NORTH ATLANTIC FISHERIES COLLEGE
SHETLAND FISHERIES TRAINING CENTRE TRUST

The Improvement of the Shetland Lobster Fishery Through Stock Enhancement - 1

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Summary
During the summer of 1995 a pilot scale lobster hatchery was established to investigate the practicalities of producing juvenile lobsters for a stock enhancement programme in Shetland. A novel broodstock holding system was developed, and different methods of rearing the larval lobsters were assessed. The results of the project were extremely encouraging, and culminated in the release into the wild of over one thousand juvenile lobsters.

Introduction
The European lobster (*Homarus gammarus*) has supported a small but locally important fishery in Shetland for many years. However, increasing fishing pressure in the 1960s resulted in over exploitation of local lobster stocks and, after peaking at around 60 tonnes per annum, catches collapsed. Despite a substantial decrease in fishing effort since then, stocks have never recovered and catches currently remain around seven to eight tonnes per annum (approximately 5000 individual lobsters).

In the light of promising results from similar projects elsewhere, it was decided that the North Atlantic Fisheries College in a joint project with the Shetland Islands Council's Development Department should carry out a pilot study to evaluate the practicalities of setting up a lobster hatchery in Shetland to provide juveniles for the enhancement of wild lobster stocks. By rearing the juveniles in a hatchery they are protected during their most vulnerable first few months of life, and research has shown that releasing juvenile lobsters can result in increased stocks of adults and increased catches by fishermen.

Background
Lobsters breed in late summer, just after the female has moulted and before her new shell has hardened. The eggs produced are carried by the female, attached to the pleiopods (or swimmerets) on the underside of her abdomen, where they develop for between nine and 12 months, depending on the water temperature. In the cold waters around Shetland, which lies near the northern limit of the lobster's European range, the development of the lobster's eggs takes significantly longer than it does further south. This has an adverse effect on egg survival, as the longer the female has to carry the eggs the greater is the chance of them being damaged or lost.

A berried female lobster, showing the eggs attached to the pleiopods under her abdomen.

The juvenile, or larval, lobsters which hatch out swim towards the sea surface where they will drift in the water, feeding on microscopic plants and animals.

After three moults, the timing of which is very dependent on temperature and food availability but probably takes up to two months in Shetland, the larval lobsters resemble miniature adults. These 'stage IV' larvae (so called because they are in the fourth stage of their larval life) sink to the sea-bed where they burrow or seek shelter from predators. They remain out of sight until they reach a size of some 30 to 40 mm, when they emerge and adopt the lifestyle of adult lobsters - occupying a sheltered hole and defending a territory, or feeding area. It is thought that lobsters generally remain in the area where they settle, rarely moving any great distance during their lives.

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In the wild, the vast majority of lobster larvae do not survive the larval phase of their lives, most of them being eaten by fish and other sea-creatures. The survival rate is lower in the colder waters around Shetland, as the larvae take longer to develop and so are exposed to the risk of predation for longer, so a smaller proportion of the lobsters which hatch will survive to reach adulthood.

***Results - Broodstock*:**
Berried female lobsters, with well advanced eggs, were obtained from local fishermen and fish processors in mid-July as broodstock for the hatchery. In practice it was found that many of the lobsters received had suffered a high degree of egg loss through handling and long exposure to air.

Two holding systems for the broodstock were tried; the first being a large shallow communal tank, as has been used in other lobster hatcheries. The second was a novel system developed to hold each lobster in isolation in an individual tank. It was though that this would relieve the lobsters of the stress, disturbance and injury to which they are subjected in the communal tank, where their combative and territorial nature leads to frequent fighting. It would also make it much easier to monitor the status of each individual lobster and her eggs, and, as the individual tanks could be stacked up, would make much more efficient use of floor space. The disadvantage of this system is its relatively high cost and the increased time required to attend to the individual tanks.

The communal tank received a continuous flow through of sea-water while the individual tanks were operated on a recirculating system which allowed the water temperature to rise significantly above ambient, speeding the development and hatching of the eggs. The water in this system was purified by passing it through a mechanical filter, to remove particulate material, a biofilter, which removed toxic ammonia and nitrite, and a foam separation tower, which removed dissolved organic material, micro-organisms and carbon dioxide, as well as oxygenating the water.

All the lobsters were fed two or three times per week on a mixed diet of chunks of white fish, salmon or crab meat, or opened mussels. Salmon was found to produce an oily scum on the water which resulted in high foam production in the purifying system.

Larvae
Due to the egg loss noted above, and to initial water quality problems in the recirculation system, the numbers of larvae produced were smaller than might have been expected, about 500 per lobster on average (a 500 g lobster will typically carry some 7000 eggs). It is certain that this figure can be substantially improved in the future by improving broodstock handling, and by improving water quality in the hatchery. Despite the small numbers produced the larvae were perfect and competent.

A newly hatched Stage I lobster larvae, shown with a new five pence coin (18 mm diam.) for scale.

Three separate larval ongrowing systems were tested, all with the common aim of keeping the larval lobsters separate from one another as much as possible. One of the biggest problems in rearing larval lobsters is stopping them from eating each other - lobsters are intensely cannibalistic at all stages of their lives.

System one used standard 80 litre conical bottomed larval holding bins with air pumps delivering about 4 litres per minute through an airstone in the bottom. The rising bubbles created a mushrooming water flow. System two again used the 80 litre larval bins, in this case with a recirculating water flow through a diffuser plate in the bottom of the bin. The diffuser had its holes angled to create an upwelling, rotating water flow. The water overflowed through a central standpipe. In both these systems the water movements were intended to keep the larvae apart.

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The bins used in two of the larval holding systems, showing the lobster larvae swirling in the water.

In system three, the larvae were held in individual mesh bottomed compartments in trays suspended in a shallow tank receiving a continual flow through of fresh sea-water. The larvae in all the systems were fed daily on freshly minced mussel and/or brine shrimps or rotifers.

In systems one and two larval survival averaged about 10%, at least ten times the likely figure in the wild. The development of the larvae was also much faster as a result of the higher water temperatures in the bins. The larvae reached stage IV (at which age they settle to the sea-bed) in eight to 12 days, compared to one to two months in the wild. Disappointingly system three failed completely, probably as a result of the relatively low water temperatures in that system (which received ambient sea water) slowing their development.

Although the juvenile lobsters can be released into the sea at Stage IV their chances of survival are significantly improved if they are grown on in the hatchery to stage V. It can be seen from the photographs below that the stage V juveniles are substantially bigger and better developed than the stage IVs The larger the juveniles are on release the fewer of them will be eaten by predators.

Post Larval Ongrowing

The stage IV lobsters, which are ready to settle to the bottom, were removed from the larval bins and, after acclimatisation to the lower temperatures, were transferred into trays of individual mesh bottomed compartments held in a shallow tank receiving a continual flow through of ambient temperature sea-water. Each compartment was siphon cleaned daily, and the juvenile lobsters fed on fresh minced mussel.

A Stage IV lobster larvae, shown with a new five pence coin (18 mm diam.) for scale.

A significant number of larvae died during the moult from stage IV to stage V, and as it was thought that this might be linked to a deficiency of calcium in the mussel diet a more varied mixture of crab meat, chopped limpets, brine shrimps and rotifers was added. Older juveniles also received a few mussel spat, necessary for the proper development of their crushing claws. The daily feeding and cleaning of the juveniles proved to be a very time consuming task, taking about four hours per day for the 750 or so juveniles in the system at any one time.

The post-larval survival rate was about 77%, a very encouraging figure. Most of the mortalities were accounted for by the deaths in the stage IV/V moult, and by an outbreak of fungal infection. Similar outbreaks have been observed in other hatcheries where they have been resolved by UV filtering of incoming water, and by periodic removal of detritus.

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Release

After about four weeks of ongrowing, more than 500 juvenile lobsters were released into the sea in September, followed by over 500 more in November, on the rubble breakwater adjacent to the College. With its holes and crevices this should provide a suitable habitat for them to survive and grow. An attempt to release the juveniles by divers from individual pots was not a great success as the juveniles were reluctant to leave the pots.

A Stage V juvenile lobster (~25 mm long) ready for release into the sea, with an adult (6-8 years old) for comparison.

Instead the approach used in other release programmes was adopted, whereby the juveniles were washed down a 3" diameter flexible pipe from the surface. A diver controlled the bottom of the hose, directing it into suitable holes and crevices. The operation was monitored by underwater camera and many of the juveniles were seen to occupy holes. It is hoped that in five to six years time the released lobsters will have grown to marketable size.

Conclusions

This pilot project has provided valuable experience and knowledge of the operations of a lobster hatchery. Despite the basic nature of the systems used, and the short lead-in time, the results were extremely encouraging.

It is planned to scale up the hatchery to full commercial size in the next couple of years, with a view to producing some 30,000 juvenile lobsters per annum for release into the sea. This should significantly increase the numbers of lobsters in Shetland waters and, on the basis of the survival rates of released juveniles determined in other lobster release programmes, could double local catches of lobsters after five or six years.

Particular attention will be focused, in the new hatchery, on improving the efficiency of the hatchery systems, i.e. decreasing the space and labour requirements, while increasing larval survival rates.

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