Meeting Minutes
Texas Commission on Environmental Quality (TCEQ)
Nutrient Criteria Development Advisory Workgroup (NCDAWG)
November 07, 2012

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Location: Building F, Second Floor, Room 2210
Time: 9:00 am – 4:150 pm

9:00 a.m. Welcome and Workgroup Introductions

- General welcome and introduction of Jill Csekitz as moderator
- Call to order, and introduction of Laurie Curra, Monitoring and Assessment Section (Jill Csekitz)
- Welcoming remarks (Laurie Curra)
  - Introduction of Water Quality Standards (WQS) Group staff and workgroup members. The Nutrient Coordinator position is vacant. Jill Csekitz is currently filling this position.
  - Jill Csekitz
  - Jason Godeaux
  - Joe Martin
  - Debbie Miller – absent
  - Round the room introductions (Jill C.)
- Housekeeping issues regarding facilities, lunch, general safety information, sign in, and list serve. (Jill C.)

<u>Morning Handouts:</u>

Agenda

9:10 a.m. Purpose, Goals, and Operating Procedures of the Workgroup

<u>Workgroup process, presented by Jill Csekitz, TCEQ.</u>

- All attendees can participate in the discussions.
- Meeting minutes, slides, and related information will be posted on the website before and after meetings.
- Communication will be primarily by through the NCDAWG listserve.

Purpose and goals of this workgroup, presented by Jill C.

- To provide an update on 2010 and 2013 WQS revisions, and describe progress made on Nutrient Criteria Development Plan revisions, including a summary of comments received during summer public comment period.
- To share information from research projects in streams and rivers, reservoirs, and estuaries that directly relate to criteria development.
- To facilitate an opportunity for stakeholders to provide input on administrative and technical processes for numeric nutrient criteria development.

9:15 a.m. Status Update on Environmental Protection Agency (EPA) Approval of 2010 WQS and Summary of Revisions to TCEQ Nutrient Criteria Development Plan

Presented by Jill Csekitz, TCEQ.

- All EPA action letters and the highlighted 2010 rule are on the TCEQ website: http://www.tceq.texas.gov/waterquality/standards/2010standards.html
- Fish tissue based mercury was not approved. The approved criteria reverts back to the water column based criteria from the previous standards (2000 WQS).
- EPA approved the removal of 'single sample' for assessment of bacteria. Contact recreation is assessed using geomean.
- EPA approved Appendix G; this includes the three water bodies with RUAAs.
- EPA approved Appendix B; this includes sole source water bodies.
- EPA approved Appendix E; this includes site specific toxic criteria.
- EPA granted conditional approval on some items. TCEQ can use these items for Clean Water Act purposes, but if an endangered species is involved, then it is subject to disapproval.
- EPA disapproved deferred aquatic life listings and high flow exemption for bacteria in §307.9 Determination of Standards Attainment.
- EPA disapproved the benthic aquatic life use in Appendix A for the North Sulphur River.
- EPA disapproved site-specific dissolved oxygen (DO) criteria for Oso Bay and Laguna Madre.
- EPA disapproved seasonal DO criteria for Lavaca River footnoted in Appendix D.

Question: What is the follow-up on the disapprovals?
Answer: We are discussing those internally. EPA has given us suggestions; for example, splitting up the Laguna Madre into two or more classified segments.

- Numeric nutrient criteria for selected reservoirs (Appendix F) is still under review. Approval status has not changed since the previous work group meeting. However, there have been discussions with EPA and progress has been made.
- Standards Implementation Procedures revisions are split from this process and are ongoing.
- The current goal is to get the WQS revision adopted in October 2013.
- TCEQ is not developing additional nutrient criteria to be included in the 2013 WQS revision, but is making updates to the Nutrient Criteria Development Plan.
- EPA asked TCEQ to update the Nutrient Criteria Plan in December 2011. The plan was last updated in 2006.

- The draft plan was presented to stakeholders during the Surface Water Quality Advisory Workgroup Meeting in May 2012 and released for public comment.
- TCEQ received 4 public comments on the draft plan by June 22.
- Commenters included Texas Parks and Wildlife Department, EPA, Texas Water Conservation Association, and City of Austin.
- Comments were considered and discussed by staff and management.
- Edits were made to the plan based on those comments and additional staff edits.
- An update to wetland guidance reference was suggested by EPA.
- There were edits to include additional reference dealing with censored (non-detect) data.
- Commenters expressed general support for methodologies and plans for progression.
- Commenter expressed support for use of periphyton and macrophytes.
- Commenter suggested considering a watershed approach.
- Commenter expressed concern that the plan did not take a balanced approach and did not focus on problem situations.
- Plan highlights include description of data analysis and options for criteria development.
- Potential options include stand-alone criteria based on thresholds of response variables (*chlorophyll a* (CHLA), biological, periphyton, DO, etc.).
- Plan considers information at multiple spatial scales (river basin, eco-region/river basin, < HUC 8, segments, monitoring station). Initial EPA criteria presented at Ecoregion level is widely considered to be too coarse of a grouping.
- Edits included updates to new and completed milestones.

9:45 a.m. Characterization of Lake Somerville

<u>Presented by Dr. Larry Hauck, Texas Institute of Applied Environmental Research (TIAER).</u>

- The project is a joint study with TIAER and Brazos River Authority (BRA) to identify causes of high eutrophication in the lake.
- Lake Somerville is a medium sized lake.
- Reservoir has abundance of suspended algae/phytoplankton growth, but not an abundance of nutrients, which makes the high rate of eutrophication a mystery.
- The project monitoring took place from 2010-2011.
- Included in the project are some techniques for characterizing internal nutrient cycling.
- Some physical characteristics of the lake that are important to consider include:
  - The lake is shallow
  - Physical mixing is important
  - Lake does not always stratify, but sometimes DO is stratified
  - Alcoa's discharge activities improve water quality in the system.
- The reservoir is included on the 303d List for high pH.
- pH swings are a response to the lake not having enough buffering capacity, and thus is susceptible to the effects of the algae growth. pH tends to increase when there are algal blooms.
- The upper range of pH criteria for the lake is 9 standard units.
  The portion of data measured above 9 are exceedances of the criteria, all of which occur during the summer. The current study confirms results from previous studies

conducted by Dr. Roelke, who thought cycling of nutrients contributed to high pH, resulting from a highly productive system.

- One objective of the study is to determine the source of nutrients available for algal growth.
- Much of the historical phosphorus and nitrogen data were below at the limit of quantitation. The upward trend exhibited by ortho-phosphorus data may be misleading since actual data values are unknown.
- Landuse was evaluated to assist with identifying source of nutrients. The dominant land uses are forest and pasture/hay; the area is not dominated by cultivated crops.
- Analysis of land use management indicates relatively low fertilizer inputs and stocking rates.
- No permitted discharges are located near Lake Somerville, although there are several in the watershed. BRA monitoring up and downstream of Alcoa indicates discharge may actually improve water quality in East and Middle Yegua Creeks.
- Small tributaries were sampled to evaluate initial loading from stormwater runoff.
- Precipitation was well below normal during most of the study period, and made stormwater sampling not quite as meaningful due to drought conditions.
- Lots of variability in stormwater monitoring results.
- Fact that TP on Birch Creek is twice as high as on Yegua Creek is probably not meaningful.
- pH from tributaries is not an issue; CHLA can build up when pooled, but otherwise low (when water is flowing).
- High sources of nutrients were not identified in specific tributaries during the study.
- Nails Creek includes City of Giddings discharge in headwaters, and is the only tributary besides Yegua Creek with a WWTP discharge.
- Moderate urban development in Brushy and Little Big Creeks could be studied further.
- Cedar Creek – looks like more cropland near lake – possibly has higher fertilizer applications or proximity factors.
- Monitoring included low TP and nitrogen concentrations, algal bioassays, and sediment fractionation to characterize internal nutrient cycling and identify limiting nutrients.
- The growing season was targeted during sampling.
- The drought made an already shallow lake even shallower.
- The hypothesis is that the depths of the lake episodically stratify by DO concentration and those stratifications disappear, or come and go.
- The study found no correlation between DO results and wind data.
- Peaks in pH > 9 in June 2010 and Aug 2011 when CHLA were generally high.
- Yegua creek was only monitored for one year.
- Initially it was believed that the lake was mixed and stayed that way. When we discovered that DO stratified we started sampling the full profile, which was a further drain on our resources, so we had to alter sampling and do fewer sites.
- TP generally followed the same pattern as CHLA concentrations.
- Peaks in pH > 9 in June 2010 and Aug 2011 (surface samples) corresponded with low %DO sat (bottom).
- Year 2 surface and bottom nutrient samples indicated some increase in PO4-P from anoxic bottom sediments.
- There were potential increases in NO3-N and NH3-N associated with low DO.
- Iron and aluminum were found in lake sediment. These constituents release P during anoxic conditions, so it's possible the lake can cycle P.

Question: Did you add P artificially when you do these sediment fractionation tests?
Answer: Yes

- Results of sediment fractionation vary, but limited data indicates sediment can be a source at times.
- Algal bioassays with native and test algae were conducted to determine limiting nutrient in the lake.

Question: Is that native algae a mixed community and what time of year?
Answer: Yes it is mixed. Sampled in March, May, June, July, August, September, and November.

- Test algae (*Selenastrum*) confirmed reservoir N limitation. Results similar for all three reservoir stations.
- The lake is nitrogen limited, but not exclusively. P is a secondary limiting nutrient
- Algal community identification sampling was conducted at same stations and sampling dates as algal assays. Results yield very different composition in Yegua than within the reservoir. All three reservoir stations show generally the same community composition. Staff still need to look at final year of samples.

Question: What are the units on the Y-axis?
BRA Answer: Cells per ML.

Question: So this was a microscopic analysis of the communities?
BRA Answer: Yes.

- Study conclusions include the following:
  - Iron is conducive to P being released during anoxic conditions
  - Limiting nutrient appears to be N
  - P is secondary limiting nutrient
  - Blue greens in summer dominate algal community composition.

Question: History of CHLA, there was a jump around 2000, which I suspect is a change in methodology. What is the status of Alcoa dewatering? Has that changed over time? What is the biological impact of pH going from 9 to 9.5?
Answer: That is more of a standards issue at this point. Unable to answer biological implication question… regarding Alcoa, not familiar with Alcoa discharges.
Note: EPA guidance criteria suggest an upper range of 9.0 units is acceptable to most species. High pH can increase toxicity of certain parameters, for example ammonia. Chronic exposure to elevated pH (>9.0 units) can disrupt fish epithelium and impact ammonia excretion, causing mortality.

Question: There was a theory that reservoirs would not be N constant because bacteria can pull N from air… is that still the prevailing theory?
Answer: When algal assays were conducted, we were seeing N limitation occur in fall. That seems to support blue green algae. Don't know about the theory.
Comment: Dogma hasn't fallen about blue green fixing algae.

Question: Any other lakes where you have a similar Fe/Al issue?
Answer: We have not explored that.

Question: Are you looking at zooplankton that would feed on the phytoplankton as part of the nutrient cycling?
Answer: Dr. Roelke did that and found that internal cycling played a part.

10:30 a.m. Data Collection Methods for Nutrients in Texas Streams

Presented by Jimmy Millican,TIAER.

- Study is a joint project by AgriLife Research, TIAER, and Parsons Engineering to support nutrient criteria development.
- Suspended CHLA in the water column is often included as part of routine monitoring. It is a good indicator of nutrient enrichment in lakes and reservoirs, but generally not in flowing streams.
- Periphyton (attached macro- and micro-algae), rather than CHLA, is often a better response variable to nutrient enrichment in streams.
- Historical data on periphyton abundance are sparse.
- The purpose of the project was to evaluate four field methods for monitoring attached macroalgae and microalgae in wadeable streams. These methods include: quantitative (scrape Method) and semi-quantitative or qualitative (viewing bucket, transect, or photo/grid methods).
- Scrape method is considered the standard, but targets the richest habitat.
- Quantitative scrape samples were not mixed. Collectors used the highest rated method present, exclusively.
- Collectors never came across a situation where macrophyte beds were the only habitat present.
- The area of substrate sampled, volume of rinse water used, and volume of each subsample (to be analyzed later in the lab) were measured in the field. Subsamples were filtered and preserved on dry ice.
- Subsample filters were analyzed for Ash Free Dry Matter (AFDM) and (CHLA).
- Results were calculated in grams per square centimeter (g/cm^2) based on field measurements of area and volume sampled.
- Viewing bucket method uses a 5 gallon plastic bucket with a transparent bottom that contains a fixed grid of 50 dots, and is based on Rapid Bio-assessment protocols developed by EPA.
- Dots were characterized as macroalgae, microalgae and bare. Maximum length of macroalgae and thickness of microalgae were also measured.
- Eighteen locations per station were surveyed with the viewing bucket.
- The transect method was derived from field protocols developed by Utah State University (Hawkins, et al. 2001).
- Three diagonal transects are uniformly subdivided into 6 sampling locations (total 18 locations). At each sampling point along the transect, the collector picks up the nearest piece of substrate to make measurements.
- According to the method SOP, select substrate nearest your right big toe; if nothing is there, then that is what you report.
- The transect method documents percent coverage of moss, percent coverage of microalgae, and estimates thickness of microalgae.
- The photo/grid method was derived from an algae growth study performed by Paul Price Associates, Inc. and Alan Plummer and Associates, Inc.

- A grid is set up in the stream and upstream/downstream photos are taken.
- Five representative locations within a 1 square meter (m^2) grid are established.
- Percent coverage of algae estimated from photos and thickness/length of algae is also recorded.
- Issues arise with the photo/grid method when there is high turbidity and glare from the photo.
- Flow and water chemistry samples were also taken at each site where periphyton was collected.
- Water samples were analyzed for:
  - CHLA & Pheophytin-a
  - Total NO_2-N+NO_3-N
  - Total Phosphorus (TP)
  - Total Kjeldahl Nitrogen (TKN)
  - Habitat Assessment (year 1)
- 30 stations were sampled for the study, all located in the Lower Brazos & Colorado River Basins.
- Stations were selected to represent a variety of water quality & substrate conditions.
- All stations were existing TCEQ SWQM Stations with biological data collected within the last assessment period (2001-2007).
- The first year's project objective was to identify which semi-quantitative or qualitative method was best related to the quantitative (scrape) method.
- The transect (toe) method had the most significant correlations to CHLA and AFDM.
- The second project object was to evaluate relationships of periphyton abundance to instream water quality and habitat parameters.
- Significant correlations of transect and scrape methods to habitat parameters and algal abundance were identified.
- Structural Equation Monitoring (SEM) was conducted by Parsons as an exploratory tool to look relationships among variables.
- Study concluded that scrape & transect methods worked well on most substrates, although some problems arose on gravel substrates using the scrape method due to large amounts of sediment collected & high AFDM; both methods have issues if streams are not wadeable; and scrape and transect methods were both positively correlated for general algal abundance. Algal abundance measures were more highly correlated to habitat than water quality parameters. SEM analysis implied that substrate size and light were the most influential factors on periphyton growth.

Question: Nice ranges of nutrient concentrations, just being out there a lot, do you have any preference on the method?
Answer: if you are sending a crew out, the transect method. There are more resources used to do the scrape method, but that is also doable.

Question: On transect method, if your toe was close to woody debris, would you pick that up?
Answer: Yes. Or quantitative method, if something is too big to pick up. For gravel, we put it in a tray to rinse. Rinse water is used as a composite sample (because it is used for multiple samples). Rinse and agitate it to get the algae off.

Question: When scrape method is developed, did they look to see if it is reproducible
Answer: I don't know if they did that.

Question: Did you talk to Paul Price on how he did this method?
Answer: These were derived from his method.
Comment: I remember he did his more controlled.
Comment: We did some simplification.
Comment: It was more involved. It (Paul Price's) was before the time of digital cameras. We wanted to simplify for routine monitoring. In eastern (more muddy) streams, this method didn't work well.

Question: Did you do comparisons with not freezing it and just taking it directly to the lab?
Answer: Usually that would be too far away from our sampling sites.

Question: When you indicate that you compared historical value concentrations, did you look at loading over that time period, because I think it is not unusual to find they differ.
Answer: We didn't look at loadings; I don't remember the period of record.

Comment: We did similar study on Brazos streams. The algal taxonomists said that snags and cobbles grow different communities. We limited our study to woody debris.

Question: Is there a corresponding study to focus on estimating the coverage of algae in streams where you find it and not just the level of enrichment?
Answer: Not by us, not aware of anyone else.
Comment: Transect method should get that
Comment: It matters how much coverage there is, not just communities (constant coverage for hundreds of meters or spotty coverage.)
Answer: We did do habitat assessment once but we did not do it continuously.

Question: The fundamental reason for the study is to find a reliable way of measuring periphyton to determine nutrient concentrations. If preliminary conclusion is substrate and light are primary factors, how is that going to influence how you describe how periphyton measures nutrients?
Answer: Collect periphyton and canopy cover with habitat assessment.
Comment: On subject of Concentration of load in instream algae, this confirms you cannot use instream N and P data alone to determine productivity. Also, if light is an important factor, it points out the importance of considering light regime at point of sampling.

11:00 a.m. Development of Land Use/Land Cover Data for Nutrient Criteria Development

Presented by Jason Godeaux,TCEQ.

- The University of Arkansas (UA) is analyzing existing ambient water quality and biological data from TCEQ.
- UA requested data on total effluent flow and land use/land cover in watersheds upstream of SWQM stations.
- USGS recently completed project for TCEQ Surface Water Quality Monitoring Team that developed upstream watersheds for every active SWQM station, including additional land-use/land-cover (LULC) data about watersheds.
- TCEQ included maximum permitted flows for municipal discharges in Texas.

- Discharge flows were summed for each watershed developed for stations established on streams. The sums were exported to an Excel spreadsheet.
- Major reservoirs were identified by the Texas Water Development Board. The watersheds for reservoirs were created using the USGS Hydraulic Use Code 12 maps.
- The watersheds are truncated by the next major reservoir.
- Unique ID's were given to each reservoir's watershed.
- Stations without nutrient data were identified and removed from stations layer.
- Watersheds without stations were removed from the watershed layer.
- Stations were associated with each watershed.
- LULC data was added to each watershed and totals calculated for each watershed.
- The data were exported and percentages calculated.
- The stations that were not in the main body of the reservoir were removed.
- The separate watershed flow data and LULC data was joined to the watershed layer and the stations within the watersheds.
- The USGS watershed layer for streams already had LULC data.
- Each watershed was already attached to a station.
- Dischargers that were not in watersheds were removed.

Question: If you are looking at a station were you only considering the area that fell within the HUC or any contributing tribs.?
Answer: For simplicity, we used what was within the HUC.

Question: It doesn't necessary include the entire contributing watershed?
Answer: No. Each analysis was based on where the station was located within the HUC watershed.

- A similar approach was taken for estuaries.
- We assumed that upstream reservoirs are a sink for the nutrients upstream of the estuary.

Question: So no concentration information can be conveyed?
Jason: Just flow data. How much flow coming down is discharge and how much is ambient flow.
Question: How do they figure this?
Jason: They have flow data which is estimated.

11:30 a.m. Getting Started with Nutrient Criteria

<u>Presented by Dr. Brian Haggard and Dr. Thad Scott, (UA).</u>

- EPA requested UA conduct a nutrient criteria development workshop and focus on why nutrients matter.
- Essentially all beneficial uses are affected by increase in nutrients.
- Since nutrients are problematic only at certain thresholds, there is great difficulty in trying to determine "how much is too much".
- EPA recommends three approaches for setting nutrient criteria:
  - Frequency Distributions- Select criteria based on the median of a percent of the data

  - Literature Review-Investigate criteria set by other states, tribes, etc.
  - Stressor-Response Relationships-Select criteria based upon how biological data responds to stressor data
- EPA suggested the overlap of 25th percentile (all streams) and 75th percentile (reference conditions) would be a good place to start.
- UA calculated medians of nutrients collected at SWQM sites and described the data with frequency distributions to help guide TCEQ in their criteria development.
- There is more variability in phosphorus concentrations in streams when we consider a greater percent of the available data.
- UA used data collected from many streams across Texas from 2000-2010.
- The study began in 2011 using all available data.
- This year, UA re-analyzed the data using only some of the data. For example, they did not use data that was collected under biased flow conditions, or for special studies or that was collected by volunteers; we used data that was quality assured.
- Culling the data did not affect median values.
- Sites will be explored when medians are different.
- We shouldn't just look at frequency distributions to develop nutrient criteria.
- We should also consider criteria reported in the literature that has been developed for other states, ecoregions and watersheds.
- UA reviewed 124 papers on nutrient criteria and studies applicable to Texas.
- And, we should consider relationships between stressors and responses---that's what we'll talk about next.
- P in literature ranges in criteria 0.01-0.10/unit.
- N ranges from 0.1-1.0/unit.
- Work is being done to classify data into different groups (high median, medium median, low median conditions).
- Basin by ecoregion has been identified as a potentially important grouping.

Question: Did you look at established reference sites to apply percentiles?
Answer: Not yet, we haven't thought about that, but we should.
Question: Do you mean identifying stations included in the Least Disturbed Streams study?
Answer: Yes.

Question: This is interesting information but, the reality is if we set criteria, it may not be related to the problem and will be substantially more conservative than what we need to protect the stream.
Answer: With that being said, our job is to provide stats to the TCEQ. Studies in the literature indicate there are threshold responses by fish. There is research that shows high nutrients can cause impacts, however we do not decide what thresholds are considered negative.

Comment: In reservoirs and estuaries, load needs to be considered when addressing algal growth; you need to look at base flow concentrations.
Comment: When considering load related to streams, you may have a concentration based on total load, not what is in the stream.
Comment: Flux is important at low concentrations.
Comment: Concentration regime can determine a biological response. Where a concern with a use is identified, we should first see if there is a bad biological response before we get involved and spend resources to fix a problem.

Comment: Impressed with the nutrient impacts slide. That paints a dramatic picture. Would it be appropriate to have a parallel slide associated with the effects which are positive? We need to find a target for lower levels of nutrients, not upper limits.
Comment: Oklahoma took the approach of targets. When a target was exceeded, a study was conducted to evaluate biological responses.
Comment: Targets will become even more evident when you get to estuaries and maintaining sufficient levels of nutrients.
Question: TCEQ has Continuous Water Quality Monitoring Network; I thought some monitored nutrients?
Answer: Yes, these instruments are in the Bosque watershed; however they are down a lot for maintenance and repair and not considered reliable.

Question: I'm not current on modeling, but even in freshwater systems, we don't have one that includes biological and physical parameters? Multivariate predicator and response…are we there yet?
Answer: The models are not there yet.
Comment: Most of them constrained by response variable. Some new models that are being developed are not yet ready.
Comment: The East central Texas plain had the highest Nitrogen. The gulf coast plains had the highest P.

Lunch Break 11:30 a.m. to 1:00 p.m.

1:00 p.m. Evaluating Stressor Response Relationships

Presented by Dr. Brian Haggard and Dr. Thad Scott, (UA).

- What is a stressor response? Example: the range of biological response varies across a range of nutrient concentrations. We can describe these relationships using statistical tools.
- The state decides which relationships are important based on:
  - Water body type
  - Designated use
  - Response variables often linked to nutrients include
  - Algal biomass
  - Water clarity
  - Biodiversity
- Stressor response relationships are evaluated with statistical methods such as regression, regression tree, and change-point analysis.
- Regression allows the development of quantitative relationship between dependent and independent variables; however a desired endpoint in the dependent variable is needed.
- Change-point analysis identifies a threshold where a change in the response variable (dependent) occurs. It is useful for identifying specific nutrient concentrations where a change in response occurs.
- Regression tree analysis is an extension of change-point analysis and quantifies thresholds in multiple independent variables in hierarchy.
- Regression tree analysis splits the data into two groups, minimizing variance each time a split is made, creating a hierarchy.

- Each threshold in the tree has a value for a partial R^2.

Question: What if you start with the wrong one?
Answer: In the regression tree, on the first variable, it goes through and finds the strongest predictor to use; it does this for each split.

- Regression tree analysis also allows an independent variable to be split multiple times.
- Caveat: it takes a lot of data. It's really an exploratory technique that is used for a lot of data that has a lot of variability. The more data you have, the better the output.
- The analysis will continue to split until it runs out of data. But it comes to a point to where it doesn't' explain more data with an extra split.

Question: When do you cut it off?
Answer: The models are built with a cross validation error which is corrected with model strength. When model strength goes away, that is where you stop splitting.
Question: Do you keep adding variables to tease out relationships?
Answer: You can add as many as you want but the more you add the more spurious the result.

- Multiple thresholds can be used to indicate both an interim change in response, as well as later stage impairment.
- Each of these analysis tools have their own benefits and limitations that should be considered along with the data and desired output.
- Regression analysis provides predictive models, but can be complex and difficult to evaluate.
- Change-point analysis yields a specific, easily interpreted stressor value, but requires lots of data and doesn't identify multiple change-points.
- Regression tree analysis identifies multiple values in one stressor, or hierarchical splits in multiple stressors, but requires lots of data.
- These statistical methods have been applied by UA in the Red River basin, using data from multiple states (New Mexico, Oklahoma, Texas, etc.). The next presentation will talk about that study.

Question: How do you plan on avoiding spurious data or not leaving out variables that are actually important?
Answer: That is a difficult thing. What we can do is use a data set that has an identified threshold, like an IBI for benthic invertebrates.
Comment: These analyses applied in this manner are similar to correlation. You need to use this tool in addition with others. You need a weight of evidence approach.
Question: Issue of "you're only as good as your matched data sets." What are the variables and how does that translate to observations?
Answer: One way to address missing data is to use a large data set over a large temporal scale, and use medians. We are trying to do this on raw data when you have nutrient concentrations, but missing bio response value. These analyses can't get around that. Use BPJ.
Question: On tree analysis, does it violate the assumption of parametric stats?
Answer: They are non-parametric techniques.

1:30 p.m. Regional Red River Project Update

Presented by Dr. Brian Haggard and Dr. Thad Scott, (UA).

- UA conducted a nutrient criteria development study funded by EPA that analyzed data from New Mexico, Oklahoma, Texas, Arkansas and Louisiana.
- The study calculated frequency distributions for the red river using states' data, and compared the results to EPA's eco-region guidance criteria.
- Overall, the total nitrogen 25th percentiles were similar across all four eco-regions, but were similar in only three eco-regions for total phosphorus.
- CHLA data for the Red River basin was limited, however some differences were noted.
- This information was published in the Journal of Environmental Quality.
- Frequency distributions are the first piece of information for the states to consider when developing nutrient criteria. These can be considered and analyzed at various geographic levels (river basin, eco regions, HUC 8 watersheds, etc…).
- Regression, change-point, and regression tree analysis were also conducted on the Red River basin data. These results were compared to the frequency distributions.

Question: What if a site had only 1 data point?
Answer: We went through and eliminated all sites with fewer than 10 points. That caused us to have too few, so we settled on sites with 4 or more data points.

- 10 ug/L was chosen as an endpoint for regression analysis. Statistical significance varied among eco regions and variables.
- The change point analysis showed that variability in CHLA concentrations significantly changed as a function of nitrogen and phosphorus concentrations, as well as conductivity.
- Regression tree analysis tells us a little more about the relationships:
  - High P, high conductivity = high CHLA; based upon independent variable put into model
  - High levels of algal species when there are these levels
  - Low P, low N = mean CHLA < 3 ug/L

Question: Did you account for canopy?
Answer: No, we didn't have habitat data
Comment: The higher the light, the more photosynthesis.

- Results indicate percentiles (25th) do not match up with numbers from sestonic CHLA change points in variation or thresholds like (10 mg chl-a L^{-1}).
- Texas has a much larger data set and more variables than was in this basin-specific project.

Question: Did you have any kind of variable for non-algal related turbidity?
Answer: Not available across states. That is why you have such high particulates.
Question: How about Lake Texoma?
Answer: We excluded all reservoir data. Oklahoma set criteria for Texoma at 10 ug/L.

2:00 to 2:15 p.m. Break

2:15 p.m. Nutrient Dynamics in the Mission Aransas National Estuarine Research Reserve

Presented by Rae Mooney, University of Texas Marine Science Institute (UTMSI)

- The goals of the presentation included introduction of the National Estuarine Research Reserve (NERR), description of UTMSI's system wide monitoring program, discussion of nutrient criteria pilot project, and identification of ideas for nutrient criteria.
- The Mission-Aransas NERR is part of a system of 28 reserves which are funded by NOAA.
- The focus of the Mission-Aransas NERR is on research, education, stewardship and training.
- System Wide Monitoring Program (SWMP) is performed at 5 locations and includes water quality, weather, plankton, nekton, and marsh plant sampling. Habitat mapping is performed as well.
- Harmful algal bloom information is also documented at the SWMP stations.

Question: Is this related to Texas Coastal Ocean Observation Network (TCOON)?
Answer: Yes, they do our telemetry also.

- UTMSI is participating in a nutrient criteria project funded by EPA and Gulf of Mexico Alliance to study nutrients in the area and develop criteria. As part of this effort, UTMSI is conducting the following research:
  - Sample storm events
  - Calculate nutrient loads from rivers
  - Biogeochemical transformations in water column and sediment
  - Look at effects of nutrients load on estuary concentrations of nutrients and CHLA, water quality parameters, etc.
- Storm events deliver large amounts of freshwater inflows, organic matter, and nutrients to stimulate production in estuaries. They also alter the salinity gradient of estuary. Frequency and intensity of storm events vary, and could become more variable in the future.
- More data are needed along the hydrograph to better characterize storm events.
- Productivity is supported in major droughts through the processes of denitrification and nitrogen fixation.
- The residence time of water in the bay is between 1-3 years. If a large precipitation event occurs, that residence time can be a day.
- Storms play a major role influencing nitrogen dynamics. However, because the NERR is a pristine area, inorganic nitrogen is not correlated well with CHLA (CHLA concentrations are very low). As such, CHLA is not a good indicator for nutria criteria purposes in the NERR.
- Dissolved oxygen was measured at high frequency to calculate gross primary production, community respiration and net ecosystem production.
  - Community respiration is higher during wet periods; the system becomes more productive in dry periods.
  - Study conclusions include the following:
    - Storms play an important role in productivity of estuaries
    - Calculating riverine loading together with measuring estuary concentrations is important

- Internal cycling of N must be considered as an important source and fate of N
- Dissolved oxygen may be a useful indicator for nutrient criteria

Question: How important is particulate organic nitrogen – big chunks, limbs, etc.? No one seems to sample that.
Answer: We have not really sampled larger items.
Comment: The literature describes massive log jams from floods.

Question: During the two years, there were 2 large flood events. Water quality seemed to be affected, then settle out after a couple of months. We like to deal with averages-long term.
Answer: Isotope work, after storms, up to 9 months after a storm, showed high productivity – mostly from freshwater. The N disappears quickly.

Question: You looked at CHLA and you measured the whole system. You have lots of other nutrient sinks involved. Did you consider other plants in the system explicitly?
Answer: We haven't gotten our WQ data worked out yet; we only sampled sea grass once a year.

Question: Your SWMP was sampling daily after pulses?
Answer: Yes, before and afterwards, every day.

Question: Any look at atmospheric deposition of N and ground water influences?
Answer: Someone from UT will be doing that with groundwater.
Comment: When you factor in atmospheric deposition and ground water, you think N fixation may not be significant when you bring in these other sources.

3:00 p.m. Towards Developing Nutrient Criteria for Galveston Bay: Current Status, Future Concerns

Dr. Antonietta Quigg, Texas A&M Galveston

- Study examined the impacts of freshwater inflows, salinity, nutrient and sediment loading regimes that impact productivity (and economically important species).
- Upstream landuse in the watershed has become much more developed in recent years (primarily in DFW and Houston).
- Freshwater inflow to Galveston Bay comes primarily from the Trinity River. Drought patterns in 2011 are similar for both the Trinity and San Jacinto Rivers.
- Galveston Bay was intensely monitored since 2008 using a Dataflow (concurrent measurements of temp., DO, salinity, pH, water clarity, chlorophyll fluorescence, and dissolved organic matter fluorescence.
- In situ measurements were mapped using on board GPS.
- Monitoring allowed for spatial and temporal changes in salinity (pre-drought 2010, drought 2011, and recovery 2012) to be identified.
- Typically freshets occur in spring, and high salinity being measured in the fall.
- In addition to in situ measurements, water quality, nutrient limitation assays, and production/respiration analyses were conducted at 6 fixed stations since 2008.
- Sampling indicates that nitrogen is readily consumed by phytoplankton in the summer months when river flow is low.
- There seems to be excess nitrogen when flows are greater (driving phosphorus limitation).

- Nitrogen patterns in the north bay mimic patterns in the Trinity River. Generally, nitrogen concentrations are lower in the south bay.
- Nitrogen limitation occurs infrequently in the north bay, indicating nutrients are likely available.
- Antecedent conditions must be considered when analyzing nutrient data.
- Statistical tools were used to identify patterns in water quality data.
- Low temperature = high nutrient concentrations
- High temperature = low nutrient concentrations
- Salinity is controlled by flow rate but because it is in an estuary.
- Resource limitation assays can be used by decision makers in developing nutrient criteria and water rights (Senate Bill 3).
- Additional work to include sediment nutrient flux, collection of discrete measurements on a monthly basis, and more frequent assays to define effects of nutrients on productivity.
- Related research includes surveys of bioindicators (phytoplankton, *Vallisneria americana*, and Rangia clams *Rangia cuneata*).
- Attendees and data collectors are encouraged to relay any information regarding the distribution of *Vallisneria americana* (wild celery) to Dr. Quigg. This species is sensitive to high salinities and has not been seen in the bay since 2009.
- Rangia clams have potential as a bioindicator.

Question: We've been talking about Galveston Bay and how it's impacted; do we need to lower nutrients in the Bay?
Answer: On the Trinity side, nutrient concentrations are ok. My concern is the San Jacinto side. We are getting 10-20 times more ammonia. It's not so much "how many" but "what kind" of nutrients are good for the bay.

Question: Is there a preference for phytoplankton of ammonia and urea nitrogen species?
Answer: We see those, but those change the demographic dynamics.

Question: Historically, there were some large industrial N dischargers and I wondered if you have looked at changes in that over time?
Answer: We've looked at historical industrial nutrient data; what we have access to is spotty.
Question: TRI (toxicity release inventory) would have that.
Comment: If you can, tell me where to find that.
Note: After the meeting, Diane Evans forwarded Dr. Quigg TRI information via email.
Comment: There is definitely a gradient in San Jacinto, which probably affects phytoplankton. You can look at ammonia and nitrates and there is definitely a big shift.

Question: Will you be doing sediment?
Answer: We have done sediment cores and are currently working up the data.
Question: Can you expand on antecedent condition and nutrient concentration criteria?
Answer: Because there seems to be a good correlation between inflows and N in the bay, knowing the volume coming into it and the nutrient concentrations in the water, we should know how it will affect the bay. We are not there yet. We cannot yet do that for the whole bay; it confounds the model.
Comment: I can't understand how criteria can be applied to that.

Comment: That situation reminds me of DO criteria in East Texas that are heavily dependent on flow regimes. We developed criteria based on flow taken at the time of measurement.
Comment: You also have to take into consideration the changes in the shipping channels and land use, etc.

Question: I assume when you measure salinity you are measuring surface salinity?
Answer: Yes, but there are fixed sites where we do profiles

3:30 p.m. Facilitated Group Discussion on Technical Considerations and Overall Stakeholder Process of TCEQ's Approach to Criteria Development

Facilitated by Chip Morris, TCEQ

Facilitator: You have all heard what has been said today regarding topics related to criteria development. This is an opportunity for you to make additional comments on items that have not yet been said. Please bring up any additional items for the group to consider.

Comment: So as we listen to the estuary talk and comments regarding desired conditions, do we have the same problem here as we have with the reservoirs? How do we address different geographic and ecologically significant portions of the estuaries with criteria (main body, sea grass beds, etc.)?

Comment: We still need to gather data to support designated use studies to associate nutrients with designated uses. We need to pick thresholds for estuaries to let us know if there is a problem.

Comment: There is a need to select regionally appropriate endpoints for sampling. When defining end points there is a regional context, because you have a Galveston Bay and Lower Bay, and you have sea grasses. One end point is good for protecting sea grasses but may not be appropriate in the other geographic places. We need to define what it is we want to happen, and what the desired goal is. What is the goal?
(Summarized: There is a need for regionally appropriate end points associated with a desired biological response to define attainment).

Comment: There is a priority question. We need to have a watershed approach in dealing with nutrients. The concern is that developing criteria for streams will have the effect of driving down concentrations in elevated streams, which reduces downstream concentrations from upstream reductions. What expectations should we maintain?
(Summarized: There is a need to establish a desired target in downstream estuaries, prior to developing criteria for streams and rivers).
Comment: I'm afraid of the unintended consequences. If we set criteria that are too low it could be good for streams but bad for estuaries. There are also affordability issues associated with nutrient limits in permits. It could be cheaper for a city to reuse the effluent rather than discharge, which reduces the flow in the stream.

Comment: Need to define the upstream / downstream extent to protect downstream uses.
Comment: It's always been EPA's wish for the states to consider downstream impacts when establishing upstream criteria.

Comment: There is a Gulf of Mexico hypoxia problem at the mouth of the river. There is some limited work on the small hypoxic zones in the Brazos River. Hypoxia in the Gulf is a condition we want to prevent.
Comment: It seems that the 1970s are the reference points for many, do people consider this to be a time when there were healthy conditions?
Comment: It coincides with implementation of the Clean Water Act (CWA).
Comment: The conclusion then was that Galveston Bay was great, but the Houston Ship Channel was not.
Comment: Today, the TCEQ's Surface Water Quality Monitoring team has a talk scheduled for their December annual workshop meeting on hypoxia on the Texas Coast.
Comment: Thermal stratification, more so than nutrients, is the cause of hypoxia off the Texas Coast.

Comment: Maybe we should have a work group meeting with the SB 3 technical groups and see what they have to say, so that we are not reinventing the wheel. Also, we don't have the same flexibility as the SB 3 folks have, due to the CWA.

Comment: The data sent to University of Arkansas... can we look at those as segments and go reservoir to reservoir?
Comment: The data TCEQ sent was broken up that way. The reservoir and streams set has land use data and stations within the watersheds. The stations are associated with rivers generally go upstream from the top (headwaters) of one reservoir to the bottom (dam) of another.
Comment: A lot of our river segments are already broken up like that.

Comment: One big issue is that Texas has taken the position that response variables are what matters (ex, CHLA). Is there any argument against going forward with using response variables?
(Summarized: Does anyone have a problem with setting criteria on a response variable?)
Comment: One problem is that it describes a condition that already indicates an impairment. You set criteria after the impact has already occurred.
Comment: On stream order, I can see periphyton for a first or second order stream, but third or fourth? Will you be specific on what the response variable will be? Response variables should be re-examined from time to time.
(Summarized: Use of periphyton for 1st and 2nd order streams may be appropriate, but not for larger streams).
Comment: Yes.
Comment: When states develop criteria with response variables they should incorporate TN and TP into the criteria.

4:15 p.m. Adjourn