Report to farmers

Aquaculture production survey Queensland 2004–2005

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1. Production summary

The total value of the Queensland aquaculture industry decreased by 6% over the last 12 months, with the value of production falling from $72.5 million in 2003–04 to $67.9 million in 2004–05. This decrease was largely due to a decrease in the farmed prawn sector of nearly 14% from $53.3 million to $45.9 million.

In Queensland, the total value of fisheries production including aquaculture in 2004–05 was similar to the levels in 1999–00. Although there has been a decrease in aquaculture production of 6% over the last 12 months the wild catch fishery has declined by 17%. The proportion attributed to aquaculture has increased from 24% to 26% over the last twelve months. (Table 1)

Table 1. Queensland fisheries production—gross value (1999–00 to 2004–05)

	ABARE figures			Queensland figures (1)		
Year	Total fisheries ($ m)	Aquaculture ($ m)	Proportion to aquaculture (%)	Total fisheries ($ m)	Aquaculture ($ m)	Proportion to aquaculture (%)
1999–00	258.5	55.3	21.4	n.a	n.a.	n.a
2000–01	277.6	56.1	20.2	n.a	n.a	n.a
2001–02	281.3	75.2	26.7	n.a	n.a	n.a
2002–03	288.0	62.9	21.8	n.a	n.a	n.a
2003–04	296.9	67.7	22.8	301.7	72.5	24.0
2004–05	255.1	64.5	25.3	258.5	67.9	26.3

(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
Department of Primary Industries and Fisheries

Production in the marine prawn sector excluding kuruma prawns (*Penaeus japonicus*) decreased by over 11% from 3249 tonnes in 2003–04 to 2888 tonnes in 2004–05. The value of this sector decreased by more than 11% and was valued at $47.6 million in 2003–04 to $42.2 million in 2004–05. Marine prawns include black tiger (*Penaeus monodon*) and banana (*Penaeus merguiensis*) prawns.

This production decrease was a result of quality and availability of wild caught broodstock during the year. The quality issues with the post-larvae stocked also continued to be a problem.

This resulted in the area harvested decreasing by nearly 20% from 913 hectares in 2003–04 to 749 hectares in 2004–05. The number of producing farms decreased from 34 to 31 over the same period.

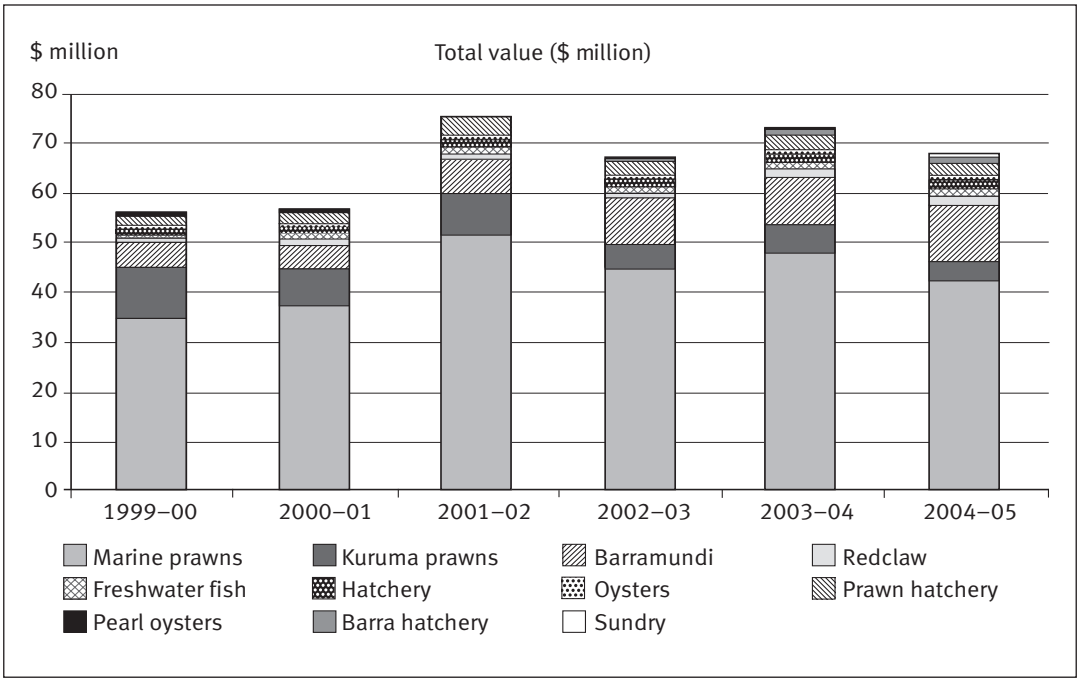
The average price of $14.60/kg was very similar to the 2003–04 price of $14.65/kg but considerably lower than $15.56/kg achieved in 2002–03. Farms held considerable quantities of frozen stock as a result of the over-supply issues, largely due to the imported vannamei prawns.

Kuruma prawn production decreased by more than 30% from 112 tonnes in 2003–04 to 76 tonnes in 2004–05, while the value decreased by 35% to $3.7 million ($5.7 million in 2003–04). The area harvested fell from 60 to 55 hectares and average yields decreased by 27% from 1885 kg/ha to 1370 kg/ha. Production estimates for the 2005–06 season predict a further fall as the number of farms stocking kuruma prawns has decreased from four to two and production is unlikely to be reported in future years.

Barramundi (*Lates calcarifer*) production increased significantly (19%) from 1204 tonnes to 1437 tonnes in 2004–05. The value of the industry increased by 18% from $10.1 million in 2003–04 to more than $11.9 million in 2004–05. The average price on a whole fish basis decreased marginally from $8.36 to $8.30/kg. Over this period the number of producing pond-based farms decreased from 30 to 25, while the number of tank-based systems decreased from 8 to 3. There was just one sea cage operation.

The type of barramundi product being marketed has changed considerably over the past few years with whole fish and filleted product collectively accounting for 97% of production. Live fish now accounts for 2.5% of production and gilled and gutted fish now only comprises 0.5% of total production.

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



Redclaw crayfish *(Cherax quadricarinatus)* production has increased by 8%, from 91 tonnes in 2003–04 to 99 tonnes in 2004–05. Over the same period the total value of the industry increased by 6%, from $1.24 million to $1.38 million which included non-food sales (juveniles, broodstock and aquarium) of $101 500.

The number of producing farms was 63, which has been relatively stable over the last three years. The number of producing farms has decreased by 31% over the last six years. Average farm productivity increased by 7%, from 1545 kg/ha in 2003–04 to 1648 kg/ha in 2004–05.

The freshwater fish growout sector currently produces silver perch *(Bidyanus bidyanus),* jade perch *(Scortum barcoo),* golden perch *Macquaria ambigua)* and Murray cod *(Maccullochella peelii peelii) as* well as eels *(Anguilla* spp.*)* that are reported separately. The Murray cod and golden perch production cannot be reported separately for confidentiality reasons, as insufficient farms produced these species.

Combined silver perch and jade perch production decreased marginally from 94 tonnes in 2003–04 to 93 tonnes in 2004–05. Jade perch production continues to decline (down 20% since 2003–04) while the price has increased by nearly 10% to $8.42/kg. The average price of silver perch increased by 3% to $8.26/kg. The number of farms selling silver perch declined from 17 to 12 and the number selling jade perch declined from 10 to 7.

Eel production decreased by approximately 10%, with 42.7 tonnes being sold in 2004–05 compared with 47.2 tonnes in 2003–04. The value of the industry increased by 10% from $517 000 to $568 000 in 2004–05. The average price obtained in 2004–05 was $13.33/kg, which was a 20% increase on the 2003–04 price of $10.95/kg.

The hatchery sector, producing native fish fingerlings and ornamental aquarium species, increased sales by 10% from approximately 8.6 million fingerlings to 9.5 million, and the total value reached $3.4 million.

The Queensland edible oyster industry has been reorganised with the introduction of a new licensing process for aquaculture enterprises under the *Integrated Planning Act 1997*. The information in this report now only refers to the oyster production from approved areas.

This 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.

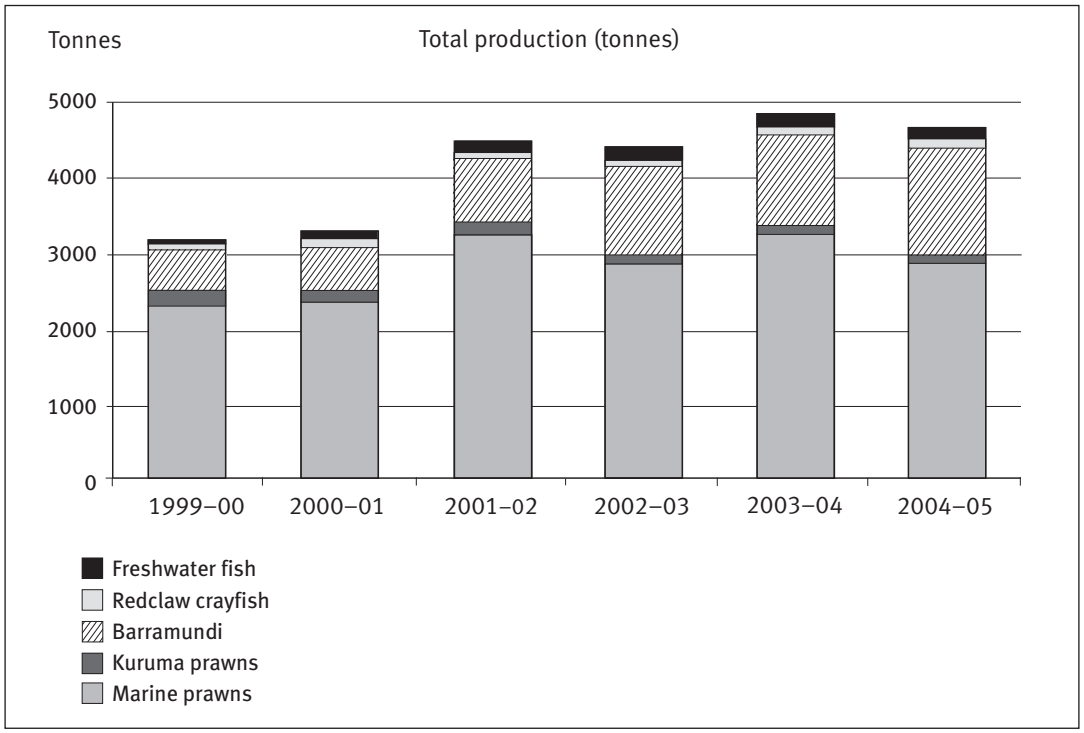
Oyster production rotationally harvested from rocky foreshore areas is no longer reported as aquaculture production and is now reported as part of the wild caught fisheries production.

Even without the production from rocky foreshores the total edible oyster production increased by 8% from 197 700 dozen in 2003–04 to 213 000 dozen in 2004–05, while the value of the industry increased by 7% to $736 000. The average price per dozen oysters decreased marginally from $3.48 to $3.45 per dozen.

The value of the pearl oyster industry in Queensland continues to fluctuate as some of the farms rebuild stocks of nucleated pearls. Two farms reported information this year and consequently the production information cannot be disclosed for confidentiality reasons.

The total permanent labour force in the aquaculture industry decreased from 579 units in 2003–04 to 502 units in 2004–05. The prawn sector (marine, kuruma and hatchery) accounted for 238 units or 47% of the total. When permanent and casual labour is combined, the employment in the Queensland aquaculture industry decreased by nearly 5% from 717 full-time equivalents (FTEs) in 2003–04 to 689 FTEs in 2004–05.

Figure 2. Queensland aquaculture production (tonnes)



2. Survey methods

Production statistics for the financial year 2004–05 were collected from farms producing marine prawns, barramundi, redclaw crayfish, freshwater growout fish, eels and hatchery and aquarium producers. Statistics collected from the edible and pearl oyster growers relate to culture areas.

Survey forms were mailed to aquaculture licence holders for the species listed below. 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 is based on operations that have these species authorised on their licence. Some licences have more than one species on their licence. Problems encountered with the mailing database resulted in some farms not receiving a return to complete this year. This resulted in lower response rates than were expected.

Table 2. Response rates to survey questionnaires

	Number mailed	Number returned	Percent returned
Marine and kuruma prawns	59	54	92
Barramundi	122	96	79
Redclaw crayfish	234	191	82
Freshwater fish	137	108	79
Eels	31	23	74
Hatchery and aquarium	69	60	87
Edible oysters	111	98	88
Pearl oyster culture areas	14	8	57
Total	**777**	**638**	**82**

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

Fingerling fish: Small fish in the 2 to 10 gram range.

Juvenile crayfish: Immature crayfish in the 1 to 15 gram range.

Fish conversion factors: Gilled and gutted to whole fish (0.89:1 on weight basis). Filleted fish to whole fish (0.48:1 on weight basis).

Labour conversion: Labour Full-time Equivalents (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 as one FTE labour unit. Information collected in hours per week was converted to FTEs by dividing total hours by 40 hours.

Note:
All holders of Aquaculture Licences in Queensland are required as a condition of license to complete an Annual Statistical Return. The Department will be corresponding with all licensees who have not completed the 2004–05 returns. Failure to accurately complete the statistical returns constitutes a breach of Aquaculture Licence conditions.

From 1 March 2005 all Aquaculture Licences were transitioned to Development Permits as prescribed under the *Integrated Planning Act 1997*. The term 'Aquaculture Licence' is used in this report to represent both approvals (Aquaculture Licence and development Approvals).

3. Marine prawns

3.1 General

The value of the Queensland prawn industry (including black tiger, banana and kuruma prawns) decreased by 14% from $53.3 million to $45.9 million in 2004–05. In addition to this, hatcheries sold post-larvae to a value of $2.4 million. The total farm ponded area decreased from 846 hectares in 2003–04 to 794 hectares in 2004–05.

The number of producing farms has declined for the first time in the last five years from 37 farms in 2003–04 down to 32 farms in 2004–05. There are a number of farms that have ceased production and are for sale as a result of import price pressures on Australian markets and lower overseas market prices.

3.2 Marine prawn production

3.2.1 Growout

Production of marine prawns has decreased by more than 11% from 3249 tonnes (34 farms) in 2003–04 to 2888 tonnes (31 farms) in 2004–05. Included in marine prawns are black tiger *(Penaeus monodon)* and banana prawns *(Penaeus merguiensis)*. Because they are sold live, predominantly into the export market, Kuruma prawns *(Penaeus japonicus)* are reported separately at prices normally three times the value of the other prawn species.

The value (ex-farmgate) of marine prawn production decreased from $47.6 million in 2003–04 to $42.2 million in 2004–05. Prices ranged from $9.50 to $17.50 per kg. The average price was $14.60 per kg, which is almost the same as farms received in 2003–04. The stable prices occurred even with the continued influx of imported cheap 'vannamei' prawns. The majority of sales were interstate (72%), while local Queensland sales accounted for 23% and 5% were exported.

Table 3. Marine prawn production by aquaculturists in Queensland (2002–03 to 2004–05)

	2002–03	2003–04	2004–05
Total production (tonnes)	2861.4	3248.7	2888.1
Average price ($/kg)	$15.56	$14.65	$14.60
Total value ($ million)	$44.5	$47.6	$42.2
Average yields (kg/ha/crop)	3400	3600	3850

There were 22 farms that produced more than 20 tonnes in 2004–05, which was the same as the previous year. Sixteen farms (17 in 2003–04) produced more than 50 tonnes (Table 4) while 9 (12 in 2003–04) produced more than 100 tonnes. Five farms (12 in 2003–04) averaged more than 6000 kg/ha/crop and three averaged over 7000 kg/ha/crop.

The total ponded area on farms decreased by 6% from the 785 hectares in 2003–04 to 738 hectares at the end of 2004–05. Over the same period the area stocked decreased by 30% from 1131 to 776 hectares. The total harvested area decreased by nearly 20% from 913 hectares in 2003–04 to 749 hectares in 2004–05.

Pond sizes ranged from 0.4 to 1.7 hectares, with an average size of 1.0 hectare. The average number of crops per pond per year decreased slightly from 1.2 crops to 1.0 crop. There were 4 farms — 6 in 2003–04 — that produced more than one crop per year. The average stocking rate increased from 33 post-larvae per square metre up to 36. Stocking rates varied from 18 to 53 with 8 farms stocking at 40 or more per square metre compared with 10 farms the previous season.

Table 4. Number of licenced marine prawn farms and production levels in Queensland (2002–03 to 2004–05)

	2002–03	2003–04	2004–05
Production (tonnes)	**No.**	**No.**	**No.**
0.1 to 5.0	8	1	3
5.1 to 10.0	0	3	3
10.1 to 20.0	5	6	3
20.1 to 50.0	10	6	6
50.1 to 100.0	6	5	7
100.1 to 200.0	4	9	7
More than 200	3	4	2
Number of producing farms	36	34	31
Number of non-producing farms	14	14	18
Number of hatcheries only	5	7	6
Total number of responses	55	55	55
Number of farms surveyed	58	60	60

The quantity of feed decreased from 7390 tonnes in 2003–04 to 6380 tonnes in 2004–05. Over the same period the estimated feed conversion ratio (FCR) has improved 2.3:1 to 2.2:1. There was a major change in feed sources. In 2004–05 feed sources were 30% from Australia (17% in 2003–04) and 70% from overseas (83% in 2003–04).

3.2.2 Hatchery

Sixteen (14 in 2003–04) prawn hatcheries in Queensland produced an estimated 330 million post-larvae (703 million post-larvae (PL) in 2003–04). The number of PLs produced has returned to stable levels of between 320 and 350 million (Table 5). The large increase in 2003–04 was the result of one farm producing large numbers of banana prawns that were not stocked. Although the number of hatcheries operating increased, this was result of one hatchery ceasing production and three farms starting up their own hatcheries.

The between-year comparative figures are further complicated by the production of banana prawns where pond reared spawners are being used for PL production rather than obtaining spawners from the wild. This has caused the discrepancy between spawners purchased and spawners used over the last three seasons and will continue in future years. The numbers cannot be released for confidentiality reasons.

Table 5. Marine prawn hatchery production in Queensland (2002–03 to 2004–05)

	2002–03	2003–04	2004–05
Number of spawners purchased	6164	5910	4502
Number of spawners used	5445	5691	3509
Number PLs produced (million)	324.4	703.7	330.8
Number stocked (million)	329.9	371.8	283.1
Number PLs sold (million)	145.0	166.5	142.0
Value PLs sold (million)	$2.59	$2.81	$2.23
Average value PLs (cents)	1.78	1.69	1.57

3.2.3 Labour

The total labour employed on marine prawn farms over the last four years is shown in Table 6. There has been a continued increase in the efficiency of permanent labour with production increasing from 13.2 tonnes per unit (2003–04) to 14.1 tonnes in 2004–05. The decrease (–17%) in permanent labour has partly been replaced by the increase incasual labour.

Total casual hours employed has increased by more than 30% over the last 12 months from 148 000 to over 188 000 hours. This has resulted in the casual hours per tonne increasing from 45 to 65 hours per tonne. The dollar output per labour unit employed in the industry has decreased by 5% over the last 12 months. There has been a 6% decrease in full-time equivalents (FTE) employed in the industry. The FTEs have decreased from 323 to 304.

Table 6. Labour use on marine prawn farms in Queensland (2002–03 to 2004–05)

	2002–03	2003–04	2004–05
Permanent labour (tonnes–unit)	12.3	13.2	14.1
Total permanent (units)	234	247	206
Casual labour (hours/tonne)	60	45	65
Total casual labour (hours)	172 426	146 760	188 250
Full-time equivalent labour units	323	323	304
$ output per labour unit	$137 660	$147 162	$138 900

3.3 Hatchery sector

There were six marine prawn hatcheries in Queensland that only operated a hatchery facility and did not have growout ponds in the 2004–05 season. These hatcheries supply post-larvae to the growout sector of the industry. Responses were received from five hatcheries that produced banana, kuruma and black tiger post-larvae for the growout farms. They supplied 60% (10 million) of the kuruma postlarvae and 87% (123 million) of the other marine prawn post-larvae in 2004–05. This large increase from 86 million in 2003–04 was a result of the prawn farms with hatcheries having had difficulty producing much above their own requirements. The total value of production from these hatchery only operations in 2004–05 was $2.2 million, which compared with $1.4 million in 2003–04.

From the returns received, this sector employed 12 permanent employees (25 in 2003–04) and together with casual employees provides employment for 14 full-time equivalents (26 in 2003–04). Total output per labour unit in 2004–05 was $149 600 compared with $65 300 in 2003–04.

3.4 Kuruma prawn sector

3.4.1 Growout

Kuruma *(Penaeus japonicus)* production decreased by more than 30% from 112 tonnes in 2003–04 to 76 tonnes in 2004–05 while the value decreased by 35% to $3.7 million. The number of producing farms remained stable at five, while the area harvested decreased from 60 to 55 hectares and average yields decreased from 1885 kg/ha to 1370 kg/ha. The total ponded area on the farms decreased from 61 hectares to 55 hectares and the area stocked decreased from60 to 55 hectares. Stocking rates decreased from 37 prawns per square metre in 2003–04 to 27 per square metre.

The average price (CIF Japan) per kilogram has decreased by 3% from $50.96 to $49.23 per kg. In 2004–05 84% (69% in 2003–04) was marketed overseas, 16% interstate (29% in 2003–04) and nil in Queensland (2% in 2003–04).

Table 7. Kuruma production by aquaculturists in Queensland (2002–03 to 2004–05)

	2002–03	2003–04	2004–05
Total production (tonnes)	94.9	112.5	75.6
Average price ($/kg CIF Japan)	$56.54	$50.96	$49.23
Total value ($ million)	$5.4	$5.7	$3.7
Average yields (kg/ha/crop)	2900	1900	1400
Number of survey responses	5	5	5
Number of producing farms	4	5	5

The total feed consumed decreased from 488 tonnes in 2003–04 to 277 tonnes in 2004–05. Over this period the FCR improved from 4.3:1 to 3.7:1.

3.4.2 Hatchery production

From the hatcheries that responded an estimated 17.2 million PLs were produced in 2004–05 compared with four hatcheries producing 23.0 million in 2003–04. Table 8 illustrates the trends in hatchery production for kuruma prawns since 2001–02.

Table 8. Kuruma prawn hatchery production in Queensland (2002–03 to 2003–04)

	2002–03	2003–04	2004–05
Number of spawners purchased	360	636	494
Number of spawners used	307	512	460
Number of PLs produced (million)	14.0	23.0	17.2
Number of PLs stocked (million)	13.7	22.3	16.1
Number of PLs sold (million)	13.8	15.6	10.5
Value of PLs sold ($ million)	$0.22	$0.27	$0.17
Average value PLs (cents)	1.59	1.73	1.67

3.4.3 Labour

The kuruma growout farms employed 20 permanent labour units (13 in 2003–04) and produced 3.8 tonnes of prawns per labour unit (8.4 in 2003–04). Total casual labour has increased from 22 760 hours in 2003–04 to 24 920 hours in 2004–05. The number of full-time equivalents employed in the industry increased from 25 to 33. The gross output per labour unit decreased from $226 600 to $112 300 in 2004–05.

3.5 Industry development

The Australian Prawn Farmers Association (APFA) and the Department of Primary Industries and Fisheries collaborated in May 2005 to engage industry and other interested parties to discuss current and future issues for the prawn farming sector in Australia. The aim was to develop an industry development plan for the prawn sector through discussion papers and regional workshops. The workshops were conducted in Darwin, down the east coast of Queensland and at Yamba in northern New South Wales. Various priority issues were highlighted and appropriate actions developed to address them.

3.5.1 Media releases

In May 2005 the APFA Executive Officer, Scott Walter, supported the recent comments made by the Premier that Queensland is 'committed to better labelling and will do everything to enforce it'. The current legislation states that a label on a package containing food must include a statement relating to where the food was made, produced, or indicating if it is imported. Unfortunately, many producers are able to distort this requirement or, in some cases, not even adhere to the law.

3.5.2 Policies–Protocols

May 2005 Version 2 of The Aquaculture Translocation Protocol, *Health Protocol for the Importation of Selected Live Penaeid Species from outside Queensland's East Coast Waters* was released.

3.6 Achievements

A consortium of DPI&F, CSIRO, Australian Institute of Marine Science, the Australian Prawn Farmers' Association, individual farms and FRDC, has sustained 30 pedigreed families over three generations — a result unprecedented internationally. Improvements were noted for reproduction, health (viral load) and weight traits over the last two generations (data taken from same age animals across different generations). More details are provided in Section 12.5.4.

3.7 Publications

Lobegeiger, R. (1996). Proceedings of the Pond Management Workshop, Conference and Workshop Series QC 96003, Saleable Publication.

Robertson, C. (2001). International Advances in Prawn Farm Recirculation Technology, Information Series QO 01008.

Lobegeiger, R. (2003). Editor. Prawn Farm Bioremediation and Recirculation — Proceedings of Prawn Farm Workshops, Information Series QI 3038.

Robertson, C.H. Burford, M.A. and Johnston, A. (2003). Recirculating Prawn Farming Project, Final Report, Information Series QO 03014.

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

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

3.8 Further information

For further information on the prawn sector contact 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 increased by 19%. The product marketed (converted to a whole fish basis) was 1437 tonnes in 2004–05 compared with 1204 tonnes in 2003–04. Production from pond-based systems increased from 1179 to 1393 tonnes, while the production from recirculating tank systems increased from 25 tonnes to 44 tonnes.

The total value of barramundi production in Queensland increased by 18%, from $10.1 million in 2003–04 to $11.9 million in 2004–05. The average price (whole fish basis) decreased marginally from $8.36 to $8.30/kg. It should be noted that a significant proportion of the product is filleted on farm and therefore incurs some additional costs to the producer which are not deducted from the sales price.

In addition to growout production, hatcheries sold barramundi fingerlings to a value of $860 000 for growout, further sales for stocking and the aquarium trade are reported under Section 8.2.

4.2 Industry production

Of the 96 licence holders who responded, 28 produced marketable fish in 2004–05. This compared with 38 from 126 in the previous year. Some licence holders did not receive statistical returns as a result of database problems and many farms were contacted where possible to get estimates. Production came from 25 farms using pond-based systems and three using recirculating systems (Table 10).

One farm is now producing large quantities of filleted fish and to maintain confidentiality this product type has been reported together with whole fish. Whole fish (including filleted product) sales have increased by 18% from 1180 tonnes in 2003–04 to 1396 tonnes in 2004–05 while gilled and gutted sales decreased by from 7.8 tonnes to 4.3 tonnes. Live fish sales increased significantly (130%) from 15.9 tonnes to 36.5 tonnes in 2004–05 (Table 9).

Table 9. Quantity, product type and value of barramundi produced by aquaculturists (pond and recirculation) in Queensland from 2002–03 to 2004–05

	Expressed as whole fish equivalents (1)			
	Live	Gilled and gutted	Whole plus fillet	Total
Production (tonnes)				
2002–03	13.5	10.4	1170.5	1194.5
2003–04	15.9	7.8	1180.2	1203.9
2004–05	36.5	4.3	1396.1	1436.9
Total value ($)				
2002–03	$147 039	$118 750	$8 742 275	$9 008 064
2003–04	$167 466	$82 363	$9 834 473	$10 065 926
2004–05	$359 953	$51 977	$11 510 615	$11 922 546
Average price ($/kg) (3)				
2002–03	$10.86	$11.47	$7.47	$7.54
2003–04	$10.50	$10.53	$8.33	$8.36
2004–05	$9.86	$12.04	$8.24	$8.30

(1) To ensure consistent reporting, gilled and gutted as well as filleted fish are converted to whole fish equivalents

4.3 Ponded production

Total farm ponded area increased slightly with 162 hectares available in 2004–05 compared to 155 hectares in 2003–04; however, the number of available ponds remained unchanged at 338. The number of ponds stocked increased from 271 ponds in 2003–04 from 288 ponds in 2004–05, but during the same period the stocked area actually decreased marginally from 119 hectares to 118 hectares. The average pond area remained unchanged at 0.4 hectares.

The reported production from cages decreased from 41% in 2003–04 to 28% in 2004–05. The total area of cages decreased from 34 000 m^2 to 10 000 m^2 over the same period. The proportion of fish produced in cages has decreased over recent years due to a change in production focus from smaller plate size fish (which are usually caged) to larger free range fish. It has, however, become increasingly difficult to accurately determine the proportion of fish produced in cages as many farms producing the larger fish still use growout cages until they determine that the fish are large enough to be free-ranged. The average yield from cages increased from 14 kg per m^2 in 2003–04 to 39 kg per m^2 in 2004–05.

Table 10. Number of licensed barramundi farms and production levels in Queensland (2002–03 to 2004–05)

	2002–03	2003–04	2004–05
Ponds–Production (tonnes)	**No.**	**No.**	**No.**
0.01 to 1.0	8	5	5
1.1 to 10.0	7	10	3
10.1 to 50.0	10	11	11
50.1 to 100.0	1	1	2
More than 100.0	3	3	4
Number of producing farms	29	30	25
Number of non-producing farms	55	57	51
Total pond-based farms responding	84	87	76
Recirculating–Production (tonnes)	**No.**	**No.**	**No.**
0.01 to 0.10	1	1	0
0.11 to 0.50	2	0	0
0.51 to 1.00	1	3	0
1.01 to 5.00	1	2	0
More than 5.00	2	2	3
Number of producing farms	7	8	3
Number of non-producing farms	30	31	17
Total recirculation farms responding	37	39	20
Total number of responses	121	126	96
Number of farms surveyed	140	142	122

The number of fingerlings stocked in ponds increased from 2.45 million in 2003–04, to 5.33 million in 2004–05. The density at which fingerlings were stocked increased significantly from 21 000 fingerlings per hectare in 2003–04 to 45 000 in 2004–05.

Total feed use increased from 2610 tonnes to 2937 tonnes in 2004–05. Over the same period the estimated FCR improved from 2.2:1 to 2.0:1. Most feed (99%) was manufactured in Australia.

The amount of product from pond-based operations marketed interstate (76%) increased from 974 tonnes to 1063 tonnes while sales in Queensland (24%) increased from 207 tonnes to 330 tonnes and overseas sales declined from 6 tonnes (0.5%) to nothing.

4.4 Recirculating tank production

There were 42 farms licensed to use these systems. Statistical returns were received from 20 farms. Production from the 3 farms (8 in 2003–04) that produced marketable fish was 44.0 tonnes, which was 75% more than the 25.1 tonnes produced in 2003–04. Like the pond raised fish the majority of the tank-grown product is now marketed interstate. Interstate markets accounted for 77% of production in 2004–05, whereas in 2003–04 it was 43% and in 2002–03 it was only 13%. Queensland markets accounted for the remaining 23% as no product was sold overseas. Average price has declined over recent years from $11.05/kg in 2002–03 to $10.05/kg in 2003–04 to $8.54/kg in 2004–05. It would appear that a lower proportion of tank grown fish are now entering live and local niche markets and consequently the average price is now only marginally (3%) above the pond-raised price of $8.29/kg.

Table 11. Recirculating farm production information in Queensland (2003–04 and 2004–05)

	2003–04		2004–05	
Production	**tonnes**	**$**	**tonnes**	**$**
Live fish	10.6	$115 756	4.3	$44 548
Whole fish plus fillets (1)	11.8	$103 326	36.9	$296 616
Gilled and gutted (1)	2.7	$33 624	2.8	$34 545
Total	25.1	$252 706	44	$375 709
Physical farm information				
Number of tanks	9		102	
Total volume (m^3)	1781		1613	
Average volume (litres)	19 570		15 810	
Total fingerlings stocked	139 900		205 500	
Fingerlings stocked/m^3	79		127	
Feed used (kg)	37 300		62 300	
Estimated FCR	1.5:1		1.4:1	

(1) Gilled and gutted and filleted fish converted to whole fish equivalents

4.5 Fingerling production

Barramundi fingerling production increased from 5.2 million in 2003–04 to 6.5 million in 2004–05. Seven farms sold fingerlings for aquaculture during the year (see Section 8.2.5 of this report for restocking and aquarium sales). A total of 3.2 million fingerlings worth $860 000 were sold for growout (1.8 million worth $646 000 in 2003–04). Average fingerling price was 27 cents each in 2004–05 compared with 36 cents in 2003–04.

4.6 Farm labour

Permanent labour employed in the pond growout sector of the industry decreased from 94 units in 2003–04 to 86 units in 2004–05. Over the same period permanent labour in the recirculating farms decreased from 8 to 5. Productivity on the pond farms has increased from 10.3 tonnes of fish per unit in 2003–04 to 12.9 tonnes in 2004–05. Productivity in recirculating farms also increased from 3.1 tonnes per unit in 2003–04 to 5.7 tonnes per unit in 2004–05.

Total casual labour for the pond sector increased from 38 090 hours employed in 2003–04 to 42 660 hours in 2004–05. Casual labour on recirculating farms increased from 2670 hours in 2003–04 to 5100 hours in 2004–05. When the permanent and casual labour inputs are combined for both sectors, the total number of full-time equivalent labour units decreased

from 124 in 2003–04 to 116 in 2004–05. The $ output per labour unit for the pond sector increased from $85 800 in 2003–04 to $106 900 in 2004–05 while for the recirculating sector the output increased from $26 600 to $48 700 per unit.

4.7 Industry development

4.7.1 Barramundi Genetic Registrar

The Department of Primary Industry and Fisheries commissioned the University of the Sunshine Coast to develop a genetic register to distinguish different Queensland barramundi strains. Industry supported the initiative and samples were collected from hatcheries across Queensland by DPI&F staff. The samples are being analysed and a report prepared on the results. The register will be an aid to both the stocking and aquaculture sectors as the register will be a reference for:

- stocking groups who need to purchase specific strains; that is, stocking groups can identify who holds appropriate genetic broodstock for their region
- aquaculture operators to identify characteristics in culture strains
- hatchery operators, who may wish to target certain strains or combinations of strains to service their clients
- DPI&F to confirm compliance that the stocking program is being conducted in accordance with good genetic practice.

4.8 Publications

Curtis, M. and Wingfield, M. (2004). Recirculation Aquaculture Systems Information, Information Series QI 04047, Saleable Publication.

4.9 Further information

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5. Redclaw

5.1 General

Survey results indicate that growout production of redclaw crayfish (*Cherax quadricarinatus*) has increased by 8% with production increasing from 91.3 tonnes in 2003–04 to 98.6 tonnes in 2004–05. Over the same period the value of the industry has increased by 6% to $1.38 million. Included in the value of production is the value of non-food sales such as juvenile sales ($101 500), broodstock sales ($61 600) and sales to the aquarium trade ($22 600).

From the 222 returns mailed (224 in 2003–04) there were 169 responses (183 in 2003–04). Sixty three farms produced redclaw crayfish compared with 60 in the previous year (Table 12).

5.2 Growout

The number of pond-based farms that produced more than one tonne decreased from 19 in 2003–04 to just 11 in 2004–05. However, these 11 farms produced 85% of the state's production compared with 89% from 19 farms the previous year. One hundred and six farms that returned statistical returns did not produce product in 2004–05 compared with 123 in 2003–04.

Table 12 shows that after increasing for a number of years the average price obtained for redclaw crayfish has now decreased for the second consecutive year with the average price being 4% below that achieved in 2003–04. The average prices were $13.92 in 2002–03, $13.54 in 2003–04 and $12.98 in 2004–05. Prices ranged from $9.40 to $25.00/kg although most sold in the $12 to $15/kg range.

In addition to food sales there were 770 kg sold for broodstock in 2004–05 compared with 556 kg in 2003–04. The average price for broodstock increased from $16.19 per kg in 2003–04 to $22.47 per kg. There were 512 kg sold to the aquarium trade (557 kg in 2003–04) at an average price of $44.04 per kg ($39.32 in 2003–04).

Table 12. Number of licensed redclaw crayfish farms and production levels in Queensland (2002–03 to 2004–05)

	2002–03	2003–04	2004–05
Total production (tonnes)	75.3	91.3	98.6
Average price ($/kg)	$13.92	$13.54	$12.98
Total value ($'000)	$1.049	$1.236	$1.280
Ponds–Production (kg)	No.	No.	No.
1 to 100	12	18	17
101 to 500	24	16	26
501 to 1000	14	7	9
1001 to 5000	10	15	6
More than 5000	3	4	5
Number of producing farms	63	60	63
Number of non-producing farms	134	123	106
Number of responses	197	183	169
Number of farms surveyed	231	224	222

The total ponded area on farms increased marginally from 116 hectares (2003–04) to 118 hectares in 2004–05. Over the same period the area of stocked growout ponds increased from 68 hectares to 74 hectares and the pondage used for juvenile production has increased from 24 hectares to 28 hectares. The average pond size has increased from 1040 square metres to 1150 square metres.

Average farm productivity (calculated from harvested growout area) reached 1648 kg/ha in 2004–05. This is a 7% increase on the 2003–04 productivity (1545 kg/ha) and a 66.5% increase on the 990 kg/ha produced in 2002–03. The average yield for the 37 farms (also 37 in 2003–04) producing more than 200 kg was 1686 kg/ha (1855 kg/ha in 2003–04). From the 20 farms (26 in 2003–04) producing more than 500 kg the average was 2230 kg/ha (1813 kg/ha in 2003–04). For the 11 farms (19 in 2003–04) producing more than 1000 kg the average was 2789 kg/ha (2119 kg/ha in 2003–04) and for the 5 farms (4 in 2003–04) producing more than 5000 kg the average productivity was 3231 kg/ha (3182 kg/ha in 2003–04).

Average yields for the 11 farms producing over 1000 kg ranged from 1330 to 5760 kg/ha with nine of these farms producing over 2000 kg/ha. The number of farms producing less than 200 kg of product has increased marginally from 23 in 2003–04 to 24 in 2004–05.

Total feed purchased was 264 tonnes in 2004–05 compared with 212 tonnes the previous year. The estimated average feed conversion ratio increased from 2.3:1 in 2003–04 to 2.6:1 in 2004–05.

The local Queensland market share has remained at 54%, while interstate sales increased marginally from 42% in 2003–04 to 43% in 2004–05. Over the same period overseas markets decreased marginally from 4% to 3%.

5.3 Recirculating tank production

There has been no reported production in tank-based systems from 2002–03 to 2004–05.

5.4 Juvenile production

Juvenile production increased from the 3.4 million produced in 2003–04 to 4 million in 2004–05. Sales increased from 132 000 ($27 000) in 2003–04 to 233 000 ($63 000) in 2004–05. The number of juveniles stocked increased from 2.9 million (44 farms) to 3.6 million (43 farms) in 2004–05. Juveniles were produced in 209 ponds covering 27.7 hectares in 2004–05 compared with 251 ponds covering 23.8 hectares in 2003–04. Juvenile production ponds yielded an average harvest of 14.4 juveniles per m^2 in 2004–05 compared to 14.3 per m^2 in 2003–04. Over the same period the average stocking rate of juveniles into growout ponds increased from 4.3 per m^2 to 4.8 per m^2.

5.5 Labour

Total permanent labour employed increased from 43 units in 2003–04 to 51 units in 2004–05 while the total hours of casual labour used on farms decreased from 3224 in 2003–04 to 2046 in 2004–05.

In terms of labour efficiency the number of permanent labour units used to produce one tonne of crayfish has remained stable at 0.5 units in 2003–04 and 2004–05. The number of casual hours has decreased from 35 hours per tonne in 2003–04 to 21 hours in 2004–05.

When the permanent and casual labour inputs are combined the sector employs 52 full-time equivalent labour units compared with 44 the previous year. The value of product output per labour unit decreased from $27 900 per labour unit to $24 600 in 2004–05.

5.6 Publications

Jones C., Jones M. (2003). Bigger, Faster Redclaw, In: Wingfield MJ (ed). Proceedings of the Queensland Crayfish Farmers Association 4th Annual Redclaw Aquaculture Conference. Queensland Department of Primary Industries, Brisbane, Cairns, 82 p.

Wingfield, M. (2003). Proceedings of the 5th Annual Redclaw Conference—17 and 18 October 2003, Conference and Workshop Series, QC 04001, Saleable Publication.

O'Sullivan D., Fielder D. and Jones C. (2003), Chapter 20. Freshwater Crustaceans, In: Lucas JS, Southgate PC (eds). Aquaculture: Farming Aquatic Animals and Plants. Blackwell Publishing, Oxford, pp 420–442.

Macbeth M., McPhee C., Burke M., Bartlett J., Jones C. and Knibb W. (2003). Genetic selection of aquatic organisms including prawns with a special focus on the way to integrate a breeding programme into private industry. In: Goarant C, Harache Y, Herbland A, Mugnier C (eds). Styli 2003. Thirty years of shrimp farming in New Caledonia. IFREMER, New Caledonia, pp 106–112.

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

5.7 Further information

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6. Freshwater fish

6.1 General

This section examines fish (other than barramundi) raised in fresh water for human consumption. Species that have been cultivated over the last few years include silver perch (*Bidyanus bidyanus*), jade perch or Barcoo grunter *(Scortum barcoo)*. More recently there has been interest in the growout production of Murray cod *(Maccullochella peelii peelii),* sleepy cod *(Oxyeleotris lineolatis),* sooty grunter *(Hephaestus fuliginosus)* and golden perch *(Macquaria ambigua)*.

Statistical returns were mailed to 137 licensed freshwater fish producers and 108 were returned. Ninety six respondents used pond-based systems and 12 used recirculating tank systems. Many of the authority holders have a number of different species on their approval. The total production of the freshwater fish sector increased from 95.3 to 104.7 tonnes, with the value increasing from $746 500 to $901 900. In 2004–05 silver perch accounted for 60% of freshwater fish production, jade perch 29% and other species 11%, whereas in 2003–04 silver perch accounted for 59%, jade perch 40% and other species 1%.

6.2 Silver perch

Statistical returns were mailed to 131 authorised silver perch producers and 98 were returned. Twelve licence holders produced and sold silver perch in 2004–05. All of the 12 producing farms used pond-based system rather than tank-based recirculation systems. In 2003–04 fifteen pond-based farms produced silver perch with additional production coming from two tank-based operations.

The value of production ($516 300) for the silver perch sector in 2004–05 was a 15% increase over the previous year. Over the last twelve months the average price (whole fish basis) also increased by 3% from $8.05 to $8.26 per kilogram (Table 13).

Table 13. Silver perch production by aquaculturists in Queensland (2002–03 to 2004–05)

	2002–03	2003–04	2004–05
Total production (tonnes whole fish basis)	43.4	55.8	62.5
Average price ($/kg)	$7.75	$8.05	$8.26
Total value ($'000)	$336	$449	$516
Average yield (kg/ha)	2500	3600	4600
Number of survey responses	113	104	98
Number of producing farms	17	17	12

6.2.1 Pond systems

The total ponded area on producing farms decreased from 39 hectares in 2003–04 to 23 hectares in 2004–05. The total area stocked to silver perch decreased from 22 hectares in 2003–04 to 16 hectares in 2004–05. Over this same period the number of fingerlings stocked decreased from 509 300 to 402 600. The average stocking rate increased to 25 800 per hectare in 2003–04 compared with 23 000 per hectare in 2003–04.

The area harvested has decreased from 15 hectares in 2003–04 to 13.5 hectares in 2004–05.

Total food used increased from 207 tonnes in 2003–04 to 245 tonnes in 2004–05. Over this same period the FCR increased marginally from 3.8:1 to 3.9:1.

6.2.2 Recirculation systems

There were 22 farms utilising tank-based recirculation systems authorised for silver perch production. None of these farms reported any production of marketable product in 2004–05 whereas two farms produced marketable product in 2003–04.

6.3 Jade perch

Statistical returns were mailed to 63 licensed jade perch producers and 46 were returned. Previously, pond-and tank-based systems have been used for production; however, in 2004–05 all jade perch production came from pond-based systems. Table 14 combines production from both pond and recirculating tank systems.

Table 14. Jade perch production by aquaculturists in Queensland (2002–03 to 2004–05)

	2002–03	2003–04	2004–05
Total production (tonnes whole fish basis)	48.6	38.5	30.8
Average price ($/kg)	$7.19	$7.69	$8.42
Total value ($'000)	$350	$296	$259
Average yield (kg/ha)	6600	5700	3950
Number of survey responses	40	51	46
Number of producing farms	14	10	7

From the responses received seven licence holders produced and sold jade perch in 2004–05 compared with 10 farms in 2003–04. Total production decreased by 20%, for the second consecutive year, from 38 519 kilograms in 2003–04 to 30 750 kilograms in 2004–05. Live product sales remained at 46% of the total product sold.

The total value of sales fell by 12% to $258 800, while the average price increased by 9% from $7.69 per kilogram in 2003–04 to $8.42 per kilogram in 2004–05. Interstate sales accounted for 72% of the product sold (64% in 2003–04), with the balance (28%) sold in Queensland.

6.3.1 Pond systems

The total ponded area on farms increased from 10 hectares in 2003–04 to 11.1 hectares in 2004–05. Over the same period the total area stocked to jade perch decreased marginally from 10 hectares to 9.6 hectares. In 2004–05 the number of fingerlings stocked in ponds was 218 500 compared with 176 000 in 2003–04. Over the same period the average stocking rate increased from 17 600 per hectare to 22 900 per hectare.

Total food used decreased from 104 tonnes in 2003–04 to 73 tonnes in 2004–05 while the FCR improved slightly to an estimated 2.4:1 (2.7:1 in 2003–04).

6.3.2 Recirculation systems

No jade perch production was reported from recirculating tank systems in 2004–05.

6.4 Other species

Other species licensed for production in both ponds and recirculation systems include Murray cod, golden perch, sleepy cod, Australian bass, rainbow trout and sooty grunter. The relatively small quantities produced and the limited number of producers means that detailed information cannot be provided in this report for confidentiality reasons. Total production for these species

has, however, increased significantly from just under 1 tonne in 2003–04 to 11.4 tonnes in 2004–05 valued at $126 900. Most of this production consisted of Murray cod with a significant amount of golden perch.

6.5 Labour (silver and jade perch and other freshwater species)

The total number of permanent labour units in the freshwater fish growout sector has decreased from 25 in 2003–04 to 16 in 2004–05 (10 silver perch, 3 jade perch and 3 for the other species). For silver perch the output has increased from 3.8 tonnes per unit in 2003–04 to 5.5 tonnes per unit in 2004–05. Over the same period jade perch production increased from 5.2 tonnes per unit to 8.3 tonnes.

Combined casual labour for all freshwater species was 2500 hours compared with 4300 hours in 2003–04. The total full-time equivalents for the freshwater sector were 18 units in 2004–05 compared with 28 units in 2003–04.

The dollar output per labour unit for silver perch increased significantly from $30 400 in 2003–04 to $45 200 in 2004–05 and for jade perch it also increased substantially from $40 000 per labour unit to $70 200.

6.6 Further information

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7. Eel culture

7.1 General

Production from the eel aquaculture industry in Queensland continues to decrease with production falling by 10%. A total of 42.7 tonnes of eels were sold in 2004–05, compared with 47.2 tonnes in 2003–04. The two species of eels that are being cultured are the long-finned eel (*Anguilla reinhardtii*) and the short-finned eel (*Anguilla australis*).

Of the 31 farms licensed for eel production 23 farms responded to the survey. Product was sold from five farms compared with four farms in 2003–04. Although production fell by 10% the total value of sales increased by 10% from $517 000 in 2003–04 to $569 000 in 2004–05 due to a 22% increase in the average price obtained for eels.

Production was obtained from a combination of 22 ponds on five farms covering 5.2 hectares and from 28 tanks on three farms with an average volume of 6300 litres. Fifty-eight tonnes of feed (89 tonnes in 2003–04) was used with it all being produced in Australia. The average FCR was 1.4:1 compared with 1.9:1 in 2003–04.

Over the last two years, all eels produced were exported and marketed live. Table 15 summarises the farm pond and tank descriptions, stocking details and production for the last three seasons.

Table 15. Eel farm stocking by aquaculturists in Queensland (2002–03 to 2004–05)

	2002–03	2003–04	2004–05
Ponds—Total area (ha)	13.0	7.1	5.2
—Average area (m^2)	2900	2030	2350
Tanks —Total volume (m^3)	128	96	176
—Average volume (litres)	4900	3900	6300
Stocking—Elvers (kg)	0	0	0
—Glass eels (kg)	47.1	87.6	97.4
Total production—(tonnes)	57.4	47.2	42.7
—($)	$590 391	$517 000	$568 812
Average price—($/kg)	$10.26	$10.95	$13.33

7.2 Labour

The industry has nine permanent staff (seven in 2003–04) and employed 154 hours of casual labour. This equates to nine full-time equivalents employed in the industry which was the same as in 2003–04. The estimated dollar output per labour unit was $65 500 compared with $57 200 in 2003–04.

7.3 Industry development

Substantial progress is continuing with regard to the new management arrangements for collection of juvenile eels.

7.4 Further information

Gooley, G.J. and Ingram, B.A. (Editors) (2002). Assessment of Eastern Australian Glass Eel Stocks and Associated Eel Aquaculture, Final Report FRDC Project No 97–312.

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8. Hatchery and aquarium

8.1 General

Sixty-one freshwater fish hatcheries were surveyed and responses were received from 56. The hatcheries produced a wide range of fish for use in aquaria, commercial growout ponds and stocking in public impoundments. Table 16 summarises statistics for the major species produced in 2003–04 and 2004–05.

The total value of this sector increased by 36% from $2.5 million in 2003–04 to $3.4 million in 2004–05. Sales of fingerlings for the total hatchery sector increased by 10%, from 8.6 million in 2003–04 to 9.5 million in 2004–05. Barramundi sales increased by more than 90%, while golden perch sales also increased by 18%. Australian bass sales decreased by 58% following strong sales the previous year. Cod species (Murray, Mary River and sleepy) also decreased by over 30%.

The hatchery sector has been expanding over the last two years to include a number of hatcheries producing a range of marine species for the aquarium trade, commercial growout and for stocking. They are reported in Table 16 as either 'marine aquarium' or 'marine hatchery'. There were 8 marine farms surveyed and responses were received from 4 farms. Species covered in these groups include oyster and pearl oyster spat, marine aquarium fish, corals, sandfish, mullet and mangrove jack. Hatchery production of species used for both farm growout operations, restocking and aquarium use are all included in Table 16.

With the exotic ornamental species there was very little change in the numbers sold compared with the previous year. Livebearers and gold fish sales were relatively stable.

8.2 Stocking and growout species

8.2.1 Silver perch

Silver perch (*Bidyanus bidyanus*) fingerling production was undertaken by 7 hatcheries (9 in 2003–04) and increased from 0.79 million to 1.03 million fingerlings in 2004–05. The number sold increased by 12% to 860 000. The sales were directed to both growout operations (490 000 valued at $59 000) and stocking of impoundments (327 000 valued at $54 000). All silver perch fingerlings were sold in Queensland in 2004–05 compared with 93% in 2003–04.

8.2.2 Golden perch

Golden perch (Macquaria ambigua) fingerling production was undertaken by in 6 hatcheries (6 in 2003–04). Production increased from 1.48 million to 1.86 million. Sales increased by 39% to 1.74 million. Once again significant sales of 150 000 fingerlings valued at $29 000 were made to the growout sector compared with 130 000 in 2003–04. Unfortunately there was no successful production Lake Eyre strain of golden perch fingerlings in 2004–05 even though they had been available in 2003–04. All fingerlings were sold in Queensland.

8.2.3 Australian bass

Australian bass (*Macquaria novemaculeata*) were produced primarily for impoundment stocking. Production occurred in 3 hatcheries. Production declined from 1.9 million in 2003–04 to 0.8 million in 2004–05. Sales also decreased dramatically from 1.8 million to only 406 000 in 2004–05. All fingerlings were sold in Queensland. Approximately 30 000 valued at $12 000 were sold to the growout sector in 2004–5 compared with none the previous year.

Table 16. Hatchery production of native fingerlings and ornamental aquarium species in Queensland 2003–04 and 2004–05

Species	2003–04			2004–05		
	Sales (No.)	Value ($)	Av ($)	Sales (No.)	Value ($)	Av ($)
Australian bass	1 825 000	284 900	0.16	405 700	152 000	0.37
Barramundi	2 130 800	768 400	0.36	4 059 650	1 227 060	0.30
Golden perch	1 473 000	262 700	0.18	1 736 000	301 100	0.17
Jade perch—Barcoo grunter	480 200	92 000	0.19	416 800	86 200	0.21
Murray cod, Mary cod and sleepy cod[1]	244 400	126 000	0.52	153 800	106 200	0.69
Saratoga (aquarium and stocking)	1473	40 960	27.80	1378	42 600	30.93
Silver perch	730 900	132 000	0.18	816 400	113 100	0.14
Ornamental (exotics)						
Goldfish	158 200	88 640	0.56	156 750	88 180	0.56
Live bearers	346 800	121 670	0.35	405 500	153 640	0.38
Egg layers	1 070 000	360 850	0.34	924 300	381 540	0.41
Ornamental (natives)						
Rainbows	30 750	43 400	1.41	35 200	52 800	1.50
Feeders and others	24 000	30 500	1.27	121 500	37 700	0.31
Barramundi	18 300	13 300	0.73	27 200	27 200	1.00
Other natives[2]	35 100	24 400	0.70	196 900	136 900[3]	0.19
Marine aquarium[4]	[5]	34 800		[5]	66 750	
Marine hatchery[6]	[5]	63 000		[5]	438 290	
Total (returns received)	**8.57 m**	**$2.5 m**		**9.46 m**	**$3.4 m**	

Note:

1. Species combined as insufficient producers to maintain individual confidentiality.
2. Species for private use—Australian bass, golden perch, sleepy cod, Mary River cod, silver perch, tandanus, macrobrachium, mangrove jack and lungfish.
3. Lungfish Included in 'species for private use' category for first time 2004–05.
4. Combines a number of different phyla so not appropriate to include numbers.
5. Includes oyster and pearl oyster spat, mangrove jack and mullet.

8.2.4 Jade perch

Jade perch or Barcoo grunter *(Scortum barcoo)* production came from 4 hatcheries in 2004–05. All sales were to the farm growout sector. Sales in 2003–04 were 480 000 but this decreased by 13% to 417 000 in 2004–05, which was similar to sales in 2002–03. The majority of fingerlings (62%) were sold in Queensland while interstate sales increased slightly and overseas sales remained relatively stable.

8.2.5 Barramundi

Barramundi *(Lates calcarifer)* fingerlings are produced for growout farms, stocking impoundments and the aquarium trade. The majority of fingerlings were sold to growout farms with 3.2 million sold for $860 000 in 2004–05. The number of fingerlings sold for stocking more than doubled from 325 000 valued at $120 000 to nearly 900 000 valued at $370 000 over the last year. Sales to the aquarium trade increased by 50% to 27 000.

8.2.6 Murray cod, Mary River cod and sleepy cod

Murray cod, Mary River cod (*Maccullochella* sp.) and sleepy cod (*Oxyeleotris* sp.) sales were combined to maintain confidentiality of the information for the small number of producers supplying these fish. Sales for these species decreased from 244 000 in 2003–04 to 154 000 in 2004–05. Approximately 10% of the fish were sold interstate. It is also estimated that 35% or 55 000 valued at $75 00 were stocked for growout on farms.

The hatchery operations that produced the seven species listed above utilised 150 ponds in 2004–05 compared with 206 ponds in 2003–04. They covered an area of 30.7 hectares compared with 40.6 hectares in 2003–04. The average pond area increased from 1950 m^2 to 2050 m^2.

8.3 Aquarium and ornamental fish

Sales destinations in 2004–05 were as follows: Goldfish—62% in Queensland (Q) and 38% interstate (I), Livebearers—70% (Q) and 30% (I), Egg layers—49% (Q) and 51% (I), Rainbows—62% (Q) and 38% (I) and other natives—45% (Q) and 55% (I). In 2004–05 61% of the exotic species (61% in 2003–04) were sold in Queensland. The numbers of hatcheries producing live bearers increased from 8 farms to 10 farms and hatcheries producing egg layers declined from 14 farms to 13 farms.

The production of Saratoga (*Scleropages* spp) fingerlings decreased from 1473 in 2003–04 to 1378 in 2004–05. There were seven growers in 2004–05 compared with six in 2003–04. Their average sale prices were $31.40 in 2002–03, $27.81 in 2003–04 and $30.93 in 2004–05. Forty three percent (46% in 2003–04) of sales were in Queensland, 0% interstate (24% in 2004–05) and 57% overseas (30% in 2003–04).

The aquarium and ornamental farms decreased from 628 ponds in 2003–04 to 454 ponds in 2004–05 as a result of one large farm surrendering its licence. They covered an area of 22.9 hectares compared with 14.6 hectares in 2003–04. The average area increased from 200 m^2 to 500 m^2. There were 1115 tanks on the farms in 2004–05 compared with 1625 tanks the previous year. The average tank volume increased from 620 litres to 720 litres in 2004–05.

8.4 Labour

Statistics for this sector now include the marine hatcheries and the sector now has 67 permanent staff (61 in 2003–04) and employed 13 200 hours of casual labour. This equates to 74 full-time equivalents employed in the industry, which was an increase of six units from 2003–04.

The aquarium industry sector productivity increased from $20 000 per labour unit in 2003–04 to $38 000 in 2004–05, whereas the native fish sector decreased from $69 700 in 2003–04 to $54 500 in 2004–05.

8.5 Further information

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9. Edible oyster production

9.1 General

Changes to the system for licensing aquaculture oyster production in Queensland have resulted in only the oyster production from approved areas being reported in this report.

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

A total of 111 Oyster Areas licensed for aquaculture purposes were surveyed during 2004–05 with 98 statistical returns received. The total production in Queensland has increased by 8% from 197 700 dozen in 2003–04 to 213 300 dozen in 2004–05. The value of the industry has increased by 7% to $736 000. The average price per dozen oysters decreased marginally from $3.48 to $3.45 per dozen.

Table 17. Edible oyster aquaculturists in Queensland (2002–03 to 2004–05)

	2002–03	2003–04	2004–05
Number of oyster areas surveyed	108	109	111
Number of responses	94	98	98
Production (dozens)	**No. of areas**	**No. of areas**	**No. of areas**
Nil	62	71	64
1 to 500	10	14	10
501 to 1000	5	4	4
1001 to 2000	3	5	6
2001 to 500	5	6	7
5001 to 10 000	2	4	2
More than 10 000	7	5	5
Total producing oyster areas	**32**	**38**	**34**

Oyster sales are one measure of change in an industry. To provide other indicators on industry performance the numbers of shells introduced on to the authorised areas and the stock on hand have been collected for the first time in 2004–05. Introductions for the year was 426 000 shells, while the stocks on hand at 30 June 2005 was estimated to be 620 000 shells. Over the 2004–05 period growers estimated losses at 310 500 dozen. Losses were due to deaths and theft.

Table 18. Edible oyster production in Queensland (2002–03 to 2004–05)

	2002–03	2003–04	2004–05
Production ('000 dozen)	202.5	197.7	213.3
Value ($'000)	$624.3	$687.5	$736.0

Oysters are sold in a range of different sizes to meet the market requirements. The majority of oysters (97.5%) are sold in Queensland with 0.9% sold interstate and 1.6% overseas. Overseas sales were only plate size oysters.

The three main size oysters marketed are bistro, bottlers and plate size. The following table (Table 19) summarises the different product types, average prices and the percentage of each product type. Bottlers make up nearly 70% of the product marketed at an average price of $2.80 per dozen. The highest value product ($6.76 per dozen) is the plate size and they make up about 10% of the product sold. Bistro oysters at $4.21 per dozen accounts for nearly 20% of production.

Table 19. Edible oyster marketing information—Queensland for 2003–04 and 2004–05

Packaging type	2003–04		2004–05	
	Price per dozen ($)	Market (%)	Price per dozen ($)	Market (%)
Bottlers	$2.81	69.1%	$2.79	69.4%
Bistro	$3.33	9.0%	$4.21	18.9%
Plate	$6.44	17.8%	$6.76	9.7%
Others	$2.24	4.1%	$1.99	2.1%
Average return-all oysters	**$3.48**		**$3.45**	

9.2 Labour

Total permanent labour employed in the industry was 18 units (29 in 2003–04) while total casual employment was 2890 hours (3100 in 2003–04). This converts to 20 full-time equivalents employed in the industry, which was down 10 from 30 from the previous year.

In terms of labour efficiency the production per Full-time Equivalent (FTE) was 11 600 dozen compared with 6500 in 2003–04. Total industry output nearly doubled from $22 700 per labour unit in 2003–04 to $36 900 per labour unit in 2004–05.

9.3 Industry development

An industry development plan was developed for the Queensland oyster industry following an industry–Government workshop in August 2004. The plan was developed by the Queensland Oyster Growers Association in collaboration with the DPI&F and identified a number of key issues restricting growth of the Queensland rock oyster industry and included a range of action items aimed at encouraging the expansion of the sector.

A number of these action items have been progressed by QOGA and DPI&F throughout the year. A QX information brochure has been published and distributed to oyster growers to increase awareness of this disease. Significant progress has been made with the development of a policy aiming to address the issue of the large number of non-productive oyster areas. The policy will establish minimum levels of development and production that are expected from an oyster area and aims at increasing overall production of the industry. Development of an oyster industry management plan for Moreton Bay Marine Park has also started. It is envisaged that the plan will reduce duplication of licensing and administration for oyster approvals.

9.4 Publications

Queensland Oyster Industry Development Plan (2005) available on the website http://www2.dpi.qld.gov.au/fishweb/16413.html
QX Disease—Information Brochure (2004)

9.5 Further information

John Dexter (Industry Development and Policy Officer) on (07) 3224 2248 or john.dexter@dpi.qld.gov.au

10. Pearl oyster culture

10.1 General

The value of the pearl oyster industry in Queensland continues to fluctuate as some of the farms rebuild stocks of nucleated pearls. Two farms reported information this year and consequently the production information cannot be disclosed for confidentiality reasons. The value of the industry has been included in the sundry category throughout the report.

Fourteen Pearl Culture Areas (PCAs) were surveyed and responses were received for eight of these areas. One of the farms that responded has four authorised areas but has not started production.

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

10.2 Labour

A total of 12 permanent labour units were involved in the industry in 2004–05 compared with 21 in 2003–04. Total casual hours employed in the industry increased from 22 528 in 2003–04 to 42 680 in 2004–05. The total full-time equivalents employed in the industry increased from 33 to 35.

10.3 Further information

John Dexter (Industry Development and Policy Officer) on (07) 3224 2248 or john.dexter@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 the results only summarise the information collected from the returned 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 who respond and this can affect the trends. Rounding errors can cause minor discrepancies in some of the totals.

Table 20. Response rates—Queensland (2002–03 to 2004–05)

	2002–03	2003–04	2004–05
Number of licensed producers (no.)	593	654	655
Questionnaires mailed (no.)	879	918	777
Questionnaires received (no.)	771	784	638
Response rate (%)	88%	85%	82%

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

The total farmgate value of production is highly dependent on marine prawns, which contributes approximately 70% (80% in 2003–04) of the total value and 65% (75% in 2003–04) of the total quantity of product sold. Four divisions (Northern, Far Northern, Moreton and Mackay) account for the majority of the production. The Wide Bay division also has significant production.

The largest decreases in industry value occurred in the Moreton (–26%) and Northern (–25%) as a result of decreased marine prawn production while the Far Northern increased (+20%) as a result of increased barramundi production.

Table 21. Farm gate value ($ million)—Queensland (2002–03 to 2004–05)

Statistical division	2002–03	2003–04	2004–05
Brisbane	$0.67	$0.00	$0.00
Moreton	$13.07	$15.20	$11.99
Wide Bay	$6.04	$6.09	$5.73
Darling Downs	$0.16	$0.28	$0.26
Fitzroy	$0.25	$0.58	$0.55
Central West	$0.00	$0.00	$0.00
Mackay	$10.69	$7.65	$7.62
Northern	$20.46	$25.41	$19.00
Far Northern	$14.42	$17.27	$22.25
Total	**$66.76**	**$72.48**	**$67.40**

Table 22. Total production (tonnes)—Queensland (2002–03 to 2004–05)

Statistical division	2002–03	2003–04	2004–05
Brisbane	0	0	0
Moreton	631	722	628
Wide Bay	243	268	264
Darling Downs	20	24	21
Fitzroy	16	21	26
Central West	0	0	0
Mackay	584	516	515
Northern	1395	1748	1355
Far Northern	1486	1500	1826
Total	**4375**	**4799**	**4635**

Mackay, Far Northern and Northern divisions have the majority of the ponded areas in Queensland with Wide Bay and Moreton also having significant areas.

Table 23. Total ponded area (hectares)—Queensland (2002–03 to 2004–05)

Statistical division	2002–03	2003–04	2004–05
Brisbane	0	0	0
Moreton	181	172	180
Wide Bay	143	149	143
Darling Downs	11	22	17
Fitzroy	30	19	22
Central West	0	0	0
Mackay	289	262	239
Northern	277	345	267
Far Northern	296	262	309
Total	**1227**	**1231**	**1177**

The largest employment occurs in the Moreton, Mackay, Northern and Far Northern divisions with the Mackay and Wide Bay divisions having significant levels of employment. Total employment has fallen by 4% over the last 12 months.

Table 24. Total employment (full-time equivalents)—Queensland (2002–03 to 2004–05)

Statistical division	2002–03	2003–04	2004–05
Brisbane	0	0	0
Moreton	155	148	122
Wide Bay	68	88	92
Darling Downs	9	8	4
Fitzroy	15	16	7
Central West	0	0	0
Mackay	71	64	53
Northern	157	174	196
Far Northern	137	219	212
Total	**612**	**717**	**686**

12. Specialised Areas—Status Report

12.1 Aquaculture policy and industry development

In the latter half of 2004 a major policy was released which contained a number of significant high risk activities relevant to aquaculture production.

The policy was titled *Management Arrangements for Potential High-Risk Activities in the Context of Environmentally Sustainable Development (ESD) for Aquaculture Facilities; FAMOP001*. Within this document were the following:

- Translocation of Live Aquatic Organism
- Management Arrangements for Flood Prone Land
- Management Arrangements for Exotics
- Management Arrangements for Barramundi in Inland Catchments
- Management Arrangements for use of Aquaculture Product for Bait.

The objective of this policy is to assist in achieving the main purpose of the *Fisheries Act 1994* and to protect fisheries resources by minimising the risk of translocation of aquacultured fisheries resources into natural waterways, particularly where they:

- are non-indigenous to the area
- have the potential to impact on of wild populations
- minimise the risk of introducing disease agents into wild populations
- minimise the socio-economic impacts that may result from the above risks.

12.2 Site identification for aquaculture

DPI&F has prepared a guideline to assist existing industry and new investors in assessing and controlling the risk of chemical contamination to aquaculture enterprises. The guideline outlines a minimum 11-step approach, including recommended actions, which should be undertaken when determining the suitability of a specific site for aquaculture to reduce potential risks from residues and contaminants.

Residues and contaminants represent an unseen risk to any aquaculture development. Therefore, determining the suitability and safety of a specific aquaculture site with regard to chemical residues is vitally important. In many cases the main concern is not the direct short-term toxic effects of residues or contaminants, but rather the indirect effects on product quality, food safety, and market access that may arise through bio-magnification processes.

Contamination sources commonly arise from current and/or previous land use practises on or around a given site. The most likely sources of exposure to contamination come from contaminated soil and water, or accidental exposure from unrelated activities.

The guideline is available for download from http://www.dpi.qld.gov.au or by contacting the DPI&F Call Centre on 13 23 25.

12.3 Wildlife management

Recent events have increased industry awareness of the potential consequences resulting from the unauthorised and inappropriate destruction of native wildlife.

Aquaculture proponents need to be aware of their legal responsibilities regarding the control of native birds and animals, as severe penalties apply for inappropriate behaviour.

The following information sheet on wildlife management and the steps required to gain a Damage Mitigation Permit has been provided by the Environmental Protection Agency.
Application forms for Damage Mitigation Permits can be downloaded from:
http://www.epa.qld.gov.au/ecoaccess/plants_and_animals/
or by calling 1300 368 326.

12.4 Research and development team

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

12.4.1 Who are we?

The team includes approximately 42 scientists and their technical support staff located across the three DPI&F centres:

- Northern Fisheries Centre, Cairns (NFC)—19 scientific staff
- Freshwater Fisheries and Aquaculture Centre, (FFAC), Walkamin—4 scientific staff
- Bribie Island Aquaculture Research Centre (BIARC)—19 scientific staff

Work is also conducted on industry facilities.

12.4.2 What do we do?

Conduct quantitative and molecular approaches to improve the performance of aquaculture species, including:

- the selective breeding of prawns and barramundi
- moulting control of soft-shell crabs and sex-change control of barramundi
- Investigate water use and environmental management systems
- water use efficiency, cleaning of waste water (remediation) by animal or plant species or mechanically
- recirculation with marine, fresh and artesian aquaculture systems
- investigating and developing 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 unutilised water sources for aquaculture
- coal seam gas water
- seeking to domesticate various aquaculture species to allow intensification and potential for land-based rearing
- reef fish, tropical rock lobster, crabs (and scallops at sea)
- assessing 'new' and alternative species for future potential, e.g. tropical abalone, oyster, giant freshwater prawn and various fish
- supporting sustainable aquaculture
- technology for sea cucumber production in the Pacific region and northern Australia
- improving hatchery practices in PNG and northern Australia
- exporting technology in the form of training.

12.5 Research and development outcomes

12.5.1 Wastewater remediation

Research into aquaculture wastewater remediation now falls within the DPI&F Sustainable Intensive Systems Program. Research has been directed towards reducing nutrient discharge from ponded systems, with the overall objective being to economically convert and trap nutrients in forms that can be harvested from the water body.

Duckweed-based wastewater treatment (DWT) was trialled as part of the 2004–05 Inland Prawn project. An average of 985 kg of (wet weight) duckweed biomass was harvested from each treatment pond over six weeks, equating to a net removal of nitrogen and phosphorous from the system while improving water quality to enable recirculation. Further evaluation of DWT, including refinement of large-scale harvesting techniques and duckweed reuse options, are proposed for the trial of partitioned barramundi production systems. (See Section 12.5.3)

Other work has focused on marine wastewater treatment that combines the functional role of plant and animal nutrient sinks with mechanical water filtration devices. Marine polychaete (worm) assisted sand filtration and high flow rate algal systems are being evaluated. In addition, the bacterial processing of post-production wastewater, similar to the activated sludge systems used in traditional sewage treatment, is being developed for marine aquaculture conditions. Finally, trials have commenced in partnership with a manufacturing company to test and develop a modular water purification system for prawn farms.

Willett, D. (2005). Duckweed-based Wastewater Treatment Systems: Design Aspects and Integrated Reuse Options for Queensland Conditions, Information Series QI 05019.

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

12.5.2 Assessment of lotus 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 through allowing concentration of fish in particular areas permitting increases in feeding, harvesting and protection procedures.

This project has just commenced with sowing of native lotus seeds in ponds stocked with barramundi in January 2006. Preliminary assessment of the capabilities of lotus in extensive fish production systems suggested a high potential to assimilate nutrients.

This is a new project initiative supported by 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 Aquaculture Association of Queensland and is working in conjunction with an industry partner (Daintree River barramundi). This project uses the pond facilities of the FFAC, Walkamin.

For further information contact Brett Herbert (Fisheries Biologist) on (07) 4092 9913 or brett.herbert@dpi.qld.gov.au

12.5.3 Bioremediation for aquaculture in northern Australia and Papua New Guinea

This new project was developed with the Australian Barramundi Farmers Association (ABFA) and aimed to investigate and compare two plant-based partitioned systems and evaluates fish carrying capacity limitations of these partitioned systems. It was a joint proposal with FFAC, Walkamin and BIARC. Elements of this proposal have funding support from the Australian Centre for International Agriculture Research (ACIAR).

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, as detailed in 12.5.2 of this publication. This project also intends to investigate other methods currently being developed at BIARC, including bacterial floc and mechanical filtration techniques for water treatment on a pond scale.

For further information contact Brett Herbert (Fisheries Biologist) on (07) 4092 9913 or brett.herbert@dpi.qld.gov.au

12.5.4 Black tiger prawn genetic improvement

During the last two decades, there were various attempts to close the lifecycle of the black tiger prawn *(Penaeus monodon)*. No group was able to do this with numbers sufficient to permit a genetic program without severe inbreeding. A consortium of DPI&F, CSIRO, Australian Institute of Marine Science, the Australian Prawn Farmers' Association, individual farms and FRDC, has sustained 30 pedigreed families over three generation—a result unprecedented internationally. The following report reflects the contribution of all parties.

The pedigree is maintained by both physical and molecular DNA tags. This has created a platform for genetic improvement of a number of traits. Improvement in a number of these economic traits has occurred over the last two generations. This positive situation is in contrast with the results of the previous 15 years of research on *(P. monodon)* where the lifecycle was not closed without severe inbreeding, and where fertility levels as assessed by various criteria— also growth rates and survival—had not improved at all for captive stocks. Previously, fertility levels were so low that is was not economically viable for farms to use captive stock as broodstock.

Improvements were noted for reproduction, health (viral load) and weight traits over the last two generations (data taken from same age animals across different generations). An accurate assessment of the contribution genetics makes to these improvements will be done in August 2006 on-farm by comparing selected with wild unimproved stock. Heritabilities for growth, survival, and some fertility traits are approximately 0.5.

Fertility: No intentional selection was undertaken for fertility; however, 'natural' domestication selection for fertility may have resulted in selection response. The number of eggs per spawn, nauplii per spawn and % females that spawn, all showed fairly large improvements in fertility traits over the last two generations. Industry assesses these improvements as large enough to justify industrial uptake.

Growth: The modest improvements in growth for same age males and females across generations are consistent with the weak selection imposed for growth.

Survival and disease status: While no deliberate selection was made for survival, less than one in ten PLs survive to take part in reproduction, giving much scope to natural selection for survival in captivity. From generation two to three, survival to broodstock more than doubled from 12% to 26%. The presence of gill associated virus (GAV) is thought to correlate with mortality, and it is very clear that the level of GAV has declined dramatically, from 100% to 0% incidence over the three generations.

Variation: There is substantial variation for between family estimated breeding values predicted for the present generation in terms of grams deviation from zero, suggesting that if between family selection can be applied, selection response can, in future, be accelerated.

From 100 to 2000 captive broodstock are planned to be released to industry from BIARC in August 2006 using a heated pond to maintain fast growth through winter.

For further information contact Wayne Knibb (Principal Scientist) on (07) 3400 2052 or wayne.knibb@dpi.qld.gov.au

12.5.5 'Super elite' females for the barramundi industry

New genetic concepts have been explored to improve growth rate and returns to the barramundi industry. Using advanced computer modelling in quantitative genetics the value of progeny testing has been examined in detail. The progeny test is so accurate that selection using DNA markers for growth cannot be justified.

The progeny test utilises the unique biology of barramundi with technologies, including cryopreservation of milt samples, strip spawning, mechanical mixing of milt and eggs, mechanical grading, DNA pedigree analysis, progeny testing, sex inversion and novel methods of statistical analysis to produce 'super elite' females from two rounds of selection.

Three different strategies to use these 'super elite' females have been evaluated. The simplest way is to maintain the 'super elite' females for the duration of their reproductive life (e.g. 10 years), and mate them to wild males to yield a 20% improvement in growth in the commercial farms. This may suit operations in which home grown males are not reliable. Alternatively, three unrelated groups of 'super elite' females could be formed with males home bred and rotated between the groups, to yield up to 40% improvement in growth. The greatest gains can be achieved through long-term selection requiring infrastructure to maintain 24 families over successive generations.

A detailed report 'Genetic improvement in growth rate for the barramundi industry—details of the progeny test concept' has been released to the Australian Barramundi Farmer's Association executive.

For further information contact Michael Macbeth (Quantitative Geneticist) on (07) 3362 9522 or michael.macbeth@dpi.qld.gov.au

12.5.6 Biotechnology applications

Advancing puberty in fish: The point in time when a fish begins to undergo gonadal development is a commercially significant one, as some species are late maturing, and broodstock are required to be maintained for many years before any spawning occurs. Also, regulation of the time of puberty is important for reliable hatchery productions as some species do not undergo natural reproductive development in captivity. It has still not been established what are the exact cascade of events that trigger puberty. Puberty is the change from a fish that is spending all of its energy on growing to a fish that will now spend significant energy resources into gonadal development.

In order to understand the mechanisms regulating the onset of puberty in fish, genes that are involved in reproductive function from the grey mullet were isolated and cloned. The mullet is a model species for late maturing fish. The key genes include those coding for reproductive hormones and the factors which regulate them. One of the cloned genes (GPR54), codes for a receptor similar to that identified in mammals, where it is considered to be *the* puberty gene. Characterisation of its expression in female grey mullet undergoing maturation also suggests its involvement in the process of puberty. The overall results provide groundwork for developing hormonal manipulations to control puberty.

Regulating moulting in crustaceans: Moulting is an important physiological event in crustaceans as it is essential for their metamorphosis (change from larval to adult stages), growth, and reproduction. Moulting occurs in cycles and involves the shedding of the hard exoskeleton to expose a soft new shell, the uptake of water from the animals' immediate surroundings causing the new exoskeleton to expand, and finally the hardening of the new exoskeleton. It is at the soft shell stage, a very short window of between two and six 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 approach to study moulting in the blue swimmer crab (*Portunus pelagicus*) has been twofold. In the first instance, classical molecular techniques were used to isolate several genes important to the moulting process. Second, a new and powerful technology—the microarray—has been used to offer a holistic approach to comprehensively study gene expression and to discover new genes involved in moult cycle regulation. This 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. The isolation of genes involved in the process of shell hardening has been of particular interest.

Identifying important traits in prawns: The identification of genes coding for important commercial traits in prawns was undertaken using a microarray approach. The available crab microarray has been used, and now a specific prawn microarray is under construction aimed specifically at examining genes associated with reproductive performance and fecundity.

The prawn research also involves the development of DNA markers. These include microsatellites that can be used in family tracking and pedigree analysis. Currently a new generation of DNA markers, single nucleotide polymorphisms (SNPs), are being developed in association with the isolation of genes relevant to commercial traits.

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

12.5.7 Inland aquaculture

Evaluating the potential for aquaculture in cotton catchments: DPI&F has been investigating the potential for aquaculture in Queensland's cotton water catchments for a number of years as part of its integrated agri-aquaculture program. Further funded projects will build on DPI&F's experience, industry partnerships (Arrow Energy) and the Cotton Catchment Communities CRC institutional support to enable significant, profitable and sustainable growth of aquaculture in cotton catchments to be achieved.

The testing of various aquaculture production systems, both extensive and intensive, and including floating raceways, on a range of species (Murray cod, barramundi, mulloway, whiting and/or prawns) provides an opportunity to offset the cost of current irrigated water and to add value to existing farm infrastructure, with water for irrigation now being a substantial and

recurring cost to cotton farmers and to aquaculture. Further investigation into water use potential has revealed a previously untapped source of water extracted as a bi-product of methane gas extraction from coal seams. The millions of litres of water extracted daily is currently too costly to be treated for irrigation, but aquaculture holds the potential to provide a cost-effective off-set pricing of the water such that irrigators can now potentially use the resource.

If successful, integrated fish farming will provide cotton growers with an option to diversify their enterprises and its adoption will also continue the aquaculture industry's broader movement towards environmentally sustainable production systems and the potential for inland aquaculture to become one of Australia's largest producers of fish.

Production of marine prawns using low salinity groundwater: Previous trials have demonstrated that black tiger prawns (*Penaeus monodon*) can be grown at salinities as low as two parts per thousand in a recirculated pond system. An abundance of low salinity and brackish groundwater suitable for prawn production exists in several heavily irrigated regions of Queensland. The production of black tiger and banana prawns (*P. merguiensis)* in inland areas must, however, compete favourably with the cost of production of prawns in coastal regions and with imported product.

The series of trials now underway at Bauple aims to further validate this cost of production by consolidating previous results with results from a RIRDC sponsored project investigating the organic production of marine prawns in inland ponds.

Publication

Collins, A., Russell, B., Walls, A. and Hoang, T. (2005). Inland prawn farming—studies into the potential for inland prawn farming in Queensland, Information Series QI 05051 or available on the website http://www2.dpi.qld.gov.au/far/17819.html

For further information contact Michael Burke (Fisheries Biologist) on (07) 3400 2051 or michael.burke@dpi.qld.gov.au or Ben Russell (A/Fisheries Biologist) on ben.russell@dpi.qld.gov.au

12.5.8 Inland organic prawn production

Growing world demand for certified organic foods is one reason why a research project looking at producing organic prawns has begun at a commercial farm near Bauple in southern Queensland. Organic seafood products including farmed prawns attract a premium in overseas markets. This approach may offer domestic and export market diversification options for existing coastal farmers, and may be particularly suited to developing inland production systems.

This study aims to investigate each of the requirements to obtain certification of prawns as organic; that they must be farmed using organically certified production methods, feeds and packaging practices. It involves studying the commercial viability of organic production using black tiger and banana prawns as an extension to the investigation of the inland production of marine prawns using groundwater in Queensland, work which has been underway for the last five years and carried out by BIARC's integrated agri-aquaculture group. DPI&F's Innovative Food Technology group in Brisbane will assess new packaging technologies that will satisfy organic standards and extend the shelf life of farmed prawns.

The trial is jointly funded by DPI&F and RIRDC. It will run for one year and if successful may pave the way for further organic aquaculture research and development in the near future.

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

12.5.9 Tropical marine finfish

This project continued to focus on developing both broodstock reproduction and maintenance protocols and on developing hatchery production techniques for high-value marine finfish. Artificial photo-thermal (day length and temperature) regimes are used to control reproductive condition and spawning in both flowery cod (*Epinephelus fuscoguttatus*) and estuary cod (*E. coioides*).

Small numbers of both flowery cod and estuary cod were produced. Both flowery cod and estuary cod are being used in collaborative grow-out trials with two industry partners, with some flowery cod being retained for use as future broodstock. To support the development of hatchery techniques for tropical marine finfish, the Live Feeds group have developed innovative techniques for culturing copepods to feed to early stage fish larvae.

Associated projects, funded by ACIAR, have contributed to the development of tropical marine finfish aquaculture by better defining the nutritional requirement and optimal environmental parameters of larvae, and in developing feeds for grow-out.

For further information contact Mike Rimmer (Senior Biologist) on (07) 4035 0109 or mike.rimmer@dpi.qld.gov.au

12.5.10 Tropical rock lobster

Rock lobster aquaculture research has continued at Northern Fisheries Centre (NFC) through 2004–05 with a focus on broodstock management and larval rearing. The research is on the tropical lobster (*Panulirus ornatus*), and is strongly supported by FRDC and a commercial partner, MG Kailis Group. The project also includes the Australian Institute of Marine Science as a collaborator, and represents one of several rock lobster aquaculture projects in Australia, coordinated by the Rock Lobster Enhancement and Aquaculture Subprogram of FRDC.

Broodstock management has proved to be relatively straightforward, and through control of photoperiod and temperature, mature two-year old lobsters are now spawned throughout the year, continually providing high quality larvae. Although broodstock social factors and nutrition are still being examined to fine tune the breeding process, the broodstock management technology already established is robust and commercially transferable.

The rearing of lobster larvae has been of much greater difficulty. The larval life of *P. ornatus* extends to four to six months, and comprises eleven stages; in that context it is an order of magnitude more difficult than, say, prawns or crabs. The focus of the current work has been to consistently achieve reasonable survival (60%) to stage V, which takes approximately five weeks.

The project is close to achieving that goal, through a series of experiments examining husbandry, nutrition and system design. The next step will be to move on to mid- and late-stage larvae, with a goal of producing the first post-larvae (i.e. the puerulus) in captivity for this species, thus closing the lifecycle. The current project runs until June 2006.

For further information contact Clive Jones (Senior Biologist) on (07) 4035 0182 or clive.jones@dpi.qld.gov.au

12.5.11 Crabs

The crab aquaculture team is collaborating with researchers from Queensland University of Technology (QUT) on a two-year ACIAR project that examines the feasibility of developing low cost feeds for mud crabs (*Scylla* spp.) in south east Asia. Institutions in Vietnam and Indonesia are working on corresponding diets using locally sourced ingredients.

Experiments at BIARC this year showed that mud crabs (*Scylla serrata*) grew as well on one particular commercial black tiger prawn diet as they did on higher quality kuruma diets (which

had hitherto provided the growth benchmark in the recently concluded Fishing Industry Research and Development Corporation (FRDC) work). Alongside the feed trials, the growth and maturation of individually-reared mud crabs was also tracked indoors as a precursor for commercial mud crab production using this method.

Watermark Seafoods used facilities at BIARC to hatch and rear blue swimmer crab (*Portunus pelagicus)* larvae in anticipation of switching production to that species. Honours projects associated with the soft-shell crab project, with students from Griffith University and Curtin University of Technology, showed that stable isotope ratios could be used to demonstrate the onset of cannibalism in nursery production of blue swimmer crabs; and that container size had surprisingly little effect on growth of 3-spot crabs, clearing the way for testing of highly intensive containerised nursery systems. The write-up of the final report to FRDC has been started.

Publications:

Mud crab aquaculture workshops, (2004). Copy on CD produced from the material presented at FRDC mud crab farming workshops in early 2004–05.

Shelly, C. (2004). Editor. Crab farming: a new opportunity for Australian aquaculture, Proceedings of a workshop held in Brisbane 13 October 2004, Information Series QI 05067.

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

12.5.12 Scallop marking

The marking of scallops (*Amusium balloti*) for release and recapture is part of the FRDC supported project designed to distinguish hatchery-produced stock from wild stock.

Saucer scallop fishery is one major component of multi-species fisheries in Queensland and Western Australia. Annual landings have fluctuated dramatically in both states. Saucer scallop is widely recognised as the world's finest scallop meat and attracts landed prices of more than $20/kg on domestic markets, and significantly more in overseas markets.

Overseas experiences have shown that sea ranching of scallops could not only reduce the landing fluctuations, but also increase production by more than ten times. In Australia, to offset the variable catches of saucer scallops resulting from the wild fishery, sea ranching of saucer scallops is currently being undertaken by industry in Western Australia and Queensland using hatchery-produced juvenile.

One of the key issues to evaluate the success of the sea ranching venture is to be able to identify hatchery-produced stock. Managers can then determine the contribution of hatchery stock to the final harvest as well as being able to monitor survival and dispersal. Identification of hatchery seed is also essential to determine the optimal size of scallops and time for deployment to the seabed. However, the choice of identification method is restricted by the cost, ease of use, stability and precision.

A wide range of chemicals have been evaluated and tested for marking hatchery-produced juveniles. These chemical candidates must be harmless to the animals and safe for human consumption. Preliminary trials indicated that a number of chemicals showed very promising results. Based on these, experiments are being conducted to systematically evaluate a suitable treatment time and concentration of potential chemicals. Also, the retention time and intensity of these chemical marks on the juveniles are being assessed.

Publication:

O'brien, E., Bartlett, J., Crump, P., Dixon, B. and Duncan, P. (2005). Enhancement of Saucer Scallops *(Amusium balloti)* in Queensland and Western Australia—Genetic Considerations, Project Number 2003–033.

For further information contact Liz O'brien (Fisheries Biologist) on (07) 3400 2019 or liz.obrien@dpi.qld.gov.au

12.5.13 Finalisation of golden perch aquaculture feasibility trials

This research project was based at the FFAC, Walkamin and explored opportunities to improve the profitability of both existing and future aquaculture farms, located throughout Queensland. It aimed to establish whether golden perch (*Macquaria ambigua*) could be farmed commercially in Queensland. All of the initial hurdles to aquaculture of this species were overcome and several issues regarding marketing identified and addressed, with golden perch aquaculture product fetching a slight premium over wild caught product.

As departmental priorities changed it was suggested to industry that they investigate the Lake Eyre strain of golden perch due to the economic advantages apparent in this species. Industry took up the challenge: two hatcheries met, produced fingerlings (developing novel techniques to do so) and these proved easier to wean than Murray-Darling fish and promised faster growth at lower temperatures than silver perch. Major issues involving handling still need to be addressed. James Cook University is comparing the performance of different strains of golden perch in conjunction with industry.

For further information contact Brett Herbert (Fisheries Biologist) on (07) 4092 9913 or brett.herbert@dpi.qld.gov.au

12.5.14 Climate-based risk management strategies for NQ aquaculture

This innovative research project was based at the FFAC, Walkamin and explored opportunities to improve the profitability of both existing and future aquaculture farms located in north Queensland through climate-based risk assessment and use of on-farm temperature control strategies.

Involving DPI&F staff from Aquaculture, Climate and Biosecurity (disease) groups, initial research examined the underlying relationship between pond water temperature resulting from annual and seasonal variations in climate and growth performance of a selected aquaculture species under farm conditions, e.g. barramundi.

Findings included: the identification of a species-related, lower threshold temperature of 21°C for barramundi was linked with decreased survival and production through the occurrence of disease, reduced growth, poorer feed conversion efficiencies and increased predation losses. This lower threshold temperature also enabled the preliminary assessment of improved temperature management strategies for aquaculture ponds, e.g. wind breaks. The collection of real-time air and pond temperature data during specific cold events also enabled the comparison of 'low temperature risks' between different farm sites and the assessment of the frequency of medium- to long-term risks of severe winters, using historic air temperature records. The first attempt to develop a forecasting system to forewarn farmers of severe winters using the SOI (Southern Oscillation Index) was also developed as part of this project.

Two mini-workshops will be conducted during 2006 to inform interested farmers of the results of this study and the need for further applied work to demonstrate the financial benefits of climate based risk management and related on-farm investment.

For further information contact Les Rodgers (Senior Technical Officer) on (07) 4092 9917 or les.rodgers@dpi.qld.gov.au

12.5.15 Collaborative on-farm disease diagnosis, CODD

This is a new initiative commenced in late 2005 and is also based at the FFAC, Walkamin. The project will investigate the development of 'real-time' technologies to digitally document on-farm disease events and case histories from a distance, and so complement existing disease diagnostic services.

The project aims to assess the potential for farmers, aquaculture research staff and veterinarians, located at geographically separated sites or centres to preliminary assess disease problems in 'real time' using digital cameras, basic microscopes and modern communication (e.g. broadband–internet) technologies. The earlier diagnosis of disease and water quality problems (wherever possible) will result in improved animal health, the development of better stock management practices, improved training methods for farmers and more profitable aquaculture farms.

Normal disease notification, reporting and specimen submission procedures involving Fisheries and Biosecurity diagnostic staff at Regional Veterinary Centres will continue during 2006. However, assistance is being sought from farmers during 2006 to actively be involved in the trial as case studies for the diagnosis of disease or water quality related fish health problems on-farm. So, if a related fish health problem develops on your north Queensland farm during 2006, please also contact Les Rodgers to see if some local and additional on-site assistance is available to investigate the health issue.

For further information contact Les Rodgers (Senior Technical Officer) on (07) 4092 9917 or les.rodgers@dpi.qld.gov.au

12.6 Aquaculture planning program

12.6.1 General

A new aquaculture planning initiative commenced in 2004–05. The program was funded initially for a four-year period to develop both land-based and marine aquaculture regional plans.

During the year, work focused on the formation of collaborative linkages between stakeholder agencies and industry representatives, and the preparation of overarching state-wide principles for the selection of suitable sites and for planning frameworks. DPI&F is working closely with the Department of State Development, Trade and Innovation (DSDTI) to progress aquaculture planning.

12.6.2 Marine aquaculture planning

An inter-agency Technical Advisory Group was set up in late 2004 to determine site selection criteria for aquaculture in marine areas and methodologies for short-listing sites. Documents describing marine aquaculture site suitability assessment and planning strategies for marine aquaculture in Queensland are being developed for review by the Technical Advisory Group. These documents will form the basis for regional marine planning to be undertaken in 2005–6.

12.6.3 Land-based aquaculture planning

DSDTI completed development of a geographic information system (GIS) for broad-scale land suitability assessment for aquaculture in the coastal region. This system is now being used to assist potential investors through regional DSDTI offices.

12.7 Further information

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