Water Quality Of The West And Rhode Rivers Pertaining To Oyster Population

Stephen Gauss – astro@westriveroyster.org
Revised February 2011

In July 2007 the West and Rhode Riverkeeper began a program of sampling the water quality in the two rivers every week on Wednesday through the end of October. Sampling has begun since 2008 in early May. There are now data available for three complete seasons and the 2007 partial season comprising measurements of dissolved oxygen (DO in mg/l), percent of saturation of dissolved oxygen (DO in %), salinity (parts per thousand – ppt) and temperature. Measurements were taken one foot below the surface (top) and one foot above the bottom (bottom). The sites chosen for this study are shown in Figure 1.

Oyster characteristics

While the West and Rhode Rivers have traditionally had productive oyster harvests, there are few oysters left on natural bars now. Efforts by POWeR, CBF and others to restore oysters to the rivers have created several new oyster "sanctuary" reefs and from all appearances the oysters are doing well. A recent sample brought up oysters over 150mm in length from two of these sites. However, no evidence has yet been found of an oyster set; that is, no small oysters on the shells of live large oysters. So a look at the water quality data to determine the likelihood of spawning seemed to be in order.

In general oysters spawn in temperatures greater than 20^{o}C[1]. This has occurred in the study years from the last week in May through the end of September. Oysters do best in salinities of 10 to 30 ppt and 15 – 18 is considered optimal.[2] These measurements began at the end of the drought years in the middle 2000's. In 2010 there was little rain and a drought warning was in effect for much of the summer. Then at the end of September, Tropical Storm Nicole brought a deluge. In figure 2 it can be seen that the salinity for 2010 was almost exactly in line with that of 2007, the last major drought year, until September 30.

Caveats

The readings were taken by varying crews of volunteers with meters made by YSI, but of different models at various times[3]. Accurate readings, especially of the dissolved oxygen components, depend on careful calibration of the meter, careful use of the meter in taking the measurements and care in recording the data. In some cases data could not be taken at one or many sites due to weather conditions. Apparently little checking was done to confirm the validity of aberrant readings at the time of measurement, although unusual readings may have been discarded at a later time. Odd readings are especially apparent in

[1] http://www.ca.uky.edu/wkrec/OysterCultivation.pdf
[2] http://www.ca.uky.edu/wkrec/OysterCultivation.pdf
[3] 2007 – one YSI-85 meter was used by one team
2008 – two YSI-85 meters were used by two teams
2009, 2010 – one YSI-600Qs and one YSI-600XL meter used by two teams

the 2007 data, the first year of the program. No readings were taken during the week of TS Nicole, readings were taken at CBF's Oyster Restoration Center on Parrish Creek and those values were substituted.

Sites chosen for analysis

Four sites were chosen for this study – two in the West River and two in the Rhode River. Selection was limited due to the desire to include data from 2010. At the start of 2010 the locations of most of the sites were changed by the riverkeeper and many of the site numbers were re-used. Therefore it was necessary to select site numbers that represented a similar area for all four years.

- W1 – Tenthouse Creek – this site is close to the POWeR oyster reef #1 (Benning sanctuary site), although it changed to a site further upstream by about 400 yards (but still a fairly wide area of Tenthouse Creek) in 2010.
- W17 – Parish Creek day marker #1 – this is open water near the mouth of the West River and is located in essentially the same place for all four years.
- R4 – Whitemarsh – this site remained in the same location for all four years and is in an open area within a branch off the Rhode River.
- R7 – Cadle Creek – this is a narrow creek, but open to the Rhode River and the location is the same in all four years.

Depth at same date					Normalized to 2007 depths			
	2007	2008	2009	2010	2007	2008	2009	2010
R4	10.6	8.6	10.0	9.0	10.6	8.6	10.0	9.0
R7	6.0	5.1	6.0	6.0	10.6	9.0	10.6	10.6
W1	3.9	3.2	4.8	8.8	10.6	8.7	13.0	23.9
W17	9.3	8.4	9.0	7.0	10.6	9.6	10.3	8.0

All sites were in 6 feet of water or more, except for site W1, the closest to the POWeR site. Unfortunately, that site was moved in 2010 to much deeper water (the POWeR reef is on the side of a bar that rises from about 8 feet to about 4 feet of depth). Also, site W9 at the second POWeR oyster reef was eliminated. So there presently are no samples being taken in the actual proximity to the two oyster sites.

However, by comparing the graphs for the different sites, it appears that there is not a great variation in any of the parameters from site to site and, therefore, the conditions at any site <u>may</u> approximate the conditions at the POWeR reef sites.

Since oysters are bottom dwellers, the samples taken at one foot above the bottom are of most interest.

Salinity

Figure 2 shows the salinity readings. In years 2008-2009 they did not reach 10 ppt until mid-July at most sites, reaching 12 ppt in August or September and not reaching 15 ppt until mid-October – about the same time that the temperature (Figure 3) was heading down past 20^{o}C. However, in the drought years of 2007 and in 2010, the salinity was higher, reaching 10 ppt in mid-June and 12 ppt in mid-July.

Dissolved Oxygen

Both the quantity of dissolved oxygen and the percent of air saturation are recorded. Oysters are very tolerant of low oxygen – undoubtedly because they are unable to move if the levels become low. While more is better, the data of figure 4 show that the oxygen content in mg/liter remains between 4 and 8 in the West River and between 3 and 6 in the Rhode River sites. While there are occasional dips below the minimum, they are almost always recorded in a single week and may, in fact, last for a shorter time. Furthermore, the DO readings are the most difficult to take accurately. It depends on proper movement of the probe through the water, ensuring that stabilization has occurred, keeping the probe solution fresh and always calibrating the meter. It is likely that no sanity check is performed on the data while the readings are being taken, so almost certainly some readings are spurious. Most of the extreme data points occur in the 2007 year, when the project was just beginning and the methods were still being developed.

The quantity of oxygen in the water is an important indicator of the quality of the oysters' environment. But it is also important to know how much oxygen the water is <u>able</u> to hold at a given temperature. Readings of the dissolved oxygen in percent are also taken (figure 5), but it should be understood that these are relative to air. By mixing air with the water, levels as high as 100% can be achieved. However, if pure oxygen is introduced, the levels can exceed 100%. For example, plants expel oxygen, not air, and can raise the oxygen levels substantially – hence the need for aquatic vegetation. While this does not necessarily explain levels above 100%, such levels are possible. Again, many of these occur in the 2007 season and may be spurious. The amount of oxygen that the water can hold is inversely related to the temperature of the water. Therefore, one might expect the oxygen levels to be lower in mid-summer, simply because the water cannot hold as much. Graphs in figure 6 may show this effect – the average dissolved oxygen for all four years is plotted along with the inverse of the temperature for the same period. A 2nd order polynomial fit through the data show the same trend as the temperature. The effect is much less pronounced when compared against the percent of dissolved oxygen –which should remain constant if only temperature is removing it from the water.

Summary

The conclusion regarding the oysters on the POWeR reef site is that the dissolved oxygen levels should not be our main concern. However, for reproduction to occur the conditions are only optimal for a very short time at the end of the summer. Figure 7 shows the average temperature and salinity plotted to show the period when the temperature is above 20^{o}C (T>20) and the salinity is above 12 ppt (S>12). These conditions only overlap in the area shown as optimal (Optimal). Relaxing the salinity criterion to 10 ppt gives an overlap shown by S>10. If all other conditions are right, it seems possible that the oysters <u>could</u> reproduce and set throughout July, August and September in most years. However, conditions are more favorable on average only in September – probably too late to encourage oyster spawning.

During so-called drought years, the salinity level rises as the lack of incoming fresh water allows the saltier ocean water to move up the bay. The same values are shown in figure 8 for years 2007 and 2010. Now the salinity is seen to be high enough that optimal conditions prevail starting in mid-July.

No oyster spat were seen as a result of the 2007 conditions. 2010 appears to have good conditions for a spat set. A mild drought was in effect through August and the salinity was trending exactly the same way as in 2007. On September 30-October 1, Tropical Storm Nicole brought over 9 inches of rain to the area and over 12 inches in other parts of the Bay. The Riverkeeper took no samples during the week covering that period, so data from the daily sampling at ORC on Parrish Creek were used. Immediately following the storm the salinity plummeted by almost 1 ½ ppt. However, it remained above 12 ppt and, therefore, conditions were favorable throughout the setting period. Sampling in the spring of 2011 will be our opportunity to see whether a spat set has occurred.

It would seem that oysters provably do not set very frequently in these rivers. Any restoration of the historic oyster population will likely depend on continually adding oysters to existing bars and creating new bars. It almost certainly will be a slow process.

Sampling Sites

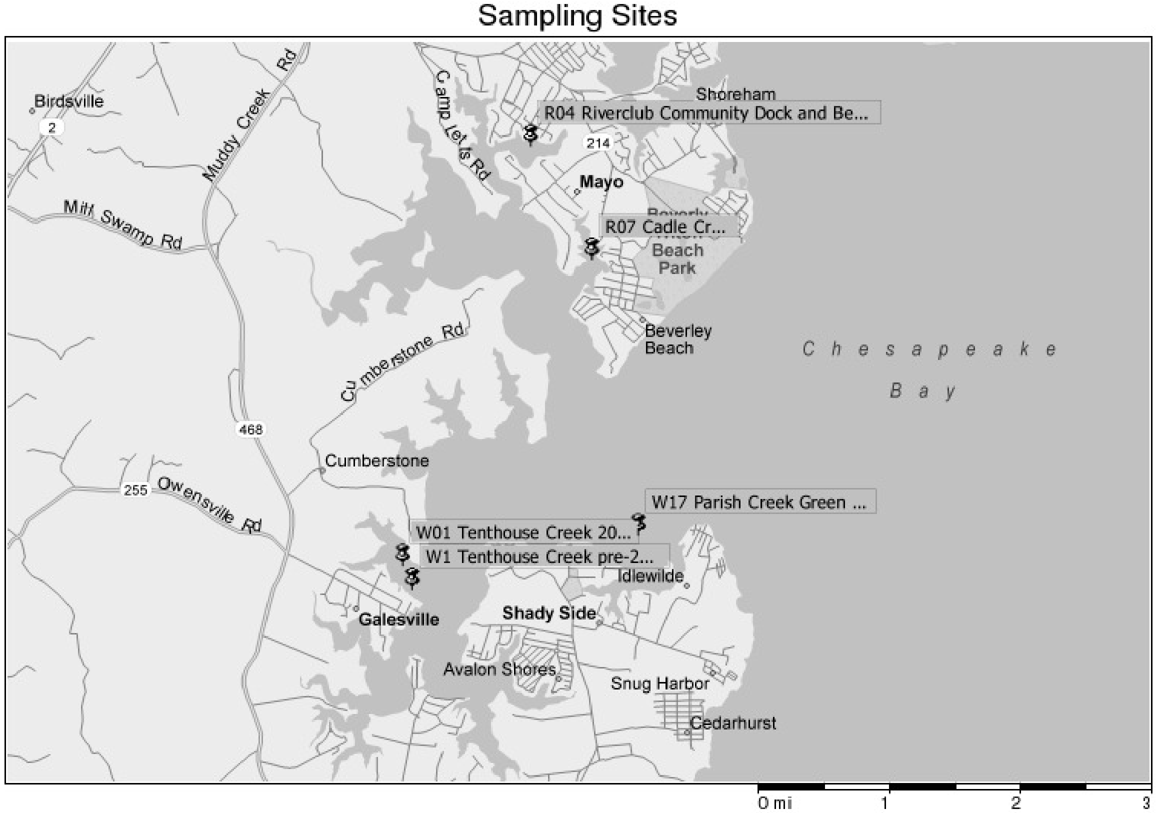


Figure 0 - Sampling sites in the West and Rhode rivers

Salinity of West and Rhode Rivers 2007-2010

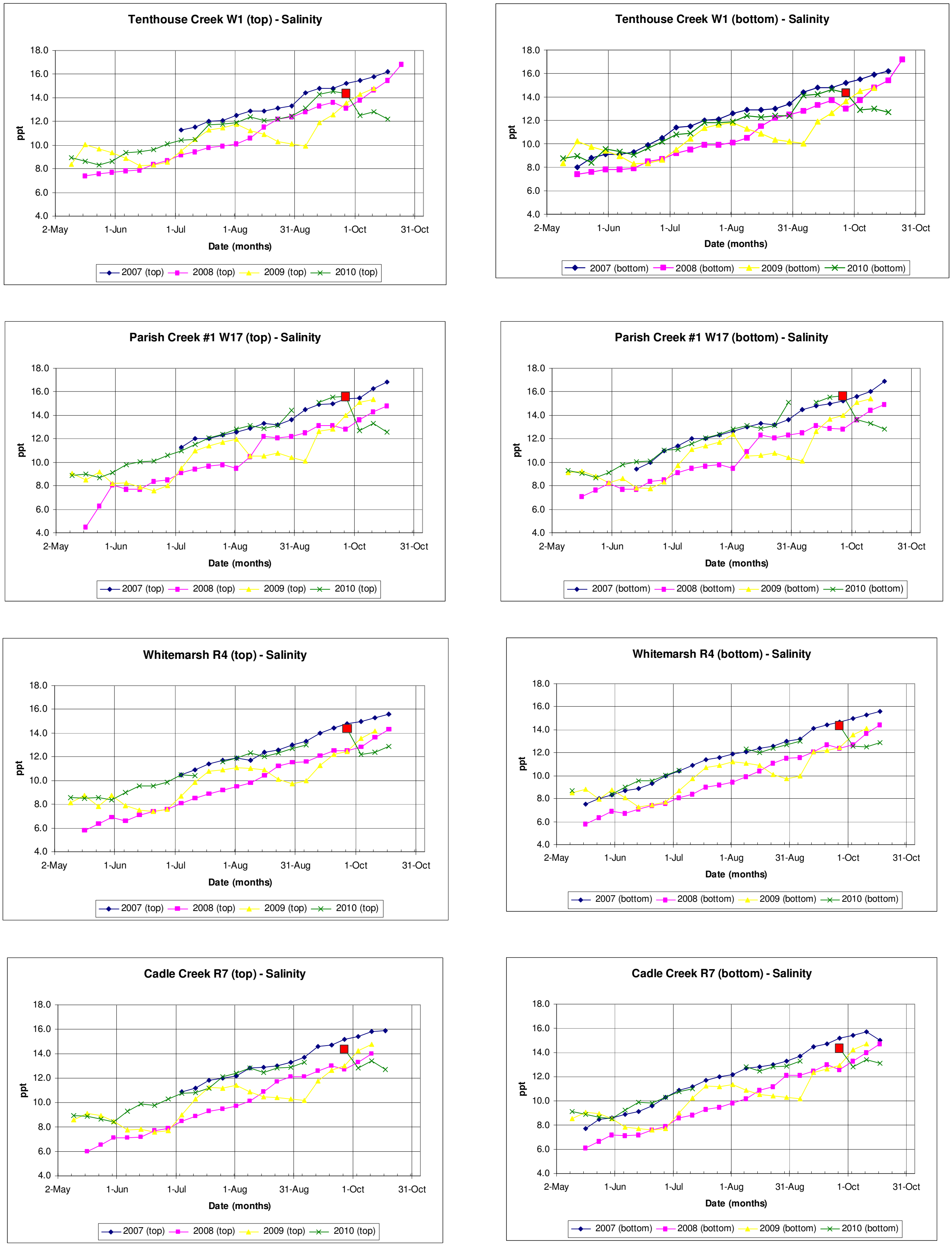


Figure 2

Average Temperature of West and Rhode Rivers 2007-2010

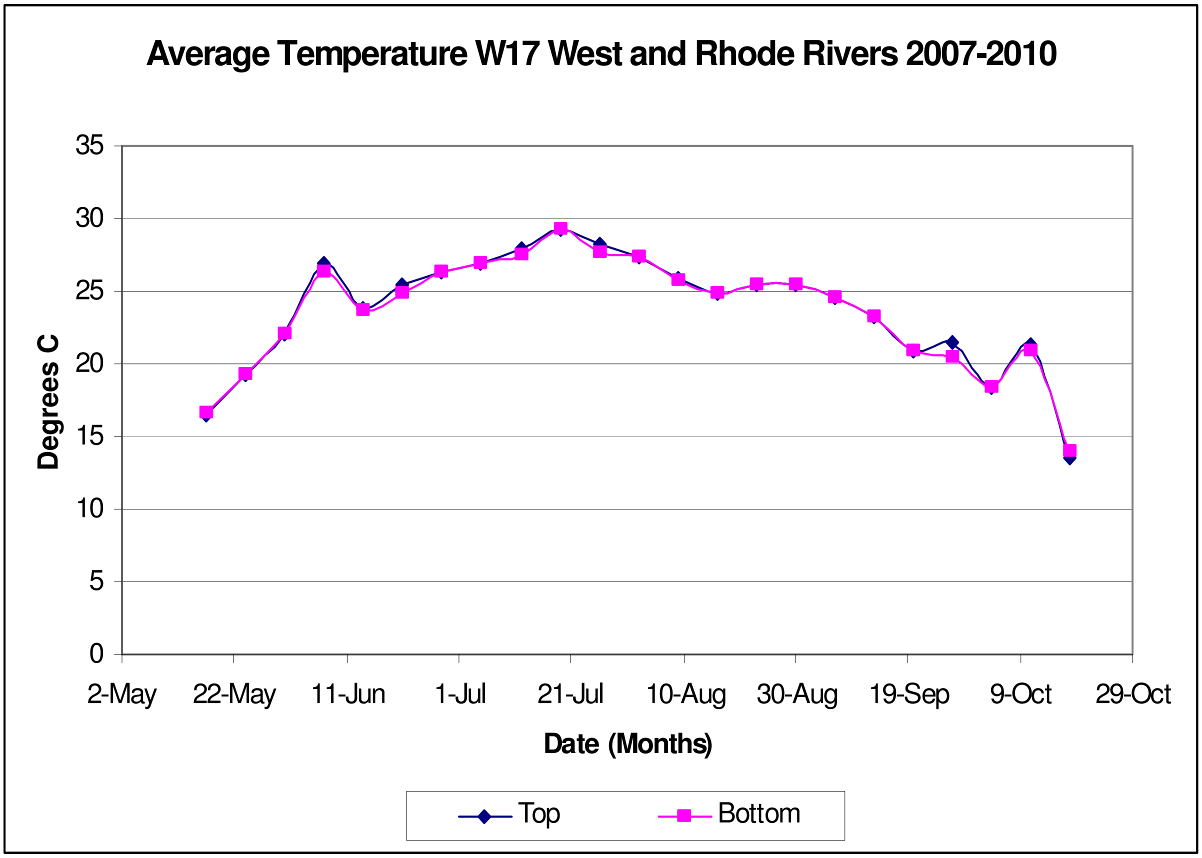
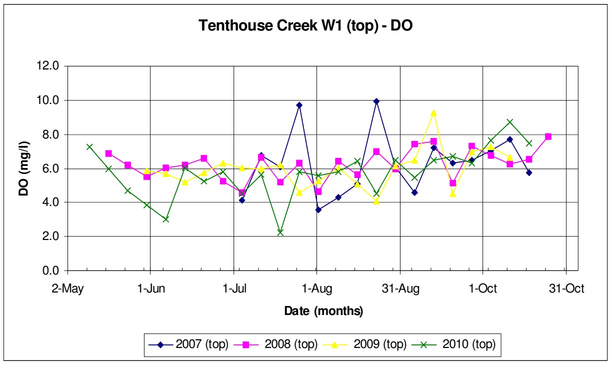
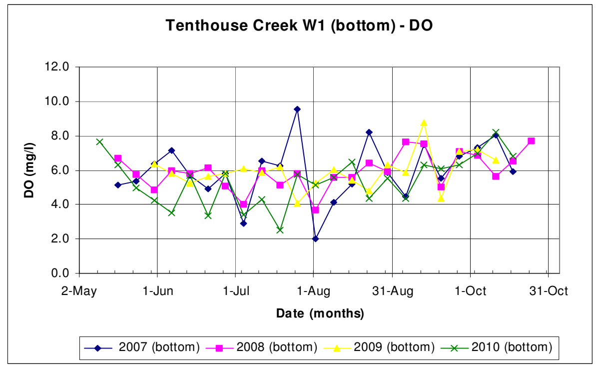
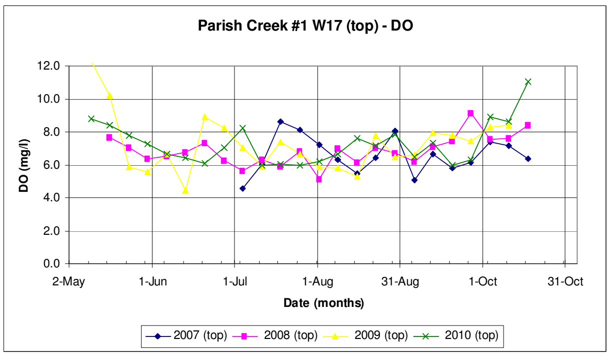


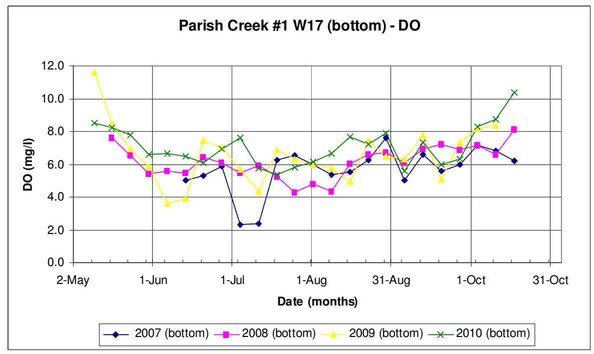
Figure 3

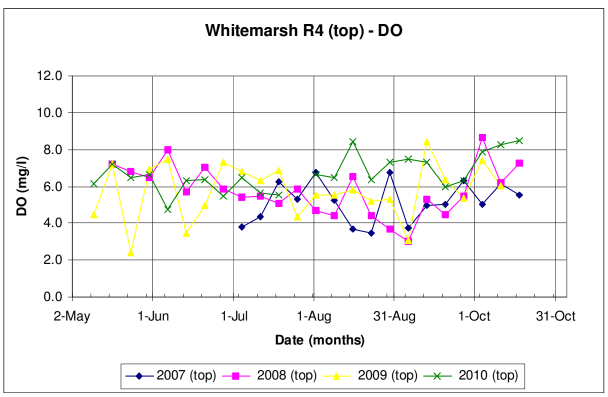
Dissolved Oxygen of West and Rhode Rivers 2007-2010

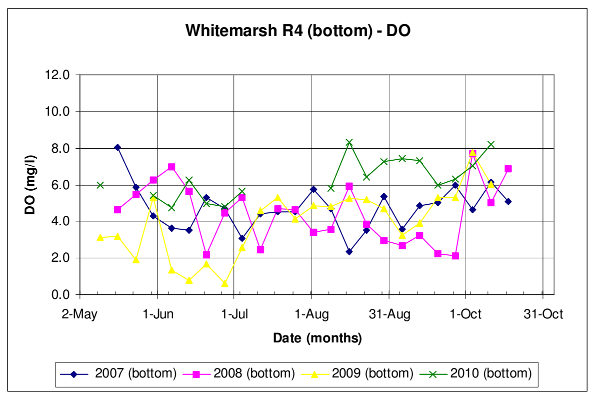


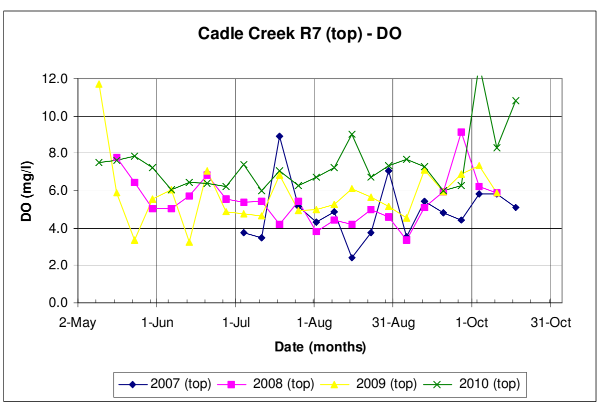












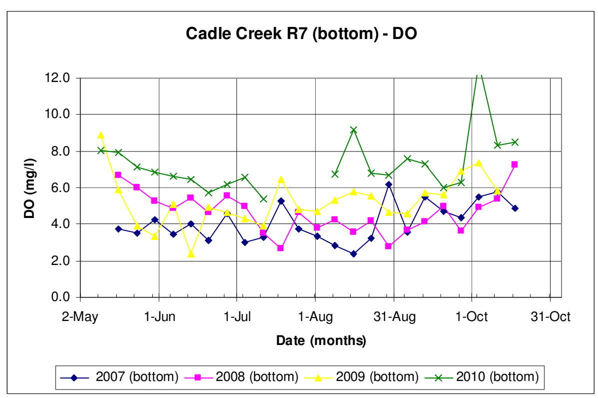
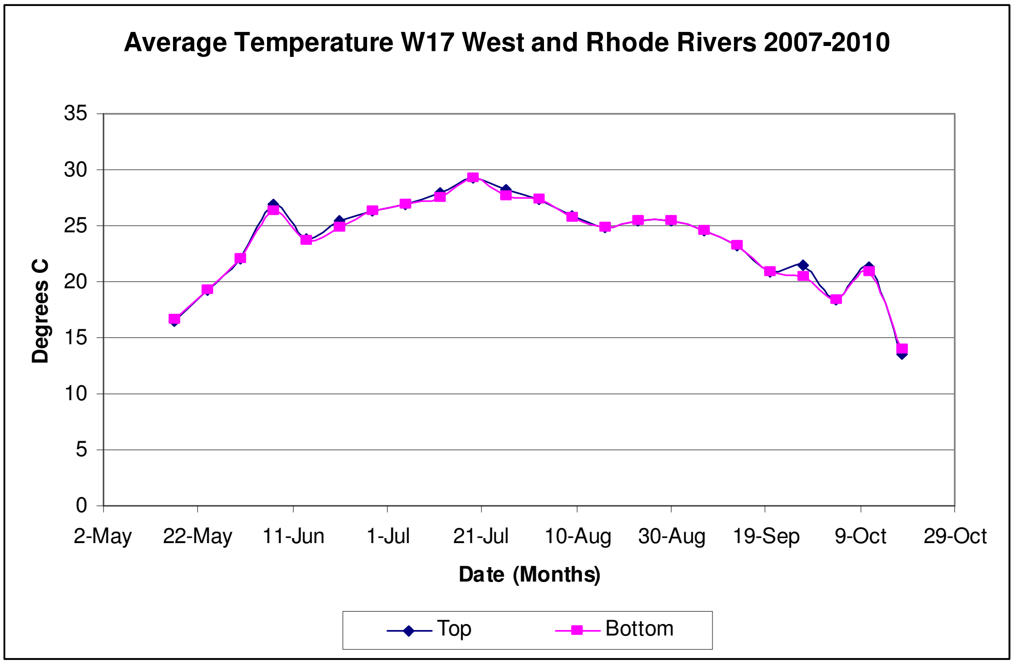


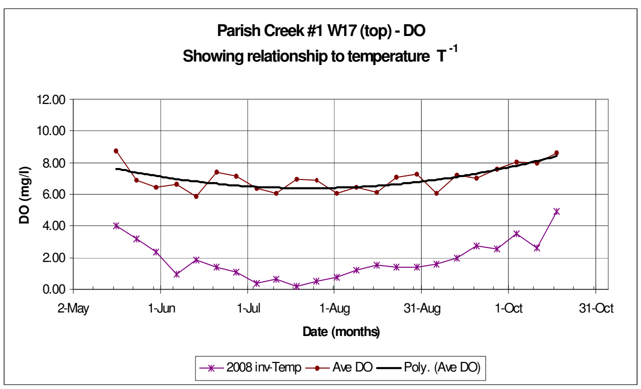
Figure 4

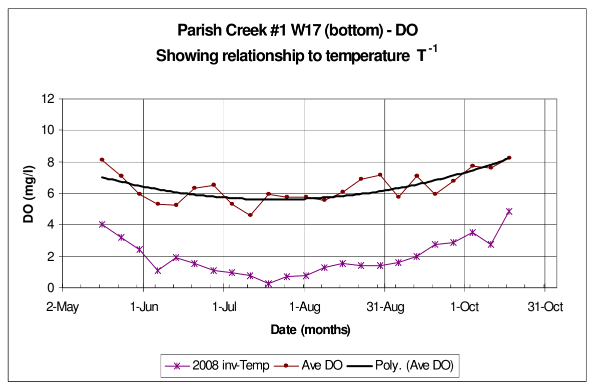
% Dissolved Oxygen of West and Rhode Rivers 2007-2010

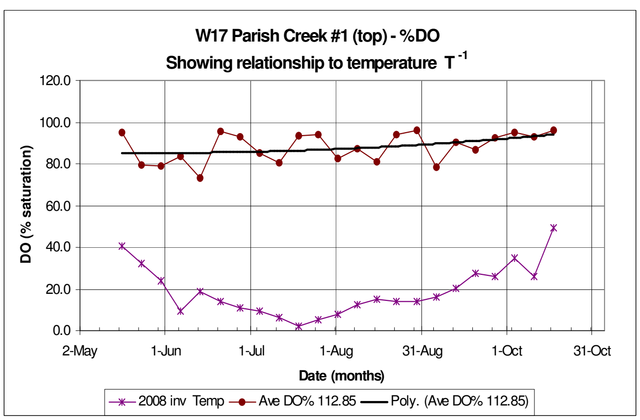
Figure 5

Average Temperature of West and Rhode Rivers 2007-2010









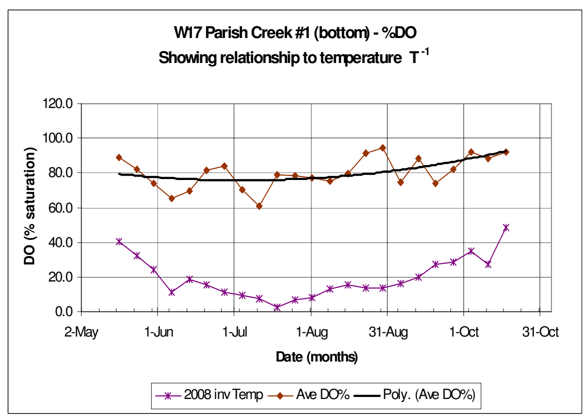


Figure 6

Optimal Oyster Conditions In West and Rhode Rivers 2007-2010

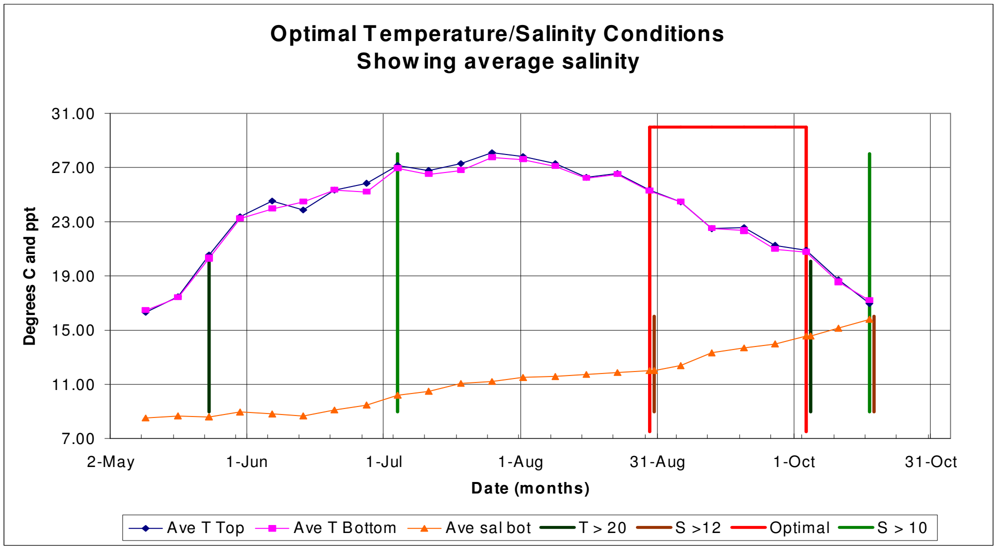
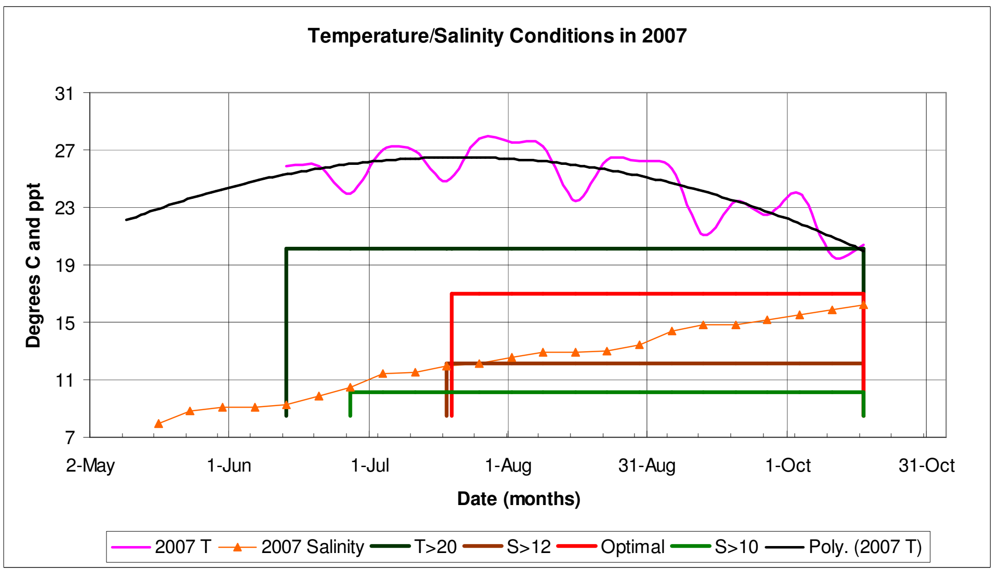


Figure 7



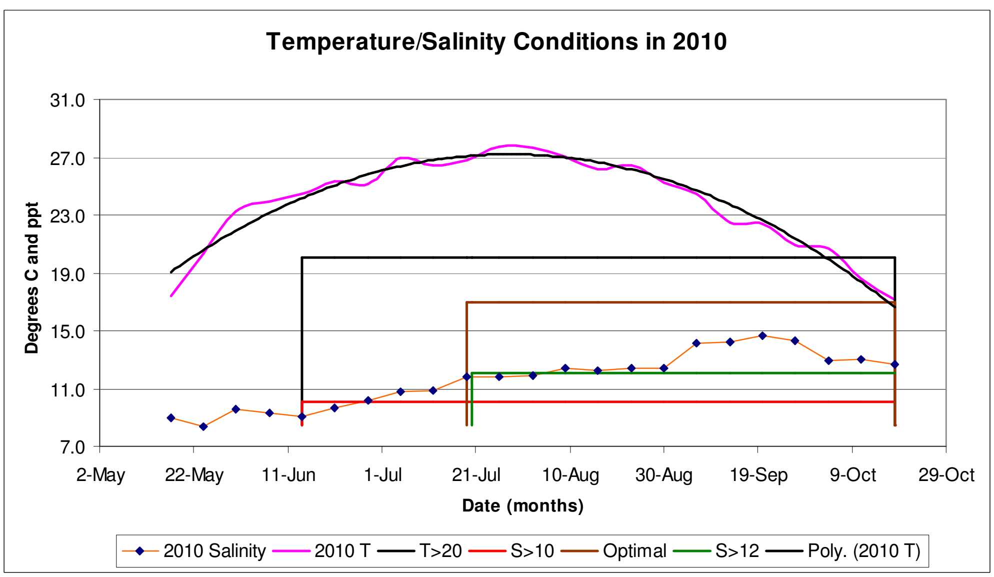


Figure 8