Comparative Growth Rates of 4 Strains of the American Oyster Using Two Grow-out Methods

Abstract

4 strains of the American oyster were grown using two grow-out methods; rack and bag as is done in France, and bottom trays stacked on PVC racks. Growth was measured over a 10-month period and the suitability of each grow-out method was qualitatively evaluated for suitability for use in oyster aquaculture in the Chesapeake Bay. There appeared to be little difference in growth rate between strains, however growth appeared more rapid using the rack and bag method for all strains. In addition, the rack and tray method was slightly more expensive far more labor intensive and difficult to manage than the rack and bag method.

Introduction

Intensive oyster aquaculture has great potential in the Chesapeake Bay and could offer commercial watermen another option for income production, as Chesapeake Bay fisheries become less sustainable. Currently there are only several intensive commercial oyster aquaculture operations in the Chesapeake Bay, and those operations are only done on a small scale. The Chesapeake Bay is nearly 30 years behind French oyster aquaculture. France produces approximately 150,000 metric tons (over 4 million bushels) of oysters per year using intensive oyster aquaculture (Allen et al, 2000).

The main deterrent to successful oyster aquaculture in the Bay is oyster disease. MSX and DERMO have ravaged the Bay's wild oyster population, and cultured oysters are subject to the threat of disease as well. Several strains of the native oyster have been developed at the Virginia Institute of Marine Science and Rutgers University to be more disease tolerant. The CrosBreed strain was originally developed to be more tolerant of MSX while the DEBY strain was developed to be more tolerant of DERMO. In addition, commercial hatcheries have collected large healthy oysters in excess of 6 inches, which were presumed to be disease tolerant, and bred them through multiple generations in attempt to develop a disease resistant oyster. To date there are no published accounts of growth rate comparisons between the various strains of oysters in a commercial setting.

Early attempts at intensive oyster aquaculture have depended on Taylor Floats; a wire basket attached to an enclosed PVC donut for floatation. Drawbacks to this grow-out method include aesthetics and conflicts with adjacent waterfront property owners, and difficulty in handling without some means for lifting the float from the water for oyster maintenance. The French have used a rack and bag method for many years. Commercially available oyster growing bags (ADPI bags) are laid across a rack with legs, and constructed of steel reinforcing rod. The rack sits on the bottom with the bags being approximately 12 inches off-bottom. Ideally the racks are placed such that the bags ebb out at low tide. This controls some of the fouling on the bags and oysters.

Another method that may have some potential in the Bay is tray culture. The Aquatray is a commercially available product produced in Australia, and distributed by Coastal Aquaculture Supply in Rhode Island. The trays can be stacked or can be connected side by side.

Methods

The study was conducted in Sarah Creek, a tributary of the York River, VA. Salinity is typically 18-22 parts per thousand. The tide range is approximately 2.5 feet and water temperature is in the low 80s F during summer and upper 30s-low 40s F during winter.

Racks for the rack and bag grow-out method were constructed of 1-inch PVC pipe (Figure 1). PVC pipe was used instead of steel reinforcing rod (rebar) because of the reduced cost of construction and PVC pipe will not degrade like steel exposed to saltwater. 3 sizes of ADPI bags were used: 2 mm spat bags, 3/16, and 3/8 sealed oyster bags. All bags were purchased from Eastfields Farms in Mathews County, VA. 4-6 mm oyster seed were purchased from Middle Peninsula Aquaculture in September 2000. The 4 test strains were Lynnhaven (Lynn), DEBY, Crosbreed (XB), and Mobjack Bay (MOB). Each strain of oyster was grown in quadruplicate with approximately 2,000 seed oysters per bag. Each month for the first 3 months, seed volume per bag was used as an indicator of growth. This measure of growth was used until the seed were large enough to effectively measure with calipers. Each month thereafter, 50 seed per bag were randomly selected and measured to the nearest mm using calipers. Bags were shaken weekly to redistribute the seed and remove excess fecal material. As the seed oysters grew, they were transferred to larger mesh bags up to 3/8 inches, and thinned or split to decrease the density per bag. The end point of the research was set as the time when at least 25% of the oysters measured reached market size, or 3 inches. From a commercial standpoint, 25% of the oysters from one growing bag or tray is a worthwhile number to harvest and sell.

For the rack and tray grow-out method, Aquatrays 3 feet square and 4 inches tall were purchased from Coastal Aquaculture Supply Corp., Inc. in Rhode Island. A rack was developed and constructed of 1 inch PVC, to hold 4 Aquatrays stacked one on top the other, with each tray acting as the lid for the one below (Figure 2). The top tray had a prefabricated lid with a 1-inch mesh size opening. Initially, each tray was stocked with one 2 mm spat bag containing 2,000 seed oysters. There were only enough seed for 3 trays for the Lynnhaven strain. For the Crosbreed and Mobjack strains, the top tray only had approximately 400 and 800 seed oysters, respectively. Maintenance and grow-out methods were identical to the rack and bag method until the oysters out-grew the 3/8 inch mesh bag and were then split to 1,000 oysters per tray and dumped loose.

The rack and bags were placed at a water depth where the oysters would be exposed at most low tides. The rack and trays were placed such that the trays were always covered.

Because there were not enough seed oysters for 4 replicates in all four strains for the rack and tray method, growth data were only collected on trays 2-4. To be consistent, only 3 bags in the rack and bag method were used for growth measurements. Towards the end of the project it became apparent that there was a difference in growth rate between trays, so on the last month of measurement, 50 oysters were randomly chosen for measurement from the top tray, except for the Lynnhaven oysters for which there was no top tray.

Results

Oyster Growth Rates

Data collection was terminated September 2, 2001, when replicates from the rack and bag grow-out method had 25% market sized oysters. Oysters in the rack and tray method lagged behind with only one replicate from the Mobjack strain having 25% market oysters. The average size oyster for each strain and treatment is found in Table 1. The Crosbreed strain grown in the rack and bag method performed the best, achieving an average size of 71.81 mm. Lynnhaven oysters were the low performers in both grow-out methods only reaching 63.29 and 60.21 mm for the rack and bag and rack and tray methods respectively.

There appeared to be little difference between replicates in the rack and bag grow-out method, however, the replicates for the rack and tray method appeared to vary with position on the rack. The top tray generally grew fastest while the bottom tray grew slightly slower and the two middle trays grew the slowest. For this reason, the trays within each grow-out method probably shouldn't be treated as true replicates. If the bottom three trays are ignored, the growth rate for the top tray is very similar to the average growth rate for replicates for each strain.

Excluding the Lynnhaven oysters, size is not appreciably different among strains (Tables 1 and 2). There does appear to be a slight difference between the 2 grow-out methods with the rack and bag method performing slightly better. Averaging the final size for all strains, the rack and bag oysters were 68.42 mm while the rack and tray oysters were only 65.23 mm after 10 months (Table 1).

Comparison of Grow-out Method

Bags on racks would foul on the bottom side and could be turned to allow the sun to kill the growth. Since the trays were constantly covered, fouling was severe after only several months and required frequent pressure washing. The predominant fouling organism was sea squirts and all sides of the rack and tray assembly would become covered from month to month.

The cost of the rack and bag system was slightly less than the rack and tray system for growing the same quantity of oysters. Each rack will hold 6 bags containing 250 oysters to grow-out, while it is recommended that 750- 800 oysters be grown per Aquatray. Tables 3 and 4 show the approximate costs to grow 100,000 oysters using each grow-out system.

Discussion

Oyster Growth Rates

The only explanation for the faster growth rates in the rack and bag method is attributable to the lack of fouling on the bags. Several hours per day at low tide killed enough of the fouling to allow better water flow to the oysters contained in the bags. Because there was more surface area associated with the Aquatrays, fouling was far greater and more difficult to keep up with.

It appears as though either the DEBY, Crosbreed, or Mobjack strain is well suited for cultivation in the Chesapeake Bay, with market size easily attainable within a year and one half. The one difference between the 4 strains is that the Lynnhaven broodstock for this research was collected the year of the study and there was no hatchery selection for fast growth. On the other hand, the other 3 strains had been selected for fast growth in the hatchery, i.e., the broodstock was the second or third generation of the fastest growers from the year before.

The difference in growth between trays in the rack and tray method is attributable to water flow through and around the trays. The top tray seemed to perform better because there was unobstructed flow to the top of the tray while the 2 middle trays competed for water flow on both the top and bottom of the trays. Growth rate in the bottom tray would be expected to be the lowest due to the proximity to the bottom with decreased food and oxygen, however oysters in the bottom tray grew only slightly slower than the top tray but faster than the 2 middle trays. Again this is most likely attributable to unobstructed water flow to the bottom of the bottom tray. The only way to eliminate the position effect on the rack is to reduce the number of trays to 2 or to rotate the position on a regular basis; an operation that is both time consuming and labor intensive.

Comparison of Grow-out Method

There are advantages and disadvantages to both grow-out methods. One obvious advantage to the rack and tray method is the lack of dependence on working at low tide. Racks and trays can be worked at any tide, however the boat must be equipped with gear suitable to left the racks which can weigh up to 300 pounds with oysters and associated fouling. Fouling does appear to be more severe than with the rack and bag method and the cost of the system is slightly higher. The Aquatray system is probably more suited to deep-water areas where fouling is less and the trays can be suspended from large floating buoys. For the present study the only visible obstruction from an aesthetic point of view is the buoys marking the racks, but using dull colored buoys can minimize even that effect. There are potential user conflicts with the rack and tray method, especially if used in areas with significant recreational boating activity and commercial fishing activity.

The rack and bag method is a time proven method. The French have been successfully using this method for nearly 30 years and production is over 4 million bushels per year in the South of France. In the Chesapeake Bay, racks can be placed in areas with little boat traffic, but the bottom substrate must be firm enough for walking at low tide. The obvious draw back to this method is the dependence on working at low tides and the repetitive stress on the lower back when bending to conduct maintenance on the oysters. In addition, the racks are visible at low tide and may present aesthetic problems with adjacent property owners. The grow-out system is relatively inexpensive, however, PVC will not hold up as well as rebar, and rebar is slightly less expensive than PVC pipe and all the fittings. Barnacle set on PVC is greater and the barnacles don't slough off as they would on rusting metal. Dense clusters of barnacles present a hazard to bare legs during summer months, and will even tear holes in chest waders.

Conclusion

The rack and bag method for oyster cultivation appears to have more benefits than the rack and tray method, and is more suitable in areas with a firm substrate. The method is straightforward, relatively inexpensive, and has proven efficient in areas similar to the Chesapeake Bay. Market sized oysters can be obtained in as little as one year, however these results can vary at different locations.

Acknowledgments

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Literature Cited

Allen, S. K., R. D. Brumbaugh, and J. Carter Fox, 2000, A consensus report from the 2000 Chesapeake Bay delegation to review French aquaculture: Oyster recovery strategy for the Chesapeake Bay – Proactive recommendations, jointly published by the Virginia Institute of Marine Science, Gloucester Point, VA, Dominion Resources, and the Chesapeake Bay Foundation, Norfolk, VA.

Table 1. Average size of oysters by strain and grow-out method

	Strain				
	Lynnhaven	**DEBY**	**Crosbreed**	**Mobjack Bay**	**All Strains**
Grow-out Method					
Rack and Tray	60.21	67.47	65.52	67.73	65.23
Rack and Bag	63.29	68.26	71.81	70.33	68.42

Table 2. Growth of oysters by replicate, strain and grow-out method

Replicate	Lynnhaven	DEBY	Crosbreed	Mobjack Bay
		Rack and Tray		
1	-	69.51	71.46	70.58
2	57.20	66.10	64.48	70.72
3	60.1	65.76	58.40	63.44
4	63.32	68.52	67.74	66.16
		Rack and Bag		
2	63.96	69.76	71.18	70.48
3	63.90	66.52	70.12	71.06
4	62.02	68.50	74.12	69.46

Table 3.

Rack and Bag Grow-out

Price list for 67 racks to grow-out 100,000 oysters using PVC or rebar racks.

PVC racks (67 racks)

335 10' sections 1" schedule 40 PVC @ $2.40 ea.	$ 804
268 1" schedule 40 PVC elbows @ .30 ea.	$ 80
871 1" schedule 40 PVC tees @ .38 ea.	$ 331
67 1" schedule 40 PVC crosses @ $1.25 ea.	$ 84
10 qts. PVC glue @ $6.08 ea.	$ 61
4 qts. PVC primer @ 5.40 ea.	$ 22
2 coils #8 crab pot line @ $40 ea.	$ 80
50 2mm ADPI spat bags @ $2.80 ea.	$ 140
100 3/16" ADPI OBC cages @ $3.50 ea.	$ 350
200 3/8" ADPI OBC cages @ $3.50 ea.	$ 700
400 5/8" ADPI OBC cages @ $3.50 ea.	$1,400
33 ten foot sections ¾" sch. 20 PVC for spat bag closures @ .80 ea.	$ 26
1000 cable ties	$ 40
100,000 4-6 mm oyster seed @ $12.00/1000	$1,200
TOTAL	**$5,318**

Rebar racks

3350' ½" rebar @ .20/ ft.	$ 670
labor for 67 racks @ $5 ea.	$ 335
	$1,005
Total cost using rebar racks instead of PVC	**$4,941**

Table 4. **Rack and Tray Grow-out**

Price list for 50 PVC racks with 2 Polyethylene Aquatrays each to grow-out 100,000 oysters.

PVC racks built using schedule 20 PVC

1500' 1" schedule 20 PVC @ .122/ft	$ 183
600 1" schedule 40 tees @ .30 ea.	$ 180
400 1" schedule 40 elbows @ .38 ea.	$ 152
10 qts. PVC glue @ $6.08	$ 61
5 qts. PVC primer @ $5.40 ea.	$ 27
2 coils #8 crab pot line @ $40.00 ea.	$ 80
50 small buoys @ $1.40 ea.	$ 70
100 aquatrays @ $28.00 ea.	$2,800
120' sch. 40 1 ½" PVC @ .30/ft.	$ 36
50 ten foot sections 5/8"rebar @ $3.50 ea.	$ 175
50 lids @ $4.00 ea.	$ 200
50 2mm ADPI spat bags @ $2.80 ea.	$ 140
100 3/16" ADPI OBC cages @ $3.50 ea.	$ 350
100 3/8" ADPI OBC cages @ $3.50 ea.	$ 350
33 ten foot sections ¾" sch 20 PVC pipe for spat bag closures @ .80 ea.	$ 26
1000 cable ties	$ 40
100,000 oyster seed @$12.00/1000	$1,200
TOTAL	**$6,070**

Figure 1. Design For PVC Rack to Hold 6 ADPI Bags

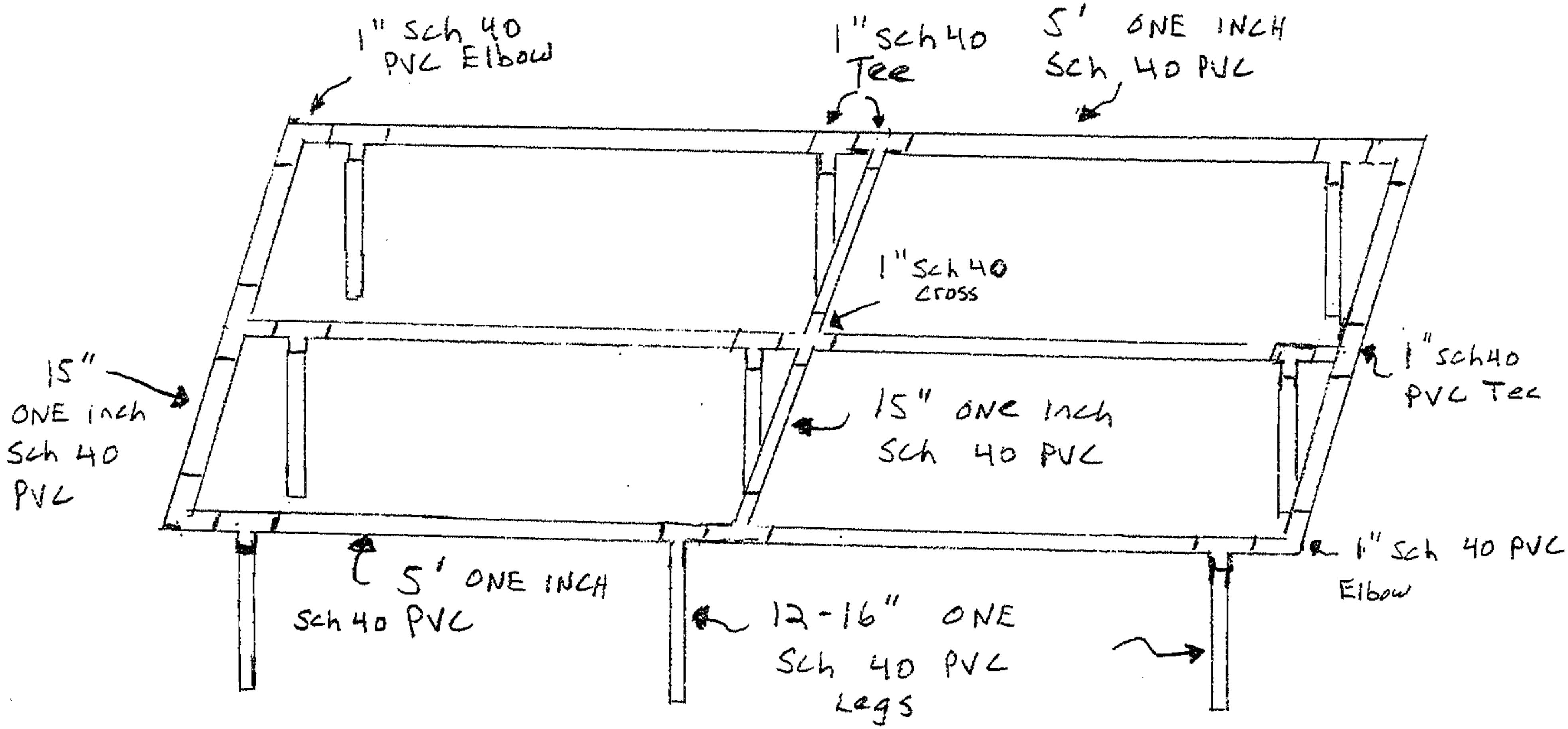

Figure 2. PVC Rack for Aquatrays