Aquaculture

Greenshell™ mussels: solving the case of the disappearing spat

New Zealand's Greenshell ™ mussel aquaculture industry is one of the country's aquaculture success stories. ***Carina Sim-Smith*** *explains how NIWA's research has tackled the critical problem of spat retention.*

Longline mussel culture was established in this country in the late 1970s, after wild stocks of mussels were harvested to commercial extinction. Since then, the mussel aquaculture industry has grown phenomenally, and mussels are now New Zealand's second most valuable seafood export, generating $167 million in export earnings last year.

Tracking down the spat

Most farmed mussels are collected from the wild as tiny juveniles – usually smaller than an apple pip – commonly known as 'spat'. These juvenile mussels are mainly collected from the surf zone of Ninety Mile Beach in Northland, where they can be found in their millions attached to drifting seaweed and other flotsam. The seaweed and spat are stuffed into a cotton mesh stocking or 'mussock' along with a culture rope, which is then hung out on a mussel farm. As the seaweed and mussock rot away in the seawater, the spat attach themselves to the culture rope. Wild mussel spat are also collected directly from the sea by placing hairy 'Christmas tree' ropes in the water; these act like filamentous seaweeds, attracting mussel larvae to settle on them in high numbers.

Keeping on the trail

A major problem for our mussel aquaculture industry is poor retention of mussel spat on the culture ropes. Losses of up to 100% have been reported at times, and losses of more than 70% are commonplace. These spat losses can be caused by natural predation, mortality, and/or secondary settlement. Secondary settlement is the ability of small spat to let go of the culture rope if conditions are not favourable and drift off to reattach somewhere else.

Poor spat retention costs the mussel aquaculture industry many hundreds of thousands of dollars as farmers must purchase and seed out additional mussel spat to compensate for spat losses. The expense becomes even greater when the more costly hatchery-produced spat are used.

Mussel spat attached to a culture rope.

Photo: Barbara Hayden

Following the clues

- Juvenile mussels – spat – are grown in mussel farms on longlines.
- If conditions aren't just right, the spat may die or else abandon the longline and drift away.
- NIWA and Sealord Shellfish Ltd are investigating the factors that spell success or failure in growing the spat to maturity: nutrition, water flow, settlement surfaces, environmental stress, disease, and predation.
- We've developed a new tool for testing spat condition in the field.

Unravelling a complicated case

The issue of spat retention is complex; numerous factors affect retention, including nutrition, water flow, stress, disease, predation, and settlement surfaces. Together with the mussel aquaculture industry, NIWA is working on pulling all these factors together in order to increase the efficiency of mussel farms by improving spat retention.

Nutrition

Research at NIWA's Bream Bay Aquaculture Park with Sealord Shellfish Ltd has shown that well fed spat have better retention rates than spat with reduced food supply. Comparisons of the nutritional profile of well fed and starved spat found that important carbohydrates used for storing energy decreased dramatically when spat were starved. This led NIWA toward developing a useful field tool for reliably measuring the important carbohydrates in spat to provide an indication of their nutritional condition before seeding out (see 'Instant health check').

Water flow

Slow water movement has also been shown to reduce mussel spat retention. In a laboratory study, spat held in still water had only a thirteenth of the retention of spat held in turbulent and aerated water. Likewise, spat held in low current speeds (0.01 m/s) had a seventh of the retention of spat held in high current speeds (0.4 m/s).

Settlement surfaces

As spat grow, their preference for settlement-surface changes. Very small spat like fine, filamentous materials such as finely branched seaweeds and Christmas tree rope; larger spat

(0.5–6 mm) prefer more coarsely branched materials. This change in preference poses a problem for the mussel industry: the hairy Christmas tree rope initially used to seed or catch spat will lose its appeal as the spat grow, and they are likely to move off in search of a more favourable secondary settlement site.

Environmental stress

An experiment conducted at Bream Bay Aquaculture Park found that exposing spat to air for five hours significantly reduced the retention rate. This finding highlights the need to keep spat moist after harvesting, either on beach-cast seaweed or on spat-collection ropes.

Disease

Very little is known about diseases that affect mussel spat. In 1994 a virus was thought to have caused high mortalities (50–100%) in recently reseeded wild spat, but no further outbreaks of the virus have since been recorded. In 2005–06 there was a report of poor retention in wild spat; careful examination of the spat found no signs of disease, but they were found to be in poor nutritional condition.

Predation

The predation of small mussels, especially by fishes such as spotties and snapper, can be extremely high on mussel farms, with reported losses of up to 100% in 24 hours. In comparison, small mussels on farms protected by experimental fish-exclusion cages showed more than 60% retention after two weeks. Predation is difficult to control on a mussel farm, but there are ways to reduce it: by holding small mussels near the surface (less than 5 m deep); by moving spat-catching ropes from areas of high predation to areas of low predation within 8 weeks of settlement; and by reducing the amount of disturbance to the growing-ropes, which appears to attract predators.

Putting solutions to work

Our research shows that good harvesting and farming practices can greatly reduce mussel spat losses. Spat should be kept moist and transported quickly to mussel farms. They should be seeded out in areas with good food availability, higher current speeds, and low numbers of predators. Spat retention may be compromised by the poor nutritional condition of the spat.

NIWA's future research with the mussel industry will focus on establishing effective spat-quality and phytoplankton monitoring systems, and investigating the benefit of holding and feeding spat before seeding. Finding ways to consistently increase spat retention will ultimately deliver significant economic benefits for the whole mussel industry. W&A

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Instant health check on mussel spat

During the summer of 2005–06, a number of mussel farmers experienced significant spat losses after seeding wild-caught spat onto their longline ropes. Through careful examination of samples, NIWA ruled out disease (as initially suspected by the mussel farming industry). Together with Sealord Shellfish Ltd, we developed nutritional analyses that indicated the wild spat were in poor nutritional condition before seeding out. Previous research has shown that poor nutrition is a major cause of low retention of reseeded mussel spat.

NIWA and Sealord have been looking for a simple way to identify spat suffering from poor nutrition. Existing methods for determining spat retention are unsuitable, as they are time-consuming and clumsy, and often require observing spat behaviour through a microscope. Likewise, chemical techniques for measuring nutrition are complex and require a laboratory, and are therefore unsuited to the field.

Now NIWA scientist Carina Sim-Smith has successfully adapted a tiny battery-operated blood-glucose meter (as used by diabetics) to quickly determine the nutritional condition of mussel spat. With the meter, we can test the spat in only 15 minutes, and we can run the test in the field, where spat are collected. Experiments using this novel technique have shown that the assay can reliably differentiate between well fed spat and spat that have been poorly fed for as little as four days.

Sealord Shellfish Ltd has agreed to allow the technology to be used for the wider benefit of the mussel industry and NIWA is now field-testing it. This novel monitoring tool will be invaluable for improving the quality and retention of spat and reducing financial losses associated with harvesting and reseeding poor-quality spat.

Carina Sim-Smith and the new instrument for field-testing spat condition.

Photo: Michael Kearney

Further reading and useful links

Buchanan, S.; Babcock, R. (1997). Primary and secondary settlement by the Greenshell mussel *Perna canaliculus*. *Journal of Shellfish Research 16(1)*: 71–76.

Dawber, C. (2004). Lines in the water: a history of Greenshell mussel farming in New Zealand. New Zealand Marine Farming Association, Blenheim. 306 p.

Hayden, B.; Woods, C. (1997). Current speed has an effect on mussel spat retention. *Aquaculture Update 19*: 9.

Sealord website:
www.sealord.co.nz (see 'Farming seafood')

New Zealand Greenshell™ Mussel website:
www.greenshell.com