Foreword

Freshwater crayfish occur naturally throughout Australia. Three species, yabby (*Cherax destructor*), redclaw (*Cherax quadricarinatus*) and marron (*Cherax tenuimanus*) are exploited commercially.

This study assesses the potential for expansion of the industry over the period 1999/2000 to 2004/2005. The report is based on a survey of industry personnel in all mainland States of Australia. The potential for expansion and the routes by which this expansion might be achieved are documented. The importance of legislative changes governing the licencing of yabby production in NSW and Victoria are highlighted.

This project was funded from RIRDC Core Funds which are provided by the Federal Government and is an addition to RIRDC’s diverse range of over 600 research publications. It forms part of our New Animal Products R&D program, which aims to accelerate the development of viable new animal industries.

Most of our publications are available for viewing, downloading or purchasing online through our website:


Peter Core  
Managing Director  
Rural Industries Research and Development Corporation
Acknowledgments

This report is based on responses to a survey of industry personnel in all mainland States of Australia. The author would like to sincerely acknowledge the time and expert information generously given by each of the sixteen people contributing to the survey.

Queensland

Jim Gillespie – General Manager (Aquaculture and Industry Development), QDPI.
Bill Keast – President, Queensland Crayfish Farmers Association.

New South Wales

Ian Lyall – Principal Manager (Aquaculture Industry Development), NSW Fisheries.
Robert McCormack – Principal, Crayhaven Aquacultural Industries, Karuah, NSW.
Robert Cruickshanks – Principal, Aqua Farms, Moama, NSW.

Victoria

Anthony Forster – Manager Aquaculture, Fisheries Victoria.
Greg Williams – Secretary, Victorian Yabby Association.
Louis Vorstermans – CEO, Victorian Aquaculture Association

South Australia

Tara Ingerson – Client Manager Freshwater Aquaculture, PIRSA.
John Luckens – Secretary/Treasurer, Australian Freshwater Crayfish Growers Association, South Australian Branch.
Carol Schofield – Principal, Galloway Yabbies, Inman Valley, SA.
Peter Redden – Director and Marketing Manager, Marron Marketing Ltd, Kingscote, SA.

Western Australia

Craig Lawrence – Research Scientist (Aquaculture), Fisheries Western Australia.
Steve Kolb – Principal, Southern Yabby Farms, Pingelly, WA.
Dennis Gaunt – Managing Director, Mulataga Aquaculture, Gosnells, WA.
Greg Maguire – Supervising Scientist, Aquaculture Development and Fisheries Environment, Fisheries Western Australia.
## Contents

Foreword .................................................................................................................................................. iii
Acknowledgments ........................................................................................................................................ iv
List of Tables ........................................................................................................................................ vi
List of Figures ......................................................................................................................................... vi
Executive Summary ................................................................................................................................. vii
Introduction ............................................................................................................................................ 1
Methodology ............................................................................................................................................ 3
Current Production .................................................................................................................................. 4
Relevant Legislation and Recent Changes .............................................................................................. 6
  NSW ....................................................................................................................................................... 6
  Victoria ................................................................................................................................................... 6
  SA and Qld ............................................................................................................................................ 7
  Tasmania ................................................................................................................................................ 7
Predicted Future Production ..................................................................................................................... 8
  Volume and Value ............................................................................................................................... 8
  Species Contribution to Predicted Increase in Production ................................................................. 9
  Culture Systems to Achieve the Predicted Increase in Production ..................................................... 9
Product Price and Markets ....................................................................................................................... 11
  Current Prices .................................................................................................................................... 11
  Future Prices ...................................................................................................................................... 11
Enterprise Profitability ............................................................................................................................ 13
  Yabbies – Farm Dam Model of Production ......................................................................................... 13
  Yabbies – Purpose Built Ponds ......................................................................................................... 14
  Redclaw and Marron .......................................................................................................................... 14
Domestic and Export Markets .................................................................................................................. 15
  Yabbies ................................................................................................................................................. 15
  Redclaw and Marron .......................................................................................................................... 15
  Export Markets .................................................................................................................................... 15
Impediments to Industry Expansion ......................................................................................................... 16
Government Incentives for Expansion of Exports .................................................................................. 17
Research and Development ..................................................................................................................... 18
  Nutrition ............................................................................................................................................. 18
  Husbandry .......................................................................................................................................... 18
  Genetics and Breeding ....................................................................................................................... 18
  Engineering and Pond Architecture .................................................................................................... 18
  Economics ......................................................................................................................................... 18
  Post Harvest ....................................................................................................................................... 18
Technology Transfer and Adoption .......................................................................................................... 19
Conclusions ............................................................................................................................................. 20
Appendices ............................................................................................................................................. 21
  Appendix 1.-.Survey of Potential for Expansion of the Australian Freshwater Crayfish Industry – WA Format ......................................................................................................................... 21
  Appendix 2 – Terms and conditions of the Class E Permit introduced by the NSW Government.... 24
  Appendix 3 - Growing Yabbies in Farm Dams – An Economic Case Study ................................. 26
  Appendix 4 – Estimating response to selection for market weight in yabbies ............................. 28
References .............................................................................................................................................. 29
List of Tables

Table 1. Volume* (tonnes) and Value ($000’s) of Production from Freshwater Crayfish in Australia. ................................................................. 2
Table 2(a) Freshwater crayfish production by State 1996/97 ................................................................. 4
Table 2(b) Freshwater crayfish production by State 1997/98 ................................................................. 4
Table 2(c) Freshwater crayfish production by State 1998/99 ................................................................. 4
Table 3(a) Predicted freshwater crayfish production by State 1999/00 .................................................... 8
Table 3(b) Predicted freshwater crayfish production by State 2004/05 .................................................... 8
Table 4. Contribution of the three Cherax species to the predicted increase in production ..................... 9
Table 5. Percentage of predicted increase in production that is expected to be achieved by utilisation of different production system options ................................................................. 9
Table 6. Typical price ranges ($/kg)* for yabbies sold by farmers to WA multiple site license holders ............................................................................. 11
Table 7(a) WA farm dam model - Initial capital expenditure ................................................................. 13
Table 7(b) WA farm dam model – Annual operating costs ..................................................................... 13

List of Figures

Figure 1. Distribution of marron, redclaw and yabby in Australia (adapted from Kailola et al., 1993) ... 1
Executive Summary

Declining terms of trade for rural commodities in Australia generates a requirement for increased productivity. Risk spreading strategies such as diversification of income streams in mixed farming enterprises may assist rural economies.

Freshwater crayfish occur naturally throughout Australia. Three species, yabby (Cherax destructor), redclaw (Cherax quadricarinatus) and marron (Cherax tenuimanus) are exploited commercially.

Commercial marron production is largely based in its natural habitat in south-west Western Australia (WA) and there is an expanding base of production in South Australia (SA) especially on Kangaroo Island. Commercial redclaw production is mainly confined to coastal regions of Queensland (Qld) and there is a small amount of recorded production from coastal areas of northern NSW. Yabbies are produced commercially throughout their natural distribution range in NSW, Victoria (Vic) and SA but the majority of current production is derived from the translocated population in WA.

Marron and redclaw production is based almost entirely on semi-intensive aquaculture in purpose built ponds. By contrast, commercial yabby production is currently derived from harvesting of farm dams especially in Western Australia, from wild catch in South Australia, Victoria and NSW and to a lesser extent from purpose built ponds in all four States.

The opportunity exists to expand the use of existing or purpose built farm water resources for commercial production of freshwater crayfish, particularly given the recent changes to government regulations in respect of harvesting from farm dams in NSW and Victoria. These changes create a new class of aquaculture permit which enables a single license holder to harvest yabbies, in collaboration with the relevant landholders, from multiple farm dams spread across multiple properties. Previous regulations required a separate license for every property.

The information on which this Report is based was gathered from sixteen leading industry personnel across all mainland states of Australia. Tasmania and the Northern Territory were not included in the survey because in the years 1996/97 through 1998/99 there was no recorded aquaculture production of freshwater crayfish from either location.

The methodology employed was to design a questionnaire covering all aspects of the information being sought and to refine the questionnaire format after consultation with colleagues and a small sample of industry personnel. The final form of the questionnaire was the same for all respondents but the freshwater crayfish species that were relevant varied between the states.

Levels of freshwater crayfish production have been slowly increasing over the past 5-10 years and for the past three years (1996/97 to 1998/99) have averaged 421 tonnes with a value of $4.968 million. Yabby production averages 73 percent of total volume, with over half (58 percent) coming from WA. Reflecting the lower average price for yabbies, their production averages 58 percent total value.

Levels of freshwater crayfish production are predicted to show modest increases in 1999/2000 but are predicted to increase around threefold by 2004/2005 to a level of 1589 tonnes with a value of $20.718 million.

For the three species of commercially farmed freshwater crayfish, yabby, redclaw and marron, the levels of production are predicted to increase between 1999/2000 and 2004/2005 by 293%, 239% and 381% respectively.

For redclaw and marron the predicted increase in production will be based on semi-intensive aquaculture in purpose built ponds. For yabbies, the majority (72%) of the predicted increase is...
estimated to come from increased utilisation of existing farm dams with the remainder coming from purpose built ponds.

Despite the magnitude of the predicted increases in production, prices received by farmers for freshwater crayfish are predicted to remain relatively stable. This prediction is based on assessments of the size of possible export markets and on the ability of the local market to absorb more product at current prices.

Yabby aquaculture based on harvesting from farm dams can be profitable and provide an additional source of income from water resources that have already been created for land based agriculture purposes.

Crayfish aquaculture in purpose built ponds can also be profitable but economies of scale apply and larger scale operations are more likely to be economically sustainable. Because of higher yields and prices, semi-intensive reedclaw and marron operations may be more viable than semi-intensive yabby aquaculture systems.

Commercial fin fish operations typically have higher production yields than reported for freshwater crayfish and there may be scope for polyculture involving fin fish and freshwater crustaceans to increase total returns from investment in purpose built ponds.

Potential export markets for Australian freshwater crayfish have been reported to be capable of absorbing as much as 2000 tonnes p.a. Existing export markets are in Europe and south east Asia but additional market development activity will also be focussed on Japan, Korea, Taiwan and the USA.

Perceived impediments to industry expansion included:
- Lack of understanding of rural based aquaculture by government and local government authorities who place unreasonable and restrictive conditions on development applications.
- Inability to attract major investors or finance due to perceived low and inconsistent productivity and profitability of freshwater crayfish aquaculture.
- Processor capacity.
- Lack of availability of genetically improved strains of crayfish
- Import tariffs and bans, particularly on live product in some countries.
- Lack of industry coordination, research and promotion funding.
- Cost effective diets and husbandry systems.
- Lack of resources for technology transfer.

Increased funding for R&D and technology transfer is required to support expansion of a more productive, profitable and economically viable freshwater crayfish industry. These needs have been recognised at the broader level of planning for increased support for aquaculture in most states.
Introduction

Declining terms of trade for rural commodities in Australia generates a requirement for increased productivity. Risk spreading strategies such as diversification of income streams in mixed farming enterprises may assist rural economies. The opportunity exists to expand the use of existing or purpose built farm water resources for commercial production of freshwater crayfish, particularly given the recent changes to government regulations in respect of harvesting from farm dams in NSW and Victoria (Jerry et al. 1999).

Freshwater crayfish occur naturally throughout Australia. Three species, yabby (*Cherax destructor*), redclaw (*Cherax quadricarinatus*) and marron (*Cherax tenuimanus*) are exploited commercially. The natural and translocated (yabbies only) distributions of these species are shown in Figure 1.

Figure 1. Distribution of marron, redclaw and yabby in Australia (adapted from Kailola et al., 1993)

Commercial marron production is largely based in its natural habitat in south-west Western Australia (WA) but there is an expanding base of production in South Australia (SA), especially on Kangaroo Island. Commercial redclaw production is mainly confined to coastal regions of Queensland (Qld). However, there is a small amount of recorded production from coastal areas of northern NSW. Yabbies are produced commercially throughout their natural distribution range in NSW, Victoria (Vic) and SA but the majority of current production is derived from the translocated population in WA (O’Sullivan, 1991, 1995, 1998).

Marron and redclaw production is based almost entirely on purpose built ponds (Merrick and Lambert, 1991). By contrast, commercial yabby production is currently derived from harvesting of farm dams especially in Western Australia, from wild catch in South Australia, Victoria and NSW and to a lesser extent from purpose built ponds in all four States. Current volume and value of production are shown in Table 1.
Table 1. Volume* (tonnes) and Value ($000’s) of Production from Freshwater Crayfish in Australia.

<table>
<thead>
<tr>
<th>Species</th>
<th>96/97 Volume</th>
<th>96/97 Value</th>
<th>97/98 Volume</th>
<th>97/98 Value</th>
<th>98/99 Volume</th>
<th>98/99 Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marron</td>
<td>52</td>
<td>1274</td>
<td>48</td>
<td>1169</td>
<td>49</td>
<td>1187</td>
</tr>
<tr>
<td>Redclaw</td>
<td>65</td>
<td>876</td>
<td>62</td>
<td>833</td>
<td>61</td>
<td>875</td>
</tr>
<tr>
<td>Yabby**</td>
<td>288</td>
<td>2625</td>
<td>343</td>
<td>3261</td>
<td>296</td>
<td>2803</td>
</tr>
<tr>
<td>Total</td>
<td>405</td>
<td>4775</td>
<td>453</td>
<td>5263</td>
<td>406</td>
<td>4865</td>
</tr>
</tbody>
</table>

* Source ABARE and State Fisheries. ** Includes estimated production from wild catch.

This study was aimed at assessing the potential for expansion of the industry over the period 1999/2000 to 2004/2005. It is based on responses to a survey of industry personnel in all mainland States of Australia. It attempts to estimate the likely expansion of production, to investigate the routes by which this expansion might be achieved and to summarise industry views and publications on future markets, product prices, research needs and production technology information sources. The importance of the proposed legislative changes governing the licencing of yabby production in NSW and Victoria is highlighted. In the case of yabbies, but not for marron or redclaw where the system of production (purpose built ponds) seems likely to remain stable, an attempt has been made to summarise the small amount of information on enterprise profitability.
Methodology

The information on which this Report is based was gathered from sixteen leading industry personnel across all mainland states of Australia. Tasmania and the Northern Territory were not included in the survey because in the years 1996/97 through 1998/99 there was no recorded aquaculture production of freshwater crayfish from either location (ABARE, 1999).

The methodology employed was to design a questionnaire covering all aspects of the information being sought and to refine the questionnaire format after consultation with colleagues and a small sample of industry personnel. The final form of the questionnaire was the same for all respondents. However, the freshwater crayfish species that were relevant varied between the states. An example of the Questionnaire used in WA, which covered marron and yabbies, is provided in Appendix 1. The same two species were included on the questionnaire used in SA. In Vic only yabbies were included and in NSW and Qld the species covered were yabbies and redclaw but there is no significant commercial yabby production in Qld (Jim Gillespie, pers. comm.; ABARE, 1999). There is a fledgling redclaw industry in the north of WA based on translocated stock from Qld and in 1996/97 there were two farms growing marron in NSW. In both cases, current levels of production are very small and are recorded as zero in Australian Fisheries Statistics 1999 (ABARE, 1999).

All respondants were first approached by telephone to determine their willingness to participate in the study. Each respondent was then sent a copy of the questionnaire and asked if possible to answer the questions prior to a subsequent face to face visit by the principal investigator so that the responses could serve as a basis for discussion during that visit. Due to other commitments of the respondants, this was not always possible and the questionnaires were sometimes completed during the visits. In three cases, the questionnaire was completed but there was no follow up visit and the majority of commercial industry respondants provided answers only for their particular species.

Data from the original questionnaires were then transferred to a spreadsheet and the information gathered, along with input from relevant literature sources, is summarised in the following sections of this report.
Data summarised in this section are derived from ABARE and State Fisheries sources. The volume and value data are derived from the published figures for freshwater crayfish aquaculture production (ABARE, 1999). Production figures for yabbies in NSW have been increased by addition of the estimated production from wild catch (NSW Fisheries, 1999). For redclaw, the small amount of production from NSW (Ian Lyall, pers.comm.) has been added to the production figures from Qld contained in Australian Fisheries Statistics, 1999 (ABARE, 1999).

Table 2(a) Freshwater crayfish production by State 1996/97

<table>
<thead>
<tr>
<th>State</th>
<th>Yabby</th>
<th>Value ($000's)</th>
<th>Redclaw</th>
<th>Value ($000's)</th>
<th>Marron</th>
<th>Value ($000's)</th>
<th>All</th>
<th>Value ($000's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qld</td>
<td>0</td>
<td>0</td>
<td>63</td>
<td>850</td>
<td>0</td>
<td>0</td>
<td>63</td>
<td>850</td>
</tr>
<tr>
<td>NSW*</td>
<td>103</td>
<td>869</td>
<td>2</td>
<td>26</td>
<td>0</td>
<td>0</td>
<td>105</td>
<td>895</td>
</tr>
<tr>
<td>Vic</td>
<td>25</td>
<td>250</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>250</td>
</tr>
<tr>
<td>SA</td>
<td>10</td>
<td>110</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>116</td>
<td>15</td>
<td>226</td>
</tr>
<tr>
<td>WA</td>
<td>150</td>
<td>1396</td>
<td>0</td>
<td>0</td>
<td>47</td>
<td>1158</td>
<td>197</td>
<td>2554</td>
</tr>
<tr>
<td>All</td>
<td>288</td>
<td>2625</td>
<td>65</td>
<td>876</td>
<td>52</td>
<td>1274</td>
<td>405</td>
<td>4775</td>
</tr>
</tbody>
</table>

* NSW data for yabby production includes 73 tonnes from wild catch

Table 2(b) Freshwater crayfish production by State 1997/98

<table>
<thead>
<tr>
<th>State</th>
<th>Yabby</th>
<th>Value ($000's)</th>
<th>Redclaw</th>
<th>Value ($000's)</th>
<th>Marron</th>
<th>Value ($000's)</th>
<th>All</th>
<th>Value ($000's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qld</td>
<td>0</td>
<td>0</td>
<td>60</td>
<td>800</td>
<td>0</td>
<td>0</td>
<td>60</td>
<td>800</td>
</tr>
<tr>
<td>NSW*</td>
<td>77</td>
<td>709</td>
<td>2</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>79</td>
<td>742</td>
</tr>
<tr>
<td>Vic</td>
<td>24</td>
<td>184</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>184</td>
</tr>
<tr>
<td>SA</td>
<td>11</td>
<td>115</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>134</td>
<td>17</td>
<td>249</td>
</tr>
<tr>
<td>WA</td>
<td>231</td>
<td>2253</td>
<td>0</td>
<td>0</td>
<td>42</td>
<td>1035</td>
<td>273</td>
<td>3288</td>
</tr>
<tr>
<td>All</td>
<td>343</td>
<td>3261</td>
<td>62</td>
<td>833</td>
<td>48</td>
<td>1169</td>
<td>453</td>
<td>5289</td>
</tr>
</tbody>
</table>

* NSW data for yabby production includes 37 tonnes from wild catch

Table 2(c) Freshwater crayfish production by State 1998/99

<table>
<thead>
<tr>
<th>State</th>
<th>Yabby</th>
<th>Value ($000's)</th>
<th>Redclaw</th>
<th>Value ($000's)</th>
<th>Marron</th>
<th>Value ($000's)</th>
<th>All</th>
<th>Value ($000's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qld</td>
<td>0</td>
<td>0</td>
<td>60</td>
<td>850</td>
<td>0</td>
<td>0</td>
<td>60</td>
<td>850</td>
</tr>
<tr>
<td>NSW*</td>
<td>83</td>
<td>781</td>
<td>1.4</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>84</td>
<td>806</td>
</tr>
<tr>
<td>Vic</td>
<td>21</td>
<td>200</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>21</td>
<td>200</td>
</tr>
<tr>
<td>SA</td>
<td>27</td>
<td>231</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>160</td>
<td>34</td>
<td>391</td>
</tr>
<tr>
<td>WA</td>
<td>165</td>
<td>1591</td>
<td>0</td>
<td>0</td>
<td>42</td>
<td>1027</td>
<td>207</td>
<td>2618</td>
</tr>
<tr>
<td>All</td>
<td>296</td>
<td>2803</td>
<td>61.4</td>
<td>875</td>
<td>49</td>
<td>1187</td>
<td>406.4</td>
<td>4865</td>
</tr>
</tbody>
</table>

* NSW data for yabby production includes 43 tonnes from wild catch.
For the period 1996/97 to 1998/99 the total production of freshwater crayfish has averaged 421 tonnes with an average value of $4.968 million. Total production has been relatively stable with some variations due to seasonal conditions (eg below average rainfall in WA in 1998/99). Yabby production averages 73 percent of total volume, with over half (58 percent) coming from WA. Reflecting the lower average price for yabbies, their production averages 58 percent total value. The vast majority of WA yabby production is derived from farm dams under a licensing system which allows entrepreneurs to franchise large numbers of individual farmers each with several to many dams incorporated into the production system. By contrast, production from the other states is largely from purpose built ponds or wild harvest. However, during the 1998/99 financial year the legislation governing licensing of freshwater crayfish production for human consumption has changed significantly in Vic and NSW. The new licensing regulations, which will be discussed in more detail in the next section, allow production of yabbies for human consumption from franchised farm dams. These changes are predicted to lead to significant increases in production as outlined in a later section of this report.

For redclaw and marron, production is almost entirely based on purpose built ponds and current licensing regulations in the relevant states will ensure that this remains so in the foreseeable future.
Relevant Legislation and Recent Changes

**NSW**

The *Fisheries Management Act 1994*, introduced a classification system for aquaculture permits based on intensity of farming. In addition to the traditional intensive aquaculture permit which is issued for constructed ponds with high stocking rates and feed input, there has been provision made to recognise that extensive aquaculture (no feed or nutrient input), often conducted in existing farm dams, can also be an important contributor to the aquaculture industry of NSW.

Under this legislation, Class C permits allow extensive aquaculture to be undertaken with careful site and species selection to minimise environmental impact and safeguards in place to ensure that there is (i) no nutrient input to dams or ponds and (ii) no escape to the surrounding environment of species which are outside their natural range. Class C permits are issued on an individual site basis, ie 1 site – 1 permit. Minimal environmental impact means the activity is not necessarily an “activity” that requires development consent from local government thus simplifying the approvals process.

In February 2000, changes to the relevant NSW legislation were announced which created a new Class E (Multi-site Aquaculture) permit for yabbies. This permit allows its holder to extensively culture yabbies in man-made storages (eg. farm dams) at multiple sites. The Class E permit creates the opportunity for permit holders to lease private water storages from farmers for the purpose of commercial yabby production. The effect of this change in the legislation is to create the potential for a significant increase in commercial yabby production by bringing into play a large currently unutilised source of farm dam water.

This model is similar to that operating in WA which currently results in over half the total volume of yabby production in Australia. However, it differs in several important respects. First, there can be no input of nutrient (artificial pellets, meat, live feeds or fertilisers) to constructed dams, but lining with hay or planting crops in the bottom of dams is permissable prior to stocking. Second, landholders whose constructed dams are covered under the Class E permit will be allowed to harvest yabbies but must hold them on site for collection by the Class E permit holder or by authorised persons listed under the Class E permit. In WA, the landholders are permitted to artificially feed yabbies in constructed dams and to deliver them to the permit holder’s depot(s). The terms and conditions of the Class E permit are listed in Appendix 2.

**Victoria**

A Review of policy relating to the culture and harvest of yabbies in Victoria was initiated in line with the Victorian Aquaculture Strategy’s (Fisheries Victoria, 1998) aim to increase the value of aquaculture production. A discussion paper was prepared and circulated to interested parties in July 1998. Resulting from this review, two methods for increasing yabby production were proposed. The first is to continue semi-intensive production practices and the second to increase harvest opportunities from existing farm dams by amending existing policy. In response to submissions from key stakeholders, the Victorian Yabby Aquaculture Development Strategy (Fisheries Victoria, 2000) was developed and launched on 3 February 2000.

The Victorian Fisheries Regulations 1998 created two types of Aquaculture licences: the Aquaculture (Private Land) License and the Aquaculture (Crown Land) Licence. Under Section 52 of the *Fisheries Act 1995*, Aquaculture licences can have conditions placed on them which would enable the listing of multiple waters not actually owned by the applicant. This mechanism creates a new sub-category of Yabby Aquaculture Licence referred to as Aquaculture (Private Land) Licence – Multiple Waters. Listing of these waters on the one licence will enable the licence holder to extensively culture, harvest...
and sell yabbies from many separate farm dams without the cost of having each farm dam or property separately licensed.

There are a number of conditions that apply to the granting of such Multiple Waters licences including compliance with an established Victorian Yabby Aquaculture Code of Practice and all relevant food and export standards as appropriate. The conditions are outlined in the Victorian Yabby Aquaculture Development Strategy (Fisheries Victoria, 2000) and do not preclude artificial feeding of yabbies in farm dams. As in NSW, the effect of creating the new Multiple Waters sub-category of Aquaculture (Private Land) License is to create the potential for a significant increase in commercial yabby production by harvesting from a large and currently underutilised source of farm dam water.

**SA and Qld**

At the present time there are no provisions in either Qld or SA for aquaculture licences enabling utilisation of multiple property waters. In each of these states, an aquaculture licence (Qld) or permit (SA) is required for each property where it is planned to undertake aquaculture production for sale of product to the public. For all practical purposes, the freshwater crayfish aquaculture licences issued in Qld are for production of redclaw.

**Tasmania**

Tasmanian Government regulations in respect of translocation of non-native fish or freshwater crayfish prevent utilisation of any of the three commercially grown freshwater crayfish species for aquaculture production in Tasmania. There is no commercial production of freshwater crayfish from native Tasmanian species.
Predicted Future Production

Volume and Value

The data below on predicted future production are based on responses to the survey questionnaire and have been summarised by averaging separately the responses for volume and value of production from each state for each species.

With one exception, the production levels in all states and for each species are predicted to increase by a modest amount in 1999/2000 compared with the previous 3 years. The one exception is the production of yabbies in SA where production levels are predicted to be above the levels seen in 1996/97 and 1997/98, but below the unusually high level of production for 1998/99. It is thought that the 1998/99 level was inflated above more normal levels by an unusual contribution from wild catch.

Table 3(a) Predicted freshwater crayfish production by State 1999/00

<table>
<thead>
<tr>
<th>State</th>
<th>Yabby Volume (tonnes)</th>
<th>Yabby Value ($000's)</th>
<th>Redclaw Volume (tonnes)</th>
<th>Redclaw Value ($000's)</th>
<th>Marron Volume (tonnes)</th>
<th>Marron Value ($000's)</th>
<th>All Volume (tonnes)</th>
<th>All Value ($000's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qld</td>
<td>0</td>
<td>0</td>
<td>85</td>
<td>1100</td>
<td>0</td>
<td>0</td>
<td>85</td>
<td>1100</td>
</tr>
<tr>
<td>NSW*</td>
<td>84</td>
<td>856</td>
<td>3</td>
<td>60</td>
<td>0</td>
<td>0</td>
<td>87</td>
<td>916</td>
</tr>
<tr>
<td>Vic</td>
<td>30</td>
<td>317</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>30</td>
<td>317</td>
</tr>
<tr>
<td>SA</td>
<td>15</td>
<td>155</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>224</td>
<td>30</td>
<td>317</td>
</tr>
<tr>
<td>WA</td>
<td>265</td>
<td>2558</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>379</td>
</tr>
<tr>
<td>All</td>
<td>394</td>
<td>3886</td>
<td>88</td>
<td>1160</td>
<td>59</td>
<td>1349</td>
<td>541</td>
<td>6395</td>
</tr>
</tbody>
</table>

* NSW data for yabby production includes 40 tonnes from wild catch

By contrast to the modest increase predicted to occur in 1999/2000, the levels of production are predicted to increase substantially by the year 2004/2005 (Table 3(b)).

Table 3(b) Predicted freshwater crayfish production by State 2004/05

<table>
<thead>
<tr>
<th>State</th>
<th>Yabby Volume (tonnes)</th>
<th>Yabby Value ($000's)</th>
<th>Redclaw Volume (tonnes)</th>
<th>Redclaw Value ($000's)</th>
<th>Marron Volume (tonnes)</th>
<th>Marron Value ($000's)</th>
<th>All Volume (tonnes)</th>
<th>All Value ($000's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qld</td>
<td>0</td>
<td>0</td>
<td>200</td>
<td>2800</td>
<td>0</td>
<td>0</td>
<td>200</td>
<td>2800</td>
</tr>
<tr>
<td>NSW*</td>
<td>353</td>
<td>4582</td>
<td>10</td>
<td>200</td>
<td>0</td>
<td>0</td>
<td>363</td>
<td>4782</td>
</tr>
<tr>
<td>Vic</td>
<td>227</td>
<td>2333</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>227</td>
<td>2333</td>
</tr>
<tr>
<td>SA</td>
<td>49</td>
<td>490</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>676</td>
<td>74</td>
<td>1166</td>
</tr>
<tr>
<td>WA</td>
<td>525</td>
<td>5137</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>200</td>
<td>4500</td>
<td>725</td>
</tr>
<tr>
<td>All</td>
<td>1154</td>
<td>12542</td>
<td>210</td>
<td>3000</td>
<td>225</td>
<td>5176</td>
<td>1589</td>
<td>20718</td>
</tr>
</tbody>
</table>

* NSW data for yabby production includes 40 tonnes from wild catch

The survey results indicate strong expected growth in production with the total volume and value of production predicted to increase by around threefold over the period 1999/2000 to 2004/2005.
Species Contribution to Predicted Increase in Production

The actual and percentage contribution of the three *Cherax* species to the predicted expansion of production is shown in Table 4.

<table>
<thead>
<tr>
<th>Species</th>
<th>Predicted production 99/00 (tonnes)</th>
<th>Predicted production 04/05 (tonnes)</th>
<th>Predicted increase (tonnes)(%)</th>
<th>Contribution to predicted increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yabby</td>
<td>394</td>
<td>1154</td>
<td>760(293%)</td>
<td>72</td>
</tr>
<tr>
<td>Redclaw</td>
<td>88</td>
<td>210</td>
<td>122(239%)</td>
<td>12</td>
</tr>
<tr>
<td>Marron</td>
<td>59</td>
<td>225</td>
<td>166(381%)</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>541</td>
<td>1589</td>
<td>1048(294%)</td>
<td>100</td>
</tr>
</tbody>
</table>

All three species are predicted to increase their production. The percentage increase is substantial in each case and is predicted to be 293%, 239% and 381% for yabbies, redclaw and marron respectively. However, because yabbies comprise around 73% of the predicted 1999/2000 production and essentially retain that position in respect of the predicted 2004/2005 production, their contribution to the total predicted increase is around 72%, compared with 12% for redclaw and 16% for marron.

Culture Systems to Achieve the Predicted Increase in Production

In the survey questionnaire, respondents were asked to apportion the predicted increase in production among four options. These were (i) wild catch (ii) farm dams brought into production under “multiple water licence” arrangements (iii) purpose built ponds for semi-intensive culture and (iv) polyculture with finfish in purpose built ponds. The responses are summarised in Table 5.

<table>
<thead>
<tr>
<th>Species</th>
<th>Wild harvest</th>
<th>Licenced farm dams</th>
<th>Purpose built ponds</th>
<th>Polyculture with finfish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yabby</td>
<td>1</td>
<td>72</td>
<td>24</td>
<td>3</td>
</tr>
<tr>
<td>Redclaw</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Marron</td>
<td>1</td>
<td>7</td>
<td>89</td>
<td>3</td>
</tr>
</tbody>
</table>

From Tables 4 and 5 it is clear that the majority of the predicted increase in total production of freshwater crayfish will come from farm dams not currently being utilised for aquaculture purposes. If 72% of the predicted increase in total production is from yabbies (Table 4) and if 72% of that increase is coming from farm dams not currently being utilised for aquaculture (Table 5), then 52% of the predicted total increase in production will be derived from yabbies in farm dams. The remainder of the predicted increase in total production is estimated to come largely from purpose built ponds (including polyculture) with contributions from yabbies, redclaw and marron of 19%, 12% and 14% respectively. The remaining 3% of the predicted increase in total production is estimated to come from a small increase in wild catch (2%) and from marron in farm dams in SA (1%).

It is therefore worth asking whether there is sufficient underutilised farm dam water to enable the predicted increases in yabby production to occur. Enquiries were directed to senior Fisheries personnel in WA, SA, Vic and NSW. Information was sought in each state on estimates of the area (hectares) of existing farm dam water that is suitable for yabby production and on the proportion of that area currently being utilised for yabby production. Answers have not proved easy to provide.
In WA, there may be about 90,000 potential yabby dams (average surface area around 0.15 ha) excluding those west of a line from Albany to Perth where yabby farming in prime marron fishery regions is discouraged. It is estimated that currently there are about 2000 yabby farmers managing 10 - 15 dams each which means that 20,000 to 30,000 farm dams are currently being utilised to produce around 180-220 tonnes of yabby. That leaves 60,000 to 70,000 dams to produce the predicted increase production in WA of 300-350 tonnes by 2004/2005. Presumably the dams currently being utilised are more efficient in terms of reliability of production and proximity to markets etc., but even without increases in productivity the predicted increase in production should be achievable.

The situation in SA, Vic and NSW is not clear. In NSW and Vic the predicted increases in production by 2004/2005 are approximately 260 and 200 tonnes respectively. Given (i) that very few farm dams in these states are currently being utilised for yabby production, (ii) the rainfall in these states relative to the translocated yabby production area in WA and (iii) the fact that 24% of the predicted increase in production is estimated to come from purpose built ponds, it seems reasonable to suppose that enough farm dam water is available in these states to facilitate the predicted production increase. In SA the predicted yabby production increase by 2004/2005 is only 30-35 tonnes. Given that there are no current provisions in SA for multiple water/site permits this increase will have to come from purpose built ponds.
Product Price and Markets

Current Prices

Cyclical supply and demand variations aside, the price received for freshwater crayfish is determined for each species by weight and quality grade. The prices received by yabby producers are further subdivided according to whether they sell direct to wholesalers/retailers or whether they are selling to multiple site (waters) license (permit) holders who in turn sell the product to wholesalers/retailers. Quality grade is determined by evenness and size of claws, colour and condition of external shell, health, condition of tail meat and on whether the product has been purged prior to delivery. The definitions of grade and the weight x grade price grids vary between species, states and producers.

Table 6. Typical price ranges ($/kg)* for yabbies sold by farmers to WA multiple site license holders

<table>
<thead>
<tr>
<th>Size (g)</th>
<th>Export</th>
<th>Domestic</th>
<th>Seconds</th>
<th>Restockers</th>
<th>Bait</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-10</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>0.25/yabby</td>
</tr>
<tr>
<td>15-20</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>0.45/yabby</td>
<td>na</td>
</tr>
<tr>
<td>30-40</td>
<td>4-6</td>
<td>4-6</td>
<td>4-6</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>41-50</td>
<td>6-8</td>
<td>4-6</td>
<td>4-6</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>51-70</td>
<td>8-10</td>
<td>4-6</td>
<td>4-6</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>71-90</td>
<td>9-11</td>
<td>6-8</td>
<td>5-7</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>91+</td>
<td>10-12</td>
<td>6-8</td>
<td>5-7</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>

* Prices received by farmers will be approximately $2/kg less if the licence holder does the harvesting

Other arrangements include a fixed price for all of the product supplied by the farmer with the multiple site license holder then sorting and selling the product in size/grade categories. Averaged across all states and all size x grade categories a typical price range for yabbies would be $6-10/kg. The prices charged to wholesalers/retailers/restaurants by multiple site license holders or semi-intensive producer operations are higher but for reasons of commercial sensitivity, reliable figures are not easy to obtain. A probable price range may be $10-20/kg depending on size and grade and on whether the product is destined for local or export markets.

For redclaw, typical price ranges in Qld may be $7-9/kg, $9-11/kg, $11-13/kg and $12-14/kg for “small”, “medium”, “large” and “extra large” categories respectively, with an overall average farm gate price of around $13-14/kg. Prices paid in NSW may be higher but reliable data are hard to obtain because of the low volume of production.

Farm gate prices for marron are the highest of the the three *Cherax* species and typical ranges in WA are $16-26/kg depending on size and grade (70-100g, $16-19/kg; 100-160g, $19-21/kg; 160-250g, $21-23/kg; 250-400g, $23-26/kg). Prices paid in SA appear to be higher in some areas which may reflect tighter control by local marketing cooperatives and/or proximity to the larger eastern states city markets.

Future Prices

Given that total production is predicted to increase three fold by 2004/2005, prices might have been expected to decrease. However, there was a remarkable unanimity of agreement among the survey respondents that on balance prices would remain relatively stable for all three species. Some respondents thought there would be short term declines in price while others thought there may even be some initial rises with both opting for prices to return to current levels. The main determinants of price will continue to be size and quality. The predictions of relatively stable future prices are based on three main premises.
1. Australian freshwater crayfish are significantly larger than the main international competition species (Red Swamp Crawfish – adult size 30-35g (Huner and Lindqvist, 1995)) and are regarded as a high quality, relatively scarce and unique product in overseas markets. On these grounds, it is thought that higher volumes are likely to find ready acceptance at current prices in Europe, Japan, Korea and South-East Asia and in the larger coastal cities on the eastern and western side of the USA. During interviews, a number of respondents mentioned export market opportunities of up to 2000 tonnes per annum if regular supply of quality product could be assured.

2. The local market is also likely to absorb increased volumes of product with no diminution in price as increased production leads to regular availability of quality product in retail and restaurant outlets.

3. The larger end of the freshwater crayfish production competes favourably on price and quality grounds with the smaller end of the marine crayfish product.
Enterprise Profitability

Yabbies – Farm Dam Model of Production

A case study of the economics of harvesting yabbies in the WA farm dam system of production was undertaken by Fisheries WA over the 1994/95 financial year (Roe, 1996 – Appendix 3). The farm under study had 46 dams ranging in size from approximately 2000m² to 6000m². The dams had been actively harvested for 2-3 years and there had been regular supplementary nutrient input in the form of lupins and hay. The financial data in respect of costs are summarised in Tables 7(a) and 7(b) (Lawrence 1998 b).

Table 7(a) WA farm dam model - Initial capital expenditure

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yabby mover (including trays)</td>
<td>2200</td>
</tr>
<tr>
<td>75 Yabby traps</td>
<td>2475</td>
</tr>
<tr>
<td>Buckets to gill wash yabbies</td>
<td>50</td>
</tr>
<tr>
<td>Grading tray</td>
<td>47</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4772</strong></td>
</tr>
</tbody>
</table>

Table 7(b) WA farm dam model – Annual operating costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed (lupins, hay)</td>
<td>2200</td>
</tr>
<tr>
<td>Fuel, vehicle cost</td>
<td>2900</td>
</tr>
<tr>
<td>Bait</td>
<td>243</td>
</tr>
<tr>
<td>Ice</td>
<td>300</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5496</strong></td>
</tr>
</tbody>
</table>

The total production for the year was 3000 kg which provided a gross income of $19,000. The profit for the year (excluding initial establishment costs) was $13,504. This does not include labour and the farmer spent 360 hours or around 7 hours a week on this component of the overall farm business. The profit of $13,504 therefore represents a return of $37.51/hour. This particular operation was producing a gross income of $413/dam/year which is reported to be a little below the average for WA farm dam producers ($500/dam/year) and well below the average for the top operators ($1000/dam/year). Even if initial establishment costs are included by depreciating them over an appropriate period, the operation is returning a reasonable reward for the labour input.

It must be emphasised that the major cost of investing in the farm dams has not been included in the calculations. However, the merit of this model of production is that it is generating additional income from expensive resources constructed for other purposes. It should also be emphasised that this model of production depends on the existence of processors who purchase yabbies directly from farmers or from local depots and who take responsibility for marketing the product through local and export outlets. This model of production therefore requires a high degree of integration and collaboration between the central processor/marketer and the individual farmers and depots to ensure regular supply of quality product.

Under the new Victorian yabby aquaculture licencing arrangements (Yabby Aquaculture (Private Land) License – Multiple Waters – see above), levels of production similar to those obtained in WA should be achievable because nutrient input to dams is permitted. Three Multiple Water Licences have been applied for and one has been awarded (A Forster, personal communication). It is estimated that in the next 12 months, 10-12 Multiple Water licences may have been applied for and issued (A Forster, personal communication). The first licence to be issued is associated with a new live yabby
export facility with an initial capacity of 20 tonnes p.a. which became fully operational on March 31
2000 (Vorstermans, 2000). This facility is planning to source 80% of production from around 150
farmers who are currently being recruited. The facility has been designed for expansion and the
owners expect to be handling 50 tonnes p.a. within 3 years. The markets they will be focussing on are
in Europe and S E Asia.

In NSW the new Class E licences do not permit nutrient addition to farm dams. Production/hectare of
farm dam water is therefore likely to be lower than in WA and Vic but production costs will also be
lower. Since February 2000, around fifty expressions of interest have been received by NSW
Fisheries in respect of new Class C and Class E licences (I Lyall, personal communication). This
indicates widespread interest in extensive yabby aquaculture and several processor/marketer operators
are now beginning to recruit farmers into supply groupings to take advantage of the licensing changes.

**Yabbies – Purpose Built Ponds**

A study by Wilson (1998) examined the financial feasibility of establishing a 10 hectare purpose built
pond yabby farm using irrigation water. Based on an assumed harvest rate of 60% and base domestic
and export prices of $12/kg and $18/kg respectively, the venture was estimated to provide a profitable
and sustainable return to investors. However, sensitivity analyses indicated that the financial outcome
was highly responsive to variations in harvest rate and base prices and was a relatively high risk
investment.

At the present time, the relatively modest yields of product from semi-intensive or intensive
aquaculture with yabbies (1 to 2 tonnes/hectare/year) would probably not compete in profitability
terms with yields of product from native fin fish (eg Silver Perch - up to 10 tonnes/hectare /year). However, it may be possible to utilise polyculture systems combining yabby production from the
bottom of the pond with fin fish production from the column of water. Some form of separation
would probably be required to reduce predation of the yabbies and maximise production and returns
from the significant investment in purpose built ponds. Polyculture production systems combining fin
fish and freshwater crayfish may therefore be an area worthy of R&D investment.

**Redclaw and Marron**

Production of redclaw and marron is almost entirely based on semi-intensive culture systems in
purpose built ponds. Because of commercial sensitivities accurate information on income and
operating costs in commercial farms is not easy to obtain. Economic analyses of model farms for both
species have returned favourable outcomes when yields and/or prices are average to above average (eg

Economies of scale apply and larger farms (above 4 ha in the case of redclaw in the study by Hinton
1994) are more likely to be economically viable. (This would almost certainly be true for larger scale
semi-intensive yabby enterprises but the higher yields of product and higher prices/kg for redclaw and
marron make them more attractive propositions for semi-intensive culture systems). However, larger
scale operations involve larger initial capital outlays and the perceived investment risks may have
limited expansion of the redclaw and marron industries to a fairly modest rate.

The increases in production that are predicted to occur from 1999/2000 to 2004/2005 may reflect a
changing confidence in the financial outlook for semi-intensive production systems for both species.
Domestic and Export Markets

Yabbies

Averaged over all respondents who proffered an opinion, around 70% of current yabby production is consumed locally and about 30% is exported. The proportion exported from WA is higher and is reported to be as high as 70% (Lawrence, 1998a, D Gaunt, personal communication). Of that consumed locally the majority is sold direct to restaurants with the balance going to wholesalers and retailers. It is estimated that by 2004/2005 the proportion exported will have risen to around 70-80% of total production.

Redclaw and Marron

For redclaw, the vast majority of current production is consumed locally. There was some divergence of view on the distribution of product between local and export markets for marron, but it seems likely that the majority of current production is also consumed locally. Direct sales to restaurants probably account for the majority of current production.

Export Markets

Current export markets are largely in Europe (especially Sweden) and south east Asia. Europe has become a market because local populations of freshwater crayfish have been devastated by a fungal disease, *Aphanomyces astaci*, introduced from the USA.

Future export market targets will include Europe and south east Asia, but will also focus on Japan, Korea, Taiwan and the USA. The USA is a major producer of freshwater crayfish (around 50,000 tonnes p.a., Treadwell *et al.*, 1991) but the market weight of the local species averages around 25-35 g. It is felt that the larger average size of the Australian product (40-90 g for yabbies and larger for redclaw and marron) will give it a competitive advantage, particularly in the larger coastal cities of the east and west coast of the USA.

The view was expressed on a number of occasions that development of export markets was hampered by reliable supply of quality product. On the other hand, potential investors in freshwater crayfish production may be hesitant because of lack of clearly identified export markets with known demands for product.

Just how this dilemma will be overcome is not clear, but if the predictions of industry expansion identified in this study are realised, supply of quality product will no longer be an impediment to export market development. Promotion and marketing skills will then become paramount in securing the potential export markets. Organisation of growers through marketing cooperatives or other franchising arrangements like those currently in existence for farm dam yabby production in WA, will be critical in facilitating the development of promotion and marketing skills and resources.
Impediments to Industry Expansion

Responses to this section of the questionnaire were many and varied and often reflected local issues. Some of the more common responses were as follows:

- Lack of understanding of rural based aquaculture by government and local government authorities who place unreasonable and restrictive conditions on development applications.
- Inability to attract major investors or finance due to perceived low and inconsistent productivity and profitability of freshwater crayfish aquaculture.
- Regulations in all other states except WA which restrict production from existing farm dams. *(NB. This impediment has been overcome during 1999/2000 in Vic and NSW by introduction of new multiple site/water licencing arrangements).*
- Translocation regulations designed to protect local species or production from local species.
- Processor capacity.
- Import tariffs and bans, particularly on live product in some countries.
- Lack of industry coordination, research and promotion funding.
- More cost effective diets and husbandry systems.
- Possible future problems with chemical contamination, particularly of farm dam water.
- Lack of resources for technology transfer.
Government Incentives for Expansion of Exports

The common response to this question was that respondents were not aware of any specially targetted incentives for expansion of freshwater crayfish exports. It was also said on a number of occasions that effort and private finance invested in seeking matching Government grants for overseas market development/business development projects was not attractive because the markets were already there if supply of quality product could be increased to meet existing demand.

State Government assistance may be available to assist with development of new industries in regional areas, but it is not specifically targetted to expansion of exports.

Successful Commonwealth Government intervention in respect of current import tariffs and bans in certain target export markets would be a valuable contribution to industry development.
Research and Development

Responses to this section of the questionnaire were also many and varied but there were some common themes. These are listed below in no particular order of priority.

Nutrition
- R&D to determine protein and energy requirements for growth and reproduction.
- R&D to develop more cost effective and growth maximising diets.
- R&D to develop “food signatures” technology as an aid to improved understanding of natural dietary constituents.

Husbandry
- R&D to improve understanding of the relationships between productivity and water depth, water temperature and oxygenation.
- R&D focussed on production and best practice husbandry systems to lift sustainable levels of production.
- R&D to develop early and cheap sexing (including monosex) technologies for control of pond density.
- R&D to investigate the impact of farming practices on chemical residues in freshwater crayfish.
- R&D to define effects of disease on production.

Genetics and Breeding
- R&D to support selective breeding for the development of highly improved strains of freshwater crayfish.
- R&D to develop highly productive monosex and/or sterile lines of freshwater crayfish.

Engineering and Pond Architecture
- R&D to improve water quality management.
- R&D on optimal pond design and the value of shelters.

Economics
- R&D to define and categorise available water resources.
- R&D to evaluate marketing and promotion strategies.

Post Harvest
- R&D to define causes of mortality and improve post harvest holding and transport technology.
- R&D to investigate further processing and value adding options.

It is clear that the freshwater crayfish industry is currently based on un- or very recently domesticated species which have undergone no systematic genetic improvement. It is evident from land based animal production systems and from recent experience with aquaculture species that very significant improvements in production can be obtained from the application of controlled, well designed, measurement based breeding programs. Based on the limited amount of information on genetic variation in growth rate, annual genetic responses of 5-10% of the mean could be expected from relatively simple breeding programs for freshwater crayfish (eg Jones and McPhee, 1993 and see Appendix 4). All of the other improvements that will accrue from well directed R&D will add to improvements from selective breeding and create the possibility of annual productivity gains in the freshwater crayfish industry that are now being achieved in other aquaculture industries.
Technology Transfer and Adoption

Sources of information in respect of current and developing technologies for freshwater crayfish production and methods of delivery are broadly similar across all states and species. Sources of information include state government research and extension agencies especially Fisheries Departments (or their equivalents), CSIRO, grower/producer associations, processors, consultants and other producers. Methods of delivery include conventional research and extension literature, grower association regional and state newsletters, rural press, websites, videos, rural radio, field days and in some states, face to face consultation with state government agency extension specialists.

In NSW and Vic, a special effort will be required to encourage and technically equip new farmer participants in the new multiple waters/sites farm dam systems for extensive aquaculture of yabbies. If additional resources, in the form of qualified personnel and funds to support their activities, are not made available for this purpose, the rate of increase in yabby production and the eventual new levels of production will be lower than predicted by industry in this study.
Conclusions

The conclusions arising from this study are based on analysis of industry responses to a questionnaire which was designed to discover information on the potential for expansion of the freshwater crayfish industry in Australia. The main conclusions are as follows:

- Levels of freshwater crayfish production have been slowly increasing over the past 5-10 years and for the past three years (1996/97 to 1998/99) have averaged 421 tonnes with a value of $4.968 million.
- Levels of freshwater crayfish production are predicted to show modest increases in 1999/2000 but are predicted to increase around threefold by 2004/2005 to a level of 1589 tonnes with a value of $20.718 million.
- Recent changes to the licensing provisions governing yabby aquaculture in NSW and Vic have created the potential for significant expansion of yabby production in these states.
- For the three commercially farmed freshwater crayfish, yabby, redclaw and marron, the levels of production are predicted to increase between 1999/2000 and 2004/2005 by 293%, 239% and 381% respectively.
- For redclaw and marron the predicted increase in production will be based on semi-intensive aquaculture in purpose built ponds. For yabbies, the majority (72%) of the predicted increase is estimated to come from increased utilisation of existing farm dams with the remainder from purpose built ponds.
- Despite the magnitude of the predicted increases in production, prices received by farmers for freshwater crayfish are predicted to remain relatively stable. This prediction is based on assessments of the size of possible export markets and on the ability of the local market to absorb more product at current prices.
- Yabby aquaculture based on harvesting from farm dams can be profitable and provide an additional source of income from water resources that have already been created for land based agriculture purposes.
- Crayfish aquaculture in purpose built ponds can also be profitable but economies of scale apply and larger scale operations are more likely to be economically sustainable. Because of higher yields and prices, semi-intensive redclaw and marron operations may be more viable than semi-intensive yabby aquaculture systems.
- Commercial fin fish operations typically have higher production yields than reported for freshwater crayfish and there may be scope for polyculture to increase total returns from investment in purpose built ponds.
- Potential export markets for Australian freshwater crayfish have been reported to be capable of absorbing as much as 2000 tonnes p.a. Existing export markets are in Europe and south east Asia but additional market development activity will also be focussed on Japan, Korea, Taiwan and the USA.
- Perceived impediments to industry expansion identified during the survey included:
  - Lack of understanding of rural based aquaculture by government and local government authorities who place unreasonable and restrictive conditions on development applications.
  - Inability to attract major investors or finance due to perceived low and inconsistent productivity and profitability of freshwater crayfish aquaculture.
  - Processor capacity.
  - Import tariffs and bans, particularly on live product in some countries.
  - Lack of industry coordination, research and promotion funding.
  - More cost effective diets and husbandry systems.
  - Lack of resources for technology transfer.
- Increased funding for R&D and technology transfer is required to support expansion of a more productive, profitable and economically viable industry. An annual investment of $150,000 to $300,000 for a period of 3-5 years (1.5% - 3% of the estimated value of production over that period) would make a significant contribution to industry expansion.
Appendices

Appendix 1.-Survey of Potential for Expansion of the Australian Freshwater Crayfish Industry – WA Format

State...Western Australia

Person Interviewed/Surveyed...

Contact Details
Position:
Address:

Tel: Fax: Mobile:

Email:

Date:
Questionnaire to serve as a basis for discussions with personnel from Industry and State Fisheries

1. What is the current size of the Freshwater Crayfish Industry in WA? (Values in Table from Australian Fisheries Statistics)

<table>
<thead>
<tr>
<th>Year</th>
<th>Yabby Tonnes</th>
<th>Marron Tonnes</th>
<th>Yabby Value($'000)</th>
<th>Marron Value($'000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996/97</td>
<td>150</td>
<td>47</td>
<td>1396</td>
<td>1158</td>
</tr>
<tr>
<td>1997/98</td>
<td>231</td>
<td>42</td>
<td>2253</td>
<td>1035</td>
</tr>
<tr>
<td>1998/99</td>
<td>107</td>
<td>42</td>
<td>1127</td>
<td>1035</td>
</tr>
</tbody>
</table>

2. Will the industry expand its production in WA (Y/N) and if so what do you expect the production to be by say 2005.

<table>
<thead>
<tr>
<th>Year</th>
<th>Yabby Tonnes</th>
<th>Marron Tonnes</th>
<th>Yabby Value($'000)</th>
<th>Marron Value($'000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999/2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000/2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001/2002</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2002/2003</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003/2004</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004/2005</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Will the expansion be based on(%):

- Wild catch
- Licensed Farm Dam production
- Purpose built ponds
- Polyculture with farmed finfish

4. What are current prices and how are they determined (size?, quality grade? etc)

Yabby

Marron

5. What do you expect future prices to be and how will they be determined (size?, quality grade? etc)

Yabby

Marron
6. What are the main sale outlets for freshwater crayfish (%)

<table>
<thead>
<tr>
<th></th>
<th>Restaurants</th>
<th>Wholesalers</th>
<th>Retailers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Local</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td></td>
<td>Export</td>
<td>Export</td>
<td>Export</td>
</tr>
</tbody>
</table>

Yabby

Marron

7. What countries are the export targets

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Yabby

Marron

8. Are there any impediments (Government regulations/other) to expansion of the industry (Y/N)? If so what is the nature of these impediments and are they likely to be overcome (Y/N).

9. Will there be Government (State/Federal) incentive schemes for expansion of exports (Y/N). If Yes how significant?

10. What are the main R&D requirements of the Freshwater Crayfish Industry?

11. What are the main technical/market information sources for commercial freshwater crayfish producers?
Appendix 2 – Terms and conditions of the Class E Permit introduced by the NSW Government

MULTI-SITE AQUACULTURE PERMIT FOR EXTENSIVE CULTURE OF CHERAX DESTRUCTOR IN CONSTRUCTED DAMS
(CLASS E PERMIT CONDITIONS)

1. Only the yabby, *Cherax destructor*, will be cultured under this permit. This relates to yabbies that have arrived in constructed dams opportunistically, have been historically stocked by landholders or those intended for stocking as part of future aquaculture operations.

2. Constructed dams will not be approved if built in natural waterways, eg billabongs or isolated outreaches of creeks or rivers. Western drainage dams must not be susceptible to inundation by 1/100 year floods.

3. There will be no nutrient input to constructed dams. Supplementary feeding, for example using artificial pellets or meat, or introducing live feeds or fertilisers (both inorganic and organic fertilisers), will not be permitted. Lining of dams with hay or planting crops into the bottom of dams is permissible prior to stocking.

4. The permit authorises the setting of traps, collecting of traps and yabby stock, and transport or market sized yabby stock to holding facilities from nominated constructed dams at multiple sites under an agreement with the landholders(s).

5. The permit will authorise a reasonable number of staff to undertake the activities listed in Condition 4. Authorised staff will be identified by a Photo Identification Card. This must be carried whilst harvesting and transporting yabbies under a Class E yabby permit and produced to a Fisheries Officer on demand.

6. Landholder(s) whose constructed dams are covered under the Class E yabby permit will also be allowed to harvest yabbies using legal recreational means and held on-site for collection by the Class E permit holder.

7. Only the permit holder is to introduce stock into any dam covered under the permit.

8. The maximum number of constructed dams to be authorised on a permit will be 1,000 dams on a multiple number of properties.

9. Authorised staff will be limited to a total of 100 approved yabby traps each to undertake collection activities. A non-removable plastic tag, marked with the permit number, must be attached to each trap.

10. Yabbies harvested for sale from nominated constructed dams must be of a table-market size, that is, no smaller in weight than 30g.

11. No berried females or soft shelled yabbies may be removed from a nominated property and kept for sale, they may only be returned to permitted constructed dams for restocking purposes on the nominated property where taken.
12. An agreement between the permit holder and the dam owner, specifying terms and conditions relating to the use of constructed dams for purposes of aquaculture must remain current.

13. Reasonable access to public water by licensed commercial fishers through Western Division properties under a Class E permit is not to be restricted by the permit holder or property owner.

14. Class E permit holders will need to maintain records of yabby harvest (volumes and locations) whilst harvesting and transporting yabbies, in addition to prescribed records under clause 225 (1) of the Fisheries Management (General) Regulation 1995. A record of lost traps must also be maintained.

15. Unless specified elsewhere in the Class E permit, all provisions of the NSW Fisheries Management Act, 1994 and Regulations must be complied with.
Appendix 3 - Growing Yabbies in Farm Dams – An Economic Case Study

Ms Juana Roe
Aquaculture Development Officer
Fisheries WA, Narrogin.

What all farmers want to know is whether yabby farming is profitable? This article looks at one case-study I have compiled.

‘Liz” has 46 dams which are quite muddy (some Milky, some brown) and rang in size from approximately 2000m2 to 6000m2 surface area. The dams have been actively harvested for 2-3 years and have been fed lupins, with some additional hay. In this case Liz treats the yabbies as a separate enterprise to the farm, feeding every fortnight in concentrated blocks instead of feeding dams when driving past to check sheep etc. Liz harvests every 6 weeks. Liz uses the farm vehicle, so for our purpose, fuel, depreciation, and wear and tear have been accounted for by a $0.50 charge/km.

In 1994/95, Liz produced 3000kg of marketable yabbies from 46 dams which grossed $19,000.00. It should be noted that approximately 25% of dams went dry.

<table>
<thead>
<tr>
<th>WORKING COSTS</th>
<th>INDIVID. COST</th>
<th>COST/ROUND</th>
<th>COST/YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 smallest dam @ 7.5kg lupin/fortnight for 24 feeds ($170/tonne)</td>
<td>$1.28/dam</td>
<td>$32.00</td>
<td>$768.00</td>
</tr>
<tr>
<td>21 larger dams @ 15.00kg lupin/fortnight for 24 feeds ($170/tonne)</td>
<td>$2.55/dam</td>
<td>$53.55</td>
<td>$1285.20</td>
</tr>
<tr>
<td>75km round trip to feed @ 50 cents/km for 24 feeds</td>
<td>$37.50</td>
<td>$900.00</td>
<td></td>
</tr>
<tr>
<td>35km/harvest trip (6 trips/harvest) @ 50 cents/km for 8 harvests</td>
<td>$145.00</td>
<td>$1160.00</td>
<td></td>
</tr>
<tr>
<td>290km/harvest delivery to processor @ 50 cents/km for 8 harvests</td>
<td>$150.00</td>
<td>$3600.00</td>
<td></td>
</tr>
<tr>
<td>6h to feed @ $25/h for 24 trips</td>
<td>$600.00</td>
<td>$4800.00</td>
<td></td>
</tr>
<tr>
<td>3 days @ 8h/day to harvest @ $25/h for 8 harvests</td>
<td>$75.00</td>
<td>$600.00</td>
<td></td>
</tr>
<tr>
<td>Bait (50g dog biscuits/trap @ Ave 11traps/dam/harvest 46 dams and 8 harvests ($25 for 20kg)</td>
<td>$0.06/trap</td>
<td>$30.36</td>
<td>$242.88</td>
</tr>
<tr>
<td>Ice ($300/yr. for power to produce ice for in yabby mover)</td>
<td>$37.50</td>
<td>$300.00</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td>$14,496.08</td>
</tr>
</tbody>
</table>

PROFITABLE?
(Note: these results do not take into account the first 1-2 years.)
The calculations above include a wage of $25.00/h. This provided a net profit of $4,503.92 (depreciation of capital items not included) to purchase capital items etc. If no wage was allocated, working costs would have been minimal, allowing a profit of $13,503.92 or an equivalent $37.51/hour return. Liz spent 360 hours working, equivalent to approximately 7 hours/week.)
Gross Income  19,000.00
Less
Working costs  14,496.08
Net Profit **  $4,503.92

** Calculations have not taken into account any depreciation or purchase of capital items.

**BENEFITS**
An extra $19,000.00 was made off the farm by utilizing a resource which already existed. Important observations were made while driving around the farm including finding fly blown sheep, trees fallen onto fences, etc. The $ value this provides the farm is unknown.

**IS THERE ROOM FOR IMPROVEMENT/ A HIGHER RETURN**
From conversations with the major processing companies, their average farmers are earning $500 gross/dam/year, and their better farmers (often those who have been in the industry longer) are earning $1000.00 gross/dam/year. Liz earnt approximately $415.00 gross/dam/year.

There are lots of variables however, which could affect the level of profitability, including type and regularity of feeding, regularity of harvesting, number of dams farmed, dam dimensions, water supply, water quality, water turbidity, predators, climate, proximity of processing facilities, the list goes on.

**EXAMPLE OF DEPRECIATION**

<table>
<thead>
<tr>
<th>Initial capital expenditure</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$2,200.00 for Yabby mover (including trays)</td>
<td>$2,200.00</td>
</tr>
<tr>
<td>$2,475.00 for 75 yabby traps $2,475.00</td>
<td></td>
</tr>
<tr>
<td>$50.00 for buckets to gill flush</td>
<td>$ 50.00</td>
</tr>
<tr>
<td>$47.00 for grading tray</td>
<td>$ 47.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$4,772.00</strong></td>
</tr>
<tr>
<td>Less Depreciation (Ave: 25%)</td>
<td></td>
</tr>
<tr>
<td><strong>Capital value after 1st yr. depreciation</strong></td>
<td><strong>$3,579.00</strong></td>
</tr>
</tbody>
</table>

**NOTE:** Liz does not use polystyrene boxes to transport product to the processing facility. Liz has a special carry box called a yabby mover. It is made from fibreglass and holds trays similar to a bakery tray. Product can be stored in a yabby mover for 3-4 days if treated well (gill flushed, kept cool and moist), which is a lot easier then storage socks to hold product for three days harvest, and then to pack product into 38 boxes (an average of 375kg of yabbies were sold each harvest last year). This system is only used by processing facilities and large individual growers.

For more information, please contact Juana Roe on:
Phone:      (08) 9881 0222
Facsimile:  (08) 9881 1950
Appendix 4 – Estimating response to selection for market weight in yabbies

For the purpose of these calculations I have assumed that the breeding program is based on farm infrastructure which allows selection within full-sib families. I assume that 1 male and 1 female are chosen from each family and that a mating scheme is used which minimises inbreeding. Heritability ($h^2$) of market weight is assumed to be 0.3 which is around the mean of published estimates for other crayfish species (eg Jones, McPhee and Ruscoe, 1998; Henryon, Purvis and Berg, 1999). Further assumptions include an average family size of 150, a value of 0.5 for the phenotypic intra-class correlation ($t$) of market weight among full-sibs and a coefficient of variation (CV) of market weight of 20% or 40%. Based on data for yabbies at CSIRO Livestock Industries’ Aquaculture Unit at Armidale NSW, (Jerry, Purvis and Piper, unpublished), the values for $t$ and CV are conservative.

Response to selection within full sib families, $R_w$, is given by Falconer and Mackay (1996) as:

$$R_w = \frac{1}{2} h^2 i \sigma_p \sqrt{(1-t)}$$ \text{ for large family size} \ (1)

Where

- $i$ = the standardised selection differential and
- $\sigma_p$ = the phenotypic standard deviation of market weight

If we further assume that the generation interval for yabbies is one year and express $R_w$ as a percentage of the mean market weight, we may rewrite the annual response to selection as

$$R_w*100/\text{Mean} = \frac{1}{2} h^2 i \text{ CV}(\%) \sqrt{(1-t)}$$ \text{ for large family size} \ (2)

The value of $i$ for a selection intensity of 1 in 75 for each sex is 2.4 and substituting in (2) above, we obtain estimates of annual genetic response as follows:

$$R_w*100/\text{Mean} = 0.5 * 0.3 * 2.4 *20 * 0.7071 = 5\% \text{ for a CV of 20\% and}$$

$$R_w*100/\text{Mean} = 0.5 * 0.3 * 2.4 *40 * 0.7071 = 10\% \text{ for a CV of 40\%}$$

This range of values is the same as that given by Jones and McPhee (1993) for redclaw. Selection schemes combining within and between family selection could achieve higher annual rates of gain but with some additional increase in the rate of inbreeding.
References


