Texas Watershed Coordinator Roundtable
"Bacteria Dynamics, Assessment Methods, and BMPs"

July 27, 2011
9:30 a.m. — 3:30 p.m.
LCRA Dalchau Service Center, Austin, Texas

Summary Notes

Welcome & Introductions

Kevin Wagner, Texas Water Resources Institute

- Bacteria: the number one water quality impairment in Texas and throughout the U.S.
- Our ability to assess bacterial loadings is really limited due to our lack of data on source contributions, especially those from wildlife
- Fate and transport mechanisms – we do not know very well the effectiveness of BMPs in reducing bacterial levels
- Issues with quantifications of uncertainty and the risks related to the bacterial levels we are seeing in water bodies
- Touch just the tip of the iceberg in today's discussion and recent research findings on some of these issues
- Click HERE to view video of the Roundtable introduction.

Stakeholder Questions Regarding Bacteria

Mel Vargas, Parsons

- How do we take all of this research and science from different arenas around the state and infuse it into our decision making processes into each of our watershed protection plans?
- How do we take these ideas and issues that are presented, and the findings from this research and these studies, and integrate them into the 9 key elements of watershed protection plans?
- Use this information to do a better job of identifying the sources of impairments; reduce uncertainty in the models that we use; estimate pollutant loads;
- We need to find better ways to present this information to the stakeholders and answer their questions about bacteria
- Click HERE to view video.

Effect of Fish and Wildlife on Bacterial Levels

Dr. Michael Barrett
Department of Civil, Architectural, and Environmental Engineering, University of Texas

Evaluation of fecal indicator bacteria loadings from a wildlife point source and sediment resuspension in inland streams

- Support for study provided by TxDOT

- Studied bridges and the wildlife that live under bridges as a source of *E. coli* and we wanted to look at both under dry weather conditions and wet weather conditions and assess the magnitude of the impact
- We looked at the persistence downstream; die off or regrowth; and how sediment in the water will affect the die off rate of bacteria
- Study area: Bull Creek in Austin; spring feed creek; inhabited by cliff swallows
- We've created a habitat for cliff swallows because there are way more bridges than cliffs; build mud nests; feces accumulates below nests
- Feces from nests over land could accumulate and be flushed into stream by runoff
- For almost every sampling period in dry weather there is a substantial increase in fecal coliform but again, most of the points being below the standards
- Increase in presence of fecal coliform when swallows are present
- *E. coli* statistically higher downstream whether the birds are present or not
- Fecal coliform statistically higher only when birds are present
- Dry weather: seeing birds as a source and increase in concentration; but not throwing into non-attainment threshold
- Wet weather: upstream concentrations extremely low when birds were present; downstream really high (possibly due to small dataset)
- Study area: Gilleland Creek; northern Travis county; rural watershed; effluent-dominated stream; existing *E. coli* TMDL; 7 wastewater facilities
- Collected water and sediment – concentration of *E. coli* three times higher in bottles with sediment; sediment is a source and hurts you by both increasing the concentration and reducing the rate of die off
- Click HERE to download or view video of Dr. Barrett's presentation.

***Dr. George Guillen*, Environmental Institute of Houston, University of Houston—Clear Lake**

The role of fish as sources and vectors of bacteria and the influence of bat colonies on indicator bacterial levels

- There is a couple of sources of bacteria that concerned some in Houston: fish and bats
- Fish study: lab and field component; fish feed at different locations (look @ different trophic levels); determine whether wild caught fish from Harris County waterways produce feces with detectable levels of indicator bacteria, *E. coli*
- Studies found that about 10% of fish were able to isolate *E. coli*; high levels of bacteria in fish guts (based on research); Benthic fish harbored *E. coli* at a rate 10 times higher than Pelagic fish; Fish may acquire through feeding
- Collected in field, euthanized and extracted their guts; fecal matter extraction
- Urban streams had very elevated concentrations of bacteria
- Bacteria levels between sites – did not see a significance difference; at a minimum, fish are definitely transporters of *E. coli*

- Bat study: in Houston area (Buffalo Bayou); focused on one bat colony (Waugh Street); Mexican Free tailed bats produce large quantities of feces; emerge after dark to forage
- Results show bats are definitely contributing to the *E. coli* loads in Buffalo Bayou; additional research critically needed
- Click HERE to download or view video of Dr. Guillen's presentation.

Environmental Effects on Bacterial Survival and Growth

Dr. Saqib Mukhtar

Department of Biological and Agricultural Engineering, Texas A&M University

Fate and transport of *E. coli* in rural Texas landscapes and streams

- Study area: east central part of Texas – Navasota River Watershed; Cedar Creek watershed; predominantly a rural-type watershed; most sources of bacteria are nonpoint type sources – agricultural and wildlife
- Identify and characterize fecal contamination sources in Cedar Creek watershed and quantify the *E. coli* concentration from the sources
- Monitor survival, growth, and re-growth of *E. coli* under different environmental conditions
- Samples collected from raccoons, white-tailed deer, opossums, feral hogs, and cows
- Concentrations highest for raccoon and opossum; cattle had the lowest concentration for *E. coli* load (one of the reasons perhaps is that raccoons, opossums and hogs are omnivores)
- Summer and winter sampling – differences across seasons for average load shedding
- *E. coli* (in feces) survival in Creek water – took three random fecal samples from each species; when you reach temperatures of 20 degrees Celsius, had the highest count of *E. coli* in cattle sample; 50 degrees Celsius – no more survival
- *E. coli* growth/decay in Creek water – reduction over time in 25 degrees Celsius; significant reduction in 35 degrees Celsius
- *E. coli* survival in soil – isolated *E. coli* strains; maintained aerobic and anaerobic conditions in soil; 3 replicates and 2 species; saw maximum growth when soil moisture was at 25%
- Click HERE to download or view video of Dr. Mukhtar's presentation.

Dr. Hanadi Rifai

Civil and Environmental Engineering Department, University of Houston

Relationship between Bacteria and Conventional Water Quality Parameters

- Conventional Water Quality Parameters that we found a lot of good relationships with pathogen contamination associated with those: Total suspended solids; temperature turbidity; solar radiation conductivity; dissolved oxygen; pathogens
- Suspended solids: increase turbidity, make water less clear, increase in amount of bacteria
- Dissolved oxygen is critical for life forms in water body; oxygen demanding materials consume dissolved oxygen

- Pathogenic organisms (bacteria, viruses, and protozoa from diseased persons or animals): relevant to TMDL process; water unsafe for drinking, swimming, fishing
- Temperature: very important; affects dissolved oxygen
- Houston Metropolitan Watersheds: diverse and big set of watersheds; early 1970s, Houston had worse bacterial levels
- Whiteoak Bayou Watershed: highly urban and forested; manual and automated sampling;
- Upstream locations had lower median and geometric mean *E. coli* concentrations; downstream locations had similar variability of *E. coli* concentrations (sample between 12 and 6 p.m.)
- As watersheds urbanize, less correlation between biological water quality and other parameters
- Correlation may be observed at high resolution scale, e.g., EC and turbidity during storm event
- Some conventional water quality parameters no longer sufficient indicators, e.g., TSS
- Other indicators needed for urbanizing watersheds to characterize particulate, biological, and chemical water quality
- Click HERE to download or view video of Dr. Rifai's presentation.

Methods for evaluating bacteria sources and loads

Emily Martin

Soil and Aquatic Microbiology Lab, Texas A&M University

Comparison of *E. coli* methods

- Monitoring for *E. coli* – thought to be most specific of indicator organisms
- IDEXX Technology www.idexx.com (minimal training and set up; pre-packaged; isolation cultures or confirmatory test requires secondary plating)
- Membrane filtration (more advanced training; prepared medias available but more expensive; isolations and/or confirmation steps can begin in 24 hours)
- Study: Sercu et al. (2011) – Colilert allowed growth of non-target taxa
- Study: Looking at diversity of *E. coli* isolates obtained from surface water samples using different enumeration methods (Burton Creek and Carter's Creek in College Station; Lake Bryan)
- Used three standard water quality assessment methods; 200 isolates per sampling site per media type
- Used fingerprint technique – ERIC-PCR; grouped and analyzed
- ERIC fingerprint patterns obtained from both the mTEC and m-ColiBlue24® were more diverse whereas the Colilert patterns displayed much more clonality
- Colilert appears to select for the least diverse E. coli populations
- Enzyme-based methodologies yield comparable enumeration results, but not necessarily the same communities
- Two methods – QuantiTray® vs Membrane offer different 'habitats' for growth and thus different communities are selected
- Choose the enumeration method most fitting to the question being asked
- Click HERE to download or view video of Emily's presentation.

***Rocky Freund*, Nueces River Authority**

Arroyo Colorado Bacteria Indicator Study

- Study area: Arroyo Colorado, above tidal segment (63 miles)
- The above tidal portion listed on 303(d) list for bacteria in 1996; Arroyo Colorado Watershed Partnership was formed in 1998 in response to dissolved oxygen TMDL
- Water quality samples collected monthly at 6 sites in 2009; analyzed for fecal coliform, *E. coli*, and Enterococcus
- Results – fecal coliform: many samples exceeded standards
- Results – *E. coli*: fewer samples exceeded standards
- Results – Enterococcus: almost all samples exceeded criteria
- With this study, do not have the data if the Partnership has an effect on bacteria levels
- Recently completed RUAA on Arroyo Colorado
- Click HERE to download or view video of Rocky's presentation.

Effect of management and land use on bacterial concentrations and loading

Dr. Terry Gentry

Soil and Crop Sciences Department, Texas A&M University

Effects of agricultural management, land use, and watershed scale on *E. coli* concentrations

- Study looked at three different scales: field, small watershed, river basin
- Land use: grazed pasture; cultivated; cultivated and grazed
- Small watershed: mixed rural; and mixed rural with dairies, wastewater treatment plant
- River basin: mixed rural with dairies, WWTPs, small communities
- Study area: Leon River Basin (Resley Creek – more human impact; and Mustang Creek);
- Sampling sites: 6 field scale sites; 2 small watersheds; Leon River
- Types of water samples: edge-of-field runoff; stream; samples collected from 2005 to 2009
- Grazed fields had higher levels of E. coli in edge-of-field runoff samples than did cultivated fields
- No significant difference in E. coli levels due to land use at the small watershed-scale
- E. coli levels decreased as watershed scale increased
- Click HERE to download or view video of Dr. Gentry's presentation.

***Kevin Wagner*, Texas Water Resources Institute**

Effects of fencing, alternative water, grazing management, and other agricultural BMPs on bacteria loading

- Has worked to identify good BMPs that cattlemen can implement on their ranches to reduce bacteria contributions to streams and rivers across the state
- Livestock deposit manure on pasture-lands and bacteria is carried to surface water bodies in rainfall events; livestock also have direct access to streams and deposit manure directly into stream
- Reduce the amount of time cattle spend in and near the stream; maintain adequate ground cover to increase infiltration which reduces runoff

- Cattle spend time in streams: shade, drinking water, grazing, cooling
- What can you do to address these? Provide other sources of water and shade; practice good grazing management; fence off stream; practice good herdsmanship
- Alternative water supply effectiveness (cattleman may be more likely to adopt): what would be the effects on providing alternative water on the amount of time cattle spent in or near the stream.
- Ranch had water troughs throughout ranch – year one of study – turned water troughs off forcing cattle to stream; year two of study – turned water troughs on (used GPS collars around cattle)
- Water troughs significantly decreased time (by 43%) that cattle spent near the stream
- Found no significant difference in bacteria reduction during year 1 and year 2 of study (57% reduction but not significantly different because of a huge variability)
- Alternative shade structures: (South Bosque River) shade coupled with alternative water and salt/mineral locations encouraged cattle to spend less time in riparian areas; Oct. 2010 showed 31% reduction of time spent near stream; June 2011 showed 11% reduction
- Exclusionary fencing: eliminates access to stream; expensive to construct and maintain; have only seen 30 to 66% reduction; cannot do a great deal to address runoff
- Maintain ground cover: grazing management system and stocking rate; forage selection and managing forages (wide ranges of productivity); nutrient and pest management
- *E. coli* not correlated with grazing management (in rotationally grazed pastures)
- *E. coli* not correlated with stocking rate (in rotationally grazed pastures)
- *E. coli* correlated with percent of events occurring while stocked (in rotationally grazed pastures)
- Rotational stocking can be an effective practice
- Lone Star Healthy Streams (http://lshs.tamu.edu)
- Click HERE to download or view video of Dr. Gentry's presentation.

Bacterial Regrowth

Dr. Jacqui Peterson

Soil and Crop Sciences Department, Texas A&M University

Effect of carbon on bacterial regrowth

- In terms of *E. coli* and dissolved organic carbon, does it matter where in the watershed it is derived?
- Extracted grass and leaves; used this source of carbon to get difference concentration
- Carbon and Nitrogen are limiting for growth of *E. coli* in vitro
- BMPs to keep carbon and nitrogen on the landscape:
  - Run ON not run OFF
  - Don't over irrigate
  - Rain harvesting
  - Rain gardens
  - Wet cells
  - Detention ponds
  - Grassy swales
  - Avoid vegetation getting into road gutters and storm drains
- Click HERE to download or view video of Dr. Peterson's presentation.

Roundtable discussion of implications of research findings to watershed planning and implementation

***Mel Vargas*, Parsons**

How do these findings affect your watershed planning efforts?
What are other questions regarding bacteria (i.e. current research needs)?

- Most data in models used are monthly at best; quarterly usually; some models are equipped to do daily time steps (money is a problem when it comes to monitoring plans)
- Could be a general agreement that Watershed Protection Plans to-date have certainly not been able to benefit from high-resolution monitoring plans
- Monitoring strategy – maybe consider applying money to a high-resolution focused effort; influences 12-month or 24-month sampling strategy
- Potentially re-thinking the indicator that you are using to evaluate whether the watershed protection plans implementation strategies are effective and going in the right direction – what does this mean to the 10-year timeframe in the way the WPP was initially developed and set-up (based on a certain target)
- EPA (Jane Watson): slated to release new criteria – Oct. 15, 2012 – which revisits the 1986 epidemiological study which examined the relationships between water quality and swimming-associated health effects; the agency's current guidance will be modified
- Click HERE to hear more and view video of the discussion.

Wrap-Up

***Kevin Wagner*, Texas Water Resources Institute**

- State Bacterial Source Tracking Conference
  - February 28-29, 2012 at T Bar M in New Braunfels
- Upcoming training opportunities
  - Texas Watershed Steward Program (one-day training designed to improve Texas water quality by education stakeholders about their watershed)
  - Next Texas Watershed Planning Short Course – November 14-18 @ Mayan Dude Ranch
  - Next Roundtable (possibly January 25, 2012; will be paired with a Stakeholder Facilitation training)
- Other Announcements:
  - Neal Denton, Texas Stream Team: Meeting of the Monitors – 3-day environmental education conference, September 29 through October 1 @ Hilton Houston NASA Clear Lake
- Click HERE to view video of the Roundtable wrap-up.