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Stock assessment for eastern oyster seed production and field grow-out in Louisiana

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ABSTRACT

There is little information on the performance of oyster populations from Louisiana estuaries limiting the ability to choose stocks for hatchery seed production and field grow-out. The objectives of this study were therefore to compare the mortality, growth, dermo (*Perkinsus marinus*) infection intensity and condition index of the progeny of wild oysters collected from three Louisiana estuaries differing in salinity regime and oysters specifically selected for dermo resistance. Progeny were deployed in cages in the field, along a salinity gradient in coastal Louisiana. Overall, salinity and temperature had major impacts on the mortality, growth, dermo infection intensity and condition index of oysters of all four stocks and a few differences between stocks could be shown at some sites. At the lowest salinity site, the progeny of wild oysters from Sister Lake, a low salinity estuarine lake, had the lowest mortality suggesting enhanced tolerance to low salinity conditions compared to the other stocks. At the highest salinity site, the progeny of wild oysters from Lake Calcasieu, a high salinity estuarine lake, had the lowest mortality during summer concomitant with increasing dermo infection intensities suggesting a better resistance to dermo disease compared to the other wild stocks and confirming an earlier finding. This initial result suggests that the stocks used are genetically differentiated with respect to low salinity tolerance as well as dermo-related mortality at high salinity and that stock selection for aquaculture grow-out or restoration effort will benefit from being site-specific and dependent on the dominant environmental conditions.

Statement of relevance: Assessment of eastern oyster stocks in Louisiana or other Gulf of Mexico estuaries for seed production and field grow-out is lacking.

1. Introduction

Louisiana leads the nation in the production of oysters, typically accounting for about 34% of the nation's landings and over 55% of the landings along the Gulf of Mexico in 2012 (Louisiana Department of Wildlife and Fisheries, LDWF, 2014). The success of the Louisiana eastern oyster industry is due in large part to an effective public/private partnership in which the LDWF manages the public grounds for the production of seed oysters (25–75 mm) for transplant to private leases where they are cultivated on-bottom and subsequently harvested. While eastern oysters continue to support a viable industry, increased harvest of seed and market oysters from public grounds in recent years has resulted in a net deficit of shell negatively impacting the availability of seed oysters for private leases (Soniat et al., 2012). Moreover, the variability in seed availability from year to year due to natural fluctuations in reproduction and recruitment of wild oysters along with unpredictable mortalities due to predation and disease during on-bottom grow-out on leases that can reach 50 to 85%, continue to be problematic for oyster farmers (Owen, 1953; Powell et al., 1996; La Peyre et al., 2016).

Intensive oyster aquaculture, which combines hatchery production of seeds and improved grow-out methods, could play an important role in increasing production and sales of oysters from Louisiana and other Gulf States (Maxwell et al. 2008; Walton et al., 2013). Hatchery production can also serve to augment production of public oyster beds as previously attempted in Chesapeake Bay and recently implemented in Louisiana estuaries by LDWF, or in restoration activities (Carlsson et al., 2008; La Peyre et al., 2014). A major advantage with using hatchery produced seed is that it enables selection of broodstocks best adapted to local environmental conditions (Frank-Lawale et al., 2014). Previous studies have shown that optimal temperature and salinity combinations for oyster health and reproduction are population-dependent (Barber et al., 1991 Dittman et al., 1998; Brown et al., 2005; Burford et al., 2014). Moreover, oysters can also be selected on the basis of their increased survival after challenge with *Perkinsus marinus*, the protistan parasite causing dermo disease that is prevalent in Gulf of Mexico estuaries. The need to develop stocks of locally adapted oysters that are resistant

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to disease has long been recognized (Haskin & Ford, 1979; Matthiessen et al., 1990; Ragone Calvo et al., 2003a).

To date, little information has been gathered on the performance of Louisiana oyster populations from various Louisiana estuaries limiting the ability to choose stocks for hatchery seed production and predict their performance in varying environmental conditions. Given Louisiana estuaries wide range of salinity and the increasing interest in oyster aquaculture and restoration efforts, there is a need to determine the performance of oysters from various Louisiana estuaries. This is especially critical as LDWF policy is to avoid the introduction of out of state oysters into Louisiana waters. The objectives of this study were therefore to compare the mortality, growth, condition index and dermo infection intensity of the progeny of wild oysters collected from public oyster grounds of three Louisiana estuaries differing in salinity regime. In addition, a fourth group of Louisiana oysters consisting of the progeny of a stock selected for increased dermo resistance was included for comparison. The hatchery produced progenies of the four oyster broodstocks were deployed at three sites along a salinity gradient in Breton Sound estuary, LA and at a high salinity site off Grand Isle in Barataria Bay estuary, LA to represent different grow-out environmental conditions. Breton sound is a key public oyster ground that has experienced a significant decline in harvest in recent years and has been targeted for seeding with hatchery propagated oysters by LDWF (Soniat et al., 2012; La Peyre et al., 2013; LDWF, 2014).

2. Materials and methods

2.1. Oysters

The wild stocks used in the study were collected in October and November 2010 from three public oyster grounds, Sister (Caillou) Lake (29.2341°N; 90.9172°W), Breton Sound (Bay Gardene, 29.5910°N 89.6425°W) and Lake Calcasieu (29.5100°N; 93.1900°W). These grounds have different salinity regimes with yearly means (±standard deviation) calculated from 2003 to 2011 (N = 9) of 11.9 ± 2.4 for Sister Lake, 10.4 ± 2.5 for Breton Sound's Bay Gardene and 20.4 ± 2.2 for Lake Calcasieu. Daily salinities for each of these areas were obtained from USGS data recorders (SL-07381349, BG-07374527, LC-08017118) to calculate yearly means. All oysters collected were transported to the Louisiana Sea Grant Oyster Research Hatchery and Demonstration Farm in Grand Isle, LA (29.2380° N, 90.0030° W), where they were placed in labeled aquaculture bags held in an adjustable long line system (ALS, BST Oyster Co., Cowell, South Australia) prior to spawning.

The oyster stock named 'OBOY', selectively bred for dermo-resistance in Grand Isle, consists of the descendants of large oysters, collected in 1999, from a dermo endemic area (i.e., Oyster Bayou, Cameron Parish, 29.7941°N; 93.3872°W). The stock progeny has been challenged in the field (F0) and in the laboratory (F1 and F2) with *P. marinus* for two subsequent generations.

All four stocks were spawned at the Louisiana Sea Grant Oyster Hatchery in May 2011 to produce an F0 generation for the wild stocks and an F4 generation for the OBOY stock. Each stock was naturally spawned using about 150 oysters and the resulting larvae were reared using methods similar to Dupuy et al. (1977). Pediveliger (~280 μm) larvae were then set on micro-cultch material (~500 μm ground oyster shell) to produce single oyster spat. After 48 h, the resulting oyster spats were transferred to an upwell nursery system, where they were grown to 25 mm in shell height (i.e., seed oysters) prior to placement on the ALS at the Sea Grant Oyster Research and Demonstration Farm in Grand Isle. Seed oysters were held in the ALS until the start of the study.

2.2. Study sites

The oysters were deployed in bags at three different sites along a low to intermediate salinity gradient in the lower Breton Sound estuary in Southeast Louisiana and at a high salinity site at the Sea Grant Oyster Research and Demonstration Farm in Grand Isle (Fig. 1). The sites were chosen based on nine years (2003 − 2011) of salinity data from USGS real-time monitoring stations located in Breton Sound and Barataria Pass, which is adjacent to Grand Isle. In Breton Sound, Cow Bayou (CB) was selected as the low salinity site (yearly mean of 6.2 ± 2.3, USGS Recorder 073745258), Bay Gardene (BG) as the low-intermediate salinity site (yearly mean of 10.4 ± 2.5, USGS Recorder 07374527), and Mozambique Point (MP) as the intermediate salinity site (yearly mean of 13.1 ± 2.5, LDWF weekly salinity data). Grand Isle (GI), a barrier island bordering the Gulf of Mexico, was selected as the high salinity site (yearly mean of 20.9 ± 1.9, USGS Recorder 073802516).

2.3. Study design and measurements

On October 12, 2011, 16 ALS culture bags containing 75 oysters per bag were prepared for each stock at the Louisiana Sea Grant Oyster Research Hatchery and Demonstration Farm. The shell heights of 25 oysters from each bag were sampled haphazardly and the bags were returned to the ALS. On November 4, 2011, 12 bags from each stock were deployed in Breton Sound, four bags of each stock per site. Bags deployed at the three sites in Breton Sound were held just off-bottom by 0.3 m PVC legs. The four bags from each stock that remained at the Sea Grant Oyster Research and Demonstration Farm in Grand Isle were suspended beneath the water surface in the ALS. These bags were not air dried to maintain consistency with the bags deployed in Breton Sound. In summary, four ALS culture bags containing 75 oysters per bag were deployed for each stock at each of the four sites, or three hundred oysters per stock per site, for a total of 1200 oysters deployed at each site. All bags used for the study were fully enclosed to prevent predation mortality. Since predation was largely removed, mortality could be more readily attributed to stressful abiotic conditions and *P. marinus*. At all four sites, oyster mortality (counts of live/dead) and growth (shell height) data were collected about bimonthly for a total of seven sampling periods (Table 1). In addition, 15 oysters from each stock at each site were sampled in March (CB, BG, MP) or April (GI), July and September 2012 to determine changes in *P. marinus* infection intensities and condition index from the time of deployment following protocols listed below.

Hourly water salinity and temperature data were obtained from real-time monitoring stations located in Cow Bayou (USGS station 073745258), Bay Gardene (USGS station 07374527) and Barataria Pass at Grand Isle (USGS station 073802516) adjacent to where the oysters were deployed. An YSI-650 sonde (YSI Incorporated, Yellow Springs, OH) was placed at Mozambique Point which lacked a USGS real-time monitoring station, to record salinity and temperature hourly. Daily salinity and temperature means calculated from the hourly data at each site were used to determine interval salinity and temperature (mean ± standard deviation) between sampling about every two months.

Mortality was measured by counting dead oysters and the proportion of dead to total oysters was calculated to determine interval mortality for each stock at each site. Dead oysters were discarded at each sampling. Cumulative mortality was calculated following Ragone Calvo et al. (2003a).

Twenty-five oysters from each bag were sampled haphazardly and their shell heights were measured from shell umbo to distal edge using a digital caliper (ABS Coolant Proof Calipers, Mituyoto Corporation, Japan). Monthly interval growth rate was calculated as the increment in mean shell height between two consecutive sampling times divided by the number of days between sampling and standardized to a 30 day period. Mean growth rate was calculated using the mean shell height of each bag (N = 4).

Perkinsus marinus infection intensity was determined by sampling 15 oysters (i.e., 3–4 oysters per bag) from each stock at each site (Table 1). The number of parasites per gram of oyster wet tissue was