

CLIMATE CHANGES PUT HEAT ON FISHERIES

A severe marine heatwave and associated warmer ocean temperatures off Western Australia have changed the nature of marine life, presenting opportunities and challenges for fishers and fisheries management

Something strange has been happening lately in the waters off Western Australia. Something that indicates a significant shift in the ocean environment. Fishers as far south as Albany on the Southern Ocean have reported for the first time catching Spanish Mackerel (*Scomberomorus commerson*), which is usually confined to the tropics. Other tropical species such as Threadfin (*Polynemidae*) and Common Dart (*Trachinotus botla*) are regularly turning up in catches off Perth. Even Manta Rays (*Manta birostris*) have been spotted.

While the change may appear positive for these tropical species, the impact on temperate species, particularly in the transition zone between tropical and temperate waters around Shark Bay, midway up the WA coast, are less welcome. The fisheries for Saucer Scallops (*Amusium*) and Blue Swimmer Crabs (*Portunus armatus*), once prevalent in Shark Bay, are doing it tough and there are real questions being raised about the potential effects on Snapper (*Pagrus auratus*) that are at the northernmost end of their range there.

These unprecedented changes are the result of a warmer south-east Indian Ocean over the two past summers, which has seen

an increase of 1°C to 2°C in WA waters. These warmer temperatures followed the extreme marine heatwave of 2010-11, in which WA waters were more than 3°C above long-term seasonal averages, peaking at more than 5°C above average for two weeks across February and March between Shark Bay and the Abrolhos Islands.

Caused by several climatic drivers including unusually hot, still weather, this dramatic event allowed tropical species to move south on an abnormally strong Leeuwin Current. But it also had a severe impact on the marine ecology. Fish kills were reported down the coast, corals were bleached and a Roe's Abalone (*Haliotis roei*) fishery at Kalbarri was wiped out.

To make matters worse for Shark Bay, which has already been hit by the marine heatwave, two major cyclones caused the Gascoyne and Wooramel rivers to flood and flush fresh water and sediment into Shark Bay. This contributed to the devastation of its Scallop and, in particular, Blue Swimmer Crab populations and the forced closure of both valuable fisheries.

Since the heatwave, fisheries managers in WA have been keeping a keen eye on the effects. A workshop held in the weeks afterwards detailed an inventory of fish kills,

coral bleaching and species reported out of their traditional ranges by recreational and professional fishers, researchers, divers and beach-walkers all along the coast.

This included thousands of dead fish, eels, crabs and rocklobster washed up on beaches, as well as dead pelagic fish floating on the sea surface. Coral bleaching was reported at the Abrolhos Islands and Rottneest Island, where new records of Red Bass (*Lutjanus bohar*) and Parrotfish (*Scaridae*), among other species, were also reported. At Dunsborough, a dead Leatherback Turtle was washed up well south of its normal range.

But it is information gleaned from a follow-up workshop, 'The Heatwave: Two Years On', supported by the FRDC that is helping build a fuller picture of the effect on fisheries of not only the heatwave, but also the above-average sea temperatures that have followed.

That workshop, held in March this year as part of a broad FRDC-funded project looking at the effects of climate change on WA fisheries, heard from fisheries scientists investigating a range of marine species including crabs, prawns, scallops, seaweeds, seagrasses, finfish and even penguins.

Workshop co-convenor Gary Jackson says that while much of the research is still



Common Dart collected by Department of Fisheries WA netting surveys at Pinnaroo Point, just north of Perth. The smaller fish were collected in September 2011 after the heatwave and the larger fish about one year later in 2012, indicating they have survived over two winters and grown.

Seagrass in Shark Bay before (opposite page) and after (above) heatwave and flooding.

PHOTO: MATT FRASER

work-in-progress, a clear theme emerging from the workshop is that species are moving from their traditional ranges at unprecedented rates. This is prompting fisheries' managers to re-evaluate the landscape of the fisheries themselves.

The evaluation of fishery boundaries is an important consideration not only because higher sea temperatures over the past three years have led to species' movement, but also because the average temperature of WA waters is expected to rise permanently by 1°C to 2°C in the next 50 years. Therefore, the changing distributions of species are likely to be more lasting.

Evidence of this from the ocean is that fish species have already adapted to the changing conditions and are being found in new areas that can support their survival. This happened, Gary Jackson says, in two waves. First, adult fish species as well as eggs and larvae came down on the strong 2010-11 Leeuwin Current and then, in the ongoing warmer conditions further south, were able to survive.

Now, two years later, with continued warmer-than-average temperatures, those fish have been breeding and are now spawning in southern waters, further growing the populations.

"We have had a number of species turn up around Perth and further south such as Threadfin and Common Dart, which we

haven't had in our records before," Gary Jackson says. "We know they've arrived as very small juveniles but they've persisted and there's even evidence that a couple of species have become sexually mature and are now possibly spawning in southern waters."

Gary Jackson says this is the real test of whether conditions are changing: "that a tropical species can move hundreds of kilometres and find conditions so that individuals are able to go through a full life cycle and reproduce".

While tropical fish species that are extending their range southwards could be considered 'winners' of the changed conditions (along with the recreational fishers who are happy to see them), there have also been species – and fishers – that have lost out.

The Roe's Abalone population at Kalbarri that was wiped out by the heatwave is undergoing a translocation program, with hope the species will recolonise from a population that has been sourced from a site further south. This temperate abalone species is very sensitive to temperature changes, and a large recreational abalone fishery near Perth could also struggle as warmer sea temperatures are increasingly experienced.

One of the biggest challenges is that facing the Scallop and Blue Swimmer Crab fishers operating in Shark Bay, whose resource was decimated by the conditions

and whose fishery two years later remains closed. While an FRDC-funded project into Blue Swimmer Crabs is showing signs of rejuvenation, the outlook is not so optimistic for the Scallops, which are showing little sign of recovery.

Temperate seaweeds around Jurien Bay took a 'hammering' in the heatwave. This has implications for both the seaweed itself and for other species that may rely on it.

While the ink is not yet dry on much of the science, researchers are working closely with fisheries managers and fishers in the Shark Bay fishery – and others – to monitor the progress of the affected stocks and to discuss future options including whether fisheries are opened, closed, expanded or changed.

Fisheries scientists and managers are operating in "unchartered waters", says Gary Jackson, but while they have no control over a warming ocean they can control the management of the mobile marine populations and protect the breeding stocks.

"It's our job to try and understand the changes that are going on and then look ahead to try to manage the outcomes for fisheries," he says. "What we're trying to achieve is to manage fisheries sustainably the way we always have but now against a backdrop of the warming oceans. As long as we've got the science in place I'm confident we will be able to do what needs to be done." **F**

NINGALOO NIÑO – MARINE HEATWAVE EXPLAINED

By Melissa Marino

The events that conspired to create the deadly marine heatwave – the ‘Ningaloo Niño’ of 2010-11 – can be traced all the way to Alaska.

Ming Feng is the CSIRO Wealth from Oceans Flagship scientist whose research inspired the term ‘Ningaloo Niño’, referencing the specific Western Australian phenomenon.

He says that a long-term trend in the Pacific Ocean that affects fisheries as far north as Canada and Alaska set the scene for the events that led to the extreme sea temperatures recorded off the Western Australian coast in 2011. This trend, known as the Pacific Decadal Oscillation (PDO), was identified by North American fisheries scientists in the 1990s. It refers to the warming or cooling of surface waters in the northern realm of the Pacific Ocean, which affects salmon production regimes.

In the PDO’s current cool phase, more heat builds in the western Pacific Ocean, the Indonesian seas and waters off north-west Australia. There is also a greater likelihood of *La Niña* events, in which sea surface temperatures north of Australia are often warmer than normal. The summer of 2010-11 witnessed the second strongest *La Niña* of the past century, sweeping a body of warmer water through Indonesia on fierce easterly winds and driving it down the WA coast on an unseasonably strong Leeuwin Current.

The Leeuwin Current is a warm ocean current that flows southward all year, bringing tropical water with it. Usually it runs strongest in autumn but in the summer of 2010-11 it surged due to the strong *La Niña* associated with the PDO. Ming Feng

says the *La Niña* also drove a pressure system off the coast, which caused a southward wind anomaly to further enhance the strength of the current.

These events also helped create an on-land heatwave that saw no real sea breeze and a long run of days of more than 40°C; the hot, still air lying over the ocean further increased the sea temperature.

“The combination of remote and local wind forces caused the warming event in February and March 2011, where the temperature was almost 3°C higher than normal, centred around Shark Bay and the Abrolhos Islands,” Ming Feng says. “This was more than double the previous recorded temperature increase set in 2000 in line with another *La Niña* event.”

The water temperature peaked during a two-week period at 28°C, up from the usual 23°C. It was so high it was underestimated by the numerical models and surprised the marine community. “We have seen what I would call ‘normal’ temperature fluctuations according to *El Niño* or *La Niña* events but these kinds of temperature extremes we have probably never seen here before,” he says.

In the two years since the heatwave, sea temperatures have remained high at 1°C to 2°C above average. In 2011-12 this was attributed to another, weaker *La Niña* event, but in the most recent summer in which there was no *La Niña*, the higher temperatures were probably linked to the continued cool phase of the PDO, according to Ming Feng.

He says WA fishers and fisheries managers

should get accustomed to operating in warmer waters as higher ocean temperatures are expected to become the norm, with an increase of 1°C to 2°C in 50 years. This is despite indications that the Leeuwin Current will weaken in that time. “In 50 years’ time we will see these higher temperatures as normal,” he says.

In the meantime there will be year-to-year temperature fluctuations and the possibility of another extreme event such as the Ningaloo Niño cannot be ruled out, he says, particularly while the PDO remains in a cool phase. Intergovernmental Panel on Climate Change scientists are working on models to better predict the duration of PDO phases, he says.

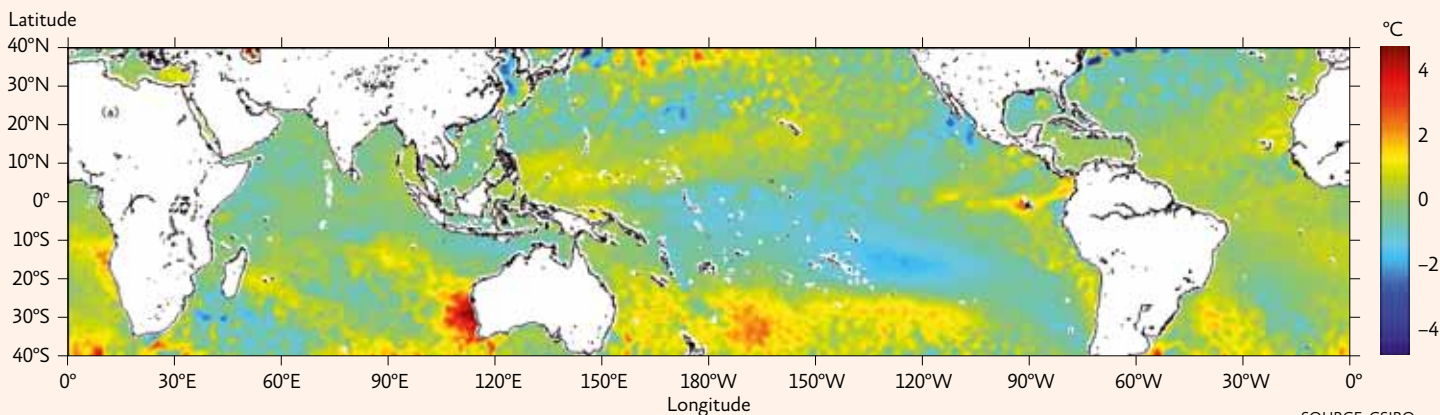
While present climate models can predict the likelihood of a *La Niña* or *El Niño* event about one to three seasons in advance, models would need to improve to predict such extremes as were witnessed in 2010-11, he says. Ming Feng and other oceanographers are continuing to work with the Department of Fisheries WA to optimise communication of climate information with stakeholders.

The FRDC is also funding research with collaborators from CSIRO and the Department of Fisheries WA on the projected impact of climate change on WA fisheries. Ultimately, climate information will help fisheries managers design optimal fishery management plans, he says.

FRDC Research Code: 2010/535

More information: Ming Feng,
08 9333 6512, ming.feng@csiro.au

SEA SURFACE TEMPERATURE ANOMALIES 21 FEBRUARY – 6 MARCH 2011 AT THE PEAK OF THE EXTREME WARMING EVENT.



DEVASTATION IN SHARK BAY NIPPED BY DIVERSIFICATION

By Melissa Marino

If it was not for diversification, the freak natural events that two years ago closed the Shark Bay crab trap fishery in Western Australia where Peter Jecks' vessels catch Blue Swimmer Crabs (*Portunus armatus*) may have also shut down his business.

Whether it was dumb luck or foresight, his decision a few years ago to branch into hand-picked crabmeat – and other value-added seafood products – on top of his premium whole cooked crab has kept Abacus Fisheries afloat in an extremely challenging environment.

Developed as part of an Australian Seafood Cooperative Research Centre project with support from the FRDC, Peter Jecks' crab cake product has continued to sell while the fishery has been closed thanks, in part, to a quantity of crabmeat he had previously processed.

As the project's name suggests, the 'Accelerated new product development: Blue Swimmer Crab pilot' fast-tracked the product's development from concept to market. It also established a template that Peter Jecks is using to create more diverse products including 'seafood shots' using Australian seafood and a soon-to-be-released Shark Bay King Prawn burger.

"Normally product development takes a considerable period of time, but we effectively in 18 months had gone from the water to a product that was plate-ready," he says. "The project I believe catapulted us two or three years ahead of where we would have been."

While the experience has not been easy – the original plan was to underwrite the new product development with the established whole crab business – it has at least provided some revenue. And it has shown a clear way forward.

Before the 2010-11 marine heatwave and cyclone-associated floods closed the fishery, more than 90 per cent of his business was reliant on fresh crabs. But now, and even when the fishery re-opens, Peter Jecks wants fresh crabs to make up no more than 30 per cent of sales.

Not only will this spread risk across the business should another natural calamity occur, but it is also a better business model in its own right, he says.

Consumer-ready products, such as his recently developed prawn with tom yum and salmon with wasabi and sesame 'shots', provide consistent

margins while giving better yield and cost control than fresh seafood sales.

"We are making Australian products you just cook and eat and the good news is there is an opportunity to grow that market in Australia as consumers are becoming more discerning of the origin of the food they order," he says. "When this all turns around we will have a very robust business model that will have a diverse range of incomes."

Risk is also being spread by the use of seafood products from areas other than Shark Bay, such as Atlantic Salmon. As well, Peter Jecks is investigating the potential to develop products made from the thousands of tonnes of locally grown fruit and vegetables that would otherwise end up in landfill because they are not the right shape or colour for the big supermarkets.

Peter Jecks says the fishery's closure has woken up a lot of people in the seafood game, including himself.

"We are taking advantage of a bad situation and trying to make it better," he says. "It's been challenging, but I actually like a challenge and it's made me get off my arse and go back and do things that I'd got past having to do."

Despite his optimism, the experience has not been without losses that he will never be able to redeem. One of the biggest was his staff of 40 people who, since losing their jobs, have also for the most part left the business's base in Carnarvon.

The Jecks also lost a treasured family home in Perth, which had to be sold to sustain the business when the fishery was closed. "The impact has been devastating," he says. "There is no other way to describe it."

The Shark Bay Blue Swimmer Crab and Scallop fishery was closed voluntarily by fishers in the wake of the marine heatwave that increased temperatures by an unprecedented 5°C above average for two weeks in the area.

While heat stress affected crab numbers,

Peter Jecks with a haul of Blue Swimmer Crabs he relied on before his Shark Bay fishery was closed in the wake of the 2010-11 marine heatwave.

PHOTO: MELISSA MARINO



Peter Jecks says a deluge of cyclone-related freshwater that flooded into the bay also had an effect, decimating seagrass beds and changing salinity levels and water quality in the bay. The immediate result on the seabed, he says, was chaos, with the usual crab distribution patterns thrown into disarray. Then within a few months the entire population collapsed.

The positive news is that recent surveys have shown a re-emergence of juvenile crabs. Given the species' rapid growth rate, he hopes to see plenty of mature crabs in the fishery by the end of the year.

That data is being assessed by Department of Fisheries WA researcher Mervi Kangas, who is leading an FRDC-funded project on Blue Swimmer Crab recruitment and biology in Shark Bay, including sampling crab stocks five times a year.

She says that while early 2013 surveys show signs of recovery, a "softly, softly" approach is required to the fishery reopening because surveys from 2012 also showed an abundance of small crabs but by November they had almost disappeared.

"We have to take it survey by survey but we are keeping our fingers crossed that they do grow into sizeable crabs and that fishing can follow," Mervi Kangas says. "That is what we are all hoping for."

More information: Peter Jecks, peter@abacusfisheries.com.au, www.abacusfisheries.com.au; Mervi Kangas, 08 9203 0164, mervi.kangas@fish.wa.gov.au