Determining the need for a Multi-species Mollusc Hatchery in Western Australia

ACWA Study Report

By RMB Aqua

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Executive Summary

Background

The Aquaculture Council of Western Australia (ACWA) recently conducted a survey of its current members to determine the issues they are facing, the factors that may be inhibiting growth and/or development of the aquaculture industry in Western Australia (WA), and how ACWA and the Department of Fisheries WA (DoFWA) may assist in resolving these issues.

Some sectors of the WA aquaculture industry (mussel and black-lip pearls) indicated that a lack of access to spat (bivalve mollusc seed or juveniles) is a major impediment to industry growth and sustainability. They requested that ACWA investigate the potential for establishing a multi-species mollusc hatchery in WA.

Following a workshop held in Fremantle on 7th April 2014 to discuss the establishment of a multi-species mollusc (MSM) hatchery, ACWA appointed the services of RMB Aqua to undertake a review of the existing non-maxima bivalve mollusc aquaculture sector in Western Australia (mussels, non-maxima pearl oysters, scallops and edible oysters). The review included the mollusc sector's current status and forecast future spat requirements, as well as current supply options, to assist in determining the need for a government-supported multi-species mollusc hatchery in WA.

Findings

There is a strong and growing demand for edible oyster, mussel and non-maxima pearl oyster spat to supply the Western Australian aquaculture industry. However, there are currently no mollusc hatcheries operating to supply these spat, and therefore industry development and growth is being constrained. Moreover, production volumes are declining and some sectors may be at risk of potential collapse.

Current spat requirements (2015) are estimated to be:

- Mussels - 120,000,000
- Sydney Rock Oysters - 6,000,000
- Blacklip Pearl Oysters - 450,000
- Akoya Pearl Oysters - 190,000
- Scallops - 15,000,000 (for R&D purposes)

Estimated Gross Value of Production (GVP) derived from the mollusc spat (2015) if available would be approximately $3.5 million (Table 1).

Spat requirement forecasts for 2019 are estimated to be:

- Mussels - 384,000,000
- Sydney Rock Oysters - 16,000,000
- Blacklip Pearl Oysters - 600,000
- Akoya Pearl Oysters - 310,000
- Scallops - Unknown

Estimated Gross Value of Production (GVP) derived from the mollusc spat (2019) if available would be approximately $8.8 million (Table 1). These figures are from what is effectively a base of zero production from hatchery spat currently. There is some mussel aquaculture production currently in WA, using wild spat settlement as opposed to hatchery spat. The spat requirements stated in this study are on top of wild-settlement.

Table 1 - Estimated GVP from selected species of mollusc hatchery spat in WA

Species	Mussel	Black-lip Pearl Oyster	Akoya Pearl Oyster	Rock Oyster	Total
Estimated GVP from hatchery spat year produced					
2015	$ 1,140,000	$ 540,000	$183,502	$ 1,666,667	**$ 3,530,169**
2016	$ 1,824,000	$ 660,000	$183,502	$ 2,083,333	**$ 4,750,835**
2017	$ 2,489,000	$ 660,000	$280,082	$ 2,500,000	**$ 5,929,082**
2018	$ 3,211,000	$ 660,000	$280,082	$ 3,333,333	**$ 7,484,415**
2019	$ 3,648,000	$ 720,000	$299,398	$ 4,166,667	**$ 8,834,065**

There was no hatchery spat supply for the non-maxima pearling industry last year, there will be none this year and at the time of publication there are no options for spat supply next year. Without a reliable supply of hatchery produced Akoya and Blacklip Pearl Oyster spat, this sector will continue to contract and potentially disappear altogether.

The Western Australia mussel industry production volumes have contracted over the years, with some companies exiting the sector and license holders ceasing operations. Without hatchery production of mussel spat, the sector will not be able to expand to meet current and future market demand and may not survive if wild spat settlement continues declining (Figure 1). The edible oyster sector also requires a well-run hatchery that can consistently produce spat to their requirements in order to establish a solid base to expand from.

Figure 1 - WA aquaculture production volumes, with trendline for mussels

Victoria experienced a similar trend in its mussel aquaculture sector in the early 2000s. Mussel production went from 1,600 tonnes per year in 2002 to 450 tonnes per year in 2008. The response from the Victorian government was to design and fit-out a mollusc hatchery at the Queenscliff Marine Research facility and lease it to an industry co-operative entity, initially made up of five mussel producers. The Victorian Department of Environment and Primary Industries provided technical support and scientific services to solve issues and assist in developing the appropriate knowledge base, systems and techniques.

The Victorian Shellfish Company venture at Queenscliff, a joint government – industry initiative, has been a resounding success with production volumes back from 450 tonnes per year before the hatchery began producing to around 1,000 tonnes recently. The hatchery has also afforded the mussel farmers the advantage of a shorter grow-out time to market, by using fast-growing pedigrees from the hatchery breeding program, providing Victorian mussel farmers a competitive advantage over farmers in other States. There are now new aquaculture sectors emerging as other mollusc species are cultured at the facility, such as flat oysters (*Ostrea angasi*), and scallop production is currently being evaluated.

Running just one of the species investigated in this study, such as mussels alone or oysters alone, is unlikely to support a hatchery for at least the first four years or so, if the hatchery is to be run throughout the year (Figure 2). Even after four years it is likely to be only marginal economically. Combining production of a minimum of two mollusc species would be beneficial in order to share resources and fixed operating costs and to attain economy of scale. It will also help to attract and retain a highly skilled and experienced team of staff, which is one of the most critical elements to a successful mollusc hatchery.

ACWA multi-species mollusc hatchery study, species combination options and estimated revenue from spat sales, 2014

Multi-species hatchery combination			Estimated hatchery spat sales ($)				
			2015	2016	2017	2018	2019
Mussel			$ 116,000	$ 188,000	$ 262,000	$ 336,000	$ 380,000
	Blacklip & Akoya		$ 118,500	$ 138,500	$ 153,500	$ 153,500	$ 166,500
		Oyster	$ 180,000	$ 225,000	$ 270,000	$ 360,000	$ 450,000
Mussel	Blacklip & Akoya		$ 234,500	$ 326,500	$ 415,500	$ 489,500	$ 546,500
Mussel		Oyster	$ 296,000	$ 413,000	$ 532,000	$ 696,000	$ 830,000
	Blacklip & Akoya	Oyster	$ 298,500	$ 363,500	$ 423,500	$ 513,500	$ 616,500
Mussel	Blacklip & Akoya	Oyster	$ 414,500	$ 551,500	$ 685,500	$ 849,500	$ 996,500

Figure 2 - WA mollusc hatchery species combination options and estimated revenue from spat sales

A potential location for Mussel and Oyster hatchery production would be Albany at the DoFWA Aquaculture Park due to suitable water quality, distances for live transport of broodstock and spat, and local climate. There are a couple of potential options to consider:

- the old abalone hatchery
- the Ocean Foods International hatchery (if suitable terms can be negotiated with OFI)
- a combination of both

The Ocean Food International Hatchery is a potential candidate for the multi-species mollusc (MSM) hatchery, with some infrastructure in place and refurbishment of the facility currently under consideration, with the aim of producing oysters and potentially mussels. OFI have expressed an interest in discussing potential collaboration, resource-sharing or spat supply arrangements for other mollusc sectors with ACWA and the relevant industry parties.

The site of the old abalone hatchery next door is another, and potentially better, alternative located at the Albany Aquaculture Park. It is Crown Land held under the Department of Fisheries WA, which includes the buildings. At the time of publication the old abalone hatchery site is not being leased out to a tenant. The buildings are of sufficient size and appear to be in relatively good condition.

Alternatively, mussel hatchery production could be located in Perth, possibly at DoFWA Hillarys Boat Harbour, at least in the early stages where more technical support is required.

The Blacklip and Akoya Pearl Oyster hatchery spat production could occur at either Albany or Perth. If the non-maxima pearl oyster spat production was also at the MSM hatchery together with mussel and oyster production it would strengthen the business case and economics of a MSM hatchery.

The Shark Bay scallop fishery is based on a single species *Amusium balloti* and is the most valuable scallop fishery in Western Australia. The Shark Bay and Abrolhos Scallop Fisheries have produced catches ranging from 121t up to 4,414t / annum, ranging in value from $2 million to $58 million (Kangas et al 2006). This species is short-lived, has a fast growth rate and is relatively sedentary. *Amusium balloti* appears to be an ideal candidate for fishery enhancement through hatchery production of scallop spat that are deployed into wild fisheries, left to grow under natural conditions and then harvested at market size.

The scallop industry requires an R&D program of approximately 3 – 5 years to develop technology and systems, attain knowledge and skills and evaluate the economic viability of scallop fishery enhancement in WA. The scallop hatchery production and fishery enhancement research and development program would suit being located at the Department of Fisheries WA, with good access to technical, research and scientific services.

Conclusions

The following is a summary of the conclusions drawn from this study:

- There is a strong and growing commercial demand for mussel, edible oyster, Blacklip and Akoya pearl oyster hatchery-produced spat. The industry is not meeting the demand for hatchery-produced mollusc spat, with no non-maxima mollusc hatcheries currently operating in WA. With no options for purchasing spat mollusc aquaculture production will decline and some sectors may risk potential collapse

- A single species hatchery is unlikely to have sufficient demand in WA for large enough volumes of spat to cover operating costs if the hatchery, if operated throughout the year. A mollusc hatchery in WA that produces at least 2 – 3 species of mollusc spat could potentially attain economy of scale. Mussels and edible oysters are a good pairing of species to share resources and form the basis of the MSM hatchery

- The Victorian Shellfish Hatchery, a government – industry co-operative initiative, has been very successful in reviving the mussel industry that was previously experiencing a precipitous decline in production. The Victorian venture sets a precedent for a multi-species mollusc hatchery for Western Australia.

- All the aquaculture sectors involved in this ACWA study are keen to receive hatchery-produced spat as soon as possible. With this in mind the assessment of potential site options has focused on existing government and commercial aquaculture facilities and hatcheries, as opposed to green field sites

- Using an existing mollusc hatchery or aquaculture facility that has the main infrastructure in place and is already partially fitted out and in reasonable condition means production could potentially begin within 6 months – assuming all negotiations and approvals go smoothly. If there are major capital works and / or hold-ups in negotiations and approvals the process could take 12 - 18 months. A green field site is likely to take a minimum of 24 – 36 months

- The option best-suited to the scallop R&D program is the DoFWA Hillarys aquaculture facility in Perth. Using Hillarys aquaculture facility, which is operational, serviced and staffed, the scallop sector can get the scallop research underway relatively quickly. Blacklip and Akoya sectors could potentially also be produced from Hillarys, as could mussels for the early stage R&D and low volume production

- From the information on hand at time of this study, the option that appears best-suited to larger-scale commercial mussel and oyster spat production is the Albany Aquaculture Park, at either one of the two hatcheries there – the Ocean Foods International oyster hatchery, currently not operational, or the old disused abalone hatchery, or a combination of both hatcheries. The Blacklip and Akoya spat can also potentially be produced at the Albany Hatchery

- The old abalone hatchery buildings appear to be in relatively good condition. The facility would need refurbishment but appears to be the better of the option due to its size and land tenure

- An alternative to Albany for mussel hatchery production, at least in the early stages, is the DoFWA facility at Hillarys. R&D such as out-of-season broodstock conditioning and spawning and determining the best timing for spat deployment could be supported by the Department of Fisheries technical and scientific staff. R&D and low volume production for other mollusc species could also potentially occur at the DoFWA facility

- There is a bottleneck for spat demand between the species investigated, particularly the mussels, oysters and non-maxima pearl oysters. However, based on the study participant feedback it appears likely that a successful outcome can be negotiated between stakeholders for a relatively even spread of hatchery production and spat delivery throughout much of the year

- Bivalve mollusc aquaculture has the potential to provide a sustainable increase in aquaculture production without significant environmental impacts. It also has the potential to provide rural employment

There is a strong demand for mollusc spat in WA, and clearly there is a need for a multi-species mollusc hatchery to supply these demands. It is possible that one hatchery could supply all demands. 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 hub, located for example in Perth, which carries out research and development for scallops, mussels, Blacklip pearl oysters and other mollusc species to support the commercial MSM hatchery and wider nursery and grow-out mollusc industry sectors.

The notional Marine Mollusc Research Centre could also evaluate other local mollusc species for culture in Western Australia, e.g. Kimberley Oysters (*Striostrea mytiloides*), as well as identifying suitable grow-out culture areas for new and existing species to facilitate the expansion of edible oyster and mussel culture in WA.

The Australian fishing zone 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. 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 only 18,722 tonnes. This represents 0.13% of the total world mollusc production in 2010 of 14.1 million tonnes.

Western Australia has 12,889 kms of mainland coastline and 20,781 of coastline including islands, which equates to a third of the total Australian coastline. Mollusc aquaculture production in WA was 350 tonnes in 2011/12 (Table 4), or less than 2% of Australian mollusc production by volume from aquaculture. Clearly there is a tremendous opportunity to expand mollusc aquaculture production in Western Australia. Bivalve mollusc aquaculture has the potential to provide a sustainable increase in production without significant environmental impacts. It also has the potential to provide rural employment.

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

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1 Introduction

1.1 Study Objectives

The objectives of this study are to determine the following:

- Current and future spat requirements - determine the current and future spat requirements of existing aquaculture industry members for non-maxima mollusc aquaculture industry (mussels, edible oysters, scallops and non-P. maxima pearl oysters) in Western Australia
- Current spat supply source - determine the current mollusc spat supply sources, the capacity to meet current and future spat requirements and reliability of the existing spat supplies
- Current spat price – determine the current price of spat (and estimate the approximate % of gross value of product)
- Timing of spat requirements - determine the timing of spat requirements for each species and the allocation of resources
- Need for nursery systems – determine the need for nursery systems
- Existing mollusc hatchery operators – identify current mollusc hatchery operators and determine their willingness, ability and capacity to supply other species of mollusc spat to the industry, and if so under what terms
- The number of hatcheries required - is one or more multi-species mollusc hatcheries required
- Commercial production or R&D - Are the needs of all of the industry sectors the same? (i.e. supply of spat only or is there an R&D requirement)
- Staffing – determine the staff requirements and availability in Australian of appropriately skilled and experienced personnel
- Potential sites - identification and preliminary assessment of suitability of potential pilot or commercial mollusc hatchery sites
- Hatchery Requirements – preliminary identification of key requirements for a multi-species mollusc hatchery (e.g. land, building floor space, water quality, equipment, etc.)
- Timelines – estimate the timelines for development of a new facility including for funding and licensing approvals, construction and commissioning

1.2 Scope of Study

The scope of the study is to deliver a preliminary overview of the current and future spat requirements for the non-maxima mollusc aquaculture industry in WA. The study will also investigate the current WA mollusc hatchery capability to meet current and future demand.

The study identifies potential multi-species hatchery sites. Some broad, high level criteria for selecting a site and some of the requirements for setting up a mollusc hatchery will be discussed. However, this is a desktop study and travelling to potential sites for first-hand assessments is not included in the scope. Further evaluation of potential sites and detailed cost estimates and timeframes are part of the next stage of this process, if the project proceeds to the next stage.

Economic estimates included are a preliminary guide only, intended to give an indicative cost of the spat to match up potential operating costs of the hatchery in order to estimate the size where a hatchery might cover operating costs and break-even. A more in-depth business plan is part of the next stage of this process, if it is deemed that there is a strong case for developing a multi-species hatchery for the WA mollusc industry.

1.3 Study Proponent

The Aquaculture Council of Western Australia (ACWA) has commissioned this study, with the support of the Department of Fisheries Western Australia.

ACWA is a member-driven organisation based in Perth, Western Australia. ACWA is the State's peak 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 Background

2.1 Global mollusc aquaculture

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. Global aquaculture production has continued to grow, albeit more slowly than in the 1980s and 1990s. World aquaculture production attained an all-time high in 2010, at 60 million tonnes (excluding aquatic plants and non-food products), with an estimated total value of US$119 billion (FAO 2012), up from 32.4 million tonnes in 2000.

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.

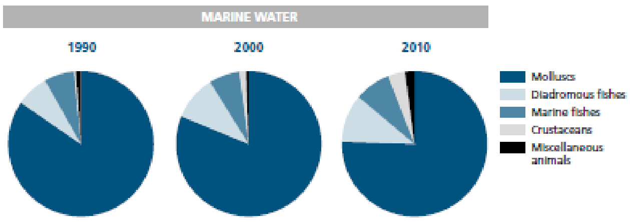

Figure 4 - World marine aquaculture production composition (FAO 2012)

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

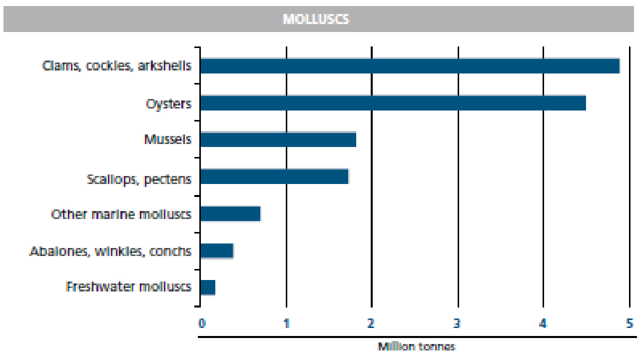

Figure 5 - World mollusc aquaculture production composition (FAO 2012)

The FAO predicts that there will be continued strong growth in world aquaculture production. It is likely that aquaculture remains the fastest growing animal production sector. Bivalve mollusc aquaculture production has the potential to provide a sustainable increase in production without significant environmental impacts, due to the filter-feeding nature of bivalves requiring no net nutrient input.

2.2 Australian mollusc aquaculture

Figure 6 - Microalgae lab

Mollusc production, including pearl production, in Australia was valued at $435 million in 2009-10 (Table 2), making up around 15% of the total Australian fisheries and aquaculture total production value. In quantity terms, Australian aquaculture production for 2009–10 increased 5% over the previous year.

	NSW $'000	Vic. $'000	Qld $'000	SA $'000	WA $'000	Tas. $'000	NT $'000	Cwlth $'000	Aust. $'000
Finfish									
Tuna	—	—	—	102175	32	na	37	58430	125299
Salmonids(c)	1602	5102	—	na	na	362422	—	—	369126
Other	49924	11659	107555	73692	36682	4920	27506	149014	460951
Total	**51,526**	**16,761**	**107,555**	**175,867**	**36,714**	**367,342**	**27,543**	**207,444**	**955,376**
Crustaceans									
Prawns	16004	904	155860	31142	27940	—	—	92242	324,092
Rock lobster	6753	14422	5850	85834	184101	65219	—	6660	368,839
Crab	3977	721	28570	4804	6897	1903	9262	59	56,193
Other	1099	314	12463	898	2295	—	—	2271	19,340
Total	**27,833**	**16,361**	**202,743**	**122,678**	**221,233**	**67,122**	**9,262**	**101,232**	**768,464**
Molluscs									
Abalone	1904	21919	—	38445	9227	102132	—	—	173,627
Scallops	4	—	10250	na	9141	—	—	6407	25,802
Oysters	43000	—	520	35027	—	21264	—	—	**99,811**
Pearls	—	—	na	—	85500	—	18980		104,480
Other	4038	3069	710	12086	4718	5192	206	1638	31,657
Total	**48946**	**24988**	**11480**	**85558**	**108586**	**128588**	**19186**	**8045**	**435377**
Other fisheries production	**4957**		**1940**	**10260**	**1188**	**768**	**730**	**16**	**697127**
Total	**133,262**	**58,110**	**323,718**	**394,363**	**367,721**	**563,820**	**56,721**	**316,737**	**2,856,344**

Table 2 - Australian fisheries production value including aquaculture 2009-10

The Australian Fishing Zone covers an area of almost 9 million square kilometres (Figure 7). 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).

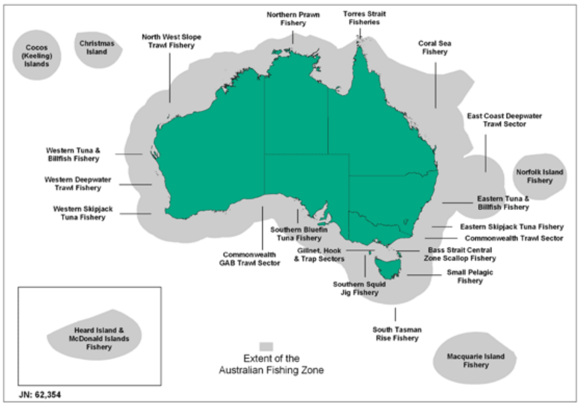

Figure 7 - Australian fishing zones (AFMA 2008)

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 3). This represents only 0.13% of the total world mollusc production in 2010 of 14.1 million tonnes. Clearly there is a tremendous opportunity to expand mollusc aquaculture production in Australia.

Western Australia has 12,889 kms of mainland coastline and 20,781 of coastline including islands, which equates to a third of the total Australian coastline. Mollusc aquaculture production in WA was 350 tonnes in 2011/12 (DoFWA 2012)(Table 4), or less than 2% of Australian mollusc production by volume from aquaculture. Clearly there is a tremendous opportunity to expand mollusc aquaculture production in Western Australia.

2.3 Oyster aquaculture in Australia

Edible oysters from aquaculture production were the second most plentiful product in Australia at 14,804 tonnes, whilst in value terms oysters ranked fourth behind, salmon, pearl oysters and tuna (Table 3). The value of oyster aquaculture production in Australia increased by 12%, 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 Australia and New Zealand. In Australia it is found in eastern Victoria, along the east coast of New South Wales and up to Hervey Bay Queensland, around northern Australia and down the west coast to Shark Bay in Western Australia. Rock oysters are also cultured further South in Western Australia in Albany. Whilst they are the same species as the Sydney Rock Oysters (*Saccostrea glomerata*) they are sometimes referred to as Western Rock Oysters.

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

Table 3 - Australian aquaculture production - quantity and gross value

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. Production of Western Rock Oysters has declined over recent years, but there are plans adrift for reviving this business in the Southwest.

2.4 Mussel aquaculture in Australia

Mussel farming is an international aquaculture sector established in many parts of the world, including Scandinavia, UK, Ireland, France, Spain, New Zealand, Canada and many countries across Asia including China. In Australia, mussel farming is a relatively new venture undertaken in sheltered bays of the southern states (NSW Fisheries) and southern parts of Western Australia. The mussel species cultured in Australia is the blue mussel (*Mytilus galloprovincialis*).

The value of WA edible mollusc aquaculture production consists almost entirely of mussels, with a value of $1.37 million in 2011/12 (DoFWA, 2012).

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%

Table 4 - WA aquaculture production volumes 2006/07 - 2011/12

Australian mussel production is around 3,100t per annum and worth around $10 million per year (Duthie 2010) by gross farm-gate value. Tasmania and Victoria have experienced highly variable wild spat settlement and trends of significant decline in numbers of wild spat settlement over the past 10-15 years. 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 - similar to recent trends in WA. Both Victoria and Tasmania invested in mollusc hatcheries to produce mussel spat to prevent their industries from collapsing completely and then once operational to expand production back upwards towards the peak years of wild settlement. The Victorian mussel industry is now back up to 1,000t production per annum, and growing.

Mussel production in WA was over 600 tonnes in 2006/07 (Table 4) but the industry has experienced a trend of decline since then, with production only 350 tonnes in 2011/12 (Figure 8). The average mussel price in 2011-12 was $3.91/Kg (DoFWA, 2012). Currently there is no mussel hatchery spat production in WA, therefore this decline in production is mainly due to the decline in wild mussel spat settlement. In recent years ocean temperatures have often been significantly higher than long-term averages and this is likely to be having a detrimental effect on wild mussel spat settlement.

Figure 8 - WA Aquaculture production volume composition and recent trend for mussel production (DoFWA 2012)

Higher than optimal water temperatures may adversely affect breeding, spawning, larval development and the critical settlement stage for mollusc species. Water temperatures off the south-western coast of Western Australia rose to unprecedented levels during February and March 2011. This warming event has been termed a “marine heat wave”. While surface temperatures were more than 3°C above the long-term monthly average over an extended area in February 2011, the temperature in some localised areas in coastal waters exceeded the long-term monthly average by 5°C for periods of a day or two in late February/early March (DoFWA 2011).

Figure 9 – TCBS agar plate showing colony forming units

2.5 Blacklip and Akoya aquaculture in Australia

The Akoya pearl oyster (*Pinctada fucata*) 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).

The Blacklip, *Pinctada margaritifera,* and Akoya, *Pinctada fucata* (also referred to collectively as non-maxima), pearl oyster industries share a similar constraint to that affecting the mussel industry - i.e. inconsistent and declining spat supply, but arising from a different set of issues. The non-maxima pearling companies are not able to collect significant numbers of wild-settled Blacklip or Akoya spat. They are also unable to fish for mature wild shell as the maxima pearling industry is often able to do when maxima hatchery spat is in short supply. The commercial, non-maxima pearling industry relies entirely on hatchery-produced spat.

There have been three 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 Post 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 numerous occasions and has had no success. The Abrolhos Islands Blacklip and Akoya pearl farmers were not able to source spat last year and are unable to source any spat again this year. Without new developments, next year does not offer any Blacklip or Akoya spat supply options either. Non-maxima pearl production value has declined by 90% over 7 years from 2006/07 – 2012/13 (Figure 10). Lack of reliable spat supply is reported by this sector to be one of the main 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.

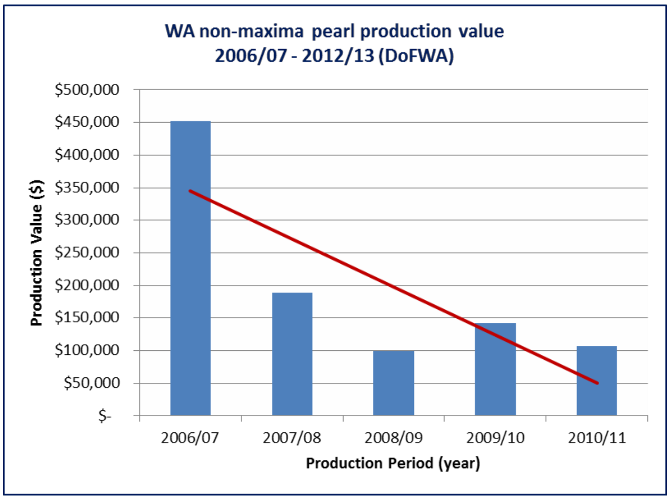

Figure 10 - Non-maxima pearl production value with trendline for WA

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.

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 11. 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 up to 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).

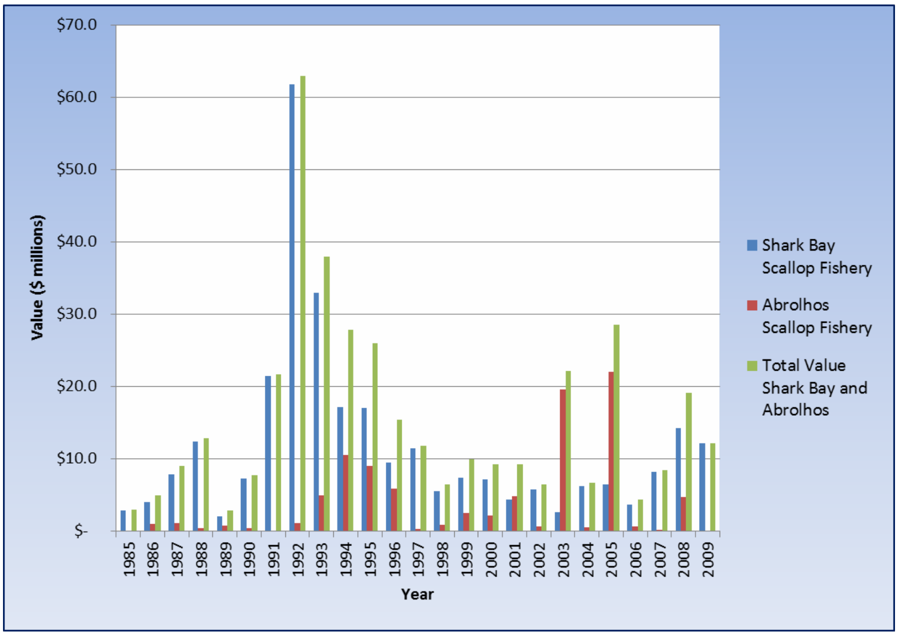

Figure 11 - Shark Bay and Abrolhos annual scallop landings value (DoFWA 2011)

For the past couple of seasons stocks have remained too low to open the Shark Bay and the Abrolhos scallop fishery, due to several years of poor recruitment. Initially the WA scallop industry requires an R&D program to precede commercial, or even pilot-scale, hatchery production of scallop spat for fishery enhancement. Industry has indicated having an interest in an R&D program with DoFWA to determine the feasibility and long-term economic viability of a commercial-scale scallop fishery enhancement program. Objectives during the R&D stage will include removing production bottlenecks encountered in previous hatchery production trials carried out in WA in the early 2000s, developing appropriate technologies for reliable cost-effective hatchery spat production, determining recapture rates of hatchery spat deployed in the fisheries, determining optimum size, timing, grounds etc. for deployment and ultimately determining if enhancement is an economically viable business proposition.

Figure 12 - experimental scallop hatchery project, Geraldton WA (FRDC 2002/048)

2.7 Wild versus Hatchery spat

Often in aquaculture species start off being cultured or on-grown using wild seed or spat. As grow—out techniques are developed, improved upon and become more successful, profitable businesses emerge. The industry begins to mature and seeks greater control over all areas of the production process, but especially breeding and seed-stock production. Without a reliable supply of seed / spat there is always a high degree of uncertainty over future production forecasts, hindering or preventing business planning in areas such as capital investment, labour, sales and marketing, which are required for expansion.

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 / less annual variation
- Control over timing of spat deployment, allowing the 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
- Improved product and faster growth rates by using techniques for producing sterile stock, for example triploid / polyploidy oyster stock
- Greater consistency of product through having control over the duration of spawning and settlement process
- Greater control for planning production, sales and marketing
- Greater scope for expanding companies and business sectors

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).

3 Development of a Mollusc Hatchery in Victoria – a case study

Until 2002, the Victorian 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 Victorian Department of Primary Industries (DPI), 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 DPI, 2008).

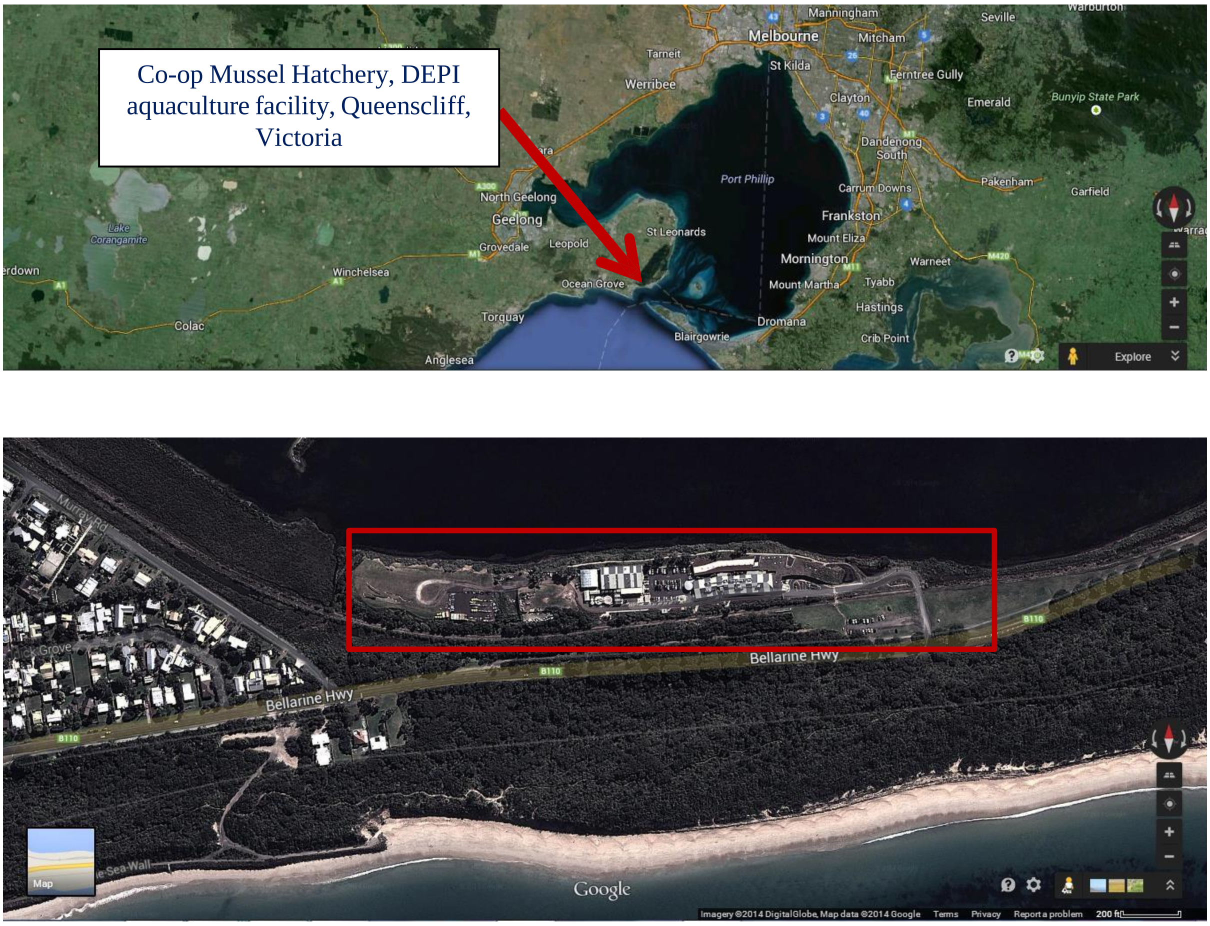

Figure 13 - Victorian DEPI marine research facility and co-op mollusc hatchery (Google Earth)

Mussel production in Victoria dropped to around 450t per annum by 2008. 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.

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 a co-operative "entity", called the Victorian Shellfish Company and entered a five year agreement with the Victorian state government. The government had an aquaculture and marine research facility at Queenscliff. The mussel hatchery has a steering committee made up of DEPI scientists / representatives, hatchery staff and mussel industry co-op company representatives. The steering committee meets a couple of times a year to work out production targets and research priorities, and to decide how best to utilise the resources available.

DEPI upgraded the facility and fitted it out with the tanks and equipment required for a mollusc hatchery, at a cost of approximately $500,000 (initial cost of $250,000 for the hatchery, but there was an additional $200,000-250,000 for the nursery and other equipment and infrastructure). The government then leased the facility to the co-op. The co-op provided a manager and technicians to run the mussel hatchery, whilst the Victorian government provided technical support for resolving issues and R&D, through its aquaculture staff and research scientists.

The mussel hatchery is approximately 15 x 15m with 8 x 400L larval rearing tanks and the nursery is around 15 x 10m, with 8 x 5t settlement tanks. 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. There are no seaweed build-ups near the intake year.

Figure 14 - Queenscliff mussel hatchery 5t settlement tanks (DEPI**)**

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

Two companies dropped out of the co-op and there are now 3 companies that form the co-op. The hatchery produces 400-500 million mussel spat per year. Industry is back up to around 1,000-1,200t p.a.. 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. Surplus spat are sold to other Victorian farmers, or interstate, at commercial rates.

The hatchery needs to run all year, to keep staff. Good, well-trained experienced staff are the key to a successful mollusc hatchery. The Victorian Shellfish Hatchery is now starting to produce flat oysters (*Ostrea angasi*) and considering scallop spat production (*Pecten fumatus*). 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 the DEPI, with the objective of improving economically important traits. Already they are reporting improvements to growth rates. The grow-out production time has 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. Overall the government – industry collaboration to support the development of a mollusc hatchery in order to sustain and expand the mussel industry in Victoria has been a resounding success.

4 Study Findings

4.1 Spat Requirements

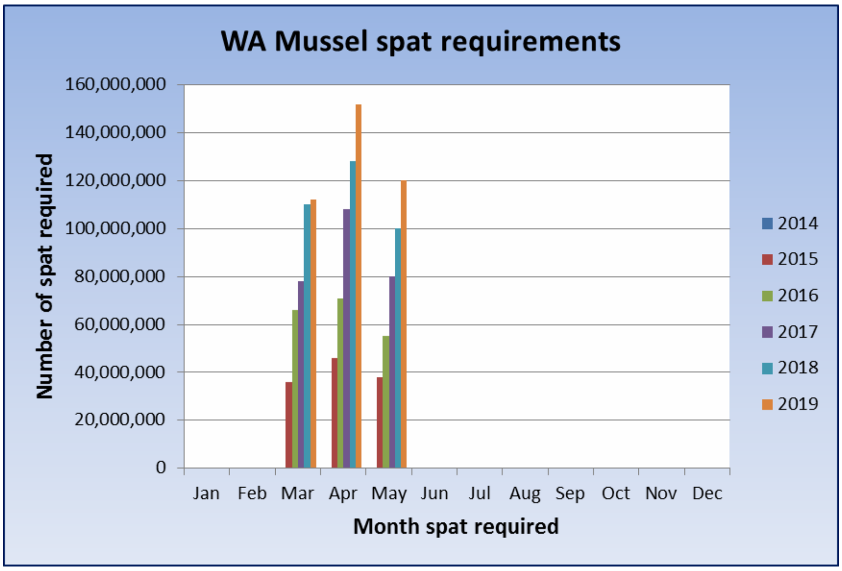

Figure 16 - Mussel hatchery forecast spat requirements for WA

At an estimated survival rate of 10% (based on Victorian figures) and a harvest weight of 25g the mussel spat requirements are 120 million in year 1 building up to 384 million in year 5 (Table 5 & Figure 16). It is fairly optimistic expecting the hatchery to produce over 100 million mussel spat in year 1. Production in year 1 will be influenced by the site selected, quality and design of the facility and fit-out, staff experience and site / system specific knowledge.

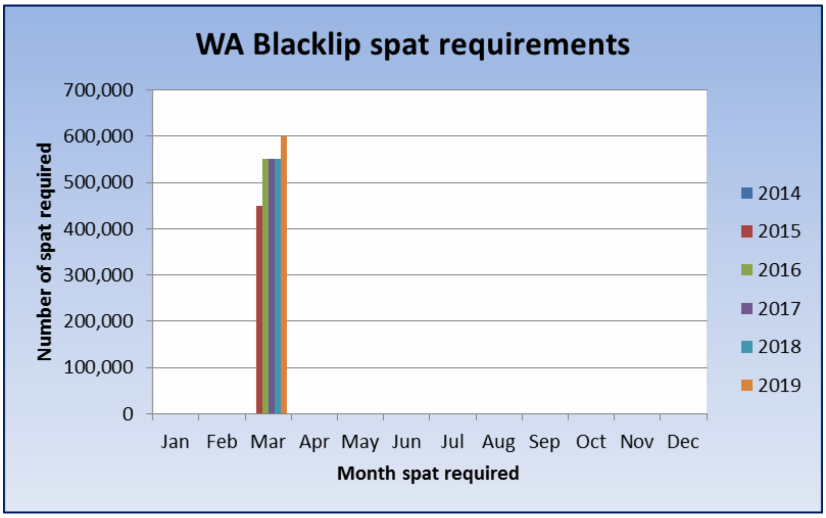

Figure 17 - Blacklip pearl oyster forecast spat requirements for WA, preferred timing

The companies with Blacklip pearl oyster spat requirements that were identified in the study are all from the Abrolhos Islands. Blacklip spat requirements begin in year 1 (2015) with 450,000 spat per year and increase over a five year period to around 600,000 spat per annum (Table 5 & Figure 17).

The companies with Akoya spat requirements that were identified in the study are based in the Abrolhos Islands and also in Albany. Akoya spat requirements begin at around 190,000 spat per year and increase up to around 310,000 spat per annum in year five (2019) (Table 5 & Figure 18).

WA Mollusc spat forecast requirements **Forecast Schedule, June 2014**													
Forecast number of spat required per month (**Mussels**) - **ALL companies**													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (m)
2014	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	36,000,000	46,000,000	38,000,000	0	0	0	0	0	0	0	**120,000,000**
2016	0	0	66,000,000	71,000,000	55,000,000	0	0	0	0	0	0	0	**192,000,000**
2017	0	0	78,000,000	108,000,000	80,000,000	0	0	0	0	0	0	0	**266,000,000**
2018	0	0	110,000,000	128,000,000	100,000,000	0	0	0	0	0	0	0	**338,000,000**
2019	0	0	112,000,000	152,000,000	120,000,000	0	0	0	0	0	0	0	**384,000,000**
Forecast number of spat required per month (**Blacklip**) - **ALL companies**													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (m)
2014	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2015	0	0	450,000	0	0	0	0	0	0	0	0	0	**450,000**
2016	0	0	550,000	0	0	0	0	0	0	0	0	0	**550,000**
2017	0	0	550,000	0	0	0	0	0	0	0	0	0	**550,000**
2018	0	0	550,000	0	0	0	0	0	0	0	0	0	**550,000**
2019	0	0	600,000	0	0	0	0	0	0	0	0	0	**600,000**
Forecast number of spat required per month (**Akoya**) - **ALL companies**													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (m)
2014	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2015	0	0	190,000	0	0	0	0	0	0	0	0	0	**190,000**
2016	0	0	190,000	0	0	0	0	0	0	0	0	0	**190,000**
2017	0	0	290,000	0	0	0	0	0	0	0	0	0	**290,000**
2018	0	0	290,000	0	0	0	0	0	0	0	0	0	**290,000**
2019	0	0	310,000	0	0	0	0	0	0	0	0	0	**310,000**
Forecast number of spat required per month (**Rock Oyster**) - **ALL companies**													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (m)
2014	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2015	2,222,222	2,222,222	2,222,222	0	0	0	0	0	0	0	0	0	**6,666,667**
2016	2,777,778	2,777,778	2,777,778	0	0	0	0	0	0	0	0	0	**8,333,333**
2017	3,333,333	3,333,333	3,333,333	0	0	0	0	0	0	0	0	0	**10,000,000**
2018	4,444,444	4,444,444	4,444,444	0	0	0	0	0	0	0	0	0	**13,333,333**
2019	5,555,556	5,555,556	5,555,556	0	0	0	0	0	0	0	0	0	**16,666,667**

Table 5 - Forecast mollusc spat requirements for WA, preferred timing

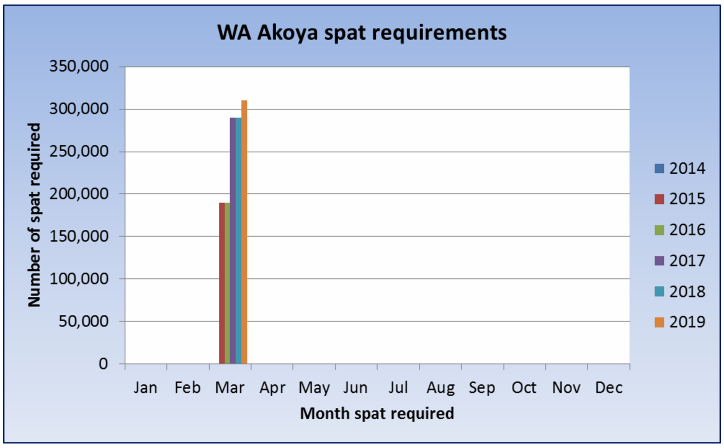

Figure 18 - Akoya pearl oyster forecast spat requirements for WA, preferred timing

Edible oyster spat requirements have been estimated at around 6 million per year in 2015 up to 16 million per year in 2019. The oysters are Sydney Rock Oysters (*Saccostrea glomerata*), sometimes referred to as Western Rock

Oysters. There is interest amongst some companies in the Abrolhos Islands and Shark Bay area to trial edible oyster production.

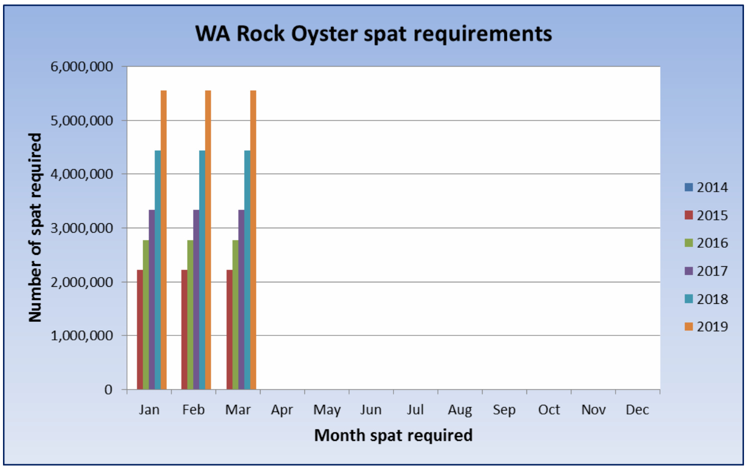

Figure 19 - Rock Oyster forecast spat requirements for WA, preferred timing

Even when combined the non-maxima pearl oyster spat requirements are relatively small at 640,000 per year in year 1 up to 910,000 p.a. in year 5. A medium-sized maxima pearl oyster hatchery will produce 3+ million spat per batch. Without significant expansion of the non-maxima industry a stand-alone hatchery for Blacklip and Akoya is highly unlikely to be an economically viable option. Non-maxima hatchery spat production should be combined with other species of molluscs to share the capital investment and operating costs.

The oyster and mussel spat requirements are relatively low in the first few years of production, when taken on their own. Oyster hatcheries in Tasmania can produce 30 million spat per production batch, and 100+ million spat per year, whilst the Victorian mussel hatchery can produce around 100 million per batch and 400 – 500 million spat per year. Combining spat requirements for oyster, mussels and non-maxima pearl oysters makes a lot of sense from a business perspective, in order to share resources and lift spat requirements up to a high enough volume to reach economy of scale.

Scallop requirements are estimated to be around 15 million spat per year for a 3 – 5 year R&D program for the purposes of this study. The spat will be deployed at various times of the year whilst controlled deployment and genetic markers used for monitoring recapture rates will attempt to determine the optimum time of year, spat size, bottom type, depth etc. for scallop spat deployment.

4.2 Spat timing

The natural spawning times for each of the WA mollusc species of interest to this study are in Figure 20. These spawning times are from discussions with the various parties from the mollusc aquaculture sector that have taken part in this study.

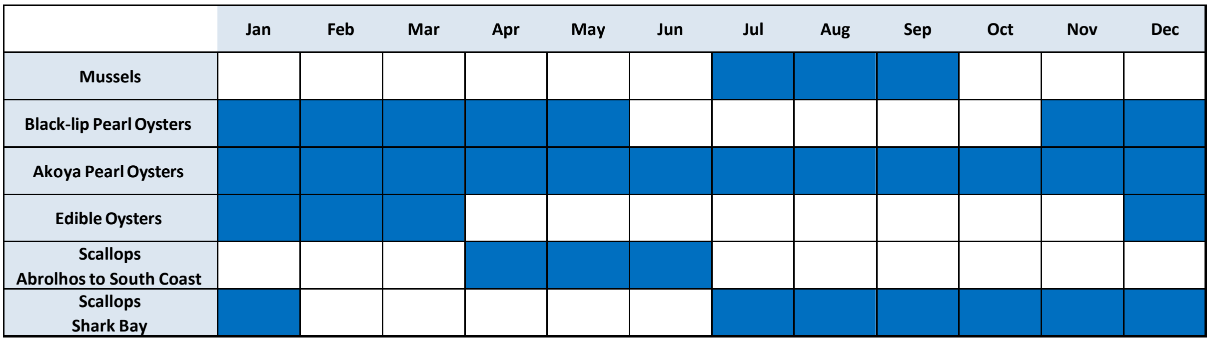

Figure 20 - Natural spawning windows for non-maxima WA mollusc species of commercial interest

There is a relatively good spread across the year for natural spawning times. However, mussel producers would like to see mussels being spawned out-of-season and spat deployed earlier in the year, around March – April - May (Figure 21). Most Blacklip and Akoya producers have indicated they would prefer their spat around March/April. 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 hatchery producing mussels, oysters and non-maxima pearl oysters in the February, March, April period.

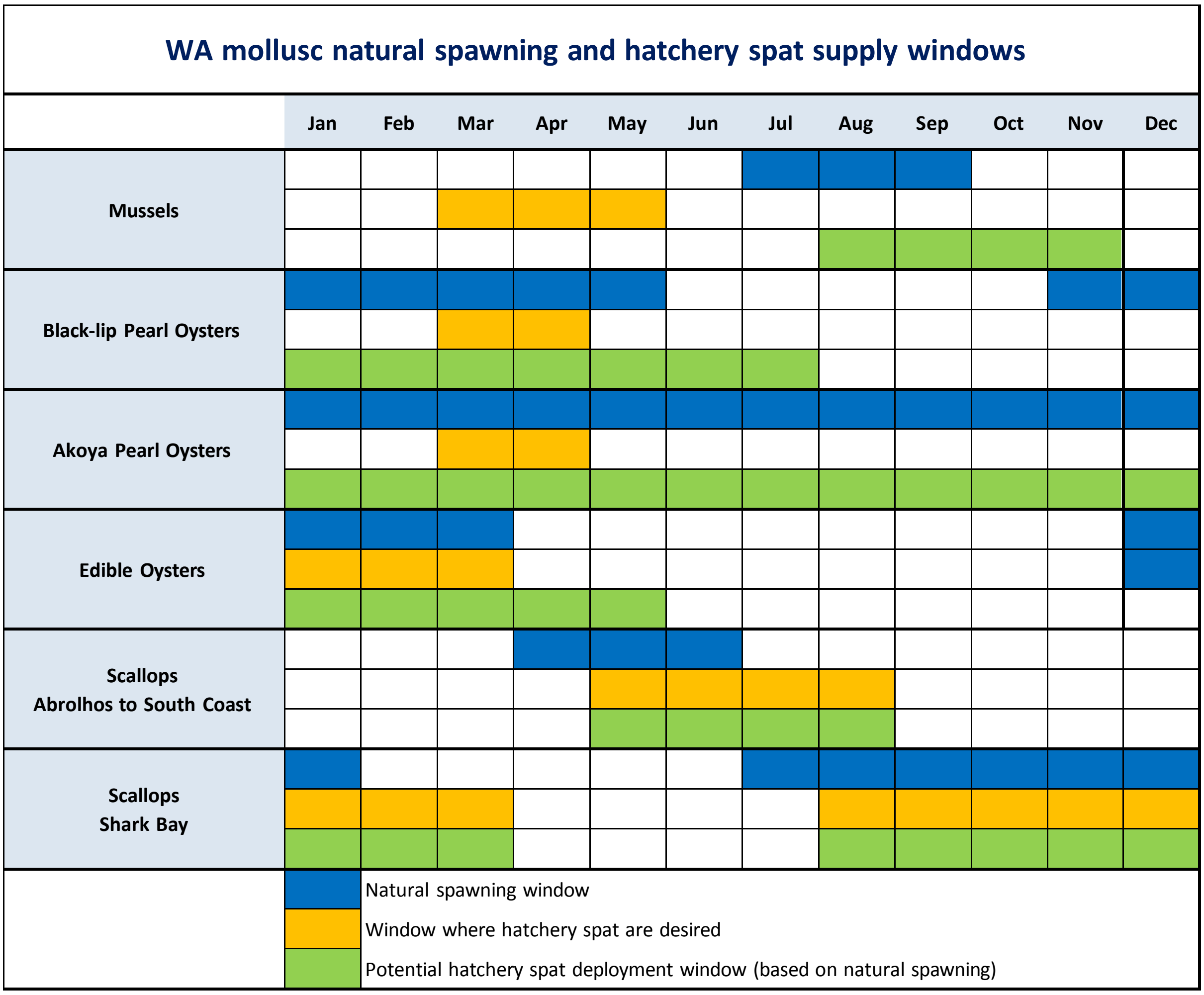

Figure 21 - WA mollusc spawning and hatchery spat supply preferred timing

The bottleneck can be mitigated if the deployment times are moved around, with some of the mussel production moving later to 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 than autumn. The non-maxima pearl oyster spat production could potentially be moved back from a March / April to April / May deployment (Figure 22). The scallop spat production is part of an R&D program that is likely to be based at an alternative facility.

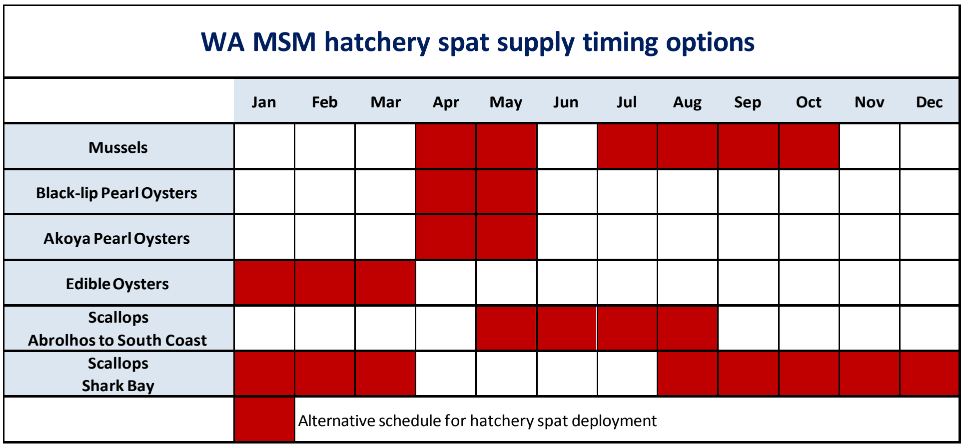

Figure 22 - WA multi-species mollusc hatchery alternative schedule for spat deployment

4.3 Economics

Mollusc hatchery operating costs in Western Australia are likely to be approximately $400,000 - $500,000, for a small- medium sized hatchery. Approximately $350,000 in operating costs would be about the minimum you could run a small hatchery throughout the year, for one or two species. Getting the hatchery systems set up and running smoothly will take a year or two, during which time a hatchery requires a higher labour component compared to when it is up and running and in a steady state. Labour is estimated to be approximately $250,000 - $315,000 for a small – medium sized mollusc hatchery, assuming 3-4 FTE, plus 1 casual employee. Including on-costs of 25% (super, LSL, leave loading, PRT etc.) this is between $310,000 – 390,000. Labour costs are generally around 70% of a mollusc hatchery's operating costs.

For a medium to relatively large size multi-species hatchery, running up to four different mollusc species, running throughout the year and with significant post-settlement / pre-nursery requirements the labour costs could be between $400,000 and $520,000 per year plus on-costs, assuming between 5 - 7 FTE and 2 – 3 casual employees. The operating costs for this type and size of hatchery are estimated to be between $650,000 – 900,000. Again these costs are highly dependent on the nursery requirements, species and site specific costs.

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 and evenness of spread – running species in parallel may mean increasing staff levels and require more tanks, equipment and infrastructure
- Lease and services cost
- Hatchery location ambient temperatures (power – heating and cooling water and buildings)
- Levels of automation / efficiency gain measures

- Post settlement / “pre-nursery” requirements
- Breeding Program size and scope
- R&M levels - age of facility infrastructure, tanks and equipment
- Depreciation
- Interest / cost of capital

The operating costs for a multi-species hatchery in WA are likely to be for a small-medium or medium size hatchery initially, based on spat requirement forecasts from this study, or between $450,000 - 650,000.

The capital costs are highly site specific, being dependent on buildings, infrastructure, tanks and equipment. Capital costs are likely to be around $400,000 - 500,000, for building refurbishment, water filtration, water delivery, tanks, algae production system (autoclave, pasteuriser, carboys, bag system, lights etc.), temperature control systems (air and water), poly-tunnels etc.. The capital costs could be lower at around $250,000 for a facility that is in fairly good condition and well-appointed, or they could be as high as $1,000,000 for a facility that is in disrepair and requires significant capital works (water intake, water treatment, buildings etc. etc.).

Indicative spat prices are based on recent industry prices except for scallops which do not have an industry price. There are no commercial scallop spat prices available for *Amusium 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 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 $27 per 1,000 spat ($0.27 per spat) for Sydney Rock Oysters at around 3.5mm screen size (J Bilton 2014 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.).

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 of the business for consistent production, or highly efficient production. Therefore the most common model in aquaculture, whether fish, crustaceans or molluscs, is some kind of vertical integration of the hatchery, nursery and grow-out sections of the business. A hatchery is doing OK to break-even or to make a small profit.

ACWA multi-species mollusc hatchery study, species combination options and estimated revenue from spat sales, 2014

			Estimated hatchery spat sales ($)				
Multi-species hatchery combination			**2015**	**2016**	**2017**	**2018**	**2019**
Mussel			$ 116,000	$ 188,000	$ 262,000	$ 336,000	$ 380,000
	Blacklip & Akoya		$ 118,500	$ 138,500	$ 153,500	$ 153,500	$ 166,500
		Oyster	$ 180,000	$ 225,000	$ 270,000	$ 360,000	$ 450,000
Mussel	**Blacklip & Akoya**		$ 234,500	$ 326,500	$ 415,500	$ 489,500	$ 546,500
Mussel		**Oyster**	$ 296,000	$ 413,000	$ 532,000	$ 696,000	$ 830,000
	Blacklip & Akoya	**Oyster**	$ 298,500	$ 363,500	$ 423,500	$ 513,500	$ 616,500
Mussel	**Blacklip & Akoya**	**Oyster**	$ 414,500	$ 551,500	$ 685,500	$ 849,500	$ 996,500

Figure 23 - WA mollusc hatchery species combination options and estimated revenue from spat sales

Figure 23 shows the estimated revenue from spat sales for stand-alone and multi-species mollusc hatchery options. These estimates are based on current spat prices, however it should be noted that the current spat prices for Blacklip and Akoya may not be sustainable.

It is assumed that the WA mollusc hatchery this study is investigating the need for should be cost-neutral at minimum or profitable if possible. The matrix shows that running a hatchery for a single species in WA will not be an economically viable proposition for the first 4 years at the forecast levels - if relying on spat sales revenue alone to cover operating costs. The oyster hatchery may be able to break-even at around 12 – 15 million spat per year, and the mussel hatchery could potentially break even at around 400 million spat, if the hatchery can keep operating costs below $350,000 – 400,000 per year.

Running both edible oysters and mussels in a hatchery looks to be a good option, potentially covering operating costs with spat sales revenue by between years 2 and 3, using the assumptions from this study. The Mussel and Blacklip & Akoya combination and Oyster and Blacklip & Akoya combination in the matrix show breakeven somewhere between years 3 and 4, using the assumptions from this study. The best scenario would be a multi-species hatchery could run all three species, assuming that the spat production could be spread throughout the year fairly evenly to maximise efficient use of resources. And assuming all other risks and issues could be covered, such as live transport of broodstock and spat and biosecurity.

Species	**Mussel**	**Black-lip Pearl Oyster**	**Akoya Pearl Oyster**	**Rock Oyster**	**Scallop**	**Total**
Estimated Spat Requirements (millions)						
2015	120,000,000	450,000	190,000	*6,666,667*	*15,000,000*	
2016	192,000,000	550,000	190,000	*8,333,333*	*15,000,000*	
2017	262,000,000	550,000	290,000	*10,000,000*	*15,000,000*	
2018	*338,000,000*	550,000	290,000	*13,333,333*		
2019	*384,000,000* 220%	600,000 33%	310,000 63%	*16,666,667* 150%		
Indicative spat price	$ 0.001	$ 0.200	$ 0.150	$ *0.027*	$ 0.004	
Estimated hatchery spat sales ($)						*excluding scallops*
2015	$ 120,000	$ 90,000	$ 28,500	$ *180,000*	$ *60,000*	**$ 418,500**
2016	$ 192,000	$ 110,000	$ 28,500	$ *225,000*	$ *60,000*	**$ 555,500**
2017	$ 262,000	$ 110,000	$ 43,500	$ *270,000*	$ *60,000*	**$ 685,500**
2018	$ 338,000	$ 110,000	$ 43,500	$ *360,000*	$ -	**$ 851,500**
2019	$ 384,000	$ 120,000	$ 46,500	$ *450,000*	$ -	**$ 1,000,500**
Estimated survival to market size	10%	5%	11%	*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*)	$ 3.80 /Kg	$ 24.00 /p	$ 8.78 /p	/Kg	$ 35.00	
Estimated gross product value ($/animal)	$ 0.10	$ 24.00	$ 8.78	$ *0.42*	$ 0.53	
Estimated production increase (Kg, animals or saleable pearl pieces)						
2015	300,000	22,500	20,900	*4,000,000*	11,250	
2016	480,000	27,500	20,900	*5,000,000*	11,250	
2017	655,000	27,500	31,900	*6,000,000*	11,250	
2018	*845,000*	27,500	31,900	*8,000,000*	-	
2019	*960,000*	30,000	34,100	*10,000,000*	-	
Estimated GVP from hatchery spat year produced						*excluding scallops*
2015	$ 1,140,000	$ 540,000	$183,502	$ *1,666,667*	$ 393,750	**$ 3,530,169**
2016	$ 1,824,000	$ 660,000	$183,502	$ *2,083,333*	$ 393,750	**$ 4,750,835**
2017	$ 2,489,000	$ 660,000	$280,082	$ *2,500,000*	$ 393,750	**$ 5,929,082**
2018	$ 3,211,000	$ 660,000	$280,082	$ *3,333,333*	$ -	**$ 7,484,415**
2019	$ 3,648,000	$ 720,000	$299,398	$ *4,166,667*	$ -	**$ 8,834,065**
Estimated cost of spat per market size product	$ 0.01	$ 4.00	$ 1.36	$ 0.05	$ 0.08	
Estimated cost of spat (% of GVP)	10.5%	16.7%	15.5%	*10.8%*	15.2%	

Table 6 - WA multi-species mollusc hatchery economic overview (estimated)

Market prices for mussels, oysters and scallops are based on current commercial wholesale prices. The prices for Blacklip and Akoya 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 (Table 7). The Akoya average pearl price from the FRDC report in 2010 has been used as an assumption for this study.

Revenue per seeded Akoya oyster in FRDC project was calculated to be $3.10 (Cropp 2010), when rejects / non-saleable pearls were included. It is difficult to see how an Akoya business would be profitable at this price, considering it costs around $2.00 per oyster to seed and $1.36 in spat costs per pearl harvested ($0.15 x (1/11%). This leaves very little for operating costs for the 36 – 42 month grow-out time from spat deployment to pearl harvest.

	Price				Number Harvested				Value				Total Value
Pearl Size	A	B	C	D	A	B	C	D	A	B	C	D	
6.0-6.4	15	10	5	0	1	12	73	47	$ 15	$ 120	$ 365	$ -	**$ 500**
6.5-6.9	20	13	10	0	5	41	233	77	$ 100	$ 533	$ 2,330	$ -	**$ 2,963**
7.0-7.4	25	18	11	0	4	26	211	51	$ 100	$ 468	$ 2,321	$ -	**$ 2,889**
7.5-7.9	35	22	13	0	3	11	59	20	$ 105	$ 242	$ 767	$ -	**$ 1,114**
8.0-8.4	40	24	12	0		7	11	5	$ -	$ 168	$ 132	$ -	**$ 300**
8.5-8.9	45	30	18	0		2	5	3	$ -	$ 60	$ 90	$ -	**$ 150**
9.0-9.4	55	33	19	0		1	1	1	$ -	$ 33	$ 19	$ -	**$ 52**
9.5-9.9	70	36	23	0					$ -	$ -	$ -	$ -	**$ -**
10.0-10.4	100	39	24	0					$ -	$ -	$ -	$ -	**$ -**
													$ 7,968

Table 7 – Pearl prices, numbers, grades harvested from 2,585 Akoya seeded, FRDC Project 2007/216 (Cropp 2010)

Estimated survival / success rates from spat deployment to harvest of a saleable pearl for Akoya are assumed to be around 11% (Table 8). Estimated mortality rates and cumulative survival rates assumptions are shown below in Table 8. The survival / success rates from spat deployed to saleable Blacklip pearl is estimated to be 5%, based on industry figures provided. This survival / success rate is comparable to the survival / success rate from spat to saleable pearls for the maxima industry.

Pearl Oyster Production phase	Mortality / pearl rejection rate	Cumulative Mortality	Cumulatitve survival
Nursery	50%	50%	50%
Grow-out	35%	68%	33%
Seeding - Nucleus rejection rate	12%	71%	29%
Seeding - Post-op mortality	15%	76%	24%
Pearl culture	33%	84%	16%
Pearl rejection rate (non-saleable)	32%	89%	**11%**

Table 8 - pearl oyster "survival" rates / saleable pearl production rates - spat deployed to saleable pearls

The spat cost as a % of gross product value at market is highly dependent on market price of the final product. If the Akoya average pearl price is around the average of $9 per pearl price point stated in the FRDC report from 2010, then the reported Akoya spat price of $0.15 is potentially around 50% above the estimated expected price, which is around $0.10 based on other mollusc industry sector's % spat cost relative to gross product value at market.

The Blacklip spat price also appears to be high in comparison with other mollusc sectors based on % spat cost relative to gross product value, with Blacklip 16.7% compared to 10.8% for mussel and oyster. A spat cost at 10.8% of Blacklip GVP at the assumed survival rates and market prices would be around $0.13 per spat, compared to the current Blacklip spat price of $0.20 each. Some of the non-maxima pearling companies have indicated the spat price is too high, but without any choice of spat suppliers they are price-takers. Taking another perspective - the hatchery producers have been producing for a very small market, so cannot gain economy of scale. From the non-maxima hatchery perspective the price is perhaps arguably fair and reasonable.

4.4 Schedule

The forecast schedule for the project is shown in Figure 25. The schedule 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 schedule shows a scenario where first spat production from the hatchery (or hatcheries) is in late 2015 / early 2016, depending on the speed of decision-making and the extent of capital works the selected facility requires.

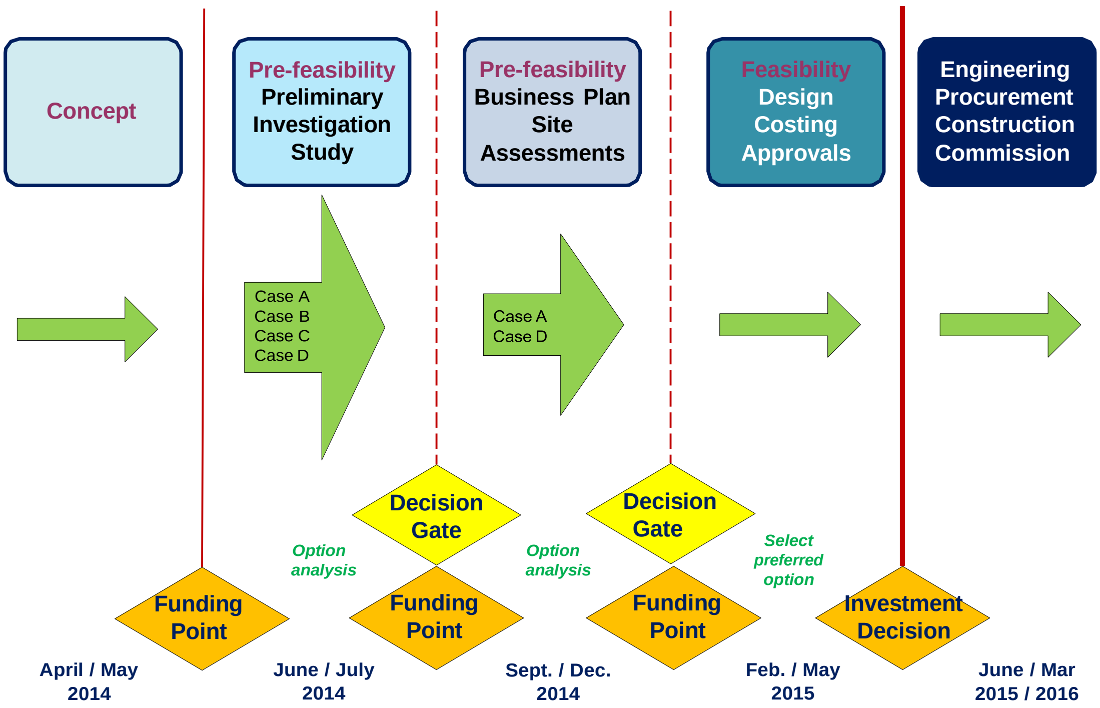

Figure 25 – WA multi-species mollusc hatchery schedule chart ("brown field" site with capital works required)

Timing for getting spat production underway at the multi-species mollusc hatchery is also highly dependent on site specific factors of the facility that is selected. An existing mollusc hatchery that is already fitted out and operational could produce spat earlier than indicated in the schedule Figure 25, potentially in early 2015 if business negotiations were to run smoothly and efficiently (Figure 26). The study is focusing on either existing operating hatcheries or "brown field" sites, as opposed to "green field" sites, in order to minimise time elapsed until spat production can begin.

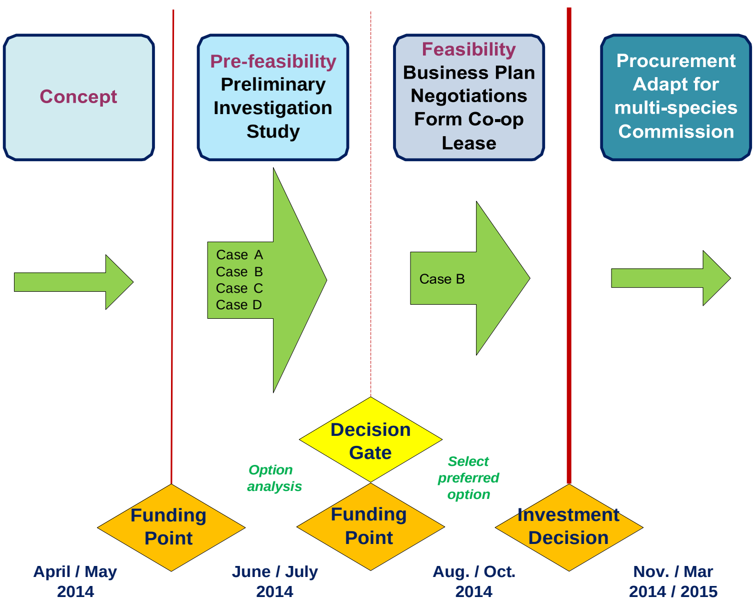

Figure 26 - WA multi-species mollusc hatchery schedule chart (existing operational mollusc hatchery)

The final Feasibility Study will be conducted on the preferred option, studying and establishing:

- All the project risks, including agreed mitigation measures to control any critical risks
- Detailed design and costing
- The detailed engineering scope of the project
- The likely Capital and Operating costs, developed to an agreed methodology and an accuracy of nominally ±10-15%
- The project schedule and detailed plans necessary to meet the schedule
- The organisational structure of the MSM Hatchery required to deliver the project
- Identifying key staff and contractors

This work will be conducted in parallel to:

- The preparation of the Environmental Impact Statement (EIS) and supporting baseline environmental studies and other submissions to Govt to secure project Approvals

5 Mollusc Hatchery Requirements & Potential Sites

5.1 Water quality requirements

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. This scope of this study does not include an in-depth analysis of the water quality at the various sites across the state. Basic, fundamental water quality aspects have been outlined where possible in this broad preliminary scan of the potential sites.

The water supply of a mollusc hatchery should be:

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

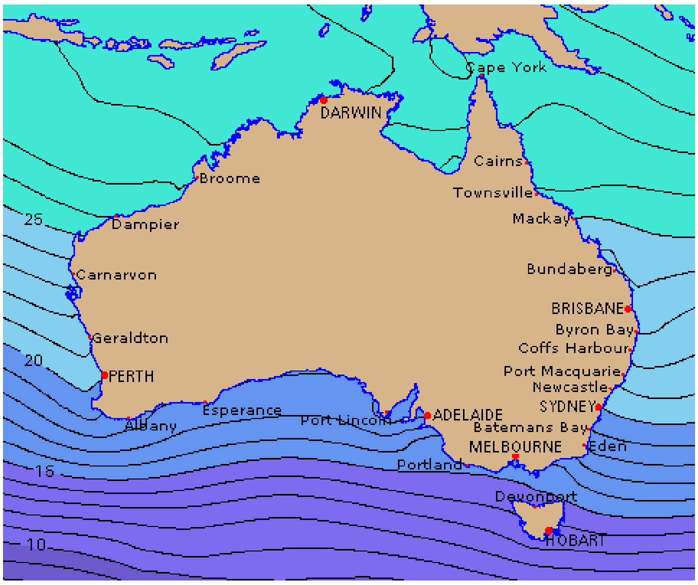

Figure 28 - Australian coastal sea surface average monthly temperatures (Navy METOC)

Ambient water and air temperature of the hatchery site will affect the operating costs through heating and cooling of the water for the hatchery. It will be difficult to find the perfect balance as the oyster culture temperatures will be around 25 – 26°C and the mussel hatchery culture temperatures are generally around 16 - 18°C. The mussel optimal hatchery culture temperature may be a couple of degrees higher for WA strains of mussels - 18 - 20°C perhaps. Early replicated trials can determine the optimal culture temperature range.

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. For mussels latitudes further south are likely to be better due to cooler ambient water temperatures being advantageous in the post-settlement / pre-deployment phase. It is worth noting that summer ambient temperatures, even in Albany, may restrict nursery production to an extent.

This study is focused mainly on existing hatchery sites, either government or commercial. 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.

More detailed investigations and analysis of site selection criteria will be carried out in the next phase, if a decision to proceed to the next phase is reached and further studies are required.

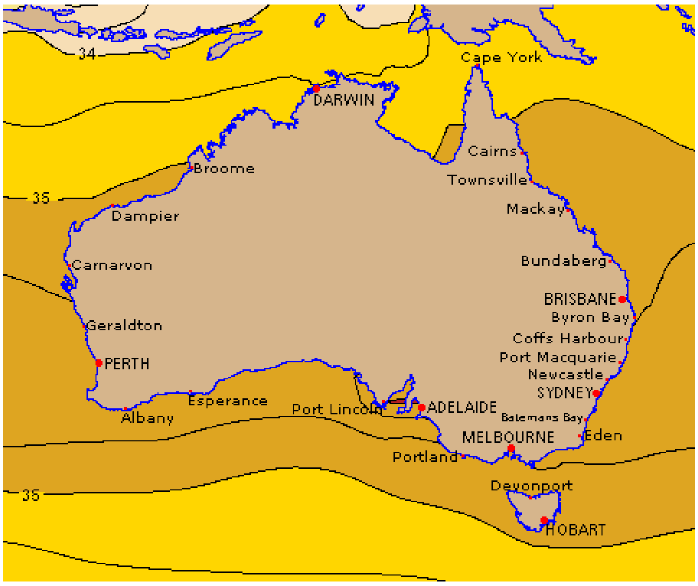

Figure 29 - Australian sea surface average monthly salinity (Navy METOC)

5.2 Site and facility requirements

"Brown field" hatchery sites, government institutes and aquaculture research facilities, and existing mollusc hatcheries have been considered as potential sites. Where possible, if the knowledge is available for the sites, the following criteria have been considered:

- Land tenure
- Water intake depth
- Water intake capacity and storage
- Filtration and temperature control
- Building and land footprints available
- Building condition
- Mains power supply and back-up
- Services
- Liveability / staff retention
- Climate – ambient temperature and rainfall
- Distance for live transport of broodstock and spat
- History of success for mollusc hatchery production

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 an advantage for the site chosen for the MSM hatchery to be Crown Land. If the lessor was the Department of Fisheries WA, that would also be advantageous.

Similar to the Victorian mollusc hatchery, the State government could assist in setting up the facility and providing a secure lease to a co-operative industry company / entity on terms favourable to industry development. If the site is owned or leased by a mollusc company, risks of conflicts of interest, equitable allocation of resources and balance of power should be carefully considered.

A good seawater intake is an important asset for a potential site, as they are often very expensive to install. Mollusc hatcheries use relatively large volumes of water and require filtration down to 1 micron in the hatchery for larviculture, pre-settlement. Water storage is useful in case of temporary issues with water supply – mechanical or water quality 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 should carry a high weighting.

Without proper care in a nursery phase of production, the survival through early grow-out and beyond can be seriously compromised. A pre-deployment land-based nursery (or "pre-nursery") is generally required for rearing spat post-settlement 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. An ocean-based "post-nursery" can be used to ensure adequate care and attention for the spat post-deployment in order to maximise survival rates.

5.3 Staff 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 FTE and one casual employee, a medium hatchery 4-5 FTE and one or two casual employees whilst a large hatchery will require around 7 or more FTE and three or more casuals. The hatchery must aim to operate throughout the year (9 – 10 months production, 2 – 3 months of dry-outs) in order to be able to retain a core team of experienced highly skilled staff.

It is likely that there is enough mollusc experience in Australia to manage a facility in WA competently, if the remuneration is attractive enough for persons with the requisite experience and skills to relocate from Eastern States. Most mollusc experience has been gained in Tasmania, Victoria and New South Wales, and to a lesser extent South Australia. Some individuals also have overseas experience.

Recent experience and trends from aquaculture operators in Queensland point towards problems for the future in finding the next generation for the industry, with fewer and fewer young people choosing to dedicate their careers to aquaculture. Prawn farms in Queensland have started to employ experienced foreign workers on 457 visas as technicians for hatcheries and farms.

5.4 Potential Site characteristics

Multi-species mollusc hatchery potential sites

Potential hatchery facility		888 Abalone	Ocean Foods oyster hatchery	Fisheries site - old Abalone Hatchery	Australian Centre for Applied Aquaculture Research (ACAAR)	Watermans Centre	DoFWA Hillarys Aquaculture facility	Batavia Coastal Maritime Institute (BCMI)	Abrolhos Islands	MG Kailis Hatchery	Manbana Hatchery
Location		Bremer Bay	Albany	Albany	Fremantle	Perth	Perth	Geraldton	offshore Geraldton	Exmouth	Broome
Criteria	Desired range										
Water quality (raw, pre-treatment)											
Water type	Coastal	Coastal	Coastal	Coastal	Estuarine (&bore)	Coastal	Coastal	Coastal	Oceanic	Coastal	Coastal (& bore)
Salinity (ppt)	33-37	34-37	34-37	34-37	34-37	34-37	34-37	35-37	35-37	32-38	30-36
Nutrient levels	low	Low	Low	Low	medium	Low-medium	Low-medium	Low-medium	Very low	Low	Low-medium
Suspended solids	low	Low	Low	Low	medium	Low	Low	Low	Very low	low-medium	High
Overall variability	low	Low	Low	Low	Variable	low-medium	low-medium	low-medium	Very stable	Stable	medium
Distance from significant rivers (km)	10+*	*4*	10	10	0	20	>20	>20	>20	>20	>20
Overall WQ	Good	Good	Good	Good	Potential issue	OK	OK	Serious issue?	Excellent	Good	Potential issue?
WQ Comments		Reported to be good	Reported to be good	Reported to be good	Seawater and borewater WQ is not ideal. SW variable, bore has low pH	Generally good	Generally good. History of hatchery production of abalone	H2O2 from dead seaweed / design flaw?	Pristine oceanic "bluewater"	Good WQ most of the time. Can become turbid	Less than ideal. Turbid seawater. Borewater no good
Infrastructure / Tenure											
Land tenure	Crown / Govt.	Govt. & freehold	Govt.	Govt.	Govt.	Govt.	Govt.	Govt.	Govt.	Govt.	Govt.
Lessor	DoFWA		DoFWA	DoFWA	Challenger TAFE	?	DoFWA	BCMI	?	DoD	DoFWA / DoT
Lessee	Nil	888 Abalone	Ocean Foods Int.	Nil	Challenger TAFE		DoFWA	BCMI	NA	MG Kailis	Ocean & Earth
Water intake depth	>8	10	5 - 6	NA	NA				NA	5-6m	
Water intake capacity / day (m3)	500+	86,400,000	144,000	NA	4,320,000		1,680		NA	1,200	
Water storage / settlement capacity (m3)	500+	20	0	NA	20		150		NA	500	
Water filtration (microns)	1	1	1	NA	5		5		NA	1	
Water temperature control	Heat and Cool	Heat & cool	Heat & cool	NA	no (18-22)		Heat & cool		NA	Heat and Cool	
Building footprint (hatchery area m2)	300+	~50	~400	~500	~2,340	~300?	~300?	~600?	NA	750	300?
Land footprint (approx. m2)	300+	~12,000	1,500+	1,500+	2,000+	~300?	~300?	~1000?	NA	7,000	1,200
Building condition	Good		Needs some work	run-down	Old but OK	Undergoing re-furbishment	Very good	Good?	NA	run-down	Structural issues. Very run down
Mains Power	Yes	Yes	Yes	Yes?	Yes	Yes	Yes	Yes	No	Yes	Yes
Back-up power supply	Yes	Yes	No	?	Yes	Yes?	Yes?	Yes?	NA	Yes	?
Comments		Abalone hatchery. No spare hatchery space currently	Not currently operating	Hasn't operated for many years. Reportedly run-down and no SW intake line	No seawater intake, only bore. Good services otherwise. Plenty of space	Centrally located. Research focus. Space limited	Centrally located, good design and layout. 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	Good site but infrastructure run-down. Potnetial issues with DoD lease	Very poor hatchery design. Limited space assigned to hatchery

Table 9 - Potential multi-species hatchery site criteria and characteristics

Table 9 and Table 10 show multi-species mollusc hatchery criteria used in this study and 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.

Potential hatchery facility		Ocean Foods oyster hatchery	Ocean Foods oyster hatchery	Fisheries site - old Abalone Hatchery	Australian Centre for Applied Aquaculture Research (ACAAR)	Watermans Centre	DoFWA Hillarys Aquaculture facility	Batavia Coastal Maritime Institute (BCMI)	Abrolhos Islands	MG Kailis Hatchery	Manbana Hatchery
Location		**Albany**	**Albany**	**Albany**	**Fremantle**	**Perth**	**Perth**	**Geraldton**	**offshore Geraldton**	**Exmouth**	**Broome**
Criteria	**Desired range**										
Services											
Distance from domestic airport (km)	**<50**	200	30	30	27	26	30	12	85 (SEA/AIR)	5	8
Distance to nearest airstrip / aerodrome	**<50**	6	30	30	16	26	30	12	0 - 20 (SEA)	20	8
Distance to town	**<50**	3	20	20	1	1	1	1	*50* (SEA/AIR)	35	8
Science support services	**Good**	None	Minimal	Minimal	Good	Good	Good	Limited	none (Geraldton)	None	Limited
Engineering support and supplies	**Good**	Limited	OK	OK	Excellent	Excellent	Excellent	Good	none (Geraldton)	Limited	Limited
Livability	**Good**	Remote	OK	OK	Excellent	Excellent	Excellent	OK	Remote	Small town	Remote
Staff stability / skills retention	**High**	Low	Medium	Medium	High	High	High	Medium	Low	Medium	Medium
Ease of managing hatchery production	**High**	Low-medium	Medium	Medium	High	High	High	Medium	Low	Medium	Medium
Ease of managing R&D programs	**High**	Low	Medium-low	Medium-low	High	High	High	Medium	Low	Low	Low
Facility staffed	**Yes**	Yes	No	No	Yes		Yes	Yes	No	No	No
Facilities serviced and maintained		Yes	No	No	Yes	Yes?	Yes	Yes	No	No	No
Environmental / Climate											
Annual Rainfall (mm) (*BOM*)	*	*928*	928	928	732	732	732	442		264	612
Mean annual min. / max. air temp. (°C) (*BOM*)	**species specific**	*11.7 - 19.5*	11.7 - 19.5	11.7 - 19.5	12.7 - 24.7	12.7 - 24.7	12.7 - 24.7	13.6 - 25.9		17.7 - 31.8	21.2 - 32.2
Mean annual min. / max. water temp. (°C) (*BOM*)	**species specific**	*14 - 22*	*15 - 21*	*15 - 21*	18 - 22	14 - 26	14 - 26			19 - 30	
Successful mollusc hatchery production history	**Yes**	Yes	Yes	Yes	Some issues	Yes?	Yes	Failures	Yes	Yes	Sporadic/ Inconsistent

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

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

Table 10 - Potential multi-species hatchery site criteria and characteristics cont.

Table 11 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.

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.

Figure 30 - Australian Centre for Applied Aquaculture Research (ACAAR), Fremantle

Multi-species mollusc hatchery potential facilities transport distances (kms)

Potential hatchery facilities	Source / Destination	888 Abalone	OFI / Abalone Hatchery	ACAAR / Challenger TAFE	Watermans Centre	DoFWA Hillarys	Batavia TAFE	Abrolhos Islands	MG Kailis Hatchery	Manbana Hatchery
Location		Bremer Bay	Albany	Fremantle	Perth	Perth	Geraldton	offshore Geraldton	Exmouth	Broome
Transport of livestock										
Distance from broodstock source (Blacklip)	Abrolhos	1,000	800	400	400	400	50	50	800	1,800
Distance to spat destination (Blacklip)	Abrolhos	1,000	800	400	400	400	50	50	800	1,800
Distance from broodstock source (Akoya)	Abrolhos	1,000	800	400	400	400	50	50	800	1,800
Distance to spat destination (Akoya)	Abrolhos	1,000	800	400	400	400	50	50	800	1,800
Distance from broodstock source (Scallops)	Rotto	600	400	50	50	50	400	400+	1,200	2,200
Distance to spat destination (Scallops)	Abrolhos	1,000	800	400	400	400	50	50	800	1,800
Distance from broodstock source (Mussels)	Perth	600	400	50	50	50	400	400+	1,200	2,200
Distance to spat destination (Mussels)	Perth	600	400	50	50	50	400	400+	1,200	2,200
Distance from broodstock source (Akoya)	Albany	200	50	400	400	400	800	800+	1,600	2,600
Distance to spat destination (Akoya)	Albany	200	50	400	400	400	800	800	1,600	2,600
Distance from broodstock source (Mussels)	Albany	200	50	400	400	400	800	800+	1,600	2,600
Distance to spat destination (Mussels)	Albany	200	50	400	400	400	800	800	1,600	2,600
Distance from broodstock source (Oysters)	Albany	200	50	400	400	400	800	800+	1,600	2,600
Distance to spat destination (Oysters)	Albany	200	50	400	400	400	800	800	1,600	2,600

Table 11 - Live transport distances to and from facilities for broodstock and spat

5.5 Suitability of potential sites considered

Using the current information attained in this study, the following sites are considered *unlikely* to be suitable for a multi-species mollusc hatchery to supply mussel, edible oyster and non-maxima pearl oyster spat:

- **888 Abalone Hatchery, Bremer Bay** – Very small building footprint available, with not enough space in existing buildings. Site unlikely to be suitable due to biosecurity risks to core business

- **ACAAR Challenger, Fremantle** – Water quality is not ideal for a mollusc hatchery. The water from the ocean is of variable quality being situated at the Swan River mouth, and the bore water has a lower than optimal pH. The bore water is also likely to vary in water chemistry compared to ocean water. Significant de-risking would be required to gain confidence that the water supply was suitable for a successful commercial mollusc hatchery. The ACAAR facility may be able to carry out some mollusc R&D, for example for mussels

- **Batavia Coast Maritime Institute, Geraldton** – Multiple attempts over multiple seasons with different staff have failed to produce mollusc spat successfully. Issues with sub-optimal water quality, and / or a design flaw in water supply system, are likely to be the cause of the failures to produce mollusc spat. It has been mentioned that there are often significant build-ups of dead seaweed close to the intake. The decomposing organic matter is likely to release toxic hydrogen sulphide when it turns anaerobic. Images on Google Earth shows what appears to be large swathes of dead seaweed nearby the intake (Figure 31)

Figure 31 - Batavia Coast Maritime Institute, Geraldton WA

- **Abrolhos Islands** – the Abrolhos Islands are not suitable for large-scale mussel or large-scale edible oyster spat production destined for the South-West due to logistical difficulties, problems with staff retention and high operating costs. A small hatchery for non-maxima pearls, run with minimal labour for periods of the year, is a possible option to consider. Whilst there is a barge set up as a hatchery, there is no existing land-based hatchery facility

- **MG Kailis Hatchery, Exmouth** – the Department of Defence is the lessor. MG Kailis are unable to sub-lease the site without approval from DoD, whilst the DoD are reportedly keen on future lessees being associated with Defence activities and DoD support services, which aquaculture clearly is not. This means they may not approve the sub-lease or renew the lease that is due to come up for renewal shortly. This site in Exmouth has very good water quality and an excellent track record of spat production, but on top of land tenure issues the site is too remote for mussels and edible oyster spat for the South-West market. It could potentially supply spat to the non-maxima pearling sector.

- **Manbana Hatchery, Broome** – Clipper Pearls have registered an expression of interest to potentially supply non-maxima mollusc spat from Broome if they can obtain a lease over the Manbana hatchery in the Broome aquaculture precinct. The site is far from ideal, being poorly designed as a hatchery, supplied with water of sub-optimal quality and the water supply is also prohibitively expensive ($15.30 per kL). It is also too remote to be considered for mussels and edible oysters. It is too remote to be high up the list for potential non-maxima pearl oyster spat production sites, and there are biosecurity risks to consider. The causative agent for oyster oedema disease that has decimated maxima spat nurseries up and down the Northwest coast has yet to be identified and therefore no screening options are currently available and the disease has a poorly understood etiology.

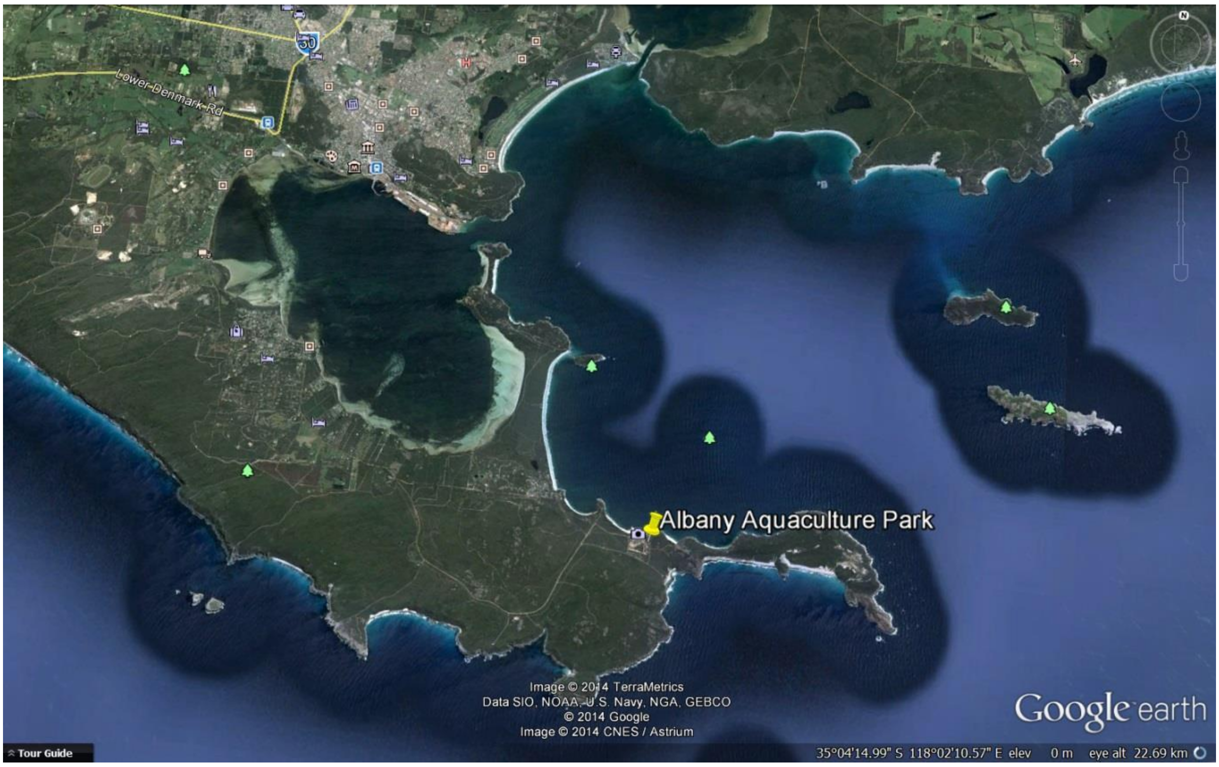

Figure 32 - Albany Aquaculture Park location in relation to Albany to the Northeast

Using the current information attained in this study, the following sites are considered likely to be the most suitable for a multi-species mollusc hatchery to supply mussel, edible oyster and non-maxima pearl oyster spat:

- Ocean Foods International oyster hatchery, Albany – Good water quality, history of successful production of mollusc spat (oysters), reasonable 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 as a business risk and the risk managed appropriatelyOld Abalone hatchery, Albany – Good water quality, successful history of producing mollusc spat (abalone), reasonable 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 OK as lessor is DoFWA and currently no lessee. Unfortunately, apparently the water intake has been removed. Building footprint is large and buildings appear in relatively good condition

- DoFWA aquaculture research facility, Hillarys Boat Harbour, Perth – Fairly good water quality. Previous successful mollusc hatchery production history with abalone (Kolkovski pers. comm.). Well-designed, well fitted out with good building condition. Fully serviced and partially staffed. Well located for scientific, technical support and R&D programs (DoFWA and universities etc.). The most suitable site for the scallop breeding, hatchery spat production and fishery enhancement research program. Hillarys is also suitable for mussel and other mollusc species R&D. The facility is space limited. There could be the capacity to carry out other mollusc hatchery production in the early stages (e.g. Mussel, Blacklip and Akoya spat), but at current size it is not big enough to become a large multi-species commercial hatchery.

- Watermans Centre, Watermans Bay, Perth - Fairly good water quality. Currently being re-fitted to carry out marine research between several institutes - DoFWA, AIMS, CSIRO and UWA. Not enough information at hand re the facility plans and mandate, water quantities, floor-space, etc. available to make a call on the potential suitability for either mollusc hatchery commercial production or R&D projects / programs. Could be suitable for mussel and other mollusc species breeding and larviculture R&D.

Figure 33 - Albany Aquaculture Park

Figure 34 - Dept. of Fisheries WA, Hillarys Boat Harbour aquaculture facility

6 Conclusions

The following is a summary of the conclusions drawn from this study:

- There is a strong and growing commercial demand for mussel, edible oyster, Blacklip and Akoya pearl oyster hatchery-produced spat. The industry is not meeting the demand for hatchery-produced mollusc spat, with no non-maxima mollusc hatcheries currently operating in WA. With no options for purchasing spat mollusc aquaculture production will decline and some sectors may risk potential collapse

- A single species hatchery is unlikely to have sufficient demand in WA for large enough volumes of spat to cover operating costs if the hatchery, if operated throughout the year. A mollusc hatchery in WA that produces at least 2 – 3 species of mollusc spat could potentially attain economy of scale. Mussels and edible oysters are a good pairing of species to share resources and form the basis of the MSM hatchery

- The Victorian Shellfish Hatchery, a government – industry co-operative initiative, has been very successful in reviving the mussel industry that was previously experiencing a precipitous decline in production. This sets a precedent for a multi-species mollusc hatchery for Western Australia

- All the aquaculture sectors involved in this ACWA study are keen to receive hatchery-produced spat as soon as possible. With this in mind the assessment of potential site options has focused on existing government and commercial aquaculture facilities and hatcheries, as opposed to green field sites

- Using an existing mollusc hatchery or aquaculture facility that has the main infrastructure in place and is already partially fitted out and in reasonable condition means production could potentially begin within 6 months – assuming all negotiations and approvals go smoothly. If there are major capital works and / or hold-ups in negotiations and approvals the process could take 12 - 18 months. A green field site is likely to take a minimum of 24 – 36 months

- The option best-suited to the scallop R&D program is the DoFWA Hillarys aquaculture facility in Perth. Using Hillarys aquaculture facility, which is operational, serviced and staffed, the scallop sector can get the scallop research underway relatively quickly. Blacklip and Akoya sectors could potentially also be produced from Hillarys, as could mussels for the early stage R&D

- The option best-suited to larger-scale commercial mussel and oyster spat production is the Albany Aquaculture Park, at either one of the two hatcheries there – the Ocean Foods International oyster hatchery, currently not operational, or the old disused abalone hatchery, or a combination of both hatcheries. The Blacklip and Akoya spat can also potentially be produced at the Albany Hatchery. The old abalone hatchery would need refurbishment, but is perceived to be the better of the options in the long-term

- An alternative to Albany for mussel hatchery production, at least in the early stages, is the DoFWA facility at Hillarys. R&D such as out-of-season broodstock conditioning and spawning and determining the best timing for spat deployment could be supported by the Department of Fisheries technical and scientific staff. R&D on other mollusc species could also occur at the DoFWA facility.

- There is a bottleneck for spat demand between the species investigated, particularly the mussels, oysters and non-maxima pearl oysters. However, based on the study participant feedback it appears likely that a successful outcome can be negotiated between stakeholders for a relatively even spread of hatchery production and spat delivery throughout much of the year

- Bivalve mollusc aquaculture has the potential to provide a sustainable increase in aquaculture production without significant environmental impacts. It also has the potential to provide rural employment

There is a strong and growing demand for oyster, mussel and non-maxima pearl oyster spat to supply the Western Australian aquaculture industry. However, there are currently no mollusc hatcheries operating to supply these spat, and therefore industry development and growth is being restricted. Current spat requirements (for 2015) are estimated to be:

- Mussels - 120,000,000
- Sydney Rock Oysters - 6,000,000
- Blacklip Pearl Oysters - 450,000
- Akoya Pearl Oysters - 190,000
- Scallops - 15,000,000 (for R&D purposes)

Estimated Gross value of Production (GVP) derived from the mollusc spat if there were to be available would be approximately $3.5 million.

Spat requirement forecasts for 2019 are estimated to be:

- Mussels - 384,000,000
- Sydney Rock Oysters - 16,000,000
- Blacklip Pearl Oysters - 600,000
- Akoya Pearl Oysters - 310,000
- Scallops - Unknown

Estimated Gross value of Production (GVP) derived from the mollusc spat if there were to be available would be approximately $8.8 million. This is from what is effectively a base of zero production from hatchery spat currently. There is some mussel aquaculture production currently in WA, using wild spat settlement as opposed to hatchery spat. The spat requirements stated in this study are on top of wild-settlement.

Table 12 - Estimated GVP from selected species of mollusc hatchery spat in WA

Species	Mussel	Black-lip Pearl Oyster	Akoya Pearl Oyster	Rock Oyster	Scallop	Total
Estimated GVP from hatchery spat year produced						*excluding scallops*
2015	$ 1,140,000	$ 540,000	$183,502	$ 1,666,667	$ 393,750	**$ 3,530,169**
2016	$ 1,824,000	$ 660,000	$183,502	$ 2,083,333	$ 393,750	**$ 4,750,835**
2017	$ 2,489,000	$ 660,000	$280,082	$ 2,500,000	$ 393,750	**$ 5,929,082**
2018	$ 3,211,000	$ 660,000	$280,082	$ 3,333,333	$ -	**$ 7,484,415**
2019	$ 3,648,000	$ 720,000	$299,398	$ 4,166,667	$ -	**$ 8,834,065**

Without a reliable supply of hatchery produced Akoya and Blacklip Pearl Oyster spat, these sectors are likely to contract and potentially fade away altogether. The mussel industry production volumes have already contracted over the years, with many companies exiting the sector. Without hatchery production of mussel spat, the sector will not be able to expand and may not survive if wild spat settlement continues to decline. The edible oyster sector requires a well-run hatchery that can consistently produce spat to their requirements in order to establish a solid base to expand from.

The species investigated in this study are unlikely to support a hatchery on their own for the first four years or so. Combining production of a minimum of two mollusc species would be beneficial in order to share resources, fixed operating costs and to attain economy of scale.

Mussel and Oyster hatchery production would suit being located in Albany at the DoFWA Aquaculture Park. There are a couple of potential options using:

- The old abalone hatchery
- The Ocean Foods International (if suitable terms can be negotiated with OFI)
- A combination of both

The Ocean Food International Hatchery is a potential candidate for the multi-species mollusc hatchery, with some infrastructure in place and refurbishment of the facility currently under consideration, with the aim of producing oysters and potentially mussels. OFI have expressed an interest in discussing potential collaboration, resource-sharing or spat supply arrangements for other mollusc sectors. The site of the old abalone hatchery next door is a good option for a MSM hatchery located at the Albany Aquaculture Park.

There could also be a smaller mollusc hatchery facility used as a research hub, located in Perth, which carries out research and development for scallops, mussels, Blacklip pearl oysters and other mollusc species to support the commercial MSM hatchery and wider nursery and grow-out mollusc industry sectors.

The Blacklip and Akoya Pearl Oyster hatchery spat production could occur at either Albany or Perth. If the non-maxima pearl oyster spat production was also to be in Albany it would strengthen the business case and economics of a multi-species hatchery.

The Shark Bay scallop fishery is based on a single species Amusium balloti and is the most valuable scallop fishery in Western Australia. The Shark Bay and Abrolhos Scallop Fisheries have produced catches ranging from 121t up to 4,414t / annum, ranging in value from $2 million to $58 million (Kangas et al 2006). This species is short-lived, has a fast growth rate and is relatively sedentary. *Amusium balloti* appears to be an ideal candidate for fishery enhancement through hatchery production of scallop spat that are deployed in wild fisheries.

The scallop industry is likely to require a 3 – 5 year R&D program to develop technology and systems, attain knowledge and skills and evaluate the economic viability of scallop fishery enhancement in WA. The scallop hatchery production and fishery enhancement research and development program would suit being located at the Department of Fisheries WA, with good access to technical, research and scientific services.

There is little in the way of published information available on mollusc spawning times in WA. The data provided in this report is information provided by the representatives of the industry who took part in this study. From the information provided, it appears that there is a fairly good spread of natural spawning windows across the entire year. However, the study survey on spat requirements and timing revealed that the mussel, rock oyster, Blacklip and Akoya pearl oyster producers all want their spat at the same time, in late summer early autumn causing a bottleneck especially in March (Figure 35).

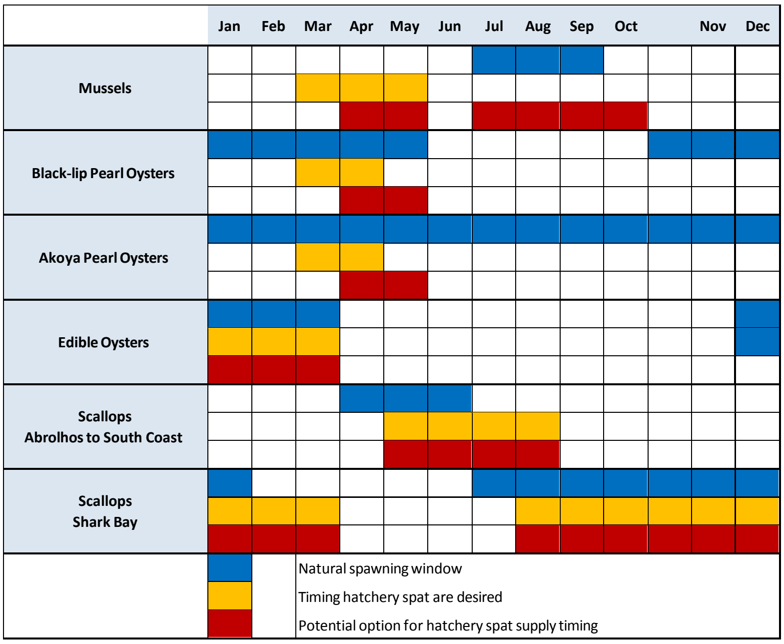

Figure 35 - WA mollusc natural spawning windows with hatchery spat supply timing options

The bottleneck for the potential multi-species mollusc hatchery can be mitigated if the majority of the mussel spat are produced in the natural spawning season of late winter early spring, and the Blacklip and Akoya hatchery production supply is moved back slightly to April / May. Some mussel production can be trialled out of season, also in April / May.

The Victorian Shellfish Hatchery has been a resounding success, potentially saving an important and valuable industry from collapse and then allowing the sector to grow and expand production and markets with confidence. The hatchery has also afforded the mussel farmers the advantage of a shorter grow-out time to market, by using fast-growing pedigrees from the hatchery breeding program giving Victorian mussel farmers a competitive advantage over farmers in other States. There are now new aquaculture sectors emerging as new species are cultured at the facility. A couple of key lessons learnt from the Victorian mollusc hatchery are:

- Good water quality is one of the main foundations for success
- The hatchery needs to run for all or most of the year to retain highly skilled and experienced staff
- The Victorian hatchery needs more than one mollusc species in order to operate throughout the year

The model that the Victorians used, with the industry sector forming a co-operative company / entity that then formed a collaborative partnership with the State government, worked well. The hatchery was overseen by a Steering Committee comprising of industry and government to ensure resources for research and production were allocated in the best way. A similar model should be considered for the development of multi-species mollusc hatchery in WA. The business plan along with models for the structure of the multi-species hatchery and its partners and supporting services are not in the scope of the current study, and are instead planned for the next stage of this project.

There is a strong demand for mollusc spat in WA, and clearly there is a need for a multi-species mollusc hatchery to supply these demands. It is possible that one hatchery could supply all the demands, or there could be two hatchery facilities each supplying 2 – 3 mollusc spat species. The other alternative is one main multi-species mollusc hatchery and a research centre that carries out research and development to support the commercial multi-species mollusc hatchery and wider nursery and grow-out production for the mollusc aquaculture industry sectors.

The FAO predicts that there will be continued strong growth in world aquaculture production. It is likely that aquaculture remains the fastest growing animal production sector. 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 3). This represents only 0.13% of the total world mollusc production in 2010 of 14.1 million tonnes.

Western Australia has 12,889 kms of mainland coastline and 20,781 of coastline including islands, which equates to a third of the total Australian coastline. Mollusc aquaculture production in WA was 350 tonnes in 2011/12 (Table 4), or less than 2% of Australian mollusc production by volume from aquaculture. Clearly there is a tremendous opportunity to expand mollusc aquaculture production in Western Australia Bivalve mollusc aquaculture production has the potential to provide a sustainable increase in production without significant environmental impacts, due to the filter-feeding nature of bivalves requiring no net nutrient input. This sector also has the potential to provide rural employment

Without a reliable supply of seed / spat there is always a high degree of uncertainty over future production forecasts, which hindered or prevents business planning in areas such as capital investment, hiring of new staff, sales and marketing. The long term success of aquaculture sectors is heavily reliant on the success of breeding and hatchery production for each species.

7 Discussion

Marine Mollusc Aquaculture Research Centre

There is a strong demand for mollusc spat in WA, and clearly there is a need for a multi-species mollusc hatchery to supply these demands. It is possible that one hatchery could supply all the demands. 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 hub, 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 mollusc industry 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 36. 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, Watermans or ACAAR Challenger.

Figure 36 - Kimberley Tropical Blacklip Oyster, *Striostrea mytiloides* (DAC, NT govt.)

Alternative potential sites to consider

Alternative potential sites to consider for a multi-species mollusc hatchery that have not been evaluated in this preliminary study, are Live Lobster (Crayfish) holding facilities that may be non-operational or may lay redundant for a parts of the year. A list of some of the potential sites is in the Appendices (Table 14). A site at Two Rocks north of Perth has been flagged as a potential hatchery site. It currently does not have buildings and infrastructure in place but has been identified as a potential aquaculture site in regional plans. Being essentially a "green-field" site, a MSM hatchery at Two Rocks would be a longer term project.

If negotiations to use suitable existing aquaculture facilities are unsuccessful then Rock Lobster facilities and the Two Rocks site can be further investigated.

Hatchery Operating Costs

Trying to reduce hatchery staff numbers and labour costs too much 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 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 side of the business.

A hatchery could potentially be operated for $250,000 – 350,000 per year, however the quality of the spat and subsequent grow-out survivals are likely to suffer. Losing revenue and market share due to a hole in production can be very costly to a sizeable business.

Non-labour operating costs will include lease, power, microalgae nutrients and concentrates, chemicals, filters, consumables, communications, vehicles, R&M and administration. Non-labour operating costs will be largely driven by the cost of the lease and the cost of power. A significant portion of the power cost will come from heating and chilling the water, which will in turn be influences by local ambient water and air temperatures. Both lease and power costs will be specific to the site chosen.

<u>Blacklip and Akoya spat survival rates</u>

Similar to the non-maxima pearling industry views on average pearl prices, there is a large disparity between feedback from different companies and individuals on average spat survival rates. There will be variation in survival rates achieved across the sector, as different companies will have different husbandry practices and systems, some better than others, and some better resourced than others. Blacklip survival rates from spat deployment through to a saleable pearls are assumed to be 5%, based on some of the more conservative production data provided by the industry.

The maxima survival / success rates of around 5% from spat deployed to harvested pearl include culling out of slower-growing animals, which occurred as some of the companies in the sector developed scale and the ability to produce spat quantities consistently in high numbers, surplus to their demands, and at a relatively low cost. When a company is small, together with spat supplies that are sporadic and spat that are expensive it is unlikely slower growing oysters will be culled, which will potentially increase the survival rates above those used for this study.

<u>Blacklip and Akoya pearl price</u>

Whilst the Akoya sector and production volumes are low, growers may be able to attain more than an average of $8.78 per Akoya pearl if sold locally through their own retail outlets.

Non-maxima pearl production numbers and values are shown below in Table 13. The numbers of pearls produced are not believed to be entirely reliable, in which case the pearl prices in the table are not entirely accurate. However, the trend shows pearl prices declining sharply post-GFC.

Production numbers (pearls harvested) have declined fairly dramatically in 2011/12 and 2012/13, whilst the price per pearl has shown a recovery back to around 2008/09 prices in 2012/13 (*DoFWA data for years 2011/12 and 2012/13 is confidential, therefore this data is not included in the table*).

Table 13 - Non-maxima pearling production figures 2006/07 - 2010/11 (DoFWA data)

Year	2006/07	2007/08	2008/09	2009/10	2010/11	% change on 06/07
Number of Pearls harvested	18,432	14,591	11,871	24,939	21,964	19%
Blacklip and Akoya production value	$ 452,050	$ 188,900	$ 99,060	$ 141,880	$ 107,330	-76%
Mean pearl price	$ 24.53	$ 12.95	$ 8.34	$ 5.69	$ 4.89	-80%

Blacklip and Akoya spat price

Blacklip hatchery production in the past has been inconsistent, with many failed production runs along the way. Some in the industry suggest there were more failed batches than successful batches. The price for the spat the hatcheries have produced may reflect some of the costs of the failed production runs. With the low required spat numbers forecast, including expansion plans for the next 5 years, it is unlikely that the price will come down due to economy of scale due to the required spat numbers being too low. The price can only come down if the non-maxima pearling industry can work alongside and with other mollusc species sectors, such as the edible oyster and mussel sectors, to share costs of infrastructure and retaining highly skilled staff.

Blacklip and Akoya production volumes and markets

The non-maxima industry could potentially gain from a significant increase in scale (beyond the forecasts attained through this study) in order to drive production costs down and significantly increase efficiencies and productivity. This could be through for example minimising labour through novel technology / automation, increased growth and survival performance and pearl quality through breeding programs etc.. A thorough analysis of domestic and international market and production volumes, current and future forecasts, would be required first.

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. The markets and prices of mussels and oysters are also well-established. 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 considered.

Identification of new potential sites for edible oysters and mussels would be useful. Oysters grow relatively slowly in Albany due to the cool temperatures. Where in WA would oysters grow quicker and potentially be more highly profitable? For example, could rock oysters be cultured in Shark Bay, Exmouth or other areas in the southwest? Aquaculture zoning for mollusc aquaculture could assist in expansion of this sector.

Scallops

There are no commercial scallop spat prices available for *Amusium 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. It can also give a preliminary insight into the scope of production efficiencies that need to be developed in the R&D program, and the recapture rate required of hatchery-produced spat deployed. To produce scallop spat at a price of $0.004 will be challenging. It is likely that they will have to be deployed at a small size, similar to mussels or smaller, for cost of hatchery production to be that low. That will in turn mean that attaining a recapture rate of 5% will become challenging.

Non-native oyster species

Consider where the Tasmanian aquaculture industry would currently be positioned without the introduction and culture of non-native species (Atlantic Salmon and Pacific Oysters). Or indeed where the Australian agricultural industry would stand if only native species were farmed.

The Pacific Oyster (*Crassostrea gigas*) has been talked about by some WA shellfish producers during this study as a potential game-changer for the Western Australian mollusc aquaculture industry, if they could be imported from the Eastern States. Their significantly faster growth rate could potentially allow farmers to grow 2 crops of Pacific Oysters for every 1 crop of Western Rock Oysters. However, it's unlikely that there will be a sufficiently high level of confidence that they are disease-free prior to translocation. Plus even if the progeny are produced as triploid / polyploidy, therefore sterile, the rate is never quite 100%. And 99.999% is probably not going to be enough to satisfy translocation conditions.

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 MSM hatchery. A thorough risk analysis of the multi-species mollusc 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 MSM hatchery.

Information contained in this study report

There is very little in the way of published material on mollusc aquaculture in Western Australia, and few if any peer-reviewed papers relevant to the study. 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 rest of the 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.

8 Acknowledgements

Thanks go to:

- All the ACWA members that responded to the study survey of current and future forecasts for mollusc spat requirements
- Other individuals and companies from the WA mollusc aquaculture industry that contributed spat requirement and other information
- Steve Nel and Hayley Perhavec at DoFWA for the WA aquaculture data that they provided
- The government staff from other states that provided information that contributed to this study, in particular John Mercer and Brett Ingram from DEPI, Victoria and Wayne O'Connor DPI, New South Wales
- Jonathan Bilton who provided information regarding the history of the WA mollusc industry
- Tina Thorne for her support during the compilation of study information and writing of the report

9 Appendices

Terms of Reference (The Service)

1. Scan of existing industry members (mussels, edible oysters, scallops and non-*P. maxima* pearl oysters) as to:

   - Their current operation and current trends (uncertainty) in wild spat supply;
   - Their current and five year out requirements (numbers and timing) for spat;
   - What they are prepared to pay for what size spat;
   - What conflicts regarding the timing of spat requirement exist between the species groups? Can such issues be overcome with one hatchery?; and
   - Are separate hatchery and nursery facilities required or advantageous and what are the cost implications?

2. Discussion with current mollusc hatchery operators in WA (including P. maxima Pearl operators) and their ability and capacity to supply spat to other operators; need to discuss with owners under what terms, if any, they would undertake to do this. This is important because if they are prepared to sell to other industry members then government cannot fund a hatchery in competition with them. OFI?

3. If the need for a government funded or subsidised mollusc hatchery is identified then will just one hatchery suffice? Are the needs of all of the industry sectors the same? (i.e. supply of spat only or is there a R&D requirement?).

4. What staffing levels and skills base is required? Are the people available in Australia or is training required? Are the hatchery needs seasonal and what resourcing issues result? How can competing resources and timelines be allocated?

5. Identify potential sites for a mollusc hatchery (pilot or commercial), including the use of existing ex-crayfish facilities and government infrastructure (TAFE's, Fisheries). Will one hatchery to supply all species be sufficient with mussels and edible oyster operations located from Perth to Albany, and scallops and black-lip industries from Perth to Geraldton?

6. The undertaking of a preliminary investigation into the requirements for a new hatchery including the area of land required, necessary water quality and quantity, equipment and approximate cost of each component.

7. Timelines for development of a new facility including for funding and licensing approvals, construction and commissioning

Table 14 - Rock Lobster Holding Facilities, WA

Rock Lobster Holding Facilities in WA				
Location	**Name**	**Type**	**Address**	**Phone**
Kalbarri	GFC	Depot	19 Magee Cres, Kalbarri	9965 9000
Geraldton	GFC	Registered Receiver Premises	206 Connel Rd, Geraldton Fishing Boat Harbour, Geraldton WA 6530	9965 9000
	Blue Wave	Registered Receiver Premises	202 Connel Rd, Geraldton Fishing Boat Harbour, Geraldton WA 6530	9652 1790
	Kailis Factory	Registered Receiver Premises	Clarke Road, Geraldton	9921 1666
Port Denison				
Leeman	GFC	Depot	Thomas Street, Leeman	9953 1202
Greenhead				
Jurien Bay	GFC	Depot	Breakwater Drive, Jurien Bay	9652 1498
	Kailis	Depot	Breakwater Drive, Jurien Bay	9652 1377
	Bluewave	Depot	Breakwater Drive, Jurien Bay	9652 1555
Cervantees	Indian Ocean Rock Lobster	Registered Receiver Premises	11 Madrid St, Cervantes WA 6511	9652 7010
Lancelin	GFC	Depot	Lot 619 Gingin Rd, Lancelin WA 6044	
	Blue Wave	Registered Receiver Premises	Lot 619 Gingin Rd, Lancelin WA 6044	9655 1405
	Kailis	Depot	Lot 619 Gingin Rd, Lancelin WA 6044	
Ledge point	GFC	Depot		
	Blue Wave	Depot		
	Kailis	Depot		
Seabird	Blue Wave	Depot	McCormick St, Seabird WA 6042	
Two Rocks	GFC	Depot	Two Rocks Marina, Two Rocks WA 6037	
	Blue Wave	Depot	Two Rocks Marina, Two Rocks WA 6037	
	Kailis	Depot	Two Rocks Marina, Two Rocks WA 6037	
Hillarys	Lobster Alive	Registered Receiver Premises	U 3/8/ Whipple Street, Balcatta WA	0418 566 103
Fremantle	GFC	Registered Receiver Premises	Rous Head Road, North Fremantle WA 6159	9345 8900
	Blue Wave	Registered Receiver Premises	Molfetta Quay, Fremantle Fishing Boat Harbour,	
	Kailis	Depot	Molfetta Quay, Fremantle Fishing Boat Harbour,	
	Freo Ice	Registered Receiver Premises	8/6 Strang St, Beaconsfield WA 6162	9335 7044
	Nicholas Tee			
Mandurah	GFC	Depot	Breakwater Parade, Mandurah Ocean Marina	9435 8900
Bunbury				