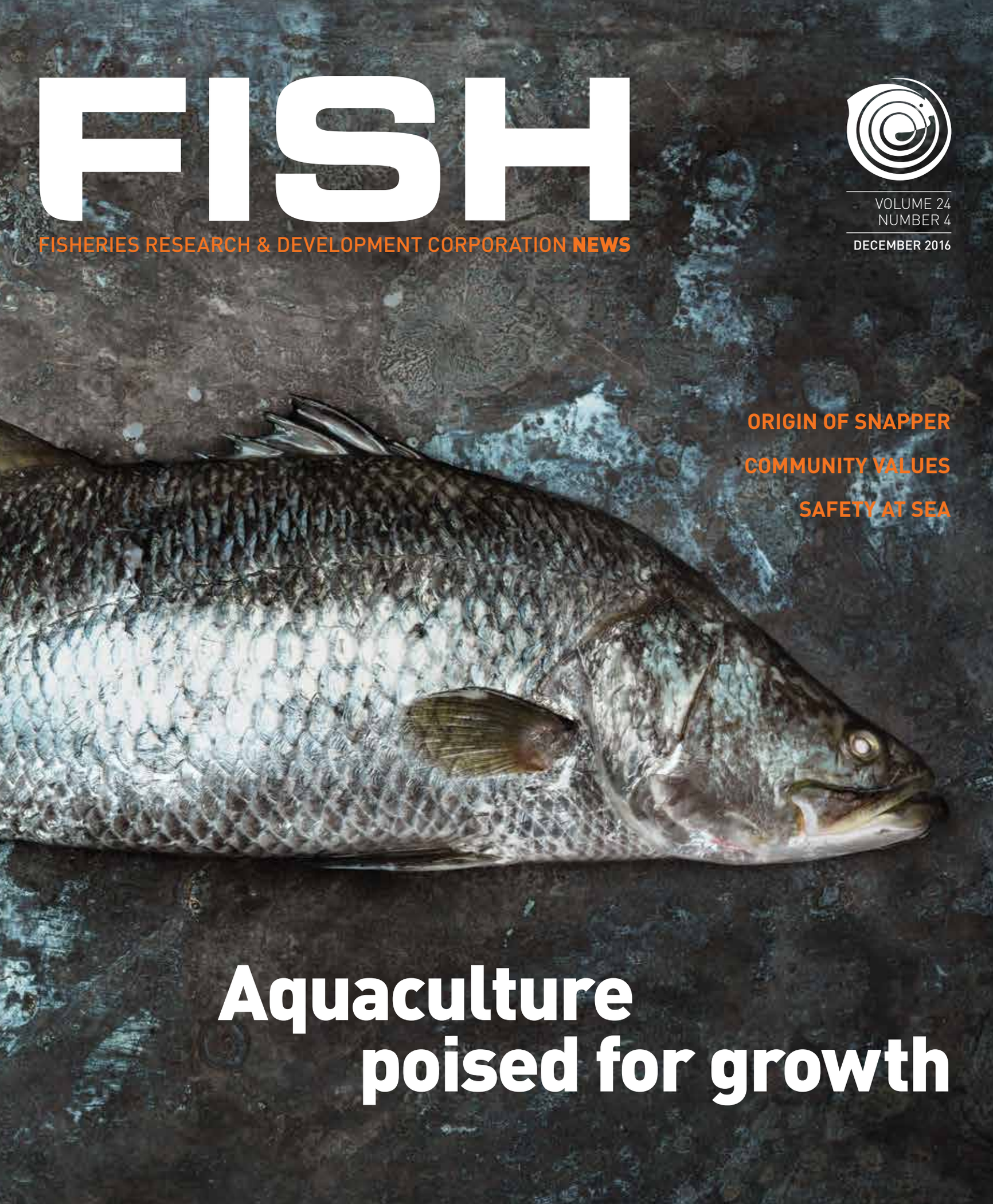
FISH

FISHERIES RESEARCH & DEVELOPMENT CORPORATION **NEWS**

VOLUME 24
NUMBER 4

DECEMBER 2016



ORIGIN OF SNAPPER

COMMUNITY VALUES

SAFETY AT SEA

Aquaculture poised for growth

AUSTRALIAN PRAWN FARMERS COMMENT INVITED ON THE ESTABLISHMENT OF FARMED PRAWN DOMESTIC MARKETING LEVY

The Australian Prawn Farmers Association (APFA) is embarking on a consultation programme to engage members and farmers about the proposal to develop a national farmed prawn domestic marketing levy.

Members and Australian prawn farmers are encouraged to be part of the consultation process and provide comment on the proposal. As part of the consultation on-farm face-to-face meetings will be held from November to January 2017. Farmers will be provided material outlining the case for and against the establishment of a farmed prawn domestic marketing levy.

The APFA's new domestic Market Plan (Sept 2016) has identified both opportunities and challenges for the $87m farmed prawn sector. The establishment of a farmed prawn domestic marketing levy aims to provide the sector the funds to address their needs and build for the future.

APFA Members have indicated that central to this is a desire to implement its marketing strategy over the next five years. This strategy will promote Australian farmed prawns and boost domestic market and supply chain awareness. It will also enable the sector to improve collaboration between farmers, chain partners and regulators.

Following the consultation phase a poll of members and farmers will be undertaken by mail in February-March 2017 to vote on progressing the levy and determine the scale and scope of the marketing levy and related investment. The farmed prawn domestic marketing levy will be managed jointly to the APFA and FRDC.

Further information
Helen Jenkins at APFA
P: 0417 006 639
E: helen.jenkins@apfa.com.au
W: apfa.com.au/marketing/marketing-levy-page

Australian Prawn Farmers - Promoting Australian Prawns

AUSTRALIAN Prawn Farmers ASSOCIATION

FRDC

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

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

FRDC
Fisheries Research House,
25 Geils Court, Deakin, ACT 2600;
Locked Bag 222, Deakin West ACT 2600
T 02 6285 0400 **E** frdc@frdc.com.au
W www.frdc.com.au
To contact the FRDC or individual staff members see the FRDC website (www.frdc.com.au)

SUBSCRIPTION
FISH is available free. To subscribe, contact the **FRDC**
T 02 6285 0400 **E** frdc@frdc.com.au
FISH is online at www.frdc.com.au

FISH is written and produced by the FRDC and **Coretext Pty Ltd**.

FRDC executive editor: Peter Horvat
Deputy editor: Annabel Boyer

Coretext editor: Catherine Norwood
Creative director: Tim Claeys
Coretext, PO Box 12542, Melbourne Vic 8006
T 03 9670 1168 **F** 03 9670 1127
E enquiries@coretext.com.au **W** www.coretext.com.au
ISSN: 1833-4784 (Print) **ISSN:** 2202-7122 (Digital)

FRDC HOME **www.frdc.com.au**
UPCOMING EVENTS **www.frdc.com.au/pages/calendar.aspx**
RESEARCH **www.frdc.com.au/research**
KNOWLEDGE **www.frdc.com.au/knowledge**
ENVIRONMENT **www.frdc.com.au/environment**
SEAFOOD CONSUMERS **www.fishfiles.com.au**
STOCK STATUS REPORT **www.fish.gov.au**
VIDEOS
FRDC FISHERIESRESEARCHAU
www.youtube.com/user/fisheriesresearchAU/videos
FISHFILES **www.youtube.com/user/FRDCFishfiles**

FISH

WWW.FRDC.COM.AU
DECEMBER 2016

CONTENTS

Crime researchers take on industry theft

Australia on track for aquaculture growth

Proverbial truths offer economic insight

Features

Regular

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

GET IT ON Google play
AVAILABLE ON THE App Store
FISH

FISH magazine is available as an app.
Please follow these steps:

- Open Google Play or the App Store on your device
- In the search function type: FRDC FISH magazine
- Tap to download the app
- Once downloaded, open the app and enjoy reading

COVER
Barramundi, a leading species in the growth of Australian aquaculture.
Photo: William Meppem

MORE INFORMATION
Tracy Hill, 08 8575 1716, 0427 604 047,
info@coorongwildseafood.com.au
FRDC RESEARCH CODE 2015-504

Handmade fisheries forge global bond

Tucker Sheehan (left) and Glen Hill represent fisheries from opposite sides of the globe, but have found much in common as part of small, community-based fisheries. Photos: Brad Collis

From Maine to Meningie, time spent in South Australia's Coorong provides an international perspective on community fisheries for Tucker Sheehan

By **Brad Collis**

Pembroke, a small fishing community in the far north-east corner of Maine, is famed among seafood lovers up and down the US east coast for its clams and lobster.

Named after a boat-building village in Wales, it has been a seafaring and fishing community since its settlement in the 1770s.

At first glance, with its North Atlantic environs, it would seem a far cry from Meningie, South Australia, where the turbid waters of the Murray River empty into estuarine lakes flowing ultimately to the fabled Coorong lagoon, a sand dune away from the Great Australian Bight.

Young Pembroke native and environmental science student Tucker Sheehan recently spent two months working with Coorong fisher Glen Hill during his summer break to experience a very different type of fishery to the clam business in which he was raised.

The actual practices used in the two fisheries could not be more different. Clamming involves back-breaking hours digging into mudflats with a short-handled rake. The mullet fishing he did with Glen Hill actually involved a boat, albeit an impressively dented aluminium 'tinnie'.

But for Tucker Sheehan there were also important similarities: "They are both community-based fisheries and hand operated," he says. The role of both fisheries in their local economies, and the resource sustainability, is restricted by the built-in limits of manual labour.

"The catch is restricted to how much people can actually catch in the time available. For clammers this is low tide, and for most that also means just daytime low tides.

"It's the same on the Coorong. Each licensed fisher can only have a few nets in the water and it takes time to pull them back into the boat and each time you might get one box of fish – if the seals don't beat you to it.

"Over the weeks as we moved to different areas of the lagoon the catch was very consistent, indicating an evenly distributed, healthy population," he says.

Given its importance to the local community and economy, Tucker Sheehan was surprised at the antagonism from some quarters towards the fishery, but says he also soon learned there was little interest in debate: "People seem to have set positions, but what you hear or see written and what I found to be the reality are quite different.

"It was obvious, from what I saw and from the daily data, that the fish population is healthy.

"But if you try and show the critics the catch figures, they don't want to know."

Given the Lakes and Coorong Fishery's international acclaim as a Marine Stewardship Council (MSC)-certified fishery, which it obtained with help from the international environmental group World Wildlife Fund, the opposition from

Below Tucker Sheehan and Glen Hill at work on the Coorong.

other environmental lobby groups surprised Tucker Sheehan: "It was something I hadn't expected and it has given me something to think about when I return to university.

"I'm studying environmental science and sustainability and I'm interested in how people perceive this or respond to this. So it was instructive to experience firsthand how the fishers operate and what they have to do to keep their MSC credential, and then against this a prevailing view that commercial fishing at any level is bad.

"The reality is actually about management. Good management means people can be fishing and making money, contributing to the community, and not harming the environment."

Community focus

Tucker Sheehan was invited to spend time at the Coorong by Glen and Tracy Hill when they visited Pembroke in early 2016 as part of an FRDC-supported study tour of community-supported fisheries. (See the June 2016 issue of *FISH* for more on the study tour.)

His father, Tim Sheehan, is a marine biologist-turned-clam trader who supplies a larger distribution business that services markets and restaurants on the eastern seaboard down to Boston and New York.

The family business has given Tucker Sheehan a keen insight into the role of the fishery in the community.

"It's really the only income for low-skilled people, and it's one of those jobs where what you earn relates directly to how hard you work. So some people work just enough hours to sustain a hand-to-mouth existence, others put in long hours and make good money. If you take it seriously you can earn $US50,000 to $US60,000 a year.

"After I graduated from high school I earned $20,000 in three months, going out at every low tide. It enabled me to pay for my first year of college in cash.

"But unfortunately we see in our community the debilitating effects of low education or drug addiction. A lot of people make good money and lose it just as quickly, but at least the clamming gives them a chance."

Because of clamming's capacity to provide an income for the unskilled, the disabled or people with drug or alcohol problems, local poverty alleviation was part of the Sheehans' business plan when they started. Pembroke is in Maine's poorest county, where 20 per cent of the 32,000 residents live in poverty. This has made the Sheehans creative problem-solvers for the local clammers. They make the tools and baskets that people use and guide them through the regulatory processes. They are vocal and practical advocates for the fishery's potential to lift the local economy.

> "Good management means people can be fishing and making money, contributing to the community, and not harming the environment."
>
> Tucker Sheehan

The clams from the fishery resemble an Australian cockle, but much larger: ranging from the minimum legal size of five centimetres across up to 12 centimetres. The clams are harvested with a handheld rake that looks like a bent pitchfork, and fishers are paid by weight.

Regulatory process

Clammers need two licences, one local and one state, which cost $US50 and $US100 respectively. Tucker Sheehan says there are about 150 licensed clammers supplying his family, but only about 20 would be considered full-time or regular.

The fishery is considered robust in terms of sustainability, but is closely monitored nonetheless. Every clammer has a card on which they have to record the time and date they fished, where they fished and for how long they fished, and this information has to be submitted when they sell their catch. This data and the weight of the catch is sent to Maine's Department of Marine Resources. Failure to provide the information incurs a US$400 fine.

While the department keeps a close watch on the take, the fishery itself is largely self-regulated. "Clammers generally move on to a new beach before having to be asked," Tucker Sheehan says. "And if a beach is closed because stocks are getting low it only takes a few months for the population to replenish itself, especially in the warmer months when the microorganisms the clams feed on are in abundance."

While he plans to stay in the fishing industry, "but more on the science side", Tucker Sheehan says working on the Coorong was a fascinating experience and he will be watching with interest how the fishery manages its future. One of his main hopes is for the fishers to get a fair hearing in the public debate about small commercial fisheries, which some also see as impeding recreational fishing.

"The general impression I gained is that there is an attitude that dismisses what the fishers say because they are not scientists – a crazy

→

Below Glen and Tracy Hill, marketing the virtues of a sustainable community fishery.

Below Clammers delivering their catch at Pembroke, Maine.

situation because they know more than anyone about the water, the species, the population densities, the state of the environment generally. Their livelihoods depend on that knowledge."

To be a fisher

Glen Hill has fished on the Coorong and adjacent lakes for 25 years and cannot imagine life without the daily routine of cold pre-dawn starts, motoring out to place a net in the opaque brown waters, years of experience guiding where he works from day to day, hauling in the net, holding the fish in an ice slurry, then back to the processing shed and later the cleaning, filleting and marketing.

"Some days nothing works, and then come the days when all your efforts come together and you get a great result: a good catch," he says of the variety and uncertainty of the job.

"To be a fisher is to be drawn by something deep inside you," he says. "When I was a small boy I would stand for ages in front of a local fish shop window in Melbourne. My mum would go off and do the shopping and leave me there. I was mesmerised by the fish. Still am."

The study tour on which Glen and Tracy Hill met Tucker Sheehan's parents was to investigate community-supported fisheries in the US.

Glen Hill says the idea of a community fishery is to garner local understanding and support: "Commercial fishers have been very poor at promoting their value in terms of local jobs, health benefits and sustainable management.

"In the US, one example we studied was in a small town in Oregon called Port Orford, about 700 kilometres north of San Francisco. The fishers there started getting community support by offering people a chance to buy into their activities," he says.

"Broadly speaking, it was about people putting in some money up front and then once a week or once a fortnight [and] getting a hamper of fresh fish. Other fishing communities up and down the west coast were doing something similar as a way of promoting themselves and their value to the community.

"Similarly, our challenge back home is to increase awareness of who we are and what we have to offer."

> "To be a fisher is to be drawn by something deep inside you. When I was a small boy I would stand for ages in front of a local fish shop window in Melbourne. My mum would go off and do the shopping and leave me there. I was mesmerised by the fish. Still am."
>
> Glen Hill

Identity and trust

Tracy Hill says that for them a community fishery is about maintaining strong relationships between fishers and their markets, and establishing a clear identity for the fishery.

She explains how their business, Coorong Wild Seafood, builds personal supply relationships with upmarket restaurants or distributors servicing independent supermarkets. Benchmarks are put in place for quality and supply reliability.

"We have put a lot of effort into marketing, and have attended workshops, Regional Development Australia courses, and social media and management courses. But the standout influence, for us, has come from attending Seafood Directions conferences. That has been one of the keys to growing our business. It took us from just being Glen and Tracy down at the Coorong trying to work things out by ourselves to being part of a large body of expertise.

"From this has come a more focused approach to marketing and the development of a diverse product range: adding smoked and frozen products to the fresh product and developing our own distinctive brand and label."

The Hills are also working with a local distributor on a value-added product for the native foods market and are even hoping to extend this to an export product.

Tracy Hill says their business is based on building relationships with customers and the supply chain and selling people the values of an MSC-certified fishery.

"We then back this up with the way we operate so that our integrity and values are obvious. It can't just be talk … your story has to be genuine." F

FRDC leads National Carp Control Plan

The FRDC will lead the newly announced $15 million National Carp Control Plan, which will evaluate the benefit of biological control of carp through the use of a carp virus (*Cyprinid herpesvirus*). Minister for Agriculture and Water Resources Barnaby Joyce has appointed Matt Barwick to lead development of the plan, dubbing him 'the Carpinator'.

Matt Barwick also leads the FRDC's Recfishing Research subprogram. In developing the carp control plan, he will work with state and federal government departments and non-government stakeholders, including researchers, industry and environmental organisations, recreational fishers, Indigenous and community groups, tourism operators and landholders. The plan is expected to be complete by the end of 2018.

Barnaby Joyce says CSIRO, the NSW Department of Primary Industries and the Invasive Animals Cooperative Research Centre have put in years of work to assess the ability of a carp virus to put a stop to the pest, which causes up to $500 million damage a year.

The next step is to evaluate whether the virus will effectively deliver a significant reduction in carp impacts and achieve a 95 per cent reduction in carp by 2045, at an acceptable cost. The earliest possible release date for carp virus, pending approvals, is late 2018.

The National Carp Control Plan is funded by the Department of Agriculture and Water Resources, the Department of Environment and Energy and the Department of Industry, Innovation and Science.

National Carp Control Plan leader Matt Barwick.

Fisheries fields two scholars for 2017

The FRDC has sponsored Queensland's Glenn Wormald (above left) and South Australia's Jonas Woolford (above right) as two of the 23 Nuffield Australia Farming Scholars for 2017.

Jonas Woolford's family company harvests wild abalone in the Eyre Peninsula. He plans to investigate cohesion between primary industry, community and government for the effective co-management of natural resources.

He says the seafood industry is inherently complex: wild fisheries resources are owned by government and commercial licences provide an allocation for a specific period of time. The resource is shared with recreational groups and Indigenous fishers, and access to fishing grounds can also be affected by other sectors, including aquaculture, shipping, mining, oil and gas exploration, defence, and biodiversity conservation (marine parks).

"This means that effective co-management really is key to ensure that our precious natural resources are cared for and utilised in the best way for all concerned," he says.

Glenn Wormald is manager of larval rearing at Pacific Reef Fisheries' hatchery, based at Guthalungra near Bowen, Queensland. He says current prawn farming practices in Australia involve breeding and rearing larvae in a hatchery, then transferring them to grow-out ponds, but this technique leads to variable survival rates and restrictions on the growing period due to low temperatures.

An intermediary nursery phase allows for the animals to be held to a larger size in a smaller, temperature-controlled system before moving to the grow-out ponds. "The opportunity to study nursery systems already in operation overseas will enable us to avoid known pitfalls and harness best-practice management."

Call for leaders

Applications are open for the 2017 National Seafood Industry Leadership Program, which encourages participants representing the diverse sectors related to the seafood industry and supply chain. This includes fishers, aquaculture producers, processors, managers, researchers, extension staff, exporters, importers, marketers, deckhands and employees.

The program involves three residential sessions of three days each in April, July and November, and ongoing work on group projects throughout the year.

Applications close on 13 January 2017. To apply go to: www.ruraltraininginitiatives.com.au.

For more information contact Rina Cooper on 0417 535 822 or admin@ruraltraininginitiatives.com.au

Stock status reports

The 2017 'Status of Australian Fish Stocks' report will be released in December, with an additional 15 species added to the report this year. The report assesses fisheries across state, territory and Australian waters, with a total of 83 species or species complexes included. The new report will be available at: **www.fish.gov.au**

Torres Strait fisheries grants

Fisheries-related grants are available through the Torres Strait Regional Authority as part of a program to enhance the region's wealth by creating and managing an economically and environmentally sustainable fishing industry. The program also aims to increase employment opportunities for Torres Strait Islander and Aboriginal people in the Torres Strait region.

For more information visit: www.tsra.gov.au

MORE INFORMATION
Rodger Watson, rodger.watson@uts.edu.au;
Troy Billin, troybillin@live.com.au
FRDC RESEARCH CODE 2015-039

Forces combine to tackle crab pot crime

One of the most innovative teams of crime researchers in the world is helping crab fishers with the pervasive and damaging impact of crab pot theft

Below Crab fisher Troy Billin
Photos: www.debrahnovak.com.au

By **Gio Braidotti**

Crab fishing is a popular pastime in estuarine areas, with pots or dilly hoop nets the most commonly used equipment. While bag limits and permitted gear do vary from state to state, what remains constant between jurisdictions is thefts of pots at a frequency common enough to hurt commercial fishers.

Sometimes fishers lose their catch, sometimes they lose their pots, and theft can include both catch and equipment, a significant loss. It is likely that theft also has an effect on how sustainable fisheries remain.

The thefts are mostly going unreported and unpoliced, but the impact is damaging enough that fishers, their regulatory agencies, and industry knowledge-brokers banded together in 2016 to do something about it.

To determine precisely what anti-theft actions to take, the industry turned to an internationally unique crime research unit at the University of Technology Sydney (UTS) called the Designing Out Crime research centre. Its aptly named deputy director, Rodger Watson, says the centre has worked on more than 100 projects,

partnering with communities, governments, police and non-government organisations affected by crime to arrive at innovative solutions.

"There is 50 years' worth of research into how the design process solves problems," Rodger Watson says. "We have translated the design research into a way of working with people to solve crime-related problems.

"In effect, we help design new ways of thinking and solving problems related to crime." An initial consultative workshop is followed up to facilitate development and roll out preferred actions.

An example of the solutions that have come about using the UTS design approach is on display across the Sydney rail transport network in the form of innocuous-looking rubbish bins that consist of clear plastic bags. These were designed in consultation with police as a solution to the counter-terrorism problem of detecting bombs concealed in public bins. What is not immediately obvious about the clear bins is that they incorporate now patented technology that allows police robots to attach an X-ray slide to the bins that can form an image of the interior of suspect packages as a new way to detect bombs.

Identifying pot options

To discuss the estuarine pot theft problem, 20 people gathered at a workshop at the Sydney Fish Market in July. Included were commercial and recreational fishers and their professional associations from the Northern Territory, Queensland and NSW, the fisheries departments from those same states, and other interested parties such as fisheries equipment manufacturer Shimano. The workshop was sponsored by the Professional Fishermen's Association (PFA) and the project was initiated and assisted by the FRDC.

In all, the group designed 17 possible actions that were mapped out within five domains or 'solution directions': justice/policing, marketing, stewardship, community trust and innovation (see Table 1). These have been summarised in a report produced by the UTS team for the PFA and its stakeholders as they decide what further action to take in a consultation process mediated by the FRDC.

Solutions under consideration include a theft reporting system, increased penalties, and marketing activity to rebrand the thefts as socially damaging. Technical solutions such as modifications to the buoys that identify the location of pots is also being considered. This could involve introducing submersible buoys that are tracked using a mobile phone-based app. F

CRAB FISHING ON THE CLARENCE

Among the commercial fishers who attended the crab pot anti-theft workshop was Troy Billin, based at Yamba in northern NSW. The multi-method fisher has been in the business for 18 years, supplying the Sydney Fish Market with line-caught ocean finfish – Snapper, Mulloway, or Spanish and Spotted Mackerel – but also Sea Mullet, Whiting and Bream, which he catches using mesh nets in the Clarence River.

It is mud crabs, however, that constitute 70 per cent of his income, and he expects this will increase in the future.

"The theft of crab pots can have a huge impact on my business," Troy Billin says. Besides the loss of the crabs, replacing the gear costs about $50 a trap. He is only allowed 10 traps under NSW regulations.

"The stealing can get so out of control that I lose all my traps in one day, forcing me to move away from an area or stop crabbing until the thieves move on."

Commercial fishers feel that theft on this scale is likely due to repeat offenders who supply the black market. Occasional theft by tourists is also thought to happen, but generally involves the loss of only a few traps.

"I was excited about some of the items we came up with in the workshop because they involved thinking outside the box," he says. "What really struck me is that while individual ideas address an aspect of the issue, we could achieve a more comprehensive solution by linking a few different items together."

Troy Billin volunteered to attend the anti-theft workshop as soon as he heard about it through the PFA. He says that generally he tries to do as much as he can on behalf of the fishing industry he loves, including helping to navigate through the raft of changes that have affected commercial fishers in recent times.

Underlying his involvement supporting the fishing industry are skills such as communications, strategy and business, learnt as a graduate of the FRDC's National Seafood Industry Leadership Program.

TABLE 1 Potential actions identified to mitigate harm caused by estuarine pots theft

DOMAIN	TOP ITEM ACTIONS
Justice/ policing	Raise the profile of pot theft within the police and justice system, and work with them to develop appropriate responses, including: • establishment of a reporting system • increased penalties to reflect community expectations and to act as a deterrent • development of a national Crime Stoppers strategy.
Marketing	Raise the social profile and perceived gravity of the problem and personalise the impact for affected businesses and their families. Build anti-theft messages into education programs on how to crab legally. Introduce a certification program and a new tagging system to ensure crabs are legally sourced and promote their adoption by consumers through the media and restaurants.
Stewardship	Partner with government to allow affected communities to become stewards of the local environment, including through fishing clinics, community groups and classrooms. Build a strong profile/brand for affected fishing communities around acting as overseers of natural resources.
Trust	Build social licence around the common good within fishing communities through awareness raising and education.
Innovation	Technical innovation targeting tracking of tags, submersible buoys, apps that replace buoys; engineer anti-theft mechanisms into the traps.

MORE INFORMATION
National Aquaculture Council, nac@tsic.org.au;
Seafood Industry Australia,
www.unitedseafoodindustries.com.au

Take five: for the future

Reflecting on his 40 years in the Australian aquaculture sector, Pheroze Jungalwalla highlights the top five issues he believes need to be addressed to ensure continuing success

By **Catherine Norwood**

Australia is a small player on the international aquaculture scene, but outgoing chair of the National Aquaculture Council (NAC) Pheroze Jungalwalla says Australia is capable of punching well above its weight with a few carefully chosen strategies.

He has been intimately involved in the development of aquaculture in Australia since the 1970s. This has given him a broad understanding of international issues and trends, and how Australia can fare well in both a local and global context. For the past five years he has acted as an advocate for the expanding sector as NAC chair.

As Pheroze Jungalwalla wraps up his time as NAC chair, he takes us through the five issues he believes could make or break Australian aquaculture.

1 Reputational risk

In Tasmania, plans to expand the production of Atlantic Salmon have generated increasing controversy in recent months. Despite international recognition that local practices meet and exceed international sustainability standards, there is local opposition to the expansion of aquaculture operations.

This serves as an immediate example of the importance and difficulty in managing reputational risk, Pheroze Jungalwalla says.

"Aquaculture in Australia is a well regulated and monitored industry, but we need third parties to help us convey that message and to engage with the community who grant our social licence," he says. "Regardless of industry credentials, it will be community opinion and support, not industry capabilities or competence alone, that will determine ongoing success."

He says community expectations are frequently manipulated by an amalgam of organisations creating a sense of "doom, gloom and guilt" in the community.

"Investment in social-licence activities may appear to take away from production activities, but it is worthwhile in the long term because it reduces an otherwise unmanageable risk: community and consumer rejection."

2 Regulation

To date, the industry's development has occurred within the bounds of regulation. This has ensured it has developed to sustainable international standards.

But Pheroze Jungalwalla says there are opportunities to revise both red and green tape to provide a framework that is more supportive towards continued investment and development. He hopes the Australian Government's National Aquaculture Strategy, currently being drafted, will go some way to addressing this, while also ensuring the industry continues to operate sustainably and responsibly.

Regulatory changes could improve biosecurity and protection from exotic pest and disease threats by recognising regional differences in disease status.

"Inadvertent importation of exotic disease organisms on seafood products or material is a real risk. The Australian Government has the sole responsibility of regulating imports of products or material that may carry a biosecurity risk. We need to balance trade considerations against the potential threat to our industry," he says.

3 High-value markets

Australia is an expensive place to grow food, including fish and seafood. This includes costs associated with operating to high standards of environmental sustainability and social responsibility. Of necessity, Australian aquaculture has been geared to high-value products, including Southern Bluefin Tuna, Atlantic Salmon, abalone, prawns and Barramundi.

"We should also consider profitability as a performance indicator for the aquaculture sector, rather than volumes produced, or gross value of production," Pheroze Jungalwalla says.

"Australian aquaculture cannot afford to be geared to producing low-cost protein. We must aim for a product that commands a higher value. It is essential that we focus on a 'distinctive edge' to trade on."

This 'edge' could be the quality, wholesomeness or safety of Australian products, sustainable practices, a unique product such as Native Oysters or Murray Cod, or a product suited to specific, limited geographic conditions, such as cold-water abalone species. Australian prawns have managed to compete successfully against cheaper imports, based on superior quality and size.

4 Research and development

Pheroze Jungalwalla says Australian success has also been the result of consistent investment in research and development. This has improved husbandry and handling, health and disease management, feeding regimes, genetic selection and marketing.

"While it is imperative for aquaculture enterprises and sectors to invest in proprietary R&D, governments should also be involved in developing innovative solutions," he says. "Some nationally valuable R&D would not be undertaken if the government didn't underwrite it."

However, he says, it is a real challenge for industry to demonstrate its own investment in tactical and applied R&D. This is vital in order for industry to lobby government for supporting investment.

He says while individual sectors and businesses have their own research needs, national priorities identified in the Australian Government's *National Marine Science Plan 2015–2025* with links to aquaculture include DNA sequencing, remote sensing applications, environmental sensor networks, aquaculture feed formulation (using alternative ingredients), bioproducts from marine organisms, and marine ecosystem remediation.

Environmental sustainability, productivity, profitability, and resilience in the face of social, environmental and market changes are among the priorities the FRDC has listed for aquaculture in its *Research, Development and Extension Plan 2015–20*. Over the period of the plan, the FRDC has committed $2.25 million to RD&E on new and emerging aquaculture opportunities, of which $750,000 has been used to leverage further investment from industry and the Australian Government through the Rural R&D for Profit Programme, to a total of $6 million.

Further, there remains a need for investment in R&D on issues such as biosecurity and disease management.

"Biosecurity and disease management is a complex issue, particularly in an open aquatic environment where disease and pest pathways are difficult to identify and there are multiple users sharing the environment," Pheroze Jungalwalla says.

"Another challenge for the aquaculture industry is to explain, and if necessary lobby for, better understanding of the risks and potential impact of exotic diseases on Australian aquaculture."

The need for R&D in this space is an issue that would benefit from cooperation across the whole of the seafood sector.

Right Outgoing chair of the National Aquaculture Council, Pheroze Jungalwalla.

5 Industry collaboration

The Australian aquaculture industry comprises several species-based sectors, ranging from a collection of "rugged individualists" to well-organised and sophisticated operators in agribusiness.

"In most cases each species sector has its own industry association, focused on sector-specific issues. The aquaculture industry does have a common voice, the National Aquaculture Council, but this lacks the funding of similar primary production sector peak bodies," Pheroze Jungalwalla says.

"Arguably, aquaculture is a subset of the seafood industry and could be part of a national peak body representing all seafood industries. There are undoubtedly advantages in a peak body addressing matters of aggregate national interest to the whole seafood industry.

"And while there is cautious optimism in discussions underway to establish such a body, it will be a challenge to cater for the sometimes differing interests and needs of fishers, farmers and vendors of seafood." F

FUTURE INDUSTRY REPRESENTATION

With Pheroze Jungalwalla's departure, the National Aquaculture Council (NAC) is operating without a dedicated executive officer, but with Adam Main from the Tasmanian Salmonid Growers Association and Aaron Irving from the Pearl Producers Association as co-chairs.

Aaron Irving says the current arrangements are expected to continue for a year or so. This is pending the outcome of efforts to establish a national peak body, Seafood Industry Australia, incorporating all commercial elements of the Australian seafood sector.

"We definitely need a peak body, but the NAC needs to be sure the interests of Australia's diverse aquaculture sector will continue to be represented at all levels. So understanding the level of representation on the peak body is important to us," he says.

"The NAC could be incorporated into the new body, or it may continue as a separate organisation to represent members on aquaculture-specific issues, while supporting the new organisation on issues of broader interest such as country-of-origin labelling for seafood."

Although stepping down from his position with the NAC, Pheroze Jungalwalla will remain involved in the aquaculture industry through his private consultancy work.

Aquaculture on a rising tide

MORE INFORMATION
Joshua Fielding
joshua.fielding@frdc.com.au
02 6285 0421

With planning approvals finalised, and crucial research underway, Australia appears to be poised for a surge in aquaculture production

By **Catherine Norwood**

In 2008 it seemed optimistic, but not unreasonable, that Australia would be producing 100,000 tonnes of fish and seafood from aquaculture by 2015. At the Skretting Australasian Aquaculture 2008 International Conference and Trade Show, then-chairman of the National Aquaculture Council Craig Foster offered a list of targets for the aquaculture industry, based on innovation in technology and production that were by then underway (*FISH* June 2008).

Some of the anticipated growth has not eventuated and aquaculture production in 2014-15 reached about 85,000 tonnes. However, several major developments and expansions are underway or in the final planning stages, which suggests a surge in production in the next two to five years.

Tasmania's Atlantic Salmon sector production more than doubled to 48,614 tonnes from 2006 to 2015, and the sector has a growth strategy that targets a further doubling of production by 2030. Atlantic Salmon remains the strongest sector to see increased growth over the coming five years.

More prawns

The prawn sector is set to be another big mover in aquaculture in the next decade. The Australian Research Council Industrial Transformation Research Hub for Advanced Prawn Breeding is sequencing the genome of the Black Tiger Prawn as part of efforts to advance domestication of this species and launch production on an industrial scale.

Project Sea Dragon, an initiative of the Seafarms Group, expects to begin construction next year on an industrial-scale facility in the Northern Territory, capable of producing 100,000 tonnes of Black Tiger Prawns. The venture is scheduled to come on-line in 2019, capitalising on these projected advances in breeding.

Expansion is also underway in Queensland, where stringent environmental regulations related to water discharges into the Great Barrier Reef have restricted development for many years. Pacific Reef Fisheries, James Cook University, CSIRO and the Queensland Departure of Agriculture and Fisheries have all worked on the development of new (government-approved) water treatment options. This has been key to winning approval for Pacific Reef's plans to expand production from 1000 to 4000 tonnes, with construction of new ponds to begin next year.

White fish options

Yellowtail Kingfish was expected to be a major growth sector and although volumes have increased to 1200 tonnes, this has still fallen well short of projections for 2015 that ranged from 5000 to 15,000 tonnes.

Cleanseas Tuna has been the only commercial producer. It is now one of several partners in a $6 million Australian Government research project coordinated through the FRDC to improve production.

Other partners include the South Australian Research and Development Institute, Indian Ocean Fresh Australia in Western Australia, NSW Department of Primary Industries and Huon Aquaculture. It is expected that production of Yellowtail Kingfish will double in the next five years.

The aim is to establish a white fish equivalent to Atlantic Salmon in the domestic market – a position both Yellowtail Kingfish and Barramundi producers are seeking to fill.

Chris Calogeras, executive officer of the Australian Barramundi Farmers Association, says an industry survey indicates production reached about 6000 tonnes in 2016. The sector's target is for 25,000 tonnes by 2025. Chris Calogeras anticipates this will be achieved, particularly with new aquaculture leases announced in Western Australia that will increase production capacity from 1400 to 20,000 tonnes. "We already have the commitment from our members for expansion," he says. "Now it's just a matter of making it happen."

Policy initiatives

The new aquaculture leases in WA are part of 'investment-ready' aquaculture zones being developed to fast track new investment. Executive officer at the Pearl Producers Association, Aaron Irving, says changes to WA legislation are also expected to open pearl leases to the production of other species. "At a policy level, small changes like this can really advance development," he says.

At national level, the Department of Agriculture and Water Resources is developing a national aquaculture strategy to coordinate aquaculture development, which has increased in value from $806 million in 2006 to $1.186 billion in 2015.

The development of this national strategy follows the release of its National Aquaculture Statement in 2014 by then Parliamentary Secretary to the Minister for Agriculture Senator Richard Colbeck at the World Aquaculture Conference in Adelaide. The strategy is being drafted and is expected to be finalised in 2017.

The FRDC also sees the potential in aquaculture. Developing new and emerging aquaculture opportunities is one of three national priority areas for research the FRDC will lead on, as identified in its RD&E Plan 2015-20. It has established a subprogram of experts and a budget to lead investment in research areas to help the commercialisation of new or emerging aquaculture species (*FISH* June 2016). F

Australian aquaculture production: Actual and projected production

Species	2006-07 production tonnes	2014-15 projection tonnes	2014-15 production tonnes	2021-22 projection tonnes
Fish	36,101	65,758	62,802	81,450
Crustaceans	3,583	7,600	5,425	10,155
Molluscs	17,912	21,500	17,216	20,500
Seaweed				5,000
Total	57,596	94,858	85,443	117,105

Source: FRDC and ABARES

Comparison of actual and projected aquaculture production

Product	2006-2007 Production tonnes	2014-2015 Projection [1] tonnes	2014-2015 Production tonnes	Looking forward	2021-2022 Projection [2] tonnes
Fish					
Salmon and trout	25,253	40,000	48,614	Growth has continued with improved production from existing areas. This is expected to continue at similar rates and may accelerate if additional farming areas, likely to be offshore, are established.	60,000
Tuna	7,486	13,000	8,418	Tuna growth predicted in 2008 was based on a strategy to ranch fish for longer, growing them to a larger size, which would increase overall tonnage. This did not eventuate. No major increase likely other than from slight increases in quotas, allowing more fish to be ranched.	7,500
Silver Perch	322	361	314	Silver Perch likely to continue at similar levels.	350
Barramundi	2,590	7,000	3,772	Barramundi is likely to see more growth in production in the next few years due to new farms and expanded area on existing farms. Growth in production after industry consolidation and improved farming efficiency has already seen good growth, with preliminary estimates putting 2016 production at about 6000 tonnes.	8,000
Yellowtail Kingfish		5,000	1,200	Trials in Western Australia and New South Wales with more favourable growing conditions are expected to increase commercial production in 3-5 years. CleanSeas Tuna in South Australia also plans to increase its current 1200 tonnes production.	5,000
Other (including Kingfish)	450	397	484	Includes: Murray Cod, Cobia, Tropical Groupers. NSW in particular has seen significant growth in Murray Cod production. Cobia and Tropical Groupers may see some growth in coming years with potential new entrants and investment in RD&E through the new and emerging aquaculture subprogram.	600
TOTAL	36,101	65,758	62,802		81,450
Crustaceans					
Prawns	3,284	7,000	5,282	With new approvals recently granted there is likely to be good growth over the next few years in Queensland. Potential for significant growth with Project Sea Dragon in Northern Territory.	10,000
Yabbies	110		34		40
Marron	89	600	64		70
Redclaw	100		45		45
TOTAL	3,583	7,600	5,425		10,155
Molluscs					
Edible oysters	14,299	15,000	12,689	Edible oyster production has gone backwards. Recent disease issues may see further declines. However, investment in R&D to build resilience and disease resistance should see the industry rebuild to recover to pre-disease production levels.	14,000
Pearl oysters				Research and product development for a commercial pearl meat product is underway in Western Australia.	
Blue Mussels	3,145	5,000	3,678	There is development underway and the industry is expected to reach the original projection of 5000 tonnes within the next five years.	5,000
Abalone and other	468	1,500	849	Current development in the abalone industry is likely to see good growth towards the original target in the coming five years.	1,500
TOTAL	17,912	21,500	17,216		20,500
Seaweed				Emerging as an option in co-production with other aquaculture.	5,000
GRAND TOTAL	57,596	94,858	85,443		117,105

SOURCE: FRDC AND ABARES

1. Projection made in 2007 2. Projection made in 2016.

MORE INFORMATION
The Seafarms Group, www.seafarms.com.au;
John Moloney, john@pacificreef.com.au,
www.pacificreef.com.au

Black Tigers an industry in the making

Project Sea Dragon is a $US1.45 billion Black Tiger Prawn venture from the Seafarms Group, based at several sites across northern Australia with the grow-out facilities to be on Legune Station in the Northern Territory. With an export-oriented production target of 100,000 tonnes, it has been granted 'major project' status by the Australian, Northern Territory and Western Australian governments.

The Seafarms Group already has farms at Cardwell and Ingham in Queensland that produce about 1500 tonnes of Black Tiger Prawns and Banana Prawns a year under the Crystal Bay brand. These operations have provided a proving ground for the production systems it plans to roll out at Legune Station over eight years. Construction of the first 1120 hectares of ponds at Legune Station is expected to begin in 2017, with commercial production to start in 2019.

Breeding initiative

Seafarms Group is the only producer to be part of the Australian Research Council (ARC) Industrial Transformation Research Hub for Advanced Prawn Breeding, along with James Cook University, CSIRO, Australian Genome Research Facility, University of Sydney and Vlaams Instituut voor Biotechnologie. The aim of the five-year project is to sequence the genome of the Black Tiger Prawn. More than 40,000 DNA markers have already been identified to help develop a breeding program based on genomic selection.

Seafarms Group's executive director Chris Mitchell says that the cost competitiveness of aquaculture compared with producing other sources of animal-meat protein means large-scale aquaculture will play an increasingly important role in meeting rising global demand.

"The project will leverage Australia's comparative advantages in biosecurity, marine science, access to key raw materials and expertise in large-scale resource and agricultural development. A project of such large scale means Australia can be a low-cost producer, and Australia's strong biosecurity credentials and the project's relative remoteness will assist in mitigating biosecurity risks."

Queensland challenge

Construction is also scheduled to begin in 2017 on an expansion for Pacific Reef Fisheries in northern Queensland. In addition to its farm at Ayr, which produces more than 1000 tonnes of prawns a year, the company will build new ponds at Guthalungra, where its hatchery is based, taking annual production capacity to about 4000 tonnes.

The expansion at Guthalungra has been 15 years in the planning, with investment in the past eight years into water discharge treatment options. General manager John Moloney says this has been the main challenge. The company operates within the Great Barrier Reef water catchment so must meet strict nutrient discharge requirements.

To achieve this, new water treatment systems, including mangrove wetlands and seaweed beds, have been developed and verified in partnership with James Cook University and the university's commercial offshoot MBD Energy. The Guthalungra farm is 260 hectares – of this, 25 hectares will be set aside for seaweed beds. Mangrove wetlands have also been established on the company's farm at Ayr.

"The reality is that we're in a much better position to expand now than when we first put the plans together. The time is right, from a lot of different perspectives. The prawn farming industry has matured a lot in the past five years."

Marketing initiatives have helped to build domestic demand, which far exceeds local production. Australia imports 70 per cent of its prawns and John Moloney says while domestic producers will not compete on the smaller, lower-value prawns widely used in food processing, there is room to replace the significant volume of larger, cooked product being imported. F

MORE INFORMATION
Marine Produce Australia, 08 9381 4483, www.marineproduce.com
Humpty Doo Barramundi 08 8988 8121, www.humptydoobarramundi.com.au

Barramundi sector poised for rebound

Barramundi production is little more than half of that predicted a decade ago, but two projects on the drawing board have the potential to increase production to 25,000 tonnes.

In Western Australia, Marine Produce Australia was this year given ministerial approval for an 800-hectare expansion, bringing the total of its Cone Bay Ocean Barramundi lease to a production capacity of 15,000 tonnes. The lease is part of the 2000-hectare Kimberley Aquaculture Development Zone, the first of at least two investment-ready aquaculture zones being established by the WA Government.

Cone Bay Ocean Barramundi is the only seacage producer in Australia, with several others in the Northern Territory and Queensland having succumbed to climatic hurdles. Operations manager and Nuffield scholar Steven Davies says Marine Produce Australia has spent more than a decade refining production processes suited to the conditions at Cone Bay. Scaling up will also be done with new markets in mind. "As it stands we can't keep up with domestic demand, however, we are excited by the prospect of taking Australia's only true saltwater Barramundi to the world," Steven Davies says. He will be investigating export market opportunities, particularly in Singapore, Japan and Hong Kong, as well as the development of value-added and consumer-ready products.

Investment in R&D has been fundamental to ongoing productivity improvements at Cone Bay Ocean Barramundi, including working with its supplier of juvenile fish, MainStream Aquaculture, based in Victoria.

MainStream Aquaculture has reported more than 20 per cent improvement in growth rates from its breeding program, which is entering its fourth generation. Group managing director Boris Musa says the improved performance has already resulted in Barramundi becoming more productive to farm than Atlantic Salmon, despite Atlantic Salmon's 30-year head start.

Meanwhile, in the Northern Territory, the family-owned business Humpty Doo Barramundi has already finished stage one of new saltwater ponds that will expand its annual production from 1700 tonnes to more than 3000 tonnes within the next three years. Managing director Bob Richards says that using current technology, the business could comfortably expand its production to 10,000 tonnes as markets are developed.

Humpty Doo Barramundi also secured its export licence this year and has sent product trials to China and the US, and has hosted delegations from Singapore and Japan.

"But at this stage the domestic market is our main market. We deal largely with the wholesale and food service industry, but we believe there is unrealised opportunity in large retailers. There is a growing sophistication in the retail sector, with more focus on strategic relationships than playing the market," Bob Richards says. "Reliability of supply, quality of product and stability of price are key."

Biosecurity is one of his greatest concerns, with a number of diseases identified in Barramundi produced overseas, which he says have the potential to threaten not just aquaculture, but also Australia's wild stocks. He says an updated import risk assessment is urgently needed, given that the last one was in 1992. The business's R&D initially focused on environmentally sustainable systems. "We now have good systems and our focus has moved on to mechanisation." This work has included a joint project with other Australian businesses to develop an acoustic feeding system to improve feeding efficiency.

Bob Richards says on the finance side he has found bankers' attitudes towards aquaculture have become more positive. "In our last expansion, in 2012, the banks would not put any collateral value on either the stock or the improvements we had already made to our business, and it was difficult to raise funds. There's been a shift now – we're being courted by banks and they're prepared to be more flexible in what they will value." F

MORE INFORMATION
Joshua Fielding
joshua.fielding@frdc.com.au
02 6285 0421

Murray River fish ready to join the party

Widely recognised as an icon of Australia's inland waterways, Murray Cod is emerging as a species with significant commercial potential. Between 2009-10 and 2014-15 Murray Cod farmgate production value increased on average 29 per cent a year, to more than $3.6 million, with several new entrants to the industry.

Hatchery techniques for both Silver Perch (*Bidyanus bidyanus*) and Murray Cod (*Maccullochella peelii*) were developed in the 1970s at the Inland Fisheries Research Station at Narrandera, to stock farm dams and impoundments – NSW has been the main centre for commercial production of both.

Since 1994 Silver Perch has been the focus of expanding freshwater aquaculture and projections were for incremental growth. Murray Cod was barely a blip on the horizon. Manager of aquaculture for NSW Department of Primary Industries (DPI), Ian Lyall, says the Silver Perch industry pioneered the farming of native freshwater fish species. Although the number of growers has consolidated in recent years, those remaining are operating profitably to meet existing market demand.

Today, there is a new groundswell of support for Murray Cod. From just 16 tonnes produced in NSW in 2006-07 Murray Cod production rose to an estimated 230 tonnes nationally in 2014-15 – 176 tonnes of this from NSW, with smaller quantities from Queensland, Victoria and South Australia.

Ian Lyall says the research into the fish handling, production systems, diet, health management, and even some marketing for Silver Perch, is also proving valuable for Murray Cod. Earlier this year the FRDC and NSW DPI jointly funded a review to identify R&D needs for Murray Cod. This was presented at a freshwater aquaculture forum in Griffith in September 2016 in conjunction with the Freshwater Native Fish Association and NSW Aquaculture Association. It attracted more than 120 participants and Murray Cod was a major focus of the two-day event.

"One of the exciting aspects of Murray Cod is the potential to incorporate it as part of a diversified farm business, to integrate it with cropping or hydroponics and reuse the water," Ian Lyall says.

Silver Perch and Murray Cod are popular as a live fish sold in metropolitan centres, particularly to Asian restaurants. However, Murray Cod offers greater versatility for chefs, and graces menus at many high-profile Australian restaurants.

Among those investing in Murray Cod production is Timpetra Resources. It has bought Silverwater Native Fish hatchery and fish nursery Bidgee Fresh. It has also bought Riverina Aquaculture, which built new ponds this year to expand its production. Timpetra chairman Ross Anderson says this will increase capacity from 40 to 100 tonnes within the next few years.

"Using contract farmers, we want to expand production to 900 to 1000 tonnes within five years," he says. "We need to build the domestic market for a start. There is high demand from chefs for the fish, which has clean, white flesh with a high fat content. Western restaurants particularly want two to three kilograms of whole fish. We've also had interest from overseas but they want large quantities we can't supply yet – 500 tonnes or 1000 tonnes."

The potential of Murray Cod aquaculture featured on ABC's *Landline* in September. F

MORE INFORMATION
Stephan Schnierer, stephan.schnierer@scu.edu.au
FRDC RESEARCH CODE 2012-216

Right Fingal Beach, Tweed region, NSW.

A voice for Indigenous fisheries

A Tweed region survey gathers Indigenous ideas on sharing and managing local fisheries

By **Bianca Nogrady**

As the world's oldest continuous culture, Aboriginal Australians have not only maintained a connection to the land for tens of thousands of years, but also to the waters that encircle and run over it. These waters have provided a wealth of food and other resources to countless generations.

With the arrival of European settlers, Indigenous cultural fishing practices and access to fisheries were dramatically changed. But Stephan Schnierer, an adjunct professor at Southern Cross University, is working to ensure that Indigenous fisheries are recognised as the original fisheries in Australia. This will help to ensure that Indigenous people have a strong presence in both management and use of Indigenous fisheries.

Stephan Schnierer says that for a long time, Indigenous fishing was lumped in with recreational fishing in Australia. This failed to acknowledge the unique and often vital role that fisheries play in the day-to-day life and culture of Indigenous communities on the coast and inland.

"We need to build greater awareness within the broader community as well as with policy makers, managers, researchers etc, to ensure that Indigenous Australians get access to a fair share of their fisheries resources and a say in the way those resources are managed," Stephan Schnierer says.

"When you look at fisheries management today, a big problem for Indigenous fisheries has been its invisibility. This is due, in part, to the lack of research that could help guide appropriate management strategies within agencies and provide communities with documented evidence of the value of their fisheries," Stephan Schnierer says.

With support from the FRDC and its Indigenous Reference Group, Stephan Schnierer and colleagues recently undertook a comprehensive survey of the Indigenous community's relationship with fisheries in the Tweed region of far northern NSW. But there is more to it than simply asking who is catching what and how much.

Seeking the big issues

He and his colleagues organised a series of workshops in which they spoke to the local Indigenous people in the Tweed region about what species they were catching and why, and at the same time listened to what the community saw as the big issues for them in the fisheries space. The workshops were also attended by representatives from the NSW Department of Primary Industries (DPI).

"This kind of data is sensitive, because people don't like giving up what they catch and how much they catch, because they're worried that it will come back to haunt them in the form of policies that further reduce their access to fisheries resources.

"What we wanted to do with the Tweed project was to try working with the community in a two-way process to collect data," Stephan Schnierer says. "We do this research so that managers are better informed, so they get some benefit out of it, but the community also become better informed too."

What emerged was a clear message that the community wanted more of a say in fisheries management, including on issues such as bag limits, gear and economic opportunities. It also raised the possibility of Indigenous governance of fisheries.

Following on from these workshops, the Tweed community has developed its own local Aboriginal fisheries management plan, which it hopes to implement in conjunction with the NSW DPI. It is a big change from the usual top-down approach to fisheries management and does require a shift in government thinking, Stephan Schnierer says, but the end result is likely to be worth the effort.

The 'Tweed Plan' contains information on both historical and contemporary Aboriginal cultural fishing in the region, and makes suggestions for cultural bag and size limits, Aboriginal fishing gear, waters that can be fished, and identification of who can fish under the plan.

"If we can get an agreement then the community can go ahead and catch fish the way they want to catch them; once you've got an agreement on bag limits, then compliance is likely to be a lot easier."

While negotiations are underway with NSW DPI to implement the 'Tweed Plan', other communities have expressed a desire to develop their own plans. F

MORE INFORMATION
Jason Tanner, SARDI Aquatic Sciences, 08 8207 5489, jason.tanner@sa.gov.au;
Ben Cameron, Cameron of Tasmania, 03 6253 5111
FRDC RESEARCH CODE 2010-201

Seaweed on shortlist in co-culture trial

Interest is mounting in the economic and environmental potential of seaweed co-cultivation with other aquaculture operations, from finfish to oysters

By **Bianca Nogrady**

Below Kathryn Wiltshire collecting brown seaweed for use in the trials.
Photos: Kathryn Wiltshire

Below Red seaweed (*Solieria robusta*) growing during the pilot field trial in Adelaide.

Native seaweeds could be the next big thing in Australian aquaculture, as businesses look to diversify their income streams and improve water quality at the same time.

Researchers at the South Australian Research and Development Institute (SARDI) have been investigating integrated multitrophic aquaculture. This describes the co-culture of organisms where one species benefits from and therefore removes the wastes from another species, and both species have an economic value.

The project had its genesis when a team of researchers from SARDI and CSIRO began working to improve their understanding of nutrient cycling in the water around Southern Bluefin Tuna and Yellowtail Kingfish farms off the South Australian coastline. The project investigated the hypothesis that farmed seaweed would absorb nutrients generated in the farm, producing a usable product and decreasing the industry's environmental footprint.

Nutrient use

Countries including Norway, Canada, Chile and China are investigating the use of seaweeds to offset nutrient inputs from fish aquaculture. Seaweed farming is also big business in Japan, China and parts of South-East Asia, but many of those regions are struggling to meet consumer demand for a higher-quality product not tainted by pollutants.

Seaweed derivatives are routinely used in a host of other products including other foodstuffs and industrial products. They are also attracting attention from the nutraceutical industries as a food ingredient with specific health-promoting functions.

SARDI's Jason Tanner says co-culturing seaweed with finfish farming offers a "natural fix" that could potentially provide an additional income stream. "There's a whole host of different strands coming together to show that it's a good time to start thinking about seaweed production here in Australia," he says.

With funding from the FRDC and SARDI, Jason Tanner and Kathryn Wiltshire began looking into the potential of native rather than introduced seaweed species. They were on the hunt for what might thrive in a more nutrient-rich environment and also have economic potential.

Seaweed shortlist

The researchers began with a search of seaweed species that grow along the South Australian coastline. "We screened them to come up with a shortlist of species that we thought might be fast growing, might be able to survive in that habitat, and might be able to produce something of value," Jason Tanner says.

Kathryn Wiltshire then studied the shortlisted species, looking at how well they coped with being handled and whether they could be grown in the laboratory under simulated fish farm conditions. She also conducted a small-scale pilot field trial in Adelaide in partnership with Cleanseas Tuna.

From this, they identified four species of seaweed that grow naturally in Australian waters with potential for co-cultivation with finfish farms. These included two red species, *Solieria robusta* and *Gelidium australe*, and two brown species, *Ecklonia radiata* and *Cystophora subfarcinata*.

The red *Solieria robusta* has a history of human consumption and also grows outside of Australian waters. The other three have potential in more indirect industrial or pharmaceutical applications, Kathryn Wiltshire says.

Oyster interest

Shellfish producer Cameron of Tasmania has brought a researcher on board to look at the viability of multitrophic aquaculture for its oyster farm. General manager Ben Cameron says seaweed co-culture could offer significant benefits, both economic and environmental, to oyster farmers.

"Firstly, we were after species diversification, so we can shed some of the risk of being a monoculture," Ben Cameron says. "Oysters also rely on pristine, beautiful water quality, so we were looking at what could we do that can enhance water quality." They will initially focus on species that make up the kelp forests off the Tasmanian coast.

Ben Cameron sees potential in co-cultured seaweeds becoming a premium product within the Australian market. "Increasing the size and breadth of that total seafood basket is where you can attract very high-value dollars and build further upon that Brand Tasmania, Brand Australia, for fresh, high-quality seafood." F

MORE INFORMATION
Anthony Fowler, 08 8207 5432, anthony.fowler@sa.gov.au,
Michael Steer, 08 8207 5435, michael.steer@sa.gov.au
FRDC RESEARCH CODES 2012-020, 2014-019

Moving in on Snapper

New insights into the population dynamics in South Australia's Snapper fishery are being driven by innovative research approaches and technological advances

By **Natasha Prokop**

Research to investigate unexpected and relatively dramatic changes in the distribution of South Australia's Snapper (*Chrysophrys auratus*) population has revealed three separate fish stocks across the state, leading to changes in the way the fishery is managed.

It has not been uncommon for catches in South Australia's Snapper fishery to fluctuate from year to year. The fishery had historically relied on significant catches from the Spencer Gulf. But from 2007 onwards, things started to change. Catches in the northern Gulf St Vincent and south-east regions increased exponentially, while those in the traditional fishing grounds of Spencer Gulf declined to record lows.

This redistribution of biomass was not necessarily a concern. The statewide catch actually increased over that time, so much so that between 2007 and 2011 the highest-ever annual commercial catches were recorded. But significant changes were happening over very short periods of time.

"The problem was that we didn't understand the processes that were responsible for those rapid changes," says Anthony Fowler, principal research scientist at the South Australian Research and Development Institute (SARDI).

The changes that began in 2007 drove an investigation to better understand processes within the fishery, including recruitment, mortality and migration between regions.

Key drivers

An FRDC-funded project, initiated in 2012, has helped to address this knowledge gap. Researchers at SARDI, a division of Primary Industries and Regions South Australia (PIRSA), used comparisons of regional data to get a better picture of complex population dynamics. These included otolith (fish ear bone) chemistry, acoustic tracking of fish (telemetry) and morphological studies.

They found that the key driver of the dramatic spatial changes in Snapper biomass was the year-to-year variation in recruitment success in the three major nursery areas – northern Spencer Gulf, northern Gulf St Vincent and Victoria's Port Phillip Bay. The number of fish surviving to enter the fishery changed each year in the three nursery areas in response to environmental conditions.

Anthony Fowler says these variations and the subsequent migration of fish have the capacity to alter the biomass distribution of the entire fishery. "We found that it was really

Left Snapper sampled by researchers in order to collect biological information on the species.
Photo: Leigh Warneke, SARDI

the high recruitment of fish in Port Phillip Bay in 2001 and 2004 – two really strong year classes – which led to the increase in biomass in the south-east region of South Australia.

"The south-east population is sustained by fish that move about 600 kilometres from Port Phillip Bay," Anthony Fowler says. "That's in contrast to what happens in the northern Gulf St Vincent, where the population has increased over time due to local recruitment." Anthony Fowler says these findings have given researchers an appreciation for the population dynamics in the different regions.

Stock structure

Having a better handle on the movements of Snapper in South Australia also helped the researchers to determine the biological stock structure of the fishery – another important component for management.

Biological stocks are discrete, self-sustaining groups of fish with similar life history characteristics. If the Snapper in SA were found to move large distances and mix with fish from other regions, there would be only one well-mixed stock throughout the state. But if they were found to mix very little, regional differences would arise, causing stock differentiation.

Several techniques were used to determine the degree of movement and connectivity among South Australia's regional Snapper populations. The biggest clues came from the chemical fingerprints found in the ear bones, or otoliths, of Snapper, which told the researchers where the fish were residing throughout their life. This, along with differences in head shape, helped the researchers to determine that across South Australia's waters there are three biological stocks. They were identified as the Spencer Gulf/West Coast stock, the Gulf St Vincent stock and the Western Victorian stock, which spans south-east South Australian and western Victorian waters.

Anthony Fowler says these findings have changed the way researchers and managers think about the structure of the fishery and triggered a rethink of research strategies. "We used to carry out stock assessments at the regional scale. But now we know that we're dealing with three biological stocks, we're reporting at this larger spatial scale."

This will mean more accurate assessments and fewer surprises in the future, if things begin to shift once more.

Population estimates

Over the same period that the distribution of biomass was changing within the fishery, so were the dynamics of the fishery's operation. In 2009, there was a shift from hand-lining to more efficient longlining technologies. Consequently, catches, fishing effort and catch rates increased dramatically.

Then a 2011-12 review of management arrangements for the South Australian Snapper fishery saw several changes implemented the following year. This included extending the statewide seasonal Snapper fishing closure by an additional 15 days, introducing spawning spatial closures in both gulfs, reducing catch limits, and additional gear restrictions, including long-line hook limitations.

This meant that traditional means of assessing the sustainability of the fishery, such as catch and effort, were difficult to compare year to year. Michael Steer, subprogram leader of finfish fisheries at SARDI, says this was the motivation for fisheries managers to initiate an FRDC-funded project to develop an innovative, and fishery-independent, method for estimating the biomass of South Australian Snapper.

"Understanding biomass in fisheries is critically important because you need to know how large the resource is to ensure you're harvesting at appropriate levels," he says.

The daily egg production method (DEPM) does not rely on fishing to estimate populations. It involves determining how many eggs are in the water column and how many eggs each spawning female is producing. This can then be used to back-calculate the number of fish required to produce that number of eggs.

"We used to carry out stock assessments at the regional scale. But now we know we're dealing with three biological stocks, we're reporting at this larger spatial scale."

Anthony Fowler removing snapper otoliths to collect biological information.
Photo: Heather Riddell, SARDI

Adapting DEPM to estimate the spawning biomass of Snapper involved overcoming several challenges. The first was that Snapper eggs look much like any other demersal fish egg and are spawned at the same time of year as many other species. "We needed a way to identify and validate the Snapper eggs within a mixed sample," Michael Steer says. "It's really important to get that right because if you don't, you'll overestimate or underestimate the spawning biomass."

Andrew Oxley, a SARDI molecular biologist, says they did this using a molecular probe (a radioactively labelled fragment of DNA or RNA) that seeks out a Snapper-specific sequence in the DNA of a fish egg, dyeing it blue. "This effectively removes all of the human error because we no longer have to go through and identify the eggs by eye," he says.

A tough egg to crack

Andrew Oxley says the Snapper eggs initially proved to be really tough to crack. "The egg chorion, or egg shell, has been so robust that we've had trouble getting the probe to penetrate the developing embryo," he says.

They developed a mechanical method for breaking the egg, so that they could get the molecular probe to penetrate the egg and do its work. Now with the probe working, Michael Steer is confident this approach will have wide-ranging applications, and the technique has been successful in identifying Snapper eggs collected annually between 2013 and 2015.

He says the results from the DEPM will be used to develop improved harvest strategies and to evaluate management strategies that are already in place, such as assessing the effectiveness of spawning closures. And he says other fisheries could also benefit.

"It's something that other jurisdictions can potentially use, such as the Victorian and West Australian Snapper fisheries. There's also potential to extend the use of this method to other commercial species where we've had difficulties in identifying the eggs," he says.

SARDI researchers are already working to extend the technique to King George Whiting, through the FRDC Project 2016-003. F

MORE INFORMATION
Sean Pascoe, 07 3833 5966, sean.pascoe@csiro.au;
Kate Barclay 02 9514 1579, kate.barclay@uts.edu.au
FRDC RESEARCH CODES 2014-301, 2013-301

Beyond the catch

Fresh food choices, tourist experiences, local marine knowledge and a sense of belonging are just some of the values local fisheries provide to their communities

By **Anne Crawford**

Studies on the professional fishing industry have often concentrated on the profitability of fisheries. Two innovative FRDC-funded projects take a different tack and demonstrate that the benefits of the fishing industry extend well beyond the landed value of the catch.

The first analysis, by researchers at the CSIRO and James Cook University, reveals that Queensland inshore fisheries have a substantial flow-on effect in generating income for regional economies and in benefits to local consumers.

The second study, conducted by the University of Technology in Sydney, shows the importance of wild-catch fishing to the social and economic lives of NSW coastal communities, the value coastal residents place on having a local industry, and the contributions that professional fishers make to their communities.

Understanding such aspects is vital to any consideration of resource management and allocation, the researchers say.

Sean Pascoe, lead author of the Queensland Beyond GVP project, says it quantified the potential economic benefits to regional communities generated by inshore fisheries (pot, net and line fisheries) on Queensland's east coast, beyond the much-used gross value of production (GVP).

It also looked at the industry's value to consumers.

"The GVP just measures the value of the catch – it doesn't measure what the importance of that is in terms of local incomes or other business flow-on effects," Sean Pascoe says.

Lack of information

The three-year study was prompted by frustration within the industry at the lack of understanding of the contribution the sector makes to regional economies and the scarcity of information about this. It comes amid growing concerns about increasing pressure on inshore fisheries as a result of coastal and port development, and the loss of fishing areas due to closures for conservation or recreation activities.

The study was carried out by economists and social scientists from the CSIRO and James Cook University, assisted by Queensland University of Technology research students.

Researchers initially conducted a survey to gather economic data about the industry, which ran alongside another project interviewing 188 fishing operators in key Queensland fisheries. In a second survey they interviewed fishers on the east coast to collect data about what they spent their income on.

Multiplier effect

The researchers then used mathematical modelling to estimate the extended benefits of the industry. "We estimated what's called the 'multiplier effect' that measured the flow-on effect to the regional economy," Sean Pascoe says.

The study found the estimated average regional 'multiplier' was 2.94, meaning that for every dollar of value produced by the fishing industry, an additional $1.94 was generated in the local economy due to fishers' demand for fuel, gear, supplies and services. Given the fishery GVP of around $46 million in 2012-13, an additional $74 million may have been generated in regional economies.

Another consumer survey found most Queenslanders bought fresh seafood at least once a month and were willing to pay an average 11 per cent more for locally sourced fish, which further added value to the product.

Retail value, and the additional sum gained by consumers and retailers as a result of the product being fresh, pushed the combined economic value of the Queensland inshore commercial fisheries to around $143 million in 2012-13 – more than three times the amount represented by the GVP, although the report cautions that retail estimates were based on limited observational data.

"I was surprised at the magnitude of the effect," Sean Pascoe says. "Inshore fisheries are relatively small scale – they don't have a huge value of production – but the value that's generated back to the local economies in terms of flow-on effects compared to this are substantial.

"The study really highlighted the benefits to the local economies and also to consumers

Key research findings

- Commercial fisheries have a significant 'multiplier' effect for regional economies (an additional $1.94 produced for every $1 of fish caught)
- There are high levels of public support for commercial fishing in coastal communities
- Local residents value fresh local fish and will pay a price premium
- Tourists to coastal communities expect fresh local seafood to be part of their holiday experience

Photo: Michelle Voyer

Photo: Hayley Egan

"There are five generations of fishermen in my family, I've been a fisherman since I was 15, it's always been a part of my life, I just love it. You just blend in, it's your country, you just feel relaxed and comfortable. I can't imagine doing anything else. I will die a fisherman."

Andrew Nye (pictured above) , Indigenous professional fisher, NSW South Coast

who have access to fresh fish," he says. "Such information is invaluable when assessing the potential impacts of coastal development resource allocation decisions that may result in the loss of inshore fisheries production."

A spin-off study by PhD student Samantha Paredes, who worked on this project, will measure how important local fishing is to tourism in coastal areas.

Social contributions

Social and Economic Evaluation of NSW Coastal Professional Wild-Catch Fisheries dovetails neatly with the Queensland report, demonstrating too the value-added economic benefits of the state's industry while looking more broadly at its social contributions.

"Fishers do many things that can't be estimated in dollars and cents – they're part of the fabric of rural communities," says lead researcher Kate Barclay, an associate professor at the University of Technology Sydney (UTS).

She oversaw a collaboration of social scientists and economists from UTS, the University of Wollongong, ENVision Environmental Consulting and the Western Research Institute who, for the first time, developed a multi-faceted picture of the NSW wild-catch fishing industry's contributions to community wellbeing.

The research involved in-depth interviews of more than 160 people with connections to the industry, an economic survey of NSW fishers, a phone survey of 1400 people to gauge public perceptions of it, and questionnaires and interviews with fish merchants, co-operatives, retailers, wholesalers including the Sydney Fish Market, and tourism operators. It found that professional fishing and the secondary seafood sector in 2012-13 had a likely direct and indirect output of $436–$501 million and an added value of $215–$248 million. It supported up to 3857 full-time jobs across NSW – of which about 1000 people were working full-time in fishing, with another 403 full-time jobs involved in supplying fishers with goods.

Tourism impacts

"Professional fishing is a vital part of rural communities both economically, in its own right, and through its connections with other sectors," Kate Barclay says. Local tourism was one such sector. The survey of the general public found that almost 90 per cent of NSW residents expect to eat local seafood when they visit the coast, with 64 per cent indicating they would be interested in watching professional fishers at work.

Nelson Bay Co-op manager Grahame Lewis said: "People love watching – they come down and watch the boats unload, they see what sort of fish are coming in, they see it getting wheeled over to the shops and they know there's stuff going in there from

➔

Left Local fish suppliers, like the Sydney Fish Market, are tourist drawcards. Photo: Catherine Norwood
Top Processing mullet at Marwell's Fisheries, Tweed Heads. Photo: Richard Brown
Bottom right Fishers haul in mullet on a South West Rock beach.

the local fishermen. It's a drawcard really."

In a telling finding, recreational fishers were significantly more likely to be interested in these aspects of a coastal holiday, challenging assumptions that recreational and professional fishing are in conflict in regional communities.

The professional industry directly supports the recreational sector by providing bait, particularly sardines (pilchards) and School Prawns, accounting for up to a quarter of the $39 million recreational fishers spend on bait and burley annually. Almost 80 per cent of recreational fishers prefer fresh bait even if it is more expensive.

Public support

The study revealed a high level of public support for, and concern about, the local industry. Ninety-six percent of NSW coastal residents indicated the desire to support their local community was a major motivation in buying local product. More than three-quarters were concerned about potential job losses and the loss of identity of NSW fishing towns.

The NSW industry, dominated by small-scale family businesses, has significantly declined over the past 25 to 30 years. In the mid 1980s there were more than 3000 fishing licences in NSW; there are fewer than 1000 now.

"There are very few fishers now who are operating in some historical fishing towns on the NSW coast. Some of them expressed the opinion that their numbers are so low that the support industries are starting to find there's not quite the critical mass for freight, the co-ops, fuel and so on. If those things fall past a certain point it won't be viable to fish there any more," Kate Barclay says.

Professional fishing has provided job opportunities for a wide range of people, including men with limited levels of education and people from diverse cultural backgrounds, such as Italian, Vietnamese and Croatian families who migrated to NSW coastal communities and built businesses in fishing.

It has also been important to Indigenous communities as a source of income and nutritional food, as a way of working "on country" and with natural resources, and for making social connections through sharing fish.

Andrew Nye, an Indigenous professional fisher from the South Coast, said: "There are five generations of fishermen in my family, I've been a fisherman since I was 15, it's always been a part of my life, I just love it. You just blend in, it's your country, you just feel relaxed and comfortable. I can't imagine doing anything else. I will die a fisherman."

Local knowledge

Fishers overwhelmingly learned skills through accumulated knowledge passed down between generations or between mentor and trainee, or by trial and error.

"We talked to some people who said that they'd been fishing in the same areas for 30 or 40 years and can tell you that the species have changed and that some of that's due to climate change – it's knowledge that no one else has," Kate Barclay says.

"That link can be broken. That knowledge about how to fish in that area could be gone in a generation if you didn't have a wild-catch seafood industry there any more."

The fishers contribute to society in many ways. They share information about fish movements, weather patterns and the local environment with the wider community, regulators, scientists and recreational fishers; participate in activities such as cleaning up rubbish and rescuing injured wildlife; help maintain public jetties, slipways and ice machines; and donate fish and ice to community events. More than 60 per cent of fishers have taken part in search and rescue operations.

Data gained in the study will be disseminated in informational brochures through fishing co-operatives, local government departments, the NSW Department of Primary Industries and the Sydney Fish Market. Another report on aquaculture, due to be released soon, similarly shows how this industry is closely connected to other sectors in regional areas such as tourism, is an important employer, and that aquaculturists undertake significant environmental stewardship, especially in promoting water quality in estuaries.

Emily Ogier, who manages the FRDC's Social Sciences and Economics Research Coordination program, says these projects are generating important information for policymakers and regional communities.

"Australian fisheries and aquaculture, like all natural resource-based industries, face pressure from different groups that suggest these industries don't have a lot of community support," she says.

"It's important that the industry has a way to identify – in a relatively easy and replicable way – what it's giving back to particular regional communities for the use of these resources. It's been exciting to see that the novel methods used to tackle the question of how to measure the contributions to community wellbeing were so successful." F

MORE INFORMATION
Nicholas Payne, Behavioural Energetics Lab,
University of Roehampton, UK;
nick.payne@roehampton.ac.uk, rubel.org.uk

Right Grant Clark of the NSW Department of Primary Industries holding a Mulloway caught for the NSW fish activity study. Photo: Dylan van der Meulen

In praise of stealth

Recreational fishers hunting the mighty Mulloway may want to minimise noise levels if they hope to bag this enigmatic species

By **Gio Braidotti**

A new study has uncovered the reason why Mulloway can be so fickle and hard to catch. The culprit is human-induced noise, particularly in the form of boat engines.

The reason was revealed as part of a broader project that tracked changes in the activity of Mulloway (*Argyrosomus japonicus*), Dusky Flathead (*Platycephalus fuscus*), Sand Whiting (*Sillago ciliata*), Yellowfin Bream (*Acanthopagrus australis*), Luderick (*Girella tricuspidata*) and various stingray species in response to environmental conditions in estuaries across New South Wales. The research was funded by the NSW Recreational Fishing Saltwater Trust and the Australian Research Council. Marine biologist Nicholas Payne jumped at the chance to take part in the study. He developed a fascination for fishing – for Mulloway in particular – during his childhood. Weekend trips with his father were spent tracking down giant Mulloway along remote beaches in South Australia.

"Mulloway are considered one of the most sought-after recreational species in Australia," he says. "They have an enigmatic status and I put that down to the superb fight they put on when hooked, and the difficulty catching them."

While at the University of New South Wales (UNSW), and in collaboration with the NSW Department of Primary Industries, Nicholas Payne helped to tag dozens of Mulloway. Project leader Matthew Taylor says the tags used in the three-year project are helping researchers to understand the feeding and breeding habitats of estuarine predators.

Fisher advice

"During the project we spoke to local fishers and many believed that to catch Mulloway you need stealth tactics – electric rather than combustion engines and any other ways of reducing noise levels," Nicholas Payne says. "At first I was a bit sceptical of this idea, but I was intrigued by the possibility that Mulloway are so sensitive to noise."

This idea was shown to have substance when the fish activity data was examined and revealed Mulloway activity to be lower on weekends – when boating activity is increased. "The Mulloway didn't completely shut down on weekends, but it was a noticeable difference," Nicholas Payne says.

Obtaining the activity data involved the use of 'acoustic accelerometer' tags deployed into the Clyde River at Batemans Bay. The tags, about the size of an AA battery, measure acceleration as the fish swim.

The tags were implanted – carefully angled – into the belly of an anaesthetised Mulloway in a water bath using medical-grade surgery techniques in a procedure that took up to 15 minutes from capture to release. Underwater receivers deployed throughout the targeted estuaries were then used to detect acoustic 'pings' that transmit information about the average activity exhibited by the fish every five minutes.

Tracking behaviour

"This technology provided remarkable insight into the habits of fish and what drives their behaviour, making it possible to understand behaviours in the wild," Matt Taylor says. "We have only just scratched the surface, and I expect there will be a great deal more interesting findings from a range of species into the future."

The boat noise hypothesis was further supported by existing data on Mulloway stomach contents sampled throughout the Georges River, NSW. "Mulloway caught on weekends had around 60 per cent less food in their stomachs than Mulloway caught during the week – that amounts to a huge difference," Nicholas Payne says. "Not only do Mulloway eat less on weekends, but species that take more effort to catch are particularly absent from their diet."

Taken together, the data pointed to a drop in predation on weekends, coinciding with increased noise from boating activity.

Studies increasingly indicate that sources of underwater noise affect animals – from birds to marine mammals. Aquatic ecosystems are particularly vulnerable because noise travels further in water than in air, creating an impact over larger areas.

"Reducing noise provides a simple way to minimise harm," say Nicholas Payne. F

How to save a life

Whether you call it a life jacket or a personal flotation device, an outlay of as little as $60 could save your life – but only if you wear it

By **Catherine Norwood**

Whether it is for work or recreation, your best personal flotation device (PFD) is the one you're wearing when you find yourself in the water. That's why comfort is one of the most important considerations when it comes to buying a PFD, says supplier Peter Campbell-Burns, who has been working in marine safety training and sales for more than three decades.

"PFDs are only effective if you actually wear them," he says, "and the more comfortable they are, the more likely they are to be worn."

Advances in technology mean today's PFDs are much smaller and lighter than the bulky foam-block life vests that were once the operating standard. As a director of Queensland's MarineSafe Australia, Peter Campbell-Burns says inflatable PFD technology has taken over the market with its superior wearability and comfort. "Fifteen years ago, foam PFDs were 70 per cent of our sales," he says. "Now that's less than five per cent."

Foam-style PFDs are still the only legal option for babies and children weighing up to 15 kilograms. For children weighing 15 to 40 kilograms automatic inflatable PFDs are the preferred option. In most instances, Australia wide, it is mandatory for children to wear a PFD at all times while on a boat.

Fit for purpose

PFD buoyancy is measured in newtons (N), which refers to the force of the 'lift' it offers. The Australian Standard for traditional foam PFDs is 87N. Gear with a rating of less than this is considered a 'buoyancy aid' suitable for someone conscious and capable of swimming, rather than a 'flotation device' suitable for non-swimmers or those who may be incapacitated.

International standards provide performance ratings of 100N, 150N and 275N for PFDs. Under the 2010 Australian Standard, a 100N or Level 100 PFD is the minimum requirement for offshore boating.

However, a 150N, or Level 150 PFD, is considered the buoyancy required to keep an unconscious person afloat. This is widely used both recreationally and commercially. Heavy-duty PFDs with a rating of 275N are designed for use in severe weather conditions and for those carrying equipment when they enter the water, such as water police or emergency rescue workers.

Buyers are offered a choice of automatic or manual inflation, and PFDs are generally fitted with a mouthpiece for manual inflation as well. Automatic PFDs have a water-sensitive spring-loaded device that triggers inflation. Manual PFDs require the wearer to pull on a tag to trigger the inflation. Automatic vests generally cost $30 to $50 more, but can usually be converted to manual operation and back again by the user if required.

Maintenance checks

Prices for inflatable PFDs range from $60 to $500 depending on the make and style, although maintenance requirements and the longevity of the product should also be considered in the cost of purchase. Some inflatable PFDs require servicing every year; others have a recommended two-year service regime.

Authorised service centres check the integrity of the seams and that a PFD can be inflated to the correct pressure. Peter Campbell-Burns says he has seen PFDs come apart during maintenance testing because the seams could not withstand the pressure of the gas during inflation. Servicing may also include checking that the accompanying gas cylinder is in good condition and matches the prescribed 'full' weight.

Location technology

Peter Campbell-Burns says while PFDs are the first line of defence in maritime and boating safety, location technology has an increasingly crucial role as it becomes more sophisticated, lightweight and affordable – starting at around $300.

Personal location beacons (PLBs) can be fitted into PFDs – they are now about the size of a highlighter texta and operate in a similar way to emergency position-indicating radio beacons (EPIRBs) used on vessels. Both systems use the international COSPAS-SARSAT satellite rescue data system to transmit signals to the nearest rescue centre, and the signal can be tracked to within three metres.

"We are selling more and more personal locator beacons all the time. They are on you, they are in your life jacket, and accurate to within three metres. There's no reason for people to get lost any more, really," he says.

Another option is an automatic identification system (AIS) man overboard device, which is a similar size to a PLB and uses the VHF radio system to send an emergency signal. These can be connected to an onboard chart plotter to locate a person who has fallen overboard, and can also be set to trigger an audible alarm on board. Peter Campbell-Burns says for those who do fall overboard: "Your best chance of survival is getting back aboard the vessel you've just come off."

Standard approach

The Australian Maritime Safety Authority is standardising requirements for all commercial vessels, including those used in aquaculture, following the introduction of the national safety standards to replace state-based laws in 2013. However, regulations continue to differ from state to state when it comes to recreational boating.

Peter Campbell-Burns says wearing a PFD on the water at all times is the best option, particularly when there is a 'heightened risk'. That includes whenever a vessel is "underway" as well as when anchored if weather warnings have been issued, when operating alone, or when visibility is poor.

The NSW Government is also moving to introduce compulsory wearing of PFDs for rock fishers. Legislation was proposed earlier this year, with 37 people reported to have drowned in NSW during the past four years after being swept from rocks while fishing. F

PERSONAL FLOTATION DEVICE TYPES

Classic inflatable yoke-style PFDs

Come in manual and auto-inflation with buoyancy rating of 150N.

Price range $60-$250
Pictured: Stormy Life Vest Classic Inflatable
RRP $120 (manual)

Vest-style PFDs

Come in a range of buoyancy ratings, manual and auto-inflation options. 100N is popular for activities such as rock fishing and kayaking. 150N is the minimum rating for open coastal waters. Higher ratings – 180N, 200N, 300N – provide additional buoyancy for equipment being carried.

Prices range $150-$400
Pictured: Stormy Lite Pro Vest, 180N
RRP $400

Jacket-style PFDs

Suited for colder conditions, often with the option to unzip the sleeves, making the jacket a vest. Automatic inflation can be converted to manual and they can be fitted with strobe lights and personal location beacons.

Price range $250-$700
Pictured: Auto-inflating Stormy Life Jacket, 150N
RRP $399

Safety information

For more information on the wearing of PFDs and other safety requirements contact:
Australian Maritime Safety Authority
www.amsa.gov.au
Marine and Safety Tasmania
www.mast.tas.gov.au
Maritime Safety Victoria,
www.transportsafety.vic.gov.au
NSW Roads and Maritime Services
www.rms.nsw.gov.au/maritime
Maritime Safety Queensland www.msq.qld.gov.au
Northern Territory Government
www.nt.gov.au/marine/marine-safety
Western Australian Department of Transport
www.transport.wa.gov.au/imarine
South Australian Government www.sa.gov.au

MORE INFORMATION
www.rirdc.gov.au/PIHSP;
youtu.be/UZ8I63QlIbQ

Prawn fishers switched on to safety

At the Northern Prawn Fishery, skippers and their crews are taking steps to ensure that the safe return to port of all on board is an essential component of 'a successful season'

A pilot program designed to encourage members of the fishing industry to improve safety at sea through better communication has caught on in far north Queensland.

Operators in the Northern Prawn Fishery have taken part in the program, which aims to reduce deaths and injuries in the workplace by changing the way skippers and crew members communicate with each other.

An initial training session was held in July 2015 with 80 participants. Safety attitudes and actions were then monitored for 12 months, and a refresher course was held for trawler captains before the start of the Tiger Prawn season in August 2016.

Skipper of the *Gulf Bounty* Arron Jones says the program has given him the tools to better communicate with his crew, to ensure their wellbeing during months of high-stress work. "The program has made a difference to the people in the fishery in the way they manage crew and the way the crew manage themselves, too," he says.

"As a skipper you know what you need your crew to do, but being able to communicate that and make sure daily tasks are completed on time and safely is an area the training has helped us with."

Arron Jones says the simple act of thinking before speaking has encouraged a cultural shift. "Since doing the first course last year I've found I've got better responses and better work out of my crew since applying some of the communication tips on a daily basis," he says.

The program was run by the international training organisation Sentis, which uses a psychological approach to help engage staff in creating safer workplaces.

Sentis associate consultant Christiaan Knapp says that as the leaders of the crew, skippers have a responsibility to ensure crew behaviour aligns with safe work practices. The 'High Performing and Safe Teams' program provides techniques that help crews understand not just what to do, but why it is important.

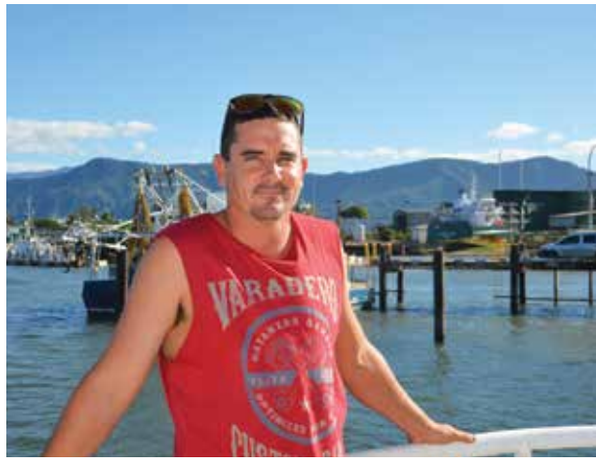
Greater awareness

"The Tiger [Prawn] season is very routine," Christiaan Knapp says. "So we brought some awareness to how skippers can influence their crews to switch on their brains in those moments when they are doing those routine tasks."

The Primary Industries Health and Safety Partnership (PIHSP) funded the program in collaboration with Northern Prawn Fishery Industry, the representative body for operators in the Northern Prawn Fishery. It is the first time a psychology-based Sentis safety program has been applied in the marine sector.

The research manager for the Rural Industries Research and Development Corporation, Kylie Brettschneider, says feedback from the Sentis program was promising, encouraging positive behaviour change in the marine sector. She says the marine sector remains one of Australia's most dangerous workplaces, losing more than 800 working weeks to injury for every 1000 employees over the period 2008-09 to 2011-12.

The goal of the PIHSP is to improve the health and safety of workers and their families in primary industries across Australia. The PIHSP is coordinated through the Rural Industries Research and Development Corporation. F



Above Trawler skipper Arron Jones says good communication helps everyone stay calm and alert and results in a safer and more efficient workplace.

TRAGIC HEADLINES IN 2016

Sunday 14 February
A 69-year-old man who was fishing alone only 50 metres from shore at Warrnambool died after his dinghy overturned.
The Standard, Warrnambool, Victoria

Wednesday 25 May
One man died and two others were injured when a six-metre, half-cabin boat capsized 1.5 kilometres off Bowen Harbour, at Bowen, south of Townsville, Queensland.
Daily Mercury, Queensland

Saturday 11 June
A 53-year-old man was reported missing after failing to return from rock fishing at Sydney's northern beaches. A body found the following day was believed to be that of the missing man.
Sydney Morning Herald, New South Wales

Sunday 17 July
A 72-year-old man died after the 5.5-metre boat he and his son were fishing from capsized in the Gulf St Vincent, North Haven, South Australia.
ABC News, South Australia

Sunday 31 July
Four men on a recreational fishing trip were reported missing after launching from Cremorne Bay, Tasmania. The bodies of a 26-year-old, a 32-year-old and a 34-year-old man were recovered.
The Mercury, Tasmania

Wednesday 10 August
A 44-year-old diver failed to surface from a chartered diving trip to Henderson Rock off Moreton Island, Queensland. His body was recovered after an air and sea search.
Tweed Daily News, Queensland

MORE INFORMATION:
Justin Williams, AMSA, 07 3001 6826,
justin.williams@amsa.gov.au

Trial tailors safety gear for northern fishers

For fishers who often work alone or in remote locations, personal flotation devices and emergency beacons are essential tools to help manage safety risks

By **Catherine Norwood**

Karumba, a small fishing town in the Gulf of Carpentaria, has become the testing ground for a modified type of personal flotation device (PFD) sponsored by the Australian Maritime Safety Authority (AMSA) to promote safety.

More than 20 members of the Gulf of Carpentaria Commercial Fishermen Association (GCCMA) and members from the commercial fishing association The Fishermens Portal are taking part in the trial of a modified PFD designed for tropical conditions, which began earlier this year.

AMSA Brisbane regional liaison officer Justin Williams said that under previous state laws smaller vessels of less than 10 metres, such as those used by crabbers, or dories attached to larger mother ships, had been exempt from commercial licence requirements, including certain safety requirements. Under the National System for Domestic Commercial Vessel Safety, which came into effect in July 2013, new standards are being introduced for these smaller vessels, including safety requirements related to PFDs and emergency position indicating radio beacons (EPIRBs).

AMSA has been working with operators to improve industry safety culture and practical safety awareness, such as wearing PFDs and using personal locator beacons. It has also been helping operators to understand their safety requirements under the national system, including the need to comply with general safety duties and to develop, implement and maintain a safety management system.

Comments from the coroner

AMSA approved the Gulf PFD trial in May 2016. This was about the same time a Queensland coronial inquest into the 2013 death of a Townsville fisher released its findings. The fisher drowned when the boat he was in overturned. He was not wearing a PFD at the time.

The coroner was highly critical of the high numbers of marine-related deaths in Queensland where those who died were not wearing a PFD. The coroner cited a 2013 Queensland marine incident report, which indicated that of the 13 fatalities during the reporting period 10 people had drowned, and none were wearing a PFD.

He also cited the findings of a Marine Safety Queensland investigation into the death of another fisher who fell overboard while retrieving a net, which found that wearing a PFD fitted with an EPIRB (or personal locator beacon) would have increased the probability of survival.

Safety challenge

Queensland crab fisher Ben Day is among those taking part in AMSA's PFD trial in the Gulf of Carpentaria. A fisher in the region for the past 10 years, he says there have been times when he has felt unsafe while crabbing at night – particularly as monsoon season arrives. Despite this, he acknowledges that in the past he was unlikely to have donned a life jacket.

The PFD he is trialling for AMSA is fitted with a personal locator beacon, which operates in a similar way to the EPIRB used on vessels. Ben Day says it is a welcome bonus, given the remoteness of the locations he fishes in – he often travels alone more than 100 nautical miles in a day. "If you go overboard you can just trigger the signal, and know that someone will be on their way," he says.

Ben Day says wearing a PFD is mandatory in the work he does as a pilot boat master, so it has not taken him long to adjust to wearing one while crabbing. "You can always find a reason not to wear one – it's heavy or it's hot, or something else. But at the end of the day this would save your life."

Justin Williams says the PFDs chosen for the trial are designed for the working conditions of fishers in the tropics. "It was a challenge to find something that was versatile and hard-wearing, which could withstand the spikes of Barramundi being landed, while also remaining comfortable to wear in the heat of the tropics."

A similar PFD trial is about to begin in South Australia's Lakes and Coorong Fishery. F

Monday 15 August
A 40-year-old man was lost at sea after disappearing from a commercial crab-fishing vessel west of Steep Point, Denham, WA. A search was called off after police determined he was unlikely to have survived.
WAtoday.com.au, WA

Thursday 22 September
A 52-year-old crab fisher who set off from the Karratha Back Beach boat ramp was reported missing. His boat was recovered but the fisher has not been found.
Mandura Mail, WA

MORE INFORMATION
Dirk Welsford 03 6226 8237, dirk.welsford@aad.gov.au
FRDC RESEARCH CODES 2010-064, 2013-013

Toothfish tagging reveals territory dynamics

Australia is leading an international research collaboration to understand how shared Patagonian Toothfish populations in the Southern and Indian Oceans are connected, and to support the sustainable management of fishery resources

By **Catherine Norwood**

For every tonne of the highly prized Patagonian Toothfish (*Dissostichus eleginoides*) harvested from Australian waters this winter, at least two fish were tagged and returned to the Southern Ocean as part of an accelerated monitoring program for the fishery.

With a total catch of about 3400 tonnes in 2016, that's 6800 fish released in pursuit of better information to improve fishery management. In 2015, the tally was 8800 fish tagged and released.

The past two years represent a doubling of the previous tagging rate. The tagging has been done in conjunction with a new research project funded by the FRDC which aims, in part, to determine more conclusively the nature of the relationship between the Australian Heard Island and McDonald Islands (HIMI) Patagonian Toothfish fishery and adjacent French Kerguelen Islands fishery.

Are they a single population, requiring joint management, or are they independent populations, with some shared genetics? The answer is a crucial one for the Australian and French governments managing their respective fishing territories and catch quotas.

International concerns

Patagonian Toothfish are known to spend most of their lives within a 40-kilometre home range. However, genetic testing has revealed that toothfish populations in the two territories are closely related. The recapture of Australian-tagged fish in French waters, and more recently French-tagged fish in Australian waters has shown that fish can and do migrate up to 2500 kilometres.

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), whose oversight includes both Australian and French territories, wants to ensure the potential implications of this migration on resource assessment and management are well understood and taken into account by fisheries managers.

The Marine Stewardship Council, which has independently assessed both Australian and French Patagonian Toothfish fisheries as sustainable, has also made its certification subject to joint strategies to address this issue.

Marine scientist Dirk Welsford at the Department of the Environment and Energy's Australian Antarctic Division (AAD) is leading the search for answers through the FRDC's four-year project. The outcome is expected to be a resource assessment model that includes improved understanding of both Australian and French Patagonian Toothfish populations and accounts for migration between the two fishing zones. This migration is currently thought to represent a few per cent of the population.

The project began in 2014 and has access to almost 30 years of commercial and research data from both fisheries, which are based around the Kerguelen Plateau, where the Southern and South Indian Oceans meet.

Dirk Welsford says there have been sensitivities around fishing data, given the illegal fishing that plagued the region during the 1990s and 2000s. "The data sharing has been a major act of goodwill between the two countries, and it is starting to provide a much better picture of fish habitat and dynamics."

Industry involvement

Only two companies hold concessions to fish Patagonian Toothfish in Australian waters: Australian Longline and Austral Fisheries. Both have been involved in the tagging and research for nearly 20 years to better understand the fishery.

Over this time the fishery has transitioned from trawl to longline fishing operations, a change that has revealed new information about its catch.

Fish caught in trawls, tagged and returned to the water do not travel far and trawls tend to go over the same ground repeatedly. There are a limited number of fishing locations and it also tends to target smaller fish.

Dirk Welsford says data from trawls is valuable, but not entirely representative of the whole fish population. "As the fishers have begun targeting larger fish with longlines they have covered a more diverse area. So the tags are more widely dispersed and provide more information about the movement of fish and stock structure."

Data from the HIMI fishery shows that larger fish generally live in deeper water, and females grow to 1.8 metres, while males of more than one metre are less common.

Southern spawning

Other information from longline fishing has included evidence of spawning activity in Australian waters. Prior to 2009 spawning was known only to occur in French territory. A 2010 FRDC project identified spawning grounds in the Southern Ocean, with males and females congregating between May and August, in waters between 1500 and 1700 metres deep.

Dirk Welsford says the discovery of more

widely distributed spawning grounds is good news for the Patagonian Toothfish population across the whole region, reducing the risk should recruitment fail in any particular part of the fishery.

The modelling the AAD uses for stock assessments has incorporated longline tagging data for the past two years, and this has led to some fundamental changes in the way the algorithms behind the model have calculated the resource. For fishers, this has meant some variability in the total allowable catch (TAC) as the model 'readjusts' to account for tagging data. The HIMI TAC increased from 2730 tonnes in 2013 to 4410 tonnes in 2015, and then decreased to 3405 tonnes in 2016.

Martin Exel, general manager of environment and policy at Austral Fisheries, says despite the quota fluctuations, the company is confident the tagging is helping to get a better understanding of the movement of fish stocks and the age classes of stocks.

He says this year, however, it has been a challenge to catch even the reduced quota, and a range of factors is being investigated for the sudden drop in catch rates. Chief among these is an increase in Southern Ocean temperatures by 2°C in May and June 2016 – a delayed effect of the 2015 El Nino weather pattern.

Changes in fish condition, size or maturity, the prevalence of sea lice (which eat baits) and other fishery-induced changes are also being investigated, in conjunction with comparisons of trawl data from previous years. While no single definitive cause has yet been identified, Martin Exel says there is mounting evidence it is the result of environmental factors, rather than overfishing.

Combined data

As the HIMI fishery transitions from trawl to an exclusively longline fishery, the longline tagging data is being added to ongoing trawl data in stock assessments.

"The AAD randomly select locations around the Australian side of the Kerguelen Plateau for us to survey," says Martin Exel. "This year, over 20 days, we did 167 trawl survey shots. The focus is on three to four-year-old fish, and it helps to assess the health of recruits to the fishery, as well as stocks of other species such as icefish," he says.

Combined trawl and longline tagging is expected to continue until 2020. The Australian Fisheries Management Authority, which manages the fishery, says trawls will not be phased out until stakeholders are confident data from longline tagging provides enough information for resource assessment.

Martin Exel says Australian fishers are also considering adding more monitoring equipment to longlines to record water temperature, salinity and other chemistry. This might help identify current and future shifts affecting the movement of fish.

Dirk Welsford and his team are now working to expand the model used for Australian stock assessment to include the French fishery interactions. "As part of this project we are also trying to account for biases in earlier, more limited data," Dirk Welsford says.

A workshop with fisheries managers from Australia and France is planned for mid 2017 to report on the final modelling and implications for management. F

"The data sharing has been a major act of goodwill between the two countries, and it is starting to provide a much better picture of fish habitat and dynamics." Dirk Welsford

Below right Tagging Patagonian Toothfish is revealing new information about the fishery.
Photo: Austral Fisheries

Map of Australia's maritime jurisdiction

Australia's Heard Island and McDonald Islands (HIMI) Patagonian Toothfish fishery (at bottom left) lies on the Kerguelen Plateau, south of France's Kerguelen Islands fishery.

Australian exclusive economic zone limit

Exclusive economic zone and continental shelf treaty boundary with an opposite or adjacent state

Map: Geoscience Australia

MORE INFORMATION
Sarah Jennings, sarahjennings306@gmail.com
FRDC RESEARCH CODE 2008-306

The getting of economic wisdom

Everyday proverbs offer simple 'truths' that can help explain the economic principles underpinning everything from the way we shop to complex fisheries management decisions

By **Sarah Jennings**

As we grow older, we all tend to have those sobering moments when we hear ourselves sounding just like our parents. For me, many of these moments come while explaining (to audiences of varying experience and enthusiasm) how economists think about problems involving the exchange, allocation and distribution of resources.

For example, one of the fundamental issues examined in economics is the scarcity of resources, relative to all the things we want to do with them. At every turn there is the need to make a choice and, consequently, there is an inevitable cost in the form of opportunities forgone.

As an economist I explain this to my audience using hypothetical examples involving commodities like wine or widgets. However, my mother's sayings cut straight to the point: *You can't have your cake and eat it too* and *There is no such thing as a free lunch*. These proverbs capture this fundamental economic problem incredibly effectively and resonate with my audiences.

My mother had a black belt in proverbial expression, tossing these pearls of wisdom into conversation at any opportunity. While her fondness for proverbs used to irritate me, I have grown to appreciate their power in demystifying many of the concepts and ideas found in economics.

Fisheries are complex biophysical-human systems, where neither an individual fisher's best decision, nor the socially preferred management action, is always obvious. However, the ability to think as an economist, and a familiarity with economic approaches and tools, can help with both. Here my mother's expressions come into their own.

The nature of value

Beauty is in the eye of the beholder was my mother's way of asserting the subjective nature of value – that the value of a good is not determined by any inherent property of the good or solely by the cost of producing it, but instead by the importance individuals place on a good for the achievement of desired ends.

Knowing that an individual's assessment of value is subjective, expressed through their willingness to forgo other desired ends, can open the door for seafood marketers to create new markets and expand existing markets for previously under-utilised species, such as Australian Salmon and Bonito.

And recognising the diverse preferences and capabilities of individuals – *One man's trash is another man's treasure* – helps make sense of economists' assertions that voluntary exchange between individuals (be it the barter of services between fishers or the purchase of new fishing gear in the market) can increase wealth in society as goods and services move from those who value them less to those who value them more. (*Fair exchange is no robbery*.)

Illustration: Sonia Kretschmar

Choice on the margin

When considering how best to allocate scarce resources between different uses, *One step at a time* cautions of the need to focus our thinking at the 'margin'. Take a commercial fisher deciding whether to stay a day longer at sea this season in the hope of increasing his catch, or to return to port as planned to enjoy time with family. The answer to this problem lies not in comparing the value the fisher puts on the total amount of time he devotes to the two activities (fishing and leisure) but rather the value of an extra day spent fishing and the value of this same day were it instead spent with family.

It is only when the value of fishing exceeds the value of time with family that the day is best spent at sea; otherwise the fisher will do better by returning to port.

Sunk costs

But, in calculating these 'marginal values', the fisher should heed my mother's caution: *It's no use crying over spilt milk*. The extra day at sea will incur additional fuel, crew and bait costs (among others). But there will be no additional costs in terms of his vessel insurance and fishing licence. In the language of economics, these are 'sunk' costs and are not affected by how the fisher decides to spend the day in question.

Many a recreational fisher has succumbed to the pitfall of prioritising sunk costs, and staying too long on the water when the fish are not biting in a bid to 'get their money's worth' from money spent on items such as insurance and licence fees.

Market signals

On the working of markets, my mother insisted that *In the country of the blind, the one-eyed man is king*, recognising that it is relative (and not absolute) prices and profits that signal shortages and surpluses in markets. These signals encourage buyers and sellers to change their behaviour and reallocate resources to where they are most valued.

In competitive seafood markets (where there are many buyers and sellers) these adjustments occur continually. Shifts in tastes away from one seafood product will reduce its demand and price, motivating suppliers of the affected product to move their resources to other now more lucrative ventures.

Spillover effects

It takes two to tango echoes the words of Nobel laureate and economist Ronald Coase on two fronts. First, Coase emphasised the reciprocal nature of externalities or spillovers – consequences of an economic activity that are experienced by a third party. For example, a farmer may build a barrier to prevent water flowing through his property, giving him more land to farm, and the opportunity to increase farm productivity and profit. But restricting the flow of a waterway may cause downstream harm to a fisher because it has a negative impact on the breeding of targeted fish species. Efforts to restore water flows and fish breeding by removing barriers then impact on the farmer's ability to farm – the reciprocal externality.

Second, Coase also argued that if the right to determine the fate of the waterway is well defined and there are no or low costs in 'transacting' to resolve the issue, the two parties will coordinate to strike an efficient, mutually beneficial deal regardless of whether the rights are assigned to the farmer or the fisher. These 'transactions' might range from compensation for lost productivity, to a joint environmental initiative to balance the productivity of both parties.

The challenge is to apply economic thinking by comparing the costs and benefits of alternative courses of action to find the best mix of Coasian, market and government solutions. In cases where the costs of addressing the externality exceed the benefit, again we could heed my mother's words and do nothing (*Let sleeping dogs lie*).

Illustration: Sonia Kretschmar

Consumer preferences

My mother's insight that *Actions speak louder than words* was none other than a reference to 'revealed preference', an economic theory of consumption behaviour which maintains that consumers consider a set of alternatives before settling on a purchase decision, and that the chosen option must therefore be the preferred one.

Revealed preference theory provides the basis for empirical studies that use data on observed seafood buying behaviour to measure consumers' preferences, potentially including their willingness to pay for a certified or eco-labelled product. My mother's words suggest this kind of data is more credible than consumers' statements of purchasing intent, which may, for example, reflect higher-order ethical values.

Proverbial policy making

I have discovered that my mother's words also resonate with policy makers and managers. On the perils of allowing unfettered access to an open-access resource, such as a wild fish stock, my mother's saying *Too many cooks spoil the broth* foreshadows the inevitability of a poor outcome, with too many fishing boats chasing too few fish, each boat owner being rewarded with low profits, or, in the very worst case, fishery closures.

My mother even had an expression for one of economists' historically favoured solutions to this so-called 'race to fish' problem, namely the establishment of property rights – *Good fences make good neighbours*. By creating a long-term interest in a share of the total harvest in a fishery, individual transferable quotas (ITQs) have been shown to reduce fishing capacity, increase fisher profit, and discourage 'race to fish' behaviours.

Even a broken clock is right twice a day was my mother's way of warning of the law of unintended consequences, whereby *The best-laid plans of mice and men* lead to outcomes that are not foreseen or intended by a purposeful action. Attempts to maintain fish stocks at desired levels by controlling fishers' inputs (such as gear restrictions) have been shown time and again to result in 'effort creep'. More time and effort is needed to catch the same amount of fish, which wastefully dissipates profits.

Needless to say, not all of my mother's sayings accord with sound economic thinking. *One man's loss is **not always** another man's gain*, as evidenced by the negative outcomes that sometimes perversely arise, such as when spatial closures relocate fishing, alter fishing practices and undermine fisheries management goals, turning anticipated overall gains into losses.

And while past fishers and fisheries managers may sometimes have behaved as if there were no tomorrow, we now know that at any specific time and place *there are **not** always more fish in the sea*.

My mother wasn't an economist. Nor is economic thinking merely an obscure restatement of the wisdom imparted by our parents through their sharing of proverbial expressions.

Rather, these 'pearls', where their meaning aligns with the economic way of thinking, can help people grasp important concepts that can enhance decision making in their personal and professional lives, and in civil society.

There may also be important lessons to be gleaned by economists from the study of proverbial expressions. As culturally relevant expressions of 'truths' based on common sense or experience, proverbs may provide a powerful lens through which to understand economic behaviour and stakeholder values and attitudes. In so doing, they help us shape more effective approaches to support resource allocation, to achieve compliance and to design institutions that promote cooperative behaviours.

The FRDC has been working to address the shortage of economic expertise to support the development of policy around the fishing and aquaculture sectors. Over the upcoming issues of FISH magazine, we will showcase some of the work being done in this space. Sarah Jennings is a resource economist who has been leading the FRDC's fisheries economics capacity building initiatives, which are managed through the Social Science and Economics Research Program. Sarah acknowledges the vital contribution of Michael Brooks to helping her unpack their mother's words in the getting of economic wisdom. F

Tariff cuts help boost seafood profits

Tariff cuts are making Australian seafood more attractive for consumers and importers in North Asia, with demand on the rise

By **Free Trade Agreement Division, Department of Foreign Affairs and Trade**

Australia's free trade agreements (FTAs) with China, Japan and South Korea are giving Australian fisheries businesses a competitive edge in North Asia. In 2015-16, these three powerhouse economies together accounted for 53 per cent of Australia's total goods exports. And with strong outcomes for a broad range of seafood products, there are significant opportunities for the Australian seafood sector to make further headway into these promising markets.

The tariff reductions under each agreement vary, so producers need to ensure they understand the outcomes for their specific products into each market. Traders also need to be aware they **must** obtain FTA-specific certificates or declarations of origin for shipments to have the preferential FTA tariff apply. And those tariff-cutting benefits are worth pursuing (see Table 1).

For example, under the China–Australia Free Trade Agreement (ChAFTA), China has started progressively removing tariffs on all Australian seafood exports, to reach zero by 1 January 2019. Many tariffs on Australian seafood exports into Japan have already been eliminated, and the progressive elimination of the tariff on Southern Bluefin Tuna began on 1 April this year.

TABLE 1 Australia's North Asia FTAs – selected seafood tariff cuts

Product	Tariff outcome
ChAFTA – all seafood tariffs eliminated by 1 January 2019	
Atlantic Salmon	Previous 10% tariff already cut to 6%
Fresh or chilled abalone	Previous 14% tariff already cut to 8.4%
Fresh rock lobster	Previous 10% tariff already cut to 9%
Fresh and frozen prawns	Previous tariffs of up to 8% either eliminated already, or eliminated by 1 January 2019
Fresh and frozen oysters	Previous 14% tariff already cut to 8.4%
Fresh Spanner Crabs	Previous 14% tariff already cut to 8.4%
JAEPA – many seafood tariffs eliminated between 2015–2024	
Abalone	Previous tariffs of up to 9.6% already eliminated
Oysters	Previous 7% tariff already eliminated
Smoked salmon	Previous 10.5% tariff already eliminated
Southern Bluefin Tuna	3.5% tariff progressively eliminated by 1 April 2024
Lobsters, shrimps and prawns	Previous tariffs of up to 9.6% already eliminated
Fresh Spanner Crabs	Previous 4% tariff already eliminated
KAFTA – seafood tariffs between 5-50% eliminated between 2016–2028	
Fresh and frozen lobster	Previous 20% tariff already eliminated
Frozen Southern Bluefin Tuna	Previous 10% tariff already eliminated
Prawns	Previous tariffs of up to 20% eliminated by 1 January 2023, with many reaching zero before then
Oysters (fresh and preserved)	Previous tariffs of up to 20% eliminated by 1 January 2020
Fresh crab	Previous 20% tariff already cut to 11.4%

These and other tariff results available on the FTA Portal: ftaportal.dfat.gov.au

Crab exports

Queensland company Aussie Red Crab supplies sustainably caught wild Spanner Crabs, with exports making up around 30 per cent of sales. With reduced tariffs under the FTAs, in 2015-16 it sold Spanner Crabs worth $320,000 to China and $240,000 to Japan.

The business is now planning to add to its domestic fisheries quota to meet increasing overseas demand, particularly from China. Jason Simpson, co-owner of Aussie Red Crab, says profit margins increased in the 2015-16 financial year, which he attributes to ChAFTA.

Looking more broadly, trade data to these three North Asian markets show good growth for the first half of 2016 for Australian live, fresh and chilled crab exports, compared with the corresponding period last year.

Oyster equipment

It is not just seafood producers that benefit; the supply chain also wins. South Australian company SEAPA designs, manufactures, markets and supplies injection-moulded oyster baskets and aquaculture equipment for worldwide distribution. Under the Japan–Australia Economic Partnership Agreement (JAEPA), the 3.2 per cent tariff on its products has been eliminated, giving the company a competitive boost in a market where it is building a strong reputation as an expert in oyster farming technology.

Tariffs on SEAPA's products into Korea and China have also already been eliminated, giving it a further edge over competitors. Alex Jack, from SEAPA, says the North Asia FTAs are positive. "We can look at our pricing strategies and maybe have a look at how we can market more into those countries ... with the FTAs under our belt, it's definitely going to help us." F

MORE INFORMATION
denise.hardesty@csiro.au; www.redmap.org.au
australianmuseum.net.au/2016-eureka-prizes-winners
FRDC RESEARCH CODE 2010-531, 2011-088

Right CSIRO's Marine Debris Team members Denise Hardesty and Chris Wilcox. Photo: CSIRO

Tracking marine debris wins Eureka award

A CSIRO project tracking marine debris has won the annual Eureka Research and Innovation Prize for Environmental Research

By **Rebecca Thyer**

A project that has helped uncover the scale of marine debris around Australia and its journey to the sea has won the Eureka Research and Innovation Prize for Environmental Research.

Presented annually by the Australian Museum, the Eureka Prizes reward excellence in research and innovation, leadership, science communication and school science.

CSIRO's Marine Debris Team won the award for its work combining field data and laboratory analyses with oceanographic and ecological modelling to understand patterns of marine debris distribution as well as its impact on wildlife.

Project leader Denise Hardesty, a CSIRO research scientist, says it is the first time an environmental issue has been tackled so rigorously, with a systems-based approach and with such a high level of engagement from all levels of society.

Coastal hotspots

The work initially began as a way to identify coastal debris 'hotspots'. And it found them. These hotspots were concentrated near urban centres, suggesting local sources. It also found that three-quarters of rubbish along the coast was plastic and mostly from Australian sources.

The team also tracked how debris made its way to the sea and found that human behaviour (littering) was by far the most important factor in determining the amount of rubbish at a site. Transport by water was second, with a smaller effect from wind transport. Using this information, a model was developed to predict debris loads at unsurveyed sites.

Denise Hardesty says that while the information in itself is important, it is also valuable in helping to cost-effectively target areas for waste reduction.

For example, addressing sites with high littering rates should be a priority, while mapping work has shown where allocating and installing debris traps would be most effective.

"Instead of finding this information overwhelming, we can use the knowledge to make mindful decisions, and to inform government and policy makers.

"I think the public has an appetite for the topic. Most Australians live near the coast and have an attachment to the beaches, the water, the oceans and their shores."

She says litter affects wildlife directly through entanglement and ingestion and indirectly through chemical effects. Marine debris is also an issue of ongoing concern for fishers, who have initiated clean-up campaigns in many areas.

Denise Hardesty's interest in marine debris began in the 1990s while a researcher on Midway Atoll in the North Pacific Ocean, where she was confronted by the impact of plastic waste on seabirds. Today she is based in Tasmania at CSIRO Oceans and Atmosphere where she oversees many marine debris projects with partners that include the Federal Department of the Environment and Energy, The Australia Packaging Covenant and Ocean Conservancy.

Gear loss mapping

Mapping fisheries gear loss is another area the CSIRO Marine Debris Team is working on. With PhD student Kelsey Richardson, CSIRO and the University of Tasmania will:

* map fisheries associated with higher and lower levels of gear loss;
* map geographic regions where gear loss is highest;
* identify regions of higher and lower impact to biodiversity due to abandoned, lost, discarded or derelict fishing gear (ALDFG);
* evaluate the circumstances and/or environmental factors most associated with gear loss; and
* understand potential policy intervention, mitigation, offset and strategies to reduce gear loss and economic and biodiversity impact associated with ALDFG.

If you have information to share or would like more information, email kelsey.richardson@csiro.au

Redmap finalist

The University of Tasmania's Redmap Australia was also a 2016 Eureka finalist – in science communication. Redmap Australia is a citizen science-based range extension database and mapping project. It aims to engage the public in producing knowledge on how the distribution of marine species may be affected by climate change. F

MORE INFORMATION
Tom Robinson, Real Time Data,
0427 262 553
FRDC RESEARCH CODE 2011-250

The Deckhand app will help South Australia's rock lobster fishers to submit their data electronically through the 2016-17 season. Photo: Tom Robinson

Strong buy-in for Deckhand reporting app

Tested, refined, adopted – digital reporting in SA's Rock Lobster fishery has the thumbs up

By **Tom Bicknell**

South Australia's Southern Rock Lobster fishers are the first to go fully digital for their government reporting requirements, with all 168 vessels in the fishery's southern zone opting to submit data electronically for the 2016-17 season.

It is a voluntary decision by the fishers, made possible by two crucial elements: a software program they feel confident using, and the compatibility of that software with the state government's data systems.

The Deckhand app has been developed by South Australian commercial Pipi fisher Tom Robinson, who is also a director of Real Time Data, a software company he founded with business partner Simon Dick.

Deckhand received FRDC funding in the early development phase and runs on Apple iOS devices. It allows fishers to capture data electronically even while out of range of the mobile phone network. It can record all the details of a fishing session, from path and pots to catch, time and location.

The first step in connecting the app to government reporting requirements began in 2012, when 22 boats in the Southern Zone of the South Australian Rock Lobster fishery began trials to refine the app.

In the following years the number of boats involved in the trial expanded, with fishers using both Deckhand and paper reporting simultaneously. The data submitted through the app was then used to test a new 'back-end' data system developed by Primary Industries and Regions South Australia (PIRSA), known as eCatch, which has been launched this year.

PIRSA has also developed the Fisheries and Aquaculture Commercial Reporting app, as a free web-based connection to eCatch, which can be used by any of the state's fishers and aquaculture producers as an alternative to paper-based reporting.

Electronic reporting – and the choice of app – remains voluntary, but executive officer of the South Eastern Professional Fishermen's Association, Justin Phillips, says the Southern Zone rock lobster fishers plan to stick with Deckhand.

Time factor

"The main advantage of electronic reporting is time," he says. After fishers lodge paper reports, it can take up to a month for the information to appear on a consolidated database. Justin Phillips says all catch information will now be available almost instantly for use in fisheries modelling and management decisions.

He says the close working relationship between the developers and industry is behind Deckhand's high adoption rate.

"There's buy-in within the industry for this software because we've been closely involved," says Justin Phillips. "We've invested not only the industry's financial resources, but also fishers' knowledge and their operational practices into tailoring the app and getting it right for our fishery."

Tom Robinson says the app was initially developed for the Pipi fishery, but the trials in the Rock Lobster fishery have demonstrated its flexibility. "The way we've set the system up you're recording a fish coming out of a net, or out of a pot, or off a long line. It's all the same logic, it's just that the interface needs to change to reflect the different fishing types."

This adaptability has sparked the interest of other fisheries. Real Time Data has had interest from interstate and internationally, and is working closely with South Australia's Northern Zone Rock Lobster fishers to adapt the app to their needs, particularly for multi-day fishing trips.

The universal adoption of an electronic data capture system in South Australia's Southern Zone Rock Lobster fishery has also revealed opportunities to begin layering additional data. This could include record keeping for pre-start checklists for occupational health and safety, as well as capturing data from new technology such as Bluetooth callipers for measuring catch or 'smart' lobster pots that record environmental conditions. F

Revealing the world underwater

A fascination with life underwater, the excitement of new discoveries and a passion to protect what so few of us ever see are motivating forces for marine biologist Karen Gowlett-Holmes

By **Rose Yeoman**

From her home at Eaglehawk Neck on the Forestier Peninsula in south-east Tasmania, Karen Gowlett-Holmes has a sweeping view of the ocean. It's a fitting place to live for someone whose passion for the marine environment has inspired a 35-year career in marine biology and taxonomy.

She is the collection manager of marine invertebrates in the CSIRO Division of Marine and Atmospheric Sciences in Hobart. It's a rather dry-sounding title for the adventurous work that has taken her from Antarctica to the tropics, led to a host of newly discovered marine life, and allowed her to create an extensive collection that documents life underwater.

Taxonomy – the systematic classification of organisms – is a key component of her role at CSIRO, and invertebrates are her specialty. Everything from crustaceans to jellyfish. Less than 40 per cent of marine invertebrate species have been described, which makes the opportunity to find a new species relatively common. "For a taxonomist, this is very exciting," she says.

Karen Gowlett-Holmes has discovered several hundred new species during her career and been responsible for the formal species description of several of these new species. She also has more than a dozen species named after her, including worms, chitons, jellyfish, sea anemones and crabs.

Captured in situ

Many of these have also been the focus of her camera. She first began photographing invertebrate species in the 1980s, when she worked as an assistant in the marine invertebrates and birds collections at the South Australian Museum. It was her first permanent job after completing her Bachelor of Science at the University of Adelaide. Combining her diving skills with photography and science helped enhance the museum's collection.

"A lot of invertebrates are brightly coloured and soft bodied. When you preserve them, their colouring, which is a significant diagnostic tool when they are alive, is lost. I began to photograph in situ and collected the animal, which was then preserved and lodged in the collection with its photograph," she says.

Her efforts helped to expand the marine invertebrate collection at the South Australian Museum, where she became collections manager, a role she held for 10 years before moving to her current position at CSIRO in the mid 1990s.

Before the advent of digital cameras, underwater photography was more difficult, she says. Even photographing fresh specimens on board vessels was a challenge. "In my early days at CSIRO, we'd be at sea in a research vessel and I'd be trying to develop film in a darkroom on a rolling boat; it was an 'interesting' experience."

The advent of digital technologies has not only made photography easier, it has also allowed CSIRO to expand its collection without having to physically store all the specimens it collects. It maintains a virtual collection; the actual material is held in various state museums. "It's a collaborative approach, beneficial to both CSIRO and the museums," Karen Gowlett-Holmes says.

Many of these permanent museum collections date back to the 1800s, and play an important role in the ongoing process of identifying and describing species.

"Museums are vital for taxonomy, and taxonomy is vital for all other natural sciences – if you do not have an accurate species identification, you basically don't know what you're studying," she says. "Sometimes what has been called one species may in fact be several, and this can really change the meaning of research results.

"A misidentified species can be a significant issue. For example, different species can have different life cycles and for managed fisheries this can mean the difference between a well-managed fishery and one that collapses.

"Misidentifying a species with a very restricted distribution with one that has a more widespread distribution can mean the difference between a local population only disappearing and an entire species becoming extinct."

Karen's expertise in identification has come in handy in her work advising the FRDC's Fish Names Committee.

Unique identifiers

To help prevent such outcomes, every aquatic species is assigned a unique identifier akin to a barcode. Karen Gowlett-Holmes' role at CSIRO includes managing the invertebrate part of this identifier system, known as the Code for Australian Aquatic Biota (CAAB).

The eight-digit coding system was originally designed by CSIRO for selected organisms of research or commercial interest and was revamped in the 1990s to include all aquatic groups. The CAAB is continuously expanding as new species are discovered. It is the reference standard for scientific and common names or marketing names, as well as for legislation and export. It ties into the Australian Fish Names database, which sets fixed marketing names for seafood species.

Karen Gowlett-Holmes says a greater range of invertebrates are now being commercially harvested and sold in Australia and overseas –

these include sea cucumbers, clams, prawns, crabs and rock lobsters – and it is important to be able to correctly identify what is being fished and sold.

Early inspiration

Karen Gowlett-Holmes credits her early years in England accompanying her father on fishing expeditions around the Thames estuary with sparking her interest in aquatic life. When she was six years old her family moved from Billericay in Essex to Adelaide, South Australia, and she discovered the sea. She enjoyed collecting bait, was fascinated by rock pools and fell in love with the beauty and diversity of shells. At the age of nine she announced to her family that she would study marine science.

In the early days of her career, she says she was often the only woman on a boat or in a research team. She was the first female Australian Fisheries Management Authority (AFMA) fisheries observer, working mainly on foreign trawlers.

She credits her father for not supporting the gender bias that was prevalent when she was a child. "I am one of those rare people who was able to follow my childhood dream into a career for life."

Unseen changes

Among her career highlights, she nominates the magic of the Giant Kelp forests (*Macrocystis pyrifera*) off the eastern Tasmania coast – now in tragic decline. Since 2000, 95 per cent of the kelp forests have disappeared as a result of climate change.

"If the equivalent had happened on land in Tasmania, thousands of hectares of forest disappearing, there would have been a public outcry. As it is in the sea, most people have no idea it has happened – out of sight, out of mind.

"There have been huge changes in the marine environment during my lifetime. Things that I saw when I started diving, the kids of today will never see. The only record of some of these will be photos and preserved materials in jars in a museum."

These include the records in Karen Gowlett-Holmes' own publications, which include a major reference book, *A field guide to the marine invertebrates of South Australia*, illustrating more than 870 species with 1500 images. She is currently working on a companion volume for Victoria and Tasmania.

"If my photographs and work can educate or inspire people about what is in the sea and that causes them to want to protect it, then I have achieved something with my life," she says. F

Below Karen Gowlett-Holmes has spent 35 years studying, identifying and photographing species. These include (clockwise from below right) *Phyllopteryx taeniolatus* (weedy seadragon), *Macrocystis pyrifera* (giant kelp – also main image opposite), *Botrylloides anceps* (colonial ascidians) and *Brachiopsilus dianthus* (pink handfish).
Photos: Karen Gowlett-Holmes

Limiting impact of urchins 2012-058

This report details the outcomes of two workshops that considered the strategic direction of research on limiting the impact of urchins on abalone and coastal reef ecosystems in south-east Australia. Urchins are capable of clearing large areas of reef of macro-algae, and reducing the productivity of abalone and other reef species. Urchin populations in south-east Australia have been increasing over the past decade and there is concern for the potential impacts on commercial abalone production in NSW, Victoria and Tasmania. There is therefore a strong need for consolidated, cross-jurisdictional research.

Workshop participants raised the need for ongoing and regular consultation among researchers, managers and industry, particularly in coordinating responses to the impacts of urchins. The workshop also identified a series of strategic research priorities, including research into the efficacy of interventions such as clearing urchins from historically productive areas of reef, and translocating abalone to rebuild populations. Broader research priorities included: attempting to understand the cause of the spread of urchins, their distribution and abundance now and in the future, and potential controls on abundance (e.g. predators). Recommendations from the workshops were used to design a survey of the presence of urchins in western Victoria, which was implemented in 2014.

More information: Geoff Ellis, Eastern Zone Abalone Industry Association, 03 5156 5429, geoff@tyers.net.au

First look at endangered skate 2013-008

This study represents the first major investigation into the ecology and biology of the endangered Maugean Skate (*Zearaja maugeana*). Maugean Skate are only known from two estuarine systems on the west coast of Tasmania: Macquarie Harbour and Bathurst Harbour. In Macquarie Harbour they appear to be relatively abundant, but are subjected to multiple impacts due to human activities. They are a bycatch species in recreational gillnets, they occur in close proximity to salmonid aquaculture and are subject to significant environmental variability within Macquarie Harbour as a result of human-induced alteration to the system.

The best estimate of the population size of the Maugean Skate in Macquarie Harbour is about 3000 individuals. They appear to be shallow-water-dwelling, nocturnal feeders with a short lifespan of up to 15 years. Their reproductive cycle is highly variable and discontinuous. There was no evidence of long-term movements of Maugean Skate outside of Macquarie Harbour, nor of any direct interactions between Maugean Skate and aquaculture operations. The findings of this study have implications for recreational gillnetting in Macquarie Harbour.

More information: Jeremy Lyle, University of Tasmania, 03 6227 7255, jeremy.lyle@utas.edu.au

Oceanographic influences 2013-020

This project examined coastal and oceanographic influences on the catch rates of Coral Trout (*Plectropomus leopardus*) and Saucer Scallops (*Amusium spp*) in Queensland. Specifically, it looked at the physical oceanographic conditions along the Queensland coast, including the Capricorn Eddy, variations in sea surface temperatures and tropical cyclones. This research was undertaken to explain the variation observed in catches of both these species, and to improve the reliability of stock assessments and management strategies.

This study found that inshore fetch (area over which wind blows, which generates waves) is the most important environmental variable for explaining the decline in Coral Trout catch rates after a cyclone. This decline is believed to stem from reduced catchability, rather than reduced abundance of Coral Trout. The report recommended that historical inshore wave-height measurements be used in developing new fishery catch rate standardisations to better account for the effects of tropical cyclones.

This study also found that no one single area is responsible for supplying larvae of Queensland Saucer Scallops to the fishery and that larval advection patterns differ significantly between years. Key environmental variables affecting commercial catch rates were identified. These included chlorophyll-a levels, sea surface temperatures and freshwater flows, indicating catch rates in November (when the fishery commences each year) might potentially be predicted using environmental data.

More information: Tony Courtney, Department of Agriculture and Fisheries, Queensland, 07 3255 4227, tony.courtney@daf.qld.gov.au

Disease management 2013-036

This project sought to determine the disease status of wild-caught broodstock of Black Tiger Prawns (*Penaeus monodon*) from northern Australia. This information is essential to supporting Australia's claims of pathogen-free produce. This project was initiated in response to the discovery of a locally found virus in *P. monodon* at a hatchery in north Queensland. The infected prawns were thought to be associated with broodstock collected from Joseph Bonaparte Gulf (JBG) in the Northern Territory. The study found no evidence of white spot syndrome virus, infectious myonecrosis virus or the exotic yellow head virus (YHV1) in any of the *P. monodon* tested from any of the study locations. The study did, however, confirm the presence of the locally found yellow head virus (YHV7) in broodstock originating from JBG and also found the virus in progeny of prawns sampled from Queensland hatcheries. The report recommended targeted surveillance of farms in Queensland to determine the true prevalence and distribution of the YHV7 virus. During this project, molecular methods to specifically detect YHV1 and YHV7 were designed and evaluated. When validated, the revised YHV1 and YHV7 PCR tests and non-infectious synthetic artificial controls will be valuable for state government diagnostic laboratories, and commercial diagnostic laboratories.

More information: Jeff Cowley, CSIRO, 07 3214 2900, jeff.cowley@csiro.au

Heavy metal detection 2012-223

This study investigated the spatial and temporal occurrence of heavy metals in tropical Blacklip Oysters (*Saccostrea mytiloides*) and Milky Oysters (*Saccostrea mordax*) in the Northern Territory. It was initiated in response to a 2011 finding of high levels of cadmium and arsenic in oysters from an Indigenous oyster enterprise farm. In 2011 the Indigenous oyster enterprise program was in its developmental phase, so there was a crucial need for an extensive assessment of the occurrence of heavy metals in potential oyster grow-out areas.

The study found that wild-harvest Blacklip Oysters accumulated cadmium at levels that exceeded the maximum residue levels (MLs) set by Food Standards Australia New Zealand (FSANZ) at all sites and on all sampling occasions. Farmed Blacklip Oysters exceeded food safety standards for cadmium consistently at only one site. Similar to the farmed Blacklip Oysters, wild Milky Oysters consistently exceeded safety standards at one site. By comparison, the levels of arsenic and lead in both species were below MLs for all sites over the sampling period. However, the report recommended additional analysis of the arsenic findings.

The report also recommended limiting wild harvesting of Blacklip and Milky Oysters to particular sites, and using only farmed Blacklip Oysters for cultivation and then sale into the Australian seafood market. The engagement of the local Indigenous aquaculture team throughout this project also highlights the support processes needed to build Indigenous science capacity.

More information: Ann Fleming, Department of Primary Industry and Fisheries, Northern Territory, anne.fleming@nt.gov.au

Small pelagic spawning biomass 2013-053

This study sought to apply the daily egg production

method (DEPM) for estimating spawning biomass to the only two species in the Small Pelagic Fishery (SPF) yet to be subject to dedicated DEPM surveys off eastern Australia: Jack Mackerel (*Trachurus declivis*) and Australian Sardine (*Sardinops sagax*). This project was conducted to acquire the knowledge needed to support ongoing ecologically sustainable management of these species. This study was the first dedicated application of the DEPM to Jack Mackerel. Large numbers of eggs and adult samples were collected from eastern Australia during January 2014. The study established an effective method for sampling adult Jack Mackerel and provides the first estimates of the adult reproductive parameters required for use of the DEPM. The spawning biomass of Jack Mackerel off eastern Australia was estimated to be approximately 157,805 tonnes. Sensitivity analyses produced estimates between 95,000 and 215,000 tonnes.

This was also the first study to investigate the spawning habitat of Australian Sardine off eastern Australia during summer. It showed that during January 2014, spawning occurred between northern Tasmania and southern Victoria. This estimate should be treated with caution as adult samples were not collected during the study. It is only an estimate of the portion of the population that was spawning in this southern part of the range during that period. The main spawning area of Australian Sardine off eastern Australia occurs off southern Queensland and northern NSW, during late winter and early spring. The spawning biomass was estimated to be approximately 10,962 tonnes.

More information: Tim Ward, SARDI, 08 8207 5433, tim.ward@sa.gov.au

Improving Snapper spatial management 2012-020

This project investigated the regional movements and stock structure of Snapper (*Chrysophrys auratus*) in south-eastern Australia and its implications for the spatial management of the fishery. The project was motivated by the significant management and population dynamic changes to the fishery in recent years, which had put its sustainability into question. These changes highlighted the poor understanding of the movement behaviour of Snapper at different life history stages, its consequences for stock structure and the need to address this knowledge deficit.

The South Australian Research and Development Institute (SARDI) and Fisheries Victoria-led study included the largest and most comprehensive otolith chemistry study and the first acoustic telemetry study of Snapper in Australia. The study considered the structure among six regional populations, currently managed as distinct units, and found three self-sustaining stocks: the Spencer Gulf/west coast Eyre Peninsula stock, the Gulf St Vincent stock and the western Victorian stock. The study also identified three main nursery areas: northern Spencer Gulf (NSG), northern Gulf St Vincent (NGSV) and Port Phillip Bay (PPB). The southern Spencer Gulf population relies on emigration of recruits from the NSG and west coast Eyre Peninsula. The southern Gulf St Vincent population relies on the NGSV, and the western Victorian population relies on recruitment from PPB.

More information: Anthony Fowler, SARDI, (08) 8207 5432, anthony.fowler@sa.gov.au

Interpreting marine park audit 2010-226.20

This report reviews the findings of the *Independent Scientific Audit of Marine Parks in New South Wales* and interprets the relevance of its recommendations to commercial and recreational fishers. It was commissioned in response to the complex nature of the *Audit Report* and the difficulty fishers had interpreting the implications of its recommendations.

The Audit Report is underpinned by two overarching recommendations relating to governance and scientific oversight of the NSW Marine Estate. The review raises concerns that priority will be given to these overarching recommendations, to the detriment of the other Audit Report recommendations, in particular, those relating to reviewing the zoning process in NSW. The review recommended that the commercial and recreational fishing sectors be actively involved in the re-zoning process and that their position be considered, consolidated and, where possible, evidence-based.

More information: Robert Kearney, University of Canberra, bob.kearney@canberra.edu.au

Catch recording app 2011-250

This project delivered a functional and cost-effective on-board electronic data capture system for the rock lobster industry in South Australia. The aim was to complement existing land-based electronic weigh stations and remove the need for paper catch records in the South Australian Southern Zone Rock Lobster Fishery (SZRLF), while also improving profitability for operators.

In 2012, the South Eastern Professional Fishermen's Association (SEPFA) trialled an iPad (iPhone-compatible) app, Deckhand, on 22 vessels in the SZRLF. The trial sought to determine the utility and cost-effectiveness of the program under real conditions. The success of the trial has provided evidence that the modified Deckhand app is a functional and robust on-board electronic reporting mechanism.

The Deckhand app has now been developed in the SZRLF for the 2016-2017 season. It is envisaged that this will lead to enhanced resource sustainability through the provision of improved information and more efficient, and therefore profitable, operation for individual businesses.

More information: Justin Phillips, South Eastern Professional Fishermen's Association, justin@jp-consulting.com.au

Prawn fishery ecological impacts 2013-047

This synthesis project updated our understanding of the ecological impact of the Joseph Bonaparte Gulf (JBG) prawn sub-fishery on at-risk species, habitats and ecosystems. The JBG sub-fishery is one of three sub-fisheries making up the Northern Prawn Fishery (NPF). It is a Marine Stewardship Council accredited fishery.

This synthesis strongly indicates that the JBG sub-fishery is currently ecologically sustainable. Catch and effort models indicate that the biomass of Redleg Banana Prawns in JBG has remained above maximum sustainable yield levels since around 2005. The synthesis also indicates that threatened, endangered and protected (TEP) and 'at risk' bycatch species in the JBG sub-fishery are managed sustainably. This suggests that the combination of bycatch reduction device implementation and fishery structural adjustments has ultimately reduced the catch of non-target species.

This information will assist the NPF industry and AFMA in managing the fishery and identifying research priorities to give consumers confidence in the sustainability credentials of the fishery and its Marine Stewardship Council accreditation. Increased confidence in the sustainability of the JBG sub-fishery will assist in enhancing the value of the yield.

More information: Annie Jarrett, NPF Industry Pty Ltd, 07 5437 0513, annie.jarrett@bigpond.com

Pacific Oyster disease management 2012-032

This project investigated the biology, epidemiology and risk management of Pacific Oyster (*Crassostrea gigas*) mortality syndrome (POMS) in the Georges and Hawkesbury rivers. POMS is a viral disease of Pacific Oysters which is caused by the ostreid herpesvirus-1 µVar. It has the potential to devastate Pacific Oyster culture in Australia, as it has done overseas. In the summer of 2011-12, the re-emergence of POMS in the Georges and Hawkesbury rivers reasserted the need to fill key knowledge gaps. POMS was first detected in Australia in 2010.

The source of the virus in farmed Pacific Oysters in the Georges and Hawkesbury rivers was found to be external, and likely marine in origin, but the exact source of contamination could not be identified. Wild Pacific Oysters, as well as other mollusc species

and other marine organisms, tested positive for low levels of the virus. The virus appears to remain stable in seawater for less than 48 hours and several disinfectants were identified as effective against the virus. A consistent seasonal pattern of disease outbreak was observed in both rivers. POMS was seen between October and May each year, but was not detected in cooler months. The major factors determining the extent of mortalities during an outbreak were found to be the age of oysters, growing height/immersion time and location.

Some of the recommendations from this report can be adopted immediately by industry. Hatcheries can treat incoming seawater using the simple procedures outlined, to prevent mortality of Pacific Oyster spat. It is possible to safely farm oysters in affected estuaries, except between late October and mid-May. The report also identified knowledge gaps and future research needs.

More information: Richard Whittington, University of Sydney, 02 9351 1619, richard.whittington@sydney.edu.au

Building economic capacity 2008-306

This report outlines the efforts of the 'Building Economic Capability Project' to increase Australia's capacity to incorporate economic considerations into marine management. The increasing demand for economic input into fisheries and aquaculture management and other marine resource issues has highlighted the persistent undersupply of suitably trained and qualified individuals capable of providing such economic analysis.

This project developed a 'Fisheries Economics Graduate Research Training Program'. Through this, postgraduate higher-degree study options in fisheries/marine economics were made available at three participating universities: the University of Tasmania, Queensland University of Technology and the University of Adelaide. Program graduates have produced theses and published papers in peer-reviewed journals that have contributed to our understanding of the economic implications of marine resource management.

This project also developed two short courses in collaboration with the Seafood Cooperative Research Centre (SCRC), with the aim of improving the economic literacy of non-economist marine-sector stakeholders. These courses have been delivered to individuals from a wide range of stakeholder groups.

More information: Sarah Jennings, UTAS, sarahjennings306@gmail.com

Developing clam farming 2010-233

This project sought to fill gaps in knowledge required for the development of commercial-scale aquaculture production of Mud Cockles (*Katelysia rhytiphora*) in South Australia. Specifically, the project investigated the genetic structure of cockles in SA, potential biosecurity risks from translocations and effective methods for distinguishing wild from hatchery cockles.

In SA, three species of Mud Cockles in the genus Katelysia are commercially harvested: *K. scalarina, K. rhytiphora* and *K. peronii*. Using Cox I barcoding genetic techniques, samples from SA thought to be *K. rhytiphora* were revealed to be multiple species. This has implications for cockle aquaculture development, as different cryptic species (identical morphologically) might perform differently in the key traits important to aquaculture development, such as growth rate, optimal temperature and sensitivities to diseases. The key challenge is distinguishing these species practically. The results from this preliminary study have indicated the Cox I barcoding technique is suitable for distinguishing between Katelysia species in SA. Recommendations for further research to support the development of Mud Cockle aquaculture in SA were also made.

More information: Xiaoxu Li, South Australian Research and Development Institute, 08 8207 5464, xiaoxu.li@sa.gov.au

Mitigating mammal interactions for SPF 2014-046

This report outlines the presentations, discussions and recommendations of a technical workshop on marine mammal interactions and potential mitigation options for the Small Pelagic Fishery (SPF). Following the arrival and commencement of fishing by the mid-water trawl vessel the FV *Geelong Star* in the Commonwealth Small Pelagic Fishery (SPF), fishery stakeholders agree that efforts are needed to mitigate and minimise any interactions. Several recommendations were agreed upon, including: establishing an industry code of practice, a Marine Mammal Working Group (MMWG) to provide AFMA and industry with ongoing advice, and reviewing current management arrangements for mitigating interactions with marine mammals.

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

Detecting exotic catfish disease 2012-050

This report contains the findings of the first survey of the exotic bacterium *Edwardsiella ictaluri* in wild freshwater fish populations in Australia. *E. ictaluri* causes enteric septicaemia of catfish (ESC), a serious disease of farmed Channel Catfish in the US. The bacterium has previously been detected in imported ornamental fish and in native catfish held in Australian aquarium facilities, but wild fish populations in Australia have, to date, been considered free of the disease. This study conducted a survey of wild catfish populations in 15 river systems in northern Australia for the presence of *E. ictaluri*.

Edwardsiella ictaluri was detected in eight *Tandanus tropicanus* catfish sampled at one site in the Tully River in northern Queensland. No infected catfish were found at any other site in Queensland, the Northern Territory or Western Australia. It is possible that the bacterium is present at these sites, but at low prevalence. Yet because of the detection of infected catfish in the Tully River, Australia can no longer be considered to be free from *E. ictaluri*. This may represent a threat to Australia's unique freshwater fish fauna and may also have consequences for Australia's growing ornamental fish industry. The report recommends actions be taken to minimise the risk of the spread of *E. ictaluri* from the Tully River to other localities in northern Australia.

More information: Alan Lymbery, Murdoch University, 08 9360 7509, a.lymbery@murdoch.edu.au

Trialling a co-management approach 2008-045

The Australian Fisheries Management Authority (AFMA) worked with three Commonwealth fishery groups between 2008 and 2011 to explore the potential for implementing a co-management approach with Commonwealth fisheries. Co-management is an arrangement where responsibilities and obligations for sustainable fisheries management are negotiated, shared and delegated between government, industry and other stakeholders. Such an approach requires a shift from consultative management to collaborative and/or delegated management.

This project involved trials to test the capacity of the fishing industry and government to adopt co-management. The trial fishery groups included the majority of fishers operating out of the Lakes Entrance port in Victoria, supported by the Lakes Entrance Fishermen's Cooperative Society; the Great Australian Bight Fishing Industry Association (GABIA); and the Northern Prawn Fishery Industry (NPFI). The three fishery groups worked closely with AFMA to scope a range of co-management activities and functions, and the frameworks under which they could be undertaken. These were put into practice on a 'trial and error' basis over a two to three-year period. The trials undertaken in Commonwealth fisheries show there is capacity within representative fishery organisations to engage in co-management and that there are benefits in adopting such an approach. However, certain pre-conditions need to be met to successfully implement co-management.

More information: Steve Bolton, Australian Fisheries Management Authority, 02 6225 5328, Steve.bolton@afma.gov.au

Movers and ...

Mark Edwards has been appointed deputy chief executive of the NZ Rock Lobster Industry Council. He joined chief executive **Daryl Sykes** and business manager **Helen Regan** in October.

Justin Phillips has taken up the position of Southern Rock Lobster executive officer.

FRDC Board member **Renata Brooks** has been appointed a commissioner for the Australian Fisheries Management Authority.

The FRDC has assembled a new team to work on the new National Carp Plan. **Matt Barwick** will lead the team, assisted by **Pele Cannon**, **Toby Piddocke** and **Tom Chesson**.

The Seafood Industry Victoria (SIV) Board has appointed **Markus Nolle** as chairman to replace **Harry Peeters**.

Kate Lord has left her role as executive manager of communications at the GRDC, with no replacement confirmed.

David Ellis is the new executive officer of Tuna Australia, formed out of the old Eastern Tuna and Billfish Association and the West Coast Tuna and Billfish Association.

New executive officer for the Great Australian Bight Fishing Industry Association (GABIA) is **Christian Pyke**.

Johnathon Davey has taken over as CEO of the National Seafood Industry Alliance from **Katherine Winchester**.

Tristan Sloan has left his position as executive officer of the Amateur Fishermen's Association of the Northern Territory to take up a role as ministerial adviser to **Ken Vowles**, NT Minister for Primary Industries and Resources.

Josh Pearce, previously of Sanford Australia, is the new chair of SETFIA.

Daniel Kimberley from Monsoon Aquatics is the new chair of the NT Seafood Council – taking over from **Rob Fish**.

Patrick Murphy takes over from outgoing chairman **Gordon Gregory** as chair of the Primary Industries Health and Safety Partnership (PIHSP) advisory committee.

FEEDBACK

FRDC WELCOMES YOUR COMMENTS

frdc@frdc.com.au

MOVERS WE'VE MISSED?

INFO PLEASE TO

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

Calendar of events

DATE	EVENT	MORE INFORMATION
2017		
25 to 26 January	**Seafood Safety: New Findings and Innovation Challenges Conference, Brussels, Belgium**	www.ecsafeseafoodconference.com
19 to 22 February	**Aquaculture America 2017, San Antonio, Texas, USA**	www.was.org
22 to 24 February	**FRDC Board Meeting, Geraldton**	02 6285 0400
22 to 24 February	**World Ocean Summit 2017, Bali, Indonesia**	www.economist.com/events-conferences/asia/ocean-summit-2017
27 to 28 April	**FRDC Board Meeting, Hobart/Dover**	02 6285 0400
4 to 7 June	**Seafood Summit, Seattle, USA**	www.seafoodsummit.org
14 to 15 June	**FRDC Board Meeting, Darwin**	02 6285 0400
27 to 30 June	**World Aquaculture 2017, Cape Town, South Africa**	www.was.org
2 to 6 July	**Australian Marine Sciences Association (AMSA) 2017, 'Connections through shallow seas'**	www.amsa.asn.au/amsa-annual-conferences
25 to 27 July	**Asia Pacific Aquaculture 2017, Kuala Lumpur, Malaysia**	www.was-apc.org/?p=22

FRDC

Available December 2016

Status of Australian Fish Stocks Reports **Third report**

- **83 species (or species complexes)**
- **More accessible, up-to-date information on the status of Australia's wild-catch fish stocks**
- **Worked on by more than 100 scientists from across Australia**
- **Independently peer reviewed by more than 50 scientists**
- **The Reports are relevant for all stakeholders: the general public, policy makers, managers, fishing industry, consumers, retailers and an international audience alike.**

The reports collate available biological, catch and effort information to determine the status of Australia's wild catch fish stocks against a nationally agreed reporting framework.

15
new species

Available online or on your device of choice December 2016

www.fish.gov.au