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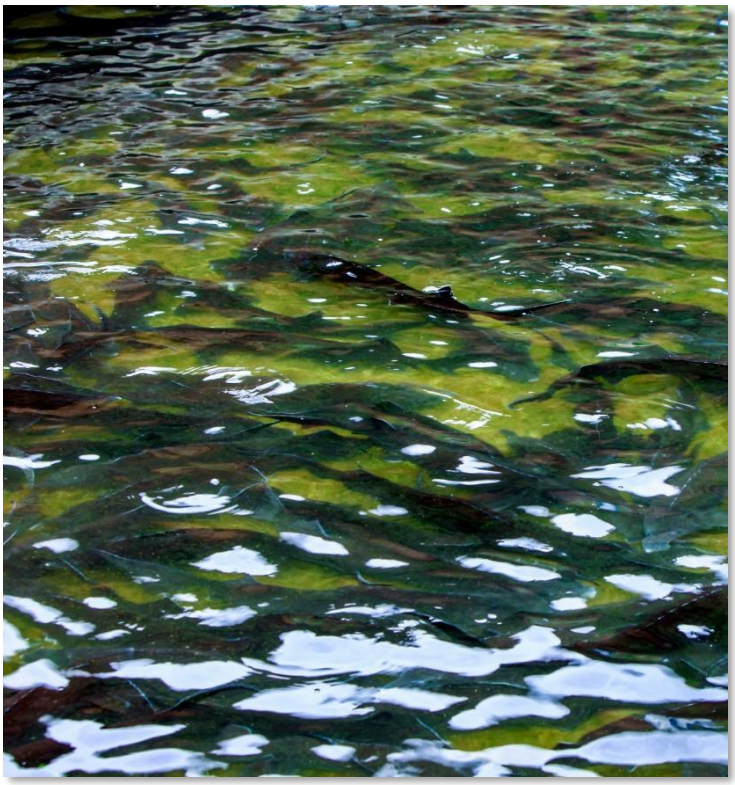
Sturgeon aquaculture in Australia: feasibility study



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Contents

Tables

Figures

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Executive Summary

This project examined the feasibility of farming sturgeons in Australia. These large fish in the Acipenseridae are the source of caviar, one of the world's highest value luxury goods. Australian aquaculture has goals to expand and one way to achieve this is to farm high-value products that require technology and high-quality environments in which Australia can deliver a competitive edge. Sturgeons are not native to Australia and the project aimed to collate information to assess if sturgeon farming in Australia is biologically and technically feasible; and if so, to gather material that could support the import of sturgeons.

A major component of the project was ongoing dialogue with the Australian Government Department of Agriculture, Water and the Environment (DAWE), the regulatory authority for importing biological commodities into Australia. The information aimed to provide input to processes, including Biosecurity Risk Analysis, that are used by DAWE to inform development of import conditions.

Project staff engaged with local and overseas experts and industry and developed networks that will be useful if an industry develops. Sources of stock were identified for eventual establishment of an Australian industry.

We assessed the business feasibility of an Australian sturgeon industry by developing a business case including a projected cost-profit model. This assessment concluded that farming sturgeons in Australia is biologically and technically feasible and has a 10-year lifecycle to profit if developed as a mixed sturgeon-trout farm. Caviar demand and sales are increasing but there are substantial threats to an Australian caviar industry. There is extensive caviar production in China which is likely to continue to grow, and world caviar prices have fallen substantially since 2010, although wholesale prices in Australia have remained high and stable over the same period.

The project team was unable to develop and negotiate approaches to overcome the regulatory barriers to importing sturgeons. Although clear pathways are identified, import consent remains a difficult goal. Alternative arrangements were rejected as an approach by DAWE in August 2020. For sturgeon import to Australia to occur, DAWE needs to commence and complete a Biosecurity Import Risk Assessment (BIRA), but DAWE lacks available resources to commence that assessment. Substantial data have been collated by this project to contribute to a BIRA. Continued effort from industry will be required if sturgeon import is going to occur, but it is also possible that the perceived benefits do not justify the work required.

Keywords

Sturgeon, beluga, Siberian sturgeon, caviar, aquaculture, Australia, feasibility study.

Introduction

Australian aquaculture needs to grow to improve production, provide seafood in response to growing demand and provide development and employment in regional areas. One way to expand Australian aquaculture is to diversify the industry to include more species that have demonstrated commercial development. The Australian Government Department of the Environment amended the Australian Live Import List in 2015 to include two species of caviar-producing sturgeon (family Acipenseridae): Siberian sturgeon (*Acipenser baerii*) and beluga (*Huso huso*).

Market demand for caviar remains high. Sturgeons, particularly the commercial species from the Black and Caspian Seas which made up the bulk of supply of caviar in the 20th century, have undergone a dramatic decline mainly exhibited in the 1990 and 2000s (Bronzi *et al.* 2019). This was caused mainly by legal and illegal overfishing, habitat deterioration, river fragmentation including damming rivers and pollution. These species are now protected in all native range states and listed in Appendices II and I of the Convention on International Trade in Endangered Species (CITES) regulations (CITES 2020). Legal fisheries for very limited quantities exist only in a few countries (e.g. Russia, Canada, USA). Wild populations continue to decrease (Bronzi and Rosenthal 2014) particularly in the Caspian Sea (Haxton and Cano, 2016). In the 21st century, caviar from farmed sturgeon entered the market and substituted production from fisheries. Although some market sectors demand wild products, farmed caviar has similar acceptance to wild origin product (Bronzi *et al.* 2019) and demand for caviar continues to grow (Sicuro 2019) including in Australia (Mobsby and Bath 2017).

The desirability of caviar and its high market price motivated substantial local farming interest, and PIRSA Fisheries and Aquaculture Division, has received numerous queries indicating commercial interest to commence sturgeon aquaculture in Australia. The Aquaculture Committee (AC) of the Australian Fisheries Management Forum (AFMA), furthermore, gave support to investigating the potential of sturgeon aquaculture in Australia. AC members cited availability of technical information on Acipenserid fish, established domestic and export markets, high value of caviar and sturgeon meat products and successful aquaculture businesses growing these species in a number of countries. Although sturgeon aquaculture appears to be a technically viable in Australia; engagement between PIRSA and the DAWE identified that PIRSA's request to have these species assessed and to obtain import consent was ranked as 'low priority' and that it is likely to be a multi-year process to obtain consent for import.

Consequently, this project conducted to collate information and provide inputs such as risk analyses and other information for DAWE to contribute to obtaining import consent, while engaging with overseas experts and industry to identify sources of stock for eventual establishment of an Australian industry. The project also had technical aims to:

- identify containment criteria for farming sturgeon after they are released from a DAWE Approved Arrangement (AA) to commercial aquaculture
- develop a business case to assess if sturgeon aquaculture in Australia is viable
- undertake import risk assessment for sturgeons on the live import list
- provide regulatory guidelines for farming sturgeons in Australia
- assess the viability of sturgeon aquaculture in Australia

The project included attendance at the European Association of Fish Pathologists (EAFP) meeting in Porto, Portugal in September 2019 to build and consolidate the network of sturgeon experts. The authors of this report were unable to attend EAFP, but proceedings from that meeting were used in the hazard identification for the risk assessment in this report, and several speakers are listed on the network of experts. Instead, this report provides containment criteria for the AA, which could be used for quarantine of sturgeon after import and prior to release into Australia, and domestic containment recommendations and a basis for developing a biosecurity plan for Australian sturgeon farming. The containment criteria can be used to develop guidelines for transitioning from Australian Government control in an AA to State or Territory control in an aquaculture facility.

Objectives

This project had the following objectives:

1. Determine requirements for importing sturgeons into Australia
2. Develop and maintain networks to establish and maintain sturgeon aquaculture in Australia
3. Develop desktop understanding of feasibility of sturgeon aquaculture in Australia
4. Provide information to facilitate import of sturgeons to Australia

Methods

Containment, transfer and regulatory criteria

The AA criteria are derived from Approved Arrangement Category 7.7 - Laboratory fish. The AA criteria are controls used to hold fish in a secure environment prior to release from quarantine. The Department of Agriculture will confirm these when an application is made to import sturgeon. These criteria form the basis for the Quarantine Containment risk assessment, and the standards for containment and transfer are based on the Australian/New Zealand Standards AS/NZS 2982.1:1997: Laboratory Design and Construction and AS/NZS 2243.3:2010 Safety in Laboratories. The transfer criteria also include some aspects of the Guidelines for Certification of a PC2 Aquatic Facility. Regulatory criteria are derived from these controls transferred into a licensing framework with guidance about the best methods for implementation (primarily aquaculture license conditions and/or biosecurity plans).

Hazard identification and risk assessment

Hazards were identified by compiling all reports of diseases and pathogens recorded in sturgeon. These were prioritised for further analysis in the risk assessment based on whether the pathogen is internationally or nationally notifiable, if it is present in the proposed export area (mainly Eurasia) and whether it would have adverse effects if introduced to Australia. Pathogens that occur in the export areas but are not epidemiologically associated with sturgeons or which do not infect sturgeons were not identified as hazards.

In the risk analysis, risk estimations were made on a semi-quantitative basis because, as is the case with most aquatic animal risk assessments, there are insufficient scientific data to take a completely quantitative approach. The methodology used in this analysis was based on Fletcher (2005) and AQIS (1999), Biosecurity Australia (2009) and is consistent with AS/NZS ISO 31000:2018 Risk.

Risk analyses for establishment of disease and pest potential comprise two components:

1. ***likelihood of introduction, spread and establishment assessment***: the likelihood that the animal (genetics) or disease agent is introduced, spreads and establishes, and
2. ***consequence assessment***: the severity of impacts (ie. short term, long term and ongoing) resulting from that establishment.

All likelihoods or probabilities of an event occurring are assessed semi-quantitatively using the following descriptors modified from AQIS (1999), Department of Agriculture and Water Resources (2016):

High: Event would be expected to occur
Moderate: There is less than an even chance of the event occurring
Low: Event would be unlikely to occur
Very low: Event would occur rarely
Extremely low: Event would occur very rarely
Negligible: Chance of event occurring so small it can be ignored in practical terms

The likelihood of establishment considers release and exposure. Taking a precautionary approach, the likelihood of establishment is taken to be the lower of the two values for the release and exposure assessments.

The following range of terms are used to describe the significance or severity of likely consequences:

Extreme**:** associated with the establishment of disease / pest that would be expected to significantly harm economic performance at a State level over a long term. Would have a significant economic impact (i.e. employment) on regional areas. Alternatively or in addition, they may cause serious, irreversible harm to the environment (e.g. to wild endemic stocks).

High**:** associated with the establishment of disease / pest that would have serious biological consequences (e.g. high mortality, low production). Such effects would normally be felt for a prolonged period (greater than or equal to a normal production cycle) and would not be amenable to control or eradication. This would be expected to significantly harm economic performance at a 'whole' industry level. Alternatively or in addition, they may cause serious harm to the environment (e.g. to wild endemic stocks).

Moderate**:** associated with the establishment of disease / pest that would have less pronounced biological consequences. Moderate impacts may harm economic performance significantly at an enterprise/regional level, but they would not have a significant economic effect at the 'whole industry' level. This may be amenable to control or eradication at a significant cost, or their effects may be temporary. They may affect the environment (e.g. wild endemic stocks), but such harm would not be serious or may be reversible

Low**:** associated with the establishment of disease / pest that have mild biological consequences and would normally be amenable to control or eradication. Low impact would be expected to harm economic performance at the enterprise or regional level but to have negligible significance at the industry level. Minor or temporary effects on the environment (e.g. wild endemic stocks).

Very Low**:** associated with the establishment of disease / pest that have few biological consequences and would normally be amenable to control or eradication. Very low impact may harm economic performance at the enterprise level but would have negligible significance at the industry level. Temporary effects on the environment (e.g. wild endemic stocks).

Negligible**:** associated with the establishment of disease / pest that have no significant biological consequences, may be transient and/or are readily amenable to control or eradication. The economic effects would be expected to be low to moderate at an individual enterprise level and insignificant at a regional level. Effects on the environment would be negligible.

Likelihood and consequence were combined as shown in Table 1. The main aim of the risk assessment was to determine if the translocation of sturgeon to Australia poses unacceptable disease risks and, if so, how the risks can be managed to make them acceptable.

Table 1. Risk Matrix.

	Consequence					
Likelihood	**Negligible**	**Very low**	**Low**	**Moderate**	**High**	**Extreme**
Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Very low
Extremely low	Negligible	Negligible	Negligible	Negligible	Very low	Low
Very low	Negligible	Negligible	Negligible	Very low	Low	Moderate
Low	Negligible	Negligible	Very low	Low	Moderate	High
Moderate	Negligible	Very low	Low	Moderate	High	Extreme
High	Negligible	Very low	Low	Moderate	High	Extreme

Colours indicate risk rankings. Note that the risk level is calculated by combining the likelihood and the consequence. Grey – negligible risk. Blue – very low risk. Green – low risk. Yellow – moderate risk. Orange – high risk. Red - extreme risk.

Acceptable level of risk

Risk was assessed in an uncontrolled fashion (i.e. without biosecurity mitigations considered) but controlled in that PIRSA Fisheries and Aquaculture controls and normal industry management were included as mitigating factors in the assessment. Generally, risks ranked as "Negligible" or "Very Low" are regarded as acceptable and the current regulatory framework is considered adequate, while risks of "Low" or higher require consideration of further management steps to mitigate risk. This approach is consistent with Department of Agriculture and Water Resources (2016) and the national Appropriate Level of Protection (ALOP) and its consistent use by Australian States and Territories (AQIS 1999).

For this risk assessment, hazards with a risk ranking of Low, Moderate, High or Extreme required further mitigation to reduce the overall level of risk. Risk mitigation was designed proportionally, with risks managed to "Very Low".

Business case and viability

The desktop business assessment was made following the frameworks of Otton (2004) and Zucker and Anderson (1999) with some modifications as recommended by Kaminski *et al.* (2020). Australian input costs and output values were estimated from a variety of sources as outlined in Table 2.

Mosby and Bath (2017) analysed the market for sturgeon and sturgeon products with the aim of contextualising a potential Australian sturgeon industry, and their analysis is used in the business viability assessment.

Table 2. Items contributing to costs and revenue (2019 data).

Item	Units	Value (AUD)	Source
Cost items			
Farm infrastructure (100 t fish)	1	$12.5M	Quote obtained for Australian farm construction by Igor Maslyuk. Consultation with various Recirculation Aquaculture Systems (RAS) builders.
Electricity	MWh	$150	Australian Energy Market Operator 12 month mean, Canstar Blue data.
Fresh water replacement	ML	$0.2	Bureau of Meteorology's water markets dashboard mean
Fry feed	T	$4,000	Mean of various Australian feed manufacturers for premium feed
Juvenile feed	T	$3,800	Mean of various Australian feed manufacturers for premium feed
Grower feed	T	$3,000	Mean of various Australian feed manufacturers for premium feed
Maintenance	-	$25,000/year	Estimate based on other Australian RAS operators
Product processing costs	-	$100,000	Estimate based on other Australian RAS operators, sturgeon farms in Western Europe (Germany, Italy, France, Spain)
Waste disposal	-	$50,000	Estimate based on other Australian RAS operators
Labour	-	$120,000/year	2 FTE 220 days work Australian award wage
General and administrative	-	$40,000/year	Australian RAS operators
Other costs			
Treatments	-	$25,000/year	Future Fisheries Veterinary Services (Dr Chun-han Lin)
Water management	-	$25,000/year	Australian RAS operators
Oxygen	-	$100,000/year	Australian RAS operators, BOC
Shipping to market	/T	$20,000/year	Australian growers
Roe and caviar distribution costs	/T	$15,000/year	Based on domestic rock lobster, blueberry costs
Revenue items			
Sturgeon meat	kg	$18	Premium white flesh fish market. Sydney Fish Market data.
Trout meat	kg	$7	Australian growers
Trout roe	kg	$200 wholesale	Australian growers
Caviar	kg	$1,000 wholesale	Australian importers

Inputs to production estimates assume a mixture of Siberian sturgeon (*Acipenser baeri*) and brook trout (*Salvelinus fontinalis*) or rainbow trout (*Oncorhyncus mykiss*) will be grown for meat and roe/caviar on a rolling basis during the caviar production cycle as outlined in Table 3. Siberian sturgeon are the fastest maturing caviar-producing sturgeon, but still take 3.5-5 years to reach maturity and produce caviar. Consequently, it is advisable to consider culture of another commercial species during this period. Trout were chosen because they are ideal for co-culture as they produce roe and meat with an existing market, have similar water quality and temperature requirements to sturgeon and can be grown in similar systems. Brook trout roe are golden, have excellent texture and flavour and are sold at a market premium (average wholesale price over $250/kg) over rainbow trout or Atlantic salmon (average wholesale price $125/kg) roe in Australia. Current supply is smaller than for rainbow trout or Atlantic salmon roe. Brook trout meat is also highly valued but production would compete with freshwater rainbow trout which already has high supply in Australia although the market price is $AU7-8/kg at the farm gate.

The biological viability of sturgeon farming was assessed using Climatch. Climatch produces scores that reflect how well climatic zones in the species' native range match the climate zones in Australia. Climatch was not developed for aquatic systems, but should prove adequate in combination with water quality criteria, which were obtained from Chebanov and Galich (2011).

Table 3. Farm production timetable for a sturgeon and trout farm

Year	Sturgeon[§]	Duration	Comments		Trout[§]	Duration	Comments
1	Fertilised egg incubation	3-7 days	In upwellers or McDonald jars		Fertilised egg incubation	2-4 weeks	In upwellers
	Maturing of prolarvae	2 weeks	Fed live feed (*Artemia*, Oligochaets)		Eyed eggs, alevins	4-8 weeks	Fish consume yolk sac
	Transition of larva to external feeding	1 week	Larvae are weaned to accept artificial feed		Parr (<1g)	6 weeks	Weaned to artificial feed
	Growing juveniles	5 months	The juveniles are grown with intensive feeding		Nursery culture (<25g)	8-12 weeks	Growout using nursery feeds
	Transfer to growout	-	Transferred from nursery to growout at 100 g		Transfer to growout	-	Transfer to growout
2	Separation of genders		Assessed by ultrasound and sex hormones at 1-1.5 years		Obtain second batch of ova	-	Commence second trout growout cycle
					Growout	-	-
	Growout of females	12 months			First harvest of meat from males	-	Harvest 750g-1kg fish
	Assessment of females		Females scanned by ultrasound to assess maturity		Assessment of maturity	-	Assess animals for maturity
	Growout of males	12 months	Reach 2.5-3 kg by end of second year		Selection of brood animals for breeding	-	Animals for breeding separated
3	Obtain second batch of ova	-	Commence second sturgeon growout cycle		Obtain second batch of ova	-	Commence second trout growout cycle
	Males harvested for meat	-	Males harvested for meat at 3+ kg				
	Assessment of female maturity	3 weeks	Females reach reproductive maturity from ~3.5 years		Purge and harvest trout roe	-	Harvest of trout roe

Table 3 continued

Year	Sturgeon§	Duration	Comments		Trout§	Duration	Comments
3	Purging	2-4 months	Mature females transferred to purging system to improve caviar flavour		Harvest of meat from males	-	Ongoing as markets dictate from this point
	Caviar maturation and monitoring	1-6 months	Females monitored by ultrasound for maturity		Selection of brood animals for breeding	-	Animals for breeding separated
	Caviar harvest	-	First harvest of caviar		First breeding of own animals	-	First production of stock from own broodstock
	Selection of brood animals for breeding	-	Animals for breeding separated				
4	Males harvested for meat	-	Males harvested for meat at 3+ kg.		Obtain third batch of ova.	-	Commence third trout growout cycle – may not be required if own broodstock perform well
	Assessment of female maturity	Ongoing	Females reach reproductive maturity from ~3.5 years		Purge and harvest trout roe	-	Harvest of trout roe
	Purging	2-4 months	Mature females transferred to purging system to improve caviar flavour				
	Caviar maturation and monitoring	3.5+ years	Females monitored by ultrasound for maturity		Harvest of meat from males and females	-	Ongoing as markets dictate from this point
	Caviar harvest	-	Second harvest of caviar		Selection of brood animals for breeding	-	Animals for breeding separated
	Commence breeding from own stock	-	First Australian reared sturgeons		Second breeding of own animals	-	Second production of stock from own broodstock

§Sturgeon data from Chebinov and Galich (2011) and trout data from Hoitsy et al. (2012).

Networks

Regular discussions were held with the aquaculture industry, importers, the FRDC staff managing National Priority 3: Development of new and emerging aquaculture growth opportunities in the 2015-2020 FRDC RD&E Plan, and at the FRDC Australasian Scientific Conferences on Aquatic Animal Health and Biosecurity in 2017 and 2019. These discussions identified a range of interested industry members, including aquaculture operators, agribusiness development companies, caviar importers and seafood processors. Regulators were contacted and staff in States and Territories that demonstrated interest were added to a regulatory contacts network.

A professional network was compiled of experts who discussed sturgeon diseases with the project team during development of this report. These experts were found through existing professional networks of the project team and contacted by email or at conferences.

Potential suppliers were identified through the World Sturgeon Conservation Society (WSCS). Although the project has ended without agreement from any supply government to provide bilateral information to support normal establishment of an import process and no clear approach to import sturgeons, several farms were willing to provide stock at normal market rates and provide assistance with packing, shipping and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) forms.

Results

Containment, transfer and regulatory criteria

The containment assessment is derived from DAWE Approved Arrangements for Laboratory Fish (7.7) following consultation with the Live Animal Import group. DAWE requested that we did not submit an AA request until the Department's internal arrangements were established. Our DAWE contacts also suggested that the AA application should be made at the same time as paperwork to import sturgeons. Given that DAWE have not committed to commencing a Biosecurity Import Risk Assessment (BIRA), it is unlikely that confirmed arrangements will be required in the immediate future and the requirements may change before sturgeons can be imported.

Containment site requirements

Containment options are based on engineering approaches in the Australian/New Zealand Standards AS/NZS 2982.1:1997: Laboratory Design and Construction and behavioural and operational guidelines in AS/NZS 2243.3:2010 Safety in Laboratories.

Containment requirements are based on Approved Arrangements for Laboratory Fish (7.7). Under these arrangements, sites require audits to establish that they meet criteria. The Department of Agriculture would confirm the criteria prior to application to import sturgeon. AA 7.7 is used as the basis for the Quarantine Containment risk assessment in Table 4.

The regulatory guidelines developed are controls that can be built into license conditions or biosecurity plans and achieve a level of regulatory control equivalent to that of an AA. The guidelines are designed so that facilities growing sturgeon under State or Territory control have a high level of biosecurity and that this is equivalent to that of an AA once the animals are under State or Territory control.

Table 4. Quarantine Containment (QC) assessment for sturgeon

Requirements	Nonconformity guide	Regulatory guideline
1. Purpose		
1.1 Sites utilised for the purpose of holding live laboratory fish while undergoing quarantine	Not applicable	Facility that meets the guidelines in the *List of Specimens Taken to be Suitable for Live Import.*
2. Site location		
2.1 Applications for approval are required to be accompanied by details of the site proximity to salmonoid hatcheries, watercourses or areas subject to frequent flooding.	Major	No salmonid hatchery within 30km. Description of the nearest watercourse.
2.2 Sites must generally be located within the metropolitan area of a declared port that has a permanently based biosecurity officer. Applications are subject to approval by the Director of Biosecurity and will be considered on their individual merits with consideration being given to the biosecurity risk and serviceability associated with the location of each site.	Not applicable	Application can be made for areas outside ports.
3. Biosecurity area		
3.1 Security measures must be in place that prevent access and removal of goods subject to biosecurity control by unauthorised persons.	Major	Locked fence, secure entry, security patrols, alarms
3.2 The fish holding capacity of the biosecurity area (biosecurity room) must be of a commensurate size with the proposed quantity of goods being handled and must be located within a secure lockable building, or within a building that is located in an area surrounded by a lockable person-proof security fence.	Major	Facility adequate for proposed purpose.
3.3 The biosecurity area may share a building with other areas that are used for other purposes (including fish wholesale or retail activities), but the biosecurity area must be separate and not used as an access way to other parts of the building.	Major	Stand-alone facility.
3.4 The biosecurity area is not to be used for any purpose other than as a place for the performance of biosecurity. Sites shall not be utilised for other purposes, such as the general storage of fish tanks, for example.	Major	Specialised facility.
3.5 No animals other than fish and live fish food are permitted in the biosecurity area.	Major	PC2 controls apply. No other organisms.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
3.6 Suitable protective footwear must be kept inside the biosecurity area. As a minimum, persons entering the biosecurity area must wear gumboots and preferably some type of water proof apron should be available. Prior to such items being removed, they must be disinfected in a manner acceptable to the department, which could include a footbath disinfection.	Major	PC2 controls apply.
3.7 The biosecurity area must comply with the following: • windows must be fly screened to prevent the entry of insects • the floor to be constructed of concrete, tiles, or other impervious material to enable hose down and disinfection with retention of water and be sufficiently smooth with sufficient grade (grade applies to freshwater fish premises only) to drain to an approved septic tank, municipal sewerage or enclosed holding tank *Note:* Waste water not draining to an approved septic tank or sewerage system must be collected in a holding tank and treated prior to release. • Floor to wall junctions are to be effectively sealed or water proof coving provided at floor to wall junctions. Walls to be constructed of impervious materials and be sufficiently smooth to enable hose down and disinfection. Gaps and cracks in the walls, floor and ceiling to be effectively sealed • Lighting of sufficient intensity, to allow proper inspection of fish, must be provided. It may be necessary to provide supplementary lighting in the form of a hand held electric light (with a double insulated lead) if tanks are insufficiently illuminated • Floor drainage with an insertable plug or other mechanism to prevent accidental escape of fish or uncontrolled release of water. Drainage must be to an approved septic tank, municipal sewer or enclosed holding tank • Doors must have a self-closer to ensure it remains shut after entry, or there must be a self-closing insect proof screen door installed • Facilities must be provided for staff and biosecurity officers to wash their hands prior to leaving the biosecurity area.	Major	No windows. Impervious floor. Sealed, bunded floor. Lighting variable, but can be bright. Drain screened, all discharge decontaminated. Doors self closing. BC2 controls apply including handwashing in facility and entry/exit way.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
3.8 Fish holding tanks must: • be identified with permanent placements of numbers or letters on the tanks • be fitted with lids or other suitable arrangements to prevent transmission of pathogens between adjacent tanks due to splash from the aeration/filter system, and to prevent fish escaping • be arranged in a manner which permits ready access for inspection purposes, including a minimum width of 75 cm for corridors between rows of tanks or tanks and walls • other than the fish, contain only sterilisable materials (e.g. plastic), provided that these materials do not interfere with fish inspection • have at least the front and sides transparent to provide good visibility, and be stacked for adequate viewing.	Major	Tanks are marked as necessary. Facility is sealed. No escape possible. Smaller tanks have lids. Broad walkways (>1 m). All materials sterilisable. Larger tanks are fibreglass. Viewing can be achieved from top or capture of fish.
3.9 Fish must be removed from the biosecurity area following their satisfactory completion of the quarantine period.	Major	All product processed and removed from site as processed.
3.10 A suitable wash-up trough must be located in the biosecurity area for cleaning and disinfection of equipment. A suitable draining rack must be provided for air drying of equipment. An approved disinfectant must be available at the wash-up trough.	Major	Equipment decontaminated on floor (large equipment) or bench (small equipment). Drying rack available.
3.11 A designated refrigerator or deep freeze must be provided solely for the storage and preservation of dead fish. The refrigerator or deep freeze must be clearly identified as being for biosecurity use only and located within or close to the biosecurity area, if outside the biosecurity area it must be lockable.	Minor	Freezer available and labelled. Fish disposed of through path waste as per BC2 arrangements.
3.12 Sites must have facilities for the sterilisation of equipment which comes in contact with fish or tank water during the quarantine period.	Major	Sterilisation facilities available.
3.13 Facilities must be available for proper disinfection of overseas water (and other waste water where necessary) to department approved standards.	Critical	Sterilisation facilities available.
3.14 Fish must be in department approved containers (usually glass tanks or jars).	Major	Larger tanks are fibreglass. Viewing can be achieved from top or by capture of fish.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
3.15 Additional standards (if applicable): • If a biosecurity officer provides approval for fish to remain in the biosecurity area after release from biosecurity control, these fish must meet biosecurity requirements while they remain in the biosecurity area. • Where separate consignments of freshwater fish share a water reticulation system, fish may only be approved for release from biosecurity control when the last consignment of fish to enter the system has satisfactorily completed its departmental requirements. • Where separate consignments of fish share a water reticulation system, then fish sharing the system may be subject to biosecurity risk management measures, (e.g. destruction, treatment or detention beyond the normal quarantine period) in the event that disease agents or pests of biosecurity concern are suspected. • Where the department has reason to believe at the end of the quarantine detention period that the fish still present an unacceptable risk of disease or pest introduction, fish may be kept in quarantine detention for further investigation, observation, treatment, testing or for any other purpose appropriate to the circumstances. If the risk cannot be effectively managed, destruction of the fish will be ordered. The cost associated with any of these measures will be borne by the importer.	Major	All animals are held in the facility and containment will follow BC2 requirements. A stock register and asset control prevents premature release of animals. Emergency management plan in place for the facility. Emergency management plan in place for the facility.
3.16 The biosecurity area must be structurally separated from operations undertaken by legal entities other than the entity operating the AA site. The structure/barrier employed to provide the required separation must ensure security of goods subject to biosecurity control and prevent against access by unauthorised persons.	Major	Site will have sole operator/licensee.
3.17 Access to the site must be through property owned, rented or leased by the Biosecurity Industry Participant (BIP) and must be available to biosecurity officers during normal business hours and at such time that fish are entering or leaving the site. The BIP must notify the department of the times when the site will be attended and any alterations to the regular hours.	Major	Site will have a sole licensee, Quarantine Officers would be provided access as requested. Site occupancy plan will be developed as part of application to import fish.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
4. Building and storage areas		
4.1 Buildings and structures must be maintained in a state of good repair and be weatherproof. Wall and floor junctions must be sealed, or some other measure must be in place to ensure that vegetation does not grow into the building.	Major	Facility is subject to a facilities management plan.
4.2 Buildings, designated biosecurity areas and biosecurity inspection areas (including storage and receival zones, chutes etc.) must be kept clean. Cargo and packaging residues, contaminants and spillages must be cleaned up and correctly disposed of as biosecurity waste without delay.	Major	Facility is subject to a facilities management and cleaning plan.
4.3 Biosecurity signs must: • be securely affixed • be durable • be prominently displayed and able to be clearly read by persons approaching the area at all times • have black lettering on yellow background • contain the words 'Biosecurity Area - No unauthorised entry or removal of goods, Penalties Apply', or words to similar effect.	Minor	Signage will be procured and affixed when application is made to import material.
5. Inspection area		
5.1 The biosecurity and inspection areas must allow for biosecurity officers to easily inspect goods without work health and safety risks.	Major	Site will have site safety management plan or WHS plan to facilitate safety and orderly inspection and a designated site WHS officer.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
6. Hygiene		
6.1 An effective pest control system must be in place to ensure that sites are managed in a way that effectively isolates goods subject to biosecurity control from environments in which pests and diseases are likely to become established. As a minimum, this will require the sites to implement, and keep associated records of a periodic inspection regime and ensure knockdown spray (i.e. standard household aerosol insecticide spray) is kept onsite. In addition to details of the inspection regime and the onsite location of the knockdown spray, the pest control system may include: • the use of insecticides, fumigation, rodenticides, periodic inspection, baits and/or traps • a site plan with numbered bait stations • if applicable, contract details. *Note:* The operations of adjacent facilities must be considered when determining any additional pest control measures to be implemented.	Major	Pest plan as per BC2 requirements is in place for the site.
6.2 There must be adequate equipment available in order to carry out cleaning (steam/high pressure) and chemical disinfection spraying operations as directed by biosecurity officers.	Minor	Cleaning equipment is available.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
7. Waste disposal		
7.1 The sterilisation of waste water (including overseas water) shall be in accordance with one of the following or an alternative method approved by the department: • hypochlorite treatment: - water must pass through a department approved filter capable of removing suspended organic material prior to hypochlorite treatment - water must pass to a retention vessel where sufficient hypochlorite must be added to achieve a final concentration of at least 200 ppm. Sodium hypochlorite (bleach) should be used at 1.6 mililitres of hypochlorite solution (12.5 per cent available chlorine) per litre of water, while calcium hypochlorite powder (e.g. Pool Chlorine, 65 to70 per cent available chlorine) should be used at 0.3 g of powder per litre of water - following addition of hypochlorite, waste water must be agitated for at least 10 minutes to ensure thorough mixing of hypochlorite and retained for a period of not less than one (1) hour - after the one (1) hour retention period, the chlorine in the waste water may be neutralised by adding sodium thiosulphate (photographic hypo) at a rate of 1.25 g (2.5 ml of 50 per cent sodium thiosulphate solution) per litre of treated waste water, then agitated for not less than 10 minutes before discharge • heat treatment: - water heating units must be approved by the department. These units shall be fitted with temperature and flow recorders and be able to heat water to 85 °C for 30 minutes.	Major or critical	Two methods of decontamination available.
7.2 The site must supply equipment required to carry out the disinfection of overseas water in accordance with the above procedure.	Major	Two methods of decontamination available.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
7.3 Dead fish may only be disposed of as directed by the department.	Critical	Standard procedure for mortalities is to dispose of the pathology waste for incineration as per BC2 requirements.
7.4 Overseas water carrying live freshwater ornamental finfish must be disinfected prior to disposal.	Critical	Equipment and consumables for decontamination are available.
7.5 Waste disposal: • freshwater ornamental finfish: waste water (other than overseas water), discharged from the biosecurity area must enter directly to an approved septic tank, municipal sewerage system or may be sterilised as described under waste disposal in the standard. Where waste water is sterilised it may be discharged elsewhere, provided that it does not flow directly into natural waterways • marine ornamental finfish: waste water (including overseas water), discharged from the biosecurity area must enter directly to an approved septic tank, municipal sewerage system or may be sterilised as described under waste disposal in the standard. Sterilised waste water must not be discharged directly into natural waterways.	Critical	Water is sterilised and discharged to sewer. Water is heat sterilised and discharged to sewer.
7.6 The disinfection of equipment shall be in accordance with the following procedures: • Tanks and tank equipment must be thoroughly cleaned and disinfected with hypochlorite solution at 200 ppm concentration for five (5) minutes, or with an iodophore containing iodine for five (5) minutes, or by other department approved disinfection procedures before removal from the biosecurity area. • Filter material must be disposed of by incineration, deep burial (by a department-approved company) or other department-approved method.	Major	Decontamination procedures are developed on a risk informed basis.
7.7 Wet bags, boxes and cartons must be either disinfected or disposed of by a department approved method.	Major	Standard procedure for solid waste is to dispose as pathology waste for incineration as per BC2 requirements.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
8. Work practices		
8.1 Packaging utilised to transport live overseas fish must comply with the following procedures: • damaged bags, damaged polystyrene boxes and cartons that are wet or contaminated with overseas water must be either incinerated (at a department approved site) or disinfected by a department approved method prior to disposal • imported bags and polystyrene boxes containing leaked overseas water, which are in good condition may be reused provided they are first disinfected by a department approved method • boxes and cartons which are free of overseas water may be reused without disinfection.	Major	Standard procedure for solid waste is to dispose as pathology waste for incineration as per PC2 requirements.
8.2 Each tank of freshwater ornamental finfish must only contain a single fish species and be kept separate and isolated from fish from other shipments.	Major	Tanks will be marked and monitored.
8.3 Nets and other equipment must be disinfected in the biosecurity area by a method approved by the department before being used for other consignments of fish.	Minor	Decontamination procedures are developed on a risk informed basis.
8.4 Equipment, footwear and protective clothing used in the biosecurity area must be restricted to this site. Equipment can only be removed from the biosecurity area after it has been disinfected in a manner approved by the department.	Major	Site specific equipment is used.
8.5 Fish found dead on arrival or that die during the quarantine period must be placed in labelled plastic bags as soon as possible and preserved (in a refrigerator or freezer) for examination by a biosecurity officer. Information on labels must identify the tank number. Dead fish must be held for inspection by a biosecurity officer.	Major	Freezer is available and labelled. Fish will be disposed of after inspection as pathology waste as per PC2 arrangements.
8.6 Equipment that has been in contact with dead fish must be disinfected before re-use.	Major	Decontamination procedures are developed on a risk informed basis.
8.7 Freshwater ornamental finfish must be transferred by net to new water in the biosecurity area and the overseas water must be subjected to a department approved disinfection treatment.	Major	Decontamination procedures are developed on a risk informed basis.
8.8 Each tank of marine ornamental finfish may contain different species but only from the same shipment.	Major	Tanks will be marked and monitored.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
8.9 A standard Tank Record Sheet must be maintained for each tank.	Major	A stock register will be maintained.
8.10 Nets, tanks and other equipment must be disinfected prior to removal from the biosecurity area.	Critical	Decontamination procedures are developed on a risk informed basis.
8.11 Staff and visitors must leave their footwear outside the biosecurity area, and use separate footwear or use disposable overshoes within the biosecurity area, or use a footbath on entry and exit. The footwear standards must comply with one of the following: • suitable protective footwear must be kept inside the biosecurity area (street footwear left outside the biosecurity area). Prior to protective footwear being removed from the biosecurity area, they must be cleaned in an approved disinfectant such as Betadine (5 per cent solution) • Disposable overshoes can be used provided they are destroyed after use by deep burial, incineration or autoclave at a department approved site • A footbath containing a suitable disinfectant such as Hypochlorite or Betadine or other department approved disinfectant. The bath must be routinely replenished for adequate disinfection, a record of bath maintenance maintained and a sign stating 'Footwear must be immersed in footbath on entry to and exit from site' appropriately displayed.	Major	Facility specific footwear is used. Street footwear is left in the entryway. Protective footwear does not leave the facility except as solid waste. Overshoes are not used. A footbath is available and used.
8.12 Waste water disposals must be by a method approved by the department and must not flow directly into natural waterways.	Critical	Wastewater is decontaminated by heat and discharged via to sewer.
8.13 Filter material must be disinfected prior to removal from the biosecurity area or disposed of by incineration or deep burial (at a department-approved site).	Major	Standard procedure for solid waste is to dispose as pathology waste for incineration as per BC2 requirements.
8.14 Staff and visitors who have had contact with water or fish must wash their hands with soap and water prior to exiting the biosecurity area.	Minor	Handwashing facilities are available. Signage indicates the need for handwashing.
8.15 Any unusual levels of mortality or unusual signs of disease/pest (levels of mortality or illness above that normally observed in imported fish) must be reported to the department immediately.	Major	Stock register and reporting are required.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
8.16 Drug/chemical treatment of fish must have departmental approval and be recorded on Tank Record Sheets. Approval of requests for on-going prophylactic or therapeutic treatments will be considered by the department, taking into account the need to ensure that exotic disease agents are not inadvertently released from biosecurity. Any treatments may result in the extension of quarantine detention or other measures as deemed necessary by the department.	Critical	Veterinary medicines recorded as required, used as per State/Territory requirements.
8.17 The importer must ensure that no fish leave the biosecurity area under any circumstances without departmental approval, excepting dead fish moved to a nearby lockable refrigerator or freezer.	Critical	The operator has sole and complete control of the site.
8.18 On completion of quarantine, freshwater fish are to be transferred by net into clean water prior to removal from the biosecurity area.	Major	Equipment and facilities are available to remove fish following this direction.
9. Office and record requirements		
9.1 Records (electronic or manual) of goods subject to biosecurity control imported through the site must be maintained (these can be commercial documents).	Minor	Records are maintained in a prescribed format.
9.2 A corresponding departmental Tank Record Sheet shall be maintained for each consignment/shipment and must be kept up to date.	Minor	Daily records are maintained in a prescribed format.
9.3 Unusually high mortalities or incidence of disease must be reported to a biosecurity officer immediately. Dead fish may only be disposed of in accordance with biosecurity directions given at the time.	Major	Stock register is used and reporting is made as required.
9.4 A biosecurity entry must be kept for each consignment.	Major	Stock register is used and reporting is made as required.
9.5 Prophylactic or therapeutic treatments of fish must be recorded on the Tank Record Sheet.	Major	Stock register includes treatments and is used and reporting is made as required.
9.6 Overseas and waste water treatment, filter disposal, and footbath maintenance must be recorded on the Biosecurity Treatment and Disposal Record Sheet or in a logbook. Where waste water treatment, filter disposal and footbath maintenance is recorded in a logbook the minimum details required are those on the Biosecurity Treatment and Disposal Record Sheet.	Major	Treatment records are made and completed as per the requirement. Disposal records are kept for all material.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
9.7 Office and general site requirements must provide the department with the confidence that applicable work health and safety standards have been met, this is achieved by: • providing a first aid cabinet/kit which is fully stocked and meets the minimum commercial Australian Standard (AS2675-1983: Portable first aid kits for use by consumers) • providing vehicle parking for visiting biosecurity officers (Note: this may require department identified parking or providing a parking permit) • ensuring adequate security for any departmental technical equipment left on the sites • providing access and the availability of: - a desk, chair and a telephone with direct outside call access - toilet facilities - hand washing facilities and a hygienic means of drying hands - suitable arrangements to ensure amenities are clean.	Minor	First Aid kit follows safety plan. Parking is available. Site is secure. Amenities are available and a cleaning schedule is in place.
9.8 The Tank Record Sheet must display: biosecurity entry number, tank number, number and species of fish in tank, exporter identification details including country of export, importers name, number and date of arrival, consignment or airway bill number, fish dead on arrival, details of any observed disease conditions and number of sick fish, daily record of number of fish deaths in tank, details of any treatments given, disposal details, disinfection details, signature of authorising biosecurity officer and date released, and number of fish released.	Major	Tank records will follow this requirement.
10. Administration		
10.1 Department instructions and relevant department Import Permit conditions must be complied with. Where goods are handled for a third party, it is a requirement of approval that Biosecurity Industry Participants (BIP) have an arrangement in place that ensures they are aware of any relevant permit conditions.	Major	No third parties to be involved.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
10.2 To ensure conformation to the site requirements, the department must be notified in writing, at least 15 working days prior to any: • alterations to site management arrangements • modification to, or closure of, biosecurity areas where goods subject to biosecurity control are stored or treated/processed or otherwise dealt with.	Major	Notification required to be made of changes if necessary.
10.3 Applications are to be accompanied by scale drawings of the proposed area and biosecurity storage, treatment/processing sites including parking for biosecurity officers. In the case of new constructions these plans must be approved before any construction is undertaken	Major	Approval will be obtained before any changes will be made.
11. General		
11.1 Goods subject to biosecurity control must be maintained and processed at an AA site appropriate for the biosecurity risk associated with the items.	Major or critical	All relevant instructions and requirements will be followed.
11.2 Goods subject to biosecurity control must be maintained and processed in accordance with the requirements of the relevant AA class.	Major or critical	All relevant instructions and requirements will be followed.
11.3 Goods subject to biosecurity control must be maintained and processed in accordance with import conditions specified in the department's Biosecurity Import Conditions Database (BICON).	Major or critical	All relevant instructions and requirements will be followed.
11.4 Goods subject to biosecurity control must be maintained and processed in accordance with an Import Permit	Major or critical	All relevant instructions and requirements will be followed.
11.5 Goods subject to biosecurity control must be maintained and processed in accordance with any other direction from the department.	Major or critical	All relevant instructions and requirements will be followed.
11.6 Goods subject to biosecurity control must be maintained and processed in accordance with the *Biosecurity Act 2015* and subordinate legislation.	Major or critical	All relevant instructions and requirements will be followed.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
11.7 Goods subject to biosecurity control must be kept physically separated from other goods (including during transport), to ensure negligible risk of cross contamination to: • imported items that have been released from biosecurity control • domestic items • the Australian environment. *Note:* Isolation can be achieved through the use of distance or physical barriers. The amount of distance or type of physical barrier required will depend on the nature of the goods subject to biosecurity control.	Major or critical	All biosecurity goods will be isolated as necessary.
11.8 The standard of hygiene at the AA site must be appropriate for the nature of the goods subject to biosecurity control.	Major or critical	BC2 controls apply.
11.9 Any equipment that has been used or brought in contact with imported items subject to biosecurity control, or which could have been potentially contaminated by the imported items, must not leave the biosecurity area until it has been processed (cleaned, disinfested, decontaminated) or disposed of in accordance with relevant AA requirements, import conditions and departmental directions.	Major or critical	All equipment is site specific. Equipment is decontaminated following a risk based approach.
11.10 Goods subject to biosecurity control are not permitted to be moved outside an AA site except for the purpose of: • moving directly and securely to another AA site, of the appropriate AA class, with prior written approval from the department	Major	All relevant instructions and requirements will be followed. Material is not planned to be removed until released from quarantine.
• moving directly and securely to an AA site of the same class (or of the same class but a higher biosecurity containment level sub-class) that is co-located with the original AA site	Critical	All relevant instructions and requirements will be followed. Material is not planned to be removed until released from quarantine.
• transport of biosecurity waste by a department approved waste transport company (operating under an AA for biosecurity waste transport). If the items are being transported by a non-accredited person (e.g. a truck driver), the forwarding Biosecurity Industry Participant (BIP) must ensure that this person is made aware of the conditions relating to the transport of the items.	Major	Standard procedure for mortalities is to dispose of to pathology waste for incineration as per BC2 requirements. Waste transport is as per BC2 and AS/NZS 3816:1998 Management of clinical wastes.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
11.11 Goods subject to biosecurity control are not permitted to leave the biosecurity area of an AA site, inadvertently or deliberately, without prior written direction or approval from the department.	Critical	All relevant instructions and requirements will be followed. Material is not planned to be removed until released from quarantine.
11.12 An accredited person must personally conduct or directly supervise activities involving physical contact with, or handling of items, subject to biosecurity control. 'Directly supervise' means that the accredited person must be present in the area where the items subject to biosecurity control are being handled and must be able to: • visually verify for themselves that the items are being handled in accordance with the department's requirements • communicate immediately and effectively with the persons being supervised.	Major	The nominated accredited person will control the site and the materials it contains. All persons given access to the site will receive training as per BC2 requirements.
11.13 Persons performing the function of an accredited person must have successfully completed the department's approved training to obtain and maintain accredited person status.	Major	Licensee must be a fit and proper person. Licensee must be an individual not a company.
11.14 Records must be maintained of accredited persons.	Minor	Records will be maintained.
11.15 Goods subject to biosecurity control must be clearly and visibly identified as being under biosecurity control to persons who can physically access the goods or the containers holding the goods. The measures taken must ensure that persons having physical access to goods subject to biosecurity control can differentiate between goods subject to biosecurity control and goods that are not subject to biosecurity control.	Major	Tanks are marked as required, stock register will be maintained. Third parties are excluded from the facility.
11.16 Ensure records are kept for a minimum of 18 months for goods subject to biosecurity control at the AA site.	Major	Records are kept indefinitely.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
11.17 Ensure goods subject to biosecurity control are traceable in terms of (where applicable): • Declaration/entry number • Import Permit number • Air Waybill or Bill of Lading number • Date of receipt • Processing (including inspection, treatment, testing) details • Release from Biosecurity Control • Disposal details • storage location • accredited person responsible for the items.	Major	Tanks are marked as required, stock register will be maintained. Third parties are excluded from the facility. Records are kept indefinitely. • All relevant instructions and requirements will be followed.
11.18 The BIP must ensure that persons having physical access to goods subject to biosecurity control are aware that such items must only be handled by an accredited person or under the direct supervision of an accredited person.	Major	All relevant instructions and requirements will be followed. Signage and training will be used.
11.19 A contingency plan must be in place to manage unexpected events that threaten to compromise the biosecurity integrity of the AA site. Unexpected events include: • Appearance of pests or symptoms of disease • Structural damage (due to storms etc.) • Unauthorised removal of goods subject to biosecurity control • Spillages of goods subject to biosecurity control • Sudden unavailability of an accredited person.	• Major	Contingency plan required. • The site will have a response plan and an associated veterinarian. • Damage will be reported and repaired as required. • Incursion, loss, spillage or unavailability of an accredited person will be reported.
11.20 Ceasing or transferring operations. The department must be informed, in writing, at least 15 working days prior to intended: • Closure of a current AA site	Major	All relevant instructions and requirements will be followed.
• Relocation of the business, including the AA class function • Ceasing of operation as a AA site. Any goods subject to biosecurity control that remain at the AA site must be treated or destroyed in accordance with a department approved method or transferred to another AA site with prior approval from the department. The BIP will be liable for associated costs.	Critical	All relevant instructions and requirements will be followed. All relevant instructions and requirements will be followed.

Table 4 continued

Requirements	Nonconformity guide	Regulatory guideline
11.21 If there is any doubt as to whether goods: • Are subject to biosecurity control • Remain subject to biosecurity control • Become subject to biosecurity control then the goods must be handled in accordance with requirements for goods subject to biosecurity control.	Major	All material is handled as though it was quarantine material.
11.22 The BIP must notify the department in writing as soon as practicable within 15 working days of becoming aware of any change of status, not previously been notified to the department, of the BIP or their associates relevant to the operation of the AA in relation to any of the following matters: • Conviction of an offence or order to pay a pecuniary penalty under the *Biosecurity Act 2015, Quarantine Act 1908, Customs Act 1901*, the Criminal Code or the *Crimes Act 1914* • Debt to the to the Commonwealth that is more than 28 days overdue under the *Biosecurity Act 2015, Quarantine Act 1908, Customs Act 1901,* the Criminal Code or the *Crimes Act 1914* • Refusal, involuntary suspension, involuntary revocation/cancellation or involuntary variation of an Import Permit, quarantine approved premises, compliance agreement or AA under the *Quarantine Act 1908* or the *Biosecurity Act 2015.*	Critical	All relevant instructions and requirements will be followed.
11.23 Biosecurity officers, biosecurity enforcement officers and department-approved auditors must be provided access to the AA site to perform the functions and exercise the powers conferred on them by the Biosecurity Act or another law of the Commonwealth.	Critical	All relevant instructions and requirements will be followed. Access will be provided.
11.24 Departmental auditors or department-approved auditors must be provided with facilities and assistance as requested, and any required documents, records or things relevant to the audit.	Major or critical	Access will be provided.
11.25 The department must be notified of any Reportable Biosecurity Incident as soon as practicable, in accordance with the determination made by the Director of Biosecurity.	Critical	Notification will be made if necessary.
11.26 Department-approved auditors must be permitted to collect evidence of compliance and noncompliance with AA requirements through actions including the copying of documents and taking of photographs.	Major or critical	Access will be provided.

Hazard identification and risk assessment

The hazards shown in Table 5 were identified, and were prioritised based on their epidemiological association with sturgeons, their status as notifiable to the World Organisation for Animal Health (OIE) or the Network of Aquaculture Centres in Asia (NACA), whether these pathogens are subject to official control in Australia and DAWE controls on Importation of ornamental fish. Specific controls include testing for particular pathogens of concern and requesting evidence of freedom from the source. Generic controls include quarantine, disinfection and observation, which contribute to mitigating a range of diseases. The following diseases require specific mitigation on the basis of the information provided in Tables 5 and 6:

- *Aeromonas salmonicida* (exotic strains)
- Enteric redmouth disease
- Sturgeon iridoviruses and Frog Virus 3
- Infectious haematopoietic necrosis virus
- Koi herpes virus
- Sturgeon nucleocytoplasmic large DNA viruses
- Spring viraemia of carp virus
- Sturgeon alloherpesviruses
- Viral encephalopathy and retinopathy

Generic and specific controls were identified for pathogens as outlined in Table 6. Testing for prioritised pathogens, historical freedom, adequate competent authority control at the source and extended holding in an AA are adequate controls to decrease the risks to an acceptable level. A range of metazoan parasites can be excluded by importing only eggs and decontaminating transport water on arrival in Australia.

Table 5. Hazard identification – sturgeon pathogen risk assessment

Pathogen	Present in source(s)	Present in Australia	Notifiable†	Official control in Australia	Further consideration?
Viruses					
Viral encephalopathy and retinopathy	Axén *et al.* (2018)	No	Yes	Yes	Specific controls
Sturgeon iridoviruses and Frog Virus 3	Hedrick *et al.* (1990)	No	Yes	Yes	Specific controls
Sturgeon adenovirus	Hedrick *et al.* (1985)	No	No	No	Specific controls
Sturgeon alloherpesviruses	Hedrick *et al.* (1991)	No	No	No	Specific controls
Sturgeon nucleocytoplasmic large DNA virus	Clouthier *et al.* (2015)	No	No	No	Specific controls
Spring viraemia of carp virus	Vicenova *et al.* (2011)	No	No	No	Specific controls
Koi herpes virus	Kempter *et al.* (2009)	No	No	No	Specific controls
Infectious haematopoietic necrosis virus	Mugetti *et al.* (2020)	No	No	No	Specific controls
Bacteria					
Aeromonas salmonicida	Colussi *et al.* (2005)	Yes	No	Yes	Specific controls
Aeromonas hydrophila	Colussi *et al.* (2005)	Yes	No	No	General only
Aeromonas sobria	Kayiş *et al.* (2017)	Yes	No	No	General only
Bacillus mycoides	Kayiş *et al.* (2017)	Yes	No	No	General only
Citrobacter freundii	Kayiş *et al.* (2017)	Yes	No	No	General only
Pasturella sp.	Costinar *et al.* (2010)	Yes	No	No	General only
Pseudomonas fluorescens	Brunetti *et al.* (2006)	Yes	No	No	General only

Table 5 continued

Pathogen	Present in source(s)	Present in Australia	Notifiable†	Official control in Australia	Further consideration?
Pseudomonas putida	Kayiş *et al.* (2017)	Yes	No	No	General only
*Streptococcus dysgalactiae**	Salogni *et al.* (2010)	Yes	No	No	General only
Vibrio alginolyticus	Costinar *et al.* (2010)	Yes	No	No	General only
Yersinia ruckeri (enteric redmouth disease)	Vuillaume *et al.* (1987)	Yes	No	Yes	Specific
*Acinetobacter baumanii***	Kozińska *et al.* (2014)	Yes	No	No	General only
*Acinetobacter johnsonii***	Kozińska *et al.* (2014)	Yes	No	No	General only
*Acinetobacter radioresistans***	Kozińska *et al.* (2014)	Yes	No	No	General only
Flexibacter sp.	Bauer *et al.* (2002)	No	No	No	General only
Parasites					
Protozoa					
Trypanosoma anura	Bauer *et al.* (2002)	No	No	No	General only
Pleistophora sulci	Bauer *et al.* (2002)	No	No	No	General only
Glugea sp.	Bauer *et al.* (2002)	Yes	No	No	General only
Haemogregarina acipenseris	Bauer *et al.* (2002)	No	No	No	General only
Zschokkella sturionis	Bauer *et al.* (2002)	No	No	No	General only
Hexamita truttae	Bauer *et al.* (2002)	No	No	No	General only
Apiosoma spp.	Bauer *et al.* (2002)	No	No	No	General only
Trichodinidae	Bauer *et al.* (2002)	Yes	No	No	General only
Ichthyophthirius multifiliis	Bauer *et al.* (2002)	Yes	No	No	General only

Table 5 continued

Pathogen	Present in source(s)	Present in Australia	Notifiable†	Official control in Australia	Further consideration?
Coelenterata					
Polypodium hydroformae	Bauer *et al.* (2002)	No	No	No	General only
Flatworms					
Monogenea					
Nitzschia spp.	Matsche *et al.* (2010)	No	No	No	General only
Diclybothriidae	Bauer *et al.* (2002)	No	No	No	General only
Cestoda					
Amphilinidea	Bauer *et al.* (2002)	Yes	No	No	General only
Spathebothridea	Bauer *et al.* (2002)	No	No	No	General only
Proteocephalus osculatus	Bauer *et al.* (2002)	No	No	No	General only
Bothriocephalus opsariichthydis	Bauer *et al.* (2002)	No	No	No	General only
Silurotaenia siluri	Bauer *et al.* (2002)	No	No	No	General only
Tetraphyllidea	Bauer *et al.* (2002)	Yes	No	No	General only
Cyclophyllidea	Bauer *et al.* (2002)	Yes	No	No	General only
Aspidogastrea					
Aspidogaster limacoides	Bauer *et al.* (2002)	No	No	No	General only
Digenea					
Ripidocotyle kovlae	Bauer *et al.* (2002)	No	No	No	General only
Acrolichanus auriculatus	Bauer *et al.* (2002)	No	No	No	General only
Deropristidae	Bauer *et al.* (2002)	No	No	No	General only

Table 5 continued

Pathogen	Present in source(s)	Present in Australia	Notifiable†	Official control in Australia	Further consideration?
Skrajbinopsolus semiarmatus	Bauer *et al.* (2002)	No	No	No	General only
Other Digenea	Bauer *et al.* (2002)	Yes	No	No	General only
Acanthocephala					
Acanthocephalidae	Bauer *et al.* (2002)	Yes	No	No	General only
Nematoda					
Capillariidae	Bauer *et al.* (2002)	Yes	No	No	General only
Cystoopsis acipenseris	Bauer *et al.* (2002)	No	No	No	General only
Anisakidae**	Bauer *et al.* (2002)	Yes	No	No	General only
Cucullanus spp.	Bauer *et al.* (2002)	Yes	No	No	General only
Camallanidae	Bauer *et al.* (2002)	Yes	No	No	General only
Cysticolidae	Bauer *et al.* (2002)	Yes	No	No	General only
Cyclozone acipenserina	Bauer *et al.* (2002)	Yes	No	No	General only
Other Nematoda	Bauer *et al.* (2002)	No	No	No	General only
Hirudinae					
Hirudinae	Bauer *et al.* (2002)	Yes	No	No	General only
Crustacea					
Argulus spp.	Bauer *et al.* (2002)	No	No	No	General only
Ergasilus sieboldii	Bauer *et al.* (2002)	No	No	No	General only
Paraergasilus rylovi	Bauer *et al.* (2002)	No	No	No	General only
Lernaea cyprinacea	Bauer *et al.* (2002)	Yes	No	No	General only

Table 5 continued

Pathogen	Present in source(s)	Present in Australia	Notifiable†	Official control in Australia	Further consideration?
Lernaea elegans	Bauer *et al.* (2002)	Yes	No	No	General only
Caligus lacustris	Bauer *et al.* (2002)	No	No	No	General only
Augulus foliaceus	Bauer *et al.* (2002)	No	No	No	General only
Pseudotracheliastes stellatus	Bauer *et al.* (2002)	No	No	No	General only
Dichelesthium oblongum	Bauer *et al.* (2002)	No	No	No	General only
Oomycota					
Saprolegnia sp.	Bauer *et al.* (2002)	Yes	No	No	General only
Achlya sp.	Bauer *et al.* (2002)	Yes	No	No	General only
Aphanomyces sp.	Bauer *et al.* (2002)	Yes	No	No	General only
Zeptolognia sp.	Bauer *et al.* (2002)	Yes	No	No	General only
Dactyunnus sp.	Bauer *et al.* (2002)	Yes	No	No	General only

† **World Organisation for Animal Health (OIE)/Network of Aquaculture Centres in Asia (NACA) notifiable**

* Probably *Streptococcus iniae*.

** Zoonotic species that pose a potential human health risk.

Table 6. Pathogen risk assessment and risk mitigation

Pathogen	Likelihood	Consequence	Unmitigated risk	Controls	Notes	Mitigated risk
Viruses						
Nervous necrosis virus	Moderate	High	High	Source from free populations. Egg treatment prior to translocation. Health assessment of stock prior to release from quarantine. Testing of stock prior to release from quarantine. Post release containment.	Sporadically recorded but widespread in sturgeon. Increasing betanodavirus diversity in Australia could be deleterious to a range of marine and freshwater finfish aquaculture industries. Specific controls required.	Very low
Sturgeon iridoviruses and Frog Virus 3	Moderate	High	High	Source from free populations. Egg treatment prior to translocation. Health assessment of stock prior to release from quarantine. Testing of stock prior to release from quarantine. Post release containment.	Widespread in sturgeons, with a range of viral genotypes observed. Iridoviruses have low host specificity, are under official control in Australia and pose a serious threat to marine and freshwater aquaculture industries, fisheries and native fish species. Conditions exist for managing iridovirus risk for imported aquarium fish.	Very low
Sturgeon adenovirus	Very low	High	Low	Source from free populations. Egg treatment prior to translocation. Health assessment of stock prior to release from quarantine. Post release containment.	Recorded only from Western North America. Less pathogenic than other sturgeon viruses; host range unknown. Lack of information makes risk estimation complex.	Very low

Table 6 continued

Pathogen	Likelihood	Consequence	Unmitigated risk	Controls	Notes	Mitigated risk
Sturgeon alloherpesviruses	Moderate	Moderate	Moderate	Source from free populations. Egg treatment prior to translocation. Health assessment of stock prior to release from quarantine. Testing of stock prior to release from quarantine. Post release containment.	Recorded only from North America. Host range unknown but herpes viruses generally have high host specificity.	Very low
Sturgeon nucleocytoplasmic large DNA viruses	Low	High	Moderate	Source from historically free populations. Egg treatment prior to translocation. Health assessment of stock prior to release from quarantine. Post release containment.	Poorly described, taxonomic affiliations uncertain. Use targeted and generalised controls to prevent entry.	Very low
Spring viraemia of carp	Moderate	High	High	Source from free populations. Egg treatment prior to translocation. Health assessment of stock prior to release from quarantine. Testing of stock prior to release from quarantine. Post release containment.	Environmentally significant in Australia. Sturgeon are asymptomatic carriers.	Very low

Table 6 continued

Pathogen	Likelihood	Consequence	Unmitigated risk	Controls	Notes	Mitigated risk
Bacteria						
Bacterial pathogens	Possible	Moderate	Moderate	Health assessment of stock prior to release from quarantine. Testing of stock prior to release from quarantine for *A. salmonicida* and *Y. ruckeri*. Post release containment.	Pathogenic species are recorded from Australia. Mitigation measures are designed to ensure Australian diversity of these pathogens is not increased.	Very low
Parasites						
Protozoa						
Protozoa	Possible	Moderate	Moderate	Translocate eggs. Health assessment of stock prior to release from quarantine. Post release containment.	Protozoan pathogens of sturgeon are mostly recorded from Australia. Importing eggs not fish reduces the likelihood for most species to remote. Mitigation measures are designed to ensure Australian diversity of these pathogens is not increased and that no sturgeon specific pathogens are introduced.	Very low
Coelenterata						
Coelenterates	Remote	Low	Low	Translocate eggs. Health assessment of stock prior to release from quarantine. Post release containment.	Importing eggs not fish reduces the likelihood for most species to remote. Mitigation measures are designed to ensure no sturgeon specific pathogens are introduced.	Negligible

Table 6 continued

Pathogen	Likelihood	Consequence	Unmitigated risk	Controls	Notes	Mitigated risk
Flatworms						
Monogenea						
Monogeneans	Possible	Low	Low	Translocate eggs. Health assessment of stock prior to release from quarantine. Post release containment.	Importing eggs not fish reduces the likelihood for most species to remote. Mitigation measures are designed to ensure no sturgeon specific pathogens are introduced. Most monogeneans have high host specificity.	Negligible
Cestoda						
Cestodes	Possible	Low	Low	Translocate eggs. Health assessment of stock prior to release from quarantine. Post release containment.	Importing eggs not fish reduces the likelihood for most species to remote. Mitigation measures are designed to ensure no sturgeon specific pathogens are introduced. Most cestodes have low to moderate host specificity.	Negligible
Aspidogastrea						
Aspidogastreans	Possible	Low	Low	Translocate eggs. Health assessment of stock prior to release from quarantine. Post release containment.	Importing eggs not fish reduces the likelihood for most species to remote. Mitigation measures are designed to ensure no sturgeon specific pathogens are introduced. Most aspidogastreans have moderate host specificity.	Negligible

Table 6 continued

Pathogen	Likelihood	Consequence	Unmitigated risk	Controls	Notes	Mitigated risk
Digenea						
Digeneans	Possible	Low	Low	Translocate eggs. Health assessment of stock prior to release from quarantine. Post release containment.	Importing eggs not fish reduces the likelihood for most species to remote. Mitigation measures are designed to ensure no sturgeon specific pathogens are introduced. Most digeneans have moderate host specificity.	Negligible
Acanthocephala						
Acanthocephalans	Possible	Low	Low	Translocate eggs. Health assessment of stock prior to release from quarantine. Post release containment.	Importing eggs not fish reduces the likelihood for most species to remote. Mitigation measures are designed to ensure no sturgeon specific pathogens are introduced. Most acanthocephalans have low to moderate host specificity.	Negligible
Nematoda						
Nematodes	Possible	Low	Low	Translocate eggs. Health assessment of stock prior to release from quarantine. Post release containment.	Importing eggs not fish reduces the likelihood for most species to remote. Mitigation measures are designed to ensure no sturgeon specific pathogens are introduced. Most nematodes have moderate host specificity.	Negligible

Table 6 continued

Pathogen	Likelihood	Consequence	Unmitigated risk	Controls	Notes	Mitigated risk
Hirudinae						
Leeches	Unlikely	Low	Low	Translocate eggs. Health assessment of stock prior to release from quarantine. Post release containment.	Importing eggs not fish reduces the likelihood for most species to remote. Mitigation measures are designed to ensure no sturgeon specific pathogens are introduced. Most fish leeches have low host specificity.	Negligible
Copepoda						
Copepods	Unlikely	Low	Low	Translocate eggs. Health assessment of stock prior to release from quarantine. Post release containment.	Importing eggs not fish reduces the likelihood for most species to remote. Mitigation measures are designed to ensure no sturgeon specific pathogens are introduced. Most copepods have moderate host specificity.	Negligible
Argulus	Unlikely	Low	Low	Translocate eggs. Health assessment of stock prior to release from quarantine. Post release containment.	Importing eggs not fish reduces the likelihood for most species to remote. Mitigation measures are designed to ensure no sturgeon specific pathogens are introduced. Argulus has low host specificity.	Negligible
Oomycota						
Water mould pathogens	Possible	Moderate	Moderate	Translocate eggs. Health assessment of stock prior to release from quarantine. Post release containment.	Some pathogenic species are recorded from Australia. Importing eggs not fish reduces the likelihood. Oomycetes have low host specificity. Mitigation measures are designed to ensure Australian diversity of these pathogens is not increased.	Negligible

Business case and viability

Two sturgeon species, *Huso huso* (beluga) and *Acipenser baeri* (Siberian sturgeon) have been added to the List of Specimens Taken to be Suitable for Live Import. Sturgeons have been grown in the southern hemisphere in Uruguay (Vizziano *et al.* 2006). Transport of eggs and small fish over long distances can be achieved with close to 100% survival (Peter Rankin, FishPac, personal communication September 2016).

The climatic characteristics of southern Australian aquatic systems are similar to the warmer parts of the native range of sturgeons (Figure 1). Figure 1 shows the Climatch mapping for Australia using the range of the Siberian sturgeon as the input data. Climatch is not designed for aquatic data and as such how well match scores demonstrate suitability for farming is unclear. In general climate matching is a suitable approach (Bomford, 2003) and much of southern Australia is suitable for farming sturgeon; sites should be specifically assessed for water quality, supply and temperature when developing farms.

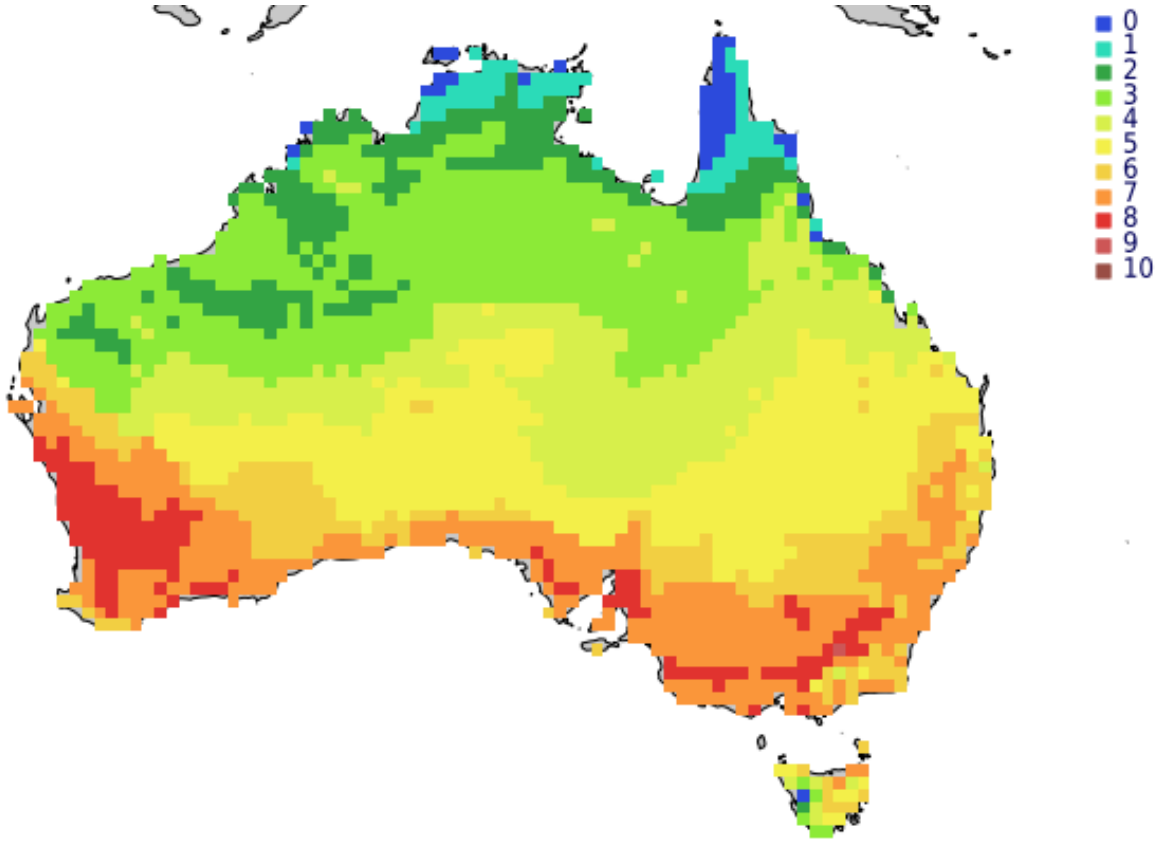

Figure 1. Climatch mapping of Australia for Siberian sturgeon climate suitability. Higher scores indicate greater suitability

Sturgeon can be grown in controlled, contained systems (Bronzi *et al.* 2019) that limit the likelihood of escape. Recirculation aquaculture systems (RAS) provide a controlled environment that can be matched to optimise the requirements of sturgeon. RAS have a small environmental footprint, can capture and re-purpose waste, and conditions can be easily and precisely manipulated. These benefits are offset by higher start-up and operational costs than less controlled systems, and the

substantial expertise required to manage a RAS system. Data used for estimating inputs related to production and costs of RAS are outlined in Tables 2 and 7. A range of finfish species are grown in RAS in Australia.

Sturgeons require freshwater with similar characteristics to trout for rearing and growout, although the upper temperature limits for most sturgeon species are substantially higher than for trout (Chebanov and Galich 2011). Most aquaculture water sources in Southern Australia meet or are better than these requirements and selected sources are described in Table 8 and basic physical needs for farming sturgeons are available broadly across Southern Australia.

There are no obvious technical or biological impediments to farming sturgeons in Australia. A 10 year lifecycle to profit is feasible for a mixed sturgeon-trout farm (Table 9), however, risks associated with such a farm are concentrated and equipment failure, disease, natural disasters or greater than expected climate variability could be catastrophic for a single facility. Reduction of risk by developing an industry in more than a single location would decrease the start-up risks associated with development of sturgeon aquaculture.

Table 7. Production and input cost estimates for a mixed sturgeon-trout RAS farm

Year		**0**	**1**	**2**	**3**	**4**	**5+**
Trout biomass	Male kg	(n=125,000)	15,000	25,000	25,000	25,000	25,000
	Female kg	(n=125,000)	15,000	25,000	25,000	25,000	25,000
Trout feed $			35,000	60,000	60,000	60,000	60,000
Trout roe kg				1250	1250	1250	1250
Trout meat $				45,000	45,000	45,000	45,000
Sturgeon biomass	Male kg	(n=20,000)	20,000	30,000	10,000	30,000	30,000
	Female kg	(n=20,000)	20,000	30,000	52,500	80,000	100,000
Sturgeon feed $			50,000	100,000	100,000	100,000	100,000
Sturgeon meat $					25,000	25,000	25,000
Caviar kg			-	-	300	500	750
Total feed kg			85,000	160,000	160,000	160,000	160,000
Electricity 1.5 kWh/kg feed		-	127.5mWh	240mWh	240mWh	240mWh	240mWh
Electricity @ $150/mWh		-	19,125	36,000	36,000	36,000	36,000

Table 8. Sturgeon water quality requirements comparison

Parameter	Sturgeon threshold	Myponga River average	Robe groundwater average
Transparency	30 cm	65 cm	>50 cm
Temperature	30 °C	17 °C	17 °C
pH	6.5-7.5	7.2	7.4
CO_2	10 $mg.L^{-1}$	<3 $mg.L^{-1}$	5 $mg.L^{-1}$
DO	4 $mg.L^{-1}$	6 $mg.L^{-1}$	6.5 $mg.L^{-1}$
PV	10 $mg.L^{-1}$	5 $mg.L^{-1}$	5 $mg.L^{-1}$
H_2S	0.002 $mg.L^{-1}$	ND	ND
Ca^{2+} [1]	180 $mg.L^{-1}$	20 $mg.L^{-1}$	40 $mg.L^{-1}$
Mg^{2+}	40 $mg.L^{-1}$	25 $mg.L^{-1}$	15 $mg.L^{-1}$
Cd	0.003 $mg.L^{-1}$	ND	ND
Fe	0.01 $mg.L^{-1}$	0.0003 $mg.L^{-1}$	>0.001 $mg.L^{-1}$
Pb	0.003 $mg.L^{-1}$	ND	ND
Zn	0.03 $mg.L^{-1}$	0.001 $mg.L^{-1}$	<0.01 $mg.L^{-1}$
$Na^+ + K^+$	150 + 50 $mg.L^{-1}$	75 + 12 $mg.L^{-1}$	55 + 5 $mg.L^{-1}$
Cl^-	30 $mg.L^{-1}$	19 $mg.L^{-1}$	12 $mg.L^{-1}$
SO_4^{2-}	50 $mg.L^{-1}$	<10 $mg.L^{-1}$	<5 $mg.L^{-1}$
PO_4^{2-}	0.3 $mg.L^{-1}$	<0.01 $mg.L^{-1}$	<0.01 $mg.L^{-1}$
Alkalinity	7-8 $mg.L^{-1}$ equiv	7.6 $mg.L^{-1}$ equiv	7.8 $mg.L^{-1}$ equiv
NH_4^+	0.5 $mg.L^{-1}$	<0.1 $mg.L^{-1}$	<0.05 $mg.L^{-1}$
NH_3	0.003 $mg.L^{-1}$	<0.001 $mg.L^{-1}$	<0.001 $mg.L^{-1}$
Nitrite	0.1 $mg.L^{-1}$ (soft) 0.2 $mg.L^{-1}$ (hard)	<0.1 $mg.L^{-1}$	<0.1 $mg.L^{-1}$
Nitrate	1 $mg.L^{-1}$	<0.5 $mg.L^{-1}$	0.5 $mg.L^{-1}$
Total hardness	6-8 $mg.L^{-1}$	6.7 $mg.L^{-1}$	7.6 $mg.L^{-1}$
BOD	2 $mg.L^{-1}$	<1 $mg.L^{-1}$	<1 $mg.L^{-1}$
Suspended solids	10 $mg.L^{-1}$	2 $mg.L^{-1}$	>1 $mg.L^{-1}$

[1] The optimum Ca^{2+} concentration for the fertilization and incubation of eggs is 6-18 $mg.L^{-1}$.

ND= not detected above the limit of detection for the test

Table 9. Ten year cost estimate/return on investment for a 100t sturgeon-50t trout farm.

Item	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	10 year profit
Farm infrastructure[a]	-12,500,000[a]	-	-	-	-	-	-	-	-	-	-	
Maintenance	-	-15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	
Electricity	-	-19,125	-36,000	-36,000	-36,000	-36,000	-36,000	-36,000	-36,000	-36,000	-36,000	
Fresh water replacement	-	-1,000	-1,000	-1,000	-1,000	-1,000	-1,000	-1,000	-1,000	-1,000	-1,000	
Trout feed	-	-105,000	-105,000	-105,000	-105,000	-105,000	-105,000	-105,000	-105,000	-105,000	-105,000	
Sturgeon feed	-	-120,000	-120,000	-120,000	-120,000	-120,000	-120,000	-120,000	-120,000	-120,000	-120,000	
Product processing costs	-	-25,000	-25,000	-25,000	-25,000	-25,000	-25,000	-25,000	-25,000	-25,000	-25,000	
Waste disposal	-	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	-10,000	
Labour	-	-120,000	-120,000	-120,000	-120,000	-120,000	-120,000	-120,000	-120,000	-120,000	-120,000	
General/Admin	-	-15,000	-15,000	-15,000	-15,000	-15,000	-15,000	-15,000	-15,000	-15,000	-15,000	
Trout stock	-20,000	-20,000	-20,000	-20,000	-20,000	-20,000	-20,000	-20,000	-20,000	-20,000	-20,000	
Trout meat	-		315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	315,000	
Trout roe	-		250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	
Sturgeon stock	-15,000	-15,000	-15,000	-15,000	-15,000	-15,000	-15,000	-15,000	-15,000	-15,000	-15,000	
Sturgeon meat	-			375,000	375,000	375,000	375,000	375,000	375,000	375,000	375,000	
Caviar	-			600,000	1,000,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	
TOTAL	-12,535,000	-465,125	83,000	1,058,000	1,458,000	1,958,000	1,958,000	1,958,000	1,958,000	1,958,000	1,958,000	1,346,875

[a] Assumes investment capital used to buy farm and equipment, with no interest repayments

Costs are in $AU.

Networks

Individual growers and other interested parties have requested confidentiality and for their details not to be shared either publically or among other interested growers.

State, Territory Governments and Australian Government contacts

Network of international experts

Suppliers

Discussion

Caviar is one of the highest value and rarest food products in the world, the proposal to facilitate farming caviar in Australia has created a lot of interest among importers, the aquaculture industry and consumers of luxury foods. This interest is undoubtedly associated with the mystique and luxury value of caviar. While caviar farming includes challenges common to aquatic animal production, caviar farming in Australia remains potentially feasible, but a number of regulatory barriers remain to be resolved before farming can commence, and emerging market factors may make caviar farming less lucrative and attractive over time.

Containment, transfer and regulatory criteria

It is relatively simple to develop criteria for sturgeon import, holding in an AA and release to a State or Territory controlled facility, yet in over 5 years of negotiation (Appendix 1), no progress has been made to legally import sturgeon for farming.

DAWE were approached through activities included in this project to investigate alternative arrangements for import. The Biosecurity Act (2015) provides flexibility through Division 3 to facilitate import of goods that are conditionally non-prohibited (goods that must not be brought into Australia unless specified conditions are complied with). For goods where there is a similar commodity a non-regulated risk review can be developed. This approach was used in 2000 to develop conditions for importation of laboratory fish and laboratory containment was taken to cover residual risk following release from an AA. Recent requests for non-regulatory risk review, however, such as for laboratory ferrets for COVID-19 laboratory studies, have not been approved. It seems unlikely that such processes can be used to import any commodity that does not have established import conditions. The Ornamental Fish Import Risk Assessment assumes that aquarium import is a closed system and that animals imported by this pathway are not for commercial aquaculture, and the Live Import List only permits entry of sturgeons for aquaculture, not for display or ornamental purposes.

The Biosecurity Act (2015) sets out that a BIRA is generally required when there are no import conditions established for a commodity and that development of a BIRA needs to be triggered and follow an agreed path. Given that alternative arrangements have been determined not to be suitable (Appendix 2), a BIRA is required to be completed to import sturgeons. PIRSA approached DAWE in 2015 to request that a BIRA be commenced. DAWE have not commenced a BIRA and appear to lack resources to undertake one for sturgeon due to ongoing work on prawns associated with the white spot syndrome virus outbreaks which began in 2016 (Appendix 2). It is unclear how or when the regulatory barriers to importing sturgeons can be overcome.

Hazard identification and risk assessment

Risk assessment showed that sturgeons are subject to a wide range of pathogens and parasites. Specific measures are required to prevent entry of serious viral and bacterial diseases, mainly involving obtaining stock from free or historically free areas, testing to provide evidence of freedom to World Organisation for Animal Health (OIE) standards and quarantine prior to release. The risks posed by important metazoan parasites such as the crustaceans *Ergasilus sieboldi* and *Argulus* spp. can be managed by importing only fertilised eggs, removing and decontaminating transport water from eggs and decontaminating eggs before hatching. Some important pathogens, particularly

sturgeon nucleocytoplasmic large DNA virus, sturgeon adenovirus and sturgeon alloherpesvirus do not have tests available in Australia, and testing approaches would need to be developed and agreed prior to release of the animals from an AA. The CSIRO Australian Centre for Disease Preparedness has developed approaches to assess infection with poorly characterised agents based on increasingly used high throughput sequencing methods (e.g. Paskey *et al.* 2019). Such approaches would provide valuable information on risk associated with import of sturgeons.

After release from an AA, State or Territory license conditions would be required to manage residual risks. This report developed a range of containment guidelines (Table 4) based on the approach that while import and quarantine decrease risk to an acceptable level, the live import consent for sturgeons remains for aquaculture only and a high level of containment is required to prevent escape and potential establishment of feral populations in open systems in Australia.

Business case and viability

Growing sturgeon in Australia is biologically and technically feasible. Water quality, climate and other requirements can be met. RAS have a small environmental footprint, can capture and re-purpose waste and conditions can be manipulated simply and with precision. These benefits are offset by higher start-up and operational costs and the substantial expertise required to manage a RAS system. A 10-year lifecycle to profit seems feasible for a mixed sturgeon-trout farm, however, risks associated with a single farm are concentrated and equipment failure, disease, natural disasters or greater than expected climate variability could be catastrophic. Reduction of risk by developing an industry in more than one location would decrease the start-up risks associated with development of sturgeon aquaculture in Australia.

Caviar demand and sales are increasing rapidly in Australia (Coates 2016) and total CITES declared import volume of sturgeon caviar was ~1.5t in 2018 (Mobsby and Bath 2017). Demand is projected to continue to rise (PIRSA 2015) as luxury food domestic consumption (Deloitte 2019) and export markets (Wang and Somogyi 2018) grow. There are, however, substantial threats to development and viability of an Australian caviar industry. While the domestic market could support a small industry, ongoing expansion would require access to export markets. Australia has environmental ("clean and green"), regulatory, food safety and other advantages, but the global caviar market has substantial additional inputs. In the USA, wholesale prices have fallen more than 50% since 2010 (Reiley 2019) linked to high production and oversupply relative to traditional market size in China (FAO 2019) and is likely to continue. Dishes such as caviar burritos or tater tots are increasingly common, even as takeaway food and it is possible that caviar may lose its status as a luxury food because the market is saturated with lower cost product (Reiley 2019). These changes in markets and status of the product would undermine the viability of an emerging Australian industry.

Conclusion

Biologically and technologically, growing sturgeon in Australia is feasible and at current market rates appears profitable. Risks associated with establishing only a single farm are substantial but could be decreased by developing sturgeon farming in more than one location.

Market demand for caviar remains high and farmed caviar has similar acceptance to wild origin product. Caviar demand and sales have increased rapidly in Australia but US wholesale prices have fallen more than 50% since 2010. In association with high production in China, which is likely to continue to grow, market shifts could undermine the viability of an emerging Australian industry.

This project has identified risks associated with sturgeon imports and developed criteria for sturgeon import, holding in an AA and release to a State or Territory controlled facility. However, over 5 years of negotiation has not progressed towards the consent to import sturgeon for farming in Australia. Alternative arrangements available through Division 3 of The Biosecurity Act (2015) will not be used to import sturgeon into Australia (Appendix 2). To progress sturgeon farming in Australia a BIRA and formal assessment of import conditions is required, and is prioritised by the regulatory authority (DAWE). Until then, this regulatory impasse remains a major barrier to overcome.

Implications

While the technical and economic aspects of surgeon caviar culture have been shown to be feasible in Australia, a sturgeon industry will not develop unless DAWE commence a BIRA. Currently it is unclear how overcoming this regulatory impasse can be motivated or championed.

Recommendations

Continued engagement with and lobbying of DAWE is required if a sturgeon industry remains an aim for the aquaculture industry in Australia.

Extension and Adoption

CONTACT WITH BENEFICIARIES:

6 August 2017

Skype meeting between Marty Deveney and Igor Maslyuk to discuss feasibility and approaches to sturgeon aquaculture.

9 January 2018

Meeting between PIRSA staff, SARDI staff, Peter Docking, Igor Maslyuk, Dnister Bank and Ukrainian Community Association to discuss feasibility and approaches to sturgeon aquaculture.

27 November 2018

Meeting between PIRSA staff, SARDI staff and DAWE Staff to discuss sturgeon import requirements.

5 September 2019

Teleconference between Marty Deveney (SARDI) and James Forwood (DAWE) about sturgeon import requirements.

5 September 2019

Teleconference between Marty Deveney (SARDI), Jade Davison (PIRSA) and Andrea Bath (ABARES) about the ABARES market analysis of the global sturgeon industry.

23 January 2020

Teleconference between Marty Deveney (SARDI) and James Forwood (DAWE) about sturgeon import requirements.

27 August 2020

Teleconference between Jade Davison (PIRSA) and Ian Ruscoe (DAWE) to discuss letter (see Appendix 2).

23 September 2020

Teleconference between Marty Deveney (SARDI) and James Forwood (DAWE) to discuss approaches to import consent and how to proceed.

PROGRESS AGAINST COMMUNICATION & EXTENSION PLAN:

- Direct engagement with DAWE through meetings and discussions ongoing.
- Direct engagement with international experts ongoing
- Direct engagement with potential sources and interested investors/parties ongoing meetings and discussions between SARDI and PIRSA held quarterly since 2016.

References

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Appendices

Appendix 1 Time line of significant events

March 2010	•Mr Peter Docking made enquiry to PIRSA to add sturgeon to his land-based aquauclture licence. PIRSA consulted Australian and State Government on import process.
September 2011	•Mr Docking submitted a draft application to PIRSA for review prior to submission to the Department of the Environment (DE).
March 2012	•Mr Docking applied to the DE to add Siberian, Russian, Beluga and a RussianxSiberian Sturgeon Hybrid to the Live Import List.
January 2014	•Public Comment Period closes and summary of actions required to be addressed is provided to Mr Docking. MrDocking provides further information.
January 2015	•DE notified PIRSA of the intent to include Siberian and Beluga Sturgeon to the Live Import List.
April 2015	•List of Specimens taken to be Suitable for Live Import amended to include Siberian and Beluga Sturgeon under section 303EB of the EPBC Act.
August 2015	•PIRSA wrote to Department of Agriculture (DA) requesting an import risk analysis on Beluga and Siberian sturgeon.
August 2016	•DA commenced BIRA scoping process.
July 2017	•FRDC Contract for Project for Sturgeon Aquaculture in Australia: Feasibility Study, partly funded by PIRSA contracted.
June 2017	•Department of Agriculture and Water Resources (DAWR) informs PIRSA resources have been diverted to respond to white spot disease in prawns, with the commencement of the BIRA delayed.
September 2018	•Following correspondence, DAWR proposes meeting to discuss alternative arrangements to a BIRA. PIRSA and DAWR officers meet and agree to explore alternative arrangements.
August 2020	•Commonwealth Minister confirms review by Department of Agriculture, Water and the Environment (DAWE) shows that alternative arrangements are not suitable, a BIRA is required but resources are not available to commence that work.

Appendix 2 Letter from Minister for Agriculture, Drought and Emergency Management on import process

The Hon. David Littleproud MP
Minister for Agriculture, Drought and Emergency Management
Deputy Leader of the Nationals
Federal Member for Maranoa

Ref: MC20-011984

25 AUG 2020

The Hon. David Basham MP
Minister for Primary Industries and Regional Development
Level 10, 1 King William Street
ADELAIDE SA 5000

Dear Minister

I write in response to the letter of 23 July 2020 from the Hon. Tim Whetstone MP, the then Minister for Primary Industries and Regional Development, concerning the potential import of live sturgeon for aquaculture.

Preliminary work towards a biosecurity import risk analysis for live sturgeon commenced in 2017. However, the Department of Agriculture, Water and the Environment has been compelled to divert resources to its response to the detection of white spot syndrome virus in prawns, including a review of Australia's import conditions for prawns and prawn products. As you are aware, this has delayed the commencement of the biosecurity import risk analysis the department had scheduled for live sturgeon.

I note that the Department of Primary Industries and Regions SA (PIRSA), in collaboration with the Fisheries Research and Development Corporation, has funded a research project to develop a business case and viability assessment for sturgeon aquaculture in Australia which is nearing completion. This research will be considered by the department when the import risk analysis commences.

I understand that the department has discussed with PIRSA alternative arrangements such as importation into an Approved Arrangement for research purposes. However, as release from any such arrangement, if approved, into commercial aquaculture would not be possible until completion of the import risk analysis, this may not be suitable for the intended purpose.

Mr Ian Ruscoe, Director of the Aquatics Unit in the department, will contact Ms Jade Davison, PIRSA Senior Aquaculture Advisor, to discuss these matters further.

Thank you for raising this matter.

Yours sincerely

DAVID LITTLEPROUD MP

Parliament House, Canberra ACT 2600 Telephone: 02 6277 7190 Email: Minister.Littleproud@awe.gov.au