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## Value Chain Analysis of the Sturgeon and Substitute Caviar Market in Australia

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### Abstract

Currently all 'true' caviar (harvested directly from the sturgeon fish) is imported into Australia, as all sturgeon species are currently considered as noxious species and live imports and production is prohibited. A 2016 proposal to the Australian Government to import beluga sturgeon and Siberian sturgeon initiated a biosecurity import risk analysis to determine the feasibility and risk involved in importing these species, and whether an appropriate level of protection can be determined to manage the risk. This risk assessment is still ongoing and, if it is deemed feasible and the risk can be managed, this will open up many economic opportunities for Australia in aquaculture and the luxury food market.

Luxury goods demand continues to grow in Australia, as does the consumption of caviar. Domestic uptake in Australia has increased by 280 per cent year-on-year from 2019-2022 and it is forecast that this growing demand will continue. There is also growing demand for substitute caviar (roe from all other species) in Australia, which is currently successfully and sustainably produced domestically. This provides further opportunity to both grow this market by increasing production and to explore the possibility of farming sturgeon fish in Australia. This will help grow the country's current aquaculture industry, enable local supply and increase exports of premium Australian-grown products.

In this analysis, the current market situation, the actors along the chain, the value chain drivers and strategic fit, and the constraints within the industry are reviewed. The opportunities to overcome the constraints and create demand for an Australian-produced luxury product that offers a point of difference are explored, so as to improve strategic fit and increase overall value chain surplus.

**Keywords:** Caviar, Caviar Substitutes, Value Chain, Australia, Sturgeon

### Introduction

Sturgeon roe (considered to be true 'caviar') is one of the world's most expensive delicacies, with sturgeon farming and caviar harvesting following a global upward trend (Bronzi *et al.*, 2019; Hughes, 2022; Technavio, 2022). Global production has more than quadrupled since the 1970-80s and, as of 2019, the industry was worth approximately \$409 million (in \$A); this value is expected to soar to \$2.75 billion by 2028 (Bronzi *et al.*, 2019; Lynch, 2023b). China currently dominates the caviar market, producing more than a third of the global total caviar production (Chin *et al.*, 2020).

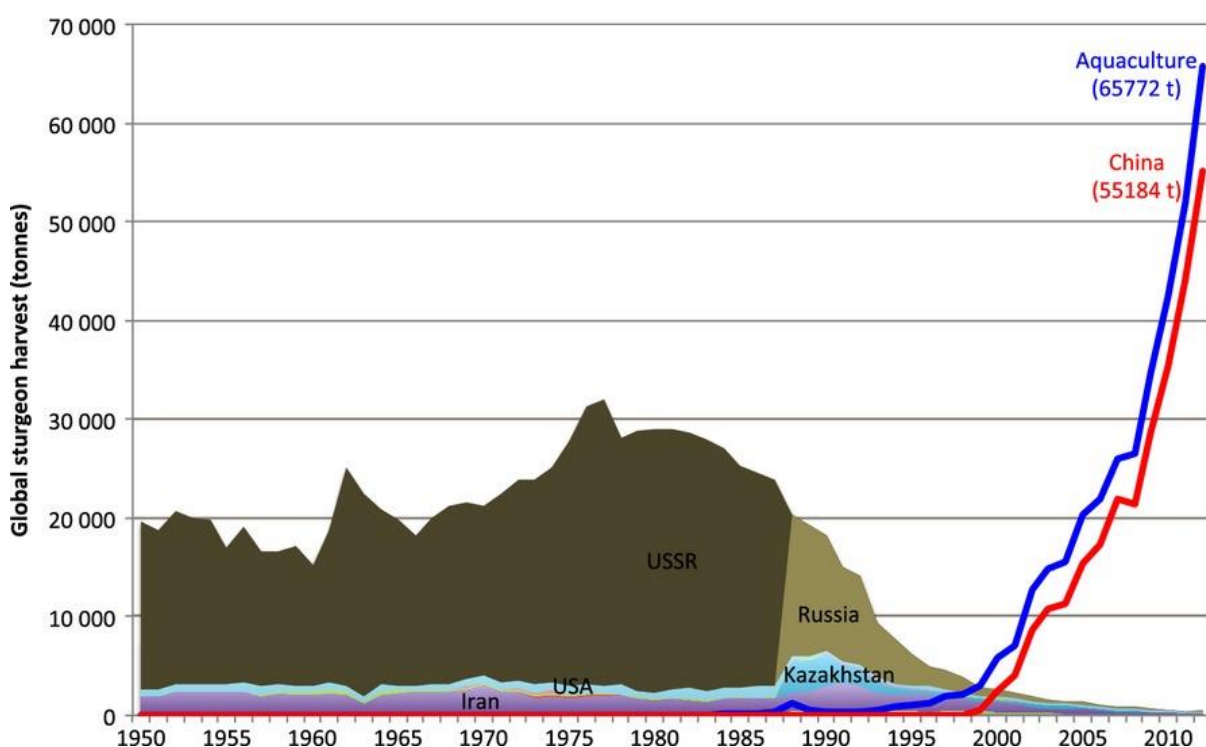
From 2012 to 2021, annual imports into Australia have increased from \$2.1 million to \$3.6 million (DAFF, 2023b). According to Australia's largest importer 'Simon Johnson', Australian uptake has increased 280 per cent every year from 2019-2022 (Simon Johnson, 2023). This aligns with research

by CSIRO (2023) which found that domestic consumption of luxury goods is growing and will continue to grow due to the increasing population and per capita income growth.

True caviar is unfertilised eggs sourced from the sturgeon fish (ranging in colour from khaki green to jet black) and then salt cured (Cormack, 2022). There are 25 species of sturgeon (family: Acipenseridae); however, only four major species dominate the caviar production market (as of 2016) – *Acipenser baerii* (31 per cent), *Acipenser gueldenstaedtii* (20 per cent), *Huso dauricus* × *Acipenser schrenckii* (13 per cent), and *Acipenser transmontanus* (12 per cent) (Bronzi *et al.*, 2019). Beluga (*Huso huso*) is considered the most exclusive and luxurious, due to its size and rarity, taking a minimum of 16 years in captivity to produce eggs (Cormack, 2022; EUMOFA, 2021).

Historically, species of sturgeon were over-fished within the seas of Eurasia and along the Chinese-Russian border in the Amur River (Black Pearl Caviar, 2017). Worldwide, as wild sturgeon are close to extinction, various species are now farmed in different freshwater aquaculture systems in more than 30 countries (DAWE, 2022). Nearly all caviar sold is currently produced through these aquaculture systems since sturgeon fishing was banned in 2006 (EUMOFA, 2021). In Figure 1 is shown total global sturgeon harvesting. This has gone from an industry being predominately wild-caught (shares colour coded by country), depleting natural stocks, to aquaculture now providing nearly all global sturgeon production (shown by lines, with China dominating other (undefined) countries who contribute around 10,500 tonnes to the total).

**Figure 1. Global sturgeon harvest development from 1950–2011 (metric tonnes, wet weight)**



Source: Simon Johnson (2023); Bronzi & Rosenthal (2014)

As sturgeon species are considered noxious in Australia, live imports and production is currently prohibited (DAWE, 2022). Therefore, all true caviar consumed in Australia is imported. There are, however, various examples of Australian-farmed 'substitute caviar' on the market: eggs derived from other fish species (Bronzi & Rosenthal 2014). These examples are harvested from Murray cod, scampi, trout, salmon and other species (Lynch, 2023a; Turner, 2022). Market demand for caviar substitutes

continues to increase globally and therefore remains a viable option for Australia to increase its production (Sicuro, 2019).

A proposal in 2016 to the Australian Government to import beluga sturgeon and Siberian sturgeon, initiated a biosecurity risk assessment by the Department of Agriculture, Water and the Environment (DAWE, 2022) under the Environment Protection and Biodiversity Conservation Act 1999 (DAWE, 2022). However, before these species of sturgeon and their alive eggs can be imported for aquacultural purposes, the biosecurity risk assessment needs to be completed and an appropriate level of protection needs to be determined, for commercial aquaculture of sturgeon to occur (DAFF, 2023b; DAWE, 2022).

If the import of these species of sturgeon is allowed, this will open many economic opportunities for aquaculture in Australia in the luxury food market. However, following on from the above biosecurity measures, there are various additional constraints that need to be considered and these are the focus in this analysis. These include: high investment and production costs; long investment periods before a net-positive financial return; cash flow concerns while waiting for the sturgeon to mature; the decrease of global prices due to China's dominance of global supply; and consumers' willingness to pay (Chin *et al.*, 2020; DAFF, 2023b; EUMOFA, 2021; Sicuro, 2019).

Opportunities to overcome these constraints and develop the Australian caviar and substitute caviar value chain are also discussed. Being a luxury, high-priced, consumer-driven product that is expensive to produce, this market has a greater focus on being responsive compared to a low-cost product value chain. It is particularly important for future development that customer needs, expectations and attitudes are accurately identified to enable maximum value chain responsiveness. As caviar consumers have changed over the last decade, it is also important to consider modern societal changes (such as increased populations with higher incomes) in future marketing and product development strategies (Sicuro, 2019).

Overall improved strategic fit by focussing on these opportunities will lead to a greater value chain surplus benefiting both consumers and the whole value chain (Mounter *et al.*, 2016). A focus on sustainability, provenance, traceability, and Australia's clean and green environment will offer a point of differentiation with lower-priced imported caviar and caviar substitute alternatives. Value chain coordination, via collaboration and communication across all actors will enable maximised value chain surplus and contribute to the success of a new caviar industry and improved substitute caviar value chain in Australia.

## **Current Australian Caviar Market**

### **Main participants**

The sturgeon caviar and substitute caviar value chain can be viewed in Figure 3, which shows the interactions of information, cash flow and product exchange between different actors. Currently, there is a need for data collection regarding information flow and financial flows between all actors of the chain.

Production, imports and distribution, and consumers of the value chain are described in detail below.

### **Production**

As noted above, currently the production and live import of sturgeon fish into Australia and, consequently, the production of true caviar, is prohibited due to sturgeon fish being considered a noxious species within Australia (DAWE, 2022). All true caviar consumed in Australia is imported.

There are, however, numerous substitute caviars produced in Australia. When marketed, the species name must preface the term 'caviar' to indicate that it is not true sturgeon caviar (Huon Aquaculture, 2022). Australian-produced caviar substitutes include Murray cod, scampi, mullet, trout, and salmon caviar, amongst other fish and crustacean species (Hughes, 2022; Lynch, 2023a; Turner, 2022). There continues to be market demand for caviar substitutes. This may be due to either demand for lower-priced caviar for new consumers, general competition with true caviar, or the lack of availability of locally produced caviar on the market (Sicuro, 2019).

Globally, it is estimated that caviar substitutes from various species have been producing up to 50,000 tonnes per annum and global markets are expanding (Sicuro, 2019; Tavakoli *et al.*, 2021). Therefore, there is potential to grow substitute caviar production and increase exports in Australia. Yarra Valley Caviar (YVC), based on the Rubican River in rural Victoria, produced 30 tonnes of salmon caviar as of 2022 (Yarra Valley Caviar, 2023; Wilden, 2022). However, there is no readily available information on the total quantity of substitute caviar produced in Australia, and on the quantities sold in Australia and exported internationally. Primary data collection is needed to understand the whole supply chain.

### **Australian imports and distribution**

In 2021, Australian sturgeon caviar imports were valued at \$3.6 million, increasing from \$2.1 million in 2012 (DAFF, 2023b). Within one year, imports almost doubled, with 2.6 tonnes of caviar being imported in 2020 and 5 tonnes imported in 2021 (DAFF, 2023b). As Australia's market for caviar is quite small, domestic producers would initially be highly reliant on the export market to ensure they achieve production growth (DAFF, 2023b).

Currently, Simon Johnson is the largest Australian importer of caviar and in 2022, brought in 2.7 tonnes of caviar (Hughes, 2022). From 2019-2022, this Australian luxury food import business saw a year-on-year uptake of 280 per cent (Hughes, 2022). Simon Johnson acts as a distributor and wholesaler, has five retail outlets and sells direct to consumers through their online store (Simon Johnson, 2023).

Although there is market data about total global exports of caviar (see Figure 2), there is no available data regarding country-of-origin across total imports into Australia. However, given that Simon Johnson and Yarra Valley Caviar are two of Australia's biggest importers of caviar, and the brands imported include Black Pearl (using Italian and Chinese produced caviar), Ars Italica from Italy, and Polanco from Uruguay, it can be assumed that the majority of imports into Australia are of Chinese, Italian and Uruguayan origin (Simon Johnson, 2023; Yarra Valley Caviar, 2023).

### **Leading exporters of caviar**

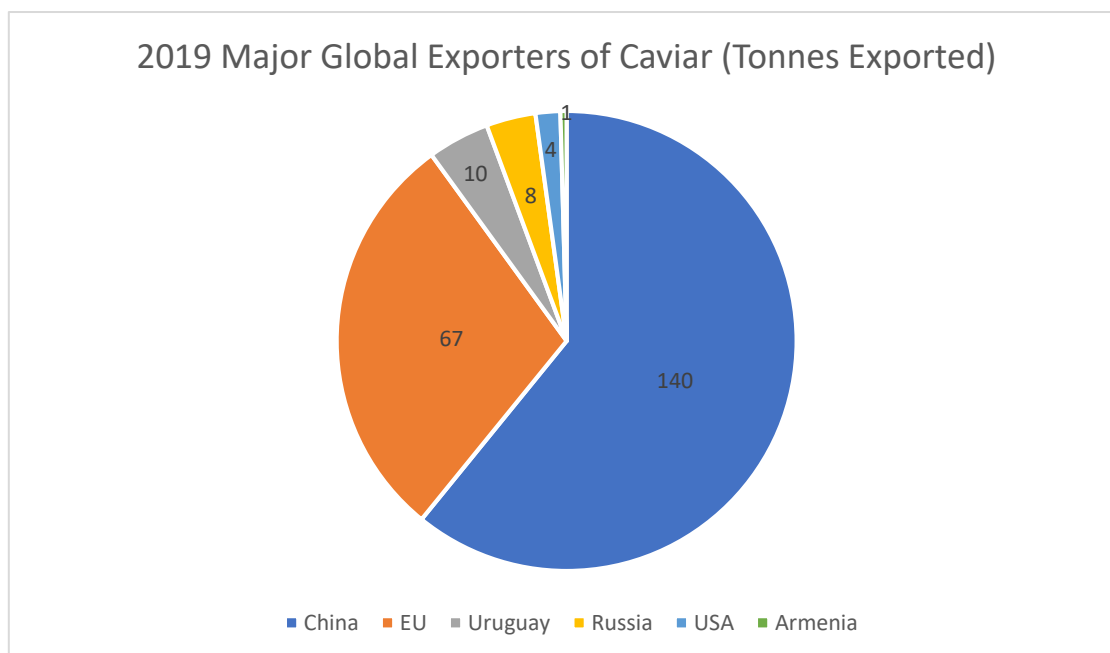
The major global exporting regions are China and the European Union, as shown in Figure 2.

### **Consumers**

Caviar consumers have traditionally purchased this product as a luxury and exclusive good (Sicuro, 2019). However, caviar is not as exclusive as it once was. The market expansion of caviar has occurred due to the increase in luxury buyers, the increase in middle-class consumers, the diversification of caviar products and substitutes, and the decrease in overall world price due to China's lower production cost supply (Chin *et al.*, 2020; Sicuro, 2019). With increased consumer income and growing

populations both domestically and globally, demand for luxury items such as caviar is expected to grow (CSIRO, 2023).

**Figure 2. 2019 leading exporters of caviar, tonnes**



Source: EUMOFA (2021); Hughes (2022)

## Value Chain Map

A value chain map (Figure 3) was created to show the flow of information, product and cash between various participants of both the caviar and substitute caviar value chain in Australia. It visually describes the efforts of vertical integration by major suppliers/producers in the chain, including their efforts of supplying to a range of market channels and direct to consumer. It also shows the lack of locally-produced caviar on the market due to the current policy prohibiting farming of sturgeon and consequently prohibiting Australian produced sturgeon caviar. The current market clearly has a focus on premium and luxury market channels, due to the price paid for caviar and caviar substitutes.

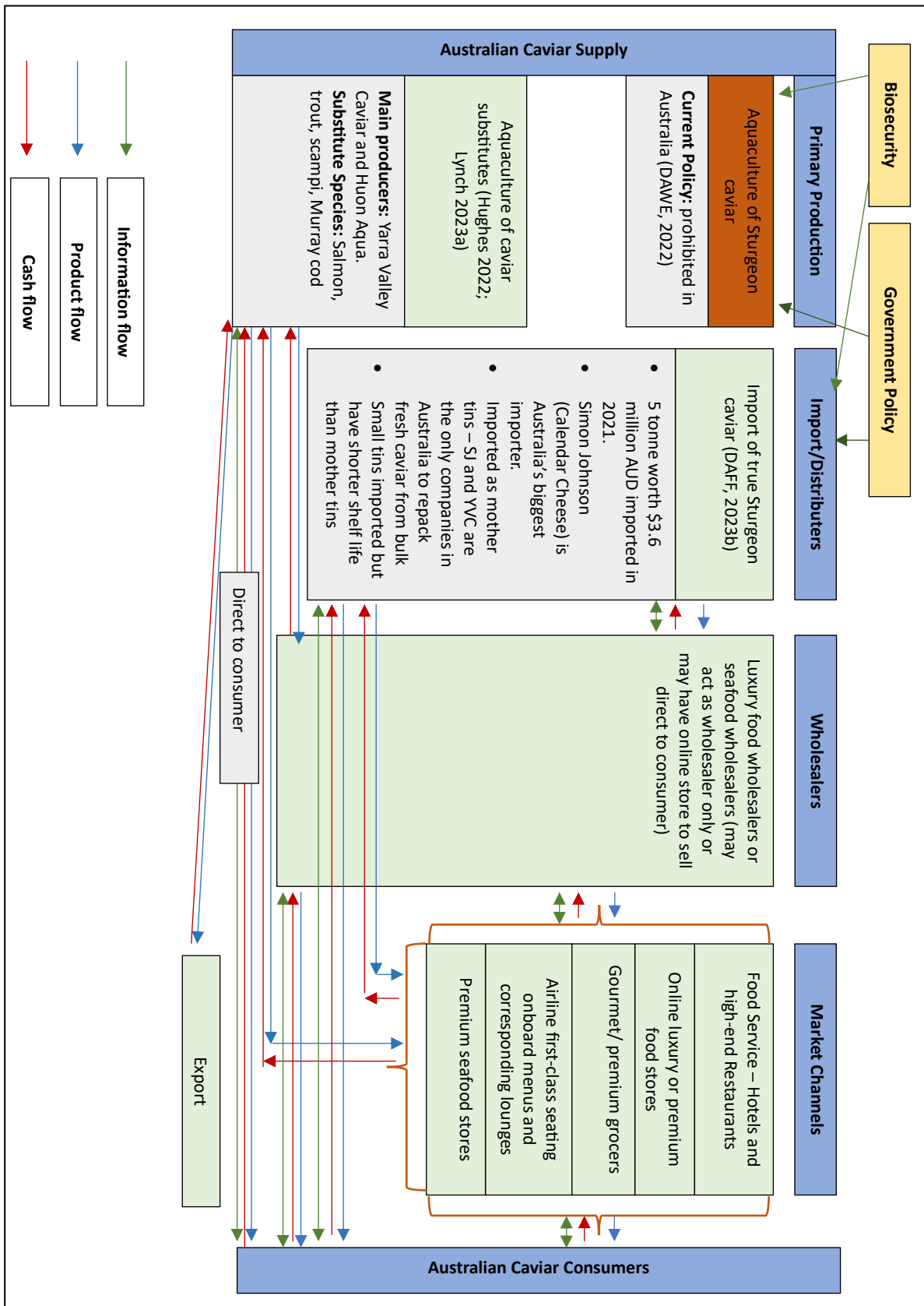
## Value Chain Drivers

### Logistical

For a substantial portion of the Australian caviar and substitute caviar market, vertically integrated business models have been used by Australia's two largest importers: Simon Johnson (SJ) and Yarra Valley Caviar (YVC). For example, YVC operate a vertically integrated system where they hatch, grow, harvest and sell substitute caviar direct to businesses and consumers (Yarra Valley Caviar, 2023). They also import true sturgeon caviar (as one of Australia's biggest caviar distributors), giving them further knowledge in supply and demand of the sturgeon caviar and substitute caviar markets.

SJ also operates a vertically integrated value chain. This business is the top importer of sturgeon caviar in Australia and acts as a distributor to food service and retail businesses, while also selling direct to consumers through their online store and retail stores.

Figure 3. Value chain map of the Australian caviar and substitute caviar industry, 2021, including information flows (green arrow), product flows (blue arrow) and cash flows (red arrow)



Source: authors own, based on DAFF (2023b); DAWE (2022); Hughes (2022); Lynch (2023a); Simon Johnson (2023); Thorn (2023); Wilden (2022); Yarra Valley Caviar (2023)

This vertically integrated business model gives them opportunity for responsiveness towards market demand and supply and reduces their competition against other Australian importers and distributors in the market. SJ's retail stores and their national distribution centre using the Calendar Cheese Company have been strategically placed in Australia. Their retail stores are in several of Australia's wealthiest suburbs with populations that have some of the country's highest weekly incomes, including Toorak in Victoria, Woollahra and Northbridge in New South Wales, and Subiaco in Western Australia (Simon Johnson, 2023; ABS, 2021). Their distribution centre is located in Truganina, Victoria, where they can have up to 100kg available in the caviar room at any given point. It is conveniently located 25 minutes from the Victoria International Container Terminal for ease of delivery of imports (Simon Johnson, 2023; Calendar, 2023). The business model of SJ's provides a capability of high responsiveness to consumer demand while centralising business to gain economies of scale.

Currently, two of the largest caviar substitute production facilities include YVC in Victoria and Huon Aquaculture in Tasmania, who both harvest salmon and trout caviar (Turner, 2022). Tasmania is currently Australia's largest aquaculture production state (ABARES, 2021). Both companies have continually invested in the growth of their facilities and infrastructure, resulting in improved economics of scale. YVC also act as the exclusive Australian importer of Polanco (sturgeon) Caviar from Uruguay (Turner, 2022). Their ability to store large quantities of caviar on site, results in greater responsiveness to consumer demand.

From information available, Simon Johnson and Yarra Valley Caviar are the only two importers of sturgeon caviar in Australia that are currently certified and have close relationships with the producers to enable them to buy bulk caviar 'mother tins', which are repackaged into smaller sizes dependent on the buyer's needs (Downs, 2023; Calendar, 2023; Yarra Valley Caviar, 2023). Through conversation with Lisa Downs, Sales Manager and Caviar Ambassador for Simon Johnson (2023), it was explained that caviar is cured with salt in these large mother tins, which is essentially a maturing process to develop complexity the longer it ages. When selling these mother tins to distributors for repackaging, the producer wants to completely trust the importer to ensure the quality of their product is being maintained at the consumer end of the value chain. Downs (2023) clarified that, although there is no overall current governing body to certify this overall process (due to it being such a niche market), there are various certifications required for repackaging to occur, including: facility and process approval through their local governing food safety body; HACCP accreditation due to the high risk environment; and CITES import and export approval by both the producer/exporter and importer/repackager to ensure that traceability and the integrity of responsibly-sourced caviar is occurring. Once repackaged into smaller tins, this starts the decline in shelf life and twelve weeks remain for it to be consumed. As CITES permits take six weeks (simultaneous applications by both the exporter and importer) to be approved, if importing just the small tins of caviar, this only gives these tins six weeks shelf life from permit approval, limiting the time for the product to be sold to market. This opportunity to import mother tins is an example of 'value chain thinking', where sharing information and working together from producer to importer/distributor creates greater control over the shelf-life of the product, increases responsiveness, and results in greater opportunity to sell the caviar to a wider market.

Both YVC and SJ also offer direct-to-consumer sales, by incorporating e-commerce into their business models, where consumers can order direct through each company's online store (Simon Johnson, 2023; Yarra Valley Caviar, 2023). Although this may increase overall transportation costs to the consumer, it increases responsiveness, resulting in greater value for the consumer.

### **Cross-functional drivers**

All sturgeon caviar is imported into Australia, while substitute caviar is both produced in Australia and imported (DAFF, 2023b; Hughes, 2022; Wilden, 2022). To decrease import costs and to increase economies of scale in the distribution of true caviar, both YVC and SJ have invested in caviar maturation and re-packaging facilities (Simon Johnson, 2023; Yarra Valley Caviar, 2023). Both are able to sell their caviar and roe at a range of premium prices dependent on the type of caviar/caviar substitute, which can be seen in Table 1. YVC have also started value-adding to their substitute caviar to include options such as truffle- or gin-infused salmon caviar (Yarra Valley Caviar, 2023).

**Table 1. Comparison of pricing for various 30g sturgeon caviar and substitute caviar examples from the online stores of Yarra Valley Caviar and Simon Johnson**

Caviar and Substitute Caviar Prices through Simon Johnson and Yarra Valley Caviar Online Australian Stores (prices in \$A/50g)			
Online Store	Brand	Type of Caviar/Substitute	Price
Simon Johnson	Black Pearl	Sterling White	\$158.95
Simon Johnson	Black Pearl	Siberian	\$193.00
Simon Johnson	Black Pearl	Oscietra Gold	\$224.95
Simon Johnson	Black Pearl	Beluga	\$350.90
Simon Johnson	Ars Italica	Oscietra	\$224.95
Simon Johnson	Simon Johnson	Salmon Caviar	\$33.45
Yarra Valley Caviar	Polanco	Siberian Reserve	\$122.90
Yarra Valley Caviar	Polanco	Oscietra Grand Reserve	\$149.90
Yarra Valley Caviar	Yarra Valley Caviar	Salmon Caviar	\$26.90
Yarra Valley Caviar	Yarra Valley Caviar	Salmon Caviar First Harvest	\$41.50*
Yarra Valley Caviar	Yarra Valley Caviar	Rainbow Trout Pearls	\$41.50*
Yarra Valley Caviar	Yarra Valley Caviar	Truffle Infused Trout Pearls	\$57.80*

\*note: Calculated 50g by using price per 30g

Source: Simon Johnson (2023); Yarra Valley Caviar (2023)

Information transfer across the value chain is an important driver to increase value for all actors involved (Chopra & Meindl, 2013). Businesses that provide additional information including exact location of manufacture, re-packing location (if relevant), aquaculture practices, harvesting methods and sustainable practices, are adding value to the chain, and consequently to the end buyers and consumers. YVC is a good example of a producer creating additional value for buyers and consumers who purchase their product, as they offer full transparency about their methods, practices, and certifications on their easily accessible website.

There are many circumstances where information about the egg harvesting method is not passed onto the consumer. As consumers are becoming more concerned with production methods and place of production, it is important that accurate information is easily accessible by the buyer and consumer (Browne *et al.*, 2000; Kappel, 2019).

It also appears that, when sellers of caviar refer to it being 'sustainable', quite often there is limited information about what defines this claimed sustainability. When it exists, most of the time it seems to be referring to it being farmed and not 'wild-caught'. Limited regulation about using the term 'sustainable' can be misleading for consumers and opens up an additional opportunity for certification and increased communication about sustainable practises with consumers. YVC, again, is a good example of a business which elaborates on its sustainable methods.



## Assessment of Performance - Strategic Fit and Profit Drivers

Being a global luxury product, the caviar value chain is not one to operate at low price, but instead be responsive to the market and be sold at a premium. In the past it has been seen as a product consumed only by the extremely wealthy. However, more consumers can now afford to buy caviar and other luxury goods, and therefore the market needs to be more responsive than ever (Sicuro, 2019). The cost of production of caviar is very high, therefore selling caviar to the consumer at a high price is necessary to ensure profitability for all actors in the value chain.

Although sturgeon caviar cannot currently be produced in Australia, caviar substitutes such as salmon and trout roe offer a premium product, albeit at a lower price (see Table 1), which can be differentiated in terms of local and sustainable production (for example, by YVC). These operate as a luxury extension, which create a greater opportunity for responsiveness in the caviar market to the middle-higher class consumers (Sicuro, 2019).

The 280 per cent year-on-year uptake of consumption (over the last three years) through SJ's yearly caviar sales, and overall global growth predicted for both sturgeon caviar and substitute caviar, are good indicators that demand, and consequently supply, in Australia will continue to expand (Bronzi *et al.*, 2019; DAFF, 2023b; Hughes, 2022).

Although luxury consumers are a small portion of society, they are the core target market for caviar sales (Sicuro, 2019). These consumers have a high willingness to pay, as caviar is purchased for its prestige and rarity, with the most expensive caviar being Strottarga Bianco Siberian Albino caviar at \$USD113,630/kg (Chayanin, 2023; Sicuro, 2019). Depending on the quality, colour, and sturgeon species, this will determine the grade and consequently price and greater profitability (Yarra Valley Caviar, 2023). Differentiating caviar products through caviar type, sustainable practices, or being locally produced can help increase retail prices and overall value chain surplus (Yarra Valley Caviar, 2023; Chin *et al.*, 2020; Mounter *et al.*, 2016; Sicuro, 2019).

Given that all of Australia's sturgeon caviar supply is currently being imported into the country, this does reduce the responsiveness of the import-based chain and creates an opportunity for the production of Australian-farmed caviar to occur. To increase performance of the chain, a focus on sustainability, reporting, information available to customers, and traceability would also bring benefits to the chain. Much like in Mounter (2016), where value chains featuring similar attributes in the 'paddock to plate' beef industry resulted in a more responsive value chain, improved strategic fit, and a potentially higher overall surplus for the whole chain.

## Constraints on the Industry

### Biosecurity requirements and procedures

A 'live import list' amendment under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) to include beluga and Siberian sturgeon imported into Australia, occurred in 2015 by the then government's Department of Environment and Energy. Under this Act, to import these species, a permit must be issued by the current Department which only covers these species to be farmed in commercial aquaculture settings that feature a secure recirculation aquaculture system (RAS) (DAWE, 2022). This is to ensure that the sturgeon species are not capable of establishing in the wild as a pest species.

Any proposal to import goods into Australia must undergo a risk analysis process as part of Australia's biosecurity policies, conducted by relevant technical and scientific experts (DAFF, 2023a). The

biosecurity risk analysis must achieve an appropriate level of protection (ALOP) for Australia and if not, risk management measures will be proposed to reduce these risks to an acceptable level (DAWE, 2022). Australia's ALOP should reflect community expectations via Government policy, while providing a high level of protection to reduce risk to a level as close to zero as possible (however risk will never be at zero) (DAWE, 2022).

Under the Biosecurity Act 2015, a Biosecurity Import Risk Analysis (BIRA) needs to be completed within 30 days, as a consequence of the lack of existing policy import conditions (DAWE, 2022). This is completed to assess whether there is an unacceptable biosecurity risk when no risk management measures are applied. If this is the case, it needs to be determined if the measures applied to reduce risk, achieve ALOP.

Due to a movement of departmental resources after the amendment in 2015 (due to funds being diverted to manage the response of the outbreak of white spot disease in Australian prawns), the due processes for biosecurity risk assessment were put on hold (DAWE, 2022). Therefore currently, importing live sturgeon and/or eggs is not legally able to occur, until conditions meeting this suitability are developed (DAWE, 2022).

On June 21<sup>st</sup> 2022, the Department of Agriculture, Fisheries and Forestry announced a Notice of Intention to proceed with a BIRA for the importation of live sturgeon for aquaculture (DAWE, 2022). Of the nine stage BIRA process (see Figure 4), the fourth step of releasing the draft BIRA report is now complete, with a 60-day consultation period with the public. It is currently in the fifth step – the development stage of writing the provisional BIRA report. The BIRA is considering the import of sturgeon species *Acipenser* and *Huso*, along with the biosecurity risks associated with importing both the live fish and reproductive material including unfertilised and fertilised eggs, and milt (DAFF, 2023b). There is no indication of timing for the conclusion of this BIRA process.

**Figure 4. Nine step BIRA process**



Source: DAWE (2022)

Although responsibility lies with the Australian Government for the regulation of animal and animal product movements in and out of Australia, territory and state governments are responsible for environmental controls and animal health in their own jurisdictions (DAWE, 2022).

One of the biggest concerns for allowing the import and farming of sturgeon species in Australian is the risk of disease. Although the most common sturgeon viral diseases typically only effect species of sturgeon, these species can transmit and carry other disease agents that could negatively impact domestic aquaculture and wildlife in Australia if transferred (DAWE, 2022). This could consequently also impact Australia's export market access for various commodities, and potentially result in Australian biodiversity loss (DAFF, 2023b). Of the possible and considered disease agents, 11 have been considered as potentially hazardous and were further analysed as part of the risk assessment.

With the 60-day public consultation process finishing 11<sup>th</sup> September 2023, all submissions received from public stakeholders regarding the draft BIRA report are, at the time of writing, being reviewed. An updated provisional BIRA report will then be provided taking into account any stakeholder comments, which will then be reviewed by the scientific advisory group (SAG). Considering any

recommendations from the SAG, the provisional report will be updated and published on the website and the World Trade Organisation and registered stakeholders will be notified. Finally, the last step will be to publish the final BIRA report, where import conditions and permits issued will be formed from these biosecurity recommendations (DAFF, 2023b).

Until the full BIRA process is complete, and import conditions are set to ensure biosecurity risk is at a level which meets Australia's ALOP, the import of sturgeon species *Acispencer baerii* and *Husu husu* for commercial aquaculture activities in secure RAS will not be able to occur.

### **High production costs**

Currently the cost structures of sturgeon recirculation aquaculture systems are uncertain, but feed, labour and electricity will all be key cost drivers (DAFF, 2023b). The high cost of aquaculture in Australia will require higher margins to cover these costs, and this will bring difficulties competing against those countries who have overall lower production costs and selling prices (Curtotti *et al.*, 2023).

Depending on the species, it can take more than a decade for sturgeon to reach maturity to harvest the first batch of caviar (Lynch, 2023b). In captivity, Siberian sturgeon take 6-8 years to reach maturity and beluga only reach maturity after 16 years (EUMOFA, 2021). Therefore, it will be many years before a return is experienced from such a significant initial investment, and it is hard to predict what the caviar market features will be in 10 years or more.

Although it might seem feasible to increase efficiencies by increasing stocking densities, this is not recommended. Quality is key in the production of caviar and higher stocking densities will likely impact the overall quality of the caviar produced (Dediu *et al.*, 2021). High stocking densities also bring the risk of increasing the prevalence of disease, presumably due to increased fish stress levels and increased transmission of disease agents (DAFF, 2023b; Dediu *et al.*, 2021).

### **Global supply and world price**

It is expected that the demand for sturgeon and substitute caviar will continue to increase (Lynch, 2023b; Sicuro, 2019). Domestic consumption of novel and luxury goods in Australia is expected to grow from \$1.0 billion in 2018 to \$1.1 billion in 2030, and it is expected these food products will also increase from \$1.1 billion to \$1.7 billion in export value by 2030 (CSIRO, 2023). This success is dependent on Australia's continued reputation for high value, quality, safety and sustainability (CSIRO, 2023).

Although sturgeon caviar products are sold at a premium, China's production of caviar is flooding the market, increasing supply and making it more accessible and cheaper in price (Chin *et al.*, 2020). As of 2019, the world's biggest consumers were Switzerland, France, the United States, the United Kingdom and Japan (Bronzi & Rosenthal, 2014). From 2015 to 2018, the wholesale price of caviar fell 58 per cent, causing smaller American caviar farms to struggle to make a profit (Chin *et al.*, 2020).

China's biggest producer is Kaluga Queen, which farms its 200,000 sturgeon in a man-made lake of 572 square kilometres (Chin *et al.*, 2020). The Deputy General Manager of Kaluga Queen was reported as stating that, over the next five years (2020-2025), the company plans on increasing production by 20-30 per cent more each year (Chin *et al.*, 2020). Therefore, as it is the world's largest supplier, it would be expected that the world price of caviar will continue to decline. Differentiation will be required to create value for the consumers, maintain a domestic premium and increase supply chain surplus.

### **Transparency in labelling**

Lack of labelling transparency and fraudulent mislabelling of sturgeon caviar has resulted in the adoption of strict labelling requirements by many countries, including those in the European Union, China and the United States (Sicuro, 2019). Nevertheless, there is currently no clear agreement on an international level for labelling requirements (Sicuro, 2019). Internationally recognised labelling requirements could include using the caviar labelling system recommended by the Convention on International Trade in Endangered Species (CITES). This requires all products to feature the species code, source code, country of origin ISO code, processing plant number, and lot identification number. As well, repackaged caviar must show: the year of harvest or re-package date, lot number and the producing plant registration code (Sicuro, 2019; TRAFFIC, 2009). However, due to China having difficulty marketing and selling Chinese-produced and -branded caviar (due to distrust of Chinese food safety and perception of quality), it is often difficult for the consumer to be able to tell where the product initially comes from, and many consumers can often mistake the branding for the country of origin (Campbell, 2017; EUMOFA, 2021; Mateer, 2017). For example, Chinese produced Kaluga Caviar (some of the finest in the world) is exported and repackaged under different countries' brands and labels. Black Pearl Caviar states that their product comes from 'the best farms in Europe and Asia'; however, there is no specific country of origin information available on their website (Black Pearl Caviar, 2017). Another example is 'Caviar Petrossian Paris', which is a French brand using the Chinese produced Kaluga Caviar (Mateer, 2017; Petrossian, 2023). Due to these difficulties marketing Chinese produced caviar, Petrossian will push its French branding to consumers (Mateer, 2017). Therefore, there is a need for strict, uniform labelling requirements worldwide and particularly if Australia creates a new industry reliant on promoting credence attributes linked to Australia as country of origin.

## **Opportunities to Overcome Constraints**

### **Production of Australian farmed sturgeon caviar**

If the current BIRA being conducted into the import of sturgeon in Australia concludes that the biosecurity risk is at a level which meets Australia's ALOP, the import of sturgeon species *Acispencer baerii* and *Husu husu* for commercial aquaculture activities in secure RAS is likely to occur.

Within Australia, aquaculture is the fastest growing livestock industry at a rate of 7 per cent per year and is expected to increase to meet global seafood demand (PIRSA, 2022). Tasmania and South Australia are the largest contributors to total aquaculture production in Australia, with both of these states featuring substantial existing aquaculture infrastructure (ABARES, 2021). Tasmania produced 87,029 tonnes, or 66 per cent, of Australia's total aquaculture volume (131,578 tonnes), and South Australia produced 14 per cent with 18,353 tonnes, in 2020-21 (ABARES, 2021).

Tasmania's aquaculture industry is predominately driven by one key species (salmonids) that contributes to the majority of its production (ABARES, 2021). Although salmonids are a potential suitable species to be polycultured (cultivating or growing two or more compatible organisms in a single area) with sturgeon, there is controversy and backlash from some of the local Tasmanian community about environmental pollution and degradation from the salmonid industry (Blackwood, 2023). Some push back could be experienced from the community upon increasing aquaculture production in Tasmania.

South Australia is considered one of Australia's most valuable aquaculture-producing states and is already committed to investing heavily into its aquaculture industry (PIRSA, 2022). It is recognised as producing premium, high-value seafood that is safe, sustainable and internationally recognised, in the context of a strong policy and regulatory framework (PIRSA, 2022). South Australia has already expressed interest in sturgeon aquaculture if regulation changes, and there are businesses who have

RAS land-based set-ups where sturgeon aquaculture could be incorporated into their business set-up (Lynch, 2023b; PIRSA, 2023a).

Although Victoria is one of the smaller contributors to Australia's overall total aquaculture production, one of its top key species which contributes to the 3,471 tonnes produced in the state is salmonids. Due to pre-existing land-based aquaculture set ups, and as salmonids make a suitable fish species to be polycultured with sturgeon (which could contribute to cash flow and profit while the sturgeon are maturing), a business such as YVC could potentially incorporate this into their production and business model (ABARES, 2021; DAFF, 2023b). However, investment into recirculation aquaculture systems (RAS) would be required to mitigate biosecurity risks.

Aquaculture businesses with current RAS set-ups and cold-chain logistics already in place will have an advantage in starting up a sturgeon farm, as initial investment into RAS for sturgeon is over many years and is substantial.

### **Focusing on sustainability, transparency and promoting Australia's 'clean & green' brand**

China currently controls the world price of caviar, due to Kaluga Queen dominating a third of the world's production. As well, they can tolerate low premiums due to their lower wage and production costs (Chin *et al.*, 2020). Due to the high cost of aquaculture production in Australia, it can be difficult to compete against those countries who have lower production costs (DAFF, 2023b). However, Chinese producers have had difficulty marketing their product (both domestically and globally) due to consumer perception being of low product quality, distrust with Chinese food safety, and lack of sustainable farming practices (Cramer, 2019; Mateer, 2017; Technavio, 2022). Although many caviar labels appear as a western brand, in very small writing it is common to see that caviar origin is China and consumers are not yet readily accepting of this (Mateer, 2017). Locally grown produce and traceability of food is becoming increasingly important for many consumers who are wanting to make informed, sustainable choices (Lehmann, 2021; Monash University, 2023). As power is one of the main cost drivers of aquaculture, focusing on using renewables to reduce power cost may be a consideration in the initial set-up phases of these facilities (DAFF, 2023b).

World-wide, Australia is known for its 'clean and green' environment and safe practices, but it is important that these credentials can be readily provided (Lehmann, 2021; PIRSA, 2022). A way that Australia can stand out on the world market is through differentiation by promoting the provenance and sustainability of each product. American producers of caviar have been able to remain competitive by differentiating their caviar by price, taste and labelling it as "Californian grown" (Cramer, 2019). Australian-grown caviar could promote 'reduced food miles' domestically and consequently add value to the consumer's purchase. Credentials such as BAP (Best Aquaculture Practices) Certification, where auditing is completed twice annually, can add a competitive advantage to the brand, showing that sustainable growing practices and ethical husbandry methods have been used (Yarra Valley Caviar, 2023). YVC are BAP certified and are renowned in Australia for their sustainability and ethical farming methods. Caviar De Riofrio are one of a growing number of businesses globally producing caviar who claim to be producing certified organic (Technavio, 2022). Technavio (2022) reported that organic caviar is predicted to be the best performing market segment between 2022 and 2027 compared to inorganic. With growing demand for organic caviar, where sturgeon farms do not use additives and hormones to increase the maturation time of the sturgeon fish, this could also be a point of differentiation to support Australia's 'clean and green' brand.

Decisions by future producers will need to include how the eggs are harvested from the sturgeon fish. Currently there are two main ways in which the eggs are harvested: harvesting (killing) the fish to then extract the eggs; or the 'no-kill' method (Leavitt, 2023). Most caviar producers use the kill method, as

this maintains a high-quality texture and flavour of the eggs. There are two 'non-kill' methods of extracting the eggs: using the milking method to massage the eggs out the sturgeon without cutting into the fish (hormones need to be administered to induce labour); or using the c-section method where a small incision is cut into the fish to access the eggs (although this method increases the risk of infection to the fish and can result in infertility) (EUMOFA, 2021). Although the 'non-kill' method can be considered by consumers as a more ethical and humane way of extracting the eggs, the hormone treatment required to induce birth reduces the quality of the eggs (both texturally and in flavour) (Leavitt, 2023). The eggs are then washed in a calcium bath to minimise this quality decline; however, this still does not result in the highest quality standard. Market research should be conducted on Australian caviar consumers as to their most preferred harvesting method if they were to purchase.

### **Exporting initial supply surplus**

As Australia's market for caviar is quite small, domestic producers would initially be highly reliant on the export market to ensure they achieve production growth (DAFF, 2023b). China, Hong Kong, India, Japan, Singapore and South Korea are all potential export markets that have growing demand for high quality caviar (PIRSA, 2023b). Within the Asia-Pacific region, the caviar market has grown, and will continue to grow, at a significant rate. This is due to the rising demand for health benefits that come from caviar, increasing consumer buying power, along with the distribution channel expansion (Tachnavio, 2022).

Australia is fortunate to have free trade agreements with two of the world's major caviar importers (the United States and Japan) (DAFF, 2023b). Given that Australia would have competitive advantage with those countries who share a free trade agreement, this puts Australia in a positive position to export this product internationally (DAFF, 2023b).

### **Creating additional value to production**

Because of the long period it takes to mature sturgeon before harvesting caviar (anywhere from 5-21 years), this means return on initial investment will be slow to arrive. One way to create a source of income and cashflow in the interim would be to farm some of the male sturgeon for their meat, which is readily eaten around the world (Lynch, 2023b). Although, as the meat is not commonly consumed in Australia, market research and brand work will need to be done to promote this style of fish to the Australian consumer. Otherwise, the focus will need to be on exporting sturgeon meat.

As mentioned above, polyculturing is another interim opportunity as a source of cash flow before gaining a return on the sturgeon caviar. Salmonids would be the most likely suitable fish species in Australia to be polycultured with sturgeon (DAFF, 2023b).

Although the core of caviar marketing is to luxury consumers, many luxury brands have opted for focusing on 'Masstige' positioning strategies (Sicuro, 2019). Masstige describes downward luxury extensions, which are luxury products that are attainable, lower in price than super-premium products, and are directed at middle-class consumers willing to pay a premium for well-made products (Silverstein & Fiske, 2003). Other species could also be farmed in the interim of sturgeon growth either for meat or to create a masstige market segment with substitute caviar.

### **Improving value chain coordination**

Success of the value chain will come about through coordination of all actors of the supply chain, resulting in maximised value chain surplus (Chopra & Meindl, 2013). According to Chopra and Mendel (2013) coordination of the value chain will result in decreased manufacturing costs, inventory costs,

replenishment lead times, transportation times, labour costs, fluctuations of product availability, and improved relationships across the supply chain. Improved coordination can come about through information sharing between different stages of the supply chain and from improved forecasting based on customer demand (Chopra & Meindl, 2013). A great example of value chain coordination is Simon Johnson with their direct relationships with caviar producers, and purpose-built facilities to repackage mother tins. This enables them to control fluctuations in availability and replenishment lead times, along with extending shelf life of the product, and having greater control over managing the caviar tin's shelf life.

In the establishment of an Australian-produced caviar market, and were it available, government investment and support in establishing local production and the supply chain would be very beneficial to help build relationships across the value chain. Communication between producers, buyers, and sellers of the chain will be crucial to maximise surplus and increase forecasting capabilities for the market. As caviar production will be a new industry to Australia, it will be important that owners and managers of sturgeon aquaculture farms build relationships and share information together, to enable discussion of production efficiencies, constraints and difficulties of sturgeon aquaculture, ensuring unnecessary labour and capital is reduced.

## **Conclusion**

The growing demand for caviar and caviar substitutes both domestically and internationally brings a great opportunity to review the current Australian caviar market and value chain. Through the analysis of the current market, actors of the chain, value chain drivers and strategic fit, constraints and opportunities were reviewed and suggested, respectively. This knowledge can be applied to improve the current value chain and bring further value to Australia's aquaculture and luxury food industries. As stated in Mounter (2016), successful value chains will result from time and effort being spent on the design and planning of chain management and operations, to create and increase chain surplus.

For an even greater understanding of Australia's caviar and substitute caviar markets, primary data will need to be collected about consumer preferences, and about information and financial flow across the chain, and about further export opportunities.

Providing biosecurity risk can be managed, and regulation to allow the import of sturgeon species is approved, sturgeon farming will be a great opportunity for the Australian aquaculture and luxury food product industry, particularly in states such as Tasmania, South Australia, and Victoria where sturgeon production seems feasible. However, although there is predicted demand for the next 5-10 years, the uncertainty of the future could have real implications on such a large investment as that required for sturgeon farming. By understanding the end buyers and consumers, and their changing needs, reviewing the market and value chain on a regular basis, and collaborating with all actors across the value chain, this should ensure a greater chance for a new industry to succeed. Polyculturing, investment into the production of caviar substitutes, and creating additional value from the farm will help create cash flow and mitigate risk in the meantime.

Given that caviar is a luxury food product, and customers have a high willingness to pay, creating value through responsiveness is important to ensure these consumers are satisfied in paying a high price. Ensuring there is a focus on provenance, sustainability, traceability, safety, and transparency, to differentiate these Australian products, should improve strategic fit and increase overall value chain surplus. By creating demand for a luxury product that offers a point of difference, such as one with these attributes, creates additional value and should enable an Australian caviar market to be able to successfully operate on a global scale and to mitigate the uncertainty of market demand.

## References

- ABARES 2021, *Fisheries and aquaculture statistics 2021*, viewed 15 July 2023 <<https://www.agriculture.gov.au/abares/research-topics/fisheries/fisheries-and-aquaculture-statistics/production#commonwealth-fisheries>>.
- ABS 2021, *2021 Census All persons QuickStats*, viewed 21 July 2023 <<https://www.abs.gov.au/census/find-census-data/quickstats/2021/SAL10465>>.
- Black Pearl Caviar* 2017, Holland & Wilde, viewed 02 July 2023, <<https://www.blackpearlcaviar.com/copy-of-our-caviar>>.
- Blackwood, F. 2023, *Opponents, defenders of Tasmania's salmon industry as entrenched as ever as fish farming continues to grow*, ABC, viewed 26 July 2023, <<https://www.abc.net.au/news/2023-05-20/the-fight-over-tasmanian-farmed-salmon/102352348>>.
- Bronzi, P., Chebanov, M., Michaels, J. T., Wei, Q., Rosenthal, H. & Gessner, J. 2019, 'Sturgeon meat and caviar production: Global update 2017', *Journal of Applied Ichthyology*, vol. 35, no. 1, pp. 257-266, viewed 18 June 2023 <[https://onlinelibrary.wiley.com/doi/full/10.1111/jai.13870?casa\\_token=9CQLnG5CkAIAAAAAA%3AdCpqvW\\_5eCbKjgyX3Izcj1skGCxxXjumVHWsg-tdJAzVLeFAzfHQihe\\_uCc-G\\_nVE3mYqjkQPofF4MICg](https://onlinelibrary.wiley.com/doi/full/10.1111/jai.13870?casa_token=9CQLnG5CkAIAAAAAA%3AdCpqvW_5eCbKjgyX3Izcj1skGCxxXjumVHWsg-tdJAzVLeFAzfHQihe_uCc-G_nVE3mYqjkQPofF4MICg)>.
- Bronzi, P. & Rosenthal, H. 2014, 'Present and future sturgeon and caviar production and marketing: A global market overview', *Journal of Applied Ichthyology*, vol. 30, no. 6, pp. 1536-1546. Viewed 18 July 2023 <<https://onlinelibrary.wiley.com/doi/abs/10.1111/jai.12628>>
- Browne, A. W., Harris, P. J., Hofny-Collins, A. H., Pasiiecznik, N. & Wallace, R. R. 2000, 'Organic production and ethical trade: definition, practice and links', *Food policy*, vol. 25, no. 1, pp. 69-89, viewed 25 July 2023, <<https://www.sciencedirect.com/science/article/pii/S0306919299000755>>.
- Calendar 2023, *Caviar Wholesale*, viewed 15 July 2023, <<https://www.calendarcheese.com.au/caviar-wholesale/>>.
- Campbell, C. 2017, 'Your High Quality Caviar Might Just Be Made in China', viewed 20 July 2023, <<https://time.com/5070817/china-caviar-beluga-sturgeon-farmed-kaluga/>>.
- Chayanin, P. 2023, '7 of the World's Most Expensive Types of Caviar', viewed 27 July 2023, <<https://www.prestigeonline.com/th/lifestyle/wine-plus-dine/worlds-most-expensive-caviar/>>.
- Chin, K., Shamo, L. & Abadi., a. M. 2020, *China is dominating the global caviar industry — and prices are plummeting because it's flooding the market*, Insider, 20 July 2023, <<https://www.businessinsider.com/china-caviar-prices-kaluga-queen-2020-2>>.
- Chopra, S. & Meindl, P. 2013, *Supply Chain Management: Strategy, Planning and Operation*, 5th Edition edn, vol. Chapter 10, Pearson Education Inc., Upper Saddle River, New Jersey, USA.
- Cormack, R. 2022, 'Caviar, Explained: Where to Find the Very Best and How to Serve It', viewed 20 July 2023, <<https://robbreport.com/food-drink/dining/what-is-caviar-where-to-source-the-very-best-and-how-to-serve-it-2884402/>>.



Cramer, L. 2019, 'Caviar prices stall as Chinese fish eggs flood market', viewed 20 July 2023 <<https://www.theaustralian.com.au/news/caviar-prices-stall-as-chinese-fish-eggs-flood-market/news-story/0f3a3118fb7efd77115ef5c1d638a04e>>.

CSIRO 2023, *Luxury and novel products*, viewed 20 July 2023, <<https://research.csiro.au/foodag/premium-interactions/luxury-and-novel-products/>>.

Curtotti, R., Dylewski, M., Cao, A., & Tuynman, H. 2023, *Australian fisheries and aquaculture outlook to 2027–28*, Australian Government, <[https://daff.ent.sirsidynix.net.au/client/en\\_AU/search/asset/1034561/0](https://daff.ent.sirsidynix.net.au/client/en_AU/search/asset/1034561/0)>.

DAFF 2023a, *Biosecurity risk analysis*, <<https://www.agriculture.gov.au/biosecurity-trade/policy/risk-analysis>>.

DAFF 2023b, *Import of live sturgeon for aquaculture - Draft biosecurity import risk analysis*, Australian Government, <<https://www.agriculture.gov.au/sites/default/files/documents/draft-report-for-the-import-of-live-sturgeon-for-aquaculture.docx>>.

DAWE 2022, *Import of live sturgeon for aquaculture: Issues Paper*, Canberra, viewed CC BY 4.0, <<https://www.agriculture.gov.au/sites/default/files/documents/issues-paper-import-live-sturgeon-aquaculture.docx>>.

Dediu, L., Docan, A., Crețu, M., Grecu, I., Mogodan, A., Maoreanu, M. & Oprea, L. 2021, 'Effects of stocking density on growth performance and stress responses of bester and bester♀× beluga♂ juveniles in recirculating aquaculture systems', *Animals*, vol. 11, no. 8, p. 2292. Viewed 20 July 2023 <<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8388450/>>

Downs, L. 2023, Phone Conversation 20 October 2023

EUMOFA 2021, *The Caviar Market. Production, Trade and Consumption in and outside the EU*, European Market Observatory for Fisheries and Aquaculture Products, viewed 10 July 2023, <<https://www.eumofa.eu/documents/20178/449260/2021+-+The+Caviar+Market.pdf/04e7de02-bdc8-d0e2-96cb-59c730436b78?t=1620208745691>>.

Hughes, M. 2022, *Australian caviar production plans underway as federal biosecurity assessment continues*, ABC Rural, viewed 21 June 2023, <<https://www.abc.net.au/news/2022-09-14/farmer-pushes-to-produce-caviar-in-australia/101428980>>.

Huon Aquaculture 2022, 'HUON SALMON AND OCEAN TROUT CAVIAR ', no. 15, viewed July 2023, <<https://www.huonaqua.com.au/wp-content/uploads/2022/06/Caviar.pdf>>.

Kappel, M. 2019, 'Transparency In Business: 5 Ways To Build Trust', viewed 25 July 2023, <<https://www.forbes.com/sites/mikekappel/2019/04/03/transparency-in-business-5ways-to-build-trust>>.

Leavitt, D. 2023, *Caviar Harvesting: Where Does Caviar Come From? | How is Caviar Made?*, Caviar Star, viewed 22 July 2023, <<https://caviarstar.com/blogcaviar-harvesting-where-does-caviar-come-from-how-is-caviar-made/#:~:text=Unlike%20the%20classic%20method%20of,eggs%20without%20harming%20the%20ish.>>>.

- Lehmann, E. 2021, *A green and gold standard for Aussie-grown food*, CSIRO, <<https://www.csiro.au/en/news/all/articles/2021/august/a-green-and-gold-standard-for-aussie-grown-food>>.
- Lynch, J. 2023a, 'From plans to import beluga sturgeon to harvesting Murray cod, Australia's next luxury food', *The Australian*, <<https://www.theaustralian.com.au/business/from-plans-to-import-beluga-sturgeon-to-harvesting-murray-cod-australias-next-luxury-food/news-story/e12576f8d1c9822ad3e0468376a2bbac>>.
- Lynch, J. 2023b, 'Regulators considering sturgeon importation in order to start a premium caviar industry', *The Australian*, viewed 20 July 2023, <<https://www.theaustralian.com.au/business/regulators-considering-sturgeon-importation-in-order-to-start-a-premium-caviar-industry/news-story/554c601764c76e1fe941e7f3cef27c78>>.
- Mateer, N. 2017, 'The World Is Eating Chinese Caviar (And Doesn't Know It)', viewed 15 July 2023, <<https://www.thatsmags.com/beijing/post/17511/the-world-is-eating-chinese-caviar-and-doesn-t-know-it>>.
- Monash University 2023, 'Food Traceability and Provenance', viewed 20 July 2023, <<https://www.monash.edu/monashfoodinnovation/research-page/draft-food-traceability-and-provenance>>.
- Mounter, S., Griffith, G. & Fleming, E. 2016, 'Achieving better strategic fit and higher surplus for Australian beef value chains by recognising and countering chain failure', *Animal Production Science*, vol. 57, no. 8, pp. 1767-1774, viewed 20 July 2023, <<https://www.publish.csiro.au/an/AN15460>>.
- Petrossian 2023, *Tsar Imperial Kaluga Huso Hybrid*, viewed 20 July 2023, <<https://www.petrossian.com/tsar-imperial-tm-kaluga-huso-hybrid>>.
- PIRSA 2023a, *Land-based aquaculture*, viewed 27 July 2023, <[https://pir.sa.gov.au/primary\\_industry/aquaculture/landbased\\_aquaculture](https://pir.sa.gov.au/primary_industry/aquaculture/landbased_aquaculture)>.
- PIRSA 2023b, *Opportunities for South Australia in Caviar*, PIRSA, <[https://www.pir.sa.gov.au/\\_\\_data/assets/pdf\\_file/0005/287708/Market\\_Opportunities\\_Luxury\\_Products\\_-\\_Caviar.pdf](https://www.pir.sa.gov.au/__data/assets/pdf_file/0005/287708/Market_Opportunities_Luxury_Products_-_Caviar.pdf)>.
- PIRSA 2022, *ZONING IN: South Australian Aquaculture report*, <[https://pir.sa.gov.au/\\_\\_data/assets/pdf\\_file/0004/428656/zoning-in-sa-aquaculture-report-2022.pdf](https://pir.sa.gov.au/__data/assets/pdf_file/0004/428656/zoning-in-sa-aquaculture-report-2022.pdf)>.
- Sicuro, B. 2019, 'The future of caviar production on the light of social changes: a new dawn for caviar?', *Reviews in Aquaculture*, vol. 11, no. 1, pp. 204-219, <[https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12235?casa\\_token=A3YT1Flrm50AAAAA%3ARL9C18LjDxw8XcNVC15TXwKm7eCSRdA2CkGE0eINBhiidP6lZlvjOCbfnNAFgUjgC6J7RDOoEuHPut8Z](https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12235?casa_token=A3YT1Flrm50AAAAA%3ARL9C18LjDxw8XcNVC15TXwKm7eCSRdA2CkGE0eINBhiidP6lZlvjOCbfnNAFgUjgC6J7RDOoEuHPut8Z)>.
- Silverstein, M. J. & Fiske, N. 2003, 'Luxury for the masses', *Harvard business review*, vol. 81, no. 4, pp. 48-59. Viewed 15 July 2023 < <https://hbr.org/2003/04/luxury-for-the-masses>>
- Simon Johnson 2023, Simon Johnson, viewed 15 July 2023, <<https://simonjohnson.com/>>.

Tavakoli, S., Luo, Y., Regenstein, J. M., Daneshvar, E., Bhatnagar, A., Tan, Y. & Hong, H. 2021, 'Sturgeon, Caviar, and Caviar Substitutes: From Production, Gastronomy, Nutrition, and Quality Change to Trade and Commercial Mimicry'. Viewed 27 June 2023 <[https://www.researchgate.net/publication/348296880\\_Sturgeon\\_Caviar\\_and\\_Caviar\\_Substitutes\\_From\\_Production\\_Gastronomy\\_Nutrition\\_and\\_Quality\\_Change\\_to\\_Trade\\_and\\_Commercial\\_Mimicry](https://www.researchgate.net/publication/348296880_Sturgeon_Caviar_and_Caviar_Substitutes_From_Production_Gastronomy_Nutrition_and_Quality_Change_to_Trade_and_Commercial_Mimicry)>

Technavio 2022, *Caviar Market by Product, Distribution Channel, and Geography - Forecast and Analysis 2023-2027*. Copyright of Infiniti Research Limited and its licensors. All Rights Reserved.

Thorn, A. 2023, 'Qantas Offers 'Larger Portions' And Calvisius Caviar In Menu Refresh' Australian Aviation, viewed 23 July 2023 <<https://australianaviation.com.au/2023/03/qantas-offers-larger-portions-and-calvisius-caviar-in-menu-refresh/>>

TRAFFIC 2009, CITES, viewed 20 July 2023, <[https://cites.org/sites/default/files/vc-files/files/universal\\_labelling\\_requirements\\_caviar.pdf](https://cites.org/sites/default/files/vc-files/files/universal_labelling_requirements_caviar.pdf)>.

Turner, A. 2022, *Jewels of the sea: all about roe*, Eativity, viewed 15 July 2023, <<https://eativitynews.com/jewels-of-the-sea-all-about-roe/>>.

Wilden, N. 2022, 'Yarra Valley Caviar may not be 'real' but it packs a huge pop', viewed 3 July 2023, <<https://www.afr.com/life-and-luxury/food-and-wine/pop-goes-the-roe-yarra-valley-caviar-comes-to-a-restaurant-near-you-20221019-p5bqyw>>.

Yarra Valley Caviar 2023, viewed July 3 2023, <<https://www.yarravalleycaviar.com.au/>>.