
The Potential for Crayfish Aquaculture in Northland

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Executive Summary

There are two species of crayfish available for aquaculture in New Zealand, the red rock lobster (*Jasus edwardsii*) and the packhorse lobster (*Sagmariasus verreauxi*). Both species appear to be well suited to aquaculture in Northland, being robust and relatively fast growing.

For the packhorse lobster the difficulty is in obtaining seed lobsters for on-growing because there is currently no known wild supply of packhorse lobster seed. Experimental hatchery rearing of packhorse larvae is underway by NIWA, but this will require further technological development before a commercial source of seed will be available. Not a great deal is known about the on-growing of packhorse lobsters, however, indications are that it will grow faster in culture than the red rock lobster, especially at the water temperatures typical in Northland.

For the red rock lobster, wild seed lobsters are available for capture and subsequent on-growing. Wild seed lobsters are currently being harvested and on-grown by several commercial aquaculture concerns in reasonable numbers. Further technological development is required for improving the scale and cost efficiency of collecting lobster seed from the wild. A great deal of information is known about on-growing this species of lobster, including food and holding requirements, growth rates etc. Conservative economic analysis of this data indicates that land-based aquaculture of this species may not be profitable using current technology. There may be opportunities to improve farming technology and efficiency, thereby greatly improving the economic prospects for lobster aquaculture. Developments in sea cage aquaculture of lobsters in New Zealand indicate that this method of on-growing may provide the best prospects for the commercial aquaculture of this species in areas such as Northland. More detailed accounts of the issues associated with lobster farming in Northland have been outlined in this report.

Introduction

The aim of this report is to outline the commercial potential for the development of crayfish farming in Northland. This report draws together and summarises previous research and experience in this field of aquaculture. Additional material has been appended to this report to provide more specific detail on the economics of lobster farming, the life history of lobsters and some further detail on aquaculture research results. Further more detailed technical information on crayfish farming is available from NIWA on request.

Crayfish, or rock or spiny lobsters, are highly prized and valuable seafood that are harvested in many parts of the world. Total world landings are around 75,000 tonnes valued at over US\$500M. The production from the global wild fisheries for crayfish have been static for a number of years, and there are indications that some of the wild fisheries are now in decline due to overfishing.

In recent years there has been extensive experimentation in the aquaculture of crayfish around the world. In most cases the biggest obstacle to commercial scale aquaculture has been obtaining a sufficiently large seed source. Eggs and larvae are difficult to raise in an aquaculture hatchery due to the long and complex larval period in the life-cycle of these creatures (See attached figure). Only small numbers of seed lobsters have been raised from eggs as part of expensive scientific research programmes. Consequently, it is currently not commercially viable to artificially raise seed lobsters in a hatchery.

The collection of seed lobsters from the wild provides an alternative to artificially reared seed lobsters. There have been difficulties catching sufficient numbers of early seed lobsters for aquaculture due to a lack of knowledge about their natural habits. However, in recent years very good numbers of seed lobsters have been taken from the wild in New Zealand for ongrowing and technological improvements in catching techniques have been continuing to increase catches of seed lobsters from the wild.

Commercial aquaculture from seed lobsters taken from the wild is now underway in Vietnam, Indonesia, Taiwan, South Africa, Australia and parts of the Pacific and the Caribbean, as well as New Zealand. Mostly, this aquaculture activity is on a small scale and is limited by the availability of the wild seed source.

New Zealand has two species of spiny lobsters that have aquaculture potential; the red rock lobster, *Jasus edwardsii*, and the packhorse lobster *Sagmariasus verreauxi*. The red rock lobster is found throughout the country and has considerable wild seed supply around the east coast of the central North Island, which is being accessed on an experimental scale by commercial interests in Coromandel and Marlborough. The packhorse lobster is mostly found around the northern half of the North Island. Currently there is no known wild source of seed packhorse lobsters and very few seed lobsters of this species have ever been caught in New Zealand waters.

Hatchery Seed Source

Broodstock

The breeding of both red rock and packhorse lobsters is well understood. In the wild the female lobsters mate and then place their fertilised eggs on the underside of their tails in late autumn to winter. The eggs are incubated for four to six months depending on the water temperature. Females produce a single brood of eggs per reproductive season. Both species of crayfish have been successfully bred in the laboratory and it is considered that the reproductive cycle of the adults can be manipulated mainly through the use of controlled water temperatures and mate availability. For example, the incubation period of the eggs can be delayed for many weeks by holding the brooding mother lobsters in colder water. Doing this would enable a year round supply of fresh eggs for hatchery rearing. The eggs are easily collected and hatched to tiny swimming larvae in captivity. Lobster broodstock are relatively easy to maintain in closed and open seawater holding systems. Lobster broodstock can be fed mussels, which provide a nutritionally complete diet.

Larval culture

The first successful culture of red rock lobster from egg to puerulus (the post-larval stage or “seed” lobster) was carried out in Japan in 1986 and shortly afterwards for packhorse lobsters. Scientists at NIWA have also reared both species from egg to puerulus in small numbers. For red rock lobsters the larvae have a very long period of development through 11 larval stages taking a total of 200 to 400 days. By contrast the packhorse lobster has a much shorter larval period of between 220 and 273 days. To maintain healthy larvae in continuous culture for this long time requires maintaining high quality culture conditions. The lobster larvae are planktonic (i.e., live and feed in the water column) and the culture system must allow them to remain suspended in the water column usually via an upweller or water current system. The larvae are particularly intolerant to rapid changes in seawater quality and to the build up of organic wastes from the larvae and the breakdown of unused food. There are also problems with pathogenic bacterial infections that can attack and kill the larval lobsters in large numbers.

There is little knowledge of the preferred natural food of the larval stages (phyllosoma). Many researchers have used brine shrimp nauplii extensively as food for the early larval stages of lobsters. NIWA has had good success with 2 - 3mm brine shrimp for the early larval lobster stages and 4mm brine shrimp for the later larval stages for both species of lobster. Chopped mussel flesh has also been used successfully as a food for lobster larvae in Japan. NIWA have also used chopped mussel flesh for feeding the later larval stages. Brine shrimp have the advantage that they are a live feed, which does not deteriorate in the culture tank providing the daily feeding ration is managed carefully. The brine shrimp can be cultured and nutritionally enriched with micro-algae, yeast and micro-encapsulated diets. The brine shrimp ration can be delivered slightly in excess of the phyllosoma requirements to ensure adequate feeding. There is, however, a potential to introduce disease organisms into the lobster larval culture by way of feeding the brine shrimps. The major problem with the use of live brine shrimps for feeding lobster larvae is the cost and the scale of operation needed to produce sufficient for commercial levels of lobster larval production.

Mussel flesh material and manufactured diets for larval lobster rearing also have problems. These larval foods start to deteriorate as soon as they are delivered into the culture system and then the water quality maintenance has to be carefully monitored to ensure that bacterial contamination of the system due to the breakdown of the food is not harmful to the larval lobsters. The food ration delivered to the culture needs to be carefully monitored to ensure that there is little waste. The tight control of the feeding of the lobster larvae may be critical to ensure that there is little waste food that would

otherwise contaminate the culture conditions. Australia and New Zealand scientists are currently putting considerable research effort into overcoming the technical difficulties in supplying a highly nutritious but biologically inert feed for use in rearing larval lobsters and considerable advances are likely in the next few years.

Overall, the development of commercial rearing of larval lobsters for aquaculture will be largely dependent on reducing the duration of the culture period and improving survivorship. At this point there appears to be some opportunity to reduce the larval development period under hatchery conditions. However, a great deal of further research and development is needed before the larval culture of rock lobsters becomes commercially viable. For New Zealand the best short-term prospects for commercial rearing of lobster larvae are with the packhorse lobster because it has a much shorter larval development period and the larvae appears to be more robust than the red rock lobster. Recent research by NIWA has suggested that higher water temperatures and the supply of sufficient food material could reduce the larval rearing period for larval packhorse lobsters by up to a third. Should it be possible to rear this species from egg in a hatchery it would be an ideal aquaculture candidate for Northland, because of its superior early growth rates in the warmer Northland waters. It is very likely that techniques and infrastructure for farming red rock lobsters could be transferred directly across to packhorse lobsters should a commercial hatchery supply of seed lobsters of this species become available in the future.

Wild Caught Seed Source

Legal Controls

The Ministry of Fisheries in New Zealand controls the taking of lobsters from the wild under fisheries legislation. The Ministry has approved the issue of special permits to take early settled rock lobsters from the wild (*J. edwardsii*) for aquaculture trials under special permit provisions of the Fisheries Act 1983 (Section 64(1c)). The Ministry's aim with allowing the special permits is to trial "the viability and biologically neutrality of a system that allows adult rock lobster to be traded off against taking juveniles that have not yet been recruited into the fishery". This trade off allows 40,000 settled juveniles (or 30 kg green weight) to be collected for each tonne of Term

Transferable Quota (TTQ) for adult rock lobster that is retired for one fishing year. There is a minimum of 20,000 (0.5t TTQ) to a maximum of 80,000 juveniles (2.0t TTQ) per special permit. There is a maximum of 200,000 juveniles, or 150kg green weight or 5t TTQ per quota management area (QMA) and a national limit of 400,000 juveniles or 300kg green weight or 10t TTQ for all QMA's. TTQ used to obtain a special permit must be unfished and owned, or leased, or there should be a contract to buy or lease quota, if the special permit application is successful. This TTQ will be leased to the Crown for one fishing year at a nominal sum and will be unfished for that year. The special permit has an operational life of 3 years. The trade off arrangement to provide access to wild seed lobsters began in 1996 with the intention of reviewing the arrangement after several years of operation, however, that has not occurred.

All necessary resource consents for deploying pueruli catching devices should have been obtained or be in the process of being obtained for the grow out facility prior to the application. A certificate of compliance for the proposed catching devices (crevice type only without specific approval) also needs to be obtained. A detailed plan for the collection of juveniles needs to be submitted to the Ministry of Fisheries showing the proposed sites, the type and number of collectors and the period for collection. A detailed description for stock tracking and monitoring of the harvested young rock lobster is also needed in addition to those required for Freshwater Fish Farm or Marine Farm permits. Although the special permit allows farming of rock lobsters to be undertaken on trial there is a potential threat that the permit could be revoked at some future date by the Ministry of Fisheries. The cost of application and compliance for legal approvals to farm rock lobsters by this means are considerable, in the order of \$10,000 for permitting as well as the significant cost of trading off unfished rock lobster quota.

The licensing of rock lobster permits is handled by the Ministry of Fisheries, 118 Vickerman Street, Private Bag 14, Nelson (Phone 03 548-1069 Fax 03 546-9327). Two special permits to catch wild seed lobsters were issued shortly after the arrangement was announced, one was held by Aqua BoP Ltd, which collected wild seed lobsters from Gisborne and locations on coast north of Gisborne. The second permit was held by Hawkes Bay Aquaculture Ltd, which collected wild seed lobsters from Gisborne and Napier, and a variety of locations further south to the Wairarapa. In this time it has been estimated that well in excess of 100,000 wild seed lobsters were taken for these aquaculture ventures. A third special permit was issued in 2001 to Konaki Aquaculture Ltd, a consortium of Maori-owned aquaculture enterprises, working with the Maori Fisheries Commission and Sanford South Island Ltd. This group is continuing to collect seed lobsters from Gisborne only.

Catching Wild Seed

In the wild, red rock lobster larvae drift and feed in the open oceans for around 12 - 15 months. The larvae then metamorphose into a puerulus, which looks like a tiny transparent lobster, but is equipped with powerful swimming paddles under its tail (See attached figure). The puerulus swims and rides currents from out at sea to eventually settle in shallow water on the coast. Under natural conditions the puerulus finds a crevice or hole in which to hide whilst it undergoes further changes into a small bottom dwelling lobster. This step is known as settlement. Most of the natural settlement of red rock lobster puerulus occurs along the eastern coast of the lower half of the North Island. This is thought to be due to offshore ocean eddies in this area, which acts to accumulate the drifting lobster larvae. Consequently, much of the commercial collection of seed lobsters for aquaculture has been focussed on this coastline.

The catching of early stages of rock lobsters from the wild for aquaculture relies on collectors that imitate the natural crevices into which puerulus prefer to settle. Most of the collectors currently in use were designed specifically for scientific research purposes and are not the most efficient means of collecting early rock lobsters. However, catches as high as 600 puerulus per collector have been recorded. It is likely that further improvements could be made to collector designs to make them much better suited to commercial collection of lobsters. Likewise, further investigations into collecting locations and habits may greatly improve the opportunities for wild caught lobster seed. For this reason NIWA researchers and other groups have been investigating pueruli collection sites, collector design and attractants to lure pueruli to the collectors in an attempt to greatly improve the efficiency of seed lobster collection for aquaculture. Research to date has shown that catches of pueruli are highly seasonal and vary enormously from year to year. This may create difficulties for aquaculture operations relying on wild caught pueruli because it may be difficult to secure sufficient seed lobsters in those years when natural settlement is very low. Such variability can be overcome with technological developments that can improve overall pueruli catches. It is likely in the future that one or more operators will collect the seed lobsters to supply a range of facilities that are focused on just lobster on-growing.

Commercial pueruli catches from the east coast of New Zealand have reportedly run to over 60,000 in a year in the past. Seasonal and interannual variation in pueruli catches can be expected as the monitoring of the pueruli arrivals in this area by NIWA has shown that in some years the expected catches of seed lobsters could be more than double other years.

On-growing

Pueruli and small juveniles of red rock lobsters have been reared successfully in New Zealand and overseas mainly by scientific researchers, but also more recently by commercial operations. The two earlier commercial trial aquaculture operations for red rock lobsters in New Zealand used land-based systems for on-growing seed lobsters to market size. One operation located near Napier used a flow through seawater system that drew water out of the sea to flow through tanks holding lobsters, and then discharged the used water back to the sea. This particular system was sensitive to changes in the local water quality and consequently there were difficulties maintaining large numbers of small lobsters in the early phase of their development. The other operation based near Mount Maunganui used a fully re-circulated seawater system, where water was pumped through tanks holding the lobsters, then was discharged to a scrubbing unit, which removed the wastes from the seawater so that it could be re-used. The heavy loading of juvenile lobsters combined with the input of food into the tanks caused the re-circulation system to struggle with maintaining adequate water quality needed for the lobsters. Both initial on-growing operations were abandoned.

Subsequently, NIWA conducted some initial trials of rearing lobsters in seacages in sheltered waters. These trials have indicated that seacage rearing may offer a less capital intensive means of farming lobsters, but may involve greater risk in terms of security and climatic vagaries. The growth rates in the seacages were better than any recorded in any land-based system, and the mortalities were lower at some of the seacage sites. Based on these findings and an economic appraisal by NIWA, a third pilot scale commercial operation has proceeded to assess the performance of wild seed lobsters in a land-based unit near Coromandel, and seacages in the Marlborough Sounds and near Coromandel. Indications from this operation are that the land-based system is performing in a similar manner to previous aquaculture efforts. However, the seacage trials are providing very promising results. As expected, the growth rates

in the warmer northern waters are higher than those in the cooler waters of the Marlborough Sounds. On the basis of all these various results it would seem that seaweed culture of red rock lobsters in Northland has commercial potential.

Captured wild pueruli and young juveniles of spiny lobsters are very easily transported and quickly adapt to culture conditions. They are naturally communal and in the wild they often live in group situations where they also often grow faster than in isolation. Under culture conditions juveniles will leave the shelters during the day to feed and often aggregate in the open. NIWA research indicates that the provision of shelters for puerulus and early juveniles does not improve their growth rate, but it significantly increases their survival. Shelters can take the form of short lengths of plastic pipe or bricks placed in the tanks.

Land-based on-growing

A great deal of information is known about the aquaculture of red rock lobsters in tanks in land-based aquaculture systems. Higher densities of lobsters in captivity does appear to slow growth rates and increase mortality. The pueruli can be held at densities of up to 100m⁻² of tank space, and lobsters of 40mm carapace length are best held at up to 50m⁻², beyond 60mm carapace length holding densities of 25m⁻² will maintain growth rates up to about 80mm carapace length. Lighting regimes also appear to affect growth rates with continual lighting reducing growth significantly. Either natural lighting or continuous darkness is suitable for maintaining good growth. Summer periods may require water cooling as temperatures over 22°C begin to cause difficulties for captive red rock lobsters. Marked short-term temperature fluctuations of several degrees are also not well tolerated by captive lobsters. In terms of using ambient water temperature regimes, farming sites in the northern North Island offer the best prospects for obtaining maximum growth rates from red rock lobsters in culture, but high summer temperatures in some areas may result in higher mortalities.

Water quality is critical to the aquaculture of red rock lobsters. This should be a primary consideration when selecting a potential farming site. Similarly, it is a vital consideration when designing any re-circulation system for holding spiny lobsters. Spiny lobsters are intolerant of high levels of seawater contaminants. The dissolved oxygen in seawater should not be less than 4.0mg l⁻¹ and the total available nitrogen

should not be greater than 0.5mg l^{-1} in an open circuit seawater system. The total available nitrogen should not exceed 0.1mg l^{-1} in a re-circulated seawater system.

The interactions between the various factors that control growth and survival of aquacultured lobsters need to be better understood. At the commercial level there is a need for more detailed technical information on food conversion efficiencies and the effect of high stocking rates, minimum water flow and minimum water quality requirements. Research to date suggests that in general water exchange of $0.5 - 1\text{min}^{-1}$ per kg of lobster held in the tank seems to be critical to removal of body wastes and maintaining oxygen levels. These are relatively high water exchange rates especially for larger animals approaching harvest size of 300g.

Seacage ongrowing

A great deal less is known about the seacage culture of red rock lobsters. The research conducted by NIWA several years ago provides the most detailed information (see appended publication). In this study seed lobsters were grown for a year in two types of sea cages at three sites and regularly fed on opened mussels. The three sites were the Waitemata Harbour, Wellington Harbour and Kawau Island in the Hauraki Gulf. The experimental seacages consisted of plastic buckets and packing crates suspended beneath floating bouys. Lobsters in the two northern sites showed the fastest growth rates, that were higher than those previously recorded in land-based culture systems. Mortalities were higher at the northern sites, although this appeared to be associated with extreme summer water temperatures at one site (over 24°C) and densities of animals that were much higher than in previous land-based aquaculture systems.

Overall, these results indicate that suspended sea cage culture has considerable potential for the aquaculture of spiny lobster juveniles, but will require the careful selection of sites and the development of effective feeding and seacage arrangements. This work is well underway by a consortium of aquaculture interests based in Coromandel and Marlborough, however, details of their seacage farming developments are not publicly available.

Nutrition

There is very little knowledge about the nutritional requirements of spiny lobsters, although there has been some research on the nutritional requirements of the American lobster, which belongs to a related group of animals, the clawed lobsters. The food cost of any lobster aquaculture operation is likely to form a large part of the input cost based on preliminary estimates for food conversion rates in red rock lobsters. For natural foods the wet weight food conversion ratios ranges from 4:1 to 15:1 (food conversion ratio = wet weight of food consumed : increase in body weight). Therefore the food cost may make up over 50% of the total cost of a farmed lobster. In the longer term an artificial diet is likely to be the cheapest and most efficient option for lobster aquaculture, while natural feeds may serve in the shorter term. The development of an artificial diet will require considerable research and development before becoming a commercial reality.

In the wild, lobsters will feed on a wide range of natural marine foods. Lobsters may be cultured using natural marine foods providing there is a continual supply of the fresh food at a reasonable cost. Fresh mussels are considered to provide a nutritionally complete diet as juvenile lobsters have grown quickly when they have been fed on only mussels under experimental culture conditions. A diet of mussels may be a viable option for the aquaculture of lobsters, however, the cost of buying farmed mussel product may be prohibitive for lobster culture (mussels wholesale for around \$1:80kg⁻¹). The large Greenshell™ mussel industry produces considerable quantities of waste mussels, which may be as much as 5000t a year. This waste includes another mussel species, the blue mussel, which is also a suitable as a feed for lobsters. It may be possible to better utilise this mussel waste for lobster farming, and this is currently being done by lobster seacage farmers in the Marlborough Sounds. To utilise this waste stream effectively it may be necessary to consider locating lobster farming operations in the vicinity of mussel farms to avoid the unnecessary cost of freighting the large quantities of waste mussels that would be required in a commercial scale lobster farm. Alternatively, mussels could be cultivated alongside a lobster farm, in order to provide a large, convenient and low cost supply of suitable food. The economics of doing so would need to be compared against alternative options, such as artificial foods.

Diseases

Spiny lobsters are considered to be hardy and robust and appear to be relatively free from disease. This may change when the animals are intensively cultured. The high stocking densities required for an economic lobster aquaculture operation coupled with inadequate control of water quality and nutrition will substantially increase the potential for disease. This will be exacerbated if elevated temperatures are used to increase growth rates in a land-based aquaculture system.

Several diseases have been reported in spiny lobsters. However, few lobster diseases have been reported from New Zealand, although a fungal infection is known to infect juvenile lobsters in land-based on-growing systems. Poor holding conditions will also cause mortalities under culture condition and these can be caused by nutritional, environmental (both physical and chemical) and toxic agents. Again careful attention to the water quality and husbandry technology will mitigate against these effects.

Transport

Lobsters are commonly transported live for over 48 hours by chilling in water and then dry packing in thermal containers with minimal handling of the animals. Small juvenile lobsters can easily be transported over 24 hours live in seawater provided a constant water temperature and oxygen levels are maintained and the animals are not over-crowded. Wild caught lobsters are currently transported from all over Northland to Auckland ready for live export by air. A number of lobster holding depots are currently in operation in Northland, including Whangarei, Awanui and Whangaroa Harbour. These facilities could conceivably be used for holding lobsters before shipping on to Auckland.

Currently small live lobsters of the size anticipated being produced from aquaculture are supplied out of the special Karitane fishery in the South Island. Attempts at live exporting these smaller lobsters to Japan have reportedly met with high mortalities. The cause of these mortalities is unclear, however, it could be possible that it is related to the small size of the animals. If this is the case, it may be necessary to develop

improved live transport methods for small aquacultured lobsters. Recent development of live lobster transport methods in Australia indicates that a number of potential improvements could be made to improve the survival of live-shipped lobsters.

Processing

The traditional methods of processing and presenting wild harvested adult spiny lobsters are straightforward. From New Zealand many lobsters are chilled, packed and air-freighted live to wholesale markets, particularly in Asia. These lobsters generally fetch the highest prices. A small proportion of wild caught lobsters sold from New Zealand have their tails removed and these are chilled or frozen before dispatch. The US market has traditionally preferred tails rather than whole lobsters, however, the returns from these markets are lower than for live lobsters.

Small lobsters (up to 350g) from aquaculture present opportunities to extend the processing and presentation to add value to the product. These small animals will initially be ideal for niche marketing, both for export and domestic markets. However, export markets have the potential to be developed further for these small plate-sized lobsters by improving their presentation. Further processing could include the development of lobsters packaged as oven or table ready items. The development of these products would be ideal for the increasingly important high quality instant food market.

Taste tests on farmed lobsters indicates that when fed on mussels their flavour tends to be sweeter and crisper than wild caught product.

Markets

In 2001 the lobster exports from New Zealand were worth around \$124M making up nearly 10% of our fisheries export returns. The largest export markets for lobsters

were Hong Kong (61%) and Japan (20%). There are thought to be further opportunities for marketing lobsters in the USA, Canada and Europe, particularly as well packaged and presented product. The average FOB* price for live lobster during this period was \$48/kg. (* FOB - Free on board. The value of export goods, including raw material, processing, packaging, storage and transportation up to the point where the goods are about to leave the country as exports. FOB does not include storage, export transport or insurance costs to get the goods to the export market).

The aquaculture of lobsters offers the opportunity to deal with lobster markets in a different manner to fisheries product. Lobster fisheries are often seasonal and the size and quality of the product can be variable. Lobster aquaculture offers the opportunity to guarantee year round supply to markets of a product that is of a consistent size, colour and taste. The development of direct sales to retailers based on these supply advantages will see significant new markets opened up for aquacultured lobsters. On this basis the comparison with prices for wild caught fish may not be relevant.

Market prices for New Zealand rock lobsters tend to vary considerably in relation to seasonal fluctuations in supply, demand and exchange rates. The strongest prices for small lobsters is in the Asian markets. For the smallest lobsters, the Japanese market has consistently returned the best prices ranging between \$6:50 to \$14:50 for a 300g lobster once packaging and airfreight has been taken into account. Timing of supply to coincide with ceremonial periods appears to be critical to obtaining the best prices in this market. Small red rock lobsters are preferred in some Asian markets, particularly Japan. The green-coloured packhorse lobster, however, is likely to obtain lower prices in these markets.

A domestic market for aquaculture lobsters is also present and has been supplied previously by red rock lobsters aquaculture operations, however, these lobsters were sold into the wild caught market channels, rather than seeking out restaurant market channels which are likely to receive higher prices.

A small novelty market exists in the Auckland pet store market which currently is purchasing small numbers of lobsters for on-selling to hobbyists at \$30 each.

Economic Feasibility

NIWA has previously prepared an economic assessment of the feasibility of the land-based farming of red rock lobsters using wild caught seed lobsters (a copy of this assessment is attached). It should be noted that our analysis was very conservative in its pricing and performance in a number of areas, including growth rates, feed costs, capital set up costs. Subsequent discussions with the commercial rock lobster farming operations confirmed this view. Regardless, the indications of the assessment was that land-based aquaculture of lobsters in New Zealand was unlikely to be profitable,

A preliminary assessment of the feasibility of seacage farming of red rock lobsters in Northland suggest that there is good potential for this activity to be commercially viable. A seacage farming area of 1 hectare of water space could be capable of gross returns of \$200,000 p.a. and would provide direct employment for up to two people.

Northland Situation

Suitable farming locations

Using the following criteria that have been identified for the seacage farming of red rock lobsters areas that meet these criteria in a general sense have been identified. These areas would need to be tested for seacage farming of lobsters probably on a pilot scale before proceeding with more intensive commercial development.

Site selection criteria:-

- Sheltered to semi-sheltered waters
- Waters of low natural turbidity and pollution
- Salinity of around 33ppm with little fluctuation
- Depth of between 5 and 30 metres preferably over soft sediments
- Low to medium water current conditions
- Summer water temperatures <24°C and low temperature fluctuation daily
- Close to boat and barge access and mooring point for servicing

- Potential to have suspended mussel holding/farming associated with the site
- Clear of navigation routes
- Preferably within site of visual monitoring of farm site from land
- Preferably distant from any land areas where chemical insecticides might be used on a regular basis (lobsters are very sensitive to insecticides).

On these criteria a number of sites are available, of the more sheltered sites would be in the Whangaroa Harbour, Inner Bay of Islands, and small areas in Houhora, Parengarenga, and Whangaruru Harbour. Areas in Rangaunu Bay and Doubtless Bay, and around shelter provided by the Cavalli Islands may also be suitable.

Conclusions

There are very good prospects for the commercial aquaculture of lobsters in Northland, particularly because of the high value of this species and its relatively robust nature in the seacage culture situation. Of primary concern to any business contemplating entry into lobster aquaculture in Northland is the careful selection of a farming location to take into account the water quality, feed requirements and growth characteristics of the lobsters. Of secondary concern is structuring the development of the aquaculture operation in such a manner that it has the opportunity to adjust to include the technological advances as they occur.

The prospects for lobster aquaculture will continue to improve with technological development in the following areas; culture conditions (both seacages and land-based farming), feeding, collection of seed lobsters from the wild, and larval culture methods. There is currently research underway aimed at addressing all of these issues, so that commercial prospects for lobster aquaculture are likely to improve rapidly over the next decade.