National Environmental Research Program

Water quality of the GBR and the Torres Strait: Understanding multiple pressures and cumulative impacts

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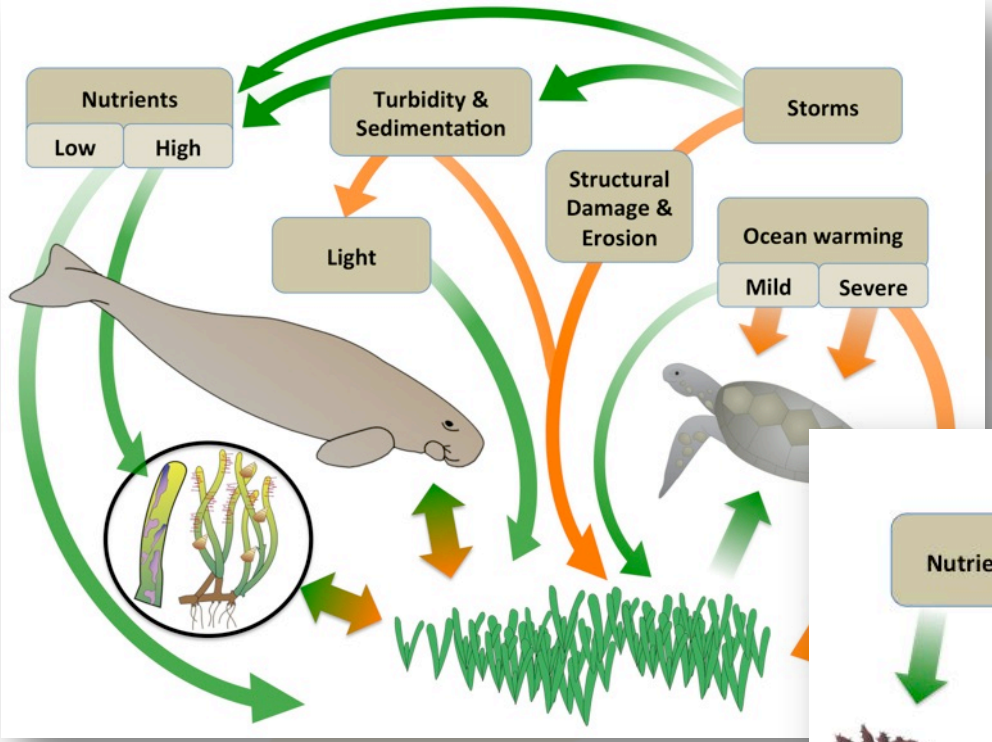
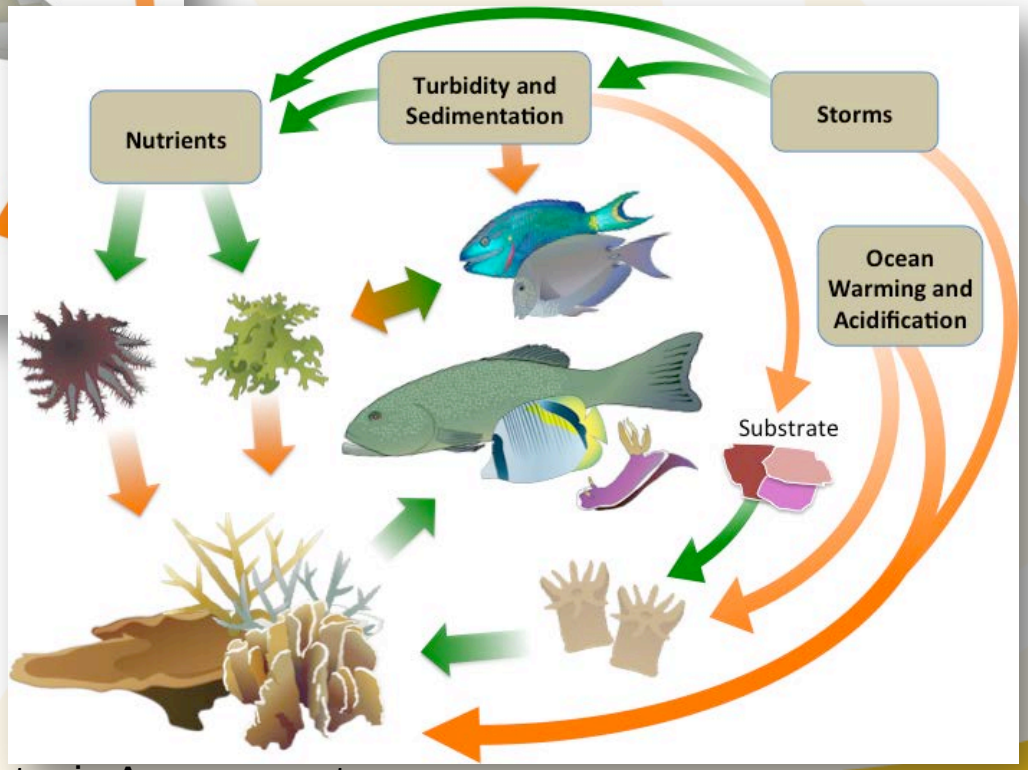
Multiple pressures affecting our coasts

Water quality influencing many, complex processes





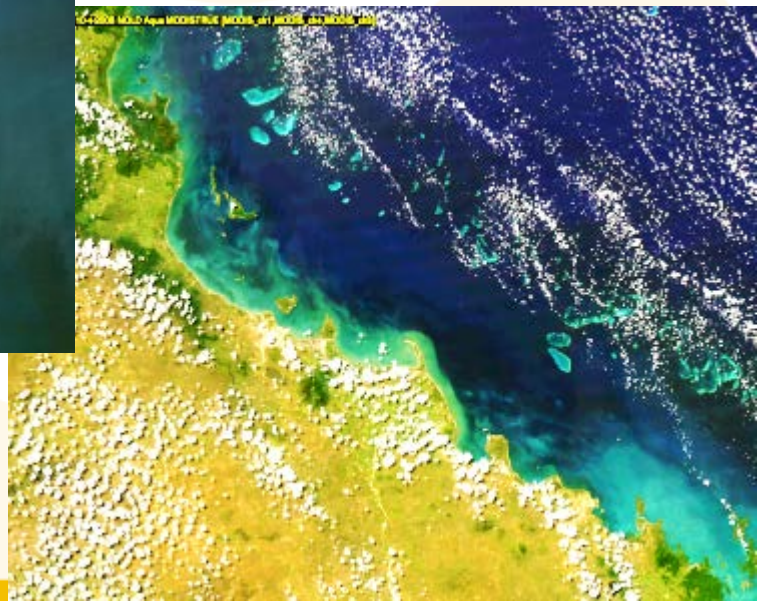
Anthony et al. 2013- report for GBRMPA Strategic Assessment

Open questions → objectives for NERP research

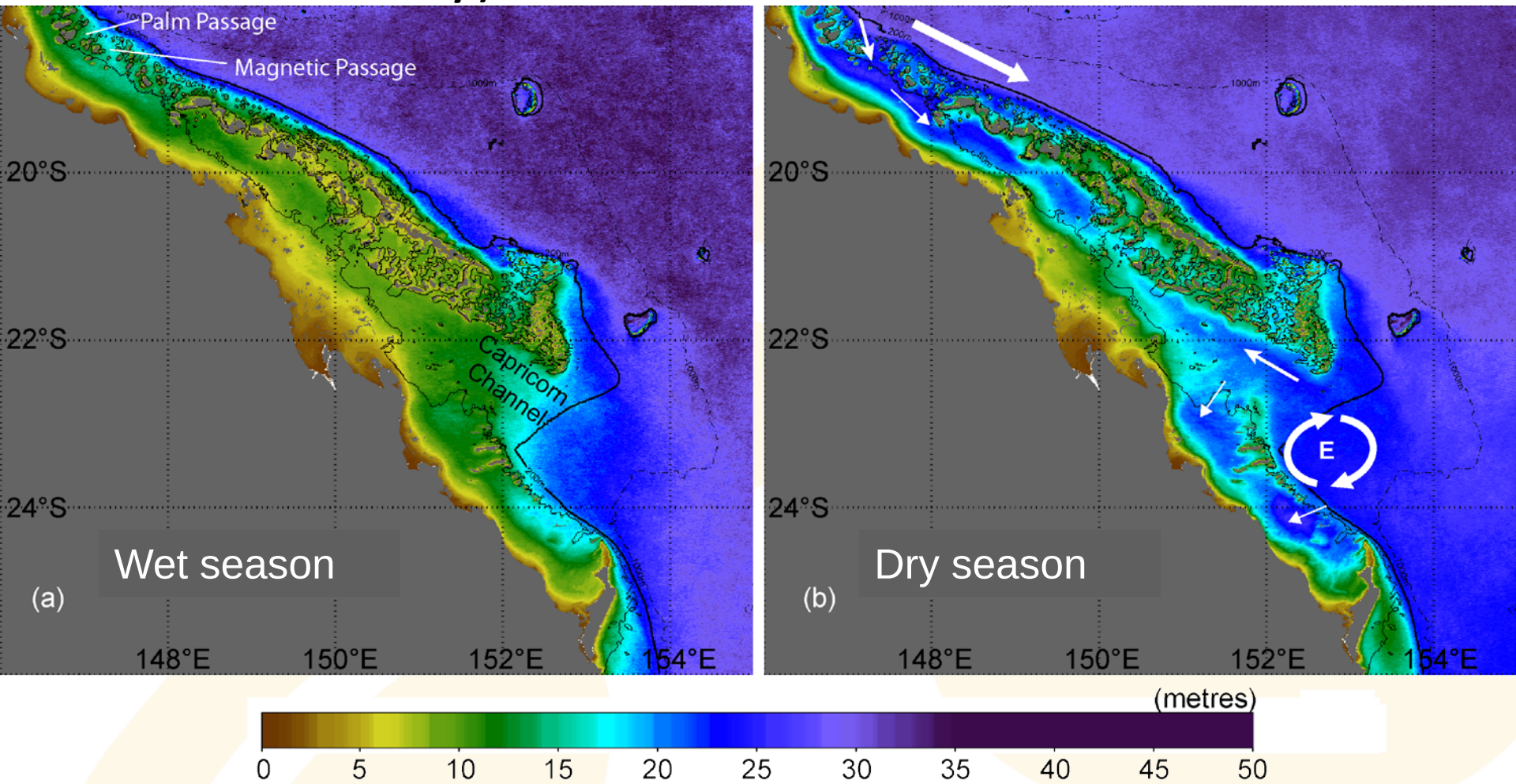
- Investigate the relationship between river discharges and water clarity in the GBR
- Investigate the responses of key marine organisms to cumulative pressures
- Investigate the threats to water quality in the Torres Strait

Research objective:

- investigate the relationship between GBR water clarity and river discharges.

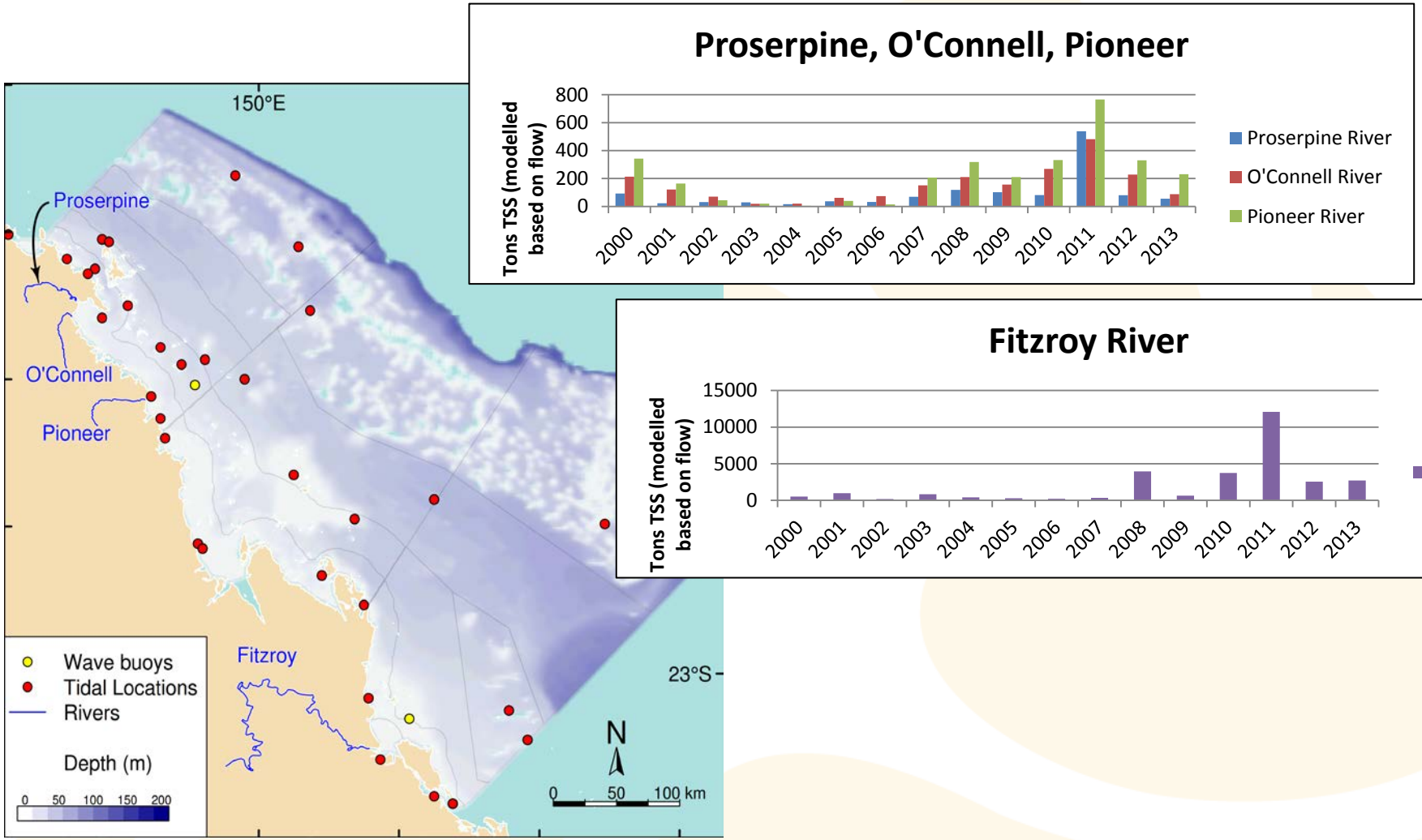


Clear differences in photic depth (water clarity) between seasons



Processed satellite imagery provided by S. Weeks, Uni QLD
Fabricius et al. 2014. Marine Pollution Bulletin 84, 191–200.

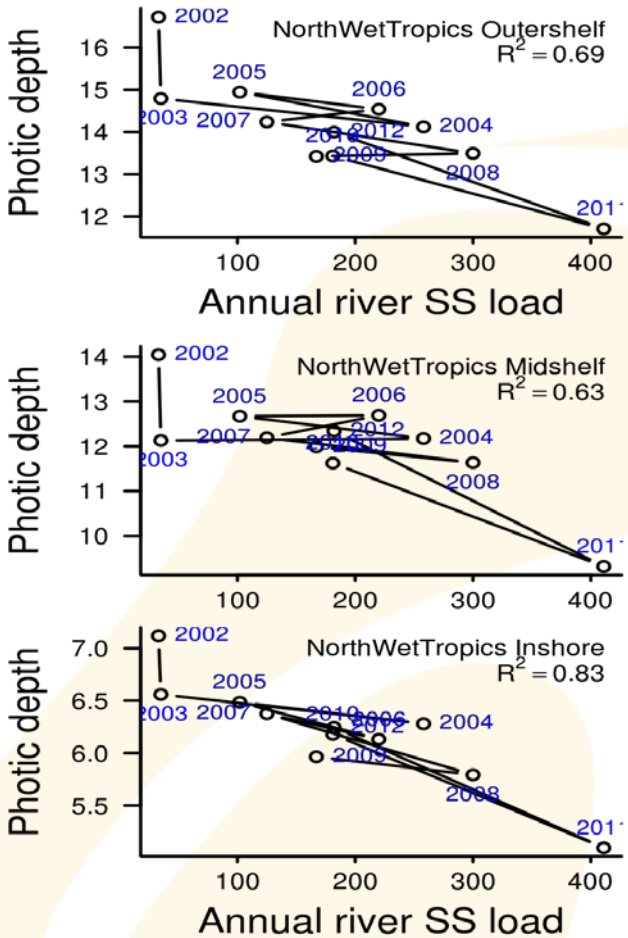
Explanatory variables:
water depth, waves and tides, river loads



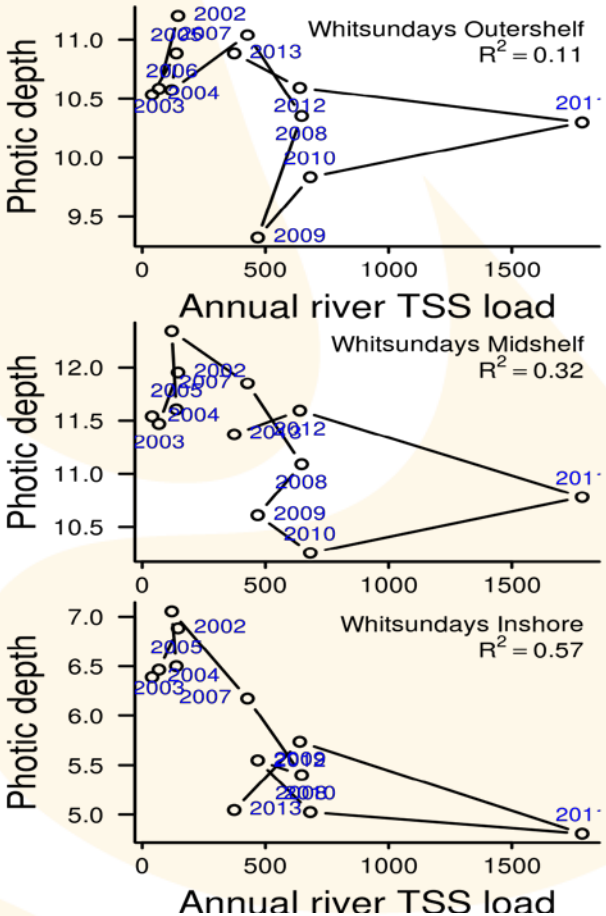
Logan et al. 2014. NERP Project 4.1 Progress Report: Southern and Northern NRM Regions. AIMS, Townsville

River sediment loads influence water clarity far into the GBR lagoon

Wet Tropics



Whitsundays

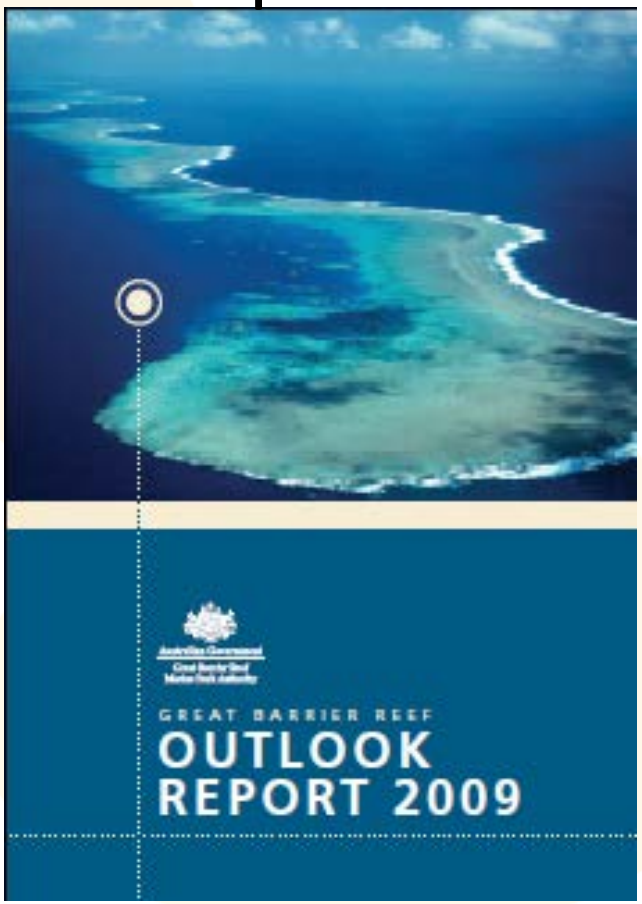


- Cross shelf and regional differences

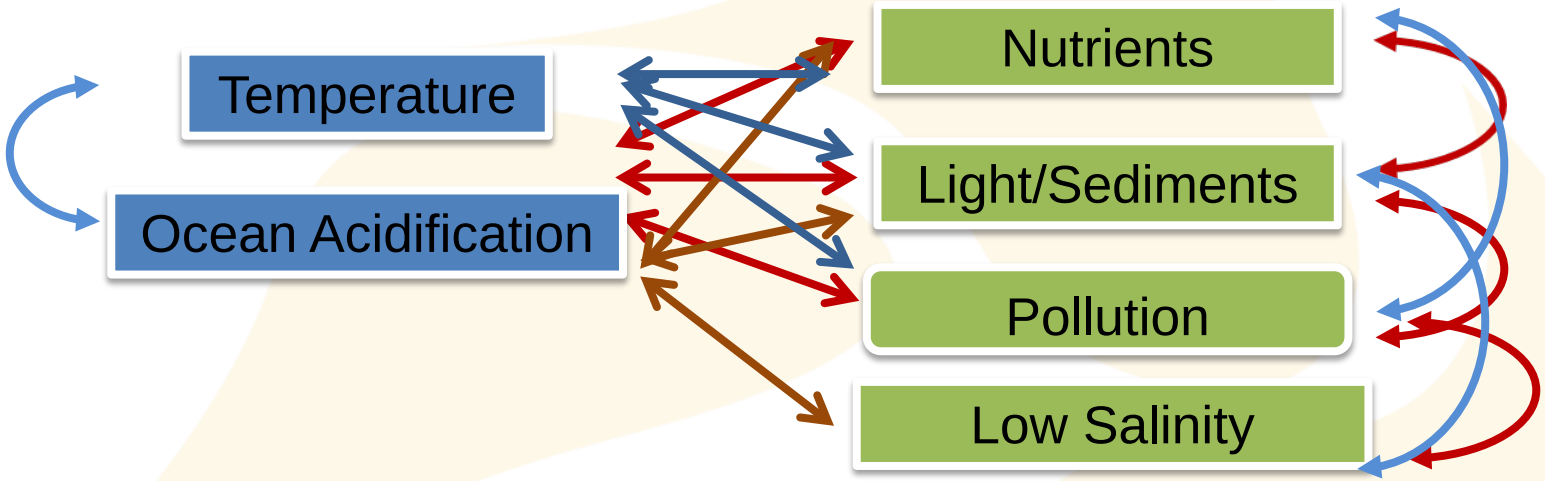
Logan et al. 2014. NERP Progress Report: Southern and Northern NRM Regions. AIMS, Townsville

Objective:
Investigate the responses of key marine organisms to combined water quality and climate pressures

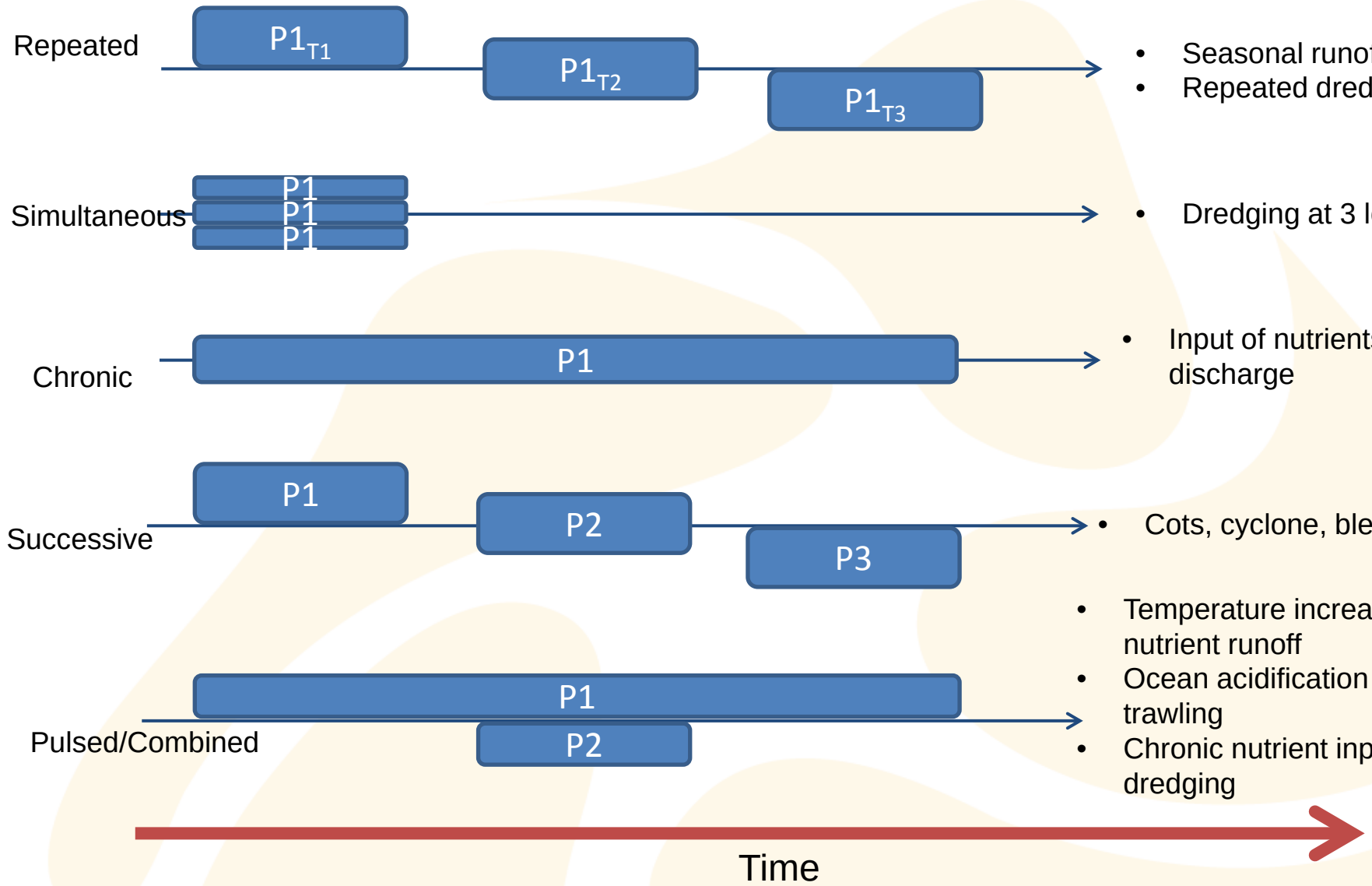
"Further building the resilience of the Great Barrier Reef by improving water quality, (…) will give it the best chance of adapting to and recovering from the serious threats ahead, especially from climate change."



Combined water quality and climate pressures



Cumulative pressures



Example

- Seasonal runoff
- Repeated dredging

- Dredging at 3 locations

- Input of nutrients from discharge

- Cots, cyclone, bleaching

- Temperature increase + nutrient runoff
- Ocean acidification + trawling
- Chronic nutrient input + dredging

Organic sediments

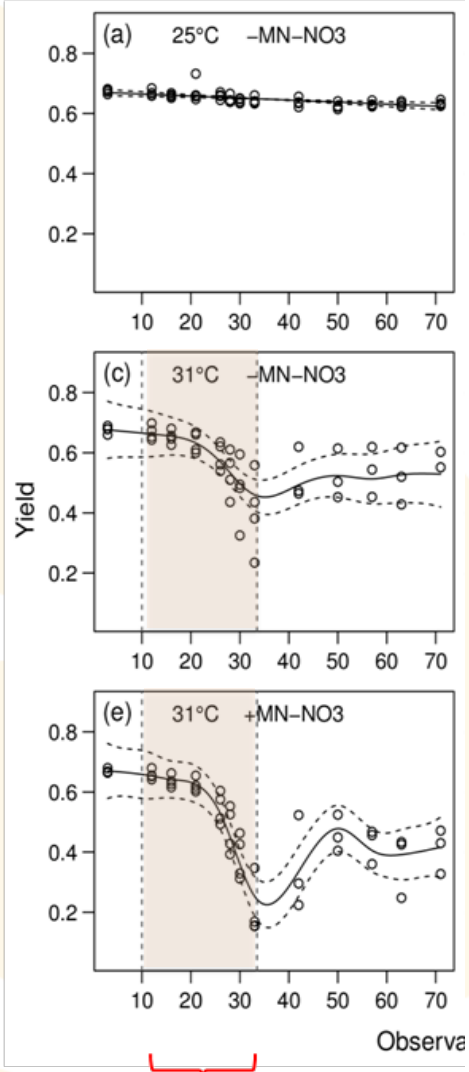
Temperature

95 day exposure to:
sediment, organic enrichment & nitrate

25° C

25-31-25° C,
no sediment

31° C,
+ sediment



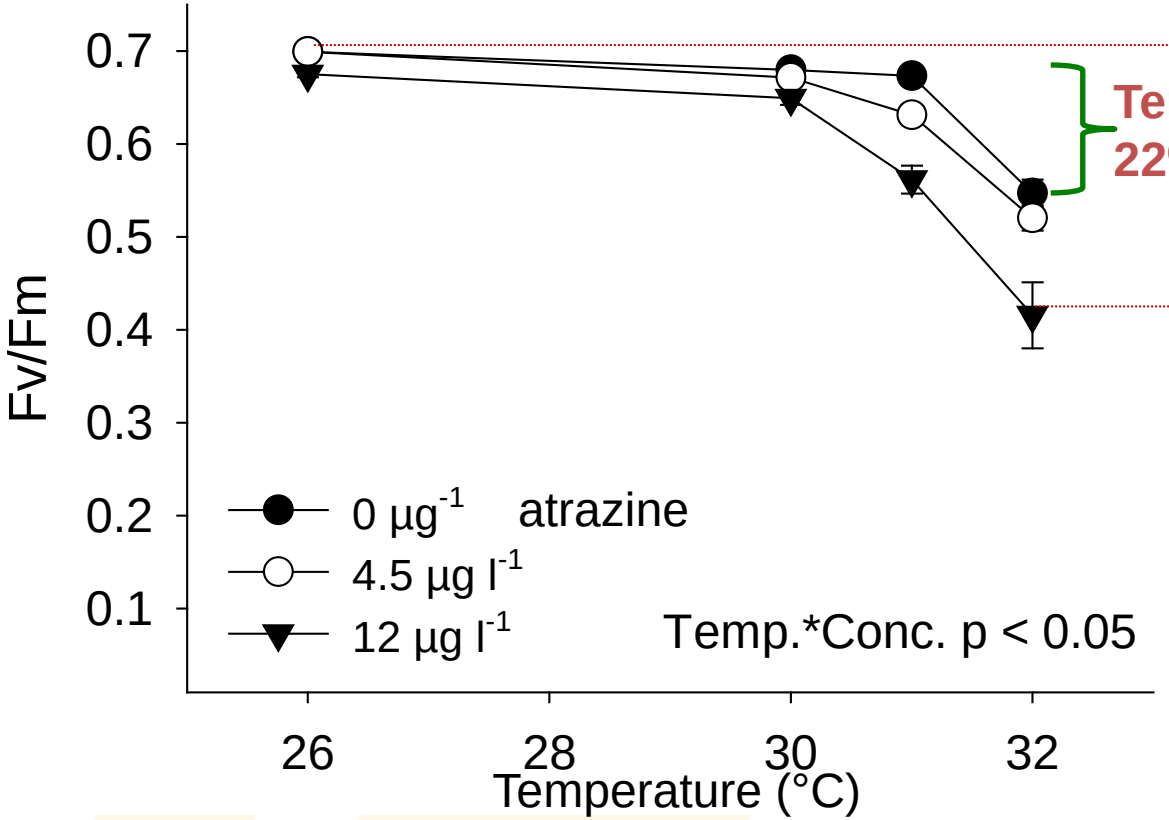
Heat stress Recovery

Corals exposed to organically-enriched suspended sediments
<u>bleach more easily</u> and
<u>die at high temperatures</u>
than those grown in water with low nutrients

Fabricius, Cséke, Humphrey, De'ath (2013), PLoS ONE

Temperature

Herbicide



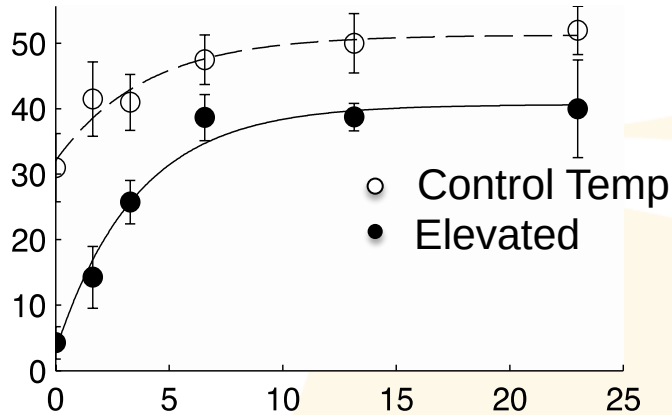
Temperature 22% damage

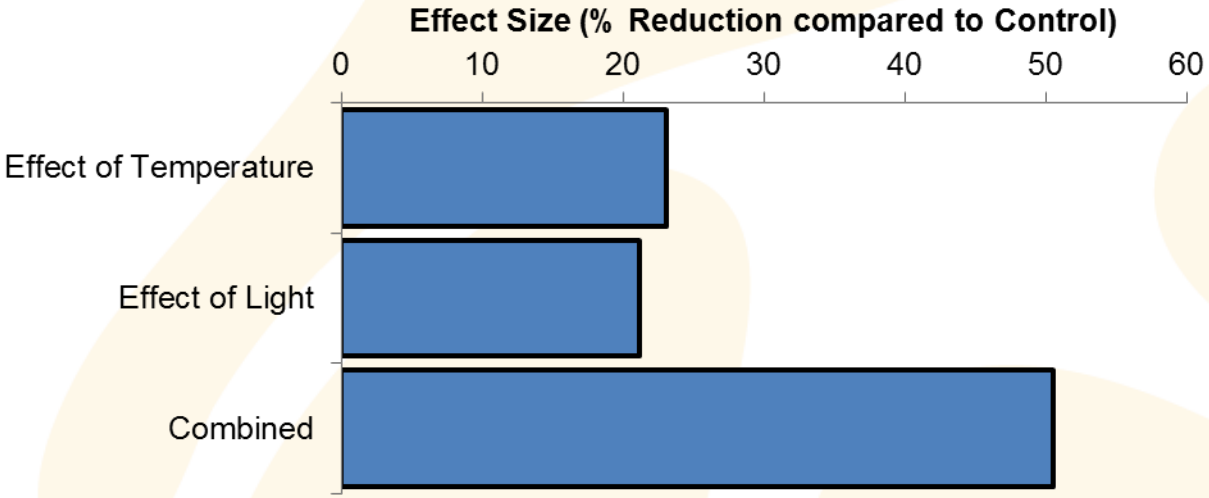
Combined damage of **41%**
= Synergistic Interaction
= Greatest problem when high temp & herbicides are combined

Seagrass

Temperature

Light



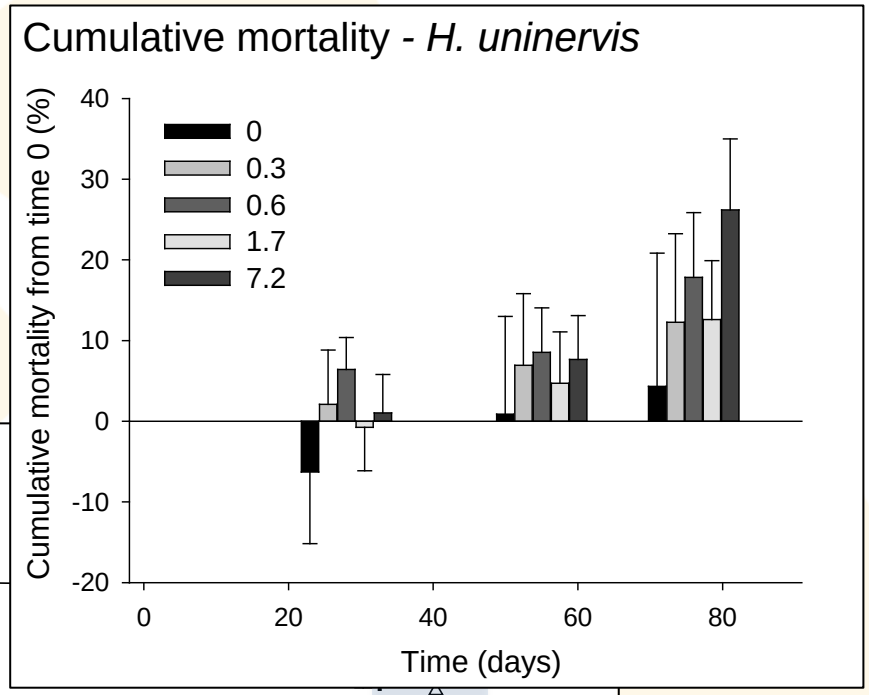


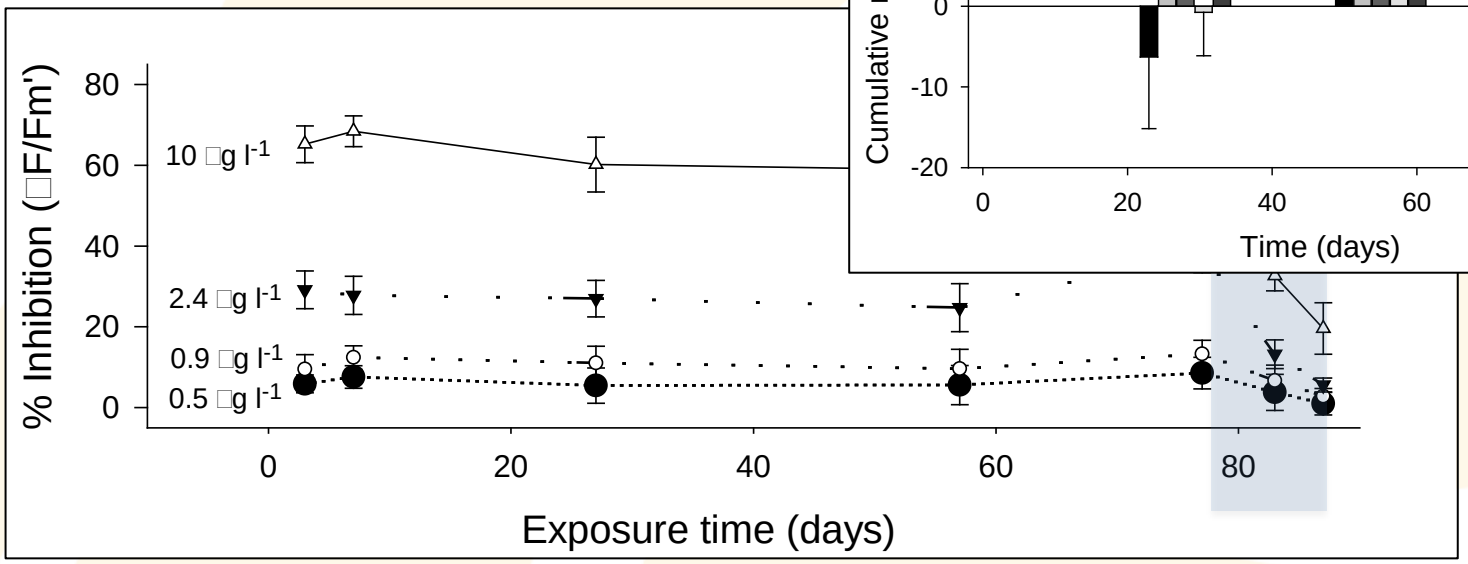
Ac**cumulative** effects (chronic)

Long seagrass exposure to herbicides

Chronic exposure experiment (11 wks):

- 2 seagrass species
- 4 diuron treatments
- Measure: photosynthesis
  growth
  energetics





Ac**cumulative** effects (chronic)

Effects on growth

Reduced energy storage

Herbicide affects PSII

Long seagrass exposure to herbicides

- Impacts become more severe over time
- Long term effects on energy storage are identical to low light stress (effects are likely to combine)

Reduce pollution to protect from other pressures

X µg/L

Pollutant increase

0 µg/L

32°C

Current threshold for Coral bleaching (no cumulative pressures)

30.5°C

Reduced threshold (in a cumulative scenario)

Quantify to develop management targets for pollution

National Environmental Research Program

Include the reality of cumulative pressures in water quality guidelines and thresholds

32°C

Temperature Increase

Low light
High light
Salinity

28°C

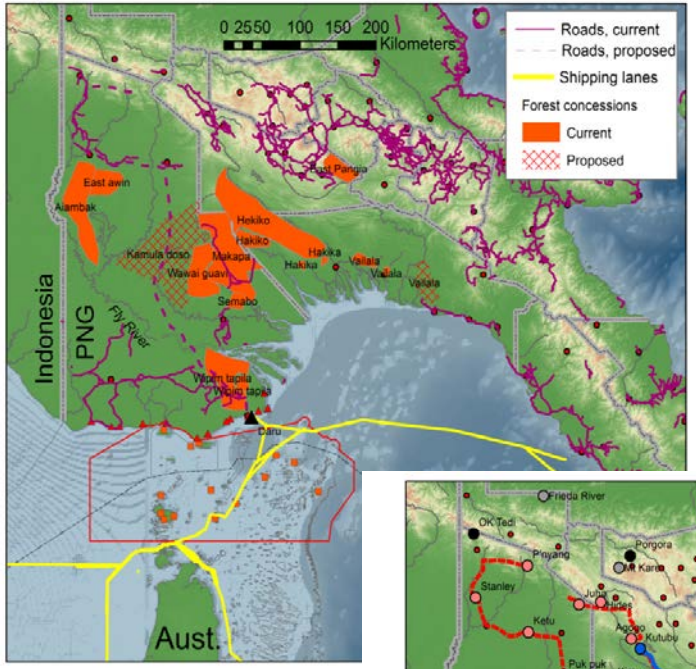
X µg/L

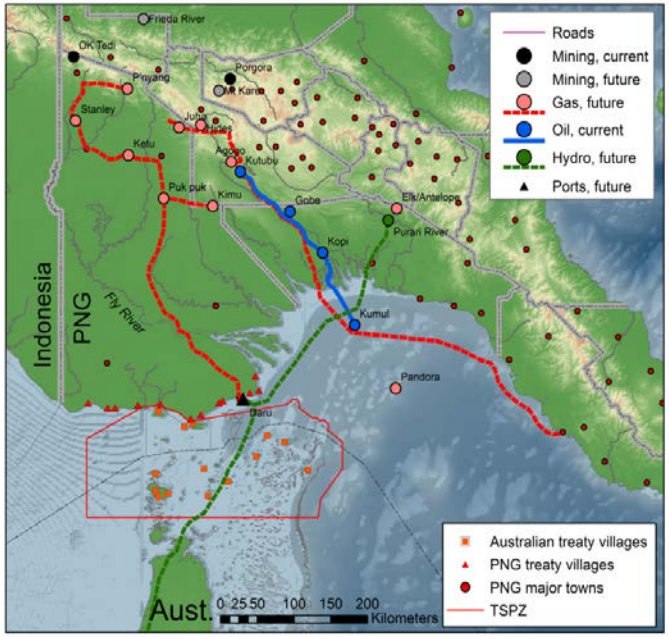
Current 99% species protection guideline (no cumulative pressures)

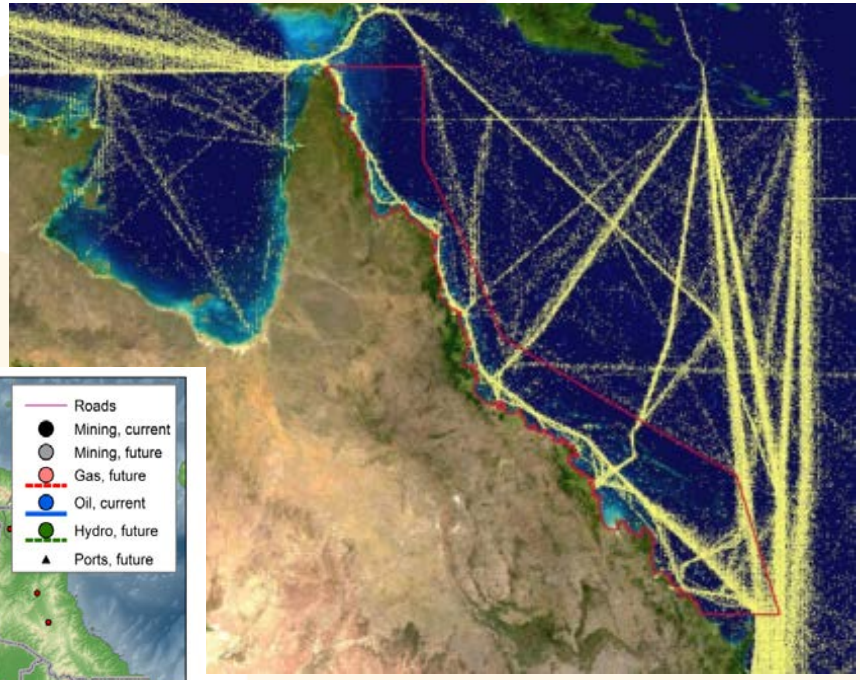
Y µg/L

99% species protection "Climate adjusted threshold) (in a cumulative scenario)

Objective:
Investigate threats to water quality in the Torres Strait







Butler et al, unpublished data.

Water quality threat analysis - local

- Ship groundings, oil spills, toxic cargoes:
  - large ships, increasing numbers
  - Limited exchange in and out of Torres Strait, polluted water would probably remain in TS for long time.
  - Ship grounding and oil spill on island/reef in TS catastrophic for small island communities. Limited response capability.
- Localised issues with management of
  - wastewater (sewage, marine outfalls) and
  - general waste (rubbish).

Water quality threats - regional

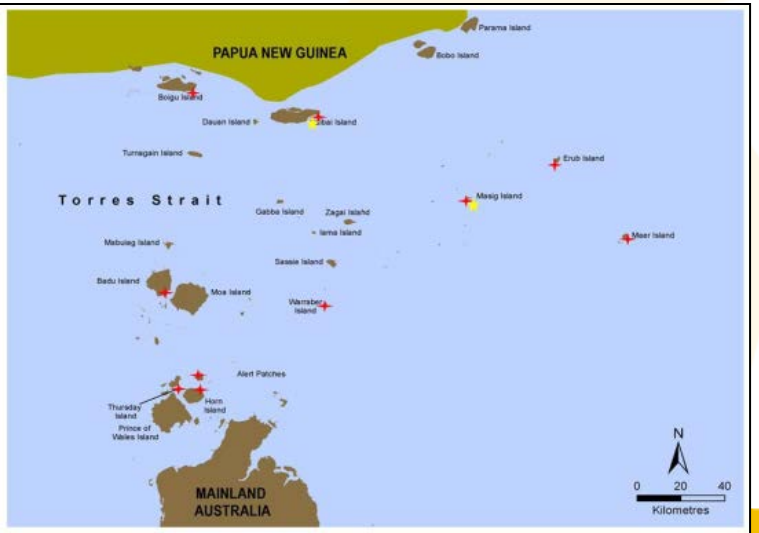
- Marine litter (ghost nets, plastic)
- Influence of large developments in PNG (continued Ok Tedi operation, gas platforms, oil palm expansion and Daru port development), likely to be restricted to the northern islands – Boigu, Saibai, Erub and Ugar.
  - Water from the Fly River predominantly moves to the east into the northern Coral Sea
  - The currents in this western region are generally from east to west

Current Project- heavy metal monitoring *

- Last heavy metal monitoring done 20 years ago.
- Will help understand the risks to Torres Strait sea country from future large scale development in PNG.

Activities:

- Measure how far heavy metals in Fly River are carried into the Torres Strait
- Use passive samplers (DGTs- *Diffusive Gradients in Thin Films)*



*Funded by the Torres Strait Regional Authority

Water quality research in the NERP- what did we achieve

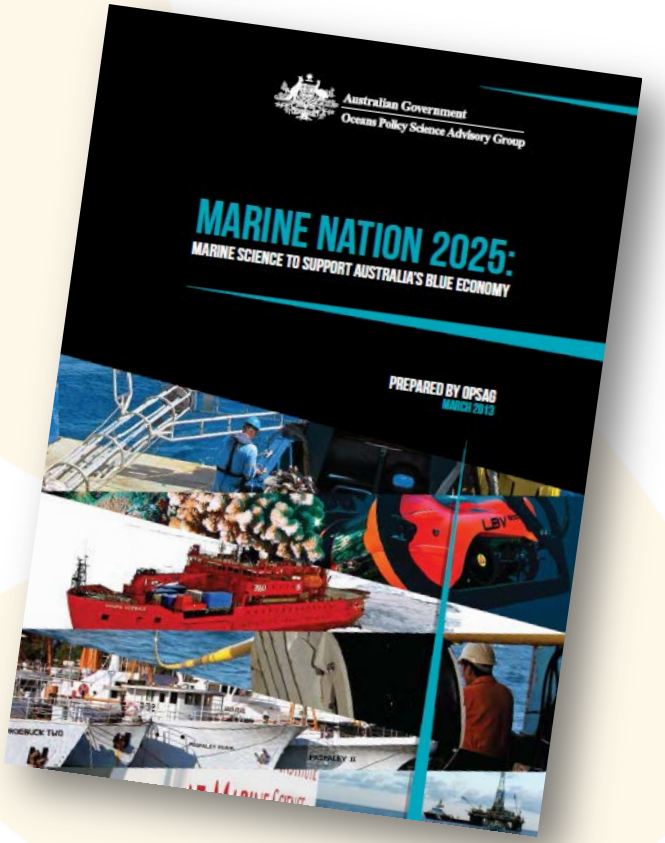
- Better understanding of
  - scale of water quality pressures
  - Interactions between water quality (local) and climate change (global) pressures
- Developed systems and techniques to
  - Quantify and attribute changes in water quality
  - Assess responses of marine organisms to cumulative pressures
  - Conduct ecologically relevant ecotox tests
- Our data and knowledge informed major policy background documents:
  - Reef Plan Scientific Consensus Statement and associated risk assessments
  - Revision of water quality guidelines (ANZECC and GBRMPA)
  - GBRMPA Outlook Report
  - GBR Strategic Assessment

Future direction: Cumulative impacts – from effects to predictions

- Shapes of **response curves**: climate change and local pressure variables on more levels
- Effects of flood plumes, dredging (light/sedimentation): **magnitude** of disturbance vs **variability**
- Verify effects/relationships in the **field**
- **Combine data into predictive ecosystem-scale models**
- Acclimatisation/Adaptation → **Multi–generational** experiments
- **"Climate-adjusted"** thresholds for pollutants/runoff
- **Markers for exposure:** new indicators for monitoring
- **Emerging pollutants**: new herbicides, micro-plastics, coal dust

Marine ‘grand challenges’

1. Sovereignty, security, natural hazards
2. Energy security
3. Food security
4. Biodiversity conservation and ecosystem health
5. Dealing with changing climate
6. Optimal resource allocation
7. Urban coastal environments
8. Infrastructure



OPSAG = National Marine Science Committee

http://www.aims.gov.au/opsag

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THANK YOU

NERP project teams:

Katharina Fabricius, Murray Logan
Sven Uthicke, Catherine Collier, Andrew Negri
Jon Brodie, Jane Waterhouse
+ students & technical staff

Torres Strait Regional Authority
Torres Shire Council
Torres Strait Islands Regional Council
+ many Torres Strait island residents

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