International Seagrass-Watch Volunteers Forum

Hervey Bay 12-15th October 2001

Local Eyes: Global Wise

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Volume 1.

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Preface

Community (citizen) groups and volunteers are assisting fisheries scientists monitor Queensland seagrass resources in a program called Seagrass-Watch.

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 abundance, presence of dugong feeding trails and possible human impacts. This information provides a reliable early warning system on the status of seagrass resources, and a broad measure of change. Seagrass-Watch is presently active with communities in southern-, central- and northern-Queensland regions.

The forum is an opportunity to share information among community groups involved in seagrass mapping, monitoring and research; to review the progress of the Seagrass-Watch program; and to consider ways of building and developing the existing program. Some of the key issues to be discussed include: Standardisation of methods, data quality, maintaining and building interest and learning from others including overseas experience.

I extend a welcome to our forum and encourage an exchange of ideas on coastal mangagement, fisheries and seagrass science.

Rob Coles
Senior Principal Scientist
Queensland Fisheries Service

Queensland Government

Office of the Premier

Tuesday May 8, 2001.

MESSAGE FROM THE PREMIER OF QUEENSLAND

Queensland's wetlands, mangroves and extensive coral reefs are a crucial part of our 6000km of mainland coastline.

Community groups willing to take on important ecological work to protect and enhance those precious resources are to be congratulated.

The Hervey Bay Seagrass-Watch Monitoring Program is the work of a dedicated group of people who are working hard to solve a serious ecological problem in their area.

In partnership with the Queensland Fisheries Service of the Department of Primary Industries, they are applying local knowledge to the important work of seagrass regeneration.

A decade ago, the Hervey Bay/Great Sandy Region supported the largest number of dugong on the east coast, south of Cape York.

Many dugong died of starvation when floods and a cyclone in 1992 reduced seagrass beds by more than a thousand square kilometres.

The program aims to rehabilitate tracts of seagrass beds back to levels which support much larger dugong populations.

It is slow, but valuable, work. It is important to ensure these vital marine habitats are protected and maintained for the future.

At the same time, we need to ensure sensible coastal development which protects and improves our State's assets.

The International Seagrass-Watch Volunteers Forum being held in Hervey Bay this year is an excellent opportunity for governments and community groups to share their experiences.

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2.

By understanding more about our marine habitats, we better appreciate their value and are able to protect them more easily.

I applaud the work of the Hervey Bay Dugong and Seagrass Monitoring Program and fully support the International Seagrass-Watch Volunteers Forum being held in Hervey Bay from October 12 to 15, 2001.

Peter Beattie MP
Premier of Queensland

Table of Contents

Forum Programme

Friday 12th October 2001

Venue: ***Hervey Bay Regional Gallery***
161 Old Maryborough Road
Pialba, Hervey Bay

Time	Activity	
1730 - 1830	Registration	
1830 - 2030	Gallery Wine & cheese (**sponsored by Con Souvlis, Betta Electrical Hervey Bay**)	
	Hervey Bay Art Gallery	*Ruth Berry - seagrass artwork*
		Meryn Jones – dugong artwork
		Local artists - marine theme on display
	Entertainment:	*Fraser Coast Anglican College pianists*
		Pied Piper Players

Saturday 13th October 2001

Venue: ***Main Lecture Theatre***
University of Southern Queensland, Wide Bay Campus
Old Maryborough Road
Pialba, Hervey Bay,

Time	Activity	Person
08 00	Registration	
08 45	Welcome to country	*Marie Wilkinson (Traditional Owner)*
08 50	Official opening	*Warren Truss (Federal Minister for Agriculture & Fisheries)* *Andrew McNamara (Local Member for Hervey Bay)*

Session 1

Chair (*TBA*)

Time	Activity	Person
09 00	Welcome	*Ian McPhail (QPWS)*
09 10	Overview of DPI Seagrass research program	*Rob Coles (DPI)*
09 40	Bentley Park – CRC Seagrass WebSite	*Bentley Park College students*
10 00	**Morning Tea**	
10 30	Seagrass-Watch program design & methods	*Len McKenzie (DPI) & Jerry Comans (HBDSMP)*
10 50	Seagrass-Watch volunteer involvement & perceptions (3-5 min each)	*Jerry Comans (HB)* *Yarrilee students (HB)* *Gary Nielsen (GSS)* *Fraser Coast College (HB)*

		Jackie Shiels (OUCH)
		Whitsunday Volunteers
		Tom Collis (CNS)
		Dez Wells (TSV)
		Simon Baltias (WPSQ)
11 30	Seagrass-Watch monitoring results	*Stuart Campbell (DPI)*
12 00	Seagrass-Watch & seed monitoring	*Michelle Waycott (JCU)*
12 20	Coastal Management & Seagrass-Watch	*Kirsten Wortell (QPWS)*
12 40	**Lunch**	

Session 2

Chair *(Len McKenzie (DPI)*)

13 30 Focus group overview

13 40 Focus groups (*15-20 delegates per group*) convene to USQ rooms to discuss all of the following:

1. *Data quality assurance – quality control*
2. *Maintaining & building interest*
3. *On-ground program structure (local vs state)*
4. *Communication*
5. *Program expansion & future funding*
6. *Open*

16 00 **Finish**

19 00 **Forum Dinner & Welcome**
Venue: Kondari Resort Convention Centre
Dress: Neat casual
Master of Ceremonies: Jack McKeon
Welcome address: HBCC Mayor Ted Sorrenson
Guest speaker: *Olga Miller (Storyteller and Senior Elder of the Butchella tribe, Fraser Island Traditional Owners)*
Entertainment: *Pied Piper Players*
Urangan High String ensemble

Sunday 14th October 2001

Venue 1: ***Hervey Bay Boat Club***
Cnr Miller St & Charton Esplaande
Urangan, Hervey Bay

Time	Activity
08 00	Breakfast **(partly sponsored by Hervey Bay Boat Club)**

Venue 2: ***Park***
Cnr Boat Harbour Drive & Charlton Esplanade
Urangan, Hervey Bay

Sunday is dedicated to the Hervey Bay Seafood Festival which starts at 10 00am (*see official Hervey Bay Seafood Festival Programme*). Field demonstrations of monitoring methods start at midday and are repeated every 30min – you can chose which time you would like to attend (*numbers of people attending each demonstration is limited to **15***).

Children's games are also organised by QPWS over the same time period.

(bring hat, sunscreen, towel and appropriate footware)

Time	Activity	Person
12 00	Intertidal Monitoring – demonstration 1	*Yarrilee State School*
12 30	Intertidal Monitoring - demonstration 2	*Kohler Family*
12 45	Children's games	*By QPWS*
13 00	Intertidal Monitoring - demonstration 3	*Fraser Coast College*
13 30	Intertidal Monitoring - demonstration 4	*HBDSMP Volunteers*
19 30	**Civic reception and dinner for Invited Guests and Councillors Sponsored by Hervey Bay City Council**	

Monday 15th October 2001

Venue: ***Main Lecture Theatre***
University of Southern Queensland, Wide Bay Campus
Old Maryborough Road
Pialba, Hervey Bay,

Session 3

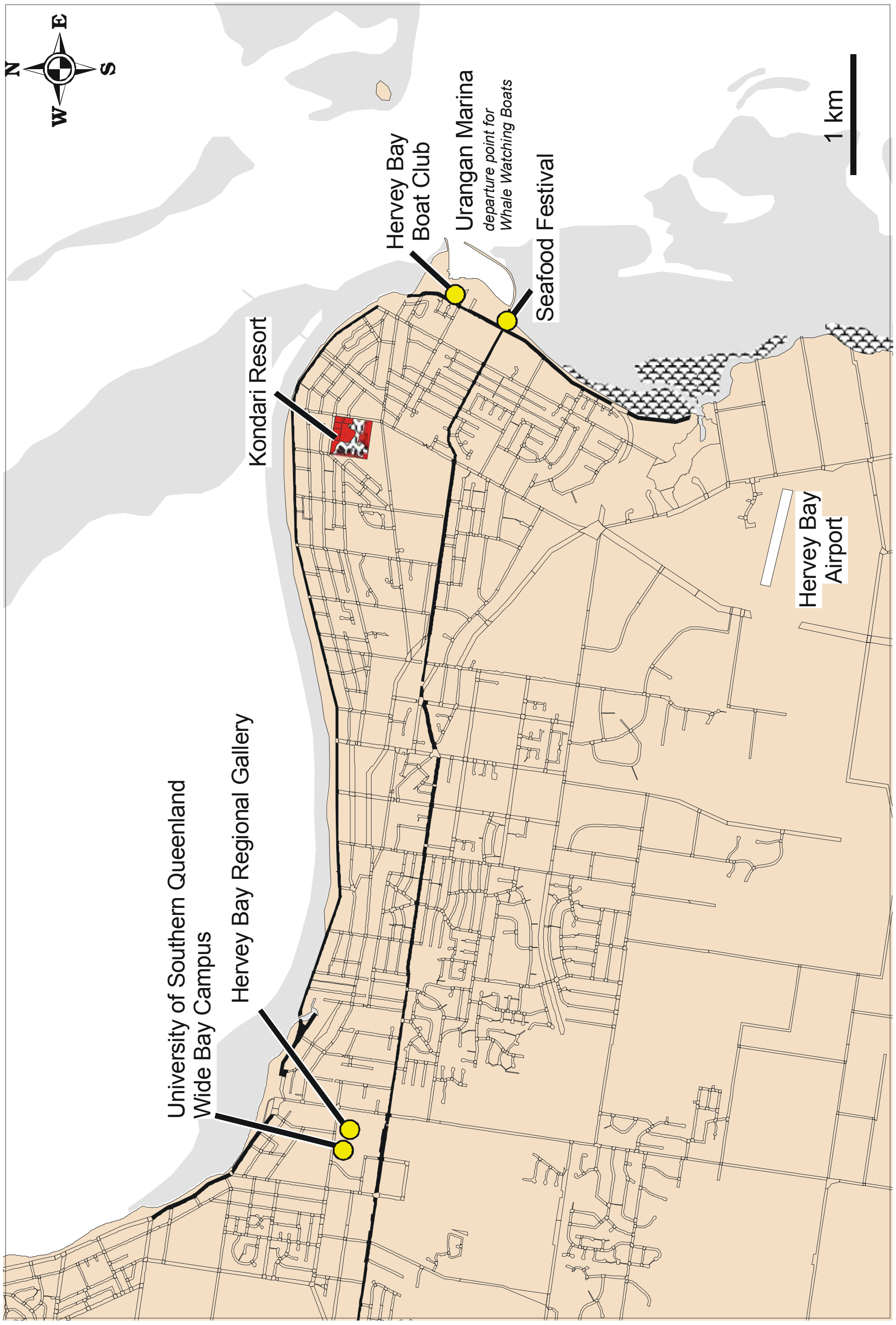
Chair *(Peter Finglas QFS)*

Time	Activity	Person
09 00	Moreton Bay/HealthyWaterways experience	*Bill Dennison (UQ)*
09 20	Western Australian Experience	*Prof Di Walker*
09 40	Ulugan Bay tourism master plan	*Prof. Mike Fortes*
10 00	SeagrassNet	*Rob Coles*
10 15	**Morning Tea**	
11 45	Summary of group discussions from Session 1 General Discussion	*Focus Group spokepersons*
12 55	Forum Close	*Peter Finglas*
13 00	**Lunch**	

Additional Activity
Monday 15th October 2001

19 00 HERVEY BAY GENERAL PUBLIC MEETING

Venue: Kondari Resort
MC: Jack McKeon
Guest speakers' question and answer time
Entertainment by Pied Piper Players & Bands from Fraser Coast College and Urangan High.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E
S
W
Hervey Bay
Boat Club
Urangan Marina
departure point for
Whale Watching Boats
Seafood Festival
1 km
Kondari Resort
Hervey Bay
Airport
University of Southern Queensland
Wide Bay Campus
Hervey Bay Regional Gallery





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HERVEY BAY
CITY COUNCIL
HERVEY BAY DUGONG &
SEAGRASS



Seagrass-Watch Science Delegates from Queensland

Dr Stuart Campbell

Dr Stuart Campbell is a Fisheries Biologist with Queensland Fisheries Service North region, Department of Primary Industries. He coordinates the Seagrass-Watch program throughout Queensland. Stuart has 15 years experience as a Marine Research Scientist working for government and non-government agencies in Australia and the U.K. He has worked as a fisheries scientist in the sub-Antarctic region and as an environmental scientist in Australia. His research on macroalgal/seagrass ecology and physiology has contributed to temperate and tropical marine plant monitoring programs, fisheries habitat resource assessments and assessment of environmental impacts in marine environments. He has extensive experience in advising governments on marine protection policies and fisheries management. He has worked closely with conservation and community groups on environmental issues concerning marine habitats and coastal resource issues.

Current projects

- Monitoring of seagrass habitats in Queensland and the Western Pacific
- Temporal and spatial patterns in seagrass ecosystems
- Assessment of impacts on seagrass ecosystems
- Primary productivity and eco-physiology of tropical seagrass ecosystems

Dr Rob Coles

Rob Coles is a Senior Principal Scientist at the Department of Primary Industries and has also been Acting Industry Manager, Department of Primary Industry (North Region) responsible for all fisheries issues in Queensland. His extensive experience as a prawn fisheries research scientist including seagrass research, mapping, taxonomy, biodiversity, recovery after loss and resource evaluation, fisheries statistics and analysis. Rob has also been involved in the Torres Strait Treaty arrangements and bilateral Aust/PNG fisheries agreements.

Current Projects

- CRC Project Leader for Ports and Shipping
- Overseas Marine Plant Ecology Projects
- Represents the Department of Primary Industries on various Scientific Advisory Committees
- Co-editor of book on Seagrass methods

Len McKenzie

Len McKenzie is a Senior Research Scientist with the Queensland Fisheries Service (DPI). He is a chief investigator for the CRC Reef Research Centre task on the critical marine plant habitats of the GBRWHA. He is also the project leader for the Marine Plant Ecology Group and a series of projects involving the assessment and sustainable use of coastal fisheries habitat. Len has 13 years experience as a research scientist on seagrass ecology and fisheries habitats. This includes experience within Australia and overseas in seagrass research, resource mapping, resource assessment and biodiversity. He has provided information on Queensland seagrass communities that has been vital in management of seagrass resources of the Great Barrier Reef and also at the state, national and international levels. He has also advised on fisheries and coastal resource-use issues for managers, fishing organisations, conservation and community groups.

Current Projects

- Seagrass-Watch community seagrass monitoring
- Status and mapping of seagrass resources in Queensland
- Assessment of primary and secondary productivity of tropical seagrass ecosystems
- Investigations on the macrofauna associated with seagrass meadows
- Deepwater seagrass resources of the GBRWHA
- Investigations on the effects of nutrients on tropical reef associated seagrasses

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Dr Michelle Waycott

Dr Waycott's is a post-doctoral fellow at James Cook University and her research interests include investigating seagrass population dynamics, genetics and evolution, molecular genetics, conservation genetics and biodiversity assessment. Dr Waaycott has been working with community groups as part of the Seagrass-Watch program on seagrass resilience, assisting with development of methods for determining seed banks and how they vary spatially and temporally.

Current projects:

- Describing the processes of seagrass meadow establishment through reconstructing recruitment processes using molecular genetic markers.
- Defining the evolutionary relationships within and between seagrass families.
- Seagrass conservation issues and management.
- The molecular evolutionary biogeography of seagrasses.
- The adaptive significance of clonality to survival in evolutionary timeframes.
- The application of molecular biological techniques to questions in ecology, population biology and evolution.
- The evolution of the Gondwanan flora.
- Australian estuary management and functioning

See also http://cathar.tesag.jcu.edu.au/~tgmw/

The Marine Plant Ecology Group

The Marine Plant Ecology Group established the Seagrass-Watch program in Queensland, developed the methods used throughout the program and provides the main scientific support. The program has grown beyond tropical seagrasses in Australia, and the group is part of SeagrassNet, monitoring seagrasses on a global scale throughout the Western Pacific Region. The group is based at the Northern Fisheries Centre in Cairns, and currently has ten scientists in the team.

In the early 1980s, the Marine Plant Ecology Group noted a strong link between the presence of marine seagrass meadows and the abundance of juvenile tiger prawns. The Marine Plant Ecology Group embarked on a 20-year program to document the seagrasses of Queensland to protect their fisheries values.

This exercise involved some 8000 dives to visit the ocean bottom. In water too deep to dive they filmed around 1400 images of the sea floor using a video camera towed behind a research vessel. In intertidal regions many hours walking and flights in light aircraft and helicopters were used to complete maps. There are now maps available for the distribution of seagrasses for almost all Queensland waters to a depth of 60 metres providing an excellent record of our species and where they are found.

Ongoing projects include:

- Ensuring areas of seagrass critical to fisheries productivity in Queensland are identified and suitably managed
- Monitoring the health and status of seagrasses, fisheries resources, and other marine plants in ports and near shipping lanes
- Monitoring changes in seagrass populations in areas set aside as Dugong Protection Areas
- Advising of the impact on seagrasses of coastal developments
- Working with coastal communities to develop local "Seagrass Watch" expertise
- Setting up a global monitoring network program in the Western Pacific to monitor global scale changes and
- Investigating the productivity of seagrasses and nutrient levels.

Bentley Park Colleges Seagrass Web-Pages

Bentley Park College students have teamed up with the Marine Park Ecology Group and the CRC for Reef Research in the last few months to learn about seagrasses and construct fun web pages for others to access and learn about these important marine plants. The students have created web pages that are relevant to their contemporaries, and educate about seagrass in a fun and meaningful way.

The whole aim of the program is for the students to develop an understanding of seagrass plant biology, seagrass ecology and seagrass protective measures by promoting these concepts to students, and then have the students come up with the best ways of communicating this to other students via the world wide web.

The students have explored the science surrounding seagrass and the scientific techniques used in marine plant and fisheries research. Their "classrooms" have included a trawler and tropical Green Island to discover first-hand the growth of seagrasses and their place in the marine ecosystem.

Through cooperative initiatives such as this, the community reaps the benefits because it creates an educational tool that everyone with a computer can access.

The web pages are hosted on the CRC Reef website – a site that is already accessed by professionals and students around the world.

Bentley Park College teachers, Kristine Kopelke and Mary Clarke, along with students Brett Hackett and James Holland, will be presenting the seagrass Website at this Forum.

The web pages are online now available on the CRC Reef Website at www.reef.crc.org.au

Background to Seagrass-Watch

Seagrass-Watch is a community-based monitoring program developed by the Marine Plant Ecology Group (MPEG) at Queensland's Department of Primary Industries (QDPI) in conjunction with the CRC Reef, Queensland Parks and Wildlife Service and community groups. The key community groups involved in the development of the program were the Hervey Bay Dugong and Seagrass Monitoring Program, Whitsunday Volunteers and the Order of Underwater Coral Heroes (OUCH). *Seagrass-Watch* aims to collect data on the condition and trend of nearshore seagrasses throughout Queensland and provide an early warning of major changes in seagrass abundance, distribution and species composition. In Queensland *Seagrass-Watch* programs have been established in Hervey Bay, the Great Sandy Strait, the Whitsunday regions, Townsville, Cairns, Moreton Bay and soon in the Western Pacific involving more than 300 volunteers. Community groups and seagrass scientists now monitor 31 sites in the Hervey Bay/Sandy Strait region, 17 sites in the Whitsundays, 3 sites at Townsville, 2 sites at Yule Point north of Cairns 6 and sites in Moreton Bay.

Seagrass-Watch developed out of a recognition that a new approach was required to monitoring the trend and condition of seagrass meadows in Queeensland. Limited resources mean that it is logistically impossible for government agencies alone to address state-wide inquiries on seagrass issues. Coastal communities are not only concerned about the condition and loss of seagrasses in their regions but are keen to play a primary information gathering role and work in partnership with government agencies. Industry and community groups are also aware of the vital links between seagrasses and important fish, turtle and dugong populations. *Seagrass-Watch* has captured this interest and facilitates links between community networks, government agencies and local industry groups to provide scientific advice on critical seagrass resources.

Program Development

Initially to capture local enthusiasm MPEG (DPI) established and co-ordinated several steering groups to assist with the development of the program. These were comprised of representatives from local community groups, Queensland Parks & Wildlife Services (Environment Protection Authority) and the Queensland Department Primary Industries. This combined effort led to:

- A successful application for funding from Coast and Clean Seas (NHT) to support the program;
- Identification of key monitoring areas of particular management focus (eg. dugong feeding areas, areas of high catchment inputs) by the community groups and baseline surveys by QDPI;
- Direct input from community and industry groups into initial planning and ongoing monitoring;

- Research, training, extension and consultation involving all levels of government and community collaboration and communication.

Scientific underpinning

The program has a strong scientific underpinning with an emphasis on consistent data collection, recording and reporting. Scientific, statistical, logistic and GIS support underpins all monitoring efforts. Simple yet scientifically rigorous monitoring techniques include measurement at fixed sites of percentage seagrass cover, seagrass canopy height, seagrass species composition, algal cover and epiphyte cover. Photo-calibration sheets used by community members are always used to ensure consistency in seagrass cover estimates between community groups. Additional information on seed abundance and sources of nitrogen has been included by collaboration with researchers from James Cook University in Townsville and from the Department of Botany, University of Queensland. All data collected is entered onto the *Seagrass-Watch* database and GIS mapping systems.

Communication

A considerable proportion of the program effort is set aside for supporting communication and information networks. The program provides immediate feedback to the communities on technique development and monitoring findings. These are conveyed to local communities by:

- Regular interaction and monitoring between community groups, local co-ordinators, State government agencies and *Seagrass-Watch* scientists;
- Quarterly newsletters to all volunteers;
- A *Seagrass-Watch* calendar that is an education tool and can be used to record simple anecdotal observations;
- Development of a manual outlining methods for community groups to monitor seagrasses;
- Assisting community members to produce a training video outlining methods for community groups to use;
- Regular seminars and workshops with local community groups and shire councils, workshops on seagrass biology and taxonomy;
- Regular exhibitions at various local festivals;
- Briefings and reports to regional print media and television.

Effectiveness and outcomes

Seagrass-Watch monitoring has provided information to coastal managers in Queensland on the seagrass resources valuable to fisheries, turtles and dugongs. Most importantly the program has developed communication pathways between government agencies and the community to allow exchange on information on the condition of coastal habitats. The program has allowed collaboration between state government agencies (QDPI, QPWS, EPA) to develop information for use in management plans in response to development proposals and assessments of management status. These have included:

- Dredging proposals in the Hervey Bay, Sandy Straits and Whitsundays regions;
- Information for dugong and turtle management;
- Information for assessment World Heritage Area Listing (Cooloola region);
- Contributing to the review of the Great Sandy Region Management Plan;
- Reassessment of the existing Fraser Island World Heritage Area and contributions to the Great Sandy Strait Ramsar site declaration.
- Information for assessment of Laguna Quays airport and marina proposals (Whitsundays region);
- Information for development of Marine Parks management plans (Cairns region).
- Information and data on the extent of blue –green algal blooms (*Lyngbya majuscula*) in the Whitsundays.

Seagrass-Watch has educated local groups on issues related to the status and importance of seagrass resources within the Great Barrier Reef World Heritage Area and Hervey Bay. The program provides a national role model for seagrass community monitoring that will lead to nation-wide awareness of the resource status and management priorities for seagrass habitats. Numerous expressions of interest from throughout Queensland, other Australian states and internationally have been made. Challenges that face programs of this type include the maintenance of community support and feedback, continuing provision of relevant scientific information to government agencies, securing support for future community-based habitat monitoring and possibly implementing a nationally based program.

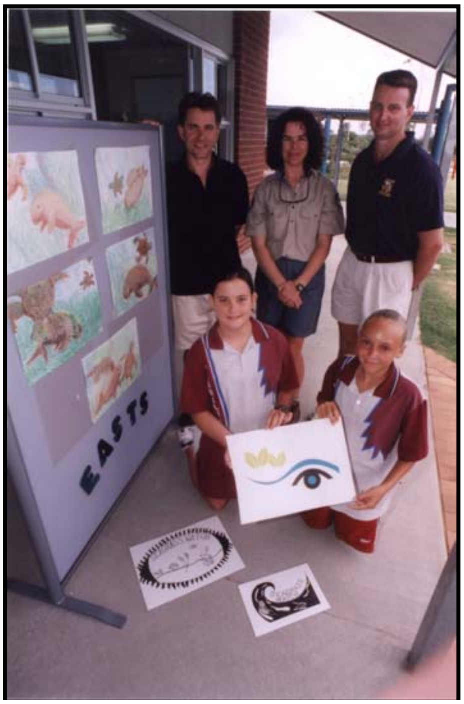
Recognition

The *Seagrass-Watch* program was honoured on Sunday June 4th 2000 with one of nine Prime Minister's Environment Awards. The award was titled "*Natural Heritage Trust Award for Rural and Regional Leadership*". Such an award recognises the efforts put into the program by all involved including local community groups in Hervey Bay, the Great Sandy Strait and the Whitsundays.

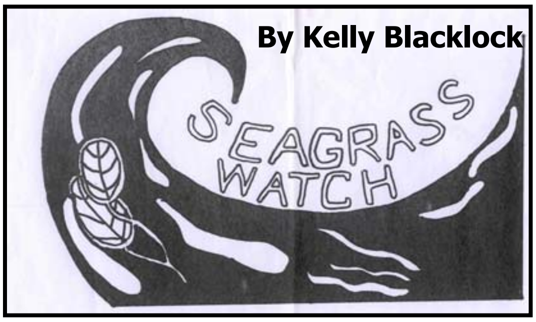
The Seagrass-Watch Logo

In the July 1999 (Issue 3) *Seagrass-Watch* Newsletter, volunteers were given the opportunity to design a logo for the program. Over 50 entries were received from throughout Queensland. A panel of members form the Marine Plant Ecology Group judged all the entries. Entries were judged on their ability to capture 3 major themes of Seagrass-Watch: seagrass, community participation (or a human element) and the marine environment.

The official winners were Kelly Blacklock and Lana Jeffrey from Yarrilee State School in Hervey Bay.



Lana Jeffrey and Kelly Blacklock show off their winning design to Stuart Campbell, Len McKenzie and Moyra McRae.



Stephen Lane of Two Dogs Barking (graphic designers based in Cairns) developed the final logo based on the winning entries. The logo includes: seagrass (represented by *H. ovalis* because it is found around the entire Australian coastline); water (represented by a wave); a human element (in this case an eye); and the text is in the hand writing of Leonardo da Vinci.

Seagrass-Watch Methodologies & Long-Term Monitoring Sites

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

Methodologies

Training

Training of volunteers is usually comprised of three components – formal lectures, field training exercises, and laboratory exercises. Training includes hands on experience with standard methodologies used for seagrass mapping and monitoring methods used in the program however were modified based on feedback from participants during the training exercises.

Participants are 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. Training aids have been developed in consultation with the community and include a manual, field data books, and seagrass species/percent cover reference (or cheat) sheets.

Follow up training ("refresher") is an important component of the program to ensure that data collection is rigorous.

Mapping Seagrass Resources

Seagrass-Watch activities initially map the distribution of seagrass meadows in a region. Community volunteers were limited to mapping the accessible intertidal seagrasses, although in some cases subtidal seagrass meadows are included.

Seagrass is mapped by volunteers walking over intertidal areas, and assessessing 3 x $0.25m^2$ quadrats at randomly chosen sites. Measurments in each of the quadrats included seagrass presence/absence, seagrass species composition and sediment type, while the geographical coordinates of each site is recorded on a GPS, or drawn on a "mud map".

Mapping activities are coordinated through the Local Coordinator to ensure that as much of the region is covered as possible within the shortest period of time. Mapping strategies are also checked with the *Seagrass-Watch* Coordinator to ensure rigour. Once field mapping is completed, the data sheets are returned to the *Seagrass-Watch* Coordinator, via the Local Coordinator (who checks for any discrepancies). After the data from the mapping activities has been validated and analysed, the information is transferred to a central GIS to draw boundaries around the seagrass meadows, to assist in selecting where long term monitoring sites would be best placed. GIS maps are prepared for the region and fed back to the community groups.

Monitoring Seagrass Resources

Using the maps of seagrass distribution, a community consultation meeting with the *Seagrass-Watch* volunteers is held to select the locations for long-term monitoring. The program initially targets inshore, intertidal seagrasses. In some cases subtidal seagrass meadows are included. Site selection is assisted by consultation with environment management agencies, local government, and seagrass researchers. The position of sites may also be dependent on volunteers, as often volunteers elect to adopt a site which is 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 increase the ability to identify impacts.

Monitoring Design & Site Selection

The monitoring strategy is a nested design and is conducted at three scales: transect (metres), sites (kilometres) and locations (10s kilometres). Long term monitoring sites are 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. Sites are selected to represent the geographic extent of seagrass communities and the complexity of threats to their survival. Threats were associated with disturbances from dredging, 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. Typically, three sites are established within each location.

At each site, three parallel 50 m transects (each 25 m apart) are established, but only the middle transect is permanently marked. The location of sites is determined by GPS. The seagrass habitats along each transect are sampled by visual observation. At each transect, eleven quadrats are sampled (1 quadrat every 5 m), every three or six months, depending on the related impacts, site access and availability of volunteers. Quadrats are photographed every 5, 25 and 45 metres along transects to ensure standardisation/calibration of observers and to provide a permanent record.

Site localities

A total of 14 localities consisting of 45 sites are monitored by community groups across the Hervey Bay (15 sites), Great Sandy Strait (11 sites) and Whitsunday regions (17 sites) (Map 1). Localities monitored in the Hervey Bay region include Burrum Heads, Toogoom, Dundowran, Urangan and Wanggoolba Creek (Fraser Island). In the Great Sandy Strait localities monitored included Poona, Boonooroo, Reef Islands and Pelican Bay. Intertidal localities monitored in the Whitsundays include Hydeaway Bay, Dingo Beach, Pioneer Bay, Midge Point and Midgeton. Subtidal localities included Whitehaven Beach and Whitsunday Island (north of Cid Harbour) (Map 2).

Seagrass monitoring

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

i. Transect method

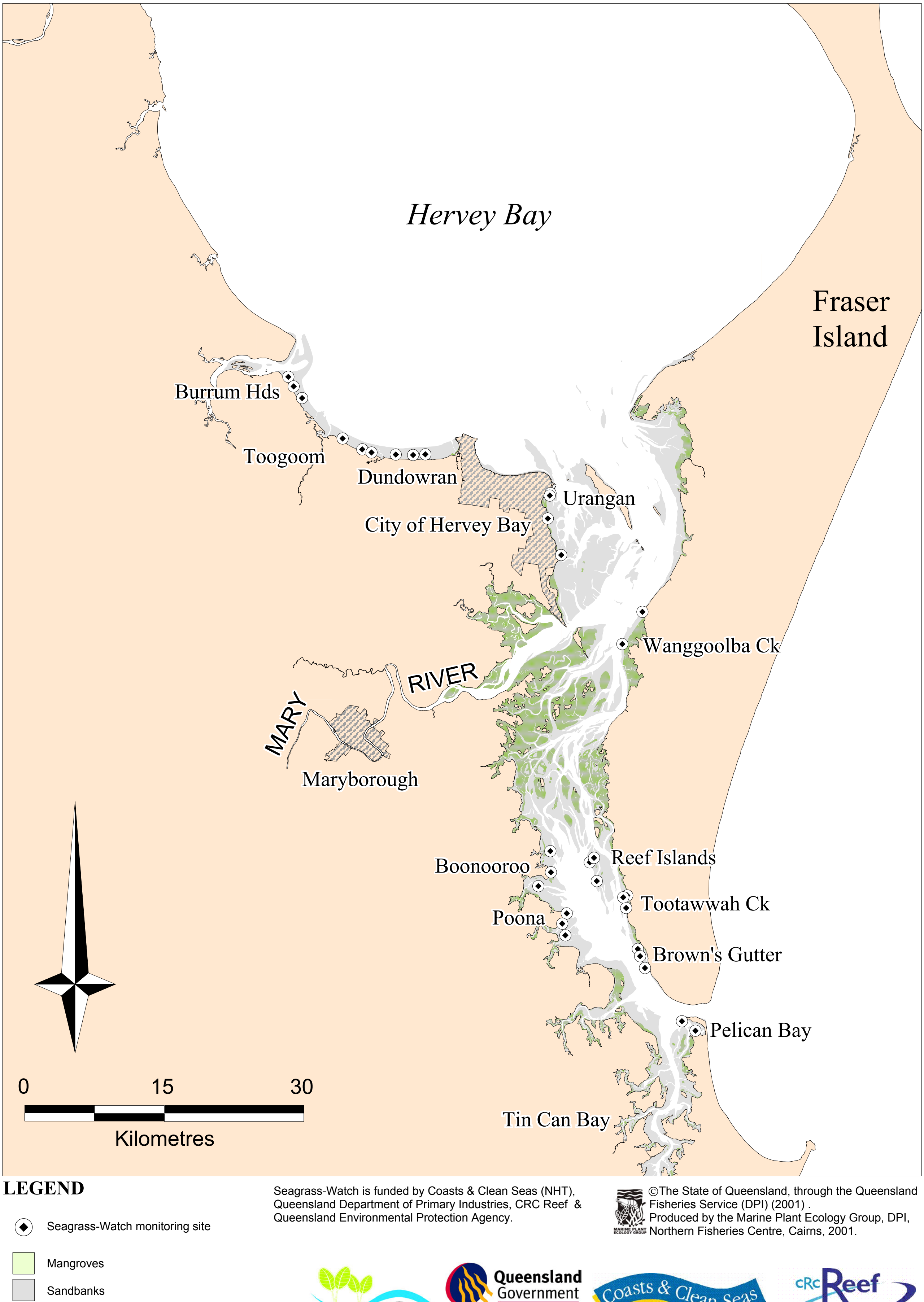
At each locality, 2 sites (50 x 50m) are permanently marked within homogenous seagrass meadows. Sites within each locality are located approximately 500m apart. At each intertidal site 3 x 50m transects are positioned perpendicular to the shore and located 25m apart. Visual estimates of percentage seagrass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

At subtidal sites where this method is employed, 3 x 100m transects are placed 50 m apart and visual abundance estimates of $0.25m^2$ quadrats are made every 10m.

ii. Free diving method

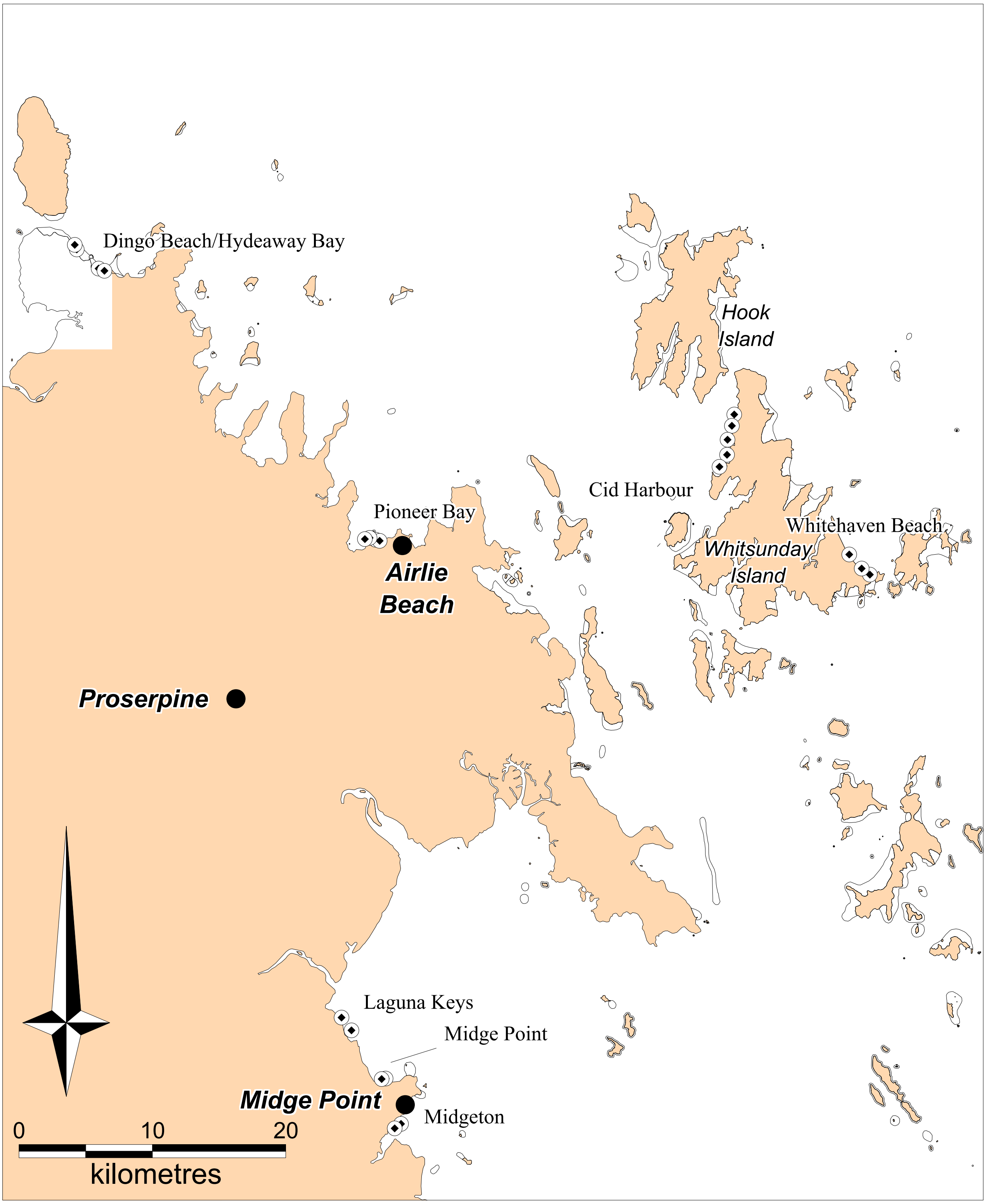
This method was used to monitor a large area ($10km^2$) of seagrass north of Cid Harbour on the west of Whitsunday Island. Five 2.1 km transects were placed 1 km apart perpendicular to the coastline. Estimates of seagrass cover were made every 700m (3 sampling locations per transect). At each location 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 $0.25m^2$ quadrats. A total of 15 locations along 5 transects are currently monitored.

MAP 1. Location of Seagrass-Watch long-term monitoring sites in Hervey Bay and the Great Sandy Strait.



Seagrass-Watch is funded by Coasts & Clean Seas (NHT), Queensland Department of Primary Industries, CRC Reef & Queensland Environmental Protection Agency.

Map 2. Location of Seagrass-Watch long-term monitoring sites in Whitsundays.



LEGEND

Seagrass-Watch monitoring site

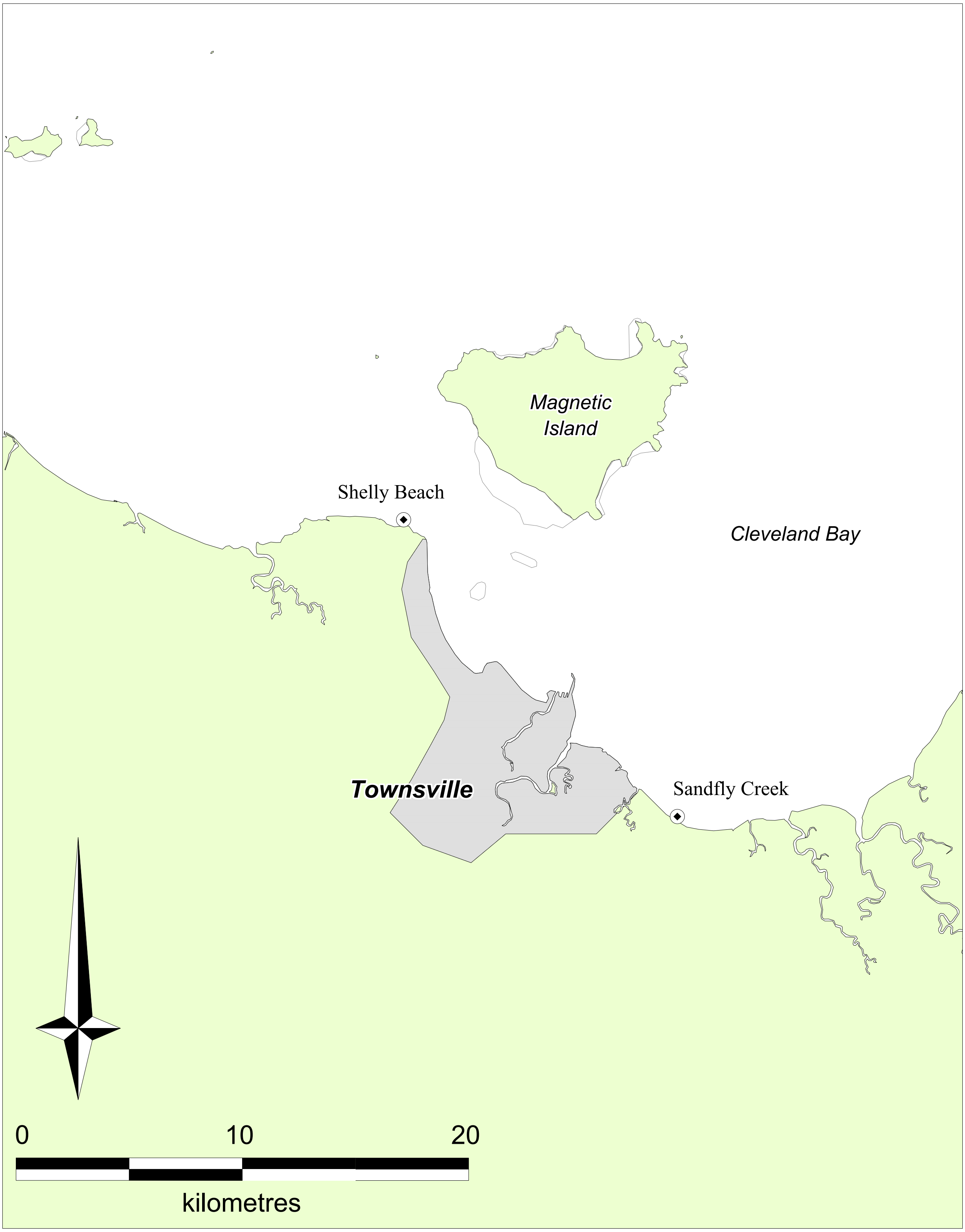
Mangroves

Sandbanks

Seagrass-Watch is funded by Coasts & Clean Seas (NHT), Queensland Department of Primary Industries, CRC Reef & Queensland Environmental Protection Agency.

Produced by the Marine Plant Ecology Group, DPI, Northern Fisheries Centre, Cairns, 2001.

MAP 3. Location of Seagrass-Watch long-term monitoring sites in the Townsville region.



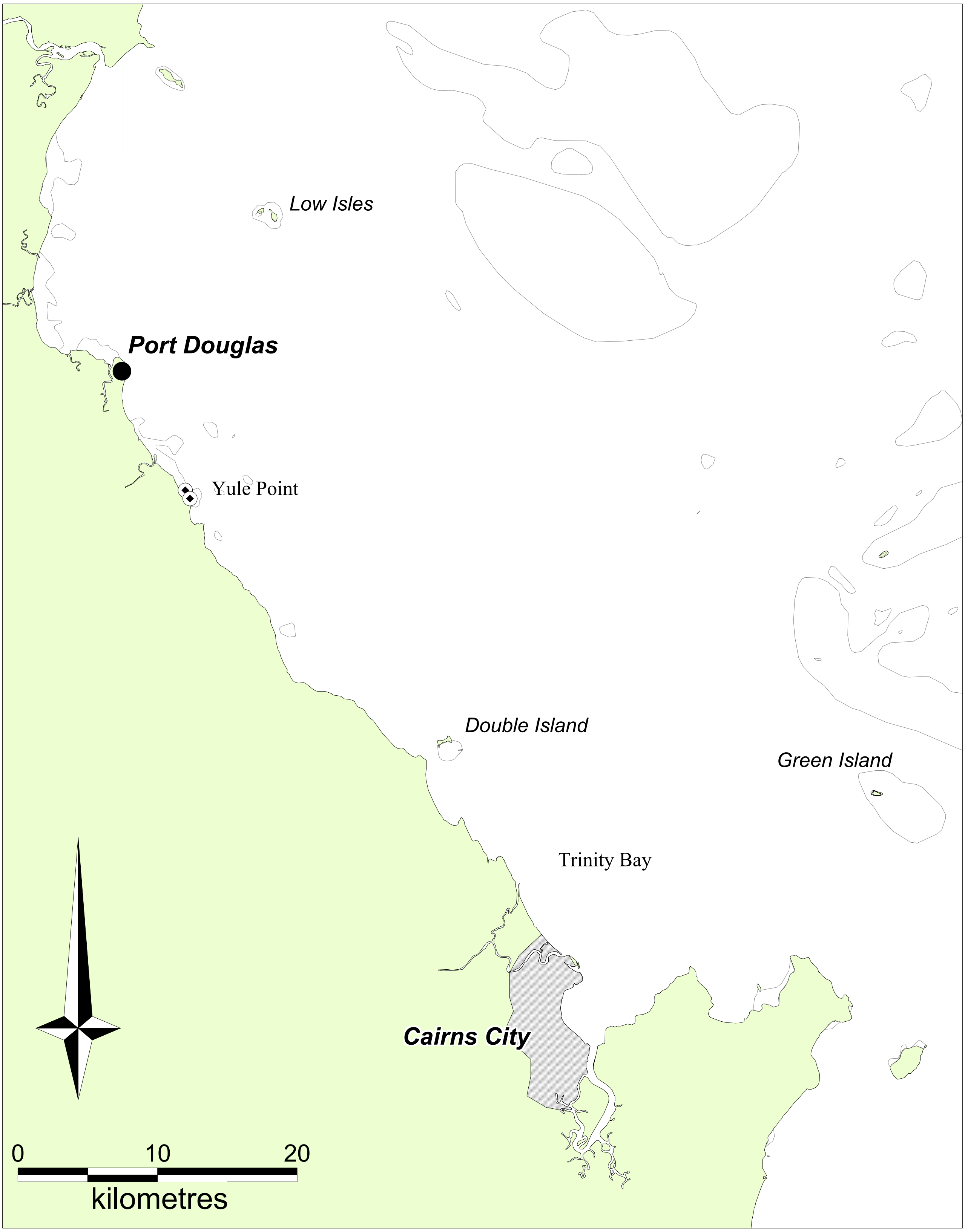
LEGEND

◆ Seagrass-Watch monitoring site

Seagrass-Watch is funded by Coasts & Clean Seas (NHT), Queensland Department of Primary Industries, CRC Reef & Queensland Environmental Protection Agency.

Produced by the Marine Plant Ecology Group, DPI, Northern Fisheries Centre, Cairns, 2001.

MAP 4. Location of Seagrass-Watch long-term monitoring sites in the Cairns region.



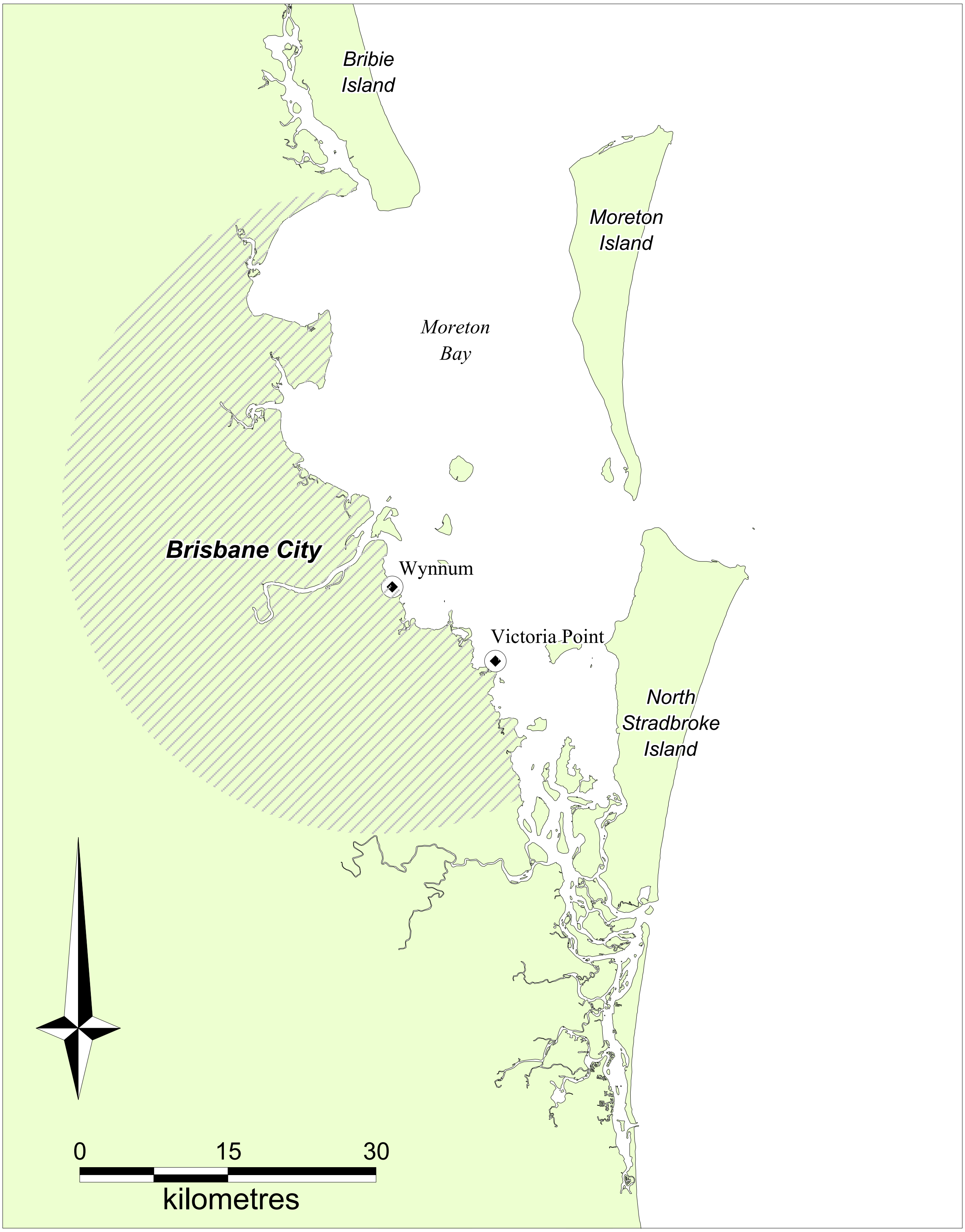
LEGEND

◆ Seagrass-Watch monitoring site

Seagrass-Watch is funded by Coasts & Clean Seas (NHT), Queensland Department of Primary Industries, CRC Reef & Queensland Environmental Protection Agency.

Produced by the Marine Plant Ecology Group, DPI, Northern Fisheries Centre, Cairns, 2001.

MAP 5. Location of Seagrass-Watch long-term monitoring sites in Moreton Bay.



LEGEND

◆ Seagrass-Watch monitoring site

Seagrass-Watch is funded by Coasts & Clean Seas (NHT), Queensland Department of Primary Industries, CRC Reef & Queensland Environmental Protection Agency.

Quality Assurance-Quality Control

The collection of data by volunteers requires that a high level of training is required to ensure that the data collected is of a standard that can be used by management agencies. Issues concerning the quality assurance and quality control of data are important especially when the collection of data is by people with no previous training in scientific methodologies. Issues of quality assurance and quality control have been summarised and are listed below by Anna Carr, a Post Doctoral Fellow at the Australian National University in Canberra

QAQC (quality assurance – quality control) is all about producing data of high quality, ensuring that your time and resources are not wasted and enhancing your group's credibility. Quality assurance (QA) refers to the management system by which your data is collected, organised, documented and evaluated. Quality control (QC) refers to the technical means by which error is controlled by both volunteers and scientists for Seagrass -Watch. QAQC is comprised of a combination of these five indicators:

Precision –determined by the degree of agreement among repeated measurements of the same characteristic at the same place and the same time.

Accuracy –measures how close your results are to a *true* or expected value. If you are collecting specimens for identification, maintaining a voucher collection can provide an expert taxonomist with a way of checking your identification.

Representativeness – the extent to which measurements actually represent the whole population at the time an observation was made.

Completeness – the comparison between the amount of valid, or useable, data you originally planned to collect, versus how much you collected.

Comparability – the extent to which data can be compared between sample locations or periods of time within a project or between projects.

How has Seagrass-Watch achieved quality assurance and control?

Seagrass-Watch has implemented a ***quality assurance*** management system to ensure that data collected by volunteers is organised and stored and able to be used easily. All data and photographic records from across Queensland are stored on a *Seagrass-Watch* database. Hard copies of data and all photographs are also stored on an easily accessible filing system.

Technical issues concerning quality control have been targetted in the following ways:

The Seagrass Watch Method is simple and easy to use. Calibration sheets are used to ensure ***precision*** and consistency between on observers and across sites at monitoring times. Repeated scientific training throughout the year has allowed volunteers to become familiar and cognisant with scientific techniques. Training of volunteers by scientists and use of field calibration sheets also allows ***comparability*** of data between sites. Issues concerning ***representativeness*** are addressed within *Seagrass-Watch* before monitoring begins. This is achieved by the careful selection of localities based on their capacity to represent the composition of seagrass meadows throughout a chosen region. Replicate sites within localities are chosen to accurately describe the broader location and scientific techniques (eg power analysis) are used to ensure sufficient sampling effort (ie quadrats) is used to describe a seagrass meadow.

The ***accuracy*** of seagrass cover measures has also been assessed. The following assessment was used to determine how close volunteer's estimates of seagrass cover were to a pre-determined value.

The ***accuracy*** of observer's estimates of seagrass cover was measured by volunteers estimating the percentage cover of a series (12) of photographs of seagrass abundance in quadrats. Observers estimates were plotted against the pre-determined seagrass percentage cover for each of the 12 photographs (Figure 1). For each observer the ratio of observed to known percentage cover estimates were calculated for each of the 12 photos (eq. 1).

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

For each of the 12 values the mean (± 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).

$$(Stdev/mean)\ \text{x}100 \qquad \text{(equation 2)}$$

A strong positive relationship was found between observer's estimates and actual pre-determined cover values.

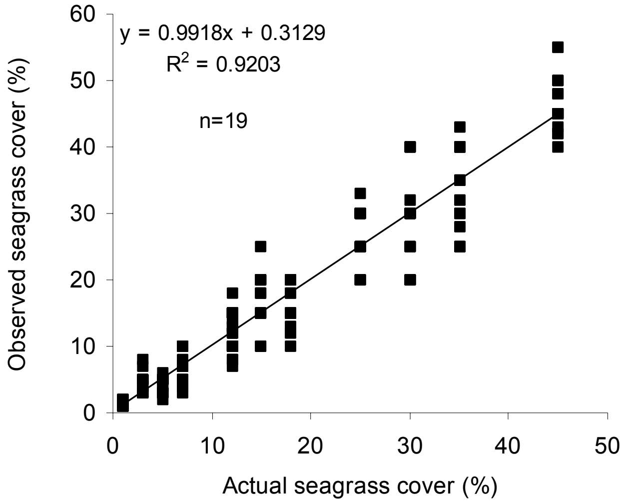


Figure 1. Estimates of seagrass cover (%) of observers versus actual seagrass cover (%).

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 2). Although visual estimates of cover at low abundances are achievable there remains a high degree of error associated with observer bias of these estimates.

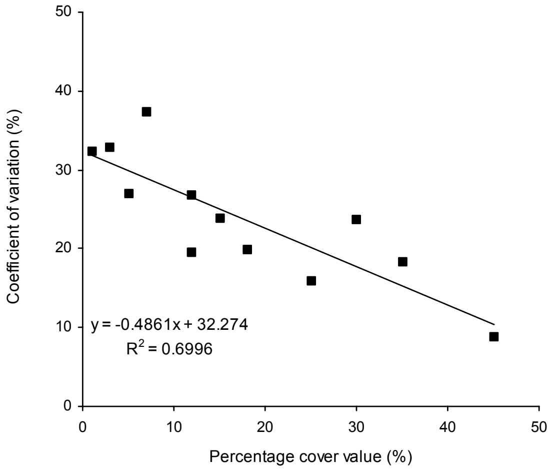


Figure 2. Coefficient of variation (CV%) for each photo-quadrat versus percentage cover value.

Seagrass-Watch Herbarium

Maintaining a herbarium of voucher speciments improves the **accuracy** of the program as it can provide an expert taxonomist with a way of verifying identifications**.**

A standard practice when monitoring or mapping using *Seagrass-Watch* methods is to collect voucher seagrass plant specimens. Voucher specimens are a sample of the representative plants observed in the field. When collecting a voucher specimen, keep in mind that all marine plants in Queensland are protected under the *Queensland Fisheries Act*. *Seagrass-Watch* volunteers are permitted to collect voucher specimens under QDPIs Fisheries Resource collection permit no. G00/282 (valid until 29th Map 2003). A label is filled out with relevant information to where the plant was collected and dept with the specimen.

Seagrass-Watch voucher specimens are archived in the Northern Fisheries Centre (NFC) herbarium. This herbarium is a catalogued collection of dried or preserved seagrass plant specimens and corresponding site information from wherever the plant was collected. The NFC herbarium is a specifically designed cupboard in a humidity and acid free environment ideal for keeping dried plant material from deteriorating.

The *Seagrass-Watch* herbarium was established in February 1998. The specimens form a valuable historical archive that can be referred to when comparing various forms or morphologies and represents a library of genetic material. A database stores the information about each herbarium specimen and can be accessed by the staff at Northern Fisheries Centre.

The *Seagrass-Watch* herbarium currently has 96 specimens logged at the Northern Fisheries Centre. Representative specimens from 7 seagrass species, and other algae (mostly *Caulerpa*) have been lodged from Hervey Bay, Whitsunday's and Yule Point.

Seagrass-Watch Photo Catalogue

An important part of *Seagrass-Watch* monitoring is to photograph selected quadrats (at 5m, 25m and 45m) along transects on each monitoring event, giving an irreplaceable record of changes in seagrass cover and species composition over time. The photo also allows for checks on **accuacy** and **precision** of observations.

The *Seagrass-Watch* photo catalogue contains photographic records of monitoring quadrats, habitats, and volunteers in the *Seagrass-Watch* program. Each photograph has been labelled, catalogued and archived at Northern Fisheries Centre in Cairns. These photographs have also been scanned and stored digitally on CD rom.

Over 530 photos of monitoring quadrats have been taken since August 1999 at the monitoring localities.

An additional 352 photos of people and habitat/landscape have been lodged since August 1999 from Hervey Bay, the Whitsundays and Yule Point.

Digital copies of the photos in the catalogue can be made available to Seagrass-Watch volunteers on request. Contact Stuart Campbell on 07 4035 113.

Case Studies of Seagrass-Watch Mapping

Burrum Heads to Eli Creek (Hervey Bay)

Seagrass meadows are a major component of the Hervey Bay marine ecosystem and they are the basis for regionally important dugong and turtle populations and productive fisheries.

Approximately 1000 km^2 of seagrasses in Hervey Bay was lost after two major floods and a cyclone within a 3 week period in 1992. Recovery of sub-tidal seagrasses (at depths >5m) began within two years of the initial loss, but recovery of inter-tidal seagrasses was much slower and only appeared evident after 4-5 years.

In mid-late 1998, the Hervey Bay Dugong and Seagrass Monitoring Program community group was approached to assist the Department of Primary Industries QDPI) in mapping seagrass meadows in the region. Between 14th June - 5th September 1998 community volunteers (Jerry Comans, Karen Kirk & Samantha Andersen) mapped a significant portion of the intertidal seagrass meadows between Burrum Heads and Eli Creek. They reported extensive *Zostera capricorni* with *Halophila ovalis* meadows (generally <10% cover) across the intertidal banks (Map 6).

In mid February 1999, the Mary River flooded into Hervey Bay. The flood was the fifth highest in the last 50 years. Concerned about the impact the flood and recovery of the seagrass meadows, John Lindberg on the 15th May 1999, mapped a transect across the intertidal areas adjacent to Beelbi Creek. He found patchy *Zostera capricorni* (<7% cover) seagrass meadows extending from 100m from the beach to the middle of the bank. From the mid bank, the seagrass meadow became *Halodule uninervis* dominated and extended to the edge of the intertidal bank.

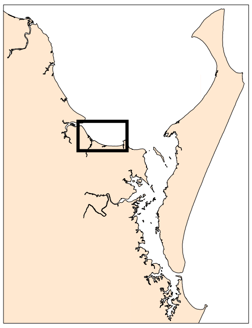
On the 16th June 2001, the Hervey Bay Dugong and Seagrass Monitoring Program conducted mapping to assess the recovery of the subtidal seagrass meadows nearly 2.5 years after the February 1999 flood. A group of volunteers (lead by John Roberts, Vanessa Jamieson, Larry Arnold, David Kohler and Jerry Comans) using volunteer divers (Garry Pomroy, Gary Williams, Les Williams, Mick, Peter East, Jacque East, Ken Grunday and Scott Pforr) found that the subtidal *Zostera caprrcorni, Halodule uninervis* and *Halophila ovalis* meadows had recovered to abundances and distributions similar (although seasonally lower) to December 1998.

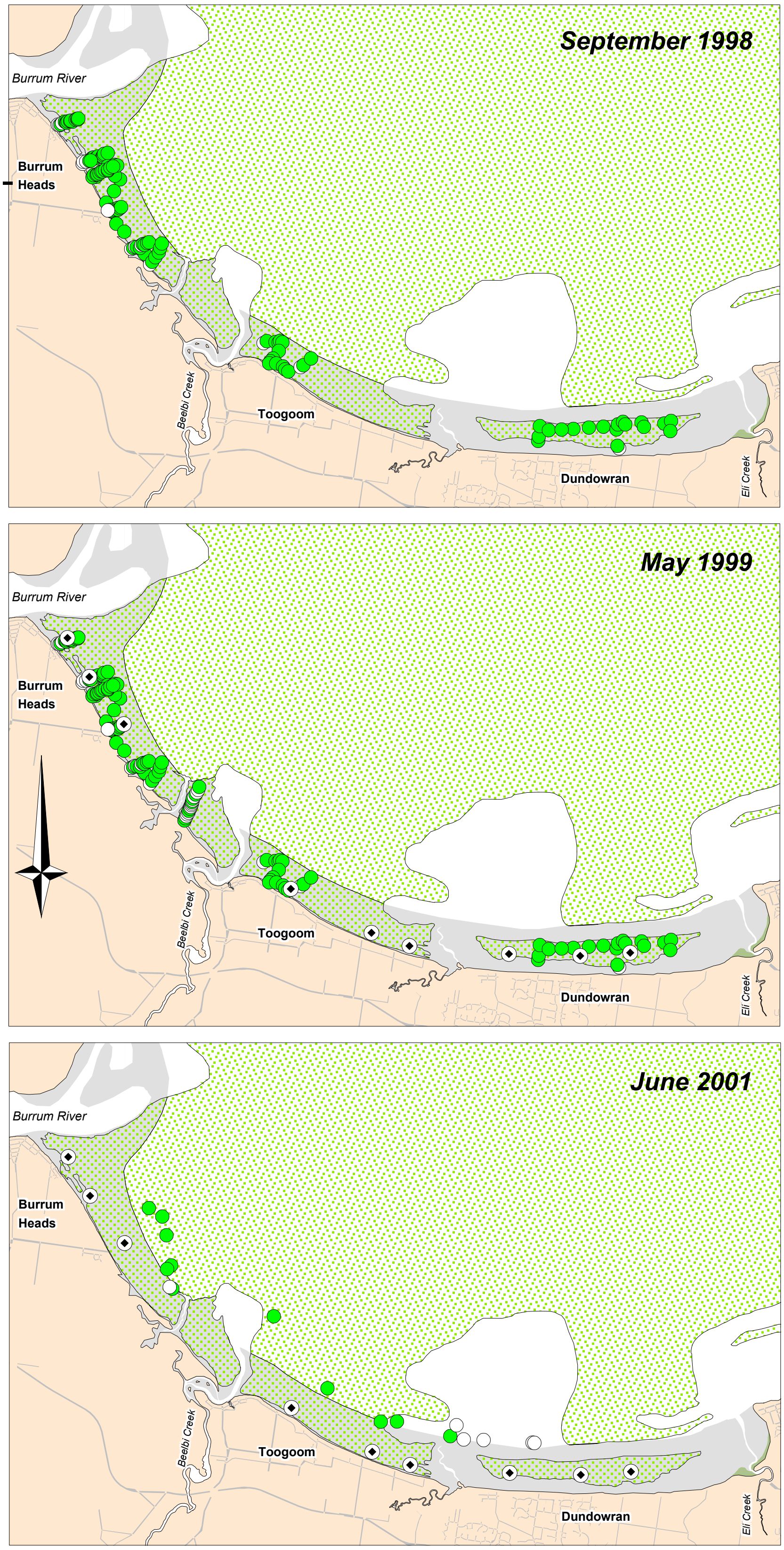
Management application:

Maps of seagrass distribution (1998) and preliminary results of Seagrass-Watch monitoring at all three Burrum Heads sites, were provided to coastal managers (QPWS - EPA), state government (QDPI), local government (Hervey Bay City Council), James Cook University and other interested stakeholders to assist with the assessment of dredging and development proposals in the Burrum River.

MAP 6.

Community seagrass mapping sites & seagrass distribution - Burrum Heads to Dundowran





Legend

- *Seagrass present*
- *No seagrass*
- *Seagrass-Watch monitoring site*
- *Subtidal seagrass meadows - December 1998*
- *Intertidal seagrass meadows - December 1998*

Survey Dates:
community mapping 14 June - 5 September 1998.
15 May 1999
16 June 2001
DPI mapping 6-14 December 1998

Source: McKenzie, L.J. (2001). Seagrass communities of Hervey Bay & the Great Sandy Straits: December (Summer) 1998. (DPI, Cairns) In Prep.

Hervey Bay Dugong and Seagrass Monitoring Program
Coasts & Clean Seas
Queensland Government
Primary Industries
Environmental Protection
Parks and Wildlife
CRC Reef Research Centre





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1st SEAGRASS BATTALION

Poona (Great Sandy Strait)

Seagrass meadows are a major marine habitat of the Great Sandy Strait. A major population of dugong and green sea turtles are dependent on these meadows. Coastal meadows also are important nursery habitat to juvenile fish and prawns, and provide important habitat for wading birds. The area and density of seagrass meadows in the strait changes seasonally and periodically.

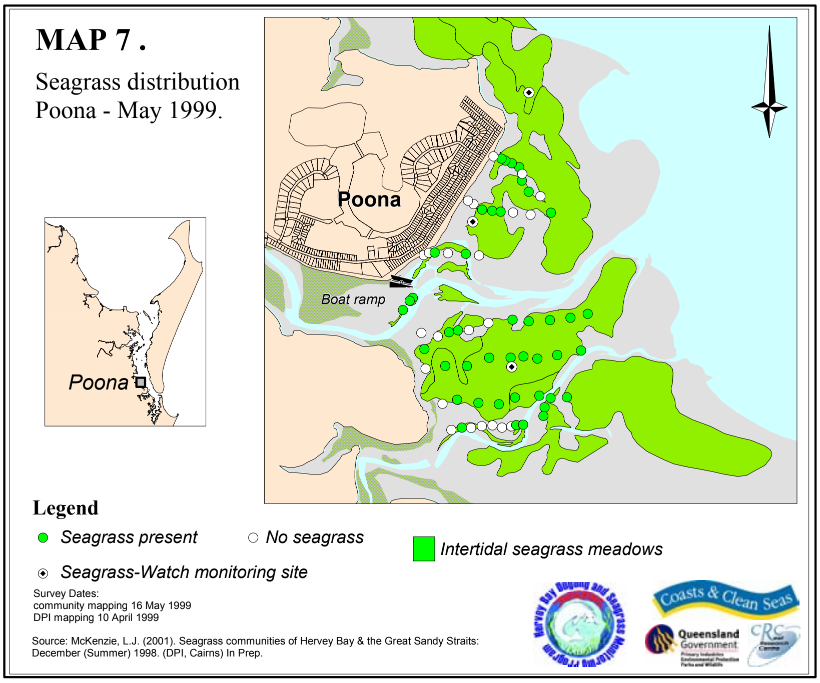
Seagrass distribution was first mapped in the Great Sandy Strait in July/December 1973. Over the subsequent years several surveys were conducted by government departments and private consultants, however it is difficult to identify accurately the amount of change in seagrass resources in the strait, due to the significant errors in different mapping techniques and the extent of ground truthing.

In 1999, to assist QDPI with resurveying seagrass distribution in the Great Sandy Strait and the suitable positioning of permanent Seagrass-Watch monitoring sites, voluneteers from the Hervey Bay Dugong and Seagrass Monitoring Program community group were approached to assist.

On 16th May 1999, two groups of volunteers (lead by Vanessa Jamieson and Greg Lynch, respectively), mapped the intertidal seagrass meadows around Poona. The meadows around Poona were predominantly sparse low abundance (<1 - 10% cover) *Zostera capricorni* with *Halophila ovalis* (mud/sand substrate). Meadows on the edge of the creek were the same species composition, but slightly higher cover (10-50%) and very patchy.

Management application:

Maps of seagrass distribution (1998/99) and preliminary results of Seagrass-Watch monitoring at all three Poona sites, were provided to coastal managers (QPWS - EPA), state government (QDPI), local government (Hervey Bay City Council), and other interested stakeholders to assist with the assessment of a dredging application for the Poona boat ramp.



MAP 7. Seagrass distribution Poona - May 1999.

Muddy Bay, Shute Harbour and Pioneer Bay (Whitsunday Region)

Seagrass meadows are a vital marine habitat of the Whitsunday region. Dugong and green sea turtle populations are dependent on these meadows. Coastal meadows also are important nursery habitat to juvenile fish and prawns, and provide important habitat for wading birds.

Between January 1999 and Jaunary 2000, the distribution of seagrass meadows in the Whitsundays region was mapped in detail. Local "Order of Underwater Coral Heroes" (OUCH) and Whitsunday volunteers also gave assistance whilst continuing to build their seagrass knowledge.

In March 1999, several Whitsunday Volunteers assisted members of the Marine Plant Ecology Group to survey the shallow intertidal areas of Muddy Bay (low density *Halodule uninervis* on very muddy sediment), Shute Harbour (low density *Halophila ovalis* on gravel) and Pioneer Bay (medium density *Halodule uninervis* on sand) (Map 8). In particular Rob Salmon, Cate Radclyfe and Bob Bower were integral in the team to map the upper intertidal reaches of these meadows. Their feedback was also invaluable in selecting the long-term monitoirng sites in Pioneer Bay.

Seagrass was found at all areas, and the meadows surrounding Pigeon Island in Pioneer Bay had many dugong feeding trails.

Management application:

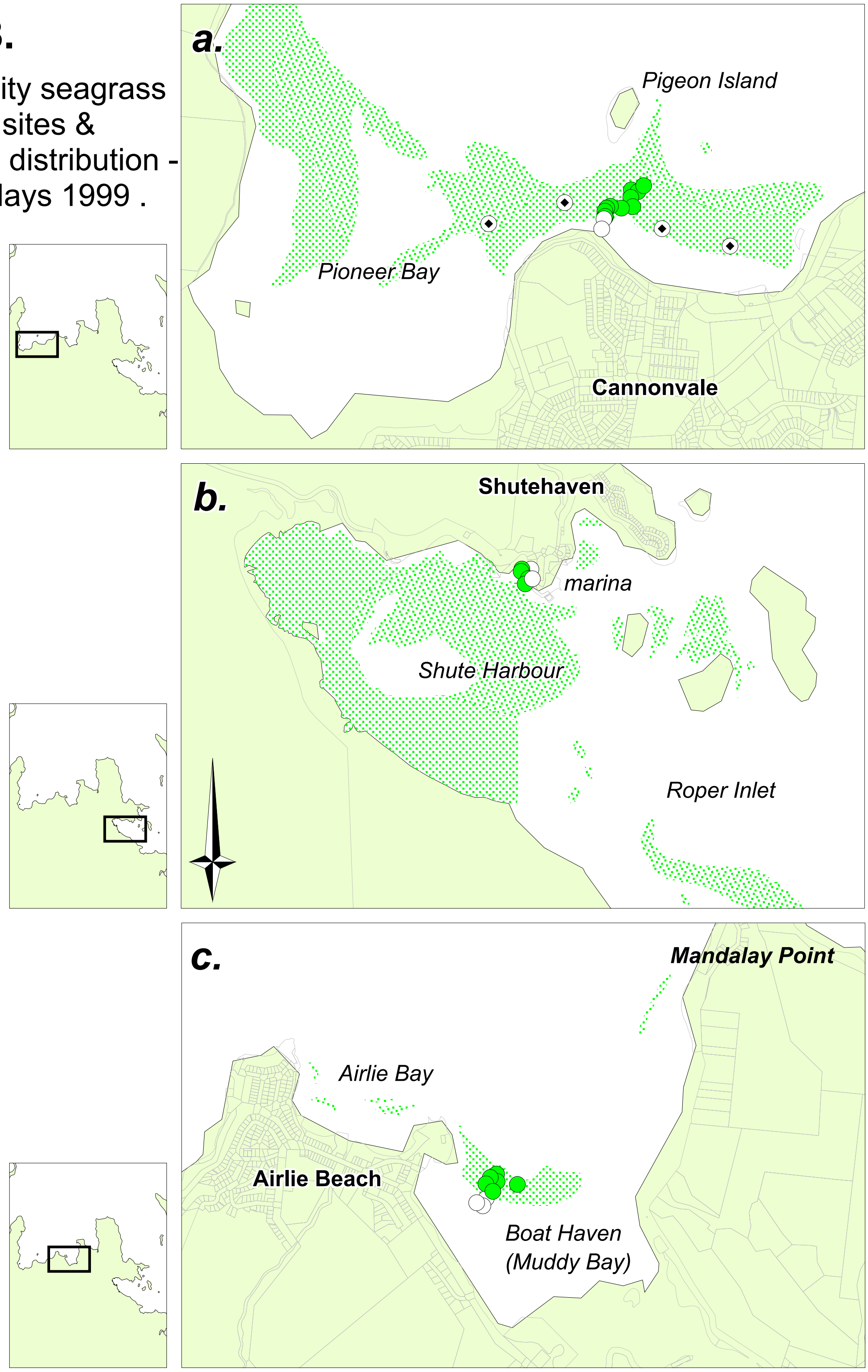
Maps of seagrass distribution (1999) in Shute Harbour were provided to coastal managers (Great Barrier Reef Marine Park Authority, QPWS - EPA), state government (QDPI), and other interested stakeholders to assist with the assessment of a dredging and spoil dumping ground application for the Lloyd Roberts Jetty development.

Maps of seagrass distribution (1999) and preliminary results of Seagrass-Watch monitoring at all four Pioneer Bay sites, were provided to coastal managers (QPWS - EPA), state government (QDPI), local government (Whitsundays Shire), and other interested stakeholders to assist with the assessment of a development application for the construction of a boat ramp in the eastern side of Pioneer Bay.

Similarly, maps of seagrass distribution (1999) in Muddy Bay were provided to coastal managers (QPWS - EPA), state government (QDPI), local government (Whitsundays Shire), and other interested stakeholders to assist with the assessment of a development application for a proposed marina.

MAP 8.

Community seagrass mapping sites & seagrass distribution - Whitsundays 1999 .



Legend

- Seagrass present
- No seagrass
- Seagrass-Watch monitoring site
- Subtidal seagrass meadows - January 1999
- Intertidal seagrass meadows - January 1999

Survey Dates:
community mapping 20 - 28 March 1999
DPI mapping 10-15 January 1999 & 30 January 2000.

Laguna Quays (Whitsundays)

Seagrass meadows are a major marine habitat of Repulse Bay. Populations of dugong and green sea turtles use these meadows which are situated between intertidal seagrass to the south at Midge Point and extensive meadows in the Dugong Protection Area in northern Repulse Bay. Coastal seagrass meadows in this region also provide important nursery habitat to juvenile fish and prawns, and provide important habitat for wading birds.

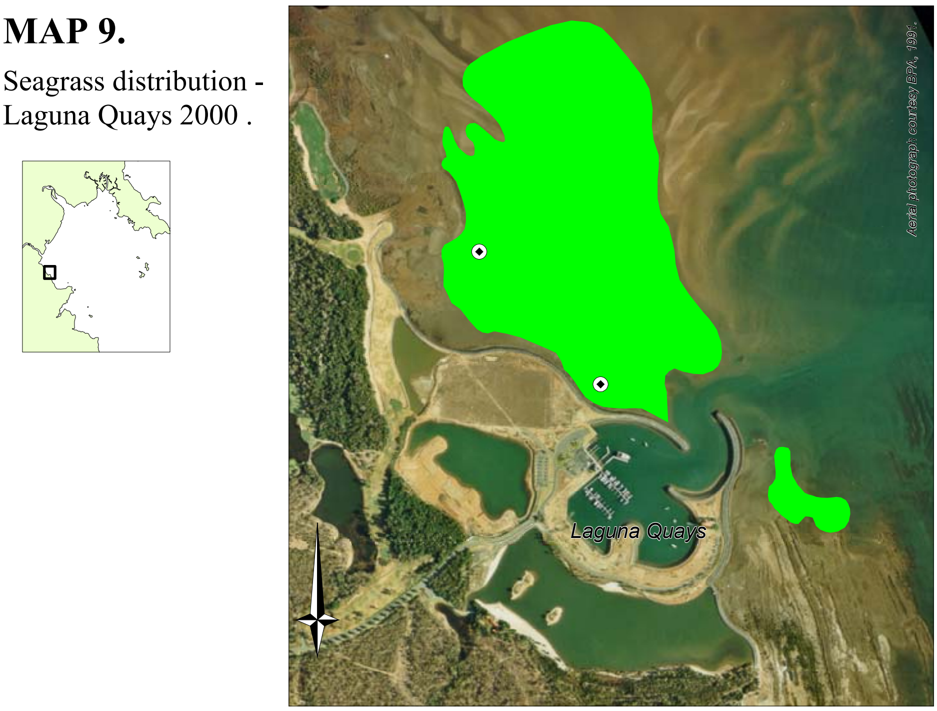
In January 2000, the distribution of seagrass meadows in Repulse Bay were mapped. In March 2000, Seagrass-Watch volunteers John and Tracy Thornley from the Laguna Quays marina, helped establish monitoring sites in the area. Seagrass was found at all areas, and at meadows near the marina dugong turtle feeding has been evident. The meadows have shown seasonal growth patterns and have been assessed to be in "good" condition.

Management application:

Maps of seagrass distribution (1999) and preliminary results of Seagrass-Watch monitoring at both sites adjacent Laguna Quays were provided to Environment Australia for their consideration under the Environment Protection and Biodiversity Act (1999) to assist with the assessment of an application to expand the airport and runway at Laguna Quays Resort.

MAP 9.

Seagrass distribution - Laguna Quays 2000 .



Legend

Seagrass-Watch monitoring site

Intertidal seagrass meadows - January 2000

Seagrass-Watch is funded by Coasts & Clean Seas (NHT), Queensland Department of Primary Industries, CRC Reef & Queensland Environmental Protection Agency.

Produced by the Marine Plant Ecology Group, DPI, Northern Fisheries Centre, Cairns, 2001.

Blue-green algae in the Whitsundays

Coastal seagrass meadows in the Whitsundays, particularly those adjacent to mangrove habitats, support very productive fish and prawn populations of commercial and recreational fisheries value. They are also used for feeding by dugong and turtle populations.

16 — THE COURIER-MAIL

Pristine beach hit by algal menace

SOUTHEAST Queensland's blue-green algal menace has been discovered at the Whitsundays tourist icon Whitehaven Beach.

A kilometre-long outbreak occurred off the beach in January this year amid conflicting reports of the algae known as lyngbya at other sites along the state's coast.

Tony Fontes, a volunteer in the Seagrass Watch program which discovered the outbreak, said he had not seen its like over the 23 years he had visited Whitehaven beach.

"That's the icon of the Whitsundays and it's well known for its pristine white beaches and here you have this – well, it's just short of an oil spill," Mr Fontes said.

Dr Stuart Campbell, from the Department of Primary Industries marine plant ecology group, said lyngbya had also been discovered at Airlie Beach as well as Hardy Reef, 80km northeast of the town.

"At this stage, there hasn't been any detection of toxicity to humans as far as I know", he said.

In Moreton Bay, a massive 30sq km lyngbya outbreak last year led the State Government to close beaches and issue health warnings after its toxins were found to trigger allergic reactions, including asthma attacks.

Dr Campbell said lyngbya appeared to extend beyond the Whitsundays, with another identification made at a beach near Townsville.

— Siobhain Ryan

In September 2000 and January 2001 *Seagrass-Watch* volunteers noted excessive amounts of of algae growing on seagrasses at Pioneer Bay and Whitehaven Beach sites. Data on the abundance of algae was recorded and collections of algae sent to the University of Queensland for identification. The alga was identified as the blue-green alga *Lyngbya majuscula*, an alga known to cause severe skin irritations and blistering to humans, smother seagrass and cause seagrass die-off. The persistence and frequent abundance of filamentous blue-green algae in the Whitsundays region is cause for concern as these algae place at risk the future health of these seagrass meadows.

Management application:

In March 2001 a report on the presence of the blue-green alga *Lyngbya majuscula* was presented to the Environment Protection Authority and Queensland Parks and Wildlife Service Detailed maps of locations of the blue-green algal blooms at Pioneer Bay and Whitehaven Beach were presented. The data collected by *Seagrass-Watch* is important to investigations made by state government agencies and the University of Queensland. These investigations aim to assess the influence and contribution of localised sources of nutrients and other potential factors to filamentous algal growth at intertidal and subtidal sites in Pioneer Bay and other sites in the Whitsundays.

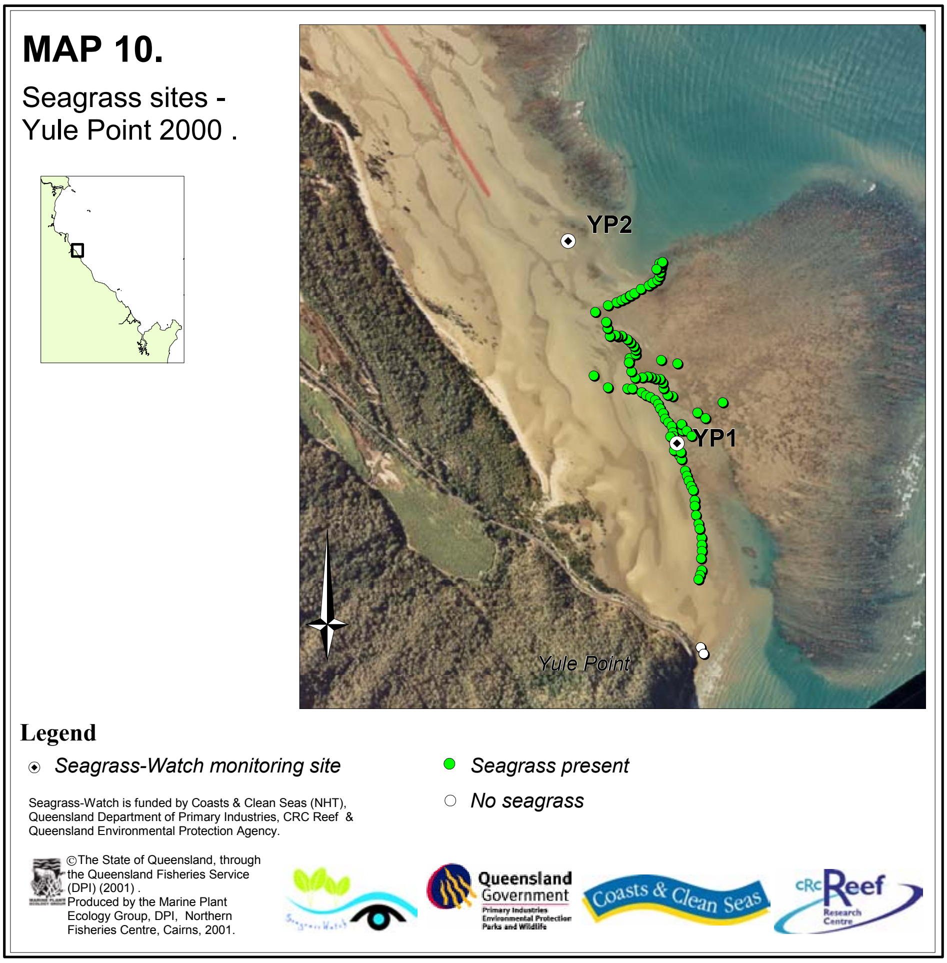
Source: Campbell, S.J. and McKenzie L.J. (2001): Seagrass and algal abundance in the Whitsundays region. Status report (QDPI, Cairns) 14pp.

Yule Point

Intertidal seagrass meadows isolated at Yule Point, between Cairns and Port Douglas, provide important habitat for feeding dugong and wading birds.

In August 2000, indigenous students from the Cairns TAFE "Caring for Country" course were trained in the application of *Seagrass-Watch* methods. They have been monitoring the seagrass meadows at Yule Point for the past 12 months. The students have detected seasonal growth patterns of seagrasses at this northern Queensland site and documented times when dugong feeding is evident.

In early 2001 information on seagrass abundance and dugong feeding activity from the Yule Point region was made available to the Environment Protection Agency in Cairns for input into the development of Coastal Management Plans for the region. The information has also been made available to the Port Douglas Shire Council for use in their Sustainability Strategy and input to their database on environmental monitoring for future State of Environment reports.



Case Studies of Seagrass-Watch Monitoring

Burrum Heads

Burrum Heads is located in the western section of Hervey Bay, a large embayment (3,940 km^2) situated on Queensland's southern coast. Extensive intertidal banks (2,307 km^2) consisting of fine to medium grained sands fringe the landward component of the bay supporting extensive yet sparse seagrass meadows. Intertidal seagrass meadows are situated near the mouth of the Burrum River.

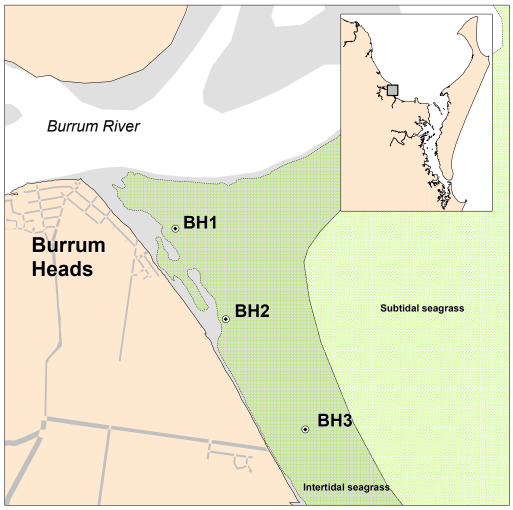


FIGURE1

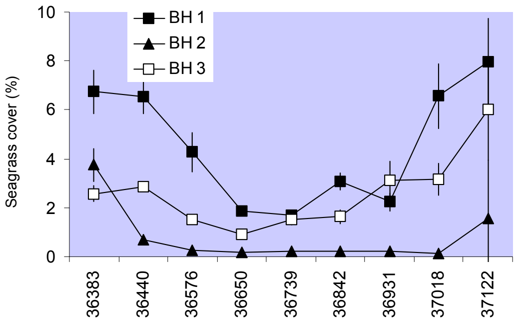


FIGURE 2

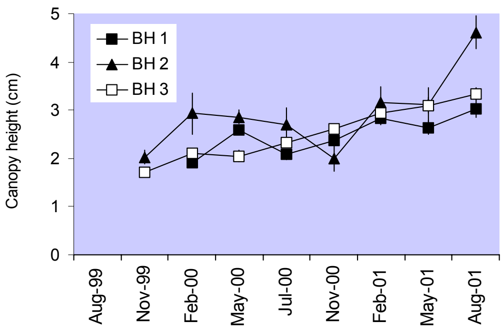
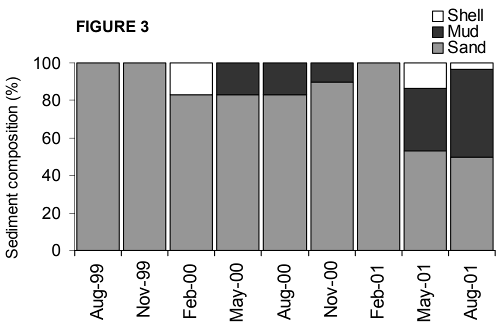


FIGURE 3

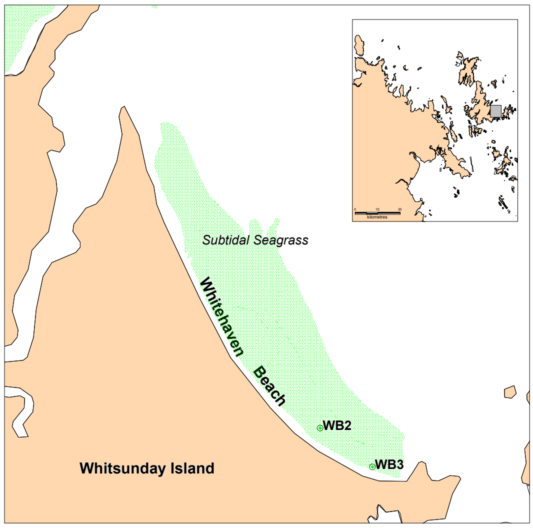


The dominant seagrass species at Burrum Heads, include *Halodule uninervis* (narrow leaf morphology), *Halophila ovalis* and *Zostera capricorni.* From August 1999 to August 2000 the abundance and canopy height of intertidal seagrass meadows at Burrum Heads appeared to decline (<2 % cover; ~2cm respectively) (Figs. 1 and 2). In the latter half of 2000, seagrass meadows showed signs of recovery with increased abundance and canopy height (8% cover; 3-5cm respectively).

Since monitoring began in August 1999, two dugong feeding trails were first sighted at Burrum Heads (site 1) in February 2000. Due to the absence of available seagrass no dugong feeding trails were found throughout the remainder of 2000 or in the first half of 2001. In August 2001, however, many (>50) dugong trails were found near BH1, coinciding with the increase in seagrass cover. Dugong have returned to feed at these meadows after an 18 month absence.

During the period of seagrass decline sediments were highly mobile (evident from the rippling) and composed of a high proportion of sand (Fig. 3). Burial from sediment movement is a likely cause for the observed loss of both *Z. capricorni* and *H. uninervis* throughout the year 2000. An increase in the proportion of mud in sediments coincided with seagrass recovery, a finding consistent with the capacity of seagrasses to trap and bind fine sediments.

Whitehaven Beach



Extensive seagrass meadows support turtle, dugong and fish species throughout the Whitsunday Islands. Threats to the ecological "health" of these ecosystems include impacts from anchors from numerous boats visiting the region. In other countries persistent anchor and propellor damage has been shown to uproot and break rhizomes essential for sediment stability. The monitoring of seagrass meadows at Whitehaven Beach aims to examine the ongoing impacts associated with anchor damage.

FIGURE 1

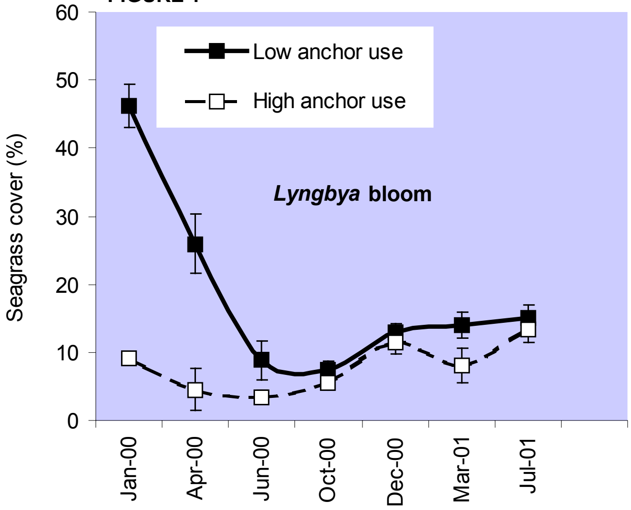
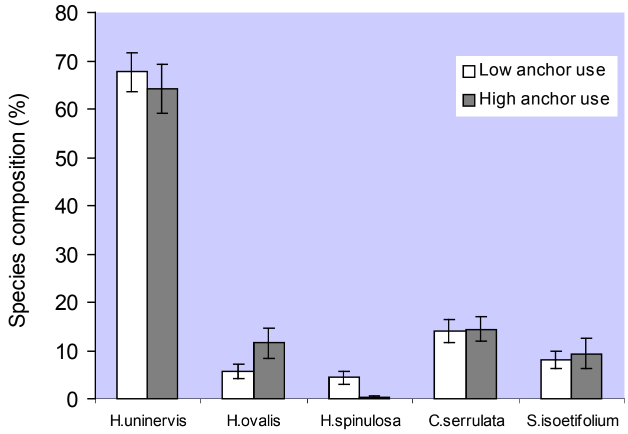


FIGURE 2



Seagrass abundance (%cover) was generally highest in summer (January) following spring growth and lowest in winter (June). In December 2000 seagrass cover showed only a small increase and was subsequently impacted by an extensive bloom of the blue-green alga *Lyngbya majuscula*. The cause of the bloom remains unknown, but is possibly related to inputs of nutrient (iron, nitrogen) rich waters from nearby freshwater creeks.

The percentage cover of seagrasses at Whitehaven Beach was lower (<10% cover) at high anchor use (10-15 boats per day) sites compared with low anchor use (1-3 boats per day) sites (>10% cover). The data suggests that the anchoring of boats is having a persistent effect on seagrass abundance (Fig. 1) and species composition (Fig 2). A decline in seagrass abundance can lead to a reduction in sediment stability that may lead to increased sedimentation, reduced water quality and negatively affect "tourism" values of the area. Seagrass recovery may be possible if anchor disturbance were to be reduced by the placement of permanent mooring for boats. The growth characteristics of seagrass species and the size, type and timing of disturbance are factors likely to influence recovery.

Southern Repulse Bay

Repulse Bay is situated in the southern region of the Whitsundays on the central east Queensland coast. It receives flows from the Proserpine and the O'Connell rivers that are supplied by catchments extensively cleared for grazing and cane production. The high loads of sediments and nutrients from both catchments are considered to pose a high risk to the inshore marine habitats (GBRMPA 2001). The northern region of Repulse Bay include Dugong Protection and declared Fish Habitat Protection Areas.

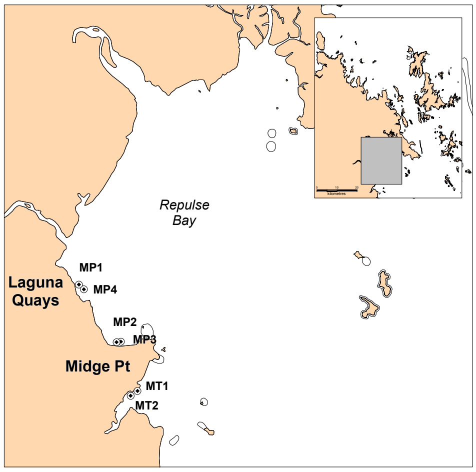
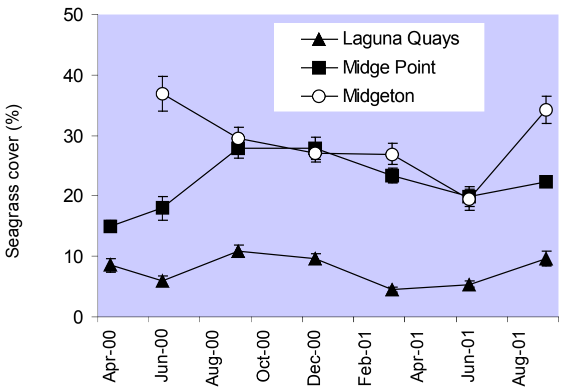


FIGURE 1



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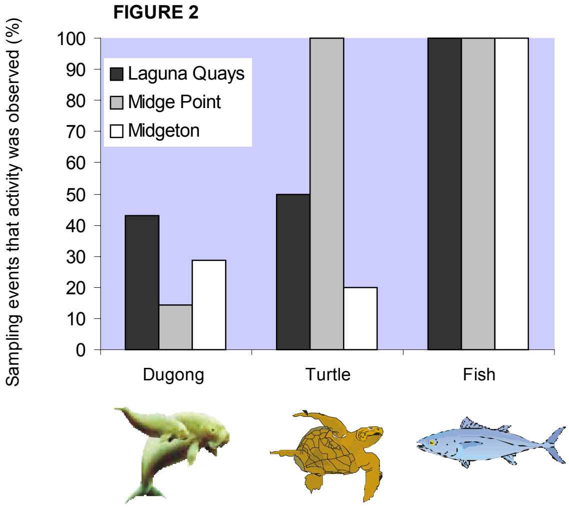


Monitoring of intertidal seagrasses in southern Repulse Bay at Laguna Quays and Midge Point has shown that seagrass meadows are in good condition and relatively unaffected by catchment inputs.

Low seagrass abundance in winter (June-July) and high abundance in spring/summer (September - December) suggest that natural factors (ie temperature, light) are influencing seagrass growth. A decline in seagrass abundance over time to the south at Midgeton, was associated with sediment disturbance and strong southerly winds. Recent trends of increased seagrass cover (ie spring growth) suggest that seagrass meadows here are "healthy" and responding to an increase in temperature and light availability. Dugong feeding in the meadows at Laguna Quays and Midgeton occurred between autumn to spring and was more frequent than at Midge Point (Figure 2) where *Z. capricorni* is the dominant seagrass species. Evidence of turtle feeding (ie cropped, short seagrass leaves) was apparent at Midge Point year round. Many fish species are also dependent on seagrass habitats throughout their lifecycle and evidence of fish activity and feeding (holes/markings in sediment) across all sites was high. It is likely that deterioration in seagrass habitats would have negative effects on fish abundance, as well as turtle and dugong survival.

Urangan and Wanggoolba Creek

Seagrass-Watch sites at Urangan and Wanggoolba Creek (Fraser Island) are in close proximity to the mouth of the Mary River in the northern section of the Great Sandy Strait. The flooding of the Mary River in February 1999 caused a catastrophic loss of seagrass at these sites. Post-flood monitoring of seagrasses provided a unique opportunity to monitor the recovery of seagrass meadows following this loss.

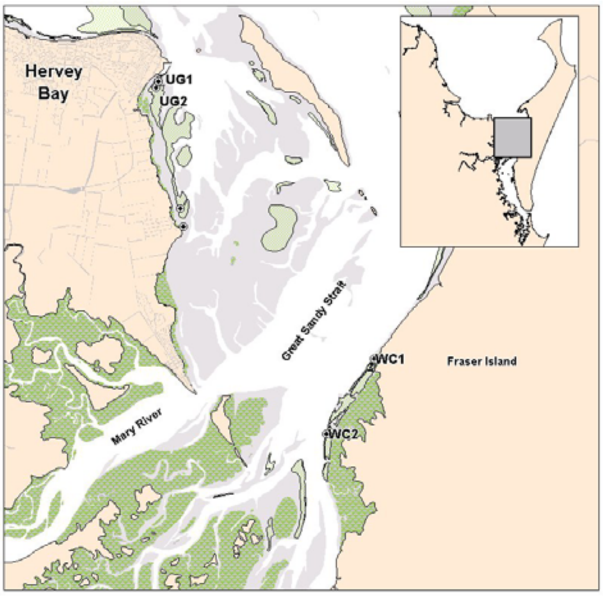


FIGURE 1

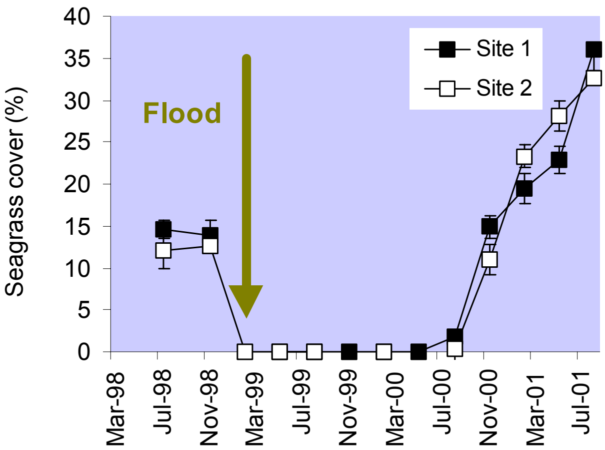
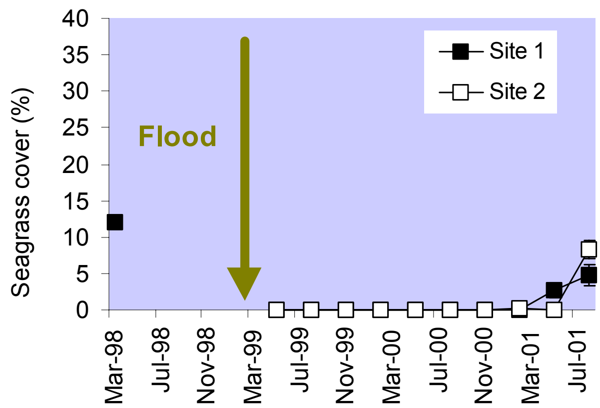


FIGURE 2



Regeneration of *Zostera capricorni* occurred at Wanggoolba Creek sites 18 months post-flood and after 2 years the abundance of seagrasses had recovered to pre-flood abundance levels (>30% cover) (Fig. 1). At Urangan regeneration of seagrass also occurred 18 months following the flood, but the standing crop of seagrasses remained low (<3% cover) (Fig 2). It took approximately 30 months following the flood for seagrass abundance at Urangan to recover to pre-flood levels (Fig. 2).

The first signs of seagrass recovery at all sites was the profusion of small seedlings sprouting from the sediment surface in May 2000, 18 months after the flood. Regeneration of *Z.capricorni* was from seeds, rather than vegetative, suggesting that seeds had remained dormant in the sediments for at least 18 months. Recovery was site specific as intertidal seagrass meadows located on sites adjacent to Wanggoolba Creek recovered faster than those situated on the mainland (Urangan). The reasons for this difference are not completely known but are likely to be associated with factors controlling water quality in the region. Light availability is an important factor influencing the growth of seagrasses and inputs from the Mary River and other creeks reduce available light.

Pioneer Bay

Pioneer Bay is situated in the urbanised central coast of the Whitsundays region, consisting of tourism precincts, residential development, sewage outfalls, marinas and boating facilities. Nutrient inputs from a range of sources potentially threaten the viability of extensive seagrass meadows in Pioneer Bay. The meadows are used extensively by turtle, dugong and fish species for food and/or shelter.

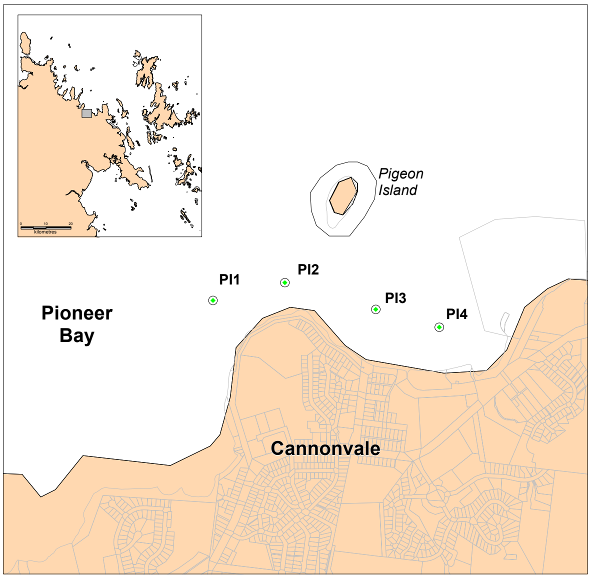
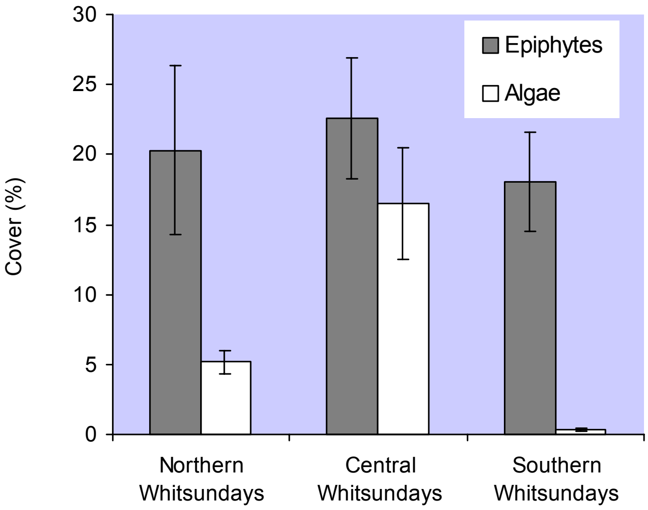


FIGURE 1



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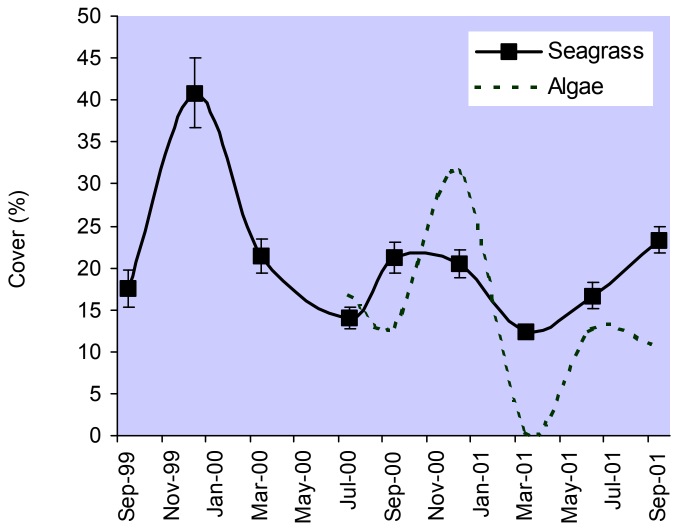


Shading from epiphyte and algae can reduce light reaching the photosynthetic seagrass leaves and inhibit seagrass growth. Epiphytic growth occurs naturally and the abundance of epiphytes on seagrass leaves at Pioneer Bay (Central Whitsundays) was no higher than reported from other localities in the Whitsundays (Fig. 1). In contrast algal cover was higher in the central Whitsundays (Pioneer Bay) than in the northern and southern localities (Fig. 1). The persistent year-round algal growth suggests that nutrient availability at this locality remains high. Nutrient inputs are from a number of sources including sewage outfalls, boat facilities and catchment runoff.

Over the 2 years of monitoring the seasonal responses of seagrasses (high cover in spring-summer; low cover in winter) (Fig. 2) demonstrate the effectiveness of the *Seagrass-Watch* method in detecting natural fluctuations in seagrass abundance. The negative effects of algal growth on seagrasses are well known, and the high abundance of algae during the 2000-01 summer coincides with a lower summer peak observed in seagrass cover than the previous year (Fig. 2). The detrimental effects of algae on other resources is unknown, however the ingestion of large quantities of algae may have negative health effects on local dugong populations that regularly feed on seagrass at

Pioneer Bay.

The Great Sandy Strait

The Great Sandy Strait is a sand passage estuary between the mainland and Fraser Island and is the fifth largest enclosed embayment in Queensland. The surrounding catchments consist of extensive areas of pine plantations, grazing, cane lands and native vegetation. Threats to the viability of seagrass habitats include inputs from the Mary River to the north and inputs of nutrients and sediments from numerous rivers and tributaries draining into the estuary.

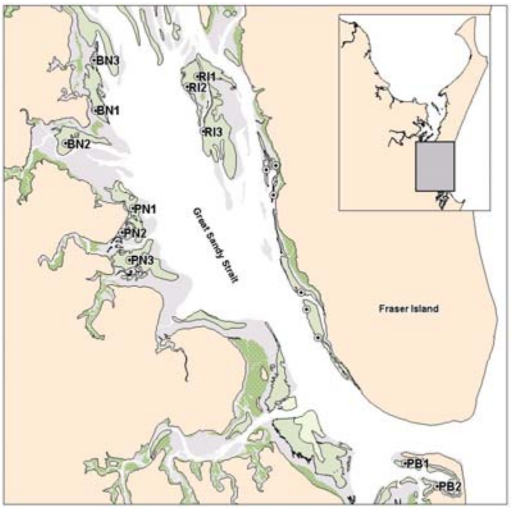


FIGURE 1

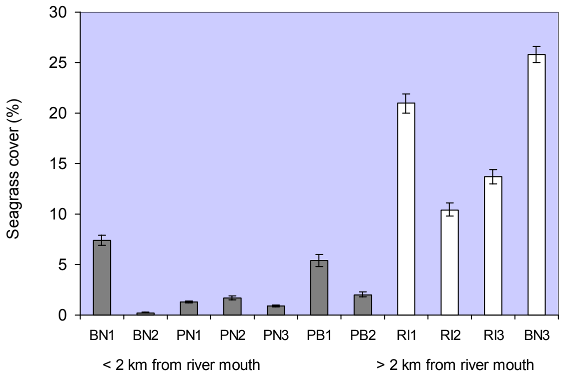


FIGURE 2

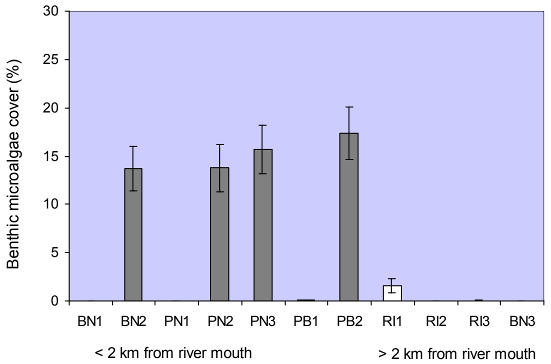
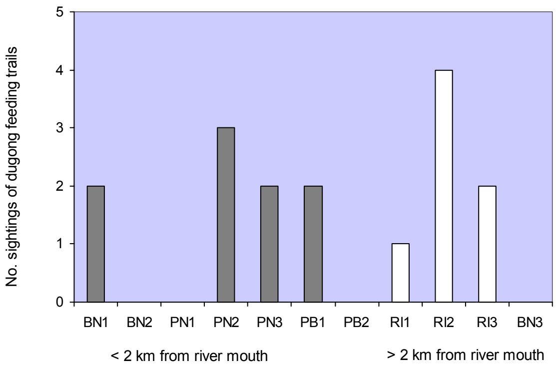


FIGURE 3



The standing crop of seagrass varies considerably throughout the region. Generally seagrass abundance is lower at sites close to river mouths (<1 km) than at sites at a distance (>2km) from river inputs. The monitoring data suggests that inputs from rivers may be one of the factors that result in lower seagrass abundance, an impact likely to be higher following rainfall and flooding.

Following the flooding of the Great Sandy Strait during February 1999, measures of phytoplankton biomass remained high indicative of nutrients inputs remaining trapped within the ecosystem (EPA data). These nutrients promote algal and epiphyte growth on seagrass leaves and reduce light available for seagrass photosynthetic processes. High amounts of benthic microalgae that grow on the sediment surface and use nutrients in the sediment were found to colonise sediments close to river mouths, also indicative of high nutrient availability (Fig 2).

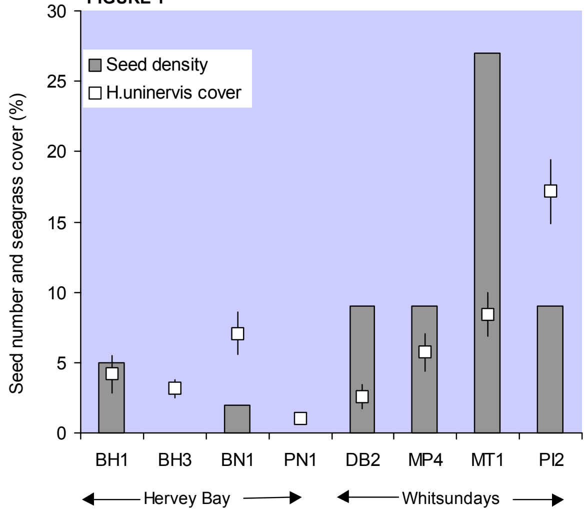
Despite the low seagrass abundance at many sites close to river mouths, the number of times that dugong feeding trails were found at sites was comparable to sites at a distance from river inputs. Hence these meadows nevertheless provide a valuable food resource for dugong populations (Figure 3).

Flowering and seeds

Seagrasses are flowering plants that release seeds into the sediments. Flowering in *Halodule uninervis* is seasonal (October - February) with new fruits appearing predominately between January and April. Seeds are released from the fruits and under favourable conditions germinate into seagrass seedlings.

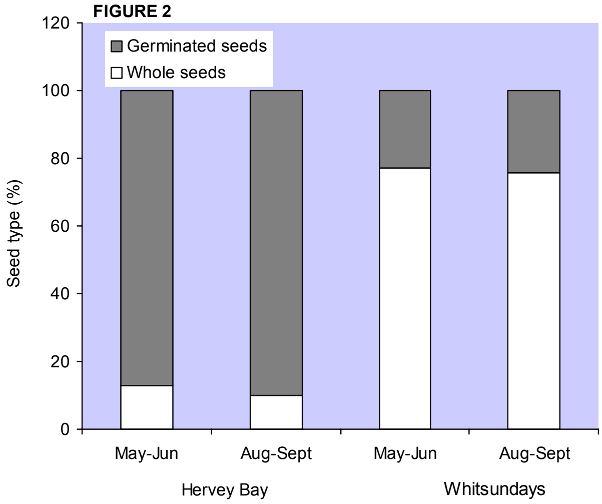
Flowers are quite difficult to find in the field so information about the intensity of flowering at a seagrass meadow may be obtained by investigating the density of seeds within the sediment. In this study *Halodule uninervis* seed abundance was found to be higher at sites in the Whitsundays than in Hervey Bay (Fig. 1). Higher seed densities allow a higher potential for seagrass recovery to occur if after an acute impact.

FIGURE 1



Seagrass abundance (%cover) generally did not differ greatly between regions (Fig. 1). Factors other than seagrass abundance are therefore likely to influence the amount of seeds stored within a meadow. For example, flower and seed production can be affected by changes in water temperature and photoperiod. Studies have also shown that the timing of flowering and seed germination can vary with different species and geographic location, and may be influenced by catchment-wide processes as well as local conditions.

FIGURE 2



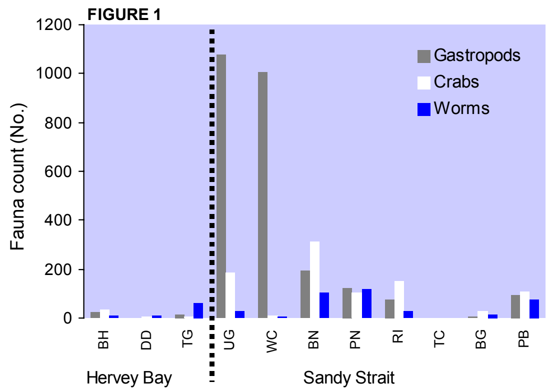
The higher proportion of non-germinated (whole) seeds to germinated (half) seeds at Whitsundays than in Hervey Bay (Fig. 2) is a function of higher seed densities in the Whitsundays. The higher proportion of germinated seeds at Hervey Bay indicates that a high proportion of seeds germinate and that meadows have a low reserve of non-germinated seeds. Hence, these meadows may have a low capacity for regeneration following loss. Data also suggests that germination of *H. uninervis* is likely to occur from May to September.

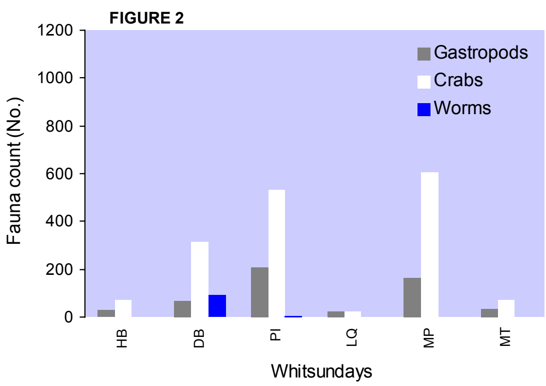
Gastropods, crabs and worms

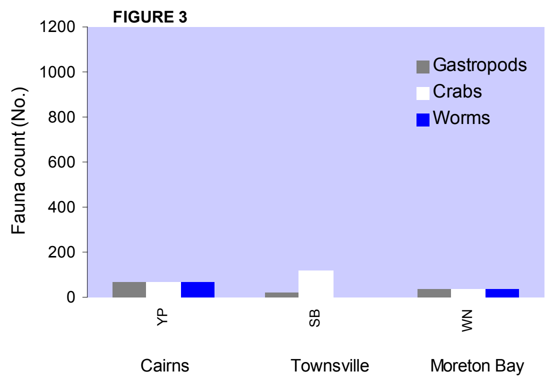
Polychaete worms feed on detrital matter on the sediment surface, whereas the feeding behaviour of gastropods is species dependent. Some gastropods also scavenge detrital matter, others graze on seagrass leaves, and some are predatory in their feeding habit. Crabs are generally scavengers preying upon small shrimps, worms and detritus.

From Burrum Heads to Dundowran (Hervey Bay), polycheate worms, gastropods, crabs are relatively scarce at intertidal sites compared with sites closer to the Mary River (Urangan and Wanggoolba Creek) and sites throughout the Great Sandy Strait (Fig.1). The paucity of gastropods in seagrass meadows in the Hervey Bay region may be related to the low availability of detritus, grazing matter and faunal prey associated with low seagrass abundance.

Mud whelks (a type of gastropod) have increased in number since the recovery of seagrass at Wanggoolba Creek (site 2). Their abundance may be due to high amounts of mud and organic detrital matter in the sediments that have their origin in the Mary River. Polychaete worms are also abundant at Urangan sites. Both animals are detrital feeders and competition for available detrital matter may explain the dominance of one over the other.







The numbers of polychaete worms are high at Boonooroo and Poona in the Great Sandy Strait where seagrass cover is low. The occurrence of polychaete worms at sites low in seagrass abundance suggests that these animals are likely to survive on low amounts of food relative to the larger gastropods and in certain areas may be typical of low seagrass abundance.

The high numbers of crabs in the Whitsundays (Fig 2) would benefit predatory fish who primarily target crustaceans in seagrass meadows. The highset numbers of crabs were found at Pioneer Bay and Midge Point, common recreational fishing grounds. Low numbers of all invertebrate fauna types were found at Cairns, Townsville and Moreton Bay sites (Fig. 3).





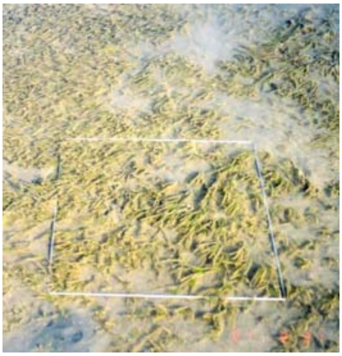












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SEAGRASS Monitoring

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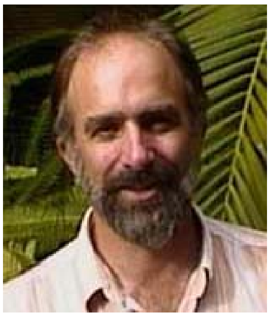

Assoc. Prof. Bill Dennison

Assoc. Prof. Dennison's research interests are in the area of marine botany, with projects that relate marine plant processes to environmental factors. Various collaborative projects are being undertaken in Moreton Bay and throughout Australia with CSIRO Divisions of Marine Research and Mathematical and Information Science. Assoc. Prof. Dennison is a member of the Marine Botany research group.

Current projects:

- Development of bioindicators - using marine plants to infer ecological health of marine ecosystems
- Effect of nutrient enrichments on phytoplankton, macroalgae, seagrasses and mangroves
- Relationship of water quality to marine plant productivity and distribution
- Ecophysiology of seagrasses.

See also http://www.botany.uq.edu.au/staff/academic/dennison.html

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Prof Di Walker

Assoc. Prof. Di Walker's research interests are in the area of the ecology and physiology of seagrasses and microalgae. The research is aimed at providing a better understanding of the biology of seagrasses and other marine organisms on the West Australian coastline. It requires extensive interaction and collaboration between stakeholders, community, and other marine research groups in the state.

Current projects:

- Issues of revegetation of seagrasses in Cockburn Sound including their recruitment biology, sexual reproduction and landscape ecology
- Seagrass pollination in relation to small scale water circulation and hydrodynamics within seagrass meadows
- Seagrass population genetics, evolution and molecular genetics (in conjunction with Dr M. Byrne, WA Department of Conservation and Land Management)
- Seagrasses and epiphytes in Wilson Inlet on the south coast
- The nutrient dynamics and impact seagrasses have on the Swan River
- The nutrient dynamics of seagrass systems in relation to sewage outfalls along our coastline including Geographe Bay

See also http://www.botany.uwa.edu.au/marine/Marine.htm

Prof. Fred Short

Prof. Short's research interests are in the area of understanding and restoring coastal, estuarine and oceanic systems. Fred's current interests in the decline of the world's seagrass

See Fred Shorts paper prepared for this forum in this proceedings

Current projects:

- Restoration and mitigation of coastal and estuarine ares
- Estuarine and marine seagrass habitat ecology
- Coastal pollution and nutrient loading
- Modelling estuarine habitat change

See Also http://marine.unh.edu/facilities/jel/fred/short.html

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Prof Evamaria Koch

Prof. Koch conducts research on the hydrodynamics of aquatic and marine plants; ecophysiology of seagrasses; the effect of global changes (specially CO2 increase) on shallow marine/estuarine macrophytes; the effect of UV-B on salt marsh vegetation and it's consequences (erosion/sedimentation/hydrodynamic cycle).

See Evamariaes paper prepared for this forum in this proceedings

See also: http://www.umsa.umd.edu/Leadership/Workgroups/GraduateFaculty/koch.html

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Prof Miguel Fortes

Prof. Fortes work had clearly established that the seagrass beds of Southeast Asia are comparatively well developed, and that the 27 countries to the Indo-West Pacific region are devisable into seven distinct "seagrass provinces". Moreover, his research has shown that seagrass beds, as areas of high organic productivity, are ecosystems that rival coral reefs and mangrove swamps in importance. Prof. Fortes is also the president of the Worlds Seagrass Assoication.

A Message from Fred Short

UNIVERSITY of NEW HAMPSHIRE

I regret not being at Hervey Bay. I had very much looked forward to the workshop and to meeting people involved in Seagrass Watch from Australia. Since I can't be there, I want to describe some of the seagrass restoration work we've been doing in New Hampshire and the northeastern U.S.

Seagrasses are important coastal habitats, contributing to the productivity of the world's oceans, filtering runoff from the land, and buffering the effects of waves and suspended sediments. Most coastal nations are beginning to recogize the importance of seagrasses; clearly their preservation is critical. Where seagrass habitat has been lost or degraded, restoration efforts can reinstate seagrass. Preservation is preferable to restoration because it maintains original habitat, costs far less, and underscores the importance of sustainable coastal management practices. But restoration can be an important step, recreating seagrass habitat in important locations and contributing to the clean-up of degraded areas, acting as a seed source, and creating community awareness of the importance of seagrasses.

In the northeastern United States, work has been under way to restore seagrass habitat for about a decade. Unlike Australia, this part of the U.S. has only one seagrass species: *Zostera marina* L., commonly known as eelgrass. Eelgrass grows across much of Europe and both the east and west coasts of the U.S. and the North Pacific, is a fairly robust, strap-bladed grass with highly variable leaf length, from a few centimeters to over two meters, and often occurs in dense meadows. A wasting disease of eelgrass decimated the habitat in the 1930s, but the plants regained much of their former distribution by the 1970s, although the wasting disease has occured again to a lesser extent in the 1980s.

However, the wasting disease is not the biggest challenge to eelgrass habitat: nutrient loading of estuaries, sediment runoff, fishing activities, and dredging have caused the loss of eelgrass habitat in many heavily populated parts of the northeastern U.S. At the University of New Hampshire, we have been working to develop and test eelgrass transplanting methods that can successfully restore the habitat in estuarine locations where its functions are particularly valuable to coastal waters.

Our first major project planted 2.3 hectares of eelgrass in the Piscataqua River, a tidal river that forms the border between New Hampshire and Maine. An eelgrass bed was slated for destruction so that the local Port Authority could build a new dock, and regulations required mitigation of this loss of habitat. We transplanted eelgrass using the Horizontal Rhizome Method, a bare root methodology in which two plants are pinned into the sediment with a bamboo stake. Disturbance of these planting units by worms and crabs proved to be a major challenge in this transplanting project. The 10 x 10 m transplanted patches required caging in order to allow the plants to get a good start. Despite some losses to ice scouring in winter and to bioturbation, the project was a success overall, with new areas of eelgrass persisting near the Port impact site several years after transplanting.

However, transplanting using the Horizontal Rhizome Method proved expensive: much of the work was done using SCUBA, and the caging needed to protect the new transplants was costly and work-intensive to install and maintain. Our next step, therefore, was to develop and test a method that could transplant eelgrass without SCUBA and that provided its own caging to the transplanted shoots. We called this method "TERFS", which stands for Transplanting Eelgrass Remotely with Frame Systems. (The acronym has been trade-marked by the University of New Hampshire.)

TERFS use a weighted wire frame to install seagrass plants. The plants are attached to the frame at a coastal location. Citizen volunteers have been involved in the process of preparing the TERFS, tying the plants to the frames using degradable paper string. Although we have no comparable group to Seagrass Watch in the U.S., volunteers have been found locally with an interest in contributing to coastal health and many work days have been donated to creating TERFS for transplanting. The TERFS are then deployed into the selected transplanting area, usually by boat. The wire frame acts to protect the transplants from bioturbation. About a month later, when the eelgrass has taken root and the degradable paper ties have dissolved, the frames are retrieved for re-use. In our experience, the method has been more successful than the Horizontal Rhizome Method and is much less costly.

We have now used TERFS to complete a major eelgrass transplanting project in outer New Bedford Harbor, an extremely degraded industrial area of Massachusetts that is trying to restore its coastal habitats. Additionally, TERFS were used in the summer of 2001 in Little Harbor, New Hampshire, where a major channel dredging project occurred. The frames from that transplanting project will be taken out at about the time of the Hervey Bay workshop.

Besides the planting process itself, we have found two other crucial factors in all seagrass restoration: site selection, which happens before actual installation of the plants, and monitoring, which happens afterwards. In both cases, trained volunteers such as those with Seagrass Watch can make a valuable contribution. We have developed a site selection model which compares unvegetated potential seagrass tranplanting sites to areas of healthy seagrass habitat to find preferred eelgrass transplant sites. Monitoring to track the long term outcome of seagrass transplanting contributes to our knowledge of successful practices. Here in the U.S., we lag behind Australia in our protection of seagrasses and the involvement of community members in the important work of monitoring seagrass habitats; we have much to learn from your efforts.

Fred Short
Department of Natural Resources
Jackson Estuarine Laboratory

Paper prepared for the 1st International Seagrass-Watch Volunteers Forum

FRED SHORT

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TRANSPLANTING EELGRASS REMOTELY WITH FRAME SYSTEMS (TERFS): A LOW-COST AND EFFECTIVE HABITAT RESTORATION METHOD

ABSTRACT

Seagrasses are valuable coastal marine habitats that support fisheries, contribute to ocean food webs, and filter estuarine waters. As seagrasses are lost due to human impacts to coastal environments, techniques are being developed to effectively mitigate these losses by transplanting. In transplanting seagrasses, both site selection and transplanting method are critical for success at the lowest possible cost. In the northeastern U.S., we have developed a model to choose sites most likely to sustain eelgrass, *Zostera marina* L., transplants. The high cost of restoring eelgrass beds in subtidal environments, and the difficulty in protecting transplants from various bioturbating organisms, led us to develop a new method not requiring SCUBA. "Transplanting Eelgrass Remotely with Frame Systems" (TERFS™) is a modification of bare-root transplanting methods. Eelgrass shoots are attached with biodegradable ties to weighted wire frames that provide mechanical protection from uprooting and bioturbation. The TERFS™ are then deployed from any small boat. After three to five weeks, the frames are retrieved for reuse, leaving behind dense patches of eelgrass. We tested TERFS™ first in the Great Bay Estuary, NH (USA) and again in New Bedford Harbor, Massachusetts (USA); in both cases the TERFS™ method was successful. The ease and success of this technique provides an approach to restoration that can involve citizen volunteers and it significantly reduces the cost of eelgrass restoration.

INTRODUCTION

Eelgrass (*Zostera marina* L.) meadows provide a wide array of ecological functions that are important for maintaining healthy estuarine and coastal ecosystems. Eelgrass meadows form a basis of primary production that supports ecologically and economically important species. Over the last decade, eelgrass populations have declined due to pollution associated with increased human populations and episodic occurrences of the wasting disease, as well as other human-induced and natural disturbances. Because of the critical role eelgrass habitat plays in estuarine and coastal systems, efforts are underway to prevent further losses and, more recently, to restore eelgrass populations to historic distributions. Once eelgrass cover is lost, physical and biological site characteristics may change. Such changes can prevent natural recolonization of historic eelgrass sites even when water quality is adequate. Transplanting can establish eelgrass habitat decades before natural processes might permit recolonization. Eelgrass transplanting has been used to restore habitat as well as to mitigate for eelgrass loss or damage.

A site selection model for eelgrass restoration is important to select optimal areas for eelgrass transplanting (Short et al. 2001). The site selection model synthesizes available historic data and literature, data from reference sites, and simple field measurements to identify and prioritize locations for large-scale eelgrass transplanting. Model development was based on the physical and biological characteristics associated with the most successful transplants sites in a mitigation project in New Hampshire. In lieu of application of the complete site selection model, an assessment of the depth range in which eelgrass grows and a test transplanting study will provide critical information for helping to identify successful transplant sites.

Many methods have been developed to restore degraded seagrass habitat or to mitigate damage to seagrass beds. Although some work is being done to restore seagrasses from seed, the most widely used and most consistently effective methods transplant shoots from healthy donor beds (Fonseca et al. 1998). Because transplanting is labor intensive and often requires heavy reliance on SCUBA, these methods are very costly. In New Hampshire (USA), we developed and tested a less expensive eelgrass restoration method that simultaneously transplants and protects eelgrass shoots without the need for SCUBA, using remotely deployed wire frames. The method, which we named "Transplanting Eelgrass Remotely with Frame Systems" (TERFS™; the acronym is registered as a trademark of the University of New Hampshire) was then used to meet the objectives of an eelgrass habitat restoration project in New Bedford Harbor, Buzzards Bay, Massachusetts

(USA). New Bedford Harbor is an estuary contaminated with polychlorinated biphenyls (PCBs) and heavy metals (particularly copper) from years of industrial dumping; the TERFS™ method allowed us to transplant eelgrass while avoiding direct contact with these sediments. Additionally, TERFS™ provided caging of newly transplanted shoots, protecting them from bioturbating organisms, and also allowed us to build community support for the project by involving citizen volunteers in TERFS™ preparation.

METHODs

TERFS™ is a seagrass transplanting method that is a modification of the horizontal rhizome method (HRM) developed by Davis and Short (1997). In the TERFS™ method, opposing pairs of eelgrass shoots are attached with biodegradable ties to rubber-coated wire frames. Twenty-five pairs of plants are tied to each frame 5 cm apart. The frame, which is weighted with bricks and deployed from a boat, presses the eelgrass rhizomes into the top centimeter of substrate. The frame acts to hold the new transplants in place while they take root, and also to protect them from bioturbating organisms. After a period of about one month, eelgrass shoots have rooted, and the frame is removed. The frame can then be used again. This technique creates a 0.25 m^2 patch of eelgrass at the relatively high shoot density of 200 m^{-2}.

Preliminary testing of the TERFS™ method was conducted in 1996 at a site in Broad Cove in the Great Bay Estuary, New Hampshire (USA). Donor shoots were harvested from an intertidal eelgrass bed at Gerrish Island, Maine (USA). Eelgrass was previously transplanted in Broad Cove using the HRM, but failed to due toproblems with bioturbation by clam worms (Davis 1999). One year after transplanting with TERFS™, all four created eelgrass areas persisted and had increased four times in shoot density.

In the summer of 1998, the TERFS™ method was again tested at three sites in the Great Bay Estuary. In addition, 20 sites were selected for test transplanting in the greater New Bedford Harbor area. Donor beds for the New Bedford trials were located within the study region, and shoots were transplanted within three days of their harvest. At each test site, four TERFS™ were deployed at least 0.5m apart. After a period of approximately one month, the TERFS™ were retrieved and the initial success (percent shoot survival after one month) determined. We compared TERFS™ with the HRM by planting 12 of the New Bedford sites using both methods. Similar to the TERFS™, the HRM plots consisted of 25 pairs of plants; however, in the HRM, the paired plants were on 0.5m centers in 2m x 2m plots.

Costs were compared between HRM and TERFS™. Direct cost comparison is difficult because each method and each project have specific requirements. In both cases, the monitoring costs represent a post-planting spring assessment of eelgrass survival and measurements of canopy structure, biomass, and habitat function (fish use, benthic infauna and epibenthic community). Administrative costs were included and represent actual salaries and wages including costs for design and implementation of each project.

RESULTS

Our results showed the TERFS™ method to be highly effective in creating eelgrass patches, even at sites where conventional transplanting previously failed. Initial success (one month survival) of transplant stock ranged from 50 to 95%. TERFS™ create 0.25 m^2 patches at a relatively high shoot density of 200 m^{-2}. In a side-by-side comparison in New Bedford Harbor, the TERFS™ method outperformed HRM at nine of ten sites. Initial success (one month survival) of eelgrass planted using the TERFS™ method in the Great Bay Estuary in 1998 ranged from 53% to 86% at various sites. Initial success of eelgrass in New Bedford Harbor in 1998 ranged from 47% to 85%, with three of three of eight sites having at least 80% one-month survival. Comparison of initial success (one month survival) between the HRM and TERFS™ at twelve sites in New Bedford Harbor showed that four of the twelve HRM sites had eelgrass survival, while eelgrass survived at all twelve TERFS™ sites. Eelgrass survival using the HRM exceeded survival using TERFS™ at only one site.

Bioturbation is the disturbance of plants by living creatures. A wide variety of bioturbating organisms, from worms to swans, have been identified in relation to seagrasses (Short et al. 2001). The TERFS™ method protects the newly transplanted seagrass with a wire, cage-like frame which holds down the roots and surrounds the leaves. By the time the frame is removed, the eelgrass is well established enough to deter or survive most bioturbation problems.

Costs were compared between the HRM and TERFS™ eelgrass transplanting methods on a "per planting unit" basis. A planting unit consists of two shoots of eelgrass. Collecting plants from the donor site cost the same in both cases: $0.19 per planting unit. Monitoring and administration costs were also the same per planting unit: $0.70 and $0.80, respectively. Equipment was more expensive for the HRM than for the

TERFS™ method: $0.78 as opposed to $0.55. The HRM also had the cost of caging, at $0.42 per planting unit. TERFS™ do not require caging, so that cost is avoided. The major difference in cost between HRM and TERFS™ is in the actual transplanting. Transplanting with HRM costs $2.39 per planting unit while transplanting with TERFS™ costs only $0.40 per planting unit. In total, the cost per planting unit for HRM is $5.28 while for TERFS™ it is $2.64. On a per acre basis, HRM costs $85,470 and TERFS™ costs $42,735. All costs are expressed in 1998 dollars (US).

DISCUSSION

- Choosing the site for transplanting is a critical step and may require detailed site selection protocol or, at a minimum, depth assessment and test transplanting.

- TERFS™ are ideal for test transplanting.

- TERFS™ are lower cost per planting unit than other bare root methods

- TERFS™ are self-caging, creating protection from bioturbation

- TERFS™ can be used in contaminated areas or in conditions adverse to diving

- TERFS™ are a useful method for test transplanting
some shoots may be attached to the frame with durable ties for growth studies
some shoots may be grown hydroponically for water quality studies

- TERFS™ leaves behind no staples or other debris; frames are reusable

- TERFS™ allows citizen volunteer participation in preparation of transplanting frames

- TERFS™ provides high density (200 m^{-2}) patches of eelgrass

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A Message from Evamaria Koch

October 2, 2001

Dear volunteers and participants of the International Seagrass-Watch Forum,

It saddens me that I will not be able to be present during this fascinating event. Volunteers make all the difference in environmental programs. I have heard so much about your activities and think about your program often (the Seagrass Watch calendar stands on my desk and I admire your diverse seagrasses on a daily basis). I was certainly looking forward to learn from you and to share some of my excitement with you. I wanted to show you how fascinating sediments in seagrass habitats can be and how much they can tell us about processes in these vegetated areas. I have attempted to summarize some of these thought in a short paper but showing you pictures and going in the field with you would have been so much more fun. I hope the paper will inspire you to spend time snorkeling/diving in your fantastic seagrass beds observing the sediment and its features. I also hope you will understand my decision not to come to Australia at this time. The current political chaos and the uncertainty of what the future holds made me decide to cancel my commitment with you. Please accept my apologies. I will be there in spirit. Do not hesitate to contact me (koch@hpl.umces.edu) if I can be of any help.

Fondly,

Evamaria W. Koch
University of Maryland Center for Environmental Science

Paper prepared for the 1st International Seagrass-Watch Volunteers Forum

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WHAT CAN SEDIMENTS TELL US ABOUT SEAGRASS HABITATS?

Introduction

The same way that seagrasses integrate the environmental conditions that surround them (making them good indicators of habitat quality, Dennison *et al.*. 1993), sediments integrate the physical, chemical and biological processes around them. Unfortunately, most studies on seagrasses tend to focus only on biotic parameters such as plant density, biomass, epiphytes, growth etc. Water column parameters (light availability, nutrient levels, temperature) are also often addressed but the sediments are usually ignored (Koch 2001). In the few studies that also quantify sediment parameters, these are usually restricted to sediment grains size and organic content or sediment nutrient concentrations.

As seagrasses alter the habitat they colonize, they affect the sediment characteristics. In turn, these sediment characteristics affect the seagrasses. Therefore, a feedback exists between seagrasses and the sediment they colonize making sediments an important part of any seagrass study. This paper summarizes a series of simple observations that can be made to contribute to the understanding of present and past physical, chemical and biological processes occurring in seagrass habitats.

Sediments as indicators of physical processes

Currents and waves are major forces shaping the sediment characteristics at any site. Therefore, sediment grain size, organic content, superficial structures such as ripples and sand waves and internal structures such as stratification can provide evidence of physical processes that occurre(d) in the area. In high-energy environments (high waves and fast moving currents), the sediments are usually coarse (Fonseca 1996). These areas can also be characterized by abundant rocks. In contrast, in low energy environments, the sediments are usually fine. Grain size appears to be limiting to seagrasses when the silt + clay content exceeds 15% (Terrados *et al.*.. 1998). A strong positive correlation also exists between water flow and organic content in the sediments (Fonseca and Bell 1998). As seagrass beds tend to reduce current velocity and attenuate wave energy, the sediment within the vegetation is usually finer and more organic than in adjacent unvegetated areas (Scoffin 1970, Wanless 1981, Almasi *et al.*.. 1987), a characteristic used by geologists to identify the presence of seagrasses in historical records (Petta and Gerhard 1977, Wanless 1981). Sediment organic contents above 5% may be limiting to seagrasses (Barko and Smart 1983) possibly due to the excess formation of sulfide which is toxic to seagrasses (Carlson *et al.*.. 1994).

Most seagrasses colonize soft substrates (sand, silt) but plants from the genus Phyllospadix colonize rocks. Some seagrasses have the capacity to colonize both types of substrates. For example, Posidonia in the Mediterranean (Koch, personal observation) and Thalassodendron ciliatum in Mozambique (Bandeira 2000) can colonize cracks in rocks in areas where the sediment is in constant motion due to strong currents and/or waves.

It is quite common that seagrass beds are elevated above the sea floor. This elevation difference can be as small as a few mm or as much as half a meter and is believed to be due to the higher deposition of particles within the vegetation than outside the bed (Scoffin 1970, Almasi *et al.*.. 1987). Recent studies suggest that this difference in sediment height may also be due to sediment stabilization (reduced sediment resuspension) (Gacia *et al.*.. 1999). Independent of the cause, seagrass habitats in which a difference in the height of the sea floor can be seen between vegetated and unvegetated areas are usually found in relatively high energy environments and the seagrass density is sufficiently high to modify water flow (sediment trapping or reduced erosion). In instances when seagrass rhizomes are bare (not covered by sediment) at the edge of the bed, erosion is probably occurring; another indication of a high-energy environment.

Sand ripples and sand waves are also indicative of physical forces in seagrass habitats. A gradient of such structures can be distinguished as water flow increases. At relatively slow flows (but strong enough to move sediment particles), linear ripples appear on the sediment surface. As the flow increases, these ripples become undulatory, cuspate and rhomboid (Fig. 1). Currents stronger than 10 cm s^{-1} are normally required to move sandy particles and the formation of ripples and sand waves requires flows of 50 and 60 cm s^{-1}, respectively (de Vries Klein 1985). Currents in seagrass beds are often reported to be lower than 10 cm s-1 (review by Koch 2001) suggesting that ripples and sand waves would usually not occur in vegetated areas. Unfortunately, little information is available on bedforms in seagrass beds. From personal observation, I have noted linear ripples and sand waves in seagrass beds in areas with strong currents and waves, respectively. Marba *et al.*.. (1994) also observed fast-moving sand waves in a *Cymodocea nodosa* bed.

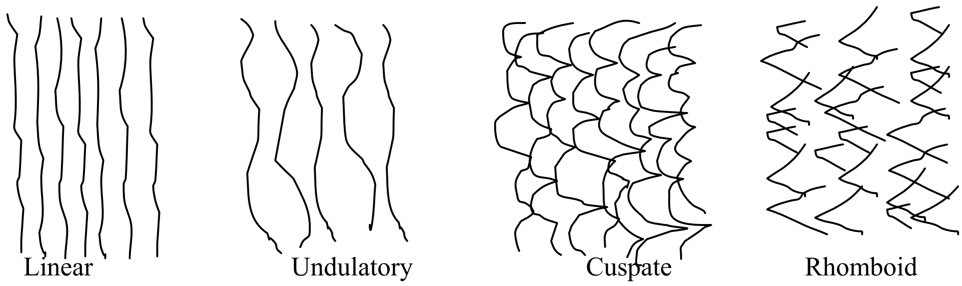

Figure 1. Change in ripple characteristics as flow strength increases from left to right.

The epiphytic layer on seagrass leaves which is composed of a variety of organisms including bacteria, micro- and macro-algae, grazers, mucus, sediment particles and debris can also provide clues about the physical processes occurring in the seagrass habitat. The amount of sediment (inorganic material) in an epiphytic layer is a function of sediment resuspension. In areas where sediment resuspension is high (high energy site or storm event), the amount of sediment particles in the epiphytic layer will also be high (Brandt and Koch, submitted). This general pattern may be altered by grazers, currents and waves (Horner *et al.*. 1990, Strand and Weisner 1996) but in general, more sediment resuspension in a seagrass habitat (or adjacent areas) results in a higher percentage of inorganic matter in the epiphytic layer.

Sediment cores can provide valuable data on past physical processes in the area. For example, a layer of coarse particles between layers of finer particles indicates that a storm event (strong enough to move the coarser particles) occurred in the area. In seagrass beds, it is common to find a decreasing amount of fine particles as one penetrates into the sediment (Wanless 1981). This is believed to be due to the increasing capacity to trap fine particles as the seagrass bed develops and the area it colonizes becomes shallower.

Sediments as biological indicators

Sediments colonized by seagrasses can be calcareous or siliceous. Calcareous sediments are usually light in color and of biological and marine origin (coral reefs, carbonate algae, carbonate epiphytes on seagrass leaves, planktonic organisms with carbonate skeletons) while siliceous sediments are usually darker in color and derived from the erosion of terrigenous rocks and soil. Calcareous algae have been estimated to contribute 0.5 mm yr^{-1} to sediment accumulation in Shark Bay (Walker and Woelkerling 1988).

Microalgae living on/in the sediments can often be located by their distinctive coloration (dark yellow or green) on the sediment suraface. Since these are photosynthetic organisms, they need light in order to survive. Therefore, they can only penetrate the top few mm of the sediment. Their depth of penetration can be visualized by scraping a shallow trough into the sediment and observing where the distinctive coloration ends. As light availability within seagrass beds is often low, the sediments usually containg a reduced number of benthic microalgae (MacIntyre *et al.*.. 1996). When such layers are observed, it can assume that they are contributing to sediment stabilization as the microalgae secrete substances that bind the sediment particles together (Miller *et al.* 1996).

Sediment cores taken in seagrass beds can provide evidence of present and past biological activity. Burrows and shells of organisms associated to seagrass beds can be quantified. Despite its importance in understanding fluxes across the sediment-water

interface, sediment oxygenation, nutrient cycles and meadow dynamics, bioturbation and sediment, reworking by benthic fauna has hardly been studied in seagrass habitats. Fortunately, more data are available for below-ground structures of seagrasses. The thickness of the rhizome layer in the sediments can give an indication of the development of the seagrass bed over time. If it is acreting, several layers (or one thick layer) of rhizomes can be expected. In the Mediterranean, a 3 m thick mat of Posidonia oceanica suggested that this seagrass bed had been growing vertically for 3,370 years (Mateo *et al*... 1997).

Sediments as chemical indicators

Although only direct measurements can describe the chemical processes occurring in sediments, some general statements can be made based on sediment characteristics. For example, as grain size decreases, nutrient concentrations as well as phytotoxins such as sulfide in the marine sediments tend to increase (Kenworthy *et al*... 1982, Erftemeijer and Middelburg 1993, Idestam-Almquist and Kautsky 1995, Holmer and Nielsen 1997). Additionally, carbonate sediments tend be limiting to seagrass growth as phosphorous tends to bind to the carbonate particles making this nutrient available at limiting concentrations in the porewater (Forqurean *et al*... 1992). Seagrasses growing on carbonate sediments can also be very prone to sulfide toxicity (Hemminga 1998). Therefore, carbonate sediments can often be associated with limited seagrass growth.

Sediment cores can reveal the depth of the "black sediments" where reducing conditions dominate. Such conditions have been shown tocontribute to the mortality of some seagrasses (Terrados *et al*... 1999). If the sediment pH is measured in the seagrass-colonized sediments, clues about the biological activity of the plants can be obtained. As the amount of oxygen released into the sediments increases over the day, the pH decreases (Morse *et al*... 1987). The opposite is expected during night hours. The degree to which this diel fluctuation can be observed depends on the root biomass and the proximity of the roots to the measuring site. Sediment pH also depends on temperature as well as sediment characteristics like organic content and bacterial activity.

Summary

Observation of simple geological features and sediment characteristics can provide clues about seagrass habitats. For instance, rocks, coarse sediments, low organic content in the sediment, high inorganic loading on seagrass leaves, ripples and sand waves are indicators or high-energy seagrass habitats. Exposed seagrass rhizomes at the edge of the seagrass beds and significantly elevated seagrass beds in relation to the seafloor are also indicative of high-energy environments. Due to the capacity of seagrass beds to reduce currents and waves, a gradient in these characteristics may be observed from the area outside the seagrass bed to the center of the bed. Sediments can also be indicators of the biological activity in seagrass beds via the imprint that benthic organisms such as mussels, worms, microalgae and seagrasses leave in the sediment. Possible nutrient and phytotoxin availability in seagrass habitats can be evaluated based on a rapid examination of the composition of the sediments.

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SeagrassNet - Global Seagrass Monitoring Program

Introduction

The International Seagrass Biology Workshops (ISBW) have been held periodically since 1993. Seagrass scientists from around the world have now gathered four times to share research findings and discuss the status of the world's seagrasses and the challenges of seagrass science. At the ISBW-3 meeting in the Philippines, the group agreed that three main efforts were important to seagrass science and to sustaining seagrass habitats worldwide. First, the formation of the World Seagrass Association, to expand and facilitate global seagrass research and information sharing. Second, a compilation of scientific methods for seagrass research which would yield for the first time truly comparable data worldwide, a volume to be called Global Seagrass Research Methods. Both these objectives have been achieved.

A third long-term objective was to initiate a Global Monitoring Program to collect and disseminate comparable seagrass information on a "seagrass network" to be called SeagrassNet. It was acknowledged by all attending the meeting that there is a lack of information on the status and health of seagrasses worldwide, particularly in the less economically developed parts of the world. Natural resources are being lost due to lack of basic knowledge of their existence. The efforts to monitor known seagrass areas and to reconnoiter uncharted seagrasses were affirmed as important first steps in an understanding of the extent of the seagrass resource and in sustaining that resource worldwide. It was acknowledged at ISBW-3 that adequate monitoring of seagrasses will necessitate reaching beyond scientists and researchers to incorporate community monitors of seagrass.

Aims of SeagrassNet are to:

- Develop a global monitoring network to monitor global change of seagrasses.
- Raise worldwide community awareness of the importance of seagrass loss to the integrity of marine ecosystems.

Science and communities

The problem in the past has been not knowing how to initiate community-based monitoring that is reliable and comparable to research-based efforts. It was proposed that monitoring would be initiated with two components, one research-oriented and the other community-based. The community-based seagrass monitoring effort that is proposed is modelled after *Seagrass Watch*, and will be conducted simultaneously with research-based monitoring so that resulting data can be compared.

Pilot Surveys in the Western Pacific

The first stage of the Global Monitoring Program has been carried out in the Western Pacific region. The seagrasses of the Western Pacific Ocean are prolific and occur in mixed species stands of great variety. The largest proportion of the world's seagrass species are found in the region, which has been suggested as the "centre of origin" of seagrasses (den Hartog 1970). The Western Pacific is the area of the world that has the highest concentration of seagrass species, extensive and diverse seagrass habitats and many industrial and non-industrial impacts threatening seagrass growth and survival. Their importance to the fisheries and overall marine biological productivity of the region is unquestioned. Some of the Earth's largest seagrass meadows occur in the Western Pacific. Yet the seagrasses of area are some of the least studied, although recently important research has been done. The research monitoring protocol based on Global Seagrass Research Methods will receive a thorough testing in its initial application in the Western Pacific.

In July 2001, a team comprising visiting American Scientist Professor Fred Short, and DPI staff, Rob Coles, Stuart Campbell, and Len McKenzie visited Kosrae, Pohnpei, Palau, The Philippines, Malaysia, Papua New Guinea and Fiji.

In each country the project set up a seagrass monitoring site as part of a Global Network to monitor change in seagrass beds and to provide training to local science staff in seagrass monitoring methods. The project linked up with local Fisheries Organisations, Government Agencies, and Universities to develop a short training course and jointly set up a sampling site.

At each site information on seagrass species, biomass proportions of the plants above and below the sediment surface, canopy height, shoot density and sediment type was recorded. Depth and location of the seagrass beds was measured and temperature and light data loggers deployed.

The training provided was designed to enable local staff to resample the site every three months. A further training course will be run in the Philippines in January 2002 to iron out any problems with the techniques. A training manual written for the trip will be finalised in The Philippines. This is the first part of a project that is ultimately designed to extend CRC/DPI "Seagrass Watch" style community monitoring to the Western Pacific.

Summary

The intent of SeagrassNet is to establish generic methodologies that can be used not only throughout the Western Pacific, but that in the future can be expanded into a broad global seagrass monitoring program of both research-based and community-based monitoring. After review of the first years' data, local scientists, in conjunction with Dr. Coles's Seagrass-Watch team from Cairns, Australia, will establish community-based monitoring efforts at each location and conduct a training workshop for local volunteer monitors. The results will be incorporated into the SeagrassNet database. A manual will be finalised based on review and updating after a year of field use. The manual will be produced both as a bound handbook and as a CD-ROM (with photos and video). At the end of the final year of this study, a minimum of a full year of community-based monitoring and 2 years of research-based monitoring will be complete and can be statistically analysed for comparability.

Project leaders of SeagrassNet

Professor Fred Short will be the project director of the Western Pacific Pilot Seagrass Monitoring Program and will be responsible for the project overall.

Dr. Rob Coles will lead the effort in community-based monitoring, using his experience as the head of Seagrass-Watch in Australia.

Dr. Miguel Fortes will be the on-site coordinator of the research-based and community-based monitoring activities.

Dr. Evamaria Koch will be responsible for development and implementation of the SeagNet database and the web-based system.

For more information about SeagrassNet visit the website at www.seagrassnet.com

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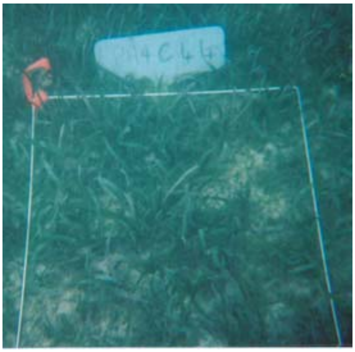

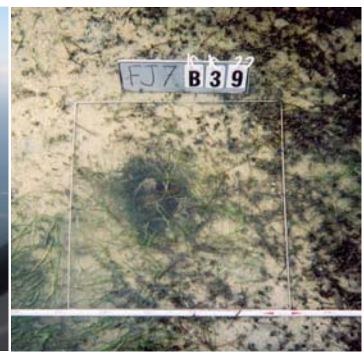
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SEAGRASS-WATCH: COMMUNITY BASED MONITORING OF SEAGRASS RESOURCES.

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Abstract

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 change. 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 abundance, presence of dugong feeding trails and possible human impacts. Seagrass-Watch is currently underway with communities in southern-, central-, and northern-Queensland regions.

Key-words: Seagrass, Community involvement, monitoring, mapping.

Introduction

The Seagrass-Watch 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 in 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.

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.

Methods

1. Program Structure

The success of 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 is 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 (local festivals and displays).

2. Training

Training of volunteers is usually comprised of three components – formal lectures, field training exercise, and laboratory exercise. Training includes 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") is 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.

3. Seagrass resource mapping

Seagrass-Watch activities initially map the distribution of seagrass meadows in a 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 is 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 has been validated and analysed, GIS maps were prepared for the region and fed back to the community groups.

4. Seagrass resource monitoring

Using these maps of seagrass distribution, a community consultation meeting with the Seagrass-Watch volunteers is held to select the locations for long-term monitoring. The program initially targeted inshore, intertidal seagrasses. In some cases subtidal seagrass meadows have be included. Site selection is assisted by consultation with environment management agencies, local government, and seagrass researchers. The position of sites may also be dependent on volunteers, as often volunteers elect to adopt a site which is 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 increase the ability to identify impacts.

The monitoring strategy is a nested design and is conducted at three scales: transect (metres), sites (kilometres) and locations (10s kilometres) (see McDonald and Kendrick, 1997). Long term monitoring sites are 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, three sites are established within each location.

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

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 Straits region seagrass communities in December 1998.

Long-term monitoring sites have been established in each region. In the Hervey Bay region, a total of 21 sites, including areas of high impacts and 'control' sites were established across eight locations between August and October 1999. Preliminary results indicate that the minimum detectable difference (MDD) varied from 3% to 86% (at the 5% level of significance with 90% power) based on a survey every 3 months for a period of 2 years (as per Gibbs 1995). MDD of as little as 3% change in cover was identified for uniform Halodule uninervis cover. In variable seagrass cover, MDD was as high as 86%, requiring a much larger alteration in seagrass cover of a sparse and patchy Zostera capricorni meadow before the change could be identified. Monitoring of sites is ongoing.

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.

Discussion

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. 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.

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 is a cost-effective method of collecting data and maintains local interest and ownership in coastal seagrasses. The most powerful aspect of Seagrass-Watch is its potential as an educational tool to raise community awareness. It has generated local support and closer 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 help achieve this. A Data Management System with efficient data entry, validation and synthesis is essential for prompt feedback.

A Seagrass-Watch calendar/diary has been 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.

Acknowledgments

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SEAGRASS –WATCH: Refresher notes for monitoring a site

Steps to set up intertidal seagrass monitoring site

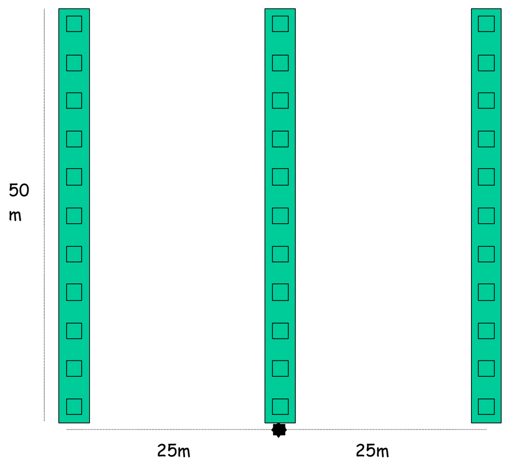
Sampling is done to the right hand side of the tape, therefore you should always walk to the left of a transect to avoid footprints where you will be sampling.

You will need:

- ❑ *3x 50m fibreglass tapes*
- ❑ *6 plastic tent pegs*
- ❑ *Compass*
- ❑ *Map for site location*
- ❑ *NB. Replace any equipment if necessary*

- **Locate the start of transect 2** using site directory and/or known reference points
- Clean any algal growth or other fouling organisms off the buoy and site tag.
- **Place peg at beginning of transect and attach tape**. Push a plastic tent peg into the substrate alongside the star picket and attach one end of the 50 m tape to the hook.
- **Locate the star picket and tag at the 50 m point at the end of transect 2.** Using your compass, site the direction (using bearings) of the transect line. Hold the compass flat to allow the compass needle to move freely.
- **Lay out Transect 2.** Holding the tape handle in your right hand, run your transect out the whole 50m. Leave the tape in place.
- **Mark out transects 1 and 3.** Transects 1 and 3 always lie 25 metres to the left and 25 metres to the right respectively of transect 2.
- Leave all three tapes in place, held down with the tent pegs.

Transect layout – 3 transects



Commencing Seagrass Monitoring

You will need:

- 2x standard (50cmx50cm) quadrats
- Magnifying glass
- Monitoring datasheets
- Clipboard, pencils & 30 cm ruler
- Camera
- Quadrat photo labeller
- Percent cover standard sheet

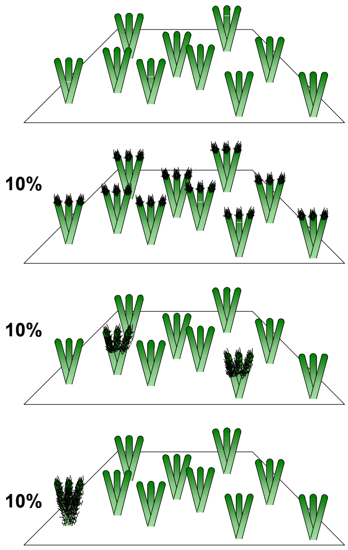
Sediments, seagrass cover

- **Measure the cover and other characteristics of seagrass** within a single quadrat at every 5 metre mark for the 50 metres, starting at 0m.
- The quadrat is always placed on the right hand side of the tape measure with the bottom left corner of the quadrat at the 5m mark (ie.let the quadrat fall forward along the tape).
- **Note the type of sediment** (eg. Sand, Fine sand, Fine sand/Mud).
- **Note any features which may be of interest** (eg. Dugong feeding trails, epiphytic algae, number of yabby burrows, number of gastropods and worms, ripples in the sand, *etc*).
- **Determine the total cover of seagrass within the quadrat** – use the percent cover photo standards as a guide. Then identify the species of seagrass within the quadrat and determine the percent contribution of each species to the total cover.
- **Measure 3 blades of seagrass** in centimetres using the ruler and record each length.

Remember
Composition of all species must equal 100 %,
***eg. Zostera capricorni* 70%, *Halophila ovalis* 30% or *Zostera capricorni* 100%**

Epiphyte and algae cover

- **Next, determine the percent cover of epiphytic algae.** The percentage cover of epiphytes is measured by estimating "the percentage of total surface area of leaves covered by algal growth". The diagram to the right shows how the distribution of epiphytes on seagrass leaves can vary throughout a quadrat. In this example



☞ 1.The top quadrat has no epiphytes present.

☞ 2.The second quadrat – 10% all of the leaves in the quadrat are covered by epiphytes

☞ 3.In the third quadrat – some leaves may be covered by epiphytes, and

☞ 4.In the forth, bottom, quadrat – only 1 shoot is totally covered by epiphytes.

- **Next, determine the percent cover of non-epiphytic or "other" algae in the quadrat.**
- Algal cover is recorded using percent algal cover photo standards.

Photography

- Photographs are usually taken at the 5m, 25m and 45m quadrats along each transect, **or** of quadrats of particular interest (eg. Dugong feeding trail, high algal abundance, lots of gastropods).

How often to sample or monitor a site?

- Determining how regularly to repeat each site is not simple, as it depends on the issues of concern and the availability of people (time). The most frequently a site should be examined is every 3 months (90 days) unless otherwise advised by the Seagrass-Watch Coordinator. Times when the Seagrass-Watch Coordinator would recommend more frequently than 90 days would be after a major flood event or similar impact (eg. extensive dredging or major storm event). These decisions are made after consultation with researchers and other specialists.

Seed monitoring

Halodule uninervis produce simple, single seeds (approximately 2mm diameter) that are released below the surface of the marine sediments. Flowering is seasonal (October - February) with new fruits appearing predominantly between January and April. Sampling for seeds involves collecting 30 cores within a 50 metre by 50 metre site. Cores have a diameter of 50mm and are taken to a depth of 10 cm.

You will need:

- *1x standard (50mm diameter x25cm long) PVC seed corer & cap*
- *Seed monitoring datasheets*
- *Stainless steel mesh kitchen sieve (1-2mm mesh)*
- *Clipboard and pencils*

Remember
Check each sieve thoroughly for seeds before discarding contents. If you can, have someone verify the sample.

Seed monitoring method

- 5 transects are sampled in total (3 with tapes, 2 without tapes). Seed cores are repeated every 10 metre mark along each of the 3 transects and along the 2 mid-way transects. When sampling mid-way between transects, you may estimate the distance and position, it does not have to be precise.
- Push the PVC corer into the sediment to a depth of 10 cm, adjacent to the 0.25 metre squared quadrat.
- With the mouth of the corer over the sieve, remove the cap to release the sediment core into the sediment.
- Sieve the sediment core in a little water and check the retained material for seeds
- Count the number of whole and half seeds retained by the sieve and enter into the corresponding position on the seed monitoring data-sheet. Also note any seedlings (*newly sprouted seeds*) in the comments section. Replace the seeds to the sediment.

The monitoring design has been designed to give the observer an idea of the spatial distribution of seeds within the site. This spatial pattern can provide information on the "dispersal shadow", that is, the distribution of seeds at increasing distances away from the parent plant. Seed densities may vary from 1-10 seeds per core.

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