# Tests of time and tide

In 1841, amateur meteorologist Thomas Lempriere – in the company of Antarctic explorer Captain Sir James Ross – made a rough cut in the sandstone cliffs at Port Arthur's Isle of the Dead. Its purpose was to serve as a benchmark against which to measure sea-level change.

Lempriere, who was deputy assistant commissary at the prison colony, also operated a tide gauge and three years of its records have been tracked down at the Royal Society, London. They are perhaps the oldest record of tidal movements in the Southern Hemisphere, according to Dr John Hunter of CSIRO Marine Research.

Hunter and his colleagues have installed a new tide gauge at Port Arthur. They believe a comparison of the modern and historical records will shed light on changes in global climate during the industrial era, and on changes in the geology and geophysics of the Earth.

'We aim to ensure that the imaginative work begun by Lempriere in the days of sailing ships has a comparative value in these days of satellites and modern instrumentation.' Hunter says.

## From sail to satellite

Many other ocean movements, such as currents, eddies and deep-water upwellings, are of similar interest to oceanographers. It's a body of knowledge that began anecdotally with sailors under square sail, developed with coastal stations and research vessels and is being completed by powerful computers and satellite-borne instruments.

CSIRO studies of the East Australian Current began in 1950. Salinity and temperature readings, gathered during cruises aboard the naval research frigates, were used to plot the current's swirling eddies off the coast of Eden. Oceanographers now know much more about how the current and its eddies develop, and the knowledge benefits shipping, fishing and defence industries, recreational boaters and search and rescue operations.

In the 1970s, satellite-tracked buoys were used to help characterise the Leeuwin Current whose rich waters sustain Western Australia's rock lobster fishery and bring rain to Perth and surrounding regions.

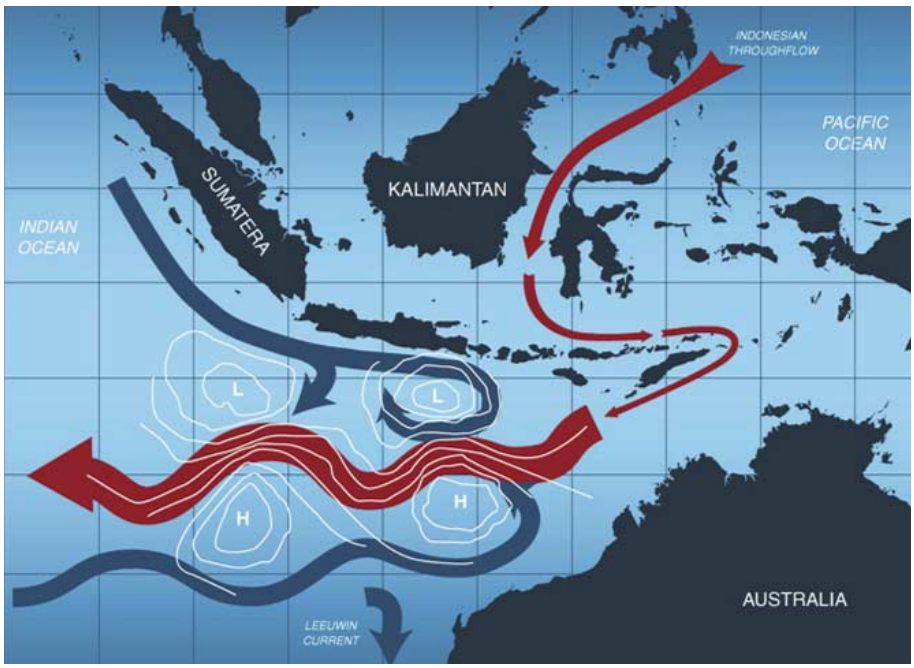
A more sophisticated satellite instrument figured in the recent discovery of dramatic eddies larger than Tasmania and a kilometre deep in the Indian Ocean, north-west of Australia. A satellite altimeter, which detects changes in sea level of a few centimetres, revealed the system of ocean eddies which peel off a major ocean current flowing across the Indian Ocean towards Africa.

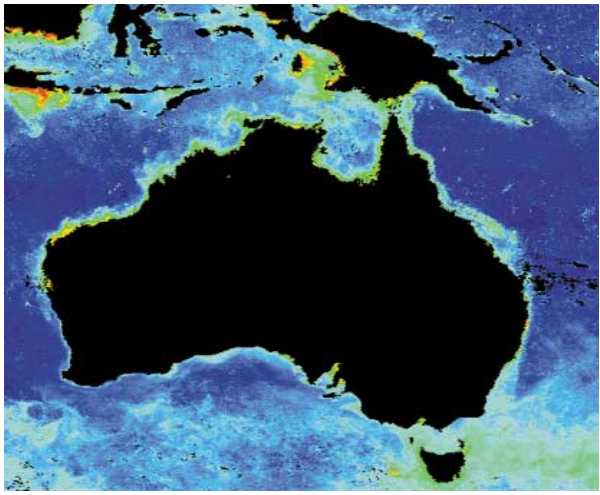
The South Equatorial Current is fed by the northern and southern Indian oceans, and by the Pacific Ocean through the Indonesian archipelago. Dr Susan Wijffels, chief scientist on two CSIRO research expeditions, says this mixing process alters the characteristics of the ocean in a region that is a source for rainfall across southern and western Australia. She says a better understanding of this process should aid the recognition of El Niño and La Niña features extending into the Indian Ocean, and improve Australian rainfall predictions.

## The coloured ocean

Another important influence on the climate system are microalgae, microscopic plants that make up the floating pastures of the world's oceans. They constitute more than a quarter of the planet's total vegetation and nourish the entire marine food chain.

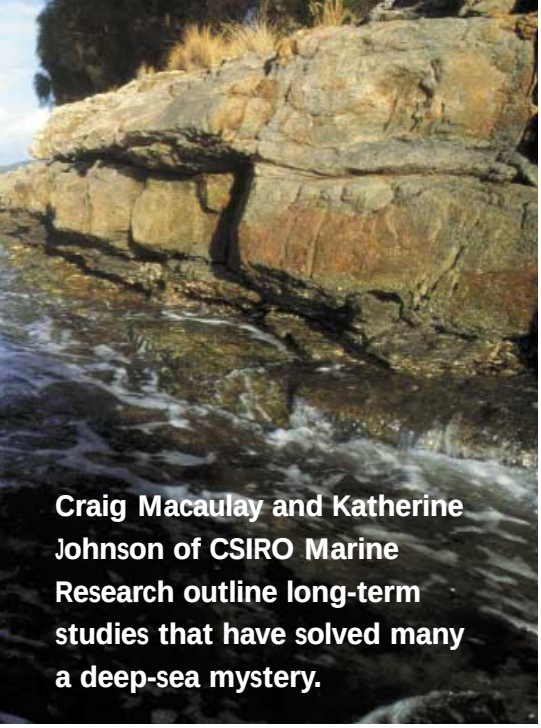
Microalgae play a role in the global climate system by influencing the exchange of carbon dioxide between the ocean and



**Left: Scientists have discovered dramatic eddies in the Indian Ocean north-west of Australia, a region with a major influence on Australia's climate.**

**Below: Decades of research into microalgae pigment processes have enabled ocean 'colour' images to be produced from satellite data.**



**Craig Macaulay and Katherine Johnson of CSIRO Marine Research outline long-term studies that have solved many a deep-sea mystery.**

the atmosphere. They also affect biogeochemical processes and cloud formation via the release of volatile sulfur compounds.

Dr Shirley Jeffrey of CSIRO Marine Research has made a life-long study of microalgae and their pigment processes. 'Initially we had to grow a variety of microalgae, identify their many pigments, purify and crystallise new key components, and develop accurate techniques for measuring their production,' Jeffrey says.

'We are now applying this knowledge to quantify the ocean's plant biomass, map regional and global microalgae distribution, ground-truth ocean 'colour' images remotely-sensed from satellites, identify ocean processes including seasonal variability, and monitor the ocean's response to climate change.'

There are more than 25 000 species of microalgae known, though only a small percentage is in culture. The CSIRO Collection of Living Microalgae has 700 strains, making it the largest collection in the Southern Hemisphere. These microalgae are widely used for research, aquaculture, teaching, as pigment standards for environment and ocean processes, for biotechnology, and for safeguarding biodiversity.

## Prawns need protection

Long-term studies have also highlighted the need for sustainable fisheries management. The northern prawn fishery was 'discovered' more than 30 years ago by a CSIRO prawn survey in the Gulf of Carpentaria. It is now Australia's most lucrative Federally-managed fishery, worth $119 million a year.

But the fishery has not been without its challenges. After expanding rapidly in the 1970s, tiger prawn catches fell during the next decade. Long-term research by CSIRO indicated excessive fishing may be reducing the tiger prawn stock to critical levels and offered clues to sustainable management. In response, fishery managers reduced the number of fishing vessels by 60% between 1987 and 1993 and are aiming for a 15% cut in fishing mortality by 1999.

Dr David Die of CSIRO Marine Research says the long-term commitment to research on the northern prawn fishery is unique among the world's large prawn trawl fisheries. 'It has given managers access to critical information for making management decisions and has shaped the evolution of the fishery,' he says.

In the case of banana prawns, CSIRO research has established a correlation between rainfall and banana prawn stocks in some regions, with good rainfall in the wet season translating to a good banana prawn season. The link has proven so tight that CSIRO scientists can now provide catch predictions based on rainfall.

Other CSIRO research has established the vital importance as nursery grounds of seagrass for tiger prawns and mangroves for banana prawns. But these critical habitats are not well understood.

## Tuna tracks

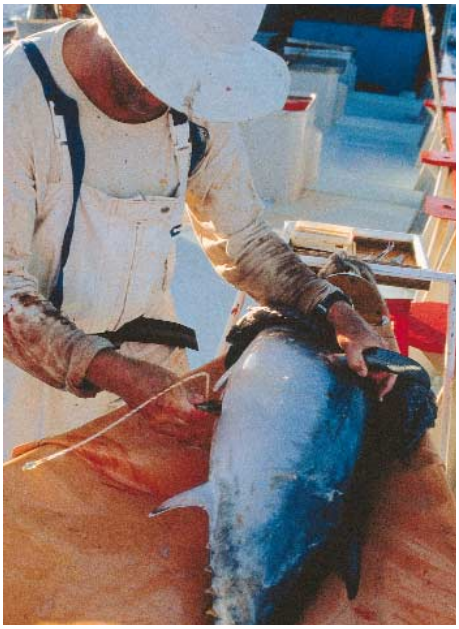
CSIRO has been studying the southern bluefin tuna for more than 40 years, providing important baseline data for monitoring the species.

Long-term stock assessments have revealed that the tuna's parent stock is at its lowest level since fishing began in the 1950s, down to just 10% or less of its original size. These assessments, and others by scientists in Japan and New Zealand, have provided the information needed by the Commission for Conservation of Southern Bluefin Tuna to reduce fishing quotas and rebuild the stock.

**Left: A new tide gauge has been installed at Port Arthur to compare modern and historical sea-level records. The original cut made by Lempriere in the sandstone cliffs can be seen at the right of this picture.**

**Right: Long-term maps of changes in mangrove and seagrass habitats are needed to assess the impact of coastal development on Australia's northern prawn fishery.**

**Below right: Tagging southern bluefin tuna. With the help of stock assessments dating back 40 years, scientists can predict the likely recovery of southern bluefin tuna parent stock under different catch scenarios.**



The commission aims to rebuild the parent stock to pre-1980 levels by the year 2020. Long-term data held at CSIRO has made it possible for scientists to calculate the probability of the parent stock recovering by this date under different future catch scenarios. Under present catch rates, the probability is low.

Since the first tagging studies in the 1960s, more than 131 000 southern bluefin tuna have been tagged, and about 10% of these returned to scientists. Information and biological samples have also been collected from catches. 'These data enable us to distinguish between cyclical or long-term environmental fluctuations and changes to the population caused by fishing,' John Gunn of CSIRO Marine Research says.

'The long-term tagging research has revealed that a major increase in the growth rate of juveniles occurred in the 1970s, coinciding with a major increase in the catch of juvenile southern bluefin tuna. It is thought this increase in growth rates may be the result of reduced competition between individuals for food and other resources.'