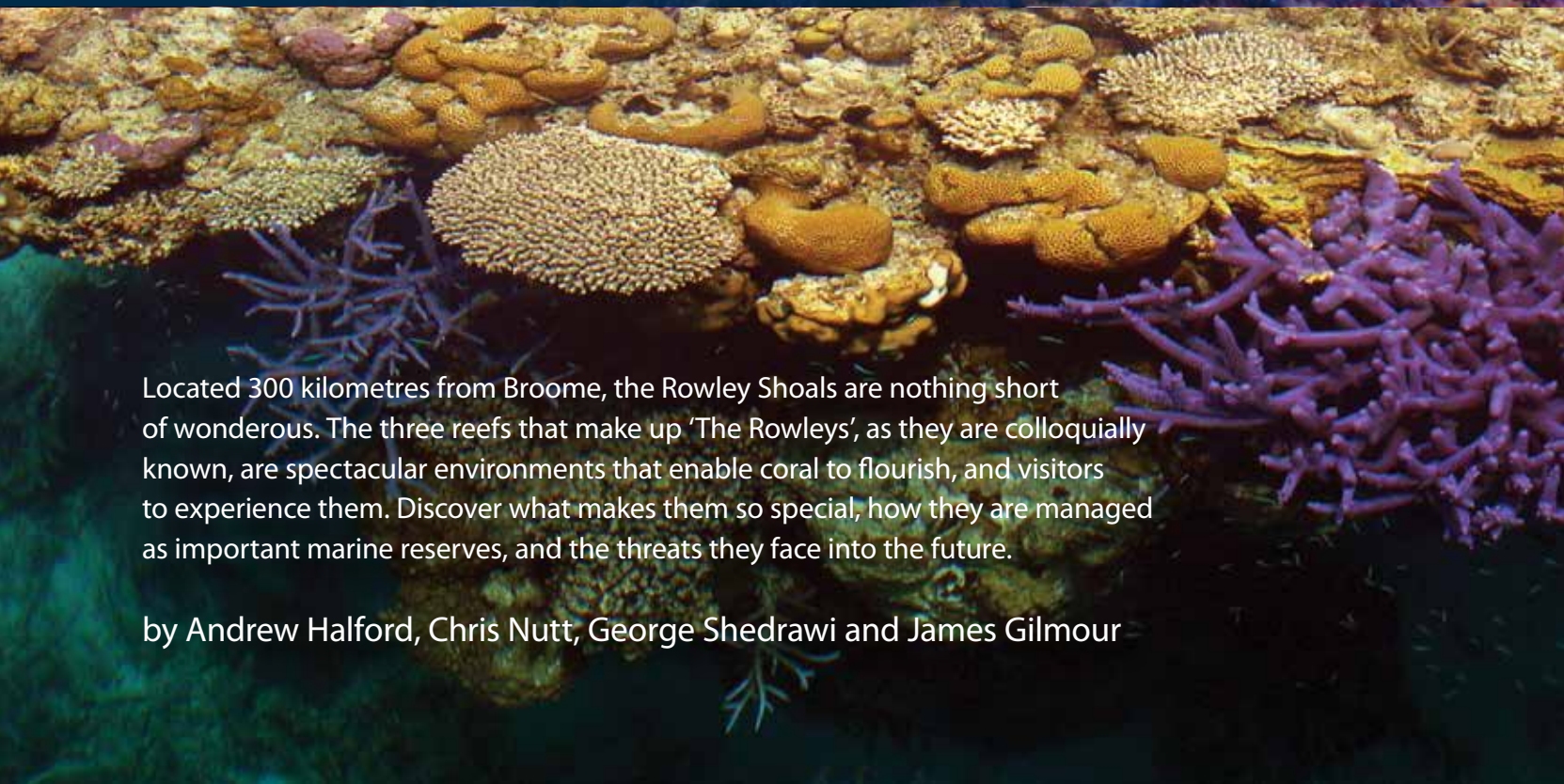
JEWEL IN THE CROWN

THE MAGNIFICENT ROWLEY SHOALS



Located 300 kilometres from Broome, the Rowley Shoals are nothing short of wonderous. The three reefs that make up 'The Rowleys', as they are colloquially known, are spectacular environments that enable coral to flourish, and visitors to experience them. Discover what makes them so special, how they are managed as important marine reserves, and the threats they face into the future.

by Andrew Halford, Chris Nutt, George Shedrawi and James Gilmour

If Western Australia's crown is the incredible range of coral reef communities that inhabit the coastal waters of sub-tropical and tropical WA then one of the crown jewels is the Rowley Shoals. The 'Rowleys' as they are known, consist of three individual reefs – Mermaid, Clerke and Imperieuse – sitting 30 to 40 kilometres apart and located some 300 kilometres due west of Broome. Their relatively small size (about 17 kilometres long by seven kilometres wide) and remoteness belies their significance as spectacular examples of oceanic coral reefs that have evolved into highly diverse ecosystems, all while being surrounded by nutrient-poor waters. Moreover, their significance has actually increased with time.

IDYLLIC CONTEXT

While the Rowley Shoals were officially named in 1818 by Captain Phillip Parker King, the earliest visitors to these shoals were Indonesian fishermen who still visit the more northerly reefs of Scott, Seringapatam and Ashmore hunting for beche-de-mere, trochus and fish in their elegant sailing prahus. The Rowleys' popularity as a tourist destination began to gain traction in the mid-1970s and has increased as people have become aware of the world-class snorkelling, diving and fishing experiences available.

Mermaid is the most northerly reef in the chain with Clerke and then Imperieuse lying in a direct line to the south-west. All three reefs have inner lagoons protected by reef on all sides save for small channels on their north-east flanks that enable boats to enter. The lagoons get progressively shallower from Mermaid to Imperieuse, limiting the size of vessels that can enter each reef respectively. While the tide rises and falls up to 4.5 metres twice a day the tidal range in the lagoons is much lower as water becomes trapped at low tide, only able to escape through the narrow channels. This entrapment of water limits the flushing of these lagoons and provides an incredibly sheltered environment which enables corals to flourish in their most fragile and beautiful forms.

These lagoonal 'ponds' are a favourite for visiting snorkelers and divers who can soak in the warmer water while looking at an underwater tapestry of coral bommies surrounded by sand and algae-covered rubble, and a bewildering assortment of fishes and invertebrates – the number and size of giant clams, sea cucumbers and trochus shell distinguish the Rowleys from the other oceanic reefs to the north, and around the world, where these valuable stocks have been depleted. The uniqueness of these lagoons is further typified by the presence of juveniles of the iconic bumphead parrotfish and the Maori wrasse, which have been hunted to virtual extinction in many other locations around the world. Protected lagoonal environments such as that found at the Rowleys are key habitats for these species to grow to adulthood before they venture out into the wider reef environment.
A keystone predator, the passionfruit trout (*Plectropomus areolatus*) is also a common inhabitant of the lagoons but relatively rare on the outside reef edges. This species preys especially on the clouds of damselfishes that live in and around the thickets of branching staghorn corals. It is also a voracious assailant of lures, providing hours of fun for visiting fishermen who catch and release this species according to management regulations designed to ensure its longer-term survival in this extremely isolated location.

Opposite page
Top Abundant life found on the 'bommies' on the reefs.
Below The spectacular Rowley Shoals are an excellent example of a healthy reef environment.

Left Aerial view of the Rowley Shoals.
Photos – Nick Thake/Australian Institute of Marine Science

THE BIG BLUE

Outside the lagoons is where the environment becomes really fascinating. These reefs rise quickly from water greater than 300 metres deep with vertical walls which appear to drop away into the abyss. Open ocean, vertical walls and a 4.5-metre tidal range generates strong currents, which are 'oceanographic catnip' for stimulating food chains. Corals and other filter feeding organisms such as gorgonian fans expand their appendages into the currents looking to snare whatever morsels of organic matter that might be floating by.

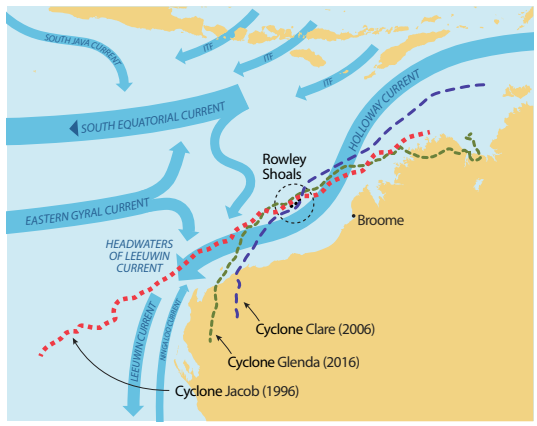
Clouds of fish hover in the water column above the corals, feeding on tiny planktonic animals that are also drifting past in the currents. The presence of all these fish actively darting this way and that as they catch their dinner transmits an unmistakeable message up the food chain to the predators! Cods, trouts and trevallies are energised by the veritable feast that is dancing around them, undertaking high speed sniping attacks to grab a meal. Meanwhile all of this action is being overseen by black-tip, grey and silvertip sharks that are ubiquitous at the Rowleys. Waiting for their moment to grab a meal, their very presence is a primary indicator of the health of fish communities at the shoals with a recent study finding much greater numbers, species types and bigger sizes of sharks at the Rowleys, compared with atoll reefs to the north where sharks have been a target of fishing for decades.

PRECIOUS PARADISE

Undoubtedly the remoteness of the Rowleys plays a role in why they are in such good health today. The effort and resources required to visit these reefs will always provide a hold on the total number of visitors. However, being such a relatively small and isolated reef system means the Rowleys are vulnerable to large-scale disturbances; and managers must question how susceptible the system is to disturbance and how well it could recover from significant damage (i.e. what scientists call 'resilience').

Rowley Shoals Marine Park

Rowley Shoals Marine Park – which includes Clerke and Imperieuse reefs – was declared in 1990 and extended four-fold in 2004. The marine park is managed by Parks and Wildlife. The nearby Mermaid Reef Marine National Nature Reserve (encompassing the northernmost reef) is managed by the Commonwealth Department of Environment and Energy with the assistance of Parks and Wildlife. Both Border Protection and the WA Fisheries Department also assist with management of the shoals. For more information about the management of the Rowley Shoals Marine Park visit parks.dpaw.wa.gov.au.



Top Corals provide protection for schools of fish like juvenile damselfish.
Photo – Parks and Wildlife

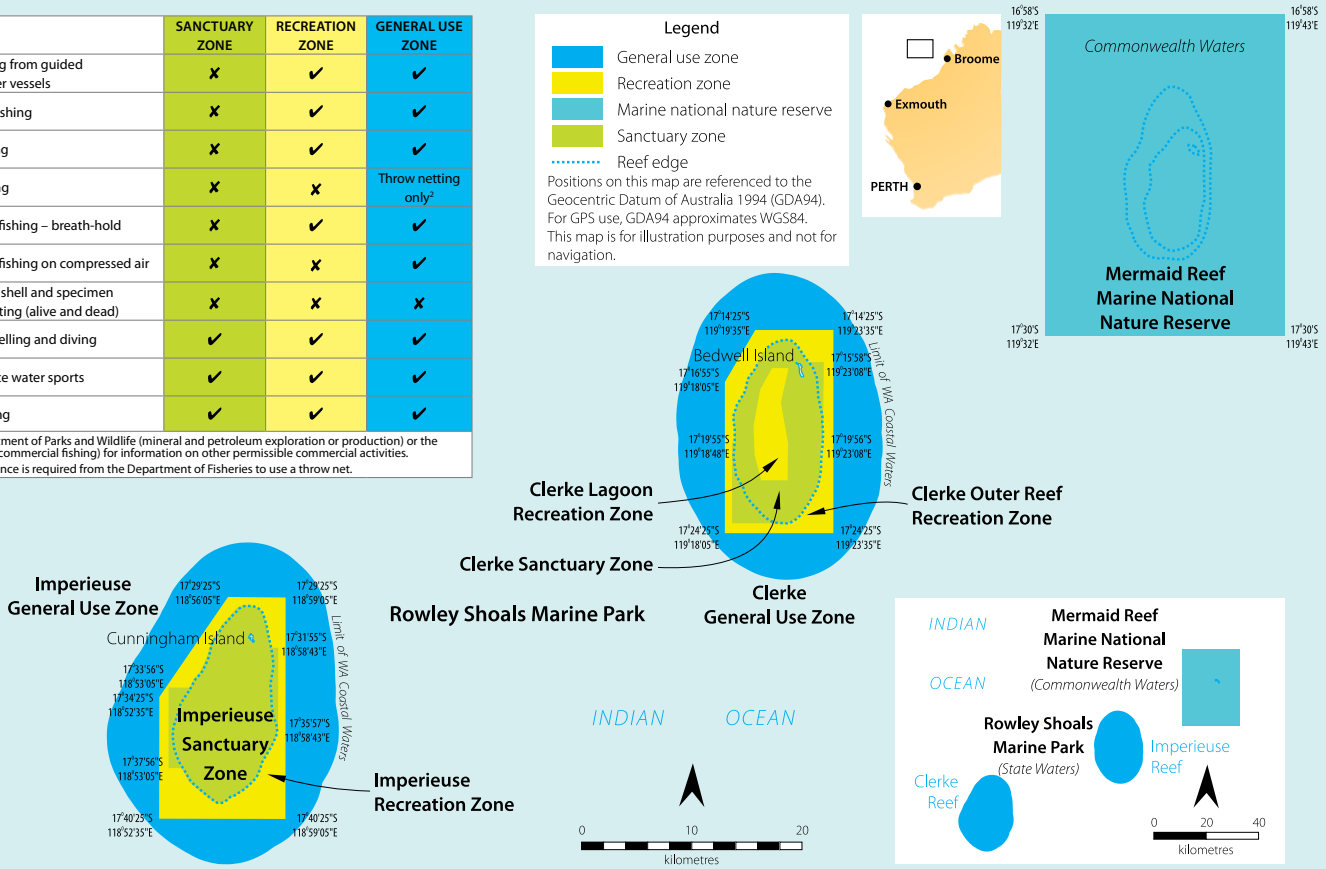
Above Significant cyclone events at the Rowley Shoals in 1996 and 2006.
Image – Bureau of Meterology

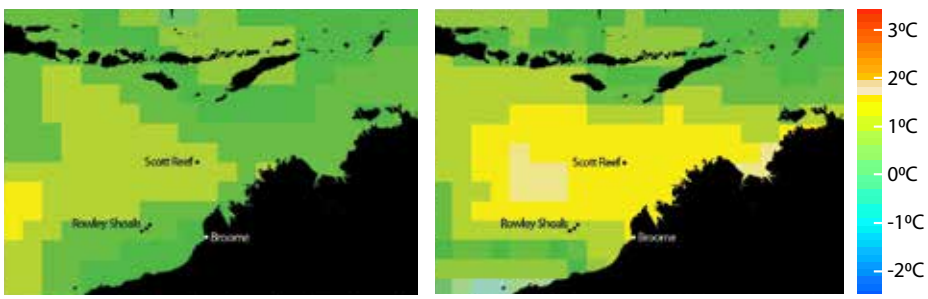
There are two types of disturbances capable of causing damage to the Rowleys at a whole-of-reef scale: cyclones and hot water. Cyclones cause physical destruction of corals through generation of extreme waves and their associated shearing forces while elevated sea water temperatures will cause corals to bleach and die if temperatures remain atypically high for an extended period.

Cyclones are a common event in the north-west of Australia with 10 cyclones passing within 100 kilometres of the Rowleys over the past 20 years; although most of these did not cause notable damage. The most destructive path is one that exposes reefs to the front left-hand quadrant of the cyclone where the most damaging winds (and swell) are generated. Only three cyclones have followed such a path since the early 1990s with all causing significant damage to the coral communities – Cyclone Jacob in February 1996 when the mean wind speed past the shoals reached 130 kilometres per hour; and cyclones Clare in January 2006 (when the mean wind speed past the shoals was 130 kilometres per hour), followed closely by Glenda in March 2006 (when the mean wind speed past the shoals was 195 kilometres per hour). However, in each case the coral communities have recovered, demonstrating a remarkable degree of resilience. How is this possible? Well, no matter how destructive the cyclone, damage will always be patchy,

ACTIVITIES		SANCTUARY ZONE	RECREATION ZONE	GENERAL USE ZONE
COMMERCIAL FISHING[1]	Fishing from guided charter vessels	✘	✔	✔
RECREATIONAL FISHING	Line fishing	✘	✔	✔
	Trolling	✘	✔	✔
	Netting	✘	✘	Throw netting only[2]
	Spearfishing – breath-hold	✘	✔	✔
	Spearfishing on compressed air	✘	✘	✔
	Coral, shell and specimen collecting (alive and dead)	✘	✘	✘
BOATING/ WATERSPORTS	Snorkelling and diving	✔	✔	✔
	Surface water sports	✔	✔	✔
	Boating	✔	✔	✔

1. Please contact the Department of Parks and Wildlife (mineral and petroleum exploration or production) or the Department of Fisheries (commercial fishing) for information on other permissible commercial activities.
2. A recreational netting licence is required from the Department of Fisheries to use a throw net.





Right and far right Mean monthly temperature differences from long-term April average in 1998 (far left) and 2016 (left) indicate why bleaching was severe at Scott Reef but mild at the Rowley Shoals.

both within reefs and between reefs, and some corals will be injured, rather than killed. This ensures plenty of corals remain to help repopulate the damaged and denuded areas. As long as no further disturbances occur, then recovery is usually well advanced within a decade.

This brings us to the other trigger for large-scale damage to coral reefs – persistent, elevated sea water temperatures. As the global climate warms, our oceans are getting warmer. Corals which have evolved under stable temperature regimes for millennia are now being regularly subjected to prolonged exposure events with temperatures up to two degrees celsius higher than the long-term average. Once a warm water event has been sustained for eight, degree heating weeks (a term used to describe the accumulated heating required to cause severe bleaching mortality), corals start to bleach and die. When corals bleach they lose the tiny algae that lives inside their tissues, which provides both their colour and their nutrition. These large-scale or 'mass' bleaching events have recently decimated the Great Barrier Reef and, perhaps less well known, the atoll reefs to the north of the Rowleys. Scott Reef, which is the closest reef system to the north of the Rowleys, suffered up to 90 per cent mortality of its shallow water corals in early 2016, having only just recovered from a previous large-scale bleaching event in 1998. Why have the Rowleys escaped relatively unscathed?

Well it appears that the oceanographic conditions that resulted in significant warming of sea water on reefs to the north have not extended south to the Rowley Shoals and, as a result, the Rowleys have suffered only minor bleaching episodes in recent times. There is no simple explanation for these serendipitous outcomes as the greater north-west shelf region is an area where large circulation systems converge, with their individual flow strengths and direction dependent on seasonal temperature differences and interannual differences in the strength of the El Nino Southern Oscillation Index. For example, the Holloway Current flows in a south-

westerly direction during autumn and winter but slows down and often changes direction during summer. This weakening can increase the influence of the large coastal tides of the Kimberley which have been suggested can generate upwelling of deeper cooler water onto the outer shelf where the Rowleys reefs reside. In addition, the cooling effect of the many cyclones in the region can help reduce the long periods of ocean heating. Indeed, Cyclone Stan cooled waters in February 2016, and only minor bleaching was observed at the Rowleys in April. Research is continuing in an effort to understand whether there is a persistent oceanographic pattern here that will continue to imbue resilience in the Rowley Shoals, or have we just been lucky?

DISTANCE: A DOUBLE-EDGED SWORD

Here we come to the paradox of the Rowley Shoals, their isolation is both their strength and their weakness. Their location appears to be far enough south to have avoided the environmental conditions that led to the previous bleaching episodes but without a relationship with surrounding reef systems they are totally reliant on their own resources for their continued existence. Connections between reef systems allow for the dispersal of larvae between locations, with healthy populations supplying new individuals to those areas damaged by disturbances. However, the scale of these connections can vary considerably among reefs and regions. Using the resolving power of genetics, researchers have established that larvae of fish and corals rarely travel between the Rowleys and the other isolated systems in the region (Scott and Ashmore reefs) and not in sufficient number to aid recovery within a few decades. Herein lies one of the fundamental processes underlying the management of fishing at the Rowleys. Given their isolation, fishing regulations are aimed at ensuring there remain healthy stocks of those reef associated species that people like to catch. If the Rowleys were to sustain major decreases in targeted fish species we cannot expect recovery to come from larvae making their way from other reef systems. We have to think smaller in this case, and for the very few studies of this type that have been carried out at the Rowleys, researchers have found that there is plentiful exchange of larvae between the shoals. This result helps us understand how and why the Rowleys have recovered from significant cyclone damage in the past.

As regional managers we cannot remove the effects of climate change. However, by minimising any other potential impacts to these reefs and continuing to further our understanding of the processes that imbue resilience we can remain active participants in maintaining the health of our environmental heritage. At a time when coral reefs are under severe stress around the globe, the Rowley Shoals remain as one of the world's most spectacular examples of a healthy reef system, and a testament to the value and beauty of coral reefs with good management and global stewardship.

Above left Passionfruit trout.
Photo – Parks and Wildlife

Above Rowley Shoals is a diver's paradise.
Photo – Nick Thake/Australian Institute of Marine Science

Below Maori wrasse.
Photo – Australian Institute of Marine Science

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