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GIS Project Update

Temporal Variations in Dissolved Oxygen Levels of Impaired Stream Segments in the Texas Region

Note: Thank you again for allowing me to change project topics. I had originally proposed a groundwater transport model but am now working on an analysis of temporal shifts in dissolved oxygen levels at several Texas river basins and streams of concern.

According to §307 of the Texas Administrative Code (TAC), which was developed in accordance with the Clean Water Act to regulate standards for surface water quality, dissolved oxygen levels in streams must be maintained to support aquatic life, meaning that they must be sufficient to support existing, designated, presumed, and attainable aquatic life uses. Each stream segment has been classified as to whether it supports exceptional, high, moderate, or limited aquatic life. Minimum dissolved oxygen levels become more stringent with increased aquatic life use (TAC[1]). Appendix A[2] in §307 of the TAC lists all minimum 24-hr average allowable concentrations for each classified stream segment in Texas, the average of which lies around 4.0-5.0 mg/L.

According to the Texas 303d list, or the Texas Integrated Report of Surface Water Quality, there are 83 streams that show impaired dissolved oxygen data (see Figure 1).

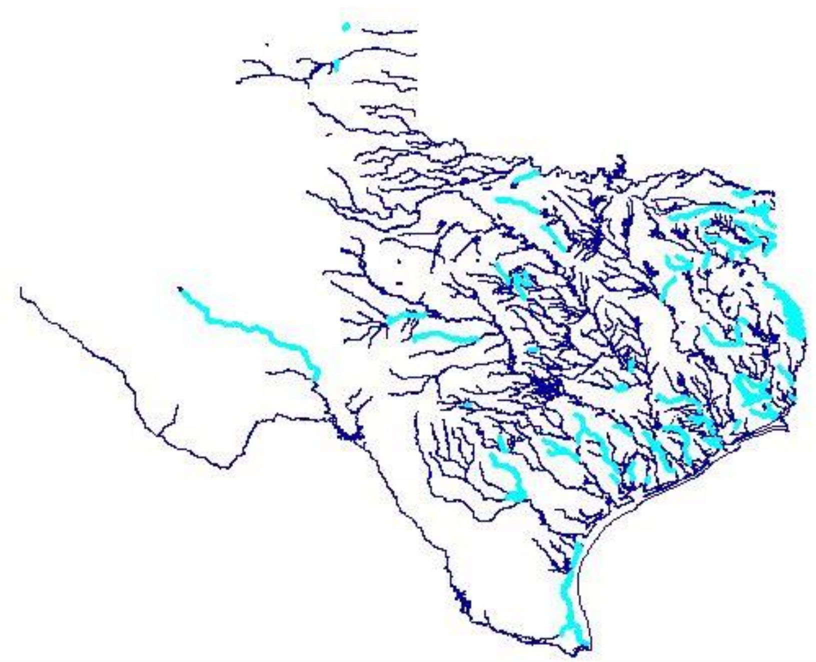

Figure 1. Preliminary map of dissolved oxygen impaired streams in Texas (as of 2010)

[1] http://info.sos.state.tx.us/fids/201003720-4.pdf
[2] http://www.tceq.state.tx.us/assets/public/legal/rules/rule_lib/adoptions/07002307_adoREVBU.pdf

I have spoken to two representatives of the Surface Water Quality Monitoring (SWQM) team at TCEQ, Kelly Rodibaugh and Christine Kolbe, in an attempt to collect daily mean dissolved oxygen concentration monitoring data for each of the impaired streams. Unfortunately, the surface water data collectors only go out to the streams on a quarterly basis for the majority of the streams due to labor limitations. For the 83 stream segments that are classified as impaired segments in terms of dissolved oxygen levels, the majority of the data available is therefore not useful since quarterly reports do not show an adequate assessment of temporal variations. There are, however, several streams that fall under the Continuous Water Quality Monitoring (CWQM) category and therefore do have daily mean dissolved oxygen data. TCEQ will be able to provide me with that data by the beginning of next week.

Once I have that dataset, which includes surface water temperatures, I am hoping to compare the expected seasonal variations of temperature with measured dissolved oxygen concentrations. Dissolved oxygen naturally fluctuates diurnally with small temperature variations as well as seasonally with larger temperature variations. When water is colder, its dissolved oxygen capacity is higher, and when water is warmer, its dissolved oxygen capacity is lower. Therefore, it may be typical to see lower DO levels in the summer and early fall, when water temperatures are higher (see Figure 2). However, levels consistently falling below 5.0 mg/L can lead to fish kills and destruction of other aerobic life forms.

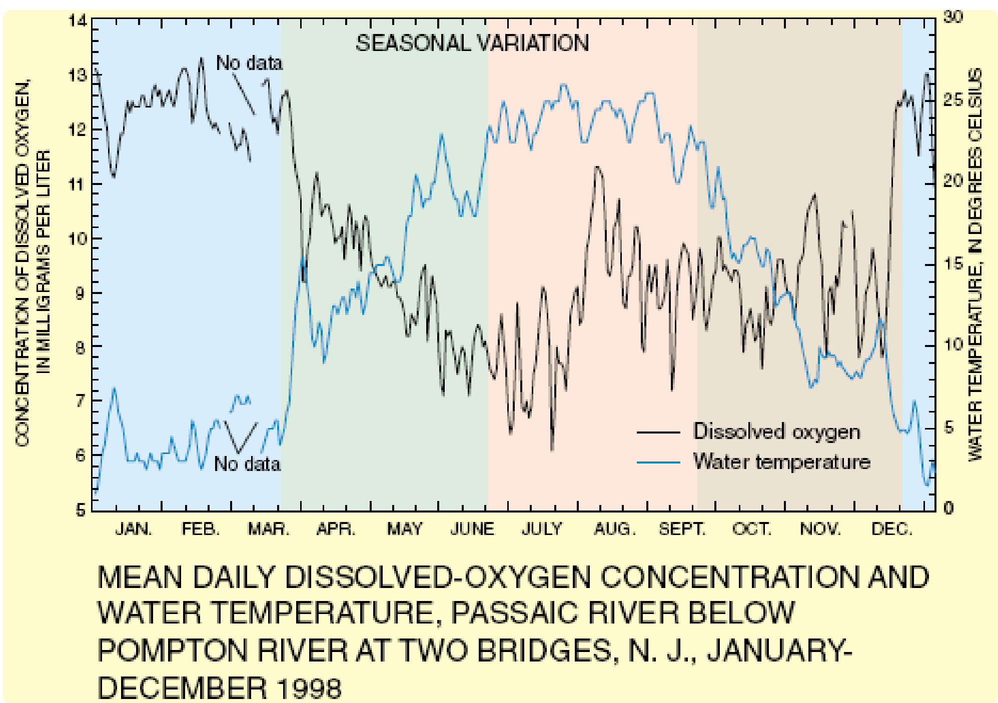

Figure 2. DO concentration vs. water temperature
(Source: http://ga.water.usgs.gov/edu/dissolvedoxygen.html)

Excess nutrients and eutrophication can lead to the reduction of dissolved oxygen levels. Treated wastewater effluent is often allowed to outflow into these river streams, and the higher effluent temperatures may be attributed to an overall increase in water temperatures above expected levels. My goal is to see for the impaired stream segments how well the dissolved oxygen levels follow expected seasonal patterns. If, for example, DO levels are unusually low even in the winter months when they are expected to be higher, that may reveal anthropogenic impact as a possible cause.

I plan to make stream gages representing the sampling conducted at each impaired stream. The color gradients of these gages will change to show temporal fluctuations in water temperature and dissolved oxygen levels across the course of 2012-2013 water year. I will show the percentage of time when the streams fall below their minimum 24-hr DO concentrations and create graphs of DO v. Temperature for each impaired stream showing when the levels do not match seasonal expectations. I will also overlay wastewater treatment plant locations that outflow to relevant streams to determine segments in which anthropogenic effluent outflow might have potential impact on DO levels.

Another possibility is to assess the ecoregions of Texas[3] based off SSURGO soil water data and display whether vegetation differences could affect dissolved oxygen levels. Regions with high soil water are associated with denser vegetative growth. The presence of increased vegetation leads to excess nutrients flowing into surface waters with runoff from precipitation, and excess nutrients in surface waters leads to enhanced vegetative algal growth and eutrophication, which in turn depletes dissolved oxygen.

Any feedback on additional comparisons possible using this data in GIS would be appreciated!

[3] ftp://ftp.epa.gov/wed/ecoregions/tx/tx_front.pdf