A voyage to protect an *ocean oasis*

In April and June 2019, a team of scientists and marine park managers travelled to the remote Ashmore Reef to carry out a range of marine and terrestrial surveys. The valuable information they collected provides a greater understanding of the reef's biodiversity values and will help shape future management to safeguard this internationally important ecosystem.

by Lauren Hardiman, Bruce Webber and John Keesing

On the north-west edge of Australia's continental shelf, 320 kilometres from shore, is the incredible ocean oasis of Ashmore Reef. Measuring just 25 kilometres in length and covering 227 square kilometres, Ashmore is a biological powerhouse, noted for its diversity of corals, invertebrates and fish and importance as a nesting, breeding and feeding site for many larger marine species.

The reef includes three low-lying vegetated islands, sand cays, seagrass beds, intertidal sand flats, sheltered lagoons and of course, coral reefs. These habitats are home to an incredible array of species. Each year, about 100,000 seabirds from 15 different species flock here to breed, while, for migratory shorebirds en route from northern Asia to Australia, the islands provide an important spot to rest and refuel. The reefs are home to an abundance of fish and coral species and the sheltered seagrass beds are used by marine turtles including the endangered and migratory loggerhead (*Caretta caretta*) and vulnerable and migratory hawksbill (*Eretmochelys imbricata*) and green (*Chelonia mydas*) turtles. A small, genetically distinct population of dugong (*Dugong dugon*) are also known to breed and feed within the lagoon.

Ashmore Reef has a rich history. Thought to have been discovered by Foe Mpura, a local ruler on the nearby Indonesian island of Rote in 1729, the reef was named Nusa Solokaek or Sand Island. Lured by the promise of fresh water and rich harvests, Rotonese fishers and migratory Bajau Laut sea people started to regularly visit the reef, most coming in search of trepang or sea cucumber. This highly sought after delicacy drove a major industry across northern Australia during the nineteenth century. Today, commercial fishing has ceased, but a Memorandum of Understanding (MoU) between Australia and Indonesia allows Indonesian fishers to seek safe harbour; access fresh water and visit graves on the islands; and continue traditional, subsistence fishing activities. In the mid-1800s, American whalers used the islands as a base, which led to the discovery of guano, and subsequently phosphate mining on West Island. In the early 1930s, Britain transferred control of the islands to Australian sovereignty and, in 1983, Ashmore Reef was declared a national nature reserve.

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Main Ashmore Reef.
Photo – Ruchira Somaweera/CSIRO

Above Nesting crested terns and boobies.
Photo – Belinda Cannell/CSIRO

This formal recognition of Ashmore Reef's environmental importance has endured, with successive legislation affording the highest level of protection to its marine and terrestrial ecosystems. The reef is now protected within the Ashmore Reef Marine Park, one of 58 Australian marine parks, and is also a designated Ramsar site under the Convention of Wetlands of International Importance.

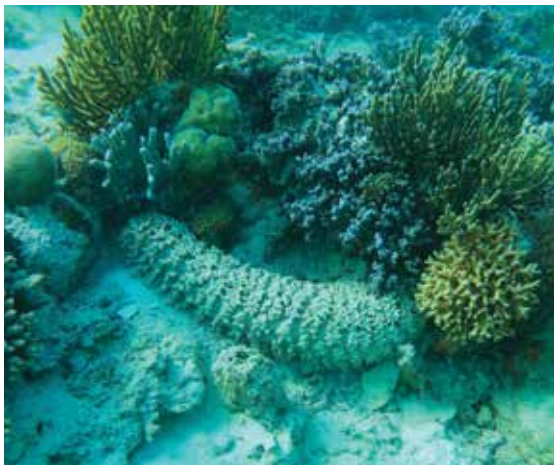
DIVING INTO RESEARCH

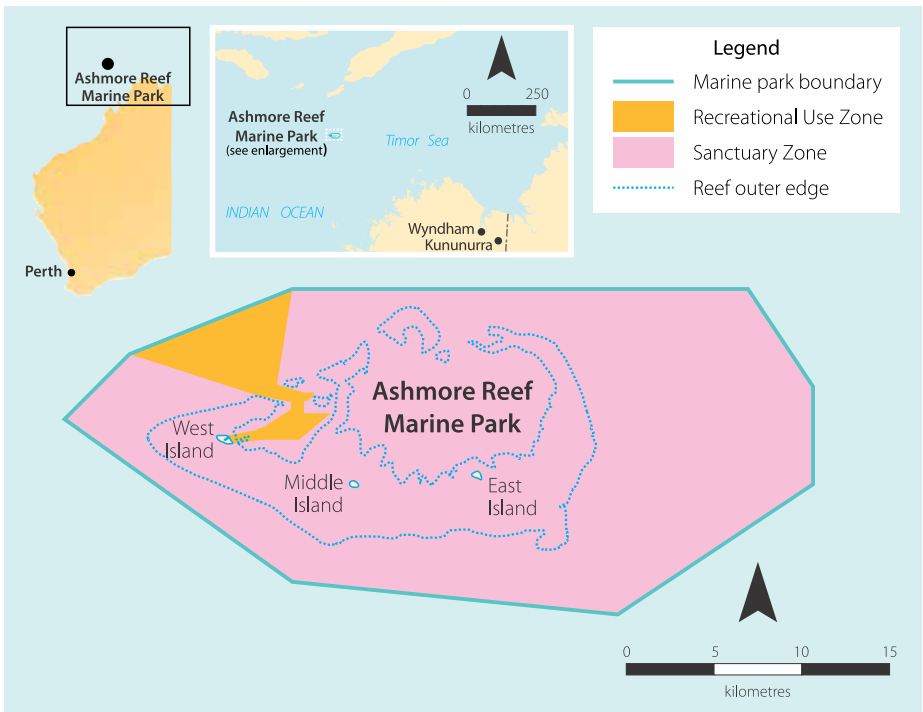
In July 2018, a new management plan was introduced for the North-west Marine Parks Network including Ashmore Reef Marine Park. Parks Australia commissioned research to assess the health of the reef's marine and terrestrial ecosystems to better understand the effectiveness of current management measures. A multi-disciplinary team was assembled, bringing together marine park managers and researchers from CSIRO and The University of Western Australia. Armed with a combination of traditional and new technologies and data-gathering techniques, the team set off from Broome for the 30-hour journey.

EMBRACING INNOVATION

The survey schedule included the usual variety of standard survey techniques such as transects and visual species identification, all of which have previously been used at Ashmore Reef. But this voyage also offered the opportunity to employ a number of novel approaches, many of which drew on the latest technologies.

One such technique is environmental DNA or eDNA. Fish and other marine species shed skin and other cells as they move through the ocean. These fragments contain DNA, which can be used to





Top A holothurian (prickly redfish sea cucumber) found on the reef.
Photo – CSIRO

Above Hermit crab on the beach at Ashmore Reef.
Photo – Ruchira Somaweera/CSIRO

Above right Reef flat and dive vessel on the outer reef of Ashmore Reef Marine Park.
Photo – Lauren Hardiman/CSIRO

identify species in three steps: collecting and filtering seawater samples; extracting and analysing the DNA; and finally, matching the markers against a database. These data can reveal the biodiversity of an area, offering a much more efficient and cost-effective approach to monitoring marine communities. It can also be a much more effective method for surveying shy, nocturnal or well-camouflaged species that are difficult or even impossible to detect through normal survey methods.

Above water, the vegetation and bird surveys incorporated a remotely piloted aircraft system, paired with traditional ground survey techniques. As with the use of eDNA, this method brought efficiencies to the project and enabled the team to complete more surveys in the same amount of time and with fewer challenges and greater opportunities. By combining the two methods, the team created the first high-resolution quantitative picture of the vegetation structure and composition on the Ashmore islands, and conducted comprehensive bird surveys, especially valuable for difficult-to-access areas.

ISOLATION DOES NOT AFFORD COMPLETE PROTECTION

Like so many reefs around the world, Ashmore faces a range of pressures, including climate change, over-harvesting of resources and the introduction of non-native species. The reef's long fishing history has taken its toll on a number of target species including trochus shells (large sea snails whose shells are traditionally used to make buttons), sea cucumbers and giant clams. Fish, turtles and seabirds and their eggs are also known to have been harvested. In 1968, management measures were introduced to try and address fishing impacts, but activities continued to threaten reef health. A survey carried out in 1998 raised concerns about harvest levels of sea cucumbers and research undertaken

Top The introduced Asian house gecko found at Ashmore Reef.
Photo – Ruchira Somaweera/CSIRO

Above Introduced fire ant.
Photo – CSIRO

Above right Green turtle above branching coral.
Photo – Ruchira Somaweera/CSIRO

Opposite page
Above right Nesting booby and two frigate birds on West Island.
Far above right Exposed reef flat near West Island.
Right The survey vessel, *Kuri Pearl II*.
Photos – Ruchira Somaweera/CSIRO

in 2006 recorded further declines. Since 2008, strict enforcement of the no-fishing and MoU rules have been applied.

Climate change is another significant threat to the reef. As the world's oceans warm, coral bleaching is becoming more frequent and severe, leading to mass mortality. Extensive coral bleaching occurred at Ashmore in 1998 and 2003. In the 2006 surveys, low coral cover was observed, but during the 2019 voyage, promising signs of recovery were seen.

Over the years, a number of non-native species have been introduced to Ashmore's islands, including weeds (such as *Cenchrus* species), tropical fire ants (*Solenopsis geminata*) and the Asian house gecko (*Hemidactylus frenatus*). The tropical fire ant, which gets its name from the burning sensation its powerful sting causes, poses a serious threat to ecosystems and economies worldwide. The impacts of non-native species on Ashmore ecosystems are poorly understood and gaining insights into this potential pressure was a key focus of this project.

FILLING IN THE BLANKS

Ashmore Reef's isolation has meant the research and monitoring efforts have been infrequent; trips to this remote part of the world are difficult to arrange and expensive to conduct. Adding further complexity is that different research methods have been used from trip to trip, making it very difficult to build an understanding of how Ashmore's habitats and species have changed over time. Finally, each of these trips have typically focused on a specific habitat, species or community, but no project has sought to bring all this knowledge together, with a view to understanding the system as a whole.

With the introduction of new management for Ashmore Reef Marine Park, there is a renewed focus on addressing these knowledge gaps and improving management efforts.

To achieve this, the team took a different approach to understanding how to improve the management of the marine park. One of the challenges was to develop an effective and rigorous approach to monitoring, based on a statistically robust sample design that was comprehensive and cost-effective. The project brought together marine and terrestrial expertise that will bolster efforts to build understanding of interactions and processes between

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species and communities at a reef-scale. This knowledge is vitally important for conservation and effective management; interactions are the glue that hold ecosystems together and conversely, in the case of introduced species, can threaten health and resilience. The hope is that, by shedding light on these hidden linkages, this project will make a real difference to conservation outcomes.

However, a combined approach does not come without complexity. The marine component of this project included surveys to assess the status of key habitat-forming species such as corals, macroalgae and seagrass, as well as other invertebrates and fish. The terrestrial surveys included topographic mapping surveys, assessments of the cover and diversity of native and non-native plant species, bait traps to identify the presence of non-native animals, and counts to identify and assess the population status and diversity of birds. Evidence of interactions, for example disturbance of birds and turtles by fire ants, was recorded. This wide range of data will help scientists and park managers develop a comprehensive picture of the health of Ashmore Reef and focus management responses.

PLANNING FOR THE FUTURE

Conservation management in the face of ongoing pressures is no easy feat. Extreme weather events, ocean acidification, ocean pollution, introduced species, ecosystem imbalances, a growing human population and mass species extinctions will all continue to take their toll on the natural world. The quest to understand how habitats and species will respond to these pressures has never been more important. The capacity to work on the blue frontier, in places like Ashmore Reef, is continually being improved with the advent of new technologies, scientific innovations and collaborative action. This project has brought fresh insights, understandings and ideas to the management of Ashmore Reef Marine Park, and will ensure the best possible position to safeguard this ocean oasis for future generations.

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For more information about Ashmore Reef Marine Park visit parksaustralia.gov.au/marine/parks/north-west/ashmore-reef.