

State-of-the-Science: Fecal Source Identification and Associated Risk Assessment Tools

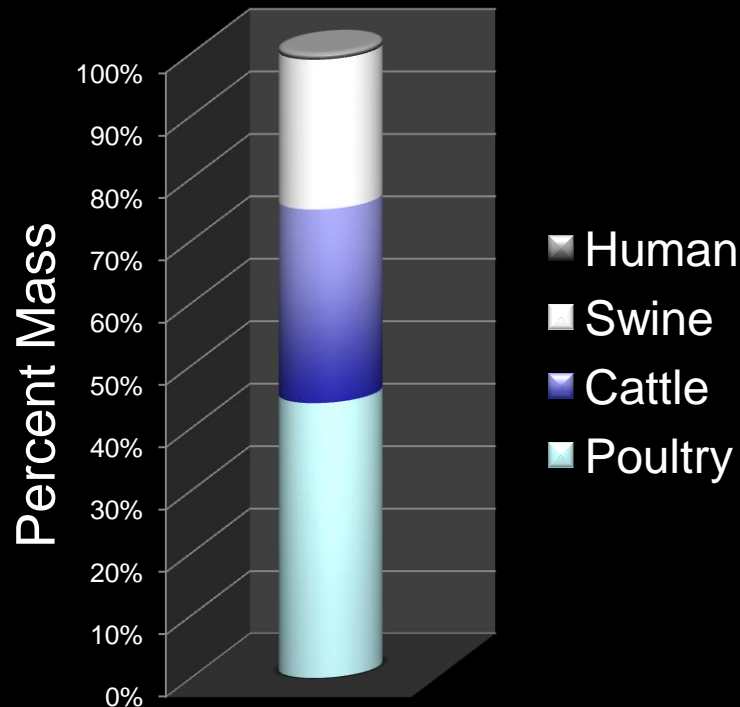
- ▶ Session 1: How accurately can we distinguish between human and non-human fecal sources?
- ▶ **Current prospects for detecting human sources of fecal pollution**
- ▶ Dr. Charles Hagedorn, Virginia Tech

Current prospects for detecting human sources of fecal pollution

- Brief overview of microbial source tracking (MST)
- Different strategies currently used in MST
- Approaches for detecting human sources of fecal pollution

Fecal Pollution is a Worldwide Problem

Agricultural and Human Sources of Feces in the U.S.



- Fecal microbes are a common biological contaminant worldwide
- Estimated 1×10^9 tons/year of agricultural and human feces
- Contribution from wildlife unknown
- Current U.S. EPA and World Health Organization (WHO) recommended indicator methods do not discriminate between animal sources
- Some three million deaths occur annually from water-borne diarrheal diseases worldwide (WHO fact sheet #114)

Many Uses for Reliable Fecal Source Identification Methods

- Supplement sanitary surveys and watershed assessments
- Indicator of public health risk; can inform epi studies
- Data generation for quantitative microbial risk assessment modeling
- Allocation of fecal loads from different sources for TMDLs
- Evaluation of human and agricultural fecal treatment and implementation of best management practices
- Assessment of hazardous events (sewage spills, CSOs, etc.)



Microbial Source Tracking

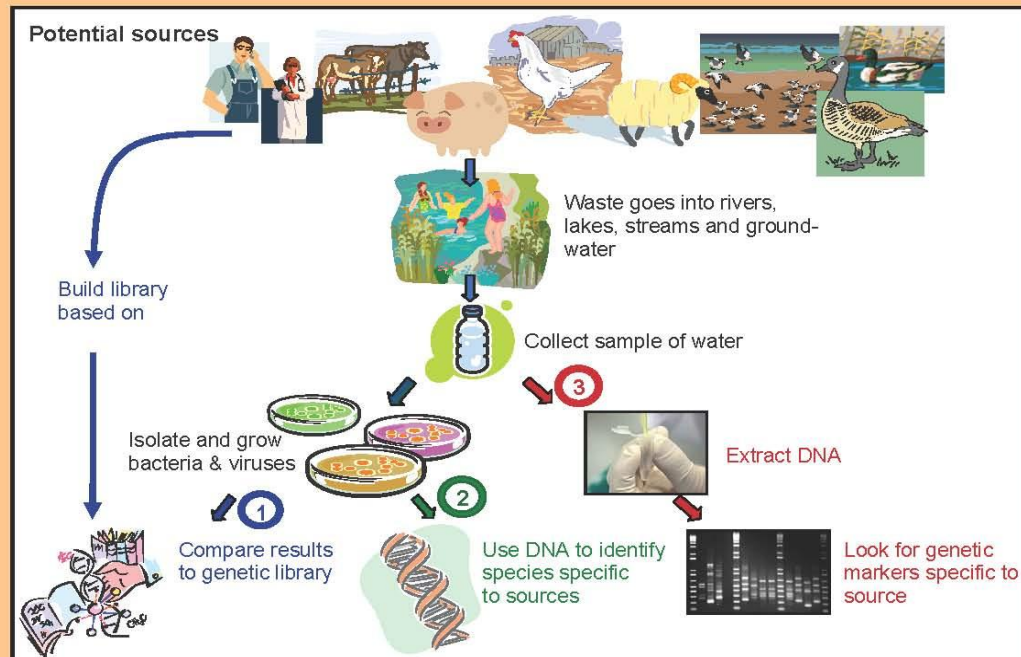
What is Microbial Source Tracking?

Microbial source tracking is a process of identifying a particular source (such as human, cattle, or bird) of fecal contamination in water, which is generally measured through fecal indicator bacteria, like *Escherichia coli* (*E. coli*) or Enterococci. The basic assumption of microbial source tracking is that there are characteristics unique to the fecal bacteria from a particular host and these characteristics allow researchers to identify the source of the contamination. Most of these target key genes that can be “fingerprinted” or tied to a type of mammal, human or bird.

How is Microbial Source Tracking Done?

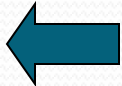
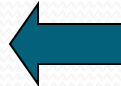
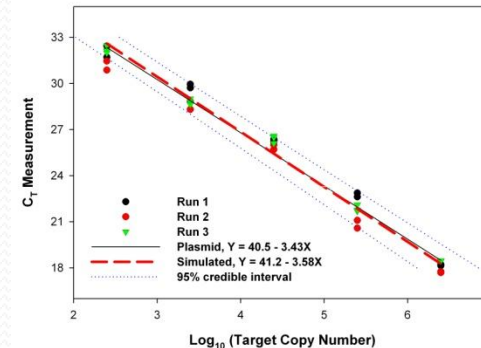
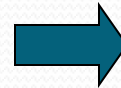
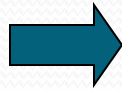
There are several different methods for microbial source tracking:

- ① **Library-dependent, culture based:** Samples are collected from all over a watershed and researchers grow bacteria in the lab to create a library from a variety of source organisms. Then, water samples are collected from rivers, lakes, or beaches and the bacteria in the samples are also grown in the lab. The results of the water sample are compared to the library to determine sources of contamination.
- ② **Library-independent, culture based:** Water samples are collected and the bacteria and viruses in the samples are grown or cultured in the lab. The bacteria and viruses grown are known to be from specific hosts or sources of fecal contamination so there is no need to compare results to a library.
- ③ **Library-independent, culture independent:** Water samples are collected and molecular techniques are used to isolate and identify DNA directly from the sample without first having to grow or culture the bacteria and viruses in the sample.



A Fecal Source Identification Solution

DEFINITION... Process designed to collect, isolate, and characterize presence and/or concentration of a source identifier from an environmental sample.



Methodological Approaches to MST

- DNA markers (SIPP Study)
 - HF183 and HumM2 (examples of human markers)
- Community analysis (SIPP Study)
 - PhyloChip and *Bacteroidales* 16S TRFLP
- Chemical surrogates
 - Phospholipid fatty acids, caffeine, pharmaceuticals, fecal sterols and stanols, optical brighteners
- Physical methods
 - Fate and transport of FIBs, marker degradation and FIB die-off
- Uncertainty issues and human detection
 - Assess the results of the source tracking effort

Visitor's Center area of Mission Bay – Toolbox approach

- Cooperative project with SCCWRP and San Diego Wastewater Sanitation District
- Persistent counts over standard
- Systematic sampling led to beach wrack and storm drains
 - Source tracking component includes:
 - Testing stormwater and diversion system with dye;
 - Community analysis to compare wrack vs. stormdrains vs. water;
 - Species identification of enterococci in beach wrack;
 - Add human markers where needed.



Can you have success in finding human sources of pollution?

Yes, but multiple approaches are usually needed.

Persistent exceedances at certain Virginia Beach locations

Infrastructure designed to collect and pump ground water to lower the water table

Approaches included intensive sampling, dye tests, *Enterococcus* speciation in biofilms, BacHum source marker, groundwater wells, chemical surrogates.

Combination of dye tests and groundwater levels proved connections from sewer lines to storm drain pump system.

Army COE built line extensions several hundred yards offshore.



Beaches influenced by periodic severe storm events



Hurricane Sandy at Virginia Beach



Thank you.

