

# Monitoring spatfall and seasonal survivorship of the Eastern oyster, *Crassostrea virginica*, in the Mullica River–Great Bay estuary, New Jersey

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## Abstract

New Jersey's coastline has over 100 miles of small coastal bays that separate the barrier islands from the mainland. Of these bays only the Mullica River-Great Bay (MRGB) system has a viable oyster fishery (Figure 1a). The State's Bureau of Marine Shellfisheries conducts limited annual assessments of the MRGB oyster beds but has not had the resources available to assess larval availability via spatfall monitoring. Stockton University has initiated an annual spatfall monitoring program supported by a number of internship and small funding opportunities, among them a NJDEP internship in 2014 and support from the Stacey Moore Hagan Memorial Scholarship (Rutgers University) during both seasons. Spatfall of the eastern oyster *Crassostrea virginica* in the MRGB system was assessed (2014 and 2015) at 10 sites along the salinity gradient (~15-25 ppt) from the Fitney Bit beds to an area approximately 8 km upriver (Collin's Point). Following methods generally adapted from regional efforts (Rutgers HSRL, NJDEP), spatfall was measured using (20) clean oyster shells suspended in a bag 0.5m from the bottom. An additional component of seasonal survivorship and growth was measured by leaving a collection bag on site through the growing season. The 2014 season was highlighted by a single moderate set in mid-July with set numbers increasing upriver. Seasonal bag growth was highest upriver, as was survivorship with most downriver sites experiencing near 100% mortality due predominantly to oyster drill predation. The 2015 season also saw a moderate set in mid-July but with more uniform spatial distribution and greater survivorship and higher per shell set numbers down river (than 2014). Additional set continued through the 2015 season with some set occurring after September 1, 2015. Water quality data from the Jacques Cousteau NERR's Chestnut Neck site was used to compare temperature and salinity trends during the study periods.

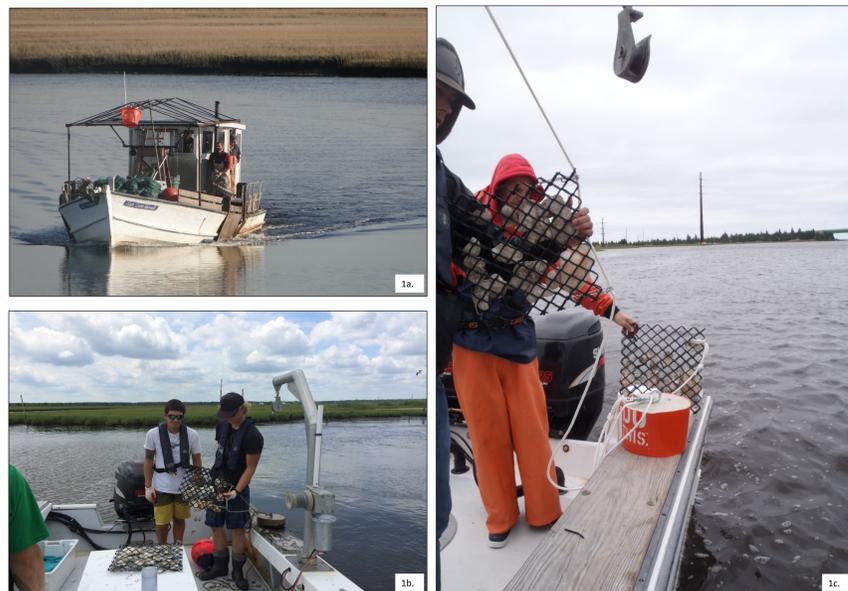


Figure 1a. Local oyster boat returning to Nacote Creek with a load of bagged MRGB oysters (photo courtesy Kim Maxwell). 1b. The authors show bags used to collect spat data using 20 clean oyster shells per site along with one single surf clam shell. Surf clam shell data is being kept separately to assess collection methods for future efforts and it is not considered in data analyses here. 1c. Deployment set up showing one suspended bag and a seasonal bag which lies on the bottom for the entire study period to help assess survivorship and growth at each site.

## Methods and Materials

In order to measure settlement of the common eastern oyster *Crassostrea virginica* in the Mullica River-Great Bay (MRGB) estuary, 10 sites along the salinity gradient were chosen. These sites begin downstream at the known beds of Fitney Bit - to areas approximately 6-10 km upriver (Collin's Point) where local waterman and NJDEP data collection efforts note increasing spatial coverage of oyster seed (Figure 2). Spat collection bags (370 mm x 300 mm / 25mm mesh size) consisting of 20 clean and flat oyster shells of average size (~3") were deployed from June 1 - September 30 of each year (2014 and 2015). In addition to the bi-weekly monitoring bags, five "seasonal" bags spread evenly (Collin's Point, East Bridge, Moss Point, Doctor's Point, Mullica Lump) along the salinity gradient were established for the entire spawning season to assess survivorship and growth at the season's end. During sampling events bi-weekly bags were removed and replaced with new spat bags while qualitative notes were taken to track general health of settled spat, obvious predation, bio-fouling and sedimentation. The settlement of spat was recorded from the smooth inside surface of each shell using 20x magnification. Examination of spat with 40x magnification was done periodically to confirm the 20x observations and raw data was entered into Excel for later analysis.

At the end of the study period the seasonal bags were retrieved and all available spat set (both sides of the shells) were analyzed for spat growth and mortality. In 2014 digital images were taken of each valve (front and back) from seasonal bags and the Image Pro image analysis software suite used to measure spat size from saved images. In 2015 time constraints allowed only max and min measurements per shell per site. Where possible the cause of mortality was noted when dorsal shell remained (i.e. oyster drills were prevalent in 2014 and that data was captured via observation of the cleanly drilled hole). If no dorsal shell remained or there was no clean oyster drill hole the mortality was recorded as "other".

Water quality data was collected within 1m of the bottom during each sampling event using a YSI 6000 series instrument. In 2014 an unattended data logger was provided at the river mouth by a NJDEP Bureau of Marine Water Monitoring/Stockton partnership and funded by an internship program with NJDEP Bureau of Shellfisheries. Staff and funding constraints in 2015 prevented the river mouth site from being deployed but unattended sampling data from the nearby Jacques Cousteau NERR's Chestnut Neck site has worked well to compare temperature and salinity trends during the two study periods.

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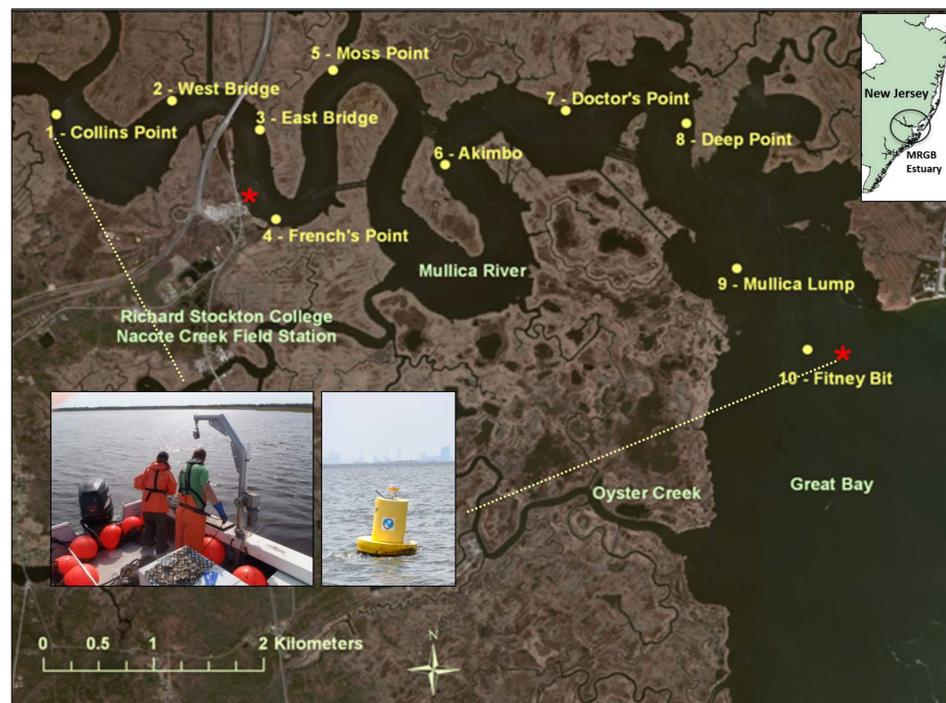


Figure 2. Ten sites within the Mullica River-Great Bay estuary were chosen based on their spatial distribution and the location of historical harvest and seed beds. The area encompasses both State and private leases with most natural seed beds occurring upriver of Akimbo Point and most grow-out by local waterman occurring East of Fitney Bit (and not shown in this image). Water depths range from 3 - 10 meters throughout the area. The water quality data collection site near Fitney Bit was active only in 2014 whereas the Chestnut Neck site near French's Point made data available for both study periods.

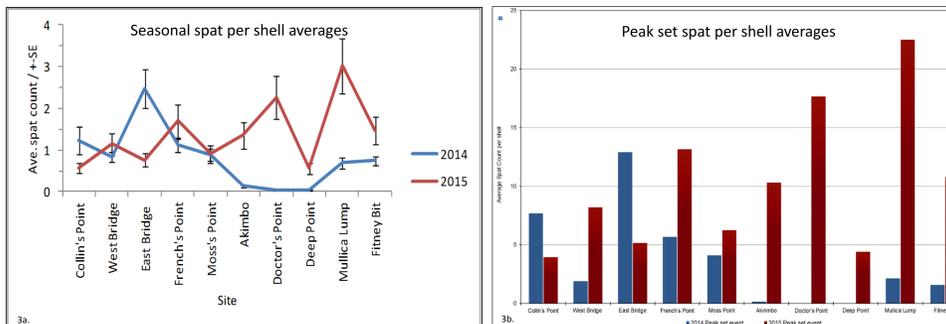


Figure 3a. Average spat count per shell as collected and averaged over the course of the full study period June - October. 3b. Average spat count per shell during the peak oyster spat settlement only (mid-July for both 2014 and 2015).

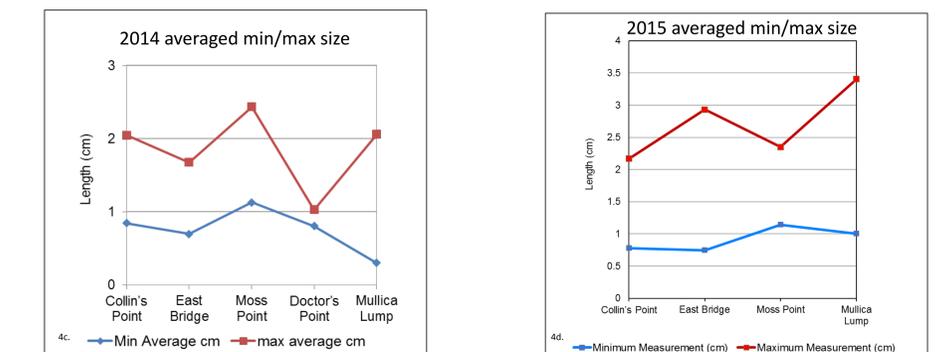
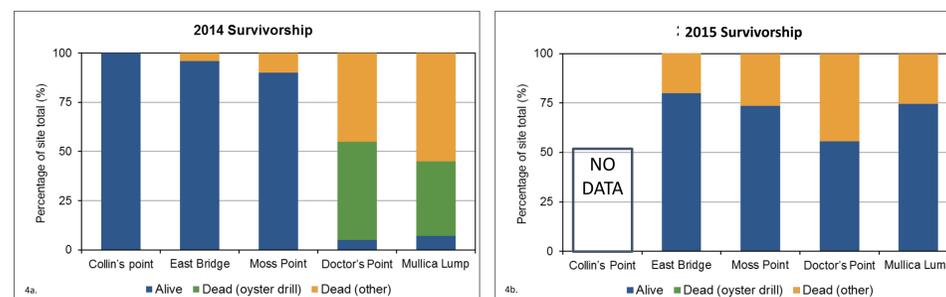


Figure 4a. Survivorship data from 5 sites in 2014. 4b. Survivorship data from the same 5 sites in 2015. 4c. Averaged maximum and minimum spat size as taken from seasonal bags collected at the end of the study period in 2014. 4d. 2015 size data.

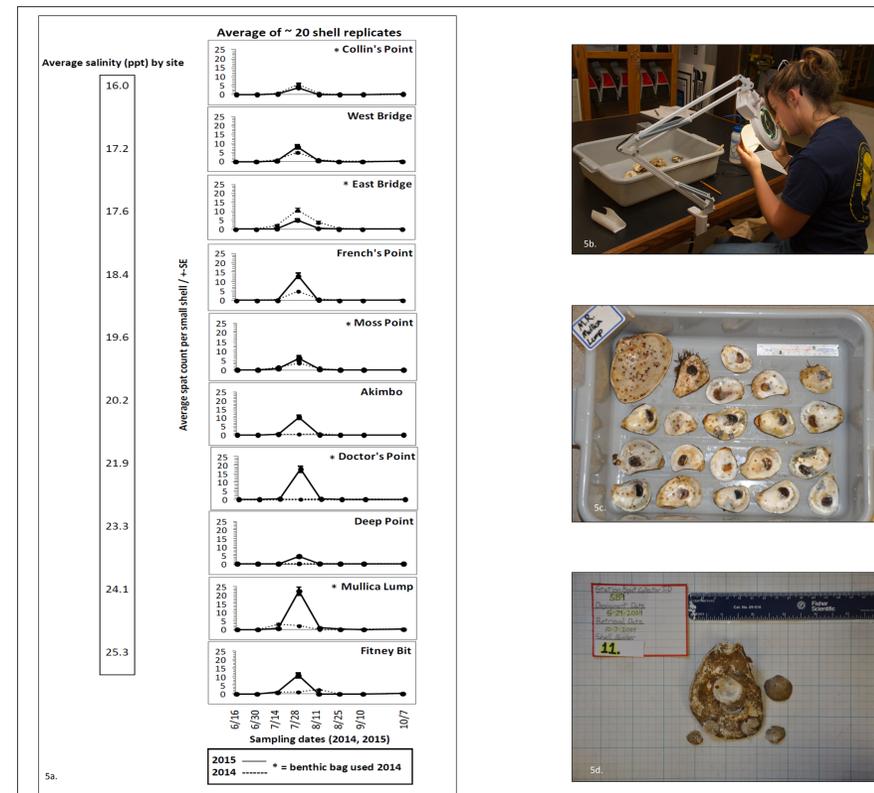


Figure 5a. Average spat count per shell throughout the setting season in the MRGB system, 2014 and 2015. 5b. Stockton students funded through various internships contributed to the data analysis. 5c. Bi-weekly bags included 20 clean oyster shells and one surf clam (data for surf clam not included here). 5d. 2014 growth data was documented by camera and here shows the obvious oyster drill predation hole used in survivorship and growth data.

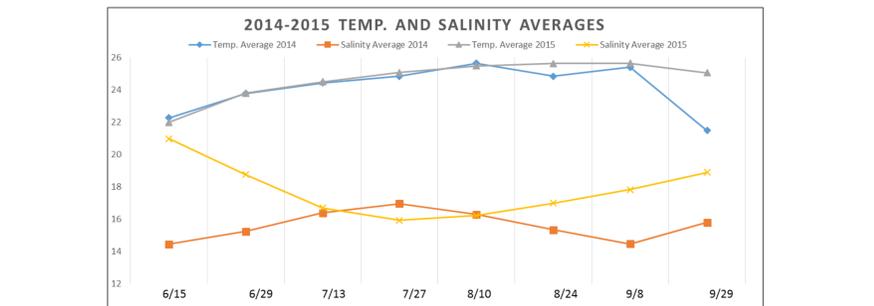


Figure 6. Temperature and salinity data averaged in two week periods. Data provided by the JC NERR chestnut Neck site and compliments of CDMO (<http://cdmo.baruch.sc.edu/>).

## Results and Discussion

While the authors recognize that longer term datasets will be needed to draw conclusions that may aid local waterman and shellfish managers, two years of spatfall data does allow for some level of spatial and temporal comparisons. The apparent similarity between seasons was highlighted by the relative timing of the peak spat set (Figure 5a) and the corresponding similar salinity and temperature averages for the week's preceding those sets (Figure 6a.). During both seasons the peak spat set occurred in mid-July under relatively similar water conditions. The majority of data collected in this program revealed differences between 2014 and 2015, among them were spatfall numbers (per shell avg.), locations, survivorship and growth rates.

Seasonal spat per shell averages and peak-set spat per shell averages (Figure 3a and b) were greater at all sites in 2015 except at two upriver sites (Collins Pt. and East Bridge). Of particular interest was the significantly higher set downriver in 2015, a set that also saw much higher survivorship in 2015 relative to 2014 (Figure 4a. and b.). The Mullica Lump site experienced 93% mortality in 2014, 38% of which was directly attributable to oyster drill predation (Figure 4a). The 2015 Mullica Lump set experienced 26% mortality, none of which could be confirmed to be oyster drill predation. It is possible that the harsh winter of 14/15 dampened oyster drill predation in 2015. This could also be true of disease prevalence (J. Maxwell, personal communication). Growth rates determined by averaging maximum and minimum sized spat per shell (on seasonal bags left out) are shown in Figure 4c. and d. The average maximum length of spat set in 2015 was approximately 40% larger (than 2014) across the five sites (Figures 4c. and d.).

The establishment of a spatfall monitoring program in the MRGB estuary will allow local waterman and shellfish managers access to data that has otherwise been difficult to collect due to funding constraints and the relatively small size of the oyster fishery (i.e. compared to Delaware Bay). While only two years into the program certain trends have evolved and the relevance of the data being collected will increase over time. Stockton University will be actively seeking programs to provide student funding to keep this long term data program in place.