Business Case and Business Plan Study for a Multi-species Mollusc Hatchery in Western Australia

(Commissioned by the Aquaculture Council WA and Department of Fisheries WA)

RMB Aqua Pty Ltd

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1 Executive Summary

1.1 Background

The Australian Fishing Zone covers an area of almost 9 million square kilometres. This amounts to an expanse 16% larger than the Australian land mass and is the third largest fishing zone in the world. In 2009–10, the total value of seafood exports fell by 18% to $1.2 billion, leaving Australia as a net importer of fisheries products by value, for the third year in a row (ABS 2012).

Australia's mainland coastline length is 35,876 kilometres, with an additional 23,859 km of island coastline – a total of almost 60,000 kms. Whilst Australia has a vast coastline and clean pristine waters, its mollusc production from aquaculture is 18,722 tonnes (Table 1). This represents only 0.13% of the total world mollusc production in 2010 of 14.1 million tonnes. There remains enormous potential for the expansion of mollusc aquaculture in Australia.

Western Australia has 12,889 kms of mainland coastline and 20,781 of coastline including islands, which equates to around 35% of the total Australian coastline. Mollusc aquaculture production in WA was 350 tonnes in 2011/12 (Table 2), or less than 2% of Australian mollusc production by volume from aquaculture.

Due to the filter-feeding nature of bivalve molluscs they do not require feeding during grow-out production in the ocean, meaning there is no net nutrient input. Bivalve mollusc aquaculture production has the potential to provide a sustainable increase in production without significant environmental impacts. Whilst there are some parts of WA that have low levels of nutrients and productivity, there are vast areas of higher productivity in the North West, through the Gascoyne, Pilbara and Kimberley. Clearly there is an opportunity to expand mollusc aquaculture production in Western Australia.

Without a reliable supply of mollusc spat (seed stock) there remains a high degree of uncertainty over future production forecasts for mollusc farmers that hinders or prevents the capital investment required to expand their businesses. Historically mollusc hatchery production in Western Australia (WA) has been inconsistent and unreliable, constraining development and growth of this sector.

This is in part due to "critical mass" not yet having being reached in the mollusc grow-out/farming sector, which means hatchery orders have not been high enough or consistent enough to sustainably fund a well-resourced mollusc hatchery in WA.

1.2 Case Study – the Victorian Shellfish Hatchery

Until 2002, the Victorian mussel industry was thriving, achieving peak production at approximately 1,600 tonnes and valued at $3.7 million. Following that time the rate of natural settlement on ropes and survival of spat declined, affecting reliability of harvest and production. In 2008 mussel production in Victoria had dropped to around 450t per annum. Many companies were either exiting the industry or considering doing so. A study was undertaken and it was decided that the Victorian State Government would support the development of a mussel hatchery.

The most important benefit of the Victorian Shellfish Hatchery (VSH), located at Queenscliff near Melbourne, has been to provide the Victorian mussel farmers with more control over mussel production through not having to rely solely on highly variable wild mussel spat settlement. VSH also provides the mussel farmers with the opportunity to start production cycles outside of standard natural spawning and settlement windows, thereby enabling the mussel farmers to produce product outside of their "standard" harvest window and therefore potentially expand their markets.

VSH is developing the capability for a Breeding Program that will provide the Victorian mussel farmers the advantage of a shorter grow-out time to market by using fast-growing pedigrees from the hatchery breeding program. This could lead to providing Victorian mussel farmers with an advantage over farmers in other States. The VSH also creates other opportunities with the potential for new aquaculture sectors to emerge in Victoria as other mollusc species are cultured at the facility, such as flat oysters (Ostrea angasi) and scallops.

The Victorian Shellfish Hatchery now produces 400-500 million mussel spat per year. Mussel production is back up to around 1,000-1,200t. The government/industry collaboration to support the development of a mollusc hatchery in order to sustain and expand the mussel industry in Victoria appears to have been successful.

1.3 WA Mollusc Aquaculture Sector Requirements

If there was a reliable, consistent supply of hatchery-produced mussel spat available in WA, then demand for the product in the sector is forecast to more than triple to almost 300 million spat per annum from current requirements of 78 million spat.

Blacklip pearl oyster spat requirements are forecast to almost double to 825,000 spat in Year 5 from today's requirement of 425,000 spat (**Table 10**). Akoya spat requirements are currently expanding considerably, whilst Western Rock Oyster spat numbers required are forecast to increase, potentially quadrupling to 16 million spat from current demand of 4 million.

1.4 Site Selection

The ACWA Mollusc Hatchery Study in 2014 identified the Albany Aquaculture Park as the most suitable site for a multi-species mollusc hatchery. Whilst Albany is not an ideal hatchery location for Blacklip Pearl Oyster producers in the Abrolhos, it is a highly suitable location for rock oyster and mussel hatchery production. Albany is a proven location for Akoya spat production. The Great Southern Marine Hatcheries (GSMH) site is the preferred location for the WA Shellfish Hatchery (Multi-Species Mollusc Hatchery). For the purposes of this Study it is assumed that the WA Shellfish Hatchery will be located at the Great Southern Marine Hatcheries site in Albany.

1.5 Business Model

The Study puts forward a business model whereby the Department of Fisheries WA (DoFWA) enacts a Facility Access Agreement (FAA) with a multi-species mollusc hatchery “Operator”. The Operator would be identified through an EOI/tender process, with the terms and conditions for the FAA determined following negotiations with stakeholders and potential Operators. The Operator would staff and run the hatchery, paying staff wages, consumables and other operating expenditure. The WA government, through DoFWA, would support the WA Shellfish Hatchery and its Operator through administration of funding, R&D and specified aspects of maintenance of the hatchery facility.

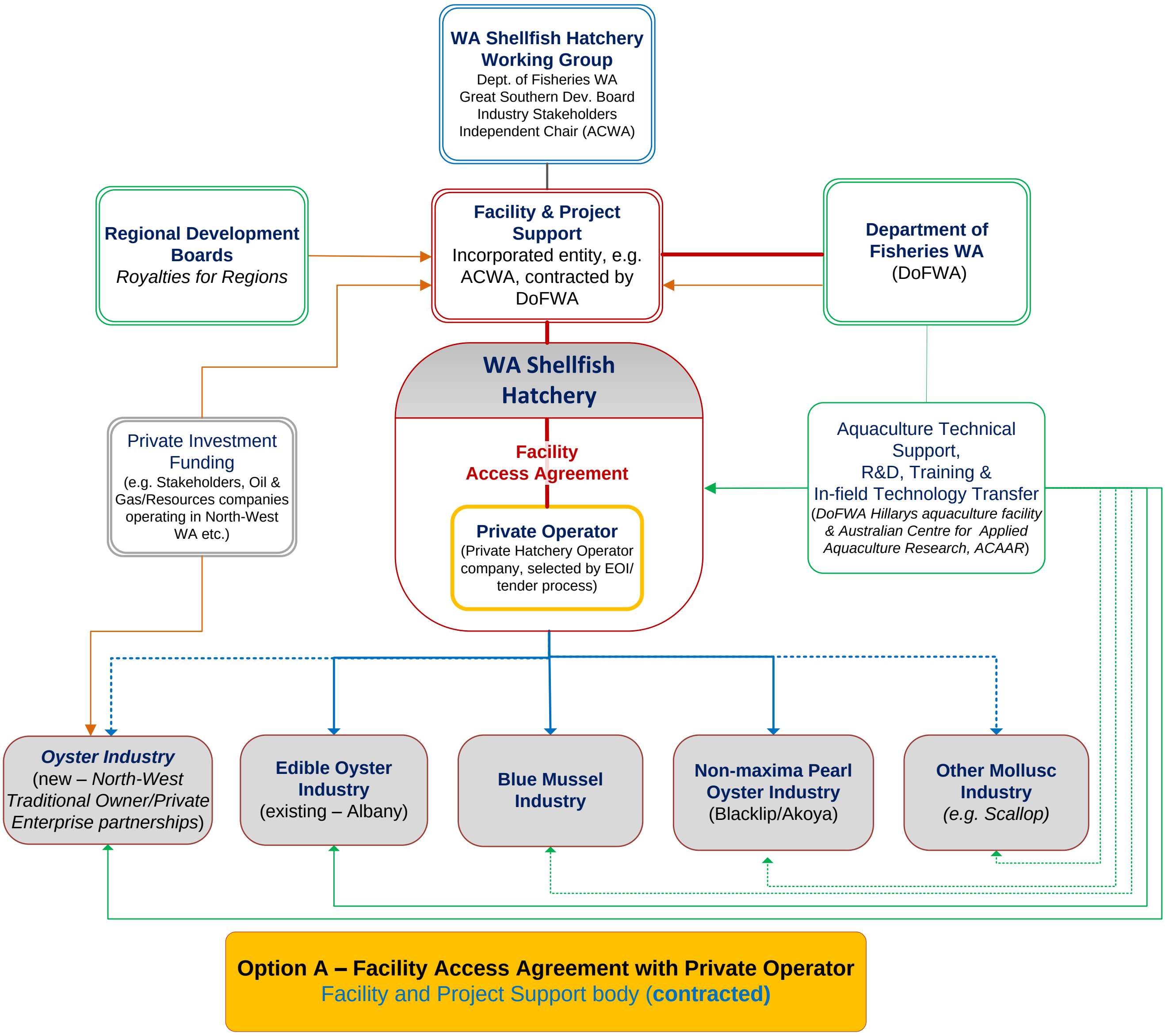

Figure 1 - WA Shellfish Hatchery Potential Business Structure

DoFWA could maintain the hatchery facility and manage the Project using internal resources, or it could consider contracting an incorporated entity such as the Aquaculture Council of WA (ACWA) to oversee management of the Project, maintenance of the hatchery facility, R&D and administering of funds (Facility and Project Support in Figure 1).

The Study recommends forming a Steering Committee, or Working Group. The Working Group's role is to monitor and support the WA Shellfish Hatchery and act as a link between the proposed WA Shellfish Hatchery, government and industry. The Working Group's roles and responsibilities could include:

- Monitoring hatchery performance and production outputs
- Identifying research requirements
- R&D Program planning
- Applying for research funding
- Planning and monitoring the use of funds
- Monitoring spat prices
- Monitoring requirements of the industry, and the extent to which these are being met

1.6 Capital Expenditure

Capital Expenditure (Capex) requirements for the WA Shellfish Hatchery Project are estimated to be between $700,000 - $900,000, excluding Building and Improvements.

The Building and Improvements Capex estimates will be determined during the proposed Feasibility Study, which will follow on from the proposed Hatchery Design stage and site and structural surveys. Construction costs will include internal layout modifications determined by design and biosecurity requirements (walls, insulation, drains, etc.), air-conditioning, lighting and other electrical supply and distribution works (transformers, boards, wiring, outlets etc.), internal and external water and air supply plumbing works, water intake, water discharge etc..

For the purposes of economic analysis, in order to estimate in broad terms the quantum of funding required by the WA Shellfish Project, an estimate of $120,000 has been used for the Hatchery Design and Feasibility Study stages, based on 10% of EPC (Engineering, Procurement and Construction) cost estimates. $480,000 has been used for building and improvements capital expenditure estimates in Year 0. $80,000 and $140,000 have been forecast for building and improvements in Years 1 and 2 respectively. The Hatchery Design, Feasibility Study and EPC / Building and Improvements estimates are *un-costed* at this stage.

1.7 Economic Modelling

WA Shellfish Hatchery revenues are forecast to be $350,000 in Year 1 of hatchery production. By Year 5 spat sales revenue may be as high as around $940,000, assuming there is 100% uptake on spat requirement forecasts obtained in this Study. Hatchery revenue is highly sensitive to both spat sales numbers and spat prices.

It should be noted that this is an optimistic revenue forecast, based on full uptake of requirement forecasts by WA companies approached during this Study. The model also forecasts additional Rock Oyster spat sales of 20-50% in Years 3-5 to allow for pilot oyster farms spat requirements for the North West.

The estimated Gross Value of Product (GVP) generated from the WA Shellfish Hatchery spat sales is around $5 million in Year 1 rising to around $12 million in Year 5. This is an optimistic estimate, assuming 100% uptake on spat requirement forecasts obtained during this Study, plus additional rock oyster production of around in the Gascoyne, Pilbara and Kimberley in Years 3-5 worth approximately $2.5 million in Year 5. Without the North West Rock Oyster projections, the forecast GVP would be around $9.5 million.

Net Loss after tax for the Operator is forecast to be around -$60,000 in Year 1. The Profit in Year 5 is +$225,000. Cash flow of the Operator is forecast to be around -$150,000 in Year 1, and +$230,000 in Year 5 (R&D tax concession is offset by one year, claimed for the previous year). Closing cash balance of the Owner is forecast to be around $400,000 in Year 5.

Economic modelling forecasts a total of around $2.6 million funding will be required in Years 0-3 for the WA Shellfish Hatchery project. Funding sources are more likely to be from government (e.g. Royalties for Regions, Going for Growth or State Government Consolidated Funds), than from private sources (see Funding 1.8). Cash flow models forecast a closing cash balance at the end of Year 5 of $1.2 million for the Owner (government in this model). Amongst the assumption in this scenario is the sale of the facility - buildings, plant and equipment (not land) depreciated over 5 years.

Design, Feasibility and EPC/Building and Improvements requires a forecast $2 million, $1.5 million for Capex. plus contingency and cash reserves of $0.5 million. Years 1-3 require $200,000 per annum to be used primarily as Facility and Project Support.

The estimates provided in this study are to a nominal accuracy of +/- 50%, excluding building and improvements. With so many variables and unknowns the hatchery capital expenditure, operating expenditure, spat sales revenue and GVP forecasts cannot be forecast with any greater degree of accuracy at this stage.

1.8 Funding

It appears unlikely that the Project will be funded entirely, or in large part, by the private sector, based on the assumptions and economic modelling in this Study. If the government wishes to exert some control and influence over the development and expansion of the mollusc farming sectors in WA to achieve critical mass over the next 3-5 years then public funding will be required. “Royalties for Regions” and “Going for Growth” are two of the most prospective sources of funding for the WA Shellfish Hatchery Project in Albany.

1.9 Timelines

An indicative timeline for the project is shown in Figure 2. Hatchery Design is scheduled to occur in January-March 2016, with the Feasibility Study occurring in May – July 2016. Engineering, Procurement, Construction (EPC) and Commissioning is scheduled for September 2016 – January 2017. The timeline indicated would lead to first spat production from the hatchery in early 2017. This timeline for the WA Shellfish hatchery Project is highly dependent on the speed of decision-making around funding.

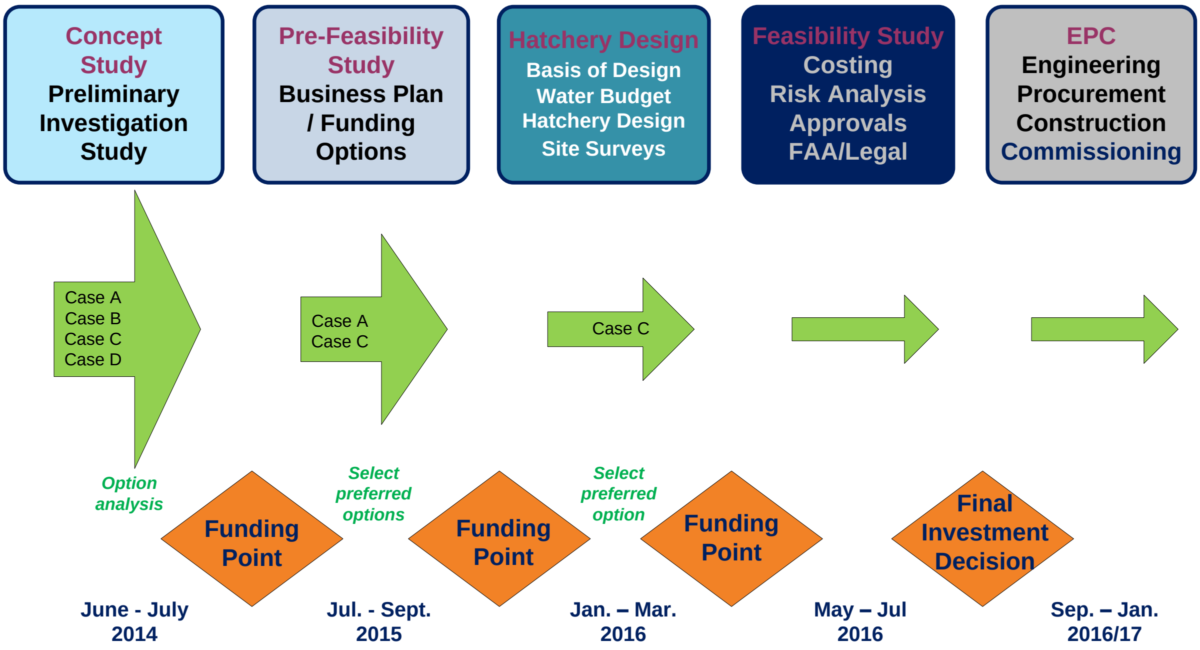

Figure 2 - WA Shellfish Hatchery Project Indicative Timeline

1.10 Conclusions

Hatcheries in the aquaculture industry are rarely highly profitable. It is the grow-out business that produces the volumes and margins to make large profits. However, without a hatchery, and often a breeding program, grow-out cannot sustain enough control over the value chain for consistent production, or highly efficient production. Therefore a common model in aquaculture, whether fish, crustaceans or molluscs, is some kind of vertical integration of the hatchery and grow-out/farming sections of the business. Vertical integration on this model requires some economies of scale which this report shows have not yet been reached in Western Australia.

The analogue case of the Queenscliff hatchery model supplying the Victorian industry has been put forward as a possible catalyst for facilitating the development of a mollusc industry of significant scale in Western Australia. This Study indicates that local private industry does not have the appetite for creating a common-user hatchery capable of supporting an industry of scale; on the basis of the funding hurdle which is large in both dollars and years.

This report indicates that funding from an external source is required. Funding from government sources is recommended in order to retain some control over the expansion of the mollusc farming sectors through to reaching critical mass, with Royalties for Regions seen as the most promising avenue.

Governance of the funded operation should be determined through consultation with government, funding agencies and industry. This report recommends two models which differ primarily in their level of governance.

Should the ACWA committee of management decide to continue with this study, the next steps would include undertaking Hatchery Design and Feasibility Study stages prior to making a Final

Investment Decision on the WA Shellfish Hatchery Project. The Feasibility Study should include further Economic Modelling and sensitivity analyses, together with the development of measures for the industry to commit to future spat sales, for example Spat Offtake Agreement.

Bivalve mollusc aquaculture has the potential to provide a sustainable increase in aquaculture production without significant environmental impacts. Mollusc aquaculture is able to provide a steady, sustainable form of employment, together with multiplier effects, in rural WA communities. The mollusc aquaculture sector (Mussel, Rock Oyster, Black-lip and Akoya pearl oysters) requires a *reliable, consistent* source of hatchery-produced spat in order to successfully expand mollusc farming in rural WA.

Once operational, forecasts indicate that the WA Shellfish Hatchery should become self-funding within five years, at which time it can be privatised. By Year 5 of production the hatchery will be capable of supporting a forecast $12 million of grow-out production.

In 2012-13 production value for oysters in South Australia was AUD$35 million, employing approximately 687 people in direct activities associated with the oyster industry in 2012-13 (PIRSA, 2013). Using the SA oyster aquaculture sector as an analogue, WA mollusc aquaculture sectors could potentially employ around 230 people directly associated with mollusc aquaculture in rural WA by Year 5 of the Project.

Figure 3 - Shellfish Hatchery

2 Introduction

2.1 Background

The Australian Fishing Zone covers an area of almost 9 million square kilometres. This amounts to an expanse 16% larger than the Australian land mass and is the third largest fishing zone in the world. In 2009–10, the total value of exports fell by 18% to $1.2 billion, leaving Australia as a net importer of fisheries products by value, for the third year in a row (ABS 2012).

In the last three decades (1980–2010), world food fish production from aquaculture has expanded by almost 12 times, at an average annual rate of 8.8 percent. World aquaculture production reached 60 million tonnes in 2010 (excluding aquatic plants and non-food products), with an estimated total value of US$119 billion (FAO 2012).

Approximately one third of all farmed fish production is currently achieved without supplementary feeding. Unfed aquaculture species include bivalve molluscs. 14.2 million tonnes of molluscs were produced in 2010, which makes up 75% of all marine aquaculture production (Figure 4) and almost 25% of total world aquaculture production.

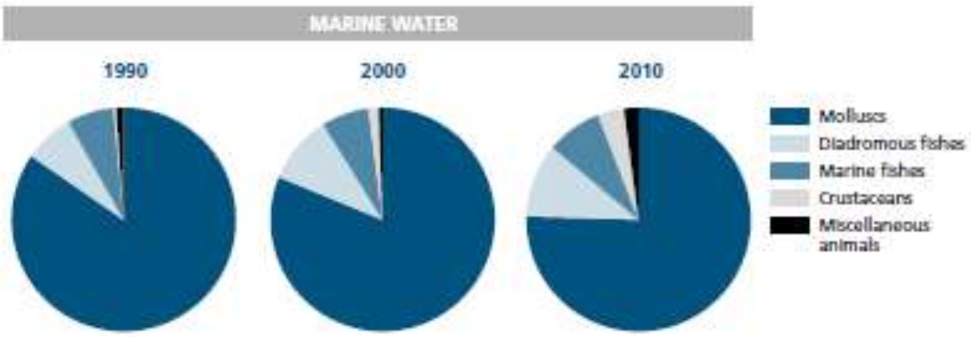

Figure 4 - World marine aquaculture production composition (FAO 2012)

Oysters account for around 30% of world mollusc aquaculture production, whilst mussels make up around 13% of production. Together oyster and mussel aquaculture production was 6.2 million tonnes in 2010 (FAO 2012), or 44% of total mollusc production (Figure 5).

The FAO (Food and Agriculture Organization) predicts that there will be continued strong growth in world aquaculture production. It is likely that aquaculture will remain the fastest growing animal production sector. Due to the filter-feeding nature of bivalve molluscs they do not require feeding during grow-out production in the ocean, meaning there is no net nutrient input. Bivalve mollusc aquaculture production has the potential to provide a sustainable increase in production without significant environmental impacts.

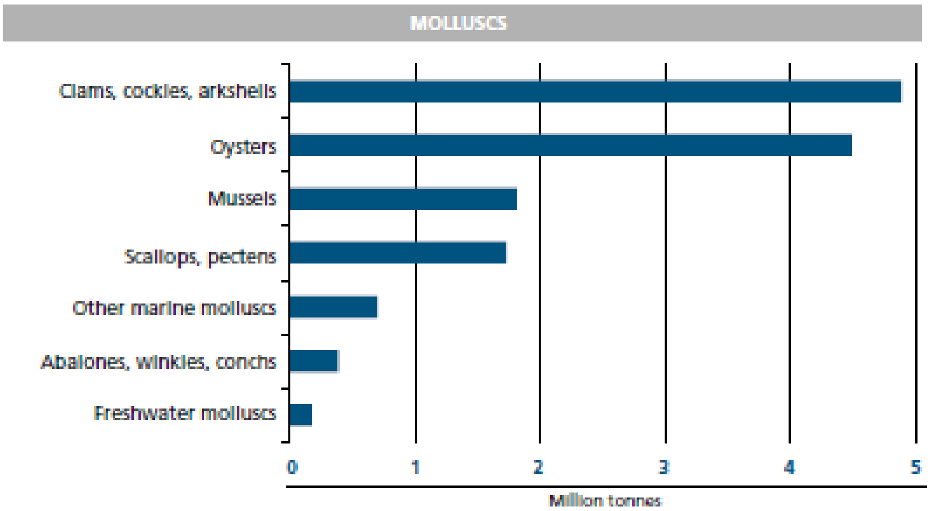

Figure 5 - World mollusc aquaculture production composition (FAO 2012)

Australia's mainland coastline length is 35,876 kilometres, with an additional 23,859 km of island coastline – a total of almost 60,000 kms. Whilst Australia has a vast coastline and clean pristine waters, its mollusc production from aquaculture is 18,722 tonnes. This represents only 0.13% of the total world mollusc production in 2010 of 14.1 million tonnes. Clearly there is an opportunity to expand mollusc aquaculture production in Australia.

In 2014 the Aquaculture Council of Western Australia (ACWA) commissioned a study to identify the industry requirements for the hatchery cultivation of spat (bivalve mollusc seed) with the aim of facilitating growth of the aquaculture industry in Western Australia.

Objectives of the ACWA Mollusc Hatchery Report in 2014 objectives included:

- Determining current and future spat requirements for non-maxima mollusc aquaculture industry (mussels, edible oysters, scallops and non-P. maxima pearl oysters) in Western Australia
- Determining current mollusc spat supply sources, the capacity to meet current and future spat requirements and reliability of the existing spat supplies

The Report was completed in July 2014 and concluded:

Without a reliable supply of mollusc spat (seed stock) there remains a high degree of uncertainty over future production forecasts for mollusc farmers that hinders or prevents business planning in areas such as capital investment, hiring of staff, sales and marketing, which are required for business expansion. The long term success of aquaculture sectors is heavily reliant on the success of controlled breeding and hatchery production.

2.2 Mollusc Aquaculture in Australia

In 2009–10, the gross value of production of Australian aquaculture increased slightly to $870 million, or 40% of the total value of fisheries production. Mollusc production, including pearl production, in Australia was valued at $230 million in 2009-10 (Table 1), making up around 26% of the total Australian fisheries and aquaculture total production value. Edible oyster aquaculture production was valued at $100 million in 2009-10, making up 11.5% of total aquaculture production value and 43% of mollusc production value (ABARE 2012).

Table 1 - Australian aquaculture production - quantity and gross value

	2007–08		2008–09		2009–10	
	tonnes	$m	tonnes	$m	tonnes	$m
Finfish						
Salmon	25,867	302	30,036	326	31,915	369
Tuna	9,757	187	8,786	158	7,284	102
Other	5,906	58	7,282	72	8,396	73
Total	**41,530**	**547**	**46,104**	**556**	**47,595**	**544**
Crustaceans						
Prawns	3,088	44	3,985	57	5,381	78
Yabbies	84	1	60	1	51	1
Other	140	3	144	3	132	3
Total	**3,312**	**49**	**4,189**	**61**	**5,564**	**81**
Molluscs						
Pearl oysters	na	114	na	90	na	105
Edible oysters	13,536	89	14,227	93	14,804	100
Other*	3,762	25	4,022	32	3,918	26
Total	**17,298**	**229**	**18,249**	**215**	**18,722**	**230**
Other fisheries production	1,892	44	1,550	35	1,660	15
Total	**64,032**	**869**	**70,092**	**867**	**73,541**	**870**

Source: Australian Bureau of Agricultural and Resource Economics and Sciences, 2010
* - includes mussels, scallops, giant clams and abalone

Tasmania began mollusc breeding and hatchery production in the late 1970s, adopting and adapting technology from Europe and the US for hatchery spat production of the Pacific Oyster *Crassostrea gigas*. Now there are several oyster hatcheries operating in Tasmania, New South Wales and South Australia. In 2006 Tasmania started developing a mussel hatchery (Duthie 2010) and in 2008 Victoria started a co-op mussel hatchery with the support of the Victorian State Government / Department of Environment and Primary Industries (DEPI, 2010).

2.3 Oyster aquaculture in Australia

Edible oysters from aquaculture production were the second most plentiful product in Australia at 14,804 tonnes in 2009-10, whilst in value terms oysters ranked fourth behind, salmon, pearl oysters and tuna (Table 1). The value of oyster aquaculture production in Australia increased from $89 million in 2007-08 to $100 million in 2009-10 (ABS 2012).

Oyster production is mainly from Sydney Rock Oysters, *Saccostrea glomerata*, and Pacific Oysters, *Crassostrea gigas*, whilst there is also some flat oyster, *Ostrea angasi*, aquaculture production in the Eastern states. The Sydney rock oyster, *Saccostrea glomerata*, formerly known as *Saccostrea commercialis*, is an oyster species endemic to the East Coast of Australia and New Zealand, whilst the Pacific Oyster, *Crassostrea gigas,* is an introduced species.

Figure 6 - Shellfish Hatchery Microalgae Lab

Western Rock Oysters (*Saccostrea* spp.) are cultured in the south of Western Australia, in Albany. Flat oysters used to be cultured in Albany, but suffered heavy losses from *Bonamia* disease and there was a subsequent switch over to production of Western Rock Oysters. A project was recently announced to re-stock flat oysters in Oyster Harbour, Albany, for environmental purposes. Production of Western Rock Oysters has declined over recent years, but recently there has been planning and activity for reviving this sector in the Southwest.

2.4 Mussel aquaculture in Australia

The mussel species cultured in Australia is the blue mussel (*Mytilus galloprovincialis*). Duthie (2010) reported Australian mussel production was around 3,100t per annum and worth around $10 million per year by gross farm-gate value. In the past the mussel industry has relied solely on wild spat settlement. More recently the mussel farming industries in Tasmania and Victoria are moving over to hatchery-produced spat.

In recent years Tasmania and Victoria experienced highly variable wild mussel spat settlement and trends of significant decline in numbers of wild spat. Victoria went from producing around 1,600t in the late 90s and early 2000s to as little as 450t by 2008. The industry was at risk of collapsing, with many Victorian mussel companies exiting the industry. Both Victoria and Tasmania invested in mollusc hatcheries to produce mussel spat to support their mussel farming sectors.

2.5 Blacklip and Akoya aquaculture in Australia

The Akoya pearl oyster *Pinctada fucata* (Gould, 1850), sometimes referred to as *Pinctada imbricata* Röding, 1798 (Welladsen 2010), has been fished for pearls for centuries and is amongst the most widespread of the pearl oyster species. Akoya oysters are found on areas of the eastern coastline of North and South America, the east-coast of Africa, the Mediterranean and throughout the Indo-Pacific. Most notably, the Akoya oyster is found in Japan, where it has formed the basis of a multi-million dollar pearling industry.

Recently, a dramatic decline in Japanese pearl production, resulting from a variety of factors including disease, has created an opportunity for Australia to enter the industry (NSW Fisheries 2014).

Culture of Akoya pearl oysters is relatively new to Australian waters, although pearl culture with other species (*Pinctada maxima* - South Sea Pearls) has been underway since 1959. The Blacklip and Akoya pearl oyster farming industries in WA are relatively small, with the Blacklip industry from the Abrolhos Islands producing 36,500 pearls in 2006 (Cropp 2011). The industry's production value in 2006/07 was $452,050 (DoFWA 2104).

Figure 7 - Pearl Oyster spat

2.6 Scallop wild fishery production in Australia

The Shark Bay scallop fishery is based on a single species *Amusium balloti* and is the most valuable scallop fishery (AUD 10 - 58 million) in Western Australia. This species is short-lived, has fast growth and highly variable recruitment which is primarily environmentally driven. The scallop industry is different to the mussel, edible oyster and non-maxima pearl oyster industries. The scallop industry relies solely on Western Australian natural wild fisheries for breeding, recruitment and grow-out to market size, with no culture phase at any stage of the life cycle. The product is harvested at market size from the wild using trawlers during specific times of the year, with quotas and pre-season surveys helping to determine catch levels and opening and closing times.

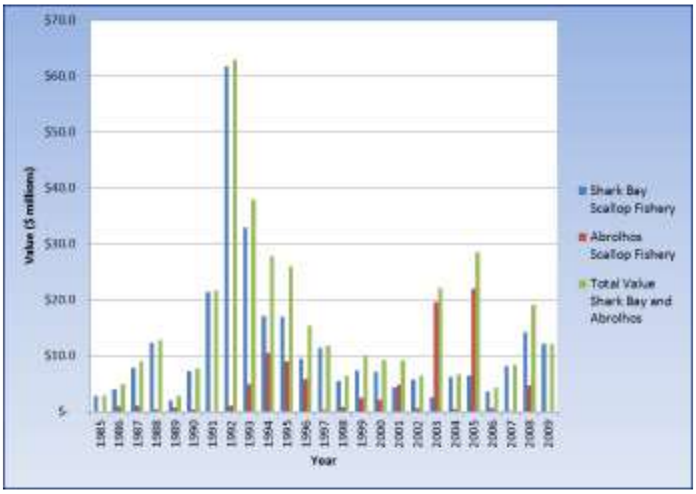

Figure 8 - Shark Bay and Abrolhos annual scallop landings value (DoFWA 2011)

Australian scallop fisheries production was around 7,500 tonnes, valued at around $25 million in 2009-10, down from production of over 10,000 tonnes in 2007-08 (ABS 2012). The WA scallop catch is highly variable, see Figure 8. As with wild mussel spat settlement, scallop breeding and recruitment success is likely to be heavily influenced by environmental factors, such as ocean temperatures. The Shark Bay and Abrolhos Scallop Fisheries have produced catches ranging from 121t - 4,414t / annum, ranging in value from $2 million to $58 million (Kangas et al 2006).

The Shark Bay Scallop fishery is a significant employer in the Gascoyne region, employing in excess of 300 individuals including the fishing fleet, processing and fleet maintenance, plus indirect employment for service providers during the season from March to November (Kangas et al 2011).

Since 2010 there have been some seasons where stocks have remained too low to open the Shark Bay and the Abrolhos scallop fishery. The WA scallop industry has initiated a research program together with DoFWA that will investigate development of techniques for consistent scallop hatchery spat production. If these trials are successful it may lead to up-scaling of scallop spat production for pilot-scale fishery enhancement projects in order to determine the feasibility and long-term economic viability of a commercial-scale scallop fishery enhancement program.

Figure 9 - Experimental scallop hatchery project, Geraldton WA (FRDC 2002/048)

2.7 Mollusc Aquaculture in Western Australia

Table 2 - WA aquaculture production volumes 2006/07 - 2011/12 (DoFWA)

Common Name	Units	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	% change on 06/07
Barramundi	tonnes	43.2	365.9	455.2	433	862.5	1127	**2509%**
Mussels	**tonnes**	**621.9**	**481.2**	**433.5**	**506.5**	**364.9**	**349.8**	**-44%**
Marron	tonnes	58.1	51.1	52.8	53.9	51.1	50.5	-13%
Yabbies	tonnes	87.9	60.8	44.1	46.7	19.7	18.8	-79%
Silver Perch	tonnes	26.5	16.9	28.5	27.2	18	14.1	-47%
Rainbow trout	tonnes	11.7	13.3	11.7	7.5	11	4.2	-64%
Other species with <5 producers	tonnes	65.2	97.2	94.9	94.2	75	97.4	49%

The WA edible mollusc aquaculture production consists almost entirely of mussels, with a value of $1.37 million in 2011/12 (DoFWA, 2012). In 2006/07 mussel production in WA was over 600 tonnes but since then the industry has experienced a trend of decline, with production of only 350 tonnes in 2011/12 (Table 2). Currently there is no mussel hatchery spat production in WA. This decline in production could be partly due to the sector's reliance on wild mussel spat settlement, with wild spat settlement appearing to be more highly variable than previously (*G. Dibbin pers. comm.*). Feed availability may also be declining in the Cockburn/Warnbro Sounds, which may also be contributing to the productivity decline. The declining feed availability could be due to a number of factors including reductions in fertiliser use on lawns and gardens, fewer market gardens in the adjacent catchment area, together with lower rainfall.

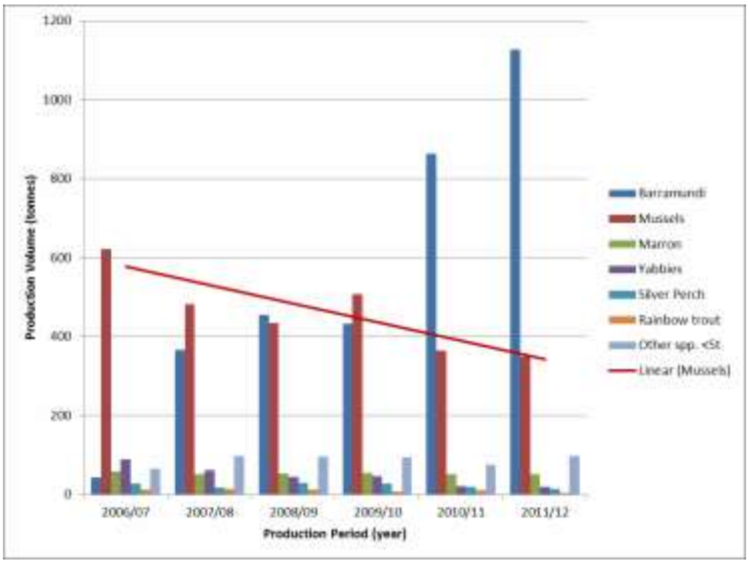

Figure 10 - WA aquaculture production volumes showing trend line for mussels

Western Australia has 12,889 kms of mainland coastline and 20,781 of coastline including islands, which equates to around 35% of the total Australian coastline. Mollusc aquaculture production in WA was 350 tonnes in 2011/12 (Figure 10), or less than 2% of Australian mollusc production by volume from aquaculture.

Whilst some parts of WA's coastal waters have low levels of nutrients and productivity (South and South West), there are vast areas of coastal waters with higher productivity potential in the North West, through the Gascoyne, Pilbara and Kimberley. Clearly there is an opportunity to expand mollusc aquaculture production in Western Australia.

2.8 The Need for a Mollusc Hatchery in WA

The Blacklip, *Pinctada margaritifera,* and Akoya, *Pinctada fucata* (also referred to collectively as non-maxima), pearl oyster sectors share a similar constraint to that affecting the mussel farming sector - i.e. inconsistent and declining spat supply. However, the non-maxima pearling companies are not able to collect significant numbers of wild-settled Blacklip or Akoya spat and are also unable to fish for mature wild shell like the South Sea (maxima) pearling industry does. The commercial, non-maxima pearling industry relies entirely on hatchery-produced spat.

There have been several hatcheries producing non-maxima spat over the last 10 – 15 years – Bealwood in Carnarvon, Blue Lagoon in Shark Bay and the Abrolhos Pearls hatchery barge moored at Coronation Office Island at the Pelsaert Group of islands. None of these hatcheries are now operating. The Batavia Coast Maritime Institute has tried to produce Blacklip spat on a number of occasions with no success.

The Abrolhos Islands Blacklip pearl farmers were unable to source hatchery spat for the 3 years (mid-2012 – mid-2015). Non-maxima pearl production value has declined by 90% over 7 years from 2006/07 – 2012/13. Lack of reliable spat supply is reported by this sector to be one of the factors, if not the main factor, contributing to the decline in non-maxima pearl production. The decline in pearl prices post-GFC has also undoubtedly had an effect on the value of pearl production. There are indications that the pearl market has improved recently, but without a source of spat the industry cannot react to the demand by expanding. Recently Jonathan Bilton at the OFI Albany Hatchery has produced some much-needed Akoya spat.

Rock Oyster spat have been produced in the past at the Ocean Foods International (OFI) hatchery in Albany. However, the hatchery ceased operating between 2011 and 2014, therefore there was no oyster spat available for around three years. Recently the hatchery has starting producing Rock Oyster spat and has also produced a batch of Akoya spat.

Historically there has been a trend in WA for hatcheries to operate and then cease operations – that is, produce mollusc spat for a couple of years and then stop producing spat for a couple of years. This is seen as a major constraint on the development and growth of the mollusc aquaculture production in WA.

The long term success of a species in aquaculture is heavily reliant on the ease of breeding and rearing the larvae of that species in the hatchery. The advantages of hatchery-produced mollusc spat over wild-settled spat are as follows:

- Greater consistency in spat numbers available / less annual variation
- Greater control over production volumes
- Control over spat deployment, allowing extension of the harvest window and expansion of live and fresh markets (through development of out-of-season spawning techniques)
- Increased biosecurity. Better control over disease through screening broodstock and progeny before deployment to nursery and farm sites
- Decreased grow-out time by increasing growth rates through selective breeding programs
- Increased survival rates by developing pedigrees with greater disease-resistance through selective breeding programs
- Improved product quality and development of product to market preferences through selective breeding (e.g. improving shell shape and appearance)
- Improved product and faster growth rates by using techniques for producing sterile stock, for example triploid / polyploid oyster stock
- Greater control for planning production, sales and marketing
- Greater scope and opportunity for expansion of businesses and sectors

There is a strong and growing demand for edible oyster, mussel and non-maxima pearl oyster spat to supply the Western Australian mollusc aquaculture sector. However, historically mollusc hatchery production has been inconsistent and unreliable, constraining development and growth of these sectors. This is in part due to “critical mass” not yet having been reached in the grow-out/farming sectors.

Bivalve mollusc aquaculture has the potential to provide a sustainable increase in aquaculture production without significant environmental impacts. Mollusc aquaculture also has the potential to provide a steady form of rural employment. The WA mollusc aquaculture sector (Mussel, Rock Oyster, Blacklip and Akoya pearl oysters) requires a *reliable, consistent* source of hatchery-produced spat in order to successfully expand mollusc farming in rural WA.

2.9 Study Proponent

The Aquaculture Council of Western Australia (ACWA) and Department of Fisheries Western Australia (DoFWA) are proponents for the WA Shellfish Hatchery Business Plan study.

ACWA is a member-driven organisation based in Perth, Western Australia. ACWA is the State's leading aquaculture industry body, representing more than 80% of the industry earnings of the Western Australian aquaculture industry, and consists of institutions, corporations, aquaculture sector associations and individual members.

2.10 Study Author

RMB Aqua Pty Ltd is a Perth-based company specialising in aquaculture consultancy services. The owner Roger Barnard has over 25 years of experience in the aquaculture industry, including 15 years managing shellfish hatcheries.

www.rmbaqua.com

2.11 Study Scope

The scope of work for the project includes the following:

- Investigate the establishment of the Victorian Shellfish Company at Queenscliff as a potential model for the WA Hatchery proposal;
- Hold discussions directly with potential stakeholders regarding their willingness to participate in this program and contribute to the operational costs of the facility;
- Make recommendations on the most appropriate site for the WA hatchery that provides the best opportunity for success;
- Prepare a capital expenditure budget to establish the hatchery and the likely production capacity of the facility and the industry sectors (species) it could potentially service;
- Prepare an operational budget stating the likely production capacities and indicative operational costs for various species production runs (i.e. indicative costs to industry);
- Identify and articulate a model (or models) including transitional arrangements for Government investment in early stage operational costs, that will enable the key beneficiaries of the facility to contribute to the ongoing operational costs of the facility on a user pays basis;
- Identify if the hatchery is able to be self-funded within 5 years; and
- Identify appropriate sources of funding to assist with the capital cost of the facility, and preliminary advice on the likelihood of success in attracting funding.

3 Case Study - Victorian Shellfish Hatchery

3.1 Background of the Victorian Shellfish Hatchery

Until 2002, the Victorian mussel industry was thriving, achieving peak production at approximately 1,600 tonnes and valued at $3.7 million. Following that time the rate of settlement on ropes and survival of spat declined, affecting reliability of harvest and production. Through collaboration between industry and the then Victorian Department of Primary Industries (DEPI), now the Department of Economic Development, Jobs, Transport and Resources (DEDJTR), research between 2002 and 2005 was initiated to investigate the cause of these changes. While the specific source of the decline was not able to be determined, the research suggested that larval and juvenile stages of mussel development are vulnerable to environmental changes (Victorian DEPI, 2008).

In 2007-2008 mussel production in Victoria had dropped to around 450t per annum. Many companies were either exiting the industry or considering doing so. A study was undertaken and it was decided that the Victorian State Government would support the development of a mussel hatchery. Without a mussel hatchery there was the risk that the mussel industry may disappear altogether.

3.2 Victorian Shellfish Hatchery Objectives

The project objectives were:

- For DPI and the Victorian Shellfish Hatchery (VSH) to co-invest in research with the aim of reliably and cost- effectively producing improved quality mussel spat for the Victorian mussel industry, using DEPI's marine hatchery infrastructure
- To utilise technologies developed by the Research and Development Project or through technology transfer to enable the reliable and cost-effective production of seed stock for the mussel industry

Figure 11 - Victorian DEPI marine research facility and co-op mollusc hatchery (Google Earth)

3.3 Victorian Shellfish Hatchery Corporate Structure

The State government stipulated it would not deal with multiple parties for the development of a mussel hatchery. Five companies from the mussel industry formed an incorporated entity called the Victorian Shellfish Hatchery (VSH) and entered into a five year Research & Development and Facility Access Agreement (R&D FAA) with the Victorian State Department of Environment, Planning and Infrastructure (DEPI).

The Victorian government owned and operated an aquaculture and marine research facility at Queenscliff. Part of this facility was provided to VSH through the R&D FAA for the project. Oversight of the project was undertaken by a Steering Committee consisting of two DEPI staff and two of the VSH mussel farming stakeholders. The steering committee met bi-monthly or as determined by the Project needs. The Steering Committee developed the Production Plan and targets and Research Plan and priorities, ultimately deciding how best to utilise the resources available.

Three of the six companies dropped out of the project in the early years, leaving three companies with shares in VSH. A condition in the FAA states that the VSH must make 20% of the mussel spat available to the other Victorian mussel companies that did not have a stake in the hatchery. DEPI contracted a mollusc hatchery expert to assist in facility design, development of protocols and technical support for the 5 year period of the project.

3.4 Victorian Shellfish Hatchery Funding

DEPI provided the project capital expenditure for building fit-out, improvements and equipment. DEPI upgraded the facility and fitted it out with the tanks and equipment required for a mollusc hatchery at a cost of approximately $450,000, circa 2007. The initial cost was $250,000-300,000 for the hatchery but there was an additional $150,000 for the nursery and other equipment and infrastructure.

Figure 12 - Queenscliff mussel hatchery 5t settlement tanks (DEPI)

VSH provided some staff, some of the consumables and accounting requirements for the project. VSH staff were required to undertake a facility induction and work according to facility regulations and procedures. VSH provided a manager and technicians to operate the mussel hatchery, whilst the Victorian government provided technical support for resolving issues and carrying out R&D using the DEPI aquaculture staff and research scientists. DEPI also provided salary contributions for parts of the research projects by contracting VSH staff.

The government provided access to the facility for VSH through an R&D Facility Access Agreement (R&D FAA). The agreement had various operating conditions as well as a funding schedule. Included in the R&D FAA were conditions for VSH to pay DEPI an Annual Depreciation Fee, an Annual Research Fee, an Operational and Consumables Fee and a Production Revenue Fee, which was based on annual spat production volumes.

3.5 Victorian Shellfish Hatchery Facility and Infrastructure

The mussel hatchery consists of an enclosed area of approximately 181 m^2 and a semi-enclosed greenhouse nursery area that is approximately 160m^2. The shellfish hatchery enclosed area is inclusive of a dry laboratory room, an algal room, a broodstock conditioning room and an open wet area suitable for hatchery work.

One of the keys to the mussel hatchery's success is the water quality. The water quality is excellent, drawing from a depth of 8 – 10m from the "Rip". The water is crystal clear for much of the year. It is 12kms from the nearest river and there are no seaweed build-ups near the intake (*pers. comm. J. Mercer, 2014*).

Figure 13 - Victorian DEPI marine research facility and co-op mollusc hatchery_2 (Google Earth)

3.6 Benefits of the Victorian Shellfish Hatchery

The most important benefit of the Victorian Shellfish Hatchery is to provide the Victorian mussel farmers with more control over mussel production through not having to rely solely on highly variable wild mussel spat settlement. VSH also provides the mussel farmers with the opportunity to start production cycles outside of standard natural spawning and settlement windows, thereby enabling the mussel farmers to produce product outside of their "standard" harvest window and therefore potentially expand their markets.

The Victorian Shellfish Hatchery is developing the capability for a Breeding Program that will provide the Victorian mussel farmers the advantage of a shorter grow-out time to market by using fast-growing pedigrees from the hatchery breeding program. This could lead to providing Victorian mussel farmers with an advantage over farmers in other States. The VSH also creates other opportunities with the potential for new aquaculture sectors to emerge in Victoria as other mollusc species are cultured at the facility, such as flat oysters (*Ostrea angasi*), and with scallop production currently being evaluated.

3.7 Lessons learned from the Victorian Shellfish Hatchery

In 2008 the mussel hatchery was commissioned. The first year the hatchery had a number of issues that adversely affected production. A group of industry experts with experience in mollusc hatchery production from around Australia and overseas were brought together to attempt to identify potential sources of the problems. Several changes were made, and the following year the issues were largely resolved and the hatchery began commercial production of mussel spat.

Lessons learnt from the VSH include:

- The VSH Production and Research Plans were too detailed and prescriptive, whereas production systems and research requirements tend to evolve and change (*pers. comm. A. Clarke, 2015*). Broader terms for the Facility Access Agreement, with greater freedom to operate and determine research requirements as they are identified are recommended
- It's all about building a trusting working relationship and less about covering default risk (*pers. comm. A. Clarke, 2015*). A lot of time and money can be spent writing up complex terms, conditions and indecipherable legal frameworks. However, the terms, conditions and legal obligations are not the most important aspect to making the project work.
- Hatcheries are very complex biological systems and the solutions to problems cannot always be reached in given time frames, or at all (*pers. comm. A. Clarke, 2015*)
- The VSH has, at the time of writing, only one larval room and one nursery area, which means that multiple species cannot be cultured concurrently. VSH are currently seeking funds to expand and have two separate larval rooms and nursery/set areas. It would have been preferable to have multiple biosecure culture areas in order to enable multiple species to be cultured concurrently. This would increase productivity and improve the economics of the hatchery.
- The success of the project relied heavily upon significant collaboration between many parties with expertise in the various facets of bivalve hatchery and nursery production, with sometimes differing views depending upon their own experiences.

The hatchery produces 400-500 million mussel spat per year. The Victorian mussel farming industry is back up to around 1,000-1,200t per year. The hatchery deploys spat at around 0.5 - 1mm in size. They are sold for approximately $0.0007 - 0.001 each. There are 3 - 4 batches produced each year. Now that the hatchery has ironed out most of the glitches and fine-tuned operations, it can now produce surplus mussel spat.

A hatchery needs to run all year in order to keep good, well-trained, experienced staff (*pers comm. J. Mercer, 2014*). Good, well-trained, experienced staff are the key to operating a successful mollusc hatchery that can consistently and reliably produce spat.

The Victorian Shellfish Hatchery is now starting to produce flat oysters (*Ostrea angasi*) and starting to research scallop culture (*Pecten fumatus*). VSH also cultures Sydney Rock Oysters (SRO - *S. glomerata*) under contract for NSW oyster farmers. There are strict quarantine requirements for culture of SRO in Victoria using NSW broodstock. The hatchery needs these extra species to increase revenue to sufficient levels to cover hatchery operating costs and to make better use of resources throughout the year.

It is more difficult to condition the mussels to spawn out of season, so the hatchery usually runs with the natural spawning cycle, although there are plans to work on expanding this to out-of-season spawning. The company has begun a breeding program with assistance of the

DEPI, with the objective of improving economically important traits. Already they are reporting improvements to growth rates. The grow-out production time has reportedly come down from 18 months to 12 months. The farmers now prefer using hatchery spat and would not go back to using wild-settled spat even if natural settlement rates bounce back (J. Mercer 2014, pers. comm.).

The government/industry collaboration to support the development of a mollusc hatchery in order to sustain and expand the mussel industry in Victoria appears to have been successful.

Figure 14 – Mollusc farm surface longlines

4 Industry Requirements

4.1 Spat Numbers Required

Nine WA aquaculture companies were consulted on spat requirements of their mussel, oyster and non-maxima pearl oyster businesses during the Study. Mollusc farmers who participated in the spat requirement survey for this study estimated their current spat requirements and their forecast requirements for the next 5 years (shown in the table as Year 1-5). Consolidated spat number requirement forecasts for each species are shown below in Table **3**.

Table 3 - WA Mollusc Farmer Spat Requirement Forecasts

Forecast number of spat required per month (**Mussels**/Mytilus galloprovincialis) - **ALL companies**													
Year / month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (m)
current	0	0	26,000,000	31,000,000	15,000,000	0	0	0	0	0	0	6,000,000	**78,000,000**
1	6,000,000	0	36,000,000	41,000,000	15,000,000	0	0	0	0	0	0	7,000,000	**105,000,000**
2	13,000,000	0	53,000,000	63,000,000	20,000,000	0	0	0	0	0	0	13,000,000	**162,000,000**
3	20,000,000	0	70,000,000	78,000,000	30,000,000	0	0	0	0	0	0	20,000,000	**218,000,000**
4	20,000,000	0	87,000,000	97,000,000	30,000,000	0	0	0	0	0	0	20,000,000	**254,000,000**
5	20,000,000	0	106,000,000	116,000,000	30,000,000	0	0	0	0	0	0	20,000,000	**292,000,000**
Forecast number of spat required per month (**Blacklip**/*Pinctada margaritefera*) - **ALL companies**													
Year / month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (m)
current	0	0	25,000	200,000	0	200,000	0	0	0	0	0	0	**425,000**
1	0	0	25,000	200,000	0	300,000	0	0	0	0	0	0	**525,000**
2	0	0	25,000	300,000	0	400,000	0	0	0	0	0	0	**725,000**
3	0	0	25,000	300,000	0	400,000	0	0	0	0	0	0	**725,000**
4	0	0	25,000	400,000	0	400,000	0	0	0	0	0	0	**825,000**
5	0	0	25,000	400,000	0	400,000	0	0	0	0	0	0	**825,000**
Forecast number of spat required per month (**Akoya/***Pinctada Fucata*) - **ALL companies**													
Year / month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (m)
current	0	0	0	200,000	0	200,000	0	0	0	200,000	0	0	**600,000**
1	0	0	0	200,000	0	200,000	0	0	0	200,000	0	0	**600,000**
2	0	0	0	300,000	0	200,000	0	0	0	200,000	0	0	**700,000**
3	0	0	0	300,000	0	200,000	0	0	0	200,000	0	0	**700,000**
4	0	0	0	400,000	0	200,000	0	0	0	200,000	0	0	**800,000**
5	0	0	0	400,000	0	200,000	0	0	0	200,000	0	0	**800,000**
Forecast number of spat required per month (**Rock Oyster/***Saccostrea spp.*) - **ALL companies**													
Year / month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (m)
current	1,000,000	2,000,000	1,000,000	0	0	0	0	0	0	0	0	0	**4,000,000**
1	2,000,000	2,000,000	2,000,000	0	0	0	0	0	0	0	0	0	**6,000,000**
2	3,000,000	3,000,000	2,000,000	0	0	0	0	0	0	0	0	0	**8,000,000**
3	4,000,000	5,000,000	3,000,000	0	0	0	0	0	0	0	0	0	**12,000,000**
4	5,000,000	6,000,000	3,000,000	0	0	0	0	0	0	0	0	0	**14,000,000**
5	6,000,000	7,000,000	3,000,000	0	0	0	0	0	0	0	0	0	**16,000,000**

Spat requirements for the mussel sector are forecast to more than triple to almost 300 million spat per annum, an increase of 274% from current requirements of 78 million mussel spat.

Blacklip Pearl spat requirements are forecast to increase by almost 100% to 825,000 spat from today's requirement of 425,000 spat.

Akoya spat numbers are forecast to increase by 33% to 800,000 spat per year, whilst Western Rock Oyster spat numbers are forecast to quadruple to 16 million spat from current demand of 4 million, an increase of 300%.

4.2 Timing of spat requirements

The peak natural spawning times for each of the WA mollusc species of interest to this study are in Figure 15. These spawning times are based on discussions with the various parties from the WA mollusc aquaculture sector that have taken part in this study.

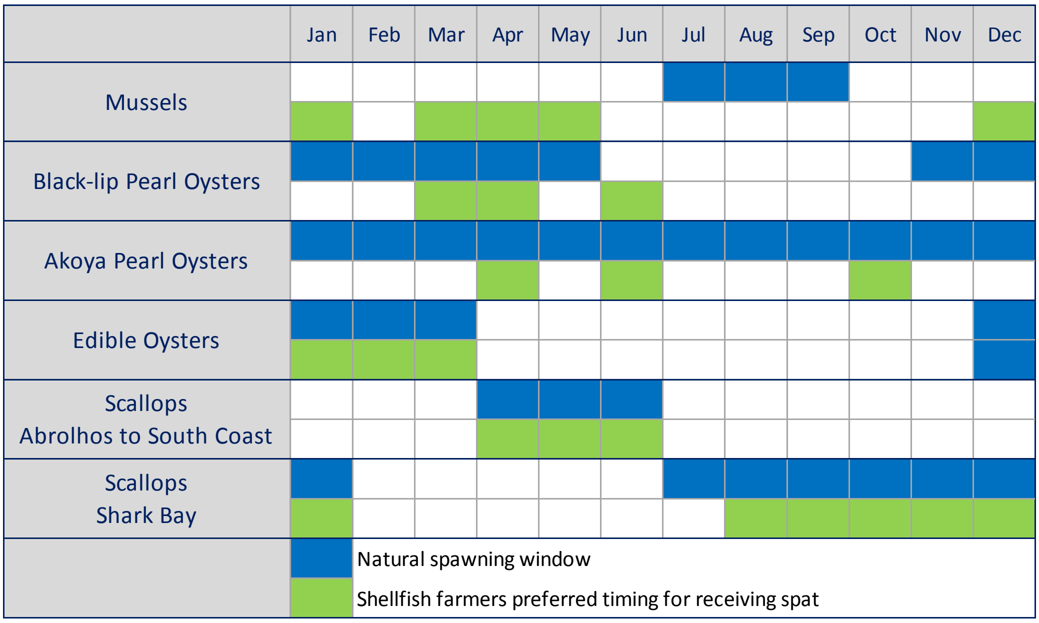

Figure 15 - Natural spawning windows and preferred timing for receiving spat

There is a relatively good spread across the year for natural spawning times. However, most mussel producers would like to see mussels being spawned out-of-season and spat deployed earlier in the year, around March-May (Figure 15). Most Blacklip and Akoya producers have indicated they would prefer their spat around March/April and some in June. Edible oysters are likely to be starting slightly earlier than the rest of the species, with hatchery production starting in December and deployment through January, February and March. Therefore there is a bottleneck for a multi-species mollusc hatchery producing mussels, oysters and non-maxima pearl oysters in the February, March, April period.

The bottleneck can be mitigated if some of the mussel spat production is moved to later in the year, around the natural spawning time in early spring. It may be prudent to split the mussel spat production between natural spawning season and out-of-season, as out-of-season spawning is not straightforward for many mollusc species, and it may take several years to develop successful techniques. The ambient water and air temperature profile for late winter/early spring would also be more favourable for mussels – i.e. lower in spring than autumn.

The non-maxima pearl oyster spat production could potentially be moved back a month or two from a March/April to April/May or May/June deployment (Figure 16) – assuming this is acceptable to farmers. Another option to consider is a September/October production run for non-maxima pearl oyster spat, if the oysters can be conditioned to spawn at this time of year. In the maxima pearl oyster industry survival rates and yields are generally significantly higher from hatchery spat deployed in spring compared to autumn. The mid-winter July/August period could be the main disinfection/dry-out and maintenance period.

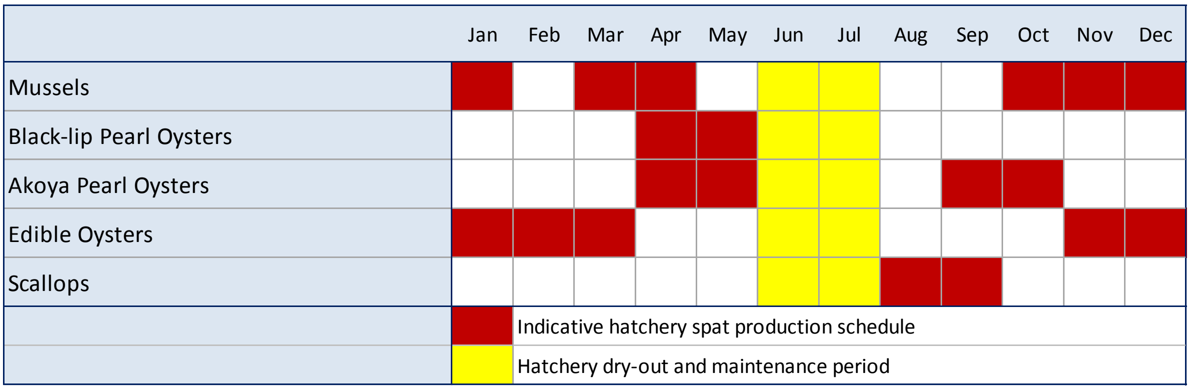

Figure 16 - Indicative Production Schedule Option for WA Shellfish Hatchery

Whilst plans can be made for the major production periods of each species in the WA Shellfish Hatchery, the plans will inevitably vary according to the market (farmer) requirements. There will also be cases of delays in production due to for example difficulties in finding broodstock in spawning condition. Therefore it should be assumed that there will be timing overlaps in species produced and multiple species will be cultured concurrently.

The Study recommends that the WA Shellfish Hatchery is of modular design, designed for culturing a minimum of two species concurrently. This will require a minimum of two larval culture rooms and two post-set/spat culture rooms. Another option to consider in the design process is having two larval culture rooms and three post-set/spat culture rooms to allow greater production flexibility across the different species, as the post-set culture period is generally around twice as long as the larval culture period.

Ultimately the hatchery Operator will work out the optimal timing of the hatchery production schedule. Through consultation with the customers (farmers) the Operator will be able to determine the best production batch timing for the different species and companies involved.

4.3 Research & Development

The WA mollusc aquaculture sector will require R&D and technical support in the following areas:

- **Development of broodstock transport protocols under WA conditions**
  - Blacklip Pearl Oysters (*P. margaritifera*)
  - Scallops (if scallop spat are to be produced in the future at the WA Shellfish Hatchery)
- **Development of spat transport protocols under WA conditions**
  - Mussels
  - Blacklip Pearl Oysters
  - Rock Oysters (for pilot-scale production in the North West)
  - Scallops (if scallop spat are to be produced in the future at the WA Shellfish Hatchery)
- **Development of reliable, consistent Blacklip Pearl Oyster hatchery production**
- **Selective Breeding Programs**

- Rock Oysters (separate family lines for the Northern Gascoyne, Pilbara and Kimberley Bioregions, as well as a Southern line)
- Mussels (potentially Cockburn and Albany lines)
- Blacklip Pearl Oysters
- Akoya (Albany and Abrolhos lines)

- **Disease management and biosecurity**
  - Disease screening
  - Disease resistance through breeding programs (e.g. *Bonamia* resistance in flat oysters, *Ostrea angasi*)
- **Triploid/Polyploid shellfish production**
- **Investigate and identify additional potential sites for mollusc culture in WA**, for example
  - Esperance
  - Wilson Inlet
  - Leschenault Inlet
  - Peel-Harvey Estuary
  - Shark Bay
  - Exmouth Gulf
  - Onslow
  - Pilbara region
  - Kimberley region
- **Development of hatchery production for new mollusc species** to provide the aquaculture industry the opportunity to diversify production (e.g. scallops, clams, rock oyster species for the North West)

Figure 17 - Dept. of Fisheries WA, Hillarys Boat Harbour Aquaculture Facility

5 Hatchery Site Selection

5.1 Mollusc Hatcheries in WA

Table 4 - Existing Mollusc Aquaculture Hatchery Licence Holders (DoFWA)

Company Name	Location	Notes
ABROLHOS PEARLS WA PTY LTD	ABROLHOS ISLANDS	
AUSTRALIAN CENTRE FOR APPLIED AQUACULTURE RESEARCH (ACAAR)	FREMANTLE	*Multi-species Hatchery (not specifically molluscs)*
BATAVIA COAST MARINE INSTITUTE	GERALDTON	*Multi-species Hatchery (not specifically molluscs)*
BEALWOOD PTY LTD	CARNARVON	
BLUE LAGOON PEARLS PTY LTD	DENHAM, SHARK BAY	
KIMBERLEY TAFE INSTITUTE	BROOME	*Multi-species Hatchery (not specifically molluscs)*
OCEAN FOODS INTERNATIONAL PTY LTD	ALBANY	
888 ABALONE PTY LTD	BREMER BAY	

- Bealwood, Abrolhos Pearls and Blue Lagoon hatcheries are not currently producing spat, and have not produced spat for several years
- Batavia Coast Marine Institute (BCMI) has previously attempted producing non-maxima pearl oyster spat on several occasions with no success
- ACAAR’s water quality may not be suitable for a multi-species mollusc hatchery and would require further investigation and de-risking before significant investment for mollusc production is made. It should be noted that ACAAR has however, cultured both abalone and Akoya with their bore water in the past.
- 888 Abalone site in Bremer Bay is not suitable for a multi-species mollusc hatchery because of the biosecurity risks posed by other mollusc species on the core business, i.e. abalone
- The Ocean Foods International (OFI) hatchery located at the Aquaculture Park in Albany recently re-commenced spat production in late 2014, following the release of the ACWA study findings. The OFI Hatchery has successfully produced oyster spat in the past, and also more recently. However, like the other WA mollusc hatcheries the oyster hatchery in Albany has had a patchy production history, not producing spat for around 5 years (2009-2014)

5.2 Selecting a Site for the WA Shellfish Hatchery

5.2.1 Green-field or Brown-field

All the mollusc aquaculture sectors involved in the ACWA 2014 Study reported a requirement for hatchery-produced spat as soon as possible. With this in mind assessment of potential site options was focused on existing government and commercial aquaculture facilities and hatcheries, as opposed to green field sites, in order to minimise lead time for spat production.

5.2.2 Distance for Live Transport of Broodstock and Spat

Table 5 shows the live transport times for broodstock and spat to and from the potential sites under consideration. Edible oyster and mussel hatchery spat production is best located in Albany when considering the live transport distance as a site assessment criterion. Akoya spat for deployment in Albany is also best produced in Albany. Fremantle and Perth are next best placed for mussels and edible oysters, whilst Geraldton is borderline. The Abrolhos Islands, Exmouth and Broome are too far away for live transport of broodstock and spat to be considered high in the rankings of potential multi-species mollusc hatchery sites, based on this criterion.

Table 5 - Transportation Distances for Broodstock from Source to Hatchery, Spat from Hatchery to Farm (km)

Potential hatchery facilities	Source / Destination	OFI / GSMH Hatchery	ACAAR / Challenger TAFE	DoFWA Hillarys	Batavia TAFE	Abrolhos Islands	Manbana Hatchery
Location		Albany	Fremantle	Perth	Geraldton	offshore Geraldton	Broome
Transport of livestock							
Distance from **BROODSTOCK** source (**Blacklip**)	Abrolhos	800	400	400	50	50	1,800
Distance to **SPAT** destination (**Blacklip**)	Abrolhos	800	400	400	50	50	1,800
Distance from broodstock source (**Akoya**)	Abrolhos	800	400	400	50	50	1,800
Distance to spat destination (**Akoya**)	Abrolhos	800	400	400	50	50	1,800
Distance from broodstock source (**Scallops**)	Rotto	400	50	50	400	400+	2,200
Distance to spat destination (**Scallops**)	Abrolhos	800	400	400	50	50	1,800
Distance from broodstock source (**Mussels**)	Perth	400	50	50	400	400+	2,200
Distance to spat destination (**Mussels**)	Perth	400	50	50	400	400+	2,200
Distance from broodstock source (**Akoya**)	Albany	50	400	400	800	800+	2,600
Distance to spat destination (**Akoya**)	Albany	50	400	400	800	800	2,600
Distance from broodstock source (**Mussels**)	Albany	50	400	400	800	800+	2,600
Distance to spat destination (**Mussels**)	Albany	50	400	400	800	800	2,600
Distance from broodstock source (**Oysters**)	Albany	50	400	400	800	800+	2,600
Distance to spat destination (**Oysters**)	Albany	50	400	400	800	800	2,600

Scallops are best located Geraldton or the Abrolhos followed by Perth, based on live transport distances. Blacklip and Akoya spat (destined for the Abrolhos) are best located at the Abrolhos, followed by Geraldton and then Perth, whilst Albany and Exmouth are both marginal options for non-maxima pearl oyster spat production (except for Akoya spat destined for Albany).

5.2.3 Site Selection Criteria Overview

Table 6 - Potential Multi-Species Mollusc hatchery Site Criteria Matrix

Potential hatchery facility		Great Southern Marine Hatchery	Ocean Foods oyster hatchery	Australian Centre for Applied Aquaculture Research (ACAAR)	DoFWA Hillarys Aquaculture facility	Batavia Coastal Maritime Institute (BCMI)	Abrolhos Islands	Manbana Hatchery
Location		Albany	Albany	Fremantle	Perth	Geraldton	Abrolhos Islands	Broome
Criteria	Desired range							
Water quality (raw, pre-treatment)								
Water type	Coastal	Coastal	Coastal	Estuarine (&bore)	Coastal	Coastal	Oceanic	Coastal (& bore)
Salinity (ppt)	33-37	34-37	34-37	34-37	34-37	35-37	35-37	30-36
Nutrient levels	low	Low	Low	medium	Low-medium	Low-medium	Very low	Low-medium
Suspended solids	low	Low	Low	low	Low	Low	Very low	High
Overall variability	low	Low	Low	low-medium	low-medium	low-medium	Very stable	medium
Distance from significant rivers (km)	10+*	10	10	0	>20	>20	>20	>20
Overall WQ	Good	V. Good	V. Good	Sub-optimal	OK	Serious issue?	Excellent	Sub-optimal
WQ Comments		Very Good	Very Good	Borewater WQ is not ideal - has low pH. Seawater variable -would need extra SW storage capacity		H2O2 from dead seaweed / design flaw?	Pristine oceanic "bluewater"	Less than ideal. Turbid seawater. Borewatersub-optimal
Infrastructure / Tenure								
Land tenure	Crown / Govt.	Govt.	Govt.	Govt.	Govt.	Govt.	Govt.	Govt.
Lessor	DoFWA	DoFWA	DoFWA	Fremantle Ports	DoFWA	BCMI	?	DoFWA / DoT
Lessee	Nil	Nil	Ocean Foods Int.	Challenger TAFE	DoFWA	BCMI	NA	Ocean & Earth
Water intake depth	>8	5 - 6	5 - 6	NA			NA	
Water intake capacity / day (m3)	500+	TBD	144,000	4,320,000	1,680		NA	
Water storage / settlement capacity (m3)	500+	No	0	20	150		NA	
Water filtration (microns)	1	No	1	5	5		NA	
Water temperature control	Heat & Cool	No	Heat & cool	Heat & cool	Heat & cool		NA	
Building footprint (hatchery area m2)	300+	~500	~400	~2,340	~300?	~600?	NA	300?
Land footprint (approx. m2)	300+	1,500+	1,500+	2,000+	~300?	~1000?	NA	1,200
Building condition	Good	Needs a lot of work	Needs a lot of work	Old but OK	Very good	Good?	NA	Potential structural issues
Mains Power	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Back-up power supply	Yes	No	No	Yes	Yes?	Yes?	NA	?
Comments		Hasn't operated for many years. Possibly no SW intake line. History of mollusc hatchery production	Currently operating. Hoistory of successful mollusc hatchery production	Currently no seawater intake, only borewater. Good services otherwise. Plenty of space	Centrally located. Scientific services. Not a great deal of space	Location good for BL, AK SC re proximity to Albrolhos Is. and Shark Bay	Close proximity to nursery sites. Very difficult logistically to manage hatchery	Very poor hatchery design. Limited space assigned to hatchery
Services								
Distance from domestic airport (km)	<50	30	30	27	30	12	85 (SEA/AIR)	8
Distance to nearest airstrip / aerodrome	<50	30	30	16	30	12	0 - 20 (SEA)	8
Distance to town	<50	20	20	1	1	1	*50* (SEA/AIR)	8
Science support services	Good	Minimal	Minimal	Good	Good	Limited	none (Geraldton)	Limited
Engineering support and supplies	Good	OK	OK	Excellent	Excellent	Good	none (Geraldton)	Limited
Livability	Good	OK	OK	Excellent	Excellent	OK	Remote	Remote
Staff stability / skills retention	High	Medium	Medium	High	High	Medium	Low	Medium
Ease of managing hatchery production	High	Medium	Medium	High	High	Medium	Low	Medium
Ease of managing R&D programs	High	Medium-low	Medium-low	High	High	Medium	Low	Low
Facility staffed	Yes	No	No	Yes	Yes	Yes	No	No
Facilities serviced and maintained		No	?	Yes	Yes	Yes	No	No
Environmental / Climate								
Annual Rainfall (mm) (*BOM*)	*	928	928	732	732	442		612
Mean annual min. / max. air temp. (°C) (*BOM*)	species specific	11.7 - 19.5	11.7 - 19.5	12.7 - 24.7	12.7 - 24.7	13.6 - 25.9		21.2 - 32.2
Mean annual min. / max. water temp. (°C) (*BOM*)	species specific	*15 - 21*	*15 - 21*	18 - 22	14 - 26			
Successful mollusc hatchery production history	Yes	Yes	Yes	Yes/Variable	Yes	Multiple Failures	Yes	Sporadic/ Inconsistent

Criteria status key
- OK
- Sub-optimal
- Potential issue
- Issue

BM - Bivalve Mollusc
* - dependent on the size of river / catchment area

Table 6 shows some of the selection criteria used for the Multi-Species Mollusc Hatchery in the ACWA 2014 study, indicating the characteristics of the potential sites considered where available. The characteristics have been provided by persons familiar with the specific sites. Whilst some criteria data are subjective, the table gives a broad indication of the site suitability. There is a "traffic light" system where green indicates OK, green with orange stripe indicates OK but not ideal, orange indicates a potential issue and red indicates a serious issue.

Using the current information attained in the 2014 and current Study, the following sites are considered likely to be the most suitable for a role in mollusc hatchery spat production to supply mussel, edible oyster and non-maxima pearl oyster spat:

- **Great Southern Marine Hatcheries, Albany** – **Preferred Site**. Good water quality, successful history of producing mollusc spat from water source, good lot size. Good potential site for edible and mussel spat production. Whilst remote from the Abrolhos (800 kms), therefore not ideal, it could be considered for non-maxima pearl oyster production as well. Land tenure preferred as lessor is DoFWA and currently no lessee. There are some reports that the water intake has been removed. Building footprint is large and buildings are a bit run-down but generally condition appears to be OK.
- **OFI oyster hatchery, Albany** – Good water quality, history of successful production of mollusc spat (oysters), good lot size. Potential site for edible oyster and mussel spat production. Whilst remote from the Abrolhos (800 kms), therefore not ideal, it could be considered for non-maxima pearl oyster production as well. Tenure and lease arrangements would need to be considered and managed through negotiations with OFI. Buildings not as large as GSMH. At the time of writing OFI Hatchery is in operation. Facility has tanks and some equipment.
- **DoFWA aquaculture research facility, Hillarys Boat Harbour, Perth** – Fair water quality. Well-appointed with good building condition. Fully serviced and partially staffed. **Well located for scientific services, R&D programs and technical support role**, e.g. small-scale scallop propagation R&D for the fishery enhancement research program. Hillarys is also likely to be suitable for mussel and other mollusc species R&D. Hillarys is size limited but there could be the capacity to carry out some small-scale hatchery production (e.g. Blacklip) if required.
- **ACAAR, Fremantle** – Very stable water but bore water. Previous successful mollusc hatchery production history with abalone and Akoya. Extensive aquaculture facilities and space. Fully serviced and staffed. **Well located for scientific services, R&D programs and technical support role.** May be suitable for mussel and other mollusc species R&D. Capacity to carry out some hatchery production if required.
- **Watermans Centre, Watermans Bay, Perth** - Fair water quality. Currently being re-fitted to carry out marine research between several institutes - DoFWA, AIMS, CSIRO and UWA. Could be suitable for some mollusc breeding/larviculture R&D projects.
- **Abrolhos Islands** – the Abrolhos are not suitable for large-scale mussel or rock oyster spat production destined for the South-West due to a number of factors including climate, economics and logistical difficulties. A small hatchery for non-maxima pearls is a possible option to consider. There is an existing licensed hatchery in the Abrolhos and the licence is currently being assessed in respect of an application to vary it to enable the current barge-based hatchery to be relocated onshore at Coronation Island.

The ACWA Mollusc Hatchery Study in 2014 identified the Albany Aquaculture Park as the most suitable site for a multi-species mollusc hatchery. Whilst Albany is not an ideal location for Blacklip Pearl Oyster producers in the Abrolhos, it is a highly suitable location for rock oyster and mussel hatchery production. Albany is an adequate location for Akoya spat production. The Great Southern Marine Hatcheries (GSMH) site is the preferred location for the WA Shellfish Hatchery. **For the purposes of this Study it is assumed that the WA Shellfish Hatchery will be located at the GSMH site in Albany**.

The proposed site for the WA Shellfish Hatchery, the old Great Southern Marine Hatcheries site, is located in the Aquaculture Park on Murray Road approximately 22 kms from Albany CBD, and takes approximately 20 minutes by car.

5.2.4 Albany

Table 7 - Albany Climate Data (BoM)

[hide]Climate data for Albany													
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Record high °C (°F)	41.7 (107.1)	44.8 (112.6)	40.8 (105.4)	37.7 (99.9)	35.2 (95.4)	24.6 (76.3)	22.8 (73)	27.3 (81.1)	30.6 (87.1)	36.2 (97.2)	41.1 (106)	42.2 (108)	44.8 (112.6)
Average high °C (°F)	22.8 (73)	22.9 (73.2)	22.2 (72)	20.8 (69.4)	18.6 (65.5)	16.5 (61.7)	15.7 (60.3)	16.3 (61.3)	17.2 (63)	18.4 (65.1)	20.3 (68.5)	21.8 (71.2)	19.5 (67.1)
Average low °C (°F)	15.1 (59.2)	15.4 (59.7)	14.6 (58.3)	12.7 (54.9)	10.7 (51.3)	9.0 (48.2)	8.1 (46.6)	8.3 (46.9)	9.2 (48.6)	10.4 (50.7)	12.4 (54.3)	14.0 (57.2)	11.7 (53.1)
Record low °C (°F)	10.0 (50)	7.2 (45)	6.1 (43)	4.8 (40.6)	2.4 (36.3)	1.7 (35.1)	0.1 (32.2)	1.6 (34.9)	2.0 (35.6)	3.4 (38.1)	5.6 (42.1)	6.7 (44.1)	0.1 (32.2)
Average rainfall mm (inches)	23.9 (0.941)	22.8 (0.898)	38.2 (1.504)	69.0 (2.717)	117.2 (4.614)	133.8 (5.268)	143.6 (5.654)	126.0 (4.961)	101.3 (3.988)	79.2 (3.118)	44.9 (1.768)	29.7 (1.169)	929.6 (36.6)
Average rainy days (≥ 1.0 mm)	3.4	3.4	5.3	8.0	11.1	12.5	13.9	13.0	11.4	9.5	6.5	4.3	102.3
Average relative humidity (%)	67	67	69	69	70	70	70	68	69	70	68	67	68.7
Source: Australian Bureau of Meteorology[36]													

Albany is a port city in the Great Southern region of Western Australia, 418 km SE of Perth, the state capital. Albany has a population of around 30,000. The main industries are tourism, fishing, timber (wood chips) and agriculture. From 1952 to 1978 whaling was a major source of income and employment for the local population. The Whaling Station, which closed operations in 1978, has been converted to a museum of whaling. The Great Southern Marine Hatcheries site that is the proposed site for the WA Shellfish Hatchery is adjacent to the Whaling Museum.

5.3 Site Assessment – Great Southern Marine Hatcheries

The Great Southern Marine Hatcheries site is deemed suitable for the WA Shellfish Hatchery for a number of reasons, including:

- Good water quality
- Proven shellfish hatchery production from water source
- DoFWA own the lease
- Land parcel size of approximately 1 hectare
- Existing infrastructure
- Adequate building size of approximately 400m^2 footprint, with an additional 180m^2 roofed area
- Suitable climate/water temperatures for mussel and oyster hatchery and nursery production
- Proximity to town/city and services

5.3.1 Water Quality and Water Source

Water quality is generally considered the most important characteristic to consider when selecting a site for a mollusc hatchery. Mollusc hatcheries require high standards of water quality, either good quality coastal waters or oceanic waters.

Figure 18 - Albany Aquaculture Park Waterfront

The water source should be drawn from >5 metres, preferably 8 – 10 metres depth. Water intakes situated in deeper waters supply water that is generally more stable in most parameters, including turbidity, salinity, temperature and pH. Shallow water intakes are often highly turbid and highly variable in many parameters.

The water supply of a mollusc hatchery should have the following characteristics:

- constant full –strength salinity (34-37ppt)
- have low concentrations of suspended solids
- low concentrations of nutrients and organic matter (TN, TP and TOC)
- stable, with low variability in major parameters
- free from pollutants such as industrial chemicals and pesticides from the agricultural industry

The best indicator of a hatchery site's suitability for a mollusc hatchery is a past history of successful mollusc hatchery production, and preferably consistent success over several years. A successful history of mollusc hatchery production at a site carries a high weighting in considering potential sites for the purposes of this Study. Without such a history, a detailed water quality analysis study will be required along with an in-depth site assessment including identification and assessment of biological indicators nearby the proposed water intake before an investment decision is made. To be meaningful the water quality analysis and baseline environmental monitoring should occur over a prolonged duration. The water source for the Great Southern Marine Hatchery has successfully and consistently produced mollusc spat in the past (J. Bilton 2015 pers. comm.).

5.3.2 Climate

Ambient water and air temperature of the hatchery site will affect the operating costs through heating and cooling water for the hatchery. It will be difficult to find the perfect balance as the rock oyster culture temperatures will be around 23-25°C and the mussel hatchery culture temperatures are generally around 16-18°C.

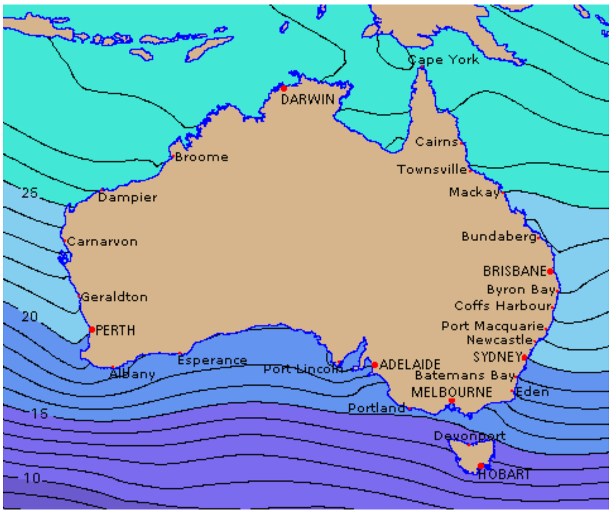

Figure 19 - Australian coastal sea surface average monthly temperatures (Navy METOC)

Heating and cooling power costs will also depend on what time of year the different species are being produced in the hatchery and nursery. It is more efficient and cheaper to heat water compared to cool water, therefore from this aspect Perth to Albany may appear to be better than North of Perth.

Ambient water temperature is not a highly critical criterion for a hatchery using relatively small volumes of water, as it can be heated or cooled. However, post-settlement land-based nurseries can use large volumes of water and it is generally uneconomical to heat or cool these volumes. Latitudes further south (e.g. Albany) are likely to be better for mussels due to cooler ambient water temperatures being advantageous in the post-settlement/pre-deployment phase.

5.3.3 Topography

The site should be situated a good distance from rivers with significant catchment areas, nominally 10 kms but dependent on river size and catchment area.

Figure 20 - Proposed WA Shellfish Hatchery Location in Relation to Albany

The nearest river/significant catchment area is the Oyster Harbour estuary a little over 10kms from the GSMH site proposed for the WA Shellfish Hatchery south-east of Albany. The influence from this catchment area on the water quality of the GSMH water source is minimal and infrequent (J. Bilton 2014, pers. comm.).

5.3.4 Land Tenure

Land tenure of potential sites is important for several reasons. If the State government is going to provide support to a multi-species mollusc hatchery in order to facilitate sustainment and expansion of the mollusc aquaculture sector in WA, it would be advantageous if the site chosen for the WA Shellfish Hatchery was on Crown Land, with the government as owner/lessor. With the government as owner/lessor of the facility it affords greater potential for operating the hatchery on terms that provide all species and all companies equal opportunity to expand their businesses in WA. In addition to this, if the government intends investing funds for building and improvements, it makes things simpler if the facility is government-owned.

The Albany Aquaculture Park is on Crown Land, which is vested with the Minster for Fisheries for the purpose of 'aquaculture'. The Great Southern Marine Hatcheries (GSMH) covers Crown Reserve 45115. The Department of Fisheries WA is owner/lessor of the GSMH facility.

5.3.5 Site and Existing Infrastructure

A good seawater intake is an important asset for a potential site, as seawater intakes are often very expensive to install. Water storage is useful in case of temporary issues with water supply – e.g. mechanical breakdowns or water quality issues in the ocean (coral spawn, algal blooms, high turbidity etc.). The buildings are one of the highest capital items, so existing buildings of a suitable size and in reasonable condition carry a high weighting in site assessment.

There is plenty of indoor culture area at the Great Southern Marine Hatcheries (GSMH) site, with capacity to separate culture areas for increased biosecurity when culturing multiple species concurrently. The GSMH indoor building footprint is around 400m^2. The roofed outdoor area is suitable for nursery and/or algae culture, with a footprint of around 180m^2. Building structures appear to be in reasonable condition, at least in comparison to other hatchery facility alternatives viewed. A full building and structural report by a qualified building surveyor is required to determine building and infrastructure condition.

It is unclear whether the GSMH still has a seawater intake in place. General consensus is that the seawater intake was removed following the closure of the facility. Others have reported that it is still in place.

A pre-deployment land-based nursery (or "pre-nursery") is required for rearing the post-settlement spat of some species to a suitable size, depending on the species and type of post-deployment nursery or grow-out system that follows. Land-based nursery tanks can be housed in sheds or poly-tunnels depending on climate, species and timing. The GSMH site provides plenty of room for expansion of mass algae production and land-based nursery facilities as required.

Figure 21 – Great Southern Marine Hatcheries site, Albany Aquaculture Park

6 Business Plan

6.1 Business Model

The Victorian Shellfish Hatchery (VSH) entered a "Research and Development & Facility Access Agreement" with the Victorian state government for the mussel hatchery project. This model is unlikely to be the most suitable model for the WA Shellfish Hatchery due to the location of the hatchery in Albany and the fact that the hatchery is not staffed by DoFWA scientists and aquaculture technicians able to carry out research and facilitate scientific support services.

Whilst there is a significant research and development component to the WA Shellfish Hatchery, there should be an overriding commercial focus, with government research and science in a supporting role based in Hillarys and/or at ACAAR in Fremantle. The WA Shellfish Hatchery could use a variation of the VSH model – a Facility Access Agreement (FAA) instead of a lease agreement.

The Study puts forward two business model options for consideration:

A. Facility Access Agreement with Operator (conditions TBD). DoFWA (Department of Fisheries Western Australia) contracts an incorporated entity for Facility and Project Support, to oversee management of the facility and administer funds (Figure 22)

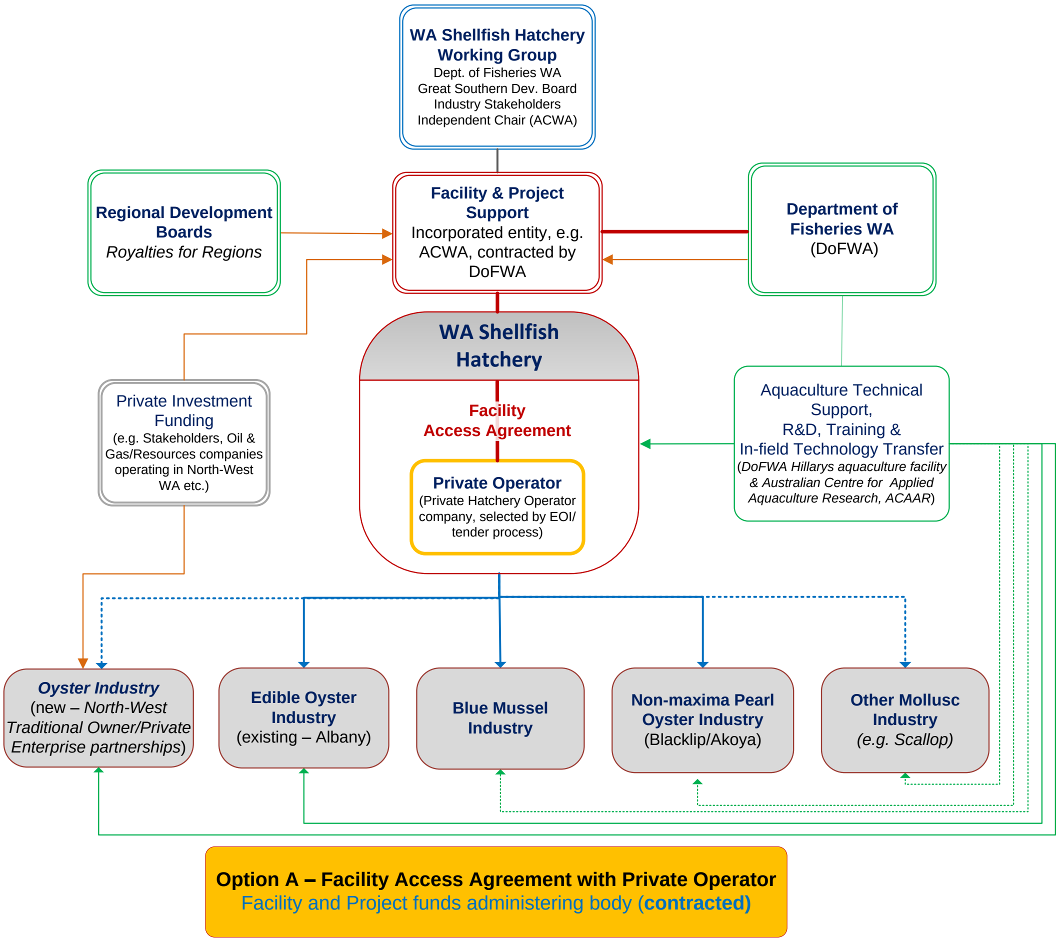

Figure 22 - WA Shellfish Hatchery Option A (recommended) Org Chart Structure

In the Option A Org Chart the "Facility and Project Support" incorporated entity would receive funding, for example from Royalties for Regions and/or Going for Growth, and manage the disbursement of funds. The Facility and Project Support body should be a legally constituted organisation that will take legal and financial responsibility for grants and other funding received. The entity could be an incorporated association or incorporated company limited by guarantee. The incorporated entity could be sought through an EOI/tender process or preferred entities could be identified, selected and negotiated with directly.

The Aquaculture Council of WA (ACWA) could be considered for the role of the Facility and Project Support/Administration. ACWA would be required to employ additional resources for this role. Other incorporated entities to consider for the administration role could be accounting firms. The WA Shellfish Hatchery will require funding for the management of the Facility and Project funds, if the DoFWA chooses not to undertake this using internal resources.

B. Facility Access Agreement with Operator (conditions TBD). DoFWA manages the hatchery facility and administer funds internally

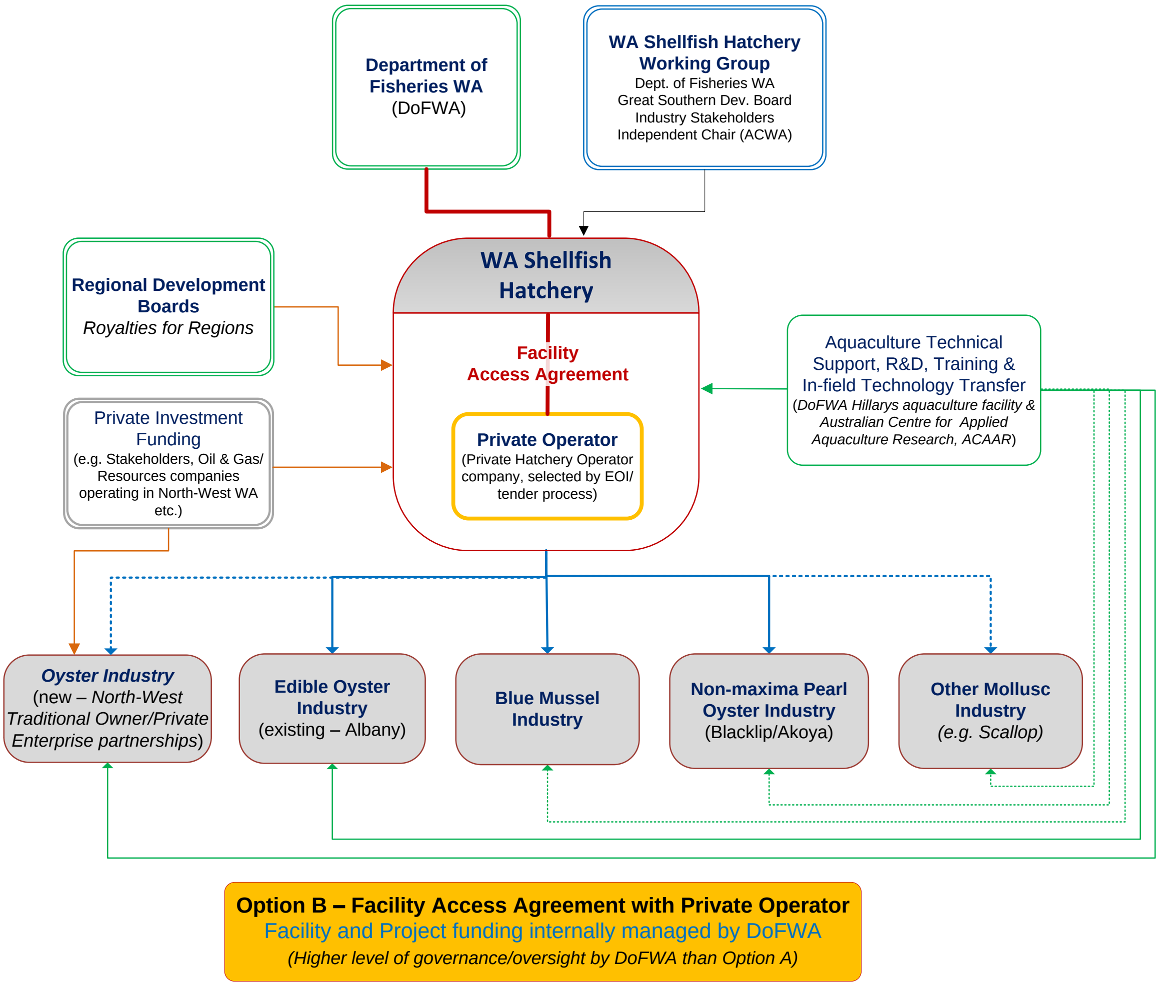

Figure 23 - Option B WA Shellfish Hatchery Org Chart

Under Option B (Figure 23) DoFWA (Department of Fisheries Western Australia) provides the Facility and Project Support, managing the Facility and Project funds internally. This does not mean necessarily internally funding the Facility and Project, but instead internally *managing* the Facility and Project funds (receiving and administering funds).

It is also worth considering a combination of Option A and B where the Facility and Project administration roles are shared between DoFWA and a contracted entity. For example ACWA administer the funds and oversee the R&D program whilst DoFWA manages the facility Repairs and Maintenance.

The quantum of funding for the Facility and Project administration will need to be determined through negotiations with suitable parties, possibly using an EOI process, following development of the full scope of the role.

6.2 Alternative Business Models

6.2.1 Spat Supply Contracts Tender Process

An alternative business model for the DoFWA to consider is to go through an EOI/tender process for "Spat Supply Contracts". The supply contract would involve supplying specified quantities of spat, of a specified size, for each species at specified times of the year for periods for example of 3 years. The tenderer could bid for part or all of the spat contracts. The EOI/tender process would not specify where the spat are produced, the tenderer would determine this.

The government would in effect underwrite mollusc spat production, for specified quantities of spat over a specified time. Government could consult private industry prior to the EOI to determine spat requirements. Government could also seek some sort of commitment from the stakeholders, potentially in the form of a "Spat Offtake Agreement" with companies. The offtake agreements would specify species, size, quantities, price and supply timing.

There would need to be a full technical evaluation of "Spat Supply Contract" (SSC) bids, before the price of the bid is even considered. The most important aspect of this project is for farmers to have a reliable, consistent supply of spat in order to consolidate and expand their businesses. In order to achieve this, therefore, a high weighting should be placed on hatchery location, standard of facility, financial backing, resources and experience of operator. In order to properly assess the bid a business plan, including detailed technical specifications, could be requested in the EOI.

Due to the limited number of suitable mollusc hatcheries the outcome could end up being similar to Options A and B outlined. This alternative SSC model is less prescriptive on hatchery location and Operator conditions however, and it carries additional potential risks including:

- Less control over design of facility
- Potentially less control over biosecurity (although could be managed by licence conditions)
- Potential for over-production of spat/production of unrequired spat
- Less flexibility in production – species, timing, numbers etc. locked in for several years

6.2.2 Public Private Partnership

A further alternative business model option is a Public Private Partnership (PPP). The formal definition of a PPP as per the COAG guidelines is as follows:

"A PPP is a long-term contract between the public and private sectors where government pays the private sector to deliver infrastructure and related services on behalf, or in support, of government's broader service responsibilities. PPPs typically make the private sector parties who build infrastructure responsible for its condition and performance on a whole-of-life basis. PPP projects cover economic and social infrastructure and typically include both a capital component and an ongoing service delivery component of non-core services."

The output specification of a PPP clearly sets out the outputs that government is seeking. The requirements should be expressed, as far as possible, in output terms and not in prescriptive input terms. One of the main value for money drivers of PPPs is sufficient scale and long-term nature, with the project representing a major capital investment with long-term requirements (Infrastructure Australia, 2008).

PPPs are generally complex, with a high level of legal and governance requirements, making a formal PPP expensive to set up and run. PPP's are more suited to larger infrastructure projects such as hospitals. The WA Shellfish Hatchery is likely to be too small a project to make an economically compelling case for a formal PPP. In addition to this, the output specification over a five year period will not be clearly known and definable. For these reasons, this Study does not recommend using a PPP as the Business Model for WA Shellfish Hatchery.

6.3 Facility and Project Support

The Study recommends supporting the WA Shellfish Hatchery Project with a Facility and Project Support body. The roles and responsibilities of the Facility and Project Support body could include:

- Receiving and disbursing of funds
- Monitoring Operator compliance to Facility Access Agreement terms and conditions
- Research and Development
- Technical support
- Repairs & Maintenance Program - monitoring and maintaining condition of facility buildings, plant and equipment
- Contracting legal and accounting services/audits
- Insurance, licences, rates
- Compliance oversight
- Contracting consultants and contractors

6.4 Project Working Group

The Study recommends forming a Steering Committee, or Working Group. The Working Group's role is to monitor and support the WA Shellfish Hatchery and act as a link between the WA Shellfish Hatchery, government and industry. The Working Group roles and responsibilities could include:

- Monitoring hatchery performance and production outputs
- Monitoring spat prices
- Planning and monitoring the use of funds
- Monitoring requirements of the industry, and the extent to which these are being met
- Identifying research requirements
- R&D Program planning
- Applying for research funding

6.5 Business Operations

The Study recommends an EOI/tendering process for identifying the most suitable Operator of the WA Shellfish Hatchery. The successful tender for operating the hatchery should be an incorporated company that will enter into a Facility Access Agreement with DoFWA.

The FAA will have terms and conditions (to be determined) for the Operator to comply with, for example conditions relating to spat production efforts, liaising and working with the Working Group to deliver to the requirements of the WA mollusc industry to the best of the Operator's ability, effecting and maintaining product and public liability insurance, property insurance, workers compensation insurance, revenue and accounting reporting requirements, etc..

The Study recommends supporting the hatchery in order to allow the hatchery to produce spat at a reasonable price whilst "critical mass" in the spat market is built up over the first couple of years. This support could come in the form of Facility and Project Support, including administration, facility R&M, training, assistance with compliance, and R&D.

The Study suggests considering separating "Facility and Project" overheads from the "Operator" operating costs. The WA Shellfish Hatchery operating costs could be separated into:

i. Operator's operating expenses; and ii. Facility and Project overheads

Separating Facility Repairs & Maintenance (R&M), R&D and Project administration would help ensure that the facility is kept in good repair and good working order by the Owner (DoFWA), thereby maintaining optimal asset condition and value. It will also help ensure R&D is targeted in the right areas, where it will benefit industry most. This structure will assist the Operator to concentrate on spat production and delivering to industry requirements.

Project overheads would consist of Facility and Project Support costs including general administration, Working Group costs, R&D oversight and funding applications, R&D, legal services, accounting audits, compliance audits, licences and R&M. These costs are estimated to range between around $180-210k per year in Years 1-3. A percentage of these costs could potentially be eligible for claiming as R&D tax incentive rebate, which would reduce these costs.

DoFWA could consider using Going for Growth funding of $200k p.a., if the DoFWA application is successful, for funding the "Facility and Project Overheads" (Facility and Project Support costs) rather than using these funds for staff for the hatchery. This way the Operator maintains full control over the Hatchery staff, plus carries the associated liability.

6.6 Setting and Monitoring Spat Prices

There may be some options for operators to purchase spat from interstate, e.g. from the Victorian Shellfish Hatchery, which would assist in market forces determining spat prices. However, market forces are unlikely to be able to work in full to determine the spat prices, due to the lack of alternative sources of spat and therefore lack of competition.

The WA Shellfish Hatchery Working Group could monitor the spat prices. DoFWA could consider the inclusion of a condition in the Facility Access Agreement that spat prices should be within a certain range, e.g. 20% or 25%, of spat prices for the same species in the Eastern States.

The downsides to being too prescriptive with spat prices should also be noted when considering this issue. The VSH Steering Committee and DEPI in Victoria monitored spat prices for the first couple of years before coming to the conclusion that it was not necessary and that market forces were working adequately.

Some stakeholders consulted during this Study were supportive of the notion of government subsidised spat, others believed that free spat for several years might be a good thing. There were also established farmers that believed that paying the full “market” price for spat was important in order for the business buying the spat to have a sound business plan and the resources to culture them through to market size.

Subsidising the spat price could have several downsides including:

- attracting fly-by-night, inexperienced and ill-prepared operators
- sectors building a reliance on subsidised spat that could be hard to relinquish
- lower resources being put into husbandry and maintenance of stock than would otherwise have been if the spat were full market price

Figure 24 - Pearl Oyster spat (viewed using microscope, x20 magnification)

6.7 Risks

Key Risks include:

- Real or perceived threat of a government-supported mollusc hatchery in direct competition with a private company holding an existing mollusc hatchery licence. DoFWA and ACWA are best positioned to manage competitive neutrality of the WA Shellfish Hatchery
- Low take-up levels on forecast spat requirements – farmers committing to buying specified quantities of spat, for example through Spat Offtake Agreements, will mitigate this risk
- "Key man risk" – mollusc hatchery performance is primarily driven by the Hatchery Manager. The loss of a good hatchery manager can often mean disruption to production, which can last for a sustained period. If a suitable hatchery manager cannot be found as a replacement disruption to spat production can last for several seasons. Even if a suitable, highly experienced quality operator is secured as a replacement it can often take some time for a new manager to adjust to components, procedures and protocols that are specific to the site and systems
- Disease and Bio-security – transferal of disease from one species to another, or from one region to another is a key risk that needs to be managed carefully, through hatchery and system design together with the development of operating protocols, backed up by strict enforcement and monitoring set down in legally binding licences and agreements
- Spat Pricing / Spat Supply Monopoly – lack of competition within the spat market if only one mollusc hatchery is operating creates risk of elevated spat prices
- Lack of alternative, back-up sources of spat – with only one mollusc hatchery operating, the farmers growing out the spat will be reliant on one supplier for their spat. If a hatchery production run fails there should ideally be alternative sources for supplying spat to the farmers.
- Scheduling and negotiating annual timeslots, by species and by company
- Capital Cost and Operating Costs outside of forecast ranges
- Insufficient funding
- Lack of equitability between companies/farmers and species
- Lack of interest in EOI from Operators
- Too *much* oversight of the project – being too prescriptive in the FAA terms and conditions may discourage potential Operators from putting in a tender
- Too *little* oversight of the project – too little oversight and support could mean more of the same for WA mollusc farmers – small, poorly-resourced sporadic hatchery operations delivering unreliable, inconsistent spat production, operating for a year or two then disappearing for several years, or for good
- Time slippage

6.8 Staffing requirements

Together with water quality and hatchery design, staff are the fundamental key to the success (or otherwise) of a mollusc hatchery. A small hatchery will need around 3-4 FTE and one casual employee whilst a medium-large hatchery 4-5 FTE and one or two casual employees. This will be highly dependent on requirements for nursery production, levels of automation, R&D requirements, size and sophistication of Breeding Programs and duration periods of operation.

This Study recommends not being overly prescriptive on conditions contained in the FAA, including regarding levels of staffing/staff numbers. The FAA could contain a condition with words to the effect of:

"The Operator shall provide a Hatchery Manager and adequate staffing for operating the WA Shellfish Hatchery in a sustainable manner with sufficient capacity to carry out works to current Best Practice level, and with sufficient quality of work and attention to detail required for good hygiene and required levels of bio-security."

It is likely that there is enough mollusc experience in Australia to manage a facility in WA competently, if the remuneration/business opportunity is attractive enough for persons with the requisite levels of skills and experience. Most mollusc experience resides or has been gained in Tasmania, Victoria and New South Wales, and to a lesser extent South Australia. Some individuals in the Australia also have experience in overseas mollusc hatchery operations, including from New Zealand, Europe, US and Canada.

Figure 25 - BST "fenceline" Oyster Farming System (communitywebs.org)

7 Economics

7.1 Capital Expenditure Estimate

Table 8 - Capital Expenditure Estimate

Description	Total Cost (NEW)	Total Cost (NEW & USED)
Water treatment and supply	$ 110,650	$ 110,650
Plant and equipment	$ 262,100	$ 177,100
Tanks	$ 347,400	$ 253,000
Algae Production	$ 108,440	$ 108,440
Building, improvemments, plumbing and electrical	*TBD*	*TBD*
Laboratory equipment	$ 46,815	$ 38,815
Office equipment	$ 7,140	$ 7,140
Tools	$ 16,420	$ 16,420
Total	**$ 898,965**	**$ 711,565**

The Capital Expenditure (Capex) requirements for the WA Shellfish Hatchery Project are estimated to be between $700,000 - $900,000 (Table 8), excluding Engineering, Procurement and Construction (EPC)/building and improvements and seawater intake.

The EPC/Building and Improvements Capex estimates will be determined during the proposed Feasibility Study, which will follow on from the proposed Hatchery Design stage and site and structural surveys. Construction costs will include internal layout modifications determined by design and biosecurity requirements (walls, insulation, drains, etc.), air-conditioning, lighting and other electrical supply and distribution works (transformers, boards, wiring, outlets etc.), internal and external water and air supply plumbing works, water intake, water discharge etc..

For the purposes of economic analysis to estimate in broad terms the quantum of funding required by the WA Shellfish Project, an estimate of $120,000 has been used for the Hatchery Design and Feasibility Study stages, based on 10% of EPC cost estimates. $480,000 has been used for Building and Improvements Capital expenditure estimates in Year 0. $80,000 and $140,000 have been forecast for building and improvements in Years 1 and 2 respectively. The Hatchery Design, Feasibility Study and EPC (Engineering, Procurement and Construction)/ Building and Improvements estimates are *un-costed* at this stage.

7.2 Operating Cost Estimate

The WA Shellfish Hatchery operating expenditure (Opex) cost estimates are shown in Table 9, separated into "Operator" Opex and "Project & Facility Support" overheads.

Operator Opex includes wages, electricity, freight, motor vehicle, communications, office, chemicals, filters, lab consumables, personal protective equipment (PPE), algae and nutrients. Some R&M costs are attributed to Operator Opex for specific Hatchery equipment.

Project & Facility Support Overheads includes Project & Facility administration, Working Group costs, consultants, accounting, legal, insurance, licences, rates, training, compliance and auditing, R&M site, building, plant and certain equipment.

Table 9 - Operating Expenditure Estimate

Forecast		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
Operating Costs - Operator							
Wages		$ 334,884	$ 390,659	$ 416,248	$ 432,898	$ 450,214	$ 2,024,904
Human Resources (shared with Project)		$ 3,220	$ 3,910	$ 4,600	$ 17,600	$ 19,200	$ 48,530
Business Services (Operator)		$ 19,700	$ 23,050	$ 26,408	$ 28,724	$ 31,049	$ 128,932
General overheads		$ 88,180	$ 106,030	$ 123,890	$ 138,481	$ 163,181	$ 619,761
R&M Electrical and electronic equipment		$ 6,090	$ 7,395	$ 8,700	$ 9,570	$ 10,440	$ 42,195
Office		$ 1,610	$ 1,955	$ 2,300	$ 2,530	$ 2,760	$ 11,155
Disinfectants and Cleaning Products		$ 3,591	$ 4,361	$ 5,130	$ 5,643	$ 6,156	$ 24,881
Filters - Filters, filter media, screens		$ 11,760	$ 14,280	$ 16,800	$ 18,480	$ 20,160	$ 81,480
Laboratory - glassware,tubing,containers, vials		$ 3,969	$ 4,820	$ 5,670	$ 6,237	$ 6,804	$ 27,500
Lab Misc. - consumables		$ 6,258	$ 7,599	$ 8,940	$ 9,834	$ 10,728	$ 43,359
Safety equipment		$ 679	$ 825	$ 970	$ 1,067	$ 1,164	123675
Algae - innoculants, nutrients, CO2, bags, plating etc.		$ 17,850	$ 21,675	$ 25,500	$ 28,050	$ 30,600	
Deployment and Broodstock		$ 2,835	$ 3,443	$ 4,050	$ 4,455	$ 4,860	$ 19,643
Operating Costs (Operator)		**$ 500,626**	**$ 590,000**	**$ 649,206**	**$ 703,569**	**$ 757,316**	**$ 3,200,718**
R&D		40%	40%	35%	30%	25%	
R&D Tax Claim	45%	$ 90,113	$ 106,200	$ 102,250	$ 94,982	$ 85,198	$ 478,743
CPI	4.0%						
Total Operating Costs (Operator)		**$ 410,513**	**$ 483,800**	**$ 546,956**	**$ 608,587**	**$ 672,118**	**$ 2,721,975**

Forecast		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
Overheads - Project/Facility Administration and Support							
Business Services (Project/Project Working Group)		$ 97,200	$ 101,088	$ 105,132	$ 19,348	$ 20,122	$ 342,889
Human Resources/Training		$ 13,300	$ 16,150	$ 19,000	$ -	$ -	$ 48,450
Repairs & Maintenance (building/site)		$ 17,140	$ 19,314	$ 21,502	$ 23,094	$ 24,701	$ 105,750
Repairs & Maintenance (plant)		$ 36,910	$ 43,913	$ 50,924	$ 55,679	$ 60,443	$ 247,870
Repairs & Maintenance (equipment)		$ 9,807	$ 10,445	$ 11,095	$ 11,660	$ 12,239	$ 55,246
Testing/Compliance		$ 4,900	$ 5,096	$ 5,300	$ 5,512	$ 5,732	$ 26,540
Total Project Administration and Facility Support		**$ 179,257**	**$ 196,006**	**$ 212,953**	**$ 115,292**	**$ 123,237**	**$ 826,745**

Operator Opex is estimated to be $500,000 in Year 1, rising to a forecast of around $760,000 by Year 5, not including an R&D tax incentive rebate. Operator Opex is estimated to be $410,000 in Year 1, rising to a forecast of around $670,000 by Year 5 including an indicative R&D tax incentive rebate of 40% of Operator Opex in Year 1 falling to 20% in Year 5.

Project Overheads are estimated to be around $180,000 in Year 1, falling to around $120,000 in Year 5, not including an R&D tax incentive rebate. Project Overheads are estimated to be around $155,000 in Year 1, falling to a forecast of around $110,000 by Year 5 including an indicative R&D tax incentive rebate of 25%.

The Study shows the Project Support overheads reducing over the 5 year period, as administration costs are phased out in Year 4 and 5. Some of the Business Services costs are transferred over from Project Support to Operator in Years 4 & 5.

The Facility Access Fee charged by the Owner to the Operator is based on a flat rate or a nominal rate of 15% of the previous year's gross profit, whichever is the greater.

The hatchery operating costs are dependent on a number of factors including:

- Number of spat required
- Species type and number of species
- When the spat are required/evenness of spread
- Lease, Access Agreement and services costs
- Timing of production, ambient temperatures and power costs (heating and cooling water and buildings)
- Levels of automation/efficiency gain measures
- Post settlement/"pre-nursery" requirements
- Breeding Program size and scope
- R&M cost - age of facility infrastructure, tanks and equipment
- Depreciation
- Interest/cost of funding

7.3 Economic Modelling

7.3.1 Spat Sales Revenue

WA Shellfish Hatchery revenues from spat sales are estimated to be $260,000 on current demand in 2015, rising to around $350,000 in Year 1 of hatchery production. By Year 5 spat sales revenue may be as high as around $940,000, assuming there is 100% uptake on spat requirement forecasts obtained in this Study (Table 10). Hatchery revenue is highly sensitive to both spat sales numbers and spat prices.

It should be noted that this is an optimistic revenue forecast, based on full uptake of requirement forecasts by WA companies approached during this Study. There are also additional Rock Oyster spat sales of approximately 30-50% forecast in Years 3-5 to cater for potential pilot rock oyster farms spat requirements for the North West. Whilst there may be shortfalls in what farmers actually buy compared to what they forecasted they would buy, there are likely to be additional companies in the market for buying spat that identify themselves as spat becomes available in WA on a consistent, reliable basis.

Indicative 2015 spat prices for Mussels, Rock Oysters, Akoya and Blacklip Pearl Oysters have been estimated using Eastern States spat prices, historical WA spat prices and consultation with stakeholders and hatchery operators. Spat prices are between approximately 4.4 – 5.2% of the Gross Value of Product (GVP) for Akoya and Blacklip respectively, based on the survival rates and market value of product assumed in this Study. The cost of mussel spat is estimated to be 11.4% of forecast GVP and for Rock Oysters the Study estimates around 8% of GVP.

Table 10 - Spat Requirement and GVP Forecasts

Species	Mussel		Black-lip Pearl Oyster		Akoya Pearl Oyster		Rock Oyster		Scallop *(speculative)*		Total
Estimated Spat Requirements (millions)											
Current	78,000,000		425,000		600,000		4,000,000				
Year 1	105,000,000		525,000		600,000		6,000,000				
Year 2	162,000,000		725,000		700,000		8,000,000				
Year 3	218,000,000		725,000		700,000		12,000,000		*15,000,000*		
Year 4	254,000,000		825,000		800,000		14,000,000		*15,000,000*		
Year 5	292,000,000	274%	825,000	94%	800,000	33%	16,000,000	300%	*15,000,000*		
Indicative spat price (2015)	$ 0.0010		$ 0.1000		$ 0.1000		$ 0.0200		$ 0.0040		
Estimated hatchery spat sales ($)											*excluding scallops*
Current	$ 78,000		$ 42,500		$ 60,000		$ 80,000		$ -		**$ 260,500**
Year 1	$ 109,200		$ 54,600		$ 62,400		$ 124,800		$ -		**$ 351,000**
Year 2	$ 175,219		$ 78,416		$ 75,712		$ 173,056		$ -		**$ 502,403**
Year 3	$ 245,220		$ 81,553		$ 78,740		$ 269,967		$ 67,492		**$ 675,481**
Year 4	$ 297,144		$ 96,513		$ 93,589		$ 327,560		$ 70,192		**$ 814,806**
Year 5	$ 355,263		$ 100,374		$ 97,332		$ 389,329		$ 72,999		**$ 942,298**
Estimated survival to market size	10%		8%		15%		60%		5%		
Estimated time to market size (months)	8 - 13		42		30 - 42		18 - 42		9 - 12		
Market product unit	Kg		pearls (saleable)		pearls (saleable)		oysters		Kg		
Assumed size at market (Kg)	0.025								0.015		
Estimated gross product value ($/Kg or $/pearl*)	$ 3.50	/Kg	$ 24.00	/p	$ 15.00	/p		/Kg	$ 35.00		
Estimated gross product value ($/animal)	$ 0.09		$ 24.00		$ 15.00		$ 0.42		$ 0.53		
Estimated production increase											
(Kg, animals or saleable pearl pieces)											
Current	195,000		34,000		90,000		2,400,000		-		
Year 1	262,500		42,000		90,000		3,600,000		-		
Year 2	405,000		58,000		105,000		4,800,000		-		
Year 3	545,000		58,000		105,000		7,200,000		11,250		
Year 4	635,000		66,000		120,000		8,400,000		11,250		
Year 5	730,000		66,000		120,000		9,600,000		11,250		
Estimated GVP from hatchery spat year produced (assuming inflation of 4%)											*excluding scallops*
Current	$ 682,500		$ 816,000		$1,350,000		$ 1,000,000		$ -		**$ 3,848,500**
Year 1	$ 955,500		$ 1,048,320		$1,404,000		$ 1,560,000		$ -		**$ 4,967,820**
Year 2	$ 1,533,168		$ 1,505,587		$1,703,520		$ 2,163,200		$ -		**$ 6,905,475**
Year 3	$ 2,145,678		$ 1,565,811		$1,771,661		$ 3,374,592		$ 442,915		**$ 8,857,742**
Year 4	$ 2,600,011		$ 1,853,056		$2,105,745		$ 4,094,505		$ 460,632		**$ 10,653,317**
Year 5	$ 3,108,548		$ 1,927,178		$2,189,975		$ 4,866,612		$ 479,057		**$ 12,092,313**
Estimated cost of spat per market size product	$ 0.01		$ 1.25		$ 0.67		$ 0.03		$ 0.08		
Estimated cost of spat (% of GVP)	11.4%		5.2%		4.4%		8.0%		15.2%		

Blacklip and Akoya spat prices are at the lower end of the % of GVP range due to a prolonged culture period, therefore higher husbandry costs, together with pearl seeding and harvesting costs. It is worth noting that spat numbers and spat prices are dependent variables, especially with low number requirements of non-maxima pearl oysters for a typical commercial mollusc hatchery.

The costs for producing 200,000 or 1.2 million spat are similar for a standard (medium)-sized, well-resourced hatchery due to the majority of costs being fixed. As the quantum of the hatchery spat production rises, and the hatchery produces higher numbers of spat per batch the unit price of the spat subsequently comes down. Therefore if the Blacklip sector requires 850,000 spat instead of 425,000 it is likely that the price of spat will drop by approximately 50%

to around $0.05, or if the requirement is 1.2 million spat the price is likely to drop to $0.03 – 0.04. The Hatchery Operator might opt to charge per batch rather than charge per spat for Akoya and Blacklip, especially in the early years whilst establishing the business.

The 2014 Study used Akoya and Blacklip spat prices based on historical production of spat from very small hatcheries, often in remote and challenging conditions, for example a hatchery on a barge out at the Abrolhos Islands. These small non-maxima pearl oyster hatcheries had no other source of income therefore the spat prices appeared relatively high compared to other sectors, as noted in the 2014 Study. As Akoya, and possibly Blacklip, spat are cultured in larger commercial hatcheries, which also cater for other mollusc sectors such as mussels and rock oysters, it is likely that Akoya and Blacklip spat prices will come down. Due to this, non-maxima pearl oyster spat prices have been revised down from the last study.

It is also worth noting that if the Akoya and Blacklip spat are produced in Albany the transport time is likely to be around 14 – 18 hours, instead of a transport time of less than one hour when the spat were produced at the Abrolhos Island hatchery. Due to the significantly longer transportation duration, post-deployment mortality rates are likely to be significantly higher. It should be noted that Dr Gavin Partridge of ACAAR is a highly regarded expert in the live transport of aquaculture species. Gavin has consulted to various companies and institutions around the world and could assist in this area if required.

If the Abrolhos Akoya and Blacklip farmers do experience elevated mortalities caused by extended transport durations they are likely to revise upwards their spat number requirements to compensate for the transport losses. As previously noted this should not affect the overall cost to the farmer significantly, as the cost of a spat batch remains similar whether it produces 400,000, 800,000 or 1,500,000 spat in a hatchery production run.

Figure 26 - Pearl Oyster Spat, settled and deployed on plastic "slat" media

The mussel price is based on the Victorian Shellfish Hatchery spat price of around $0.0007 – 0.001 (J Mercer 2014, pers. comm.), using the higher end of the price range. The Blacklip and Akoya spat prices are based on the historical prices paid by Abrolhos pearling businesses. The edible oyster price is based on the spat prices of around $20 per 1,000 spat ($0.02 per spat) for

Rock Oysters at around 1.8mm screen size (J Bilton 2015, pers. comm.). Spat are sometimes supplied by hatcheries to specialised nurseries in NSW at $12/1,000 ($0.12 per spat) for 1.5mm spat (W O'Connor 2014, pers. comm.). The Tasmanian price for Pacific Oyster spat is around $35 per 1,000 at around 2.2mm screen size (M Bermudes 2014, pers. comm.).

There are no commercial scallop spat prices available for *A. balloti.* An indicative price has been included to assist in determining what contribution the scallop industry might make if it was to be part of a multi-species mollusc hatchery venture. The spat price as a % of GVP is higher for scallops due to there being no husbandry costs post-deployment for fishery enhancement.

7.3.2 Gross Value of Product

The estimated Gross Value of Product (GVP) generated from the WA Shellfish Hatchery spat sales is around $5 million in Year 1 rising to around $12 million in Year 5. This is an optimistic estimate, assuming 100% uptake on spat requirement forecasts obtained during this Study, plus additional rock oyster production (estimated GVP of $2.5 million Year 5) in the Gascoyne, Pilbara and Kimberley. Excluding potential Rock Oyster production in the North West, GVP is forecast to be $9.5 million in Year 5.

Market prices for mussels, oysters and scallops are based on current commercial wholesale prices, whilst prices for non-maxima pearls have been much more difficult to determine. The average price stated for Blacklip and Akoya pearls varied greatly from company to company, from an average wholesale price of $56 and $50 respectively to $24 for Blacklip. Cropp 2010 reported average wholesale Akoya prices to be an average of $8.78 per pearl harvested during an FRDC project in which 2,585 oysters were seeded (from 69,660 spat deployed) and 910 pearls were recovered (1.4% success rate).

The Akoya average pearl price assumption used in this Study has been increased from the price used in the last Study ($8.78) to $15, based on feedback from industry and reported overseas auction prices of around $22 per pearl (G. Glazier 2015 pers. comm.). The price used is around the mid-point of the FRDC price and recent reported auction prices from Japan. Estimated success rates from spat deployment to harvest of a saleable pearl for Akoya are assumed to be around 15%. The success rates from spat deployed to saleable Blacklip pearl is estimated to be 8%, based on revised industry figures provided.

A success rate of 8% is comparable to the success rate from spat deployed to saleable pearls for the maxima industry of approximately 5–10%. The success figure includes losses from detachment from media during or following deployment, selection pressure during de-stocking, culling out of slow growing spat, saibo donors sacrificed, post-op mortality, nucleus rejection ("x-ray negatives"), pearl culture host mortality and % non-saleable pearls.

7.3.3 Cashflow – Operator

Net Loss for the Operator is forecast to be around $60,000 in Year 1 (Table 11). The Profit in Year 5 is $225,000. Cash flow of the Operator is forecast to be around -$150,000 in Year 1, and +$230,000 in Year 5 (R&D tax concession is offset by one year, claimed for the previous year). Closing cash of the Owner is forecast to be around $400,000 in Year 5.

Table 11 - Projected Cash Flow - *Operator*

Projected Cash Flow Summary - OPERATOR	Year	1	2	3	4	5
Spat sales numbers (estimated)						
Total Revenues	**$**	**351,000**	**502,403**	**675,481**	**814,806**	**942,298**
Direct Operating Costs						
Total Direct Operating Costs	**$**	**-500,626**	**-590,000**	**-649,206**	**-703,569**	**-757,316**
Gross Profit						
Revenues	$	351,000	502,403	675,481	814,806	942,298
Direct Operating Costs	$	-500,626	-590,000	-649,206	-703,569	-757,316
Total Gross Profit	**$**	**-149,626**	**-87,597**	**26,275**	**111,237**	**184,981**
EBITDA (*Consolidated*)	**$**	**-149,626**	**-87,597**	**26,275**	**111,237**	**184,981**
Taxation estimate	$	0	0	-6,569	-27,809	-46,245
R&D tax concession estimate	$	90,113	106,200	102,250	94,982	85,198
Net Profit After Tax	**$**	**-59,513**	**18,603**	**121,956**	**178,410**	**223,934**
Net Cash Flow (*excluding depreciation*)	**$**	**-149,626**	**2,516**	**125,906**	**185,678**	**233,718**
Opening Cash	$	0	-149,626	-147,110	-21,204	164,474
Closing Cash	$	**-149,626**	**-147,110**	**-21,204**	**164,474**	**398,192**

7.3.4 Cashflow – Owner

Assumptions in the Owner cash flow (Table 12) include:

- Owner is the WA State Government/Department of Fisheries WA
- Design and Feasibility cost estimates at 10% (4% and 6% respectively) of capital expenditure estimates
- Building/Improvements capital estimates are un-costed (not within defined levels of accuracy)
- $2.0 million funding received from government in Year 0 for Project Capex ($1.5 million for Design, Feasibility Study, Building/Improvements plus contingency/cash reserves of $0.5 million)
- $200,000 p.a. funding received from Going for Growth Years 1 – 3, primarily for Facility R&M, Project administration, R&D
- Project administration costs ceasing in Year 4
- Facility Access Agreement/lease costs at $1,200 p.a. + CPI inflation (4%) or 15% of previous year's Operator profit, whichever is the greatest
- Buyout valuation of $850,000 based on estimated unimproved building value of $400,000 plus building/improvements, buildings Capex depreciated at 15% p.a., with plant and equipment Capex depreciated at 20% p.a..
- Minimum cash in reserve of $400,000 modelled

Closing cash flow of the Owner (government) is forecast to be around $1.2 million in Year 5 (Table 12).

Table 12 - Projected Cash Flow – *Owner (Govt.)*

Projected Cashflow Summary - OWNER	Year	0	1	2	3	4	5
Project Administration and Facility Support							
Sub.Total Project / Facility Admin. & Support	$		-179,257	-196,006	-212,953	-115,292	-123,237
Total Project Admin. and Facility Support	**$**		**-179,257**	**-196,006**	**-212,953**	**-115,292**	**-123,237**
Cashflows From Operating Activities							
Net Income	$		-179,257	-196,006	-212,953	-115,292	-123,237
Net Cash Provided by Operating Activities	**$**		**-179,257**	**-196,006**	**-212,953**	**-115,292**	**-123,237**
Capital expenditure							
Basis of Design, Hatchery Design, FS scoping	$	-47,663					
Feasibility Study - Risks, Legal, Costing etc.	$	-71,494					
Plant and Equipment	$	-711,565					
Building/Improvements Capital *	$	-480,000	-80,000	-140,000			
Net Cash Used for Capex	**$**	**-1,310,722**	**-80,000**	**-140,000**	**0**	**0**	**0**
Cashflows from Financing Activities							
Facility Access Agreement/Lease			1,200	1,248	1,298	3,941	16,686
Buyout Valuation*	$						**853,528**
Govt. Grants - *Royalties for Regions*	$	2,000,000					
Govt. Grants - *Going for Growth*	$		200,000	200,000	200,000		
Private Funding							
R&D tax concession estimate	$			20,166	22,051	23,957	12,970
Net Cash Provided by Financing Activities	$	**2,000,000**	**201,200**	**221,414**	**223,349**	**27,898**	**883,184**
Net Cash Flow *(excluding depreciation)*	**$**	**689,279**	**-58,057**	**-114,591**	**10,396**	**-87,394**	**759,947**
Opening Cash	$	0	689,279	631,222	516,630	527,026	439,632
Closing Cash	$	**689,279**	**631,222**	**516,630**	**527,026**	**439,632**	**1,199,579**

* - uncosted

7.4 Funding

7.4.1 Funding Requirements

Cash flow for the WA Shellfish Hatchery has been estimated in order to estimate the quantum of funding required in the early stages of the Project. A minimum of $400,000 cash in reserve was used in the economic modelling. More detailed monthly cash flow modelling should be undertaken in the Feasibility Study stage and audited by an independent accounting firm.

The WA Shellfish Hatchery Project will require funding estimated to be $2.6 million. Year 0 (*2016* - Design and Build year) requires an estimated $2 million Capex for EPC/Building and Improvements, plus contingency and cash reserves. Years 1-3 (*2017-2019*) require an estimated $200,000 per annum to be used primarily for Facility and Project Support.

Specialist advice from an appropriate accounting firm will be required for determining the amount of claimable expenses for R&D tax concession rebate, following the Working Group determining the Project research requirements and development of a structured, defined R&D program.

It is important to note that the estimates for Design, Feasibility and Building/Improvements (Engineering, Procurement and Construction) are currently un-costed (see section 7.1).

7.4.2 Potential Funding Sources - Owner

It appears unlikely that the Project will be funded entirely, or in large part, by the private sector, based on the assumptions and economic modelling in this Study. If the government wishes to exert some control and influence over the development and expansion of the mollusc farming sectors in WA to achieve critical mass over the next 3-5 years then public funding will be required. “Royalties for Regions” (RfR) and “Going for Growth” are the two most prospective sources of funding for the WA Shellfish Hatchery Project in Albany.

Albany is a regional area, therefore there is potential for Royalties for Regions funding. RfR in Albany is managed by the Great Southern Development Commission. If the WA Shellfish Hatchery is going to be used for producing Western Rock Oyster spat for pilot oyster farming projects in the Gascoyne, Pilbara and Kimberley then the Mid- and North West Development Boards RfR funding could also be considered as a potential source of funding. Other potential public funding sources include Going for Growth, which is part of Royalties for Regions. DoFWA has submitted a Going for Growth funding application (S. Nel 2015 pers. comm.).

Private investment could be sought to fund the project. One option would be to capitalise the asset through private funding, which would buy an equity stake in the asset (hatchery building and equipment). This option may complicate the running of the hatchery as the investors are likely to want a say in how the operations run. If the Hatchery is independent it can negotiate with and service all companies (and species) without prejudice. Once the hatchery has investors/shareholders from one or two companies, or species sectors, this may influence how the Hatchery operates and the “level playing field” may lose shape.

The business model would remain simpler if the asset (facility) remained 100% owned by the government for the five or so years the Project will run for, by which time

i. the grow-out industry expanded and reached critical mass
ii. the hatchery is a self-standing profitable business
iii. the hatchery can be sold/privatised

Stakeholders consulted during this Study have expressed that they would prefer to invest their limited funds into expanding their grow-out farming, instead of investing limited resources in the hatchery which would mean that their farming businesses remain the same size.

Another option to consider would be corporate sponsorship of the WA Shellfish Hatchery. Private companies could provide funds for contributing to the capital expenditure (building costs, pumps, tanks, equipment e.g. autoclaves) and in turn receive marketing and advertising benefits through recognition of their support during publicity events such as media releases.

7.4.3 Royalties for Regions

The business case for Royalties for Regions applications needs to demonstrate that all relevant approvals have been obtained and that there are no barriers to the progression of the project should RfR funding be provided. This includes (but is not restricted to):

- project approvals;
- planning approvals;
- land title;
- native title;
- heritage approval;
- incorporation; and
- legal requirements or licences.

If the Project is being undertaken on land (whether freehold or Crown land) that is not owned, leased or managed by the applicant the applicant must obtain and have in place for the duration of the Project, an agreement, or suitable authority to undertake the Project on that land.

The RfR funds, or funds and grants from other sources, require an incorporated entity to accept legal responsibility for management and disbursement of the funds.

Prior to the RfR application being made all approvals would need to be in place and accurate costings of the project completed. This would require detailed design, a Feasibility Study including detailed engineering scope, and quotes for Engineering, Procurement and Construction (Building and Improvements) capital expenditure – see section 8 Next Steps and Timelines.

Figure 27 - Great Southern Marine Hatcheries facility, Albany

7.4.1 Potential Funding Sources - Operator

An option for financing the Operator is a model whereby the Operator requests a percentage of operating costs/Cost of Goods Sold (e.g. 30-50%) for the spat order placed. These funds are to be paid by the farmer before commencing a production run to assist managing cash flow in the early stages for the Hatchery Operator. Warranties, or lack of, would need to be negotiated by Operator and Buyers.

An alternative option is using “Spat Offtake Agreements” for the WA Shellfish Hatchery, whereby industry stakeholders and other supporters of the project, private and/or government, commit to buying defined quantities of spat over defined periods. The Agreement would formalise the intention of the buyer to purchase a portion of the hatchery’s future spat output. The Offtake Agreement model would provide the DoFWA and the WA Shellfish Hatchery Operator with assurance that there is quantifiable market for the spat.

This Study proposes that it is the role and responsibility of the Operator to develop their own specific “Operator Business Model”, which will include how they will run and fund their operations. The Operator Business Model would be requested for submission during the EOI/tender process.

7.4.2 Funding recovery (Owner)

Recovery of some public funding used on the Project could be made through the sale of the Hatchery facility once the business is established and profitable. The cash flow model used in this Study shows the asset sale in Year 5 at an estimated value of $850,000. The main benefit of the Project would be the GVP of the end-products plus multipliers - i.e. the value of the oysters, mussels and pearls at market, together with the direct and indirect jobs, most of which will be in rural areas.

7.4.3 Funding R&D

Early R&D funding (Year 1-5) is likely to require government support until the industry has expanded and matured. R&D funding could come from in-kind support and scientific services from DoFWA (Hillarys Aquaculture unit and the Fish Health unit), ACAAR, FRDC, Seafood CRC or other government grants and funding sources.

R&D into transporting product to overseas markets and increasing shelf-life could potentially come from the Going for Growth fund or the Austrade Export Market Development Grants. R&D and studies for pilot-scale production of rock oysters in the Mid- and North West could potentially be applied for through Regional Development Commission and Royalties for Regions.

Later, once the mollusc farming sector is more established and has expanded beyond its current size, funding for R&D could be partly funded by a levy put on spat sales. The levy could be a small percentage of the value of the spat, so as not to discourage investment and further expansion in the mollusc farming sector. A better model could be for the research levy on the end product sold.

Some Australian agricultural industries such as pork and horticultural industries, such as bananas and avocados, invest around 1-2% of turnover in research. A mollusc research levy would be leveraged against FRDC and Seafood CRC. NSW and SA have a levy on the oyster farming industry based on size of farms leases ($36 – $58 per hectare for NSW and SA respectively) and Tasmania has a spat levy of $1.25 per 1,000 spat (Australian Seafood CRC Oyster Consortium discussion paper, 2009)

7.5 Break-even / Profitability

Table 13 presents a very broad, high-level indication of the likely economic viability of the WA Shellfish Hatchery showing various combinations of species/sectors. Blacklip and Akoya have been combined to form a non-maxima pearling sector. The top three rows show scenarios of the hatchery running with single species. The bottom four rows show three scenarios of the WA Shellfish Hatchery running two species and one scenario running all three sectors.

The analysis is indicative, not definitive. Inflation has not been accounted for in the model and neither have complexities such as the varying operating expenditure of the hatchery under the various species/sector combination scenarios, nor effects on operating expenditure of increasing levels of production, nor variations in levels of government support.

Table 13 - Species combinations and indication of likelihood economic viability of hatchery

WA Shellfish Hatchery species combination			Number of species	Forecast hatchery spat sales gross revenue ($/year)					
				Current	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Mussel			1	$ 78,000	$ 109,200	$ 175,219	$ 245,220	$ 297,144	$ 355,263
	Blacklip & Akoya		1	$ 175,000	$ 202,800	$ 232,544	$ 241,846	$ 251,520	$ 261,580
		Oyster	1	$ 108,000	$ 140,400	$ 175,219	$ 242,971	$ 315,862	$ 394,196
Mussel	Blacklip & Akoya		2	$ 253,000	$ 312,000	$ 407,763	$ 487,066	$ 548,664	$ 616,843
Mussel		Oyster	2	$ 186,000	$ 249,600	$ 350,438	$ 488,191	$ 613,006	$ 749,458
	Blacklip & Akoya	Oyster	2	$ 283,000	$ 343,200	$ 407,763	$ 484,816	$ 567,381	$ 655,776
Mussel	Blacklip & Akoya	Oyster	3	$ 361,000	$ 452,400	$ 582,982	$ 730,037	$ 864,525	$ 1,011,039

Hatchery Revenue		
from	to	Likelihood of Economic Viability
$ -	$ 350,000	Very Low
$ 350,001	$ 400,000	Low
$ 400,001	$ 550,000	Borderline
$ 550,001	+	Fair

In broad terms the high-level analysis indicates that if a WA Shellfish Hatchery:

- produces a single species it is unlikely to be a profitable business within a 5 year timeframe
- produces two of the species/sectors it has the potential to become a profitable business in Years 4 and 5
- produces three species (Mussel, Rock Oyster, non-maxima Pearl Oysters) it has the greatest potential for becoming a profitable business within a 5 year timeframe

The best scenario would be where a multi-species hatchery running all three species (four including both non-maxima pearl oysters), assuming that the spat production could be spread fairly evenly throughout the year to maximise efficient use of resources. And assuming other risks and issues are covered, such as live transport of broodstock and spat and biosecurity.

The economic analysis carried out has assumed 100% uptake of the spat requirement forecasts obtained in this Study from current industry stakeholders, plus additional spat sales forecast for pilot-scale rock oyster projects in the North West, therefore these are optimistic future spat sales assumptions.

7.6 Estimate Accuracy

The estimates provided in this study are to a nominal accuracy of +/- 50%, excluding Building and Improvements. With so many variables the hatchery capital and operating expenditure, spat sales revenue and GVP forecasts cannot be forecast with any greater degree of accuracy at this stage. A staged approach is recommended for increasing the accuracy of the cost estimates and economic modelling, working towards a Final Investment Decision.

Building and Improvements (EPC) Capex costs can only be estimated once the Feasibility Study has been completed. On completion of the hatchery design and the development of a detailed engineering scope during the Feasibility Study stage, the market can be approached with the proposed designs through an EOI process in order to determining Engineering, Procurement and Construction costs with appropriate levels of accuracy.

8 Next Steps and Timelines

8.1 Timelines

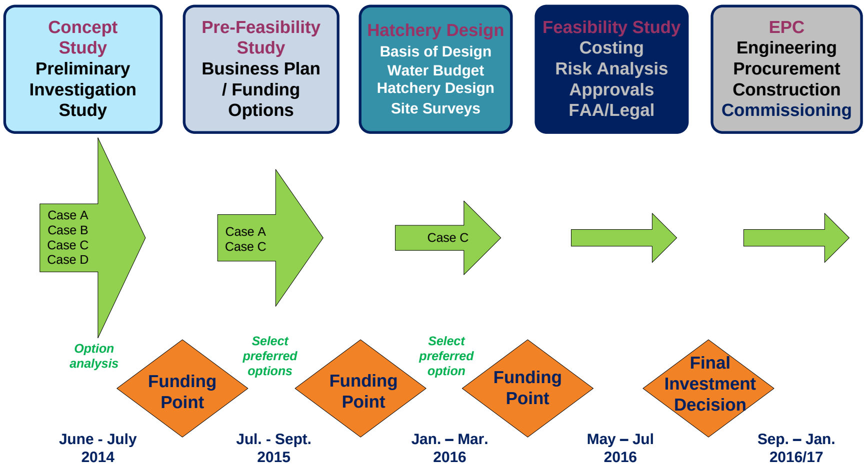

Figure 28 - Indicative Timeline for the WA Shellfish Hatchery Project

The indicative timeline for the Project is shown in Figure 28. The timeline has a range of outcomes depending on how quickly consensus can be reached on the various issues likely to be encountered along the way, and how quickly decisions can be made. The forecast timeline would lead to first spat production from the hatchery in early 2017, which would be dependent on the speed of decision-making.

Hatchery Design is scheduled to occur in January-March 2016, with the Feasibility Study occurring in May – July 2016. Engineering, Procurement, Construction (EPC) and Commissioning is scheduled for between September 2016 and January 2017.

8.2 Hatchery Design

Further work is needed to gain more accurate cost estimates for the WA Shellfish Hatchery. Cost estimates of +/- 10-15% should be determined before a final investment decision is made. Accurate cost estimates will also be required for funding options such as Royalties for Regions (RfR). In order to determine more accurate cost estimates a detailed facility design is needed.

The Hatchery facility layout should be designed, showing tank and equipment positions in order to determine drains, water supply, aeration supply, electrical outlets, lighting, air-conditioning etc. Building and Piping and Instrumentation Diagrams (P&ID) are required for obtaining quotes from industry for building, plumbing and electrical work.

The Hatchery Design study will include:

- Buildings structural report
- Site survey

- Basis of Design. This will include specifications for tank culture space, tank numbers, tank sizes, water volume requirements, filtration requirements, aeration, algae volumes required etc., calculated from spat production requirements and timing
- Water supply and discharge
- Facility design plan
- Detailed hatchery internal design layout (CAD plan views and elevations)
- Piping and Instrumentation Diagrams (P&ID)
- Biosecurity review of hatchery design
- Building material specifications

The Hatchery Design study could be undertaken using:

i. Private contractor(s), selected using a tender process

ii. Internal government resources, using DoFWA and Australian Centre for Applied Aquaculture Research (ACAAR)

iii. A combination of government internal resources and private contractors

The Hatchery Design project could also include development of the scope for the Feasibility Study, as well as the subsequent EOI process for the Feasibility Study. This will assist in determining funds required for undertaking the Feasibility Study, smoothing the transition from one stage to the next, thereby expediting the process.

8.3 Feasibility Study

The Final Feasibility Study should be conducted on the preferred site, studying and establishing:

- All the project risks, including agreed mitigation measures to control any critical risks
- The detailed engineering scope of the project
- Facility valuation in current state
- The likely Project Capital and Operating costs, to an accuracy nominally of ±10-15%
- The project schedule together with detailed plans outlining how the schedule will be met
- The organisational structure of WA Shellfish Hatchery Project
- Resources required to deliver the project
- Finalising the Business Plan and Structure, including:
  - Drafting the Facility Lease (or Access) Agreement
  - Legal review
  - Accounting review
- Review of spat sales forecasts and development of measures for industry commitment
- Hatchery Operator EOI/tender process
- Further economic modelling and sensitivity analyses (prior to Final Investment Decision)

The work on the Feasibility Study should be conducted in parallel to:

- Submissions to Govt. to secure project Approvals
- Applications for funding

8.4 Indicative Works Schedule

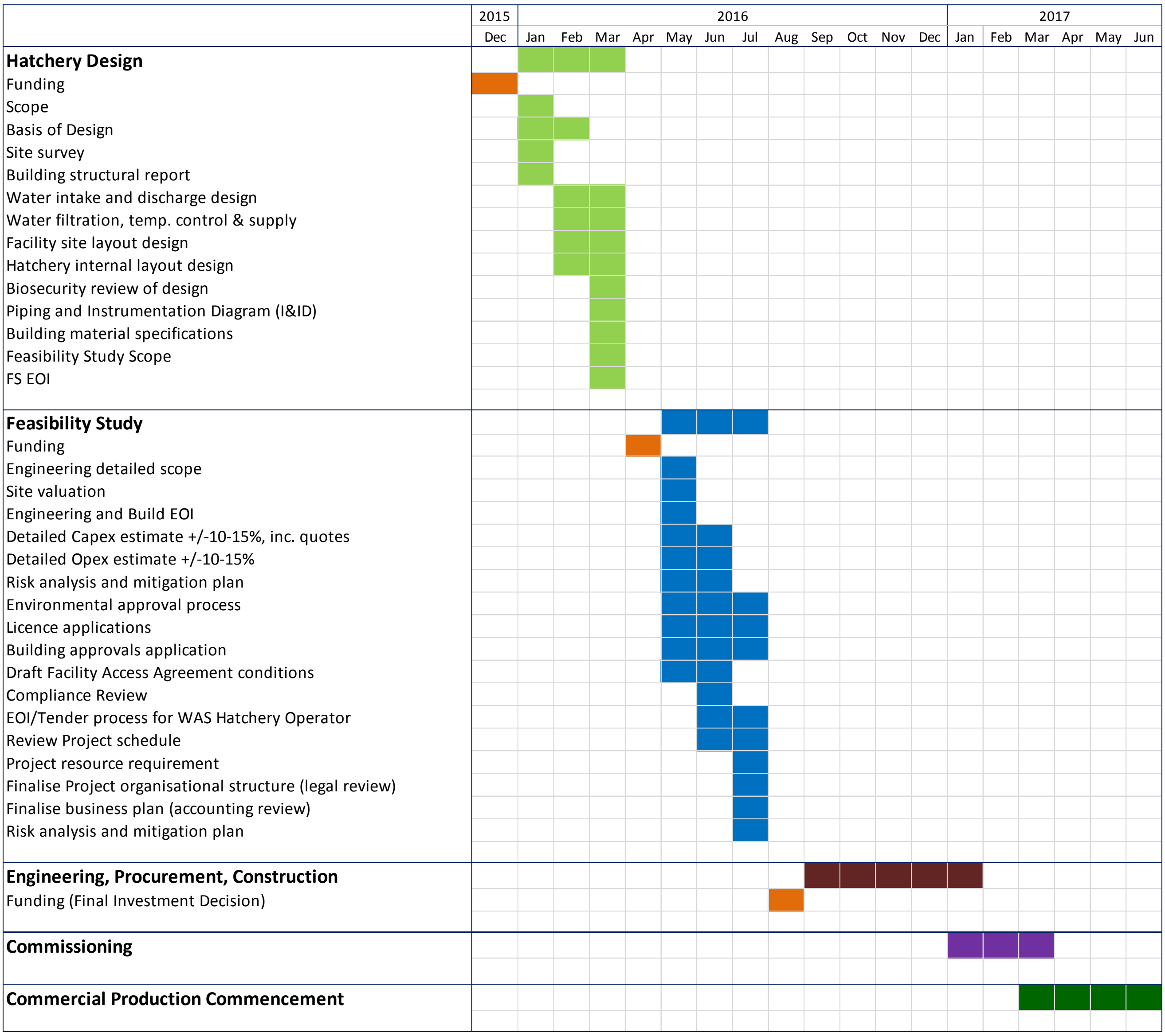

Figure 29 - Indicative Project Works Schedule

9 Conclusions & Recommendations

The long term success of aquaculture sectors is heavily reliant on the success of controlled breeding and hatchery production. Hatcheries in the aquaculture industry are rarely highly profitable. It is the grow-out business that produces the volumes and margins to generate large profits. However, without a hatchery, and often a breeding program, grow-out cannot sustain enough control over the value chain for consistent production, or highly efficient production. Therefore a common model in aquaculture, whether fish, crustaceans or molluscs, is some kind of vertical integration of the hatchery and grow-out sections of the business.

Vertical integration on this model requires some economies of scale which this report shows have not yet been reached in Western Australia. This report recommends considering the use of government funds for providing the WA mollusc farmers with a form of vertical integration (a reliable spat supply from the WA Shellfish Hatchery) in order to expand the industry.

The analogue case of the Queenscliff hatchery supplying the Victorian mussel farming sector has been put forward as a possible catalyst for facilitating the development of a mollusc industry of significant scale in Western Australia. This Study indicates that local private industry does not have the appetite for creating a common-user hatchery capable of supporting an industry of scale; on the basis of the funding hurdle which is large in both dollars and years.

This report indicates that funding from an external source is required. Funding from government sources is recommended in order to retain some control over the expansion of the mollusc farming sectors through to reaching critical mass. Governance of the funded operation should be determined through consultation with government, funding agencies and industry. This report recommends two models which differ primarily in their level of governance.

Once operational, forecasts indicate that the WA Shellfish Hatchery should become self-funding within five years, at which time it can be sold/privatised. By Year 5 of production the hatchery will be capable of supporting a forecast $12 million of grow-out production.

Should the ACWA committee of management decide to continue with this study, the next steps would include Hatchery Design and Feasibility Study stages prior to making a Final Investment Decision on the WA Shellfish Hatchery Project. The Feasibility Study should include further Economic Modelling and sensitivity analyses, together with the development of measures for the industry to commit to future spat sales, for example Spat Offtake Agreement.

Bivalve mollusc aquaculture has the potential to provide a sustainable increase in aquaculture production without significant environmental impacts. Mollusc aquaculture is able to provide a steady, sustainable form of employment, together with multiplier effects, in rural WA communities. The mollusc aquaculture sector (Mussel, Rock Oyster, Black-lip and Akoya pearl oysters) requires a *reliable, consistent* source of hatchery-produced spat in order to successfully expand mollusc farming in rural WA.

In 2012-13 production value for oysters in South Australia was AUD$35 million, employing approximately 687 people in direct activities associated with the oyster industry (PIRSA, 2013). Using the SA oyster aquaculture sector as an analogue, WA mollusc aquaculture sectors could potentially employ around 230 people directly associated with mollusc aquaculture in rural WA by Year 5 of the Project.

10 Discussion

10.1 Potential Temporary Alternatives to the WA Shellfish Hatchery

Sourcing spat from interstate, e.g. Victorian Shellfish Hatchery, may be a short-term solution, but longer term the WA industry would benefit from greater control over spat supply. Buying spat from interstate is likely to put further constraints around timing of spat supply, plus increase biosecurity risks. A Biosecurity risk analysis would need to be carried out. The OFI oyster hatchery has already produced rock oyster spat and Akoya spat. There are plans for some mussel spat production out of the OFI hatchery in Albany for late 2015, which would be highly preferable from a biosecurity perspective compared to purchasing spat from interstate.

10.2 Scallops

Scallop spat number requirements are not included in the forecasts. There is an R&D program currently underway at DoFWA Hillarys aiming to develop reliable scallop seed production techniques. If successful there may be requirements to scale-up scallop seed production for supplying to pilot-scale fishery enhancement programs with the objective of determining the potential economic viability of scallop fishery enhancement.

To determine economic viability of scallop fishery enhancement one option would be to genotype the scallop parents (broodstock) and progeny (spat) using specifically developed microsatellite markers. A statistically significant sample of the scallop catch in the fishery enhancement zone would in turn be genotyped at a point in time when the hatchery-produced spat recruitment cohorts reach market size. Genotypes would then be compared and matched against hatchery-produced spat genotypes to estimate the recovery rates.

10.3 Rock Oyster species in WA

There is currently some debate over the species of edible rock oysters found in Western Australia. Lam (2005) reports that there are three species of *Saccostrea* rock oyster present in Western Australia – *Saccostrea cucullata*, *Saccostrea glomerata* and *Saccostrea mordax*. Stenzl (1971) and Lam (2005) believe that *S. glomerata* are a sub-species (lineage) within the superspecies of *S. cucullata*. This report refers to rock oysters found in Western Australian as Western Rock Oysters or simply Rock Oysters.

Industry will require elucidation of the classification of rock oysters as it may affect breeding and translocation. Department of Fisheries WA could lead the investigation into species type and distribution of rock oysters in WA.

10.4 Mollusc Research Centre

There could be one main MSM hatchery, located for example in Albany, to supply the commercial spat requirements for mussels, edible oyster and non-maxima pearl oysters. There could also be a smaller hatchery facility used as a research centre, located for example in Perth, which carries out research and development for mussels, Blacklip pearl oysters, edible oysters and other mollusc species to support the commercial multi-species mollusc hatchery and wider nursery and grow-out farming sectors.

The notional Marine Mollusc Research Centre could also evaluate other endemic mollusc species for culture in Western Australia, e.g. Kimberley Oysters (*Striostrea mytiloides*) Figure 30. It could also identify suitable grow-out culture areas for existing species to facilitate the expansion edible oyster and mussel culture in WA. This marine mollusc research centre could potentially be located at Hillarys Boat Harbour. ACAAR could also assist in R&D projects, technology transfer and staff training.

Figure 30 - Kimberley Tropical Blacklip Oyster, Striostrea mytiloides (DAC, NT govt.)

10.5 Hatchery Operating Costs

Trying to reduce hatchery staff numbers and labour costs to a minimum usually ends up being a false economy for an integrated aquaculture business model. An understaffed hatchery will result in the staff having less time for good hygiene practices and attention to detail, having to take short-cuts and making more mistakes. Subsequently there is less consistency in hatchery production output. The economic impacts arising from failure to produce and deploy spat on time are magnified downstream in grow-out/farming side of the business.

10.6 Edible oysters and mussels

Edible oyster hatchery spat production is well established and mussel hatchery spat production is becoming more established, with two successful mussel hatcheries now operating in Australia. Profitable aquaculture industry sectors for mussel and edible oysters are established and proven in Australia, as they are around the world. With the growing demand for food, in particular seafood and furthermore good quality seafood grown in clean unpolluted waters, encouraging and facilitating the expansion of edible oyster and mussel aquaculture production in WA should be given high priority.

Identification of new potential sites for rock oysters and mussel culture is required. Oysters grow relatively slowly in Albany due to the cool temperatures. Rock oyster farming should be considered for the North West. South Sea Pearl Oysters (*P. maxima*) grow well from Exmouth, parts of the Pilbara coast and up through the Kimberley. Maxima are filter-feeding mollusc with high feed requirements. This indicates that other bivalve mollusc species with suitable optimal temperature ranges, for example endemic rock oyster species, also have the potential to grow well in these areas of North West Australia. A private company has been in discussions with Traditional Owners (TO) in the Pilbara and Kimberley regions and is interested in potential collaborations between private and TOs for farming rock oysters in the North West. Funding from Oil and Gas and Resources companies could be sought for pilot-scale oyster farms, together with RfR funding.

Figure 31 - Oyster farming - inter-tidal rack system

10.7 Biosecurity

Molluscs are particularly susceptible to disease, being filter feeders and lacking an advanced immune system. Biosecurity is one of the most significant risks for a multi-species mollusc hatchery. A thorough risk analysis of the WA Shellfish Hatchery should be carried out, including a full biosecurity risk review and analysis carried out by the DoFWA, which could potentially be reviewed by independent experts. The output should be a risk management plan that includes a biosecurity policy and protocols for the design and operation of the WA Shellfish Hatchery.

Figure 32 – TCBS agar plate showing colony forming units

10.8 Information contained in this study report

There is very little in the way of published material on mollusc aquaculture in Western Australia. Department of Fisheries WA annual reports and data sets have been used where pertinent, as has the FRDC 2007/216 report on development of Akoya pearl culture. Much of the other information, for example natural spawning times of the various species, survival rates, spat prices and site assessment characteristics, is anecdotal and derived from personal comments from individuals in the industry and from government staff from WA and the Eastern States.

11 Acknowledgements

Thanks go to:

- The ACWA members that responded to the study survey of current and future forecasts for mollusc spat requirements
- Jonathan Bilton who provided information regarding the history of the Albany mollusc industry
- Other individuals and companies from the WA mollusc aquaculture industry that contributed spat requirement and other information
- Staff at DoFWA for information provided
- The government staff from other states that provided information that contributed to this study, in particular John Mercer and Andrew Clarke from DEDJTR, and Wayne O'Connor DPI, New South Wales
- Tina Thorne, Steve Nel and Greg Jenkins for their support during the compilation of study information and writing of the report

12 Appendices

12.1 Terms of Reference (original)

PROJECT

BUSINESS MODELING FOR A PROPOSED MULTI-SPECIES MOLLUSC HATCHERY IN WESTERN AUSTRALIA

Calling for Expressions of Interest

The Aquaculture Council of Western Australia (ACWA) recently commissioned a study to identify the industry requirements for the hatchery cultivation of spat (bivalve mollusc seed or juveniles) to encourage and accelerate industry growth of aquaculture in Western Australia.

The Study Report (attached) was completed in July 2014 and reviewed by the ACWA Committee of Management (CoM).

ACWA now seeks an experienced consultant to prepare the necessary Business Case and ongoing Business Plan for the establishment of a multi-species mollusc (MSM) hatchery facility in Western Australia.

The scope of work for the project includes the following:

- Investigate the establishment of the Victorian Shellfish Company at Queenscliff as a potential model for the WA Hatchery proposal;
- Hold discussions directly with potential stakeholders regarding their willingness to participate in this program and contribute to the operational costs of the facility;
- Make recommendations on the most appropriate site for the WA hatchery that provides the best opportunity for success;
- Prepare a capital expenditure budget to establish the hatchery and the likely production capacity of the facility and the industry sectors (species) it could

potentially service;

- Prepare an operational budget stating the likely production capacities and indicative operational costs for various species production runs (i.e. indicative costs to industry);

- Identify and articulate a model (or models) including transitional arrangements for Government investment in early stage operational costs, that will enable the key beneficiaries of the facility to contribute to the ongoing operational costs of the facility on a user pays basis;

- Identify if the hatchery is able to be self-funded within 5 years; and

- Identify appropriate sources of funding to assist with the capital cost of the facility, and preliminary advice on the likelihood of success in attracting funding.

Note that members of the ACWA Committee of Management with relevance to this project will be available for advice as required.

Experience of the consultants

1. Outline relevant industry experience of proposed personnel;
2. Propose detailed project methodology, deliverables, budget and timelines.

Please forward responses to:

Tina Thorne
Executive Officer
Aquaculture Council of Western Australia

Email: eo@aquaculturecouncilwa.com

Post: PO Box 1605
Fremantle WA 6959

12.2 ToR Additional Information

ACWA

AQUACULTURE COUNCIL OF WESTERN AUSTRALIA

PROJECT

BUSINESS MODELING FOR A PROPOSED MULTI-SPECIES MOLLUSC HATCHERY IN WESTERN AUSTRALIA

Additional Information to the Calling for Expressions of Interest

The Aquaculture Council of Western Australia (ACWA) recently sought Expressions of Interest from an experienced consultant to prepare the necessary Business Case and ongoing Business Plan for the establishment of a multi-species mollusc (MSM) hatchery facility in Western Australia.

ACWA has now identified Additional Information that may assist the successful consultant and modify the scope of work for the project:

- ACWA has been approached by Mr Jonathon Bilton who in December 2014 has reopened an existing hatchery in Albany Western Australia for Ocean Foods International (OFI). Mr Jonathon Bilton has expressed his interest in offering his long experience of operating mollusc hatcheries to the Project and participating in any potential model for the WA Hatchery proposal;

- The principals of Ocean Foods International have met with ACWA to discuss a separate project. During this meeting OFI expressed interest in considering any potential model for the WA Hatchery proposal;

- Mr Barry Humphry of Abrolhos Pearls (WA) Pty Ltd of Geraldton has approached ACWA for support to re-establish a hatchery in the Geraldton region.

ACWA believe this information will reduce the scope of work necessary to prepare the Business Case and ongoing Business Plan and therefore would invite those organizations who responded to the Expression of Interest to resubmit a brief response detailing any changes to their proposed scope or costings.

Please forward responses to:

Tina Thorne
Executive Officer
Aquaculture Council of Western Australia

Email: eo@aquaculturecouncilwa.com

Post: PO Box 1605
Fremantle WA 6959

Geoff Glazier
Chair - Aquaculture Council of WA

12.3 Capital Expenditure - consolidated

Table 14 - Consolidated Cash flow (Owner and Operator combined)

Projected Cashflow Summary - CONSOLIDATED	Year	0	1	2	3	4	5
Spat sales revenues							
Total Revenues	**$**		**$ 366,600**	**$ 493,750**	**$ 637,235**	**$ 779,711**	**$ 922,831**
Direct Operating Costs							
Manufacturing costs (COGS)	$		-479,626	-564,500	-619,206	-669,332	-721,187
Total Direct Operating Costs	**$**		**-$ 479,626**	**-$ 564,500**	**-$ 619,206**	**-$ 669,332**	**-$ 721,187**
Gross Profit							
Revenues	$		366,600	493,750	637,235	779,711	922,831
Direct Operating Costs	$		-479,626	-564,500	-619,206	-669,332	-721,187
Total Gross Profit	**$**		**-$ 113,026**	**-$ 70,750**	**$ 18,030**	**$ 110,378**	**$ 201,644**
Project Administration and Facility Support							
Total Project Admin. and Facility Support			**-$ 179,257**	**-$ 196,006**	**-$ 212,953**	**-$ 115,292**	**-$ 123,237**
EBITDA (*Consolidated*)	**$**		**-292,283**	**-266,755**	**-194,923**	**-4,914**	**78,407**
Taxation estimate	$		0	0	0	0	19,602
Net Profit After Tax	**$**		**-292,283**	**-266,755**	**-194,923**	**-4,914**	**58,805**
Cashflows From Operating Activities							
Net Cash Provided by Operating Activities	**$**		**-292,283**	**-266,755**	**-194,923**	**-4,914**	**58,805**
Capital expenditure							
Basis of Design, Hatchery Design, FS scoping	$	-47,663					
Feasibility Study - Risks, Legal, Costing etc.	$	-71,494					
Plant and Equipment	$	-711,565					
Building/Improvements Capital *	$	-480,000	-80,000	-140,000			
Net Cash Used for Capex	**$**	**-1,310,722**	**-80,000**	**-140,000**	**0**	**0**	**0**
Cashflows from Financing Activities							
Facility Access Agreement/Lease			1,200	1,248	1,298	2,704	16,557
Buyout Valuation*	$						**853,528**
Govt. Grants - e.g. RfR	$						
Govt. Grants - *Going for Growth*	$						
Private Funding	$						
R&D tax concession estimate	$			106,499	110,959	107,550	88,270
Net Cash Provided by Financing Activities	$	**0**	**1,200**	**107,747**	**112,257**	**110,254**	**958,355**
Net Cash Flow (*excluding int. & depreciation*)	**$**	**-1,310,722**	**-371,083**	**-299,008**	**-82,666**	**105,340**	**1,017,160**
Opening Cash	$	0	-1,310,722	-1,681,805	-1,980,813	-2,063,479	-1,958,138
Closing Cash (Consolidated)	$	**-1,310,722**	**-1,681,805**	**-1,980,813**	**-2,063,479**	**-1,958,138**	**-940,978**

* - uncosted

12.4 Photos of Great Southern Marine Hatcheries Facility