Flood plumes: what makes seagrass meadows vulnerable?

By Suzi Moore, CANEGROWERS Communication Manager

Seagrass meadows form a buffer between catchments and the reef, trapping sediments and absorbing nutrients. But these seagrass meadows have been in decline in the Great Barrier Reef over the past few years, and researchers from the National Environmental Research Program (NERP) are looking into what effect flood plumes – resulting from the extraordinary rain events we have seen in far north Queensland in recent years – are having on water quality on our reef.

Seagrass meadows have an important ecological role in the Great Barrier Reef (GBR). Many estuarine, coastal and reef animals, including species of fisheries importance, use seagrass meadows as habitat. Dugongs and turtles feed directly on seagrasses and changes to seagrass health have direct consequences for these fauna.

A project led by Dr Catherine Collier of James Cook University (JCU) is setting out to determine the actual impact of runoff from catchments feeding onto the reef.

There has been much speculation that water quality has deteriorated due to above average runoff from modified catchments, but Collier and her team have been working on a project to establish if water quality is impacting the seagrasses and what impacts seagrasses can withstand.

Most of these sites have either high turbidity (reducing light) and/or extra nutrients (destabilizing the natural balance for these marine plants). Flooding and cyclones have caused further declines in an already fragile system, particularly through flood plume effects. There was severe loss of seasgrass under the path of Cyclone Yasi.

Collier's project investigates the impacts of exposure of seagrass meadows to light, nutrients and salinity for the purpose of predicting thresholds to be used in future risk assessments.

Basic premise confirmed

After many years of careful data collection and logging, the research has identified that the impact of flood plumes on seagrass is strongly linked to the type of plume waters and duration of exposure.

Now the project needs to establish the extent to which seagrass meadows are impacted by extreme events and changes in water quality in the GBR. That's where fellow researcher Michelle Devlin comes in.

Using a novel approach to model exposure of seagrass to flood plumes, satellite images have helped researchers establish that seagrass meadows with the highest exposure to flood plumes have reached lowest abundance in recent years.

It's what's in it that counts

Water quality is complex and there are a number of ways in which it can impact upon seagrass health. Collier and her team are systematically testing these possibilities.

Colliers team has found that seagrasses have broad salinity tolerance, with seagrass death only occurring at salinities <9ppt after 10 weeks exposure. These results indicate that low salinity was probably not the cause of recent seagrass loss.

However, when analysing the in-situ monitoring data, there was a strong correlation between low light (turbid water) and seagrass loss, so the team are now focussing on testing the impacts of low light conditions and elevated nutrients on seagrass to simulate flood plumes.

Analysis of correlation between low light and seagrass loss is still in progress but initial indicators are showing that seagrasses exhibit early-warning signs of water stress.

How the science works

The team has been mapping surface plume exposure and the introduction of water types. This will then be matched against seagrass ecological data and water quality risk maps.

Above: Seagrass meadows on the Great Barrier Reef form a buffer between catchments and the reef, trapping sediments and absorbing nutrients. *Photographs supplied by JCU*

About 2,000 remote sensing images have been extracted for the last decade, particularly focussing on images in the wet season – between December and May – when cyclones and floods are most prevalent.

The extent of the plumes are identified through quasi true colour analysis. The team then uses drills down into the ▶

data, seeking to map water types with selected characteristics.

These water types are analysed through time to allow the team to hindcast the number of days/flood periods in which a seagrass saw elevated concentrations of nutrients, total suspended solids, and light reduction.

Using these methods, the researchers can now estimate the number of seagrass meadows in areas of high surface exposure to flood plume waters carrying high concentrations of pollutants (DIN, total suspended solids and PS-II herbicides).

This exposure mapping has allowed the number of seagrass meadows which are located in the high to moderate exposure areas to be identified for the Great Barrier Reef.

High exposure was identified in areas where plume waters occurred at least two to five times per year from land use activities specific to a pollutant. Moderate exposure was identified in areas where plume waters occurred at least once or twice per year. Proximity and direction of the seagrass meadow to the riverine influence are the main influences on the area of exposure. Recent high flow periods have also influenced the areas of exposure and the number of seagrass meadows within these areas.

The researchers will now focus on the seagrass meadows within high exposure areas and relate measurable declines in seagrass habitat quality against seagrass meadows in no or low exposure areas.

Ongoing

While it has been established that low light is an important environmental driver within shallow subtidal seagrass meadows, there are complex interactive factors and some of these are being experimentally tested. For example, how do elevated nutrients affect seagrasses ability to cope with low light levels during flood events.

Interlinked

There are several projects run under NERP, and the researchers share data collected across projects, saving money and time.

Above: The aquaria system used to experimentally test water quality impacts on seagrasses.
Right: Michelle Devlin conducting water quality testing. *Photographs supplied by JCU*

Collier and her team interlink with projects on herbicide effects on seagrasses (Negri et al) and climate effects (Uthicke et al).

Collier has also been engaged in a review of global seagrass indicators to highlight consistent indicators of light reduction and guide indicator selection for upcoming experimental work on light/nutrient interactions.

Outcomes from this project feed directly into the Reef Rescue Marine Monitoring Program, assisting with the interpretation of monitoring data in the development of indicators. ■

Dr Catherine Collier

Postdoctoral Fellow, Seagrass Ecophysiologist

James Cook University (JCU)

Dr. Collier has a background in ecophysiology and marine conservation with work on morphology, physiology, growth and meadow characteristics of seagrasses, and their vulnerability to climate change. Between 2007 and 2010 she was a postdoctoral fellow in the Marine and Tropical Sciences Research Facility, supported by the Commonwealth Environmental Research Program (CERF).

Dr Michelle Devlin

Water Quality Scientist

Michelle has been undertaking research in the areas of tropical and temperate marine ecosystems for the past 14 years. She specialises in the environmental monitoring of water quality and eutrophication and the provision of regulatory advice on eutrophication. Michelle has been the project manager for a number of national and international research programs relating to the fate and consequences of human activity and pollutants on freshwater, coastal and offshore marine waters, establishing links between the freshwater zone and marine systems, and coastal zone management.