Offshore heatwave alters marine ecosystem

An unprecedented ocean heatwave in 2011, which saw ocean temperatures along parts of the Western Australian coastline rise by 2°C to 4°C, has opened up a new question in research on climate change: can extreme events result in ecosystem change earlier than would be the case with mean warming trends?

"The question is really quite important," says Dr Thibaut de Bettignies, a researcher with ECU's Centre for Marine Ecosystems Research. "When there has been change in a marine ecosystem, such as we've observed from Jurien Bay to Hamelin Bay, that change will either persist in a new equilibrium or the compositional species mix will trend back towards its original state.

"We're suggesting that the effects of extreme events should be considered in the development of predictive climate change models and in planning for reducing the impacts of climate change."

The multi-institutional research team, which includes ECU's Centre for Marine Ecosystems Research, the UWA Oceans Institute and the Australian Institute of Marine Science, plans to continue research to evaluate species diversity and abundance along the WA coast.

Meanwhile the results of their work to date, just published in Nature Climate Change, are drawing attention for the

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degree to which the 2011 event resulted in changes in the biodiversity patterns of seaweeds, invertebrates and fish.

Changes in marine ecosystems, correlated with increasing mean temperatures, have been well documented around the world and support the development of predictive models.

One prediction is that extreme events such as cyclones, storms, droughts, cold spells and heat waves will increase in frequency and intensity, but their influence is poorly understood with only a few events having been studied.

Dr de Bettignies says there is a transition zone along the WA coastline from tropical to temperate marine ecosystems, each with their own endemic biota and with significant overlap between the two zones where the mix of species results in unusual species richness.

"It is a global biodiversity hotspot," he says. "For this reason alone it is of intense scientific interest, but when we see the sort of change that can arise from this sort of anomalous event it becomes even more interesting."

The warming of the southwards-flowing Leeuwin current, driven by unusually strong La Niña conditions, imposed this temperature anomaly onto the pre-existing warming trend, with unprecedented consequences.

The two regions, which were more than 500km apart, recorded different changes in the populations of rocky reefs to around 10 metres deep even though both site experienced much higher water temperatures.

Fish and benthic (bottom-dwelling) communities at Jurien Bay, the warm temperate study region, were significantly different eight months after the heatwave compared with a year earlier, but the response at the cooler site, Hamelin Bay, was minimal.

"There was a substantial reduction in kelp at Jurien Bay," Dr de Bettignies says. "The thermal stress on this temperature-sensitive species was most likely the cause of a significant reduction in seaweed canopy cover, which had further consequences.

"The opening up of space and light at Jurien Bay allowed a proliferation of turf-forming algae and, along with other changes, resulted in a depauperate ecological state."

Warmer-water fish species suddenly appeared at Jurien Bay in much greater numbers and possibly, with the warming trend, will be shown to have tropicalised the area. However, colder-water species did not experience a population collapse so the overall outcome eight months after the event was an increase in diversity and abundance of fish species.

Again, this was not observed at the cooler Hamelin Bay site, which did not have a pre-existing marginal population of warmer and colder water species.

The research team warns that these contrasting patterns highlight the importance of biogeographic context and absolute thermal thresholds, and add a further element of complexity to understanding and predicting ecosystem response to abrupt warming.

"It will be fascinating to see what comes out of our seventh annual survey, next November," Thibaut says. "In other parts of the world there has been a lot of variation in recovery rates following discrete warming events, so we cannot predict whether this one has tipped the balance off parts of our coastline, or whether these reef communities will normalise over time."

The team's research will come under the spotlight early next year when Perth hosts, for the first time, the 10th International Temperate Reef Symposium. This is the world's premier conference on the ecology of rock reefs, and is expected to showcase Western Australia's unique marine ecosystem. (http://10itrs.org/)

For further information on this topic please contact Dr Thibaut de Bettignies at t.debettignies@ecu.edu.au.

Reference: Wernberg, T. et al (2013) Nature Climate Change, Vol. 3, 78–82, doi:10.1038/nclimate1627