Report to farmers

Aquaculture production survey Queensland 2006–07

Queensland Government
Department of Primary Industries and Fisheries

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Department of Primary Industries and Fisheries, Queensland
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The Department of Primary Industries and Fisheries (DPI&F) seeks to maximise the economic potential of Queensland's primary industries on a sustainable basis.

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List of acronyms

AAQ	Aquaculture Association of Queensland
ABFA	Australian Barramundi Farmers' Association
ACIAR	Australian Centre for International Agriculture Research
BIARC	Bribie Island Aquaculture Research Centre
CSG	Coal seam gas
DA	Development approval
DPI&F	Department of Primary Industries & Fisheries
FFAC	Freshwater Fisheries and Aquaculture Centre
FRDC	Fisheries Research and Development Corporation
FTE	Full-time equivalent
NFC	Northern Fisheries Centre
PCA	Pearl culture areas
QOGA	Queensland Oyster Growers Association
QSS	Queensland Sea Scallop Ltd
QSWAMP	Queensland Shellfish Water Assurance Monitoring Program
RIRDC	Rural Industry Research Development Corporation
SAC	Self-assessable code
TMF	Tropical marine finfish

1. Production summary

The total value of the Queensland aquaculture industry has increased by 7% over the last 12 months, with the value of production increasing from $70.5 million in 2005–06 to $75.5 million in 2006–07. This increase was largely due to an increase in the barramundi sector by more than 30% from $14 million to $18.5 million.

Although there has been a 7% increase in the value of aquaculture production over the last 12 months, the wild catch fishery has increased by 8%. The proportion attributed to aquaculture has remained stable at 27% over the last 12 months (Table 1). In Queensland the total value of fisheries production, including aquaculture, in 2006–07 was $280.5 million, which was 8% higher than the previous year.

Combinations of all species of prawns (black tiger (*Penaeus monodon*), banana (*P. merguiensis*) and kuruma (*P. japonicus*)) are grown in Queensland. The kuruma prawn sector is currently represented by one farm where production is minimal.

Production in this sector decreased by 6% from 3300 tonnes in 2005–06 to 3085 tonnes in 2006–07. The value of this sector has decreased by 8% from $46.3 million in 2005–06 to $42.5 million in 2006–07.

The area harvested decreased from 802 hectares in 2005–06 to 776 hectares in 2006–07. The number of producing farms decreased by 16% over the last three years, with only 26 farms in production in 2006–07.

The average price of $13.79/kg was marginally lower than the average price of all species of prawns in 2005–06.

Barramundi (*Lates calcarifer*) production increased significantly (20%) from 1745 tonnes to 2091 tonnes in 2006–07. This was on top of a 21% increase from the previous year. The value of the industry has increased by 30%, from $14.0 million in 2005–06 to over $18.5 million in 2006–07. The average price on a whole-fish basis increased from $8.04/kg to $8.86/kg.

The majority of production came from pond and cage-based systems.

Over this period the number of producing pond-based farms increased from 25 to 26. The number of tank-based systems decreased from 11 to 6. There was just one sea cage operation.

Table 1. Queensland fisheries production—gross value (2001–02 to 2006–07)

	ABARE figures			Queensland figures(1)		
Year	Total fisheries ($m)	Aquaculture ($m)	Aquaculture (%)	Total fisheries ($m)	Aquaculture ($m)	Aquaculture (%)
2001–02	309.2	75.2	24.3	na	na	na
2002–03	290.9	62.9	21.6	na	na	na
2003–04	305.7	67.7	22.1	309.3	71.3	23.0
2004–05	262.8	64.5	24.5	265.9	67.9	25.5
2005–06	256.7	67.7	26.4	259.5	70.5	27.2
2006–07	276.9	71.9	26.0	280.5	75.5	26.9

(1) The Queensland figures include hatchery production for farm stocking and impoundment restocking. Farm stocking details are excluded from the ABARE figures. Details on numbers and values of the species stocked are included in Section 8.2 of this report.

Sources: Australian Bureau of Agricultural and Resource Economics (ABARE), Department of Primary Industries & Fisheries

Redclaw crayfish (*Cherax quadricarinatus*) decreased marginally from 105 tonnes in 2005–06 to 100 tonnes in 2006–07. Over the same period the value of redclaw sold as food increased marginally from $1.30 million in 2005–06 to $1.45 million in 2006–07.

The number of producing farms in 2006–07 was 46, which was 13 less than in 2005–06. There were 140 farms that reported no production at all for 2006–07 (compared with 128 farms in 2005–06). Dry conditions resulted in some farms having to abandon production.

Average farm productivity increased by 12% from 1495 kg/ha in 2005–06 to 1670 kg/ha in 2006–07. The average price obtained for redclaw crayfish increased by 16% from $12.43/kg in 2005–06 to $14.45/kg in 2006–07.

The freshwater fish growout sector currently produces silver perch (*Bidyanus bidyanus*), jade perch (*Scortum barcoo*), golden perch (*Macquaria ambigua*), Murray cod (*Maccullochella peelii peelii*) and sleepy cod (*Oxyeleotris lineolatus*). Golden perch and sleepy cod production can not be reported separately for confidentiality reasons as insufficient farms produced these species.

Freshwater fish (other than barramundi) production has increased in value by nearly 50% from $1.5 million in 2005–06 to over $2.2 million in 2006–07.

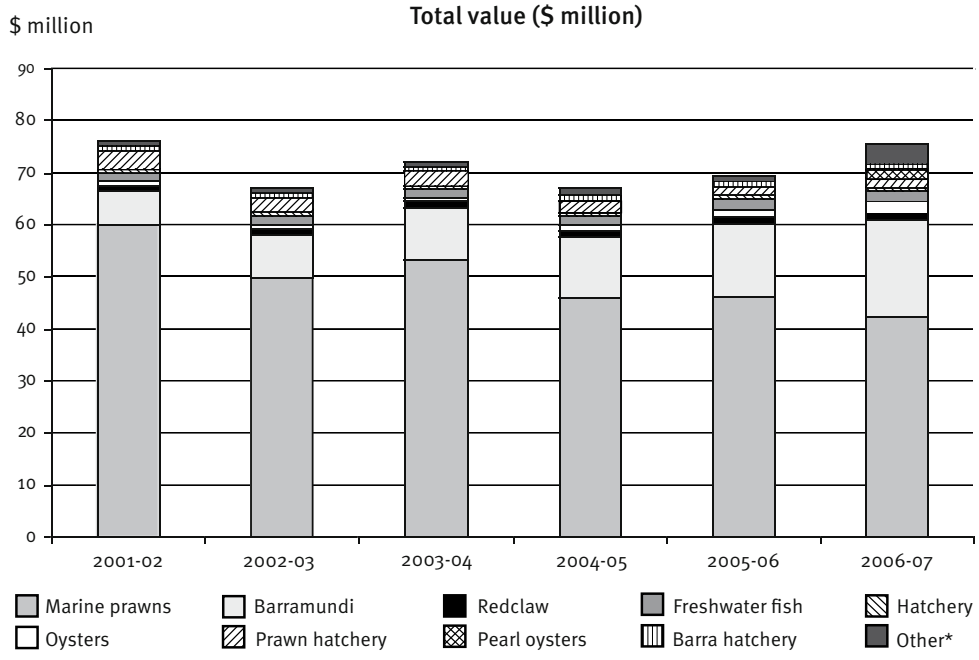
In 2006–07 silver perch accounted for 43% of freshwater fish production, jade perch 24%, Murray cod 31% and other species 2%, whereas in 2005–06 silver perch accounted for 40%, jade perch 28%, Murray cod 28% and other species 4%. Recirculating tank systems accounted for 23% (49 tonnes) of the total freshwater fish production.

Murray cod production increased by 50% from 2005–06. Production now exceeds 65 tonnes and is valued at $937 000; Murray cod production represents the most valuable species sector within the freshwater fish group, with silver perch production valued at $790 000 and jade perch production at $454 000.

In 2006–07 there were 4 Murray cod producers, 8 jade perch producers and 13 silver perch producers. The average prices for silver and jade perch were $8.81/kg and $8.86/kg respectively, while Murray cod averaged just over $14.40/kg.

Production from the eel sector (*Anguilla* spp.) has stabilised over last two years even though there were only four producers operating during this time. Production increased from 21 tonnes in 2005–06 to just over 32 tonnes in 2006–07. During this period, the average price remained almost the same at $16.80/kg.

Figure 1. Value of Queensland aquaculture production ($ million)



* Other includes crabs, sea scallops, eels, marine hatchery and marine aquarium

The hatchery sector, producing native fish fingerlings and ornamental aquarium species, had a 14% decrease in the number of sales. However, the value of the sector increased by nearly 4%, rising from $3.38 million in 2005–06 to $3.51 million in 2006–07.

The reported oyster production all occurs on leases south of Hervey Bay and is confined to the culture of rock oysters (*Saccostrea glomerata*) on 'furniture' placed on tidal land, predominantly above mean low water.

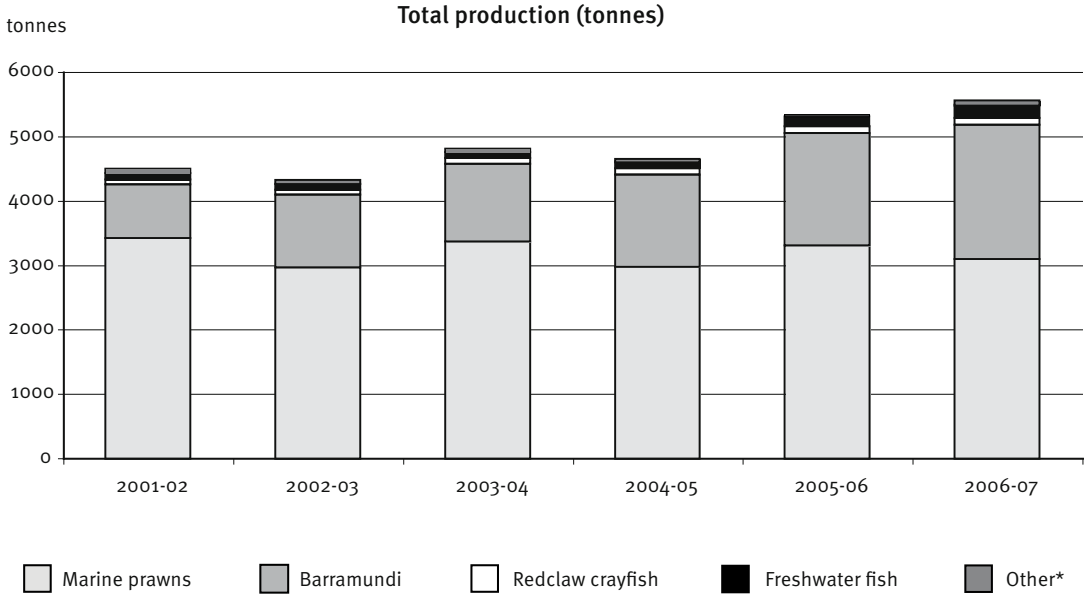
Total edible oyster production decreased by 24% from 161 000 dozen in 2005–06 to 141 000 dozen in 2006–07; the value of the industry decreased marginally from $574 000 in 2005–06 to $534 000 in 2006–07. The average price per dozen oysters increased by 6% from $3.56 per dozen to $3.79 per dozen. This production came from 36 oyster areas in 2006–07 (compared with 30 oyster areas in 2005–06).

The value of the pearl oyster industry in Queensland continues to fluctuate as some of the farms rebuild stocks of nucleated pearls. Four farms reported information this year with production for 2006–07 estimated at $1.7 million. Comparisons with previous years can not be made as insufficient farms supplied information in those years and details can not be disclosed for confidentiality reasons.

The total permanent labour force in the aquaculture industry increased from 444 units in 2005–06 to 471 units in 2006–07. The marine prawn sector accounted for 226 units or 48% of the total permanent labour force.

When numbers for permanent and casual labour are combined, employment in the Queensland aquaculture industry increased by 16% from 584 full-time equivalents (FTEs) in 2005–06 to 674 FTEs in 2006–07.

Figure 2. Queensland aquaculture total production (tonnes)



* Other includes crabs, sea scallops, eels, marine hatchery and marine aquarium

2. Survey methods

Production statistics for the financial year 2006–07 were collected from farms producing marine prawns, barramundi, redclaw crayfish, freshwater growout fish and eels, as well as hatchery and aquarium producers. Statistics collected from the edible and pearl oyster growers relate to culture areas.

Survey forms were mailed to development permit (aquaculture authority) holders for the species listed below. The number of forms mailed increased from 784 in 2005–06 to 793 in 2006–07. The results presented in this report reflect the information provided by the industry through the statistical returns. Non-producing farms were able to respond by ticking the 'nil production box' and were not required to provide further details about their operations. In some sectors, non-response by some of the larger growers can provide a result that under-represents the true industry situation.

The total numbers recorded for each species group are based on operations that have these species authorised on their development permit. Some development permits have more than one species on their approval.

The 88% response rate for 2006–7 (Table 2) was higher than the 87% response rate achieved in 2005–06.

The following are conversion factors and definitions used in the report:

Conversion factors

Fish production is reported on a whole-fish basis. For example, gilled and gutted barramundi to whole fish (0.89:1 on weight basis) and filleted barramundi to whole fish (0.48:1 on weight basis).

Fingerling fish

Small fish in the 2–10 gram range.

Juvenile crayfish

Immature crayfish in the 1–15 gram range.

Labour conversion

Labour FTEs are calculated by adding the total permanent labour units to the casual labour units converted to FTEs. Forty hours per week casual labour for 48 weeks per year is considered one FTE labour unit. Information collected in hours per week was converted to FTEs by dividing total hours by 40 hours.

Table 2. Response rates to survey questionnaire

	Number mailed	Number returned	Per cent returned
Marine prawns	61	56	92%
Barramundi	129	118	92%
Redclaw crayfish	204	186	91%
Freshwater fish	165	143	87%
Eels	29	26	90%
Hatchery and aquarium	79	71	90%
Edible oysters	114	97	85%
Pearl oyster culture areas	12	10	83%
Total	**793**	**707**	**89%**

Note:
All holders of development permits in Queensland are required, as a condition of their approval, to complete an annual statistical return. The Department will be corresponding with all permit holders who have not completed the 2006–07 returns. Failure to accurately complete the statistical returns by the due date constitutes a breach of aquaculture approval conditions and will result in the issuing of a fisheries infringement notice. From 1 March 2005 all aquaculture licences were transitioned to development permits as prescribed under the *Integrated Planning Act 1997*.

3. Marine prawns

3.1 General

The value of the Queensland prawn industry decreased by 8% from $46.3 million in 2005–06 to $42.5 million in 2006–07.Total production decreased by 6% from 3300 tonnes in 2005–06 to 3085 tonnes in 2006–07. Additionally, the hatchery sector sold post-larvae to a value of $1.9 million.

Previous reports have separated kuruma prawn (*Penaeus japonicus*) production from the other two main species—black tiger (*P. monodon*) and banana prawns (*P. merguiensis*). Kuruma prawn production has almost ceased in Queensland with only one farm producing limited quantities for the Australian market. This sector has now been included in the general marine prawn group.

Of the 56 authority holders that responded in 2006–07, 26 were producing growout farms (29 in 2005–06) and 4 were independent hatcheries (5 in 2005–06).

The Queensland industry faced a number of production and marketing problems during 2006–07, which has caused the decline in value of this sector. Post-larvae produced during the early part of the season were of poor quality and many batches had to be discarded before stocking. The cool January period slowed growth on many farms, although the Logan River farms did have a warmer April that extended harvest into May. In the latter part of the season some farms had some ponds affected by losses, probably due to mid-crop mortality syndrome. This resulted in farmers having to harvest these ponds before prawns could grow to large and extra large sizes.

The increase in imported prawns was the main reason for a decrease in the market value of prawns received by Australian farms in the market place. Although the prices ranged from $9.50/kg to $17.50/kg the average farm gate price fell by 3% from $14.14/kg in 2005–06 to $13.79/kg in 2006–07 (Table 3). The majority of sales occurred in Australia (99%), with only 1% exported (compared with 2% exported in 2005–06).

3.2 Marine prawn production

3.2.1 Growout

The following table (Table 3) illustrates the production in 2006–07. Production was similar to 2004–05 but average yields per hectare decreased by 3.5% over the last 12 months. Average prices ($/kg) over the same period have decreased by 5% of the prices in 2006–07, which were 11% lower two years earlier.

In 2006–07, 24 farms (22 in 2005–06) produced over 20 tonnes. In 2006–07, 18 farms (21 in 2005–06) produced over 50 tonnes (Table 4) while 10 farms (12 in 2005–06) produced over 100 tonnes. In 2006–07, 4 farms (4 in 2005–06) averaged over 6000 kg/ha/crop.

The total ponded area on farms has increased by 3%, from 713 hectares in 2005–06 to 737 hectares at the end of 2006–07. The area stocked increased by 28% from 835 to 1070 hectares. The total harvested area decreased from 802 hectares in 2005–06 to 776 hectares in 2006–07.

Pond sizes ranged from 0.65 to 1.77 hectares with an average size of 1.03 hectare. The average number of crops per pond per year increased from 1.0 to 1.1 crops per year. There were 5 farms (6 in 2005–06) that produced more than one crop per year. The average stocking rate decreased from 33 post-larvae per square metre to 26 per square metre. Stocking rates varied from 9 to 50 with 8 farms stocking at 40 or more per square metre (compared with 4 farms the previous season).

Table 3. Marine prawn production by aquaculturists in Queensland (2004–05 to 2006–7)

	2004–05	2005–06	2006–07
Total production (tonnes)	2964	3300	3085
Average price ($/kg)	$15.49	$14.14	$13.79
Total value ($ million)	$45.9	$46.3	$42.5
Average yields (kg/ha/crop)	3684	4118	3974

Table 4. Number of approved marine prawn farms and production levels in Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Production (tonnes)	**No.**	**No.**	**No.**
0.1 to 5.0	3	3	1
5.1 to 10.0	3	1	1
10.1 to 20.0	3	3	0
20.1 to 50.0	6	1	6
50.1 to 100.0	7	9	8
100.1 to 200.0	7	7	4
Over 200	2	5	6
Number of producing farms	31	29	26
Number of non-producing farms	18	19	23
Number of hatcheries only	6	5	6
Total number of responses	55	53	55
Number of farms surveyed	60	59	60

The quantity of feed decreased from 7325 tonnes in 2005–06 to 6286 tonnes in 2006–07. Over the same period the estimated feed conversion ratio (FCR) decreased from 2.2:1 to 2.0:1. There was a change in the source of feed with an increase in the use of Australian feed. In 2006–07 feed sources were 50% from Australia (36% in 2005–06) and 50% from overseas (64% in 2005–06).

3.2.2 Hatchery

Fourteen prawn hatcheries (15 in 2005–06) in Queensland produced an estimated 320 million post-larvae (338 million post-larvae in 2005–06). The number of post-larvae produced has returned to stable levels of 320–340 million (Table 5). The between-year comparative figures are further complicated by the production of banana prawns where pond-reared spawners are being used for post-larvae production rather than obtaining spawners from the wild.

3.2.3 Labour

The total labour employed on marine prawn farms over the last three years is shown in Table 6. The increase (29%) in permanent labour almost raises this total to the same levels as 2004–05.The efficiency of permanent labour decreased to 13.7 tonnes per unit, which was similar to 2004–05 but over 25% lower than the 18.9 tonnes in 2005–06.

Total casual hours employed has increased by 6% over the last 12 months from 136 300 hours to 145 676 hours. This has resulted in the casual hours per tonne increasing from 41 hours to 47 hours per tonne. The dollar output per labour unit employed in the industry has decreased by 25% over the last 12 months. In the last 12 months FTEs employed in the industry increased by 23%. FTEs have increased from 245 to 302.

Table 5. Marine prawn hatchery production in Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Number of spawners purchased	4996	3521	4070
Number of spawners used	3969	3505	7928
Number of post-larvae produced (million)	330.8	338.5	320.2
Number of post-larvae stocked (million)	299.2	295.7	267.7
Number of post-larvae sold (million)	142.0	97.7	188.6
Value of post-larvae sold (million)	$2.23	$1.56	$1.89
Average value of post-larvae (cents)	1.57	1.60	1.50

Table 6. Labour use on marine prawn farms in Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Permanent labour (tonnes/unit)	12.4	18.9	13.7
Total permanent (units)	239	175	226
Casual labour (hours/tonne)	72	41	47
Total casual labour (hours)	213 172	136 302	145 676
FTE labour units	350	245	302
$ output per labour unit	$131 254	$188 770	$141 088

3.3 Hatchery sector

There were seven marine prawn hatcheries in Queensland that did not have growout ponds in the 2006–07 season. These hatcheries supply post-larvae to the growout sector of the industry. Responses were received from six of these hatcheries. Three of the hatcheries produced black tiger post-larvae and supplied 30% of the marine prawn post-larvae sold in 2006–07 (or 12% of the total post-larvae stocked). The total value of production from these hatchery-only operations in 2006–07 was $1.9 million (compared with $0.9 million in 2005–06).

From the returns received, this sector employed 6 permanent employees (11 in 2005–06) and, together with casual employees, provides employment for 6 FTEs (11 in 2005–06). Total output per labour unit in 2006–07 was $87 100 (compared with $80 500 in 2005–06).

3.4 Industry development

The prawn sector aquaculture industry development plan 2005–07 has now expired. An assessment was made and this was published in *Australian prawn farming: development plan: implementation report*. The assessment showed that while some of the issues had yet to be resolved, the planning process was useful and an updated version of the industry plan was instituted. The next version has been finalised; this version will be published in early in 2008 and remain current until 2010.

The department and the Australian Prawn Farmers Association both expressed ongoing concern about biosecurity risks associated with importing green prawns into Australian. In July 2007, Biosecurity Australia, an arm of the Commonwealth Government, introduced interim quarantine measures prohibiting the entry of uncooked or unprocessed prawns.

Domesticated families of black tiger prawns *(P. monodon*) have been successfully maintained in commercial facilities, and the domestication of prawns is likely to progress; however, there is still a strong reliance on wild-caught broodstock.

3.5 Publications

Palmer, P. (2004). Wastewater remediation options for prawn farms, Project Report Series, QO 04018.

Robertson, C. (2006). Editor. Australian Prawn Farming Manual—Health Management for Profit, ISSN 0727-6273.

Biosecurity Australia Policy Memorandum 2007/16 Importation of prawns and prawn products—revised interim quarantine measures is available on the DPI&F website at **http://www.dpi.qld.gov.au/cps/rde/xchg/dpi/hs.xsl/30_4946_ENA_HTML.htm**

Guidelines for constructing and maintaining aquaculture containment structures are available on the DPI&F website at **http://www2.dpi.qld.gov.au/fishweb/18753.html**

The Prawn Industry Development Plan is available on the DPI&F website at **http://www2.dpi.qld.gov.au/fishweb/18002.html**

3.6 Further information

Kerrod Beattie (Senior Policy Officer) on (07) 3224 2247 or **kerrod.beattie@dpi.qld.gov.au**

4. Barramundi

4.1 General

Barramundi (*Lates calcarifer*) growout production continued to increase strongly over the last 12 months.

The product marketed (converted to a whole-fish basis) increased by 20% from 1745 tonnes in 2005–06 to 2091 tonnes in 2006–07.

The majority of production came from pond- and cage-based systems, while the production from recirculating tank systems decreased marginally from 105 tonnes to 96 tonnes.

The total value of production has increased by 32%, from $14.0 million in 2005–06 to $18.5 million in 2006–07.

The average price (whole-fish basis) increased from $8.04/kg to $8.86/kg.

Hatcheries sold barramundi fingerlings for growout, stocking and to the aquarium trade. These figures are reported under Sections 8.2 and 8.3.

4.2 Industry production

Of the 118 authority holders who responded, 33 produced marketable fish in 2006–07. This compared with 37 from 115 respondents in 2005–06. Production came from 26 farms using pond-based systems, 1 farm using sea cages and 6 farms using recirculating systems (Table 7).

Table 7. Barramundi production and authorities in Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Total production (tonnes—whole-fish basis)	**1437**	**1745**	**2091**
Average price ($/kg)	$8.30	$8.04	$8.86
Total value ($ million)	$11.92	$14.03	$18.52
Pond production (tonnes)	**No.**	**No.**	**No.**
0.01 to 1.0	5	2	3
1.1 to 10.0	3	8	10
10.1 to 50.0	11	10	7
50.1 to 100.0	2	2	2
Over 100.0 (1)	4	4	5
Number of producing farms (1)	25	26	27
Number of non-producing farms	51	52	54
Total pond-based farms responding (1)	76	78	81
Tank production (tonnes)	**No.**	**No.**	**No.**
0.01 to 1.0	0	3	0
1.01 to 5.00	0	4	4
5.1 to 10.0	1	1	0
Over 10.00	2	3	2
Number of producing farms	3	11	6
Number of non-producing farms	17	26	31
Total recirculation farms responding	20	37	37
Pond & tank production (tonnes)	**No.**	**No.**	**No.**
Total number of responses	96	115	118
Number of farms surveyed	122	134	129

(1) Includes one sea cage farm

4.3 Pond production

Total farm ponded area increased by 9% with 164 hectares available in 2006–07 (compared with 151 hectares in 2005–06); however, the number of available ponds increased only fractionally to 344 (342 in 2005–06).

The number of ponds stocked decreased from 240 ponds in 2005–06 to 217 in 2006–07. During the same period the stocked area decreased from 107 hectares to 101 hectares. The average pond area was 0.5 hectares (Table 8).

The number of fingerlings stocked decreased from 3.40 million in 2005–06 to 2.85 million in 2006–07. The density at which fingerlings were stocked in ponds also decreased from 29 800 fingerlings per hectare in 2005–06 to 28 300 fingerlings per hectare in 2006–07.

All of the barramundi produced in pond-based systems were sold domestically in both 2005–06 and 2006–07.

The total feed used in ponds increased from 2710 tonnes in 2005–06 to 2926 tonnes in 2006–07. The data for this period includes details from Queensland's only sea cage farm that can not, for confidentiality reasons, be released in its own category. However, this data has not been included in the pond volume and density calculations as it is not directly comparable and would significantly alter these averages. FCR improved slightly from 1.7:1. to 1.6:1. All feed was manufactured in Australia.

4.4 Tank-based production

In 2006–07, 42 tank-based farms were authorised to grow barramundi (46 in 2005–06). Statistical returns were received from 37 farms. Production from the 6 farms (11 in 2005–06) that produced marketable fish was 96 tonnes, which represents a decrease of 8% from the 105 tonnes produced in 2005–06.

Traditionally, tank systems have been able to achieve a higher average price than pond systems due an increased focus on direct sales to niche markets and a higher proportion of live sales. This margin has decreased from $2.69/kg in 2005–06 to $1.08/kg in 2006–07. This still represents a 12% price premium over pond-raised fish.

Table 8. Pond production information in Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Total production (tonnes—whole-fish basis) (1)	**1393**	**1640**	**1995**
Average price ($/kg) (1)	$8.29	$7.88	$8.81
Total value ($ million (1))	$11.55	$12.92	$17.57
Market (% sold within Australia) (1)	100%	100%	100%
Number of ponds stocked	288	235	217
Total area stocked (hectares)	118	107	101
Average area (hectares)	0.4	0.4	0.5
Total fingerlings stocked (million) (1)	3.16	3.40	2.85
Fingerlings stocked/hectare	24 800	29 800	28 300
Feed used (tonnes) (1)	2 940	2 710	2 926
Feed source (% Australia manufactured) (1)	100%	100%	100%
Estimated FCR (1)	2.0:1	1.7:1	1.6:1

(1) Includes one sea cage farm

4.5 Fingerling production

Barramundi fingerling production decreased from 5.3 million in 2005–06 to 4.5 million in 2006–07. Ten farms sold barramundi fingerlings during the year (see Section 8.2 and 8.3 of this report for restocking and aquarium sales).

A total of 3.4 million fingerlings worth $1.271 million were sold for growout (3.5 million worth $1.065 million in 2005–06). Average fingerling price was 37 cents each in 2006–07 (compared with 30 cents in 2005–06).

Table 9. Recirculating farm production information in Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Total production (tonnes—whole-fish basis)	**44**	**105**	**96**
Average price ($/kg)	$8.54	$10.57	$9.89
Total value ($ million)	$0.38	$1.11	$0.95
Market (% sold within Australia)	98%	65%	99%
Number of tanks stocked	102	227	138
Total volume stocked (m^3)	1600	1400	1400
Average volume (litres)	15 800	6100	10 100
Total fingerlings stocked	205 500	533 000	325 250
Fingerlings stocked/m^3	127	384	233
Feed used (tonnes)	62	112	111
Feed source (% manufactured in Australia)	100%	84%	100%
Estimated FCR	1.4:1	1.1:1	1.2:1

4.6 Farm labour

Permanent labour employed in the pond and cage growout sector of the industry decreased from 85 units in 2005–06 to 78 units in 2006–07. Over the same period permanent labour in the recirculating farms decreased significantly from 18 units to 7 units.

Productivity on the pond and cage farms has increased from 19.3 tonnes of fish per unit in 2005–06 to 25.5 tonnes of fish per unit in 2006–07. Productivity in tank farms more than doubled from 5.3 tonnes per unit in 2005–06 to 14.0 tonnes per unit in 2006–07.

Total casual labour for the pond and cage sector increased from 37 400 hours in 2005–06 to 49 200 in 2006–07. Casual labour on recirculating farms decreased from 2700 hours in 2005–06 to 1700 hours in 2006–07.

When the permanent and casual labour inputs are combined for the total industry the total number of FTE labour units decreased from 124 in 2005–06 to 111 in 2006–07.

The dollar output per labour unit for the pond sector increased from $115 700 in 2005–06 to $170 100, while for the recirculating sector the output increased from $56 400 to $122 800 per unit.

4.7 Industry development

4.7.1 Barramundi industry development plan

From an Australian Barramundi Industry Planning Workshop held in Oonoonba, Townsville, March 2006 a draft industry development plan, supported by the Fisheries Research and Development Corporation (FRDC), was circulated by the Australian Barramundi Farmers' Association (ABFA), in early 2007. The draft plan has projected a future vibrant and progressive sector, conditioned by ongoing strong and cohesive membership and capable of achieving a list of goals and actions.

Although Graham Dalton's appointment as executive officer is part-time, several priorities have been progressed; these include animal health, ABFA joining the Cooperative Research Centre (CRC), finalisation of the European Union testing program and approval of a genetics scoping study. Early next year it is hoped that a funding application for a research and development manager will be approved, the ABFA website will become operational and an industry environmental management sector will be established.

Through appointment of the new industry development and policy officer, DPI&F has been reviewing the priorities of the plan and working on environmental management systems and water quality industry issues. DPI&F is continuing to assist the industry with key issues, which include reviewing an inter-agency agreement to develop a discharge policy for barramundi.

A number of farm visits have been undertaken and it has been identified that on-farm operational guidelines and procedures would be useful for small to medium farms to increase production.

4.8 Publications

Curtis, M., and Wingfield, M. (2004). Recirculation aquaculture systems information, Information Series QI 04047.

Macbeth, M., *et al*. (2002). Selective breeding in barramundi: technical report for the Australian Barramundi Farmers Association, Information Series QI 02067.

4.9 Further information

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5. Redclaw

5.1 General

Production of redclaw crayfish (*Cherax quadricarinatus*) decreased marginally from 104.9 tonnes in 2005–06 to 100.2 tonnes in 2006–07. Over the same period a strong increase in the average price resulted in the total value of the industry increasing by 5% from $1.30 million $1.45 million. In addition to food sales, there was a small quantity of juveniles sold to aquaculture farms and some stock was sold to the aquarium trade (now reported under Section 8.3.3 of this report).

From the 204 returns mailed (211 in 2005–06) there were 186 responses (187 in 2005–06). Forty six farms produced redclaw crayfish in 2006–07, compared with 59 farms in the previous year (Table 10).

5.2 Growout

The number of farms that produced more than one tonne increased from 15 in 2005–06 to 17 in 2006–07. These 17 farms produced 91% of the state's production with the top 6 farms producing 71% of the total production. There were 140 farms that reported no production at all for 2006–07 (compared with 128 farms in 2005–06).

In 2006–07 the average price obtained for redclaw crayfish was $14.45. This was a 16% increase on the $12.43 achieved in 2005–06. The average price reported ranged from $11.27/kg to $19.16/kg/, although most sold in the $13/kg to $16/kg range.

The total available ponded area on farms decreased from 125 hectares in 2005–06 to 100 hectares in 2006–07. There were 684 ponds stocked with redclaw in 2006–07, totalling 83 hectares; however, only 555 ponds (60 hectares) were harvested. The average pond size has remained at 0.012 hectares.

Average farm productivity (calculated from harvested growout area) was 1670 kg/ha, which was a slight increase on the 1495 kg/ha achieved in 2005–06. The average yield for the 25 farms producing over 500 kg was 1900 kg/ha. For the 17 farms producing over 1000 kg the average was 1990 kg/ha and for the 6 farms producing over 5000 kg the average productivity was 2250 kg/ha. Average yields for the 17 farms producing over 1000 kg ranged from 670 kg/ha to 4170 kg/ha with 8 of these farms producing over 2000 kg/ha.

Total feed purchased was 227 tonnes in 2006–07 (compared with 257 tonnes purchased in 2005–06). The estimated average feed conversion ratio improved slightly from 2.5:1 in 2005–06 to 2.3:1 in 2006–07.

In 2006–07 the majority of product (88%) was sold on the domestic market. This was similar to the previous year when 86% of product was sold domestically.

Table 10. Number of authorised redclaw crayfish farms and production levels in Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Total production (tonnes)	**98.6**	**104.9**	**100.2**
Average price ($/kg)	$12.98	$12.43	$14.45
Total value ($'000)	$1.280	$1.304	$1.448
Pond & tank production (kg)	**No.**	**No.**	**No.**
1 to 100	17	18	9
101 to 500	26	20	12
501 to 1000	9	6	8
1001 to 5000	6	11	11
Over 5000	5	4	6
Number of producing farms	63	59	46
Number of non-producing farms	106	128	140
Number of responses	169	187	186
Number of farms surveyed	222	211	203

5.3 Tank-based production

No tank-based production was reported in 2006–07.

5.4 Juvenile production

The reported juvenile production decreased from 6.5 million in 2005–06 to 3.4 million in 2006–07. Sales decreased from 83 000 ($18 000) in 2005–06 to just 5000 ($850) in 2006–07. Over the same period the average price payed for juveniles decreased from $0.22 to $0.17. The reported number of juveniles stocked decreased from 5.0 million (46 farms) in 2005–06 to 4.2 million (30 farms) in 2006–07. The average stocking rate of juveniles into growout ponds decreased from 6.2/m^2 to 5.3/m^2.

5.5 Labour

Total permanent labour employed increased from 37 units in 2005–06 to 38 units in 2006–07. The total hours of casual labour used on farms also increased from 1120 hours to 2168 hours.

In terms of labour efficiency the number of permanent labour units used to produce one tonne of crayfish has increased from 0.3 units in 2005–06 to 0.4 units in 2006–07. The number of casual hours has doubled from 11 hours per tonne in 2005–06 to 22 hours per tonne in 2006–07.

When the permanent and casual labour inputs were combined, the sector employ 39 FTE labour units (compared with 47 FTE labour units the previous year). The product output per labour unit increased from 2200 kilograms ($27 500) to 2570 kilograms ($37 200) in 2006–07.

5.6 Publications

McPhee C., Jones C., Shanks S. (2004). Selection for increased weight at nine months in redclaw crayfish (Cherax quadricarinatus), Aquaculture 237:131–140.

Stevenson, J. (2005). Notes from the 6th annual redclaw conference—9 and 10 September 2005. Publication of the Queensland Crayfish Farmers Association.

Wingfield M., (2004). Editor. Queensland Crayfish Farmers Association—Proceedings of the 5th annual conference, Conference and Workshop Series QC 04001.

5.7 Further information

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6. Freshwater fish

6.1 General

Freshwater fish (other than barramundi) production has increased in value by nearly 50% from $1.5 million in 2005–06 to over $2.2 million in 2006–07. The three main species—silver perch (*Bidyanus bidyanus*) jade perch, or Barcoo grunter, (*Scortum barcoo*) and Murray cod (*Maccullochella peelii peelii*) all contributed to this outstanding result. There was only minor production of sleepy cod (*Oxyeleotris lineolatis*) and golden perch (*Macquaria ambigua*).

Silver perch production was valued at $791 600 with an average price of $8.81/kg (5% higher than 2005–06), jade perch production was valued at $453 700 with an average price of $8.86/kg (7% higher than 2005–06) and Murray cod production was valued at $937 500 with an average price of $14.40/kg (14% higher than 2005–06).

Silver perch production grew by 45% to nearly 90 tonnes, jade perch grew by over 20% to over 50 tonnes and Murray cod grew by 50% to over 65 tonnes. This provided a total of nearly 210 tonnes for the year (compared with 150 tonnes in 2005–06). This follows on from the large increase from 100 tonnes to 150 tonnes during the proceeding 12 months.

In 2006–07 silver perch accounted for 43% of freshwater fish production (40% in 2005–06), jade perch 24% (28% in 2005–06), Murray cod 31% (28% in 2005–06) and all other species 2%. Recirculating tank systems accounted for nearly 23% (49 tonnes) of the total freshwater fish production (compared with 27% or 40 tonnes in 2005–06).

Statistical returns were mailed to 165 licensed freshwater fish producers and 143 were returned. One hundred and nine respondents used pond-based systems and 34 used recirculating tank systems. Many of the authority holders have a number of different species on their approval and produce these species in ponds, tanks or a combination of both systems.

6.2 Silver perch

Statistical returns were mailed to 130 authorised silver perch producers and 115 were returned. Thirteen authority holders produced and sold silver perch in 2006–07. Twelve of the 13 producing farms used pond-based systems, with just one tank-based system producing silver perch. In 2005–06, 16 farms produced fish and only one was from a tank-based system.

The silver perch industry experienced its largest production increase ever recorded with production increasing by more than 45%. With increased returns per kilogram for the product, the total value of this sector increased by more than 50%. Production totalled 89.9 tonnes (61.2 tonnes in 2005–06) and the total value of the industry was $791 600 ($512 000 in 2005–06). The average price (whole-fish basis) increased by 5% from $8.37/kg to $8.81/kg. Table 11 combines production from both pond and tank systems.

6.2.1 Pond systems

The total ponded area on producing farms decreased from 30 hectares in 2005–06 to 24.5 hectares in 2006–07. The total area stocked with silver perch increased from 20 hectares in 2005–06 to 24 hectares in 2006–07. The number of fingerlings stocked increased from 358 200 in 2005–06 to 515 000 in 2006–07. The average stocking rate also increased from 18 000 per hectare in 2005–06 to 21 500 per hectare in 2006–07. The area harvested increased from 17.1 hectares in 2005–06 to 21.1 hectares in 2006–07.

Table 11. Silver perch production by aquaculturists in Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Total production (tonnes—whole-fish basis)	**62.5**	**61.2**	**89.9**
Average price ($/kg)	$8.26	$8.37	$8.81
Total value ($'000)	$516	$512	$791.6
Average yield (kg/ha)	4600	3550	4162
Number of survey responses	98	106	115
Number of producing farms	12	16	13

Note:
Total food used decreased from 174 tonnes in 2005–06 to 170 tonnes in 2006–07. Over this same period the FCR improved significantly from 2.9:1 to 1.9:1.

6.2.2 Recirculation systems

In 2006–07, 29 farms using tank-based recirculation systems were authorised for silver perch production. Only one of these operations reported any production in 2006–07 and therefore (for confidentiality reasons) the production details can not be released. In 2005–06, 21 farms using tank-based recirculation systems were authorised for silver perch production and only one of them reported any sale of product.

6.3 Jade perch

Statistical returns were mailed to 72 licensed jade perch producers and 66 were returned. Jade perch production in 2006–07 totalled 51.2 tonnes, which was a 22% increase from the 41.9 tonnes produced in 2005–06. In 2006–07 production came from seven pond-based systems and one tank-based operation. Table 12 combines production from both pond and tank systems.

From the responses received the number of authority holders that produced and sold jade perch has remained stable over the last two years. The total value of sales increased by more than 30% to $453 700, while the average price increased by 7% from $8.25/kg in 2005–06 to $8.86/kg in 2006–07.

6.3.1 Pond systems

The total ponded area on farms increased from 7.1 hectares in 2005–06 to 9.1 hectares in 2006–07. Over the same period the total area stocked to jade perch increased from 6.3 hectares to 7.6 hectares and the average yield improved by 33% from 6.5 t/ha to 8.7 t/ha. In 2006–07 the number of fingerlings stocked in ponds was 143 700 (compared with 204 300 in 2005–06). Over the same period the average stocking rate decreased from 35 550 per hectare to 19 000 per hectare.

Total food used increased from 88 tonnes in 2005–06 to 101 tonnes in 2006–07 while the FCR remained the same as the previous year at an estimated 2.1:1.

6.3.2 Recirculation systems

In 2006–07, 27 farms using tank-based recirculation systems were authorised for jade perch production. Only one of these operations reported any production in 2006–07 and therefore (for confidentiality reasons) the production details can not be released.

Table 12. Jade perch production by aquaculturists in Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Total production (tonnes—whole-fish basis)	**30.8**	**41.9**	**51.2**
Average price ($/kg)	$8.42	$8.25	$8.86
Total value ($'000)	$259	$346	$453.7
Average pond-based yield (kg/ha)	3950	6550	8740
Number of survey responses	46	50	66
Number of producing farms	7	8	8

6.4 Murray cod

The 2006–07 year is the second year that Murray cod production could be reported in detail. This was due to significant increases in both the quantity of Murray cod being produced and the number of aquaculturists that are now producing this species.

Statistical returns were mailed to 41 authorised Murray cod producers in 2006–07 and 38 were returned.

Murray cod production in 2006–07 totalled 65.1 tonnes, which represents an increase of more than 50% from 2005–06. In 2006–07, four farms produced Murray cod (compared with five farms in 2005–06).

6.4.1 Murray cod production details

Because all Murray cod production came from only four farms, all published information must combine production from both pond-based and tank-based systems so as not to breach client confidentiality. There were a total of 370 000 Murray cod fingerlings stocked in 2006–07 (compared with 214 300 in 2005–06). The total food used increased from 72.5 tonnes in 2005–06 to 81 tonnes in 2006–07. The FCR improved from 1.7:1 to 1.2:1.

Table 13. Murray cod production by aquaculturists in Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Total production (tonnes—whole-fish basis)	**na**	**42.2**	**65.1**
Average price ($/kg)	na	$12.60	$14.40
Total value ($'000)	na	$530.7	$937.5
Average pond-based yield (kg/ha)	na	6780	5160
Number of survey responses	14	33	38
Number of producing farms	3	5	4

Note:

na—not available for publication

6.5 Other species

Other species authorised for production in both pond-based and tank-based systems include golden perch (*Macquaria ambigua*), sleepy cod (*Oxyeleotris lineolatis*), Australian bass (*Maquaria novemaculeata*) and sooty grunter (*Hephaestus fuliginosus*). The relatively small quantities produced and the limited number of producers means that detailed information can not be provided in this report. The production in 2006–07 was 3.5 tonnes valued at $60 000 (compared with 6.3 tonnes valued at $93 000 in 2005–06). Because both golden perch and sleepy cod are well regarded in the market place, the average price was relatively high at $17.50/kg.

6.6 Labour (freshwater fish)

The total number of permanent labour units in the freshwater fish growout sector decreased from 30 in 2005–06 to 22.9 in 2006–07. For silver perch the output has increased from 5.0 tonnes per unit in 2005–06 to 8.3 tonnes per unit in 2006–07. Over the same period jade perch production increased from 5.8 tonnes per labour unit to 9.5 tonnes. The output for Murray cod increased from 4.2 tonnes per labour unit to 9.3 tonnes per unit.

Combined casual labour for all freshwater species was 1800 hours (compared with 1060 hours in 2005–06). The total FTEs for the freshwater sector was 24 units in 2006–07 (compared with 31 units in 2005–06).

The dollar output per labour unit for the sector nearly doubled to $94 000 (compared with $48 000 in 2005–06). For silver perch the output increased from $41 600 in 2005–06 to $73 500 in 2006–07; jade perch increased from $48 100 to $84 000 and Murray cod increased from $52 700 to $134 200.

6.7 Industry development

Freshwater fish production continues to demonstrate strong growth. The growth is even more significant given that it has been achieved in well-publicised drought conditions.

The sector continues to be well represented by the Aquaculture Association of Queensland (AAQ) through quarterly workshops and its annual conference. As these systems operate as closed systems, the continuation of bioremediation research at the DPI&F Walkamin Research Station to mitigate nutrient build-up is most important.

A joint meeting in November between Queensland and New South Wales departmental research managers and AAQ agreed to establish whole-of-industry support across Queensland and New South Wales for a national industry development plan that identified key research priorities.

6.8 Publications

Rowland S.J., et al. (2007). Development of a health management strategy for the silver perch Aquaculture Industry pp. 219.

Rowland S.J., et al. (2007). Diagnosis, treatment and prevention of the diseases of the Australian freshwater fish silver perch (*Bidyanus bidyanus*).

6.9 Further information

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7. Eel culture

7.1 General

Production from the eel aquaculture industry in Queensland reached 32.4 tonnes and constitutes a 54% increase in production from the 21 tonnes produced in 2005–06. This increase is particularly significant as it ends a five-year trend of diminishing production.

In 2005–06 there were three operations selling eels (comprising four farms), and in order to maintain client confidentiality detailed production information was not published. The same situation arose in 2006–07; however, this time producing farms were contacted and agreed to release the current and previous year's production data for publication.

The primary species of eel grown by aquaculturists is the long-finned eel (*Anguilla reinhardtii*), with much smaller quantities of short-finned eel (*A. australis*) also grown.

Over the last two years all eels produced were exported and marketed live. Table 14 summarises the farm pond and tank stocking and production details for the period 2004–05 to 2006–07.

In addition to the sale of adult eels, new management arrangements introduced in 2005 allow for the sale of juvenile eels. This has resulted in the sale of a significant quantity of weaned juvenile eels. The details relating to the sale of juvenile eels can not be released due to confidentiality issues but the value is included in the sundry category of this report.

Total feed purchased was 53.5 tonnes in 2006–07 (compared with 30.5 tonnes in 2005–06). The estimated average feed conversion ratio increased slightly from 1.4:1 in 2005–06 to 1.6:1 in 2006–07.

Table 14. Eel farm stocking by aquaculturists in Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Number of producing farms (1)	5	4	4
Ponds—Total area (ha)	5.2	2.1	2.6
Ponds—Average area (m^2)	2350	1930	2000
Tanks—Total volume (m^3)	176	24	32
Tanks—Average volume (L)	6300	3960	1810
Stocking—Glass eels and elvers (no.)	682 000	1 019 000	423 000
Total production (t)	42.7	21.0	32.4
Total production ($)	$568 810	$355 100	$544 800
Average price ($/kg)	$13.33	$16.92	$16.80

(1) Two of the farms work closely and effectively sell as a single entity.

7.2 Labour

The industry has six permanent staff (six in 2006–07) and employed 400 hours of casual labour. This equates to six FTEs, which is one less than the previous year. The dollar output per labour unit increased significantly from $51 000 in 2005–06 to $91 500 in 2006–07. The output per labour unit would be significantly higher if the juvenile eel sales were also included.

7.3 Industry development

Since a new management regime for eel aquaculture was formed in 2005 (whereby juvenile eel harvesting and aquaculture are managed separately), production has remained at low levels. Environmental conditions have remained unfavourable, which has stalled renewed industry investment. However, declaration this year that the European juvenile eel industry is in a precarious position is significant, as most adult eels are exported and the domestic industry competes with this supply market. Working alongside other federal and state investor agencies, DPI&F has facilitated recent interest from established international eel producers and other investors assessing the viability of the industry.

To achieve progress the industry may need to consolidate—either collectively across juvenile eel harvesting or structurally by re-establishing a peak body and developing an industry development plan. This needs to be industry-driven for DPI&F to commit larger resources. This should make the industry more attractive internationally and support greater effort across harvesting, production and research.

Industry consultation has identified research that provides management of gender ratios in immature eels as a way to stimulate increased aquaculture production.

7.4 Publication

Policy for the management arrangements for the commercial harvesting and use of juvenile eels (February 2006). Available on the DPI&F website at **http://www2.dpi.qld.gov.au/extra/pdf/fishweb/juveelspolicy.pdf**

7.5 Further information

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8. Hatchery and aquarium

8.1 General

A total of 79 hatchery and aquarium operations were surveyed and responses were received from 71. The hatcheries produced a wide range of fish for use in aquaria, commercial growout and stocking in public impoundments. Table 15 summarises statistics for the major species produced in 2005–06 and 2006–07.

The total value of this sector rose slightly from $3.38 million in 2005–06 to $3.51 million in 2006–07. Over the same period sales for the sector decreased from 10.4 million to 8.9 million.

For the second consecutive year, the number of fingerlings species sold for farm stocking decreased slightly from the previous year. This down-turn is largely due to reduced stocking activity associated with drought conditions. The one possible exception to this trend was jade perch where the number of fingerlings sold increased slightly. However, jade perch is not a species that is used for impoundment stocking.

Exotic ornamental sales decreased by nearly 23% from the previous year; however, sales increased for the other ornamental sectors.

The hatchery sector has been expanding over the last few years to include a number of hatcheries that produce a range of marine species for the aquarium trade, commercial growout and stocking. They are reported collectively in Table 15 as 'marine hatchery and aquarium'.

Table 15. Hatchery production of native fingerlings and ornamental aquarium species in Queensland (2005–06 and 2006–07)

Species	2005–06			2006–07		
	Sales (No.)	Value ($)	Aver($)	Sales (No.)	Value ($)	Aver($)
Barramundi (farm and stocking)	3 538 170	1 065 240	0.30	3 429 410	1 271 050	0.39
Golden perch (farm and stocking)	1 813 130	325 520	0.18	724 600	161 200	0.22
Australian bass (farm and stocking)	1 448 000	252 340	0.17	1 192 020	228 040	0.19
Silver perch (farm and stocking)	617 670	110 080	0.18	446 560	100 050	0.22
Jade perch (farm)	200 000	45 560	0.23	238 540	52 680	0.22
Murray cod, Mary River cod and sleepy cod (farm and stocking) (1)	166 570	113 220	0.68	61 900	43 715	0.39
Ornamental fish (exotics) (2)	1 710 110	843 210	0.49	1 320 480	725 450	0.55
Ornamental fish (natives) (2) (3)	864 840	387 420	0.45	1 186 790	475 150	0.40
Ornamental invertebrates	305 000	45 320	0.15	340 500	44 720	0.13
Marine hatchery and aquarium (1)(4)	(5)	242 700		(5)	402 960	
Total (returns received)	**10.40 m**	**$3.38 m**		**8.94 m**	**$3.51 m**	

Notes:

(1) Species combined as insufficient producers to maintain individual confidentiality.

(2) Species grouped as individual species data was not obtained.

(3) All native freshwater fin fish sold to aquarium trade (e.g. rainbows, native ornamentals, saratoga and lungfish, as well as barramundi, golden perch etc.).

(4) Includes oyster and pearl oyster spat, mangrove jack, mullet aquarium fish, seahorses, corals and sandfish production.

(5) Combines different phyla and developmental stages and therefore not appropriate to include numbers.

8.2 Stocking and growout species

The hatchery operations that produced the stocking and growout species listed below used 222 ponds in 2006–07 (compared with 212 ponds in 2005–06). Over this period the total ponded area decreased from 47 hectares to 43 hectares. The average pond area decreased from 22000 m^2 in 2005–06 to 1950 m^2 in 2006–07. The sector also used 187 tanks totalling 955 m^3 in 2006–07 (up from 160 tanks totalling 890 m^3 in 2005–06).

8.2.1 Barramundi

Barramundi (*Lates calcarifer*) fingerlings were produced in 10 hatcheries (down from 12 in 2005–06). Total production was down from 5.3 million fingerlings in 2005–06 to 4.5 million fingerlings in 2006–07. The majority of fingerlings were sold to growout farms with 3.2 million sold for $1.123 million. Although the number of fingerlings sold to farms increased by 6% from the 3.0 million sold in 2005–06, the value of these sales increased by 30% (from $867 000 in 2005–06). The increased value was largely a result of the average price rising from $0.29 to $0.36 per fingerling. The number of fingerlings sold for stocking decreased from 561 000 ($198 000) in 2005–06 to 127 000 ($148 000) in 2006–07. Over this period the average price for fingerlings sold to stocking increased from $0.35 to $0.55. The price increase for fingerlings sold to both farms and stocking primarily resulted from increased sales of larger fingerlings. A significant portion of fingerlings produced were not sold as they were required to stock the farm that produced them.

8.2.2 Golden perch

Golden perch (*Macquaria ambigua*) fingerling production was undertaken by five hatcheries (seven in 2005–06). Production totalled 725 000 in 2006–07, which represents a 60% decrease from the previous year. Stocking accounted for the vast majority of sales (719 000) valued at $158 500. The farming sector purchased only 5400 fish.

Unfortunately, Queensland producers have not been successful in producing the Lake Eyre strain of golden perch fingerlings since 2003–04.

8.2.3 Australian bass

Australian bass (*Macquaria novemaculeata*) were produced primarily for impoundment stocking. Production occurred in four hatcheries (five in 2005–06). Production decreased slightly from 1.46 million in 2005–06 to 1.28 million in 2006–07. Sales also decreased from 1.45 million ($252 000) in 2005–06 to 1.19 million ($228 000) in 2006–07. The farming sector purchased only 5000 fish.

8.2.4 Silver perch

Silver perch (*Bidyanus bidyanus*) fingerling production was undertaken by 9 hatcheries (10 in 2005–06) and increased from 705 000 fingerlings in 2005–06 to 792 000 in 2006–07. However, the number sold decreased from 618 000 in 2005–06 to 446 600 in 2006–07. Sales to growout operations dropped slightly from 261 000 ($43 000) in 2005–06 to 196 100 ($49 300) in 2006–07. Over this period the average fingerling value increased from $0.16 to $0.25. This increase was largely a result of some hatcheries selling larger fingerlings. Sales to stocking decreased slightly from 357 000 ($67 000) in 2005–06 to 250 500 ($50 800) in 2006–07. The average price of fingerlings sold for stocking increased from $0.19 to $0.20.

8.2.5 Jade perch

Jade perch, or Barcoo grunter, (*Scortum barcoo*) fingerlings came from four hatcheries (four in 2005–06). All sales were to the farm growout sector; however, a significant proportion was sold overseas. Sales increased slightly from 200 000 ($46 000) in 2005–06 to 239 000 ($53 000) in 2006–07.

8.2.6 Murray cod, Mary River cod and sleepy cod

Murray and Mary River cod (*Maccullochella* sp.) and sleepy cod (*Oxyeleotris lineolatus*) sales were combined to maintain confidentiality of the information supplied by the six hatcheries that produced any of these fish. Sales for these species decreased by 63% from 167 000 ($113 000) in 2005–06 to 61 900 ($43 700) in 2006–07. Growout farms purchased 61% of the fingerlings with the rest going to the stocking program.

8.3 Freshwater aquarium and ornamental species

The producers growing freshwater aquarium and ornamental species (listed below) used 328 ponds in 2006–07 (compared with 371 ponds in 2005–06). Ponds covered an area of 14 hectares in 2006–07 (compared with 17 hectares in 2005–06). The average pond area decreased marginally from 466 m^2 in 2005–06 to 438 m^2 in 2006–07. The sector also used 714 tanks totalling 1335 m^3 in 2006–07 (compared with 668 tanks totalling 1185 m^3 in 2005–06).

8.3.1 Exotic ornamental fish

Exotic freshwater ornamental fish were produced in 14 hatcheries in 2006–07 (15 in 2005–06). The number of fish sold decreased from 1.7 million fish ($843 000) in 2005–06 to 1.3 million ($725 500) in 2006–07.

8.3.2 Native ornamental fish

Native freshwater ornamental fish (including lungfish and saratoga) were produced on 21 farms in 2006–07 (22 in 2005–06). The number of fish sold increased to 1.19 million, representing an increase of 210% over a two-year period (382 000 sold in 2004–05). Over the same two-year period the value of this sector has increased from $297 000 to $475 000.

8.3.3 Ornamental invertebrates

Invertebrates (primarily freshwater prawns, redclaw crayfish and some tadpole shrimp) were sold into the aquarium trade by six farms in 2006–07 (also six farms in 2005–06). The number of invertebrates sold rose slightly from 305 000 ($45 300) in 2005–06 to 340 500 ($44 700) in 2006–07.

8.3.4 Farm details

The number of ponds used by aquarium and ornamental farms decreased from 371 in 2005–06 to 328 in 2006–07. Ponds covered an area of 14.4 hectares in 2006–07 (compared with 17.3 hectares in 2005–06). The average area decreased from to 470 m^2 to 200 m^2.

There were 1610 tanks on farms in 2006–07 (compared with 1596 tanks on farms in 2005–06). The average tank volume increased from 740 litres in 2005–06 to 860 litres in 2006–07.

8.4 Marine hatchery and aquarium

The marine hatchery and aquarium group covers a diverse range of species including oyster and pearl oyster spat, marine aquarium fish, corals, sandfish, barramundi cod, mullet and mangrove jack. There were five hatcheries that sold product in 2006–07 (compared with six in 2005–06). Only the value of sales is reported in this section—the group is so diverse that it is not meaningful to tally and compare numbers of oyster spat with numbers of fish. The value of production has risen by 66% from $243 000 in 2005–06 to $403 000 in 2006–07.

8.5 Labour (hatchery and aquarium)

Statistics for the whole sector show that it employed 55 permanent staff in 2006–07 (56 in 2005–06) and 18 800 hours of casual labour (19 500 hours in 2005–06). This equates to 64 FTEs employed in the sector, which was a decrease of 2 units from 2005–06. Output per labour unit increased from $50 900 in 2005–06 to $54 300 in 2006–07.

8.6 Industry development

Drought has affected some individuals within the industry, whereas other farms have maintained strong production. Overall, drought has had some impact on the supply of certain species.

Introduction of logbooks for culture stock collection and development of an AAQ Hatchery Code of Practice are two DPI&F-assisted industry development programs. All holders of general fisheries permits allowing for culture stock collection are now required to complete Broodstock and Culture Stock Collection (BR 01) and Species of Conservation Interest (SOCI 01) logbooks. Introduction of the system included updated inland maps identifying Queensland waters by grid and site. This was achieved after extensive industry consultation.

A voluntary Hatchery Code of Practice managed by AAQ and supported by Freshwater Resource Management was developed by industry to ensure high quality and disease-free fingerling production. This scheme is similar to the Hatchery Quality Assurance Scheme implemented in New South Wales. Future interstate recognition of both schemes is sought to maintain high quality trade of fingerlings between states.

Biosecurity of the ornamental aquaculture sector is managed by DPI&F exotic and translocation policies via development approvals (DAs) and self-assessable codes (SACs). In a recent review of DPI&F policies the transition of ornamental licences to DAs was finalised in late November 2007. The aquaculture production coming from developments approved under a SAC will be quantified in future as SAC conditions have been amended to include an annual reporting requirement.

Biosecurity of the aquarium/ornamental industry in Australia has been under review for some time via a Whole-of-Government review panel (DAFF, 2006). The recommendations of this national report are being implemented. The aim is to ensure biosecurity measures across the whole industry match the controls of the aquaculture section.

8.7 Publications

DAFF (2006). A strategic approach to the management of ornamental fish in Australia.

Lupton C., Cheetham R. (2007). Draft report: Aquaculture Association of Queensland (AAQ) commercial hatchery code of best practice.

NSW DPI (2007). Draft report: Hatchery quality assurance scheme.

DPI&F (2007). Draft report: Implementation of the national ornamental strategy in Queensland.

8.8 Further information

Gerry Hawkes (Policy Officer) on (07) 3404 3368 or **gerard.hawkes@dpi.qld.gov.au**

9. Pearl oyster culture

9.1 General

The value of the pearl oyster industry in Queensland continues to fluctuate as some of the farms rebuild stocks of nucleated pearls. Four farms reported information this year. The value of the industry has been included in the sundry category throughout the report.

Twelve pearl culture areas (PCAs) were surveyed and responses were received for 10 of these areas. Four farms produced marketable pearls. The lack of responses from previous years makes it impossible to provide details on production etc. between years.

The main species cultured are the gold lip oyster (*Pinctada maxima*), black lip oyster (*P. margaritifera*), and penguin oyster (*Pteria penguin*). Three new lease areas are being stocked with the akoya pearls (*Pinctada imbricata* or *P. fucata*).

Production of round and baroque pearls accounted for over 60% of the 42 200 pearls sold in 2006–07. The value of production was estimated to be $1.7 million. Over 95% of the pearls were marketed in Australia. The value of round pearls averaged $60 each while half pearls only averaged $5 each.

Stocks on hand as of 30 June 2007 were grouped as follows:

Stock after 1st operation	43 700
Stock after 2nd operation	15 300
Stock after 3rd operation	300
Unseeded	70 600

9.2 Labour

A total of 12 permanent labour units were involved in the industry in 2006–07 (compared with 4 in 2005–06). Total casual hours employed in the industry was 63 680 in 2006–07 (compared with 8160 in 2005–06). The total FTEs employed in the industry was 45 and the value of production per FTE was estimated to be $37 900.

9.3 Further information

Amy Jones (Industry Development and Policy Officer) on (07) 3229 3050 or **amy.jones@dpi.qld.gov.au**

10. Edible oyster production

10.1 General

In Queensland all of the aquacultured oyster production occurs south of Hervey Bay and is confined to the culture of rock oysters (*Saccostrea glomerata*) on 'furniture' placed on tidal land, predominantly above mean low water.

Oyster production from rotationally harvested rocky foreshore areas is no longer reported as aquaculture production and is now reported as wild-caught fisheries production. The species harvested in this manner are the milky oyster (*S. amasa*) and the black-lip oyster (*S. echinata*). Production is limited to selective harvesting, retention of broodstock and maintenance of areas.

A total of 114 oyster areas authorised for aquaculture were surveyed during 2006–07, with 97 statistical returns received. The total production in Queensland has decreased by 13% from 161 500 dozen in 2005–06 to 141 000 dozen in 2006–07; however, the value of the industry has only decreased by 2% from $574 200 in 2005–06 to $534 000 in 2006–07. The average price per dozen oysters increased by 6% from $3.56 per dozen in 2005–06 to $3.79 per dozen in 2006–07.

Oyster sales are one measure of change in an industry. To provide other indicators on industry growth and performance the numbers of shells introduced on to the authorised areas, stock losses and the stock on hand were collected for the first time in 2004–05.

Industry has indicated that problems with obtaining QX disease-free stock from New South Wales were having an impact on growth of the Queensland industry. With introductions doubling (compared with the previous season) the number of shells held on leases has remained relatively stable. Losses of shells from lease areas continue to affect total Queensland oyster production.

Table 16. Edible oyster aquaculturists in Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Number of oyster areas surveyed	111	112	114
Number of responses	98	97	97
Production (dozens)	**No. of areas**	**No. of areas**	**No. of areas**
Nil	64	67	76
1 to 500	10	10	16
501 to 1000	4	5	5
1001 to 2000	6	6	5
2001 to 5000	7	2	4
5001 to 10 000	2	3	2
Over 10 000	5	4	4
Total producing oyster areas	**34**	**30**	**36**

Table 17. Edible oyster introductions, losses and stocks on hand in Queensland (2005–06 and 2006–07)

	2005–06	2006–07	Change (%)
Shells introduced (dozen)	131 900	263 217	+ 100%
Losses (dozen)	88 700	104 710	+ 18%
Number on hand (30 June)	340 500	335 629	- 1%

Table 18. Edible oyster production in Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Production ('000 dozen)	213.3	161.5	141
Value ($'000)	$736	$574.2	$534

Oysters are sold in a range of different sizes to meet market requirements. The three main categories used by the industry are bistro, bottlers and plate size. Table 19 summarises the different product types, average prices and the percentage of each product type. Bottlers make up 54% of the product marketed at an average price of $3.35 per dozen (15% higher than 2005–06). The highest value product ($6.96 per dozen) is the plate size and they make up 12% of the product sold. Prices for this size increased by more than 20% per dozen. Bistro oysters at $5.49 per dozen accounted for 15% of production. Average prices increased by 6% from the previous year.

Table 19. Edible oyster marketing information for Queensland (2005–06 and 2006–07)

Packaging type	2005–06		2006–07	
	Price per dozen ($)	Market (%)	Price per dozen ($)	Market (%)
Bottlers	$2.91	67%	$3.35	53%
Bistro	$4.78	18%	$5.49	15%
Plate	$5.78	11%	$6.96	12%
Others	$2.64	4%	$1.90	20%
Average return—all oysters	**$3.56**		**$3.79**	

10.2 Labour

Total permanent labour employed in the industry was 17 units (15 in 2005–06) while total casual employment was 1 200 hours (1 050 in 2005–06). This converts to 17 FTEs employed in the industry (16 in 2005–06).

In terms of labour efficiency the production per FTE was 8100 dozen (compared with 10 400 dozen in 2005–06). Total industry output decreased from $37 000 per labour unit in 2005–06 to $30 700 per labour unit in 2006–07.

10.3 Industry development

The Queensland Shellfish Water Assurance Monitoring Program (QSWAMP) continued during 2006–07 and industry maintains responsibility for undertaking sampling. DPI&F continue to manage the program and to date this has been a favourable decision with successful sampling undertaken by industry.

An Australian Quarantine and Inspection Service (AQIS) audit was conducted in May 2007. The Moreton Island growing area remains the only AQIS export-approved area.

The 2004 oyster industry development plan was considered a success. Some of the major actions resulting from this development plan included:

- Implementation of a policy for maximising rock oyster production through a reduction in latent effort and reallocation of unused oyster areas. This has resulted in the introduction of a productivity condition to all resource allocation authorities for oystering.
- The production of a QX information brochure in conjunction with Queensland Museum and New South Wales Department of Primary Industries (NSW DPI) to give growers a greater knowledge base regarding this disease.
- DPI&F finalised a Memorandum of Understanding with NSW DPI to allow for increased sharing of information on disease outbreaks and investigations.
- Queensland Oyster Growers Association (QOGA) information flow has increased due to QSWAMP changes that have resulted in greater communication between industry participants. It is now a requirement that all growers are a part of the QSWAMP water quality sampling group or an equivalent DPI&F-approved water quality program.
- An oyster aquaculture management plan was completed for the Moreton Bay Marine Park Management Plan, which clarifies the requirements of oyster industries in Moreton Bay Marine Park.

10.4 Publications

Queensland Oyster Industry Development Plan (2005) is available on the DPI&F website at **http://www2.dpi.qld.gov.au/fishweb/16413.html**

Queensland Oyster Industry Development Plan: Implementation Report (2007) is available on the DPI&F website at **http://www2.dpi.qld.gov.au/fishweb/16413.html**

QSWAMP sampling guideline is available on the DPI&F website at **http://www2.dpi.qld.gov.au/extra/pdf/fishweb/FAMOP005.pdf**

Policy for maximising oyster production: management of non-productive areas (2007) is available on the DPI&F website at **http://www2.dpi.qld.gov.au/fishweb/18748.html**

10.5 Further information

Amy Jones (Industry Development and Policy Officer) on (07) 3229 3050 or **amy.jones@dpi.qld.gov.au**

11. Regional summary

Information has been analysed to provide a regional overview of the aquaculture industry in Queensland. The regions are based on the statistical divisions adopted by the Australian Bureau of Census and Statistics.

The information presented in Tables 20 to 24 was compiled from the annual statistical returns received from licensed aquaculture producers. The totals include all sectors of the industry described in the earlier part of this report.

The results presented in these tables need to be interpreted carefully as they only summarise the information collected from the farms that responded and submitted statistical returns.

The number of returns received varies between years as shown in Table 20. In any one year it may not be the same producers responding and this can affect the trends. Rounding errors can cause minor discrepancies in some of the totals.

The main sectors (marine, barramundi, freshwater fish and freshwater crayfish) have a major influence on value and quantities produced.

The total farm gate value of production is highly dependent on marine prawns, which contributes approximately 59% (prawn growout and hatchery) of the total industry value and 55% of the total quantity of product sold. Barramundi is the next most significant industry sector with steadily increasing production. In 2006–07 barramundi growout and fingerlings contributed 26% of the total industry value and 38% of the total quantity of product sold. Four divisions (Northern, Far Northern, Moreton and Mackay) accounted for the majority of the production. The Wide Bay division also has significant production.

The largest increases in industry value occurred in the Northern division (16%), Wide Bay division (7%) and the Moreton division (6%). The value of marine prawn production in Queensland has decreased by 9% while the value of barramundi production increased by 27% from the previous year.

Table 20. Response rates—Queensland (2004–05 to 2006–07)

	2004–05	2005–06	2006–07
Number of authorised producers (no.)	655	617	509
Questionnaires mailed (no.)	777	784	793
Questionnaires received (no.)	638	684	708
Response rate (%)	82%	87%	89%

Table 21. Farm gate value ($ million)—Queensland (2004–05 to 2006–07)

Statistical division	2004–05	2005–06	2006–07
Brisbane	$0.00	$0.00	$0.0
Moreton	$11.99	$14.54	$15.47
Wide Bay	$5.73	$4.69	$5.02
Darling Downs	$0.26	$0.40	$0.72
Fitzroy	$0.55	$0.39	$0.30
Central West	$0.00	$0.00	$0.00
Mackay	$7.62	$9.13	$8.44
Northern	$19.00	$21.13	$24.57
Far Northern	$22.25	$20.21	$21.00
Total	**$67.40**	**$70.50**	**$75.52**

Table 22. Total production (tonnes)—Queensland (2004–05 to 2006–07)

Statistical division	2004–05	2005–06	2006–07
Brisbane	0	0	0
Moreton	628	901	1143
Wide Bay	264	267	293
Darling Downs	21	34	58
Fitzroy	26	23	24
Central West	0	0	0
Mackay	515	646	583
Northern	1355	1676	2037
Far Northern	1826	1772	1713
Total	**4635**	**5319**	**5851**

Mackay, Far Northern and Northern divisions had the majority of the ponded areas in Queensland, with Wide Bay and Moreton also having significant areas (Table 23).

The largest employment occurred in the Far Northern division, which employed over 30% of the aquaculture workforce in Queensland (Table 24). Total employment increased by 15% from 2005–06.

Table 23. Total ponded area (hectares)—Queensland (2004–05 to 2006–07)

Statistical division	2004–05	2005–06	2006–07
Brisbane	0	0	0
Moreton	180	171	171
Wide Bay	143	131	127
Darling Downs	17	18	20
Fitzroy	22	13	8
Central West	0	0	0
Mackay	239	225	225
Northern	267	255	248
Far Northern	309	309	313
Total	**1177**	**1122**	**1112**

Table 24. Total employment (FTEs)—Queensland (2004–05 to 2006–07)

Statistical division	2004–05	2005–06	2006–07
Brisbane	0	0	0
Moreton	122	144	122
Wide Bay	92	64	80
Darling Downs	4	8	7
Fitzroy	7	9	6
Central West	0	0	0
Mackay	53	60	47
Northern	196	149	194
Far Northern	212	150	218
Total	**686**	**584**	**674**

12. Specialised areas—status report

12.1 Aquaculture planning program

12.1.1 Marine aquaculture planning (Great Sandy)

Using geographic information system (GIS) mapping, the DPI&F, in collaboration with the Department of Tourism, Regional Development and Industry (formally Department of State Development), produced a draft map of areas requiring further investigation in the Great Sandy region.

A large number of regional groups (around 200 organisations) were then invited to provide local information to help refine these proposed investigation areas. Interested regional groups took part in meetings held in Bundaberg, Hervey Bay and Brisbane between mid-March and mid-April 2007. Records of these meetings have been posted on the DPI&F website at **http://www2.dpi.qld.gov.au/fishweb/18736.html**. In addition, the planning team consulted with officers from Hervey Bay City Council and Maryborough City Council, and presented to the Wide Bay Burnett Regional Managers' Coordination Network meeting in Gympie. DPI&F arranged to use the Burnett Mary Regional Group's indigenous consultation networks to engage indigenous stakeholders.

As a result of feedback gained from the targeted stakeholder consultation, the investigation areas were revised.

The next step was to engage a consultant to undertake a characterisation study of the short-listed sites, to further assess the suitability of each site for the proposed types of aquaculture. Field work has been completed and the consultant is currently finalising the report.

DPI&F expects to release a draft Great Sandy Regional Marine Aquaculture Management Plan for public comment around April 2008.

12.1.2 Land-based aquaculture planning

DPI&F has developed a framework for implementing planning for land-based aquaculture. Discussions are currently underway to determine how best to fit in with the proposed revisions to the *Integrated Planning 1997 Act* and DPI&F's rural industry planning.

12.1.3 Further information

Sam Miller (Senior Planning Officer) on (07) 3224 2108 or **aquaculture.planning@dpi.qld.gov.au**

Further information on aquaculture planning is available online at **www.dpi.qld.gov.au/fishweb**

12.2 Research and development team

The Profitable Aquaculture Systems Program of DPI&F exists to support profitable, sustainable aquaculture industry development. This program works very closely with the Fisheries and Aquaculture Industry Development group of the department and in partnership with species-based industries and agriculture. The majority of aquaculture research and development is funded by the state because most of the species-based industries are not yet large enough to fund their own research.

12.2.1 Who are we?

The team includes over 40 scientists and technical support staff located across the three DPI&F centres:

- Northern Fisheries Centre, Cairns (NFC)—18 scientific staff
- Freshwater Fisheries and Aquaculture Centre, (FFAC), Walkamin—4 scientific staff
- Bribie Island Aquaculture Research Centre (BIARC)—17 scientific staff.

In addition to the research centres, work is also conducted on industry facilities.

12.2.2 What did we do in 2006–07?

- Quantitative and molecular approaches used to improve the performance of aquaculture species:
  - selective breeding of prawns and barramundi
  - moulting control of soft-shell crabs and sex-change control of barramundi
  - identification of reproductive traits in the tiger prawn using a genomic approach.
- Enhanced production capacity and improved environmental management systems. For example:
  - water-use efficiency, cleaning of waste water (remediation) by animal or plant species or mechanically
  - recirculation with marine, fresh and artesian aquaculture systems.
- Investigated and developed inland aquaculture systems—either integrated with existing agriculture or stand alone aquaculture ventures to improve or diversify whole-of-farm profitability, water use efficiencies and/or profitability of existing water use operations.
  - integrating aquaculture with cotton production systems
  - establishing inland finfish and prawn farming systems
  - exploiting additional and currently unused water sources for aquaculture (such as coal seam gas (CSG) water).
- Facilitated intensification and potential for land-based rearing through domestication of various aquaculture species. For example:
  - reef fish, tropical rock lobster, crabs (and scallops at sea)
- Export technology in the form of training.

12.3 Research and development outcomes

12.3.1 Integrated aquaculture systems

Considerable research effort over the past several years at BIARC has focused on developing more efficient water management options for pond-based farmers. While current BIARC research continues to develop technologies to economically capture waste nutrients and suspended solids once released from production ponds (e.g. polychaete-assisted sand filtration), a holistic view of water management recognises that production pond processes greatly influence post-production water treatment requirements.

An alternative approach to pond-based aquaculture aims to integrate crop production and wastewater management so that they are no longer distinct components of a flow-through operation. New research at BIARC is investigating enhanced bacterial-based processing of nutrients in production ponds.

Termed 'biofloc' water treatment, natural heterotrophic bacteria populations in ponds are encouraged through the manipulation of carbon: nitrogen (C:N) substrate levels—namely, by adding carbohydrate at levels based on feed nitrogen content to achieve residual nutrient ratios that favour bacterial development rather than phytoplankton. Bacteria can then proliferate in ponds, scavenging residual nutrients while regulating water quality and eliminating—or greatly reducing—the need to discharge water.

Assessing precise carbon-dosing requirements and physical conditions necessary to promote biofloc production has now been completed at pilot-scale levels. Collaborative trials with Western Australian scientists this year have demonstrated the usefulness of this technology for maintaining good water quality conditions for barramundi and trout grown in zero-discharge inland saline water. Results were impressive, with superior fish growth, survival and feed conversion in the biofloc pond due to the more favourable water quality conditions.

12.3.1.1 Current trial

Greater productivity in ponds can be realised using this approach since the bacteria flocculate around suspended particles—which themselves can become an additional food (protein) source for grazing cultured stock. This process forms the basis for a current trial at BIARC, which simultaneously cultures sand whiting (*Sillago ciliata*) and banana prawns (*Penaeus merguiensis*) within a pond where water is managed using biofloc treatment.

This trial aims to demonstrate, on a commercially relevant scale, a new profitable production system model that allows farmers to:

- improve economic security through crop diversification
- improve nutrient use efficiency through nutrient recycling
- comply with environmental regulations by limiting water discharge requirements.

There are a number of sound reasons for the selection of sand whiting as an alternative species for marine pond culture; these include their high market value, well established larval culture methods and demonstrated performance in growout ponds (previous BIARC research). The polyculture of sand whiting with banana prawns takes advantage of the species' complementary feeding habits and dietary requirements to potentially produce greater yields per area and feed input. Both species have a similar growout period to market.

Compared with monoculture environments, there may also be additional benefits of disease control in polyculture environments. While the performance of sand whiting in biofloc conditions has not yet been determined, both the prawns and the whiting are omnivorous feeders and this should make them particularly suitable for biofloc ponds where generated bacterial-based bioflocs can in turn become an additional food source. The grazing nature of these species complements the biofloc process by maintaining particles in suspension and regulating organic loading.

Such an integrated polyculture model has not yet been attempted with Australian species. Its successful demonstration would offer a new model to current marine aquaculture farmers seeking diversification and better water management strategies.

For further information contact Dan Willett (Research Scientist) on (07) 3400 2037 or **daniel.willett@dpi.qld.gov.au**

12.3.2 Inland aquaculture

For a number of years the DPI&F has been investigating the potential for developing aquaculture within Queensland's inland communities, particularly to add further value to the water resources of existing agricultural and industrial operations. Industry partnerships have been fostered to enable this developmental work, with current projects supported by the Cotton Catchment Communities CRC, Arrow Energy N/L and McVeigh Enterprises P/L.

Cotton-farming areas in the Dalby region overlap major natural gas reserves within underground coal seams, which are now being commercially exploited. A feature of CSG operations is the necessary uplift of associated water from the coal beds to liberate the adsorbed methane gas.

The water brought to the surface is slightly salty, similar to the water within the region's aquifers, and therefore unsuitable for many direct beneficial uses. CSG water represents a potentially significant resource for aquaculture; however, this potential needs to be measured against the actual suitability of the infrastructure and water source for the purpose of farming fish. Analysis of water chemistry at a potential trial site at Kogan revealed a unique ionic profile. The water is low in potassium, calcium, magnesium and sulphate and 10 times higher in bicarbonate than seawater at the same dilution.

Bioassay trials have been completed to determine water quality effects on acclimation, growth and survival of Murray cod, mulloway and barramundi, and trials have shown that raw CSG water is unsuitable for the production of these fish species; however, with the addition of potassium, fish grew equally as well as experimental controls. This important osmoregulatory ion (K^+) is simple to administer, cost-effective and typically required in groundwater aquaculture operations in Australia.

Further implications of other ion deficiencies, however, will have a bearing on the type of production system used to culture the fish in CSG water. For instance, trials showed that as salinity increases to above 8 parts per thousand, calcium is additionally required due to its positive effect on membrane permeability. To successfully add

calcium to CSG water (in order to prevent calcium carbonate precipitation), the pH level needs to be reduced to below 8.3. While this can be achieved with the addition of sulphuric acid, it is logistically difficult and likely to be cost-prohibitive to implement on a large scale.

Establishing a large-scale demonstration floating raceway system (based at Arrow Energy's Kogan evaporation dam) appears unlikely due to these inherent difficulties. A more viable fish production system at this site would seek to use the water before salinity concentrates in the evaporation dam. Discussions continue with project partners to advance aquaculture development in this area.

For further information contact Dan Willett (Research Scientist) on (07) 3400 2037 or **daniel.willett@dpi.qld.gov.au**

12.3.3 Marine polychaetes and worm-assisted sand filtration

A trial of this new method of saline wastewater treatment was successfully conducted at the Bullock Creek Prawn Farm in 2007. While the trial was conducted at an experimental scale, it has proven that the system can operate in a commercial environment using wastewater from earthen ponds.

The trial involved filtering prawn pond wastewaters through constructed sand beds where cultured sea worms were also growing. Water handling rates were scaled so that a 1 ha sand bed could treat the water from 10 ha of prawn ponds with 10% exchange per day.

The results are currently being compiled but have shown excellent solids and chlorophyll removal and some very encouraging worm biomass production. When the worms were harvested at an age of 20 weeks, about 50% of the biomass was immediately suitable for use as bait. A very broad range of fatty acids have been found in this worm biomass, suggesting that worms too small for sale as bait are useful for use as prawn or fish broodstock conditioning diets.

Innovation funding from the National Landcare Program has supported this year's proof of concept work. Future work currently being planned aims to enable larger scale operations to proceed by integrating these systems into whole-of-farm models that have greater nutrient use efficiency and diversity of product.

For further information contact Dr Paul J. Palmer (Senior Biologist) on (07) 3400 2050 or **paul.palmer@dpi.qld.gov.au**

12.3.4 Assessment of lotus lilies for wastewater treatment

This project aims to determine whether lotus lilies (*Nelumbo nucifera*)—a native freshwater plant—will trap sediment and improve water quality in a treatment pond that recycles water from a production pond full of fish (barramundi being the test species). It also aims to increase water use efficiencies and farm production efficiencies by allowing concentrations of fish in particular areas—thus improving feeding, harvesting and bird protection procedures.

Although this project was initially hampered by many issues, they appear to have been resolved. The modification of using a pioneer native species of aquatic plant (*Hydrilla* sp.) in the pond has assisted greatly with the establishment of the lotus plants. *Hydrilla* established the pond area rapidly, improving the soil and water, which allowed the lotus to follow. The lotus then sends out runners through the *Hydrilla*, shading and out-competing the *Hydrilla* plants. The lotus then becomes the dominant species in the pond. Preliminary results indicate that the two plants work well together in establishing the pond and assimilating nutrients from the water.

Meanwhile, the industry partner component of the project is progressing well. Preliminary assessment of the capabilities of lotus lilies in extensive fish production systems suggests a high potential to assimilate nutrients. The industry partner has also been successful in marketing the lotus pod to the local florist.

This project is supported by the Rural Industry Research Development Corporation (RIRDC) that will run for one production cycle and is due to finish in 2008. It was developed with support of the AAQ and works in conjunction with an industry partner (Daintree River Barramundi Farm). This project uses the pond facilities of the FFAC, Walkamin.

For further information contact Evizel Seymour on (07) 4091 9313 or **evizel.seymour@dpi.qld.gov.au**

12.3.5 Bioremediation for aquaculture in northern Australia and Papua New Guinea

The project aims to investigate the use of duckweed in partitioned recirculation systems to achieve essentially similar objectives to the lotus proposal for Australian aquaculture (above). This project also intends to investigate other methods currently being developed at BIARC, including biofloc (see Section 12.3.1) and mechanical filtration techniques for water treatment on a pond scale.

It has been shown that duckweed is very efficient in removing ammonia from wastewater in integrated wastewater treatments. The DPI&F is examining its efficiency for removing the nutrient from a partitioned aquaculture system (using barramundi as the test species).

This new project was developed with the ABFA and aims to investigate and compare two plant-based partitioned systems and then evaluate their fish-carrying capacity limitations. This DPI&F-led project has funding support of the Australian Centre for International Agriculture Research (ACIAR) for a period of five years. The project commenced in March 2007, but was delayed by 2007's extremely cold winter. Consequently, re-stocking was completed in November 2007.

For further information contact Evizel Seymour on (07) 4091 9313 or **evizel.seymour@dpi.qld.gov.au**

12.3.6 Biotechnology applications

12.3.6.1 Advancing puberty in fish

The time it takes a fish to undergo gonadal development is commercially significant— some species are late-maturing and broodstock require maintenance for many years before any spawning occurs. Regulation of the time of puberty is also important for reliable hatchery productions—some species do not undergo natural reproductive development in captivity. The exact events that trigger puberty in fish have yet to be established. Puberty can be defined as the change from a fish that spends all of its energy growing to a fish that spends significant energy on gonadal development.

In order to understand the mechanisms regulating the onset of puberty in fish, genes that are involved in the reproductive function of the grey mullet (*Mugil cephalus*) have been isolated and cloned. (The mullet is a model species for late-maturing fish.) The DPI&F has isolated and characterised the KiSS1-receptor, also called GPR54, which belongs to the KiSS1 system and is considered the 'gatekeeper' of puberty in mammals—and possibly all vertebrates. These findings have paved the way for the development of new hormonal manipulation approaches that have the potential to advance puberty and spawning in fish.

12.3.6.2 Publications

Nocillado, J.N., Levavi-Sivan, B. Carrick, F., Elizur, A. (2007). Temporal expression of G-protein coupled receptor 54 (GPR54), gonadotropin-releasing hormones (GnRH) and dopamine receptor D2 (drd2) in pubertal female grey mullet, *Mugil cephalus*, Gen. Comp. Endocrinol., 150(2):278–87.

Nocillado, J.N., Elizur, A., Avitan, A., Carrick, F., Levavi-Sivan, B. (2007). Cytochrome P450 aromatase in grey mullet: cDNA and promoter isolation and brain, pituitary and ovarian expression during puberty, Mol. Cell. Endocrinol., 263:65–78.

Nocillado, J.N., Elizur, A. (2007). Neuroendocrine regulation of puberty in fish: insights from the grey mullet (*Mugil cephalus*) model. Molecular Reproduction and Development.

12.3.6.3 Regulating moulting in crustaceans

Moulting is an important physiological event in crustaceans. It is essential for metamorphosis (the change from larva to adult), growth and reproduction. Moulting occurs in cycles and involves shedding a hard exoskeleton to expose a soft new shell, the uptake of water from the crustacean's immediate surroundings (causing the new exoskeleton to expand) and, finally, the hardening of the new exoskeleton.

It is during the soft shell stage, a very short window of 2–6 hours, that a particularly valuable seafood product—the soft shell crab—can be produced. The moulting process can be affected by a range of environmental cues (such as temperature and

photoperiod) and is regulated by a cascade of hormonal signals. In spite of extensive research, there is still no clear understanding of the hormonal processes involved in moult regulation.

The BIARC has adopted two approaches in its study of moulting in blue swimmer crabs (*Portunus pelagicus*). In the first instance, classical molecular techniques were used to isolate several genes important to the moulting process. In the second instance, a new and powerful technology—the microarray—has been used to comprehensively study gene expression and to discover new genes involved in moult cycle regulation. This second approach enables the examination of thousands of genes simultaneously.

Using microarrays, the expression profiles of genes of interest have been tracked during the entire moult cycle and these profiles have been used to find new, as-yet-undiscovered genes. Of particular interest has been the isolation of genes involved in shell hardening.

12.3.6.4 Prawn research

The identification of gene coding for important commercial traits in prawns was undertaken using a microarray approach. Both the available crab microarray has been used, as well as a specific prawn microarray that been constructed and used to examine genes associated with reproductive performance and fecundity.

Research into creating an all-female black tiger prawn (*Penaeus monodon*) has commenced as part of an international collaboration with Israel. Efforts are focused on understanding the role of the androgenic gland in sex determination.

12.3.6.5 Publications

Kuballa, A.V., Guyatt, K., Dixon, B., Thaggard, H., Ashton, A.R., Paterson, B., Merritt, D., Elizur, A. (2007). Isolation and expression analysis of multiple isoforms of putative farnesoic acid O-methyltransferase in several crustacean species. Gen. Comp. Endocrinol., 150:48–58.

Kuballa, A.V., Merritt, D., Elizur, A. (2007). Gene expression profiling of cuticular proteins across the moult cycle of the crab *Portunus pelagicus*. BMC Biology.

For further information contact Abigail Elizur (Principal Scientist) on (07) 3400 2055 or **abigail.elizur@dpi.qld.gov.au**

12.3.7 Inland organic prawn production

This RIRDC-funded project investigated the feasibility of growing organically certified prawns in Australia. Work in this area is timely, as evidenced by the immense worldwide interest in this food sector and the current developmental work being performed overseas by aquaculture interests looking to service this developing market.

The project was coordinated by Steve Slattery from Innovative Food Technologies in DPI&F. The project involved activities conducted over two years at several sites and employed a multidisciplinary approach (including farm-based and controlled laboratory feed trials and analyses, and packaging and product storage trials).

Unfortunately, the farm trial could not be fully executed because the supply of the planned organic feed source failed. Several alternative organically certifiable feed sources that could be supplied at commercial scale were investigated in terms of their nutritional contents and ability to be built into simple diets for prawns. Prawn feed trials demonstrated organic formulations that could produce weight increases of up to 66% of that possible with locally produced commercial (though uncertified) feed.

Some of the critical issues identified for success in this endeavour were the improved water stability of organic feed formulations, the need for more reliable protein source supplies and the possible stocking density of ponds for economic viability and adherence to organic standards. Prawn packaging experiments demonstrated an extended storage life of prawns in a chilled but unfrozen state, which, regardless of organic status, represents a potentially new product that is not marketed anywhere yet. The project has recently concluded and the final report should be available from RIRDC soon.

For further information contact Dr Paul J. Palmer (Senior Biologist) on (07) 3400 2050 or**paul.palmer@dpi.qld.gov.au**

12.3.8 Greenwater larval culture techniques

The desire of Australian fish and prawn farmers to diversify farm produce has prompted the DPI&F to review some of the widely applicable seed production technologies it has developed and refined over the last two decades, and to continue taking the risks necessary to explore and develop opportunities for new culture techniques and species. In particular, the DPI&F has recently reviewed the larval rearing technologies commonly referred to as 'greenwater culture'.

These methods were developed in Australia by the DPI&F in southern Queensland and have since been extended to many other research agencies and industry participants. They have been successfully applied to a wide variety of endemic fish species (including barramundi, Australian bass, whiting, flathead, snapper, mullet and bream), and similar methods have been reported around the world for a variety of other species likely to interest Queensland mariculturists (e.g. cobia).

12.3.8.1 Publications

Palmer, P.J., Burke, M.J., Palmer, C.J., Burke, J.B. (2007). Developments in controlled greenwater larval culture technologies for estuarine fishes in Queensland, Australia and elsewhere. Aquaculture 272:1–21.

For further information contact Dr Paul J. Palmer (Senior Biologist) on (07) 3400 2050 or **paul.palmer@dpi.qld.gov.au**

12.3.9 Tropical marine finfish

The tropical marine finfish (TMF) project has continued to increase its focus on industry development and the extension of marine finfish culture technology. In 2006–07, approximately 30 000 juvenile fish were supplied to industry for pond-based growout using existing prawn farm infrastructure. The majority of these fish were estuary cod (*Epinephelus coioides*) and were supplied to an industry partner in Cardwell. These fish should reach market size by December 2007.

This was also the year when the first aquaculture-produced grouper in Australia were sold into the Sydney–Melbourne market. These flowery cod (*E. fuscoguttatus*) were grown by an industry partner at Mossman from juveniles supplied by the TMF project. The product was well received in the market, with demand far exceeding the limited supply. The taste and quality of the fish was praised, although the size (400–600 g) was considered rather small.

A small population of flowery cod are currently being grown in DPI&F ponds at Oonoonba. These fish are being grown in floating cages where growth is likely to be much faster than that of free-ranging fish grown at low density in a pond.

A major increase in broodstock numbers has been accomplished. As reported last year, research effort on barramundi cod (*Cromileptes altivelis*) was to be phased out. The barramundi cod broodstock were put out to tender and sold, allowing for increased numbers of the targeted grouper species. Numbers of flowery cod were increased slightly and a population of F1 fish were established as future broodstock. A major increase in numbers of estuary cod was achieved through the purchase of newly caught fish and through a donation of broodstock from our industry partner in Cardwell. A population of coral trout (*Plectropomus leopardus*) was acquired to target their spawning season.

Queensland grouper (*Epinephelus lanceolatus*) was identified in the TMF project review as a priority grouper species. This species has not previously been part of the TMF project focus and presents a number of major difficulties. The protected listing of the species has prevented its collection from the Great Barrier Reef Marine Park (GBRMP). Collection is currently only possible in a few small zones annexed from the GBRMP and from areas outside the park (such as the Gulf of Carpentaria).

To facilitate collection of broodstock, the project has acquired a live-fish transport truck and upgraded the quarantine facilities to hold larger fish. The first Queensland grouper collection trip was to the Townsville Port where, with the cooperation of the Townsville Port Authority, a four-day fishing effort resulted in the capture of a single large (95 kg) fish. This fish is currently housed in a broodstock tank at the Northern Fisheries Centre. Further collection trips to Weipa are scheduled for 2007–08.

Commissioning of the new larval rearing tanks has been successful and has enabled the production and supply of increased numbers of juveniles to industry. A second set of larval tanks has been ordered for delivery in 2007–08 and will further increase capacity. Noda virus has continued to be a major problem, resulting in mortalities of around 50% when juvenile fish have become infected. To combat the virus, ozone washing of eggs prior to their addition to the larval tanks was instigated; results are encouraging, with larvae testing negative to the virus.

The TMF project continues to benefit from its links with the ACIAR project 'Improved hatchery and growout technology for marine finfish aquaculture in the Asia–Pacific region' with staff exchanges enabling access to advances being made in grouper aquaculture within the region. A technical member of the TMF team attended a three-week grouper aquaculture training workshop in Situbondo, Indonesia.

For further information contact Richard Knuckey (Principal Scientist- Aquaculture) on (07) 4057 3709 or **richard.knuckey@dpi.qld.gov.au**

12.3.10 Tropical rock lobster

Aquaculture research of the tropical rock lobster (*Panulirus ornatus*) has continued to refine larval rearing technology in collaboration with our long-term partners—MG Kailis and FRDC—at the DPI&F NFC, Cairns. The successful production of pueruli (post-larval lobsters) in June 2006 has not been reproduced, and the failure of many larvae to progress through metamorphosis has highlighted a potential lack of energy reserves (resulting from inadequate nutrition earlier in the larval phase). Consequently, recent work has focused on nutrition—improving the enrichment of brine shrimp (*Artemia* spp.), developing manufactured diets and working with the nutrition of broodstock to ensure optimal quality eggs and larvae.

The results of the research by the DPI&F have encouraged MG Kailis to establish a subsidiary company (Lobster Harvest Pty Ltd) to facilitate the commercialisation of lobster aquaculture. The proximity of commercial production has generated great interest in the protection of intellectual property. It has also caused some difficulties finalising funding contracts for the ongoing research program.

Given the protracted larval phase of rock lobsters, the issue of water quality is of great concern. The NFC rock lobster team has a long-term goal of comparing the estuarine water available at NFC (Trinity Inlet) with oceanic water. This goal has been pursued vigorously and permits have now been issued to allow the team to use the Monkman Research Station on Green Island, 20 km east of Cairns on the Great Barrier Reef. A larval rearing system will be established there and tested during 2007–08.

The work is extremely demanding and involves nurturing delicate lobster larvae (that are normally accustomed to pristine oceanic conditions) and performing multiple feeds each day. The exceptional commitment of existing staff has been responsible for the successes to date, but additional resourcing is being sought to ensure the research and development effort necessary is sustainable in the longer term.

For further information contact Clive Jones (Senior Biologist) on (07) 4057 3782 or **clive.jones@dpi.qld.gov.au**

12.3.11 Sea cucumber aquaculture

A component of ACIAR project FIS 2001/075 'Sustainable aquaculture development in the Pacific Islands region and northern Australia' is the transfer of sea cucumber production technology to Australia. The project focused on NFC staff training in the production of sandfish (*Holothuria scabra*) and assessed the use of this species as a bioremediator in prawn culture.

Trials carried out on prawn farms indicated that sandfish were not suitable for co-culture—a result supported by similar research overseas. There may, however, be potential to grow hatchery-produced sandfish in prawn ponds and produce commercial-sized animals using nutrients already in the sediments. Juvenile sandfish produced at NFC in late 2006 were stocked into a prawn pond in Ayr in March 2007. The growout trial will conclude in mid-2008. Survival, growth and value of the sandfish will indicate whether this species has any potential as a commercial commodity in Queensland.

12.3.11.1 Publications

Hair, C., Rimmer, M., Nash, W., Ponia, B. (2007). Sustainable aquaculture development in Pacific Islands region and northern Australia. Final Report to ACIAR Project FIS2001/075. September 2007.

Hair, C., Johnston, A. (in press) Sea cucumber aquaculture in Far North Queensland. Australasian Aquaculture.

Sandfish (*Holothuria scabra*) induction and spawning demonstration DVD. ACIAR and QLD DPI&F, PR07-3008.

For further information contact Cathy Hair on (07) 4035 6152.

12.3.12 Crabs

In June 2008 the crab aquaculture team at BIARC will complete a collaborative project with researchers from Queensland University of Technology (QUT). This two-year ACIAR project examines the feasibility of developing low cost feeds for mud crabs (*Scylla* spp.) in South-East Asia. Institutions in Vietnam and Indonesia have been working on corresponding diets for *S. paramamosain* using locally sourced ingredients, while DPI&F have been investigating *Scylla serrata*. A PhD student from Vietnam is completing a comparative study of carbohydrate utilisation and feeding responses of both mud crab species.

A review of the project last year recommended that further attempts to maximise growth of crabs in laboratory experiments should be equivalent to the growth of crabs free in ponds (which always have food available).

This year both the timing and amount of feed delivered to seventh instar mud crab juveniles were studied. This work required the development of an innovative self-cleaning, container-based laboratory culture system and an automatic feeder that enabled the delivery of specific rations to 256 individual crabs on a programmed schedule.

Expressions of interest have been called for further commercial development of the laboratory growout system. To reduce handling of crabs in experiments, the development of a wireless infrared video system for photographing crabs in their darkened containers and estimating their size using image analysis was required.

Crabs were fed one of three types of diet—fresh (squid, mussels etc), a commercial prawn diet (Turbo, CP) and a research pellet based on the ACIAR rock lobster diet. These diets were fed at 5–20% body weight per day, divided into two or three meals per day. The high ration treatments were used because of evidence that early crab instars may be capable of eating more than 5% body weight per day. A workshop was held on 4 December and 5 December to discuss preliminary results from the feeding experiment and to plan future crab research.

Preliminary statistics show that growth of crabs fed different types of diet was not significantly different (though, as might be expected, the average size of 'fresh diet' crabs was the highest). Increasing the ration supplied to juvenile crabs above 5% did not increase growth rate—the average growth rate did not even increase progressively.

It may be that dietary effect is greatest in very early instars (e.g. fourth instar)—the size that would normally be grown communally in nursery ponds—but by the time crabs are harvested for experiments their moult increment and food consumption has probably settled down to approach sub-adult growth and consumption patterns. Similarly, splitting the same ration into three meals (adding a midnight feed) showed no significant size improvement when compared with crabs fed twice a day (morning and afternoon), though perhaps an increase in statistical power would render significant the slightly higher mean for three meals.

It is conceivable that delivering food more frequently in smaller batches would increase growth because the food would be more efficiently eaten and less prone to leaching. Observations are being made on gut-filling and clearance times to verify this.

This year the DPI&F also discussed R&D issues with both Queensland soft-shell blue swimmer crab farms (in Brisbane and Bundaberg). For example, increased experience with holding

crabs indoors has raised questions about stress imposed by intensive holding systems on the condition and moulting of crabs. Operators of intensive recirculation culture systems know that accumulation and spoilage of uneaten feed and water quality deterioration are undesirable, but subtle, sub-lethal effects involved with moulting crabs in containers remain to be investigated. In discussions with farmers and DPI&F vets consideration was given to what routine methods of health/condition assessment are available for crabs in farms or feeding trials, and also what opportunities exist for postgraduate student research into more specific stress tests.

12.3.12.1 Publications

Mann, D.L., Asakawa, T., Kelly, B., Lindsay, T., Paterson, B., (2007). Stocking density and artificial habitat influence stock structure and yield from intensive nursery systems for mud crabs *Scylla serrata* (Forsskal 1775). Aquaculture Research 38: 1580–1587.

Paterson, B., Mann, D., Kelly, B., Barchiesi, M., (2007). Limb-loss in pond-reared blue swimmer crabs *Portunus pelagicus* (L.): effect on growth in an indoor shedding system. Aquaculture Research 38, 1569-1579.

For further information contact Brian Paterson (Principal Research Scientist) on (07) 3400 2003 or **brian.paterson@dpi.qld.gov.au**

12.3.13 Scallop marking

In Queensland and Western Australia, ranching of saucer scallops (*Amusium balloti*) is being undertaken in order to reduce the variability of wild catch between seasons and to increase overall scallop production. Queensland Sea Scallop Ltd (QSS), based in Bundaberg, has been able to produce large numbers of scallop spat from wild-caught broodstock in recent years. QSS then release 2–4 mm spat into specific seabed leases with the aim of recapturing a proportion of them the following season.

In order to evaluate the success of ranching, methods needed to be developed for discriminating hatchery-reared scallops upon recapture. Marking the hatchery-reared stock would also facilitate monitoring of scallop growth and movement after release. Since 2005, a project has been underway to develop and optimise methodology for marking the shell of the saucer scallop using fluorescent chemicals. The original list of three possible marking chemicals has now been narrowed down to one—oxtyetracycline—which can be incorporated into the calcium carbonate of the shell during shell formation with low cost, low stress for the scallops and no residues in the meat, which is sold for human consumption.

Recent trials at the BIARC have demonstrated that scallops can be immersed in an oxtyetracycline chemical solution for three days, resulting in a mark that is easily visible under a microscope using ultra-violet light. The scallops showed negligible mortality during or after chemical immersion. Scallops can even be treated twice a month to produce two fluorescent growth rings, which will allow specific batches to be tracked in the wild. A mark retention trial has shown that these marks can remain visible for at least 10 months in living scallops, and are therefore likely to be useful for commercial purposes. QSS is currently undertaking shell marking trials for scallops released into the wild.

This project is supported by the FRDC and our industry partners, QSS.

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