Industry Management and Commercialisation of the Sydney Rock Oyster Breeding Program

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NON-TECHNICAL SUMMARY

2005/209	Industry management and commercialisation of the Sydney rock oyster breeding program

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OBJECTIVES:

1. To survey industry breeding requirements and establish the economic values of different SRO traits in order to determine the market sustainability of developing and marketing multiple lines and to determine the optimum breeding objectives of different lines.
2. To evaluate alternative methods for selection for the most desirable traits, as identified by industry (faster growth, QX, disease resistance, winter mortality resistance etc).
3. To review breeding program designs and apply the best approach to develop a new 10 year breeding strategy for SRO, in consultation with industry.
4. To develop a risk assessment and reduction model against the loss of broodstock.
5. To determine the best methods for use and protection of existing & future intellectual property for industry development.
6. To prepare a technical manual for the continued operation of an SRO breeding program.
7. To prepare fully costed options for funding a breeding program for the next 10 years.

8 Review the genetic status of the current breeding lines by examining genetic variation.

NON TECHNICAL SUMMARY:

Outcomes Achieved

The NSW oyster industry has actively sought the development of a commercial vehicle to take on the responsibility of Sydney rock oyster breeding line management and distribution of resultant improved stock. In 2004 in consultation with FRDC and Industry and Investment NSW, the two existing industry associations, Oyster Farmers' Association of NSW and NSW Farmers' Association, Oyster Section, cooperated to form the Select Oyster Company P/L (SOCo). This company is intended to take control of the management and future development of the oyster breeding lines. This project seeks to increase the operating efficiency of the Sydney rock oyster industry through the provision of direct access to management systems and knowledge that will allow industry greater and more direct determination of their future. In doing so it seeks to increase the quality of industry output, allow access to improved technologies and facilitate development of an effective and efficient Business Plan for commercialisation of selected stock. The following key outputs and outcomes have arisen from this project.

1. Information on industry breeding requirements and inputs to estimate the economic values of different SRO traits were obtained by survey and interview of oyster farmers from southern Queensland to southern NSW; seafood wholesalers were also consulted. Traits included growth rate, disease resistance, shell shape and strength, along with meat condition and colour. Production and economic data collected during the survey of farmers was used to develop simple models to estimate economic values for individual traits.
2. The respective merits and deficiencies of alternative methods of selection were evaluated. It was considered that mass selection techniques are satisfactorily effective for traits such as growth rate and survival (disease resistance), but other traits which are destructively measured, such as condition, need to be pursued through structured or family matings.
3. Currently there is a paucity of genetic parameter estimates for economically important traits for molluscs generally and SROs specifically. The original aims of the breeding program were to improve growth and to achieve disease resistance to two specific diseases, QX and winter mortality (WM). Excellent progress has been made in respect of growth rate and QX disease while good progress is being made against winter mortality under mass selection. While progress is possible without knowledge of genetic parameters, their knowledge is necessary for the development of the most efficient breeding program design. Accordingly the structured matings being made under Project 2006/226 have been altered to begin to gather this information through the development of full sibling and half-sibling family lines. At the same time mass selection for growth and disease resistance continues and it is estimated that it will take 6 to 10 years to acquire the family information required to allow replacement of mass selection with selection from family lines only. It is planned to gather this information in this time span by breeding the successive new generation at about 12 to 15 months rather than waiting until the oysters reach or exceed market weights (i.e. about 3 years) before recording. Whether mass selection will in fact be discontinued is a decision for a later date.
4 A loss of broodstock risk reduction model has been developed and put in place. The risks examined included disastrous loss from outbreaks of disease, gross change in water quality inimical to oyster growth/survival, extreme or extraordinary weather events, theft and vandalism. This has been achieved by placing reserve supplies of multiplication stock on commercial farms in 5 different estuaries. The range of sites selected will provide hatcheries with a greater choice of oysters to select from when commencing a spawning for either commercial production or for experimental purposes. The breeding nucleus will be held by DPI in Georges River and Port Stephens with replicates at two sites in each estuary. Two additional "new lines" have been created to provide diversity and counter inbreeding should it arise and are being selected for growth, QX and WM resistance, and growth and WM resistance in Georges River and Port Stephens respectively.

5. Protection of existing and future intellectual property is very difficult to guarantee. Basically the property manifests itself in the selected stock itself and in the data recorded over the successive generations. The improved stock is distributed to nurseries and thence to end user farmers with its reproductive capability intact. They are not crossbreds and we don't have the convenience of "terminator" genes. Hatcheries, nurseries and farmers are advised that all reproductive rights remain with SOCo. Legal actions against suspected infringements of intellectual property are notorious for their difficulty, uncertainty, and expense and the form of this advice and associated documentation has been cleared with legal advisers. A partial or complete move to family lines will assist in the protection of IP. Vigilance and a readiness to confront promptly any suspected infringement seem the best course at present.
6. The technical manual for the operation of an SRO breeding program has been prepared by Dr Nell and has been amended in accordance with recommendations from Dr Nell and research arising from this project. This manual operates in conjunction with the SRO hatchery manual developed by Dr O'Connor within FRDC project N^{o}. 2003/209 and has been updated with operating protocols for the production of pair mated family lines FRDC Project N^{o}. 2006/226.
7. Review of microsatellites (MS) by the Queensland University of Technology of the current G6 (sixth generation) breeding lines did not find evidence of significant inbreeding. However, this outcome was based on only four microsatellites whereas recent studies suggest that around fifteen are needed for confidence in parent verification. Macquarie University has recently developed an additional suite of nine MS markers of which four were suitable for parent identification and, in evaluations of six generation Port Stephens and Georges River (Lime Kiln Bar) stock with non-selected controls, significant inbreeding has not been uncovered. A further five G7 lines have been submitted to QUT for investigation; hopefully examination of these will confirm the previous finding.
8 Revenue from SOCo's levy on sales of select spat is inadequate at current sales levels of SOCo stock to fully fund continued development of the mass selection lines and the development of family lines which have been a by-product of Project 2006/226. Based on sales for the past two seasons a contribution of $20,000 to $25,000 from SOCo is possible towards I&I NSW's costs of about $100,000 per annum for the mass selection lines. There is scope for SOCo's contribution to grow in future years as at present it has captured only about 20 % of the spat market and NSW would be seeking continued support for breeding research from the Seafood CRC. The first stage of this support has been provided in the form of a project to investigate "Incorporation of selection for reproductive condition, marketability and survival into a breeding strategy for Sydney rock oysters and Pacific oysters" which will see approximately $100,000 per annum invested in broadening the traits used for broodstock selection.

KEYWORDS:

Sydney rock oyster; commercialisation; industry management; breeding program

1. BACKGROUND

Industry and Investment NSW (formerly NSW Fisheries but now Department of Industry & Investment) established a breeding program in 1990 in Port Stephens and the Georges River with the aim of selecting Sydney rock oysters (SRO) for faster growth. The program was later expanded to include selection for resistance to the two major diseases, winter mortality and QX. As a result, oysters breeding lines were produced that are capable of reaching harvest size 11 months earlier, with others which as well as fast growing are resistant to QX or winter mortality. Prior to 2003, commercialisation of the breeding lines was hampered by the failure of hatcheries to produce commercial quantities of spat. In 2003 New Tech Aquaculture P/L at Hervey Bay, Queensland and Industry and Investment NSW achieved reliable commercial scale hatchery production. New Tech Aquaculture P/L commenced commercial SRO hatchery operations in 2004 and by 2005 had taken on sole responsibility for production. Consolidation of this breakthrough was addressed through a FRDC/Industry and Investment NSW/ORAC project and significant improvements were made in hatchery and nursery rearing. Originally four breeding lines selected for fast growth were maintained in Port Stephens, NSW. Parallel breeding lines were also maintained in the Georges River, NSW.

Outbreaks of QX disease in Georges River in 1994 and 1995 devastated breeding lines and in January 1997, the program was re-established and modified to incorporate one line to be selected for resistance to winter mortality, one for resistance to QX disease and one for resistance to both winter mortality and QX disease. The progeny of third generation SRO were evaluated in July 2002 – February 2005 for resistance to both QX disease and winter mortality against non-selected controls. The Lime Kiln Bar Line had excellent resistance to one season of exposure to disease, but suffered high mortality during the second season of exposure. However, these oysters had reached market size of 50 g whole weight, with low mortality at 2 years of age, before the second episode of QX disease. The Woolooware Bay Line showed good improvement in resistance to both diseases, whereas the Quibray Bay Line had good resistance to winter mortality. All three lines displayed faster growth than controls.

Selection for faster growing oysters in Port Stephens had also been successful. In April 2003, the fifth generation progeny of the most improved line had reached market size (50 g whole weight) in 26 months, which was more than 11 months earlier than controls. Although oysters were selected for fast growth, the percentage shell weight and meat yield of the oysters had not changed.

In 2003 FRDC funded the University of NSW to review the status of hatchery production and breeding programs in NSW. This report made broad ranging recommendations for further development of these programs and highlighted the importance of industry involvement in these processes. The report stated it is clear that genetic improvement programs must be planned with an integrated approach to industry and technology development. The logical extension of this process is that, with suitable technical and research support, industry itself takes ultimate responsibility for the adoption of the results of the breeding program. In response the NSW oyster industry actively sought the development of a commercial vehicle to take on the responsibility of breeding line management and distribution of resultant improved stock. In consultation with FRDC and Industry and Investment NSW, the two industry associations (Oyster Farmers' Association of NSW and NSW Farmers' Association, Oyster Section) combined in 2004 to form the Select Oyster Company P/L (SOCo) to organise production and distribution of stock from the improved breeding lines and to ultimately take control of the management and future development of the current breeding lines.

With respect to the FRDC strategic challenges, this project sought to increase the operating efficiency of the Sydney rock oyster industry through the provision of direct access to management systems and knowledge that:

- Allow industry greater and more direct determination of their future.
- Allow an increase in the quality of industry output.
- Allow access to improved technologies.
- Facilitate development of an effective and efficient Business Plan for commercialisation of selected stock.

2. NEED

To ensure the successful adoption of the technology producing faster growing disease resistant oysters, a previous FRDC review of oyster hatchery and breeding programs (Benzie *et al*., FRDC 2001/213) strongly emphasised the need to inform, equip, and assist industry to understand and adopt this technology. Accordingly, there was a need to 1) conduct an independent assessment of current selection practices and their relevance to ongoing breeding line maintenance and improvement, 2) establish the genetic status of the current breeding lines with respect to the natural populations of SRO and 3) assist in the development of cost effective strategies and technology for the maintenance of selected lines and their genetic integrity. The outcomes of these assessments have been presented in a form that is suitable for incorporation in the company's business plan, and also of value to other industries undertaking or contemplating breeding programs.

3. OBJECTIVES

1. To survey industry breeding requirements and establish the economic values of different SRO traits in order to determine the market sustainability of developing and marketing multiple lines and to determine the optimum breeding objectives of different lines.
2. To evaluate alternative methods for selection for the most desirable traits, as identified by industry (faster growth, QX, disease resistance, winter mortality resistance etc).
3. To review breeding program designs and apply the best approach to develop a new 10 year breeding strategy for SRO, in consultation with industry.
4. To develop a risk assessment and reduction model against the loss of broodstock.
5. To determine the best methods for use and protection of existing & future intellectual property for industry development.
6. To prepare a technical manual for the continued operation of an SRO breeding program.
7. To prepare fully costed options for funding a breeding program for the next 10 years.
8. Review the genetic status of the current breeding lines by examining genetic variation.

4. RESULTS AND DISCUSSION

Dr John Nell of Industry and Investment NSW (DPI), originally a Co-investigator but retired during the course of the project, produced a "Manual for mass selection of Sydney rock oysters for fast growth and disease resistance". The manual described the methodology used by Industry and Investment NSW in the mass selection program for the Sydney rock oyster from the beginning of the program in 1990 to March 2006. The program established breeding lines in Port Stephens and Georges River, selecting for fast growth in Port Stephens and both fast growth and disease resistance (QX disease, *Marteilia sydneyi* and winter mortality, *Bonamia roughleyi*) in Georges River. In Georges River the program successfully developed dual resistance against these two major diseases whilst increasing the growth rate. The Port Stephens breeding lines, which did not suffer major disease problems, also grew significantly faster than controls, achieving a reduction of 10 months out of a usual 38 months to reach market weight of 50 grams. The manual comprehensively documented the hatching, selection and husbandry practices employed, the equipment used and discusses a number of issues relevant to the program.

A "Literature Review: Oyster Breeding" was produced by M.Sc student, Ms Anna Hansson who was based and registered at UNE under the direct supervision of Co-Investigator Dr Kim Bunter of the Animal Genetics and Breeding Unit (AGBU) within the Institute for Genetics and Bioinformatics (TIGB) at UNE. The review summarised current knowledge of aquaculture breeding programs particularly oyster breeding programs and addressed issues of selecting for greater growth and disease resistance, breeding objectives, candidate evaluation and selection, genetic parameters, economic weights, response to selection and inbreeding issues. The review found that response to selection is achievable for growth rate, meat yield and disease resistance. So far, most programs are based on simple mass selection procedure and little has been done, especially in shellfish, to establish genetic parameters that are necessary to optimize breeding programs. Identification of individual animals and family structures are recommended for gathering the data for the development of genetic parameters.

SOCo conducted an assessment of the risk of loss of broodstock and in conjunction with DPI has placed a risk reduction model in place. The risks examined included disastrous loss from outbreaks of disease, gross change in water quality inimical to oyster growth/survival, extreme or extraordinary weather events, theft and vandalism. SOCo made arrangements with an oyster farmer in each of five estuaries to host and care for 2,500 select line spat which are intended for use as multiplication stock for future commercial runs. The estuaries were chosen after consideration, inter alia, of their history of disease outbreaks, their legislative status with regard to translocation of stock (e.g., no estuary with a history of a QX outbreak was selected) and susceptibility to acid sulphate events or to prolonged influx of fresh water. Nucleus breeding stock is held under DPI's care in each of Port Stephens and Georges River at two sites. The stock in Port Stephens is challenged for fast growth and resistance to winter mortality while the stock in Georges River is challenged for resistance to QX disease as well as winter mortality and fast growth.

Mr Damian Ogburn was engaged as a consultant to review SOCo's business strategy for development and delivery of multiple breeding lines. Mr Ogburn visited and interviewed a range of selected Sydney rock oyster farmers along the coast from southern Queensland to southern NSW regarding their operations, plans for future development and specific views on SOCo stock, and priority attributes for selection in SRO stock. Mr Ogburn's report provided a risk analysis of potential/emerging business issues for SOCo and recommendations for managing them and evaluated likely market demand for SOCo stock. His report analysed the strengths and weaknesses of competitors and their products and discussed priority attributes for selected breeding lines for

industry. Mr Ogburn recommended that SOCo continue to focus on presenting a select line to industry which combined resistance to QX disease and winter mortality with fast growth.

Ms Hansson and Dr Bunter produced a report "Economic weights of commercially important Sydney rock oyster traits". Economic weights are the estimated change in profit associated with a single unit change in a trait, all other traits held constant. Breeding objectives aim to improve the overall phenotype by improving the average genetic merit. The economic weights or values of particular traits are estimates of the relative importance of different traits that will contribute to the breeding objective. From this, particular genotypes can be ranked against each other using a single aggregate value derived from breeding values and the economic weights for traits included in the aggregate genotype. Multiple-trait selection is important as individual traits should not be considered in isolation (as occurs with single-trait selection). This is because traits may be unfavourably co-related. Unfavourable changes were evident in the meat condition of the select line (L2) oysters that had been selected purely for increased growth. A similar finding has also been reported in the Australian Pacific oyster breeding program where there was a high unfavourable genetic correlation between weight at 25 months and condition index.

The approximate importance of each trait covered in the survey to a breeding goal was illustrated by the economic value standardised to represent a $ value per genetic standard deviation. The traits were ranked in their economic importance to a breeding program in the following order (absolute standardised values are presented in brackets):

1. Overall mortality (0.91 to 2.72)
   Mortality due to QX disease (2.72)
   Mortality due to WM disease (1.13)

2. Growth rate (weight)
   Sales in 3 grade classes (0.58)
   Sales in 5 grade classes (0.82)

3. Meat condition (0.56)

4. Shell shape (0.016)
   Shell strength
   Thin shells (0.014)
   Thick shells (0.021)

5. Meat colour had a neutral economic value (0)

These values indicated that the current breeding program is improving the most economically important traits in Sydney rock oysters by decreasing mortality from the two major SRO diseases and improving growth rate. The ranking of these traits showed that the level and maintenance of meat condition is the next trait that should be selected for under the SRO breeding program.

There were a number of constraints to obtaining specific, reliable estimates of variable costs and returns from the survey of individual SRO farmers. This particularly included a lack of detailed costs data and considerable variability in returns with overlapping grades and prices.

The report was based on information gathered from 31 farmers spread from Moreton Bay in southern Queensland to Merimbula in southern New South Wales and from five wholesalers/retailers based in Sydney. The farmers surveyed were referred by industry representatives and comprised about 22 % of farmers producing more than 10,000 dozen oysters in

the year 2004/2005. Not all farmers surveyed gave total production figures, but the 24 farmers who did were responsible for approximately 29 % of total SRO production.

The data collected included production information, variable costs and returns. As farmers used a variety of bases to express their costs, the raw data was re-calculated onto the same basis (dollars /dozen) for each producer. The values were then entered into a variety of models for analysis with some results from literature to ensure sensible outcomes. The report characterised the respondents by region (northern or southern NSW – virtually equal), by length of time in the industry, by size of enterprise and by production system (traditional stick culture, single seed culture or mix of both).

The survey addressed a wide range of production variables (e.g., sale age, grade classes, grade class weights, condition, mortality, returns, sale destination, whole oyster returns, opened oyster returns, price differentials, proportion of sales for each class grade, costs and returns). The costs considered important were variable costs. Variable costs vary with the level of output of the operation and include costs such as wild spat collection, grading, depuration, packaging and freight. As no producer was able to provide complete information regarding variable costs of production, values used for economic models were a combination of literature and survey values. Regarding the relative importance of traits to farmers, growth was first priority with meat condition second and shape third followed by disease resistance. It is surprising that disease resistance did not rank higher, although this may reflect an understanding that this had been achieved with respect to QX. For the processors condition was clearly first priority well ahead of shape in second place with presentation and meat colour equal third.

Dr Kim Bunter of the Animal Genetics and Breeding Unit (AGBU) at the University of New England, with input from Industry and Investment NSW (Dr John Nell and Dr Wayne O'Connor), produced a "Technical Evaluation of the SRO Breeding Program" which built on the previous reports produced in this project. Dr Bunter proposed strategies to increase the effectiveness of the current mass selection program for improving growth rate and developing disease resistance and examined ways of obtaining progress in other commercially valuable traits such as meat condition and shell shape. In particular she recommended that the number of mass selection breeding lines for growth rate and for disease resistance plus growth rate be reduced from four to one and from three to one respectively to simplify management and save resources while at the same time enlarging the genetic variation in the parent pool. Dr Bunter further recommended that the structured matings program for analysis of phenyloxidase under FRDC Project 2006/226 be varied to enable the capture of family data which could be used to calculate genetic parameters. Both these recommendations have been or are being implemented. (We will reduce PS from four to one, however, we will only reduce GR lines from 3 to 2 when we confirm the dual disease resistance is possible).

Dr Bunter emphasized that genetic parameters were essential to technically evaluating a breeding program and without these she was unable to perform a cost/benefit analysis of the current SRO breeding program. She also pointed out that based on the early age of reproductive maturity in oysters (12 – 18 months), a clear opportunity exists to reduce generation intervals in the existing breeding program, thereby increasing annual rates of genetic gain under selection. To make use of this possibility, it will be necessary to consider how selection at an earlier age can be achieved while also facilitating improvement in oyster condition, shell shape and oyster survival to two seasons of exposure to diseases such as QX. If improvement in the latter traits is hindered by shorter generation intervals, then this opportunity becomes less valuable. The lack of known complete disease aetiology, uncontrolled infection status, and unknown mechanisms of tolerance and/or resistance remain outstanding issues that potentially limit the response that can be achieved in the disease resistance lines. Industry and Investment NSW is attempting to overcome these limitations and increase the effectiveness of response to selection by increasing exposure of oysters

to disease conditions (e.g., lowering racks, rotating oysters between sites of known occurrence of the two diseases). The discovery of Adlard (2007) might open opportunities for artificial infection with QX, particularly for younger oysters if two seasons of exposure are desired.

Dr Bunter queried whether the disease resistance line oysters are resistant or merely highly tolerant to the disease organisms. This is difficult to resolve, but the reduction in numbers of the parasite in selectively bred oysters and the absence of the parasite following the infective period are strongly suggestive of resistance. A further query is whether resistance to QX disease and resistance to winter mortality are additive genetically and Dr Bunter suggested that specific test crosses could be created to assess this. This information will be important if the program develops separate lines for resistance to the two diseases and line crossing is contemplated.

The economic weights paper indicated that oyster condition, shell shape and shell strength were the next most important traits to include in SRO breeding goals after the traits of disease resistance and growth rate. These traits are important to both farmers and processors and the breeding program should take account of the interests of both sections of the industry.

Dr Bunter noted that there is no widely accepted definition of meat condition for sales or reproductive purposes. Also, to date there do not appear to be any cost-effective non-destructive methods of measuring the traits of condition and shell strength. The difficulty of establishing a breeding program that incorporates these other economically important traits thus lies with developing meaningful trait definitions and measurement strategies for these traits, both for estimating genetic parameters and selection purposes. Dr Bunter argued therefore that, ultimately, an alternative mating, recording and evaluation structure is required, which could arise from the structured population required to estimate genetic parameters. The structured matings occurring under Project 2006/226 provide an opportunity to derive data relevant to condition. Knowledge of family structures also allows selection and mating decisions to be altered in such a manner as to control response to selection and rates of inbreeding simultaneously. In the meantime monitoring the condition of selected oysters against that of non-selected across a range of sites should be conducted so that corrective action can be taken if any negative correlation between condition and the traits under selection is detected.

Dr Bunter recommended that protocols be developed for the creation of overlapping generations through use of some common parents across generations to provide a means of better establishing response to selection each generation, and alleviate the need for extensive testing of progeny of control oysters that will not be eligible for selection.

In a study separate to this project work was undertaken to develop a microsatellite library which was used to assess genetic variation within and between breeding lines and wild stocks. This study developed a limited number of microsatellite markers (4), which did not find any significant inbreeding had occurred in the mass selected lines. In a concurrent study, Banks *et al.* (2006) also developed a suite of markers for Sydney rock oysters. Recently, these two suites have been combined and further evaluations have been undertaken (Nguyen *et al.* 2009). Initially, this work has focussed on parental assignment in pair mated family studies, however this will be expanded to diversity assessment and the results of this study will feed into the design of the breeding program and risk management strategies.

Preparation of fully costed options for funding the breeding program for the next ten years could not be completed due mainly to uncertainties on the funding side. Costs of maintenance and development of the mass selection lines were identified with reasonable clarity, while costs of structured matings are starting to emerge but are not yet clear. On the funding side the inflow of funds into SOCo from the levy on sales of spat from its breeding lines is impossible to predict with certainty.

5. BENEFITS AND ADOPTION

The project outputs, i.e. its various reports, benefit SOCo and industry at a fundamental level by setting the SRO breeding program against an international background of aquaculture research and have confirmed SOCo's view that the program is producing valuable positive results and that it is heading in the right direction. This is a boost to the confidence of SOCo and the industry in general that substantial gains are available from a well managed and appropriately resourced breeding program.

The project has conducted an independent assessment of current selection practices and their relevance to ongoing breeding line maintenance and improvement. This has brought into sharp focus that while mass selection techniques have made excellent progress in traits such as disease resistance and growth, traits such as meat condition which currently are measured by destructive methods require gathering of family information. Dr Bunter's technical evaluation of the program emphasised that to optimise the program, information on genetic parameters was necessary. Accordingly experiments with select stock at DPI's hatchery were adjusted to gather the information needed to derive genetic parameters.

The rearrangement of the breeding lines in Port Stephens offers benefits of simpler management, greater diversity of the potential parent pool and some cost savings.

While the potential to incorporate pair mated breeding lines within the SOCo breeding plan offers the capacity to estimate and to an extent control inbreeding, this program has fostered the continued development of a microsatellite suite for Sydney rock oysters and has arrived at the point at which it has become a useful experimental tool. Microsatellites can now be used to assess the level of inbreeding in the current commercial breeding lines and the technical evaluation has pointed out the standard needed to arrive at a sound conclusion. Work on this aspect is incomplete but ongoing.

The revelation of the difficulty encountered in establishing economic weights because comprehensive data on costs and returns was not available can be viewed as a benefit to helping SOCo and industry to realise the benefits which could come from a benchmarking project. Benchmarking is an issue which has been regarded as a priority by the Oyster Consortium in the Seafood CRC.

Overall SOCo has gained a number of insights that will assist it to revise its business plan as well as the breeding program.

6. FURTHER DEVELOPMENT

The timing and reporting of this project have been such that the keys areas for further development have now become the basis of ongoing work. The consultative meetings, the linkages established and the findings of this project have had a significant influence on the development of subsequent research programs and have highlighted avenues for further breeding line development.

- The breeding program review influenced the structure of matings in FRDC/CRC Project 2006/226 in which the techniques for the pair mating Sydney rock oysters were developed and upon which further pair mated breeding will be based.
- This program highlighted the importance of condition as a factor in marketing Sydney rock oysters, which has now become the subject of a Seafood CRC research program.
- Finally, this program highlighted significant efficiencies that could be gained through changes in breeding protocols; notably:
    a) the rationalisation of the number of mass selected breeding lines in both Port Stephens and the Georges River and the locations in which they are held, and
    b) the opportunities for accelerated assessment of breeding line performance.

7. PLANNED OUTCOMES

The oyster industry in NSW and southern QLD has access to selected line oysters that improve its productivity and profitability.

SOCo is of the view that in its management of the breeding program it is using the best science available to it. SOCo's commitment to seeking the best science available to it for continuous improvement of selected lines is evidenced by its commitment to the Seafood CRC. Regrettably at this stage SOCo's finances are inadequate to fully fund the program. Sales of spat from the selected lines after exceeding 30m initially have fallen to around 20m. Currently SOCo has engaged an experienced and respected long term member of the industry to visit farmers to seek to elicit what issues have led to this reduction in sales. The industry has committed all its research levy – a figure between $80,000 and $90,000 – to the Seafood CRC. It is of course the responsibility of SOCo not this project to generate funding to support the breeding program. Clearly SOCo needs to attend to its business plan.

In the event of the further spread of QX disease, disease resistant oysters would be available if necessary for restocking for "public good".

8. CONCLUSIONS

The project has provided SOCo with a comprehensive examination and evaluation of the SRO breeding program. The project outputs, i.e. its various reports, benefit SOCo and industry by setting the SRO breeding program against an international background of aquaculture research and have confirmed SOCo's view that the program is producing valuable positive results and that it is heading in the right direction. The project has brought into sharp focus that while mass selection techniques have made excellent progress in traits such as disease resistance and growth, traits such as meat condition which currently are measured by destructive methods require gathering of family information. Co-investigator Dr Bunter's technical evaluation of the program emphasised that to optimise the program, information on genetic parameters was necessary. Accordingly experiments with select stock at the Port Stephens hatchery were adjusted to gather the information for genetic parameters. Dr Bunter also recommended that the Port Stephens and Georges River lines be reduced in number from 7 to 3 which has been or is being put into effect. More information on the recommendations in the outputs is to be found elsewhere in this document.

Overall SOCo has gained a number of insights, which will assist it to revise its business plan as well as the breeding program.

9. APPENDICES

9.1. Intellectual Property

No intellectual property issues have been identified as arising from this project.

9.2. Staff List

Mr **Ray Tynan –** Principal Investigator
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Mr Damian Ogburn – Consultant
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Ms Anna Hansson – M.Sc. student
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University of New England, Armidale

Mr Ben Perkins – Technician
Industry & Investment NSW
Port Stephens Fisheries Institute

Ms Rachel King – Administrative Officer
NSW Farmers' Association, Sydney

9.3. Extension Material

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