Gulf and Caribbean Research

Volume 8 | Issue 2

January 1989

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Gulf Research Reports, Vol. 8, No. 2, 173–179, 1989 Manuscript received August 31, 1988; accepted January 5, 1989

THE GROWTH OF CULTCHLESS *CRASSOSTREA VIRGINICA* SPAT AT BILOXI BAY, MISSISSIPPI USING DIFFERENT METHODS OF CULTURE

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ABSTRACT Oyster spat produced from the experimental hatchery of the Gulf Coast Research Laboratory at Point Cadet, Biloxi, Mississippi, were grown under a variety of conditions. Recovery of spat planted on adjacent bay bottom was negligible, despite the use of either whole oyster valves, crushed oyster shell or clam shell as a substrate. Negligible growth occurred for spat held in vertical and horizontal water tanks. Growth of spat in horizontal tanks was affected by the density of stocking, with lower densities producing faster growth. Growth in all studies was slower than anticipated and a comparison on growth for spat from a Maryland hatchery with locally-produced spat suggests that the low growth was related to the local waters. Overall, growth as determined by increase in greatest shell dimensions of spat is as follows: on-bottom, 2.90 mm/mo; raft culture, 1.78 mm/mo; upwelling tank, 1.19 mm/mo; and horizontal trough, 2.0 mm/mo.

Introduction

One effect of the decline in oyster production in the United States has been the development of oyster hatcheries. New techniques for handling spat developed at these hatcheries include the production of cultchless seed oysters. These cultchless seed are easier to handle and ship, but as yet, adequate field techniques have not been developed for grow-out of these seed. Few of the small spat planted on bottom in any of the various states have been recovered. Reasons suggested for this poor survival are that spat are washed away by currents, silted in or consumed by crabs. One possible solution to the problem would be to plant larger seed oysters for which adequate field experience is available, but this requires the development of a nursery system for raising cultchless spat (1–25 mm in height) to seed (26–50 mm in height). In the present study, growth of hatchery reared spat was slow in all treatments. To determine possible reasons for the slow growth, the effect of density on growth of spat held in trays was determined. Additionally, the growth of cultchless spat from another hatchery was compared with the growth of spat from our hatchery.

Materials and Methods

Unless otherwise noted, cultchless spat were produced according to the procedure of Dupuy, Windsor and Sutton (1977) at the Oyster Biology Research Facility (OBRF) hatchery located on Point Cadet in Biloxi, Mississippi. Treatments of the various spat were: (1) on bottom, planted adjacent to the hatchery; (2) raft culture, placed in trays suspended in the bay; and (3) upwelling, placed in trays in a deep tank receiving vertically upflowing bay water. In the next three treatments, the spat were all placed in troughs receiving horizontally flowing bay water to be referred to as: (4) horizontal; (5) density, varying numbers placed in Nestier trays; and (6) Maryland versus OBRF spat. The final treatment was (7) pond, a tank containing static water (Figure 1).

1. On-bottom Growth Study

During low tide on December 23, 1976, 1,600 spat were planted on bottom in 16 one-square-meter plots at a density of 100 spat per plot. The plots were prepared in Biloxi Bay on cleared bottom in a matrix of four treatments consisting of bare mud, clusters of whole oyster shells, crushed oyster shells, and clam shells. A wooden weir was constructed on the outer sides of the plots to protect them from wave action.

2. Raft Culture Growth Study

In September 1976, 100 spat were placed in each of three Nestier trays stacked vertically and suspended off a pier adjacent to the bottom plots in Biloxi Bay.

3. Upwelling Growth Study

Also in September 1976, 600 spat were distributed inside the hatchery into six trays containing 100 oysters per tray, stacked vertically into a 1.5 m^2 tank receiving pumped bay water in an updraft flow.

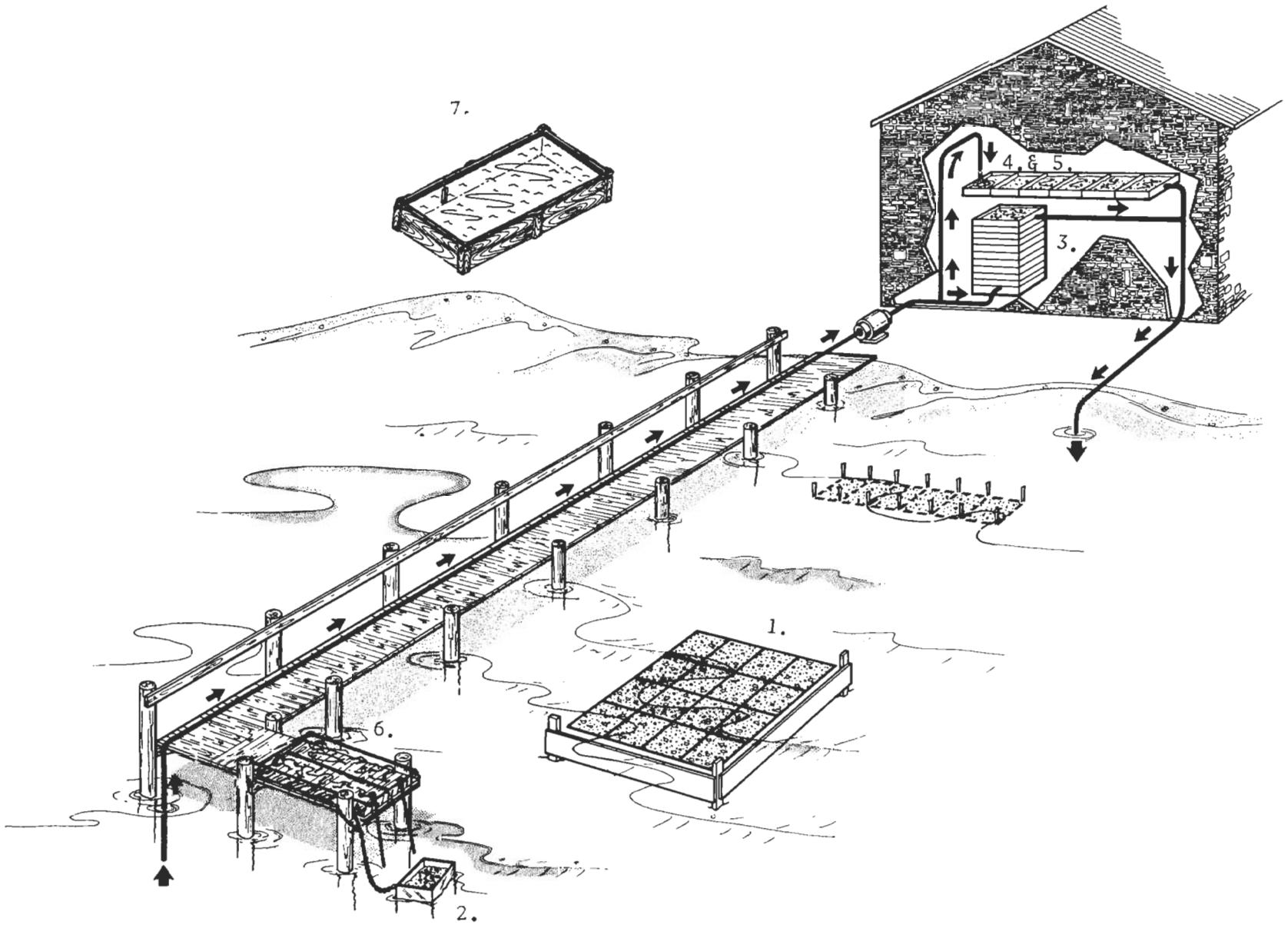

Figure 1. Diagram representing various treatments of oysters used in this study. (1) On-bottom, (2) Raft culture, (3) Upwelling, (4) Horizontal, (5) Density, (6) Maryland vs. local, and (7) Pond.

4. Horizontal Growth Study

During September 1976, an additional 600 spat were placed inside the hatchery into six trays (100 oysters per tray) distributed linearly in a 3.7 m long water trough receiving pumped bay water at one end (Figure 1). Flow rates were determined daily and the system adjusted as required to maintain a flow equal to that of the upwelling treatment above (3).

5. Density Growth Study

In February 1977, 4,200 cultchless spat were placed in a horizontal trough and distributed into six trays sequentially from one end in the following numbers per tray: 100, 400, 1,600, 100, 400, 1,600.

6. Maryland vs. OBRF Growth Study

In October 1977, a tray of 100 spat from the OBRF hatchery and a tray of 100 spat from a hatchery in Maryland (Horn Point Environmental Laboratory, P.O. Box 775, Cambridge, Maryland 21613) were placed into separate troughs receiving horizontally-flowing bay water at equal rates.

7. Pond Growth Study

In March 1979, 100 oyster spat averaging 19.6 mm were placed in a rectangular box (1.8 x 3.6 m) constructed of wood framing supporting a plastic liner and filled with approximately 8,000 liters of 15 parts per thousand (ppt) bay water. A dense bloom of phytoplankton imparted a green color to the "pond" water. The oyster spat held in a Nestier tray suspended above the pond bottom were recovered monthly for measuring during the six month study.

In all treatments, the oysters were measured monthly for the greatest shell dimension (umbo to bill) or height (Galtsoff 1964) using calipers read to the nearest mm. Data were recorded and a mean and standard deviation calculated monthly. In trays containing more than 100 oysters, 100 were arbitrarily selected to be measured. Ambient bay water temperature entering the tanks was determined to the nearest degree C with a mercury thermometer and salinity was determined with a refractometer in ppt on a daily basis.

RESULTS

In treatments one through four, the salinity of the bay water ranged from 2 ppt during March 1977 to 28 ppt during July 1977 (Figure 2). The temperature of the bay water ranged from a low of 5°C during January 1977 to a high of 31°C during July 1977 (Figure 3). In treatment five, the bay water salinity varied from 2 ppt during March 1977 to 28 ppt during July 1977 (Figure 2). Bay water temperature varied from a low of 6.5°C during February 1977 to a high of 31°C during July 1977 (Figure 3). In treatment six, the bay water salinity varied during the course of the Maryland vs. OBRF spat study from a low of 2 ppt in June 1978 to a high of 26 ppt in December 1977 and October 1978 (Figure 2). The bay water temperature varied from a low of 5°C in January and February 1978 to a high of 34°C in July 1978 (Figure 3).

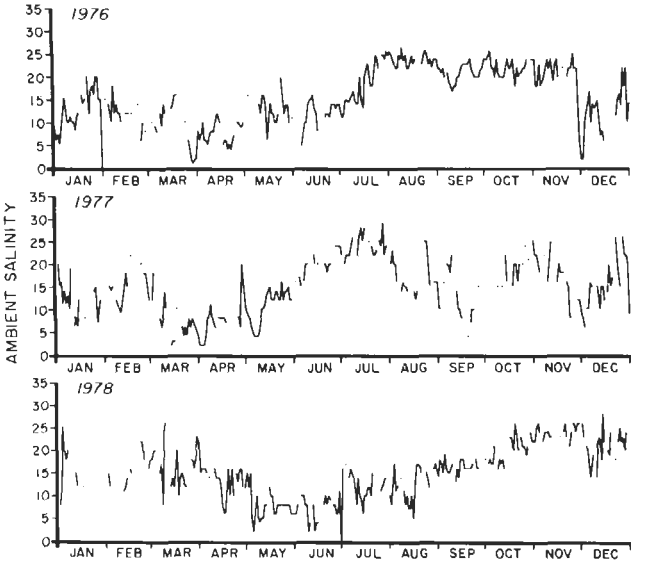

Figure 2. Ambient salinity for Biloxi Bay, Biloxi, Mississippi recorded daily 1976 – 1977.

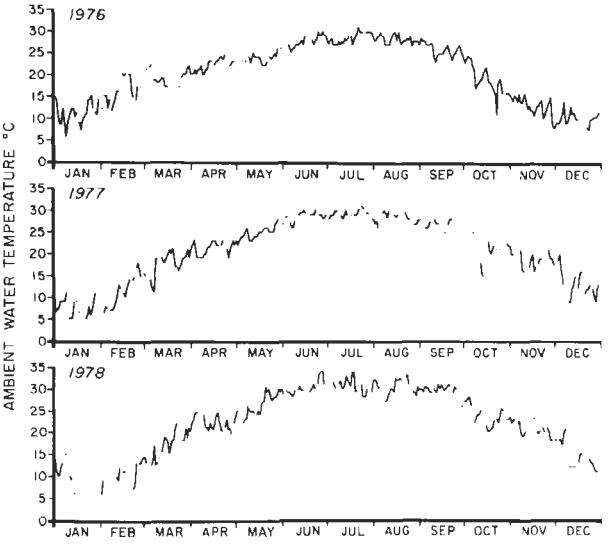

Figure 3. Ambient water temperatures for Biloxi Bay, Biloxi, Mississippi recorded daily 1976 – 1978.

1. On-bottom

After one year, none of the 1,600 spat planted on the bottom were recovered.

2. Raft culture

Spat placed in stacked Nestier trays suspended off the pier grew an average of 1.78 mm per month (Table 1) during the 11 month period (September 1976 – July 1977). These spat increased from an average of 12.9 mm to a final average length of 32.0 mm. Of the original 300 spat, only 31 individuals or 10% were recovered.

3. Upwelling

Spat placed in the vertical upflow tank grew an average of 1.19 mm per month, increasing from an average initial size of 14.1 mm to a final length of 25.9 mm over a 10 month period (September 1976 – June 1977). Of the original 600 spat in the vertical upflow tank, 349 survived (58%). Water flow varied daily, ranging from 2 to 22 liters per minute throughout the study.

4. Horizontal

Spat placed in the horizontal tank grew 2.0 mm per month, increasing from 13.8 mm to 35.7 mm in 11 months (September 1976 – July 1977). Of the original 600 spat, 167 survived (27.8%). Water flow varied daily, also from 2 to 22 liters per minute, throughout the study.

5. *Density*

Growth of spat placed in the horizontal tank at three densities was greatest near the water inlet and least near the water outlet. With one exception, the tray containing 100 spat which was located fourth tray from the inlet, growth decreased in relation to relative distance from the water inlet. Spat ranged in size from 24.4 mm to 39.3 mm after eight months, (February – September 1977), representing a range in growth of from 1.56 mm to 4.15 mm per month (Table 1). Growth also decreased as a function of increased density. Water flow through the water trough ranged from 8 to 15 liters per minute.

6. Maryland vs. OBRF

Oyster spat from the GCRL hatchery grew slightly faster than did those spat from the Maryland hatchery (1.9 mm per month vs. 1.68 mm per month). Spat from the OBRF hatchery increased from an initial size of 16.1 mm to 40.8 mm, while the spat from the Maryland hatchery increased from an initial size of 16.4 mm to a final size of 38.3 mm from October 1977 to October 1978 (Table 1). Of the original 100 spat from each location, 82 of the Maryland spat survived and 61 of the GCRL spat survived.

7. Pond

The oyster spat stocked into the saltwater pond did not grow. In fact, due to mortality, the average size decreased over the period March through August 1979 (Table 1). The spat were stocked at an initial average size of 19.6 mm, and after six months the average size was 19.4 mm with a survival of 84%.

DISCUSSION

The failure to recover any of the oysters planted on the bottom was not surprising. Even though an attempt was made to protect the planting from wave action, later studies in the same area indicate that shells are transported (Ogle and Chestnut 1979), and even small blue crabs are capable of opening fairly large spat (Ogle 1978) and will consume oyster spat during most of the year (Ogle 1980a).

Growth of the oyster *Crassostrea virginica* in the northern Gulf of Mexico is known to be rapid. Menzel (1951) has reported growth rates for oysters from Florida as high as 11 mm to 25 mm per month. Ingle (1951) reported growth rates of 13.5 mm per month for oysters from the same area in Florida, while Ingle and Dawson (1952) reported a growth rate of only 5.6 mm per month. Hofstetter (1977) has reported growth rates for oysters from Texas as 6.3 mm per month. Gunter (1951) reported growth of oysters on offshore platforms as ranging from 5.1 mm to 8.1 mm per month. The Louisiana oyster industry requires that a commercial size, three inch (76.2 mm), animal be produced in 18 months in order to minimize loss from disease. This means that a minimum growth of 4.2 mm per month must be maintained, although none of the animals in this study achieved that rate of growth. In the raft culture experiment, growth (1.78 mm per month) of oysters suspended off the pier would require 3.5 years to produce a marketable oyster. Growth of oysters in the trays suspended from the pier may have been reduced due to agitation from boat traffic and wave action. Turbulence may have reduced estimates of growth due to breakage of the rapidly growing shell edges caused by the oysters rolling around in the trays as has been reported for oysters cultured in trays suspended from offshore oil rigs (Ogle, Ray & Wardle 1977, 1978). Indeed, in a study reported later, Ogle and Chestnut (1979) found that growth of oysters planted on bottom and adjacent to the pier was 2.9 mm per month. The growth rate of 1.19 mm per month from the upwelling tank and the

TABLE 1

Average size and standard deviation (in parentheses) of *Crassostrea virginica* spat measured monthly with a calculated growth rate in mm/mo.

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	$\bar{X}$ mo
1976							Treatment 2		raft culture		12.9 (1.71)	15.9 (2.91)	19.61 (3.92)	20.9 (4.07)	
							Treatment 3		upwelling tank		14.1 (2.86)	19.2 (4.09)	21.5 (4.33)	19.6 (3.92)	
							Treatment 4		hori-zontal trough		13.8 (2.14)	19.0 (3.98)	21.8 (4.23)	21.7 (3.88)	
1977	raft culture		21.1 (4.18)	22.2 (3.25)	23.3 (3.34)	23.0 (3.24)	24.9 (3.81)	25.5 (5.31)	32.0 (5.09)						1.78
	upwelling tank		23.1 (4.74)	22.8 (4.45)	22.9 (4.64)	23.3 (5.34)	23.3 (4.06)	25.9 (5.79)							1.19
	horizontal trough		22.5 (4.29)	23.8 (4.78)	23.1 (4.55)	22.5 (4.26)	23.5 (4.17)	27.2 (4.82)	35.7 (6.72)						2.0
Treatment 5 density study		100A	10.2 (2.35)	11.2 (2.51)	11.5 (2.60)	12.2 (2.47)	20.1 (3.21)	— —	37.1 (6.12)	39.3 (5.87)					4.15
		400A	10.7 (2.11)	11.3 (2.49)	12.4 (2.09)	11.8 (2.38)	17.1 (3.42)	— —	37.2 (5.78)	37.8 (7.14)					3.87
		1600A	10.7 (1.84)	21.1 (1.7)	12.2 (1.61)	12.6 (2.24)	17.1 (4.40)	— —	30.8 (5.09)	31.8 (5.96)					3.00
		100B	10.4 (2.20)	11.3 (2.50)	11.3 (2.18)	12.0 (2.37)	14.9 (2.78)	— —	24.1 (4.75)	24.6 (5.12)					1.96
		400B	10.4 (2.05)	12.1 (1.95)	11.8 (1.70)	12.9 (2.14)	17.0 (3.54)	— —	25.9 (4.35)	27.0 (3.89)					2.22
		1600B	11.3 (2.27)	12.0 (2.24)	12.2 (2.04)	13.2 (1.94)	16.1 (4.10)	— —	22.3 (4.40)	24.4 (4.09)					1.56

TABLE 1 (Continued)

Average size and standard deviation (in parentheses) of *Crassostrea virginica* spat measured monthly with a calculated growth rate in mm/mo.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	$\bar{X}$ mo
								Treatment 6		OBRF spat vs Maryland spat	16.1 (2.16) 16.4 (2.35)	— —	19.4 (3.61) 21.8 (3.57)	
1978	OBRF spat vs Maryland spat	21.1 (3.68)	21.5 (3.37)	23.4 (4.03)	25.2 (4.46)	25.6 (4.69)	28.3 (5.10)	33.0 (4.94)	33.1 (5.04)	38.0 (5.94)	40.8 (6.71)			1.90
		22.3 (3.02)	22.0 (3.63)	24.2 (4.51)	28.5 (4.50)	30.0 (4.28)	31.3 (4.02)	34.2 (4.25)	33.5 (3.94)	35.6 (4.27)	38.3 (4.38)			1.68
1979	Treatment 7		Pond	19.6 (2.72)	20.4 (2.93)	19.6 (2.71)	18.7 (2.83)	19.1 (2.65)	19.4 (2.66)					0

growth rate in the horizontal flow tank of 2.0 mm per month would require a growth period of 5.3 and 3.2 years, respectively, to produce a marketable oyster. The slow growth of the oysters inside receiving pumped water was unexplained. The greater number of oysters (600 versus 300) inside may have limited food; however, the growth of oysters from the density study produced substantially greater growth rates (4.15 mm per month). Growth was reduced as a function of increasing distance from the water inlet and increasing numbers of oysters. Growth was still 3.00 mm per month in the middle of the tank after the incoming water had passed over 500 oysters. Growth was again reduced in the study comparing OBRF oysters with those from a Maryland hatchery (1.90 mm versus 1.66 mm per month), even though there were only 200 oysters in the entire tank. No growth was recorded in the static pond. Eymard and Ancelet (1979) compared oyster growth in a large pond with oyster growth in an adjacent canal and reported little growth in the pond (1.00 mm per month).

It appears from this study that even though the OBRF site is an excellent one for reproducing oysters, (Ogle 1980b and Ogle 1982), it is not optimum for growing oysters inside the hatchery. In a later study (McGraw 1980) comparing oyster growth at five locations in Mississippi Sound, growth at the Biloxi Bay was reported as 2 mm per month. That growth rate was exceeded at two of the other sites (Davis Bayou, 2.1 mm per month and Horn Island, 3.3 mm per month). Growth of spat from a location in the Western Sound (Pass Christian) was reported by MacKenzie (1977) as 6.57 mm per month although Ogle (1980c) found growth rates of oysters at Horn Island were more rapid than at Pass Christian.

It is recommended that oysters can be produced at this location on Biloxi Bay, but the grow-out should be at a different location or an effort undertaken to supplementally feed the spat until they are planted out.

ACKNOWLEDGMENTS

The author wishes to express his appreciation to Ms. Linda Smith and Ms. Kathy Beaugez for data collection, to Dr. Al Chestnut, to Dr. Edwin Cake and the Bureau of Marine Resources for initial funding of the Oyster Biology Research Facility, and to Dr. Harold Howse, Director of the Gulf Coast Research Laboratory, for his continued support of the project.

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