Potential for genetic improvement of Sydney rock oysters

(*Saccostrea glomerata*)

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DECLARATION

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree.

I certify that to the best of my knowledge any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

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To all those who assisted with this thesis. I hope my work meets your expectations. I anticipate that this project can provide the SRO industry as a whole with a valuable insight into their industry, and highlights the potential for vast genetic progress under a breeding program.

Abstract

Since 1990, Sydney rock oysters (SRO: *Saccostrea glomerata*) have been successfully selected for fast growth and resistance to the two major SRO diseases; QX disease and Winter mortality in a mass selection breeding program operated by the NSW Department of Primary Industries and Fisheries (DPI&F). However, these are not the only traits of economic importance to SRO farmers and their customers, thus a survey was conducted to establish which traits are of importance to their businesses. Weighted totals from survey results indicated that, in decreasing order of importance, growth rate, meat condition, shell shape, general mortality, WM resistance, QX resistance, meat colour, appearance and eating quality were all considered to be traits of importance to SRO farmers. In comparison, wholesalers did not consider factors that did not directly affect their business (e.g. growth rate or mortality) as important but regarded meat condition, shell shape, meat colour, presentation and size as important factors affecting their operation.

Survey results also included production and economic (returns and variable costs) data. Strategies were developed to estimate the economic values for the first seven traits reported above, using this data. Economic values have not previously been available for SRO traits, possibly because industry standards for measuring traits are largely absent. Consequently, trait genetic parameters are also largely unknown for SROs, compounded by difficulties in achieving planned mating structures to ascertain these parameters. Nevertheless, after assumption were made regarding trait measurement procedures and parameters, the relative importance of traits were established by multiplying the calculated economic values by the assumed genetic standard deviation (GSD) for each specific trait. Economic values were derived on a dollars per dozen basis for each one unit change of the trait expression. Mortality due to QX and WM were the most important traits ($2.72/GSD and $1.13/GSD), followed by growth rate (average $0.70/GSD), meat condition ($0.56/GSD), shell shape ($0.016/GSD) and strength (average $0.018/GSD). Since the measurement of meat condition, an important trait, is typically destructive, strategies will need to be developed to measure condition on live animals for mass selection. Alternatively, improvements in hatchery reproductive performance are required to generate family structures for

developing more sophisticated breeding programs, whereby sacrificed relatives can provide some of the necessary data.

The potential for genetic gain and inbreeding under different mass selection breeding program alternatives were compared, with particular reference to the current SRO breeding program. The population size was varied from 200 to 4000 animals with a fixed number of broodstock selected from each population (N: 200), thus selection intensities also varied. As expected, response increased with population size. However, when population sizes were increased from 2000 to 3000 or 4000 animals the differences in response were relatively small, thus a population size of 2000 was considered efficient to achieve a genetic gain of 0.31 units per generation while maintaining rates of inbreeding at 0.29% per generation, assuming single-trait mass selection for a moderately heritable (h^2: 0.2) trait. When the population (N: 2000) was sub- divided into four separate sub-lines; genetic response decreased to 0.30 units per generation and resulted in a high rate of inbreeding (1.1% per generation). Therefore, sub-lines were not recommended. The final scenario investigated increasing the proportion of females selected relative to males while maintaining 200 broodstock, similar to what is expected to occur in the SRO breeding program. This scenario had a smaller effect on response (0.32 units per generation) relative the rate of inbreeding 0.33% per generation. An increase in trait heritability to 0.4 resulted in an increased response (0.59 units per generation) but also an increase in inbreeding (0.33% per generation. Overall, trait heritability had the largest influence on response and dividing the population into four lines had the greatest impact on inbreeding.

Further investigation into the estimation of genetic parameters for economically important traits is warranted for SROs. This is because progress in the current SRO breeding program is limited without parameters to predict how changes in breeding structures will affect genetic response and inbreeding, as well as correlated responses in traits. In addition, increased knowledge regarding the aetiology of the two major SRO diseases will improve options available for selecting to increase resistance. This will facilitate the calculations of expected changes in genetic gain and inbreeding under different breeding program recording and selection strategies. Sex identification before spawning would enable the proportion of males and females selected as broodstock to be optimised.

Contents

List of Tables

List of Figures