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Fish tales

A world-leading approach
to aquaculture



FISH TALES

Melbourne may be an unlikely spot to find barramundi, but it is now home to the largest indoor fish farm of its type in the world, thanks to its proximity to market, a well-placed aquifer, and some leading-edge refrigeration technology. **Sean McGowan** reports.

Think barramundi, and your mind is automatically taken to the Top End. This famed fighting fish thrives in the wetlands, rivers and coastlines of the Northern Territory, Queensland's Cape York and Western Australia's Kimberley region.

Deriving its name from the indigenous language of the first Australians, barramundi (*Lates calcarifer*) means large-scaled river fish. But we can't claim the "barra" all to ourselves. In the wild they can be found from the Persian Gulf to Southern China, Papua New Guinea and Australia's north.

And thanks to the eating qualities of the fish – its white, flaky flesh and mild flavour – the species has grown in commercial importance.

Although wild-caught Barramundi is still much sought after and fished internationally, it is also being heavily farmed. Aquaculture facilities have sprung up across

Australia, Malaysia, India, Singapore, Indonesia, Israel, Thailand, Saudi Arabia, Vietnam and the United States of America.

Said to be the fastest growing animal food producing sector in the world, aquaculture has grown at 8 per cent per annum for the past 50 years. It now produces almost 100 million tonnes of product per annum globally.

In fact, the sector's growth saw it surpass wild fisheries in 2014 as the world's largest source of seafood products.

TAKING IT MAINSTREAM

Australian company Mainstream Aquaculture was founded in 2001 with the vision of becoming the world's leading provider of recirculating aquaculture seafood products.

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The aquifer supplies hatchery-quality water to the facility at around 29°C – hot enough to sustain the growth of barramundi without the need for heating

Through over a decade of research and development, the company has perfected its proprietary technology to enable the year-round production of barramundi from two facilities in Australia.

One is an award-winning pond system and research facility located in Far North Queensland.

The other is the largest recirculating aquaculture system in mainland Australia located in Werribee, Melbourne, a suburb 32km south-west of Melbourne's CBD that is better known for its vegetable farms than anything of a piscatorial nature.

The site was carefully selected by Mainstream in 2003 for its proximity to Melbourne's wholesale fish markets. But even more important was the unique geographic feature that lies beneath the site: a pristine geothermal water source.

Located some 300m below ground, the artesian aquifer is said to be five times the size of Port Phillip Bay and extends from Little River and Ballan in the west, to the Great Dividing Range in the north, and as far as Phillip Island to the south-east.



Only part of the 4m deep tanks are visible at ground level – the rest can be accessed via a basement level.

The aquifer supplies hatchery-quality water to the facility at around 29°C – hot enough to sustain the growth of barramundi without the need for heating.

“When we found the land, we ran a trial before we purchased it,” says Matthew Mangan, commercial project manager for Mainstream Aquaculture.

“The former owner allowed us to drill pilot bore holes, deep and shallow, and then run some growth trials of the barramundi. We ran every combination we could and found that fish grown in the water sourced from the deep bore were growing exceptionally well.”

Mainstream originally constructed a facility on the site capable of producing 50 tonne of fish per year, but further research and testing allowed them to scale the business fourfold by 2007. In 2012, the company began the development of a Melbourne-based hatchery, designed to produce over 20 million commercial-grade barramundi fingerlings (juvenile fish) per year. This supported the acceleration of its selective breeding program.

But the huge local and international demand for barramundi led them to think bigger. And in mid-2016, the company set about building the largest indoor production facility of its type in the world.

INSIDE AQUACULTURE

The size of Mainstream Aquaculture’s Werribee operation is staggering. Designed across four levels, it features eight 4m deep tanks that hold approximately 600m³ (600,000L) of water sourced from the aquifer.

This water is recirculated twice every hour via a complex system of pipes and pumps. To maintain a pristine growth environment, the water is filtered to remove all fish waste and other contaminants – the product of which is turned into a liquid fertiliser.

“We really pride ourselves on being full cycle,” says Mangan. “We take the water from the ground, reuse it over and over again, and any waste by-products – liquid or solid – are turned into our fertiliser product.”

In the industry, this is known as a grow-out facility. Fish enter the tanks at around 250g and spend 20–25 weeks growing to “plate size” – on average 700g.

Fish for the fillet market are grown to 3kg before being harvested.

All fish feeding is automated, with silos using compressed air to send feed to each tank according to the size of stock within it.

Over the course of its business, Mainstream has also developed technology to conduct a fully automated part-harvest of a tank. This means it can vary its production according to demand to keep the final product as fresh as possible.

“There may be 60 tonnes of fish in a tank,” says Mangan, “but with this system we can take just 20 or 25 tonnes.”

To do this, fish and water are pumped to the fish-handling facility on a mezzanine level of the building where they are automatically size-classed and laser-counted. This enables a single person to move fish around without damaging the product or causing stress to the fish.

“It’s a bit like a water park,” says Mangan. “The fish just move along and end up in the destination we’ve predetermined.”

The systems used to grade the fish allow for them to be returned to the tanks for further growth. Harvestable fish are sent to a purging tank where they are given a high water exchange to prepare them for market.

Those set for processing are chilled via a state-of-the-art ice slurry system imported from Canada. And this is where refrigeration comes into play.

DEEP CHILLING

A bespoke ice slurry system was sourced, engineered and supplied to Mainstream Aquaculture’s by Cold Logic, as part of the Werribee facility’s construction. This type of system is used throughout the world, and also closer to home by operators in Tasmania’s salmon fishery.

According to Cold Logic’s Dr Michael Riese, M.AIRAH, the cost-effective system was designed to drop the core temperature of the fish to 2°C without increasing the stress on the fish, and facilitate the chilling of batches of 5,000kg at a time during the harvesting process.

GOING THE METRIC MILE

According to Cold Logic’s Dr Michael Riese, M.AIRAH, one of the unforeseen challenges arising from the installation of the ice slurry system at Mainstream Aquaculture was overcoming the differences in design standards between foreign-made equipment and Australian standards.

“Even though the equipment was sourced from North America (Canada), it was all in metric piping,” he says.

So what’s the problem, you might ask – we did!

Well, despite the metrication of Australia that began in 1966 with the conversion to decimal currency (and subsequently saw the conversion of measurements from imperial to metric under the direction of the Metric Conversion Board), many types of pipe and associated fittings used in Australia still use imperial measurements, or versions of.

“Matching Australian pipework to Canada’s truly metric pipework specifications was a challenge,” says Riese, “and made it more difficult to interface the system.”

"Ice slurry was of particular use in this application because it has a very large surface area and facilitates an increased heat transfer when compared with block or flake ice," says Riese.

"Additionally, the manufacturer – based in Canada – has an expansive track record in providing ice slurry systems to the Australian aquaculture industry, and they have been found to work reliably in Australian environmental conditions."

The ice slurry used at Mainstream is produced from saline water at a temperature of -1°C by a 15kW refrigeration system operating on R404a.

The entire system was shipped from Canada to Australia on a skid, complete with reciprocating compressor, water-cooled condenser, pumping and control station, brine control unit, ice silo and slurry dispenser.

During non-harvesting times the system grows a block of freshwater ice within an insulated silo.

When ice slurry is required, an automated system removes ice crystals from the block and transfers them to a mixing tank. Here, saline water is added to achieve the pre-determined slurry mix ratio before it is pumped to a bulk vessel.

The barramundi are then plunged into the ice slurry and immediately enveloped in spherical ice crystals that draw heat from the fish, reducing the core temperature of 5 tonnes of fish in 90 minutes.

"The texture we're looking for is almost like a slushy you get from a 7-Eleven store," says Mangan. "Just liquid enough that when the fish come in, they sink in."

"We have sensors on the vessels that monitor the temperature, so if it is telling us the slurry is warming up too much [barramundi are warm-blooded], the system will dump more slurry in to maintain the correct temperature."

For smaller orders, slurry can also be delivered to 1,000L bins.

The cold temperature of the slurry not only maintains the quality of the fish flesh, but also manages bacterial growth.



Ice is held in this silo, ready for harvest and use.



The saline slurry is noticeably colder to the touch than normal ice water.

According to Mangan, company trials have shown that this process chills the fish around twice as quickly as any other.

"It's a really great piece of equipment – well worth the investment," he says. "At this scale, you've got to make it as easy as possible for the technicians working. So with this, they come in around 2am in the morning, turn the slurry machine on and have ice ready for the harvest."

And why 2am?

"It's the seafood market (in Melbourne)," Mangan says. "Their hours are generally 2am until lunchtime, and we service those guys. Unlike suppliers from the Top End, we are able to supply fish that were swimming just hours beforehand."

According to Riese, Cold Logic has a history of taking on different and interesting projects and this was no exception.

The ice slurry system selected for this project was a first for Cold Logic, and it was therefore important that the team understood the constraints of the equipment and how it operated.

A significant amount of time was invested in ensuring that the operators at Mainstream were familiar with its function and operation, which required additional training during the initial set-up.

One of Cold Logic's locally based refrigeration technicians was also engaged to provide routine service and maintenance and has become what Riese describes as "the company's expert in all aspects of the system".

A representative from the Canadian manufacturer was also engaged to commission the unit onsite.

Riese says that above all, it was also important to fully understand the usage pattern of the equipment by the client.

As well as ensuring the equipment is appropriately sized, this knowledge can also lead to a reduction in capital costs and avoid additional problems resulting from not being able to accommodate required future growth.

"As the ice slurry system was only a small part of the larger, overall construction project at Mainstream Aquaculture, it was also important to coordinate with the head contractor and Mainstream," says Riese.

"By establishing a good working relationship with Hutchison, everyone's life was made much easier. And when delays occurred during construction, an open channel of communication allowed us to adapt quickly to changes in site access and delivery timelines."

EXPORTING WORLDWIDE

The Werribee facility has allowed Mainstream Aquaculture to cement itself as a leading supplier of both barramundi table fish and fingerlings, both in Australia and overseas.

In fact, through its research and development arms, it is now the largest supplier of barramundi fingerlings in the world, distributing them to producers in 24 countries across five continents.

Combined with advances in refrigeration technology, the scalability of sustainable aquaculture is significant. And its ability to meet global food demand is likely to become more important as wild fisheries are protected. ■

PROJECT AT A GLANCE

HVAC EQUIPMENT

- ▲ Chillers: **Sunwell**
- ▲ Compressors: **Bitzer**
- ▲ Condensers: **BAC**
- ▲ Controls: **Sunwell / Cold Logic**
- ▲ Electrics: **Sunwell / GPS Electrical**

THE PERSONNEL

- ▲ Client: **Mainstream Aquaculture**
- ▲ Controls: **Sunwell / GPS Electrical / Cold Logic**
- ▲ Mechanical Services Design: **Cold Logic**
- ▲ Mechanical Services Contractor: **Cold Logic**