ALLIANCE™

(https://debug.globalseafood.org)

**Responsible Seafood ADVOCATE**

🦐 Health & Welfare

# Pacific oyster selective breeding in Australia

2 May 2012

By **Peter Kube, Ph.D.  and Matthew Cunningham**

## Economics, computing combine to deliver gains

Regular handling is part of the farming system. Oysters can receive 10 handlings during growout, which is a significant factor in the cost of production. Photo by Bruce Miller, CSIRO.

Selective-breeding programs are a standard part of animal production and have been an important contributor to improving growth rates and product quality while decreasing the cost of production. Selective-breeding improvements have transformed terrestrial animal production, and although relatively new to Australian Pacific oyster production, are expected to provide a similar transformation of Australia's oyster industry.

## Oyster breeding in Australia

Pacific oyster selective breeding started in Australia in 1997. Although it faced all sorts of challenges, this early work was successful in building a breeding population and establishing the processes and protocols required to run a commercial, industry-based program. However, program limitations hindered the commercial uptake of the selectively bred oysters.

In 2007, Australian Seafood Industries (ASI), the industry-owned company responsible for Pacific oyster selective breeding, teamed up with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Food Futures Flagship and, with funding assistance from the Australian Seafood Cooperative Research Center, started a "modernization" of the breeding program. This successful partnership brought together ASI's practical oyster-breeding experience and knowledge of the industry with CSIRO's skills and experience in genetics and applied selective-breeding programs.

## Trait selection for economics

The main limitation to the program was a lack of understanding of which genetic traits to select. While the program was achieving genetic improvements in growth, little was known about other traits that influenced grower profitability and how these should be balanced in selection decisions.

The Australian Pacific oyster industry, which is based solely on half-shell sales, is selling a luxury product, and good appearance and high quality are essential requirements. The production system requires grading and mechanical tumbling to raise that high-quality product. An oyster may receive up to 10 handling events, which significantly influences the cost of production.

When using the selected lines, growers noticed that growth was fast, but product quality, particularly with regard to shell shape, had decreased. And, at times, the fast-growing oysters required an increased amount of handling. The program had slipped into a situation where it was making genetic gains, but probably failing to make economic gains. It also highlighted the complex nature of the Pacific oyster production system, where "best-guess" decisions about the relative trait weightings did not necessarily give good economic outcomes.

Australian Pacific oysters are produced exclusively for the half-shell market, so good product appearance is essential. Photo by Bruce Miller, CSIRO.

## Bioeconomic model

The solution was to redefine the breeding objectives and prioritize traits according to their economic values. Although this is commonly done in terrestrial animal-breeding programs, this was the first time it was done in oyster breeding. Assigning economic values to traits required building a bioeconomic model of the Australian half-shell oyster production system.

The model was able to predict how a change in biological traits influenced economic metrics, with cost of production the main measure. The model identified five economically important traits: growth time, shell shape, survival, time required to reach market condition and uniformity. An economic value was calculated for each trait.

For example, improving the survival of oysters from 65.0 percent, the approximate Australian average, to 71.5 percent, a 10.0 percent gain, would decrease the cost of production by 3.5 percent. Similarly, decreasing the throughput time by 10.0 percent by increasing growth rate would decrease the cost of production by 2.5 percent. Increasing the ratio of shell width to length by 10.0 percent, so fewer oysters had unacceptable shell shapes, would decrease costs by 3 percent. Such measures were the basis for weighting traits in selection decisions.

## Overcoming slow progress

A second limitation was the slow rate of genetic progress being made, which manifested as growers reporting a "lack of noticeable difference" in the oysters. Data from the breeding program showed the Pacific oyster traits were under rather strong genetic control, so noticeable changes should be expected. The challenge was to accelerate the rate of genetic change.

It is always possible to select more intensively to get more genetic gain, but this must be balanced by the need to manage inbreeding. Genetic gains and inbreeding pull in opposite directions, and finding the right balance is one of the fundamental decisions – and dilemmas – for applied breeders. It is also possible to "do more breeding" to get more gains, but this must be balanced against the logistical and budgetary restraints of the program.

For the oyster program, computer simulations were used to help find that desired balance. Computer simulations are an ideal tool for this because they allow a complex range of "what-if" scenarios to be quickly evaluated on a desktop. The program is now based on producing 50 pedigreed families every year, and although relatively small, there is confidence that a revised population structure and selection strategy can produce better and sustainable gains without the risk of inbreeding.

## Better data use

Another aspect to improving the rates of gain was to make better use of the data collected as part of the breeding program. Full use of computing power and modern statistical algorithms can make noticeable differences in applied breeding, a point that is sometimes overlooked in aquaculture breeding.

Revisions of the breeding strategy involved a complete overhaul of the ways in which data analyses were done. Adopting these methodologies also vastly improved the quality of information that flowed to both the breeding program manager and the growers. For example, genetic trends across year classes can be easily and accurately plotted, the precise genetic value of any individual in the breeding population can be estimated and the level of inbreeding between any two animals can be easily determined to assist in selection and mating decisions.

Moving to a data-centered breeding strategy also involved developing data systems and computer software that supports the breeding program. Oyster breeding works to a biological cycle that waits for no one, and there is no point in having economic values of traits, a carefully planned breeding strategy and sophisticated data analyses if breeding decisions cannot be made on time.

Most Australian Pacific oysters are grown using the rack and basket system in the intertidal zone. Farms typically range 15 to 25 ha in size. Photos by Bruce Miller, CSIRO.

# Improvements to impact industry

Improvements to the breeding program have allowed the selection of oysters with the best economic mix of traits, better identification of those oysters and more effective management of inbreeding. But the final measure of the changes is the extent to which the growers benefit.

By combining new knowledge of the economic values of traits, the genetic inheritance of these traits and the gains projected in computer simulations, it is estimated that the breeding program will reduce the cost of production by 40 percent over a 10-year period.

*(Editor's Note: This article was originally published in the May/June 2012 print edition of the* Global Aquaculture Advocate*.)*

## Authors

**PETER KUBE, PH.D.**

Aquaculture Geneticist
CSIRO Food Futures Flagship
Castray Esplanade
Hobart, Tasmania, Australia

peter.kube@csiro.au (mailto:peter.kube@csiro.au)



**MATTHEW CUNNINGHAM**

General Manager
Australian Seafood Industries Pty. Ltd.
Hobart, Tasmania, Australia