Posters Presentations

Complexity of Relation between Measured Indicator Microbes, Pathogens, and Human Health Effect Levels in a Non-point Source Subtropical Marine Recreational Beach

Presenter: Amir Abdelzaher
University of Miami, Department of Civil, Arch., and Environmental Engineering

Authors: Amir Abdelzaher, Helena Solo-Gabriele, Lora Fleming, Jay Fleisher

Abstract

The relationship between indicator microbes, pathogens, and human health at recreational beaches is yet to be firmly established in order for improved regulation to be implemented which would protect public health while minimizing economic burdens. The objective of this study was to measure pathogen and indicator microbe presence and to determine if a relationship exists between them, as well as with environmental conditions and health outcomes. During the BEACHES epidemiology study conducted in Miami (FL) at a non-point source subtropical marine beach, composite samples as well as individual samples were collected throughout the day by each bather randomly assigned to enter the water over the 15 study days. These 15 composite samples (one per sampling day) were analyzed for several pathogens, microbial source tracking markers, and indicator microbes. Preliminary analysis demonstrated that rainfall is a significant factor in determining the presence of both indicator microbes and pathogens, and that human health effects were associated with non-composite individual microbial indicators. However, significant associations between the composite sample indicator organisms, pathogens, and human health effects were not identified. The lack of relationship between human health effects, indicator microbes, and pathogen presence within the composite samples demonstrates the complexity of this beach system, and how more novel and comprehensive approaches will be needed to assess beach water quality. More analysis should also be conducted as the limited number of samples (only 15) may be the reason for the lack of relationship between these different factors.

Biosketch

No biosketch available.

Automated Real-Time On-Line Measurement of Bacteria in Water Using Multi-angle Light Scattering Techniques

Presenter: Alexis Strauss
John Adams, JMAR Technologies, Inc.

Author: John Adams

Abstract

Monitoring beach water quality typically entails routine screening for waterborne microorganisms through daily grab sample analysis by standard methods. This approach, however, is severely limited in both scope and response capability. JMAR's BioSentry water-monitoring system is on-line and detects waterborne pathogens in real-time. The system utilizes multi-angle light scattering (MALS) to detect and classify microorganisms through continuous slip-stream analysis. The MALS principle provides for the generation of a unique, species-specific, light-scattering pattern when a microorganism passes through the flow cell laser beam. As a microbe passes through the detection area, the pattern is captured by a photo detector and classified using proprietary algorithms. The system accurately classifies microorganisms based on size, shape and morphology in real-time. Based on data generated through the system's EPA evaluation process, BioSentry was able to accurately detect the presence of microbes (e.g. *E. coli*) down to 600 organisms per ml, compared with other conventional water sensors, which had a detection minimum of 25,000 organisms per ml.

Biosketch

No biosketch available.

Genes Associated with Pathogenic *E. coli* are Widely Distributed in Freshwater Environments

Presenter: Elizabeth Alm
Central Michigan University

Author: Elizabeth Alm

Abstract

Evidence that the fecal indicator bacterium *Escherichia coli* may be a natural component of the freshwater beach habitat raises questions about the persistence of enteric pathogens. Pathogenic *E. coli* may also be able to persist in freshwater environments. PCR technology was used to analyze samples for genes associated with *E. coli* pathotypes. An analysis of 153 sand samples collected from Great Lakes beaches showed that genes coding for attachment proteins in *E. coli* pathogens were abundant. Seventy-eight percent of samples were positive for eae and 34% were positive for bfp; shiga toxin genes were rarely detected. Water birds and agricultural animals may contribute *E. coli* pathogens to fresh water systems. Analysis of 42 samples of pooled gull feces collected at Grand Haven beach, Michigan showed 12% of samples positive for eae. The eae gene was detected in 39% of water samples collected from small water bodies frequented by Canada geese. Twenty-five percent of these water samples were also positive for the stx2 shiga toxin gene, and 18% for bfp. Samples of river water impacted by farm run-off were also positive for pathogenic *E. coli* genes. Forty-five percent of water samples were positive for eae. Shiga toxin genes stx1 and stx2 were each detected in two samples. One sample was positive for eae, stx1, and stx2. The presence of pathogenicity genes does not mean that pathogenic organisms are present; however the widespread distribution of these genes suggests that some pathogenic lineages of *E. coli* may be persistent in freshwater environments.

Biosketch

No biosketch available.

Enterococci Enumeration in Medium to Coarse Beach Sands: A Methods Comparison Study

Presenter: Alexandria Boehm
Stanford University

Authors: John Griffith, Charles McGee, Thomas Edge, Helena, M. Solo-Gabriele, Richard Whitman, Martin Getrich, Jennifer A. Jay, Donna Ferguson, Yiping Cao, Stephen B. Weisberg

Abstract

The absence of standardized methods for quantifying fecal indicator bacteria in sand hinders comparison of results across studies. This study aimed to compare methods for extraction of enterococci from sand and recommend a technique for research and compliance monitoring. We compared 22 different methods of extracting enterococci from sand including shaking, blending, and sonication. We varied parameters including shaking type and duration, number of rinses, settling time, eluant to sand ratio, eluant composition, prefiltration, and decantation method. Each method was performed in duplicate by two analysts on one marine siliceous sand from California, one marine calcareous sand from Florida, and one lacustrine siliceous sand from Lake Michigan. The simplest method that had the highest recoveries consisted of two minutes of hand shaking with one rinse step, a 30 second settling time, and a 10:1 eluant volume to sand weight ratio. Eluant composition did not have a significant effect. Sonication produced equivalent enterococci counts as shaking, but both were significantly higher than using blending. Varying most parameters had insignificant effects on enterococci enumeration. The hand shaking method was simple and robust, and should be used to monitor sands for enterococci to understand their contribution to poor surface water quality and beach advisories and closures.

Biosketch

Alexandria Boehm is a professor at Stanford University in the department of civil and environmental engineering. Her primary research area is coastal water quality, and a secondary area is sanitation more broadly. The work on coastal water quality is focused on understanding the sources, transformation, transport, and ecology of biocolloids – specifically fecal indicator organisms, pathogens, and phytoplankton – as well as sources and fate of nitrogen. This knowledge is crucial to directing new policies and management and engineering practices that protect human and ecosystem health at the coastal margin. Projects focus on understanding both the influence of terrestrial runoff and submarine groundwater discharge on coastal water quality. The work on sanitation aims to gain a better understanding of how pathogens are transmitted to humans through their contact with water, feces, and contaminated surfaces. The goal is to design and test novel interventions and technologies for reducing the burden of waterborne disease. Current projects include a microbial risk assessment of rotavirus transmission to children via fomites, studies on water quality and health in Dar es Salaam, Tanzania and Papua New Guinea, and lab and field work to understand the efficacy of alcohol-based hand sanitizer and hand washing with soap in reducing bacterial levels on hands and reducing illness in developing countries.

The Health Risk of Bathing in Southern California Coastal Waters

Presenter: Mitchell Brinks
Oregon State University

Authors: Mitchell Brinks, Ryan Dwight, Nathaniel Osgood, Gajapathi Sharavanakumar

Abstract

Bathers exposed to microbiological contamination in coastal waters have an excess risk of gastrointestinal and respiratory illness. This study investigated gastrointestinal and respiratory illness rates in Southern California from 2000 to 2004 with a simulation model that incorporated water quality, beach attendance, and bathing rate data, along with three published dose-response relationships.

An estimated 689,000 episodes of gastrointestinal illness and 693,000 episodes of respiratory illness occurred each year. Most illnesses (57% – 80%) occurred during the summer season and a relatively small proportion of beaches (12 of 67) accounted for half of all illnesses. Coastal water contamination is a serious health risk for bathers at Southern California beaches. California's marine water contact standards may be inadequate to protect the health of bathers.

Biosketch

Dr. Brinks is a physician and public health researcher based in Portland, Oregon. His five year collaboration with the Coastal Water Research Group based in Huntington Beach, California has focused on the health risk associated with the microbial contamination of recreational coastal waters. Dr. Brinks received his medical training from the Oregon Health Sciences University and the University of Hawaii, which he completed in 1996. He directed territorial eye care and eye related public health in American Samoa from 1996 to 1999. He worked as a physician and surgeon in Maui, Hawaii from 2000 until 2004 when he returned to Oregon to pursue additional training in epidemiology and public health. He is now initiating a series of epidemiology studies into the causes and treatments of eye disease in the country of East Timor.

North Carolina Recreation Water Quality - Central Region Sanitary Survey:

Presenter: Erin Bryan-Millush
NC Recreational Water Quality - Division of Environmental Health

Authors: Erin Bryan-Millush, Ginger Kelly

Abstract

North Carolina has been working diligently conducting shoreline surveys in and around monitored recreational swimming areas. The shoreline survey program is a collaborative effort between state Shellfish Sanitation and Recreational Water Quality Programs, and is used to locate and assess pollution sources that could have an effect on area water quality. Most monitoring areas are covered by the Shellfish Sanitation federally mandated triennial sanitary survey, which is conducted to assess the proper classifications of shellfish growing waters. The Recreational Water Quality program's role has been to assess the areas which are located outside of commercial shellfish harvest areas.

The survey methodology uses both GIS and GPS mapping technology to identify and spatially map potential sources of pollution, including stormwater outfalls, marinas, slip docks, agriculture, and new subdivisions. This information, along with recreational monitoring and notification data, has been compiled to create the first set of Sanitary Survey Reports for the NC Recreational Water Quality Program. Overall, these reports, along with the enhanced survey methodology, have made interagency data sharing more structured and concise. While North Carolina's coastal waters are generally very pristine, there are certain problem areas where advisories are posted often, referred to as "repeat offenders." It is hopeful that continued cooperation state-wide will lead to improvements in water quality within both shellfishing and recreational swimming areas along North Carolina's coast.

Biosketch

Mrs. Bryan-Millush is an Environmental Specialist with the North Carolina's Recreational Water Quality Program, which is a section of the state Division of Environmental Health in the Department of Environment and Natural Resources. She received her B.S. in Environmental Science with emphasis in biological sciences from the University of North Carolina at Wilmington. Mrs. Bryan-Millush has worked with the state of NC for 6 years and had previously worked for North Carolina State University researching surface and subsurface water quality using constructed wetlands for bacteriological removal. Her main responsibilities now consist of managing and overseeing all aspects of data collected and public information including exceedance notification, outreach and education.

Evaluation of Optical Brightener Photodecay Characteristics for Detection of Human Fecal Contamination

Presenter: Yiping Cao
Southern California Coastal Water Research Project (SCCWRP)

Authors: Yiping Cao, John Griffith, Stephen Weisberg

Abstract

Detection of optical brighteners by fluorometry combined with ultraviolet light (UV) exposure has been proposed as an inexpensive method for detection of human fecal contamination, but has received limited testing. This study evaluated the approach in southern California by applying it to a variety of detergents, sewage and septage samples from the region, as well as to natural stream water as a negative control. The concept of using UV exposure to differentiate fluorescence from natural organic matter proved valid, as the method produced no false positives. However, the method failed to detect half of the detergents tested in natural stream water at 5 µl/L, due to its conservative thresholds. This study identified a method modification that provides greater sensitivity by taking advantage of differences in shape of photodecay curves between optical brighteners and natural organic matter. This method modification resulted in detection of all detergents, sewage at 1:10 dilution and septage at 1:100 dilution. Several caveats for its use remain, including our observation that the optical brightener signal degraded rapidly in strong sunlight. Additionally, there was low sensitivity for some environmentally friendly detergents, which does not present a problem on a community basis where a mix of detergents are used, but could be of concern for assessing septic inputs from individual homes. Still, the method is simple to employ in the field, yields rapid results and is useful as low-cost initial screening tool.

Biosketch

Dr. Cao is a microbiologist at Southern California Coastal Water Research Project. She received her B.S. in Environmental Chemistry from Nanjing University in P.R. China, her M.A. in Applied Statistics and Ph.D. in Environmental Molecular Microbiology from University of California, Santa Barbara. Dr. Cao worked on microbial ecology in estuarine systems, denitrifier biofilms in salt marshes, and bioremediation of organic contaminants in groundwater. Her current research focuses on developing and evaluating technology for microbial source tracking, and understanding PCR inhibition for applying molecular method in environmental monitoring.

QPCR Determined Fecal Indicator Bacterial Densities in Marine Waters from Two Recreational Beaches

Presenter: Eunice Chern
US EPA

Authors: Eunice Chern, Kristen Brenner, Larry Wymer, Richard Haugland

Abstract

The use of real-time qPCR to determine fecal indicator bacteria (FIB) densities is currently being investigated by the U.S. EPA. The present recreational water quality guidelines, based on culturable FIB, prevent same day determinations of water quality whereas results from the qPCR method can be available within several hours. Epidemiological studies at POTW-impacted freshwater beaches have shown a strong correlation between qPCR determined *Enterococcus* densities and swimming-related illness rates. This study provides an initial assessment of qPCR estimated *Enterococcus*, Bacteroidales, *E. coli* and Clostridium densities in marine water from two recreational beaches sampled over one summer. The estimated geometric mean cell densities per 100 ml of marine water from both beaches across sampling visits were 3.28 x 101, 1.71 x 103, 7.37 x 102, and 9.26 x 102 for *Enterococcus*, Bacteroidales, *E. coli* and Clostridium, respectively. These cell equivalent density estimates, determined using whole cell calibrator samples by a comparative cycle threshold (CT) approach, did not correspond with the relative target sequence density estimates of the different FIB in the samples which gave geometric means of 1.28 x 103, 2.35 x 104, 3.04 x 102, and 1.03 x 104 for *Enterococcus*, Bacteroidales, *E. coli* and Clostridium, respectively. This discrepancy was determined to be attributable to differences in recovery of target sequences from cells of the different organisms. QPCR analyses using whole cell calibrator samples provides a simple approach for comparing both total cell and target sequence density estimates of different FIB groups in water samples.

Biosketch

Dr. Chern is a postdoc with the U.S. Environmental Protection Agency's Office of Research and Development. She obtained her B.S. in Biology from the University of California, San Diego and her M.S. and Ph.D. in Environmental Health, Science and Policy from the University of California, Irvine. Her research focuses on recreational water quality and quantitative detection of fecal indicator bacteria.

Occurrence and Variability of Enteric Viruses in Coastal and Riverine Settings

Presenter: Jennifer Clancy
Clancy Environmental Consultants

Authors: Timothy Bartrand, Jeffrey Soller, Mark Gibson, John Ravenscroft

Abstract

Studies reviewed during recent literature surveys suggest that enteric viruses are often prevalent, may be persistent, and are highly variable in coastal and riverine settings. The importance of waterborne enteric viruses has been suggested in recent epidemiological studies. It has been postulated that enteric viruses may be potentially one of the main etiological agents responsible for illness (usually acute gastroenteritis) attributable to water-contact recreation. In addition, studies collected during literature reviews on fecal indicator performance and microbial risk were used to explore the association of enteric virus occurrence with fecal indicator bacteria density, temporal trends in virus density, and use of statistical distributions to characterize enteric virus occurrence variability. Results from these studies intimate that enteric virus occurrence differs from fecal indicator organism occurrence in several regards. First, in studies conducted in both inland and coastal waters, enteric viruses were frequently not detected, whereas fecal indicator organisms are nearly always detected in natural recreational waters. Second, seasonal trends in enteric virus density and survival were reported to be different than those of fecal indicator organisms. Third, enteric virus loads to receiving waters were reportedly episodic and likely from different fecal sources than the sum of sources for fecal indicator bacteria, which can also be non-enteric. Frequent non-detection and episodic loading hamper characterization of enteric virus occurrence with statistical distributions, though two studies have attempted to do so with mixed success. The forgoing observations indicate data gaps related to risk analysis of enteric viruses and inform future water-contact recreation risk studies.

Biosketch

Dr. Jennifer Clancy is the co-founder and President of Clancy Environmental Consultants, Inc. headquartered in Saint Albans, Vermont. She has more than 30 years of experience in water microbiology, with an emphasis on occurrence and controls of pathogens. She leads a multidisciplinary team of scientists and engineers that provide solutions to problems for clients in the public and private sectors in the US and around the globe. This group has used their skills to develop and maintain a strong, applied research-based program to assist clients addressing specific water quality problems and to contribute to advancing water quality knowledge. Dr. Clancy is a microbiologist and holds a BS from Cornell University, MS from the U. of Vermont and Ph.D. from McGill University, all in microbiology, as well as an MS in Environmental Law from Vermont Law School. Dr. Clancy has presented hundreds of papers at local, national and international conferences on water microbiology and treatment She has published more than 50 articles in peer-reviewed journals including *Applied and Environmental Microbiology, Journal of the American Water Works Association, Journal of Microbiological Methods, Canadian Journal of Microbiology, Journal of Eukaryotic Microbiology, Journal of Water & Health,* and *Water Research.*

Dr. Clancy was one of founders of the International UltraViolet Association (IUVA) and served as its international president from 2001–2003. She has consulted with water utilities and regulatory agencies worldwide on water quality and treatment and environmental issues.

Combining the NHDPlus and Watershed Boundary Dataset HUC12s as Spatial Frameworks for Organizing Beach Sanitary Surveys

Presenter: Michele Curtofello
RTI International

Authors: Michele Curtofello, William Cooter, Brandon Bergenroth, Paul Andrews

Abstract

The National Hydrography Dataset (NHD) is a comprehensive set of digital spatial data for surface water features. In cooperation with the U.S. EPA, the USGS has developed an enhanced version of the NHD called the NHDPlus. The NHDPlus incorporates the best features of the NHD and special value-added attributes to provide velocity and time of travel information for inland waters. The NHDPlus can be linked with other GIS systems such as the National Watershed Boundary Dataset (WBD). The WBD defines a series of next watershed, including small subwatershed units called HUC12s. There is considerable interest on the part of EPA and other parties to make substantial use of these WBD GIS materials in a broad range of assessment and management applications. RTI has developed a framework that links the NHDPlus flowlines for both inland and coastal waters with the WBD HUC12s. From an initial starting point related to a public bathing area, an area of investigation can be generated based on HUC12 units and features from the NHD for both inland waters and NHDPlus coastal catchments along coastal areas. These beach spatial areas of investigation can be the foundation for tools to organize special sanitary surveys and beach sanitary models to document potential pollutant sources related to pathogen risks for important public bathing areas.

Biosketch

No biosketch available.

Rapid Microbial Detection Using Liquid Crystal Technology

Presenter: Crystal Diagnostics™

Author: Crystal Diagnostics™

Abstract

Crystal Diagnostics™ is developing a novel rapid microbial detection platform that can detect the presence of microbes and pathogens in fluids. This technology is based on using liquid crystals as a biosensor. Liquid crystals offer an advantage for microbial detection due to the unique alignment and optical qualities. These qualities can be harnessed to specifically and rapidly detect microbes by creating disruption in a liquid crystal matrix. This disruption is analogous to the creation of pixels that can be read in real-time. Unfortunately, the alternate techniques currently in use for pathogen detection suffer from one or more of the following limitations: 1) low sensitivities that require large concentrated sample volumes; 2) high false positive rates, 3) prolonged preparation/assay times; 4) the inability to simultaneously test for multiple pathogen species (multiplexing); 5) high cost; 6) the need for highly trained technician/operators. Liquid Crystal technology offers the aftermarket the opportunity for rapid, selective, and easy to use solutions for determining the presence of unwanted microbes and/or indicbators. EXPERIMENT: To validate the specificity of the technology we conducted an experiment to demonstrate that a selective antibody for *E. coli* will differentiate *E. coli* from negative controls. METHOD: Three conditions were used for this preliminary experiment: 1) Positive sample - Anti-*E. coli* coated microspheres (10^7/ml in final solution) + *E. coli* (10^6/ml in final solution) (n=4); 2) Negative control 1: Anti-*E. coli* microspheres (10^7/ml in final solution) (n=5); 3) Negative control 2: Negative Control 1 microspheres (10^7/ml in final solution) + B. cereus (10^6/ml in final solution) [not recognized by antibody] (n=5). 200μl of each condition was mixed with 800μl of liquid crystal and allowed to align in our device. RESULTS: Counts of the events (pixels) from the device indicate that Positive Sample had a value of 2783 ± 847, Negative control 1 had 325 ± 137, and Negative control 2 had 362 ± 159 with a $p<0.005$ (data = mean ± S.E.). These results indicate the specificity of our technology for the detection of *E. coli*. Future iterations of the functional device developed by Crystal Diagnostics for pathogen detection will consist of a portable analysis hub, called the Pathogen Detection Reader, and disposable cartridges where the samples are introduced. Cartridges can be specifically tailored to identify the desired pathogen. This liquid crystal technology will determine selected pathogen levels in under an hour and in some case fewer than 15 minutes with minimal user training needed.

The Human Tide: Beach Attendance and Bathing Rates for Southern California Beaches

Presenter: Ryan Dwight
Coastal Water Research Group

Authors: Ryan Dwight, Mitch Brinks, Jan Semenza

Abstract

Five years of daily beach attendance was collected for 75 beaches along the Southern California coastline. Over 129 million beach visits occurred each year, with 54% of visits occurring at only 15 beaches. An average of 45% of beach attendees swims in the coastal waters. Beach attendance exhibits distinct patterns with the calendar. The magnitude and distribution of beach usage across the region produces data for predictive modeling, beach management, tourism, and public health.

Biosketch

Dr. Dwight is Director of the Coastal Water Research Group based in Huntington Beach, California. The groups' research efforts focus on coastal water pollution and the impacts on public health. Dr. Dwight received his B.A. in General Biology from U.C. San Diego in 1988, and his doctorate in Environmental Health Science and Policy from U.C. Irvine in 2001. He has held professional positions in both the private and public sectors. He was a marine microbiologist and research diver at Scripps Institution of Oceanography where he collected and tested marine organisms for new medicines. He has worked at the Smithsonian Institution in Washington, D.C., where he was involved in a range of governmental and non-governmental projects. Dr. Dwight has also held positions at law firms, a consulting firm, and positions as a teacher and researcher.

Assessment of nearshore bacteria loading through offshore bottom shear stress and wave run-up at a beach

Presenter: Zhongfu Ge
U.S. Geological Survey

Authors: Zhongfu Ge, Richard Whitman

Abstract

It has been increasingly recognized that hydrodynamic phenomena, such as waves, currents, wave breaking, and sediment suspension, play an important role in the transport and fate of pathogens in coastal regions. Accurate prediction of the concentration of fecal indicator bacteria at beaches cannot be achieved without proper consideration of these effects. On the other hand, most previous studies on nowcasting and forecasting of beach bacteria concentration, using combinations of popular hydrometeorological predictors such as wind speed, direction, and wave height, were not capable of sufficiently assessing the contribution of coastal hydrodynamics. In order to include hydrodynamic effects, the present work focuses on two derived variables, offshore bottom shear stress on the seabed and maximum wave setup (up-rush) distance. These two newly established variables can be deduced from existing historical 2002 wave and current data at the 63rd Street Beach in Chicago by means of well developed empirical and mathematical models in geophysical fluid mechanics and coastal engineering. Adding these two new variables into historical regression models can shed light on the relative statistical significance of the deep water bottom shear stress and the bacteria concentration in the foreshore sand. A preliminary test on the 63rd Street Beach data clearly indicated significance of these two variables. Our results are the key to a further evaluation of beach sand as a bacteria source for coastal waters and its role in the nearshore bacteria budget.

Biosketch

Zhongfu Ge is currently a joint research associate of the Department of Civil and Environmental Engineering at Michigan State University and USGS Lake Michigan Ecological Research Station. He received his Ph.D. from Virginia Polytechnic Institute and State University with a major in Fluid Mechanics. Before joining USGS he worked with EPA for three years on recreational water quality modeling and the development of Virtual Beach, a water quality forecasting and risk assessment expert system. His recent research is focused on characterizing coastal hydrodynamic parameters and their impact on fate and transport of pathogens in recreational waters.

Assessing Exposure during Water Associated Recreational Activities

Presenter: Charles Gerba
University of Arizona

Author: Charles Gerba

Abstract

In quantitative microbial risk assessment exposure presents the greatest amount of uncertainly because of the potential wide variation I pathogen concentrations which could occur in the water and difficulties in estimating the amount of contact with the water via different routes of exposure (i.e. ingestion, inhalation, dermal). Exposure is influenced by the type of recreational activity. In primary recreational activities (swimming) ingestion may be the most important, but dermal (eye contact) and inhalation may be also play a role. Estimating exposure for various types of non-contact recreation becomes more difficult to estimate. Non-contact exposure may involve boating, fishing, canoeing or playing on the beach. In these activities inhalation and dermal exposure may be more important. In addition dermal exposure may also result in ingestion when the hands are place on the lips or mouth. Ingestion of contaminated soil on beaches may also be another route of exposure. Other factors such as age and length of exposure will also play a role. A model of exposure via secondary contact recreation (boating) is given as an example of how these factors can be estimated for this type of activity.

Biosketch

No biosketch available.

Detection of Staphylococcus aureus in Beach Water and Sand: Comparison of Culture, Immunoassay, and Molecular Analyses

Presenter: Kelly D. Goodwin
NOAA

Authors: Kelly D. Goodwin, Melody Pobuda

Abstract

Beach sand and water samples were analyzed for Staphylococcus aureus and methicillin resistant S. aureus (MRSA) as part of the Southern California Coastal Water Research Project (SCCWRP) epidemiological study. Samples were collected from Avalon (2007, 2008) and Doheny Beach, CA (2008) during summer months. Membrane filtration followed by incubation on CHROMagar(R) Staph aureus and CHROMagar(R) MRSA was used to enumerate S. aureus and MRSA, respectively. Performance of these media with beach samples was evaluated by comparing identification via colony morphology to immunoassay (Staphyloslide(R) Latex Test), PCR (clfA, 16S, and mecA genes), and sequencing results.

Biosketch

Dr. Goodwin is a Principal Investigator with the National Oceanographic and Atmospheric Administration (NOAA) working to develop molecular assays and sensors to detect microbial contaminants in marine systems. The work involves adaptation of biotechnologies used in clinical settings for use in coastal field programs. Various sensor platforms are evaluated and molecular targets include traditional and alternative fecal indicating bacteria, bacterial and viral pathogens, source tracking markers, and harmful algae.

Dr. Goodwin received a B.S. degree in Neurobiological Sciences from the University of Florida ('88). She received M.S. ('90) and Ph.D. ('96) degrees in Environmental Engineering Science from the California Institute of Technology in Pasadena. She received a minor in Oceanography from Caltech during a program in residence at the Scripps Institute of Oceanography ('93). From 1995-1998, she served as a National Research Council Postdoctoral Associate at the U.S. Geological Survey in Menlo Park, CA working on the microbial biogeochemistry of halocarbons. In 1999, she returned to Florida as a researcher with NOAA's joint institute with the University of Miami—the Cooperative Institute of Marine and Atmospheric Studies (CIMAS). She entered federal employment with NOAA in 2003 and became adjunct faculty to the Marine Biology and Fisheries Department at the University of Miami's Rosenstiel School of Marine and Atmospheric Science (RSMAS).

Dr. Goodwin is stationed at the Southwest Fisheries Science Center in La Jolla, CA, is employed by the Atlantic Oceanographic & Meteorological Laboratories in Miami, and is a team member of two NOAA Centers of Excellence for Oceans and Human Health (at the Hollings Marine Laboratory & the Northwest Fisheries Science Center).

Species Distribution and Antibiotic Resistance of Enterococci Isolated from Surface and Ocean Water

Presenter: Joseph Guzman
Orange County Public Health Laboratory

Authors: Joseph Guzman, Douglas F. Moore, Paul B. Hannah

Abstract

Enterococcus is one of the indicator bacteria used in California to monitor marine waters, and in many sites, is the primary cause of water quality failures. In this study, speciation and susceptibility testing was performed on *Enterococcus* isolates recovered during water quality testing of ocean, bay (harbors, bays and wetlands), urban runoff, and sewage in two contrasting study locations, a large coastal urban area and a small isolated town on an offshore island. A total of 1413 isolates were speciated from 373 samples collected from 36 sites along the coastal areas of Orange County and Avalon, California. Overall the five most frequently isolated *Enterococcus* species were *E. faecalis (18%), E. faecium (20%), E. hirae (7%), E. casseliflavus (20%), and E. mundtii (10%).* Receiving waters at both study locations contained similar distribution of these five species with a frequency of 7–36%. In urban runoff, *E. casseliflavus* was the single most frequently isolated species at both study locations making up 36% of isolates in Orange County and 65% of isolates in Avalon. The Orange County urban runoff species distribution was similar to the receiving water distribution while the Avalon urban runoff species distribution was dominated by *E. casseliflavus* (65%) and *E. faecium* (21%). In both study locations sewage samples were dominated by *E faecium* (53–78%) with *E. faecalis* and *E. hirae* (5–18%) also present. No vancomycin or high level gentamycin resistance was detected in *E. faecalis* and *E. faecium* isolates from all the environmental water samples or sewage. Four isolates (0.7%) were resistant to high level streptomycin and four (0.7%) were resistant to penicillin. Resistance to erythromycin, rifampin and tetracycline was common for both *E. faecalis* and *E. faecium* with *E. faecium* having a higher frequency of resistance to erythromycin and tetracycline. *E. casseliflavus* and *E. mundtii* as well as *E. faecalis* and *E. faecium* are commonly isolated from urban runoff and receiving waters in Southern California. Determination of the *Enterococcus* species isolated from receiving waters and in potential pollution sources may assist in understanding the sources of pollution.

Biosketch

Joe Guzman is the Supervising Public Health Microbiologist overseeing the Orange County Public Health Water Quality Laboratory. He received his B.S. in Medical Microbiology from California State University, Long Beach. For the last 17 years he has been with the Orange County Public Health Laboratory working in all areas of microbiology. He first started to focus on water quality testing in 1998, becoming involved in the bacterial monitoring of Orange County's beaches, harbors, and estuaries. The laboratory continues to do routine monitoring while also doing research in the development of rapid indicator methods and determining sources of bacterial pollution in receiving waters.

Protecting Beaches and Preventing Closures: The Aquatic Filter Barrier as an Effective Solution

Presenter: Melissa Hamlin
GUNDERBOOM, Inc.

Author: Melissa Hamlin

Abstract

Beach closures plague many coastlines, reducing visitor volume and associated local revenues. A newer technology, the Aquatic Filter Barrier (AFB), has been proven to protect these bathing waters and keep beaches open by preventing exceedance events more than 75% of the time. This is accomplished by controlling contaminants from stormwater and other sources, such as bacteria, turbidity and suspended solids.

AFB technology is utilized in the Beach Protection System (BPS), which incorporates site-specific design considerations for effectiveness and a desired waterfront use and appearance. One such BPS is located at the Harbor Island Beach in the Village of Mamaroneck, NY. Multiple studies have been performed on the Mamaroneck BPS and are published in peer-reviewed scientific and engineering journals. The results of these studies demonstrating its effectiveness will be discussed, along with results of other AFB applications such as an EPA sponsored project for drinking water reservoir protection, dredge containment and other issues related to beach pollution.

Biosketch

No biosketch available.

Comparison of *Enterococcus* qPCR analysis results from fresh and marine water samples on two real-time instruments

Presenter: Richard Haugland
USEPA, National Exposure Research Laboratory

Authors: Richard Haugland, Manju Varma, Robin Oshiro, Mano Sivaganesan

Abstract

EPA is currently considering a quantitative polymerase chain reaction (qPCR) method, targeting *Enterococcus* spp., for beach monitoring. Improvements in the method's cost-effectiveness may be realized by the use of newer instrumentation such as the Applied Biosystems StepOne™ and StepOnePlus™ series instruments that can retail for under $20 K and provide 48 or 96 sample analysis capacity. In this study we compared the results obtained on a StepOnePlus™ 96 well instrument with those obtained on the Cepheid Smart Cycler' which has been the primary source of the method's results to date. Analyses were performed simultaneously on DNA extracts from multiple, replicate filter retentates of 12 marine and 12 freshwater samples from diverse locations using study and data analysis designs from EPA's microbial alternate test procedure protocol. Precision among log10 target sequence copy (TSC) estimates in the samples from the two instruments were compared with no significant difference ($p > .05$) based on the one-way ANOVA of Levene's Test for Homogeneity of Variance. Three-way ANOVA with fixed factors: instrument, matrix, instrument*matrix; and random factors: sample (nested in matrix) and inst*sample (nested in matrix) was used to compare the mean log10 TSC estimates with no significant difference seen between the instruments ($p > .05$). Given the wide variety of qPCR instruments that are already available and the likelihood that additional advances will occur in instrument technology, this study may provide a useful model for the design and implementation of additional comparative studies in the future.

Biosketch

Dr. Haugland is microbiologist in the Microbiological & Chemical Exposure Assessment Research Division of the National Exposure Research Laboratory. He received a B.S. in Biology at Muskingum College, Ohio and a Ph.D. in Developmental Biology at the Ohio State University. His past research has addressed diverse problems including improvement of nitrogen fixation in crops, biodegradation of hazardous chemicals in the environment, assessment of the microbiological quality of indoor environments, and most recently, homeland defense and water quality monitoring. A common feature of these research activities has been the development and application of technologies based on genetic characterization and detection. Dr. Haugland joined the USEPA in 1991. Since then he has authored or co-authored more than 40 publications and has received numerous awards for his work including the EPA bronze and gold medals.

Tiered Monitoring Approach in Massachusetts

Presenter: Chris Huskey
Massachusetts Dept. of Public Health

Author: Chris Huskey

Abstract

In 2003, the Massachusetts Department of Public Health/Bureau of Environmental Health developed the Public Health-Based Beach Evaluation, Classification, and Tiered Monitoring Plan in order to ultimately direct water quality monitoring resources to the beaches that pose the greatest health concerns. In this system, every public and semi-public marine bathing beach was classified in different tiers based on their historical sampling data. The poster presented will illustrate how Massachusetts implemented the Plan by identifying pollution problems through sanitary surveys, increasing regular monitoring at beaches with historically chronic closures, and providing the framework to allow those beaches with more pristine records to be monitored less often. The reduction of sampling at more pristine beaches has allowed MPDH/BEH to shift limited sampling resources from beaches with a low risk of bacterial contamination to beaches with a higher risk of bacterial contamination. As a result, MDPH/BEH beaches staff have been able to conduct several in-depth sanitary surveys at beaches with historical beach closure issues to identify pollution sources and over 100 sanitary surveys at beaches eligible for reduced sampling to ensure less testing will not threaten public health.

Biosketch

Mr. Huskey is the Bathing Beaches Project Coordinator for the Massachusetts Department of Public Health. He has been the Bathing Beaches Coordinator since 2004. His responsibilities include overseeing a system of regional laboratories that provide funding for environmental monitoring for 55 coastal communities, enforcement of bathing beaches regulations, maintaining the internet-based public notification system, and technical assistance to all of the communities of Massachusetts. He received his B.S. in biology from the University of Kansas in Lawrence, KS.

Six Key Zoonotic Waterborne Pathogens in Ambient Waters

Presenter: Audrey Ichida
ICF International

Authors: Audrey Ichida, Jennifer Clancy, John Ravenscroft

Abstract

EPA currently recommends Clean Water Act Ambient Water Quality Criteria for recreational water impacted by all fecal sources as measured by fecal indicator bacteria (enterococci and/or *E. coli*). The degree to which health risks differ from human fecal sources versus animal fecal sources has not been well characterized or quantified. In order to evaluate the potential risks posed by animal fecal contamination, it is important to understand what human illnesses are caused by exposure to waters contaminated with animal fecal material. The authors evaluated 70 pathogens from warm-blooded animals for their potential to be both waterborne and zoonotic. Twenty of the 70 pathogens evaluated had all 4 of the following attributes:

1. The pathogen spends part of its lifecycle within one or more warm blooded animal species.
2. Within the lifecycle of the pathogen, it is probable or conceivable that some life stage will enter water.
3. Transmission of the pathogen from animal source to human is through a water related route.
4. The pathogen causes infection or illness in humans.

Six of the 20 waterborne, zoonotic pathogens from warm-blooded animals were selected for further evaluation based on their relevance in the United States. Five were selected based on their potential for outbreaks in recreational water (pathogenic *E. coli, Campylobacter, Leptospira*, *Cryptosporidium*, and *Giardia*), and one (Salmonella) was included based on outbreaks in drinking water. This research will be published by EPA Office of Water, Health and Ecological Criteria Division, under the title Review of Zoonotic Pathogens in Ambient Waters.

Biosketch

Dr. Audrey Ichida received her Ph.D. in Plant Molecular Biology from the University of California San Diego (1996). She is currently a Senior Microbiologist and Manager at ICF International. Prior to joining ICF, from

2000–2002, she was an American Association for the Advancement of Science Risk Policy Fellow. As a AAAS fellow at FDA, she served as the Deputy Chairman for the Interagency Risk Assessment Consortium (RAC). Since joining ICF, Dr. Ichida has been involved in many projects related to microbial and other risks from water, such as development of a Microbial Risk Assessment Protocol and a Methodology for Derivation of Microbial Ambient Water Quality Criteria for the Protection of Human Health for EPA's Office of Water. She has managed risk assessments on *Cryptosporidium* and *Giardia* in water for EPA as well as updated the *Cryptosporidium* Health Advisory and Criteria Document Addendum. She has authored several white papers and literature reviews for EPA on topics related to Ambient Water Quality Criteria.

Discrepancies between Colilert® total coliform quantitative results and those of traditional methods for several samples from two ambient fresh water sites.

Presenter: Daniel E. Jackson
East Bay Municipal Utility District (EBMUD) Laboratory

Authors: Clayton C. Thompson, Daniel C. Mills, Yanru Yang, and Daniel E. Jackson***
East Bay Municipal Utility District Laboratory, Oakland, CA
***corresponding author, **retired**

Abstract

California regulations require Total Coliform (TC) monitoring in addition to Fecal Coliform/E. coli and *Enterococcus* of marine recreational waters. Many California jurisdictions extend this monitoring to recreational freshwater. The use of rapid methods, such as Colilert-18 (IDEXX, Westbrook, ME), is desirable to facilitate timely closure or reopening of beaches. We compared TC results yielded by Colilert-18® with those of Membrane Filtration using mEndo-LES (MF) and Multiple Tube Fermentation (MTF) using Lauryl Tryptose Broth (LTB) confirmed in Brilliant Green Lactose Bile Broth (BGB).

Daily water samples were taken from the centers of two pristine freshwater lakes in the San Francisco Bay Area in the spring of 2008. Samples from lake "A" usually yielded TC results of >/=2400 MPN/100 mL by Coliert-18 and <2 MPN/100mL by MTF. Samples from lake "B" gave closer results by the two methods, but Colilert results were higher in 85% of the samples.

To determine whether these discrepancies were due to false negative TC in MTF or false positive TC in Colilert-18, testing was also performed using MF. Presumptive TC isolates were taken from m-Endo plates. Those isolates that showed coliform presence in Colilert-18 media, but did not verify in LTB/BGB, were identified using the API-20E system (bio-Merieux). Data will be shown that 12 of 13 of these discrepant isolates from "Lake A" were identified as an environmental true coliform, *Enterobacter amnigenus*. Most isolates from "Lake B" were identified as *Aeromonas hydrophila*, a non-coliform that can sometimes produce positive results in Colilert, as has been reported by others.

Biosketch

Daniel Jackson is the Biology Supervisor for the East Bay Municipal Utility District (EBMUD) Laboratory in Oakland, California. Mr. Jackson received his B.S. in Chemistry from the University of California at Berkeley in 1977. He began working as an analyst at the EBMUD Laboratory in 1987, and went on to work for EBMUD in various capacities, including environmental compliance, site remediation, and bioassay toxicity identification, before rejoining the Laboratory in 2008. Research interests include applying molecular biological methods to wastewater process control and identifying sources of aquatic toxicity.

Beach Notification and Monitoring Data Management

Presenter: Bill Kramer
USEPA

Authors: Bill Kramer, Paul Andrews, Erik Richards

Abstract

This Poster Session will present Information from Sunday's Beach Monitoring 101 Training Session on the eBEACHES Data System, preliminary modernization plans, and EPA's BEACON website. Attendees will also be able to engage in follow-up discussions from Sunday's training and receive technical assistance on their jurisdictions' issues.

Biosketch

Mr. Kramer is an Environmental Protection Specialist in the U.S. EPA, Office of Water (OW), Office of Science and Technology, Standards and Health Protection Division, in Washington, D.C. He manages EPA's eBEACHES data system which makes available to the public historical state, tribe, and territory data on beach water quality and advisories or closings. Previously, he worked for the State of Maryland where his responsibilities included planning the development of beaches at State Parks. Mr. Kramer also serves as the EPA Advisor to the Interstate Shellfish Sanitation Conference (ISSC), which protects public health by reducing exposure to pathogens through consumption of raw molluscan shellfish from coastal and marine waters.

He has delivered papers internationally on the acute and chronic effects of hydroxyl acid (dihydrogen monoxide) on humans and molluscan shellfish.

Mr. Kramer was certified an Environmental Professional (EP) by the National Association of Environmental Professionals, has served as Vice-President of the Maryland Chapter, and is an Emeritus member of the Academy of Board Certified Environmental Professionals. Mr. Kramer received a Masters degree in Regional Planning and a Bachelor of Science in Forest Resources Management, both from the Pennsylvania State University.

Covalently-coupled antibody-magnetic beads enable robust, rapid, and in field measurements of Escherichia coli and fecal pollution input identification in marine and freshwater environments

Presenter: Christine Lee
UCLA

Author: Christine Lee

Abstract

We devised a covalently-linked anti-*E. coli* bead complex that was used to characterize freshwater and marine systems by immuno-magnetic separation and ATP quantification (IMS/ATP). The detection limits for freshwater and marine samples are 50 and 31 cells per mL resuspension, corresponding to detection limits in water of 25–50 cells/100 mL (freshwater) and 15–30 cells/100 mL (marine). The correlations between IMS/ATP and culture-based measurements were good in freshwater (R2 = 0.92), marine (R2 = 0.81) and in the combined regression (R2 = 0.88). IMS/ATP was also used on-site to rapidly distinguish differential loading of fecal pollution loading between two channels and reflect the mixing of these waters at the confluence. The implications of being able to identify pollution inputs with a rapid method will be discussed in the context of a tiered source-tracking strategy.

Biosketch

No biosketch available.

Implementation of a Bird Exclusion Project to Improve Recreational Water Quality at Pier 4 Beach

Presenter: Jane Lee
City of Hamilton, Public Health Services

Authors: Jane Lee, Natasha Mihas, Eric Mathews

Abstract

Hamilton Harbor is listed as an Area of Concern by the International Joint Commission. One criterion for delisting Hamilton Harbor is that the water quality must permit opening of beaches with no significant restriction on water sports, targeted for 2015. The two recreational swimming areas, Pier 4 and Bayfront Park, have been plagued with an increasing number of poor recreational water quality postings/warnings, which are assessed using *E. coli* as an indicator organism. In 2005, a bird exclusion project was initiated at Pier 4 Beach to test if hindering the access of waterfowl to the swimming area would produce a change in recreational water quality. The impetus for this project was the steady decline in microbiological water quality and some local research that indicated waterfowl (and their feces) may be a major contributor of *E. coli* at Hamilton Harbor beaches (Edge and Hill, 2005, 2007). Also, despite the subsequent diversion of combined sewers to storage tanks that significantly reduced municipal wastewater discharges into Hamilton Harbor, recreational water quality continued to decline. The 'percentage of weeks that beaches were bacteriologically safe for swimming' during the bathing season was compared for Pier 4. Between 2006 and 2008 the water quality at Pier 4 Beach has improved approximately 10% per year, and a large improvement was observed from 2004 (20%) to 2008 (73%). Results demonstrate and are consistent with the local research that waterfowl are likely a major contributor to poor recreational water quality, and their exclusion can increase number of weeks the beach is safe for public use.

Biosketch

No biosketch available.

Comparison of Virus Survival at Avalon Bay, Catalina Island, CA and in a Laboratory Solar Simulator-Corroborating Evidence of Virus Inactivation by Solar UV

Presenter: David Love
University of California Berkeley

Authors: David Love, Andrea Silverman, Kara Nelson

Abstract

Sunlight inactivation of viruses isolated from Avalon Bay, CA and reference strains of ssRNA viruses [poliovirus type 3 (PV3); RNA bacteriophages (MS2, Sp, Fi, QBeta)], ssDNA viruses (Phi-X174; M13), and dsDNA viruses [Adenovirus type 2 (Ad2); PRD1] was investigated in a laboratory solar simulator (SS). Inactivation rates of 17 bacteriophage field isolates revealed that F+ RNA coliphages (n=4, k = 0.57 to 0.99 h-1) were more resistant than F+ DNA coliphages (n=4, k= 1.84 - 1.94 h-1) or somatic coliphage (n=8, k=1.28 - 2.18 h-1; and n=1, k=7.51 h-1). The inactivation rates of somatic coliphage field isolates in the SS compared well to the inactivation rate of indigenous somatic coliphage measured in the field in Avalon Bay (k = 0.98 h-1 at 11 AM, when the UVB intensity was comparable to that in the SS). Note that the rate measured in the field is an average for the entire water column, so is expected to be lower than laboratory rates due to light attenuation in the field. Among reference strains, the relative resistance was: RNA bacteriophages (n=6, k=0.43-0.65) ≥ Ad2 (n=4, k=0.59-0.04) > PRD1 (n=3, 1.27-0.006) > M13 (n=1, k=2.13) > PV3 (n=4, k=2.16-0.08) > Phi-X174 (n=1, k=7.31). Future work will further explore the wavelength-dependence of inactivation with the goal of developing second-order rate expressions that explicitly account for sunlight spectrum and intensity. These rate constants will allow organism-specific modeling of viral indicators and pathogens in beach water.

Biosketch

No biosketch available.

Determining Research Needs at Ohio Inland Lakes Not Covered by the BEACH Act

Presenter: Jason Marion
The Ohio State University

Author: Jason Marion

Abstract

The Beaches Environmental Assessment and Coastal Health Act of 2000 (BEACH Act) was established to reduce the risk of illness to users of the Nation's recreational waters. This amendment to the Clean Water Act prohibits BEACH Act grants to be authorized by the U.S. EPA to support inland beach projects. Despite being excluded from the BEACH Act, many inland lakes may pose health risks comparable to coastal waters. In Ohio, the annual population at risk at each type of beach is equal, 2 million use Lake Erie and 2 million go to inland beaches. Nationally, 7% of water samples from coastal waters exceeded national human health standards in 2007. In Ohio, 6% of 2007 samples from inland beaches exceeded the 235 CFU/100 ml standard. Three-year averages from the Ohio Department of Health data show 8 out of 42 Ohio inland lakes with complete data had greater than 7% of samples exceeding human health standards. One inland Ohio lake exceeded the national health standard in 33% of samples collected over the last three years (2006–2008). Comparable waterborne disease risks may exist in non-coastal waters in other states. Predictive modeling tools established from Great Lakes funded projects may prove valuable to inland beaches, where sampling often occurs less frequently. Other support mechanisms may need to be established to address and indentify unique issues associated with the Nation's inland beaches.

Biosketch

Jason Marion is a Doctoral Candidate in Environmental Health Sciences and is the Public Health Preparedness in Infectious Diseases Fellow in the College of Public Health at The Ohio State University. He received his B.S. in Environmental Science and M.S. in Biology from Morehead State University in Kentucky. Mr. Marion has previously worked on water quality issues in Eastern Kentucky and for the past 10 years he has worked for the Ohio Department of Natural Resources, Division of Parks and Recreation. His main research interest is developing real-time indicators and models for protecting public health at inland lakes as well as exploring ecological indicators predictive of fecal pollution.

Forecasting Tools to Predict Bacterially-Induced Beach Closures at Boston Harbor Beaches

Presenter: Diane Mas
University of Massachusetts Amherst, Dept. of Civil and Environmental Engineering Marston Hall

Authors: Diane Mas, David Ahlfeld

Abstract

Balancing the need for access to recreational waters and protection of public health is a challenge for many beach managers that make open/close decisions based on prior day concentration of fecal indicator organisms (FIOs). Due to the lag time in processing of samples and the spatiotemporal variability inherent microbial water quality in coastal waters, beaches may be closed/open when current conditions are in fact safe/unsafe. This is a concern at the Boston Harbor Beaches where over the period 2000-2004, the use of FIOs to predict safe/unsafe conditions relative to the recreational water quality standard resulted in true positive rates of less than 35% and false positive rates as high as 21%. Consequently, there is interest in forecasting or nowcasting of microbial water quality conditions at Boston Harbor Beaches since regression-based methods have been shown in recent years to be a valuable tool in assessing recreational water quality conditions at several Great Lakes beaches.

This research examines the viability of forecasting to predict exceedances of the single sample maximum concentration for *Enterococcus* at selected beaches in Boston Harbor. The models developed use readily available hydrologic and meteorological input variables in order to make them practical for implementation. The predictive capability of (1) prior day FIO concentrations, (2) regression models, and (3) models using artificial intelligence methods will be compared and the strengths and weaknesses of each method discussed.

Biosketch

Diane M.L. Mas has more than 10 years of environmental consulting and research experience in the areas of water quality, watershed management and pollution prevention, and environmental impact assessment. Diane received her B.A. in Geology from Amherst College and her M.S.E. in Water Resources Engineering from Princeton University. She received her Ph.D. in Civil Engineering from the University of Massachusetts Amherst and her dissertation research focused on the application of data-driven modeling techniques for the prediction of bacteria water quality in urbanizing watersheds. Diane is currently a post-doctoral research associate in the Department of Civil and Environmental Engineering at the University of Massachusetts Amherst and a Senior Environmental Engineer at Fuss & O'Neill, Inc. in West Springfield, MA. Her research interests include the development of nowcasting methods for the prediction of same day water quality in recreational waters, the assessment of horsekeeping practices on water quality, and the development of outreach materials for horse environmental awareness. Her professional practice focuses on water quality assessment in coastal and inland watersheds/beachsheds and environmental impact evaluation.

Improving Water Quality at Easton's Beach, Newport, Rhode Island: Selection and Design of a UV Disinfection System for Stormwater

Presenter: Diane Mas
University of Massachusetts Amherst, Dept. of Civil and Environmental Engineering Marston Hall

Authors: Diane Mas, Laura Marcolini, James Riordan, Dean Audet

Abstract

Over the past several years, Easton's Beach in Newport, Rhode Island has experienced high bacteria levels that have closed the beaches during and just after rainfall events. An investigation of the watershed, including wet weather sampling, and review of historical water quality data from the beach, was conducted in 2006–2007 for the City of Newport. The 5.5 mi^2 beachshed is highly developed and nonpoint source pollution from stormwater runoff was identified as the major source of beach closures. This research describes the development of a strategy for water quality improvement at Easton's Beach. Development of a strategy was complicated by the highly developed nature of the watershed and the fact that over half the beachshed is located in the adjacent municipality of Middletown. As a result, a more decentralized approach to treating stormwater was not feasible. Based on a review of treatment technologies, a UV disinfection system was selected for pilot testing at the major outfall to Easton's Beach. A pilot study was conducted in Fall 2007 and treated seven storm events. The full-scale UV treatment system will be designed to treat 100% of the runoff generated from 1.2 inches of rainfall in 24 hours, which will include approximately 93% of the storm events in Newport. It will be sized to treat 96 cfs and achieve a 30-day geometric mean of less than 104 cfu/100 mL *Enterococcus*. When constructed, the system will be the first application of UV treatment of stormwater applied at a beach in New England.

Biosketch

Diane M.L. Mas has more than 10 years of environmental consulting and research experience in the areas of water quality, watershed management and pollution prevention, and environmental impact assessment. Diane received her B.A. in Geology from Amherst College and her M.S.E. in Water Resources Engineering from Princeton University. She received her Ph.D. in Civil Engineering from the University of Massachusetts Amherst and her dissertation research focused on the application of data-driven modeling techniques for the prediction of bacteria water quality in urbanizing watersheds. Diane is currently a postdoctoral research associate in the Department of Civil and Environmental Engineering at the University of Massachusetts Amherst and a Senior Environmental Engineer at Fuss & O'Neill, Inc. in West Springfield, MA. Her research interests include the development of nowcasting methods for the prediction of same day water quality in recreational waters, the assessment of horsekeeping practices on water quality, and the development of outreach materials for horse environmental awareness. Her professional practice focuses on water quality assessment in coastal and inland watersheds/beachsheds and environmental impact evaluation.

Sources of Pollution in Hilo Bay, Hawaii Under Baseline and Storm Conditions

Presenter: Stephanie Molloy
California State University East Bay

Authors: Stephanie Molloy, Kathy Seiber, Lucas Mead, Tracy Wiegner

Abstract

Hilo Bay waters are on the USEPA 303(d) list of water bodies impaired for turbidity, nutrients, chlorophyll (a) and fecal bacterial indicator, however there is little information on the distribution or sources of these pollutants into the Bay. We investigated levels of indicator bacteria and other pollutants in the plumes of discharge from the Wailuku and Wailoa Rivers into Hilo Bay. The Wailuku River is the main input to Hilo Bay, and discharge is largely affected by rainfall. Soils are also known to be sources of fecal bacteria in tropical environments; during periods of high rainfall, soils are washed into the rivers and subsequently into Hilo Bay. This study evaluated the dispersion of pollutants in Hilo Bay under both baseline and storm conditions. Nitrate levels in Hilo Bay increased by 1.5x under storm conditions, and were 18x higher in the Wailoa River discharge plume than in the Wailuku River discharge plume. Turbidity in Hilo Bay increased 3-5x during storm conditions. There was a 60-fold increase in *Enterococcus* levels in storm events compared to baseline conditions. Molecular analysis of Entercoccus for the human-sourced esp-gene were negative during storm conditions, indicating that the river and not sewage overflows is the likely source of these indicator bacteria in the Bay.

Biosketch

No biosketch available.

Integrating GPS/GIS Technologies into the Shoreline Survey Process

Presenter: Heather Morehead
Shellfish Division/Beaches Division, Maryland Department of the Environment

Author: Quentin Forrest

Abstract

Maryland Department of the Environment (MDE) utilizes a pollution source survey system to document and geo reference observed pollution sources that may impact water quality at beaches and shellfish harvesting waters. The Geographic Information System (GIS) based software developed by Maryland Environmental Services (MES) enables MDE to develop an electronic database for watersheds where surveys are conducted. This makes the data more readily available for analysis and provides a unique overview of bacteria sources in a watershed.

When performing a survey, MDE staff can analyze an areaýs topography, population density and land use, and interview homeowners about the condition of their waste disposal systems. MDE personnel utilize equipment which includes:

- Tablet laptop computer
- Internal or hand-held GPS unit
- Database that includes a Maryland Property View GIS layer
- Digital data entry form

During a survey, MDE personnel can identify and record potential sources of bacteria including failing septic systems and sewer infrastructure, as well as domestic animals, wildlife and agriculture.

MDE shares its findings with local health departments who have the authority to take actions toward correcting failing waste disposal systems. Local authorities can use the information to make informed decisions about measures needed to mitigate pollution sources.

Biosketch

Heather Morehead is the Beaches Coordinator for Maryland Department of the Environment (MDE) in the Science Services Administration (SSA). Heather has a B.S. degree in Wildlife Science from Virginia Tech in Blacksburg, VA, and an M.S. degree in Environmental Science from Marshall University in Huntington, WV. She worked for three years as environmental scientist for KEMRON Environmental Services, Inc. and began working at MDE in 2006. Heather has worked as the Beaches Coordinator for 2½ years. She has enjoyed learning about beach water quality and is looking forward to incorporating the new water quality standard into the program.

Expansion of coastal beach monitoring to include Vibrio vulnificus: A pilot study

Presenter: Joanna Mott
Texas A&M University-Corpus Christi

Authors: Joanna Mott, Gregory Buck, Gabriel Ramirez, Amanda Smith

Abstract

Public concern resulting from media reports of severe wound infections caused by *Vibrio vulnificus* in recreational waters prompted a pilot study incorporating *V. vulnificus* analysis into the routine beach monitoring conducted through the Texas Beach Watch program. Two water samples collected monthly from six of the Beach Watch stations from April through July 2007 were analyzed for both *Enterococcus* (EPA Method 1600) and *Vibrio vulnificus* (U.S. FDA Bacteriological Analytical Manual colony blot hybridization method). Of a total of 52 water samples, *V. vulnificus* was confirmed in 42 samples (80.8%). Means (of two samples) ranged from <1 to 16,667 CFU/100 mL. Means for each station over the study period ranged from 487 to 5,433 CFU/100 mL. Enterococci were isolated from all but one of the samples. There were six reports of a station exceeding the EPA *Enterococcus* criterion (104 CFU/100mL), based on means for each station for each sampling event, which ranged from 1 to 770 CFU/100mL throughout the sampling period. While a correlation ($r = 0.669$; $P < 0.01$) was found between enterococci and *V. vulnificus*, these results must be treated with caution due to the small size of the database and short period of the study. Inclusion of *Vibrio vulnificus* analysis in the normal monitoring increased lab time and costs considerably. Additional studies are needed to determine seasonal variation in levels of *V. vulnificus* and relationships with *Enterococcus* levels, temperature and salinity at area beaches for possible use in developing predictive models and to inform the public.

Biosketch

Dr. Mott is a professor of biology at Texas A&M University-Corpus Christi. She received her B.S. degree in Biological Sciences from Aston University, U.K., her M.S. in Biology from the University of Waterloo, Canada and her Ph.D. in Soil Sciences (Microbiology) from Texas A&M University. She has been a faculty member at Texas A&M University-Corpus Christi for 15 years, and is currently the Chair of the Life Sciences Department. Her research interests are in coastal microbiology and human health with a focus on fecal contamination of surface waters, microbial source tracking, and marine pathogens (*V. vulnificus*). Her lab has NELAP-Recognized Laboratory Accreditation for three fecal indicators and monitors 51 stations in four coastal counties on a weekly/bi weekly basis for the Texas Beach Watch program.

Methicillin Resistant Staphylococcus aureus in recreational marine waters

Presenter: Lisa Plano
University of Miami Miller School of Medicine

Authors: Lisa Plano, Anna Garza, Helena Solo-Gabriele, Lora Fleming

Abstract

Staphylococcus aureus, including methicillin resistant MRSA are common commensal bacterium colonizing humans, animals and the environment, capable of causing numerous types of serious infections. They are responsible for significant morbidity, mortality and healthcare costs. MRSA infections are projected to cause more deaths this year than HIV/AIDs. As infections increase, determination of sites or sources where MRSA may survive and be shared among individuals is needed to devise plans to decrease their spread. Our studies investigate a popular marine recreational beach as a potential reservoir for MRSA to be shared by individuals using these waters. Our hypothesis: Bathers using recreational waters not only contribute organisms to the water, serving as a pathogen source, but may become colonized or infected by bacteria they are exposed to while in the water or on the beaches. In the first large epidemiology study investigating potential pathogens at a beach not impacted by sanitary sewage discharges, 1303 adult habitual bathers were randomly assigned to bather or non-bather groups, with subsequent follow-up for reported illness and environmental sampling of indicator organisms and potential pathogens. S. aureus, including MRSA, were isolated from the water associated with 37% (2.7% MRSA) of bathers during recreational use. Additional studies using marine waters in small and large pool settings confirmed that bathers, adults and young children in diapers, were a source of S. aureus and MRSA isolated from study waters and sand samples. These findings support our hypothesis and demonstrate that human health risks occur in non-point source recreational marine beaches.

Biosketch

No biosketch available.

Collecting, Organizing and Disseminating Beach Data with the Online BeachGuard System

Presenter: Bill Rensmith
Windsor Solutions

Authors: Bill Rensmith, Shannon Briggs

Abstract

BeachGuard is a Web-based tool that allows local beach managers to post real-time beach monitoring and notification data online. BeachGuard collects monitoring and notification data from local agencies using a secure Internet portal, eliminating the burdensome process of collecting and managing beach data via spreadsheets and email. In addition to being a powerful public notification mechanism, BeachGuard serves to organize and harvest beach information accurately and quickly for program management purposes, as well as serving as a complete data source for BEACH Act grant reporting.

Originally developed and implemented by the State of Michigan, the BeachGuard System has been implemented in Illinois and Indiana and is licensable to be customized and implemented by other governmental agencies. In autumn of 2008, BeachGuard was completely rebuilt to take advantage of the latest technology and required data elements.

Biosketch

No biosketch available.

Towards 48 Hour Beach Forecasting Models for the Great Lakes

Presenter: David Rockwell
NOAA Center of Excellence for Great Lakes and Human Health

Authors: D. Rockwell, D. J. Schwab, S. Joseph, and R. Wagenmaker

Abstract

The best current methods for assessing recreational water quality are based on nowcast models using the concentration of *E. coli*, a measurement involving incubation over at least 18 hours. These models reduce occurrences where people unintentionally swim in contaminated water as well as lost revenues from unnecessary restrictions of swimming. Contamination by bacteria, viruses and protozoa in recreational waters is a health risk and having timely accurate forecasts of water quality is critical to protect human health against adverse exposure situations. The Center of Excellence Great Lakes and Human Health is developing and testing new models incorporating 48-hour forecasts into beach nowcast models. Recent developments in operational Ocean Observing Systems in the Great Lakes allow parameters such as rainfall, wind direction, wind velocity and lake currents to be used as explanatory variables of *E. coli* concentration levels at the beach. These models link the parameters that impact waterborne pathogens and provide swimming safety probabilities so individuals are better informed about contaminated water risk factors.

The goal of a 48-hour forecast model is to provide the public with the likelihood for swimming at modeled beaches. This service will be relevant because the swimming public can plan where to recreate several days in advance.

Biosketch

David Rockwell is a research specialist for the University of Michigan's Cooperative Institute for Limnology and Ecosystems Research and the School of Natural Resources and Environment. He is the Beach Water Quality Forecasting Coordinator for the Center of Excellence for Great Lakes and Human Health (CEGLHH) at NOAA's Great Lakes Environmental Research Laboratory located in Ann Arbor, Michigan. He received, from the University of Chicago, a M.S. in the Division of the Physical Science and a M.B.A. from the Graduate School of Business Management Science. While employed by the Great Lakes National Program Office (GLNPO), David was Project Officer for grants on Great Lakes beach issues including beach nowcast models and rapid test techniques.

In 2005, he was GLNPO's lead for developing the Coastal Health Strategy chapter of the Great Lakes Regional Collaboration (GLRC). He helped develop in 2006 and test in 2007 sanitary survey tools at 61 Great Lake beaches both in the U.S. and Canada. In 2009, he joined CEGLHH to help coordinate activities at USEPA, USGS, and NOAA to develop beach health forecasting models. Making regional predictive models available using local data and forecasts of water mass movements derived form the Great Lakes Observation System is a 2010 milestone of the GLRC's Coastal Health Strategy.

What is the relative health risk to swimmers from California Seagull feces compared to bather shedders?

Presenter: Mary Schoen
Office of Research and Development, National Exposure Research Laboratory, USEPA

Authors: Mary Schoen, Nickolas Ashbolt

Abstract

Estimated infection risks to swimmers from seagull and bather sources of fecal contamination at a beach in Southern California were compared using quantitative microbial risk assessment (QMRA). The risk to swimmers of gastro-intestinal infections was estimated from *Campylobacter jejuni, Cryptosporidium parvum,* and *Rotavirus* from human bathers and *Campylobacter jejuni* from seagulls for bathing waters with a surfzone enterococci (ENT) concentration of 104 cfu/100ml. A beta-Poisson dose-response model was utilized with pathogen specific parameters to calculate the probability of infection using Monte Carlo analysis of the uncertain input variables. Overall, the individual risks from *C. jejuni* and *Rotavirus* were greater than that from *C. parvum*. Specific predictions of risk remain uncertain due to large uncertainty in model parameters; particularly the density of Rotavirus in feces of infected human shedders and the proportion of *Campylobacter* strains in gull feces that are human infectious. When human bathers are present in the bathing water, the predicted risk of gastro-intestinal infection from accidental ingestion of bathing water containing human fecal matter is greater than the predicted risk of infection from accidental ingestion of water containing fecal matter from seagulls. The probability of infection from accidental ingestion of bathing water containing gull feces is generally low with median predictions less than the illness benchmark 0.01 for waters with enterococci concentrations below the recreation standard of 104 CFU/100mL if the proportion of infections *Campylobacter* strains from seagulls is less than 0.1. The best estimate model predictions indicated that gull fecal-derived enterococci counts contribute less of a health threat to swimmers than human sources; however there remains large uncertainty in prediction due to the remaining uncertainty in human infectious *Campylobacter* species in gull feces, their unknown environmental persistence and the level of bather shedding of human pathogens.

Biosketch

Mary Schoen recently joined the US EPA as a cross-ORD post doc to develop Quantitative Microbial Risk Assessment (QMRA) tools for waterborne pathogens. Mary is mentored by Dr. Nick Ashbolt in the National Exposure Research Laboratory. She has a B.S. degree in Civil and Environmental Engineering (May 2003) from Bucknell University, Lewisburg, PA and M.S. (Civil and Environmental Engineering, May 2006) and a Ph.D. degree (Engineering and Public Policy, May 2008) from Carnegie Mellon University in Pittsburgh, PA. While at EPA, she will develop stochastic QMRA models for recreational waters and biofilm-related drinking water pathogens that will underpin future risk management-based water regulations.

Health Effect Associations of Recreational Water Exposure and Alternative Fecal Indicator Bacteria Measurements at a Non-Point-Source Subtropical Marine Beach

Presenter: Chris Sinigalliano
University of Miami, NSF Oceans and Human Health Center

Authors: Chris Sinigalliano, Jay Fleisher, Tomoyuki Shibata, Kelly Withum, Maribeth Gidley, Lora Fleming, Helena Solo-Gabriele

Abstract

Fecal Indicator Bacteria (FIB) measurements based on culture methods have been shown to have associations with swimming related illnesses (SRI) in recreational waters with point sources of fecal contamination. The work shown here involves an epidemiological study conducted over 15 separate days from December 2007 through June 2008 at a sub/tropical marine beach in Florida with no point-source of fecal pollution. We report an evaluation of associations between illness and selected traditional and alternative FIBs at this beach, including several different methods for enterococci (membrane filtration, MF, chromogenic substrate, CS, and quantitative polymerase chain reaction, qPCR) and Bacteroidales source-tracking assays. A total of 1303 adults were randomly assigned to bathing and non-bathing groups and each bather collected a personal water sample. Epidemiological analysis utilized logistic regression modeling to assess each FIB detection method for dose response associations with SRIs. Results show that 13% of individual water samples exceeded the US EPA's recommended single sample limit for enterococci of 104 cells/100ml based on the MF and CS methods while 60% exceeded this level based on qPCR enumeration. Bathers had higher risks of SRIs than non-bathers. Enterococci abundance measured by MF showed a dose response with some SRIs. Human-specific microbial source tracking markers have so far not shown a clear dose response under these particular conditions. The lack of relationship may be due to limited number of participants in the study.

Biosketch

Dr. Sinigalliano earned an MS in Microbiology from University of South Florida (USF) and later a Ph.D. in Biology from Florida International University (FIU) in Miami. He served as research faculty in environmental microbiology and molecular biology with the Southeast Environmental Research Center (SERC) at FIU from 1998–2006. While at SERC, he served as director of the Environmental Molecular and Cytometric Imaging Facility. Since 2006, Dr. Sinigalliano has been employed by the University of Miami's Cooperative Institute for Marine and Atmospheric Studies to serve as the director of the Environmental Microbiology Program at the NOAA Atlantic Oceanographic and Meteorological Laboratory, located on Virginia Key in Miami, Florida. He is also a member of the NSF Oceans and Human Health Center at the University of Miami. His responsibilities include overseeing the development, adaptation, and deployment of molecular assays, sensors, and methodologies for improved microbial water quality assessment and characterization to improve coastal ecosystem and public health and further the NOAA mission of fostering good stewardship of the coastal and oceanic environment.

City of Long Beach Recreational Water Quality Microbial Source Investigation at Coastal Beaches

Presenter: Marty Stevenson
Kinnetic Laboratories, Inc.

Authors: Marty Stevenson, Tom Leary, Nelson Kerr

Abstract

Nearshore waters along the coastal beaches in the City of Long Beach have experienced excessive incidences of bacterial contamination as documented by weekly sampling by the City for fecal indicator bacteria (FIB). An intensive tiered study was designed and implemented to identify whether contamination at the beach was from onshore sources or from offshore waters and whether this contamination was from human or non-human sources.

Phase I involved spatial and temporal sampling on the distribution of FIBs and salinity to identify hot spots and determine spatial sources of FIBs. Phase II investigated other possible sources such as subsurface water discharges and sand reservoirs of FIBs. Phase III involved investigating whether samples contaminated with FIB were from human or non-human sources by use of Bacteroidales and quantitative polymerase chain reactions (qPCR). Work accomplished included:

- 30-day Beach Water Quality Study
- 24-hour Intensive Beach Water Quality Study
- Subsurface groundwater investigations
- Beach sand FIB investigations
- Initial Bacteroidales and virus qPCR measurements at selected beach monitoring sites

The results of Phase I and II investigations implicated the Los Angeles River as the major source of bacterial contamination to the ocean beaches along the City of Long Beach. This was supported by a number of lines of evidence including direct measurement of FIBs, salinity, and hourly wind data.

Results of the two initial water quality surveys conducted to screen for potential human sources showed no evidence of human, dog, or cow markers at low sample limits of detection.

Biosketch

No biosketch available.

Agricultural activities and antibiotic resistant Escherichia coli in recreational waters in Quebec

Presenter: Patricia Turgeon, DVM, PhD (candidate)
Faculte de medecine veterinaire, Universite de Montreal

Authors: Patricia Turgeon, Pascal Michel, Patrick Levallois, Marie Louie
ARO research group

Abstract

Exposure to microorganisms resistant to antibiotics is a health risk to human populations. One route of exposure is thought to be recreational activities in water contaminated with microorganisms from surrounding animal production activities. The main objective of this study was to assess specific risk factors related to agricultural activities and their possible role in the presence of antibiotic resistant *Escherichia coli* in recreational waters of beaches in southern Quebec. This study was conducted using a case-control design. Beaches were considered cases when an *E. coli* resistant to at least one antibiotic was found in water samples. Controls consisted of beaches with water samples in which the *E. coli* found were susceptible to all antibiotics. Two risk factors were significantly associated with the presence of antibiotic resistant *E. coli:* percentage of land used for liquid manure spreading and whether the lake was artificial or natural. Recreational waters from beaches in southern Quebec represent a source of antibiotic resistant *Escherichia coli* for people engaging in water activities. Data suggest that agricultural activities and animal production in proximity to recreational waters are risk factors for contamination of these beaches by antibiotic resistant *Escherichia coli*. Further research into the role of the agroenvironment on the microbiological quality of recreational waters and on the possible applications of remote-sensed indicators to support surveillance programs is being pursued.

Biosketch

Patricia Turgeon is a veterinarian who obtained her DVM in 2004 from the Universite de Montreal, where she is currently a PhD candidate in epidemiology. She is working in the Epidemiology of Zoonoses and Public Health Research Unit at the Universite de Montreal and her research project is on the impact of agricultural activities on the quality of recreational waters. Her research interests lie mainly in agroenvironment and waterborne diseases, and on landscape epidemiology and spatial analysis.

Chemical Markers to Determine High Bacteria Counts in Southern Lake Michigan

Presenter: Kizhanipuram Vinodgopal
Indiana University Northwest

Authors: Kizhanipuram Vinodgopal, Julie Peller, Murulee Byappanahalli, Richard Whitman

Abstract

Bodies of water such as lakes and streams receive bacteria-infiltrated sewage that is discharged from treatment plants nearby. Normally, detection of bacteria is determined using biological methods that can take days to obtain results. Fluorescent whitening agents as chemical markers have the potential to detect levels of bacteria while providing a more efficient quantification process. Fluorescent whitening agents (FWAs) are components of household laundry detergents. Tinopal CBS-X and 4,4'-Diamino-2,2'-stilbenedisulfonic acid are two of the main FWAs used in detergents. By following these hydrophilic markers and detecting their levels, it is possible to quantify the amount of bacteria present in water.

In this experiment, the levels of the two FWAs mentioned above were quantified by direct analysis using fluorometry and high performance liquid chromatography (HPLC) using a fluorescence detector. Samples were obtained from two locations along the shores of Lake Michigan, one was taken from Burns Ditch, and another sample was obtained from the Portage Reclamation Facility. The samples were first filtered to remove particulates, and then the FWAs were concentrated by the use of solid phase extraction. The levels of the FWAs could be detected at concentrations as low as ppb or ppt. The correlation of the concentration of FWAs with bacteria levels has not yet been performed but will begin in the near future.

Biosketch

Dr. K. Vinodgopal is a Professor of Analytical Chemistry at Indiana University Northwest, in Gary, Indiana, where he began in 1990 as an Asst. Professor. He received his Ph.D. in Physical Chemistry from the University of Vermont in 1985. Dr. Vinodgopal is currently investigating the use of spectroscopic methods including fluorescence and Surface enhanced Raman Spectroscopy (SERS) to identify the presence of chemical markers as sewage contaminants in recreational waters. His other research interests include advanced oxidation processes for contaminant removal.

Identification of Sources of Fecal Pollution Impacting Pillar Point Harbor

Presenter: Dan Wang
University of California, Davis

Authors: Dan Wang, Carolann Towe, Barry Hecht, Stefan Wuertz

Abstract

Pillar Point Harbor is an enclosed harbor that receives complex inputs and water flows. Its five beaches are heavily used for recreational purposes and are frequently closed due to impaired water quality. This multi-year study aims to identify sources of fecal pollution and recommend appropriate remediation measures.

Surface inflows from creeks, outfall pipes and a marsh are monitored along with all five beaches. We use qPCR based microbial source tracking (MST) methods to identify and quantify the alternative fecal pollution indicator, *Bacteroidales*, originating from various animal hosts. To date, traditional fecal indicator bacteria (FIB) only correlate with the universal fecal *Bacteroidales* marker BacUni-UCD, but not with *Bacteroidales* from any specific host. Importantly, there is no general correlation with the human-specific marker BacHum-UCD. However, there are site-specific findings. Human-specific fecal signals were found at all 10 sites, with the highest signal originating from the two pipe outfalls and the lowest signal from the two creeks. Cow fecal material is carried in from one creek and dog fecal markers are present at several beaches and one pipe outfall. Samples taken before, during and after first-flush and storm events revealed the locations and extent of accumulated fecal signal from the mixed-use lands. Circulation patterns inside the harbor were determined in a dye release study to predict the fate of bacteria flushed into the harbor. Pockets of local, isolated circuits such as at the northwest corner of the harbor prevent inflowing bacteria from settling down, which explains the high after-flush *Bacteroidales* signal at that site.

Biosketch

Dan Wang is a Ph.D. candidate in the Department of Civil and Environmental Engineering at the University of California-Davis. Her Ph.D. research is to develop a framework for Microbial Source Tracking. Before moving to Davis, she received her M.S. in Environmental Engineering from University of Washington, working on the microbial population dynamics in Anaerobic Digestion Process.

A Model of Microbial Water Quality at a Non-Point Source Recreational Beach

Presenter: John D. Wang
Rosenstiel School of Marine and Atmospheric Science, University of Miami

Authors: John D. Wang, Xiaofang Zhu, Helena Solo-Gabrielle, Lora E Fleming

Abstract

In marine beach monitoring proxy microbes, enterococci are sampled at regular intervals and used as indicators of microbial contamination. High *in situ* concentration variability of enterococci in both space and time combined with inherent analysis shortcomings for the standard membrane filtration method for enterococci level determination make accurate and timely preventive action difficult, while direct measurement of pathogens is daunting and costly.

We present a predictive numerical model of water column proxy concentrations for a non-point source subtropical recreational marine beach. The first phase of the model was used as a tool to investigate microbe processes and source functions, as well as helping to elucidate the causal relationship in existing data. The microbe model is based on the coupled solution of hydrodynamic and advection-diffusion equations for transport and mixing. Sun light is assumed to be the only cause of deactivation of enterococci, and this is modeled as a first order decay process. Quantitative estimates of enterococci loadings from human shedding and animal fecal events obtained from our collaborators' observations are integrated with visitation frequencies derived from beach camera images to estimate the total source input as a function of time and space. Model simulations illustrate the transient concentration plumes associated with heavy bather use, and contrast this with a dog fecal event for a recreational beach in South Florida. Future model enhancements will provide predictions of spatial-temporal microbe fields to complement beach monitoring efforts for more reliable beach assessment.

Biosketch

Dr. Wang is a professor of Applied Marine Physics in the Rosenstiel School of Marine and Atmospheric Science at the University of Miami in Miami Florida. He received his M.Sc. in civil engineering from the Technical University of Denmark, and his Ph.D. in civil engineering from Massachusetts Institute of Technology. He has worked on coastal hydrodynamics and mass transport throughout the world and pioneered the use of the finite element method in coastal hydrodynamic numerical modeling. His main research interests are in development and application of numerical mass transport and fate models in the coastal environment.

Optical Properties of Three Beach Waters: Implications for Predictive Modeling of *Enterococci*

Presenter: Emily M. White
USEPA NERL ERD

Authors: Emily M. White, Richard G. Zepp, Marirosa Molina, Mike Cyterski

Abstract

Sunlight plays an important role in the inactivation of fecal indicator bacteria in recreational waters. Solar radiation can explain temporal trends in bacterial counts and is commonly used as an explanatory variable in predictive models. Broadband surface radiation provides a basic measure of sunlight exposure. However, the amount and quality of light that bacteria are exposed to is largely dependent on the optical properties of the water. In this study, we investigated the optical properties of waters at a temperate freshwater beach (Milwaukee, WI), sub-tropical marine beach (Miami, FL), and a tropical marine beach (Luquillo, PR), during summer 2008. UV sensors were deployed in the water column to model light attenuation as a function of depth. Surface solar (300-1100 nm) and photosynthetically active radiation (PAR, 400-700 nm), turbidity, chlorophyll, suspended sediments, dissolved organic carbon, and chromophoric dissolved organic matter were also measured and compared with respect to culturable enterococci levels. The tropical marine beach had the most intense solar irradiance (860 W/m^2 at noon) and the clearest water (2 NTU, 100 uM DOC, 0.1 RFU) compared to the sub-tropical marine (730 W/m^2, 7 NTU, 240 uM DOC, 0.4 RFU) and temperate freshwater (630 W/m^2, 2 NTU, 260 uM DOC, 1 RFU) beaches. Observed differences between beaches were complicated due to variations in extent of microbial contamination, water temperature, salinity, and tidal influence. Bacterial counts were better correlated with UV irradiance (325 nm), compared to PAR and solar radiation, suggesting that the inclusion of more detailed light data will help improve the accuracy of predictive models.

Biosketch

Dr. White is a biogeochemist and post-doctoral scientist at the United States Environmental Protection Agency, National Exposure Research Laboratory, Ecosystems Research Division in Athens, Georgia. She received a B.S. in Chemistry from Tufts University in Massachusetts, a M.S. in Environmental Science from The Ohio State University, and a Ph.D. in Chemistry from the State University of New York, College of Environmental Science and Forestry. For her dissertation research, Dr. White studied the role of photochemistry on carbon cycling in the Delaware Estuary. Her current research focuses on the role of light, dissolved organic matter, and suspended sediments on the fate and transport of pathogens and fecal indicator bacteria in recreational waters.

Evaluation of holding time of freshwater and marine samples for qPCR analysis

Presenter: Larry Wymer
USEPA

Authors: Larry Wymer, Richard Haugland, Jack Paar, Kevin Oshima

Abstract

Holding times for water samples to be used in evaluating recreational water compliance with criteria based on membrane filtration (MF) or multiple fermentation tube assays are well-established, set at six hours or less for Methods 1600 for *E. coli* and 1603 for enterococci. Time limits in these cases are largely influenced by decline in culturability of the target organism. If quantitative polymerase chain reaction (qPCR) assays are used in the future for this purpose, a loss in viability may not be important to the qPCR result. While the primary advantage of rapid qPCR methods over culture-based methods is the potential for rapid results and, thus, timely beach management decisions, the persistence of DNA may enable meaningful analysis of samples held over longer periods of time, maybe even years. This would make possible archival of samples for future re-analysis, say for reanalysis of unusual spikes in indicator levels or for evaluating newly developed PCR assays in the context of historical samples. Of immediate concern to the U.S. EPA is determining the effects of holding samples for 24–48 hours, as may be required for samples sent out in inter-laboratory studies on the recovery and relative precision of the qPCR enterococci assay, which is planned to occur within the next year. To evaluate the effects of sample holding time on qPCR assay results, the EPA's is conducting a study on marine and freshwater samples collected from sources in the Boston, MA area. Preliminary results from this study, which is scheduled to continue for a total of 24 months, indicate that for the enterococci qPCR assay used samples may be successfully held for at least 48 hours without substantial loss of signal.

Biosketch

No biosketch available.

Growth of indigenous enterococci in natural beach sands subjected to tidal wetting measured using culture-based and nucleic acid-based methods

Presenter: Kevan Yamahara
Stanford University

Authors: Kevan Yamahara, Sarah Walters, Alexandria Boehm

Abstract

Enterococci concentrations in coastal waters are regulated by state water quality standards and are used to assess risk of acquiring enteric disease from swimming in marine waters. Exceedance of water quality standards can lead to 303d listings under the Clean Water Act, which can trigger the development of expensive TMDLs. Our previous work has established the wide-spread occurrence of enterococci in beach sands along the California coast. We also showed that enterococci can be transported from the sand to the sea where they may instigate beach advisories. The present study illustrates that naturally occurring enterococci can grow in beach sands under environmentally relevant conditions. In un-seeded non-sterile microcosm experiments, it is shown that intermittent wetting of sands by seawater, as would occur at a high tide line, stimulates the transient replication of enterococci at rates of 0.20–0.63 per day (equivalent to double times of 1.1–3.5 days). Replication was not observed in control microcosms not subjected to wetting. Enterococci were enumerated using both culture-based methods (membrane filtration and mEI media) and nucleic acid-based detection (QPCR, 23S gene based) techniques, which allowed the tracking of both culturable and total enterococci populations. Inhibition of QPCR reactions and DNA extraction efficiencies were taken into account in the interpretation of QPCR results. The results provide evidence that enterococci may not serve as an appropriate indicator of enteric disease risk at recreational beaches subject to non-point sources of pollution.

Biosketch

No biosketch available.

Skin-related symptoms following exposure to recreational water: A systematic review and meta-analysis

Presenter: Vincent Yau
University of California, Berkeley

Authors: Vincent Yau, Timothy Wade, Carol deWilde, John Colford

Abstract

Background: Exposure to contaminated recreational waters (defined by levels of fecal and other types of indicator bacteria) is associated with adverse health outcomes. The principal health outcome studied previously has been gastrointestinal illness. Although many studies included reports of frequent skin complaints (e.g. rash or itch) following recreational water exposure, no systematic reviews have examined the association between indicator levels and skin-related symptoms.

Methods: Twenty relevant peer-reviewed studies were identified. The relative risks (swimmers vs. non-swimmers) of skin-related symptoms among those exposed to recreational water with bacterial indicator concentrations above threshold levels were determined using meta-analysis. Similarly, the relative risks (swimmers vs. non-swimmers) of skin-related complaints after exposure to water with bacterial indicator concentrations below threshold levels were determined. The ratio of these odds ratios (ROR) was then computed for each indicator.

Results: The risk of skin-related symptoms was significantly elevated in marine water with high levels of total coliforms ROR 1.86, (95% CI 1.21, 2.87); fecal coliforms ROR 1.45 (95% CI 1.02, 2.07); *E. coli* ROR 1.98, (95% CI 1.43, 2.75); enterococci ROR 2.04 (95% CI 1.34, 3.09) and fecal streptococci ROR 1.70 (95% CI 1.07, 2.71). However, no significant associations with water quality indicators were demonstrated for the freshwater indicators examined (total coliform, fecal coliform, *E. coli*).

Conclusions: Swimmers exposed to marine water at high levels of several indicator bacteria experience a significant increase in skin-related symptoms compared to non-swimmers. This relationship was not demonstrated in freshwater settings.

Biosketch

No biosketch available.

Predictive Modeling of a Fecal Indicator at a Subtropical Marine Beach

Presenter: Richard G. Zepp
USEPA NERL ERD

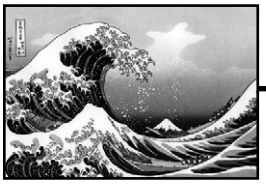
Authors: Richard G. Zepp, Emily M. White, Marirosa Molina, Mike Cyterski

Abstract

The Virtual Beach Model Builder (VBMB) is a software tool that can be used to develop predictive models at beaches based on microbial data and observations (explanatory variables) that describe hydrometeorological and biogeochemical conditions. During the summer of 2008, a study was conducted to evaluate the use of VBMB in developing models for predicting enterococci concentrations at Hobie Beach, Miami, FL. Water samples were collected at shin-deep and waist deep sites in the swim area (three times a day, four days a week). The samples were then processed to determine culturable enterococci and perform enterococci qPCR analysis. Instruments were deployed at the beach to log data that were used to develop the models. The instruments included: a weather station; an acoustic doppler current meter (ADCP); a sonde for water quality parameters; a UV radiometer system equipped with two optical sensors, each measuring UV-A and UV-B irradiance, positioned at two different depths underwater. The microbial and explanatory variables data were used by VBMB to produce multilinear regression models that optimally fit the data. Using backward elimination with Mallows Cp, VBMB was also used to develop the most parsimonious model for fitting the culturable enterococci data and also to identify the best explanatory variables from the array of potential variables available for fitting. Preliminary analysis with VBMB (using multiple linear regression without transformation of explanatory variables) identified water depth, wave height, photosynthetically active radiation, wind speed, and water temperature as the most important predictors for this beach (adjusted R-Square was 44.1%).

Biosketch

Richard G. Zepp is a Senior Research Scientist at the U.S. Environmental Protection Agency, National Exposure Research Laboratory, Ecosystems Research Division in Athens, Georgia. He received his B.S. in Chemistry at Furman University and Ph.D. from Florida State University. His research interests include predictive modeling and fate and transport processes of pathogen indicators, environmental transformations of fullerenes and other nanomaterials, and interactions of solar UV radiation with chemical and biological contaminants and biogeochemical cycles in freshwater and marine environments. He is a member of the United Nations Environment Programme (UNEP) Panel on Environmental Effects of Ozone Depletion (1993-present), and is currently serving as an Associate Editor for *Limnology and Oceanography: Methods.* He is Adjunct Professor at the Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, Miami, Florida and the Department of Chemistry, State University of New York, Syracuse, New York. He is also a member of ACS, ASM, ASLO, AGU, Sigma Xi, AAAS, and SETAC.



Beach Sand Microbiologic Analysis and Search for Pathogens

Presenter: João Brandão
Project manager, Department of Infectious Diseases, National Institute of Health Dr. Ricardo Jorge, Lisboa - Portugal

Abstract

The quality of coastal and inland recreational waters and sand are of great importance as people use them both for bathing or water-contact sports. In 1989, the Mycology group of the National Institute of Health Dr. Ricardo Jorge worked on this subject for the first time, in a joint study with the Portuguese National Directorate of Health. During the following 10 years, several local beach sands were randomly analyzed.

Between 2000 and 2002 by invitation of the Portuguese Blue Flag Association, and based on the work previously done, a project involving several national institutions took place, aiming to define beach sand quality parameters and associated methods: "Microbiologic Quality of Coastal Beach Sands". During this project we split our country in 5 regions and from each region 3 beaches were selected: One blue flag awarded (thus with documented good maintenance and water quality), one wild (with the least possible human influence), and one with documented poor water quality (as a close reference of microbiological poor quality). Samples were collected every 2 months for 13 months. Based on the results obtained we were able to build mean values which we used as standard indicators of microbiological quality. These have been extended to inland beaches through our participation a European project (ICReW), and have recently been revised and asserted to raise the quality standards according to our experience on beaches with best results. Wet sand analysis is unnecessary as it correlates with water and dry sand. Water falls under the European and local water directives, being monitored by default in order to allow public use - not more then 5% of the samples (one sample per fortnight during bathing season) may be under the imperative limits (total coliforms <10000c.f.u./100ml, faecal coliforms <2000c.f.u./100ml) nor more then 20% under the recommendation limits (total coliforms <500 c.f.u./100ml, faecal coliforms <100c.f.u./100ml). We found no indicator of fungal quality of either sand or water amongst physical-chemical parameters (Total Nitrogen, Nitrates, Nitrites, BOD5, COD, Total Phosphorus, Phosphates, pH and turbidity) measured in the water samples and in sand washings.

The fungal sand quality indicators currently detected and measured are (a) Yeasts (*genuses Candida, Cryptococcus, Saccharomyces. Rhodotorula*), (b) Alergogenic and potential pathogenic fungi (genuses *Aspergillus, Fusarium, Scopulariopsis, Scedosporium, Chrysosporium, Scytalidium*), (c) Dermatophytes (genuses *Microsporum, Epidermophyton* and *Trichophyton*). Total coliforms, *E. coli* and intestinal *enterococci* are the bacterial parameters which correlate only partially with fungal group (a) and should therefore be monitored independently. Fungal group (b) is typically airborne, indicating contamination from immediate surrounding areas as well as from the beach. Fungal group (c) is associated with related pathologies in warm-blooded animals, including humans.

We currently provide this service to the community and the demand has been growing every year; and not only for beach sand but also for construction and non bathing-related samples. We now analyze at least 100 beaches throughout the summer (different samplings per beach) and the overall quality has been increasing tremendously with the awareness of the main negatively influencing factors, by beach managers.