Sanitary Surveys and Their Value for Hazard Identification

Presentation to the Produce Safety Alliance

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BACKGROUND

• Sanitary surveys were originally developed as part of the framework to protect drinking water systems

• Typically conducted by a Registered Sanitarian or specially trained third party inspector

• Comprehensive evaluations
  – Cover all aspects of the system, including water source, treatment, distribution system, operator training etc.
  – Standard format and checklists ensure uniformity
SANITARY SURVEYS MORE RECENTLY DEVELOPED FOR BATHING WATERS

• EPA created separate surveys for marine and freshwater beaches

• Intent is to improve water quality by helping beach managers synthesize beach and watershed information
  – Water quality data
  – Pollutant source data
  – Land use data

• Survey data can be used to assess potential health risk to bathers
  – Also serves as a baseline for assessing effectiveness of pollution remediation efforts
SANITARY SURVEY VS. ANNUAL INSPECTION UNDER PSR

• Sanitary surveys take a comprehensive approach to protecting and maintaining the source water and distribution chain
  – PSR only requires inspection of water sources, water distribution systems, facilities, and equipment under your control

• Sanitary surveys examine all activities in the watershed that may influence source or receiving water quality
  – Rely heavily on fine-scale, historical monitoring data
  – PSR asks only that you consider:
    o Water quality monitoring data
    o Nature of the water source (ground or surface)
    o Extent of your control over the water source
    o Degree of protection of the water source
    o Adjacent land use
    o Likelihood that an upstream agricultural user may introduce contaminants
HOW LIKELY IS THE PSR GUIDANCE TO DETECT AND IDENTIFY MICROBIAL CONTAMINATION?

• Required monitoring is adequate to detect long-term trends
  – Will not catch random events

• Farmers need to be aware of activities that may negatively impact source water quality

• More frequent monitoring may be required when conditions change
  – Changes in land use, development, road construction
  – Natural disruptions such as fires and floods
  – Migrating wildlife
WHAT CAN BE DONE WHEN SOURCE WATER CHRONICALLY FAILS TO MEET STANDARDS?

• Treating water is only a short term solution
  – Expensive
  – May reduce productivity
  – May produce harmful by-products

• Change water source

• Best solution is to find and remediate the source of contamination
THE PROBLEM

• Indicator bacteria like E. coli are non-specific indicators
  – Found in the gut of most animals
  – Can grow in the environment

• > 50 source-specific genetic methods of fecal identification have been developed

• Need to know if they work
THE SOLUTION

• Conduct a Microbial Method Evaluation Study

• Blind samples with various sources of fecal material

• Most Methods run by multiple labs
SOURCES

• Human
  – Individuals, sewage, septage

• Dog

• Gull

• Cattle

• Pig

• Horse

• Geese

• Deer

• Pigeon

• Chicken
PARTICIPATING LABS

- Ali Boehm, Stanford
- Jenny Jay, UCLA
- John Griffith, SCCWRP
- Trish Holden, UCSB
- Stefan Wuertz, UC Davis
- Jed Fuhrman, U Southern California
- Chris Sinigaliano, U Miami
- Rachel Noble, U North Carolina
- Mike Sadowsky, U Minnesota
- Jody Harwood, U South Florida
- Jill Stewart, U North Carolina
- Gary Andersen, UC Berkeley
- Jiyoungh Lee, Ohio State U
- Joan Rose, Mich State U
- Vijay Kannappan, Wayne State U Michigan
- Scott Reynolds, Environmental Canine Services
- Huw Taylor, U of Brighton, UK
- David Diston, Switzerland
- Melanie Wicki, Federal Office of Health, Switzerland
- Wim Meijer, U of Dublin, Ireland
- Andreas Farnleitner, Vienna U of Technology, Austria
- Michele Gourmelon, Ifremer Laboratoire de Microbiologie Plouzané France
- Raquel Rodriguez, National Institute of Health, Portugal
- Orin Shanks, EPA
- Kelly Goodwin, NOAA
- Jorge Santo Domingo, EPA
- Murulee Byappanahalli, USGS
- Theng Fong, Tetra Tech
- Mauricio Larenas, Source Molecular
CLASSES OF METHODS

- **Presence/ Absence**
  - Detect single source
  - Provide binary answer

- **Quantitative**
  - Detect single source
  - Provides information on concentration of source in sample

- **Community**
  - Detect multiple sources
  - May provide some information about relative concentration in sample
EVALUATION CRITERIA

• Correctly identify presence/absence of a host source?

• Correctly identify the dominant source?
  – Relative contribution from each source?

• How repeatable are the assays?

• Do assay combinations provide more information than a single assay?
  – Which combinations work best?
OUTCOME

• Identified methods that were both specific and sensitive for five key fecal sources:
  – Human
  – Dog
  – Pig
  – Cow
  – Gull

• Consensus among scientific community
  – Almost every key scientist in the field participated
  – Brought them together to help develop the conclusions
  – Water Research dedicated an entire journal issue to the study
  – Achieved a level of consensus that is rare in science
DEMONSTRATION PROJECTS

• Not enough to have high tech laboratory techniques
  – How do the different pieces fit together?
  – How many samples are needed?

• Four teams selected a “beach bummer” to begin testing source identification approaches
  – Stanford University – Cowell Beach
  – UCSB – Arroyo Burro Beach
  – UCLA – Topanga State Beach
  – SCCWRP – Doheny State Beach

• Goals
  – Apply and refine source identification protocol
WE FOUND SOURCES

• **Cowell Beach**
  - Initial community suggestion: Bacterial growth in the beach wrack
  - Not the case: Fecal indicator bacteria growing in wrack were a minor source. Main sources were birds and humans
  - Subsequent efforts pinpointed a buried storm drain discharging sewage

• **Doheny**
  - Initial community suggestion: Fecal indicator bacteria are from resident gulls
  - Gulls were part of the problem, but there was a distinct human signature
  - Dye testing found leaking sanitary sewers

• **Arroyo Burro**
  - Initial community suggestion: Dogs on the beach
  - Source markers confirmed that dogs were the primary source
  - However, higher levels of dog marker were found upstream; dogs in the watershed were a larger problem than dogs on the beach
LESSONS LEARNED

• Get everyone in the same room
  – There are many agencies with management responsibility
  – They all hold different pieces of the puzzle and don’t always interact

• The simplest answer is often the right one
  – Start by looking for obvious issues like leaking pipes
  – Create a GIS inventory of the infrastructure

• Use a toolbox approach
  – The genetic tools are great, but the traditional tools are also an important part of the solution
  – Dye testing followed by camera inspections were critical
• Captured what we learned into a written guidance document
  – How does a beach manager get started?

• Extensive outside review
  – Clean Beach Task Force
  – Beach Water Quality Workgroup
  – US EPA

• A tiered approach
  – Hypothesis-driven
  – Start with less costly methods to localize and refine the problem
  – Use more expensive methods in a focused manner

TECHNOLOGY TRANSFER

• Trained labs from throughout state to perform qPCR methods for source specific markers
  – Varying levels of familiarity with molecular methods
  – Mix of government agencies, research labs and consultants

• Training schedule
  – Day 1 – Classroom and pipetting proficiency
  – Day 2 – Hands on (Basic qPCR proficiency, DNA extraction)
  – Day 3 – Independent analysis, data review and management

• Goal was that participants felt confident running method independently
  – Provided support after participants returned to home labs
  – SCCWRP acted as “Help Desk”
  – Developed a web tool for data analysis and reporting
AGENCIES TRAINED

- LACSD
- OCSD
- City of Los Angeles
- City of San Diego
- Ventura County Public Health
- San Diego County DPW
- OC Public Health Lab
- Long Beach Public Health Lab
- San Mateo County Public Health Lab
- San Francisco Water Utility
- Santa Cruz County Environmental Health
- Monterey Bay Aquarium Research Institute
- NOAA
- Weston Solutions
LABORATORY INTERCALIBRATION STUDY

- **Need to know if the training stuck**
  - Only labs that demonstrate proficiency will be allowed to process samples from the Bight ‘13 Microbiology Study

- **Eight participating labs**
  - Each provided with a pre-intercalibration training package
  - 6 weeks to practice and refine skills prior to study

- **Labs ran qPCR for human marker on a suite of blinded samples**
  - Duplicate sewage-spiked test samples and blanks

- **Evaluated on 3 basic criteria**
  - Ability to produce high quality standard curves from reference material
  - Ability to accurately measure target concentrations in unknown samples
  - Ability to avoid cross contamination during sample analysis
RESULTS OF LAB INTERCALIBRATION

- Labs did reasonably well

- Most were capable of analyzing samples independently

- Provided support to labs (2) that underperformed
  - SCCWRP still serves as a reference lab
PARTING THOUGHTS

- Microbial Source Identification technology is mature and are available when Sanitary Surveys cannot identify the source of contamination.

- The *California Microbial Source Identification Manual* outlines a hypothesis-driven approach to conducting source identification investigations.

- There will be instances where farmers will need to identify and remediate fecal contamination in agricultural water from unknown sources.

- The Produce Safety Alliance and other support organizations are well positioned to facilitate training of local laboratories (and maybe even some farmers!)