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Demonstrating the Capacity of Western King Prawns for Live Export

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SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

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Project No. 99/422

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99/422	Demonstrating the capacity of Western King prawns for live export

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OBJECTIVES

1. Develop a preliminary handbook for handling and packing
2. Conduct preliminary assessment of the suitability of handling and packing techniques established for kuruma prawns
3. Test product on export markets
4. Evaluate transfer of technology to South Australia

NON TECHNICAL SUMMARY

The purpose of this project was to transfer and adapt the technology developed for the live export of kuruma prawns to the South Australian prawn fishery.

The study was divided into three phases following the first three stated objectives. That is:

Phase 1 develop a preliminary handbook for handling and packing'

Phase 2 conduct preliminary assessment of the suitability of handling and packing techniques established for kuruma prawns and

Phase 3 test product on export markets.

The undertaking of the third phase was subject to the attainment of 95%+ survival in Phase 2. As the best mean survival was well below that, Phase 2 was repeated instead, with the inclusion of a recovery tank (24hr) before the packing phase of the operation. The results were presented and discussed at an Industry workshop held on Tuesday the 29th of August 2000.

The major outcomes of the project were the preliminary and final manuals, three trials involving commercial fishing and processing (ie. technology transfer) and survival up to a mean of 82% (overall mean of 73.41 + 1.53) after twenty-four hours in kuruma boxes during the repeated Phase Two, up from a mean of 56.35 (+ 1.23%) without the recovery tank.

With respect to future direction, it is felt that survival rates were very promising, given the method of harvest. The trials represent a good starting point, with refinement, survival should reach an average of 80%. Any increase over that would probably necessitate a change in harvest method. The fourth objective was to evaluate transfer of technology to South Australia.

It is considered that the project successfully transferred the technology to industry, especially given that the work was conducted on an industry vessel and the packing took place at a commercial facility. There is definite interest from industry in developing the opportunity, given the promising levels of survival. We anticipate further collaborative R&D on this issue in the future with industry partners.

BACKGROUND

The Western King Prawn (*Penaeus latisulcatus*) fishery in South Australia produces about $30 million (beach price) worth of prawns annually.

In terms of economic benefits, it is expected that development of live export techniques will significantly add value to the fishery by providing access to premium markets. The catch in 1998/99 was about 330 tonnes, at an average price of about $14/kg. An expected premium would be between $21 and $36/kg (ie. total price between $35 and $50/kg) for live prawns (pers. Comm. B. Goodrick, QDPI, CFT). If 10% of that catch had been exported live, its value would have increased by between 28 and 40%, from $4.16M to $5.31-5.8M.

This work extends the FRDC funded projects 89/92 *Transportation and storage of live penaeid prawns* and 91/71 *Transportation and post-harvest handling of ocean caught prawns destined for live export* by considering a new species for which there is a potentially lucrative market. It can also potentially be extended to other *P. latisulcatus* fisheries (ie. WA) and to other seafood species. FRDC 89/92 dealt mainly with the farmed kuruma (*Penaeus japonicus*) and black tiger prawns (*Penaeus monodon*) and 91/71 with wild-caught brown tiger prawns (*P. esculentus*).

Central to the proposed study is the adaptation of existing techniques, developed for kuruma prawns, to the live export of the Western King Prawn (*Penaeus latisulcatus*). This prawn is similar is size to *P. japonicus* (20mm vs 225mm) and is considered to be as hardy (N. Carrick pers. comm).

The successful techniques for temperate wild-caught species are likely to be different from those used for tropical pond-raised species. In comparison to the environment experienced by wild-caught tropical species (ref. Dall and Smith, 1981), the Gulf St. Vincent environment has relatively low temperatures (15 to 21°C (pers. comm. M. Kangas, Y Xiao)), compared to 20-30°C (Goodrick and Paterson, 1992) and relatively high and stable salinity.

There are several persuasive reasons for embarking on this study. First, South Australian prawns are large and thus well positioned for premium export markets. The two size grades that have been targeted are "under 10 per pound" (U/10) and 10/15 per lb. These have been identified by industry as the premium sizes for the intended market. Second, Gulf St. Vincent offers close access to international air terminals. Finally, the western king is very similar to the kuruma prawn and thus is expected to be as hardy (pers. Comm. N. Carrick).

It should be emphasised that this is the first stage in evaluation of the potential of Western King Prawn live export. Its purpose is to get live prawns on to the Japanese market using the best available methods and to determine how attractive the product is to consumers. If there is good market acceptance, the work will be the subject of a larger FRDC application to further refine the techniques for *P. latisulcatus*.

The principle investigator (Dr. Howel Williams) and co-investigators, Dr Richard Musgrove, Mr Jim Raptis, Mr Ivan Kolic, and Mr Martin Smallridge along with a CFT representative (Mr Bruce Goodrick contact by phone and e-mail) will make up the steering committee. The principal investigator will be responsible for overall project administration, particularly referring and budget changes to the steering committee. Dr Musgrove and another CFT staff

member (Mr. Steve Grauf) will be responsible for the experimental design and execution and statistical analysis. Dr Musgrove has developed techniques for monitoring condition in crustaceans (FRDC 95/017, 96/160) and has expertise in physiology and biochemistry. The other co-investigators bring expertise with the prawn fishery, fishing and processing methods. In particular, Mr Steven Grauf has worked extensively on the kuruma prawn live export program.

NEED

The successful marketing of live farmed prawns shows that there us significant potential for adding value to Australia's prawn catch by exporting live wild-caught prawns. South Australia's Gulf St. Vincent (GSV) provides an ideal environment for examining export opportunities. Firstly, GSV produces a large prawn (the western king prawn *Penaeus latisulcatus*) by world standards; certainly relative to farmed prawns. Consumers in premium seafood markets prefer large prawns. Secondly, GSV is situated within easy access of an international air terminal with prawns capable of being airfreighted within hours of capture. Thirdly, the GSV fishery has actively supported initiatives in gear design to minimise damage to prawns and is keen to promote value-adding initiatives in its low volume (200-300 tonnes per annum) fishery. Lastly, the clean, green environmental work practices established in the GSV fishery provide additional promotional opportunities in positioning Australian seafood in premium export markets. The need for improved product handling and distribution channels, addressed in relation to prawns, extends to other South Australian seafood sectors.

OBJECTIVES

1. Develop a preliminary handbook for handling and packing
2. Conduct preliminary assessment of the suitability of handling and packing techniques established for kuruma prawns
3. Test product on export markets
4. Evaluate transfer of technology to South Australia

METHODS, RESULTS & DISCUSSION

The project was divided into three phases, each of which will be individually reported in terms of methods, results and discussion. The Handbook for Handling and Packing was a major outcome and is attached as Appendix 3.

Phase 1 - Develop a Preliminary Handbook for Handling and Packing.

An initial evaluation was made of harvesting and packing methods and the packing methods were demonstrated and trialed. A preliminary handbook for handling and packing was then produced, based on the assessment of current practices.

Methods

Live prawns for the trial were collected from survey shots (20min /shot) during normal fishing operations on the A.R. Raptis and Sons vessel the Jillian Sandra in mid-December 1999. Fishing was undertaken in St Vincent's Gulf, off Adelaide in South Australia. Once landed, prawns were removed from the sorting tray and placed in buckets of seawater. Those which appeared especially vigorous were then placed in prawn crates submerged in larger tanks (four crates/tank) with flow-through water (from the deck hose) and aeration. In this, and subsequent phases, individual prawns were handled as little as possible, full crates were moved about, not prawns. Those prawns handled were generally moribund or dead and usually graded out. The larger tanks were strapped on either side of the refrigerated brine tank. The water temperature was about 18.5°C. No prawns were collected during the commercial trawls (60 min). During the night crates were checked and dead/dying prawns removed. Few mortalities were recorded.

Upon arrival at the jetty (about 0900h) the crates were transferred to a Xactics bin on the back of the Raptis vehicle. The bin seawater was at about 17°C and was oxygenated via an air-stone (a cylinder of industrial-grade oxygen had been hired for this purpose). The Xactics bin was transported to the SA Aquatic Sciences Centre (SAASC) for the "packing" phase of the trial. At SAASC, moribund or dead prawns were removed and the remainder chilled to torpor by immersing the crates in 16°C then 11°C seawater for twenty minutes per temperature. They were then packed in the 1kg "inner" packs from the kuruma prawn boxes (Goodrick et al, 1994). One or two layers of prawns were packed in moist, chilled hoop pine shavings in each pack. Six packs of prawns (about 1kg/pack) were then placed in each of two temperature-controlled (TC) rooms set at 12 and 14°C. No size grading was carried out although an effort was made to pack the same range of sizes into each room. Data loggers (Hastings Data Loggers) were placed in both rooms. Packs were opened, and survival assessed, at intervals, over the following 34h: at 10, 23, 28 and 34h. Note that, although checked prior to the experiment, the thermostats in the TC rooms were found to have malfunctioned; the average temperature in the 12°C room was 13.4°C ($\pm$ 0.02) and in the 14°C room it was 15.6°C ($\pm$ 0.01).

Results

Survival declined and variability increased with storage time (Table 1). After 10 hours one pack was opened from each temperature and top and bottom layers counted separately. Survival was between 88 and 100 percent in both temperatures. For the remaining times, two packs were opened from each room. After 22.5 hours, survival ranged from 79 to 88% (median (pooled layers) = 83%) for prawns in the 13.4°C room. In the 15.6°C room it was between 53 and 60 % (median (pooled layers) = 56%). This was marginally significant (Kruskel Wallis, X= 4.5, P=0.034, df=1). After 28 hours, survival was 39% (top) and 67% (bottom) for one pack of prawns from the 13.4°C room. In the 15.6°C room the equivalent was 60 and 70% respectively. After 34 hours, survival ranged from 33 to 85% (average 48%)

for prawns in the 13.4°C room. In the 15.6°C room it was between 27 and 60 % (average 47%).

Table 1. Phase 1: Survival over 34 hours by prawns packed in inner boxes within temperature-controlled rooms set at either 13.4°C or 15.6°C

Temperature (°C)		Hours			
		10	22.5	28	34
13.4	Average/Median	93.75	82.63	52.78	47.66
	SE		2.58		12.84
	N (boxes)	2	4	2	4
15.6	Average/Median	97.37	56.30	65.00	47.41
	SE		1.96		10.45
	N (boxes)	2	3	2	3

Discussion

This phase has shown that King prawns can survive trawling. They can also survive short term pack-out within chilled, slightly moist wood shavings in small packs in CT rooms. If the prawns, and those on the bottom layers of the packs, tended to survive better than larger or top layer animals. Prawns in the harvest area had just spawned, possibly contributing to the lower survival in larger prawns. In addition, although soft prawns were excluded from the trial, there may have been some which had moulted relatively recently, potentially adding to trial mortality. Given the rough treatment that these prawns had, it is apparent that they are much more robust than trawled tiger prawns, having more in common with the kuruma prawns. However, these prawns are much more docile than kuruma prawns, a feature which might make it difficult to judge mortality at a glance and may lessen their impact in the marketplace.

A preliminary handbook for capture, handling and packing of live western king prawns in the Gulf of St Vincent was drawn up based on the above experience and that of SG in the previous prawn live-export studies (FRDC 89/92, FRDC 91/171, FRDC 92/125). This handbook was further modified during subsequent phases of the project and is attached (Appendix 3).

Phase 2 - Conduct preliminary assessment of suitability of handling and packing techniques established for kuruma prawns.

This section of the work was intended to refine the guidelines. It was decided by the steering committee that if the refinements did not produce 95%+ survival, the objective of Phase 3 (export trial) would be re-evaluated.

Method

A trawling trip was undertaken on the 27th/28th of March 2000 on the same vessel as before and during normal fishing operations. The modifications to the above method are listed below (Table 2). The trawling time was reduced to 5 minutes. As before, only the most vigorous prawns were selected. They were then placed in purpose-built interlocking wooden crates floating in a 250 litre plastic tank. As each crate was filled (about 8 kg prawns) it was stacked in an insulated "Xactics" bin (Fig 1a and b) full of fresh seawater. Water was supplied via the deck hose as before then run through a cooling coil (19 mm diameter black NylexTM irrigation hose) placed in the chilled brine tank to bring the temperature down to 19°C, two degrees below ambient. At sea, aeration was supplied using a 240 v oil-less air pump via a 13 mm NylexTM hose attached to the inside of the bin feeding down to a loop of porous hose glued to the bottom (Fig.1a).

Before the Xactics bin was transferred to the flat bed truck at the jetty, the lid was clamped down and the aeration port opened in the top of the lid. On the truck this was connected to an oxygen cylinder as before. The valve (Goodrick et al, 1993) in the bin's lid allowed air to escape without loosing water.

Table 2 Modifications made to methodology for Phase 2

Method	Phase1	Phase 2
Trawling time	20min	5min
Holding crates for prawns	Prawn crates	Interlocking wooden crates
On-board holding tank for crates	Plastic bin large enough to hold four prawn crates	Insulated plastic Xactics bin (1000l). Held 12 wooden crates
Transfer of prawns to land transport	Crates transferred to Xactics bin on Raptis vehicle	Whole Xactics bin transferred from boat to vehicle
Packout	Inner boxes in temperature controlled rooms	Inner boxes packed into prawn crates

Dead/moribund prawns were removed before each cooling step and before packing. At packing, prawns were also graded into two sizes - medium and large, 1 size to an inner 1kg box. Inner boxes were marked with the size of prawn and the initials of the packer responsible so this might be included in the data analysis. The boxes were randomly packed in polystyrene 8 kg kuruma prawn crates (Goodrick et al, 1994) (Fig 2). There were two of prawns in each inner box and 8 boxes per crate. The boxes were arranged in pairs, which means that there were four layers of inner boxes in each crate.

Fig 1 Insulated Xactics bin (not to scale). This was tied to the deck at sea with the lid off . Water from the deck hose was continually pumped in via a cooling coil and allowed to over flow. Water was turned off when approaching port and the lid clamped on. Air was supplied via a 240v airpump while on the boat. When the bin was transferred to land oxygen was pumped in via the inlet in the lid

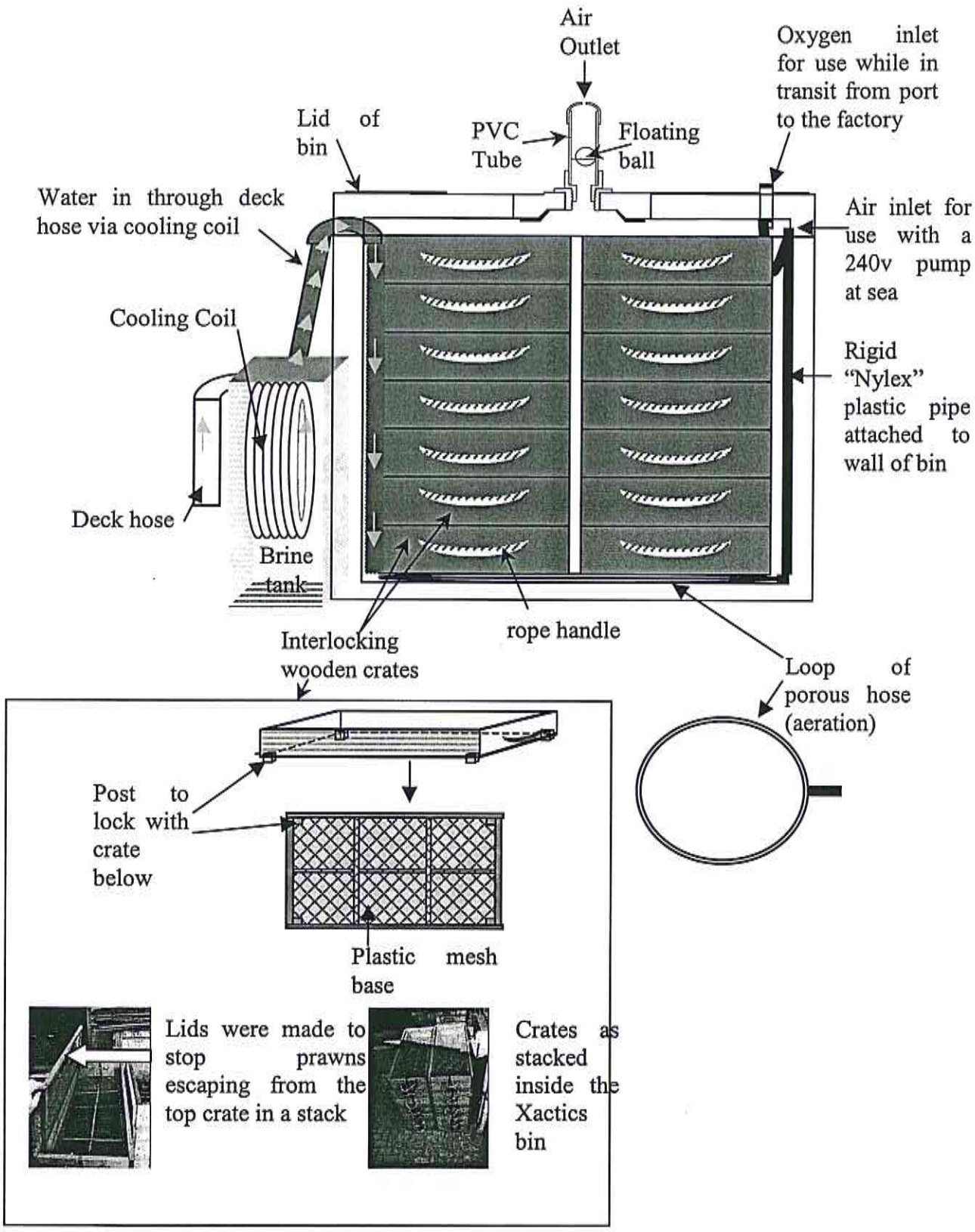
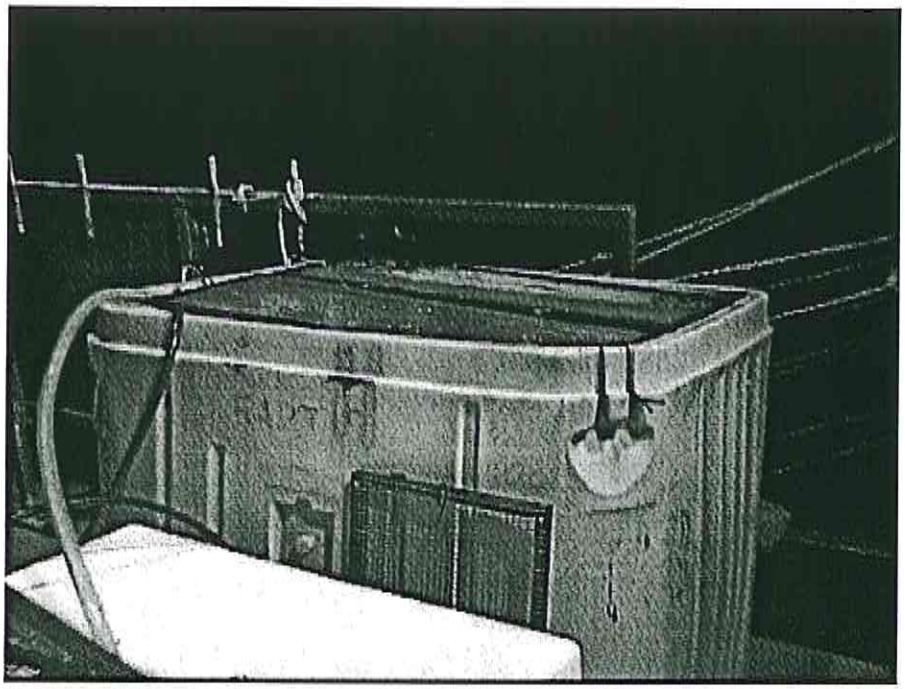


Fig 1b Xactics bin on board the A.R. Raptis vessel Jillian Sandra. i. Bin in operation loaded with wooden crates full of prawns. The translucent pipe to the left of the shot is the water inlet hose. ii The lower photo shows the bin being lifted by crane onto the truck for transport to the factory.



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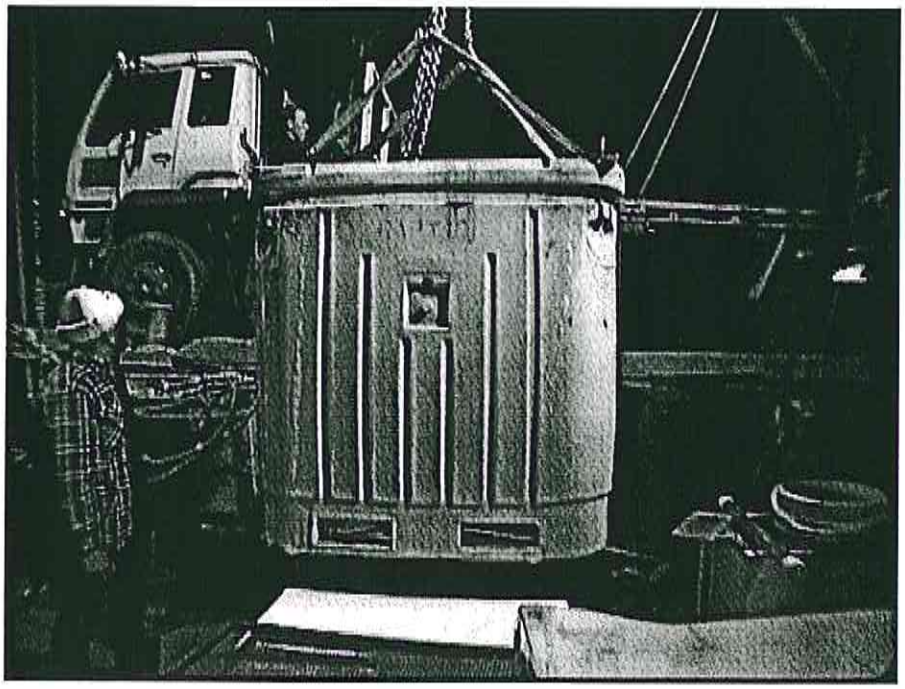
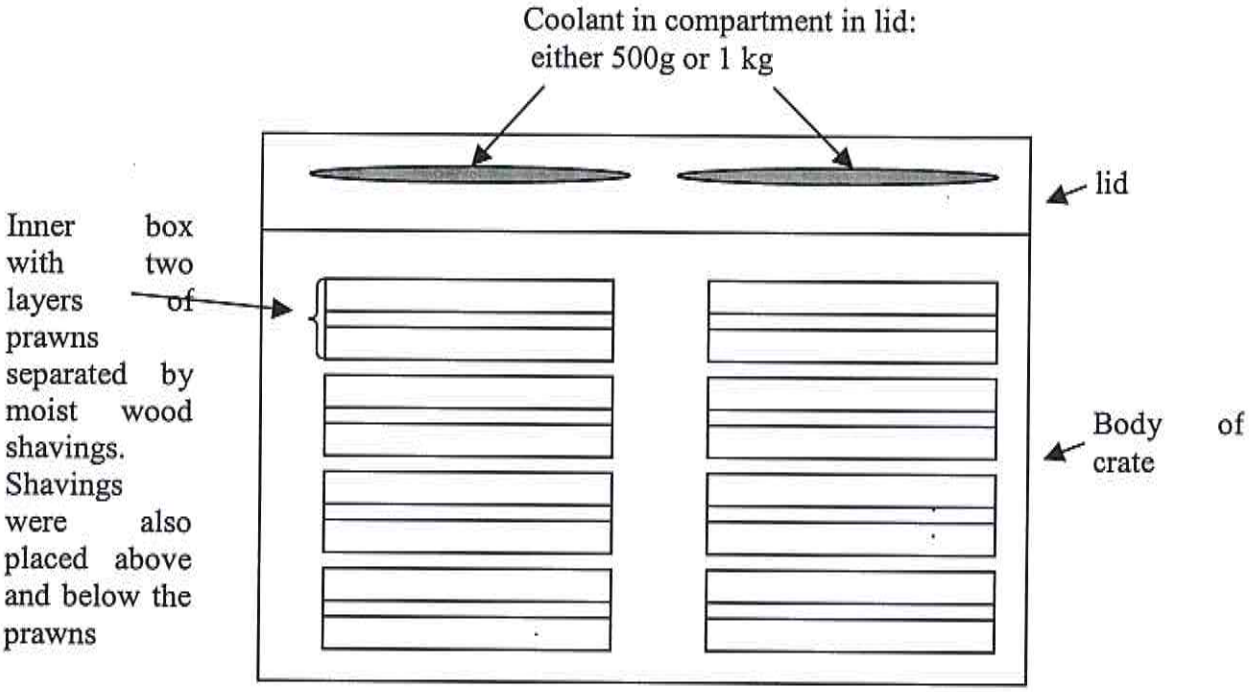


The temperatures in the crates were maintained using either 0.5 kg (6 crates) or 1kg (3 crates) gel packs. The crates were transferred to SAASC where they were left at room temperature (22°C) for 24 hours then opened and survival assessed. The 24 hour period was selected as transit time to the Tokyo market (17hrs) plus a contingency of 7 hours.

Figure 2. Kuruma Crate containing 8 inner boxes



Results

During the trial, 215kg were harvested, average size was 13.2 per pound. Of this 143 kg (66.5%) were either dead on the sorting table (the majority :80 - 90%) on the Jillian Sandra or died during transportation and sorting at the factory. There was also a small component which were found to be too weak during sorting and were included with those which had died. The majority of prawns caught were hard shell. Sexing was not carried out as it was judged to be impractical during a commercial operation. It has also been the experience of the QDPI that sex makes no difference to survival in kuruma prawns.

72 kg (33.5% of the catch) were packed out. The following data are presented in terms of layers of prawns within inner boxes within crates. Average overall % survival was 56.35 + 1.23% (n=144). Percent survival was highly variable (11 to 100%) to the extent that there were no coolant, placement in box, packer or prawn size effects.

Discussion

The wide range of results indicated that trawl stress was the major issue. Besides the mechanics of the trawling process and the stress that it causes, it is felt that the high bi-catch (especially leatherjackets) would have contributed to the problem. Although leatherjacket

spines are non-venomous, it is likely that physical damage (spiking) and resulting infection contributed to stress and death of prawns.

Overall survival should have been a great deal better than that in Phase 1, given the improvements in prawn treatment. Further to this, as we did not achieve 95+% survival it was agreed that the export trial would not take place In its stead Phase 2 would be repeated with the inclusion of a 24hour period of recovery before cooling and packing.

Phase 3- Test product on export markets and assess market response.

Methods

As explained above, the previous phase did not return the required 95+% survival for this phase to proceed. Therefore another packing trial was carried out with the following changes in methodology.

- trawl speed was minimised (without "power-up") and 5 minute shots were used,
- any shot with substantial by-catch was not used,
- live prawns were collected from the cleanest shots.

Water temperature was 17°C and this was reduced to 15-16°C in the Xactics bin. Once the prawns arrived at the factory were they were placed, still in the wooden trays, in a series of recovery tanks in a temperature controlled shipping container (at 15°C) for 24 hours then graded, cooled and packed. Given the low sea water temperature, one step (to 11°C) was used to induce torpor prior to packing.

Six cartons were packed (43kg plus 5 dummy boxes (inner boxes with moist sawdust) to make up the space). Two cartons were packed with 500, two with 750 and two with 1kg gelpacks. After twenty four hours the prawns were unpacked and survival measured.

Results

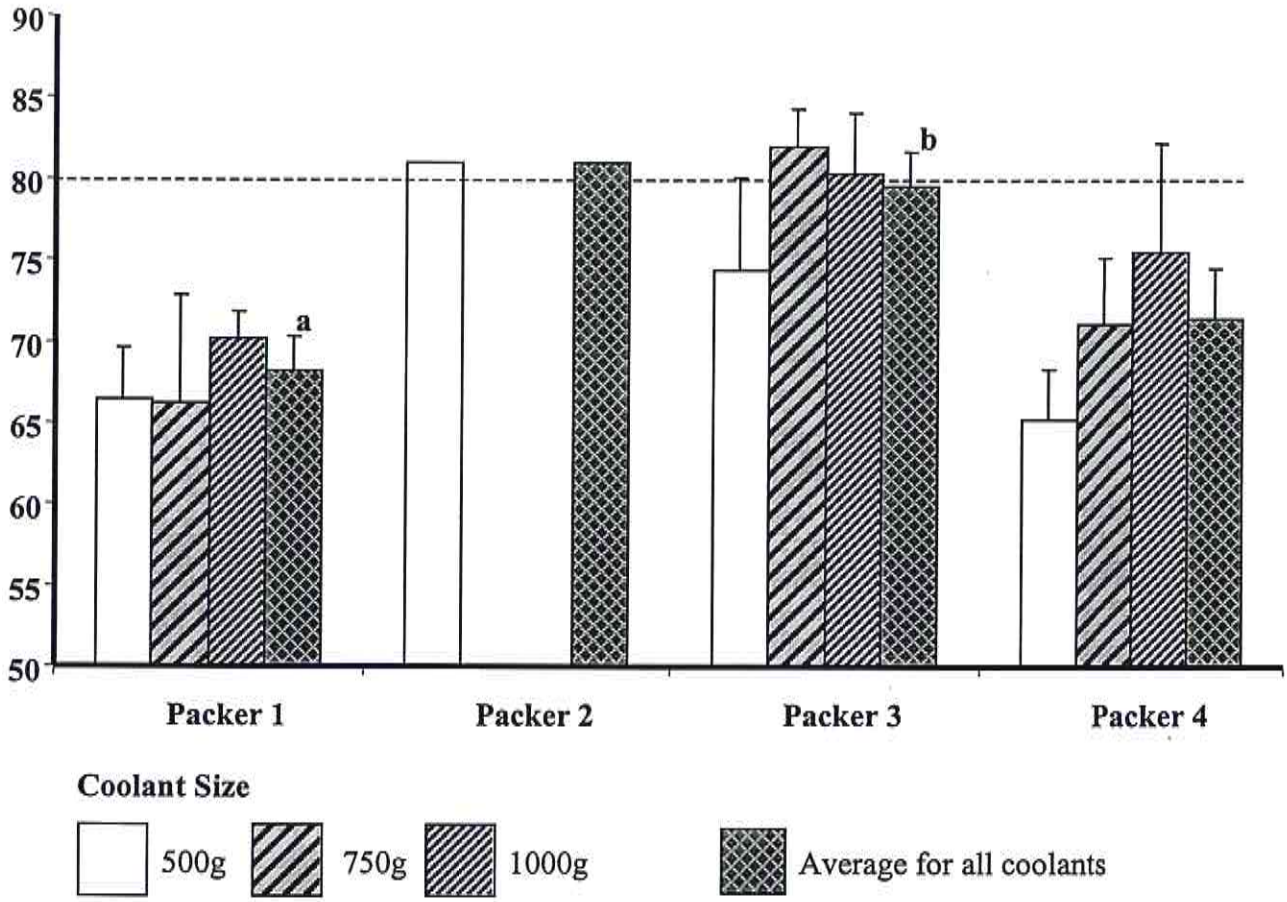
159.5 kg of live prawns were caught. Of this, approximately 79.5 kg were brought back to the factory using the same method as used in Phase 2. From arrival at the factory a further 36.5kg of prawns was rejected (Table 3). This figure includes dead, moribund, soft (just moulted) and inactive prawns. 27% of the catch was packed "for live"

Table 3 Grade-out and Packing statistics for Phase 2

	Rejected (kg)
After 24 hr	10.3
During grading	15.3
During weighing and packing	10.9
Total Rejected	**36.5**
Total Packed	**43**
Percentage of total catch packed	26.9%

After 24 hours the overall survival varied from 40-100% and averaged 73.42 + 1.53% (n=43). Layer (ie. top or bottom), position in crate and coolant size and prawn size had no effect on % survival (Kruskel Wallis, $P \leq 0.05$). However, there was a significant packer effect (Kruskel Wallis, $\chi^2 = 10.43$, $P = 0.001$) with average survival varying from 65 to 82% (Fig 3).

Figure 3 Percent survival (+ SE) of western king prawns per inner box for each of four packers and three coolant sizes for Phase 3 of the trial. Comparisons were carried out on pooled percent survival data (coolants pooled) for each packer. Super scripts (a,b) indicate significant comparison (P = 0.001)



Discussion

Practice in packing should bring overall average survival up to about 80%. Increasing survival above 82-85%, using the current harvesting methods, would be difficult. The consensus is that the current method has maximised survival from trawled prawns.

BENEFITS

The beneficiaries from this project are the western king prawn fisheries, particularly in South Australia (Gulf St. Vincent, Spencer Gulf and West Coast) and Western Australia.

Survival up to 80% has been demonstrated under commercial conditions and although the project did not achieve the level of survival originally intended, or conduct an export trial, it has provided a basis for further development from within industry via successful technology transfer and demonstration of results.

FURTHER DEVELOPMENT

There are several components in the postharvest handling process which would benefit from development.

Developing market strategies that would make live export with the currently achieved survival rate viable.
Reducing transit times from consignment to market could allow the delivery of prawns with acceptably high survival rates. For instance, if exports were to wholesale markets rather than auction markets (such as Tsukiji in Tokyo), then transit time would be significantly shortened.

Developing a relationship with a wholesaler through an agent would also present opportunities for collecting data on trial shipments and monitoring the fate of prawns.

Delivery to wholesalers may also present opportunities for the dead prawns to be separated and sold as a fresh chilled product. This may also make longer transit times and higher mortalities more profitable.

Improving survival rates.
It is unlikely that survival could be taken significantly above 80% using current methods. Unless alternative markets can be developed then higher survival rates must be achieved. This may be achieved by developing better capture techniques or improved processing techniques.

Improvements to capture techniques would involve significant modifications to trawling or the development of alternatives such as trapping.

Improvements in processing should investigate the use of extended periods in recovery tanks.

CONCLUSION

The project has successfully modified techniques developed for the kuruma prawns produced by aquaculture and translated these for the Western King prawn harvested from the wild. A handbook for handling and packing live wild caught Western King prawns has been developed. The close involvement of companies involved in commercial fishing and commercial packing and processing throughout the project has seen an effective exposure to the techniques and technology and an effective technology transfer.

The initial adaptation of the techniques has achieved an 80% survival in simulated export consignments and indicated further areas where improvements could be made. Although the level of survival achieved is marginal for commercial live export to retail markets it may prove viable for other markets.

There is clearly interest in developing the technique further in South Australia and we anticipate further collaborative R&D to support this development.

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APPENDIX 1 - INTELLECTUAL PROPERTY

The FRDC's proportion of ownership of the project intellectual property, based on Part C of the application or unless otherwise justified, is 40.16%.

APPENDIX 2 - STAFF

The following staff were engaged on the project;

Richard Musgrove (SARDI)
Steve Grauf (QDPI-CFT)
Howel Williams (SARDI)

In addition the following personnel made significant contributions
Jim Raptis (A Raptis & Sons)
Staff of A Raptis & Sons including
Grant Birrel
The skipper and crew of the Jillian Sandra
The packing and engineering staff of the Adelaide plant
Ivan Kolic (GSV FMC)
Florian Valcic (GSV FMC)
Martin Smallridge (Prawn Industry SA)
Bruce Goodrick (QDPI-CFT)

APPENDIX 3

Handbook for capture, handling and packing of live western king prawns in the Gulf of St Vincent

Richard Musgrove and Steve Grauf

An outcome of the FRDC Project 99/422 - Demonstrating the Capacity of Western King Prawns for Live Export

SARDI

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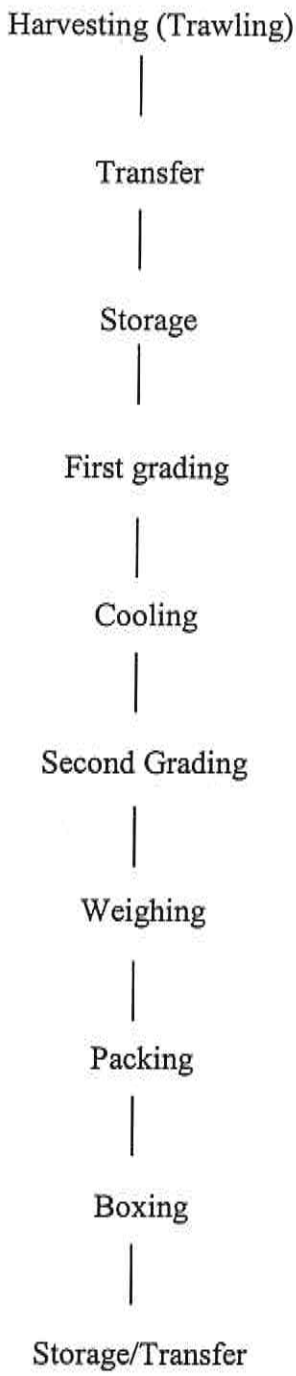
Introduction

The success of live exports of farmed kuruma prawns from Australia to Japan has raised the question of whether these techniques are applicable to the ocean harvest of western king prawns from the Gulf of St Vincent in South Australia.

Prawns from the Gulf St. Vincent fishery, and other such fisheries in Australia, are harvested by trawling and are most likely stressed in nets by exercising to exhaustion and by injury. In Japan, a significant proportion of live kuruma prawns already come from the wild fishery, where gentle harvesting techniques (eg. trapping) are employed. Even though these methods are not used in Australia, small numbers of Australian prawns are already trawled live for use as aquaculture broodstock or for "tag-and-release" studies. There appears to be no reason why existing harvesting methods cannot be modified to minimise the stress of capture for larger quantities of prawns.

This work extends FRDC 89/92 and 91/71 by considering a new species for which there is a potentially lucrative market.

Processing Flow Chart



Harvesting (Trawling)

Before harvesting for live prawn transport, the moult cycle of the prawns has to be checked. From the live kuruma work it has been shown that survival can drop from 85-90% to 50-55% depending on the moult stage. Harvesting should also not be undertaken around a spawning period as the prawns may be weak after a spawn.

20 minute survey shots have been initially trialed but it is suggested that 5 minute shots be undertaken as this should increase the chances of harvesting stronger and healthier prawns. The trawl speed should be as slow as possible to reduce trawl stress to the prawn. It is also advisable to not "power up" on net retrieval to further reduce stress. There is optimum areas/times of season to catch for live product. The more rubbish that comes up in the net (coral, sponges, rays) the lower will be the chances of survival for the prawns due to crushing. Bycatch reduction devices may help in this area. An area with fewer leatherjackets would also be advantageous so as to reduce the possibility of prawns being stabbed.

Care with bringing the cod-end on board is imperative so as to not bash the cod end against the back of the boat and tray. The cod-end should be lowered close to the sorting tray before being undone so that the prawns don't drop far to the sorting tray.

Sorting Tray

The prawns should be sorted straight into buckets of water on the sorting tray until being transferred to the holding tank. The holding system should be similar to the system in Figure A1 (also refer Fig 1 in main body of report). When sorting the prawns, only healthy vigorous prawns are collected for live transport. Any prawn that is soft, weak, injured, dirty gills or dead is rejected. It is a good idea to have a recovery swim tank set up on the deck. The buckets of prawns can be tipped into a holding crate that is sitting in this tank. Once the crate is full, it can be quickly sorted for dead or sick prawns before it is placed into the holding tank. Adequate aeration and/or flow through water must be supplied for the prawns in the recovery swim tank and the holding tank.

Holding Trays

The trays should be designed so that the prawns won't be injured. If prawns are overly active, crowded conditions can result in stress and mortality. Physical damage (i.e. leg loss) through holding in small plastic prawn crates is also an issue. In Queensland, deeper wooden trays are used. These are wooden sided, interlocking and have a black garden mesh bottom (example in Figure A1). The mesh is softer than plastic, so when the prawns flick, damage is minimal. Similar trays can be used here. Note that the trays must "lock" to each other and be fixed within tanks so they don't capsize or come apart. Also the trays must fit tanks at all stages of the operation - the boat, the storage tanks and the factory cooling tanks, as all prawn transfers occur in the trays.

Holding tanks

The holding tanks need to be big enough to hold 100 kg of prawns. Assuming a ratio of 1:10 prawn weight:water volume, this means a requirement of 1 tonne of water. The tanks should

have a lid that can be fitted over the last tray but this is not clamped down tightly while at sea (unless the sea is rough) and water is allowed to overflow.

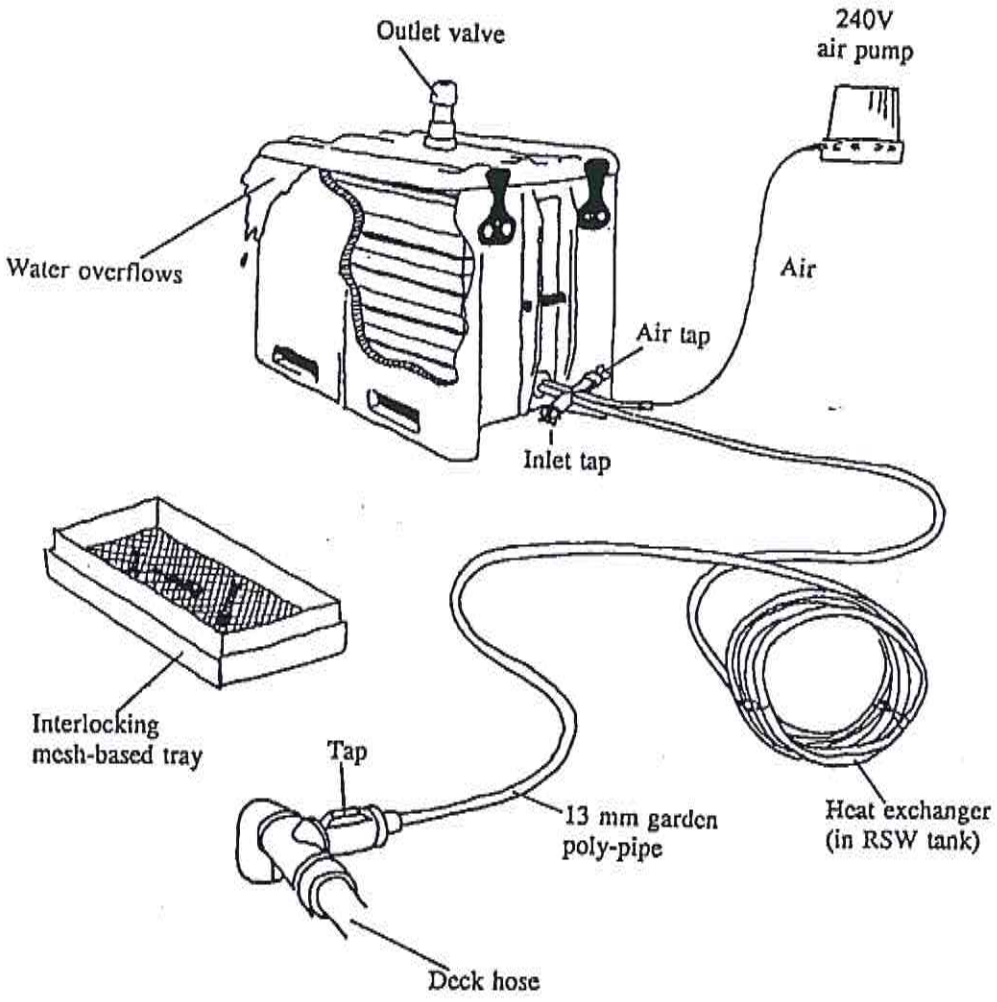
Holding tank temperature and control

The holding tank water should be 2-3 degrees below ambient seawater temperature to slightly slow down the prawns metabolism. Water is controlled using poly-pipe coils in the brine tank (Figure A1). The water temperature is regulated by adjusting the tap on the deck hose. The deck hose may need a manifold to allow continuous supply to all tanks containing prawns. It is important to remember to switch off the deckhose when entering port to avoid pumping contaminated water into the tank

Aeration

The most important part of the system as it needs to be vigorous and reliable. Water circulation and aeration is achieved using airstones or airwick placed in a frame on the floor of the bin and connected to a high capacity 240v pump. After several hours, it will be noticed that excessive amounts of foam appear on top of the tank. This is a good sign of protein denaturation and excess waste being removed via the aeration.

Figure A1. Holding tank for storing live prawns at sea.



Transfer

The minimum requirement is a tank on a truck with water at the same temperature as the boat tank and an oxygen cylinder with airstones for aeration. The trays can then be lifted from the boat tank up to the truck tank.

A better method is for the boat tank to be craned off onto a waiting truck. The airpump is simply disconnected on the boat, the tank lifted up to the truck where a waiting oxygen cylinder is plugged in to the airhose.

Storage

A storage tank is required to allow recovery of prawns immediately after arrival at the factory. This tank is set to the same temperature as the boat tank and setup in an area where the prawns will not be disturbed by activity in the factory. As the trays are removed from the transfer bin they are quickly checked for weak or dead prawns and these removed before the tray is placed in the storage tank. A dim light should be left on near the tanks so that the tanks can be checked regularly without stressing the prawns. Previous work on kuruma prawns also showed that leaving prawns in dark conditions resulted in higher mortalities and damage through cannibalism. After approximately 24 hours the prawns are ready to be packed. An added advantage of a recovery tank is that it also allows flexibility with meeting flights. Note: It is recommended that further research is undertaken in this area.

Cooling

The temperature range required will vary with season. The tanks should be capable of holding temperature at between 10°C and ambient. The trays of prawns are usually placed in the first stage cooling tank which is approximately 4-5°C below the storage temperature where they will sit for a minimum of 20 minutes before grading. Note: Cooling temperature drops will vary with the season. For example – summer water temperature of 23°C, boat storage temp 21°C, first stage cooling 16-17°C, second stage cooling 11-12°C; whereas in winter it may only be one cooling step - water temperature of 18°C, boat storage temp 16°C, first stage cooling 10-11°C with no second stage cooling. Further research is needed to determine the Western King prawns lower lethal temperature.

Aeration

An important part of the system as it needs to be vigorous and reliable. Water circulation and aeration is achieved using airstones placed in a frame on the floor of the tanks and connected to a high capacity 240v pump.

Grading

The grading table should be stainless steel and close to the cooling tanks. During this operation prawns are graded into sizes which are very large, large, medium and small. Any prawns that are dead, soft, weak or damaged in any way must be removed. Prawns should have their legs splayed as though they could grab onto your finger, and their head should be back with their back arched.

With king prawns, grading will occur at the higher tank temperature as the prawns are easily handled. Once graded (one size grade per tray) each grade goes back into trays and into the same tank. The prawns go into the final cooling tank for a minimum of 20 mins before packing.

Second Stage Cooling

As described in the Cooling section. Approximately 4-5°C below the first stage for a minimum of 20 minutes.

Weighing

Graded prawns are drained in tared baskets and weighed to 1.12kg (allowing for the water on the prawns) for 1kg nett boxes immediately before being placed ready for packing. These baskets should be plastic mesh to allow the water to drain but not cause damage to the appendages of the prawns ie long slots will break legs. The table should also have some form of drainage facility for the baskets.

Grading should occur at this stage as well. Any prawns that are soft, weak or damaged in any way must be removed. Prawns should have their legs splayed and their head should be back with their back arched. Excess baskets of prawns should not be stacked up instead it is best to just keep ahead of the packers.

Packing

The table should be stainless steel. On the table, each packer will need a plastic tray (solid bottom) big enough to hold an inner box, wood shavings and prawns; a bin containing wood shavings (a bin between 2 people); spray bottles; tape guns and a marker to write the count per box on the box.

Wood shavings

Hoop pine is recommended but *Pinus radiata* may be acceptable. The pine must be kiln dried, untreated and free of residues. The shavings are kept in the freezer until approximately 30 minutes before needed, then brought into the air-conditioned room.

Spray bottles

The spray bottles are filled with chilled seawater from the final cooling tank temperature.

Prawn packing

The bottom of the inner box is covered with a 5mm layer of chilled wood shavings at approximately 5-10°C.

The wood shavings are sprayed lightly with the cooled seawater. The prawns are finger packed in alternate head/tail configuration with care taken to avoid damage to the prawns. On the completion of each layer the prawns are sprayed lightly with water and wood shavings are added to fill the spaces and create a minimum wood shavings layer of approx 5mm between the prawn layers.

The prawns should be moving their legs when picked up and the rear legs should be well spread. Prawns which feel soft or weak or have their legs folded close to the head should not be packed but checked for strength by gently caressing the legs in a forward direction. Rejected prawns should be put aside and replaced at the end of the pack to make up the correct weight.

After spraying the top layer of prawns the hollows are filled with wood shavings. The box is closed and taped. The contents number and packer initials should be written in the appropriate position on the box and then the boxes stacked on the pallet or racks provided according to number of prawns per box.

Boxing

After completion of the packaging operation the inner boxes are placed in the outer cartons according to the number of prawns in each inner, ie all like counts are placed together as far as possible. The number of inners of each count is marked on the outer packaging of each carton on the label.

Freezer blocks must be frozen flat, otherwise will bulge and may not fit into the box. The freezer blocks must also be of a size where they don't cover any of the convection holes in the base of the coolant section. Freezer blocks must be removed from the freezer 30 minutes before being placed in the outer packaging and spread out flat on a bench to remove the specific heat and bring the coolant temperature up to approximately –5-0°C. If this is not done mortalities will occur in the top boxes.

Materials

At Sea

Buckets (for sorting and transfer to holding tank/s)
Swim tank
Holding tank with lid (with outlet valve) that can be clamped.
Inlet for air and water
Interlocking trays (must fit in all 3 tank types - boat, truck, factory).
Airpump/blower
Continuous supply of seawater from deck hose. If two tanks used, a manifold to allow water supply to each tank.
Cooling coil built into deck hose
Air pump/blower – reliable and able to supply vigorous aeration constantly

Onshore Handling and Packing

Storage tank
Cooling tanks (2)
Aeration (as above)
Sorting table
Balance (accurate to 0.00g)
Plastic mesh baskets (to hold 1 kg prawns)
Packing table
    Plastic tray
    Wood shavings
    Bins to hold the wood shavings (1 between 2 people)
    Spray bottles
Tape guns
Marker pens
Kuruma prawn boxes
    Gel Packs
    Inner boxes