Equipping the mud crab industry with innovative skills through extension of best practice handling

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OBJECTIVES:

1. Develop targeted information packages specific for different supply chain sectors acknowledging the various demographics involved
2. Communicate the specific information in the most relevant format for each sector
3. Demonstrate and guide industry implementation of best practice protocols
4. Achieve maximum adoption of best practice protocols throughout mud crab supply chains
5. Assess impact gained for industry

NON TECHNICAL SUMMARY

OUTCOMES ACHIEVED

Industry upskilled on best practice handling methods for the commercial sectors

- more than 85% of the industry from all sectors have participated in the extension events
- there was strong engagement with targeted content and an appreciation of communication methods used
- a very high proportion (91%) of participants indicated they had learnt something new
- strong ownership of information now exists within all sectors of the industry
- extension has fostered practice change within all sectors of the industry
- adoption of simple changes was often immediate, with further change occurring progressively
- the industry supply chain has developed a real connectivity, along with greatly increased cross-sectoral awareness, setting the basis for continued communication and interaction

Increased industry revenue return

- industry reports of at least 10% (and up to 20%) fewer slow and dead mud crabs at market
- therefore higher revenue return from the resource through a greater proportion of crabs attaining full price
- major wholesaler reporting a premium of $1/kg mud crab averaged across total product sold

- mud crabs have attained number one position at the Sydney Fish Market by value and volume
- increased end-user and consumer satisfaction with crab quality

Sustainable use of fishery resource

- sustainability of resource is improved through the large decrease in crabs wasted
- an additional outcome is new effort directed towards recovering mud crab otherwise rejected at market in a project supported through Seafood CRC funding
- the fishery sustainability is also strengthened by greater revenue return achieved for the same level of harvest
- the industry supply chain has developed a real connectivity, along with increased cross-sectoral awareness, setting the basis for continued communication

Industry profile improvement

- duty of care and responsible fishing practices visible to all
- the strong ownership of information within the industry will result in continued improvement

Extension Learnings - for future extension work

- it is important to develop trust with industry participants. This leads to strong links being forged with consequent increased communication success. Very strong linkage relationships are now established within the mud crab industry and can be used for ongoing improvement
- repeat contact was shown to be critical
- is beneficial to differentiate current extension by government researchers from industry stakeholders previous experiences
- use of Bennett's Hierarchy as a planning tool to develop specific sector approaches clarified extension focus

Mud crab is a highly valuable resource for commercial fisheries in the northern half of Australia, currently returning $35M to the harvest sector and an estimate of over $100M within the retail/restaurant sector. However, the resource is of limited size and this prescribes a need to maximise economic return for the same level of catch.

This project sought to achieve responsible use of resource through extension of Best Practice handling knowledge gained from previous research, along the entire supply chain from harvester to end-user. The new information was targeted to the different sectors with approach to communication made pertinent to specific sector and delivered in appropriate format. Extension occurred through:

- direct one on one contact
- small and large group forums of industry participants with a common interest
- printed articles and television formats to raise awareness of extension objectives
- presentations showcasing the extension work at regional seafood events
- hardcopy laminated factsheet guides incorporating visual information
- web-based video footage
- YouTube; and
- a DVD illustrating techniques of best practice.

The impact of extension was evaluated using Bennett's Hierarchy.

More than 80% of the mud crab industry has participated in the project. There has been strong engagement with extension content and an appreciation of communication methods by industry. Of the different approaches employed, the most successful was always one-on-one communication which is inherently responsive to the individual. The use of hardcopy material was readily accepted and it was observed during further extension visits, that this material was prominent onsite. Best Practice handling methods illustrated by DVD was highly valued and automatic ownership of content was evident when familiar, particularly self, imagery was present.

Adoption of Best Practice handling for mud crabs is at a high level. In many instances adoption of simple practice change was immediate, with consequent significant improvement in revenue return, and further change is occurring progressively. The impact of practice change within the industry is evidenced in the marketplace, with fewer mud crabs seized due to death and a significant reduction in downgraded crabs. The enthusiastic response from the end-user sectors of the industry has been palpable. The impact of widespread adoption of information extended through this project ensures consistent premium quality mud crabs in the marketplace. This underpins achievement of greater revenue gain for the industry through increased demand for product.

A robust connectivity has developed within the industry supply chain, along with greatly increased cross-sectoral awareness. This sets the basis for continued communication within industry and interaction in both directions along the chain. Strong ownership of information within all sectors of the industry now exists and adoption with continued improvement will result in positive public perception of the industry from recognised duty of care taken and responsible resource use.

KEYWORDS: mud crab, best practice, extension, supply chain, handling, premium quality

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- **Doug Neville**, President, Northern Territory Mud Crab Licensee Committee
- **Tony Riesenweber,** Chairman QSIA Crab Committee
- **Sherwood Thorbjornsen,** Managing Director Bevwood Crab Pty Ltd
- **Peter Jackson,** President East Coast Crabfishers Industry Network Inc
- **Gary Ward,** Chairman Gulf of Carpentaria Commercial Fishermen Association
- **Robert Pender,** QSIA Area 9 Representative
- **John Harrison,** Executive Officer Professional Fishermen's Association
- **Malcolm McLaughlin,** Managing Director, McLaughlin Consolidated Fishermen Ltd
- **Spencer Wilkinson,** Director, S H Wilkinson Pty Ltd.

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Background

Mud crab is the basis of a highly valuable resource for commercial, recreational and indigenous fisheries, extending from northern Western Australia, across the Northern Territory and Queensland into northern New South Wales. The supply chain extends to all mainland states and territories and there is a vibrant export market.

The commercial mud crab industry, currently returns approximately $35M to the harvest sector and has an estimated value $100M within the retail/restaurant sector. These values have been attained from consultation with key industry stakeholders within each state. Exact figures are difficult to ascertain as the usual source of such data collection, the Australian Bureau of Agriculture and Resource Economics and Sciences (ABARES) does not differentiate mud crab as a separate commodity, but rather mud crab production and value are included under the combined grouping of 'crabs' which also contains sand and spanner crabs. Over the last four years, the value of mud crabs sold through the Sydney Fish Market (SFM) has increased to number one positioning and sits at close to $10M. Current 2012 SFM data show that mud crabs are also the most important product commodity through the market by volume. These figures illustrate the importance of this fishery to the Australian seafood industry.

Sustainability of the resource, and its revenue, relies heavily on optimising its use. The fishery has a low production level and there is little opportunity to increase catch volume. Profitability within the fishery as a whole, does not reach its full potential due to high mortality amongst post-harvest animal and mortalities can be strongly correlated to poor handling practices throughout the supply chains (Final Report FRDC 2003-240).

The market relies solely on live product. Market price is mostly driven by crab liveliness, as measured by active crab and strong limb movement, and meat content. Slow, damaged or frothing crabs are either rejected or downgraded obtaining a lower price. Dead crabs are not only a full loss to the industry (through seizure at market as they are unsaleable) but also contribute to further mortalities within a consignment. Losses due to mortality throughout the supply chain have been reported as commonly around 10% and up to 35% in extreme conditions. A 10% loss to the QLD and NT commercial mud crab fishery represents 120 tonne of crabs per year, with a retail value in excess of M$3.6 per year.

The initial focus as the FRDC 2003-240 project was on the harvest sector where crabs are held in harsh environments and in rudimentary facilities (perhaps just a tarp) for up to seven days before transport to Darwin. It was suggested by industry that this was the major sector contributing to mortalities and where greatest gain could be achieved in modified handling practices. Having determined stress bio-markers, industry simulation trials in later stages of project work revealed that greatest gain in alternative handling procedures apply at the retail end of the supply chain. Within this sector information on best practice handling is extremely limited or non-

existent. It became evident that some industry practices at the retail end of the supply chain were actually harmful and causing unnecessary crab mortalities. Delivering best practice handling to the retail sector of Australia was outside of the scope of the original project and just not feasible with the time frame.

The supply chain from harvest to market for mud crabs can take up to 15 days. The physiological condition (moult stage) of the crab at capture also contributes to mortality with post moult crabs being most susceptible. The physical demand on the emersed crabs (those held out of water as is the practice in the fishery) throughout the supply chain is extreme and customers, whether they are chefs, seafood retailers, or consumers demand premium quality live crabs.

The major outcome of the completed FRDC research project No. 2003/240 was to identify how to maximise the survival of mud crabs through the supply chain to the end consumer. This was achieved through identification of stress biomarkers that were used as tools to understand which handling steps along the chain imposed the greatest stress on the crabs. Stress not only affects the well-being of the animal but also the ultimate eating quality of the product. Live seafood must be handled and transported with minimal stress on the animal throughout all stages to market.

With this information, alternative handling practices were developed to minimise mud crab stress and improve survival rates. These alternative handling practices have been prepared for inclusion into the new NT Code of Practice for mud crab fishermen and generally included:

- minimising the handling of crabs through the transportation
- minimising their exposure to breeze which was found to be highly stressful
- limiting sudden temperature fluctuation changes
- a recovery step at key stages within the supply chain.

During the course of the previous project, research findings were constantly delivered to participating industry sectors including regular presentations at NT Mud Crab Fishermen's Association's[1] annual general meetings. However, even within the time frame of the project information that had been extended to industry partners was lost due to people leaving the industry and businesses closing. Also during this time some information was passed on which was either misinterpreted or vital steps omitted, leading to greater crab mortalities. An example of this occurred after a brief discussion with a leading NT distributor and a licence holder enthused them to trial the recovery process on weak crabs and access the impact at the next stage of the supply chain. Unfortunately the information delivered was slightly misinterpreted and mixed results were obtained. The aim of this project is to broaden the coverage of the information exchange and instil systems and networks that will keep the information and alternative handling techniques active within the entire supply chain.

[1] Now the Northern Territory Mud Crab Licensee Committee

A major recommendation from this research was the inclusion of a recovery step within the distribution chain for live mud crab. Improved vigour and reduced mortalities further down the chain are achieved after a 2-3 hours recovery step where the crabs are returned to aerated water to allow excretion of accumulated ammonia. The timing and undertaking of this process is critical as if it is undertaken incorrectly mortalities are significant (up to 100%). Of major importance for broad industry uptake was the newly discovered information that if seawater is not available for the recovery step, town water can readily be used with comparable results. Importantly, no discernable difference in the flavour of the cooked meat was detected in town water revived crabs. This is a major breakthrough as in most instances those involved in the post harvest supply chain do not have ready access to saltwater to undertake this step, but freshwater is readily available. This step however is difficult to implement at the harvest, or wholesale stage, due to the logistical practicalities in undertaking the process for a large volume of crabs.

Harvesters, wholesalers and the retail sector involved in the research have reported that when the recommended alternative handling methods were employed (even without a recovery step) there was a 50% reduction in mortalities across the supply chain. Feedback from retailers has also indicated that overall mud crab quality has improved in relation to vigour, weight and flavour. Sustained adoption of the results from this project will result in improved market perception and reputation of mud crab quality, leading to greater market demand, better utilization of the fishery and increased revenue for the seafood industry in Australia.

This project sought to engage and provide support to the broader mud crab industry, including indigenous and recreational fishers, to actively utilise best practice handling protocol knowledge that has been attained, proven and welcomed from previous research findings. Target audiences within the mud crab value chain come from of a wide range of sectors, from harvesters to chefs. As such, information needs to be delivered in the appropriate format for each succinct sector and within each sector; different methodologies for each adult learning technique and demographics.

This was an industry driven project in response to industry demand for improved handling protocols for live mud crab which were developed within a recent research project (Final Report FRDC 2003-240). Isolated pockets of the Industry are now becoming aware that new information exists to achieve robust premium quality mud crabs. A limited number of stakeholders, directly involved in the previous work on increasing survival of crabs to market, are conversant with and utilising the recommendations arising from that work. However a number of these people have already left the Industry and information was not transferred or unfortunately transferred incorrectly). Extension of new knowledge needs to be clearly and accurately disseminated across the industry.

In developing the specific project design, there was extensive consultation with all sectors of the mud crab industry and supply chains. This was a nationally focussed project to achieve maximum adoption throughout the entire supply chain. The most

effective way to achieve maximum industry uptake of new knowledge was focal point of consultation.

The work effort within the project contributes the National Research Priority: *Frontier technologies for building and transforming Australian industries* and Rural Research Priorities of *Productivity and Adding Value* and *Supply Chain and Markets*.

Need

The mud crab resource in northern Australia is highly valuable but limited in size. This dictates a need to improve economic return to all sectors along the supply chain, including the harvesters. Critical aspects of the value-chain are:

- the fishery takes place in remote locations often with little or no infrastructure
- distribution chains are varied and often very long, with unexpected delays
- crabs reach market sale-point in varying condition
- sole dependence is for supply of live product
- market price is largely driven by SFM, where crab liveliness is a key price setting criteria
- acknowledged insufficient information of handling live crab by end-chain stakeholders
- current handling knowledge varies greatly between operators and is self taught by trial and error
- Industry personnel are of various nationalities and English is often not their first language.

The recently completed FRDC project delivered recommendations for best practice protocols to achieve premium quality mud crab. Only those few stakeholders directly involved in the project currently have access to that knowledge. From the limited implementation of the research findings, industry has reported an impressive 50% reduction in mud crab mortality rates. If information was further extended, this would equate to a revenue gain within the mud crab industry of >M$2 per annum.

To achieve maximum value-addition to the mud crab resource, there is a strong need to extend and support awareness of best practice along the entire supply chain. Specific handling procedures need to be targeted to the different sectors and communication with each sector to be delivered in various appropriate formats.

Ensured premium quality mud crabs available to the consumer and increased revenue by >10% to the industry can only be realised if best practice is correctly adopted throughout the entire supply chain. This project is designed to achieve that aim.

Objectives

1. Develop targeted information packages specific for different supply chain sectors acknowledging the various demographics involved
2. Communicate the specific information in the most relevant format for each sector
3. Demonstrate and guide industry implementation of best practice protocols
4. Achieve maximum adoption of best practice protocols throughout mud crab supply chains
5. Assess impact gained for industry

The project objectives were all fully achieved with a high level of industry practice change and adoption of new techniques across supply chain sectors. The impact of extension communication for engendering Best Practice has been assessed using the recognised evaluation framework of Bennett's Hierarchy.

Methods

Specific handling procedures for live mud crabs have been developed through previous research (Final Report FRDC 2003-240) with recommendations for industry Best Practice. The handling protocols were trialled with selected industry partners to confirm that techniques reduced crab mortalities and maximised crab liveliness and quality. Due to success achieved, Industry participants involved in these trials suggested that the new protocols need to be extended through *in situ* demonstration and follow-up, to targeted sectors along the entire supply chain from harvest point to restaurant, to maximise the benefit to Industry as a whole. Communication to each sector needed to be in an appropriate format most relevant to the specific sector and its demographics.

Methodology included:

1. Developing targeted and innovative information packages specific for different supply chain sectors, acknowledging the various demographics involved
2. Developing a flexible plan for delivery of targeted information packages, including risk mitigation allowing catch-up sessions for individuals and sectors unable to attend event presentations
3. Communicating the specific information in the most relevant format for each sector
4. Demonstrating and guiding industry implementation of best practice protocols
5. Achieving maximum adoption of best practice protocols throughout mud crab supply chains
6. Assessing impact gained for industry
7. Providing underpinning support for the national industry for trouble shooting and feedback

Scope of project

The goal was to achieve 80% coverage of key stakeholders within the supply chains. All sectors of the chain (harvesters, wholesalers, distributers and transporters; retailers and restaurateurs/catering sector with live product on the menu) were involved including locations of Manangoora Station, McArthur River, Roper River, Adelaide River, Maningrida in the NT; Gulf of Carpentaria, (including Karumba, 17% of QLD catch 2005) Cairns, Cardwell, Townsville, Ayr, Gladstone, Bundaberg, Brisbane in QLD; Northern coast and Sydney in NSW; Melbourne. There was limited extension interaction with the small mud crab industry in Western Australia and no communication with buyers or end-users in South Australia. There was specific extension communication with indigenous operations in Maningrida (NT) and Lockhart River (QLD).

An initial short-list of appropriate industry contacts has been developed through the previous research and while developing this project. This list was fully augmented and updated throughout the project conduction.

Industry interaction

It was important to contact and include as many industry participants handling live mud crab as possible and there was no peak body heading the Australian mud crab industry. Additionally, in Queensland there are three mud crab associations and a collection of fishers, including a large number of recreational fishers, not part of a peak body. To this end, extensive effort was directed towards compiling a comprehensive list of industry personnel and interconnections between groups and sectors. Additionally, distribution networks and supply chains were mapped.

Extension occurred through direct one on one contact; small and large group forums of industry participants with a common interest; media publicity – printed articles and television formats to raise awareness of extension objectives; and presentations showcasing the extension work at regional seafood events.

Approach and methods selected for communication with participants of non-English background and indigenous heritage followed the guidance suggested in the work undertaken by Jane Lovell and project team as part of the Australian Rural Leadership Program (Final Report, FRDC 2009-329).

Communication methods varied according to industry sector and target audience and included:

- informal contact - using intermediaries, phone or email - prior to visitations
- meeting arrangements and schedules determined to maximise information transfer coverage and minimise project costs
- practical face to face demonstration of best practice protocols *in situ*, along with guidance on implementation methods specific to business operation
- printed and laminated concise and brief hardcopy material – best practice guides in the form of factsheets incorporating visual material, specific and relevant to each sector of supply chain; factory wall posters, retail and

consumer handling recommendations, avoiding scientific language
- Sydney Fish Market Quality Grading Guidelines poster
- web-based information with video footage on YouTube hosted on several accessible sites
- stand-alone DVD illustrating Best Practice for handling live crabs.

Translation of information for both spoken word and text into Vietnamese and Cambodian (key players in the supply chain) was proposed as a likely requirement. However, through conduction of the project interacting with these different cultural groups, sufficient English was available for transfer of meaning for almost all parties. Inquiry and feedback from these industry participants indicated that physical translation into other languages was not needed and could be misleading in some instances if context was incorrect. This was obviated to some extent by the use of visual format to describe techniques wherever possible.

Assessment of impact of extension

Effectiveness of extension was assessed continually to evaluate how successful the information had been communicated and transferred within the industry. Assessment was initiated 10-12 months following start of the project to allow for industry absorption and up-take. Measurement was primarily qualitative resulting from verbal feedback and response during extension communications. However, specific quantitative data was obtained through paper-based and on-line survey of industry participants.

Key measures assessed were:

- Industry take-up and transference of knowledge to new personnel
- impact on fishery and supply chain practice changes
- reduced crab mortality rates
- improved robustness of crabs measured by a universal vigour index
- consumer satisfaction and feedback.

Impact evaluation was assessed using a recognised extension evaluation framework, Bennett's Hierarchy. This formalised structure for evaluation measures incremental change during, and resulting from, an extension programme through assessment at seven hierarchal steps along the continuum of activity. It is a clear indication of achievement success in attaining goals of the extension programme.

Results and Discussion

Section 1: Extension Preparation and Approach

1.1 Identifying target contacts and audience

A comprehensive list of key industry personnel throughout the entire supply chain was collated, and all personnel contacted. Strong interaction was established with all mud crab fishery peak industry bodies including:

- QSIA Area Delegates
- East Coast Crab Fishers Industry Network Inc.
- Gulf of Carpentaria Fishermen's Association (GoCFA)
- NT Mud Crab Licensee's Association
- NSW Professional Fishermen's Organisation
- Queensland Seafood Marketer's Association

1.2 Distribution pathways mapped

The supply chain pathways of mud crabs from harvest location to consumer are many and varied. They can be simple, with two direct steps harvester to sale point, but are often complex with multiple steps (up to fifteen), involving many separate hands. Schematic distribution maps were prepared for review by supply chain participants.

An example of a relatively simple distribution chain is from Moreton Bay to southern markets (Figure 1). However, what appears to be a fairly straightforward distribution chain can still have more than 10 individual handling steps before a consumer sees a crab:

1. crab in pot
2. boat transport to port
3. road transport to fishers facilities
4. road transport to wholesaler
5. road transport to airport
6. air cargo transport to aircraft
7. air flight *****
8. aircraft to air cargo
9. road transport to market or dealer
10. road transport to restaurant or retail outlet
11. road transport to consumer

****** if connecting flights are involved steps 6 to 8 are repeated*

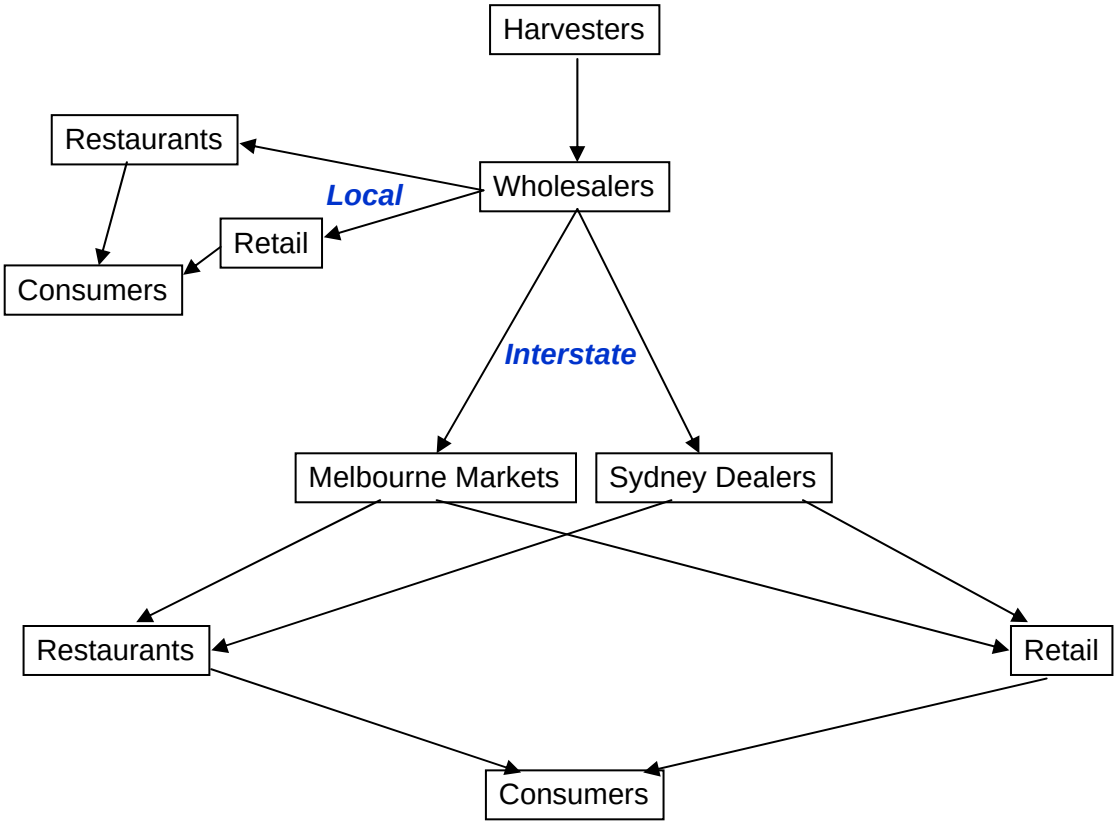

Figure 1. Moreton Bay distribution chain.

The interstate supply chains from the Northern Territory not only cover great distances but are also complex with many agents involved (Figure 2).

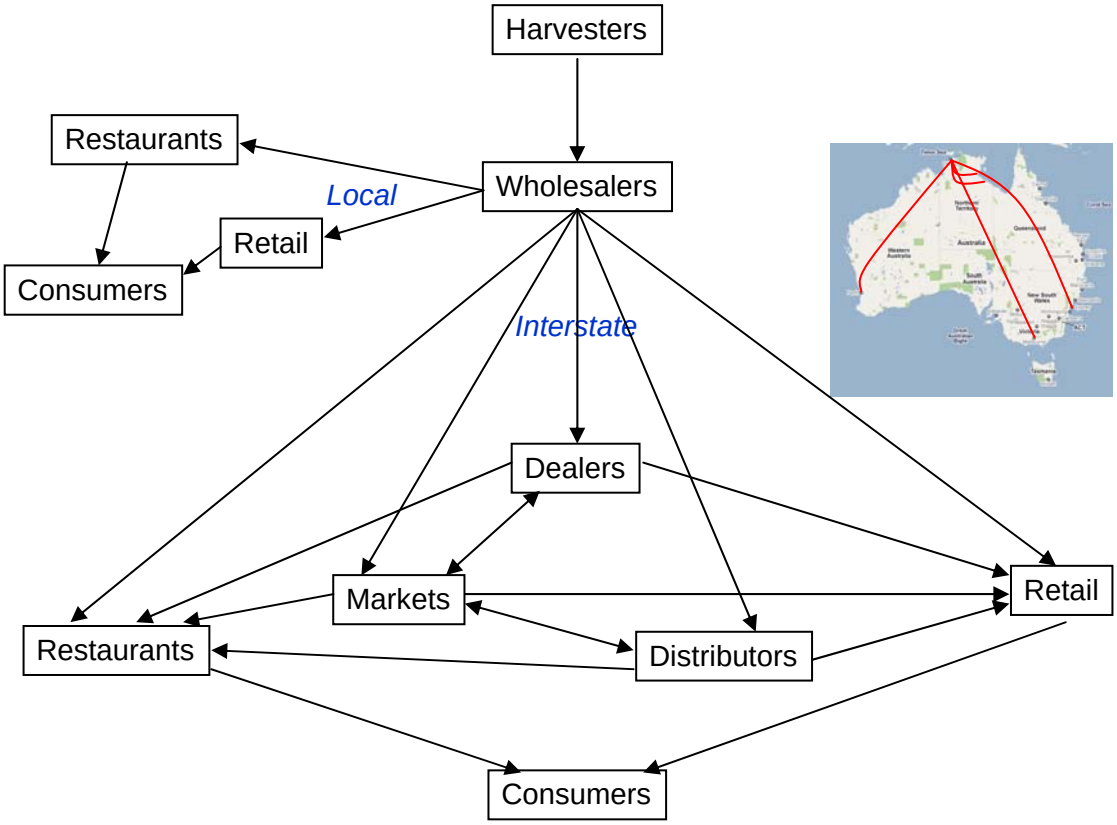

Figure 2. Northern Territory distribution chain.

There are frequently further complications of split catches (where crabs from one harvester are split through two different supply chains), additional agents and more transport steps involved with the added effort of consignments being shipped between different state markets, dealers and distributors.

Future markets driving new distribution chains

Distribution chains for the supply of mud crabs within Australia continue to be explored and developed. Markets are constantly expanding and adapting in response to supply and demand together with improved handling mechanisms that are ensuring alive and kicking mud crab. Examples of new or renewed supply chains include:

- Mackay to Hong Kong and Adelaide
- Darwin to Adelaide, Perth and Singapore
- Broome to Sydney
- and all sectors developing alternative markets in Melbourne and Sydney.

Continued communications of the concept and detail of the supply chains to different industry parties was deemed critical to motivation for care in handling of mud crabs and improving quality of crabs to the consumer. Isolated harvesters in the western Gulf of Carpentaria (NT) have gained a new understanding of the breadth of the supply networks and the vast distances, time and varied hands their crabs go through before reaching a consumer. Even in relatively short supply chains, as in NSW there has been a need for all stakeholders to be aware of the different stages

and many operators that exist to market. Supply chains in frozen product have also expanded with the introduction of a NT frozen product to high-end restaurants and various harvesters experimenting with cooked and green frozen product for smorgasbord restaurants.

1.3. Extension communication hurdles recognised

Several hurdles were identified that required addressing to achieve greatest success in communication:

- *how to change views of harvesters who think they are doing the best practice?*
  - gain their trust and respect through listening and encouragement
  - distribute widely best practice information to the supply chain

- *what is Best Practice? Every aspect from capture to product distribution varies between individuals: tie crab immediately or delay; store below deck or in hessian lined crates on deck; storage environment at camp; wet/dry/hessian/no hessian; maintenance procedures during storage – dunking/hosing/light spray, checking, pre-shipment grading practices, distribution practices*
  - addressed through gently correcting misplaced beliefs and adapting discussed information to individual operation
  - providing scientific evidence of impact of the range of variables that lead to mortalities

- *different languages – overcoming barriers. English is not the first language for many stakeholders. Poor literacy and numeracy skills are evident across all sectors in the industry.*
  - pictorial / visual formats used
  - everyone had some sort of access to basic translation available for simple information

- *most crabbers, if not all, had never seen the NT Crab Fishermen's Association Code of Practice, although they did think it is good to have one*
  - during follow up trips the new augmented Code of Practice was presented and distributed
  - liaise with peak body to improve distribution chain

- *co-operative approaches can reap benefits in efficiencies - harvesters are thinkers*
  - co-operation between individuals and disparate groups has been encouraged and where appropriate facilitated

- *mistrust between operators – individual knowledge is power*
  - this is related to individual competitive advantage and mistrust will take time to overcome. Each harvester thinks he has some secret method that gives him an advantage. Discussed the wider picture for whole industry and wider outcomes of greater mud crab consumption and demand for

product if premium quality can be assured and minimal negative experiences occur at the buyer/consumer end of the chain

- *wary of, or frustrated with, government officers and researchers*
  - harvesters complain about the total lack of feedback from other past research projects
  - best endeavours to counteract this through our attitude and practicality of information transferred. Worked to gain acceptance and respect for our industry understanding and knowledge

- *the quality of refrigeration systems in bulk transports to Darwin is variable*
  - engagement of transporter in this extension project, continuing to regularly interact with positive results

- *storage prior to transport loading can be in full sun after bouncing around on the back of a 4WD, either covered under a tarp or no cover at all*
  - ensured relevant industry members aware of correct practice, reinforcement helps

- *grading crab that have already been graded by harvesters and so carapace segment weakened thought to cause problems – yet there is a need to tell that grading and sorting is good practice*
  - re-iteration of gentle handling, pressure needed sufficient to test
  - always encourage them to look for other indicators

- *incorrect interpretation and application of new handling practices can result in loss of product*
  - wherever possible use repeated physical demonstration, follow-up important

- *lack of continuation or resourcing of avenues for ongoing support and information*
  - *physical information outputs will assist for the best practice protocols*
  - *but ensured offering our availability as an on-going process, provided options for contactability*
  - *look to social media options that have longevity*

1.4 Adoption and impact

The major measure of success of communication of Best Practice for handling mud crabs throughout the supply chain will be quantified data with respect to fewer mortalities and less 'down-grading' of crabs at sale. Few businesses will have documented records available to undertake this analysis, but the major wholesaler (Sydney Fish Market) do keep mud crab quality records and have kindly offered to allow us access to these (under a Commercial-in- Confidence agreement).

1.5 Communication and Approach

Communication methods required
During early contact periods, it was determined that different methods of communication, material, education and follow up would be required for each industry sector to ensure the success of extension and ongoing aspirational outcomes.

Feedback on communication methods/format
Much discussion was held on the preferred information delivery options for different sectors and the following was recommended:

- face to face
- DVD suitable format for fishers, retailers and restaurants - English language was acceptable
- multi-media productions – presentations, videos
- fact sheets (laminated) – presented in English acceptable - all have someone to translate them
- full FRDC Mud Crab Survival Report
- practical demonstrations - better to demonstrate eg. a simple double tub spray holding system. Demonstrating information via DVD or YouTube format also thought worthwhile as have time to consider at a later stage, show other individuals, and/or repeat sections
- on-line web-based source or physically distributed.

Stakeholder matrix
Each industry sector (stakeholder) required a separate targeted focus. The proposed tangible communication tools included, but were not limited to, those presented in Table 1.

Table 1. Communication tool for different industry sectors.

Sector	Challenges/Considerations	Proposed Communication Tools
Harvesters	The harvesting sector of the industry is comprised of individuals from widely varying cultural and educational backgrounds. Additionally, degree of operational isolation and level of infrastructure resources prescribe the relevant communication method likely to achieve success. Consideration was needed to all these factors in selecting information format and approach.	• Face to face • printed recommendations with strong visual depiction • DVD – multilingual, subtitled, peer reviewed. Also need to respect low technology levels ie. not reliant on computer driven delivery, only DVD player
Wholesalers and	Within this group we have included wholesalers, Fishermen's Co-ops, and distributors. The stakeholders within	• face to face • summary information in poster format – full visual

Distributors	this sector range from large companies to one or two person operations and form a completely different category to harvesters requiring a separate targeted approach. Communication frequently occurred in conjunction with speaking to the harvesters and in most situations this worked extremely well as the wholesaler gained an understanding of the harvest Best Practice.	depiction of quality parameters and small bright coloured reminder formats (e.g. acceptable temperature). Such format can be readily displayed in appropriate location within pack-out rooms, factory holding and similar • printed format – Fact Sheets of handling recommendations specific to sector for inclusion in standard operating manuals • DVD – potentially useful for illustrating some aspects of holding storage and similar. These are then readily on hand as an information resource for individuals within the other sectors of the chain
Retailers and Restaurants	These end sectors of the supply chain require most assistance as the cumulative stresses in the crabs are now at their highest levels. Detailed handling options including a recovery step for the crabs, would need to be demonstrated as well as hard copy material developed and delivered. Within this sector, different levels of staff seniority are involved and hence various communication formats are appropriate. Consideration of formats most effective for different handling protocols were required.	• demonstration of the recovery procedure and alternative holding systems • series of posters; various messages and formats – various sizes (some laminated) • printed recommendations - specific to these stakeholders • DVD – multilingual, subtitled, peer reviewed. Also need to respect medium technology levels ie. not wholly reliant on computer driven delivery • Internet material to be considered eg. YouTube, PDFs, Blogs • point of sale material describing provenance to be investigated

General communication approach

On first contact with industry members, the project and its objectives and goals were introduced, along with explanation of why the project was being undertaken, its scope, and that it was based on previous research about reducing mortalities and improving quality and survival in mud crabs.

The basic fundamentals of handling and holding crabs would be emphasised:

- cool and constant temperature
- avoid sun, light and breeze
- minimise handling and disturbance
- maintain moisture at all times so gills never dry out
- minimise noise
- remove dead crab as soon as possible
- keep flies away
- weak crabs are unlikely to survive further distribution.

These points generated much discussion and many individual viewpoints were expressed. Where opinion was at variance, the results from the previous science research was used as the defining platform. Printed material was handed out to reinforce and consolidate what was discussed, including the Mud Crab Survival Report (Final Report, FRDC 2003-240) to select individuals or groups that can and would read it. The Handling Recommendations and Fact Sheets were provided to all.

Continual improvement communication considerations

Where and whenever possible it is important to take the time to discuss and document interactions. Each field trip day is so filled with activities, experiences and information exchanges that it is critical to capture details as close to the source as possible. A reflective learning approach facilitates this process (Figure 3). Delivery mechanism successes and failures can be identified preferably on a daily basis, thus improving the next interactions. Photographs are particularly useful in recapturing a situation at a later date.

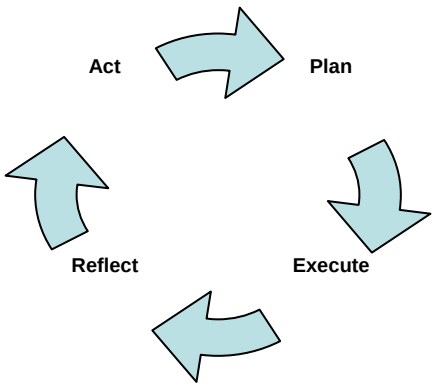

Figure 3. Reflective learning cycle important in the field.

1.6. Communication undertaken

Reactive communications

Communication occurred variously with individuals, small groups (either within a supply chain sector or across sectors) and in larger forums (often as an adjunct to a general fisheries meeting). Discussions of content and style were modified according to the situation and also modified on-the-spot directed by initial reaction/response

from the participants. It is abundantly clear that to gain maximum response, communication in small groups (or individually by preference) was the most effective. In large groups, response and interaction was inherently restricted to confident out-spoken individuals with the rest remaining silent.

During discussions, it was evident that it was important to seek information and clarification on why and how certain things are done within mud crabbing operations as these can be quite operationally specific. Another important observation was the very positive reaction and 'ground-gaining' achieved when commenting on things that were already happening that fall into Best Practice. The attitude and responses from the participants is important to watch as many (especially those who operate in isolated regions) are cautious of strangers and especially 'government' people.

Through direct interaction with the different sectors along the mud crab supply chain it was clearly evident that different methods of communication, information content level and relevance, delivery format and interactive follow-up would be required to ensure the success of information transfer from science outcomes to industry understanding and implementation.

Practical demonstration

For particular aspects of the handling protocols presented, practical demonstration was invaluable. This occurred with mud crabs brought to the meetings by the harvesters and relevant points or examples could be illustrated on the spot. Such demonstration frequently engendered lively discussion between the participants (with much contrary opinions offered), however with further discussion among themselves and gentle addition of information from us – common agreement was reached. For those aspects that could not be physically demonstrated, short video clips also proved highly successful and palpable understanding ensued.

Benchmarking baseline practices

It was evident that handling methods are often dependent on geographical location and degree of isolation, as well as historic factors such as facilities, business relationships and individuals' pre-conceptions. This was clear within all Qld, NSW and the NT fisheries. Specific operational procedures varied widely between and within sectors. An overview of the range of practices occurring across the supply chain was obtained. Qualitative data (limited as it is) was collated to establish a baseline understanding of crab condition within the supply chain.

Extensive interaction occurred across a wide range of industry participants from those with many years experience of mud crab fishing to new entrants.

1.7. Industry participants involved in extension and methods

Industry discussion meetings

Presentations were made formally with PowerPoint, followed by group discussion sessions at:

- NSW Fishing Co-ops – n= 9

- Ballina to Newcastle – 50 people
- Mackay - 4 people
- Townsville – 80 people
- Karumba – 50 people
- Cairns – 25 people
- Ayr – 11 people

Similar session was not held in the Northern Territory due to there being no centralised location for gathering industry members together. This section was approached on an individual or small regional group basis.

Direct face to face

- Harvesters (n=111) – new and renewed contacts – very keen for any information at all, evident that impact made and curiosity spiked
- Wholesalers (n=32) – mixed level of interest
- Retailers (n=40) – mixed level of interest, less in Asian outlets
- Restaurants (n=16) – most too busy, some interest and most successful when delivery combined with a trusted supplier.

When dealing with individual stakeholders, discussion is based on specific handling methods. It is important to listen to them first to recognise their wealth of experience. The approach is to support and add extra information (or corrections) as needed. If they are still interested or asking questions - add more information. Sometimes this gets lost – through overload. Small chunks of information are more effective. Verbal discussions are better supported by printed material.

Fact sheets

Five fact sheets specific to industry sectors have been widely distributed and this was a preferred format according to feedback. Fact sheets uploaded to various industry web sites. A further fact sheet on grading live mud crab was prepared due to requests from Industry and distributed to a few key people for feedback. Responses were mixed and it was evident that the issue was greater than could be dealt with by just one Grading Fact Sheet for the entire Australian mud crab industry. This grading issue has since been addressed through funding and support by the Fisheries Research and Development Corporation (Project 2011/225 Tactical Research Fund: Using Industry Expertise to Build a National Standard for Grading of Live Mud Crabs – see discussion 1.8 below).

In response to direct demand from Industry, an additional fact sheet was developed on testing live mud crab for meat fullness using a refractometer method. This was only provided to particular industry operators on the basis of capability to use correctly. Before wider distribution of this tool can be permitted, the relationship between crab blood protein and meat fullness for mud crabs from different growing environments requires validation.

Code of Practice

The 2001 version of the NT Fishermen's Association Code of Practice was reviewed and updated by the project team, Lyn Lambeth, SeaNet's Extension Officer, and

Doug Neville, Chairman, NT Mud Crab Licensee Committee. The new 2011 version has been widely distributed throughout the Northern Territory and to other Australian industry members.

During visits to Queensland and NSW industry stakeholders there was a strong indication expressed by all to have a similar code produced for Industries specific to both these States. The previous Code of Practice had lost relevance over time and was generally not readily available to NT harvesters and wholesalers. The new code has been distributed to all NT stakeholders, in particular to all harvesters. Delivery to harvesters in remote locations was done on a one to one basis to maximise impact, ownership and gather feedback (Plate 1). All harvesters, despite language barriers, responded very well to the updated format and content. There is no doubt with project staff that the document will be well read and benefits to the industry gained.

Best Practice Project Final Report

Copies of the full final report (Project 2003/240), '*Maximising revenue within the Northern Territory mud crab fishery by enhancing post-harvest survival of mud crabs*.' Poole et al 2008) continue to be distributed to interested parties – 41 in total to date.

Plate 1. One-on-one discussion with mud crab harvester.

Media exposure

Ongoing collection by media monitors was part of this project. Exposure has occurred in the following:

- Ministerial Statement - The Honourable Tim Mulherin, Minister for Primary Industries, Fisheries and Rural and Regional Queensland (Tuesday, 24th May, 2011) "*Arrive alive - helping industry prevent crab losses in transit*"
- demonstration at Mackay Regional Parliament with Minister Mulherin (Tuesday, 24th May, 2011) (Plate 2) 4000 attendees, additional 750 Fact Sheets distributed to public

Plate 2. Minister Mulherin and John Mayze at Regional Parliament.

- ABC Regional radio interview (Tuesday, 24th May, 2011)
- 2 page article in Queensland Seafood (2011 Number 1) covering some of the Fact Sheets. 'Mud crabs: careful handling increases survival and quality.' Distribution - 732
- SeaNet's Lyn Lambeth radio interview ABC Darwin - Guestroom (Feb, 2011)
- DEEDI Direct newsletter (2nd June, 2011) "*Crab research to save industry money*"
- News@DEEDI (10th June, 2011)
- high profile food television show, Alistair McLeod's 'Off the Eaten Track' featuring North Queensland seafood (Series 1 episode 1 segment 2). A high profile mud crab harvester was interviewed on mud crab quality and Best Practice

1.8. Additional finding

Although outside the scope of this extension project focus, it is notable that there was a compelling need for a universally agreed grading system.

Throughout all discussions with industry stakeholders it became abundantly clear that the main stumbling block along the supply chain was the grading of mud crabs into various classes for market. Different interpretations of grading standards for live mud crabs between harvesters and buyers is highly emotive and greatly impacts industry revenue and relationships throughout the supply chain.

The current grading employed by harvesters and wholesalers is historic and now adapted to the grades required by the Sydney Fish Market (SFM). SFM have led the industry in this area with the initiative of setting defined parameters for different grades of crab to underpin the SFM quality assurance system. The motivation from SFM to be proactive arises from live mud crabs being their most valuable product

through the auction market and, one of the most problematic seafood commodities (Plate 3). The main basis of controversy with mud crab quality is grading disagreements.

Plate 3. SFM auction floor pre-Easter, 700 crab boxes!

Whomever we spoke with, at whatever port or venue – all revealed a high level of confusion with respect to the definition of parameters that differentiate crabs between grades. This was especially obvious and strong within the harvester, wholesaler and buyer sectors but was also evident at retail and consumer level. Within the harvester sector, while they are all aware of the SFM grades, all interpret them individually. At several meetings we were called on to adjudicate on whether a particular crab was an 'A' Grade or a 'B' Grade crab. We were fortunate with this as we have developed a total blood protein level index that objectively separates crabs between the grades, as per the NT grading system, very effectively – so this was not solely based on our opinion.

The harvesters were frequently astonished at how many of their crab that they graded as 'A' under the traditional 'underside' press test were actually 'B' grade. During these times there was enormous dispute between the harvesters on what the crab should be graded as. Given the confusion that exists at the catch end of the chain – it is little wonder that crabs are 'down-graded' at the SFM (Plate 4). This event happens so frequently that it gives rise to 'conspiracy theories' amongst the harvest sector against their main wholesaler.

Plate 4. Rejected female crab visibly not 'A' or 'B' grade.

Clearly – there is an urgent need for common agreement and development of a universal Australian grading system. The importance of this issue has been recognised by the Fisheries Research and Development Corporation and is addressed through successful funding support (FRDC project 2011-225 Tactical Research Fund: Using Industry Expertise to Build a National System for Grading of Live Mud Crabs) to develop a National mud crab grading scheme.

1.9. Major observations

Critical points strongly evidenced during industry communications:

Information – industry members love it and want it, however the majority won't actively seek it out themselves. When information is taken to them, they respond with alacrity and readily respond interactively, always indicating a situation of wanting more. Diversity of information material needed to meet all sectors and individuals needs.

Supply chain connectivity – previous total lack of this mostly due to unawareness of other sectors and their roles rather than isolationary attitude. However, the extension within this project work has raised awareness enormously. Each sector has gained concept of forward and previous handling and requirements:

Prime examples:

- isolated harvesters – once the crabs had left their camps, they no longer 'existed' to them. This has changed to an understanding of the complexity of the supply chains and an improvement in handling procedures and product quality has been observed
- wholesalers – improved polystyrene box adaptations to allow for temperature variations on route, improved packing of crabs to reduce crab stress, increase revenue and to match the buying behaviour of clients

- retailers – previous lack of knowledge of where crabs are caught or stresses they are subjected to – realisation has resulted in an increased care factor illustrated
- restaurants have been made aware that crabs do not come from just up the road, however in general, little change in handling practices are evident to date with some notable exceptions
- a clear learning illustrated through follow-up interaction with the harvesting sector in particular, was the existence of multi-stepped communication pathways. In some instances these paralled the supply chain paths but in other instances there were clear blockage points occurring. One of the prime examples of this arises from the Licence holder (owner) not necessarily being the harvester directly involved in the fishery. The licence is frequently fished on a lease arrangement with separate individuals. This affects communication flow as peak body associations extend information to the Licence holder who may, or may not, pass on to the lease operator. Such blockage was substantiated with lease operators in the NT fishery where harvesters had not laid eyes on the existent Code of Practice or Fact Sheets. This again emphasises the importance of through-chain connectivity and we made strong efforts to surmount blockages through ensuring direct interaction with each sector.

Direct feedback received - some examples of comments:

- follow-up visits to some Co-operatives (Port Macquarie) - "*They* (SFM) *know we know things now, so they're treating us better.*"
- Samies Seafoods customer feedback – "*crabs really strong and active*"
- George's Seafood customer feedback – "*crabs sweeter than usual*"
- Robert Pender – "*just wanted to let you know that the guy I sell my crabs to has told me that my crabs in particular are the most lively and hostile creatures they get from anywhere, he said his staff are terrified of them because they are so strong. This is a terrific improvement, still incurring marginal losses, but it is very hot in the Gulf at the moment*"; "*just wanted to let you know that I have handed out a lot of the information papers you sent up and they have been well received thankyou*"
- Mark Kleinschmidt – "*tried the recover procedure and had to get the whole family to help pack the crabs as they were so lively*"; "*over the moon*" mortalities now <2%, wants to develop alternative markets
- extract from a stakeholder's letter providing really good feedback to the QSIA "*If it is purely an economic problem that we are looking at reducing effort for then to me that is a marketing problem. The Government has experts out there to help us with that. I personally believe there is too much emphasis on the live crab market - what other markets are available in the world for blanched crabs being snapped frozen and cooked fresh when product is scarce? Or frozen cooked mud crabs that are suitable for smorgasbord - again at the time of year when product is scarce? I am sure you guys could come up with some other*

value adding ways that we could get Government to look at how we market out crabs."

- Malcolm McLaughlin congratulating us for doing worthwhile extension. "*Should be more of it*"
- Minister Mulherin's office – "*Kate Lennox has asked me to pass on the Minister's thanks for today's crab event. They were very happy with the display and John as a media talent.*"
- Darwin Fish Market – *"Well done, thanks for thinking of us...the fact sheets look fab and well informed for Consumers + us. A project long overdue*"
- buyers aware harvest sector understand best practice and that it is being adopted

Retailers Feedback

With respect to communication format, by far the most effective was direct face to face discussion and it was important to include retail staff as well as the manager/owner. Most retailers responded keenly to delivery of information on what was happening within the crab when they received it, with common reaction being:

- "*I had no idea*" "*Really? .. Gosh! …*(or similar)"
- "*so what exactly do I need to do?*"
- *"can you set one* (spray tank) *up for me?"*

1.10. Outcomes

Face to face direct communication was by far the most successful method for attaining absorption of information, whether on an individual basis or in small groups. It was noted that within a group situation there were obvious leaders amongst those present. However, the quiet attendees had absorbed all the information as evident when spoken to individually after the group session and were eager to discuss further on a one to one basis. This illustrates the importance of the communicator allowing and responding to a range of personality types to achieve greatest success.

Access to technical expertise

From frequent contact and interaction with industry members to extend knowledge and encourage adoption of best handling practice of live mud crab, a clear need evidenced for additional technical expertise to assist the industry operationally. Surmounting initial negativity, we have gained a high level of acceptance with respect to being an information resource for the mud crab industry. Providing practical information and simple action suggestions for adapting current handling practices resulted in recognition that we were 'useful' and a direct, easy way to gain real information. This again emphasises the value of the face to face communication method. A large portion of industry members do not have ready access to simple relevant information and are not motivated to search it out even when available. When presented to them in easily digestible format with the ability to discuss on the

spot to resolve misunderstandings, they 'lap it up' and demonstrate true duty of care behaviour. After all, this is their livelihood.

Adding Value – Crab Fishery review (Qld)

From recognition of our knowledge with post-harvest aspects of mud crabs, we have been invited to participate in the Queensland Review of the Crab Fishery which presents another structure for information communication to the industry.

Market expansion

- business decisions – greater market penetration due to more robust crabs. New markets reported in Adelaide, Perth and alternative markets developed in Sydney and Melbourne
- trialled NT product to high-end restaurants - blast frozen mud crab in 10kg branded boxes
- export markets opening up
    - Mackay Reef – exporting to Hong Kong – increase in confidence as they receive well handled crab in prime condition
    - Bradley Seafoods – has developed local markets and is ready to enter the export market depending on available product
    - Moreton Bay processor looking at developing contacts in New Zealand
    - Darwin wholesaler export to Singapore.

Once direct contact was made and credibility gained, we were flooded with questions on all aspects of mud crab handling, processing – and the fishery itself!

Printed material - Major wholesalers

Sydney Fish Market staff have been involved in harvester meeting discussions throughout the NSW coast which presented a strong co-operative supply chain approach to the industry. This strengthened communication impact with the industry members by demonstrating clear transparency among players with disparate agendas. Within the Melbourne Fish Market, the communication format of Fact Sheets and the Handling Recommendations were found to be highly successful.

Harvesters

A specific sector of the harvester group are those whose first language is not English with this group having greatest representation within the NT mud crab fishery. For communication of best practice techniques, and especially science-based information, this presents extra challenges. Several salient points have evidenced through progressive discussion with these harvesters:

- face-to-face discussion – important to listen (!) and allow expression of their viewpoint first. An initial approach that worked well is to support the proffered statements and add extra information (or corrections) as needed. It was found important to use English-language words that individuals could relate to and

understand even where the actually term may not be 'officially' or scientifically correct. Time and effort was well spent in developing a common agreement as to meaning of particular terms and what was meant or referred to when that term was used. This was especially important with words describing the condition and robustness of the mud crabs. As discussions continued, there were times where conversational connection got lost and it was apparent that this usually occurred when a point of information overload was reached. Presenting small bites of information with frequent natural breaks when moving topic was more effective

- printed information format – brief fact sheet style - acceptable but needs to include strong visual depiction along with the written words. Visual 'right' and 'wrong' pictorial posters were considered and discussed, however lack of physical infrastructure at many remote harvest locations impedes display
- DVD format and You Tube– also acceptable with the restrictions of needing to be mostly visual with minimal explanatory voiceover and short in duration. A further limitation is low technology level available – not computer reliant, DVD player only. Additional consideration with this format is inclusion of multi-lingual voiceover or subtitling thereby illustrating respect for individuals' culture. Awareness was gained that strong benefit would be gained from industry peer review of the content presentation prior to release
- we gained trust with harvesters and have established extensive long-term networks.

1.11 Issues evident but outside scope of this project

The interactive communication between industry and scientists that occurred during this project resulted in industry raising many operational and fishery issues with us. The subjects were broad ranging from specific technical queries to whole of fishery management concerns, as listed briefly below. Technical queries (denoted by an asterisk *) have been actioned on the spot or with subsequent follow up information provision. Fishery issue concerns are beyond our realm of expertise but have been raised with appropriate State and Territory managers.

Technical issues

- cooking /chilling – best protocol *
- product format requests – not only live – diversify product range to market: frozen portions or crab sections; cooked and vacuum-packed etc
- Melbourne Fish Market – had issues from the RSPCA – tied crab is 'cruel' (!) *
- use of Aqui-S to sedate crab while handling - keen for trials (Clarence River Co-operative)
- ammonia issues in crab holding tanks (Mackay) *
- increased crab mortalities associated with environmental influences – floods, cyclones and earthquakes

- retarded growth rates of crabs from Wallis Lakes – small crabs up-river don't grow and even large size crabs take very long time to harden – queried why
- development and support for the Western Australian mud crab fishery – particularly on the different species of *Scylla* captured within the fishery and its robustness for long distance distribution transport
- technical advice for retail tank set up and maintenance (Tuncurry and Port Macquarie) *
- guidance for crab holding enterprise in NT *
- consideration for closed season based on 'weaker crab', social needs and major safety issues during wet seasons
- request for advice from Fresh Export Company, Madagascar – request for further information on fattening crabs and future sharing of knowledge *

Whole of fishery issues:

- Queensland female take
- recreational fishing rules
- poaching resolution
- dedicated Client Service Manager for whole of fishery industry government interactions

Section 2: Extension Interaction

In this section, Background, Observations, Activity, Learnings, Feedback and Outcomes are reported in a logical and chronological order of each extension interaction (trip) within each location within each State, within each Sector.

2.1. Harvester Industry Sector

Communication occurred through direct contact and discussion, with sector representatives transferring information more widely to those individuals unable to attend meetings. Coverage included Harvesters operating along the full Queensland seaboard from Gold Coast to Karumba, including Weipa, as well as the major harvesting locations of the NT western Gulf of Carpentaria (Plate 5), Maningrida and Northern NSW.

Plate 5. Fishing regions of NT Gulf of Carpentaria

Feedback

Harvesters were keen to know which buyer purchased their crabs. This emphasised the importance of showing (via DVD), the beginning of the supply chain and what happens at the end (SFM), along with the auction process, QA grading and the process of disputes raised by buyers.

Main responses to project objectives after initial contact:

- response to a paper survey to gain information on industry operations was highly successful with >60% return – a great outcome (example survey form sent to supply co-operatives is in Appendix 3 attachments)
- Area Delegates willing to organise special meetings or suggested meetings are linked with port visits to assist extension
- there has been direct input by key industry personnel into project operational structure and methods for greatest effectiveness of extension
- wide buy-in by all, whether experienced fishers or new to the industry, to establishing a greater knowledge base
- facilitation offered to access different supply sectors including consumers for example: arranging all local industry members to be at one premises for project team demonstrations; offer of co-activity at regional Seafood Festivals
- increased awareness of the whole supply chain. Many fishers were not really conscious of market and consumer end and are keen to know more

- very strong interest in the use of temperature loggers from harvest through the chain – to gain understanding of what happens to the crabs and active buy-in to project involvement.

Harvester attitude:

- leasing a licence is a different commitment to owning the licence – illustrated by several who have leased for years and have moved to buy a licence
- this causes exacerbation of communication issues/breakdowns – due to differences in drivers and perceptions

Locational differences also contribute – isolated with little infrastructure and highly restricted human interaction and exchange; (Roper and Maningrida)

Northern Territory

Background

Communication strategy was to visit Harvester camps and engage in direct information exchange with all industry members. This was undertaken in collaboration with Chris Calogeras (C-AID), who has both extensive interaction with the NT mud crab fishery and was well known to the fishers. A range of nationalities involved: Australian; Cambodian; Vietnamese. This created inherent language and cultural considerations which needed to be addressed in information hard copy format/s.

Observations and Activity

Discussions were modified according to situation and initial reactions. Focus was on crab holding systems and conditions, highlighting anything that could cause stress. For those genuinely interested, a brief explanation of how the ammonia (toxins) would normally be expelled through the gills when the crab is in the water given. Also the effect on the crab when out of water and how they release it on return. There was emphasis on it taking three hours for all the ammonia to be released in aerated water and therefore a short dunk can be lethal. Some understood this concept but the right words were needed to clearly and fully explain what a ”stressed crab” is in their own language.

Discussion then moved to describing the entire supply chain and how many crabs die further on along the chain. Hence re-emphasising crabs need to be as strong and healthy as possible before leaving camp to minimise deaths later and maximise the value to the fishery and the return in dollars to them.

The recovery step was discussed and there was much interest in the ability to use freshwater as opposed to seawater. Comments received indicated that fishers 'lost' interest in the crabs after they left camp and there was dawning awareness that these crabs are actually eaten in far distant restaurants by consumers. There was also keen interest in measuring meat fullness in crabs. They see this as relevant as lately they were catching many large old crabs that are hard shell but potentially empty – terminal moult.

Printed material was handed out. Most say a DVD would be good and in their language preferably, although in English would be OK as most have some English language skills. Certainly, in their language would be more respectful to them.

Temperature recording through the supply chain was discussed. Thermocrons were shown and how it connects to the computer to produce a graph. They really like to see the graphs and certainly understand the importance of temperature. We offered several thermocrons to individual fishers to monitor their next shipment and there was a very positive response. We undertook to get the graph of this temperature profile with explanation of stages in the supply chain back to them so they can see the results

Learnings

It was evident that it was important to seek information and clarification on why and how certain things are done and comment on things that are deemed 'good'. The attitude and responses from the Harvesters was important to watch as some were cautious of strangers and especially 'government' people.

When asked about what format they would prefer information, they liked the concise printed material. It was noted pictures would be of great benefit. This was demonstrated when discussing specific topics from the Mud Crab Survival Report, when it was observed that the pictures were more readily understood than graphs or voluminous words.

Outcomes

Harvesters keen to use Thermocrons to view and better understand temperature profile through the supply chain.

Maningrida – visit 1

Background

The Bawaninga Aboriginal Corporation (BAC) rangers were primary contact and there is a focussed role for mud crab harvesting. Indigenous crabbers are encouraged to harvest mud crab commercially and the BAC officer organises and supports the

crabbing operation. The Indigenous rangers appeared interested in who we were and what we were doing and saying.

Observations and Activity

Commercial harvesters:

- experienced harvesters - excellent crabbers with a long successful history
- lots of discussion around the large amount of crab in the area and catch rates good
- noted heaps of females around at this time (Sept, 2012).
- raised his opinion that the new NT size limits were "ok" and seemed to be working.
- opinion is that crabs are legal size at 9 months old and that small (undersized) female have roe. Other crabbers have said this too.
- observed that all crab were A grade. (tested one by RI = 1.37).
- provided a set of DVD/Fact Sheets/Code of Practice/Environmental Management Systems.

Developing indigenous harvest:

- current catch is low - 3 – 4 baskets/week.
- awareness that there were "plenty" of crabs in the area and lots of big ones. This opinion has been proffered a few times over the last few years for this area.
- supply Darwin Fish Market. Crabs are flown or trucked out of Maningrida, the latter could cause high degree of stress in the crabs due to very rough road condition at certain times of the year.
- aware that mud crabs should be be 'purged' however the process used had been a little misinterpreted during transfer from others in industry and so further discussion allowed correct information to be extended.
- a major problem in the area is significant pot damage and loss due to crocodiles.
- construction of a new mesh holding enclosure is underway. Project team suggested double doors for flies.
- this indigenous operation has great potential as a commercial business, however will not be truly successful without support and provision of accurate Best Practice information directly to the harvesters. It was noted a workshop to go through handling techniques in detail with all those involved would be highly beneficial.

Learnings

- Issue of little interaction between mud crab industry personnel and scientists – comments about all the mud crab tagging work they assisted with – yet were disappointed they hadn't been told any results or what the outcome was.
  evidence of importance of building rapport and trust in relationships : scientists to industry

- needs repeated and frequent contact to engender ownership and commitment from the industry
- a useful assistance to 'proving yourself' is to give something in return – even if this initial gift is a research project T-shirt or similar
- this point was illustrated by the respect the commercial harvesters had for the consultant on the project team – have interacted >20yrs and "Chris always tells us what is happening both as affects us and within the broader industry. The depth of their regard was demonstrated by their coming in from sea especially to keep the meeting time even though they had not finished clearing all their pots.
- communication IS everything – both ways – needs face to face and listening

Outcomes

- second hand information (i.e. not provided directly by the project team) with regard to recovery process could create more problems and damage project's reputation (by loss of product/stock)

Roper River – visit 1

Background

This sector of the fishery operates from some of the most remote and harshest regions in the country. Combined with these harsh conditions and being very isolated dictates limited options for improvement. There was interest in factors that 'stress' crabs and simple things that can be done to minimise crab stress and mortalities eg. no realisation breeze or noise bothers crabs. Common transport providers from this harvest area and supply chains were documented while there. The project team was invited by all the Harvesters to both revisit, and spend/allow more time at that next visit.

There are a number of camps of Asian fishers located at the mouth of the Roper River. There are two ethnic groups, Vietnamese (approximately three camps) and Cambodian (one camp). The commonality is they all rely on one transport agent for transfer of crabs out and supply of all inward goods. (Plate 6 & 7).

Observations and Activity

Most fishers have been in the industry for many years and have firm views on what's right and what's wrong. With some, this created a challenge to introduce new information, but others were willing to listen and learn. All are competitive with their catch and mortality numbers, hence at this stage, actual mortality rate was difficult to quantify. Comments made about poor crab condition immediately post-capture included:

- the low tides in the middle of the day which leaves crabs in hot water especially as water moves off the flood plains. Some crabs have a red cooked colour to them and are almost dead in the pot
- slow, old, potentially empty crabs that die anyway
- claw loss from pot mesh and other crabs
- damaged crabs due to aggression and cannibalism.

The number of crabs lost due to these factors is not recorded, but often mentioned to be quiet high.

Plate 6. Remote harvester camp on the Roper River

Plate 7. Supply transport at established fisher's camp, Port Roper

Learnings

- each fisher had their own idea on the best way to hold crabs in camp; some methods were good whilst others needed reviewing and revising.
- a pictorial depiction of the supply chain provided to this sector would be useful to raise their awareness. Most fishers were aware of the distances within the supply chain but did not really consider the operation outside of their door. Most had no concept of what happens to their crabs once loaded onto the truck.
- there is a clear need to build trust with government officers and this will take time. It was important to disassociate our project work from Fisheries Police or local regulatory research. Fishers are all resentful of policy decisions and research projects undertaken without their involvement. They see the need for industry driven development of their fishery yet paradoxically, don't have a formal association or reference group as the NT Mud Crab Licensee Association only has licence owners as members – not leasees (which most harvesters in the area are).

Roper River – visit 2

Observations and Activity

- contact with 7 harvesters
- logistical problems as the road to the port and their camps had been impassable for supply truck all season due to heavy wet season rain
- one Harvester does not own a vehicle so crab drop off and supply pickup is done by a dingy trip up river (Plate 8). This has extra fuel costs and lost time as opposed to the road trip. His crabs arrive in poor condition having been exposed to the elements and the rough dingy trip. Many flies are evident around the crates indicating dead crab. As he needed to undertake the return journey immediately, contact time was limited to less than 20 minutes.
- all other harvesters transport their catch by 4WDs over the rough dirt road from their camps at the port to the junction where the supply truck awaits. The 84km round trip takes three to four hours to complete and uses approximately 20 litres of fuel per vehicle. Transfer of crab to truck and resupply of fuel, bait and provisions is completed as fast as possible (Plates 9). Leaving little time available for dialogue. Vehicle breakdowns are common place.

Plate 8. Harvester unloading and re-supply at Tomato Island

Plate 9. Crabs loaded unto supply truck

Outcomes

We were invited to stay at the Port Roper camp overnight where a good questions and answer discussion was held that evening and in the morning. The opportunity to spend a reasonable amount of time like this with Harvesters is rare and allowed for the best exchange of information in which all parties can be involved.

Roper River – visit 3

Observations and Activity

- each harvester (corresponds to licence lease/holder) approached individually for discussions; all remembered project was happening and its content focus
- were very receptive and responsive – having built trust on previous visits. Chris Calogeras known some for over 20 years and this engendered instant openness in discussions and contribution by harvesters
- hardcopy material previously distributed was 'on-hand', including Code of Practice
- most harvesters had made practice change – some practices were perhaps not fully correct, but the new concepts had been transferred and with discussion the complete picture was recognised
- comments that usually "only 1 dead crab" in shipments after making changes compared to (sometimes many) previously

- provided DVD to each – eager and excited by this; promptly put it on to play and proactive in comments, picked up on mention of 'C' grade crabs which are not allowed to be taken in the NT. Reactions were especially positive where self-images or familiar people were on camera
- grading diagrams on wall above crab sorting area
- There was encouraging feedback in talk surrounding markets and supply chain awareness. These comments were volunteered and not immediately arising from conversations
- 'leader' of this area expressed keenness to be actively involved in and lead research - also keen to have an annual meeting organised between harvesters, wholesaler/distributors, marine police and fisheries managers and researchers

Additional:

- camp areas and surrounds noticeably neat and tidier – could be related to improved commitment to the industry resulting from owning licences rather than leasing
- not safe or practical to tie crab immediately after capture as seas are too short with constant wind in harvesting areas, therefore dangerously unpredictable. Marine Police caught and fined harvester as law states must tie crabs as soon as practicable. However, fine imposed ignores Safety First (harvester had capsized boat and nearly drowned trying to comply). Fine flies in the face of the intent of the law. This fellow could talk of nothing else (apologised next day)
- poor year, currently <1 basket/day, 40 litres of fuel to do 1 run of pots. $3/kg bait.
- supplier and transporter building harvester new accommodation and a floating wharf
- one harvester (current 'tying champion') ties differently to that on video and has actually created own video
- head of family's camp relocated back up bank, so not to collapse in river.

Learnings

- DVD and printed material left with 'quiet' harvester not commented on next day, because not prepared to comment or in front of "head of family" who was present
- self-images and familiar faces engendered an instant ownership of the DVD content
- there has been an enormous growth in awareness of the whole supply chain and their position at the beginning of it. This was previously unrecognised, so involvement has increased understanding of the entire industry
- observed the importance of 'giving' items – value not important but particularly like T-shirts caps etc. There was a feeling of involvement if these were directly associated with the project work and fosters 'worth' of harvester to project. Such items are used and therefore there is a constant reminder on location

- as they are so isolated – once trustful relationships are developed – very excited by return visits to their locations
- trust was also the underpinning reason for offers of active involvement in further research
- effect of owning rather than leasing licences evident in increased commitment to the mud crab industry and Best Practice operation – seemed to 'matter more'
- a definitive hierarchy exists at the location – with one harvester respected as the 'head' – this results in a communication hierarchy also where most harvesters sit back and let the leader talk. It is engenders some degree of negativity and competitiveness. So very important to create a strong relationship with the leader, but also very important to treat other harvesters individually and with respect. This results in an excellently positive reaction from the 'others'
- the transporter/wholesaler hugely supportive not just as a transporter and goods supplier – physically helping to build new camp and a true connector in the supply chain. He has also offered to supply figures of slow/dead over past years.

Outcomes

- crates almost touching water high tide. Air under crates – 'breathes'- "wet and air equals reduced dead and slows". Modified handling which means has "fewer deads"
- one harvester - first market return ever with no deads or 'slow'
- Code of Practice recognised and accepted. Fact Sheets recognised from last time.

King Ash Bay – visit 1

Background

Several crab fisher camps line the bank of the McArthur River mixed in with semi-permanent and recreational fisher camps.

Observations / Activity

As opposed to the fishers at Port Roper, this mix of Asian and Australian fishers operate more independently of each other but within small groups and are highly competitive. Some crabs are transported directly from these camps via a coordinated transporter to Darwin and others are dropped off at Pandion Haulage in Borroloola (Plate 10).

Plate 10. Crabs delivered to the Pandion Haulage, Borroloola.

Fishing grounds from this area extend from the Limmen River, south east to the Robinson River. Similar to operations at the Roper River some fishers travel long distances each day or may stay in temporary sub-camps or in their boat during the week (Plate 11).

Plate 11. Crab harvester in McArthur River.

South east of Borroloola on the Wearyan River are three other fishers' camps. Each fishing operation has different circumstances and unique challenges. These differences needed to be understood and considered when creating the communication strategy.

King Ash Bay – visit 2

Observations and Activity

- Vietnamese harvesters not at camp – Fact Sheets and Code of Practice left
- helpful discussions with Greg Quale crab fisher for over 10 years, currently not fishing but will restart next season. Fact Sheets explained and copies left for distribution (Plate 12.) Offer of ongoing assistance gratefully received. Greg has extension contacts throughout the GoC.

Plate 12. Discussion with industry

- renewed contact with 4 Cambodian Harvesters and 1 new Asian Harvester
- two Australian local residents were also present who were very vocal and dominated conversations
- questions mostly asked through better English speaking Cambodian Harvester
- lots of questions asked in relation to material provided and dialogue from previous visit – very encouraging
- much interest displayed in recovery procedure
- shell hardness as an indicator of meat fullness discussed at length
- they have experienced 'B' grade crab that is said to be full of meat. I explain this is likely due to inter-animal variation or seasonal food supply and smaller crab can often have some carapace flex and be full of meat or previous carapace damage.
- debate over cooking times, 12min vs. recommend 18min/kg. Hard to convince otherwise. Perhaps a cultural preference or misinterpretation in detailed cooking procedure
- observations over many hours with escape hatches show no benefit in their view. Crabs come and go through entrance funnel as they please. A pot with an escape hatch can be full of small crab one day and have none the next

Learnings

- harvesters questioned the usefulness of the durometer. They expressed disappointment with lack of follow up information regarding durometer and escape hatch trials
- seemed to now have greater appreciation of supply chain and customer satisfaction with crab. Were unaware that a crab dinner in southern restaurants can be excess of $100. Understood that a bad experience at this price the customer would not buy mud crab again
- all happy with current size restrictions, but would also be happy with 140mm minimum size for both male and female and importantly for both recreational and professional harvesters
- pots with escape hatches show no benefit
- general concern that new regulatory officers are inconsistent and too strict with the laws that they see as being ambiguous and interpreted differently by various officers.

Outcomes

- increased awareness evident of only supplying strong, healthy, intact 'A' grade crab
- damaged legs or claws are now shaken to promote the crab to discard them. They see an improved price for single clawed over damaged or lost/dead product

King Ash Bay – visit 3

Observations and Activities

- re-acquaintances and introductions to a few new harvesters were made.
- poor catches and inconsistent regulatory actions dominated the conversations.
- very interactive and conversational – " the most they have ever been" (CC)
- highly appreciative of DVD's
- keenness to have real, meaningful and ongoing, two way interactions with researchers and regulatory officers was expressed.
- acknowledged efforts made by project team in providing information that has lead to improvements in crab quality, but see grading especially by regulatory officers still as an issue to be addressed.
- an opportunity to visit crabbers on location out in the extensive waters ways of the rivers systems was taken. The Harvesters mid week camp (Plate 13) was visited and crab holding systems discussed.
- all harvester are now working 7 days per week and late in the season are only just starting to break even. The potential access closures (marine park) hangs heavily over their heads with the added complication of their requirement to invest in

capital (new motor, licence fees etc) at the beginning of the season and no indication when a decision might be forth coming,

- Cambodians just acquired new ***i***-phones and very keen to use for information searching.

Plate 13. McArthur River mid-week camp.

Outcomes

Several requests for on-going business support information will be provided.

Wearyan River – visit 1

Background

This is a very isolated harvesting area and like Roper River, has challenging handling issues of tying claws when clearing pots due to rough seas, however it is noted that all do tie as they catch. Operations in this area are separate from King Ash Bay with no collaboration in transport to Darwin.

Observations and Activity

- individual supply chains were documented.
- project team was invited by all the harvesters to both revisit, and spend/allow more time at that next visit

Wearyan River – visit 2

Observations and Activity

- contact with the 3 harvesters
- updated NT Code of Practice released and immediately gained much attention (Plate 14.)

Plate 14. Harvester engrossed in Code of Practice

- still some improvement required in holding shed design and maintenance, some great (Plate 15), some poor.

Plate 15. Excellent quality holding shed

- trust with buyer of crabs is crucial. All have their own preferences and long term relationships
- recent investment of $80,000 in a purpose built boat allows for access to a greater harvest area and improved product. Specialised flooring material that reduces crab damage, is always cool and is easily cleaned is a great innovation (Plate 16.).

General comments were offered on other research, done in conjunction with harvesters, with the common frustration that they never heard anything about the results. The project team was complimented for doing differently from this.

Plate 16. Purpose built boat.

Learnings

- all harvesters continue to have problems with pots built from weaker imported mesh. These pots fall apart under pressure when lifted resulting in lost harvest. The life expectancy of these pots is only a few months. All harvesters are attempting alternatives to strengthen their pots but the base material is under-specked. They are seeking assistance to have the Chinese supplier upgrade the quality of the product. All harvesters spend a lot of time redesigning pots, some using stainless steel bait holders to great effect
- specialised flooring material in the boat floor that reduces crab damage, is always cool and is easily cleaned is a great innovation
- consensus that escape hatches are not needed
- huge lack of trust / disrespect for NT Fisheries. It was always important to distance ourselves from any regulatory authority but rather promote our role is providing support through best handling practice information.

Outcomes

- improved sorting of crabs by sex maximising returns
- business skills were evidently improving – understanding of tax law implications and benefits especially.
- one harvester showing enormous improvement over last year, however another harvester had no improvement at all; yet another has made significant improvements in most aspects of his fishing operation and has impressive plans for the future.

Wearyan River **– visit 3**

Observations / Activity

- harvesting mostly females at this time (Sept 2012); sources meats locally for bait
- another fisher - lots of small female – waste of resource (typical for this area) – not reach maturity.

- poor catch- going backwards
- gifts good (including communication tools); evidence of relationship building – SeaNet logo seen everywhere
- no marine park affect on business planning decision
- recreational issues outweigh everything currently
- US "expert" sustainability of fishery statements challenged, but no data – indicates awareness of issues within the fishery and their passion
- wet seasons = crab quantity – all said that. Seven years since good wet (at Sept 2012)
- bait $30/carton
- Project Team boat trip experience with two fishers - conditions rough.
- now 2 transport options for crabs from Borroloola – some loyalty to original but other much cheaper
- comments on fishery management - seen to be failure / ineffective
- awareness that the project is completed – asking what happens then
- mud crab poster given to Savannah Way Motel at Daly Waters (inland). Great interest – diversity.

Learnings

- need long period to allow frequent contact over time as opposed to drive-in drive-out.
- reiteration of knowledge and concepts
- strong competition within a harvesting location, but loyalty to known individuals shown strong also
- business models of operation definitely private and hence need to respect restrictions on data given to research purposes

Outcomes

- written survey inappropriate – one on one dialogue best after them venting issues
- DVD appealing
- willing to participate in research. Trust both ways
- Code of Practice recognised and commented on
- overall positive response. We are perceived as different from the "tagging" NT Fisheries.

Overall Learnings – NT Harvester Sector

- poor industry representation. NT Mud Crab Licensee Committee (NTMCLC) is largely unknown to the harvesters and NT Seafood Council has minimal interaction with the coal face industry. NTMCLC is mostly concerned with licenses and fishing regulations

- there is limited support for escape hatches and definitely only to be introduced if it can also be applied to the recreational sector
- increased 'perceived' pressure from recreational sector. Stolen pots becoming a big issue
- old hard empty crabs being returned to water now. Whereas only some last year doing this
- all interested (particularly Asian) to know life cycle information of crab, including recruitment indicators
- co-coordinated fishery management and extension is preferred
- explore cross &/or intra agency communication extension delivery options
- remoteness / isolation expensive for extension activities. Maximise knowledge circle
- trust most important with crabbers and buyers. Valued. Long memories. Inter-relations all areas
- no mention by harvesters of NT Fishery or research staff.
- all keen to see Code of Practice – pictures viewed first (Plate 17)
- good acceptance of Code of Practice.

Plate 17. Harvesters first look at new Code of Practice.

Queensland

The structure of the Queensland mud crab fishery is very diverse and geographically disparate. It has no one overarching industry body but several small separate network groups, however most industry personnel work individually or in conjunction with only 2-3 others.

Background

Key industry personnel invited project staff to attend at AGMs and to both participate and present which meant that these interactions were more formal than the meetings held in NT.

Karumba – Gulf of Carpentaria (GoC) Fisherman's Association AGM

- 50 attendees (Plate 18)

Plate 18. GoC Fishermen's Association AGM, October 2010, Karumba.

- this rare event provided an ideal forum to deliver the project overview and attract buy-in from interested participants
- most were unaware of the findings of the previous research undertaken within the NT industry and were very keen on obtaining information
- fact sheets, handling research report distributed, presentation and interactive discussion.

Cairns – Queensland Seafood Industry Association (QSIA) AGM

- 25 attendees
- most very willing to share their experiences and knowledge.
- most of the fishers were long-term in the industry
- key contacts established
- factsheets, handling research report distributed, presentation and interactive discussion

Townsville – Queensland Seafood Industry Association AGM

- 80 attendees
- factsheets, handling research report distributed, presentation and interactive discussion
- crab committee discussions

Moreton Bay – multiple visits

Contact was made with a fisher from Moreton Bay who was having high mortalities at market and was looking for help. This fisher has only been involved in the mud

crab industry for three years. His knowledge of crab handling was mostly self taught and he had trialled many holding systems and transport options to achieve the best quality product. Current transport to market was via refrigerated road transport. His mortalities at market had been averaging 10% every week.

We visited his operations and suggested changes to his holding system. He was extremely excited to learn of the work our research team had done on reducing mortalities and eager to adapt his practices to our suggestions. We gave him a copy of the report FRDC 2003/240 '*Maximising revenue within the Northern Territory mud crab fishery by enhancing post-harvest survival of mud crabs*.' (Poole *et al* 2008) and its condensed recommendations.

Further contacts were made and the next visit showed that he was actively improving his procedures to maintain optimum mud crab health during the holding period. He also stopped sending slow crabs to market as he now realises the unlikely chances of them surviving and the impact even one dead crab has on a shipment and ultimately auction price achieved. A greater understanding of the auction process at SFM prompted an improvement in his quality grading practice. Separating his grades into separate eskies attracted a higher price for the 'A' grade crab.

Temperature loggers were provided to the fisher so that details on his holding system and the road freight transport temperatures to market could be obtained. Analysis showed that temperature within the esky reached a low 12.5°C. Optimum holding range for live mud crabs is 18° to 24°C. The stress incurred from exposure to 12.5°C would have been responsible for mortalities. Also, auction price attained is related to a crab's liveliness and in a comatose state his crabs would have been viewed as slow, accounting for the poor prices and 'Fresh Adjustments' (FRAD, a reduction in auction price of 20%) received.

Despite initial scepticism, he trialled the freshwater recover procedure. During packing of these 'recovered' crabs his entire family was needed to help keep these 'alive and kicking' crabs in the eskies. Modification to his esky using fewer holes and more packing material, together with the recovery process resulted in an improved result. He rang as soon as he got his payment to inform that for the first time in 3 years he had zero mortalities and no FRAD for slow crab. He was rapt!

Outcomes

- he stopped sending slow crabs to market as he now realises the unlikely chances of them surviving and the impact even one dead crab has on a shipment and ultimately auction price achieved
- separating his grades into separate eskies attracted a higher price for the 'A' grade crab.
- he rang as soon as he got his payment to inform that for the first time in 3 years he had zero mortalities and no FRAD for slow crab. He was rapt!

Mackay

- QSIA area representative was contacted. Harvesters he represents were not painted in a good light
- one meeting was held at local seafood shop with a part time harvester
- good interaction and extension material provided for shop and other harvesters

Ayr

- A Notice posted beside the weigh in scales about a "crab expert' meeting – "*…opportunity to ask questions and learn…*" (Plate 19)

Plate 19. Notice of meeting at weighing scales

Observations and Activity

- 8 harvesters attend meeting. Not all QSIA or ECCNA members (Plate 20.)
- factsheets, handling research report distributed presentation and interactive discussion
- some angst with Harvesters who were considered renegades – 2 not liked by the others. The practice of some newer Harvesters of license buyout and

buying another license back the next day as well as over-potting and potting in green zones is frowned on by the long term "responsible" Harvesters

- laminated Fact Sheets distributed to all

Plate 20. Industry discussion at Pro Quality Seafoods, Ayr

Learnings

- all very interested in best practice & holding systems
- only one had seen Fact Sheets through QSIA representative, which had been scanned at low resolution and was illegible
- blood protein by refractometer demonstrated on two just off hard crabs. Both RI's in the 1.3475 range. Perfect result indicating crabs likely to be low in meat fullness. 1 hard digger tested. 1.3580 Perfect result indicating likely to be a full crab. The single clawed crabs are kept for local market
- asked if the refractometer system could be automated e.g. no needles – yes possible – digital options available
- questions asked of other method of grading determination – had heard or durometer and knew "*it was in doubt*"
- meeting organizer is not part of the QSIA crab committee and has recently resigned from Queensland Crab Review Committee. He recommends the review be postponed for 6mths until after the state elections to allow for a greater chance of a real outcome to be made
- common view that Sunfish are too powerful and that their surveys are biased
- crabbers saying some times of year there are lots of crusty old crab and other times of year lots of soft crab
- most in favour of closed season to 'trade-off' against taking female crab. "*Some* (female crab) *are so big you'd think they were turtles*" These large females are found out wider. High proportion of females out a bit from shore/green zone
- lots of crabs in pots! But 80% undersize or female. Each pot has 2-3 keepers. Catch from 25 pots was ~42kg

- one of the meeting participants phoned on our return to the airport. He wanted to discuss his holding systems. Request to arrange to see him next time and other non attendees. He has personal issues with the local organizer and the way the meeting was arranged. "*Not transparent.*" This highlights the difficulties other DEEDI Fisheries staffs also have in contacting harvesters and arranging meetings. Harvesters may or may not be members of the several representative bodies

Outcomes

- preferred information delivery method – all agreed written format not generally read. Suggested DVD best. Additional benefit that DVD can be displayed in shops etc.
- NT Code of Practice drew much interest and all agreed a Queensland version would be very useful
- most in favour of national grading standards and to include terminology for single clawed & old crusty crab
- most in favour of closed season to 'trade-off' against taking female crab.

East Coast Crab Fishers Industry Network (ECCFIN)

Background

A face to face meeting between the ECCFIN and SFM QA personnel was requested by this crab association. It was held at SFM and facilitated by Chris Calogeras, C-AID Consultants (Co-Investigator)

Observations and Activity

- a full complement of relevant SFM staff joined the discussions which was highly appreciated by the harvesters (a 3h meeting)
- demonstrated example of co-operation; proof of willingness to find a solution and further evidence that direct one to one interaction is often the most effective way to resolve issues and achieve common ground
- see Attachment 1- Action plan as outcome from meeting

Overall Learnings – QLD Harvester Sector

Temperature supply chain monitoring

One thing that all stakeholders understood was the importance of temperature on live mud crabs and the many benefits in providing individuals in the supply chain with detailed temperature profiles of their crabs en route to market. These include:

- conditions immediately post catch on the boat
- holding systems

- transport to freight forwarder (air or road)
- conditions during freight forwarding (air or road)
- transport to market
- conditions at market
- and engagement with this project objectives

The temperature profile of a shipment from Moreton Bay to Sydney Fish Market (Figure 4) shows a severe drop in temperature to 12.5°C during the refrigerated road transport. Once the optimum temperature range for live mud crabs of 18°- 24°C was explained, the fisher adapted his eskies to reduce the exposure to the cool air within the transport container and immediately improved his crab survival rate. His next shipment to SFM was the first shipment in 3 years with no mortalities.

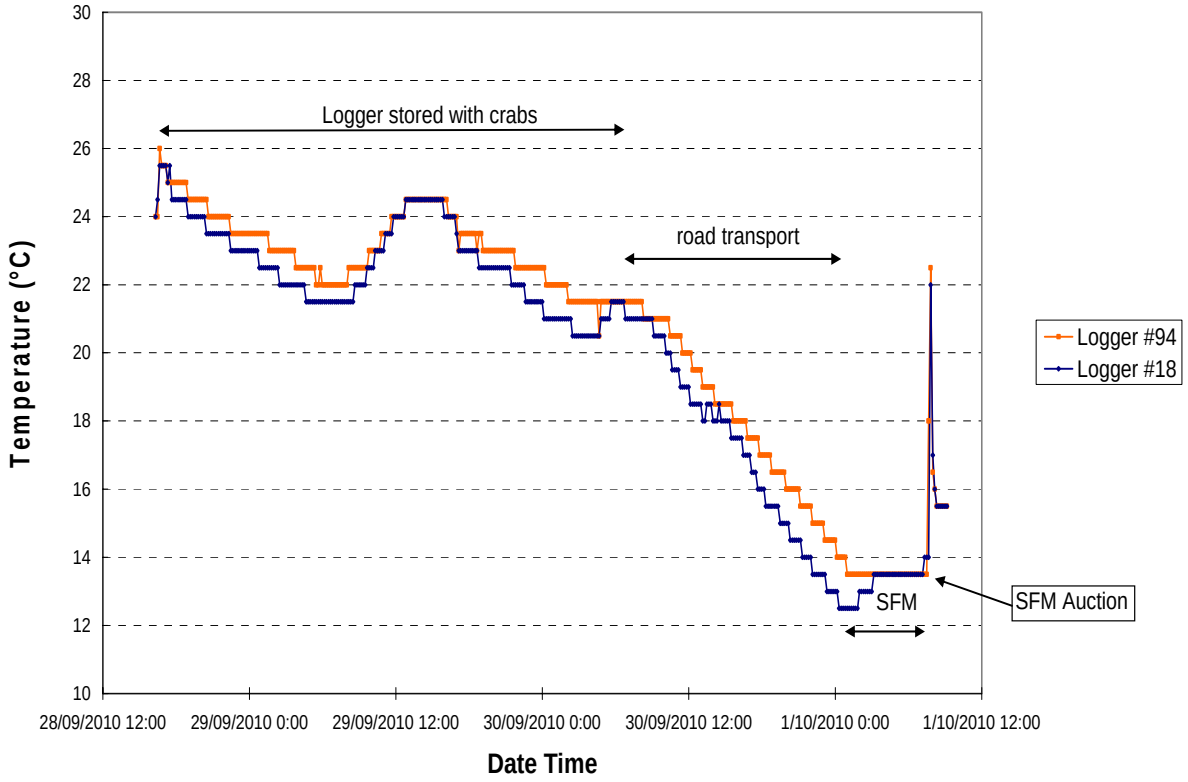

Figure 4. Moreton Bay to SFM temperature profile.

The temperature profile of a shipment from Karumba to Sydney Fish Market (Figure 5) showed an alarming spike to 45°C during the holding period. The harvester was unable to explain this. Also highlighted here is the potential problem with connecting flights where extra handling, temperature abuse and delays are possible.

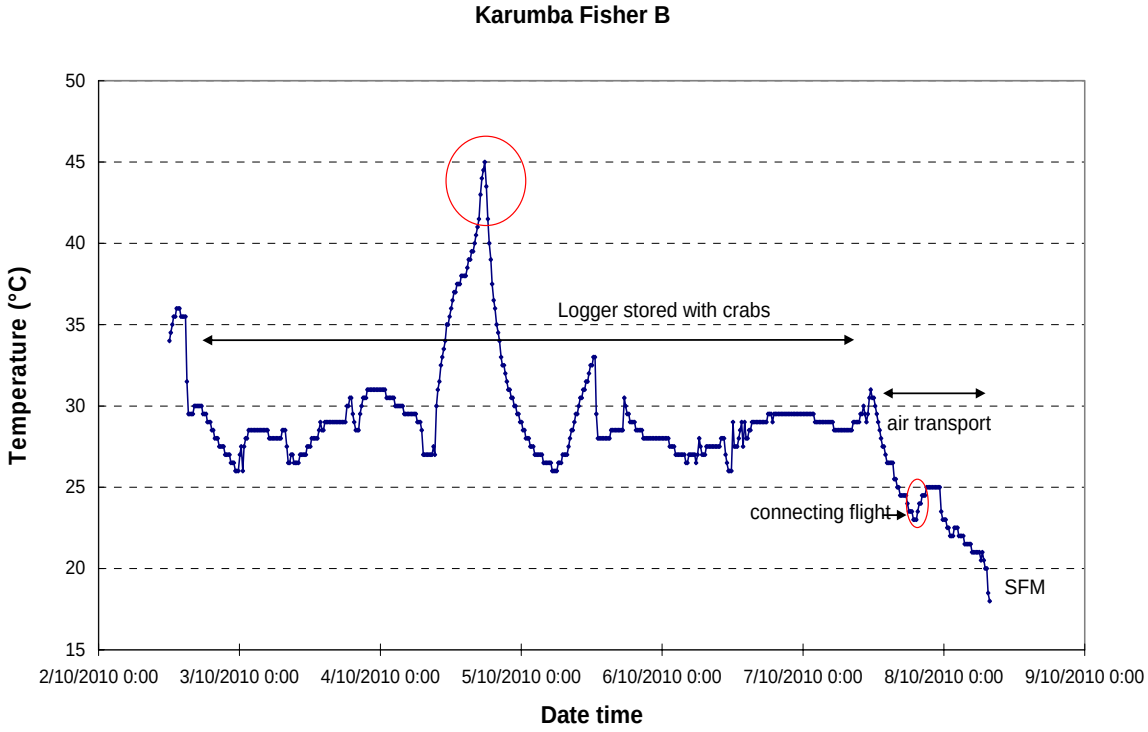

Figure 5. Karumba to SFM highlighting temperature abuse.

22 loggers were distributed to fishers and wholesalers to monitor a wide range of distribution chains. Additional chains were monitored to expand the geographical and seasonal coverage. This has proven to be an extremely valuable tool in engendering co-operation and active participation in the project. Linking the supply chain is a critical factor in reducing mortalities by providing a detailed temperature profile of a crab from pot to consumer. This engaged all sectors of the industry in a unified understanding of the issues involved.

Outcomes

To actually see a graph of the temperatures of their shipment has already invoked changes in operations that have produced an immediate reduction in mortalities. Some experienced people in the industry have not seen these simple thermocron data loggers and as part of this project, we provided details to them in order to purchase their own.

Encouraging fishers and wholesalers to work together with inclusion of loggers has proven to be an extremely valuable tool in engendering co-operation and active participation in the project.

Fisher adapted his eskies to reduce the exposure to the cool air within the refrigerated transport container and immediately improved his crab survival rate. His next shipment to SFM was the first shipment in 3 years with no mortalities.

New South Wales

The New South Wales mud crab fishery extends from the Queensland border down the coast to Newcastle. It is structured as multiple localised pockets in proximity to a central Fisherman's Co-operative. The groups are small and there is much competition between them but very little interactive communication.

The NSW sector was targeted with forums organised at all seaports trading in mud crab. Erik Poole, Customer Account Manager (SFM) was present at the port meetings from Ballina to Port Macquarie. His involvement was especially beneficial as a lot of negative attitudes regarding the operations at SFM were expressed. Erik was readily able to explain actual market practices and debunk many conspiracy theories.

Ballina

- 3 attendees
- all product is pooled through the Co-operative and sold at SFM.

Learnings

- evident that harvesters had little concept of what occurs at the SFM live auction
- due to the co-operative pooling system there is little incentive for those harvesters with poor quality crab to improve their practices and those with good quality crab receive lower prices due to the mixed grade product
- all harvesters also harvest spanner crabs - lengthy discussions regarding recent problems with grading at SFM of both spanner and mud crabs
- some harvesters had heard of previous research undertaken within the NT industry and unaware that finding with the northern fishery could be applied to theirs.

Outcomes

- all very keen on obtaining any information as no information on handling mud crabs available through NSW Fisheries Department.

Evans Head

- only 1 harvester supplying product (not available).

Outcomes

- Co-op staff very interested in our research and extension and very willing to distribute information on our behalf.

Clarence River

Observations and Activity

- 6 attendees over a four hour session; formal PowerPoint presentation delivered
- practical demonstration on crab grading with meat yield indicator via blood protein refractometer

- emphasised the importance of harvesters identifying their own crab or polystyrene boxes even when sent through Co-op – we explain that buyers get to recognise polystyrene box markings and target their buying needs to known quality floor stock.

Learnings

- crabs trucked to SFM ~10h trip in refrigerated multi-use truck
- Clarence River Co-op has a good reputation with SFM and buyers – usually lively crab; smaller size most suitable for Asian markets in Australia
- grading again the issue – some 'C' grade sent to market and confusion existing around 'B' grade
- price pooling at Co-op a cause of disgruntlement because poor crab from non-caring harvesters bring the overall price down.

Outcomes

- very interactive and interested in the science behind findings – especially attentive to video clips.

Coffs Harbour

Observations and Activity

- 2 attendees – discussions were highly interactive and receptive
- active Co-op with excellent floor manager who was supportive and very interested
- interested in holding live crab in tanks prior to sending to market. We discouraged this option as the facilities were problematic and could potentially create mortalities
- grading confusion evident – so discussions focussed on this.

Learning

- First definite claim by Harvester that crabs are tied as pots are cleared – none of the others so far tie crab on capture.

Jerseyville

- very small Co-op on Maclean River
- always very good crab – large and graded well.

Observations and Activity

- 8 harvesters – reputation within other sectors of industry as highly independent group (not PFA members)
- mortalities not a big issue

- several harvesters were holding crab in water prior to pack-out: systems included hanging crate off jetty in river; dedicated land tanks – 10 crabs per m^3 water
- grading disagreement despite their good reputation for this. An example was provided of very large crab harvesters judged as 'A' grade and 'heavy' therefore full. We explain that large crab can have no carapace flex as they are generally recently moulted. A sample of blood was extracted for total protein determination by refractometer. The level corresponded to borderline 'C'/'B' meat fullness indicating that the crab was recently moulted despite only having slight carapace flex on the 3rd segment of the undercarriage. Crabbers **very** impressed there was a potential objective testing method. Other indicators of a recently moulted crab were explained
- long and diverse discussions on all aspects of handling – very passionate group who care
- interesting comments on temperature tolerance of the mud crab from this area – claims that crab were perfectly happy at very low temperatures – warmed back up for 20mins and they returned to full liveliness. Suggestion that crabs were adapted to lower latitude temperatures
- one crabber even put his crab straight onto ice for up to 15 min before tying
- evident that operations are based on passed on knowledge: "*always done this way*" – and response to new information strongly positive – really pleased with Fact Sheets on how and what to do as Best Practice. Lack of any other information evident
- know that when Sydney temperature was low (~1-2°C) you have higher mortalities.

Outcomes

- positive interest in packing options – commitment by one to change his pack out method to using cardboard between layers of crabs and provide extra packing for part full polystyrene boxes
- crabbers very impressed there was a potential objective testing method (refractometer to test meat fullness)
- we described a spray system as better alternative – much interest was expressed.

Port Macquarie

Small mud crab fishery – consisting of 4 estuary harvesters

Observations and Activity

- 3 attended discussions – and highly receptive
- Fact Sheets provided and again much interest in video footage
- held live crabs in tank at Co-op

- interesting comment that with Wallis Lakes crab the shell never hardens as much as Port Macquarie crabs – is this attributable to different salinity levels in the different waters? Possible follow up to do shell index and total blood protein on range of crabs from both locations
- these harvesters very keen for temperature logging to continue through the supply chain to the retail sector to get a full picture of what happens there.

Outcomes

- much interest in video footage
- very appreciative of practical information – and that there is someone with knowledge to ask questions

Taree

- meeting cancelled as unable to reach CEO or Co-op Manager
- non-members of PFA and not much interest shown from previous communications
- some of the interested crabbers proposed to attend the Wallis Lake meeting.

Laurieton

Observations and Activity

- 4 attendees (10 crabbers based in Laurieton)
- great support and enthusiasm from Co-op Manager
- major concern with SFM actions again – aware of Asian buyer issues
- queried whether SFM could return rejected crabs to harvesters (Co-op) and they want to know who buys their crab (*realise this is commercial –in-confidence*)
- good handling practices in place – wets crabs twice a day – never allow to dry out
- general opinions:
    - that females are down-graded more frequently than males
    - ¾ full crab is regarded as a good 'A' grade crab. We refuted this with the analogy of "*Would you be happy to buy a half empty beer?*"
    - last 3-4 years noticed a lot more 'soft-shelled' crabs that never harden. Is this related to no prawns (food source) or crabs just not growing?
    - boxed good crab and marked 'A' grade is often a cause of disillusion because they often get a low price for it ("*often lesser grade crab get better price*")
    - again, we are asked why some crab at capture are foaming
    - crabs increased in value ($ return) over the last 11 years
    - loses of at least $3000/yr to poachers (pots and crab).

Outcomes

- harvesters were keen on temperature loggers. Want logging done in winter and in summer.

Tuncurry

Two years ago the Co-op was losing steam / presence / membership – turned around and starting to thrive. Retail section manager was very keen and excited to build up the Co-operative. They recently closed the takeaway shop – only wet seafood sold now (and frozen) – now customers are rapt – giving positive feedback: "*Aaah – thank you – now I can come and buy fresh fish as it should be…*"

Observations and Activity

- great response - 12 attendees. Only one other harvester in the area that couldn't attend. Plus Barry, Co-op Manager

Learnings

- each crab is tagged with a different colour zippy tie for each harvester – this is the only Co-op visited to date that has traceability to the harvester
- all crabs pooled to SFM and dollars split to Co-op and harvesters. However, due to individual tagging, claim they can tell which harvester's crabs are rejected or downgraded
- available crabs all good 'A' grade and active – wide range of sizes
- one very large male crab – good / full – crinkly claws
- a couple of harvesters have tried tanking – but unsuccessful by their reaction
- comment on old crusty crab – hard shell – but weak and about to die – want method to tell when they are 'has-beens'
- temperature an issue again
- short weights outside of norm an issue. They suspect they are losing crabs in between the Co-op and SFM. Again this is very contentious.
- crabs are soldier packed well with interleaved newspaper and holes in corners of polystyrene boxes so that next stacked box doesn't block air flow
- "*soft-shells*" at certain times of the year that takes longer than 3 weeks to harden up – quite definitive about the length of time. Seem to harden up quicker in summer. Is this due to temperature or salinity?
- "*small crab stay up the river and don't grow – the freshwater comes through after the rain – and then they grow*".

Outcomes

- communication format preference - DVD would be good; Fact Sheets OK

Newcastle

- just 1 attendee (3 in total work out of Newcastle)

- very experience harvester with high opinion of his operations
    - only lost about 3 crabs in last 30 years!
    - does things well
    - ties straight out of the pot
    - doesn't send too many in any one box
    - has no hassles himself
- others mishandle – he reckons.

Outcomes

- will pass on Fact Sheets to others

2.2. Wholesaler / Distributor industry sector

Within this group we have included wholesalers, Fishermen's Co-operatives, and distributors. The stakeholders within this sector range from large companies to one or two person operations and form a completely different category to harvesters requiring a separate targeted approach. Communication frequently occurred in conjunction with speaking to Harvesters and in most situations this worked extremely well as the wholesaler gained an understanding of the harvest Best Practice.

General observations of Sector:

- several Co-ops visited are very dependent economically on mud crab throughput – a few almost totally ("*we wouldn't exist if it weren't for mud crabs*." Laurieton)
- therefore any information that will assist is valuable and readily accepted
- all have long standing relationships with their mud crab suppliers and know how to deal with the different personality types. Hence it is often the case that, for on-going information transfer, the Co-op Manager is an excellent resource
- an unmistakable observation was the very positive (almost surprised) reaction and response from a follow-up visit and further interaction within a short space of time from the first contact

Northern Territory

- NT (NTW1) – Distributor (wholesaler) for Roper River crabs. Has trialled recovery system with partial success – desires actual demonstration. NTW1 is a key conduit for further extension.
- Darwin wholesaler (NTW2) has trialled recovery system but needs to do it again for the recommended length of time. Has potential to recover many slow crabs. Needs to introduce some moisture into packing process.

- Darwin wholesaler (NTW3) has options to introduce recovery system. Has also offered to supply names of dealers in southern markets. This information is usually impossible to obtain so very appreciated.

Queensland

Queensland major operators identified and contacted (n=6).

- Moreton Bay (MBW1) – very experienced mud crabber and still very keen to learn more. Eager to assist the project in any way.
- Mackay Reef Fish Supplies
  - distributed Fact Sheets and final report NT project
  - shipping to Hong Kong, Adelaide and southern markets
  - keen to have all 'B' grade crab excluded from market
- Pro Quality Seafood, Ayr
  - shop operates like a Co-op and only best quality product is accepted. Only 'A' grade. Won't except bleeding crab "*I know they die.*"
  - shop Manager supplied with cooking and cooling temperature charts and 2 copies of the NT report
  - has one other well trained staff doing QA
  - shop had just won the Queensland Seafood Business Award 2011
  - clearly running an excellent business already but still willing to learn more and very appreciative of information supplied.
  - all crabs shipped to Claudio's at SFM via Charters (13:30 pickup) to Australian Air Express in Townsville for delivery Saturday morning
  - two small holes on both ends of polystyrene box
  - crabber doing the packing into polystyrene boxes. All very well soldier packed and interlined with newspaper (Plate 21)

Plate 21. Crab packing at Pro Quality Seafoods

New South Wales

Contact was made with 10 wholesaler Fishing Co-operatives in New South Wales

Observation and Activity

- John Harrison, EO Professional Fishermen's Association (NSW) promoted the meeting events at all NSW Co-ops. John expended a huge amount of time and effort towards organising harvester meetings at each port, following up with reminders to ensure that all participants were aware of the opportunity. John's effort was a driving factor in successfully achieving contact with all the major players in the NSW mud crab industry. John also joined meeting discussions at 6 ports which strengthens the network of contact points for information transfer
- for the first 3 ports (Ballina, Clarence River and Coffs Harbour) we were joined by Erik Poole, project collaborator and Client Account Manager, Sydney Fish Market. Erik's presence was invaluable at each of the ports as he had been in one-to-one contact onsite with mud crab harvesters a short space of time prior to the trip. His contribution to discussions with respect to systems and actions that occur at the market end of the supply chain was excellent and provided additional whole-of-picture information directly to the supply chain participants
- for many of the Co-ops, mud crabs are 50% of the total through put value ("*The Co-op wouldn't survive without them*"). Hence any information on maximising revenue was greatly appreciated
- grading and short weights are their biggest issue with live seafood (Plate 22)
- some Co-ops have a better consistency in quality than others.

Plate 22. SFM grading reference on packing room wall

Outcomes

- all Co-op managers were keen to listen, learn and pass on information to their suppliers

- feedback has shown that the information they now have has improved relations and quality of crab with their markets - "*They* (SFM) *know we know things now, so they're treating us better.*"
- all very appreciative of practical information supplied and that there is someone with knowledge to ask questions

Sydney Fish Market

SFM is the major wholesaler of mud crab in Australia and runs the only live auction as the sale mechanism. SFM is a Co-Investigator on this current project and has provided willing participation as a central stakeholder in direct contact with many sectors of the crab supply chain. As part of the main role of wholesale distribution of mud crab, SFM has an advanced quality assurance system through which all crabs pass after purchase. The mud crab buyers are mostly very experienced and know their product well, hence tend to operate and purchase mud crabs on the basis of individual harvester reputation and trust. In addition, there are several large independent seafood retailers who have a significant throughput of live mud crabs located on site. Fact Sheets have been distributed to all major buyers and retailers.
The willing communication and input from SFM has been invaluable to achieving the goals of this project. The Quality Assurance team are actively involved in both communicating information to buyers and providing feedback from buyers and retailers to us. Due to their experience in dealing with mud crab buyers every day, we have been fortunate to be able to use SFM staff as evaluators for communication formats likely to best convey needed messages in the most appropriate format

New South Wales – follow up visited

NSW – Co-Investigator (Sydney Fish Market) contacted key industry operators (n=4) in northern NSW during the end of last season. The NSW fishery is just commencing harvest for this season.

Sydney – Sydney Fish Market

Discussions held with the six main buyers who are also direct buyers from other wholesalers and co-op style fisher groups. Most have extensive experience in dealing with mud crabs and some are willing to share their knowledge. Two were very willing to listen to new information and will be recontacted further. A general reluctance to buy NT crab was noted. Possible option for SFM to recover slow/seized crab and resell as 'B' grade next day to be explored.

SFM has generously allowed access to restricted commercial-in-confidence grade data to assist in assessing quality improvement achieved within the project. Ongoing discussions with SFM revealed that in their opinion the project's objectives and outcomes have been successful. Further recommendations to SFM staff were made about the QA facilities and operations aimed at reducing exposure to crab stress eg. place washable padding on sorting table to reduce crab damage when dumped out of boxes.

It was noted that there was excessive old crusty crab being supplied especially from Queensland and this was suspected to be related to potential changes to fishery management eg. quota driven. As always, there were a higher percentage of excessively soft crabs being supplied from NSW. This is an ongoing problem that has kept QA staff busy trying to rectify.

A good relationship with one of the major buyer crab has been developed and he has offered to do a tour of his buyers next time we visit. This is a privilege to be introduced to the inner sanctum of the trading scene as it is a closely guarded closed system. Despite having visited the SFM mud crab auction on numerous occasions over the years, it was only this visit that the largest buyer of mud crab finally made contact with project team staff. He bought 3 pallets of crabs on the day and took over 1 hour to carefully quality assess each and every crab. This buyer only buys mud crabs and provided team staff with further introduction to his major customer. Again, a sign of trust shown after repeat contacts.

Sydney wholesaler – A request was made from a NT wholesaler/distributor to offer advice and assistance to a major distributor of crab in Sydney. This Sydney agent also buys a lot of his crabs from the leading buyer WH4 mention previously. Advice was provided on alternate holding systems including the recommend spray system for medium term storage.

Port Macquarie – quotes:
"*They (we researchers) came back. Didn't expect to see that, great!*"
"*They* (SFM) *know we know things now, so they're treating us better.*"

Victoria

Melbourne

Contact was made with 3 major wholesalers in Melbourne.

Good relations were developed with McLaughlin Consolidated Fishermen Ltd based at the Melbourne Fish Markets, Fitzroy and this has resulted in Fact Sheets being delivered to all their major customers/shops (30x5 copies). This market reputes to be the largest wet fish market in the southern hemisphere and sells the largest quantity of live mud crab outside of the SFM. In what was initially a very cold and disinterested reception ended up him congratulating us for doing worthwhile extension. "*Should be more of it*"

Attempts were made to interact with another wholesaler at the Fitzroy Markets. Material was left for consideration

A major dealer of NT crab greatly assisted us gain an insight into the Melbourne supply chain. He took out on his delivery rounds to 9 restaurants, mostly based in Chinatown. This was a unique and valuable introduction to these businesses. Project

staff had previously experienced the difficulties in getting past the various levels of 'gate-keepers' at Asian restaurants in an effort to speak with someone directly involved with the supply and handling of live crab. His introductions took us to each key person at all restaurants visited. Good dialogue was had even given the limited time available. His view is risk mitigation – passing the crab on to the client before it dies. It seems a strange relationship with clients in that they must trust him and tolerate slow crab. He has the facilities to undertake a recovery step but chooses to transfer the crabs as soon as possible. Hours are crucial in his view.

A major retail outlet in the Asian Footscray district has many dual tiered tanks filled with live seafoods of all varieties. All tanks have individual large bio-filters. This is run by an extremely diligent and knowledgeable young Vietnamese fellow. He has developed systems over many years to keep product in premium condition. Cleaning agents and ozone filters are used for specific seafood holding systems at specific strengths and times. Has done extensive self-research on what species can tolerate ozone, how much, and when. This outlet has the most and largest variety of live seafood seen to date. Mud crabs are held up to 6mths. Plans to expand tanks to a 3 tier system to provide greater flexibility for stock control

Melbourne Seafood Centre

With Chris Calogeras, visit the new Melbourne Seafood Centre - McLaughlin Consolidated Fishermen. Aim to talk with staff, and meet their mud crab buyer.

They have plans to move the crab holding space to a specific area that is warmer and out of direct traffic and wind. The floor was actually warm in an area outside a cold room, so they are going to build a new wall and make a purpose built dry, temperature stable room for live mud crabs. This is a great indication that the information given on the last visit has had positive impacts on their operation and crab condition; ultimately reducing mortalities and improving prices.

Outcomes:
Holding temperature for pre sale storage and product kept over to next day is now of greater importance. Ice bin for holding crab had a room heater distributing warm air into the bin (Plate 23). This has improved the liveliness of the crabs at next auction and hence sale price.

Overall they have seen improved crab quality, grading and prices and were pleased with our extension activities.

Plate 23. Room heater positioned with ice bin.

Wholesalers of Queensland and Northern Territory crab

Meetings with wholesalers of Qld and NT crab both commented on a noticeable improvement in crab quality and grading. Overall they have seen improved crab quality, grading and prices and were pleased with our extension activities. Some of their suppliers are still providing out of grade crab but they are educating them and expects them to soon come up to standard.

Outcomes:
Very glad we are helping improve crab quality. Can't get enough crab. A very competitive market and all wholesalers want to out-do their competition in crab volume, quality and consistency.

2.3 Retailer Industry Sector

Background

This stakeholder group represents a wide range of business size and style from large specialist seafood retailers to small operations only selling a little wet fish. However, it is only the larger businesses that handle mud crabs live (and/or cooked) and it was noted that even where a seafood shop was attached to a Fishermen's Co-op that dealt with mud crab, not all these retail shops 'bothered' with selling crabs.

The specialist retailers generally demonstrated a good knowledge of handling seafood product but the extent of knowledge for handling mud crabs by Best Practice was overall very poor. Live mud crabs are regarded as just another seafood

item and there was little realisation that at this stage of the distribution chain the crabs are suffering maximum accumulative stress build up and therefore require special handling to prevent mortalities.

At the retail level, there are many critical handling protocols that can be applied to reduce the likelihood of mortalities occurring. These include the fundamental best practice handling protocols surrounding temperature and holding conditions, but also at this point in the supply chain benefit is gained from the recovery step to refresh the crabs and reduce stress levels prior to further on-holding. This is particularly the case where crabs are likely to be held for a period of time prior to final sale.

Northern Territory

Darwin Fish Market is a major retailer of crab for the Darwin market. Their long association with the research team has enabled them to consistently supply a high quality product.

Queensland

Brisbane (n=6).

Some improved practice already in place from previous trial work. Some good spray systems in use. All wet tank systems need modifying – temperature is the only factor most were concerned about. Unaware that recovery method essential prior to transfer to a wet tank holding system.

There was ongoing contact and discussion with major Brisbane wholesalers. Early meetings had been held with the head buyer of live mud crabs, but this time we meet with the Director of the company to explain that his holding systems and operations can easily be improved. Crabs are stored in a large purpose built holding tank as well as individual, temperature controlled display tanks in the retail shop. The holding tank has frequent breakdowns and at times massive loss of stock. The pumps stop when the filters clog. We demonstration the re-immersion recover procedure to show how much waste comes from a crab after just 15minutes. This and excess external matter which should be rinsed off was the cause of most pump failures. We went away confident he would give the recovery procedure a go. Gave Fact Sheets and a draft Grading Fact Sheet and the latest edition of NT Code of Practice

Outcomes

- very appreciative of information supplied and will follow up on any further needs
- initial contact where few mortalities reported now more honestly reported to be 10 -15%

Mackay and Ayr

- three retail outlets visited that sell live mud crab
- operators very enthusiastic to participate in project
- best quality crab exported to Hong Kong (Plate 24); provided packout best practice information changing to ensure crabs held only 2 layers deep
- lesser quality grade crab kept for local market

Plate 24. Bulk crab bin being packed out for export market

New South Wales

NSW Co-operatives

- five retail outlets visited that sell live mud crab
- all Fact Sheets distributed and good interest particularly shown in Consumer Fact Sheet
- some operations have tanks for live mud crab – dubious water quality in all. Tanking Fact Sheets will at least give them information they need to know
- suggestion of using 'black' light in retail tanks similar to aquariums.

Retailers at Sydney Fish Market

Project team interviewed retailers at the SFM site (n=7). Various holding systems are used, most were poor in providing a suitable environment for holding crabs. These retailers focussed on immediate sales rather than longer term holding and animal survival. Many basic factors to address (sun, light, breeze, noise, temperature, moisture) to minimise mortalities in the market place and beyond. Those that hold in wet systems all need modifications.

Follow up visits:

- ongoing contact with two of the major retail outlets at SFM
- no obvious improvements in crab holding

- doubt expressed on ability to get uniform consensus on crab grading guides.

Victoria

Melbourne

- eight retailers were visited in Melbourne and information left for their perusal
- Springvale has a large Asian community and several shops selling both NT and QLD live mud crab (Plate 25). All product was positioned for easy inspection and maximum exposure to customers. Crab seemed in good condition as through put would be high

Plate 25. 'A' grade Qld crab $37.99 and one claws $29.99.

- Queen Victoria Markets only had one store selling live crab and these were located in the refrigerated display cabinet. One crab was near death and the other close behind. Apparently the Victoria Heath officials are requiring all seafood products to be behind glass. However this doesn't appear to be heavily policed in Asian stores
- most Asian traders are hard to approach and appear wary

Follow up visits

David Tran at D & K Seafoods was very busy unloading a tanker form SA of live barramundi. He had a bin full of dead crab and a bin full of slow crabs with dropped legs from his tanks that he suspected had been contaminated. This level of mortality was very uncommon for his operations. It was the most sophisticated live seafood holding outlet visited. He has specific holding conditions for each species based on his years of learning through trial and error. Other wholesalers say his crab have a taste this customers don't like, but I'm not sure about that; just competitive rivalry. He is satisfied with a normal mortality of 4% but not in this case 10%. These dead

and dying crab were for sale at the front of the shop at ½ price and customers were buying them!

Visited Cam Ly, Seafood Smart, Springvale Shopping Centre. There is a massive fresh seafood and vegetable store downstairs and huge frozen store upstairs with every conceivable variety of seafood imaginable. Cam takes particular care in storing crabs. They are held outside a cold room in a quiet space and kept off the floor by placing in a plastic bins. Held in original carton or styrofoam box depending on source. Room heater used to keep at optimum temperature (Plate 26).

Plate 26. Room heater in crab storage area and information exchange.

Comment on all Retail Sector interactions

A common theme illustrated through contact with retailers was the need to demonstrate a simple double bin spray system. The benefits of an improved crab holding environment and less stress to the crabs by customers not handling and constantly disturbing the crabs needs to be shown directly to the retailer.

Feedback

- point-of sale information seen as valuable for their customers
- agreed that one to one the most effective
- physical demonstration really helpful

2.4 Restaurants / Food Service Sectors

Little progress has been experienced within the Restaurant sector, particularly in the Chinatown precincts of Sydney and Melbourne. Hurdles are many and varied and perhaps only marginal gains can be expected. The practice of using just dead crab in certain dishes is perhaps one reason that keeping crabs stress free does not seem to be of importance. All product gets used dead or alive. Non Asian restaurants that buy live crab have also been observed to par cook crab on arrival and use the picked meat as an ingredient in dishes, again a lack of importance for them to keep crab

alive. This attitude alternative expresses the need for product options to supplement the traditional live product to be explored.

Northern Territory

Numerous Asian restaurants trading in iconic NT crab served in a variety of formats. Crabs are sourced locally and by demand, hence requirement to store for even short periods are unnecessary. They simply buy 'fresh' as they require.

Queensland

There was no interest evidenced at all from Brisbane restaurants and this was the same situation in several restaurants in coastal tourist regions. It is likely for a similar reason as restaurants in the NT - they can access those few crabs they need 'locally' and easily.

New South Wales

Chinatown - Sydney

Various holding systems – poor water quality tanks observed with dead animals present; crabs held dry and physically located in highly human traffic exposed areas with constant disturbance. No holding system observed was viewed as satisfactory and the paucity of knowledge was clear. All operators expect crab survival for only two to three days. They want to sell them as fast as possible or hold minimal stock: "Don't want to hold them – just want to sell them", a common quote. Temperature seemed to be main factor they thought was important. High through-put of crab equated to fewer deaths in their opinion.

Learnings

Some common hurdles for the communication project within this sector of the supply chain was that all restaurants have various levels of 'gate keepers' to limit contact with key managerial staff. None were willing to share supplier details. There appears to be a perceived market advantage in having a particular supplier but no comment on why specific suppliers were chosen. However, all wanted information on best practice holding sent to them. All are interested in the project. None were interested in evaluation of communication strategy. None knew of the FRDC.

Outcomes

Need to demonstrate simple double tub spray system for holding crabs.
Prior appointments preferred for face to face discussion and information exchange. Indicated that video/DVD may be a suitable communication method for this sector.

Leading NSW central coast restaurant

Specialist seafood restaurant with an excellent reputation and river frontage - specialising in live mud crab.

- live seafood tank in centre of restaurant – holds mud crab and lobsters (together)
- discussion with Chef:
  - tank old but no issues
  - changes water when needed – no biofilter
  - takes river water from jetty at restaurant
  - watches weather and exchanges prior to heavy rain to maintain salinity
  - manages water quality by exchange only – no tests
  - keeps mud crabs and lobsters together – but not with oysters as he thinks this is dangerous because of additional micro organisms
  - only purchases excellent quality crabs
  - no crab available today. Two crab were offered to him that morning but they were empty so the crabber was sending them to SFM
  - views holding tanks as problematic. Better results from holding crab in tubs with damp hessian
- customer enquiry re Birthday dinner – husband definitely wanted mud crab but baulked at $100/kg even though it was for a special occasion – so walked away! Unwillingness to pay is an issue. An alternative to whole live crab is required e.g. frozen portions or picked meat for dishes. There is a need for a continual supply or an alternative offer.

Sydney Winter Harvest

The project team was invited to present research finding at the DAFF facilitated Winter Harvest event at GOMA, Sydney. Over 100 invites were sent out to chefs, caters and event managers.

Live crab is always a draw card at events so two live muddies were purchased from a leading retailer at SFM. The main buyer of crab from this establishment says he only has 'A' grade, but I soon found a 'B' grade as I wanted to present the different grades at the event. Unfortunately despite his lengthy experience in the trade he is still grading his crabs wrong by pressing 1st segment of the bottom carapace. He also categorises a crab state location by belly colour, which is also incorrect.

Nobody at the event actually knew how to grade a crab or how to store crab in the correct condition.

Outcomes:

- quote from a major Leagues Club Manager, " I was working in seafood for 30 years and never knew that", in response to live mud crab handling and cooking. This type of comment was often expressed on the day.
- all surprised by the fresh water recovery system, and gave the impression that it was something they were willing to try.

- several asked for further information to be sent. 7 sets of facts sheets sent in addition to the 30 sets snapped up at the event.
- traceability was a key item they wanted to talk about and see on the products. A Barramundi was on display at Qld industry fishery display with a traceability tag in its mouth. This was applauded.

Victoria

Chinatown - Melbourne

Nine restaurants visited in Melbourne - seven of which were Asian,

Similar hurdles as in Sydney's Chinatown restaurants:

- space is a premium, hence live crab kept in containers wherever possible and not in the best place to be stress free
- crabs held dry and physically located in highly human traffic exposed areas with constant disturbance
- some with live tanks of dubious water quality. Other species upside down or dead. Temperature seemed to be the only parameter of importance
- "*Don't want to hold them – just want to sell them*" attitude

Learnings

Wholesaler contact introduced us to the chef at one of the more friendly obliging establishments. Mixed grades are purchased for different meals. 'A' for whole crab dishes and single clawed and slow crab for dumplings. If a crab appears dead he tries to "*resuscitate*" it by pumping its heart!? Near dead crab meat is picked for dumplings. If it is just dead he double washes it then steam cooks it to check for any ammonia smell. The picked meat is then used for dumplings.

Outcomes:

Chef was interested in percent meat content of crab parts body vs. claw, male vs. Female, and this information was provided.

Comment on Restaurant Sector interactions

It is our opinion that communication format is not the underlying reason for lack of adoption but rather business decision based. However, we have some success with using major suppliers to extend information life and are continuing to develop a network of distribution points.

2.5 Consumers

This sector comprises the end of the supply chain and we have not focused a large amount of effort here to date. It was considered important to first follow through the chain from harvest with extending information therefore improving the quality of the mud crabs along the way. This will ensure robust lively crabs reaching the

supply chain end point and available to the consumer. However, some interaction with the consumer and general public sector has revealed relevant learnings of:

- positive responses to concept of point-of-sale material being available where live mud crabs are sold. This was not so much about recipes but an appeal for knowledge and handling information:
  - "*how do I know it's a 'good' crab?*"
  - "*how do I know it's full (of meat)?*"
  - "*what's the best way to kill it?*"
  - "*how long can I keep it live or do I need to cook it today?*"
- there were also a few comments received surrounding provenance, although it was the retailers who commented that a "*where a mud crab comes from*" loop video available to play in the shop would be a great idea. They considered that it would be a popular talking point with consumers, even in locales where the public were aware there was a commercial mud crabbing fishery

2.6. General public and recreational fishers

This group was not a target sector within the current project, however a few observations and comments applying to this sector have been gained:

Recreational fisher – conversation with a local cabbie (Central Coast, NSW) – he caught mud crabs and wanted to know how to handle them, as well as best freezing method (should he catch more than one!). He froze them green (after long period sitting dry in the tinnie!) in a domestic freezer (therefore slow freezing rate) and asked why they were often mushy or stringy. He was most interested when we explained it was better to cook them then freeze in this case. He considered that point-of-sale material similar to that mentioned above for consumers, available at mud crab suppliers would be a fine conduit for this information.

From several of the meetings up and down the coast with commercial harvesters, opinion was voiced that it would be an excellent idea to make all the information available to the recreational mud crabbers as well. The keenness for this to happen indicates potential whole-of resource cohesion.

There is a long history of competition for resource between the recreational and professional sectors within NSW and QLD. This competition is also increasing, according to both sectors in the NT. As such many professional harvesters see an advantage to all if the recreational sector is informed of best grading and handling practices as the professional sector is. They see this improved knowledge within the recreational sector as a benefit to managing the shared limited resource. As seen in many other fishery sectors the lead taken by the professional sector is commonly taken up by the recreational sector. There is also an improved public perception for the professional sector by them showing their uniform adherence to best practice handling and environmental management systems

Benefits and Adoption

Benefits of extension effort

Industry sectors right along the mud crab supply chain benefited directly from extension communication of new information, from harvesters to end-users. Within each sector, the diversity of operators and operations was often extreme and direct benefits gained corresponded to situation.

Harvesters
A very high proportion of harvesters participating in extension events indicated that they had learnt something new. There was also strong appreciation of the availability of information resources for future use. Repeat contact with individuals or groups illustrated that the new knowledge had been targeted correctly as they all had retained the information and queried deeper.

All within this sector gained increased awareness for supply and value chains within the mud crab industry. This was evidenced many times over by feedback from participants commenting on markets and aspects of distribution, including request for information on possible new markets, during repeat extension visits. This indicated an significant attitude change had occurred from providing information as, for many previously, the crabs 'did not exist', 'they were gone' from immediate relevance after they left the harvesting location. To have crabbers in isolated locations, for example at Roper River Bar, speak of and query on issues in the markets was an impressive advance.

The benefit of information extension to the indigenous operation in Maningrida was patently clear. They were in early stages of start-up as a commercial concern and, while experienced at catching mud crabs, had little knowledge of best handling techniques for transporting crabs to market and no awareness of the complex steps and time delays within the supply chain. Information resources and availability of expertise was highly valued by this group.

Adoption of change by participants within this sector was, in many cases, immediate. For those less experienced, learning how to tie claws effectively was useful; others picked up on the significance of temperature and disturbance as critical stress factors for mud crabs and almost all gained new knowledge on packout methods.

Harvesters were very appreciative of the extension 'coming to them' as many do not have access to internet or mobile connections at harvest location. For those participants that do have such access, there was a clear response that they valued the personal interaction.

Wholesalers and distributors
Commercial operations within this sector vary in size enormously and existent knowledge on the best way to handle mud crabs varied accordingly. Low volume operations often had a fairly direct supply and distribution chain and existing

handling knowledge was adequate. Feedback from these businesses indicated positive interest in new information and extension was appreciated and considered worthwhile.

Medium-size enterprises, including many of the Fisherman's Co-operatives, had varying levels of knowledge for handling mud crabs and responded that the benefits of the extension visits were immense. Feedback indicated that at these venues having a mixed and broad-based participant supported their management operations within the mud crab fishery as everyone heard the same information at the same time. This negated accurate information 'lost-in-transfer' between individuals and underpinned Manager orders.

Larger volume operations, such as Bevwood Crab (NT), Sydney and Melbourne fish markets, were very keen to participate and accept Best Practice. Extra benefit was gained from these operators as they voluntarily acted as a hub for further and continual extension of information to their local industry members.

Buyers

This sector also incorporates a variety of enterprise sizes. There is a good proportion of major buyers – some very big – who then distribute from the days purchase. Participants in this category stated that getting good handling information 'out there' within the industry was of enormous benefit. The claim was based on recognition that they would be some of the 'winners' with respect to purchasing improved quality crabs. They could readily see the advantage both financially and reduction in client arguments and complaints.

Some small volume purchasers, were not as eager to fully participate but they also recognised the worth of mud crabs being handled under Best Practices from the point of capture.

Feedback as qualitative evidence of the impact of extension of Best Practice:

- major buyer at Sydney Fish Market – excited about the quality of mud crab now available; "…it has really made a noticeable difference"
- major buyer in Melbourne – highly appreciative of the transfer of Best Practice information; "… its important that it has gone right through the supply chain; I am getting far better quality crabs now."

Retailers

Communication effort within this project focussed on those retailers who regularly handled live mud crab as part of their business. Smaller business that did not hold crabs alive did not participate in the extension events. The larger volume mud crab retailers were very appreciative of information extended and considered there was genuine benefit gained throughout the supply chain. Similarly to the buyers, they recognised the financial gains to be made, both through customer satisfaction and reduction in crab deaths.

Restaurateurs and Food Service

This sector was the least participatory in extension events. When approached at a convenient time of their choosing and on a one-on-one basis, many were unresponsive and didn't see the benefit of changing practices. This was particularly the case in Asian restaurants with the claim that handling practices for them were irrelevant because they stored the crabs for as short a time as possible and wanted them 'on the table' as quickly as possible for cash flow reasons.

Contrary to this, a few individual restaurants were very eager to understand more of the mud crab industry and the supply chain structure involved. The benefit to these operators was based around provenance as well as quality. There was keen interest in harvest locations; how the crab was handled through the chain and the evidence that employing Best Practice does retain the characteristic qualities of the crabs. A common reaction amongst these participants was that they cared about product quality; were pleased that best practices had been extended to the industry and they were going to seek out those operators that had made improvements in their handling practices. This has the flow-on benefit for the industry as whole by acting as a driver for change.

Consumers

There was also benefit gained for consumers as evidenced from unsolicited feedback to live crab retailer (Brisbane) that "the crab purchased yesterday tasted great and better than usual. What are you doing?" The particular retailer had adopted a recovery step for the crab prior to sale. Similar comments have been reported by retailers in Sydney and Melbourne also.

Where retailers and restaurateurs talk to customers about the mud crab product they are selling, consumer awareness is increased and the public image of entire industry improved on the basis of demonstrated duty of care.

Recreational sector

While not a primary focus of extension effort within this project, the recreational sector has also benefited by the provision of all forms of hardcopy information developed through this work. There has been an appreciative and positive response from this sector, with genuine interest in the handling practices the commercial sector is adopting. This again has benefits in raising public opinion of the commercial mud crab industry.

Specific benefits achieved

- all industry stakeholders have up to-date knowledge of best practices for handling live mud crabs from harvest to plate
- the project has fostered change behaviour of industry personnel with a high level of adoption of Best Practice in all industry sectors
- a sound basis has been provided for improved business decisions within the supply chain
- losses through mortalities and downgraded crabs minimised ensuring

sustainability of the resource
- associated information on crab quality extended to industry, for example meat fullness, cooking and chilling times
- greater consumer confidence in purchasing premium quality crabs resulting in increased likelihood of frequency of purchase and willingness to pay
- the supply chain is better positioned to meet varying supply and demand cycles
- enhanced opportunities for ongoing knowledge transfer within and between sectors, including indigenous and recreational sectors.

The specific benefits achieved in this project address all the performance Indicators proposed to measure success of the project at funding application time:

Performance Indicators

- interaction with at least 80% of the Industry supply chain
- relevant communication to targeted sectors measured through Industry comprehension
- practical assistance with implementation of handling protocols provided
- reduced mud crab mortalities and improved vigour of mud crab in the supply chain
- assessment of consumer satisfaction achieved
- confirmation of alternative handling practices in use.

Current extent of adoption

The rate of adoption and extent of practice change varied by region and with industry sector. Participants recent to the industry were more readily open to adopting change, likely due to new information for them and perceptions that they had gained new skills. Extent of practice change needs to be accepted within industry sector limitations of location and logistics.

The quantitative assessment survey indicated that of those participants, who had implemented changes, an extra 46% of the industry experienced reduced mortalities and reductions were all > 3%, with most stating 6-10%. This direct outcome of change of practices resulted in increased sales of crabs for 8 out of 22 respondees, with statements of up to 20% increased revenue gained and a higher price/kilo. Additionally, several respondees commented on positive feedback from customers with respect to improved mud crab quality and liveliness.

Further evidence of a high proportion of the mud crab industry increasingly adopting Best Practices is illustrated in recent information from the Sydney Fish Market auction. Sales records indicate a significant decrease (~30% during 2011-2012) in downgraded crab (‘slows’) and mortalities (rejects), with a consequent increase in revenue return and an average of $1/kg premium added to mud crab product. This has resulted in the repositioning of mud crabs to the number 1 spot for the SFM, by both value and volume.

Specific examples of adoption:

Moreton Bay harvester – new to industry, little handling knowledge; grateful of gaining new information and adopted best practice. Outcome: rang excitedly one Friday night to say he had achieved a return from market of zero mortalities and no downgrades – the first ever for 3 years.

Western Gulf of Carpentaria harvesters – immediately adopted the change in practice to storing mud crab correctly at camp; return visits elicited that mortalities were a thing of the past.

NSW Central Coast harvester – upon learning best methods for packing out crabs for transport to market - " I can change and will do that straightaway". Return visit – " I have fewer deads and slows.

Major retailers – many requests for recovery step and spray system information again and grateful for discussions on how best to adapt the methods to their specific operations. The response from one, after employing the techniques: "… had repeat purchase from satisfied customer who asked what I was doing because the mud crab was so lively and quality great."

The outcome of widespread adoption of best practice handling methods has contributed to the number one positioning, by value, of mud crabs within the Sydney Fish Market.

Comparative analysis of communication methods

Extension messages were communicated using different methods which varied according to industry sector and target audience within a sector

Participants were consulted on preferences for communication format (Table 2).

Table 2. Preferred communication format.

Method	Response (%)
Fact Sheet in English)	50
DVD (in English)	33
YouTube	33
Queensland Government website	7
Face to Face Presentation	33
Workshops	20
Information Sessions to Select Groups	20
Sessions to Industry Associations	13
One on One Meetings	10

Multiple selections have been included as many participants desired multiple formats for different reasons. For example, frequently there was request for face to face discussion and practice demonstration at the appointed extension, along with a desire for hardcopy material as future reference and further transfer of information to industry members not present.

Qualitative feedback received clearly indicated a preference for face to face interactive meetings, especially where techniques could be demonstrated. The advantage with this communication form is that allows interaction on specific application to individual operations. It also fosters trust in communication which is critical to developing strong links with industry participants, leading to increased communication success. . A comparison of noted benefits and drawbacks of methods used is presented in Table 3.

A frustration was noted with respect to electronic methods of communication, usually arising from difficulties in finding information on websites of large organisations. Participant responses showed that 36% had difficulty with accessing information online. Additionally, within the harvester sector, their remoteness dictates exclusion to this information source.

Evaluation of extension at completion of the 2 year project showed that 79% of participants agreed the project had been successful indicating that the communication methods were appropriate and effective for information transfer. Repeated contact was observed to be essential and highly beneficial to continual improvement success.

Table 3. Comparison of communication methods used

Method	Positives	Negatives
Fact Sheet (in English)	• mostly pictorial • continued reference • waterproof • inclusion in SoP manuals • reasonable cost	• language barrier • loss of sheet
DVD (in English)	• visual demonstration • learn at own pace • continued reference	• language barrier • production expensive and time demanding
YouTube	• visual demonstration • can return to often • continued reference	• language barrier • internet access restrictions • production expensive and time demanding
Websites	• continued reference • low cost	• internet access restrictions
Face to face	• engages conversation • ability to listen • responsive • ability to repeat • builds trust • develops relationship • fosters ownership	• time demanding • travel costs high
Group sessions	• mass communication efficiency • interactive • non-threatening	• group hierarchy influence • inter-relationships dependant • individual dominance • time demanding • travel costs high
Email	• very rapid • convenient for receiver • low cost • allows recontact and discussion	• open to misinterpretation of information • time demanding on receiver • literacy skill dependent • requires internet access
Telephone	• rapid • engenders discussion	• contact time can be difficult • no phone access • language barrier

Evaluation of communication and extension

Within extension and knowledge transfer, funds are often expended with a protracted time lapse prior to benefits and impact being evident. Four major variables affect any extension programme: context, input, process and product. It is argued that success of any extension effort should include evaluation of each variable separately, as any one factor is dependent on the other three (Stufflebeam and Shinkfield. 1985). The reality of this concept was clearly illustrated within extension work of this project. For example, rate and ability of adoption of complex techniques was restricted within harvesting groups operating in remote locations. Their drive is simple – to catch crabs; their interaction with technology and the rest of the industry is limited; their physical infrastructure severely restricted and learning opportunities and interaction non-existent. All these contextual factors were highly relevant to communication method selection (input and process) and product (outcome).

Working in the US Department of Agriculture, Bennett developed a hierarchy of outcomes to best evaluate the success and impact of extension programs (Bennett, 1975). To measure incremental change during and resulting from an extension programme, Bennett developed a 7-step hierarchy that showed the causal links between the steps of extension from inputs to outcomes (Bennett and Rockwell, 1995). The hierarchal structure formalises the point along the continuum where the extension programme is likely to reach the desired goal. Each higher level provides increased evidence of achievement and the difficulty (and consequent cost) of obtaining such evidence increases as the hierarchy is ascended. Summative evaluation of this kind demonstrates how effectively the extension has influenced outcome goals. However, the cost of obtaining summative data within a programme evaluation requires high investment, as recognised by Snibbe (2006).

Bennett's Hierarchy is widely used in evaluation of extension programmes within Australian agriculture industry and many other sectors (Fisher *et a*l, 2001, Dart *et al*., 1998, Van den Ban and Hawkins, 1996). It is noted (Department of Primary Industries, 1995) as being of particular use for evaluation of extension programmes that are goal-focussed, as was the work in this reported project.

We have used the framework of Bennett's Hierarchy to assess the effectiveness of the extension of best practice handling for mud crabs. The systematic approach to extension evaluation allows assessment of project performance and useful improvements.

Impact of extension assessment

The aim of extension within this project was to transfer scientific knowledge surrounding best practice handling techniques for achieving maximum survival and liveliness of mud crabs at market and retail point of sale. Information to be transferred was targeted to specific sectors along the supply chain summarised

following (Table 4) with cross-sector information extension included to achieve full industry supply chain understanding between different sectors.

Table 4. Information transferred targeted to sector.

Industry sector	Targeted Information
Harvesters	point of capture handling; effect of stress factors; holding protocols immediately post-capture; quality grading; pack-out for transport
Wholesalers	effect of stress factors; holding/storage protocols; quality grading; recovery protocols; packout procedures ; transport options and protocols
Distributers	effect of stress factors; holding/storage protocols; recovery protocols , quality grading; packout procedures; transport options and protocols
Retailers	effect of stress factors; holding/storage protocols; recovery protocols ,quality assessment; cooking protocols
Restaurants and Caterers	effect of stress factors; recovery protocols , storage protocols; cooking protocols for pre-service preparation

To this end, funding was gained in support of a 2.5 year project focussed on communicating information and techniques to all sectors of the mud crab industry throughout the supply chain.

Three key evaluation criteria were defined to focus achievement assessment:

- strength of mud crab industry groups – this noted participation amongst and between diverse sectors; attendance and active contribution at networking and extension discussions; continued networking interaction
- practice change – measured adoption of information transferred
- process improvement – was assessed from direct feedback, uptake levels and recognition of successful and ineffective communication methods specific to the mud crab sector

Table 5 provides a summary of Bennett's Hierarchy levels and the type of input information used to adjudge extension success. The first four levels are process evaluation and the next three evaluate achievement and outcomes.

Table 5. Impact evaluation of extension within Bennett's Hierarchy framework

Hierarchy Level		Description	Information	Source of information
1	**Inputs**	Funds Time Resources used	Total cost project – *FRDC DAFF Industry stakeholders* Time - travel - *dispersed sectors* Expertise – *JM SP CC SFM industry consultant*	Project budget tracking Project management Info gained from FRDC 2003-240 and Industry
2	**Activities**	Extension material Communications	Fact sheets – *sector specific* DVD - *universal, across sectors* Code of Practice – *NT (Qld)* Face to face; Groups; Network leaders	Developed for project from FRDC 2003-240
3	**Participants**	Industry sectors Scientists	No.s contacted; Frequency of contact Attendance/involvement	Industry contact list and distribution chain maps
4	**Reactions**	Degree of interest Response to extension Perception of information	Feedback Liked/disliked Worth	Verbal responses Interaction; Involvement Receptive / argumentative
5	**KASA change**	Knowledge – *what they know* Attitudes – *care factor* Skills - *capability* Aspirations - *motivation*	Base information from FRDC 2003-240 and direct interaction Change in attitude New skills acquired	Verbal feedback Current practices survey Temperature capture Evaluation survey
6	**Practice change**	Adoption • Improved crab survival • Increased return	% A grade crabs pre/post fewer downgrades total $ return	SFM and other wholesalers participant surveys; feedback
7	**End results**	Measures of impact Outcomes	Economic; Sustainability; Individual gain Need for National Grading scheme	Participant survey; feedback

1. Inputs

A total project cost of $442,253 (of which $182,913 was contributed by the FRDC) was committed to the mud crab handling extension programme. Costs included:

- staff time – scientific and Sydney Fish Market staff and mud crab consultant (0.8 FTE staff)
- industry personnel time and commercial crabs
- travel – a high cost due to diverse locations for project specific communication (NT, QLD, NSW, VIC), many of which were geographically isolated within the harvesting sector
- operating costs – printed and electronic media output, project management communication costs

2. Activities

At the start of the project, comprehensive preparations for communication were required to ensure efficient and relevant coverage of the diverse industry sectors addressing geographical, cultural and industry sector priority differences.

Key pre-communication activities:
A comprehensive list of key industry stakeholders was prepared, including notation of networks and major groups. Distribution supply chains were documented – these are multiple within the Australian mud crab industry; some simple and direct, others complex containing many steps.

Communication narrative – messages targeted to specific sector audiences and at a level of relevance for different groups according to background.

Media publicity on the purpose of extension activities was important to generate interest and awareness of project effort and goals. Media opportunities (Table 6) included brief background articles in Industry magazines and Association newsletters; online and print newspaper articles; presentations and showcasing the work at key industry events such as regional and Seafood Festivals. The latter was not so much directed at industry participants but to reach a general public audience to raise their awareness of the duty of care happening within the mud crab fishery.

Table 6. Publicity extension events.

Outlet	
Magazine	3
Ministerial release	4
Newsletter	11
On-line	7
Presentation	8
Radio	5

Preparation of hardcopy extension material – simple plain English summarised Factsheets (7) were developed for different supply chain sectors, incorporating pictorial format wherever possible. All information has been uploaded in electronic format on accessible websites (5).

An instructive DVD illustrating best practice handling techniques throughout the supply chain was developed. The NT Code of Practice for the mud crab industry was updated to incorporate Best Practice Handling developed from previous research and this was distributed as hardcopy reference material for the NT sectors. With prior approval from the NT industry association, this document was also distributed within other States.

Organisation of appropriate communication sites – care was taken to demonstrate extension occurrence at convenient locations for each sector: remote harvesting hubs; centralised regional meeting room venues; distribution and wholesaler centres; Fisherman's Co-operatives and one-to-one visits to retail/restaurant sites.

Communication methods – these were selected according to industry sector, region and from extension officers' prior knowledge of industry stakeholders and operational capabilities.

3. Participants

For this extension project, target audiences were variable in their priority focus and for industry sector, of different skills and infrastructure bases and from diverse cultural backgrounds. Additionally, industry personnel operated as individuals, in small adherent teams or were part of an organised crabbing network or association. These differences needed to be accommodated when approaching communication and extending specific knowledge.

It is estimated that the number of people with a direct and committed interest in the Australian mud crab industry, including the product-user end of the supply chain, is higher than 800 people. More than 109 industry extension events conducted within this project work between May 2010 and September 2012, were attended by 705 participants (not including general public and recreational fishers which totalled several thousands). This represents a high degree of coverage (86%) within such a dispersed industry (Table 7).

Extension often occurred on an individual basis as applicable to the respondent stakeholder and this was most relevant in harvester or retail/restaurateur sectors. Group size varied according to industry sector and location from 3 to the upper extreme of 50. Not all of the participants in the large groups were directly involved in the mud crab industry and this proved to be disruptive to extension focus. Frequently, extension events involved 5-10 people and these usually had common interest, both regionally and sector-wise. Larger groups differed in their dynamics incorporating different supply chain sectors.

Table 7. Number of participants for each sector and by method of contact.

Sector	Forum	One-on-one	Email
Harvester	155	111	533
Wholesaler / Distributor	12	32	79
Retailer	20	40	14
Restaurant / food service	80	16	79
General Public / Recreational	340	84	8

Group meetings (especially if more than 5-6 participants) illustrated dominance by some individuals and 'backseat' response from others according to personality. However it was also noted that in some situations a larger group fostered greater discussion and engendered information absorption in quieter members through peer respect. Repeat contact through the extension programme (up to 4 times for some groups) usually involved the same participants which was excellent for more detailed interaction responding to individual issues experienced and feedback on best practice adoption rate. Revisits also strengthened trust and rapport making communication significantly more effective. It was also observed that there were 'extra' participants at follow-up events indicating that group networking was occurring and others were motivated to be involved.

4. Reactions

Following initial reserve at initial contact time, a strong degree of interest in gaining additional information was evidenced by attendance of almost all industry members invited to participate. This was further underscored by apologies from those accepting the invite but were unavoidably detained on the day. The interactive involvement shown by participants at the extension events was clearly illustrated through detailed discussions, specific queries on individual operations and how best to overcome hurdles in adopting best practice aspects.

At first-contact extension events, communication evaluation was not formally sought through survey responses. Interconnection and information absorption success was assessed 'in-the-moment' and communication approach adapted as needed. Participant reception of the information both delivered and transferred was very positive and acute, with voluntary addition of constructive and in-context information from personal experience.

Immediate follow-up contact by extension officers to obtain background industry information for those industry sectors of the supply chain not previously interacted with, was in the form of a paper questionnaire survey. The response was surprisingly

successful with >60% return rate, again depicting an eagerness to be involved and upskill operations.

Extension to participants from different cultural backgrounds, often for whom English was not the spoken language or not the native tongue, necessitated a different and slower approach. However when employed, the reaction to gaining new knowledge was extremely eager and many questions were reframed and re-stated to satisfy themselves they had grasped the details correctly.

Response to all extension communications was overwhelmingly positive. At repeated extension events, feedback was so encouraging towards the supply of knowledge that it was deemed unnecessary to burden commercial stakeholders with further paperwork in the form of a formal survey. Unsolicited feedback, some examples below, repeatedly commented on the satisfaction among industry participants on the availability of a recognised and readily contactable reference source for information.

Qualitative feedback received:

- harvester, new to industry, adopted best practices and contacted us late one Friday evening ecstatic that he had achieved 0% rejects at market for the first time ever
- major buyer: "can't get enough"
- major buyer: "should be more of it"
- harvester: "..(best practices have worked so well) now staff are scared of the very lively crabs"
- retailer – customer, returning for repeat purchase commented: "back because the mud crab was excellent. What are you doing?"
- retailer – customer satisfaction feedback, feedback on flavour and liveliness
- food service - "been doing this for 30 years and never knew that…"
- and many similar across all sectors.

Specific participant reaction to hardcopy extension materials was also very positive. Responses received showed genuine appreciation of factsheets in a practical and visual format that were retainable for on-going reference. This reaction was uniform across all supply chain sectors. The DVD information format and the NT Code of Practice were particularly valued and inclusion of 'self-images' of industry participants (or people they knew) engendered instant ownership of the content.

5. KASA change

KASA refers to Knowledge, Attitude, Skills, Aspirations and for evaluation of extension the change in each of the attributes is an important measure of success of the extension work.

Knowledge

PRE-extension effort:

- most participants have been operating in the mud crab industry for extended periods

- nearly all (90%) considered they knew all there was to know within their industry sector operations
- however breadth and depth of knowledge varied enormously – this was even more evident progressing through the supply chain to the end-user point
- existing knowledge was historically passed, commonly passed down through industry/family members. A lack of information resource was frequently mentioned
- most confessed to scanty knowledge of industry sectors other than their own and there was no supply chain awareness or connectivity

POST-extension effort

- knowledge and best practice handling information communicated to >86% key industry participants
- a high proportion of participants indicated that they had learnt something new relevant to their handling practices and were pleased new information available to them
- >90% of participants indicated far greater awareness of the mud crab supply chain and factors affecting different industry sectors
- connectivity within the supply chain was greatly evidenced. For example, harvesters understood the way they handled the crabs was reflected in revenue attained at market. In reverse, distributors and buyers expressed increased awareness of environmental and remoteness conditions of crab harvest.

Attitudes

PRE-extension effort:

- some exceptionally good operators, a large number good to average and some below par (as measured against Best Practice) and this was mostly a reflection of individual attitude
- in a small proportion of participants, care factor was low – it was "all about the money"
- distrust and disregard of government scientists – appeared historically-based
- some disbelief that science information was relevant to practical industry operations
- "I've been doing this for years – I know more than you"
- Some 'conspiracy' theories regarding market operations and behaviour.

POST-extension effort

- recognition of relevance of science information to operations
- "I have learnt something !"
- change in attitude to market operations through greater understanding gained
- repeat contact demonstrated acceptance of extension officers and recognition of worth, along with increased willingness to participate by industry personnel
- 92% were willing to make a change – most commonly this was related to packout and grading assessments immediately prior to packing
- a few (7)% were unwilling to change their practices – from the belief they were doing it perfectly already
- 35% completed the post-extension survey (and in 7d) which soundly illustrates positive involvement. Typically, surveys of this nature achieve an average 17%

response rate (electronic discussion forum, enabling change and innovation 2012).

Skills

PRE-extension effort:

- Skills required within most industry sectors of the supply chain are straightforward and simple
- high level of physical capability for most industry sectors
- some exceptionally good operators, most were good to average and some below par – and this partly correlated to length of time in the industry as exemplified by ability to tie crab claws well.

POST-extension effort

- 61 % stated they could apply the new handling practices they had learnt, the remaining participants mentioned physical and logistical restraints
- all participants valued the hardcopy materials as on-going skill knowledge reference, especially useful for future new industry entrants
- all participants valued practical demonstrations as upskilling.

Aspirations

PRE-extension effort:

- High proportion of participants felt 'fault' for slow or rejected crabs and hence reduced return, lay in other industry sectors of the supply chain:
    - " the crabs will fetch what they get on the day price-wise"
    - "nothing I do will make a difference"
    - " I'm a fisher and the crabs are good when they leave here – its issues down the chain "
    - "recreational fishers take 'B' grade crabs - so I may as well get a dollar for them too"
- Sense of apathy amongst many.

POST-extension effort

- recognition of their practices do carry through the supply chain – motivation to do things well and take more care obvious both, immediately post-communication sessions and response during follow up contact
- most participants appreciative of existent and on-going knowledge resource and support available – feeling of empowerment
- positive response to new handling techniques: " I can do that" and "I will do that"
- need for traceability through the supply (customer driven).

6. Practice change

Current practice was known to the investigators in this project as it had been documented within previous work (FRDC 2003-240) and this knowledge and data was used as the base point for evaluation of handling practice change.

Within every extension event, there was statement from some participants that they were going to affect immediate adoption of one or more changes to their current practices. Greater than 60 % indicated making a change in the near future.

The rate of adoption and extent of practice change varied by region and with industry sector. Participants recent to the industry were more readily open to adopting change, likely due to new information for them and perceptions that they had gained new skills. Extent of practice change needs to be accepted within industry sector limitations of location and logistics.

The quantitative assessment survey indicated that of those participants who had implemented changes, an extra 46% of the industry experienced reduced mortalities and reductions were all > 3%, with most stating 6-10%. This direct outcome of change of practices resulted in increased sales of crabs for 8 out of 22 respondees, with statements of up to 20% increased revenue gained and a higher price/kilo. Additionally, several respondees commented on positive feedback from customers with respect to improved mud crab quality and liveliness.

Further evidence of a high proportion of the mud crab industry increasingly adopting Best Practices is illustrated in recent data from the Sydney Fish Market auction sales. Sales records indicate a significant decrease in downgraded crab ('slows') and mortalities, with a consequent increase in revenue return and an average of $1/kg premium added to mud crab product. This has resulted in the repositioning of mud crabs to the number 1 spot for the SFM, by both value and volume.

This extension project was the enabler for practice change rather than the driver – the motivation inherently within the industry is tied to achieving greater revenue return for individuals along the entire supply chain.

7. End results

This last step in Bennett's Hierarchy focussed on contributions of the extension programme to achievement of outcomes.

Outcome 1. Increased industry revenue return

- significantly fewer slow and dead mud crabs at market. Recent (September, 2012) observations at the Sydney Fish Market demonstrated only 1 in 25 crabs was down-graded. This results in higher revenue return for the SFM and back to the Co-operatives and harvesters. The minimised loss of return adds to the increase in revenue return
- increased end-user and consumer satisfaction with crab quality.

Outcome 2. Sustainable use of fishery resource

- sustainability of resource is improved through the large decrease in crabs wasted
- resource sustainability is also strengthened by greater revenue return achieved for the same level of harvest.

- harvesters are more keenly aware of the significance of returning soft-shell crabs (early phases of post-moult) back into the water during pot clearing

Outcome 3. Industry profile improvement

- public perception of the commercial fishery improved through visible 'duty of care';
- recognition that responsible fishing practices are used and hence greater acceptance of license-to-operate
- strong ownership of information within all industry sectors of the industry now exists which will result in continued improvement within industry – this is exemplified by industry request for action on a standardised grading system for mud crabs, as well as requests on other aspects – for example, different product format of marketing crabs : frozen, portions, picked meat and exporting.

Outcome 4. Extension Learnings - for future extension work

- it is important to develop and maintain trust with industry participants and this leads to strong links being forged with consequent increased communication success. If possible utilise a person who has established industry recognition and trust.
- repeat contact was shown to be critical
- is important to identify researcher origin and to keep the focus on the specific extension content to avoid confusion with other research activities.
- use of Bennett's Hierarchy as a planning tool to develop specific sector approaches clarified extension focus.

With greater returns being achieved by industry participants, it is noted that there is on-going request for information from different and like industry sectors (for example Spanner Crab industry). This is especially so within the restaurant end-user sector.

Extension Process improvement

Qualitative inquiry was used to show why adoption of some best practice techniques was slow within particular industry sectors and groups and illustrate differences between regions. In future extension effort, it is worth planning more frequent contact with shorter time lapse between visits. It was noted that an immediate follow-up contact a few days after the extension event, was not seen as 'checking' but rather perceptions were surprise and pleasure.

Qualitative feedback was also employed over the project period to adapt delivery of communication and information format appropriate to industry group and cultural background. This approach resulted in increased trust and respect earned, facilitating more ready flow of communication in both directions and a consequently greater uptake of knowledge and awareness of supply chain flow-on effects. Future extension should be very alert to and focussed on cultural background, together with literacy and numeracy skills.

Quantative response obtained at the end of extension described a commonly held perspective that it is beneficial and of importance to continue interaction and extension activities.

Further Development

This project has been highly successful in achieving its objectives to meet the goal of improved resource use in the Australian mud crab fishery. More than 80% of the industry has engaged in the work and a strong cohesion within the supply chain has developed along with increased cross-sectoral awareness.

With this foundation, continued interaction along the industry supply chain is likely to occur but requires encouragement through on-going contact and extension. Such continued communication and connection with industry will act as a reminder keeping Best Practice as a forefront issue. It will also perform as a motivator for continued improvement.

Further communication focus to develop commercial activities within indigenous communities is noted of importance and is recommended. This demands specific approach by expert extension staff experienced in the mud crab industry and communication with groups of different cultural backgrounds.

It would be beneficial to direct further effort towards strengthening industry sector networks and facilitate continued dialogue between them.

Further development beyond this current project's objectives has already occurred during conduction of the work:

Mud crab grading system – from industry contact during extension activities it was noted that the strongest outstanding issue universally expressed by industry was inconsistent and vague grading of mud crabs, resulting in confusion across all sectors. This is now addressed through recognition and support from the FRDC:
FRDC 2011-225 *Using industry expertise to build a national standard for grading of live mud crabs*

Mud crab recovery system – as a direct outcome of extension within this current project, the Sydney Fish Market wish to adopt the Best Practice handling techniques for recovery of mud crabs at their point in the supply chain. Due to mud crab being the highest product through the market by value and volume, crabs which are seized or slow represent high revenue loss. However, a large capital investment is required from the SFM because of the number of crabs handled on a daily basis and hence assistance was sought to adapt the technologies previously developed to SFM's particular operations. To this end, a research proposal has been submitted by the SFM to the Australian Seafood Co-operative Research Centre: Seafood CRC MB085 *Increase sustainable use of crab fisheries resources by recovering revenue from crabs currently rejected at market*

National Industry peak body – an overarching industry peak body has been established: the *National Mud Crab Industry Reference Group*. This incorporates 25 industry members representing all sectors of the industry. It arose directly out of the Grading System forum and was an unsolicited Industry proposal - which is excellent!

Planned Outcomes

This project has resulted in a good understanding by all major stakeholder groups along the supply chain of how best to adopt and incorporate alternative or improved handling procedures into their best practice management. Identified end-users of the extension transfer include: harvesters; wholesalers; retailers; restaurateurs.

An outcome of this project is the potential opportunity for development of new markets through ability to distribute lively mud crabs over longer distances and provides additional export market opportunity.

The impact of widespread adoption of the knowledge extended through this project ensures consistent premium quality mud crabs in the marketplace. This underpins achievement of greater revenue gain for the industry through increased demand for product.

Strong ownership of information within all sectors of the industry now exists and adoption with continued improvement will result in positive public perception of the industry from recognised duty of care taken and responsible resource use.

Experience gained during conduction of this project provides a basis for broader application of extension of science knowledge in other fishing industry sectors. The learnings gained offer a sound platform for approach methods of communicating to disparate groups and different cultural backgrounds.

Conclusion

This project set out to extend best practice handling techniques for mud crabs towards achieving reduced mortalities and better quality lively crabs available to end-users. The project has been highly successful in achieving its objectives to meet the goal of improved resource use in the Australian mud crab fishery.

More than 80% of the industry has participated in the work. There has been strong engagement with extension content and an appreciation of communication methods by industry. Different approaches were employed targeted at specific audiences and appropriate to industry sector. The most successful was always one on one communication which is inherently responsive to individual situation. However, the use of straightforward hardcopy material incorporating as much visual content as possible was readily accepted due to belief in its source of origin (trusted personnel) and it was observed during further extension visits, that this material was prominent onsite. Best Practice handling methods illustrated by video footage on a DVD and

The Code of Practice was highly valued and automatic ownership of content was evident when familiar, particularly self, imagery was present.

Adoption of Best Practice handling for mud crabs is at a high level. In many instances adoption of simple practice change was immediate, with greater change occurring progressively. The impact of practice change within the industry is evidenced in the marketplace, with fewer mud crabs seized due to death and a significant reduction in downgraded crabs. The enthusiastic response from the end-user sectors of the industry has been palpable.

The impact of widespread adoption of the knowledge extended through this project ensures consistent premium quality mud crabs in the marketplace. This underpins achievement of greater revenue gain for the industry through increased demand for product.

A robust connectivity has developed within the industry supply chain, along with greatly increased cross-sectoral awareness. This sets the basis for continued communication within industry and interaction in both directions along the chain.

Strong ownership of information within all sectors of the industry now exists and adoption with continued improvement will result in positive public perception of the industry from recognised duty of care taken and responsible resource use.

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Appendix 1: Intellectual property

There is no intellectual Property arising out of the project work to be retained. All information is in the public domain and is available for publishing, wide dissemination, promotion, and/or training and extension.

Appendix 2: Project Staff

Sue Poole – Principal Investigator, Qld Government
John Mayze – Co-Investigator, Qld Government
Chris Calogeras – Mud crab consultant, C-AID Consultants
Erik Poole – Co-Investigator, Sydney Fish Market
Lucas Woolford - Co-Investigator, Sydney Fish Market
Beniomi Iakobi - Co-Investigator, Sydney Fish Market

Appendix 3: Attachments

…following pages

- Fact sheet for Harvesters.pdf
- Fact sheet for Transport recommendations.pdf
- Fact sheet for Recovery Procedure.pdf
- Fact sheet for Tanking recommendations.pdf
- Fact sheet for Retailers.pdf
- Fact sheet for Consumers.pdf
- Fact sheet for Testing for meat fullness.pdf
- Logger instructions and details.pdf
- Summary of Outcomes of Meeting between ECCNI and Representatives.pdf
- NT Code of Practice 2011.pdf
- Mudcrabs live and snapping, *Territory Q* article.pdf
- Retailer support email.pdf
- Survey Summary.pdf
- Survey form sent to supply chain – example to Co-operatives

Department of **Agriculture, Fisheries and Forestry**

Alive and kicking

Best practice handling of live mud crabs for harvesters

The Queensland Government has developed best practice guidelines for the handling and storage of mud crabs from harvest to table. These guidelines were developed as a way to reduce the stress levels of muddies, decrease mortality after harvest and to increase the eating quality of the catch.

This fact sheet provides key information on the handling, sorting and storage of live mud crabs **for harvesters** before transport.

At catch

- Confirm legal size, sex and not berried as per state/territory regulations.
- Return newly moulted crabs to water. These are prone to stress and do not tolerate transport and temperature changes at all.
- Dispose of any contaminated, badly damaged, deformed, diseased or parasitic crabs.
- Tie crab's claws hard against the body to restrict movement as soon as possible. This minimises crab stress, aggression and damage to other crabs and handlers.
- Hold in clean, damp hessian-lined crates to limit disturbance, minimise moisture loss and stop direct breeze and sunlight affecting the crabs.

Sorting crabs

- Apply care when legs are caught in basket. pulling on legs can cause bleeding which increases likelihood of death.
- Remove weak, slow or bleeding crabs. These may be revived using a recovery procedure.
- Dead crabs are a health risk to the crabs around them. Remove these immediately.

During storage

- Keep temperature constant. Avoid large changes in temperature (10°C either way). Let crabs adjust slowly to new temperatures and hold at around 18°C to 25°C.
- Air conditioning can dry crabs out - but may be used to avoid very high temperatures.
- Avoid exposure to sunlight and breeze. Wind and breeze cause death.
- Minimise moisture loss - use damp hessian to line and cover crates.
- Ensure crates are insect proof - watch for flies.
- Limit any loud noises as these will cause increased stress.
- Handle gently - disturb as little as possible.
- Crabs held out of water for more than 5 days will benefit from a recovery step (see Recovery Procedure Fact Sheet).

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Transport of live mud crabs to wholesalers and retailers

The Queensland Government has developed best practice guidelines for the handling and storage of mud crabs from harvest to table. These guidelines were developed as a way to reduce the stress levels of muddies, decrease mortality after harvest and to increase the eating quality of the catch.

This fact sheet provides key information on **packing** and **transporting** live mud crabs to wholesalers, distributors and retailers.

Packing crabs

- Cool crabs to 18-25°C if possible prior to packaging.
- Provide air holes in eskies/boxes (2 in winter or dry season, 4 in summer or wet season). If refrigerated transport is less than 15°C, reduce the number of air holes.
- Line bottom of eskies/boxes with damp old newspaper (fresh newsprint can be toxic). Consider also using styrofoam packing material for very rough situations.
- Use dry old newspaper for middle and top layers (damp newspaper can smother them).
- Discard weak crabs - badly damaged, very slow or frothing crabs should be killed and cooked. These crabs will not survive further transportation.
- Sort separate grades into separate eskies/boxes.
- Soldier pack with largest crabs on bottom layer.
- Mark eskies/boxes with:
  - Live Product
  - Fragile
  - This Way Up
  - Keep Cool but **NOT** Refrigerated
  - Provide traceability of product – state of origin at least

Transporting crabs

- Keep temperature constant. Avoid large changes in temperature (no more than 10°C either way).
- Handle gently - disturb as little as possible.
- Avoid exposure to sunlight and breeze.
- Transport vehicle cargo area should be cooled at 18ºC to 25ºC.
- Use direct air freight when ever possible.

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Recovery procedures – steps to increase longevity of live mud crabs

The Queensland Government has developed best practice guidelines for the handling and storage of live mud crabs from harvest to table. These guidelines were developed as a way to reduce the stress levels of muddies, decrease mortality after harvest and to increase the eating quality of the catch.

This fact sheet provides information on a recovery step for live mud crabs. Mud crabs stored for more than five days are more likely to die. If they survive, these crabs are liable to be poor eating quality. A recovery step can reduce mortalities and loss of quality by eliminating the crabs waste and toxins.

You will need

- Fresh, clean sea water, bore water, town water or rain water at around 25ºC.
- 1:10 ratio of live crab weight to water, for example 1kg crab + 10 litres of water.
- Aeration to create fine bubbles.

Before recovery

- Make sure crabs and water are about the same temperature.
- Sort crabs - badly damaged, very slow or frothing crabs should be killed and cooked. These crabs will not survive further transportation.
- Gently clean/rinse crabs of excessive mud, faeces or other contaminates. Ensure crabs are well tied.
- Isolate damaged or bleeding crabs, blood in the recovery water will increase animal aggression during purge.

Recovery procedure

1. Aerate the water. Without fine bubble aeration of water, all oxygen is depleted within 15 mins and crabs will die.
2. Immerse crabs individually – hold with flippers down and mouth just under water. Hold crab until water starts flowing over the gills and out of the mouth. This is important as crabs risk drowning if dumped in water without releasing trapped air and allowing gill action to start.

   Some crabs will go upside down and this is fine as long as air has been released.
3. If crab can not pump water across gills after 2 mins, then recovery is not possible.
4. Immerse for 3 hours. No shorter, no longer.
5. Return crabs to damp hessian lined crates, store at 18°C to 25°C. Be aware that air-conditioning and the cooling effect of damp hessian can drop temperature by another 5°C. This can stress crabs.
6. Recovery water is high in ammonia after treatment. Dispose of water by following appropriate local regulations.

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Alive and kicking

Tanking recommendations for live mud crabs

The Queensland Government has developed best practice guidelines for the handling and storage of mud crabs from harvest to table. These guidelines were developed as a way to reduce the stress levels of muddies, decrease mortality after harvest and to increase the eating quality of the catch.

This fact sheet provides key information on holding live mud crabs in **aquariums** or **tanks**.

Tanking crabs

- Recover crabs as per Recovery Procedures Factsheet. This will minimise contamination in your tank's water.
- Use clean seawater and monitor water quality regularly by checking:
  - temperature (18°C – 25°C)
  - pH (7.9 - 8.1) use sodium bicarbonate to increase
  - salinity (15 - 35ppm)
  - ammonia (<0.1mg/L)
  - nitrate (<50mg/L)
  - nitrite (<0.3mg/L)
- Conduct regular water exchanges as nitrites do not break down readily and will reach toxic levels over time.
- Provide adequate but not vigorous circulation and/or aeration.
- Install a bio-filter to suit the tanks volume/stocking density.
- Cover tank to reduce exposure to light, breeze, evaporation and disturbance.
- Ensure crabs are tied tightly.
- Check all crabs regularly – one dead crab can cause others to die.
- Do not feed crabs as it is unnecessary and may effect water quality.
- Larger storage tanks – as above and:
  - Store crabs in lug baskets lined with shade cloth to stop leg tip damage. Raise baskets 25mm off the tank floor
  - Pack crabs tightly to reduce movement.

Alternate holding systems

Several innovative systems have proved useful.

- Consider a spray tank system. This will:
  - minimise stress to the crabs
  - provide a constant (ambient) temperature
  - produce less maintenance on system
  - provide a fail safe in power outages
  - promote self cleaning of crab waste
  - encourages a low weight loss %
- Install a solid false bottom floor with drainage to a submerged pump.
- A garden irrigation system or similar will create even mist.
- Use saline water for short-term holding.
- Ensure the surface area is large enough to hold crabs stacked a maximum of three high – this enables easy checking for mortalities, reduces crowding and allows adequate exposure to mist.
- Crabs should be covered to reduce exposure to light, breeze, evaporation and disturbance.
- Drain and clean tanks regularly (crab through-put dependent).

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Alive and kicking

Best practice handling of live mud crabs for retailers

The Queensland Government with funding assistance from the Fisheries Research and Development Corporation has developed best practice guidelines for the handling and storage of mud crabs, from harvest to table. These guidelines aim to help reduce the stress levels of crabs, decrease mortality after harvest and increase eating quality.

This fact sheet provides information on sorting and storage of live mud crab for **retailers.**

Sorting crabs on receival

- Dead crabs are a health risk to the crabs around them. Remove dead crabs immediately and dispose of them.
- Make sure crabs are firmly tied, lively and not blowing bubbles from their mouth.
- Remove weak, slow or bleeding crabs. These may be revived using a recovery procedure (see Recovery Fact Sheet), or cooked.
- Confirm grades by checking shell hardness and other signs (see **Figures 2-6**).
- Gently clean crabs of any faeces or dirt.

During storage

- Crabs can live for several days if kept moist. They can 'breathe' only if their gills are moist. Once the gills dry out, they will die.
- Avoid exposure to sunlight and breeze. Wind and breeze cause death.
- Air conditioning will dry crabs out, but may be used to avoid very high temperatures. A damp, clean hessian bag will help crabs stay moist (see **Figure 1**). This will limit disturbance, moisture loss and direct breeze and sunlight.
- Keep temperature as constant as possible at between 18°C to 25°C. Avoid large, sudden changes in temperature (10°C either way).

Figure 1. Live mud crabs stored under a wet hessian bag.

- Ensure crates are insect proof. Flies will lay eggs, causing maggots.
- Limit loud noises as these increase stress.
- Handle gently. Disturb as little as possible.
- Crabs held out of water for more than 5 days will benefit from a recovery step (see Recovery Procedure Fact Sheet).
- See Tanking Fact Sheet for immersed longer term storage.

Cooking crab

- Humanely kill the crab either by:
  - putting it in the freezer for 20 minutes; or
  - putting it in an ice slurry for 30 minutes.
- Clean the crab's shell.
- Boil salty water and cook for 20 mins/kg, timed from water returning to rapid boil.
- Cool in salty, iced slurry for 90 minutes to reach a food safe temperature of 4°C.

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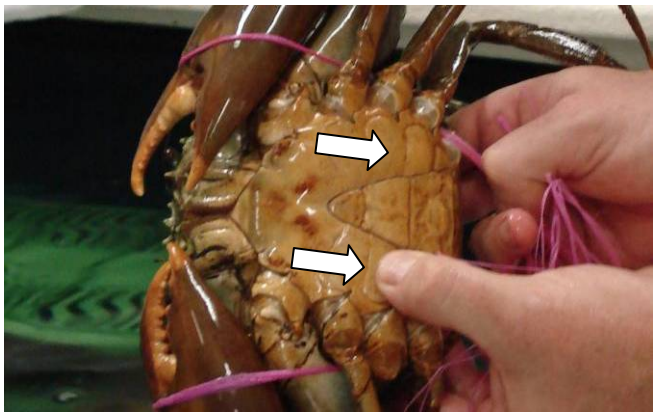

Figure 2. Checking a male mud crab.
Firmly press the abdominal plates adjacent to the 2nd walking legs (arrowed). If there is no flex the crab is likely to be full of meat. The abdominal carapace should be fully opaque and solid in colour.

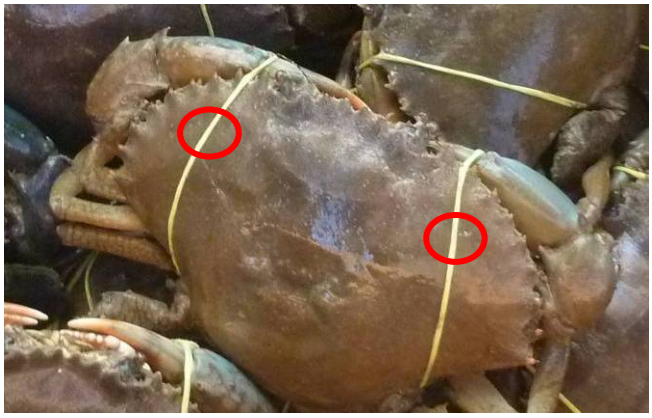

Figure 3. Checking a female mud crab (Take of female mud crab is prohibited in Qld).
Firmly press the top carapace at the areas circled. If there is no flex on both sides, the crab is likely to be full of meat.

Figure 4. A damaged segment from previous testing.
Do not press on a segment that has already been damaged (circled) as it will give a false indication of shell hardness.

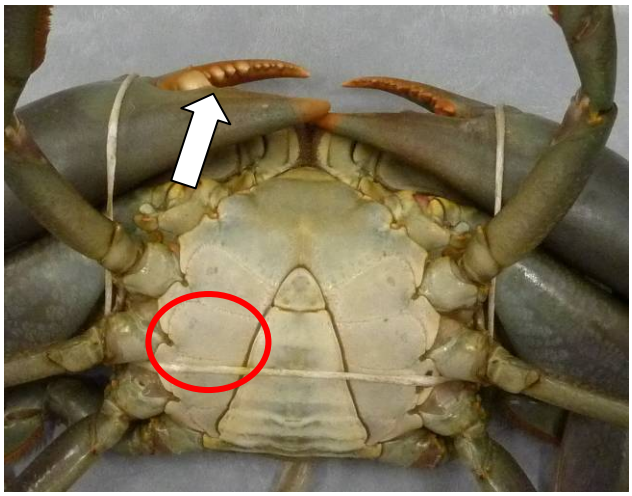

Figure 5. Newly moulted mud crab.
A crab with a clean, semi-transparent shell, transparent leg attachments and no wear on its claw teeth (arrowed) is less likely to be full of meat. The carapace will flex with light or moderate pressure on the segment circled. These newly moulted crabs will not survive extended periods out of water.

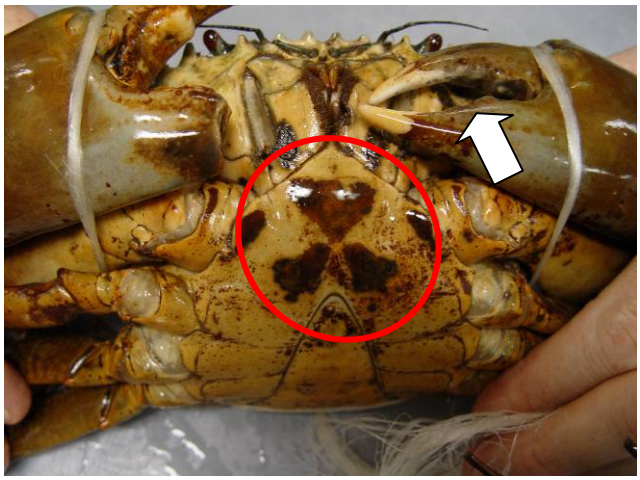

Figure 6. Signs of very old mud crab.
Dark mating scar (circled), worn claw 'teeth' (arrowed), carapace scars and damage, excessive large barnacles, or excessive amount of algae around the mouth parts indicate the crab has not moulted recently and is unlikely to be full of meat. They are often light in weight for their size. These crabs are often slow, weak and prone to die early.

Department of **Agriculture, Fisheries and Forestry**

Alive and kicking

Selecting, preparing and cooking your live mud crab

The Queensland Government has developed best practice guidelines for the handling and storage of mud crabs from harvest to table. These guidelines were developed as a way to reduce the stress levels of muddies, decrease mortality after harvest and to increase the eating quality of the catch.

This fact sheet provides information for **consumers** on choosing a live mud crab, preparing and cooking it for the table.

Selecting your live crab

- Handle carefully! Claws are dangerous and can cause serious injury!! If in doubt seek assistance from shop staff.
- Make sure the crab is firmly tied, lively and not blowing bubbles from its mouth.
- Confirm it is full of meat by checking shell hardness and other signs of age as in Figures 1-4 (see over).
- Meat yield ranges from 20% of total live weight in a newly moulted “B” grade crab up to 35% in a full “A” grade crab.
- Keep your crab cool (18°-25°C), moist and out of direct sunlight and breeze.

Cooking

- Humanely kill the crab either by:
  - putting it in the freezer for 20 minutes
  - putting it in an ice slurry for 30 minutes
- Boil salty water and cook for 20 minutes per kg from when the water returns to a rapid boil.
- Cool in salty, iced water for 90 minutes as the meat continues to cook in the shell.
- Alternative cooking methods include steaming, poaching in milk or in camp fire coals.

Cleaning and preparing cooked crab

- Clean the shell of the crab under running water with a brush.
- Lift the tail flap and push your thumb under the top shell near the flipper and pull the shell off the crab.
- Remove the gills, guts and mouth parts from the body, rinse out any muck from the inside.
- Remove the claws from the body.
- Crack each portion of the claws with a sharpening steel or the back of a knife (Figure 5).
- Enjoy!

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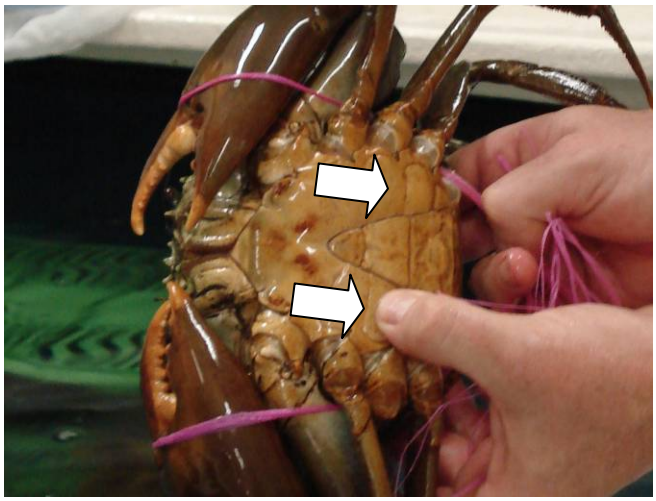

Figure 1. Checking a male mud crab.
The crab is not full of meat if there is any flex when the abdominal plate adjacent to the 2nd walking leg is pressed.

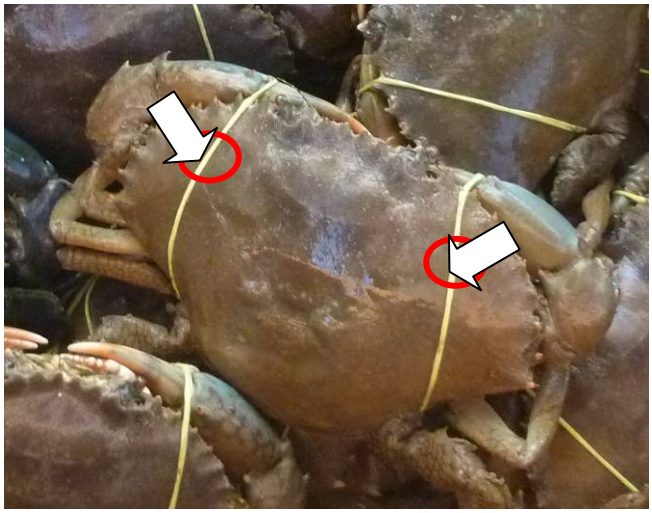

Figure 2. Checking a female crab (Take of female mud crab is prohibited in Qld).
Any flex or clicking sound when areas circled are pressed indicates a newly moulted female crab not full of meat.

Figure 3. Signs of an older male crab.
Mating scars (arrowed) and barnacles indicate the crab has not moulted recently and is more likely to be full of meat.

Figure 4. Newly moulted crab.
A crab with a clean, semi-transparent shell and no wear on claw teeth is less likely to be full of meat.

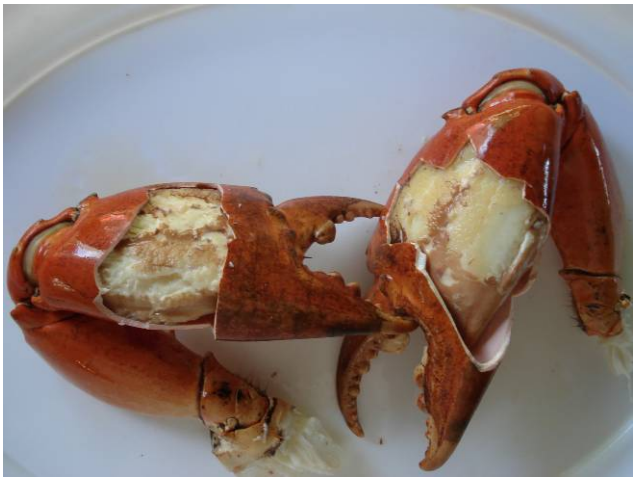

Figure 5. Cracked claws.
Crack claws near the nippers to reveal the meat from a full crab.

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Alive and kicking

Testing live mud crab for meat fullness

The Queensland Government, in conjunction with the National Mud Crab Industry Reference Group has developed guidelines for grading live mud crabs based on shell hardness and other signs of shell age. However, to provide greater certainty on whether the crab will be full of meat when cooked, a simple method of sampling the live mud crab's blood can be used.

This fact sheet gives instructions on how to test a live crab's blood for cooked meat yield.

The moulting cycle

- Crabs grow by an incremental moulting process. This occurs approximately 18 times at increasing intervals over the crabs 3-4 year life span.
- The moulting procedure and subsequent shell growth is assisted by the crab absorbing water, splitting the old shell, backing out of it and expanding the new soft shell by up taking more water.
- It can then take up to 4 weeks until the shell is hard, during which time the crab can be graded as either 'C' or 'B' grade depending on the amount of shell flex.
- The up take of water during the moulting process dilutes the protein in the crab's blood. The level of protein will then increase as the crab hardens and fattens up until is it ready to moult again.

Equipment required

- A clinical refractometer 1.3400 to 1.3600 RI.

- Syringe (3cc/mL) and needle ($22^{Gx3/4"}$). Follow safety precautions when using syringes.

Taking a blood sample

- With the crab securely tied, turn it over and hold back the last walking leg. Insert the needle through a triangular opaque area close to the body and insert just under the membrane a few millimetres, pointing the needle towards the top of the flap as in the black line in Figure 1. This procedure is harmless and does not cause crab to bleed.

Figure 1. Taking a blood sample.

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Taking a blood sample (continued)

- Slowly pull back on the syringe plunger until a small amount of blood enters the syringe tube. Remove the needle and place a drop or two of blood on the open glass pane of the refractometer and close the lid.
- Hold the refractometer to a light source and take a Refractive Index (RI) reading at the intersection of the white and blue background colour (Figure 2).

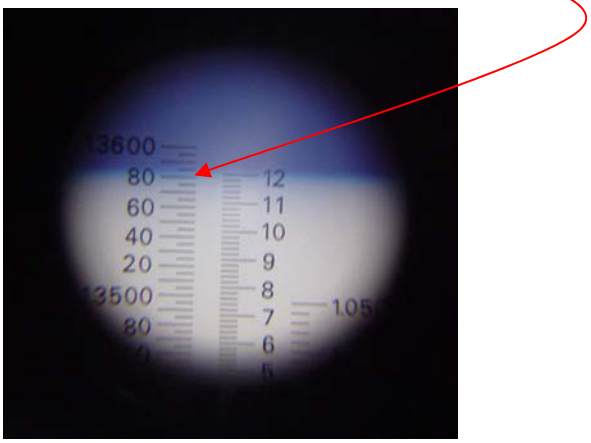

Figure 2. RI reading of 1.3582

Interpreting the result.

- The total amount of protein circulating in the blood of a crab is, in the first instance, correlated to feeding cycles in the animal. Blood protein has also been observed to decline significantly during periods of prolonged starvation.
- Mud crab blood protein concentrations measured using a refractometer (units measured as RI) have been validated against total protein determined by the commercial test kit Randox TP245.
- RI of 1.3400 is seawater.
- RI of 1.3400 to 1.3500 indicates ‘C’ or B’ grade crab.
- RI of 1.3500 to 1.3550 indicates ‘A’ grade and usually nearly full of meat.
- RI of 1.3550 to 1.36+ will be an excellent ‘A’ grade crab, full of meat and ready to moult again or eat.
- Cooked meat yields range from 20% of total live body weight in a newly moulted crab (Figure 3) and up to 35% in a full ‘A’ grade crab (Figure 4).

Figure 3. Newly moulted crab claws not full of meat.

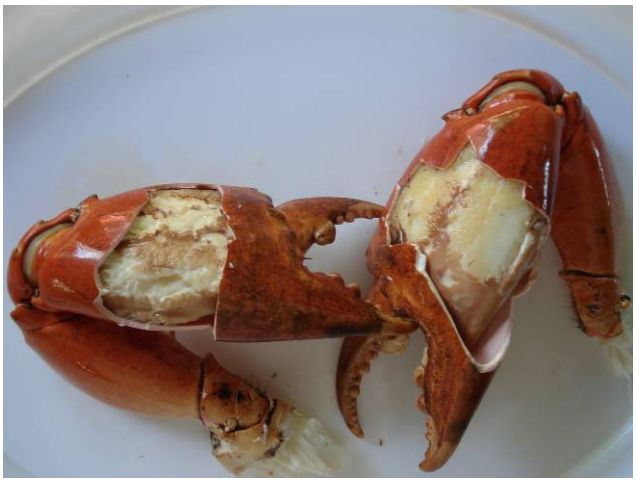

Figure 4. Cracked claws of an ‘A’ grade crab full of succulent meat.

- Some very old crabs with hard and scarred shells reach a stage where they no longer feed. The available protein in the blood, subsequent meat content and crab weight decreases over this starvation period.
- A recently moulted crab with any flex in its shell and a corresponding low RI will have little meat content if cooked. By returning these crabs to the water were they will continue to feed and fatten in just a few more weeks. Then we can all enjoy the pleasurable experience of mud crabs full of meat.

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Record of Details.

1. Your details:
    - Name:
    - Address:
    - Phone:
    - Fax:
    - Mobile:
    - Email:
    - Typical kg of catch per week:
    - Mortalities % or number of crabs per week:

2. Logger number:
3. Date and time and location (at capture or after) logger attached to crab:
4. Date and time crab returned to land:
5. How crabs stored prior to packing:
6. Date and time crabs packed:
7. Type of carton – cardboard, styro, both or other:
8. Thickness/type of styro esky:
9. How many and size of holes in carton/esky:
10. Packing material used:
11. Date/time esky/carton sent:
12. Type of transport:
13. Destination:
14. Date and time esky/carton arrive at next transport - drop off:
15. Type of transport :
16. Final destination:
17. Expected date and time at final destination:

Instruction for logger

1. Logger is already recording temperature (±1°C) every 15 minutes for 3 weeks. It is waterproof. No need to do anything to it.
2. Attach to 1st crab of the weekly catch as soon as the crab caught and tied.
3. Attach logger under the string on the back of the crab so it can't get bitten.
4. Pack with stored crabs as normal.
5. Pack crab with logger in the top of esky or carton so it's easy to recover.
6. Mark esky or carton with '**LOGGER INSIDE'** for receiver to collect it.
7. Contact John Mayze that a consignment with logger has been sent.
8. Inform receiver to collect logger and send to:

   John Mayze
   Innovative Food Technologies, DEEDI
   P.O. Box 156, Archerfield Queensland 4108

9. Send this 'Record of Details' to:

   John Mayze
   Innovative Food Technologies, DEEDI

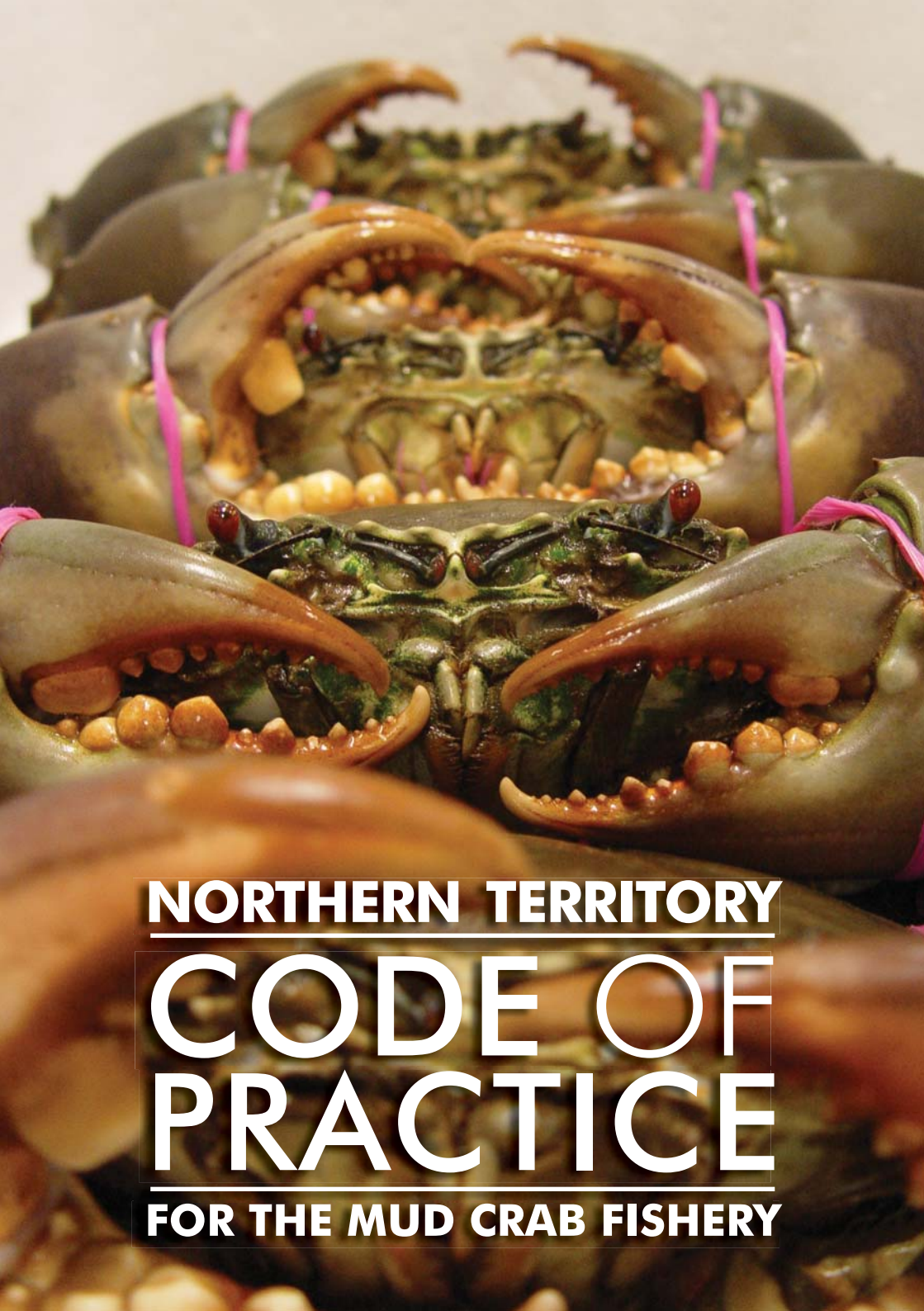
   Telephone 07 3276 6023 **Facsimile** 07 3216 6591
   Email john.mayze@deedi.qld.gov.au **Mobile** 0418 870 488

   Mail P.O. Box 156, Archerfield Queensland 4108

   Location Health and Food Sciences Precinct
   Block 10, 39 Kessels Road Coopers Plains, Brisbane QLD 4108

Summary of Outcomes of Meeting between East Coast Crabfisher Network Inc and Representatives from the Sydney Fish Market 2 August 2011.

Action	Timeline	Responsibility
Provide a summary of sales adjustments over complete year by all fishers by jurisdiction and region	October 2011	SFM
Adjust fisher summary report to include mortalities and downgrades on a daily and annual basis	October 2011	SFM
Include a non-identifiable buyer ID against all adjustments on fishers daily summary report	October 2011	SFM
investigate protocols for dealing with 'old, rusty' mud crabs	November 2011	SFM and ECCFN
Assess possible commercially viable uses for 'frothy/slow' crabs	March 2012	SFM
Provide a brief overview of ECCFN meeting with SFM in upcoming SFM Newsletter	August 2011	SFM and ECCFN
Assess impacts of cold on crabs along supply chain, including whilst being held on market floor	November 2011	DEEDI, SFM and ECCFN
Assess cost and opportunity to develop video of SFM staff undertaking role as QA officers in crab pen showing grading and assessment processes	December 2011	SFM
Investigate opportunity to increase FRDC contribution for proposed Crab Standards Project so as to develop high level video of grading process to improve extension and take up along supply chain – especially for those without English as a first language	August 2011	Chris Calogeras and DEEDI
ECCFN to revisit SFM with possibly larger group after AGM and revised reporting processes have commenced	November 2011	ECCFN and SFM



NORTHERN TERRITORY

CODE OF PRACTICE

FOR THE MUD CRAB FISHERY

OBJECTIVE

Every person *involved in the* ***mud crab*** *fishery should strive to* ***maximise*** *the* ***sustainability****, quality and* ***value*** *of the catch by only keeping commercially suitable,* ***quality*** *crabs and maintaining them in the* ***best*** *possible condition for supply to the* ***consumer.***

MAXIMISE SUSTAINABILITY

The Northern Territory mud crab fishery is harvested and managed sustainably. In the interests of the stock, the industry and the wider community, the NT Mud Crab Licensee Committee fully supports continued management for the production of sustainable, quality Australian seafood.

In 2002 the NT mud crab fishery was assessed by the Commonwealth Department of the Environment and Heritage as being ecologically sustainable for export, under Australian Government guidelines based on the *Environment Protection and Biodiversity Conservation Act 1999*. In 2007 the mud crab fishery was reassessed under the guidelines and accepted for further export approval.

Maximise value

The value of the mud crab fishery to both participants and the Northern Territory community is maximised when only full, healthy mud crabs are taken and then cared for appropriately. Commercially unsuitable crab, as described in this Code of Practice, together with undersized animals and berried animals (a female with eggs), must always be returned to the water as soon as possible after being removed from a pot. Maintaining healthy mud crabs in and out of the water is the key to maximising value.

Maximise quality

A strong, healthy mud crab commands the highest price. Ensuring that mud crabs are handled, transported and stored according to this Code of Practice will maximise a quality product to the consumer and help obtain the best price for everyone involved – from capture to sale.

FEMALE

Underside view of a female mud crab

Minimum size limit 150 mm across the carapace

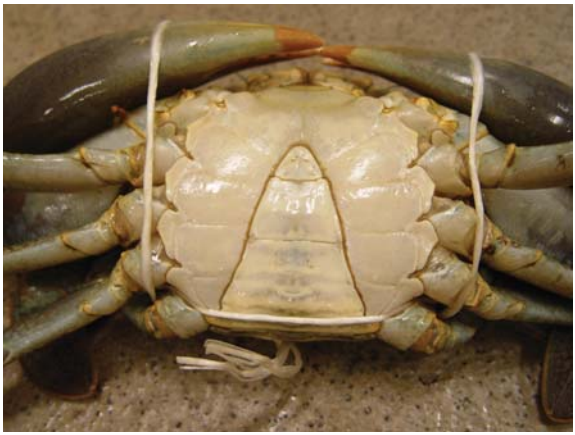
Females with eggs must be released

Female with eggs attached under the abdominal flap – "berried female"

MALE

Underside view of a male mud crab

Minimum size limit 140 mm across the carapace



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INTRODUCTION

In 2001 the Mud Crab Fishery was the first fishery in the Northern Territory to develop a voluntary Code of Practice. Ten years later, recognising the need to review the code and include new information, the fishery will also be the first to review and update their Code.

A best-practice guide for the Mud Crab Fishery, this Code of Practice is specifically designed to assist operators to maximise the quality and value of product, minimise wastage and contribute to the ongoing ecological and economic health of the Mud Crab Fishery and those businesses that rely on its sustainability.

The Code covers handling, storing, transporting, recovery and tanking procedures from capture to wholesale operation and provides fishers, transporters and wholesalers with clear recommendations to ensure the post-harvest survival of mud crabs along the supply chain. The intention is to maximise revenue for those involved in the fishery by maintaining the crab in the best possible condition from capture to sale. This also contributes to sustainability by reducing post-harvest mortality, thus maximising the use of the resource.

The Code has been guided by the results of research undertaken by Innovative Food Technologies (Primary Industries and Fisheries, Queensland) in conjunction with the NT Seafood Council (NTSC) and the NT Mud Crab Licensee Committee. The research project Maximising Revenue Within the NT Mud Crab Fishery by Enhancing the Post-Harvest Survival of Mud Crabs was funded by the Fisheries Research and Development Corporation (FRDC).

This voluntary Code of Practice has been developed by the NT Mud Crab Licensee Committee of the NTSC, with assistance from OceanWatch Australia's SeaNet Program and Innovative Food Technologies, Department of Employment, Economic Development and Innovation (DEEDI), Queensland. Financial support has been provided by DEEDI and the FRDC.

THE FISHERY

The Northern Territory Mud Crab Fishery operates in tidal waters between the Western Australian and Queensland borders, with most activity concentrated in the Gulf of Carpentaria. Commercial crabbing is not permitted in Darwin Harbour and in most creeks adjoining Shoal Bay, Leaders Creek and the waterways of Kakadu National Park.

Many commercial fishers work from remote locations under difficult environmental conditions and limited, if any, infrastructure. Crab pots are baited with fresh meat or fish and set in estuarine or coastal waters. The majority of crab fishers work from 5 to 6.2 metre outboard powered dinghies and have semi-permanent land-based camps where the crabs are stored prior to transport to Darwin.

Crabs are transported to Darwin by road in temperature controlled trucks, usually inside crates lined and covered with damp hessian bags. At the trader/processor premises the crabs are repacked in waxed cardboard or foam boxes for shipment interstate or to export markets.

The supply chain from harvest to market for mud crabs in the NT can be up to 15 days. The physical demands on the crab are extreme as they are transported and distributed by road and air.

Mortality rates of mud crab can be minimised through development of appropriate, practical and cost-effective handling procedures along the harvest-to-market supply chain.

The Mud Crab Fishery is a valuable fishery in the NT and the sustainable use of the resource is supported by both industry and government.

A highly regarded fishery aims to maintain a top quality product while operating in an environmentally responsible way in all its activities.

DURING CRABBING

Clear pots at least once every 24 hours

Don't allow crab pots to dry out or be left in hot, shallow water – sun and hot water can stress the crab. Stress makes the crab more likely to die or to reach market in poor condition.

One of the biggest causes of crab deaths is when hot water comes in over the mud flats on the incoming tide.

Haul pots in a steady, continuous motion

Steadily hauling pots and placing them gently in the boat will avoid physical damage and stress to crabs.

Remove crabs from pots gently

Open the pot door and let the crabs slide out. Don't shake them out as this causes physical damage and stress.

Crabs must be sorted and tied as soon as possible after being removed from pots

Carefully return berried females, undersized animals, and commercially unsuitable crabs (CUC) to the water as soon as you can after being removed from a pot. The crab then has more chance of surviving to reproduce or grow to a legal size.

Newly moulted crabs are easily stressed and can't handle transport and temperature changes.

Crabs kept for market must be tied as soon as possible. If the weather is bad, tie the crabs in the nearest calm water. They must not be returned to camp untied.

Tying a crab is a legal obligation

Tie the crab's claws hard against the body to restrict movement. This will minimise the crab's stress, aggression and the possibility of damage to other crabs and handlers.

A well tied crab should have its mouth clear of string, its claws firmly restricted and the string cut no more than 30 mm from the knot. Too much string looks bad when the crab gets to market, can get caught around legs leading to leg loss and can break loose and clog up holding tanks.

String ends should be kept on the boat and appropriately disposed of at camp.

Always handle crabs gently

A carefully handled crab has a much higher chance of survival, whether it is being returned to the water or kept for market.

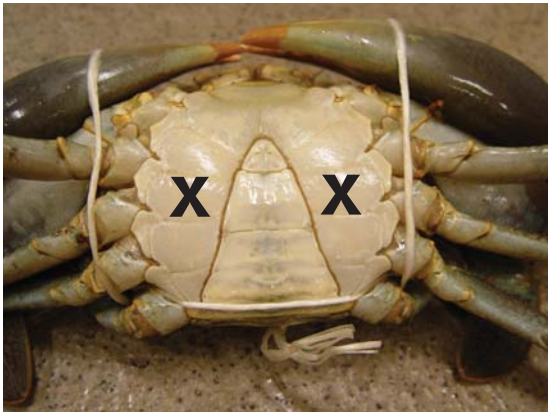
By-catch

While by-catch in the fishery is very low, all attempts should be made to quickly release non-retained animals alive with the minimum of stress and injury.

COMMERCIALLY UNSUITABLE CRABS (CUC)

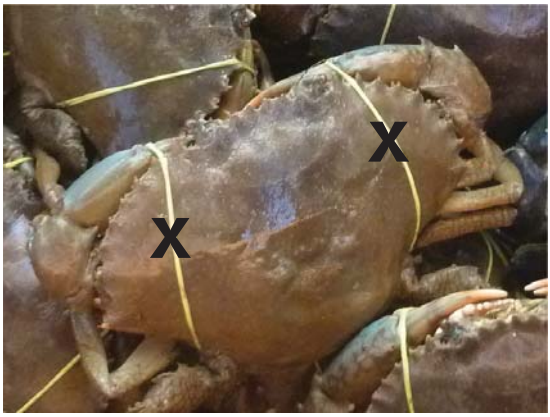
Male (Buck)

A commercially unsuitable male is one whose underside opposite the middle leg (marked with an X on the diagram) can be depressed. CUCs must be returned to the water unharmed.



Female (Jenny)

A commercially unsuitable female is one which makes an audible clicking sound when both forward quadrants (see diagram) of the shell (carapace) are pressed. CUCs must be returned to the water unharmed.



There are only two to three weeks between a commercially unsuitable and a full, healthy crab once it is returned to the water.

STORING CRABS ON THE BOAT

Avoid breeze and sunlight

Hold crabs in clean, damp, insect-proof, hessian-lined and covered crates to limit disturbance, minimise moisture loss and stop breeze and sunlight affecting the crabs.

Exposure to sun and wind will dehydrate a crab, lower its body weight and value and possibly lead to its death.

Water

Crabs can die from contamination by polluted water and contact with fuel. They should not be stored in the bilge compartment as it may have spilt fuel in it. Dual decks can avoid this problem.

Use only clean water to maintain crab safety and quality. Seawater from polluted waters must not be used on surfaces or containers containing crabs.

Keep quiet and disturb as little as possible

Limit any loud noises, vibration and impacts as these will cause increased stress levels in the crab. Avoid disturbing the crabs – each time you disturb the crabs you are increasing stress levels. Disturbance includes physical movement in rough weather or during road transport.

Handle gently

Minimise the handling movements and be careful when legs are stuck in baskets or caught on another crab. Pulling on a leg that is stuck can cause bleeding and lead to crab deaths.

STORING CRABS AT CAMP

Provide a stress-free environment

As with storing crabs on the boat, avoid breeze, sunlight, and contaminated water and minimise noise, disturbances and handling.

Store crabs out of direct sunlight in a cool, moist, wind proof and insect and vermin proof shelter. In a camp, this is best done with crates raised off the ground and with a pump and sprinkler system to keep conditions cool and moist.

The best storage area sheds are those constructed with double lined shade cloth on all sides and doors, and with a roof which is sun proof.

Packing

Hessian sacking should be double folded to keep flies out and to maintain a humid environment. Crates should not be overfilled as this can lead to crabs in some crates being crushed if other crates are stacked on top. Packaging used for crabs must be stored in a clean environment.

Keep temperature constant

Temperature fluctuations can be simply avoided by keeping the hessian damp at all times. Avoid large or sudden fluctuations (>10°C) of holding temperatures as sudden changes will cause stress.

Allow crabs to slowly get used to new temperatures and hold around 18°C to 25°C – no more than 10°C below their normal environmental temperature. Damp hessian will cool the temperature inside a crate of crabs by up to 5°C, so don't dampen on cool, dry season evenings.

Stored crabs should be checked regularly and weak or dead crabs removed

Remove weak, slow or bleeding crabs. These crabs have been stressed at some stage and they may benefit from a recovery step (see later section).

Dead crabs must be removed as their presence is harmful to adjacent live crabs. Best practice is to bury, burn, or dispose of dead crabs in deep water once the string ties have been removed.

By removing dead crabs, insects and vermin are less likely to be attracted to the storage area. It also removes a bacterial contamination source, which can infect healthy crabs.

Bury any contaminated, badly damaged, deformed, diseased or parasitic (loxi) crab.

SUMMARY OF HANDLING RECOMMENDATIONS FOR FISHERS

- Confirm legal size and not berried as per regulations
- Confirm the crab is not a commercially unsuitable crab (CUC). Newly moulted crabs are prone to stress and will not tolerate transport and temperature changes. CUCs returned to the water will become "A" grade crabs within weeks
- Bury or dispose of responsibly any contaminated, badly damaged, deformed, diseased or parasitic (loxi) crab
- Tie crab's claws hard against the body to restrict movement as soon as possible. This will minimise the crab's stress, aggression and the possibility of damage to other crabs and handlers
- Hold in clean, damp, insect proof, hessian-lined and covered crates to limit the disturbance, minimise moisture loss and stop direct breeze and sunlight affecting the crabs
- Avoid direct wind/breeze. Holding crabs in drafts during transport and storage will cause mortalities. Air-conditioning will also dry crabs out, but may be required to avoid very high temperatures
- Keep quiet. Limit any loud noises, vibration and impacts as these will cause increased stress levels in the crab
- Disturb as little as possible. Each time you disturb the crab you are increasing stress levels in the crab
- Handle gently. Minimise the handling movements and be careful when legs are stuck in baskets or caught on another crab. Pulling on a leg that is stuck can cause bleeding and increases the risk of mortality

- Keep temperature constant. Avoid large or sudden fluctuations (>10°C) of holding temperatures as sudden changes will cause stress. Allow crabs to slowly acclimatize to new temperatures and hold around 18°C to 25°C
- Remove weak, slow or bleeding crabs. These crabs have been compromised at some stage and may be included in a purge/ recovery step to help revive them but must be closely monitored
- Dead crabs must be destroyed/dumped. Even a recently dead crab is inedible and can be a health risk to adjacent live crabs
- All crabs held out of the water for more than 5 days would benefit from a recovery step (see later section)

BEFORE GOING CRABBING

Make sure your boat and motor are in good working order and regularly maintained

Fishing can be a dangerous occupation. Make sure boats and motors are always in good working order. Safety at sea is the first rule of a fishing operation.

Good boat design and maintenance also minimise the chance of contamination and physical damage to the crabs.

It is a legal requirement to have all the relevant safety gear on your fishing boat. If you are unsure, contact the NT Marine Safety Branch for manning requirements, safety equipment and boat buoyancy requirements.

Occupational health and safety

It is important that clear occupational health and safety guidelines are in place for the entire fishing operation and those involved clearly understand these and other relevant food safety and regulatory obligations.

When those involved in the fishery understand their responsibilities during fishing operations the chances of accidents are minimised.

Hygienic handling

Those involved in the fishery must comply with regulations relating to the hygienic handling of food products, such as mud crabs.

Any person with a contagious or notifiable illness must not be allowed to come in contact with crabs unless the integrity of the product can be guaranteed.

Smoking, eating and drinking should be prohibited in sorting and storage areas.

Secure harmful materials

Harmful and poisonous materials such as oils, insecticides and cleaning products must be stored and/or secured in an area where they cannot contaminate crabs or storage areas.

Never discard chemicals, fuel, oil or other non-environmentally friendly products in the water or in the bush – this is not only illegal but can have long term detrimental effects on crab and other marine species, as well as the environment generally.

Pest control

Rodents, birds and insects are all potential carriers of diseases which could contaminate crabs and it is important that adequate steps are taken to control pests on a boat and in storage areas. Domestic animals should not be kept on board.

Environmental and camp hygiene are essential for a continuing healthy fishery

Deck, mats, crab pots, holding containers and other potential crab contact surfaces should be clean to prevent any contamination.

The boat should be thoroughly cleaned before (and kept clean during) each fishing trip to remove any contaminants that may be present.

Ensure only "food safe" cleaning and sanitising products are used and always follow manufacturer's directions when using them.

Make sure you are familiar with and comply with the legislation that governs the management of the mud crab fishery

This Code of Practice is a guide only and doesn't remove your obligation to understand and comply with the legislation.

The legislation that governs the management of the mud crab fishery is a result of industry and government consultation over many years. It is there to ensure the continuing sustainability of the stocks that, in turn, our industry depends upon for our continuing viability. Copies of the Mud Crab Fishery Management Plan are available to download at www.ntsc.com.au/legislation.html

Overpotting is not only illegal, it affects the continuing viability of all who have investments in our fishery

The Licensee Committee has supported significant penalties in Fisheries legislation on those operators who use more than the pots they are allowed.

The Licensee Committee will not provide any support to those who overpot.

Respect the laws governing Aboriginal land

Aboriginal land in the Northern Territory is held as inalienable freehold title. Permits from the appropriate Aboriginal Land Council are required before entering on to this land.

When in the vicinity of an Aboriginal community, work should be conducted in a manner that is respectful of the community.

Pollution of the marine environment is strictly controlled by law and penalties for not complying are large

Plastics are not allowed to be discharged into the sea. All plastics must be kept on the boat and disposed of at appropriate facilities. Plastic waste which forms a continuous loop, such as bait bands, should be cut on board to minimise impacts in case it is accidentally lost at sea.

The discharge of noxious and hazardous liquids that are harmful to the aquatic environment are prohibited by law.

The law does not permit the disposal of non-plastic garbage, including food waste and string ends, within the area of the fishery.

The law does not allow oils or oily mixtures to be discharged into the sea. Waste oil and oily residues must be stored for disposal at appropriate waste disposal facilities.

Lost fishing gear and garbage can pose a significant threat to aquatic life. All efforts should be made to retrieve lost fishing gear. If it is not possible to collect, report the location of the gear to the relevant authorities.

Efforts should also be made to retrieve any non-degradable garbage or wastes found during fishing operations, for proper disposal at onshore facilities.

Any oil or chemical spills or other incidences of environmental damage in the area of the fishery should be reported to the Pollution Hotline 1800 064 567.

THREATENED SPECIES

There are a number of species listed as protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and under the Northern Territory's *Territory Parks and Wildlife Conservation Act*.

All interactions with protected species must be recorded in your logbook. Interactions can also be reported to Marine WildWatch.

Under the EPBC Act it is not an offence to interact with a protected species when conducting your regular fishing operations, even if the interaction results in the animal's death. However, it is an offence to not report an interaction with a protected species. Record the date of interaction, species involved, number of animals, approximate length, location, gear or bait used and whether the animal was released alive or dead.

Some examples of interactions that require reporting are:

- Any action resulting in the killing or injuring of a listed species
- The accidental capture of a listed species in a fishing operation
- A humane action that is necessary to relieve or prevent the suffering of a listed species
- An action taken to prevent risk to human health
- An action that is necessary to deal with an emergency where there is a serious threat to human life or property

Protected species include marine turtles, crocodiles, dugong, dolphins and sawfish.

THE TRANSPORT OPERATION

The role of the transport driver is crucial in ensuring crabs arrive at their destination in the best possible condition

Drivers should ensure they have permission to enter or cross Aboriginal land or private property and observe any restrictions that might apply, such as being in possession of alcohol.

A significant percentage of crab deaths occur during long distance transport by road to Darwin.

Vehicles should be properly maintained, cooling units regularly serviced and cargo areas kept clean and cool during transport of crabs.

Cargo areas should be shielded from the sun and wind, be free from fuel and exhaust odours, allow airflow around crates and have mechanisms to secure crates in place during transport.

For journeys longer than 3 hours a cooling system that keeps transport area at 18°C to 25°C will minimise stress in the crabs.

Healthy, full crabs that are loaded on a vehicle will handle a journey of many hours on the road if the vehicle transporting them is fitted with these basic but very necessary requirements.

Drivers should ensure that only live crabs are loaded into trucks

While it is the fishing operator's responsibility to provide only healthy crab, it is also the driver's responsibility to make sure that crates loaded on a truck do not obviously contain dead crabs or crabs infected by insects.

Crates should not be overfilled as this can lead to crabs in some crates being crushed if other crates are stacked on top.

An alert nose and pair of eyes can mean the difference between a healthy cargo delivered safely and a cargo that has unnecessary deaths and reduced quality that costs everyone financially.

Ensure that crates are suitably moist and appropriately stacked for transport for both short and long distances

Wet hessian bags before loading crates onto a truck. Securely fasten crates so they cannot move during transport. The forward cargo area provides a gentler ride.

Remember, gently handled crabs have a greater chance of reaching the consumer in the best possible condition.

Be aware that other people use boat ramps and conduct loading of trucks accordingly

Be aware of the rights of others at boat ramps and ensure that access to them is not denied because of the truck loading operation. Avoiding conflict with other user groups is important in ensuring continued access to the resource and support from the general public.

Do not leave rubbish or rejected crabs at boat ramps. The Licensee Committee will not provide any support to those who behave in such a manner.

THE TRADER/PROCESSOR OPERATION

The trader/processor is the final quality control point before mud crabs reach the buyers. As such, the trader/processor can have a major impact on prices received back through the chain to the fishing operation.

Sorting, packing and storage rooms on trader/processor premises must comply with all health regulations and be clean, sun proof, wind proof, insect and vermin proof

The care taken in the fishing and transport operations can be severely compromised if the trader/processor's premises are less than satisfactory. With the introduction of tough food safety laws, sub standard premises could mean the loss of a licence to handle crabs as a trader/processor.

Check and record temperature of the truck cargo area before unloading

The temperature of the cargo area of a truck at the premises is a critical point in the process of transporting crabs from point of capture to point of sale.

Unacceptably high or low temperatures at this point can cause a significant deterioration in crab quality between here and the market.

Both the transport operator and the fisher should be advised of any abnormal temperatures recorded as a matter of priority.

Unloading of trucks should be conducted as soon as possible with as little disturbance as possible

As the crab has been out of the water for some time, the gentle handling of crab at this point is crucial in maintaining quality and therefore value.

Crabs should be sorted and graded for market as soon as possible after being received by the trader/processor

Any crabs that are dead, slow or damaged should be separated out accordingly.

This will ensure that healthy crabs have the greatest chance of reaching the consumer in a healthy state.

Dead crabs should be double bagged if they are to be disposed of at a Council dump.

Maintain crabs in approved boxes at 18°C to 25°C until delivery to airport or local market

The temperature range of 18°C to 25°C is the optimum to ensure that live mud crabs have the best chance to reach the consumer in premium marketable condition. A healthy crab packed in an appropriate box and kept at this temperature will provide the best financial return to all sectors of the industry.

Crabs should be delivered to the airport as close to flight departure time as possible in a vehicle that has a covered cargo area. Best results are achieved if an air-conditioned vehicle is used.

Ensure that clean, dry crates and hessian bags are provided to the transport driver for delivery back to the fishing operation

The maintenance of quality control throughout the chain from harvest to the consumer is crucial to the continued economic and ecological health of the mud crab fishery.

Communication and cooperation between sectors is vital to ensure this.

TRANSPORT RECOMMENDATIONS FOR SHIPPING TO MARKET

- Cool crabs to 18°C to 25°C if possible prior to packaging
- Provide air holes in packaging container
- Line bottom of container with damp, old newspaper (fresh newsprint can be toxic)
- For middle and top layers use dry, old newspaper (damp newspaper smothers them)
- Place very large crabs on bottom layer
- Minimise rough handling and vibration during transport
- Provide traceability of product if possible – state of origin at least
- Mark containers as "live product, fragile, this way up, keep cool but not refrigerated

SUMMARY OF RECENT RESEARCH

High mortality rates of mud crab can be minimised through development of appropriate, practical and cost-effective handling procedures along the harvest-to-market supply chain.

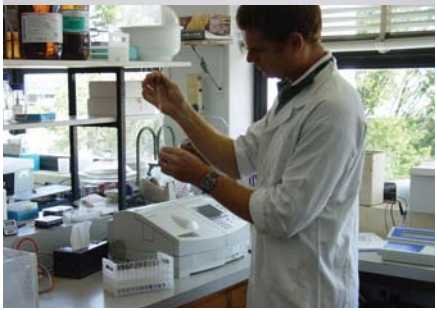
Research undertaken by Innovative Food Technologies, Department of Employment, Economic Development and Innovation (DEEDI, QLD) looked at how to enhance the post-harvest survival of mud crabs along the supply chain.

The research was able to identify which handling steps along the chain impose the greatest stress to crabs. With this information, alternative handling practices were developed to minimise stress and improve survival rates.

Feedback from harvesters, trader/processors and the retail sector has indicated increased survival and improved vigour of mud crabs when the alternative handling methods have been employed.

Industry has reported a 50% reduction in mortalities in the processing sector and a further 10% reduction at retail level. Mud crabs reach the consuming public in premium quality, raising public confidence in the product and improving public perception of the commercial operators.

Increased survival of the crabs within this fishery not only improves resource sustainability, but also improves public perception of commercial activities within the mud crab fishery.



The research found that the major causes of stress include emersion (holding crabs out of water), handling disturbance and temperature changes. When mud crabs are out of water, but held quietly, undisturbed and in a moist environment, stress levels are low.

Dehydration is a significant factor as the consequent water loss from the crabs reduces the total weight of a crab. This has implications for all sectors of the industry with respect to revenue return.

Mud crabs are handled frequently at different points during the supply chain. Each handling event involves physical movement of the crabs and often a degree of shock, with all such disturbances adding stress to the crabs. If carried out gently and with care, the physical disturbance only imposes temporary stress on the crabs, from which they recover quickly.

Grading and loading/unloading for transport involves greater physical movement and was found to be stressful to the crabs. A particular stress factor was exposure of the crabs to breeze. This caused very high stress levels and resulted in a high proportion of mortalities.

Holding crabs at an appropriate temperature and limiting temperature change is optimal for minimising stress. Sudden variations in temperature within the supply chain are common and the damp hessian used during storage and transport is not always effective in moderating these changes. The research concluded that mud crabs best tolerate a temperature range between 18°C to 25°C.

The major recommendation from the research is the inclusion of a recovery step within the distribution chain for live mud crab. It is important to include a purge step of 2-3 hours where the crabs are returned to aerated water to allow excretion of accumulated ammonia. The crabs can then be held in fresh seawater tanks to fully recover.

A copy of the full report can be obtained from John Mayze or Sue Poole. Please contact john.mayze@deedi.qld.gov.au or sue.poole@deedi.qld.gov.au

RECOVERY PROCEDURE FOR TRADERS/ PROCESSORS AND BUYERS

Prior to re-immersion

- Crabs and water should be about the same temperature before re-immersion
- Sort the crabs – badly damaged, very slow or frothing crabs should be killed and cooked as they are unlikely to survive additional stress from further transportation
- Isolate damaged or bleeding crabs, as blood in the water will increase inter-animal aggression
- Gently clean/rinse crabs of excessive mud, faeces or contaminates
- Ensure crabs are well-tied so they can't work their claws loose

Recovery stage (re-immersion) parameters

- Fresh, clean seawater, bore water, town water or rain water around 25°C
- 1:10 live crab weight (kg) to litre of water i.e. 1 kg crab to 10 litres of water
- Aeration is essential – without fine bubble aeration of the water all available oxygen is depleted within 15 minutes and crabs may die
- Immerse crabs individually – held with flippers pointing down and mouth just under water. Hold crab until water starts flowing over the gills and out of the mouth
- Immediately release into the water any lively crab that starts clawing at its mouth parts
- If a crab is not able to pump water across its gills after 2 minutes, then it is usually not able to recover successfully – cook as soon as possible

- If a crab drops a claw, remove it from the water immediately to stop it physically damaging others
- 3 hour immersion time – no longer, no shorter
- Return crabs to damp, hessian-lined crates, store at 18°C to 25°C. Be wary of air-conditioning and the evaporative cooling effect of damp hessian that will drop temperature by another 5°C
- Dispose of water (following appropriate local regulations) after crabs have been purged – the water will have high levels of ammonia

Notes

- The use of town water does not affect the flavour of the cooked product
- Some crabs will want to go upside down – let them as long as the air has been released from the crab
- If there is an ample water supply, run water through or replace some after one hour (use water of the same temperature)
- Hold crabs semi-immersed as above or they risk drowning if they are dumped in the water without releasing the trapped air and without the gill action starting

SEPARATE TANK HOLDING RECOMMENDATIONS FOR LONGER TERM STORAGE

- Recover crabs as previously outlined. This will minimise ammonia contamination in your tank's water
- Fresh **seawater** 18°C to 25°C – monitor water quality regularly
    - pH (7.9 - 8.1) use sodium bicarbonate to increase
    - salinity (15 - 35ppm)
    - ammonia (<0.1mg/L)
    - nitrate (<50mg/L)
    - nitrite (<0.3mg/L)
- Line lug baskets with shade cloth to stop leg tip damage or raise bottom of crates 25mm of tank floor
- Pack crabs tightly to reduce movement
- Ensure crabs are tied tightly - untied crabs can cause significant damage to other crabs
- Check all crabs regularly – one dead crab can cause others to die
- Regular water exchanges – toxic crab waste doesn't break down readily
- Tank covered to reduce exposure to light, evaporation and disturbance
- Bio-filter to suit tank volume/stocking density
- Protein skimmer to suit capacity
- Adequate but not vigorous circulation and/or aeration
- No feeding necessary or advisable for water quality issues

CONTACT LIST

Aquatic Biosecurity	
www.fisheries.nt.gov.au	
www.marinepests.gov.au	
Vessel Inspection	0413 381 094
Reporting	(08) 8999 2126
Customs and Border protection	
www.customs.gov.au	
Enquiries	1300 363 263
Reporting	1800 06 1800
Fishwatch/Fishkill info	
Illegal/suspicious fishing activities, fish kills	
	1800 891 136
Fisheries Police	
	(08) 8936 4819
	0407 794736
Marine Safety Branch	
www.marinesafety.nt.gov.au	
	(08) 8924 7100
Marine WildWatch	
www.nt.gov.au/marinewildwatch	
	1800 453 941
NT Fisheries	
www.fisheries.nt.gov.au	
General Enquiries	(08) 8999 2144
Fisheries Fax	(08) 8999 2065
Licensing	(08) 8999 2305
Licensing Fax	(08) 8999 2057
Indigenous Liaison	(08) 8999 2164
	0401 115 813
NT Pollution Hotline	
www.nt.gov.au/nreta/environment/waste/hotline.html	
	1800 064 567
Northern Territory Seafood Council	
www.ntsc.com.au	
	(08) 8981 5194
Rescue Co-ordination Centre Australia (RCC Australia)	
Reporting close collisions and pollution at sea beyond 3nm	
	1800 641 792
	(02) 6230 6811
SeaNet NT/OceanWatch Australia	
www.oceanwatch.org.au	
	(08) 8981 5194
	0421 054 274

Keep them cool. Keep the stress levels low and the chances of survival increase. Treat them with tender loving care. You look after the crab, and they look after you.

Sherwood Thorbjorsen, mud crab producer and exporter

When the lid comes off at the marketplace if the crabs jump out at them, the buyers light up and so does the price.

Sue Poole, principal seafood scientist and seafood team leader for Innovative Food Technologies, DEEDI Qld.

If he jumps out at you it is very exciting. That means the meat will be tender and sweet.

Jack Ho, Chef of Dragon Court Restaurant, Darwin

By following the handling recommendations fishers, wholesalers and retailers will ensure they get the best price for their crabs and enjoy the best reputation for their product and business.

Doug Neville, Chair, NT Mud Crab Licensee Committee

An initiative of the

NT Mud Crab Licensee Committee

2011

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OceanWatch Australia

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Australian Government
Fisheries Research and Development Corporation

"If he jumps out at you it is very exciting.
That means the meat will be tender and sweet."

MUD*crabs* *live*AND SNAPPING

Chef Jack Ho of the Dragon Court Restaurant at Darwin's SkyCity Hotel looks for particular traits in a live mud crab that will deliver a culinary adventure to the customer. A half dozen are displayed in the dining room's aquarium and customers are encouraged to make their choice. In the kitchen, just before the mud crab is chopped and steamed or deep fried, it is killed. If it is vigorous and attacking before death, Ho knows the animal is a healthy specimen, certain to provide fine dining. "If he jumps out at you it is very exciting," says Ho. "That means the meat will be tender and sweet."

Main image above > A mud crab ready for export.
Right image > Mud crab cooked after being chosen live.

Mud crabs must be delivered live, so getting them to Darwin and every other Australian capital city in good condition, from the remote areas in which they are caught, takes an enormous effort.

The rewards, however, are worth the trouble. The NorthernTerritory Seafood Council reports that the wild-harvest commercial mud crab fishery is the highest value fishery in the Territory, providing a gross value of production of over $6.4 million in 2007—even though catches have been the lowest in the last 10 years. A large proportion of the mud crab harvest is sold through the Sydney Fish Market with 2007–08 sales figures showing mud crabs to be the third highest species by value at $5.7 million.

The mud crab market is dominated by Asian customers from Sydney, Melbourne and, to a lesser extent, Perth and Adelaide. They demand a quality live product, a difficult task considering the animals are caught in remote Territory locations like Arnhem Land and the Gulf of Carpentaria, sometimes taking up to 15 days to get from the point of capture to the restaurant.

Often captured in humid tropical conditions, the physical demands on the crabs throughout the supply chain are intense, accounting for mortality rates of between 4 and 10 per cent, and up to 35 per cent in extreme conditions. A 10 per cent loss to the Queensland and NT commercial mud crab fishery represents 120 tonnes of crabs per year, with a retail value of $2 million.

Now a Territory producer has won an NT Seafood Industry production award and the NT Crab Fishermen's Association and Innovative Food Technologies of Queensland innovation award for devising and employing new techniques to enhance survival and vigour in mud crabs. Darwin based producer-exporter Sherwood Thorbjornsen transports crabs from Port Roper on the Gulf Region's Roper River to Darwin before packing them and air-freighting the catch to southern capital city seafood buyers.

He owns three mud crab licences, leases seven others and supplies five fishermen with all their fuel and living requirements for bush life in the remote Gulf. "They do it hard," says Thorbjornsen who drives the 2000km round trip between Darwin and the Gulf weekly. "Our bus is their lifeline. It takes everything in and brings everything out."

Thorbjornsen has adopted the new techniques for crab handling that have led to a decrease in mortality. They are refrigerated to 23 degrees celsius at every step of the process. "Now the mindset's changed. Keep them cool. Keep the stress levels low and the chances of survival increase. Treat them with tender loving care. You look after the crab, and he looks after you," says Thorbjornsen.

The research project that led to the establishment of new techniques came after wholesalers, backed by the Territory Fisheries Department, went to the Queensland Department and their Innovative Food Technologies section that had a history of post-harvest research work. Every player on the supply chain had a different opinion of what added to the likelihood of death, but no one had produced any hard evidence.

The group had to document the supply chains, many of which are extraordinarily long, placing a great deal of stress on the animals. "Although most do survive to some extent—they are not all robust and lively," explains Sue Poole, principal seafood scientist and seafood team leader for Innovative Food Technologies of Queensland Primary Industry and Fisheries. "And one of the critical purchasing parameters is that when the lid comes off at marketplace, if the crabs jump out at them, the buyers light up and so does the price. The degree of liveliness is an absolute measure of the price attained at the marketplace."

From their experience with other species, the researchers identified areas where the chain would be vulnerable: emersion (being out of the water), disturbance (having the crabs sitting in a breeze), and very sudden temperature changes.

Left image > Award winner Sherwood Thorbjornsen.
Image below > Mud crab fishermen on the Roper River.
Middle image > Crates of mud crabs cooled with wet burlap for transport to Darwin from the Roper.
Bottom image > Mud crabs boxed for air freight to southern capitals.

They produced chemical tests with objective measures delivering hard data. "Once we identified the stress levels, we wanted to come up with alternatives—handling protocols to minimise those factors. We can't do much about the time factor because mud crabs are found in very isolated areas, but why not put in a recovery phase during the transport process?" says Poole.

The researchers report that "feedback from harvesters, wholesalers and the retail sector has indicated increased survival and improved vigour of mud crabs when the alternative handling methods have been employed." Industry trials have demonstrated a 10 per cent reduction in mortalities in the processor sector and a further 50 per cent reduction at retail level. "Now we know what the problems are and how to fix them," says Poole, "all we need to do is now get out into the industry and tell everyone at the marketplace and the restaurants."

totalSERVICE

When Bobby Hayes and his family pulled his bus and trailer into a Darwin caravan park after four years on the road, he was unemployed, with a quarter tank of petrol, and short on cash. Today, just five years later, he is the owner-operator of six successful businesses under the banner of the Total Group, offering a variety of services from trades to transport and home building. How was he able to grow from zero to contracts worth millions in just five years? He offered a product that was lacking in the Darwin building trades both then and now.

Right image > Total Group's Bobby Hayes and daughter Beau.

As a house painter, he and his wife Karen quickly realised there was a market in Darwin for anyone who offered a strong service component to their customers. "We found that, as painters, we were always the last in," Hayes recalls. "All the other trades were too slow. It took six months to finish a house. The service from most businesses was shocking." Hayes decided to be different.

People accustomed to having to wait for quotes from tradesmen who didn't show up or, worse, did not front for work, told their friends about Total Painting. The Hayeses were flat out and making good money. They took bush jobs in Kakadu and the Tiwi Islands, kicking off a love affair with the Territory. Service was the key, so Hayes decided to provide a wider range of trades. "I started using other tradesmen, doing competitive pricing, and giving good service. If you rang me for a quote, we'd be there that day and you'd have it the next morning," says Hayes. I realised that, in Darwin, if you could supply an honest service—you can't fail."

Today Total has about 45 employees, including 16 full-time carpenters (all multi-skilled in a variety of trades), 18 painters, plus labourers, apprentices and office staff. While painting is still a core service, Hayes (a fitter and turner by trade) started Total Mobile Welding—with tradesmen on the road repairing things that cannot be transported. He started Total Transport Solutions to move steel economically and reliably for welding and building.

Most recently, Hayes saw a market for transportable accommodation so he tried his hand at building demountables and then complete homes. His latest business, Total Homes Solutions, builds on site to the clients' specifications. "Some are homes costing under $200,000," explains Hayes. "People will find it hard to compete with prices like that. I can build a three-bedroom house, all gyprock inside, finished on the outside, with a veranda, split systems, kitchen, the works. I use all my own people and keep costs down."

The growth of the Total Group is remarkable even by Territory standards. Those looking for service with a smile can contact the family that came up with a bus and a trailer five years ago at their busy premises on Stuart Highway in Berrimah. "This place has given us everything," says Bobby Hayes.

Mayze, John L

From: Neil Vj [fishmongervj@hotmail.com]
Sent: Saturday, 29 September 2012 1:44 AM
To: Mayze, John L
Subject: RE: Mud Crab Best Handling Practice Project - Survey Responses

Hi John,

Thanks for the opportunity to take part in the mudcrab best handling project. It is excellent to see governmental boards helping to further Australian seafood, and we offer our continued support.
It is rare and enjoyable to see new technique and standards being applied in an industry which I have always sought to learn the most about, and I look forward to new projects in the future.

Sincerely,

Neil VJ
VJ's Seafoods

Mudcrab Best Handling Practice Project

1. Are you aware of the Mudcrab Best Handling Project?

	Response Percent	Response Count
Yes	**75.0%**	**27**
No	8.3%	3
A little	16.7%	6
	answered question	**36**
	skipped question	**0**

2. What improvements have you heard of?

	Response Percent	Response Count
Mortality	63.6%	21
Slows	30.3%	10
Quality	45.5%	15
Grading	**69.7%**	**23**
Meat Fullness	33.3%	11
	Other (please specify)	3
	answered question	**33**
	skipped question	**3**

3. In your eyes, has this project been successful?

		Response Percent	Response Count
Yes		**78.8%**	**26**
No		21.2%	7
		answered question	**33**
		skipped question	**3**

4. How accessible was the information about the Mud Crab Best Handling Practice Project?

		Response Percent	Response Count
Easy to access through DAFF		29.0%	9
Easy to access through C-AID		29.0%	9
Easy to access through email contact		**41.9%**	**13**
Easy to access through Qld Government website		6.5%	2
Didn't know it was available		25.8%	8
Difficult to find how to access		3.2%	1
Gave up trying to access		3.2%	1
Asked but never received		3.2%	1
		answered question	**31**
		skipped question	**5**

5. What is your preferred information format/s?

	Response Percent	Response Count
Fact Sheet (in English)	**50.0%**	**15**
DVD (in English)	33.3%	10
YouTube	33.3%	10
Queensland Government website	6.7%	2
Face to Face Presentation	33.3%	10
Workshops	20.0%	6
Information Sessions to Select Groups	20.0%	6
Information Sessions to Industry Associations	13.3%	4
One on One Meetings	10.0%	3
Other (please specify)		4
answered question		**30**
skipped question		**6**

6. How relevant was the information? Did it ring true?

	Response Percent	Response Count
Fair/Poor	0.0%	0
Okay/Average	33.3%	9
Really Good/Excellent	**66.7%**	**18**
answered question		**27**
skipped question		**9**

7. How confident and capable were you to undertake these changes? Was there enough clear information for you to implement the suggested changes?

	Response Percent	Response Count
Not at all	0.0%	0
A little	7.4%	2
Confident	**48.1%**	**13**
Very confident	44.4%	12
answered question		**27**
skipped question		**9**

8. Did you implement any of the changes suggested?

	Response Percent	Response Count
Yes	**60.7%**	**17**
No	39.3%	11
answered question		**28**
skipped question		**8**

9. If not, why not?

	Response Count
	13
answered question	**13**
skipped question	**23**

10. BEFORE the project information, briefly what were your handling practices with mudcrabs?

	Response Count
	19
answered question	19
skipped question	17

11. AFTER the project information, what are your current handling practices with mudcrabs?

	Response Count
	21
answered question	21
skipped question	15

12. Did you experience a reduced mortality rate?

		Response Percent	Response Count
Yes		45.5%	10
No		**54.5%**	**12**
		answered question	22
		skipped question	14

13. If yes, how much? Please express in either percentage or in AUD dollar value.

	Response Count
	13
answered question	13
skipped question	23

14. Did you experience increased sales?

		Response Percent	Response Count
Yes		36.4%	8
No		**63.6%**	**14**
		answered question	**22**
		skipped question	**14**

15. If yes, how much? Please express in either percentage or in dollar value.

	Response Count
	13
answered question	**13**
skipped question	**23**

16. Around outcomes, have you received any customer feedback about quality, positive or negative?

	Response Count
	20
answered question	**20**
skipped question	**16**

17. Around outcomes, what other comments/feedback would you like to provide?

	Response Count
	13
answered question	**13**
skipped question	**23**

18. Are you aware of the National System for Grading Live Mud Crab?

		Response Percent	Response Count
Yes		**85.7%**	**24**
No		14.3%	4
	answered question		**28**
	skipped question		**8**

19. How important to you is meat fullness in your mud crab?

		Response Percent	Response Count
Very important		**88.9%**	**24**
Moderately important		11.1%	3
Not at all		0.0%	0
	answered question		**27**
	skipped question		**9**

20. Which of the following categories best describes your business sector/s?

		Response Percent	Response Count
Catcher		**52.4%**	**11**
Distributor		33.3%	7
Transport Operator		4.8%	1
Wholesaler		42.9%	9
Retailer		14.3%	3
Restauranter		0.0%	0
Consumer		0.0%	0
		Other (please specify)	6

answered question	**21**
skipped question	**15**

21. Which of the following categories best describes your Business Volume?

		Response Percent	Response Count
Kilos per week		**81.8%**	**18**
Volume per period		13.6%	3
$ per period		27.3%	6

answered question	**22**
skipped question	**14**

22. In Kilo or AUD value, how much per period/week? If a period, what timeframe does this represent?

	Response Count
	20
answered question	**20**
skipped question	**16**

23. In which States do you source your mudcrabs?

		Response Percent	Response Count
Northern Territory		34.8%	8
Queensland		**69.6%**	**16**
New South Wales		34.8%	8
	Other (please specify)		1
	answered question		**23**
	skipped question		**13**

24. In which seasonal periods do you catch mudcrab?

	Response Count
	22
answered question	**22**
skipped question	**14**

25. Any final comments...

	Response Count
	15
answered question	15
skipped question	21

Page 1, Q2. What improvements have you heard of?		
1	none	Sep 16, 2012 11:07 PM
2	I've heard of no improvements	Sep 14, 2012 4:29 PM
3	the grading system has not been released to public, cannot get a hold of it. however, grading at sfm in the last 6 months has been terrible, suppliers are getting ripped off while buyers downgrade good quality crabs to get discounts, inlcuding classing b grade as unsellable, which has only started happening, and downgrading good a grade to b grade. .	Sep 14, 2012 11:31 AM

Page 2, Q5. What is your preferred information format/s?		
1	email	Sep 16, 2012 11:01 PM
2	Add onto DAFF/FRDC website	Sep 16, 2012 7:06 PM
3	more workshops ie annually	Sep 14, 2012 5:36 PM
4	emails	Sep 14, 2012 4:32 PM

Page 2, Q9. If not, why not?		
1	still looking for the info	Sep 20, 2012 7:07 PM
2	We are working on this at our end of the supply chain with the research team currently	Sep 17, 2012 10:53 AM
3	Was already handling in simmilar process	Sep 17, 2012 10:17 AM
4	n/a	Sep 17, 2012 9:56 AM
5	i fish in gladstone harbour or should i say was	Sep 16, 2012 11:07 PM
6	Industry association secretary - not fisherman	Sep 16, 2012 9:06 PM
7	Waiting for SFM to apply the new grade system into SFM's guidelines	Sep 16, 2012 7:06 PM
8	Industry rep not fisherman	Sep 16, 2012 4:49 PM
9	Not directly involved in the supply chain	Sep 16, 2012 10:52 AM
10	Didn't know there was any information available for anyone to excess.	Sep 14, 2012 7:59 PM
11	need more information n technical support from relervant govt. department.	Sep 14, 2012 5:36 PM
12	I was already doing what was on the fact sheets anyway.	Sep 14, 2012 4:32 PM
13	We already handle our crabs in this way, as such no changes were made to our business operations, and the information was relevant but not any more useful than what we already know.	Sep 14, 2012 11:43 AM

Page 3, Q10. BEFORE the project information, briefly what were your handling practices with mudcrabs?		
1	No change	Sep 20, 2012 8:49 PM
2	place in tub with et rag over them	Sep 20, 2012 7:08 PM
3	Basically pick up from airport, deliver to customer let them tell me what quality was like.	Sep 20, 2012 4:13 PM
4	Very similar to the fact sheet	Sep 20, 2012 3:43 PM
5	Dropped crabs onto bottom of the boat	Sep 19, 2012 8:43 PM
6	same	Sep 17, 2012 6:01 PM
7	We had a product spec that our QA officers assessed pproduct against and we gave formal and informal feedback to suppliers as required.	Sep 17, 2012 10:54 AM
8	Keep in self drain tubs or live tank in cool sh Keep in self draintubs IN SHADEor in live tank	Sep 17, 2012 10:21 AM
9	n/a	Sep 17, 2012 9:56 AM
10	fishermen grading poor	Sep 17, 2012 9:49 AM
11	no	Sep 16, 2012 11:07 PM
12	n/a	Sep 16, 2012 9:07 PM
13	I used standard techniques common to handling mud crabs. Techniques used by crabbers and buyers.	Sep 16, 2012 7:09 PM
14	Not directly involved	Sep 16, 2012 10:54 AM
15	sorting into live 1/claw,slow,dead,isolating any B's,cuc's	Sep 15, 2012 12:40 AM
16	For the last 22 years I have always stored my crabs in a dark, moist, aircondisioned room set at around +18 degrees prior to shipment to the SFM. This keeps them in top shape for up to 5 days if necessary.	Sep 14, 2012 7:59 PM
17	Mine were the same as in the project information	Sep 14, 2012 4:33 PM
18	not to standard	Sep 14, 2012 12:39 PM
19	As stated.	Sep 14, 2012 11:43 AM

Page 3, Q11. AFTER the project information, what are your current handling practices with mudcrabs?		
1	no change	Sep 20, 2012 8:49 PM
2	TBA	Sep 20, 2012 7:08 PM
3	Convey back to fisherman grading concerns as i have educated customers about different grading practices. Fisherman slowly understanding why n the long run it will reflect in there prices	Sep 20, 2012 4:13 PM
4	now have it confirmed that the old brown carbs may be reasonably empty.	Sep 20, 2012 3:43 PM
5	Now place crabs onto foam rubber	Sep 19, 2012 8:43 PM
6	same	Sep 17, 2012 6:01 PM
7	We are planning to adopt the national grading scheme in the next few months. we have also increased our informal feedback to suppliers considerably.	Sep 17, 2012 10:54 AM
8	in tubs now more than live tank	Sep 17, 2012 10:21 AM
9	better	Sep 17, 2012 9:59 AM
10	n/a	Sep 17, 2012 9:56 AM
11	improvment of fisher grading	Sep 17, 2012 9:49 AM
12	if i was still fishing it would same as all ways	Sep 16, 2012 11:07 PM
13	I kept noise to a min, took care to avoid knocks such as was occurring when running the crabs in to town. John tole me to put padding under them. I also used the recovery bath (in tap water) prior to packing and sending (from Karumba). I now understand that urea will kill them and the need to keep them cool and moist	Sep 16, 2012 11:05 PM
14	n/a	Sep 16, 2012 9:07 PM
15	Same as above.	Sep 16, 2012 7:09 PM
16	Not directly involved	Sep 16, 2012 10:54 AM
17	sorting into live, i/claw,slows,deads,isolating any B's/cuc's/3 missing legs damaged/bleeding crabs	Sep 15, 2012 12:40 AM
18	I havn't seen any information at all but I doubt that I'd change my normal practises as they have been working very well.	Sep 14, 2012 7:59 PM
19	I carried on the same as before. see above	Sep 14, 2012 4:33 PM
20	meets standardfs	Sep 14, 2012 12:39 PM
21	Look after them. Keep them still, cool and out of wind.	Sep 14, 2012 12:38 PM

Page 4, Q13. If yes, how much? Please express in either percentage or in AUD dollar value.		
1	As high as 10% to as low as 0% . And it has been a cold winter in Melbourne.	Sep 20, 2012 4:19 PM
2	4%	Sep 19, 2012 8:46 PM
3	We are still working through all this.	Sep 17, 2012 10:58 AM
4	From 10% to2%	Sep 17, 2012 10:25 AM
5	about 3 %	Sep 17, 2012 10:05 AM
6	n/a	Sep 17, 2012 9:57 AM
7	n/a	Sep 17, 2012 9:54 AM
8	from up to 8% down to 2%	Sep 16, 2012 11:08 PM
9	n/a	Sep 16, 2012 9:08 PM
10	NA	Sep 16, 2012 10:57 AM
11	3-4%	Sep 15, 2012 9:52 AM
12	na	Sep 14, 2012 5:39 PM
13	10%	Sep 14, 2012 12:40 PM

Page 4, Q15. If yes, how much? Please express in either percentage or in dollar value.		
1	4%	Sep 19, 2012 8:46 PM
2	Sales of crabs did go up during 11/12 and mud crabs now represent our No1 by value. Average prices per kg have gone up as well as the volume traded. So clearly the supply chain is doing better things than it did before.	Sep 17, 2012 10:58 AM
3	about 8% up better $ per kg	Sep 17, 2012 10:05 AM
4	n/a	Sep 17, 2012 9:57 AM
5	n/a	Sep 17, 2012 9:54 AM
6	we sell to one buyer so this is NA	Sep 16, 2012 11:08 PM
7	n/a	Sep 16, 2012 9:08 PM
8	Approx - $60k for the financial year 2011-2012.	Sep 16, 2012 7:13 PM
9	NA	Sep 16, 2012 10:57 AM
10	10-20% through continuous improvement /excellent supply and educating customer difference between Qld and Darwin crabs	Sep 15, 2012 9:52 AM
11	na	Sep 14, 2012 5:39 PM
12	5%	Sep 14, 2012 12:40 PM
13	Actually, this past 12 months has seen lower prices in SFM than previous years, at one point we recieved $9/kg for a grade crab, and the crab grading disscussions held by frdc/sfm has caused confusion as the national grading system has not been released to suppliers, and we have found that buyers/sfm are downgrading excellent a grade quality crabs to be grade-even in some cases unsellable if they don't want the whole box- based on buyer confusion about what is a grade, what is b grade, what is unsellable, and the colour of the crabs is also not always an indication of whether it has just moulted, it can also reflect the habitat (living in areas of white sand, dark mud etc) and buyers seem to be confused over the colour/grade.	Sep 14, 2012 11:48 AM

Page 4, Q16. Around outcomes, have you received any customer feedback about quality, positive or negative?		
1	no change	Sep 20, 2012 8:51 PM
2	No doubt it all has been positive.	Sep 20, 2012 4:19 PM
3	no, we were handling very similar to recommendations	Sep 20, 2012 3:44 PM
4	No	Sep 19, 2012 8:46 PM
5	Quality is improving, hence the price increases outlined above that we are seeing.	Sep 17, 2012 10:58 AM
6	Yes positive	Sep 17, 2012 10:25 AM
7	positive	Sep 17, 2012 10:05 AM
8	n/a	Sep 17, 2012 9:57 AM
9	better working relationship with sfm QA	Sep 17, 2012 9:54 AM
10	Our buyer is in Cairns and buys all our crab anyway. He has told me I am getting much better and that my crab is very lively when it gets there.	Sep 16, 2012 11:08 PM
11	n/a	Sep 16, 2012 9:08 PM
12	Yes, I have received excellent feedback from buyers at the SFM.	Sep 16, 2012 7:13 PM
13	NA	Sep 16, 2012 10:57 AM
14	Always receive more negative feedback than posiitve however as customers become more aware of grading /quality control then builds more trust with supplier	Sep 15, 2012 9:52 AM
15	no	Sep 14, 2012 5:39 PM
16	no	Sep 14, 2012 4:33 PM
17	feedback from SFM negative i graded crabs as per instruction,i believe this has given them an excuse to go overboard with grading	Sep 14, 2012 12:45 PM
18	positive	Sep 14, 2012 12:40 PM
19	Better quality	Sep 14, 2012 12:40 PM
20	SFM and our other wholesaler keep telling us that there is nothing wrong with our crab, that it is well packed, fresh, well handled etc and yet there is still confusion over grading at the market. but overall, our practices have been excellent for years, well before the project results were released.	Sep 14, 2012 11:48 AM

Page 4, Q17. Around outcomes, what other comments/feedback would you like to provide?		
1	fishers need a quick test on boat to remove the interepritation of fullness	Sep 20, 2012 8:51 PM
2	I can only comment on my supply chain and surely i sell my crab with more confidence achieving higher prices for them.	Sep 20, 2012 4:19 PM
3	None	Sep 19, 2012 8:46 PM
4	IT would be great if more awareness of this project could be achieved at the buying end of the supply chain, with the retail buyers. they are paying more because crabs are better but they proably dont know WHY....	Sep 17, 2012 10:58 AM
5	poor roll out of information to comsumers	Sep 17, 2012 10:05 AM
6	n/a	Sep 17, 2012 9:57 AM
7	more extention of the program to continue to reduce any waste of this fishery resource	Sep 17, 2012 9:54 AM
8	n/a	Sep 16, 2012 9:08 PM
9	Many of our major suppliers aren't up to date with the status of the new grading scheme.	Sep 16, 2012 7:13 PM
10	Feed back I have received is positive in that it has reinforced current good practices and that the recovery process works as stated.	Sep 16, 2012 10:57 AM
11	continuous education of supplier and customer necessary not only on grtading/quality but differentiation between Darwin and Queensland species	Sep 15, 2012 9:52 AM
12	if SFM continues to grade this way we will have no alternative but to sell elsewhere,as other buyers are happy to take crabs graded my way	Sep 14, 2012 12:45 PM
13	need everyon eto do it	Sep 14, 2012 12:40 PM

Page 5, Q20. Which of the following categories best describes your business sector/s?		
1	Sydney Fish Market	Sep 17, 2012 11:03 AM
2	Industry Association	Sep 17, 2012 9:59 AM
3	QA officer	Sep 17, 2012 9:59 AM
4	Industry rep	Sep 16, 2012 4:52 PM
5	Licence owner	Sep 16, 2012 11:05 AM
6	supply chain	Sep 14, 2012 12:41 PM

Page 5, Q22. In Kilo or AUD value, how much per period/week? If a period, what timeframe does this represent?		
1	500k to 1tone depend on the price	Sep 21, 2012 9:26 AM
2	$2000.00 per week	Sep 20, 2012 8:55 PM
3	Ave 500 kg/ week	Sep 20, 2012 4:25 PM
4	can be up to 1 tonnes per week in season	Sep 20, 2012 3:45 PM
5	200 kilos a week over a 5 mth period	Sep 19, 2012 8:48 PM
6	7500	Sep 18, 2012 12:39 PM
7	10/11 $8.6 million $$$ 10/11 392 tonnes 11/12 figures will be higher when they are published.	Sep 17, 2012 11:03 AM
8	100	Sep 17, 2012 10:29 AM
9	n/a	Sep 17, 2012 9:59 AM
10	n/a	Sep 17, 2012 9:59 AM
11	%20000 month	Sep 16, 2012 11:15 PM
12	between 300kg to 500kg per week	Sep 16, 2012 11:10 PM
13	$22 average for Male mud crabs and $27 average for Female mud crabs.	Sep 16, 2012 7:18 PM
14	NA	Sep 16, 2012 11:05 AM
15	high season 1400-2000 kgs/week reducing to less than 700kgs /week low season	Sep 15, 2012 10:09 AM
16	AUS$17,150.00 per week avg for the 2012 season.	Sep 14, 2012 8:02 PM
17	7 months a year	Sep 14, 2012 4:36 PM
18	250 to 350kg/week depending on time of year	Sep 14, 2012 12:49 PM
19	2000	Sep 14, 2012 12:41 PM
20	1200 to 4500kg over 40 weeks	Sep 14, 2012 12:41 PM

Page 5, Q23. In which States do you source your mudcrabs?		
1	n/a	Sep 17, 2012 9:59 AM

Page 5, Q24. In which seasonal periods do you catch mudcrab?		
1	all year	Sep 20, 2012 8:55 PM
2	sept -Nov than Feb to May	Sep 20, 2012 7:09 PM
3	12 months access	Sep 20, 2012 4:25 PM
4	Nov Dec, Jan FEb-July	Sep 20, 2012 3:45 PM
5	December to April	Sep 19, 2012 8:48 PM
6	april-october	Sep 17, 2012 6:04 PM
7	We dont catch we sell.	Sep 17, 2012 11:03 AM
8	nov to sept	Sep 17, 2012 10:50 AM
9	Sept, to may inclusive	Sep 17, 2012 10:29 AM
10	n/a	Sep 17, 2012 9:59 AM
11	all year round more though summer/ warmer months	Sep 17, 2012 9:59 AM
12	as a Gulf diversified fisher, (net and crab) I target mud crab when fishing is slow and mud crab prices are high Aug Sept are crabbing months. Also with the four month netting closure in the Gulf I consistently fish mud crab	Sep 16, 2012 11:15 PM
13	from nov to may,june	Sep 16, 2012 11:10 PM
14	N/A	Sep 16, 2012 7:18 PM
15	April to November	Sep 16, 2012 11:05 AM
16	medium to high season April to November Darwin low season December to March Darwin high season Qld 1st half December /January to May	Sep 15, 2012 10:09 AM
17	1st November - 30th June	Sep 14, 2012 8:02 PM
18	November to July	Sep 14, 2012 4:36 PM
19	november to june	Sep 14, 2012 3:49 PM
20	nov to june	Sep 14, 2012 12:49 PM
21	but all year	Sep 14, 2012 12:41 PM
22	april to mid December	Sep 14, 2012 12:41 PM

Page 5, Q25. Any final comments...		
1	industry needs to be able to trust the grading at the point of sale IE SFM	Sep 20, 2012 8:55 PM
2	Hopefully we can start to see young crabbers start to push through to keep this part of the fishing industry going. With some structure from industry guiding them along the way so there returns match their effort.	Sep 20, 2012 4:25 PM
3	We look forward to doing further work with the QDPI team in the near future to further imporve on the gain already achieved.	Sep 17, 2012 11:03 AM
4	john & sue chris well done	Sep 17, 2012 10:50 AM
5	national grading standards has made huge positive differance	Sep 17, 2012 10:29 AM
6	The grading system is eagerly awaited so that a national system can be implemented	Sep 17, 2012 9:59 AM
7	There is alway more more to learn lets continue to make this industry not just sustainable but also economcally sustainable.	Sep 17, 2012 9:59 AM
8	I really appreciate all the work John has put into this. I have seen operators who have not been equipped with the skills John has provided and they still have the huge losses like I used to. It is not only during transit that mortalities occur but in the Gulf we store the crab for a week before sending it out.We used to have large losses during that period and now have almost none. Johns' advise has helped us, and many others improve their bottom line.	Sep 16, 2012 11:15 PM
9	crab fullness does not worry me to much because i keep all legal mud crab but grade them for sale. The reason for that is because i crab in a area with a lot of rec pressure if i let go B grade crab they keep them when caught.So i moswell get something for them than nothing if i was not able to keep B grade crab and rec fishers were i would go broke	Sep 16, 2012 11:10 PM
10	We need a specific launch date for the new grading scheme to be declared nation wide as the national standard and we need to get the message out to all suppliers and buyers through an effective information campaign.	Sep 16, 2012 7:18 PM
11	The project has been beneficial to the Industry and most importantly the extension component has been well executed. The credibility of the researchers and consultant has been enhanced by these extension activities	Sep 16, 2012 11:05 AM
12	Extremely important with grading system to maintain integrity of Darwin crab over Qld species and not mix the species either overtly or by ommision as Darwin crab has already higher grading system in place for a number of years and is the preferred choice of the buyers	Sep 15, 2012 10:09 AM
13	For the last 21 years I have always used excape hatches on all of my crabpots. Big crabs eat smaller and weaker crabs period!! Expierments of my own have shown that one large male crab can eat up to 6 smaller crabs per day with these smaller crabs having a shell measurement averaging 3" across. I believe that because I use excape hatches in my area this is the sole reason why I catch more crabs then anyone else along the entire QLD coast. Excape hatches that will let all undersize crabs excape from pots needs to be made compulsery!!	Sep 14, 2012 8:02 PM
14	I would like a copy of the National Grading System sent to me so I can forward it to other commercial crabbers.	Sep 14, 2012 4:36 PM
15	mud crab grading is very important to our business,but both parties have to	Sep 14, 2012 12:49 PM

Page 5, Q25. Any final comments...
be playing the game

Department of **Employment, Economic Development and Innovation**

DRAB CRABS DON'T SELL

Thank you for taking part in this brief survey.

As you would know, stressed out mud crabs don't survive well and are unlikely to sell for a top price. Previous work we have done has focused on where and why mud crabs get stressed during their trip from catch to market. If you want a brief overview of that study go to this web address http://www.dpi.qld.gov.au/4791_17272.htm
We are hoping to share this information with people in the live mud crab industry. We also want to find out what *you* and other crabbers think and to get some feedback on some of the ideas we have that we feel might help.

Before we can do this we need to ask you some questions about the industry so we can reach everybody. All you need to do is answer the following questions as best you can and email it back to us via your area representative. Alternatively, you can call the number below and just tell us.

If you have any questions about this survey, or about the work we are doing, please contact John Mayze on 3276 6023 or after hours on 0418 870 488.

Further information about our current project can be found at http://www.dpi.qld.gov.au/4791_18089.htm .

All information will be remain confidential.

About the industry

We’d like to be able to talk to people about what we’ve been doing in our research on prolonging crab life. This includes people such as yourself, and also the people you buy from and those who buy from you.

Could you please list the names of the people/businesses who supply you with live mud crabs?

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Could you please list the names of the people/businesses who you supply live crabs to?

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How do the crabs get to you? For example are the crabs transported by you by road, or are they air-freighted by commercial air-ways?

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How do the crabs get to the people you supply to? For example are the crabs transported by you by road, or are they air-freighted by commercial air-ways?

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We understand that time is often short in this industry. What is the most convenient way for us to get information to you? For instance, a meeting at your place of business might be the best way for talking in depth to a number of people at once.

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In order to understand the economic cost of crab mortality to people in the industry, it would be good for us to know a bit more about your experience. The information you provide will be added to other people's data, and *your specific answers* will remain confidential.

Could you give us an estimate on crab mortality rates that you experience, and at what stage?

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What is your experience with the quality of the mud crabs? This could be the liveliness of the product etc.

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Also, what volume (kg/year) does your business generate?

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Your thoughts

Is there anything else you would like to add?

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Thank you for your help.