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VOLUME 26
NUMBER 1
MARCH 2018

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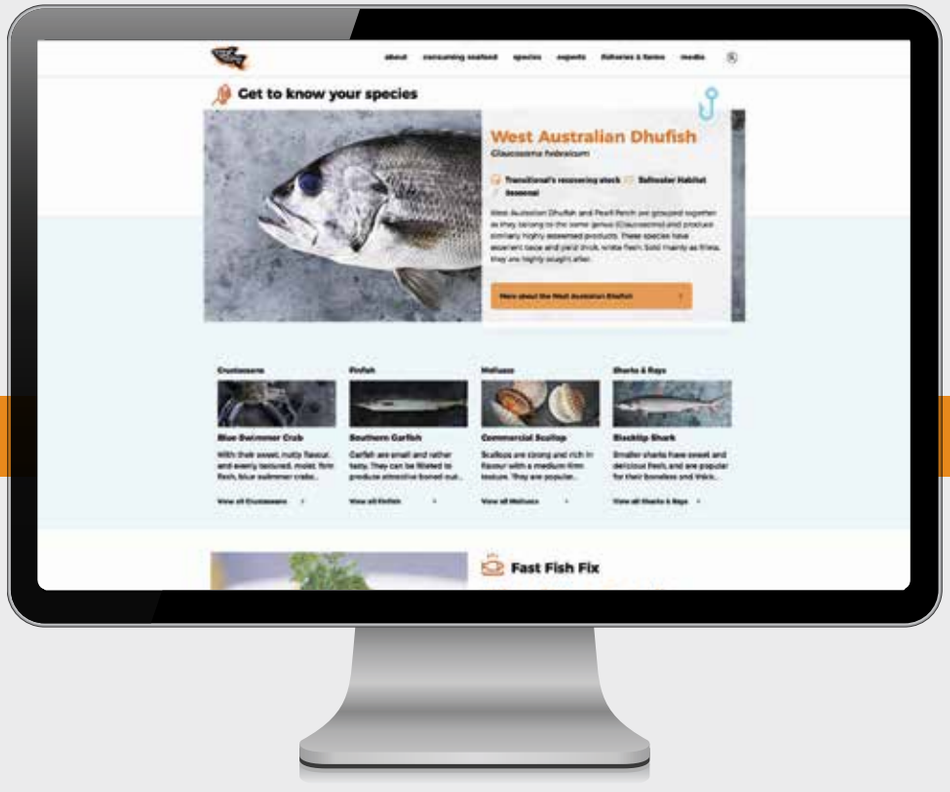

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REGULAR

FISH is published by the FISHERIES RESEARCH AND DEVELOPMENT CORPORATION (FRDC)

The FRDC plans, invests in and manages fisheries research, development and extension activities throughout Australia.
It is a statutory authority within the portfolio of the Federal Minister for Agriculture and Water Resources, jointly funded by the Australian Government and the fishing industry.

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W www.coretext.com.au
ISSN: 1833-4784 (Print)
ISSN: 2202-7122 (Digital)

Cover: Gloria Jones (left) and Christine Jackson setting out for a day's work on the Coorong. Photo: Brad Collis

MORE INFORMATION
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Proactive testing tackles algal challenge

A step forward in monitoring and surveillance is helping fishers and shellfish producers address risks that have begun blooming with increased regularity in the southern waters

By **Catherine Norwood**

An internationally validated test kit that can identify the presence of paralytic shellfish toxins (PSTs) in seafood will be a crucial tool in helping Australia's aquaculture and wild-harvest operators manage the risk of toxic algal blooms.

The kit is just one tool in a suite of new monitoring and management strategies designed to protect food safety and the reputation of Australian seafood.

Algal blooms that produce the potentially deadly PSTs have affected most Australian states intermittently over the years. However, the toxic *Alexandrium tamarense* (Group 1) has appeared repeatedly in Tasmania since 2012, when the state experienced its first major bloom of the species on the east coast.

Farmed bivalve shellfish including mussels and Pacific Oysters, as well as wild populations of rock lobsters and abalone, have all been found to accumulate the PSTs. After ingesting the algae, each species eliminates the accompanying toxins at varying rates. As filter feeders, shellfish quickly accumulate the toxins and quickly eliminate them once blooms have passed. Other species are slower in their responses.

The more recent emergence in Tasmania of a strain of *A. tamarense* that produces highly concentrated toxins has added further impetus to the development of new monitoring and management strategies.

Last year, Tasmanian testing recorded the highest ever level of toxins in shellfish generated by blooms of the new *A. tamarense* strain, in conjunction with high algal counts.

Blooms occurred along the east coast, persisting in the south-east in particular for several months through spring and into early summer at specific sites. This caused some waters to be closed for shellfish harvesting for up to 17 weeks during what is historically the busiest time for industry, until the bloom abated and the shellfish flesh from the area was declared clear of toxins by official laboratory testing.

New strategies

The manager of Australia's SafeFish program, Alison Turnbull, says PSTs are a massive business and reputational risk for the Australian seafood sector and have already caused many domestic and international product recalls in the past five years.

Funded by the FRDC, SafeFish conducts and coordinates food safety and trade-related research for the seafood industry, based at the South Australian Research and Development Institute (SARDI).

Alison Turnbull says weekly water sampling and analysis for algal cell counts were previously the first line of defence and the main trigger for further testing of PST levels in shellfish flesh.

"With our previous toxic species it would take 5000 to 50,000 cells per litre in water samples before we would get toxins in the shellfish. But with this species we're getting toxins in the shellfish with cell counts of only 2000 to 3000 cells per litre. We're only just starting to detect the algae, and we're already over the toxin limit," she says.

This shift has led to a new focus on proactive and more frequent sampling of seafood itself.

In 2015, the FRDC funded Gustaaf Hallegraeff, Juan Dorantes-Aranda and Sarah Ugalde of the Institute for Marine and Antarctic Studies (IMAS) at the University of Tasmania to research which of the four commercially available PST kits was most reliable in identifying the PSTs produced by algae in Australian waters.

Top Juan Dorantes-Aranda (left) and Gustaaf Hallegraeff from the University of Tasmania were instrumental in validating test kits for paralytic shellfish toxins. Photo: University of Tasmania

The Neogen™ PST kit was found to be highly accurate for Pacific Oysters, providing positive results for target toxins in oyster meat at 50 to 100 per cent of the regulatory level. It also identifies PSTs in mussels at much lower levels, potentially triggering formal testing and harvest concerns even when PSTs are well below the regulatory limit. This sensitivity could limit its use for this species as a potential pre-emptive decision-making tool for growers.

Standardising testing

Following this work, SafeFish obtained a grant from the Australian Department of Agriculture and Water Resources (DAWR) Package Assisting Small Exporters that has allowed SARDI and

Above Casey Nicolas (left) at the recent grower workshop with Scott Singleton (right) preparing an oyster sample for the Noegen tester. **Above left** The Neogen™ test kit unpacked and ready for use. Photos: Rohan Nicholls

IMAS to validate the Neogen™ kit internationally – an important step in improving confidence in testing protocols for trade partners.

A second SafeFish–DAWR grant is also funding workshops for oyster growers, the first of which was held in January 2018, providing training and accreditation in the use of the Neogen™ kit.

Among those at the workshop was Hayden Dyke, who operates Oyster Bay Oysters at Little Swanport on the Tasmanian east coast.

He has been using the Neogen™ kit since 2015, when it was first introduced to industry. He admits to some early errors with the kits, and says the testing process is very time critical – down to the second – which is why the January workshop to standardise protocols has been essential.

"It's an incredibly useful tool in conjunction with all the other data to gauge the level of risk. Without something like this you're flying blind," he says. "It allows me to make decisions about whether I will continue to harvest, particularly as a bloom is beginning or starting to decline."

He combines the PST testing of oyster meat with algal cell counts, algal species and toxin identification, and water temperature monitoring. *A. tamarense* is a cold-water, winter-blooming species, so when ocean temperatures reach 14°C to 15°C it is too warm for the algae to survive.

"The regulatory environment is changing quickly to respond, and new testing methodologies are being developed in the laboratory, all of which gives me confidence that we can continue to operate and ensure food safety," Hayden Dyke says.

Although other states have not been as affected by PST algal blooms as Tasmania has, as a member of the Australian Shellfish Quality Assurance Program, Hayden Dyke says there has been increase in awareness of and surveillance for algae and their toxins in shellfish around the country.

The potential human health effects of ingesting the toxins are significant, ranging from slight nausea through to death. The secondary financial and reputational effects are also significant for specific growers or producers affected, given the time and costs involved in a recall process.

There is also the potential for further long-term damage to the brand of the producer, the state and national brand, and for the image of seafood as a whole.

Oysters Tasmania executive officer Sue Grau says the organisation is now working with government to incorporate the kit as part of the official regulatory testing regime.

"Waters that have been closed to harvesting require two 'compliant' PST results a week apart to allow harvesting to resume. Currently, these are both laboratory tests. But it may be possible to use the Neogen™ tests for one of these 'compliant' results, with a laboratory test providing follow-up confirmation a week later."

It is a discussion in progress, Sue Grau says. Meanwhile, growers are already using the kits to make management decisions, which include the potential to suspend harvest even before waters are officially closed. Often one grower in each harvest area does the sampling, providing all other growers in that area with advice about the results.

New capabilities

The Tasmanian Government's recent $1.2 million upgrade of the Analytical Services Tasmania laboratory in Hobart, which was officially opened in December 2017, has already begun to improve the timeliness of formal testing.

It provides results in two days, rather than the four or five days it takes when samples are sent to Sydney. As this allows testing twice a week, the shellfish industry has benefited by having closure times reduced in some instances. The initial focus is on oysters and mussels, but testing is also expected to benefit other potentially affected industries, including rock lobster, Abalone, Scallop and clams, as well as recreational fishing for these species.

As executive officer of the Tasmanian Rock Lobster Fisherman's Association (TRLFA), John Sansom has already made use of the new Hobart capabilities, sending off mussel meat for testing in early January.

The TRLFA uses mussels as a sentinel species to detect toxic algae in areas where there is no regular water sampling by mussel or oyster growers. There are eight sentinel sites along

WHAT IS PARALYTIC SHELLFISH POISONING?

Paralytic shellfish poisoning (PSP) is caused by eating seafood containing paralytic shellfish toxins. These toxins are produced by some naturally occurring algae.

Algae are consumed by shellfish including mussels, oysters, clams, pipis, scallops, abalone, rock lobsters and crabs. The toxins build up in their flesh or organs and can be dangerous to humans when eaten.

What are the symptoms?

Symptoms of PSP begin within minutes or up to 24 hours after eating shellfish.

Initial symptoms include tingling and numbness around the mouth, these sensations can spread to the face, neck, arms and legs.

Other symptoms include:

- nausea and vomiting;
- weakness;
- blurred vision;
- change in temperature sensation;
- loss of balance;
- difficulty speaking or swallowing; and
- in severe cases, difficulty breathing, paralysis and death can occur.

There have been no deaths reported in Australia as a result of PSP. However, there have been multiple hospitalisations over the past decade and anecdotal reports of people whose limbs have been partially paralysed for short periods.

Source: www.dhhs.tas.gov.au

the Tasmanian east coast, maintained by the TRLFA as part of the industry's Biotoxin Management Plan, established in 2014 in the wake of the first major PST algal outbreak.

John Sansom says Southern Rock Lobsters are slower to take in the PSTs than shellfish, and the toxins accumulate in the hepatopancreas (the equivalent of a liver). They are also slower to depurate themselves of the toxins.

While the rock lobster flesh is not affected, another FRDC research project found that 15 to 20 per cent of recreational fishers and a similar proportion of Chinese consumers eat the hepatopancreas of rock lobsters, putting them at risk.

John Sansom says rock lobster fishers are often better placed than shellfish growers when a bloom does occur, in that they "have boat, will travel".

"But we need to be conservative in closing waters, as much as that might make it difficult for some fishers. We have to look after our product, we cannot take the risk of putting rock lobsters onto the market that are not safe to eat."

He says a PST test kit for rock lobsters, similar to the one being used for oysters, would go a long way to helping fishers actively monitor and manage this risk.

Further research

Alison Turnbull says there is still more to learn about the algae itself. "We know it forms cysts (enclosing itself in a membrane) when it dies, but we are not sure if the blooms are recurring because of the cysts sinking and getting trapped, or whether it is coming in again on the ocean currents.

"Last year was also the first year we've seen abalone on the east coast actually test positive above regulatory limits, although we're not entirely sure how they are accumulating the toxins – through feeding or directly through the foot."

She says there is also more to learn about how PSTs actually affect the health and growth of animals, with Southern Rock Lobsters of particular interest. She says some experimental work suggests rock lobsters reduce their feeding, which may have implications for growth rates and harvest management.

"There have been some major gains in management since 2012 and it's improving every year. We're developing new tools and new ways of thinking; the whole industry is being proactive," she says. F

Self-testing helps manage safe mussel harvests

Product safety, waste prevention and reputation protection all benefit from increased monitoring for algal toxins

By **Catherine Norwood**

In September 2017, staff at Spring Bay Seafoods at Triabunna, on Tasmania's east coast, decided they needed to suspend their mussel harvest to protect the safety of their product.

The decision was based on evidence gathered in the company's own laboratory: cell counts of potentially harmful algae in water samples, DNA testing that identified the presence of a toxic algal species, and a 'positive' result for high levels of paralytic shellfish toxins (PSTs) using a test kit that had recently received international validation.

That was on Monday 11 September 2017, as the mussel harvest was gearing up towards a peak of 20 tonnes a week. But it was not until the following Friday 15 September 2017 that formal laboratory testing of samples sent from Triabunna to Sydney confirmed that PSTs in the mussel meat exceeded regulatory limits and waters were officially closed.

Without that decision earlier in the week, Spring Bay's managing director Phil Lamb knows the company was likely to have been subject to a product recall.

It is a heartache Phil Lamb is all too familiar with, in the wake of repeated blooms of the toxic *Alexandrium tamarense* (Group 1) species. The first major bloom in Tasmania and an international product recall was in 2012. Recurring blooms have varied in intensity, but have become more common along the length of Tasmania's east coast, persisting for longer in some years and also becoming increasingly toxic.

Spring Bay is naturally keen to prevent any further recalls. After four years of its own 'extension' work, including collaborative investigations and a lot of field testing to develop some proactive decision-making tools, the Spring Bay laboratory now pre-emptively tests for both PSTs and diarrhetic shellfish toxins, the latter of which emerged as an issue during a bloom of a different algal species in 2016.

Australian Blue Mussels are able to quickly eliminate toxins once algal blooms abate. Photo: Spring Bay Seafoods

Its efforts won the company the FRDC's Research, Development and Extension Award at the biennial National Seafood Industry Awards in September 2017.

But more importantly, Phil Lamb says, the suite of tools it is using has prevented potentially unsafe seafood being sent to market, and averted many tonnes of wasted product. Mussels in the water will happily live on, gobbling through the algae but then quickly flushing themselves of the toxins once the bloom abates.

At Spring Bay's main marine farm near Triabunna, waters remained closed to harvesting until 5 January 2018, almost 17 weeks that included the entire peak demand period of Christmas and New Year.

Maintaining product supply during closures has been a critical issue for the sustainability of the business. On the supply front, the company moved to diversify production geographically by joining forces with a former competitor and long-time mussel grower in Victoria, Sea Bounty Pty Ltd. In a combined venture, they opened a new processing plant in Geelong, Victoria, in 2015. The arrangement provides both businesses with better certainty, two brands and a continuous supply of Australian Blue Mussels (*Mytilus galloprovincialis*) for domestic and international customers. F

MORE INFORMATION
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JOIN INVENTA AQUACULTURE OPPORTUNITY AUDIT

What are the next big opportunities in aquaculture? More than 90 species have been investigated in the past few decades but only a few have led to commercial outcomes.

The FRDC and CSIRO are conducting a joint audit of related Australian and international research, called INVENTA 2018, to better understand opportunities for and barriers to the development of aquaculture for new species.

Researchers, representatives of the aquaculture industry, investors and relevant stakeholders are all invited to take part.

CSIRO senior research scientist Tung Hoang is leading the project. He has extensive experience in aquaculture research both in Australia and South-East Asia.

Tung Hoang has already begun contacting aquaculture researchers and industry representatives in Australia and globally to collect information for the project.

MORE INFORMATION: Tung Hoang, CSIRO, tung.hoang@csiro.au; Joshua Fielding, FRDC, joshua.fielding@frdc.com.au

NEW MINISTER

Fisheries has a new federal minister. The Hon. David Littleproud has taken on the Agriculture and Water Resources portfolio from the Hon. Barnaby Joyce, as of 20 December 2017. The Assistant Minister for Agriculture and Water Resources, Senator Anne Ruston, remains the official ministerial contact for fisheries-related matters.

David Littleproud is the Member for Maranoa, Queensland, elected in 2016. Before entering parliament he worked in agribusiness across Queensland, a background that gives him an understanding of the important role of agriculture and small business in creating jobs and promoting economic growth across rural, regional and remote Australia.

AUSTRALIA DAY HONOURS

Colin Creighton, one of Australia's leading environmental scientists, has been recognised in the 2018 Australia Day Honours, as a Member (AM) in the General Division of the Order of Australia.

He received the honour for his "significant service to environmental science and natural resource management, particularly to marine biodiversity, coastal ecology, fisheries and sustainable agriculture".

Colin Creighton is an adjunct principal research scientist for the Centre for Tropical Water and Aquatic Ecosystem Research at James Cook University. His research focuses on coastal restoration ecology, especially for enhanced productivity of our catchments, rivers, estuaries, wetlands and nearshore-linked ecosystems.

He has contributed to research for the FRDC, including projects on climate change, habitat planning and management.

Other fisheries-related honours were awarded to Tasmania's Jason Garrett (AM) for significant service to fly fishing and tourism, and to ocean and climate change scientist Trevor McDougall (AM) from New South Wales.

Vale Professor Joe Baker

Pioneer of marine pharmacology Joe Baker died on 16 January 2018. During his long research career he worked tirelessly to ensure the sustainable management of natural resources in the water and on land.

He founded aquaculture and marine biodiscovery research at the Australian Institute of Marine Science (AIMS) in Townsville, Queensland. This has enabled AIMS to contribute significantly to the growth of the prawn aquaculture industry in Queensland and led to the discovery of two chemical compounds in sponges that are in pre-clinical trials as potential anti-cancer drugs. In 2011, the Australian Marine Sciences Association recognised his outstanding contributions.

PROMOTING FISHERIES RESEARCH

Do you want to learn how to communicate your research to the public effectively?

The FRDC will hold writing workshops for researchers to help better promote fisheries and aquaculture to the general public.

Workshops in collaboration with Coretext (*FISH* magazine's publishing house) will be held in Sydney, Port Stephens and Brisbane. Other locations can be considered if there is sufficient demand. The one-day events will cover writing for and explaining your research to a non-scientific audience and taking great photos to make your work stand out.

To be notified about workshop dates or to have your research showcased in our 2018 media campaign, please contact the FRDC's Ilaria Catizone (ilaria.catizone@frdc.com.au). F

ECOLOGY

The brightly coloured male Redfin Blue Eye.
Photo: Adam Kerezsy

Spring survivors

The three-centimetre-long Redfin Blue Eye (*Scaturiginichthys vermeilipinnis*) is Australia's rarest fish. Wild populations are found in only one location. Their total habitat consists of four springs, which are part of the Great Artesian Basin system that feeds Lake Eyre. The springs make up about 4000 square metres found within the Edgbaston Reserve (formerly Edgbaston Station), 140 kilometres north-east of Longreach, in Central Queensland.

The springs are home to a world of unique creatures in addition to the Redfin Blue Eye, including snails, crustaceans and plants. Isolation, stability and environmental variance create the perfect conditions for rapid speciation.

The species is included in the International Union for Conservation of Nature's list of the world's 100 most critically endangered species. Redfin Blue Eye is also listed as endangered under Australian and Queensland legislation.
More information: Bush Heritage Australia, www.bushheritage.org.au

TECHNOLOGY

MARINE LITTER TRACKING TOOLS

Fishers are on the front line of the marine debris and ocean plastic pollution issues that have received increased public attention during the past year. Several smartphone apps are available to record what is found and where, as part of global efforts to track and prevent further pollution in our oceans, rivers and lakes.

Two apps that have global databases and are available for both iOS and Android operating systems are Global Alert – Floating Trash and Marine Debris Tracker. The first focuses on where trash is accumulating, the second collects more detailed data about types of rubbish found.

Global Alert has been produced by conservation group the Ocean Recovery Alliance. Its primary aim is to identify 'hot spots' in need of clean-up and priority locations for long-term rubbish catchment devices. You can upload real-time smartphone data and photos to the database. It helps coordinate clean-up efforts and also alerts government officials to larger issues surrounding waste management.

Global Alert is officially endorsed by the World Bank's Global Partnership for Oceans as the official trash hot-spot reporting app.

The Marine Debris Tracker smartphone app logs the type of trash found on our coastlines and waterways, including fishing gear. It provides a list of common items established by a range of organisations. There is no Australian group among those registered to date, but GPS tracking allows items to be logged anywhere in the world using a smartphone. Via the Marine Debris Tracker website you can view your own data or global data, which are mapped anonymously using the GPS coordinates. You can also share your tracking data through a story on social media.

Marine Debris Tracker is a joint effort of the NOAA Marine Debris Program and the Southeast Atlantic Marine Debris Initiative at the University of Georgia College of Engineering.
More information: www.marinedebris.engr.uga.edu

WORD WISE

SIGNIFICANT

'Significant' is one of those red-flag words for researchers. The problem is that people regularly use the term 'statistically significant' to show that a finding is important or noteworthy. But it actually means something very specific: that a result is unlikely to occur by chance. It does not necessarily reflect how meaningful the finding is.

"If a scientific experiment is set up correctly, then a statistical significance might reveal a lot," according to www.futurism.com, in 'The seven most misused words in science, according to scientists'. "If the experiment is set up poorly, as is the case with many pseudosciences, then significance doesn't mean anything because all of the variables weren't controlled."

IN PRINT

THE CATCH: THE STORY OF FISHING IN AUSTRALIA

Indigenous, recreational and commercial fishing and aquaculture – there is a place for it all in Anna Clark's comprehensive history of fishing in Australia.

Bringing her personal passion for throwing in a line, author Anna Clark celebrates the enduring pleasure of fishing in *The Catch: The Story of Fishing in Australia.* This book charts the history of fishing, from the first known accounts of Indigenous fishing and early European encounters with Australia's waters to the latest fishing fads; from the introduction of trout and fly fishing to the challenges of balancing needs of commercial and recreational fishers. As a general history of Australian fishing it also incorporates the involvement of women in fishing, from Indigenous catches through to game fishing, with historic illustrations, articles and advertisements also documenting the progress of the sector. **Available from the National Library of Australia (bookshop.nla.gov.au). RRP $39.99**




Photos: Courtesy Colin Barker

Boathouse on Blackwattle Bay executive chef Colin Barker prepares fish using dry-filleting techniques in the kitchen at his Sydney seafood restaurant. All fish at the Boathouse are dry-filleted, Colin says, because they then have a much longer shelf life and respond better to cooking processes.

The dry argument

Rising demand for high-quality product includes a focus on processing and preparation techniques to optimise flavour, shelf life and handling

By **Andrew Cooke**

Given that fish spend their entire lives in water, it may come as a surprise that they can be badly affected by the same substance – particularly the chlorinated variety – when they are being prepared for dining tables.

Most Australian fish are processed using fresh water at some point, and there is an inherent cost in that.

"Fundamentally, fresh water is the antichrist to fish quality during processing," says seafood marketing consultant and industry adviser John Susman. "It removes the oils that produce much of the flavour, it affects the texture and it shortens the shelf life of the fish."

"In the industrial process, wet processing is easier, quicker and more efficient. But chefs these days are looking for a higher quality product, so there is a renaissance in commitment to dry processing. It is more time consuming, but it results in a better quality eating product.

"Dry filleting is effectively the butchery of fish without the presence of water. It's obviously a fairly messy process – there's scales, guts and gills – so it requires a bigger commitment to the process."

While some processing factories use salt water to help minimise the problem, this is not always possible. "In any processing plant you will generally see fish and fillets floating in fresh water," John Susman says. "That means there is water uptake by the fish and there are temperature changes. And seafood is so fragile that this can really shorten the shelf life."

Tony Wearne, a buyer at Sydney wholesaler Nicholas Seafood Traders, says about 80 per cent of his company's product is wet filleted – primarily because it is easier and quicker. "But we also have a sashimi bar and our own restaurants, and all of the fish for those is dry filleted," he says.

"It really depends where the product is going. There are people who are processing bulk amounts of fish who do all wet filleting; then there are niche wholesalers who supply top-end restaurants and they only do dry filleting.

"The dry process takes a lot longer because you have to wipe the fish down with paper towels and you have to clean surfaces and equipment without water. This means that there will be a cost difference between the two processes, simply because of the time that dry processing takes. It can take up to twice as long in some instances."

The executive chef at leading Sydney seafood restaurant The Boathouse on Blackwattle Bay, Colin Barker, says longer shelf life is one of the main reasons that all fish are dry filleted in-house. "We keep chlorinated tap water well away from our fish, and it can last seven to nine days in our static fridge, which hovers around 0.5°C, with no deterioration in skin or flesh quality. Wet processing severely reduces that.

"Also, dry-filleted fish behaves better in the pan. If you are cooking skin-on Barramundi, for example, and you have eliminated water from the start of the process, it is easier to handle and you end up with a crisper, drier final product."

Colin Barker says most suppliers provide dry-filleted fish on request. "But we have hinged our reputation on dry-filleted fish and we take it very seriously, so we do it all ourselves. Recently, more people in the restaurant industry have started receiving or preparing dry-filleted fish and it was a real 'wow' moment for them. Customers are becoming much more aware of it too."

Colin Barker says the degree of quality deterioration after contact with fresh or chlorinated water varies between species. "Fish with higher oil content – the salmonids, for example – react more to water than others. As soon as they come into contact with chlorine it dramatically shortens the shelf life." F

MORE INFORMATION
www.frdc.com.au/en/About-us/Corporate-documents/Annual-reports
FRDC RESEARCH CODES: 2010-200, 2016-134

New fishery founded on smart investment

Targeted investment has helped kickstart a new *Octopus tetricus* (pictured) fishery in Western Australia. Photo: WA Department of Primary Industries and Regional Development

Evaluating the impact of research will help to maximise the outcomes for future funding

By **Catherine Norwood**

The 'Innovative development of the *Octopus tetricus* fishery in Western Australia' project was completed in 2016 with a total of $890,000 in funding from all sources (in present value terms), including the FRDC and WA Department of Fisheries. That is a benefit–cost ratio on the investment of 7.2:1, as highlighted in the impact assessment conducted in 2017 by Agtrans Research and Consulting for the FRDC.

The impact assessment has demonstrated how a relatively small investment can 'kickstart' a whole new industry, and is part of a broader program of impact assessments the FRDC is undertaking to maximise funding outcomes.

The assessment uses a time frame of up to 30 years from the last year of investment for accrued benefits, with impact categorised into a triple bottom line framework (Table 1). Past and future cashflows were expressed in 2016-17 dollar terms.

A three-year research investment of less than $1 million is expected to generate benefits of more than $6.4 million to the Australian fishing sector in the coming years. It has also helped Western Australia improve its resource management and provided scientific evidence to support the growth of a new fishery in the state.

The benefits of the project and the expansion of the fishery are expected to accrue principally to the octopus fishery and its licence holders. However, the improved resource management also provides environmental benefits, with wider social benefits accruing from increased regional income.

Table 1: Triple bottom line categories of impact from the research into innovative development of the *Octopus tetricus* fishery in Western Australia

Economic	→ Increased profit due to larger octopus catch. → Improved beach prices as a result of consistent catch. → Cost savings from the matching of gear and boat operation to a more consistent catch. → Increased lobster catch due to reduced octopus predation.
Environmental	→ Improved resource management with more accurate data used to set sustainable octopus catch.
Social	→ Increased regional income along south and west coasts of Western Australia. → Additional revenue for the Western Australia Government from licence fees in the new octopus fishery. → Increased octopus research capacity and research techniques that can be applied in other Australian and overseas cephalopod fisheries.

Source: FRDC Annual Report

Octopus resource

The octopus research project was initiated on the back of fisher-driven innovations, specifically a new trigger trap that was 15 times more efficient than traditional open shelter octopus pots.

The trigger traps were introduced commercially in 2010 and the catch in the Western Australian Developmental Octopus Fishery increased 260 per cent in just one year – from 33 to 119 tonnes. By 2012 the traps were the dominant gear type, producing 95 per cent of the catch, and by 2013 the number of fishers targeting octopus had increased to 17 vessels, up from six vessels in 2009.

This surge of interest in commercial octopus fishing saw vessels operating from Kalbarri in the state's north to Busselton in the south, at depths of 40 metres or more. Traditional open shelter traps are generally limited to much shallower waters.

The research into the *O. tetricus* species and the initial biomass assessment for the fishery identified considerable room for growth, from development stage through to the current interim management stage, moving towards a fully managed fishery as more data about octopus populations becomes available.

The project estimated the harvestable area with the new, more robust traps to be 34,000 square kilometres, with the potential to sustainably increase annual harvests from 200 tonnes to more than 1000 tonnes a year. The research also validated the effectiveness of the trigger traps compared with open shelter traps.

The study was the first of its kind to age a wild population of octopus, developing a new rapid ageing protocol that can be applied in other octopus fisheries.

Ageing octopus

Octopus stylets – the reduced remnant internal shells found in the mantle musculature of many octopus species – have concentric rings that can be used to estimate age. The technique is similar to using fish otoliths (ear bones) to directly age animals, but it is time consuming and requires specialist equipment and considerable expertise.

In this project researchers validated a strong relationship between the number of growth rings in a stylet and the stylet weight. Using stylet weight as a proxy for age they were able to rapidly and reliably age 3500 octopuses.

Maximum age was calculated at about 1.5 years for both males and females, with males maturing at 240 days or so compared with 380 days for females.

Testing the trigger traps showed that 75 per cent of their catch was mature males of more than one kilogram; traditional shelter pots caught a mixture of mostly immature males and females weighing less than one kilogram. This high selectivity for adult males effectively protects the reproductive capacity of the fishery. Spawning was also found to occur throughout the year with six-monthly hatching pulses during transitional temperatures.

The impact assessment of the 'Innovative development of the *Octopus tetricus* fishery in Western Australia' project is one of 20 conducted in the first year of the FRDC's five-year program to evaluate its research, development and extension portfolio. The average benefit–cost ratio of the 20 projects was about 4.5:1.

The Industry and People Programs reported the best performance, with a benefit–cost of up to 9.7:1 while the Communities Program had no quantified benefits. F

More impact assessments are reported in the FRDC's 2017 Annual Report on the FRDC website (www.frdc.com.au/en/About-us/Corporate-documents/Annual-reports).

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FRDC RESEARCH CODES: 2016-407, 2017-058

Voyage to an electric future

Smarter technology could be the drawcard that brings new respect and a new generation to the fishing industry

Story and photos by **Brad Collis**

Dennis Holder is a career fisher, a 31-year veteran of fishing for Blue Swimmer Crab off the South Australian coast. In that time he has owned 11 boats, two of which he built and project managed, progressively modernising and innovating to keep in step with changing environmental, regulatory and consumer influences.

But with each progression there has remained a seemingly unresolvable issue: the high cost of running diesel motors, and also more recently his awareness of their hefty carbon footprint. The issue came to a head in 2010 when he built his latest boat, *Silver Spectre*, a state-of-the-art 24-metre vessel able to harvest about 250 tonnes of Blue Swimmer Crab a year.

"We'd built this fantastic boat, incorporating all the experience-based improvements we had made through the succession of boats we have operated, but were still handicapped by the motors. We agonised for months on what motors to install and even after this deliberation, the two engines we eventually selected were still going to cost us $10 an hour just in repairs and maintenance," Dennis Holder explains.

"Because of the long periods of idling when pulling crab pots we knew we would be burning out injectors about every 1500 hours … so we came to the inevitable question: what else can propel a boat?"

That simple musing launched Dennis Holder onto an extraordinary journey of discovery that has brought him to the point he is at today: building Australia's first commercial diesel–electric fishing vessel. It has also caused him to reflect deeply on the industry's standing in society and the role that technology could play in reviving its reputation and morale.

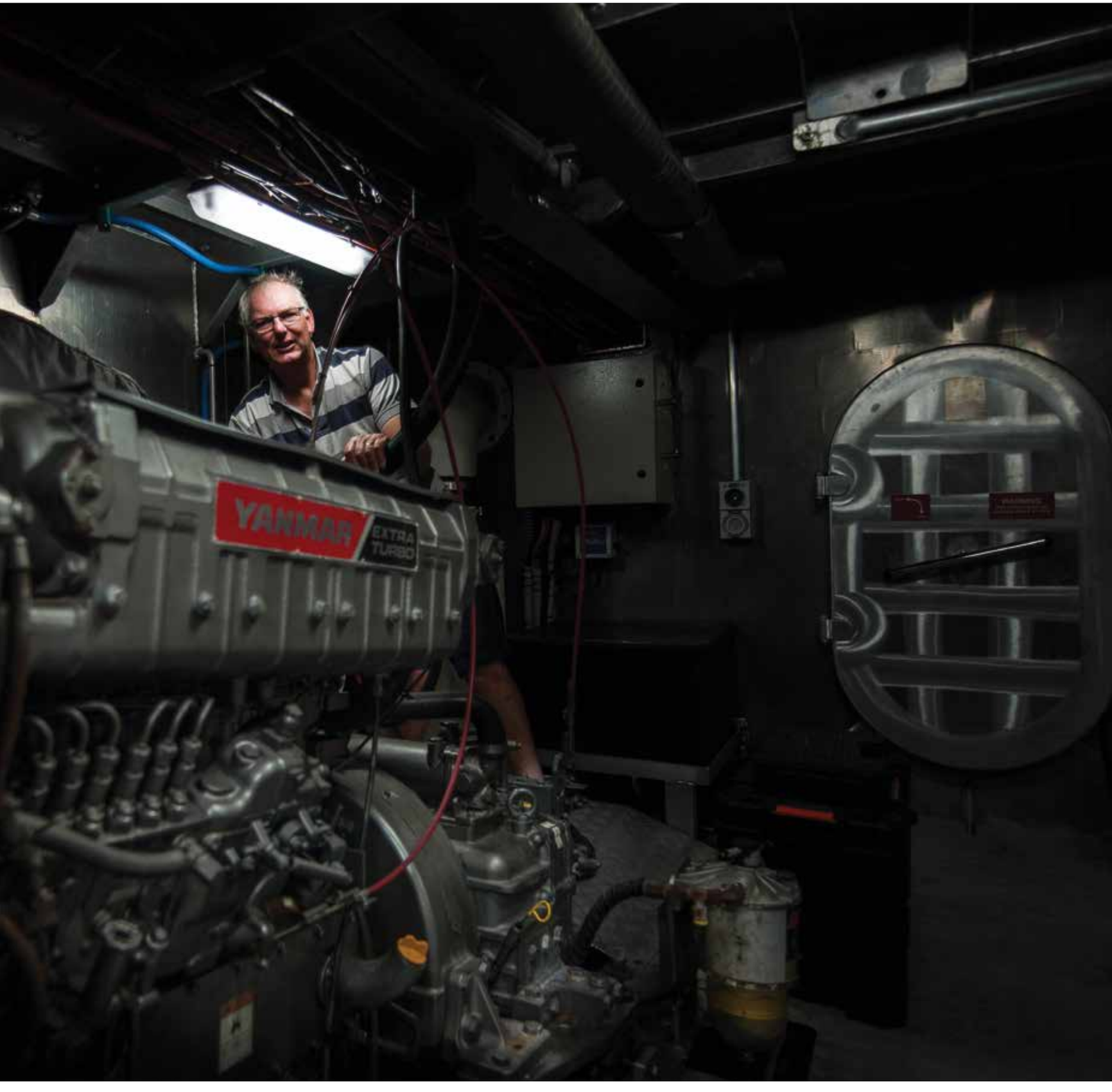
His initial search for alternative engines was on the internet, where he found numerous pleasure boats running on electric motors and then finally a diesel–electric trawler built in Holland as part of a European Union investigation into 'greening' fishing fleets.

The reviews on the test trawler were outstanding – a 75 per cent reduction in diesel fuel consumption and a 70 to 80 per cent reduction in repairs and maintenance. It was clearly worth investigating further and his wife Karen encouraged him to apply for a Nuffield Scholarship to do so.

"Because of the long periods of idling when pulling crab pots we knew we would be burning out injectors about every 1500 hours … so we came to the inevitable question: what else can propel a boat?"

Dennis Holder

Dennis Holder – looking to replace his big diesels with a state-of-the-art electric system.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"I applied in 2015, not thinking I would be successful because at 52 I was over the age cut, but I was accepted as an FRDC scholar. It started a journey of inquiry into diesel–electric fishing vessels, but it has brought me to a far broader industry awareness."

Surprise finding

Dennis Holder travelled to Florida, The Netherlands, Norway, Iceland, Ireland and the UK, studying work being done on batteries, electric motors and power propulsion electrics. In his examination of the data he came across an unexpected, significant side benefit – a reduction in human fatigue.

"Take away the constant noise and vibration and the whole working environment is changed. I spent six hours on an electric-powered fishing boat in Norway (the first diesel–electric battery commercial fishing vessel in the world) and the operator said the reduced fatigue was allowing them to spend 20 per cent more time fishing. Their cod season is three months with no catch limits so this extra fishing time during that fixed period considerably increases his catch."

But this was only one aspect of Dennis Holder's journey: "My Nuffield project was titled 'Old men, older boats, electric drive power storage, and power generation in commercial fishing vessels'. And it was the first part of this description that began to worry me more and more – the age of fishers and the age of their boats … translating to a lack of innovation and 'get up and go'.

"I felt it was clearly connected to the overt negativity towards the industry from the community and governments over the past 30 years and the increasingly tough regulatory environment in the name of sustainability.

"In other words for the past 30 or so years our industry, in Australia and internationally, has constantly been hammered by people telling us how bad we are. So it's no surprise that we are not attracting young people or the new investment needed to stop the ageing process.

"It was actually heartbreaking to drill down through what started as a technical exploration and come to this realisation about a much more fundamental status affecting industry investment and innovation. Yes, there have been advances in equipment and fishing practices, but when it comes to our prime piece of equipment we, as an industry, are continuing to pour money into old boats."

So for Dennis Holder, modernising boats gradually became a much bigger objective than electric motors; it was about embracing technologies that would once more make the industry respected and valued – particularly when considering the world's population still relies on it for 30 to 40 per cent of its food protein needs.

Dennis Holder's *Silver Spectre* will soon have an electric sister ship.
Photo: Evan Collis

He describes his Nuffield journey as opening his eyes to this wider challenge, and also to opportunities. He became president of the peak industry group in South Australia, Wildcatch Fisheries SA, and joined the newly established national peak body Seafood Industry Australia as a director, where he says he has found like-minded visionaries.

Fish-X insight

In the meantime, he continued to pursue alternatives to diesel motors and became involved with FRDC's entrepreneurial program, Fish-X: "That really clarified the way we needed to proceed. We interviewed a lot of fishers, looking at barriers to people changing or upgrading their vessels with technology such as hybrid propulsion and the common feedback was, 'sounds good, but I can't risk being the first to try'.

"It became apparent that we needed a boat in the water proving, for all to see, what was possible and what could be achieved.

"This was the main lesson to come out of Fish-X … that we needed to show, not tell."

Dennis Holder started working with Oceantech Design in Adelaide to begin building a sister ship to *Silver Spectre*, but with one clear difference. It will be diesel–electric. The plan is to have two similarly equipped working boats so that anyone in Australia will be able to look at the costs of the conventional diesel boat and the costs of the diesel–electric and judge accordingly.

In his own business, based on what he has already observed, Dennis Holder is anticipating the diesel–electric will eliminate 80 per cent of his diesel consumption and about 80 per cent of repair and maintenance costs – a substantial amount of money.

For the sister ship to match the *Silver Spectre's* 880 kilowatts of power in the propeller he is looking at a 360-kilowatt diesel–electric set-up plus 600 kilowatt-hours of battery storage. The batteries would provide enough power for 10 operating hours pulling crab pots.

"Basically you head out in the morning, charging the batteries. Once you are on your fishing gear the diesel generator will be shut down and you'll be operating on batteries only, although we plan to supplement this with solar generation on the boat's roof.

"Our initial calculations suggest we can generate about 15 per cent of power needs on the boat, and the rest to come from the batteries, however the final battery and generating set-up will be determined once we've calculated all of the power requirements for machinery, refrigeration, lights, and the boat's electronics."

Dennis Holder, a 31-year veteran of blue crab fishing off the South Australian coast.

> "I think we are on the way back to again being a respected group as fishers in society, doing what we love to do – providing a high-quality protein to consumers – which remains a service the world will always need."
>
> Dennis Holder

The budget for the prototype vessel is $3.5 million, for which Dennis Holder will seek funding from his bank, NAB Agribusiness, through its Greening Fund. He says the bank has been quite open in its enthusiasm to finance the first such commercial fishing vessel in Australia.

In an article in *The Guardian* newspaper reporting on Dennis Holder's time on the Norwegian electric-powered fishing vessel, NAB's Head of Agribusiness South Australia and Western Australia, Matt O'Dea, described Dennis and Karen Holder as pioneers in sustainability. He expressed the bank's support for "the courageous ideas" that will create a more sustainable industry.

The diesel-electric sister ship will cost about 30 per cent more to build than a conventional diesel-powered boat, but Dennis Holder says he is working with an electrical design engineer on ways to reduce this differential because overlaying all of this is his burning ambition to showcase a modern, sophisticated industry that is embracing new technology, including technologies that reduce its environmental footprint.

Dennis Holder says he is optimistic because he senses the industry has already turned a corner. "There is a building optimism, partially driven by the television food culture which has driven home the message about knowing where your food comes from, and partially by an awareness that the recreational fishing sector must be accountable for its effort and catch rather than only having leisure activity as a benefit.

"When these two influences are combined, more and more commercial fishers can see a light at the end of the tunnel and are now worrying less and less that it's an oncoming train.

"I think we are on the way back to again being a respected group as fishers in society, doing what we love to do – providing a high-quality protein to consumers – which remains a service the world will always need." F

The *Austral Hunter*, Austral Fisheries' new prawn trawler. Photo: Austral

Building better boats

The latest additions to Australia's fishing fleet are lighter and faster, and have more capacity and improved working conditions

By **Ilaria Catizone**

Increased confidence in the future of the Australian fishing sector is generating a new wave of capital investment to upgrade the status of the fleet. Top priorities for those taking this major financial plunge are improved workplace safety and more cost-efficient fishing.

Safety was the number one priority for family-owned business Abbott Fisheries, which recently invested in a new catamaran to replace an older boat and to expand its operations out of Narooma on the New South Wales south coast.

Future stability

"We decided to buy now because we couldn't supply enough fish for our second business – Narooma Seafood. This will also support our growing families into the future," says Hayley Abbott, who is managing director of both Abbott Fisheries and Narooma Seafood. Their fish are harvested from NSW and Commonwealth waters and sold for export and direct to customers at farmers' markets on the south coast of NSW and Canberra.

The Abbotts chose a catamaran to replace their previous mono-hulled steel boat built in 1972. The new vessel has increased stability and reliability with two motors. The aluminium construction is lighter, offering improved fuel efficiency and also reducing maintenance – all features that allow them to travel further and faster.

It also features a working area designed to easily move gear and heavy objects on the large sheltered deck, making the work environment safer than on their previous boat. The improved design means the boat can also hold more fish, and allows for the potential to process the catch on board as a future option.

Below The Abbott family with its new catamaran *D&D*.
Photo: Stan Gordon, *Narooma News*

The family named the 23-metre boat *D&D*, after their grandparents Des and Dottie Creighton, who started the business in 1949. The *D&D* was built in Adelaide and fitted out locally in NSW. "We wanted to try and keep it within the community and help support Australian families," explains Hayley Abbott.

Resource confidence

Having his new boat built locally was also important for Western Australia's Bruce Cockman, who found it easier to deal with people he knew. He fishes for Western Rock Lobster out of the Port Denison marina at Dongara, south of Geraldton. Most of his catch is destined for China. His aim is to deliver higher volumes of catch during the Chinese festival season when rock lobster prices are highest.

A better understanding of what is happening with rock lobster populations based on monitoring the recruitment into the fishery, fisheries management changes and his own personal circumstances have all combined to give Bruce Cockman the confidence to invest in a larger boat.

"The fishery went to quota (catch limit) in 2010 and we've had good lobster recruitment in 2013 and 2016, so this is a good time to maximise returns," he says. "Plus, I am 50 years old now so it is good to get the boat while I can still use it."

His new vessel is 24.85 metres, replacing an older 22-metre model. It includes better quality crates, which are more comfortable to handle and hold more live lobsters. This results in handling efficiencies and a better-quality product.

"The old boat was 25 years old and still rolling along well, but we wanted more capacity. The new boat holds six tonnes of rock lobster that will be delivered to the Geraldton Fishermen's Co-operative."

Northern expansion

Management changes resulting in quota increases also informed Australia Bay Seafoods' decision to expand and upgrade its fleet. Operating as part of the finfish trawl fishery in the Northern Territory, Australia Bay Seafoods' fleet mostly catches Saddletail Snapper, Crimson Snapper and Sweetlips 250 to 300 kilometres from Darwin.

The business retrofitted a second-hand boat, with a state-of-the-art cooling system to provide better quality products to consumers. When the fish come out of the water at 30°C to 31°C, cooling them quickly to 1°C using an ice slurry and holding the temperature at between +/– 1°C can extend shelf life to 30 days.

"For this particular vessel we paid nearly $120,000 for an ice-slurry machine from New Zealand. The boys have their hoses with a couple of tonnes of slurry available to cool the fish right away. You need really good refrigeration," Australia Bay Seafoods' Bill Passey says.

Once the fish are released from the net into the hopper, conveyors take the catch into the processing room where it gets sorted by species and put into open-sided bins with lids, stored into brine tanks. Once the fish's core temperature reaches 1°C, it is essential that it does not fluctuate. This means having faster conveyers and monitoring the temperature of the tanks, adding more slurry as needed.

"Brine tanks are not a new concept," Bill Passey says. "All boats have them. But these are bigger and better."

Greater flexibility

The *Austral Hunter*, the new boat just built by Austral Fisheries, also represents an upgrade in safety, endurance and efficiency as well as the ability to use a range of packaging styles to respond to customer needs.

Austral's new boat is a 30-metre prawn fishing vessel, the first northern prawn fishery boat built in almost 30 years. This is an addition to the existing fleet and the company plans to build more boats in the near future.

"The *Austral Hunter* was built in Mauritius where we have a solid relationship with the boat builder CNOI, but our refrigeration, electrical, electronic and hydraulic systems were all supplied by the Australian companies that we work with," says David Carter, CEO of Austral.

This new trawler provides increased fuel efficiency and, being bigger, it has the capacity to store more catch. "The larger size grants us much more freedom. We don't have to keep stopping to unload. Psychologically it keeps the catching momentum going for the crew," he says. **F**

> "We decided to buy now because we couldn't supply enough fish for our second business – Narooma Seafood. This will also support our growing families into the future."
>
> Hayley Abbott, managing director of Abbott Fisheries and Narooma Seafood

MORE INFORMATION
The Western Australian Fishing Industry Council's series of seafood posters and educational resources can be found at wafic.org.au.

Engineering new seafood opportunities

While fishers are proud producers of an essential food, research is identifying new processes that have the potential to increase marketability and bring more of the local harvest to our tables

By **Catherine Norwood**

Emerging food and processing technologies, along with the adaptation of existing processes, suggest new ways that Australia's seafood sector can make more of its catch and reduce waste.

With an estimated 25,000 tonnes of seafood that could be caught left at sea each year, and another 59,000 tonnes of processing waste created from the 170,000 or so tonnes of seafood that is farmed or harvested, there is huge potential for Australia to increase returns from its fisheries resources.

Collating these figures and identifying potential opportunities has been the focus of the FRDC-funded post-harvest research program, which includes several projects led by Janet Howieson at Curtin University in Western Australia.

The 'unfished' allocations represent more than the total wild-harvest catch from New South Wales and Victoria combined. But part of the challenge in bringing this catch home is that the unharvested fish are not all the same species, and they are not all in one place waiting to be caught. Additionally, some of these species only occur in very small numbers, making fishing efficiencies very difficult to achieve.

Janet Howieson has identified 107 underutilised species, which are scattered around Australia's 36,000-kilometre coastline. The review (completed in 2016) focused on species where less than half of the allowable catch was actually harvested, or the value of the catch was less than $6 per kilogram. That is a potential value of about $150 million to the national economy at that time, or more if prices could be increased.

Advice from seafood marketing experts prioritised 42 species from the initial list as 'commodity' for high-volume export, or 'premium' for lower-volume domestic consumption.

In some cases, the fresh fish market has taken up the challenge to raise the profile of species. Pilbara-region finfish including Bluespotted Emperor, Frypan Bream and some Tropical Snappers have increased their profile, partially as a result of the research project, and have been enjoying broader support from consumers.

In an aligned sub-project the Western Australian Fishing Industry Council (WAFIC) produced an education package about the underutilised species with posters, recipe cards and lessons for school students.

Janet Howieson's work on Western Australian Salmon (unrelated to Atlantic Salmon) has meanwhile highlighted both potential opportunities and barriers. The species is generally beach-seined, with a relatively short harvest season. As a case study for the underutilised species research, best-practice handling procedures to preserve the flesh quality and flavour of the fish were developed.

New products trialled from fish harvested this way included canned fish, smoked fish, fish in oil, fish burgers and premium pet foods, as well as premium fresh fish for export and for domestic restaurants. Well-known WA chef Peter Manifis generated interest in the species at several local restaurants. However, due to the short season it was difficult for fishers to maintain supply of quality fish to sustain the interest.

These logistical issues are shared by many other similar fisheries.

Offshore harvesting and processing, including freezing – not a current practice – might also be considered to provide a longer harvest and supply period and consistently higher quality fish. Currently, there may not be enough regional freezer capacity to hold all the harvested fish, should much larger amounts be landed, Janet Howieson says.

In addition to the 'New Opportunities for Underutilised Species' project, she has also worked on 'New Opportunities for Seafood Processing Waste' and 'Waste Transformation for the Catering Market' projects for the FRDC.

In developing new products from waste and underutilised species, the research team has tapped into the considerable expertise and specialised equipment of the broader food-processing sector around Australia, including private operators and other research groups such as CSIRO. The aim has been to develop 'investment-ready' seafood opportunities.

Janet Howieson says some of the technologies trialled to add value, such as hydrolysis or high-pressure pasteurisation, could be applied equally across fresh seafood and waste streams.

"However, despite good outcomes from the product development phase of the trials, there are often practical or cultural barriers that limit the commercialisation of new products and markets," she says. Distances between harvesting, processing and markets as well as species diversity are among the major issues to overcome in making more of both underutilised species and processing waste.

Volatility within the fishing sector also plays a role, with short seasons for harvesting and limited regional infrastructure for processing and storage. Fluctuating prices and seasonal conditions may also lead fishers to chase the highest price available in the moment, instead of uncertain and potentially lower longer-term returns from new products. Maintaining a consistent, commercially viable supply of quality raw material is one of the greatest barriers to commercial success.

The poster produced by WAFIC: Efforts towards making more of underutilised species and increasing returns for fishers include improving handling protocols and raising the profile of these species in the marketplace.

"It can be difficult for smaller fishers or seafood processors to initiate the changes needed, to secure finance and to develop feasible marketing and distribution requirements. And even where we develop new processes, or tailor applications for a specific species, and provide proof of concept, success depends on having the commitment of the harvest industry, as well as whole-of-supply-chain commitment, including logistics, distribution and marketing channels," Janet Howieson says.

She says future research in this area may fall within the scope of the proposed Fight Food Waste and Fraud Cooperative Research Centre (CRC), which has made a bid for federal funding. The FRDC is a major supporter of the CRC bid, and an announcement is expected in March. F

A GUIDE TO SEAFOOD VALUE-ADDING TECHNOLOGIES

Processing technologies standard in other food sectors are now being adapted and trialled for the seafood sector through a range of FRDC post-harvest and waste-prevention research projects. Fishers and processors are encouraged to consider whether trialled technologies might have applications that could improve the value or reduce the costs of their products.

Fish handling to improve quality

Handling protocols that preserve the quality of seafood have the potential to take a product that would otherwise be rejected, raise the price and put it on the 'preferred' or 'premium' buying list. Harvesting processes, including killing techniques, the use of sanitisers to control spoilage bacteria following harvest, and consistent, best-practice cold-chain logistics, all influence flesh quality and shelf life. Improved protocols to lift quality have been developed for Australian Salmon, Australian Sardines, pearl oyster meat and a variety of finfish from the Pilbara region.

Paspaley Pearls is among the companies that has implemented improved handling protocols to ensure pearl meat, previously considered simply a byproduct of pearling, is handled to meet food safety standards, including export standards, with new premium value-added products expected to be launched in 2018.

Injection technology

Injection technology is widely used in other food industries, often for applications such as infusing meats with marinades. In the case of seafood, Janet Howieson has worked with Australia Bay Seafoods as a seafood supplier and Catalano's Seafood as a processor to adapt injection technology specifically for Saddletail Snapper.

The aim has been to stabilise flesh quality and address a 'tough texture' issue that plagues the fish, and which only becomes evident when the fish is cooked. The new injection process

appears to provide a consistent eating quality in all fish, improving marketability of the species.

Hydrolysis

Acids and enzymes have both been used in seafood trials to break down larger protein molecules into smaller components, generally to turn a 'waste' product into something more useful, or enable it to be disposed of more effectively. In the Curtin University research program, enzymes have been the preferred catalyst, because they provide more consistent end products.

In one food-related project an enzyme-based process was able to convert second-grade mussels into a potentially marketable mussel stock product.

In another waste treatment project, the South Australian fish processor SAMPI was able to move from an acid-based hydrolysis process to a faster enzyme process that also produces a higher quality liquid product. Saleable products from the process include soil conditioner, aquafeed ingredients and fishing berley.

A small enzyme hydrolysis unit has also been developed, capable of breaking down up to 50 kilograms of mixed-species seafood waste, with the final hydrolysed product suitable as a liquid fertiliser. Trials of the unit are still underway, with some modifications being made, but this could offer small seafood businesses and fishmongers an alternative to landfill for their waste.

The hydrolysis process allows specific chemical components to be extracted for further testing of functional properties. This has been the case for cold-tolerant enzymes extracted from hydrolysed Patagonian Toothfish heads, provided by Austral Fisheries. A multinational detergent manufacturer is now looking at the functionality of the extracted enzymes for use in cold-water washing detergents.

High-pressure pasteurisation

Operating at temperatures of 15°C to 20°C, this process uses pressure at increasing rates to achieve different end results. For the seafood sector, three different applications have been identified: the easy shucking of shellfish, meat extraction and extended shelf life.

In trials with Fresh Produce Alliance, a private operator at Manjimup in Western Australia, packaged seafood – both raw and cooked – was processed under high pressures in cycles of two to 10 minutes. High pressure proved a viable option for the easy shucking of seafood, particularly oysters and abalone. Pressure at 250 to 350 pounds per square inch breaks the muscle that holds the animals to their shells. When the oysters or abalone are unpacked, the meat simply slides out of the shell – no knives required.

A preliminary trial provided reasonable meat extraction of intact portions of raw meat from the claws of Champagne Crab. This could improve the meat recovery and marketability of the species, which can be difficult to handle because of its small spines and hairs.

Higher pressures of up to 650 pounds per square inch effectively kill most organisms present in the meat, and this process was able to extend the shelf life of cooked crabmeat from five days to four weeks. A chilled, packaged, cooked crabmeat product with an extended shelf life was developed using this process and it was a finalist in the 2017 Delicious Produce Awards, with further trials and commercial production proposed in 2018.

The trials did show that high-pressure pasteurisation may affect texture, colour and other sensory properties so individual detailed product development is needed to optimise opportunities from this technology.

Protein separation

Fillet recovery rates for finfish vary from 30 to 50 per cent. However, mechanical meat separation technologies applied to filleted fish frames and other seafood 'waste' has recovered more than 20 per cent of the protein from the waste portions.

Trials used a drum separator with sieves ranging from two to 10 millimetres to produce mince of varying grades and 'chunkiness' from a variety of finfish, which could then be used to create new products such as fish cakes or croquettes, or potentially for use in high-temperature extruded products (see below).

A successful variation of this technology has also been applied to crustaceans, where a finer mince of low-value Coral Prawns was mixed with larger 'chunks' of King Prawns to produce King Prawn cakes, which were sold in local supermarkets. (Production was suspended when prices for all local prawns increased following the White Spot Disease outbreak in Queensland and a ban on imported prawns.)

Screw press technology was also trialled and improved the texture of cooked and thawed seafood meat. It effectively squeezes the water from the flesh, which enhances the flavour and texture of the meat for use in other products.

Reforming technologies

Once seafood protein has been extracted from processed frames, a variety of technologies can be used to reform it into useable portions.

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FRDC RESEARCH CODES: 2013-711.30, 2013-711.40, 2014-704

Ingredients used to create a high-value retail product from recovered fish protein that would normally be discarded as waste.

Photo: Andrew Molyneux

"In developing new products from waste and underutilised species, the research team has tapped into the considerable expertise and specialised equipment of the broader food-processing sector around Australia including private operators and other research groups such as CSIRO. The aim has been to develop 'investment-ready' seafood opportunities".

Cold-set binding

Commonly used in meat processing, cold-set binding allows for the 'restructuring' of raw meat proteins into portions that can be cooked and used in similar ways to fresh cuts of meat.

Preliminary trials with CSIRO, later modified in trials at commercial food processing facilities, identified alginate products that provide an effective 'glue' to bind seafood mince recovered from fish waste into useable portions that could be 'sliced and diced'. Crumbing portions was found to further protect the flavour and texture of the final product when thawed from frozen, which otherwise deteriorated. Further work is required to optimise the final product.

High moisture extrusion

Extrusion technology is widely used in the food sector, creating products that range from breakfast cereals to pet foods. Raw ingredients are shaped as they are cooked at temperatures of 100°C or more.

In trials with CSIRO, finfish and crabmeat were processed at up to 120°C. The major challenge to be overcome was the high moisture content of seafood – initially about 80 per cent, with a requirement of 70 per cent or more in the final product.

The best result came from a trial using a mix of 'waste' fish protein that had been recovered through improved separation processes, which was then pureed and pre-mixed with other dry proteins to produce a seafood cake. The final moisture content was 75 per cent and the end product achieved both a good texture and flavour.

While more work is needed to refine the application of extrusion processes for seafood, the trials demonstrated that different ways of mixing and cooling were likely to solve the production challenges.

Surimi

While the recent research project did not trial surimi processing, one seafood company did send samples of reclaimed protein overseas for testing.

The commercial process for creating surimi was developed in Japan in the 1960s, but is based on almost 1000 years of traditional practice. It was originally a way to save unused fish by salting it and grinding it to a gel.

The modern surimi process is more complicated and uses sugar in gel formation to increase shelf life. It is now manufactured around the world, with products including fishcakes and crabsticks. F

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Fisher calls for management innovation

With an in-depth look at fisheries management regimes around the world, Wayne Dredge has come to a clear position on what is needed to encourage innovation and efficiency in Australia's fisheries

By **Annabel Boyer**

Wayne Dredge got more than he bargained for when he set out to travel the world on a Nuffield Scholarship in 2014.

From joining global discussions on food security to suffering malaria in Malawi, fishing in an Arab dhow and surveying the mind-boggling scale of cold storage in China, his study tour has expanded his world and changed his life in ways he could not have predicted.

It also changed the course of his intended research. When Wayne Dredge set out on his Nuffield tour in 2014, he sought to answer a specific question borne out of his experience as a fisher. His topic was to compare different hook fishing techniques being used around the world.

The aim was clear and simple: to identify alternatives to gillnets. Closures are applied to gillnet fishing due to interactions between shark gillnet boats and Australian Sea Lions and Common Dolphins. Alternative gear use could result in returned fisher access to available waters, and corresponding increase in catch and incomes.

Based at Lakes Entrance in Victoria, Wayne Dredge has fished in the Southern and Eastern Scalefish and Shark Fishery (SESSF) for the past 10 years. He owns two boats and spends five to six months at sea each year. Over the years, he has worked in squid, prawn, estuary, scallop and longline fisheries at different times, and he has also spent seven years in the Victorian and Tasmanian rock lobster sectors.

With the help of the Nuffield Scholarship, he planned to visit a plethora of fishing nations from countries in South and North America to the UK and Europe.

However, as he embarked on his journey, his perspective changed.

"As I began my research it became apparent that even if I did identify alternative methods it was unlikely they could have been implemented here in Australia without causing conflict with other fishing sectors or between fisheries management jurisdictions," he says.

Three years on and the report that resulted from his Nuffield research has been published. Titled *Innovation and Accountability in Commercial Fisheries: The case for reform of harvest and management practices for Australia's SESSF and related fisheries*, it makes a case for a thorough review and reform of Australia's management system.

Wayne Dredge says that his journey has shown him that Australia's fisheries excel on a range of indicators – they are innovative and environmentally conscious. But staying ahead requires continual progress.

"In effect, our regulatory structure here in Australia very much inhibits innovation, rather than encouraging it," he says. To illustrate, he points to his original research concern: fishing methods. Potentially viable alternatives to gillnets in Australia's SESSF are at odds with regulatory arrangements and so cannot even be considered.

Another example is the practice of discarding high-value fish due to licence restrictions, a regulatory issue resulting from Australia's Offshore Constitutional Settlements between the Commonwealth and states. It is a practice he says that both harms fishers and wastes a valuable resource.

Above An electronic pulse trawler operating overseas would not meet Australia's fishing regulations.

Right The Pike Place Market in Seattle, USA, is a popular outlet for local seafood.

Far Right Wholesale seafood for sale at the Barcelona seafood market.

Photos: Wayne Dredge

In the course of his travels Wayne Dredge took an in-depth look into the Integrated Groundfish Fishery (IGF) in British Columbia, Canada, and the case of European Union (EU) fisheries management.

Like the SESSF, these are multi-species fisheries with many stakeholders including external groups concerned about overfishing, waste and bycatch. Like the SESSF, they require sophisticated management solutions, and both places hold lessons for Australia.

"The key to resolving issues in Australia will lie in joining the dots that exist between

Below The catch from an electric pulse trawl.
Bottom Wayne Dredge visited a net-making factory in Belgium while researching alternatives to the gillnets used in Australia.

solutions being used in other countries and making those solutions relevant in an Australian context," Wayne Dredge says.

Canada's groundfish

In the mid-1990s, due to overharvesting and high grading, British Columbia's trawl fishery was completely shut down by Canada's Department of Fisheries and Oceans (DFO). It was eventually reopened subject to 100 per cent on-board observer coverage, the burden of which had grave economic effects for many in Canada's trawl fishing industry.

However, in 2006, the DFO accepted a proposal put forward by the industry to integrate all seven of British Columbia's fisheries as an integrated groundfish fishery under one management plan, with 100 per cent monitoring (on-board observer or electronic monitoring) and an individual transferable quota system.

Wayne Dredge says none of the IGF fishers he spoke with had wanted electronic monitoring on their vessels, but they now saw it as a positive step.

It makes fishers individually accountable by making their activities 100 per cent transparent. This means they can prove they are doing the right thing and that those doing the wrong thing can be individually penalised by authorities instead of punishing the entire sector for the actions of a few.

It also levels the playing field because all fishers can be certain that their counterparts in the fishery are complying with the same regulations.

Transferability of quota in a mixed-species fishery means fishers can eliminate discards and waste within the fishery by transferring the necessary quota for

STAND UP, BE SEEN

In the course of his Nuffield tour, Wayne Dredge was invited to the Food and Agriculture Organization of the United Nations (FAO) and attended its 2015 Committee on World Food Security meetings – a series of policy discussions about food security.

There he found himself the only person with a business background in fisheries and certainly the only fisher attending.

"The discussion was so far removed from what the real issues are facing farmers and fishers globally that I was extremely disillusioned by the entire process."

Yet he says this experience led to a breakthrough realisation that was really the defining moment of his entire Nuffield journey.

"If you are not part of the discussion, then you are also not part of the solution and the discussion only takes place between the people who bother to turn up."

He says he is continually surprised at how people, including farmers, dismiss the role of fisheries in the context of food security.

This visibility issue has ramifications for fishers and fishing at high-level discussions such as the Committee on World Food Security, but also in other ways. Consumers often have little understanding of the fishers who catch their fish, or their work practices. In Australia, despite the majority of fisheries being well managed and sustainable, this lack of visibility has harmful consequences to fishers' image and their wellbeing.

Wayne Dredge says the loss of human capital when young people choose careers other than agriculture or fisheries is one of the greatest issues facing the future of food security. For his part he is using his exposure at the FAO to push for policies that encourage young people to enter agriculture and fisheries-related careers.

He remained involved at the Committee on World Food Security in 2016 and 2017, and recently negotiated a partnership between the FAO and Nuffield to allow young people from both the agriculture and fishing industries to take part in more international events and even undertake short-term internships within the FAO at its offices around the world.

"One issue producers all around the world face is that our governments sign UN policy agreements that our nations then begin to implement within their own countries that impact on producers.

"While these initiatives are well intentioned, they are most often formulated without input from the people they affect the most. It is critically important that more people from small and medium agricultural or fishing enterprises become engaged in these processes," he says.

Right An electronic pulse trawl underway.

"If you are not part of the discussion, then you are also not part of the solution and the discussion only takes place between the people who bother to turn up."

Wayne Dredge

Biodegradable Plastic Hook prototypes at Mustad Autoline Factory in Belgium.

non-target species between vessels.

Currently, 300 Canadian vessels participate in the IGF under a single management plan with strict and fully accountable output controls in place for more than 70 species, with up to five management areas per species. There is only one logbook across all fishing sectors, streamlining data collection. All data collected, while managed by a private company, remains the property of businesses or vessels from which it is collected. Skippers and crew have also been trained to take on the role of on-board observers as the data can be validated through electronic monitoring and this brings down the cost for operators.

Wayne Dredge says learning about the traceability built into the IGF in Canada was a light-bulb moment.

"Australian fisheries are environmentally sustainable but don't do enough to prove it," he says. Fishers unload at a port and the fish they catch makes its way to consumers through myriad wholesalers and retailers. They are invisible to their consumers and this disconnect translates into a loss of social licence and understanding of their sustainability credentials and professionalism.

Management in the EU

In contrast to the positive turnaround for the IGF in Canada, Wayne Dredge's Nuffield report contends that EU fisheries provide an example of regulation imposed without industry consultation and guided primarily by political objectives.

EU fish stocks are a shared resource between the 28 member states, each of which has ownership over 12 nautical miles from their coastline. All other waters out to the 200 nautical miles line, which was the traditional exclusive economic zone for each member, is now common water that can be accessed by all EU fishing vessels who possess licences and quota for the respective region.

Member states all receive an annual quota for these common zones that is based on historical catch. The quotas, along with technical measures and input controls decided by the EU governance bodies, are the result of political rather than scientific processes.

Wayne Dredge says the discard ban imposed in 2014 is an example of those politics combined with restrictive regulations that make innovation impossible.

The discard ban ensures that all fish are retained on board, landed and counted against individual quota holdings. Fish that cannot be consumed by humans must be sold for fishmeal.

The theory behind the discard ban is that it will operate as an incentive for greater selectivity in fisheries. However, the technical measures that mandate specifications such as mesh size mean that fishers are without the flexibility that would allow them to achieve the improved selectivity the discard ban aims to ensure. This is a good example of rules inhibiting innovation and stopping fishers from making changes that achieve goals and their objectives.

With a lack of uniformity in accountability, compliance and transferability of rights, Wayne Dredge contends that the EU fishery can be compared with Australia's complicated system of competing management regimes.

Change in Australia

By seeing what works and what does not work in other regions, Wayne Dredge's report makes a range of recommendations for Australia's management system. In addition to a comprehensive review to examine conflicts and overlaps, he says that the case in Canada shows that 100 per cent electronic monitoring and a standard data collection platform are central to a management system that truly ensures the welfare of both fisheries and fishers.

While he admits that the recommendations he makes are politically unpalatable and thus challenging, he says the international case studies demonstrate how some of these things can be achieved.

Foremost among these is to ensure that reform should be led by the fishing sector itself. He says this can be achieved by providing a choice to the sector to develop a solution themselves or have one imposed on them by management, something that all fishers will be keen to avoid.

"The first need would be acceptance of the need for reform and this acceptance is not limited to just those within the fishing industry. Fishery managers, and indeed politicians whose portfolios cover fisheries, must also concede that while Australia's fisheries are in good shape environmentally, the way in which they are administered is outdated, counterproductive, inefficient and in contrast to a more ecosystem-based model.

"Without serious Commonwealth and state reform it is likely that conflicting political objectives will continue to hinder innovation and cause a greater loss of human talent from the industry than we have already seen." F

Wayne Dredge's Nuffield Scholarship was sponsored by the FRDC.

Nuffield scholar helps fishers make themselves heard

A focus on new opportunities to involve fishers in policymaking brings an international Nuffield Scholar to Australia

By **Ilaria Catizone**

Belgium-based policy specialist Kathryn Stack has been on both sides of fisheries policymaking.

While working at the European Parliament, she tried to develop solutions that would balance what seemed to be competing needs of fishers and non-government organisations.

And as managing director of Europêche, the representative body for European fishers, she was lobbying policymakers to ensure a better outcome for fisheries.

Finding better ways to help fishers get their voices heard is what brought her to Australia recently as part of a 16-week Nuffield Australia Farming Scholarship study tour. She is the first fisheries-focused international scholar; for most of its history the Nuffield Scholarship program has been country-specific.

Originally from England, Kathryn Stack is also exploring on her study tour how the political changes that will come with the UK's exit from the European Union (EU) will affect the country's fisheries.

Her Nuffield Scholarship has allowed her to travel to 12 countries to study the role of primary industry associations and how they can be most effective in engaging with decision-makers and the environmental lobby.

"I am looking at the role of industry associations and how influential they are in forging policy around the world. I am also studying the powerful role of the environmental lobby and how it is influencing decision-making," Kathryn Stack says.

She aims to help by providing fishers with knowledge about how to get their message across.

"A more engaged fishing sector will be of interest to all parties since it is the fishers themselves who have to make the rules work in practice. If they have a say at the start, the rules will be fairer and more balanced and compliance will increase."

In the EU, fisheries regulations can be very rigid, she says, and applying one set of rules to all 28 EU countries means that fisheries in many countries may not be operating as efficiently as they could.

Protecting national interests is a high priority and member countries are often competing with each other in the marketplace. While all EU countries have to abide by the same set of rules and often share fishing waters, fishers in each country have different operating zones and environments and they use different gears and vessels.

Kathryn Stack says for the UK, Brexit presents its fishing sector with a unique opportunity to forge its own policy, suited to its specific circumstances.

Her Nuffield study tour began early in 2017 in Brazil where she attended a seven-day, intensive Nuffield Contemporary Scholars Conference. She then joined 10 fellow Nuffield Scholars of diverse nationalities and agricultural professions on a Global Focus program, a seven-week intensive program of travel that visited Chile, the US, Canada, the Netherlands and Italy.

Above Kathryn Stack
Photo: Chelli Edri, FRDC

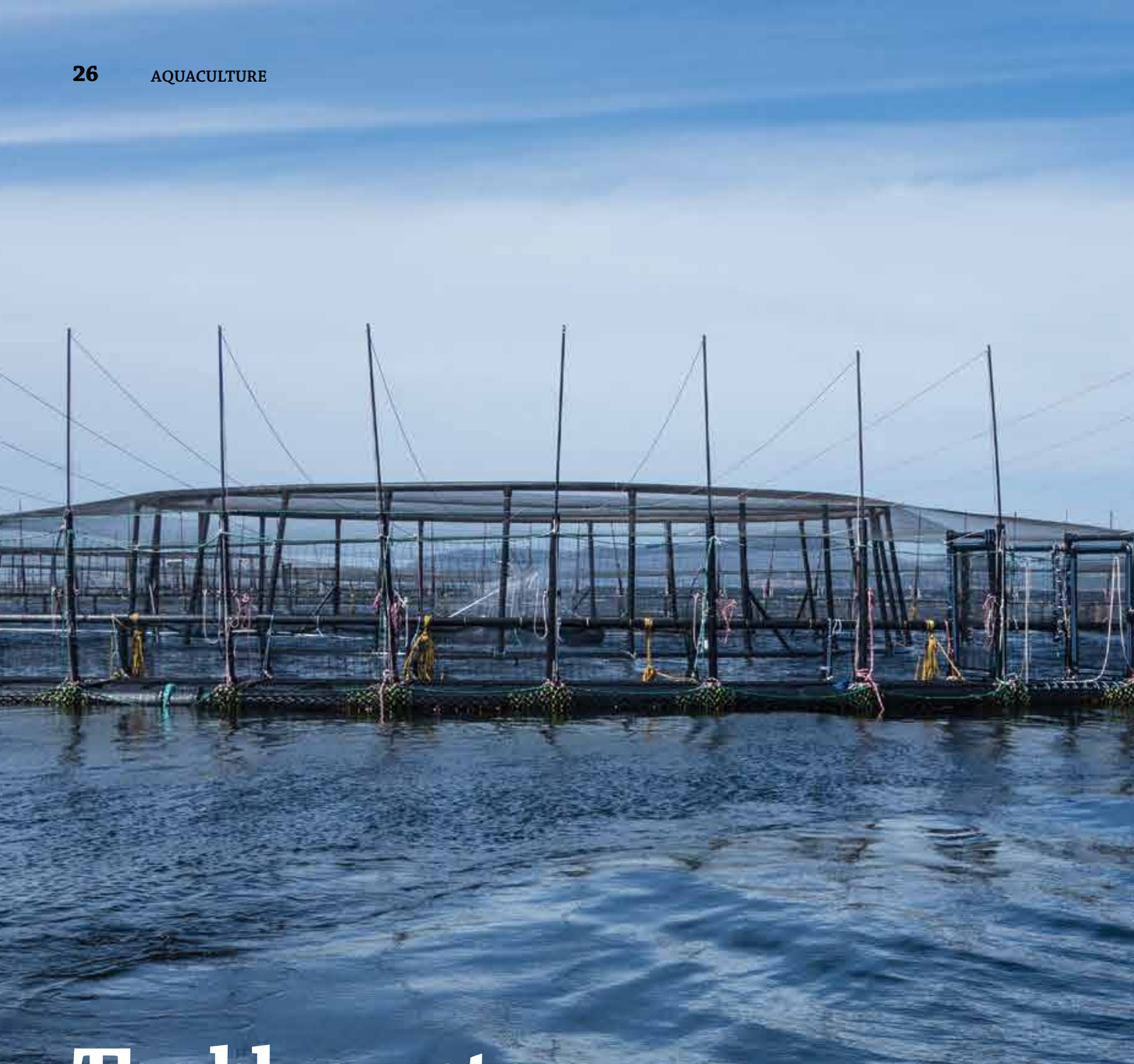
Recently, Kathryn Stack capped off her scholarship travels with trips to Australia, New Zealand, Norway and Iceland. "Policymakers in Australia seem to engage much more with the sector," she says.

"This is the most important thing when forging policy, to have all stakeholders involved from the start. It not only breaks down barriers between industry and civil society but allows everyone to have a say."

Kathryn Stack's scholarship is sponsored by the Atlantis Fisheries Consulting Group and the Nuffield International Foundation Fund.

The FRDC has sponsored the Australian Nuffield Scholarship program since 2007. Applications for the next round of scholarships will open on 1 April 2018. For more information visit the Nuffield Australia website (www.nuffield.com.au).

Nuffield is a non-profit organisation that provides the opportunity for those working in the primary industries to develop the skills to make a difference in the world. It supports up to 16 weeks of travel for scholars working in Australia's primary industries to research a topic of their choice. F



The blue waters of salmon farming

International experts gather to help Australia's Atlantic Salmon industry navigate a course for sustainable growth

Story and photos by **Catherine Norwood**

International experts discussed trends in the design and location of Atlantic Salmon pens at the Blue Future forum in Hobart.

Is the future of Atlantic Salmon farming in Australia at sea, or all ashore? It is an issue that has generated much local debate in the state of Tasmania and was a focus of the 'Planning for a Blue Future' Global Salmon Symposium in Tasmania in December, along with biosecurity and environmental issues.

Held at the University of Tasmania in Hobart, the event was coordinated by the university and Atlantic Salmon production companies, recognising that the industry is 'at a crossroads' in Australia.

The symposium brought local players together to learn from government, production and research leaders from Norway, Denmark, the Faroe Islands, Scotland and Canada, who provided examples of the issues that had shaped the industry in their countries.

Local participants are keen to provide a common direction to development so that, going forward, they can better meet the challenges of increasing production in a sustainable way and address community concerns.

On a global scale, Tasmania's industry may be 'boutique', but in Tasmania, and in Australian terms, it is big business and a leading example of industrialised food production. That, in itself, generates some opposition. But Atlantic Salmon producers effectively put more fresh, locally grown fish on Australian tables than any other species, with all the attendant health, economic and social benefits that this brings.

In Tasmania there are ongoing tensions over the location of new and even existing farms, with production intensity and environmental impact all proving highly contentious. Views also differ among the state's three producers – Tassal, Huon Aquaculture and Petuna – about what the future of farming might look like.

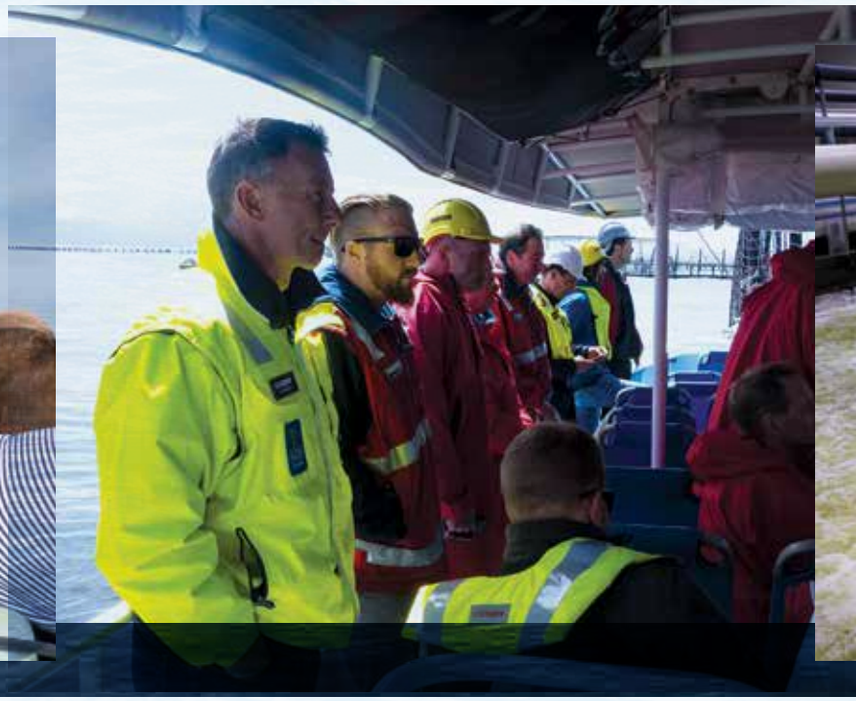
Tasmanian Deputy Premier and Minister for Primary Industries and Water Jeremy Rockliff opened the symposium by outlining the government's support for Atlantic Salmon aquaculture. He launched the government's *Sustainable Industry Growth Plan for the Salmon Industry*, committing to ongoing reviews of the plan and a process of continuous improvement.

In the water

Speakers highlighted international production trends, including the latest designs and increasing sophistication of ocean cage and land-based recirculation technology.

MORE INFORMATION
Tasmanian Salmonid Growers Association, www.tsga.com.au
FRDC RESEARCH CODE: 2017-149

Above Manager of the Experimental Aquaculture Facility at Taroona, Polly Hilder (left), explains the Atlantic Salmon research underway to visitors.



Above A field expedition to Hideaway Bay in south-east Tasmania was provided for speakers attending the Blue Future symposium.

Joachim Buaro works for Norwegian-based Aquastructures, which specialises in offshore aquaculture. He provided an overview of the latest pen developments, including rigid versus flexible design as well as surface and subsea pens.

He said for exposed locations, such as those that the Tasmanian industry is seeking to move into, flexible cages were suited to sites with waves of up to 10 metres.

Huon's Fortress cages are the largest and most advanced in Australia, with a diameter of 76 metres and capable of dealing with swells of up to seven metres.

It is important to match designs with locations, he said, as animal welfare could become an issue; fish can be injured in wild seas if they are 'thrown' against inflexible pen walls.

Cage sizes are continually increasing and the world's largest pen system to date is being operated by Viewpoint Seafarm in Norway. Looking more like an oil rig than a fish farm, it combines 600,000 cubic metres of pens with the capacity to process 13,600 tonnes of fish a year, and it can withstand 15-metre waves.

On land

Danish company Billund Aquaculture is a global leader in recirculating aquaculture systems (RAS). The managing director of the company's Australian operations, Patrick Tigges, outlined how the technology has evolved over more than a decade and what it might hold for the future. Billund has already completed two recirculation systems for Atlantic Salmon hatcheries in Australia and is working on a third hatchery, now under construction.

Recirculation systems filter and treat water used in fish farming, which is then reused within the fish grow-out system as far as possible – an alternative to systems where water flows into a fish production system, is used, treated and released back into waterways.

Globally, RAS are becoming standard for hatcheries and Atlantic Salmon production of smolt up to 150 to 200 grams because they provide greater control over the environment and biosecurity.

However, there is also an increasing move towards RAS for the post-smolt phase after fish have transitioned to their saltwater life stage. Some producers are growing fish post-smolt up to 600 grams in RAS where they would typically be put into a marine site at between 100 to 200 grams. This provides a more robust fish transferred to ocean pens and reduces time at sea.

Patrick Tigges said Billund had also proven that it was possible to raise fish to market size on land. It has a RAS operating in Langsand Laks, Denmark, which has provided a testbed for the technology and produces about 800 tonnes of fish a year. A more recent development is the construction of a 7700-tonne Atlantic Salmon farm in Miami, US, by Atlantic Sapphire Homestead.

Patrick Tigges said with improving technology, the economics of total grow-out RAS could stack up when they were close to markets. However, he said it was not a case of ocean or land, but rather "how much of each".

"You might build a grow-out facility in Sydney because you're close to markets; that's why they're building one in Miami. You wouldn't build something like this in Tasmania, because you have the ocean, and you still have all the logistics and transport costs," he said.

Fish health

However, biosecurity emerged as a more urgent issue. Presenters highlighted how animal health and environmental health were intertwined. Unavoidable environmental factors could trigger disease outbreaks. Specific management practices such as fallowing and reduced stocking densities could help reduce disease pressure, as could other operational changes to limit the spread of infection.

Above A recirculating aquaculture system at a Huon Aquaculture hatchery filters and treats water before it is reused in the fish grow-out tanks at the site.

In Australia, amoebic gill disease has been the most well-recognised foe of producers to date. Breeding programs and new treatment regimes developed during the past decade have significantly reduced the extent and cost of treatment. However, new diseases continue to arise and mutate. Pilchard Orthomyxovirus has recently been identified as new threat to fish health, for all Tasmanian producers, causing fish mortalities in several production areas.

Regin Jacobsen from Bakkafrost, the largest salmon producer in the Danish Faroe Islands, told the symposium that the industry in the Faroe Islands had been reduced from 65 players down to just three over the course of 20 years.

This was principally the result of a series of disease outbreaks, and particularly Infectious Salmon Anemia (from the same virus family as Pilchard Orthomyxovirus), which saw annual production drop from a peak of more than 70,000 tonnes in 2002 to less than 20,000 by 2005.

Regin Jacobsen said surviving in the Faroe Islands had required a cultural shift and cooperation among the remaining producers including higher standards of biosecurity, which later became the basis of revised regulations.

New veterinary protocols mandated fallowing, age-class segregations, vaccinations and stocking densities. Companies also agreed to swap some marine leases, providing a sole operator in each region, which made it easier to manage production processes and eliminate the risk of cross-company contamination.

Larry Hammell from University of Prince Edward Island, Canada, also spoke about the need for biosecurity planning, and a scientific approach with agreed monitoring, prevention, protection and control strategies. He said while the protocols he helped to develop related to Infectious Salmon Anemia, they applied more generally to the transmission of disease pathogens in "a sea of unknowns".

Environment

Stuart Baird, area manager for the Scottish Environment Protection Agency, outlined the environmental monitoring processes used in Scotland, where there are 450 licence holders who produce 177,000 tonnes of fish a year.

He said regulations in Scotland were changing to incorporate higher standards of monitoring and compliance. The industry had a growth target of five per cent a year, but achieving this would require growers to be more actively involved in environmental management and to move beyond mere compliance.

Former head of section for Directorate of Fisheries Norway Henrik Hareide also discussed the complex regulatory environment in his country and efforts to control or reduce the impact of sea lice, which have become widespread. He said while the framework for Norwegian regulation was complicated, overarching principles were less prescriptive and put the onus on operators to meet high standards.

For example, the environmental standard in the Norwegian *Aquaculture Act 2005* requires that aquaculture "be established, operated and abandoned in an environmentally responsible manner". Regulations also provided some flexibility, such as the ability to relocate cages or farms, in response to changing environmental conditions.

Canadian speaker Thierry Chopin, a professor of marine biology at the University of New Brunswick, outlined the emerging practice of integrated multi-trophic aquaculture as one way to address the environmental impact of Atlantic Salmon farming.

This approach is being trialled in Australia by Tassal at its newly established Okehampton Bay marine farm.

It involves establishing complementary 'crops' – typically shellfish and seaweed species – in the nutrient zone of finfish aquaculture to take advantage of nutrients from the fish farm and provide water-filtration services. Thierry Chopin advocated regulations that encouraged this approach to reduce the potential impact of aquaculture.

The public symposium was followed by two days of workshops with invited industry, research and government participants. The workshops looked in more detail at the information gaps and the roles different parties needed to play to address biosecurity and environmental issues in particular.

Research efforts

International visitors were able to visit the operations of all three Atlantic Salmon producers as part of pre and post-conference tours. They also visited the Experimental Aquaculture Facility at the Institute for Marine and Antarctic Studies (IMAS) Taroona fisheries and aquaculture research centre. This is operated in partnership with Huon Aquaculture, Skretting, the University of Tasmania and the Tasmanian Government.

IMAS works with industry, government and the community to undertake world-class research that supports the efficiency, regulation and sustainability of salmon aquaculture in Tasmania.

As part of this work it has developed the video *Listening to the harbour*, which features research being undertaken at Macquarie Harbour, where Huon, Petuna and Tassal all have Atlantic Salmon farms.

In the video, researcher Jeff Ross describes the important natural features of Macquarie Harbour, the environmental responses to salmon farming, and the role that science is playing in determining the level of farming that is ecologically sustainable into the future. F

View *Listening to the harbour* at the IMAS YouTube channel (https://youtu.be/f5peYJrBw_Q).

FUTURE EVENT

- The 2017 'Planning for a Blue Future' symposium was the precursor for a larger Global Salmon Symposium to be held in Tasmania later this year.

MORE INFORMATION
Global analysis, http://www.pnas.org/content/114/31/8301.full; Australian report, http://onlinelibrary.wiley.com/doi/10.1111/ddi.12622/full; Status assessment method, http://onlinelibrary.wiley.com/doi/10.1111/2041-210X.12705/abstract

Seabed ecology in the spotlight

Large datasets and modelling tools are creating new capability for both the sustainable harvest and conservation of seabed ecologies

By **Gio Braidotti**

As part of a global trawl best practice project an international team of researchers that includes several Australians has succeeded in compiling data that outlines the degree of impact of bottom-trawling fishing gears on the world's seabeds.

The researchers are also developing new modelling tools to estimate seabed disturbance and recovery over large spatial areas. These tools can be used to assess the condition of even 'data-poor' fisheries.

Towed bottom-fishing gears are used to catch fish, crustaceans and bivalves living in, on or above the seabed; they include otter trawls, beam trawls, towed (scallop) dredges and hydraulic dredges.

Combined, these fishing methods accounted for almost one-quarter of global seafood landings between 2011 and 2013.

Trawling forms the basis of numerous commercial industries – including Australia's wild-caught prawn industry – but the gear is used near seabed fauna that is critical to the health of marine ecosystems. For example, seabed invertebrates help oxygenate the seabed, break down organic material, and provide habitat structure and food for other organisms.

Global analysis

The global data compilation was undertaken by an international team of researchers from the UK, the Netherlands, the US, Argentina, Australia and the Food and Agriculture Organization of the United Nations. Included were Nick Ellis, Tessa Mazor and Roland Pitcher from CSIRO Oceans and Atmosphere in Brisbane, Australia.

In total, 70 studies were compiled and analysed to estimate trawling impact on unprecedented spatial scales.

Twenty-four studies accounted for the spatial extent, frequency and temporal variability in fishing activity, and provided estimates of recovery rates on fishing grounds. Forty-six studies provided estimates of the mortality of biota (sea life).

Most of the compiled data was sourced from studies undertaken in temperate zones and concentrated in north-western Europe and the north-eastern US.

In a jointly written scientific paper, the researchers reported that otter trawls caused the least depletion, removing six per cent of biota per pass and penetrating the seabed on average down to 2.4 centimetres.

In contrast, hydraulic dredges caused the highest impact, removing 41 per cent of biota and penetrating the seabed on average 61 centimetres.

"We need to view these results in the context of the footprint of each of these activities," CSIRO marine ecologist Roland Pitcher says.

"Otter trawling has the least impact per trawl pass, and is also the most widely used bottom fishing gear so that its effects are more widespread than are those of more specialised fishing gears such as hydraulic dredges."

The researchers found that the majority of benthic life took 1.9 to 6.4 years to return to 95 per cent of its pre-trawling amount

Roland Pitcher, CSIRO marine ecologist, says the new modelling tools provide objective analysis of the trade-offs between harvesting fish and the wider ecosystem implications, even for fisheries with limited information.

Because of this new capability, the modelling is being adopted by the Marine Stewardship Council as an assessment tool for the sustainability certification of fisheries.

"The results have global policy relevance for conservation and food security policy development. This is because they enable an objective analysis of the efficacy of different harvesting methods of harvesting food from the ocean to be considered in the light of the wider ecosystem effects of such activities on the marine environment," the research team concluded in their report.

In Australia, trawl catches account for about 24 per cent of the total wild catch, with nearly 86 per cent of all marketed prawns caught this way as well as 19 per cent of other demersal species.

Of the trawling methods used in Australia,

"The results have global policy relevance for conservation and food security policy development. This is because they enable an objective analysis of the efficacy of different harvesting methods of harvesting food from the ocean to be considered in the light of the wider ecosystem effects of such activities on the marine environment."

otter trawls dominated and accounted for 99.9 per cent of the trawl footprint. Dredging for scallops accounted for the remainder.

The analysis was published in the *Proceedings of the National Academy of Sciences of the United States of America* (PNAS) in August 2017 (Volume 114, number 31). In another paper produced by the same international trawl best practice project, the analysis focused on Australia's exclusive economic zone (EEZ), a marine area of 8.14 million square kilometres.

Focus on Australia

The current trawl footprint was found to be 1.1 per cent of the entire EEZ, with 58 per cent protected from trawling by closures and reserves (see map) – a much higher proportion of protection than in most other countries.

Seabed biodiversity survey data was collated to build a large-scale distribution of seabed communities and to assess exposure to trawling in the Great Barrier Reef region, the Gulf of Carpentaria, Torres Strait, south-east Australia, Great Australian Bight and Western Australia.

"We found that most regional seabed communities around Australia have higher protection (average 38 per cent) than exposure to trawling (average seven per cent)," CSIRO lead author Tessa Mazor says. "An average of 55 per cent of each community was neither protected nor trawled."

The study also identified the need to improve information on the presence and distribution of the more sensitive habitat-forming benthos types, such as long-lived species that may struggle to recover after trawling.

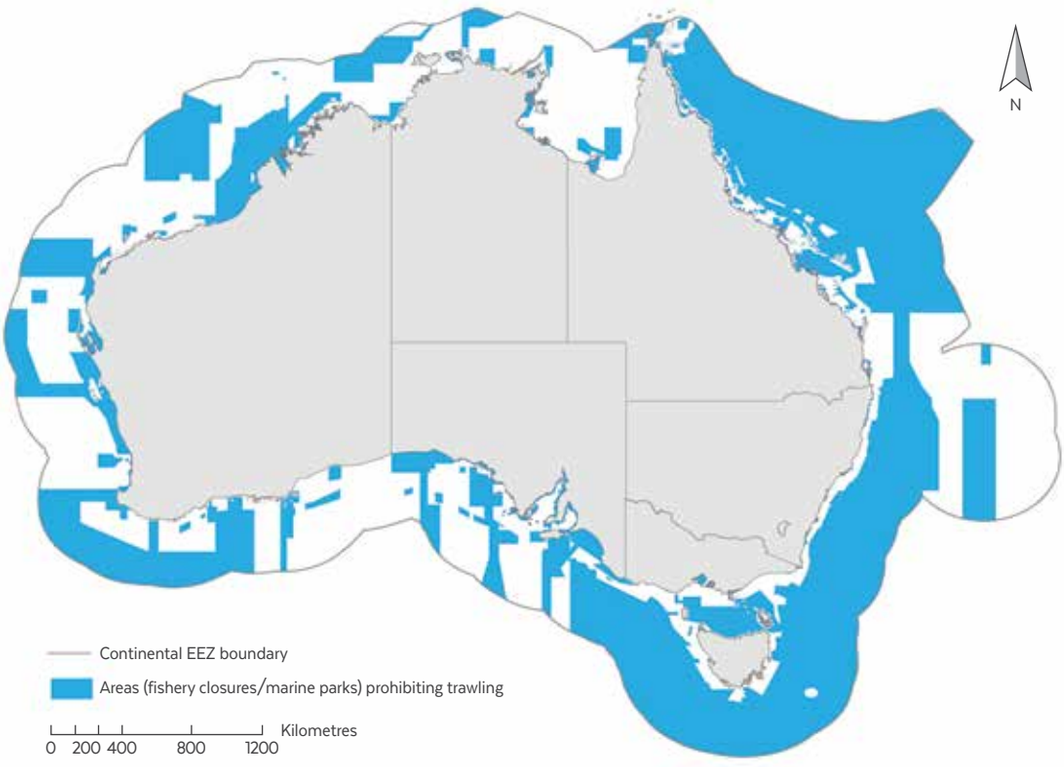
These are of interest to stakeholders as markers of seabed health.

The authors concluded that: "These results help identify regions and taxa that may be at greatest potential risk from trawling and support managers to achieve balance between conservation and sustainable industries in marine ecosystems."

Roland Pitcher says that the next step is a national assessment of the sustainability of seabed habitats and communities.

Australia's trawling footprint can be explored using the trawl footprint and swept area in the interactive table and maps at the State of the Environment website (https://soe.environment.gov.au/theme/marine-environment/topic/2016/commercial-and-recreational-fishing#marine-environment-box-2). F

Map showing the continental EEZ boundary and areas (blue) prohibiting trawling.



Source: CSIRO

Research voyage to investigate long-term trawl impact

From the 1950s Australia's North West Shelf was a focus for national and international trawling. This reached a peak when Taiwanese vessels landed about 40,000 tonnes of fish from the area in 1974.

When catches began to decline in the 1980s, CSIRO sent a team of scientists to assess the impact on seabed organisms and the region's recovery from intensive trawling.

At the time, the research team found it was too early to make a full assessment of recovery rates. However, it was able to ascertain that the reductions in targeted fish species were associated with a loss of three-dimensional seabed habitats.

Thirty-five years later, in October 2017, the Marine National Facility research vessel *Investigator* undertook a research voyage, supported by FRDC funding, to reassess and compare those early findings.

Foreign vessels have not trawled in the region since 1989. The current Australian fishery is operated over a much smaller area with fewer vessels, and in 2015 caught 1779 tonnes. CSIRO researcher John Keesing is chief scientist on the voyage and says the absence of trawling for many years on parts of the North West Shelf makes it an ideal place to carry out this research.

"To understand the recovery, we will look at the species and size of fish in the region, the types of organisms living on the sea floor and the amount of phytoplankton and zooplankton in the water, which along with providing food for fish are key indicators of productivity in a region.

"How animals on the seabed recover from trawling is an important global issue and the research will provide the latest science to both Australian and international management agencies."

Findings from the study are expected to be available later this year and will be shared with industry, management agencies and the general public.

FRDC Research Code: 2017-038

MORE INFORMATION
https://bushdogs33.wordpress.com/exhibition_2017_sushi-train

Prints reveal beauty in each fish

Traditional methods of recording a fisher's catch take on new meaning

By **Rebecca Thyer**

Using a paintbrush and a water-based ink, north-Queensland-based artist Jane Dennis carefully applies paint to one side of a fish. Then by pressing a sheet of paper onto the fish and gently rubbing it, the fish's details are transferred, revealing a mirror image on the paper.

The process, called *Gyotaku*, is Japanese. It translates as 'fish rubbing', and is behind the artist's 2017 collection called 'Sushi Train'.

The collection comprises 50 smaller 'sushi' pieces (at 30 x 30 centimetres) and 15 large pieces. With a focus on edible fish, the artworks feature different fish species printed in various colours on Japanese Kozo rice paper.

'Bait Ball', pictured far right, and part of the collection, won a Queensland Regional Art Award.

Jane Dennis works from her studio in Far North Queensland where the hot and humid conditions often make working at night easier. "It is cooler, quieter and there are less flies," she says.

The *Gyotaku* technique Jane Dennis adopts is ***Chokusetsu-ho***, a fast and spontaneous method.

Originally ***Chokusetsu-ho*** was used by Japanese fishers for recording species and catch numbers. "They would take paper and ink out on the fishing boats and take a rubbing of the fish after the kill. Each species was duly recorded on paper and the catch counted," she says.

By the mid-1800s, fish rubbing had developed into an art form, and it is still practised by artists today. Today the technique is utilised by artists in Japan and around the world.

For Jane Dennis, fish capture the essence of life. "They are ocean dwellers, our distant cousins, these living fossils mythically swimming in a parallel world. They are also our food source, our hobby. Their physical diversity is an abundant encyclopedia of aesthetics."

She was introduced to the technique about five years ago. "The whole concept has completely captured my imagination as it combines my love of biology, archaeology and art," she says.

"Each time I paint a new fish it is a mystery as to how it will work out. Each fish has a different oil content and reacts differently to the process. It's as random as fishing."

With her freezer kept full of fresh 'plates', Jane Dennis has printed many types of sea life. "Currently, I deal with what we catch and eat. But there are a lot of strange things I've just found on the beach."

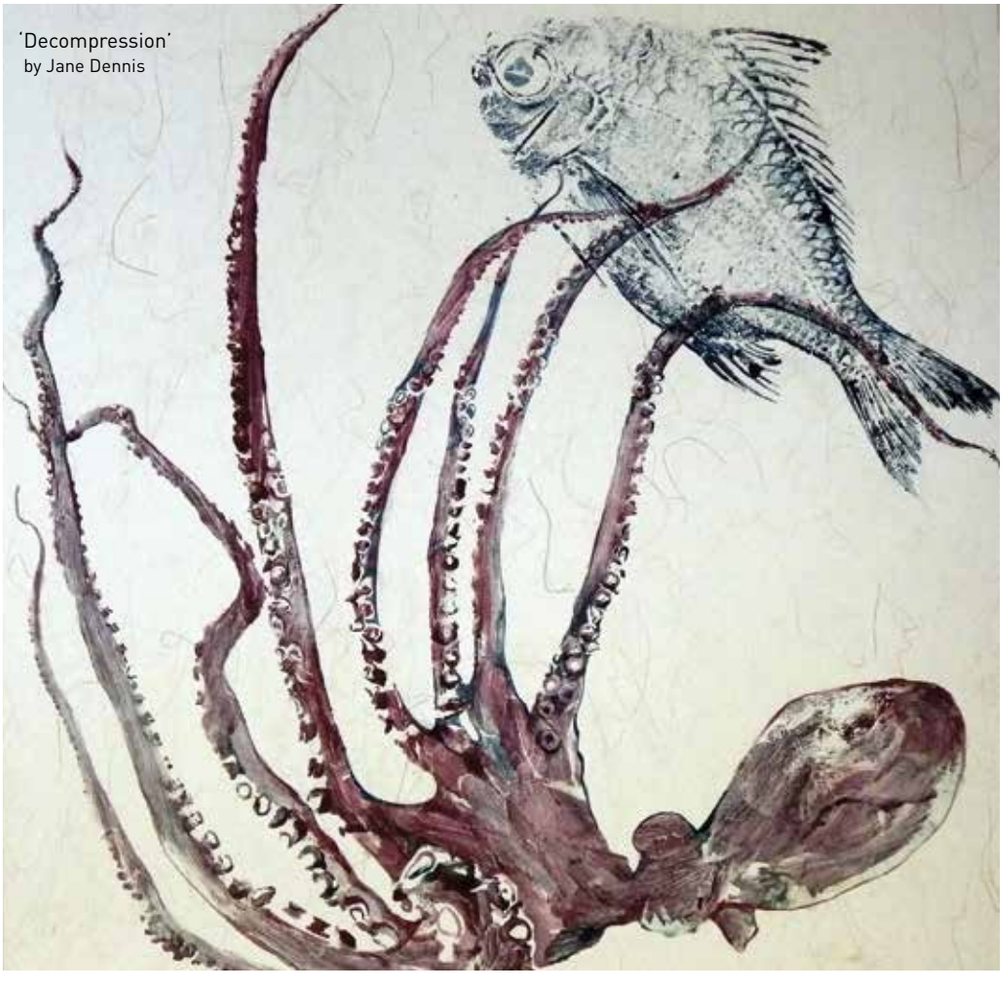
The technique is more about texture than colour and can lead to surprising outcomes. "Tilapia, for example, with its large scales, prints beautifully. There is also the huge variety of fins. I've also printed prawns, stingrays and look forward to doing jellyfish!"

Chokusetsu-ho also suits Jane Dennis's 'scientific' approach to art, which began as a child, when she collected anything she could find to investigate it further.

"I was a collector. I loved dead things like insects and I spent years drawing what I collected. My mother was scientifically minded and I think that also played a part. As a physiotherapist she had lots of anatomy books around and that spiked my interest."

Her collections soon became known as Jane Dennis's 'Boxes of death'.

"I consider that I'm researching them from



'Decompression'
by Jane Dennis

an artistic point of view, like Leonardo da Vinci did.

"Art, for me, is about creating an image and stories. And this printmaking technique offers a fresh approach to my collection of the dead. Death is an enduring part of life, and holds the key to survival and evolution.

"My approach to making this body of work has been a simple combination: catch, print, eat." Indeed, she says she often has a friend over to eat the fish after it has been painted.

Her ideas for using the technique continue to grow. She is experimenting with using the technique on silk and is in the process of approaching scientific groups on the Great Barrier Reef about recording the sea life found there. F

Jane Dennis's work won a Queensland Regional Art Award for her *Chokusetsu-ho* print called 'Bait Ball' (pictured left). It is part of a group exhibition, 'Iconic', on tour throughout regional Queensland 2018-19.

MORE INFORMATION
Australian Recreational Fishing Foundation, www.recreationalfishing.com.au;
The Fly Program, www.flyprogram.org.au
FRDC RESEARCH CODES: 2015-501, 2016-505

Reporting progress, planning future opportunities

A national discussion is underway on how to improve recreational fishing and share the many benefits it offers with more Australians

By **Joshua Fielding**

Recreational fishing has been shown to improve mental health and forge new friendships for participants in The Fly Program. Photo: Brad Collis

Leadership, marketing and fisheries habitat improvement – these three topics were the focus of presentations and discussion at Australia's second National Recreational Fishing Conference held in Darwin in November last year.

The Australian Recreational Fishing Foundation (ARFF) coordinated the event. About 75 delegates attended, including fishers, peak body representatives and fisheries managers.

Assistant Minister for Agriculture and Water Resources Senator Anne Ruston officially opened the event with supporting comments from Brett Cleary, chair of the ARFF. They set the direction for discussion, with a theme of reinventing the way we think about and manage recreational fishing.

The keynote address was delivered by Martin Salter, a retired British politician, keen angler and fisheries habitat advocate. He is also the author of the *Keep Australia Fishing* report, commissioned by the Boating and Fishing Council of Australia in 2011. The report's aims were to counter threats to recreational fishing, build greater political and public support, and formulate some policy items, with details of lessons and best practice from elsewhere.

It also helped to develop a public narrative on the benefits of recreational fishing, reposition environmental issues and marine parks, and create a national voice for recreational fishers.

> "By having a single runsheet of what we want to achieve we stand a much greater chance of getting buy-on in the political sphere. But most important is that everything we do must be underpinned by ensuring healthy and sustainable fish habitats and stocks. Without this we have nothing."
>
> Martin Salter

Charter needed

Martin Salter said positive steps in the six years since the report was released included the establishment of effective peak bodies in all states, a fully representative national body (ARFF) and a clear economic narrative and policy program.

Environmental partnerships and sources of secure, independent funding had been developed and there was also federal recognition of recreational fishing as a stakeholder in the public fishery.

However, Martin Salter is of the opinion that Australian recreational fishing still needs greater recognition politically, and an Australian Charter for Recreational Fishing could help do this.

"By having a single runsheet of what we want to achieve we stand a much greater chance of getting buy-on in the political sphere. But most important is that everything we do must be underpinned by ensuring healthy and sustainable fish habitats and stocks. Without this we have nothing," Martin Salter said.

Following sessions continued the themes of sustainability and management of recreational fishing, community involvement in habitat rehabilitation to improve fishing opportunities and expanding recreational fishing opportunities.

Habitat and jobs

Matt Hansen, from the Inland Waterways Rejuvenation Association, talked about the efforts of his team to improve fishing opportunities by restoring fish habitat in their local waterways of western New South Wales, which is part of the OzFish Unlimited national habitat community.

From raffling an "esky full or lures", the association now raises tens of thousands of dollars through the Lake Burrendong Fishing Classic, which is used to rejuvenate inland waterways – putting snags back into rivers, removing weeds and planting native vegetation.

"Probably our proudest investment and activity to date has been the River Repair Bus," Matt Hansen said. "We have purchased a mini-van and launched one of the biggest 'work for the dole' projects ever in western NSW."

The River Repair Bus has been active since late 2016 and has planted more than 7000 trees

and removed about 100 trailer loads of rubbish.

"What makes me most proud is not just the work we have done for the rivers but that we have had 24 local Indigenous and non-Indigenous job-seekers working weekly on our program, and 16 of them have now moved into full-time work," Matt Hansen said.

Gone fishing

An extremely passionate recreational fisher, Paul Nagy is also chief creative officer at Y&R Group Australia, a brand-development, marketing and advertising agency that has helped develop the increasingly popular Gone Fishing Day for the ARFF.

His presentation was titled 'Brand Fishing, should you care?' "People find it hard to answer how they feel about fishing as a brand. Responses mostly outline the fact that fishing is a recreation or a sport," Paul Nagy said.

"But what about those recreations that we traditionally see as competitors to fishing, like cricket, golf, video games and even TV? People in the US spend more time watching Netflix on an average day than they spend with their friends or exercising. This doesn't happen by chance; brands and marketing have got them there."

He said branding of fishing was limited. "But the good news is we have a spectacular product to market. It's about much more than just catching a fish; it's time in the wild, with family, teaching about all the outdoor experiences that come along with it, et cetera. Importantly this marketing needs to be done as a collective and outside of individual brands," Paul Nagy said.

Fishing for health

One of the final presentations, on the social impact of recreational fishing, was from Matt Tripet, a keen fisher who runs his own guiding business. The presentation focused on The Fly Program, a health-promotion charity he has developed to take men into the wilderness of the Snowy Mountains to enjoy all that the outdoors has to offer, including fly fishing in the highland streams.

"After losing my brother-in-law, who was also my best mate, through mental illness, I was determined to show the power that recreational fishing has to help with mental illness," Matt Tripet said.

He said the program brought together complete strangers who forged connections over a few short days in the Australian wilderness, fishing, to help rejuvenate their mental health.

Conference actions

FRDC executive director Patrick Hone provided a final wrap-up of the conference and noted several key areas that need action:

- consolidate and capture the shared voice and vision of the conference – in state peak bodies and in their collective voice into a national peak body – to make ARFF an effective body for its members;
- change the terms of trade with politicians and for funding to improve recreational fishing;
- create a united front irrespective of brands or states to engage more people in this activity through relevant branding;
- understand the importance of talking to others and obtaining an outside perspective;
- improve capacity, harness the resources especially in areas such as habitat rehabilitation, and better understand resources still needed; and
- discuss the significant benefits of general licensing systems, including revenue generation and opportunities this might bring. **F**

Above OzFish coordinates projects including tree plantings to improve habitat and water quality for fish. Photo: OzFish

NATIONAL HABITAT INITIATIVES

OzFish Unlimited is a not-for-profit organisation established to help educate and empower fishers to take control of the health of recreational fisheries by improving fish habitat and waterway health.

It has chapters across the country and has helped kick off projects to improve fish habitat, including habitat mapping, riparian revegetation, river resnagging and reef construction as well as shellfish reef restoration.

Through the FRDC's Recfishing Research Subprogram, OzFish has established the National Fish Habitat Strategy, working with fisheries agencies and key recreational fishers representative groups around the country. The draft strategy has four objectives.

1. Make more fish: achieve fish habitat conservation results by restoring natural processes and preventing decline.
2. Get more fishers involved: broaden recreational fishing community support for habitat action.
3. Get smart: carry out research and development to support fish habitat action.
4. Get the story out: communicate fish habitat outcomes and issues to the general community.

Craig Copeland, the chief executive officer of OzFish, says there is a growing movement among recreational fishers who want to put back into the sport they love by looking after the habitats that the fish depend upon.

"If you are one of these fishers and want to help make a difference please contact us." **F**

More information: www.ozfish.org.au

MORE INFORMATION
www.frdc.com.au/en/About-us/Corporate-documents/Annual-reports

Production, perceptions improving

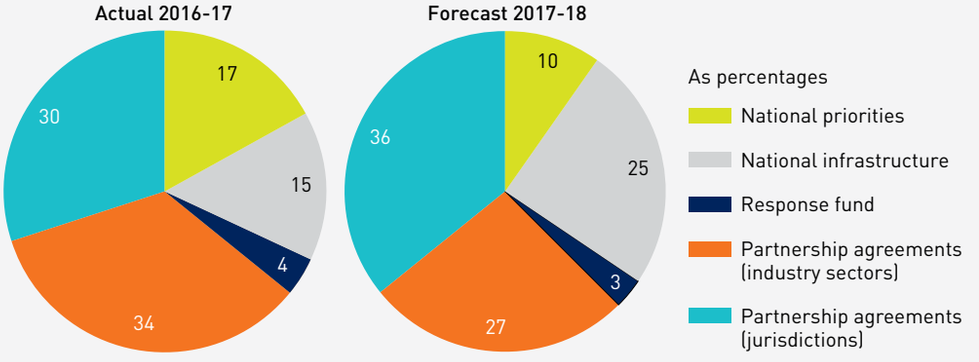
A look back at the last financial year shows that addressing the environmental factors that affect fishing continues to dominate research, but investment out of the water is also providing good returns

The business environment for the Australian commercial fishing industry saw continued growth in 2016-17 with the value of production increasing to $3 billion, up from $2.71 billion the previous year. This has been driven by increased aquaculture production, with Atlantic Salmon, Yellowtail Kingfish and Barramundi all set to further increase production in 2017-18.

The stable Australian dollar has helped seafood exporters remain competitive in most markets. Further benefits are expected from the final phase of free-trade agreements with South Korea and China.

Community perceptions of the industry's sustainability also increased to 41 per cent. However, the big movement was an 8 percentage point improvement in positive perceptions of the commercial wild-catch sector, with 32 per cent answering affirmative in regard to the sector's sustainability. This is the best result for the sector since the FRDC began perceptions surveys in 2012. The full perceptions survey report is on the FRDC website (www.frdc.com.au/Services/Market-research).

Figure 1: RD&E budget expenditure 2016-17 versus forecast expenditure 2017-18



Community perceptions of the industry's sustainability also increased to 41 per cent. However, the big movement was an 8 percentage point improvement in positive perceptions of the wild-catch sector to 32 per cent, which is the best result for the sector since the FRDC began perceptions surveys in 2012.

Year in review

The Australian Government has been developing a new harvest strategy and bycatch policy that will provide greater consistency in management across the country.

A new national peak body, Seafood Industry Australia, was also launched to represent the seafood sector as a whole to help develop national policy and programs, address collective risks and seize opportunities.

Biosecurity continued to be a major focus following outbreaks of White Spot Disease, Pacific Oyster Mortality Syndrome (POMS) and the discovery of the invasive Asian Green Mussel near Weipa, Queensland.

FRDC-funded projects also focused on improved practices and management for Atlantic Salmon production, particularly in Macquarie Harbour, Tasmania, to better understand oxygen dynamics, benthic recovery and risks to the endangered Maugean Skate.

The FRDC is coordinating the $15 million National Carp Control Plan, and intense research and engagement is underway to evaluate the possible release of carp herpes virus (*Cyprinid herpesvirus*), This includes how best to release the virus, clean-up, ecological impact, legislative approvals and community consultation. The earliest possible release date for carp virus, pending approval, is late 2018.

Marine noise control was in the spotlight following several Australian research findings demonstrating effects from seismic testing. That will mean ongoing negotiations between the seafood, oil and gas sectors on ways to work together into the future.

Marketing

A large number of participants at the inaugural

Queensland Seafood Marketing Symposium revealed strong interest in marketing and promotion. Changes to the *Primary Industries Research and Development Act 1989* were introduced in the 2017 autumn session of Federal Parliament, allowing for the voluntary collection of marketing funds.

The FRDC worked closely with the Australian Prawn Farmers Association and the Abalone Council Australia Ltd to develop a marketing levy, but an industry vote on the issue was put on hold following the outbreak of White Spot Disease.

The FRDC partnered with state and territory fishing industry councils on a new approach to inform consumers on the sustainability of Australian fisheries, developing the national Fish and Chip Awards in 2017. This included coordinating promotion of the awards with fish and chip shops. The FRDC's new people's choice award garnered more than 75,000 votes for 900 fish and chips shops in the three months to 30 June 2017.

Fish stocks

The third edition of the *Status of Australian Fish Stocks* (SAFS) reports was published in December 2016, assessing 294 stocks across 83 species chapters. This represents about 90 per cent of the volume and value of Australia's total wild-harvest fisheries production, with 60 per cent evaluated as sustainable. SAFS reports are online at a new FRDC website (www.fish.gov.au).

Within the FRDC

Senator the Hon. Ron Boswell was appointed as the FRDC chair in 2016, taking over from Harry Woods who steered the FRDC through a period of transition, including the launch of the new research, development and extension (RD&E) plan in 2015.

New members and chairs were also appointed to the FRDC's Research Advisory Committee (RAC), with appointments to the Commonwealth and Tasmanian RACs finalising the process. More on the RAC chairs and members can be downloaded at the FRDC website (www.frdc.com.au/Partners/Research-Advisory-Committees).

In October 2016 the FRDC finalised *Success through innovation: The National Fishing and Aquaculture Research, Development and Extension Strategy 2016*, one of 14 sectoral-specific strategies that underpin the National Primary Industries Research, Development and Extension Framework.

Table 1: Financial indicators of R&D investment

Expenditure	2012-13	2013-14	2014-15	2015-16	2016-17
	$m	$m	$m	$m	$m
Total expenditure	**25.69**	**27.56**	**28.16**	**28.34**	**29.26**
Total of R&D projects	22.14	22.87	24.85	24.58	24.41
R&D Program 1 (Environment)	8.25	10.20	10.44	8.68	7.46
R&D Program 2 (Industry)	9.57	8.33	10.09	11.54	12.31
R&D Program 3 (Communities)	0.74	0.75	0.83	0.86	0.98
R&D Program 4 (People)	1.80	1.94	1.49	1.55	1.34
R&D Program 5 (Adoption)	1.78	1.66	2.00	1.95	2.32
Management and accountability	3.55	4.69 [1]	3.31	3.76	4.85
Total income	**25.98**	**26.89**	**31.75**	**30.12**	**37.32**
Industry contributions	7.98	8.46	8.57	8.29	8.18
Total government contributions	17.23	17.93	18.71	20.05	21.76
Project funds from other parties	0.48	0.17	4.27	1.48	5.63
Other revenue	0.29	0.33	0.20	0.30	1.75
Maximum matchable (government) contribution [2]	5.83	5.99	6.25	6.78	7.25
Actual government matching	5.57	5.96	6.22	6.48	7.25

1. In 2013-14, FRDC had a $1.2 million write-down of assets which increased the cost of management and accountability.
2. Government funding and maximum matchable contribution (the maximum amount to which the Australian Government will match industry contributions).

A new social and economic research subprogram has been established to tackle the human dimensions of shared fisheries resources.

The FRDC is also taking a more proactive approach to identifying and commercialising intellectual property arising from research. It has partnered with a leader in start-up science, X-Lab, and the Cotton Research and Development Corporation to run two workshops to help stakeholders take advantage of innovative ideas, with a view to turn them into a commercial reality.

Impact

In 2016-17, the FRDC started a five-year program of impact assessments on investments across the RD&E portfolio, undertaken by Agtrans Research and Consulting. The 20 investments analysed during the first year of assessments were evaluated to have an average benefit–cost ratio of about 4.5: 1. The Industry and People Programs reported the best performance (of up to 9.7:1), while the Communities Program had no quantified benefits.

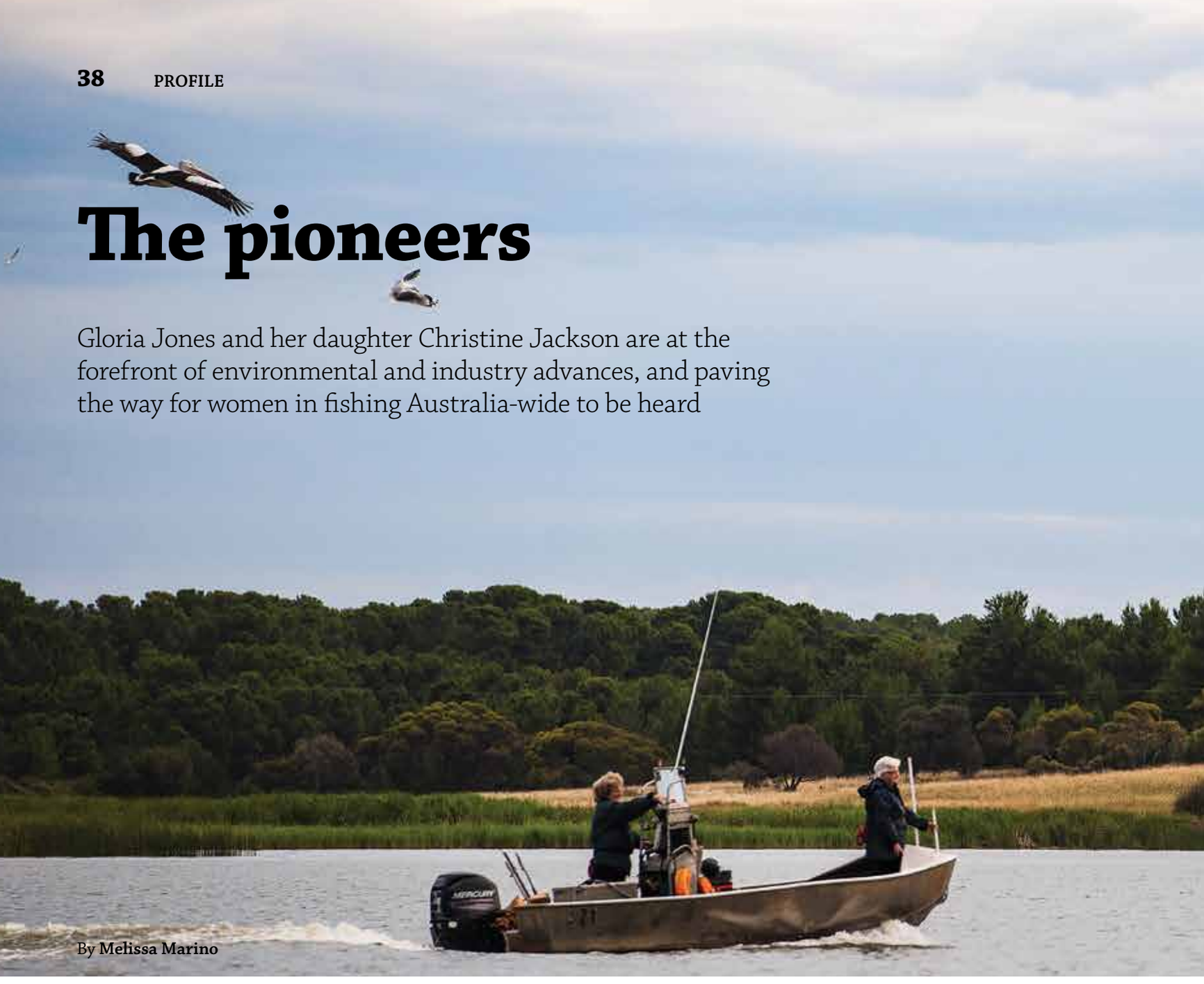
People

In 2016-17, the FRDC invested five per cent of its total R&D investment in developing the people and skills of those in the fishing industry, with an audited benefit–cost ratio of 3:1 from this investment. There were 16 people who completed the National Seafood Industry Leadership Program, and the FRDC sponsored two Nuffield Australia Scholarships.

During the year, the FRDC continued its strong partnerships with Indigenous groups, seafood industry councils, recreational fishing bodies, peak bodies, fisheries managers, science providers, and the Australian Department of Agriculture and Water Resources, and remains highly regarded by stakeholders. F

The pioneers

Gloria Jones and her daughter Christine Jackson are at the forefront of environmental and industry advances, and paving the way for women in fishing Australia-wide to be heard



By **Melissa Marino**

Gloria Jones was 19 years old when she moved with her fourth-generation fisher husband, Henry, to a remote outpost on the banks of South Australia's Lake Alexandrina at the Murray River mouth. Clayton Bay was home to only one other couple at that time and "a bloke in a cave".

It was 1962 and the only access to their home was a dirt road that bogged cars with sand in summer and mud in winter. There was also no power or telephone. But a lack of services did not stop the newlyweds from wholeheartedly embracing their new roles as owner–operators in the Lakes and Coorong Fishery.

There was never any doubt, Gloria Jones says, that she would join her husband on the water despite having no fishing experience. She was more than just a companion, thriving as a fisher, working the nets and gutting and packing fish every day. "Henry was the love of my life so wherever he went I went," she says.

It was not until their third child was born that she rested her sea legs. And even with young children at her heels, Gloria Jones remained hands-on in business: running a retail fish shop they built alongside their house, expanding it into a bustling mixed business and then a popular restaurant, Yabby City. It featured their own produce and there were queues down the street, despite the location at the end of an unmade road.

"There was yabby soup, yabby cocktail, garlic yabbies, curried yabbies and people just loved them," says Gloria Jones, who combined her career as a fisher, restaurateur and retailer with a school bus run and as an activist for the environment and women's representation in the industry.

In 2011 her efforts were recognised when she became the first woman inducted into the National Seafood Industry Hall of Fame.

Raw beauty

But life was not easy for the young couple in their first few years in the Lakes and Coorong. They would rise before 3 am, working under the glow of kerosene lamps to pack wooden boxes of fish insulated with ice and newspaper. Boxes were nailed shut before being loaded onto the back of their truck for the bumpy 15-kilometre journey to the Finniss station to meet the 8.30am train.

"The roads were extremely bad and we had

Christine Jackson (left) and her mother Gloria Jones set out for a day's work on the Coorong.
Photo: Brad Collis

to take shovels and bits of wood in case we got bogged on the way," Gloria Jones says.

But despite the trying conditions, she says the pristine environment of her beautiful new hometown captivated her. "When we pushed off from the shore each morning we travelled into a wilderness of birds and fish and animals and a very healthy aquatic system," she says.

This early experience is behind the Jones family's efforts to protect the environmental sustainability and credentials of the fishery.

"We believed it wasn't right that children who had not experienced this Lakes and Coorong wonderland were going to accept dying ecosystems as the norm," Gloria Jones says. "And that is the reason we would fight so hard for the Murray–Darling system."

Through the 2000s, Gloria and Henry Jones (who died in 2014) took their fight to Canberra, and were instrumental forces in protecting the health of the Murray River along its entirety through the development of the historic Murray–Darling Basin Plan. Their work helped to secure adequate water flows to sustain the Lower Lakes and Coorong against competing interests.

Environmental warriors

Gloria and Henry Jones's dedication and passion has inspired their daughter Christine Jackson to continue the fight for water through the Murray–Darling Basin system with her mother, who says water allocation remains the most critical issue for the fishery's future.

The campaigning is sometimes exhausting, Christine Jackson says, but well worth it to sustain flows down to the river mouth.

The flows issue first hit home when she returned to the Clayton Bay area in 2005, after five years away, and witnessed the system's degradation at the height of the Millennium drought. "We couldn't even get the boats into the water at that stage," she says. "There was no water where we were."

She says living through the drought highlighted the importance of ensuring that strong environmental policy around the fishery was in place to ensure its long-term viability – especially once the water returned.

This is one of the reasons the 38 families of the fishery, led by Gloria and Henry Jones among others, worked to get Marine Stewardship Council certification; in 2008 it became the world's first multi-species multi-method fishery to receive the coveted certificate.

While there were several administrative hoops to jump through, including an ongoing annual audit, Gloria Jones says certification proved "a natural progression" thanks to the practices already in place under an environmental management plan established at Henry's suggestion and backed by other fishers and scientists as far back as 1996.

"We really haven't had to make any changes to our operations – we've just had to get better at doing the paperwork," she says.

Woman power

And paperwork, she says, is what many women in the fishing industry are best at. In fact, if it was not for female partners managing the accounts many fishing businesses would not survive, she says.

Gloria Jones realised that while women were often half of a fishing team, cleaning and mending gear, taking orders, doing book work and generally keeping the business going, they were seldom involved in policy or decision-making. It is what led her efforts, along with those of June Gill and Charmain Wait, to establish the Women's Industry Network in South Australia in 1996.

The idea to unearth talent and hone skills through media and leadership workshops and networking was a great success, and two years later, with funding and support from the FRDC, it went national with the Women's Industry Network Seafood Community (WINSC).

This year, WINSC turns 20 and Gloria Jones, who has served as both its secretary and president, says it has transformed the role of women in Australia's fishing industry.

"We wanted women to be able to speak on behalf of their fisheries to the media and politicians and now there are many women making policy and decisions for our industry," she says. "And many friendships have also been formed through our group."

As well as figuring in fishery policy and businesses, women play a vital role in the survival of fisheries by providing the social licence that supports a fishery's existence, Christine Jackson says.

"A fisher is not just a bloke with a beanie and a boat," she says. "They have a family and communities know the value of fishing families in their area, keeping schools and hospitals and activities such as ballet and football going," she says.

Christine Jackson now runs the family's fishing business in Lake Alexandrina and Lake Albert, the Coorong and three nautical miles offshore. Her own two grown daughters work in the area teaching swimming and in the local school, while one of her nephews works alongside her on the water. Her husband, who flies in and out of the Pilbara, Western Australia, for his job is also "put to work" when he is home. "Anyone who is standing around gets a job," she says.

Gloria Jones, who has just turned 75, also cannot keep away from the business, still packing fish and overseeing a raft of changes, from the new facilities to state-of-the-art equipment and systems, which have cut costs, saved time and provide optimum-quality fish to customers.

"I've made lots of lovely friends, we've had lots of fun and I've loved every minute of it," Gloria Jones says of her lifetime in the fishing industry. "It was a hard slog, but I can tell you, what a ride!" F

RAPID RESPONSE STRATEGIES

Researchers from the Arthur Rylah Institute (ARI) for Environmental Research remove carp downstream from Yarrawonga Weir, on the Murray River. ARI is leading a project that aims to answer the question: how many carp are in Australian waterways?

The results of the NCCP's other research will define the clean-up challenge and calculate how many carp there are to be removed. Understanding the practicalities of collecting and removing these fish is essential.

To ensure the NCCP benefits from Australian and international experience with fish kill clean-up, Luiz Silva, from Charles Sturt University, has teamed up with commercial carp fisher Keith Bell.

Luiz Silva has helped to clean up numerous fish kills downstream of hydropower plants in Brazil. Keith Bell has also cleaned up several major fish kills in Australia, including carp, and has extensive commercial fishing experience.

Access issues

Their review reveals that fish kill clean-ups are most effective and prevent water-quality issues when the response is rapid. Physical access and ease of movement on a given water body determine the best clean-up approach.

In small waterways constricted with snags, physical collection using basic equipment such as scoop nets may be required. In open water, boat-based clean-up is feasible. Mechanised approaches such as modified trawls and vacuum pumps can reduce labour requirements.

It may be possible to modify vessels used for aquatic harvesting of waste or weed removal to collect carp.

Productive uses

Once collected, dead carp need to be disposed of. Janet Howieson, from Curtin University in Western Australia, is leading research to identify economically viable and productive uses for carp. She is conducting commercial-scale trials of carp-based fertilisers, compost, fishmeal and aquaculture feeds.

One project component will consider the feasibility of using carp waste as insect feed – specifically for the Black Soldier Fly, which produces larvae that can be used as a high-quality aquaculture feed. Products from the trials will be then be market tested to evaluate acceptance.

The research that will shape the NCCP clean-up strategy is now well underway. Future progress reports will provide updates on results and emerging challenges.

HOW CAN YOU GET INVOLVED?

The NCCP has been consulting extensively with communities across areas affected by carp. This work will continue in 2018.

The project team wants to understand your local waterways, what's important about them and how you use them, and your concerns and questions so that they can be addressed in the plan.

For more information contact the National Carp Control Plan team at:
carp@frdc.com.au

To stay up to date with progress and submit comments online:

www.carp.gov.au

1800 CARPPLAN

NATIONAL CARP CONTROL PLAN
RESTORING NATIVE BIODIVERSITY

THE NATIONAL CARP CONTROL PLAN

PROGRESS REPORT – MARCH 2018

University of Adelaide researcher Richie Walsh heads out to sample water quality at the site of a carp decomposition experiment near Berri, South Australia.

Anyone visiting freshwater habitats in coastal or inland south-eastern Australia is likely to encounter invasive common carp (*Cyprinus carpio*). Feeding carp siphon sediment from the riverbed, muddying waters, damaging aquatic plants and triggering cascading impacts through aquatic ecosystems.

A species-specific virus, Cyprinid herpesvirus 3 (CyHV-3), may offer an opportunity to substantially reduce carp numbers and restore the balance for native species. Decision-making on whether virus release should proceed is awaiting evidence from research, planning and consultation underway as part of the National Carp Control Plan (NCCP).

If the carp virus is released, major carp mortality events are likely. Determining best strategies for cleaning up these dead carp to protect water quality for human consumption, stock watering, and native aquatic species is central to the NCCP.

Maintaining water quality following carp kills emerged as an urgent priority at more than 70 NCCP community consultation events held throughout Victoria, South Australia and New South Wales between October and December 2017.

Social scientists helping the NCCP understand community attitudes towards carp biocontrol have also identified the importance of delivering an effective clean-up strategy as a recurring theme in survey responses. In this NCCP progress report we discuss some of the research that is playing a critical role in developing clean-up solutions. This will be an important part of the Australian Government's considerations on whether or not the virus should be released.

Maximum impact

A capacity to predict the size, seasonality and location of carp kills following a future virus release is fundamental to planning the clean-up. The NCCP's epidemiological modelling project, led by CSIRO veterinary epidemiologist Peter Durr, will provide this ability.

Epidemiologists investigate the distribution and movement of disease, often with a particular focus on the mechanisms underlying disease transmission and spread. Famous historical epidemiological studies include John Snow's work tracing cholera outbreaks in Victorian London to contaminated water pumps, and Louis Pasteur's discovery that earthworms perpetuated anthrax outbreaks by bringing bacterial spores from buried sheep carcasses to the surface.

These historical examples relate to halting disease spread; epidemiologists working on biocontrol identify ways to enhance spread of the biocontrol agent through the target population.

Key ingredients for success

Kill rates from the carp virus are likely to be most strongly influenced by water temperature, concentration of virus particles and the prevalence of dense schooling (aggregating) behaviour. The carp virus can cause disease in carp at water temperatures between 16°C and 26°C, with 20°C to 24°C optimal for infection and disease.

Viral transmission is also maximised at high carp densities, especially when fish are in direct physical contact. Infection is also most likely when carp are stressed.

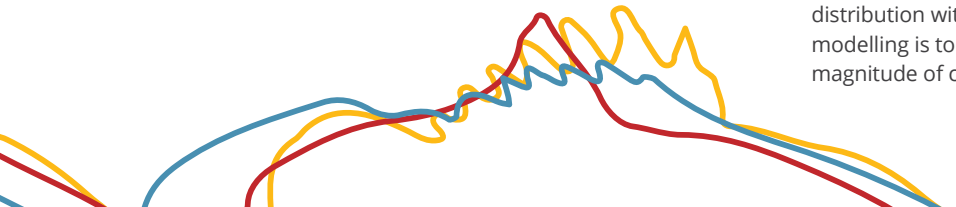
Infection windows

By assessing the factors that influence carp virus transmission and spread, Peter Durr's team has identified seasonal 'windows' within which virus-induced carp kills are most likely.

Water temperatures in south-eastern Australia are suitable during spring to autumn, but temperature is only part of the picture. Carp in Australia form spawning aggregations in spring and early summer, and spawning is physically stressful for carp.

Spring spawning events therefore provide the 'full house' of optimal temperatures, dense aggregations and compromised immunity necessary to achieve optimal levels of mortality.

Peter Durr's early results have important practical implications for both potential virus release and clean-up. A spring window of viral effectiveness means virus release will need to be carefully targeted, yet also simplifies clean-up planning to some extent.



Advance notice

Clean-up equipment can be prepared and crews recruited well in advance of conditions likely to trigger kills. A narrow seasonal window also facilitates an 'adaptive management' approach, providing the opportunity to refine clean-up approaches between seasons. Nonetheless, natural systems are inherently variable and clean-up strategies will need the capacity to deploy resources at short notice.

The understanding of viral behaviour that Peter Durr and his colleagues are building requires computer modelling to assess outcomes of different combinations of environmental and carp behaviour variables. While powerful, predictive computer models are only as good as the data driving them.

This work consequently requires data on water temperature and carp abundance and behaviour across the varied habitat types inhabited by the species in Australia. Some of these data will be supplied by the NCCP's biomass project.

How many jelly beans? A carp biomass estimate for eastern Australia

Jarod Lyon, principal investigator for the NCCP's carp biomass estimation project, likens his project to guessing the number of jelly beans in a jar. Except in this case, the 'jar' is the entire carp habitat in Australia.

Carp population density varies substantially across the species' distribution in Australia. Carp density is believed to play a critical role in sustaining viral spread. This means that good estimates of the total weight (biomass) of carp present in Australia and its distribution within our waterways are essential if epidemiological modelling is to accurately predict the seasonality, location and magnitude of carp kills.

The project uses multiple biomass estimation methods to 'triangulate' the most accurate result across techniques. Collation of historical datasets was the first step.

Historic records

Numerous fish surveys and environmental monitoring programs have recorded carp captures, but the sampling techniques these used inevitably varied considerably. To enable a direct comparison across this disparate data, the biomass group is developing statistical conversion factors based on field experiments.

Mining existing datasets is an efficient way to estimate biomass, allowing field sampling to target areas where there are real data gaps.

DNA estimates

In addition to techniques commonly used by fisheries scientists, the biomass project is also testing the use of environmental DNA (eDNA) to estimate carp abundance. eDNA refers to detection of the target species' DNA in water or sediment samples. The technique was originally developed to detect the presence or absence of rare species, but recent advances suggest that eDNA can also be used to measure biomass as well.

The project team have also been working with water authorities as they conduct planned lake and wetland drainings. These events provide valuable opportunities to crosscheck eDNA biomass estimates with absolute measures of carp biomass.

Water quality and decaying carp

Carp biocontrol cannot proceed unless the effects of decaying carp on water quality are understood and effective mitigation strategies are developed.

Justin Brookes, from the University of Adelaide, is leading the NCCP's water-quality research, complemented by parallel work led by scientists from WaterNSW, the University of Technology Sydney and SA Water.

At the simplest level, dead carp – if present in sufficient amounts – can promote hypoxic (low-oxygen) or anoxic (no-oxygen) conditions as the microbes feeding on the dead fish use oxygen from the water column. The research aims to identify the level of decaying carp biomass – or how many dead carp are needed to cause oxygen depletion. This will allow clean-up activities to be planned and prioritised.

Role of river flows

Justin Brookes's research also focuses on the role of decaying carp and the nutrients they release as part of complex interactions involving river flows, oxygen levels and both harmful and beneficial algae. Harmful algae of the kind that cause blue-green algal (cyanobacterial) blooms are able to exploit degraded, nutrient-rich environments, such as warm, slow-moving water filled with decaying carp.

Cyanobacterial blooms are more likely in deep, still water where the water column can split (stratify) into layers of different temperature. Stratified conditions favour cyanobacteria, which possess tiny gas bladders that help them regulate buoyancy. Algal species lacking these gas bladders may sink to the riverbed in still water, losing access to the sunlight they need to grow.

The competitive advantage cyanobacteria hold under stratified conditions forms the basis of a chain reaction. Still water near the riverbed becomes deoxygenated as organic processes in the sediment use up dissolved oxygen.

As oxygen declines, chemical reactions cause nutrients to move from the sediment into the water column. Cyanobacteria can use their capacity to regulate buoyancy to travel down through the water column to access these newly liberated nutrients, before rising back to the surface layers.

Nutrients liberated from decaying carp could exacerbate this situation, providing extra fuel for cyanobacteria growth. Increasing cyanobacterial populations in turn demand increasing amounts of oxygen as they metabolise nutrients, driving an ever-tightening feedback loop.

Adding oxygen

Manipulating river flows could break this cycle by mixing and oxygenating the water column, diverting nutrients away from cyanobacteria and into environmentally benign pathways.

Critically, nutrients that could benefit native species are currently 'locked up' in carp bodies. Allowing some of the nutrients and carbon locked up in carp to productively re-enter aquatic systems is desirable.

Water-quality research is identifying the flow regimes needed to achieve these goals, combining computer modelling and experimental approaches.

The modelling combines river flow conditions with chemical transfers between living organisms and the environment (a 'hydrodynamic–biogeochemical' model). The data comes from field and laboratory experiments assessing the impact of dead carp on dissolved oxygen and algal abundance.

Field experiments are currently underway at a closed wetland adjacent to the Murray River near Berri, SA. The wetland trials involve stocking approximately 6 tonnes of dead carp (harvested elsewhere) into the 2.5 hectare waterbody and measuring water-quality responses. The wetland trials are intended to mimic high carp biomass levels, providing an insight into a worst-case scenario. Early results indicate rapid decomposition and associated declines in dissolved oxygen. These findings reinforce the importance of identifying critical biomass thresholds and implementing effective rapid clean-up responses.

Final reports

Indigenous input 2014-404

The FRDC's Indigenous Reference Group (IRG), established to provide advice to the FRDC on its Indigenous investment and manage its Indigenous Subprogram, has made significant progress in broadening stakeholders' understanding of the sector and its place in the broader fishing and seafood industry.

A report into the IRG's role also found it was successful in articulating priorities for the Indigenous sector and formally engaging at a national level in a very short period.

The work of the IRG has seen increased investment in research, development and extension (RD&E) that acknowledges and engages with Indigenous Australians. Ten projects are underway and additional projects to address areas of capacity building and data collection will start soon. In addition, via the involvement of the IRG, the views of the Indigenous sector are now being incorporated in the many forums that consider RD&E, policy, and fishing and seafood governance.

However, a range of challenges and opportunities still exist and IRG members believe there is a need to continue the subprogram.

More information Chris Calogeras, 0401 692 601, chris@c-aid.com.au

Storm Bay baseline 2014-031

Before salmon farming starts in a new region, a major baseline assessment of water quality is initiated. Storm Bay, at the mouth of the River Derwent, Tasmania, was sampled monthly from 2009–15 for water quality – its physical characteristics, nutrients, and phytoplankton and zooplankton – by the Institute for Marine and Antarctic Studies at the University of Tasmania.

The data is crucial to future impact assessments of salmon farming on the ecosystem and to the development of a cost-effective monitoring program.

Improved knowledge of the influence of the three main oceanic currents on coastal waters, including the Storm Bay region, and associated effects on productivity, are also important to the local fishing industry.

The longer term environmental dataset will help in predictive modelling of how climate change and human activities may affect the region.

More information: Christine Crawford, christine.crawford@utas.edu.au

Paralytic shellfish toxins 2013-713

In a bid to address data gaps and help the rock lobster industry understand the food safety risks associated with paralytic shellfish toxins (PSTs), the South Australian Research and Development Institute (SARDI) led a research program from August 2013 to February 2017.

The work followed the 2012 discovery of PSTs in the hepatopancreas of Southern Rock Lobster (*Jasus edwardsii*) in Tasmania, which saw precautionary closures put in place. (Foods contaminated with PSTs can lead to paralytic shellfish poisoning, a serious illness that can result in death.)

The SARDI work comprised field sampling of rock lobsters and their prey organisms, experimental contamination in a biosecure facility, cooking studies, consumption assessments and a risk-assessment exercise.

Although a clear route of PST uptake to the rock lobster hepatopancreas was not identified, field studies showed that rock lobster along the east coast of Tasmania accumulate significant concentrations of PSTs in the hepatopancreas during blooms of *Alexandrium tamarense*, but not in the tail meat. And while PST concentration in the hepatopancreas did not change during cooking, there was significant tissue loss, resulting in a smaller amount of toxin per hepatopancreas. Toxins did not transfer to tail, leg or spider meat.

The study found that consuming rock lobster hepatopancreas during blooms may be a concern for a small proportion of consumers. Implementing harvest closures at the bivalve regulatory level can appreciably reduce PST exposure.

However, PST concentrations at each location and time varied considerably between individuals, creating implications for developing appropriate sampling plans.

More information: Alison Turnbull, alison.turnbull@sa.gov.au

Research body review 2014-238

A review into the role and operations of the FRDC's Fisheries Research Advisory Bodies (FRABs) has recommended developing and implementing a schedule of objectives and key performance indicators; designating three FRAB regions; appointing an FRDC officer as executive officer for each regional FRAB; and co-locating regional FRAB administration in non-fishery research body premises.

The recommendations follow a 2014 FRDC decision to review the role and operations of FRABs. The review aimed to ensure that the FRAB role was integrated into the implementation of the FRDC's five-year RD&E plan, while identifying opportunities to improve the networks' effectiveness and efficiency. FRABs provide advice to the FRDC board on priorities and needs for investment in their respective jurisdictions.

More information: Crispian Ashby, crispian.ashby@frdc.com.au

Lean, green rock lobsters 2016-502

The FRDC is in the process of assisting Southern Rocklobster Ltd (SRL) to understand how its certification standard measures up to international requirements of integrated standards for wild-capture seafood.

As part of that process a gap analysis was undertaken. It found that there were many parts of the Clean Green Australian Southern Rock Lobster Product Standard (CGASRL) that were in alignment, in partial alignment, or could be easily addressed by including wording that reflects the essential components of the global benchmarking tool.

The SRL could use this analysis as an opportunity to get its standard endorsed by the Global Sustainable Seafood Initiative. Many of the gaps between the global benchmarking tool and the CGASRL could be addressed.

More information: Belinda Yaxley, byaxley@gmail.com

Utilising discards 2015-204

There is considerable potential to increase the use of fish – particularly Latchets and Ocean Jackets – currently discarded by the Great Australian Bight Trawl Sector (GABTS) to decrease the sector's wastage and increase its profitability.

A report into GABTS bycatch found that Ocean Jacket has the greatest potential for export to the Asian market or distribution to the local Asian market. Australian-caught Leatherjackets also attract a higher price from Asian export markets than those caught elsewhere.

On average, 44 per cent of the total weight of the GABTS catch is discarded, dominated by a few species. For example, Latchet and Ocean Jacket are commercially marketable species, yet account for about a third of the weight of GABTS discarded species. There is also significant discarding of Stingarees, Dogfish, Barracouta and various Skates and Rays. Small amounts of many other species comprise the remainder of the discarded bycatch.

The main barriers to improved GABTS discard use relate to a lack of restaurateur, chef and consumer product knowledge, which can best be resolved through education and publicity.

For species less suited to human consumption, fish silage could be a profitable option. Underutilised hold capacity on GABTS vessels could be retrofitted to process and store species not suitable for human consumption, but at-sea trials to test feasibility and performance would be needed.

More information: Matt Koopman, Fishwell Consulting, 03 5258 4399, matt@fishwell.com.au

Building R&D adoption 2016-418

Opportunities for the FRDC to more effectively support increased adoption of its R&D outputs through education and training pathways exist, despite thin markets and low student numbers.

A project has found there are opportunities for the FRDC to generate resources and material in subjects such as biosecurity.

Other recommendations include: developing partnership agreements with the University of Tasmania, James Cook University, Seafood Training Tasmania and the Australian Fisheries and Maritime Academy in South Australia; introducing an FRDC standard or accreditation; considering a forum to discuss core higher education subjects and curricula; considering strategic engagement to communicate the importance of courses and degrees to industry's future; producing an annual or six-monthly bulletin promoting R&D outputs; and engaging with PhD and masters students through annual briefings and scholarships.

More information: Ross Ord, rossord@hotmail.com

World Recreational Fishing and Study Tour 2016-129

A delegation of young leaders from Australia's recreational fishing sector attended the World Recreational Fishing Conference in Vancouver, Canada, in July 2017, through the FRDC's Recfishing Research Subprogram.

Some in the group, which included those working in existing leadership, scientific and grassroot fisher roles, also took part in the conference, with six presentations.

A post-conference study tour saw investigations into salmon and halibut allocation and management processes, habitat restoration following natural and human impacts, the White Sturgeon fishery and management of wilderness fishing for Cutthroat Trout and Bull Trout.

There was considerable international interest in the FRDC-structured study tour, with several countries looking to emulate the program.

Tour participants performed well, identifying synergies with issues or opportunities investigated in Canada, and have started to develop strategies and procedures for integrating several elements in Australia.

The compressed nature of the application process to tour meant there was little time for planning. It would have been ideal for participants to connect prior to the trip.

More information: Frank Prokop, 0419 949 118, fprokop60@gmail.com

Mystery shop research 2017-146

Discovering information about the origin of seafood on the menus of cafes, pubs and restaurants is not always straightforward, a 'mystery shopper' research project has found.

The project, which was undertaken at 121 venues across Victoria in November 2017, found that when asked about the origin of seafood on their menu, 27 per cent of frontline staff did not know. It usually took from two to five minutes for this information to be found, typically from the head chef or senior manager.

Further investigation found that 31 per cent made reference to their supplier but were unable to provide more information about the actual seafood origin. (There was often a clear misunderstanding that the seafood provider's location represented the origin of the seafood.)

Of the 42 per cent who were able to provide this information, 28 per cent indicated it was Australian-sourced seafood and 14 per cent said it was either imported or a mix of imported and Australian-sourced seafood.

The research illustrates three primary customer experiences:

- one in three cases: information was provided and there was confidence in that information;
- almost one in 10 cases: information was provided but there was less confidence in it; and
- almost six in 10 (58 per cent) cases: information about the origin of the seafood on the menu was not provided.

More information: Michael Sparks, Intuitive Solutions, 03 9077 8321, msparks@intuitivesolutions.com.au

Harmonised data 2017-089

An FRDC-organised workshop of key data stakeholders was held in July 2017 to advance the potential of fisheries digital data, opportunities for a national fisheries digital data framework, and what such a framework could look like.

It identified the next steps towards a fisheries data framework, stating they include: developing a statement of intent; consulting to ensure the framework has the end user in mind; undertaking an audit of the data capture, cleansing/checking and storage process used by each jurisdiction, to develop best practice and a consistent set of procedures; and FRDC-funded case studies.

More information: Norm Jenkins, X-Lab (facilitator), norm@x-lab.com.au; Allen Haroutonian, X-Lab (facilitator), allen@x-lab.com.au

Fisheries and aquaculture statistics 2016-246

This project produced data on Commonwealth, state and Northern Territory fisheries' production volume and value, and the volume and value of Australian fisheries trade, by destination, source and product, covering the years 2004-05 to 2014-15.

An important aspect was implementing a process of continuous improvement. This was aimed at enhancing fisheries' coverage, incorporating industry employment data where available, maintaining the relevance of the data presented in production and trade tables, and refining fishery divisions and important species categories. Processes were also implemented so that the valuation of commercial fishing was undertaken in a consistent framework.

The project: achieved a reliable time series of economic data; provided accurate information to stakeholders on the value associated with the commercial fisheries and aquaculture sectors; provided baseline information fundamental to establishing the importance of individual fisheries and trends within them; and provided accurate information to stakeholders on exports and imports.

More information: ABARES, 02 6272 3933, info.abares@agriculture.gov.au

Recreational and commercial fishing in Port Phillip Bay 2014-207

A project to assess the social and ecological issues associated with commercial and recreational fishing in Port Phillip Bay, Victoria, has found that most risks directly associated with the sub-fisheries tend to be of 'moderate' or lower consequence and are considered sustainable, given current management controls.

However, many of the assessments have a low confidence associated with them, because of a lack of data. In particular, the research found it is important that assessments of total catch and effort for the recreational fishery are undertaken at regular intervals.

The greatest risks to the ecological sustainability of fishing in Port Phillip Bay come from external hazards, those associated with population, catchment, industry and development impacts.

Careful assessment of the risk pathways to important fish populations would be beneficial in identifying potential management actions that could mitigate risks associated with these hazards.

More information: Ian Knuckey, 03 5258 4399, ian@fishwell.com.au

Refining a Nordmøre grid in the Spencer Gulf 2015-019

Bycatch reductions achieved in a project for the Spencer Gulf Prawn Fishery in South Australia found the greatest reductions by weight in total bycatch (at about 80 per cent) were achieved with a large, low-angled Nordmøre grid.

It has 38-millimetre bar spaces, a support bar two-thirds up the length, a 2.7-metre guiding panel terminating about 0.6 metres anterior to the grid base and a large escape exit (>0.8 square metres).

This configuration did not negatively impact catches of prawns, but rather improved their quality and value (presumably owing to fewer crabs causing less damage). In a global context, the reduction in total bycatch with the preferred grid was within the upper range of those observed for mechanical separators tested in other crustacean trawl fisheries.

These findings demonstrate the potential for improved selectivity in this fishery using a Nordmørev grid – primarily by mechanical exclusion of bycatch from the target species owing to size and/or morphological differences.

More information: Craig Noell, 08 8207 5400, craig.noell@sa.gov.au

Recreational fisheries data 2012-021

A project to trial and validate the chain referral sampling method, respondent-driven sampling (RDS), for obtaining representative data from specialised 'hard-to-reach' components of recreational fisheries has found it may not be cost-effective.

Without a highly motivated population of socially closely connected fishers, RDS does not appear to be a cost-effective method for obtaining representative catch, effort, social and economic data.

Future trials of similar methods for surveying recreational fisheries may consider using other types of survey administration, such as those that do not require direct voice contact with staff, and may result in more recruitment. However, such methods need careful consideration and testing prior to use since they may introduce a suite of poorly understood sampling biases that compromise sample representativeness.

A repeat of previous economic surveys of the recreational rock lobster fishery, based on a representative sample of the licence frame, could provide an interesting assessment of the high value placed on landing rock lobsters.

More information: Dr Tim Lynch, 03 6232 5239, tim.lynch@csiro.au

Movers and ...

Ruben Alvarez has taken over as CEO of Petuna Seafoods.

After eight years as executive officer at the Australian Barramundi Farmers Association, **Chris Calogeras** is stepping down from the part-time position, which **Jo-Anne Ruscoe** will now take on (contact via info@abfa.org.au). Jo-Anne Ruscoe will leave her role as projects manager – research at the FRDC at the end of March.

Toby Piddocke, projects manager – carp with the FRDC, has stepped down from his role, with the position to be filled by **Jennifer Marshall**.

Scott Parkinson has left his role as breeding manager with Shellfish Culture, becoming the new technical sales manager with PFG Group in Hobart.

Brian Jones stepped down from his position with the New Zealand Ministry for Primary Industries in January 2018. He is now at the School of Veterinary and Life Sciences, Murdoch University.

Graham Mair, director of Marine Sciences and Aquaculture at Flinders University, is leaving his post to take up a role with the Food and Agriculture Organization of the United Nations.

Robert Gott has left his position as director of Marine Resources at the Tasmanian Department of Primary Industries, Parks, Water and Environment. **Grant Pullen** is currently acting in the position.

Cathy Dichmont will be the new chair of the Queensland Research Advisory Committee.

Wayne Hoskings is stepping down as CEA of the Geraldton Fishermen's Co-operative.

Sean Sloan is now director of fisheries at the Department of Primary Industries and Regions, South Australia.

The participants in the 2018 National Seafood Industry Leadership Program (NSLIP) have been announced. The first session will be held in Hobart in March.

Lachlan Bassett, Fresh By Design, NSW;
Andrew Bollinger, fisher, NSW;
Toni Clark, Petuna, TAS;
Markus Gerlich, Austral, NSW;
Richard Hamilton, self-employed fisher, QLD;
Kim Hooper, Australian Prawn Farmers Association, QLD;
Portia Kyros, Chaceon, WA;
Ashley Lukin, fisher, SA;
Thomas Moyle, Mainstream Aquaculture, VIC;
Stephen Masters, Sydney Fish Market, NSW;
Santha Nakandage, Humpty Doo, NT;
Bronte Nardi, Recfishwest, WA;
Michael Thomas Passi, fisher, QLD;
Giulia (Julia) Porro, Department of Agriculture and Water Resources, ACT;
Ryan Rossi, The Company One P/L, QLD;
Cameron Shield, Tassal, TAS;
Sarah Ugalde, Institute for Marine and Antarctic Studies, TAS; and
Angela Williams, Paspaley, NT.

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Annabel Boyer, 02 6285 0415,
annabel.boyer@frdc.com.au

Calendar of events

DATE	EVENT	MORE INFORMATION
11 to 13 March	**Seafood Expo North America, Boston, US**	www.seafoodexpo.com/north-america
15 to 20 April	**6th International Otolith Symposium, Taiwan**	www.facebook.com/ios2018tw
18 to 19 April	**FRDC Board Meeting, Adelaide**	02 6285 0400
24 to 26 April	**2018 Seafood Expo Global, Brussels, Belgium**	www.seafoodexpo.com/global
7 June	**World Oceans Day**	http://www.worldoceansday.org/
13 to 14 June	**FRDC Board Meeting, Hervey Bay**	02 6285 0400
18 to 21 June	**SeaWeb Seafood Summit, Barcelona, Spain**	www.seafoodsummit.org
1 to 5 July	**Canyons to Coast: Australian Marine Science Association Conference, Adelaide**	www.amsa.asn.au/amsa-annual-conferences
16 to 20July	**International Institute of Fisheries Economics & Trade Conference, Seattle, US**	www.xcdsystem.com/iifet/website
12 August	**Hervey Bay Seafood Festival, Hervey Bay**	https://herveybayseafoodfestival.com.au
14 to 15 August	**FRDC Board Meeting, Canberra**	02 6285 0400
4 to 6 September	**Seafood Expo Asia, Hong Kong**	www.seafoodexpo.com/asia

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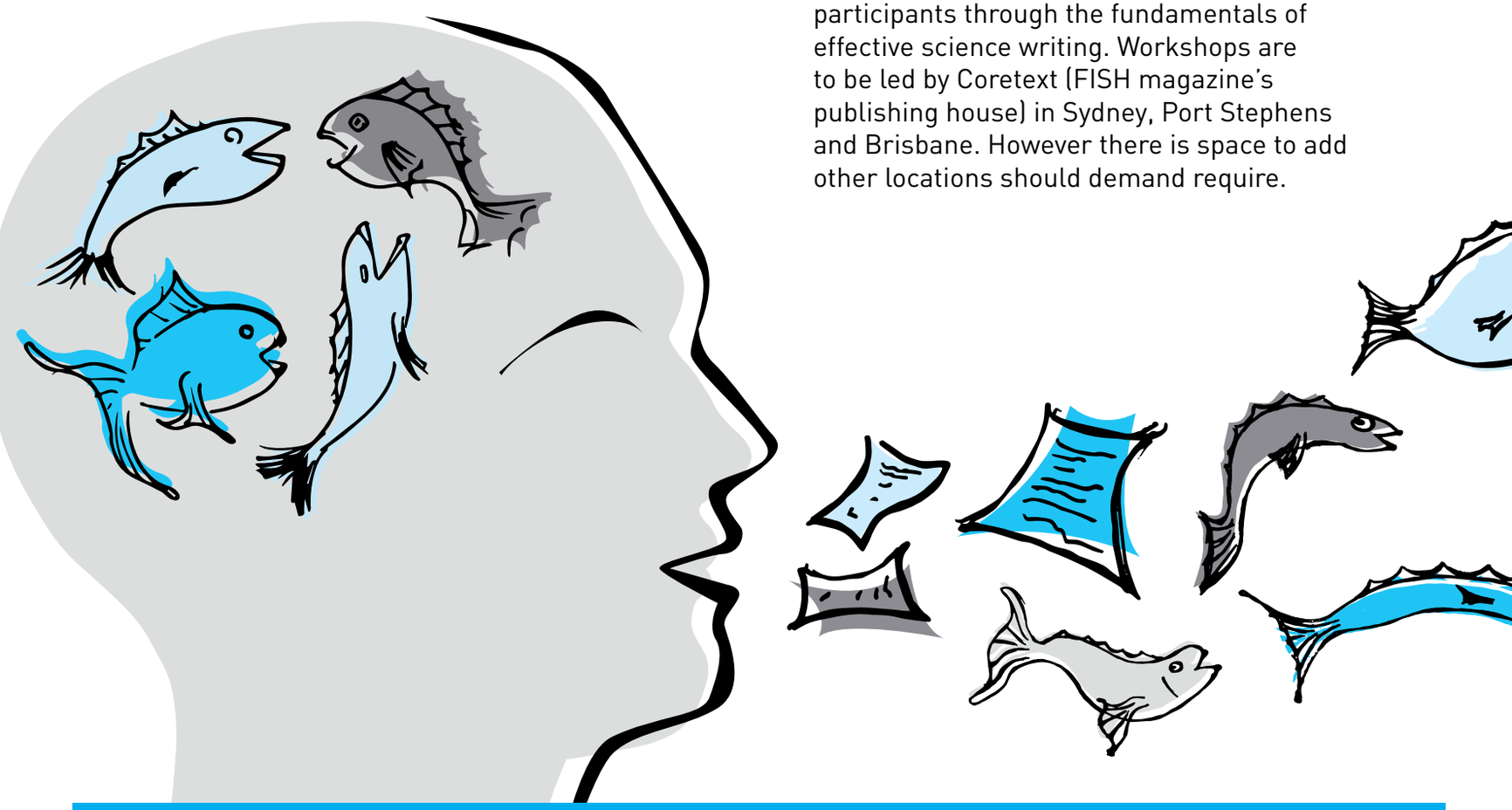
In 2018, the FRDC will hold writing workshops for researchers, which will take participants through the fundamentals of effective science writing. Workshops are to be led by Coretext (FISH magazine's publishing house) in Sydney, Port Stephens and Brisbane. However there is space to add other locations should demand require.



To be notified about dates or request a workshop in your area email the FRDC's Ilaria Catizone at Ilaria.catizone@frdc.com.au