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Reproductive cycle of Sydney rock oysters, *Saccostrea glomerata* (Gould 1850) selectively bred for faster growth

Michael C. Dove *, Wayne A. O'Connor

Industry and Investment NSW, Port Stephens Fisheries Institute, Taylors Beach, New South Wales, 2315, Australia

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ABSTRACT

Since 1990, Industry and Investment New South Wales' (NSW) Sydney rock oyster (SRO) breeding programme has successfully used selective breeding to improve oyster growth rates. But, some oyster growers have observed that selected oysters condition at a different rate and to a different extent compared to naturally caught oysters grown under similar conditions. The condition index, sex, gametogenic stage and gonad area of fifth generation SROs selectively bred for fast growth were investigated by collecting monthly samples at a northern, mid and southern site in NSW between June 2005 and July 2006. Non-selected oysters farmed under the same conditions were also sampled at the same time. Overall, selected and non-selected oysters developed and spawned at each site synchronously, however, selectively bred oysters, in most instances, had a lower condition index, different meat conditioning cycle and reduced gonad area than their non-selected counterparts. Although selective breeding for fast growth hasn't changed reproductive timing, the variation in meat condition is consistent with oyster grower's observations and has encouraged further research to better understand the environmental responses of selected oysters and improve reproductive condition in SRO through breeding.

1. Introduction

Sydney rock oysters, *Saccostrea glomerata*, form the basis of the largest and oldest aquaculture industry in NSW, generating approximately US$29 million annually (O'Connor and Dove, 2009). Production of Sydney rock oysters peaked at 7700 tonnes in the mid 1970s but has since declined to around 3300 tonnes in 2007/2008 (O'Connor and Dove, 2009). This decline has arisen from a number of factors including the impact of disease and competition from the faster growing Pacific oyster *Crassostrea gigas*. To address these challenges and support industry, a SRO selective breeding programme was initiated in 1990.

The Sydney rock oyster breeding programme began with the aim of developing faster growing, winter mortality resistant stock (Nell et al., 2000). To achieve this, four lines of oysters were produced and representatives of the lines were held in two estuaries, Port Stephens and Georges River. Selection within each line in Port Stephens was based on weight gain whereas in the Georges River, selection also included resistance to disease. After five generations of selection in Port Stephens, the average time to grow an oyster to market size (50 g) was reduced by more than 12 months (Nell and Perkins, 2005) and in 2004 the first progeny of the fastest growing line (Line 2 = L2) were made commercially available to the oyster industry (O'Connor and Dove, 2009).

Performance of fifth generation selectively bred fast growth oysters was monitored in seven estuaries across NSW and on average, grow-out time was reduced in accordance with expectations (Dove and O'Connor, 2009). However, observations made during the study of Dove and O'Connor (2009) indicated that the reproductive condition of selected oysters differed from that observed in controls and wild oysters at some sites.

The quality and marketability of *S. glomerata* is mostly dependant upon the appearance of the flesh presented in the left valve and "plumpness" or condition of the meat (Ruello, 2006). Condition index (CI) is a ratio of the dry meat weight over the internal shell cavity capacity and is an effective measure of the nutritive status of bivalves (Crosby and Gale, 1990). This measure has been used to compare the quality of meat of Sydney rock oysters and Pacific oysters (*C. gigas*) (Mason and Nell, 1995) and to assess the performance of triploid Sydney rock oysters versus diploids in five estuaries of New South Wales (Hand and Nell, 1999).

A dry weight CI of 100 has been recommended as a minimum for marketing SRO (Hand and Nell, 1999). Oyster growers have observed that selectively bred oysters condition at a different rate and to a different extent compared to naturally caught wild oysters grown under similar conditions. Given that *S. glomerata* are a luxury food, it is critical to understand what happens to the quality of the meat when selection for growth rate is applied over multiple generations.

* Corresponding author at: Industry and Investment NSW, Port Stephens Fisheries Institute, Locked Bag 1, Nelson Bay NSW 2315, Australia. Tel.: +61 2 49 821232; fax: +61 2 49 821107.
E-mail address: michael.dove@industry.nsw.gov.au (M.C. Dove).

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The effect of five generations of selection for fast growth on gonadal development of *S. glomerata* is not known. Oysters are able to manipulate energy allocations for maintenance, growth and reproduction and have considerable capacity to change their behaviour in response to environmental fluctuations (Bayne, 2004). Oyster growth rates are extremely variable but are strongly influenced by genetics (Hedgecock et al., 1996). Additionally there are genetic controls on temperature thresholds for gametogenesis (Ford et al., 1990; Newkirk, 1980). Improvement of oyster growth is likely to be at the expense of other traits but understanding the exact trade-offs is particularly complex (Bayne, 2004).

To investigate changes putatively caused by breeding for faster growth, samples of fifth generation selected oysters were periodically collected at three commercial farm sites spread throughout the NSW *S. glomerata* growing range. Samples were measured and processed so that CI, gonad area and gonadal stage could be determined. Non-selected, equivalent aged oysters were concurrently collected from the same sites to better understand changes caused by selective breeding.

2. Materials and methods

2.1. Experimental stock

The selectively bred oysters used in this study (referred to hereafter as selected oysters) were from the same batch of oysters produced

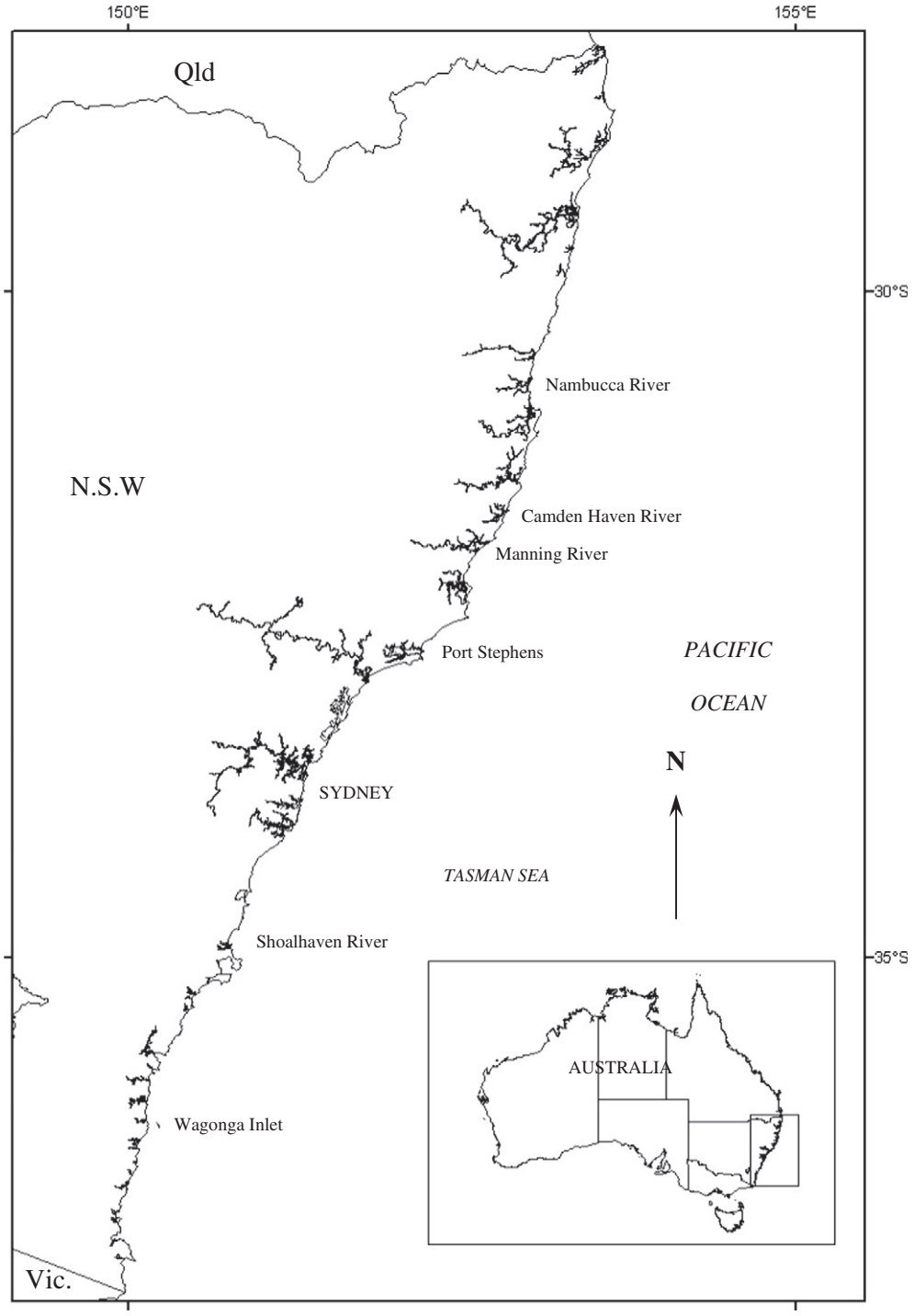

Fig. 1. Map of the NSW coast showing locations of estuaries used as field sites and origin estuaries of non-selected oyster broodstock.