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MARINE EXTENSION BULLETIN

Tools to aid on-bottom oyster culture in deeper waters

Ensuring upright orientation of cages placed on the bottom

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SUMMARY

Oyster farms are not limited to nearshore areas where access to the farm is gained through low tides and/or very shallow embayments. Oysters can also be grown in deeper waters; however, managing the farm in deeper waters can be more challenging given the farmer's limited ability to observe the operations of their farm once the culture apparatus – the cage – has been released from the surface vessel for distribution on the bottom. This project, conducted at a subtidal oyster farm operating in 20 feet of water, evaluated multiple means of deploying cages in deeper water with the goal of determining a better system for

Figure 1a: An empty bottom cage for growing oysters configured as a 3 x 3 array with loops added for buoy attachment.

Figure 1b: The same bottom cage filled with oyster bags, each stocked with approximately 500 sublegal size oysters.

positioning the cage on the bottom for optimal oyster growth. The investigators make recommendations for a deployment method that ensures the cage will settle on the bottom in an upright position, which is favorable for oyster growth.

INTRODUCTION

Oyster farms are not limited to nearshore areas where access to the farm is gained through low tides and/or very shallow embayments. While managing a nearshore farm often has more simplified access, oysters can also be grown in deeper waters. In some environments, growing oysters on the bottom in deeper waters provides better protection of the crop and equipment from events such as heavy ice cover, large storm events, and heavy biofouling. Furthermore, as coastal areas become more populated and less available, there are opportunities for oyster farms to move into deeper waters where there is potentially less conflict for space.

However, managing the farm in deeper waters can be more challenging given that the farmer has limited ability to observe the operations of their farm once the culture apparatus is sent over the side of the boat to descend to the bottom. For example, monitoring the proper orientation of oyster cages on the bottom can be very problematic. Bottom cages are configured to hold plastic mesh oyster bags in an orientation such that they provide a maximum amount of surface for juvenile oysters to spread across the flat growing area of the bag (Figures 1a & b). This requires the cage to land in an upright position when "dropped" from the surface. Should the cage land in something other than an upright position, the result is often oyster seed crowded into a much more limited space, thereby reducing their capacity to feed and respire. In the end the crowding conditions compromise growth and can increase mortality. This is also true should the cage land upside down on the bottom where the first layers of oyster bags are pinned to the bottom and the seed are potentially smothered in soft substrate. Yet the farmer has no ability to observe the orientation of the cage once it has left the surface and traveled beyond the limits of visibility in the waters. Often, in highly productive waters, visibility can be a yard or less in depth. For farms in depths greater than 10 feet of water, the possibility of observing cage deployments can only be accomplished at certain times of the year when the productivity of the water is minimal and particulates in the water are reduced. To allow for more active management, a better system of cage positioning is needed.

METHODS

To address the lack of ability to observe proper cage orientation in deeper water farms, this project evaluated multiple means to ensure that cages placed on the bottom from a surface vessel in deeper water landed in the proper orientation to ensure the best growth conditions for the oysters held in the cage. Our overall goal was to establish the easiest and most cost effective method to release cages from the surface with assurance that the cage would land in an upright state when arriving at the bottom. To meet that goal, we evaluated two different means to lower cages from a surface vessel. These were 1) attaching a buoyancy device to the top of the cage such that the cage would flip to the proper orientation once released at the surface, and 2) lowering the cage while attached to a line that allows for the release of the cage once it rests on the bottom in an upright position.

The techniques were evaluated as to their efficacy in establishing the proper cage orientation on the bottom, the amount of time it took to engage the release tool, and the overall cost for the tool to be implemented.

Method 1: Flotation devices on bottom cages

Just as a parachute uses air resistance to impart the proper orientation for the falling apparatus dropped from on

Trial No.	Description	Measured Buoy Size (D x L; inches)	Standard Buoy Size (D x L; inches)	No. of buoys	Total Buoyancy (lbs)	Average cost
1	toggle	2.75 x 4.5	3 x 5	1	1.3	$4.11
1a	toggle	2.75 x 4.5	3 x 5	4	5.0	$16.43
2	bull nose	4.5 x 10.5	5 x 11	1	6.6	$11.22
3	round	5.5 x 6.5	6 x 7	1	4.5	$4.99
4	acorn	7 x 7	7 x 7	1	7.3	$7.60
5	bull nose	6 x 14.5	6 x 14	1	10.8	$12.79
6	bull nose	6.5 x 13	7 x 14	1	14.6	$18.36
2a	bull nose	4.5 x 10.5	5 x 11	4	26.2	$31.60

Table 1: Size, buoyancy and cost of buoys evaluated in this study.

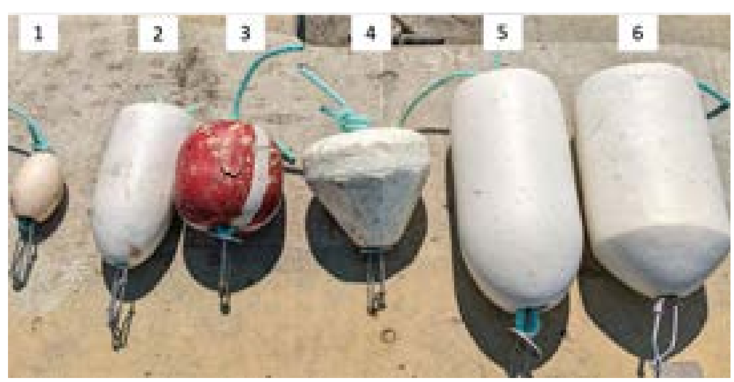

Figure 2: The variety of buoys evaluated in this study.

high, buoys could provide a similar buoyancy effect for cages dropped in the water. Buoys come in a wide variety of shapes, sizes and buoyancies. For this study, we selected six different buoy types that were attached to the top panel of the oyster cage in two different orientations. The buoy characteristics are listed in Table 1 and depicted in Figure 2, and the configurations of the buoy attachment to the cage is demonstrated in Figures 3a & b. To test each buoy type and configuration, the buoys were outfitted with a tuna clip to allow for rapid attachment of the buoy to rope loops installed on the cage. Functionally, the buoys would remain attached to the cage if this method were used commercially. Additionally, a GoPro camera was mounted on the outside of the cage with a range of view that projected down to allow for visualization of the substrate should the cage land in the proper orientation.

Each buoy type and configuration was evaluated via six releases of the buoyed cage from the surface and allowed to drop unimpeded to the bottom. The buoyed cages were released in either an upright orientation from the deck of the vessel (3 releases) or intentionally flipped upside down with their release to evaluate a worst case scenario (3 releases). Each drop was video recorded independently, and the video was observed to determine the orientation of the cage as it landed on the bottom (upright or not upright – Figure 4) as well as the elapsed time it took for the cage to drop from surface to bottom. Additionally, the average cost of each buoy type was determined from a general survey of buoy suppliers listed on the web.

Figure 3a: A 5"x11" buoy attached to a single point at the center of the cage.

Figure 3b: Four 5"x11" buoys attached to the top corners of the cage.

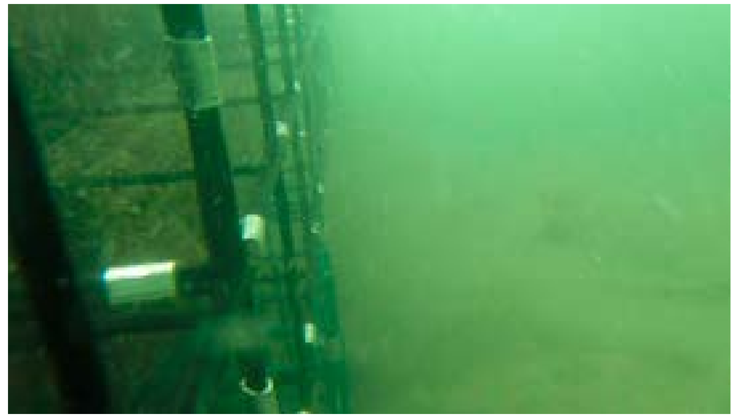

Figure 4: A frame grab from a video demonstrating a buoyed cage that has landed in the correct upright position.

Method 2: Line release of cages on the bottom

Lowering a cage from the surface via an attached line at the cage top would also impart the proper tensioning force to ensure that the cage remain in an upright orientation as it is lowered to the bottom. However, having a large concentration of vertical lines at a farm site is routinely discouraged due to possible entanglement issues with critical marine fauna. Therefore, the lowering line cannot be permanently attached to the cage. Two means of temporarily attaching a line to a cage for lowering were evaluated. The first is a device called a "snap shackle" (Figure 5) that allows a tensioned line to be attached to the shackle which in turn is attached to the top of the cage. The shackle can be released from the tension by tripping a second line that opens the shackle and releases the cage to allow for retrieval of the lines and shackle. The second is a simple loop of line that is threaded through the center mesh of the top of the cage and its length is double the depth of the water where the cage is being deployed. The doubled line threaded through the top of the cage allows the farmer to lower the cage until it rests on the bottom. Then one side of the loop is released and pulled back through the mesh thus releasing it from the cage for retrieval.

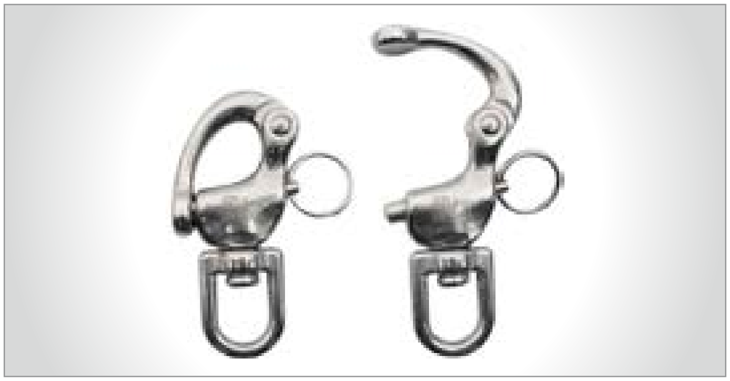

Figure 5: An example of a snap shackle.

RESULTS & DISCUSSION

Floation devices on cages

After a series of drop tests on an empty cage to work out the protocols, the experimental cage was stocked with 9 oyster bags, each bag containing approximately 500 2-inch oysters, resulting in a filled cage estimated weight of approximately 250 lbs. The drop tests were conducted in approximately 18.5 feet of water depth at our farm site in Fairhaven, Mass. with the cage being slid off the deck of our aluminum work barge or intentionally flipped upside down when launched. A summary of the results of the series of drops under differing conditions of buoy size and placement are presented in Table 2.

The ability of a buoy to induce enough buoyancy to force the cage into an upright condition while free falling through the water column was dependent on both the overall degree of buoyancy of the attached buoys coupled with the orientation of the cage release. As might be expected, the greater the amount of buoyancy attached to the cage resulted in more consistency in righting the free fall of the cage. For example, the best performance of a buoy system (4 correct landings out of 6 attempts) was the combination of a single 7x14 buoy in the cage top center with four 5x11 buoys at the corners. This buoy configuration provided a combined buoyancy of 30.8 lbs. or approximately 12% of the total cage weight. No buoy configuration tested was able to right the fall of the cage 100% of the time, although the above referenced 5-buoy system was able to ensure a proper landing when the cage was released from the surface in an upright orientation.

Cages that were released in an upside down configuration took longer to drop (average transit time for right side up drops in 18.5 feet was 7.23+1.12 and for upside down drops was 8.91+0.95 seconds), required a higher amount of buoyancy to correct the orientation, and would not consistently flip to the proper orientation when released. Two factors may have been in play to prevent upside down releases from orienting properly. The first is that when handling the oyster cages on the deck, often the mass of oysters in each bag is concentrated at one end of the bag leading to an imbalance of mass in the cage. When the cage is released upside down with buoyancy, the momentum of the flip induced by the buoy cannot overcome the tendency of the cage to drop with the heavy side down as it rotates in the water. When the cage is released in an upright position from the surface, the buoy can stabilize the orientation of the cage enough such that when the cage hits bottom in the short amount of time in transit, although not square to the bottom, the tilt of the cage is not severe enough to prevent the cage from settling in an upright position.

The second factor in preventing upside down cage releases from correcting their orientation while falling, specifically with the corner attachment points for the buoys, was the means of attaching the buoys to the cage. Loops of line were tied to each cage corner for buoy attachment and, combined with the tuna clip attachment device, the overall distance from cage to buoy was over 1 foot (Figure 3b). Thus when the cage was released in an upside down orientation, the corner buoys would flip up along the side of the cage enough that the buoyancy being exerted tended to slow down the cage drop rather than impart a torsion to the drop to flip the cage into the upright position. After observing this in our cage drops, we shortened the attachment points for the 5x11 bull nose buoys at the corners to about six inches for a final trial. As can be seen in Table 2, with the corner buoys held tighter to the cage top, the performance of the buoyancy improved the ability of the flipped cage to correct itself in free fall (1/6 for the loose rope trial compared to 3/6 for the tight attachment).

This project evaluated multiple means of deploying cages in deep water to determine a better system for positioning the cage on the bottom for optimal oyster growth.

Buoy Type	Buoy Configuration	Release type	Upright landing	Average time of freefall (sec)
3x5 Toggle	One at Center	upright	0/3	8.53
		upside down	0/3	9.66
		combined	0/6	9.21
3x5 Toggle	Four at Corners	upright	1/3	7.65
		upside down	0/3	9.27
		combined	1/6	8.46
5x11 Bull Nose	One at Center	upright	1/3	6.23
		upside down	0/3	7.24
		combined	1/6	6.57
5x11 Bull Nose	Four at Corners	upright	1/3	6.58
		upside down	0/3	10.42
		combined	1/6	8.88
7x7 Acorn	One at Center	upright	0/3	6.29
		upside down	0/3	8.31
		combined	0/6	7.30
6x7 Round	One at Center	upright	3/3	6.75
		upside down	0/3	8.79
		combined	3/6	7.77
6x14 Bull Nose	One at Center	upright	1/3	7.22
		upside down	1/3	8.70
		combined	2/6	7.96
7x14 Bull Nose	One at Center	upright	0/3	7.01
		upside down	2/3	8.06
		combined	2/6	7.54
7x14 Bull Nose combined with 5x11 Bull Nose	One 7x14 at Center; Four 5x11 at Corners	upright	3/3	9.00
		upside down	1/3	9.47
		combined	4/6	9.24
5x11 Bull Nose	Four tight at Corners	upright	2/3	7.61
		upside down	1/3	8.61
		combined	3/6	8.11

Table 2: The results from a series of drop tests of a 9-bay bottom oyster cage filled with approximately 4,500 oysters. The conditions of each drop test series are outlined in the table.

Line release of cages on the bottom

Observations of cage releases controlled by line attachments consistently resulted in the cages arriving at the seafloor in the proper upright orientation, 100% of the time. The drop of 9-bag bottom cages can easily be controlled by a single person on deck at the surface as the weight and thus the freefall of the loaded cage in water is manageable by one person. Both means to control line deployments worked well; however, the snap shackle apparatus had a tendency to trip unexpectedly as the trip line was free on deck and often would entangle in apparatus, thereby releasing the mechanism and allowing the cage to free fall from the time of release. The dual rope loop system was more reliable to ensure the cage was lowered to the bottom and also was effective in ensuring the proper landing orientation in all trials.

FINAL RECOMMENDATION

Attaching buoys to cages as parachutes to control the decent of the cage to the bottom worked with limited success. Even with 30 lbs. of buoyancy attached to the cage, there was only a 67% assurance that the cage would land in the proper orientation. The success rate increased to 100% if the crew deploying the cage carefully released the cage from the surface with an upright orientation to the release. However, employing the 5-buoy configuration to each bottom cage increased the overall cost of the apparatus from $244 for a 9-bag cage kit by an additional $49 for the buoys. That is a 20% increase to the cost of a cage. Given the additional cost and uncertainty of the success rate of the apparatus, the farm manager has decided to not employ this strategy for cage deployments.

A rope-controlled cage drop proved to be 100% reliable and relatively simple and inexpensive to implement. While the snap shackle was problematic at times, the dual-loop rope-release worked flawlessly. Therefore, this method has become the one of choice for deploying bottom cages in deeper waters at farm. This method has provided greater confidence in cage orientation post deployment and more predictability in subsequent growth and survival of the oysters in the cages.

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