QX disease seminar and RD&E prioritisation workshop

Dr Len Stephens

December 2022

FRDC Project No 2022-087

QX Disease seminar and RD&E Prioritisation Workshop
2022-087

2022

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

Contents

Abbreviations

EMAI	Elizabeth McArthur Agricultural Institute
FFVS	Future Fisheries Veterinary Service
NSW DPI	New South wales Department of Primary Industry
PSFI	Port Stephens Fisheries Institute
QX -	Queensland Unknown
RRRO	Richmond River Rock Oysters
SCU	Southern Cross University
SRO	Sydney Rock Oysters
UTS	University of Technology Sydney

Acknowledgments

The contributions of Andy Myers, Executive Officer of Oysters Australia and all the oyster growers and researchers that participated in the workshop are gratefully acknowledged.

Executive Summary

In response to recent outbreaks of QX disease in NSW, a workshop was convened to identify and consider short & long-term ideas for research & development to control/manage/co-exist with the disease. Twenty-seven people attended the workshop and heard eleven presentations concerning past research and new research proposals.

Ten projects were evaluated by twenty of the workshop participants using an attractiveness and feasibility analysis.

Most of the projects were found to be worthy of support. However, since FRDC oyster RD&E funds are limited, a list of priority projects was produced. The list of suggested projects is contained in the following recommendations.

The recommendations to FRDC and Oysters Australia are:

1. Provide funding for the continuation of the NSW DPI QX resistance breeding program. In doing so it should be ensured that:
    a. The Richmond River Rock Oysters (RRRO) are well represented in the breeding mix.
    b. Cost savings can be made in the project design.
    c. The recently approved Sydney Rock Oyster (SRO) genomics project addresses QX disease as a priority.

2. Support the use of genomics at NSW DPI EMAI to develop and implement *M. sydneyi* strain typing.

3. Noting that NSW DPI has applied for $620,00 for new QX projects on top of $620,000 already approved for SRO genomics, consult with NSW DPI senior management to determine if efficiencies can be found.

4. Investigate the need to support the production of RRRO spat for use in research trials, to be placed side by side with standard SRO and QX resistant SRO in several estuaries.

5. Consider the appointment of a QX research coordinator to periodically review QX research projects in detail and make suggestions for accelerating the adoption of the findings.

6. Depending on funds requested, and those available, consider supporting SCU/OzFish ARC linkage proposal to investigate the factors that prevent the expression of Qx disease in RRRO.

1. Introduction

QX is a seasonally occurring disease of Sydney Rock Oysters. Very little is known about the disease agent (the protozoan parasite *Marteilia sydneyi*) and what causes it to sporulate in some estuaries and not others.

There are also significant knowledge gaps related to pathogenicity, transmission pathways, and the robustness of natural populations in response to disease and other environmental stressors. A recent outbreak of QX in Port Stephens (NSW) has brought this lack of knowledge into sharp focus. The local industry is reeling, with 12 businesses closing their doors in the space of 14 months. Oyster farmers elsewhere in the state are fearful that their estuary may be next, and this is stifling investment and undermining confidence in the sector.

There are mixed opinions on the strategies proposed to tackle QX Disease and limited RD&E funds under management by Oysters Australia to implement projects. A long-term program of RD&E is required, which needs to be well-coordinated, informed by the latest research and guided by the NSW oyster industry.

1.1. Objectives

The objectives of the workshop were:

1. Bring researchers and industry together to exchange knowledge and insights about QX disease.

2. Help prioritise knowledge gaps, and identify those elements that, once resolved, have a clear pathway to delivering benefits to growers. That is, to tease apart the pure research and nice-to-knows from the critical information that can lead to the biggest gains on farm.

The overall objective agreed upon by participants at the start of the workshop was to develop a prioritised list of projects that could be implemented to reduce the impact of QX disease.

1.2. Method

The one-day workshop was attended by twelve oyster growers, thirteen researchers and four staff from industry bodies (see Appendix). Twelve presentations were given by researchers, three of which were given by Zoom.

Prior to the workshop, participants were provided with primer information about the event, and a draft agenda (Appendices 2 & 3)

Following discussion during the workshop, a list of ten potential projects was agreed upon. Each participant then recorded their opinion of the Attractiveness and Feasibility of each project, using a score from 1 to 10. The collective results were used to draw up a priority project listing.

2. Results

2.1. Project List

The ten projects put forward for evaluation are shown below.

Project Number	Project Description
1	High resolution qPCR testing for *M sydneyi* and environmental monitoring to establish the window of infection, provide an early warning tool and identify risk factors. (NSW DPI/EMAI)
2	Strain typing using genomics to determine if there are pathogenicity variations in *M sydneyi* that could assist in the development of an evidence-based policy for the translocation of oysters between estuaries and help prevent the spread of QX disease. (NSW DPI/EMAI)
3	Identification of the intermediate host for *M sydneyi* to improve the effectiveness of controls on the translocation of oysters between estuaries and to prevent the spread of QX disease to new areas. (NSW DPI/EMAI)
4	SRO Family based breeding (NSW DPI/PSFI)
5	Establishing genetic distinctiveness of Richmond River Rock Oysters (SCU/OzFish)
6	Determine optimal height for culturing RRRO (SCU/OzFish)
7	Confirm whether RRRO are infected by *M. sydneyi (SCU/OzFish)*
8	Identify molecular mechanisms of resistance and molecules for marker assisted selection (SCU/OzFish)
9	Modelling and prediction of environmental conditions associated with the presence and abundance of *Marteilia sydneyi*. (UTS)
10	Epidemiologic historical appraisal of environmental risk factors for QX disease (FFVS)

Table 1. List of projects evaluated.

2.2. Project Ranking Using Attractiveness & Feasibility Scores

A graph of each project's Attractiveness and Feasibility scores averaged over 20 workshop participants shows most of the projects in a cluster around scores of 7 and 8 out of 10. See Figure 1. Graphs showing ranking for growers only (n=8) and researchers/others only (n=12) are shown in Figures 2 and 3.

The average scores were used to rank the projects. Ranking was conducted for all participants as a group (n=20) and separated between growers (n=8) and researchers/others (n=12). See Table 2.

Figure 1. Overall average attractiveness and feasibility scores for the ten individual projects by 20 workshop participants.

Figure 2. Average attractiveness and feasibility scores for the ten individual projects by 8 grower workshop participants.

Figure 3. Average attractiveness and feasibility scores for the ten individual projects by 12 esearchers/other workshop participants.

Project Number	Project Description	Average Attractiveness and Feasibility Ranking		
		Overall	Growers	Researchers
4	SRO Family based breeding	1	3	1
5	Establishing genetic distinctiveness of Richmond River Rock Oysters	2	1	3
2	Strain typing using genomics to determine pathogenicity variations in *M sydneyi* that could assist in development of a policy for translocation of oysters between estuaries.	3	4	5
7	Confirm whether RRRO are infected by *M sydneyi*	4	2	4
1	High resolution qPCR testing for *M sydneyi* and environmental monitoring to establish the window of infection, provide an early warning tool and identify risk factors. (DPI/EMAI)	5	8	2
3	Identification of the intermediate host for *M sydneyi* to improve the effectiveness of controls on the translocation of oysters between estuaries and to prevent the spread of QX disease to new areas.	6	7	6
8	Identify molecular mechanisms of resistance and molecules for marker assisted selection	7	6	8
6	Determine optimal height for culturing RRRO	8	9	7
10	Epidemiologic historical appraisal of environmental risk factors for QX disease	9	5	10
9	Modelling and prediction of environmental conditions associated with the presence and abundance of *Marteilia sydneyi*.	10	10	9

Table 2. Projects ranked according to their average overall score, average growers' score and average researchers' score.

The blue shaded boxes indicate two projects with significant disparity between grower and researcher scores.

2.3. Project Details

PROJECT 1	**High resolution qPCR testing for *M sydneyi* and environmental monitoring to establish the window of infection, provide an early warning tool and identify risk factors. (NSW DPI/EMAI)**
Cost:	$160,000
Timing:	2 years
Detail:	This project builds on the current FRDC project 2021- 129, *Understanding of spatial extent, infection window and potential alternative hosts for the oyster disease QX in Port Stephens.* The project will use the recently developed quantitative PCR test, which can determine the degree of *M sydneyi* infection in the host rather than a simple positive/negative result. The methods will include: • A longitudinal study in Port Stephens as a model for emerging QX. • Deploy, remove and test >1500 oysters using qPCR, representative cytology and/or histology. • Use of environmental data loggers for water monitoring (range of nutrients).
Comment:	This project is based on the premise that once QX disease begins in an estuary, its spread is reasonably predictable, hence an early warning might enable growers to move oysters out of high risk areas. The results may also provide the data needed for some growers to attempt window farming (deploying oysters at certain locations and times of year when the risk of *M sydneyi* infection is low). This project ranked fifth on the overall attractiveness and feasibility assessment but it was ranked much lower by growers.

PROJECT 2	**Strain typing using genomics to determine if there are pathogenicity variations in *M sydneyi* that could assist in development of an evidence-based policy for translocation of oysters between estuaries and help prevent the spread of QX disease. (NSW DPI / EMAI)**
Cost:	$120,000
Timing:	3 years
Detail:	This project would leverage previous work to develop a M sydneyi genome map. It is built on the observation that M sydneyi can be found in estuaries that do not have QX disease. The project would explore differences in the genome of M sydneyi isolated from oysters expressing QX disease and from oysters that are not expressing the disease. The research would involve sampling and testing of SROs from QX and non-QX affected estuaries.
Comment:	This project was highly rated, ranking third on the attractiveness and feasibility assessment. It was thought that the existence of strain variations might explain the variation in severity of QX disease between estuaries, and the detection of M sydneyi in some estuaries where there is no QX disease.

PROJECT 3	**Identification of the intermediate host for M sydneyi to improve the effectiveness of controls on the translocation of oysters between estuaries and to prevent the spread of QX disease to new areas. (NSW DPI / EMAI)**
Cost:	$120,000
Timing:	3 years
Detail:	The methods would involve repeat sampling and testing of plankton, polychaetes and other environmental biota to detect M sydneyi. Species that may be candidates for intermediate hosts would be further tested in challenge transmission trials using diseased oysters.
Comment:	If the definitive intermediate host was confirmed, it might be possible to correlate the prevalence of QX disease with the distribution of the host in estuaries, and thus avoid risky locations for oyster leases. This project ranked sixth on the overall attractiveness and feasibility assessment. Even if the intermediate host was known with certainty, it would not be possible to eliminate the host from the environment.

PROJECT 4	**Sydney Rock Oysters family based breeding to provide QX resistant oysters for production in QX affected estuaries and safeguarded the industry against QX disease. (NSW DPI PSFI)**
Cost:	$220,000
Timing:	2 years
Detail:	This project builds on the long running NSW DPI SRO breeding program that has succeeded in breeding SRO that are partially resistant to QX. The methods will include: • An expanded number of sites over which QX survival is tested • QX field progeny test trials in Tilligerry Creek and Karuah, Georges River and Port Stephens • Commercial 'proof of concept' trials using families and hatchery lines at multiple sites • Determining the impact and implications of QX disease on marketing of selected stock • Incorporation into the breeding program of the Richmond River Rock Oysters (RRRO) genetic group • Delivery of QX resistant broodstock through commercial hatchery production of selected Sydney Rock Oysters
Comment:	This project ranked highest on the overall attractiveness and feasibility assessment, reflecting the predominant view that genetics offers the most direct and reliable method of overcoming QX disease. There were concerns that previous batches of QX resistant oysters did not cope well with second and third infection waves, and growers were looking for improved performance by new generations. It is notable that growers scored projects involving genetics of RRRO higher than this project. The reason for this is thought to be because growers consider the general survivability of RRRO to be superior to the stock currently in the breeding program. Given recent challenging weather events, and it's impact on oyster resilience, robustness / general survivability is seen are being very important. RRRO oysters have been added to the NSW DPI breeding program, but there was concern voiced by growers that only two male RRRO oysters were available to be mated. If this

	project is funded, it will be important for the applicants to clearly explain how the RRRO genetics will be incorporated into the NSW DPI genotypes. This project, plus the genomics project about to begin, accounts for an $840,000 investment in SRO genetics by NSW DPI, Oysters Australia and FRDC. Every effort should be made to ensure this investment will result in the production of highly QX resistant oysters in sufficient quantity to supply the needs of all hatcheries.

Projects 5, 6, 7 and 8 would be led by Southern Cross University and combined with an ARC linkage grant proposal involving OzFish, Griffith University and James Cook University. All four projects aim to capitalise on the emergence in the Richmond River of oysters that are naturally resistant to QX disease. Research by the OzFish group, NSW DPI and Southern Cross University has convincingly shown in comparative trials that the naturally occurring oysters survive deliberate exposure to QX, while SRO introduced from other estuaries suffer significant mortalities. The naturally occurring oysters have been given the working name of Richmond River Rock Oysters (RRRO). As noted previously, these oysters have now been included in the NSW DPI breeding program and two commercial hatcheries are also breeding them for distribution to growers in other estuaries.	
PROJECT 5	**Establishing genetic distinctiveness of Richmond River Rock Oysters (SCU/OzFish)**
Detail:	This project involves comparisons of the DNA sequences of RRRO with SRO from other estuaries. This will determine the degree of genetic separation between the two groups and may give an indication of the mechanism of resistance in RRRO. This project ranked second on the attractiveness and feasibility assessment.
PROJECT 6	**Determine optimal height for culturing RRRO (SCU/OzFish)**
Detail:	Observations over recent years show that RRRO colonise substrates at a higher tidal level than other SRO. This project use field surveys and controlled experiments to investigate whether RRRO have adapted to a higher intertidal environmental niche. This information will be useful for growers attempting to produce commercial volumes of RRRO. This project ranked eighth on the attractiveness and feasibility assessment, presumably because growers can work out the answer themselves.
PROJECT 7	**Confirm whether RRRO are infected by *M sydneyi* (SCU/OzFish)**
Detail:	This project will investigate if RRRO can completely resist infection with M sydneyi, or whether RRRO become infected but do not express clinical disease. The project should also help explain whether the apparent disease resistance is due to an increased tolerance to environmental stress. On a practical level, it may be useful for QX disease control purposes to know that oysters may test positive for M sydneyi but remain disease free. This project ranked fourth on the attractiveness and feasibility assessment.
PROJECT 8	**Identify molecular mechanisms of resistance and molecules for marker assisted selection (SCU/OzFish)**
Detail:	This project will apply proteomics and transcriptomics to investigate how RRRO resist QX disease, for example by expression of different genes, or activation of different enzyme systems. It will further investigate the relationship between tolerance to environmental stress and specific resistance or immunity to M sydneyi infection.
Cost:	$288,000 for the four projects. In addition, $360,978 would be provided from an ARC Linkage proposal and in-kind contributions would be valued at $524,122.
Timing:	3 years

Comment:	The identification of specific genes or specific proteins that are associated with RRRO's ability to resist disease may be useful in the breeding program (project 8). The use of these molecules as markers to screen breeding populations may accelerate the rate of genetic gain in QX resistance. This project (#8) only ranked seventh on the attractiveness and feasibility assessment. The NSW DPI breeding program is already making good progress towards QX resistance based on live/dead analysis alone and is certain to continue to deliver genetic gain for this trait. It is also noteworthy that the NSW DPI breeding group is about to begin a genomic study of SRO which is likely to identify gene markers for QX resistance. The research proposed in these projects is primarily aimed at achieving a deeper understanding of the factors that determine the expression of QX disease. The complex interaction between the oyster (as host), *M sydneyi* (as pathogen) and the suboptimal environment (as stressor) will be investigated. An understanding of what triggers disease expression and how it can be moderated may lead to better methods of controlling the disease in the long term. However, even though these projects were highly ranked, it must be questioned whether knowledge of disease processes will control QX disease now. Of more importance is the evaluation of RRRO under a range of commercial growing situations, in comparison to standard SRO. Significant volumes of RRRO spat will be needed for this to proceed.

PROJECT 9	**Modelling and prediction of environmental conditions associated with presence and abundance of *Marteilia sydneyi*. (UTS)**
Cost:	$105,212
Timing:	2 years
Detail:	This proposal builds on a Food Agility CRC project that has conducted weekly water sampling at 13 estuaries over 104 weeks. DNA has been extracted from the samples and stored. Aliquots can be made available for ongoing scientific experimentation. Environmental water parameters are also available for the time of each sampling. This project proposes a retrospective analysis of the samples using metabarcoding, qPCR and bioinformatics, to determine if there is any correlation between observed parameters and the presence or absence of M sydneyi and QX disease.
Comment:	This project was poorly ranked in the overall assessment for feasibility and attractiveness. The observation was made that by the time the results were available, it would be up to four years since the samples were collected, making interpretation and use of the results difficult.

PROJECT 10	Epidemiologic historical appraisal of environmental risk factors for QX disease (FFVS)
Cost:	$60,000
Timing:	1 year
Detail:	This project is based on the theory that the primary cause of QX disease is environmental degradation leading to the suboptimal condition of estuary waters. The implication is that in healthy estuaries M sydneyi co-exist with SRO and that disease occurs when environmental pollutants compromise the resilience of the oysters. The environmental degradation is linked to factors such as land clearing & sediment influx into rivers, extensive cropping and use of herbicides, insecticides, fungicides, and wetting agents that run off the land following rainfall events and enter estuaries. The proposed epidemiologic study would identify likely contributory risks which trigger QX outbreaks, so research can be directed, and presumptive corrective action can be undertaken. The proposed solution would involve many factors, such as: • Widespread outreach, education, and community involvement • Clearer accountability between Councils, NRM, State and Commonwealth Government • Agrichemical regulatory reform • Wastewater treatment upgrades • Improved regulation on diffuse source polluters An example of this approach working was seen in the recovery of the Tweed River.
Comment:	This project ranked ninth in the overall attractiveness and feasibility assessment, but growers ranked it fifth, after the genetic studies. While the cost of the study would be $60,000, the cost of the solution would run into many millions of dollars. The real problem is to garner enough community and government support to stimulate the massive effort that would be needed for estuary & catchment remediation. The results of the proposed epidemiologic study might help to gain the required support. However, there are concerns over the availability of adequate historical data for the study and the need to develop unbiased methodology. The presentation to the workshop left no doubt that the authors believe QX disease is caused by environmental degradation. If this is generally accepted the study may not be required.

ADDITIONAL PROJECT	Queensland QX disease research
Detail:	Max Wingfield from QDPI gave a presentation on proposed research to determine QX resistance in five oyster lines grown under normal conditions in Moreton Bay. The research is part of a larger FRDC project: 2021-047: Harnessing the aquaculture potential of Queensland's native rock oysters. This project will compare production outcomes (health, survival, growth and condition) of the five varieties of oysters at eight sites around Moreton Bay. There is no plan to assess the lifecycle, infection pathways, or to directly study environmental and epidemiological factors that may influence the occurrence of QX. The five oyster varieties are: 1. Selectively breed QXR oysters from the NSW DPI breeding program 2. RRRO oysters produced at the Victorian Shellfish Hatchery 3. Unselected wild spat from Moreton Bay farm spat collectors 4. Tropical Blacklip rock oysters (BRO) 5. "Lineage G" rock oysters (LGRO). The BRO will not be included in the project until approval is obtained to translocate them from northern Queensland to Moreton Bay. The LGRO is a newly identified species that is endemic right along the Qld coastline. In Moreton Bay LGRO cohabit with SRO and the 2 species are indistinguishable without genetic analysis. Very little is known about LGRO and this project will assess its QX susceptibility and its potential for commercial aquaculture. The first step requires production of spat for the trials.

3. Discussion & Conclusions

It was clear from discussions at the workshop that urgent action is needed to control QX disease. Many growers have already suffered substantial losses, not once, but several times. There is a risk that more estuaries will become unprofitable for oyster production.

Against that background, it is not surprising that most of the projects put forward at the workshop were given high feasibility and attractiveness scores by the workshop participants. There was a cluster of highly ranked projects. Seven proposals scored seven or greater for attractiveness, while six proposals scored seven or higher for feasibility.

Based on scoring alone, projects numbered 2,4,5 and 7 should be supported.

However, the scoring system can only be used as a guide when considering which projects should be supported financially and should not be used to separate closely scored projects. The severity of the QX disease problem and the level of support for most projects could indicate that funding should be made available to most of the projects if possible. However, the balance of the oyster RD&E funds held by FRDC currently sits at approximately $250,000, while the total value of the proposed projects is over $1 million. Consequently, alternative sources of funding will be required for most projects.

The overall top ranking project identified at the workshop was the continuation of the NSW DPI program of selective breeding for QX resistance in SRO, although growers ranked work on RRRO genetics higher. The NSW DPI breeding program has already had some success and the continued selection of new generations will yield improved QX resistance if the progeny of each generation can be reliably challenged by naturally occurring QX disease. In past years there has been a slow take up of genetically improved SRO bred by NSW DPI, due to the complexity of the supply lines through commercial hatcheries and competition from wild spat suppliers. The growers' need for QX resistant stock is likely to significantly increase demand and it will be important for hatcheries and nurseries to confirm its ability to fill the supply line.

Since FRDC funds are limited, it should be noted that the NSW DPI breeding program has already received $620,000 for a genomics program, which among other things, intends to look at genetic adaption to climate change in SRO. It is to be hoped that sufficient phenotype differences will be detected in QX resistant oysters across families to enable the development of a genomic test for the trait.

The provision of another $220,000 to the NSW DPI breeding program will clean out the remaining FRDC funds. Consequently, the NSW DPI projects valued at $400,000 dealing with control options for QX put forward to the workshop, may not be funded. It is recommended that FRDC consults with senior NSW DPI staff about achieving some savings and efficiencies in the implementation of SRO projects with a total value of $1,240,000.

The three projects from NSW DPI EMAI were ranked third, fifth and sixth in the overall attractiveness and feasibility assessment. The package of projects presents a logical approach to the investigation of the disease and control options for it. However, with limited funds hard decisions are necessary. The investigation of strain differences in the pathogenicity of *M sydneyi* was acknowledged as being useful. The work to establish the window of infection and provide an early warning tool was not strongly supported by growers. The search for intermediate hosts of *M sydneyi* had limited appeal because it is hard to visualise how any discovery would be applied. It is recommended that the suite of three projects be reviewed by the proponents to reduce the scope and budget.

Two of the four projects proposed by SCU and OzFish were ranked highly. The project to determine the genetic distinctiveness of RRRO was second in the overall ranking. This is perplexing because the industry is already treating RRRO as a distinct population, and it is known from work at NSW DPI that SRO and RRRO can interbreed. It would seem to be of academic interest only, to prove or disprove the point at a DNA level. The remaining three projects proposed by SCU and OzFish are all concerned with determining the mechanisms of resistance and immunity and have limited immediate application to the control of QX

disease. However, some growers have made the point that it would be good to have some scientific understanding of RRRO before they invest in their production on a commercial scale.

The intense interest in the RRRO is understandable given their apparent emergence from the sludge by natural evolution. The finding that the oysters themselves have overcome human degradation of their environment is a compelling story, and it is understandable that people who made the discovery want to grasp such a rare opportunity to understand the mechanisms of disease resistance and environmental adaption. Untold advantages may accrue from such an investigation, and it should be supported, if possible, through the university sector. This suite of research proposals fits well with the university and ARC research mandate. The proposed financial arrangements of the ARC linkage grant represent good value to FRDC and ~~o~~Oysters Australia if funds are available. In the absence of sufficient funding, it is recommended that projects 5, and 7 are supported in an ARC linkage grant application at a much lower level of investment than the amount requested.

The most useful evidence of the value of RRRO will come from the evaluation of their performance under a range of commercial conditions. Replicated research trials of RRRO side by side with standard SRO and QX resistant SRO in several estuaries are needed. Some of these trials have been planned in Moreton Bay and NSW. Significant volumes of spat will be required for those trials, and, fortunately, individual growers and NSW DPI are supporting two commercial hatcheries in Hervey Bay and Queenscliff to produce RRRO.

The possibility that QX disease should be regarded as an environmental insult rather than an infectious disease has some support, particularly from growers. However, the scope of estuarine degradation was too complex for the workshop to consider. Overcoming estuary pollution was seen as a long-term activity involving many conflicted parties. The Tweed River Estuary Management Plan is a good guide to what is possible. Providing funds for the proposed epidemiologic study might be an appropriate entry point. However, there are concerns over the availability of adequate historical data for the study and the need to develop unbiased methodology.

This workshop was a valuable exercise in bringing together key individuals involved in QX research. While there was no sign of duplication in the proposed projects, opportunities for collaboration will likely emerge. Collaborations that reduce the overall cost of the research would be valuable in the absence of sufficient funds to support all the proposed projects. The workshop was also an opportunity for growers to see the extent of work underway and the range of projects proposed. It was also useful for researchers to receive direct feedback from growers on the utility of their proposed research.

Considering the significance of QX disease it is suggested that FRDC and Oysters Australia appoint a QX research coordinator to periodically review the QX research projects in detail and make suggestions for accelerating the adoption of the findings.

4. Recommendations

The recommendations to FRDC and Oysters Australia are:

1. Provide funding for the continuation of the NSW DPI QX resistance breeding program. In doing so it should be ensured that:
    a. The Richmond River Rock Oysters (RRRO) are well represented in the breeding mix.
    b. Cost savings can be made in the project design.
    c. The recently approved Sydney Rock Oyster (SRO) genomics project addresses QX disease as a priority.

2. Support the use of genomics at NSW DPI EMAI to develop and implement *M. sydneyi* strain typing.

3. Noting that NSW DPI has applied for $620,00 for new QX projects on top of $620,000 already approved for SRO genomics, consult with NSW DPI senior management to determine if efficiencies can be found.

4. Investigate the need to support the production of RRRO spat for use in research trials, to be placed side by side with standard SRO and QX resistant SRO in several estuaries.

5. Consider the appointment of a QX research coordinator to periodically review QX research projects in detail and make suggestions for accelerating the adoption of the findings.

6. Depending on funds requested, and those available, consider supporting SCU/OzFish ARC linkage proposal to investigate the factors that prevent the expression of Qx disease in RRRO.

5. Extension and Adoption

This report will be distributed to workshop participants and the NSW oyster industry through Oysters Australia, NSW DPI and NSW Farmers Association.

Appendix 1: Participants

Growers

Matt Burgoyne

Dean Cole

Brandon Armstrong

Noel Baggaley

Bob Hill

Brad Verdich

John Stubbs

Peter Brierley

Mark Salm

Researchers / Government

Cheryl Jenkins – NSW DPI

Ben Rampano – NSW DPI

Jeffrey Go – NSW DPI

Ian Lyall – NSW DPI

Michael Dove – NSW DPI

Wayne O'Connor- NSW DPI

Kirsten Benkendorff – Southern Cross University

John Larsson – OzFish (Richmond Chapter)

Laura Parker - UNSW

Elliott Scanes – UTS

Max Wingfield – QDPI – By Zoom

Shauna Murray – UTS – By Zoom

Matt Landos – USyd / Charles Sturt Uni. – By Zoom

Industry Bodies

Andy Myers – Oysters Australia

Wayne Hutchinson – Fisheries Research Development Corporation

Ian White – NSW ARAC

Laura Stoltenberg – OceanWatch Australia

Len Stephens – Oysters Australia (Facilitator)

Appendix 2: Workshop Primer Information

QX: Knowledge Exchange & Project Prioritisation Workshop

WHEN: Tuesday 22nd November
WHERE: Nelson Bay Bowling Club, Nelson Bay (1 Stockton St, Nelson Bay)
TIME: 10am - Approx. 4pm

BACKGROUND:
QX is a seasonally occurring disease of Sydney rock oysters. Very little is known about the disease agent and what causes it to sporulate in some estuaries and not others. There are also significant knowledge gaps related to pathogenicity, transmission pathways, and the robustness of natural populations in response to disease and other environmental stressors.

This session has been designed to:

- Bring researchers & industry together to exchange knowledge and insights
- Help prioritise knowledge gaps, and identify those elements that, once resolved, have a clear pathway to deliver benefits to growers.

OBJECTIVE:
To identify short & long-term ideas for research & development to control/manage/ co-exist with QX disease

FLAVOUR OF RESEARCH BEING DISCUSSED:

- Do different pathogenic strains of causative agent (*Martellia sydneyi*) exist?
- Understand the transmission pathways, and close the lifecycle of the parasite
- Are there environmental triggers or stressors prior to outbreaks?
- Can archived water & meat samples provide any insights?
- Susceptibility of blacklip oysters to Qx
- How are Richmond River oysters archiving low mortality?
- Are Richmond River oyster genetically different to other SRO populations?

QUESTIONS?
Contact Andy on 0488656366 / Management@oystersaustralia.org

ACKNOWLEDGMENT: This workshop is supported by the Fisheries Research & Development Corporation

Appendix 3: Agenda

QX Seminar & Workshop: Draft Agenda

Focus on Research, Development & Extension (RD&E)

Tuesday 22nd November – Port Stephens

Time	What	Who

10:00am – 10:15am	• Introduction
	• Acknowledge of country
	• Housekeeping
	• Format
	• Objectives
	  ○ Short & long-term strategy for Qx RD&E
	  ○ Funding sources
		Len Stephens (OA)

10:15am – 10:45am	Exercise 1: What questions have you got? Exercise 2: What does success look like?	
10:45 – 11:00am	Morning tea	
11:00am – 11:45am	Basic background knowledge of Qx	Jeffrey Go (NSW DPI)
	Findings from research in Port Stephens 2022 (FRDC – TRF project)	Cheryl Jenkins (NSW DPI)
	Research proposed (using template)	Cheryl Jenkins (NSW DPI)
	Application of Qx resistance into the breeding program	Mike Dove (NSW DPI)
	Research proposed (using template)	Mike Dove (NSW DPI)
11:45am – 12:15am	Background to the Richmond river oysters and exposure to Qx . Research to date	John Larsson (OzFish)
	Research proposed (using template)	Kirsten Benkendorff (SCU)
12:15am – 12:45pm	Anecdotal insights from farmers	Various
12:45pm – 1:15pm	Lunch	
1:15pm – 2:45pm	Prioritisation workshop	Len Stephens (OA)
2:45pm – 3:00pm	Afternoon tea	
3:00pm – 3:30pm	Prioritisation workshop (continued)	Len Stephens (OA)
3:30pm – 4:00pm	Does the prioritised research address questions & provide a pathway to success?	Len Stephens (OA)

This workshop is supported by the
Fisheries Research & Development Corporation