Marine heatwaves threaten the future of underwater forests

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Kelp covered landscape in Western Australia. Dan Smale, Author provided

Western Australia's marine environment is unique. Two world heritage areas, the largest fringing coral reef in Australia, and more than a thousand kilometres of underwater forests, supporting incredible wildlife, important fisheries, and tourism.

But these precious habitats were decimated in 2011 by a record-breaking marine heatwave, with temperatures rising more than 2°C above normal for ten weeks. The culprit: warm water pushed south by the same La Niña event that caused devastating flooding in Queensland.

Research released this week shows the oceans are continuing to warm steadily despite an a slowdown in the rate of warming at the earth's surface, increasing the likelihood of extreme heat undersea.

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Disclosure statement

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Partners

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And La Niña events are forecast to become twice as frequent thanks to climate change, according to research released in late January.

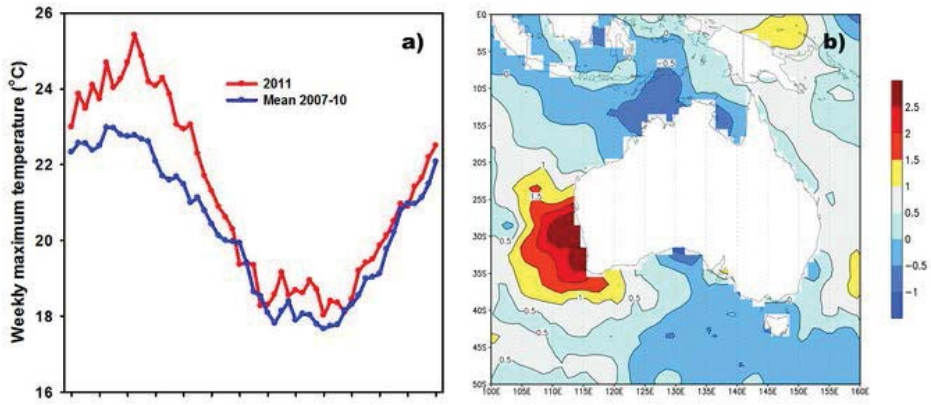
Sadly, these changes could spell the end for large swathes of Western Australia's underwater forests and much of the marine life that depends on them for food and shelter.

WA's extreme marine heatwave

La Niña refers to the positive phase of the El Niño–Southern Oscillation (ENSO) climate pattern, which brings cyclones, rain and floods to southeast Asia and Australia. While the devastating impacts of such extreme weather is clearly visible on land, many are unaware of the similarly destructive consequences under water.

The diverse, expansive marine ecosystems along the vast coastline off Western Australia are no strangers to the devastating impacts of La Niña events. In 2011, strong La Niña conditions increased the southward flow of the Leeuwin Current, which pushed warm water from the tropics into cooler temperate latitudes.

At the same time, winds were calmer than normal resulting in unusually high transfer of heat from the air into the upper layers of the ocean. The outcome was an unprecedented marine heatwave which affected more than 2,000 km of the west Australian coastline from north of Ningaloo Reef to Cape Leeuwin on the southwestern corner of the continent. Water temperatures soared past anything recorded for at least 140 years.



Ocean temperatures measured by loggers off Perth, at 10m depth where the seaweed forests are found a) and Sea Surface Temperature anomalies (relative to 1971-2000) measured by satellites throughout Australia during March 2011, the peak of the marine heatwave b) Thomas Wernberg a) Thomas Wernberg/NASA b)

Climate variability driven by El Niño and La Niña is a natural phenomenon that has influenced Earth's ecosystems for millennia. However, the recent modelling experiments, which are the most sophisticated to date, suggest that anthropogenic climate change will intensify extreme climate variability driven by El Niño and La Niña events.

The projected increased frequency of extreme La Niñas, from an average of once every 23 years to once every 13 years, will mean that temperate marine ecosystems will have less time to recover in between periods of excessive temperatures.

King hit: the unique west

The west Australian marine environment is unique by global standards. It hosts two World Heritage areas – Ningaloo Reef, Australia's largest fringing coral reef; and Shark Bay, home to extensive seagrass meadows, turtles, sharks and dugongs.

Seagrass meadows and seaweed forests also fringe more than 1,000 km of coastline from Ningaloo Reef and south to Cape Leeuwin. These underwater forests harbour some of the highest diversity of seagrasses and seaweeds in the world, and hundreds of other species that are found nowhere else on Earth.

Harlequin fish thrive among the kelp covered rocks. They are endemic to western and southern Australia, and are found nowhere else on Earth. Thomas Wernberg, Author provided

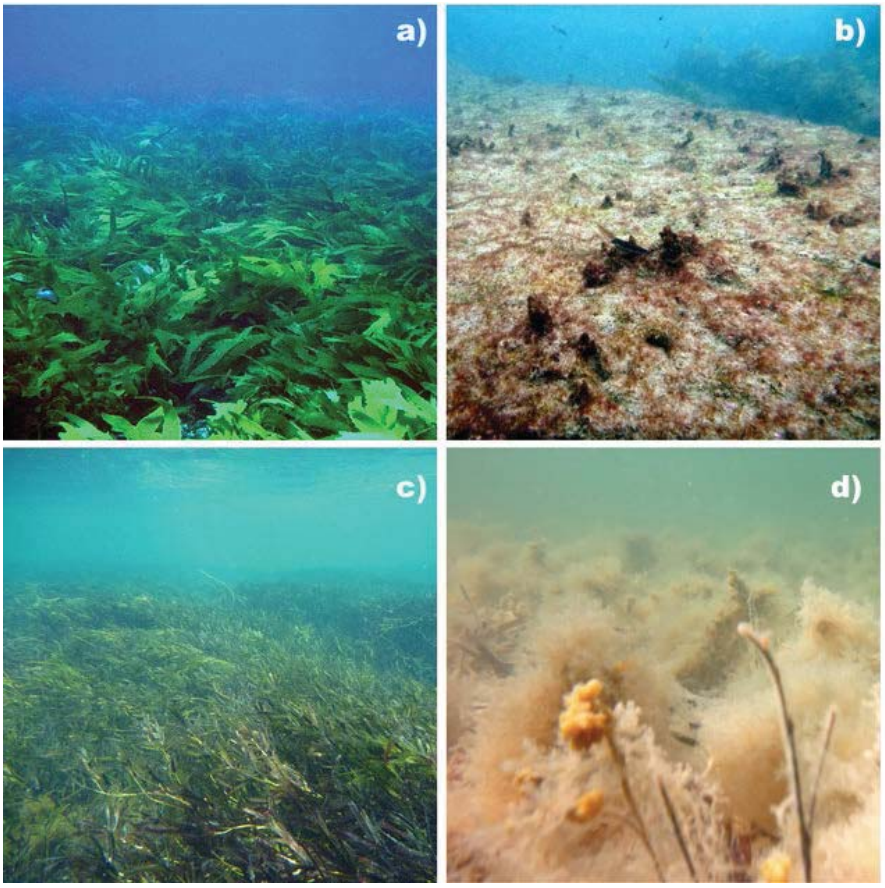
Temperate seaweed forests and seagrass meadows are like tropical coral reefs and forests on land - they provide a 3D habitat, food and shelter for a myriad of associated species, many of which have economic importance such as abalone and rock lobsters.

Many of the species found along the coastline of southwestern Australia have evolved to live in cooler temperate waters. When peak summer sea temperatures soar, as they did in early 2011, many species overheat and become physiologically stressed or even die.

Following the 2011 La Niña event, mass deaths occurred in a wide range of species, including seaweeds, seagrasses, shellfish and finfish.

Plants that formed forests such as kelps and seagrasses were particularly hard hit, with knock-on effects on the wildlife that depend on these forests for food and shelter.

One forest-forming seaweed was eradicated from over 100 km of coastline in just a few months as a result of the marine heat wave. Further north, unprecedented levels of coral bleaching and mortality were recorded for a range of reef-building coral species.



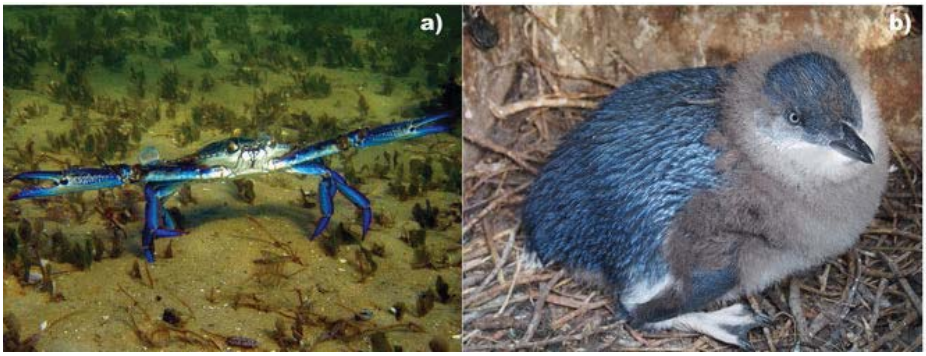
Extensive kelp forests a) and seagrass meadows c) were severely impacted by the 2011 marine heatwave, which cased complete canopy loss, population decimation an overgrowth by epiphytes b, d) Thomas Wernberg a, b), Matt Fraser c) and John Statton d)

Rapid loss of underwater forests in response to recent oceanic warming has also been observed in other temperate regions of the world.

And tropical plant-eating fishes moving into temperate zones often help finish off what heatwaves and warming starts.

The grim future

The La Niña also affected important fisheries and tourism. For example, a regional abalone fishery in Kalbarri was decimated and stocks of scallops and blue swimmer crabs in Shark Bay have crashed.



Blue swimmer crabs a) and little penguins b) were heavily impacted by the 2011 marine heat wave Thomas Wernberg a) and Belinda Cannell b)

High water temperatures and a lack of available food also killed and reduced the breeding success of Little Penguins, while the highly-valued Western Rock Lobster also suffered many deaths. On the other hand, many warm water species were found further south than usual, presenting opportunities for recreational and commercial fishers alike.

In many cases, species' populations have not returned to normal in the four years since the marine heat wave, with some species showing no signs of recovery. For example, northern populations of Roe's abalone have not recovered naturally and a large-scale restocking programme is underway to re-establish the fishery. Similarly, populations of forest-forming seaweeds have not yet bounced back.

The increasing frequency and severity of marine heatwaves set to follow the doubling of La Niña events may eventually sound the death knell for west Australia's globally significant underwater forests, and will have profound socioeconomic implications.

As millions of people rely on ecological goods and services provided by temperate marine ecosystems, a better understanding of what conditions boost resilience to climate variability is needed to maximise chances of protecting and sustaining them in decades to come. Recent research on coral reefs has shown that tropical ecosystems can recover from extreme warming events, if local conditions are favourable. The capacity of temperate reef ecosystems to recover from marine heatwaves is, however, far less understood.

The question that remains is whether our seaweed forests will have time to recover between the blows dealt by these underwater heatwaves - or shift to a new, more impoverished state.

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