Kimberley Marine Research Program

WAMSI Project 2.2.4

Benthic primary productivity: production and herbivory of seagrasses, macroalgae and microalgae

The Kimberley is vast and hosts a wide variety of different habitats and species. It is also remote, and so there has been relatively little research into how its ecosystems function. Our researchers have been investigating the productivity of seagrasses and other marine plants in the Kimberley, and how important this is for the animals of the region.

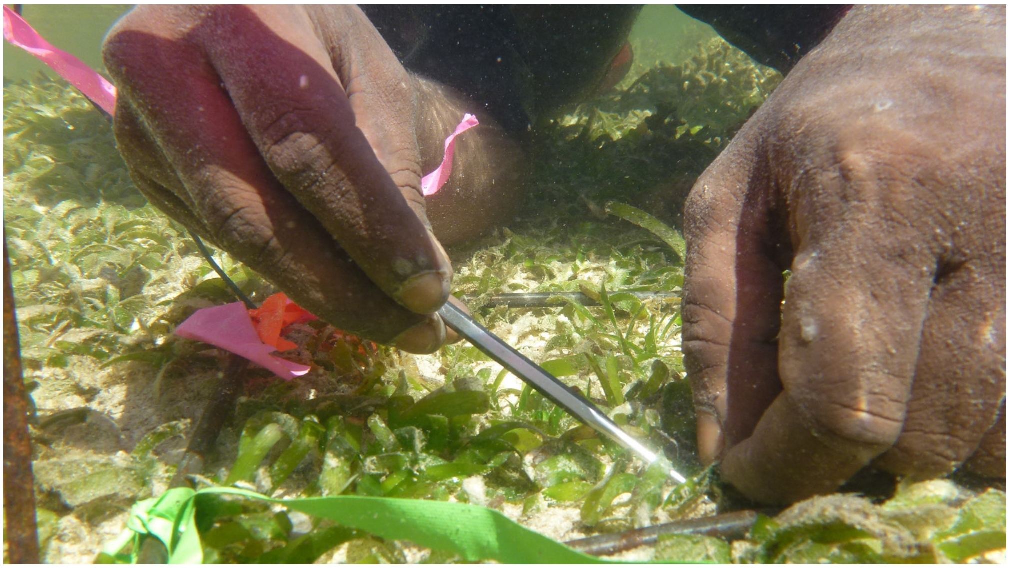
Background

Almost everywhere on Earth, life relies on the sun. Plants capture energy from the sun and use it to grow through a process called photosynthesis. The plants themselves are food for animals, and so form the base of food webs. However, the types of plants and the rates at which they grow are not the same everywhere, and differences from place to place can have a profound influence on food webs.

The Research

A team, comprising of scientists from The University of Western Australia, CSIRO, and Edith Cowan University, in collaboration with the Bardi Jawi Rangers, have been studying how the abundance and growth of marine plants (including large plants like seagrasses and seaweed but also small microscopic algae) change between seasons and from place to place.

The team conducted five expeditions to the Bardi Jawi Indigenous Protected Area (IPA), and collected data on plant biomass and growth, rates of consumption by herbivores, measurements of chemical composition, abundance of microscopic algae and bacteria, nutrients in water and sediment, light at the seafloor, and more.



Seagrass collection in Bardi Jawi Indigenous Protected Area

Outcomes

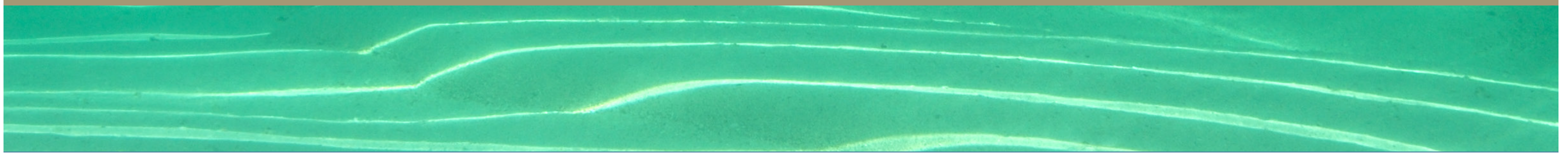
The main plants found in the lagoon habitats by the team were the seagrasses *Thalassia* (also called turtlegrass) and *Enhalus*, and the large brown algae *Sargassum*.

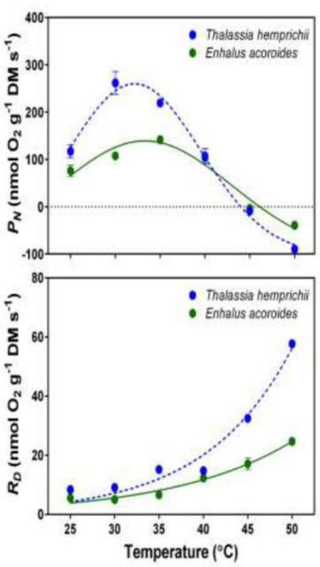
All of these plants have high growth rates throughout the year, sometimes exceeding a centimetre a day.

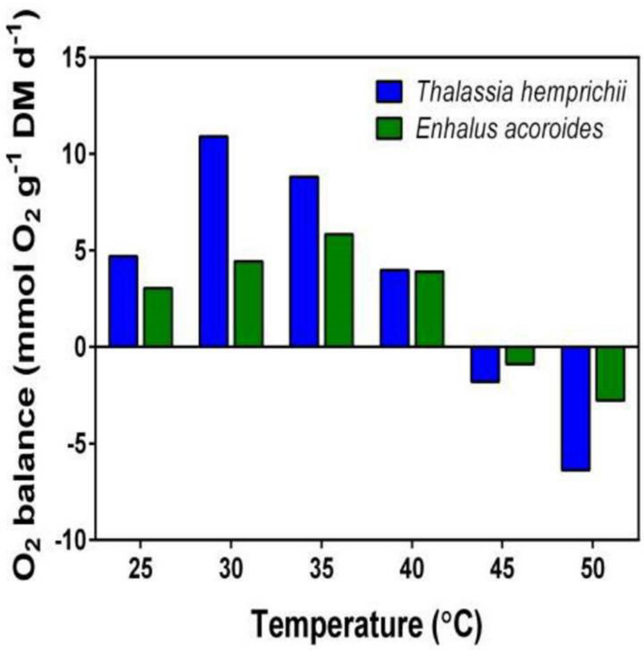
Microscopic algae were very abundant in some places, but not everywhere, and bacteria were particularly abundant in the sediment under mangroves and seagrasses.

The team discovered that herbivores were abundant and ate a lot of the seagrass.

One of the main herbivores was the rabbitfish (*Siganus lineatus*) which is also a highly sought after food source for the Bardi Jawi people. Green turtles were also abundant, moving at high tide onto the seagrass beds.







Net underwater photosynthesis (PN), dark respiration (RD; c, d) and estimated diel leaf level O2 balance temperature of two tropical seagrass species, Thalassia hemprichii and Enhalus acoroides. Rates are expressed per unit mass. Values are means SE (n = 4–5)

During daytime low tides these seagrasses experience extremely high oxygen concentrations, light levels and water temperatures (32-38oC).

During night-time low tides seagrasses and associated animals respire reducing oxygen levels such that hypoxic conditions occur within the plants for extended periods (> 8 hours), affecting their capacity to undergo cellular repair.

Even under these extreme conditions, seagrasses in the Kimberley maintain high productivity, which in turn supports a diverse animal community.

The importance of seagrasses to large vertebrate herbivore consumers can be easily monitored and used to assess both seagrass health and the health of the grazers.

The research team found that grazing patterns by a range of large vertebrate herbivores, like fish and turtles, was very

Collaborations with the Bardi Jawi Rangers, who are custodians of the Indigenous Protected Area, added enormous value to the research. The exchange of knowledge with the rangers during the project recognised the importance of seagrass to rabbitfish.

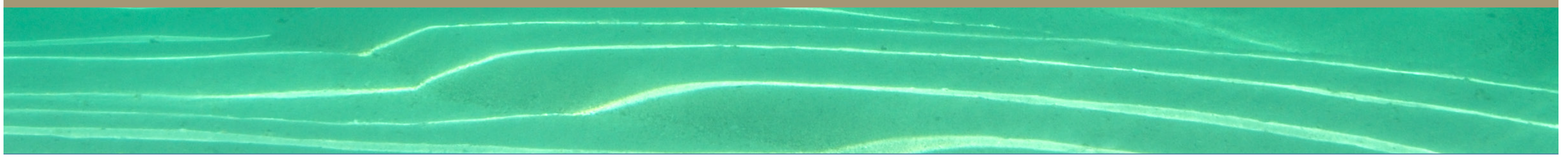
Key Findings

The tropical seagrasses *Thalassia* and *Enhalus* are the dominant species of seagrasses in the intertidal lagoons of the western Kimberley.

The research team estimated *Thalassia* leaves grow a whopping 0.5 - 1.0 cm each day, while *Enhalus l*eaves grow 0.5 - 1.5 cm per day.

These very rapid growth rates took the research team by surprise, given the extremes in temperature and oxygen conditions that these plants experience.

A Bardi Jawi ranger and a UWA researcher collect seagrass



variable, and at some places and times herbivores consume all new growth. One experiment found that 27% of the biomass of *Thalassia* was consumed in a single day.

Microalgae in soft sediment environments was another focus of the research.

Microalgae in intertidal ecosystems in the study area are productive and important in nutrient cycling, especially around mangroves.

Monitoring seagrass growth enables us to keep an eye on their resilience to disturbance, and community outreach programs such as Seagrass-Watch can play a key role to help drive the management of these meadows.

The partnerships that were established between scientists and the Bardi Jawi Rangers are a key success of this project and demonstrate how combining science and traditional knowledge can help to develop a deeper understanding of how these complex habitats function.

Given these seagrasses are already living on the edge, the question remains, how will such an important habitat adapt to climate change?

Future work

- Development of robust methods for monitoring marine plants that can be applied in the Kimberley, especially by Indigenous rangers.
- Greater understanding of recruitment and seed ecology of seagrasses to recognise pressures and future trajectories of Kimberley seagrasses.
- Develop a combination of distribution modelling and surveys to verify predictions of models to help prioritise where surveys and monitoring should occur. This should be augmented in selected places by the sorts of seasonal studies that we have been able to do, because the patterns are probably different for other species.

Type of data collected and how will the information be stored.

Data has been collected on seagrass and macroalgae abundance and growth rate as well as consumption, measurements of stable isotopes – mapping trophic levels as a basis for herbivory, abundance of microscopic algae and bacteria, nutrients in water and sediment, light and satelite tagging of foraging sea turtles.

1. *Seagrass production, biomass and phenology* (Productivity - growth [mm per day, dry weight], biomass [grams per square metre], shoot growth and flower densities)

2. *Macroalgae production and biomass* (growth [mm per day, dry weight in grams])

3. *Benthic microalgae* (chlorophyll a, pigments [BMA community composition], particulate organic carbon and nitrogen [POC/PON], sediment moisture content, sediment pore water nutrients, and sediment particle size. Water column chlorophyll a, pigments, POC/PON, total suspended material (TSM), nutrients, and salinity), Benthic Microalgal production

4. *Microbial cycling* (bacterial carbon production [BCP] and utilisation, concentrations of dissolved organic carbon [DOC] and total dissolved nitrogen [TDN], Microvial community structure using Automated Ribosomal Intergenic Spacer Analysis [ARISA], Ammonia oxidation (nitrification) rate, chlorophyll-a, photopigments, sediment biogeochemistry and physical parameters [C and N isotopic composition; sediment grain size; water content; porewater nutrients], bacterial abundance and DOC pool characterisation using SUVA (specific UV absorbance) and FI (Fluorescence index)

6. *Environmental variables* (Conductivity, Temperature, Depth [CTD] and (Photosynthetically Active Radiation [PAR])

All data will be made publically available via the CSIRO and Pawsey data portals.

Project Team

Gary Kendrick[1], Mat Vanderklift[2], Doug Bearham[2], James McLaughlin[2], Christin Säwström[3], Bonnie Laverock[1,2], lucie Chovrelat[2], Andrea Zavala-Perez[1], Lisa de Wever[2]

[1]School of Plant Biology and Oceans Institute, The University of Western Australia, Crawley, 6009, WA, Australia

[2]CSIRO Wealth from Oceans Flagship, Floreat, WA, Australia

[3]Edith Cowan University, Centre for Marine Ecosystems Research, Joondalup, WA, Australia

Contact

Project Leader: Professor Gary Kendrick

The University of Western Australia

Phone: +61 8 6488 3998

Email: gary.kendrick@uwa.edu.au

Kimberley Marine Research Program

WAMSI Project 2.2.4 Seagrass

western australian
marine science institution

The $30 million Kimberley Marine Research Program is funded through major investment supported by $12 million from the Western Australian government's Kimberley Science and Conservation Strategy co-invested by the WAMSI partners and supported by the Traditional Owners of the Kimberley.