

Determining Sources of Fecal Pollution in Washington D.C. Waterways

Kimberly R. Porter

Thesis Submitted to the Faculty of Virginia Polytechnic Institute and State University

In Partial Fulfillment of the Requirements for the degree of

MASTERS OF SCIENCE

IN

ENVIRONMENTAL SCIENCE AND ENGINEERING

APPROVED:

Charles Hagedorn III, Chair

Tamim Younos

Carl Zipper

November 19, 2003

Blacksburg, Virginia

Keywords: bacterial source tracking, antibiotic resistance analysis, fecal bacteria,
water pollution

Determining Sources of Fecal Pollution in Washington D.C. Waterways

Kimberly Rae Porter
Dr. Charles Hagedorn III, Chair
Crop and Soil Environmental Sciences

(ABSTRACT)

Antibiotic resistance analysis (ARA) of *Enterococci* was used to determine sources of fecal contamination in three District of Columbia waterways: Rock Creek, the Anacostia River, and the Potomac River. These three waterways were identified as exceeding water quality standards set for fecal coliform levels and were designated by the District of Columbia to the Environmental Protection Agency's 303 (d) impaired waters list.

A library profile of 1,806 enterococcus isolates from known sources was built based on antibiotic resistance patterns from thirty concentrations of nine antibiotics. These sources included human, cattle, chicken, horse, goat, sheep, deer, raccoon, muskrat, goose, seagull, coyote, duck, wild turkey, dog, and cat.

Antibiotic profiles were characterized for 24 unknown enterococci isolates on each of 198 samples (38 samples from the Potomac River, 79 samples from the Anacostia River, and 81 samples from Rock Creek) collected periodically from July 2002 through April 2003. Two major storm events were also sampled during this period. These isolate profiles were compared to the known source library using logistic regression. Three dominant sources of fecal pollution were detected in the Potomac River: livestock (30%), human (29%), and wildlife (22%). Three dominant signatures were also detected in Rock Creek: horse (26%), human (26%), and wildlife (24%). Human was the only dominant source detected in the Anacostia River, averaging 43% over the sampling period.

The results of this study indicate that human is a substantial contributor to the fecal contamination problems, especially in the Anacostia River, but there are significant agricultural and wildlife contributions as well. Significant and predictable seasonal variations were also detected, indicating the influence of precipitation on source distributions. The results of this study will aid the Metropolitan Washington D.C. Council of Governments in making important management decisions to help improve the water quality in and around the Washington D.C. area.

Expanding the limits of ARA was also an integral part of this research. Three new and even controversial analytical techniques were run on the data collected from this project in an attempt to improve confidence and provide direction to the results of this study. The first was a comparison of the more commonly used statistical analysis model discriminate analysis (DA) with logistic regression (LR). No significant difference was found between the output of the two models for the known source libraries, therefore no suggestion could be made in favor of one model over the other. Another analytical test of the data was the introduction of a standard requiring isolates to meet a minimum of 80% similarity to the known source profiles where it was classified. With the 80% cutoff, between 41% and 44% of the isolates could not be classified to any source and were placed in an unknown category. Based on the remaining isolates, source distributions were recalculated and were not statistically different than those calculated with no restriction for isolate similarity for matching. The last major test of the data was the analysis of the library for representativeness via pulled sample cross validation and the exclusion of all duplicate patterns from the known source library. These analyses did not confirm the representativeness of the databases, but results were further analyzed based on the implications these analyses have on library based methods.