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By T.C. Visel, Nancy E. Follini, Joseph J. Gilbert and Lance L. Stewart

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T. C. VISEL[1], NANCY E. FOLLINI[2],
JOSEPH J. GILBERT[2], AND LANCE L. STEWART[3]
[1]Connecticut Sea Grant Marine Advisory Program
University of Connecticut
Avery Point, Groton, CT 06340
[2]Briarpatch Enterprises, Inc.
Stonington, CT 06378
[3]National Undersea Research Center
University of Connecticut
Avery Point, Groton, CT 06340

ABSTRACT

In Connecticut, container relaying has been an approved method to cleanse oysters of bacterial contaminants for more than ten years. Oysters are relayed in nylon mesh bags attached to a bottom longline. With modifications, this method has been used to relay hard clams (quahogs) in VEXAR bags with equal success. Bag relaying continues to be an effective way for shellfishermen to reduce normal relay losses and utilize a resource that formerly was wasted in many Connecticut shoreline towns.

KEY WORDS Container relaying, purification of shellfish, closed shellfish areas

INTRODUCTION

The relaying of oysters and hard clams (quahogs) from closed areas to certified waters for purification is an important industry procedure in Connecticut. Historically, the transplanting of shellfish such as seed oysters from areas deemed unsafe for direct shellfishing to deeper, cleaner waters has been an accepted industry practice. Many of these procedures originated when shallow grow-out areas (such as The Beach in West Haven, Connecticut) were closed in 1918 due to pollution. Later, adult shellfish were transplanted, to allow them to cleanse themselves of bacteria in shorter time periods. Such relays relied upon the storm protection of shore features such as islands in the western section of Long Island Sound. Areas suitable for relays were quickly leased, and the remaining potential sites were closed to commercial shellfishing.

In spite of the success of the relay process, losses do occur. The process varies from site to site, and losses occur through predation, breakage in the harvesting process, and poor retrieval procedures. In Connecticut, it is estimated that up to 40% of the relayed stock can be lost to the industry as a result to the above factors, especially for short relays of less than 180 days. The shellfish industry has expanded rapidly (leasing has increased 90% in state waters) in eastern Connecticut where environmental conditions such as deep water, strong tides and storm losses make open water relay recovery difficult, if not impossible. A new relay method for clams and oysters was developed in

1978 incorporating large mesh bags on a longline (Visel, 1978). Initial results of this relay system reduced losses to less than 10%.

BAG RELAY STUDIES

To our knowledge, the first bag relay occurred on August 7, 1978 (Visel, 1980). After receiving permission from the State Department of Health Services (DOHS) and the local Madison Shellfish Commission, 15 bushels of oysters were relayed in mesh bags in 10 feet of water off the shore of Madison, Connecticut, using a longline trawl similar to that traditionally used for lobster pot trawls.

EQUIPMENT AND DEPLOYMENT METHODS

In the 1978 Madison relay, oysters were loosely packed (1/2 bushel) in one-bushel capacity nylon mesh bags. Mesh bags were cut from a rectangular sheet of nylon two-inch mesh number 21 thread seine webbing. The sheet of webbing was then folded in half and laced along one side and the bottom edge, creating a bag approximately 40 inches across and 40 inches deep.

To complete the bag, a nylon drawstring was passed through the top meshes, creating a continuous loop when tied end to end. Utilizing this draw string, mesh relay bags were attached to a lobster trawl line. The longline consisted of 5/16-inch polypropylene lobster pot rope. Bights (loops) of line six inches in diameter were placed approximately every 10 feet with a single overhand knot. Two trawls 150 feet long, each containing 15 relay bags, were used with lobster pot buoys at each end to mark recovery. No additional weight other than the oysters themselves kept the trawls on the bottom. In setting the trawl, each bag drawstring was drawn tight and tied to the bight of line with half hitches. It took approximately 30 minutes to set each trawl.

RELAY PROCEDURES

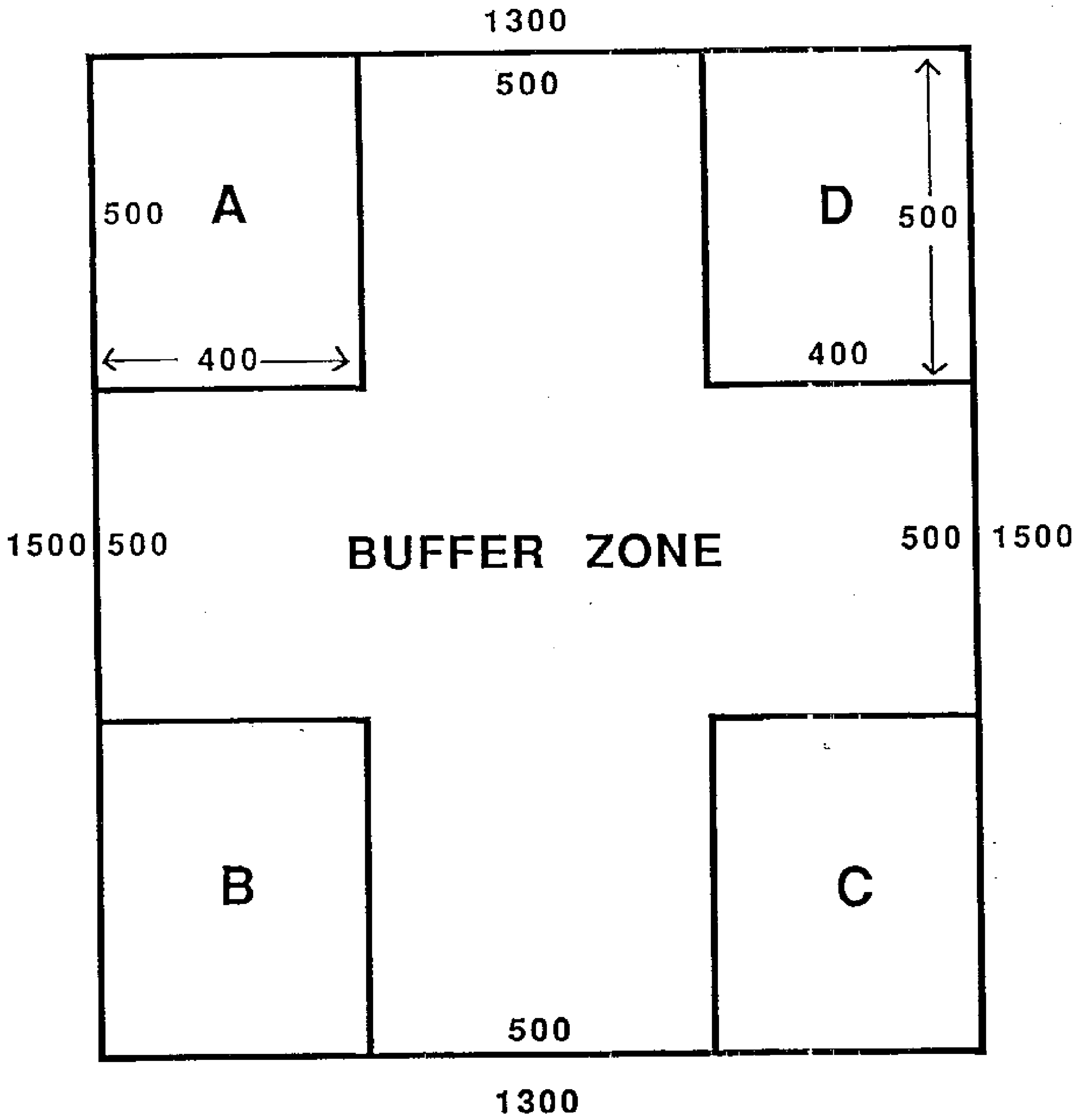
The bag relay procedures utilized by Briarpatch Enterprises, Inc., of Stonington, Connecticut, can be applied to most bag relay operations. Briarpatch Enterprises, Inc., has been bag relaying hard clams, *Mercenaria mercenaria* , and oysters, *Crassostrea virginica* , since August, 1985. In the summer of 1986, Briarpatch redesigned its depurating bag, replacing disposable VEXAR with reusable nylon webbing.

A water temperature of 50^{o} F or above for both harvest and transplant sites is required for all relay operations in Connecticut, according to NSSP guidelines (1988 revision) and DOHS regulations. (Water temperatures below 50^{o} F have been shown to inhibit purification of relayed shellfish.)

The first step in the process is the identification of an exploitable population of shellfish. The sources of contaminated shellfish vary; Briarpatch Enterprises has processed product from Pawcatuck River, Mystic River, Tom's Creek, Neck River, East River, Indian River, and Housatonic River. When a suitable source is located, a sample from each source is provided to the DOHS at the start of the transplanting operation for bacterial examination.

Next, a depuration site in certified water with a hard bottom is selected and the lot is designed. The depuration lot designed by Briarpatch Enterprises is divided into four sublots (A, B, C, and D), separated by 500-foot buffer zones and so staked (see Figure 1).

Figure 1 Diagram of Four Depuration Lots
(all measurements in feet)



Note: All corners are buoyed.

Next, proper town and state harvest permits are obtained, sublot A is officially closed and a DOHS transplant permit is obtained in preparation for receiving shellfish.

Shellfish are removed from closed areas, using a hydraulic clam dredge, a bull rake or oyster dredge. The product , hard clams or oysters, are sorted from the culling table directly into the depurating bags. The capacity of each bag is controlled by using a bottomless five-gallon bucket as a measure. The bucket is inserted into the mouth of a bag, filled to capacity and then lifted so as to funnel shellfish into the bag.

Full bags are stacked forward of the work area until harvest operation is suspended. Enroute from the contaminated area to the depuration lot, the full bags are spread out in straight lines on the clear area of the work deck. The bags are tied on polypropylene floating lines at 12-foot intervals with up to 30 bags per string. Upon reaching the lot, the vessel is positioned on a starting point by the use of ranges, position is recorded, and strings of bagged shellfish are deployed off the stern while the vessel moves slowly forward. Each bag must be handled to evenly distribute the shellfish as it is dropped. A finishing point position is recorded and procedure is repeated for each string. When several days' product has been relayed to lot A, the lot is closed, transplant permit canceled, transplant permit is obtained for lot B, and the procedure is repeated. Hard clams are relayed on the same day they are removed from the closed area.

Relaying procedures are the same for clams and oysters, except for the difference in time from harvest to relay. Oysters are usually harvested with hand equipment, in lesser volumes which do not merit daily deposition to a depurating lot. Therefore, one or two days' catch may be consolidated before being bagged and relayed.

When a depuration lot's transplant permit is canceled and the lot is closed, the depurating countdown, usually 14 days, begins. During this time, security is achieved in several ways. All strings of bagged shellfish are set blind (without buoys) and are thus not visible. The 12-foot spacing of bags on the line makes retrieval without power equipment very difficult in 15- to 20-feet of water. The weight of the bags of shellfish is sufficient to resist being lifted by the occasional rod and reel drift fisherman who happens to snag one. (Reports of broken fishing lines found tangled in the equipment are common.) In addition, Briarpatch representatives and other fishermen observe their depuration lot many times per day during periods of activity.

When sufficient time passes, usually 14 days, sampling takes place in the presence of a disinterested party acting in an official capacity. Random samples of 12 shellfish are bagged, sealed, marked and refrigerated for transport to the State laboratory. These samples are compared to the original sampling from the source bed. When satisfactory results are reported, the DOHS issues a harvest permit for the appropriate sublot.

Harvest begins with grappling along the recorded coordinates and hauling several strings of bagged shellfish aboard the vessel. The bags are removed from the line and washed with a high pressure sea water hose to remove silt and algae from the shellfish. When washing is complete, shellfish are sorted as to shape, size, and species, then bagged and tagged for market. Product mortality is assessed for predation, cracked shells and mud clams, and recorded in the back of the shellfish log book. The log book is also a record of the source and quantity of shellfish harvested and to whom they were sold.

Upon arrival at the dock, shellfish are transferred into refrigerated vehicles for transport or onto pallets in a refrigerated area to await transport vehicles. After harvest, the lot is closed, the harvesting permit is canceled,a transplant permit issued by the DOHS and the cycle continues.

RESULTS AND DISCUSSION

Some of the questions about bag relaying that had to be addressed were the causes of and extent of mortality, the condition of the product, the configuration of the bags on the bottom, and, of course, demonstrable reduction of bacterial contamination. All bag relay programs are permitted and monitored by the Connecticut DOHS under guidelines issued on April 26, 1988.

Mortalities differ according to bottom type. Bag relays realize substantially lower mortalities than open water relays and subsequent recovery. Stewart (1988) found that 1.5 bushel capacity nylon bags with one inch mesh approved by the Connecticut DOHS for hard clams at no time experienced more than one percent mortality in depuration (relay) times of one to two-and-a-half months. The product was clean, sand-free and highly marketable in the restaurant trade.

Filling the bags to 1/3 to 1/2 capacity ensures that proper respiration posture is assumed. Underwater observations conducted by Stewart (1988) using SCUBA revealed that the bags flatten out on bottom, and the majority of contained hard clams bury in sediment and assume normal siphon feeding/respiration posture. Depuration grounds which allow ebb and flood bottom current achieve thoroughly adequate circulation and no restrictions are obvious. Gilbert and Follini (1989) reported that bag relay mortalities for oysters have been less than five-percent. Fifty percent of the mortality is due to starfish predation, the remainder to cracked or damaged shells. Visel (1981) reported that mortalities for oysters can vary according to bottom types, with lowest mortalities, four to eight percent, occurring in hard sand bottoms, and up to 20-percent in soft mud bottoms. Underwater observations of bag shape by Gilbert and Follini (1989), using SCUBA equipment, have helped to refine bag design to its present form, which deploys very well on the bottom. Observations have shown that hard clams are able to spread out and actually dig into the bottom. Oysters were observed to be evenly distributed through the bags, in layers not more than two oysters deep.

Analysis of ten years of data compiled by Malcolm C. Shute (unpublished), Principal Environmental Sanitarian of the Connecticut DOHS, shows that bacterial levels are substantially reduced in the bag relaying process. Examples of before-and-after bacteria examinations obtained from Mr. Shute are included in Table 1.

Table 1. **Bacterial Examination of Oyster and Clam Meats**
Connecticut State Department of Health
Laboratory Division, Hartford, Connecticut

Date	Location (source)	Coliform organisms MPN/100 grams	Fecal organisms MPN/100 grams	Standard plate count per gram	Relay period
9/9/78	Hammonasset River	3500	170	900	8/26/78
9/19/78	oysters BED 101	78	<18	100	9/19/78.
8/5/85	Tom's Creek	54,000	170	8,600	7/25/85
8/5/85	oysters BED 101	110	<18	720	8/5/85
4/27/87	Thames River	11,000	490	3,400	4/27/87
5/11/87	hard clams BED 4-A	<18	<18	1,100	5/11/87
5/18/87	Thames River	3,300	1,300	3,000	5/18/87
5/31/87	hard clams LOT A-2	130	<18	7,900	5/31/87
6/9/87	Thames River	3,300	78	22,000	6/9/87
6/21/87	hard clams LOT A-1	20	<18	680	6/21/87
4/2/88	Neck River	490	330	N.A.	4/2/88
5/23/88	oysters BED 413-D	170	45	500	5/23/88
6/16/88	Gulf Pond	490	45	500	5/2/88
6/15/88	oysters BED 413-D	4,600	<18	4,400	6/14/88

CONCLUSION

Research to date has shown bag relaying to be an effective and economic way for small-scale shellfishermen to cleanse polluted shellfish. The authors feel that for independent baymen, the opportunity to relay with minimum loss can sustain fisheries in areas closed to shellfishing. The limiting factor, of course, is suitable water temperatures required for relaying, and therefore relaying must be considered a supplemental or seasonal fishery.

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