Scoping Analysis

REDCLAW INDUSTRY DEVELOPMENT

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1. PROJECT CONCEPT

GENERAL DESCRIPTION

The project under consideration is facilitation of development of a large scale (50 to 100 hectare of ponds and production target of 500 tonnes plus) redclaw farm, on a site to be determined. An initial thought is that this development may add value to the Bowen Triangle concept, the agricultural and industrial precinct under consideration to enhance economic development in the Bowen-Mt Isa - Townsville triangle. The region has water in the form of the Burdekin Irrigation Scheme, existing broad acre farming with which aquaculture may be developed as a best practice sustainable model, available land and access to transport systems.

Such a development could also contribute to water efficiency objectives, through multiple use of water and be seen as a responsible development in the context of climate change in relation to its low emissions as compared to other agricultural land uses. (E.g: grazing).

The perceptions have been that there is a combination of factors that make redclaw an outstanding candidate for major industry development, an export earner for Queensland, with sustainable competitive advantages.

Production technology is proven, financial models indicate robust profitability and there is an existing industry with profitable farms. DPIF models indicate that redclaw aquaculture is relatively capital intensive and operationally cheap, indicating true economy of scale. Globally markets are apparently large, growing and price accepting for premium crustaceans.

However the industry has not attracted large scale operations and total production is small, thus severely limiting market development. This is thought to be through the combination of:

- Industry development history – (predisposing small family developments)
- The failure of a publicly floated large scale operation in 1990 - (which was poorly considered, with obvious design flaws, but has nevertheless made investors wary)
- Lack of a well-considered and promoted business case
- Little engagement with **appropriate** interests to attract interest in investment

The steps anticipated in this project are:

- Initial desktop review of project potential to test perceptions (this document)
- Full feasibility assessment, including site considerations and market analysis
- Preparation of Information Memorandum
- Research and development of target list of investors / investor sectors
- Organisation and delivery of investment pitch to investors. This might include:
    - Website development
    - Marketing ‘kit’ to back up the feasibility report and Information Memorandum

- One on one pitches to key investor targets
- Special events to pitch this investment opportunity
- Linking with other agencies and organisations to disseminate the opportunity through their networks. (E.g: Invest Australia, Queensland Government agencies, including the DPIF Trade, Markets & Investment Group), Seafood industry organisations, CEDA – Committee for Economic Development Australia)
- Linking into events where other investment opportunities are presented

OBJECTIVES

The objectives for this document and the overall project concept are summarised as:

This document:

- Establish if there is scope for development of large scale redclaw farming, including:
  - A desktop review of the strength of the business case
  - Export market development potential
  - Sustainability
- Make recommendations as to the way forward

Proposed Project:

- Prove up the business case for large scale redclaw farming;
- Attract investment to secure the first such farm;
- Create a critical mass of redclaw production that will provide the foundation for development as a significant, viable industry and an export earner for Queensland;

2. KEY FINDINGS

1. There is a very strong business case for development of an export scale redclaw industry, beginning with a large scale farm. In fact it is rare to find what seems to be such a robust opportunity. A long standing DPIF Redclaw Profit model tested viability of a large scale farm with 50ha of grow-out ponds. Despite high cost estimates and pessimistic return figures being assumed, the model nevertheless indicated viability, indicating the following:

Output Summary		Economic Indicators	
Annual production in kg	340,585	Net present value	$10,782,999
Annual gross revenue	$4,631,957	Annual Return	$1,098,272
Production cost	$3,533,685	Internal Rate of Return	24.6%
Product cost per kg	$10.38	Benefit / cost ratio	1.31
Revenue per kilogram	$13.60	Break even production (kg)	223,387

   Capital investment required was a little over $6 million.

2. The current industry features many small farms, which collectively do not produce enough to reliably service any significant market.

3. The industry scale and structure has been strongly influenced by the particular industry history, including:

   a. the requirement for an EIS for any farm above 5ha,

   b. DPIF literature observing that a redclaw farm required a minimum of 4ha of ponds to be viable,

   c. the approach taken to industry development at the time by DPIF, which was basically to stimulate diversification in farming operations,

   d. the failure of a public company which raised capital for a large scale farm, but failed to produce any significant crop due to ignoring technical advice.

4. The outcome is a case of market failure, as to industry investment attraction, justifying government intervention to stimulate investment, especially in view of the size of potential export earnings for the State.

5. Aquaculture globally has come from nowhere in the past 15 years, consistently exceeding FAO predictions for annual growth, to now provide almost 50% of world fisheries production. Australia, including Queensland, is far behind in aquaculture industry development, despite having some premium fisheries species. This is illustrated by Australia having 0.01kg aquaculture production per 1,000ha of coastal land, while New Zealand has 1.3kg and Japan 33.8kg.

6. Aquaculture of redclaw can be highly sustainable, especially compared to other crops. For example:

    a. Norway produces the same tonnage of Atlantic salmon as Queensland does beef (400,000 tonnes), with a similar market value. However the Norway production takes up an area equivalent in area to only four times the size of the main runway at Brisbane Airport;

    b. Redclaw require 399 litres of water per dollar of output compared to sugar (1,239 litres) and beef (571 litres) for instance. This is without adding efficiencies to be had from an integrated operation where waste water and nutrients from redclaw farming could be utilised to feed field crops;

    c. Reclaw diet does NOT require the use of fish meal or oils, unlike most other aquaculture operations and a number of stock rearing practices. This is a major competitive advantage, due to current world supplies of fish meal and oils thought not to be sustainable. At the very least there are likely to be major price increases in this commodity, apart from the questionable sustainability of using this resource to produce other protein.

7. Redclaw as a species stand head and shoulders above many others of interest for aquaculture as to their potential, especially due to:

    a. Ease of breeding

    b. Established, proven production technologies, with 3 to 4 tonnes per hectare of ponds demonstrated as feasible

    c. Low cost diet, not reliant on fish meal

    d. Fast growth rates and excellent potential for selective breeding to increase average sizes on harvest

    e. Physically robust - easy to handle, harvest and tolerates wide environmental conditions, including high stocking densities

    f. It is a lobster-like crustacean, with good eating attributes, potentially placing it into a large, premium, growing global market constrained by supply

8. There are opportunities to even further improve the appeal of redclaw as an aquaculture species:

    a. Development of a complete diet pellet to optimise nutrition and probably increase growth rates and harvest yields

    b. Selective breeding and brood stock management to produce larger animals more directly in the category of ‘small lobsters’. Initial research indicates that increased mean weights may be cumulatively increased by 7 to 9% per generation

c. Development of a purpose designed cool-chain to facilitate live trade

d. Development of more cost-effective shelter

9. Markets have never been an issue for redclaw. The key constraint has been ability to supply any significant market segment. All test shipments into markets have reportedly received favourable responses. Because there has been no significant supply, there is no existing market from which to assess demand. However likely demand is beyond almost any level of production in Queensland that could be foreseen, even in the medium to long term. (Given good marketing strategies).

10. The likely market for redclaw can be inferred from the global markets for other shellfish. There would seem to be strong export potential:

    a. World production of lobster species is around 230,000 metric tonnes and stable. There is virtually no potential for growth, yet demand is rising each year. World imports of lobster are valued at about $2.1 Billion.

    b. Darden, a US casual dining company with a specialisation in lobster dishes, is a Fortune 400 corporation with sales in excess of US$5.5 billion, yet represents only an 8% share of the US casual dining sector.

    c. Darden are concerned with the security of supply of lobster and are interested in viable alternatives to meet their specification of main meal prices of US$15. They have expressed some interest in the larger grades of redclaw.

    d. The Bay Lobster catch in Australia is between 400 and 500 tonnes, worth between A$5.2 to $8.2 million. This might not represent total market capacity, as demand could be constrained by supply.

    e. 'Crawfish', if defined as freshwater crayfish, cover a range of species globally, with only a few regarded as commercially viable for food. Redclaw would seem to naturally most fall into this class of fisheries product. Of these:

        i. Noble crayfish (Astacus actacus) are the preferred species in Europe and freshwater crayfish are a traditional food in many countries, especially in Scandinavia, where there is an annual crayfish festival. This species has been almost wiped out by 'the crayfish plague' and most freshwater crayfish consumed is now of substitute species. However Noble crayfish fetch a premium when available of up to double the price of substitutes.

        ii. The Swedes are thought to consume around 3,000 metric tonnes per annum, with 3,300 MT in Spain, 2,800 in France and 1,600 in Italy.

iii. Redclaw average sizes are thought to be larger than all the species now consumed. No extensive comparison with these other species appears to have been undertaken, nor any work on consumer preferences.

iv. Freshwater crayfish are also a tradition in the US, especially in Southern States, including Louisiana. The red swamp crawfish is the most prevalent and is exported to Europe. Average sizes are much smaller than redclaw.

v. Americans consume some 32,000 tonnes of crawfish per annum. It is a commodity and quite cheap. Nevertheless US imports are worth some US$23.7 million and the domestic crop worth some US$120 million for Louisiana.

11. Redclaw needs to be differentiated from US swamp crawfish and the Australian 'yabbie'. It is unlikely to compete against commodity prices. Its present position in Australia would seem to be on par with Bay Lobster and this is where the market seems to place it.

12. Selective breeding to produce larger animals especially appears to provide great potential to position it as a 'champagne lobster', or perhaps 'scampi'. These larger animals would place it as an alternative to the 'Maine' or 'Canadian' marine lobster (*Homarus americanus*), for which there is no aquaculture potential, there is a limit to wild caught supply and robust global demand. The marketing tags need to be carefully considered and the potential for positioning and differentiation has not as yet been realised. These marketing tags may be different in different markets.

13. Nevertheless, the review of various species above, indicate that redclaw could gain a level of market penetration into what is a huge and high value sector of the global fisheries industries. Even small successes in market penetration would provide a robust market for at least one and probably several export scale redclaw farms in North Queensland.

14. Attaining sufficient production levels to enable entry into any significant sector of the market for shellfish has always been a core constraint for redclaw rather than market potential.

15. Test shipments overseas have all produced positive feedback from merchants. Taste, appearance and average sizes (even without selective breeding) place it in a premium market segment. This is augmented by its potential to have strong credentials in sustainability and food safety as an Australian product.

16. Even if a major export operation is developed in Queensland, it will not be in a position to target 'world markets'. It will need to develop prioritized market entry strategies in order of the most practical, lucrative markets that it can feasibly service in terms of meeting demand. More information is required as input for development of such strategies. It is likely that the in market services of Austrade

posts overseas could be engaged to at least begin to provide the market data required

17. Overall, in the medium to long term, there would seem potential for redclaw to be positioned as a premium shellfish, in a market featuring increasing demand yet constrained supply. The product has the particular competitive advantage of being supported by environmentally sustainable credentials, especially the lack of reliance on fish meal. This advantage represents unrealised potential as marketing to date has not featured this.

3. RECOMMENDATIONS

The key overarching recommendation is to take this scoping analysis forward in a business planning framework, if possible, in partnership with an interested party or parties. Development of any final business plan would desirably include site selection and a specific operating entity. However, the following are actions that can take place before this stage is reached. The first two are seen as essential, while the balance are seen as highly desirable:

1. Confer with leading existing farmers as to:
   a. Review DPIF financial model with the benefit of their practical experience;
   b. Level of labour intensity of stock management systems in use;
   c. Where they see efficiencies of scale being gained

2. Conduct in depth market research, including:
   a. Objective comparisons with key shellfish product – (taste, texture, nutrition, yield etc);
   b. In market research as to wholesaler & consumer preferences & specifications, utilising the services of Austrade posts;
   c. Possibly wholesaler and consumer responses to redclaw samples in key markets. (This might only involve follow up of responses to previous shipments)

3. Develop a dialogue with the US Darden restaurant chain as to their requirements and level of interest in redclaw industry development

4. Develop dialogue with food pellet manufacturers as to production of complete diet pellet

5. Develop specifications for cool chain designed for redclaw

6. Conduct further research into redclaw strains in various river catchments and implement a selective breeding program at Walkamin for supply to farmers

4. INDUSTRY

AQUACULTURE

Growth in global aquaculture over particularly the past 15 years or so has been dramatic. While annual wild caught fishery catches have remained consistently between 80 to 90 million tonnes per annum, aquaculture production has been increasing cumulatively at around 10% per annum. The global industry has consistently outpaced United Nations FAO predictions of annual output.

Dr Peter Drucker of Harvard, an internationally respected thinker, commented on the potential in 1999. In an article in *The New York Times* as to his choice for the growth industry in the next 30 years he observed that it would not be e-commerce. He predicted that it would be fish farming.

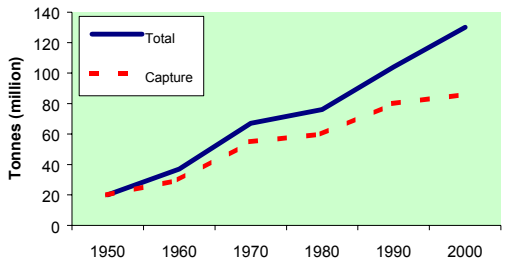
A more recent observation on the profound global changes in aquaculture comes from the office of the Chief Scientist of Queensland in a paper on realising Queensland potential for aquaculture:

> ***A revolution***. *It is some 10,000 years since the first agriculture revolution and transition of hunter-gathers into settled agriculture societies. We are now in the midst of another revolution, a transition from hunting and gathering wild resources from the sea to producing sea-food using intensive farming technologies.*
>
> (**Source:** Realising the potential- Queensland Aquaculture 2020, A Draft discussion paper prepared for the Office of the Chief Scientist – page 7)

The same paper outlines the pace of change in the following terms:

> *Since 1980, global production from marine and freshwater aquaculture has grown dramatically, and is now greater than 40 millions tons and worth about A$100 billion per annum (Figure 1).*
>
> *World wide, aquaculture is increasing in value by 10% per year making it one of the fastest growing food industries in the world. While there is an uneven contribution from different countries to the global aquaculture volumes – Asia is dominant - most aquaculture producers are experiencing significant production increases, including output in Queensland (which is 6% of national, and 0.04% of global output).* (Page 5)

Figure 1. Global Fisheries Production



Aquaculture production is therefore approaching around 50% of the total global wild caught fisheries production. Asia is the dominant producer by volume, with China said to account for nearly 70% of global volume. (According to FAO figures).

While the veracity of Chinese statistics may be challenged, it is nevertheless the largest global producer, by deliberate design.

There has been some speculation in the course of development of the aquaculture industry of its suitability for high labour cost economies. A number of examples have emerged over the past 20 years which illustrate the potential in such high cost economies. One notable example are the sea cage production systems of sea bream and sea bass in the Mediterranean, which have grown at 2,500% during the last ten years to yield a billion (AUD) dollar industry. (Reference: Chief Scientist Office paper page 6).

The same paper (page 7 – 8) lists a number of facts which places aquaculture industry development in some perspective:

- *Norway produces as many tonnes of Atlantic salmon as Queensland does of beef (~ 400,000 tonnes.) with a similar market value. If you could round up all the salmon cages in Norway they would occupy an area ONLY four times the size of the main runway at Brisbane Airport.*
- *Globally, the aquaculture sector has grown at an Annual Percentage Rate (APR) of 10.9% since 1984, compared with 3.1% for terrestrial livestock meat production. The fastest growing livestock sector over the same period was chicken meat production with an APR of 5.3%, followed by pig meat 3.4%, mutton and lamb 1.4%, and beef and veal 0.9%.*
- *Nearly one third of all fish for human food is produced by aquaculture.*
- *4000 new jobs were created in the west of Scotland in the last 10 years through aquaculture*
- *More than 1000 new jobs were created by the SA tuna aquaculture industry*
- *Vietnam plans to develop a new marine finfish industry from "zero" current production to 1,000,000 tonnes per annum within the next 10 years.*
- *Fourteen of the sixteen major fishing areas in the world are overfished*
- *About 600 marine and freshwater seafood species are caught and sold in Australia (under about 300 marketing names) for local and overseas consumption. Most known species are at or near full exploitation; several have been over-exploited.*
- *Australia has 0.01 kg of aquaculture production per 1,000 hectares (ha) of coastal land while New Zealand has 1.3 kg and Japan 33.8 kg.*

It also notes that with an appropriate approach the industry can be environmentally sustainable and in fact make a contribution to broader environmental objectives.

It is interesting to note that in a recent article by Dr Kenneth Brooks a past employee of Washington State where he served in a policy-making position as Chairman of the State Conservation Commission, he discussed the effect of salmon farming in Canada. The summary is as follows;

> *The bottom line is that the environmental cost of producing 1,000,000 kg of edible salmon is the partial degradation of 1.6 hectares of deepwater habitat for perhaps two years, while the cost of producing an equivalent amount of beef is the diversion of 3,573 hectares of upland from wildlife habitat to pasture and a decade long (or longer) degradation of our streams, rivers and lakes due to the bed load of eroded soil.*

The Chief Scientist's Office paper goes on to argue that Queensland is well-placed to develop a major aquaculture industry sector and that market failure justifies Government intervention. It notes:

> *However, Queensland has appropriate resources (physical and human) which could be brought together to capture a substantial part of the world's aquaculture production within the next two decades and generate significant regional industries worth A$2 billion per year. By international precedent, it is likely that success will depend primarily on the Government's awareness of the enormous benefits from State investment in aquaculture, and subsequent commitment to drive the transition from small scale to significant industries. This transition process involves innovation over strategic time frames and across various sectors in: (1) science to deliver ecologically sustainable technologies, (2) in management to recruit Queensland's existing strengths and expertise in land agriculture for aquaculture, and (3) in policy to create supportive financial and regulatory platforms.*

The paper makes reference to the constraint represented by the finite supply of marine fishmeal, which is of interest due to redclaw production **not** being reliant on such a supply – discussed later.

The paper makes brief reference specifically to redclaw as follows:

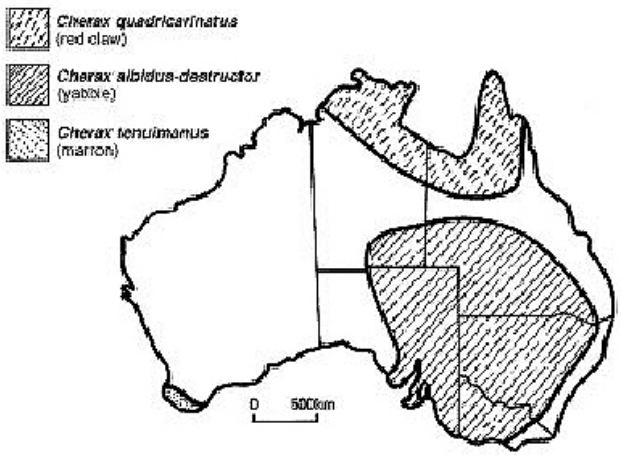
> *Red Claw offers good returns but while there is plethora of small players, there have been no entrants of sufficient size to achieve either economies of scale or continuity of supply to the market. In theory this should be a booming industry.* (Page 37)

REDCLAW INDUSTRY HISTORY

There are more than 100 species of Australian freshwater crayfish, but only three to date are regarded as a species suitable for aquaculture. These are:

- The marron (Cherax tenuimanus)
- The yabbie (Cherax destructor)
- The redclaw (Cherax quadricarinatus)

Each has distinct attributes and different natural distributions in Australia, as generally indicated in the following diagram:



Natural distributions of cultured species of Australian Crayfish

Very little was known about the culture of any Australian crayfish before 1975, the year sales of farm raised crayfish was first legalised in Australia. Since then a significant body of knowledge has been developed, especially on these three target species, with farm development gaining pace in the 1980's. A comparison of the three is included in the competitive assessment in the Market Analysis Section.

Marron tend to be the largest and for that reason attracted considerable early attention. They were the species chosen to stock some of the pioneer farms in Queensland in the early to mid 1980's. However they were soon discarded in favour of redclaw for the following reasons:

- Slow growth rate
- Tolerate only a very narrow range of environmental conditions. (Best growth in water temperatures between 21 and 24^{0}C)
- Sensitive to handling and water quality changes

Apart from being larger than yabbies, redclaw were seen to have advantages over both marron and yabbies, discussed elsewhere.

Pioneer producers with an optimistic view of the industry sent sample product to wholesalers in European markets and received quite strong, favourable responses. However they were never able to supply in the significant volumes required as minimums. This probably damaged redclaw's potential as a serious product in Europe at the time.

Various marketing names were proposed, with the industry at the time finally agreeing on the name 'redclaw'. There was some debate partly due to only the male having the distinctive red strip on the claw. However the name has endured and is what the species is now commonly known as internationally.

DPIF promoted redclaw through its extension services in the mid 1990's and two demonstration farms were established under the then *Choices* and later *Directions* Programs for the Atherton Tablelands. The emphasis of this program was to establish diversification and value adding options for farmers affected by downturns in traditional regional industries, especially tobacco.

This approach attracted many under-capitalised enthusiasts and existing farmers looking for supplementary income for their main farming activity. The result has been many small scale operations, inadequate investment in establishment infrastructure and systems and / or non-compliance with best practice, due in part to lack of skills, time and aquaculture experience.

Another factor that has influenced small scale development has been a financial model developed by DPIF, together with the conditions placed on license applications. The financial model indicated 4ha of ponds being the minimum viable farm size, while an environmental impact assessment is required for license applications for farms of in excess of 5ha. It is thought that new entrants have been wary of the EIS requirement. Current industry structure features farms of less than 5ha, with 1 -2ha farms being in the majority.

Also, once a farm grows to larger than 4 to 5 hectares of ponds, it becomes greater than a family operation. Some operators have attempted to resolve this by involving more family members, with mixed success as could be expected.

At one stage there were over 250 licences, but many found their operation to be unviable. The number of farms in Queensland dwindled to 195 in 2001 / 02, but of these 129 were not producing crayfish.

Part of the attraction for new entrants was the perceived competitive advantage that redclaw can be cheaply delivered live to market, as they will survive out of water, packed in styrene containers in cool, damp conditions. As a result operations were mostly developed with only very basic processing infrastructure to supply this live trade.

Both inherent assumptions in the above have not been demonstrated to be entirely true. Firstly the market segment that prefers live product tends to be fairly specialised. There is a segment of the market that prefers live crayfish. This particularly applies to Asian restaurants and markets catering to Asian operations, both in Australia and overseas, with demonstrated markets in Hong Kong and Japan. However generally speaking chefs are looking for guaranteed fresh, good quality product. This does not necessarily mean live. Fresh chilled and part processed tends to be preferred in busy kitchens. The last thing they tend to want is the trouble of killing, cooking and preparation time. As far as general retail to the Australian public is concerned, it is doubtful that live product would have strong appeal. There is some evidence that more farms are beginning to process their crop before shipment.

The second assumption about being robust for live transport has also been shown as not entirely accurate. Redclaw live shipments have not been as reliable as other live export seafoods. Export shipments in particular experience mortality of stock in varying degrees from minor to serious. The reasons are not entirely clear, except when a serious breakdown in the cool chain can be identified. (Such as containers left in the sun). One reason may be that shippers treat them like other species and keep the temperature too low for what are tropical animals. For redclaw, 14^0C is very cold. In any event the packaging and shipping arrangements are fairly basic at present, whereas other species shipped in higher volumes have been able to justify production of purpose designed packaging and cool chain specifications for that particular species.

The reputation of the redclaw for tolerance to a wide range of physical conditions has also seen farming operations spread into southern, temperate zones of Queensland. This has been used as a marketing strategy for farms with a prime focus on production of juveniles for the stocking of other farms and has pushed the animal's range of distribution. While the animal survives and has been successfully farmed in temperate areas, it is a tropical animal and conditions will not necessarily be optimal for production and growth, as evidenced in a 2004 article on a farm based at Kalbar:

> *Pond temperatures range from 12^0C to 32^0C with extremes of 10^0C and 33^0C. Once the temperature gets above 32^0C the productivity in the ponds falls away noticeably. At the other end of the scale, at temperatures below 15^0C – three months of the year – pond activity ceases.*

> *Winter kills do occur but not so much from the actual cold. If the onset of the cooler weather is gradual the crayfish can acclimatise but every three years or so there'll be a cold snap that creates thermal trauma in the ponds.*
>
> (Reference: Austasia Aquaculture (Oct / Nov 2004) *Redclaw pioneer explains the facts of farming life)*

There was one attempt at attraction of investment to a large scale development in 1990. This involved a public float through a company 'Farmer Johnson', a blueberry producer from New South Wales. The site chosen was Liverpool Creek, south of Innisfail. The farm had 65 ponds, each 1.5ha in area. However not all were ever stocked.

The whole project was ill-considered, ignored technical advice received and failed. In fact there were some challenges to the bona fides of the float, reminiscent of other public floats based on pioneer crops promising big returns. Since then more robust standards for public floats have been put in place under ASIC. Obvious flaws included:

- 1.5ha ponds are too large and could not be managed – (drained for harvest and control of pathogens etc);
- Stocking was based on creation of natural populations. There was no management of juveniles in ponds, selective breeding nor effective control of stocking rates;
- Harvest was based on progressive harvest for size. This left stock with the poorest growth rates as brood stock for the next generation;
- No aeration was provided to control oxygen levels. Wind action across the large pond surface area was relied upon;
- No habitat was provided. Redclaw require physical complexity in their environment. Visual inspections of ponds revealed vast central 'deserts' devoid of crayfish;
- Little protection against predators was provided in the form of adequate fencing and / or netting. Since the farm was built on an area where waterways flow east into the Pacific ocean, predators may have included eels, which are well known as serious predators of redclaw.

Reportedly each pond never produced more that 200kg, despite their size, whereas commercial growers regularly produce some 4 tonnes per hectare of pondage.

This failure has made it more difficult to attract significant investment to redclaw farming, added to by the failure of the industry to achieve the large scale potential seen for it.

What is remarkable is that **despite** this early history and structural constraints that evolved from it, the commercial production of redclaw has survived. Average prices have increased and total industry production value has shown an upward trend.

The foundation for this industry survival and much of its potential is derived from the particular attributes redclaw has as a species.

SPECIES ATTRIBUTES

Redclaw species attributes that enhance its attractiveness for aquaculture are as follow. The implications of these are considered further in the SWOT analysis later.

- Breed easily, with no larval stage development;
- Potential improvement with selective breeding, with many wild population strains to draw from. Size and flesh recovery rates could be increased;
- Tolerates high stocking densities;
- Low protein diet, not reliant on fishmeal;
- Identifiable as a high value crustacean:
    - Flesh texture and flavour compares favourably with other crustaceans
    - Meat recovery rate acceptable (equal to a little less than with Moreton Bay Bugs and crabs)
    - Has the appearance of a lobster, especially for larger specimens
- Reaches commercial size in 9 months grow out
- Survives out of water;
- Straightforward production technology;
- Tolerant of variations in water quality, low dissolved oxygen, wide daily pH changes, low alkalinity, temperature variations, high nutrient loads. (Unlike Marron, which are far more sensitive);
- Tolerates saline water, providing a means of enhancing flavour, purging and cleaning before sending to market;
- No destructive burrowing (as per Cherax destructor – 'yabbies');
- Non aggressive – cannibalism not regarded as an issue;

To place some of the above in perspective, the following table compares redclaw with two popular commercial aquaculture species – prawns and barramundi:

Criteria	Redclaw	Prawns	Barramundi
Ease of breeding	Easy, all year round	Reliant on wild broodstock	Technically demanding
Larval rearing	None, born in adult form	+28 days, technically demanding	+28 days, technically demanding
Diet cost	low protein	Expensive, hi protein	Expensive, hi protein
Amenable to selective breeding	1 year generation, proven	Difficult, not yet established	Very difficult,
Marketability	Market responses good – not proven	A commodity	High demand

INDUSTRY CAPACITY

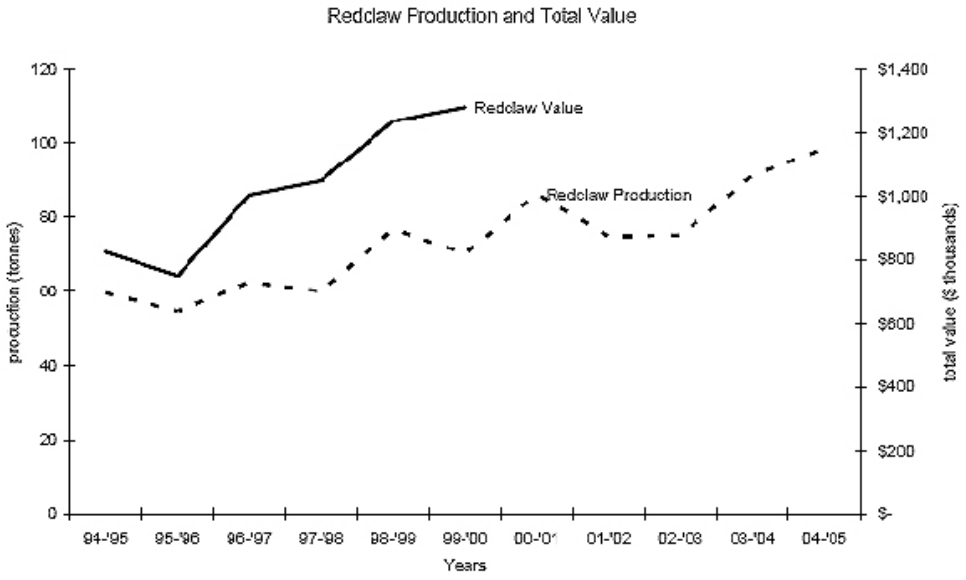
It is clear that historical factors have crippled the ability of the industry to build capacity and therefore engage with significant market segments.

The number of pond-based farms that produced more than one tonne of crayfish per annum in Queensland decreased from 19 in 2003-04 to 11 in 2004-05. These larger farms were responsible for 85% of the overall production and produced an average of around 2,789 kilograms per hectare from ponds in 2004-05. This was up from 2119 kilograms per hectare in 2003-04.

There are over 220 licensed red claw farms covering 150 ha of ponds located throughout Queensland. However, only a small proportion of the farms are producing. Production has increased by 8% to 98.6 tonnes in 2004 - 05 up from 91.3 tonnes in 2003-04. The value of production for the entire Queensland red claw sector was $1.28 million in 2004-05. Although growth is relatively low, there is significant confidence in the industry, with new investments and expansions by established growers.

(Reference: www.dtrdi.qld.gov.au)

A graph indicating trends over time as to production and value follows:



The predominance of small operations leads to fragmentation of marketing effort. It is estimated that some **44%** of product is sold locally either to retail markets such as restaurants and farm gate sales, or through local wholesalers, such as Johnny Mudcrab. Some **55%** is sold into the Sydney fish market, with live product largely finding its way to specialty restaurants. Some **1%** may be exported, largely as brood stock.

On harvest of each pond, there will be a range of sizes, representing a classical normal population distribution in a bell shaped statistical curve. This reduces industry capacity to supply volumes of one particular size grade to meet demand from a market segment.

In Australia Redclaw are commonly marketed in 20 g size grades ranging from 30-50 g (at approximately AU$11.50/kg) to greater than 120 g (at approximately AU$19.00/kg). The smaller grades are commonly used in buffet presentations, with the larger animals featuring in a-la-carte restaurants, both as entree and main course dishes.

One farm reported current 'local' per kg prices as:

30 – 50g	$12.50
50 – 70g	$14.00
70 – 100g	$16.00
100+g	$18.00

Sydney market prices were reported as $20 per kg, irrespective of size grade.

PRODUCTION TECHNOLOGY & PRACTICE

While there are still significant opportunities for improvements in culture and production technologies, production of redclaw is supported by proven technology and best practice models. These technologies are relatively straight-forward and the skill levels required of practitioners are not onerous.

Redclaw have attracted extensive interest as an aquaculture species since the early 1980's due to their broad range of strengths as a target species for aquaculture. This attracted in depth research and development work, mainly through the DPIF facilities at Walkamin, North Queensland. A selection of the reports on this work is provided as the **Attachment** to this report. Redclaw are now a proven commercial species, with 4 tonnes per hectare production being demonstrated as feasible and indeed represents commercial reality for the larger, most efficient growers.

This is a key point, as the strong combination of natural attributes plus proven technology and practice is not in place for many other species in which there is interest as an aquaculture species. Many also require the application of reasonably sophisticated technology. This is despite in some cases extensive research and effort.

Key areas where there are opportunities for improvement in the case of redclaw are:

Nutrition

A major cost in aquaculture is food supply, with it sometimes being a fine balancing act between the input cost of food per kilo produced as against the price per kilo received. According to the United Nations Food and Agriculture Organisation (FAO):

> *Feed accounts for about 60–80 percent of operational costs in intensive aquaculture, while feed and fertilizers represent about 40–60 percent of the total cost of aquaculture production in semi-intensive aquaculture systems.*
>
> (**Reference**: United Nations, FAO Fisheries Department, *State of world aquaculture 2006* FAO Fisheries Technical Paper 500, page 60 - ISBN 978-92-5-105631-8)

Major components of most feed formulations for aquacultured species are fish protein and oils. This source of protein is finite and more likely to shrink than expand over time.

Global catch levels can certainly be affected by weather conditions, such as the impact of severe El Nino patterns in the Pacific on the Peruvian anchovy fishery – an important world source of fishmeal. There are questions about the ultimate sustainability of the practice of feeding fishmeal in aquaculture. However it also represents a barrier to the ongoing expansion of aquaculture globally and a significant financial risk. The FAO describes the situation in the following terms:

> *Since 1985, global production has stabilized at 6 to 7 million tonnes of fishmeal and one million tonnes of fish oil (IFFO, 2006). This means that the expanding aquaculture and livestock sectors will be competing for a resource that is not increasing – a situation that has been referred to as the "fish meal trap" (FAO, 2002). Under a situation of apparently limited supply of fishmeal and fish oil, and assuming little or no improvement in the efficiency of use of fishmeal and fish oil, the expansion of some types of aquaculture could be constrained if not altogether stopped. Even with stable (neither increasing nor decreasing) supplies of raw fish for fishmeal production, it is also argued that the growing demand for fishmeal will continue to drive the price of fishmeal and fish oil upwards. Upon reaching a certain price level, the use of fishmeal and fish oil may no longer be financially viable. This highlights the need to reduce reliance on fishmeal and to improve the efficiency of use, and considerable research is currently underway in many producing countries.*
>
> (**Reference**: United Nations, FAO Fisheries Department, *State of world aquaculture 2006* FAO Fisheries Technical Paper 500, page 61 - ISBN 978-92-5-105631-8)

In the case of redclaw, their nutrition requirements are well understood. Their requirements are one of their most important competitive advantages compared to most other aquaculture species. **Redclaw do not require a high protein, fishmeal and oil based diet.**

Reclaw are naturally omnivores. In the wild, their food is mostly decaying plant and animal material or detritus. Bacteria and fungi associated with the decomposition process are nutritious and particularly high in protein. It is not necessary for redclaw to consume animal material to obtain a protein supply.

In aquaculture farming operations, the practice adopted has been generally a supplemental feeding regime. This is partly due to no complete diets being available for redclaw, as for marine prawns for instance. It is also partly because commercial growth has been achieved by distributing low cost, low protein, high carbohydrate pellets in combination with organic matter. This stimulates the detrital food chain. The pellets are either ingested directly and / or the food chain produces small invertebrates suitable for the redclaw. Growers reported that redclaw feed is available from Ridley's, on the Atherton Tablelands for $595 + GST, (Including the refundable bulk bag cost).

However while commercial growth rates are being achieved, it is thought that nutrition regimes and so growth rates could be improved with production of an improved commercial feed as a complete diet formulation. This would be straightforward due to the level of understanding of their nutrition requirements and would still not require fish based proteins. For instance redclaw can derive proteins from grains. However the industry is not presently large enough to justify a manufacturer producing such a formulation.

This represents a future opportunity to build on the pre-existing key competitive advantage redclaw nutrition requirements represent.

Selective Breeding

Aquaculture is a very young industry compared to other agricultural pursuits (with perhaps the exception of China). It is worth noting that in most forms of animal production, the process of stock improvement through selective breeding has been practiced for many generations and has usually resulted in enormous improvements to productivity.

There are many examples of the gains achieved. Chickens are a recent reminder of the extent of potential, illustrated by the following passage as part of an examination of the potential of the aquaculture industry:

> *The study compared the growth, food conversion ration (FCR) and cost/unit meat produced from 1957 and 1991 strain chickens reared with 1957 and 1991 formula feeds. The major difference in this table is between the genetic strains of chickens regardless of feeds. The 1991 strain chickens grew more than three times as fast as the 1957 strain chickens on both 1957 and 1991 formula feeds. Over a thirty year period from 1957 to 1991, it was possible to increase their growth rate threefold by using genetics and stock selection.*
>
> (**Reference**: Lucas *Aquaculture: Farming Aquatic Animals and plants*)

There is strong evidence to support the view that major gains can be made through selective breeding and better stock management regimes for redclaw. There are a number of strains which occur across this species' range. This variability of biological characteristics provides a basis for domestic stock improvement. To date the Gilbert and Flinders River strains have indicated advantages as to numbers of young, fast growth rates and tolerance of high densities. Not all strains have been assessed so there may be further potential in wild stocks for improvements.

Some long-standing redclaw farmers have selectively bred their perceived 'best' crayfish and cross-bred strains to improve their stock. There are clear indications that these improved stocks are superior to wild, undomesticated stock, and to stock from farms where managed reproduction has not occurred. This is supported by research findings.

Experimental work carried out on redclaw (Jones et al. 1998) demonstrated that the heritability of growth rate in redclaw is at least 24%. It is probable that further work will determine that heritability is even more significant as experiments with yabbies Cherax destructor and marron C. quadricarinatus (both closely related to redclaw) show that heritability of growth rate is between 30 and 60% (Lawrence 1998). Assuming one generation of selection per year, an annual improvement in growth rate (or weight at a given age) of 5 to 10% could be expected.

This work was confirmed in an experimental selective breeding program, conducted at DPIF facilities at Walkamin. After only two generations of selective breeding (selecting for fast growth rate), the yield was increased by 9.5%. This research provides the basis for some prediction of what could be achieved for the future. If a five year time frame is

adopted as a reasonable period in keeping with corporate planning horizons and more conservative annual gain of 7.5% adopted, the following results can be modelled. These are based on real data from a harvest of 3,125 animals of Walkamin stock in 2005:

Harvest Period	Mean Wt.		Yield (Tonnes/ha)		Gross Value	
	Year 0	Year 5	Year 0	Year 5	Year 0	Year 5
9 months	56.7g	81.3g	3,963	5,091	$40,688	$71,792
12 months	85.0g	122.0g	5,949	8,311	$76,598	$124,437

While the above is theoretical, it demonstrates the order of gains thought possible, which would dramatically affect the profitability of redclaw farming. It should be noted that the above is based on mean sizes. However at present It is common knowledge that growth rate in a crop of redclaw is extremely variable. A pond of redclaw, stocked together after hatching and grown for 12 months, may be represented by crayfish ranging in size from 40 to 200 grams, excluding juveniles reproduced in the pond.

A breeding program may serve to narrow the size variations in the pond and so provide a higher proportion of larger stock, which generally attract a higher price per kg. There should also be more animals of 200gm plus. This is an important point as at this size, they are more likely to gain premium market recognition as 'small lobsters', rather than 'crawfish' (Europe) or 'yabbies' (Australia).

At present this potential is largely unrealised. In fact the opposite process may be occurring on some farms.

While no one is likely to select inferior stock deliberately, at harvest time it is normal practice to cull all the biggest crayfish (usually greater than 50 to 60g) and sell them. In an effort to maximise return on investment, it makes economic sense to sell everything that is marketable. Sub-marketable crayfish are left in the pond, or restocked elsewhere. Although small, many of these crayfish are sexually mature and are likely to breed. The offspring from such breeding often become the stock for restocking of harvested ponds. This effectively represents a selective breeding program for slow growth rate which may quickly lead to a significantly reduced mean size for each crop and therefore reductions in total production, price per kilogram and the proportion of marketable crayfish.

Stock Management

The ease with which redclaw breed is both a significant strength and weakness. Because redclaw breed so readily and profusely, the pond populations must be managed intensively. Without management, ponds become overcrowded and control over genetic strains and production is lost. Farmers have observed females as small as 15 grams berried with eggs.

An active stock management approach is an accepted component of best practice management for redclaw farming and a range of management practices are employed by existing farmers, no doubt at varying efficiency levels. These may include DPIF

recommendations to stock ponds with known numbers of advanced juveniles of at least 5g mean weight.

No matter what systems are employed, stock management is a major component of redclaw farming, which represents a major call on farm resources. It is suspected that this is one facet of the industry which contributes to the preponderance of small operations. Small family operations absorb the labour intensity, whereas such labour costs could be unacceptably high for large commercial operations. This is not necessarily a barrier for large scale operations, which would need to adopt state of the art feeding, harvesting, sorting and process systems and technologies.

In pond breeding may also be a factor in industry preference for harvest after 9 months grow-out as the most cost effective at present.

There is currently a joint project between DPIF and the Israeli Ben Gurion University of the Negev to develop monosex populations in crustacean aquaculture production, using endocrine and molecular manipulations. (QICARP Research project QB-9308-06). It is not known when or if this might produce techniques suitable for redclaw, but the prospects for success are reportedly encouraging.

This should contribute to increased stock management efficiency, but there would seem to be scope for a review of this area of husbandry in consultation with the industry to seek improved systems.

Shelter

Redclaw live in river systems with varied environments which they appear to make extensive use of. Ponds require habitat and these have been provided over the years utilising a variety of systems and materials. These have included discarded tyres, onion bags, prawn net remnants, pistia (‘water lettuce’) and short lengths of plastic pipe. Plastic pipe habitats appear to be the most appropriate for adult grow out ponds, but are time consuming to fabricate. At least one grower purchased his own plastic extrusion machine to address the issue.

A large scale farm will require a great deal of habitat and the most cost effective system would need to be established.

Live Packaging

As noted above, current live transport arrangements are fairly basic. Purpose designed cool-chain packaging and cool-chains would be of benefit.

WATER EFFICIENCY

Global demand for fresh water is predicted to produce widespread water shortages, beyond the local effects seen for centuries with variable weather patterns. The performance of any crop in terms of water usage efficiency will therefore grow rather than diminish in importance. The following demonstrates where redclaw sits with respect to other crops and production systems, in comparing the number of litres required to produce one dollar worth of output, set out from highest to lowest water usage:

CROP	Litres of Water per Dollar Output
Rice	4,700
Cotton	1,600
Milk	1,470
Sugar	1,239
Beef	812
Barramundi (in ponds)	571
Redclaw (in ponds)	**399**
General fruit and vegetables	379
Wheat	245
Barramundi (in re-circulating tanks)	25
Hydroponic lettuce	6
Aquaponics (ie barramundi & lettuce)	4

Certainly in the case of redclaw, it should be possible to achieve higher efficiencies through integrated agricultural and aquaculture systems. This would utilise waste water and pond wastes from ponds to irrigate another crop. This water tends to be high in plant nutrients due to crayfish wastes and thus achieves two crops from a single unit of water.

CONSTRAINTS

Redclaw is an existing industry with proven production technologies and viable operators. However there are a number of constraints to achievement of its full potential as an industry, canvassed in this section. These are summarised below (marketing strategies are considered more comprehensively later):

- Small scale operations due to historical factors that skewed development to 5ha developments;
- Consequent to the above, lack of ability to reliably supply any but the smallest local market;
- Some loss of confidence by investors after failure of the only large-scale farm attempted;
- Lack of industry standard practice in breeding and stock management limiting availability of desirable grade sizes;
- In pond breeding spreading harvest sizes, creating the need for labour intensive stock management and possibly limiting growth rates due to crowding;
- Lack of complete diet formulation possibly leading to less than optimal growth rates;
- Lack of emphasis in marketing on environmental credentials;
- Cost / labour intensity of providing appropriate in pond habitat / shelters;
- Lack of purpose designed cool chains for optimal live product delivery to market.

All the above appear capable of being addressed. As such, they represent more opportunities than constraints.

Since the structural issues have been in part created due to the approach initially taken to industry development and in view of the apparent strength of the industry development opportunity, there would seem to be a strong case for government intervention.

5. SWOT Analysis – Large Scale Redclaw Farm

The analysis is to assess the potential of redclaw in broad scale pond farming to underpin its development as a significant commercial aquaculture industry in Queensland. As such it is broader than the species attributes discussed previously:

STRENGTHS	STRATEGIC IMPLICATIONS	POSSIBLE RESPONSES
Breeds easily, no larval stage	▪ Lowers costs & risks of production ▪ Increases attractiveness as an aquaculture species as compared to others ▪ Reduces need for rearing infrastructure and specialist skills	▪ Place emphasis on this attribute in attraction of industry investors
Low protein diet, not reliant on fishmeal	▪ **Significantly** reduces industry risks, in the face of likely supply constraints and price escalations as to fishmeal ▪ Reduces costs & competitiveness ▪ Increases industry sustainability ▪ Increases attractiveness as an aquaculture species as compared to others	▪ Place emphasis on this attribute in attraction of industry investors as a **major** competitive advantage
Proven high yields per hectare (4 tonnes)	▪ Reduces overall risk for new industry entrants ▪ Improves base lines for profitability	▪ Place emphasis on this attribute in attraction of industry investors
Optimal nutrition requirement well-understood	▪ Reduces overall risk for new industry entrants ▪ Provides opportunity for production of holistic diet ▪ Optimises growth rates	▪ Develop action plan to achieve commercial production of optimal diet formulation ▪ Place emphasis on this attribute in attraction of industry investors

STRENGTHS	STRATEGIC IMPLICATIONS	POSSIBLE RESPONSES
Lobster like appearance	▪ Increases market appeal in premium market sectors ▪ Supports premium pricing ▪ Positions redclaw to take up excess demand for lobster / crayfish	▪ Undertake detailed market research to supplement existing ▪ Re-assess current market positioning with the benefit of market research input
Flesh texture & flavour compares favourably to other crustaceans	▪ Sustains competitive positioning against other crustaceans ▪ Supports premium pricing	▪ Factor into marketing strategies ▪ Draw attention to this attribute in attraction of industry investors
Strong growth rates	▪ Reduces production cycle ▪ Supports profitability	▪ Draw attention to this attribute in attraction of industry investors
Survives out of water	▪ Reduces weight / costs in live shipments ▪ Increases ability to service market sector preferring live shipments ▪ Provides a hardy animal for harvest & processing operations, thus reducing losses	▪ Design cost effective live packaging system ▪ Establish, implement & promote optimal cool chain specification
Straightforward, established production technology	▪ Reduces overall risk for new industry entrants ▪ Increases attractiveness as an aquaculture species as compared to others	▪ Place emphasis on this attribute in attraction of industry investors ▪ Adopt the philosophy of continuous incremental improvement.
Model redclaw farm health plan in place	▪ Reduces risk & establishes disease risks are manageable ▪ Reduces difficulty in new farm establishment	▪ Draw attention to this in attraction of industry investors
Species attributes highly suitable for pond culture	▪ Reduces overall risk for new industry entrants ▪ Reduces risk of stock loss due to errors in pond management & changed environmental conditions ▪ Increases attractiveness as an aquaculture species as compared to others	▪ Place emphasis on this attribute in attraction of industry investors

STRENGTHS	STRATEGIC IMPLICATIONS	POSSIBLE RESPONSES
Large, established global markets for commercial 'lobster', 'crayfish' & 'crawfish' species	▪ Increases confidence in market potential & so investor confidence ▪ Increases the likelihood of significant export earnings for Queensland ▪ Supports the case for allocation of resources for industry development	▪ Market research to specifically determine market prioritised market targets, entry, growth and positioning strategies ▪ Effective marketing strategies to achieve profile & recognition
Some market recognition established	▪ Proven appeal & reduced risk for new entrants ▪ Established excess demand over supply market conditions	▪ Place emphasis on this attribute in attraction of industry investors ▪ Consult with established customers as to their ideal specifications & requirements
Clean, green Australian product image	▪ Improves competitive position compared to other countries' product ▪ Increase ability to achieve & sustain premium export prices	▪ Emphasis in marketing strategies

WEAKNESSES	STRATEGIC IMPLICATIONS	POSSIBLE RESPONSES
Breeds too easily	▪ Increases time & costs involved in stock management ▪ Produces percentage of non-commercial sizes at harvest, with disposal / usage issues ▪ Creates a barrier to entry for large operations with significant labour costs	▪ Consult with existing significant operations as to what they have found to be best practice ▪ Review and appraise model for best commercial practice ▪ Support research for production of monosex production
Current industry features small commercial production disbursed over small operators	▪ Produces fragmentation in marketing ▪ Dilutes presence in multiple markets ▪ Reduces ability to target and service market segments ▪ Precludes entering retail markets & limits product to niche markets ▪ Increases difficulty in creating substantive product profile ▪ Reduces ability to meet industry support needs, such as: o Special diet formulations o Habitat production o Technology to extract tail meat	▪ Facilitate development of larger scale operations ▪ Develop marketing group concept with reference to Western Australian model for marketing yabbies through a central agency
Live product to market predominant	▪ Limits appeal to specialty markets ▪ Increases difficulty in supply chain requirements ▪ Reduces product range	▪ Include processing infrastructure in business model for significant farm developments

WEAKNESSES	STRATEGIC IMPLICATIONS	POSSIBLE RESPONSES
Wide variation in sizes at pond harvest	▪ Increases the number of grades an reduces volumes available for targeted market segments	▪ Develop technology for extraction of tail meat ▪ Investigate options for use of under-sized animals. E.g: Use as foundation for 'lobster bisque / sauce' as flavour base and additive for chef's redclaw recipes ▪ Adopt partial harvest regime ▪ Selective breeding program
Identification as either a yabbie or 'crawfish'	▪ Reduces ability to gain standing as premium crustacean in Australian markets ▪ Creates confusion with US Louisiana crawfish in Europe and reduces ability to gain standing as premium crustacean in that market	▪ Develop marketing & promotion strategies to differentiate product ▪ Aim for production of larger average sizes than yabbies ▪ Leverage larger sizes in Europe to take advantage of an apparent market drift towards crayfish, away from 'crawfish' ▪ Undertake market research in Europe as to why the traditional crayfish astacus astacus ('noble crayfish') command higher prices than other species ▪ If possible associate redclaw as perhaps a 'tropical noble crayfish'
Detailed knowledge on the nature of export markets lacking	▪ Increases risk ▪ Increases difficulty in formulating effective export marketing strategies	▪ Definitive export market research, including identification of customer requirements, preferences and specifications, together with market testing of redclaw in target markets

OPPORTUNITIES	STRATEGIC IMPLICATIONS	POSSIBLE RESPONSES
Increase average size for classification as 'small lobster'	▪ Provides capability to access premium markets featuring increasing demand, but finite wild caught supply ▪ May generate increased interest from potential investors ▪ Emphasises importance of selective breeding program	▪ As per item 2 under 'strengths'
Development of optimal diet formulation	▪ Increases production efficiency & yields ▪ Optimises competitive advantage of low cost diet	▪ Increase industry production levels to justify commercial production of optimal diet formulation
Freshwater crayfish a highly valued traditional food in Sweden and other European countries	▪ Provides incentive to expand industry production to achieve export capacity ▪ Points to a need to establish processing to specification to suit Swedish & European customer requirements	▪ Research customer requirements in Europe & supply to specification ▪ Analyse systems, costs & risks in export to Europe as to profitability, compared to other markets (Asia, US, domestic)
Creation of sustainable integrated farming systems with minimal to beneficial environmental impacts	▪ Increases water usage efficiency ▪ Contributes to viability of mixed farming operations ▪ Increases attractiveness as an aquaculture species as compared to others ▪ Reduces difficulty in finding sites and meeting regulatory requirements	▪ Place emphasis on this attribute in attraction of industry investors ▪ Gain recognition as an 'ethical investment' industry ▪ Include options for integrated model in site selection & feasibility assessment for large scale redclaw operation
Demand for crustaceans is increasing in global markets	▪ Increases scope of market opportunities ▪ Increases demand gap between supply and finite wild caught markets	▪ Place emphasis on this attribute in attraction of industry investors
Asian markets for live seafood are significant	▪ Increases market scope & appeal of product if reliable live transport systems are developed	▪ Market research & confirmation of customer specifications ▪ Development of best practice transport and cool chain systems ▪ Comparative consideration with other markets to set market entry priorities

OPPORTUNITIES	STRATEGIC IMPLICATIONS	POSSIBLE RESPONSES
Increased production of a range of processed products	▪ Extends the range of market sectors that can be targeted & supplied ▪ Increases capability to access retail markets	▪ Market research into target market preferences & requirements
Development of specific packaging & cool chain for live transport	▪ Increases ability to access export markets with a preference for live seafoods	▪ Develop packaging & systems
Application of Western Australian (cooperative) yabbie marketing model	▪ Increases ability of small producers to supply significant markets ▪ Provides more orderly marketing	▪ Develop appropriate cooperative marketing model for inclusion in marketing and distribution strategies
Better technology for optimal stock management systems	▪ Decreases labour costs and increases viability for especially larger operations	▪ Support research into improved systems ▪ Consult industry regarding existing practices ▪ Support development of monosex production
Production of more cost-effective habitat	▪ Decreases costs ▪ Increases likelihood of sufficient habitat being provided ▪ Increases likelihood of optimal animal growth and health	▪ Analyse options for habitat production
Food technology systems to extract tail meat	▪ Extends product range ▪ Increases ability to find markets for under-size animals ▪ Increases profitability	▪ Determine markets and financial viability for tail meat production ▪ Research available systems & their applicability ▪ Support new technology as appropriate
Existing Industry access to export markets	▪ Increases existing industry operators opportunities for growth & diversification across more markets	▪ Consider options for the proposed export scale farm to act as an industry hub for export

OPPORTUNITIES	STRATEGIC IMPLICATIONS	POSSIBLE RESPONSES
Use of uneconomic sizes for value-added product	▪ Potential for increased profitability & total use of biomass available ▪ Increased product appeal with complementary product ▪ Increases ability to manage stock for optimal size production	▪ Use small animals on harvest to create enhanced flavoured ingredients for lobster bisque, chowder and sauces for redclaw
Establishment of a hub for regional farm distribution systems	▪ Increase supply available to service a market segment ▪ Facilitate wider adoption of product standards ▪ Provide access for smaller farmers to significant markets	▪ Examine the West Australian model for cooperative marketing of yabbies
Diversification of existing North Queensland aquaculture entities	▪ Reduce risk to operations through diversification ▪ Increase access for redclaw to established marketing and distribution systems	▪ Market opportunity to existing industry

THREATS	STRATEGIC IMPLICATIONS	POSSIBLE RESPONSES
Fuel price increases	▪ Increases likelihood of lack of viability in markets remote from production centres	▪ Maintain diversification as between domestic and export markets ▪ Build retail market in Australia ▪ Target domestic growth areas, such as tourism centres and high population growth areas
'Food carbon miles' concept becomes a consumer benchmark	▪ Increases barriers to participation in markets remote from production centres ▪ Increases need to present the environmental credentials of the industry	▪ Develop the environmental credentials of the industry as part of the marketing strategy ▪ Review the Tourism Tropical North Queensland 'Planet Safe Partnership' campaign for application to the redclaw industry
Competition from production of same or like species in low cost countries	▪ Less competitive in export markets ▪ Increases need to build on and support Australian product reputation for quality, cleanliness and health	▪ Develop and adopt an Industry Quality Assurance scheme ▪ Build Australian brand recognition to include quality, cleanliness and health messages ▪ Adopt a policy of no export of live improved stock strains ▪ Pursue the development of mono-sex population techniques

6. PRODUCT

The following considers redclaw as the basis for a range of products, rather than its attributes as a species, discussed earlier.

FEATURES

- Commercial size range possible from 30 to 200gm
- Lobster like appearance
- Is confused with yabbies in Australian markets
- Attractive shell colours live & make interesting live displays in restaurants
- Cooked shell is a lobster red colour
- Flesh to weight recovery tests on unimproved stock (1990) indicated recovery was widely variable (14.5% to 36.9%) with a mean of around 24%. Contemporary industry advice is that with improved strains, the mean is now between 28 and 30%
- This compares to weight recovery for:
    - prawns (49 – 52%),
    - lobster (40 – 45%)
    - crab (25 – 30%),
    - Bay lobster (28-30%)
    - Yabbies (12%)
    - Marron (26%)
- Taste and texture subtle, sweet and judged to be of good quality
    - At least equivalent to Bay Lobster
    - Superior to yabbies
    - Equivalent to Marron
- Large animals (200gm +) may rate as small lobsters

PRODUCT RANGE

Present size grades being sold into the market and typical farm gate prices are:

30 – 50gm
50 – 70gm
70 – 100gm
100+gms

Product options utilising these grades encompass:

- Live to restaurant for aquarium display
- Graded sizes for restaurants
    - Entrée
    - Main course
    - Decorative

- Frozen
    - Whole
    - Halved
    - Tail meat
- Chilled
    - Whole
    - Halved
    - Tail meat
- Cooked to Swedish specification for export
- Cooked for retail (Frozen, chilled, whole, halved, tail meat)
- Perhaps processed under-sized crayfish as bisque or sauce base for restaurant trade
- Aquarium specimens ('Runt' surplus stock sizes)

There may be an opportunity for large redclaw (200gm+) as a substitute for lobster. This is subject to the ability to produce sufficient quantities, with flesh recovery ratios close enough to that of lobster.

KEY SELLING POINTS

Redclaw have been well-received in virtually all markets in which they have been trialled, over the past 15 years, with the common complaint from wholesale merchants domestically and internationally being availability.

Key selling points, (distilled from 'features' above), would appear to be:

• Lobster like appearance	identifies it as a premium seafood
• Texture and flavour	reinforces expectations derived from appearance
• Attractive colours	for live aquarium presentation and red cooked, especially for Scandinavian requirements
• Live presentation	for those markets placing a premium on this
• Size grades	suitable for a range of restaurant applications & includes the traditional size preferred for the annual Scandinavian crayfish festival
• Eco-friendly	sustainable, low environmental impact and safe

PRICING

It was reported that typical prices being received farm gate are presently:

30 – 50gm	$12.50 / kg
50 – 70gm	$14.00 / kg
70 – 100gm	$16.00 / kg
100+gms	$18.00 / kg

This is into regional local markets. Sydney markets are presently paying $20 / kg for all grades.

7. MARKET ANALYSIS

GLOBAL FISHERIES MARKET

Globally fishery industry conditions feature stable production from wild-caught sources, but increasing demand, largely being met by increases in aquaculture production. At the same time international price trends have been overall downwards. Increasing demand is thought to be fueled at least in part by perceptions of 'seafood' being healthy and partly by increasing living standards. The situation is summarised by the FAO:

> *Capture fisheries and aquaculture supplied the world with about 106 million tonnes of food fish in 2004, providing an apparent per capita supply of 16.6 kg (live weight equivalent), which is the highest on record (Table 1 and Figure 1). Of this total, aquaculture accounted for 43 percent. Outside China, per capita supply has shown a modest growth rate of about 0.4 percent per year since 1992 (following a decline from 1987), as growth in supply from aquaculture more than offset the effects of static capture fishery production and a rising population.*
>
> (**Reference:** FAO -*The State of World Fisheries and Aquaculture 2006* page 3)

The majority of the volume of trade is in lower value products as a source of proteins and oils.

The same document later observes:

> *While fish supply from wild capture fisheries has stagnated over the years, the demand for fish and fishery products has continued to rise. Consumption has more than doubled since 1973.* (Page 88).

Consolidation of power to global retail chains is producing an impact on market based standards for all foods, including seafood, with some direct implications as to the market conditions for suppliers. These are highly significant for redclaw aquaculture production. The following extracts from the above FAO publication (Pages 88 – 90), are therefore of considerable interest as to the market and market opportunities for redclaw:

> *As a result of the globalization and expansion of international food trade, the food industry has experienced significant consolidation and concentration in the industrialized countries. This has led to the emergence of fewer but more powerful food firms, with substantial bargaining power vis-à-vis other players up and down the supply chain. Although wholesale and restaurant chains strongly influence fish distribution in many countries, power has been shifting to the retailers as a result of increased consolidation of retailers, inter alia, into supermarket chains and the growth of goods produced under a retailer's or private label. This supermarket system is expanding rapidly to developing countries in Africa, Asia and Latin America. As the last link in the supply chain between producers and consumers, retailers have seen their responsibility towards consumers increase, resulting in a greater need for controlling safety, quality and other food attributes to prevent any risk of damage to their reputation.*
>
> *……*

The growing importance of global trade in fish has developed in a setting of the increasing influence of civil society and consumer advocacy groups over the agendas of governments, companies and international organizations on different aspects of the food systems. Food demand has been changing with the evolution of lifestyles, demographics and increase in household incomes. Increasingly demanding consumers expect not only safe and high-quality foods but also a transparent and informative trail that can be used to trace the origin of food, its quality, and the environmental and/or social conditions current during its production, processing and distribution. Retailers have been translating and transmitting these consumer Selected issues in fisheries and aquaculture demands back through the supply chain to producers and processors by developing standards.

……..

Global coalitions for setting food safety standards, such as the Global Food Safety Initiative (GFSI) and the British Retail Consortium (BRC) have emerged. The economic losses and negative publicity impact of food scares are so high that firms in such coalitions have agreed that food safety is a pro-competitive issue of high importance for the coalition members.

……...

There is increased concern that expanding international fish trade may further strain the sustainability of fish stocks and the marine environment and, where resources are not effectively managed, impede efforts to reduce pressures that drive overfishing. As a response, several retail companies have committed to purchasing only fish harvested from certified sustainable fisheries.

……...

Small but potentially lucrative market niches (organic aquaculture, fair trade, etc.) have also emerged, which private companies try to enter and occupy.

……...

The market standards currently used in international fish trade primarily address consumer protection and resource sustainability. Small market niches are governed by specific standards such as "label rouge" in France, "Quality Mussels" in Ireland or Canada or "organic farmed fish" labels. Furthermore, some countries and producers' associations have established labels to certify implementation of best practices or codes of conduct.

……

In the past decade, significant resources have been used worldwide in the seafood industry to promote the purchase of seafood only from sustainable sources, and several major corporations have built comprehensive food-sourcing campaigns around sustainable seafood initiatives. These initiatives aim to tap into growing consumer demand for environmentally preferable products, channelling purchasing power towards seafood products from sustainably managed fisheries and/or aquaculture activities.

> *Consequently, a number of ecolabelling initiatives have been introduced in the fisheries sector as market-based incentives to improve fisheries management systems. Ecolabels are certifications given to products that are deemed to have a lower negative impact on the environment than other similar products. By appealing to consumer preferences, the ecolabelled products may generate higher returns than those that either do not qualify for ecolabelling or those whose producers do not seek to obtain such labelling. Several national, international, industry-sponsored, NGO-led and consumer–supplier partnership certification and standards schemes in the fisheries sector already exist – each with distinct criteria and assessment methods that have variable levels of transparency. The claims made by ecolabels also vary widely – some indicate that a product is not overfished, others focus on the absence of marine mammal bycatch and still others promise that their product is "ecosystem friendly". Some schemes focus on ensuring that a management system or process is "sustainable", while others focus on the performance or outcome of the management system.*

In a broad sense, redclaw will compete for consumer attention against all other 'seafood'. The above trends provide opportunities for redclaw differentiation, thus higher profile and competitive advantage.

There are clearly significant, growing opportunities for fisheries products that can demonstrate sustainability and good environmental credentials. Redclaw would seem to have the opportunity to be a certified, 'ecolabelled' product. Integration into mixed farming systems that use any excess water and waste products will add to this status, as will the fact that no fishmeal need be used in feed pellets. This, if added to Australia's general reputation for quality, safe fisheries products should be a significant competitive advantage.

It can be expected that 'eco credentials' will become even more important as the concept of 'food carbon miles' is taken up. Already the French wine industry is using this as a powerful marketing tool against Australian wine in Europe.

While perceived Australian standards and 'clean, green' image is presently an advantage against many Asian produced product, seen as having questionable standards, global trends and pressure will see Asian producers increasingly striving to meet better standards. This will produce more competitive pressure on Australian products to perform well in this area.

AUSTRALIA

The latest Australian Bureau of Resource Economics (ABARE) Fisheries statistics provides a review of Australian fisheries. The overview notes in part:

> *In 2005-06:*
>
> - *The volume of Australian fisheries production fell by 13 per cent to 241 000 tonnes, while the value of fisheries production increased by 1 per cent to $2.13 billion*
> - *The value of Australian exports of fisheries products remained steady at $1.5 billion*
> - *The value of Australian imports of fisheries products increased by 8 per cent to $1.3 billion.*
>
> *Overview*
> *Production in Australian fisheries has recently been affected by unfavourable movements in a number of important macroeconomic variables. Fishing effort and catches have been influenced by cost increases, particularly fuel prices, which have reduced profit margins for operators. Many fisheries have also been affected by reductions in total allowable catches, changes to access arrangements and more restrictive input controls. The appreciation of the Australian dollar since 2002-03 has simultaneously made exports less competitive and imports more attractive to consumers.*
>
> (**Source:** ABARE 2007, *Australian Fisheries Statistics 2006*, Canberra, June – Page 1)

Australia is generally an importer of low value fisheries products and exporter of small volumes of high value species. As the above report notes:

> *In value, Australia's major production species are rock lobster, prawns, abalone and tuna. Despite fluctuations in value, on average these four species account for more than half of Australia's gross value of production (55 per cent in 2005-06). (Page 2)*

The price trend for these species has been downwards, partly due to the appreciation of the Australian dollar. However the downward trend is also being driven by increased competition from aquacultured product internationally, especially from China. Prawns are an illustration noted in the above report:

> *The real gross value of production of prawns has fallen by 42 per cent since 2000-01. This is the result of a 23 per cent fall in production quantity and a 24 per cent fall in average real prices. Local producers have faced competition from imported prawns, particularly from Viet Nam and China. Approximately 60 per cent of Australia's prawn production is sold on the domestic market, yet over the past decade the quantity of imported prawns more than doubled, while the price nearly halved. This has reduced the price that Australian buyers are willing to pay for domestic caught prawns.*

More recently, labelling requirements as to country of origin of product in Australia have reportedly seen a resurgence of local support for Australian product, thought to be mainly due to the perception of it being better, safer and cleaner.

Although aquaculture production growth in Australia has not kept pace with world trends, it has nevertheless grown to be an important component of fisheries production, especially in high value species such as salmon, trout, tuna and pearl oysters. The above report notes:

> *Between 1996-97 and 2005-06, aquaculture's share of the total value of Australian fisheries production grew from 25 per cent in to 35 per cent.* (Page 8)

Japan, Hong Kong, Chinese Taipei, United States and Peoples Republic of China are the main export destinations for Australian fisheries products. Until recently Japan was the largest market, but Hong Kong overtook Japan as the main export market in 2005-06. The above report outlines the export value as follows:

> *The total value of Australian exports of fishery products increased by $5.3 million in 2005-06, to $1.55 billion.. Rock lobster remained Australia's most valuable fisheries export product, followed by pearls, abalone and tuna.* (Page 9).

In the case of an emerging new product such as redclaw, it would seem sensible to look to established export markets for development, dependent on market preferences and requirements in the various possible market targets.

CRUSTACEANS

Most pertinent for redclaw are the market conditions for crustaceans and crayfish style products in particular. These tend to lie at the higher value, premium end of the market spectrum and therefore fit with Australia's export emphasis in fisheries products.

Lobsters

There are a number of lobster species fished commercially world wide. They are no doubt one of the premium fisheries products, with strong and growing global demand. There is limited growth potential from wild caught species and perceived potential for larger redclaw to be developed to take a place as a component of this market. The nature of this market segment is therefore of interest.

Whatever the scale of redclaw production developed in Queensland, it will be a minor component of a large, valuable segment of the fisheries industry. According to FAO and ABARE figures:

- World production of lobster increased steadily from 157,000 metric tons (MT) in 1980 to more than 233,000 MT in 1997 before stabilizing at levels near 230,000 MT through 2003 and rising to about 239,000 MT in 2004. Catches of American lobster (Homarus americanus) and spiny lobster (Panulirus spp.) accounted for 67 percent of world lobster production in 2004. Other important species included European lobster (Homarus gammarus) and rock lobster (Jasus spp.).

- The United States and Canada are the world's largest lobster producing countries, accounting for 37 percent of global production in 2004. Other major producers included the United Kingdom, Australia, among others.

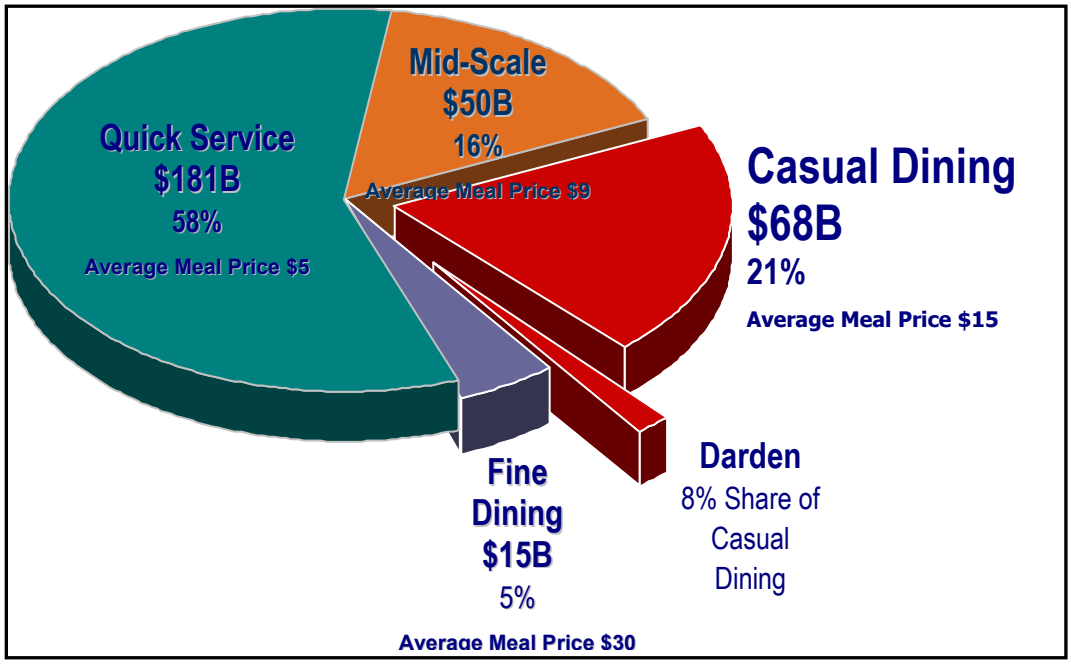
- For 2005-06, Australian production was 16,170 tonnes, valued at $470,366.

- World exports and imports of lobster grew steadily over the last decade. World lobster exports rose 87 percent, from $1.2 billion in 1992 to $2.2 billion in 2004, due primarily to increased sales of frozen and fresh/chilled products. World lobster imports increased 63 percent, from $1.3 billion in 1992 to $2.1 billion in 2004, due mainly to increased demand for frozen and particularly live products in the hotel and restaurant sector.

- The United States was the major importer of live lobster with $290 million in 2004, followed by Canada with $138 million, and France, Spain and Italy, each with imports exceeding $50 million. The United States remained the largest importer of all lobster products, accounting for $1 billion or nearly 47 percent of global imports, followed by Japan with $178 million.

Further insights into the US market, its potential and relevance flow from the *5th National Rock Lobster Congress*, held in Cairns in August 2007. A paper presented by George Chamberlain and executive Darden Restaurants, a large US restaurant chain with a specialty in lobster meals noted:

- Darden is a Fortune 400 corporation with sales in excess of US$5.5 billion in the 06-07 year;
- It is the largest casual dining restaurant company in the world, with over 160,000 employees & ranking 25 on the list of largest corporate employers in the US;
- It has 1,400 restaurants in the US and Canada and a Red Lobster licensee in Japan (Red Lobster being one of their brands);
- US consumer spending on food and beverage totals some US$1.3 trillion, with restaurant industry sales comprising US$314 billion of this;
- Of the US$314 billion, Darden has **only an 8% share** of the casual dining sector, indicated in the following pie chart:



The same presentation went on to quote from an FAO report, which indicated:

> *US imports of spiny/rock lobster total approximately 10,000 tonnes a year. The vast majority consists of frozen tails from Brazil, the Bahamas, Nicaragua, Honduras and Australia. The US also imports approximately 1,000 tonnes of live spiny/rock lobster annually, primarily from Mexico. Some frozen spiny/rock lobster is alo imported from New Zealand, South Africa and increasingly China.*
>
> *Domestic spiny/rock lobster consumption is estimated to grow by 6% annually.*

The presentation went on to outline the state of global lobster fisheries and Darden's concerns in this regard, as not only can no growth be expected in supply but also some fisheries are over-exploited, with the consequent prospect of collapse. One response by Darden has been establishment of an Environmental Trust.

In follow up discussions with DPIF Officers at the conference, Mr. Chamberlain reiterated Darden's concerns. Their challenge is how to source supply in the face of increasing demand, with a finite resource and still deliver average meal prices of $15.00 for their casual dining market segment. He indicated the company is considering options and would certainly be interested in larger redclaw.

Bay Lobsters

(*Thenus spp*.), commonly known as Morton Bay Bugs in Australia are an established seafood in Australia. Their flavour, size range and prices, place them as a comparable product to redclaw. Information on world trade in this class of lobster species was not sourced. However the Queensland catch was estimated to be 400 to 500 tonnes as a by-product of prawn and scallop trawling, with a wharf-side value of $5.2 to $8.2 million as at 2001.

It would be reasonable then to take 500 tonnes as providing some idea of the potential market for redclaw in Queensland. This assumes that redclaw can be positioned as a similar class of product and that increasing demand for crustaceans generally ensures minimal displacement of one product for another. These seem not unreasonable assumptions. Of course bay lobster demand may be a lot higher than 500 tonnes and is simply constrained by supply. However, even at this level, production in Queensland alone in 2001 was over five times the size of the current 2007 redclaw industry.

Crawfish

There are large numbers of freshwater crayfish species globally but only a few established as fisheries products. It is of course in this group that certainly the smaller grades of redclaw will compete most directly. However due to the higher average size of redclaw, it may find a final position somewhere between rock lobster and crawfish, as a new class of seafood on its own. As such there is really no market data directly relevant. It is also more difficult to establish a clear market snap shot for freshwater crayfish globally. This is partly due to the various generic names under which the different species are grouped in reporting, which leads to some confusion including the possibility of mixing saltwater 'lobster' or 'crayfish' figures with the fresh water varieties.

Three species of particular interest are discussed below:

Noble Crayfish *(Astacus astacus)*
This was the most common species of freshwater crayfish in Europe, also known as the 'European crayfish'. It was originally widely distributed and is found in France, throughout central Europe, to the Balkan Peninsula and North as far as the British Isles, Scandinavia and the western parts of the former Soviet Union. It has been a prized traditional delicacy in Europe for well over 1,000 years. It is considered the finest edible crayfish in Europe and attracts a premium price, often twice the price of the Signal crayfish, which is a substitute.

Sweden has had a traditional crayfish festival in August since the Middle Ages, based on Astacus astacus and this has spread to Finland and other Scandinavian countries. The consumption of crayfish has become a significant part of Scandinavian culture, including the August *krafstkiva* festival marking the end of summer.

Crayfish are cooked to a traditional recipe, involving adding crayfish to a pot of water with salt, sugar and crowns of dill (harvested after the plant has flowered) - some recipes also call for a small amount of beer. The shade of red the crayfish turn after cooking is reportedly also a part of the specification for this market.

Today the vast majority of crawfish are imported from Spain, China, Turkey or the US, due to the decline in Astacus. These exporters prepare the crayfish to Swedish specification for exporting. An Australian export operation to this market would be likely to need to do the same.

Males reportedly grow 'up to' 16cm long and females to 12cm. In terms of size redclaw would seem comparable, but probably on average larger. It would be interesting to know the basis for the price premium Astacus attracts. Is it tradition only, or more tangible? How does redclaw compare to Astacus as a food product and could it compete directly with Astacus, Signal crayfish and other imported product? These appear to be unanswered questions, but critical if the Scandinavian and EU markets were to be targeted. If it could be positioned as being on par with Astacus, it would be likely to attract a substantial premium on its price point.

Dredging of waterways and acid rain are thought to have contributed to a major decline of the Astacus. However the most significant impact has been that from the 'crayfish plague', inadvertently introduced into Europe through US species.

Signal Crayfish (*Pacifastacus leniusculus*)
It is not clear from the literature if this crayfish was the prime agent for the spread of the crayfish plague which has devastated Astacus populations, or was a response.

Apparently Swedish biologists searched for a crayfish that could replace the native European crayfish (Astacus). It is not clear if this was to find a cheaper substitute for Astacus, or in response to crayfish plague that had already devastated native populations.

In any event, They found the signal crayfish and started to introduce it into Swedish rivers and lakes.

The species is endemic to northwestern USA and southwestern Canada, from where it was introduced into more southerly states, as well as into Europe and Japan. It is an aggressive competitor and has been responsible for displacing indigenous crayfish species wherever it has been introduced. This has caused difficulty for efforts to reintroduce Astacus. In addition, as a vector for the crayfish plague fungus, Aphanomyces astaci, to which all non-North American crayfish are susceptible, but to which it is relatively immune, it provides an ongoing threat to native species.

Males are up to 16 cm in length from tip of rostrum to end of telson, females up to 12 cm; much larger individuals have been recorded, i.e. 95 mm carapace length. The weight is typically 60 and 110 g at 50 and 70 mm carapace length.

Both Astacus and Signal crayfish are produced in Sweden but only in small quantities, with only 49 metric tons produced in 2002, according to a USDA report on Swedish fishery products. (Lexmon, A USDA US Embassy Stockholm (2003) *Sweden Fishery Products Annual 2003*)

The above figure may refer to wild-caught, excluding aquaculture, as it does not line up with estimates of local and imported product consumed later in the document. At the same time the document refers to aquaculture in Sweden as being 'relatively limited'. No figure is given for crayfish aquaculture production.

Red Swamp Crawfish *(Procambarus clarkii)*
This is one of the two commercially important species often collectively known as 'Louisiana crawdads'. The second is the white river crawfish *(Procambarus zonangulus)*.

The Wikpedia entry for this species notes that:

> *P. clarkii grows quickly, and is capable of reaching weights in excess of 50 gm, and sizes of 5½–12 cm long. It is also able to tolerate slightly saline water, which is unusual for a crayfish.*

The species therefore shares its tolerance to saline water with redclaw, but its average size would seem to be smaller.

They have been a traditional and favourite food dating back to the native Americans and early European settlers. They are regarded as an inherant part of Louisiana culture.

Both market incentives and technological advances have expanded the Louisiana crawfish industry to include farming as well as fishing in the wild. In the 1960's, crawfish farming made its debut with the cultivation of crawfish in man-made ponds, using controlled water levels, forage management and water reticulation techniques to produce a highly marketable product.

During the next 35 years, crawfish farming developed into the largest freshwater crustacean aquaculture industry in the United States. Louisiana leads the nation, producing more than 90% of the domestic crop. More than 1,600 farmers produce

crawfish in some 111,000 acres of ponds. More than 800 commercial fisherman harvest crawfish from natural wetlands, primarily the Atchafalaya Basin. The combined annual yield ranges from 75 million to 105 million pounds (34 million to 47 million kg). The total economic impact on the Louisiana economy exceeds US$120 million annually, and more than 7,000 people depend directly or indirectly on the crawfish industry. (Source: Louisiana Crawfish Promotion and Research Board website. http://www.crawfish.org/pages/history.html)

Some of the production is exported, with some supplied for the Scandivanian crayfish festival in August each year. There are third party reports that these are prepared according to Swedish recipes and specifications in the US before export.

There would seem to be little opportunity for redclaw to compete directly with the Louisiana product in the US. It is a traditional well-recognised food, there are no particular indications of short supply to meet market demand and it is traded as a commodity, at commodity price points.

This is not the case in Europe, US crawfish is a substitute for a preferred product. There would need to be further analysis to determine its competitive position, as is the case with other fresh water crayfish supplied to this market.

In the US, there may be potential as a substitute for salt water species, in the case of the large redclaw that might feasibly be produced,as discussed earlier under the section on Lobster. A 1997 paper from the US Auburn University of Alabama on Australian redclaw included the following comment on market potential:

> *No one knows what price red claw crayfish will bring in the U.S. A market for red claw will have to be developed. If red claw have to compete in the native crayfish market their production will not be economically feasible. Because of its size (4 to 6 per pound), however, it should fall into a totally new market niche and not compete with native crayfish or large lobsters. Contacts with marketing specialists indicate that red claw should have high appeal and command a high price when sold as "small lobsters." Until large numbers are available, however, all marketing potential is speculative.*
>
> (Source: Michael P. Masser & David B. Rouse (1997*) Australian Redclaw Crayfish* Southern Region Aquaculture Centre Publication 244)

US Markets

Although the above quotation is some 10 years old, the current US market situation is likely to be largely the same.

The volumes of freshwater crayfish (or crawfish) consumption are nevertheless of interest as a guage of the size of the market for this class of product.

A paper on crawfish produced through the Louisiana State Unitversity estimated that US per capita consumption of crawfish in 2002 was approximately 0.25 pounds. That translates to a total consumption of some 32,000 tonnes based on US census figures for 2002. Of this, the same paper noted that the United States imported approximately 9.1 million pounds of frozen and peeled crawfish meat during 2002, (approximately 4,100 tonnes). The value of imports during that period was US$23.7 million. (**Source**: Lutz, G; Sambidi, P & Harrison W (April 2007) Crawfish Profile, Louisiana Agricultural Centre).

EU Markets

Subject to further study, the EU is also a logical market to consider, since:

- Fresh water crayfish are a traditional, popular dish in many countries;
- This minimises the need to build market recognition and appeal;
- There is a specific festival devoted to crayfish in Scandinavian countries at which large quantities are thought to be consumed;
- The crayfish festival is at the same time each year, which on the face of it facilitates production planning;
- Traditional species are in short supply and substitutes are acceptable;
- It would seem the comparative qualities of redclaw and the Noble crayfish have not been examined. There may be the opportunity for strong competitive positioning;
- The EU is generally a large market.

Some fragmented market information has been sourced to indicate the size of this market.

The same USDA report referenced previously, provides some idea of the Swedish market. Under 'Consumption' it notes (page 4):

> *Swedes are purported to be the world's leading crayfish consumers. Swedes consider crayfish to be a very special delicacy. They are cooked according to traditional Swedish recipes using brine, dill and beer. Consumption is estimated around 3,000 metric tons per year, of which 2,500 tons are imported.*

Later, under 'Trade', commencing on the same page, the report provides some analysis:

> *Total imports of crayfish amounted to 1,782 metric tons in 2002, compared to 3,500 metric tons in 2001. Imports from the U.S. have been rather small during recent years due to a supply shortage in Louisiana and strong price competition from China, Turkey and Spain. In 2002, however, imports from China decreased substantially due to findings of antibiotic residues in Chinese fish products which caused the EU to put a temporary ban on imports of various seafood products from China. In 2002, imports from China accounted for 26 percent of Swedish crayfish imports, down from 65 percent the previous year. Imports from the U.S. amounted to 86 metric tons, compared to 100 metric tons in 2001.*

(**Source:** Lexmon, A USDA US Embassy Stockholm (2003) *Sweden Fishery Products Annual 2003*)

The two quotations do not seem to be consistent as to market size, but in general they provide some idea of aspects of the market.

Some further idea of market size and value is provided by Infofish reports (an FAO agency). Successive reports have observed that 'crawfish' imports into Europe have been declining at the same time as lobster imports have been increasing. It is thought the growth in demand for lobster is displacing crawfish demand. This is interesting for redclaw, which is likely to be a product that could 'sit between' crawfish and lobster.

Despite these recent declines the crawfish market is still significant. Their Lobster market report for June 2007, includes figures for crawfish imports to Spain, France and Italy, for 2006, as follows:

Country	Tonnes Imported	Value in $A
Spain	3,300	$135,080,160
France	2,800	$70,963,080
Italy	1,600	$35,641,700

Figures for other countries were not recorded in this report, but apart from Scandinavian countries, the above are thought to be the major crawfish markets. The report did not indicate what species are included in the category of 'crawfish', but clearly does not include *Homarus* species.

Asian Markets

As noted earlier, presently the major export markets for Australian fisheries products in Asia are Hong Kong, Japan, Chinese Taipai and Peoples Republic of China.

While it would seem sensible to build on existing major marketing chains into existing markets, the particular competitive position of Redclaw would need to be established. This is especially in a market that is geographically quite close and seems to have a preference for live product – an attribute competitors are unlikely to be able to match into these markets. Small amounts have been exported to Hong Kong and reportedly have been well-received.

However it should be noted that the Peoples Republic of China is a major producer and exporter of 'crawfish'. The species is thought to be US red swamp crawfish. In the recent past, these exports were the subject of a trade dispute with the US, with the US claiming 'dumping' at low prices which were wiping out their domestic industry. Australian produced Redclaw are unlikely to be able to compete directly with Chinese product, except on food quality and safety criteria. Again they would probably need to be established as a 'small lobster' – a new type of product differentiated to crawfish.

Scampi

Scampi became a fashionable name based on a popular European seafood. As a result, marketing efforts seem to have extended the meaning to apply to other than the original species, including to large fresh water prawns.

It is of some interest firstly due to 'scampi' having a fashion following and secondly as it refers to what is effectively a smallish lobster. According to Wikipedia and other sources:

> *Scampi is the plural of scampo, the Italian name for the Norway lobster (Nephrops norvegicus), also known as the Dublin Bay prawn (especially in Ireland and the U.K.) and langoustine (the French name). The name is used loosely both in Italy and elsewhere, though in Britain, food labelling laws define "scampi" as Nephrops norvegicus. The fleshy tail of the Norway lobster is closer in both taste and texture to lobster and crayfish than prawn or shrimp.*

Nephrops norvegicus, (pictured), is a slim orange-pink lobster up to 24cm long found in the north-eastern Atlantic Ocean and North Sea as far north as Iceland and northern Norway, and south to Portugal; it is not common in the Mediterranean except in the Adriatic, notably the north Adriatic.

The Norway lobster is an important species for fisheries, being caught mostly by trawling.

Around 60,000 tonnes may be the annual catch, half of it in the United Kingdom's waters. While the literature places the length as 'up to' 24cm, it would be interesting to know that average catch size and market preferences for size. The catch figure quoted may not be reliable, as the source was Wikipedia.

It would be useful to compare the food attributes of redclaw and scampi and the possibility / desirability of marketing as 'Australian freshwater scampi' in Europe, or some other marketing variation that associated the two.

COMPETITIVE ASSESSMENT

Redclaw is intrinsically as yet a new product in the context of the global fisheries industry. It will compete generally with all other 'seafood' products, but more specifically with shellfish. In this category, the size grades being marketed will have a significant bearing on what other products are likely to be its closest competition.

Of course other attributes (taste, texture, nutrition data, sustainability), can also play an important part, but until a market following is established, size will be especially important.

In Australia, the smaller grades risk and presently are, categorised by consumers as 'yabbies'. Internationally, these smaller grades risk being lumped into a commodity category with US red swamp crawfish.

The larger grades would seem to have more intrinsic opportunity to be categorised as a premium product. This may be as 'small lobsters', 'scampi' or other appropriate marketing sub tag to gain profile and recognition in this product class. Later the tag 'Redclaw may be sufficient on its own, depending on the level of differentiation, market penetration and level of recognition that may be achieved.

In the absence of objective comparisons with other species, especially those mentioned above, it is difficult to provide much more in the way of competitive assessment. It would be useful for these comparisons to be undertaken.

Nevertheless, the review of various species above, indicate that redclaw could gain a level of market penetration into what is a huge and high value sector of the global fisheries industries. Even small successes in market penetration would provide a robust market for at least one and probably several export scale redclaw farms in North Queensland.

Attaining sufficient production levels to enable entry into any significant sector of the market for shellfish has always been a core constraint for redclaw rather than market potential.

Test shipments overseas have all produced positive feedback from merchants. Taste, appearance and average sizes (even without selective breeding) place it in a premium market segment. This is augmented by its potential to have strong credentials in sustainability and food safety as an Australian product.

POSITIONING

As with competitive assessment, it is difficult to be definitive about market positioning at this stage, based on current knowledge, which appears mainly driven by opinion, (informed though it may be).

Size grades will have a bearing on positioning, but the objective must be to achieve recognition as a premium, quality product, with size more a determinant of **use** than price, although smaller grades will inevitably fetch a lower price. Smaller grades will be suitable for entrée, Cajun and pasta dishes, as one ingredient in the dish. Larger grades are likely to be the feature of a main course meal, much the same as a lobster or steak dish.

The appropriate positioning in Australia would seem to on par with Bay lobster for the larger grades and this seems to be where the market has placed it. Should selective breeding produce larger average sizes in commercial qualities, the positioning for these would seem to be on par with 'champagne lobsters'. In the US the positioning target would seem to be similar, with follow up discussions with Darden required.

In Europe it is less clear what the appropriate positioning for redclaw might be. It is not likely to be viable if positioned against US imports of Swamp crawfish. These imports are mainly frozen and / or tail meat only. The current redclaw average sizes are in any event larger than crawfish, and **may** also be larger than commercial grades of Signal crayfish and the traditional Noble crayfish. Further investigation of the European market, current products available and market preferences and requirements is required. It may be that redclaw can be positioned alongside 'Langoustine' or 'scampi' in this market.

There has been a small amount of export to Hong Kong, apparently with some market acceptance, but no significant market penetration due to the small quantities involved. The assumption has been for live trade. This is probably where it should be pitched, but follow up investigations in market would be useful.

Even if a major export operation is developed in Queensland, it will not be in a position to target 'world markets'. It will need to develop prioritized market entry strategies in order of the most practical, lucrative markets that it can feasibly service in terms of meeting demand. More information is required as input for development of such strategies. It is likely that the in market services of Austrade posts overseas could be engaged to at least begin to provide the market data required.

8. LOGISTICAL CONSIDERATIONS

Like any large scale operation, an export scale redclaw farm will rely substantially on efficient logistics for profitability. One of the weaknesses of some existing farms and proposals reviewed in the past is their location.

For instance, there have been proposals for redclaw developments on Cape York Peninsula. High transport costs for production inputs and product, together with remoteness from a point of export will mitigate against likely profitability.

The ideal site is likely to have the following attributes:

- Good access to regular, cost efficient transport;
- Close to sources of production input supplies, especially feed, but including other equipment and maintenance services;
- Good supply of fresh water with appropriate attributes;
- Opportunities for integration or at least a partnership with production of an agricultural crop;
- Soil with water holding qualities for minimal pond losses;
- As close as practicable to a point of export;
- Sloping site to provide gravity feed from water supply to ponds;
- Sited north of Rockhampton, at coastal to low elevation, where water temperature averages range from 26 to 31^0C;
- Access to stable, qualified labour supply. An existing agricultural area with farm labour to meet casual needs at peak times and for intermittent tasks would be useful.

The above is the ideal. Obviously any site is likely to involve some compromise.

9. REGULATORY ENVIRONMENT

Discussion with agencies indicates that there are no particular constraints seen for an export scale redclaw industry due to the current regulatory environment.

Any development is likely to have the following attributes:

- Use only fresh water;
- Inland, remote from potential runoff issues into the marine environment;
- Water re-circulation & re-use systems;
- Waste water & waste material from pond floors containing nutrients can be used as input for agricultural crops;
- It is not likely that Commonwealth approval will be necessary.

The agency web sites which set out the approvals process for aquaculture projects are:

Qld Dept Tourism Industry Regional development & Industry - Pre-Planning Guide for Aquaculture Developments:

http://www.sdi.qld.gov.au/dsdweb/v3/documents/objdirctrled/nonsecure/pdf/12896.pdf

Qld Dept Tourism Industry Regional development & Industry - Information Manual for Aquaculture Development (contains an Assessment Framework like the Guide):

http://www.sd.qld.gov.au/dsdweb/docs-bin/publications/aquamanual.pdf

IPA Guideline for Aquaculture Development Approvals :

http://www.ipa.qld.gov.au/docs/Forms/IDAS/Guides/Guide21/Guide21v1_3.pdf

10. FINANCIAL CONSIDERATIONS

No independent financial model has been developed for this scoping examination. This would be a requirement in subsequent stages of business planning, especially when 'live' assumptions can be better developed in the context of a specific site and a specific proposed operation.

However there has been a long standing model developed by the Department of Primary Industries and Fisheries, based on a hypothetical farm. This is the 'Redclaw Profit model'. For this report, this model was set up for a farm with 50ha of grow-out ponds and 7ha of juvenile ponds. The assumptions fed into the model were oriented to deliberately high estimates of establishment and operational costs, while conservative production levels and market prices were assumed.

The assumptions were based on contemporary knowledge of industry operations and conditions. There can therefore be a reasonably high level of confidence that the assumptions are derived from realistic costs and prices.

A nine month grow-out period was assumed, based on current industry practice.

Average size on harvest was assumed at 70gms. Even small increases in this figure through a selective breeding program would have a dramatic effect on yields and profitability.

A mortality rate of 30% and costs for high specification feed were assumed. It could be expected that the mortality rate would be far less and that lower cost feed would produce be equally effective.

Eleven staff members were assumed. In considering existing larger scale redclaw operations, with processing, this is generous. In addition generous amounts for netting, earthworks and other capital costs were adopted, against known cost levels.

Using these assumptions, the model indicated the following. (Model outputs are provided as **Attachment 2**:

Output Summary		Economic Indicators	
Annual production in kg	340,585	Net present value	$10,782,999
Annual gross revenue	$4,631,957	Annual Return	$1,098,272
Production cost	$3,533,685	Internal Rate of Return	24.6%
Product cost per kg	$10.38	Benefit / cost ratio	1.31
Revenue per kilogram	$13.60	Break even production (kg)	223,387

Capital investment required is in the order of $6 million. Positive cash flow is achieved in the fifth year. Production cost per kilogram is high compared to that reported by existing

redclaw farmers, but their calculations may not adequately factor in the labour costs of the owner.

For the purposes of this study, one existing and successful redclaw farmer was prepared to supply his own financial model for examination. This provides some cross-checking of the DPIF model. This private moel is based on the DPIF redclaw profit model, but incorporates changes in assumptions and formulae to reflect his actual experience. The model does include an estimate for hired labour costs, but makes no allowance for owners' labour. Due to commercial in confidence considerations, only general comment can be made as follows.

Based of an assumption of a discount rate of 6% on NPV, an IRR in excess of 19% is projected over 10 years and in excess of 25% projected over 20 years. The model shows a negative cash flow for the first four years, which is encouraging, as models that demonstrate positive cash flows too early are often optimistic.

Cost of production was calculated to be a little over $5 per kg. The model is based on an average weight of 70gm, price per kilo of $15 and pond production level of a little less than 3 tonnes per hectare. As noted earlier, Sydney market prices are reportedly currently $18kg for all grades.

There would therefore seem to be cause for a high level of confidence that a large scale redclaw farm could be a profitable operation and attractive investment. This is especially if the investor has some linkages into existing fisheries marketing and distribution supply chains.

11. RISK ANALYSIS & IMPEDIMENTS

IMPEDIMENTS AND GENERAL RISK

At this desktop, scoping level, no critical impediments or unacceptably high risks have been identified that would block development of an export scale redclaw industry in Queensland. That is not to say there are no risks. There are always risks to business ventures and the following has not sought to list the most common and general facing most business operations.

These include general global economic circumstances which presently feature some uncertainty. This is of some significance to redclaw aquaculture, in view of the product positioning being likely to be pitched as premium seafood. This places it in the category of discretionary spending for consumers, at the top of the list in household budget pruning.

Those risks identified are mostly those most specific to development of an export scale redclaw farm.

Risks are analysed below, together with a risk management strategy in outline at this stage, only to test that acceptable strategies are feasible.

ANALYSIS

Key risks are summarised as:

LIKELIHOOD	CONSEQUENCES		
Likely	- Failure to produce mono-sex populations	- Low cost country develops major redclaw industry	
Possible	- Global market demand contracts due to recession	- Disease destroys significant proportion of stock	
Unlikely			- Selective breeding / stock management unsuccessful
	Minor	Moderate	Major

The further risks move diagonally upwards from the left hand lowest category, the more serious the risk, as they increase in both in likelihood and consequences (impact). Any in the red category are highly likely and have major business impact and be cause to re-consider industry entry. All in the coloured zones are significant risks

RISK MANAGEMENT STRATEGIES

Risks identified above are in order of the most important to least important in considering their combined likelihood and impact levels. This is a judgement and others may change the ranking, but the important point is for all risks to have a convincing, effective management strategy.

Risk	Possible Strategies
Low cost country develops major redclaw industry	• Development of improved brood stock; • Live export of males only; • Achievement of mono-sex population technology; • Very efficient production systems minimising labour components; • Stringent QA systems; • Marketing emphasis on environmental, sustainable credentials (**Note**: This risk has the potential to be disastrous for Australian industry development, but has been classed as 'moderate' mainly on the expectation that a local Australian market could be defended on quality grounds and that some market share could be maintained internationally on the same grounds. This is especially in view of the large and growing demand for this class of product. If this is not a reasonable expectation then the proposed development would be classed as high risk)
Disease destroys significant proportion of stock	• Maintain a robust farm health plan; • Screen all input materials for sources of contaminants
Selective breeding / stock management unsuccessful	• Support and monitor research & trials • Implement a farm stock management system
Failure to produce mono-sex populations	• Optimise stack management systems to reduce in-pond breeding • Live export of males only
Global market demand contracts due to recession	• Minimise costs • Accurately calculate break even points • Identify & build market presence in market segments least likely to be impacted by recession • Avoid over exposure in narrow market sectors

An overall strategy available to address general business risks, is the integration with redclaw operations with agricultural crop production and so spreading risks.

ATTACHMENT 1

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ATTACHMENT 2

DPIF Redclaw Profit Model
Large Scale Farm

Summary Statistics

Output summary

Annual production (kg)	340,585
Annual gross revenue	$4,631,957
Annual production cost	$3,480,791
Production cost per kilogram	$10.22
Revenue per kilogram	$13.60

Economic indicators

Net present value	$11,302,317
Annual return	$1,151,166
Internal rate of return	25.90%
Benefit - cost ratio	1.33
Break-even Production (kg)	223,387

Cost structure summary

	Annual cost	Cost per kilogram
Juveniles	$0	$0.00
Feed	$742,197	$2.18
Labour	$669,324	$1.97
Processing & Packaging	$90,974	$0.27
Marketing & Freight	$607,145	$1.78
Electricity	$200,000	$0.59
F.O.R.M	$100,000	$0.29
Operating	$458,000	$1.34
Capital	$613,150	$1.80

Additional Operating Expenses

Fuel and oil	$50,000	Water charges (usage charge per ML)	$200	$300,000
Repairs and maintenance	$50,000	Water supply or pumping licences	$2,000	
Electricity	$200,000	Aquaculture licences and permits	$5,000	
Accounting and legal	$15,000	Salt (medicinal)	$1,500	
Administrative expenses	$25,000	Chemicals (cleaning)	$3,000	
Phone (domestic and mobile)	$10,000	Chemicals (medicinal)	$2,500	
Travel (related to business)	$12,000	Miscellaneous items		
Vehicle registrations	$3,000	Fertiliser	$20,000	
Vehicle insurance	$2,000	Hay	$12,000	
Other insurances	$20,000	Lime	$20,000	
Council rates	$5,000		$0	

Capital Cost of Crayfish Farm

Project Length (Years) 20

Capital Item	No. of items	Cost of items ($)	Total cost ($)
Land and Buildings			
Land	-	$600,000	$600,000
Storage sheds	1	$150,000	$150,000
Workshop	1	$50,000	$50,000
Staff accomodation	0	$300,000	$0
Office	1	$25,000	$25,000
Processing / purging / quarantine facility	1	$50,000	$50,000
3 phase electricity connection	-	$100,000	$100,000
Vehicles and Machinery			
Utes	2	$30,000	$60,000
Motorbikes / four wheelers	2	$15,000	$30,000
Tractor / bobcat	1	$75,000	$75,000
Boats and outboards	0	$0	$0
Trailer	1	$5,000	$5,000
Mower / slasher	1	$10,000	$10,000
Ponds			
Pond construction (per pond)	128	$15,000	$1,920,000
Pond piping and infrastructure (per pond	128	$3,000	$384,000
Pond electricity connection (per pond)	128	$1,000	$128,000
Aerators	400	$800	$320,000
Crayfish shelters	120000	$5	$600,000
Moorings and walkways	128	$500	$64,000
Bird netting (or other exclusion devices)	-	$875,000	$875,000
Other Infrastructure and Equipment			
Generator	1	$50,000	$50,000
Pumps	5	$15,000	$75,000
Purging tanks and plumbing	4	$25,000	$100,000
Biofilter for tank system	2	$25,000	$50,000
Feeding equipment	-	$60,000	$60,000
Water monitoring equipment (and other t	2	$12,000	$24,000
Harvesting equipment (bins, flow traps)	-	$100,000	$100,000
Scales	5	$2,000	$10,000
Processing equipment	-	$0	$0
Ice machine	1	$5,000	$5,000
Blower and air system	2	$25,000	$50,000
Workshop tools and equipment	-	$50,000	$50,000
Water allocation	-	$0	$0
	0	$0	$0
Other capital items	0	$0	$0
Other capital items	0	$0	$0
Total capital outlay			$6,020,000

Physical Property Description

General Description

Total farm area	100.0	hectares
Area for growout ponds	50.0	hectares
Area for juvenile ponds (if required)	7.0	hectares
Area available for infrastructure	43.0	hectares

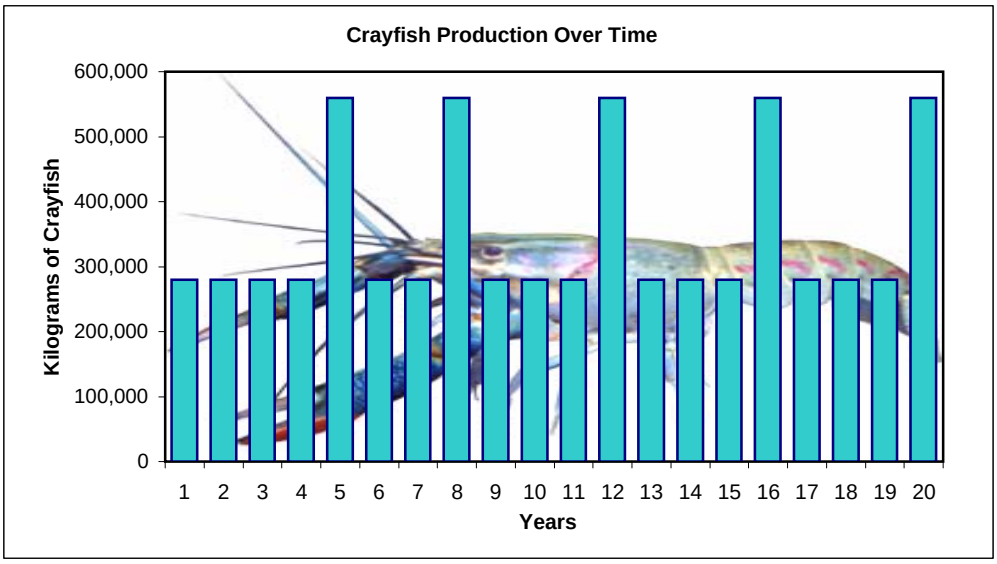
Growout Pond Dimensions and Requirements

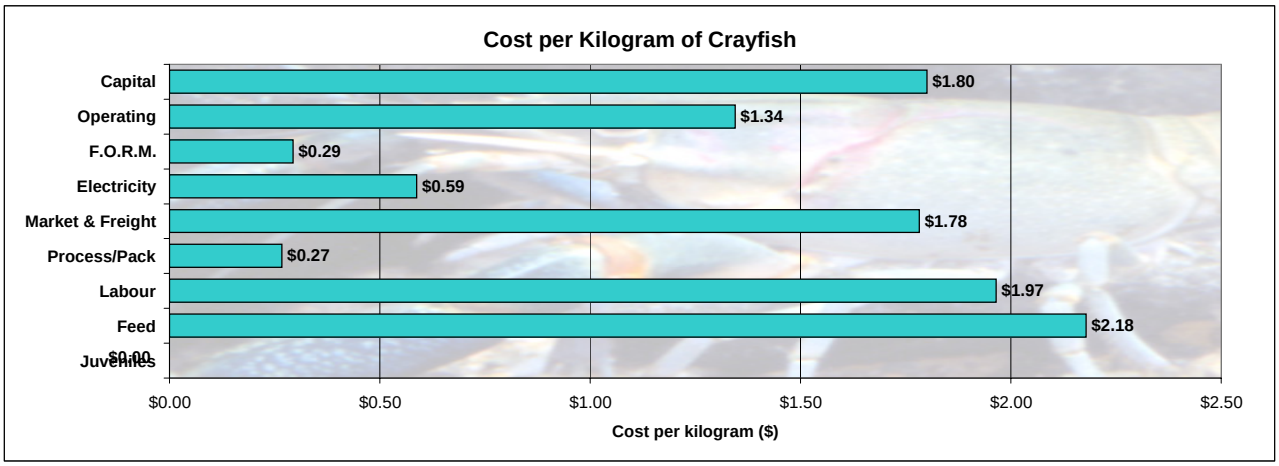
Length of ponds	125.00	metres
Width of ponds	40.00	metres
Depth of ponds	1.50	metres
Number of water exchanges per crop	2.0	
Number of aerators allocated to each pond	4	(average)
Pond surface area	0.50	hectares
Maximum number of ponds	100	
Pond volume	7.50	megalitres
Water required each season	1,500	megalitres

Farm Production Summary

Average Production	340,585

Years	Total annual production
1	280,000
2	280,000
3	280,000
4	280,000
5	560,000
6	280,000
7	280,000
8	560,000
9	280,000
10	280,000
11	280,000
12	560,000
13	280,000
14	280,000
15	280,000
16	560,000
17	280,000
18	280,000
19	280,000
20	560,000




Cost per Kilogram of Crayfish
Capital
Operating
F.O.R.M.
Electricity
Market & Freight
Process/Pack
Labour
Feed
Juveniles
$1.80
$1.34
$0.29
$0.59
$1.78
$0.27
$1.97
$2.18
$0.00
$0.00
$0.50
$1.00
$1.50
$2.00
$2.50
Cost per kilogram ($)


Discounted Cummulative Cashflow
$14,000,000
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
-$2,000,000
-$4,000,000
-$6,000,000
-$8,000,000
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Years

Growout Feeds

	FCR	% of Diet	Feed Cost ($/kg	Feed (kg)
Growout feed A	2.00	80%	$0.70	448,000
Growout feed B	2.00	20%	$1.50	112,000
Growout feed C	2.50	0%	$0.10	0
Growout feed D	2.50	0%	$0.10	0

Total cost of growout feed	$481,600

Growout Parameters

Regional growth factor	90%	% of maximum growth
Growout period	9.0	months
Pond dry-out period	0.5	months
Stocking density	8	
Death rate during growout	30%	
Mean weight of crayfish at harves	70	grams
Month first juveniles are stocked i		
Number of crayfish stocked per cr	5,714,286	
Number of crayfish at end of prod	4,000,000	
Farm production of crayfish per p	2,800	kilograms
Farm production of crayfish	280,000	kilograms

Juvenile Stocking or Production

Please choose either to purchase juveniles for stockin or on-farm production using juvenile production ponds. On-farm juvenile production

Juvenile purchase

Juvenile price	**per juvenile**	**$0.50**
Number of juveniles required per crop		**0**
Total cost of juveniles		**$0**

On-farm Juvenile Rearing

Pond surface area	**hectares**	**0.25**
Number of ponds allocated		**28**
Advanced juveniles per broodstock female		**100**
Females required		**57,143**
Broodstock ratio (females : males)		**3**
Males required		**19,048**
Density of juveniles/adults in pond	**crayfish per squa**	**83**
Mean weight of juveniles at harvest	**grams**	**10**
Estimated cost per juvenile produced		**$0.04**

Feeds	FCR	% of diet	$ per kg	Feed (kg)
Juvenile feed A	**2.50**	**80%**	**$0.75**	**114,286**
Juvenile feed B	**2.50**	**20%**	**$1.50**	**28,571**
Juvenile feed C	**2.50**	**0%**	**$0.10**	**0**
Juvenile feed D	**2.50**	**0%**	**$0.10**	**0**

Total cost of nursery feed	**$128,571**
Economic loss from broodstock retention	**$72,533**

On-farm juvenile production
Purchase juveniles

Labour Requirements

On-costs	% of weekly wage	
Workers compensation	1.50%	
Superannuation contributior	5.00%	
Leave loading	17.50%	percent of 4 weeks wages
Training	5.00%	

Casual employees		
Hours of casual employment	0	
Pay per hour	$13.00	
Annual expense	$0	

Salaried Employees	Skilled Staff	Labourer	Manager
Number of employees	6	4	
Weekly salary	$750	$961	$1,634
Annual expense	$301,860	$257,856	$109,609

Market and Freight Costs

Freight cost - styrofoam pack	**$1.00**	**per kilogram**
Market floor commission	**5.00%**	
Agents commission	**2.00%**	
Promotional levy	**$0.00**	**per kilogram**

Year	Live	Green	Levy/Comm	Totals
1	$56,000	$224,000	$266,560	**$546,560**
2	$56,000	$224,000	$266,560	**$546,560**
3	$56,000	$224,000	$266,560	**$546,560**
4	$56,000	$224,000	$266,560	**$546,560**
5	$112,000	$448,000	$266,560	**$826,560**
6	$56,000	$224,000	$266,560	**$546,560**
7	$56,000	$224,000	$266,560	**$546,560**
8	$112,000	$448,000	$266,560	**$826,560**
9	$56,000	$224,000	$266,560	**$546,560**
10	$56,000	$224,000	$266,560	**$546,560**
11	$56,000	$224,000	$266,560	**$546,560**
12	$112,000	$448,000	$266,560	**$826,560**
13	$56,000	$224,000	$266,560	**$546,560**
14	$56,000	$224,000	$266,560	**$546,560**
15	$56,000	$224,000	$266,560	**$546,560**
16	$112,000	$448,000	$266,560	**$826,560**
17	$56,000	$224,000	$266,560	**$546,560**
18	$56,000	$224,000	$266,560	**$546,560**
19	$56,000	$224,000	$266,560	**$546,560**
20	$112,000	$448,000	$266,560	**$826,560**

Processing and Packaging

	% of Crop	Live	Whole - Green	Cooked
Live product	20%	56,000	-	-
Chilled whole (green)	80%	-	224,000	-
Chilled whole (cooked)	0%	-	-	

Chilled - Green and Cooked			Live	
Crayfish per box	18.00	kg	Crayfish per box	10.00
Gross weight of packed box	20.00	kg	Gross weight of pac	12.00
Cost per syrofoam box	$3.60		Cost per syrofoam b	$3.60
Ice per box	0.50	kg	Number of plastic lir	1
Cost of ice	$1.00	$ per kg	Cost of plastic liners	$0.10
Number of plastic liners per b	1		Label or Logo	$0.10
Cost of plastic liners	$0.10	each	**Total cost per box**	$3.80
Label or Logo	$0.10			
Total cost per box	$4.30			
Number of boxes required	12,444		**Number of boxes r**	5,600
Cost per kilo of green/cook	$0.24		**Cost per kilo of live**	$0.38
Cost of packing green & co	$53,511		**Cost of packing liv**	$21,280

Live Fish (Bulk Bins)		
Size of bulk bins	1000	litres
Fish holding capacity of bulk	150	kg