

The Australian Barramundi Farming Industry

**Can Australian Barramundi be the white fish
equivalent to Salmon?**

A report for



By Dan Richards

2016 Nuffield Scholar

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Executive Summary

Aquaculture is the fastest growing global protein industry and in 2015, for the first time in history, more seafood was consumed from aquaculture sources than from wild caught industries. Global aquaculture industry production leaders, salmon and marine shrimp, have successfully stimulated demand to absorb their growing production (Rabobank, 2017).

The Barramundi (*Lates calcarifer*) industry is growing strongly and can potentially become the white fish equivalent to salmon. Australian domestic production of Barramundi is projected to increase by 60% in the next two years (ABFA, 2017). In 2014, the global production of farmed Barramundi was 71,581t some 32 times smaller than global salmon production of 2,300,000t (FAO, 2014).

The objective of this Nuffield report was to look at key factors influencing the likelihood of the development of Barramundi as a premium aquaculture species and to assess Australia's ability to capture this production and market opportunity. This project examined three areas including genetics (creating the potential), management (realising the potential) and disease (destroying the potential). The author visited aquaculture and other farming operations, met with aquaculture regulators, research facilities, veterinary laboratories and attended various conferences and trade shows. Each interaction has led to a better understanding of the range of issues to consider.

The key shortcomings of Barramundi compared to salmon are its potential for skin and fillet discolouration (melanisation) and lower flesh yield (higher bone ratio) resulting in lower processing recoveries. Significant improvements in the performance of Barramundi will be achieved through research and development into genetic improvement. For the ongoing competitiveness of Australian Barramundi farming, investments into genetic breeding programs are essential.

Ongoing commitment by all Australian farmed Barramundi producers to maintain and improve quality standards is required to ensure that consumers have consistently positive experiences when eating Australian product. The industry can learn from the salmon industry in terms of its development of a range of value-added consumer ready products that are easy to use and identify in the market.

Barramundi production has few bacterial or viral diseases endemic to Australia that could cause mass mortality in the wild or farmed conditions. A number of key disease risks have been identified in imported Barramundi products. The risk of disease introduction has been assessed as moderate. Enhancement of Australian biosecurity regulation of imported Barramundi products is required to prevent introduction of new Barramundi diseases into Australia.

It is hoped that this distillation of a Nuffield Farming Scholarship experience can contribute to the betterment of the knowledge base and the advancement of the Australian Barramundi farming industry.

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Foreword

In 2017, Humpty Doo Barramundi Pty Ltd employed approximately 40 people, is the largest Australian Barramundi producer with a branded product, and produces approximately 2000t annually of premium Australian grown Barramundi for domestic and international markets

In 1993, our Barramundi farming story began. We were an average family from the isolated tropical, laid back city of Darwin, who had a passion for fish and fishing. We came across the opportunity to start farming Barramundi, a much-prized sport fish and highly regarded table fish from the tropical north.

A friend of dad's had started a small-scale trial Barramundi farm in 1993 with a couple of mates out on the edge of the crocodile infested tidal Adelaide River. There was strength of the quality of an endless saltwater resource and adjacent space to grow. It was a basic setup, with one employee sitting amongst the mosquitoes growing a small handful of fish. After the first year they figured out it would take longer and cost more than they planned to make money. One of the shareholders wanted out, so he invited us over for a look. Dad was a trained agricultural scientist and my brother Jim and I were still at school. My stepmother, Julii had grown up on a marginal dairy operation in NSW and was not in love with the idea of returning to farming. However, for the boys it was love at first site and we were hooked on the dream and Julii ultimately gave way to dad's enthusiasm. By the time we had financially bought in, all the fish had died. And so was the learning curve that continues to this day.

The early years were very tough with no money, Julii working to support the business and keep the family fed and lots of challenges just keeping our few fish alive. But a motley crew of family and friends soon bought out the original shareholders. We all volunteered our time and passion to try and make it work. From the humblest beginnings of 6kg of fish a week that were delivered to the back doors of local restaurants we became Barramundi farmers.

Fast forward another six years to 2002 and dad did his own scholarship, a Churchill Fellowship, and we suddenly had access to global knowledge. Dad went on to become a founding member of the Australian Barramundi Farmers Association (ABFA) and later President.

Following a university education in environmental science and biology and nearly ten years in the environmental management field working with an airport company, I was still passionate

about our farm. So, I joined a team of four people working in the business in 2007 that was then producing around 200t of Barramundi. Initially working across all areas, I set about a role of identifying and implementing new opportunities. This role has continued to this day as I move across the business looking inside and outside for ways to grow a better fish, make our people safer, serve customers better and make our industry a stronger one. While dad continues to sit on the ABFA Executive, for the last six years I have contributed as a board member of the NT Seafood Council and hold the role of Chair of the Aquaculture Licensee Committee and Board Secretary. We are highly committed to the betterment of our industry.

Growth achieved over the last 24 years is happening within the context of a fast-growing global aquaculture sector, where Barramundi is no exception. There are new and emerging producers and business models as well as domestic and global industry consolidation.

Some Industry players are referring to Barramundi as having the potential to become the white fish equivalent of salmon. I aimed to investigate this proposition by looking at the genetic potential of Barramundi as a species, the management of aquaculture industries to realise this potential in Australia and the disease risks that may destroy the potential of this species and Australian aquaculture more broadly.

I hope this distillation of my Nuffield Scholarship experience can contribute to the betterment of the knowledge base and the advancement of the Australian Barramundi Farming industry.

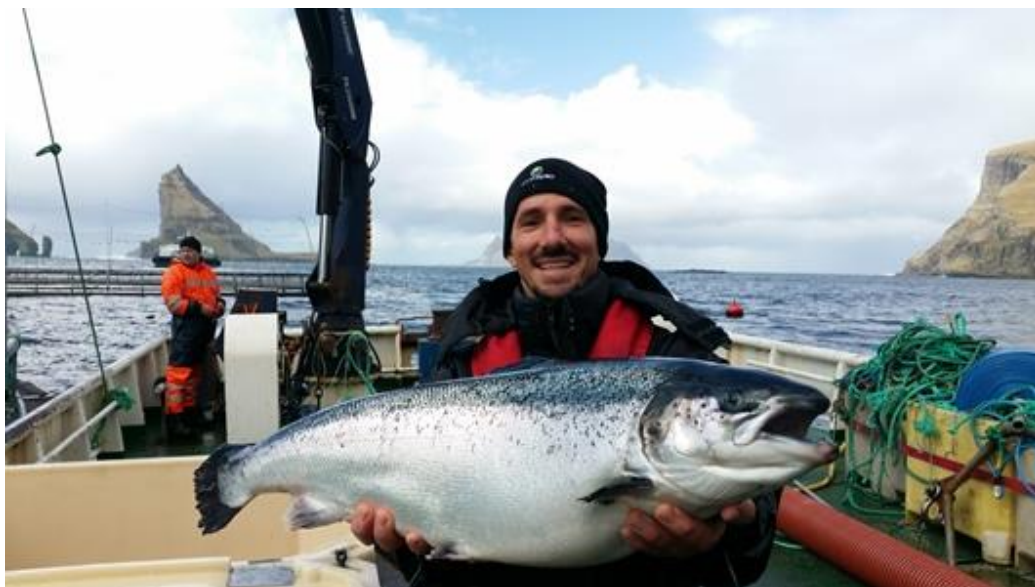


Figure 1: The Author on a visit to a Faroe Islands salmon farm located between the Norwegian Sea and the North Atlantic Ocean

Acknowledgments

I would like to express my gratitude to the Nuffield Australia team who together have made my scholarship experience a great one. The opportunities afforded to me throughout this scholarship have been a real privilege and I have no doubt will continue to shape my thinking and progress in farming and life well into the future.

I would like to thank Woolworths Australia for their support of Nuffield to provide my scholarship. I believe the investment of getting behind projects and individuals provides significant and wide-reaching benefit to the farming industry and broader society.

Across the 20 countries that I have journeyed I have been generously hosted and provided with the opportunity to be shown and exchange ideas by many people. For this I am eternally grateful. I have also had the opportunity to share this experience with a remarkable group of impressive Scholars and support people enhancing the lessons learned.

I have been very fortunate to be supported by a team of people within and around our business who have ensured the smooth operation and prosperity of our operation. Thank you to Peter, Tracey, David, Laura, Alex, Nathan(s), Anthony, Santha, Paul, Fiona, Elton, Stuart and all the rest of the Humpty Doo Barramundi team. You guys are awesome!

I would like to thank my peer review team who have taken the time to consider the drafts of this report to ensure a credible analysis fit for publication under the Nuffield banner. Namely Chris Calogeras- CEO ABFA, Katherine Winchester – CEO NT Seafood Council and Australian Rural Leadership Program graduate, Marty Phillips – 2010 Nuffield Scholar and former ABFA President, Bob Richards –Humpty Doo Barramundi Managing Director, 2002 Churchill Fellow and former ABFA President, Jim Richards - Humpty Doo Barramundi, Corporate Services Manager.

And most importantly I must thank my family. My Parents Bob, Julii and Suzy, my wife Tarun and children Isabel, Cameron and Alex who together have shouldered the extra burden to enable me to put the necessary effort and focus into my Nuffield experience to ensure we could make the most of the opportunity. Without your endless support of each other and me it would not have been possible for me to have this extraordinary scholarship experience.

THANK YOU!

Abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABFA	Australian Barramundi Farmers Association
CoOL	Country of Origin Labelling
FRDC	Fisheries Research and Development Corporation
SEA	South East Asia

Objectives

To investigate the proposition that Barramundi (*Lates calcarifer*) has the potential to be the premium white fish, equivalent to Atlantic Salmon within the Australian industry context. This project will generate further understanding in the following areas:

- The genetic potential and features of the species;
- The management and market conditions required to realise the potential of the species; and
- The disease and biosecurity risks faced by the species.

The interrelationships between the above.

Chapter 1: Introduction

The Blue Revolution is upon us as aquaculture continues to be the world's fastest growing protein industry. Meanwhile global wild caught fisheries are stable in terms of volumes and prices as many fisheries are being managed towards their sustainable maximum (Rabobank, 2017). In contrast, aquaculture continues to drive growth with increasing investment into farming of new species, genetic development, farming systems and movements globally into new frontiers. An example of this includes the recent trend in the Tasmanian and Norwegian salmon industry to move out of farming in the scarce protected waterways towards farming in unprotected waters in the open ocean. If open water farming proves successful it will significantly increase the space available for aquaculture production.

In 2015, aquaculture surpassed wild caught fisheries to supply over half of seafood consumed globally (Rabobank, 2017). Key global players in this aquaculture success story have been salmon and marine shrimp species. With production of global aquaculture of salmonids sitting at over 2,300,000t is a powerhouse in the sector (FAO, 2014). In this environment, global Barramundi production is estimated at 71,581t per annum, (FAO, 2014) so is a relatively small player in global aquaculture (Figure 2).

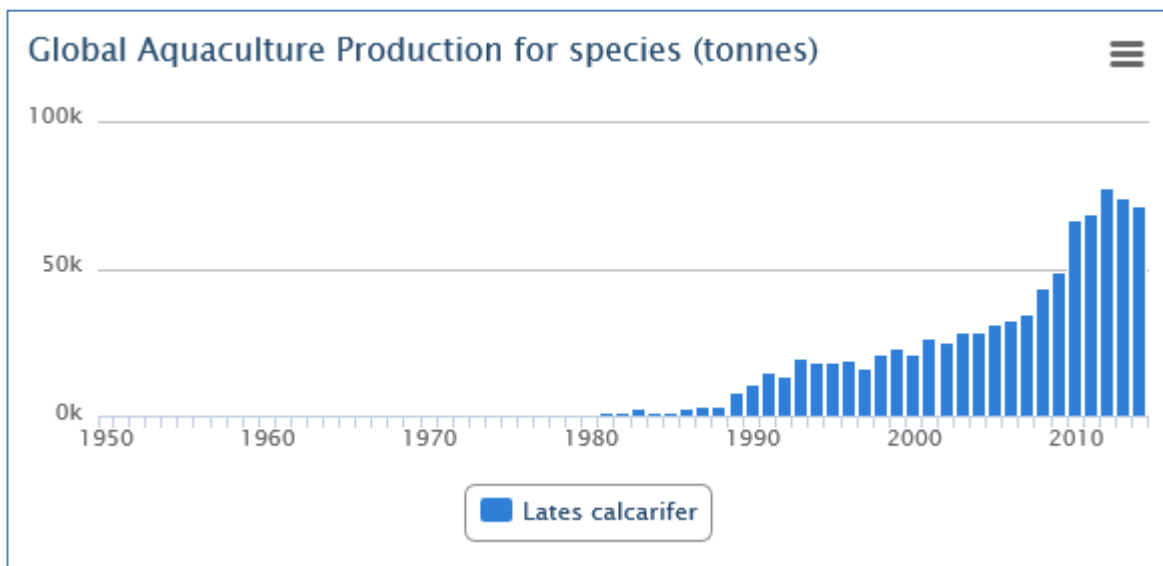


Figure 2: Global Barramundi production. Source (FAO 2014)

In Australia, Barramundi has a long history as a prized sport and table fish and a history that extends back long before European settlement, as detailed in Australian Aboriginal rock art

that exists to this day. The Australian-farmed Barramundi (*Lates calcarifer*) industry is a relatively new industry having only been in place since the early 1990's. Total production of farmed Barramundi in Australia in 2015/16 was 3,542 tonnes with a value of \$35 million value (ABARES, 2017).

The peak body for the Australian farmed Barramundi industry is the Australian Barramundi Farmers Association (ABFA) and its ten members represent 90% of national production. ABFA has reported aggressive growth aspirations with the 2016 farm data indicating 6,000t of production valued at \$60 million, 2018 projections of 10,000t valued at \$100 million and 2025 production of 20,000t valued at \$200million (ABFA, 2017).

With this level of domestic growth and some interested parties describing Barramundi as the next Atlantic Salmon. The author felt it worthy to investigate this proposition and explore the validity of the statement or the conditions required to make this a reality. As such, a direct comparison between salmon and Barramundi, and their respective industries may sometimes be useful to determine the strategic direction of the industry.

Whilst attending the 2016 Nuffield Contemporary Scholars Conference in Cavan, Ireland, the author came across a concept that provided the necessary framework to conduct this investigation. It has three elements that form the basis of this report:

- Genetics creates the potential.
- Management realises the potential.
- Disease destroys the potential.

Chapter 2: Genetics Creates the Potential

It is the genetic attributes of a species that provide the foundations upon which commercial production and industry development may be built. These attributes may be the sweetness or firmness of the fruit, the rate of growth, the protein content or size of the product or even resistance to diseases. This section attempts to look at some of the genetic attributes of Barramundi and how they may impact the commercialisation of it as a species.

Attributes of Barramundi

Barramundi have a number of biological attributes that make them amenable to commercial production:

- They are a tropical euryhaline species (living in fresh and salt water);
- Catadromous (born in salt water and naturally migrate to fresh water);
- Start life as male and transition to female;
- Produce large numbers (millions) of eggs during spawning (Davis, 1984); and
- Relatively tough and resilient to low dissolved oxygen and handling compared to many other high value commercially farmed fish species such as salmon, sea bass or king fish (Smullen, R 2017).

Barramundi have evolved in estuarine environments, where they predate on a diverse range of animals including, insects, fish, crustaceans, amphibians and reptiles. Their adaptation enables them to digest and assimilate a wider range of proteins than salmonid species or king fish, which are typically more reliant of fish based raw materials in formulated diets (Smullen, R 2017). Barramundi meat has a mild flavour and a white, flaky flesh, with varying amount of body fat.

Distribution

Barramundi have current known distribution across the Indo-West Pacific: eastern edge of the Persian Gulf to China, Taiwan and southern Japan, southward to southern Papua New Guinea and northern Australia (FAO 2014).

Growth Rates

Due to the relatively short history of domestication, the genetic advancement of farmed Barramundi is not highly developed. Growth rates of the fish while kept in their optimum

temperature range of around 27°C are in about the middle range of farmed fish species, similar to Atlantic Salmon species. In farmed conditions, individual fish are known to reach 3-4kg within 24 months from spawn. This compares favourably to common aquaculture species such as Mediterranean Seabream, although well short of fast growing pelagic species such as Yellow Tailed King Fish (YTK) and Cobia ref (Figure 3).

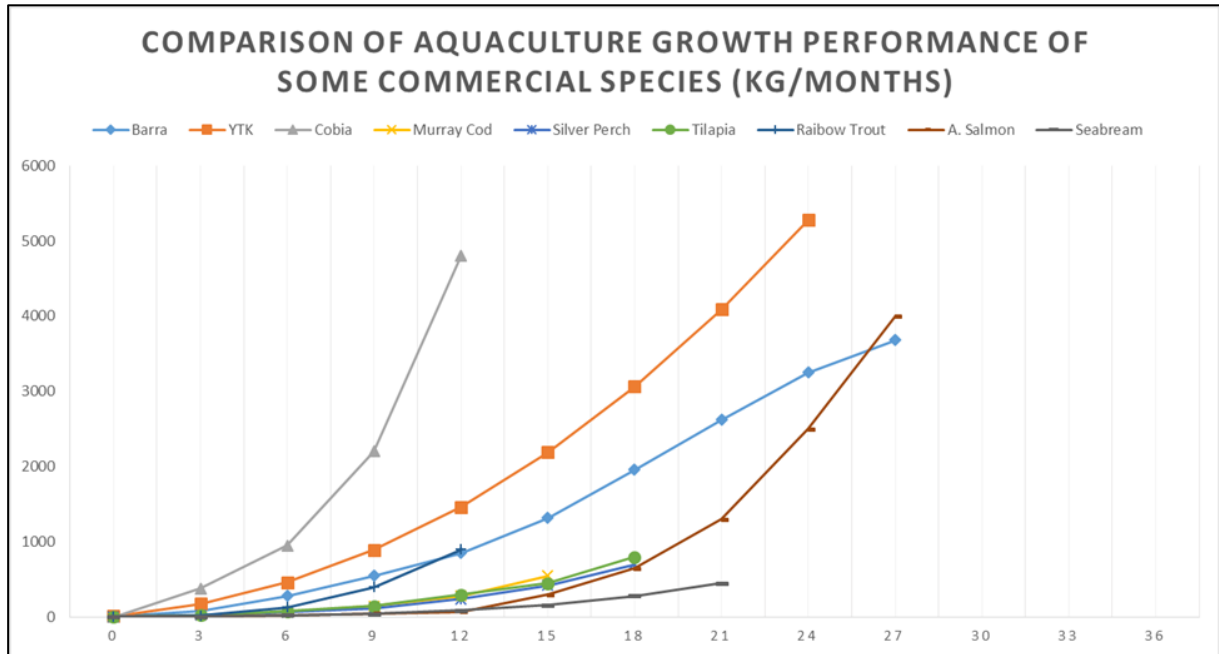


Figure 3: Comparison of Aquaculture Growth Performance of some Commercial Species (Grams/Month) Note, YTK is Yellow Tailed King Fish (FAO)

Optimal farming systems

Barramundi can be cultured under a wide range of farming production systems. During the study, Barramundi was observed being grown in many different environments including intensive indoor tank systems in Iowa, USA while surrounded by snow drifts, sea cages in the Red Sea and extensive both fresh and salt water pond culture in South East Asia, the Middle East and Australia.

Melanisation

In response to the environment in which they are grown, Barramundi can develop a melanisation of the skin and flesh (Howieson et al, 2011). This can be clearly observed in skin colouration across a range from a silver chrome through to jet black. Barramundi can also display colouration of the flesh from white through to grey. Greying of the fillets is common in farmed Barramundi and is associated with the creation of melanin in the fat cells of the flesh (Howieson et al, 2011). The author is aware of a number of commercial hatcheries within

Australia that are seeking isolate and breed albino type animals in an effort to develop a Barramundi strain that is free of melanisation such as Mainstream and Coral Coast. To date there remains no commercially available melanisation free strain on the global or domestic market.



Figure 4: Sea cage reared Barramundi from the Red Sea in Saudi Arabia displaying black melanisation of the skin making it more difficult to market as a premium product (Cahill, D. 2017).



Figure 5: Saltwater pond reared Barramundi from Australia displaying silver / chrome coloration of the skin which is preferred in the Australian market.

Post slaughter processing

While the growth performance of Barramundi may be comparable to that of salmon, it is a different story during processing. The bone structure of Barramundi is such that fillet yields in the region of 40% of total body weight are common. This compares to around 60% fillet yield in Atlantic Salmon, meaning that relatively they have a 50% better fillet yield than Barramundi. (Cahill, D. 2017). The same issue occurs when Barramundi are processed using typical automated salmon equipment. In one factory visit, the author observed the latest

German made mechanical filleting equipment sitting idle while beside it a Nepali filleting team manually filleted and trimmed barramundi. The reason put forward was that the hand filleting delivered a 3% greater fillet yield. This equates to a 7.5% increase in fillet recovery of a fish with a yield around 40%. The economic decision to fillet manually or mechanically will also depend on the relative cost of fish flesh and labour in the farming and processing region.

The case for genetic improvement

As a species, Barramundi have been domesticated for only a few decades and many hatcheries in Australia and abroad continue to draw broodstock from wild stocks. If sourced strategically these wild broodstock may provide the greatest genetic diversity however natural selection in the wild will have selected them for traits such as aggression and camouflage that may not be compatible with the best farming stock. Case studies in many domesticated species have clearly demonstrated that significant and cumulative benefits in growth rates, disease resistance and quality factors can be achieved through investment in genetic research and selective breeding. It is likely that the same types of benefits may be achieved with investment into Barramundi genetics. (Phillips, M.2017). In a discussion with Patrick Hone CEO of the Fisheries Research and Development Corporation (FRDC), Patrick mentioned a presentation that he had seen with a prominent Norwegian salmon figure where they had identified two major flaws with the Norwegian salmonid genetics program. Genetic research had initially focussed on two species rather than just one, Atlantic Salmon and Rainbow Trout (saying they should have focussed on the Atlantic Salmon). The second point being that they should have started their program ten years earlier because improvements take time so the earlier the program commences the earlier gains are made. It is interesting to note that the answer was different when discussions were held with salmon farmers about the benefits of selective breeding or the benefits of sourcing from one hatchery or another. The farmers were generally more concerned about the reliability of the supplier and where in the batch their juvenile supply was sourced i.e. is the farmer receiving the fastest growers or the poorer performing individuals from the batch.

Key findings with respect to ‘genetics creates the potential’:

The genetics of Barramundi provide for a moderately fast-growing species that is robust and widely appealing to eat. This robustness enables Barramundi to be produced in a range of farming conditions that deliver significantly different product attributes. The genetics of the species can cause unfavourable attributes such as melanisation and poor fillet recoveries.

Genetic improvement programs to target the unfavourable genetic attributes may improve in the commercial performance of the Barramundi over time.

Barramundi is a hardy and adaptable animal to farm. It can be farmed in a diversity of farming systems and has growth rates that are not dissimilar to salmon although not as high as pelagic marine species such as King Fish or Cobia. It has disadvantages against salmon such as the potential for skin and fillet discolouration (melanisation).

Due to the naturally heavy bone structure of Barramundi, processing recoveries tend to be significantly lower than species such as salmon. In addition, it is likely that significant improvements in the performance of Barramundi will be achieved through investment in genetic research and development.

Chapter 3: Management Creates the Potential

While it is the genetic potential of Barramundi that may allow it to develop further as an aquaculture species, it is the management environment that will enable Australia to realise this potential. This section aims to analyse some of the key factors of management that can impact the successful development of the Australian Barramundi farming industry. This analysis includes consideration of aquaculture regulation, farming systems available for Barramundi, research and development, as well as the marketing considerations that are necessary to deliver a profitable Australian Barramundi farming industry. For it is the market where the economic value is realised for all of the hard work that goes into growing Australia's iconic fish.

Case Study: Norway

As Norway is the world's largest producer of salmon, it was an obvious destination to visit to investigate aquaculture industry management. Visits to various hatcheries, research, technology, farming and processing facilities were conducted in addition to a meeting held with Henrik Hareide from the Norway Directorate of Fisheries. For the purpose of this investigation, the development and management of the Norwegian salmon industry provided a useful case study. There are some similarities, such as high cost of labour and dispersed coastal communities. There were also some marked differences between Australia and Norway, most notably that Norway has an extraordinary level of access and infrastructure along the coastline compared to the relative isolation in Australia.

Operating environment

Production levels of Australian Barramundi in 2017 at 6,500t per year are at the same level as Norwegian Salmon industry was in 1979 (Hareide, H. 2016). From this base the Norwegian Salmon industry had grown to 935,000t in 2009 and was estimated at 1,400,000t in 2016, making up 96% of Norway's total aquaculture production (Hareide, 2016). Norway has a number of natural advantages that underpin its success in the salmon aquaculture industry:

- Enough clean freshwater required for juvenile salmon production.
- Clean sea water with a high-water replacement rate and good water quality.
- A long, protected, coastline with accessible areas.

- Sparsely populated, but with good infrastructure.
- Good quality supply of fish feed.
- Robust technology application and availability.
- High level of scientific research in aquaculture.

Australia shares some of these above attributes with Norway, including the ample natural resources, sparse population, the ability to access technology and high-quality research. The Norwegian west coast has extensive areas of sheltered, deep glacial fjords that provide the perfect conditions for sea cage aquaculture. In contrast, the north Australian coastline lacks significant areas of coastline sheltered from storm and cyclone activity. This is particularly relevant in the tropical zones where Barramundi can be most efficiently grown outdoors. Three separate Barramundi sea cage operations in Northern Australia have been destroyed by tropical cyclones and flooding. Low levels of access and coastal infrastructure in the remote North of Australia can also be significant hurdles for industry development.

Aquaculture regulation

The Norwegian salmon Industry has a well-developed aquaculture regulatory framework of aquaculture zones, impact monitoring and management (Hareide, H. 2016). This comprehensive regulatory regime has evolved and developed as a national approach over time to keep pace with the development of the Norwegian salmon industry and is commensurate with the significant value of this production to the Norwegian economy.

There are a number of factors that would contribute to the mature level of aquaculture regulation in Norway and the common regulatory framework which they have applied. The industry has been in existence for nearly 50 years, 96% of aquaculture is salmon grown in much the same way with on-land freshwater juvenile production and sea cage grow out in fjords. The value of this industry in 2016 being estimated at around \$24 billion AUD (Rabobank, 2017), (Hareide, H. 2016).

By contrast, Australian aquaculture regulation is managed at the state level and is fragmented with a diversity of approaches and levels of commitment from the various state governments. For example, in Queensland where much of the coastline and aquaculture development borders the World Heritage listed Great Barrier Reef Marine Park, the regulatory approach has been extremely cautious. This has had the effect of limiting development of aquaculture on Australia's East Coast. One prominent recent example is the Guthalungra prawn farm

development in North Queensland, where it took approximately 16 years for the proponent to gain regulatory approval.

In recent times a number of Australian state governments have taken the proactive step of identifying and pre-approving aquaculture zones to clear the way for aquaculture development. For example, the West Australian government has recently announced a number of aquaculture zones along its coastline with pre-approval for King Fish and Barramundi production (DPIRD, 2017). Meanwhile in Tasmania, the salmon industry is continuing its growth with expansion into new production areas. While at the same time there is a very public struggle underway to find the right balance between maximising aquaculture production of Atlantic Salmon and Rainbow Trout in Macquarie Harbour and stewardship of the natural environment. (Meldrum-Hanna, C. Balendra, J. and McDonald A. 2016). As the scale of the Australian aquaculture industry grows, its value contribution to the Australian economy is likely to increase and government regulatory, regimes will further develop and mature.

Research and Development

Major aquaculture industries across the globe are underpinned by both public and private investment into research and development. Where a single species dominates the industry e.g. 96% of Norwegian aquaculture being salmon, there is a clear focus for R& D investment. In the process of this investigation the author visited R&D facilities from the National Warmwater Aquaculture Centre in Mississippi (NWAC) USA to several facilities in Norway and also the Tasmanian IMAS salmon research facility. At the NWAC the research team are highly passionate and focussed on supporting the Southern USA catfish industry that peaked at around 300,000kg in 2004 (then declining and consolidating as a result of the importation of Mekong catfish from SEA).

Research extends to areas that address industry priorities including genetics, feeding trials, humane treatment, processing, disease management etc. Norway is clearly going to focus much of its research on supporting salmon, whilst in Australia there are a wide range of aquaculture research priorities including prawns, abalone, king fish, Barramundi and Murray cod, so financial, human and technical resources are naturally spread. The point to be made here is that while Australia has a high standard of research and science, until clear industry

priority species emerge, there is likely to be fragmentation of research and development funding between a wide range of species.

Global Barramundi Production

Barramundi Production

Global Barramundi production was reported as 71,581 tonnes per annum in 2014 (FAO, 2014). It is already being cultured across the globe in a diversity of culture systems, this is evidence of the versatility of this hardy tropical species. In an Iowa winter while snow drifts were piling up against the side of the “barn”, inside the insulated building tropical conditions were the norm with Barramundi being successfully farmed in fresh water raceways. From Singapore to Vietnam to Saudi Arabia, Barramundi are being grown successfully in sea cages although various streptococcus bacterial strains can be a threat to these production systems (Cahill, D. 2017). In Australia and Asia, fresh, brackish and saltwater pond culture has been used for culturing Barramundi for many years. These include the author’s own farm. Each production system can present different opportunities and challenges thus the different systems have been able to co-exist. For example, fresh water indoor recirculation farms are capital intensive to establish and expensive to operate. However, they can be located close to large cities and outside of the tropical climatic zones that naturally suit Barramundi so are able to supply high value live fish markets. While tropical North Australian farms are located in the natural climatic zone of wild Barramundi so are able to achieve scale of production without the need for tight environmental temperature regulation. These farms however have to contend with the logistical issues of being thousands of kilometres from Australia’s major population centres and therefore their main markets. Sea cage farms are capital intensive to establish and operate, they effectively outsource the treatment of nutrients to the natural environment however are particularly exposed to environmental events such as cyclones, with three separate Australian sea cage Barramundi farms having been destroyed by natural events.

The author’s own farm is a land based saltwater pond farm located on a large and isolated tropical floodplain between Darwin and Kakadu National Park. This production system includes extensive supporting constructed saline wetlands that ensure consistent availability of high quality salt water and minimal release of nutrients to the outside environment. This system has been selected to provide the following benefits:

- A consistent high-quality salt water grown product.

- The wetland system treats water on site reducing regulatory risk.
- Biosecurity is improved by minimising the intake of outside waters. Evidenced by a long history of antibiotic free production.
- Warm tropical water ensures optimal fish growth.

Diversity of product attributes: (The Rub)

One of the challenges presented by the diverse range of environments under which Barramundi can be cultured is the impact on product attributes. Fish grown in freshwater or indoor Recirculating Aquaculture Systems (RAS) can take up earthy flavours from the organic volatile Geosmin created by fresh water microbes (bacteria and algae) (Poole and Exley, 2009). Fish grown in clear water sea cages can present jet black colouration and unpleasant grey colouration of the flesh, which whilst still being acceptable to eat, can be more difficult to market (Cahill, D. 2017).

Barramundi can be grown in high tech facilities with developed country quality and labour arrangements and also in tropical developing countries with different standards and cost structures (Phillips 2010). During the study, farms in SEA that faced multiple disease loads and veterinary treatments were routinely applied including multiple vaccinations and antibiotics just to ensure fish survival. To compete, some producers in developed countries may have the opportunity to differentiate their product for the reduced veterinary treatments that good biosecurity can allow e.g. antibiotic free production. This diversity of production methods and impact on quality attributes make it necessary to differentiate Barramundi in the market between producer farms, farming systems and countries of origin (Calogeras, C. 2017).

2010 Nuffield Scholar Marty Phillips identified in his report that it is essential for the Australian Barramundi farming industry to have measures in place to ensure a consistently high-quality product is produced (Phillips, 2010). This is required to ensure that the consumer will have a consistently positive experience when they sit down to a plate of Australian Barramundi. It is very positive to see that a number of Phillips' key recommendations have already been implemented within the Australian industry, with the development of the "Gold Tick" sustainability and quality standard for Australian farmed Barramundi, (Calogeras, 2014). The challenge being that once the Australian industry has ensured consistently high-quality it must then ensure that it can differentiate its product from that grown elsewhere to fully realise the benefits of the quality difference.

Differentiating Markets

During the study, a common theme were instances of producers in developed countries competing with cheaper products produced in countries with a lower cost base. The USA catfish markets have suffered as a result of the importation of cheap Mekong catfish (Basa) from SEA. In this instance, Country of Origin Labelling (CoOL) had been introduced to the southern states where catfish was produced and marketed. Even achieving economies of scale of production does not completely insulate producers from competition from lower cost base competitors. In Saudi Arabia, where the largest Barramundi farm in the world has been established, the low market price of government subsidised products from South East Asia remained an issue in the market (Cahill, D. 2017).

Without differentiation in the market how do higher cost base producing countries like Australia compete? The case for strong marketing is a clear one. The question is, should this be done at the individual business enterprise level where all Australian Barramundi farm license holders compete directly to tell their story? At the regional level e.g. North Queensland, Barramundi farmers collaborate to promote their region as an “appellation” for fine Barramundi production? Or at the national level through the peak body e.g. Brand Australia promoting Australian Barramundi as the tastiest and safest Barramundi choice in the world. The answer probably lies in a combination of all three. The focus of this report is not solely on marketing and there are countless examples of individual enterprise marketing strategies so this discussion will only look closely at the concept of Brand Australia.

Country of Origin Labelling (CoOL)

In Australia, such is the demand for Barramundi that the majority consumed is imported (Wilkinson, S. 2012). While 90% of Australians think that the Barramundi they are eating is Australian (Davey, M. 2014). This has placed significant economic pressure on Australian producers, both fishers and farmers, whose costs are significantly greater than Asian imported product due to remoteness of many of the farming and fishing sites and to meet the stringent environmental, labour and food safety standards placed on them by government. While country of origin labelling has given consumers greater certainty over the origins of their Barramundi at the retail level, other than in the Northern Territory no requirement exists for the food service and restaurant trades to label the origins of their Barramundi.

In Australia, it is possible to walk into the major supermarkets to see Taiwanese Barramundi (sold as Asian Sea Bass outside of Australia) in the seafood cabinet for \$15/kg AUD while

alongside it Australian Barramundi is priced between \$29 and \$38/kg AUD. Labelling such as this clearly provides the option to consumers. In contrast in restaurants and food service outside of the Northern Territory there is no legal requirement to label the origin or even species of fish served. To quote Australian TV Chef Matt Evans:

“We do a shocking job of labelling our seafood. You can’t go into a takeaway shop and order a ‘mammal burger’ — it’s going to say beef or pork or whatever. But you can order a fish burger, despite the fact that we catch hundreds of species of fish in Australia alone” (Davies, N. 2017).

Studies such as Calogeras et al, (2011) highlight the demonstrated benefits of CoOL to sales of Australian seafood. A campaign to achieve CoOL at the Australian federal level is ongoing and is what is required to make policy change in this space. An Australian Seafood Cooperative Research Centre study highlighted that Australian 79.3% of survey respondents were willing to pay a higher price for Barramundi that is identified as Australian (Colmar Brunton 2010). While companies may compete and promote on the individual business enterprise level, it is in the common interest of Australian producers of all products to promote Brand Australia in the market for the common values that they share.

Product offerings and branding

Walking into a UK-based Waitrose supermarket in Dubai (see Figure 6), the choice of forms of salmon and other fish species in the retail space was staggering. Smoked salmon, cutlets, whole fish and even gold leaf speckled salmon loins from Scotland could be observed in the offering. Many of these products are also in forms that are highly branded and consumer ready.



Figure 6: Showing the diverse forms of fish product offerings available in Waitrose supermarkets. (Source: Author in Dubai, United Arab Emirates, May 2017)

In contrast with the Dubai salmon example, the majority of Australian Barramundi is sold as whole fish for processing through wholesalers. Often destined for anonymous sale into the food service sector, where in some instances the identity of the producer, country of origin and occasionally even the species can be lost or substituted (Calogeras, C. 2017).

In Australian supermarkets where salmon can be found in many places and forms throughout the store – ready to eat/cook, dips, fresh behind the counter, Barramundi is notably absent or restricted to the fresh behind the counter offering among a range of other wild and farmed white fish and alongside a much cheaper imported product. The white fish space can be a very crowded one. Beside it Atlantic Salmon sit in an attractive uniform orange colour as a clearly differentiated product and many product forms available to the consumer. An investment into new product development by both individual Barramundi producers and the industry may contribute to market development and security for the Australian industry.

In summary, consistent and mature regulation is an important enabler for the development of Australian aquaculture. Research and Development tends to be more focussed when there is dominance of a single species industry. In Australian aquaculture, there are many competing priority sectors for research funds and it may be more productive to pick early winners and focus R&D funding on these areas.

Barramundi can be grown in a wide range of farming conditions such as fresh or salt water, indoors and outdoors but the production system can impact on quality attributes including colour, flavour and texture. It is critical to control the quality attributes of the Barramundi product to ensure the overall brand is protected. Differentiating product in the market based on its attributes, including country of origin, is important for Australian producers to realise the value for their product in the market.

The industry can learn from the salmon industry in terms of its development of a range of consumer ready products that are easy to use and identify in the market.

Chapter 4: Disease Destroys the Potential

The Australian Barramundi farming industry is currently not affected by many endemic disease issues of concern. The Author's own farm has operated for many years with antibiotic and vaccine free production. In contrast, there are a number of serious diseases known to affect Barramundi in South East Asia (SEA) (Hernandez-Jover, Shamsi & Hays 2017) which is the primary source of Barramundi imports into Australia.

The impacts of disease can be disastrous to any agricultural production business. Aquaculture has had its fair share of such cases. In shrimp (prawn) farming, outbreaks of White Spot Disease affecting shrimp aquaculture has devastated production internationally and lead to changes in species cultured. For example, the author visited a major shrimp farming operation in Saudi Arabia that had been the world's leading producer of *Penaeus indicus*. A high value niche prawn product that had proved to be highly profitable. The introduction of White Spot Disease wiped out the *Penaeus indicus* production and ultimately forced the operation into culture of another shrimp species, (*Litopenaeus vannamei*) which is a relatively low value global commodity shrimp. The impact of this disease has cost this operation many millions of dollars and forced a complete restructure of the operation (Maclean, C. 2017). The Australian prawn industry is now affected by a strain of White Spot Disease, with the result that all farms in the Logan river system in South East Queensland have been destroyed with no prawn farming taking place in this area in 2017. The source of introduction is not yet clear, although a breakdown in Australian biosecurity is apparent as importation of prawns testing positive to White Spot Disease was common practice. Barramundi like any species face the same types of disease risks. A recent FRDC sponsored study has comprehensively identified known diseases and their risks. The details of which are summarised in the following section.

Diseases affecting Barramundi

A study by Hernandez-Jover, Shamsi & Hays in 2017 identified the four main diseases of concern being pot belly disease, scale drop syndrome, infectious spleen and kidney necrosis virus and red seabream iridoviral disease. Barramundi are also susceptible to strains of *Vibrio* and *Streptococcus*. The diseases were assessed against international disease risk assessment guidelines to have moderate chance of introduction and an impact level on industry and wild populations of Barramundi ranging between significant and very significant. The report also noted that once these diseases became established within Australia they would be "practically

not possible” to eradicate from the country. In production systems the report identified that the high cost of materials and labour would be likely to compromise the success of a control strategy.

One SEA Barramundi farm visited in the course of this investigation was known to have five serious diseases that they had to vaccinate for. This was done at three points along the growth cycle to ensure their survival. With so many disease issues, this operation had needed to develop competency in disease isolation and vaccine development and as a result had spun off their own related vaccine development company. The additional cost and complexity of living with the disease reality puts a significant burden on an already highly competitive industry. The key point here being that prevention is a lot easier and cheaper than the cure.

The fact that this same fish and others similarly affected from the SEA region are imported into Australia every day in raw fresh and frozen form, with no kill step to eliminate the pathogens, should be of serious concern to the Australian industry and authorities. Many viral and bacterial disease agents are not killed by freezing.

Australian Biosecurity

According to www.farmbiosecurity.com.au:

“Farm biosecurity is a set of measures designed to protect a property from the entry and spread of pests and diseases. Farm biosecurity is your responsibility, and that of every person visiting or working on your property.”

If this definition is applied to the national context it is everyone’s responsibility to maintain Australia’s biosecurity.

The study by Hernandez-Jover, Shamsi & Hays in 2017 identified a number of key recommendations to assess and mitigate the risk of disease introduction via imported Barramundi products. These include:

- There is considerable uncertainty about the level of risk posed by the identified key diseases to Australian Barramundi, as such the precautionary principle should be applied.
- Imported Barramundi should have a Harmonised Tariff Item Statistical Code to enable improved tracking of the origin, volume and form of all Barramundi imports.

- Greater epidemiology work needs to be done in Barramundi disease affected countries to better understand the level of risk.
- Fish labelling systems reviewed to better differentiate Australian from imported Barramundi with forensic trace element analysis to assist with identifying mislabelling and product substitution.
- Education of recreational and commercial fishers of the risks of disease introduction through the use of imported bait products.
- Update and improve the outdated and generic Australian Government Barramundi importation risk assessment.

The author also notes these particular risks are concern for members of the industry regarding the importation of fresh chilled Barramundi, and whole imported Barramundi in particular.

The Hernandez-Jover, Shamsi & Hays study also identifies the risk of the processing waste from these fish being used as bait and finding their way directly into the Australian aquatic environment, from which disease eradication is “practically not possible”.

The author has observed the response to the biosecurity breakdowns and the resulting incursion of various agricultural diseases in the Northern Territory.

Examples such as cucumber mosaic virus have seen cucurbit production plummet, financially impacting on some operators and forcing a change of selected crops among the surviving farms. In addition, banana freckle has resulted in the eradication and of all bananas within the Darwin region for several years with sentinel plantings now in place to assess success of the program. Despite initial optimism, efforts to contain White Spot Virus in South East Queensland have proven impossible with government authorities admitting publicly that it has escaped containment and has become established in wild prawn populations in the Moreton Bay area. These types of disease eradication campaigns can be expensive and futile. Clearly, prevention of incursion is better than reactive strategies after incursion has occurred.

Disease Prevention

The author believes that disease management for Barramundi operations should consist of the following practices:

1. Maintaining disease free inputs such as broodstock, seedstock and feeds = biosecurity.

2. Maintaining culture conditions that do not allow the introduction, promote the creation of, or spread of, diseases within or between the culture environment and the external environment.
3. Ensuring disease monitoring by routine sampling and analysis is carried out to identify any changes to the health status of animals or the presence of pathogens. For aquaculture such specialist laboratories exist in various locations across the globe.
4. Outside of the farm environment, national biosecurity measures required to prevent the introduction of exotic diseases into Australia.

Disease management

Once a disease has developed or been introduced to a new area or species, the focus moves from exclusion to ongoing management. Assuming an industry or operation remains economically viable to enable recovery the ongoing management options may include:

- **Destocking**, to break the cycle of the disease. In some cases, this may lead to the end of the farming operation indefinitely.
- **Increased monitoring**, to track the development and spread of the disease – this can cause significant cost to the production of a species potentially making it unviable.
- **Restricting further spread**. As seen in the case of the White Spot disease infection in South East Queensland, this has not only impacted on the farming operations it has also caused significant damage to surrounding commercial wild catch and recreational fishing operations.
- **Development of vaccines**. Isolation of diseases and development of vaccines is an option for
- **Genetic selection** for disease resistance.

Level of disease risk to Barramundi

The panel of experts contributing to the Hernandez-Jover, Shamsi & Hays study assessed the likely impact on Australian Barramundi of the establishment of Scale Drop Syndrome or Pot Belly Disease as being significant to extremely significant.

“With an effect on the economic viability of the industry that in some cases could be irreversible.”

This same situation has been observed in many instances across agriculture. Disease can substantially change the economic viability and production options available to producers. As such, the cost to industry of disease can be catastrophic and should be prevented wherever possible. The importance of disease prevention over disease cure cannot be overstated.

In summary, at least five key disease risks have been identified in imported Barramundi products from SEA countries. The risk of disease introduction to Australia through imported Barramundi products is moderate.

The potential consequences of diseases have been independently assessed in a study by Hernandez-Jover, Shamsi & Hays as very significant to the viability of the Australian Barramundi industry, including aquaculture, recreational and wild catch. Prevention of entry of these diseases by instituting a kill step for imported Barramundi products is needed e.g. limit Barramundi imports to those that have been pre-cooked or otherwise sterilised to kill Barramundi diseases prior to importation into Australia. The impact on the Australian economy from a disease incursion would be significant.

Conclusion

There is significant opportunity to grow the Barramundi Industry in Australia and capitalise on Barramundi's robustness, high eating quality and high growth rates. This report has explored the importance of accelerating genetic gain, improving management and marketing and disease prevention and management to achieve this potential.

Barramundi has the genetic potential to develop further as an aquaculture species, with mid to high range growth rates and investments being made globally to increase production capacity. There are a few limitations to the species, such as melanisation of the flesh and relatively low fillet yields, that can be improved incrementally over time with genetic selection and breeding programs.

To gain consumer confidence, the industry needs to ensure consumers have a positive and consistent experience when buying and eating Australian grown Barramundi. An industry-wide quality standard is an important tool to ensure quality is maintained and improved. An industry level differentiation strategy must be a feature going forward, based on the interests that are shared, such as country of origin. In parallel, market differentiation between enterprises based on unique product features is also likely to be a feature of the market.

The market for Barramundi is very competitive with other white fish. This includes faster growing species, wild species and low-cost species from producers out of regions such as SEA. In this environment, Australian Barramundi, with high costs for Australian labour and Australian food safety standards, will not be competitive on price alone. So, the Australian industry needs to compete on other factors such as quality, food safety and provenance.

Through effective product development, the salmon industry has penetrated many parts of the retail space in which Barramundi has little or no presence. An investment by the Australian Barramundi industry would be worthwhile into new value-added Barramundi products that can provide consumers with ready to eat products to appreciate Barramundi and enable brand carry through. To ensure future success, farmers from high cost production countries, like Australia, will need to invest continuously in strategies to 'sell the story' of the advantages of Australian-based production. Australian producers must differentiate themselves in order to realise the true value for the investment that being an Australian farmer represents.

The introduction of disease from uncooked, imported Barramundi products poses a significant threat to the Australian Barramundi sector. Lobbying to push for change to government policy on Barramundi importation regulations must be a priority going forward. Alongside this, a high standard of domestic biosecurity must be a feature of the industry going forward.

Barramundi is widely known in the Australian market with increasing numbers of producers and levels of production. It is likely that this industry momentum will see the ongoing growth and development of the Australian Barramundi farming industry.

In answer to the question *“Can Australian Barramundi be the white fish equivalent to salmon?”* the answer is yes, provided the industry adopts recommendations as stated in this report.

Recommendations

- For the ongoing competitiveness of Australian Barramundi farming, investments into genetic breeding programs are essential.
- Ongoing development of aquaculture regulation regimes will be required nationally to enable the growth of the Australian aquaculture industry.
- Ongoing commitment by all Australian farmed Barramundi producers to maintain and improve quality standards is required to ensure that consumers have consistently positive experiences when eating Australian product.
- An investment into marketing of Barramundi at both the enterprise and national level, based on product differentiation, is essential to compete with other white fish. This investment will be essential to support the planned increases in domestic production and avoid significant market price decline.
- Investment into new product development for Australian farmed Barramundi may enhance its ability to penetrate domestic markets and absorb production increases.
- Enhancement of Australian biosecurity regulation of imported Barramundi products is required to prevent introduction of new Barramundi diseases into Australia.
- Investment is required into Barramundi disease monitoring and vaccine development.
- The Australian Industry must continue its growth path in order to achieve economies of scale and critical mass of domestically produced product to enable development of domestic and overseas markets.

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Figure 3: Comparison of Aquaculture Growth Performance of some Commercial Species (Grams/Month). Graph derived and compiled from the following scientific publications:

- <http://www.fao.org/fishery/affris/species-profiles/barramundi/growth/en/>
- <http://www.fao.org/fishery/affris/species-profiles/gilthead-seabream/growth/en/>
<http://www.dpi.nsw.gov.au/fishing/aquaculture/publications/species-freshwater/murray-cod-aquaculture->
- <http://www.dpi.nsw.gov.au/fishing/aquaculture/publications/species-freshwater/silver-perch-aquaculture-prospects>
- http://www.appropedia.org/Tilapia_Fish_Farming_Notions
- <http://www.fao.org/fishery/affris/species-profiles/rainbow-trout/growth/en/>
- <http://www.fao.org/fishery/affris/species-profiles/atlantic-salmon/growth/en/>
- <http://www.abc.net.au/news/rural/2017-03-16/what-is-white-spot-disease-in-prawns/8359476>

- http://www.seafoodsource.com/news/supply-trade/barramundi-poised-to-become-the-world-s-next-biggest-premium-hitefish?utm_source=informz&utm_medium=email&utm_campaign=newsletter&utm_content=newsletter
- www.fishbase.org/summary/346 -Barramundi-

Plain English Compendium Summary

Project Title:	Can Australian Barramundi be the white fish equivalent to Salmon?
Nuffield Australia Project No	1708
Scholar:	Daniel Richards
Organisation:	Humpty Doo Barramundi Pty Ltd. PO Box 770 Humpty Doo NT 0836
Phone:	+61 402 088 659
Email:	dan@hdbarra.com.au
Objectives	<p>To investigate the proposition that Barramundi (<i>Lates calcarifer</i>) has the potential to be the premium white fish, equivalent to Atlantic Salmon within the Australian industry context. This project will generate further understanding in the following areas:</p> <ul style="list-style-type: none"> • The genetic potential and features of the species; • The management and market conditions required to realise the potential of the species; and • The disease and biosecurity risks faced by the species. <p>The interrelationships between the above.</p>
Background	<p>The Barramundi (<i>Lates calcarifer</i>) industry is growing strongly and can potentially become the white fish equivalent to salmon. Australian domestic production of Barramundi is projected to increase by 60% in the next two years (ABFA, 2017). The global production of farmed Barramundi was 71,581t 32 times smaller than global salmon production of 2,300,000t (FAO, 2014).</p>
Research	<p>Traveling to 20 countries in 18 weeks, the author examined three areas including genetics (creating the potential), management (realising the potential) and disease (destroying the potential). The author visited aquaculture and other farming operations, met with aquaculture regulators, research facilities, veterinary laboratories and attended various conferences and trade shows.</p>
Outcomes	<p>There is significant opportunity to grow the Barramundi Industry in Australia and capitalise on Barramundi's robustness, high eating quality and high growth rates. Barramundi has the genetic potential to develop further as an aquaculture species, with mid to high range growth rates and investments being made globally to increase production capacity. There are a few limitations to the species, such as melanisation of the flesh and relatively low fillet yields, that can be improved incrementally over time with genetic selection and breeding programs.</p>
Implications	<p>In answer to the question "Can Australian Barramundi be the white fish equivalent to salmon?" the answer is yes, provided the industry adopts the following strategies:</p> <ul style="list-style-type: none"> • The industry must continue its growth path in order to achieve economies of scale and critical mass of domestically produced product to enable development of domestic and overseas markets. • The industry must adopt product quality and sustainability standards to enable it to ensure that consumers have consistently positive experiences with the product.
Publications	The Nuffield Australia National Conference in Darwin – September 2017.