



MTSRF Water Quality Program: Synthesis and Highlights



Australian Government
Department of the Environment, Water, Heritage and the Arts



Marine and Tropical Sciences Research Facility



About the MTSRF

- Largest hub of the CERF program (\$40 million over five years), 2006-2010
- Aimed to ensure the health of north Queensland's key environmental assets – reef, rainforest/catchments, and Torres Strait – through end-user driven research
- 300 scientists, 15 research providers, at least 38 end user organisations
- Administered on behalf of DSEWPaC by the Reef and Rainforest Research Centre (RRRC)



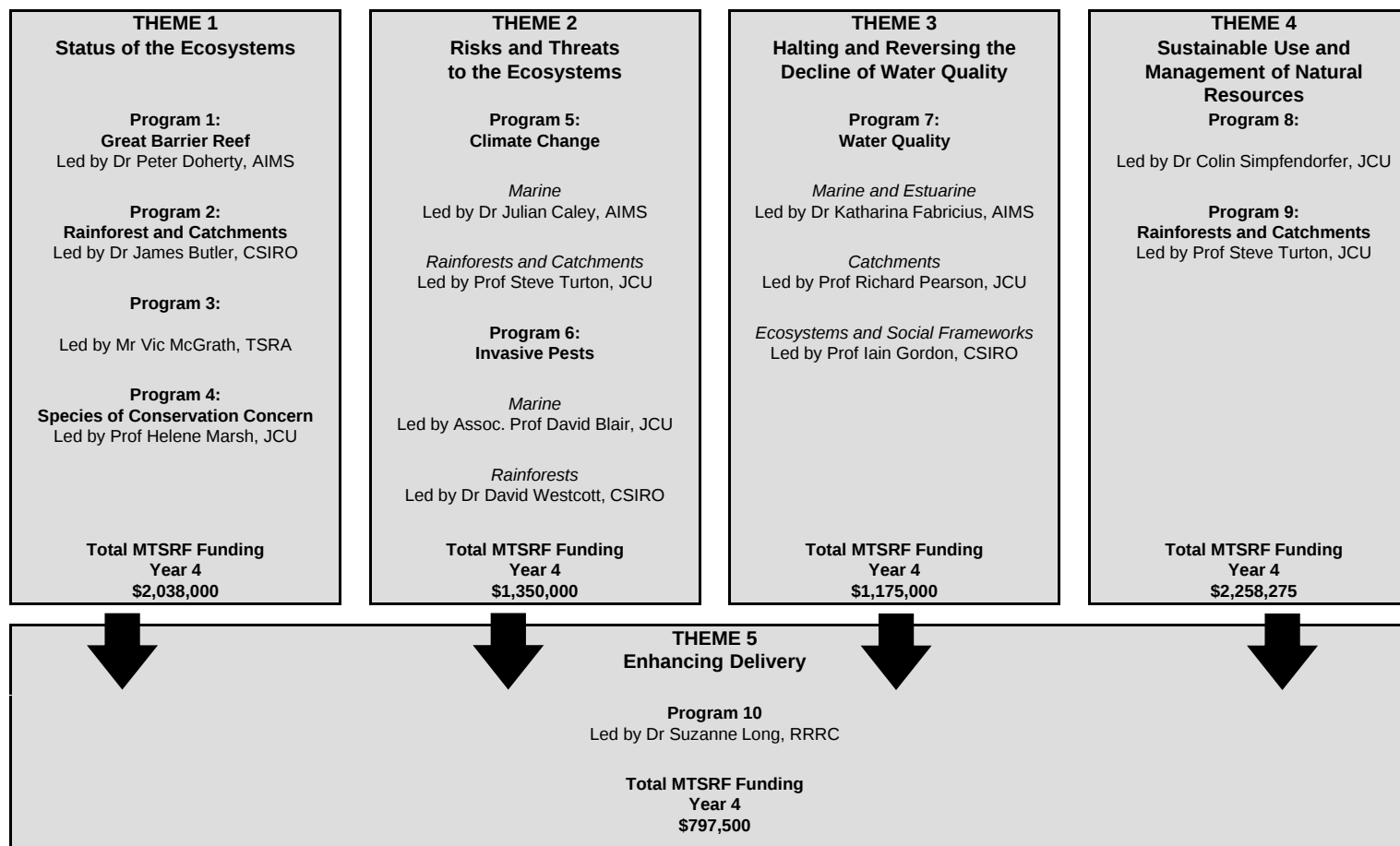
Australian Government

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Reef &
Rainforest
RESEARCH CENTRE



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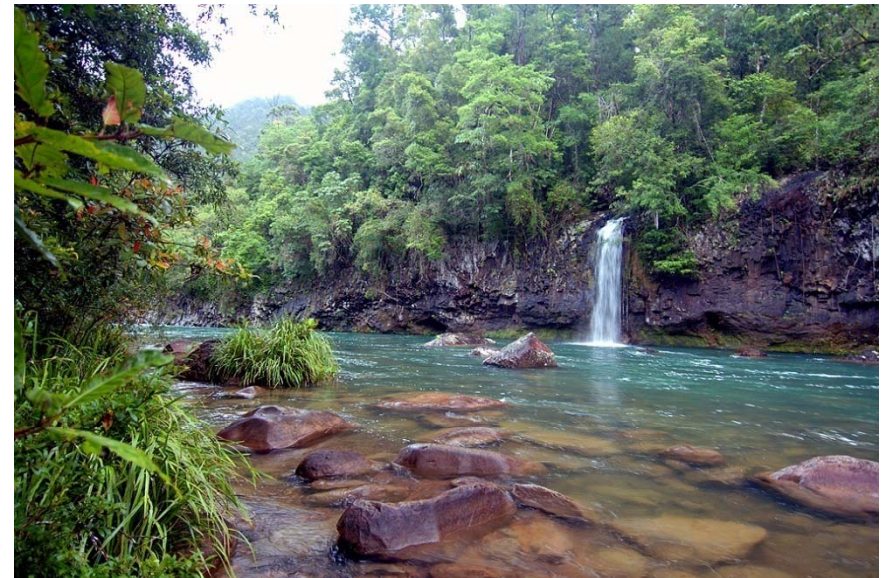
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Delivery of MTSRF Theme 3

- 12 research projects aiming to build a comprehensive understanding of the causes and effects of changing water quality and water resource use patterns
- Results are already helping to develop management options for improving practices, reducing risks and mitigating impacts, as well as methods for measuring the effectiveness of management efforts



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Overview

Six MTSRF Research Projects:

1. Marine and estuarine indicators and thresholds of concern
2. Connectivity and risk: tracing sediments from the upper catchment to the reef
3. Freshwater indicators and thresholds of concern
4. Wetlands and floodplains: connectivity and hydro-ecological function
5. Socio-economic constraints to and incentives for the adoption of land management options for water quality
6. Estimates of loads for compliance against targets and tracking trends in loads

Five Reef Rescue Marine Monitoring Projects:

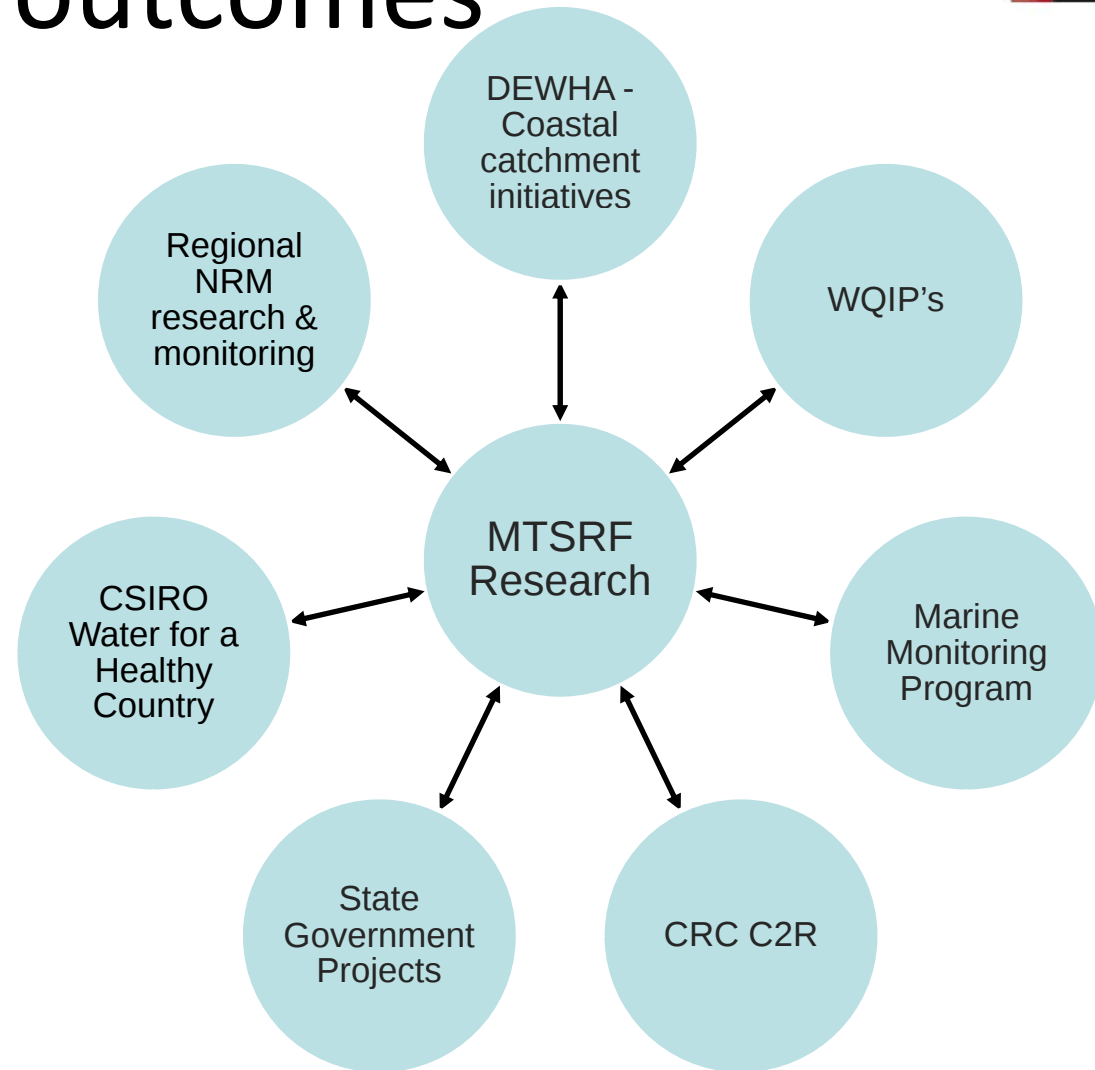
- 7 – 10. WQ monitoring: lagoon, flood, pesticide, remote sensing;
11. Inshore reef benthos monitoring





Collaborative outcomes

MTSRF builds on previous efforts and continues to foster collaboration between government and science agencies, end-users and stakeholders





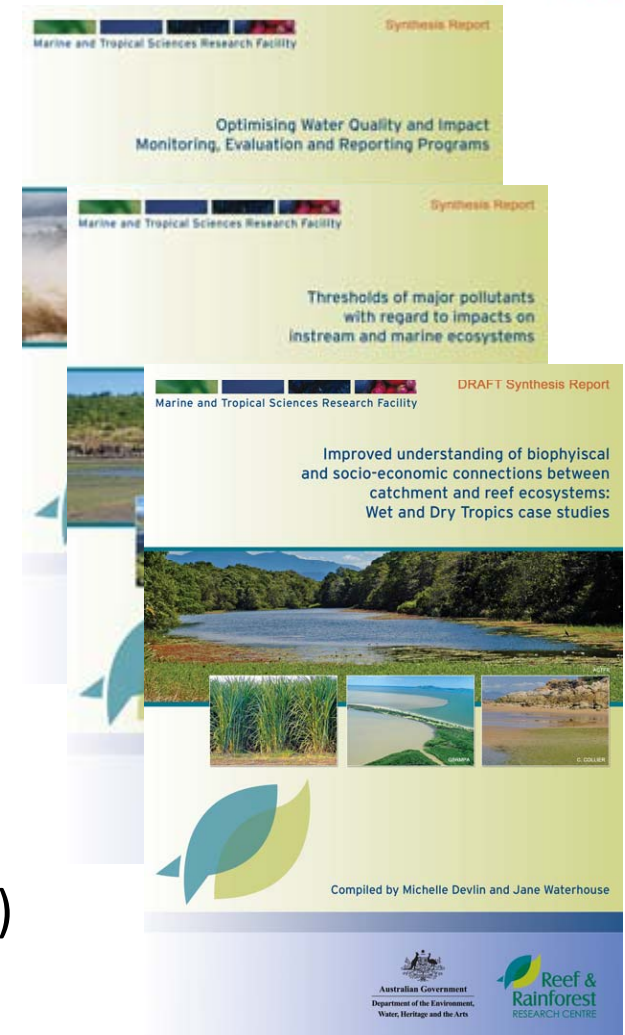
Synthesis Products

3 summary reports (~10-30 pages):

1. WQ research overview
2. WQ thresholds of concern
3. Pesticides in the GBR (*draft*)

5 comprehensive synthesis reports:

1. Priority pollutants & priority areas
2. Catchment to Reef connections
3. Optimising M&E programs
4. Social and economic influences on WQ (*draft*)
5. WQ & climate change interactions (*draft*)

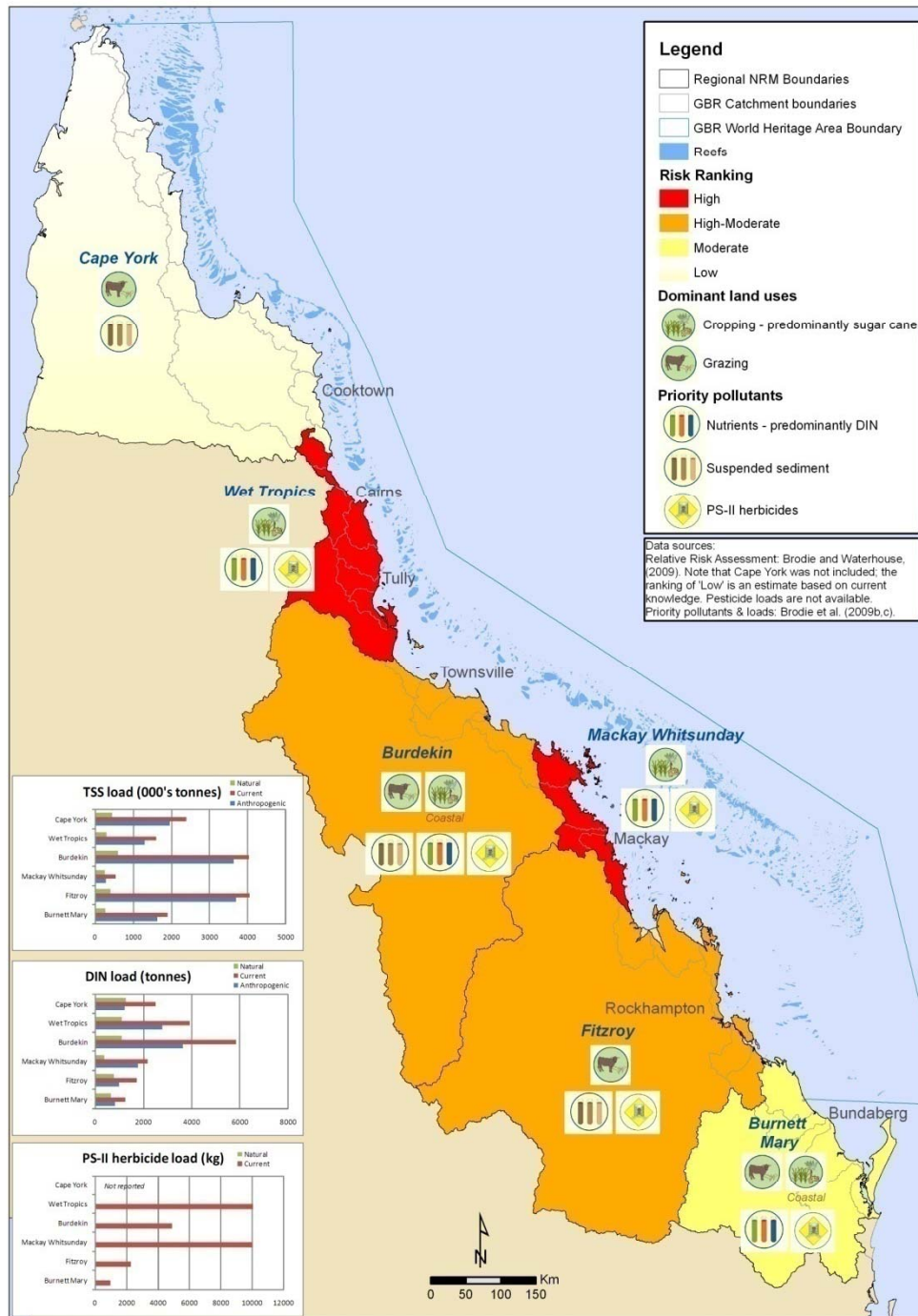




Focus areas

1. Priority pollutants & areas for management
2. Load estimation techniques & improvements
3. Ecological dynamics in GBR wetlands and floodplains
4. Tracing materials from the catchment to the GBR
5. WQ impacts on GBR ecosystems and pollutant exposure
6. Indicators for M&E – management practices, streams, wetlands, EoC loads, estuarine, marine (coral & seagrass), institutional & governance, social resilience
7. Indicator thresholds of concern
8. Predictive tools to inform target setting





Priority Pollutants

- **DIN** - Sugar cane in the Burdekin and Wet Tropics regions;
- **Suspended sediments** - grazing lands in the Burdekin and Fitzroy regions;
- **PS-II herbicides** - sugar cane in the Wet Tropics and Mackay Whitsunday regions.



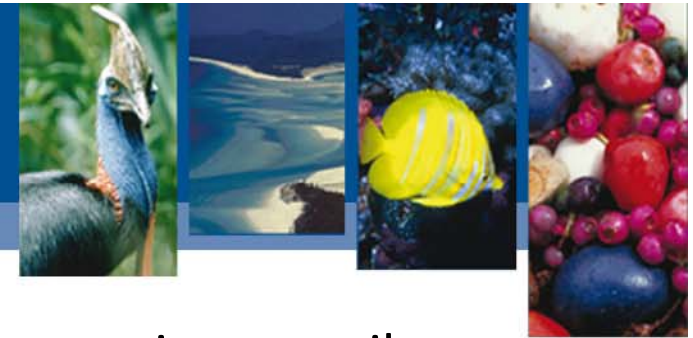


Better load estimations

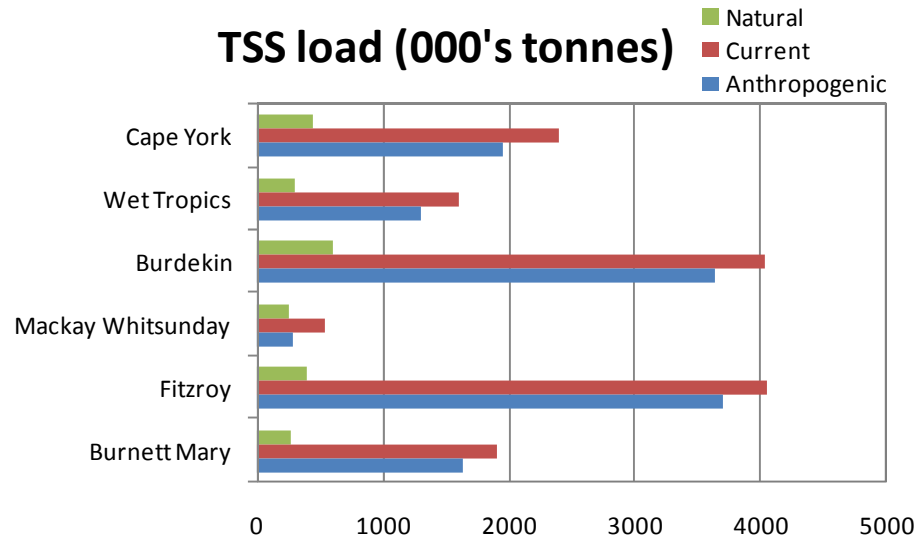
- Improvements in estimating statistical uncertainty in annual load calculations. Uses all available monitoring data to characterise relationships between flow & concentration.
- A large proportion of suspended sediment (~60%) is trapped by the Burdekin Falls Dam and hence most of the 'bulk' suspended sediment load is derived from the catchments below the dam (15% of catchment area)
- 30-50% of nutrient discharges are from overbank rather than river flows in the Tully -> not included in past load estimates



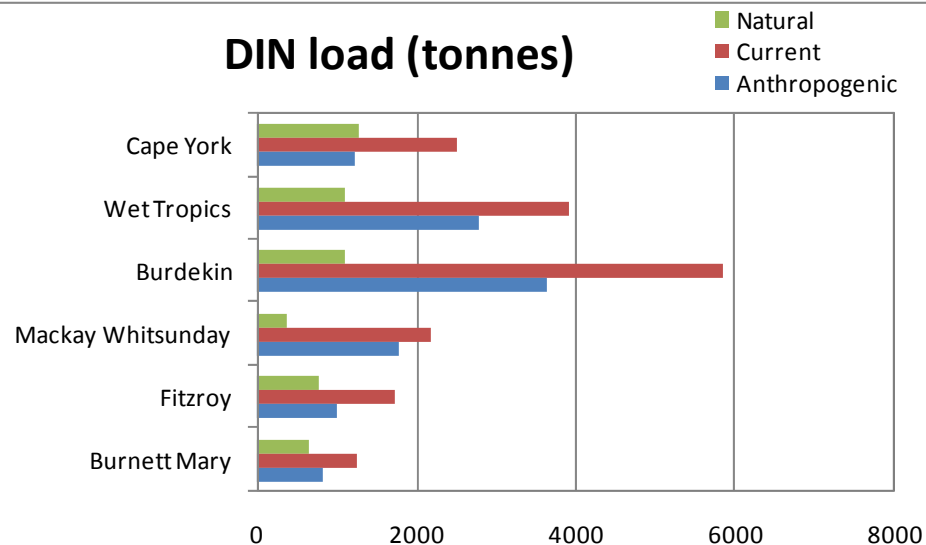
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TSS load (000's tonnes)



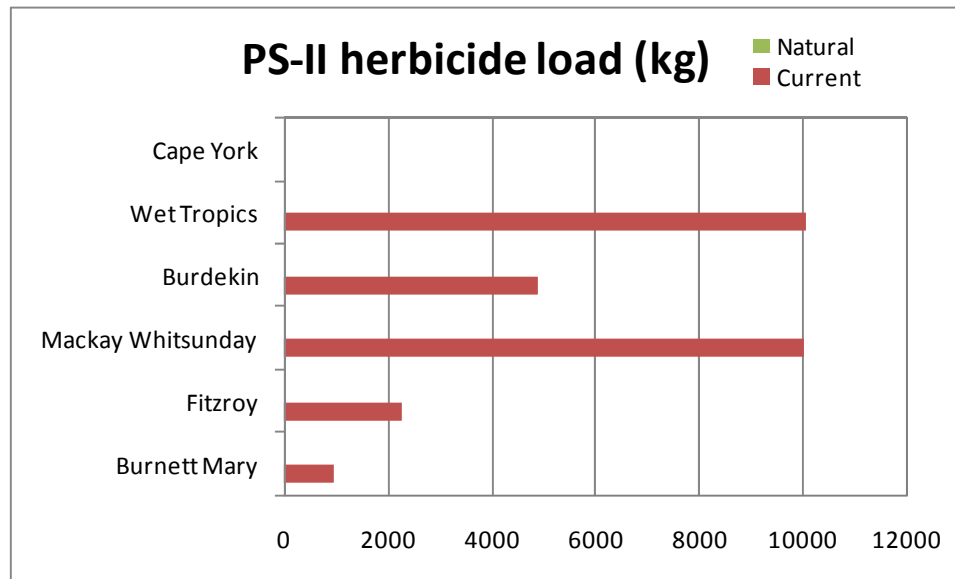
DIN load (tonnes)



- Hillslope erosion contributes the most SS to the overall load across the GBR catchments in comparison to bank and gully erosion.
- ~80% anthropogenic DIN is derived from sugar cane fertiliser losses (Wet Tropics 84%, lower Burdekin 80%, Mackay Whitsunday 88%), except in the Fitzroy region where almost all of the DIN load is from cereal grains and cotton.



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- Diuron - Wet Tropics, lower Burdekin and Mackay Whitsunday region. Associated with areas of sugar cane, but is also found in other cropping areas.
- Tebuthiuron - Burdekin and Fitzroy regions associated with grazing lands.
- Atrazine is associated with other crops (including grains and cotton) in the Fitzroy region.



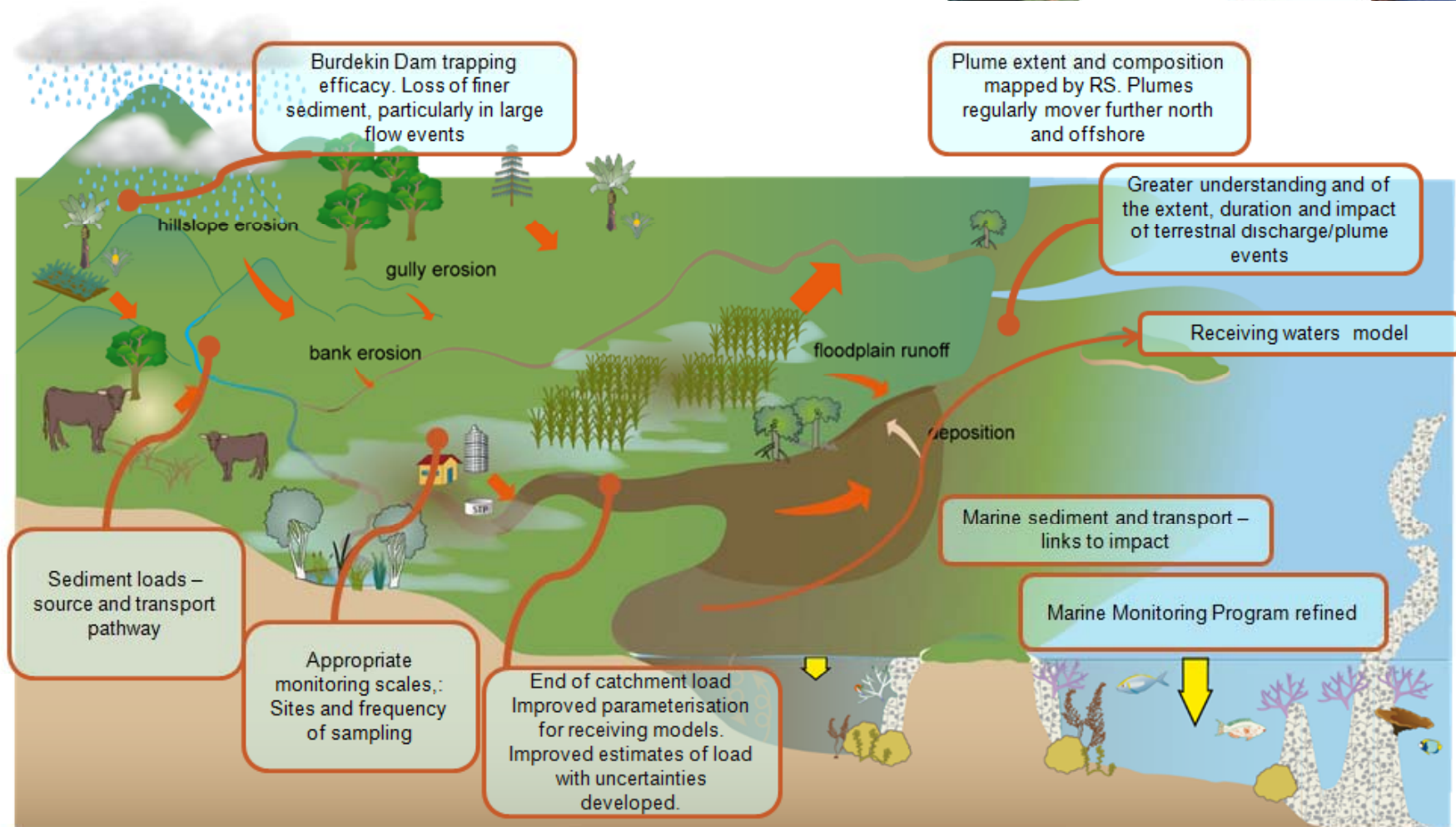


Pollutant risk across regions

Region	Relative Risk	Dominant agricultural land use for pollutant delivery	Priority contaminants
Wet Tropics	High	Sugar cane	DIN, PSII Herbicides
Burdekin	Medium-High	Grazing with sugar cane in the lower Burdekin	TSS, DIN, PSII Herbicides
Mackay Whitsunday	High	Sugar cane	DIN, PSII Herbicides
Fitzroy	Medium - High	Grazing	TSS, PSII Herbicides
Burnett Mary	Medium	Grazing with sugar cane in the coastal areas	DIN, PSII Herbicides



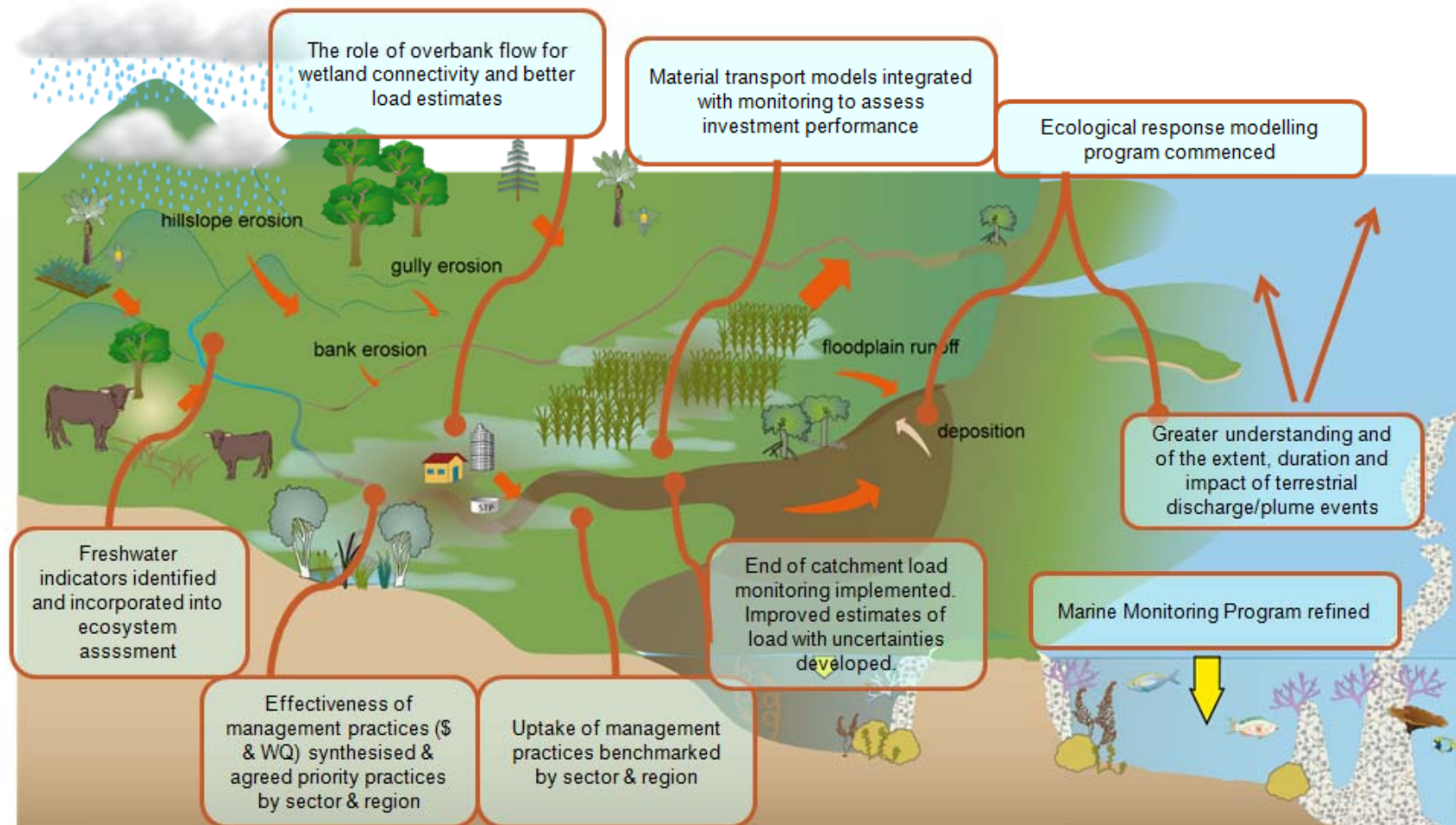
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Advances in our conceptual model understanding of the Burdekin catchment and marine region



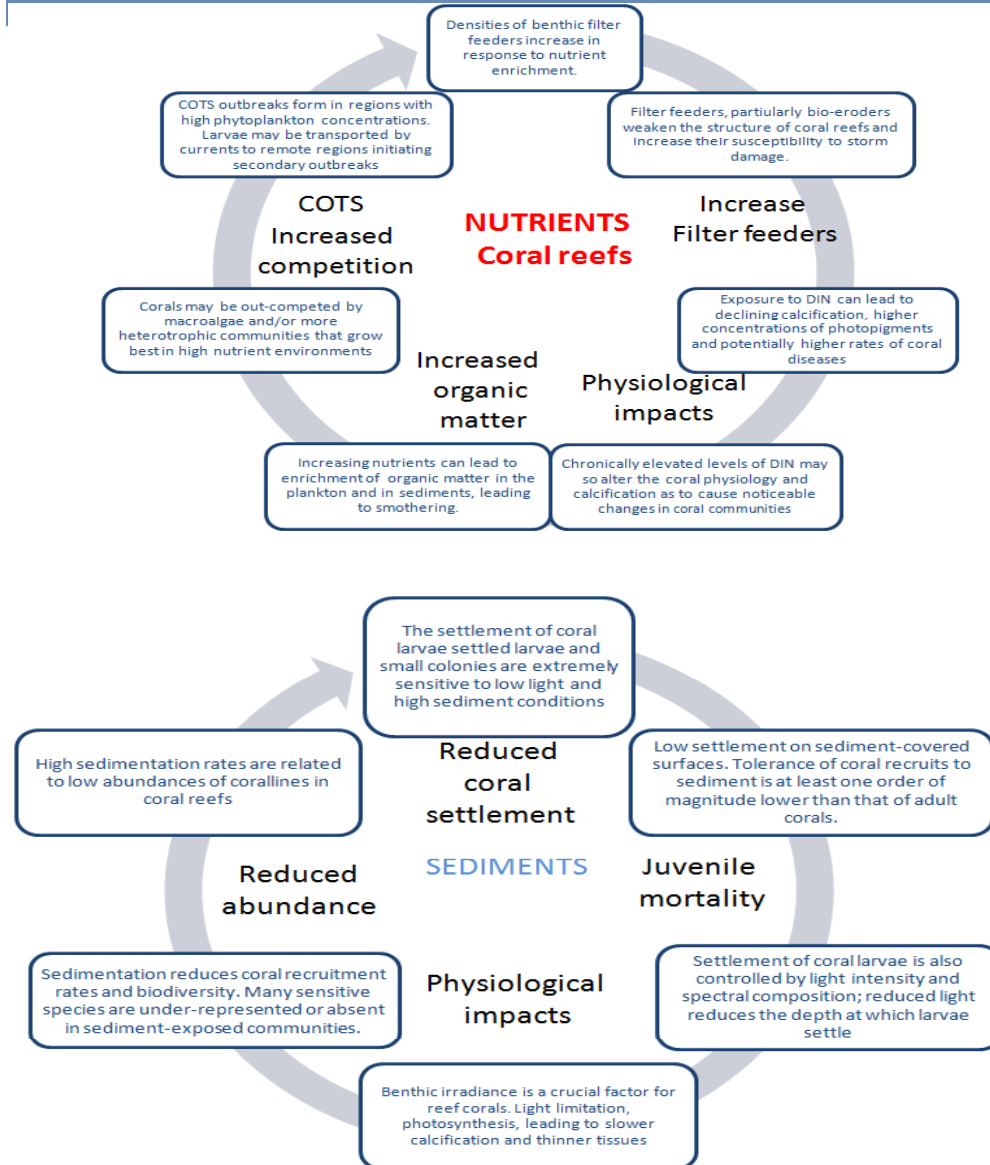
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Advances in our conceptual model understanding of the Tully catchment and marine region



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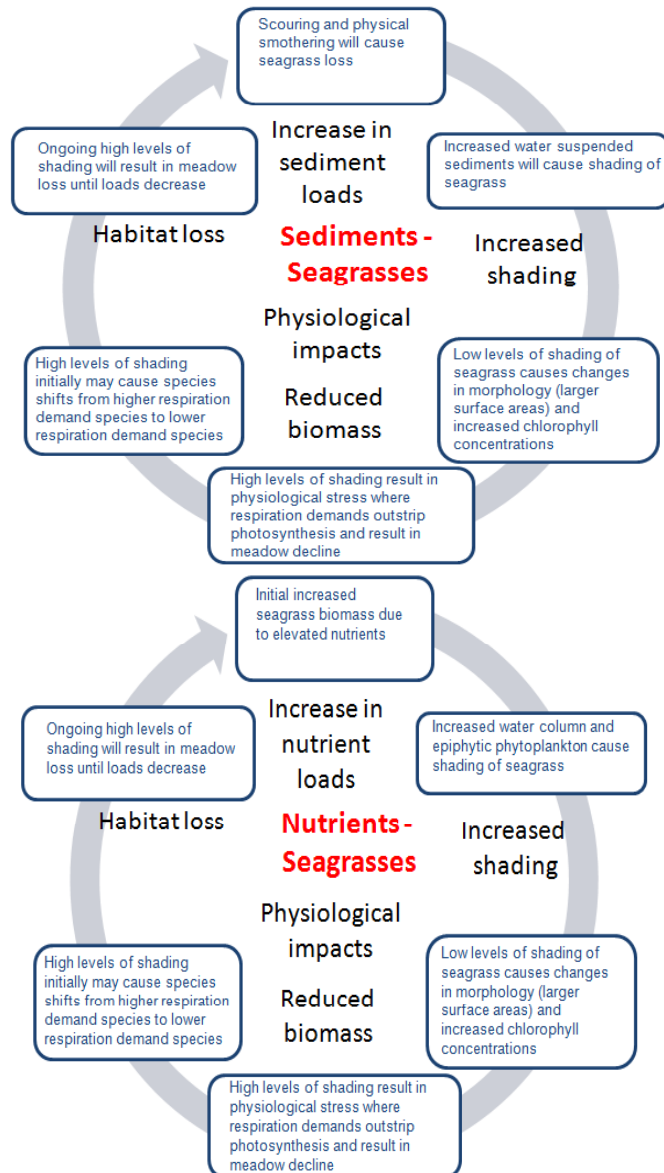
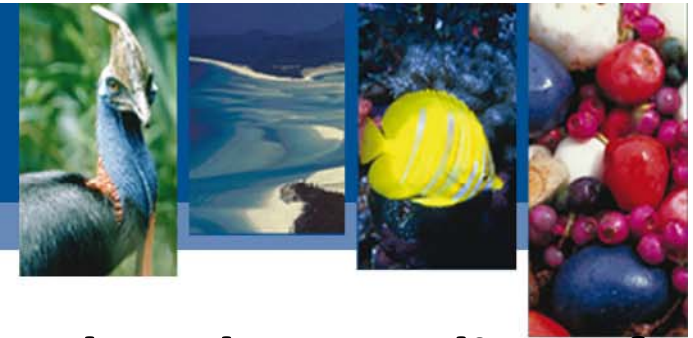


Improved understanding of links between WQ condition and coral reefs

- Understanding of the impact of pollutants on GBR ecosystems.
- Thresholds to trigger management response
- Greater confidence in MMP biological indicators
- Feedback into receiving water models.
- Better links between exposure mapping and risk analysis



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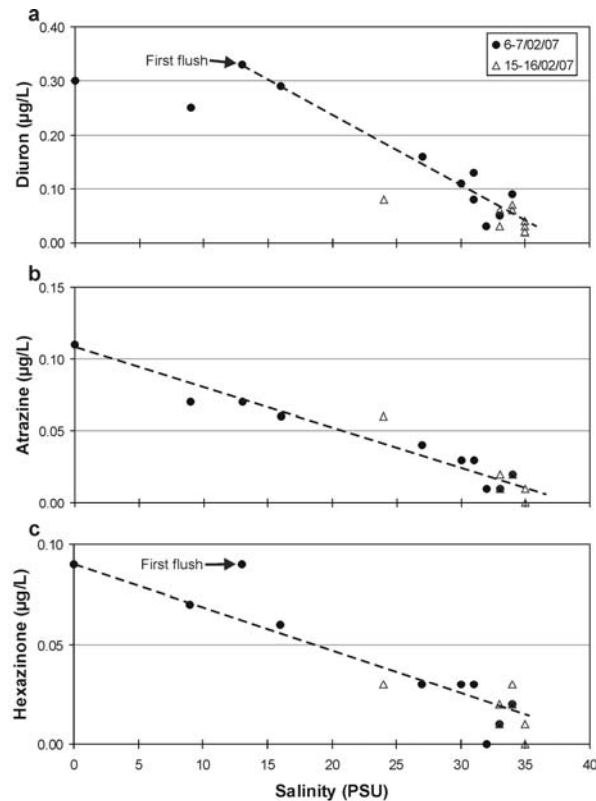
Improved understanding of links between WQ condition and seagrass beds

- Continued understanding in the importance of seagrass beds to GBR health
- Seagrass indicators – important component of P2R reporting

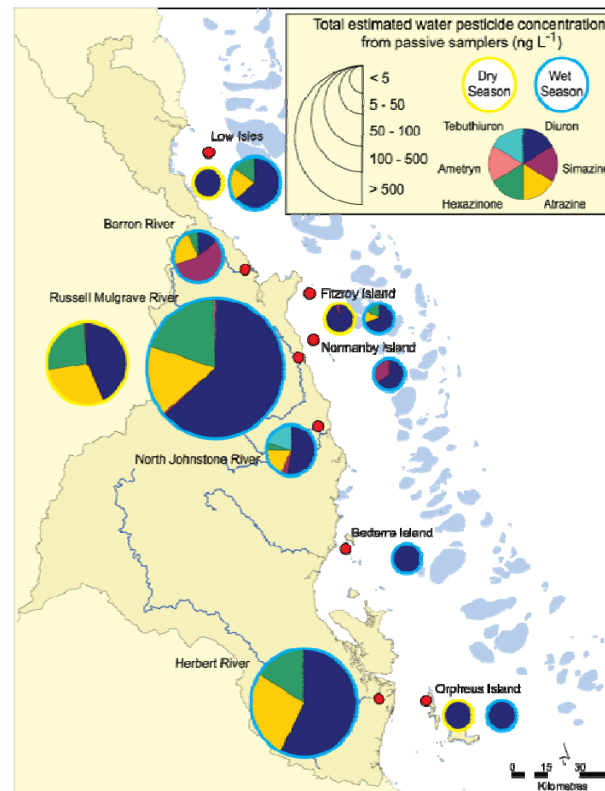




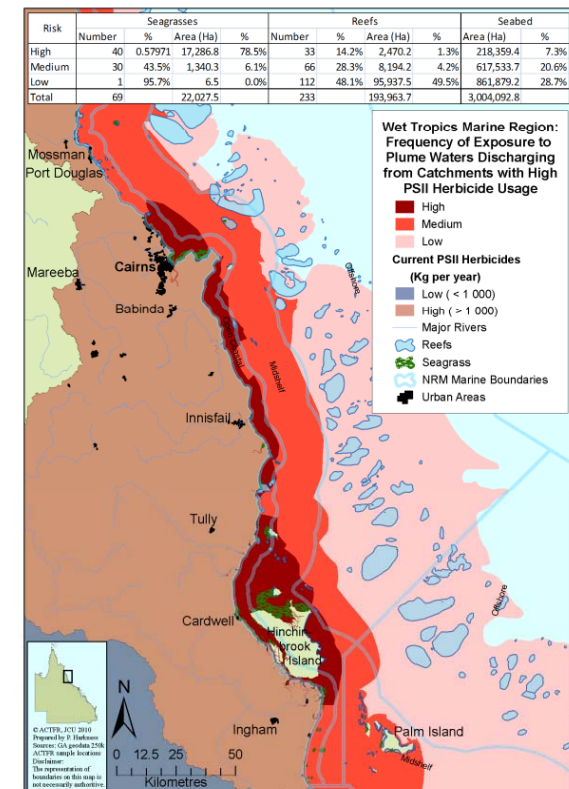
Pesticides



Marine concentrations &
C2R pathway



Use of passive samplers
for long term mean/
exceedances



Identifying high
exposure areas





Thresholds of concern

Indicator thresholds have been developed for:

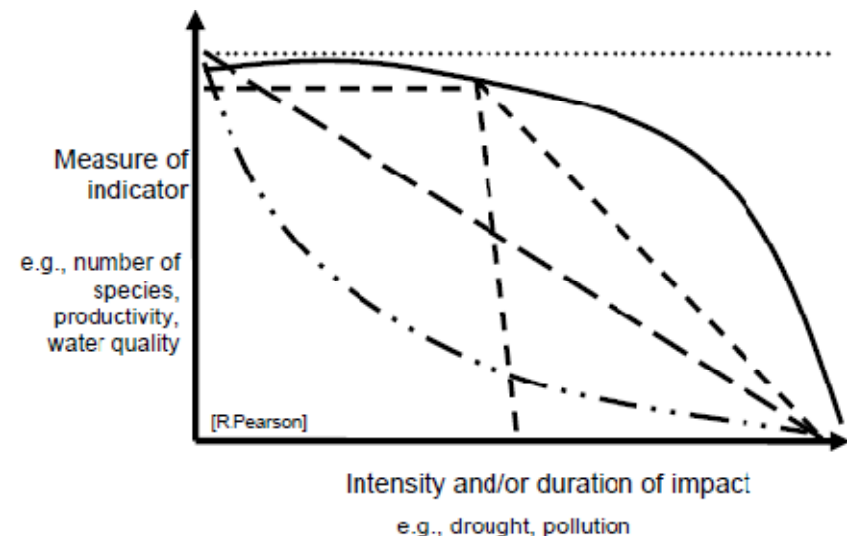
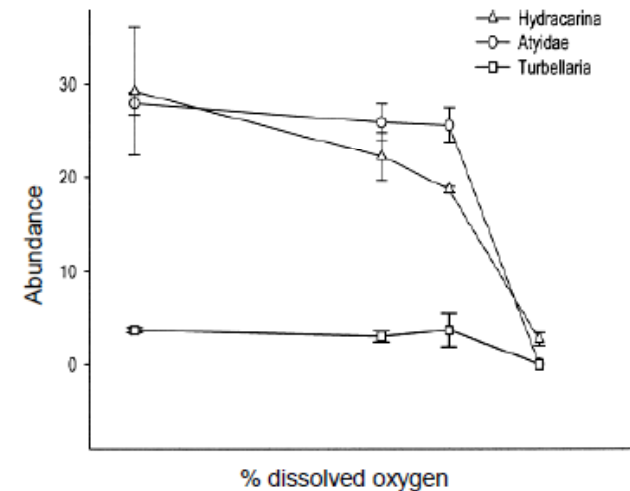
1. Freshwater ecosystems (streams) – Pearson et al
 2. Coral reefs - Fabricius et al (GBR WQ Guidelines)
 3. Seagrass – Waycott & McKenzie
- Investigations along natural gradients to define thresholds for wetland ecosystems proved to be difficult but the work provides a substantial baseline for comparative assessment.





Freshwater ecosystems

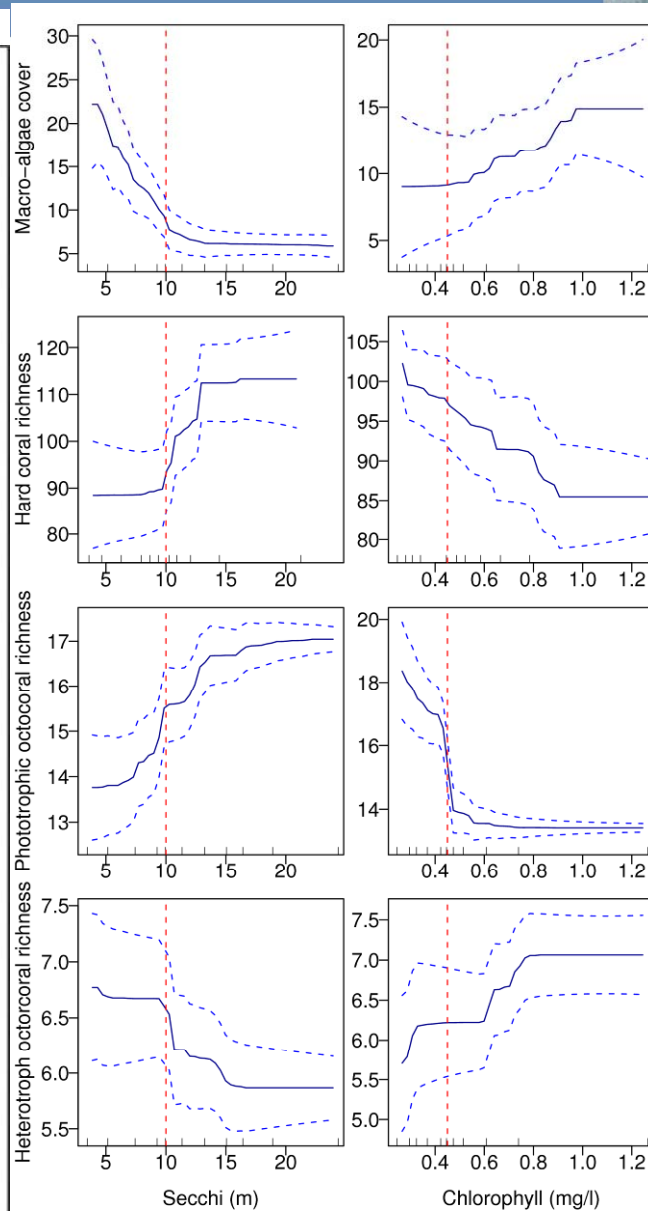
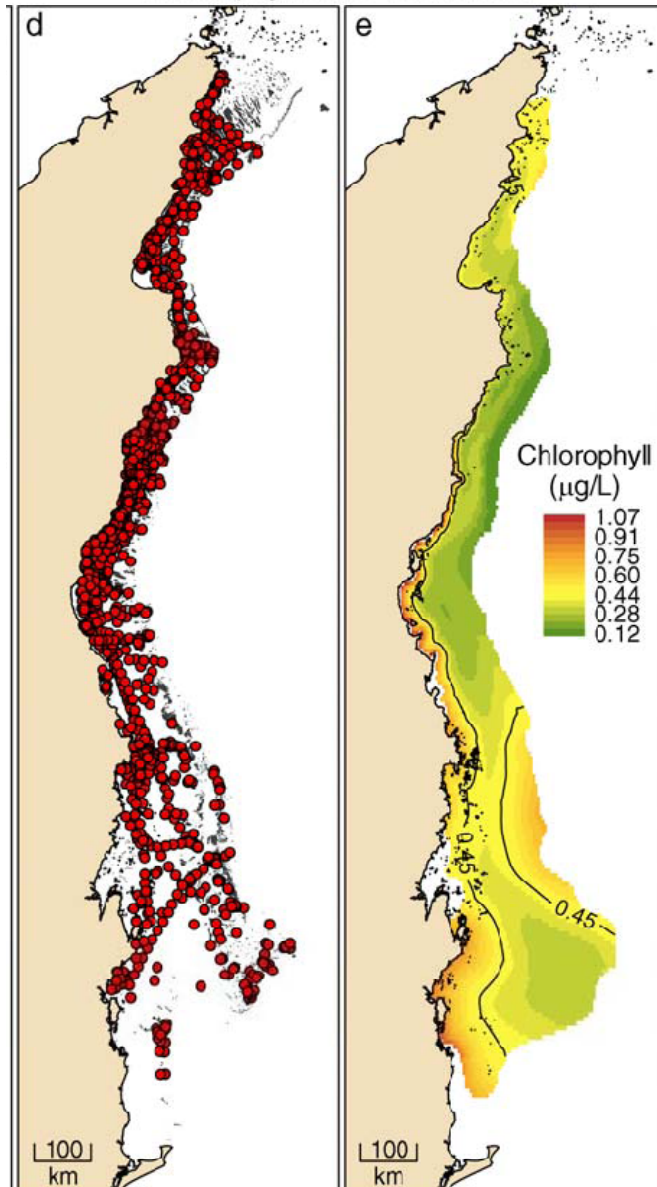
- Clear gradients in species/community distributions
- Distributions related to habitat and water quality
- Impossible to dissect out individual cause-effect relationships (but see ACTFR, Pearson et al)
- But overall picture is a gradient of land use with concomitant gradients in ecological communities



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Chlorophyll: sites and values

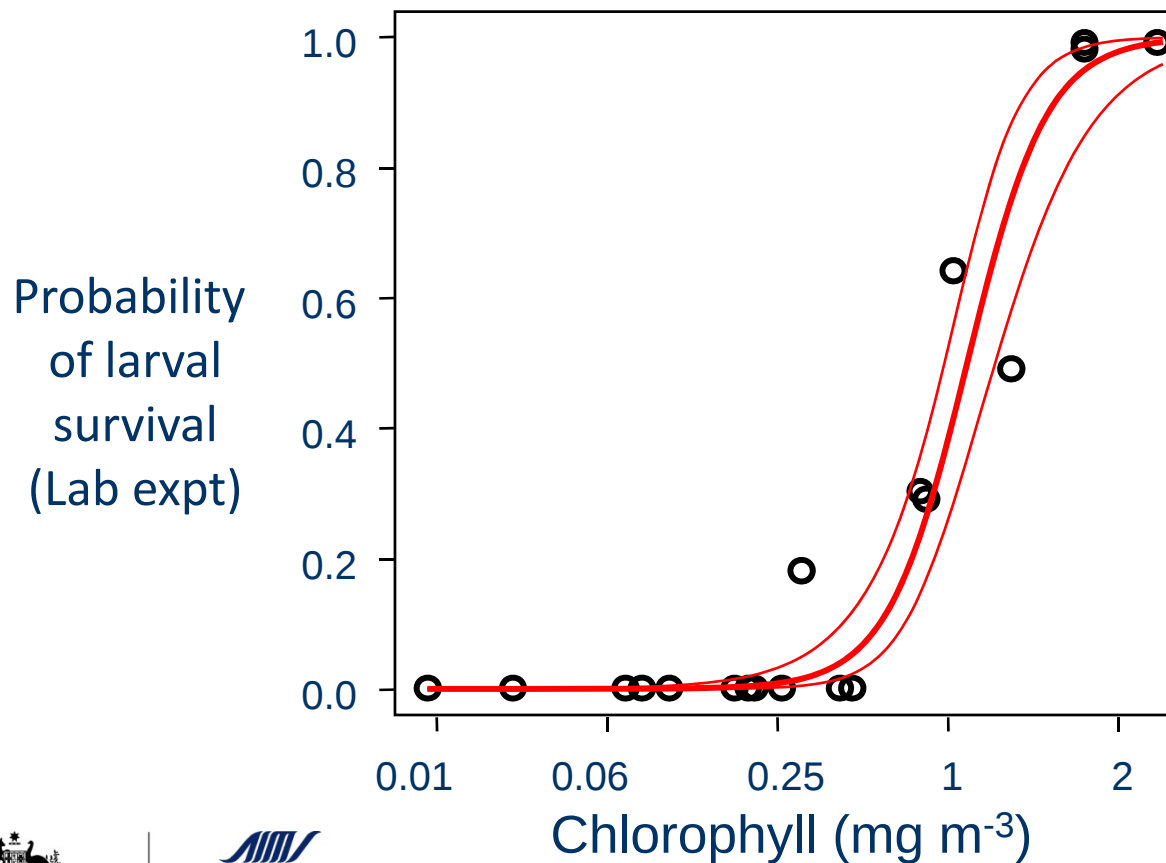


Water Quality Guidelines





Crown-of-thorns outbreaks & chlorophyll



A 2-fold change in
chlorophyll increases
the odds of
survival by a
factor of 8.3
95% CI = (4.6, 16.1)

(Fabricius, De'ath, Okaji; 2010)

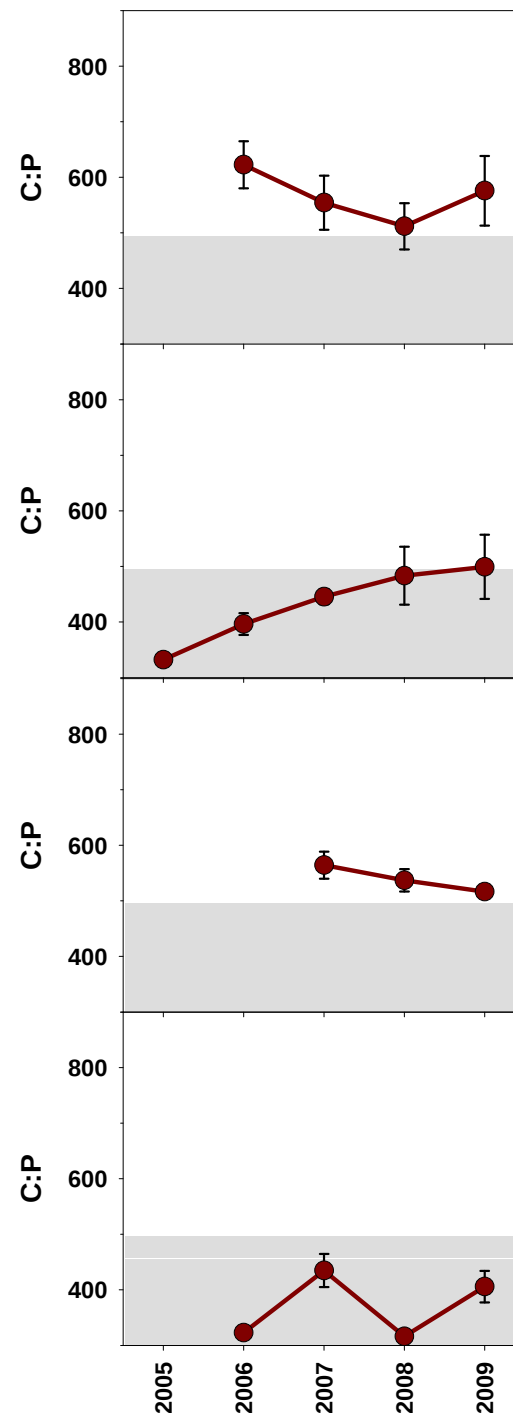
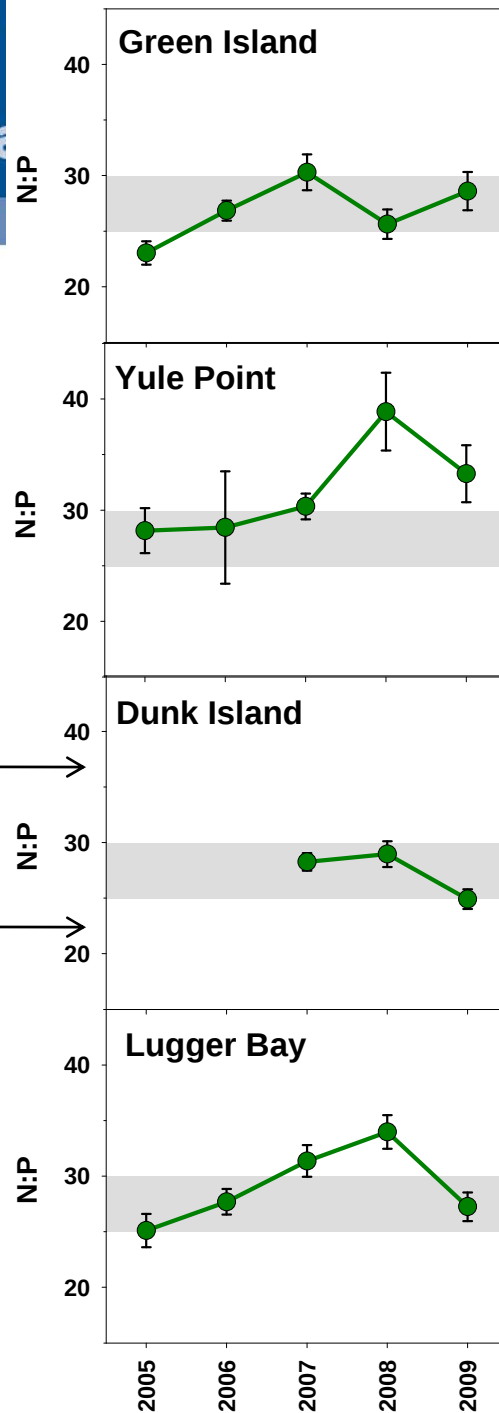




*Seagrass leaf
tissue ratios
N:P & C:P
ratios*

P limitation

N limitation



Nutrient rich
habitat

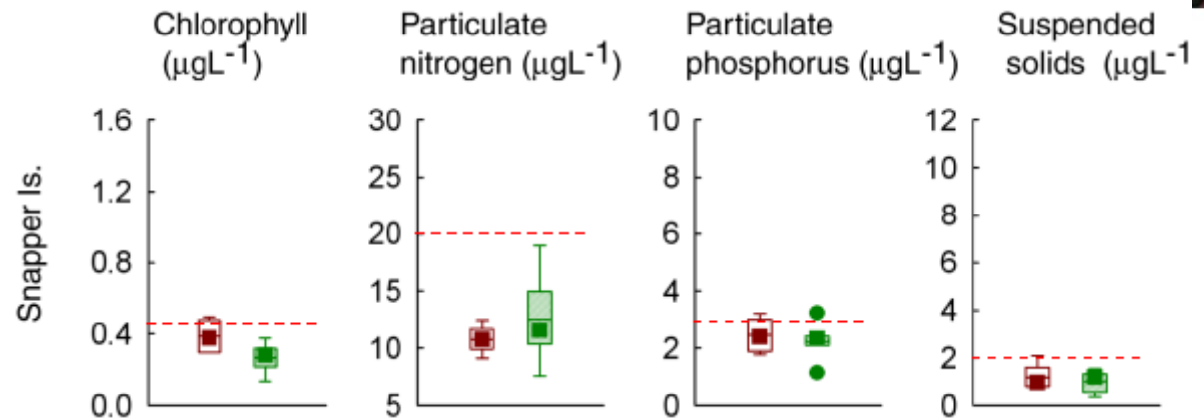


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WQ reporting (MMP and P2R)

- Combination of in-situ WQ data plus remote sensing
- In-situ data – WQ logger data.
Assessment of mean and median against WQ guidelines
- RS data – exceedances over regional areas
- Plume exposure and extent



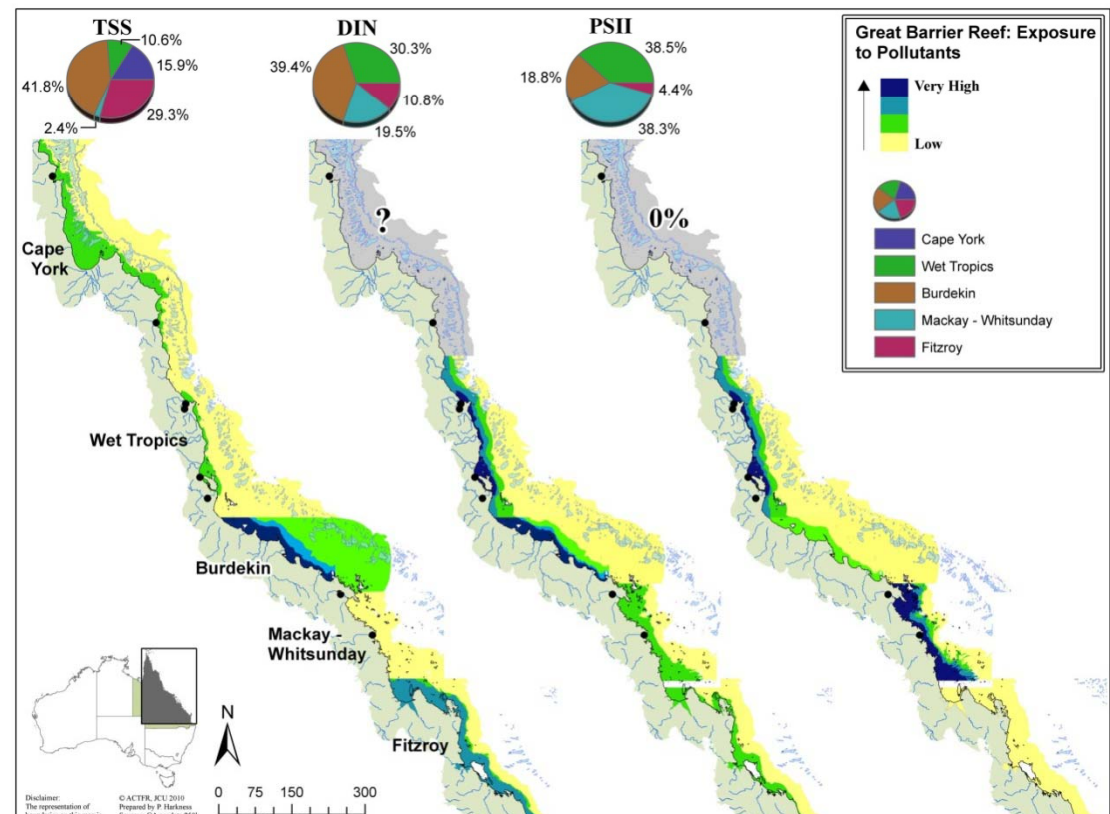
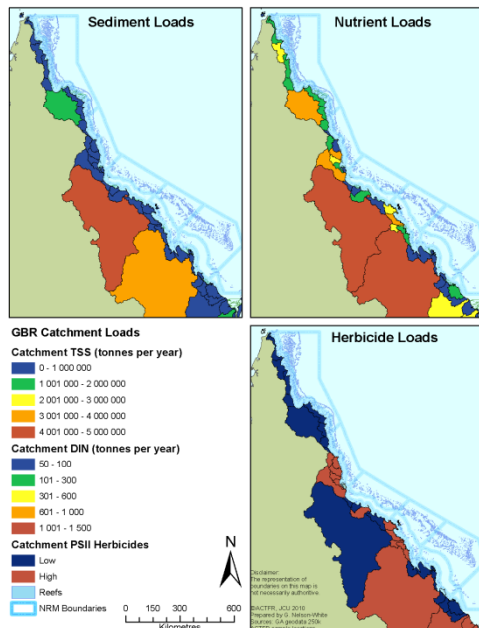
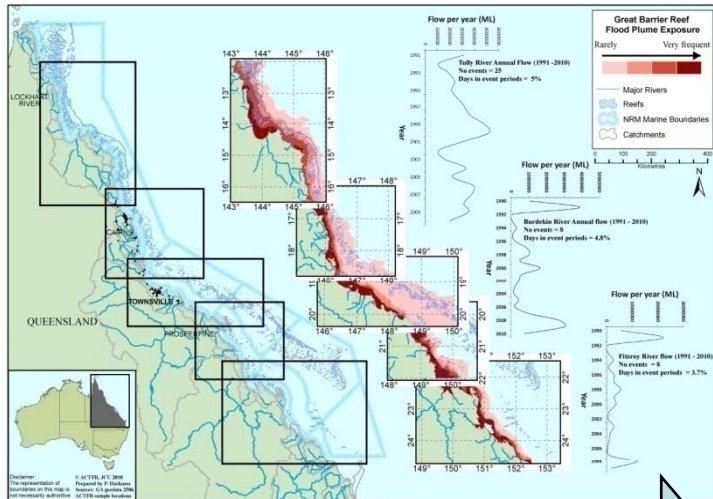
Region	Location	Turbidity/SS	Chlorophyll	PN	PP	Secchi
Wet Tropics	Cape Tribulation	2*	2*	2	2	0
	Snapper Island North	0	1	2	2	0
	Port Douglas	2	2	2	2	0
	Double Island	2*	2*	2	2	2
	Green Island	2*	2*	2	2	2
	Yorkey's Knob	0*	0*	2	0	0
	Fairlead Buoy	0*	0*	2	0	0
	Fitzroy Island	2	2	2	2	2
	High Island	2	2	2	2	0
	Russell Island (Franklands)	2	2	2	2	2
	Dunk Island	0	2	2	0	0
Burdekin	Pelorus / Orpheus Island	2	1	2	2	0
	Pandora Reef	2	1	2	2	0
	Magnetic Island	0	2	0	0	0
Mackay Whitsunday	Double Cone Island	1	1	2	2	0
	Daydream/West Molle Island	0	1	2	2	0
	Pine Island	0	0	2	2	0
Fitzroy	Barren Island	2	1	2	2	2
	Humpy Island	2	1	2	2	2
	Pelican Island	0	0	2	0	0

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Mapping exposure to pollutants

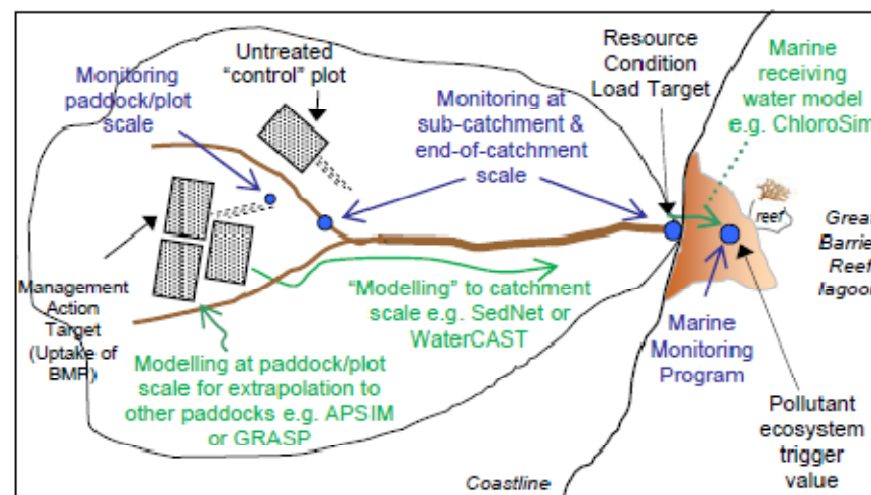
- Link between pollutant loads and plume movement and frequency





M&E framework

- Catchment to Reef monitoring and evaluation framework



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Management practices

- Types of classes / management practices
- Adoption of practices (by class)
- Plot/paddock water quality – sediments, nutrients, pesticides
- Cost effectiveness of practices
- Capacity to adopt (landholder profiling)



Catchment health

- Habitat variables inc riparian extent & condition, flow, aquatic vegetation
- Physical condition inc velocity, bank stability, channel form, width, depth, sediment
- Water quality characteristics
- Invertebrate species & family richness
- Fish species richness & assemblage composition
- Abundance & diversity alien fish species
- Benthic habitat (floodplain lagoons & wetlands)
- Wetland & riparian extent



Catchment loads

- Sub-catchment & catchment water quality - Sediments, nutrients, pesticides
- Deterministic process-based model
- Statistical modelling framework - Loads Regression Estimator



Socio economic influences

- Population pressures
- Environmental, social & economic attitudes & aspirations
- Quality of life
- Public/private benefit of practice change
- Use indicators e.g. No. guest nights
- General capacities & participation
- Evaluation of management performance
- Networks & links to other organisations

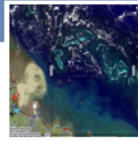


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Estuarine health

- Ambient water quality – DO, pH, turb, temp, nutrients
- Change in fish assemblage taxonomic structure
- Fish assemblage indices
- Fish Stable Isotope Analysis (\$\$)
- Fish Biomarker Analysis (\$\$)



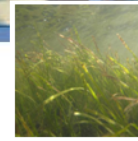
Marine water quality

- Ambient – SS, nutrients, carbon, salinity, temp, chl, pesticides,
- Flood plume – SS, nutrients, salinity, temp, chl, pesticides
- Flood plume extent & exposure



Coral health

- Porites brightness
- Macro-bioeroder density in massive living Porites
- Foram index
- Macroalgal cover
- Acropora cover
- Acropora / Hard coral cover ratio
- Hard coral juvenile density & richness
- Soft coral juvenile density & richness



Seagrass health

- Tissue nutrient ratios (N:P, C:N, C:P)
- Seed bank & reproductive structure surveys
- Leaf number per shoot & area
- Seagrass species composition
- Changes in seagrass cover & meadow area





Institutional & governance indicators

- Framework and process for management evaluation at different scales.
- Evaluation of collaborative governance performance tested in Terrain NRM Reef Rescue program. Enables feedback for next round of investment.
- Examples of improvements:
 - ✓ regular communications with partners
 - ✓ enhancing partner engagement in planning and priority setting
 - ✓ further developing tools, processes, and procedures to support efficient and effective program delivery





Assessing social resilience



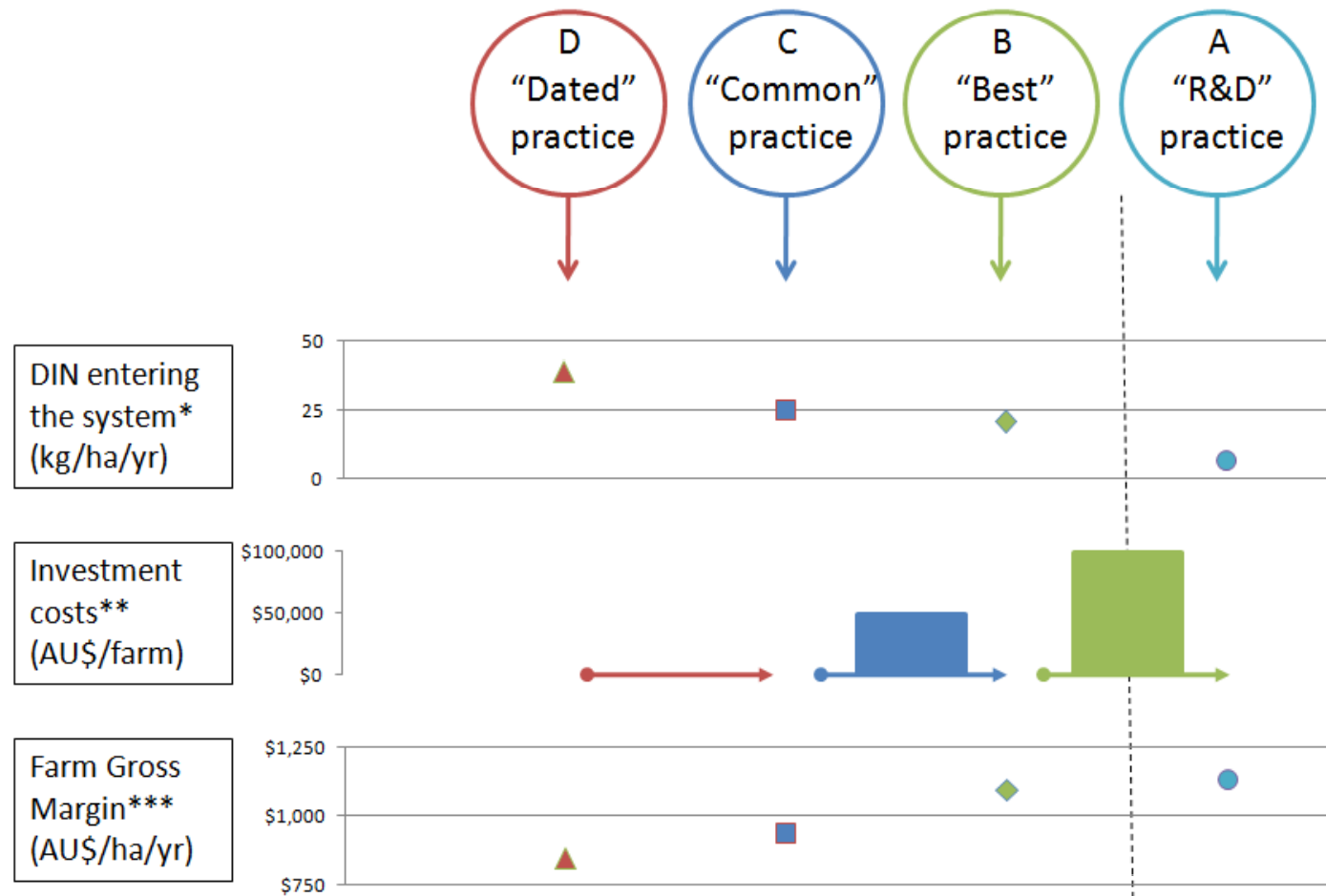
- Explore the likely impacts of interventions to achieve water quality on the adaptive abilities of society
 - a) indicators of the likelihood of a social system adapting to environmental or other change in the GBR region
 - b) a process of collecting information on these indicators; and
 - c) a robust approach to using this information to assess and predict the likelihood of adaptation.
- A step-by-step user guide – templates, assessment approaches.



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Wet Tropics (Tully)



Assessment of management practices & targets

* Total DIN equals DIN available for runoff and deep drainage, based on APSIM modelling

** Based on representative farm with 'typical' farm size for the region

*** Yearly average from full crop cycle (plant, ratoon 1-3 and fallow)





Management Applications

- Identified 'hot-spots' of pollutant delivery & land use sources
 - Reef Rescue expenditure (loads used in Multi Criteria Analysis)
 - Translation into priorities for Reef Regulations
- Approaches for assessing wetland condition
- Whole of system 'paddock to reef' monitoring and modelling framework used in Reef Plan P2R Program design and regional WQ plans, and components
- Tools for assessing management practice targets
- Suite of M&E indicators for freshwater, wetlands, estuarine, marine ecosystems.
- GBR Water Quality Guidelines
- Reporting frameworks for water quality, seagrass & coral
- Contributions to 2008 Scientific Consensus Statement





Keys to success

- Credible & reliable researchers!
- Collaboration – between researchers & with a wide range of end users
- Building on previous efforts
- Multi-disciplinary
- Linkage across research & monitoring initiatives
- Formal communication mechanisms & events
- Strong leadership
- Strong push for scientific publication





Data management & knowledge platforms

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The e-Atlas is a partnership between many research providers in order to develop a portal to information about Australia's tropical terrestrial and marine environments.

Featured Article

The Great Barrier Reef Today

James Kerry
Australian Institute of Marine Science (AIMS)
 Posted on **18 January 2011**



Extending over 2,000 km along the coast of Queensland, Australia and comprising some 2,900 individual coral reefs, the Great Barrier Reef [GBR] is the largest coral reef ecosystem to have existed in recent times.

Featured Dataset

Reef Rescue Marine Monitoring Program - Condition of inshore coral reefs on the Great Barrier Reef

Britta Schaffelke
Australian Institute of Marine Science
 Posted on **15 March 2011**



Regular monitoring of the condition of reefs in the inshore GBR lagoon has commenced in 2005 as part of the [Reef Rescue Marine Monitoring Program](#)(MMP), which is supported by the Great Barrier Reef Marine Park Authority, through funding from the Australian Government's Caring

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Reef Rescue Marine Monitoring Program - Condition of inshore coral reefs on the Great Barrier Reef

Britta Schaffelke

Australian Institute of Marine Science

Posted on **15 March 2011**



Regular monitoring of the condition of reefs in the inshore GBR lagoon has commenced in 2005 as part of the [Reef Rescue Marine Monitoring Program](#)(MMP), which is supported by the Great Barrier Reef Marine Park Authority, through funding from the Australian Government's Caring for our Country and the Australian Institute of Marine Science.

The condition of inshore coral reefs is monitored at 32 inshore coral reefs in the same four NRM regions. Of these reefs, 15 are surveyed annually (and 14 of these have regular water quality monitoring, see above), while 17 additional reefs are surveyed every other year. Monitored reefs are located along gradients away from the mouths of regionally important rivers (generally in a northward direction). Reefs are assessed for their cover of hard coral, soft coral and macroalgae, as well as taxonomic diversity, coral demographics (monitoring of juvenile coral colonies, their sizes and their diversity) and coral larval settlement rates. The composition of benthic [foraminiferal assemblages](#), as a bioindicator for water quality, is also assessed at the 14 core coral reef and water quality monitoring sites, including calculation of the FORAM index.

Done

Example: Reef Rescue Marine Monitoring Program Current data includes coral and WQ datasets (AIMS), pesticide data (UQ), plume maps (JCU). Page shows metadata, references, related articles, link to maps




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Interactive Maps

The e-Atlas Interactive Mapping Service helps users to display, access and interrogate information about properties of the Great Barrier Reef and adjacent catchments. Users can view and explore spatial data across a range of topics. Specific values at any particular point can be obtained via an interactive feature request.

Comparisons can be made between different topics by displaying side-by-side maps, each with a different topic selected. Choose from:

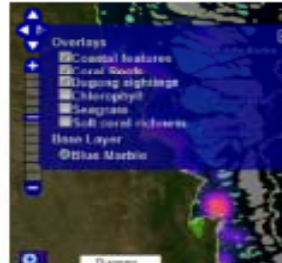
- [An Individual Map](#)
- [A Two Map Comparison](#)
- [A Three Map Comparison](#)

How to Use the Maps

The *layer selector*, , can be found on the upper right hand side of each map. Clicking on this selector will pop-out the layer list and allow you to add or remove layers for display on that map.

When the *panning hand* is selected, , a single click can be used to grab and drag the map to show the area you are interested in and a double click will cause the map to be redrawn at the next zoom level with the point clicked placed at the centre of the display.

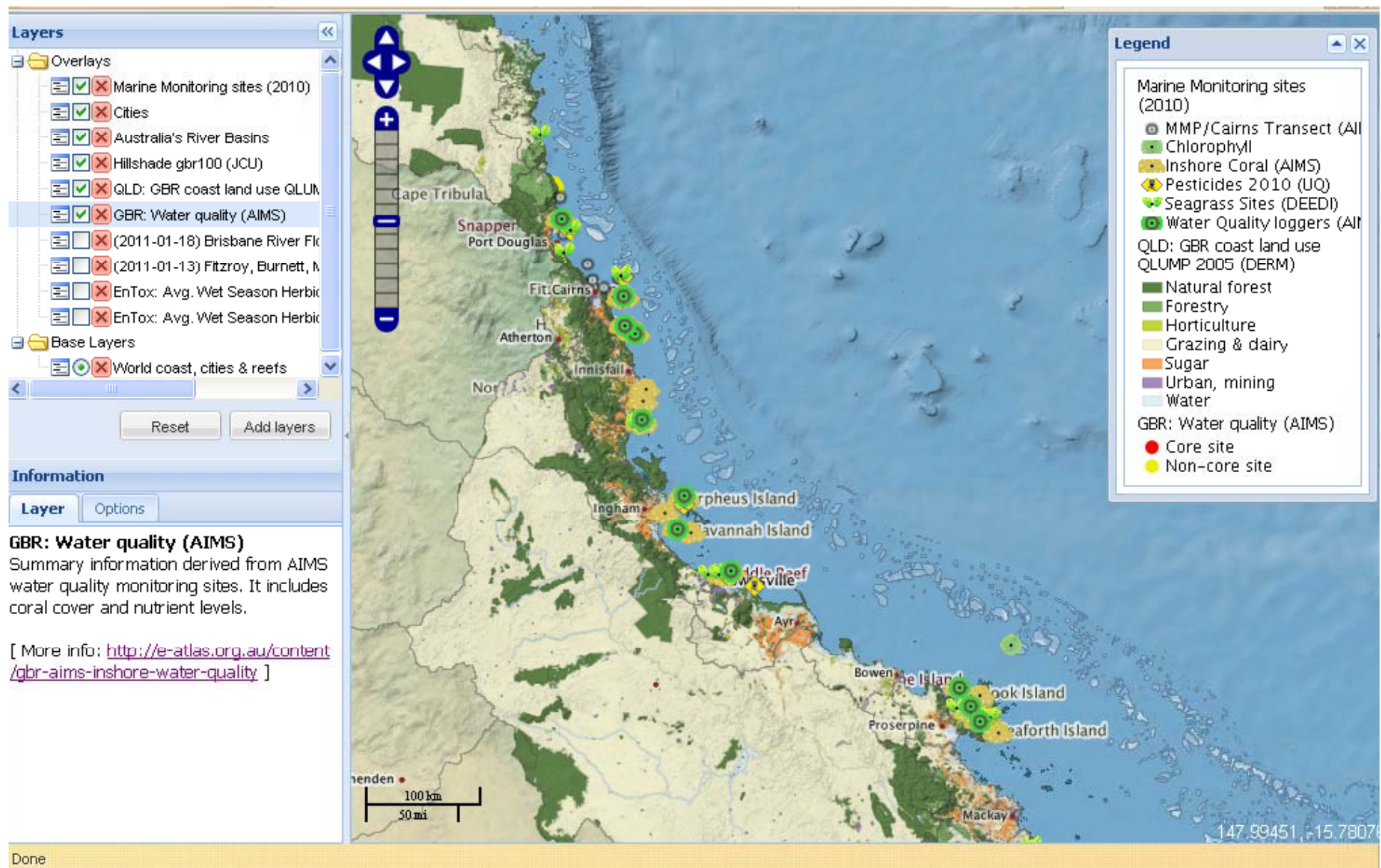
When the *magnifying glass* is selected, , a single click will cause the map to be redrawn at the next zoom level with the point clicked at the centre of the display. A click and drag can be used to select a region, when the click is released the map will be redrawn, zoomed in on this region. A feature request can be made by holding down the Ctrl key while clicking on the area of interest.




Interactive Maps: Comparisons between up to 3 maps, zoom, add layers.





e-Atlas Mapper: Reef Rescue MMP example. Displays wide range of datasets. Example here shows MMP sites, GBR catchment land use etc. Layer information is captured (bottom left), creates legend depending on what is displayed.



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Topics

Biology And Biodiversity

- Coral Reefs
- Freshwater Systems
- Jellyfish Of The GBR
- Mangroves
- Rainforests
- Seafloor
- Seagrass
- Species Of Conservation Concern
- Wetlands

Human Use And Economics

- Fishing And Harvest
- Shipping
- Socio-economy
- Tourism

Physical Environment And Geography

- Climate And Weather
- Geographic Features
- Marine Water Quality
- Oceanography

Threats And Risk Assessment

- Climate Change
- Diseases
- Fishing
- Invasive Species
- Resilience And Ecosystem Health Measures
- Shipping
- Water Quality

Biology and biodiversity

-  [Middle Reef - Coral Status and Trends \(1993-2009\) \(AIMS LTMP\)](#)
-  [Rainforest Expansion in Far North Queensland: A preliminary analysis of the Windsor and Carbine Tablelands \(MTRSF Transition Project T28\)](#)
-  [What is Biodiversity?](#)

Climate and weather

Physical environment and geography

-  [A Synthesis of Climate Change and Coastal Science to Support Adaptation in the Communities of the Torres Strait \(MTRSF Synthesis Report\)](#)
-  [R Tools for Generating Maps and Spatial Modelling](#)
-  [Rainforest Expansion in Far North Queensland: A preliminary analysis of the Windsor and Carbine Tablelands \(MTRSF Transition Project T28\)](#)

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Water Quality Topics

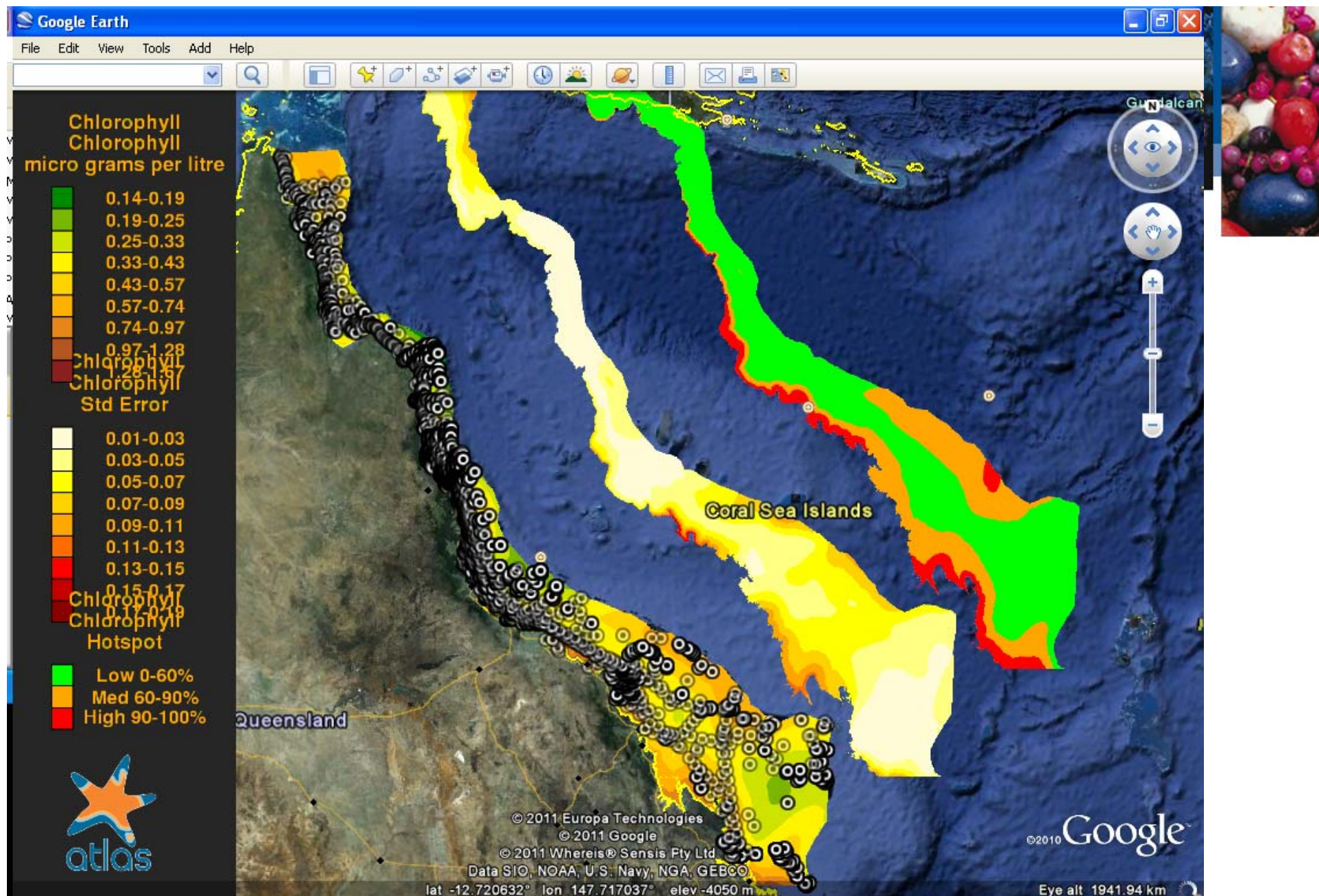
- [Eutrophication](#)
- [Flood Plumes](#)
- [Ocean Acidification](#)
- [Pesticides](#)
- [Sedimentation](#)
- [WQ Exposure Models](#)

Water Quality

-  [GBR - Dating and mapping historical changes in Great Barrier Reef coral communities \(UQ\)](#)
-  [GBR - Lagoon water quality data \(AIMS\)](#)
-  [GBR - Pesticide monitoring of the inshore Great Barrier Reef by the Reef Water Quality Marine Monitoring Program \(EnTox UQ\)](#)
-  [Optimising Water Quality and Impact Monitoring, Evaluation and Reporting Programs \(MTSRF Synthesis Report\)](#)
-  [R Tools for Generating Maps and Spatial Modelling](#)
-  [Reef Rescue Marine Monitoring Program](#)
-  [Reef Rescue Marine Monitoring Program - Inshore Water Quality of the Great Barrier Reef](#)
-  [Thresholds of major pollutants with regard to impacts on instream and marine ecosystems \(MTSRF Synthesis Report\)](#)
-  [Water quality guidelines for the Great Barrier Reef](#)
-  [Water quality of the Great Barrier Reef: spatial and seasonal patterns](#)

Example: Water Quality Topics. Contains spatial datasets, reports, papers etc







Further information

General: www.rrrc.org.au

Synthesis Reports: http://www.rrrc.org.au/publications/synthesis_products.htm

e-Atlas: www.e-atlas.org.au

Contact us:

Jane Waterhouse: j.waterhouse@c2o.net.au

Michelle Devlin: m.devlin@c2o.net.au

Sheriden Morris: Sheriden.Morris@rrrc.org.au

David Souter (e-Atlas): David.Souter@rrrc.org.au

