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UVA AND CUTANEOUS MELANOMA INCIDENCES

Spatial Patterns and Communities At Risk

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ABOUT THE COVER

In this month's cover feature, "UVA and Cutaneous Melanoma Incidences: Spatial Patterns and Communities At Risk," the authors examined the associations of cutaneous melanoma incidence rates with specific ultraviolet exposure metrics across the U.S. An increasing trend of cutaneous melanoma incidence and mortality rates was observed during the last decade. The ratio of mortality to incidence decreased, however, due to earlier detection and advances in the treatment of cutaneous melanoma. The authors' study identified an excess of cutaneous melanoma incidence in northeast U.S. and a deficit in the southern U.S., a discrepancy that may be due to increased use of tanning beds in northern states.

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PRESIDENT'S MESSAGE

Carolyn Hester Harvey, PhD, CIH, RS, DAAS, CHMM

NEHA Has a New Executive Director

I am very happy to announce to you, our members and colleagues, that NEHA has a new exciting and excited executive director who will come on board in early May. The NEHA board of directors and the executive director search committee have succeeded in hiring the very best qualified individual whom we were privileged to meet and interview. Dr. David Dyjack will assume his duties as the executive director and chief executive officer of NEHA on May 4, 2015.

Dr. Dyjack has an environmental/occupational health background in both public and private organizations with a work history of over 29 years. Dr. Dyjack's resume reads like a man on a mission to spread the word about our profession and its diverse and unique disciplines. He has been a leader in the field of environmental health his entire career. His employment has included consulting firms, industrial firms, a university, and a nongovernmental organization (NGO). Dr. Dyjack comes to NEHA with experience as an associate executive director of programs for an NGO with a staff of 115 employees and a budget of $30 million. Dr. Dyjack supervised over 75 of those employees and a budget of $28 million while obtaining grant funding of over $73 million during his nearly five year tenure in that organization.

Dr. Dyjack has over 18 years' experience as an academic; he started as a professor of environmental health, which led to his promotion as department chair and subsequently his appointment as dean of the School of Public Health and vice president for Health Education at Loma Linda University in California.

David Dyjack, DrPH, CIH

We have chosen our new executive director who will lead NEHA to greater heights.

As an academic myself, I think our board and our executive director search committee struck gold with Dr. Dyjack. His experiences in other areas of environmental health give him a broad perspective and hands-on knowledge of our profession.

Dr. Dyjack was a joy to interview and set the stage for the other candidates. His enthusiasm and his apparent love and appreciation of our profession were contagious. He was interviewed by members of the board of directors and NEHA staff and gave us a new appreciation for the many things NEHA can and should do to spread the word about what environmental health is and can accomplish with the right leadership. He is a global environmental health enthusiast and wants NEHA to be at the table in that arena. His views on membership are to increase our membership as well as to give our members more access to, and variety of, opportunities. As a manager, Dr. Dyjack likes to meet with his staff weekly to discuss the week's progress and problems. He listens and observes to become familiar with the operations of the organization. He plans to interact with partners, NEHA members, the board of directors, and constituents to learn the culture of the organization. Communications are essential in all areas of developing, leading, and managing an organization like NEHA.

Dr. Dyjack has an impressive resume, having received a Doctorate in Public Health in occupational/environmental health, a Master of Science in Public Health in industrial hygiene, and a Bachelor of Science in biology as a foundation for his career in environmental health. His work experience has given him opportunities to explore many of the areas of environmental health that are essential components of public health.

Dr. Dyjack has the ability and opportunity to elevate NEHA to a higher level in the environmental health arena both nationally and globally, which our members have been working to attain for many years. He brings to NEHA a wealth of knowledge, experience, and expertise in areas that can only enhance our organization's future in obtaining grants, increasing our membership, and positioning NEHA with opportunities to interact with private and public entities on a more active and larger landscape. NEHA's future and its continuing and lasting impact will be in a more positive position as Dr. Dyjack takes the reins of our organization.

In closing this column, I want to assure you that we have chosen our new executive director who will lead NEHA to greater heights with your support and involvement. I believe you will find him to be an excellent choice to continue the current work and enhance the opportunities for NEHA.

Dr. Dyjack will be the keynote speaker at NEHA's 2015 Annual Educational Conference & Exhibition in Orlando, Florida, July 13–15, 2015 (www.neha2015aec.org). Please join us to hear his comments on the future of NEHA as the new executive director and chief executive officer. I look forward to seeing and talking with you in Orlando in July.

carolyn.harvey@eku.edu

Did You Know?

Registration prices for the NEHA 2015 AEC will go up on May 29. This is your last chance to take advantage of early bird pricing so act now! You can register for the 2015 AEC at www.neha2015aec.org. While registering don't forget to purchase a ticket to the UL Event or one of the field trips NEHA has arranged for attendees. Space for these events is limited.

UVA and Cutaneous Melanoma Incidences: Spatial Patterns and Communities At Risk

Ilias Kavouras, PhD
Tina Gomez, MPH
Marie-Cecile Chalbot, MS, PhD
Fay W. Boozman College of Public Health
University of Arkansas for Medical Sciences

Abstract **The authors examined the associations of melanoma of the skin (i.e., cutaneous melanoma) incidence rates with specific ultraviolet (UV) exposure metrics across the U.S. No correlation between the age-adjusted incidence rates of cutaneous melanoma and annual average, maximum, and cumulative UV levels was observed. The authors then estimated two indicators, the UV-weighted melanoma rate and the melanoma-weighted UV level. A linear relationship was computed for the UV-weighted melanoma incidence rate while an exponential decay simulated the melanoma-weighted UV level. The slope of the UV-weighted melanoma linear model was indicative of the mean cutaneous melanoma incidence rates attributed to solar UV exposures in the U.S. An excess (i.e., above the average) of cutaneous melanoma cases was observed in the northeast U.S. A deficit of cutaneous melanoma cases for the estimated UV levels was observed in Texas, Nevada, and Arizona and to a lesser extent in California and New Mexico.**

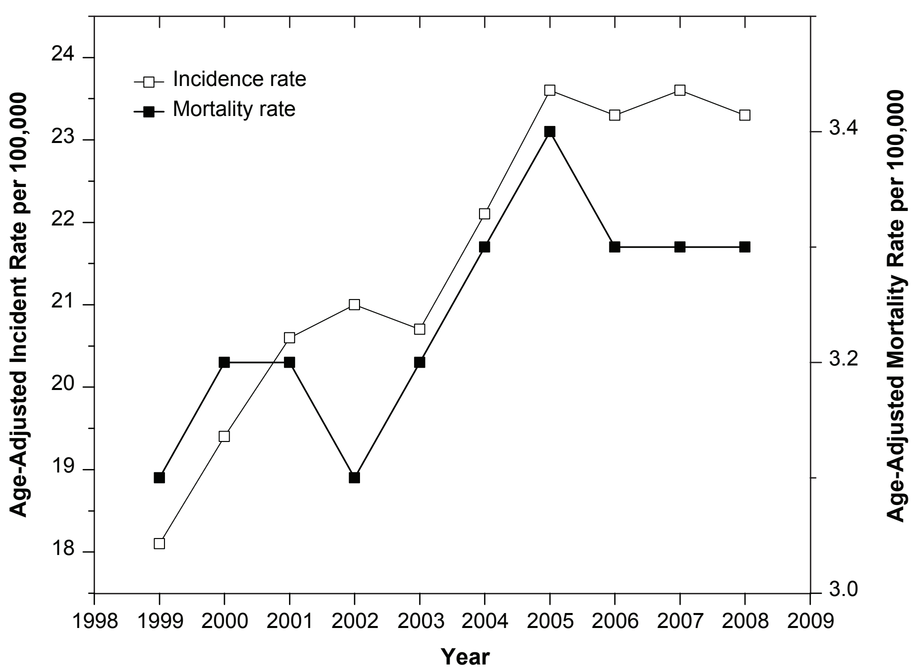
Introduction

Skin cancer is defined as the uncontrolled growth of various cells of the skin tissues. The process is either triggered by external factors such as ultraviolet (UV) radiation from natural sources and artificial lamps, chemical exposure, or genetic mutation within the cell (Biniek, Levi, & Dauskardt, 2012; Vernez, Milon, Vuilleumier, & Bulliard, 2012). Many types of skin cancers exist; cutaneous melanoma is responsible for 4% of diagnosed skin cancer but 77% of skin cancer–related deaths. An increasing trend of skin cancer incidence and mortality rates has been observed during the last decade (Jemal, Siegel, Xu, & Ward, 2010). Melanoma, basal cell carcinoma (BCC), and squamous cell carcinoma (SCC) are associated with intermittent intense exposure or chronic UV radiation (Moan, Baturaite, Porojnicu, Dahlback, & Juzeniene, 2012). Epidemiological studies found increased risks for BCC and SCC when cumulative sun exposure was between 8,000 and 10,000 hours and exceeded 70,000 hours, respectively (Rivas, Araya, Caba, Rojas, & Calaf, 2011; Rosso, Zanetti, & Martinez, 1996). Associations of BCC and SCC with outdoor sports, however, were weak and nonsignificant. An analysis of the Surveillance, Epidemiology, and End Results Program showed that melanoma incidence was associated with increased UV index and lower latitude only in non-Hispanic whites (Eide & Weinstock, 2005).

UV is divided into three categories: UVA, UVB, and UVC. UVA includes radiation with wavelengths of 315–400 nm and represents 95% of UV at Earth's surface. It penetrates deep into the skin and can cause DNA damage and skin cancer. Since UVA does not cause sunburn, existing sunscreens do not offer significant protection against UVA (Godar, Landry, & Lucas, 2009; Petkov et al., 2011). Only in the last few years has an effort begun to use broad spectrum sunscreens, which offer protection against both UVA and UVB (Moan et al., 2012; Seité et al., 2010). UVB extends from 280 to 315 nm and is mostly absorbed by the outermost layer of the skin. UVB causes sunburns. UVC (100–280 nm) is the most damaging of all three types of UV radiation but is removed by the stratospheric ozone layer. Each percentage of destruction of stratospheric ozone would result in an increase of about 2% in skin cancer incidence (Henriksen, Dahlback, Larsen, & Moan, 2008). Thus, people residing at higher latitudes (e.g., Nordic countries, Russia, Canada, and northern U.S. states) may be disproportionally affected in the near future. Erythemal UV includes the sun-burning effect of both UVA and UVB. Previous studies showed that

FIGURE 1

Annual Age-Adjusted Mortality and Incidence Rate for Cutaneous Melanoma for Non-Hispanic Whites in the U.S.



moderate doses of ambient UVB can produce vitamin D and help prevent diseases including colorectal and breast cancer. Mason and Reichrath (2012) provided recommendations for activities that reduce the risk for developing skin cancer while maintaining healthy levels of vitamin D.

The objectives of our study were 1) to identify an indicator that categorizes U.S. states based on cutaneous melanoma in response to atmospheric UV levels; 2) to determine the fraction (UVA, UVB, erythemal UV [UVery], or UV vitamin D [UV-VitD]) that was better associated with cutaneous melanoma; and 3) to analyze the spatial trends of the indicator. Three indicators were evaluated, namely, UV level, ratio of the age-adjusted cutaneous melanoma incidence rate to UV (UV-weighted melanoma), and ratio of UV to age-adjusted cutaneous melanoma incidence rate (melanoma-weighted UV). The UV-weighted melanoma was the number of cutaneous melanoma incidences per m^2 for 10^5 kJ of UV radiation. It increased as the number of cutaneous melanoma cases increased for the same UV radiation or decreased as the UV radiation increased for the same number of cancer incidents. Thus, it ranked the states based on their susceptibility to skin cancer corrected for UV exposures. Susceptibility factors may include genetic predisposition or health behavior. Changes in population would influence the findings by resulting in abnormally low values for states with a large influx of new residents. The melanoma-weighted UV ratio was the amount of UV per cutaneous melanoma incidence. It decreased as the number of skin melanoma incidences increased for the same UV levels but increased as the UV radiation increased for the same number of skin melanoma incidence. Therefore, this ratio ranked the states based on their susceptibility to UV radiation. Twelve exposure metrics were analyzed to investigate the possible effect of short- and long-term exposures. These were maximum, average, and cumulative for each UV fraction.

Methods

State-Level Cutaneous Melanoma

The 1999–2008 annual age-adjusted incidence rates per 100,000 of cutaneous melanoma of non-Hispanic whites (both men and women) for each state were obtained from the Centers for Disease Control and Prevention Wonder database. No data were available for Arkansas in 1999–2000, Mississippi in 1999–2002, North Carolina in 1999–2000, South Dakota in 1999–2000, Tennessee in 1999–2002, and Virginia in 1999–2001. Hawaii was excluded due to its extremely high incidence rate and Rhode Island and the District of Columbia were excluded due to their small geographical sizes.

Solar UV Radiation

The monthly distributions of UVA, UVB, UVery, and UV-VitD for the periods 1979–2000, 1979–1989, and 1990–2000 were obtained from the National Oceanic and Atmospheric Adminstration's tropospheric ultraviolet and visible radiation model (Lee-Taylor & Madronich, 2007). The model outputs were corrected for aerosol scattering and cloud cover using the TOMS satellite observations. The resolution of UV estimates was 1.25º. We calculated UVA, UVB, UVery, and UV-VitD for 0.2º x 0.2º using universal kriging with linear drift (Tatalovich, Wilson, & Cickburn, 2006). We then estimated the average, maximum, and cumulative UVA, UVB, UVery, and UV-VitD in each state for each time period by converting the format of databases from "feature" to "raster" and spatially joining them with U.S. states' "shapefile." The processing was done in ArcMAP version 10.

Statistical Analysis

First, we determined an exposure-effect indicator that better described the association of UV with cutaneous melanoma incidence rate. Second, we identified which of the 12 metrics was better associated with the cutaneous mortality incidence rates. Third, we determined the temporal and spatial trends of the indicator and attributed them to specific demographic and behavioral parameters.

We performed simple regression analysis of UV level, the UV-weighted melanoma rate, and the melanoma-weighted UV level (where UV was the average, maximum, or cumulative UVA, UVB, UVery, and UV-VitD) against state-level annual age-adjusted cutaneous melanoma incidence rates for the years 1999–2008. Analysis was done in SPSS version 21 and Origin version 8.1.

Results and Discussion

Figure 1 shows the age-adjusted annual incidence and mortality rates for cutaneous melanoma in the U.S. An increasing trend of cutaneous melanoma incidence and mortality rates was observed during the last decade. The ratio of mortality to incidence, however, decreased from 1-in-6 in 1999 to 1-in-8 in 2008 due to earlier detection and advances in the treatment of cutaneous melanoma. According to the American Skin Cancer Foundation, one in five Americans will develop cutaneous melanoma in his/her lifetime.

Figure 2 shows the relationships of cutaneous melanoma incidence rates to (a) average UVA, (b) UVA-weighted melanoma, and (c) melanoma-weighted UVA. The cutaneous melanoma incidence rate was poorly correlated to UVA exposures (Figure 2a) (R^2 = -.01). Conversely, both the UVA-weighted melanoma and melanoma-weighted UVA ratios demonstrated a better correlation with state cutaneous melanoma incidence rates (R^2 = .77–.78; Figures 2b–c). For the UVA-weighted cutaneous melanoma, a linear relationship was observed with values increasing as the cancer incidence rate increased. An exponential decay curve provided the best fit for the melanoma-weighted UVA to melanoma incidence rate data. The differences of the fitting curves for the two indicators further highlighted the nonmonotonic dependence of cutaneous melanoma and UVA exposures. Consequently, we used the UVA-weighted cutaneous melanoma as the indicator describing the causal coupling between UVA and cutaneous melanoma to rank the states. Similar plots were drawn for all 12 exposure metrics for the two exposure periods; however, we only present the UVA because existing sunscreens do not provide effective protection.

FIGURE **2**

Dependence of State 2008 Cutaneous Melanoma Incidence Rates to the Three Indicators Using Statewide Maximum UVA for the 1979–1989 Period

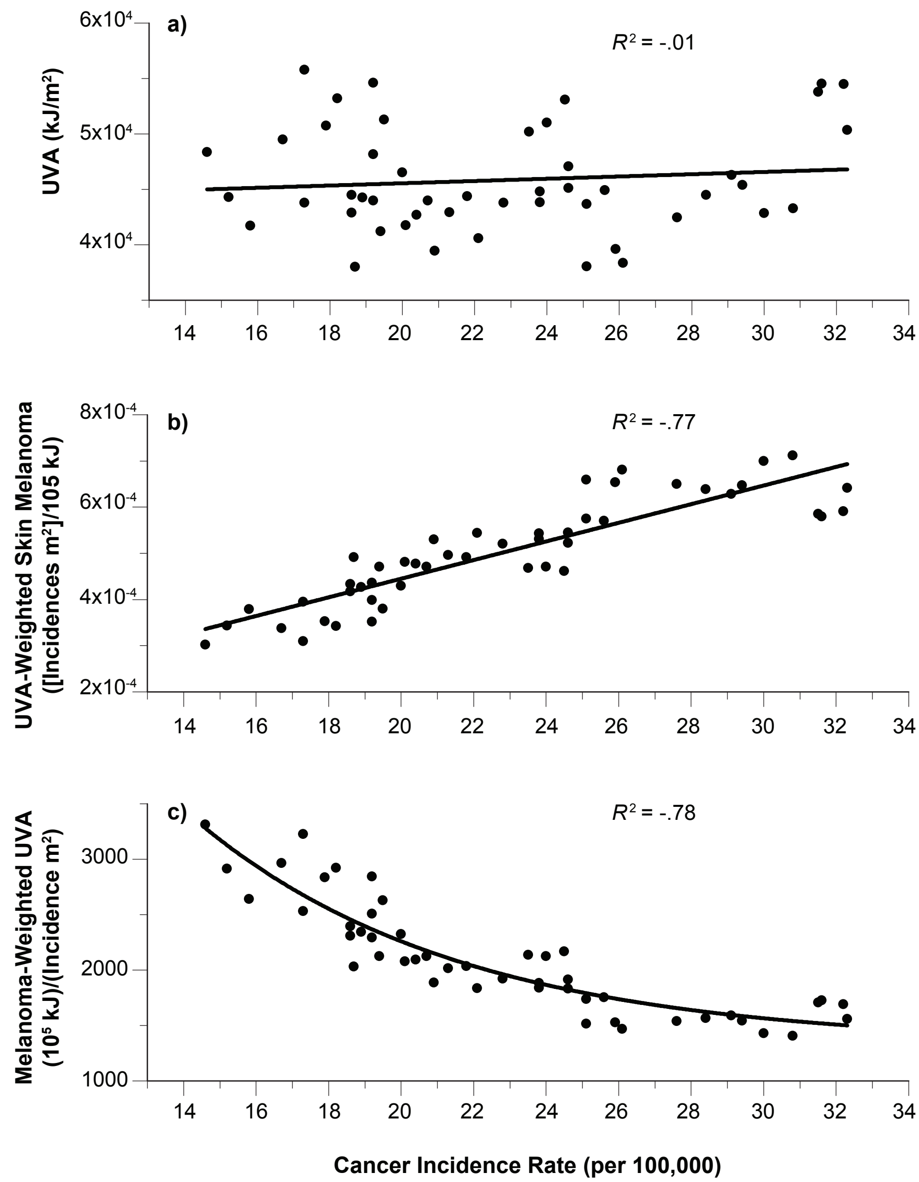


Table 1 shows the slope, intercept, and R^2 values for the linear models with the UV-weighted cutaneous melanoma as the dependent variable and the 2003 state cutaneous melanoma incidence rates as independent variables for the 12 combinations of UV (4 fractions x 3 metrics) for each of the two periods (1979–1989 and 1990–2000). For all UV fractions, higher R^2 values were computed for the maximum metrics (.42–.81) than average (.10–.31) and cumulative (.10–.11) metrics. Among the four UV fractions, UVA exhibited a better correlation with cutaneous melanoma incidence rates as compared to UVB, UV-VitD, and UVery. No significant differences were computed when using UV levels for 1979–1989 and 1990–2000 periods. These results were in agreement with previous studies showing good associations of cutaneous melanoma with summertime UVA exposures (Volkovova, Bilanicova, Bartonova, Letasiova, & Dusinka, 2012).

Figure 3 depicts the 2008 UV-weighted melanoma rate vs. melanoma incidence rates for each state. The states with the highest 2008 cutaneous melanoma incidence rates were Oregon, California, New Mexico, and Utah. For these states, relatively high UVA-weighted melanoma rates were computed, providing an initial indication of the impact of UVA exposures to cutaneous melanoma.

TABLE **1**

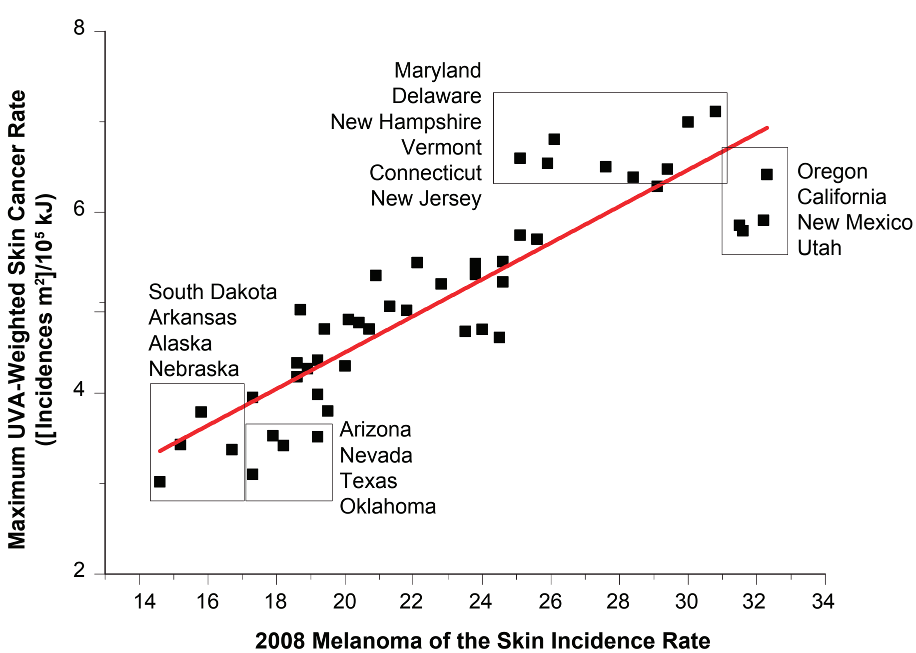
Regression Coefficients of Ultraviolet (UV)-Weighted Skin Melanoma to State-Level 2008 Skin Melanoma Incidence Rates for Each UV Exposure Metric

Determinant	1979–1989			1990–2000		
	R^2	Slope	Intercept	R^2	Slope	Intercept
Mean UVA	.30	3.43×10^{-5}	1.41×10^{-4}	.31	3.48×10^{-5}	1.34×10^{-4}
Maximum UVA	.77	2.02×10^{-5}	4.16×10^{-5}	.81	2.00×10^{-5}	3.78×10^{-5}
Cumulative UVA	.10	4.54×10^{-7}	-7.34×10^{-6}	.11	4.59×10^{-7}	-7.41×10^{-6}
Mean UVB	.14	1.47×10^{-3}	1.47×10^{-2}	.15	1.42×10^{-3}	1.32×10^{-2}
Maximum UVB	.59	7.61×10^{-4}	3.52×10^{-3}	.58	7.50×10^{-4}	3.11×10^{-3}
Cumulative UVB	.10	2.38×10^{-5}	-3.82×10^{-4}	.10	2.26×10^{-5}	-3.63×10^{-4}
Mean UV-VitD[a]	.11	5.52×10^{-3}	6.68×10^{-2}	.10	5.83×10^{-3}	7.32×10^{-2}
Maximum UV-VitD	.49	2.88×10^{-3}	1.46×10^{-2}	.42	2.94×10^{-3}	1.68×10^{-2}
Cumulative UV-VitD	.10	9.51×10^{-5}	-1.53×10^{-3}	.10	1.02×10^{-4}	-1.64×10^{-3}
Mean UVery[b]	.15	1.05×10^{-2}	9.38×10^{-2}	.14	1.09×10^{-2}	1.03×10^{-1}
Maximum UVery	.52	5.42×10^{-3}	2.32×10^{-2}	.48	5.53×10^{-3}	2.61×10^{-2}
Cumulative UVery	.10	1.67×10^{-4}	-2.69×10^{-3}	.10	1.76×10^{-4}	-2.83×10^{-3}

[a]UV-VitD = ultraviolet vitamin D.
[b]UVery = erythemal UV.

FIGURE **3**

Relationship of Maximum UVA-Weighted Cutaneous Melanoma vs. Cutaneous Melanoma Incidence Rates



The states with the highest UVA-weighted melanoma rate were Maryland, Delaware, New Hampshire, Vermont, Connecticut, and New Jersey, indicating an excess (relative to the maximum UVA levels in the state) of cutaneous melanoma cases. This discrepancy may be attributed to the widespread use of artificial tanning in these states or increased exposures to UVA during vacations in destinations outside the state (Robinson, Kim, Rosenbaum, & Ortiz, 2008). The use of indoor tanning facilities exploded to almost one in three adults in the U.S. with alarming trends among young white women. Given the associations of exposure to UV radiation from indoor tanning devices and increased risks of melanoma, it is likely that incidence rates will continue to increase for the foreseeable future. Measures to reduce the burden of tanning beds include restricted use by minors. In the U.S., only six states ban the use of tanning facilities for those younger than 18 years old.

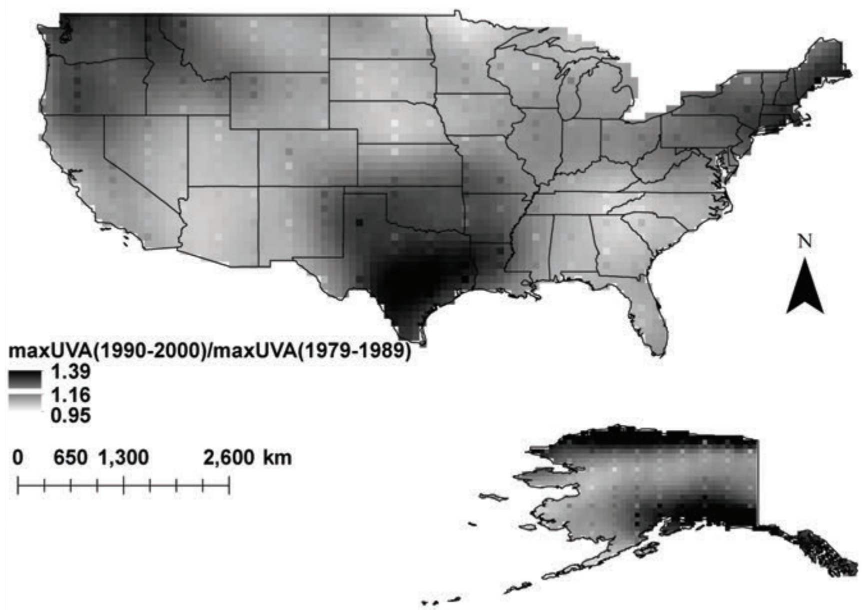
Most of the states with the lowest 2008 cutaneous melanoma incident rates (South Dakota, Arkansas, Nebraska, Texas, Nevada, Arizona, and Oklahoma) had UV-weighted melanoma rate values lower than the slope, suggesting that solar UV was the most likely trigger of skin cancer. The largest deficit between cutaneous melanoma incidence and exposures to solar UV was computed for Arizona, Nevada, Texas, and Oklahoma. Interestingly, these states experienced high exposure to UV but low cutaneous melanoma incidence rates (17–19 per 100,000). This deviation may be attributed to everyday behavioral practices for protection against solar UV as well as to differences in demographics. Residents of regions with frequent and high-level UV levels are more inclined to wear hats and use sunscreen than those living in northern latitudes. Previous studies showed that the cutaneous melanoma incidence rates for Hispanics and African-Americans were substantially lower than that for whites (Rouhani, Hu, & Kirsner, 2008).

Figure 4 shows the ratio of maximum UVA in 1979–1989 and 1990–2000 in the 48 contiguous states and Alaska. Values higher than one suggested that UVA exposures in the 1990–2000 period were higher than that in the 1979–1989 period. The northeast, Pacific Northwest, and Texas experienced an increase in UVA exposures, while southeast, southwest, and the northern plains states observed a moderate decrease in UVA exposures. Since the intensity of incoming UVA radiation does not follow a spatial trend, the observed spatial variability may be associated with atmospheric changes, such as decreased cloud cover (promoting increased UVA) or air pollution events (dust storms, wildfires), that promote the scattering of solar radiation by particles (and thus reduced UVA exposures).

Figure 5 shows the variation of slopes and intercepts of the regression models using the cutaneous melanoma incidence rate for each year and the max UVA exposure for the two periods. High slopes and low intercepts are indicative of a stronger association of cutaneous melanoma with UVA radiation. The lowest slopes of the regression models were computed for skin cancer incidence rates in 2000 and 2001 (a moderate decrease from 1999), followed by a rapid increase in 2002 and remaining elevated until 2007. For 2008, a drastic decrease was computed (value similar to that computed for 1999). The slopes of the regression models using UV exposures during the 1979–1989 period were somewhat higher than those computed using UV exposures during the 1990–2000 period, providing initial evidence that the exposures to environmental UV in the past 13–28 years (computed as the difference between 2002–1989 and 2007–1979, respectively) may have contributed to the development of skin cancer. This was consistent with the estimated timeframe of 10–15 years between skin damage and skin cancer development. Note that diet, exposure to carcinogens, genetic vulnerability, skin pigment types, and weak immune system were previously identified as effect confounders and they may influence the rate of development of cancer in a person. Moreover, lifetime individual mobility and health behavior may also have an effect that cannot be described in retrospective studies.

FIGURE 4

Spatial Distribution of Maximum UVA Ratio Between 1990–2000 and 1979–1989 Periods



Conclusion

We observed that state-level incidence of cutaneous melanoma rates did not relate with average, maximum, or cumulative exposures of UVA, UVB, UVery, or UV-VitD for the past 30 years. The findings of our study are consistent with those of previous studies in the literature. We subsequently used the UV-weighted cutaneous melanoma incidence rate to identify the spatial and temporal trends of the relationships between UV and melanoma of the skin. The best correlation was observed for maximum UVA exposures. Through this analysis, we observed consistent associations of cutaneous melanoma incidence rates with exposures of UVA 13–28 years prior to the detection of the incidence. Our study was able to identify an excess of cutaneous melanoma incidence in northeast U.S. and a deficit in southern U.S. Future studies may include the analysis with finer resolution of cutaneous melanoma incidence rates (e.g., specific level, age groups), annual UVA exposures over longer periods (going back 50 years), and in smaller regions (e.g., county level) with less mobile populations (e.g., rural communities).

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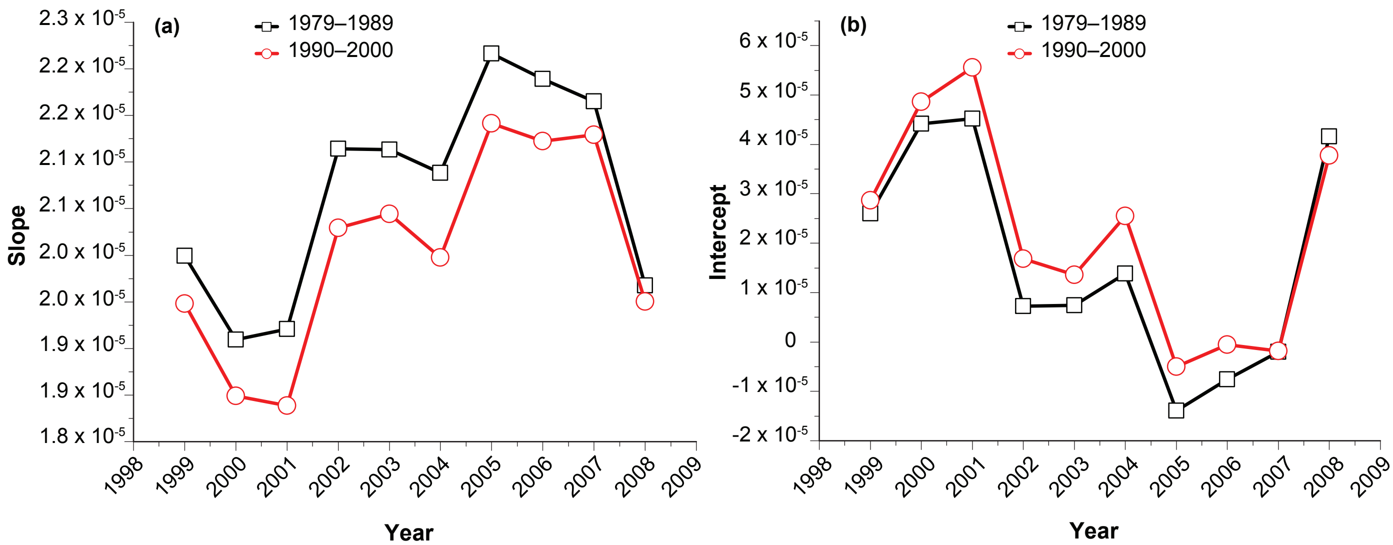
FIGURE **5**

Slope and Intercept of Maximum UVA-Weighted Cutaneous Melanoma vs. Cutaneous Melanoma Incidence Rates for 1999–2008 for the Two Exposure Periods



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Evaluation of Ultraviolet Germicidal Irradiation in Reducing the Airborne Cultural Bacteria Concentrations in an Elementary School in the Midwestern United States

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Abstract **This article describes a case study the authors conducted in an elementary school in the Midwest. The objective was to evaluate the performance of ultraviolet germicidal irradiation (UGVI) to reduce the bioaerosol concentration in a classroom. Two fourth grade classrooms with the same dimensions were studied. One classroom was designated as the UVGI group and the other as the control group. Two-stage Tisch culturable impactors were utilized for collecting airborne bacteria with monthly samples collected from October 2012 to January 2013. Nonparametric methods were applied and *p*-values smaller than .05 were deemed significant. The concentrations of airborne cultural bacteria with a smaller size (1–8 µm) and the total bacterial concentrations from the UVGI classroom were significantly lower than those of the control room in three of four sampling months. These results could provide the preliminary results necessary to determine the effectiveness of upper-room UVGI in reducing the concentration of airborne cultural bacteria in classrooms and other buildings.**

Introduction

Associations between adverse health effects and airborne biological particles have been reported, including allergic sensitization to air microbes and nonspecific responses to biological indoor air pollution (Bornehag, Sundell, & Sigsgaard, 2004; Douwes, Thorne, Pearce, & Heederik, 2003; Lacey & Crook, 1988). Fungi and bacteria have been implicated in building-related illnesses (Menzies & Bourbeau, 1997). Combined with other building characteristics such as excessive dampness, microbiological contaminants could reduce the attendance of students significantly (Mendell & Heath, 2005).

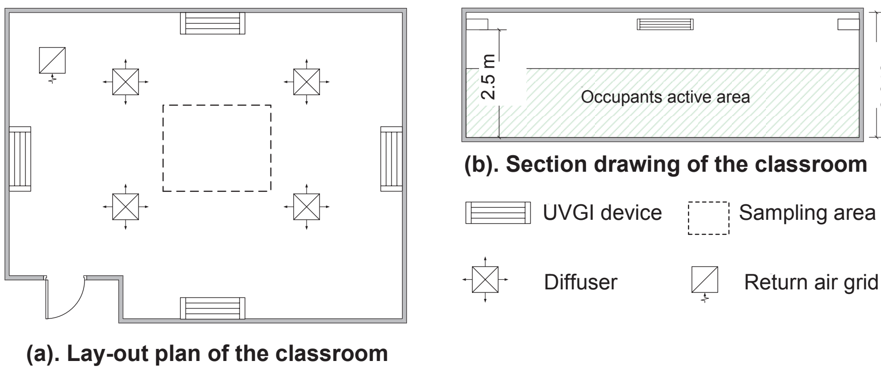
It has been shown that ultraviolet germicidal irradiation (UVGI) does disinfect specific bioaerosols in laboratory experimentation (Green & Scarpino, 2002; Ko, First, & Burge, 2002; Kujundzic, Matalkah, Howard, Hernandez, & Miller, 2006; Kujundzic, Hernandez, & Miller, 2007; Miller & MacHer, 2000; Ryan, McCabe, Clements, Hernandez, & Miller, 2010; Xu et al., 2003; Xu et al., 2005). UV light has also been installed in the upper part of rooms to reduce the concentration of bioaerosols. Sufficient laboratory-based research studies have been conducted to demonstrate UVGI can remove or inactivate bioaerosols. The effectiveness of upper-room UVGI systems is affected by room airflow patterns, air mixing, and other factors (Xu et al., 2005). In Xu and co-authors' study, *E. coli* was aerosolized into a chamber with upper-room UVGI units installed at the corners to simulate bioaerosols in real buildings. These studies demonstrated that the upper-room UVGI could reduce the concentrations of bioaerosols in chambers (Xu et al., 2005).

Several on-site evaluations of UVGI have been conducted over the past few decades. One of the earliest on-site studies showed that the UVGI device was effective in controlling an epidemic of measles when UVGI was applied in a hospital office and the airborne bacteria were found significantly reduced to below 100 CFU/m^3 (Riley & O'Grady, 1961). In previous field studies of UVGI, Menzies and co-authors (2003) found that UVGI could lead to a 99% reduction of cooling coil surface microbial contamination. No significant decrease of the airborne microbial concentrations occurred, however, even though they found significantly fewer respiratory and mucosal symptoms when using UVGI. In another study, the on-site performance of upper-room UVGI to reduce the infection rates of tuberculosis (TB) was evaluated within groups of guinea pigs. The TB infection rate of the UVGI group was reduced to 9.5% from 35% in the control group (Escombe et al., 2009).

Most evaluations on the reduction of airborne culturable bacteria by upper-room UVGI have been carried out in chambers and a lack of field measurement studies

FIGURE 1

Layout Plan and Upper-Room Ultraviolet Germicidal Irradiation (UVGI) Locations of Tested Classrooms



exists. Therefore, our study was developed to begin filling this knowledge gap. Our study was conducted with the hypothesis that we would observe a lower concentration of bioaerosols in classrooms with upper-room UVGI units compared to those without UVGI. Other factors exist that could significantly influence the bioaerosol concentrations as well, including the number of occupants, sampling time, number of samples, and sampling methods. The ideal situation would be to sample while rooms were occupied; however, the sampling pumps generated noise loud enough to distract children and teachers. The alternative method applied in our study was used to collect samples right after the children left the classrooms.

Methods

Location

An elementary school within an hour's drive to the laboratory was selected as the sampling location. Two classrooms used for reading and mathematics classes were sampled for culturable airborne bacteria over a four-month period. The floor area of both the UVGI and control classrooms was approximately 85 m^2 (915 ft^2) with between 25 and 30 students in each classroom. Each classroom had a separate ventilation system without recirculation from other rooms. Students in each room shared the same class schedules and had similar activity levels.

Ventilation and Environment Parameters

Each classroom had four supply air inlets, one exhaust air outlet, and a separated heat pump system (Figure 1). Both rooms were kept pressurized during the day, which could have excluded infiltrations and cross contamination between classrooms and corridors. The air flow rate of both inlets and outlets were tested by an air flow hood. Temperature and relative humidity (RH) were measured with a temperature/humidity data logger.

UVGI Parameters

Upper-room UVGI units were installed in selected classrooms. In each room, four UVGI units each with a 36-watt UV lamp were installed above 2.4 m (7.87 feet) in height (Figure 1) to keep the UV irradiance in the lower area below the safety requirement for occupants < 0.2 μw/m^2 (Kowalski, 2009). A radiometer was used to measure the UV irradiance of upper-room UVGI units.

Sampling Procedures for Airborne Culturable Bacteria

The classrooms were visited monthly for the measurement. Samples were collected within 10 minutes of the students exiting the room, three times per day, as shown in Table 1. Samples were collected from the same areas in each room on different occasions. As teachers rearranged the furniture every couples of weeks, it was impossible to collect samples from exactly the same spots but all samples were collected within a small area, which was also the activity area of students (Figure 1). Three two-stage culturable impactor samplers were operated simultaneously in each classroom. The samples from UVGI and non-UVGI classrooms were collected simultaneously. Two sampling periods, 10 minutes and 5 minutes, were taken. Since organism recovery might have been low, 10-minute samples were used to collect the maximum amount of bioaerosols with 5-minute samples as an alternative if the 10-minutes samples were overgrown. Triplicates were collected in both time periods.

Two-stage Tisch culturable impactor samplers (Anderson Samplers, Inc., 1976) were used to collect the samples of airborne cultural bacteria. The samplers included two stages, which represented the fine (1–8 μm) and coarse size (>8 μm) distributions of the microorganisms. The airborne cultural bacteria of coarse size captured by the first stage of the sampler represented the particles unlikely to reach human lungs. The fine size captured by the second stage of the sampler represented the bioaerosols that could reach human lungs. Before each round of sampling, the impactor samplers were disinfected with 70% isopropyl alcohol (U.S. Environmental Protection Agency [U.S. EPA], 2000). Vacuum pumps were calibrated before and after sampling to 28.3 l/min. (1 cfm) with a calibrator (U.S. EPA, 2003). Trypticase soy agar (TSA) was used to collect airborne cultural bacteria. All agar plates were poured with 27 mL of agar per manufacturer instructions within one week prior to the sampling day.

Sample Handling and Analysis

Samples were transported in a cooler with ice packs to the laboratory for incubation within an hour of the completion of the day's sampling. Bacteria plates were incubated at 37°C and counted at 24 and 48 hours. The possibility existed that multiple viable particles had penetrated the same sampling hole and formed one single colony. The observed numbers of colonies were adjusted using the positive-hole correction table (Macher, 1989). The CFU/m^3 were calculated for each plate and used to calculate the culturable CFU/m^3 of bacteria for coarse (>8 μm) and fine (1–8 μm) particle size. The total bacteria combining the coarse and fine bacteria together were also analyzed. Quality control was maintained

TABLE **1**

Sampling Schedules in Two Procedures

Class Schedules	Procedure
Class 8:20–9:35	–
Morning break	Indoor samples
Class 10:15–11:45	–
Lunch break	Indoor samples
Class 12:25–2:55	–
After school	Indoor samples

Note: The breaks lasted 40 minutes and the samples were collected within 10 minutes after students leaving classrooms.

TABLE **2**

Descriptive Statistics of Culturable Bacterial Bioaerosols in CFU/m³ Air

Month	*n*	Mean	*SD*	Median	Range	95% *CI* [a]
October						
UVGI [a]	3	152	102	122	378 (58–436)	96–208
non-UVGI	3	358	217	321	707 (55–762)	238–479
November						
UVGI	3	118	68	107	261 (43–304)	102–204
non-UVGI	3	357	237	321	790 (59–849)	226–488
December						
UVGI	3	72	45	59	150 (14–164)	48–97
non-UVGI	3	178	156	109	512 (22–534)	92–264
January						
UVGI	3	62	58	33	121 (11–132)	29–94
non-UVGI	3	71	43	65	175 (7–182)	47–95

Note: The density of microbes in air is always given in units of CFU/m³ (although some older texts use CFU/ft³).
[a] *CI* = confidence interval; UVGI = ultraviolet germicidal irradiation.

with unexposed plates of TSA taken to the sampling site during collection and processed along with the samples collected.

The samples in the same test day but from different times were first compared with each other to evaluate the appropriateness of excluding time effect. Considering that the numbers of samples for each group were limited and three groups were dependent on each other, the Friedman test was applied. A Wilcoxon ranked sum test (nonparametric, dependent test) was utilized to compare the airborne cultural bacteria concentrations from UVGI and control classrooms. SPSS version 19 was used to achieve the statistical analysis.

Results

A total of 24 airborne culturable bacterial samples were collected in four months, 12 for the UVGI classroom and 12 for the control room. Table 2 presents the descriptive statistics of the total recovered airborne culturable bacterial. The highest concentrations of culturable bacterial bioaerosols in the UVGI classroom appeared in October with a mean value of 152 CFU/m³. For the non-UVGI classroom, the month of highest concentration was November with a mean value of 357 CFU/m³. The concentrations of coarse bacteria were lower than fine bacteria throughout the total sampling visits (Table 3). Samples from the same test day but different times were first compared by the Friedman test as shown in Table 3. No statistically significant difference occurred among samples collected from morning, noon, and afternoon, since all the *p*-values were greater than .05. This could indicate that no difference occurred or that we did not have enough power to detect the difference.

With Wilcoxon rank sum tests, the fine and total bacterial concentrations observed in the UVGI classroom were significantly lower than those for the control classroom ($p < .05$, Table 4). The same trend existed from October to December. Figure 2 presents the differences between UVGI and non-UVGI classrooms. For coarse bacteria, no significant statistical differences occurred between UVGI and control classrooms.

The area-weighted averages of the UV irradiance at two UVGI classrooms were 50.2 μW/cm² and 43.6 μW/cm². The values of UV irradiance are comparable to the results of other research of upper-room area UVGI and the installation fulfill the recommendation of 30W for each 19 m² (First, Nardell, Chaisson, & Riley, 1999). The average indoor temperature and RH for UVGI and non-UVGI classrooms were within the same range. The indoor temperatures were controlled within a narrow range of 22.3°C–22.7°C through the entire test period as shown in Figure 3. The range of RH was 24.1% to 34.6%. Based on the results of ventilation measurement, the supply air rates and return air rates were stable throughout the sampling. The supply air and return air rates for the UVGI classroom were 0.47 m³/s and 0.38 m³/s, respectively. For the control room, the supply air and return air rates were 0.45 m³/s and 0.38 m³/s, respectively. The measurement error of the flow hood was ±0.017 m³/s.

Discussion

By applying the culturable impactor sampling method in this case study, we demonstrated that using upper-room UVGI as the intervention to reduce the concentrations of airborne cultural bacteria was potentially an effective control measure. In our study, the concentration of airborne cultural bacteria in the school was comparable to other previous studies (achieved with similar methods) and a range of total concentration of bacteria from 24 CFU/m³ to 1,447 CFU/m³ was monitored in two elementary schools (Liu et al., 2000). In similar environments the total concentration of bacteria varied from 200 CFU/m³ to 500 CFU/m³ (Kalogerakis et al., 2005). The sampling methods applied in these studies were similar to those used in our study.

During the tested months, RH ranged from 24.1% to 34.6%. Studies have found that the UV efficiency was adversely affected by RH when higher than 50% (Xu et al., 2005). Ventilation conditions could influence the UV efficiency (Riley, Permutt, & Kaufman, 1971). In our study, the ventilation rates stayed consistent throughout. Similar ranges

TABLE **3**

Comparison of *p*-Values to Evaluate Time Effect for Samples Within Each Sampling Day

Comparison		Morning	Noon	Afternoon	*p*-Value
October					
Coarse	UVGI[a]	30±13	12±4	15±10	.086
	non-UVGI	21±17	7±0	12±9	.273
Fine	UVGI	87±30	222±185	131±89	.717
	non-UVGI	290±116	665±88	237±190	.097
Total	UVGI	117±37	234±181	146±94	.717
	non-UVGI	311±120	672±87	249±198	.097
November					
Coarse	UVGI	25±14	7±7	11±7	.060
	non-UVGI	9±7	24±29	31±23	.150
Fine	UVGI	73±40	152±12	106±89	.368
	non-UVGI	227±179	498±57	364±282	.368
Total	UVGI	98±53	160±9	117±94	.717
	non-UVGI	236±181	522±73	395±295	.368
December					
Coarse	UVGI	2±3	9±8	14±9	.135
	non-UVGI	9±10	21±7	26±18	.223
Fine	UVGI	37±19	88±9	79±53	.050
	non-UVGI	65±35	399±101	135±103	.097
Total	UVGI	40±19	98±11	92±55	.050
	non-UVGI	73±39	420±107	161±114	.097
January					
Coarse	UVGI	5±3	10±4	11±10	.060
	non-UVGI	10±12	12±8	8±5	.761
Fine	UVGI	15±7	61±31	87±66	.060
	non-UVGI	35±25	92±30	71±48	.097
Total	UVGI	20±8	71±29	99±73	.097
	non-UVGI	45±32	104±24	80±49	.097

[a]UVGI = ultraviolet germicidal irradiation.

TABLE **4**

Comparison of *p*-Values Between UVGI[a] and Control Classrooms

UVGI vs. non-UVGI	Coarse Bacteria	Fine Bacteria	Total Bacteria
October	.140	.003	.005
November	.363	.001	.001
December	.019	.003	.002
January	.916	.427	.460

[a]UVGI = ultraviolet germicidal irradiation.

of environmental factors like RH, temperature, and ventilation rates in UVGI and non-UVGI classrooms suggest that their influences should be consistent between classrooms.

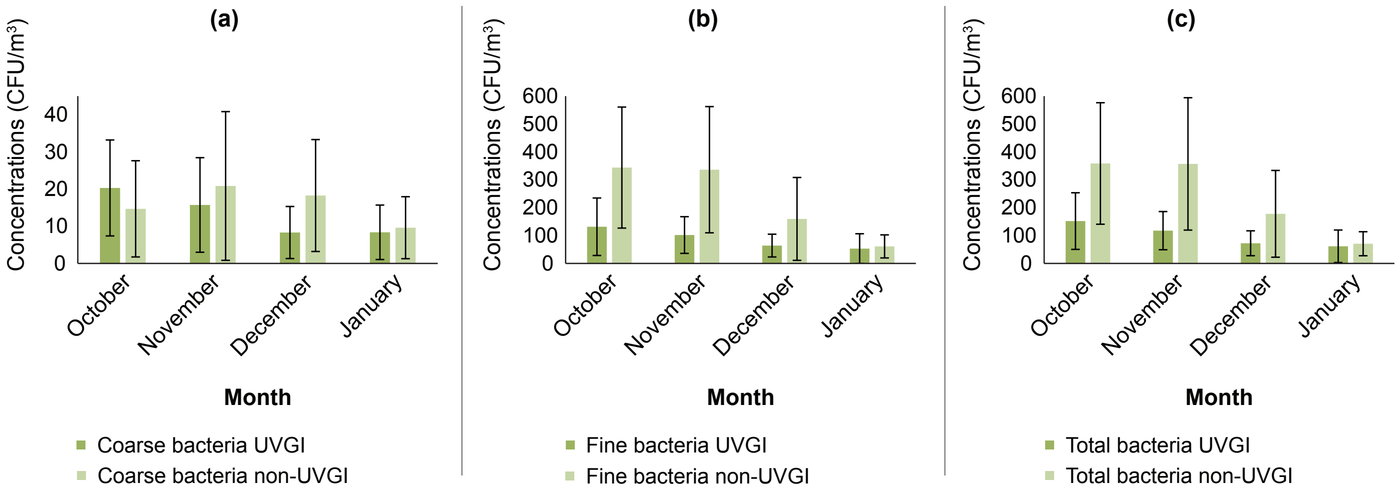
The concentrations of airborne cultural bacterial were much lower when compared with other studies in chambers with artificially released bioaerosols. The concentrations of microorganisms released in chamber tests have ranged from 1.01 x 10^3 to 2.57 x 10^8 (Xu et al., 2003) or were not reported (Ko et al., 2002; Kujundzic et al., 2006; Ryan et al., 2010). Efficiencies of UV were directly shown in all four previous studies (Kujundzic et al., 2006; Ryan et al., 2010). In Menzies and co-authors' study, it was concluded that the amounts of the airborne fungi and endotoxins were too low to indicate a significant difference between conditions when UV was on or off (Menzies et al., 2003).

Under the observed concentrations in our study, the reduction on the airborne cultural bacteria concentration caused by the UVGI may not be reflected when the indoor concentration is too low. When the concentrations of airborne cultural bacteria in the control classroom were above 100 CFU/m^3, statistically significant differences occurred in the concentrations of airborne cultural bacteria between the UVGI classroom and control classroom. The concentrations of airborne cultural bacteria in October and November were higher than those of December and January. One of the possible reasons was the changing of outside environmental parameters, which created a seasonal effect. The change of activity levels and number of students may also have led to this trend in both UVGI and non-UVGI classrooms. The low RH during January could be another reason for the lower level of airborne bacteria, which could reduce the number of microorganisms that could be cultured. With lower concentration of airborne cultural bacteria, the effect of the UVGI device might be harder to detect.

Our study had limitations. Airborne culturable bacteria are known to be a fraction of all airborne bacteria, so the results may not provide a complete picture for all the airborne bacteria in classrooms. The existence of viable but nonculturable bacteria was not explored, but should be considered in future studies (Kell, Kaprelyants, Weichart, Harwood, & Barer, 1998; Oliver, 2005). The sample size in our study was limited and all

FIGURE **2**

Concentrations of Coarse (a), Fine (b), and Total (c) Bacteria in Ultraviolet Germicidal Irradiation (UVGI) Classrooms and non-UVGI Classrooms



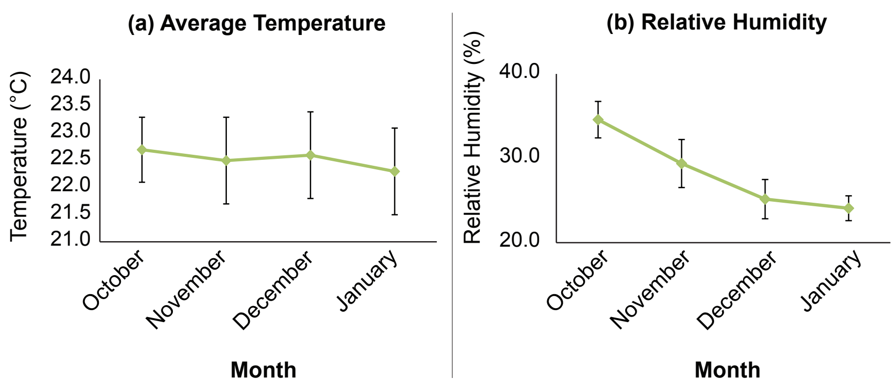
samples were collected from a single school. The samples were collected near the occupied time but still not within the occupied time, which could have altered the concentrations. Alternative methods such as real-time bioaerosol monitors will be applied to obtain data from actual occupied time in the next phase of the research.

Conclusion

The objective of our study was to evaluate the performance of UVGI to reduce the bioaerosol concentration in a classroom environment. Significant statistical differences were found between UVGI and non-UVGI classrooms for fine and total airborne cultural bacteria in three out of four months. These results could provide preliminary support that upper-room UVGI has an impact on reducing the culturable airborne concentrations of bacteria in school buildings. Future studies will be needed to provide a more general conclusion on upper-room UVGI in real buildings.

FIGURE **3**

Average Temperature (a) and Relative Humidity (b) of Classrooms During Test Periods



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Fate and Transport of Enteric Microbes From Septic Systems in a Coastal Watershed

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Abstract **Onsite wastewater treatment systems (OWTS) are commonly used in coastal areas to treat household wastewater. These systems represent potential sources of fecal pollution of groundwater and nearby surface water. OWTS are expected to reduce microbial concentrations in wastewater; however, system and environmental factors can affect treatment efficiency and impacts on ground and surface water. In the study of OWTS described in this article, the authors sampled septic tanks and groundwater at two households in coastal North Carolina between October 2009 and October 2011. Samples were tested for the fecal indicator microbes *E. coli*, enterococci, and *Clostridium perfringens*. Microbial source tracking was also performed in year two. Results showed that enteric microbe concentrations in groundwater significantly decreased with distance from the OWTS. Human markers of fecal contamination were also detected in the OWTS and downgradient groundwater, indicating that OWTS can impact the microbial quality of shallow groundwater.**

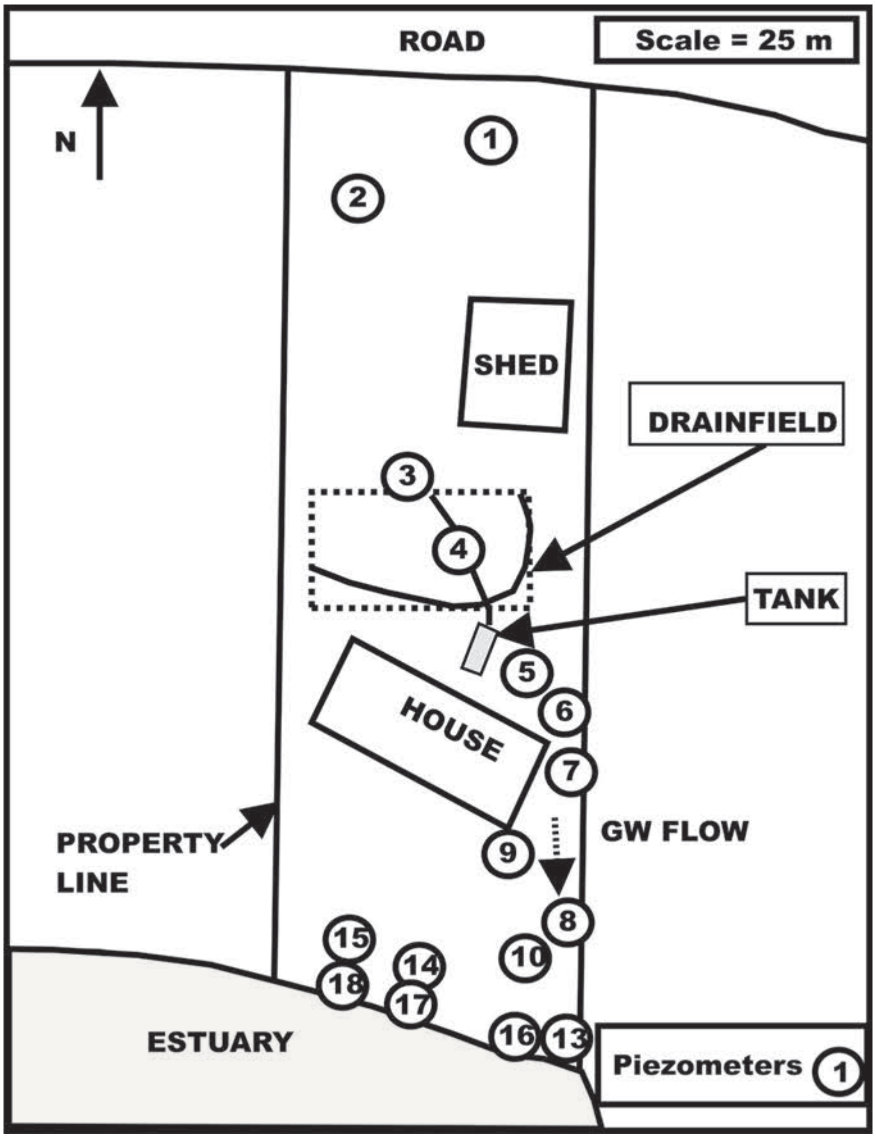
Introduction

During the 2007–2010 surveillance periods, the U.S. National Waterborne Disease and Outbreak Surveillance System reported that more than half of drinking water–associated disease outbreaks were associated with untreated or inadequately treated groundwater, indicating that contamination of groundwater remains a public health problem (Hilborn et al., 2013). Fecal contamination from humans and animals is one of the primary factors contributing to microbial pollution of both groundwater intended for drinking (Geary & Whitehead, 2001; Hagedorn, Mc Coy, & Rahe, 1981; Scandura & Sobsey, 1997; Whitehead & Geary, 2000; Yates, 1985) and coastal surface waters (Bechdol, Gold, & Gorres, 1981; Carroll, Hargreaves, & Goonetilleke, 2005; Lipp, Farrah, & Rose, 2001; Rose, Griffin, & Nicosia, 1999). Microbial contamination of groundwater continues to be a public health concern as nearly 2.7 million North Carolinians rely on private groundwater wells for drinking water (North Carolina Groundwater Association, n.d.), and approximately 60% of residences use onsite wastewater treatment systems (OSTW) in coastal North Carolina (North Carolina National Estuarine Research Reserve, 2004). After analyzing data from 2011 made available by the U.S. Environmental Protection Agency (U.S. EPA, 2012), the National Resources Defense Council reported the third highest number of beach closing and advisory days in the U.S. in 22 years. Sixty-nine percent of these beach closings/advisories were due to increased bacteria levels exceeding beach water quality standards, indicating the presence of human or animal feces in the water (Dorfman & Rosselot, 2012). From 2010 to May 2013, over 230 proclamations of polluted waters were released (not including individual closures), resulting in temporary closures of shellfish waters in North Carolina (North Carolina Department of Environmental and Natural Resources, 2012).

OWTS discharge septic effluent into the subsurface and are frequently reported as a source of groundwater contamination, resulting in environmental and public health risks (Carroll et al., 2005; Hagedorn et al., 1981; Yates, 1985; Yates & Yates, 1989). Along with

FIGURE 1

Schematic of Site 1 Sampling Points



GW = groundwater.

high densities of OWTS, groundwater contamination can occur as a result of improper construction and maintenance of septic systems, leading to their malfunction (Ahmed, Neller, & Katouli, 2005; Geary & Gardner, 1998; Geary & Whitehead, 2001; Lipp et al., 2001; Whitehead & Geary, 2000; Yates, 1985). An average of nearly 1,500 septic systems in coastal North Carolina hydraulically malfunction each year (Humphrey, 2010), creating significant impacts on groundwater and adjacent surface waters (Ahmed et al., 2005).

This two-year study was conducted to evaluate the impact of two household septic systems on shallow groundwater and adjacent surface water quality in coastal North Carolina.

Microbial indicators of fecal contamination were studied to help improve understanding of the nature and extent of potential impacts of OWTS discharge to aquifer systems and nearby surface waters. Previous researchers have recommended using a suite of indicator microbes for better assessments of water quality, including *E. coli*, enterococci, and *Clostridium perfringens* (Griffin, Lipp, McLaughlin, & Rose, 2001). Molecular microbial source tracking for human- and animal-specific markers was also evaluated to provide additional evidence indicating whether OWTS are a source of groundwater contamination. Microbial source tracking using *Bacteroides* gene targets and mitochondrial DNA has been reported to identify human (Haugland et al., 2010; Shanks, Kelty, Sivaganesan, Varma, & Haugland, 2009) and animal (Caldwell & Levine, 2009; Schill & Mathes, 2008) waste sources in surface water, but application of such microbial source tracking tools to groundwater investigations has been less frequently reported. Microbial source tracking detections can be assessed in combination with fecal indicator data to evaluate whether septic systems are associated with groundwater contamination.

Methods

Site Selection and Study Design

In August 2009, seven sites in coastal North Carolina were evaluated for inclusion in this two-year study by methods previously described (Deal et al., 2007). These sites included residential homes served by OWTS, two of which met inclusion criteria (depth to groundwater and distance to surface water were in accordance with current state regulations). Year one sampling at sites 1 and 2 occurred between October 2009 and May 2010. Year two sampling was conducted from January 2011 to October 2011 at site 1 only, with the exception that the septic tank at site 2 was also sampled in year two. Site 2 groundwater was monitored during year one only due to funding constraints. Site 1 housed a single compartment septic tank, while the septic tank at site 2 contained a baffle wall dividing the tank into two compartments. Pipes were installed midway down into each tank to facilitate connection to a peristaltic pump for sample collection; septic tank lids at site 1 were modified to connect two pipes in the single compartment (one near the inlet side and one near the outlet side), while one pipe was installed in each compartment at site 2.

Piezometer development and preliminary groundwater testing was done by methods previously described (Humphrey et al., 2013). An OhmMapper TR1 electrical resistivity map-per was used to estimate the orientation of the septic plumes, while direction of groundwater flow was estimated based on the hydraulic gradient as determined from a three-point problem solution at each site (Humphrey, Deal, O'Driscoll, & Lindbo, 2010). Piezometers were installed upgradient and downgradient of OWTS flow paths for groundwater sample collection and monitoring. Piezometers were driven into boreholes at depths ranging from 1.3 to 3.7 m for collection of groundwater samples. Nineteen piezometers were installed at site 1, and 14 piezometers were installed at site 2. Most piezometers were installed adjacent to and downgradient of drainfields, and several were installed upgradient from the OWTS to assess background groundwater conditions. After installation, piezometers were purged to remove sediment and were also purged prior to each sampling event.

Sample Collection

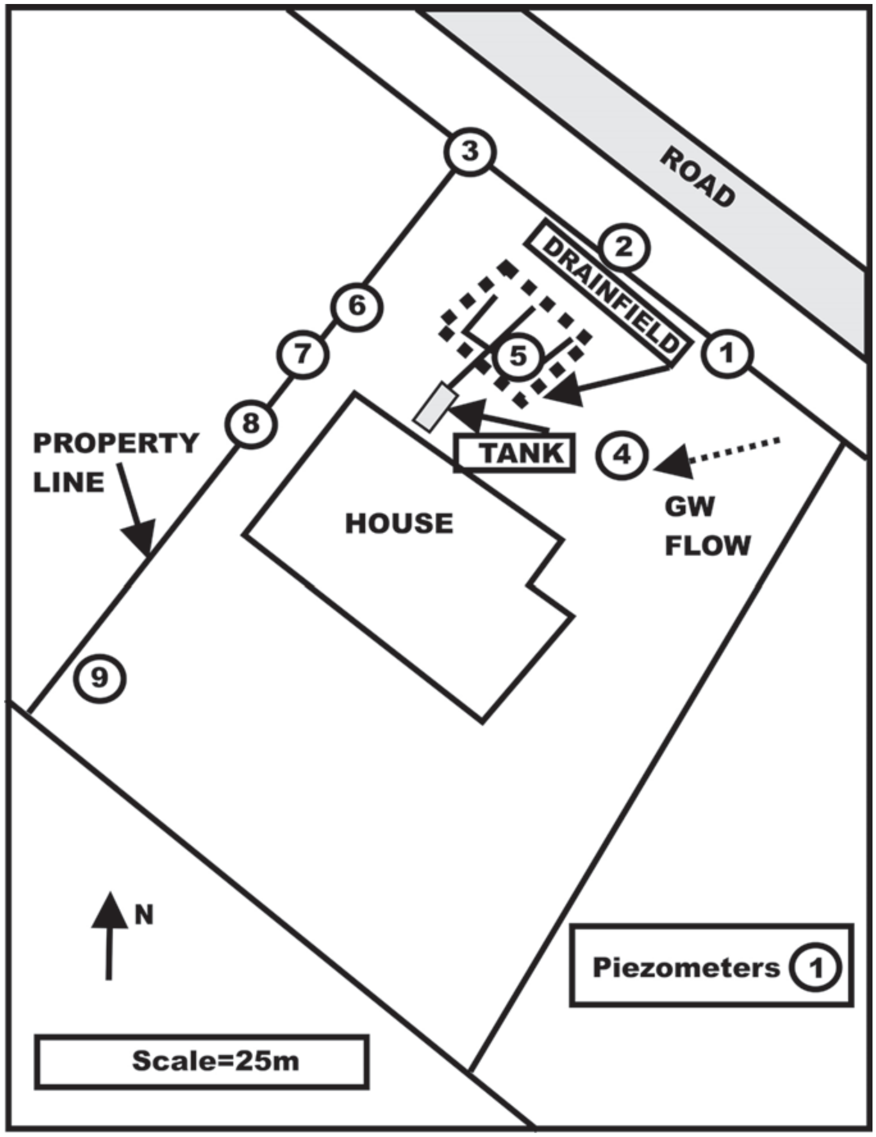
During year one, monthly samples were collected from septic tanks while piezometers and estuary surface water samples were collected bimonthly (November 2009, January 2010, March 2010, and May 2010). Year two included bimonthly (February, April, June, August, and October 2011) sampling of piezometers at site 1, along with septic tank samples at both sites (Figures 1 and 2). Septic tank samples were collected in sterile 500-mL bottles at the outlet location followed by the inlet location. Ground and surface water samples were collected in sterile 1-L bottles. All samples were shipped on ice to the Centers for Disease Control and Prevention in Atlanta for analysis within 24 hours.

Sample Analyses

All samples were processed by membrane filtration for quantification of bacterial indicators using 0.45-µm mixed-cellulose ester filters (Millipore) and subsequent culture on agar plates. Indicator microbes were cultured using the following methods: *E. coli* by membrane filtration and mTEC agar according to Method 1603 (U.S. EPA, 2009); enterococci by membrane filtration and mEI agar using Method 1600 (U.S. EPA, 2002); and *C. perfringens* by membrane filtration and mCP agar according to U.S. Geological Survey (USGS) Ohio Water Science Center method (USGS, 2007). During year 2, *E. coli* was enumerated in septic tank samples using Standard Method 9223B for Colilert (American Public Health Association, American Water Works Association, & Water Environment Federation, 2005).

FIGURE **2**

Schematic of Site 2 Sampling Points



GW = groundwater.

Microbial Source Tracking

DNA Extraction

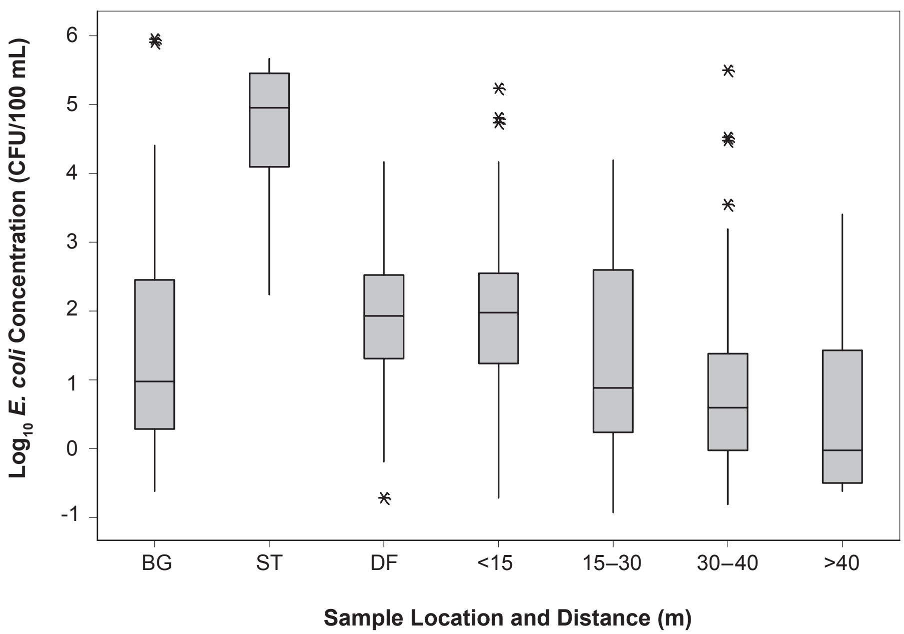
During year 2, DNA was extracted from septic tank, ground, and surface water samples at site 1 only. Samples were filtered onto 0.45-µm pore-sized cellulose nitrate membrane filters and DNA extraction was performed using a soil DNA isolation kit. DNA extraction was modified by placing membrane filters, instead of a soil sample, into the provided bead solution tubes. The homogenization step was also modified using a mini-beadbeater for three minutes.

Real-Time Polymerase Chain Reaction (PCR)

Five molecular targets were assayed using real-time PCR including human waste biomarkers (*Bacteroides* 16S rRNA [*Bacteroides* HF183] [Bernhard & Field, 2000; Haugland et al., 2010] and *Bacteroides* hypothetical human-specific protein [*Bacteroides* HumM2] [Shanks et

FIGURE 3

Log$_{10}$ *E. coli* Concentrations for Sites 1 and 2



*Represents outlier values. BG = background groundwater; ST = septic tank; DF = drainfield groundwater; <15 m = groundwater samples <15 m from DF; 15–30 m = groundwater samples 15–30 m from DF; 30–40 m = groundwater samples 30–40 m from DF; >40 m = groundwater samples >40 m from DF.

al., 2009]) and animal waste biomarkers (mitochondrial cytochrome *b* of dog and deer hosts [Schill & Mathes, 2008] and the mitochondrial NADH dehydrogenase subunits 5 and 2 of cat and avian hosts [Caldwell & Levine, 2009]).

Statistical Analyses

Mann-Whitney tests for *E. coli*, enterococci, and *C. perfringens* were performed using Minitab 16 statistical software to determine if significant differences existed between septic tank and drainfield groundwater concentrations. Septic tank and pooled data for drainfield groundwater concentrations at sites 1 and 2 were compared to pooled data for background groundwater at both sites to help assess the impacts of OWTS on shallow groundwater.

Results

Source Characterization of Septic Tank Wastewater

E. coli

E. coli concentrations for septic tank wastewater at site 1 ranged from 2.4 x 10^3 to 9.8 x 10^4 CFU/100 mL (geometric mean 2.3 x 10^4 CFU/100 mL). Since the two samples collected from the septic tank at site 1 were from a nondivided compartment, geometric means reflect concentrations within the whole septic tank; no appreciable differences existed between first and second compartment data. Between the last two sampling rounds, site 1 was flooded during Hurricane Irene, which resulted in the family having to leave their home. Samples from October 2011 following the hurricane resulted in lower-than-normal levels of all indicators, with *E. coli* levels at 258 CFU/100 mL. *E. coli* concentrations in domestic wastewater typically range from 10^4 to 10^6 CFU/100 mL (Humphrey, 2010; Lowe et al., 2009). Site 2 had higher fecal indicator concentrations overall than site 1 during the two-year study, with first compartment levels ranging from 2.1 x 10^4 to 6.8 x 10^5 CFU/100 mL (geometric mean 2.0 x 10^5 CFU/100 mL), and second compartment levels ranging from 1.4 x 10^4 to 6.1 x 10^5 CFU/100 mL (geometric mean 1.9 x 10^5 CFU/100 mL).

Enterococci

As observed for *E. coli*, enterococci concentrations in the septic tank at site 2 were higher than concentrations at site 1. The geometric mean at site 1 was 2.4 x 10^4 CFU/100 mL, ranging from 1.7 x 10^3 to 3.7 x 10^5 CFU/100 mL. The final sampling round (in which the residents were not living in the house) resulted in a lower-than-normal concentration of 490 CFU/100 mL. Enterococci concentrations in domestic wastewater are typically slightly lower than *E. coli*, ranging from 10^4 to 10^5 CFU/100 mL (Humphrey, 2010; Lowe et al., 2009). Site 2 first compartment levels ranged from 9.1 x 10^3 to 3.1 x 10^6 CFU/100 mL (geometric mean 5.7 x 10^4 CFU/100 mL). The geometric mean concentration in the second compartment was 7.5 x 10^4 CFU/100 mL, ranging from 1.1 x 10^4 to 3.1 x 10^6 CFU/100 mL.

C. perfringens

C. perfringens at site 1 was inconsistently detected, with only 15 detections out of 26 samples collected and concentrations ranging from 30 to 700 CFU/100 mL (geometric mean 197 CFU/100 mL). More consistent detections and higher concentrations of *C. perfringens* were found at site 2, ranging from 65 to 3.1 x 10^4 CFU/100 mL (geometric mean 924 CFU/100 mL) for first compartment samples and 100 to 4.2 x 10^4 CFU/100 mL (geometric mean 829 CFU/100 mL) in the second compartment.

Microbial Source Tracking

All wastewater samples collected from the site 1 septic tank were positive for both *Bacteroides* human-specific genetic markers, with average crossing threshold values of 24.1 and 31.0 for HF183 and HumM2 markers, respectively. Animal-specific genetic markers were not detected.

Microbial Characterization of Shallow Groundwater

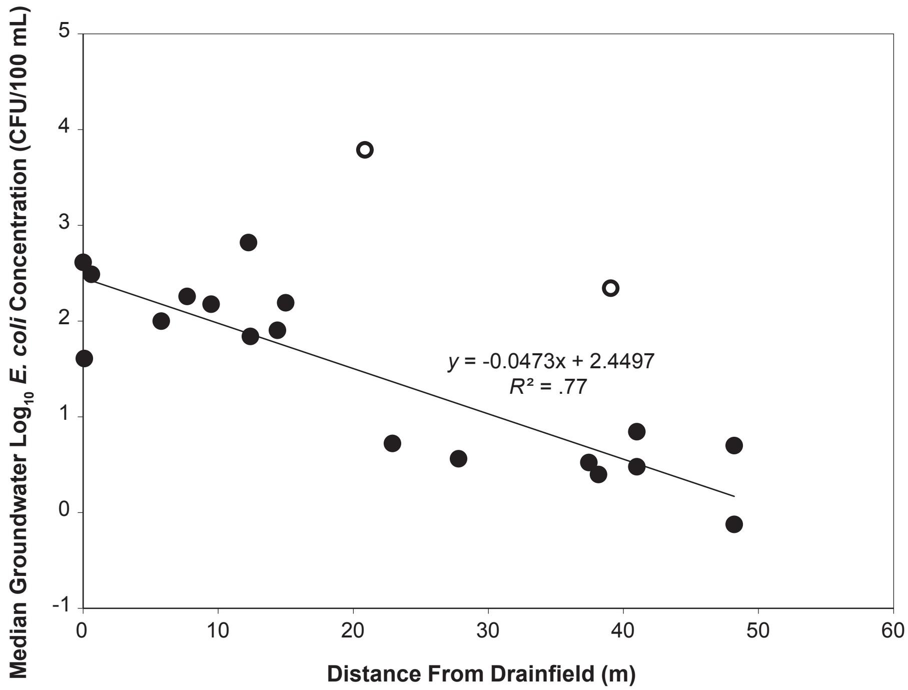
E. coli

E. coli concentrations in groundwater generally decreased with increasing distance downgradient from the septic tanks and drainfields at sites 1 and 2 (Figure 3). Median concentrations in groundwater beneath the drainfield (89 CFU/100 mL) were similar to those found within 15 m of the drainfield (median 95

CFU/100 mL). *E. coli* levels in groundwater samples taken 15–30 m away were a median of 7.9 CFU/100 mL, while median *E. coli* concentrations decreased to 4.0 CFU/100 mL in samples taken 30–40 m from the septic tank and 1.0 CFU/100 mL in samples collected >40 m away. Median concentrations in background piezometers (10 CFU/100 mL) were similar to those taken >15 m and beyond. Median *E. coli* concentrations in septic tank samples (4.0 x 10^4 CFU/100 mL) were significantly greater than levels observed in background piezometers ($p < .001$). Drainfield and groundwater piezometers within 15 m also had significantly higher median concentrations of *E. coli* than those observed in background groundwater, with *p*-values of .031 and .012, respectively. Median *E. coli* levels in piezometers 15–30 m downgradient from the drainfield were also appreciably higher than those in the background piezometers, though not significantly ($p = .4867$). Regression analysis revealed a log-linear relationship ($R^2 = .77$) between median *E. coli* concentrations in groundwater and distance from drainfield, with outliers shown by hollow circles (Figure 4). Generally, after 20 m downgradient from the drainfield, median concentrations of *E. coli* in groundwater were below median background water levels.

FIGURE **4**

Log_{10} *E. coli* Concentrations for Site 1 and 2



○ = statistical outliers.

Enterococci

Enterococci concentrations in groundwater samples followed similar trends that were observed with *E. coli* (Figure 5). Drainfield samples contained a median of 224 CFU/100 mL, and groundwater samples collected within 15 m of the drainfield had a slightly lower median density of 195 CFU/100 mL. Piezometer samples collected 15–30 m and 30–40 m had decreasing median concentrations of 47 and 12 CFU/100 mL, respectively. Groundwater samples collected >40 m from the drainfield had a low median concentration of 1.0 CFU/100 mL. Enterococci concentrations in septic tank samples were significantly greater (median 3.6 x 10^4 CFU/100 mL) than median levels of 20 CFU/100 mL observed in background groundwater ($p < .001$).

Drainfield and piezometer samples within 15 m also had significantly higher median concentrations than those observed in background piezometers ($p = .047$ and .018, respectively). Median levels in groundwater downgradient 15–30 m from the drainfield were also appreciably higher than background samples, though not significantly ($p = .1249$). Enterococci concentrations exhibited a similar log-linear relationship as was observed for *E. coli*, with a consistent decrease in concentration with increasing distance from the septic tank ($R^2 = .66$), with the exception of outliers at site 2 that had elevated concentrations (data not shown). Generally, in groundwater 25 m downgradient from the drainfield, median enterococci concentrations fell below median background levels.

C. perfringens

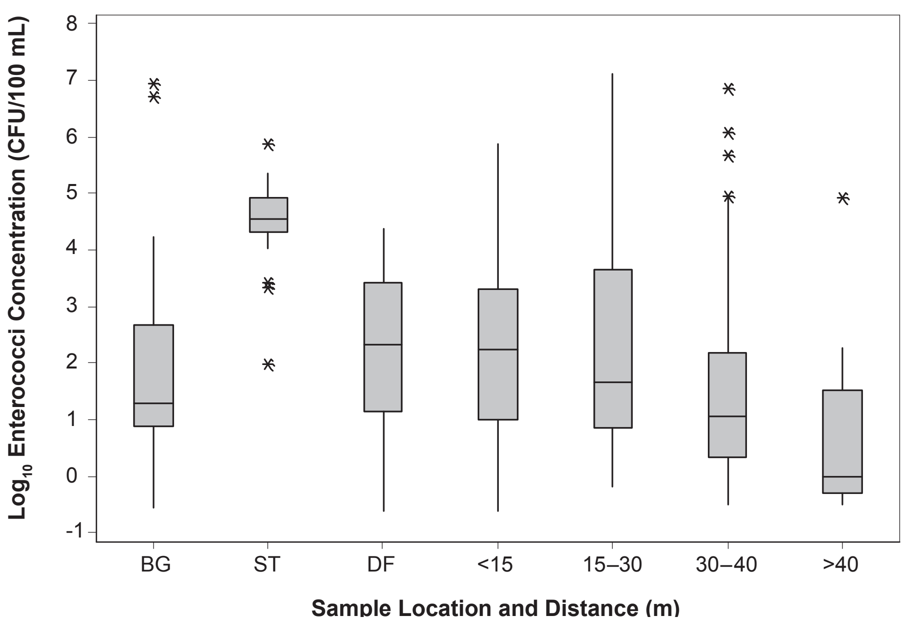
C. perfringens concentrations were relatively elevated in background groundwater samples versus downgradient groundwater samples, compared to differences observed for *E. coli* and enterococci (Figures 3, 5, and 6). Drainfield groundwater samples, as well as those collected <15 m and 15–30 m downgradient from the drainfield, all contained similar median concentrations of 37, 32, and 40 CFU/100 mL, respectively. *C. perfringens* concentrations in piezometers 30–40 m and >40 m from the drainfield (median 16 and 6 CFU/100 mL, respectively) were found to be significantly lower than median background levels (median 100 CFU/100 mL) ($p = .005$ and .001, respectively). Median *C. perfringens* levels in septic tank samples (224 CFU/100 mL) were higher than levels observed in background groundwater, although not significantly ($p = .273$).

Microbial Source Tracking

Human fecal markers were detected in groundwater at multiple piezometers at site 1. Repetitive detections of human fecal markers occurred at piezometer locations 4 and 5 (Figure 1), which were within the drainfield and <15 m from the septic tank, respectively. At piezometer location 4, human fecal markers were detected a total of three times during two sampling events in February and April of 2011. During one of the two sampling events, only the *Bacteroides* HF183 marker was detected, while during the other sampling

FIGURE 5

Log_{10} Enterococci Concentrations for Site 1 and 2



*Represents outlier values. BG = background groundwater; ST = septic tank; DF = drainfield groundwater; <15 m = groundwater samples <15 m from DF; 15–30 m = groundwater samples 15–30 m from DF; 30–40 m = groundwater samples 30–40 m from DF; >40 m = groundwater samples >40 m from DF.

event both *Bacteroides* markers were detected in the same sample. Piezometer location 5 included single detections of both *Bacteroides* markers, each from samples collected during separate sampling events. Seven additional downgradient groundwater samples (locations 8, 9, 10, 13, 14, 15, and 17) and one surface water sample had single detections of the *Bacteroides* HF183 marker. The *Bacteroides* HF183 marker was also detected once in background piezometer at location 1. An animal biomarker (the MitoDog assay) was also detected once in the location 1 piezometer (October 2011), the only animal marker detected in any piezometer during the study.

Discussion

The data from this study indicate that the OWTS at sites 1 and 2 contributed significantly to concentrations of fecal indicators in shallow groundwater. *E. coli* and enterococci concentrations in septic tank wastewater at the two sites were significantly elevated relative to all other sampling points (Figures 3, 4, and 5). Groundwater beneath the drainfields and within 15 m of the OWTS contained the next highest median concentrations, followed by groundwater >15 m from OWTS, background water samples, and the estuary.

OWTS at both sites contributed to elevated concentrations of *E. coli* and enterococci in shallow groundwater, with significant contributions (relative to background) identified in piezometers within 15 m of the septic tanks. When pooling the *E. coli* and enterococci data for sites 1 and 2, similar spatial trends were observed for both indicators. More specifically, the highest concentrations of *E. coli* and enterococci were found in septic tank effluent, followed by groundwater beneath the drainfield, groundwater within 15 m of the OWTS, groundwater >15 m, background groundwater, and finally, samples 30–40 m and beyond. The largest declines in *E. coli* and enterococci were observed between the septic tank and drainfield groundwater at both sites. A decline between the drainfield and groundwater downgradient also occurred but was more subtle. *E. coli* levels fell at or below background concentrations in groundwater 15–30 m from the drainfield, while enterococci levels fell below background levels closer to 30–40 m from the drainfield. *E. coli* concentrations in groundwater were lower at site 1 relative to site 2, possibly because of higher salinity in groundwater due to the influence of the nearby (<45 m) estuary, as indicated by elevated chloride levels (data not shown). Enterococci are generally more persistent in the environment than *E. coli* and are also more tolerant to higher saline conditions. Also, it is possible that groundwater at site 1 >40 m downgradient from the system was most influenced by the estuary and thus diluted *E. coli* and enterococci concentrations to lower than background wells. An aquitard (confining layer) was discovered at site 2 approximately 5 m below the surface. This aquitard may have promoted lateral, rather than vertical, movement of groundwater, thus preventing deeper groundwater contamination.

In the U.S., geometric mean ambient water quality criteria for primary contact with surface water for enterococci and *E. coli* in freshwater are 33 CFU enterococci and 126 CFU *E. coli*/100 mL, respectively (U.S. EPA, 2003). Concentrations of both fecal indicators exceeded these surface water contact standards in groundwater from both the drainfield and piezometers downgradient from the OWTS.

Concentrations of *C. perfringens* in background groundwater were not significantly different among those found in the septic tank, drainfield, and downgradient piezometers. *C. perfringens* was not consistently detected in septic tank samples at either site, and concentrations were highly variable when they were detected. *C. perfringens* is known to be present at lower concentrations in feces and domestic sewage than *E. coli* and enterococci (Vithanage, Fujioka, & Ueunten, 2011). Data from our study indicate that *C. perfringens* concentrations in the surficial aquifer decreased with closer proximity to the estuary, however with no apparent influence by the OWTS. The relatively higher background level of *C. perfringens* was not unexpected because *C. perfringens* is a spore-forming bacterium whose spores can survive in the environment for years (Fujioka & Shizumura, 1985), compared to *E. coli* and enterococci vegetative cells, which die off in the environment relatively rapidly.

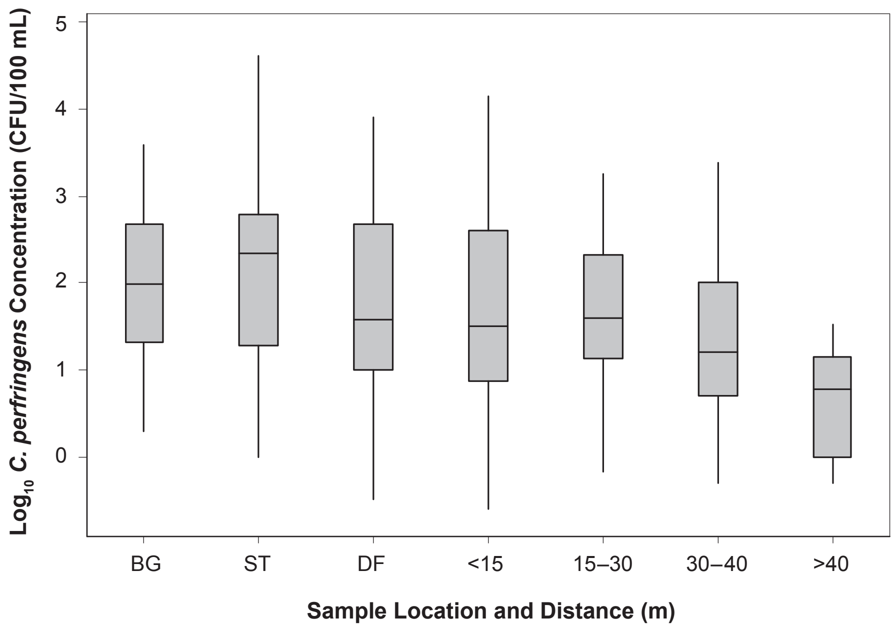
The molecular source tracking results supported the fecal indicator culture data indicating that the site 1 septic system affected the microbial quality of shallow groundwater. Human waste markers were detected in background groundwater once, but were consistently detected in the septic tank and in drainfield groundwater samples three times and twice in a piezometer <15 m from the drainfield. The only animal fecal marker (for dogs) was detected once in one background piezometer. The use of five different genetic targets to detect five different potential sources increased the likelihood of identifying fecal pollution sources for this study. While both *Bacteroides* HF183 and HumM2 markers were detected in septic tank wastewater, the HF183 marker was detected more often in groundwater samples, suggesting that it may be a more reliable marker to use as a source tracking tool related to OWTS.

Background piezometers were upgradient from the OWTS, but background groundwater quality could have been influenced by other human and animal waste sources in the neighborhood, such as other OWTSs and animals. Such influence was also suggested by the detection of the dog mitochondrial biomarker in the background location 1 piezometer.

North Carolina requires a separation distance of 45 cm from OWTS trenches to seasonal high water table. Prior studies have shown, however, that in order to reduce the likelihood of elevated groundwater microbial concentrations, a separation distance of 60 cm or more may be needed (Humphrey, O'Driscoll, & Zarate-Bermudez, 2011; Stall, Amoozegar, Graves, & Rashash, 2014). On several occasions groundwater was less than 60 cm from the trench bottom of the OWTS at both sites.

FIGURE 6

Log_{10} *C. perfringens* Concentrations for Site 1 and 2



*Represents outlier values. BG = background groundwater; ST = septic tank; DF = drainfield groundwater; <15 m = groundwater samples <15 m from DF; 15–30 m = groundwater samples 15–30 m from DF; 30–40 m = groundwater samples 30–40 m from DF; >40 m = groundwater samples >40 m from DF.

Study Limitations

Most of our study was conducted during periods of below-average rainfall; the area was under drought conditions during the spring and summer months. The site experienced two major storm events (tornado outbreak on April 16 and Hurricane Irene on August 27), however, in which two piezometers near the estuary were torn from the ground. The hurricane caused flooding of site 1, forcing the family to leave their home while it was rebuilt. This was apparent in fecal indicator data collected from the septic tanks during the final sampling round two months after the hurricane.

Chloride concentrations and specific conductivity were also elevated during the final sampling round in October 2011, indicating that brackish floodwaters had impacted the septic tank (data not shown). These extreme weather events likely contributed to increased variability during the study.

The funding level for our study did not allow for inclusion of additional households. Field and laboratory work for such intensive sampling would make such a study very expensive, and funding only allowed for inclusion of two households.

Conclusion

Data from our study showed that OWTS at both sites contributed to significantly elevated concentrations of *E. coli* and enterococci in groundwater beneath the drainfields relative to background groundwater concentrations. Groundwater from impacted piezometers contained *E. coli* and enterococci at concentrations exceeding ambient water quality criteria. In addition, molecular source tracking data demonstrated that human fecal markers were most often associated with piezometers downgradient of the site 1 septic system and could be detected as far away as 40 m from the drainfield. The data indicate that molecular fecal source tracking assays can be a useful addition to the "toolbox" approach to detect and identify sources of fecal contamination in water samples. While data from our study indicated that the OWTS impacted the microbial quality of shallow groundwater, general trends from sites 1 and 2 indicated that *E. coli* and enterococci concentrations decreased with increasing distance downgradient from OWTS (toward the estuary). Median concentrations of *E. coli* and enterococci in shallow groundwater dropped to below median background concentrations after approximately 30 m downgradient of the OWTS.

This study provides evidence of OWTS influence on groundwater quality and indicates the benefits and constraints for a diverse set of fecal indicator and fecal source tracking methods for groundwater quality studies. In particular, for the study location in North Carolina, the findings of our study provide information that can be used to assess North Carolina OWTS setback and separation distance regulations. Since the study sites were adjacent to an estuary, results suggest that current OWTS setbacks of 15–30 m may not be sufficiently protective to prevent elevated microbial concentrations in shallow groundwater from reaching nearby surface water and adjacent waterways (e.g., shellfish harvesting areas). Future studies are warranted to evaluate the potential impacts of OWTS on groundwater quality in different hydrogeological areas and how observed impacts relate to regulated setback and separation distances for these systems.

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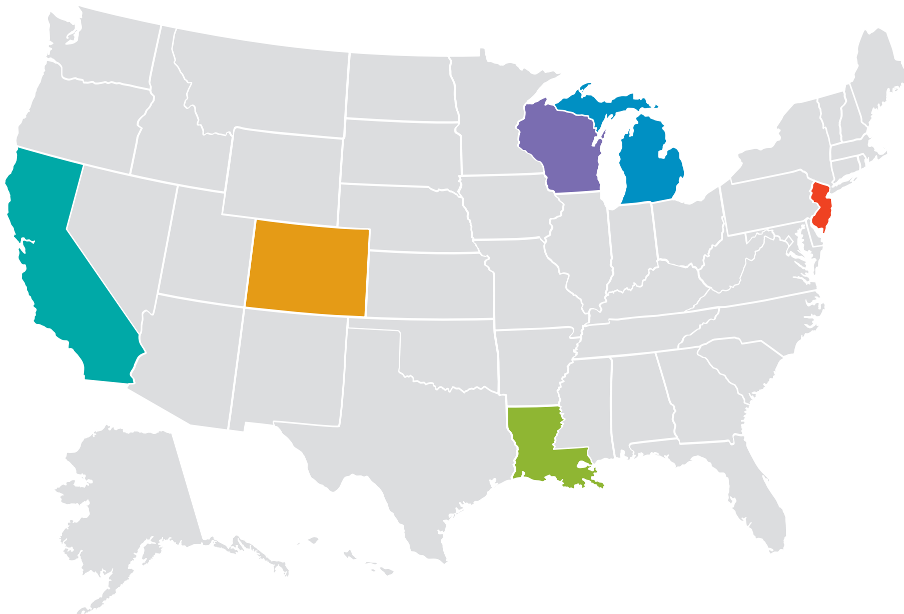
Did You Know?

With more than 15 million U.S. households relying on private wells for drinking water, properly installing effective onsite wastewater treatment systems (OWTS) is critical to keeping well water uncontaminated and safe for consumption. NEHA's Certified Installer of Onsite Wastewater Treatment Systems (CIOWTS) credential holders are trained in assessment, staging, and installation of OWTS at either a basic or an advanced level. Go to www.neha.org/onsite/index.html for more information.

ACROSS THE COUNTRY WHAT'S HAPPENING IN ENVIRONMENTAL HEALTH



Editor's Note: This feature in the *Journal* is intended to provide readers with interesting and novel stories of environmental health being practiced across the country and to offer an avenue for story sharing and community building. Do you have a story to share? Please send your story ideas to jeh@neha.org.

CALIFORNIA

Further Water Restrictions Imposed

With another dry year for California, state officials imposed further emergency drought regulations on March 17, 2015, that direct urban agencies to limit the number of days residents can water their yards. Local agencies that don't currently limit watering days will have to restrict landscape irrigation to no more than two days a week if they don't adopt their own regulations before the new ruling goes into effect. Agencies and cities that already have limits in place can maintain those, even if they permit watering on more than two days a week.

The move is not expected to affect most major southern California cities that already have watering restrictions. For example, Los Angeles has restricted outdoor watering to three days a week since 2009. The State Water Resources Control Board will discuss in the coming months additional actions that it may take if local agencies don't ramp up conservation efforts. These steps could include making the emergency restrictions permanent, requiring water districts to perform leak audits, and setting targets for per capita water use that would vary according to climate zones.

Source: www.latimes.com/local/lanow/la-me-state-officials-watering-restrictions-20150317-story.html.

COLORADO

Rocky Mountain High Spill Clean Up

A tanker truck containing between 5,000 and 5,500 gallons of triazine rolled over in mid-March on Rabbit Ears Pass. The pass straddles the Continental Divide at the southern end of the Park Range on the boundary between Grand and Jackson counties. It is estimated that it could take three weeks for a crew to excavate the area. Triazine is used in oil and gas operations as part of the fracking process to help find and neutralize hydrogen sulfides.

Within hours of the spill, government agencies and local water providers were notified of the spill. These included the Colorado Department of Public Health and Environment, U.S. Forest Service, Colorado Parks and Wildlife, and water system operators from the surrounding region. The chemicals spilled into a gully downhill from the runaway truck ramp. According to the Colorado State Patrol, the tanker was sliced open when it collided with a concrete barrier wall. The gully is located on the uphill side of the road, but it was suspected that there was a culvert in the area that drained water onto the other side of the road down a steep slope.

"At this time, after consideration of the chemicals involved and environmental conditions, it appears unlikely for harmful quantities of the released material to reach the Yampa River," Environmental Health Director Mike Zopf wrote in a news release. "However, work continues to assess the situation and clean up this material and any contamination that has occurred to minimize impacts to wildlife and the environment."

Source: www.steamboattoday.com/news/2015/mar/17/chemical-spill-clean-continues-rabbit-ears-pass/.

LOUISIANA

Explosive Debate on How to Get Rid of Tons of Propellant

In October 2012, over 18 million pounds of M6 propellant was discovered in Minden, Louisiana, on a site of land that was previously used by private companies engaged in military-related work. The M6 propellant, which is used in firing artillery rounds and can spontaneously ignite, was found stuffed into plastic bags and piled into sagging cardboard boxes, many of which were out in open fields. The material was discovered after two massive explosions took place on the site and since that time, the M6 propellant has been gathered and put into 97 separate bunkers to reduce the risk of further explosions.

Over two years later, the question still remains on how to dispose of the materials. A plan was announced in October 2014 to burn all the material outdoor in large trays—a disposal method used by the U.S. Army, but not on this scale. The plan was made without reaching out to private citizens in the area and without community consent. Residents, scientists, activists, and government officials have formed a committee to propose other ways to remove the material. A delay in the October plan was announced in January and in mid-March, the committee made a final recommendation of six technologies that members believe would be both safe and effective.

Source: www.nytimes.com/2015/03/19/us/louisiana-parish-fights-plan-to-burn-tons-of-propellant-no-one-wants.html?ref=energy-environment&_r=0.

MICHIGAN

Fire Proof Flyers

According to recent research, Michigan's bald eagles are among the most contaminated birds on the planet when it comes to phased-out flame retardant chemicals in their livers. Over four decades ago, polybrominated diphenyl ethers (PBDEs) were placed into electronics, furniture cushions, and clothing to reduce the spread of flames if they caught fire. While PBDEs were phased out staring in the early 2000s, the chemicals are still widespread in the environment—in the air, dirt, and people in nearly every corner of the globe. Nil Basu, an associate professor at McGill University, led the study and stated, "They build up in the food chains so that top predators—such as bald eagles—accumulate high levels."

The eagles were likely exposed through eating contaminated fish, though the chemicals also can enter landfills, latch onto dust and be inhaled, or be licked off the feathers. While Michigan's population of bald eagles is stable, the compounds have been linked in other birds to impaired reproduction, weird behavior and development, and hormone disruption. Flame retardants have been found in birds all over the world—from the U.S. to China.

Source: www.scientificamerican.com/article/bald-eagles-prove-full-of-flame-retardants/.

NEW JERSEY

New Jersey: Four Strikes and You're Closed

In an attempt to make sure restaurant workers are washing their hands and keeping the kitchen clean, Hamilton Township officials are preparing to bring the hammer down on restaurant owners who frequently violate health codes. The township council was scheduled to introduce an ordinance that would stiffen penalties for restaurants with a history of failing health inspections, imposing fines as much as three times the current amount and imposing mandatory closures.

Under the current model, restaurants that receive a "conditionally satisfactory" rating, which denotes health issues that need to be addressed, are charged a $250 reinspection fee after each of their second, third, and fourth consecutive violations. Township health officer Jeff Plunkett said that some businesses do not take the $250 fee seriously—one owner simply tried to hand a health inspector $250 in cash from his wallet.

The new ordinance would impose steps in the reinspection fees: $250 on the second consecutive offense, $500 on the third, and $750 on the fourth. After four consecutive offenses, the township will shut down the restaurant for a minimum of two days, even if the violations are resolved quickly. "You keep trying to educate the ownership that they have a responsibility to every customer who walks through their door. It cannot be taken lightly," Plunkett said.

As of press time, the township council voted to table the proposed ordinance.

Source: www.nj.com/mercer/index.ssf/2015/03/restaurants_four-strike_rule_hamilton_considering.html.

WISCONSIN

Remembering the Largest Waterborne Outbreak in U.S. History

Twenty-two years ago last March, residents of Milwaukee started falling ill with nausea, diarrhea, and abdominal cramps. The symptoms struck tens of thousands of people, closing schools and businesses and nearly bringing the city to a standstill. Health officials discovered the culprit—cryptosporidium. Cryptosporidium, also known as crypto, had made its way through Milwaukee's water treatment plant and into the city taps. Since then, utilities nationwide have made improvements in water treatment and monitoring.

Public water technology to prevent crypto may have improved, but not the drugs to treat it, said Washington State University researcher Jennifer Zambriski. "Crypto is hardy and doesn't die easily. When someone contracts it, there's simply no drug to make it go away," said Zambriski, whose research focuses on finding ways to disrupt the parasite's pathway through the digestive tract before it gains a stranglehold on its host.

Cryptosporidiosis is one of the most frequently occurring waterborne diseases among humans in the U.S., according to the Centers for Disease Control and Prevention. In Asia and Africa, the parasite is a leading cause of diarrheal disease and death among infants.

Source: https://news.wsu.edu/2015/03/16/tiny-parasite-big-disease-22-years-since-fatal-outbreak/#.VQnMfrl0ypr.

DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES BRANCH

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It's All About the Return on Investment: The Model Aquatic Health Code

Editor's Note: **NEHA strives to provide up-to-date and relevant information on environmental health and to build partnerships in the profession. In pursuit of these goals, we feature a column from the Environmental Health Services Branch (EHSB) of the Centers for Disease Control and Prevention (CDC) in every issue of the *Journal*.**

In this column, EHSB and guest authors from across CDC will highlight a variety of concerns, opportunities, challenges, and successes that we all share in environmental public health. EHSB's objective is to strengthen the role of state, local, tribal, and national environmental health programs and professionals to anticipate, identify, and respond to adverse environmental exposures and the consequences of these exposures for human health.

The conclusions in this article are those of the author(s) and do not necessarily represent the views of CDC.

Michele Hlavsa is chief of the Healthy Swimming Program in CDC's National Center for Emerging Zoonotic and Infectious Diseases (NCEZID). CDR Jasen Kunz serves as CDC liaison to the Conference for the Model Aquatic Health Code (CMAHC) on behalf of CDC's National Center for Environmental Health. Michael Beach is associate director for Healthy Water in CDC's NCEZID and president of the CMAHC board of directors.

An excellent return on investment (ROI) is something each of us personally strives for financially. But shouldn't we, as public health professionals, also strive to maximize ROI when preventing and controlling illness and injury?

In 2005, local, state, and federal public health officials and representatives from the aquatic sector met in Atlanta to discuss and develop a strategy to tackle the increasing incidence of recreational water–associated outbreaks, particularly cryptosporidiosis outbreaks associated with public pools (Hlavsa et al., 2014). Public health and the aquatics sector quickly reached consensus. They identified the lack of uniform national standards for the design, construction, operation, and maintenance of public pools as the key barrier to preventing outbreaks and called on the Centers for Disease Control and Prevention (CDC) to lead development of national guidance.

For the next seven years, CDC and New York State Department of Health spearheaded a national, multi-partner effort to create the Model Aquatic Health Code (MAHC; www.cdc.gov/healthywater/swimming/pools/mahc/index.html). In August 2014, the first edition of the MAHC was released. This 316-page resource is based on the latest science and best practices to maximize prevention of recreational water–associated outbreaks, pool chemical–associated health events, and drowning. The accompanying 371-page annex provides the rationale behind the guidance. The MAHC and its annex represent the culmination of the hard work of more than 150 public health, aquatic sector, and academic volunteers and their response to 4,407 public comments, of which 72% were accepted.

So where do we go from here? Together, we need to set up systems to assess the MAHC's ROI and use system data to maximize the MAHC's ability to provide long-term public health dividends.

Tracking MAHC Adoption

MAHC items must be voluntarily adopted before public health can assess their benefits. The latter calls for tracking MAHC adoption and is easier said than done given state and local jurisdictions' varying processes and timelines to create, adopt, and update code. But it is a challenge worth undertaking. CDC has worked carefully over the past two years to develop an algorithm designed to measure uptake of key MAHC code items. Through a critical partnership with CDC's Public Health Law Program, the groundwork for tracking MAHC adoption was laid in 2013; baseline data were collected in 2014; and prospective tracking began January 1, 2015. Data from the MAHC adoption tracking system will provide MAHC stakeholders with a snapshot of MAHC adoption. For example, the adoption tracking system will assess adoption of secondary disinfection requirements for increased risk aquatic venues (Table 1). Note that most design and construction code items apply to only newly constructed or significantly renovated pools.

Tracking MAHC's Impact on Public Pools

In contrast to the data collection effort to assess MAHC adoption, the data collection effort to assess MAHC's impact on public pools

TABLE **1**

Tracking Model Aquatic Health Code (MAHC) Adoption: Examples

Key MAHC Provision	What Is the Tracking System Specifically Examining?
"Increased Risk Aquatic Venue" means an aquatic venue, which due to its intrinsic characteristics and intended users has a greater likelihood of affecting the health of the bathers of that venue by being at increased risk for microbial contamination (e.g., by children less than five years old) or being used by people that may be more susceptible to infection (e.g., therapy patients with open wounds). Examples of increased risk aquatic venues include spray pads, wading pools, and other aquatic venues designed for children less than five years old as well as therapy pools.	Does the code define "increased risk aquatic venues" (e.g., pools designed for diaper-aged children and therapy pools)?
The new construction or substantial alteration of the following increased risk aquatic venues shall be required to use a secondary disinfection system after adoption of this code: 1) aquatics venues designed primarily for children under five years old, such as a. wading pools, b. interactive water play venues with no standing water, and 2) therapy pools.	Is secondary disinfection (e.g., UV, ozone) required for "increased risk aquatic venues"?

TABLE **2**

Tracking the Model Aquatic Health Code's Impact on Public Pools: Examples

Prevention of	What Inspection Data Is the Tracking System Specifically Examining?
Recreational water–associated outbreaks	• Proper disinfectant level • pH 7.2–7.8 • Automated chemical feeder: in good repair and operable • Recirculation pump and filter: approved, in good repair, and operating • Qualified operator or responsible supervisor on site
Pool chemical–associated health events	• Pool chemicals labeled, stored safely, and secured
Drowning	• Enclosure: fencing, walls, gates, and doors in good repair with self-closing and latching gates or doors • Water clear, main drain visible • Appropriate safety equipment present and in good repair • Qualified lifeguards and/or adequately staffed

is more straightforward. The latter can be accomplished using data state and local environmental health specialists collect during public pool inspections. CDC is collaborating with environmental health colleagues in the top five public pool states and their respective top five public pool counties or cities. Analyses of inspection data will focus on inspection items likely to result in immediate closure, across collaborating jurisdictions, because violations of the corresponding standard could lead to an outbreak, pool chemical–associated health event, or drowning (Table 2). Previous analyses of inspection data across jurisdictions have yielded powerful public health decision-making data (Centers for Disease Control and Prevention, 2010).

Tracking MAHC's Impact on Public Health and Optimizing It

CDC will also continue to track long-term outcomes such as outbreaks, pool chemical–associated injuries, and drowning at public pools, given that decreased incidence of illness and injury is the MAHC's ultimate ROI. In the interim, data from the MAHC adoption and pool inspection tracking systems and the latest available scientific reports will be used to optimize the MAHC. To expedite this process, the nonprofit Conference for the Model Aquatic Health Code (CMAHC; www.cmahc.org) has been created and tasked with relaying national input on needed MAHC changes back to CDC. To accomplish this, the CMAHC will hold a biennial conference to deliberate and vote on proposed changes to the MAHC; the first CMAHC conference will be held October 6–7 in Phoenix. The CMAHC's role in driving MAHC improvements makes it imperative that public health, the aquatics sector, and consumer groups become CMAHC members so that all stakeholder voices are at the table. Joining the CMAHC (www.cmahc.org/getinvolved.php) and making public health's voice heard is the next step in providing healthy and safe experiences at public pools for everyone and increasing the return on what we have all invested and will continue to invest in the MAHC.

Acknowledgments: The authors thank state and local environmental health collaborators and CDC's Sharunda Buchanan, John Sarisky, Rob Blake, Matthew Penn, Montrece Ransom, Julie Gilchrist, Staci Close, Taryn Mecher, Sarah Collier, and Gouthami Rao.

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E-mail: acz3@cdc.gov.

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DIRECT FROM CDC ENVIRONMENTAL PUBLIC HEALTH TRACKING NETWORK

Gonza Namulanda, MS, DrPH

Biomonitoring and Environmental Public Health Tracking

Editor's Note: As part of our continuing effort to highlight innovative approaches and tools to improve the health and environment of communities, the *Journal* is pleased to publish a bimonthly column from the Centers for Disease Control and Prevention's (CDC's) Environmental Public Health Tracking Network (Tracking Network). The Tracking Network is a system of integrated health, exposure, and hazard information and data from a variety of national, state, and city sources. The Tracking Network brings together data concerning health and environmental problems with the goal of providing information to help improve where we live, work, and play.

Environmental causes of chronic diseases are hard to identify. Measuring amounts of hazardous substances in our environment in a standard way, tracing the spread of these over time and area, seeing how they show up in human tissues, and understanding how they may cause illness is critical. The Tracking Network is a tool that can help connect these efforts. Through these columns, readers will learn about the program and the resources, tools, and information available from CDC's Tracking Network.

The conclusions of this article are those of the author(s) and do not necessarily represent the views of CDC.

Gonza Namulanda is a health scientist with the Environmental Health Tracking Branch. She works primarily on the biomonitoring and childhood blood lead content areas and electronic health records and metadata for environmental public health tracking.

People can be exposed to chemicals in air, water, food, soil, or other environmental media such as consumer products (Centers for Disease Control and Prevention [CDC], 2009). Biomonitoring can help determine which environmental chemicals people have been exposed to by measuring how much of these chemicals actually get into people's bodies (CDC, 2009). These measurements in blood or urine can then be associated with a hazard present in the environment or, along with health-related information, with a health effect that would follow exposure (Needham, Calafat, & Barr, 2007). This makes the connection between environmental hazards, exposures, and health effects.

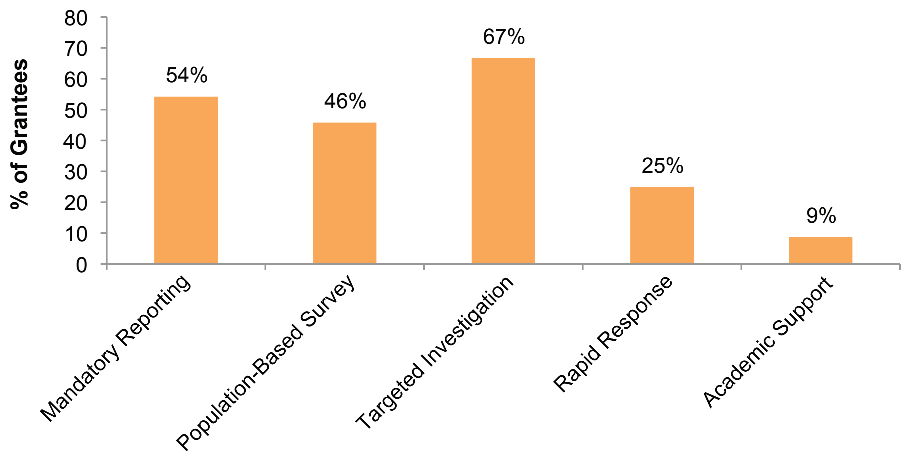
Biomonitoring data can also be used to monitor trends of body burdens of chemicals, identify at-risk populations, and determine effectiveness of regulations (Needham et al., 2007). This column describes the role of biomonitoring data in the Environmental Public Health Tracking Program (Tracking Program) and the work that has been undertaken so far to integrate biomonitoring data into the Environmental Public Health Tracking Network (Tracking Network).

Environmental public health tracking or surveillance is defined as the ongoing collection, integration, analysis, interpretation, and dissemination of data on environmental hazards, exposures to those hazards, and health effects that may be related to the exposures (McGeehin, Qualters, & Niskar, 2004). Therefore, environmental public health tracking typically integrates data from the following three types of surveillance: environmental hazard, exposure, and health effect (Thacker, Stroup, Parrish, & Anderson, 1996). Hazard surveillance documents hazards in the environment (e.g., ozone in air), while exposure surveillance determines the extent of human contact with environmental hazards (e.g., childhood blood lead testing) (Thacker et al., 1996). Health effects surveillance documents the disease burden in populations (e.g., prevalence of birth defects) (Thacker et al., 1996). This is the "three-legged stool" that characterizes environmental public health tracking data (The PEW Environmental Health Commission, 2000). These three data types complement each other.

The Tracking Network is a national web-based system that presents environmental haz-

FIGURE 1

Number of Tracking Program Grantees With Biomonitoring Projects by Category (*N* = 24)



ard, exposure, and health effects data in one place. The Tracking Program funds 24 states and one city health department (grantees) to develop and maintain state tracking networks. Currently, the national Tracking Network presents data on the following topics from the three categories of surveillance data:

Environment
- Climate change
- Outdoor air
- Community water
- Homes
- Community design

Exposure
- Pesticide exposures
- Childhood blood lead testing
- Biomonitoring population exposures

Health Effects
- Asthma
- Birth defects
- Cancer
- Carbon monoxide poisoning
- Heart attacks
- Heat stress
- Reproductive and birth outcomes
- Developmental disabilities

Integrating Biomonitoring in the Tracking Network

In 2011, the Tracking Program's biomonitoring taskforce was formed. One of the taskforce's objectives was to develop a module to integrate biomonitoring data into the Tracking Network.

National Data

For the first phase, biomonitoring data on these 11 analytes (e.g., the chemical or a metabolite) from the Centers for Disease and Control and Prevention's *National Report on Human Exposure to Environmental Chemicals* were selected to be presented on the Tracking Network.

Metals measured in urine or blood:
- Arsenic (urine)
- Cadmium (blood and urine)
- Lead (blood)
- Mercury (blood and urine)
- Uranium (urine)

Volatile organic compounds measured in blood:
- Benzene
- Toluene

Disinfection by-products measured in blood:
- Chloroform

Polycyclic aromatic hydrocarbons measured in urine:
- Naphthalene metabolites
- Pyrene metabolite

and
- Cotinine measured in blood serum

The analytes were selected based on one or more of the following criteria: 1) high detection frequency in the U.S. population (i.e., detected at the 50th percentile); 2) have known environmental exposures; 3) can be linked with environmental hazard data from the Tracking Network and U.S. Environmental Protection Agency's air toxics or safe drinking water information system data; 4) good understanding of association with health effects; and 5) good potential for mitigating exposures through policy or other means.

State/Local-Level Data

Another taskforce objective was to document and assess biomonitoring data collected by the then-24 Tracking Program grantees that show exposures on a state or local scale. The goals of this project were to provide an inventory of biomonitoring data in Tracking Program grantee states, identify strengths and limitations of the data for use in environmental public health tracking, and make recommendations about the use of these data on the national and grantee tracking networks. The state-level data and projects conducted in the last 10 years (2001–2011) were grouped into the following five categories.

Mandatory reporting: passive collection of data from the mandatory reporting of chemical exposures to a public health agency.

Population-based survey: active population surveillance to detect spatial or temporal differences in exposure or to evaluate the efficacy of public health actions to reduce exposure.

Targeted public health investigation: conducted in response to community exposure or health concerns.

Rapid response: conducted in response to an exposure event to evaluate clinical measures in individuals and support diagnosis of poisonings and assessment of need for medical treatment.

Support of academic research projects: providing laboratory support to academic research projects.

Results

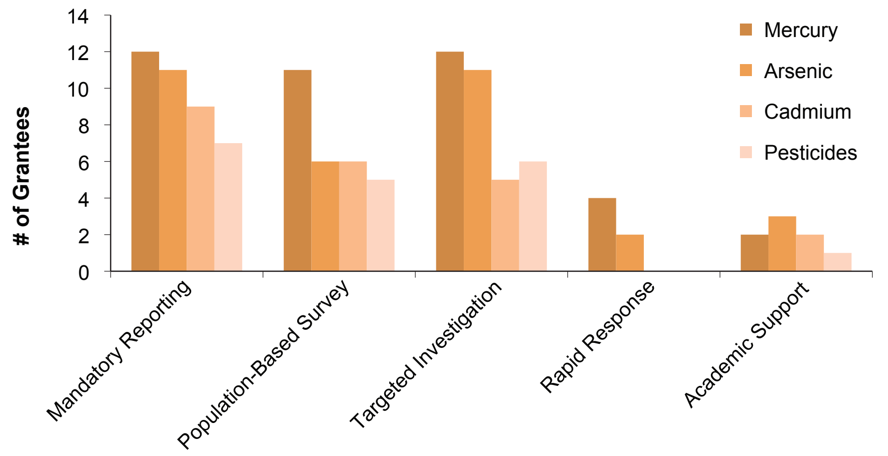
Project Categories and Analytes

All 24 grantees provided information. The distribution of grantees with projects by category was as follows: 54% mandatory reporting projects apart from childhood blood lead testing (*n* = 13); 46% population-based surveys (*n* = 11); 67% targeted investigations (*n* = 16); 25% rapid response (*n* = 6); and 9% support of academic research projects (*n* =

2) (Figure 1). Mercury, arsenic, cadmium and pesticides were the analytes most frequently tested across the five categories of projects (Figure 2). Other analytes included cotinine, polychlorinated biphenyls, phthalate metabolites, polybrominated diphenyl ethers, polychlorinated dibenzodioxins, polychlorinated dibenzofurans, bisphenol A, triclosan, selenium, uranium, perfluorinated compounds, parabens, benzophenone, manganese, and antimony.

FIGURE **2**

Analytes Most Frequently Measured by Project Category



Strengths and Limitations

Tracking Program states have conducted a wide variety of biomonitoring activities. A number of grantees have conducted mandatory reporting, population-based surveys, or targeted investigations for the same chemicals. Results from these similar projects could be compared across states or provide a reference for other states with similar projects. Laboratory methods may differ from state to state, different study populations were used in different projects (e.g., adult vs. infant or child populations), and the type of sampling used also differed (e.g., probability vs. nonprobability sampling), however. Most projects used nonprobability or convenience sampling methods. This limits the data that could be compared across states. Only two respondents documented biomonitoring projects in support of academic research. This taskforce project likely did not capture all existing projects in this category, however.

Next Steps

More work remains to be done to further develop the biomonitoring module on the Tracking Network. A next step is to determine how best to present the results of the state biomonitoring data project on the Tracking Network. One example could be presenting information about these projects to facilitate collaboration with researchers. Another next step is expanding the analytes from the *National Report on Human Exposure to Environmental Chemicals* presented on the Tracking Network, for example, to include pesticides analytes, which were some of the most frequently measured analytes in state biomonitoring projects. These pesticide measurements can provide a national reference for data collected at the state level.

Acknowledgements: The author would like to acknowledge the Tracking Program biomonitoring taskforce that worked on developing the biomonitoring module (particularly, Dr. Mary Mortensen from CDC's Division of Laboratory Sciences and Len Flowers) and the state biomonitoring data project (particularly, Dr. Jean Johnson, co-chair of the taskforce, Dr. Jessica Nelson, and Christina Rosebush from MN Tracking Program, and Jennifer Major from Ross Strategic). Thanks to all Tracking Program grantees that participated in the project (CA, CO, CT, FL, IA, KS, LA, ME, MD, MA, MN, MO, NH, NJ, NM, NYC, NY, OR, PA, SC, UT, VT, WA, WI).

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DEMYSTIFYING THE FUTURE

Thomas Frey

101 Endangered Jobs by 2030

Editor's Note: Significant and fast-paced change is occurring across society in general and our profession in particular. The clearer our sense for the future is, the more able we are to both understand and take advantage of trends working their way through virtually every aspect of our lives today. To help us see what these trends are and where they appear to be taking us, NEHA has made arrangements to publish the critical thinking of the highly regarded futurist, Thomas Frey.

The opinions expressed in this column are solely that of the author and do not in any way reflect the policies and positions of NEHA and the *Journal of Environmental Health*.

Thomas Frey is Google's top-rated futurist speaker and the executive director of the DaVinci Institute®. At the Institute, he has developed original research studies enabling him to speak on unusual topics, translating trends into unique opportunities. Frey is a powerful visionary who is revolutionizing our thinking about the future.

Business owners today are actively deciding whether their next hire should be a person or a machine. After all, machines can work in the dark and don't come with decades of HR case law requiring time off for holidays, personal illness, excessive overtime, chronic stress, or anxiety.

If you've not yet heard the phrase "technological unemployment," brace yourself; you'll be hearing it a lot over the coming years.

Technology is automating jobs out of existence at a record clip, and it's only getting started.

Yes, my predictions of endangered jobs will likely strike fear into the hearts of countless millions trying to find meaningful work. But while crystal balls everywhere are showing massive changes on the horizon, it's not all negative news.

For those well attuned to the top three skills needed for the future—adaptability, flexibility, and resourcefulness—more opportunities will be available than they can possibly imagine.

As an example, for people who lived 150 years ago, having never seen a car, the thought of traveling 1,000 miles seemed like an impossible journey. But today, 1,000-mile trips are not only common, they're trivial.

This is precisely the shift in perspective we're about to go through as the tools at our disposal begin to increase our capabilities exponentially.

As I describe the following endangered jobs, understand that thousands of derivative career paths will be ready to surface from the shadows.

We live in an unbelievably exciting time, and those who master the fine art of controlling their own destiny will rise to the inspiring new lifestyle category of "rogue commanders of the known universe."

Cause of Destruction: Driverless Cars

When the Defense Advanced Research Projects Agency (DARPA) launched their first Grand Challenge in 2004, the idea of autonomous driverless vehicles for everyone seemed like a plot for a bad science fiction novel about the far distant future. The results of the first competition even bore that out with few of the entrants even getting past the starting blocks.

The 2005 contest, however, was far different, with five teams completing the 132-mile course through the dessert, setting the stage for the 2007 DARPA Urban Challenge. The Urban Challenge proved for all that these vehicles were rapidly coming up the acceptance curve.

Over the past few years, Google's involvement has made driverless cars a common water cooler topic, causing virtually every transportation company in the world to launch their own driverless research team working on autonomous features.

Between now and 2030, driverless features will pave the way for fully autonomous vehicles and the demand for drivers will begin to plummet. On-demand transportation services, where people can hail a driverless vehicle at any time, will become a staple of everyday metro living.

Endangered Jobs

Drivers

1. Taxi driver
2. Limo driver
3. Bus drivers
4. Rental car personnel

Delivery Positions

5. Truck drivers
6. Mail carriers

Public Safety

7. Traffic cops
8. Meter maids
9. Traffic court judges
10. Traffic court lawyers
11. Traffic court DAs
12. Traffic court support staff

Miscellaneous

13. Parking lot attendants
14. Valet attendants
15. Car wash workers

Cause of Destruction: Flying Drones

Flying drones will be configured into thousands of different forms, shapes, and sizes. They can be low flying, high flying, tiny or huge, silent or noisy, super-visible or totally invisible, your best friend, or your worst enemy.

Without the proper protections, drones can be dangerous. The same drones that deliver food and water can also deliver bombs and poison. We may very well have drones watching the workers who watch the drones, and even that may not be enough.

Even though drones will be eliminating huge numbers of jobs, they will be creating tons of new opportunities for professions that haven't been invented yet.

That said, here are a few of the jobs that drones will help make disappear.

Endangered Jobs

Delivery Positions

16. Courier service
17. Food delivery
18. Pizza delivery
19. Postal delivery

Agriculture

20. Crop monitors/consultants
21. Spraying services
22. Shepherds
23. Wranglers/herders
24. Vermin exterminators

Surveying

25. Land and field surveyors
26. Environmental engineers
27. Geologists

Emergency Rescue

28. Emergency response teams
29. Search and rescue teams
30. Firefighters

News Services

31. Mobile news trucks

Remote Monitoring

32. Construction site monitors
33. Building inspectors
34. Security guards
35. Parole officers

Cause of Destruction: 3D Printers

3D printing, often described to as additive manufacturing, is a process for making three dimensional parts and objects from a digital model. 3D printing uses "additive processes," to create an object by adding layer upon layer of material until it's complete.

Manufacturing in the past relied on subtractive processes where blocks of metal, wood, or other material has material removed with drills, laser cutters, and other machines until the final part was complete. This involved skilled machine operators and material handlers.

3D printing reduces the need for skilled operators as well as the need for expensive machines. As a result, parts can be manufactured locally for less money than even the cheapest labor in foreign manufacturing plants.

This technology is already being used in many fields: jewelry, footwear, industrial design, architecture, engineering and construction, automotive, aerospace, dental and medical industries, education, GIS, civil engineering, and many others.

Endangered Jobs

Manufacturing

36. Plastic press operators
37. Machinists
38. Shipping and receiving
39. Union representatives
40. Warehouse workers

Cause of Destruction: Contour Crafting

Contour crafting is a form of 3D printing that uses robotic arms and nozzles to squeeze out layers of concrete or other materials, moving back and forth over a set path in order to fabricate large objects such as houses. It is a construction technology that has great potential for low-cost, customized buildings that are quicker to make, reducing energy and emissions along the way.

A few months ago the WinSun Decoration Design Engineering Company used contour crafting to "print" 10 houses in a single day using a massive printer that was 490 feet long, 33 feet wide, and 20 feet deep.

Recently, an Italian 3D printer company named WASP demonstrated a giant three-armed printer filled with mud and fiber to build extremely cheap houses in some of the most remote places on Earth.

This type of technology will have major implications on all construction, building, and home repair jobs.

Endangered Jobs

Home Construction

41. Carpenters
42. Concrete workers
43. Home remodeling
44. City planners
45. Homeowner insurance agents
46. Real estate agents

Cause of Destruction: Big Data and Artificial Intelligence (AI)

It's becoming an ever increasingly blurred line between big data and AI.

A few months ago, Stephen Hawking opened the world's eyes to the dangers of AI, warning that it has the potential of outsmarting humans in the financial markets.

More recently, Elon Musk made headlines when he said AI could be "unleashing the demons," and researchers from some of the top U.S. universities say he's not wrong.

In spite of growing fears, AI will be entering our lives in many different ways ranging from smart devices, to automated decision makers, to synthetic designers.

When Kristian Hammond, CTO of Narrative Sciences predicted, "By 2030, 90% of all the news will be written by computers," he was referring to AI software that is quickly coming up the learning curve.

Endangered Jobs

Writing
47. News reporters
48. Sports reporters
49. Wall street reporters
50. Journalists
51. Authors

Military
52. Military planners
53. Cryptographers

Medical
54. Dietitians
55. Nutritionists
56. Doctors
57. Sonographers
58. Phlebotomists
59. Radiologists
60. Psychotherapists
61. Counselors/psychologists

Financial Services
62. Financial planners/advisors
63. Accountants
64. Tax advisors
65. Auditors
66. Bookkeepers

Legal Services
67. Lawyers
68. Compliance officers/workers
69. Bill collectors

Miscellaneous
70. Meeting/event planners
71. Cost estimators
72. Fitness coaches
73. Logisticians
74. Interpreters/translators
75. Customer service representatives
76. Teachers

Cause of Destruction: Mass Energy Storage

Any form of mass energy storage will dramatically improve renewable energy's role in the marketplace. The first companies to commercialize utility-scale energy storage stand to make a fortune and pioneer some of the most significant advancements to the world's power generation and distribution system in decades.

While we are not quite there yet, significant technological breakthroughs are on the horizon and major installations will soon become commonplace.

Large-scale methods of storing energy storage include flywheels, compressed air energy storage, hydrogen storage, thermal energy storage, and power to gas. Smaller scale commercial application-specific storage methods include flywheels, capacitors, and supercapacitors.

In 5–10 years the mass, grid-scale, bulk energy storage industry will likely be a rapidly growing industry much as solar and wind are today. Electricity generated but not consumed is a waste of natural resources and money lost. Energy storage will change all that.

Endangered Jobs

77. Energy planners
78. Environmental designers
79. Energy auditors
80. Power plant operators
81. Miners
82. Oil well drillers, roughnecks
83. Geologists
84. Meter readers
85. Gas/propane delivery

Cause of Destruction: Robots

Robots taking jobs from manufacturing workers has been happening for decades. But rapidly advancing software will spread the threat of job-killing automation to nearly every occupation.

Anything that can be automated will be. A robotic "doc-in-a-box" will help diagnose routine medical problems in many areas, while other machines will perform surgeries and other procedures.

If the human touch is not essential to the task, it's fair to assume that it will be automated away.

Over the coming decades, robots will enter the lives of every person on earth on far more levels than we ever dreamed possible.

Endangered Jobs

Retail
86. Retail clerks
87. Checkout clerks
88. Stockers
89. Inventory controllers
90. Sign spinners

Medical
91. Surgeons
92. Home health care
93. Pharmacists
94. Veterinarians

Maintenance
95. Painters
96. Janitors
97. Landscapers
98. Pool cleaners
99. Groundskeepers
100. Exterminators
101. Lumberjacks

Final Thoughts

The question remains, will technology become a net destroyer of jobs or a net creator?

For each of the endangered jobs listed above, I can easily come up with several logical offshoots that may amount to a net increase in jobs.

As an example, traditional lawyers may transition into super-lawyers handling 10 times the caseload of lawyers today. Limo drivers may become fleet operators managing 50–100 cars at a time. Painters may become conductors of paint symphonies with robot painters completing entire houses in less than an hour.

If it costs one tenth as much to paint your house, you'll simply do it more often. This same line of thinking applies to washing your car, traveling around the world, and buying designer clothes.

In a recent column I wrote titled, "The Laws of Exponential Capabilities" (www.futuristspeaker.com/2014/07/the-laws-of-exponential-capabilities/), I explained how every exponential decrease in effort create an equal and opposite exponential increase in capabilities. As today's significant accomplishments become more common, mega-accomplishments will take their place, and we need to set our sights on far more of tomorrow's mega-accomplishments.

It is simply not possible to run out of work to do in the world. But whether or not a job will be tied to the work that needs to be done is another matter entirely.

Interested in sharing your thoughts? Go to www.FuturistSpeaker.com.

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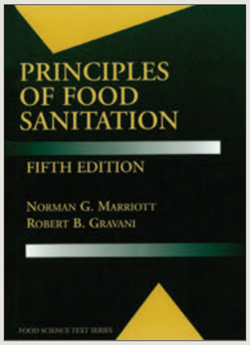
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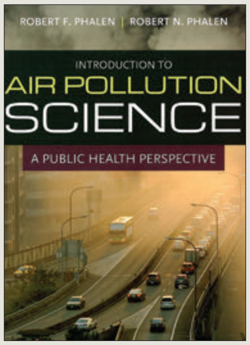
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A PUBLIC HEALTH PERSPECTIVE


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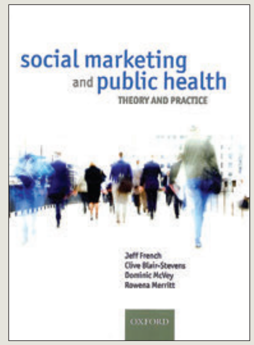
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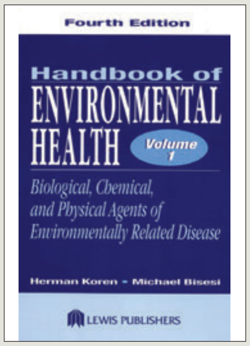
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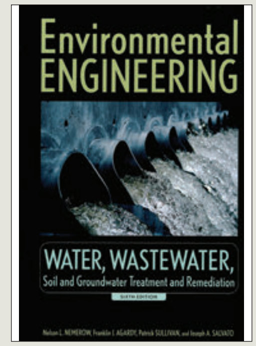
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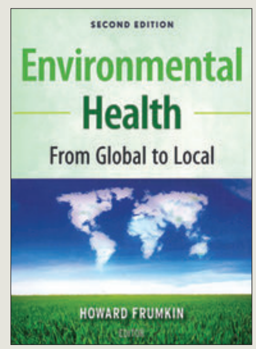
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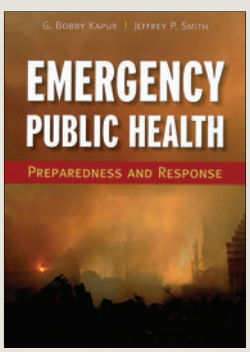
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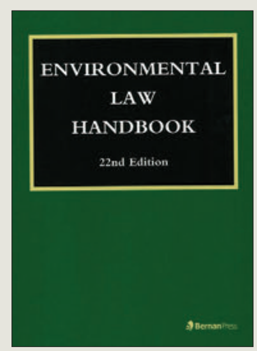
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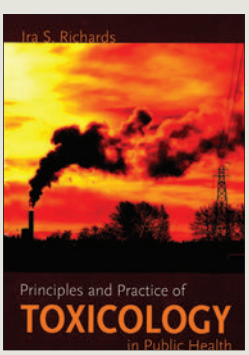
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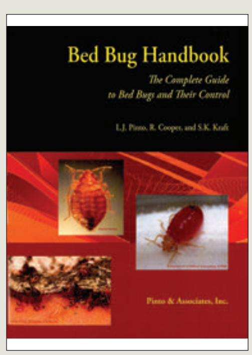
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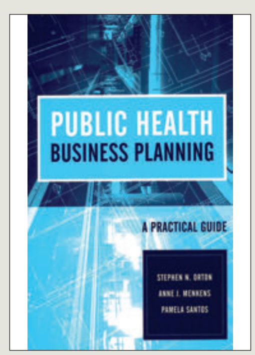
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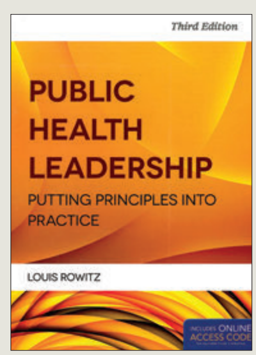
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CAREER OPPORTUNITIES

Food Safety Inspector

UL Everclean Services is the leader in the restaurant inspections market. We offer opportunities throughout the country. We currently have openings for professionals to conduct Q.A. audits of restaurants. Past or current food safety inspecting is required.

U.S. Listings
Alaska
Albany, NY
Billings, MT
Birmingham, AL
Bismarck, ND
Boise, ID
Boston, MA
Buffalo, NY
Butte, MT
Chattanooga, TN
Cleveland, OH
Grand Junction, CO
Jackson, MS
Jacksonville, FL
Knoxville, TN
Little Rock, AR
McAllen, TX
Milwaukee, WI
Minneapolis, MN
New Orleans, LA
Owatonna, MN
Pittsburgh, PA
Pocatello, ID
Portland, OR
Puerto Rico
Rapid City, SD
Rochester, NY
San Jose, CA
Sioux Falls, SD
Spearfish, SD
St. Louis, MO
St. Paul, MN
Syracuse, NY
Tulsa, OK
Washington, DC
Yuma, AZ

Canada Listings
Edmonton, AB
Kamloops, BC
Mississauga, ON
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Interested applicants can send their resume to: Bill Flynn at Fax: 818-865-0465. E-mail: Bill.Flynn@ul.com.

Did You Know?

Even if you can't attend every session that interests you at the NEHA 2015 AEC, it doesn't mean that you have to miss out. NEHA will be recording about 25 sessions in several topic areas, allowing you to stay educated and earn continuing education credits from your home or office. These will be available for free to all 2015 AEC attendees and NEHA members about two weeks after the conference.

EH CALENDAR

UPCOMING NEHA CONFERENCE

July 13–15, 2015: NEHA's 79th Annual Educational Conference & Exhibition, Renaissance Orlando at SeaWorld, Orlando, FL. For more information, visit www.neha2015aec.org.

NEHA AFFILIATE AND REGIONAL LISTINGS

Alaska
October 6–9, 2015: Annual Educational Conference, hosted by the Alaska Environmental Health Association, Anchorage, AK. For more information, visit https://sites.google.com/site/aehatest/.

Colorado
September 22–25, 2015: Annual Education Conference & Exhibition, hosted by the Colorado Environmental Health Association, Fort Collins, CO. For more information, visit www.cehaweb.com/aec.html.

Georgia
June 10–12, 2015: Annual Education Conference, hosted by the Georgia Environmental Health Association, Helen, GA. For more information, visit www.geha-online.org.

Iowa
October 7–8, 2015: NEHA Region 4 Environmental Health Conference, hosted by the Iowa Environmental Health Association, Waterloo, IA. For more information, visit www.ieha.net.

Kentucky
July 29–31, 2015: 69th Annual Interstate Environmental Health Seminar, hosted by the Kentucky Association of Milk, Food, and Environmental Sanitarians, Corbin, KY. For more information, visit www.wvdhhr.org/wvas/IEHS/index.asp.

Minnesota
May 13–15, 2015: Annual Spring Conference, hosted by the Minnesota Environmental Health Association, Alexandria, MN. For more information, visit www.mehaonline.org.

Utah
May 13–15, 2015: Spring Conference, hosted by the Utah Environmental Health Association, Bicknell, UT. For more information, visit www.ueha.org/events.html.

Wyoming
October 6–8, 2015: Annual Education Conference, hosted by the Wyoming Environmental Health Association, Saratoga, WY. For more information, visit www.wehaonline.net/events.asp.

TOPICAL LISTINGS

Preparedness
May 10–13, 2015: Public Health & Disasters Conference, hosted by Public Health Professional Education at the University of Utah, Park City, UT. For more information, visit www.tinyurl.com/uofu-ph-disasters.

RESOURCE CORNER

Resource Corner highlights different resources that NEHA has available to meet your education and training needs. These timely resources provide you with information and knowledge to advance your professional development. Visit NEHA's online Bookstore for additional information about these, and many other, pertinent resources!

NEHA BOOKSTORE
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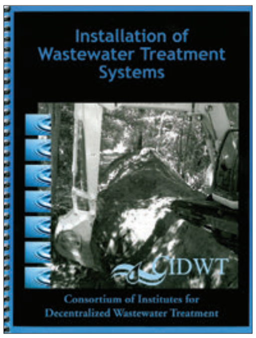
Installation of Wastewater Treatment Systems

Consortium of Institutes for Decentralized Wastewater Treatment (2009)

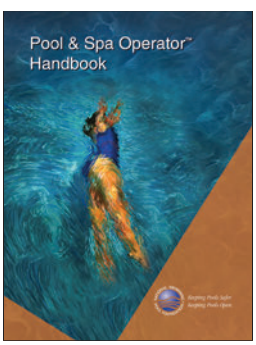


This manual is the definitive source for information on installing decentralized wastewater treatment systems. Developed by a team of experts, this manual provides installers with training materials geared specifically to address installation—one of the many vital aspects of programs for managing decentralized wastewater treatment systems. Installers, regulators, and designers of onsite wastewater treatment systems will gain a better understanding of the activities related to proper installation and startup to maximize system efficiency, longevity, and performance. This manual is a recommended study reference for NEHA's Certified Installer of Onsite Wastewater Treatment Systems (CIOWTS) credential.

454 pages / Spiral-bound paperback / Catalog #1125
Member: $68 / Nonmember: $79

Pool & Spa Operator™ Handbook

National Swimming Pool Foundation (2014)

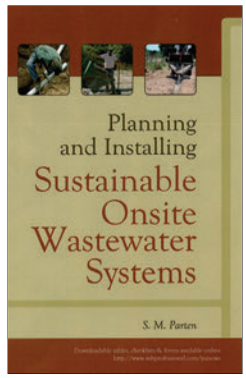


This fundamental training and reference manual is for professionals who help protect those who use aquatic venues, including operators, health officials, service technicians, retailers, property managers, and manufacturers. Industry leaders recognize it as the single most important resource for the recreational water industry. This *Handbook* educates readers on how to reduce risks in and around the water; provides valuable information to prevent drowning, recreational water illness, suction entrapment, evisceration, diving accidents, electrocutions, chemical hazards, and slips and falls; and summarizes regulatory guidelines, disinfection, water balance, water problems, troubleshooting, chemical testing, record keeping, chemical feed, and control technology. The *Handbook* also serves as a textbook for the Certified Pool-Spa Operator® certification. Study reference for NEHA's REHS/RS exam.

298 pages / Spiral-bound paperback / Catalog #1014
Member: $55 / Nonmember: $59

Planning and Installing Sustainable Onsite Wastewater Systems

S.M. Parten (2010)



Covering technical principles and practical applications, this comprehensive resource explains how to design and construct sound and sustainable decentralized wastewater systems of varying sizes and in different geophysical conditions. This book covers state-of-the-art techniques, materials, and industry practices, and provides detailed explanations for why certain approaches result in more sustainable projects. In-depth design and construction information highlights nonproprietary methods proven to be very sustainable and cost effective on a long-term basis for many geographic settings.

412 pages / Hardback / Catalog #1084
Member: $69 / Nonmember: $73

Certified Pool/Spa Inspector™ Online Training Program

National Swimming Pool Foundation (NSPF) (2011)

Jointly launched by NSPF and NEHA, this online course expands upon and replaces the popular Certified Pool/Spa Inspector™ training CD introduced by both organizations in 2005. The program is designed to help environmental health specialists conduct effective pool and spa inspections and to minimize exposure to public health hazards. The interactive self-paced course features narration, images, video, and exercises and can be completed in about two hours. The topics included in the course are operation and maintenance practices that focus on reducing risk, the workings of the circulation system and its components, procedures to evaluate a facility for Pool & Spa Safety Act compliance, the unique hazards of spas, how to minimize recreational water illnesses, the ways that operation and maintenance records relate to an inspection, how aquatic play features have unique hazards, and teaching about swimming pool design standards and their impact on public health.

Online Course and Handbook (68 Pages / Paperback) / Catalog #1067
Member: $50 / Nonmember: $55

JEH QUIZ

FEATURED ARTICLE QUIZ #6

UVA and Cutaneous Melanoma Incidences: Spatial Patterns and Communities At Risk

Available to those holding an Individual NEHA membership only, the *JEH* Quiz, offered six times per calendar year through the *Journal of Environmental Health,* is a convenient tool for self-assessment and an easily accessible means to accumulate continuing-education (CE) credits toward maintaining your NEHA credentials.

1. Read the featured article carefully.
2. Select the correct answer to each *JEH* Quiz question.
3. a) Complete the online quiz at www.neha.org (click on "Continuing Education"),
   b) Fax the quiz to (303) 691-9490, or
   c) Mail the completed quiz to
   JEH Quiz, NEHA
   720 S. Colorado Blvd., Suite 1000-N
   Denver, CO 80246.
   Be sure to include your name and membership number!
4. One CE credit will be applied to your account with an effective date of May 1, 2015 (first day of issue).
5. Check your continuing education account online at www.neha.org.
6. You're on your way to earning CE hours!

Quiz Registration

Name

NEHA Member No.

Home phone

Work phone

E-mail

JEH Quiz #4 Answers

January/February 2015

1. a	4. c	7. c	10. b
2. d	5. a	8. d	11. b
3. a	6. b	9. a	12. d

➔ Quiz deadline: August 1, 2015

1. According to the American Skin Cancer Foundation, __ in __ Americans will develop cutaneous melanoma in his/her lifetime.
   a. one; four
   b. one; five
   c. one; six
   d. one; nine

2. Cutaneous melanoma is responsible for __ of diagnosed skin cancer.
   a. 4%
   b. 15%
   c. 54%
   d. 77%

3. Cutaneous melanoma is responsible for __ of skin cancer-related deaths.
   a. 4%
   b. 15%
   c. 54%
   d. 77%

4. Ultraviolet A (UVA) includes radiation with wavelengths of
   a. 100–280 nm
   b. 280–315 nm
   c. 315–400 nm
   d. 400–480 nm

5. Exposure to UVA causes sunburns.
   a. True.
   b. False.

6. __ is the most damaging of all three types of UV radiation.
   a. UVA
   b. UVB
   c. UVC

7. Which of the following indicators was not evaluated in the study?
   a. UV level
   b. melanoma level
   c. UV-weighted melanoma
   d. melanoma-weighted UV

8. __ trend of cutaneous melanoma incidence and mortality rates was observed during the last decade.
   a. A stable
   b. A decreasing
   c. An increasing

9. States with the highest 2008 cutaneous melanoma incidence rates were
   a. Maryland, Delaware, New Hampshire, Vermont, Connecticut, and New Jersey.
   b. Arizona, Nevada, Texas, and Oklahoma.
   c. Iowa, Michigan, Illinois, Indiana, and Ohio.
   d. Oregon, California, New Mexico, and Utah.

10. States with the largest deficit between cutaneous melanoma incidence and exposures to solar UV were
    a. Maryland, Delaware, New Hampshire, Vermont, Connecticut, and New Jersey.
    b. Arizona, Nevada, Texas, and Oklahoma.
    c. Iowa, Michigan, Illinois, Indiana, and Ohio.
    d. Oregon, California, New Mexico, and Utah.

11. States with the highest UVA-weighted melanoma rate were
    a. Maryland, Delaware, New Hampshire, Vermont, Connecticut, and New Jersey.
    b. Arizona, Nevada, Texas, and Oklahoma.
    c. Iowa, Michigan, Illinois, Indiana, and Ohio.
    d. Oregon, California, New Mexico, and Utah.

12. The study was able to identify an excess of cutaneous melanoma incidence in __ U.S. and a deficit in __ U.S.
    a. southern; northeast
    b. southern; western
    c. northeast; southern
    d. northwest; southern

SUPPORT

THE NEHA ENDOWMENT FOUNDATION

The NEHA Endowment Foundation was established to enable NEHA to do more for the environmental health profession than its annual budget might allow. Special projects and programs supported by the foundation will be carried out for the sole purpose of advancing the profession and its practitioners.

Individuals who have contributed to the foundation are listed below by club category. These listings are based on what people have actually donated to the foundation—not what they have pledged. Names will be published under the appropriate category for one year; additional contributions will move individuals to a different category in the following year(s). For each of the categories, there are a number of ways NEHA recognizes and thanks contributors to the foundation. If you are interested in contributing to the Endowment Foundation, please fill out the pledge card or call NEHA at 303.756.9090.

Thank you.

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Shakopee, MN

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❍ **You have my permission to disclose the fact and amount (by category) of my contribution and pledge.**

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Albuquerque Environmental Health Department
www.cabq.gov/environmentalhealth

Allegheny County Health Department
www.county.allegheny.pa.us

American Academy of Sanitarians (AAS)
www.sanitarians.org

Anua
www.anua-us.com

Arlington County Public Health Division
www.arlingtonva.us

Ashland-Boyd County Health
hollyj.west@ky.gov

Association of Environmental Health Academic Programs
www.aehap.org

ATSDR/DCHI
www.atsdr.cdc.gov/hac

Camelot International Health Organization
www.camelot.gr

CDP, Inc.
www.cdpehs.com

Chemstar Corporation
www.chemstarcorp.com

Chesapeake Health Department
www.vdh.state.va.us/lhd/chesapeake

City of Bloomington
www.ci.bloomington.mn.us

City of Fall River Health & Human Services
(508) 324-2410

City of Houston Environmental Health
www.houstontx.gov/health/environmental-health

City of Milwaukee Health Department, Consumer Environmental Health
http://city.milwaukee.gov/Health

City of San Diego Environmental Services Department
www.sandiego.gov/environmental-services

City of St. Louis Department of Health
www.stlouis-mo.gov/government/departments/health

Coconino County Public Health
www.coconino.az.gov

Decade Software Company, LLC
www.decadesoftware.com

DEH Child Care
www.denvergov.org/DEH

DeltaTrak, Inc.
www.deltatrak.com

Digital Health Department, Inc.
www.dhdinspections.com

Diversey, Inc.
www.diversey.com

DuPage County Health Department
www.dupagehealth.org

Eastern Idaho Public Health District
www.phd7.idaho.gov

Ecobeco
www.ecobeco.com

Ecolab
www.ecolab.com

EcoSure
charlesa.arnold@ecolab.com

English Sewage Disposal, Inc.
(756) 358-4771

Erie County Department of Health
www2.erie.gov/health

Florida Department of Health
www.doh.state.fl.us

GLO GERM/Food Safety First
www.glogerm.com

HealthSpace USA Inc.
www.healthspace.com

Industrial Test Systems, Inc.
www.sensafe.com

Inspect2Go
www.inspect2go.com

International Association of Plumbing and Mechanical Officials
www.iapmo.org

ITW PRO Brands
http://itwprofessionalbrands.com

Jackson County Environmental Health
www.jacksongov.org/EH

Jefferson County Health Department (Missouri)
www.jeffcohealth.org

Jefferson County Public Health (Colorado)
http://jeffco.us/health

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Maricopa County Environmental Services
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McDonough County Health Department
www.mchdept.com

Merced County Public Health, Division of Environmental Health
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Mesothelioma Lawyer Center
www.mesotheliomalawyercenter.org

mesotheliomalawyers.com
www.mesotheliomalawyers.com

Micro Essential Lab
www.microessentiallab.com

Mid-Iowa Community Action
www.micaonline.org

Mitchell Humphrey
www.mitchellhumphrey.com

Mycometer
www.mycometer.com

National Environmental Health Science and Protection Accreditation Council
www.ehacoffice.org

National Registry of Food Safety Professionals
www.nrfsp.com

National Restaurant Association
www.restaurant.org

National Swimming Pool Foundation
www.nspf.org

Neogen Corporation
www.neogen.com

New Mexico Environment Department
www.nmenv.state.nm.us

New York City Department of Health & Mental Hygiene
www.nyc.gov/health

North Bay Parry Sound District Health Unit
www.healthunit.biz

Nova Scotia Department of Agriculture
www.gov.ns.ca

NSF International
www.nsf.org

Omaha Healthy Kids Alliance
www.omahahealthykids.org

Oneida Indian Tribe of Wisconsin
www.oneidanation.org

Orkin
www.orkincommercial.com

Ozark River Hygienic Hand-Wash Station
www.ozarkriver.com

PerkinElmer, Inc.
www.perkinelmer.com

Polk County Public Works
www.polkcountyiowa.gov/publicworks

Presby Environmental, Inc.
www.presbyenvironmental.com

Procter & Gamble Co.
www.pg.com

Prometric
www.prometric.com

QuanTEM Food Safety Laboratories
www.quantemfood.com

Racine City Department of Health
www.cityofracine.org/Health.aspx

Remco Products
www.remcoproducts.com

Sacramento County Environmental Management Department
www.emd.saccounty.net

San Jamar
www.sanjamar.com

Sarasota County Office of Environmental Health
https://sarasota.floridahealth.gov

Seattle & King County Public Health
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Shat-R-Shield Inc.
www.shat-r-shield.com

Skillsoft
www.skillsoft.com

Sonoma County Permit and Resource Management Department, Wells and Septic Section
www.sonoma-county.org/prmd

Starbucks Coffee Company
www.starbucks.com

Stater Brothers Market
www.staterbros.com

Sweeps Software, Inc.
www.sweepssoftware.com

Target Corp.
www.target.com

Taylor Technologies, Inc.
www.taylortechnologies.com

Texas Roadhouse
www.texasroadhouse.com

The Steritech Group, Inc.
www.steritech.com

Tri-County Health Department
www.tchd.org

Underwriters Laboratories, Inc.
www.ul.com

Waco-McLennan County Public Health District
www.waco-texas.com/cms-healthdepartment

Washington County Environmental Health (Oregon)
www.co.washington.or.us/HHS/EnvironmentalHealth

Waukesha County Public Health Division
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Winn-Dixie Stores, Inc.
www.winn-dixie.com

WVDHHR Office of Environmental Health Services
www.dhhr.wv.gov

Educational Institution Members

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www.StudyatAPU.com/NEHA

East Tennessee State University, DEH
www.etsu.edu

Eastern Kentucky University
http://eh.eku.edu

Michigan State University, Online Master of Science in Food Safety
www.online.foodsafety.msu.edu

Ponce School of Medicine, Public Health Program
www.psm.edu/php

The University of Findlay
www.findlay.edu

University of Illinois Springfield
www.uis.edu/publichealth

University of Vermont Continuing and Distance Education
http://learn.uvm.edu

University of Wisconsin–Oshkosh, Lifelong Learning & Community Engagement
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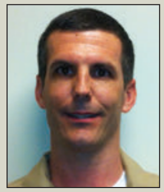

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To update information, contact Terry Osner at tosner@neha.org.

NEHA NEWS

NEHA General Election 2015—Results

Elections are a critical part of the democratic process and are one way to provide members a voice in the running of their organization. National officers of NEHA's board of directors serve a one-year term in each officer position—progressing from second vice president to board president and then immediate past president—for a total of five years. Regional vice presidents serve a three-year term. NEHA voting members have an opportunity to vote for candidates of a contested board of director's seat.

For more information about NEHA elections and the critical deadlines for nomination forms, eligibility dates to become a NEHA voting member, and ballot dates, please visit the election page on the NEHA Web site at www.neha.org/about/elections.html.

For the 2015 NEHA general election, the results are as follows.

Regional Vice Presidents (RVPs)

The terms of three RVPs expired in 2015:

- Region 2—RVP Marcy Barnett
- Region 3—RVP Roy Kroeger
- Region 8—RVP LCDR James Speckhart

There was a single candidate for the pending Region 2 vacancy as RVP Barnett decided to step down from the vice president position. There were no opposing candidates to RVP Kroeger and RVP Speckhart. Board policy does not require an election if candidates are unopposed. The terms of these RVPs will start at the close of NEHA's 2015 Annual Educational Conference (AEC) & Exhibition in Orlando, Florida. The vice presidents for the three regions are as follows:

- Region 2—Keith Allen (term expires 2018)
- Region 3—Roy Kroeger (term expires 2018)
- Region 8—LCDR James Speckhart (term expires 2018)

Second Vice President

There was a single qualified candidate for the second vice president position, Vince Radke. As previously noted, board policy does not require an election if candidates are unopposed. Radke will assume the second vice president position at the close of the 2015 AEC.

ENVIRONMENTAL HEALTH
EDUCATION & TRAINING

ENVIRONMENTAL HEALTH
ADVANCEMENT

ENVIRONMENTAL HEALTH
NETWORKING

ENVIRONMENTAL HEALTH
POLICY INVOLVEMENT

79th NEHA AEC

JULY 13–15, 2015

79th National Environmental Health Association (NEHA)
Annual Educational Conference (AEC) & Exhibition
Orlando, FL

IMAGINE THE NEW NEHA

REGISTER NOW, EARLY REGISTRATION ENDS IN MAY!	Member / Nonmember Until May 29	Member / Nonmember After May 29
Full Conference Registration Includes admission for one person to the Networking Luncheon, Exhibition Grand Opening & Party, and Presidents Banquet.	$575 / $735	$675 / $835
Retired/Student Registration Does not include any food functions. Tickets must be purchased separately.	$155	$230
One-Day Registration Does not include any food functions. Tickets must be purchased separately.	$310 / $365	$345 / $395

Registration information is available at neha2015aec.org.
For personal assistance, contact customer service toll free at 866.956.2258 (303.756.9090 local), extension 0.

A WISE INVESTMENT
for You and Your Organization

- Gain the skills, knowledge, and expertise needed to build capacity for environmental health activities.
- Help solve your environmental health organization's daily and strategic challenges and make recommendations to help improve your bottom-line results.
- Learn from speakers that are environmental health subject matter experts, industry leaders, and peers that share common challenges.
- Earn continuing education credit to maintain your professional credential(s).
- Receive a return on investment (ROI) with both immediate and long-term benefits.

See For Yourself
Visit neha2015aec.org/about for ROI and other information about the NEHA AEC.

Continuing Education Hours

Attendees of the 2015 AEC can earn up to 24 hours of continuing education for their NEHA credential.

NEHA has been recognized as a provider of relevant continuing education and recertification credits for these organizations:

- Florida Department of Health Registered Sanitarian
- Florida Department of Health Certified Environmental Health Professional
- California Registered Environmental Health Specialist

NEW TO THE NEHA AEC?

Check out our video from last year's conference using the E-*Journal* to get a peek of what it's all about!

Or, you can view the video at neha2015aec.org/about.

KEYNOTE SPEAKER

Meet NEHA's New Executive Director
David Dyjack, DrPH, CIH

We welcome David Dyjack to NEHA as our new executive director and 2015 AEC Keynote Speaker! Dyjack—a board certified industrial hygienist with advanced degrees in public health—most recently served as the associate executive director of programs at the National Association of County and City Health Officials. He brings a wealth of management and leadership experience ranging from local health departments to federal agency collaboration. His 30-year career spans a wide range of environmental health disciplines and experience in association management, a perfect combination for NEHA's new leader.

Join us at the 2015 AEC and hear firsthand our executive director's exciting new vision for charting a path forward to advance and elevate the environmental health arena, nationally and globally.

"Environmental health is the sun around which the well-being, safety, and security of our communities orbit. I admire our 20,000 environmental health professionals, and am energized by NEHA increasingly recognized for delivering results, relevance, and integrity," said Dyjack.

Americans value their health and the environment. Quarantine and isolation are discussed by the general public. The presence of adulterated and contaminated food is in the news. Water quality and quantity, and compromised distribution systems are increasingly worrisome. New and exotic sounding diseases keep us up at night. Land use planning and urban design intended to promote health are featured by local governments. Health advocates espouse the benefits of clean air, water, and whole foods.

Sound like your recent Twitter feed? Check again—these are headlines from 17th and 18th century America.

A recent study found that Americans believe that everyone is entitled to a safe and healthy environment, no matter where they live. History teaches us that people will rally to combat a perceived threat, and that their enthusiasm and attention to the issues quickly wanes after the threat dissipates, particularly if taxes or investments are required. New thinking, a new language, and new forms of leadership are required to break the cycle of the last 200+ years. Disruption of the status quo and relentless commitment to understanding the values and beliefs of society are critical to our profession's future and the health of the nation.

NEHA is on the brink of a new era, engaging global players from a variety of disciplines in an increasingly crowded and competitive world.

Attend the 2015 AEC and be part of envisioning the new NEHA!

MAP YOUR VISIT FOR EDUCATIONAL AMUSEMENT *at the* NEHA AEC

ENVIRONMENTAL HEALTH
EDUCATION & TRAINING

OUR MOST POPULAR PARKS

Food Safety Focus Series sponsored by Skillsoft & Prometric

Monday, July 13

The series objective is to provide information, updates, and a forum for discussion regarding the creation, implementation, and functioning of an integrated food safety system. This year's 5-part series will kick off with members of NEHA's board of directors and representatives from the FDA Office of Partnerships updating attendees on the Partnership for Food Protection and the initiatives of its workgroups as related to the **local** health agency. Subsequent presentations will focus on initiatives specific to foodborne illness outbreak investigations and food-related emergency responses.

5 sessions

The Florida Onsite Sewage Nitrogen Reduction Strategies Study Series

Tuesday, July 14

This half-day series will cover state-mandated research on nitrogen loading from onsite wastewater treatment systems. Presenters will address different types of systems and possible cost-effective, passive strategies for nitrogen reduction that complement the use of conventional onsite wastewater treatment systems. The results and models created by this project have implications for nitrogen reduction efforts far and wide.

5 sessions

Leadership & Management Communications & Outreach Series

Wednesday, July 15

This 3-hour series begins by looking at the why and how behind your agency's communications strategy and walks you through planning a strategic approach. Then, using the example of hand washing, attendees will apply an evidence-based model to optimize messages that target populations and produce desired outcomes in behavior. Finally, see how one agency is leveraging video technology in social media to create environmental health education that sticks.

3 sessions

DISNEY MAGIC ATTRACTIONS

Monday, July 13
Protecting, Conserving, Reclaiming, and Reusing the Water that Gives Us Life

Tuesday, July 14
Thinking Inside the Box: Using Cartoons to Imagineer Food Defense

Wednesday, July 15
Conserving the Magic: Creating a Culture of Environmentality™

Sustainable Solid Waste Management Tour: The Magical World of Biodigestion (*Separate registration is required for this field trip.*)

LAND, SEA, AND SPACE ATTRACTIONS

Monday, July 13
Navigating the Seas of Technology: Computer-Based Training for an International Cruise Line

Wednesday, July 15
Fire, Security, and Emergency Management Challenges for NASA's Space Program

Wednesday, July 15
Florida Onsite Wastewater Association Training Center
(Separate registration is required for this field trip.)

Wednesday, July 15
Tour of Aquatica, SeaWorld's Waterpark
(Separate registration is required for this field trip.)

UNIVERSAL APPEAL

Our comprehensive menu of environmental health and safety training and education programs includes over 150 educational presentations in over 20 different tracks, and well over 24 hours of continuing education credit. See neha2015aec.org/sessions-and-events for a complete listing.

- Super Bowl 2015: From Planning to Execution
- Health, Safety, and Security During an Outbreak of Ebola Virus Disease
- Legalized Trouble: What Legalized Marijuana Means for Environmental Health
- Everyone Deserves a Decent Throne Series
- "Doggie Dips" at Swimming Pools: Is This For Real?
- Drop In Learning Labs: attendee-driven educational interactions that consist of hands on demonstrations and small group consultations

AWARD WINNING ATTRACTIONS

AWARD WINNER PRESENTATIONS

AEHAP/NCEH Student Research Competition Winners

NEHA/UL Sabbatical Exchange Award Winner: To Glove or Not to Glove?

2015 Excellence in Sustainability Award Winner

**APSP 2013 Dr. R. Neil Lowry Grant Award Winner:
Developing a Drowning Prevention Awareness Program that Works for You**

**APSP 2014 Dr. R. Neil Lowry Grant Award Winner:
Geared Towards Compliance: A Public Pool and Spa Operator Regulatory Training Program**

GO AHEAD GIVE IN

VISIT THE ORLANDO ATTRACTIONS YOU'VE *always* WANTED TO SEE!

NEHA AEC DESIGNATED HOTEL

Renaissance Orlando at SeaWorld
Room rate: $129 per night + taxes.
AEC attendees will not have to pay the hotel's resort or Internet fees.

For more information, visit neha2015aec.org/hotel.

With dozens of theme parks and attractions, world-class golf courses, and miles of ocean and gulf beaches a short drive away, you will want to plan an extended stay in Orlando before or after (or both!) the conference. Cool off at a water park, visit an orange grove, take an airboat ride, or drive a NASCAR race car!

So Much to Explore!

- SeaWorld Orlando
- Disney's Magic Kingdom, Animal Kingdom, Hollywood Studios, Epcot
- Kennedy Space Center and Visitor Complex
- Discovery Cove
- Legoland
- Universal Studios Florida including the Wizarding World of Harry Potter
- Richard Petty Driving Experience
- Busch Gardens Tampa
- Gatorland and Wild Florida Gator Park

NETWORKING

Strengthen your business and personal relationships and build a network of colleagues that you can call on at anytime!

ANNUAL UL EVENT

Join us as we welcome attendees to Orlando with the ever popular UL Event. You're invited to the Hard Rock Café at Universal's City Walk where you'll be treated to a red carpet entrance, cocktails, and appetizers in the John Lennon Room. This private room within the world's largest Hard Rock Cafe is an ideal way to network with one another in one of the city's premier VIP venues. You'll also have plenty of time afterwards to enjoy a night on the town visiting the other City Walk hot spots.

The UL Event is $30 per person and is not included in the registration pricing for the AEC. Visit neha2015aec.org for pricing and registration details.

CONNECT

Lunch in Exhibition
This year we've combined the Exhibition and a concession lunch so that you have more chances to network with one another and with our fabulous AEC exhibitors.

More Ways for You to Connect

- Community Event on Sunday
- Networking Luncheon on Monday, sponsored by American Public University
- Exhibition on Monday and Tuesday
- Breakfast & Town Hall Assembly and Presidents Banquet on Wednesday

JOIN US FOR THE COMMUNITY EVENT!

Kick off the conference on Sunday afternoon by joining us to volunteer with the Clean the World Foundation. It was such a worthwhile activity last year in Las Vegas, and we're fortunate that our conference is held in Orlando where Clean the World has a second facility. Visit neha2015aec.org for details and to sign up!

BE INSPIRED!

In a world where environmental health professionals are often unsung heroes, the AEC is the ideal time and place to recognize and congratulate your peers for their contributions. With almost two dozen awards given, hear the inspirational stories and learn about the people in the honored spotlight.

The diversity you will find in the 2015 award winners covers a broad spectrum of excellence in the field. From sustainability and education to food safety and leadership—the award winners represent the best in the field and the past, present, and future movers and shakers for our profession.

Learn more about last year's environmental health award winners and scholarship awards at neha.org/about/Awards/2014-Awards.html.

NEW FOR 2015!

New networking opportunity: the **Award Winners' Circle!**
This will be a place where attendees can connect, chat with, and be inspired by the award winners recognized at the AEC.

The first annual **Secretary's Awards for Healthy Homes**—from the U.S. Department of Housing and Urban Development in partnership with NEHA—for excellence in healthy housing innovation and achievement in

- Public Housing/Multifamily Supported Housing
- Public Policy
- Cross Program Coordination among Health, Environment, and Housing

ENVIRONMENTAL HEALTH
ADVANCEMENT

PRE-CONFERENCE COURSES AND EXAMS

Schedule is subject to change.

Advance your expertise and career potential by obtaining a NEHA credential or certification at the AEC. You may choose to take just a credential/certification course, just an exam, or both a course and an exam. *Note: Only qualified applicants will be able to sit for an exam.*

Visit neha.org/credential for details on each exam or pearsonvue.com/neha for alternate test options.

Certified Professional – Food Safety (CP-FS)

Saturday & Sunday, July 11 and 12, 8 am – 5 pm

This two-day refresher course is designed to enhance your preparation for the NEHA CP-FS credential exam. Participants are expected to have prior food safety knowledge and training equal to the eligibility requirements to sit for the CP-FS exam. The course will cover exam content areas as described in the job task analysis. The instructor will be available during and after the course for questions.

Cost: *$325 for members and $425 for nonmembers. Includes the CP-FS Study Package (*CP-FS manual, *NEHA's* Professional Food Manager *book, and the* 2009 and 2013 FDA Food Codes *on CD), a $235 value.*

Exam: Monday, July 13, 8 – 10:30 am
Separate application and exam fee required. $245 member/$390 nonmember. Deadline to apply to take the exam is May 29, 2015.

Certified in Comprehensive Food Safety (CCFS)

Friday & Saturday, July 10 and 11, 8 am – 5 pm
Sunday, July 12, 8 am – 12 pm

NEHA is pleased to offer the course for the CCFS credential at the 2015 AEC. The CCFS is a strong core credential for food safety professionals with a primary concern of overseeing the producing, processing, and manufacturing environments of the U.S. food supply. It has been designed to meet the increasing need for highly qualified food safety professionals from both industry and the regulatory community that provide oversight in preventing food safety breaches at U.S. production and manufacturing facilities and abroad. The credential course will cover exam content areas as described in the job task analysis. The course will utilize different learning modalities from critical thinking exercises to small group breakouts and videos.

Cost: *$375 for members and $475 for nonmembers. Includes NEHA's* CCFS Preparation Guide.

Exam: Monday, July 13, 8 – 10:30 am
Separate application and exam fee required. $245 member/$390 nonmember. Deadline to apply to take the exam is May 29, 2015.

Registered Environmental Health Specialist/ Registered Sanitarian (REHS/RS)

Friday & Saturday, July 10 and 11, 8 am – 5 pm
Sunday, July 12, 8 am – 12 pm

This two and a half day refresher course is designed to enhance your preparation for the NEHA REHS/RS credential exam. Participants are expected to have a solid foundation of environmental health knowledge and training equal to the eligibility requirements to sit for the REHS/RS credential exam. This course alone is not enough to pass the REHS/RS credential exam. The class will cover exam content areas as described in the job task analysis. The instructor will be available during and after the course for questions.

Cost: *$499 for members and $599 for nonmembers. Includes the* REHS/RS Study Guide*, a $179 value.*

Exam: Sunday, July 12, 1 – 6 pm
Separate application and exam fee required. $265 member/$450 nonmember. Deadline to apply to take the exam is May 29, 2015.

HACCP—Managing Hazards at the Retail Level

Sunday, July 12, 8 am – 5 pm

The course is designed to teach the requirements needed for HACCP team/staff and to provide managers, regulators, and frontline food safety personnel in retail food facilities with an understanding of how behavior and active participation in creating, implementing, and maintaining a HACCP plan can greatly impact the likelihood for success. Special emphasis is placed on the process HACCP approach.

Managing Hazards at the Retail Level is offered and certified by NEHA; the course is further accredited by the International HACCP Alliance.

Cost (course and exam): *$249 for members and $299 for nonmembers.*

Exam: Monday, July 13, 8 – 10 am

PRELIMINARY SCHEDULE

Friday, July 10

Review Courses: REHS/RS, CCFS

Saturday, July 11

Review Courses:
REHS/RS, CP-FS, CCFS

Sunday, July 12

Review Courses: REHS/RS, CP-FS, CCFS, HACCP
Exam: REHS/RS (afternoon)
Events:

- Community Event
- First Time Attendee Workshop
- Annual UL Event

Monday, July 13

Exams: CP-FS, CCFS, HACCP
Events:

- Education Sessions
- Networking Luncheon
- Keynote Presentation
- Award Presentations
- Award Winners' Circle
- Exhibition Grand Opening & Party

Tuesday, July 14

Events:

- Education Sessions
- Exhibition
- Lunch in Exhibition
- Student Research Presentations
- Poster Session

Wednesday, July 15

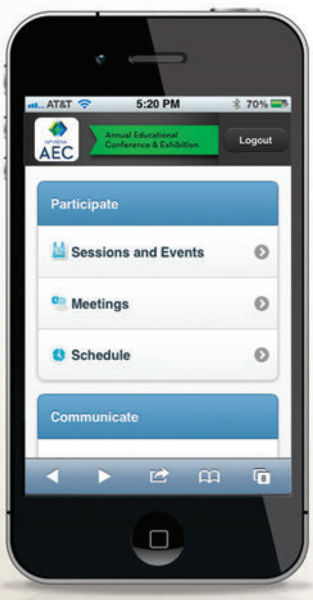
Events:

- Breakfast & Town Hall Assembly
- Education Sessions
- Field Trips
- Presidents Banquet

Schedule is subject to change.

Deadline for REHS, CP-FS, and CCFS exam applications is May 29, 2015.

YOUR AEC MEETING COMPANION



Download the AEC App from Google Play or iTunes

Enhance your learning experience whether you attend the AEC or participate online from your home or office.

- **Stay connected and informed:** View interactive maps, session descriptions, speakers, exhibitors, and attendee profiles. Get the latest AEC news and announcements via live social feeds sent directly to you.
- **Create your customized conference schedule:** Add sessions and events you want to attend to your schedule. Then, export the schedule to your Outlook or other electronic calendar.
- **Network and converse:** "Meet" other attendees, speakers, and exhibitors via the chat forums. Request meeting connections, swap digital business cards, or connect digitally with others in your area of specialty or geographic region.
- **Learn:** Use the chat feature to ask questions, post comments, and communicate with speakers and other attendees. Discover the latest innovative products and services shared by AEC exhibitors.

Your Continuing Education Resource

After the conference, you can still access the educational sessions, view presentation slides, and obtain supplemental materials through the continuing education resource.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You are ready for American Public University.
With more than 90 degrees to choose from, there's almost no end to what you can learn. Pursue a respected Environmental Science degree or certificate online — at a cost that's 20% less than the average in-state rates at public universities.*
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Ready when you are.™
*College Board: Trends in College Pricing, 2013.
We want you to make an informed decision about the university that's right for you. For more about our graduation rates, the median debt of students who completed each program, and other important information, visit www.apus.edu/disclosure.
BEST
ONLINE PROGRAMS
US News
BACHELOR'S
2015

QUESTIONS?

HOW DOES THE MAHC **APPLY?**

IS THIS HOOD APPROPRIATE FOR THIS COOKING EQUIPMENT?

WHICH STANDARDS **APPLY TO** FOOD CARTS?

WHERE DO I FIND INFORMATION ABOUT DRINKING WATER **ADDITIVES?**

HOW DO I STAY **AHEAD OF** EMERGING PATHOGEN **ISSUES?**

WHAT IS THE PROCESS FOR FIELD EVALUATION OF EQUIPMENT?

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