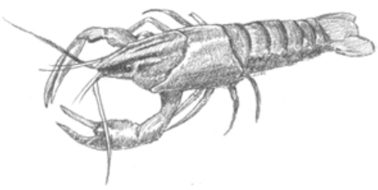
Marron farming in South Australia



The marron, *Cherax tenuimanus*, is native to the south-western region of Western Australia. Marron were introduced to Kangaroo Island during the 1960s and now inhabit a number of waterways throughout the island. In South Australia marron farming commenced during the early 1990s. There are now close to 200 registered growers and this figure is rising. However only a modest number of marron growers are producing on a commercial scale and at this stage no grower in South Australia is making a full-time living from marron farming.

Marron have many biological, economic and marketing attributes that make them a promising candidate species for aquaculture. Some of these include their large size, good feed conversion efficiency and their direct life cycle. Marron farms are also relatively inexpensive to construct compared to other forms of farming with some people utilising existing farm dams to produce marron. As marron farming is practised on privately-owned land, it is an industry that is readily accessible to the majority of South Australian primary producers.

Marron farming is practiced throughout the State with approximately 95% of production from Kangaroo Island. Other areas of marron production include Eyre Peninsula, Fleurieu Peninsula and the South-East.

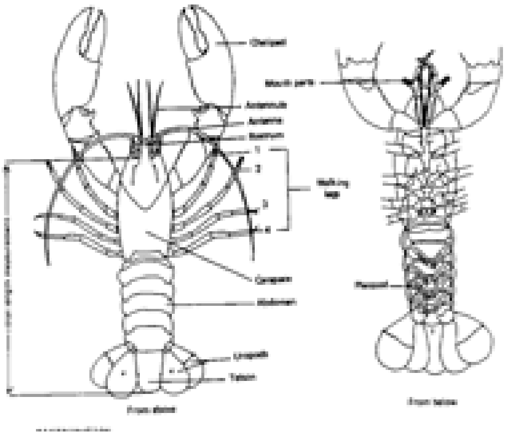
To be able to establish a successful marron aquaculture venture, a number of issues must be considered.

- Suitable land for pond construction must be available.
- An adequate supply of good quality water.
- Climate suitable for marron growth.
- Availability of transport to markets.
- A good level of commitment to management of the marron farm.

Before someone can venture into marron farming an aquaculture permit must be obtained through the Aquaculture SA within Primary Industries and Resources South Australia (PIRSA). This permit will record the applicant as a registered fish farmer and therefore enable them to stock ponds or dams with marron and sell their produce. Before a permit may be granted by the Aquaculture SA for a land-based applications it may be required that approval be sought by the Department of Environment, Heritage and Aboriginal Affairs (DEH), the Environment Protection Authority (EPA) and local councils.

Anatomy and morphology

The opposite figure gives the morphology of Marron.



Water quality

Good water quality is essential to maintain optimum marron growth. To manage water quality, regular testing needs to be conducted. Relatively inexpensive testing kits are available through analytical supply stores. The following parameters should be monitored on a regular basis.

Water temperature

The optimum growth rates for marron is achieved between 17^0C and 25^0C. Growth will decline and eventually cease when temperatures hit below 12.5^0C. Mortalities will start to occur when temperatures reach 30^0C.

Ponds can also undergo thermal stratification and occurs when the pond divides into two separate layers. This will depend on the amount of light that penetrates the water column and is mainly due water depth and the turbidity in the pond. Thermal stratification is caused by the upper surface layer being warmed by the sun and therefore will remain on the surface as it is less dense than the bottom cooler layers of water in the pond. Unless the stratification is broken down by some sort of mechanical aeration (*ie* wind action, airlift systems etc), its effect can be detrimental to pond life.

Thermal stratification will also cause oxygen stratification. This occurs when oxygen rich waters on the surface can not mix with the cooler bottom waters where oxygen is being continually consumed by plant, organic and animal matter. If the stratification persists, oxygen levels on the bottom will drop to levels that would be lethal to bottom dwelling marron.

Dissolved oxygen

Oxygen levels in pond systems depend on water temperatures, stocking rates, and the amount of aquatic vegetation growing in the pond. Oxygen levels experience day and night fluctuations where levels are high during the day and then drop at night. This is due to aquatic plants within the pond producing oxygen during the day via photosynthesis (which requires sunlight) and respiring (consume oxygen) at night.

It is recommended that oxygen levels within a pond be maintained above 6ppm. However marron can withstand oxygen levels as low as 3ppm although not for extended periods.

pH levels

pH is the measure of the concentration of Hydrogen ions (H^+) in the water. Water with a pH of above 7 is considered to be alkaline (low concentration of H^+) whereas a pH level of below 7 is acidic (high concentration of H^+). pH levels in freshwater ponds depend on factors such as nature of the catchment area (eg: limestone areas would have a high pH) and the amount of respiration and photosynthesis occurring in the pond (*ie* the amount of carbon dioxide present – carbon dioxide dissolves in water to form carbonic acid).

Water with a pH between 7.5 and 8.5 are recommended however marron can tolerate a pH of 7.0 and 9.0. A pH of below 7.0 will increase the toxicity of dissolved metals within the water column and soften the exoskeleton of the marron. A pH of above 9.0 will greatly increase the toxicity of ammonia within the ponds.

Alkalinity and water hardness

Alkalinity refers to amount of carbonates and bicarbonates in the water and water hardness refers to the concentration of calcium and magnesium. As calcium and magnesium bond with carbonates and bicarbonates, alkalinity and water hardness are closely interrelated and produce similar measured levels.

It is recommended that alkalinity and hardness levels are maintained around 50 to 300 mg/l which provides a good buffering (stabilising) effect to pH swings that occur in ponds due to the respiration of aquatic flora and fauna. A lack of calcium in the water will also result in soft shelled marron as they rely on the intake of calcium from the water column to harden their shells after moulting.

Water alkalinity and hardness can be increased by liming ponds which involves adding a measured amount of lime to the pond.

Salinity

Salinity is a measure of the saltiness of the water. Marron can withstand salinities up to 17 ppt however their growth rates start decreasing when the salinity reaches 4 ppt.

Turbidity

Water turbidity in freshwater ponds is caused by phytoplankton and zooplankton (microscopic plants and animals) and suspended solids such as clay and silt particles in the water column. Water turbidity is important as it determines the amount of light penetration that occurs in the water column of a pond. This in turn will have an affect on the temperature of the water and the amount of vegetation and algae that will grow in the pond itself. For example a highly turbid pond will allow less light penetration therefore the temperature of the water will be lower. A combination of less sunlight and lower temperatures will result in a decreased amount of vegetation present with in the ponds which depend on sunlight and warmth to grow. A low turbid pond will of course have the opposite affect.

Turbidity is measured in centimetres using a Sechii disk which consists of a round plate divided into alternate black and white “pie” sections. This disk is attached to a graduated rope or a metal handle divided into measuring units (usually at 2 cm intervals). The disk is lowered into the water until it can not be seen and then raised until it re-appears. Sechii depths between 20cm and 60cm are recommended for optimal management of marron ponds.

Ammonia

Ammonia in ponds is produced from the decomposition of organic wastes resulting in the breakdown of decaying organic matter such as algae, plants, animals and uneaten food. Ammonia is also produced by the marron as an excretory product.

Ammonia is present in two forms in water – as a gas NH_3 or as the ammonium ion (NH_4^+). Ammonia is toxic to crayfish in the gaseous form and can cause gill irritation and respiratory problems.

Ammonia levels will depend on the temperature of the pond’s water and its pH. For example at a higher temperature and pH, a greater number of ammonium ions are converted into ammonia gas thus causes an increase in toxic ammonia levels within the marron pond.

Units of measurement		**Conversions**	
"g"	= grams	1 g/l	= 1000 mg/l
"kg"	= kilograms	1 ppt	= 1000 ppm
"m"	= metres	1 mg/l	= 1 ppm
"m^2"	= square metres	1 g/l	= 1 ppt
"mg"	= milligrams	1 gpg	= 14 mg/l (or 14 ppm)
"l"	= litres		
"ppm"	= parts per million		
"ppt"	= parts per thousand		
"gpg"	= grains per gallon		

Pond management

Water supply

Before commencing any aquaculture venture, a suitable and plentiful water supply is required. Marron growers throughout South Australia obtain their water from a number of sources. These sources include soaks (where water seeps into a pond or channel from the water table), artesian bore water or run-off from the water catchment. It is however not recommended that ponds or dams are built directly into the water table and applications for marron farming permits using this method are usually rejected.

As South Australia is the driest state in the driest continent, water is an extremely important resource in marron aquaculture and must be effectively managed. The majority of marron growers recycle their water into storage dams when draining their ponds to harvest or clean so that it can be used again in the same or a different pond. It is also advised that if a grower is to rely on run-off water from a catchment area, they should construct a number of dams to store water to ensure that marron ponds can be topped up during the summer months when water evaporation is at its peak.

Aeration

Artificial pond aeration is used to help maintain oxygen levels in the water throughout the day by aerating and circulating water throughout the pond. Aeration is usually required when ponds are stocked at higher densities and when supplementary feeding occurs. The majority of growers aerate only when oxygen demand within the ponds is high which is usually around dawn and midday.

Mechanical aeration can be achieved using a number of methods. The most popular method in South Australia is using an air-lift pump system which is effective and relatively cheap to construct. There are also a variety of other methods which can be used to effectively to aerate ponds and include paddle wheels, aspirators or even an outboard motor on the back of a boat!

Pond design

Marron ponds are usually constructed on relatively flat or slightly sloping land that allows for water to be supplied or drained to or from the ponds via gravitation. Grow-out ponds are usually rectangular in shape and range anywhere between 500 m^2 to 5000 m^2. Some growers have indicated that a pond size between 1000 m^2 and 2000 m^2 are easier and can be more effectively managed. Grow-out ponds are usually around 1 to 2 metres deep.

Other factors which aid in pond management include:

- A definite deep and shallow end to aid in water drainage.
- A sump (well defined low point) in the deep end to aid in pond drainage and crayfish collection during a harvest.

- A central channel down the middle of the pond to aid in water drainage and the collection of wastes.
- Sloping sides to allow for the gravitation of waste products toward the channel of the pond and to allow for the marron to locate themselves at an appropriate depth to suit water quality conditions during that time.
- Drainage and overflow systems

It is advised that ponds are built in "blocks" which reduces building costs, area of used land and the costs of associated infrastructure such as water piping, aeration and netting. Ponds should be relatively close together for ease of management but far enough apart to allow for a vehicle to pass between them which aids in transport for feeding and harvesting.

Diet

Marron are described as opportunistic feeders which means that they will consume any food that is readily available within the pond system. This includes:

- *Plant material* – aquatic plants, flooded crops, lucerne, phytoplankton (tiny algae cells) and algae. As marron are unable to digest cellulose they are not able to obtain sufficient minerals and nutrients from eating these products. However many plants provide a medium for aquatic animals to colonise which in turn provides food for marron.
- *Animal material* – aquatic insects and zooplankton (tiny aquatic organisms). This includes free-swimming animals as well as animals (alive and dead) inhabiting the pond floor. Animal material provides a good source of protein in the marron's diet. Zooplankton blooms are usually induced by generating a phytoplankton bloom which results after fertilising a pond with measured doses of fertiliser.
- *Detritus* – decomposing plant matter which is colonised by bacteria and fungi. Detritus is thought to be a major component of the marron's diet and is a good source of protein.

As well as the natural food available in the grow-out pond, marron growers also provide supplementary feed. The most common type of feed used in the South Australian marron industry is lupins, a type of legume. Lupins provide a high source of protein and are relatively inexpensive. Some marron growers also use other feed or supplement lupins with grains such as wheat and barley, lucerne, vegetable scraps, grass clippings and processed crayfish pellets manufactured by a feed company.

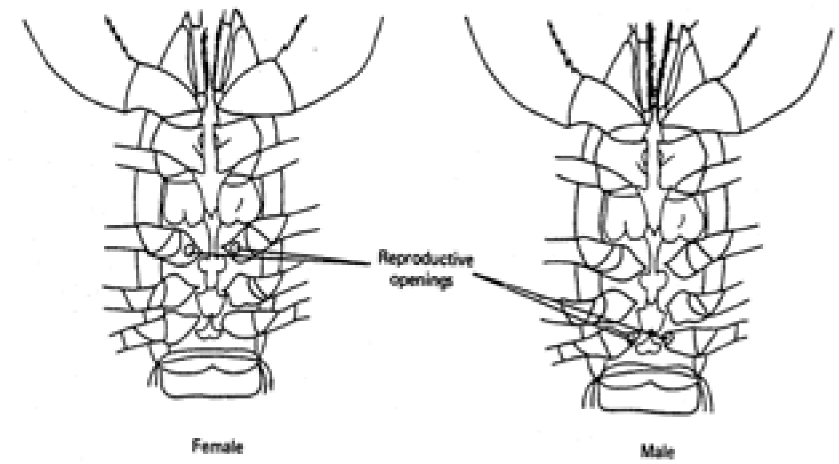
Marron are currently fed around twice per week during the summer months which tapers down to around once per fortnight during winter when the activity of the marron slows down. The amount of feed marron are given is around 3% of their body weight per day however most marron growers determine the amount of feed according to the proportion of previous feed which is left over. It is important not to overfeed as this can result in oxygen depletion problems within the ponds when uneaten food decomposes.

Little is known about the nutritional requirements of marron. The above information is based on previous observations but there is still a lot to discover. For example it is not completely known how important the natural pond flora and fauna is on the nutritional component of the marron's diet. The relative importance has been speculated by previous studies showing that crayfish fed the best processed pellet diet in tanks do not achieve the same growth rates as marron grown in earthen ponds. More research is required to investigate into the nutritional requirements of the marron and the role of plant and animal matter, detritus and processed pellets in providing those requirements.

Marron production

Breeding

The sex of marron can be determined very easily by examining the underside of the marron. Female marron have oviducts which are located at the base of the second pair (from the head) of walking legs and males have male genital papillae located on the base of the fourth pair of walking legs. Marron reach sexual maturity after one year of age.



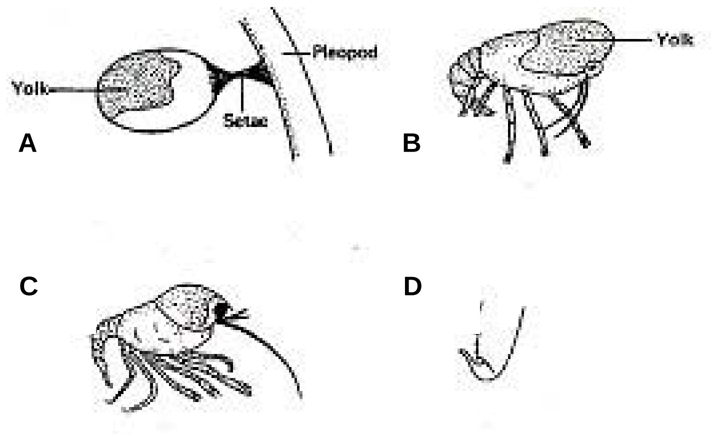
The position of female and male reproductive openings used in sex determination.

Marron only breed once per year in early spring. Spawning is stimulated by changes in light and temperature. Mature females can produce from 100 to 900 eggs per brood depending on her size with larger females producing a greater number of eggs. The male deposits a spermatophore within the vicinity of the female's oviducts where her eggs are produced. The female then releases her eggs, mixes them with the male's sperm and attaches them to her swimmerets (pleopods) located underneath her tail. The eggs are then incubated underneath the tail of the female. After hatching, the juveniles pass through three distinct stages before they become completely independent from their mother. The eggs and larvae are incubated for a period of 12 to 16 weeks and will depend on the temperature of the surrounding water.

Supply of juveniles

Stocking of juveniles in grow-out ponds can be achieved using a number of methods. These include:

- Stocking the pond with a parent population of marron and allowing the natural population dynamics to occur. This method is very extensive and can result in overcrowding and decreased growth rates if the pond is not regularly trapped to remove the large individuals.
- Stocking the ponds with brood-stock marron at a ratio of one male to three females, allowing them to breed and then trapping out the adults.
- Stocking the ponds with berried females however the handling of berried females can sometimes result in the loss of eggs from underneath her tail.
- Breeding the marron within a smaller pond or tank, harvesting the juveniles and then re-stocking them in a separate grow-out pond. This method can be very time consuming and can also result in a loss of juveniles due to handling stress.



Prejuvenile stages of development

- A Attachment of egg to pleopod.
- B First stage of young showing domed carapace.
- C Second stage of young.
- D Hooked tip of thrid and fourth walking legs of first, second and third stage young used to grip the pleopods of their mother.

Growth rates and survival

Marron grow via a series of moults which involves a period of no growth (known as the intermoult period) followed by rapid increase in size after moulting. Moulting occurs when the entire exoskeleton of the marron is shed to accommodate for a new larger exoskeleton underneath.

There are many factors that affects the growth rates and survival of marron. Some of these include:

- Water quality conditions.
- Stocking rates.
- Predation mainly due to cannibalism and birds.
- The availability of shelters or hides.
- Diet.
- Pollutants.

Stocking rates within a marron pond usually depend on the initial size of the marron and the extent of pond management (ie aeration, water quality, supplementary feeding, provision of shelter *etc*). Growth rates and survival depend heavily on the stocking density of marron. As a general rule juveniles are usually stocked at a rate of 4 to $8/m^2$. More research is required in this area to determine an optimum stocking rate for marron held under various degrees of pond management.

Marron can attain a maximum size of 2.5kg however this is not economically viable due to the costs and time associated in producing a marron of this size. A market size marron between 200g to 250g can usually be attained within two to three years.

Harvesting

Marron can be harvested using several methods:

- Trapping – baited traps are thrown into the pond during dusk and marron are collected in the morning from the traps.
- Drain down #1 – ponds are drained and marron are manually collected. One problem encountered with this method is that marron burrow in response to dropping water levels which can result in no marron being present once the pond is empty.
- Drain down #2 – ponds are again completely drained however a cage is placed around the outlet pipe which collects marron has they follow the water from the pond into the sump area and down through the outlet pipe.

After harvesting is completed, marron are graded into various size classes and then purged in cold water to remove the gut contents. Marron are then packed in styrene foam containers ready for transporting to the market.

Marketing

Presently marron are marketed anywhere between 200g and 250g. Marron are sold live to various markets both domestically and interstate (mainly Sydney and Melbourne). At this stage production of marron is not sufficient to support an international export market however there is an interest overseas for our marron once production increases. Currently marron are selling at a farm gate price of around $20 per kg.

Marketing can be accomplished either individually or through a marketing co-op. The advantages of marketing through a co-op are:

- Consistency of the quality of the product.
- Consistency of supply of product.
- Stability of the price of the product.
- Market advertising is done by the co-op.
- Allow even the smallest grower to supply marron to the market.

Yabbie co-operatives around the state are licensed to market both marron and yabbies. These Co-ops was developed in South Australia to "co-ordinate the orderly marketing of freshwater crayfish grown aquaculturally by registered growers throughout South Australia". There are three distributions centres located throughout the state in Fleurieu Peninsula, the South East and Eyre Peninsula.

Marron have excellent marketing attributes due to their presentation on the table and substantial meat yield of around 32% of the total body weight. Marron are sold live however there is opportunity for value adding.

Health issues

To manage the introduction of potential diseases into South Australia, the PIRSA Aquaculture SA have protocols in place to control the importation of fish species, including marron, into our state. This allows the marron industry to operate in a relatively disease free environment.

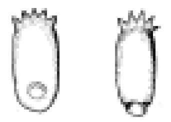
There are two main health issues that are present within the South Australian marron industry.

Thelohania

Thelohania is a microsporidian which affects the tail musculature of the marron. It is also known as "chalky tail" due to the *thelohania* organism causing the tail muscle to become white and chalky in appearance. *Thelohania* is mainly found in wild populations therefore stressing the importance of obtaining broodstock or juveniles from registered growers rather than from wild populations which increases the risk of introducing the parasite into an aquaculture pond.

Temnocephids

Temnocephids are an ectocommensal (external parasite) that reside on the exoskeleton of the marron. They are often associated with low salinity and nutrient rich waters. Eggs of *temnocephalids* are laid on the underside of the tail of the marron and sometimes within their gill cavity.



Temnocephalids

Temnocephalids are rarely harmful to marron unless they are present in extremely high densities. Presence of adult *temnocephalids* or their eggs within the gill chamber of the marron may cause respiratory problems. Their appearance may also reduce the market appearance of the marron. Adult *temnocephalids* can easily be removed by washing the marron in a salt bath for a couple of minutes. However the eggs of *temnocephalids* are extremely adherent and remain even after steaming and boiling.

The future of marron farming

There are programs in place to ensure the successful development of the marron farming industry.

Code of Practice

There is a Code of Practice for the Growing of Freshwater Crayfish (yabbies *Cherax destructor* AND marron *Cherax tenuimanus*) in South Australia. The Code of Practice was produced by the Australian Freshwater Crayfish Growers Association South Australia (AFCGA-SA), the PIRSA Aquaculture SA and the Environment Protection Authority (EPA). It provides guidelines to marron growers on site selection, pond construction and waste water management to ensure that the industry develops in an environmentally sound manner.

The Code of Practice for the Growing of Freshwater Crayfish can be obtained from a AFCGA representative, the Aquaculture SA PIRSA and the EPA.

A Code of Practice for Post Harvesting Techniques of freshwater crayfish (marron and yabbies) has been developed to ensure that a premium quality product will be delivered to the market place.

Research pond project

In 1997 the South Australian branch of the Australian Freshwater Crayfish Growers Association (AFCGA-SA) was awarded grant funding through the Rural Industry Adjustment and Development Fund (RIADF) to establish four research trial ponds. The purpose of these ponds was to conduct research projects relevant to the industry that will aid in refining and establishing best practice procedures and therefore improve production and participation in freshwater crayfish aquaculture.

The four research ponds are situated on established freshwater crayfish farms located throughout the state on Kangaroo Island, Fleurieu Peninsula and the upper South East. Each pond is divided into 24 enclosures and equipped with an airlift aeration system. Research will incorporate both marron and yabbies. Research undertaken within the ponds investigated:

- Diet and feeding regimes.
- Stocking rates and regimes.
- Importance of habitats.

Research was being coordinated and conducted by AFCGA-SA in conjunction with the Aquaculture Group in Primary Industries and Resources South Australia (PIRSA), South Australian Research and Development Institute (SARDI), the University of Adelaide and Flinders University. This research is now being managed by the Australian Freshwater Crayfish Growers Association.

Production in the future

Marron farming has a promising future in South Australia. With larger commercial operators entering the industry combined with the establishment of improved management practices due to further research and development within the industry, production is expected to increase in the future.

Further information

Please note that this fact sheet contains only guidelines to marron farming. It is strongly recommended that further information be attained from the sources below.

Contacts

The Australian Freshwater Crayfish Growers Association (SA)
Mr Keith Keen
Phone/Fax: (08) 8758 4000

Yabbie Co-operatives

Fleurieu Peninsula
Mrs Carol Schofield
PO Box 61
INMAN VALLEY SA 5211
Ph: (08) 8558 8215

South East
Mr Kevin Hillier
PO Box 501
BORDERTOWN SA 5268
Ph; (08) 8754 2021

Eyre Peninsula
Mrs Margaret Hurrell
Post Office
COFFIN BAY SA 5607
Ph: (08) 8685 4056

Aquaculture SA of Primary Industries and Resources South Australia (PIRSA)
GPO Box 1625
ADELAIDE SA 5001
Ph: (08) 8226 0314
www.pir.sa.gov.au/aquaculture

The South Australian Aquatic Science Centre Library.
The Librarian
PO Box 120
HENLEY BEACH SA 5022
Ph: (08) 8200 2423

Further reading

The SARDI Aquatic Centre Library (contact details above) contains an excellent range of books, articles and publications on aquaculture. Besides the information stated below, you will be able to source a significant amount of material regarding marron aquaculture from the library.

- Boyd, C. (1994). Water Quality in Ponds for Aquaculture. 500pp.
- Boyd, C. and Tucker, C. (1992). Water Quality and Pond Soil Analyses for Aquaculture. 200pp.
- Jones, C. (1990). Biology and Aquaculture of the Red Claw. 146pp.
- McCormack, R. (1996). Yabby Farmers Handbook. 250pp.
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- Moloney, J. (1993). Feeding in Freshwater Crayfish. (Turtle Press Pty Ltd, Tas) 24pp.
- Mosig, J. (1995). Australian Yabby Farmer. 218pp.

- Mosig, J. and Fallu, R. (1995). Australian Fish Farmer. 263pp.
- Walker, T. (1994). Pond Water Quality Management: A Farmers Handbook. (Turtle Press Pty Ltd, Tas) 68pp.

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Author:
Aquaculture SA.