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FISHERIES RESEARCH & DEVELOPMENT CORPORATION

Workshop Report

National Tropical Oyster Workshop
Darwin, 22-23 October 2018

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Workshop Report - National Tropical Oyster Workshop, Darwin, 22-23 October 2018
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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

I would like to acknowledge the contribution of the project steering committee, Wayne Hutchinson, Wayne O'Connor, Karen Gibb and Justin Fromm in planning and facilitating sessions during the workshop.

I would also like to thank Andrew Beer for coordinating travel requirements for Western Australian (WA) Aboriginal community representatives. Thank you to all the guest speakers and attendees for contributing their time and experience to the event and engaging in collaborative and open conversations to identify and progress key industry research and development needs.

Executive Summary

The first national workshop on tropical oyster aquaculture was organised by the Principal Investigator Matt Osborne, Program Leader Aquaculture and Regional Development, Fisheries Division of the Northern Territory (NT) Department of Primary Industry and Resources (DPIR). It was held in Darwin on 22 to 23 October, 2018 at the Waterfront Campus of Charles Darwin University (CDU). The workshop brought together representatives from Aboriginal communities, industry, government agencies, and Australian and international researchers, to discuss strategic priorities that needed to be addressed in order to develop a tropical oyster industry.

The workshop was held in response to recognition of the increasing interest in tropical oyster aquaculture in the NT, Western Australia (WA), Queensland (Qld) and northern New South Wales (NSW). The workshop addressed a need to foster greater collaboration across the various projects and provide strategic direction to future research and development activities. Technical experts from across Australia, Malaysia and the Pacific Islands presented on key areas, including hatchery production, species distribution, farming systems, food safety and biosecurity. A combination of small and large group discussion approaches were used to explore opportunities for Aboriginal participation and identify engagement models, challenges and opportunities to address Research, Development and Extension (RD&E) needs.

The objectives of the workshop were to:

1 Bring together representatives from all interest groups to share information on current tropical oyster research and commercialisation projects.
2 Identify key information required to progress tropical oyster aquaculture across northern Australia.
3 Identify approaches to provide culturally appropriate tropical oyster aquaculture opportunities for Indigenous communities.

The workshop provided stakeholders the opportunity to learn about previous and current research projects and hear from commercial oyster farmers to better understand the challenges facing industry development. A list of the strategic priorities was developed to inform future collaborative research and development activities. Key recommendations from the workshop were to:

- Engage early with Aboriginal groups to build collaborative partnerships.
- Undertake targeted research to improve hatchery production of Blacklip Oysters.
- Develop informed, genetic and biosecurity risk based protocols to manage the translocation of spat and broodstock.
- Address knowledge gaps to implement targeted, risk-based and informed shellfish quality assurance programs suited to the north Australian environment and remote context.
- Develop production systems suitable for northern Australia.

The workshop provided an opportunity for industry, Aboriginal communities, researchers and government agencies to develop a shared direction and identify research priorities for a tropical oyster industry development. This has supported the refinement of a tropical oyster research project application to the CRC for Developing Northern Australia. If successful, this project will provide a pathway to address some of these industry barriers in a collaborative arrangement across jurisdictions.

Workshop participants supported further events with greater industry participation, particularly southern growers and wholesalers/marketers. A follow up workshop should provide a greater focus on specific issues with more time to develop detailed research plans and accountabilities.

Keywords

Blacklip Oyster, tropical, aquaculture, Aboriginal, economic development, workshop, research, development, extension

Introduction

Currently, there is considerable and growing interest in establishing commercial culture of tropical oyster species. Across northern Australia a number of RD&E projects are being conducted to address technical, ecological, food safety and business development priorities to better understand and evaluate the commercial potential of tropical oyster farming. Since 2011, the Aquaculture Unit of DPIR has worked in partnership with Aboriginal communities and commercial partners to develop low technology, sea-based, aquaculture enterprises suitable for remote Aboriginal coastal communities. Longline oyster farming trials have been established on the Tiwi Islands and on South Goulburn Island, where 90 000 Blacklip Oyster spat were recently stocked. Wild spat collection trials were conducted over the 2017-18 wet season at Tiwi Islands, South Goulburn Island, Nhulunbuy and Groot Eylandt. The Darwin Aquaculture Centre (DAC) has been conducting research on the histology, breeding cycles, genetics and hatchery production of Blacklip Oysters (e.g. Nowland et.al. (2018))[1]. CDU has led research on shellfish quality assurance work focusing on *Vibrio* bacteria and heavy metal concentrations in oyster tissue.

In the Pilbara region of WA, a tropical oyster trial has been established near Karratha and there is a business farming Blacklip Oysters in Qld (John Collinson, Bowen) with interest also being shown by farmers in northern NSW. There is interest from existing businesses looking to diversify and Aboriginal corporations seeking culturally appropriate economic opportunities from their land and seas. In addition, there is an increased national focus on development opportunities in northern Australia. However, there are key issues unique to northern Australia that are of concern for the industry (i.e. a high tidal range, crocodiles, remoteness, environmental factors, cyclones and their impact on infrastructure) while other issues are common to all shellfish production ventures (e.g. shellfish quality assurance).

With the number of interested groups across northern Australia increasing, a workshop was suggested to bring together the diverse range of stakeholders to discuss each other's interests and progress, and provide a forum to identify key issues confronting the development of this industry and how these could be addressed. The workshop intended to provide all stakeholders the opportunity to become better acquainted personally and professionally with each other, and inform each other's intentions and identify issues so collaborative opportunities could be identified.

Objectives

The objectives of the workshop were to:

1. Bring together representatives from all interest groups to share information on current tropical oyster research and commercialisation projects.
2. Identify key information required to progress tropical oyster aquaculture across northern Australia.
3. Identify approaches to provide culturally appropriate tropical oyster aquaculture opportunities for Indigenous communities.

[1] Nowland, S.J., O'Connor W., & Southgate P.C., 2018, *Embryonic, Larval, and Early Postlarval Development of the Tropical Black-Lip Rock Oyster Saccostrea echinata*, Journal of Shellfish Research, 37(1):73-77. 2018

Method

DPIR's Aquaculture and Regional Development Unit (ARDU) was supported by the FRDC to plan and deliver a national workshop on tropical oyster aquaculture. A steering group was formed to develop the workshop program, which included Matt Osborne (Principle Investigator, ARDU), Wayne Hutchinson (FRDC), Wayne O'Connor (NSW Department of Primary Industry), Karen Gibb (CDU) and Justin Fromm (Pilbara Development Commission).

The workshop program (Appendix 1) was designed to provide an overview of the various tropical oyster programs underway in the NT, WA, Qld NSW and internationally, before providing focused sessions on key issues for the emerging industry. These were identified by the steering committee based on their shared experiences and in consultation with industry experts as species identification and genetics, hatchery production, grow out technologies and food safety. Each session comprised a number of presentations from experts, followed by an opportunity for a panel discussion and questions from the audience. Two targeted workshop sessions were designed, one to investigate opportunities to support Aboriginal participation in the industry and another to consolidate the information presented at the workshop to develop strategic research priorities.

A draft workshop program was distributed to stakeholders, industry and researchers to provide input to the agenda and gauge levels of interest in the topics and willingness to attend. There was a high level of support for the workshop with over 60 persons registering to attend (Appendix 2). Most responded with an interest to learn about current and planned projects and network with researchers and other interested stakeholders.

Aboriginal communities across the NT and WA have long recognised the opportunities that tropical oyster farming may provide. The steering committee acknowledged the need to support community representatives to participate in the workshop, learn about oyster farming developments and develop linkages to other community groups and technical experts. To achieve this, the project supported the attendance of a limited number of existing oyster farmers and Aboriginal representatives from communities in the NT and WA that were engaged in tropical oyster farming development activities.

The two-day workshop was held in Darwin on 22 and 23 October 2018 at the Waterfront Campus of CDU. The workshop was facilitated by the Principal Investigator in collaboration with CDU, members of the project steering committee and Mr Ricky Archer, CEO of the North Australian Indigenous Land and Sea Management Alliance (NAILSMA). Mr Archer facilitated the session on 'Support Indigenous participation in oyster farming". A workshop dinner was held on 22 October at the Darwin Sailing Club.

The full workshop program is included in Appendix 2. A summary of the workshop program is provided below.

Day 1

- Current tropical oyster farming developments underway - NT, WA, Qld and NSW.
- Overseas tropical oyster farming developments – Vietnam, Malaysia and Pacific Islands.
- Current oyster farming methods – John Collison's experience and gear used in high tidal areas.
- Planning and regulatory issues confronting tropical oyster farming developments:
    - species identification, distributions and genetics (WA, NT, Qld and NSW)
    - Hatchery production
    - Infrastructure and production systems.

Day 2

- Biosecurity and food safety (heavy metals, ASQAP, *Vibrio* sp.).
- Workshop - supporting Indigenous participation in oyster farming.
- Workshop - strategic RD&E needs for tropical oyster farming across northern Australia.

Results

The workshop brought together representatives from a diverse range of stakeholders including Aboriginal communities, rangers, development organisations, existing oyster farmers, representatives from Australian pearl producing companies, researchers, government agencies and oyster farming equipment suppliers. Workshop evaluations indicated 79% of respondents rated the workshop as 5/5 (excellent) with 95% of respondents agreeing that the workshop met their expectations and 100% stating that the knowledge and experience gained would be useful for their work. Respondents highlighted that the most interesting and useful topics and outcomes were:

- Networking opportunities and group discussions.
- Overview of the oyster industry and existing projects.
- Farming experiences and gear technology.
- Shellfish health, biosecurity and food safety.
- Overseas oyster industry developments.

The results of the workshop session on RD&E priorities are provided below. They have been grouped into the following themes: Aboriginal Development, Species and Genetics, Hatchery Production, Food Safety and Gear Technology and Farming Practices.

Aboriginal Development

How to collaborate:

- Conversations between communities and businesses should occur organically and often take time. The extended negotiation duration can conflict with industry and government consultation periods and draw out decisions. This is often due to not engaging early with communities and developing a communication process that recognises the needs and priorities of both parties.
- Communication pathways often change based on where the project takes place. In areas dominated by Native Title Determinations, Prescribed Bodies Corporate are the representative organisations, whereas in the NT the majority of engagement occurs through Land Councils, which are responsible for engaging with Traditional Owners. Regardless of the representative organisation structure, consultation often involves speaking with a range of stakeholder levels (board, clan, community, family) and at different locations (local, regional and in cities) depending on where Traditional Owners reside.
- A best practice tool kit and extension services would be helpful, including information on how to do business with Traditional Owner groups. The Kimberly Land Council does this in the Kimberley.

Challenges

- The impact of government and policy changes, and the resulting lack of continuity affects project sustainability and community willingness to engage.
- Governance training needs to be expanded so groups are equipped to participate from an informed position.
- Traditional Owner driven research and economic development requires resources to be available. Some groups do not have access to adequate funding and require support either through funding organisations, business partnerships or a combination of sources.
- Food safety programs need to be developed and implemented by governments.
- Development of business models tailored to appropriate scale. Communities need access to reliable and clear information, business support and training in disciplines required for success.
- Limited experiences in doing business.
- Language use and terms of reference can be a challenge when developing agreements.
- Remote areas need better logistics and affordable air transport/freight.

Opportunities

- Training and employment pathways could occur through engagement with local schools, providing linkages to training and jobs. Ranger programs could be built on to support the industry; however, it can be difficult to facilitate junior participation.
- Traditional knowledge and western knowledge working together. Traditional knowledge and science to be included in research and farming practices.
- Good to work on and care for Country.
- Collaboration opportunities and working with other communities are crucial for larger scale oyster (or other) businesses.

Species and Genetics

How to collaborate

- Transparency and willingness to share data and experiences.
- Collaborative research projects.
- Visibility via project reports and communication materials. Important to attract others working in this space.
- Where possible, standardise methods for the potential to use "reference" sites or stocks?

Challenges

Species and distribution

- Combine existing data to provide an overview of species and genetics across northern Australia. This would require an extension of the existing population genetic information.
- More sampling could identify additional lineages and/or species.
- Biosecurity sampling - have we covered key locations?
- Biosecurity concerns – existing industry (pearl oyster/prawns (white spot)). Information to support translocation policy development. How do we define the "threshold" for differences?
- Risk assessment required to inform sampling and biosecurity controls.

Opportunities

Advanced genetics and marker-assisted selection could support production optimisation.

Gear Technology and Farming

How to collaborate

- Who is the glue? Extension services are needed to assist operators and support technology and research adoption.
- Training and skills development – off/on farm and across proponents.

Challenges

- Crocodiles and sharks etc.
- Environment: tides, weather, cyclones, biofouling, hard and rubble substrates.
- Handling techniques: stocking, grading size and density of oysters.
- Site selection parameters for suitable nursery, growth, finishing areas and systems.
- Access to cool rooms.

Opportunities

- Automating cleaning, grading and other labour-intensive processes.
- Infrastructure and gear innovation: produces suitable oysters, reliable, relocatable or submersible to avoid cyclones.
- Field trips and other means to support technology transfer.
- Development of operations manuals for farming tropical oysters: sub tidal, inter tidal and at different life stages to promote optimal growth and development (e.g. air exposure to promote muscle growth and high energy to shape shell).
- Collaborative research programs and development of wrap around services to support industry development.

Food Safety

How to collaborate

- Access national expertise through the Australian Shellfish Quality Assurance Advisory Committee (ASQAAC) and the FRDC SafeFish program and local expertise at government departments, CDU and existing industries experiences.
- Collaborative research partnerships: SafeFish/State and Territory Governments, the Australian Department Agriculture and Water Resources, Cooperative Research Centre (CRC) funding sources, such as the CRC-Projects, CRC for Developing Northern Australia and the Food Agility CRC.

Challenges

- A primary production food safety legislative gap in the NT. Who in the NT Government owns this issue and can act to resolve it? This will need to involve discussions and collaboration across the Territory Government agencies, including Fisheries. This will be a long-term process; an immediate start is recommended.
- There is a distinction between the legislation gap and the risk assessment required to understand food safety risks and inform the development of an NT Shellfish Quality Assurance Program.
- Shoreline surveys are required to assess risks and determine sampling requirements for harvest zones. There is a lack of accurate information on potential food safety risks across the NT, heavy metal concentrations in oyster tissues, algal bloom patterns and *E.coli* population spikes due to heavy rain and river discharges are poorly understood.
- Remoteness, access and costs could be a challenge for testing and assessment of samples. Distance to certified laboratories and expertise for specialised services (e.g. phytoplankton identification) may require innovation and capacity development for the industry to develop in the north.

Opportunities

- As the industry is still developing, there is an opportunity for the quality assurance programs to support site selection of oyster farms in northern Australia. This could prevent farms from establishing in areas with higher food safety risks and support farm/regional planning (e.g. multiple growing areas supporting a few harvest zones). This would lessen sampling requirements but does pose market access and other risks that would need to be managed.
- Appears to be broadly supported and desired by communities.
- Validation of rapid screen tests for in field testing for paralytic shellfish toxin, amnesic shellfish toxin, diarrhetic shellfish toxin and *E.coli*. The ability to rapidly test oysters could support the remote operations and partly address the challenge of distance to certified laboratories.
- Build the capacity in the north to support the industry, including:
    - Certified laboratories to carry out necessary tests (*Vibrios*, *E.coli*, toxins etc.)
    - People: government regulators and food safety managers, samplers (potentially Aboriginal ranger programs) and growers.

- Research to identify thermal tolerances in water and throughout the cold chain to balance survival post-harvest and reduce *vibrio* populations.

Hatchery Production

How to collaborate

- Knowledge exchange and staff placements to support capacity development of hatchery staff.

Challenges

- Manipulating salinity is likely to be a key to hatchery success for tropical oysters. This may be a problem for the Albany multispecies hatchery.
- There is a high demand for Blacklip Oyster spat; supply to industry is limited by production at the DAC and inability to supply spat to other jurisdictions due to a lack of biosecurity controls and translocation policies for tropical oysters.
- There is a balance between commercial production and RD&E. The current lack of knowledge on optimum production conditions will continue without additional RD&E to resolve production bottlenecks.
- In this early phase of development, it is unclear how a commercial hatchery can be set-up appropriately when potential demand remains unknown. Commitment on ongoing hatchery supply from government hatcheries would support investment and industry development.

Opportunities

- Develop a reliable and consistent hatchery protocol to support industry. Refining settlement triggers and increasing settlement percentages are current priorities for Blacklip Oysters at the DAC. Assess settlement protocols Epi v culch set target 40% set-rate is the target.
- The industry may be made up of a combination of large and small producers; how to manage the economies of scale and hatchery production volumes? What is the minimum production run that is economically viable?

Expertise/Resources

Each workshop group developed a list of relevant expertise and resources to support industry development. Below is a list of those discussions:

- Government Agencies
    - DPIR, DAC
    - Department of Primary Industry (NSW)
    - Department Primary Industry and Regional Development (WA)
    - WA Museum
    - NT Museum.
- Universities
    - James Cook University
    - CDU
    - University of the Sunshine Coast
    - Griffith University
    - University of Western Australia.
- Organisations and committees
    - SafeFish
    - ASQAAC
    - NAILSMA
    - FRDC, Indigenous Reference Group
    - Kimberly Land Council.

Funding

Targeted and applied research will be a key factor in establishing a tropical oyster industry across northern Australia. Workshop groups were asked to identify funding streams that may be available to support future research projects. A compiled, non-exhaustive list is provided below.

- Internal university schemes.
- Australian biological resources study grants.
- Innovation connections research grants.
- ARC linkage grants.
- Cooperative Research Centres (CRCNA, CRCP, Food Agility).
- State and Territory Government sources (e.g. Advance Qld, Innovation funds).
- FRDC.
- Aboriginal Benefits Account (NT).
- Indigenous Land and Sea Corporation.
- Indigenous Business Australia.

Implications

The workshop provided an opportunity for industry, Aboriginal communities, researchers and government agencies to develop a shared direction and identify research priorities for tropical oyster industry development. This has supported the refinement of a tropical oyster research project application to the CRC for Developing Northern Australia. This is a collaborative project between industry, Aboriginal communities, WA, the NT and Qld Government agencies, the Pilbara Development Commission and the FRDC. It will address a number of the key workshop recommendations, including developing biosecurity and translocation protocols for tropical oysters across northern Australia, conduct hatchery research to improve spat supply to farms and undertake farming trials to investigate gear technology and identify optimal production systems. If successful, this project will provide a pathway to address industry barriers in a collaborative arrangement across jurisdictions.

Recommendations

Key recommendations from the workshop were:

- Engage early with Aboriginal groups to build collaborative partnerships.
- Undertake targeted research to improve hatchery production of Blacklip Oysters.
- Develop informed, risk-based protocols to manage the translocation (spat and broodstock) and biosecurity risks.
- Address knowledge gaps to implement targeted, risk-based and informed shellfish quality assurance programs suited to the north Australian environment and remote context.
- Develop production systems suitable for northern Australia.

Further Development

In addition to the already mentioned recommendations, the workshop identified clear gaps that require additional actions to resolve, not the least being work to address gaps in food safety legislation in the NT. This will require considerable work within the NT Government to implement legislation, regulation and management changes regarding primary production food safety.

Workshop participants supported further events with greater industry participation, particularly from southern growers and wholesalers/marketers. A follow-up workshop should provide a greater focus on specific issues with more time to develop detailed research plans and accountabilities.

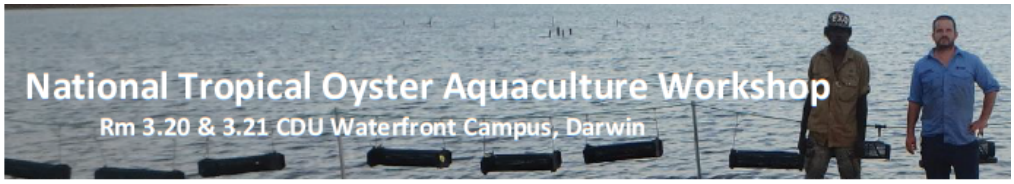
Extension and Adoption

The project provided an opportunity for researchers, industry and Aboriginal communities to share their experiences and information. This workshop report will further extend these by making the presentation slides available to the broader industry and interested stakeholders. A media release will be developed to extend the outcomes of the project. The project will also be recognised in a potential future media announcement if and when the oyster project application to the CRC NA is successful.

Appendices

Appendix 1: Workshop Program

Day 1
22/10



8:30 - 8:40 Welcome to country – Mark Motlop
8:40 - 8:50 Opening address – Hon. Lawrence Costa
8:50 – 9:10 Workshop overview and introductions

9:10 – 10:30 **Current tropical oyster farming developments**

Matt Osborne - Northern Territory Overview of research projects
Mike Snow - Western Australia Overview
Justin Fromm/Steve Gill - Pilbara FRDC project
Peter Lee - Queensland Overview
Wayne O'Connor - Northern NSW Tropical Oyster Interests

Morning tea

11:00 – 12.30 **Overseas tropical oyster developments**

Mr Alan Wong Chin Poh - Tropical oyster farming in Malaysia
Michel Bermudes - Tropical oyster farming in the Pacific Islands
Vietnam ACIAR Project - Wayne O'Connor

Lunch

Major issues confronting development of tropical oyster farming in Northern Australia

1:40 – 2:30 **Species and genetics**
Mike Snow & Carmel McDougall – Tropical oyster genetic studies
Sam Nowland - NT Population Genetics
Panel discussion - Implications for hatchery production and translocation

2:30 – 3:15 **Appropriate Oyster Farming Technology**
John Collinson - tropical oyster farming in Queensland
Alex Jack - Oyster farming technology
Panel discussion – Farming technology and application

Afternoon tea

3:45 – 4:45 **Hatchery Production**
Sam Nowland - Darwin Aquaculture Centre
Johnathon Bilton - Albany Multispecies hatchery
Michel Bermudes - Pacific Islands
Panel Discussion

4:45 – 5:00 **Overview of day one**

6:30 – 8:30 **Workshop Dinner** – Darwin Sailing Club - 8 Atkins Dr, Fannie Bay

Day 2 National Tropical Oyster Aquaculture Workshop

23/10 **Rm 3.20 & 3.21 CDU Waterfront Campus, Darwin**

8:30 – 8:45 Recap from previous day

8:45 – 10:30 **Food safety**
Matt Osborne - Heavy Metal context in NT
Wayne O'Connor - Threats from disease and food-borne illness -lessons learnt
Alison Turnbull - Managing Food Safety Hazards associated with shellfish
Phil Baker - Application of Sanitary Surveys in the NSW Situation
Anna Padovan - Vibrios in warm waters - implications for oysters and public health

Morning Tea

11:00 – 11:30 **Food Safety cont.**
Murray Barton - NT Fisheries biosecurity strategy
Panel Discussion

11:30 – 12:30 **Oyster farming opportunities for Indigenous communities**

Lunch

1:30 – 2:30 **Workshop cont.**

2:30 – 3:30 **Strategic Research Priorities**
Wayne Hutchinson - Strategic priorities for Tropical oyster aquaculture development

Afternoon Tea

4:00 – 4:45 Justin Fromm - Collaborative project application to CRCNA

4:45 – 5:00 Workshop Summary and close

Appendix 2: Attendance list

Northern Territory		
Matt Osborne	NT Fisheries	Matthew.Osborne@nt.gov.au
Murray Barton	NT Fisheries	Murray.barton@nt.gov.au
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Ricky Archer	NAILSMA (North Australian Indigenous Land and Sea Management Alliance)	ricky.archer@nailsma.org.au
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Raylene Cooper	Chair - Murujuga	chairperson@murujuga.org.au
Mike Snow	Fish Health & Aquaculture Research, WA Fisheries	Michael.Snow@dpird.wa.gov.au
Johnathon Bilton	WA Multispecies Shellfish Hatchery - Albany	jcbilton@gmail.com
Jude Tyzack	Exec Officer Albany Shellfish Hatchery Advisory Committee	ashaceo@aquaculturecouncilwa.com
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Queensland		
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Jan Strugnell	Associate Professor James Cook University	jan.strugnell@jcu.edu.au
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Other		
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Alison Turnbull	SafeFish	Alison.Turnbull@sa.gov.au
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International		
Alan Wong	SeaHarvest Aquamarine - Malaysia	oysterhatch@gmail.com
Michel Bermudes	Pacific Community, Noumea, New Caledonia (www.spc.int)	michelbe@spc.int

Presentations

NT Overview – Matt Osborne

NT Overview

Oyster workshop

Matt Osborne
Department of Primary Industry and Resources
22/10/2018

Background

Originated from request from Traditional Owners

Objective: to aid communities in developing sustainable economic opportunities through oyster aquaculture

Challenges:
Lack of information on the species
Similar barriers to many other remote areas of Australia
Weather, technology, skills and crocodiles
Policy and regulatory gaps

Tropical Rock Oyster Development Program

Four sections:

Grow- out

Shellfish Quality Assurance

Business Development

Hatchery Production

Grow out trials

On country trials

Small scale trials

Racks

Floating baskets

Hanging baskets

Learnings

Balance – labour / growth rates

Developing Skill Sets

Promising grow rates – 18 months

Wild spat collection

Trialled at 4 locations across the NT

Low cost alternative for small scale operations

Varying settlement rates across sites

High rate of non target species

Requires modification to locations and deployment times to target Black Lip oysters

Farm expansion

Warruwi farm was recently expanded to cater for increasing spat volumes.

90,000 spat currently on site

Stage 1 – 400m of longlines

Quality Assurance

Quality Assurance Program

Do not have a jurisdictional Shellfish Quality Assurance Program

Remote context – understand risk and effective food safety controls

Environmental Health Division

Sample Case Study

South Goulburn Island

22 monthly samples at two sites - 2014-17

No toxins in oyster tissue

Alert triggers for water concentrations reached on three occasions.

- *Pseudo-nitzschia pungens/multiseries*
- *Prorocentrum lima*
- *Alexandrium tamarense* - Sept 2015 site 2 closure limit

Business Development

To date...

Evidence of market product acceptance and immediate markets for remote product

Supporting community governance arrangements

Building ownership of oyster trials and linking with business support services

Moving forward

Undertaking study on: business operations, investment and production scale

Small scale (break-even) and a larger commercial operation.

Hatchery Production

Improving production

Require refined hatchery methods to supply commercial quantities of single seed spat.

Research at the DAC is addressing bottlenecks

Day of death – day 6/7

Improving settlement %

Moving forward

Aboriginal communities

Warruwi – Yagbani Aboriginal Corporation have an MoU with Fisheries, increasing the size of pilot farm, building corporate governance and business capacity to operate the farm

Tiwi Island – Working with Tiwi Island Training and Employment to increase operational capacity and training in oyster husbandry

Groote Eylandt – Anindilyakwa Land Council undertaking study on aquaculture feasibility in the region.

Interest from other communities and entrepreneurs across the NT.

Moving forward

Investigation and application of shellfish quality assurance in the NT.

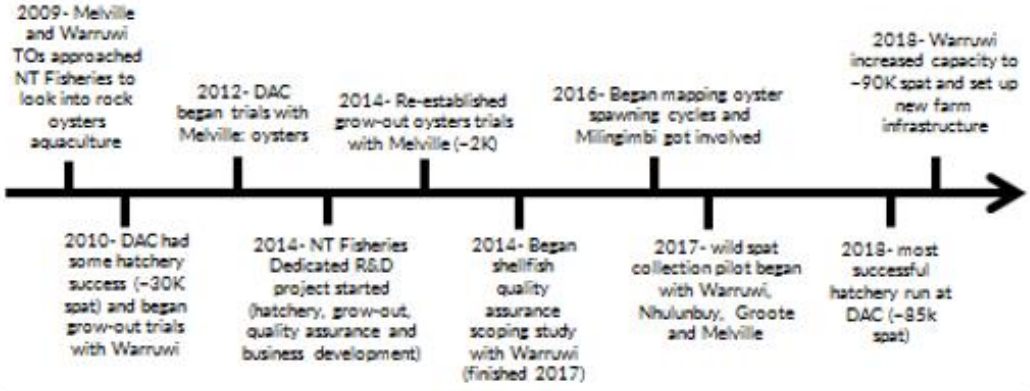
Support pilot commercial farms

consistent and commercial spat supply (DAC)

Capacity building and support for community businesses (on country)

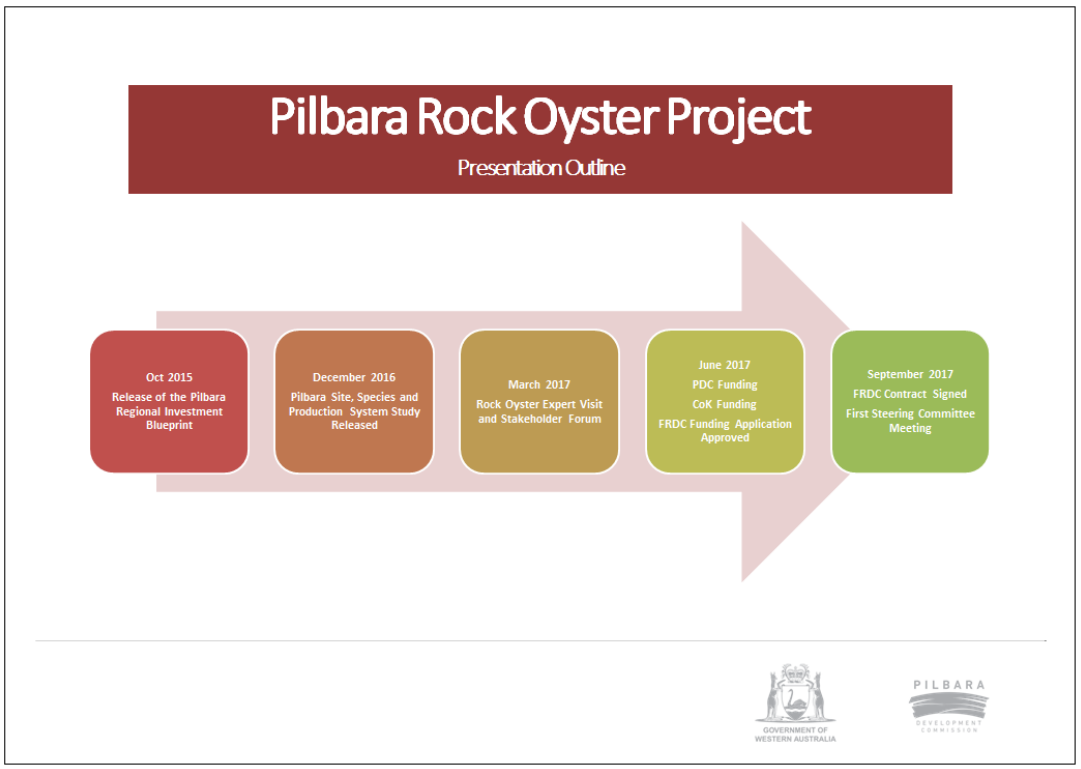
Regional approach to RD&E

Program Timeline

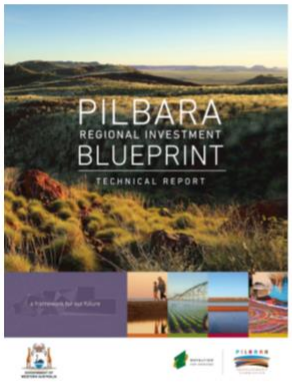



Acknowledgements
Thanks to all partners for their support and participation
Yagbani Aboriginal Corporation
CHARLES DARWIN UNIVERSITY
NORTHERN TERRITORY GOVERNMENT
University of the Sunshine Coast
JAMES COOK UNIVERSITY AUSTRALIA
NSW GOVERNMENT
Department of Primary Industries

Pilbara Rock Oyster Aquaculture Research and Development Project – Steven Gill & Justin Fromm



Pilbara Regional Investment Blueprint



ENABLING	VALUE ADDING	DIVERSIFYING
Land access, core infrastructure and facilities	Logistics, engineering and supply chains	Agriculture and aquaculture
Education, training and a skilled workforce	Innovation and advanced technology	Energy
People and communities	Diverse and robust small to medium sized businesses	Tourism

GOVERNMENT OF WESTERN AUSTRALIA

PILBARA DEVELOPMENT COMMISSION

Aquaculture Site, Species and Production System Studies

Edible Rock Oysters

- Most Potential
- History of farmed oysters (Pearl Oysters)
- Lower environmental approval hurdles
- Established technology

Challenges

- High cost structure
- Environmental conditions
- Potential for naturally occurring cadmium and other heavy metals

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PILBARA DEVELOPMENT COMMISSION

Rock Oyster Expert Visit and Stakeholder Forum

March 2017

- Invited Industry and Research experts
- Field trip to research site – Maxima Pearling Company existing pearl lease site in Flying Foam Passage

Outcomes

- Noted the wild oyster populations
- Observed that oyster culture is possible
- Advice - Get oysters in the water and see what happens!

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PILBARA DEVELOPMENT COMMISSION

Securing Funding

18-24 month R&D Project

- **Pilbara Development Commission $100,000**
- **FRDC - $150,000**
- **City of Karratha - $50,000 cash**
- **Murujuga Aboriginal Corporation - $80,000 in-kind**
- **Maxima Pearling Company - $100,000 in-kind**
- **Project Steering Committee**
- **Agreement to Cooperate**

GOVERNMENT OF WESTERN AUSTRALIA

PILBARA DEVELOPMENT COMMISSION

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the opportunity group

Long History of Pearling and Oyster production in Pilbara.

1880's	**Pearl Diving vessels very common in the Pilbara**
1950's	**Commercial operations to bottle wild harvest rock oyster from the Dampier Archipelago**
2016 – present -	**Research and pilot scale project on Tropical Rock Oysters**
• Locations:	Pilbara - Our Project
	Also - Kimberley, Gascoyne, Abrolhos Islands,
• Species:	Coral Oyster *Saccostrea scyphophilla*
	Black Lipped Oyster *Saccostrea cucullata*

Cossack Pearl fleet circa 1880's

Jarring oysters inside a tent on Conzinc Island, c1950.
Flying Foam oysters a product of Samson Fisheries

What is changing in WA?

Changing Regulatory Environment

- New Aquatic Resource Management Act 2016
  - All Pearling Leases will become Aquaculture Leases.
  - 63,000 hectares of WA marine estate are pearling and aquaculture leases.
  - 60,000 hectare are currently single species *P.maxima*

Multi-species Mollusc Hatchery (Albany, WA)

- State Government Investment
- 5 year, $2.3 Million funding commitment
- Operator with extensive oyster experience
- Full quarantine capacity (hold tropical species without risk to local environment)

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the opportunity group

Fisheries Minister at opening of Albany Mollusc Hatchery

Spat production room, Albany Mollusc Hatchery

What do we want to achieve in the trial?.

Develop techniques and data to support commercial aquaculture production of local species of oyster.

1. Trial of different species to get best product
2. Establish secure supply of oyster spat
   a) Collection of wild spat settling naturally
   b) Hatchery production of spat from wild oysters.
3. Trial different growing techniques and gear types to enable commercial production
   a) Intertidal longline system
   b) Subtidal longline system
4. Collect and Analyse growth and mortality data.
5. Environmental and food safety monitoring program
   a) Regularly monitor all aspects of water quality
   b) Ensure oyster production meets food safety and quality requirements

Our Goal is to have Pilbara Coral Oysters in the Market

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the opportunity group

Map of Sites

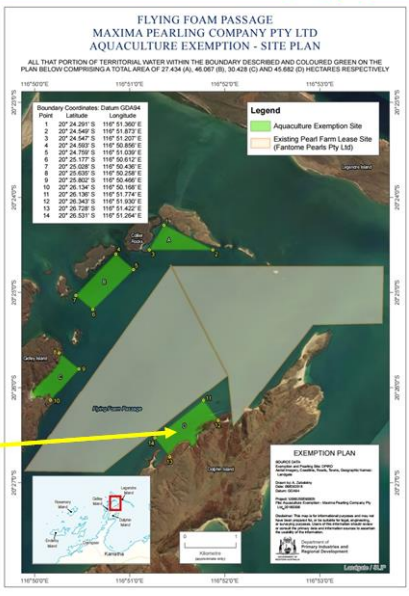
Rock Oyster Sites (green on map)

- Exemption to undertake Rock Oyster R&D
- Current trial located in Area D (45 hectares)
  - Subtidal longlines 2 X 100m
  - Intertidal longlines 4 X 50m

Pearl Farm Lease Site

- Area in the centre of Flying Foam Passage is our Maxima Pearl leases (>1330 hectares).
- Until legislative change the site can only be used for Pearl Production.

Area D



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Area of Flying Foam in perspective.

Flying Foam Rock Oyster Sites
- Area A (27 hectares)
- Area B (46 hectares)
- Area C (30 hectares)
- Area D (45 hectares)
- Total 148 hectares
- Current Pearling Lease (1330 hectares)

Cone Bay Rock Oyster sites
- Oyster Exemption sites 246 hectares
- Current Pearling lease 1900 hectares

Coffin Bay South Australia Pacific Oyster Leases
- Oyster Aquaculture Zones (2670 hectares)
- Total Leased Area (173 hectares)
- 40 Growers
- Employing 100 people
- Generating approx $30 million

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Flying Foam Passage


Coffin Bay

Equipment on site.

Wild Spat Collection Gear
Zapco Spat slats
On site at tidal height where oysters settle

Intertidal Longline system
Adjustable height, multi-line and basket systems commonly used in Australian Oyster industry.

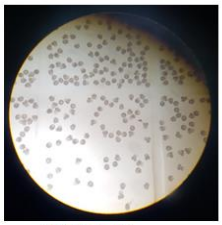
Subtidal Longline system
Surface longline with baskets suspended below
Adapted for Rock Oyster production from Pearling Longline equipment.

Oyster Species

Coral Oyster: *Saccostrea scyphophilla*
- Local to the Pilbara
- Genetics the same across WA
- Demonstrated can be produced in hatchery
- Great taste
- Heat and exposure tolerant


Coral Oysters look and taste great when in condition


Male doing its thing in hatchery


Spat 2 days old


Coral Oyster spat 2mm


Coral Oyster spat now 6 mm

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Oyster Species

Black Lipped Oyster

- Settled on spat collectors
- Local to the Pilbara
- Genetics vary across WA
- Heat tolerant
- Frilly Shell

Adult Black Lipped Oyster from Flying Foam Passage, small but very tasty

Spat settled on collectors in Flying Foam Passage

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Spat collector with 1st oyster settlement

Size of Black lipped oyster June 2018

Aquaculture in the Pilbara. Opportunities for Rock Oyster Production

What we have achieved upto July 2018.

Hatchery Spat

- Brood stock from Flying Foam Passage sent to Albany Hatchery.
- Spawning induced with approximately 500,000 Spat settled
- Grown to 4mm in hatchery.
- 130,000 hatchery produced spat deployed to Flying Foam Passage Site
- Additional 90,000 spat deployed
- Variation to gear

Wild Spat

- Collectors deployed
- Approximately 7,500 wild spat collected
- Spat placed in baskets on intertidal site
- Graded twice - good growth rates.

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2000 Coral oyster spat ready to deploy

Wild caught Black Lipped oyster in Flying Foam Passage

Aquaculture in the Pilbara. Opportunities for Rock Oyster Production

Project Research Priorities

1. Secure supply of spat
2. Shellfish Quality Assurance Program certainty
3. Research to support translocation (Zones)
4. Gear Technology (Spat handling)
   - Nursery grow out to > 12 mm
5. Gear technology (Subtidal grow out)
   - Replicatable (minimum cost)
   - Refine subtidal grow out equipment
   - Operating procedure to manage biofouling growth
   - Operating procedure to control pests
6. Gear technology (Intertidal grow out)
   - Replicatable (minimum cost)
   - Operating procedure to achieve ideal shell shape
   - Operating procedure to maximise growth

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Project role in broader industry development

- Excess spat produced in spawning run
- Collaboration with DPIRD researchers and other potential oyster growers
- Excess spat available for trials at multiple sites along the WA coast.
- Including
  - Cockburn sound
  - 2 sites at the Abrolhos Islands
  - Pilbara
  - Kimberley
- Opportunity to speed up industry development and gain results from multiple sites and environmental conditions across WA.

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Albany Hatchery Manager demonstrating grading tech to WA oyster farmer group in Cockburn Sound

DPIRD researcher discussing oyster trial with WA oyster farmer group

Media Coverage

Lessons Learnt – Number 1

Don't believe, or let key stakeholders believe, everything outside consultants tell you about what is possible in your region sight unseen.

- Aquaculture is conducted around the world in extreme weather environments
- High cost structure
  - No consideration of regional changes
- A greenfield site
  - No consideration of existing:
    - infrastructure
    - equipment
    - expertise
  - Pearl Oyster lease conversion opportunities

Cadmium and other heavy metals

- Exmouth Gulf
- Different oyster species
- Site specific
- Shallow water, high turbidity
- Did not occur in oysters held in the water column
- Shark Bay study by DoF showed low incidence of cadmium in cockles

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GOVERNMENT OF WESTERN AUSTRALIA

PILBARA DEVELOPMENT COMMISSION

Lessons Learnt – Number 3

Start building relationships very early in the investigation stage and maintain transparency on everything you are doing.

Oyster experts to visit the Pilbara

Feb 15, 2017, 5:31 PM

Experts in aquaculture and industry development will be in Karratha next month to discuss the opportunity for edible oyster...

Pilbara NEWS

Oysters a purler for investors

US Space Camp trip a dream come true

Oyster trial gets $30k grant

Alicia Perera

The partners behind a Pilbara edible oysters pilot project have won an aquaculture scholarship to travel and learn from industry peers interstate.

Murujuga Aboriginal Corporation and the Kimberley-based Maxima Pearling Company last week received $30,000 Government funding as second-round winners of the Premier's Agriculture and Aquaculture Entrepreneurship Program.

The award will allow MAC and Maxima staff to travel to established edible oyster production areas in South Australia, NSW and Tasmania to learn about industry technologies.

They are working to start a research and development trial of farming rock oysters off the Dampier Archipelago by the end of the year.

Agreement to Cooperate

Pilbara rock oyster research and development project

Between

PILBARA DEVELOPMENT COMMISSION

(ABN: 24 898 158 508)

MURUJUGA ABORIGINAL CORPORATION

(ABN: 51627395274, ICN: 4629)

MAXIMA PEARLING COMPANY

(ACN: 009 191 441)

CITY OF KARRATHA

(ABN: 83 812 049 709)

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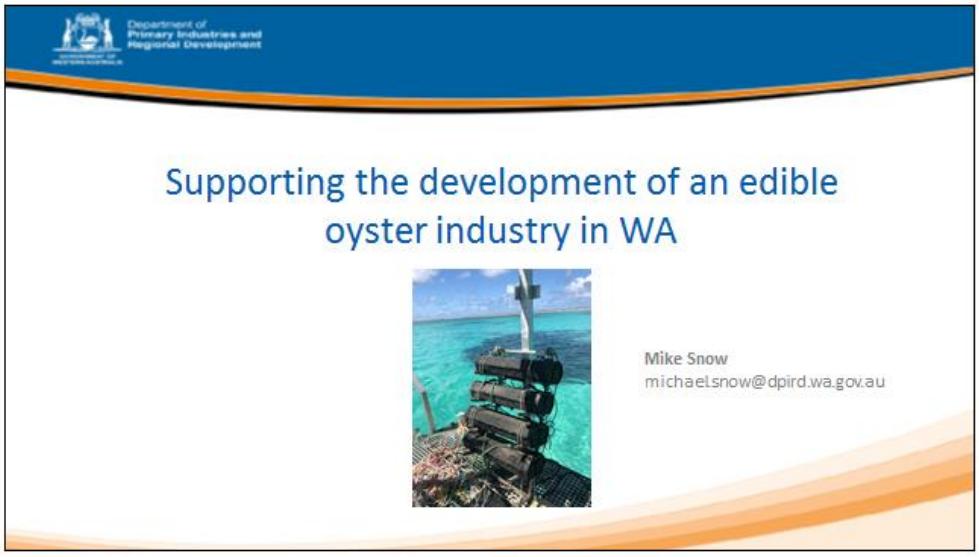
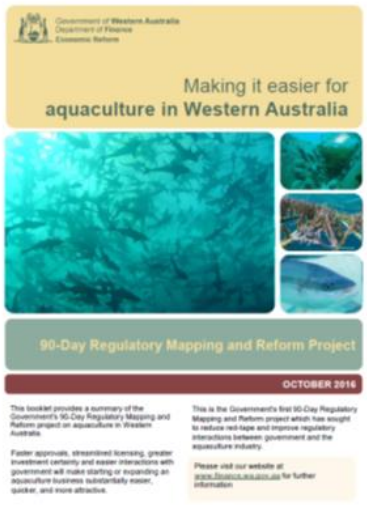
Supporting the development of an edible oyster industry in WA – Michael Snow





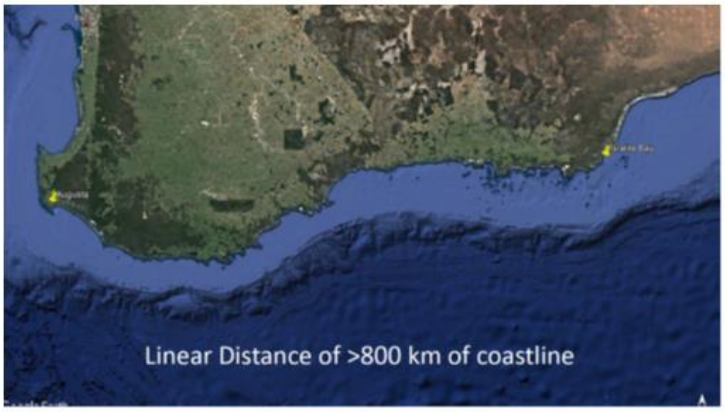
➢Support for new industry entrants to obtain aquaculture leases and licenses

- Streamlining regulatory processes and applications

- Supporting Site identification and assessment
  EPA approvals
  Management & environmental monitoring plans

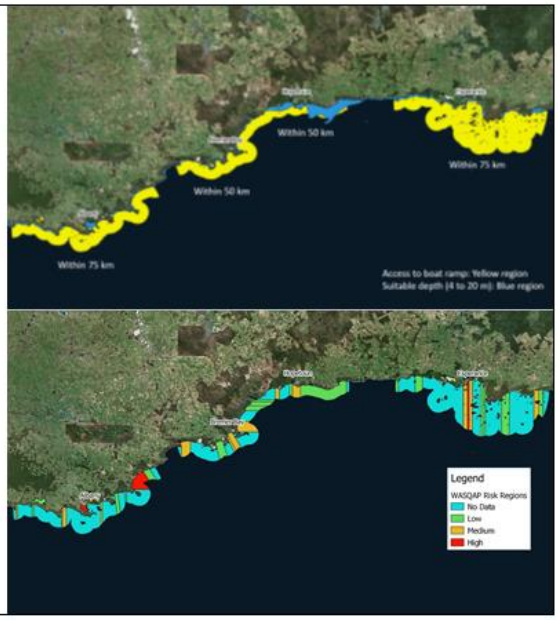
Case Study:
South Coast Project- Creating investment ready shellfish aquaculture zones

- $1.66m investment



Site Suitability Criteria developed in consultation with industry

- Site access
- Available infrastructure
- Water depth
- Water quality
- Hydrodynamics
- Minimum size requirements
- Conflicting users
- ASQAP considerations
- Accessibility



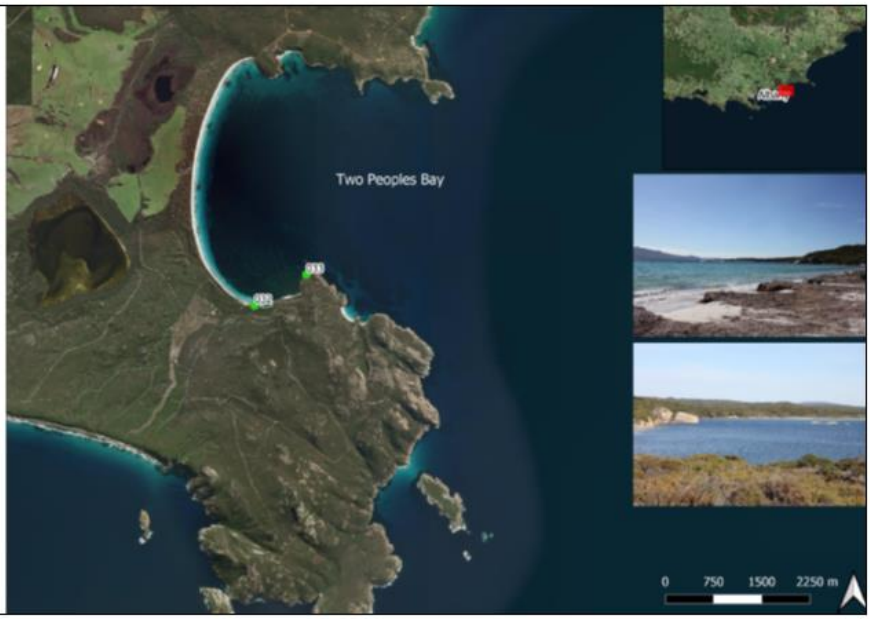
Two Peoples Bay

Favourable

- Potentially sheltered site
- Potential food availability
- Consistent depth for subtidal culture
- Bordered by a national park

Unfavourable

- Multiple users
- Septic tanks
- Heavy wrack
- Limited access via land to the site



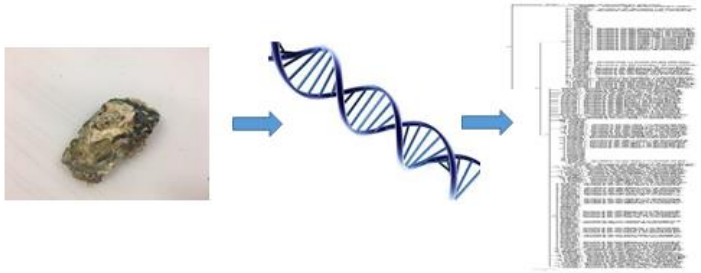
Site Ranking

Of 17 sites considered, **6** sites selected
Albany Zone includes **5** sites, total of **1461** ha
Esperance Zone includes **1** site, **1396** ha
Total proposed SCADZ = **2857** ha

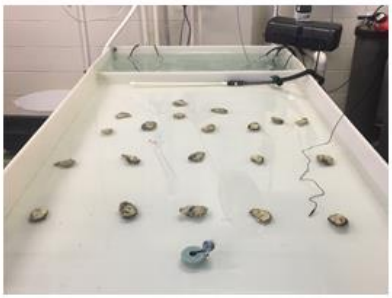
Rank	Site
1	Frenchman Bay
2	Vancouver Peninsula
3	Shoal Bay
4	Wylie Bay
5	Gull Rock
6	Oyster Harbor
7	Two Peoples Bay
8	Victoria Harbor/ Big Wharton Beach
9	Rossiter Bay
10	Lucky Bay
11	Stokes Inlet
12	Duke of Orleans Bay and Secret Beach
13	Wilson Inlet
14	West Cape Howe
15	Thistle Cove
16	Starvation Harbour
17	Doubtful Islands

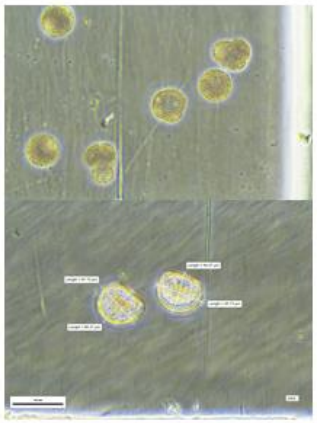
- Direct investment of $2.3million to build critical multispecies mollusc hatchery in Albany
- $$$ support for the start up phase of hatchery as it transitions to commercial viability

- R&D support to identify and obtain suitable (new) species for culture

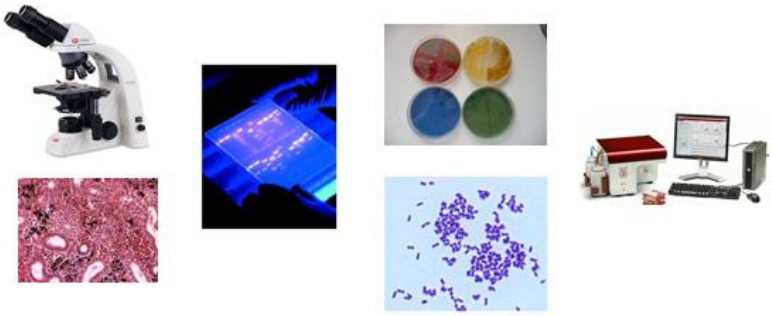


- R&D support to develop aquaculture protocols for new species through direct investment in Hillarys facility and group





- Health certification, testing and biosecurity support to maintain freedom of spat movement for industry



- Providing clear policy direction on spat movements

- R&D on other species aquaculture that may be compatible with edible oyster growing infrastructure

DPIRD's supporting role

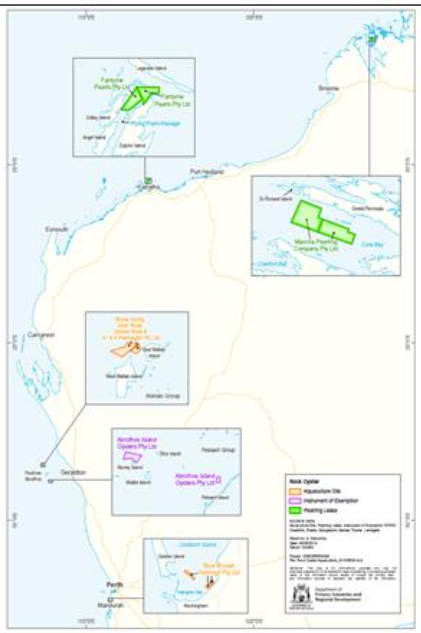
- Support a collaborative approach to R&D to support development of the industry
- Assist in developing and prioritising industry R&D needs
- Coordination of R&D (ACWA industry R&D committee)
- Leverage of R&D opportunity for industry
  - Third party research providers
  - Collaboratively identify and develop opportunities for external funding (eg NCRC, RNIF, FRDC)
- Directly investing in applied R&D to meet industry needs

Grower Science
Case Study- DPIRD Oyster Grow out Trial

- 5 ready-to-go sites identified with appropriate licenses/leases
- Informal industry group established
  - Agreement to share information
- *S.scyphophilla* species selected (more on this later.....)

- Standardised growing regime developed and agreed

2 sets of 5 baskets (thanks to Hexcyl)
Each set different starting density
5x1000; 5x 3000



Case Study- DPIRD Oyster Grow out Trial

- Broodstock obtained (Maxima/PDC)
- Training Day held
- Standard gear provided
- Hatchery run conducted (Jonathan)
- Spat deployed
- Industry monitoring program implemented
    - Growth
    - Biofouling
    - Temperature
    - Salinity
    - Turbidity
    - Total Chlorophyll
    - Phytoplankton composition
    - (Health)
    - (Contaminants)
- Every 2 month sampling

Grower Science
Lessons to date

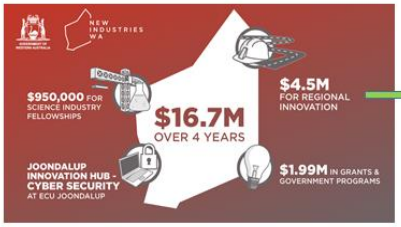
- Industry very engaged & supportive
- Great cooperation and sharing
- Some gear loss (weather)
- Some spat loss
- Fouling
- Temperature
- Density effect?

BIOSECURITY

DPIRD's supporting role

- $1 million to fit out new laboratory facility (IOMRC)
  - Quarantine lab's
- Shellfish Health R&D focus
- Applied R&D
  - Identify emerging pathogens of aquaculture
  - Factors which promote bivalve health
  - Disease mitigation strategies
- DPIRD disease investigation support
- Evaluation of MEMPs and Biosecurity Plans
- Ecological risk assessments

- Provision of guidance on WASQAP requirements
- Support meeting elements of WASQAP requirements where possible overlap with field trials
- Supporting development of rapid and local testing capacity to reduce unnecessary extended closures (FRDC)
- Supporting wider funding applications
- Seeking dedicated WASQAP support



Regional New Industries Fund (regional stream- up to 300k per region + state network stream)

>550k invested in each of WA's 9 regions per year

CRCNA
DEVELOPING NORTHERN AUSTRALIA

FRDC

Some key next steps.....

BIOSECURITY

Develop clear policy on oyster industry movements

Support hatchery production & supporting R&D /additional species

Support development of field and gear trials/additional species

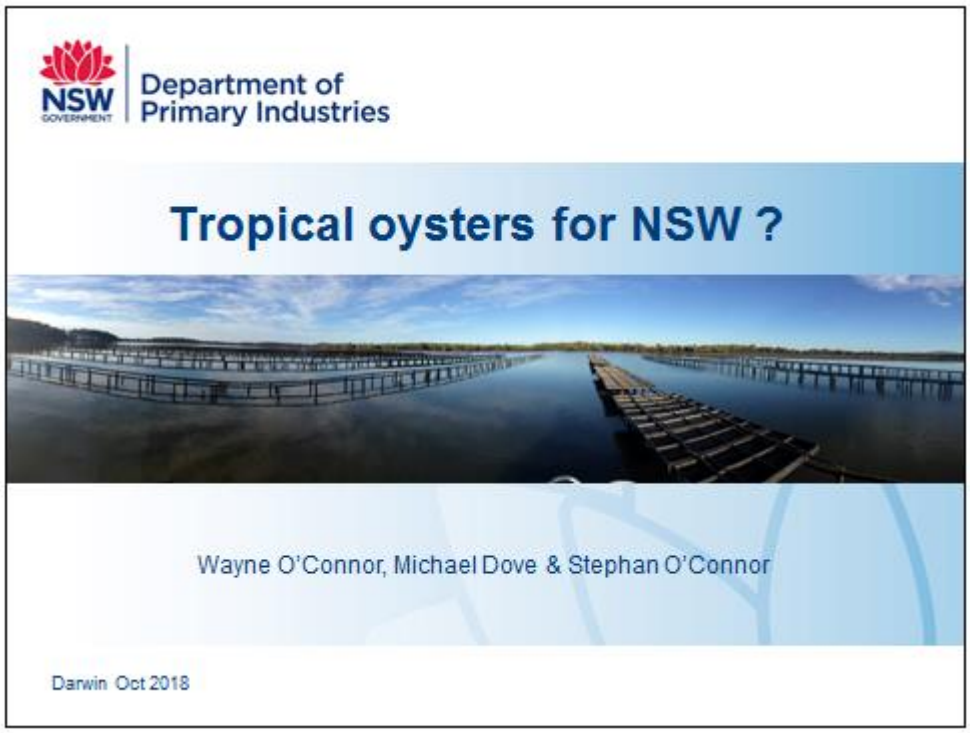
FOOD SAFETY

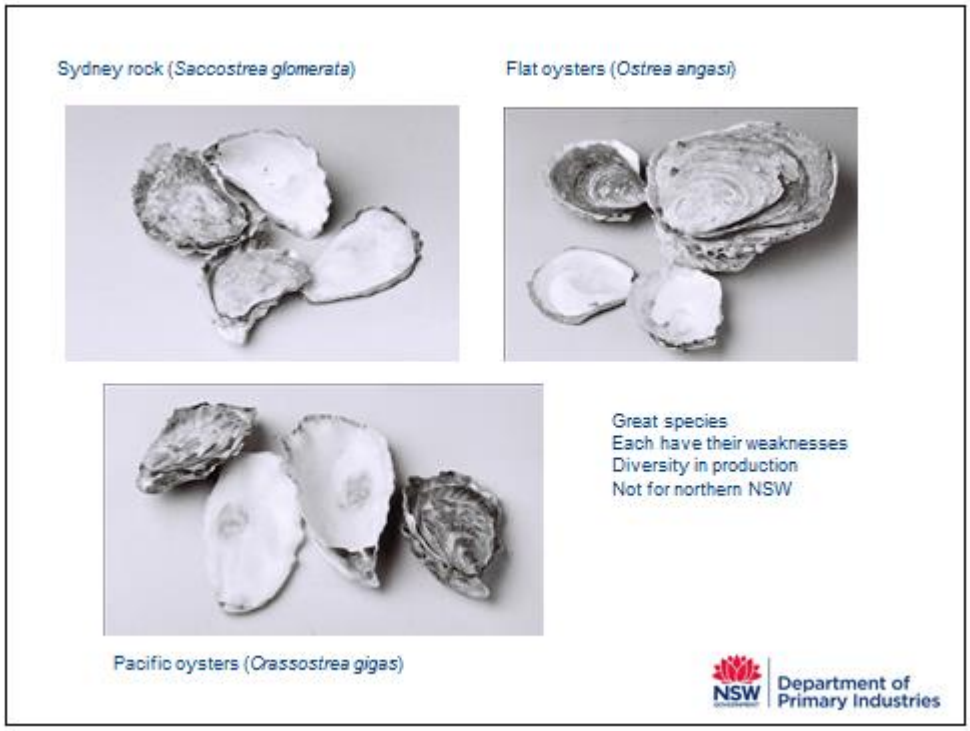
Support meeting of ASQAP requirements

Thank you for your attention

michael.snow@dpird.wa.gov.au

Tropical Oysters for NSW? – Wayne O'Connor





Options ?

- *Saccostrea echinata*
- *Saccostrea cucullata*
- *Saccostrea scyphophilla*

Department of Primary Industries

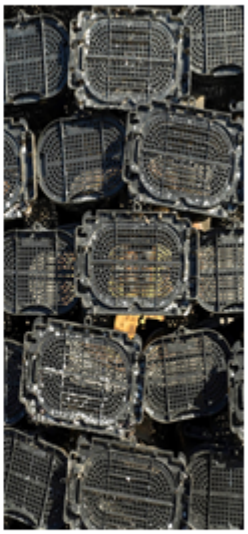
History

- Late 80s, Palm Island review
- 90s *S. cucullata* production
  - Morphology
  - Poor larval success
- Collison effect
- Diggles review
  - "based on the assumed natural distribution of S. echinata (from Atlas of Living Australia data) and if the broodstock oysters were collected from NSW waters and raised in a NSW hatchery, there would be minimal biosecurity issues associated with the proposed activity."

Department of Primary Industries

Footprints Report

- Introduction of disease
- Unknown impacts of farming
- Impacts on water quality/other farmers
- Impacts on other species
- Financial impacts on PO & SRO industries
- Lease values
- Lack of spat
- Social impacts



Department of Primary Industries

Richmond River Trials

Morphologically distinct survivors

PFSI (quarantine)

Richmond, Brunswick, Camden Haven, Port Stephens & Hawkesbury

NSW Department of Primary Industries

Where do we stand ?

- Industry interest
- Survey work is beginning
- We have hatchery support
- Permitting systems ready
- POAA
- Biosecurity considerations have commenced
- We need local broodstock

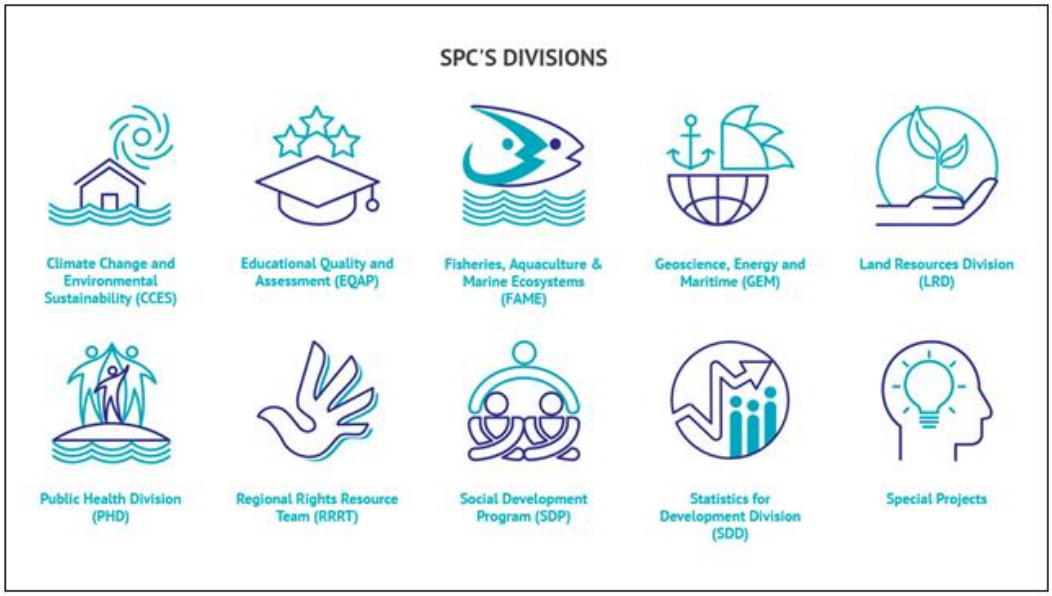
NSW Department of Primary Industries

Rock oyster farming activities in Pacific islands

Michel Bermudes
Mariculture specialist

The Pacific Community - SPC

- The principal development organisation in the region, 26 member countries (intervention in 22 countries and territories)
- Main role in capacity building:
  - transfer, adapt technology and techniques to the region,
  - develop techniques suitable for the region,
  - south-south transfer…



Rock oyster farming in Pacific islands – 1970s

- Palau: harvest + return of shells with overcatch to grow and collect more (Glude, 1984) – giant rock oyster (S. echinata)
- Oyster farming on Mago Is (Fiji) as food for copra plantation workers (Glude, 1984) – Mangrove oyster (S. cucullata)
- Experimental culture of mangrove oyster (called glomerata = echinata, cucullata?), a small-medium oyster (Ritchie, 1974)

Rock oyster farming in Pacific islands – 1980s

- Tahiti (hatchery production in the early 80s, from New Caledonia stock) – echinata. Not continued, pearl oyster instead.
- New Caledonia (imported eggs and spat from Tahiti), not continued after Tahiti stopped.
- Fiji (trial with spat imported from Tahiti), not continued after Tahiti stopped.

Rock oyster farming in Pacific islands - Recent

- Early 1990: spat collection and farming trials in villages on the east coast of New Caledonia
- 1996-97: trials by IFREMER, one small batch but not a priority species
- 2011-12: trials carried as part of a Masters study (Loic Bourgine)
- 2013: trials with the assistance of an expert from Vietnam

Current activities - In the last three years

- 2015: scoping of shellfish aquaculture potential in Samoa
- 2015: NC reaches out for rock oyster aquaculture trials in NC
- 2016: oysters in Fiji!
- 2016: MOU with ADECAL (NC) and start of hatchery trials in New Caledonia
- 2018: discovery of farmer Kuva Vatunilagi in Fiji
- 2018: Australian rock oyster tour
- 2018: start of spat collection (and farming) trials in NC and Fiji
- 2019: extension training - Mago island (Fiji)

My first oyster farmer in Pacific islands

Oysters in Fiji!

Another Farmer! Kuva, Mago Is, Fiji


Mago Island
Image © 2018 DigitalGlobe
Image © 2018 TerraMetrics


Pacific Community


Pacific Community
Communauté du Pacifique


Pacific Community
Communauté du Pacifique


Pacific Community
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Australian Rock Oyster Tour
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du Pacifique


Pacific Community
Communauté du Pacifique


Pacific Community
Communauté du Pacifique


Pacific Community
Communauté du Pacifique


Pacific Community
Communauté du Pacifique


Pacific Community
Communauté du Pacifique

Rock oyster tour = catalyst!

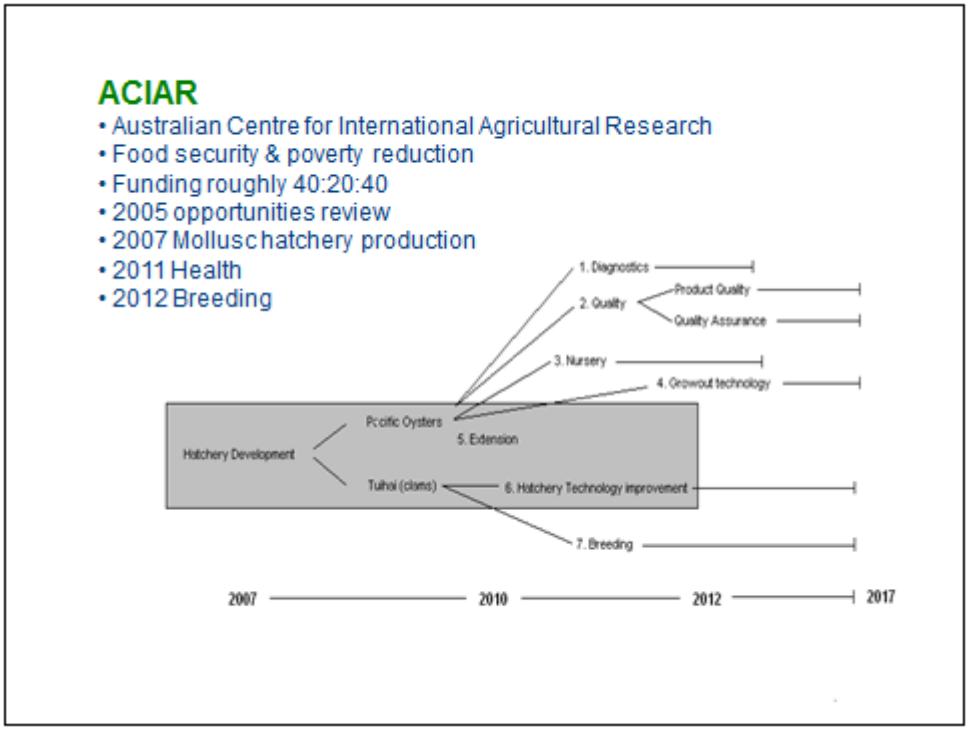
NEW CALEDONIA

- Continued hatchery trials (new MOU)
- Now also supplemented by spat collection trials
- Patrick Morlet upgrading farm (SEAPA baskets, security cameras)

FIJI

- Spat collection trials to start in November 2018
- South-south capacity building (Kuva Vatunilagi)
- Training on Mago Is for new farmers

Enhancing bivalve production in Northern Vietnam: Lessons along the way – Wayne O'Connor, Michael Dove & Stephan O'Connor



Review FIS

- 2005 opportunities review
- Fish & molluscs
- $US 6 million NMBC

NSW Industry & Investment

Hatchery Production

- To foster a bivalve hatchery facility
- To establish the knowledge base required
- To assist the establishment of nursery facilities
- Began 2007 (4 yrs)

Species

- 2003-2004 Pacific oysters from Tasmania
- 2007 Request for more from Aust
- 2007 Taiwanese Pacific oyster stocks
- CO1 nucleotide sequences *Crassostrea angulata* – *(C. sikamea, S. madrasensis)*
- Today stocks from China *(C. gigas)*

Algae

- Trained staff
- Supplied cultures
- Established systems
- Noting physical and environmental needs

Industry & Investment

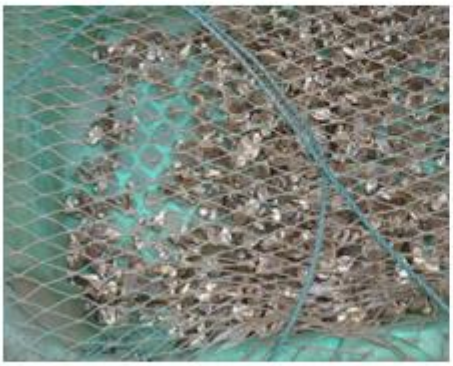
Settlement

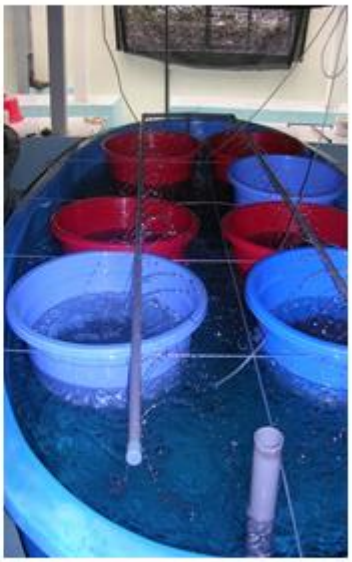
- Cultch set

Industry & Investment

Settlement

- Single seed





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Growout

NSW Industry & Investment


Growout
Small specialists …… BIM


Growout
Longlines


Marketing
• Domestic Fresh

Health & biosecurity

1) Vietnamese molluscan biosecurity and veterinary diagnostic capacity review

2) To evaluate current biosecurity for bivalve molluscs,

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Diagnostics

Task	Deliverable
A review of known infectious diseases of bivalve molluscs in Vietnam	▪ Summary Report on Aquatic diseases in Vietnam (Panaquatic).
A review of the aquatic animal health legislative and regulatory framework supporting disease diagnosis in RIA1	▪ Summary Report on the legislative and regulatory framework supporting disease diagnosis(Panaquatic).
An assessment of current diagnostic facilities and resources at RIA1	▪ Summary Report of RIA 1 Diagnostic capacity (Panaquatic).
An assessment of diagnostic capabilities of RIA1, including scientific staff, technical staff and molluscan hatchery staff.	▪ Summary Report of human capital for molluscan disease diagnosis (Panaquatic).
An assessment of internal and external biosecurity strategies at RIA1	▪ Summary Report on functional and operational biosecurity policies and practices (Panaquatic).
An assessment of human resources supporting regional biosecurity at RIA1	▪ Summary Report of recommendations for practical, cost effective operational improvements in biosecurity (Panaquatic).
Improve RIA1 Staff understanding of aquatic biosecurity principles	An interactive workshop with RIA1 scientists and hatchery technical staff focusing on aquatic animal biosecurity (Panaquatic).
Collate the findings and outcomes of the project	▪ A Final Report to ACIAR combining the components of the project and establishing a platform for further research and training (Panaquatic & I&I) ▪ A review article for Partners magazine (or like) outlining the project findings and outcomes and recommendations(I&I and Panaquatic)

Paul Hardy-Smith & Dr John Humphrey

Inform future work : EMAI

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QAP (NSW FA & UTS)

- Reviews
- Environmental monitoring programs
  - Temp, sal……., E. Coli, metals, PAHs
- HABs

Social impact

What impact has oyster farming had on the lives of oyster farmers and those in their commune?

Photovoice: Cameras & Diaries

- Image that describes *how* (oyster farming) has *impacted on you*
- Image: *what* (oyster farming) *means to you*
- Image: *social sustainability* for *your commune*
- Image: *good news* about oyster farming in your community
- Image: *bad news* about oyster farming in your community

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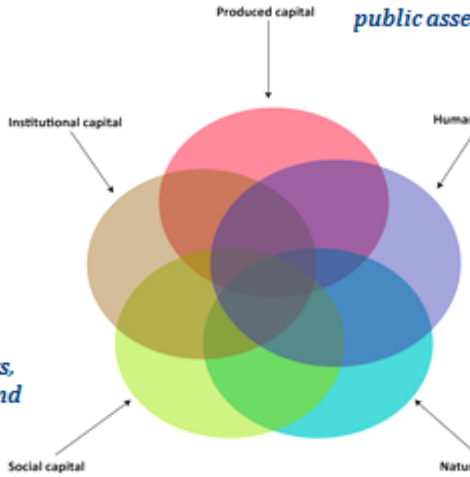
Five Capitals Framework (Cocklin & Alston 2003)

Produced: *built environment: public assets, harvested. $$$*



Institutional: *public, private, and non-government*

Human: *knowledge, skills, and abilities*

Social: *networks, values, trust, and shared vision*

Natural: *resources, ecosystems, and aesthetics*

Study question: How are these changing since oyster farming began

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The overwhelmingly good, the bad and the unexpected

Creating jobs for farmers and young people, so that they do not have to go to work in other locations.

Farmers are not sure whether oyster seeds are good or bad, resulting into not very high quality of commercial oysters. Due to non-even development in size, it takes time to classify the oysters at harvesting

Oyster farming creates many parasites for Tu Hai clams. In the high dense area of oysters, Tu Hai seeds cannot be hatched

Oyster farming brings profit. Many families in the village bought karaoke sets. Life is obviously going up.

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Where to next

ACIAR Co-funded model
Breeding to continue
Improved management
Aust 40% ????

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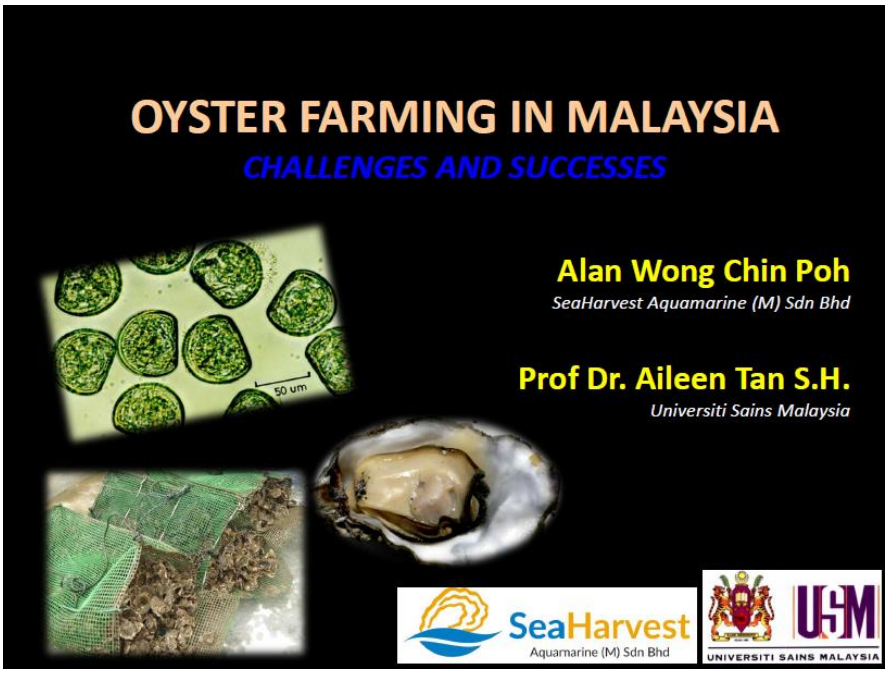
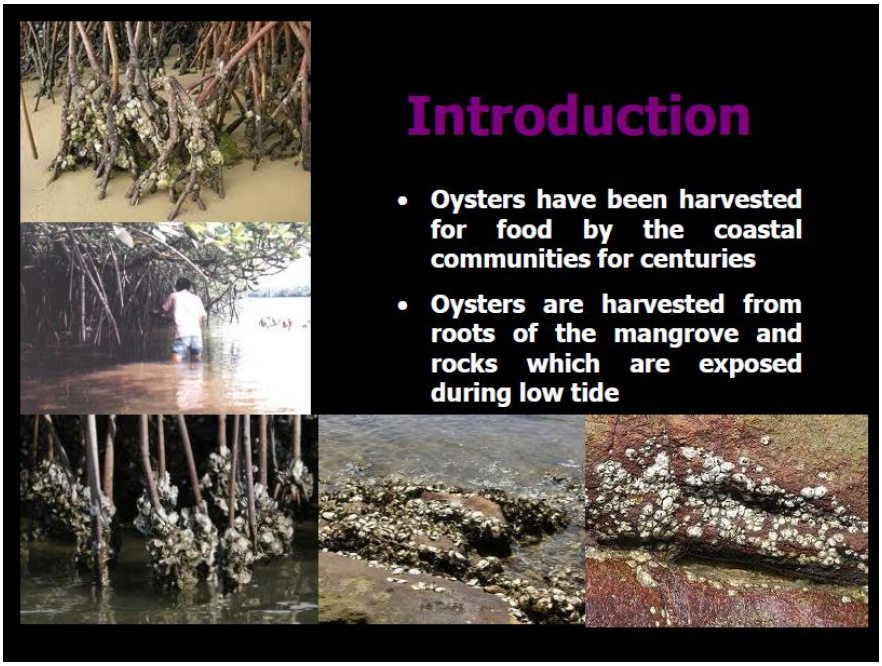
Oyster farming in Malaysia: Challenges and successes- Alan Wong and Aileen Tan





Year 1988 - 1993

- Introduction to oyster farming
- Research on oysters :
  - *general biology*
  - *reproduction*
  - *breeding*

Malaysia

Thailand

Indonesia

Philippines

Commercial oyster culture

SEEDS COLLECTION FROM WILD

using - stick collectors

- used tyres

- shell collectors

BOBP – IDRC Programme

Seed collection from the wild

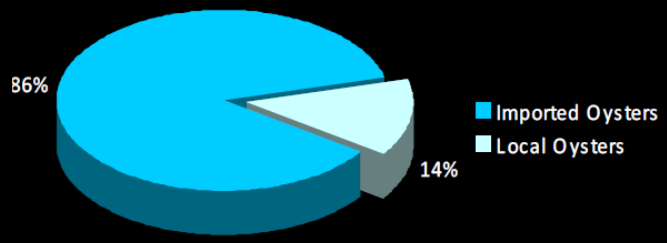
Guidance from BOBP – IDRC experts

MARKETING PROBLEM

Current Trade

(USD11 million in 2009)

Oysters in Malaysia



Is the quality of local oysters a problem?

Why the oyster industry in Malaysia did not take off earlier?

- Bottleneck

Rely solely on wild seeds from

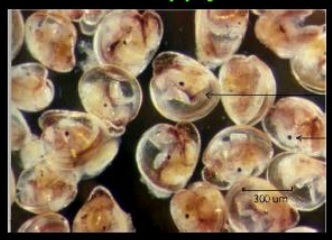
- Solution

Hatchery produ

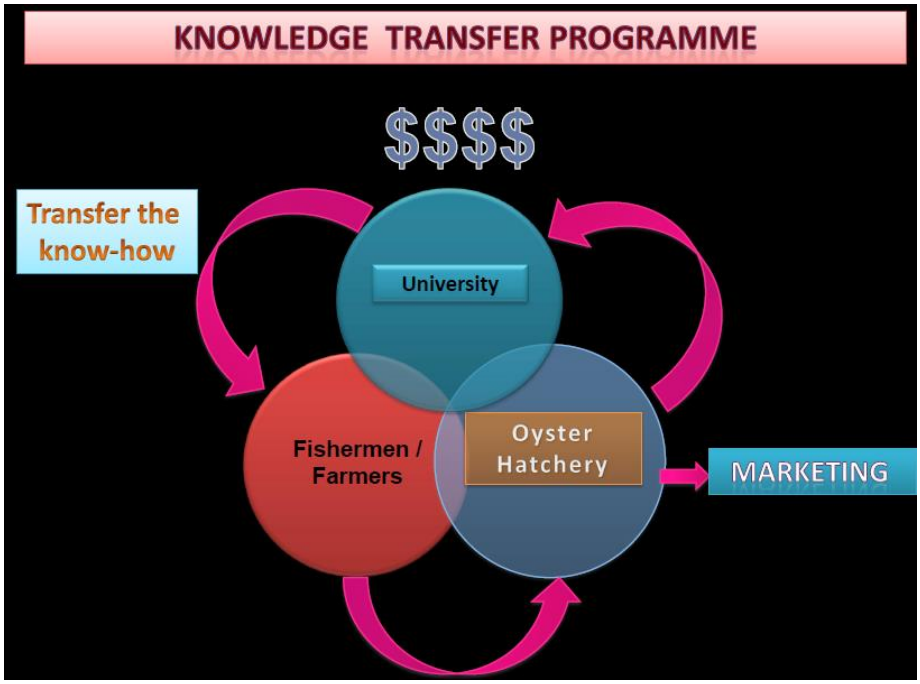
With the support from the Malaysian Government, a lot of research was focused on oyster production

High quality and consistent supply

Insufficient seeds to support the industry



KNOWLEDGE TRANSFER PROGRAMME



In year 2008....



1ST PILOT COMMERCIAL HATCHERY IN MALAYSIA


SEAHARVEST AQUAMARINE (M) SDN BHD

The 1St commercial oyster hatchery in Malaysia

(The Malaysia Book Of Records)

THE MALAYSIA BOOK of RECORDS ®

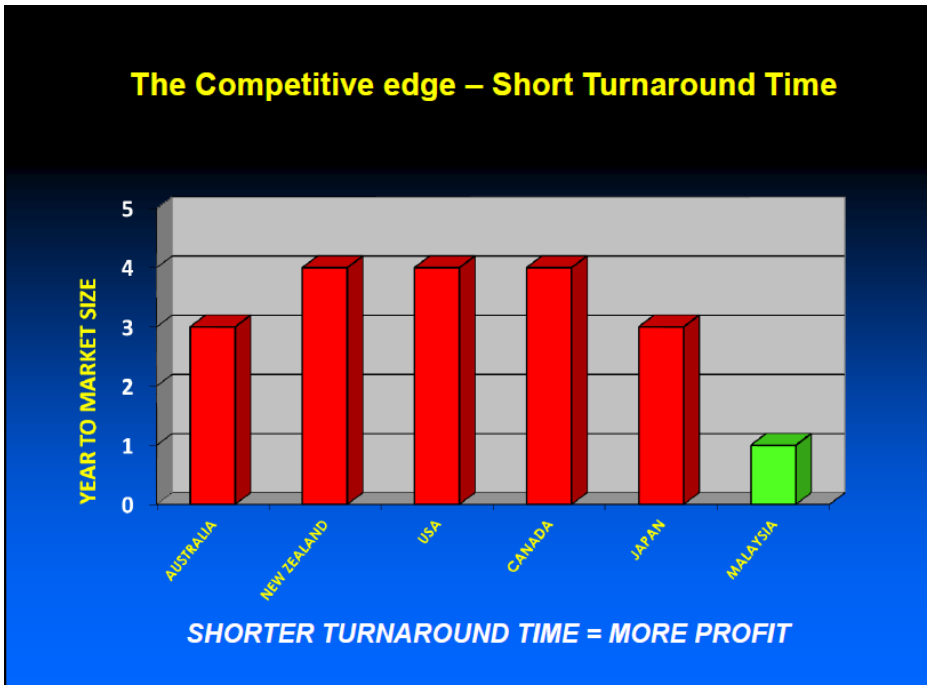
The 1st commercial hatchery in Malaysia

Bionexus Status Company






From hatchery to market....
.....10-12 months
Ten months old
Three months old
Two weeks old
One week old
One day old

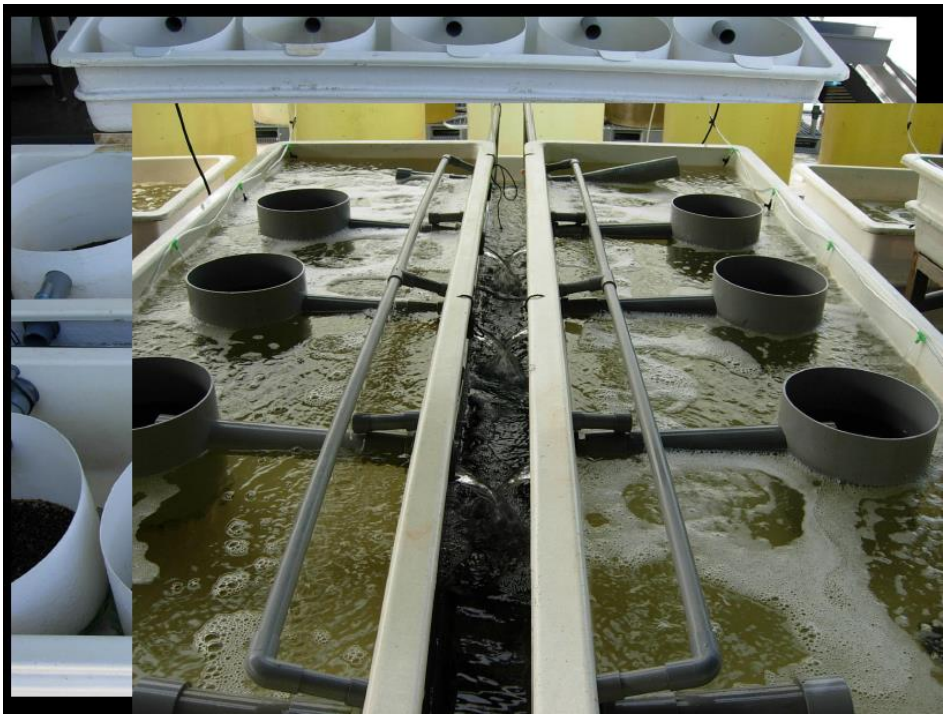

The Competitive edge – Short Turnaround Time
YEAR TO MARKET SIZE
5
4
3
2
1
0
AUSTRALIA
NEW ZEALAND
USA
CANADA
JAPAN
MALAYSIA
SHORTER TURNAROUND TIME = MORE PROFIT


Why Oyster Farming?

Advantages of Oyster farming

- No feeds
- Low risk
- Low overhead and maintenance
- Clean Culture and environmental friendly
  - No anti-biotic
  - No Mangrove cutting
  - No by-product waste
- More profitable in the long run
- Technology simplified and tailored to Farmer's & Fishermen's level of capability
- Eventually Farmers or Fishermen can do themselves and expand the industry

SUSTAINABLE AQUACULTURE
- Environment
- Social
- Economy



Crassostrea iredalei

Crassostrea iredalei

Crassostrea belcheri

The Grow-out Options

POND Culture

RAFT Culture

Pond culture of oyster at Sg Petani, Kedah

Project started : March 2012
2 two hektars pond
Production Capacity : 400,000 oysters/year
Private funding
100% Guarantee buy back

Pond culture of oyster at Selangor

Floating Cages

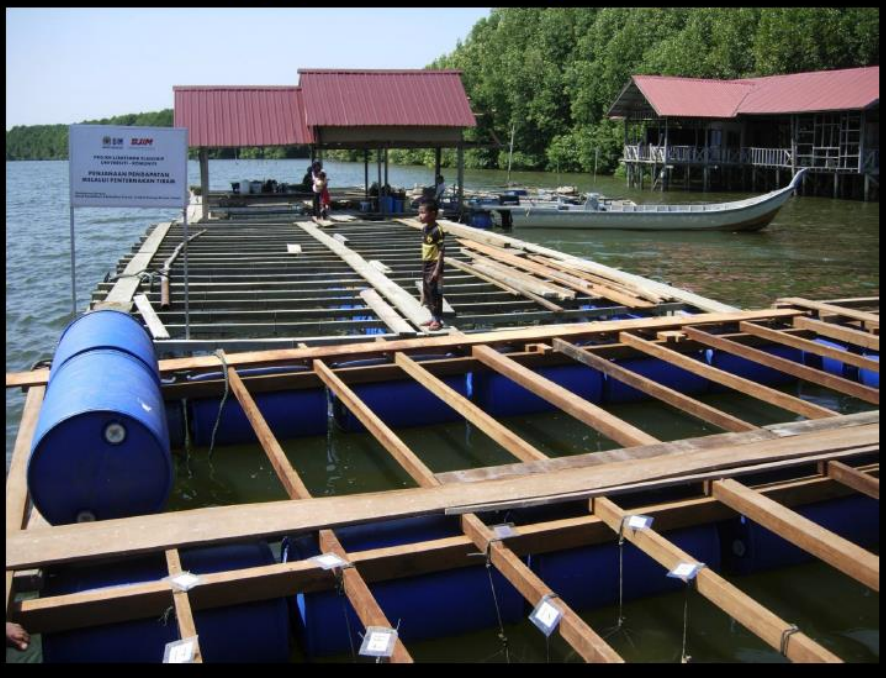
Oyster Project at Semeling, Kedah

- Community project together with BJIM (Division of Industry and Community Network Universiti Sains Malaysia), Kelab Puncak Lembah Bujang (total 6 participants from Kg Sg Batu Besi, Semeling)
- Started April 2012
- Funding : USM under – Knowledge Transfer Program, flagship project
- Capacity : 100,000 oysters/year
- Market : 100% guarantee buy back by Seaharvest
- Future business expansion : keda (Lembaga Kemajuan Wilayah Kedah)

USM UNIVERSITI SAINS MALAYSIA

BJIM Bahagian Jaringan Industri & Masyarakat *Division of Industry & Community Network*

Kg Sg. Batu Besi, Semeling, Kedah



Oyster Project with KEDA at Sungai Kerisik

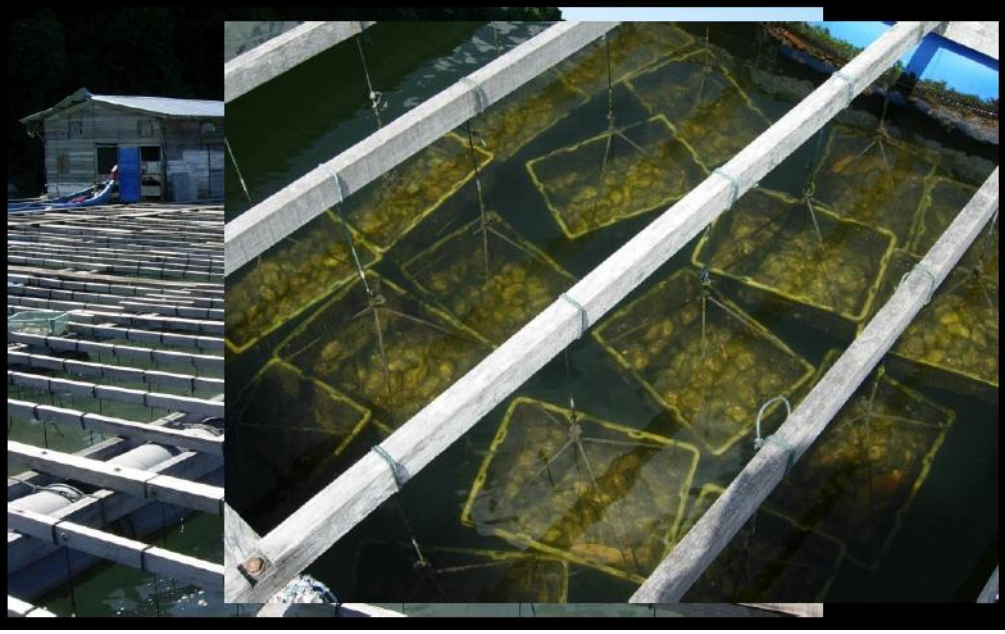
- To sign MOU with BJIM, keda (Lembaga Kemajuan Wilayah Kedah) on Community project for oyster culture at Sungai Tiram, Sungai Kerisik.
- Trial started on March 2015
- Fund from keda
- Future expansion : 200 acres along Sg Kerisik
- Market : 100% guarantee buy back by Seaharvest

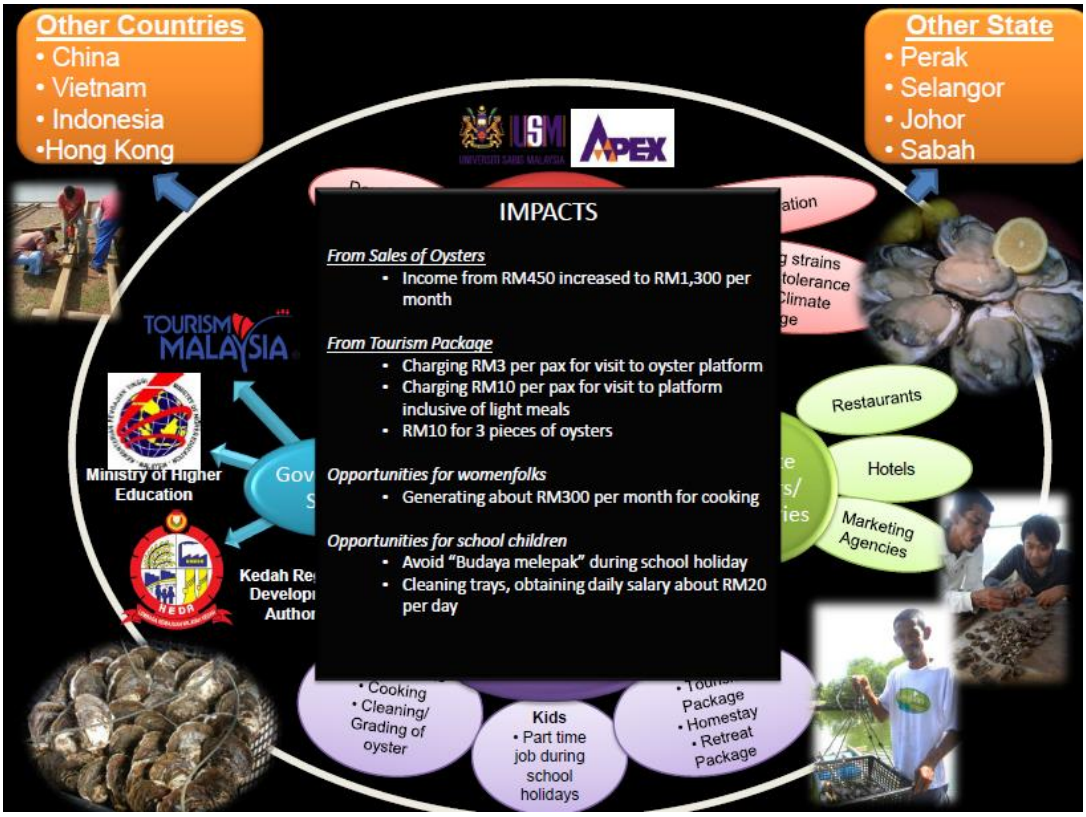
Sungai Kerisek, Kedah

Kuala Gula Oyster Farm

Kuala Gula New Oyster Farm

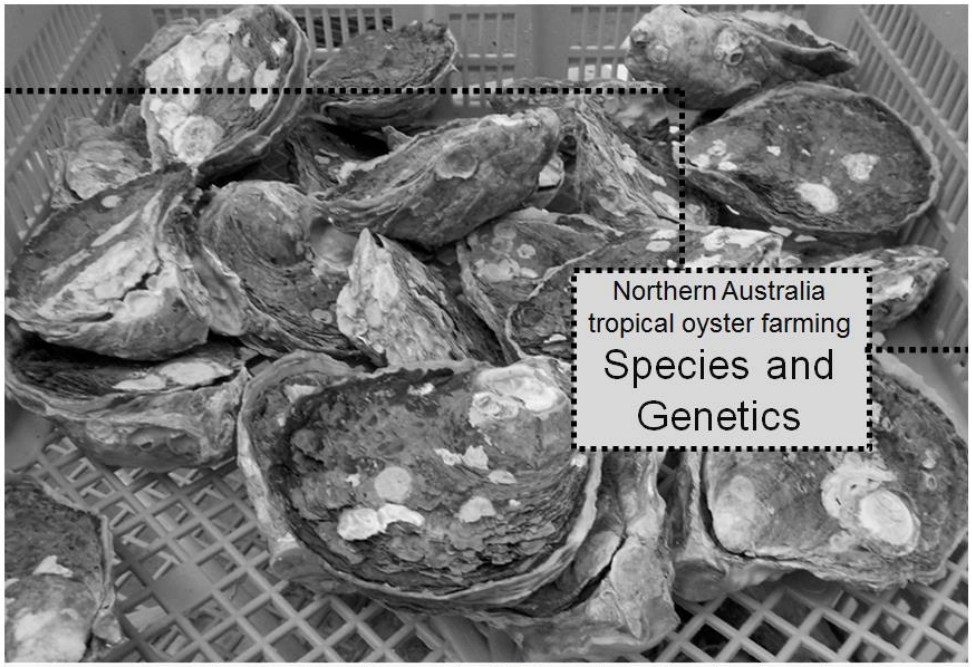
Pulau Betong Oyster Farm (Fattening Site)




Other Countries
• China
• Vietnam
• Indonesia
•Hong Kong
Other State
• Perak
• Selangor
• Johor
• Sabah
IMPACTS
From Sales of Oysters
• Income from RM450 increased to RM1,300 per month
From Tourism Package
• Charging RM3 per pax for visit to oyster platform
• Charging RM10 per pax for visit to platform inclusive of light meals
• RM10 for 3 pieces of oysters
Opportunities for womenfolks
• Generating about RM300 per month for cooking
Opportunities for school children
• Avoid "Budaya melepak" during school holiday
• Cleaning trays, obtaining daily salary about RM20 per day
TOURISM MALAYSIA
Ministry of Higher Education
Restaurants
Hotels
Marketing Agencies
• Cooking
• Cleaning/ Grading of oyster
Kids
• Part time job during school holidays
• Homestay
• Retreat Package


THANK YOU ...
Eat fish, live longer
Eat oysters, love longer...

Northern Australia tropical oyster farming: Species and genetics – Mike Snow (DPIRD), Lisa Kirkendale (WAM), Nerida Wilson (WAM), Carmel McDougall (Griffith, QLD Museum), Sam Nowland (DAC)



WA: Mike Snow (DPIRD), Lisa Kirkendale (WAM), Nerida Wilson (WAM)
QLD: Carmel McDougall (Griffith, QLD Museum) NT: Sam Nowland (DAC)

The problem....

Mitochondrial and nuclear DNA analyses of *Saccostrea* oysters in Japan highlight the confused taxonomy of the genus

Masashi Sekino[1†] and Hiroyoshi Yamashita[2†]

[1]*Research Center for Bioinformatics and Biosciences, National Research Institute of Fisheries Science, Japan Fisheries Research and Education Agency, Fuku-ura, Kanazawa, Yokohama, Kanagawa 2368648, Japan; and*
[2]*Malaco-diversity Japan, Matsugaoka, Kugenuma, Fujisawa, Kanagawa 2510038, Japan*

Correspondence: M. Sekino; e-mail: sekino@affrc.go.jp

(Received 19 January 2016; accepted 22 April 2016)

'Confused' a bit of an understatement!

The difficulty arises because oysters of one species can look very different when grown under different environmental conditions.

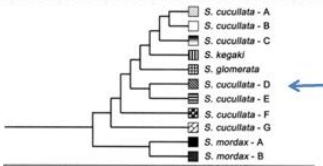
This is why we need to use genetics...

Australian distribution

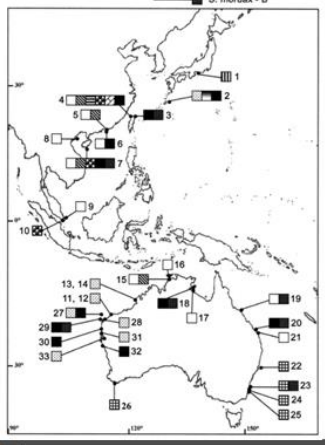
What species and where?

- Sample collection from different sites
- Evaluate morphology
- Extract DNA, sequence 'barcoding' gene, perform phylogenetic analysis
- Evaluate whether groups can be distinguished by morphology

Previous research sets the foundation

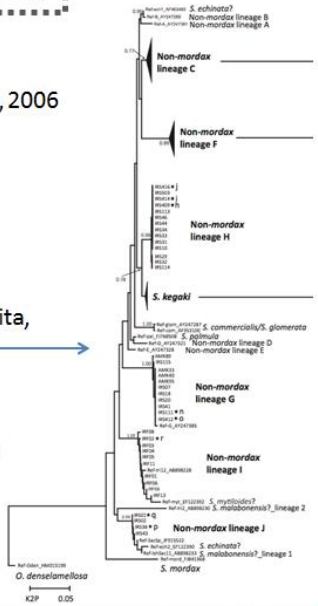


Lam and Morton, 2006

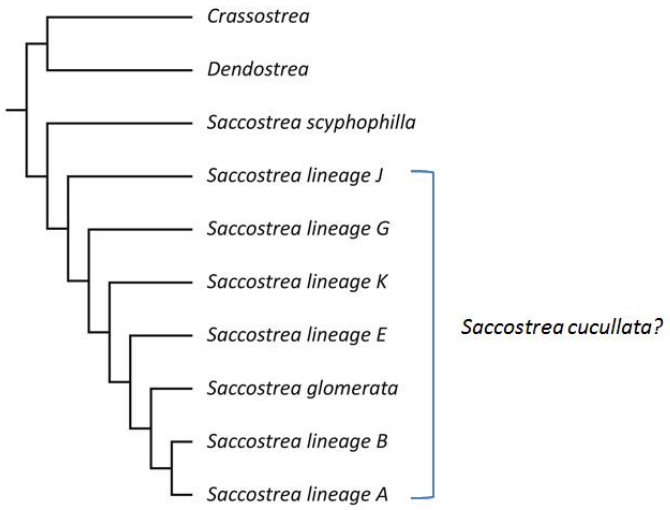


Sekino and Yamashita, 2016 (Japan)

Consistent lineages



Current progress



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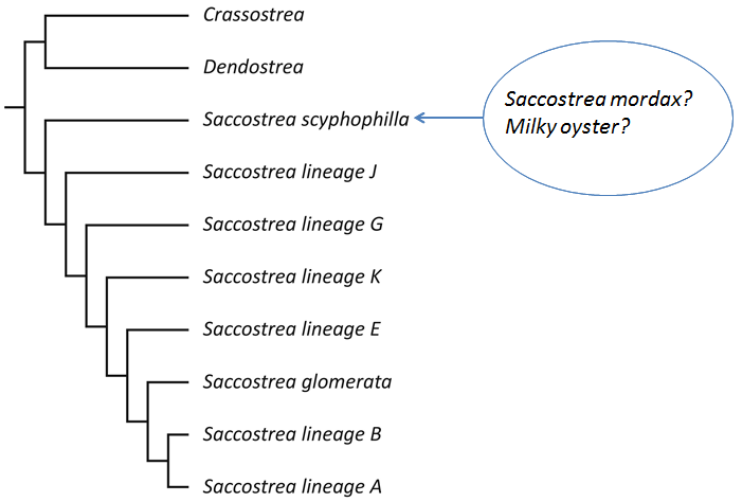
Taxonomy confusion



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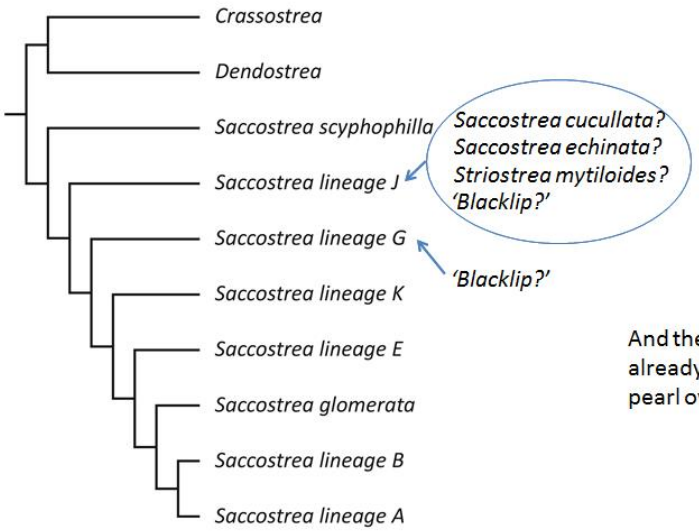
Taxonomy confusion



And there's already a blacklip pearl oyster....

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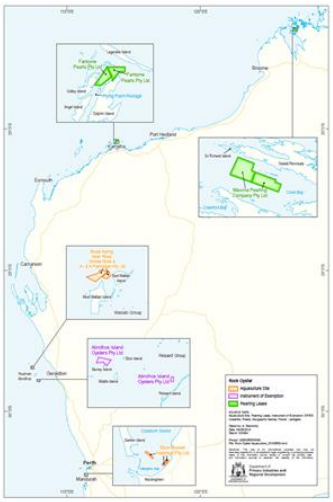
Western Australia

Methodology:

- Requested samples from prospective oyster farmers in regions where activity planned
- Over 200 samples sequenced & added to Lam/Morton's previous Indo–Pacific dataset
- Sequenced 2 gene regions- 16S to build on existing published literature
- CO1 to ensure consistency with Sam/ Carmel's study
- Sharing of data- Sam/Carmel/Lisa & Nerida (WA museum)
- Focussed on applied question of which species best suited to growing in the different regions



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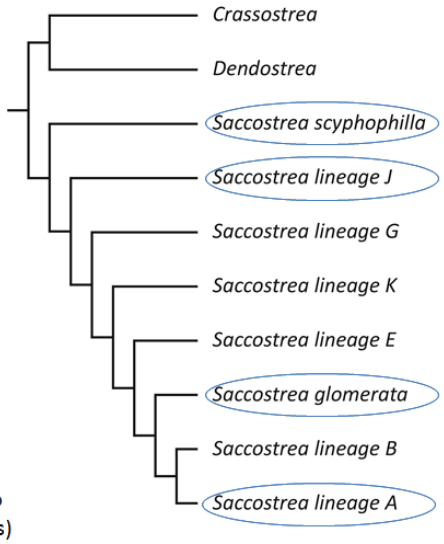
Findings:

- Consistent with previous studies
- Consistent with NT/QLD/WAM studies
- Different genes tell the same story
- 4 *Saccostrea* oyster lineages present in WA
- Seeking common Australian agreement to refer to these as the following to avoid continued confusion:
  - *S.glomerata* (Sydney Rock Oyster)
  - *S. scyphophilla* (Previously S.mordax)
  - *S.cucullata A*
  - *S.cucullata J*
- Use of common or marketing names as confused as taxonomy - Requires some consideration
- Most commonly encountered are *S.scyphophilla* and *S.cucullata A*
- Lineages in the future may be determined to be different species (one for the taxonomists)



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Anecdotal findings:

- *S. scyphophilla*
  - is genetically similar regardless of its origin
  - used as basis for initial commercial trial
  - seems to be found in more exposed locations
  - up to around 80mm
  - commonly consumed e.g. by recreational yachties
  - Distribution overlaps with *cucullata* at some locations eg Flying Foam Passage

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Anecdotal findings:

- *S. cucullata A*
  - More complex genetic structure within *cucullata* (likely multiple species within diverse *cucullata* group)
  - seems to be found in more sheltered locations
  - up to around 80mm
  - Distribution overlaps with *scyphophilla* at some locations e.g. Flying Foam Passage

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Anecdotal findings:

- *S. cucullata J*
  - Not common in WA (though have not sampled extensively)
  - Likely a different species
  - Grows larger than other *Saccostrea* species
  - Is within the same genetic grouping as the 'blacklip' oyster from NT and northern QLD

Steven Gill

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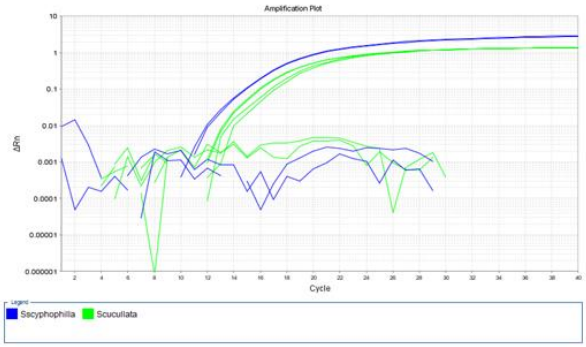
Western Australia

Distinguishing species:

- *cucullata J* and *scyphophilla* we have found difficult to reliably identify especially where overlapping distribution
- We assume that these species do not hybridise (but we don't really know this as we have only studied DNA that is inherited from the maternal line)
- Developed a rapid lab test to avoid more costly sequencing
- Demonstrated non-destructively (anaesthetising oysters in $MgCl_2$) and using swabs



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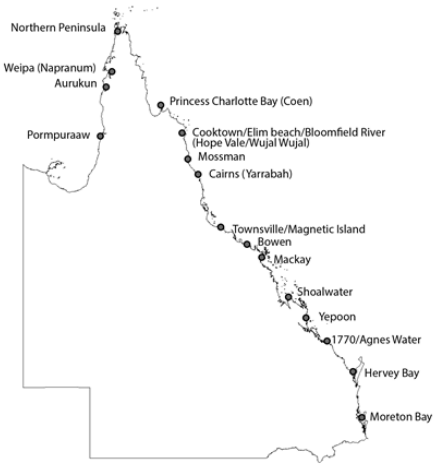
Queensland

Queensland

Methodology:

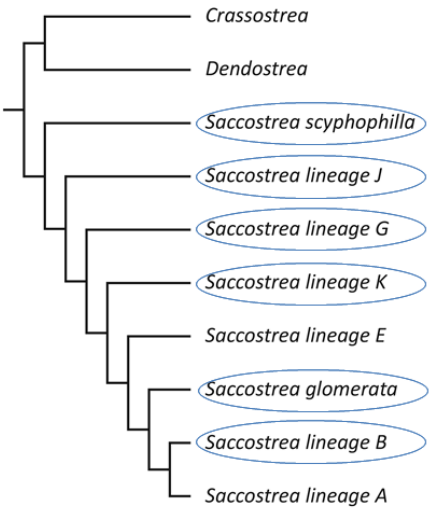
- Planned sampling from targeted areas
- Samples provided by oyster growers
- Only 2 sites sampled to date
- Sequence CO1 only – can add 16S if required
- Focus on species with commercial potential
- Sharing of data



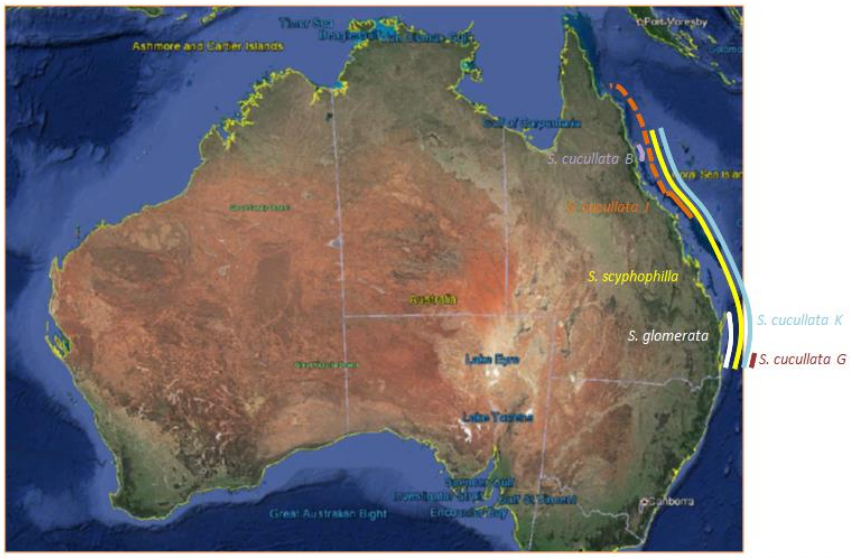
Queensland

Findings:

- Larger than realised diversity – from just 2 sites!
- *S. glomerata* most common in Moreton Bay, *S. scyphophilla* most common in northern QLD
- How patchy is the distribution?



Queensland



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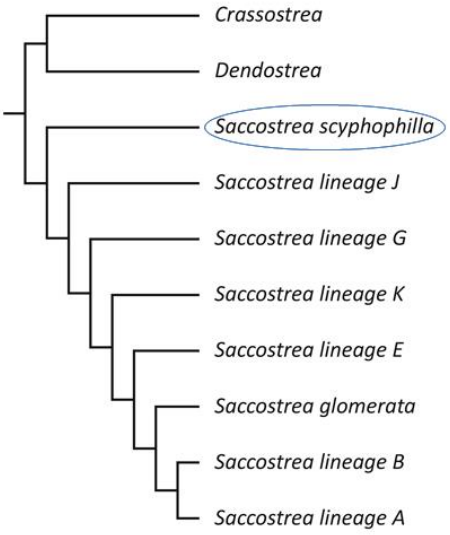
Queensland



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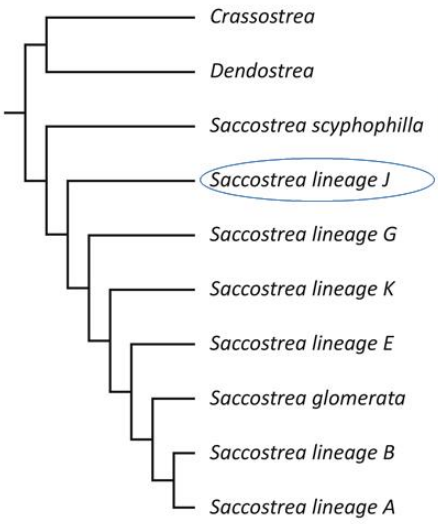
Queensland



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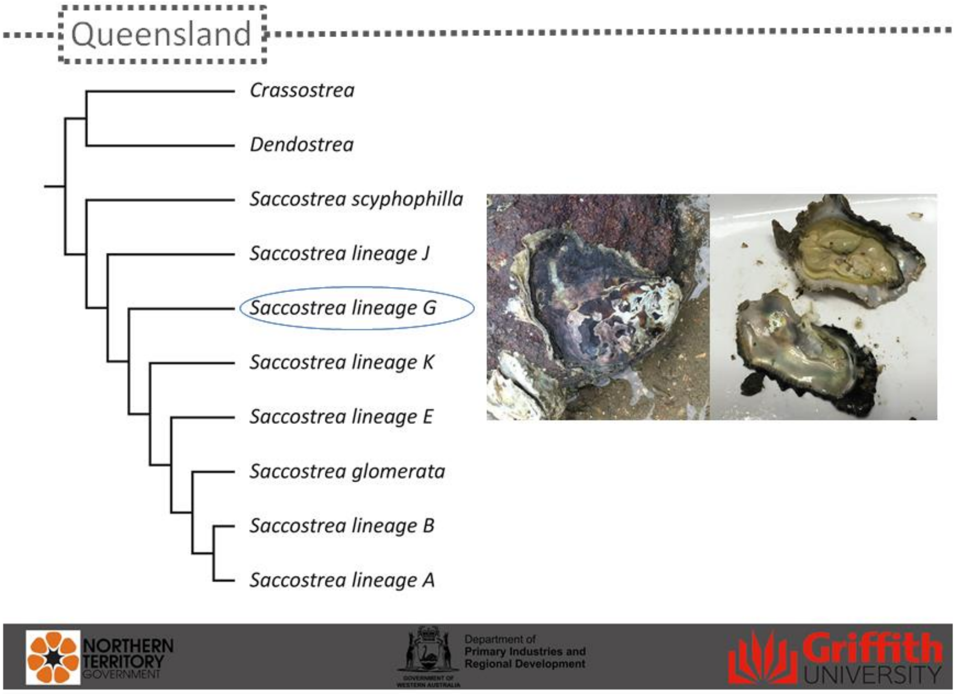
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Dendostrea
Saccostrea scyphophilla
Saccostrea lineage J
Saccostrea lineage G
Saccostrea lineage K
Saccostrea lineage E
Saccostrea glomerata
Saccostrea lineage B
Saccostrea lineage A
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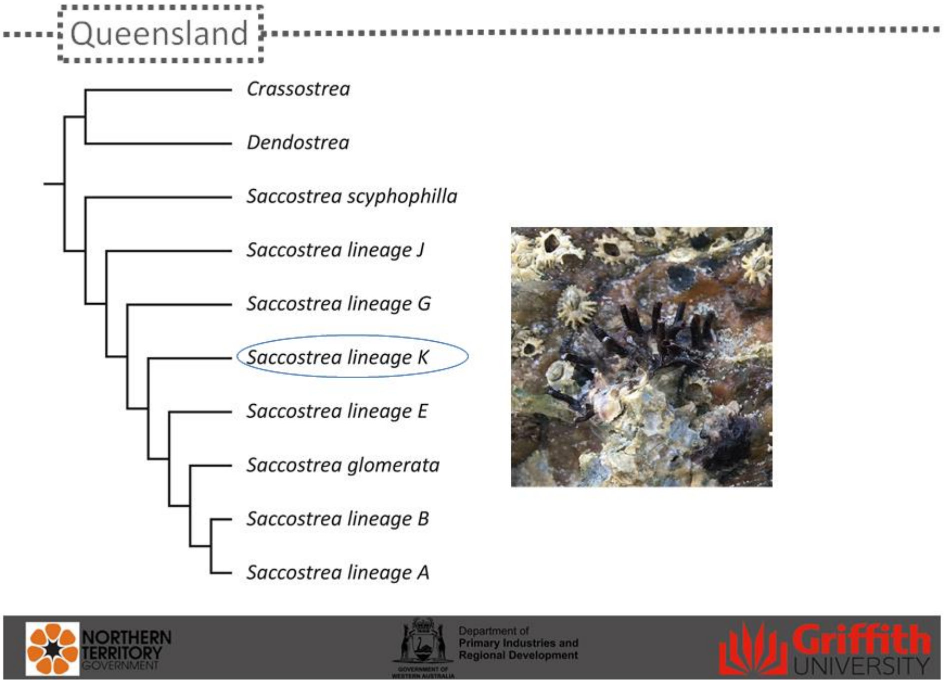
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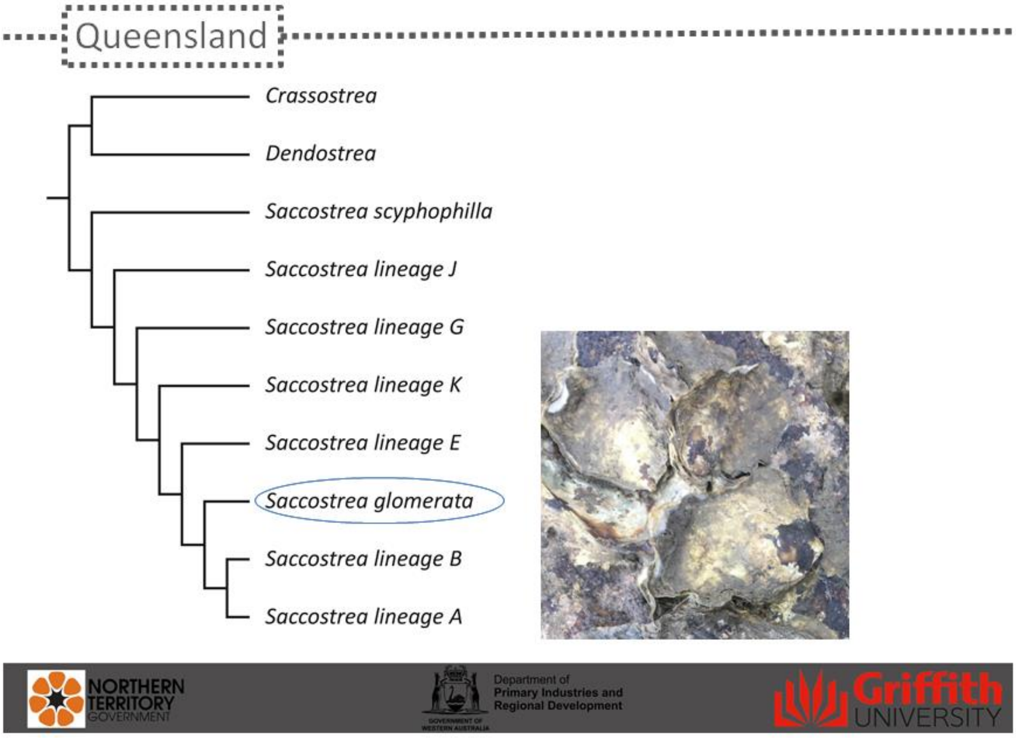
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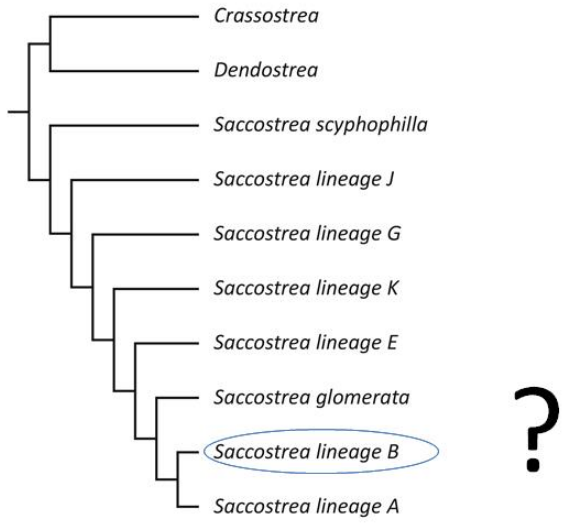
Queensland



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Genetic analysis has other uses...

- Extensive molecular resources for Sydney rock oysters, including whole-genome data
- Insights into the molecular basis of disease resistance and conditioning
- Possibility that some of this is transferrable to other oysters

The genome of the oyster *Saccostrea* offers insight into the environmental resilience of bivalves

Daniel Powell [1,*], Sankar Subramanian[1], Saowaros Suwansa-ard[1], Min Zhao[1], Wayne O'Connor[2], David Raftos[3], and Abigail Elizur[1]

[1]Centre for Genetics, Ecology and Physiology, University of the Sunshine Coast, Maroochydore DC, QLD 455 Australia, [2]NSW Department of Industry, Department of Primary Industries, DPI Fisheries, Port Stephens Fisl Institute, Taylors Beach, NSW 2316, Australia and [3]Department of Biological Sciences, Macquarie Universit North Ryde, NSW 2109, Australia

Differential expression of genes encoding anti-oxidant enzymes in Sydney rock oysters, *Saccostrea glomerata* (Gould) selected for disease resistance

Timothy J. Green [a,*], Tom J. Dixon [b,c], Emilie Devic [a], Robert D. Adlard [d,e], Andrew C. Barnes [a,f]

[a] The University of Queensland, Centre for Marine Studies, Brisbane, Queensland 4072, Australia
[b] CSIRO Livestock Industries, QLD Biosciences Precinct, St Lucia 4072, Australia
[c] CSIRO Food Futures National Research Flagship, 5 Julius Avenue, North Ryde, NSW 2113, Australia
[d] Biodiversity Program, Queensland Museum, South Bank 4101, Australia
[e] The University of Queensland, School of Molecular & Microbial Sciences, Brisbane, Queensland 4072, Australia
[f] The University of Queensland, School of Biological Sciences, Queensland 4072, Australia

Reproductive neuropeptides that stimulate spawning in the Sydney Rock Oyster (*Saccostrea glomerata*)

Vu Van In [a,b], Nikoleta Ntalamagka [a], Wayne O'Connor [a,c], Tianfang Wang [a], Daniel Powell [a], Scott F. Cummins [a], Abigail Elizur [a,*]

[a] Centre of Genetics, Ecology and Physiology, University of the Sunshine Coast, Maroochydore, Queensland 4558, Australia
[b] Northern National Broodstock Center for Mariculture, Research Institute for Aquaculture No. 1, Cattо Islands, Haiphong, Vietnam
[c] Industry and Investment NSW, Department of Primary Industries, Port Stephens Fisheries Institute, Taylors Beach, NSW, 2316, Australia

Proteomic clues to the identification of QX disease-resistance biomarkers in selectively bred Sydney rock oysters, *Saccostrea glomerata*

Margaret Simonian[a,1], Sham V. Nair[a,,1], John A. Nell[b], David A. Raftos[a]*

[a]Department of Biological Sciences, Macquarie University, North Ryde, NSW, 2109, Australia
[b]New South Wales Department of Primary Industries, Port Stephens Fisheries Centre, Taylors Beach, NSW, 2316, Australia

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Genetic analysis has other uses...

- Good-quality transcriptome (sequences of all genes expressed throughout larval development and in adult tissues) for *S. lineage J*
- Allows identification of genes of interest

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Implications

What does this all mean in practical terms for oyster growers?

- Having good knowledge of natural species distribution allows us to
  - understand what might grow well where (biology)
  - confidently identify animals selected for broodstock
  - Develop a sensible policy on species translocation (across jurisdictions?) that safeguards industry (biosecurity, negative genetic effects)
  - Identify the minimum number of oyster lines required for hatchery production (economy of scale)
  - Focus future R&D effort on these lines
    - Parallel performance trials to understand best species for culture at a given location
    - Ensure continued availability of in condition broodstock for spawning
    - Form the basis for future genetic selection programs
  - Understand what we are talking about and avoid confusion (marketing implications?)

What next?

- Extension of population genetic with regard to understanding impact of translocation
- Reporting on this work (Fisheries departments, Biosecurity, Growers, Researchers)
- Use as a basis to explore development of a cross jurisdictional policy on oyster movements
- Risk assessment approach? Peer reviewed?
- CRC-NA application?
- To finalise the taxonomy we need formal species descriptions and comparison to type specimens in museum collections around the world

Acknowledgements

We would like to acknowledge and thank all industry representatives that have provided specimens

Mike Snow is funded by DPIRD

WAM acknowledges Gorgon Barrow Island and the Net Conservation Benefits Fund

Carmel McDougall is funded by the Queensland Government and Griffith University

Population genetics of wild black-lip rock oysters S. echinata across Northern Australia – Sam Nowland

Population genetics of wild black-lip rock oysters *S. echinata* across northern Australia

Samantha Nowland
Department of Primary Industry and Resources
October 2018

NORTHERN TERRITORY

Why black-lip?

- Historically harvested by Indigenous communities for food and trade
- Local knowledge of the species; where to find broodstock
- Large oyster species that show promising growth rates
- Found across the Northern Territory
- They taste GREAT!

NORTHERN TERRITORY GOVERNMENT

Aim

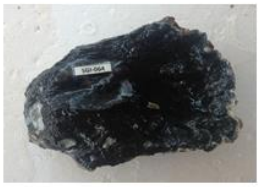
To determine if population genetic structure exists between wild populations of black-lip rock oysters across northern Australia

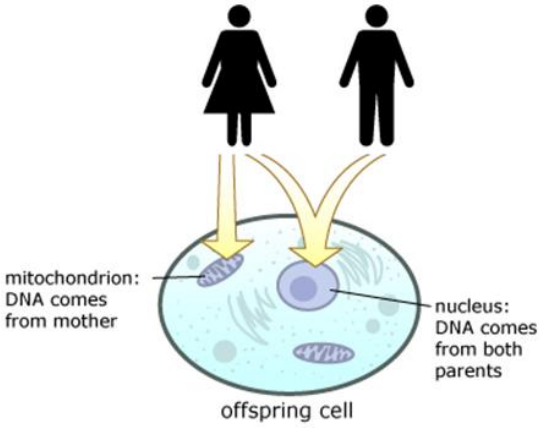
Important for translocation policy and hatchery production

PhD supervisors
Prof. Paul Southgate (USC)
A/Prof. Wayne O'Connor (NSW DPI)
A/Prof. Jan Strugnell (JCU)

Are we dealing with the same species? COI analysis

- Mitochondria DNA is inherited from the mother so it is similar among related individuals
- COI gene is a region of the mitochondria DNA
- Used to identify species





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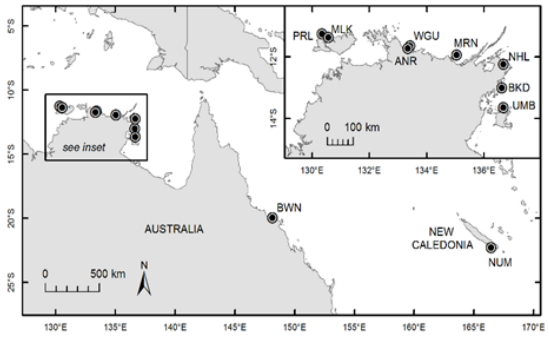
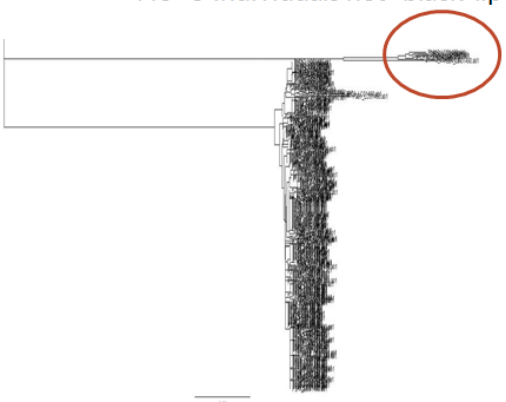
Are we dealing with the same species? COI analysis

No- 8 individuals not “black-lip”





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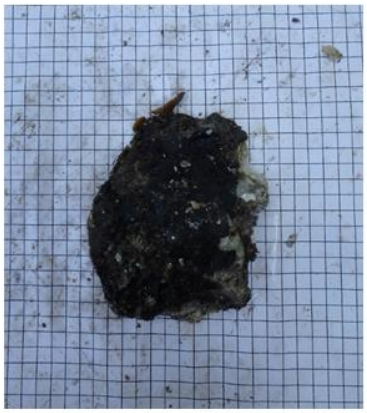
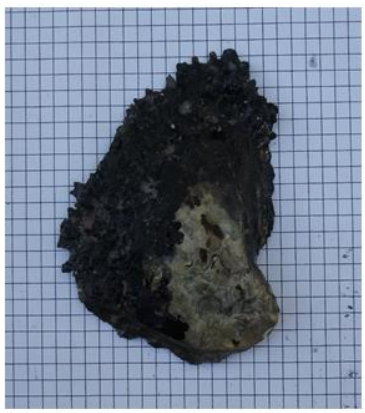
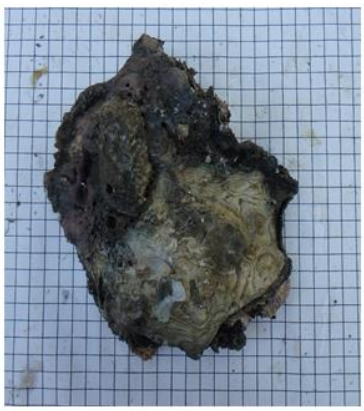
Are we dealing with the same species? COI analysis







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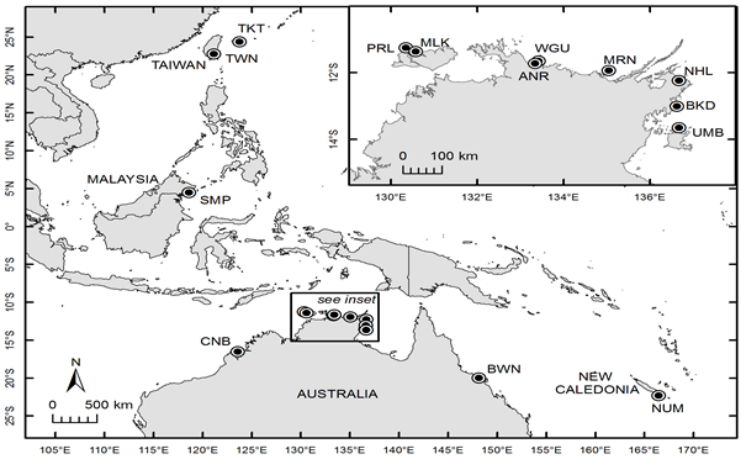
Black-lip species distribution COI analysis

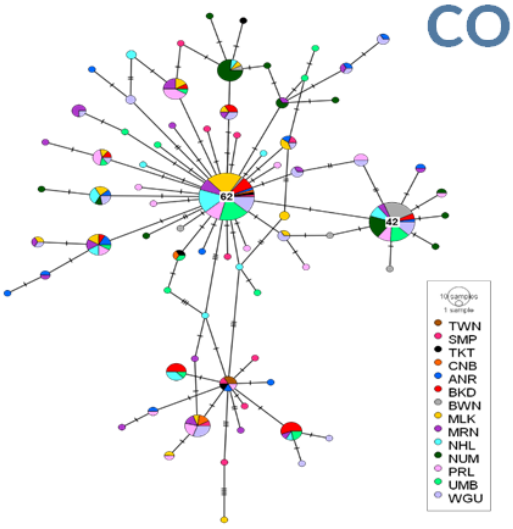


SMP= Semporna, Malaysia
TWN= Taiwan
TKT= Taketomi Island, Japan
CNB= Cone Bay, WA
BWN= Bowen, QLD
NUM= Noumea, New Caledonia

NT
PRL= Pirlangimpi
MLK= Milikapiti
ANR= Anuru Bay
WGU= Wigu
MRN= Mooroongga Island
NHL= Nhulunbuy
BKD= Bukudal
UMB= Umbakumba

NORTHERN TERRITORY GOVERNMENT

Black-lip species distribution COI analysis



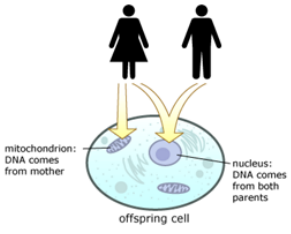
Key results:

- The haplotype network indicates lack of population genetic structure between populations
- The haplotype network is 'starlike'; 2 larger 'ancestral' haplotypes in the middle with many unique haplotypes radiating from them, this may suggest a recent population expansion after a bottleneck

NORTHERN TERRITORY GOVERNMENT

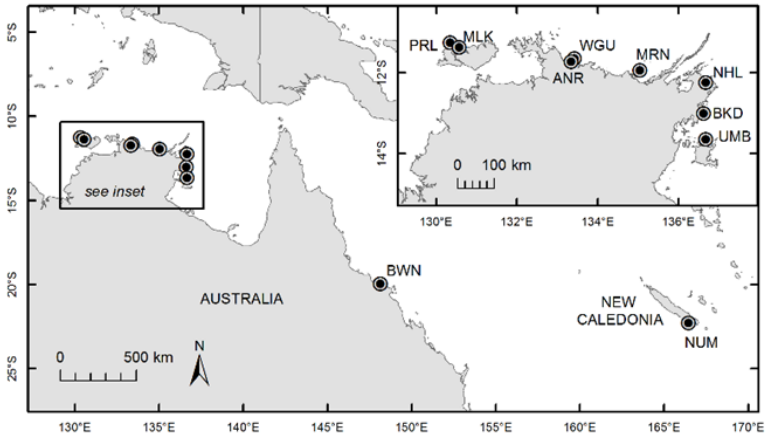
Population genetics- SNP analysis

- Single-Nucleotide Polymorphism (SNP) variation in a single nucleotide in the oyster DNA
- Variation between populations; a SNP variation may be common in one population and be much rarer in another
- SNP analysis was used to determine population structure; it is more sensitive at picking up population differences then COI



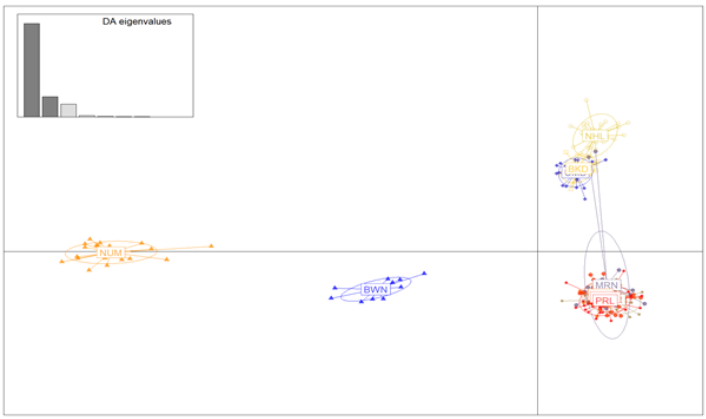
NORTHERN TERRITORY GOVERNMENT

Population genetics- SNP analysis



- 10 populations included in SNP analysis
- 15-37 individuals sampled from each population
- Only black-lip; 8 “other” species from BKD were excluded
- We found 28,000 SNPs!

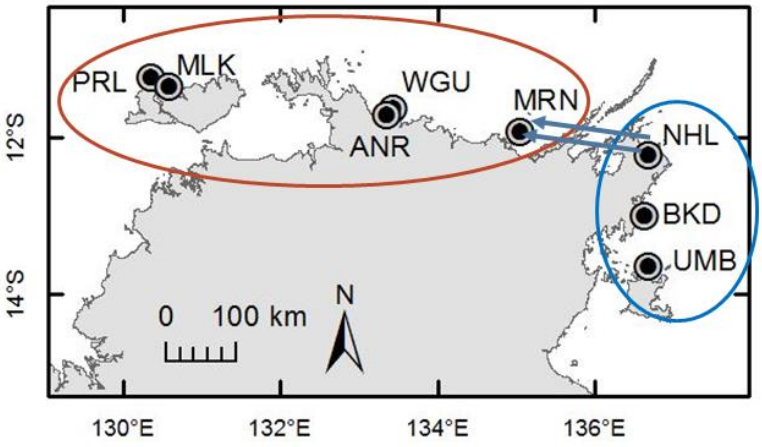
Population genetics- SNP analysis



Key results:

- Population structure does exist between the black-lip populations sampled
- The differences were significant
- Some mixing between the 2 NT populations

Population genetics- NT populations



Key results:

- Two significantly different populations
- Two individuals at MRN were more similar to NHL population
- Implications for hatchery production (2 genetic stocks)

Next steps... Outlier SNPs

- Outlier SNPs are likely to be associated with areas of the genome under selection
- 28,000 SNPs were used to analyses the population structure
- 31 outlier SNPs were identified by two methods
- Checking SNPs against published genes to determine if any are associated with a function, e.g. SNPs correlated with temperature

Outcomes

Key outcomes:

- Population genetic structure does exist between wild populations of black-lip across northern Australia
- Inform future translocation protocol
- Baseline understanding of current levels of genetic diversity in oyster broodstock

Knowledge gaps:

- Species names is probably incorrect
- Haven't looked at range of species in the NT

Acknowledgements

Thanks to all partners for their support and participation

Pacific Community
Communauté du Pacifique

DHIMURRU ABORIGINAL CORPORATION

JAMES COOK UNIVERSITY AUSTRALIA

TIWI LAND COUNCIL

ANINDILYAKWA LAND AND SEA RANGERS

CROCODILE ISLANDS RANGERS Maringa Ocean Patrol

University of the Sunshine Coast

YIRRALKA RANGERS LAYNHAPUY IPA

NORTHERN TERRITORY GOVERNMENT

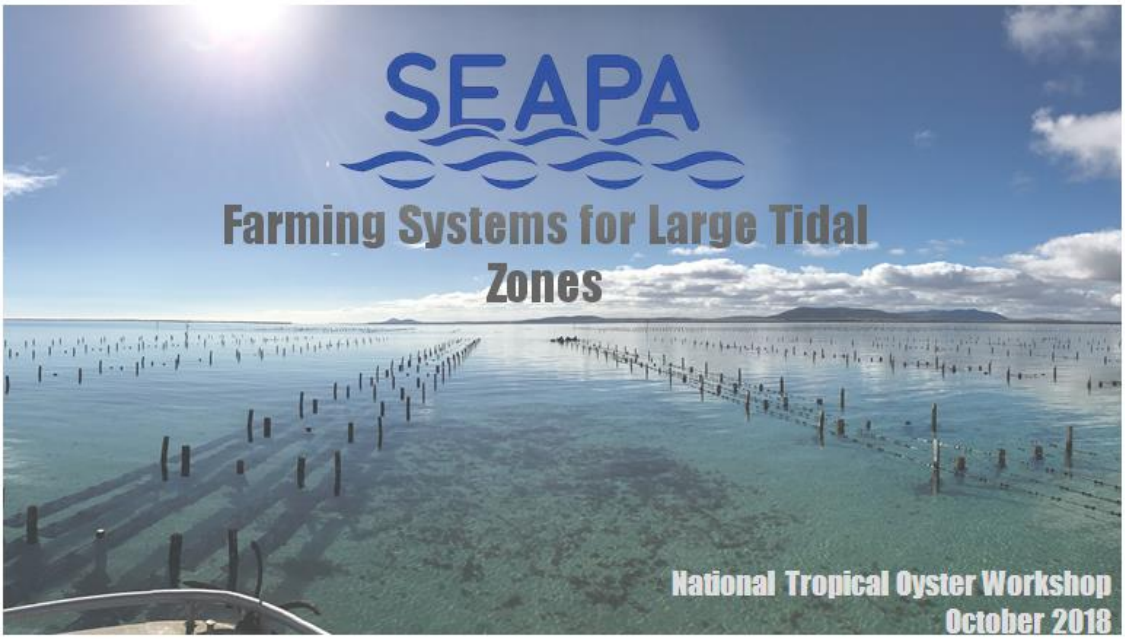
Yagbani Aboriginal Corporation

NSW GOVERNMENT Department of Primary Industries

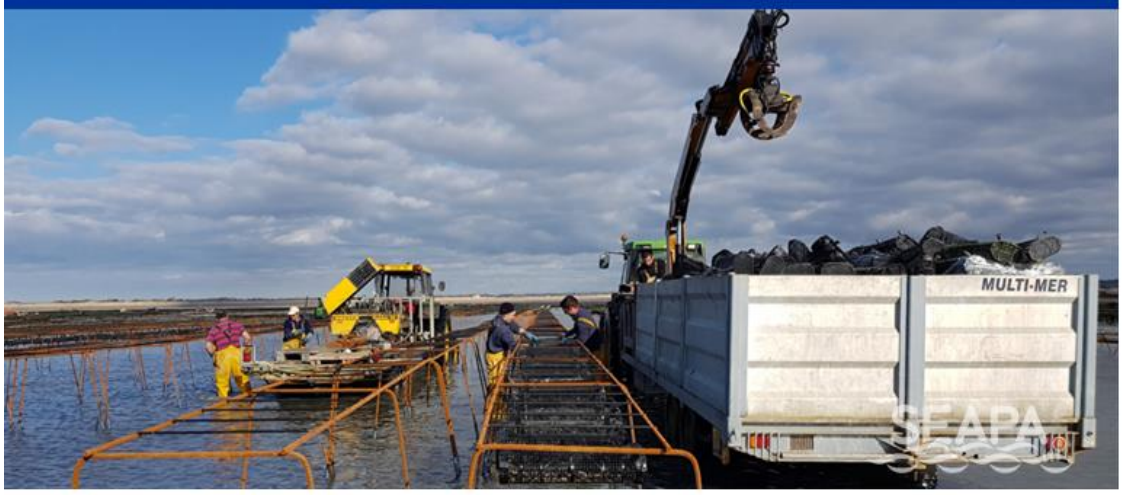
Government of Western Australia Department of Fisheries

Bowen Fresh Oysters

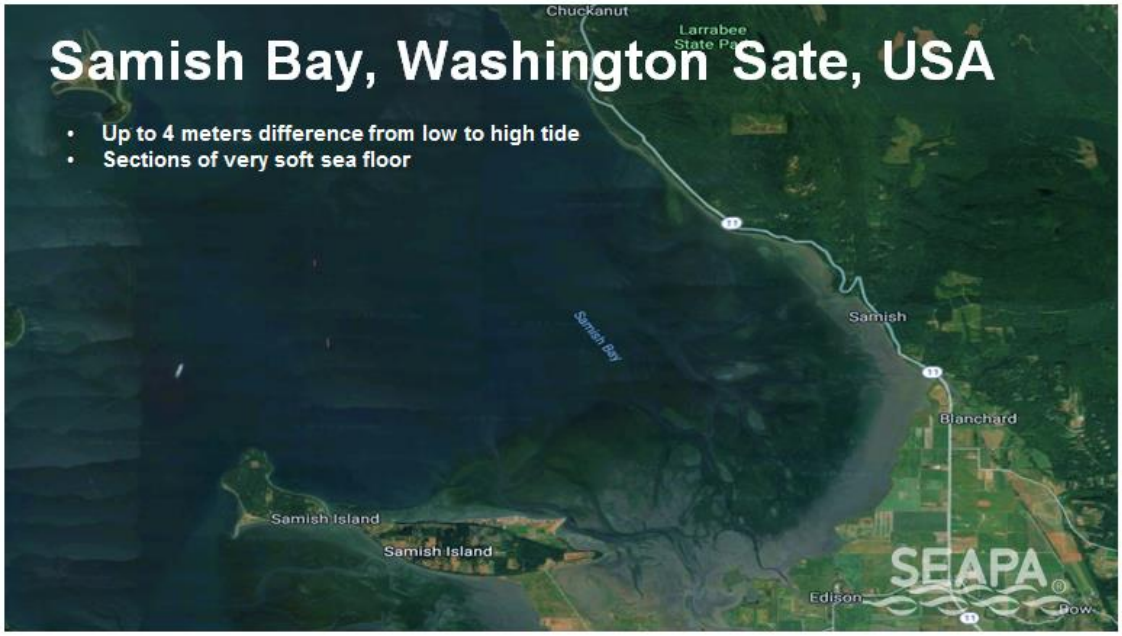
Farming systems for large tidal zones – Alex Jack



Farmers will drive out onto the sea floor with tractors and amphibious vehicles to deploy/ collect baskets



- Different clip systems are used subject to the severity of the environment
- Floats used for approximately 6 months of the year to allow extra movement
- During winter rope is used above baskets to reduce rotation

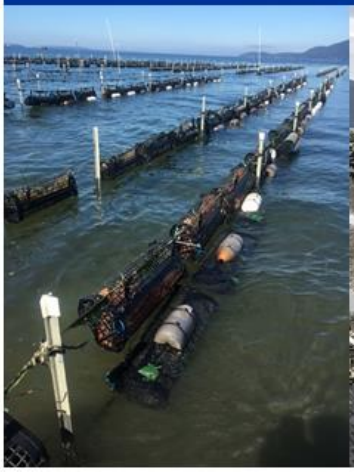

Samish Bay, Washington Sate, USA
• Up to 4 meters difference from low to high tide
• Sections of very soft sea floor
Chuckanut
Larrabee
Samish
Samish Bay
Blanchard
Samish Island
Samish Island
Edison
SEAPA


Penn Cove Shellfish
• Pacific Oyster and Clam production
SEAPA

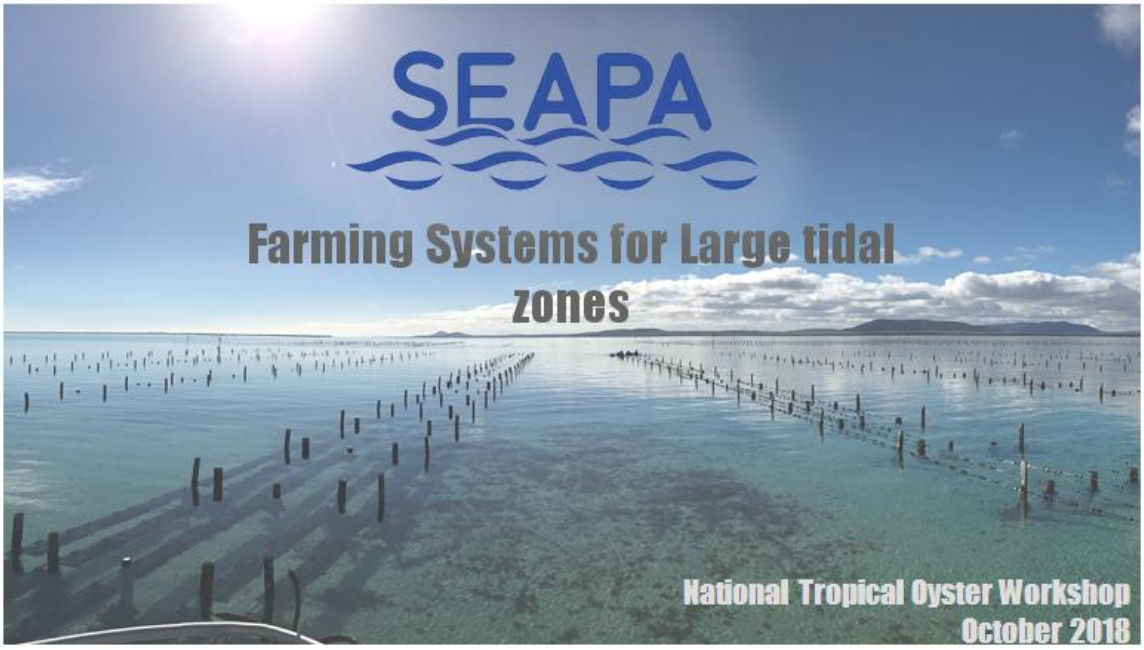
All processing is from a barge which moves around the farm at high tide

- Fixed intertidal longline farming system
- Galvanised T Posts
- Screw in anchor at either end of line
- ¼ inch rope longline
- 2 lines set one above the other on each post
- SEAPA STORMBREAKER Clip system consisting of a ¼ inch Clamp Bearing

Floats attached during calm seasons to increase time the baskets spend in the active area of the water




SEAPA


SEAPA
Farming Systems for Large tidal zones
National Tropical Oyster Workshop
October 2018

Developing hatchery culture techniques for tropical black-lip oysters (Saccostrea echinata) in the Northern Territory – Sam Nowland

Developing hatchery culture techniques for tropical black-lip rock oysters (*Saccostrea echinata*) in the Northern Territory

Samantha Nowland
Department of Primary Industry and Resources
October 2018

Background

- DAC started hatchery trials in 2010
- Limited knowledge on this species; only two published papers
- Spat production was inconsistent and not commercial quantities
- Settlement percentage of pediveliger larvae to spat was low

Aquaculture

Hatchery rearing of the tropical blacklip oyster *Saccostrea echinata* (Quoy and Gaimard)

Paul C. Southgate *, Peter S. Lee

NTG Tropical Rock Oyster Aboriginal Economic Development Program

Dedicated R&D project started in 2014

Major objectives:

- Hatchery production
- Grow-out production
- Shellfish quality assurance
- Business development

Hatchery R&D aims

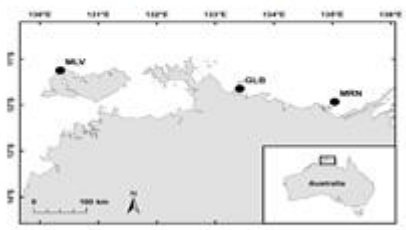
To further develop and optimise hatchery culture techniques for tropical black-lip rock oysters to permit the development of tropical rock oyster aquaculture in the Northern Territory

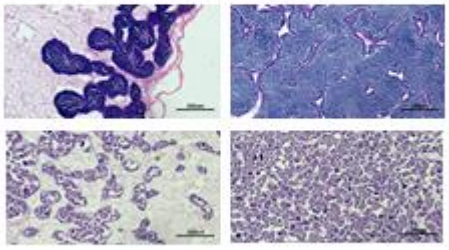
Specific aims:

1. Mapping reproductive seasonality
2. Recording and describing specific details of larval development
3. Optimising spawning induction techniques
4. Optimising tank conditions for rearing larvae
   - temperature and salinity
   - microalgae ration and stocking density

1. Mapping reproductive seasonality

Aim: determine seasonal fluctuations in the reproductive cycle of black-lip rock oysters from three locations across northern Australia and to investigate the influence of potential exogenous factors on gonad development

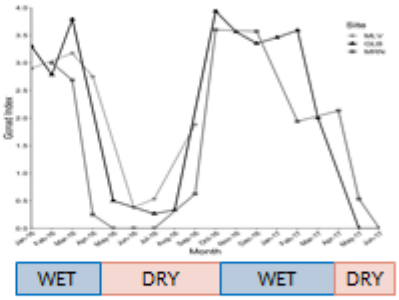




1. Mapping reproductive seasonality

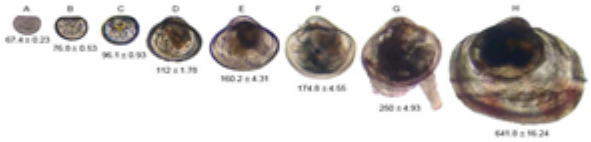
Key results:

- Clear wet/ dry seasonality
- Synchronised reproductive patterns
- Environmental cues: temperature and rainfall positively correlate with gonad index
- Very low occurrence of hermaphrodites
- Sex ratio of 1:1.4 (female: male)



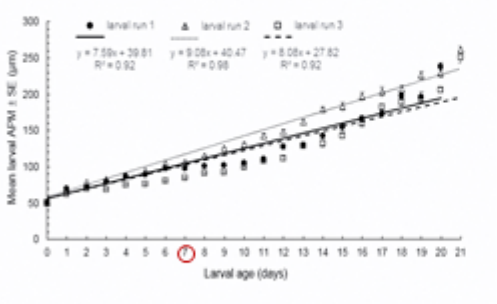
2. Describing embryonic, larval and early post-larval development

Aim: Investigate embryonic, larval, and early post-larval development of black-lip rock oysters across three larval cultures



Description of the critical embryonic and larval developmental processes and timing to fill an important knowledge gap and facilitate development of hatchery protocols

2. Describing embryonic, larval and early post-larval development



Key results:

- Black-lip is among the faster developing *Saccostrea* species
- Larval morphology is similar to that described for other *Saccostrea* species
- Poor survival past 7 dph and low spat yields

3. Optimising spawning induction techniques

Aim: To determine the most effective and reliable spawning induction technique for black-lip rock oysters

Physical shock | Strip spawning | Chemical induction

3. Optimising spawning induction techniques

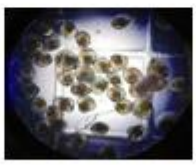
Key results:

- Salinity shock works best
- No need for temperature shock
- Serotonin will induce males to spawn (not females)
- Strip spawning works for black-lip but fertilisation is lower
- Current hatchery protocol is mass spawning with salinity shock

4. Optimal environmental conditions for rearing larvae

Aim 1: To investigate the combined effect of temperature and salinity on growth and survival of black-lip larvae.

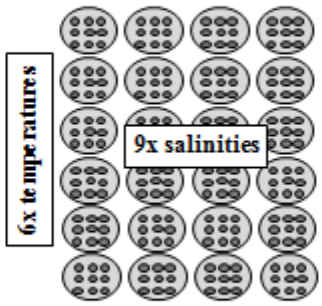
Aim 2: To investigate the combined effect of microalgae ration and stocking density on growth and survival black-lip larvae.

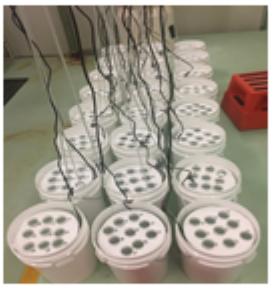


Aim 1: Combined effect of temperature and salinity on growth and survival of larvae

Each major larval stage:
1. Embryo
2. D-stage larvae
3. Umbonate larvae
4. Eyed larvae

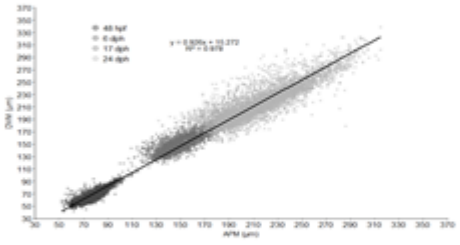
Salinity range: 11-36 ‰
Temp range: 17-32°C





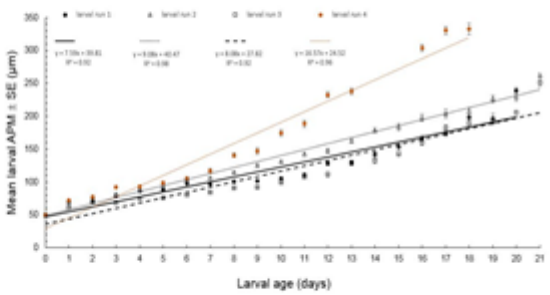
Aim 1: Combined effect of temperature and salinity on growth and survival of larvae

Key results:
- Water temperature and salinity have a significant effect on embryonic development (first 48hrs)
- Larvae are robust; survival was high across all treatments and larval stages
- Determine shell dimensions of throughout larval development, comparing DVM and APM across 20,806 larvae.
- Change salinity according to larval stage to max growth



Aim 1: Combined effect of temperature and salinity on growth and survival of larvae

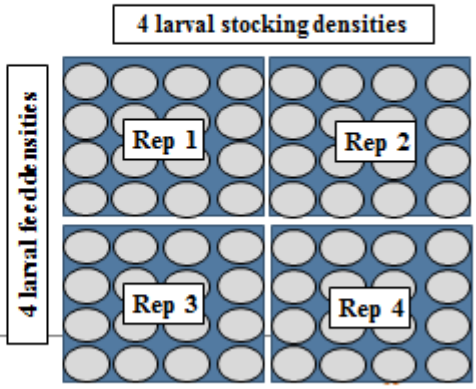
Applied recommendations to the March 2018 run:
- Percentage of settled larvae increased
- Settlement occurred 3 days earlier (18 dph)
- Settlement was spontaneous in culture tanks



Aim 2: Combined effect of algae ration and stocking density on growth and survival black-lip larvae

Each major larval stage:
1. D-stage larvae
2. umbonate larvae
3. eyed larvae

Algae range (cells larvae^{-1} day^{-1}):
D-veliger: 0-8 x 10^3
Umbonate: 0-25 x 10^3
Eyed larvae: 0-60 x 10^3
Stocking range: 0.5-10 larvae mL^{-1}



Aim 2: Combined effect of algae ration and stocking density on growth and survival black-lip larvae

Key results:

- High survival, confirming broad tolerance limits for this species (even when not fed)
- The interaction effects of microalgae ration and larval stocking density and on larval size were significant across all larval stages.

Next steps...

- Validate findings in next run- this week
- Publish hatchery manual for this species
- Develop next phase of R&D program
  - Investigate broodstock conditioning
  - Increase larval settlement percentages
  - Improve nursery system

Acknowledgements

Thanks to all partners for their support and participation

Tiwi Land Council

Yagbani Aboriginal Corporation

Crocodile Islands Rangers

Charles Darwin University

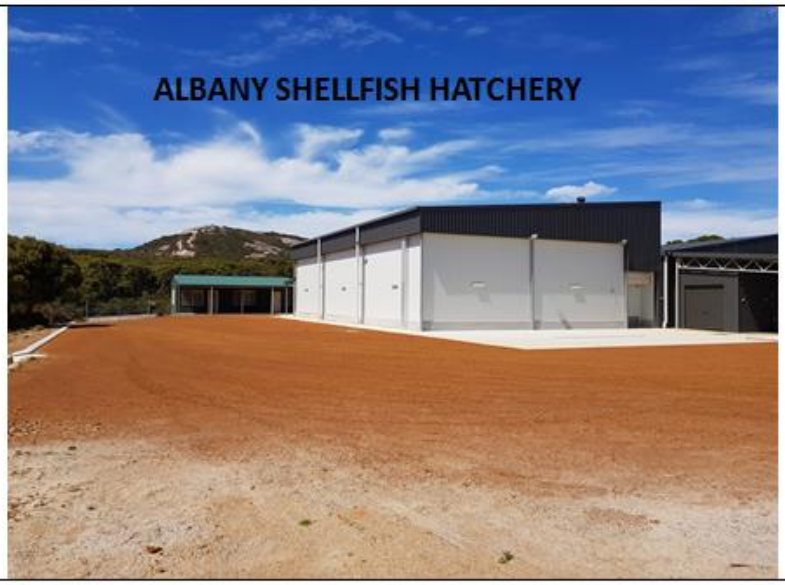
Northern Territory Government

University of the Sunshine Coast

James Cook University Australia

NSW Government Department of Primary Industries

Albany Shellfish Hatchery – Jonathan Bilton



Western Australian Multi-Species Shellfish Hatchery is located near Albany on the south coast of WA – 400 km south of Perth.

Located on the Torndirrup Peninsula at Frenchman Bay
Albany Aquaculture Park

Constructed during 2017 and opened by the Premier and Minister for Fisheries in December

Why Albany?

Albany Aquaculture Park established in 1996.

Two operations established in the park – Abalone hatchery/nursery on Lot 3 and an oyster hatchery on Lot 4. Both successful in technical terms but suffered financially.

Proven production history at AAP

Lot 4 Oyster Hatchery has been successfully producing Rock Oysters (S.glomerata) since 1994.

Ceased operations in 2009 but restarted in 2014 producing Rock Oysters (S.glomerata), Flat Oysters (O.angasi), Akoyas (P.fucata) and Mussels (M.galloprovincialis).

Condition of the building was very poor and storm events caused continual damage.

Construction underway – Winter 2017

Refurbishment and extension of Lot 3 hatchery

Design Features

To meet the requirements for Quarantine:

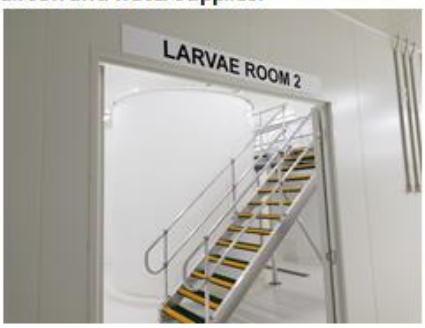
- Every room has a separate drainage system
- Each room can be designated as a "Quarantine Zone" and the wastewater diverted to a disinfection treatment system
- Access to each room is separate and independent
- Separate water supplies (ambient plus two temperature controlled supplies)

Overview of Hatchery

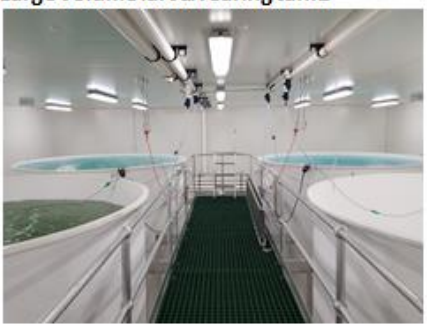
- Pumphouse with 2 x Mono 5.5kW pumps with two intakes, two discharge lines. Auto changeover.
- 3 x separate seawater supplies inside the hatchery – ring mains for Ambient, Heat Pump 1 and Heat Pump 2.
- 3 x Broodstock Conditioning rooms with individual temperature control heat pumps
- 2 x Larval Rearing Rooms
- 3 x Settlement Rooms
- Algae Bag Room, Lab, Stock Room and Prep area

Larval Rearing

Two Larvae Rooms fully equipped to operate independently with separate aircon and water supplies.



Large volume larval rearing tanks



Biosecurity

Incoming water

Wastewater

Biosecurity

- Incoming water is filtered and irradiated to prevent any local pathogens coming into contact with larvae and spat destined for export from Albany.
- 1 micron + UV
- Wastewater from any broodstock or spat not originating from local stocks are diverted to Ultrafiltration System.
- The hatchery can be set up to divert any individual room to the treatment system or the whole hatchery can be treated.

Saccostrea scyphophilla Production:

- Broodstock sourced from Flying Foam Passage near Dampier.
- Spawning induction was reasonably straightforward and much the same as *S.glomerata*.
- Hatchout and larval survival was lower than *S.glomerata*
- Settlement and nursery performance was excellent generally.
- Shaping of spat still needs plenty of work to produce a market sized oyster.

Saccostrea scyphophilla Production

Larval Rearing – Generally larvae were less robust than *S.glomerata* but this was based on a single batch.

Spat – Growth was vigorous and cohort generally grew very evenly.

Very different oysters

S.glomerata
Smooth and hard shell produced in nursery

S.scyphophilla
Lower valve is ridged and abrades more.

Distinct shell shapes.....

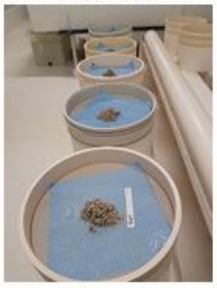
Lower valve - ridges

Distinct hinge types

Leaving home.....

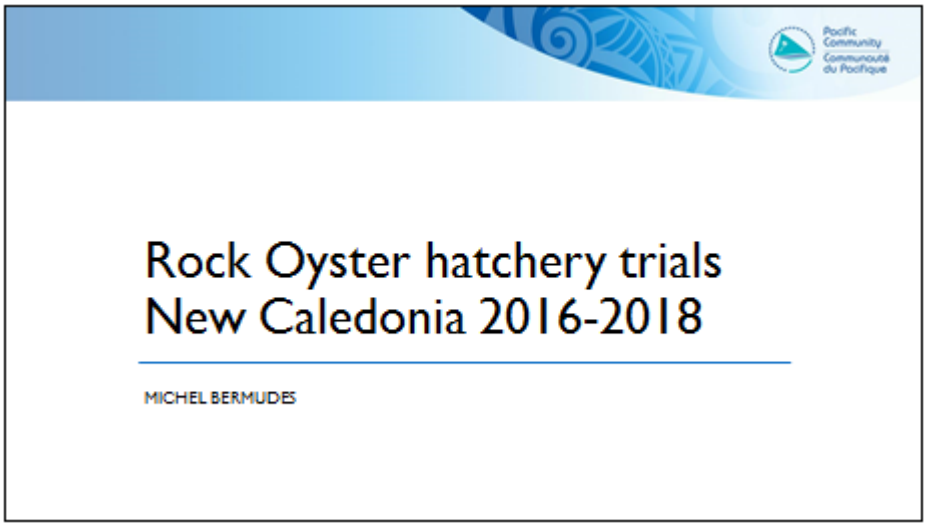
Volumed for each basket.....

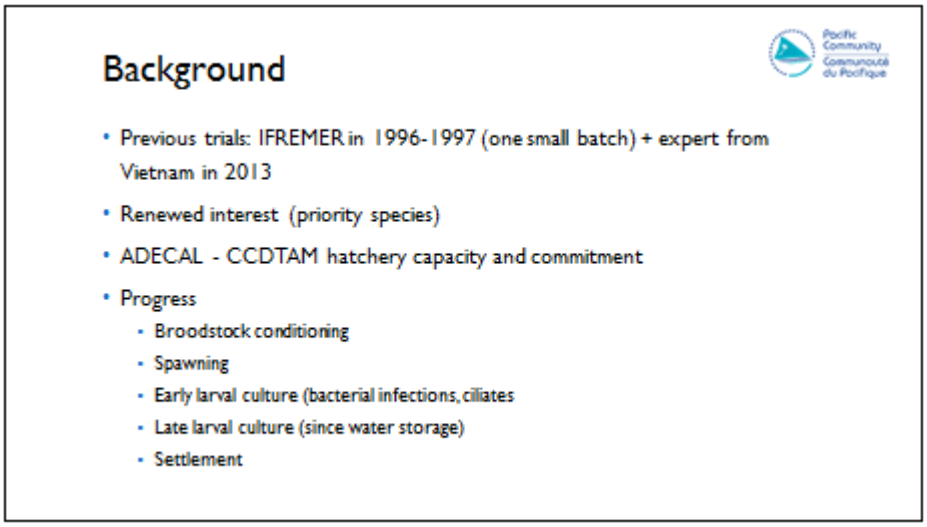
Individually wrapped.....

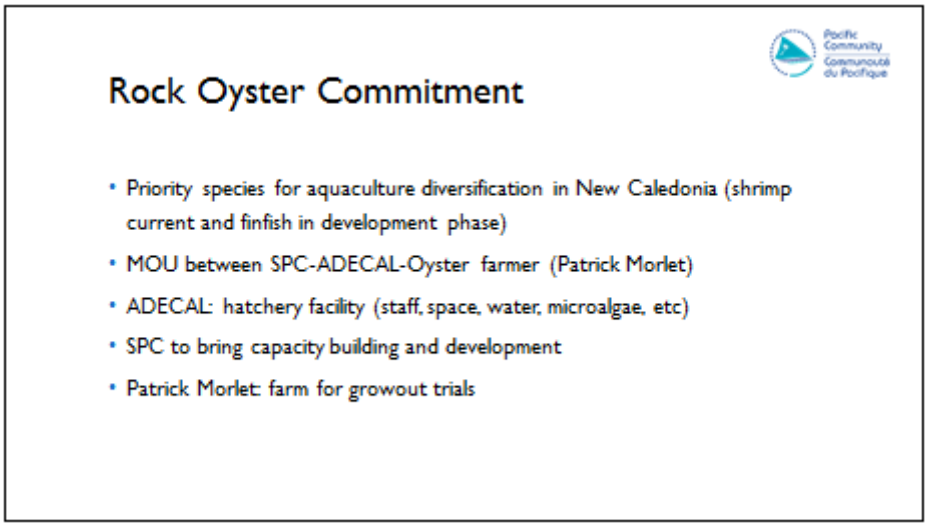


Albany Shellfish Hatchery

Rock oyster hatchery trials New Caledonia 2016-2018 – Michel Bermudes







Progress - Broodstock

- Sourcing: several sites, good natural conditioning
- Season:
  - For conditioning in hatchery: June to September
  - For direct spawning: November to April
  - Season tends to be around priority fish production (August + January to March)
- Conditioning in hatchery: about 8 weeks with temperature raising from ambient (22C to 27-28C)

BROODSTOCK CONDITIONING SYSTEM

Spawning

- **Strip spawn** vs natural spawn
- Variable water conditions:
  - pH: 7.3 to 7.9
  - Salinity: 0 to 42ppt
  - Heavy metals…
- Adjustments: pH 8.1-8.3, salinity 32ppt, ETDA
- Protocol: egg screening, timing, etc.
- Strip spawn: reliable (for small numbers), time efficient but variable
- Fertilisation rates: 30-95%; Hatch rates: 15-85%
- Work on natural spawning technique for larger spawns (commercial scale)

WATER QUALITY

Référence Client	Cd (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Mn (µg/L)	Ni (µg/L)	Pb (µg/L)	Zn (µg/L)
CTA - site pompage-marée basse	<0,025	0,045	0,028	7,06	1,01	2,49	<0,100	<1,07
CTA - site pompage-marée haute	<0,025	0,057	0,074	6,11	1,25	2,97	<0,100	1,53
CTA - eau réserve	<0,025	0,038	0,026	<0,059	0,284	4,424	0,108	<1,07
CTA - eau filtrée sable + 10 µm	<0,025	0,038	0,100	<0,059	0,258	4,259	<0,100	<1,07
CTA - eau filtré 5 µm (réserve Ecloserie)	<0,025	<0,027	0,036	<0,059	0,040	2,022	<0,100	<1,07
CCDTAM - eau brute	<0,025	<0,027	4,213	0,132	0,080	2,190	0,210	<1,07
CCDTAM - eau procès	<0,025	<0,027	0,762	<0,059	<0,028	1,046	<0,100	<1,07
CCDTAM - eau dessalée 25 %	<0,025	<0,027	2,679	37,614	6,087	2,146	0,516	<1,07
CCDTAM - eau process + eau de pluie	<0,025	0,086	1,012	<0,059	0,931	1,064	0,228	8,99
CCDTAM - eau brute	<0,025	<0,027	1,422	<0,059	0,760	0,801	<0,100	<1,07
CCDTAM - eau process	<0,025	<0,027	1,752	<0,059	0,330	0,906	<0,100	<1,07

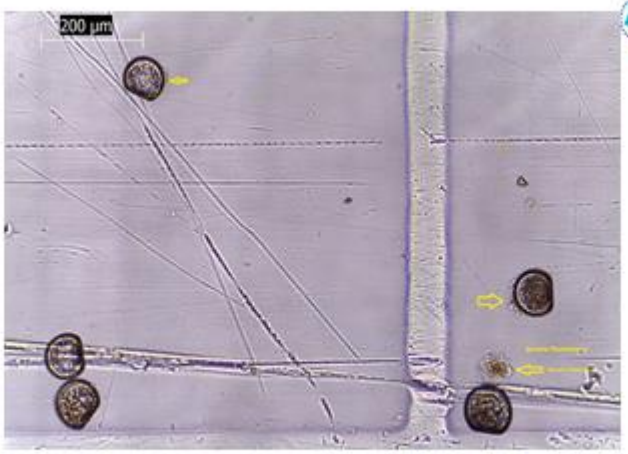
Early larvae culture

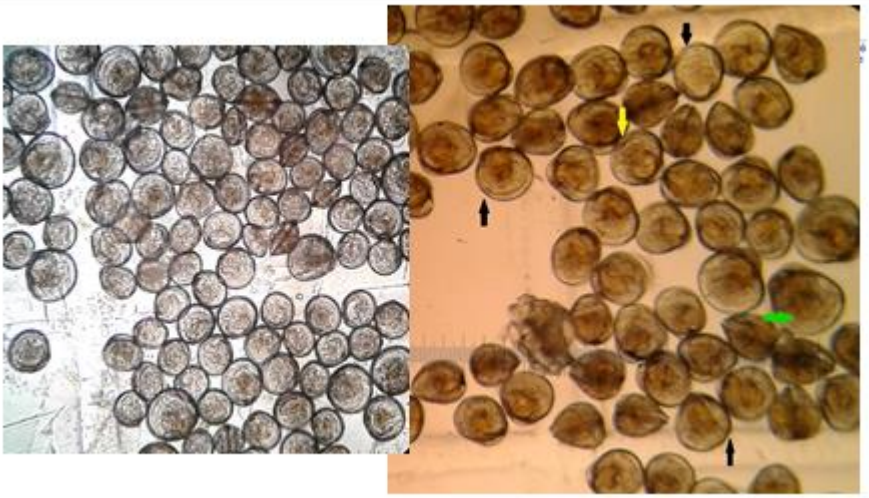
First trials (#1 to #6) failed at day 7-12 due to a range and combination of reasons:

- Poor larval quality (deformities) – revision of spawning techniques (water chemistry, salinity, pH, etc.)
- Poor water quality:
  - Mixing with tap water to reduce salinity (tap water full of heavy metals) – use rain water
  - Mix low in calcium – addition of calcium carbonate
- Bacterial infection (filamentous bacteria) – start using OTC
- Ciliate infestation (insufficient filtration) – 1 micron cartridge filtration
- Trials in a container (insufficient space for water treatment)
- **Lack of development, poor health**

WATER QUALITY – CALCIUM???

	Sea water	Seawater 32ppt + sodium metasilicate	Seawater 32ppt + EDTA + sodium metasilicate
pH	7,55	7,80	7,85
TAC	13,5°F	13,5°F	13,5°F
Calcium	260 mg/L	264 mg/L	297 mg/L

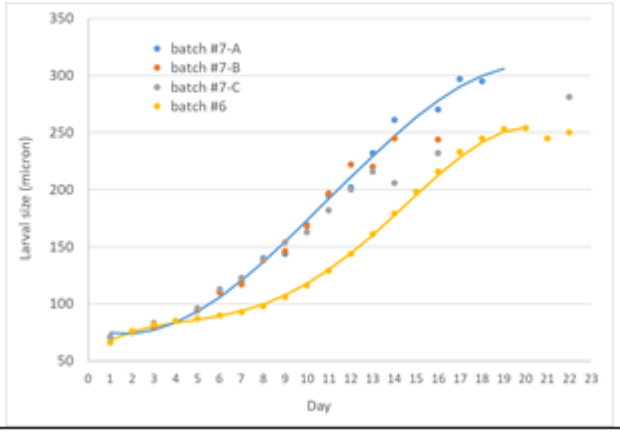




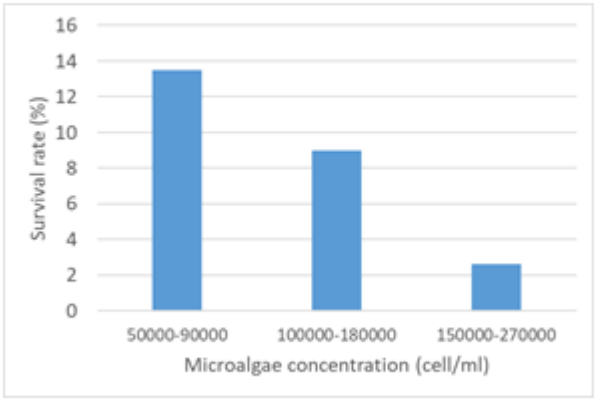
Late larvae culture

- Failed until batch #6
- Move inside hatchery
- Batch #6 = start of water conditioning
- Revised protocols (higher initial densities for more grading + high feed for more even batch)
- Slower and smaller than pacific but same growth pattern, timing of growth and feed, behaviour)
- Some differences with final development (slow) – Normal?

GROWTH



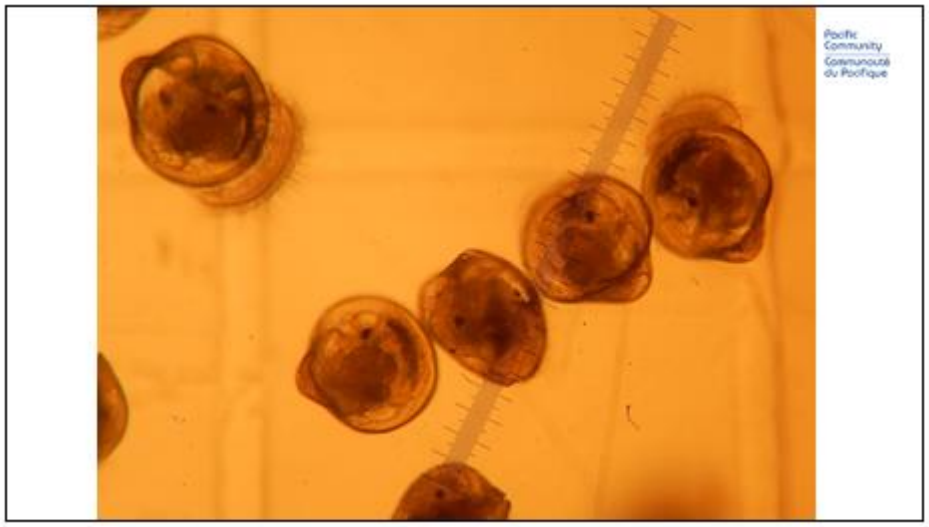
GROWTH AND SURVIVAL (#7)

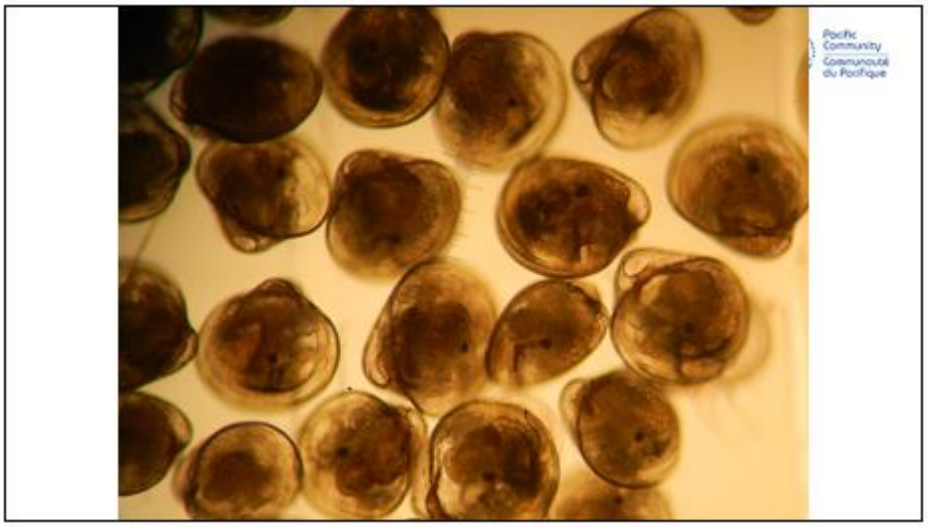


Settlement

- So far 3 batches put into set (1: zero spat, 2: 70 spat, 3: 250 spat)
- Setting techniques used:
  - Epinephrine: same techniques used for pacific, SRO and BLRO in Darwin (all failed)
  - Epinephrine: x10 and x100 SRO – Also failed
  - Micro cultch (technique used in Tahiti with 72% set rate) – Also failed
- Gains:
  - Epi/OTC drug interaction
  - Probably not the technique used but something else (diet?, water…)


R6
Pacific Community
Communauté du Pacifique


Pacific Community
Communauté du Pacifique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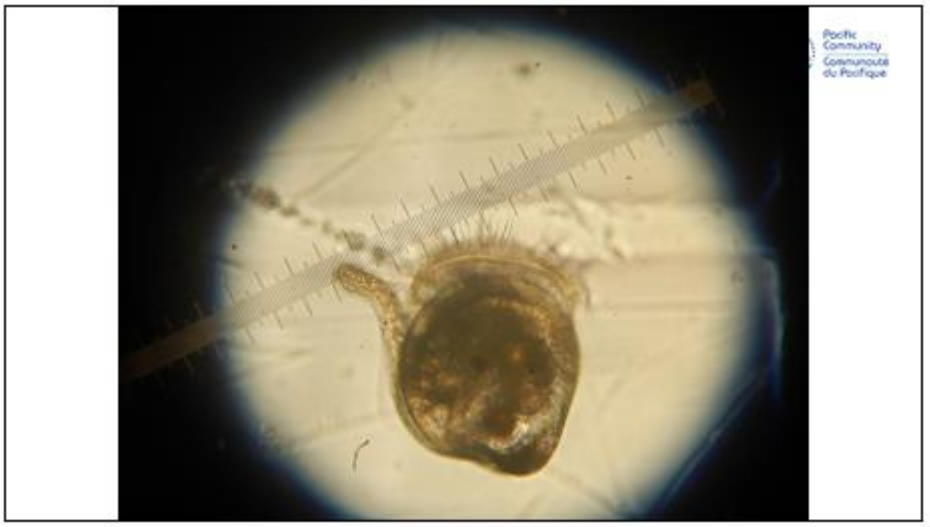
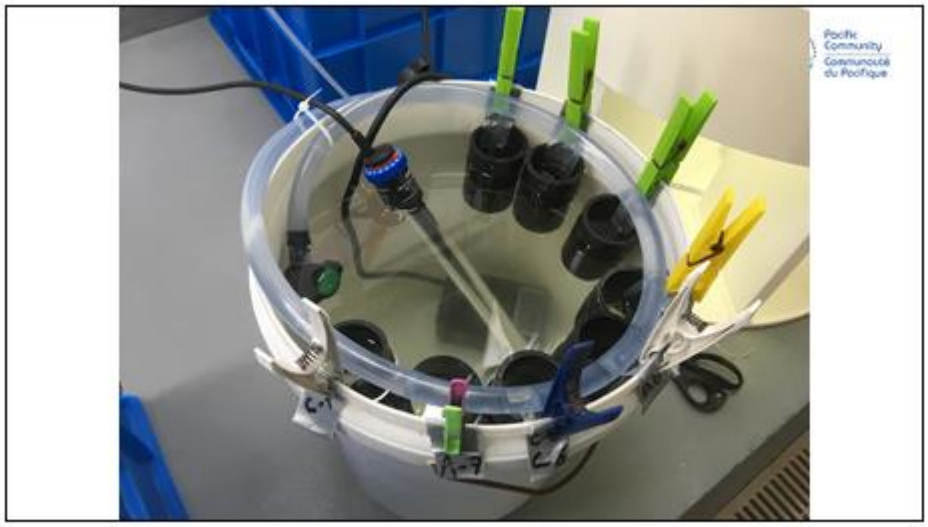
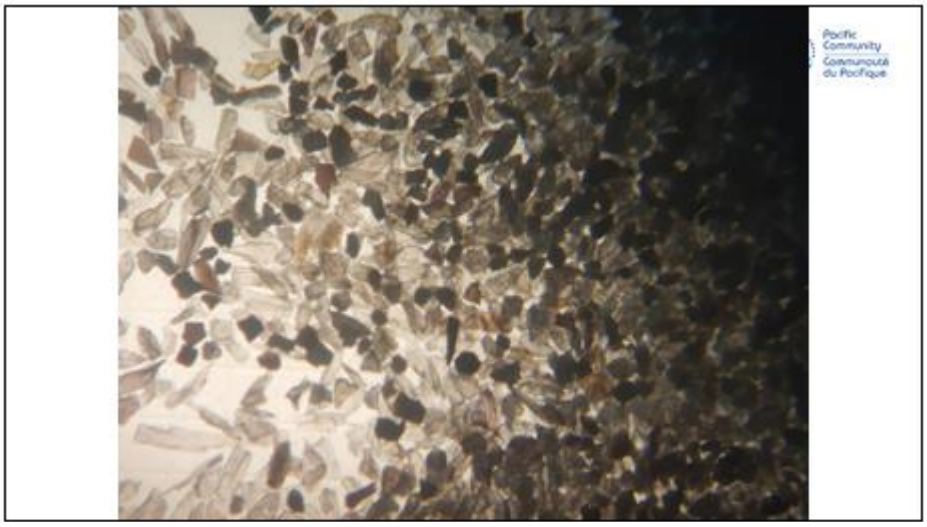
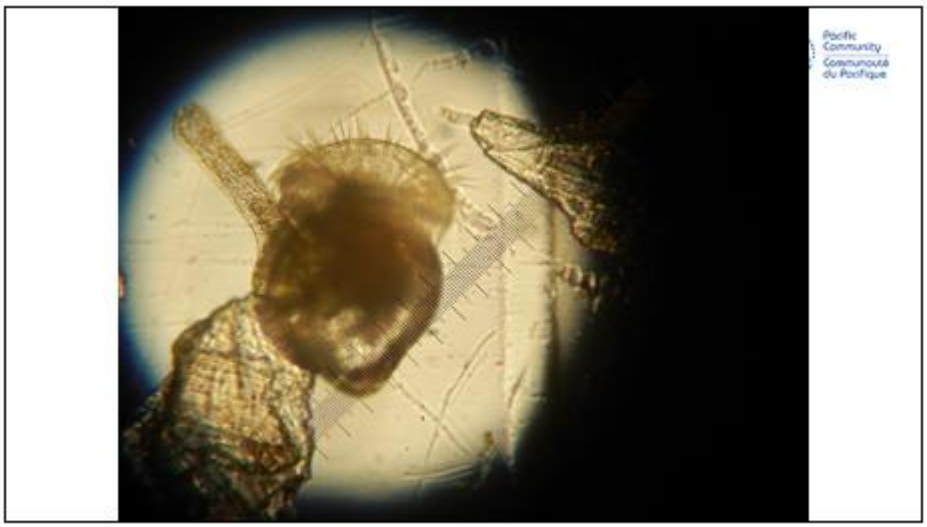
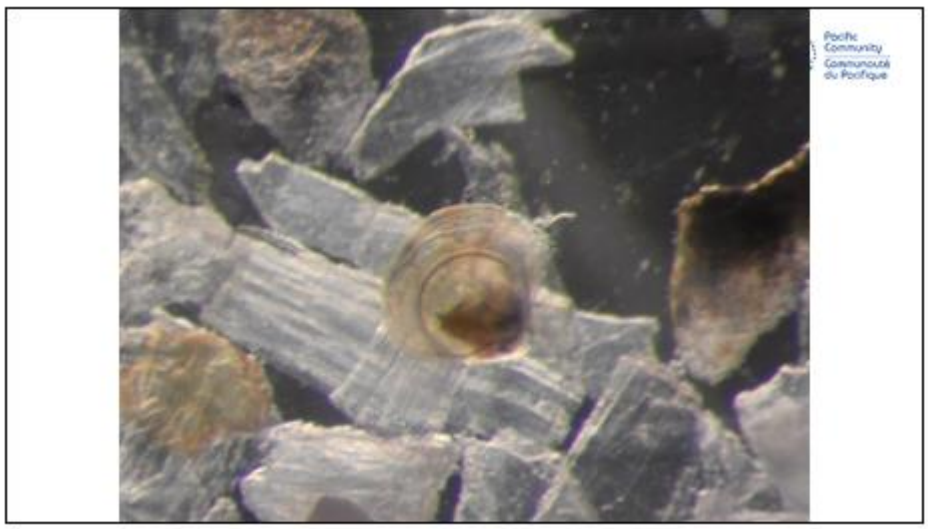

Pacific Community
Communauté du Pacifique



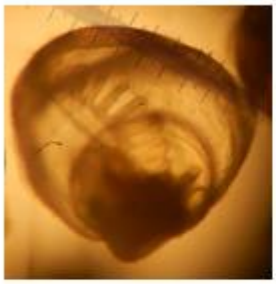






Next

- Continue optimising culture environment (water) and protocol (feed rate, density)
- Settlement: diet, test in other hatchery
- ???



THANK YOU!

Tropical oyster workshop summary – Day 1

FRDC

Mark Motlop

- Still kicking goals for Larrakia

Justin and Steve

- Large areas of water available to culture tropical oysters
- Comparing growing systems
- Coral oysters
- Successful collection of wild spat but difficult to determine species
- Collection of local broodstock and deployment of 200,000 *S. scyphophilla* spat from Albany hatchery. Await reports on growth, survival and analysis of oysters.
- Generate local support for the oyster industry from the start

FRDC

Mike

- Significant areas identified for shellfish aquaculture in WA
- Five sites included in current oyster trial with water quality and flow being monitored
- Biofouling is a problem

Wayne Oyster'Connor

- NSW interested in tropical oysters to support Northern growers
- Know very little about genetics needed to decide where oysters can be collected from and distributed to.
- NSW genetics studies show greater diversity within selected cultured stock that wild stocks.

Alan

- Possible to culture oysters in tropical areas
- Successful hatchery production and importance this has made to the business
- Use of hatchery, nursery and growout locations with specific conditions suited to growth stage
- Importance of considering salinity for tropical oyster spat production and growout

Michel

- Intermittent interest and research in the Pacific that has now been reinvigorated at the request of some countries.
- Need to be directed by social needs of people.
- Australian tour very beneficial

Wayne Oyster'Connor

- With appropriate technical and funding support, it is possible to create a significant aquaculture industry from scratch in a decade.
- Expect that technologies will be adapted to suit local environmental conditions and social needs.
- What are you setting the industry up for?
- ACIAR may help support some NSW tropical oyster research

Mike, Carmel and Sam

- Species identification, distribution and population structure of tropical oysters is "confused".
- Geneticists and policy makers are playing catch up but the picture is becoming clearer.
- There is acceptance that industry need to know what species can be grown where to direct intra and inter State translocation of broodstock and spat.
- Next step is a risk assessment to guide policy on translocation that represents an opportunity for inter-jurisdictional cooperation.

Collinson Effect

- Confirmation from a very experience oyster grower that black lip oysters are a commercial opportunity for Northern Australia when cultured by someone that knows what they are doing.
- Mechanisation is available to reduce mundane and time consuming jobs leaving staff to undertake more important stock management, farm improvement and expansion tasks.
- It is advantageous to use >10mm spat.

Alex

- Systems can be developed using adaption of current technology to allow oysters to be farmed in most coastal locations.
- Australia has a history of aquaculture innovation now be exported and adopted all around the world that is available to tropical oyster growers.

Sam

- Clear seasonal reproductive development with spawning during the wet season
- Great trials requiring huge effort to run and achieve results guiding improved protocols achieving better results in 2018.
- Settlement remains a significant problem
- Improved nursery systems being considered.

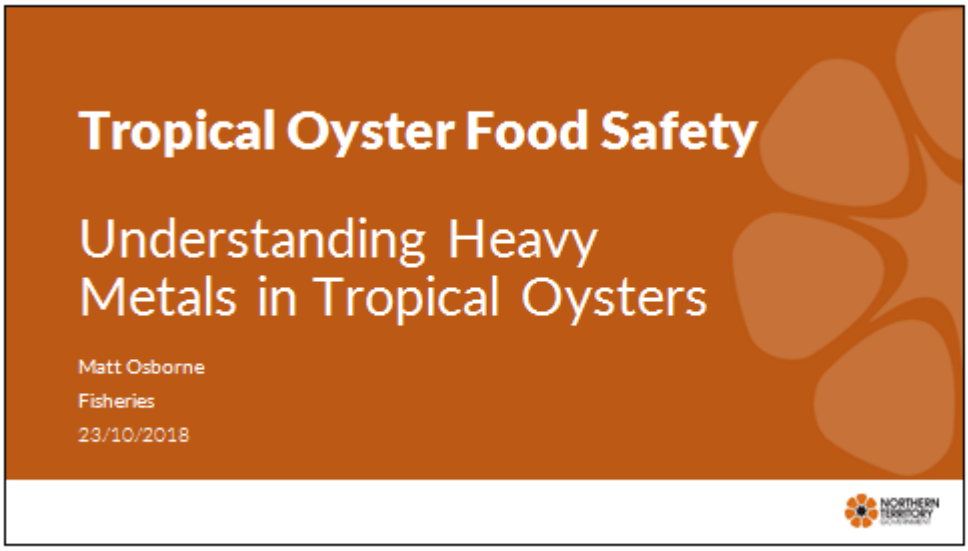
John

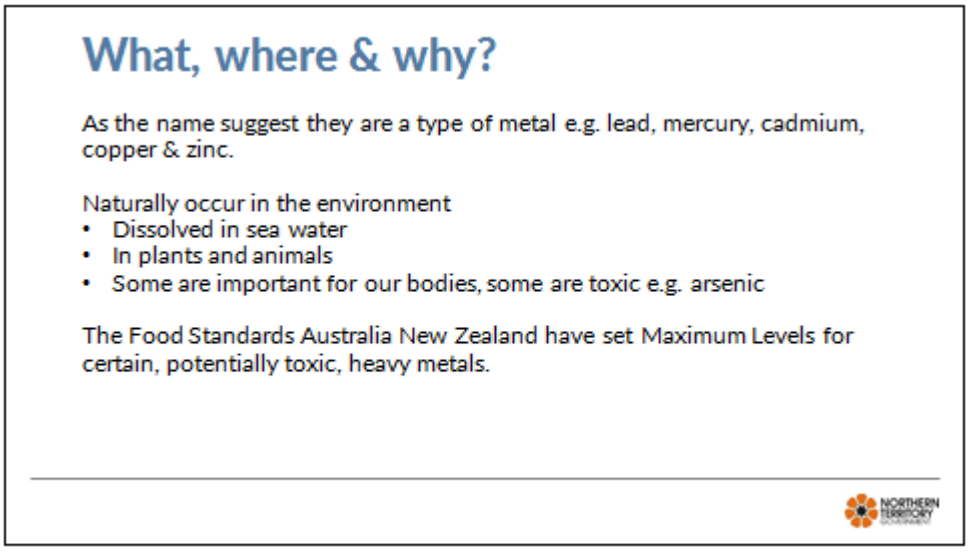
- New multi-species shellfish hatchery now operating including biosecurity features to allow supply across WA and interstate.
- First attempt produced 500,000 *S. scyphophilla* spat supplied to Pilbarra and other WA oyster trial locations.
- Larvae very fragile early but good settlement on cultch

Michel

- Importance of water quality and chemistry for larval culture
- Spat settlement is a big problem

Tropical oyster food safety – Understanding heavy metals in tropical oysters – Matt Osborne





Heavy Metals in NT Oysters

How

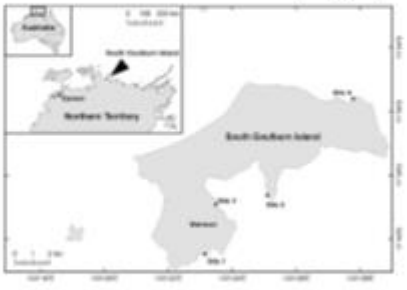
Oysters are filter feeders.

Unclear where the heavy metals, particularly Cadmium are coming from.

Accumulating in oyster tissue.

South Goulburn Case Study

3 sampling trips 2012-13



Marine Pollution Bulletin

Cadmium uptake and zinc-cadmium antagonism in Australian tropical rock oysters: Potential solutions for oyster aquaculture enterprises

	Limit	Type	Wild				Farmed		
			Site 1	Site 2	Site 3	Site 4	Site 1	Site 2	Site 3
Cd av. ppm ww	2.0 (maximum)	Milky	1.5	3.6	1.1	1.0	NA	NA	NA
		Blacklip	4.0	5.1	NA	3.3	2.0	2.5	1.4
Zn av. ppm ww	290 (expected)	Milky	21	10	267	25	NA	NA	NA
		Blacklip	22	14	NA	30	20	18	78

NORTHERN TERRITORY GOVERNMENT

What does this mean?

NORTHERN TERRITORY GOVERNMENT

Options?

Depuration is a slow process

Presence of Heavy Metals may effect farm site selection.

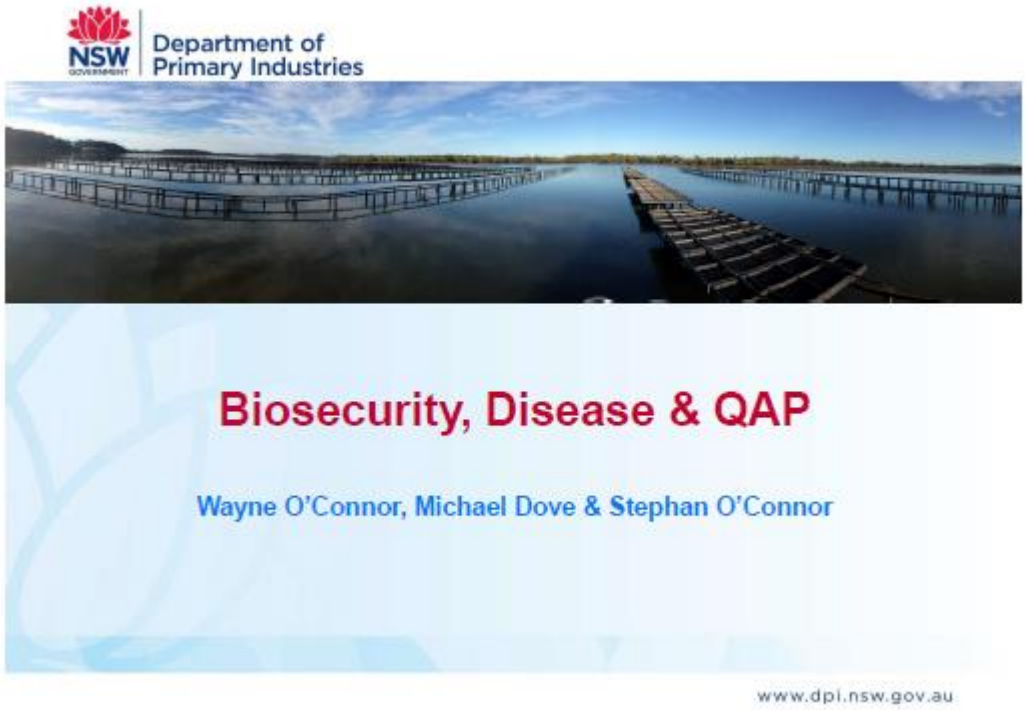
Important to know the broader context across the NT.

Results from recent testing of oysters grown on Tiwi Islands have been below FSANZ levels.

Need to better understand heavy metal oyster concentrations across the NT.

NORTHERN TERRITORY GOVERNMENT

Biosecurity, Disease & QAP – Wayne O'Connor, Michael Dove, Stepan O'Connor



"In the 1860's a man could work his warp stake into the bed and not leave that spot for sixteen or twenty days, getting fifteen to twenty bags a day all that time.

NSW GOVERNMENT | Industry & Investment

Biosecurity

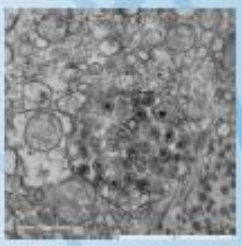
Estuary and source of information	Year of Translocation	FIRST REPORT OF WORM DISEASE
Hunter (Quinan, 1883 & 1884)	1880s? [a]	1882
Hawkesbury (Benson & Gyler, 1887)	1885	1886
Port Jackson (Quinan, 1884)	1885	1886-87
Georges (Grant, 1889)	1886	1887
Tweed/Richmond (Temperley, 1888)	1885-86	1887
Manning (Gyler, 1887; Temperley, 1888)	1887	1887
Port Stephens (Laman, 1890)	1887	1888
Clarence (Temperley, 1888 & 1889)	1885-86	1889
Crookhaven	1888	1891
Coomera, Qld (Smith, 1985)	1890s?	1895
Wallis (Temperley, 1888)	1886-87	1898
Clyde	1887-88	1899
Camden Haven	1895	1899

st known to me 35 years ago, the daily catch of oysters from
would be over 100 bags and now everything is exterminated"
Creek)
ead permanent extinction of oysters below the neap tide level
, 1925)

NSW GOVERNMENT | Industry & Investment

Diseases

- Winter mortality 1930s
- QX 1979
- OsHV 2010
- You may not have one now but its coming!



NSW GOVERNMENT | Industry & Investment

QAP

Georges River

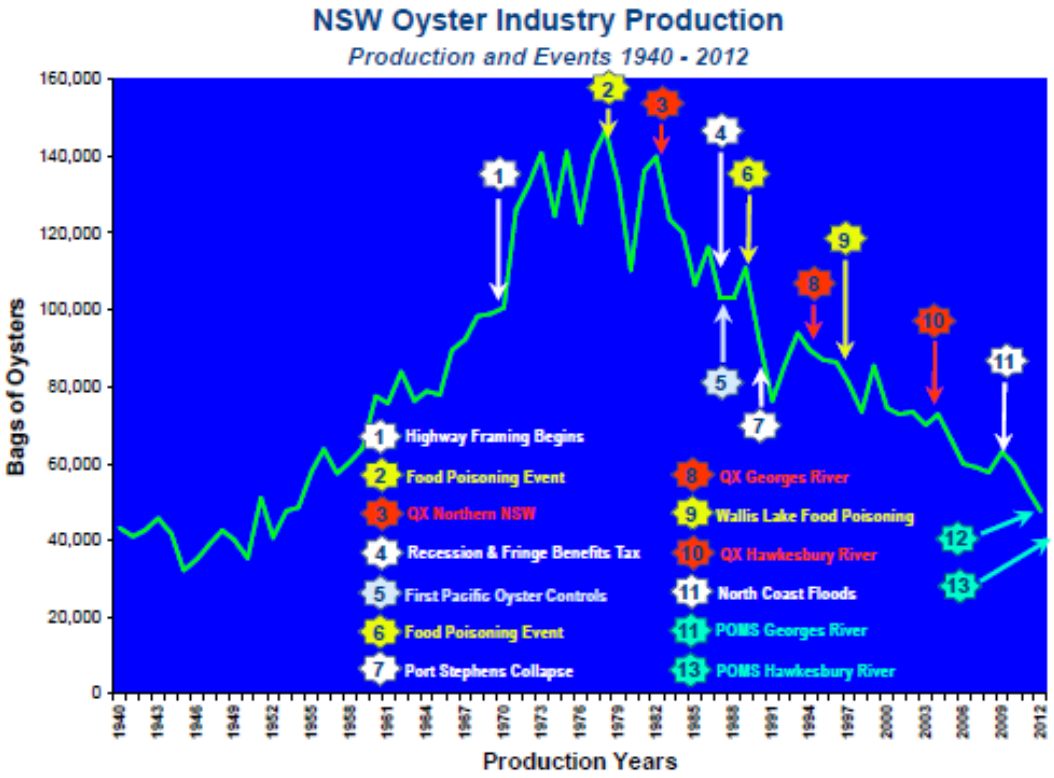
July 1978 2000 people

Dec 1978 60 people Darwin

Wallis lake

Jan- April 1997

467 cases of Hep A



Managing food safety hazards associated with shellfish – Alison Turnbull

Outline

- SafeFish
- Illnesses associated with shellfish consumption world wide
- Illness in Australia
- What are the hazards and how are they managed?
- Legislative requirements
- Australian Shellfish Quality Assurance Program
- Hurdles for NT
- How can SafeFish help?

SARDI

Acronyms

- ASQAAC – Australian Shellfish Quality Assurance Advisory Committee
- ASQAP – Australian Shellfish Quality Assurance Program
- FSANZ FSC – Food Standards Australia New Zealand Food Standards Code

SARDI

SafeFish

Objectives

- provide technical/scientific expertise to enable rapid response to sustain free and fair access to key markets, and
- underpin the safety and hygiene of seafood sold commercially in Australia

Partnership of Seafood Safety & Market Access Experts

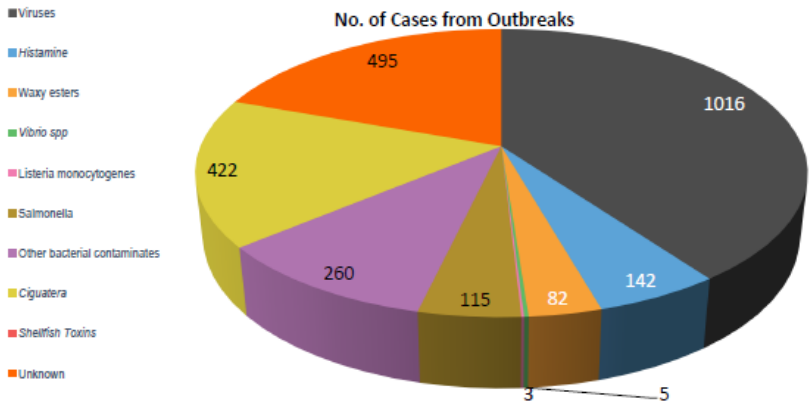
- Independent Chair, FSANZ, DAWR, Industry (domestic, processors, exporters, importers) FRDC, and Researchers

World infectious outbreaks associated bivalves 1969 - 2000

Agent	No. of outbreaks	No. of patients	Country or countries reporting outbreak	Type(s) of bivalve(s)	Reference
Calicivirus/Norwalk-like viruses/ small round-structured virus[b]	18[a]	5923	USA, UK, Australia, Japan, Spain	Clams, oysters	[6, 7] (and others)
Hepatitis A virus	8	290,965[c]	USA, Italy, China, Australia	Clams, oysters, mussels	[8–13]
Vibrio parahaemolyticus	5	669	USA, Canada	Oysters, clams	[14]
Vibrio cholera	4	120	Malaysia, Italy, USA	"Shellfish," "bivalves," oysters	[15, 16]
Vibrio vulnificus	1	72	USA	Oysters	[17]
Vibrio mimicus	1	17	USA	Oysters	[18]
Vibrio hollisae	1	2	USA	Oysters	[19]
Salmonella species	3	98	Singapore, UK, Japan	Oysters, cockles	[20]
Shigella flexneri	1	40	France	Shrimps, mussels	—
Shigella sonnei	1	24	USA	Oysters	—
Plesiomonas shigelloides	2	54	USA, Canada	Roasted oysters	[21]
Listeria monocytogenes	1	4	New Zealand	Smoked mussels	—

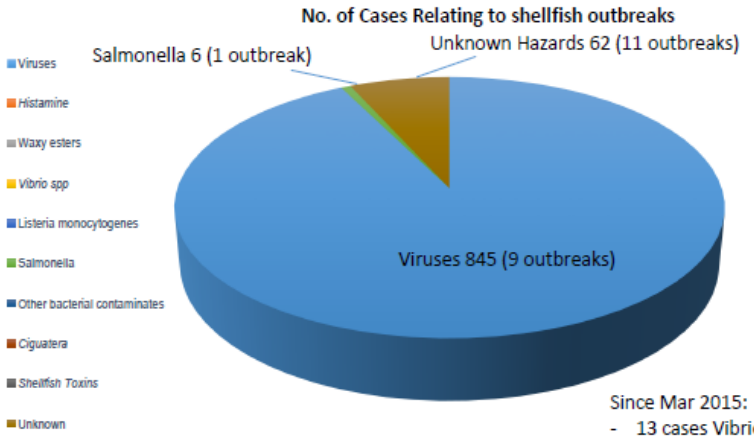
From: Infectious Outbreaks Associated with Bivalve Shellfish Consumption: A Worldwide Perspective
Clin Infect Dis. 2002;35(8):921-928. doi:10.1086/342330
Clin Infect Dis | © 2002 by the Infectious Diseases Society of America

Seafood Implicated Food Poisoning in Australia
Jan 01 - Mar 15, 211 outbreaks, ~2,305 cases



Source: OzFoodNet

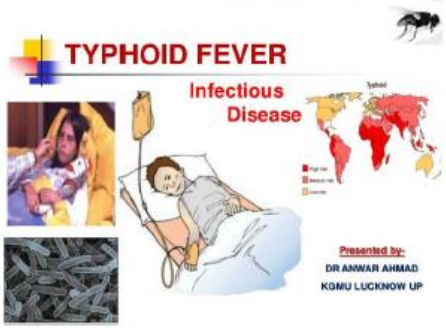
Shellfish Implicated Food Poisoning Cases in Australia Jan 01 to Mar 15, 21 outbreaks, ~ 913 cases,



Since Mar 2015:
- 13 cases Vibrio (2 outbreaks)
- 7 cases biotoxins (2 outbreaks)

Bacterial pathogens

- *E.coli, Salmonella, Shigella, Listeria*
- Bacterial gastroenteritis: vomiting, abdominal pain and diarrhoea
- Typhoid: headaches, fever, rash, toxaemia, disorientation and/or coma, death (1-4% treated cases)
- Listeriosis: muscle aches, headache, nausea, fever, miscarriage, death (immune compromised)



Bacterial risk management

- Source: faeces from animals
- Cooking >72^0 for >1 min removes risk
- Sanitary survey
  - Pollution sources: population, waste treatment, industrial, agricultural, wildlife
  - Environmental factors: rainfall, riverflow, salinity, tides, seasons
  - Water quality & shellfish quality

- Classification – Approved, Conditionally approved, Restricted, Prohibited

ONLY GROW SHELLFISH IN AREAS OF GOOD & PREDICTABLE WATER QUALITY

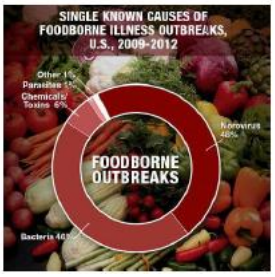
- Management plans: **ONLY HARVEST WHEN RISK LOW**

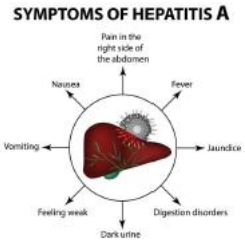
Viral pathogens

Norovirus

- Norovirus (NoV) – viral gastroenteritis
- Hepatitis A virus (HAV) – liver disease
- Both normally treatable but can result in death

Hepatitis A Virus

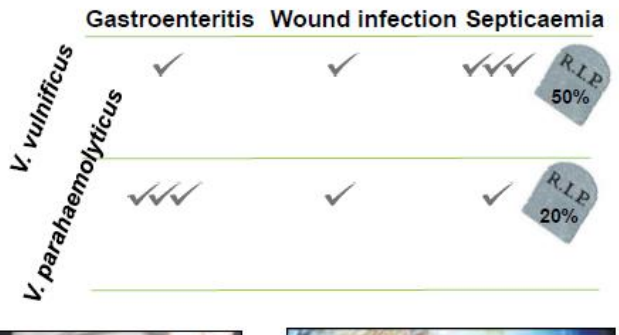




Viral risk management

- Source: human faeces/vomit and poor hygene
- Highly infectious, survive up to 90 days in environment, adhere to oyster gut
- Cooking >90^0 for >90 sec removes risk
- Sanitary survey:
  - Treatment plants, package waste systems, septics, camps, boating
  - Tides, river flows, currents, seasons
  - Prohibited zones e.g. outfalls, septics, marinas, anchor zones
- Active management: links with waste managers, **21 day closure following events**
- Grower training and sanitation, public awareness
- **Monitoring not an option**

VIBRIOSIS



Vibrio risk management

- Pathogenicity and virulence not well understood
  - marker genes are usually used to indicate pathogencity, but limited capability in Australia for this type of analysis
- Australian risk management advice sparse
  - ASQAP post harvest temperature control
  - Pre-harvest not addressed
- Food Standards Code advice for ready-to-eat foods based on *V. parahaemolyticus* levels
  - 100-10,000 cfu/gm unsatisfactory, >10,000 cfu/gm potentially hazardous
- **Codex recommends monitoring based on pathogenic strains of *V. parahaemolyticus,* and *V. vulnificus* and post harvest temp control**
- NSSP: individual growing area management plans based on epidemiology, monitoring results and environmental variables. Also looks at harvesting techniques
- NZ: Harvesting and handling practices used to mitigate *V. parahaemolyticus* illness, Risk profiles for *V. parahaemolyticus,* and *V. vulnificus*

Marine Biotoxins

- Paralytic, amnesic and diarrhetic shellfish poisoning
- All can cause nausea, disorientation, headaches, confusion
- PST: tingling extremities, muscles paralysis, death by suffocation (15% cases)
- AST: convulsions, permanent short term memory loss, coma & (rarely) death
- DST: diarrhoea, abdominal pain


Editorial: Toxic crisis threat

EDITORIAL | November 24, 2012 12:01am

THE toxic algae crisis to hit East Coast fisheries is the last thing Tasmania needs – especially in the lead-up to Christmas.


Rotorua Daily Post

Shellfish poisoning victims increase

By Kristin Macfarlane Email Kristin
8:39 AM Wednesday Dec 19, 2012

The outbreak of paralytic shellfish poisoning is the worst to be seen in the Bay of Plenty, the number of people affected rising to 20.

Marine biotoxin risk management

- Source: a range of naturally occurring marine algae
- Cooking doesn't destroy
- Can rapidly expand = high risk for human health
- Recreational harvester risk (7 recent in Tas, 20 from NZ)
- Risk assessment for every growing area
- Regular monitoring:
  - Toxins in shellfish +/- toxic algae
  - high frequency in high risk periods or areas without risk assessment
- Lab capability, expensive, long turn around times
- **Growing area closures and relay**

Heavy metals and other chemicals

- Usually chronic impact from a range of dietary sources, seafood only one contributor
- Cadmium: cancer of breast, prostrate, uterus + bone diseases
- Lead: harms kidney, nervous system, and brain development
- Arsenic: cancer of lungs, bladder, kidney, + skin diseases
- Mercury: brain development
- Pesticides and herbicides: leukemia, lymphoma, brain, kidney, breast, prostate, pancreas, liver, lung, and skin cancers, neurological and reproductive impacts

Risk management of heavy metals and other chemicals

- Sanitary survey – natural levels, industrial inputs, agricultural chemicals, mining/dredging activities (historic or current)
- Monitoring of shellfish flesh
- **Prohibited or restricted zones** with long term relaying

Australian Legislation

FSANZ Food Standards Code: Chapter 4
Standard 4.2.1: Primary Production and Processing Standard for Seafood

STANDARD 4.2.1

PRIMARY PRODUCTION AND PROCESSING STANDARD FOR SEAFOOD

(Australia only)

Purpose and commentary

This Standard sets out food safety and suitability requirements for seafood generally from pre-harvesting production of the seafood up to, but not including manufacturing operations. Chapter 3 of this Code applies to seafood manufacturing and retail sale activities.

Under this Standard, a seafood business must identify potential seafood safety hazards and implement controls that are commensurate with the risk.

Additionally, this Standard requires primary producers and processors of certain bivalve molluscs to implement a food safety management system. This particular requirement also extends to manufacturing activities relating to bivalve molluscs.

For primary producers and processors of bivalve molluscs, the food safety management system incorporates conditions on the areas from which the product may be harvested or harvested for depuration or relaying, along with conditions on the water used for wet storage.

16 Food safety management systems for bivalve molluscs

(1) A seafood business that engages in the primary production or processing of, or manufacturing activities concerning, bivalve molluscs must implement a documented food safety management system that effectively controls the hazards.

Editorial note:

'Hazard' is defined in Standard 3.1.1 as a biological, chemical or physical agent in, or condition of, food that has the potential to cause an adverse health effect in humans.

Under subclause 1(2) of this Standard, the requirement for a food safety management system in subclause 16(1) does not apply to retail sale activities concerning bivalve molluscs.

(2) A seafood business is taken to comply with subclause (1) if it implements –

(a) a food safety program set out in Standard 3.2.1; or
(b) a food safety management system set out in the Fish and Fish Products Orders (2005); or
(c) the Codex Alimentarius Hazard Analysis and Critical Control Point System (HACCP) for food safety management set out in Annex C to CAC/RCP 1-1969, revision 4 (2003); or
(d) any other Hazard Analysis and Critical Control Point (HACCP) based food safety management system recognised by the Authority.

(3) For the purposes of subclause (1), a seafood business must comply with –

(a) the conditions of the ASQAP Manual specified in the Schedule to this Standard; or
(b) conditions recognised by the Authority.

Editorial note:

The ASQAP Manual is the National guideline for managing risks in the harvesting, relaying, depuration and wet storage of shellfish.

Subclause 16(3) does not require producers or processors of bivalve molluscs to classify or close harvesting areas. Under the ASQAP Manual the classification of these areas is the responsibility of the State Shellfish Control Agency (SSCA).

The Australian Shellfish Quality Assurance Advisory Committee (ASQAAC) maintains the ASQAP Manual.

'HACCP' has a technical meaning commonly understood by the food production and manufacturing industry.

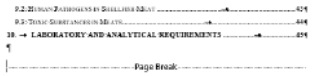
State Legislation

- Fisheries legislation defining harvest areas and types of shellfish
- Food legislation – either under Health or Primary Industries
  - Picking up the Food Standard Code requirements
  - Defining specific state requirements to administer, design, operate and audit a shellfish quality assurance program
  - Powers to close growing areas, including due to outbreaks
  - Requirement for businesses to have a documented, audited food safety plan
  - Roles and responsibilities of all parties
  - Penalties for non-compliance

SARDI

Australian Shellfish Quality Assurance Program


CONTENTS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Foreseeable hurdles for Northern Australia

Capability

- QA managers
- Samplers
- Laboratory analysis

Climate

- ? Two classifications (seasonal)
- Temperature control
- Vibrio

Tyranny of distance

- Getting to know growing areas
- Appropriate monitoring frequency
- Event sampling
- Access to freight/couriers
- Access to laboratories

Markets

- Consistent supply

COST

SafeFish

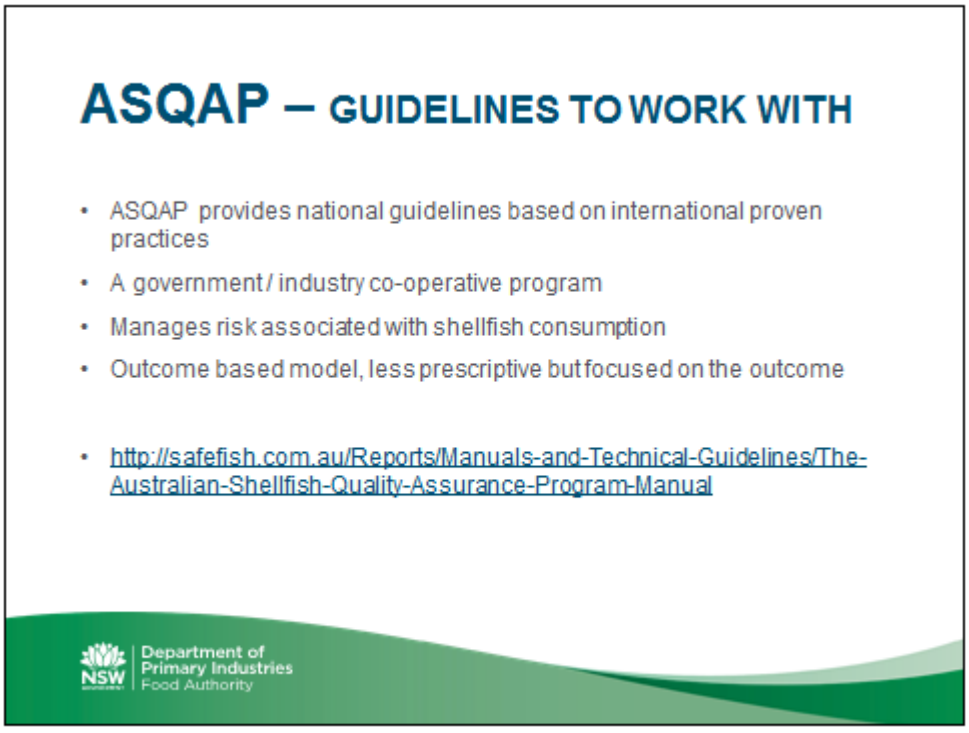
How can we help?

- Expertise
- Technical advice
- Capability training
- Reports

http://SafeFish.com.au

Alison.Turnbull@sa.gov.au

ASQAP in a remote context – NSW Pipi Industry – Phil Baker



HARVEST AREA CLASSIFICATION

- Approved – Where water & shellfish quality is exceptional which permits harvest and sale of shellfish direct from the harvest area without further treatment
- Restricted – Where water & shellfish quality is subjected to a limited degree of pollution. Shellfish must be either depurated or relayed to Approved harvest areas prior to consumption
- Prohibited – Where shellfish are so highly or frequently contaminated by pollution that harvesting controls cannot be set.
- Remote – Where a sanitary survey determine that the area has no human habitation or other sources of potential pollution & meets Approved classification

NSW | Department of Primary Industries Food Authority

CORNERSTONE OF CLASSIFICATION

- ASQAP Definition – "Shoreline survey means a survey conducted by a competent authority to identify and record pollution sources within the catchment of a shellfish growing area which contaminate or have the potential to contaminate the water quality of a shellfish harvest area"
- Guides minimum requirements for classification (min. 30 rounds or 15 rounds)
- APCS or SRS
- Don't get the cart before the horse

NSW | Department of Primary Industries Food Authority


Gosford
NSW Central Coast
Restricted

NSW PIPI INDUSTRY

A LESSON IN REMOTE CLASSIFICATION

Department of Primary Industries
Food Authority

PIPI CLASSIFICATION

- Could not financially support full adherence to ASQAP.
- Legislative changes required
- Industry nominated beaches to focus on (15 initially)
- Shoreline survey conducted. Sewage Outfalls considered
  - Beaches impacted by point sources of pollution were removed
- Sampling for E.coli & phytoplankton commenced.
  - Beaches with elevated E.coli were removed (could not meet Approved Classification standard)
- Only 12 beaches currently in operation.

Department of Primary Industries
Food Authority

CLOSED SAFETY ZONES

Used to prevent harvest within areas with high risk pollution sources or where sampling returned elevated readings.

Sewage treatment plant outfalls
Significant distance
Calculated by determining effluent volume, treatment process & dilution rates. An additional safety factor was also applied.

ESTABLISHING NEW AREAS

- New area identified
  - Industry nominate area of interest and provide maps outlining intended harvest area.
- Google earth desktop assessment conducted to determine PPS
  - If area contains PPS request denied. Advised to conducted 3rd party independent classification with full ASQAP requirements if still interested.
  - If no PPS an in field shoreline survey is conducted
  - If low risk and "Remote" harvest area approved
  - Ongoing E.coli & phytoplankton testing.

NSW Department of Primary Industries Food Authority

MANAGEMENT OF BEACHES

- Not formally classified under ASQAP – Classified "in lieu" using equivalent requirements – DID NOT DISREGARD ASQAP
- Identified risks – prohibited areas with risk
- Sewage treatment plant outfalls – Closed Safety Zones (prohibited)
- Biotoxin Management Plans – Weekly phytoplankton sampling
  - If counts exceed regulatory limits Biotoxins are taken
  - Gap identified aim to move to flesh testing (Biotoxins)
- E.coli sampling conducted monthly for each harvester. Acts "in lieu" of microbiological testing required in ASQAP.

NSW Department of Primary Industries Food Authority

IN SUMMARY

- Small scale industry where cost of formal ASQAP regulation was not financially viable
- Required legislative change backing from executive
- ASQAP not disregarded – An alternative management arrangement in place.
- Only harvest from "remote areas" with no pollution sources
- Still conduct E.coli sampling
- Still conduct phytoplankton & biotoxin sampling in line with ASQAP

Department of Primary Industries Food Authority

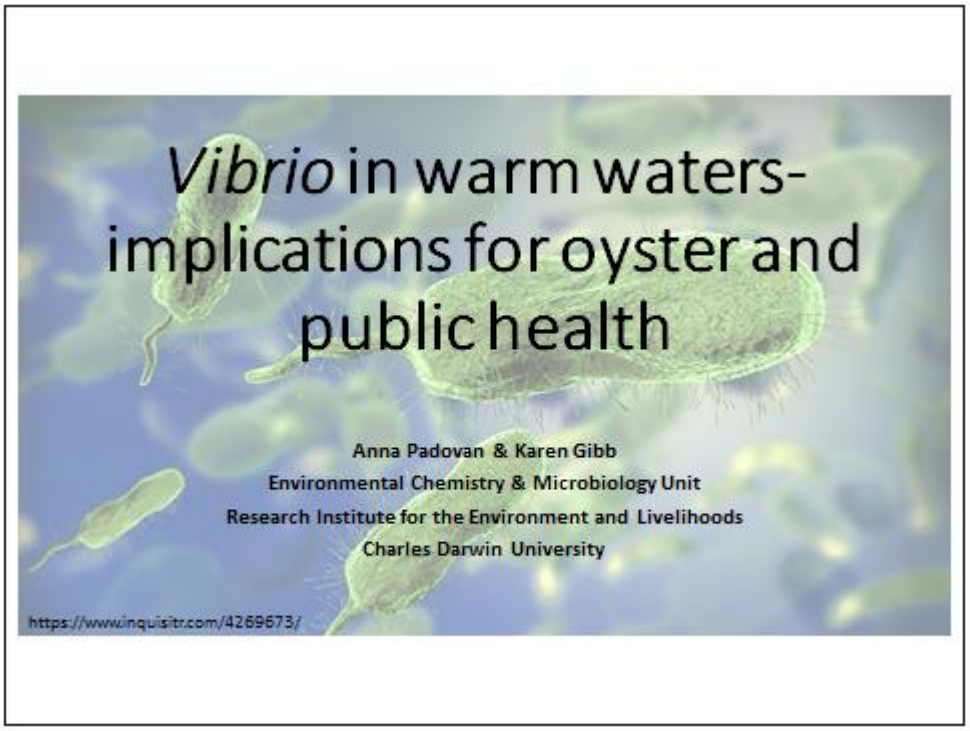
FINAL THOUGHT

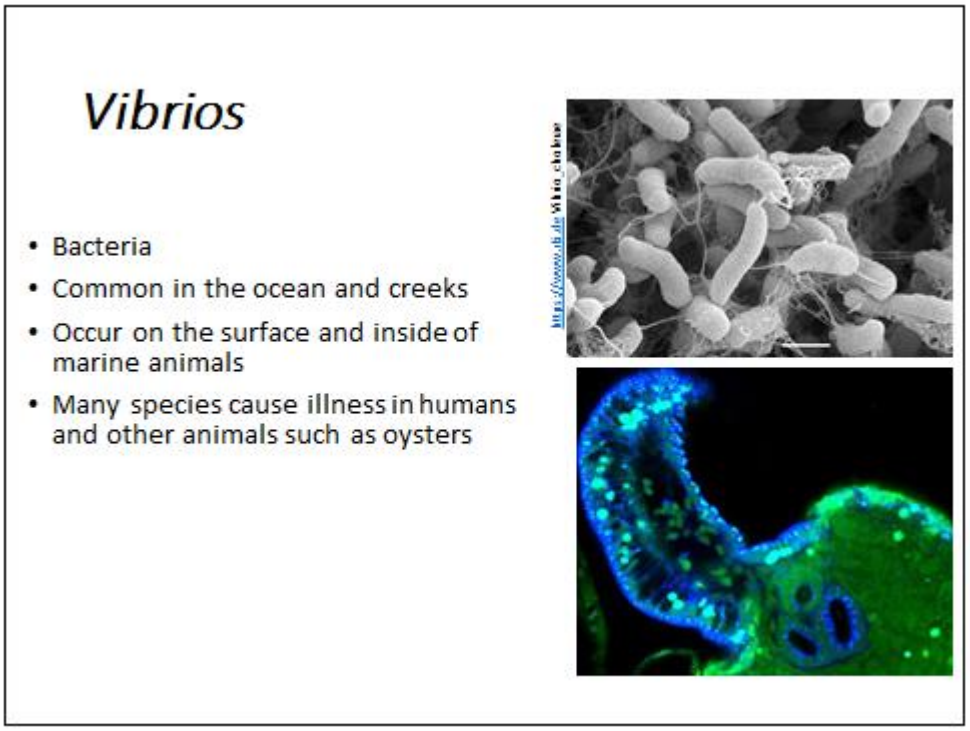
Department of Primary Industries Food Authority

QUESTIONS

Department of Primary Industries Food Authority

Vibrio in warm waters – Implications for oyster and public health – Anna Padovan & Karen Gibb





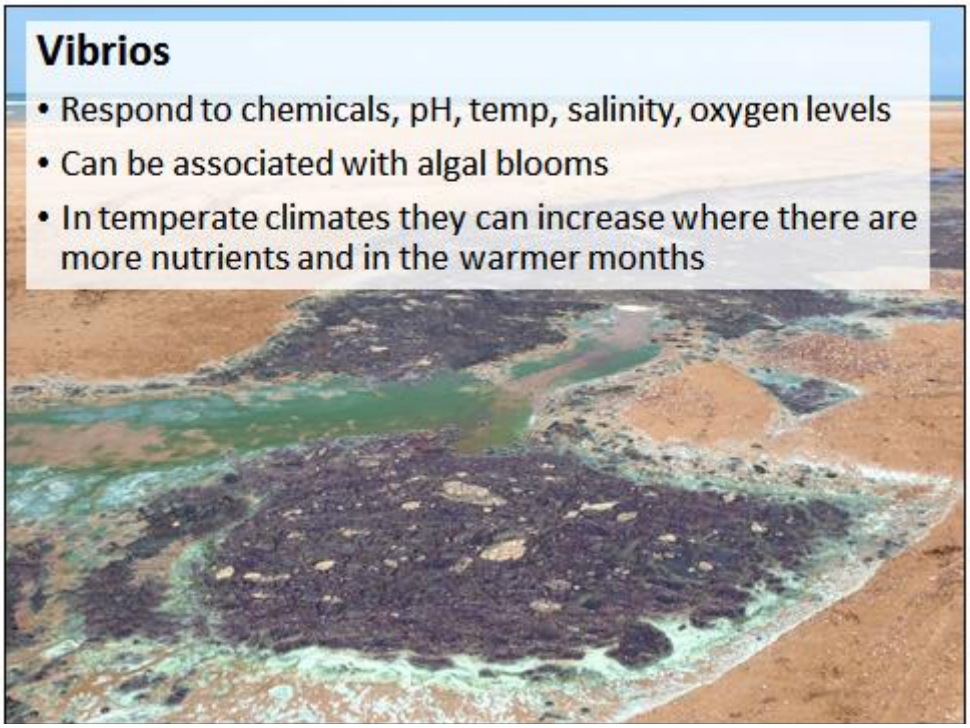
Vibrios that can make humans sick

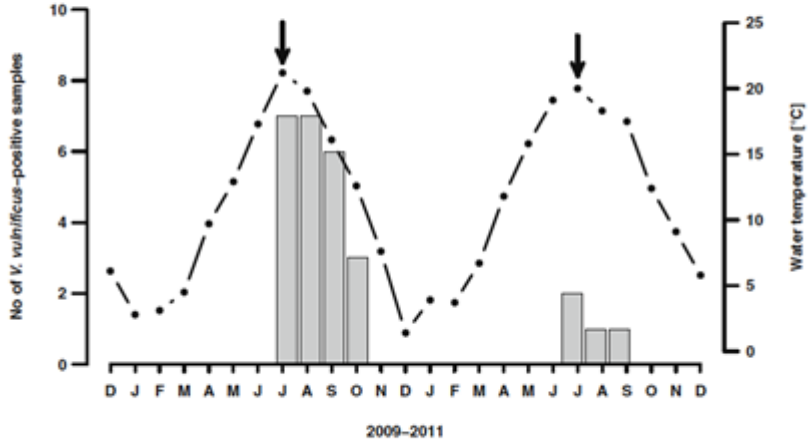
- *V. parahaemolyticus*
- *V. vulnificus*
- *V. cholerae*

- Main cause of gastroenteritis associated with eating raw or undercooked shellfish (oysters, shrimp, crab, lobster)
- Also associated with skin and soft tissue infections
- Isolated from water, sediment, shellfish and fish

Vibrios

- Respond to chemicals, pH, temp, salinity, oxygen levels
- Can be associated with algal blooms
- In temperate climates they can increase where there are more nutrients and in the warmer months





Boer et al. 2013

Australia[1]

- Limited illnesses from *Vibrios*: wound infections (NT, NSW & Vic)
- January 2016 – first outbreak of gastroenteritis from Australian seafood – Tasmanian oysters
- Coincided with unusually warm seawater temperatures (4.5°C above average)
- We do not know much about *Vibrio* dynamics in Australian tropical regions

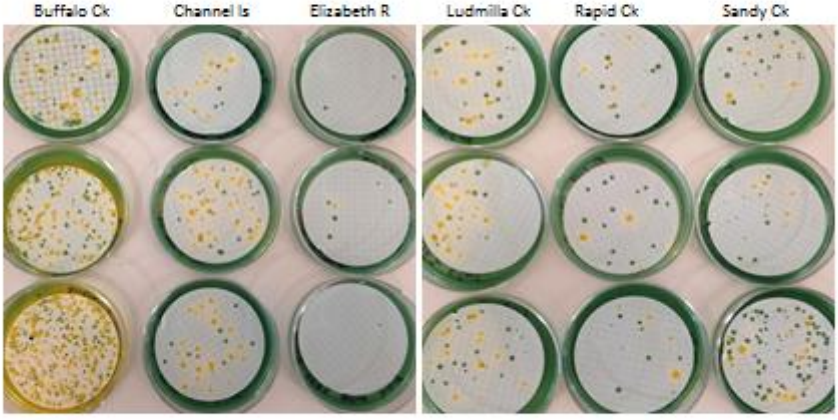
1. Madigan, Smith, Wilson, Turnbull 2016 (ASQAP meeting 2016, Sydney)

Northern Territory - cases

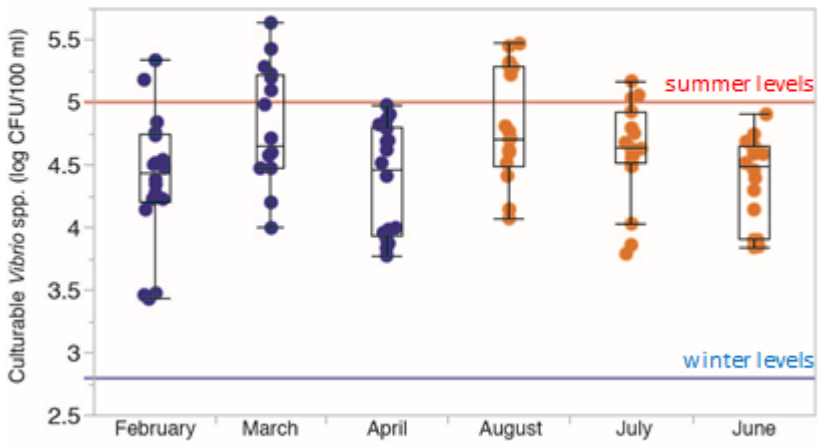
- 2000-20013 - 7 species of vibrio isolated from patients with skin/soft tissue infections[1]
- 2010-2016 - 3 cases of food poisoning (remote)[2]
- March 2016 - media alert 3 infections skin/3 wks

1. McAuliffe et al. (2015)
2. NT CDC

Seawater



Seawater



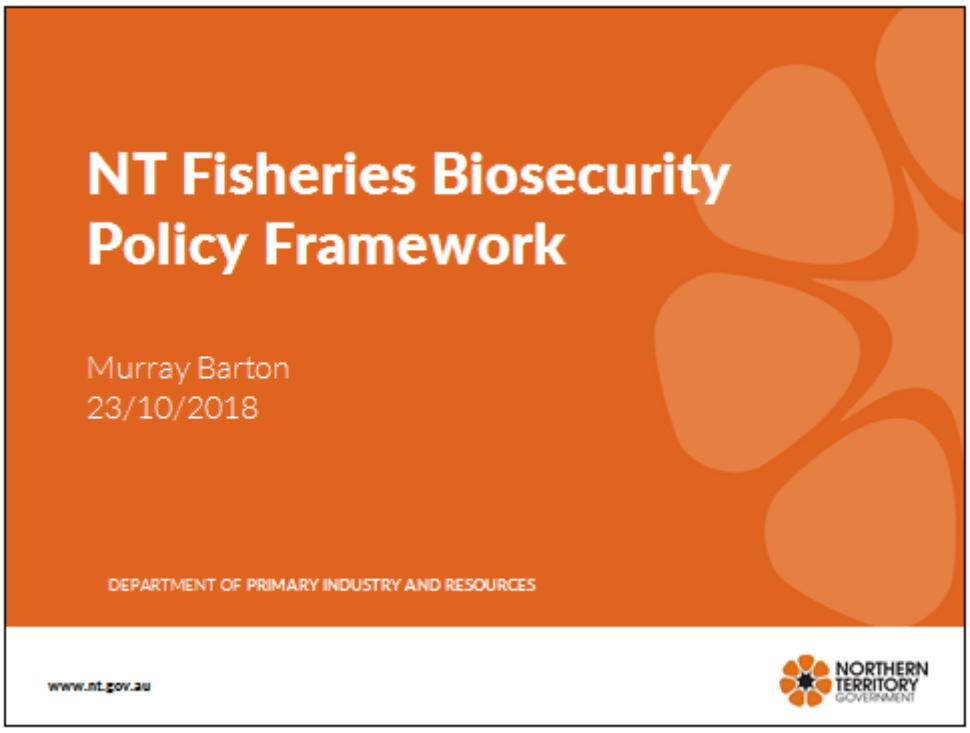
Shellfish (PWC study)

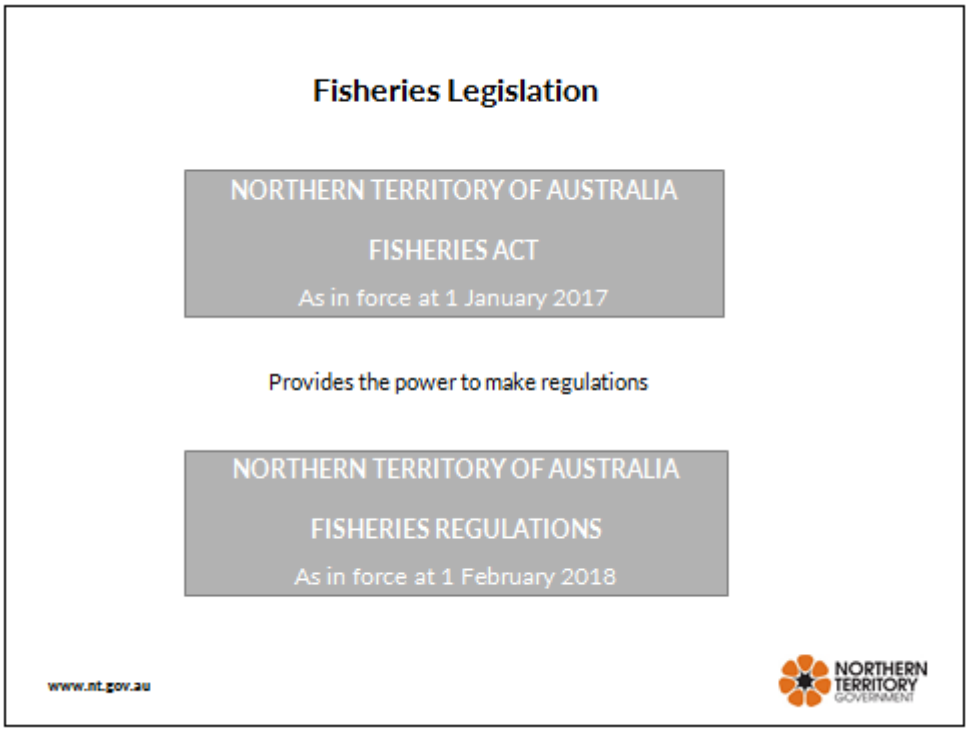
- *V. parahaemolyticus* and *V. vulnificus* in shellfish especially in the wet season
- Eight toxic *Vp* strains
- Detected *V. parahaemolyticus in oysters*; no *V. vulnificus*
- In black-lip we found: *Vp:* <3.0-240 MPN/g and *Vv:* <3.0-150 MPN/g

Vibrios can cause diseases in oysters

- Vibriosis is the most common disease in hatcheries and nurseries
- Affects larvae and juveniles
- Different *Vibrio* species to those causing human disease
- Can cause massive mortalities
- Control through:
  - good sanitation
  - good food quality
  - good water quality
  - routine testing
- Antibiotics can cause bigger problems - resistance and worse diseases
- One area of research is to find bacteria to use as probiotics

NT Fisheries Biosecurity policy framework – Murray Barton





Fisheries Act

The objects of the Act are:

1. To manage the aquatic resources of the Territory in accordance with the principles of ecologically sustainable development; and

2. To protect the environment, people and economy of the Territory from the introduction and spread of aquatic noxious species and diseases; and

NORTHERN TERRITORY GOVERNMENT

Fisheries Act cont.

3. To maintain a stewardship of aquatic resources that promotes fairness, equity and access to aquatic resources by all stakeholders, including:

(i) indigenous people; and

(ii) the commercial fishing, aquaculture and fishing tourism industries; and

(iii) amateur fishers; and

(iv) others with an interest in the aquatic resources of the Territory; and

NORTHERN TERRITORY GOVERNMENT

Fisheries Act cont.

4. To promote the optimum utilisation of aquatic resources to the benefit of the community.

NORTHERN TERRITORY GOVERNMENT

What happens if there is a major disease event

www.nt.gov.au

NORTHERN TERRITORY GOVERNMENT

Fisheries Regulations

Declare areas in which the taking of fish or aquatic life of a particular species is prohibited because of the risk of the spread of disease to other fish or aquatic life in other areas.

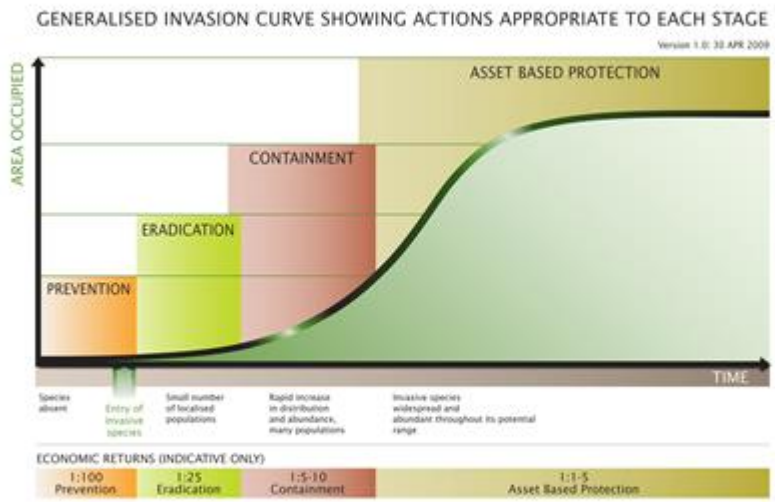
Prohibit the movement of diseased or contaminated fish or aquatic life or an aquatic pest

Destroy diseased fish or aquatic life or a noxious species necessary in order to prevent the spread of disease or aquatic pest

www.nt.gov.au

NORTHERN TERRITORY GOVERNMENT

Prevention is always better than treatment



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NORTHERN TERRITORY GOVERNMENT

Reducing the Risk of Importing or Spreading Diseases

- Need a Fisheries permit to import any live aquatic species into the NT
- Movement of any species managed under a Zoning Strategy.
- Zoning Strategy developed for these commercial aquaculture species
  - Barramundi
  - Mudcrabs
  - Pearl Oysters
  - Penaeid Prawns
  - Native Fish
  - Sea Cucumbers
  - Redclaw

Zoning Strategy

Based on developing Disease Control Zones for species, using biological, geographic, genetic and epidemiological data to form a logical basis for the implementation of quarantine and health certification strategies.

To provide mechanisms for delineating regions known to contain diseases and for preventing the spread of such diseases agents into regions free of such agents.

Zones created on a species by species basis that allows:

- Unrestricted movement of these species between and within zones of equivalent health status
- Unrestricted movement from zones of higher health status to zones of lower status
- Restricted movement from zones of lower or uncertain health status to zones of higher health status, with such translocations permitted subject to appropriate quarantine, disease testing and health certification procedures.
- A ban on movement under circumstances where a risk of disease incursion exists that cannot be satisfactorily addressed by a regime of quarantine, testing and health certification.

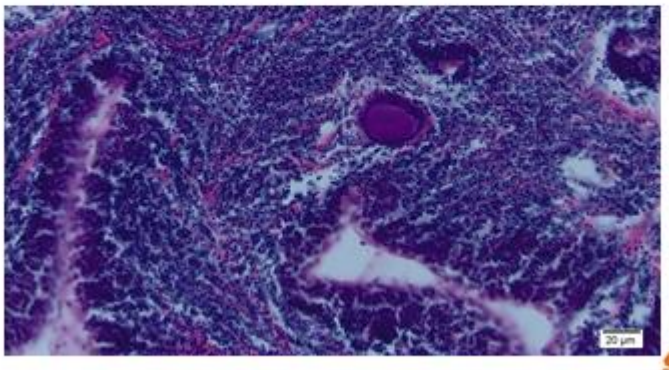
Pearl Oyster Zoning used for Black lipped Oysters

- Lack of disease surveillance data around the coast to define Black lipped Oyster zones
- Broodstock oysters from Goulburn (zone 2) when moved to the DAC (zone1) are:
  - Cleaned (scrubbed) using iodine solution
  - Placed in Quarantine for at least 4 weeks
  - Only released and added to broodstock holding tanks if no health concerns observed
- Oysters grow at the DAC before movement to Goulburn or other zone 2 sites require health certification
  - Minimum 150 oysters for Histopathology examination
  - Only progeny of zone 2 oysters are used to stock zone 2 farms.

NORTHERN TERRITORY GOVERNMENT

Disease findings

- To date nothing significant detected except in one male SGI oyster many viral inclusion like bodies found however NSW have confirmed they are not a virus or bacteria.



NORTHERN TERRITORY GOVERNMENT

Thank you

NORTHERN TERRITORY GOVERNMENT

Strategic Priorities – Wayne Hutchinson