FISH

FISHERIES RESEARCH & DEVELOPMENT CORPORATION **NEWS**

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Global spotlight on Australian fishing and aquaculture

MULTI-PRONGED SAFETY STRATEGY

ROCK LOBSTER AQUACULTURE ADVANCES

STRATEGIES FOR FUTURE HARVESTS

COMMUNITY RESILIENCE GRANTS ROUND TWO

NOW OPEN

Seafood Industry Mental Health & Wellbeing

STAY AFLOAT

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Applications are now open for Round 2 of the Stay Afloat Community Resilience Grants.

25 grants of up to $2,000 are available to support initiative and events designed to improve the mental health and wellbeing of commercial seafood communities around the country.

The grants are available for seafood communities around Australia to host community-led events that support discussions on mental health, well-being and connectedness. Short on ideas? Think about adding a BBQ and speaker to your next AGM or meeting. In lockdown? Use the funds to support a book or movie club coupled with a video catch-up.

Applications close on September 30, contact program manager Jo Marshall on jo@seafoodindustryaustralia.com.au or 0408 008 344 to help develop your ideas or to submit an application.

For more information visit www.stayafloat.com.au/grants

www.stayafloat.com.au

facebook.com/StayAfloatAustralia

Stay Afloat Australia is the national mental health pilot program for the Australian seafood industry, run by Seafood Industry Australia and supported with funding from the Australian Government Department of Health's Mental Health Program

FEEDBACK
FRDC welcomes your comments: frdc@frdc.com.au

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REGULAR

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The FRDC acknowledges the traditional custodians of the lands on which *FISH* magazine is produced, and pay our respects to their Elders past and present. We acknowledge the special relationship that Indigenous Australians have with their traditional lands and waters.

Keen amateurs prove a major force in scientific discovery

Words **Gio Braidotti**

Tidal pool volunteers. Photo: Earthwatch

Fisheries are a major beneficiary as science employs the value and power of citizen scientists

Faced with major restrictions on activities during COVID-19 lockdowns during the past year, and a renewed focus on local environments, more people than ever have joined up to participate in scientific discovery through citizen science activities.

These typically involve monitoring or sampling the environment, classifying scientific data or analysing it, either in partnership with researchers or within a community group. And fisheries have been a particular beneficiary of research activity undertaken by keen amateurs.

Chair of the Australian Citizen Science Association (ACSA) Erin Roger says engagement had been on an upward trend but it clearly accelerated with the pandemic.

"We saw a big uptake of citizen science activity with COVID-19 lockdowns, particularly projects that can be done on a computer or involve observations of the local environment," she says.

Helping the discovery process

Roger stresses that the projects are the real deal and not a coy subterfuge to promote or communicate science. In fact, public participation can be crucial to the discovery process.

This proved to be the case for Shauna Murray at the University of Technology Sydney. She runs a project to better detect ciguatera toxins in Spanish Mackerel (*Scomberomorus commerson*) caught in New South Wales waters and has established the state's first ciguatera-testing facility as part of efforts to prevent it reaching consumers.

Ciguatera are tasteless, heat-stable toxins that cause serious illness, sometimes with long-lasting neurological symptoms. They are produced by tropical microalgae and accumulate up the marine food chain.

"We have known about the danger of ciguatera in Australia since colonisation, but in the past 10 years we have seen increasing cases reach further south into NSW, possibly as part of warming trends associated with climate change," says Murray.

From one recorded case in NSW prior to 2014, the numbers have increased: 31 incidents have been recorded since then, including among recreational fishers. Testing in recent years detected the toxins in about five per cent of sampled Spanish Mackerel caught in NSW.

Past efforts to prevent contaminated fish from reaching consumers included a maximum size limit of 10 kilograms imposed by the Sydney Fish Market. This was based on the premise that larger Spanish Mackerel would be more likely to have accumulated the toxins.

Murray's preliminary analysis in 2019 indicated this proposition was not necessarily true, but she needed a larger study to identify fish characteristics that properly indicate risk.

When neither the scientists nor the Sydney Fish Market were in a position to generate the samples needed, she reached out to commercial and recreational fishers directly for help.

"We got a great sector-wide response," she says. "The partnership operates quite simply. We reach out to fishers, open up a dialogue and send out sample packs containing pre-labelled tubes, instructions and what information to record."

Fishers provided about 100 samples of flesh and liver tissue during the most recent Spanish Mackerel season.

"We are now looking at running the same citizen science initiative for the next two seasons," says Murray, who is also looking to expand the ciguatera survey with the support of the NSW Government's Recreational Fishing Trusts .

The reliability and trustworthiness of citizen scientists' contributions have often been open to

speculation, but there is now published evidence to support the idea that these contributions are robust.

For example, Zooniverse, a portal hosted by Portsmouth and Oxford universities that links the public to about 200 active science projects, has achieved just under 600 million classifications that contributed to over 100 peer-reviewed scientific papers.

While some scientists are surprised by the quality and size of the impact of citizen contributions, Roger says there is a good reason for it. "Science can look broadly or deeply at a problem, but not both. Citizen science offers a way to achieve both depth and breadth."

Mapping change

This facet is particularly apparent with Redmap – the Range Extension Database and Mapping project. It was started by Gretta Pecl at the University of Tasmania and launched in 2009. Redmap invites the Australian community to spot, log and map changes in the distribution of marine species as part of efforts to understand climate-driven impacts.

"I started Redmap in recognition of the amount of knowledge held by fishers, divers and people that are routinely out on the water, but that doesn't make it into the scientific record," Pecl says. "So, Redmap both extends our ability to monitor marine environments while incorporating industry knowledge that science typically omits."

First rolled out in Tasmania, but extended nationally with support from FRDC, Redmap relies on volunteers submitting photos of species that are unusual for a particular area, with the species identification verified by experts. Pecl says she was surprised and impressed by the level of knowledge in the community that proved capable of distinguishing species accurately and determining which did not belong to an area.

Examples of anomalous sightings include Whale Sharks (*Rhincodon typus*) in waters off Perth and Gloomy Octopus (*Octopus tetricus*) in Tasmania. These records are indicative of a greater global trend that is seeing tropical species extend into temperate zones over time.

"Data from Redmap has contributed to 25 journal articles and has helped establish that species shift isn't random but is associated with regions that are warming faster," Pecl says.

In 2021, she published a continental-scale review of climate-driven redistributions, and she told *FISH* magazine that 20 per cent of the data used in that analysis came from citizen science. The review is freely available to the public (https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.15634).

"The data is also helping us to understand the ecosystem implications, with findings becoming more relevant the longer the project runs," she adds.

The value and importance of Redmap has been widely recognised. For example, it has twice been a finalist for the prestigious Australian Museum Eureka Prize for Innovation in Citizen Science. However, with no long-term secure funding, the project has once again turned to the public for help by welcoming donations.

App engagement

Monitoring biodiversity and sampling are key activities in fisheries-related citizen science projects (see Table 1), and Rogers, from the ACSA, is impressed by the scope of fisheries-related projects available.

Fishers possess one type of data of immense importance to fisheries: how much they catch and keep. Yet when it comes to recreational fishers, catch data is often lacking or unclear.

To help address this issue, fisheries managers and researchers around the world are looking at whether citizen science-style practices can help close the information gap using smartphone app technology as the reporting interface.

This approach combines mandated reporting in the recreational fishing area (where catch and size limits can apply) with citizen science and the potential to make additional voluntary contributions.

While many voluntary projects have been enthusiastically supported, catch-size reporting projects in fisheries around the world have had varied degrees of success.

In Australia, the combined approach is being analysed in an FRDC-funded project undertaken by the University of Tasmania (UTAS) in partnership with the Victorian Fisheries Authority (VFA).

UTAS project leader Karlie McDonald says the VFA's monitoring of recreational rock lobster catches provides the basis for the analysis, and combines mandated reporting and the opportunity for additional voluntary information.

Recreational fishers are required to tag the rock lobsters they catch and report the tags they use either online or through the VicRLTag app, which was launched three years ago. This provides an estimate of the annual recreational harvest.

In addition to fishers reporting the mandatory data (catch numbers, lobster size and catch location), they can use the app to voluntarily

A Victorian recreational fisher tags a rock lobster. Photo: Victorian Fisheries Authority

Recreational fishers provide mandatory tag data and can volunteer extra information. Photo: Victorian Fisheries Authority

Australians are enthusiastic contributors to citizen science projects. Photo: Port Phillip EcoCentre

report additional information. This might include the method used to make the catch, location details, sex of rock lobsters caught, time spent fishing, instances when no catches were made and general observations of rock lobster abundance. This extra information provides much more sophisticated estimates of catch rates and fishers' satisfaction.

McDonald says the launch of these additional citizen science-style features in the app were initially greeted by fishers with enthusiasm. However, the VFA found the number of citizen scientists signed up to voluntarily provide additional information has remained at about 10 per cent of recreational rock lobster recreational fishers annually.

Surveys of fishers found the problem is not due to flaws in the app design that make it difficult to use, or unwillingness to share data.

"Fishers are more than willing to provide information as demonstrated by an 85 per cent response rate to our surveys," McDonald says.

Rather, fishers said the existing app failed to provide any opportunity for them to review their own data. This missed an important feedback loop to help fishers understand what the collated data means and what was being learnt from it.

"In other words, the app was constructed as a one-way conversation, which is unusual for citizen science initiatives," McDonald says. "Citizen science projects thrive when information and conversations flow two ways."

She recommends more-interactive apps that offer feedback opportunities for both fishers and managers to learn from each other, that report on the findings produced from the volunteered data. The app could also offer features that incentivise participation in recreational fishing, such as weather information.

"Ultimately, the optimum outcome is achieved by an app design that fits a community of engaged citizen scientists who are keen to learn within a mandatory reporting system," McDonald says. "That means the apps should engender a sense of community so that fishers feel they are contributing to the sustainable management of the fishery. Fishers also need to understand why they are being asked certain questions."

A final report on her project is expected to be published in November 2021.

Meanwhile, the VFA plans to launch phase two of the recreational rock lobster tagging program in September 2021. This includes a new reporting interface under the GoFishVic app and with functionality that allows fishers to review their personal catch data, create groups, add photos and share via social media.

Table 1: Examples of citizen science projects in the fisheries sector.

Organisation	Project
OzFish	DNA sampling project in south-western Sydney, a partnership between fishing conservation charity OzFish, Landcare NSW and Campbelltown City Council. 1800 431 308 or email OzFish at info@ozfish.org.au
Redmap	Monitoring range shift of marine and aquatic species. https://www.redmap.org.au
Ciguatera survey	Recruits recreational and commercial fishers to provide Spanish Mackerel samples for ciguatera toxin testing. https://www.redmap.org.au/news/2021/02/09/ciguatera-fish-poisoning-survey/
Australasian Fishes project	Led by the Australian Museum, it includes a platform to upload images and identify observations of fishes from Australia and New Zealand. https://australian.museum/get-involved/citizen-science/fishes/
Sharks and Rays Australia	Involves the general public in sawfish and shark research and conservation work. https://www.sharksandraysaustralia.com
Recfishwest	**Reef Vision:** Involves boat fishers in capturing footage of the state's artificial reefs using provided baited remote underwater video (BRUV) cameras to help map and monitor the growth and development of these fish structures in Esperance, Dunsborough, Busselton, Mandurah and Exmouth, Western Australia. **Send Us Your Skeletons:** Donated fish skeletons help with the long-term monitoring program of fish stocks and Western Australian fisheries science. https://recfishwest.org.au/get-involved/citizen-science/

A national obsession

McDonald's findings highlight that, given the opportunity, Australians are more than happy to be part of the discovery and learning process.

This is backed up by an analysis performed by the University of New South Wales, where Thomas Mesaglio and Corey Callaghan found that Australians are among the world's most enthusiastic when it comes to volunteering biodiversity data to the popular global platform, iNaturalist.

They found that globally 1.4 million users have contributed over 54 million observations, with Australia the top contributing nation in the Southern Hemisphere. Australia was also in the top four overall contributing nations, with more than 1.6 million observations of more than 36,000 identified species, contributed by almost 27,000 users.

The platform includes a featured project called Australasian Fishes.

With iNaturalist, artificial intelligence (AI) is used to help identify species from photos uploaded by the public. Interestingly, the pattern-recognition capability of AI has actually raised the prospect that citizen scientists may one day be usurped, at least when it comes to classifying data.

However, scientists behind leading citizen science initiatives, from the ACSA to Zooniverse, agree that is not going to happen.

They have observed there is something about how humans observe that is driven by curiosity and allows them to spot and query the anomalies and oddities that are often the precursor to important findings. It is a skill that cannot readily be taught to AI algorithms. On the contrary, data classified by the public (in the form of images of galaxies from the Sloan Digital Sky Survey) have subsequently been used to help train AI in image recognition.

"There's not going to be an AI takeover, not at all," Roger says. "Wherever science has a challenge to scale research spatially and temporally, there's a role for the public. Besides, we see lessons flow both ways with citizen science projects, with science benefiting from local knowledge, industry experience and novel insights." **F**

MORE INFORMATION
Australian Citizen Science Association Project Finder https://citizenscience.org.au/ala-project-finder/
BioCollect https://biocollect.ala.org.au

FRDC RESEARCH CODES
2019-060, 2019-213, 2019-075

In brief

Fisheries expert in leadership program

The recently announced 28th cohort of the prestigious Australian Rural Leadership Program (ARLP) includes fisheries consultant from Mount Nelson, Tasmania, Andrew Sullivan, who is sponsored by the FRDC.

Sullivan is the director of Fish Focus Consulting and the executive officer of both the Commonwealth Fisheries Association and the Bass Strait Scallop Industry Association. He has extensive experience and knowledge of Australia's commercial fishing sector.

The program gives participants valuable opportunities to enhance their capacity and create a network of like-minded leaders to positively influence their organisations, industries and communities. The ARLP is Australia's longest and most in-depth experiential leadership program designed to build leadership capability in people in rural, regional and remote Australia. Participants attend 50 days of experiential learning and mentoring across four sessions over a 15-month period.

The program, commencing in June 2022, will bring together a diverse cohort of 25 to 30 leaders from across rural Australia. **F**

More information
https://rural-leaders.org.au/our-programs/arlp/

NEW FRDC DIRECTORS APPOINTED

Minister for Agriculture and Northern Australia David Littleproud has appointed seven non-executive directors to the FRDC, five of whom are new to the board.

Directors re-appointed are:

- Colin Buxton, Adjunct Professor, Fisheries, Aquaculture and Coasts Centre, Institute of Marine and Antarctic Studies, University of Tasmania; and
- Saranne Cooke, director, Leading Age Services Australia, New South Wales

New directors are:

- Dr Chris Calogeras, director, C-AID Consultants, Queensland;
- Suzanne (Suzi) Hullick, National Head of Indigenous Banking, Westpac Bank, Northern Territory;
- Boris Musa, chief executive officer, Mainstream Aquaculture, Victoria;
- Alex Ogg, manager, National Energy Resources Australia; and
- Lyndal Thorburn, managing director, Viria Pty Ltd, New South Wales.

Assistant Minister for Forestry and Fisheries Jonathon Duniam says the FRDC's mission is to act as a national thought leader, facilitating knowledge creation, collaboration and innovation to shape the future of fishing and aquaculture in Australia for the benefit of the Australian people.

"Research and innovation will play a key role as the sector looks to new opportunities and continues to recover from the impacts of the pandemic.

Outgoing directors are Kate Brooks, Katina (Katie) Hodson Thomas, Mark King, John Lloyd and Lesley MacLeod.

Chair of the FRDC board, appointed separately in March 2020, is former Senator for NSW John Williams. **F**

More information https://www.frdc.com.au/about/frdc-directors

INDUSTRY-LED EXPORT EXPANSION

An $888,000 grant from the Australian Government has been awarded to Seafood Industry Australia (SIA) to develop and expand markets for Australian seafood exports.

The grant will be used to explore expanding Australia's seafood exports into new markets and markets with high growth potential, such as North Asia, South Asia, the Pacific, Europe and the Americas. Rock lobster and abalone will be a key focus.

Seafood Industry Australia CEO Veronica Papacosta says a key piece of the program will be the creation of a 'one-stop shop' for seafood exporters.

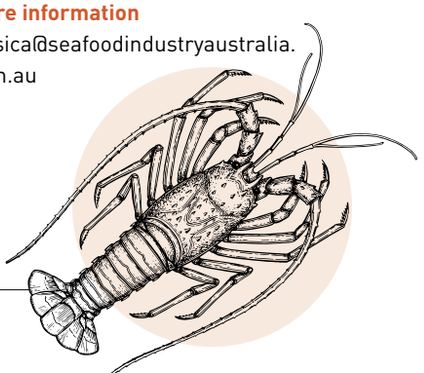
"There is a plethora of information, resources and databases out there for seafood exporters; however, it can be difficult for producers to keep track of them all and know how to find them," Ms Papacosta says.

"We are planning to create a digital platform that will curate all the resources in one place. This will allow our producers to focus their time on delivering the world's greatest seafood to all corners of the globe.

"Importantly, this funding will support whole of industry, regardless of sector or location. It will allow us to immediately put boots on the ground to quickly deliver much-needed support to the sectors who need it most."

SIA will engage two trade export managers to build capacity for seafood exporters across Australia. The grant will also go towards promoting the Great Australian Seafood brand under brand Australia. By working in partnership with Austrade, SIA will help design a promotion schedule for Australian seafood in export markets. **F**

More information
jessica@seafoodindustryaustralia.com.au



ECOSYSTEMS

Coastal mangroves provide essential habitat for thousands of species and are fundamental to a productive ecosystem.
Photo: Vishwasa Navada K/Unsplash

Engineering tides to restore coastal wetlands

University of New South Wales (UNSW) researchers have designed and built a system that mimics tides to help restore vital coastal wetlands, enhancing their ability to sequester carbon and support wildlife, including birds and fish.

Over three years, a trial of the system at Kooragang Island, in the Hunter River estuary north of Newcastle, saw saltmarsh vegetation cover in the area rise from 0.2 per cent in November 2017 to 45 per cent by December 2020.

The team from the Water Research Laboratory within UNSW Engineering has developed the 'Tidal Replicate Method', an artificial tidal regime calculated to create the best ecological conditions for the specific wetland area. It does this by controlling gates on tidal channels that connect the wetlands to the river, regulating the amount of water flowing into the wetland.

A similar project at the nearby Tomago Wetlands site – a Ramsar-listed area spread over 400 hectares – delivered similar outcomes for saltmarsh growth, resulting in increased numbers of migratory shorebirds. **F**

FOOD SCIENCE

SMART SOLUTION TO SEAFOOD SPOILAGE

A simple device that measures the increasing level of vapour coming from seafood as it begins to deteriorate provides a new and simple way to identify spoilage. Researchers at Flinders University in South Australia have developed a solid-state fluorescent sensor that is loaded onto filter papers, which instantly and accurately measured the rate of spoilage in Atlantic Salmon (*Salmo salar*) during trials.

Flinders University's professor of aquaculture Jian Qin says the technology can be easily applied to other seafood and could enable "real-time" monitoring of spoilage in seafood to ensure food safety for consumers.

Spoilage is estimated to account for at least 10 per cent of all seafood production. The core of the new spoilage analysis technology is the ability of the sensor to detect vapours from biogenic amines, which increase with rising levels of bacteria as seafood begins to spoil.

High levels of biogenic amines in seafood have an adverse impact on human health and can cause food poisoning.

The research found that as spoilage in the salmon samples increased, triggering more amine vapours, so too did the intensity of the readings on the treated filter papers. The research team is optimising its materials to develop more robust sensors for daily use in commercial applications. Results of the research were published in the journal *Food Chemistry*. **F**

Photo: 123RF

TECHNOLOGY

FOLLOW YOUR FAVOURITE SHARKS IN REAL TIME

Anzac, Bindi and Sunny – these are the names of just three sharks living in the waters off Western Australia that shark lovers and other marine enthusiasts can follow in near real time as they move along the coast. All three Tiger Sharks (*Galeocerdo cuvier*) are part of an international cast of sharks tagged and monitored by the OCEARCH Shark Tracker. OCEARCH is a US-based non-profit organisation that aims to facilitate research and education through public access to data and its global shark-tracking program. It also provides curriculum materials for students, with a focus on using its shark-tracking program to incorporate environmental awareness into science, technology engineering and maths subjects.

Through the program, you can track a wide range of shark species around the world and see the patterns of their travel since being tagged. OCEARCH has more than 400 tagged sharks in its global database, which can be followed at www.ocearch.org/tracker/ **F**

WORD-WISE

SEMELPAROUS. Describes species that reproduce only once and then die, such as some arrow squid species.

ITEROPAROUS. Describes species that reproduce multiple times. They produce offspring in successive cycles such as annual or seasonal. Examples include perennial plants and anchovies. **F**

What seafood brings to the table

New nutritional information on popular seafood species will help fishers market their catch and help consumers understand the benefits of their seafood selections as part of a healthy diet

By **Catherine Norwood**

The bank of detailed nutritional information about Australia's many seafood species continues to grow, with analyses of 25 fish and three crustaceans added to the available data.

Senior food scientist at Queensland's Department of Agriculture and Fisheries Andrew Forrest has led the project for the FRDC. The new data brings the total number of commercial wildcatch species with detailed nutritional profiles to 41.

Previous research has provided a fat analysis of 250 species of Australian seafood, including levels of the valued healthy omega-3 fatty acids. However, more detailed analysis that includes information about minerals and vitamins is required for nutritional information panels.

Forrest says the new data will help remove a barrier to retail markets and could help increase consumption of seafood in Australia by allowing more products to be offered in pre-prepared consumer-ready portions, complete with the required nutritional panels.

These panels are essential to labelling requirements under the Australia New Zealand Food Standards Code, when seafood is packaged for retail sale.

"If Australia's consumption of seafood was to increase, there would be improved health outcomes for consumers as well as a growth in the domestic market," says Forrest.

Expanded analysis

Forrest says the species initially identified for analysis changed as the project rolled out in consultation with industry, adapting to seasonal availability and priority catches. Three prawn species were added at the request of industry, and there was strong interest in profiles for many other species that the existing project was unable to take on.

For fishers or retailers keen to provide the basic nutritional information, Forrest says the costs of the required testing are in the order of $300 for a single species. However, the FRDC project tested for a much larger range of nutritional elements, beyond those required for basic compliance.

"These extra components are considered as general health claims under the Food Standards Code, as opposed to basic nutrition information," he explains. "An example would be zinc content. Zinc is not required for a nutrition information panel, but it can be added, and this would be considered a general health claim. Other examples of general health claims would be reporting of vitamin E content, or omega-3 and omega-6 fatty acid content."

He says the analysis confirmed Australian seafood as a high-quality source of protein, with other health-supporting components. Many species had similar nutritional profiles, although not similar enough for a common nutritional labelling. The greatest variation was in fat content – the omega-3 and omega-6 fatty acids.

For those keen to develop nutritional panels for packaged seafood products, the (now closed) Australian Seafood Cooperative Research Centre (ASCRC) published *Industry Guidelines for Seafood Health and Nutrition Messages* to work through the process.

The FRDC's Fishfiles website (www.fishfiles.com.au) currently provides a central repository for nutritional data and consumer information, as a companion to the Status of Australian Fish Stocks Reports (SAFS) (www.fish.gov.au). This includes nutritional profiles for 21 species previously developed by the ASCRC.

Forrest sees the growing database of nutritional information as a valuable resource for the sector as a whole. However, he points out that SAFS identifies 148 species as commercially important in Australian fisheries, which leaves many species still to be profiled.

The latest nutritional profiles are available on the FRDC website at https://www.frdc.com.au/project/2017-145 F

Table 1: Species sourced for nutritional profiling.

Fish species	Scientific name	Fish species	Scientific name
Albacore	*Thunnus alalunga*	Australian Sardine	*Sardinops sagax*
Amberjack	*Seriola dumerili*	Sea Mullet	*Mugil cephalus*
Barcheek Coral Trout	*Plectropomus maculatus*	Snapper	*Chrysophrys auratus*
Barramundi (wild)	*Lates calcarifer*	Spanish Mackerel	*Scomberomorus commerson*
Bight Redfish	*Centroberyx gerrardi*	Spotted Mackerel	*Scomberomorus munroi*
Crimson Snapper	*Lutjanus erythropterus*	Swordfish	*Xiphias gladius*
Dusky Flathead	*Platycephalus fuscus*	Tailor	*Pomatomus saltatrix*
Eastern School Whiting	*Sillago flindersi*	West Australian Dhufish	*Glaucosoma hebraicum*
Goldband Snapper	*Pristipomoides multidens*	West Australian Salmon	*Arripis truttaceus*
King Threadfin	*Polydactylus macrochir*	Yellowfin Bream	*Acanthopagrus australis*
Luderick	*Girella tricuspidata*	**Prawn species**	
Patagonian Toothfish	*Dissostichus eleginoides*	Banana prawn	*Penaeus merguiensis*
Red Emperor	*Lutjanus sebae*	Blue Endeavour Prawn	*Metapenaeus endeavouri*
Redthroat Emperor	*Lethrinus miniatus*	Brown Tiger Prawn	*Penaeus esculentus*
Saddletail Snapper	*Lutjanus malabaricus*		

MORE INFORMATION
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FRDC RESEARCH CODES
1994-136, ASCRC 2008-905, 2017-145

Sharing international fisheries science with stakeholders

Butterfly Perch
Photo: Ocean Imaging

WORLD FISHERIES CONGRESS
ADELAIDE • AUSTRALIA
20-24 SEPTEMBER 2021

By **Catherine Norwood**

As stakeholders affected by new fisheries science and management decisions, fishers and aquaculture operators will be important participants in discussions generated at the World Fisheries Congress 2021

The World Fisheries Congress 2021 is billed as the 'Olympics for fisheries science', but organisers of the 2021 event have worked hard to incorporate the fishing industry and seafood supply chain into the Adelaide program.

Congress chair Gavin Begg says this marks a new direction for the congress, which has traditionally focused on an audience of scientists and fisheries managers.

"There have always been implications for industry from past events. But we wanted to make industry a much more prominent player. Whatever comes out of the congress at the end of the day, industry is affected by the impacts," Begg says.

The 8th World Fisheries Congress will run from 20 to 24 September. Originally set to be held at the Adelaide Convention Centre, the organisers made the difficult decision to hold an entirely virtual Congress in early August, due to the worsening COVID-19 situation around the country. They are now working on ways to ensure the virtual congress will be every bit as engaging and memorable, utilising the full capacity of the virtual platform Touchpoint.

Virtual lunchtime sessions from around the country will showcase Australian fishing and aquaculture for an international audience. Competitions and other calls to action will create opportunities for virtual engagement beyond conference talks and Q&A sessions. For example delegates will be able to share their favourite seafood recipes, research photos or share where in the world they are.

Begg says the strength of interest in participating in the event, particularly to present research, management concepts and innovations in industry, has remained strong. There were 1400 abstracts for congress presentations submitted for the originally scheduled event in 2020, and a similar number submitted for the rescheduled event this year.

"About 900 of these are from international contributors, so the strength of interest is still there," Begg says.

Industry input

Seafood Industry Australia (SIA) and Seafood New Zealand are both active members of the congress steering committee, which has tried to establish an industry flavour to events.

"If industry people want to attend, even for one day, then we've tried to consolidate the sessions we think will be of most interest to them on Wednesday 22 September and Thursday 23 September," Begg says.

The plenary speaker in the opening session on 22 September will be Martin Exel from Austral Fisheries, who is also managing director of SeaBOS (Seafood Business for Ocean Stewardship). This is a collaborative venture between 10 of the world's largest seafood businesses and the Stockholm Resilience Centre in Sweden that aims to transform wild capture and aquaculture fisheries to sustainable seafood production and promote a healthy ocean, globally.

Exel's presentation will be followed by sessions on topics that include resource allocation, co-management, supply chains, traceability, marketing and advances in fishing gears and vessels.

Contingency plans

"We've worked closely with an international committee on the program, and the feedback we have received about virtual events is that the Q&A sessions are what people are really interested in.

"More than 30 live-streamed sessions focused on key topics have been brought into the program to provide dedicated time to discuss, consider and debate issues relevant to the fisheries community. This will provide both the audience with an opportunity to ask the panel questions during the 1.5 to two-hour sessions that will include keynote presentations."

All congress presentations have also been prerecorded, and delegates will have a chance to view recordings in the week prior to the actual event. This will allow them to make more of Q&A sessions, which will be a major feature of the congress.

The plenary speaker in the opening session on 22 September will be Martin Exel from Austral Fisheries, who is also managing director of SeaBOS (Seafood Business for Ocean Stewardship).

Above Martin Exel
Photo: Supplied

Delegates will also be able to submit questions to presenters via a discussion forum, from the time presentations become available in the week prior to the congress until the end of the congress.

Begg says the timing of some sessions during the five-day event has also been changed to cater for international audiences; there are now some early morning and evening presentations.

All presentations, including recordings of live-streamed sessions, will be available on demand for delegates for several months after the congress. And those who register to attend in person but find they need to swap to virtual participation due to COVID restrictions will be able to do so, receiving a refund for the price difference. F

WORLD FISHERIES CONGRESS 2021

International fisheries science congress, with the overarching theme 'Sharing our oceans and rivers – a vision for the world's fisheries'.
Monday 20 September to Friday 24 September 2021
To view the official program, visit www.wfc2021.com.au

THE AUSTRALIAN SOCIETY FOR FISH BIOLOGY VIRTUAL EVENTS

Mentor/Mentee program:
The Australian Society for Fish Biology (ASFB) will work before the congress to link up mentors with potential mentees. This mentorship will then be facilitated through the congress' virtual platform.
Tuesday 21 September 6.30-8.30 pm

Student mixer:
A student mixer will be open for all students attending the World Fisheries Congress. Introductions and mixing will be facilitated through the congress' virtual platform.

ASFB 50 event
All ASFB members will be invited to attend a virtual event to celebrate the ASFB's 50th anniversary year – even if they are not attending the WFC (i.e. not registered delegates).

MORE INFORMATION
www.wfc2021.com.au
FRDC RESEARCH CODES
2018-059, 2019-152
INDIGENOUS HERITAGE
The World Fisheries Congress will be hosted on the lands of the Kaurna people of the Adelaide region.

For all the fish in the sea

Words **Chris Clark,** Illustration **Sonia Kretschmar**

As Australia prepares to host the World Fisheries Congress 2021 in September, eminent marine ecologist Keith Sainsbury reflects on key developments within fisheries management since Australia hosted the second world congress 25 years ago

Since 1992, the World Fisheries Congress has brought the global fishing community together to tackle problems through sharing knowledge and solutions. Ahead of the 8th Wowrld Fisheries Congress, a virtual event coordinated from Adelaide from 20 to 24 September this year, *FISH* magazine asked marine ecologist Keith Sainsbury to compare fisheries management now with 25 years ago, when the congress was last held in Australia.

At the time of the 1996 congress in Brisbane, Sainsbury had already spent years helping to develop management strategy evaluation (MSE) methods, which use computer simulations to 'road test' fishery monitoring and management plans.

A lot has happened since then, he says. "For example, evaluating fisheries management by simulating and implementing harvest strategies is now pretty much standard practice, and there's been a general improvement in global fisheries standards."

This includes adopting ecosystem-based fisheries management (EBFM) globally, with varying degrees of success. EBFM is a holistic approach that considers the health of all species, including inter-species interactions, the effects of environmental changes, pollution and other stresses on habitat and water quality.

"We've made a lot of progress on single-species fishery management, and we are improving ecosystem-based approaches to management. But we're not there yet," Sainsbury adds. The cost of data collection and the associated monitoring remain a challenge.

Bycatch in focus

At the 1996 Brisbane congress, the issue of bycatch was unexpectedly highlighted when a protestor chained herself to the venue doors to

"The Australian Fisheries Management Authority (AFMA) does ecological risk assessments for more than 5000 bycatch species and is able to manage high-risk species. The risk assessment methods were not available back in 1996."

Keith Sainsbury

raise awareness of seahorses and their increasingly precarious existence resulting from both targeted fishing and as bycatch of trawl fishing.

"There are ways of tackling these bycatch issues now," Sainsbury explains. "The Australian Fisheries Management Authority (AFMA) does ecological risk assessments for more than 5000 bycatch species and is able to manage high-risk species. The risk assessment methods were not available back in 1996."

As a commissioner of AFMA for 16 years, Sainsbury supported bycatch management as part of the broader EBFM approach in Commonwealth fisheries. However, its application across all Australian jurisdictions has been a "mixed bag", he says, with some fisheries applying it well and others hardly at all.

In Commonwealth fisheries, AFMA must report its progress on managing bycatch, but not all other jurisdictions have clear processes regarding bycatch and discarding, and the reporting of these activities.

"Western Australia also does a good job of this," says Sainsbury. "Some states don't do this well and some just report bycatch they're concerned about, but not other species. This is where you get people chaining themselves to the door."

Standard for sustainable fisheries

Issues such as bycatch management, including the practice and impacts of discarding, are important to another initiative that has emerged during the past 25 years: the Marine Stewardship Council (MSC). It was officially launched in 1997 as an international, independent non-profit organisation with a mission to establish a sustainable fishing standard. Today, 446 fisheries globally, including 20 in Australia, are certified as sustainable.

Sainsbury was on the MSC Board of Trustees for 12 years and remains a member of the MSC Technical Advisory Board. He is well known for his championing of the Marine Stewardship Council approach and certification process.

The MSC requires the fishery to achieve a good score on each of three principles – sustainability of the target species, ecosystem/bycatch management and fishery governance – and to have an auditable 'chain of custody' between fish capture and fish sale to the consumer.

He says MSC certification is a transparent third-party system. Many Australian fisheries have achieved MSC certification, including the Western Rock Lobster (*Panulirus cygnus*), the South Australian Pipis (*Donax spp*.) and Australian Sardine (*Sardinops sagax*), several small pelagic species, Blue Grenadier (*Macruronus novaezelandiae*), several prawn fisheries, Patagonian Toothfish (*Dissostichus eleginoides)* and pearl oyster, among others.

"You can look at any of those with MSC certification covering Commonwealth and state-managed fisheries and they all demonstrate good practice," Sainsbury adds.

Sainsbury also sits on the advisory panel for Australia's Status of Australian Fish Stocks Reports, the fifth edition of which was released in June 2021. (The first reports were published in 2012.)

While he acknowledges the value of having the Commonwealth, state and territory jurisdictions publish national status reports, he is critical of the low threshold of 'sustainability' applied – a sustainable rating typically requires just 20 per cent of unfished stock abundance (or biomass) – rather than the higher international definitions, such as maximum sustainable yield.

Future directions

Sainsbury also sees room for refining the ecosystem-based approaches to fishery management and expects that to be a big focus of the 2021 congress.

"We've developed good indicators around target species, bycatch and habitats, which can help us understand parts of an ecosystem. The thing we've never been able to pin down properly is how we get some indicator for the sustainability of the ecosystem as a whole and link that to management. That's the big science challenge. Sustainable marine ecosystems go beyond how a fishery is managed," he says.

"Understanding and accommodating ecosystem impacts is becoming more difficult as major changes affect ecosystems through climate change, pollution, coastal development, recreational fishing, aquaculture, shipping and introduced pest species.

"Changes in a fishery must be managed in this wider context in which attribution of impacts is difficult."

Sainsbury says the level of environmental activism around global fisheries, and the need for social acceptability or social licence, also remains high.

"There's a broad, social interest in what happens in fisheries and the marine environment. How we include those interests in governance arrangements is going to be quite important. For example, the interactions between commercial and recreational fishing are big issues," he says.

He argues that generally Australia has done well in fisheries management over recent decades because of a good policy framework and science capability.

However, Australia – and the world – now face different challenges.

"I don't think that management has kept up with the needs. Australia was early to improve fishery policy and science, and that improved management.

"The challenge now is twofold. At one end, the challenge is to bring the ecosystem-based approach more properly into focus and application. At the other end, we've still got jurisdictions that just aren't doing management very well, so we must lift that tail," he says.

"The real, global challenge will be developing new tools for effective ecosystem-based fishery assessment and management, and it's where I'm putting much of my effort now." F

R&D PLAN OUTCOME 3
A culture that is inclusive and forward thinking

The recognition of Indigenous fishing in Australia's history is growing, helping to bridge cultural divides and integrating more diverse perspectives into the sector's future

Celebrating the story of Indigenous fishing on a world stage

Words **Anne Crawford**

Aboriginal fishers from Maningrida retrieving fish from a net. Photo: Supplied by Matt Osborne

This month, Matt Osborne will address the World Fisheries Congress to tell the story of customary and Indigenous fishing in Australia.

Osborne, a Kaurna and Narungga man with extensive experience in Indigenous fisheries, is the program leader for aquaculture and regional development, Department of Primary Industry and Resources, Northern Territory.

In addressing the congress, he hopes to put a 'new lens' on the story, one that celebrates the history of Indigenous people in helping create Australia's commercial fishing industry and their successes today, rather than seeing access to marine resources as a source of conflict.

Recognising the instrumental role Indigenous people have played in the sector adds a 'positive story' about the Australian fishing industry that counteracts the often defensive nature of discussion around fishing rights, fishing allocations and the pressures of commercial economies determining access, says Osborne.

"It's about resetting the relationship to be collaborative and supporting in terms of recognising traditional owner views in fisheries management and not being overly fearful about what that might mean," he says.

"This story is something that can add a lot of value and historical connection and significance on the world stage. To say that our fisheries are sustainable and our fisheries also sustain the oldest living culture in the world – that's how sustainable they are and that's a powerful message."

Commercial pioneers

Indigenous fishing in Australia was a forgotten sector within the industry for a long time, Osborne says.

"It's an important story that has examples across Australia about the pioneering days and the roles Indigenous people played supporting commercial fisheries. Various government practices later removed them from the process, but nonetheless it's a colourful, rich history worth celebrating."

The historic trade in Sandfish (*Holothuria scabra*) – the Sea Cucumber, also known as Trepang – set up centuries ago with the Macassans (Indonesians) by Aboriginal people in northern Australia, is a well-documented example. It is now a lucrative export trade.

Osborne's grandmother spoke of her father and grandfather fishing on boats in the Yorke Peninsula, South Australia, helping local settlers identify fishing grounds and lending their knowledge of fish resources. They had commercial fishing licences and exclusive access to the area around Point Pearce.

But then came a period when Aboriginal people were actively removed from the fishing industry, says Osborne. A licence change affecting the Narungga people allowed them to fish in other areas, but also prevented that licence from being transferable – so when they died that licence no longer existed. Indigenous participation in

Below Traditional fish trap built and operated by Donald Bonson, Northern Territory. Photo: Sam Nowland

Bottom Matt Osborne takes his children Oliver and Laela fishing. Photo: Carrie Osborne

Below Matt Osborne in New Zealand to present on Indigenous fishing at the 2019 Maori Fisheries Conference. Photo: Delahey Miller

the Sandfish trade was prevented through regulation in the early nineteenth century.

However, the story of customary fishing is changing for the better and the conversation around it growing, Osborne says.

"In the Northern Territory, for example, we have established a small-scale fishing licence – a low-cost entry to fishing that enables people to establish a business in remote communities – and a mentoring program.

"As part of our program within fisheries, we're out there teaching commercial fishing skills, safe fishing practices. That is resulting in an increase of fish for people in remote communities to eat and in commercial fishing activity in these communities as well. It's also about offering people the chance to reconnect and develop some opportunities and pride in the work they're doing in situations that are pretty disadvantaged."

This program is taking place in Wadeye, Maningrida, Tiwi and Elcho islands.

The Ngarrindjeri people have been harvesting Pipi (*Donax deltoides*), known as 'kutis' in Ngarrindjeri, for thousands of years. They wholly own the harvesting enterprise Kuti Co – majority funded by the Indigenous Land and Sea Corporation – and are working with Goolwa PipiCo in the Coorong, South Australia.

Narungga nation people have negotiated a new Traditional Fishing Agreement – the first in the country – and are making progress establishing an aquaculture business on the Yorke Peninsula (see 'Narungga aspirations to bring benefits home' *FISH* magazine, June 2021).

Osborne credits some of these successes as part of recalibrating the narrative to both recognise and celebrate Indigenous and customary fishing. Cases of successful Indigenous participation in the sector are increasingly being aired and celebrated.

Changing attitudes

"I think it's been an attitudinal and cultural change, particularly in some of the key organisations who really showed some leadership in early days. There have been a few 'champions' getting up at national fishery forums in the past 10 or 15 years," Osborne says.

Among these he counts organisations including the FRDC, which established the Indigenous Reference Group and funded research, the biennial industry conference Seafood Directions and magazines such as *FISH*. They have all helped communicate the importance of the sector and the experiences within it.

Osborne will appear as a plenary speaker at the World Fisheries Congress on 23 September. His session will be live-streamed for virtual attendees.

The eighth World Fisheries Congress will be held in Adelaide and online from 20 to 24 September and has the theme 'Sharing our oceans and rivers – a vision for the world's fisheries'. It is the largest gathering of fisheries research, industry and management sectors in the world.

What is customary fishing?

"The definition of customary fishing needs some work between how the Indigenous community is happy for it to be represented and what it means to them, versus how it's reflected within the regulations," says Osborne.

"The standard definition is that customary fishing is non-commercial and abides with laws and customs of those people, but then different jurisdictions [in Australia] treat that differently," he says.

There is no consistent approach between government, states and jurisdictions nor an agreement on a definition of customary fishing and how that is represented in the regulations, he says.

For example, a section within NT fisheries legislation exempts customary fishing from aspects such as size limits and gear. Other jurisdictions, however, rely on Native Title and legal decisions, and complex legal arrangements to access rights.

To Indigenous people, fishing has a strong cultural meaning.

"To a lot of Indigenous groups, part of their identity is in the ocean and waters – they call themselves 'saltwater' or 'freshwater' people," says Osborne.

Creation stories, songlines and ceremonies are associated with the marine and freshwater environments, while archaeological sites such as midden sites, burials and fish traps demonstrate a visual and physical connection, the presence of families and forefathers. **F**

MORE INFORMATION
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FRDC RESEARCH CODE 2015-205

INDIGENOUS HERITAGE
Matt Osborne will present on the topic of Indigenous fisheries at the 8th World Fisheries Congress held from 20-24 September 2021, in Adelaide, South Australia, on the traditional lands of the Kaurna people.

R&D PLAN OUTCOME 2
Best practices and production systems

Southern Bluefin Tuna.
Photo: Al McGlashan

Close-kin mark-recapture making its mark

An idea lying dormant for years re-emerged at the right time, helping to rebuild global stocks of Southern Bluefin Tuna and revolutionising fisheries stock assessments

Words **Bianca Nogrady**

Mark Bravington was attending a meeting at the International Whaling Commission in the late 1990s when he first heard of the idea of using genetic matches between parent and offspring to calculate the size of a population.

Norway had amassed a significant database of DNA and tissue samples from whale hunting as a way to keep an eye on illegal whaling. Norwegian statistician Hans Skaug had twigged that this DNA database could be analysed for matches between parent minke whales and their offspring, and that the greater the number of these familial connections that turned up in the database, the smaller the population must be .

"The idea struck me as completely brilliant," says Bravington, a statistician at CSIRO in Hobart. The only problem was, it did not work.

"It was the right idea but at the wrong time. Genetic technology wasn't advanced enough to deliver on the potential. It was also the wrong species: it didn't work in minke whales for a variety of reasons."

So that brilliant idea died, and Bravington forgot all about it.

Five years later, he was working on Southern Bluefin Tuna (SBT) (*Thunnus maccoyii*), trying to assess just how healthy or unhealthy stocks were, and it was not going well. "It was just an awful mess and extremely contentious," he recalls.

Revelations of large, unreported catches had undermined the data used to assess the stock. There were also worrying signs that the spawning stock and recent year classes were the lowest on record.

Bravington recalled the Norwegian minke whale study, and wondered if it might work in tuna. He took the idea to geneticist colleague Peter Grewe, and the two of them put forward a proposal to CSIRO to explore it.

First steps

With additional funds from the FRDC they undertook the first major survey of SBT using this approach. The study was based on about 14,000 tissue samples taken from fish caught by commercial fishers. It took five years to complete and identified 45 parent–offspring pairs. The results showed the species was slightly more abundant than previously thought.

That technique – now called close-kin mark-recapture – looks set to revolutionise the way the health and productivity of fisheries are assessed.

"Close-kin mark-recapture is a census, and a very reliable and precise one if sufficient kin pairs are retrieved," says Grewe.

The beauty of this method lies in its simplicity. At its core is the genetic and mathematical truth that the greater the proportion of related individuals found in a random sample of a population, the smaller that population must be.

"Every fish has two parents," says Campbell Davies, who leads CSIRO's international fisheries research. "And every fish genetically 'marks' or 'tags' its parents via its DNA."

Matching a parent to its offspring is genetically easy to do and very accurate. Researchers collect a predetermined number of tissue samples from a population of fish. The number of samples is decided based on available estimates of the size of that population and the species' life history. Researchers then count how many parent–offspring matches they find.

The more matches they find, the smaller the population, because the smaller the population, the higher the probability of both the parent and the offspring being in the sample. →

Russ Bradford (CSIRO senior scientist) processing tuna samples. The DNA profiles from these juvenile samples are compared with samples collected from adult fish in Indonesia (collected by Indonesia–CSIRO collaborative monitoring program) to identify parent–offspring pairs.
Photo: Supplied Russ Bradford

Conversely, if they find relatively few matches, that generally means the population is large and therefore the chance of coming across offspring and one of its parents in the same sample is much smaller.

Simple. But that does not mean that first application to SBT was easy.

"It was really a massive slog on that first attempt," Bravington says. "It took us six years to get something out of it, from convincing funders and stakeholders that it was plausible, developing the markers to reliably identify kin with really high confidence, to processing and analysing the results."

The technique relies on a solid understanding of the dynamics, reproductive biology and spatial distribution of a fish population. For example, Atlantic Bluefin Tuna (*Thunnus thynnus*) spawn at three different sites in the Mediterranean Sea, so a sample from only one of those sites would not provide a true representation of the entire population.

It also requires at least a rough estimate of the species' population size to calculate how many samples might be needed to get sufficient close-kin matches for reliable estimates.

As a rule of thumb, researchers aim for sample sizes that are likely to result in 50 to 100 kin matches.

The right timing

Despite the challenges, it was the right time for close-kin mark-recapture to evolve and, most importantly, SBT was the right species to demonstrate its value in. Scientists trying to get a handle on the actual numbers of SBT had long relied on traditional sources of abundance information, in particular fisheries-dependent catch per unit effort from the main longline fisheries.

Revelations of unreported catches in 2006 meant scientists were unable to conduct a conventional stock assessment at a time when there was consistent evidence the population was struggling.

This meant there was a strong drive for both scientists and stakeholders to find a method that did not rely on commercial catch-and-effort data and that could provide direct estimates of the abundance of the successful spawners – a primary objective of fisheries management.

Close-kin mark-recapture represented a solution to this crisis. "The data is a strict sampling of the fish in the ocean, or from the processing plant, and the DNA does the talking," Grewe says. "It is totally independent of how people are fishing, or how many trips they do, what sort of hooks they're using."

From a stakeholder perspective, CEO of the Australian Southern Bluefin Tuna Industry Association Brian Jeffriess says the close-kin technology and its scientific independence have been critical to the rebuilding of SBT stocks over the past 15 years.

SBT is managed through the Commission for the Conservation of Southern Bluefin Tuna, and it was this "groundbreaking science" that validated the biomass, Jeffriess says. It gave all international partners in the fishery the confidence to agree to much-needed management changes.

Refining techniques

Since that first study, both the technique of close-kin mark-recapture and its applications have expanded. Researchers are now getting far more information out of those tissue samples than simply a paternity or maternity test.

When geneticist Pierre Feutry joined the team at CSIRO, the genetic approach being used looked for microsatellites in the DNA – simple repetitive sequences in the genetic code that are passed from parent to offspring. The first study looked for microsatellite matches at 20 to 25 locations – or loci – in the fish genome, which is roughly the same number of loci that are examined in human paternity testing.

But the team wanted to expand their matching to siblings and half-siblings, and with a very high confidence. "So the requirements were higher and there was a need for more markers," Feutry says. The answer was

The technique relies on a solid understanding of the dynamics, reproductive biology and spatial distribution of a fish population. For example, Atlantic Bluefin Tuna (*Thunnus thynnus*) spawn at three different sites in the Mediterranean Sea, so a sample from only one of those sites would not provide a true representation of the entire population.

single nucleotide polymorphisms, or SNPs: a variation at a single point on a strand of DNA, like the change of a single letter in a book.

To do this, "thousands of loci have to be sequenced, but it provides far more information than a couple of dozen microsatellites. And with improvement in technologies, it is both cheaper, faster and, importantly, digital," says Feutry.

That opened the door to identifying juveniles who share one or – much more rarely – two parents, which reveals much more about the status and dynamics of that fish population.

For example, if one juvenile is identified in 2021 and their juvenile half-sibling is identified in 2023, that means that one of their parents survived at least three years. It is even possible to tell whether they share a mother or a father, which provides sex-specific information about population dynamics.

"By a complicated route, you get information about abundance of the parents that is statistically independent of the parent–offspring information, and you're also getting information about mortality of the adults that you've never seen," Davies says.

"This is a major strength of the approach. By using both these types of kin relationships you can test some of the fundamental assumptions about the sampling, because they're completely independent."

The combination of parent–offspring and half-sibling pairs not only provides two independent assessments of how abundant the adults are, but also, through the sibling data, sheds light on mortality rates in adults and the reproductive success of the adults relative to their size and age.

"These are essentially the four critical ingredients for a stock assessment and fisheries management, and essentially fishery independent," Davies says.

Broader applications

The success of close-kin mark-recapture in SBT has attracted global interest in its application in large commercial fisheries. Studies are underway for the Atlantic Bluefin Tuna and Northern Bluefin Tuna (*Thunnus orientalis*) fisheries.

It has also been applied to a range of conservation-listed and commercial shark species. In 2014, the FRDC funded a study using the technique to estimate the abundance of School Shark (*Galeorhinus galeus*), which used to be a fish and chips favourite until dwindling numbers led to substantial fishing reductions.

Other shark species assessed include White Shark (*Carcharodon carcharias*), Northern River Shark (*Glyphis garricki*), Speartooth Shark (*Glyphis glyphis*) and Greynurse Shark (*Carcharias taurus*). These are all listed as 'depleted' in Australia's Shark Report Card.

As genetic technology improves and becomes cheaper, so too does the application of close-kin mark-recapture. It can theoretically be applied to almost any species, marine or terrestrial – with certain notable exceptions such as the nine-banded armadillo, which gives birth to identical quadruplets – provided the populations are not so small as to be almost non-existent or so large, such as some small pelagic species, as to make finding a match very difficult.

Word of close-kin mark-recapture is spreading, with dozens of projects underway or in development worldwide. The CSIRO team is highly sought after to help with new projects or deliver courses. Bravington says they cannot keep up with the demand.

"The challenge now is getting the information and the expertise out there and continuing to build the capacity for wider applications, because there is no shortage of interest." F

Above The close-kin mark-recapture technique has been applied to other species like the Greynurse shark.
Photo: Shutterstock

Top SBT poling in the Great Australian Bight for gene-tagging.
Photo: Russ Bradford

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FRDC RESEARCH CODES
2007-034, 2014-024, 2019-016, 2017-098, 2016-018, 2016-044, 2017-021

Under-catching makes economic sense

A demand analysis has identified the influences of farmed and imported seafood on Australia's wildcatch pricing and fishers' harvest strategies

By **Gio Braidotti**

The fact that commercial fishers are not catching as many fish as regulated limits allow has perplexed industry managers for years. Now, a team of marine resource economists led by CSIRO's Sean Pascoe has discovered the answer to that conundrum. To the surprise of some, it has little to do with competition from cheaper imports.

Rather, the fishers' instincts to under-catch was validated as an optimum strategy that makes the most economic sense. The finding is the result of a demand analysis undertaken with FRDC funding to explore the relationships that cause prices to decrease as volumes of a good increase.

The study focused on variation in prices of wild-caught seafood – a subject typically considered outside the remit of fisheries regulators who set total allowable catch (TAC) quotas.

Above A fishing trawler at sea, Port Stephens, NSW, Australia.
Photo: Shutterstock

It found under-catching maximises returns, given the particularly strong price dynamics within the Australian seafood market overall. In contrast, there was strong evidence that catching to TAC limits – or even increasing those limits – does not necessarily result in better returns to fishers.

"We found that if all fishers caught their full quotas, they would end up worse off," Pascoe says. "The evidence is robust and means that the tendency of fishers and marketing cooperatives to under-catch is not necessarily a bad thing."

The reason for this unexpected state of affairs rests with the fact that prices decrease as landings increase. As a result, revenue to fishers does not increase at the same rate as the increase in catch. Fishing costs, however, continue to increase at the same rate.

A further quirk of seafood markets is that the quantity of seafood landed of one species can impact the prices received for other species. The extent of this cross-species effect (also called the substitution effect) depends on characteristics that are important to consumers, such as taste, firmness, convenience and presence of bones.

When it comes to Australians, it turns out that farmed Atlantic Salmon (*Salmo salar*) meets the seafood mark for many consumers. It is readily available, particularly in supermarkets, and this sets the stage for a profound effect on cross-species prices.

"We did examine the impact of imports on prices for Australian wild-caught fish," Pascoe says. "However, the results only made sense when we also took farmed Atlantic Salmon into account. Imports are influential, but it's the Australian farmed Atlantic Salmon having the largest impact on downward price trends for wild-caught fish, and the impact is huge."

With Atlantic Salmon production increasing, the expectation is that wild-caught fish prices will not improve. In fact, the analysis found that, given the market environment, maximising returns to fishers would require deliberately decreasing catches. That approach, however, results in a shrinking fleet in which everyone – the industry, its communities and consumers – loses out.

Rather, the economists say emerging opportunities for wild-caught fish rest with adopting traceability and sustainability credentials that link catches to specific regions and the associated ecological and community values of those regions. Seasonality also presents opportunities to optimise supply chains to maximise returns from peak demand.

"The value of wild-caught is that it is fresh and caught locally within well-maintained ecologies, in contrast to mass-produced, anonymous imports," Pascoe says.

The analysis began in 2018, and the findings are being shared with managers, fishers and researchers.

Price movement data over the past 20 years was obtained primarily from the Sydney Fish Market after it was verified that its price movements are representative across markets.

"The findings highlight the importance of taking market effects into account when prices vary with quantity landed,"

Sydney Fish Market.
Photo: Shutterstock

"Imports are influential, but it's the Australian farmed Atlantic Salmon having the largest impact on downward price trends for wild-caught fish, and the impact is huge." Sean Pascoe

Pascoe concludes. "The project also provided opportunities to present some key economic concepts that managers and industry can factor into decision-making, which is something that fishers appear to be intuitively capable of doing."

The project has also produced a resource for use by managers and industry. ***How demand analysis can help improve fisheries and aquaculture performance*** can be downloaded from the FRDC's website.

The project team included CSIRO economist Eriko Hoshino, Australian Bureau of Agricultural and Resource Economics and Sciences economist Robert Curtotti and CQUniversity and CSIRO economist Peggy Schrobback. F

Right CSIRO's Sean Pascoe led an economic study that found under-catching quotas can improve returns for fishers. Photo: Euan Pascoe

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FRDC RESEARCH CODE 2018-017

A snapshot of the global seafood sector

Based on data accumulated to 2018, *The state of world fisheries and aquaculture* 2020 report provides a global snapshot of the industry. Australian sources of data such as the Australian Fisheries and Aquaculture Statistics give us insight into the industry locally

ABBREVIATIONS **MMT** Million metric tonnes | **MT** Metric tonnes | **M** Million | **T** Tonnes | **B** Billion

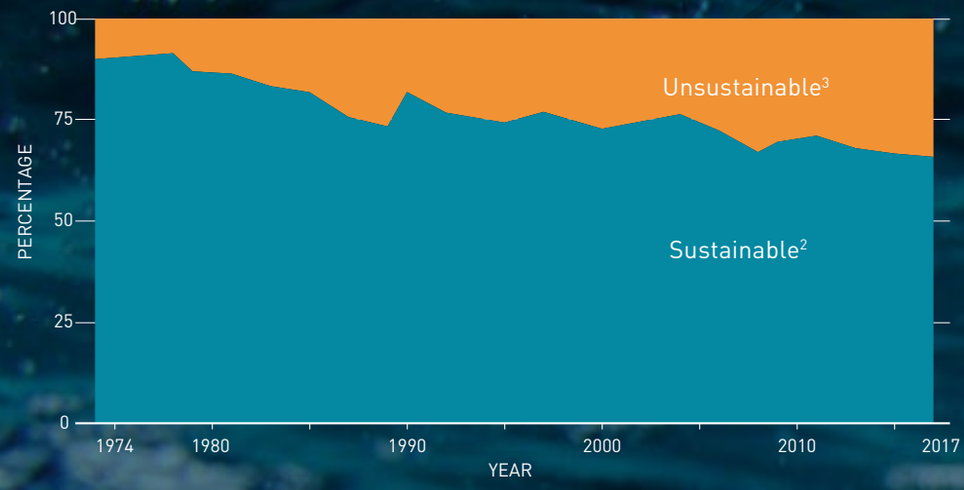
GLOBAL WILD FISH STOCKS

65.8%

of assessed wild fish stocks are within biologically sustainable levels[1]

[1]Australian Status of Australian Fish Stocks Reports

GLOBAL TRENDS IN THE STATE OF THE WORLD'S MARINE FISH STOCKS, 1974–2017



SOURCE: FAO

[2] **Fished within biologically sustainable levels**: stocks with an abundance at or above the level associated with maximum sustainable yield (MSY)

[3] **Fished at biologically unsustainable levels**: stocks less abundant than the level needed to produce MSY

GLOBAL FISH AND SEAFOOD PRODUCTION

179MMT

amount of fish and seafood produced in 2018

+14% wildcatch from 1990 to 2018

+ 527% in aquaculture

156MMT

share of production for human consumption

122% rise in total food fish consumption from 1990 to 2018

SEAFOOD CONSUMPTION ON THE RISE

Average annual fish consumption has increased at 12 times the rate of world population growth over the past 60 years. Increases in total fish consumption have also outpaced all other animal proteins.

Current production is **≈ 20.5kg** of fish or seafood a year for every person on the planet.

Worth

$3.15B

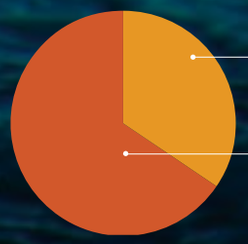
179,261MT wildcatch worth **$1.58B**

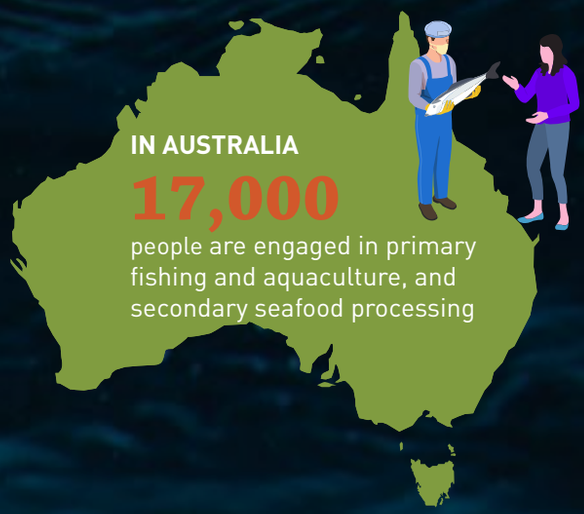
106,139T aquaculture worth **$1.57B**

WORKFORCE

59.5M

people are engaged in fisheries and and aquaculture globally





85% of fisheries and aquaculture workers are in Asia

14% of primary fisheries and aquaculture sector workers are women, but

up to **50%** of workers are women when secondary sectors such as processing and sales are included

GLOBAL FISHING FLEET

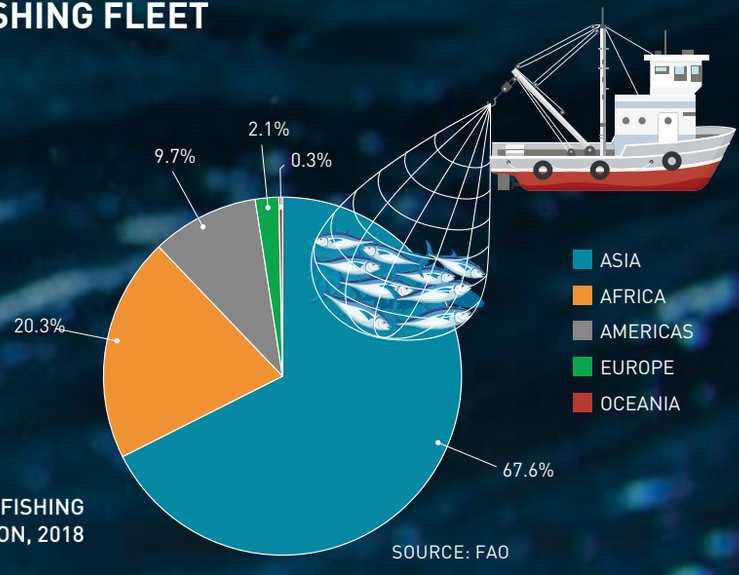
4.6M

vessels

2.8% decrease on 2016

2.9M

motorised vessels (63%)



DISTRIBUTION OF MOTORISED AND NON-MOTORISED FISHING VESSELS BY REGION, 2018

SOURCE: FAO

MORE INFORMATION

Food and Agriculture Organization of the United Nations, www.fao.org

Status of Australian Fish Stocks Reports www.fish.gov.au

Australian Bureau of Agricultural and Resource Economics and Sciences, www.agriculture.gov.au/abares

Australian Fisheries and Aquaculture Statistics report www.agriculture.gov.au/abares/research-topics/fisheries/fisheries-and-aquaculture-statistics

Photo: Chris King/ Unsplash

Joint action to tackle safety

By **Catherine Norwood**

New strategies, underpinned by research, show how shared approaches can improve safety in the seafood sector

What will it take to improve safety in the seafood sector? For John Harrison, who leads a national safety initiative for the sector, it comes down to shared responsibilities.

The industry, he says, needs to accept responsibility for the welfare of its people; individuals need to accept personal responsibility for their actions as well. Safety, both physical and mental, must be woven into the fabric of daily operations.

Harrison chairs the National RD&E Seafood Industry Safety Initiative (SISI), established in 2018 as a collaboration of the FRDC and the Australian Maritime Safety Authority (AMSA), with leadership support from the Western Australian Fishing Industry Council (WAFIC). Seafood Industry Australia (SIA) joined the initiative in 2019.

SISI focuses on commercial seafood operations, both wild-harvest fishing and aquaculture. It was established to help coordinate action responding to the findings from a new suite of research the FRDC commissioned into safety-related issues.

"The fishing industry partly funds the FRDC's research," explains Harrison. "When the FRDC was established 30 years ago, the priorities for industry were about better understanding the fish and fisheries – the 'guts and gonads'.

"We have a pretty good handle on that now, and the priorities are changing to include the people and our communities, to making the industry safer and a better place to be part of."

Over the past decade this has led the FRDC to branch out into the fields of market research and the behavioural and social sciences. "This research is helping us to find the triggers for behaviour change," Harrison says.

Recent FRDC safety projects have focused on collecting baseline data about the extent of workplace injuries and deaths, issues affecting the health and wellbeing of those in the sector, and barriers to the adoption of safety practices.

Fisheries accident data

The seafood industry is currently regarded as the most dangerous work sector in Australia. Between 2003 and 2013 there were 61 deaths reported – an average of more than five a year. But even that infamous reputation may hide the true extent of the issue.

Workplace consultant at Taylored Health and Safety Tanya Adams has led efforts to assess available accident data for the FRDC. She says the available data is a mixed bag. She believes data sourced from the National Coronial Information System, AMSA, Safe Work Australia and state and territory worksafe databases to be relatively comprehensive – although she knows of at least one high-profile fatality not included in these figures.

However, Adams says data on accidents and injuries greatly under-report the number of incidents, as this data only relates to claims made to the relevant state and territory government workers' compensation authorities. Many sole operators and even crew operating as share fishers may not be registered with their relevant authority and may not be reflected in these data.

That huge gap in the available information

R&D PLAN OUTCOME 2
Best practices and production systems

makes it hard to identify and address safety issues. And recent efforts by Adams to gather more comprehensive data as part of her FRDC benchmarking and extension have not identified any clear ways to address this, largely due to the way different agencies report incidents.

Mental health

Suicides are also not included in industry fatality data, although significant mental stress related to work factors is reported anecdotally as contributing to some instances of suicide.

Deakin University's Tanya King undertook the FRDC-funded 'Sustainable Fishing Families' project from 2016 to 2019 to identify the key health and wellbeing challenges for fishers. She conducted the first national survey of fishers on this topic.

Mental health was the highest rated issue in the survey, and levels of psychological distress among fishers were twice that reported in other industries. Factors included the 'traditional uncertainties' of weather, oceans, fishing and markets, and 'modern uncertainties' related to the regulatory environment, industry reputation and community support.

The 'Sustainable Fishing Families' project also undertook a series of health literacy workshops for fishers and their families in Victoria, to help identify and address stress factors.

King's research has provided support for several other industry initiatives including:

- **Stay Afloat**, a Tasmanian Seafood Industry Council support program, in conjunction with Rural Alive & Well, and social media campaign to #drownthestigma associated with seeking help for mental health issues;
- **Project Regard,** an initiative of Women in Seafood Australasia (WISA) to remove the stigma of mental health issues, with videos of people in the sector discussing their own experiences; and
- **Seafood Industry Mental Health Support Trial** for commercial fishers, run by SIA, which provides early intervention, engagement and education for industry participants in selected fisheries.

Barriers to adoption

Not long after recognising that safety was a priority that needed attention, the FRDC funded Kate Brooks, from KAL

Analysis, to identify barriers to better safety practices in the project 'What's stopping you from protecting yourself and your mates?'

Brooks says the project recognised that traditional approaches, including training and regulation, were failing to improve safety practices because they often failed to recognise the specific needs of a particular fishery or operation.

Her research found that there was often a systemic disconnect between different players in fisheries that resulted in the solution to one problem creating unanticipated hazards. For example, fishing lines weighted to deter seabirds can 'ping' back dangerously onto a vessel if pressure on the line is suddenly released. Larger nets and catches can also unbalance a vessel and bird-deterrent buoys can create entanglement risks for crew.

In some instances, the inherent structure of fisheries can also drive risky behaviour. Brooks points to 'race to fish' fisheries where fishers compete to catch as much as possible as quickly as possible, and time-limited fisheries where a year's worth of income needs to be generated within a much shorter set time period.

Added to this are profit-sharing practices, where crew are all essentially independent contractors earning their own income. This structure incentivises intensive work practices of long hours for weeks at a time, resulting in high levels of fatigue, with subsequent safety, mental and physical health impacts.

While industry does have the most important role to play in taking responsibility for the safety of its own, Brooks says they cannot do it alone.

"Safety is not just about individual fishers, or the fishing sector adopting particular practices. It has to be a holistic community effort that includes safety regulators, fisheries managers and industry working together; we need integrated solutions," says Brooks, who joined the FRDC board after completing the project. As an FRDC board member, she has worked over the past three years to bring this kind of inclusive and people-oriented approach to new research.

"Other industries have worked through these kinds of issues – long-haul trucking and the aviation sector, for instance. Fisheries can do this too." Brooks sees SISI as providing an important forum to discuss a more holistic approach to health and safety issues.

New strategies

In response to research findings, the FRDC has already moved to address gaps in the available

first-step training resources, which can be tailored for specific fisheries. Its SeSAFE program is co-funded by AMSA, with contributions from the Western Rock Lobster Council and the Australian Council of Prawn Fisheries.

SeSAFE provides basic, accessible training modules that cover both industry-wide issues such as 'man' overboard or sun-safe practices, and industry-specific requirements such as boom safety on prawn trawlers. Modules have been co-designed with industry and AMSA, or adapted from other industry programs, including a significant contribution of training material from Austral Fisheries.

SeSAFE's principal investigator Steve Eayrs, from Smart Fishing Consulting, aims to create widespread awareness of the program within the seafood sector and to establish it as the default starting point for safety at sea by removing as many barriers to its use as possible.

The time required from skippers or business owners is minimal; they just need to select the modules they want their staff or crew to do. Eayrs can then coordinate the training on their behalf. Each module can be completed in 10 minutes or so. They are available online or offline, formatted for computers and tablets, and also are being optimised for mobile phones.

There has been strong uptake of SeSAFE in some areas, such as the Northern Prawn Fishery, where relevant modules have been completed every year or every two years by 80 per cent of crew. In other fisheries, use of the program is more ad hoc. Challenges include a reluctance by crew to do the training, often coupled with a shortage of crew. This can make it harder for skippers to insist, or to remain committed to continually repeating training in the face of high staff turnover.

At a broader level, Eayrs says SeSAFE is one of the "reasonably practicable" steps that skippers and boat owners can take to meet their workplace duty of care. He points out an accident-free history does not waive the need for ongoing safety training.

The FRDC is also set to trial a new approach to extension activities, called Sensemaker, with a focus on safety. Through surveys of individual fishers and other industry participants, the Sensemaker process would gather information about real safety-related experiences – both good and bad – and help to unpick the thinking behind how people felt and acted in those situations. This would in turn lead to strategies for mitigation.

Adams says this could provide a baseline for the industry to better identify the issues people have experienced, as well as their thoughts on possible solutions and their interest in taking on those solutions. SISI could then address specific gaps or needs identified with targeted extension programs.

Steps for leaders

Through her current FRDC project, Adams is also working to support leadership in the safety arena and modelling safe behaviour.

Demonstrating that 'safety matters' involves committing resources, including the time and money to prepare and implement a safety management system (SMS), to provide pre-sea safety training, vessel inductions and drills, and to monitor and enforce required behaviour on board.

Among the resources she has developed are SMS templates and fact sheets designed to make it easy for boat owners and skippers to meet regulatory requirements. However, the benefits of an SMS only come when the actions identified are integrated into everyday workplace practices, she says.

Her project is also identifying safety champions from diverse parts of the seafood sector, to promote improved practices from within the sector.

More information on available resources, SeSAFE and the safety champions program is available from the Fish Safe Australia website, http://fishsafeaustralia.com.au F

MORE INFORMATION
Fish Safe Australia
www.fishsafeaustralia.com.au;
Chris Izzo, christopher.izzo@frdc.com.au;
https://www.frdc.com.au/issues/workplace-health-and-safety-in-fisheries-and-aquaculture

FRDC RESEARCH CODES
2012-402, 2016-400, 2017-046, 2020-067

Photo: Jed Owen/Unsplash

Gone Fishing Day promotes mental health

The sixth annual Gone Fishing Day in October promotes the benefits of time spent in nature, with a boost to mental health

By **Barbara Adam**

On Sunday 10 October, the official date for Gone Fishing Day this year, aged care worker Leeanne Sherwell will be at her family's "secret spot" off Caloundra, fishing for snapper, Red Emperor and Sweetlip ... and her mental health.

Sherwell's partner, Matt, and their children, Jake, 12 and Shelley, 13, take their tinnie out fishing a couple of times a month. They all agree their emotional wellbeing is boosted by these expeditions. "Sometimes when Matt is being cranky I'll send him fishing," Sherwell says.

The Australian Recreational Fishing Foundation (ARFF) has timed this year's Gone Fishing Day to coincide with the World Health Organization's World Mental Health Day on 10 October.

The mental health aspects of fishing are being highlighted this year, as the global pandemic and repeated lockdowns around Australia have affected many people's ability to cope.

Time to reset

"It is widely understood that fishing can improve a person's mindset and self-esteem, but it also helps you focus on the simple nature of wetting a line," said ARFF chief executive officer Adam Martin.

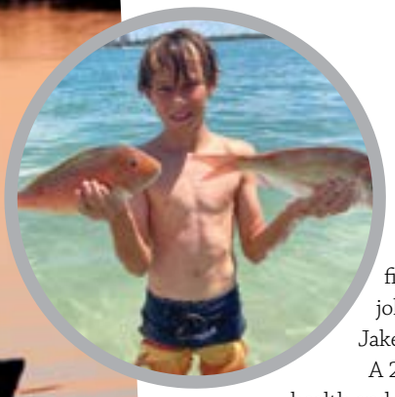
The ARFF has developed a Gone Fishing Day app, which fishers can use to upload photos of their catch and location.

An estimated 3.5 million Australians go fishing each year, and last year's Gone Fishing Day was celebrated in more than 1000 locations around Australia.

"For some it is a sport or a leisure activity, for others it is a social activity spent with family and friends," Martin says. "Whether you are young or old, recreational fishing is a lifelong activity that everyone can enjoy while connecting with Australia's unique marine and aquatic environments."

For Sherwell, spotting dolphins, whales and even crabs is part of the attraction of fishing. "Being out on the water, there's always something different to see," she says. "It's also good because it gets the kids off technology and out into nature."

Her 12-year-old son Jake, meanwhile, likes the thrill of having a fish on the line, especially if he is feeling a bit seasick. "It's good to get away from people, too," Jake says. He is so keen on fishing that there's a family joke: "If there's a puddle, Jake will drop a line in it."



Left and below
Jake and Shelley Sherwell
Photos: Leeanne Sherwell

A 2011 FRDC study into the health and wellbeing benefits of recreational fishing reported benefits for both individuals and groups. The study, led by Alexandra McManus at Curtin University, identified particular benefits for young people with behavioural and mental health issues.

"Encouraging young children, youth, adults and families to fish offers a cost-effective and healthful outdoor recreational activity that can be enjoyed throughout life," the report says.

Making connections

The bonding aspect of fishing is what appeals to Simon Spencer, a 50-something white-collar worker, who has fond memories of going fishing with his dad as a kid. Now Spencer takes his 16-year-old son Luca fishing in Melbourne. The pair leave their Mount Macedon home at around 2am and head to the pier in Port Melbourne or Altona, returning home after the sun rises, always feeling a bit better about things.

"For me, fishing is contemplative and meditative," Spencer says. "Luca, on the other hand, is into the technical side of things. He's much more focused on catching the fish. I don't try to catch the fish; I just go fishing and it doesn't worry me if I don't get anything on the hook."

Spencer also likes the social aspect of his pier-fishing trips, often recognising other pre-dawn fishers. "There's a certain sense of community when you're out fishing. The other people on the pier, if you got into trouble, they'd be there. If you fell into the water, or if you ran short of gear, they'd help you out."

For more information visit www.gonefishingday.com.au and follow Gone Fishing Day on Facebook and Instagram. The Gone Fishing Day app is available for download through both the Apple App Store and Google Play. F

MORE INFORMATION
www.gonefishingday.com.au

FRDC RESEARCH CODE
2011-217

Cone Bay, Western Australia, where the rock lobster raft trials will be undertaken.
Photo: Jennifer Blair, Ornatas

Market in sight for farmed rock lobsters

Decades in development, rock lobster aquaculture in Australia is gathering pace with hatchery success followed by a new ocean grow-out trial in the west

By **Corrina Ridgway**

Efforts to commercially grow Ornate Rock Lobster (*Panulirus ornatus*) have been hitting development milestones this year, the latest of which is a new grow-out trial launched in May at Cone Bay in Western Australia. Rock lobster aquaculture, the long-time Holy Grail of the seafood sector, finally appears within reach.

Aquaculture company Ornatas and partner Maxima Rock Lobster aim to be producing 1100 tonnes of hatchery-bred, grown-out Ornate Rock Lobster a year by 2030. The launch of their Cone Bay ocean grow-out project is a critical step on that path.

The FRDC and the Cooperative Research Centre for Developing Northern Australia (CRCNA) have together contributed $1.9 million to the $4.5 million project. It will establish Australia's first ocean grow-out facility for commercial juvenile rock lobster aquaculture.

CRCNA CEO Anne Stünzner is enthusiastic about the potential of the project to transform both rock lobster production and economic opportunities in northern Australia. "It will deliver a high-quality, sustainable Australian seafood to high-value domestic and export markets, and potentially create thousands of direct and indirect jobs over the next decade," she says.

In Australia, Ornate Rock Lobster is hand harvested from the wild by divers. As a premium seafood product, it has averaged prices of $60 to $70 per kilogram in recent years, with the bulk of Australia's annual harvest exported.

Ornate Rock Lobster aquaculture is undertaken in other countries where the species also occurs, such as Malaysia, Thailand and Vietnam. However, this is based on ranching animals – catching juveniles from the wild and raising them in farmed conditions.

The aquaculture Australia is developing is based on closing the life cycle for the species, and using hatchery-reared rather than wild-caught juveniles. Ornatas holds the Australian licence to commercialise this novel rock lobster hatchery technology, which was developed at the University of Tasmania (UTAS).

Raised on a raft

The three-year trial at Cone Bay will use raft systems to grow out juveniles, completing the aquaculture cycle for the species in a commercially scalable system. Essential requirements for the trial site include good water depth and water exchange, low seasonal biofouling, protection from excessive currents and visibility from shore.

Ornatas research and development manager Jennifer Blair says the company hopes to see raft structures in the water by September 2021 and juveniles in the system before the end of the year, dependent on satisfying biosecurity requirements and regulations.

Animals are expected to be grown in rafts for 18 months, to a market size of 1.2 kilograms. It follows the establishment of Ornatas's hatchery in Townsville, Queensland, which produced its first successful commercial hatch of Ornate Rock Lobster over the 2020-21 new year period.

Ornatas CEO Scott Parkinson says the company is ecstatic with progress so far, with the hatch resulting in hundreds of juvenile lobsters. He expects an increase in hatchlings into the thousands by August.

While the pace of development is accelerating, reaching this stage has been a lesson in patience and dogged persistence.

Research persistence

The FRDC's investment in spiny lobster aquaculture, which dates back to 1997, comes to millions of dollars, and there has been additional investment from other research and commercial partners.

Much of the research effort for the past two decades has been based at UTAS, in Tasmania. However, interest in rock lobster aquaculture dates to the 1960s, when Japan initiated research into closing the life cycle of Southern Rock Lobster (*Jasus edwardsii*) in laboratory settings. Through the decades many other countries, including New Zealand, have joined the quest for rock lobster aquaculture success.

In Australia, this research has included Ornate Rock Lobster and Southern Rock Lobster, Western Rock Lobster (*Panulirus cygnus*) and Eastern Rock Lobster (*Sagmariasus verreauxi*).

But rock lobsters have complex life cycles, including multiple larval stages. They require specific environmental conditions and diets for each developmental stage, which confounded efforts. (The first transformational phase, from larva to puerelus, when animals are actively swimming and settling, is when they are often harvested for ranching in other countries.)

By 1997, the FRDC had identified rock lobster research as a priority and created the 'Rock Lobster Enhancement and Aquaculture Subprogram'. Between 2000 and 2007, this delivered two main projects, each with dozens of subprojects nationwide, and included all four rock lobster species.

A major outcome of this work was developing technology for the commercial culture of a rock lobster species from the egg or larval stage, capacity to reseed wild fisheries using aquaculture-reared juveniles, and procedures and equipment for large-scale harvesting of rock lobster puerulus.

The research also developed cooperation between research providers, scientists and commercial partners across Australia, allowing for longer-term, self-sustaining management of lobster research.

By the end of the reseach subprogram in 2007, the FRDC had invested $16 million in rock lobster projects.

MG Kailis continued for several years as a commercial investor in research for Ornate Rock Lobster, with the Queensland Department of Agriculture and Fisheries and James Cook University using the Kailis company's Exmouth Hatchery.

UTAS and a restaurant industry investor, the Darden group from the US, formed a joint venture and secured an Australian Research Council (ARC) grant for the commercial development of rock lobster culture systems, including hatchery technologies. However, closing the whole production cycle, in a way that was scalable, proved elusive, leading successive commercial investors to withdraw.

Finally in 2017, the UTAS Institute for Marine and Antarctic Studies announced its Holy Grail discovery. They had finally developed a consistently successful, scalable method to rear rock lobsters through their full life cycle from broodstock in a commercial hatchery environment. It was a world first.

Southern Rock Lobster, although highly prized, has a significantly longer larval phase than other species, which makes it commercially unviable for aquaculture. Efforts have focused, instead, on the faster-growing Ornate Rock Lobster and commercial production opportunities in tropical Australia.

Tasmanian-owned business PFG Group Pty Ltd came on board as a new investor in 2018, after winning the bid to commercialise the UTAS technology, and establishing the spin-off body Ornatas Pty Ltd to do so.

Ornatas aims to create the world's first whole-of-life-cycle Ornate Rock Lobster aquaculture industry, ➔

Left Ornatas research and development manager Jennifer Blair holds an Ornate Rock Lobster (*Panulirus ornatus*).
Photo: Bianca Davis, Ornatas

favouring this species over the others because it grows faster and is more commercially viable.

The company projects the industry to be worth $160 million by 2030, with the potential to generate more than $500 million in economic activity a year and create 900 new jobs in northern Australia.

New research directions

The FRDC continues to facilitate rock lobster aquaculture with a $500,000 investment in the Ornatas grow-out trial. Research priorities for the trial include raft design, animal translocation issues, health and biosecurity, feeding strategies, growth performance, environment and market acceptability.

While there is existing industry knowledge about issues such as the conditions for the airfreight of juveniles from Queensland to WA, much of the research will be breaking new ground. For example, knowledge about lobster health and biosecurity issues in an offshore grow-out operation is currently non-existent.

Although raft techniques have been trialled elsewhere, the Cone Bay location itself poses unique challenges. Design criteria include predator protection for working personnel, including crocodile barriers.

"There are some principles that will be based on international design, but we're using a very different, higher tech approach. We're quite excited about what it could look like," says Blair.

Despite the challenges, project partners foresee enormous opportunities.

Working in northern WA through their Maxima partnership will allow Ornatas the opportunity to develop business opportunities in collaboration with local Indigenous communities. There's also the possibility of applying some research outcomes to other tropical aquaculture species, particularly in terms of supply chain developments or production systems.

Parkinson is keen to see a balance between shore-based and ocean-based grow-out of Ornate Rock Lobster in the next decade and is passionate about the industry's growth in general.

The use of formulated feeds will be core to production systems, and this is now the focus of the new $26 million UTAS-led ARC Research Hub for Sustainable Onshore Lobster Aquaculture, under the direction of leading lobster researcher Greg Smith.

Smith is among the small team of dogged Tasmanian researchers who have helped launch the sector on its current trajectory.

"If you look at directly connected businesses and staff on the ground, there's probably 50 to 60 people working in lobster aquaculture now," says Parkinson. "That's substantial; if you go back two years ago, it was solely a research group in Hobart. It's growing rapidly."

Above Anna Overweter from Onatas and FRDC program manager Wayne Hutchinson inspect juvenile rock lobsters at Ornatas' Queensland hatchery. Photo: Ornatas

"If you look at directly connected businesses and staff on the ground, there's probably 50 to 60 people working in lobster aquaculture now. That's substantial; if you go back two years ago, it was solely a research group in Hobart. It's growing rapidly."

Scott Parkinson

He believes the project's success lies in a combination of clear and ongoing investment from investors, innovative commercial partners, research community partnerships and world-class staff. Two of Ornatus's staff are taking part in the National Seafood Industry Leadership Program this year, funded by the FRDC.

"We're breeding a new culture of staff and the next generation of leaders in the aquaculture industry," says Parkinson. However, he is quick to stress the importance of funding bodies in making these advancements world class.

"This project is combining over 20 years of research, which was initiated by the FRDC. The combination of the FRDC with the CRCNA supporting us, shows their faith in what we're doing. Having that support from government agencies and funding agencies is really important." **F**

MORE INFORMATION
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FRDC RESEARCH CODE
2020-106

INDIGENOUS HERITAGE
The trial facilities detailed in this article are being established at Cone Bay, on the lands and waters of the Dambimangari, Mayala, and Bardi and Jawi peoples of Western Australia.

Left Golden Kelp
Photo: Ocean Imaging

Seaweed body to grow shared goals

The new Australian Sustainable Seaweed Alliance is working to focus the efforts and resources of this emerging aquaculture sector to accelerate its growth

By **Catherine Norwood**

Creating a national hatchery network and working with state governments to develop policies that support seaweed aquaculture are the top priorities for the newly formed peak industry body representing Australia's emerging seaweed sector.

The Australian Sustainable Seaweed Alliance (ASSA) officially launched in July with the aim of helping the sector achieve its goals of $100 million worth of production by 2025 and $1.5 billion by 2040. This is from a base of almost zero in 2020.

ASSA director Jo Kelly says these goals are part of the *Australian Seaweed Industry Blueprint* released by AgriFutures in 2020, which she also authored. Founding ASSA members include CH4 Global, FutureFeed, the Australian Seaweed Institute and the University of Tasmania (UTAS), with support from AgriFutures and the FRDC.

Kelly says a national hatchery network will provide access to seaweed seedstock and research expertise that will allow new growers to establish farms and quickly scale up operations.

In the same way that oyster growers can buy spat, the availability of commercial seedstock can streamline entry into seaweed aquaculture for growers, removing the requirement for every operation to have its own hatchery and seaweed biology department.

"Having access to ocean lease space for the cultivation of seaweeds is also critical to industry development," says Kelly. South Australia and Tasmania are most advanced with their aquaculture zoning and policies; however, New South Wales, Queensland and Western Australia have significant coastal areas that could provide new aquaculture opportunities.

She says it is also important that the effort and investment, in both R&D and business development, focuses strategically on providing the best returns and the greatest opportunities to scale up the industry.

"We don't want to dilute the outcomes. We want to make sure early investment is optimised to create a flourishing new industry that offers Australia a sustainable, high-tech, high-value new economic opportunity."

Kelly says ASSA will focus on implementing the recommendations of the Seaweed Blueprint and developing the opportunities it identifies:

- large-scale ocean cultivation of *Asparagopsis* seaweed, which is projected to feed at least 30 per cent of Australia's feedlot cattle herd by 2025;
- extension of kelp farming around fish farms to clean the water and provide additional revenue streams for aquaculture businesses across temperate southern Australia;
- development of seaweed biofilters to remove excess nutrients and protect the Great Barrier Reef while providing beneficial agricultural products in an innovative circular economy solution;
- development of offshore integrated food, energy and carbon sequestration platforms for sustainable food production into the future;
- biodiscovery from native Australian seaweeds to uncover valuable compounds; and
- development of new seaweed products using advanced manufacturing techniques.

Asparagopsis species are currently driving a large part of the development of seaweed aquaculture in Australia following the discovery of its ability to reduce methane emissions from cattle when used as a stock feed supplement. This could significantly help to reduce global greenhouse gas emissions and has drawn the interest of several major corporate and environmental investors.

The FRDC is investing in *Asparagopsis* propagation and cultivation with the South Australian Research and Development Institute (SARDI), the research arm of Primary Industries and Regions South Australia. The SARDI research is a collaboration with CH4 Global, which is also investing in other international *Asparagopsis* research.

The FRDC has previously invested in kelp propagation research with UTAS, in conjunction with Tasmanian aquaculture company Tassal. The company is scaling up its kelp trials towards a commercial harvest.

ASSA invites those already active within the seaweed industry to join the alliance, as well as those who are "interested but not yet involved", to support the industry and keep up to date with new developments, training opportunities and information resources being developed. Membership is now open via the ASSA website, www.seaweedalliance.org.au F

MORE INFORMATION
Jo Kelly
www.australianseaweedinstitute.com.au
Australian Sustainable Seaweed Alliance
www.seaweedalliance.org.au

FRDC RESEARCH CODES
2019-144, 2017-177

Harvest strategies set the course for sustainability

Monitoring, assessment and transparent decision-making – this is the management trifecta setting Australian fisheries on a path to sustainable futures

By **Catherine Norwood**

Although many Australian fisheries already have harvest strategies, the roll-out of harvest management strategies in those that do not is gathering pace, setting clear expectations for stakeholders and building community trust in the sustainable management of our fisheries.

The FRDC has regularly supported the development of harvest strategies and the monitoring and assessment research that makes them possible.

But as harvest strategies extend from commercial fishing in Commonwealth waters to state jurisdictions, their implementation has become more complex. Progress to include recreational and Indigenous fisheries, and smaller fisheries where data is poor, has also been more challenging.

In its simplest form, a harvest strategy provides a framework to ensure fishery managers, fishers and other key stakeholders think about, and document, how they will respond to various fishery conditions – both good and bad – before they occur.

The three key components are monitoring, assessment and decision rules (also known as harvest control rules). A harvest strategy sets explicit management objectives, including agreed ecological, economic, social and cultural aims, which should be clearly quantified, for example, harvesting to the maximum sustainable yield or maximum economic yield, or their suitable proxies. The factors determining risk levels also need to be clear.

A tale of two fisheries

From a commercial perspective, the interconnected fisheries for Australian Sardine (*Sardinops sagax*) in the South Australian fishery and Southern Bluefin Tuna (*Thunnus maccoyii*) internationally highlight two very different fishery harvest strategy development pathways. But both have ultimately incorporated harvest strategies into their fisheries management plans to ensure sustainability and economic objectives are achieved. Their stories also demonstrate the importance – and the power – of basing management decisions on robust scientific monitoring and assessment, which also boosts stakeholder confidence in those decisions.

Southern Bluefin Tuna (SBT) has been fished internationally since the 1930s, with Japan catching the major share, followed by Australia and New Zealand. By the 1980s, stocks in this relatively unregulated international fishery were in decline and catches had halved.

The three countries agreed first to regulated quotas in the fishery and then to drastic cuts in their quotas. However, catches continued to decline over the following decades. In 1994 the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) was established to manage the fishery.

Meanwhile, in South Australia, where most of Australia's SBT fleet was based, fishers responded to the quota cuts with the innovation of tuna ranching. Catching young fish at sea, they towed them inshore to Port Lincoln and raised them in pontoons to market size.

But farmed fish need to be fed, and so the SA Australian Sardine fishery came to the rescue. As it was developed, the founding principle for its management was caution. The SA fishery takes in state waters and connected Commonwealth waters, in agreement with the Commonwealth fisheries manager, the Australian Fisheries Management Authority (AFMA) under an Offshore Constitutional Settlement (OCS) Agreement. But the bulk of the catch is taken in state waters, in the Spencer Gulf, close to the SBT ranches which are the primary market.

A cautious beginning

The Australian Sardine harvest strategy was developed in partnership with the South Australian Research and Development Institute (SARDI), and the Department of Primary Industries and Regions South Australia (PIRSA). An extensive research program, supported by the FRDC, has developed nine parameters for monitoring and assessing stocks, which includes biennial, or sometimes annual, egg-production surveys.

"We began with a very low quota, until we had more robust research to assess stocks," says Paul Watson, executive officer of the South Australian Sardine Industry Association.

"Now we have baseline data for more than 20 years, and it has given us a really good understanding of what is the 'normal' anticipated stock level. This puts some certainty and stability around the quota. And it tells us how stocks are responding to changes in quota, whether those changes are increases or decreases, to ensure the fishery remains sustainable."

Changes to quota also take into account the broader ecosystem impacts of the Australian Sardine fishery. SARDI has undertaken specific research to identify the extent that other wildlife relies on sardines, to ensure enough fish remain in the oceans to support them too.

The Australian Sardine fishery's early management plan evolved into a harvest strategy that was officially adopted in 2005. But for the species it was feeding, SBT, it took another six years to reach agreement on a harvest strategy. Known in international forums as a 'management procedure', it was officially adopted by the members of the CCSBT in 2011. This was despite the continuing decline of stocks through the 1990s and 2000s.

Independent data

Final acceptance of the new procedure hinged on two factors, according to Brian Jeffriess, CEO of the Australian Southern Bluefin Tuna Industry Association. One was the close-kin genetic techniques CSIRO researchers developed to

assess the size of the spawning stock and juvenile stock (see story page 16). This breakthrough approach provided highly accurate fisheries-independent data about the global SBT biomass.

The second factor was Japan's acceptance of this data as the basis for international quota calculations and its agreement to enforce the management procedure decisions.

The accuracy of commercial catch data that had been used to set quotas had been a point of controversy in the fishery. Jeffriess says without the need to rely on commercial catch information, the new fishery-independent data allowed objective decision-making and provided a level playing field for all countries involved in the SBT fishery. Reflecting this, the CCSBT membership has also grown from three to seven member countries as more minor participants in the fishery sign on to the management procedure.

CSIRO's monitoring techniques are now charting the fishery's rebuilding efforts. In 2006 it was estimated the biomass of SBT was only eight per cent of that which had existed before commercial fishing for this species began. By 2020, this had increased to 20 per cent of the unfished biomass, with a target of 32 per cent by 2035.

For Jeffriess, the whole process has highlighted the importance of operating fisheries based on evidence, recognising that fisheries do constantly change and that management and fishers need to adapt accordingly.

Australian roll-out

AFMA manages Australia's involvement in the SBT fishery and has led the roll-out of harvest strategies in Commonwealth fisheries more broadly.

At the same time the SBT fishery was in decline, Australia's largest and possibly most complex multi-species fishery, the Commonwealth Southern and Eastern Scalefish and Shark Fishery, was also facing challenges with several overfished stocks.

A series of management changes and trials across a decade eventually led to a formal harvest strategy in 2005. That same year the federal Minister for Fisheries directed AFMA to "cease overfishing, recover overfished stocks, and avoid further species becoming overfished".

By 2011, AFMA had formal harvest strategies in place for all fisheries it manages and co-manages. By 2013, all Commonwealth fisheries managed exclusively by AFMA were assessed as "no longer subject to overfishing". The biomass status of many stocks has improved, often to levels well above the selected ecological biomass reference point of maximum sustainable yield. Commonwealth fisheries are sometimes managed to the target reference point of maximum economic yield, which generally represents a lower catch and a higher biomass level, with the aim of improving the profitability of fishing businesses.

South Australian's sardine fishery was one of the first in Australia to have a harvest strategy.
Photo: South Australian Sardine Industry Association

Some stocks have rebounded strongly from declines under harvest strategy directions, notably the eastern stock of Orange Roughy (*Hoplostethus atlanticus*) which has passed the model calculated point required for maximum sustainable yield.

But challenges remain with several species that, while now under stock recovery strategies or strict management protections, have specific stocks that have failed to recover from earlier declines, including Orange Roughy. Others are Blue Warehou (*Seriolella brama*), the eastern stock of Gemfish (*Rexea solandri*) and the south-eastern Australian stock of Redfish (*Centroberyx affinis*), all reported as depleted in the 2020 edition of the Status of Australian Fish Stocks Reports. Rebuilding strategies are in place for all of these stocks.

National guidelines

AFMA's successful roll-out of harvest strategies led to the Australian Fisheries Management Forum (including the heads of all Australian fisheries agencies) establishing the FRDC-funded project

Below
A juvenile snapper
Photo: Victorian Fisheries Authority

NSW is preparing a harvest strategy for its Eastern Rock Lobster fishery.
Photo: NSW Department of Primary Industries

that developed the *National Guidelines to Develop Fishery Harvest Strategies* to assist fisheries managers across all Australian jurisdictions.

As director of fisheries and aquaculture at PIRSA at that time, Sean Sloan led development of the guidelines with a team of experts from around Australia. "Our aim was to create a consistent approach across the country that all jurisdictions could use to develop overarching policy frameworks and individual fisheries harvest strategies tailored across what are often highly diverse fisheries," he says.

The *National Guidelines to Develop Fisheries Harvest Strategies* were adopted as best practice guidelines by the Australian Fisheries Management Forum and subsequently by all Australian fisheries ministers at the annual Fisheries Ministers' Meeting.

The national guidelines have provided practical assistance with challenges faced in various complex fisheries scenarios such as multi-jurisdictional or multi-species fisheries, those with limited data or highly fluctuating stocks, and fisheries recovering from overfishing. These factors have often been a deterrent to developing harvest strategies in the past.

While the strategies essentially represent best practice in fisheries management, Sloan points out they are also fundamentally about building trust between managers and fishers, between different fishing sectors and with the community as a whole.

In South Australia, all commercial fisheries now have a formal harvest strategy, and Sloan has moved on. Since 2019 he has been head general of fisheries with the New South Wales Department of Primary Industries, and developing harvest strategies remains part of his remit.

A new harvest strategy policy and guidelines have been developed for NSW fisheries and after undergoing a period of public consultation, will soon be released. The state's rock lobster, trawl whiting and Spanner Crab fisheries have harvest strategies underway. Work on other major fisheries will start soon and is a key commitment of the NSW Marine Estate Management Strategy (2018–2028).

Sloan highlights the inclusion of recreational and cultural fishing, along with commercial fishing as essential to NSW's new harvest strategy policy.

Recreational fisheries

In Western Australia, harvest strategies are in place for the bulk of its commercial fisheries, as well as for the Peel-Harvey Estuary crab fishery.

This is one of the few strategies to date that formally encompasses a recreational fishery. It was developed in conjunction with the commercial sector, through the Mandurah Licensed Fishermen's Association and Recfishwest as the peak recreational fishing body.

The Blue Swimmer Crab (*Portunus armatus*) fishery achieved a global landmark as the first joint commercial and recreational fishery to achieve Marine Stewardship Council (MSC) sustainability certification, awarded in 2016. Harvest strategies are an essential criterion in MSC certification to provide a transparent process for assessing the sustainability of stocks.

Senior research scientist at WA's Department of Primary Industries and Regional Development Danielle Johnston acknowledges that, although the Peel-Harvey Estuary is a popular recreational fishing spot, collecting data on the recreational catch is challenging. Phone surveys based on recreational fishing boat registrations provide boat-based estimates for some fisheries. But a significant share of the recreational crab catch in the Peel-Harvey Estuary comes from scoop netting, a popular shore-based activity. Efforts to estimate this catch are underway.

"While more detailed information about recreational catches would be ideal, it doesn't prevent us from accurate assessments based around a weight-of-evidence approach where harvest strategies are a key tool in the assessment," Johnston adds.

Snapper frontiers

On the other side of the country, the Victorian Fisheries Authority (VFA) is also treading new ground with a harvest strategy for its recreational snapper (*Chrysophrys auratus*) fishery. The VFA has already completed strategies for major commercial fisheries and its commercial snapper fishery is transitioning to hook and line only, with a total allowable commercial catch (TACC).

This leaves Port Phillip Bay as the epicentre for the state's recreational snapper fishery. It is the state's largest and most economically and socially valuable recreational fishery, on the doorstep of the five million people who live around the bay, in Melbourne and its surrounds.

VFA senior fisheries manager Michelle Wenner says the fishery is currently performing well. "And we want to safeguard that through the harvest strategy. In the case of Port Phillip Bay, managing the fishery to social objectives is very important.

"Lessons from other jurisdictions and from our fisheries with well-established harvest strategies show that having a clear framework ensures the best management outcomes. It avoids the reactionary decision-making that can happen when things go wrong," Wenner says.

Table 1: Progress on harvest strategy implementation in Australian fisheries jurisdictions

COMMONWEALTH

HARVEST STRATEGY COMPLETE

All Commonwealth fisheries*

NEW SOUTH WALES

HARVEST STRATEGY COMPLETE

Policy and Guidelines finalised and awaiting release

HARVEST STRATEGY UNDER DEVELOPMENT

Trawl Whiting Fishery
Eastern Rock Lobster Fishery
Spanner Crab Fishery
Mulloway Fishery

NORTHERN TERRITORY

HARVEST STRATEGY COMPLETE

Mud Crab Fishery
Offshore Net and Line Fishery
Offshore Snapper Fisheries – complete but not yet in place

HARVEST STRATEGY UNDER DEVELOPMENT

Coastal Line Fishery
Aquarium Fishery
Spanish Mackerel Fishery
Barramundi Fishery

QUEENSLAND

HARVEST STRATEGY COMPLETE

Harvest Strategy Policy
Reef Line Fishery
Spanner Crab Fishery
East Coast Inshore Fishery
East Coast Inshore Protected Species Management Strategy
Mud Crab Fishery
Blue Swimmer Crab Fishery
Tropical Rock Lobster Fishery
Coral Fishery
Marine Aquarium Fish Fishery
Sea Cucumber Fishery
Commercial Trawl Fin Fish (Stout Whiting) Harvest Strategy
Moreton Bay Trawl Region Fishery
Southern Inshore Trawl Region Fishery
Southern Offshore Trawl Region Fishery
Central Trawl Region Fishery
Northern Trawl Region Fishery

HARVEST STRATEGY UNDER DEVELOPMENT

Spanish Mackerel Fishery
Rocky Reef Fishery

SOUTH AUSTRALIA

HARVEST STRATEGY COMPLETE

Lakes and Coorong Pipi Fishery
Blue Crab Fishery
Spencer Gulf Prawn Fishery
West Coast Prawn Fishery
GSV Prawn Fishery
Rock Lobster Fishery
Abalone Fishery
Marine Scalefish Fishery
Giant Crab Fishery
Sardine Fishery
Lakes and Coorong Finish Fishery
Dive Fishery for Urchin and Turbo Shell
Vongole Fishery
Lake Eyre Basin Fishery

TASMANIA

HARVEST STRATEGY COMPLETE

Abalone Fishery

HARVEST STRATEGY UNDER DEVELOPMENT

Rock Lobster Fishery
Scallop Fishery
Giant Crab Fishery

VICTORIA

HARVEST STRATEGY COMPLETE

Rock Lobster Fishery
Ocean Wrasse Fishery
Abalone Fishery
Giant Crab Fishery
Scallop Dive and Ocean Fishery

HARVEST STRATEGY UNDER DEVELOPMENT

Recreational Snapper Fishery
Pipi Fishery
Octopus Fishery

WESTERN AUSTRALIA

HARVEST STRATEGY COMPLETE

West Coast Rock Lobster Fishery
Exmouth Gulf Prawn Trawl Fishery
Shark Bay Prawn Trawl Fishery
South-West Blue Swimmer Crab Resource
South-West Estuarine and Nearshore Finfish Resource
West Coast Deep Sea Crustacean Resource
Marine Aquarium Resource
North Coast Demersal Scalefish Resource
Gascoyne Demersal Scalefish Resource
WA Abalone Resource
WA Pearl Oyster Resource
WA Octopus Resource
West Coast Demersal Scalefish Resource
WA Sea Cucumber Resource
Shark Bay Blue Swimmer Crab Resource
Shark Bay Scallop Resource
Abrolhos Islands Scallop Resource

*To see a list of Commonwealth fisheries visit www.afma.gov.au/sustainability-environment/harvest-strategies

"It's always more challenging to make good, consensual, collaborative fishery management decisions when things are not travelling well and there is conflict among stakeholders."

Discussions with stakeholder representatives began last year, and the first draft of the strategy will be implemented as a pilot, to be refined before being formally adopted. "Many recreational fishing stakeholders are unfamiliar with harvest strategies," Wenner explains.

"Genuine engagement and collaboration require a focus on building trust and capacity. This is an important process for all involved to ensure stakeholders come along for the journey."

She says the science and monitoring needed to develop effective harvest performance indicators is a particular challenge for recreational fisheries, particularly compared to commercial fishing where detailed catch data is available. This requires taking a different approach to that traditionally taken in commercial settings and using innovative approaches to monitoring. The VFA has a project in the pipeline to increase monitoring of recreational effort to help with this.

Another challenge is in the design of decision rules, and associated management 'levers', to ensure the desired management objectives are achieved.

Other progress

In Tasmania, only the state's abalone fishery currently has a formal harvest strategy. But the principles are applied across all fisheries, according to Ian Dutton, director of marine resources in the Department of Primary Industries, Parks, Water and Environment.

The state is also moving towards a formal harvest strategy policy, directing a consistent approach to the development of future harvest strategies.

In the north, work underway in Queensland has prioritised its reef line fishery and Spanner Crab (*Ranina ranina*) fishery. In the Northern Territory the harvest strategy for the mud crab fishery is complete with work on offshore snapper, net and line, and coastal line fisheries underway. F

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FRDC RESEARCH CODES
2010-061, 1991-056, 1994-029, 1996-105, 1998-130

Marlin, Swordfish and sawsharks feature in winning presentations

Student research focused on improving commercial fishery and ecosystem interactions were highlights of the annual marine sciences conference

By **Catherine Norwood**

Three outstanding presentations from marine science students won FRDC-sponsored awards at the 2021 annual conference of the Australian Marine Sciences Association (AMSA).

Held as a virtual event for the first time this year, the conference ran from 28 June to 1 July, with the theme of 'Marine Science in the Anthropocene'. Anthropocene is the term coined for the latest epoch in the history of Earth's evolution, characterised by the impact of human activity on Earth's climate and ecosystems.

The presentations winning this year's FRDC awards addressed evolutionary population changes, ecological relationships and an impact on commercial fish quality.

Winners were Tristan Guillemin and Ryan Nevatte, both at Macquarie University, and Jessica Bolin from the University of the Sunshine Coast.

Below Tristan Guillemin
Photo: Supplied

Sawshark populations

Ryan Nevatte's PhD research focused on the population structure of two species of sawshark – Common Sawshark (*Pristiophorus cirratus*) and Southern Sawshark (*Pristiophorus nudipinnis*).

Both species are part of the incidental catch in commercial fisheries operating in southern Australia, but much of the biology of these species remains unknown.

Nevatte's research has identified different evolutionary paths for these sawsharks that have led to different population structures. The Common Sawshark has two genetically distinct populations, roughly corresponding to an eastern and southern population. In contrast, the Southern Sawshark has a single population. DNA sequencing was applied to tissue samples of both species collected from several locations throughout their ranges. These data also helped to identify whether populations of either species had expanded in the past and to estimate how long ago this occurred based on the mutation rate of the genes.

In addition to the different population structures, the DNA markers suggested the Southern Sawshark had expanded its population. Evidence of expansion was also found in one of the two Common Sawshark populations.

Nevatte says the population expansions are estimated to have occurred about 50,000 to 150,000 years ago during the Pleistocene, a time when repeated glaciation events caused sea levels to rise and fall.

"In southern Australia, these changes in sea level caused Bass Strait to open and close, with the formation of a land bridge between Tasmania and mainland Australia," explains Nevatte. "The signals of population expansion are likely due to this repeated opening and closing of the strait, with sawsharks recolonising the strait when it became flooded with seawater.

"The land bridge could also explain the presence of two lineages in the Common Sawshark, as this would have acted as a barrier to gene flow between sawsharks occurring to the east and west of Bass Strait."

He suggests fisheries managers should consider adopting two management units for the Common Sawshark and use a single management unit for the Southern Sawshark. The signals of population expansion and stable population size also suggest these species are resilient to the current levels of fishing activity.

This research was recently published in the journal *Reviews in Fish Biology and Fisheries*.

What marlin eat

Tristan Guillemin's Master of Research project investigated the diets of marlin species to better understand potential impacts of changes in the abundance of other species on this apex predator.

"Changes in food availability for these apex predators could have profound impacts on both our fisheries and the oceanic environment," says Guillemin. "But the vastness of the open ocean makes it incredibly difficult to study feeding behaviours of important fishery species such as marlin. Without knowing which prey species these fish depend on, we can do little to protect and maintain healthy prey populations."

He worked closely with the New South Wales Game Fishing Association (NSWGFA) and its many fishing clubs to

Left Tristan Guillemin worked with recreational fishers for his research into the diets of different marlin species. Photo: Supplied

identify the diets of two Australian marlin species, Blue Marlin (*Makaira nigricans*) and Striped Marlin (*Kajikia audax*).

Collecting tissue samples from marlin captured at game fishing tournaments, Guillemin analysed the stable isotopes in each sample.

"As fish feed on different prey species or in different environments, they retain the 'isotope signature' of what they fed on or where they fed. We can measure a fish's isotope signature to make inferences about their feeding behaviour," he explains.

"Using these methods, my supervisors and I were the first to show that Blue and Striped Marlin have different feeding behaviours on the temperate east coast of Australia."

He says Blue Marlin appear to be picky eaters when it came to the species they fed on, but not too concerned about the size of their prey, likely feeding on tunas ranging from small Skipjack Tuna (*Katsuwonus pelamis*) to big Yellowfin Tuna (*Thunnus albacares*).

Above Ryan Nevatte measuring a sawshark. Photo: Supplied

Below Jessica Bolin is investigating Swordfish meat quality. Photo: Supplied

Conversely, Striped Marlin fed on a wider range of prey species, but all of a similar size, such as smaller schooling species.

"Dietary differences suggest that these species might have different susceptibilities to changes in prey abundance, and that we need to manage them accordingly," he says.

Swordfish quality

Jessica Bolin's PhD research, meanwhile, is focused on the notoriously difficult to predict phenomenon of myoliquefaction – or 'jellymeat' – which affects Swordfish (*Xiphias gladius*) harvested in Australia's Eastern Tuna and Billfish Fishery (ETBF). Jellymeat is caused by parasitic infection by *Kudoa musculoliquefaciens*, which turns Swordfish meat into a soft and mushy texture. However, the condition only occurs post-mortem, making it difficult for fishers to identify affected fish as they catch them.

The parasite found in eastern Australian waters is not known to pose a risk to human health, but jellymeat reduces the value of the product, posing a risk to both the profitability and ecological sustainability of the industry.

Bolin says some ETBF fishers report experiencing jellymeat more often in summer, or when waters fished are warmer than usual. Her industry partners in this project are Walker Seafoods Australia and 4 Seas Pty Ltd, both based at Mooloolaba, Queensland.

Her aim is to clearly identify the relationships between the prevalence and intensity of *Kudoa* infection rates and ocean conditions. To do this, Bolin is using data science, combining ecological modelling, temperature and ocean current data, and information about the prevalence and intensity of *Kudoa* sp. infection in harvested Swordfish.

If a relationship is clearly identified, she then plans to use ecological modelling techniques to generate 'nowcasts' of where and when infected Swordfish are more likely to occur throughout the fishery, based on contemporary ocean conditions, and to collaborate with the Bureau of Meteorology to produce seasonal forecasts to help fishers better plan their trips.

Bolin says the ultimate aim of the project is to provide fishers with a proactive way to maintain the quality of their harvest by reducing the risk of catching infected Swordfish, reducing wasted effort and wasted catch in this important quota-managed fishery. **F**

MORE INFORMATION
Australian Marine Sciences Association
https://www.amsa.asn.au

The hard work, the solitude; it's a good life

The fishing life wormed its way into Ross Casey's soul, drawing him back to the sea after years as a 'land lubber', despite the rigours of the work

By **Larissa Dubecki,** Photo **Phil Copp**

Ross Casey on his boat *Moonshot*.

As July rolled around, Ross Casey headed out from his home base in Townsville for what he expects will be his final season chasing Spanish Mackerel (*Scomberomorus commerson*) in the Gulf of Carpentaria.

He counts himself lucky to have fallen in love with fishing twice in his life, first as a young man, netting Barramundi for a living. Later in life he returned and he has been making a living line fishing for Spanish Mackerel for the past 15 years.

In early July, he departed Townsville with his wife Kalie Obah, taking the seven-day journey to the tip of Cape York on their 45-foot fibreglass boat, *Moonshot*. Their arrival in Cape York marks the start of six months of work to earn the income that will see them through the rest of the year.

The fishing is tiring, time consuming and sometimes tedious. But Ross, now aged 66, still finds it hard to decide whether he prefers the land half or the sea half of his year.

"We live on the boat, but we have to go into [the northern Queensland town of] Weipa every three weeks for fresh veggies and I just feel my stress levels rising," he says. "I'm always relaxed until I go into harbour. We actually look forward to getting back on the boat and going. It's good to get away from the human race."

Ross wasn't born to a life on the water. He taught himself to fish as a 13-year-old, loved it, and became a commercial fisher. But the responsibilities of adulthood got in the way, with children, a mortgage and other commitments. "I'd been netting Barramundi but sold my boat and got a land job. I was sad to give it up but felt I had no choice."

In the intervening years he became a boilermaker, fitter and turner, and diesel mechanic before turning his hand to teaching at TAFE, specialising in mechanical engineering.

And then fate came knocking in the shape of an impressive fibreglass boat.

"I'd been watching the boat for years. It was an old prawn trawler in dry storage and I'd asked the owner for six years to sell it to me. One day he rocks up out of the blue and asks me if I still want it. It was mine for $90,000."

Solace at sea

Four years later he was made redundant and the die was cast, setting him to sea again.

Life on board revolves around the hard graft of commercial fishing. "You get up in the morning, have a shower and defrost the garfish bait, check all your lines and pull your anchor up, and head off to your mackerel grounds and fish all day."

The pace of fishing varies. Some days they get two fish, other days 100, although they average 80.

At night the work doesn't stop. Once the fish have been caught, they need to be processed.

Ross takes them out of the brine tank to fillet them while Kalie prepares the boxes and packs them into the chiller before they wash the boat down ready for another day.

"Sometimes it's 10 o'clock, 12 o'clock, 2am before you're finished. Then you wash the blood and guts off the boat, think about having a meal. Have a bath and a cold drink and go to bed. It's tough work."

The boat is a fully kitted floating home. There's hot water and a cooktop. Dinner is often pan-fried Spanish Mackerel with lemon juice and salad; sometimes a tin of baked beans. Entertainment comes in the form of a computer hard drive with movies downloaded.

At night they anchor anywhere along the Gulf beaches. "Because the wind blows south-easterly across to the west at Cape York, the land formation shelters you from the wind at night."

They meet a mothership to take on fuel and water and to offload the catch every fortnight, but otherwise their contact with the outside world is minimal. It's not the most glamorous life, Ross is

the first to admit, but he likes it. "It's good. It's just lovely to be out there."

Future challenges

Ross's boat is one of a dozen actively fishing commercially for Spanish Mackerel in the Gulf of Carpentaria.

He sees major challenges ahead for the fishery with falling fish stocks and increasing shark predation of the catch, and he believes the potential contribution of charter fishing to these issues needs greater consideration when stock assessments are undertaken.

Ross believes charter boats are attracting sharks and this is having a real impact on the Spanish Mackerel stock. There are 30 charter boats operating out of Weipa.

He knows all too well the challenges of evading sharks. He has high-speed hydraulic reels on his boat that pull the fish across the surface and out of the water quickly.

But those pulling in lines by hand are more adversely affected, he says. "I can get eight out of 10 fish, but with handlines you can land two and the sharks get eight."

Ross acknowledges that he won't have to face the existential crisis that other Spanish Mackerel fishers may be facing.

The dwindling catch, exacerbated by global warming, which is changing the Spanish Mackerel's spawning season, is biting in monetary terms. His best year saw him take home $220,000, but his worst was last year, when that dropped to $84,000.

He outlines management changes in response to changing stock levels that include a move to close the fishery off the east coast off Townsville for two years, and the introduction of quotas in the Gulf. Under quota, he suspects his allowable catch may not be enough to remain financially viable as a fisher.

Along with the aches and pains of an ageing body, he sees it as a sign that it's time to give up the sea, leaving these challenges to the next generation of fishers and fishery managers.

He says he will miss life out on the water, far from everyone. His wife, Kalie, an Indigenous woman from Palm Island, will miss the trio of Gulf dolphins she has called her pets for the past five years. "She calls them the three amigos," explains Ross. "They come right up to the boat when she calls them and dance for her. They won't do it for me."

Moonshot is on the market and he even plans to sell his two tinnies when he returns home. "No more fishing," he says. "I'm going to play pool and enjoy my three grandchildren." F

New projects

The FRDC board has recently approved the following research projects to go ahead

Project number	Project	Applicant	R&D Plan outcome
2021-036	Management and delivery of the Oysters Australia RD&E Plan 2020–2025	Oysters Australia Ltd	1
2021-028	Can novel seismic survey sources mitigate potential impacts to fisheries?	Institute for Marine and Antarctic Studies Hobart	1
2021-026	Water disinfection for influent water biosecurity on prawn grow-out farms	Queensland Department of Agriculture and Fisheries Bribie Island	1
2021-025	Resolving the biological stock structure of Southern Ocean crab fisheries	Deakin University Warrnambool Campus	1
2021-021	The ongoing development, implementation, communication and extension of the Australian Fish Names Standard (AS 5300) and the Australian Aquatic Plant Names Standard (AS 5301) for 2021–2025	Intuitive Food Solutions	5
2021-019	Future-proofing the northern Australia aquaculture industry need for skilled staff to 2050	James Cook University	3
2021-009	Identifying biological stocks of Silver Trevally and Ocean Jackets for assessment and management	NSW Department of Primary Industries Mosman	1
2021-007	Toolbox for the estimation of fish population abundance	CSIRO Oceans and Atmosphere Hobart	1
2020-127	ABFA IPA: RD&E project investment and management via ABFA strategic plan 2021–2025	Australian Barramundi Farmers Association (ABFA)	1
2020-126	Australian AgriFood Data Exchange (OzAg Data Exchange): Deliver an interconnected data highway for Australia's AgriFood value chain	Meat & Livestock Australia	1
2020-125	Investigating the use of a remotely operated underwater vehicle (ROUV) for surveying abalone on reefs in the Western zone abalone fishery, Victoria	Western Abalone Divers Association (WADA)	1
2020-124	Australian Fisheries and Aquaculture Statistics 2019-2020	Department of Agriculture, Water and the Environment	1
2020-119	New opportunities for abalone processing waste	Curtin University	1
2020-115	Demonstrating the impact of prawn viruses on prawn aquaculture production	James Cook University	1
2020-102	A review of fisheries enhancement methods to promote profitability and sustainability in Australian fisheries	Queensland Department of Agriculture and Fisheries Brisbane	1
2018-100	Optimisation of treatment of *Cryptocaryon irritans* in Barramundi aquaculture	University of Adelaide	1

R&D Plan 2020–2025 outcomes

1 Growth for enduring prosperity
2 Best practices and production systems
3 A culture that is inclusive and forward thinking
4 Fair and secure access to aquatic resources
5 Community trust, respect and value

Final reports

Northern Aquaculture vision
2019-096

This report provides a summary of the 'Aquaculture opportunities in northern Australia: Solutions and Strategies Workshop' held in Rockhampton, 5–6 February 2020. At the gathering, stakeholders endorsed the northern Australia aquaculture industry Vision 2030: "In 2030, northern Australian aquaculture will be a nationally significant ($1b a year GVP), cohesive, sustainable, respected industry, providing premium products to Australian and international markets, that contributes to the prosperity and diversification of regional and Indigenous communities across the north."

The northern Australian aquaculture industry's highest priority is to reduce the risk of exotic or endemic diseases, which threaten current production and add risk to investment in industry expansion. A more collaborative approach of industry and biosecurity agencies was advocated, through open conversation and a good flow of information, with resolution of the Aquatic Deed a key sector priority.

Market access and market development are key needs driven by the projected increase in product volume in northern Australia and the high volume required to access some markets. Enhanced understanding of consumer trends and future needs will support the interests of different-sized companies in the market.

More information
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Strategic plan for abalone growers
2019-204

The project aimed to develop a Strategic Plan for the Australian Abalone Growers Association (AAGA) for 2020–2025. AAGA established its first strategic plan in 2015 for the period 2015 to 2020. AAGA members wished to develop a new strategic plan to inform further investment in their sector for the period 2020 to 2025 and beyond. AAGA and the FRDC recognise the need for the sustainable development of the Australian abalone farming industry. This plan and related strategies consolidate and continue the industry's relationship with the FRDC and the Australian Government. Both AAGA and the FRDC recognise the need to ensure that this industry's development is supported and guided by an appropriate governance framework, with the flexibility and durability to meet the changing needs of the sector.

More information
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Strategic plan for prawn farmers
2016-259

This strategic plan was developed by farmers, the the Australian Prawn Farmers Association (APFA) and the FRDC. The plan positions the farmed prawn industry to take best advantage of its strategic and investment choices over the next five years. The Australian farmed prawn sector faces a number of existing and emerging strategic issues that will impact its performance in the next five to 10 years. The forces driving these trends are quite dynamic, which means the APFA Executive Committee requires constant access to up-to-date planning processes. Some of these drivers and trends are beyond the APFA's control (for example, weaker A$, import competition and market positioning, proposed significant new domestic investment in the sector), while others are not (improved sustainability across Australian farming systems, reliance on casual labour, communication across the sector, alignment of sector R&D with strategy direction, precompetitive marketing).

The new strategic plan comes from a comprehensive strategic and research, development and extension (RD&E) planning process to bring together and document all the relevant issues in a coordinated and focused process led by an independent party.

More information
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Oyster industry response to the COVID-19 crisis
2019-210

This project was conducted by Oysters Australia to identify ways of supporting the industry during the COVID-19 pandemic. The research was initiated in April 2020 at a time when oyster sales across the nation had dropped 95 per cent. Oysters Australia staff and subcontractors did the work from April to October 2020, conducting a comprehensive survey of the industry.

The recommendations from this project that will be considered further by Oysters Australia are:

1. Continue to participate in the Seafood Industry Australia seafood promotion campaign, with the aim of improving sales, clearing the backlog of oysters on farm and maintaining farm gate prices. In future years this will require the industry to raise its own funds to pay for the campaign.
2. Maintain the Industry Situation Summary so that it is current and can be easily refreshed to address specific issues when needed.
3. Continue conducting Industry Situation Analysis surveys as needed.
4. Continue the National Oyster Market Report if the industry determines it is worthwhile and of value.

More information
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Understanding abalone's genetic immunity
2017-117

After discovering the existence of an abalone species (Paua, *Haliotis iris*) resistant to Abalone viral ganglioneuritis (AVG), the research team exposed the AVG-resistant Paua and the AVG-susceptible Greenlip x Blacklip hybrid abalone to HaHV-1 (the etiological agent of AVG) and compared gene expression between species. Cutting-edge sequencing technology and bioinformatic analysis allowed them to investigate the gene expression of the animals at the molecular level. This approach led to pinpointing abalone genes that are likely to play a role in the protection against AVG in Paua. Furthermore, the identification of these genes may facilitate (if

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applicable) the use of a gene-silencing technology *in vitro* and *in vivo* to improve immune response to AVG. A breeding program strategy could also eventually be implemented to increase resistance to AVG in susceptible abalone species.

More information

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Investigating new aquaculture species
2017-103

This project was undertaken to assess the potential of two finfish species, Cobia (*Rachycentron canadum*) and Queensland Groper (*Epinephelus lanceolatus*) as alternative aquaculture candidates for the Rocky Point Prawn Farm (RPPF) and potentially other aquaculture enterprises. The study was developed and led by RPPF with assistance from The Company One and the Queensland Department of Agriculture and Fisheries, with staff from the Bribie Island Research Centre. It ran from March 2017 until June 2018. In the study, the commercial performance of each species was assessed when cultured in both indoor tank systems and outdoor cages. The production and market information generated by this project provided a framework to evaluate the relative costs and benefits of the two species within the range of production methods and strategies available to RPPF and guide future investment and strategies to optimise production.

More information

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Storm Bay environmental monitoring
2018-131

The report summarises an initial environmental review into interactions between salmon farming and the water column, soft-sediment, inshore reefs, deep reefs and seagrass habitats. The key indicators and sampling designs for the water column, soft-sediment and inshore reef habitats are well developed. Preliminary results from Storm Bay monitoring, and from another FRDC project to build flexibility and risk assurance into environmental management strategies nearing completion, have been used to determine the sensitivity of the sampling designs for assessing the environmental performance of these habitats at different spatial and temporal scales. Sampling methods and designs are still being refined for the deep reef and seagrass habitats. The initial results will be used to identify key indicator species or functional groups and parameters that should be monitored, and to test the power of the sampling design to detect any potential interactions with salmon farming.

More information

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Hydrodynamic model for Okehampton Bay
2018-119

The study aims to satisfy the regulatory requirements from the Tasmanian Environment Protection Authority for Tassal's use of Okehampton Bay for salmonoid aquaculture, particularly the possible fate of material released within Okehampton Bay into the receiving environment. To achieve that objective, the CSIRO Coastal Environment Modelling team developed a hydrodynamic model to investigate the far field and regional hydrodynamic connectivity around Okehampton Bay and the Mercury Passage surrounds, hereafter referred to as the OKE model. For the first stage of this project, a pilot model was developed and run over the 2016–17 period. Calibration and validation of the OKE model against observations was provided in the second phase of this project. This report provides details of the development of the calibrated model. The observations provided were sufficient to calibrate the model to a satisfactory standard.

More information

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Linking ecosystems to prawn profitability
2017-175

This project filled a significant key data gap by estimating the economic value of habitats that support the diets of economically important species of fish and prawns. The findings suggest the rehabilitation of mangroves and saltmarshes should be prioritised in Wallis Lake to promote fisheries productivity. They also emphasise the importance of seagrasses in the system for providing food and habitat resources for a range of species. The project demonstrates the steps required to produce natural capital accounts for commercial fisheries. Through stakeholder engagement, the project demonstrated that the approach was valuable for fisheries and also of great interest to local stakeholders in both government and the public. Stakeholders agreed the approach would be useful for supporting targeted rehabilitation within estuarine systems, given the inextricable link between habitats, productivity and profitability.

More information

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Fish price and market dynamics
2018-017

This final report, a collaboration between economists from CSIRO, Central Queensland University and the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), is the first detailed analysis of the interrelationship between fish prices on the Sydney and Melbourne fish markets. In addition, the study derived empirical estimates of the own-price and cross-price flexibilities for the main species on the Sydney Fish Market. Using cointegration analysis, the study established that the Sydney and Melbourne markets are highly integrated, with prices of individual species moving together. Demand models were developed to examine substitutability between key fish species on the Sydney market, along with the substitutability of imports for domestic product. The demand modelling results indicate prices of individual key fish species are sensitive to changes in their quantities landed, but less sensitive to changes of quantities supplied by other fish species. It was also found that the increased production of farmed salmon in Australia has had a substantial negative impact on the prices received for species on the Sydney Fish Market – more so than the impact of imports.

More information

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Calendar of events

DATE	EVENT	MORE INFORMATION
2021		
20–24 September 2021	World Fisheries Congress	https://wfc2021.com.au
26 September 2021	World Rivers Day	https://worldriversday.com
29 September 2021	International Day of Awareness on Food Loss and Waste Reduction	https://www.un.org/en/observances/end-food-waste-day
30 September 2021	World Maritime Day	https://www.un.org/en/observances/maritime-day
4 October 2021	World Habitat Day	https://www.un.org/en/observances/habitat-day
4–8 October 2021	Australian Wildlife Week	https://www.aws.org.au/australian-wildlife-week-2021
15 October 2021	Rural Women's Day	https://www.ruralwomensday.com.au
16 October 2021	World Food Day	http://www.fao.org/world-food-day/en
18–24 October 2021	National Water Week	http://www.awa.asn.au/AWA_MBRR/About_AWA/National_Water_Week.aspx

Movers and ...

MOVERS WE'VE MISSED?
PLEASE SEND INFO TO: Ilaria Catizone
02 6122 2128 ilaria.catizone@frdc.com.au

Agricultural Innovation Australia has appointed **Sam Brown** as its inaugural CEO. He was previously CEO of LiveCorp, Australia's live animal export industry research body.

LiveCorp has appointed its general manager of programs, **Wayne Collier**, as its new CEO, with a three-month transition period.

The Grains Research and Development Corporation (GRDC) Board's managing director, **Anthony Williams**, has left the organisation. GRDC board chair **John Woods** says current GRDC company secretary and acting managing director **Cathie Warburton** will continue in the interim while an executive recruitment campaign is put into action.

Sue Grau is no longer working for Oysters Tasmania. The organisation is in the capable hands of **David Balk** as acting chief executive.

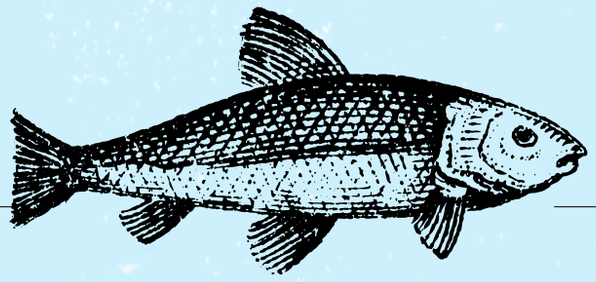
Georgie Townsend has taken on the role of national rural issues manager within the Rural Futures team at AgriFutures Australia. Georgie has come across from the AgriFutures Chicken Meat Program.

Andreas Schiller has retired from his role with CSIRO Oceans and Atmosphere, Hobart.

Research portfolio manager **Nicole Stubing** has left the FRDC to work with South Australia's Department for Environment and Water.

Simon Clarke, executive officer of the Spencer Gulf and West Coast Prawn Fishermen's Association, has moved to the NSW Department of Primary Industries.

Mike Steer has been confirmed as chief scientist of the South Australian Research and Development Institute (SARDI). Research scientist **Paul Rogers** has left SARDI to start his own consultancy.



FEEDBACK
THE FRDC WELCOMES YOUR COMMENTS

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