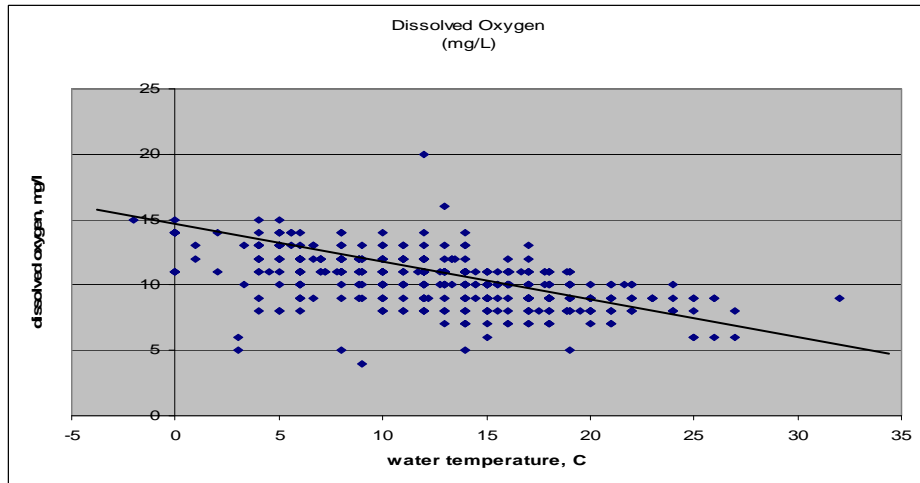


Centre County PaSEC Dissolved Oxygen Data Study

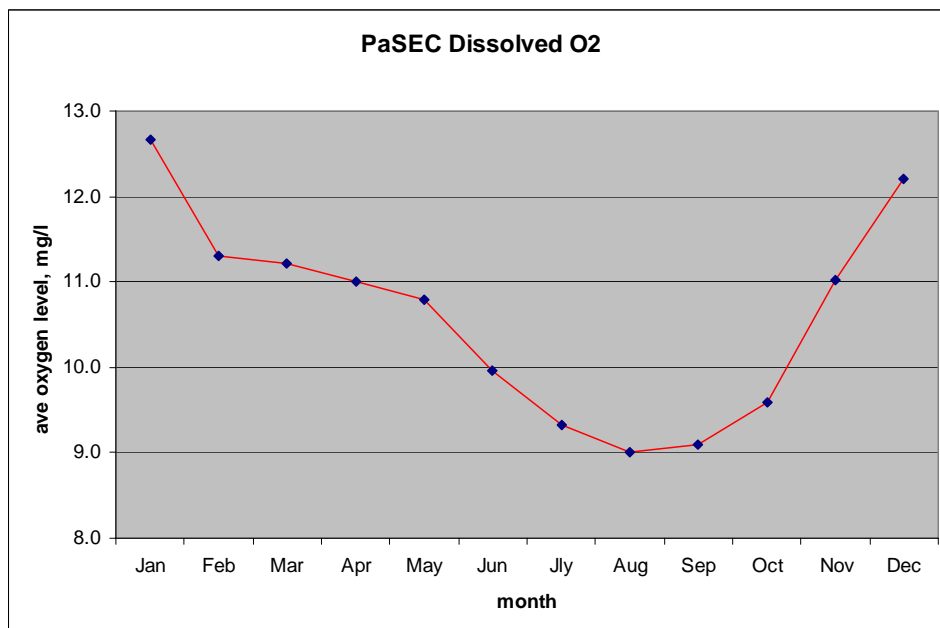
Dissolved Oxygen

The values that had been entered in the Centre County PaSEC water monitoring database in the 2002-2007 time period were studied to see what information could be gleaned in the dissolved oxygen (DO) testing by the group. Here are the observations.

1. There was a slight indirect variation of DO with water temperature, but not so strong as to be very exact. There was a large amount of variability or scatter.

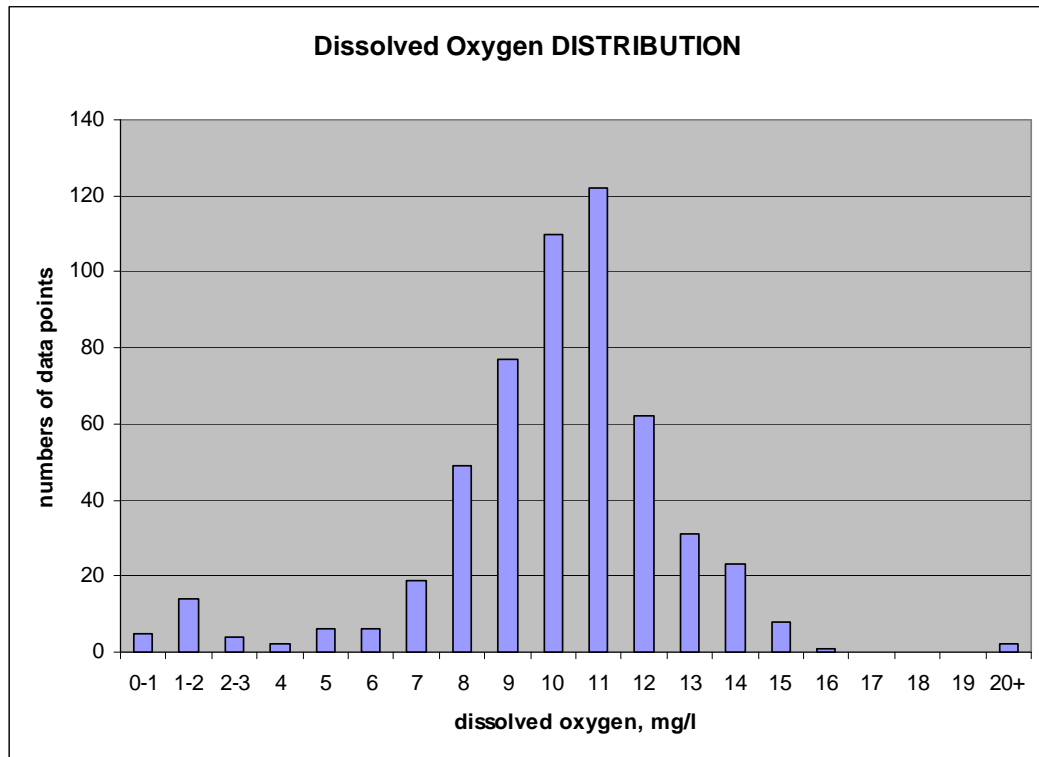


2. Rather than using the water temperature directly in comparing DO, the data was grouped by the month for the testing. The results of the average DO of the samples vs. the months showed a more understandable relationship. As observed in the graph below, the DO is highest in the winter season at an average of ~12.5 mg/l, and it is lowest in the summer at ~9.5 mg/l.



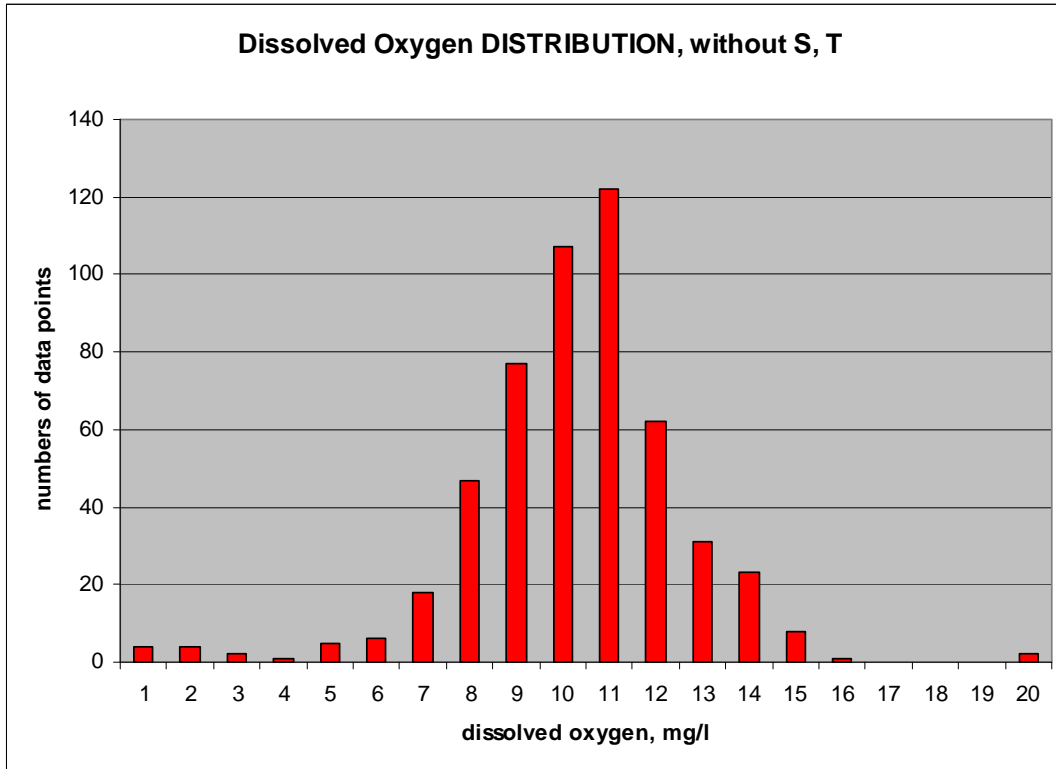
3. The data points were grouped into a distribution curve. A normal distribution shows a 'bell shaped curve' with an average, \bar{X} , in the center of the data. The standard deviation can be calculated for the distribution. Low standard deviations show low variability in the data set. The data variation can be grouped -
 - $\bar{X} \pm 1$ standard deviation contains - 68.3 % of the data points
 - $\bar{X} \pm 2$ standard deviations contains - 95.5 % of the data points, and
 - $\bar{X} \pm 3$ standard deviations contains - 99.7 % of the data points.

The DO points in the data were plotted in the blue colored distribution below. There are a greater number of low sample readings than 'would be expected'. One of the streams in the data had more of these low results as compared to the rest of the streams. The reason for the difference is not known. However, this stream passes through an acid bog upstream of the sample sites. Perhaps it reduces the oxygen holding capability, and the water has not had time to re-establish the oxygen level.



The number of samples in the lower region of the distribution is greater than expected.

4. Assuming that the acid bog experience altered the DO values as compared to conditions in the other streams, all of the data of this stream was removed from the observation study. The resulting distribution model more closely resembles a 'bell-shaped curve'. See the red colored graph.



The standard deviation for the data in this set of DO analysis is 1.5 units. Three standard deviations for this data set equal 4.5 units.

Water Monitoring Information

What can be used from this study? Future testing results should be field checked to see if they are reasonable. Future values should be expected to regularly fall within the +/- 3 standard deviation units (99.7%) of all of the data. Since the average of DO values vary from winter to summer, the minimum to maximum range of the DO values should also change with the seasons. The DO analysis would be expected to be within +/- 3 standard deviations of their seasonal values. Thus, in the winter, it would be expected to be within the range of 8-17 mg/l. In the summer, the value would be lower; it would be expected to be within the range of 5-14 mg/l.

When water monitoring teams are sampling their stream sites, use the DO test method for the 1-20 mg/l testing range first, as it covers the typical range of values in our area. Does the new analysis fall within the range for the time of year as noted above?

If it does, the analysis value is reasonable ('OK measurements'), based on the normal distribution curve just discussed. If it is outside the expected range, redo the test.

If the second analysis confirms the first value, then the result is outside the normal distribution, and it should be flagged as significant and different. Record the data and add any comments that might help explain this variation. Was there something unusual in recent outdoor conditions that would help a future user of the data to better understand the unexpected reading?

Low Dissolved Oxygen

When the DO analysis is outside the normal distribution curve, it should be communicated to the CCPaSEC QC team. The team will take appropriate action.

Most all of the 'odd' sample results in the data set have been low of normal. The values are near an alarm condition. When the DO concentration in the water is less than 5 mg/l, the stream is generally considered to be in a stressed condition. The low level of oxygen is unhealthy to certain sensitive organisms. When the DO concentration drops to only 2 mg/l, it is at a potential fatal level for some living organisms.