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Vulnerability of seagrass habitats to flood plume impacts: light, nutrients salinity

NERP 5.3

Thresholds and indicators of declining water quality as tools for tropical seagrass monitoring and management

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SEAGRASSES

- Flowering plants that evolved from the land
- 72 species distributed globally
- 15 species in the GBR – a hotspot

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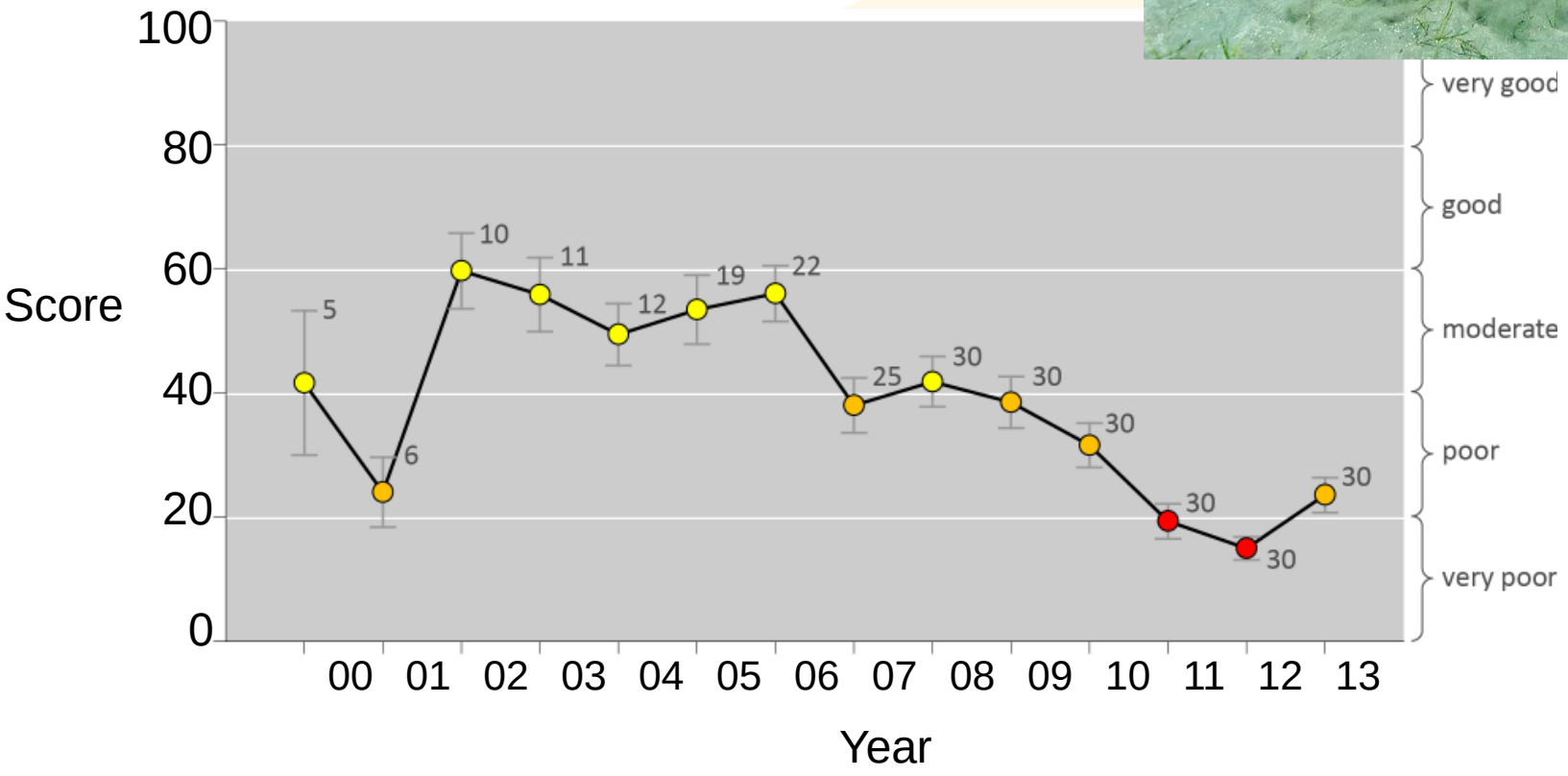
SEAGRASS LOSS IN THE GBR



McKenzie, L., Collier, C.J., and Waycott, M. (In editorial). Reef Rescue Marine Monitoring Program: Inshore seagrass annual report for the sampling period 1st September 2012 - 31st May2013 (Townsville: Great Barrier Reef Marine Park Authority).

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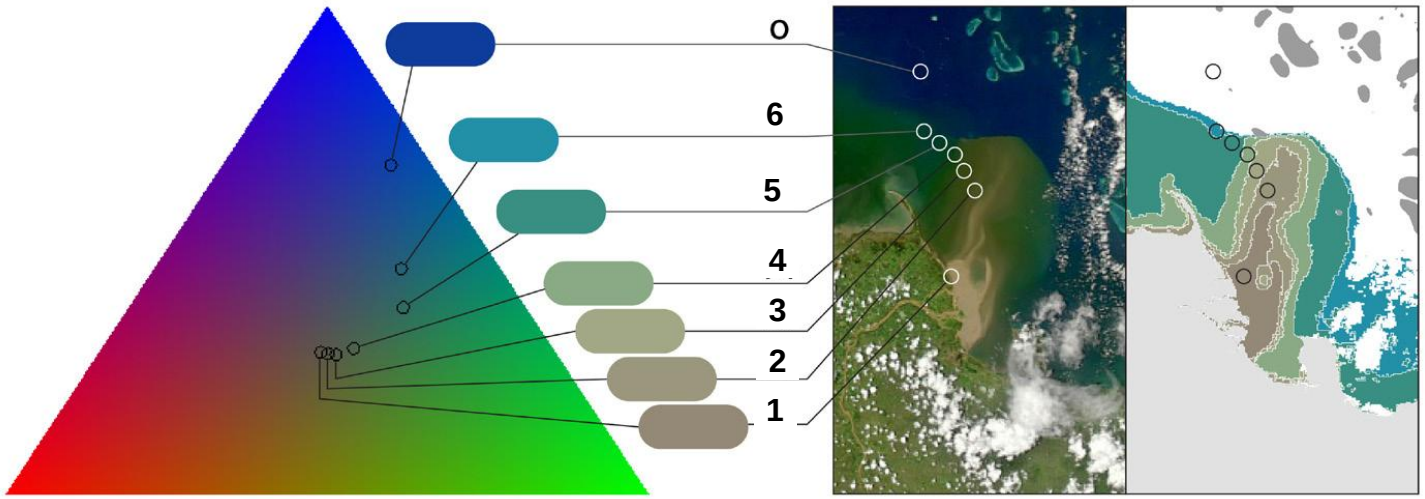
OUTLINE

- Water quality thresholds
  - Wet season water quality (RS)
    - Cleveland Bay case study
    - GBR – wide (MMP sites)
  - Light (in-situ and aquaria)
  - Salinity (aquaria)
- Seagrass indicators

GBR-SCALE: CLASSIFICATION OF WET SEASON WATER

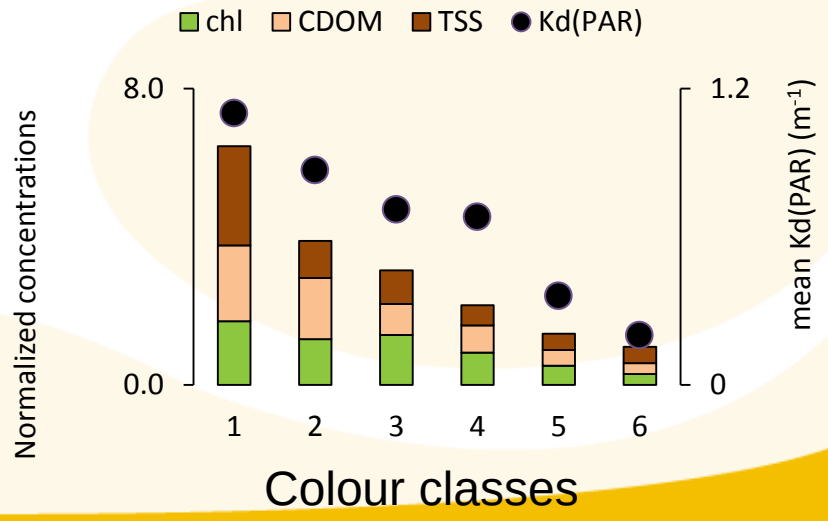
Alvarez-Romero et al., 2012



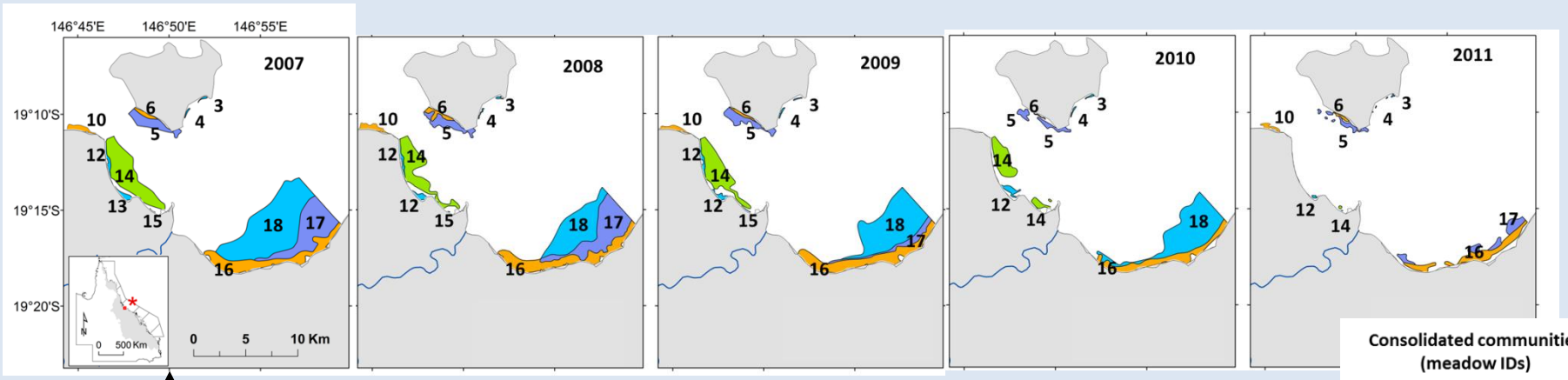
Different optical properties and colors → MODIS true color → 6 Colour Classes

GBR plume waters :

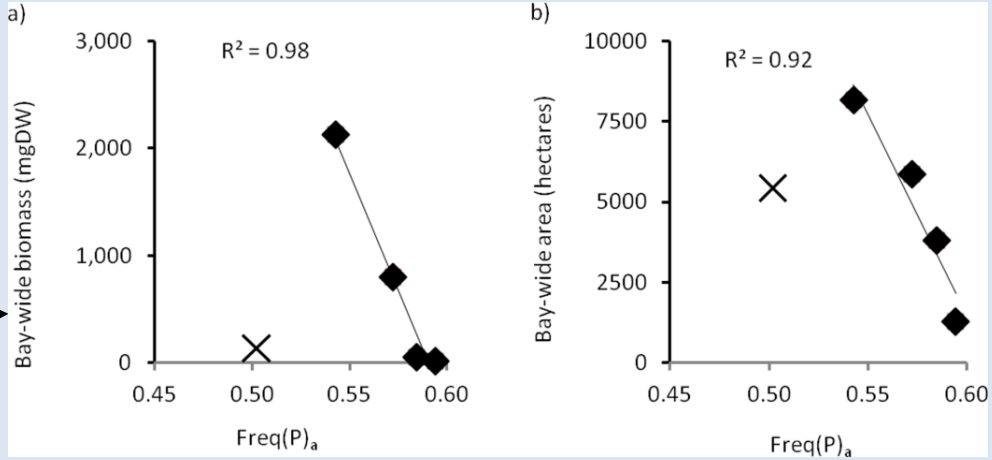
→ Gradients in water quality



CLEVELAND BAY CASE STUDY



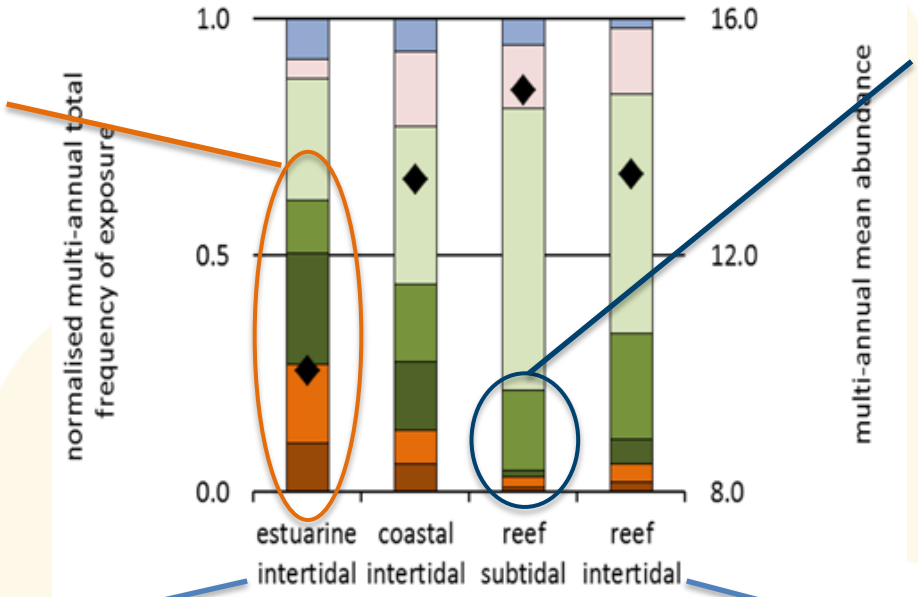
CORRELATION SEAGRASS HEALTH & Fp (turbid waters)



Petus et al., 2014b

Estuarine:

- >50% CC1-4 (turbid)
- Lowest seagrass abundance



Reef subtidal:

- <25% CC1-4
- Highest seagrass abundance

WET SEASON THRESHOLDS

Parameters leading to inter-annual seagrass loss

Habitat	Colour class (CC) 1 – 6	Frequency	TSS (mg L^{-1})	Chl-a* (ug L^{-1})	K_d (m^{-1})
Estuarine intertidal	F (CC 1 – 4)	0.6	> 10	> 1.5	> 0.7
Coastal intertidal	F (CC 2 – 4)	0.3	10 - 20	1.5 - 2.1	0.7 - 0.9
Reef subtidal	F (CC – 4)	0.1	~ 10	~ 1.5	~ 0.7
Reef intertidal	F (CC – 4)	0.2	~ 10	~ 1.5	~ 0.7

Main outcome: RS used to describe ecological condition and derive WQ thresholds for seagrass ecosystems

➔ Next : in-situ and aquarium-derived thresholds

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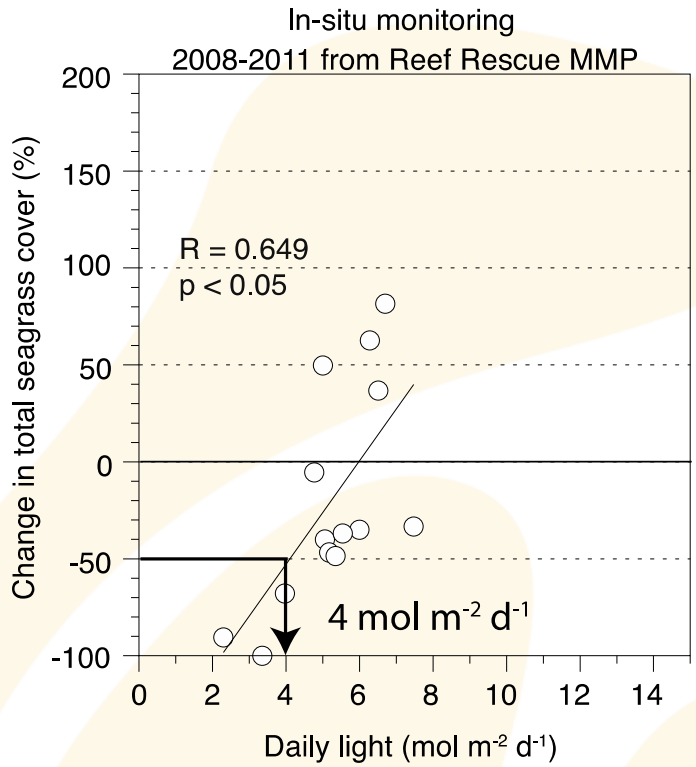
THRESHOLDS: LIGHT



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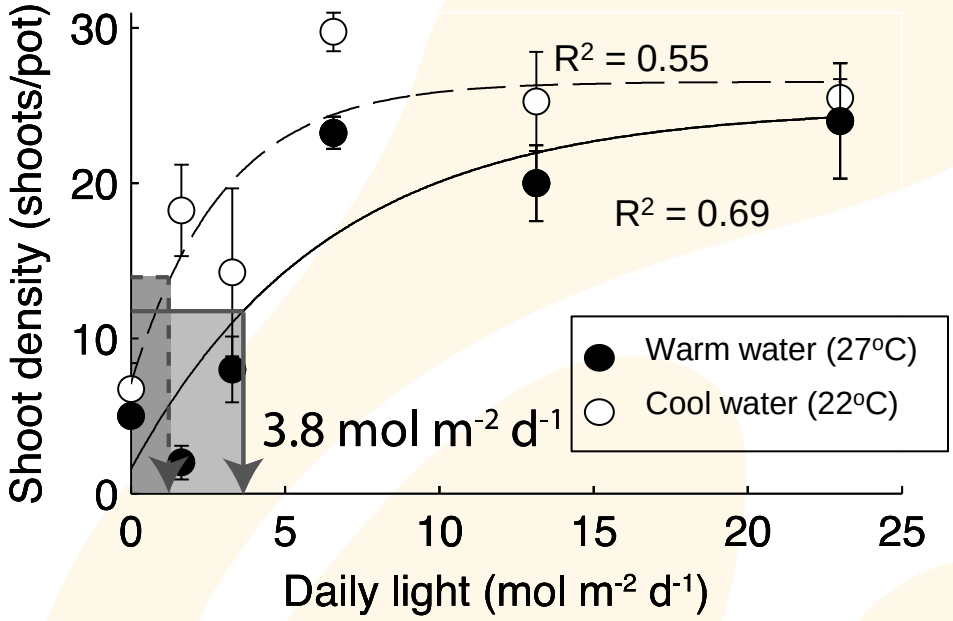
- Affected by species, time, water temperature
- 50% loss at 4mol m^{-2} d^{-1} for 3mo, Halodule
- Also affected by other conditions?

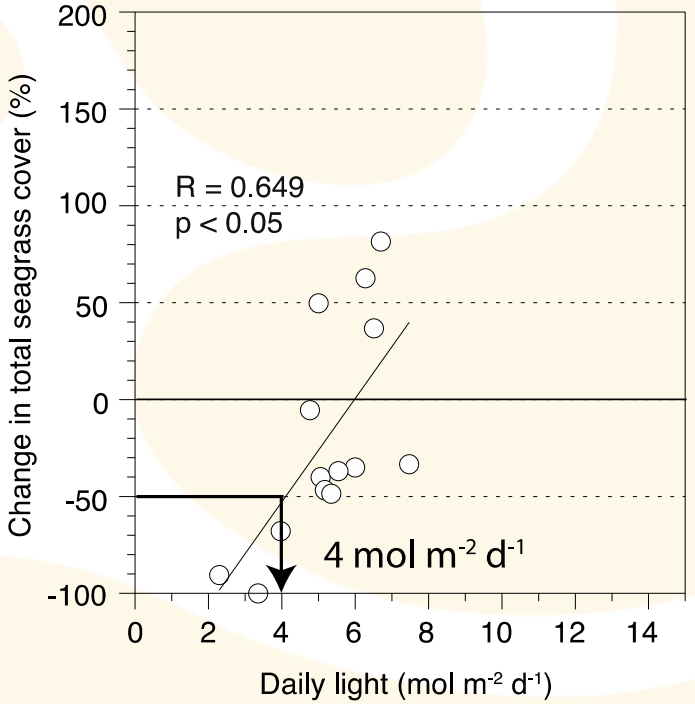
➔ Can be adapted for compliance e.g. dredging

THRESHOLDS: LIGHT EXPERIMENTS

Halodule, 3 months
Aquaria



Halodule-dominate meadows, 3 months
In-situ



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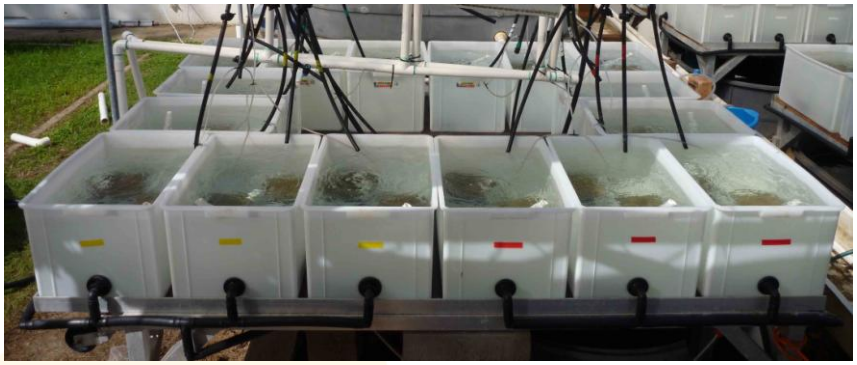
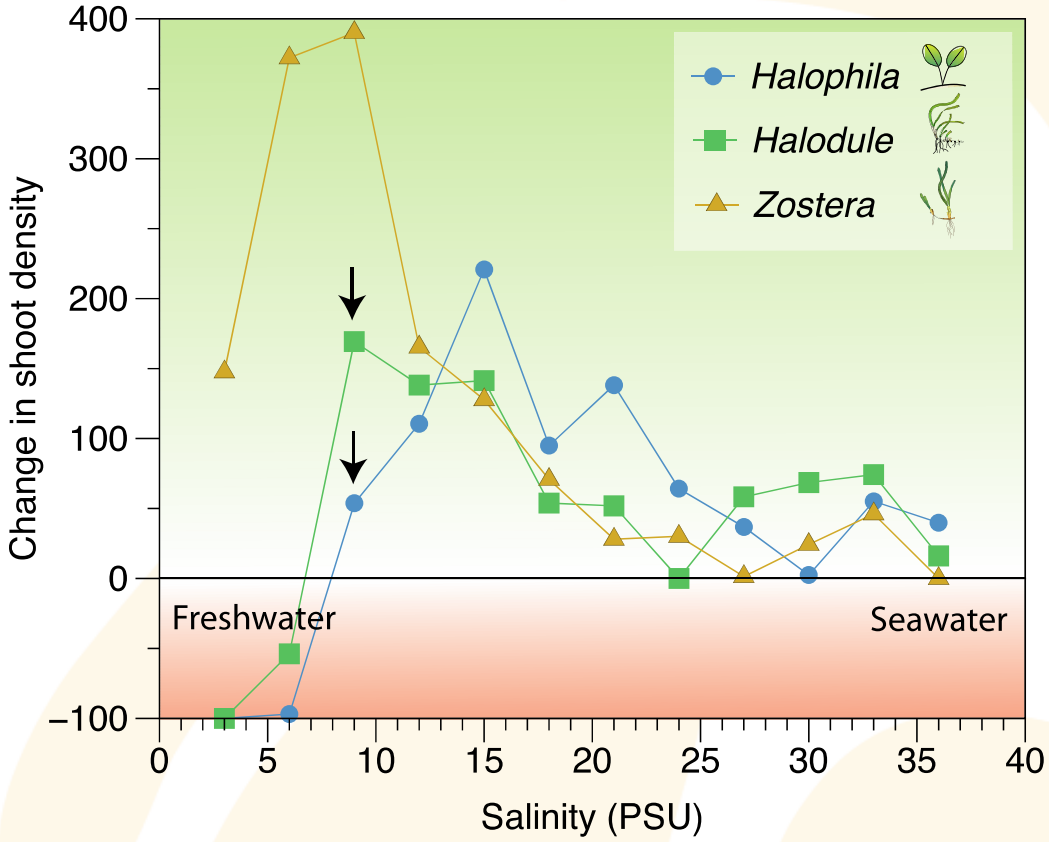


THRESHOLDS: LOW SALINITY



- Tolerant of low salinity
- Mortality at <9PSU
- Mild stress at moderate salinity
- Not a research/management priority

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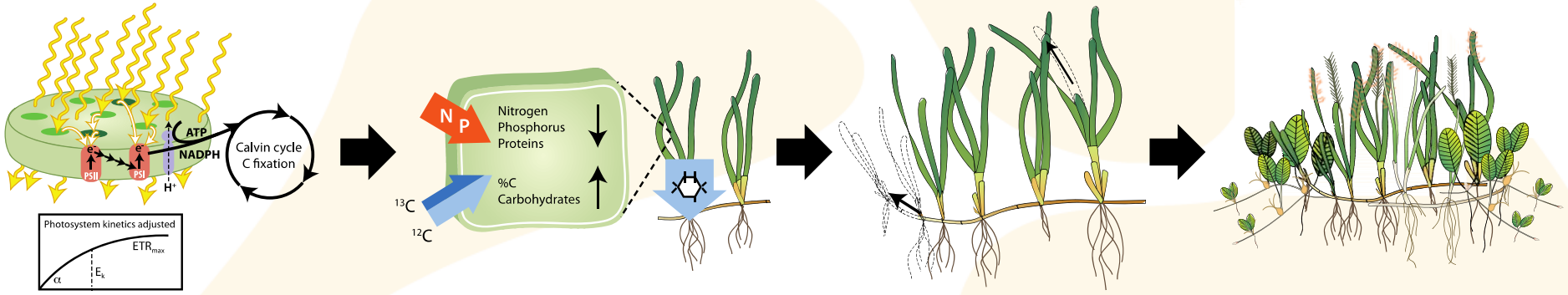
INDICATORS

Time-scales of response

Seconds | days-weeks | weeks-months



Photosynthesis
Photosystem efficiency

Physiology
Nutrient content (N,C, $\delta^{13}C$)
Energy reserves

Plant-scale
Growth
Morphology
Sexual reproduction

Meadow-scale
Abundance
Species composition

Indicators tested

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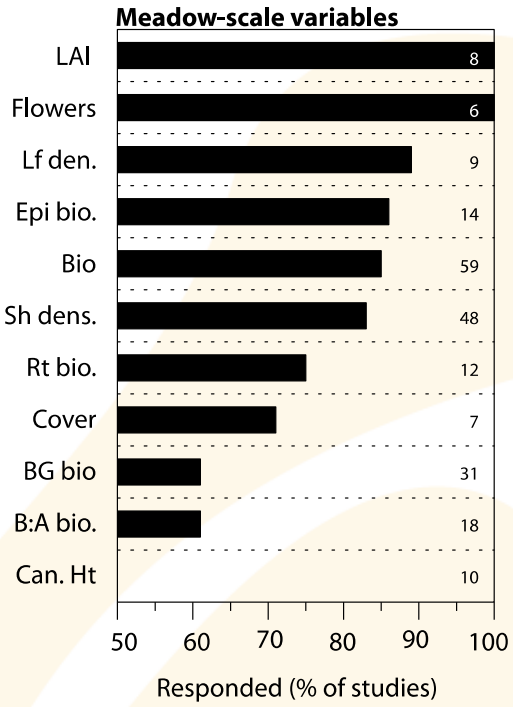
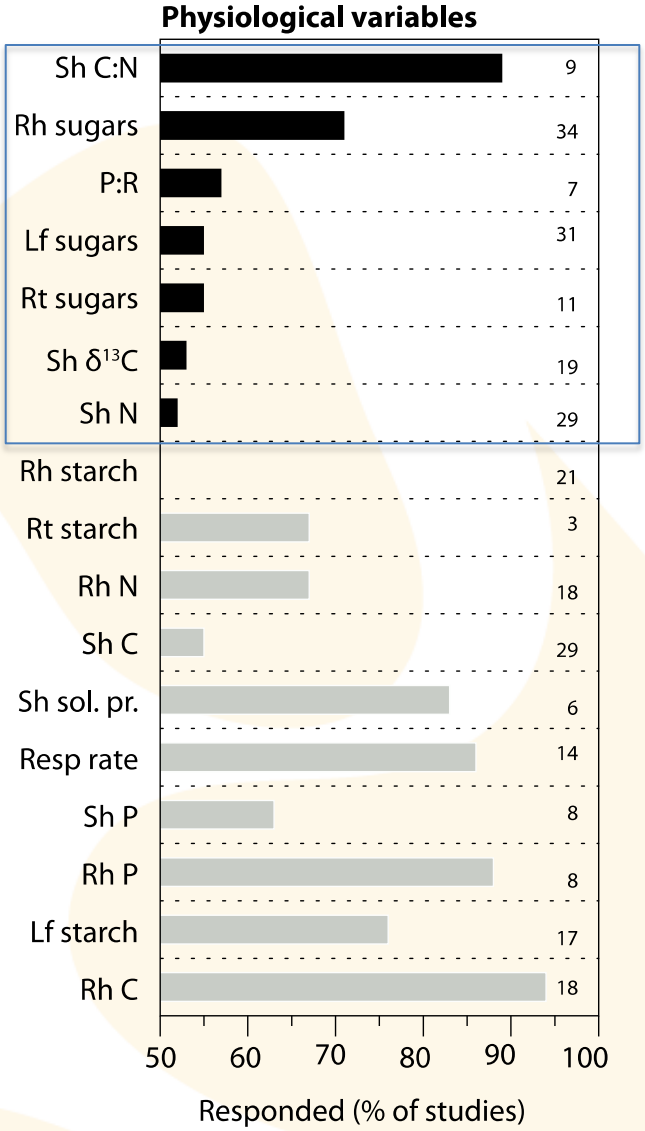
REVIEW OF INDICATORS





McMahon, K.M., Collier, C.J., Lavery, P.S., (2013). Identifying robust bioindicators of light stress in seagrasses: A review. *Ecological Indicators* **30**, 7-15.

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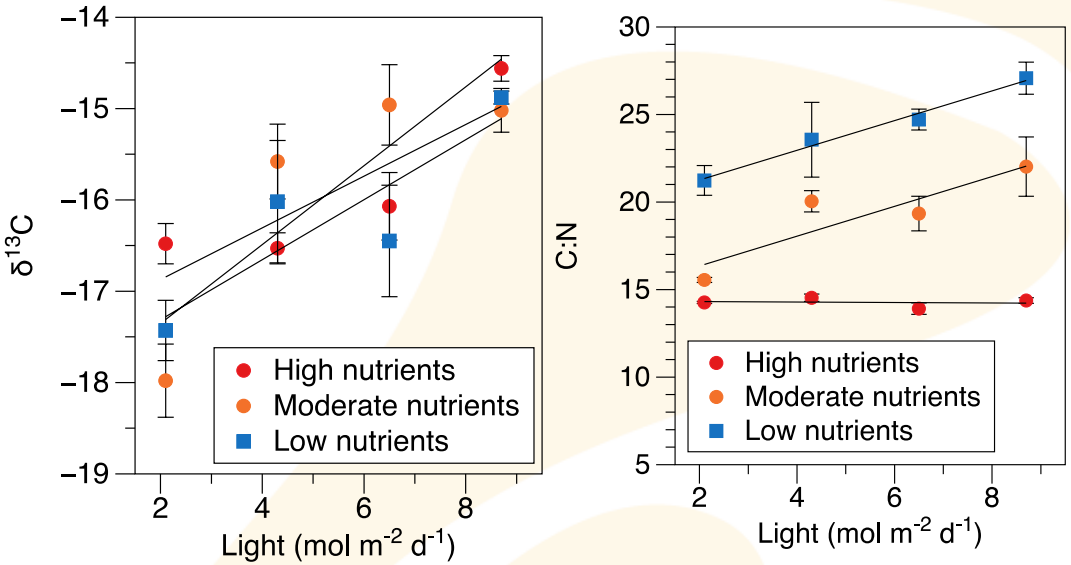
INDICATORS TESTED



- Tissue nutrients (C/N) increased with light
- But not at high nutrient levels
- $\delta^{13}C$, increase with light at all nutrients

➔ Combinations of indicators will provide more solid evidence of water quality

Nutrient levels
Low: <1umol DIN
Moderate: 4umolDIN
High: 40umol DIN

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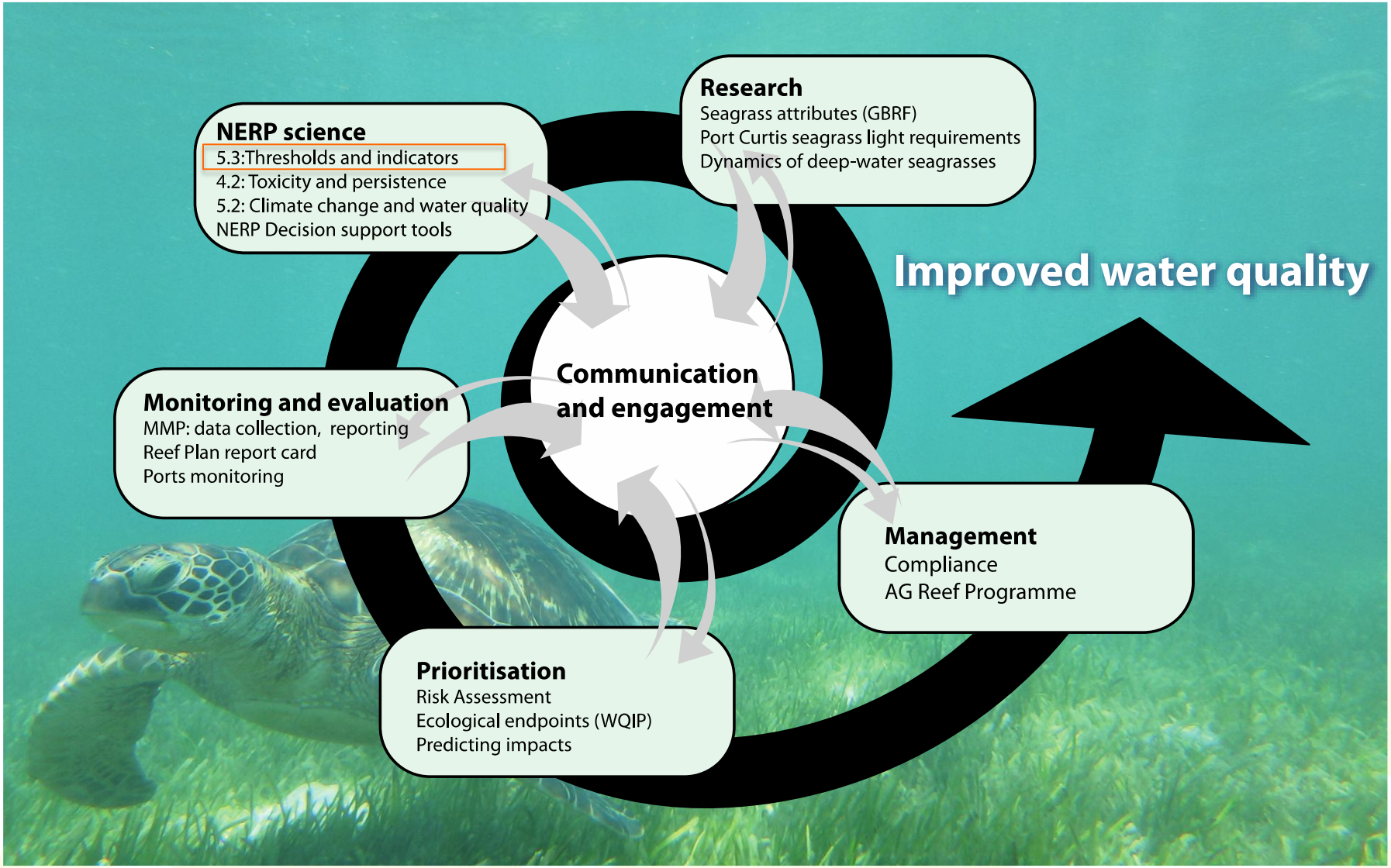
PATHWAY TO ADOPTION

- Improved integration and reporting for MMP (seagrass and wet season water quality) being implemented next year.
- Thresholds identified (species, temperature, time dependent large-scale, site-scale, aquarium scale) - working towards water guidelines e.g. compliance.
- Tested and validated MMP indicators

- Peer reviewed papers: 5 published and 3 currently in prep

THE BIGGER PICTURE



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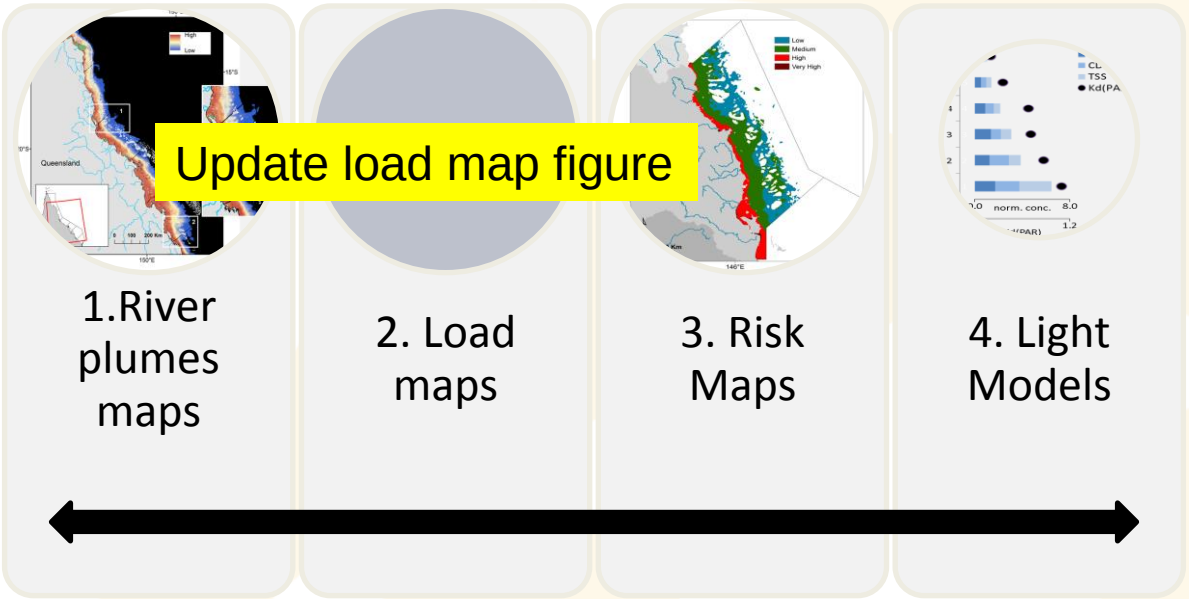
SUSCEPTIBILITY OF SEAGRASSES TO RIVER PLUMES

Water quality
GBR scale

Ecological responses
GBR-scale



Devlin et al., 2012
Devlin et al 2013
Alvarez Romero et al 2012

RRMMP
Ports monitoring