Oysters Australia IPA – Workshop – Identifying Knowledge Gaps for Development of the Native Oyster Aquaculture Industry in South Australia

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In submitting this report, the researcher has agreed to FRDC publishing this material in its edited form.

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Acknowledgments

The editors would like to thank everybody who attended the workshop for their valuable input in discussing the current status and future of the native oyster aquaculture industry in Australia. A special thank you to all those who presented for sharing their experiences with growing, breeding, researching and/or marketing flat oysters, and Mr Wayne Hutchinson and Mr Ian Duthie for facilitating the workshop discussions. This project was funded by Oysters Australia and the Fisheries Research and Development Corporation through an industry partnership agreement.

Executive Summary

The 2015-229 “Oysters Australia IPA - workshop - identifying knowledge gaps for development of the native oyster aquaculture industry in South Australia” brought together oyster farmers, hatchery operators and scientists from across Australia to share their knowledge and experience with native oyster (*Ostrea angasi*) aquaculture and help to identify the key knowledge gaps in the production chain. Through presentations and group discussions, a number of research and development needs were identified. These were categorised into seven key areas: early life history/genetic improvement, farming, oyster health, post-harvest, marketing and branding, industry network and training and education. Across these categories, 19 key research and development needs were identified and prioritised via a post-workshop survey. The following four research and development needs were prioritised as being most important:

- Having a constant and reliable spat supply;
- Development of a selective breeding program to improve *Bonamia* resistance, growth rate, meat/shell ratio, colour, lustre, etc.;
- Establishment of good husbandry practices (e.g. handling, density, growing heights, sub-tidal vs. intertidal, seasonal effects, a system to suit *O. angasi* production);
- Increase the shelf life/improve packaging/develop processing methods.

Identifying these needs will help to target future research to meet industry priorities and establish/develop the South Australian/Australian native oyster industry.

Keywords

Native oysters; *Ostrea angasi;* Australia; aquaculture

Introduction

Pacific Oyster (*Crassostrea gigas*) farming in South Australia (SA) is one of the largest aquaculture industries in the state, directly employing >600 people, with a farm gate value of approximately $40 million per annum. It is the largest Pacific Oyster industry in Australia. In recent years, outbreaks of Pacific Oyster Mortality Syndrome (POMS, OsHV-1 microvariant) have decimated local industries in parts of New South Wales (NSW) and Tasmania. POMS, which only affects Pacific Oysters, causes rapid mortalities of up to 100% within days of initial detection. A number of strategies have been put in place to prepare for a potential outbreak of POMS in SA. One such strategy is the farming of alternative species (Roberts et al. 2013-FRDC 2012/044).

The native oyster (*Ostrea angasi*) is a flat oyster endemic to southern Australia with its distribution extending from Perth, Western Australia to the Queensland and NSW border. It is closely related to the European Oyster (*O. edulis)*, a species that demands a higher price at market compared to Australian oysters (twice that of Pacific Oysters). It is currently farmed in low numbers in SA, Victoria, Tasmania and NSW. Recently, Pacific Oyster growers have shown an interest in the native oyster as the existing farming infrastructures may be suitable for some stages of native oyster aquaculture production. In 2014, most SA Pacific Oyster farms added this species to their licences.

In Australia, the native oyster industry is still in its infancy, with some knowledge gaps along the production chain. For this reason, a workshop was convened to share current farming techniques and identify key research and development needs. The ideas and methodologies discussed at the workshop will aid in the establishment of the native oyster aquaculture industry in Australia.

Heasman and Lyall (2000) held a similar workshop titled “Problems of Producing and Marketing the Flat Oyster *Ostrea angasi* in NSW” where they identified the following six key research and development needs:

- Need of a simple farming guide and development of extension services.
- Continuing supply of hatchery produced seed oysters.
- Product development especially extended shelf-life for export.
- Marketing R&D; QAP’s and export certification.
- Initiation of a grower’s network.
- Liaison with the NSW Oyster Management Advisory Committee.

This current workshop will help to assess if research and development needs have changed in the past 16 years, whether any of the needs identified by Heasman and Lyall (2000) have been met, and potential differences in industry requirements between NSW and SA.

Objectives

Objectives of the project are:

1. To identify knowledge gaps for the development of the native oyster aquaculture industry in Australia.
2. To provide advice on the key research and development requirements to support native oyster aquaculture development in South Australia.

Methods

A technical workshop was held on 22 June 2016 at the South Australian Research and Development Institute (SARDI) Aquatic Sciences Centre, West Beach. Participants in the workshop included native oyster growers and hatchery operators from SA, NSW, Victoria and Tasmania, scientists with relevant expertise in native oyster research, a New Zealand flat oyster representative and a marketing advisor. A list of attendees can be found in Appendix 2. The workshop incorporated 12 presentations (10 of which are in Appendices 5-14, the remaining two were not in electronic form), followed by a facilitated discussion. The workshop agenda can be found in Appendix 3. During the discussion session, a list of the key research and development needs was created. A preference survey listing these needs was sent out to attendees after the workshop to gain an understanding of industry priorities. A copy of the survey can be found in Appendix 4; the survey results are shown in Figure 1.

Presentations

1 "Advances in hatchery production of flat oysters" presented by Dr Stephen O'Connor - Port Stephens Fisheries Institute, NSW (Appendix 5).

Key points of presentation:

- Brooding frequency is site specific with four sites along the NSW coast showing different patterns in the number of brooders and oyster condition across a year.
- Larval diet effected growth and settlement rates. A ternary diet of *Tetraselmis chuii*, *Isochrysis* sp. and either *Pavlova lutheri* or *Nannochloropsis oculata* were the best diets to maximise larval growth rate and survival 24 h post metamorphosis.
- Salinity has an effect on settlement and shell length with lower salinities resulting in smaller oysters and a reduced number of metamorphosed spat.
- Temperature had an effect on larval survival and settlement with higher mortalities and a reduced number of spat harvested when the temperature exceeded 31 degrees.

2 "Twenty years' experience in commercial flat oyster growing: What have we learned and where to in the future?" presented by David Maidment – Australian Native Shellfish, NSW (Appendix 6).

Key points of presentation:

- Currently NSW is experiencing a small but growing boutique market for *O. angasi.*
- In recent years, production has increased in the state, which currently has 28 aquaculture permits for native oysters across 11 estuaries.
- There is a need for a market push to expand the industry.
- Research into increased shelf life is required.
- A group approach linking industry and research is required.

The following five presentations were made by Australian farmers who shared their experiences growing native oysters in their local regions:

3 "Conditions to suit angasi oysters" presented by Yvonne Young and Steve Leslie - Intertidal Oyster Solutions, Tasmania (Appendix 7).

4 "Sub-tidal angasi production in Port Phillip Bay" presented by Peter Lillie – Bay Sea Farms, Victoria.

5 "*Angasi* culture in Stansbury" presented by Steve Bowley – Pacific Estate Oysters, SA (Appendix 8).

6 "*Angasi* culture in Kangaroo Island" presented by Ken Rowe – Kangaroo Island Shellfish, SA (Appendix 9).

7 "Angasi culture in Coffin Bay" presented by Jedd Routledge – Natural Angasi, SA (Appendix 10).

Key points of presentations:

- Need to improve grading efficiency (manual vs. mechanical). Different farms have trialled different methods and it is unclear which method is best suited for *O. anagai* whilst still being commercially viable.
- Need to reduce biofouling and over settlement.
- Need to increase the shelf life of the product. Ideas include methods to keep the shell from gaping (wire, weight etc.) and potential to sell frozen or vacuum sealed product.
- Unknown if it is better to grow oysters in the intertidal or sub-tidal areas or a combination of both. Oysters grown in the subtidal zone tend to grow more undesirable 'frilly' shell, movement to the intertidal zone chips back the shell but potentially decreases growth rate.
- Current knowledge gaps in the grow-out period include ideal grading methods, stocking densities, orientation, conditioning and cage design. Some farms have grown *O. angasi* the same way that they would grow the Pacific oyster and have had mixed results. More research into native oyster specific grow out methods are required.
- Need for a reliable commercial spat supply, particularly in SA.

8 "Flat oyster (*Ostrea angasi*) reproductive strategy in SA: Toward controlling entire production process" presented by Professor Xiaoxu Li – SARDI (Appendix 11).

Key points of presentation:

- Native oysters are spermcast spawners with a high ratio of hermaphrodites. They have a long reproductive season and unsynchronised maturation.
- A SA study that sampled 60 individuals per month found larvae in the mantle cavity from May through to December.
- Sperm quality depends on the 'maleness' level of an animal, with hermaphroditic animals having poorer sperm.
- There is currently no large, industrial scale, source of reliable, hatchery produced spat in SA. Additionally, it is difficult to produce spat due to variable growth rates.
- There is a potential to selectively breed native oysters for better growth, survival, disease resistance, etc. once methods for *in vitro* fertilisation have been developed.
- Triploidy or sterile stock could improve meat quality.

9 "*Bonamia* in Native Oyster aquaculture in Australia (FRDC project 2015-001)" presented by Dr Marty Deveney and Jessica Buss – SARDI (Appendix 12).

Key points of presentation:

- *Bonamia* is a protozoan that causes disease in native oysters. It has been responsible for high mortalities in Europe, USA and New Zealand. It has been identified in Victoria, NSW, Tasmania and SA.

- Determination of the drivers for this disease is required and a management strategy is needed to minimise infection rate.
- A study is underway to research factors that may lead to disease including temperature, salinity and management techniques.
- Presently aiming to determine prevalence in SA, develop a laboratory infection model and determine *Bonamia* viability after exposure to decontaminants.
- Undertaking genetic sequencing to determine which species of *Bonamia* is present.

10 "Branding and marketing *angasi* oysters" presented by Michael Canals – Michael Canals Seafoods, Victoria.

Key points of presentation:

- There is a need for industry standards or benchmarks in relation to size and product quality. This would help to protect the industry and reduce negative market perceptions.
- It should be decided if branding occurs on an industry or individual level.
- When branding it is important to consider having an online presence, telling a story, knowing what the market wants and co-ordinating supply.
- Packaging is important for both product quality and branding.

11 "Why are so few angasi oysters cultured in Australia?" presented by Dr Christine Crawford – Institute of Marine and Antarctic Studies, Tasmania (Appendix 13).

Key points of presentation:

- Findings from "National review of *Ostrea angasi* aquaculture – historical culture, current methods, and future priorities." The review was informed by discussions with oyster famers, managers and researchers and from a review of the literature.
- The review determined that native oysters are more fragile and slower growing than Pacific Oysters and have a shorter shelf life.
- Listed a number of research and development needs including development of methods specific to *O. angasi* production, improvements in grow-out techniques, management of *Bonamia*, development of a breeding program and improved spat quality.
- The review also highlighted the need to develop and expand markets.

12 "Flat oyster aquaculture in New Zealand" presented by Helen Mussely – Cawthron Institute, New Zealand (Appendix 14).

Key points of presentation:

- The Cawthron Institute is New Zealand's largest independent research organisation. It is currently undertaking research on the New Zealand flat oyster *Ostrea chilensis*.
- *O. chilensis* brood larvae until they are competent and ready to settle, longer than *O. angasi.*
- Current research on *O. chilensis* includes synchronising reproduction, production of family lines for growth and survival and *in vitro* fertilisation and larval rearing for future triploidy production.
- Determined that conditioned oysters achieved an earlier reproductive season than farmed and MRI technology could identify brooders but had limited success in determining reproductive condition.
- *Bonamia* has had a large impact on the industry, looking into triploidy to reduce infection.
- There are currently a number of successful marketing strategies in place for New Zealand flat oysters.

Discussion to identify research and development needs

After the presentations, the attendees were divided into small groups (5-6 people) and asked to identify, discuss and record knowledge gaps, research and development needs and industry requirements for the following topics: early life history/genetic improvement, farming, oyster health, post-harvest, branding, marketing and others. The results of these discussions were then shared with the entire workshop group. Nineteen key research and development needs were identified:

Early Life History/Genetic Improvement

1. Development of triploid oysters
2. Development of a selective breeding program to improve *Bonamia* resistance, growth rate, meat/shell ratio, colour, lustre, etc.
3. Improving hatchery biosecurity to manage multi-species spat production
4. Having a constant/reliable spat supply

Farming

5. Research into site selection (i.e. preferred depth, salinity, temperature etc.)
6. Establishment of good husbandry practices (e.g. handling, density, growing heights, sub-tidal vs. intertidal, seasonal effects, a system to suit *O. angasi* production)
7. Development of grading methods

Oyster Health

8. Surveillance and monitoring of threats/pathogens/diseases (e.g. *Bonamia*, protozoans, POMS)
9. Reducing biofouling
10. Understand interactions between oyster spp. and other molluscs

Post-harvest

11. Increase the shelf life/improve packaging/develop processing methods
12. Export logistics (e.g. market, permits, live export vs. frozen, AusTrade)
13. Consumer education (shucking techniques, identifying true farm location)

Branding and Marketing

14. Development of industry accredited standards (size, condition, only selling when in top condition)
15. A marketplace response to increase production
16. Development of an industry profile/telling the *O. angasi* story (could include a website, social media, app development, etc.)

Industry Network

17. More communication between hatcheries and farmers
18. Establish farmer's network/collaborative meetings and increased liaison between growers (social media interactions, workshops etc.)

Training and Education

19. Greater availability of skilled staff and experts in oyster health

Survey to prioritise research and develop needs

In order to prioritise the research and development needs identified during the guided discussion, a ranked survey was created after the workshop and distributed to all attendees (Appendix 3). This survey asked responders to rank the 19 needs from most to least important. It also addressed the question of industry branding, a topic that received considerable discussion at the workshop. Attendees were given two weeks to complete the survey, with a reminder sent after one week; 14 responses were received.

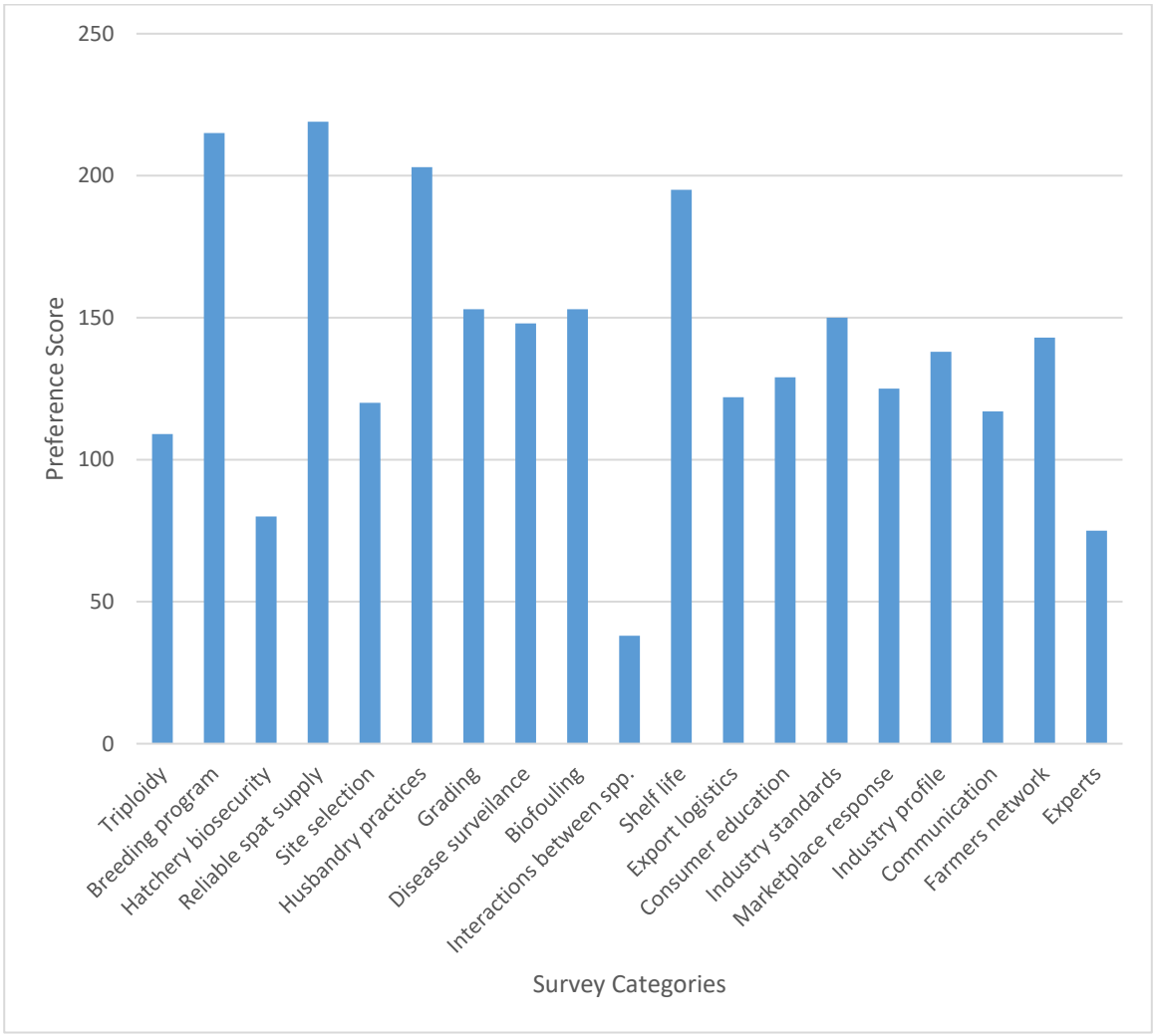


Figure 1. Results from the 2015-229 "Oysters Australia IPA –post-workshop survey. The survey categories (x-axis) are the research and development needs identified by workshop attendees and the preference score (Y axis) indicates how each category was ranked by responders (i.e. the higher the score the more important that category was considered)

Figure 1 displays the survey results, with the preference score indicating the importance of each category as ranked by the responders (i.e. the greater the preference score the more important that category was considered). The survey results show that the following four categories were considered to be the most important research and development needs for the Australian native oyster aquaculture industry.

a) Having a constant and reliable spat supply
b) Development of a selective breeding program to improve *Bonamia* resistance, growth rate, meat/shell ratio, colour, lustre, etc.
c) Establishment of good husbandry practices (e.g. handling, density, growing heights, sub-tidal vs. intertidal, seasonal effects, a system to suit angasi production)
d) Increase the shelf life/improve packaging/develop processing methods

The results of the survey are similar to the key industry needs identified by Heasman and Lyall (2000) with both workshops identifying the need for a reliable spat supply and an increase in shelf life as being of high importance. Since the workshop in 2000, spat supply has increased in NSW with the establishment of a number of on-farm hatcheries, which in turn has increased production. However, restrictions on spat translocations to other states means that in Tasmania, Victoria and SA spat supply is still an important issue. Heasman and Lyall (2000) highlighted the need for a simple farming guide, which ties into the establishment of good husbandry practices priority identified during this workshop. Additionally, marketing and an increase in liaison among and between growers and researchers were seen as a priority at both workshops. Development of a breeding program was considered a top priority at the current workshop but not during Heasman and Lyall (2000) workshop. This is likely due to the success of breeding programs in other shellfish species (e.g. Pacific Oyster, abalone) in the past sixteen years.

The marketing questions posed in the survey, “Do you think we need to brand angasi?” and “Do you think branding should occur at an industry level?” were unanimously answered with yes. However, there was no clear consensus on which brand name was preferred, with other options, such as “The Australian native ‘angasi’ oyster” and “Australian angasi oyster” suggested.

Conclusion and Recommendations

The 2015-229 “Oysters Australia IPA - workshop - identifying knowledge gaps for development of the native oyster aquaculture industry in South Australia” successfully met its objectives. Through presentations and discussions, knowledge gaps in the production chain were identified and advice on key research and development requirements are provided. A list of 19 key research and development needs was developed and prioritised, which will help to target future research to the Australian native oyster industry priorities.

The experiences learned by native oyster growers and the key hatchery and grow-out techniques that have been trialled in different environments and different states will be critical to the further development of native oyster aquaculture industry in Australia. The knowledge gaps and prioritised research and development needs identified in this workshop will assist the industry to determine the research and development priorities. In addition, the proposed establishment of industry network and marketing strategies will accelerate industry development nationally.

The establishment of an industry network would be critical to the long term sustainable development of the native oyster aquaculture sector in Australia. It is recommended that this should be formalised at the next industry workshop, proposed in the newly funded Cooperative Research Centre Project (CRC-P) – Future Oysters. The purpose of an industry network will be to promote information sharing between native oyster growers and to provide scientific support to these growers to undertake co-ordinated, collaborative on-farm investigations to improve production methods. This network should also work towards other industry priorities such as developing product standards and branding priorities for native oysters.

Extension and Adoption

Some of the key research and development priorities identified through this workshop and post-workshop survey will form the basis of a project within the CRC-P Future Oysters program that will link researchers and growers to collaboratively undertake investigations and share information to address priorities such as:

- Establishment of good husbandry practices.
- Increase the shelf life/improve packaging/develop processing methods.
- Product standards for native oysters.

References

Heasman, M. and Lyall, I. (2000). Proceedings of the workshop held on 3 March 2000 at the Sydney Fish Markets: problems of producing and marketing flat oysters Ostrea angasi in NSW. Fisheries research report series no. 6

Roberts, S.D., Chalupa, A., Bombardieri, N., Kowalski, D., Deveney, M., Lauer, P., Heaven, C., Zippel, B., Rahaley, R. and Doroudi, M. (2013). Exercise Sea Fox: testing aquatic animal disease emergency response capabilities within aquaculture, Adelaide, November. FRDC project 2012/044

Appendix 1: Project Staff

Professor Xiaoxu Li:	SARDI
Dr Penny Miller:	SARDI
Dr Stephen O'Connor:	Port Stephens Fisheries Institute
Mr Judd Evans:	South Australian Oyster Growers Association
Mr Ian Duthie:	Tasmania Oyster Research Council

Appendix 2: List of Attendees of the Workshop – Identifying Knowledge Gaps for Development of the Native Oyster Aquaculture Industry in South Australia

Name	Affiliation	State
Brendan Guidera	Pristine Oysters	SA
Bryce Daley	Spring Bay Seafoods	Tasmania
Dr Christine Crawford	Institute of Marine and Antarctic Studies	Tasmania
David Maidment	Australian Native Shellfish	NSW
Prof Gavin Begg	SARDI	SA
Gary Zippel	Zippels Smokey Bay Oysters	SA
Gerri Bowley	Pacific Estate Oysters	SA
Glen Ingham	PIRSA	SA
Heidi Alleway	PIRSA	SA
Helen Mussely	Cawthron Institute	NZ
Ian Duthie	Sea Perfect/TORC	Tasmania
Jedd Routledge	Natural Angasi	SA
Jessica Buss	Flinders University/SARDI	SA
Ken Rowe	Kangaroo Island Shellfish	SA
Lauren Holmes	PIRSA	SA
Luke Fraser	PIRSA	SA
Dr Marty Deveney	SARDI	SA
Michael Canals	Michael Canals Seafoods	Victoria
Michael Dee	Southern Yorke Oysters	SA
Mick Dee	Southern Yorke Oysters	SA
Nathan Bishop	Southern Ocean Abalone	SA
Oliver Dee	Southern Yorke Oysters	SA
Paul Dee	Southern Yorke Oysters	SA
Dr Penny Miller	SARDI	SA
Peter Lillie	Bay Sea Farms	Victoria
Sam Clarke	Natural Angasi	SA
Scott Brooks	Aquatic Resources	Tasmania
Dr Stephen O'Connor	Port Stephens Fisheries Institute	NSW
Steve Bowley	Pacific Estate Oysters	SA
Steve Cooper	Flinders Oysters	Victoria
Steve Leslie	Intertidal Oyster Solutions	Tasmania
Trudy McGowan	SAOGA/SAORC	SA
Vicki Mavrakis	PIRSA	SA
Dr Wayne Hutchinson	Oysters Australia/FRDC	SA
Win Leslie	Intertidal Oyster Solutions	Tasmania
Prof Xiaoxu Li	SARDI	SA
Yvonne Young	Intertidal Oyster Solutions	Tasmania

Appendix 3: Workshop Agenda

Workshop - Native oyster (*Ostrea angasi*) aquaculture development in Australia

Date: 22nd June 2016
Avenue: SARDI Conference Room. 2 Hamra Ave, West Beach, SA 5024
Contact: Xiaoxu Li – xiaoxu.li@sa.gov.au; 08 8207 5464

Time	Title/Activity	Presenter
9:30	Registration/Morning Tea	
10:00	Welcome	Prof Gavin Begg
10:05	Advances in hatchery production of flat oysters *Ostrea angasi*	Dr Stephen O'Connor
10:25	Twenty year's experience in commercial flat oyster growing: What have we learned and where to in the future?	David Maidment
10:45	Conditions to suit angasi oysters	Yvonne Young
11:00	Subtidal angasi production in Port Phillip Bay	Peter Lillie
11:15	Angasi culture in Stansbury	Steve Bowley
11:25	Angasi culture in Kangaroo Island	Ken Rowe
11:35	Angasi culture in Coffin Bay	Jedd Routledge
11:45	Flat oyster (*Ostrea angasi*) reproductive strategy in SA	Prof Xiaoxu Li
11:55	*Bonamia* in flat oyster aquaculture in Australia	Dr Marty Deveney/Jessica Buss
12:10	Lunch	
13:30	Branding and marketing angasi oysters	Michael Canals
13:45	Why are so few angasi oysters cultured in Australia?	Dr Christine Crawford
14:05	Flat oyster aquaculture and marketing in NZ	Helen Mussely (NZ)
14:35	Key workshop outcomes/information, and future development *	
15:30	Afternoon tea	
16:00	Key workshop outcomes/information, and future development (continue) *	
17:00	Close	
18:30	Group dinner (at own expense)	To be advised

* The key discussion points will include, but not limited to:

- Production cycle/supply chain: What are the key gaps? Where is the low hanging fruit?
- Genetics: what is the opportunity?
- Hatchery supply: What is required in the market to support commercial supply of angasi? What level is expected in short - medium - long term?
- Biosecurity: Challenges to multi-species production (hatchery & farm)?
- Market: What's the consumer's willingness to pay? What's the best route to market? What 'story' do we need to tell? How does the economic story stack up?
- Future: What type of industry do we expect/want flat oysters to be?

Appendix 4: Native Oyster R&D Priority Survey

The following letter was distributed to the attendees of workshop "Identifying Knowledge Gaps for Development of the Native Oyster Aquaculture Industry in South Australia"

Dear All,

Thank you for attending the recent Native Oyster (*Ostrea angasi*) Aquaculture Workshop at SARDI. This workshop was supported by the FRDC and Oysters Australia through the project "Identifying knowledge gaps for development of the native oyster aquaculture industry in South Australia". As agreed at the workshop, we summarised the key points identified at the workshop and are conducting this short survey to determine 1) what research and development needs you think are the most important to the industry, and 2) if branding "*angasi*" oysters is needed. All responses will be completely confidential.

1. Key research and development needs

Below is a list of the key research and development needs for the native oyster industry, as identified by the workshop attendees. Please preference 1 to 19 (or the highest number of the item listed by you), with 1 being the category that you think is the most important and 19 (or the highest number of your item) being the least.

Research and Development Need Identified		Your preference
Early Life History/Genetic Improvement		
1	Development of triploid oysters	
2	Development of a selective breeding program to improve *Bonamia resistance*, growth rate, meat/shell ratio, colour, lustre, etc.	
3	Improving hatchery biosecurity to manage multi-species spat production	
4	Having a constant/reliable spat supply	
Farming		
5	Research into site selection (i.e. preferred depth, salinity, temperature etc.)	
6	Establishment of good husbandry practices (e.g. handling, density, growing heights, sub-tidal vs. intertidal, seasonal effects, a system to suit angasi production)	
7	Development of grading methods	
Oyster Health		
8	Surveillance and monitoring of threats/pathogens/diseases (e.g. *Bonamia*, protozoans, POMS)	
9	Reducing biofouling	
10	Understand interactions between oyster spp. and other molluscs	
Post Harvest		
11	Increase the shelf life/improve packaging/develop processing methods	

12	Export logistics (e.g. market, permits, live export vs. frozen, AusTrade)	
13	Consumer education (shucking techniques, identifying true farm location)	
Marketing and Branding		
14	Development of industry accredited standards (size, condition, only selling when in top condition)	
15	A marketplace response to increase production	
16	Development of an industry profile/telling the *angasi* story (could include a website, social media, app development etc.)	
Industry Network		
17	More communication between hatcheries and farmers	
18	Have a farmers network/collaborative meetings and more liaison between growers (social media interactions, workshops etc.)	
Training and Education		
19	Greater availability of skilled staff and experts in oyster health	
Other (please specify and rank)		
20		
21		

2. "*Angasi*" branding

Do you think we need to brand "angasi"? Y/N

Do you think branding should occur at an industry level? Y/N

If yes, please preference 1-5 or 6, with 1 being the name you like best

Brand Name Identified	Your preference
The Australian Oyster	
The Native Oyster	
Australia's Oyster	
The Australian Flat Oyster	
The Australian Native Oyster	
Other (please specify)	

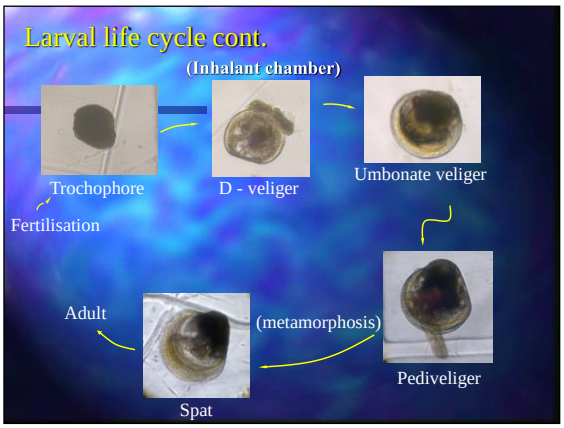
If you have any questions relating to this survey please contact Xiaoxu Li via email xiaoxu.li@sa.gov.au or phone 08 8207 5464.

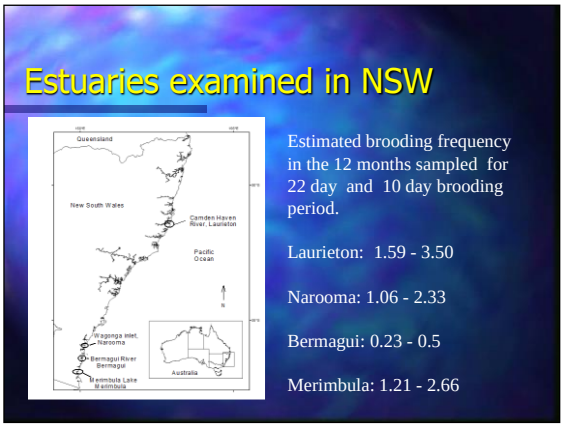
Thankyou for completing this survey.

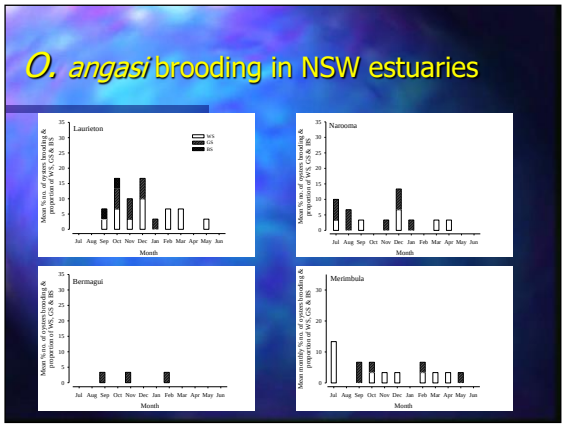
Appendix 5: Advances in Hatchery Production of Flat Oysters

Dr Stephen O'Connor

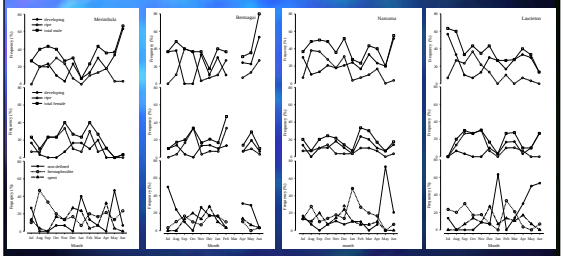
Port Stephens Fisheries Institute, NSW





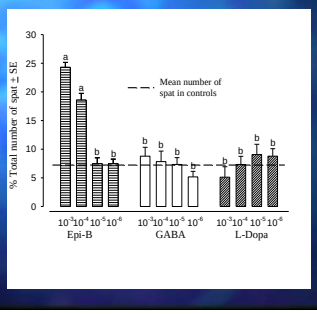


Histological examination of gametogenic stages

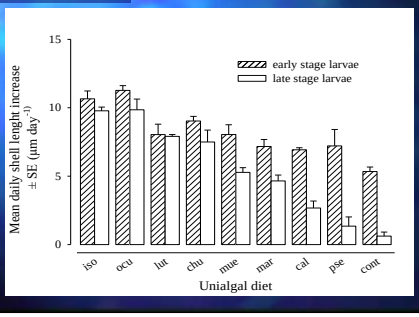


Single seed production

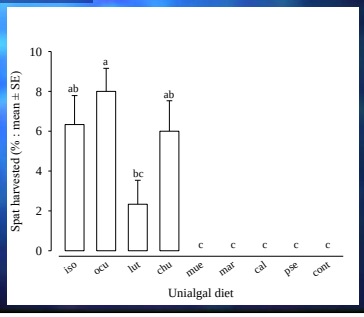
The catecholamines, epinephrine can induce rapid synchronised settlement and metamorphosis of competent *O. angasi* larvae.



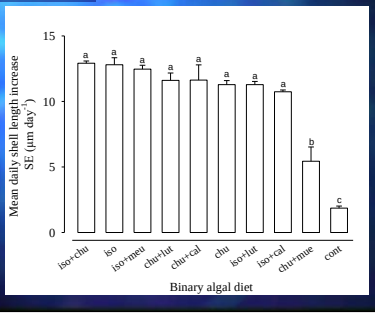
Larval diet — single algal diet – growth rates



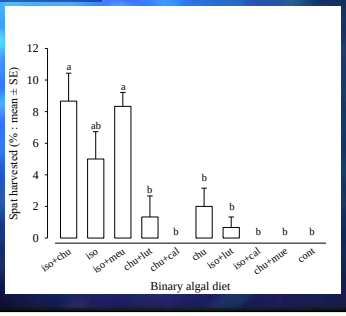
Larval diet — single algal diet – spat produced



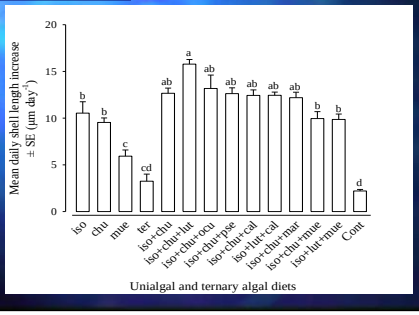
Larval diet — Binary algal diet – growth rate



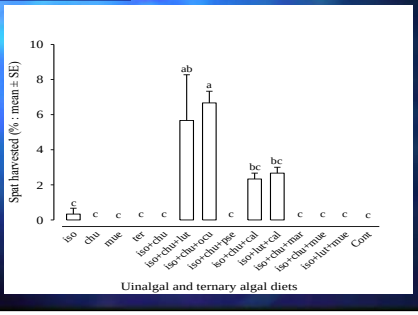
Larval diet — Binary algal diet – spat produced



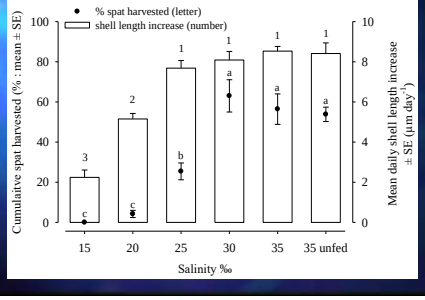
Larval diet — ternary algal diet growth rates



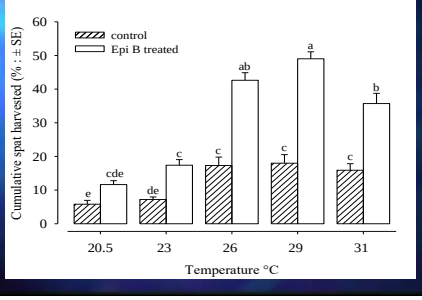
Larval diet — ternary algal diet – spat produced



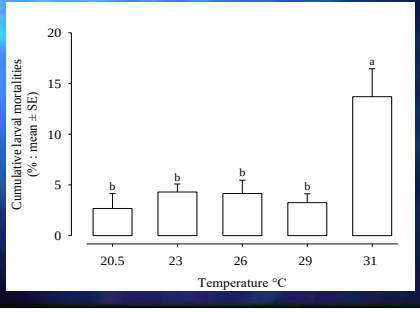
Salinity



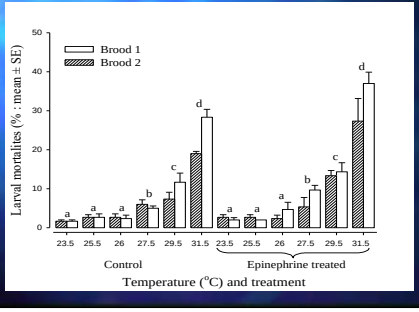
Larval rearing temperature



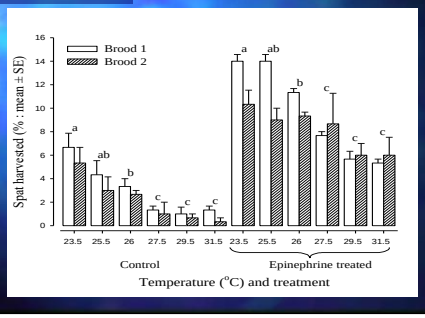
Larval rearing temperature

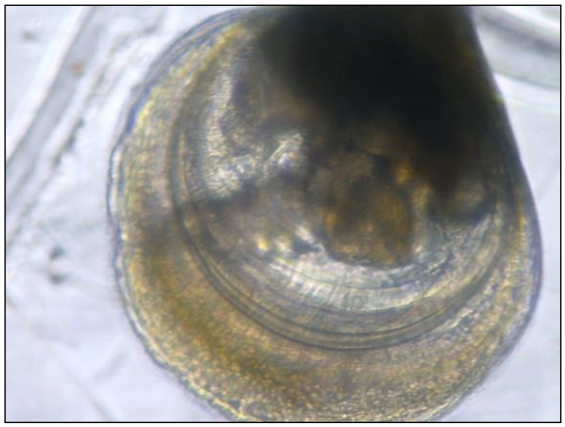


Thermal stress Mortalities



Thermal stress Metamorphosis

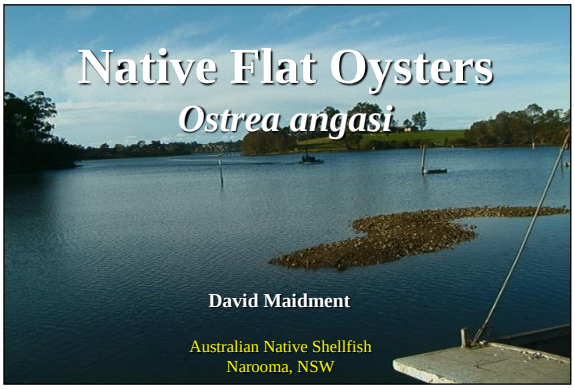




Appendix 6: Twenty Years' Experience in Commercial Flat Oyster Growing: What Have We Learned and Where to in the Future?

David Maidment

Australian Native Shellfish, NSW



Flat Oyster Distribution

Early History of Flat Oyster Production

- One of the earliest oyster industries in Australia
- Wild capture fishery
  - Dredge based
  - Soon over exploited
  - Bonamia ???
  - Market neglected

Development of the NSW Flat Oyster Industry

Late 1980's

- Southern NSW Oyster growers start cultivation and marketing Flat Oysters sourced from wild seed stock

1996

- Native Flat Oyster Development Group formed by growers which included NSW Fisheries researchers

1997

- **NSW Fisheries** start trial hatchery spat production
- Trial batches of Native Flat Oyster spat distributed to participating Development Group members for evaluation

Development of the NSW Flat Oyster Industry

2000

- Flat Oyster Workshop held in Sydney to evaluate progress
  - Issues identified requiring scientific investigation
    - Risk posed by Bonamia
    - Potential genetic issues related to the movement of Flat Oyster stocks between estuaries
  - Issues to be resolved at grower level
    - Identification of a reliable Flat Oyster seed stock supply
    - Development of reliable on farm spat nursery faculties
    - Transport and Market Development

Current Situation in NSW

What we know to-date:

- ✓ Flat Oysters grow to market size in 24 to 36 months
- ✓ Mortalities are low except where management and location is poor
- ✓ Small but growing "Boutique Market" exists
- ✓ A Research Report published in 2004 identified that Bonamia was present in southern NSW estuaries
- ✓ Research determined that the genetic population of NSW stock is similar to all other Australian states

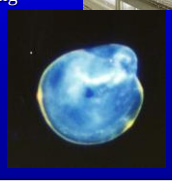
Current Situation in NSW

Flat Oyster seed supply:

- ✓ Flat Oysters seed supply is based around 2 farmer owned and operated on-farm hatcheries on the NSW South Coast

Australian Native Shellfish

- The site
  - Water supply and characteristic
- Production activities
  - Brood stock selection
  - Larvae retrieval and rearing
    - Algal feed production
  - Larval settlement
  - Nursery rearing



GROWING TECHNIQUES

GROWING TECHNIQUES

GROWING TECHNIQUES

HARVESTING

Current Situation in NSW

- Production endorsed on 28 Aquaculture Permits in 11 NSW estuaries
- Total industry production 100,000 dozen ?
- Farm gate price
  - $10 - $24 per dozen
- Grades
  - 70 – 90 mm
  - 90 – 100 mm
  - 100 mm plus

MARKETING & HANDLING

Domestic

Agent direct marketing to select restaurants in major capital and regional centres

Export potential

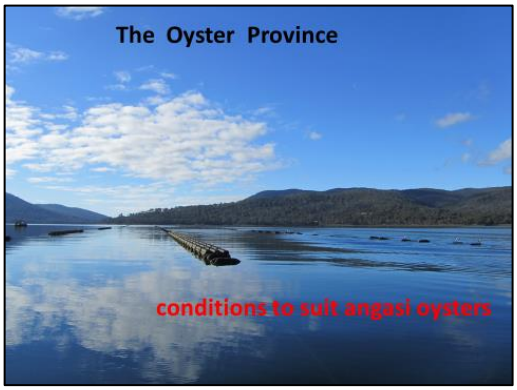
CONCLUSION

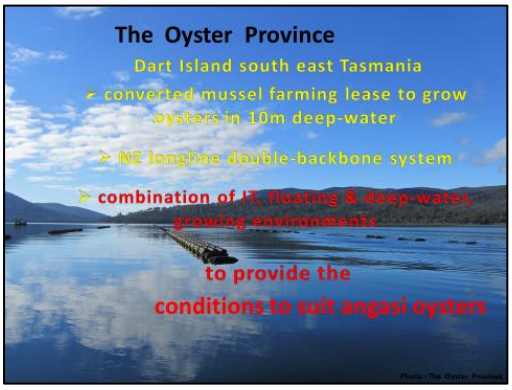
- High value shellfish product
- Small but growing “Boutique Market” exists
- Export Potential?
- Diversifies income and enhances employment opportunities in regional areas
- Group approach linking industry and research
- Environmental benefit reintroduction of native species

Appendix 7: Conditions to Suit Angasi Oysters

Yvonne Young and Steve Leslie

Intertidal Oyster Solutions, Tasmania





angasi spat-catchers
set-up like an open venetian blind

Photo - The Oyster Province

catching laths are separated
spat flexed off into water

Photo - The Oyster Province

wide variation in wild-caught spat

Photo - The Oyster Province

2-3 months - first handling
spreading into more trays

Photo - The Oyster Province

graded and numbers thinned every 6-8weeks
lids changed frequently to avoid biofouling

Photo - The Oyster Province

seed-trays free to move on swing mooring
rocking with wave action

Photo - The Oyster Province

cupped shape begins in the trays

Photo - The Oyster Province

6 month angasi spat
transferring from the deep to inter-tidal conditions

Photo - The Oyster Province

inter-tidal conditions
hardens the soft frill and chips it back

Photo - The Oyster Province

juveniles vivid colours
hand-graded after intertidal returned to the deep

Photo - The Oyster Province

hand-grading requires all hands on deck!
even Steve's 91 year old mum doesn't escape

Photo - The Oyster Province

however when the fish come around it is
difficult to keep her focused

Photo - The Oyster Province

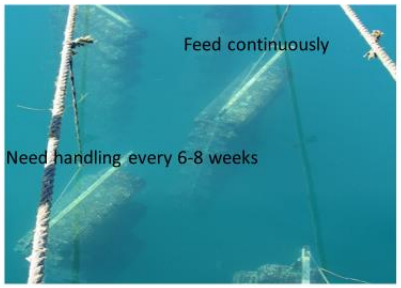
a great example

shells less fragile by 12 months

Photo - The Oyster Province

cupping follows intertidal exposure
at 18 months growth ridges seen

Photo - The Oyster Province



sub-tidal species thrive in deep-water

Photo - The Oyster Province

deep-water and intertidal conditions
water depth - 10 m
Photo - The Oyster Province

low-tide
Photo - The Oyster Province

floating system tumbles and cleans shells
and contributes to cupped shape
Photo - The Oyster Province

biofouling kept under control
shells harden and develop sheen and become cupped shape
abductor muscle strengthens
Photo - The Oyster Province

IT lines remain stable platform in all weather
Photo - The Oyster Province

Diving to set up lines
And to retrieve baskets off the IT lines
Photo - The Oyster Province

avoid this problem – by early intervention
Photo - The Oyster Province

over-settlement, not to be ignored

Photo - The Oyster Province

assessing potential of spat knocked off basket

Photo - The Oyster Province

over-settlement – time consuming whittling

Photo - The Oyster Province

mortality rate very low
cause known!

Photo - The Oyster Province

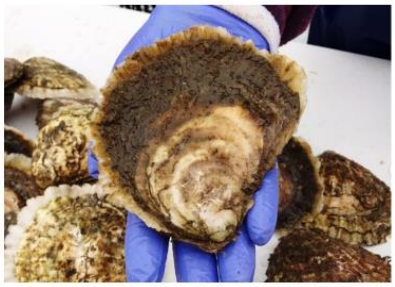
result of insufficient husbandry

Photo - The Oyster Province

Photo by Sally Dakis
ABC Rural Country Hour

interview about 6 year R&D project
culminating in angasi commercial harvest

Photo by Sally Dakis
ABC Rural Country Hour



4 years to reach this size
ready for market from 2 years

direct market sales to local chefs

Photo - The Oyster Province

would frozen product be valued by the market?
export potential!

Photo - The Oyster Province

Appendix 8: Angasi Culture in Stansbury

Steve Bowley

Pacific Estate Oysters, SA

Yorke Peninsula

Opportunities for Ostrea Angasi

June 2016

Introduction

- Industry Metrics on YP
- What we have done - Angasi
  - Applied Research 101
  - Spat
  - Grow out
- What have we learned.
  - Spat
  - Grow out
- What next in the production cycle
  - Grading – mechanical or hand
  - Market Size
  - Fattening
  - Harvest and Pack

June 2016

Industry Metrics – South Aust

Industry Metrics – Stansbury

- Currently 5 license holders in Stansbury
- 80 Hectares under Lease
- Gigas Stock in Water - in excess of 10,000,000 at any point in time
- The majority of stock held being juvenile oysters sold as "on-growers" for fattening and final sale.
- Around 200k Angasi on trial

June 2016

Industry Metrics – Stansbury

- Use adjustable long line – adjust the growing height
- Purpose built baskets (units) can swing in the tide

June 2016

PEO Metrics

- 20 Hectares under Lease
  - Shore Lease (Nursery) – 5.01 Hect.
  - Channel Lease (Fattening and Finishing) – 5.0 Hect.
  - Beacon (Grow out) - 10.0 Hect.
  - Stock in Water - in excess of 2,000,000 at any point in time

June 2016

What we have done - Angasi

- Nursery (Spat)
  - Sustainable Aquaculture Industries
    - 3 mm to 5 mm
    - In trays
    - Trial Sites
      - On each lease
      - At 3 different heights

June 2016

What we have done - Angasi

- Nursery (Spat)
  - Sustainable Aquaculture Industries
    - 3 mm to 5 mm
    - In trays
    - Trial Sites
      - On each lease
      - At 3 different heights

June 2016

What we have done - Angasi

- Nursery (Spat)
  - In Water for 12 to 16 weeks
  - Turned
  - Cleaned

June 2016

What we have done - Angasi

- Grow out
  - Grading ? – by hand
  - Into 6 mm BST baskets
  - Fast Growers are removed
  - Uniform size per basket
  - Raise in the water column

June 2016

What we have done - Angasi

- 14 months
  - Stocking Density
  - Top Clip
  - 6mm baskets
  - 200 per basket

June 2016

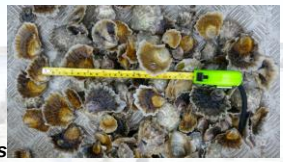
What we have done - Angasi

- 14 months
  - Growing Height
  - Top Clip
  - Lower
    - Dirty
    - Smaller
    - Overcatch (Pacific)

June 2016

What we have done - Angasi

- Typical Basket
  - 14 months
  - On Channel Lease
  - Top Clip
  - 6mm baskets
  - 200 per basket



June 2016

What we have done - Angasi

June 2016

What we have done - Angasi

- **Grow out**
  - Grading ? – by hand
  - Into 6 mm BST baskets
  - Fast Growers are removed
  - Uniform size per basket
  - Raise in the water column
  - NOT COMMERCIALLY VIABLE

June 2016

Next Steps

- **More Research in Finishing and Fattening**
  - Bag, sticks or webbing?
  - Vertical or Horizontal orientation?
  - Stocking Density?
  - Hardening

June 2016

Where to from here ?

- **Harvest and Pack**
  - How, What, When, Where…
  - Dry or Damp?
    - Seaweed
    - Wet Newspaper
    - Water crystals

June 2016

Where to from here?

- **Sales**
  - What is saleable size?
    - 2.5 inch diameter
    - 65 mm diameter
    - 65 mm Top Shell length
  - How do we generate Sales?
  - What time of year are we selling.

June 2016

Conclusion

- **Spat to Juvenile – treat exactly as we would Gigas.**
  - Significant difference in growing heights and lease position – grow well everywhere, like Gigas.
  - Variability in Growth rates.
  - Smaller Mesh baskets seem to be better.
  - No mortality in juvenile stage

June 2016

Conclusion

- **Fattening and Finishing**
  - More on farm experimentation required.
    - Basket, Webbing Sticks…
    - Vertical or Horizontal
- **Transport Logistics and Marketing**
  - More research required
  - Direct Marketing Approach – rather than through consolidators or processors

June 2016

Summary

- **Oyster Industry in Stansbury**
- **Angasi Research 101 - on Farm**
  - What we have done,
  - What we are looking to do,
- **Next Steps – Gaps in knowledge**
  - Grow out and Fattening
  - Conditioning
  - Sales and Marketing (packing)

June 2016

Questions

宝力高

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skype steven.bowley

@ongrower

June 2016

Appendix 9: Angasi Culture in Kangaroo Island

Ken Rowe

Kangaroo Island Shellfish, SA

Kangaroo Island Angasi Trials

2 years in....

Ken Rowe
Kangaroo Island Shellfish
0427 233 886
Ken.rowe@bigpond.com

Introduction

- No experience with Angasi (only 8 years oyster farming)
- But lots of interest!
- We believe Angasi are well suited to our provincial style branding amongst other benefits
- Met with Dave Maidment, and Advance Mussels briefly
- Now 2 years into our trials of subtidal versus intertidal and/or combination

Brief Summary to date

2014 1st batch SARDI	• Bigger spat to subtidal on ladders • Good start • Then crabs – left them too long dirty and crowded • >60% mortality • Survivers to intertidal low line	
2015 2nd batch Louth Bay	• Most to 3m Seapa Low, high feed line (channel) • A few to Deep Water ladders • Intertidal performed better, cleaner, still good growth (sepa3 – float) • Subtidal got dirty quickly so moved	

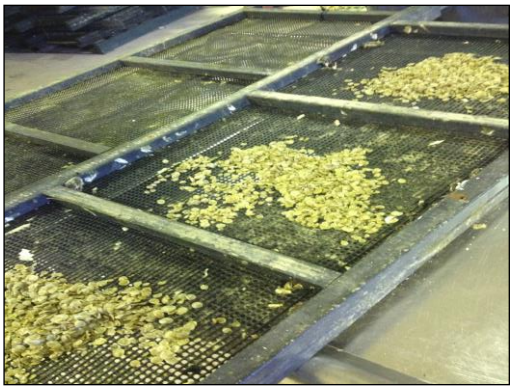
Brief Summary to date continued

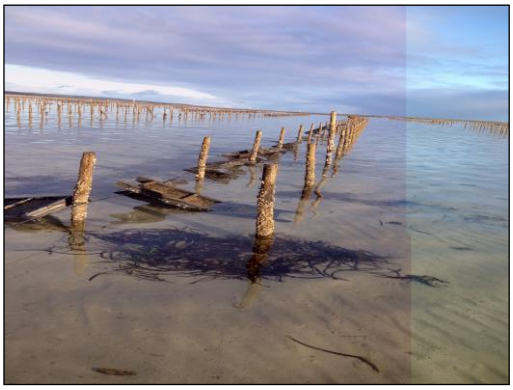
Current	• Most stuff min grades and tracking different densities • All C40 in my intertidal Angasi lines (low, good feed). Some but minimum air time. Just let oysters tell me best height. • Latest grade (2&3) >40mm to Deep water • Powering along over last 2 months 50-60+ and flatenning • (seem to have big growth spurt this time of year and water is good) • Hope to set to sale 500	
What Next	• I don't know!	

Appendix 10: Angasi Culture in Coffin Bay

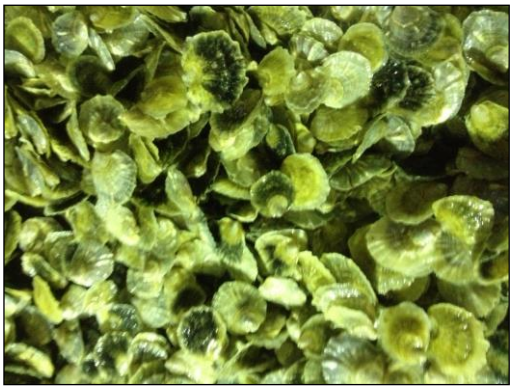
Jedd Routledge

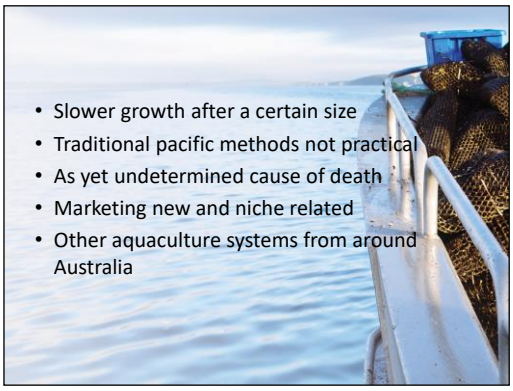
Natural Angasi, SA

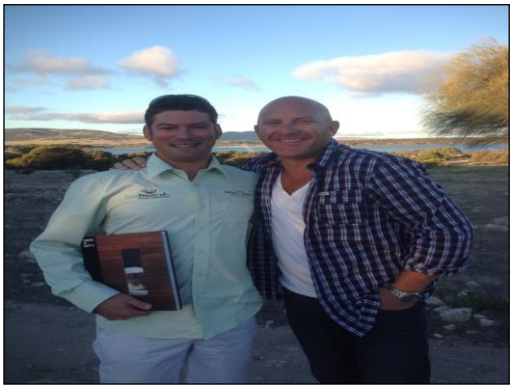





• 90% stock loss
• Angasi oysters very different than pacific
• Hard lesson
• BUT, try again!
• SARDI spat in June 2014
• LB spat in April 2015




• Slower growth after a certain size
• Traditional pacific methods not practical
• As yet undetermined cause of death
• Marketing new and niche related
• Other aquaculture systems from around Australia



Oyster fishing in South Australia

(c) **Timeline of fishery development:**

1836 Colonization of South Australia

1853 First introduction of legislation, to permit the "laying down" of oysters where beds did not occur

1873 Legislation to "prevent the wanton destruction of oysters" (fishery closures, minimum size, the deposit of "injurious matter" on a bed)

1881 Appointment of first inspector of oyster fisheries

1885 Legislation to "promote the breeding of oysters and regulate the fishery" (licensing)

1890 Highest recorded catch of 3,549 bags

1895 Inspector recommended "all further dredging on known deposits must be suspended to enable the beds to be restocked by spawn"

1911 Inspector reports on the failure of the industry, "attributable chiefly to uncontrolled overworking"

1912 Establishment of the first National Oyster Reserve and Nursery

1932 First wastewater treatment system built in Adelaide

1944 No men engaged full time in oyster fishing

1970 *Crassostrea gigas* aquaculture begun

Alleway & Connell. Loss of an ecological baseline through the eradication of oysters reefs from coastal ecosystems and human memory. *Conserv Biol.* 29:795-804

Oyster fishing in South Australia

Location	Year	Original historical records of catch or CPUE length of time fishing	Estimated total N oysters removed during the time period
Denial & Smoky Bay, West Coast	1894	8 to 10 bags^{-1} day^{-1} for 12 months	3,150 day^{-1} boat^{-1}
Coffin Bay, Eyre Peninsula	1874	16,000 bags in 3 years	5,600,000
Dutton Bay, Eyre Peninsula	1888	200 bags in 2 days	70,000
Proper Bay, Port Lincoln	1889	1,586 bags in 6 months	555,100
Mount Dutton Bay, Eyre Peninsula	1888	1,630 bags in 6 months	570,500
Spalding Cove, Eyre Peninsula	1889	3 to 5 bags^{-1} day^{-1} to each boat	1,400 day^{-1} boat^{-1}

Loss of native oyster reefs

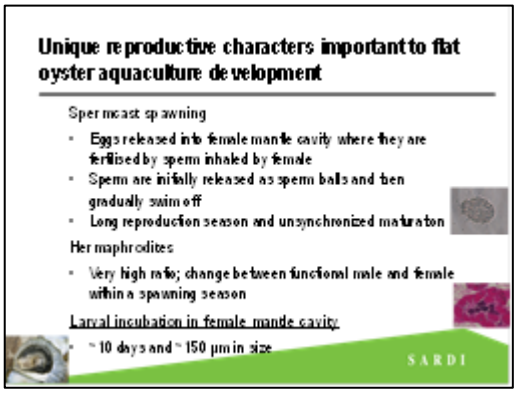
- Fishing historically considered to occur around Port Lincoln, Coffin Bay & Stansbury
- Oyster reefs historically occurred across > 1,500 km

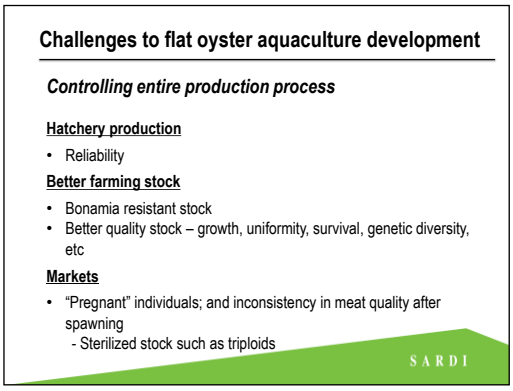
Alleway & Connell. Loss of an ecological baseline through the eradication of oysters reefs from coastal ecosystems and human memory. *Conserv Biol.* 29:795-804

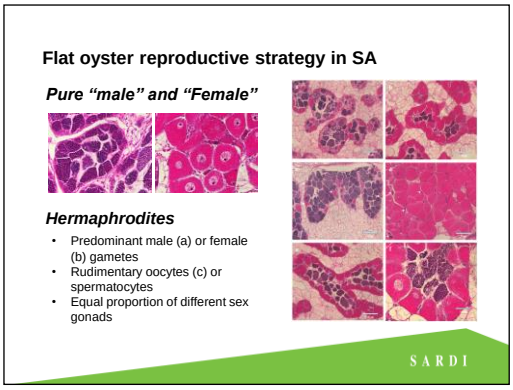
Appendix 11: Flat Oyster (Ostrea angasi) Reproductive Strategy in SA: Toward Controlling Entire Production Process

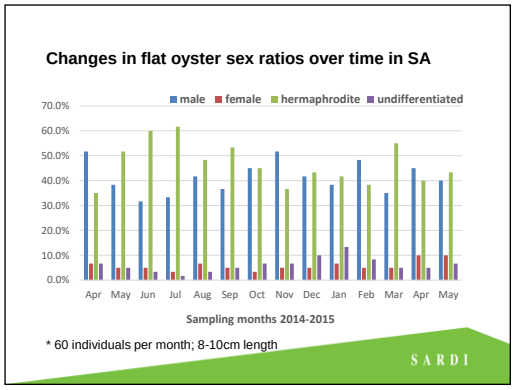
Professor Xiaoxu Li

South Australian Research and Development Institute





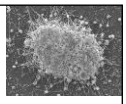


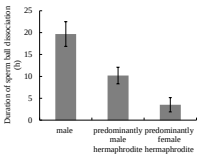


Percentage of flat oysters having larvae in their mantle cavity in SA

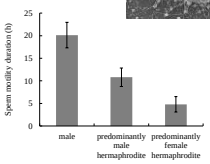
SARDI

Sperm ball and its dissociation





Dissociation duration



Duration of sperm motility

Sperm qualities depend on the maleness level of animals

SARDI

Toward controlling entire production process in flat oyster

Broodstock

- Spawning induction and gametes collection
- Self-fertilization vs strip-spawning
- Methods for in-vitro fertilization
- Sperm quality depends on maleness levels in flat oysters
- High levels of male and hermaphrodite and low larvae-bearing individuals – broodstock conditioning (biosecurity; genetic diversity)

Larval rearing

- Using our technique, newly fertilized eggs could be cultured externally to grey/black larvae with >70% survival rate.

SARDI

Acknowledgement

SAORC/SAOGA
Mr Brendan Guidera – Pristine Oysters
Mr Mahabubul Hassan – Flinders University

Thanks for your attention

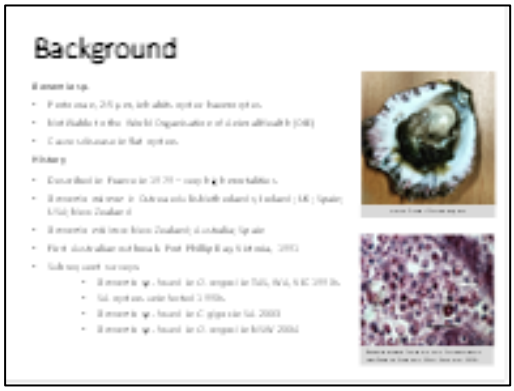
SARDI

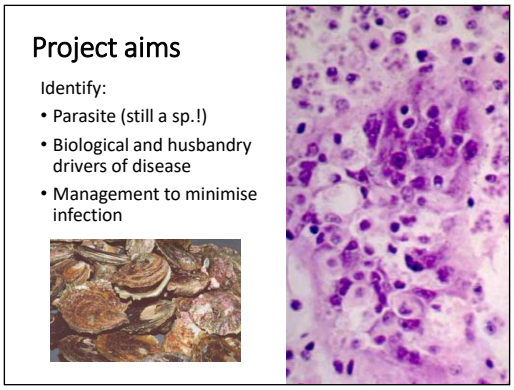
Appendix 12: Bonamia in Native Oyster Aquaculture in Australia

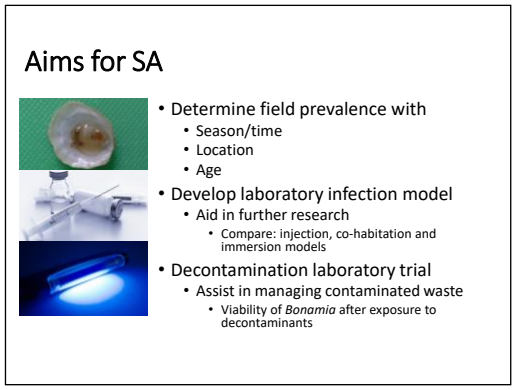
Dr Marty Deveney[1] and Jessica Buss[2]

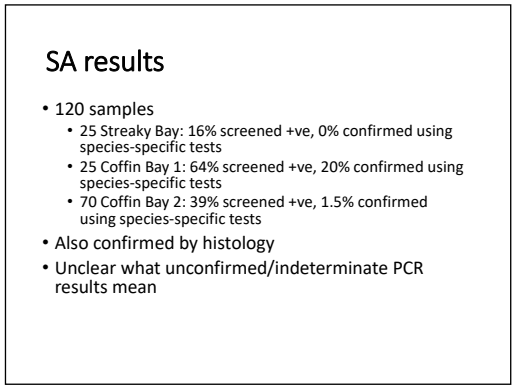
[1] South Australian Research Development Institute

[2] Flinders University of South Australia







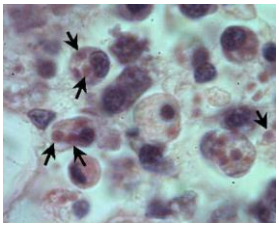


Victoria

- Lab experiments to assess factors that lead to disease:
  - temperature, salinity, feed, handling
- Field trials at two sites to identify risk factors:
  - Depth, site parameters, plankton, management

CSIRO AAHL

- Long sequencing to identify parasite



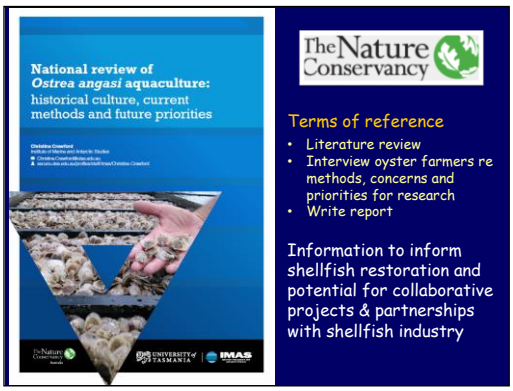
Thanks

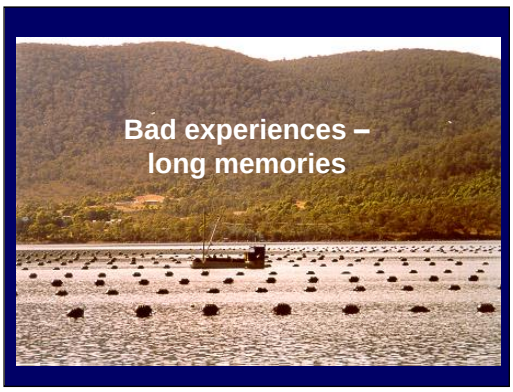
- Native Oyster industry
- FRDC
- Participating oyster farms and hatcheries
- Brian Jones, Henry Lane, MAF NZ
- Nick Moody, Mark Crane, CSIRO AAHL
- Tracey Bradley, EcoDev Vic
- SARDI Aquaculture Program
- MISA Biosecurity Node

Appendix 13: Why Are So Few Angasi Oysters Cultured in Australia?

Dr Christine Crawford

Institute of Marine and Antarctic Studies, Tasmania





How to improve angasi aquaculture?

Develop culture methods specific to angasi oysters & their environment

- Grow in low intertidal to subtidal
- Limited fluctuations in salinity, minimal flooding
- Lower densities & more careful handling
- Reduce handling and grading during stressful periods *e.g. high temperatures, spawning*
- Improved broodstock management – selective breeding and quality control of spat

R & D priorities

- Investigate grow-out techniques specific to angasi oysters
- Improved farm management to reduce effects of Bonamiosis
- Structured breeding program – for Bonamiosis resistance, growth and condition
- Improve growout techniques – size and timing (season) of placement in the sea

R & D priorities

- Investigate cost-effective methods to extend shelf life, e.g. intertidal exposure, mechanisation and new packaging methods – modified atmosphere, quick freezing
- Develop and expand markets, including SE Asia and Europe (substitute for *O. edulis*)
  - includes training wholesalers and chefs how to handle angasi oysters

Learn from one another and farmers overseas, esp. *O. edulis*

Appendix 14: Flat Oyster Aquaculture in New Zealand

Helen Mussely

Cawthron Institute, New Zealand

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FLAT OYSTER AQUACULTURE IN NEW ZEALAND

HELEN MUSSELY

CAWTHRON INSTITUTE, NELSON, NZ | JUNE 2016

CAWTHRON INSTITUTE - WHO ARE WE?

- New Zealand's largest independent research organisation
- Pioneering Science since 1921
- > 200 specialists
  - 80 Analytical R&D services
  - 60 Coastal & Freshwater
  - 30 Aquaculture
  - 30 visiting collaborators – professors, post-docs

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AQUACULTURE RESEARCH AND PRODUCTION

Ministry for Primary Industries Manatū Ahu Matua

CAWTHRON INSTITUTE

SANFORD LIMITED

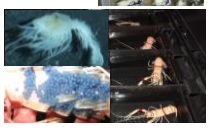
AOTEAROA

New Zealand King Salmon

nmit

KONO Pure taste of New Zealand

AQUACULTURE: MUSSELS, PACIFIC OYSTERS, FLAT OYSTERS, GEODUCK, SCAMPI, EELS, TOHEROA



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FLAT OYSTERS – *Ostrea chilensis*

Industry-endorsed as most likely candidate for a new, high-value shellfish species

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OUR SPECIES - *Ostrea chilensis*

- Most extreme brooding behaviour of any of the flat oyster species
- Larvae are held in the adult brood cavity right up to the point where they are competent to settle
- Once released the larvae settle within minutes
- Low fecundity
- No well-defined reproductive season seen in the wild with brooding taking place over a prolonged period, even all year-round in some populations
- Hermaphroditic species – some individuals are totally male, some totally female but most are both
- Sex tends to change from mostly male to mostly female with age

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NZ FLAT OYSTER FISHERY

- First fishery harvests in 1860s
- Bluff/Foveaux Strait
- Closure in 1986 due to *Bonamia exitiosus*
- From '87 to '93 catch levels varied
- Fishery closed from '93 to '96 to allow recovery
- Added to QMS in 1997

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NZ FLAT OYSTER AQUACULTURE

- Several companies are working to develop flat oyster aquaculture:
  - Kiwa Oysters (Kono)
  - Tio Point Oysters
  - Sanford
- Marlborough Sounds and Stewart Island
- Single seed in lanterns, cages, or pinned

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KIWA OYSTERS

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TIO POINT OYSTERS

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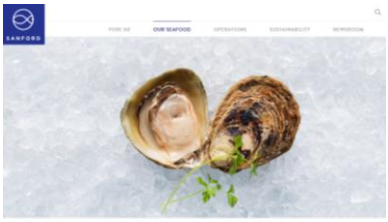
SANFORD



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The Cultured Shellfish Programme (CuSP)

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HIKINA WHAKATUTUKI

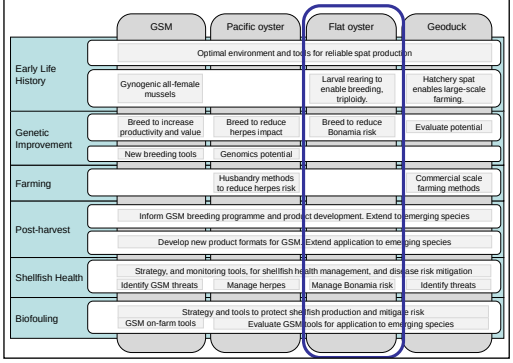
Domestication and pilot scale production of the flat oyster for export by 2016

KONO
Pure taste of New Zealand

CAWTHRON INSTITUTE

SEAFOOD INNOVATIONS LTD

TE WHĀRIKI



CULTURED SHELLFISH PROGRAMME

Flat oyster breeding generates improved seed stock for flat oyster farming

- Selective breeding to increase disease resilience
  - Synchronised reproduction for controlled matings
  - Clear breeding objectives
  - Genetic control is challenging!
- Triploidy to avoid Bonamiosis
  - Induced spawning
  - *In vitro* fertilisation
  - *In vitro* larval rearing

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SYNCHRONISED REPRODUCTION

- Understand drivers of reproductive conditioning to improve synchronisation of spawning
- Different stock types and sizes
- Manipulate temperature, food and photoperiod

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THE 2011-2013 CONDITIONING TRIALS

Precondition (ambient temp, pond algae)

Three stock types:
- Tio Point
- Bluff
- Cloudy Bay

Nursery (ambient temp, pond algae) | Controlled (controlled temp, gourmet algae) | Farm sourced (Tio Point)

Fortnightly: visual and histological assessments

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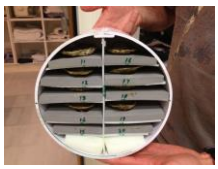
MRI

- Worked well to identify brooders
- Limited application in terms of identifying reproductive state



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PRODUCTION OF FAMILIES

- 7 half-sib families in 2012
- Crosses between different stock types as well as crosses using individuals from the same stock type

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PRODUCTION OF FAMILIES

- 40 half-sib families in 2013

- Breeding objectives?:
- Production traits, e.g. growth rate
- Survival, but what drives mortality?
  - Environmental stress?
  - Specific pathogens? (e.g. *Bonamia*)

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PACIFIC OYSTERS

- Traditionally based on wild spat
- The Cawthron's Pacific oyster family breeding programme initiated in 1999
- Initial objectives = high-surviving, fast-growing oysters with good shell shape and a high meat-to-shell ratio
- In 2010, mass mortalities caused by the oyster herpes virus (OsHV-1 µ-var) precipitated a shift in the programme's objectives and strategies
- Survival is now the single most important breeding objective

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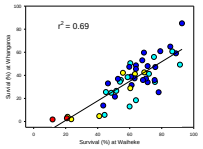
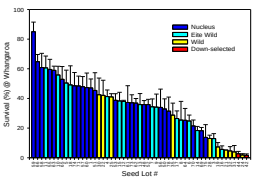
FAMILY SURVIVAL – SPAT FIELD DATA

- Wide range of survival
- High correlation between sites
- Moderate heritability
- Good potential for selection





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A LAB-BASED SYSTEM FOR OsHV-1CHALLENGE

- Standardized virus dosage
- Standardized environmental conditions
- Manipulating environmental conditions
  → understand interactions between host, virus and environment
- Effective tool for selective breeding specifically towards OsHV-1 resistance or as part of a controlled multi-trait programme.

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INDUCED SPAWNING

- Animals that had been in our 'best-practice' conditioning system
- Spawning induction by; thermal shock, denatured sperm, being left dry
- Animals left in individual containment overnight with time lapse camera

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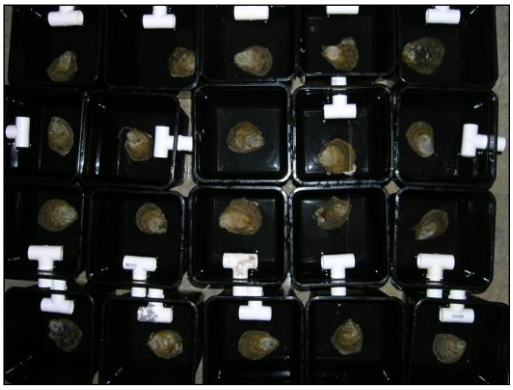

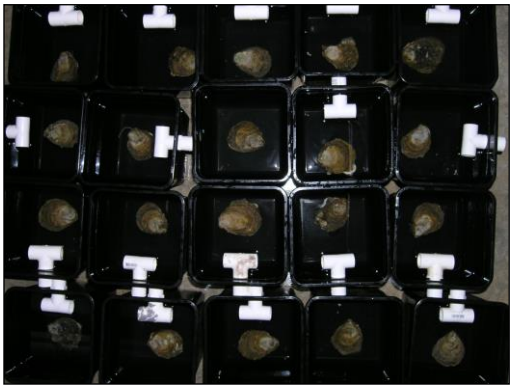

FERTILISATION AND LARVAL REARING

- *In vitro* fertilisation achieved
- Evidence of self fertilisation
- Time of spawning was quite critical as gametes seemed to get 'old' quite quickly
- *In vitro* larval rearing is very challenging
- Big void to cross to even start working on triploidy

Eggs

Larvae

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SPAT REARING

An effort to understand:

- Upper temperature limits
- Optimal rearing temperatures
- Optimal feeding rates
- Algal species preference
- Settlement substrate preference

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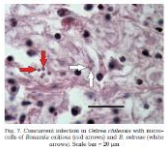
BUT THEN IN 2015…

- *Bonamia ostreae* identified
- First time reported in Southern Hemisphere
- Major implications in terms of stock movements and therefore our research programmes
- Clear path forward has not been obvious



***Bonamia ostreae* in the New Zealand oyster *Ostrea chilensis*: a new host and geographic record for this haplosporidian parasite**

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WHERE TO FROM HERE?

- Develop Industry Strategy
  → what are industry research priorities now?
- Work with MPI to find way forward to enable research
  - → how can we safely work on an OIE notifiable pathogen?
  - → ensure that industry is supported through this challenge
- Infrastructure investment for biosecurity best practice
- Continue on work that is still possible even under current restrictions (*e.g. in vitro* larval rearing)
- PhD student working on developing PCR identification for APX
- Desktop risk assessments for potential of disease transmission between shellfish species

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THANK YOU!

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HIKINA WHAKATUTUKI

Acknowledgements:

- Cultured Shellfish Programme funded by MBIE
- Team at Cawthron Aquaculture Park
- Kono

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