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IDENTIFICATION OF SOURCES OF FECAL POLLUTION IN ENVIRONMENTAL WATERS

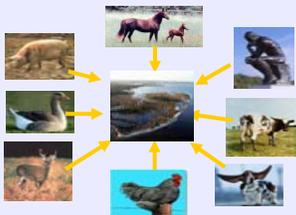
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LTG 2 Poster 05

Science Question

Can we identify the primary sources of fecal contamination in our Nation's watersheds?



How The Research Addresses WQ MYP Goals

- The major driver for this research is the Total Maximum Daily Load (TMDL) program, particularly as non-point sources are believed to be the primary pollutants responsible for listed water bodies impairments. Potential fecal pollution sources include humans (septic tanks), domesticated animals (cattle, poultry), and wildlife (waterfowl).
- We are evaluating currently available methods as well as developing novel tools to assess and diagnose the causes and pollutant sources of impairment in aquatic systems.

Research Objectives

- Evaluate different microbiological and chemical methods used to identify fecal sources of pollution in watersheds.
- Provide guidance and training to regional and state scientists on fecal source tracking methods
- Determine the relationship between the presence of microbial and chemical signatures and adverse health impacts.

Research Methods and Collaborators

Microbial Indicators

- We have evaluated several genotypic and phenotypic methods to identify sources of fecal pollution. Among the methods examined are antibiotic resistance profiles, temporal and spatial variability of indicator bacteria, and the host-specificity of several Polymerase Chain Reaction (PCR) -based methods.
- A series of working meetings were conducted with regional EPA partners, as well as scientists from Academia, NOAA, USDA, USGA, and Environment Canada to reflect on the state of the science of Microbial Source Tracking (MST).

Chemical Indicators

- We have evaluated the presence, persistence, fate and transport of wastewater compounds that might serve as indicators of human fecal contamination.
- The analyses were performed using LC/ESI/MS and GC/MS techniques.
- Results were obtained in collaboration with the USGS, through projects designed to further the understanding of the behavior of the chemicals.

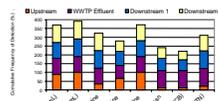
Results and Conclusions

- Data using library dependent methods suggests that while some of the methods could discriminate between different fecal sources, large site specific libraries will have to be generated for each watershed. In many cases this is not a viable option due to time and resources constraints.
- Data using host-specific PCR techniques suggests that some of the currently used assays have significant potential, but require further validation across different regions. The data also suggests that the use of multiple markers would enhance the discriminatory power in MST studies as some of them lack true host specificity.
- Overall, the results underlined the need for laboratory validation of MST assays prior to their application in field studies.



Phylogenetic affiliation of host-specific gene sequences

- Chemicals showed different persistence patterns in the samples analyzed. The persistence patterns were ubiquitous (caffeine, cotinine), ephemeral (triclosan, galaxolide), and intermediate (carbamazepine).
- The utility of these wastewater chemicals to serve as indicators of human fecal contamination is currently being evaluated in an epidemiological study (National Epidemiological and Environmental Assessment of Recreational Water Study).



Different types of chemical persistence

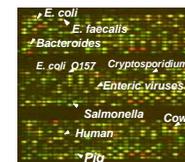
Interactions with Customers

- Thus far, our primary customers have been EPA regional offices and state environmental protection programs. We have organized several workshops, participated in national and international expert panels, and provided training to regional and state scientists interested in learning source tracking methods.
- In response to regional needs and in collaboration with ORD-regional science liaisons, members of Academia, OW, and several federal agencies, we developed a MST guide document.
- We are actively collaborating with states and regions in MST research projects via the Regional Applied Research Effort program and regional environmental programs. We are also communicating our efforts to OW, OWOW, and OWM personnel.

Future Directions

- Development of novel quantitative methods for monitoring sources of fecal pollution in surface waters.
- Evaluation of markers in Best Management Practices projects and in spatial - temporal studies.
- Establish performance standards for MST approaches.
- Develop training center for state and regional scientists.
- Evaluation of the microbial and chemical markers in epidemiological studies.
- Develop methods that can simultaneously monitor multiple indicator species, source tracking markers, and pathogens in source waters.

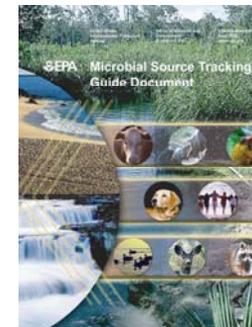
Microbial Water Quality Biochip



Indicators

Pathogens

MST



Microbial Source Tracking Guide

How Research Contributes to Outcomes

- The research data will be used to develop rapid methods to quantify specific sources of fecal pollution. This information is needed to develop accurate point and non-point source loading models.
- This research will also aid in the evaluation and implementation of best management practices and assessment of human health risks associated with different sources of pollution.
- Fully validated methods and models will assist stakeholders meet TMDL deadlines and provide the scientific community and regulators with the data needed to further improve diagnostic tools that can better identify the magnitude and sources of impairments.
- Successful application of these methods will benefit programs related to source water protection and recreational waters.

Disclaimer: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.