Innovation in Traceability for the Australian Seafood Industry: Austral Fisheries/Northern Prawn Fishery case study

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AUSTRALIAN SEAFOOD COOPERATIVE RESEARCH CENTRE

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PROJECT OBJECTIVES:

a. Identify, establish and evaluate an innovative, electronic traceability system for Austral seafood products
b. Characterise the choices, issues and opportunities around implementation of innovative traceability systems for Australian seafood.

This project investigated the suitability of three electronic traceability technologies for operation on a commercial prawn trawler at sea and subsequently through the downstream supply chain to the cold stores. The technologies investigated were: Single Dimensional (1D) barcodes, Two Dimensional (2D) barcodes and Radio Frequency Identification Devices (RFID).

The project commenced with an updated review of electronic traceability options for the seafood industry in general. This review found that whole of chain traceability was rare in the seafood industry and that in general on-board systems were paper-based, but with electronic barcoding often being used at the processing stage and into retail. In addition the review found that RFID technology was very rarely used in the seafood industry.

At the commencement of the project, it was intended that the methodology would follow the implementation of the electronic traceability framework outlined in 'Seafood Traceability Technologies' (2006) published by Seafood Services Australia (ISBN 0-9775219-2-3). This framework describes 12 steps to implement a traceability system. However, as the project evolved this framework was modified in that it was decided to separate it into internal (Austral Fisheries) and external stakeholders' consultation processes. This modified framework is described in detail in the report.

Three trials were conducted. In the first trial, a 1D barcode (Innova software and Marel hardware) which incorporated software, input screen, and printer aligned with Marel scales was installed on one of the Austral vessels. The barcode labels were aligned with the relevant information (date and area of harvest, vessel and product type) and the plan was to then print the labels following the packing and weighing of the prawns at sea. The labels were then to be attached to the cartons of prawns prior to freezer storage and then be scanned on the conveyor used to transfer the cartons from the trawler to the mother ship. This trial was unsuccessful due to the barcode label printer failing in oceanic conditions and the computer connections between the scales and the computer intermittently failing. In addition, the barcode scanner over the carton conveyor was found to have a too narrow a focus, such that if the cartons were slightly off-centre, the barcodes could not be read. The problems were exacerbated by the trawler being in operational areas where contact with the land-based barcode system engineer was only intermittent.

A second trial was instigated with improved management of the computer settings, and with the barcode label printed and attached as per the first trial, but with the scanning occurring immediately after packing by a crew member. Unfortunately the label printer still malfunctioned very early in the trial and this problem is considered to be insolvable due to the long time (up to four months) that the trawler remained at sea. However the reports generated and circulated following electronic input of the individual carton data were considered by both trawler and head office to be an improvement on the previous system, whereby catch data was manually input into the computer after each days' harvest.

Subsequently a third trial was undertaken. This trial used pre-printed labels which contained individually numbered barcodes (1D and 2D) and an individually numbered RFID attached. These labels were attached to the cartons each night before harvesting. For the 1D barcodes on the labels, and as in the previous two trials the input information about the prawns for each carton was electronically matched to the individual barcode number as the data was entered on the scales. For the 2D barcodes and RFIDs only the individual number was scanned: there was no software available to align the number with the carton product information.

The results of the third trial demonstrated that both RFID and 1D barcoding electronic traceability systems could be implemented on board the trawler. Analysis of the scanners indicated that both the barcodes and RFIDs were recorded by the scanner prior to entry to the boat freezer, and at the cold stores in Cairns and Brisbane. Electronic catch reports with the details of each individual carton were generated and transferred between the trawler and the head office and the cold stores. Based on the boat scanning results, 1D barcode scanning was more effective than RFID scanning: 5000 cartons with 1D labels were passed through the scanning equipment and 9,256 (85%) were read and registered correctly in the software whereas with the RFID scanning of the 2000 cartons with the RFID labels only 445 (22%) were read and registered properly. The RFID technician considered that this was because he had set the distances from which the scanners could read the RFIDs at too narrow levels. However, the results of the scanning at the cold stores indicated that there was in fact little difference in effectiveness between the two systems and recording and accuracy for both was increased significantly to >96% for both 1-D barcode (handheld) and RFID (fixed) systems. This was thought to be the result of the optimisation of the scanner position and read parameters.

The 2D barcode trial results were also unsatisfactory on board with 870 (43.5%) of the 2000 labels registering. At the cold store the handheld 2-D scanner registered >99% positive readings, bur disappointingly the fixed scanner had a result of 25.1% of all cartons scanned.

Although the results indicated that on board the 1D barcode systems were more effective than RFIDs, it was concluded that the RFID performance on board could be improved by optimisation of the scanner reading parameters. In addition, the cold store operators favoured the RFID systems because a whole pallet of cartons could be scanned at once with a fixed scanner, whereas when using barcodes, each individual carton label needed to be scanned. IT is noteworthy that another barrier to RFID implementation, and by implication, a preference for 1D barcoding, in that most down-chain processors and retailers only had barcode reading capacity and RFID readers and hardware were not present.

A formal cost-benefit analysis of the barcode and RFID implementation was conducted based on a previously published methodology previously published (Chryssochoidis *et al.*, 2009). Only internal cost benefits were captured as external benefits could not be calculated based on the scope and limitations of the trials. Nevertheless a positive cost benefit was shown based on a 10 year projected calculation. Further details can be found in the report.

The report recommends future trials be developed with the following considerations:

- Installation of RFID software, equipment and full implementation
- Development of a more robust iPad data entry device (for ease/accuracy of data entry)
- Pre-printing or pre-labelling of cartons at point of manufacture, either with 1D barcodes or RFIDs
- Incorporation of more down-chain partners in trial
- Re-evaluation with a full cost- benefit analysis incorporating all potential benefits as described in section 3.4
- Further investigation of the use of 'real time' temperature logging capability with the labels.

It is suggested that any future trial be extended to another aligned supply chain (e.g. farmed prawns) to increase the chance of down-chain commitment and involvement.

OUTCOMES ACHIEVED:

a. Australian seafood companies have information to assist them to investigate the feasibility of introducing various types of electronic traceability options in their operation and supply chains
b. Austral Fisheries have an informed basis for further trialling barcode and RFID technology based on project outcomes.

LIST OF OUTPUTS PRODUCED:

a. An analysis of commercially available electronic traceability options to enable seafood companies to choose the system most suited to them
b. A modified framework for seafood company actions to implement an electronic traceability system.
c. Electronic traceability system installed, trialled and result evaluated on a prawn trawler
d. A description of the costs and benefits of implementation of a whole of chain traceability system for Austral Fisheries and down-chain partners
e. An up-dated review of traceability and temperature monitoring options
f. Five presentations at industry events and scientific conferences.

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Doboy Cold Stores: David O'Brien and Nola Jones
Seafood CRC: Jayne Gallagher
Marel: Nat Greco and Alex Holloway
Datanet: Alan Webber and Keith Bland .

1. Introduction and Background

As stated in the 2007 Seafood CRC report Review of Traceability and Product Sensor Technologies relevant to the Seafood Industry (Bremner and Tamplin, 2007), two key factors dictate the need for food traceability: consumer safety and brand protection. These factors are of particular relevance to two separate stakeholders in seafood supply chains: the consumer and the primary producers.

In regard to consumers, there is a general increase in interest in the environment, climate change, animal welfare, sustainability, organic production and ecology means that there is growing public awareness about the source of seafood and whether it meets their requirements. Today consumers need to be assured that a product is safe to eat. They want to know its origins, that it was produced or harvested under approved procedures, that it consists of appropriate ingredients and that the it is true to label. In recent years, in addition to issues of food safety, consumers have become more concerned with what they eat and issues of sustainability, production, transportation and storage are increasingly raised. In addition, consumers want to know: is it healthy? What is its carbon footprint?
From the seafood producer's point of view, protection of their brand is very important as the loss of consumer and buyer confidence in their product can have far-reaching consequences. Another driver for this project from the producers' point of view is the new legislative requirement to document traceability in both local and export markets. In addition, for some specific Australian seafood operations, pending or completed Marine Stewardship Council (MSC) certification of the fishery requires that the chain of custody certification, incorporating traceability, is approved in order to display the MSC label on the products in stores.

The three most commonly used tools in food traceability systems are paper; barcodes; and RFIDs. These systems represent an increasing degree of flexibility and efficiency. The advantages and disadvantages of the various systems are described below:

Paper-based:

- Disadvantages:
  - Paper is bulky to store
  - Inflexible in collation or extraction of information
  - Transcription errors can occur.
- Advantages:
  - Any paper system can be converted to an electronic system.

Barcodes:

- Advantages
  - Used throughout the world for product identification at all points in the chain from harvest through to retail
  - Infrastructure and equipment for use exists throughout whole chain.

RFIDs:

- Disadvantages:
  - Expensive relevant to other systems.

- Advantages:
  - Can be read at a distance and does not require line of sight
  - Multiple tags read simultaneously (e.g. multiple cartons on a pallet)
  - Can record additional information
  - Can include barcode and plain words.

In Australia’s seafood industry, paper traceability systems are the norm in most of the catching and harvesting sectors, despite the fact that the catch sector uses many other sophisticated electronic instruments and devices in their operations, for example, electronic communications and computers are widespread on board, dockside and in processors. Whilst paper-based systems do work, they are inherently inefficient and offer no scope for improvement. Barcodes are widely used by processors, particularly for finished goods dispatch but RFIDs have yet to be implemented in any Australian seafood operations.

Currently there is a whole suite of non-paper-based traceability systems that could be applicable to the Australian seafood industry. However a case study was required to identify the most relevant technologies and to implement and evaluate a traceability system, in order to enable informed decision-making around applicability, costs and benefits by other sectors of the industry. The case study described in this report was conducted with Austral Fisheries, as part of the Northern Prawn Fishery (NPF). The NPF fishing area is shown in Figure 1 below.

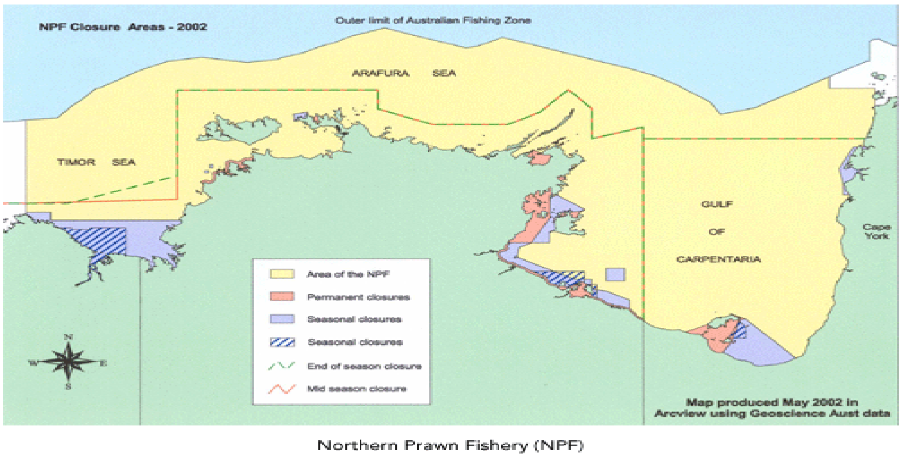

Figure 1 Northern Prawn Fishery fishing area

The NPF fishing area is very isolated with intermittent mobile/internet connection, rugged conditions and small crew numbers. It comprises 52 trawlers (Austral Fisheries has 10 of these trawlers) and there are two fishing seasons: Banana prawns (April to May); and Tiger prawns (August to November). The average Austral Fisheries total catch per annum is Banana prawns ~4,000 tonnes and Tiger Prawns ~1,300 tonnes with some by-catch. This represents a total of 52 product lines (consisting of 3kg, 5kg and bulk volumes of a variety of species and grades).

The Austral Fisheries supply chain is complex but for the purposes of this project, the supply chain under examination involved prawns captured on the Austral Fisheries trawler ’Shearwater. These prawns are unloaded into containers at sea to the mother ship and the mother ship is then unloaded in Cairns with the container transported by road Access Cold Stores for unload, and packing in pallets. , The pallets are subsequently transported by road to Doboy Cold Stores in Brisbane and from there the prawns are dispatched to various markets including via Woolworths distribution centres to Woolworths supermarkets.

The current Austral Fisheries traceability system is paper-based. Cartons are packed and manually marked with the vessel name, species, date, fishing area and grade (Figure 2). Cartons are counted into the freezer and numbers recorded daily. They are then dispatched to the company head office and to the fishing management agency via ‘Catch log'. Cartons are counted again at unload to the mother ship and at the cold stores. Often there is disparity between these carton counts at the different locations.

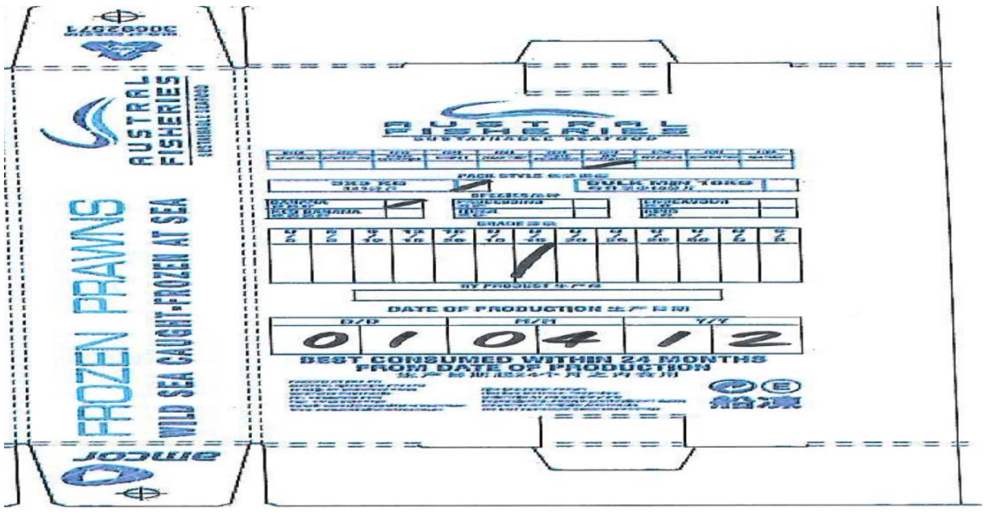

Figure 2 Typical Austral Fisheries prawn carton.

The aim of the project was to design, implement and evaluate an electronic traceability system for Austral Fisheries.

1.1 Need

In order to improve efficiency and accuracy, Austral Fisheries identified a need for the development ofan electronic traceability system for their seafood products. An ideal system would also provide real-time monitoring of temperature, location from point of harvest to retail sale and enable electronic access at purchase to provide product information.

During preliminary consultation in the course of the project application process, Austral Fisheries staff identified a number of potential advantages of implementing an electronic traceability system. These advantages are summarised below:

- Accurate identification of lots and batches to vastly improve the tracking and accounting for prawns through the various stages of handling and dispatch through transport and retail sale
- Facilitation of certainty and location of product streams, ensuring logical movement of consignments in correct order to meet appropriate market requirements
- Confidence in stock control, and the elimination of transcription and readability errors with consequent efficiencies and reductions in manpower
- Faster and more cost-effective identification of product of concern by boat or date of harvest at retail
- Reduction in product loss for both the producer and end-user and simplification of recalls
- Assistance in meeting ever- increasing legislative and/or market standards for traceability in both domestic and export markets (including MSC chain of custody requirements)
- The ability to monitor time, temperature and location of individual cartons from harvest to retail sale would enable identification/validation of cool chain issues throughout the chain, possibly resulting in an improvement in product quality

- The opportunity for the consumer toaccess information on the source of their
    - purchase, along with photos, recipes, and other information at purchase, would assist in building value in the Austral Fisheries brand;
- Transparency and easy access to information may also assist in improving community perceptions of seafood.

1.2 Objectives

The objectives of the trial were to:

a. Identify, establish and evaluate an innovative, electronic traceability system for Austral Fisheries seafood products
b. Characterise the choices, issues and opportunities around implementation of innovative traceability systems for Australian seafood.

2. Methods

2.1 Literature Review

Following consultation and an updated literature search, the 2007 CRC Review of Traceability and Product Sensor Technologies relevant to the Seafood Industry was updated to reflect new traceability/product sensor innovations (Appendix 1). This review included an examination of international traceability standards for the traceability of food products.

Aligned with this review was an assessment of the traceability system options available to the seafood industry in Australia, with criteria including that they be:

- Commercially available and supported by the manufacturer through agencies in Australia
- Implementable within current Australian seafood operations
- Able to be integrated into existing systems of down-chain partners (e.g. packaging companies, cold store operators, transport companies and supermarkets)
- Compatible with international systems (RFIDs or barcodes) and modes of transmission.

Other potential innovations included incorporation of time temperature monitoring and global positioning coordinates/links to track the product.

2.2 Preparation for and Selection of Appropriate Traceability System

Following this literature review a steering committee meeting/initial planning seminar was held with Austral Fisheries to select the pilot system for the trial.

At the commencement of the project it was intended that the methodology to select and implement the traceability system would follow the framework outlined in 'Seafood traceability technologies' (2006) published by Seafood Services Australia (ISBN 0-9775219-2-3) . This framework describes 12 steps to implement a traceability system. These steps are listed below:

- Identify the test supply chains and develop and gain agreement from all chain partners to be part of trials. This step will involve information gathering for building a traceability system as described by Opara and Mazaud (2001)
- Draw a flow chart of the product supply chain; from point of harvest to point of final sale, and include sources of material inputs (e.g. medications, micro ingredients in food etc.)
- Upper level management (Chief Executive Officer, Board) must support the traceability initiative. Appoint a person who is responsible for product quality
- Conduct a hazard analysis of the supply chain using Hazard Analysis Critical Point (HACCP) principles
- Document the reasons for embarking on the traceability of the products
- Consider what the needs and practices of your up chain and down chain partners are and talk about it with them not just for your main raw materials, but for packaging and ingredients
- Write down which data must be recorded and traced back at each step in the supply chain
- Specify the responsible persons for collecting and recording the data
- Develop a unique labelling system or bar code for easy identification of the product
- Document how the trace-back is to be carried out (include a diagram)
- Test, validate and verify the traceability system
- Document all decisions and actions.

However, the framework was modified during the project and this involved including a separation into internal Austral Fisheries and external stakeholders' consultation processes as described below.

Internal Austral Fisheries Consultation Processes

- Gain commitment and document responsibility for upper level management sign off, product quality and collection and recording of data associated with the traceability project
- Document the need for embarking on an electronic traceability adventure
- Document what the system should deliver and define minimum parameters.
- Define the traceable unit
- Develop flow charts from point of harvest to point of final sale/destination. Process mapping to include product flow, information flow, reporting flow and activity flow. Identify critical points (cf. HACCP).
- Write down which data must be recorded and traced back at each step in the supply chain
- Develop a unique labelling system or bar code for easy identification of the product.

External stakeholders' consultation process

a. Walk the supply chain: consider and understand what the needs and practices of your upstream and downstream partners are and their processes/set ups

2.3 Purchase Technology and Install and Trial

Following the literature review and implementation of the modified framework as described in Sections 2.1 and 2.2 above, a workshop/planning seminar was held with Austral Fisheries staff to select the pilot system for the trial.

The meeting to select the system included redefining criteria for the proposed system with elements such as ‘must have’, ‘highly desirable’, ‘would be nice’ etc., all costed so that when assessing the trial system, it will be clear that it meets the definitive criteria and cost that had been set by Austral Fisheries. The costs of the technology were shared between Seafood CRC and Austral Fisheries with the latter committing $20,000 cash as well as ‘in kind’ to the project.

2.4 Undertake Evaluation Based on Agreed Parameters

An evaluation and cost-benefit analysis were conducted based on the methods described by (Chryssochoidis et al., 2009) and implemented by Ewan Colquhuon, Ridge Partners (see Appendix 2).

2.5 Reporting and Extension of Outcomes

Reporting and extension of outcomes were conducted throughout the course of the project. This included publishing articles in industry magazines and presentations at industry meetings and conferences.

3. Results

The results are documented below in the sections outlined in the methods: literature review, preparation for and selection of appropriate traceability system, purchase technology and install and trial, undertake evaluation based on agreed parameters and reporting and extension of outcomes.

3.1 Literature Review

The updated literature review was completed and is attached at Appendix 1. The relevant additions to the previous review were the development of 2-D barcodes and Quick Reading (QR) codes. Some new examples of electronic traceability systems in the seafood industry were provided as well as some new data on cost-benefit analysis methodology.

3.2 Preparation for and Selection of Appropriate Traceability System

As outlined in Section 2.2, a modified framework was developed for implementing a traceability system. This framework divided the consultation activities into internal Austral Fisheries consultation processes and external stakeholder consultation processes. The results from this modified framework are described below:

3.2.1 ***Internal Austral Fisheries Consultation Process***

a. Gain Commitment and document responsibility for upper level management signoff, product quality and collection and recording of data associated with the traceability project

David Carter, CEO Austral Fisheries agreed to the project and was a consistent member of the project steering committee. Barbara Bell was appointed to manage the implementation and record all data. Lesley Leyland and Dylan Skinns were occasional members of the steering committee aligned with crossover with their company duties. Greg Johnston assisted with the cost benefit analysis.

b. Document the need for embarking on an electronic traceability adventure

The various needs for the electronic traceability system were defined in meetings with Austral Fisheries at the beginning of the project and are listed below:

i. Accurate identification of lots and batches to vastly improve the tracking and accounting for prawns through the various stages of handling and dispatch through to transport and retail sale
ii. Facilitation of certainty and location of product streams, ensuring logical movement of consignments in correct order to meet appropriate market requirements confidence in stock control, and the elimination of transcription and readability errors with consequent efficiencies and reductions in manpower
iii. Faster and more cost effectively identify product of concern by boat or date of harvest at retail (see Figure 3 for example)

Figure 3 Photo of poor quality prawns following complaint from supermarket

iv. Reduction in product loss for both the producer and end-user and simplification of recalls
v. As more fisheries are moving to MSC so chain of custody certification is a critical part of gaining accreditation and an electronic traceability system will facilitate that approval process. It would also assist in meeting ever-increasing legislative and/or market standards for traceability in both domestic and export markets
vi. The ability to monitor time, temperature and location of individual cartons from harvest to retail sale would enable identification/validation of cool chain issues through the chain, possibly resulting in an improvement in product quality
vii. The opportunity for the consumer toaccess information on the source of their purchase, along with photos, recipes, and other information at purchase would assist in building value in the Austral Fisheries brand. Such transparency and easy access to information may also improve community perceptions of seafood.

c. Document what the system should deliver and define minimum parameters

Following consultation with Austral Fisheries staff, the following desirable parameters/criteria were developed for the electronic traceability system:

i. Carton label to be produced on boat with time, date, position,vessel, grade, species, pack style, use by date, and QR code
ii. Label and aligned data management system must meet requirements of all down chain partners, and also meet international and other standards requirements
iii. System must be simple and user-friendly for boat skippers and crew. Equipment must be robust and able to maintain accuracy in difficult weather conditions. Labelling system to have capacity to interface with current boat scales. Label must be able to withstand moisture and freezing
iv. Each individual carton able to be scanned at entry to freezer on catching boat, on mother ship and at cold stores. Collated data able to be sent electronically to head office (within limits of communication systems). Exchange of data must be able to interface with downchain partner systems (e.g. cold stores)
v. Data collection can be interfaced with electronic catch log books (fisheries management regulations)
vi. Ideally to include capacity for cool chain monitoring
vii. Ideally, design label able to beremoved and stored at retail outlet until product sold

d. Define the traceable unit.

The traceable unit was defined as a single carton. Currently the traceable unit is a single day's catch.

e. Develop flow charts from point of harvest to point of final sale/destination. Process mapping to include product flow, information flow, reporting flow and activity flow. Identify critical points (cf. HACCP)

Four process flow charts were developed with Austral Fisheries staff. These flow charts documented product flow, product species flow, activity flow and documentation flow. These flow charts and the aligned legend are found in Appendix 3.

f. Write down which data must be recorded and traced back at each step in the supply chain

Data to be traced back included carton pack time, date, position, vessel, grade, species, pack style and use by date.

g. Develop a unique labelling system or barcode for easy identification of the product

The following barcode (Figure 4) was *designed for Austral Fisheries needs.*

Figure 4 Austral Fisheries carton label

3.2.2 *External Stakeholders Consultation Process*

a. *Walk the Supply Chain: Consider what the needs and practices of your upstream and downstream partners are and their processes/set ups.*

Austral Fisheries staff, accompanied by Allan Bremner (Bremconsulting,) visited two trawlers ('Shearwater' and 'Kestrel Bay'), the mother ship ('Seaswift'), cold stores in Cairns (Access Cold Stores) and Brisbane (Doboy Cold Stores), a transport company logistics centre (Rand) and a supermarket distribution centre in Brisbane (Woolworths). The aim of the visits was to better understand the individual operations which would assist in the definition of the most appropriate electronic traceability system to be trialed. Detailed reports on the visits were prepared (Appendix 4) and the executive summary is reproduced below. It is worth noting that prior to the visits with the supply chain partners, Austral Fisheries staff were in favour of the installation of an RFID traceability system.

Executive summary (Allan Bremner)

Despite the clear advantages that an RFID traceability system may bring to Austral Fisheries this report recommends that the use of barcodes alone is preferable. The main reasons for this conclusion are:-

- *Woolworths Distribution Centre has no interest in RFID. They receive no food products –no frozen, chilled or dried goods which use RFID labels to identify them. Nor has anyone else approached them to use RFID. They are interested in the status quo and are not amenable to experimentation.*
- *The industry as a whole is not resourced to deal with RFID (yet) but is thoroughly familiar with, and equipped to use, barcoding at the Access Cold Stores, at Doboys and at Woolworths.*
- *Barcoding equipment is well understood, suppliers are numerous and widespread throughout the chain of distribution – parts, service and replacements are available.*

The problem of barcoding for Woolworths can be solved by the expedient of having their barcode requirements printed on the cartons. Consequently, those cartons that go to Woolworths are ready for their system; those that don't just have some redundant codes on them, meaningless to other recipients. These barcodes are required to be printed on more than one surface of the box so they are visible from two directions –even though Woolworths only scan one box per pallet!

There is room on board boat (trawler) for a barcode printer to be undercover adjacent to the scales and to which a touch screen can be mounted nearby to key in size data. The label must also have clear large markings for prawn size to facilitate rapid sorting at Access Cold Stores.

*The barcodes can contain extra digits to ensure that a box has not been scanned twice. This will eliminate the problem of double scanning in the event of a '*logjam*' at Access or at loading onto the 'Kestrel Bay'.*

The forms of data collection, database entry and transmission were discussed at both Access and Doboy Cold Stores and it appears there could already be much more 'near real time' sharing of data with Austral Fisheries formats that can be incorporated into Excel spread sheets and thus manipulated in Green Tree.

It was always part of the plan that IT people, from whoever installs the traceability system, will discuss compatibility and issues of data transfer between Austral Fisheries, 'Seaswift', Access, Doboy and to a lesser extent (surprisingly) with Woolworths although they do scan in the pallets. The trucking company,Rand, do not scan in any deliveries at all and do not intend to. They deal with pallet numbers totals on consignment notes and as the pallets will be scanned out of Doboy into their trucks, that is verification. If they are full loads, they will proceed directly to Woolworths DC, and if part loads (but whole pallets) they unload at their depot and aim to transfer within a few hours. They have no plans to adopt scanning. There has been no history of loss of pallets; action is not necessary unless this situation changes.

The issue of reliability of the attachment of labels to damp cartons arose many times. The selection of a good adhesive label is essential. It should be possible to pre-print and attach labels to dry boxes on the times that they are catching the one species and hauls are fairly uniform. This may be more difficult if mixed sizes are being caught.

Some photos of the supply chain partners are reproduced in Figure 5 (Mother ship), Figure 6 (Transport company depot) and Figure 7 (Supermarket distribution centre).

Figure 5 Transfer of cartons between trawler and mother ship ('Seaswift')

Figure 6 Transport depot

Figure 7 Supermarket distribution centre

3.3 Purchase Technology and Install and Trial

3.3.1 *Trial 1: Installation and Implementation of Innova Barcode System*

Following internal Austral Fisheries consultation, and consultation with external stakeholders as summarised in Section 3.2 above, it was decided to install a barcode system on the 'Shearwater'. This decision was based on cost, the existing capability/infrastructure of downchain stakeholders, and the fact that barcodes are proven systems in other seafood operations.

Meetings were held with Marel to design the system and a tender and services document for the installation of Innova software and associated hardware for the barcoding system produced by Marel for comment (Appendix 4). Meetings were also held with Austral Fisheries staff, Marel and CatchLog staff to discuss the possibility of linking the proposed barcode system with the CatchLog data system.

The summary of the proposed system from Marel is reproduced below.

The scope of this proposal is to provide an Innova solution for a vessel on-board catch recording and labelling system. A successful system would be the foundation for an ambitious catch recording and traceability system for the whole Austral Fisheries fleet. This system will therefore function as a proof-of-concept for the basic areas that are considered untested by Austral and needing verification for such a venture:

- *Labour impact on crew weighing and labelling on board on top of normal duties*
- *Label adhesiveness to cartons*

- *Scanning cartons on board when unloading.*

The proof-of-concept covers the initial trial of Innova on board the vessel ‘Kodiak’ or some other vessel if the ‘Kodiak’ is unavailable.

The Innova system provided includes an M2200 packing station, a label printer, and a scanner in order to scan the boxes off the vessel.

Main areas of the solution proposed are:

- *Pack weighing and labelling*
- *Scanning packs of the vessel*
- *Reporting.*

Should this trial be a success, the future aspects for implementation, which are not included in this proposal, could include:

- *Integration with other systems, like ERP and atch log systems*
- *Distribution of product specifications and label layouts from a central system to vessels*
- *Collection of vessel catch records to a central database.*

A decision was made by the steering committee to accept the Marel proposal and for the equipment to be installed on the ‘Shearwater’ prior to the commencement of the tiger prawn season in August 2012. The system allowed for on-board printing of labels which were to be subsequently attached to the cartons.

After initial successful printing and scanning trials in the office and at the port, a conveyor was built on the ‘Shearwater’ with a fixed scanner positioned above the conveyor so cartons could be scanned as they were moved out of the trawler freezer onto the mother ship (Figure 8). Prior to departure, the crew were trained in the use of the equipment by Marel staff.

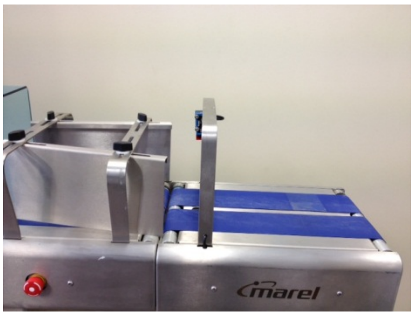

Figure 8 Labels and conveyor system with fixed scanner for Trial 1 on the ‘Shearwater’

However, the trial of the Innova barcode system was not successful for the following reasons:

- The engineer was seasick during installation which resulted in unsatisfactory testing of system and training of the crew
- The links between the computer and the scales (where data was input) on trawler were not stable and were unreliable
- The ‘Shearwater’ crew was unable to contact Marel support staff to correct problems due to intermittent mobile access
- The printing of labels was unreliable as the printer was not working optimally and there were problems adhering the labels to the boxes after packing the prawns
- The scanners were unable to scan the cartons on conveyor unless the position of cartons was very square.

3.3.2 *Trial 2: Installation and Implementation of Modified Innova Barcode System*

A second trial was developed for the banana prawn season commencing in May 2013 with the following modifications:

- Marel support staff modified the printer and cables between printer and computer
- The conveyor and fixed scanner were replaced with a scanner at the scales so that cartons were scanned and data attached immediately after packing.

This trial was also not successful due to the following reasons:

- Data was input but the printer broke down so the cartons were not labelled after the first week
- The ‘Shearwater’ crew was unable to contact Marel support staff for advice as they were out of mobile range
- There were connection problems between the computer (deckhouse) and the scales (deck)
- Data entry at the scales was not user-friendly” due to small size of screen and set of choices for product type.

However, although effective and reproducible labelling and scanning of the cartons was not achieved, the individual carton data was still input by staff and electronic reports were able to be generated and forwarded to head office staff. Results from this aspect were well received by Austral Fisheries head office staff and crew. It is also worth noting that the crew and staff had significant loss of interest during this second unsuccessful trial.

3.3.3 ***Trial 3: Joint Barcode (pre-printed) and RFID Trial***

In Trials 1 and 2, the Innova barcode system was found to be unsuitable for the following reasons:

- Individually printing the labels at the time of packing the cartons was unsustainable due to the time taken to print and adhere the labels during periods of heavy catches
- The printer was unable to keep working under the rigorous environmental conditions and prolonged periods of operation experienced during the NPF season
- There were considerable problems associated with keeping the cable connections active between the computer in the wheel house and the Marel scales on the deck.
- Contacting land-based support staff to solve problems was difficult.

It was therefore decided to retest the Marel barcoding system, but this time, using pre-printed labels with unique identifying numbers. These individual numbers could then be linked to the product information input during packing and transferred to the Innova database.

In addition, the potential for an RFID trial was revisited and, following consultation with Associate Professor Paul Turner from the University of Tasmania () and the commercial company Datanet, it was decided to run a side-by-side trial with the unique number barcodes and an RFID tag inserted into the label with the same unique number. Two dimensional barcodes with the same number were also printed onto the label. It should be noted that as no software development had been undertaken for the RFID and 2-D barcode systems, the only information recorded on these devices was the identifying number (i.e. no product information).

Five thousand pre-printed labels were produced, with individual carton numbers attached to the barcodes and also the individual numbers written on the label beneath the barcode. These pre-printed labels were attached to the cartons before each night's catch. The first two thousand labels also contained a 2-D barcode and an RFID tag, each with individual numbers matching those numbers associated with the pre-printed 1-D barcodes.

Figure 9 Carton label with 1-D and 2-D barcodes and RFID tag

The original Marel scales display panel and data entry point were used, with the 1-D barcodes on the cartons scanned and operators selecting the product type and other details to be recorded electronically 'attached' to the barcode. The information was subsequently transferred to the computer in the deckhouse. An RFID and 2-D barcode scanner was also installed and the crew were trained to also scan labels against this scanner (Figure 10).

It is noteworthy that all cartons were also manually labelled for vessel, date, species and grade as per the traditional method. In addition, cartons were manually counted before freezer storage.

At the completion of the trial, all the results for the on-board scanning with the different systems were compared (see Section 3.3.3.1 On Board Results).

Figure 10 1-D, 2-D and RFID scanners installed on 'Shearwater'

At each unload from the trawler to the mother ship, the skipper compiled the summaries of the manually recorded carton data (as collected by a manual count of the cartons) and the Innova data as downloaded from the computer using the Innova software (and based on the electronic entry of information at the scales).

Three downloads occurred and the activities are described below.

Unload 1: ~700 cartons were transferred to the mother ship and subsequently unloaded at Access Cold Stores, Cairns. At the cold store, the individual cartons were manually counted and also scanned using a barcode scanner and a fixed RFID scanner (Figure 11). The RFID scanner was also used to scan packed pallets of cartons. The individual carton data as counted by RFID was compared with the Access manual count data and the on-board manual count data (see Section 3.3.3.2 Unload 1 Results).

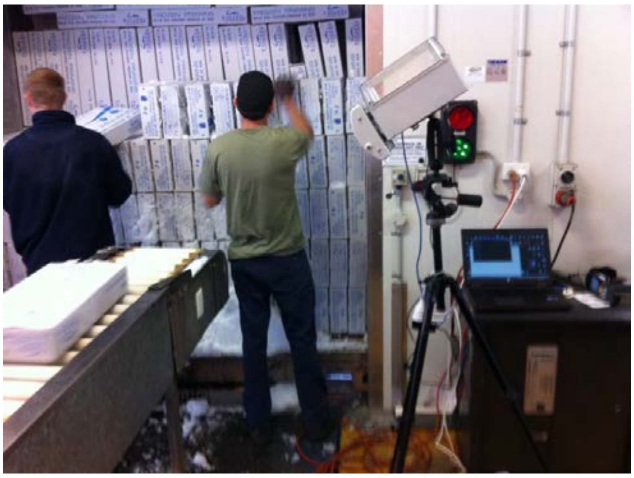

Figure 11 RFID Scanning of cartons at Access Cold Stores after first unload

Unload 2: The second unload of ~ 2050 cartons occurred at Kurumba, as the vessel had to be towed to port due to a breakdown. The cartons were manually counted following unload at the Kurumba (Raptis) cold store facility before being palleted and transported to Doboy Cold Stores in Brisbane. At Doboy Cold Stores sixteen of the pallets were unpacked and cartons individually scanned by handheld 1-D and 2-D barcode scanners and fixed 2-D and RFID scanners (Figure 12) (see Section 3.3.3.3 Unload 2 Results).

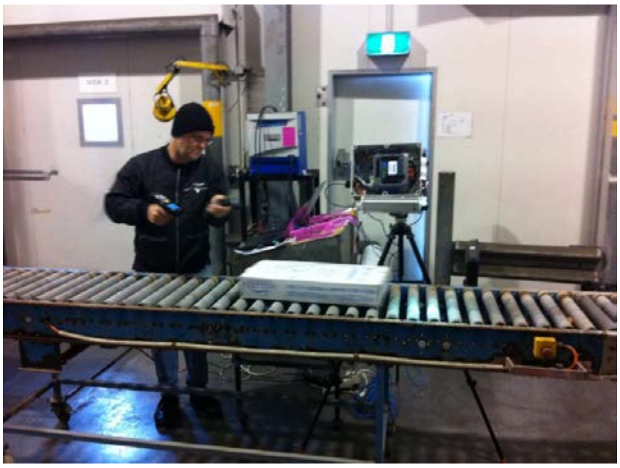

Figure 12 RFID and barcode scanning of labelled cartons at Doboy Cold Stores

Once the first 2000 cartons were labelled (with labels holding the RFID and 2-D tags) and packed, the RFID and 2-D scanners were dismantled from the boat and returned to Datanet for the download of data.

Unload 3: The remaining ~2250 labelled cartons were unloaded to the mother ship and later transferred to Access Cold Stores in Cairns. Cartons were manually counted at Access Cold Stores (see Section 3.3.3.4 Unload 3 Results).

Once the ~5000 barcode labels had been attached to cartons, all the individual carton data recorded on the Innova system on board the trawler was remotely downloaded and transferred to Austral Fisheries head office and also to downchain stakeholders within an Excel database.The Innova software expert provided examples of how this individual carton data could be reproduced into a form that would be suitable for uptake into down chain partners existing systems.

3.3.3.1 On Board Results

Table 1 shows the comparison of all recorded scans from the different electronic traceability systems (1-D barcode, 2-D barcode, RFID) from the scanners installed adjacent to the Marel scales on the ‘Shearwater’ with the 2000 (RFID) or 5000 (barcode) pre-printed labels.

Table 1 Scanning results from 1-D, 2-D and RFID scanners installed on ‘Shearwater’
.

	Actual pre-printed labels*	**1-D Barcode scans**	**2-D scans**	**RFID scans**
First 2000 cartons	2000	1702	870	445
First 5000 cartons.	5097	4795	N/a #	N/a #

* The assumption is made that all these labels were attached to cartons however the reality is that many some may have been discarded etc
# N/a: only the first 2000 labels contained RFID and 2-D barcodes as well.

The 1-D barcode scanner and aligned Innova software performed the best but, assuming all labels were attached to cartons, there were still around 300 bar codes labels on cartons that did not scan. This non-scanning was noticed by the crew and was assessed as being due to a connection breakdown between the Marel scales and the computer but it may also have been due to labels being discarded or not attached to the cartons for various reasons. It is noteworthy however that when the carton labels did scan, the recording of the >4500 individual carton numbers and accompanying information onto an Excel database as well as remote access to the database and transfer of data to stakeholders at head office and Curtin University was successfully managed.

An explanation from a Marel software engineer of an example of how the individual carton data could be provided to the cold stores and other down chain stakeholders if they require a different format from an Excel database is included below.

“I have created a report, which I have not loaded on the vessel as yet, but it exports the necessary data for a particular trip. This info we would then send onto the cold stores before the shipment arrives so that they have the barcode numbers and the relationship to the products so they can import this into their system and scan against it.

Obviously we would need to have this information specified as to exactly what the cold stores need and also possibly the product reference numbers entered into Innova first.

They would choose the Purchase Order (Figure 13). From here you can export the information and email it, etc. This same type of process can be used to get data out for any other system as well.”

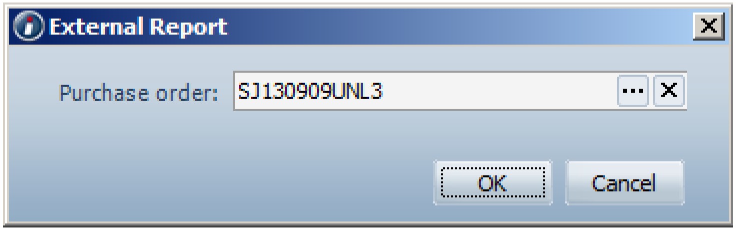

Figure 13 Example of different data treatment from Innova generated excel database.

The RFID and 2-D results from scanning on the boat were poor and inconsistent when compared with the 1-D barcode scanning. The following explanation was provided by the Datanet installation engineer:

"It is apparent that I have made a mistake with the RFID reader on the boat – The RFID reader power was set as low as practical to stop spurious reads, but I think I erred on the side of caution and set it too low which has caused very poor read results compared to the total cartons expected and even the 2-D barcode results (which were not very good either.) It seems strange though that the feedback from the boat was that all of the cartons were triggering the green LED that indicated a good RFID read. I think the result shows that active power control is required in a production system to ensure the correct carton is being read / written and also highlights the difference in results obtained from a system that required positive operator input to function and one that didn't!

I did test the antenna of the 'Shearwater' against a new one and it performed the same, showing that particular gear would be OK at sea & that the most likely reason for the bad results were my error!

The 2-D scanner also performed poorly this was explained as being due to the low resolution nature etc. of the installed scanner."

3.3.3.2 Unload 1 Results

At unload 1, cartons were unloaded to the mother ship and CatchLog data (manually recorded) and Innova spreadsheet data transferred to Austral Fisheries head office. Cartons were unloaded at Access Cold Stores, counted manually and also scanned by an RFID scanner both individually and once shrink-wrapped on the pallet.

Figure 14 below shows the comparison of the total numbers of cartons as scanned and /or counted under the different systems.

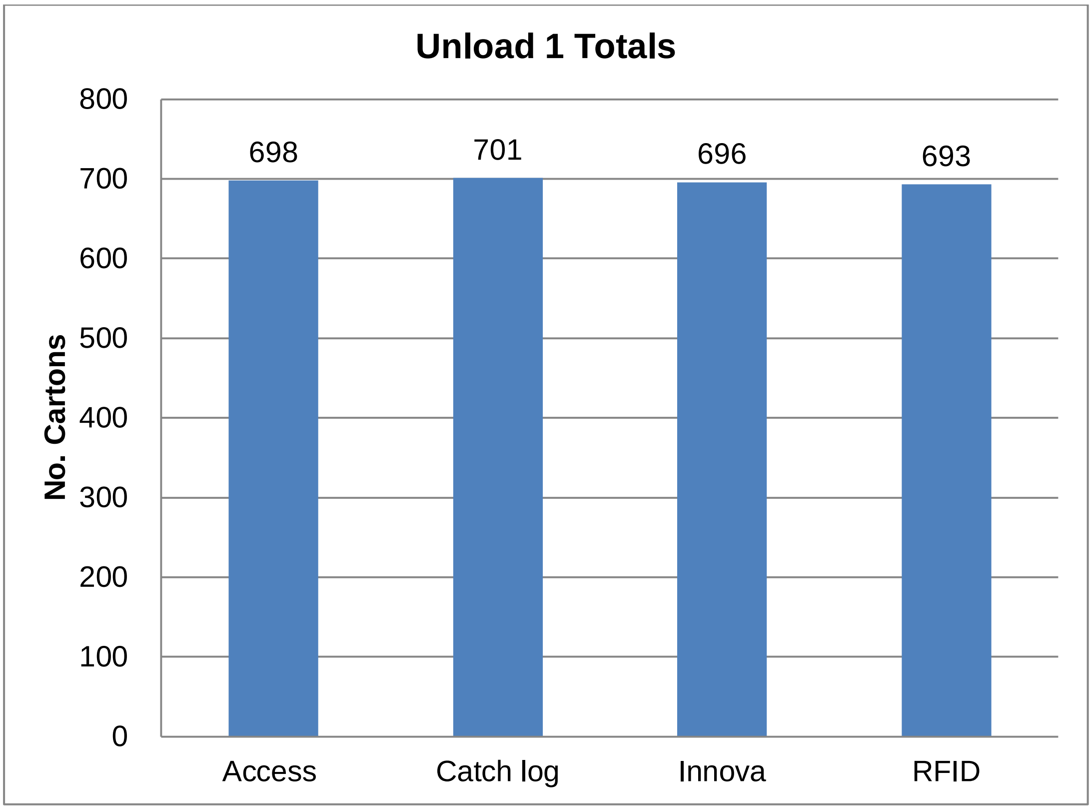

Figure 14 Comparison of Unload 1 total carton results for all systems at Access Cold Stores

For the purposes of the trial, the Access Cold Stores manual count is considered the most accurate. The RFID and Innova (barcode) scans were slightly lower, indicating some inconsistencies while the CatchLog count was slightly higher. However it was clear that both the electronic scanning systems functioned quite well, and were not affected by freezing or ice on the carton.

Comments on the RFID scans by the Datanet technician are reproduced below.

"For the unload I set up the RFID reader at ¼ power over the conveyor from the container into the cold store. We captured 290000 tag scans with 694 unique tag reads – I think this is very close to the "official" figure for the load so it shows the inlay tags have survived the freezer and manual handling OK.

The high number of reads per tag shows that we can also write to the tags at the speed they are loaded out, assuming the application controlling the writes can keep up.Once the unload was complete I relocated the fixed reader to the pallet wrapping machine. I positioned the reader antenna half way up the pallet and put it into continuous read mode at full power. While the pallet was being rotated I manually tilted the antenna up and down to simulate a 2 antenna array, or an antenna mounted on the arm that moves the plastic roll up and down the pallet.

Given the amount of ice between the outside of the pallet, I was not expecting a good read rate, but at full power and the antenna in the same orientation as the tags it appears that we can get reads all the way through the pallet!

The problem with this arrangement is that the read range of the reader in free space is very far, so a few of the results show one more carton than expected. With the tags in the grading end of the carton, spurious reads can be addressed by limiting the reader's output power so it physically cannot read a tag that isn't right in front of it – the application running the scanner could also assess the product type and grades encoded on the tags along with the total carton count to get a very accurate list for the operator to assess."

A further comparison was made between the totals for the various different types of products unloaded for the CatchLog (on board), Access Cold Stores and manual count data, and the Innova electronic data.

In many cases there is variation in the product type counts between the different systems as can be seen in Figure 15 below. In terms of Innova system, this was most likely due to the user-unfriendly display and selection screen/tablet which made it difficult to enter data accurately.

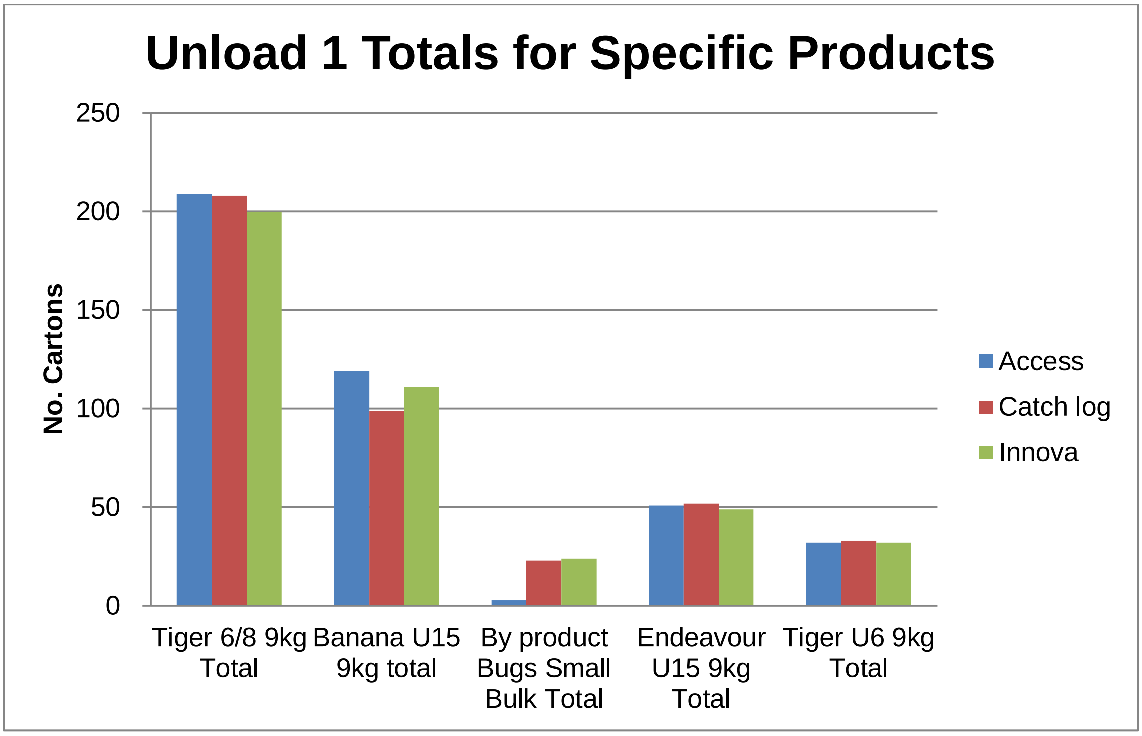

Figure 15 Comparative carton numbers of different product types as measured by the different systems

3.3.3.3 Unload 2 Results

For unload 2, labelled cartons had to be unloaded at short notice in Kurumba due to a breakdown problem with the vessel. The cartons were manually counted at the Raptis Kurumba facility, palleted and then transported directly to Doboy Cold Stores in Brisbane.

The total carton results were compared with the different systems (noting Doboys used Raptis manual count numbers and did not recount).

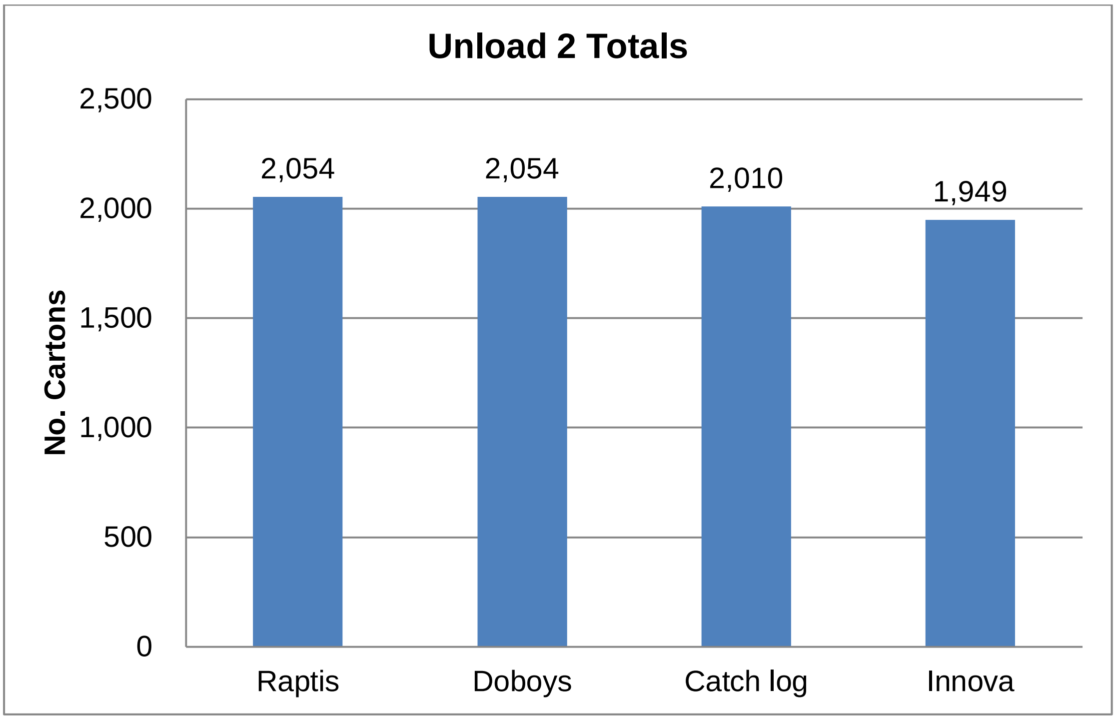

Figure 16 Total carton numbers for the different systems for Unload 2

For this unload, the Innova total carton number was less and this was thought to be due to a breakdown in the connection between the Marel scales and the computer during the voyage. It is worth noting that this breakdown was noticed by the crew and fixed following a conversation with the Marel software engineer.

Again a comparison was made between the totals for the various different types of products unloaded for the Catch log, Innova and Raptis manual count data,. It is important to note however that for this comparison, the CatchLog and Raptis data would have been generated by a count of the handwritten scoring of the cartons, whereas the Innova data would have been generated from the electronic data entry at the Marel scales.

As can be seen in Figure 17, there is variation in the product type counts between the different systems as had been seen in Unload 1.

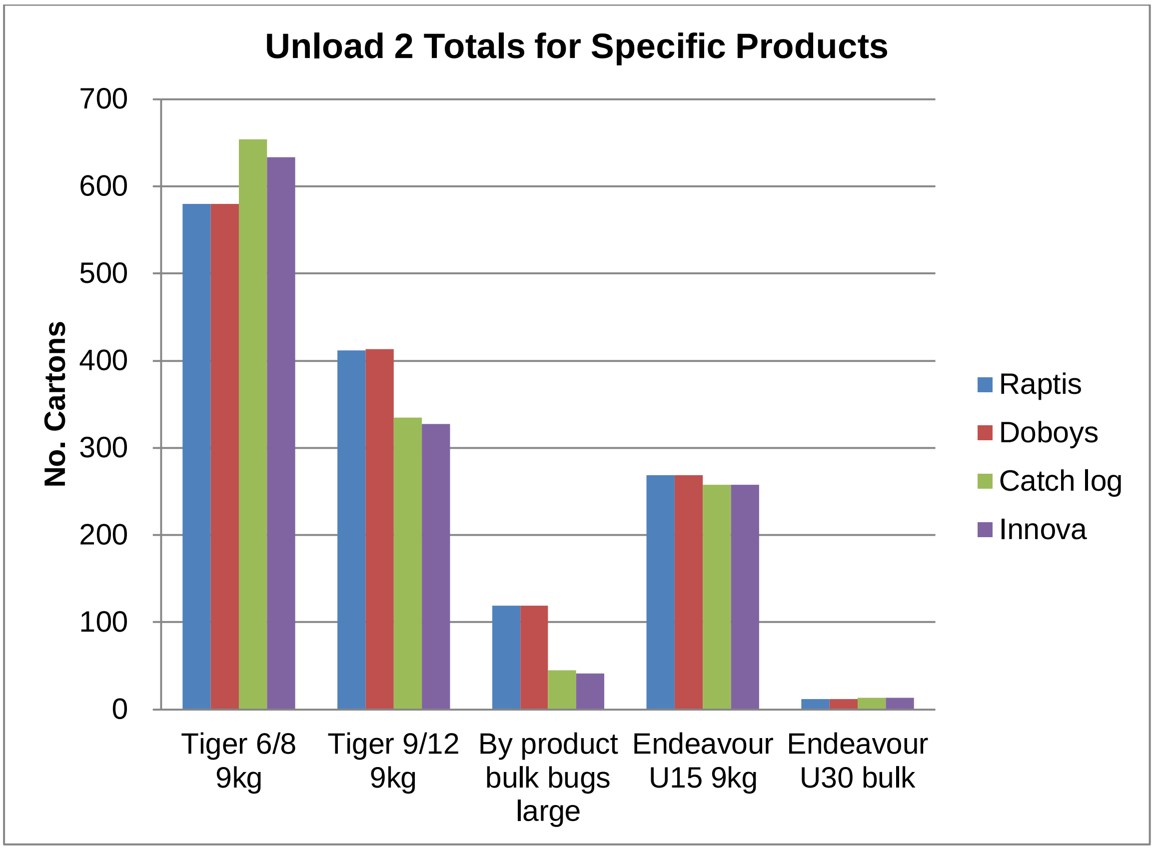

Figure 17 Comparative carton numbers of different product types as measured by the different systems

At Doboy Cold Stores 16 of the pallets from the Raptis facility pack in Kurumba were manually unpacked and individually subjected to manual 1-D barcode and 2-D barcode scanning as well as fixed RFID and 2-D scanning. As can be seen in Figure 18 the hand-held 1-D and 2-D scanning was very effective as was the fixed RFID scanning. The 2-D fixed scanner was not effective.

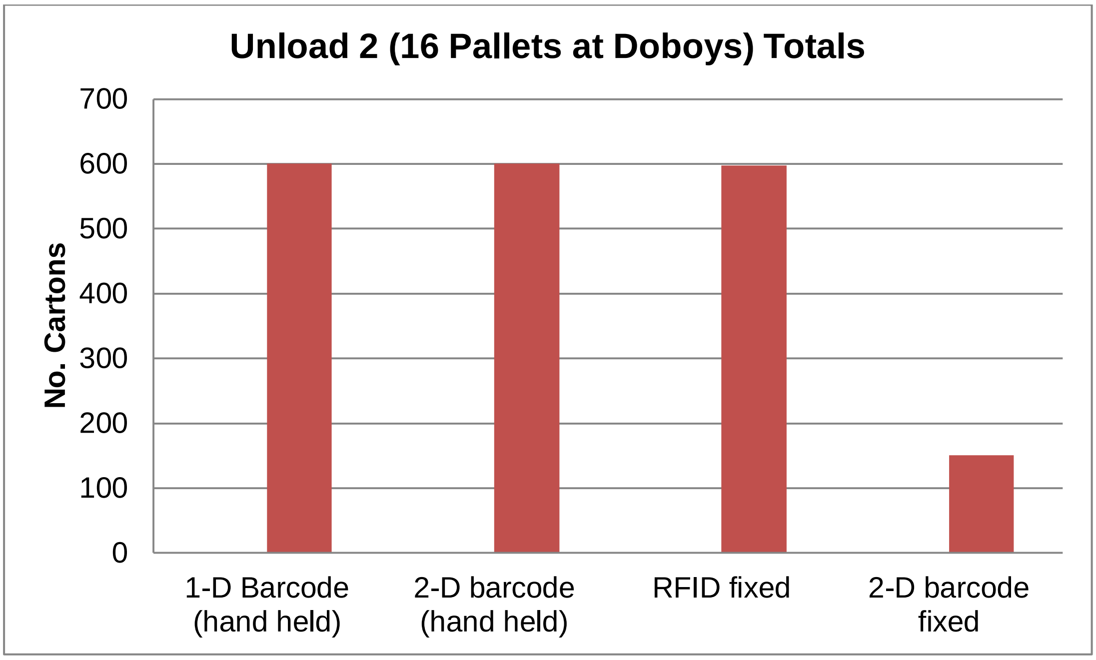

Figure 18 Total carton numbers for the different systems for 16, Unload 2 pallets unpacked and scanned at Doboy Cold Stores

Some comments related to the scanning results from a Datanet RFID technician are reproduced below.

"The Doboys results were excellent for the RFID. Considering I did not touch the RFID unit for the duration of the test, it caught as many good reads as the hand-held, manually aimed barcode scanners. The 2-D fixed scanner did poorly again. It must be noted that a few (maybe 15 or 20) of the 1-D and 2-D barcodes could not be read as the carton went by, forcing the operator to stop the line and muck about with label to scan.

In the whole test we only had a couple of barcodes that refused to scan. This test showed that unattended RFID has similar accuracy rates to a manually operated barcode reader and does not require any changes to the conveyors to lock the cartons in a particular orientation that would be required for a low cost 1-D or 2-D scanner to get a good read rate. The RFID gear does not need cleaning etc. either.

I think we have proven that the RFID tags are OK for the environment in the freezer etc. The barcodes were 99.99% OK as well."

3.3.3.4 Unload 3 Results

During Unload 3, the remainder of the labelled cartons were unloaded to the mother ship and then transported to Access Cold Stores for manual carton count. Only cartons with the 1-D barcode printed labels remained as >2000 cartons had already been unloaded. Figure 19 shows the comparative carton count from the three systems (Innova, Access and Catch log).

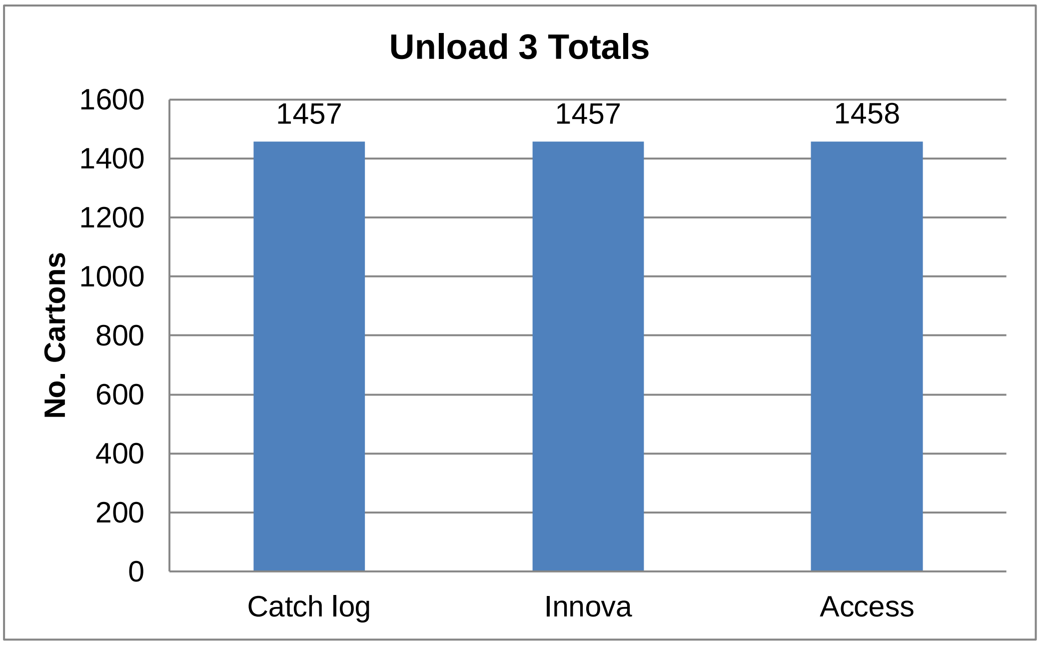

Figure 19 Total carton numbers for the different systems for Unload 3

It is noteworthy that, in spite of Unload 3 having the most number of cartons, it showed the best results as far as comparison between the different counting/recording systems. This may have been due to the crew having greater familiarity with the system or that the removal of to the need to double-scan – the 2-D and RFID scanners were no longer operationalwhich made the whole process logistically easier to undertake.

As with Unload 2 and 3, there were inconsistencies between the CatchLog, Access and Innova count for different product types (Figure 20). However these differences were significantly reduced compared with the previous 2 unloads. Again, this may have been due to the crew having greater familiarity with the system or that the removal of the need to double scan, the 2-D and RFID scanners being no longer operational, made the whole process logistically easier.

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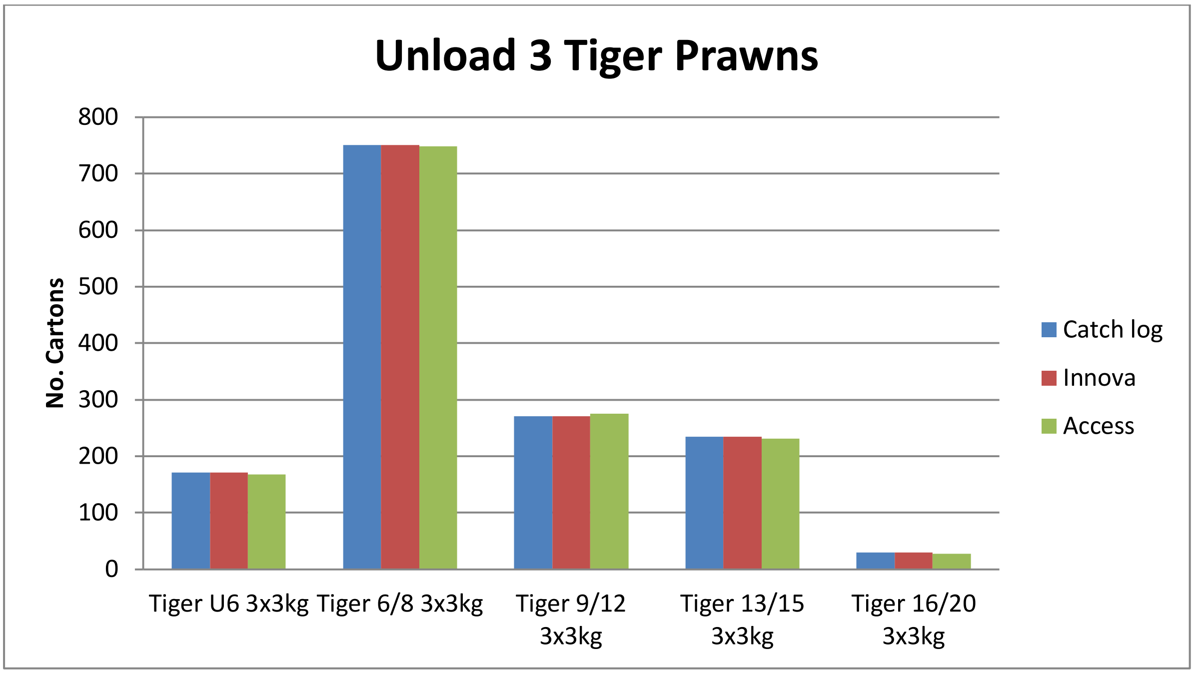

Figure 20 Comparative carton numbers of different product types as measured by the different systems

3.4 Undertake Evaluation based on Agreed Parameters

Following a literature search for applicability and discussion with a cost-benefit analysis (CBA) consultant, Ewan Colquhuon, it was decided to conduct a CBA looking at the costs of both a RFID and a barcode system using the methodology developed by Chryssochoidis et al. (2009).

In this method, traceability CBA is calculated using four target ‘impact’ areas. These areas are listed below:

- Supply-side impacts on the supply chain (operations efficiencies, improved trading partnerships, operational advantage)
- Competitive advantage and marketing impacts (build consumer trust, differentiation and information)
- Food safety and quality control impacts, (compliance with food laws and other regulations, risk management (e.g. managing recalls)
- User satisfaction and serviceability impacts.

It is important to note that, due to the limitations of the study, the CBA was only calculated on the first target ‘impact’ area.
The following steps were under taken in developing the CBA:

a. Interviews were conducted with key staff for semi-quantitative assessment of benefits (new system v old system). The interview instrument and results can be seen in Appendix 6. This instrument also provided a framework for calculating costs
b. A calculation of the full cost of RFID and/or bar-code implementation (as possible, with limitations) was undertaken

c. Interviews were conducted with the company secretary to put actual dollar values against the benefits identified by the preliminary staff interviews (tangible, dollar values) versus the costs of implementation and ongoing maintenance/annual costs
d. CBA was conducted and calculated. The full report for the CBA is presented at Appendix 2.

A summary of the CBA report is reproduced below.

This report presents a Cost-Benefit Analysis (CBA) of Austral Fisheries' proposed investment in a prawn supply traceability system. The intent of this system is to better service large domestic retail customers.

The CBA Project Team comprised company staff, a project manager from Curtin University and a consultant from Ridge Partners.

A seven step methodology was implemented to undertake this CBA using standard CBA procedures. The analysis was completed in late 2013 based on initial pilot trial outcomes, and commercial quotations and assumptions developed jointly with the company.

*The analysis has established and analysed a relatively conservative Base Case "**Prawn Supply RFID System across 10 Vessels**" and a number of key variable sensitivities over a ten year investment horizon. The CBA has taken a very conservative approach by limiting the analyses to only those impacts and net benefits derived from the investment, that are identifiable on the supply-side, operationally compelling, and financially quantifiable as a cash flow to the company within the ten year horizon. Other potential and significant net benefits from sources such as competitive advantage, food safety, or supply-chain user satisfaction and serviceability have not been incorporated into the CBA.*

This Cost Benefit Analysis found that:

- *The proposed **Base Case RFID System** investment of $185,668 at a 10% discount rate will result in a positive NPV over ten years of $436,000 before tax. This indicates that the investment will be financially attractive for the company*
- *Over 90% of this net gain in the Base Case RFID System is forecast to come from better management of and reduction in prawn over pack for domestic retail customers*
- *An alternative Barcode System technology implemented across 10 vessels will likely cost less to establish ($102,736) and deliver a higher ten year NPV ($538,803), but will not be as flexible or operationally attractive for the company and its supply chain partners over the longer term.*

*Analysis of the **sensitivity** of the Base Case investment indicates that the company's pre-tax return on investment over ten years can be boosted through a range of immediately available measures, including:*

- *Investing in an ongoing program to train and support staff and crews to implement and use the traceability system*
- *Ensuring all benefits available from the investment are captured by the company. These include reductions in transaction unit costs at each point in the supply chain, reduction in data error rates, real time exchange of information with the AFMA logbook interface, reduced need to remeasure and verify stocks in transit, labour productivity and efficiencies based on better data, and reduced insurance costs.*

3.5 Reporting and Extension of Outcomes.

Findings/Outcomes of the project have been reported in the following fora:

a. Nogrady B (2013) Keeping Track, pp 24-26 FRDC FISH magazine (September 2013)

b. Howieson JR, Denham F and Fernandes L (2013) Monitoring quality and safety through seafood supply chains: issues and opportunities. Environmental Health Australia Conference Perth 24-26 Sept 2013.

c. Howieson J (2013) Supply and Value chain Analyses for the Australian seafood industry Women's Industry Network Seafood Community National Conference, Port Lincoln October 2013.

d. Howieson J, Carter D, Bell B and Colquhuon E (2014) Implementing Traceability in a Remote, High Volume Fishery: Issues, Opportunities, Benefits. World Aquaculture, Adelaide, June 2014.

e. Spencer Gulf West Coast Professional Fishermen's Association Management Committee meeting, Port Lincoln, June 2014.

f. Howieson J (2014) The Australian Prawn Industry: Background, Quality Assurance, Supply Chain Technologies. Refrigerated Warehouse and Transport Operators Conference, Cairns, August 2014.

g. Howieson J (2104) Scombroid Poisoning and Other Emerging Issues for the Seafood Industry WA Environment Australia conference, Perth. August 2014.

4. Discussion

4.1 Review of Policy Framework to Implement Traceability Systems

The 'implementation of traceability' steps originally used for this project were based on the system described by Opara and Mazaud (2001). This method included the following steps:

a. Draw a flow chart of the product supply chain; from point of harvest to point of final sale, and include sources of material inputs (e.g. medications, micro ingredients in food etc.)
b. Upper level management (CEO, Board) must support the traceability initiative Appoint a person who is also responsible for product quality
c. Conduct a hazard analysis of the supply chain using HACCP principles
d. Document the reasons for embarking on the traceability of the products
e. Consider what the needs and practices of your upstream and downstream partners are and talk about it with them not just for your main raw materials, but for packaging and ingredients
f. Write down which data must be recorded and traced back at each step in the supply chain
g. Specify the responsible persons for collecting and recording the data

h. Develop a unique labelling system or bar code for easy identification of the product
i. Document how the trace-back is to be carried out (include a diagram)
j. Test, validate and verify the traceability system
k. Document all decisions and actions.

Based on the results of this case study a modified framework is described below.

Internal Austral Fisheries Consultation Processes

a. Gain Commitment and document responsibility for upper level management signoff. product quality and collection and recording of data associated with the traceability project
b. Document the need for embarking on an electronic traceability adventure
c. Document what the system should deliver and define minimum parameters
d. Define the traceable unit
e. Develop flow charts from point of harvest to point of final sale/destination. Process mapping to include product flow, information flow, reporting flow and activity flow. Identify critical points (cf. HACCP)
f. Write down which data must be recorded and traced back at each step in the supply chain
g. Develop a unique labelling system or bar code for easy identification of the product.

External Stakeholders' Consultation Processes

a. Walk the Supply Chain: consider and understand what the needs and practices of your upstream and downstream partners are and their processes/set ups.

A possible suggestion is the development of a fact sheet summarising the revised steps for implementation of an electronic traceability system based on the learnings from this project.

4.2 On Board Trials

The results show that, in spite of a number of technical problems, in principle, either the RFID system or barcoding system used in Trial 3 could be operational, both on board and in the cold stores. However, formats for export/transfer of data would first need to be defined as well as installation of the correct equipment at each location.

The barcode system, particularly on board the boat, was more successful. However, the cold store operator was particularly interested in the ability to scan all the cartons on one pallet with a fixed RFID scanner rather than using the individual hand-held carton scanners that are required with the barcode system.

Prior to the introduction of these systems, some further work addressing some of the technical issues and concerns would need to be undertaken. These areas are listed below:

- Test that long term storage does not affect RFID or barcode labels
- Test that RFID scanner on board can be adjusted to eliminate errors

- Improve the connection between the computer and the Innova equipment at scales or install an iPad-type device actually at the scales, thereby doing away with the need to link with computer
- Improve the data entry screen to make entering data easier and less prone to error
- Address the issue of 'naked' cartons, particularly for downchain partners. If the electronic traceability system is implemented then there may still be a need to identify the product types by using dedicated marking of the carton. One option may be to have different types of cartons printed for different product types, or an automatic sorting system based on barcodes or RFIDs
- Conduct further crew training to improve accuracy of data input
- Investigate further individual barcode numbers or RFID tags printed/added on cartons at time of manufacture.

4.3 General Discussion

The successes and problems/challenges associated with introducing these systems are summarised below.

Successes

- RFID and barcode labelling and scanning have been shown to be technically feasible in the Austral Fisheries frozen prawn supply chain. The successful scanning of the barcodes and tags was not impacted by catch conditions, freezing or long term storage. Of particular interest was the outcome that all cartons on a pallet can be scanned with an individual fixed RFID scanner
- Internal Electronic Reporting from the Innova (barcode) software (boat records to head office records) was viewed favourably by the Austral Fisheries staff
- Individual carton data can be electronically transferred between chain partners
- A cost-benefit evaluation method was developed and trialled during the project and a positive cost benefit identified
- Following presentation of the project results in various fora, other Australian seafood industry companies have expressed interest in taking part in further trials.

Problems/Challenges

- Significant on-board technical challenges were identified. These included issues with computer connectivity, hardware (e.g. printers) operation, inconsistent scanning results, inaccurate data entry and problems with attaching the labels to the cartons. It is considered that many of these problems could be addressed by the insertion of an individually numbered barcode or RFID tag at the time of carton manufacture. This is currently being discussed with carton manufacturers.
- Downchain feasibility and uptake (carton manufacturers, end-users) has not been fully addressed in the project.

5. Further Development

The recommendations for further developments are related to the undertaking of a new trial incorporating the following changes:

- Installation of RFID software, equipment and full implementation
- Development of a more robust iPad data entry device (for ease of data entry)
- Pre-printing or pre-labelling of cartons at point of manufacture
- Incorporation of down chain partners in trial
- Re-evaluation with a full cost- benefit analysis incorporating all potential benefits as described in section 3.4.
- Further investigation of the use of ’real time’ temperature logging capability with the labels.
- Alignment with QR code technology

It is suggested that the trial be extended to another aligned supply chain (e.g. farmed prawns) to increase the chance of down chain commitment and involvement.

6. Planned Outcomes

The planned outcomes are as follows:

Public Benefit Outcomes

a. An updated review of traceability options for the Australian seafood industry
b. A refined methodology for implementation of traceability systems by seafood companies
c. Preliminary results available from the implementation of RFID and barcode systems with the identification of issues and/or opportunities for each of the systems
d. A cost-benefit analysis methodology for electronic traceability developed and piloted during the study
e. The presentation of the project results to the Australian seafood industry in a variety of fora.

Private Benefit Outcomes

a. Austral Fisheries can now make an informed choice about the issues and opportunities of implementing electronic traceability into their operation.

Linkages with CRC Milestone Outcomes

Output	***Milestones***
2.1 - Traceability technologies to assure seafood quality and integrity and to deliver value chain efficiencies	2.1.1 - Frontier traceability systems applicable to Australian seafood value chains identified and demonstrated in at least two seafood sectors
	2.1.2 - Technology and capability to support

implementation of ongoing traceability systems developed

2.1.3 - Commercial roll-out of traceability technologies commenced

7. Conclusion

The conclusions of the project based on the objectives are discussed below:

1. Identify, establish and evaluate an innovative, electronic traceability system for Austral Fisheries seafood products.

This project commenced with a review of electronic traceability options for the seafood industry in general and then specifically reviewed the options aligned with the characteristics of Austral Fisheries' fishery, company operation and supply chain.

At the commencement of the project, it was intended that the methodology to implement the traceability system would follow the framework outlined in 'Seafood traceability technologies' (2006) published by Seafood Services Australia (ISBN 0-9775219-2-3). This framework describes 12 steps to implement a traceability system. However, as the project evolved this framework was modified during the project, including separation into internal (Austral Fisheries) and external stakeholders' consultation processes as described in the results section.

As specified in the framework, activities in the early part of the project included consultation with Austral Fisheries staff to determine the organisation's need, the internal management of the project, and desirable parameters that the electronic traceability system should deliver. Austral staff also 'walked the chain' to view the operations of, and meet with, Austral supply chain partners. This involved spending time on the trawlers and the mother ship, in the cold stores and with the transport operators and in the supermarket distribution centres. This data was included in supply chain maps covering product flow, activity flow, species flow and documentation flow. The need and description of what the system should deliver were also documented after 'walking the chain' and further meetings with Austral Fisheries staff.

Barcode and RFID electronic traceability systems were tested in three different trials over the course of the project. Although numerous technical problems occurred it was shown that, in principle, implementation of such a system was possible. New trial plans to reduce some of the technical issues are documented in the report.

A formal cost-benefit analysis of the barcode and RFID implementation was conducted based on a previously published methodology previously published (Chryssochoidis *et al.*, 2009). Only internal cost benefits were captured as external benefits could not be calculated based on the scope and limitations of the trials. Nevertheless a positive cost benefit was shown based on a 10 year projected calculation.

2. Characterise the choices, issues and opportunities around implementation of innovative traceability systems for Australian seafood.

An updated review of traceability options has been completed. The results of the project have been presented in a range of industry fora and interest has been shown by other Australian seafood companies in trialling the technology.

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