3-1-2018

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Recommended Citation

Rankin, C., Moltschaniwskyj, N., Morton, J. K., & Wilkie, E. (2018). Shell shape and meat condition in selectively bred Sydney rock oysters, *Saccostrea glomerata* (Gould, 1850): The influence of grow-out methods. *Aquaculture Research, 49*(3), 1189-1199. doi:10.1111/are.13572

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Keywords: Sydney rock oyster; Phenotypic plasticity; Grow-out methods; Selective breeding; oyster shell shape; Edible oyster industry

This is the peer reviewed version of the following article: Rankin, C., Moltschaniwskyj, N., Morton, J. K., & Wilkie, E. (2018). Shell shape and meat condition in selectively bred Sydney rock oysters, *Saccostrea glomerata* (Gould, 1850): The influence of grow-out methods. *Aquaculture Research, 49*(3), 1189-1199.***, which has been published in final form at https://doi.org/10.1111/are.13572. This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Use of Self-Archived Versions***

Abstract

The Australian edible oyster industry has been severely impacted by disease and declining yields since the 1970s. Selective breeding of *Saccostrea glomerata* is one measure addressing these problems by producing fast-growing, disease-resistant oysters. Farmers report that selected oysters have different growth characteristics than their wild counterparts using conventional grow-out methods. This study investigated how different grow-out methods influence commercially valuable oyster characteristics including shell height, shape, surface growth deformities and meat condition. In June 2015, selectively-bred *S. glomerata* spat were deployed in two estuaries (Hawkesbury River and Georges River) in NSW, Australia, using three grow-out methods (fixed trays, Stanway cylinders and floating baskets). In November 2015, oysters were transferred among grow-out methods to test for the effects of changing grow-out methods on oyster growth patterns. Oysters transferred from baskets to cylinders and from trays to cylinders had, on average, deeper and wider shells, a higher meat condition and fewer shell surface deformities than oysters in other grow-out method combinations. However, these oysters were smaller than oysters not grown in cylinders. While there were some differences in growth patterns between the estuaries, overall it was the grow-out methods that most influenced oyster characteristics. This was attributed to differences in the amount and magnitude of movement oysters experienced in the grow-out methods, as recorded by motion sensors. This study demonstrates how grow-out methods can be managed to achieve desired growth trajectories, and therefore improve marketability among selective bred *S. glomerata.*

Introduction

Over the past few decades, the oyster industry worldwide has experienced setbacks due to disease (Nell 2007; Buestel, Ropert, Prou & Goulletquer 2009), while domestication and husbandry techniques have aimed to improve oyster growth, shape and meat condition (Brake, Evans & Langdon 2003; Buestel *et al.* 2009; Kube, Cunningham, Dominik, Parkinson, Finn, Henshall, Bennett & Hamilton 2011). In some areas, selective breeding and innovative management techniques, or grow-out methods, have opened opportunities for improving oyster yields, quality and survival (Holliday, Maguire & Nell 1988; Robert, Trut, Borel & Maurer 1993; Nell 2003; Kube *et al.* 2011).

The Sydney rock oyster (*Saccostrea glomerata)* selective breeding program in NSW, Australia, initiated by the NSW Department of Primary Industries Fisheries in 1990 (O'Connor & Dove 2009), and currently managed by the Select Oyster Company (SOCo), has experienced significant success with selectively-bred oysters having heightened disease resistance and faster growth (Dove, Nell, Mcorrie & O'Connor 2013a; Dove, Nell & O'Connor 2013b). Currently, over 20% of NSW farmers use the selectively-bred *S. glomerata* (SOCo pers comm.) with demand still growing (SOCo Industry Survey 2016). Farmers across several NSW estuaries have reported this success with faster growth rates and disease resistance but, at times, excessively variable morphologies and lower percentage meat weight in selected oysters compared with non-selected oysters when using their usual farming methods (Dove & O'Connor 2012; Hall-Aspland, Rubio, Keating & Woodford 2015). Similar differences between selected and non-selected oysters have been observed in *C. gigas,* with those selectively bred for fast growth growing longer and narrower than non-selected oysters (Kube *et al.* 2011).

Since all edible oysters and many other aquaculture species are subject to morphological change when exposed to different environmental conditions (Galtsoff 1966; Pakkasmaa & Piironen 2000; Pigliucci 2001 2001; Bayne 2004), grow-out methods may impact oyster morphology (Sheridan, Smith & Nell 1996; Bayne 2000). Two environmental conditions that are known to significantly influence shell shape in edible oysters are rumbling (i.e. movement causing shell chipping) (Brake *et al.* 2003; Kube *et al.* 2011) and differing levels of emersion (Griffiths & Buffenstein 1981; van Erkom Schurink & Griffiths 1993). Oysters that experience rumbling tend to produce thicker shells with a shape that is deeper, wider, less elongated and with higher meat volumes than oysters not exposed to rumbling (Holliday 1991; Robert *et al.* 1993; O'Meley 1995; Brake *et al.* 2003). There is limited research on the effects of differing amounts of emersion on oyster growth and morphology but some studies noted that increased emersion times reduce oyster growth and promotes a deeper shell (Spencer, Key, Millican & Thomas 1978; Maguire & Kent 1991). Mussels, which respond similarly to oysters when exposed to rumbling and shell chipping (van Erkom Schurink & Griffiths 1993; Akester & Martel 2000; Steffani & Branch 2003), tend to grow deeper shells (Ansari, Harkantra & Parulekar 1978) with a greater meat volume (Ansari *et al.* 1978; Franz 1993) when constantly immersed.

Since the environmental conditions of rumbling and emersion can be controlled with different grow-out methods (Holliday *et al.* 1988; Robert *et al.* 1993), these could be used to influence the morphology of edible oysters. Using selectively-bred *S. glomerata,* this study aimed to identify the effects of different grow-out methods on shell shape, size, meat condition as described by percentage meat weight, and presence of surface shell deformities.

Materials and Methods

Oysters and locations

Approximately 250,000 selectively-bred *S. glomerata* spat aged four months (mean shell height 16.07mm ± 0.27mm) were purchased in equal proportions from Camden Haven Oyster Supply Hatchery, Laurieton, NSW and Southern Cross Shellfish Hatchery, Port Stephens, NSW. These oysters were from broodstock of the 'B2 line' selected for fast growth and Queensland unknown (QX) and Winter Mortality (WM) disease resistance for five generations. Before deployment, all spat from both of the hatcheries were mixed together to ensure that the distribution of spat among the grow-out methods and estuaries were independent of their source hatchery and nursery. Spat were deployed at two sites within each of the Hawkesbury River (33.53° S, 151.20° E) and Georges River (34.02° S, 151.14° E) estuaries, NSW, Australia.

Grow-out methods

To test the impacts of different grow-out methods on oyster shell shape, size, meat condition and shell deformities, oysters were deployed in three grow-out methods currently used by NSW oyster farmers: fixed trays ('trays'), Stanway cylinders ('cylinders') and floating baskets ('baskets') (Figure 1). Each of these methods started at 6mm mesh. Given that oyster farmers commonly transfer oysters between grow-out methods at different stages in their growth, this study was divided into two phases to determine how changing the grow-out method affects oyster growth. For the first six months (Phase 1) the oysters were grown in each of the three grow-out methods. For the final three months (Phase 2) a third of the oysters continued in their original grow-out method and the remaining two thirds were transferred to the other two grow-out methods. Each of these combinations exposed the oysters to different environmental conditions through their growth (Table 1).

Phase 1 started in June 2015 with five replicates of each of the three grow-out methods deployed at each of the four sites. Stocking density was set at 2L of spat in each cylinder (cylinder 270mm diameter, 740mm length), 2L in each basket (basket 400mm length, 500mm width) and 0.5L in each of four sections in a tray, covering 50% of each section (tray section 450mm width, 455mm length) (Figure 1a-c). These stocking densities, based on advice from oyster farmers and previous research (Holliday, Allan & Nell 1993; Dove *et al.* 2013a), reduce variability in oyster size and shape, and ensure fastest growth rates.

Phase 2 started in November 2015 with five replicates of each combination maintained throughout the study at each site. However, cylinders and baskets were replaced by SEAPA baskets since cylinders and baskets with 12 mm mesh were not available. In replacing the floating basket method, floats were attached to the top ridge of the SEAPA baskets (Figure 1d), which were attached to the same floating longline as used for the baskets. This maintained similar levels of emersion and rumbling as in the floating baskets. To maintain the emersion and rumbling effects of the cylinder method, floats were attached to the bottom ridge of the SEAPA baskets (Figure 1e), which were suspended from the same fixed longline as the cylinders. Attaching a float to the bottom enabled the SEAPA baskets to swing up to 180 degrees with tide and wave movements. Motion sensors, discussed below, were used to determine whether the SEAPA baskets exposed the oysters to similar amounts of movement as the original cylinders and baskets. For consistency in terminology, the three grow-out methods are referred to as 'trays', 'cylinders' and 'baskets' for Phase 1 and 2 herein. Stocking density was 2L in each of the SEAPAs as recommended by the oyster farmers.

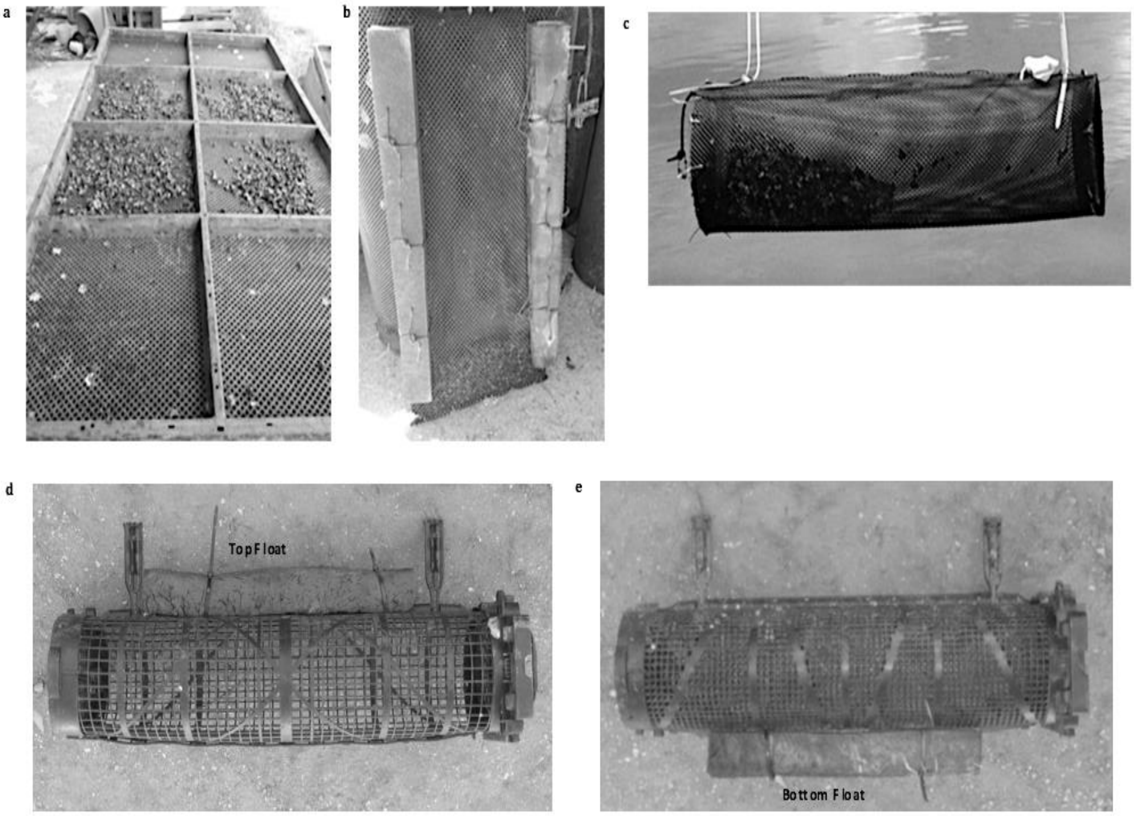

Figure 1: The three oyster grow-out methods used in Phase 1 (a-c) and a SEAPA basket with top float replacing baskets (d) and bottom float replacing cylinders (e) used during Phase 2. Also shown is the density of oysters at deployment for trays, 0.5L (50% coverage) of oysters in each of the four sections used (a). Approximately 2L of oysters were stocked in baskets (b) and cylinders(c).

Table 1: The amount of rumbling and emersion oysters were exposed to in each of the nine combinations of grow-out methods tested in Phase 2 of this study.

	To (in Phase 2)		
From (in Phase 1)	**Cylinder**	**Basket**	**Tray**
Cylinder	High rumbling and emersion in both phases.	Decreased rumbling, emersion in Phase 1 only.	Decreased rumbling, emersion in both phases.
Basket	Increased rumbling, emersion in Phase 2 only.	Minimal rumbling and emersion in both phases.	Decreased rumbling, emersion in Phase 2 only.
Tray	Increased rumbling, emersion in both phases.	Increased rumbling, emersion in Phase 1 only.	Minimal rumbling, emersion in both phases.

Oyster management

Stocking densities of the oysters were adjusted every two months to maintain a volume of oysters similar to those at deployment and comparable to commercial farming densities. This prevented overcrowding and allowed optimum growth while minimising size and shape variability among oysters (Holliday, Maguire & Nell 1991; Honkoop & Bayne 2002). To remove slower growing individuals, all oysters were graded in October 2015, four months after first deployment, on a 12mm mesh wet grader with oysters retained on the mesh remaining in the experiment. After grading, the mesh size of all grow-out methods was increased to 12mm. This is a common practice in oyster farming as the larger mesh reduces the amount of biofouling, and increases water flow and light penetration. As the 12mm mesh trays had six larger sections (600mm x 465mm) compared to the eight smaller sections in the original 6mm trays, the volume of oysters was increased to 1.5L in each tray section, keeping densities at 50% coverage. Each density adjustment and grading event involved mixing and redistributing the oysters among replicates of the same grow-out method. The oysters at each site were kept separate.

Sampling morphometric measures and shell deformities

On five sampling events (starting at deployment) 20 oysters were randomly sampled from three of the five replicates of each grow-out method. This provided a pooled sample of 60 oysters from each grow-out method, site, estuary and sampling event. Samples were stored at minus 20^0C before morphometric measurements were recorded. Measurements of maximum shell height, width and depth (mm) (Figure 2), and total whole weight and wet meat weight (g), were taken for each oyster**.** Meat condition was calculated as the percentage wet meat weight to whole oyster weight. This was done as opposed to drying the meat and using condition indices' due to time constraints and man hours. Oysters were weighed while frozen to prevent the loss of pallial fluid prior to weighing

Shell shape was determined using shell height, width and depth to calculate a value using the Shape Score equation developed by S. McOrrie, NSW DPI (personal communication):

$$Shape\ Score = \frac{(Height/Width)}{(Depth/Length)}$$

The smaller the shape score, the deeper and wider the oyster, while a larger shape score is indicative of a narrower and flatter oyster. A score of 4.5 is considered the best in terms of marketability, having as close to as possible a 3:2:1 height:width:depth ratio that has been used as a benchmark for judging favourable shell shape in oysters (Ryan 2008; Kube *et al.* 2011).

To determine differences in shell deformities between the grow-out methods, the presence of deforming shell outgrowths and curvature were visually assessed for each oyster collected in the last sampling event. Outgrowths were recorded as either present or absent, and oyster shell curvature was recorded as either upward (i.e. favourable for holding the meat) or backward (i.e. unfavourable for holding the meat) (Figure 3).

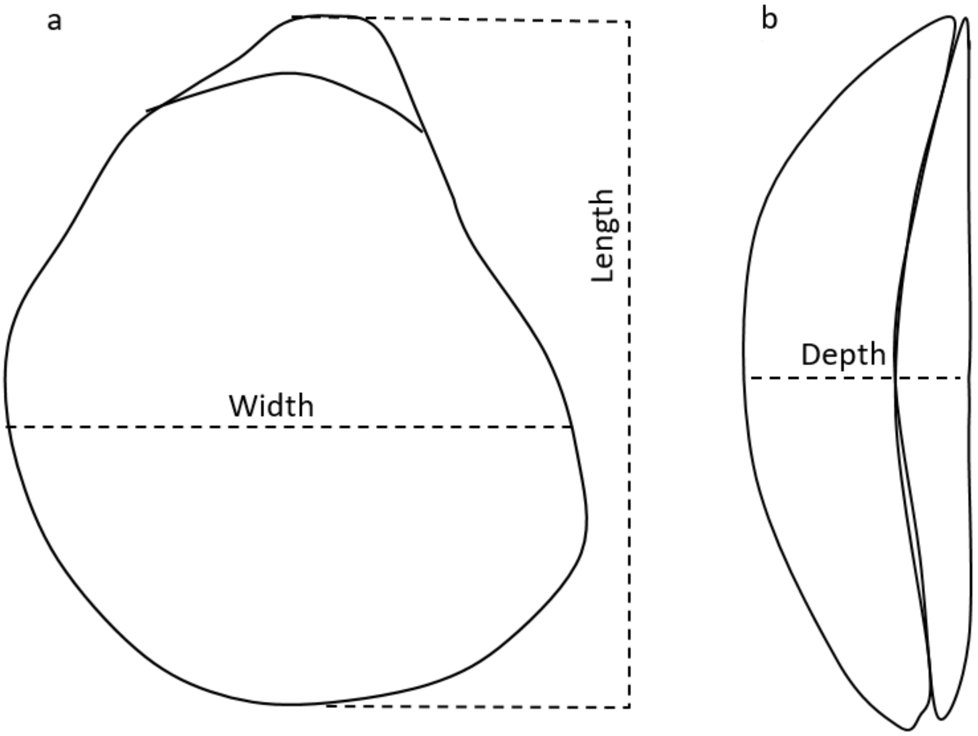

Figure 2: The axes of measurements used for oyster shell height and width (a) and depth (b)

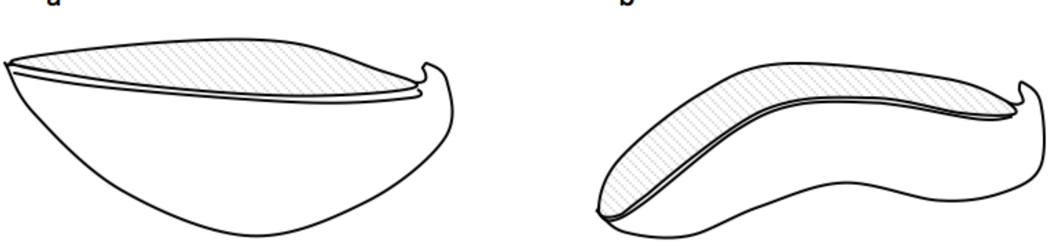

Figure 3: A comparison between an upwards oyster shell curve (a) and a backwards oyster shell curve (b)

Movement in the grow-out methods

To assess the amount of movement (i.e. rumbling) oysters experienced in each of the grow-out methods, HOBO Pendant® G Data Loggers (model UA-004-64 - size 58 x 33 x 23mm, weight 48g including a 30g lead weight) were used to log movement on the vertical, lateral and longitudinal axis every minute. Starting in July 2015 (6 weeks after deployment of Phase 1), loggers were deployed at one site in each estuary in one randomly chosen replicate from each of the three grow-out methods. Loggers were deployed for at least 202 h and up to 360 h at each site before being re-deployed in randomly chosen replicates from each grow-out method at the second site in the estuary. This retrieval/deployment system continued on a rotational basis until February 2016, resulting in each combination of site and grow-out method having loggers on five occasions in Phase 1 and twice in Phase 2.

Statistical analysis

The data for each phase was analysed separately as a single analysis cannot accommodate the change from three methods in Phase 1 to nine combinations in Phase 2. A three-way fully orthogonal analysis of variance (ANOVA) was used to compare the average shell size, shape score and meat condition of the oysters as a function of three fixed factors: grow-out method (cylinder, basket and tray), time (three occasions) and estuary (Hawkesbury and Georges Rivers). Within each estuary the sites were pooled.

The number of times the logger moved per hour and the amount of tilt (measured in degrees) was averaged across the number of hours per occasion the logger was deployed and compared among grow-out methods (cylinder, basket and tray), estuary (Hawkesbury and Georges Rivers) and site (nested within estuary) using a mixed model ANOVA.

Significant interactions or main effects were explored using a Tukey's post-hoc analysis to identify significant differences among the means. Assumptions were checked prior to analysis by visual examination of the residuals, where there was evidence of heterogeneity of variances the data were transformed.

Chi-square tests of independence were used to determine whether the frequency of shell outgrowths and unfavourable backward curvature were independent of the grow-out method for each estuary. Where chi-square tests were significant, residuals were used to determine which grow-out methods departed from expected frequencies.

Results

Shell height and shape

The height of oysters increased significantly during both phases of the experiment, with the increase in height through time differing among the three grow-out methods; but the difference among the grow-out methods depended on the estuary implicating a three way interaction between time, method, and estuary in both Phase 1 ($F_{method*time*estuary}=7.39$; df 4, 2774; $P<0.001$) and Phase 2 ($F_{method*time*estuary}=12.01$; df 8, 5039; $P<0.001$). During Phase 1, oysters grown in either trays or baskets were of similar height on the three sampling occasions and were 5 and 20% longer than oysters grown in cylinders in the Hawkesbury and Georges Rivers, respectively (Figure 4a, 5a). In the Hawkesbury River, oysters were generally of a similar height at the end of Phase 2 regardless of their grow-out method (Figure 4b-d). However, in the Georges River oysters grown in cylinders for Phase 2 were 10-15mm (18-25%) shorter than those in trays or baskets (Figure 5b-d).

Differences in shell shape changed through time and were a function of grow-out method, but with differences between the two estuaries implicating a three way interaction between time, method, and estuary in both Phase 1 ($F_{method*time*estuary}$=2.57; df 4, 2774; P=0.036) and Phase 2 ($F_{method*time*estuary}$ =4.95; df 8, 5039; P<0.001). By the end of Phase 1, oysters grown in the Hawkesbury River showed no significant difference in the mean shape score among the grow-out methods with the average shape scores between 5 and 5.5 (Figure 6a). In contrast, oysters grown in the Georges River had shape scores closer to 4.5 than those in the Hawkesbury, with oysters in the trays having a lower shape score than those in baskets and, though lower than cylinders, not statistically so (Figure 5a). During Phase 2 there was a similar pattern across both estuaries; oysters that spent Phase 2 in cylinders had an average shape score that was lower and closer to 4.5 (i.e. better shape) than the other grow-out methods, regardless of which grow-out method they were in during Phase 1 (Figure 6b-d, 5b-d).

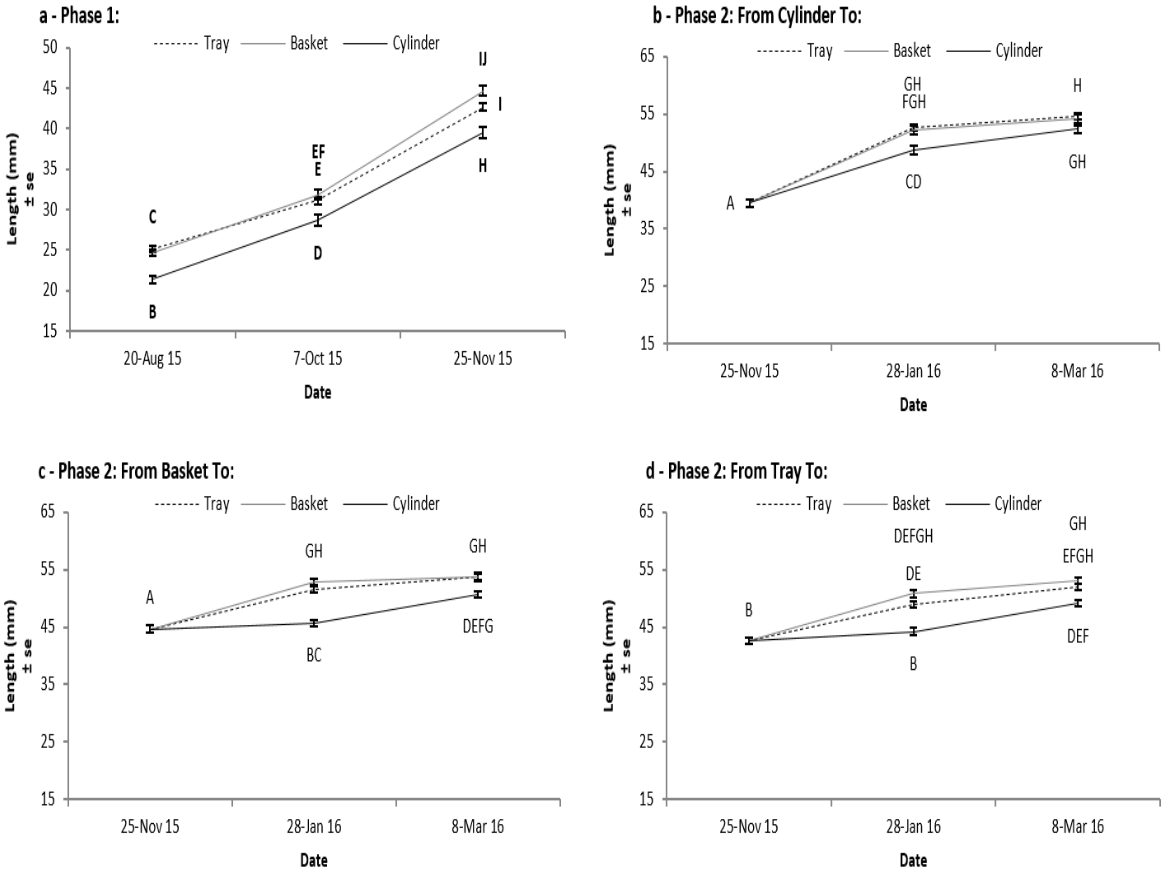

Figure 4: Mean oyster shell height for each of the grow-out methods (±se) in the Hawkesbury River throughout Phase 1 (a) and Phase 2 (b-d). For each phase, means sharing a letter are not significantly different (p>0.05).

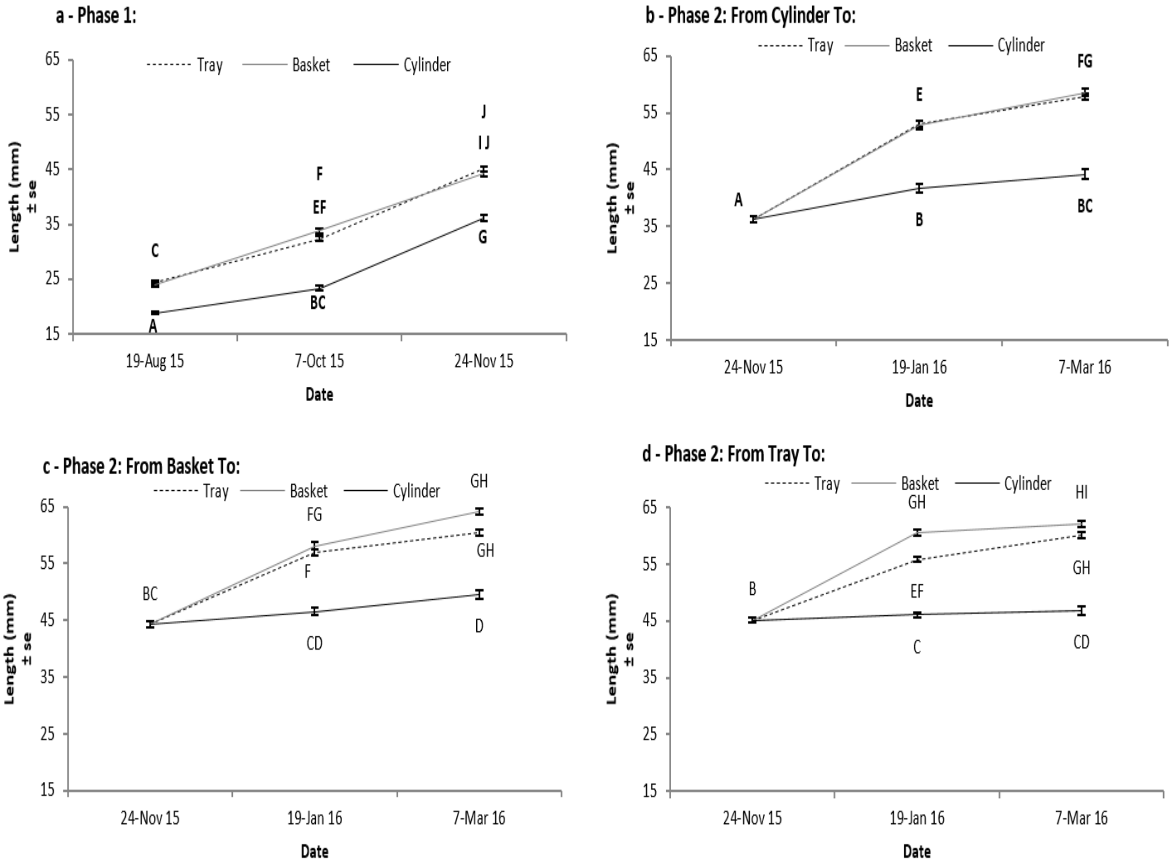

Figure 5: Mean oyster shell height for each of the grow-out methods (±se) in the Georges River throughout Phase 1 (a) and Phase 2 (b-d). For each phase, means sharing a letter are not significantly different (p>0.05).

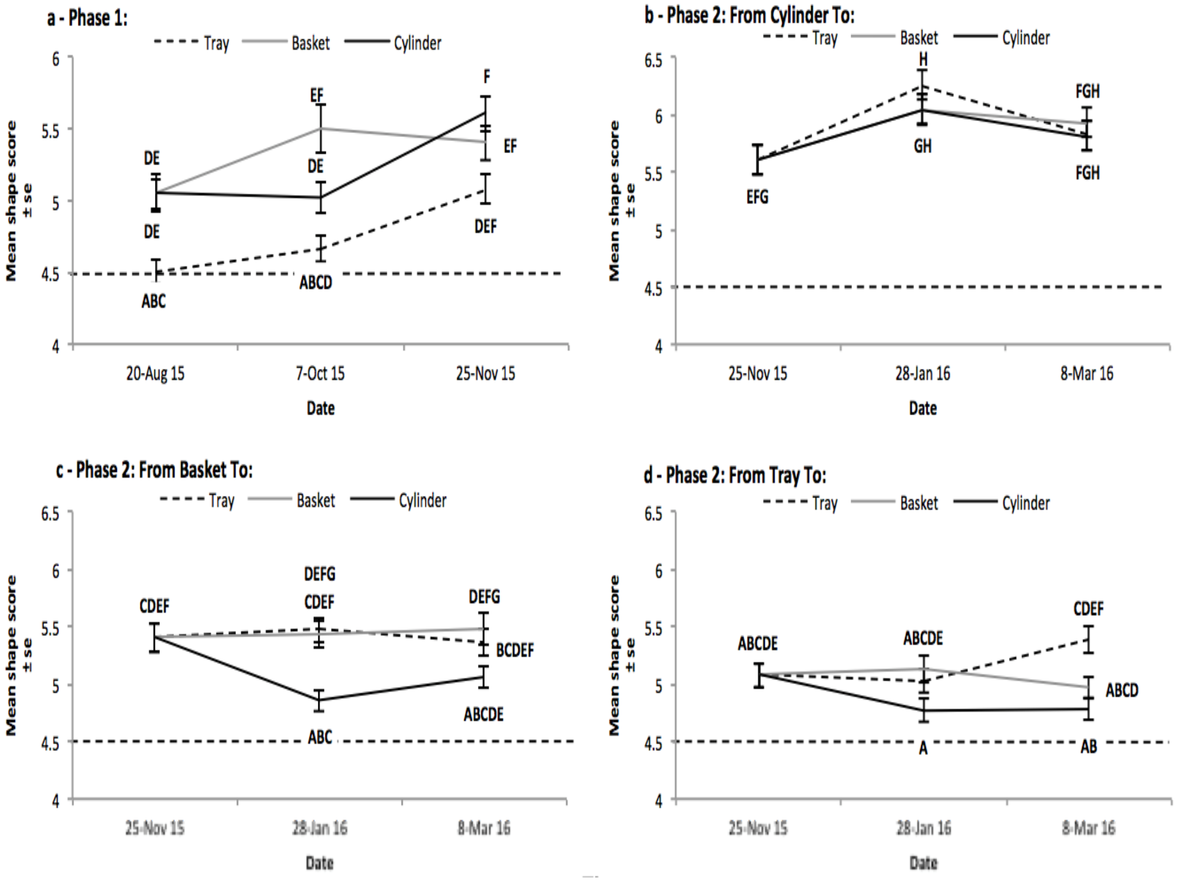

Figure 6: Mean oyster shape score as represented by the height, width and depth ratio for each of the grow-out methods (±se) in the Hawkesbury River throughout Phase 1 (a) and Phase 2 (b-d). A dashed line shows the ideal shell shape score of 4.5. For each phase, means sharing a letter are not significantly different (p>0.05).

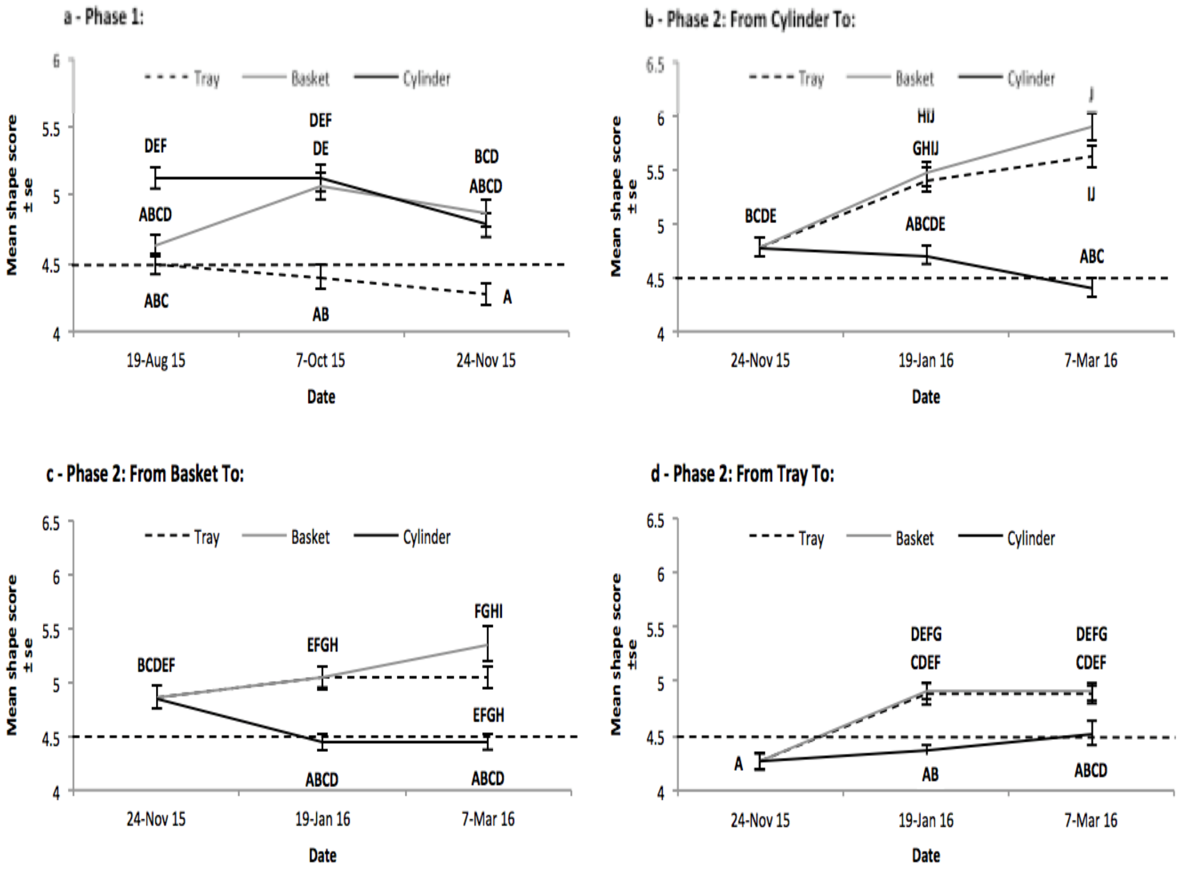

Figure 7: Mean oyster Shape Score as represented by the height, width and depth ratio for each of the grow-out methods (±se) in the Georges River throughout Phase 1 (a) and Phase 2 (b-d). A dashed line shows the ideal shell shape score of 4.5. For each phase, means sharing a letter are not significantly different (p>0.05).

Meat condition

Differences in meat condition, as described by mean percentage meat weight, among the three grow-out methods were dependent on the estuary and time since deployment implicating a three way interaction between time, method, and estuary for Phase 1 ($F_{method*time*estuary}$=32.88; df 2, 2774; P<0.001) and Phase 2 ($F_{method*time*estuary}$=12.86; df 8, 5039; P<0.001). By the end of Phase 1 in the Hawkesbury River, meat condition of oysters grown in cylinders was approximately 3% greater than oysters grown in baskets and trays (Figure 8a). In contrast, oysters grown in cylinders in the Georges River had meat conditions that were 3-4% lower than those grown in the other methods (Figure 9a). By the end of Phase 2 in both estuaries, oysters with the greatest mean condition were those grown in cylinders for both phases (Figure 8b-d, 9b-d).

Shell deformities

Among the three grow-out methods there were significant differences in the proportion of oysters displaying deforming shell outgrowths in both the Hawkesbury River (χ^2 = 392.40; df 16; $p < 0.001$) and the Georges River (χ^2 = 302.27; df 16; $p < 0.001$). Deforming shell outgrowths were most common in oysters grown in trays during Phase 1, regardless of the grow-out method they were in during Phase 2, and those oysters that were in baskets for Phase 1 and were then transferred to trays for Phase 2 (Figure 10a). No deforming shell outgrowths were found in oysters that remained in either baskets or cylinders for both phases.

Similarly there were significant differences in the proportion of oysters displaying unfavourable backwards shell curvature among grow-out methods in both the Hawkesbury River (χ2 = 100.47; df 16; $p < 0.001$) and the Georges River (χ2 = 81.51; df 16; $p < 0.001$). The greatest percentage of oysters in the Hawkesbury River with backwards shell curvature (>20%) were those that remained in baskets or trays in both phases, and oysters transferred from trays in Phase 1 to baskets in Phase 2 (Figure 10b). In the Georges River, oysters starting Phase 1 in cylinders and transferred to trays in Phase 2 had the highest frequency of backwards shell curvature.

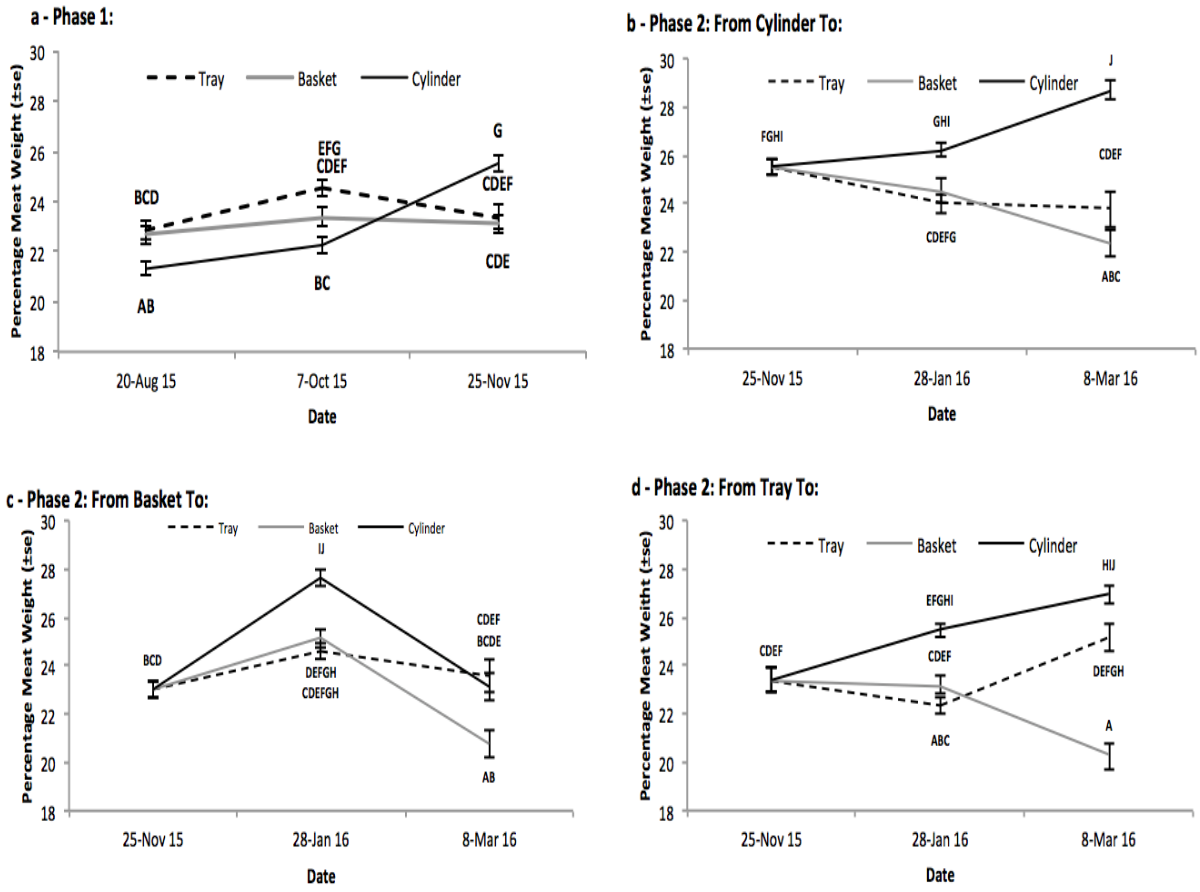

Figure 8: Mean meat condition of oysters as represented by percentage meat weight for each of the grow-out methods (±se) in the Hawkesbury River throughout Phase 1 (a) and Phase 2 (b-d). For each phase, means sharing a letter are not significantly different (p>0.05).

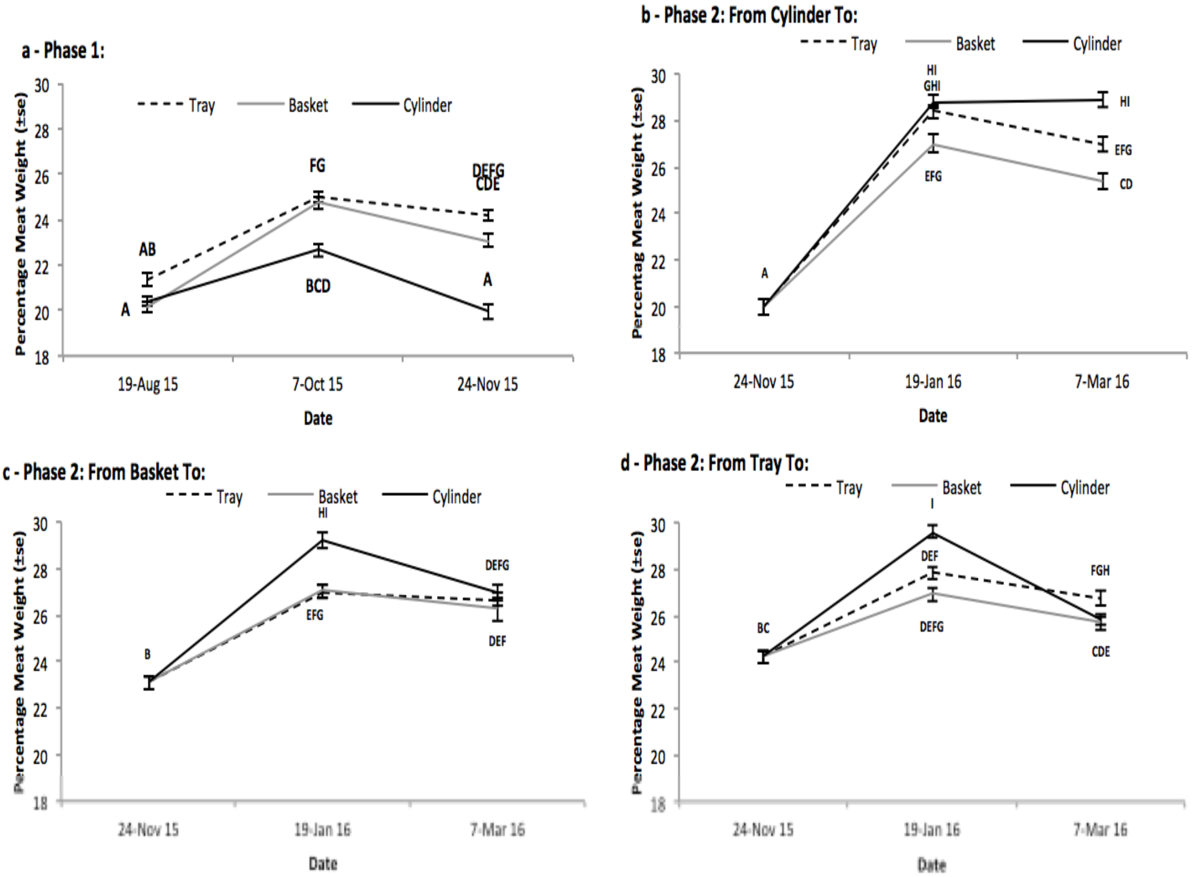

Figure 9: Mean meat condition of oysters as represented by percentage meat weight for each of the grow-out methods (±se) in the Georges River throughout Phase 1 (a) and Phase 2 (b-d). For each phase, means sharing a letter are not significantly different (p>0.05).

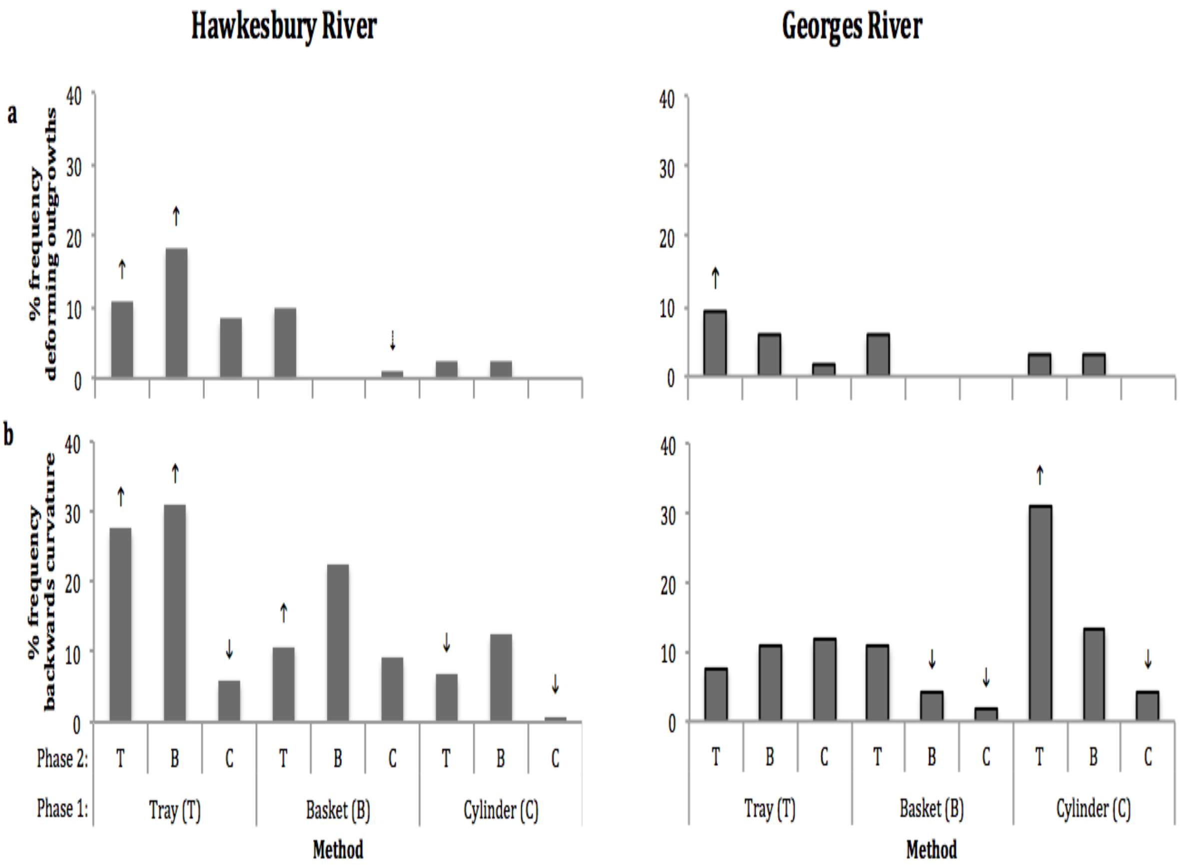

Figure 10: The frequency of oysters with deforming shell surface (a) and backwards shell curvature (b) in the Hawkesbury River and Georges River for each of the grow-out methods. n=120 oysters for each grow-out method. Methods with more outgrowths or backwards curvature than expected are indicated by ↑, while methods with fewer outgrowths or backwards curvature than expected are indicated by ↓.

Movement of data loggers

The mean number of times each data logger moved per hour differed among the three grow-out methods (F_{method}= 75.44; df 2, 858359; P=0.013) but not between estuaries ($F_{estuary}$=11.22; df 1, 858359; P=0.185) or sites ($F_{site(estuary)}$=0.66; df 1, 858359; P=0.501). There was movement in all the grow-out methods, but trays had the least with as much as 34% fewer movement events than baskets or cylinders (Figure 11a). The number of movement events did not differ between cylinders and baskets (Figure 11a)

The magnitude of logger movement, measured as the mean size of tilt changes, also differed among the grow-out methods (F_{method}=76.94; df 2, 858359; P=0.013), but not between estuaries ($F_{estuary}$=1.17; df 1, 858359; P=0.475) or sites ($F_{site(estuary)}$=1.87; df 1, 858359; P=0.305). The greatest mean size of tilt changes was in the cylinders at 10 times greater than that in trays (Figure 11b). There was no evidence of a difference between trays and baskets in the average amount of tilt (Figure 11b).

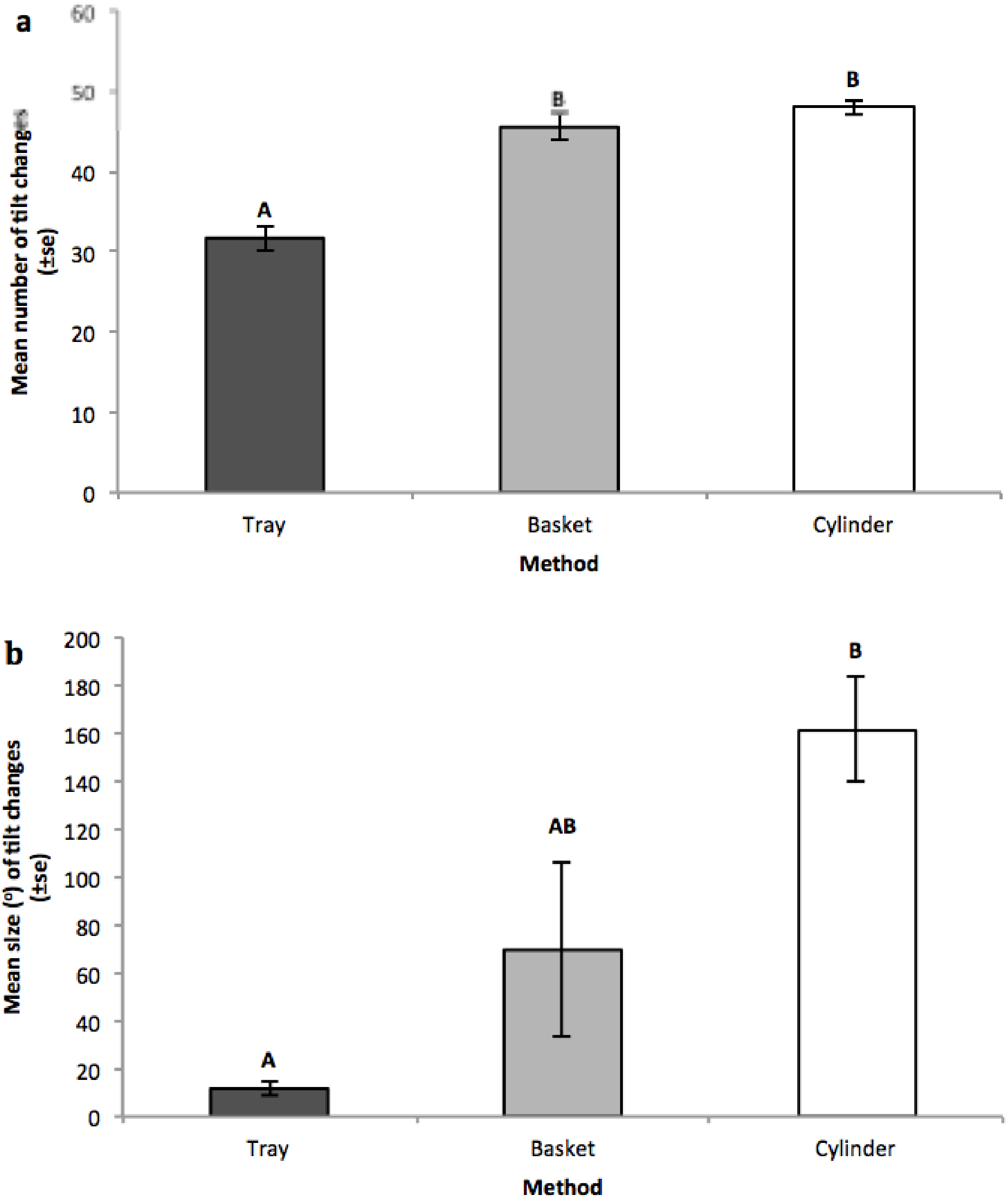

Figure 11: Mean number (a) and size (b) of tilt changes per hour in the tray (dark grey), basket (light grey) and cylinder (white) grow-out methods. Tilt was measured every minute for 14-15 day periods between July 2015 and February 2016. Means with the same letter are not significantly different.

Discussion

Our findings indicate a significant interacting impact of grow-out method and environment on edible oyster growth patterns. When grown in the same way, *S. glomerata* growth patterns were different between estuaries, suggesting environmental conditions influenced oyster morphometric qualities. Irrespective of the influence of environment, this study suggests that different grow-out methods and combinations of methods over time can be used to manage oyster morphometrics with regard to shell shape, size, meat condition and deforming outgrowths.

Each of the grow-out methods used had a significant influence on oyster morphology. Oysters had the deepest and widest shells, and fewer shell deformities, when they were grown in cylinders for Phase 2. This is likely due to the greater movement and associated shell chipping that occurs in the cylinders (O'Meley 1995; Brake *et al.* 2003) as evidenced by the motion sensor data. Others have also found similar effects on oysters and mussels in high-energy environments (Holliday *et al.* 1991; Robert *et al.* 1993; Akester & Martel 2000). This supports the concept that shell chipping is an important factor in promoting a deep, smooth, upwards curving oyster shell (e.g. Brake *et al.* 2003; Kube *et al.* 2011). Although there have been many studies on various bivalves (e.g. Akester & Martel 2000; Steffani & Branch 2003), the process by which shell chipping influences shell morphology is still poorly understood.

Rumbling and associated shell chipping may also influence the meat condition of oysters (O'Meley 1995). While not consistent across both estuaries, this hypothesis was supported in the Hawkesbury River where oysters grown in cylinders for Phase 2 generally had a greater percentage meat weight than those exposed to less rumbling. Increased meat condition may have been in part due to the decreased shell growth in cylinders (see below), and increased carbohydrate content of meat implicated with oyster rumbling (Robert *et al.* 1993).

While it was found at the end of this study that oysters grown in cylinders had lower shape scores, fewer shell deformities, and high meat condition when compared with oysters grown in other methods, it came at the cost of oyster size. Stunted growth in cylinders has also been reported by Holliday *et al.* (1993) in unselected *S. glomerata* and by Robert *et al.* (1993) in *C. gigas*. However, it was found that growth rates of oysters increased when transferred from cylinders to trays or baskets during this study and that these oysters retained fewer shell surface deformities than oysters in other methods. But, early growth in cylinders did not guard against the oysters developing a poor shell shape or meat condition when transferred to trays or baskets, which may be attributed to the malleability of juvenile oyster shells. Accelerated growth in oysters removed from the cylinders may also have contributed as has been found by Seed (1968) where faster growing mussels *(Mytilus edulis)* developed flatter shell shapes than those that grew slower. Therefore, in the event that farmers need to increase the growth rate of oysters in cylinders, they may need to compromise shape and meat condition for size by transferring oysters into trays or baskets to encourage faster growth.

This study has demonstrated that use of different grow-out methods can be used to influence, and thus improve, the quality of cultured oysters. In the case of the Hawkesbury and Georges Rivers, oysters grown in cylinders or transferred from trays to cylinders resulted in lower shape scores, fewer deformities and more favourable meat condition when compared with oysters in other grow-out methods. However, a difference in the measured oyster parameters between estuaries suggests that environmental factors also have a significant influence. Thus, it would be advisable for oyster farmers to take into account conditions in their own estuaries to better inform the best husbandry practices. As the compounded effects of environmental factors and grow-out methods on oyster morphology are still poorly understood, further research identifying the combined effects of environment with grow-out methods on the various types of edible oysters is needed.

Conclusion

The purpose of this study was to determine the impact of grow-out methods on oyster morphology and meat condition using the selectively-bred *S. glomerata* as a case study. Despite some differences between estuaries, many trends were consistent. Oysters grown in trays were the largest with the most deforming outgrowths, and oysters grown in cylinders had the best shell shape, best meat condition, and the fewest deformities, but were the smallest in one of the estuaries. Oysters that started growth in trays and were then transferred to cylinders performed well with favourable shell size, shape and meat condition, with few deforming outgrowths. Thus, this study found that grow-out methods could be used as a means to control oyster morphology and grow a more marketable selectively-bred *S. glomerata*. This study also found that, despite differences between estuaries, transferring oysters between grow-out methods can be used to positively impact their morphology and marketability, with oysters transferred from trays to cylinders performing best overall.

Acknowledgments

The authors thank Bruce Alford of Broken Bay Oysters, Keith Duggan and Robert Hill of Endeavour Oysters, and Matthew Burgoyne from XL Oysters. Stephen McOrrie NSW DPI Fisheries provided advice regarding the shell shape score and Katie Palmer provided assistance with oyster processing. Thanks also to Paul Winchcombe of Avondale College of Higher Education for providing lab space. Funding was provided by Australian Government Department of Agriculture 2015 Science and Innovation Awards for Young People in Agriculture, Fisheries and Forestry.

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