PRIMARY INDUSTRIES AND RESOURCES SA

FACT SHEET

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Aquaculture of the Blue Mussel in South Australia

Aquaculture SA

Introduction

The Australian mussel aquaculture industry is based upon *Mytilus edulis planulatus*. This species is found in the temperate waters of both the northern and southern hemispheres. *Mytilus edulis* is believed to have been introduced to Australian waters as fouling attached to the hulls of ships. These mussels have subsequently established populations along the southern coast of Australia, from Cape Hawke on the east coast to Fremantle on the west coast, including the waters around Tasmania. They also inhabit New Zealand waters.

European mussels have been cultured since the thirteenth century. Currently, a number of species of mussels are farmed globally, the most common of which is the blue mussel. China is now the largest producer of blue mussels in the world where its culture technique depends on a high proportion of spat being produced from hatcheries. Other important producers of mussels are Spain, the Netherlands, Denmark and France.

Life history

Blue mussels inhabit a wide range of estuarine and marine environments. They are sessile and attach to rocks, jetties and piers, or sometimes form dense beds on sandy flat substrates. Blue mussels can be found from the low tide level to a depth of 10 metres. Their distribution is limited by high water temperatures and low salinities (lower limit 15 parts per thousand). Blue mussels exhibit maximum growth within a temperature range 16 to 22^{o}C. They prefer sites with significant water movement.

Mussels, like most bivalves (two shelled molluscs), are filter feeds and do not require additional feeding. They strain phytoplankton (microscopic plant-like organisms) from the water. They prefer plankton in the size range of 4 to 120 microns, with the majority of food being less than 20 microns. Particulate organic matter is an important food for mussels in South Australia. This organic material is derived from a range of marine sources, particularly seagrass beds.

Gonadal egg development begins when the water temperature falls below 21oC. The gonads of South Australian mussels are generally ripe by May each year. Generally, a number of animals may spawn a second time after a 4-5 month period. In Western Australia, blue mussel populations have been reported to generate up to 6 spatfalls per year in particularly good areas.

Mussels in spawning condition are ‘fat’ and can be recognised by eye at this stage. During spawning, a mussel may produce up to 8 million eggs, each of which is 70um (0.07mm) in diameter. Depending

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upon environmental factors, such as temperature, larvae may spend from three weeks to three months living as plankton prior to settlement.

Spawning is induced by water temperatures of 14oC. They have a minor spawning period in autumn followed by a second expanded spawning period from late winter to early summer. Limited data suggests that in South Australian mussels appear to be in peak spawning condition from June to September, with peak spawning occurring during August.

Male and female mussels are sexually mature within the first year, however, it is not until they are in their second year that they are at their optimum fecundity. Blue mussels are 'broadcast spawners', releasing eggs and sperm simultaneously into the water with fertilisation taking place in open water. The sexes are separate although hermaphrodites occur occasionally. The fertilised eggs are planktonic, averaging from 0.07mm in diameter and develop into unshelled larvae within a day.

Blue mussel larvae are free swimming meaning their distribution is dependent on the tides and current. The larvae settle 2 to 4 weeks after spawning and are called 'pediveligers' at this stage. The pediveliger periodically settles to the sea-floor to test for suitable substrate. If a suitable substrate is not found, the pediveliger moves back into the water column. The settlement substrate is very important as it will determine the density of spat. Pediveligers are approximately 0.2mm long when they attach themselves to a substrate by the 'byssus', a thread-like structure. Once the pediveliger begins to undergo metamorphosis they are called 'spat'. Throughout life the blue mussel can move by releasing from the substrate and re-attaching to a new site by secreting new byssus threads.

The main period of larval settlement (spatfall) is from winter to spring, with a peak sometime between July and September. A second late spatfall may occur in late October and November, although lighter settlements can occur through to late summer.

Aquaculture

Blue mussels are cultured in Jervis Bay in New South Wales; Port Phillip Bay and Western Port in Victoria; Oyster Bay and the D'Entrecastaux

Channel in Tasmania; in Boston Bay and Kangaroo Island South Australia and in Cockburn Sound, Wanbro Sound and Geographe Bay in Western Australia. All Australian farmed blue mussels are grown using longline culture.

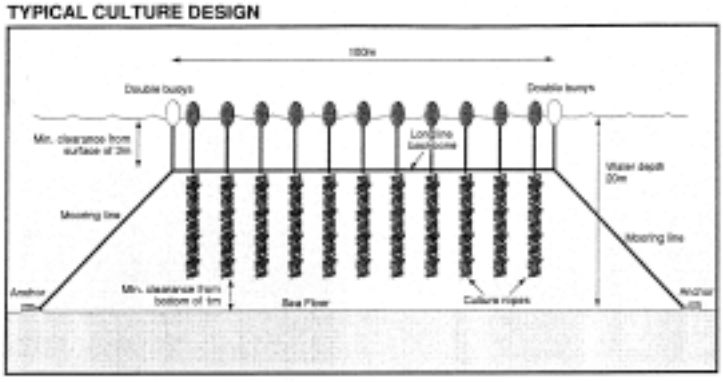
Longlining involves a system of horizontal ropes with buoys to provide flotation, to which vertical droppers are attached every 1 to 4 metres, depending on site conditions. Longlines are used for spat collection as well as for on-growing juvenile mussels to market size.

Spat collection

Mussel spat are generally collected from wild populations by "spat-collectors" although artificial hatchery product is technically possible. Due to the relatively low value of mussels and the ready availability of wild spat, hatchery production is generally not necessary or commercially viable.

Spat collectors are typically made of Christmas tree rope; a fibrous, "hairy" looking rope, which is hung from long-lines in areas which are known to have good mussel "spat-fall".

Spat collection ropes are hung in the water from June to September in South Australian waters, just in time for the peak spawning and spatfall period.



For commercial purposes, spat densities must be 500/m of collection rope or greater to be economic. A spat density of 1000/m of collection rope allows for sufficient growth without overcrowding.

High settlement densities of spat result in stunted growth and may result in excessive mortalities. Juveniles are generally stripped from the ropes during January and February when they are 12mm in length for on-growing.

Grow-out

Once the juveniles have reached 12mm in size on the spat collectors, they are ready to be re-seeded on to grow-out longlines.

Reseeding is a process whereby the juveniles are "thinned-out" to encourage further growth of the mussels. This is a full-time job for the farmers who, each day, weather permitting, take the collection ropes from the water to strip the mussels from Christmas tree collection rope.

The juvenile mussels are separated from each other by passing them through a mussel de-clumping machine before they are fed through a funnel and onto a grow-out rope. A cotton stocking, also known as a "mussock" is placed around the outside of the grow-out rope holding the juvenile mussels against the rope. As the mussels grow they re-attach themselves to the ropes by way of byssus threads the mussock disintegrates leaving just the then hung back in the water and the mussels continue growing for a further 8 to 12 months.

The commercial stocking rate for mussels on grow-out lines is generally between 200 and 400 mussels/m of rope.

It is important to reseed mussels when they are still juvenile spat as, when mussels get larger than 40mm, they do not attach as readily to the rope. This means that slippage will occur with mussels slipping down and forming clumps in the bottom of the sock. This results in a reduced growth rate and poor shell shape. The stockings and rope are skewered and tied at 0.5 metre intervals to ensure that the mussels are evenly distributed.

Ideally, grow-out farms are situated away from heavy spat settlement areas to avoid layers of spat attaching to larger mussels. Longlines require culling to remove fouling and smothering by naturally settling juvenile mussels.

Mortalities of mussels can occur if there is a lack of food in the area or if they are exposed to extreme wave action.

Re-seeding mussels with a mussock (From Jenkins, 1985)

Growth

The growth rate of mussels on longlines will vary according to density, depth and food availability with decreased growth experienced at high stocking densities and greater depths.

Growth rates of blue mussels vary but can be rapid. Blue mussels can reach 32 to 92mm in length after 12 months and 53 to 110mm after 18 months. Commercial harvest usually occurs after 1 to 2 years. As in other shellfish, the meat condition changes seasonally during the growing period. Male and female blue mussels mature within 2 years of age at 4.5 to 5cm in length, with mortality at its highest during the free-floating larval stage of the life cycle.

In South Australia, mussels reach 40mm in 4 to 6 months and reach commercial size in less than 1 year. The fast growth rate must be controlled as it can result in poor shell shape and meat to shell ratio. This can be done by manipulating stocking density on the grow-out ropes.

Harvesting

Harvesting of blue mussels for market requires that the product be removed from the longlines and the shells cleaned of external fouling before presentation. This process is usually automated and involves a washer-tumbler machine in which the mussels are rotated and rubbed against each other to dislodge small mussels, barnacles and other fouling organisms. In some ideal growing areas where there are high levels of nutrients and phytoplankton, the mussels need to be transferred to more oceanic water to clean themselves before harvesting.

There is a small window of opportunity for harvest each year, ie. it must be performed once mussels are in their best meat condition but before they spawn. It is important that prospective mussel farmers determine when they can sell their stock as this will have considerable impact on their ability to supply markets. Some areas may have a very restricted harvest period and the condition of mussels will vary annually with some years being better than others. For this reason, it is important to keep records of conditions to determine site characteristics.

Predation and competition

Mussels are susceptible to predation by fish (snapper and leatherjackets), crabs and starfish. However, if mussels are grown in areas where there is a natural spatfall, then fouling by mussel spat becomes a major problem.

Growth is inhibited by competition for space with other sessile organisms such as barnacles, tunicates, bryozans, algae, native oysters and tube dwelling amphipods, which are also filter feeders and reduce the food available to mussels.

Although not harmful to the mussels themselves, growing areas may occasionally suffer from outbreaks of harmful toxic algae which the mussels consume. When this occurs, the mussels are unfit for human consumption.

Aquaculture development regulations

Aquaculture continues to emerge as a significant issue affecting the ongoing use and management of the coastal land and water bodies. It is an industry which has considerable economic potential. At the same time, poorly sited and managed aquaculture developments can create undesirable impacts. Effective management controls and policies relating to aquaculture are therefore essential.

The policy of the South Australian Government is to provide a basis for sound management of aquaculture, so that benefits will continue to flow to stakeholders and land users now and in the future.

Further Contacts

South Australian Mussel Growers Assoc.
Mr Andy Dyer
16 Gawler Tce
PT LINCOLN SA 5063
Ph/Fax: 8682 3065