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Growth performance of Eastern oysters *Crassostrea virginica* in Atlantic Canada: Effect of the culture gear

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ABSTRACT

Size groups of Eastern oysters *Crassostrea virginica* (20–30 mm, 30–40 mm, 40–50 mm, and 50–60 mm) were individually labeled, randomly assigned to two types of floating culture gears (horizontal ropes and Vexar bags) and deployed at various locations in northern New Brunswick, Canada. Results indicated that the rope-grown oysters substantially outperformed those deployed in floating bags; after one growing season, shell growth was 60% higher and weight gain was nearly double. More than 95% of the variance in shell or weight growth could be explained by the culture gear. The difference in oyster performance between the two culture gears was greater at certain sites, or a significant culture gear by site effect. In particular, it appeared that growth in the floating bags was relatively depressed at the more dynamic sites with higher wave action. Based on the rope-grown oyster performance, we would suggest that the environmental conditions at the various locations tested in this study would support similar levels of commercial oyster production. The prediction would be quite different, however, if the site productivity assessment were based on performance data from floating oyster bags.

1. Introduction

The Eastern oyster, *Crassostrea virginica* (Gmelin), is well known to exhibit a high level of variance in shell morphology when grown under different substrate conditions. Areas of high sediment deposition tend to produce long narrow oysters, a growth strategy to prevent smothering, whereas harder substrates tend to produce rounder deep-cupped oysters. Whether this phenotypic plasticity has an underlying genetic basis is yet to be demonstrated, but it is clear that shell characters in oysters often used to evaluate biological production performance or site suitability may be strongly influenced by the physical environment (Carriker, 1996; Lavoie, 1995).

In Atlantic Canada, the management strategies and protocols for growing oysters are variable between farms and are continually evolving. Bottom culture is still practiced in some areas, but most growers now rely on off-bottom culture gear which was introduced and developed over the past decade. Environmental characteristics such as shallow bays, thick winter ice and bio-fouling pose numerous constraints on equipment design; in particular, the culture gear must have a low profile for over-wintering on the bottom under the ice, as well as provide the option to expose the product and gear to air-drying as a means of controlling biofouling. The floating Vexar bag (Mallet et al., 2006), the OysterGro™ cage system (www.oystergro.com), and more recently, the horizontal rope-grown structure (Doiron and Mallet, 2009) are typical examples of these recent culture gear developments.

Site selection criteria for shellfish production are often based on empirical production studies, where shellfish from a common source and age are placed in replicated cage containers and deployed at different locations within a site as well as across sites (Brown and Hartwick, 1988; Mallet and Carver, 1989; Mallet et al., 1986; Sonier et al., 2011a, b). Mean production values based on growth and mortality estimates from these replicated cages have been used to classify sites in terms of their biological productivity and their suitability for shellfish aquaculture. The effect of the experimental gear on the site ranking is often not discussed, either because the data are not available (*i.e.* only one cage type) or the type of cages may be too similar in design (*i.e.* lantern cages and pearl nets) to offer any possible discrimination. This paper demonstrates how the assessment of site suitability for Eastern oyster production can be affected by the culture gear. It also describes the substantial effect of the culture gear on oyster performance under a range of environmental conditions. Finally, if the primary objective is to rank the biological potential of sites over a broad geographical area or to estimate the carrying capacity of a large bay, it is important to use experimental culture gear which will not differentially impede shellfish production under variable physical conditions.

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2. Materials and methods

2.1. Scope and location

This study compared the growth of Eastern oysters reared in floating oyster bags (Mallet et al., 2006, 2009) *versus* oysters glued to ropes deployed on horizontal floating racks (Doiron and Mallet, 2009) in New Brunswick, Canada. The work was conducted in two phases; in 2008, the two culture gears were deployed using two size groups at three geographically-separated sites (Caraquet, Baie St-Simon and Tabusintac — Fig. 1) whereas in 2009–2010, these same two culture gears were deployed in three zones within a lease in Baie St-Simon Sud (Fig. 2). In each case the experimental units were individually-labeled oysters taken from a common wild-collected group from 2006 which were randomly assigned to either culture gear.

2.2. Culture gear

The floating bag typically consists of a 9-mm Vexar bag (L1.0 m × W0.5 m × D0.1 m) with polyethylene floats attached on either side of the bag by means of bungee cords and these bags are attached to a double longline. In late fall, the floats are removed and the bags are sunk to the bottom until the following spring when they are re-floated. The bags are flipped during the summer to reduce the accumulation of bio-fouling organisms by means of air-drying.

The horizontal rope culture gear is based on a L2.4 m × W1.2 m metal structure floated by means of two 4″ diameter PVC pipes with removable caps. Eleven ropes each with 23 glued oyster triplets are deployed lengthwise across this structure. In late fall, the caps are removed and the structure is allowed to sink to the bottom until the following spring when it is re-floated. The structure can be flipped to expose the oysters to the air in order to control bio-fouling.

For the 2008 trial, the floating oyster bag and the rope culture gears were randomly placed on a commercial longline. For the 2009–2010 trial, 12 experimental longline units (Fig. 3) were built and deployed at the locations shown in Fig. 2.

2.3. Oyster performance

2.3.1. 2008: Between-site comparison

On May 1, 2008, oysters from a Caraquet wild seed collection were sorted and divided into two size groups based on shell length (20–30 mm, 40–50 mm). Lots of 15 individually-numbered oysters were deployed in three replicated floating bags with densities of 500 oysters/bag (20–30 mm group) or 200 oysters/bag (40–50 mm group). For each labeled oyster, shell height and total weight (including the tag) was measured at the beginning and the end of the study (October 15, 2008). Shell growth and weight gain were calculated as the difference between the initial and final measurements. At each of the three experimental sites (Baie St-Simon, Tabusintac and Caraquet), the six floating bags were randomly distributed at three different locations on either side of a double long-line.

To set up the rope culture trials, oysters from each of the two size groups were arranged in groups of three and glued shell (left valve) to shell with the rope running through the center of each triplet. Of the 23 triplet groups on one horizontal line, all three oysters in positions 1, 5, 10, 15, and 20 for a total of 45 oysters were measured in terms of shell height and one oyster at each position was initially weighed before gluing. These individuals were re-weighed at the end of the study period after removing the glued oysters from the line. At each site, one rope of each size group was attached to a floating structure and one structure was deployed at each of three locations within each site. Nine additional ropes with glued oysters were added to each rack to mimic commercial densities.

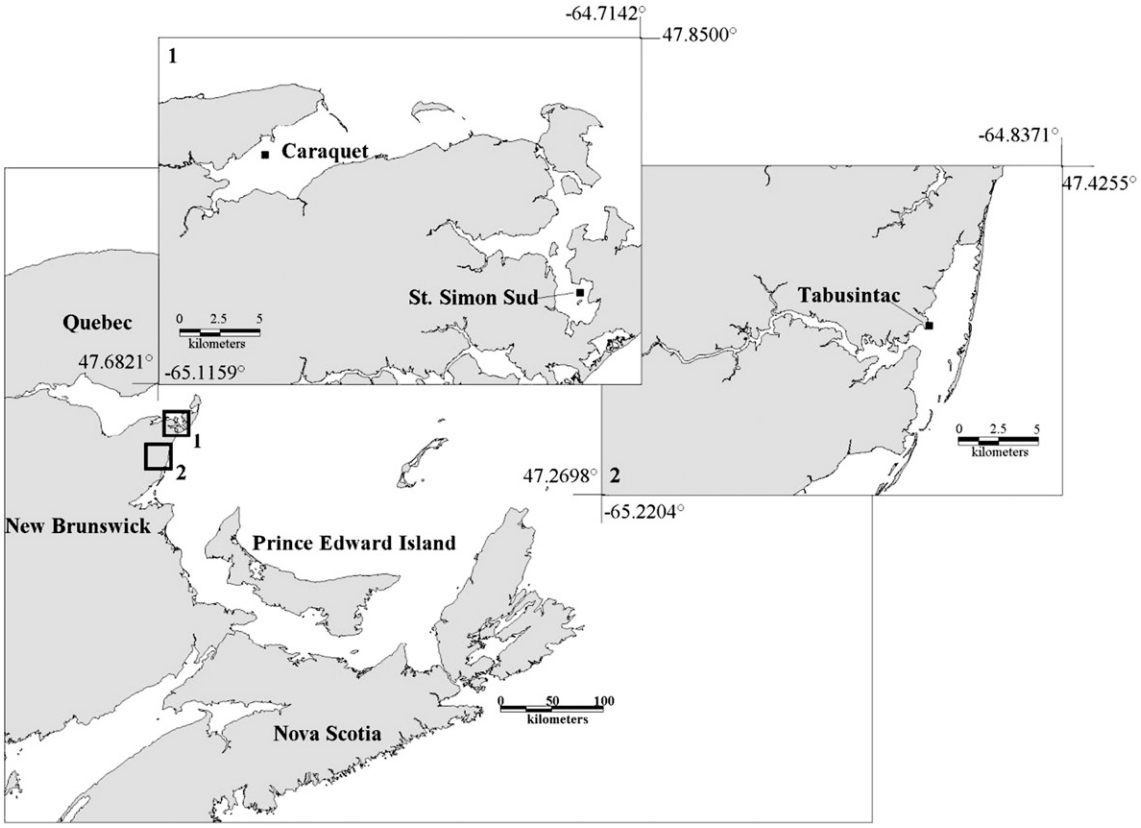

Fig. 1. Map showing the location of the three experimental sites (Baie St-Simon-Sud, Tabusintac and Caraquet) in northern New Brunswick where oysters were deployed for the 2008 trials.