

2013/711.30: New Opportunities for Underutilised Species

Final Report



Dr Janet Howieson, Kerri Choo, Andrew Tilley, Sarah Crisp

September 2017.

FRDC Project No 2013/711.30



© Year Fisheries Research and Development Corporation.
All rights reserved.

ISBN 978-0-9925568-9-1

2018: Final Report: FRDC 2013/711.30 New Opportunities for Underutilised Species.

Ownership of Intellectual property rights

Unless otherwise noted, copyright (and any other intellectual property rights, if any) in this publication is owned by the Fisheries Research and Development Corporation and Curtin University.

This publication (and any information sourced from it) should be attributed to Howieson J: Curtin University, 2017. **New opportunities for Underutilised species *Final Report (FRDC 2013/711.30)***

Creative Commons licence

All material in this publication is licensed under a Creative Commons Attribution 3.0 Australia Licence, save for content supplied by third parties, logos and the Commonwealth Coat of Arms.



Creative Commons Attribution 3.0 Australia Licence is a standard form licence agreement that allows you to copy, distribute, transmit and adapt this publication provided you attribute the work. A summary of the licence terms is available from creativecommons.org/licenses/by/3.0/au/deed.en. The full licence terms are available from creativecommons.org/licenses/by/3.0/au/legalcode.

Inquiries regarding the licence and any use of this document should be sent to: frdc@frdc.com.au

Disclaimer

The authors do not warrant that the information in this document is free from errors or omissions. The authors do not accept any form of liability, be it contractual, tortious, or otherwise, for the contents of this document or for any consequences arising from its use or any reliance placed upon it. The information, opinions and advice contained in this document may not relate, or be relevant, to a readers particular circumstances. Opinions expressed by the authors are the individual opinions expressed by those persons and are not necessarily those of the publisher, research provider or the FRDC.

The Fisheries Research and Development Corporation plans, invests in and manages fisheries research and development throughout Australia. It is a statutory authority within the portfolio of the federal Minister for Agriculture, Fisheries and Forestry, jointly funded by the Australian Government and the fishing industry.

Researcher Contact Details

Name: Janet Howieson
Address: 7 Parker Place,
Bentley
Phone: 0423840957
Fax:
Email: j.howieson@curtin.edu.au

FRDC Contact Details

Address: 25 Geils Court
Deakin ACT 2600
Phone: 02 6285 0400
Fax: 02 6285 0499
Email: frdc@frdc.com.au
Web: www.frdc.com.au

In submitting this report, the researcher has agreed to FRDC publishing this material in its edited form.

Table of Contents

Table of Contents	3
Executive Summary	5
1. Introduction	8
2. Objectives	8
3. Methods	8
3.1 Development of an Underutilised Species Database and Framework to take Underutilised Species to Market	8
3.2 Industry Consultation, Identification of Potential Opportunities and Committed Industry Partners.....	9
3.3 Laboratory and Pilot Scale Trials.....	11
3.3.1 Sample Sourcing, Handling and Storage	11
3.3.2 Processes for New Product Development	11
3.3.3 Analyses.....	11
3.4 High Pressure Pasteurisation (HPP) Trials.....	13
3.4.1 Industry Consultation and Planning	13
3.4.2 HPP Trials and Workshop	14
3.4.3 Analyses.....	16
3.5 Commercial Trials and Launch on Markets.....	16
3.6 Reporting and Extension	16
4. Results and Discussion	16
4.1 Development of Underutilised Species Database and Framework.....	16
4.2 Industry Consultation and Development of Potential Opportunities and Defined Industry Partners.....	17
4.3. Laboratory and Pilot Scale Trials to Benchmark Opportunities	18
4.3.1 Australian Salmon.....	18
4.3.2 Pilbara Trawl.....	23
4.3.3 Saddletail Snapper.....	24
4.3.4 Champagne Crabs.....	25
4.4 High Pressure Pasteurisation (HPP) Trials	26
4.5 Commercial Trials and Launch on Markets	27
4.6 Reporting and Extension	28
4.6.1 Extension Activities	28
4.6.2 Undergraduate and Post-Graduate Student Projects.....	29
4.6.3 WAFIC School Education Project based on Underutilised Species	30
5. Conclusions	31
6. Recommendations	32

Appendices33

Appendix 1: Underutilised species database.....33

Appendix 2: Australian Salmon (*Arripis Trutta*): Quality, Yield And Value-Added Product
Considerations33

Appendix 3: Options for Western Australia’s commercial Australian Salmon Fishery33

Appendix 4: Development of New Opportunities for Underutilised Finfish from the Pilbara
Trawl33

Appendix 5: Saddletail Snapper (*Lutjanus Malabaricus*) Texture Investigation: Opening New
Markets with Enzyme Treatment33

Appendix 6: Champagne Crabs (*Hypothalassia acerba*): Yield and Sensory Considerations33

Appendix 7: High Pressure Pasteurisation Trials for Western Australian Seafood Product33

Executive Summary

This report summarises the research undertaken under FRDC 2013/711.40: New Opportunities for Underutilised Species.

Using information taken from a variety of fisheries management and market sources, an underutilised species database was developed based on harvested volumes and price. Initially the database was focussed on Western Australia but, following increased stakeholder interest, it was later broadened to include the majority of Australian fisheries.

Initially, 107 possible target species were identified, however following marketing expertise input these were later reduced to 42 priority species, with these species further divided into 'commodity' (high volume for export) and 'premium' (lower volume for domestic consumption) species.

The database was developed in Excel in order to facilitate modifications and improvements, and a summary of the excel spreadsheet is now available for circulation (as a pdf document) on request from the Principle Investigator; indeed it has already been used for aligned projects.

A number of case studies for this particular project were selected based on information from the database and on meeting certain parameters under a value chain analysis framework that had been developed in a previous project undertaken with the prawn industry (CRC 2007.793.10). In order to be undertaken, case studies required whole of chain industry commitment to the project with a proposed path to market. In a couple of instances, case studies were commenced but were then stopped when whole of chain (generally producer and/or the processor) commitment was withdrawn.

The first case study involved Australian Salmon and a range of products, including value-added ones such as canned, smoked, fish in oil and premium pet food products were developed and market tested. However, although opportunities and small-scale markets were identified, the growth of the sector is hindered by the inability of the fishers at present to produce large volumes of high quality product. New management and harvest strategies are in development in order to address this issue.

The Pilbara finfish trawl case study, despite planned automatic processing options being cancelled due to commercial issues, resulted in a number of former underutilised species such as Bluespotted Emperor, Frypan Bream and Tropical Snappers (*Lutjanus* spp) achieving improved market status.

The third case study used Saddletail Snapper and the use of a technological innovation involving the injection with a plant based processing enzyme (bromelain) into the fish which improved product texture consistency. As such, the market and product options for the product have thus been increased.

Another case study looked at new options for Champagne Crab, which is characterised by low market acceptance due to low meat yields and the difficulty in extraction, and difficulty in handling due to the spines. The study involved high pressure pasteurisation (HPP) trials. HPP technology was also tested on a further 16 seafood products and new opportunities associated with meat extraction, shucking and extended shelf-life are currently still under investigation. One new product – HPP cooked crab meat with extended shelf-life - was taken to market and was a Finalist in the 2017 WA Delicious awards.

Although the New Opportunities for Underutilised Species project resulted in several new products becoming available commercially and a number of others undergoing market trials, it also identified a number of challenges when working with underutilised species:

- The need to develop consistent, quality supply to take advantage of the identified potential market opportunities. In many cases, even when possible opportunity is identified, fishers are reluctant to take the labour and other resource risks for a species which traditionally has not provided them with consistent, profitable return. This was

clear with the Australian Salmon example were opportunities were identified but the fishers are yet to be convinced of an appropriate return for effort. Therefore, a substantial, continuing business case must be provided to gain fisher uptake.

- A convincing business case is more likely to be developed when there is whole of chain commitment (fishers, processors and markets) to the research process. In accordance with the methods used in this project, it is suggested that such commitment should be mandatory before and during any project in order to give the new product the chance of successful commercial implementation. Given that some supply of infrastructure or change in management arrangements may be necessary to facilitate successful product development outcomes, this is more likely to be achieved when all the supply chain is involved, without the likelihood of a commercially valid outcome is decreased. One way to achieve this might be to add a member of the commercial entity as a principle or co-investigator on the project.
- Research of this nature is also sometimes compromised by the volatile and changeable nature of the commercial fishing industry. For example in the Pilbara trawl project, research directions had to be amended due to commercial challenges: including a temporal change in the dominant catch of the fishery, resulting in a change to the target species. Another example was in the case of the leatherjacket and Great Australian Bight (GAB) case studies where initial industry interest was lost and therefore the research was stalled. As such it is key that research planning and program development is flexible enough to adjust, if required.
- There is also a need for patience in the research process as timelines can be lengthy: there is often time needed for new technology and/or product development and/or further down the track the adoption by industry stakeholders can take time. In addition a lack of time to focus on research is typical of many seafood businesses. For example, the HPP trials conducted in 2016 attracted interest but, despite dissemination of results immediately after the trials; interest to undertake further trials was sometimes not communicated back to the researcher until 6-9 months later. It is therefore important that research timelines are flexible and adjustable, or stop/go points inserted to manage such issues.
- Technological trials for new product development must be targeted at specific products and be end-user and market-driven. For example, the bromelain injection techniques were developed specifically for Saddletail Snapper; the HPP shelf-life trials were immediately relevant to extending shelf –life in crab meat; and the fish in oil product worked particularly well for Australian salmon, due to the sensory nature of the species. It is therefore strongly recommended that each underutilised species must be researched individually with application of unique technological solutions for relevant market-ready options. Such product specific technological investigations make excellent student projects and this was apparent in this study as six aligned post-graduate research projects were completed.

This project has also identified the opportunity for leverage of available research funding if commercial companies are brought in as project partners: extra funding was accessed in both the Australian Salmon and Saddletail Snapper projects, and a school education campaign focussing on underutilised species was developed with Western Australian Fishing Industry Council (WAFIC) funding. Such leverage and attention to alternative funding sources, reduces the impost on Fisheries Research & Development Corporation (FRDC) as the traditional funding source for such research.

The project succeeded in identifying and collating a range of opportunities for underutilised species in the Australian commercial fishing industry. It also demonstrated that it is possible to work with commercial partners to realise commercially relevant outcomes from these species. It is therefore recommended that the best approach for the Australian Seafood industry to generate opportunities from underutilised species is to use the database and value chain and product development methodology as much as possible but with modifications, if required. However it is also important to note the challenges of such research, including ensuring whole of value chain commitment, flexibility around commercial volatility and patience and awareness of these issues should always be considered in any further project development. Equally, it is key to ensure technological new product innovations are end-user and market-driven and specifically targeted to each particular underutilised species case study.

1. Introduction

It has been estimated that approximately 25,000 tonnes of finfish is not harvested in Australia each year, even though there are operators licensed to do so. This is because of a variety of reasons dependent on species, for example:

- Leatherjacket have a low market value;
- Boarfish are difficult to process;
- Australian Sardines and Australian Salmon are very fragile and require an exacting supply chain to reach the market in satisfactory condition (or are harvested from remote areas with inadequate support infrastructure).

In addition, although there is tonnage of finfish such as sardines, mackerel, silver warehouse and bonito tuna harvested it is directed to low value products such as pet food, bait and aquaculture feed. Plus there are other issues such as there are areas (e.g. Western Deep Trawl) where little is known about the fishery resource and potential for commercialisation and there are also finfish discarded after being caught due to low market value or insufficient space for storage.

However, each of these underutilised species potentially could be used to produce high quality, fresh and processed products that could help meet the increasing demand for seafood. This, coupled with an emerging industry interest around underutilised species, meant developing new opportunities in this research area was identified initially as a priority area for the Centre of Excellence for Science, Seafood and Health (CESSH) Seafood CRC legacy project (CRC 2013/711), and hence developed as a sub-project FRDC 2013/711.30: New Opportunities for Underutilised species.

2. Objectives

The objectives of this research were to:

- Develop at least two new commercial opportunities for underutilized/low value species;
- Develop and trial a framework for taking underutilised species to market;
- Develop an Australian underutilised species database.

3. Methods

3.1 Development of an Underutilised Species Database and Framework to take Underutilised Species to Market

Database

At the commencement of the project an underutilised species Excel database was developed. The database was intended to describe the species, fishery, catch method, total allowable catch, actual catch and pricing as appropriate to allow the informed selection of possible case studies to be included in the project. The criteria for inclusion in the database for underutilised species was related to the harvest levels when compared to the commercially relevant tonnage able to be caught and retained, and current market value (<6/kg for whole fish).

The database was originally developed to focus solely on Western Australia fisheries but it was later broadened to all Australia as it was anticipated it would be a useful tool for all states, even after the current project was finished.

The generic methodology to build the database was as shown below:

- Species in each fishery in the relevant state or Commonwealth fishery management reporting tool/format were scanned and information from the Status of Australian Fish Stocks (SAFS) reports was also included at this stage;
- The catch method, total allowable catch and actual catch for the previous three years (generally 2012-2014) was recorded. If the average catch figures were <50% of the total allowable catch, then the species were added to the database.
- Pricing information was sought and species remained on the database if the retail price was <\$4-\$6/kg.
- Expert marketing opinion (John Susman (Fishtales) and Gus Dannoon (Sydney Fish Market) on the species on the database was sought.
- Underutilised species case studies were selected, with further work dependent on whole of chain commitment as per the value chain framework approach modified for this project (see Section 4.1).
- Once a case study had been selected, further information was sought in relation to harvest opportunities/challenges, processing opportunities/challenges and marketing opportunities/challenges.

The database was set up as an Excel spreadsheet, with the ability to be transformed into other formats.

Framework

A value chain analysis framework to develop improvement projects for seafood value chains had been developed in a previous project focusing on four prawn fisheries (CRC 2008.793/10) (Howieson *et al.*, 2016, Johns *et al.*, 2016). This framework was modified and tested in this project. The modified framework is described in Section 4.1.

3.2 Industry Consultation, Identification of Potential Opportunities and Committed Industry Partners

In November 2013, 24 Western Australian seafood industry stakeholders participated in a 'Group Explorer' consultation session. The workshop was facilitated by Prof Fran Ackermann, Director of Research, Curtin Business School and used an innovative consultative process which enabled all who participated to contribute their views via networked laptops. All participants' issues and opportunities were then anonymously displayed on a main screen allowing them to be viewed, developed, and finalised. The workshop also provided the opportunity for the stakeholders to indicate, anonymously, what level of support they were prepared to offer priority projects once these were identified: the options being 'none', 'in kind' or 'cash'.

The attendees were:

- John Sharland (Endeavour Foods);
- David Carter (Austral Fisheries);
- Steven Hood (MG Kailis);
- Simon Little (Westmore Seafoods);

- Peter Jecks (Abacus Fisheries);
- Charles Francina and Daniel McCorey (Fish Trade);
- Drew Martin (Sealanes);
- Toby Abbott (Kailis Bros);
- Paul Catalano (Catalanos Seafoods).

Apologies and request for updates were received from Richard Buczak (Central Seafoods), Arno Verboon (Fremantle Octopus) and David Thompson (Indian Ocean Lobster).

Figure 1: November 2013 ‘Group Explorer’ session to identify priorities



The results of this consultation was used in part to select initial case studies for the underutilised species project. Other initial case studies were as the result of direct enquiries by the Western Australian industry.

Further case studies were added as the project progressed, aligned with further industry consultation and extension mechanisms, as well as requests from individual industry stakeholders. However, these underutilised species case studies were only added if they fitted the modified value chain framework described in the results section.

This workshop format was repeated in October 2015, specifically for the Pilbara finfish trawl stakeholders (see Section 4.3) and again in October 2016 (see Figure 2) to review the results of the project and set new priorities for further research effort.

Figure 2: October 2016 Group Explorer session to review research results and identify new priorities



3.3 Laboratory and Pilot Scale Trials

If an identified underutilised species opportunity was selected as a case study, a series of generic protocols were instigated, with specific experimental protocols attributed to specific products. These generic protocols are described below. For the majority of case studies, a detailed experimental report was prepared for the industry partner or sector group. These individual product reports are presented as Appendices to this report.

The generic methods are described in the sections below.

3.3.1 Sample Sourcing, Handling and Storage

If the underutilised species product were sourced by the relevant industry partner from their commercial operations, packed in tubs, chilled and/or frozen and then transported to either a local processor or direct to Curtin University.

3.3.2 Processes for New Product Development

Filleting and other body parts recoveries

Filleting recoveries were analysed following filleting by a professional filleter. An average of five fish were filleted and weights of skin, head, fillets and other body parts were calculated.

Vacuum and skin packing

Vacuum and skin packing was completed at the commercial processing facilities.

Freezing

According to the experimental protocols, samples were occasionally frozen, either in a domestic chest freezer, or a commercial blast freezer.

Drying

Drying trials were generally completed in ovens set at the relevant temperature. Samples were laid on baking paper. Dried samples were sometimes milled/ground.

High Pressure Pasteurisation (HPP)

High Pressure Pasteurisation trials were undertaken as described in Section 3.4.

Value-add Product Development

Value-add product development from the underutilised species was generally outsourced to product development experts, chefs or to commercial processing facilities. Recipes/protocols were then recorded, and any relevant sensory/microbiological or sensory assessments undertaken. These value-added processes included smoking and canning, and also product specific recipe formulation (eg burgers, fish cakes etc.).

3.3.3 Analyses

Compositional Analyses

Moisture Content

The Association of Official Analytical Chemists (AOAC) official method 950.46 (AOAC, 2008) in meat moisture content was used to analyse the moisture content of a sample. Approximately 10g of each sample was weighed accurately in previously dried and tared aluminium dishes and dried in the 105 °C air oven (Contherm digital series oven, Lower Hutt, New Zealand) until constant weight. Before the samples were reweighed and the moisture content measured by difference, they were cooled in a desiccator. The moisture content of each sample was determined by weight difference before and after the drying process.

Ash

The ash content determination was conducted based on the AOAC official method 938.08 (AOAC, 2005). Approximately 5g of each sample was accurately weighed into pre-dried and cooled crucibles. Samples were ashed at 550 °C in a Thermolyne muffle furnace, model 48000 Furnace (Thermo Fisher Scientific Inc, Iowa, USA) until constant weight was achieved (approximately 18 hours). The percentage of ash was calculated by the following equation:

$$\% \text{ Ash} = \frac{(\text{ashed weight} - \text{crucible weight})}{(\text{pre-ashed weight} - \text{crucible weight})} \times 100\%$$

Protein

The protein content was measured by using the Kjeldahl method according to the AOAC Official Method 955.04 (AOAC 2005). Approximately 1g of each ground sample was weighed and then put into digestion tubes containing 1 Kjeldahl catalyst tablet (contains 1g Na₂SO₄ and 0.01g selenium) and 2 or 3 glass beads to which the 8ml digestion acid (100 parts conc H₂SO₄ and 5 parts conc H₃PO₄) and 4ml of 35% hydrogen peroxide was added. The sample was then digested in a Tecator 2020 Digester (Högånas, Sweden) at 420 °C until a clear straw colour was reached. Fifty millilitres of 40% sodium hydroxide was added then added into the digest and steam distilled in a Kjeltect System 1002 distilling unit (Foss Tecator, Högånas, Sweden). The distillate was captured in a flask containing 25ml of boric acid as an indicator (80g of boric acid, 20ml of bromocresol green solution and 14ml of methyl red solution and diluted to 2l with deionised water). The distillate was titration against 0.1 M hydrochloric acid. One gram of sucrose was used as a blank. The percentage of protein in the samples was calculated using the following equation:

$$\% \text{ protein} = \frac{(\text{sample titre ml} - \text{blank titre ml}) \times 0.1 \text{ M HCL} \times 14.1 \times f \times 100\%}{(\text{mg sample})}$$

The conversion factor (f) was 6.25, which is the general factor used for meat and fish products.

When specific amino acid species composition was required, samples were despatched to commercial laboratories (usually National Measurement Institute (NMI)) for amino acid breakdown.

Fat

The method for crude fat determination followed the AOAC official method 960.39 for meat (AOAC 2005). Approximately 1.5g dried sample was ground, weighed and put into a thimble recorded as Weight 1. An extraction cup, which is a specific glass beaker in which the fat will collect containing a glass bead, was weighed and recorded as Weight 2. The fat was extracted in a Soxhlet Buchi fat extraction unit (Model E-816, Buchi Labortechnik AG, Flawil, Switzerland) over ten cycles or a one hour period, with petroleum ether (boiling point range 40 –60 °C) as the extraction solvent. After extraction, the extraction cup was dried in the 105 °C air oven (Contherm, digital series oven, Lower Hutt, New Zealand) until it reached a constant weight and it was then cooled in a desiccator. Crude fat was calculated as per the equation below:

$$\% \text{ crude fat} = \frac{(\text{Wt of extraction cup containing fat} - \text{Wt of empty cup}) \times 100\%}{(\text{Wt of thimble and sample} - \text{Wt of thimble})}$$

When specific components of the fat were required, samples were provided to NMI for Fatty Acid methyl Ester (FAME) analysis.

Oil quality as peroxide levels or free fatty acid measurements were conducted as required by NMI.

Heavy metal analyses when required were outsourced to a NATA accredited laboratory.

Microbiological Analyses

Where microbiological testing was relevant, duplicate samples were sent for analysis at a NATA accredited laboratory. Generally the samples were analysed for Total Plate Count (TPC) and for *E.coli* and *Listeria monocytogenes*. These were measured for compliance with the Food Standards Code.

Shelf-life testing, where required, was outsourced to a NATA accredited laboratory.

Sensory Analysis

If the new products were intended for human consumption, sensory analysis by trained or untrained panelists was carried out. Ethics approval was obtained from the Curtin Human Research Ethics Committee (HREC) and information and consent forms were provided to the participants.

Specific details, where relevant, of the sensory analyses undertaken are described in the appended individual case study reports, however, in most instances samples were assessed using acceptability rating scales for appearance, odour, texture, flavour and overall acceptability.

3.4 High Pressure Pasteurisation (HPP) Trials

A commercial Hyperbaric High Pressure (HPP) processing facility, operated by Fresh Produce Alliance (FPA), was installed at Manjimup in Western Australia in 2016 (Figure 3). Dr Howieson was introduced to the owners of the facility by the WA shellfish industry, who were interested in running some trials. Following consultation with FRDC and the WA industry, it was decided to trial some of the underutilised species in the HPP facility.

Figure 3: Hyperbaric HPP machine in Manjimup



3.4.1 Industry Consultation and Planning

To assess WA seafood industry interest in the HPP facility, the following email was sent from Dr Howieson to approximately >30 potential WA seafood industry partners (see below).

Dear

You may be aware that a new food processing facility has opened in Manjimup. The facility has a High pressure pasteurisation unit and nitrogen tunnel freezer, as well as associated automated packing, and aligned distribution logistics etc.

The facility was developed for horticulture products but the part owners, Jennie and Wayne Franceschi, are interested in potential “tolling” for other industries.

For myself, I cannot ignore the HPP opportunity for seafood, an example of which is that 2 of the 5 Prix d’elite prizes at Brussels this year were HPP products. HPP can be used in seafood for meat extraction with high recoveries (eg crabs, lobsters and other crustaceans), shucking for shellfish and extending shelf-life, changing texture, for many products, including finfish.

I met with Jennie recently about the opportunity to trial some seafood products at their facility. I said I would ask for interest from the seafood industry and if anyone wanted to try, then we could organise the following:

- a. Desktop research on the specific products of interest to work out optimal packaging, pressures, treatment times etc. This research both from the scientific literature etc but also in association with expertise offered by the HPP manufacturers Hyperbaric, and the new HPP specialist soon to be relocated to Manjimup from Mexico. This will give us a good idea of initial starting parameters for the test products.*
- b. Package test seafood and take to Manjimup with a seafood group for 3-4 days of concentrated trials. The trials would be through the machine and then into a test kitchen for sensory examination, recoveries and then if looking OK sending out samples for shelf-life testing. The cycle times for HPP are 10 minutes so we think we can achieve a lot in a few days with efficient pre-research. We need to do it this way as we need to isolate the seafood trials in the facility due to potential issues with allergens.*
- c. IF these HPP trials for any of the products show promise, and industry keen, then we can consider undertaking larger scale NPD, distribution and marketing activities.*

If interested industry partners can provide packaged products, organise their own accommodation and travel to Manjimup and fund initial shelf-life testing, then, to expediate the trials, I intend using my existing underutilised species and waste operational funding to support the other costs of these initial trials. It is probably noteworthy that I have been informed that the individual company costs would be eligible for the R and D tax concession.

Can you let me know if you are interested in taking part in this initiative, would hope to schedule the trials for before December 2016. .

Thanks

Janet.

Dr Janet Howieson

Senior Research Fellow | Centre of Excellence Science Seafood & Health

From this expression of interest, a range of partners and products were selected to take part in the trial. A detailed literature review was undertaken on the various target products to be tested. This review enabled experimental planning around the various pressures and times to be tested and the appropriate packaging. Subsequently Dr Howieson and Fresh Producer Alliance (FPA) staff developed an experimental schedule based on the products, the intended outcomes and the literature. Advice was also sought from Hyperbaric staff. The trials was scheduled for 6-8 December 2016.

3.4.2 HPP Trials and Workshop

An experimental plan was developed in conjunction with the literature review, industry and FPA staff (see Table 1 below). A total of at least 12 cycles of HPP were to be performed. Seawater (as close to their natural environment as possible) rather than fresh water was recommended for products undergoing HPP in liquid.

Table 1: Experimental processing plans

Species	Proposed outcome	Final product packaging		HPP					Analyses if sensory quality is acceptable
				Pressure (Mpa)			Time (min)		
Akoya Oyster	Shucking and extended shelf-life in fresh and frozen product	Whole shell vac packed	Sealed bag with sea water	250	300	350		2	Shucking effectiveness, yield, Total Plate Count (TPC) and sensory at designated days
Blue Mussels (<i>Mytilus edulis</i>)	Shucking and extended chilled shelf-life	Whole shell vac packed	Sealed bag with sea water	250	300	350		2	Shucking effectiveness, yield, TPC and sensory at designated days
Whole raw frozen prawns	Extract meat	Sealed bag with sea water		250	300	350		2	Yield, sensory
Whole cooked frozen prawns	Extract meat	Sealed bag with sea water		250	300	350		2	Yield, sensory
Whole raw frozen deep sea bugs	Extract meat	Sealed bag with sea water		250	300	350		2	Yield, sensory
Whole raw Champagne Crabs	Extract meat	Sealed containers with sea water		250	300	350		2	Yield (hand-picked), sensory
Whole cooked Blue Swimmer Crabs	Extended chilled shelf-life	Points filed and vac packed			500	600		2	Shelf-life, sensory
Blue Swimmer Crab meat (<i>Portunus armatus</i>)	Extended chilled shelf-life	Cooked extracted meat in vac pack tray		250	300	350		2, 5, 8, 10	Colour, texture, TPC and sensory at designated days
Bluespotted Emperor raw fillets (<i>Lethrinus sp</i>)	Extended chilled shelf-life	Raw fillets in vac pack		200	350	500		2	Colour, texture TPC and sensory at designated days
Cooked barramundi, painted sweetlips and Atlantic salmon	Extended chilled shelf-life	Cooked fillets in vac pack				600		6	Colour, sensory, shelf-life
Raw and steamed octopus (<i>Octopus tetricus</i>)	Tenderising and extended chilled and frozen shelf-life of packed raw and steamed product	Vac packed raw and steamed product		200	350	500	2	5	TPC and sensory at designated days. Texture analyser?
Abalone (frozen)	Extended chilled shelf-life of packaged abalone.	Vac packed raw product		200	350	500	2	5	TPC and sensory at designated days.

3.4.3 Analyses

Sensory and Quality Assessment

Two seafood chefs with a lot of experience in product development were appointed to cook and help assess all the products against the untreated controls. Sensory assessment was informal and included colour, texture, flavour and appearance. Due to the literature stating that quality changes can occur up to 24 hours after HPP, the product was sometimes tested at 4 hours and then again at 24 hours after HPP.

Microbiological

Where relevant, samples were assessed at a National Australian Testing Authority (NATA) accredited laboratory for total plate count (TPC) and other specific pathogens depending on the Food Standards Australia and New Zealand (FSANZ) requirement for the product being tested.

Yields and Extraction

Shucking efficiency following HPP was compared with the control. Yields of extracted meat from both treated and untreated samples were calculated by weight as appropriate.

3.5 Commercial Trials and Launch on Markets

Following the laboratory based pilot trials for each of the underutilised species, where appropriate commercial trials were instigated and the results collated. Often, analyses from the smaller scale pilot trials were repeated following commercial trials. The results of the commercial trials are also summarised in the aligned case study appendix.

3.6 Reporting and Extension

Relevant reporting and extension activities were undertaken.

4. Results and Discussion

4.1 Development of Underutilised Species Database and Framework

The initial aim of the project was to identify in the database a range of underutilised species in WA whether licensed but not harvested to agree sustainable levels or not currently managed and/or licensed. Thereafter it was proposed that select case studies would then be further assessed each under harvest, processing and marketing challenges/opportunities before undertaking further research.

However, within the first twelve months it was decided to widen the database from WA only fisheries to a broader group of Australian fisheries. This decision to broaden the scope of the database to all Australia was so that other research groups could potentially use the database later for state specific activities.

The database, available as an excel spreadsheet on request from the Principal Investigator, was developed following collation of data from the relevant Fisheries management authorities, websites and publications, and in consultation with producers and down chain stakeholders. The criteria for inclusion in the database for underutilised species was related to the commercially relevant tonnage able to be caught and retained, and current market value (<\$6/kg for whole fish).

The national underutilised species database developed as part of this project now lists 107 species. Following review by two market experts (John Susman and Gus Danoon), the database list was further divided into 43 higher priority species, which were divided into 'commodity' products (high volume/low value) for the export market and 'premium' products at lower volumes that could be sought by the local market.

The database has subsequently been used to inform another underutilised species project being undertaken in New South Wales (NSW) with Ewan Colquhoun as the Principal Investigator (Dr Howieson is also part of the project team). This project is called FRDC 2016-224: Boosting fisher returns through smart value adding and greater use of underutilised species. Mr Colquhoun has also developed an alternative format to the original database.

Access to the database is also being requested by other FRDC Research Advisory Committees (RAC) (for example the South Australian RAC has requested access) for some other emerging initiatives associated with underutilised species. A summary pdf document is also available as Appendix 1 on request from the Principal Investigator.

Although the database has been useful in defining potential target species for case studies, a further requirement for case study selection was whole of chain commitment (producers, distributors/retailers, processors etc.) to develop the underutilised species opportunity. This requirement formed part of the modified value chain framework that was developed within the project for identifying new opportunities for underutilised species. This framework steps are described below:

- Selection of potential underutilised species case studies based on a national database development and scoping.
- Further detailed analysis of target species under harvest/management challenges, processing challenges, marketing challenges.
- Demonstration of whole of chain commitment for target species.
- Implement revised value chain analysis (VCA) methodology (Howieson, Hastings, Lawley, 2015 – currently in preparation) comprising the following steps:
 - Engage the chain.
 - Understand the market.
 - Map the Chain.
 - Identify improvement projects (usually associated with new/improved product development or revised marketing strategies)
 - Chain stakeholder meeting to prioritise improvement projects and commitment to invest.
 - Implement selected improvement project (new/improved product or marketing strategy).
 - Evaluate market success.

4.2 Industry Consultation and Development of Potential Opportunities and Defined Industry Partners

The first 'Group Explorer' workshop was held in November 2015.

The workshop identified possible underutilised species in WA to be selected as case studies for the project.

Hence the initial case studies, associated with the database and the Group Explorer session, with industry partners listed, were:

- Australian Salmon (South West and South Coast license holders, Catalan Seafoods, Focus Fisheries, Central Seafoods);

- Underutilised Pilbara trawl finfish (MG Kailis, Westmore Seafoods, Central Seafoods, Catalanos Seafoods, Endeavour Foods).

As the project progressed, through direct contact by industry with the Principal Investigator, Dr Howieson, new case studies were identified. These case studies included:

- Champagne Crabs (West Coast deep sea licence holders, Southern Trading Pty Ltd);
- Saddletail Snapper and other snapper species which have marketing challenges/limitations due to a tough texture (Australia Bay Seafoods, Catalanos Seafoods);
- Leatherjacket development research was requested by Esperance and Albany fishers, however, there was little commitment to providing sufficient volumes of samples for analysis so this work was forced to cease;
- Western Deepwater species were investigated (identified and photographed) following a request from Westmore Fisheries in 2015. However exploratory fishing in the area was ceased and therefore no more work was completed. It is noteworthy that exploratory fishing will re-commence in the Western deep water trawl zone in December 2017 and assistance has been requested for the post-harvest analyses of the harvested species;
- Great Australian Bight (GAB) species (Catalanos Seafoods, Raptis). Catalanos Seafoods executive requested some work on some of the GAB species following an approach to them from Raptis Fisheries in South Australia. A scoping of the GAB catch was completed and 5 species selected to be part of an initial study based on parameters described under the project framework however, this work was ceased as whole of chain commitment to the project (including by Raptis), could not be sustained;
- Cockles from Shark Bay. This product has some market issues due to grit in the cockle flesh. A Masters student supervised by Dr Howieson commenced work on this issue in mid-2017, with a report due by the end of 2017.

It is noteworthy that the Principal Investigator continues to receive enquiries about potential new underutilised species case studies from the Australian seafood industry.

4.3. Laboratory and Pilot Scale Trials to Benchmark Opportunities

4.3.1 Australian Salmon

Australian Salmon was suggested as a case study following completion of preliminary work on consumer acceptability and quality conducted at Curtin University and the WA Chemistry Centre as part of CRC 2004.794.10, as well as a market development strategy project conducted by University of the Sunshine Coast marketing students under the guidance of Professor Meredith Lawley and Dr Janet Howieson.

Dr Howieson presented the findings of the marketing strategy project to the Annual Management Meeting of the Australian Salmon license holders in November 2013 and as a result of this, an industry group was formed and the Australian Salmon research commenced.

Appendix 2 describes in detail the Australian Salmon research that was undertaken throughout the project. This appendix also provides full data and discussion of the summary presented below. The

summary of the research results is separated into activity undertaken on Australian Salmon whole fish and fillets, and activity undertaken on value-added product development.

Australian Salmon whole fish and processed product trials.

Frozen quality trials

A series of laboratory based trials were conducted to assess the optimal way to produce and freeze Australian Salmon fillets. Frozen shelf-life testing was also conducted. The results showed that frozen Australian Salmon is robust and that fillets of acceptable quality can be created from the thawing of frozen whole or headed and gutted fish. Frozen fillets were also acceptable.

Harvest, market and retail trials with Australian Salmon whole fish, headed and gutted fish, fillet, loin and cutlet products.

In 2014, 1.4 tonnes of Australian Salmon was ‘best practice’ harvested using a stunner, bleeding and immediate immersion in an ice slurry. Frozen fillet, headed and gutted and whole fish samples were frozen following rapid processing. Samples were then despatched by industry stakeholders to a variety of domestic and international markets (Thailand, China, South Korea). However unfavourable feedback was received associated with fillet colour, size of the fish, taste and cost, and, as a result, follow on orders were not received. It is noteworthy however that some of these markets subsequently requested follow up samples in 2015 following a change in the value of the Australian dollar.

In terms of the domestic market, a number of project partners were trialling retail sales of the fresh or frozen Australian Salmon fish and fillets etc. throughout the duration of the project (2014-2017). These various activities are summarised below:

Selim Processors

The Miles family have a steady number of customers buying Australian Salmon in their shop near Dunsborough. Seasonal fresh fillets and whole fish are sold, and frozen fillets during the rest of the year. During the season fresh fish are supplied to the Clancy’s Fish Pub in Dunsborough.

Central Seafoods

Richard Buczak from Central Seafoods produced packaging for a range of Australian Salmon products in 2015 (see Figure 4) but his business was sold before sales were fully developed.

Figure 4: Central Seafoods packaging for Australian Salmon product



Parrys Beach Producers

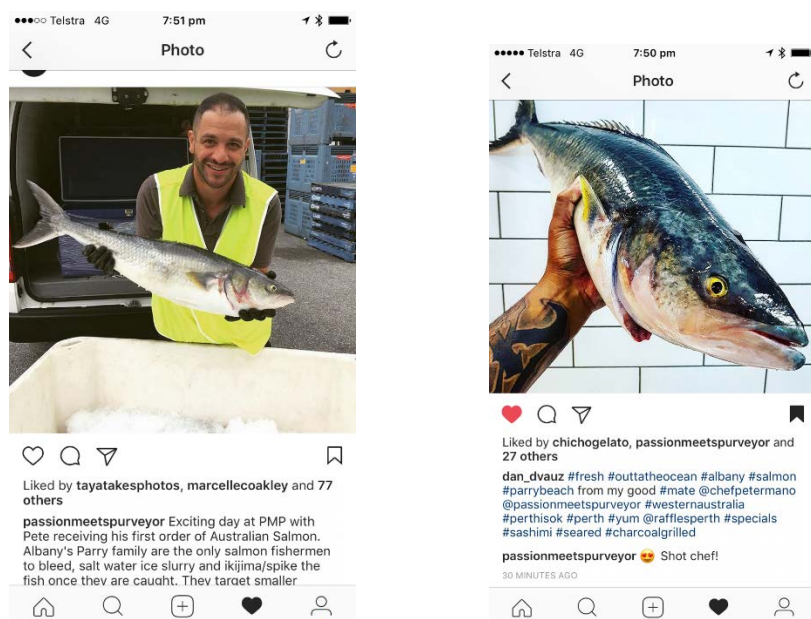
Parrys Beach Producers commenced sales of fresh whole fish product in their local area, Denmark and Albany, in 2015. The fish for sale were spiced, bled and iced immediately on reaching the beach. Sales

were assisted by a social media (Facebook) presence. These sales were continued in 2016 and 2017 with increasing support from local chefs and consumers. In 2017, whole fish were sold for \$15 each and some of the fish were also filleted and sold in vacuum packed format (\$20/kg). Dr Howieson is now working with the Parrys Beach Producers on a funding submission to implement a 3-5 year business plan to further increase sales.

Passion meets Purveyor

In 2017, a well-known local seafood chef, Pete Manifis, commenced selling fresh Australian Salmon from Parrys Beach to metropolitan chefs through his company, Passion meets Purveyor. The fish is best practice harvested and stored, and is received in Perth within 24 hours of harvest. The fish were sold to a variety number of Perth chefs and the product was well received with considerable social media interest on Facebook (see Figure 5).

Figure 5: Facebook photos from Australian Salmon sales by Pete Manifis



Mr Manifis also used Australian Salmon, produced under the optimal conditions defined by the research trials undertaken, in a number of high profile social events, including serving smoked salmon on a private flight from Perth to Broome for the Broome Gourmet Adventure and at a major wedding.

Australian Salmon Value-added product development

Several value-add products were also produced. The research summaries are shown below with the detailed experimental results and preliminary costings reported in Appendix 2.

Canned Australian Salmon was produced in Thailand in 12 different flavours (Figure 6). These products were subject to sensory and microbiological assessment at Curtin University with all results being favourable and two flavours in particular rating very highly with consumers.

Figure 6: Canned Australian Salmon provided for assessment.



Focus Fisheries subsequently produced a comprehensive market report, and summary and recommendations in developing the Australian Salmon market for various products including canning.

A range of hot smoked Australian Salmon products was also developed by three different smoking professionals (see Figure 7 for one example). Consumer reaction was very favourable and shelf-life testing completed and subsequently, initial pricing was developed.

Figure 7: Smoked Australian Salmon produced by chef Dale Sniffen.



A larger fish cake/burger and smaller Thai fish cake were developed by professional chefs with preliminary pricing agreed. A larger fish cake (Figure 8) was subsequently produced in a commercial facility and priced accordingly.

Figure 8: Fish burger produced by chef Dale Sniffen



Salmon in oil

Jim Mendolia (Mendolia Seafoods) produced a cooked Australian Salmon in oil product (see Figure 9). Preliminary shelf-life testing trials were undertaken. The product will be launched in 2017. Both a retail (200g) and food service (5kg) format will be produced.

Figure 9: Design format for fish in oil (and canned) product produced by Jim Mendolia



Following an approach from a pet food producer, Saviour Life, research was undertaken to develop a premium dried dog treat product. This was produced in laboratory scale using Australian Salmon and tested with some dogs. The results indicated dogs 'loved it' and therefore preliminary production costs were developed based on the cost of the fish, the processing costs and the weight loss from the drying. An 'expression of interest' email was subsequently sent to all the Australian Salmon producers and processors on behalf of the pet producer by Dr Howieson. However, the feedback from several of the producers and processors was that the quoted price of \$12-\$20/kg for delivery of the packaged, dried product could not be achieved economically.

Future potential directions for the Western Australian Salmon industry sub-project

During the market development/value add investigations it became clear that to meet potential markets would require a new management/harvest strategy model to ensure consistent supply of sufficient volumes of a high quality Australian Salmon product to meet market demand/expectations. Following a meeting with license holders to present all research results in November 2014, it was agreed that there was a need to seek additional funding to enable consultation to try to develop such a new model.

Ewan Colquhoun (Ridge Partners) developed a Terms of Reference for the consultation exercise, entitled 'Future Directions for the West Australian Salmon Industry'. Funding was committed from WAFIC (\$10,000), South West Development Commission (SWDC) (\$5,000), Great Southern Development Commission (GSDC) (\$5,000), Curtin University (\$2,500) with the license holders and processors contributing approximately \$2,500. Mr Colquhoun then undertook individual consultation with all license holders and produced a report and recommendations (see Appendix 3).

These recommendations were endorsed at an industry meeting in June 2015 and as a result, an industry committee was formed and a submission to the then Department of Fisheries (now Department of Primary Industry and Regional Development (DPIRD)) to change management/harvest arrangements was prepared and submitted in October 2016. However some fisheries management and industry issues arose subsequent to this and progress was stalled. This initiative and an industry committee is now being supported by the formation of the Southern Seafood Producers Western Australia (SSPWA), the association recommendations included action on Australian Salmon harvest, management and market development activities.

In 2018 Mendolias Seafoods placed orders for sufficient and quality volume to be transformed in the new facility, with aligned new value-added Australian Salmon products now on the market.

Discussion

The Australian Salmon research undertaken as part of this project has demonstrated that a range of fresh then frozen and value-added Australian Salmon products can be produced. These products have been

demonstrated to have consumer and market appeal and a number of major seafood suppliers, processors and exporters have indicated an interest in commercialising the products.

However an ongoing issue is developing consistent, supply of quality fish to meet such markets. For example, Pete Manifis of Passion Meets Purveyor, generated significant chef interest in March 2017, but was then unable to fill orders for the following week as quality supply of fish was not available and likewise, Jim Mendolia has significant market interest for his oil product but again needs to source quality, consistent supply.

It would therefore appear that collaborative effort is required as there is a short harvest season. In addition, alternative harvest strategies may need to be investigated to extend the season and ensure higher volumes of quality product are harvested. This would require enhanced regional infrastructure, in particular increased quality freezing capacity, as the Australian Salmon season coincides with the sardine season and the higher value sardines are prioritised for freezing.

Many of these issues and a series of potential solutions were discussed and as an outcome of the aligned “Future Directions for the West Australian Salmon Industry” project, the industry committee are working with WAFIC and DPIRD to implement some of the recommendations.

An ABC TV Landline feature on Australian Salmon in Western Australia on 7 May 2017, resulted in several other ABC Radio interviews and media articles (see Section 6). The articles were translated and circulated and a large number of enquiries was received from China and other parts of Asia. WAFIC are managing the enquiries.

With the research that has been undertaken, fishers and processors (perhaps in association with the Southern Seafood Producers Association) now have the opportunity to take this forward.

4.3.2 Pilbara Trawl

The second major case study for the project followed on from an approach by MG Kailis and Westmore Seafoods about how to add value to some of the high volume, low value species harvested in the Pilbara finfish trawl. It is currently often not economically viable to retain this catch.

The detailed results of this case study are available as Appendix 4 on request from the Principal Investigator, and the results are summarised below:

- Catch data was collected for 2011-2014 and all harvested species analysed as per the value chain methods described in Section 3. Based on catch volume and current market prices as well as consultation with processors and end-users, a list of possible target species was developed. These species were Rosy Threadfin Bream, Bluespotted Emperor, Trevally (smaller size), Robinson’s Seabream, Frypan Bream and Tropical Snappers (*Lutjanus* spp).
- A whole of chain Group Explorer Pilbara finfish stakeholder meeting (see Figure 10 below), was facilitated by Professor Fran Ackermann, Curtin Business School. This group determined the target species, the ongoing research plan as well as the roles and responsibilities of both industry and Curtin University and timelines.

Figure 10: Group Explorer session for Pilbara finfish trawl case study



- A key outcome of the Group Explorer session was that the main focus would be on cost effective production and retail trial of filleted and headed and gutted product. As such the ongoing research plan was to focus on understanding the relative recoveries, costs and quality of product produced by local production (hand filleting), off shore production or by filleting machine. Initial work was completed with local processors and import and export permits for the target species were applied for and granted.
- The agreed next stage was to investigate different product forms produced under the different processing scenarios. Frozen whole fish from five agreed underutilised species were to be despatched for off-shore processing trials. Comparative quality trials were to be undertaken between the locally processed fish and the local frozen fillet product from off-shore processing, once fillets were returned to Australia. Depending on the quality of fish produced, retail trails, including the development of marketing material, were to commence with each of the Group Explorer participants having agreed roles and responsibilities. Cost benefit and economic analyses were to occur concurrently.
- However the off-shore filleting trials had to be cancelled due to some quality assurance issues with the off-shore facility therefore instead, local operators embarked on a filleting and marketing trials with bluespotted emperor in particular. Fillets of bluespotted emperor are now selling for \$28-\$30/kg and the fish is gaining support in retail and food service.

4.3.3 Saddletail Snapper

Saddletail Snapper fillets sometimes exhibit an inconsistent 'tough' texture upon cooking; this has had a detrimental impact on the marketability of the species (A. Forrest, Poole, Exley, Mayze, & Paulo, 2010), resulting in significant unharvested quota. Research has identified a positive correlation between the increasing age of the fish and increasing 'toughness' of the cooked fillet (A. Forrest et al., 2010; A. J. Forrest et al., 2014). However, despite this relationship, there is still substantial variability in the 'toughness' of fish of similar age (A. J. Forrest et al., 2014). This limits the commercial viability of using fish age as a predictor of cooked texture as it involves the costly and time-consuming exercise of aging the growth rings of the ear bones (*sagittae otoliths*) (A. Forrest, Poole, Exley, Mayze, & Paulo, 2012).

Other potential ways of identifying toughness (e.g. using near-infrared spectroscopy (NIRS)) have not been fully developed in a commercial context. However, preliminary trials indicated that dipping the product in proteolytic enzymes (bromelain) had the effect of reducing the tough texture (A. Forrest et al., 2012) and

following the publication of these findings, one of the industry partners (Australia Bay Seafoods), requested a case study be undertaken to further investigate enzyme addition (preferably by injection) as a means of standardising the texture of the Saddletail Snapper fillet product and improving consumer acceptance of the species. Detailed results of this case study are available in Appendix 5 and can be requested from the Principal Investigator.

In summary, preliminary laboratory trials investigating injection of bromelain showed promising sensory results for the management of textural toughness in Saddletail Snapper. Enzyme levels were optimised in the early experiments as was the sensory assessment methodology. It was then decided to conduct commercial trials based on the preliminary results.

A Vemag Formaco injector machine was purchased by the industry partners and installed at Catalanos Seafoods. Using support funding from Food Innovation Australia Ltd (FIAL), commercially valid injection parameters and protocols were optimised, to yield a consistently acceptable product. A Texture Grading Index (TGI) was developed, for industry use, and validated in sensory trials on cooked treated fillets. Sensory analysis revealed the injection process consistently produced improved textural qualities in all fish with no resulting excessive softening.

Two frozen product forms were developed, a retail pack and a food service pack. The final products were found to comply with the FSANZ Food Standards Code; the bromelain addition is classified as a processing aid as it is not detectable in the final product. Shelf-life testing of products from large scale commercial trials suggested a thawed shelf life of 6-8 days, similar to the current shelf life given to fresh fish fillet products.

As a result of the study an injection process has been developed which provides a consistent Saddletail Snapper product with improved textural properties. Large scale commercialisation has been achieved and Australia Bay Seafoods is currently developing marketing material and researching suitable markets for the products.

4.3.4 Champagne Crabs

Champagne Crab (*Hypothalassia acerba*) occur in the southern waters of Australia generally between 100 – 200 metres in water temperatures varying from 12-21 °C. Champagne Crab are distinguished by the numerous spines on the edges of the carapace (shell) and on the legs.

In terms of overseas markets, the main market for the crabs is China via live export. The crabs are sold in small quantities on the local market, either live or cooked and as a whole animal however they are undervalued because the meat is difficult to extract after cooking and the spines make the product difficult to handle. In addition, Champagne Crab are not as highly prized on the export markets as other deep sea crab species because of their smaller size, less favourable colour and handling issues. In terms of the domestic market, champagne crabs are not a species well known for eating and as such, are in little demand. Again this is mainly because it is too time-consuming to extract the meat after cooking.

The Principal Investigator, Dr Howieson, was approached in 2015 by a crab fisher, Neil Dorrington in regard to investigating some quality and value-adding aspects of Champagne Crab, with a view to developing new markets for the species.

The detailed results from the investigation are shown in Appendix 6. The results confirmed that the Champagne Crab has a very sweet flavour and texture and if cooked whole and then frozen, a very acceptable thawed product can be produced. However, there were a couple of issues identified such as although the hairs did not appear to cause tainting, there may be a risk for consumption if the meat is not extracted for use as a food ingredient prior to serving and if the crabs are frozen raw then later thawed and cooked this results in the flesh being very mushy.

In addition, the barriers to the product other than as a live product remain in that there are very low meat recovery yields and the difficulty in extraction due to the spines and the hardness of the shell.

The results overall were promising enough for the Champagne Crab to be included in the HPP trials as described in Section 4.4.5. In these trials, efficient raw meat extraction, with pleasing flavour characteristics was achieved, and ongoing work with the champagne crabs has been proposed by the industry partners.

4.4 High Pressure Pasteurisation (HPP) Trials

The HPP trials were conducted in Manjimup in December 2016 (Figures 11 and 12). Detailed results of the trials are presented in Appendix 7.

Figure 11: Industry stakeholders at the Manjimup HPP facility



Figure 12: Industry stakeholders and chefs assess HPP seafood products



During these trials, HPP treatment of 15 different seafood products (including finfish, octopus, mussels, akoya oysters, prawns (cooked and green), crab, abalone, squid, deep sea bugs, marron) was trialled and new knowledge gained. Pressure and time parameters were optimised and shucking, recovery, sensory and shelf-life data obtained. As a result of these trials, industry awareness, knowledge and interest of HPP as a processing option was increased.

A HPP chilled, packaged cooked crab meat product with extended shelf-life (see Figure 13) developed as a result of the trials was a finalist in the 2017 WA Delicious awards and will go into commercial production in 2018.

Figure 13: HPP premium crab meat packaging



Following consultation with the producers, the other products likely to be further investigated for market development include:

- cooked chilled finfish (extended shelf-life);
- marron (meat extraction);
- abalone (meat extraction and tenderising);
- akoya oysters (shucking);
- mussels (shucking and new mussel in sauce products with extended shelf-life);
- cooked prawns (cooked in a sauce product with extended shelf-life).

It is hoped that octopus and squid could be further investigated to tenderise and extend shelf-life in chilled products, however supply is an issue for these products at the time of writing.

Due to the success of the above trials, industry had requested a further series of HPP trials, however the HPP plant was closed in March 2018 and therefore further trials could not be conducted.

4.5 Commercial Trials and Launch on Markets

The commercial outcomes of the various case studies are outlined below:

- Research effort on Australian Salmon has resulted in a variety of products being market tested and low levels sales to retail and food service continue. However, production of consistent quality supply remains the major barrier to development. An Industry Development Group formed as part of this project is now working to resolve the supply issues. An ABC TV Landline feature on Australian Salmon in Western Australia on 7 May 2017 (including an interview with Dr Howieson), resulted in several other ABC Radio interviews and media articles. The articles were translated and circulated and a large number of enquiries was received from China and other parts of Asia. WAFIC and Austrade are managing the enquiries;

- Jim Mendolia has domestic and international interest in the Australian Salmon fish in oil product;
- Pilbara Trawl fish, in particular Bluespotted emperor, are now commonly available (fresh or fillet) in the retail market;
- Research (including support from FIAL) on Saddletail Snapper has resulted in new product formats being ready for launch on the retail and food service market;
- A range of 15 seafood products, many of them underutilised species, were part of a series of HPP trials at a commercial facility in Manjimup. One new HPP crab product was market trialled and was a Finalist in the 2017 WA Delicious Awards. Further HPP seafood trials on underutilised species which came up well in the trials were planned for 2017/2018 but could not proceed due to the closure of the HPP plant.
- New underutilised products already on the market are being further investigated for alternative formats to provide a better quality product (e.g. champagne crabs and cockles).

In summary therefore, several products are already in commercial production, and others are pending commercialisation based on preliminary market feedback and managing supply issues. It is anticipated that several other products are likely to be on the market in 2018.

4.6 Reporting and Extension

4.6.1 Extension Activities

Table 2 below summarises all the extension activities, interviews and publications etc. related to this project.

Table 2: Summary of extension activities and publications

Publication/Product	Detail	Status
Annual Management Meeting presentations	Update on CESSH Australian Salmon project	Albany, Nov 2014; June 2015.
Newspaper Article	Salmon catch decline put on Ice	Albany Advertiser: 24 Feb 2014
Magazine Article	Market makeover for Australian Salmon	FISH: January 2015
TV News Broadcast	Australian Salmon comment	GWN news: April 2014
Collaborative discussion	As part of an Australia China Agricultural Cooperation Agreement (ACACA) funded trip to China, lengthy discussions with Chinese processing companies and scientists in regard to underutilised species	Janet Howieson was a participant on ACACA information exchange: May 2015
Conference abstract	Seafood Directions 2015: 'If we keep doing what we have always done.... Value creation in minor fisheries'	October 2015
Conference abstract	Seafood Directions Perth 2015: 'Reaching our End User: Examples from the small seafood business world'	October 2015

Publication/Product	Detail	Status
Workshop	Science Teachers Association of WA: Sustainable Seafood	2015
Journal article	Sensory, microbiological and chemical changes in vacuum-packaged Bluespotted emperor (<i>Lethrinus</i> sp), Saddletail Snapper (<i>Lutjanus malabaricus</i>), crimson snapper (<i>Lutjanus erythropterus</i>), barramundi (<i>Lates calcarifer</i>) and Atlantic salmon (<i>Salmo salar</i>) fillets stored at 4 °C	Accepted for publication in Food Science and Nutrition
WAFIC School Education program focussing on underutilised species	Three curricula tasks available to all Home Economics Institute of Australia (HEIA) teachers Pilot in three schools (continuing) including presentations from fishers and chefs and hands-on cooking of underutilised species by students Poster and recipes focussing on WA underutilised species Underutilised species material/information available on WAFIC website	Ongoing 2017/18
Landline ABC TV program	Australian Salmon story	7 May 2017
ABC Radio Interview	Local seafood and /underutilised species	8 May 2017
ABC News on line article	Australian Salmon stocks are healthy but no-one's biting	6 May 2017
ABC News on line article	War on Waste: Australians ignoring cheap, sustainable fish over farmed and foreign varieties	11 May 2017
Research Theses	As per student projects outlined in Section 4.7.2	2014-2017
Database	National underutilised species database available for other projects and initiatives	2014-2017

4.6.2 Undergraduate and Post-Graduate Student Projects

Operational funding from this project was used to assist with the cost of consumables for underutilised species projects undertaken by a range of undergraduate and post-graduate students..

Dr Janet Howieson co-supervised these projects and details are shown below:

- Elinsa Gilead Massawe Ahmad (with Dr Ranil Coorey) (completed 2015): 'The effect of freeze thawing on fillets of Australian Salmon (*Arripius truttaceus*)';

- Duc Minh Nguyen (Masters Food Science and Technology) (with Dr Ranil Coorey) (completed 2016): 'Utilise lower value fish for fish snack production';
- Andrew Tilley (Honours) (with Associate Prof. Vicky Solah) (completed 2016): 'Understanding tough texture in Saddletail Snapper';
- Arnold Mbunda (Masters Food Science and Technology) (with Dr Ranil Coorey) (completed in 2016): 'Factors influencing histamine production in an Australian mackerel species (Australian sardines)';
- Sudeep Sasikumar (Masters Food Science and Technology) (with Dr Ranil Coorey) (ongoing 2017): 'Crumbing trials with underutilised WA species';
- Tom Nottage (Masters in Sustainable Aquaculture) (ongoing 2017): 'Understanding and improving grit issues in Shark Bay cockles'.

4.6.3 WAFIC School Education Project based on Underutilised Species

WAFIC contracted Dr Howieson to manage a project to work with the Home Economics Institute of Australia (HEIA) and the Prepare, Produce, Provide organisation to develop a school education program about the WA seafood industry. The focus of this program is underutilised species and it is currently being piloted in WA high schools.

Relevant outcomes to the project of the program are:

- A survey of 30 Home Economics teachers was initially undertaken to better understand the scope of the resource, content, preferred format(s) and any other points to help in planning. One important finding was that schools avoid class activities with fish due to the expense of the product;
- A poster of lower value species entitled 'Your guide to affordable local seafood' was developed and 500 copies printed and distributed to schools. This poster is also available on the WAFIC education page. It is noteworthy that a number of retailers have also expressed interest in displaying the poster in their shops (Figure 14).

Figure 14: poster produced as result of program



- Pete Manifis worked with the working group to design six recipes using lower value species suitable for classroom cooking. The recipes (as individual cards) will be available on the WAFIC education site with the aim that students will cook the recipes at school then take them to cook at home;
- A teacher resource which will be available on the WAFIC page for download by the teachers for use in their classes highlighting the seafood industry has been developed by the working group. This comprises four completed tasks/outcomes (2-3 weeks of activities) focusing on seafood for different courses (ATAR and vocational courses)/year groups;
- The seafood initiative was launched at a teachers' Professional Development day on 5 December 2016. Pete Manifis cooked one of the developed school recipes for lunch and the teachers were given a take home bag with a number of seafood resources. All the resources were on display and the underutilised species poster (Figures 15 above) was provided to the individual teachers for display in their classrooms and was very well received;
- The piloting of the resources at incursions occurred at seven schools in the first half of 2017. The pilots involved a short presentation by an industry person and experienced chefs cooking recipes they have developed using underutilized species with the students. These recipes were then formatted and added to the WAFIC education page. The results from these seven schools have been evaluated and improvements incorporated into the protocols and documentation.

5. Conclusions

The development of the underutilised species database in this study has demonstrated the supply opportunity as afforded by Australian seafood species currently not, or under-harvested. One hundred and seven different species opportunities were identified with 43 prioritised by industry experts. Opportunities are varied, including both for unprocessed or slightly processed fish or crustaceans, and also for the development of value-added products, using a variety of technologies. The results have shown that the database (Excel) format for identification and the case study methodology can be varied to research new product and market opportunities for underutilised species. Some new products have been or are close to being launched on the market, hence project milestones have been met.

However the study has also identified a number of challenges identified when working with creating opportunities for underutilised species:

- The need to develop consistent, quality supply to take advantage of the identified potential market opportunities. In many cases, even when possible opportunity is identified, fishers are reluctant to take the labour and other resource risks for a species which traditionally has not provided them with consistent, profitable return. This was clear with the Australian Salmon example where opportunities were identified but the fishers are yet to be convinced of an appropriate return for effort. Therefore, a substantial, continuing business case must be provided to gain fisher uptake.
- A convincing business case is more likely to be developed when there is whole of chain commitment (fishers, processors and markets) to the research process. In accordance with the methods used in this project such commitment should be mandatory in order to give the new product the chance of successful commercial implementation. Given that some supply of infrastructure or change in management arrangements may be necessary to facilitate successful product development outcomes, this is more likely to be achieved when all the supply chain is involved, without the likelihood of a commercially valid outcome is decreased.

- Research of this nature is also sometimes compromised by the volatile and changeable nature of the commercial fishing industry. For example in the Pilbara trawl project, research directions had to be amended due to commercial challenges: including problems with the off-shore processing facilities; and changed harvest conditions and/or the dominant species and this resulted in a change to the target species. Another example was in the case of the leatherjacket and Great Australian Bight (GAB) case studies where initial industry interest was lost and therefore the research was stalled. As such it is key that research planning and program development is flexible enough to adjust, if required.
- There is also a need for patience in the research process as timelines can be lengthy: there is often time needed for new technology and/or product development and/or further down the track the adoption by industry stakeholders can take time. In addition a lack of time to focus on research is typical of many seafood businesses. For example, the HPP trials conducted in 2016 attracted interest but for many operators, interest in another set of trials, whilst now apparent, was not communicated back to the researcher until 6-9 months later. It is therefore important that research timelines are flexible and adjustable, or stop/go points inserted to manage such issues.
- Technological trials for new product development must be targeted at specific products and be end-user and market-driven. For example, the bromelain injection techniques were developed specifically for Saddletail Snapper; the HPP shelf-life trials were immediately relevant to extending shelf –life in crab meat; and the fish in oil product worked particularly well for Australian salmon, due to the sensory nature of the species. It is therefore strongly recommended that each underutilised species must be researched individually with application of unique technological solutions for relevant market-ready options. Such product specific technological investigations make excellent post-graduate student projects and this was apparent in this study as six undergraduate research projects were completed.

This project has also identified the opportunity for leverage of research funding available if commercial companies are project partners. Extra funding was accessed in both the Australian Salmon and Saddletail Snapper projects, and a school education campaign focussing on underutilised species was developed with WAFIC funding. Such leverage and attention to alternative funding sources, reduces the impost on FRDC as the traditional funding source for such research.

6. Recommendations

The project has identified and collated a range of opportunities for underutilised species in the Australian commercial fishing industry. It has also demonstrated that it is possible to work with commercial partners to realise commercially viable outcomes from these species.

It is therefore recommended that the database and value chain and product development methodology should continue to be utilised as relevant, and with appropriate modification, for the Australian Seafood industry to generate opportunities for underutilised species.

However, the challenges of such research, including ensuring whole of value chain commitment, flexibility around commercial volatility and patience should be noted and included in any further project development. It is also important to ensure technological new product innovations are end-user/market driven and specifically targeted to each particular underutilised species case study.

Appendices

Appendix 1: Underutilised species database

Appendix 2: Australian Salmon (*Arripis Trutta*): Quality, Yield And Value-Added Product Considerations

Appendix 3: Options for Western Australia's commercial Australian Salmon Fishery

Appendix 4: Development of New Opportunities for Underutilised Finfish from the Pilbara Trawl

Appendix 5: Saddletail Snapper (*Lutjanus Malabaricus*) Texture Investigation: Opening New Markets with Enzyme Treatment

Appendix 6: Champagne Crabs (*Hypothalassia acerba*): Yield and Sensory Considerations

Appendix 7: High Pressure Pasteurisation Trials for Western Australian Seafood Product