Map 1) and Whitsunday regions (21 sites) (Map 2). Localities monitored in the Hervey Bay region included Burrum Heads, Toogoom and Dundowran. In the Great Sandy Strait localities monitored included northern Urangan, Booral Wetland and Wanggoolba Creek sites and southern sites, Poona, Boonooroo, Reef Islands, Browns Gutter, Tootawwah Creek and Pelican Bay. Intertidal localities monitored in the Whitsundays were located at Hydeaway Bay, Dingo Beach, Pigeon Island, Laguna Quays, Midge Point and Midgeton. Subtidal localities included Whitehaven Beach and north of Cid Harbour.

Seagrass monitoring

The methodologies described below are summarised from the manual and were used by trained community members. Training involved attendance at workshops where participants were skilled in techniques of seagrasses taxonomy and monitoring. Techniques used to measure seagrass abundance were tailored to suit features of local site. Two methods were employed:

i. Transect method

At each locality, 2-3 sites (50 x 50m) were permanently marked within homogenous seagrass meadows. Sites within each locality were located approximately 500m apart. At each intertidal site 3 x 50m transects were positioned perpendicular to the shore and located 25m apart. Visual estimates of percentage seagrass cover and percentage species composition, epiphyte cover and algal cover in 0.25m² quadrats were made every 5m along each 50m transect (n=33 per site). Standardised percentage cover photo-indices were used as a guide to reduce observer bias and increase observer consistency in visual estimation.

At subtidal sites, where this method was employed 3 x 100m transects were placed 50 m apart and visual abundance estimates of 0.25m² quadrats were made every 10m.

ii. Free diving method

This method was used to monitor a large area (10km²) of seagrass north of Cid Harbour on the west of Whitsunday Island. Five transects were placed 1 km apart perpendicular to the coastline. Estimates of seagrass cover were made every 700m (3 sampling locations per transect). At each location two divers “free dived” to the seabed and measured percentage seagrass cover, percentage species composition, and percentage epiphyte and algal cover from 3 randomly placed 0.25m² quadrats. A total of 15 locations along 5 transects were monitored.

Measurement of Observer bias

To assess data quality and assurance measures of observer estimates were compared with pre-determined percentage cover values were. For each observer the ratio of observed to actual percentage cover estimates were calculated for each of the 12 photos (eq. 1)

$$\frac{\text{observed seagrass}}{\text{actual seagrass}} \times 100 \quad (\text{equation 1})$$

For each of the 12 values the mean (\pm s.d.) observed/ known percentage cover ratio was calculated across all observers (n=19). Coefficient of variation (CV) for each photo-cover category was calculated (eq. 2).

$$(\text{Stdev/mean}) \times 100 \quad (\text{equation 2})$$

Report card

A rating system was developed to express the overall “state” of each locality and region. The rating system was based on an assessment of the status (poor, fair, good) of each parameter (eg trend in seagrass cover) at each site. Overall ratings for each locality were based on an overview of all data for each site.

Table 1. Criteria for rating each Seagrass-Watch Monitoring Site

Category and weighting	<i>Poor state</i>	<i>Fair state</i>	<i>Good state</i>
Trend in seagrass cover and canopy height	Trend in seagrass abundance has severely declined successively between months (after 12 months monitoring abundance is significantly lower from time 0) and greater than 75% loss with little sign of recovery.	Trend in seagrass abundance has declined successively between months (after 12 months monitoring abundance is significantly lower from time 0) and less than 50% loss.	Typical seasonal trend in seagrass abundance (after 12 months monitoring abundance is not significantly different from time 0) with less than 10% loss.
Species composition	Dominant species has severely declined successively between months (after 12 months abundance is significantly lower from time 0) and greater than 75% loss with little sign of recovery.	Dominant species has declined successively between months (after 12 months abundance is significantly lower from time 0) and less than 50% loss.	Dominant species has changed less than 10% in species composition (after 12 months composition is not significantly different from time 0).
Algae & Epiphytes	Algal blooms persistent over the year changes in species composition and high abundance (>30% cover).	Algal blooms less persistent (eg 1 bloom per year). Epiphyte cover stable.	Epiphyte cover less than 50% cover and algal cover minimal (< 10%).
Dugong and turtle grazing	Dugong and turtle grazing not evident.	Dugong and turtle grazing occasional.	Dugong and turtle grazing frequent.
Associated fauna	Macroinvertebrate numbers reduced by more than 50% over 12 month period.	Macroinvertebrate numbers remained stable over a 12 month monitoring period.	Macroinvertebrate numbers and diversity increased over a 12 month monitoring period.
Physical disturbance	Sediment composition changed. Sediment movement causing disturbance.	Sediment composition fairly stable with occasional disturbance.	Stable sediments. Minimal sediment movement.

RESULTS

Seagrass-Watch programs have been established in the Hervey Bay and Whitsundays regions of Queensland with involvement of a number of volunteer community groups and individuals. Volunteers cover a diverse range of community sectors and include school groups/teachers, recreational & commercial fishers, SCUBA divers, State Agency volunteers, local Wildlife Preservation Society members, local tourism industry employees, local city councils, retirees, community youth groups, and other various interested individual community members. Local Community Coordinators and key contact people have been identified for the volunteer groups in each region.

Mapping of seagrass communities in each region has been conducted. Community groups and volunteers working with seagrass researchers successfully mapped 22% of the sites in a detailed baseline survey of Hervey Bay and Great Sandy Strait region seagrass communities in December 1998.

Seagrass-Watch data and associated GIS outputs have been used by environment management agencies for: responses to dredging proposals; assisted with assessment of flooding impacts; contributed to the information for world heritage value assessments for World Heritage Area listings; contributed to regional and local Plans of Management; and aided with the management of Dugong Protection Areas.

Community participation

Participation increased 3-fold from September 1999 to September 2001 across both regions (Figure 1). The number of sites monitored also doubled from 27 in August 1999 to 50 after 2 years of monitoring. An increase in the sites able to be monitored independently by volunteers was also achieved, ranging from 0% in August 1999 to 76% (Whitsundays) and 100% (Hervey Bay/Sandy Strait) in November 2001.

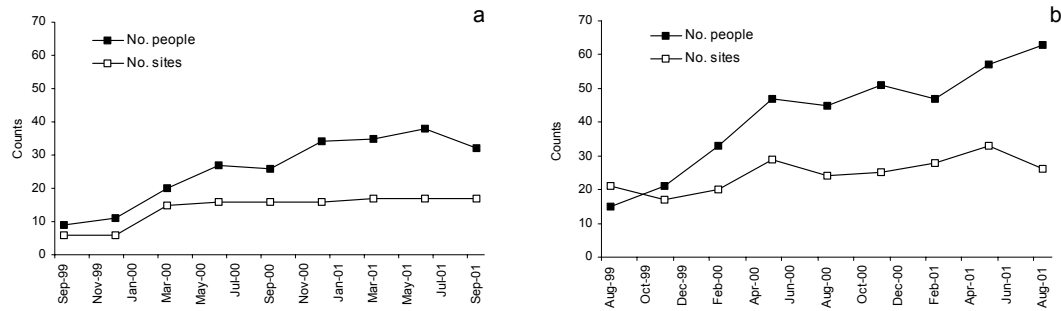


Figure 1. Number of field monitoring volunteers and sites monitored from August 1999 to September 2001 in (a) Whitsunday's and (b) Hervey Bay/Great Sandy Strait.

Measurement of Observer bias

The precision of observer's estimates of seagrass cover was measured experimentally by observers estimating the percentage cover of a series (12) of photographs of seagrass in quadrats. Observers estimates were plotted against the known seagrass percentage cover for each of the 12 photographs (Figure 2). A strong positive relationship was found between observer's estimates and pre-determined cover values.

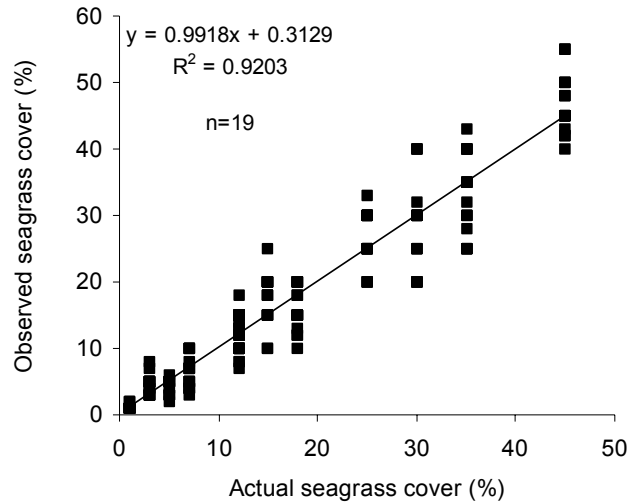


Figure 2. Estimates of seagrass cover (%) of observers versus actual seagrass cover (%).

Across all observers the variance (CV) of observers estimates was up to 40% of the known standard values. The variance decreased as the percentage seagrass cover increased suggesting that observer bias decreases with increasing estimates of seagrass cover (Figure 3). Although visual estimates of cover at low abundances are achievable there remains a high degree of error associated with observer bias of these estimates.

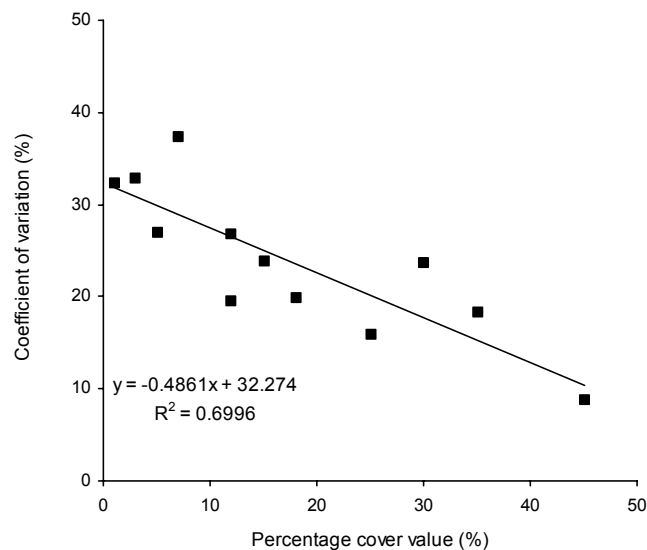


Figure 3. Coefficient of variation (CV%) for each photo-quadrat versus percentage cover value.

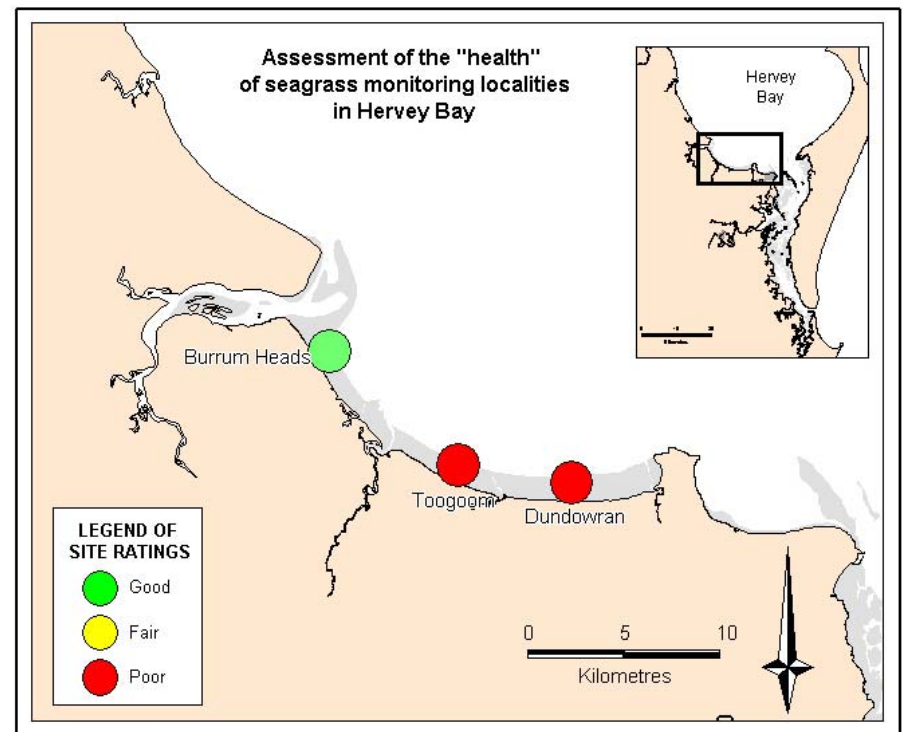
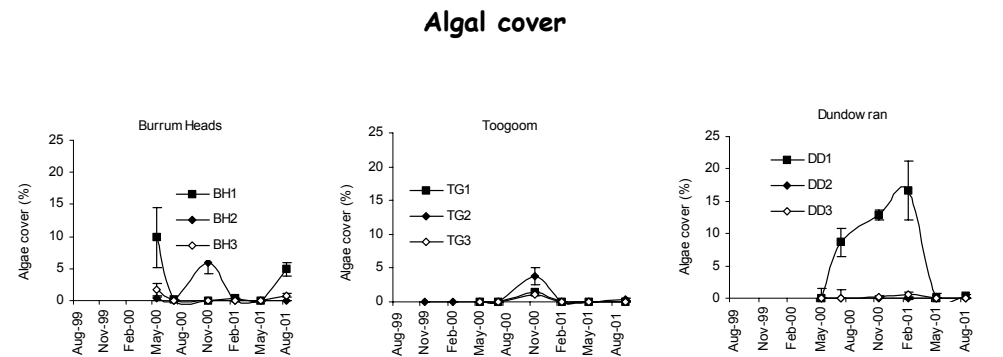
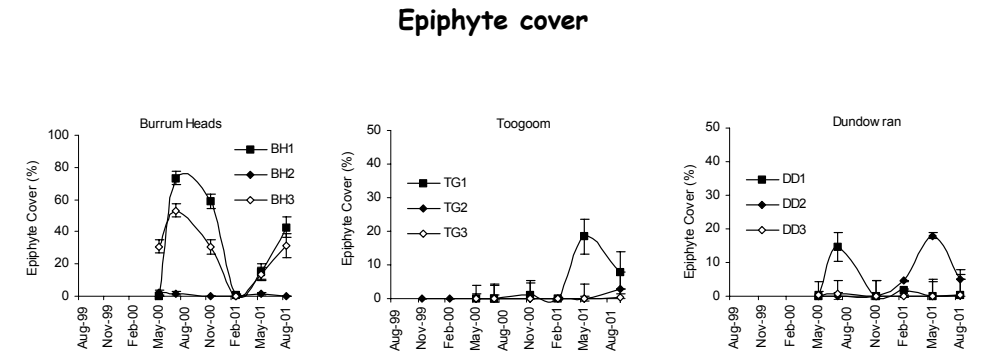
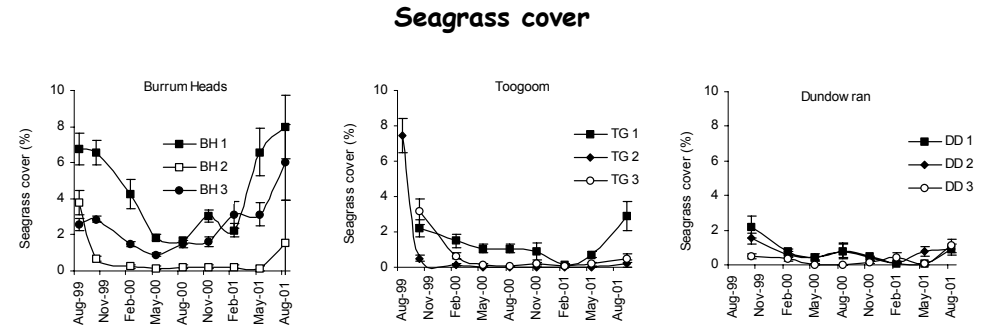
Reducing observer bias

All observers were formally trained to identify seagrass species, estimate the percentage cover of seagrass species, epiphyte loads, algal cover and other prior to survey events. Standard percentage cover sheets were used as a basis upon which visual estimates of percentage seagrass cover were made. Along a chosen transect line 2-4 observers would determine the percentage cover of each 50 x 50 cm quadrat. The use of multiple observers along transect lines reduces the variability between observers in estimating percentage seagrass cover.

STATE OF SEAGRASS HABITATS IN HERVEY BAY

REPORT CARD: HERVEY BAY

Category	Comments		
Trends in seagrass abundance and canopy height Fig 4	<p>The decline in seagrass cover from August 1999 to May 2000 at most intertidal sites between Burrum Heads and Dundowran was due to burial by mobile sediments. From May 2000 seagrass cover increased at Burrum Heads. Seagrass cover generally remained low at Toogoom and Dundowran. Seagrass abundance is consistent with previous surveys in November 1988. Canopy height increased from a mean of 2cm to greater than 3cm from August 1999 to August 2001.</p> <p>Rating Burrum Heads (good) Toogoom (fair) Dundowran (poor)</p>		
Seagrass species composition	<p>The dominant seagrass species at Burrum Heads, Toogoom and Dundowran include <i>Halodule uninervis</i> (narrow leaf morphology) and <i>Halophila ovalis</i>. At some localities (Burrum Heads, Toogoom) species composition varied over the monitoring period with losses of both <i>Z. capricorni</i> and <i>H. uninervis</i> due to sediment burial.</p> <p>Rating Burrum Heads (fair) Toogoom (fair) Dundowran (fair)</p>		
Epiphytes and algae Fig 5 and 6	<p>Epiphyte and algal cover was generally low (<2%) in February (summer) and May (autumn) and increased to 10-60% cover at some sites during August (winter) and November (spring). The absence of persistent year-round algal growth suggests that nutrient availability at these sites is unlikely to cause eutrophication. The overall trends indicate seasonal peaks in epiphyte and algal cover from late winter to spring.</p> <p>Rating Burrum Heads (good) Toogoom (good) Dundowran (good)</p>		
Dugong feeding	<p>Dugong feeding trails were found at Burrum Heads (BH1) and were most abundant in May (2000-01) and August (2000-01).</p> <p>Rating Burrum Heads (good) Toogoom (poor) Dundowran (poor)</p>		
Invertebrate fauna	<p>Polychaete worms are common at intertidal sites from Burrum Heads to Dundowran but gastropods were relatively scarce. The abundance of polychaetes may be due to high supply of detrital matter, a known food source. Gastropods not only scavenge detrital matter but some graze on seagrass leaves, and some are predatory in their feeding habit. The paucity of gastropods in seagrass meadows may due to low seagrass abundance (ie less grazing matter and associated faunal prey).</p> <p>Rating Burrum Heads (poor) Toogoom (poor) Dundowran (poor)</p>		
Physical disturbance	<p>Intertidal seagrass meadows in Hervey Bay are composed of fine to medium grained rippled sands. The sites are influenced by wave action and tidal flows with high sediment movement observed throughout the monitoring period. A likely cause for change in seagrass cover at some sites (TG2, TG3, DD2) was smothering by sand movement and scouring by water channels. Nutrient sources from agricultural lands, unsewered developments and sewage outlets, in proximity to seagrass sites include the Burnett River near BH1 and Eli Creek near DD3.</p> <p>Rating Burrum Heads (poor) Toogoom (poor) Dundowran (poor)</p>		
Parameter/site ratings	Burrum Heads	Toogoom	Dundowran
Seagrass cover	Good	Fair	Poor
Species composition	Fair	Fair	Fair
Epiphytes and algae	Good	Good	Good
Dugong and turtle grazing	Good	Poor	Poor
Associated fauna	Good	Poor	Poor
Physical disturbance	Poor	Poor	Poor
Overall Rating	Fair-Good	Poor-Fair	Poor-Fair

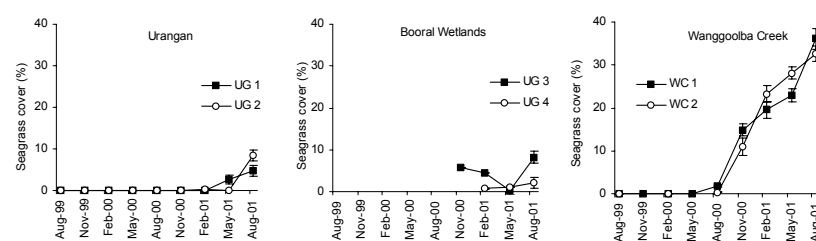


STATE OF SEAGRASS HABITATS IN THE GREAT SANDY STRAIT

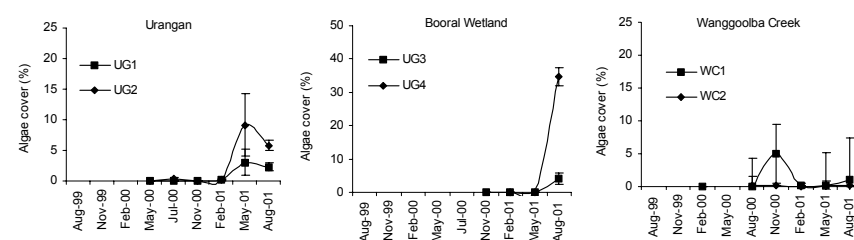
REPORT CARD: NORTHERN GREAT SANDY STRAIT

Category	Comments																																
Trends in seagrass abundance and canopy height	<p>Seagrass loss occurred at Urangan, Booral Wetland and Wangoolba Creek sites in March 1999 following the Mary River flood in February 1999. Urangan sites are located close to the Mary River mouth and following the flood in February 1999, seagrass was absent (0% cover) from August 1999 to May 2000. In July 2000 seedlings of <i>Zostera capricorni</i> germinated, and by May 2001 seagrass cover was 2-3%. In August 2001 (30 months post-flood) the abundance of <i>Z. capricorni</i> had increased to 5-8% at both UG1 and UG2. At Booral (UG3 and UG4) the cover of <i>Z. capricorni</i> and <i>Halophila ovalis</i> also increased from November 2000 (2-3%) to August 2001 (5-8%).</p> <p>Low seagrass cover (mean = < 0.1% cover) (<i>Z. capricorni</i> and <i>Halophila ovalis</i>) was recorded at WC1 and WC2 from August 1999 to May 2000. Seagrass showed signs of recovery, with mean seagrass cover values of 1.7% at WC1 and 0.3% at WC2 18 months after the Feb 1999 flood. In February 2001, 24 months post-flood, the mean seagrass cover at WC1 and WC2 had increased to 19% and 23% respectively, similar to levels found prior to the February 1999.</p> <p>The canopy height of <i>Zostera capricorni</i> across the region increased to 4-5cm over the 2 year monitoring period.</p> <p>Rating: Urangan (fair), Booral (fair) Wangoolba Creek (good)</p>																																
Species composition	<p><i>Zostera capricorni</i> and <i>Halophila ovalis</i> were common at Urangan, Booral and Wangoolba Creek. At all localities the change in species composition was due to increased <i>H. ovalis</i> colonising sites from November 2000 onwards. <i>H. ovalis</i> is a colonising seagrass species and its re-appearance indicates the first stages of meadow recovery following impact.</p> <p>Rating: Urangan (good), Booral (fair) Wangoolba Creek (good).</p>																																
Epiphytes and algae	<p>Epiphyte and algal cover was generally low (<2%) in February (summer) and May (autumn) and increased to 10-60% cover at some sites during August (winter) and November (spring). The absence of year-round algal growth at all sites suggests that nutrient availability at these sites is generally low. Algal blooms (<i>Cladophora</i> sp.) occurred in August 2001 at Urangan and Wangoolba Creek. Trends indicate a seasonal peak in epiphyte and algal cover from late winter to spring. In contrast epiphyte cover was high (35%) at Wangoolba Creek in February 2001, coinciding with high water temperatures. Epiphyte cover may also be high due to naturally available nutrients (eg. mangrove detritus) from Fraser Island catchment</p> <p>Rating: Urangan (fair), Booral (fair) Wangoolba Creek (fair).</p>																																
Dugong feeding	<p>Dugong trails were found at Wangoolba Creek sites (WC1 and WC2) in November (2000), February (2001) and August (2001). Dugong feeding was absent at Urangan until August 2001, coinciding with seagrass recovery. No evidence of dugong feeding was found at the Booral Wetlands sites (Urangan sites 3 and 4).</p> <p>Rating: Urangan (fair), Booral (fair) Wangoolba Creek (good).</p>																																
Associated fauna	<p>The high abundance of gastropods at Urangan and Wangoolba Creek may be due to high amounts of mud and organic detrital matter in the sediments. Polychaete worms were also abundant at Urangan sites and mud whelks (a type of gastropod) were abundant at Wangoolba Creek. Both animals are detrital feeders and competition for available detrital matter may explain the dominance of one over the other. The occurrence of polychaete worms at sites low in seagrass abundance suggests that they are likely to survive on low amounts of food relative to the larger gastropods. They are possible indicators of low seagrass abundance.</p> <p>Rating: Urangan (good), Booral (fair) Wangoolba Creek (good).</p>																																
Physical disturbance	<p>Sediments consisted of un-rippled fine sand and muds throughout the monitoring period at Urangan, Booral and Wangoolba Creek sites. Nutrient sources, from agricultural lands, unsewered developments and sewage outlets, in proximity to seagrass sites, include Pugul Creek, Mary River and Wangoolba Creek. Flooding of these rivers and creeks threatens the survival of seagrass meadows in the region. Recovery time of meadows in proximity to catchments modified by urban development and agriculture is double that of meadows near to native vegetation.</p> <p>Rating: Urangan (fair), Booral (fair) Wangoolba Creek (good).</p>																																
Parameter/site ratings	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;"></th> <th style="width: 33%;">Urangan</th> <th style="width: 33%;">Booral</th> <th style="width: 33%;">Wangoolba Creek</th> </tr> </thead> <tbody> <tr> <td>Seagrass cover</td> <td style="text-align: center;">Fair</td> <td style="text-align: center;">Fair</td> <td style="text-align: center;">Good</td> </tr> <tr> <td>Species composition</td> <td style="text-align: center;">Good</td> <td style="text-align: center;">Fair</td> <td style="text-align: center;">Good</td> </tr> <tr> <td>Epiphytes and algae</td> <td style="text-align: center;">Fair</td> <td style="text-align: center;">Fair</td> <td style="text-align: center;">Fair</td> </tr> <tr> <td>Dugong/turtle grazing</td> <td style="text-align: center;">Fair</td> <td style="text-align: center;">Fair</td> <td style="text-align: center;">Good</td> </tr> <tr> <td>Invertebrate fauna</td> <td style="text-align: center;">Good</td> <td style="text-align: center;">Fair</td> <td style="text-align: center;">Good</td> </tr> <tr> <td>Physical disturbance</td> <td style="text-align: center;">Fair</td> <td style="text-align: center;">Fair</td> <td style="text-align: center;">Good</td> </tr> <tr> <td>Overall rating</td> <td style="text-align: center;">Fair</td> <td style="text-align: center;">Fair</td> <td style="text-align: center;">Good</td> </tr> </tbody> </table>		Urangan	Booral	Wangoolba Creek	Seagrass cover	Fair	Fair	Good	Species composition	Good	Fair	Good	Epiphytes and algae	Fair	Fair	Fair	Dugong/turtle grazing	Fair	Fair	Good	Invertebrate fauna	Good	Fair	Good	Physical disturbance	Fair	Fair	Good	Overall rating	Fair	Fair	Good
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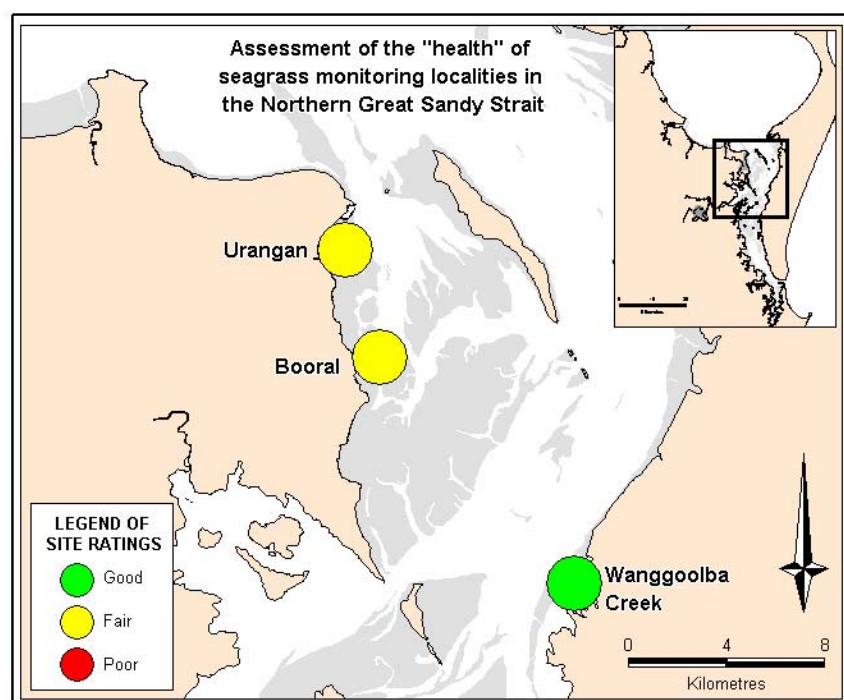
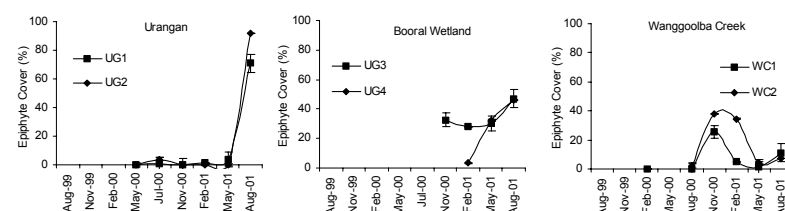
Seagrass cover



Algal cover



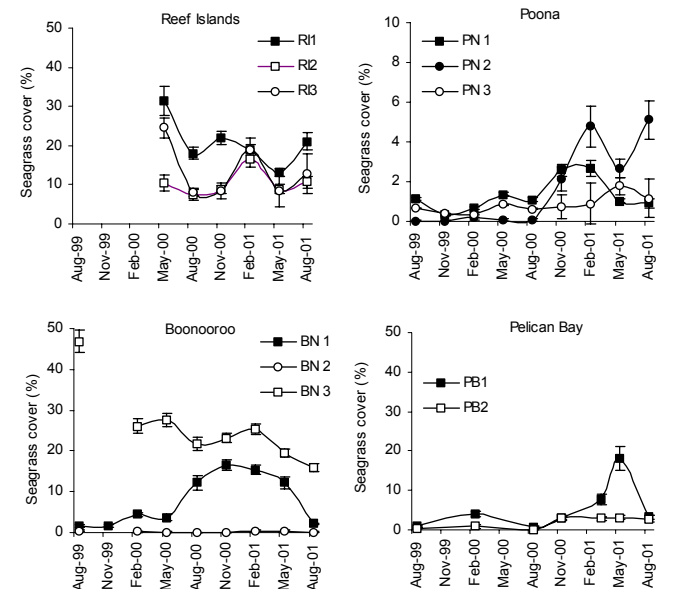
Epiphyte cover



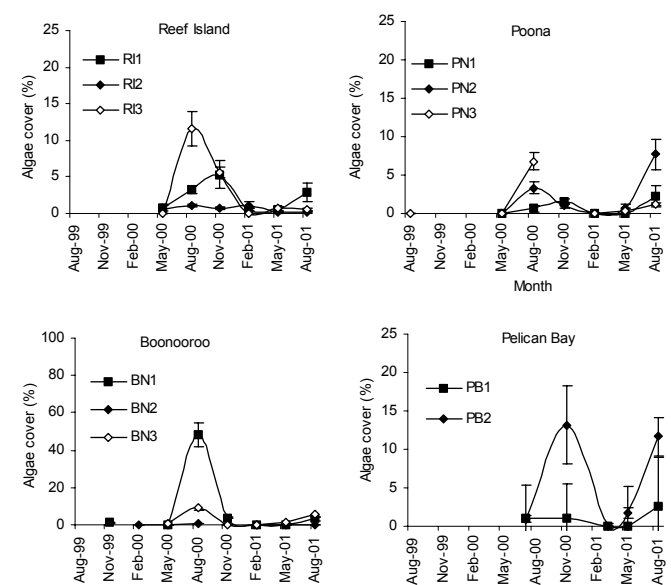
REPORT CARD: SOUTHERN GREAT SANDY STRAIT

Category	Comments																																																								
Trend in seagrass abundance	<p>Changes in seagrass cover were characterised by seasonal patterns at sites distant from freshwater inputs, and recovery at sites close to freshwater inputs.</p> <p>At meadows distant (> 1 km) from freshwater inputs (BN3, RI1, RI2 and RI3), seagrass cover was high (15-50%) reaching maxima in summer-autumn (February-May) and minima in winter (August). At sites near (< 1 km) the mouth of freshwater inputs seagrass cover was 2-3 fold lower (<2-10%) than at distant sites. At Bonooroo (BN1 and BN2), and Pelican Bay (PB1) seagrass cover increased more than 10-fold from August 1999 (mean = 0.1-1.5 %) to August 2001 (mean =12.2%- 18%). Seagrass cover at Poona sites increased more than 2-fold. Increases in seagrass cover over the 2 year period indicate post-flood recovery. At other sites where seagrass cover is low or absent (PB2, Browns Gutter, and Tootawah Creek) the absence of seasonal trends suggest that factors other than natural changes in light and temperature (ie sediment inputs, nutrients) are influencing seagrass growth.</p> <p>Rating: Bonooroo (fair), Poona (fair), Reef Island (good), Tootawah Creek (poor), Browns Gutter (poor), Pelican Bay (fair)</p>																																																								
Species composition	<p>Intertidal seagrass meadows in the region are composed of mixed meadows of <i>Halodule uninervis</i>, <i>Halophila ovalis</i> and <i>Zostera capricorni</i>. <i>H. uninervis</i> and <i>H. ovalis</i> dominate nearshore sites whereas <i>Z. capricorni</i> is most common at distant sites. Changes indicative of disturbance and re-colonisation included increases in <i>Z. capricorni</i> (BN2, PN2) and increases in <i>H. ovalis</i> (PB2) at sites close to catchment inputs.</p> <p>Rating: Bonooroo (fair), Poona (fair), Reef Island (good), Tootawah Creek (poor), Browns Gutter (poor), Pelican Bay (fair)</p>																																																								
Epiphytes and algae	<p>High epiphyte cover (30-90%), algal cover (10-50%) and sediment microalgal cover (20-95%) was recorded at 11 of the 14 sites. The year round persistence of algal flora at 6 (BN2, PB1, PB2, and BG1,2,3) of the 11 sites is indicative of nutrient availability, possibly from catchment inputs. Algal abundance was generally highest in May, August and November and lowest in February.</p> <p>Rating: Bonooroo (fair), Poona (fair), Reef Island (good), Tootawah Creek (poor), Browns Gutter (poor), Pelican Bay (poor)</p>																																																								
Dugong and turtle grazing	<p>Dugong feeding trails were found year round at Poona, Bonooroo and Reef Island sites. The most intensive grazing occurred from May to November, coinciding with the nutritional demands of calving from September to December. During this period seasonal forces support high seagrass growth ensuring that losses from grazing are outweighed by tissue production. Turtle feeding was evident year round.</p> <p>Rating: Bonooroo (fair), Poona (good), Reef Island (good), Tootawah Creek (poor), Browns Gutter (poor), Pelican Bay (fair)</p>																																																								
Associated fauna	<p>Polycheate worms and gastropods (including mud whelks) are common at most intertidal sites. The diversity and abundance of gastropods appears to be dependent on seagrass abundance, most likely due to associated detrital and prey food sources. Filter feeding bivalves and oysters are found at Reef Island sites.</p> <p>Rating: Bonooroo (good), Poona (good), Reef Island (good), Tootawah Creek (poor), Browns Gutter (poor), Pelican Bay (fair)</p>																																																								
Physical disturbance	<p>Seagrass meadows at Poona, Bonooroo and Pelican Bay are predominantly composed of fine mud and fine sand with a high organic component. Sites near Poona Creek (PN2), Big Tuan Creek (BN2) and Tin Can Inlet (PB1 and PB2) have low seagrass cover, contain muddy sediments with a low sand component. Seagrasses in these areas trap sediments, accumulate organic matter and are major sinks for sediments from the catchment. At meadows distant from freshwater inputs (RI1-3, BN3, PN3) sand rippling indicates the influence of tidal movement and/or a low exposure to catchment influences.</p> <p>Rating: Bonooroo (fair), Poona (fair), Reef Island (good), Tootawah Creek (poor), Browns Gutter (poor), Pelican Bay (fair)</p>																																																								
Parameter/site rating	<table border="1"> <thead> <tr> <th></th> <th>Browns Gutter</th> <th>Tootawah Creek</th> <th>Pelican Bay</th> <th>Bonooroo</th> <th>Poona</th> <th>Reef Islands</th> </tr> </thead> <tbody> <tr> <td>Seagrass cover</td> <td>Poor</td> <td>Poor</td> <td>Fair</td> <td>Fair-good</td> <td>Fair</td> <td>Good</td> </tr> <tr> <td>Species composition</td> <td>Poor</td> <td>Poor</td> <td>Fair</td> <td>Fair-good</td> <td>Fair</td> <td>Good</td> </tr> <tr> <td>Epiphytes and algae</td> <td>Poor</td> <td>Poor</td> <td>Poor</td> <td>Fair</td> <td>Fair</td> <td>Good</td> </tr> <tr> <td>Dugong and turtle grazing</td> <td>Poor</td> <td>Poor</td> <td>Fair</td> <td>Fair</td> <td>Good</td> <td>Good</td> </tr> <tr> <td>Associated fauna</td> <td>Poor</td> <td>Poor</td> <td>Fair</td> <td>Good</td> <td>Good</td> <td>Good</td> </tr> <tr> <td>Physical disturbance</td> <td>Poor</td> <td>Poor</td> <td>Fair</td> <td>Fair</td> <td>Fair</td> <td>Good</td> </tr> <tr> <td>Overall rating</td> <td>Poor</td> <td>Poor</td> <td>Fair</td> <td>Fair-good</td> <td>Fair-good</td> <td>Good</td> </tr> </tbody> </table>		Browns Gutter	Tootawah Creek	Pelican Bay	Bonooroo	Poona	Reef Islands	Seagrass cover	Poor	Poor	Fair	Fair-good	Fair	Good	Species composition	Poor	Poor	Fair	Fair-good	Fair	Good	Epiphytes and algae	Poor	Poor	Poor	Fair	Fair	Good	Dugong and turtle grazing	Poor	Poor	Fair	Fair	Good	Good	Associated fauna	Poor	Poor	Fair	Good	Good	Good	Physical disturbance	Poor	Poor	Fair	Fair	Fair	Good	Overall rating	Poor	Poor	Fair	Fair-good	Fair-good	Good
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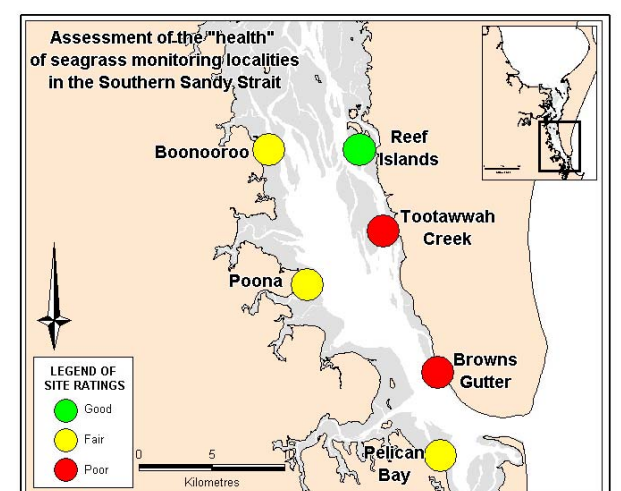
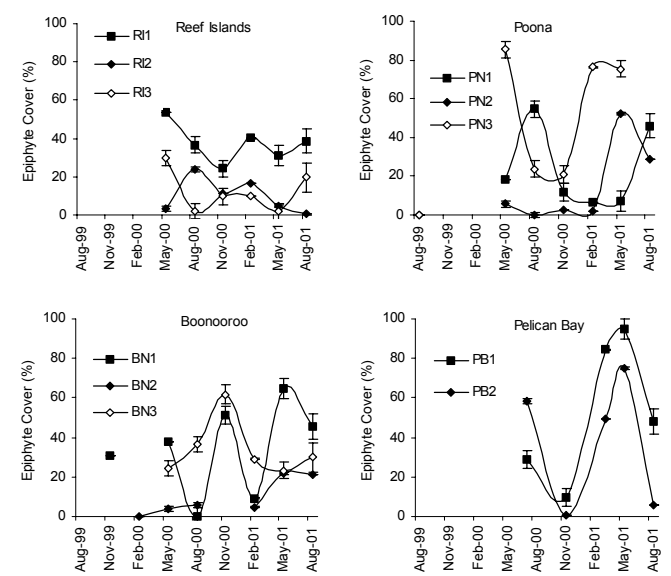
Seagrass cover



Algal cover

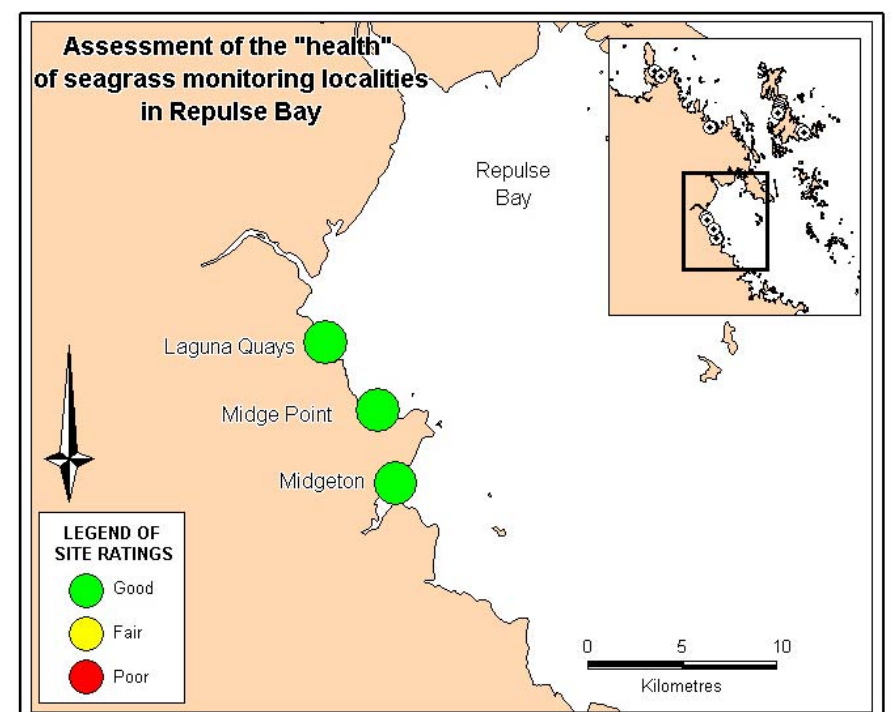
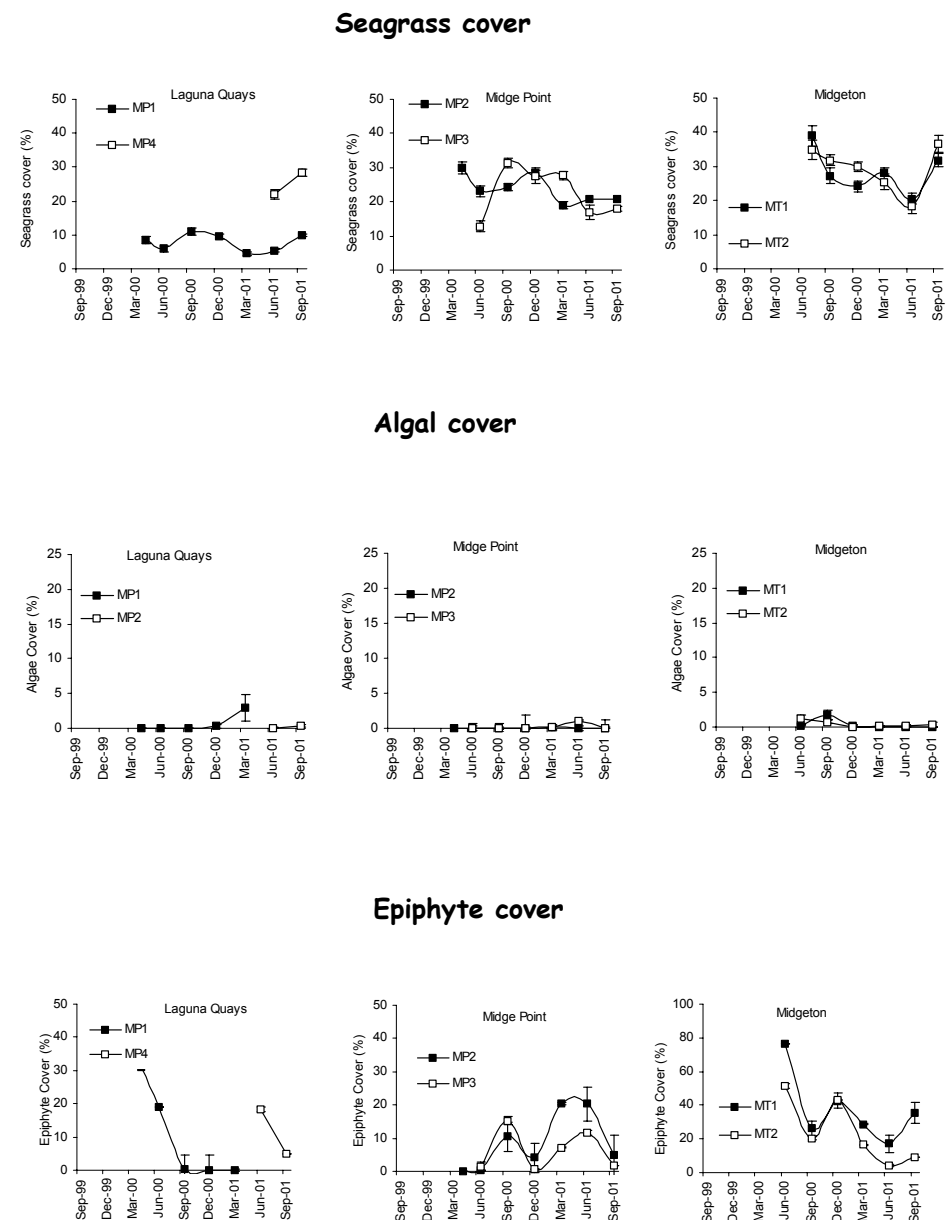


Epiphyte cover



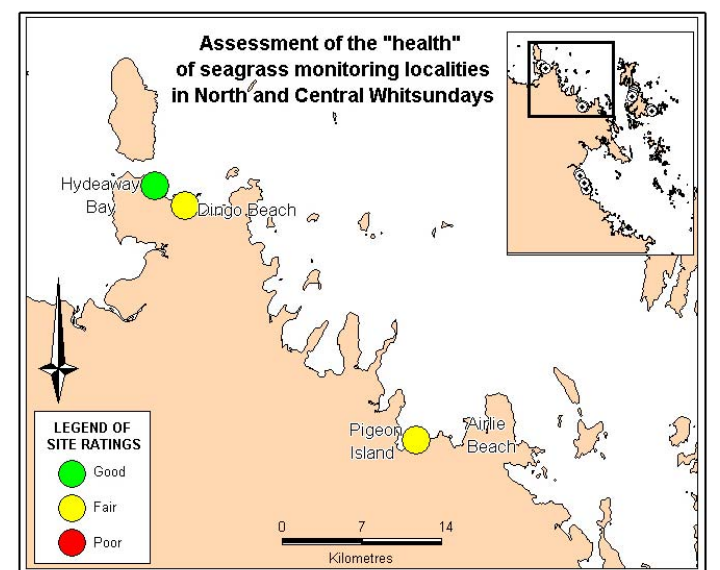
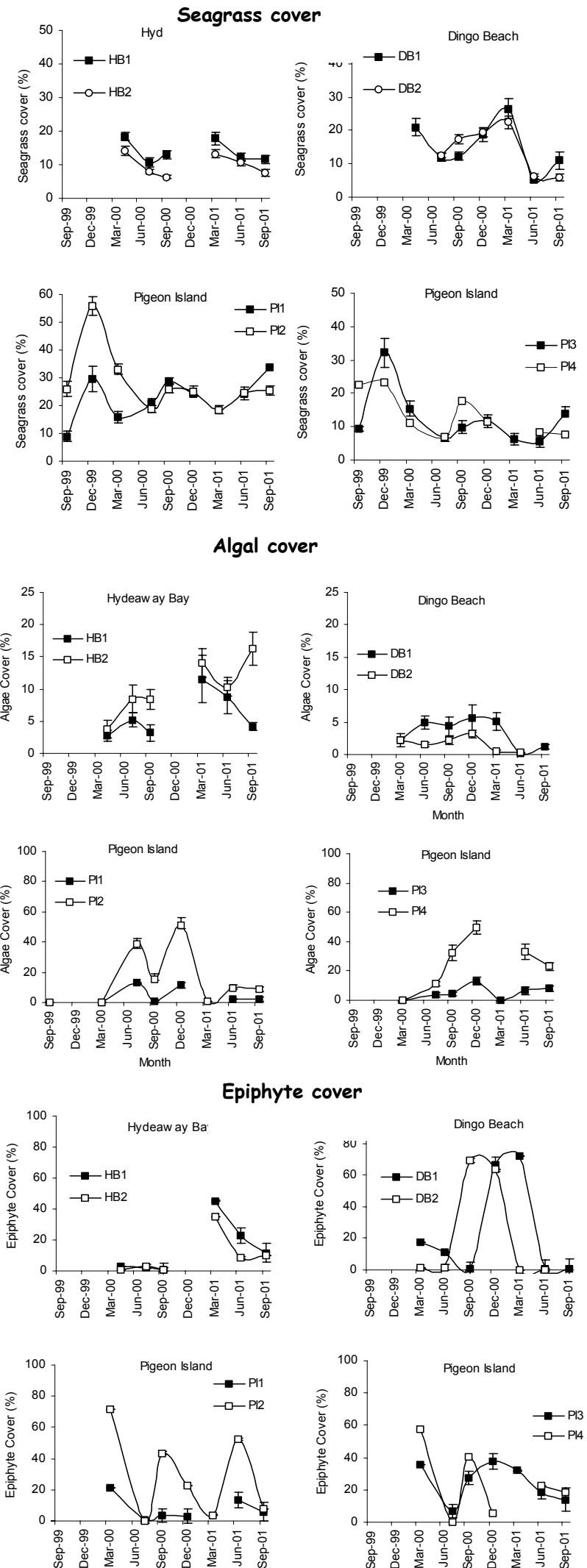
STATE OF SEAGRASS HABITATS IN THE WHITSUNDAYS: INTERTIDAL

REPORT CARD: REPULSE BAY			
Category	Comments		
Trend in seagrass abundance	<p>Seagrass abundance at Laguna Quays, Midge Point and Midgeton followed a seasonal trend, characterised by maximum cover (>20% cover) in spring/summer (September -January) and minimum cover (<20% cover) in winter (June-July). This suggests that seagrass meadows at these sites are primarily influenced by natural factors (temperature, light, wave action). In 2000 an opposite trend occurred at Midgeton with a decline in seagrass cover from July (winter) to February (summer). Midgeton is located at the mouth of Dempster Creek and this decline in seagrass cover was possibly due to disturbance from sediment movement associated with rainfall and freshwater inputs, together with strong wave action and south easterly winds.</p> <p>Rating: Laguna Quays (good), Midge Point (good), Midgeton (good)</p>		
Species composition	<p>Sites at Midge Point (MP2 and MP3) consist predominantly of <i>Zostera capricorni</i> mixed with low amounts <i>Halodule uninervis</i> and <i>Halophila ovalis</i>. At Laguna Quays MP1 was dominated by <i>Halodule uninervis</i>, and MP4 was dominated by <i>Z. capricorni</i>. Sites at Midgeton (MT1 and MT2) consist of an equal mix of <i>Z. capricorni</i>, <i>H. uninervis</i> and <i>H. ovalis</i>. The relative proportions of species at each site remained stable over the monitoring period.</p> <p>Rating: Laguna Quays (good), Midge Point (good), Midgeton (good)</p>		
Epiphytes and algae	<p>Epiphyte cover (40-70%) at Midgeton sites was high in spring-summer (December) and low in winter (June). Algal cover remained low (<2%) at these sites. Low epiphyte cover (<30%) and algal cover (<1%) was recorded at Laguna Quays and Midge Point sites.</p> <p>Rating: Laguna Quays (good), Midge Point (good), Midgeton (good)</p>		
Dugong and turtle feeding	<p>Dugong feeding trails were abundant at Midge Point, Laguna Quays and Midgeton. The occurrence of feeding trails varied between sites but highest feeding activity was recorded in March and September 2000. Evidence of turtle grazing year round was highest at Laguna Quays and Midge Point sites.</p> <p>Rating: Laguna Quays (good), Midge Point (good), Midgeton (good)</p>		
Associated fauna	<p>Gastropods and hermit crabs were common at Midge Point where high seagrass abundance provides a supply of detritus, grazing matter and faunal prey. The abundance of invertebrate fauna was less common at Laguna Quays and Midgeton sites.</p> <p>Rating: Laguna Quays (fair), Midge Point (good), Midgeton (fair)</p>		
Physical disturbance	<p>Sites at Laguna Quays had fine to medium sandy sediments, were exposed to wave action and generally had a low abundance of seagrass (<20% cover) consisting of <i>Halodule uninervis</i> and <i>Halophila ovalis</i>. Tidal dominated localities at Midge Point and Midgeton are composed of fine mud and sand sediments with a high organic component. The seagrass abundance at these sites is relatively high (15-40%) and dominated by a mixture of <i>Zostera capricorni</i>, <i>Halodule uninervis</i> and <i>Halophila ovalis</i>.</p> <p>Disturbance to seagrass meadows may be caused by a number of factors. At Midgeton wave action from prevailing south-easterly winds and strong tides results in sediment movement where fine muds are displaced with coarse sands and shell. At Midgeton sites freshwater flows from the Dempster Creek may also contribute to sediment disturbance.</p> <p>Rating: Laguna Quays (good), Midge Point (good), Midgeton (fair)</p>		
Parameter/site rating	Laguna Quays	Midge Point	Midgeton
Seagrass cover	Good	Good	Good
Species composition	Good	Good	Good
Epiphytes and algae	Good	Good	Good
Dugong and turtle grazing	Good	Good	Good
Associated fauna	Fair	Good	Fair
Physical disturbance	Good	Good	Fair
Overall rating	Good	Good	Good



REPORT CARD: NORTH AND CENTRAL WHITSUNDAYS

Category	Comments		
Trend in seagrass abundance	<p>Seagrass abundance in northern Whitsundays (Dingo Beach, Hydeaway Bay) followed a seasonal trend, characterised by maximum cover (>20% cover) in summer/autumn (December -April) and minimum cover (<20% cover) in winter (June-July). This suggests that seagrass meadows at these sites are primarily influenced by natural factors (temperature, light, wave action). At Pigeon Island, a comparable seasonal pattern also occurred, but at two sites (PI3 and PI4) seagrass cover remained low (<15%). These sites are subject to nutrient inputs contributing to algal overgrowth and reduced seagrass cover.</p> <p>Rating: Dingo Beach (fair), Hydeaway Bay (good) Pigeon Island (fair)</p>		
Species composition	<p>At Dingo Beach and most Pigeon Island sites the composition of <i>Halodule uninervis</i> and <i>Halophila ovalis</i> remained relatively stable over the monitoring period, their dominance indicative of natural and/or anthropogenic disturbance. At PI1 <i>Zostera capricorni</i> increased in dominance throughout the monitoring period, suggesting that this site is subject to less disturbance than other sites in the area. Mixed meadows of <i>Halodule uninervis</i>, <i>Halophila ovalis</i>, <i>Cymodocea rotundata</i> and <i>Thalassia hemprichii</i> found at Hydeaway Bay also remained relatively stable.</p> <p>Rating: Dingo Beach (good), Hydeaway Bay (good) Pidgeon Island (fair)</p>		
Epiphytes and algae	<p>At Hydeaway Bay and Dingo Beach maximum epiphyte cover (>35-75%) occurred in summer (December) and autumn (March), and minima in winter. Algal cover remained below 20% with no seasonal pattern. High epiphyte cover in spring-summer may be caused by high water temperatures and light availability. High rainfall during summer may also enrich waters with nutrients necessary for epiphyte growth.</p> <p>Epiphyte cover on seagrass leaves at Pigeon Island was high (30-70%) and persisted throughout much of the year. Algal cover was high (10-50%) in winter (June), spring (September) and summer (December). High algal growth at Pigeon Island indicates nutrient enrichment from local sources (ie marina development, sewage outfall, stormwater runoff) and impact on seagrass meadows.</p> <p>Rating: Dingo Beach (good), Hydeaway Bay (good) Pigeon Island (poor)</p>		
Dugong and turtle feeding	<p>Dugong feeding trails were abundant at Pigeon Island sites and less common at Dingo Beach. The occurrence of feeding trails varied between sites but highest feeding activity was recorded in March and September 2000.</p> <p>Rating: Dingo Beach (good), Hydeaway Bay (good), Pigeon Island (good)</p>		
Associated fauna	<p>Gastropods and hermit crabs were abundant at Dingo Beach and Pigeon Island and polychaete worms were abundant at Dingo Beach. The high abundance of invertebrate fauna at these sites suggests that seagrass provides an adequate supply of detritus, grazing matter and faunal prey. An exception was site PI4 where low numbers of gastropods and crabs suggest an impacted seagrass habitat. The low numbers of gastropods, crabs and worms at Hydeaway Bay may be due to the different seagrass mix at these sites and a low supply of detrital and organic matter in the coarse sandy sediments.</p> <p>Rating: Dingo Beach (good), Hydeaway Bay (fair), Pigeon Island (good)</p>		
Physical disturbance	<p>Sites at Dingo Beach and Hydeaway Bay are comprised of fine to medium sandy sediments, were exposed to wave action and generally had a low seagrass abundance (<20% cover). Hydeaway Bay sandy sediments have a low proportion of organic matter and seagrasses compete for space with corals (soft and hard) and macroalgae. At Dingo Beach and Hydeaway Bay wave action from prevailing south-easterly winds and strong tides results in sediment movement where fine muds are displaced with coarse sands and shell. Anthropogenic disturbance (sewage inputs, stormwater runoff, boat discharges) at Pigeon Island results in accumulation of fine muds with a high organic component.</p> <p>Rating: Dingo Beach (fair), Hydeaway Bay (good), Pigeon Island (fair)</p>		
Parameter/site rating	Hydeaway Bay	Dingo Beach	Pigeon Island
Seagrass cover	Good	Fair	Fair
Species composition	Good	Fair	Fair
Epiphytes and algae	Good	Fair	Poor
Dugong and turtle grazing	Fair	Fair	Good
Associated fauna	Fair	Good	Fair
Physical disturbance	Fair	Fair	Fair
Overall rating	Good	Fair-Good	Fair

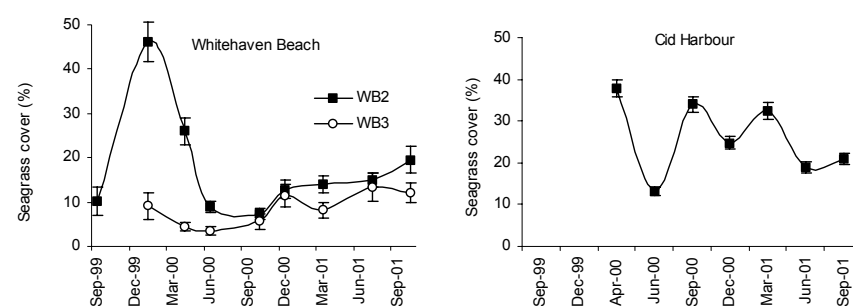


STATE OF SEAGRASS HABITATS IN THE WHITSUNDAYS: SUBTIDAL

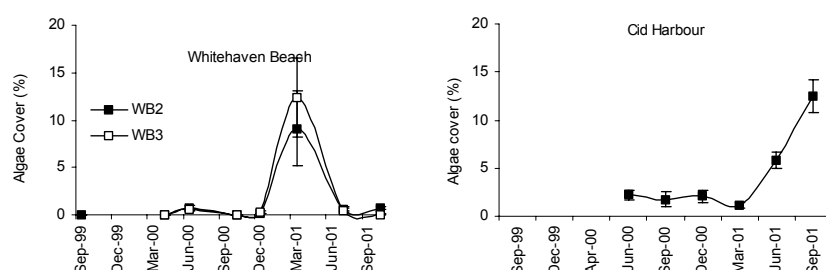
REPORT CARD: WHITSUNDAYS SUBTIDAL

Comments		
Trend in seagrass abundance	<p>Seagrass abundance was characterised by maximum cover (15-60%) in spring/summer (September - December) and minimum cover (<15%) in winter (June-July). At Whitehaven Beach seagrass cover was significantly higher at the low anchor use site (WB2) compared with high anchor use site (WB3), suggesting that boat anchors cause a reduction in seagrass abundance. Seagrass meadows near Cid Harbour are in good condition with natural factors (temperature, light) influencing growth. These areas are subject to few disturbances compared with sites situated near heavy tourism.</p> <p>Rating: Whitehaven Beach (fair), Cid Harbour (good)</p>	
Species composition	<p>At Whitehaven Beach meadows consist mostly of a mix of <i>Halodule uninervis</i>, <i>Halophila ovalis</i>, <i>Cymodocea serrulata</i> and <i>Syringodium isoetifolium</i>. Species composition at WB3 (high impact site) contains a higher proportion of <i>H. ovalis</i> and <i>S. isoetifolium</i> than at the low impact site (WB2). Both species colonise disturbed areas and are in highest abundance from spring to summer when light and temperature are favourable for fast growth.</p> <p>At Cid Harbour sites mixed meadows consist mainly of <i>Halodule uninervis</i>, <i>Halophila ovalis</i>, <i>Cymodocea serrulata</i> and <i>Halophila spinulosa</i>. Seasonal shifts in species composition varied across the meadow. A spring-summer increase in the proportion of <i>H. spinulosa</i> occurred in some area suggestive of its preference for high light conditions. <i>Halodule uninervis</i> remained the dominant species across most of the meadow. Low proportions of <i>H. ovalis</i> and negligible <i>S. isoetifolium</i> indicate little disturbance within the meadow.</p> <p>Rating: Whitehaven Beach (fair), Cid Harbour (good)</p>	
Epiphytes and algae	<p>Abundance of epiphytic and non-attached algae at WB2 and WB3 was generally low (<10%) for most of the monitoring period. In autumn (March 2001) the blue green alga <i>Lyngbya majuscula</i> covered extensive areas (35-70%) of seagrass. The cause of the bloom is unknown, but may be associated with favourable light and temperature conditions, and/or a local source of nutrients from nearby freshwater inputs and boat discharges.</p> <p>At Cid Harbour the cover of epiphytes and algae was highest in spring (September 2001), reflecting a seasonal response to increasing light and temperature.</p> <p>Rating: Whitehaven Beach (poor), Cid Harbour (good)</p>	
Dugong and turtle grazing	<p>Evidence of dugong and turtle grazing was low at Whitehaven Beach. At Cid Harbour turtle feeding was common from September to February and dugong grazing was high in September.</p> <p>Rating: Whitehaven Beach (poor), Cid Harbour (good)</p>	
Associated fauna	<p>Epi-fauna on seagrass blades at Whitehaven Beach sites were less abundant than at Cid Harbour, suggestive of disturbance from boat anchors and chains. Epi-fauna attached to seagrass blades were common throughout the Cid Harbour meadow and consisted mostly of ascidians and forams. Sponges were also common throughout the area.</p> <p>Rating: Whitehaven Beach (poor), Cid Harbour (good)</p>	
Physical disturbance	<p>Sediments at Whitehaven Beach and Cid Harbour sites were composed of fine mud, sand and shell with a high organic component. Disturbance at Whitehaven Beach sites from boat anchors was high and resulted in decreased seagrass cover and epi-faunal abundance. Anchor damage and algal overgrowth were the primary causes of seagrass damage in these areas. Disturbance from boat anchors at Cid Harbour sites was minimal.</p> <p>Rating: Whitehaven Beach (poor), Cid Harbour (good)</p>	
Overall rating	Whitehaven Beach	Cid Harbour
Seagrass cover	Fair	Good
Species composition	Fair	Good
Epiphytes and algae	Poor	Fair
Dugong and turtle grazing	Poor	Good
Associated fauna	Poor	Good
Physical disturbance	Poor	Good
Overall Rating	Poor-Fair	Good

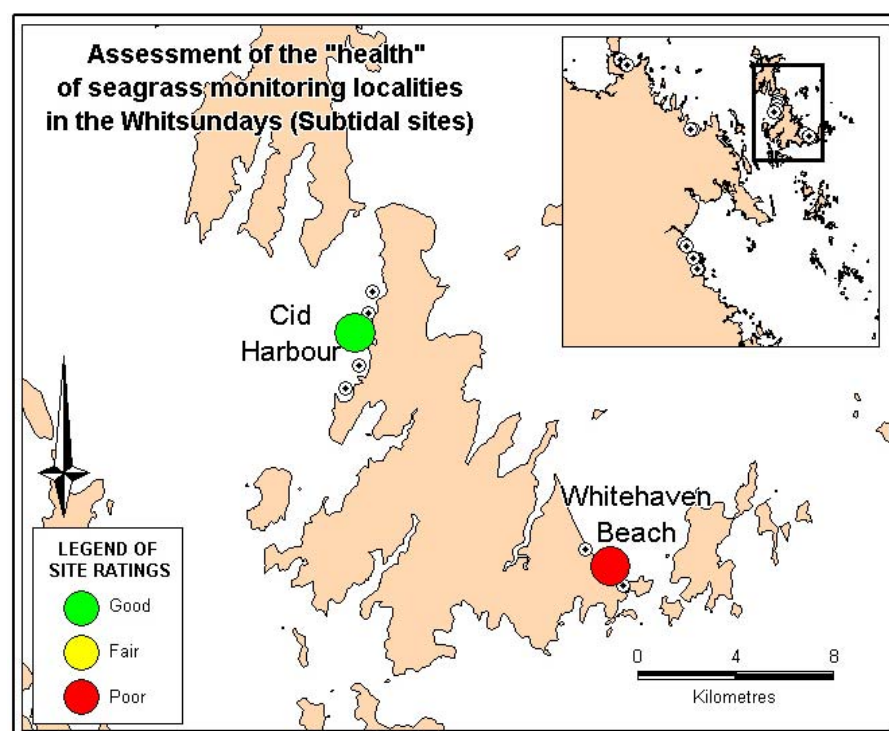
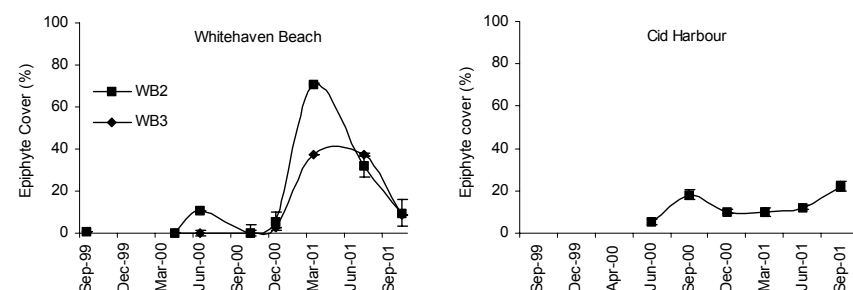
Seagrass cover



Algal cover



Epiphyte cover



Research studies

1. Recovery of seagrass meadows study

The population dynamics of *Zostera capricorni* were studied following the re-colonisation of seagrass at Urangan. In May 2000 germinating plants were first found throughout the area following complete loss of all seagrass in February 1999. Intact plant units from the site were collected and measured for rhizome length, rhizome weight and leaf weight plant⁻¹. The growth measures were grouped into cohorts and their frequency distribution plotted (Figure 4). Growth rates of dominant population cohorts (i and ii) were calculated from 28 July to 16 August (Figure 4).

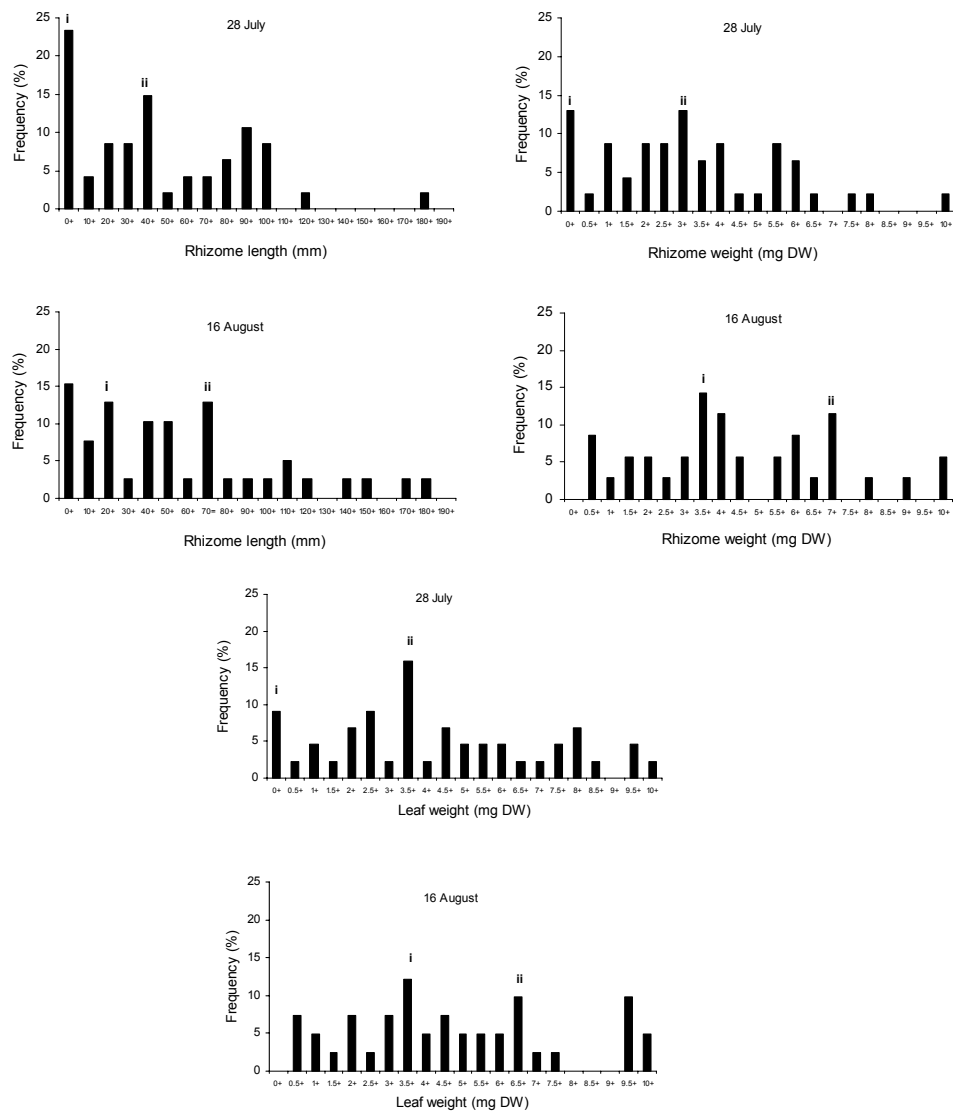


Figure 4. Frequency distributions of *Zostera capricorni* rhizome length, rhizome weight and leaf weight sampled on 28 July and 16 August 2000. Numeric values (i and ii) indicate dominant cohorts for each population.

Growth rates of the two dominant cohorts calculated for each parameter (28 July and 16 August) are presented in Table 1. Rhizome growth rates (per plant) were higher for the older cohorts compared with the younger cohorts but the opposite trend was apparent for leaf growth rates.

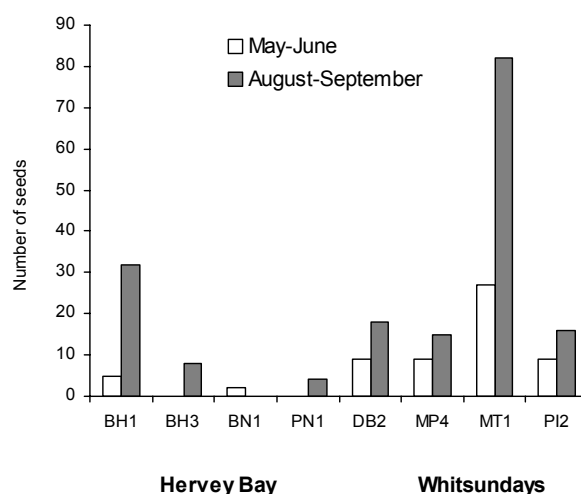
Table 2. Rhizome and leaf growth rates of 2 age class cohorts of *Zostera capricorni* from Urangan, Hervey Bay.

Growth rates	Cohort 1 28 July	Cohort 2 16 August
Rhizome	1.06 (mm shoot ⁻¹ d ⁻¹) 0.179 (mg DW shoot ⁻¹ d ⁻¹)	1.57 (mm shoot ⁻¹ d ⁻¹) 0.212 (mg DW shoot ⁻¹ d ⁻¹)
Leaf	0.182 (mg DW plant ⁻¹ d ⁻¹)	0.161 (mg DW plant ⁻¹ d ⁻¹)

The information provides an accurate estimate of the growth rates of *Zostera capricorni* populations during their initial recovery phase, and suggests that intertidal seagrass growth can recover within 2 years after loss. Reconstructing the timing of recovery was also possible assuming constant growth from germination. Using growth estimates the initial germination was estimated to occur between 17 April and 20 May, 2000.

2. Seed bank study

The density of seeds within the sediments of seagrass habitats provides critical information on the capacity of seagrass meadows to regenerate from seed germination. Data on the distribution of “seed banks” throughout the Hervey Bay, Great Sandy Strait and Whitsunday regions suggest that seed densities were highest in August-September compared with May-June (Figure 5). Recent data from seed monitoring shows a decline in seed densities in November-December. Seed reserves in the Whitsundays are greater than in the Hervey Bay and Great Sandy Strait regions, suggesting that seagrass meadows in the Whitsundays have high potential to recover from existing seed stored in the sediments.

**Figure 5.** Seed densities of *Halodule uninervis* in May-June and August-September 2001 at 8 sites in Hervey Bay/Sandy Strait and Whitsundays.

3. Nitrogen isotope study

Samples of seagrass throughout Hervey Bay, the Great Sandy Strait and Whitsundays were analysed for isotopes of nitrogen and tissue nutrients to identify sources of nutrients that may be influencing seagrass growth. The data suggests that seagrasses were not taking up high concentrations of sewage nitrogen but may have been affected by nitrogen in the form of fertilizers and from atmospheric N fixation. No evidence of sewage exposure in Pigeon Island (Whitsundays) seagrass meadows close to sewage inputs was found. Other studies (FRC 1999) have shown that filamentous algae growing on seagrasses at Pigeon Island are assimilating sewage nitrogen, thereby competing with the seagrass for available light and nutrients.

4. Seagrass – Turtle interaction study

Surveys of seagrass meadows by Rockhampton QPWS in Shoalwater Bay aim to investigate the relationship between seagrass health and the reproductive capacity of turtles in the region. Data collected by QPWS on turtle reproductive capacity suggests that a relationship exists between turtle reproduction and long-term weather patterns. The QPWS team are using Seagrass-Watch and other techniques to investigate a link between long term weather patterns (ie El Nino and La Nina) and seagrass abundance. The study aims to determine if a relationship exists between climatic conditions and seagrass abundance, as low turtle reproductive capacity may be due to low seagrass abundance following periods of high rainfall and high turbidity during the La Nina cycle. The QPWS team have been working with Seagrass-Watch scientists to develop methods to accurately monitor the abundance of seagrass meadows in Shoalwater Bay.

5. Anchor scar damage study

At Whitehaven Beach, in the Whitsundays, damage to seagrass meadows from the deployment of anchors has been identified as a detrimental impact during monitoring of seagrasses in the region. A study aimed to identify the type of damage to seagrass caused by anchor chains and anchors from boats of different size classes. Seagrass-Watch volunteers measured the size and depth of anchor and chain scars from 24 boats moored on 26 August 1999 during the annual “Whitehaven Beach party”. The study found that the length of anchor scars from small boats (9-11 m) did not differ from those of medium sized (11-15m) and large boats (15-19 m). The depth of anchor scar was, however, highest for medium and large sized boats. The size of chain scars in seagrass meadows caused by medium and large size boats was greater than that of small boats.

The findings suggest that larger boats cause greater damage to seagrass meadows than small boats because of longer anchor chains and the thickness of chain used. The commonly used “plough anchor” was recorded on 22 of the 24 boats measured. Sand anchors were only recorded in 2 of the boats examined. The use of plough anchors in preference to sand anchors may contribute to increased seagrass damage, because of the high probability of anchor and chain movement causing deep anchor scars and long chain scars. The time that boats spend moored on site and the prevailing weather conditions may also be factors that contribute to damage of seagrass meadows. The findings suggest that the damage to seagrass meadows from anchored boats is primarily from the chains attached to anchors. The anchoring of boats to fixed mooring sites is one option that would reduce the extent of seagrass damage. The information from boat anchor surveys has been supplied to QPWS for their consideration in management of the impacts associated with boats in the Whitsunday region.

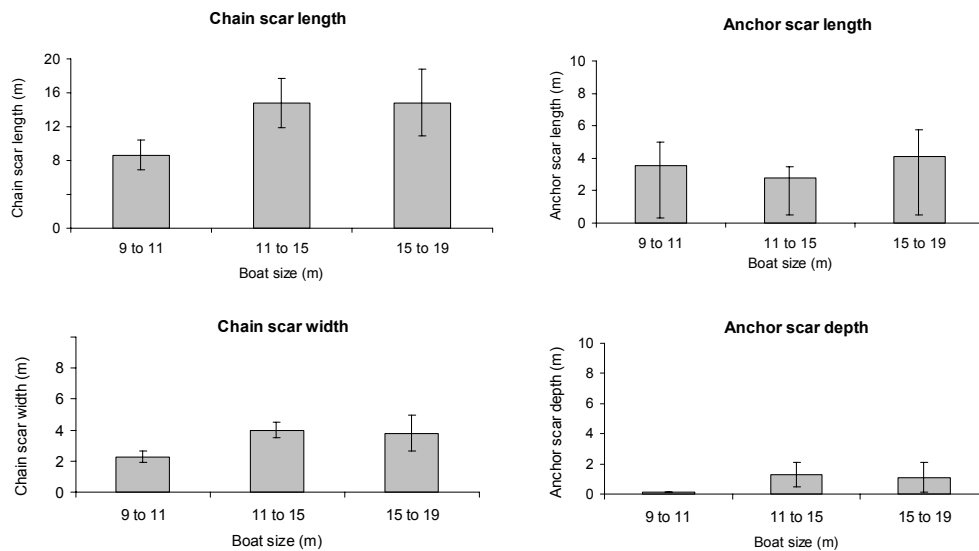


Figure 6. Chain scar (length and width) and anchor scar (length and depth) measures in seagrass in relation to boat size at Whitehaven Beach (26 August 1999).

Volunteers perceptions

A study on the perceptions of community volunteers by Leigh Bulkeley from the School for International Training in Byron Bay concluded the following:

- Volunteers were committed to the program for the long-term.
- Community volunteers believed that ongoing commitment of government co-ordination, support, reporting and feedback at state and national levels is a key element of the programs success.
- Community groups believed that scientific reporting of findings to communities and application of information for management purposes was a key element for the ongoing success of the program.
- Interactions between individuals within volunteer groups can have a great affect on the effectiveness of the group to achieve specified tasks.
- The involvement of school groups in Seagrass-Watch should be continued and strengthened.
- Local co-ordination of community groups is a key component for successful monitoring.
- Information from Seagrass-Watch can heighten awareness and understanding the impacts of catchments on marine habitats.

DISCUSSION

Community-based monitoring provides members of the community with the ability to contribute to the preservation of their local environment. The hands-on and participatory nature of Seagrass-Watch has proved to be a cost-effective method of collecting data on and engaging local interest and ownership in coastal seagrass habitats. The most powerful aspect of Seagrass-Watch is its use as an educational tool to raise community awareness. It has generated local support and invaluable networks between community groups and government for seagrass conservation and management.

Maintaining momentum and positive outcomes from the Seagrass-Watch program has required regular quality feedback to community groups. A quarterly Seagrass-Watch Newsletter, regular reports and presentations helped achieve this. Data assurance and quality has been an important focus with training programs and calibration tools used to ensure accurate and precise data collection.

A Seagrass-Watch calendar/diary was established to capture regular anecdotal information of seagrass related events and of activities which affect seagrass in a relatively standardised manner. Information recorded on the calendar is not statistical in nature but is used to interpret the monitoring data. The calendar also entices participation in the Seagrass-Watch program from a wider sector of the community.

Current levels of interest in Seagrass-Watch are high, but maintaining community participation in, and effectiveness of, the program will require continued government support to coordinate community volunteers and stakeholders. Further expansion of the program is expected as Aboriginal and Islander communities, and volunteer groups in other areas become involved in the management of their local seagrass resources.

Community group participation

The awareness and involvement of community groups and local volunteers in the monitoring of seagrass meadows is high, as evidenced by a 300% increase in participation rates across both regions, from September 1999 to August 2001. Repeat visits are also high. Of the 24 volunteers involved in on-ground monitoring in August 1999, 22 are still involved. Of the 57 involved during February-March 2000, 50 were still involved by August 2001. The number of sites being monitored has also doubled from 27 in August 1999 to 62 in August 2001 (including 1 site at Cairns, 1 in Townsville and 2 at Moreton Bay).

An improvement in the skills base has been demonstrated by an increase in the sites being monitored by volunteers without assistance from scientists. The increase in unassisted monitoring ranged from 0% in August 1999 to 88% (Whitsundays) and 100% (Hervey Bay) in November 2001. Accordingly, the time allocated to scientific input and monitoring has decreased, but this component is still considered necessary in order to maintain consistency in data collection and observation across all regions. Likewise, the demand created by increasing participation rates and turnover of volunteers necessitates ongoing training of volunteers in field based techniques.

Trends in seagrass abundance

Fifty long-term monitoring sites, approximately half in areas of known recreational/commercial usage were established throughout the regions. The locations of sites gave particular emphasis to representing ecologically important seagrass habitats.

The results of the monitoring conducted during the program suggest that the impact of human activity on the seagrass communities of each region is minimal. Twelve per cent of sites showed visual signs of human activity from impacts such as physical damage from anchors, scours in the meadows propellers and impacts from sewage outfalls. These sites included Pigeon Island and Whitehaven Beach where impact was generally ecologically localised. The areas of highest impact were found at 42% of sites in waters where catchment inputs from freshwater inputs are high (eg. Great Sandy Strait). These impacts are widespread over extensive areas of seagrass meadows, suggesting that processes affecting these meadows operate at large regional scales. Disturbance from natural forces of sediment disturbance, strong winds and wave action primarily affected 26% of sites (Burrum Heads, Toogoom, Dundowran, Dingo Beach, Midgeton). Seasonal forces of temperature and light appeared to influence 20% of all sites.

Hervey Bay

The decline in seagrass abundance over the monitoring period from August 1999 to May 2000, at 9 sites in Hervey Bay, is most likely a result of sediment accretion and burial. Despite the loss, the overall seagrass abundance at intertidal sites between Burrum Heads and Dundowran is comparable to November 1988 records. From May 2000 to August 2001 the regional increase in seagrass cover across the 3 localities in Hervey Bay suggests that factors affecting seagrass recovery are operating across the region. These factors include water quality, sediment type, meadow type and reproductive strategies of the seagrass species in the area. Ambient water quality over the past 10 years is unlikely to have negatively affected seagrass growth in Hervey Bay, as it has remained relatively unchanged over the past 10 years (EPA data unpublished). In contrast, severe flooding as occurred in February 1999, can impact seagrass meadows by reducing water quality and light availability. However, the main flood plume in 1999 did not extend to intertidal seagrass meadows in Hervey Bay so it is unlikely that reductions in available light through increased turbidity and nutrient related algal blooms would have negatively impacted seagrass growth in the region.

It is more likely that disturbance of sediments and unfavourable conditions for seed germination would have contributed to seagrass loss. The physical movement of fine to medium grained rippled sands by wave action at many intertidal sites in Hervey Bay can cause the underlying sediments to be relatively fluid with negligible trapping of detritus, resulting in low organic matter (Walker *et al.* 1999). The paucity of organic rich anaerobic sediments at some of the Hervey Bay sites may impede seed germination. This is because the germination of seagrass seeds may require anaerobic conditions, where sediments are high in organic matter and low in oxygen (Brenchley and Probert 1998). At a few sites (BH1, BH3, DD3) viable seeds and/or seedlings of *Halodule uninervis* were found in May and August 2000, supporting previous reports that *H. uninervis* seedlings can appear 1 year after loss of mature plants (Inglis 2000). *H. uninervis* seed abundance and seagrass cover were highest at BH1, suggesting that seeds buried in the sediments provide a reserve for the recovery of *H. uninervis* seagrass meadows when conditions are suitable for germination.

Great Sandy Strait (northern region)

Flood related reductions in available light due to increased turbidity and nutrient related algal blooms are the likely cause of seagrass loss in the northern Great Sandy Strait region. Longstaff and Dennison (1999) showed mortality of *Halophila ovalis* and *Halodule pinifolia* occurred after 38 and 100 days of darkness respectively. They concluded that low light caused by long duration turbidity events would have a detrimental impact on these seagrasses. During the Mary River flood in February 1999, seagrass loss occurred at *Seagrass-Watch* monitoring localities (Urangan, Booral Wetlands and Wanggoolba Creek) but high turbidity lasted for a considerably shorter period than 38 days (McKenzie *et al.* 2000). The loss of seagrass would therefore appear to be due to factors other than extended low light periods. Factors such as sediment deposition, sediment disturbance and reductions in salinity for extended periods may have impacted seagrass growth.

The re-appearance *Zostera capricorni* and *Halophila ovalis* from seeds at these sites, following an 18 month absence, indicates that seeds of this species may remain viable for a number of years. Short lived seagrass species (ie *Zostera capricorni*, *Halophila ovalis*, *Halodule uninervis*) are known to have relatively long-lived seeds (Vermaat *et al.* 1995) and the timing of germination (May-August) allows seedlings to take advantage of regional increases in light availability from winter to spring. Despite this, the recovery of seagrass cover across the region from August 2000-2001 varied between sites, taking between 6 and 12 months from initial signs of germination. By February 2001 seagrass abundance at Wanggoolba Creek sites was comparable to pre-flood levels and full recovery at Urangan sites was complete in August 2001. The data provides new evidence that intertidal seagrass recovery can occur within 2 years following flood related loss. Previous evidence suggested that recovery of intertidal seagrasses in Hervey Bay can take up to 4-5 years following catastrophic loss (J. Comans, HBDSMP, Pers Comm). Re-colonisation of subtidal meadows (>5m) has also been reported to occur within two years of initial loss (Preen *et al.* 1995, McKenzie *et al.* 2000).

The germination and re-growth of seagrass in areas following impact from flooding is likely to be dependent on the physical and chemical composition of the sediments and water in the region. Brenchley and Probert (1998) reported that that optimal conditions for *Zostera capricorni* seed germination occurs at winter temperatures (16oC) and reduced salinities (~15 ‰). Their findings are consistent with observed germination of seeds at Urangan from May to August when water temperatures range from 16 to 21oC. The germination of *Z. capricorni* seeds are also favoured by anaerobic sediments rich in organic matter (Brenchley and Probert 1998). The absence of anaerobic muds at Urangan following their removal during the 1999 flood may have delayed germination. The physical movement of fine to medium grained rippled sands by wave action may also inhibit seed germination due high sediment movement and negligible trapping of organic matter (Walker *et al.* 1999). Detailed examination of the physical and chemical composition of sediments is required to improve our understanding of the optimal conditions necessary for seagrass recovery.

Great Sandy Strait (southern region)

Inshore seagrass meadows in the Great Sandy Strait at Boonooroo, Poona and Pelican Bay are characterised by low seagrass cover (<20%) dominated by *Halodule uninervis* and *Halophila ovalis*. The increase in seagrass abundance, over the monitoring period from August 1999 to August 2001, suggests a post-flood recovery of seagrass meadows in the region. At most sites in the Great Sandy Strait the general increase in seagrass cover from September to February also parallels increasing light and water temperatures, suggesting that seasonal factors are influencing seagrass growth at these sites. The seasonality of seagrasses in tropical and subtropical regions has generally shown an increase in growth during spring

and low growth during winter (Gallegos *et al.* 1993, McKenzie 1994, Dunton 1994, Santamaria-Gallegos *et al.* 2000). The low abundance of seagrass at inshore sites suggests that other factors (eg rainfall, sediment burial, sediment chemistry, dugong grazing) may also affect seagrass growth and alter seasonal patterns. At Boonooroo seagrass abundance is lowest near the Tuan Creek mouth suggesting that factors associated with Tuan Creek and local catchment inputs are negatively impacting seagrass abundance. Preliminary analysis of water quality data (EPA unpublished) throughout the region show that post-flood (February 1999) there was a dramatic increase in nutrient and chlorophyll *a* concentrations in the water column and a decrease in salinity. The subsequent decline in water quality and light availability may have contributed to low seagrass abundance and/or loss in mid 1999 when *Seagrass-Watch* monitoring began.

Compared with inshore sites, seagrass meadows at Reef Islands and Boonooroo (BN3) are less influenced by freshwater inputs, have a higher seagrass abundance (20-50%) and are dominated by *Zostera capricorni*. Seasonal peaks in seagrass abundance during periods of increased light availability (ie. spring-summer-autumn), suggests that these meadows are relatively unimpacted by catchment inputs. Their distance from freshwater inputs allows these meadows to remain largely intact and responsive to seasonal forces. Data collected over the next 12 months will provide a more accurate account of the seasonal and inter-annual variation within seagrass meadows.

A decrease in water column ammonia concentrations throughout the region in 1999-2001 may be explained by a reduction in nitrogen (as ammonia) fluxes from the sediments into the water column. Such a trend may be associated with increased benthic microalgal productivity that traps ammonia at the sediment and water interface. High benthic microalgal and macroalgal biomass has been observed at a number of sites including Poona, Boonooroo and Browns Gutter. Microalgae colonise bare sediments and filamentous macrolagae can also bloom in areas dominated by sediment. The abundance of these algae suggests that a shift from seagrass dominated to seagrass/algal dominated primary production may be occurring. Such trends have emerged worldwide in seagrass systems exposed to high nutrient inputs and provide the indicators of eutrophication (Nilsson *et al.* 1991, Valiela *et al.* 1997, Kinney and Roman 1998).

Whitsundays

Intertidal seagrass meadows

In the Whitsundays low seagrass abundance in winter (June-July) and peaks in seagrass abundance during spring implies that seasonal factors (ie temperature, light) are controlling seagrass growth at most sites throughout the region. Low seagrass cover in late summer-early autumn is typical of tropical climates where high turbidity and low light availability from monsoonal summer rainfall inhibit seagrass growth (McKenzie 1994). High summer temperatures may also inhibit growth rates by increasing respiratory demands at the expense of photosynthetic production (Bulthuis 1982, Meling Lopez and Ibarra-Obando 1999). At some sites the amplitude or size of the seasonal variation may be reduced by other factors which suppress growth. At Pigeon Island the high abundance of macroalgae appears to smother seagrass at sites PI3 and PI4, reducing seagrass cover. The high abundance of epiphyte and/or algal cover at Pigeon Island relative to other intertidal sites in the Whitsundays suggests that high concentrations of nutrients are available for algal growth. The abundance of algae (epiphytes and non-epiphytes) showed little seasonal variation, but seasonal shifts in species composition were apparent. In autumn and winter filamentous blue-green algae (*Lyngbya majuscula*) were dominant, whilst in spring and summer brown filamentous algae (*Hincksia* sp.) were abundant. The persistence of these algae throughout the year is typical of a eutrophic, nutrient enriched embayment and is consistent with reports of high concentrations of nitrogen at Pigeon Island (FRC 1999). Reduction in nutrient inputs,

primarily nitrogen, is required to reverse the current trend observed at Pigeon Island and avoid future seagrass loss.

At Dingo Beach and Midgeton strong south easterly winds and associated sediment disturbance and high turbidity in July and August may also contribute to uprooting and mortality of seagrasses. Seagrass meadows at Midgeton are also situated close to the mouth of the Dempster River estuary, downstream from catchment inputs. Ongoing monitoring will provide baseline information necessary to distinguish seasonal trends in seagrass growth from those associated with proposed upstream prawn farm development. Similarly at Laguna Quays the monitoring of seagrasses can provide baseline data used to assess potential impacts from nearby coastal developments. Sites at Midge Point provide reference areas where minimal impact from coastal development is likely to occur.

Subtidal seagrass meadows

Subtidal seagrass meadows north of Cid Harbour on Whitsunday Island are potentially impacted by boat traffic. The seasonal pattern over 18 months of monitoring was characterised by high seagrass cover in spring-summer and low cover in winter. The trend indicates that the meadows are in good condition but threats to seagrass survival in the area do exist. An excessive amount of macroalgae was recorded growing over seagrass in September 2001, coinciding with reduced seagrass cover. The cause is unknown but could be related to low rainfall, high water temperature and high water clarity in winter-spring 2001. The proliferation of blue-green algae (*Lyngbya majuscula*) in summer (March 2001) at Whitehaven Beach sites may also negatively impact seagrass growth. The cause of this algal bloom is unknown but may be associated with high water temperatures, high water clarity, nutrient inputs from tourist boats (nitrogen) and/or local freshwater inputs (nitrogen, iron).

At Whitehaven Beach damage to seagrass from boat anchoring has resulted in a 4-5 fold lower seagrass abundance (<10% cover) in areas of high usage (6-15 boats per day) compared with sites with low (1-4 boats per day) usage. The data suggests that anchors are having a persistent effect on seagrass abundance, yet weak seasonal trends in seagrass abundance at the high impact site indicates that seagrass recovery is possible if disturbance were to be reduced. Persistent anchor damage, as found at Whitehaven Beach, has been shown to uproot and break rhizome essential for resilience and stability of the seagrass meadow (Zieman 1976; Williams 1988). For this reason anchor damage is considered more serious than grazing by turtle or dugong because anchors destroy the regenerative capacity of seagrass roots and disrupt critical nutrient re-mineralisation processes in the sediments. The size, type and timing of disturbance, as well as the growth characteristics of the seagrass species are likely to influence recovery (Rasheed 1998). The persistently low cover (and biomass) of seagrass at Whitehaven Beach therefore represents a significant disturbance that is unlikely to recover unless management strategies are implemented to reduce impact from anchors on the seabed.

CONCLUSION

The findings of this study suggest that provided with adequate support and training local communities are well equipped to monitor the changes in seagrass meadows in response to natural and anthropogenic impacts. Community-based monitoring programs are an important addition to coastal management. Government agencies with limited funding and resources are often constrained with the amount of coast they can regularly monitor and manage. Local residents and users are often the first to notice changes in coastal marine environments. They can be the best early alert to possible impacts in remote coastal locations.

The information collected by Seagrass-Watch provides rapid and useable baseline data on natural patterns in seagrass abundance. Changes to these patterns can be directly attributed to impacts from catchment sources and climatic conditions. The methods used have detected regional differences in the condition of seagrass meadows within Queensland. In Hervey Bay

and the Great Sandy Strait seagrass meadows are generally in poor to fair condition, largely influenced by catchment inputs that can obscure seasonal responses. The re-emergent growth of seagrasses in Hervey Bay has major implications for our understanding of the recovery of intertidal seagrass meadows following catastrophic loss. In addition, information on growth rates from a population recovering after loss (ie. Urangan) represents a first step to understanding the dynamics of seagrass recovery from disturbance. In the Whitsundays seagrass meadows were less affected by catchment inputs and were generally characterised by a seasonal pattern of low growth in winter and high growth rates in spring. The monitoring was also able to detect the reduced abundance of seagrass associated with impacts from freshwater influence, anchor damage and algal overgrowth.

Seagrass-Watch monitoring provides information on changes to seasonal patterns and abundance of seagrass meadows that can be used by management authorities to assess the impacts of a range of factors on seagrass meadows. The monitoring is a cost effective way to develop early warning signals of impending seagrass loss so that management action can prevent ecological damage. This information is crucial to developing the appropriate management strategies in response to seagrass loss or impending damage.

Management implications and recommendations

Human impacts

In Hervey Bay seagrass meadows appear to be influenced by local factors that mask typical seasonal responses, whereas meadows in the Whitsundays exhibit seasonal responses with low growth in winter and high growth rates in spring. The methods employed were used to detect reduced abundance of seagrass associated with impacts from freshwater influence, anchor damage and algal overgrowth. The persistent reduction in seagrass abundance is a clear signal that management action is required to reverse these trends.

Recommendation: *Additional research to address issues (eg nutrient inputs) influencing the growth of filamentous algae in Pigeon Island and its possible impact on seagrasses.*

Recommendation: *Develop strategies to reduce impacts associated with anchor damage on seagrass beds at Whitehaven Beach and at other sites where potential damage is occurring.*

Recommendation: *Develop an action management plan for response to *Lyngbya* outbreaks at Whitehaven Beach and at other sites where potential blooms occur.*

Recommendation: *Investigate the impact of catchment inputs on the seagrass ecosystems in the Sandy Strait.*

Recommendation: *Develop strategies to reduce pollutant (nutrients, herbicides, sediment, metals) runoff from catchments into Hervey Bay and the Great Sandy Strait.*

Seagrass-Watch monitoring provides an early warning alert system of impending seagrass loss. In addition, information on growth rates from a population recovering after loss represents a first step to understanding the dynamics of seagrass recovery from disturbance. This information is crucial to developing the appropriate management strategies in response to seagrass loss or impending damage.

Recommendation: *Additional funding to ensure the continuation of the *Seagrass-Watch* program to engage local communities in on-ground monitoring of seagrass habitats in Hervey Bay, Sandy Straits and Whitsundays.*

Non human impacts

Trends in seagrass abundance over time can be integrated with water quality and climatic data (eg rainfall, temperature, light) to quantify relationships between changes in the environment and seagrass growth to identify causes of seagrass loss and recovery.

Recommendation: Data on seagrass abundance to be correlated with water quality and climatic data to investigate the causes of seagrass growth and decline.

Community awareness and education

The television interviews and newspaper articles provide excellent opportunities to improve community awareness

Recommendation: An education program should be developed and incorporated as part of the marine studies program (Wet Paper) program in secondary schools to assist the management.

Recommendation: sets of standard display material should be produced for use at shows.

Recommendation: A web-based interactive database site be established to allow volunteers to enter data and source summaries of data.

Recommendation: Feedback to volunteers on data analysis to be maintained via Newsletters and annual reports.

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