Final Report on Research Activities

of the Stockton University Marine Field Station

in support of

Analysis of Oyster Larval Recruitment in Barnegat Bay

Submitted to the Barnegat Bay Partnership

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Barnegat Bay Spatfall Monitoring for LEH region

Stockton University, specifically the Faculty and Staff of the Marine Field Station (SU Field Station) provided research, technical, and reporting support to the Barnegat Bay Partnership (BBP) as part of the establishment of a system-wide monitoring program related to the Bay's oyster fishery and its annual spatfall season. The performance period of the monitoring was from June 1, 2015 – September 30, 2015, the typical spawning season of oysters in the Mid-Atlantic region. Questions about the research or results can be directed to;

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Methods and Reporting

In order to measure settlement of the common eastern oyster *Crassostrea virginica* in the southern Barnegat Bay (BB) estuary, 10 sites in the southern Little Egg Harbor (LEH) Bay region were selected cooperatively by BBP and Stockton (**Figure 1**). Additional sites to the north of the LEH Bay stations covered by Stockton are part of the overall BBP effort but are not covered in this report.

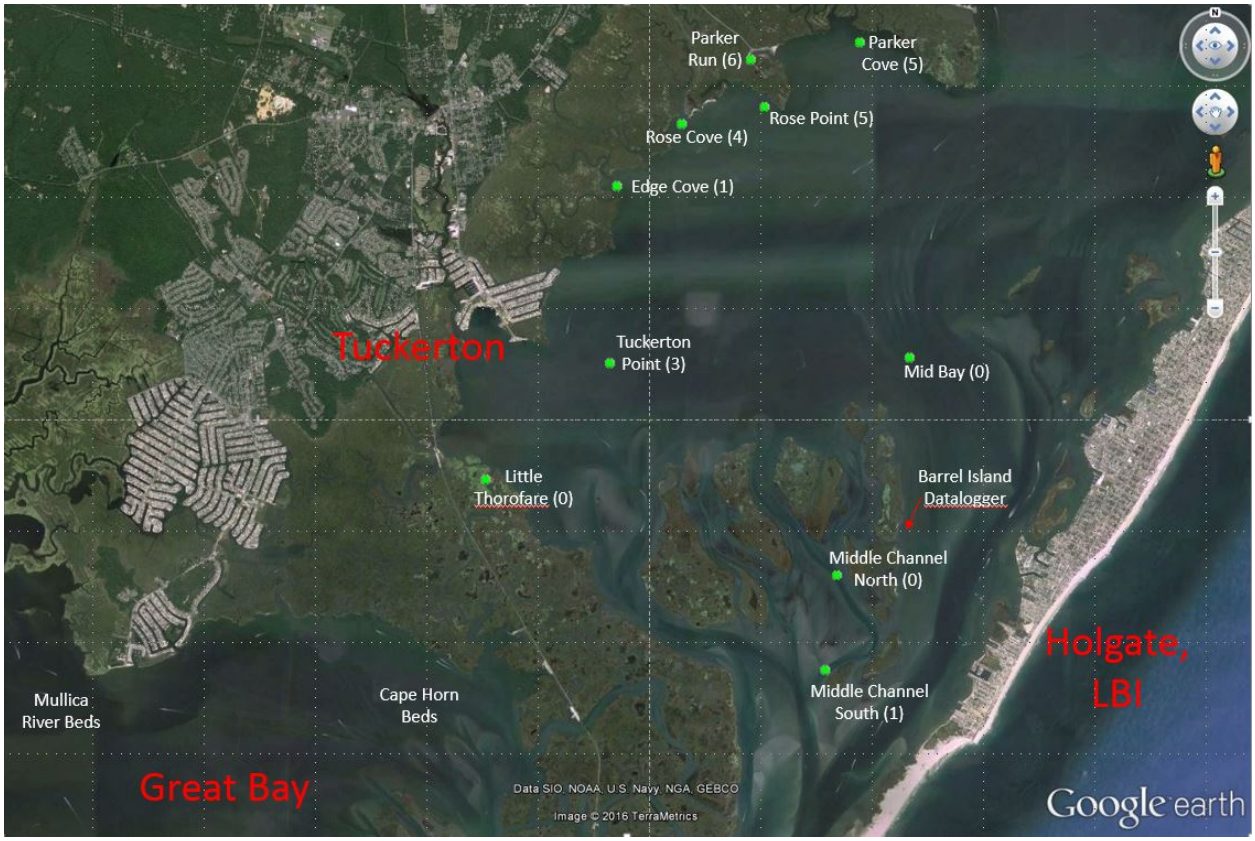


Figure 1: LEH Bay study sites where the number in (parentheses) indicates the total number of spat observed during the entire study period at that individual site.

Using established monitoring methods, a bi-weekly spat settlement (SS) collection bag consisting of 20 clean oyster shells was placed via buoy at each site and suspended approximately 0.5m from the bottom. An additional individual surf clam shell was placed in each bag as a separate proof of concept method related to other Stockton efforts – this data is not included in this analysis but is mentioned anecdotally later in this report. A student intern was responsible for swapping out bi-weekly bags and processing settlement data via conventional microscope and magnifying glass methods common to spatfall monitoring programs in the region and to the Quality Assurance Program for this particular project (Reilly, 2015). Given the very low spatfall observed in this study all spat observed by student researchers during this project were confirmed by the co-PIs before being recorded.

Upon retrieval, the bi-weekly bags were removed and replaced with new SS bags. Prior to bag retrieval, a multi-parameter sampling probe (Y.S.I. 6600) was used to collect discrete samples, including water temperature and salinity. Additional temperature and salinity data is provided from an established site in LEH Bay (Barrel Island) as a reference for seasonal values that are used to correlate spatfall events. Discussion can be found in the Results section. Stockton's water quality monitoring programs follow stringent quality controls adhering to the general practices of NOAA's system-wide monitoring programs and to the QAPs established for this study and past BBP/EPA-approved studies.

The bi-weekly collection bag was analyzed for spat settlement at each site. The settlement of spat was recorded from the ventral surface of each shell using 10X magnification. Examination of spatfall with up to 40x magnification was done periodically to confirm the 10x observations. The shells were cleaned using warm water and allowed to dry before reuse only if there were no spat present. Once dry, the shells were randomly selected for reuse in the bi-weekly SS bags if needed. Recording methods followed the Quality Assurance Program in place (Reilly, 2015).

RESULTS

Spat settlement for 2015 across the 10 sampled sites was low with spatfall being recorded during 3 of the 8 bi-weekly retrieval periods. A total spat settlement across all stations peaked at 12 individual spat on June 15th followed by 6 individual spat on July 27th and earlier in the season by 5 individual spat on July 13th. It is important to note that these spatfall numbers represent the total 10-site/20 shell per site (200 shells total) numbers – they are not per site averages but actual spat counts from 200 shells per bi-weekly retrieval event. These are extremely low spatfall numbers representing very little if any potential for recruitment to the LEH bay oyster population. The June 14 spat observations appear early for this region however they do correlate with a period of rapidly rising water temperatures following a very warm May, possibly explaining an early set. Figure 6 shows a short cool down in the first week of June, possibly just <u>after</u> a late May spawn that led to the June 14 spat observations.

Figure 3 shows the total spat count observed per station during the entire study period. Three sites (Little Thorofare, Mid Bay, Middle Channel North) received zero spat settlement over the entire study. Little Thorofare, a connecting creek from Great Bay to LEH Bay was theorized to be a potential source of spat and was found to be characterized by strong tidal flow. This site was lost by vessel cut-off, vandalism or current issues during both June deployments and again (after deployment modification) in August and September. It is possible that spatfall, especially during the observed early season peak, did occur at this site. One spat was observed (at Little Thorofare) on an "extra" surf clam shell placed

in each bag during this study (7/27/15), however observations on the extra surf clam shells are not considered here due to lack of repetition. This site should be discounted from overall analysis (per the QAP) given the frequent loss of data.

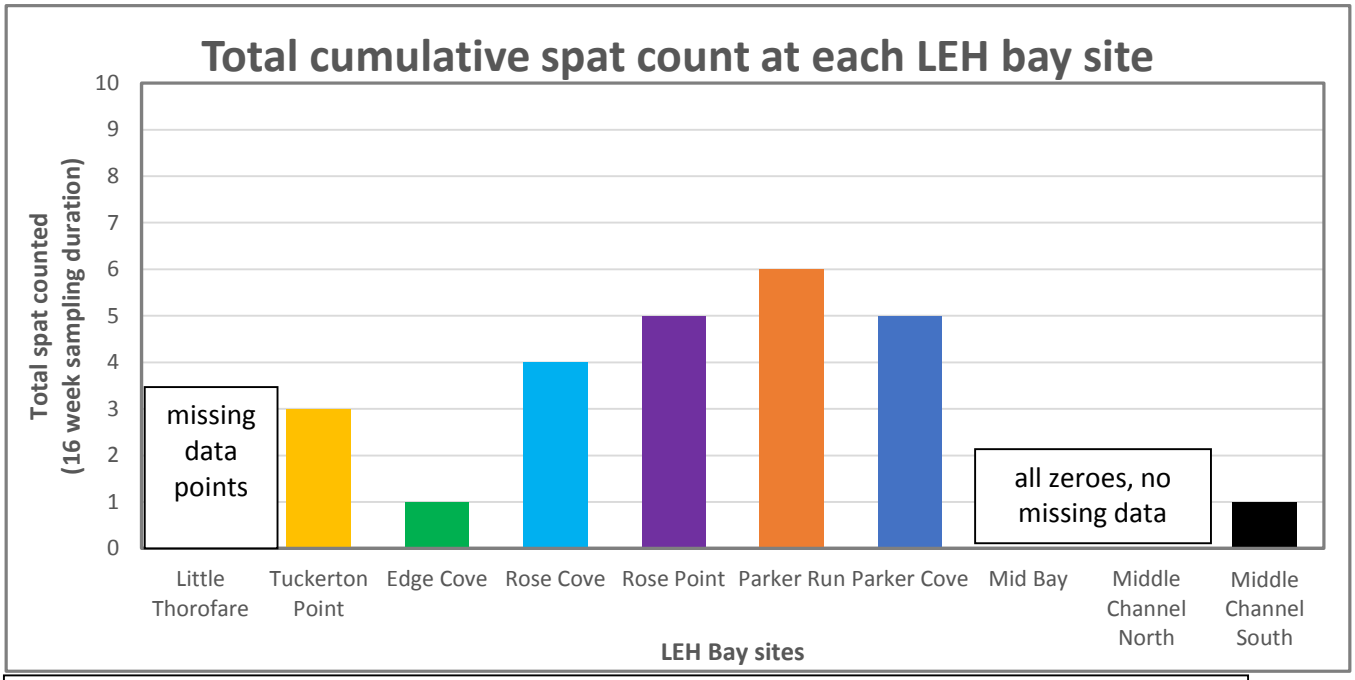
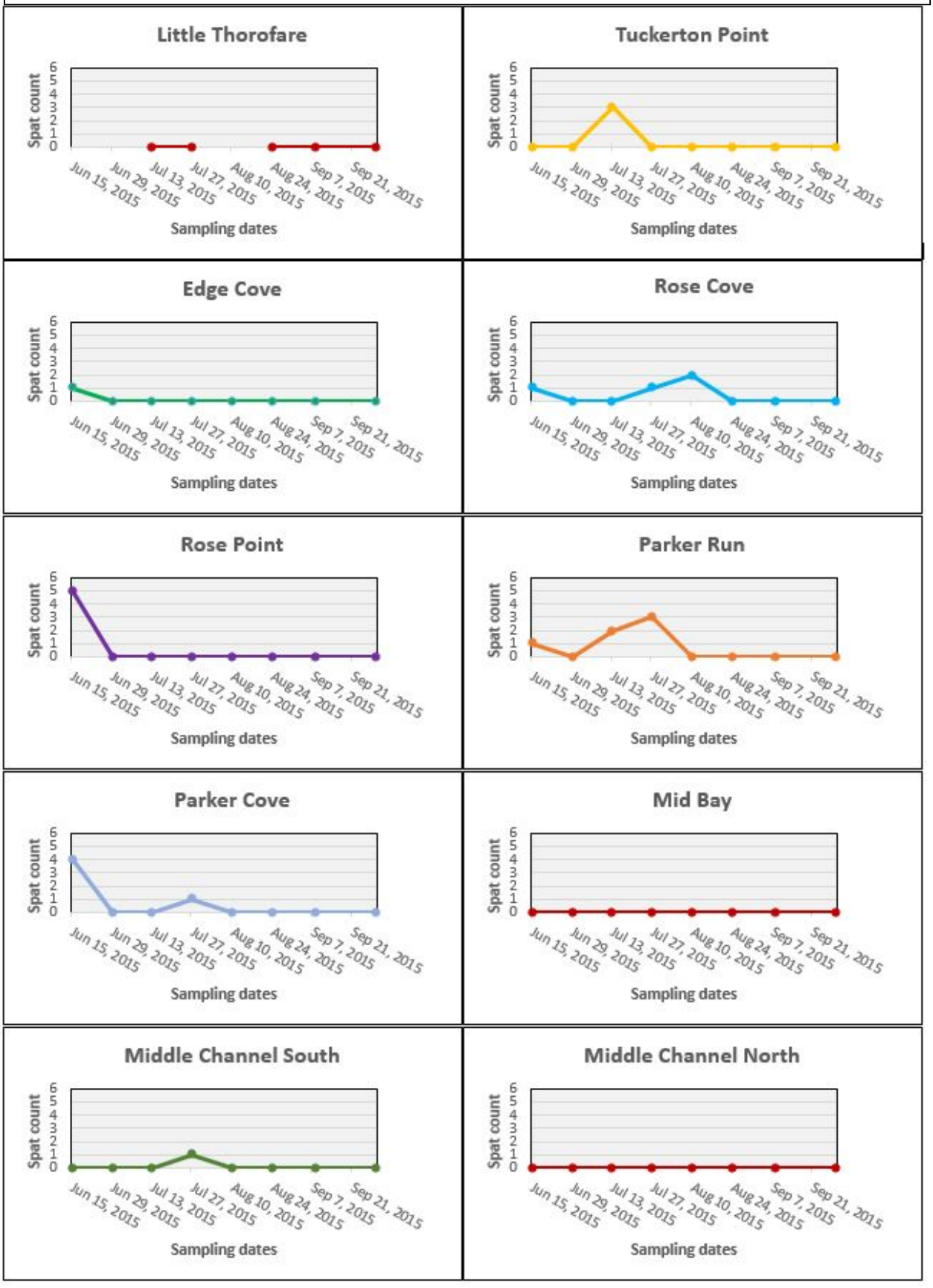


Figure 3: Total spat set per station over the entire study period.

The Parker Run site received the greatest spatfall numbers throughout the entire study period, followed by Rose Point and Parker Cove (Figure 3). It is possible that several shellfish leases in this area where diploid oysters are being grown out in cages may contribute to the observed spatfall. The Parker Run site was also characterized by the lowest average salinity value by approximately 3 ppt (27ppt vs 30 ppt) and is also an historical oyster bed (US Department of the Interior, 1963).

The following page (Figure 4) shows spat count per site per sampling event. Two general setting events, albeit very low in number, occurred. The most significant event occurred very early in the season, possibly the result of rapidly rising water temperatures during the second half of May. Figure 6 shows the uptick in water temperatures that could have led to a spawn prior to the one week of cool temperatures in early June. This event was observed in 5 of 10 stations but in very low numbers. Tuckerton Point's only set of the season was observed in mid-July when Parker Run also received a recordable set. July 26 into early August saw set numbers remaining in the very low single digits for 4 of the 10 sites. Overall, no strong pattern was observed especially given the very low spat numbers.

Figure 4: Spat set per retrieval date.



Water quality discussion

The average salinity at each of the ten sites shows a very small salinity gradient across this region of the bay, with the exception of Parker Run which is the only site located up inside of a tidal creek where some level of freshwater input occurs (Figure 5). This data is based on only eight discrete bottom measurements taken during retrieval events and does not consider tide stage. These values (8 samples per site) have been averaged together to give some feel for the salinity range of the area but it is noted that sample number is very low.

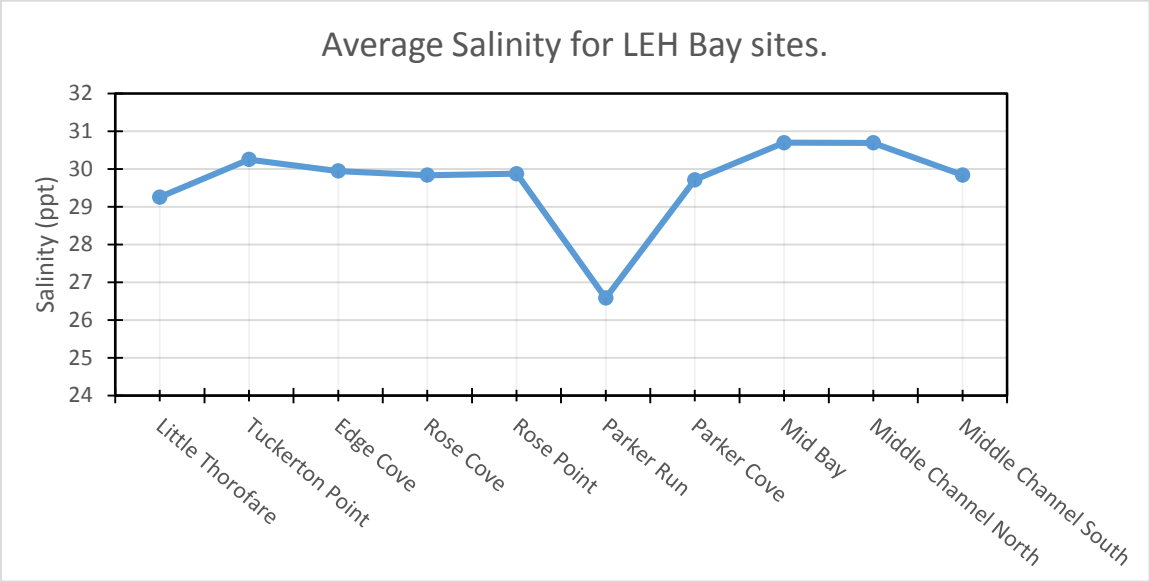


Figure 5: Average salinity from retrieval data (8 events per site).

In contrast to the small sample numbers averaged together in Figure 5, Figures 6 and 7 show data from a long term monitoring station near Barrel Island, approximately 1-2 nm from the various study sites (Figure 1). This monitoring station provides accurate seasonal values using data collected every 15 minutes 24/7; data shown in Figures 6 and 7 show the average temperature and salinity values on a per (previous) week basis from May 15 – September 30, 2015.

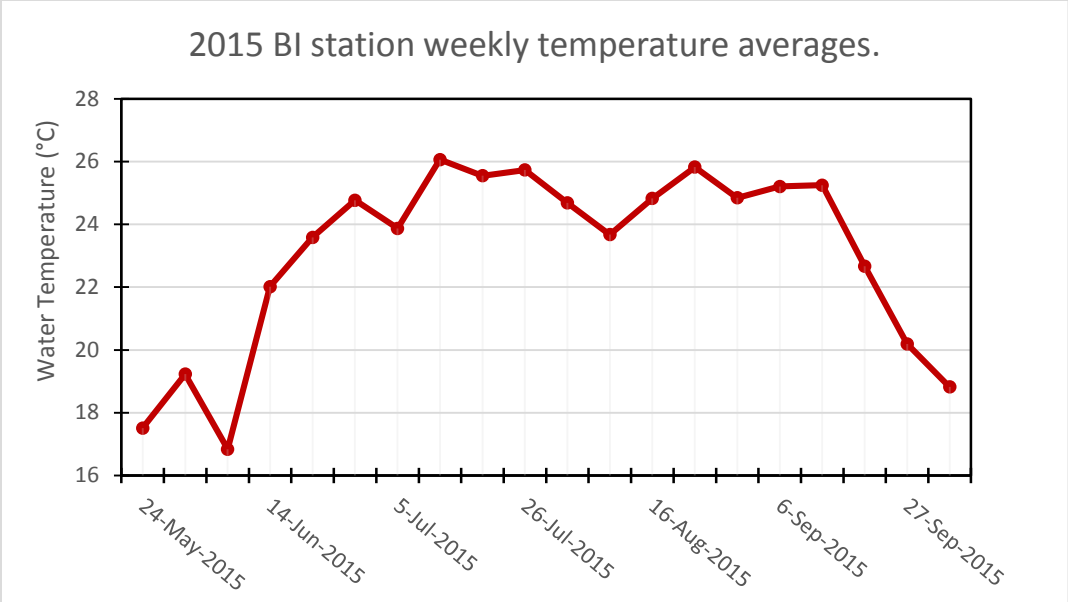


Figure 6: Average weekly water temperature from the nearby Barrel Island station.

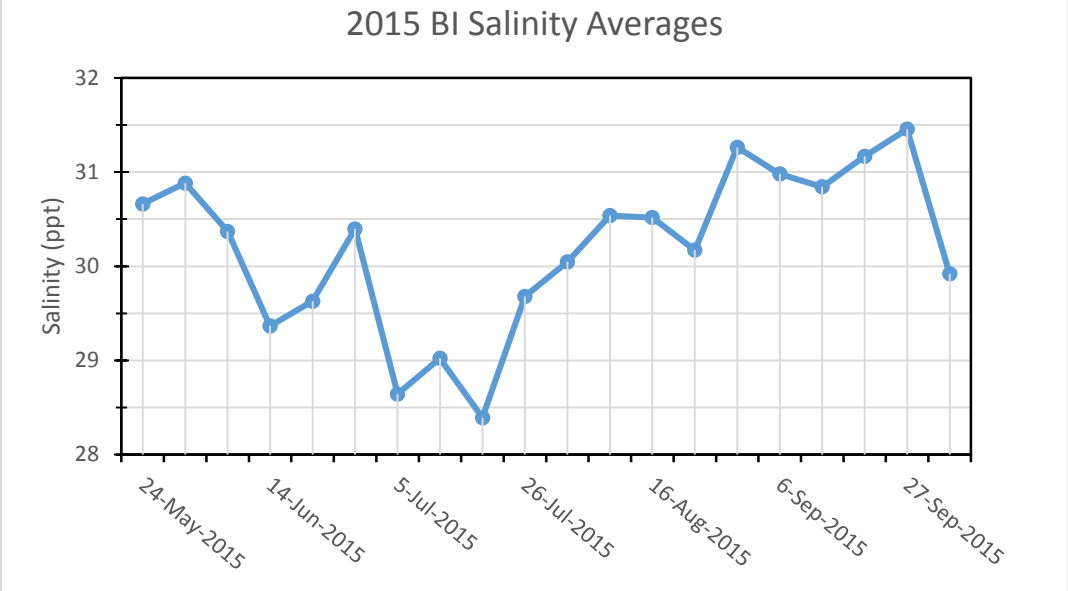


Figure 7: Average weekly salinity from the nearby Barrel Island station.

Of particular interest in the temperature data was a sharp increase prior to sampling period #1 where temperatures rose several degrees C before June 1, possibly triggering a spawning event that could explain the small set observed on June 14 which is generally considered early in this area. The June 14 spat observations (12 individuals) were very small but were agreed upon by the co-PI's to be oyster spat after careful consideration. Temperature thereafter remained fairly consistent at ~ 25C until the mid-September cool down. The salinity range at Barrel Island is fairly small, however the values in the second half of Summer 2015 clearly show the results of low rainfall and a dry season.

CONCLUSIONS and FUTURE WORK

Increasing occurrence of intertidal oysters via direct observation in the LEH bay region has been proposed to be potentially related to shifts in oyster beds in the adjacent Mullica River-Great Bay system (Figure 1).

Figure 8: Parkertown boat ramp intertidal oysters and Middle Channel oysters set on Sandy tree debris (Evert).

The MRGB oyster fishery is one of the last viable oyster fisheries in an Atlantic Coastal Bay in New Jersey and the area experienced strong spatfall in both 2014 and 2015 (Evert, 2014 and 2015). These strong year classes of oyster recruitment did not translate to the areas sampled in the LEH Bay study for 2015. While spatfall numbers were not expected to be comparable to the MRGB system, Stockton researchers and local shellfish farmers did anticipate greater set numbers than observed in this 2015 LEH Bay study. At some point over the past ~5 years a modest set of intertidal oysters occurred in the LEH Bay region as evidenced by areas of sedge oysters set on intertidal ribbed mussels. It remains unclear where the source of this spatfall originates and further study is warranted.

Continued development of assessment methods appropriate to funding levels and other available resources may provide more flexibility in future monitoring efforts and ensure some level of continuity moving forward and looking toward establishing a long-term data set for LEH bay region. This continued effort could be important if oyster aquaculture leases and restoration and research activities continue to increase in the region. Questions that may remain regardless of this year's low spatfall results could include:

- Will regional aquaculture activities have the potential to increase spatfall?
- Will regional research and restoration activities increase spatfall?
- Are intertidal sets in LEH Bay an important factor?
- Are there other areas of LEH Bay that due to circulation patterns receive Great Bay-derived spatfall?
- Does the potential for LEH Bay spatfall change according to a given season's weather and in turn its closely related estuarine water circulation patterns?

Development of a less intensive but long term data set for this effort and repeat sampling with some reference to seasonal patterns could be used to attempt to answer these questions.

Changes and/or suggestions for the 2016 data collection efforts might include;

- More sites, lower sampling frequency (less labor/expense but maintain/establish a longer term data set).
- Intertidal sites
- Intertidal assessment of natural set or current numbers (by walking the shorelines at low tide)
    - However, harvest of these intertidal oysters is known
- Current and estuarine drifter studies (larval transport)
    - Stockton new Physical Oceanography interest exists (Dr. Anna Pfeiffer-Herbert)

Establishment of the BBP-funded LEH Bay oyster bed (pilot level one acre site) during the summer of 2016 may provide an additional mechanism for monitoring spatfall in this region. It may also contribute to increased spatfall. Differentiating between spatfall generated from the LEH reef live oyster placement process versus larval transport from other beds or systems may not be feasible but will provide a mechanism to remain vigilant for spatfall at this particular LEH Bay site. Changes in the State's determinations of oyster grow-out in less than approved waters (for restoration or living shorelines) and/or increases in the number of open water oyster leases granted by the State in response to rising interest by local shellfisherman may also provide additional opportunity for increased spatfall as local agencies, organizations and shellfisherman look to increase natural populations of the Eastern oyster in Barnegat Bay.

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References

Reilly, Erin. 2015. Analysis of Oyster Larval Recruitment in Barnegat Bay. Barnegat Bay Partnership and Stockton University, Quality Assurance Program. Effective June 2015 to June 2016.

US Department of the Interior, Fish and Wildlife Service. 1963. Distribution of shellfish Resources in Relation to the New Jersey Intracoastal Waterway, Plate III.

Evert, S., P. Straub and M. Sullivan. 2014 and 2015. Report on the Mullica River-Great Bay Spatfall Monitoring Project, submitted to NJDEP Bureau of Marine Shellfisheries.