CSREES National Water Quality Program

Title: Differentiating among, and quantifying sources of fecal contamination for model development

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State: NC **Region:** Southern
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Theme: Watershed Management

Situation: Estuarine and coastal waters of North Carolina are adversely impacted by poor water quality, causing thousands of acres of shellfish beds and beach areas to be closed annually due to elevated levels of routinely monitored indicator bacteria such as fecal coliforms, E. coli, and/or enterococci. It is known that these indicators, while useful as proxies for the presence of dangerous pathogens, can also come from sources such as dogs, livestock, wild animals, and birds, and are not necessarily a risk to public health.

Objectives: This project is an expansion of an existing USDA-funded collaborative effort involving North Carolina State University, NOAA, the NC Division of Water Quality, and Duke University. Our component of the project is to identify and quantify viral and bacterial pathogens to investigate sources and loads of fecal contamination from watersheds with different land use types, silviculture, agriculture, and residential. The collaborative project involves development of hydrological models for various land uses as a tool for future implementation of TMDLs. We will support this effort using molecular techniques to assess loads of specific viral and bacterial species as input to the State's TMDL model, the Coliform Routing and Allocation Program (CRAP). We will also conduct a preliminary survey using the newly developed molecular methods to determine the effectiveness of BMPs such as constructed wetlands for pathogen removal.

Methods: We are using a novel molecular technique called Quantitative PCR (Q-PCR), also known as "real-time PCR". Our research focuses on the quantification of viral pathogens and specific bacterial species as a means for differentiating between sources of fecal pollution. We have specifically focused on utilizing Q-PCR in conjunction with the other bacterial source tracking methods that are being used for the collaborative project (ribotyping and antibiotic resistance) in order to not only differentiate between, but to also quantify different types of human and animal sources of fecal contamination. We are also developing new technologies and management strategies that will promote protection of estuarine waters from biological contamination originating from agricultural and forestry operations.

Partnerships: This project is a collaborative effort among North Carolina State University, the NC Division of Water Quality, the NC Department of Environmental Health, Duke University, and the National Oceanographic and Atmospheric Administration's Center for Coastal Environmental Health & Biomolecular Research at Charleston. The roles of these organizations is to support the development of a hydrological flow-based watershed model of microbiological contamination (NCSU), to assist with water quality sampling efforts, and data analysis (NC DWQ), to assist in determining stakeholder dissemination of information (NC DEH), to assist in model development and data analysis (Duke University), and to assist in analysis of samples for bacterial source tracking (NOAA CCEHBR).

Research: Research that is being conducted as part of this project will become the backbone for the development of an integrated curriculum in coastal management. The collaborative team conducting this research has and will continue to participate in a series of workshops supported by NOAA that serve to educate that public, stakeholders, and local decision makers about the needs for restoring shellfish waters, the impacts of stormwater on the coast, and general water quality issues.

Resources: Leverage of resources has been a key of the success of this program. As is evident, there are high numbers of institutions involved, all of which are leveraging in-kind services and matching of funds. In particular, the PI has leveraged start-up equipment that was part of here lab start up package at UNC Chapel Hill in development of the novel techniques being used for this project.

Results: Activities - The PI and the entire collaborative group has been active in reporting their results at national level water quality meetings, and will document their findings through publications in high-level peer-reviewed journals. Also, the group has been highly active in local, regional, and nationally related workshops on microbial source tracking, stormwater and water quality issues, and protection of coastal areas from development. Outcomes - Short term: The project has yielded information that demonstrates the usefulness of microbial source tracking techniques for water quality management. Medium term - The integration of water quality data into useful watershed based models is useful for development of successful tools for predicting water quality.