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Volume 82, No. 6 January/February 2020

Water Quality Trading

EXPLORING HOW IT CAN BE UTILIZED TO UPGRADE RURAL SEPTIC SYSTEMS

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ABOUT THE COVER

Water quality trading is a market-based mechanism that aims to improve water quality in a way that maximizes economic efficiency while conserving environmental integrity. This month's cover article, "Water Quality Trading Mechanism Enhances Willingness to Upgrade Rural Household Septic Systems in the Western Lake Erie Basin, Northwest Ohio," studied the willingness of rural households to participate in water quality trading for septic system upgrades. Findings show that more than half of responding households were willing to upgrade their septic systems in a water quality trading program.

See page 8.

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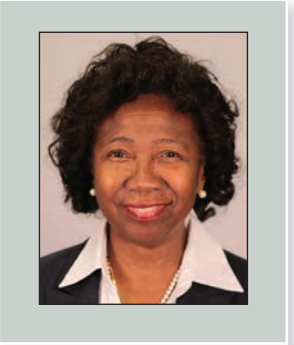

Priscilla Oliver, PhD

NEHA Is Open to Strategic Partnerships

As I reflect over my work with health and the environment, I have thought about how I want to be remembered? The one word that radiates over me is partnerships. Each day, I awaken to put on commitment and then quickly move to thinking partnerships. Sure, we make individual contributions but there is so much more that we can accomplish by partnering with others. Remember, two heads are better than one. If you want to go further, go with others. Higher education is partly accomplished individually but another important component is working in teams, study groups, and partnerships to get the degree and the dream position. I thank the National Environmental Health Association (NEHA) board members, leaders, staff, and members for continually working as a team and supporting NEHA over the years. I feel the precious moments and feel blessed to be able to enjoy the special moments when we make strides as a team.

Part of the success of NEHA is due to partnerships that have existed down through the years. NEHA needs partners at all levels: federal, state, corporate, nonprofit, and local. Current federal partners include the Centers for Disease Control and Prevention, Food and Drug Administration, U.S. Department of Housing and Urban Development, and U.S. Environmental Protection Agency. This year I have visited and spoken at affiliate annual conferences in Alabama, Florida, Georgia, Jamaica, Massachusetts, New York, and Texas. Much of the mission of NEHA is completed in the affiliates, so they are our strong partners. It has been a pleasure to travel to annual affiliate meetings, speak, and assist with thanking and motivating our professionals. There have been so many accomplishments noted. If invited to come, our NEHA leaders and board members will participate in annual affiliate and partner meetings. We also participated in an exciting corporate partner celebration, the NSF International 75th anniversary. NEHA is in the process of planning the 84th Annual Educational Conference & Exhibition in New York City in July 2020. Our partners will be visible and recognized. The many years of service in partnership to environmental health are astronomical and continue. Certainly, there are other state affiliates that we want to join or rejoin us such as Pennsylvania, South Carolina, Hawaii, North Carolina, Delaware, etc.

> *Partnerships can increase our strength and allow us to better market the profession.*

Partnerships allow NEHA to expand our reach to additional areas and reach more professionals. We want to also expand to more communities, increase diversity, and expand the reach of the association to rural, urban, regional, and global settings. The demands on environmental health and the areas of concern are expanding. Climate change, disaster relief, preparedness, food security, expanding hazards, disease outbreaks, expanded travel capabilities, environmental justice, sustainability, etc. give more challenges to the profession. The list of environmental health issues and challenges are growing with time. It takes more and varied people with different backgrounds, diverse funding streams, additional training and credentials, research, and varied resources to maintain our effectiveness in the new and old areas to protect human health and the environment. Therefore, we need to expand and grow to add strategic partnerships to the team. Just imagine in the last few years, we have added some additional challenges and expertise to environmental health. Partnerships can increase our strength and allow us to better market the profession.

First, let me say thank you to the partners, affiliates, and sponsors that we currently have. Your dedication through the years is so very much appreciated. The teamwork has fueled our fire and kept us floating and on target. We must, however, get ready for the increasing future demands, issues, and needs. As membership has grown over the years, so should our reach. It is expected that membership will continue to grow and become more diverse. New strategic partners can bring greater insight, additional solutions, and broaden our reach as needed. An example:

"NEHA and ecoAmerica work closely together to build awareness and support for climate solutions in the environmental health profession. Environmental health professionals are often the first line of defense and are in the trenches working on climate solutions that improve

the health of people in the communities they serve. Through our partnership, we have been able to distribute tools and resources for environmental health professionals across the country," Rebecca Rehr, MPH, senior program manager, Climate for Health at ecoAmerica.

There is a demand for strategic partnerships with additional federal, state, corporate, academic, and local levels. Additional expertise, expanded perspectives, creativity, innovation, and diversity are needed in these partnerships to embrace the future of NEHA. Increased collaboration, coordination, and communication of outcomes should be a part of this future. None of us can rely on the same partners to do the same work when the work and the population are expanding. Thus, let us put on our thinking caps, expand, and reach out to obtain the strategic partnerships for the future of NEHA. If you feel you can help or you want to be a part of NEHA, please become a member and/or become a partner now.

Priscilla

President@neha.org

Did You Know?

Through funding from the Centers for Disease Control and Prevention, NEHA is pleased to announce the 2020 National Environmental Public Health Internship Program. The program will support 20 environmental health student internships during summer 2020. The application period is now open for students from National Environmental Health Science & Protection Accreditation Council-accredited undergraduate and graduate environmental health programs. Local, state, and tribal health departments can apply to host one of the internships. Deadline to submit is January 15. Learn more at www.neha.org/professional-development/students/internships.

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 1 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 call NEHA at (303) 756-9090. You can also donate online at www.neha.org/about-neha/donate.

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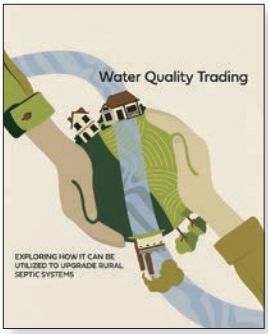

Water Quality Trading Mechanism Enhances Willingness to Upgrade Rural Household Septic Systems in the Western Lake Erie Basin, Northwest Ohio

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Abstract **Water quality trading (WQT) is a market-based mechanism that aims to improve water quality in a way that maximizes economic efficiency while conserving environmental integrity. It is a compliance approach that allows point sources, such as factories, to meet regulatory obligations by using pollutant reductions created by another source, such as local farms, which has lower pollution control costs. The objective of this study was to explore the possibility of expanding the use of WQT from agriculture to rural septic systems, an often-neglected nonpoint source of nutrients to Lake Erie. Septic system upgrades in northwestern Ohio are of special interest because the soil conditions in this area pose a limitation to the effectiveness of nutrient removal for conventional soil-based systems. We assessed the willingness of septic system users to upgrade their systems using three scenarios emphasizing climate change, governmental regulation, or WQT. We found that septic system users were most interested in upgrades under the WQT scenario. The idea of WQT was better accepted in certain locations where septic system users were more concerned about the environment, perceived the local water quality to be degraded, and were aware of the limitation of their septic systems. Pilot WQT projects should focus on approaching these users.**

Introduction

The western part of Lake Erie has suffered from increasingly severe eutrophication and frequent harmful algae blooms (HABs) since the mid-1990s (Kane, Conroy, Richards, Baker, & Culver, 2014). The toxic or potentially toxic cyanobacterial HABs have threatened the health of millions who depend on Lake Erie as a drinking water source (Michalak et al., 2013; Stumpf, Wynne, Baker, & Fahnenstiel, 2012). The Lake Erie HABs mainly have been caused by the overloading of nonpoint-source phosphorus, most of which comes from the Maumee River during springtime (Ho & Michalak, 2017). The Phosphorus Task Force of Ohio (Ohio Environmental Protection Agency, 2010) identified two main nonpoint phosphorus sources: agriculture and rural septic systems.

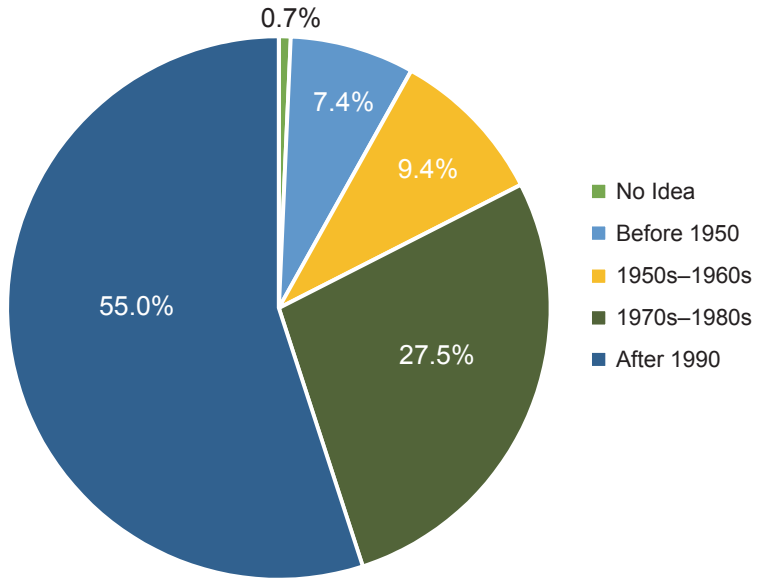
The Ohio Department of Health estimated about 352 tons/year of total phosphorus (TP) was contained in the onsite septic system effluent of the 148,000 homes discharging into the Lake Erie watershed (Ohio Department of Health, 2008). About 25% of this discharge reaches a waterway, contributing 88 tons/year of TP to Lake Erie. In our study site in the Blanchard River Watershed, a subwatershed of the Maumee River Watershed that drains into western Lake Erie, septic systems are the fourth largest source of phosphorus, contributing 7.83 tons of phosphorus to the watershed every year, which is even higher than the 6.19 tons/year contribution from point sources (Ohio Environmental Protection Agency, 2009).

In addition to their effect on Lake Erie HABs, septic systems present a public health threat. Septic systems are the major reservoir of human enteropathogens. If not properly treated, septic system effluent can contaminate groundwater and surface water. The Ohio Department of Health and Ohio Environmental Protection Agency (2013) and Vedachalam and coauthors (2012) estimated that the septic system failure rate in Ohio is around 30%. This translates to approximately 120 million gallons/day of untreated or partially treated wastewater being discharged to ground and surface waters (Vedachalam, Hacker, & Mancl, 2012).

In Ohio, the main causes of septic system malfunctioning include aging (44%), overloading (43%), soil limitations (33%), and site limitations (25%) (Ohio Department of Health & Ohio Environmental Protection

FIGURE **1**

Surveyed Household Septic System Installation Years



Agency, 2013). Soil limitations are of critical importance. Only unsaturated, deep (>4 ft), and permeable soil can effectively remove suspended solids, organic matter, ammonia, bacteria, and viruses (Mancl & Slater, 2015). While 72% of all systems installed in Ohio were traditional soil-based septic systems (Vedachalam et al., 2012), 68.2% of the soil in Ohio is considered not suitable for soil-based septic systems because the soil is <4 ft deep to the water table or a restrictive layer, subject to frequent flooding, or poorly permeable soil (Mancl & Slater, 2015).

The proportion of unsuitable soil is the highest in northwest Ohio (Mancl & Slater, 2015), so not surprisingly, the estimated failure rate of septic systems in northwest Ohio is the highest (39%) compared with other parts of the state (Ohio Department of Health & Ohio Environmental Protection Agency, 2013). Northwest Ohio is where the Western Lake Erie Basin and the former Great Black Swamp overlapped. The Great Black Swamp was one of the biggest wetlands in the U.S. over a century ago. Although the area was transformed into farmland with deep, artificial drainage ditches from the 1860s to the turn of the century, most soil in this area is still easily saturated (Levy, 2017).

From 1958–2012, the amount of rainfall in what are categorized as "very heavy rain events" has increased 30–39%. This amount is predicted to increase by up to 5 times by 2081–2100 compared with the last two decades of the 20th century in the northern part of the U.S., including northwest Ohio (Walsh et al., 2014). The negative impact of failing septic systems on water quality and environmental health is expected to worsen. Unfortunately, failing septic systems have long been ignored in watershed management programs. To fill this gap, this study aimed to promote soil-based septic system upgrades on a watershed scale using an approach called water quality trading (WQT).

WQT allows point sources, such as factories and wastewater treatment plants, to meet their regulatory obligations of the National Pollutant Discharge Elimination System (NPDES) by using pollutant reductions created by another source that has lower pollution control costs (U.S. Environmental Protection Agency, 2004). For example, The Freshwater Trust has successfully operated multiple WQT projects in Oregon. A thermal credit trading between the city of Medford's wastewater treatment plant and local landowners in the Rogue River Watershed has led to the planting of nearly 90,000 native plants along 25,109 ft of stream, reducing 594 lb of nitrogen per year and 438 million kilocalories from solar energy per day (The Freshwater Trust, 2016). Implementation of this project saved the taxpayers approximately $8 million (The Freshwater Trust, 2016).

Several WQT programs have included septic system upgrades into their design. For example, in the South Nation River WQT program in Ontario, Canada, septic system upgrades were a major credit-generating conservation measure. More recent programs, such as the Chesapeake Bay Trading program (Maryland Water Quality Trading Advisory Committee, 2017) and the Montana Nutrient Trading program (Walsh, Meyer, & Kieser, 2014), also considered incorporating septic systems into their trading schemes.

Using as an example WQT programs that use a community-based approach, such as South Nation River (O'Grady, 2011) and Alpine Cheese and Muskingum (Moore, 2014), this study investigated the feasibility of incorporating rural septic system upgrades into WQT as a part of the watershed nutrient management scheme. This approach can bridge all rural residents—both farmers and nonfarmers—to address the environmental and public health issues as a community. To meet this objective, we studied the willingness of rural households to participate in WQT for septic system upgrades. We compared three upgrade scenarios and identified a pilot project location.

Methods

The study site was the overlapping area of Hancock County, Ohio, and the Blanchard River Watershed, a subwatershed of the Western Lake Erie Basin. The Blanchard River Watershed is a HUC 8 watershed that covers 493,415 acres spanning five counties in Ohio: Allen, Hancock, Hardin, Putnam, and Wyandotte. About three quarters of Hancock County fall within the Blanchard River Watershed, taking up over 50% of the area of the watershed. This area is a part of the former Great Black Swamp, which was drained by deep ditches and transformed into an agricultural landscape more than a century ago. Due to the legacy of the swamp and the low elevation, cities in downstream Blanchard River, such as Findlay and Ottawa, frequently flood (National Oceanic and Atmospheric Administration, n.d.).

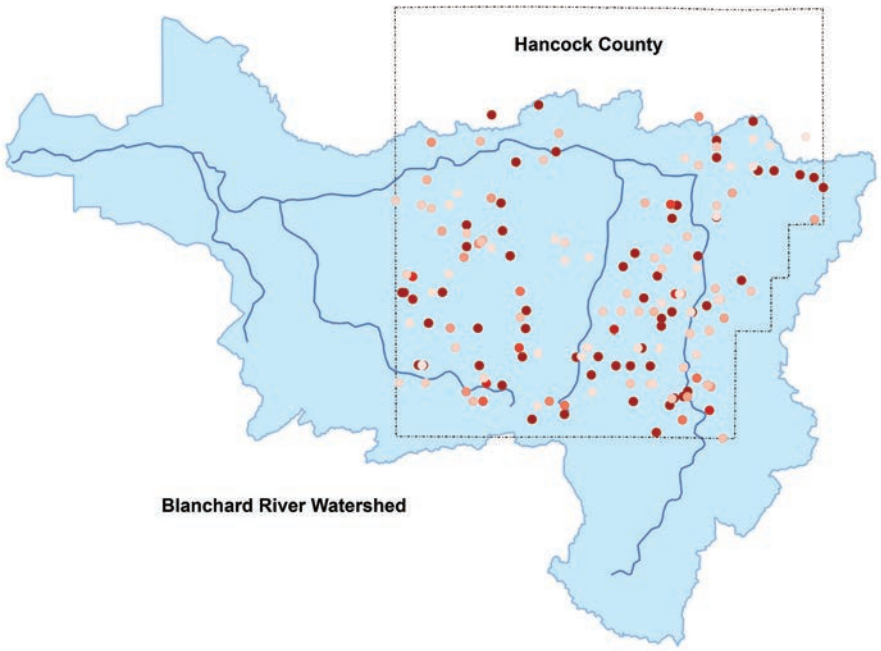
A questionnaire survey was delivered to households that use septic systems to treat their domestic wastewater within the study area. The 1,891 qualified households included 541 farming households and 1,300 nonfarming households. We used the "drop-off/pick-up" method (Melevin, Dillman, Baxter, & Lamiman, 1999) for this survey, which has the advantage of reducing nonresponse bias (Steele et al., 2001), especially in natural resource surveys (Allred & Ross-Davis, 2010). The face-to-face communication also allows the researcher to better determine the eligibility of the respondent and gain experiential insights (Allred & Ross-Davis, 2010; Steele et al., 2001).

From October 2016–February 2017, we visited 541 farming households and 359 randomly selected nonfarming households. Among these households, 578 had no adult available in the first and second visit. Of households asked to fill out the survey, the overall response rate was 57.1%. We also obtained information from the Hancock County Auditor database on house age, area, value, and number of rooms. GIS data of soil type, soil depth, elevation, and slope throughout the study area were obtained from U.S. Department of Agriculture (USDA) and U.S. Geological Survey online datasets.

Binary logistic regression models were employed to investigate the relation between willingness to upgrade the septic system under three different scenarios: 1) increased intensity rainfall scenario, 2) new regulation scenario, and 3) WQT scenario. The independent variables were septic system conditions, environmental perceptions, demographics, and house characteristics. Kernel density analysis using ArcGIS was employed to study the spatial distribution of households with different willingness to upgrade in the three scenarios.

FIGURE **2**

Age of Houses in Survey



Note. The darker colored dots indicate older houses.

Results and Discussion

Current Status of Septic Systems in the Blanchard River Watershed

Aging is the most common cause of septic system failure in Ohio (Ohio Department of Health & Ohio Environmental Protection Agency, 2013). The useful life of a septic system is between 20 to 30 years. Many (45%) of the sampled septic systems were installed before 1990 and are now considered out of date (Figure 1). Older houses tend to have older systems. It is notable that in this area, 45% of the sampled houses were over 100 years old. These old houses were scattered throughout the study site (Figure 2).

Soil limitation is also causing septic system malfunctioning. In Hancock County, approximately 40% of soils are hydric (U.S. Department of Agriculture [USDA], 2006). Pewamo is the most common soil type in Hancock County. This soil type is poorly drained, shallow to the water table, and frequently ponds—which disqualifies it from being suitable for septic system leach fields. According to the USDA Soil Survey (2006), 98% of the soil in Hancock County was ranked "very limited" for the use of septic system leach fields because "the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected" (USDA, 2006).

Fortunately, a majority of the households in the study area were responsible users of septic systems. In the past 5 years, 41% of the septic systems were inspected and 66% were pumped out. Some (39%) were treated with treatment products and 17% of the households did not do anything to maintain their septic systems. Unfortunately, septic system routine maintenance is not able to overcome the problems caused by deteriorating tanks, undersized systems, and soil limitations. Septic system upgrades are still necessary. All owners need to learn that septic systems need regular maintenance and replacement, like other home fixtures.

Household Willingness to Upgrade Septic Systems

In this study, we assessed household willingness to upgrade their septic systems in three scenarios:

1. increase in the frequency of heavy rain events in the area, causing more severe water pollution;
2. a new state regulation regarding septic systems in January 2015; and

FIGURE **3**

Household Willingness to Upgrade Septic Systems Under the Three Study Scenarios

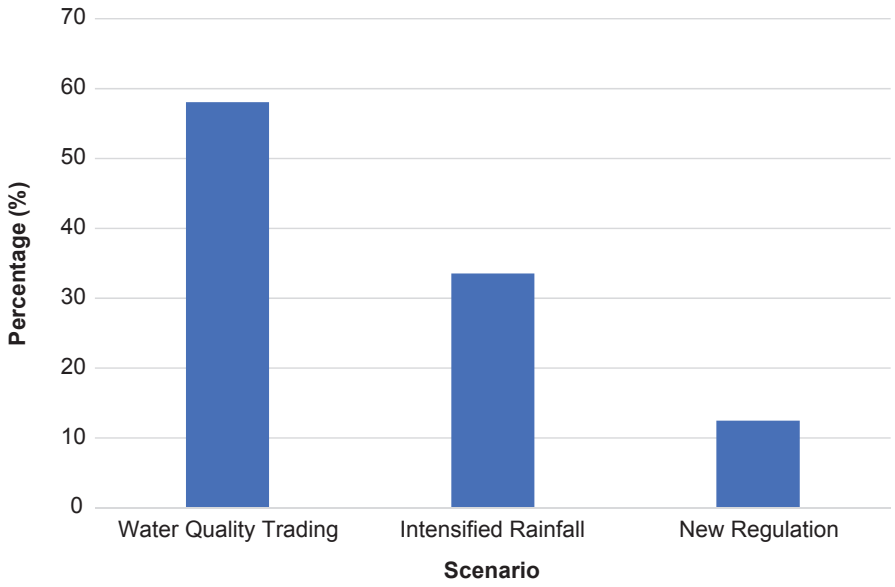


TABLE **1**

Household Interest in the Three Water Quality Trading (WQT) Models

Trading Model	Not Interested (%)	Slightly Interested (%)	Somewhat Interested (%)	Very Interested (%)
Interest in the general idea of WQT	56.79	27.78	14.20	1.23
Interest in WQT with an annual payment ($50)	57.86	30.19	10.69	1.26
Interest in WQT with a professional management plan	56.52	29.19	12.42	1.86
Overall interest in any of the above three WQT models	41.94	41.29	14.84	1.94

3. WQT concept, presented as three trading models.

The three WQT training models were:

1. the return from participating in WQT was not specified;
2. participating household would receive an annual payment of $50/household as return; and
3. instead of payment, the trading fund would be used to hire a local professional to manage the participating household septic system.

We found that the responding households were much more willing to upgrade their septic systems in the scenario of WQT than in the other two scenarios (Figure 3). The households showed no preference to any of the three WQT models (Table 1): 43.21% had some degree of interest in the general idea of WQT, 42.14% were interested in the annual payment model, and 43.48% were interested in the professional management model. Overall, 58.06% of the households showed some degree of interest in at least one of the three trading models for septic system upgrades.

O'Grady (2011) of the South Nation River WQT project, which had successfully incorporated septic system upgrades into its scheme, pointed out that community agreement was a critical condition for a WQT project to succeed. In the Blanchard River Watershed, the idea of WQT was accepted by a majority of rural households, suggesting its potential to serve as an incentive for septic system upgrades. It should also be noted that, because WQT is still a new concept in the area, more effort should be made to communicate the concept to the local community on a broader scope.

The spatial analysis showed the clustering of households that were likely to upgrade septic systems under the WQT scenario, intensified rainfall scenario, and new regulation scenario (Figure 4). The overlapping area of households willing to upgrade in each scenario was located around the upstream area of the Blanchard River main stem and Eagle Creek tributary within Jackson, Delaware, and Eagle townships of Hancock County, Ohio, suggesting that this area might have greater potential for a pilot rural wastewater management project than other areas in the watershed.

Factors Associated With Household Willingness to Upgrade Septic Systems

Among all independent variables, perceived effectiveness of septic systems, perceived water quality in nearby streams, environmental concerns, concerns about governmental regulation, household income, and age of house were significantly related to household willingness to upgrade their septic systems. The perceived effectiveness of the septic system in removing sewage, pathogens, and nutrients had a negative relationship with willingness to upgrade the system. For the perceived effectiveness to increase by 1 unit, the odds of a household becoming willing to upgrade decrease by 14.10% in the intensified rainfall scenario and decease by 10.73% in the WQT scenario.

Households that considered their septic systems to be more effective saw less necessity for upgrading, implying that the limitation of soil condition in this area and the fact that septic systems have a finite lifespan were largely neglected. As discussed previ-

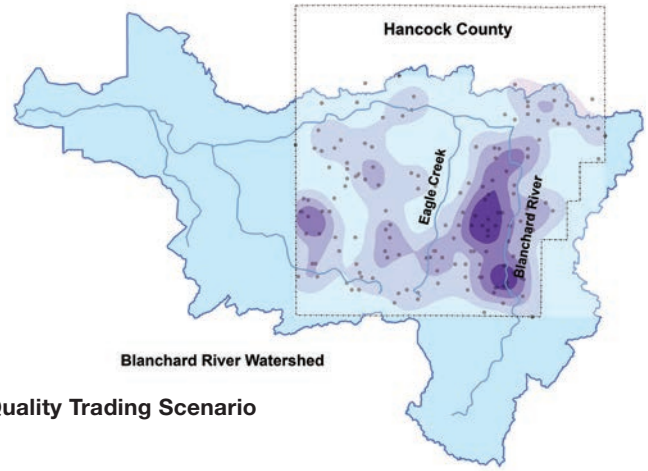
ously, education of the factors limiting septic system effectiveness is critical in enhancing household awareness of the need for system upgrades. The concerns about governmental regulation had a negative impact on household willingness to upgrade in the intensified rainfall scenario. The odds of those who were "somewhat concerned" or "very concerned" about increasing regulation to upgrade were approximately 95% lower than those households that had no idea about this issue.

The perceived water quality in nearby streams was positively related to upgrade willingness in all three scenarios. For households that considered the local water quality to be "poor," the odds of being willing to upgrade were 71.59 times higher than households that had no idea about water quality in the regulation scenario. For households that considered water quality to be "fair," the odds of being willing to upgrade were 58.38 times higher (versus those households that had no idea about water quality) in the intensified rainfall scenario and 14.64 times higher in the WQT scenario. For those households that considered water quality to be "average," the odds of being willing to upgrade were 72.75 times higher in the regulation scenario and 4.71 higher in the WQT scenario. Moreover, the odds of households that considered water quality to be "good" or "excellent" to be willing to upgrade were lower.

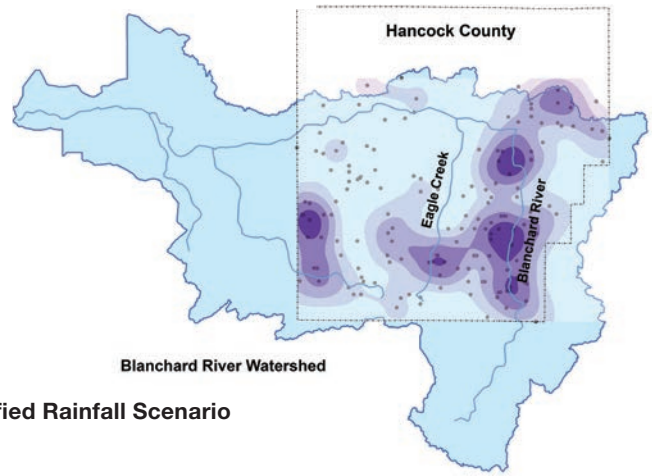
Household concern over environmental issues was also an important factor. As 1 unit increased in the environmental concern score, the odds of a household being willing to upgrade the septic system increased by 1.35 times in the intensified rainfall scenario. The more concerned a household was about the local aquatic environment, the more likely they would upgrade the septic system. As found in other studies (Moore et al., 2016; Morton et al., 2016; Prokopy, Floress, Klotthor-Weinkauf, & Baumgart-Getz, 2008; Prokup, Wilson, Zubko, Heeren, & Roe, 2017), the awareness of local environment degradation and concern of environment quality had a positive effect on behavior change. Future rural household wastewater management programs should focus on the education of local environmental issues and fostering environmental awareness.

FIGURE **4**

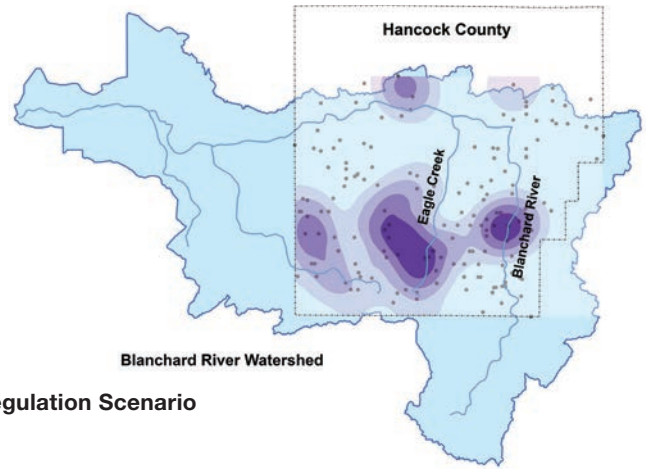
Spatial Distribution of Household Willingness to Upgrade Septic Systems in the Three Study Scenarios



A. Water Quality Trading Scenario



B. Intensified Rainfall Scenario



C. New Regulation Scenario

Note. The darker color indicates a higher willingness.

Sources: USGS, ESRI, Airbus DS, NGA, NASA, CGIAR, N. Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap, HERE, Garmin, FAO, NOAA, OpenStreetMap, and the GIS user community.

Households with high incomes were also more likely to upgrade septic systems. In the intensified rainfall scenario, the odds of high-income (annual income >$100,000) households being willing to upgrade were 3.92 times higher than the low-income households (annual income <$50,000); in the WQT scenario, the odds were 3.59 times higher. Cost is a major prohibiting factor in septic system upgrades. According to the Ohio Department of Health (2008), in northwest Ohio the average cost of installing a septic system with shallow leach lines was $7,988 and $11,355 for a sand mound system.

The high cost of replacing or upgrading a septic system could present a significant financial hardship to low-income households. In the study area, for instance, 19.4% of the households had an annual income <$50,000; financial support programs are necessary to help these households. The following are examples of programs that offer funding opportunities: the U.S. Department of Housing and Urban Development's Community Development Block Grant Program and Federal Housing Administration; USDA's Office of Rural Development, Section 502 Direct Loan Program, and Section 504 Home Repair Program; the Community Housing Improvement Program; and the Ohio Housing Trust Fund. Many of these grants, however, are either highly competitive or restricted to households with certain eligibilities (Ohio Department of Health, 2008). More funding opportunities should be made available to households that need septic system upgrades or replacement.

Limitations

This study used the drop-off/pick-up method to collect survey responses. Face-to-face interaction increases response rate but it is also time- and cost-consuming, especially when the households were less accessible, such as in the rural area. In this study, many households had no one home when the survey was delivered. Although we made sure at least one drop-off attempt was made to every potentially eligible household within the study area, the missed households (nonresponders) might introduce some bias.

Another limitation comes from the understanding of the concept of WQT, which is relatively new and has been practiced in only several states in the country. For most respondents, their first time hearing about this concept was when they took the survey. Given their heterogeneous background, respondents might have different understanding of WQT; therefore, the same response to one question might have different implications. In future research, a more detailed introduction of WQT and a focus group discussion could be helpful to minimize the bias originating from inconsistent understanding of the concept.

Conclusion

The failing rate of household septic systems in northwest Ohio where the Blanchard Watershed is located was 39%, the highest in Ohio (Ohio Department of Health & Ohio Environmental Protection Agency, 2013). The inadequately treated household wastewater from malfunctioning septic systems is a source of nutrients that can cause Lake Erie HABs and threaten public health. Failure is largely caused by old and poorly sited systems. Soil in the former Great Black Swamp in northwest Ohio is wet and poorly drained, resulting in poor performance of regular soil-based septic systems. As routine maintenance is unable to overcome these challenges, septic system upgrades are needed. Most watershed management programs, however, have failed to address the failing septic system issue.

In this study, we considered the feasibility of incorporating septic system upgrades in a WQT program. Most (58.07%) of the responding households in the Blanchard River Watershed were willing to upgrade their septic systems in a WQT program, which is much higher than the upgrade willingness in the intensified rainfall (33.55%) or new regulation scenarios (12.50%). WQT, therefore, has the potential to serve as an incentive for septic system upgrades. The households willing to upgrade were clustered in the upstream area of the Blanchard River main stem and Eagle Creek tributary within Jackson, Delaware, and Eagle townships of Hancock County, Ohio. Pilot projects are likely to work well in this area.

For a septic system upgrade program to succeed in northwest Ohio, it should focus on the following aspects:

1. Education about the impacts of soil limitations on septic system performance. Septic systems, like other home fixtures, have a finite life expectancy. Old septic systems were designed by a different standard than the modern systems and system components deteriorate over time. The soil limitations cannot be overcome with regular systems and routine maintenance. Households that better understood the limitation of system effectiveness were more likely to upgrade their septic systems.
2. Enhanced awareness of local environment degradation and concern for environmental quality have a positive effect on household willingness to upgrade septic systems. Households that perceived local water quality to be "fair" or "average" and those more concerned about local environmental issues were more willing to upgrade. Education should have a local focus and relate to the nearby aquatic environment.
3. Financial support should be made available for septic system upgrades. Given that septic system replacement or upgrades are expensive, the high-income households (annual income >$100,000) have significantly higher willingness to upgrade their septic systems compared with the low-income households (annual income <$50,000). Some funding sources for septic systems are available, but programs should make sure these opportunities are known and accessible for households that need them.

Based on the finding that certain groups of households were more willing to upgrade their septic systems in WQT, future studies should focus on the design and implementation of these programs.

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Did You Know?

Septic systems can be damaged and might fail to operate correctly after a disaster. NEHA worked with subject matter experts and national partners to develop a toolkit with guidance documents for different types of disasters such as hurricanes and flooding, wildfires, earthquakes, freezing temperatures, and power outages. Access the toolkit at www.neha.org/eh-topic/preparedness-response-septic-systems.

The Persistence of Foodborne Pathogens on Produce Box Cartons

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Abstract **Previous studies have shown that a majority of vendors at farmers markets reuse cardboard cartons to store and transport produce to and from farmers markets, rendering the cartons a potential source of microbial contamination. This study investigated the ability of foodborne pathogens to persist on cardboard cartons over 44 days. Briefly, a mixture of *Listeria monocytogenes*, *Salmonella* spp., and *E. coli* O157:H7 were inoculated onto cardboard coupons and pathogen viability was quantified for up to 44 days. The results demonstrated that while *E. coli* O157:H7 survived for no longer than 2 days, *L. monocytogenes* and *Salmonella* spp. were recovered up to 32 and 44 days, respectively. These results highlight key challenges associated with reusing cardboard containers and the potential of microbial contamination transfer onto produce. The results of this study emphasize the need for science-based food safety training for vendors and managers at farmers markets to ensure that only containers that can be easily cleaned and sanitized are used to transport and store produce.**

Introduction

According to the U.S. Department of Agriculture (USDA), the number of farmers markets in the U.S. has grown rapidly over the past two decades from 1,755 in 1994 to 8,476 in 2014 (USDA, 2013). Fresh produce that has been exposed to minimal or no pesticides is most attractive to consumers who frequent farmers markets (Yu, Gibson, Wright, Neal, & Sirsat, 2017); however, fresh produce is also considered a high-risk food because it does not undergo any thermal intervention before consumption. The Centers for Disease Control and Prevention (CDC) has reported multiple foodborne illness outbreaks associated with fresh produce due to *Salmonella* spp., *Listeria monocytogenes*, and enterohemorrhagic *E. coli* in the past two decades (Painter et al., 2013). Therefore, it is increasingly critical that farmers market vendors (i.e., farmers and prepared-food workers) and farmers market managers need to ensure that appropriate good handling practices and best management practices are followed to enhance the safety of the fresh produce commodities that they sell.

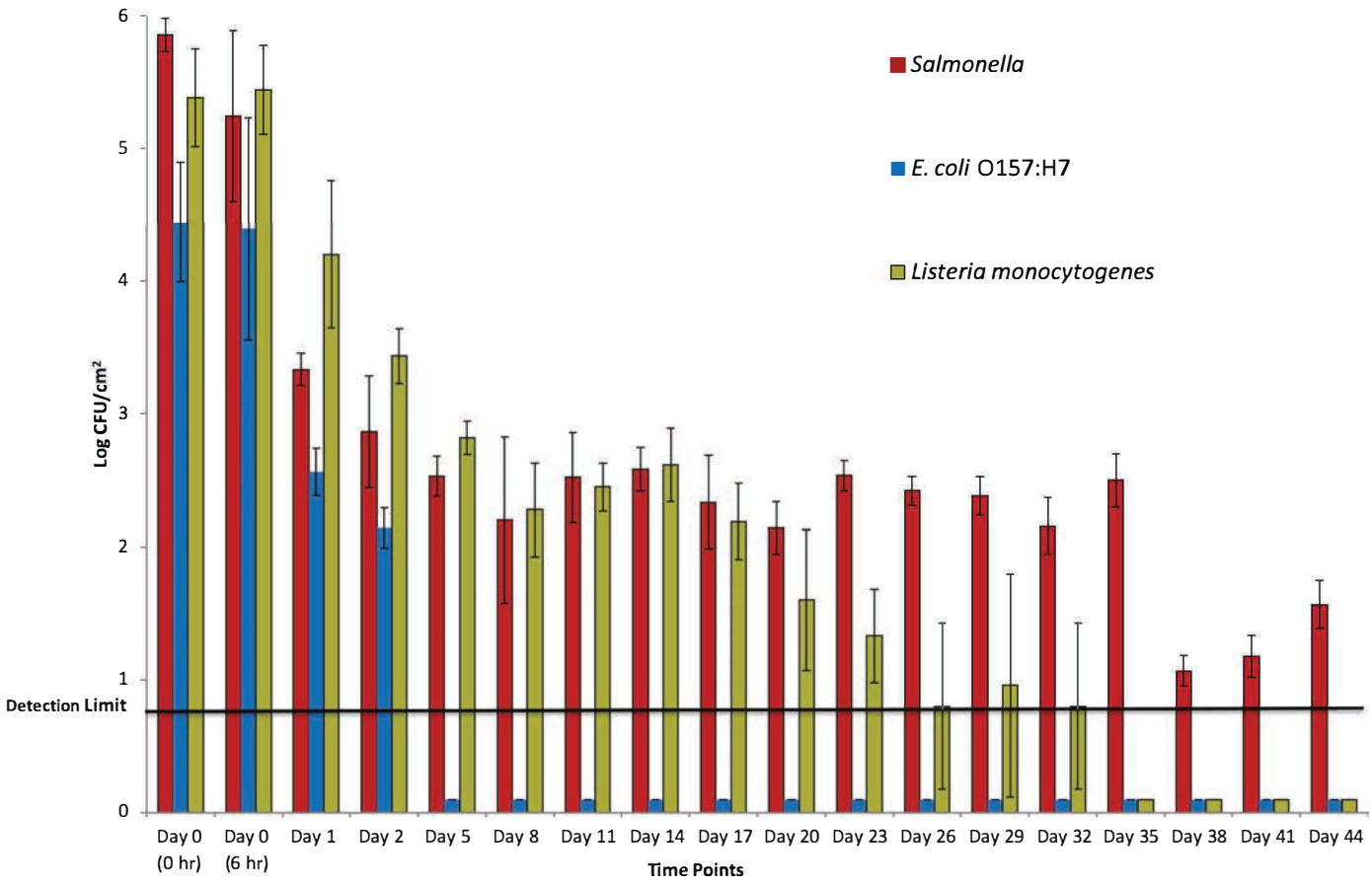
While there have been several foodborne disease outbreaks directly linked to farmers markets, the majority of foodborne disease outbreaks are never identified or reported (Sirsat, Gibson, & Neal, 2015). For instance, 18 illnesses were reported in 2008 after customers consumed contaminated bagged peas sold at an Alaskan farmers market (Gardner et al., 2011). A produce-related outbreak at an Oregon farmers market in 2011 was traced to strawberries contaminated with *E. coli* O157:H7 (Laidler et al., 2013).

There are numerous risk factors for produce contamination at various points from farm-to-fork; however, there is a paucity of literature investigating the potential role of pathogen persistence on produce containers. Personal communication with multiple farmers at a statewide farmers market annual meeting in Texas revealed that farmers reuse produce box cartons and containers for transportation and storage of fresh produce in order to save on costs. Previous survey-based studies have shown that 50% of growers use produce bins such as cardboard boxes that cannot be easily cleaned and sanitized (Pollard et al., 2016). Similar results were obtained by Li and coauthors (2018), who found that in West Virginia farmers markets, 43–52% of growers preferred to use paper-based green molded pulp baskets to store produce.

Norwood and coauthors (2019) conducted observational studies in 10 farmers markets (300 vendors) across the Houston, Texas, region and passively observed good and high-risk practices in order to design food safety training materials specific to farmers markets. The results showed that a majority of vendors at farmers markets reuse cardboard produce boxes without any interventions to sanitize the surfaces. This practice might significantly increase the potential for microbial contamination of fresh produce. Moreover, the cellulose structure of cardboard can make the material highly porous and let in oil, moisture, and gaseous substances (Nowacka et al., 2018), further highlighting the importance of not reusing these containers for a high-risk food commodity such as fresh produce that might not undergo any thermal interventions.

FIGURE **1**

Persistence of Foodborne Pathogens on Cardboard Produce Boxes Over a 44-Day Period



Note. The bars indicate the standard deviation of log CFU/cm^2 at each time point. Three experimental replicates of the study were carried out.

The objective of this study was to investigate the persistence of key foodborne pathogens (*Salmonella* spp., *E. coli* O157:H7, and *L. monocytogenes*) on cardboard produce box cartons. The study was designed to investigate whether these pathogens can survive on cardboard boxes over a period of 44 days. A period of 44 days was chosen because no viable pathogens were detected after this time point.

Methods

A mixture of pathogenic microorganisms was used to simulate the most likely real-world scenario. After overnight growth, a bacterial suspension of *Salmonella* spp. (ATCC 14028, BAA-1604, and BAA-1594), *E. coli* O157:H7 (ATCC 43895), and *L. monocytogenes* (ATCC 51414 and ATCC 43256) was made using 0.1% peptone water to a final concentration of approximately 10^8 CFU/mL. Pathogen viability on cardboard coupons was quantified for up to 44 days (at various time points) using the plate count method described previously by Sirsat and coauthors (2013).

The cardboard coupons (10 cm x 10 cm) were constructed, wrapped in aluminum foil, and sterilized by autoclaving at 121 °C for 15 min. The sterilized coupons were stored at room temperature until the experiment was conducted. Each coupon was placed on a large sterile petri dish in a biosafety cabinet and inoculated with 1 mL of the foodborne pathogen mixture at an initial concentration of 10^7 CFU/cm^2 in triplicate for each time point. The pathogen mixture was applied on each coupon using a sterile pipette and spread using a disposable sterile spreader. The coupons were allowed to dry for 1 hr and the viability assay was conducted at day 0 (0 hr and 6 hr), 1, 2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32, 35, 38, 41, and 44.

For bacterial quantification, the coupon was placed in a sterile stomacher bag with 90 mL peptone and stomached for 120 s to homogenize the sample. The solution was diluted to appropriate concentrations (in 10-fold increments) and each dilution was plated in triplicate on eosin methylene blue (EMB) agar to identify *E. coli* and *Salmonella* colonies and PALCAM *Listeria* agar base with PALCAM *Listeria* selective supplement

to identify *Listeria* colonies. The plates were incubated at 37 °C for 48 hr. Following the incubation period, the colonies were quantified and the results recorded. The experiment was repeated 3 times.

Results

The results of the study are shown in Figure 1. The detection limit line indicates the ability of the viability plate count assay to quantify pathogens, which in this study was 0.8 log CFU/cm^2. Overall, the results show that *E. coli* O157:H7 did not persist after day 2. At day 2, a total of 2.14 log CFU/cm^2 *E. coli* O157:H7 was quantified. On day 3, no *E. coli* O157:H7 colonies were quantified (Figure 1).

From day 0–32, even though the number of viable *L. monocytogenes* decreased, it was still above the detection limit line at approximately 2 to 3 log CFU/cm^2. On day 32, 0.8 log CFU/cm^2 *Listeria* spp. were quantified; however, no *L. monocytogenes* was quantified after day 32. Even if there were viable *Listeria* spp. colonies, the number of colonies would have been below the detection limit.

Compared with *E. coli* O157:H7 and *Listeria* spp., *Salmonella* spp. demonstrated longer persistence on the cardboard coupons. As per the study results, the persistence of *Salmonella* spp. did slow over time and was at approximately 2.3 log CFU/cm^2 between days 5 and 35. At day 44, *Salmonella* spp. were recovered at 1.57 log CFU/cm^2. The study was not continued beyond 44 days because no pathogen counts were observed after this time point.

Discussion

Food consumption trends have shown an increased interest among consumers for fresh produce. This trend is demonstrated in the increased consumption of produce from 45–54% during 1976–2009 in the U.S. (Cook, 2011). With this trend on the rise, the number of fresh produce outbreaks in the U.S. has also increased from 14.8% in 1998 to 22.8% in 2007 (Cook, 2011). Moreover, CDC has reported that annually in the U.S., 46% of all foodborne illness and 23% of deaths were attributed to microbial contamination in fresh produce (Painter et al., 2013).

On farms, water quality, manure, good personal hygiene of workers, equipment sanitation, and traceability have been identified as key areas for decreasing the risk of microbial contamination and hence the possibility of a foodborne outbreak in fresh produce (Parker, Wilson, LeJeune, & Doohan, 2012). In addition to these factors, food packaging paper and cardboard storage containers could potentially be a source of pathogenic (bacterial and viral) contamination onto fresh produce (Priha, Hallamaa, Saarela, & Raaska, 2004). Also, personal communication with multiple managers of farmers markets during conferences revealed that cardboard produce cartons were reused on a regular basis to store and transport produce because it is more economical. It was also noted that the containers were not lined with food grade material as a barrier to prevent cross-contamination.

Survey and observational studies at farmers markets have demonstrated that 50% of growers use produce bins such as cardboard boxes that cannot be easily cleaned and sanitized (Pollard et al., 2016). Harrison and coauthors (2013) conducted similar survey-based studies and found that almost 66% of growers did not clean and sanitize containers used to transport produce to farmers markets. Investigators conducting observational studies in farmers markets across Houston, Texas, obtained similar results, finding that several produce vendors were reusing cardboard and plastic produce containers without cleaning and sanitizing (Norwood, Neal, & Sirsat, 2019). Harrison and coauthors (2016) recruited regulators and food safety educators nationwide for an online survey to determine critical regulatory and knowledge gaps in farmers markets. Their findings demonstrated that among other violations, the reuse of cardboard boxes was a common practice among market vendors (Harrison, Critzer, & Harrison, 2016).

The current study investigated the persistence of foodborne pathogens (*Salmonella* spp., *E. coli* O157:H7, and *L. monocytogenes*) on cardboard containers for up to 44 days. The results demonstrated that while *E. coli* O157:H7 and *Listeria* spp. persisted up to 2 and 32 days, respectively, *Salmonella* spp. can persist on cardboard for up to 44 days. Li and coauthors (2018) performed similar studies on paper-based green molded pulp baskets that are often used to store produce. The investigators inoculated 25 cm^2 green molded baskets with a *Salmonella* spp. and *L. monocytogenes* mixture at room temperature and 3.2 °C. Their results showed, however, that the *Salmonella* spp. persisted for up to 21 days at 3.2 °C and 13 days at room temperature. *L. monocytogenes* persisted for up to 21 days at both 3.2 °C and room temperature. This difference in findings between the two studies can be attributed to strain and fomite differences.

Krall (2003) reported on the challenges of using cardboard containers due to their ability to harbor bacteria and sampled cardboard from plastic wrap film and foil cutter boxes in commercial kitchens. The results showed that each cardboard sample harbored an average of 27 million CFU/g of bacteria. The study conclusion was that cardboard absorbs contaminants, cannot be washed, and could be a potential vector for bacterial and viral pathogen transfer (Krall, 2003). Moreover, cardboard has a porous cellulose structure that renders it permeable to gases, moisture, and oil (Nowacka et al., 2018).

Small growers sell direct to consumers and have a small profit margin. Based on the aforementioned literature, however, the practice of reusing cardboard containers to store and transport produce could be a significant food safety hazard. Hence, it is crucial to communicate these science-based facts to small growers and provide alternative solutions that are economical and easy to implement. As per the Food and Drug Administration's *Food Code*, the recommendations related to cardboard containers are associated with recycling and no specific information on reuse is provided (U.S. Department of Health and Human Services [HHS], 2017). This lack of guidance further highlights the importance of ensuring that vendors at farmers markets recycle and not reuse used cardboard containers. Previous literature has shown that there are limited food safety resources for farmers market managers (Sirsat et al., 2015) and it is critical for public health practitioners, whenever applicable, to model guidelines for farmers market vendors and managers based on the *Food Code* (HHS, 2017).

Conclusion

The overarching goal of this study was to investigate the persistence of critical foodborne pathogens (*Salmonella* spp., *L. monocytogenes*, and *E. coli* O157:H7) on cardboard coupons to demonstrate the food safety implications of farmers market vendors reusing cardboard containers to store and transport fresh produce. This investigation

was done by inoculating a mixture of these pathogens on cardboard coupons and quantifying bacteria viability over time. The results showed that *E. coli* O157:H7 persisted for up to 2 days on cardboard coupons; however, *Listeria* spp. and *Salmonella* spp. persisted for 32 and 44 days, respectively.

The results of this study highlight the need for science-based and robust food safety-related training materials on the implication of reusing cardboard containers. This type of training would enhance safe practices among vendors and managers in farmers markets. Based on the results of this study, for food safety reasons, the recommendation would be to recycle and not reuse any cardboard containers that have already been used. While this might not be an economical solution, the alternative is to use containers for storage and transport of fresh produce that can be easily cleaned and sanitized. Some examples include food-grade containers made from high-density polyethylene that can be easily cleaned, sanitized, and reused. It is vital to communicate the risks associated with the reuse of containers that cannot be cleaned and sanitized effectively.

Future studies can be designed to focus on the microbial transfer of pathogenic bacteria from cardboard containers onto produce, produce onto cardboard containers, and other fomites commonly used in farmers markets (e.g., wicker baskets, metal, plastic, tablecloths, money) to further investigate and quantify these risks. In addition, future studies to determine the best and most economical types of produce containers that can be washed, rinsed, and sanitized effectively are also essential to pursue in order to provide sound recommendations to farmers market vendors and managers, as well as public health officials.

There is an increasing need for state and nationwide resources for food safety materials specific to vendors and managers at farmers markets. Once these recommendations and guidelines are created using science-based evidence, an extensive nationwide farmers market food safety resource toolkit can be designed and disseminated with the help of state extension agents and extensions.

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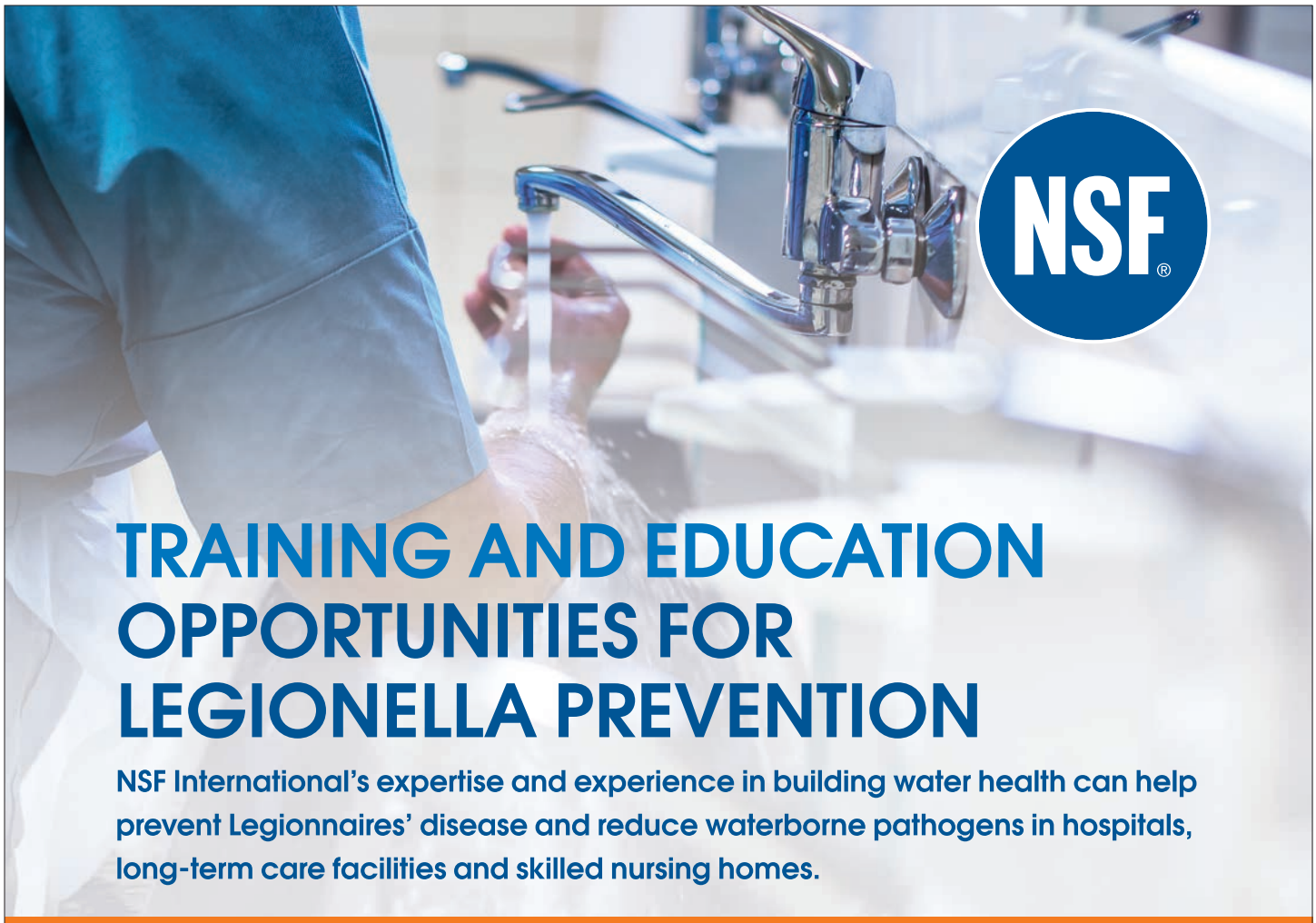

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Radon Gas Exposure Knowledge Among Public Health Educators, Health Officers, Nurses, and Registered Environmental Health Specialists: A Cross-Sectional Study

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Abstract **Radon gas exposure is the leading cause of lung cancer among nonsmokers in the U.S. People exposed to elevated levels of radon gas have a higher risk of developing lung cancer. Public health workers are change agents and their roles in protecting and improving the health of their communities are well documented. This study surveyed 386 public health educators, health officers, nurses, and registered environmental health specialists working in public health departments. We found significant differences ($p < .01$) in knowledge about radon gas exposure among public health workers. These findings suggest that the role of public health workers in disseminating information about environmental hazards to the communities they serve should be well-defined. Government agencies, including public health departments, will have to combine efforts to achieve the long-term goal of the 1988 Indoor Radon Abatement Act (IRAA). Training of public health workers about environmental hazards should be a priority to achieve the IRAA goal.**

Introduction

Radon is a naturally occurring invisible, radioactive, tasteless, and odorless gas produced by the breakdown of uranium in rock, soil, and water (U.S Environmental Protection Agency [U.S. EPA], 2012). Radon gas is found naturally in soils and rocks. Radon gas can pass through cracks and openings in walls and foundations and into spaces such as basements and lower levels of homes, where individuals can inhale radon and harm their lungs (Al Zabadi, Musmar, Issa, Dwaikat, & Saffarini, 2012; U.S. EPA, 2011, 2012). Developing lung cancer from radon gas exposure depends on the measure of radon in the home (dose), the smoking status of the individual exposed (host factor), and the amount of time spent in the house (duration).

The U.S Environmental Protection Agency (U.S. EPA, 2012) estimated that radon is responsible for approximately 21,000 deaths each year. Méndez and coauthors (2011) reported that the lifetime risk of developing and dying from radon-induced lung cancer is 62 per 100 smokers and 7 per 100 nonsmokers, based on the U.S. EPA radon action level of 4 pCi/L. The U.S. Surgeon General (U.S. EPA, 2005, 2012) recommends testing radon levels in all homes in the U.S. that are below the third floor. There are low-cost radon test kits that homeowners can purchase in retail outlets, such as hardware stores across the U.S. The New Jersey state radon offices also provide a list of trained contractors who can test for radon.

Public health workers engage with their communities to enhance, improve, and protect health (World Health Organization [WHO], 2006) and their influence on public perceptions and attitudes toward health risk factors are well documented (Backus, Hewitt, & Chalupka, 2006; Cohrssen & Covello, 1989; Institute of Medicine [IOM], 1988; WHO, 2006). Public health workers can act as risk communicators and agents of change to the public, applying their working knowledge to communicate the risks of radon gas exposure (WHO, 2009).

The U.S. Congress established the Indoor Radon Abatement Act (IRAA) in 1988, with a long-term goal to make indoor air as radon-free as the air outside (U.S. EPA, 2008). It is not mandatory to test for radon gas. Instead, the U.S. EPA administered a voluntary program to reduce radon exposure by promoting awareness, radon testing, radon-resistant construction techniques, and radon mitigation systems for existing homes. U.S. EPA is not enforcing IRAA (U.S. EPA, 2008); instead, real estate transactions have produced much of the progress made in reducing radon gas exposure (U.S. EPA, 2008).

DeAscentis and Graham (1998) reported that the Harvard Center for Risk Analysis ranked radon gas as the most potentially critical hazard in the home. The risk analysis estimated the annual cause-specific mortality rate to be 5.8 per 100,000 people. Duckworth and coauthors (2002) reported that the development of airtight and highly

insulated structures had promoted conditions that favor radon buildup. Attempts to increase energy efficiency have reduced air exchange, trapping more radon inside the house. Many homeowners use air conditioners and central heating, especially in new homes built after the 1980s that have higher levels of insulation and are constructed more tightly than those made earlier. Even though this new home equipment conserves energy, it also reduces indoor air circulation and ventilation by requiring the closing of windows and doors (Duckworth, Frank-Stromborg, Oleckno, Duffy, & Burns, 2002). Some houses have gaps around utility pipes, sump pumps, and suspended floors. Some homes have cracks in the inside walls and foundations, where radon gas can enter and accumulate (Duckworth et al., 2002).

People in the U.S. spend 90% of their time indoors (Hancock, 2002; Klepeis, Tsang, & Behar, 1996; Klepeis et al., 2001; Ott, 1989). Despite the direct link and documented evidence between radon gas and lung cancer, the lack of public knowledge of risk perception to radon exposure has not been adequately addressed by regulatory authorities that are responsible for addressing environmental health issues (Hancock, 2002). On June 3, 2008, the U.S. EPA Inspector General Report confirmed that radon exposure gets worse each year. In light of this confirmation, U.S. EPA understands and agrees that its radon program is not achieving adequate results and that the IRAA goal is not achievable. U.S. EPA has refused, however, to notify the U.S. Congress that the target set by statute is not feasible (U.S. EPA, 2008). The U.S. EPA Inspector General recommended that U.S. EPA develop a sustained strategy for achieving the long-term aim of IRAA or explain an alternative approach to prevent an annual increase in radon gas exposure in the U.S. (U.S. EPA, 2008).

On-the-job training curriculum for some public health workers, especially environmental health specialists, covers radon gas as radioactive material from an occupational health and safety perspective rather than an environmental hazard found in homes. Many studies have focused on public health workers serving as risk communicators. These include nurses (Backus et al., 2006; Dixon, Hendrickson, Ercolano, Quackenbush, & Dixon, 2009; IOM, 1995), public health workers (Shlafer, McRee, Gower, & Bearinger, 2016), pharmacists (Odedina, Warrick, Vilme, & Young, 2008; Simmons-Yon et al., 2012), and physicians (Trasande et al., 2006, 2010). These studies found that public health workers would be better prepared to serve as risk communicators to the public if they have a knowledge of radon gas as a health hazard. These studies consistently identified significant gaps in knowledge about environmental hazards among public health workers. While in training, healthcare workers did not have a proper understanding of the environmental health effects from environmental pollutants and therefore, they were not prepared to communicate with the public regarding environmental hazards such as radon gas exposure. Only public health workers with a degree in environmental health had knowledge about radon gas exposure. Many public health workers join the public health workforce with a wide range of backgrounds and degrees that are not related to environmental health or public health.

The purpose of this study was to explore differences in knowledge about radon gas exposure among public health workers. Public health department workers have a particular significance because, as government employees, they are at the forefront for threats to public health and for the implementation of many essential public health services in the face of changing community expectations (National Association of County and City Health Officials [NACCHO], 2014). Public health workers must have a knowledge of the hazards related to radon gas exposure in order to advocate home testing to the public and communicate the risks associated with radon exposure. We predicted that a significant difference would exist in knowledge about radon among public health workers.

Methods

Design

This study involved a descriptive, cross-sectional survey measuring subject knowledge with a questionnaire. The study obtained approval by the Seton Hall University institutional review board. New Jersey public health workers participated in this study. The participants were identified through the New Jersey Literacy Information and Communication System Health Services portal. In total, 935 public health workers received the survey e-mail and 386 surveys were completed (41.3% response rate). Incomplete survey responses were excluded. The public health workers who took part in this study are health educators, health officers, nurses, and registered environmental health specialists.

G*Power 3.1.9 software was used to calculate a sample size that had an effect size of 0.30 and a *p*-value of .05 with a power of .80. For this study, the minimum sample size required was 145 participants. This number was based on the number of variables studied. The actual sample size for this radon study was 386 participants. A post hoc G*Power analysis for chi-square goodness of fit was conducted with a *p*-value of .01, an effect size of 0.30, 5 *df*, and a sample size of 386. This analysis resulted in a power of 0.99.

We developed a 12-question radon knowledge survey instrument for this study as part of the 50-question survey instrument. The other 38 questions asked about public health worker beliefs, demographics, and personal and professional practices regarding radon gas exposure. The questions are from thematic topics in the literature and engagement with professionals who have expertise in radon environmental hazards research (Rinker, Hahn, & Rayens, 2014; Rosenthal, 2011; Weinstein, Lyon, Sandman, & Cuite, 1998; Weinstein, Sandman, & Blalock, 2008; Weinstein, Sandman, & Roberts, 1991). Content and face validity were established using a modified Delphi panel (Hasson, Keeney, & McKenna, 2000; Powell, 2003). This survey was conducted via SurveyMonkey, with a link provided to participants electronically via e-mail.

Data Analysis

We used descriptive statistics to analyze the demographics of the participants. SPSS version 24.0 was used for the analysis of data. Chi-squared tests of differences were used to test differences between public health workers' knowledge. The 12 general knowledge questions about radon were treated as nominal data. Answers to knowledge questions are nominal (true/false). There are dependent categorical (nominal, knowledge questions scores) and independent categorical (nominal, types of public health workers) variables.

Results

A total of 107 health educators, 50 health officers, 100 nurses, and 129 registered environmental health specialists completed the survey (Table 1). Figure 1 shows the highest educational attainment level of the responding public health workers. Education plays a vital role in knowledge acquisition. From the survey, 5 respondents (1%) indicated earning a doctoral degree, 106 respondents (27%) a master's degree, 268 respondents (69%) a bachelor's degree, and 5 respondents (1%) an associate degree. Only two respondents indicated their highest educational attainment to be a high school diploma.

Table 2 shows the result of chi-squared tests of differences used in testing the differences in knowledge among public health workers. Answers to knowledge questions are nominal. There are dependent categorical (nominal, knowledge questions scores) and independent categorical (nominal, public health workers) variables. The test was calculated comparing the frequency of knowledge questions among public health workers (health educators, health officers, nurses, and registered environmental health specialists). A significant outcome was found ($\chi^2(18) = 94.51$, $p < .01$). This result suggests that there are significant differences in knowledge about radon gas exposure among public health workers.

Table 3 shows the differences in answers to the 12 radon knowledge questions among public health worker respondents. For each question:

1. **Radon has a strong odor:** The correct answer is false. The results show that 69% of health educators, 96% of health officers, 99% of nurses, and 98% of registered environmental health specialists answered correctly.
2. **Radon exposure is linked to lung cancer:** The correct answer is true. The results show that 99% of health educators, 98% of health officers, 99% of nurses, and 99% of registered environmental health specialists answered correctly.
3. **Radon is a radioactive gas:** The correct answer is true. The results show that 98% of health educators, 94% of health officers, 98% of nurses, and 95% of registered environmental health specialists answered correctly.

TABLE **1**

Public Health Worker Knowledge Scores (*N* = 386)

	# of Respondents	% of Correct Answers
Health educator	107	90
Health officer	50	94
Nurse	100	94
Registered environmental health specialist	129	93

FIGURE **1**

Highest Educational Attainment Level of Public Health Workers (*N* = 386)

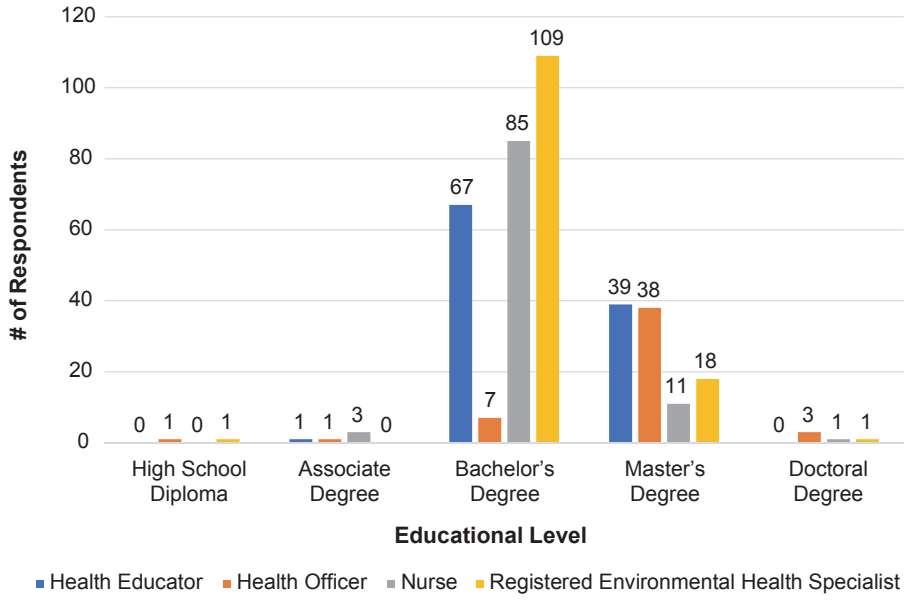

TABLE **2**

Chi-Squared Tests of Differences in Knowledge Among Public Health Workers

	Value	*df*	Asymptotic Significance (2-Sided)
Pearson's chi-square	94.51	18	.000
Likelihood ratio	97.30	18	.000
Linear-by-linear association	7.83	1	.001
Number of valid cases	386		

df = degrees of freedom.

TABLE **3**

Public Health Worker Answers to the 12-Question Radon Knowledge Survey (*N* = 386)

Question	Health Educators (*n* = 107)		Health Officers (*n* = 50)		Nurses (*n* = 100)		Registered Environmental Health Specialists (*n* = 129)	
	True # (%)	False # (%)	True # (%)	False # (%)	True # (%)	False # (%)	True # (%)	False # (%)
1. Radon has a strong odor [false]	33 (31)	**74 (69)**	2 (4)	**48 (96)**	1 (1)	**99 (99)**	2 (2)	**127 (98)**
2. Radon exposure is linked to lung cancer [true]	**106 (99)**	1 (1)	**49 (98)**	2 (2)	**99 (99)**	1 (1)	**128 (99)**	1 (1)
3. Radon is a radioactive gas [true]	**105 (98)**	2 (2)	**47 (94)**	3 (6)	**98 (98)**	2 (2)	**123 (95)**	6 (5)
4. Radon is invisible [true]	**107 (100)**	0	**50 (100)**	0	**100 (100)**	0	**127 (98)**	2 (2)
5. Radon is a solid at room temperature [false]	11 (10)	**96 (90)**	2 (4)	**48 (96)**	6 (6)	**94 (94)**	8 (6)	**121 (94)**
6. Radon is a gas at room temperature [true]	**107 (100)**	0	**47 (94)**	3 (6)	**99 (99)**	1 (1)	**129 (100)**	0
7. Radon occurs naturally in rocks and soils [true]	**106 (99)**	1 (1)	**50 (100)**	0	**98 (98)**	2 (2)	**125 (97)**	4 (3)
8. Radon levels are usually higher in the attic than the basement [false]	59 (55)	**48 (45)**	9 (18)	**41 (82)**	51 (51)	**49 (49)**	55 (43)	**74 (57)**
9. About 1 in 15 homes in the U.S. have elevated radon levels [true]	**102 (95)**	5 (5)	**46 (92)**	4 (8)	**97 (97)**	3 (3)	**123 (95)**	6 (5)
10. Being exposed to radon increases smokers' chances of developing lung cancer [true]	**105 (98)**	2 (2)	**50 (100)**	0	**99 (99)**	1 (1)	**124 (96)**	5 (4)
11. Radon is the leading cause of lung cancer in the U.S. among nonsmokers [true]	**97 (91)**	10 (9)	**38 (76)**	12 (24)	**96 (96)**	4 (4)	**113 (88)**	16 (12)
12. Testing for radon is the only way to determine if a home has an elevated radon level [true]	**107 (100)**	0	**49 (98)**	1 (2)	**100 (100)**	0	**126 (98)**	3 (2)

Note. Bolded values indicate the correct answer.

4. **Radon is invisible:** The correct answer is true. The results show that 100% of health educators, 100% of health officers, 100% of nurses, and 98% of registered environmental health specialists answered correctly.
5. **Radon is a solid at room temperature:** The correct answer is false. The results show that 90% of health educators, 96% of health officers, 94% of nurses, and 94% of registered environmental health specialists answered correctly.
6. **Radon is a gas at room temperature:** The correct answer is true. The results show that 100% of health educators, 94% of health officers, 99% of nurses, and 100% of registered environmental health specialists answered correctly.
7. **Radon occurs naturally in rocks and soils:** The correct answer is true. The results show that 99% of health educators, 100% of health officers, 98% of nurses, and 97% of registered environmental health specialists answered correctly.
8. **Radon levels are usually higher in the attic than the basement:** The correct answer is false. The results show that 45% of health educators, 82% of health officers, 49% of nurses, and 57% of registered environmental health specialists answered correctly.
9. **About 1 in 15 homes in the U.S. have elevated radon levels:** The correct answer is true. The results show that 95% of health educators, 92% of health officers, 97% of nurses, and 95% of registered environmental health specialists answered correctly.
10. **Being exposed to radon increases smokers' chances of developing lung cancer:** The correct answer is true. The results show that 98% of health educators, 100% of health officers, 99% of nurses, and 96% of registered environmental health specialists answered correctly.
11. **Radon is the leading cause of lung cancer in the U.S. among nonsmokers:** The

correct answer is true. The results show that 91% of health educators, 76% of health officers, 96% of nurses, and 88% of registered environmental health specialists answered correctly.

12. **Testing for radon is the only way to determine if a home has an elevated radon level:** The correct answer is true. The results show that 100% of health educators, 98% of health officers, 100% of nurses, and 98% of registered environmental health specialists answered correctly.

Discussion

This study found that there are differences in the way public health workers understand radon gas exposure. For example, public health worker responses to the radon knowledge questions varied for health educators, health officers, nurses, and registered environmental health specialists who participated in the study. This finding might be a result of the fact that public health workers go through environmental health literacy differently first as members of the public and then in their various specializations (Gray, 2018).

Among the public health workers surveyed, only registered environmental health specialists should have learned about radon gas exposure as an environmental hazard either in college, during the certification process, or part of in-service training. Registered environmental health specialists were expected to perform exceedingly better than other public health workers regarding knowledge about radon because their job title explains what they do in the environmental field. This study found that collectively, registered environmental health specialists had incorrect responses to 11 out of 12 radon knowledge questions. On the knowledge question "Radon levels are usually higher in the attic than in the basement," 43% of registered environmental health specialists had the wrong answer. This result is consistent with other studies that found environmental workers lacked knowledge regarding environmental issues (Jennings, Sitzlar, & Jury, 2013; Shlafer et al., 2016). This result is also consistent with a study that found that nurses lack environmental health knowledge, highlighting a need to define the critical body of knowledge and skills in environmental health that nurses require to enable them to become educators and practitioners in public health and other specialty areas (Hewitt, Candek, & Engel, 2006).

Job titles in public health are diverse, reflecting various knowledge levels about environmental hazards. Public health workers go through in-service training and professional development differently depending on their job area and specialty. These differences are consistent with findings of public health workers coming from different knowledge and academic backgrounds with the primary purpose of enhancing health within the population they serve (NACCHO, 2011a, 2011b; WHO, 2006). According to NACCHO (2014), public health workers who work in local health departments rely heavily on traditional channels of communication and acquire knowledge through in-service training and professional development based on their area of expertise, which is not entirely geared toward environmental health.

Public health departments in New Jersey, however, do not offer radon awareness classes or online training for public health workers. Online or in-class trainings are expensive and geared as a certification course for radon technicians working in the field, which might explain why public health workers have varying environmental health knowledge about radon. Public health workers many times work in silos and have no stated benchmarks that link each of the diverse areas of public health together to produce a cohesive force aligning all disciplines working in public health (NACCHO, 2011b).

Policy and Practice Implications

The role of public health workers as change agents in the community and the first line of defense in the communities they serve has been well established and documented. Exploring knowledge of radon gas exposure among public health workers provides a baseline to create more awareness to the public. This study hopes to provide guidance that will enable institutions of higher learning to include knowledge of environmental hazards in the curriculum of public health workers such as health educators, public health nurses, and environmental health scientists. Public health workers need to go through in-service training regardless of their specialization and educational background to enable them to acquire a basic knowledge of environmental hazards. Online training resources for public health workers from the Centers for Disease Control and Prevention or U.S. EPA regarding environmental hazards, including radon awareness, could be used for on-the-job training of public health workers. This type of training is not available to public health workers in New Jersey at the moment.

Competency-based training is required for public health workers to be in line with the dictates of the profession they represent in the field of public health. Public health workers should be knowledgeable about radon gas exposure and be able to reach out to the public as part of their professional practices of disseminating what they know to the communities they serve.

Limitations

This study is cross-sectional, as the sample was surveyed at a single time. It is difficult to determine temporal relationships between exposure and outcome. This study was performed in New Jersey and the generalizability of findings is limited to the sample surveyed. Furthermore, geographical location of respondents in New Jersey could not be verified. Another limitation could be with the control of the sample. This study used SurveyMonkey to gather data from public health workers. Respondents might have wanted clarification on some questions but could not get that because the survey was conducted online. Finally, respondents self-reported the data.

Directions for Future Research

Longitudinal studies should be performed to better understand radon knowledge among public health workers to ascertain if public health worker responses change over a period of time and why. A countrywide study should be performed on this topic, as the hazard of radon gas exposure is a problem not only in New Jersey but also across the U.S. Even though public health workers have a similar work structure and job titles geographically across the country, their knowledge about radon gas exposure would be informative to know. The outcome of the national study should dictate the role of public health workers in future radon gas public campaign initiatives and uncover what educational needs specifically need to be addressed on a national scale.

Finally, the logistic regression model should be utilized for future studies to under-

stand the effect of other variables that could not be identified using chi-square analysis and how these variables played a role in the study outcome.

Conclusion

The findings from this study suggest that the role of public health workers in disseminating information about environmental hazards to the communities they serve should be well-defined in order to achieve the IRAA goal. Furthermore, on-the-job training about environmental hazards should be a priority for all public health workers to better understand the environmental health hazards posed by radon gas exposure.

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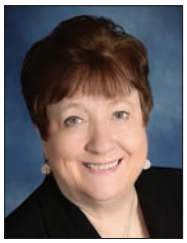


Kaye Bender, PhD, RN, FAAN
Public Health Accreditation Board

Liza Corso, MPA
Centers for Disease Control and Prevention

Public Health Department Accreditation and Environmental Public Health: A Decade of Collaboration

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 this column on environmental health services from the Centers for Disease Control and Prevention (CDC) in every issue of the *Journal*.

In these columns, authors from CDC's Water, Food, and Environmental Health Services Branch, as well as guest authors, will share insights and information about environmental health programs, trends, issues, and resources. The conclusions in these columns are those of the author(s) and do not necessarily represent the official position of CDC.

Justin Gerding leads the Environmental Health Practice Section within the CDC/National Center for Environmental Health's Water, Food, and Environmental Health Services Branch. Kaye Bender is the president and chief executive officer of the Public Health Accreditation Board. Liza Corso is a senior advisor for public health practice and accreditation with CDC's Center for State, Tribal, Local, and Territorial Support.

About a decade ago, a group of environmental public health (EPH) professionals from state and local health departments, federal and national public health organizations, and academia engaged in discussions and provided much needed input on the development process for a revolutionary advancement in public health—national voluntary accreditation for public health departments. The Public Health Accreditation Board (PHAB) formally launched the program in 2011 and accredited the first cohort of health departments in 2013. Since that time, PHAB has made significant progress accomplishing its mission to improve and protect the health of the public by advancing and transforming the quality and performance of governmental public health agencies (Ingram, Mays, & Kussainov, 2018; Kronstadt et al., 2016).

By August 2019, almost 80% of the population was served by 275 accredited health departments and 1 centralized state that includes 67 county health departments (Table 1, Figure 1). Accreditation is conferred for 5 years and PHAB began reaccrediting health departments in early 2019. A major component of the accreditation process requires conformity with a comprehensive set of consensus-based standards that incorporate the 10 Essential Public Health Services. One of the methods PHAB uses for building consensus is convening think tanks that involve public health subject matter experts and practitioner participants who provide updated information and recommendations to improve the accreditation standards (Ingram, Bender, Wilcox, & Kronstadt, 2014).

The accreditation standards reflect the collective public health practice, yet it remains important to understand the contributions and interests of particular programmatic areas and segments of the workforce, such as EPH (Corso & Thomas, 2018). In 2009 and 2011, EPH think tanks were held during the initial planning and development of the accreditation process and standards. The think tanks produced insightful recommendations for ensuring EPH inclusion and involvement in the accreditation process through suggested changes to the standards, messaging about the importance of EPH's role, defining EPH terminology, and describing connections to EPH performance improvement resources, namely the Environmental Public Health Performance Standards (Blake, Corso, & Bender, 2011).

Since the launch of the accreditation program, much has been learned about the accreditation process, including an understanding of EPH's contributions and essential roles that span across the standards and is not limited to those solely of a regulatory nature or where EPH is specifically mentioned. EPH programs participating in accreditation efforts have also realized benefits such as positive changes in policies and procedures and increased collaboration internal and external to their departments (Gerding, Carlson, & Wilcox, 2013; Kronstadt et al., 2016).

In response to an ever-changing public health practice, PHAB is currently updating

TABLE **1**

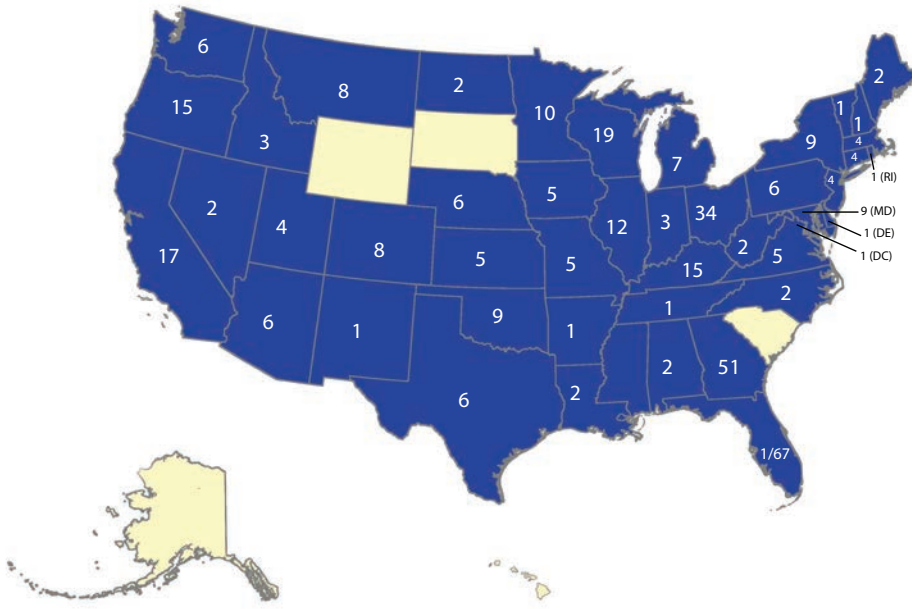
Type and Number of Accredited Health Departments in the United States

Type of Health Department	# Accredited
Local	236
State	36
Tribal	3
Centralized state with integrated system	1*
Total	275 + 1 system
Population served by an accredited health department	248,001,475

*Includes 67 county health departments.
Note. Data presented as of August 30, 2019.

FIGURE **1**

Map of Accredited Health Departments in the United States



Note. Data presented as of August 30, 2019.

the accreditation standards and measures, which will result in version 2.0. In May 2019, PHAB convened the third EPH think tank to receive input directly from EPH professionals working at accredited health departments with firsthand experience and involvement in the accreditation process. As with the previous think tanks, the meeting was held with collaborative support from the Centers for Disease Control and Prevention's (CDC) Center for State, Tribal, Local, and Territorial Support (CSTLTS) and National Center for Environmental Health (NCEH).

The purpose and anticipated outcomes of the think tank were to

- review the current health department accreditation standards and measures related to EPH,
- discuss any pertinent changes in EPH practice and/or support for health department work in this area, and
- recommend potential revisions in the accreditation standards and measures as PHAB prepares version 2.0.

The 2-day EPH think tank commenced with a presentation on accreditation progress and successes, as well as results of the Understanding the Needs, Challenges, Opportunities, Vision, and Emerging Roles in Environmental Health (UNCOVER EH) initiative regarding EPH workforce and practice trends and challenges facing the profession (Gerding et al., 2019). Think tank participants were asked to consider this information and how EPH could strengthen and leverage its contributions to accreditation for improving the workforce and practice. The think tank resulted in a number of recommendations, as described below. A summary report about this and other PHAB think tanks contributing to version 2.0 is available at https://phaboard.org/version-2-0.

Following the think tank, PHAB presented the recommendations and received further feedback during a facilitated session at the National Environmental Health Association's 2019 Annual Educational Conference & Exhibition. Among the recommendations, those requiring the most substantial consideration included the following:

- Identifying where EPH should be specifically referenced in the examples accompanying certain standards. For example, EPH is currently identified with mention of public health hazards and infectious diseases; however, there is need for EPH to be called out in other standards.
- Adding EPH in measures encompassing the social determinants of health and health equity.
- Using the term "collaborative compliance" rather than "enforcement." Emphasis should be on education and the provision of technical assistance so standards are met and problems are corrected before enforcement is needed.
- Revising, redefining, or adding EPH terms in the glossary for EPH consultation, EPH event, EPH expertise, EPH functions, EPH hazards, and environmental epidemiology.
- Emphasizing EPH data use and related workforce skills and competencies. EPH increasingly depends on robust information systems to conduct its work.
- Encouraging stronger inclusion of EPH in community health assessments and community health improvement planning.
- Determining how to incorporate emerging issues into the standards, which includes environmental justice and effects of the climate on health.
- Developing an EPH tip sheet describing opportunities for EPH to contribute to accreditation and presenting EPH documentation examples.

PHAB will consider the recommendations and determine how to best address them in ver-

Accreditation and Performance Improvement Resources

- Public Health Accreditation Board—Accreditation Information and Educational Resources: www.phaboard.org
- Public Health Professionals Gateway—National Voluntary Accreditation for Public Health Departments: www.cdc.gov/publichealthgateway/accreditation/index.html
- Environmental Public Health Performance Improvement Resources: www.cdc.gov/nceh/ehs/activities/performance.html

sion 2.0 of the standards and measures. EPH professionals can provide feedback as PHAB supports future opportunities for stakeholder engagement, such as an upcoming version 2.0 public comment period planned for late 2020. Continued collaboration between PHAB and EPH professionals, with coordinated support from CDC's CSTLTS and NCEH, can continue to ensure accurate representation and inclusion of EPH in accreditation. EPH professionals are encouraged to seek out opportunities for contributing to their department's accreditation efforts.

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DIRECT FROM NEHA'S AFFILIATES

The Business and Industry Affiliate: Meet One of the National Environmental Health Association's Newest Affiliates

Business and Industry Affiliate

Editor's Note: The National Environmental Health Association (NEHA) is proud to count 46 membership organizations as affiliates. These affiliates are independently governed associations that include 41 states, 2 regions, 2 sector specific organizations, and the past presidents of NEHA. A current listing of affiliates can be found on page 43. NEHA's affiliates represent a grassroots network of environmental health professionals working at the local level to provide education, community, and advocacy for the profession.

The *Journal* is pleased to offer a new column that highlights NEHA's affiliates and shares their work to support local environmental health professionals. Readers will gain a better understanding of the value of these affiliate organizations, as well as insight into the opportunities available through them. The conclusions of this column are those of the author(s) and do not necessarily represent the views of NEHA.

The Business and Industry Affiliate was established in 2015. As of press, it has a membership of 24 individuals. The current president is Alicia Enriquez-Collins. You can view its website at www.nehabia.org.

Introduction

The Business and Industry Affiliate (BIA) is one of the newest affiliates of the National Environmental Health Association (NEHA), committed primarily to supporting environmental health professionals who are nongovernment, consulting, or private sector practitioners. Dedicated teams of volunteers have labored the last 5 years to build an affiliate that can benefit and serve this group of practitioners, who now comprise nearly 20% of NEHA's membership.

Evolving trends among environmental health practitioners, outside of regulatory roles, reveal a need for networking and strengthened relationships between public and private sectors. Overarching goals among these cohorts are mutual—safeguarding environmental and public health by ensuring consumers and the environment are protected. We are headed in the right direction and have ample room for collaboration and growth. With environmental health practitioners employed across all sectors, there is now a greater need for building networks, establishing relationships, and effecting positive change in day-to-day practice.

Is there pending legislation that will potentially impact your industry and/or consumer? Similar to other NEHA affiliates, BIA has 501(c) 6 status that affords capacity to support or oppose legislative issues. BIA can work with industry representatives and NEHA to contact legislators and stakeholders to promote environmental health protection. BIA also provides its members with the ability to establish a forum within NEHA and nexus to network across public, private, academic, and nonprofit organizations.

Benefits and Value Added

In business, return on investment is essential as everyone's time is valuable. We also seek return on investment in the volunteer organizations and activities we participate in. What benefits are offered for environmental health professionals through BIA?

Networking and Advocacy

Examples of how BIA can be of value include providing

- a seat at the table, allowing your voice to be heard within NEHA and regulatory agencies across the country;
- access to resources and a network of industry, regulatory, and academic professionals; and
- the ability to advocate for legislative issues that matter to industry.

Professional Development

BIA is committed to providing and supporting professional development opportunities for practitioners across all sectors. You may have attended a BIA-hosted session at NEHA's Annual Educational Conference (AEC) & Exhibition or participated in an interactive webinar. BIA's intent is to share timely technical topics and collaborative strategies to

Attendees of the Business and Industry Affiliate Membership Meeting held at the National Environmental Health Association's 2019 Annual Educational Conference & Exhibition in Nashville, Tennessee, on July 11, 2019. Photo courtesy of Traci (Slowinski) Michelson.

address current environmental health concerns encountered by business and industry.

Webinars and Engagement Opportunities

Examples of educational and engagement opportunities include the following:

- Webinar: Power of Partnerships—Strengthening Agency and Industry Relationships, November 7, 2019.
- Recorded webinar: Boil Water What?! When Good Water Goes Bad (www.neha.org/node/60597).
- Recorded webinar: Coming Clean About Norovirus—How to Dodge the Spread, (www.neha.org/node/60387).
- Mid-Year BIA Meeting, January 30, 2020.
- NEHA 2020 AEC panel presentation: Public and Private Partnerships: Benefits of Engaging Stakeholders for the Long Haul.
- NEHA 2020 AEC exhibition booth: BIA members can network with conference attendees at the booth and display products and promotional materials.

Webinar and session attendees can earn continuing education contact hours toward their NEHA credentials.

Tribute to the Business and Industry Affiliate Founders

NEHA members with 15 or more years of affiliation may recall that there once was a thriving business and industry consortium, which was dissolved in 2010. Thankfully, a motivated and visionary team of NEHA leaders took the initiative to resurrect BIA! Shelly Wallingford and Dr. Bob Powitz (2017 Walter S. Mangold Award recipient) assembled a membership caucus at the NEHA 2015 AEC in Orlando, Florida. BIA's inaugural board was elected and foundational work began. Stan Hazan, Jaymin Patel, Dr. Bob Powitz, Traci Slowinski, Christine Testa, and Shelly Wallingford combined forces to establish the new affiliate. Incorporation was finalized in January 2016 and BIA achieved 501 (c)(6) status in March 2017.

The BIA board and membership have continued to evolve and have participated in at least one NEHA AEC session every year. BIA sponsored the NEHA 2018 AEC keynote address given by Frank Yiannas and have hosted an exhibition booth at the AEC. So far, BIA has hosted three webinars (as previously listed) with more planned in the coming year.

Meet the 2019–2021 Business and Industry Affiliate Board

The BIA board is comprised of steadfast volunteers with diverse environmental health backgrounds. Board members serve 2-year terms in accordance with BIA bylaws. The current board members are:

- President: Alicia Enriquez-Collins, Steritech
- Vice President: Brian Keller, ABC Home & Commercial Services
- Secretary: Kimberly Pennington, Steritech
- Treasurer: Traci (Slowinski) Michelson, Brinker International
- At Large: Michael Crea, Florida Environmental Health Association; Tracy Graham, Ecolab; and James O'Donnell, That Food Safety Guy

To contact a board member, please e-mail us at nehabia@outlook.com.

Invitation to Join

We continue to see a bright future. BIA can achieve its mission through the active participation of its members. Membership is open to all persons, businesses, and organizations working or supporting environmental health. At $25 per year, membership dues are a bargain for the resources and benefits available. Consider becoming a member.

Visit www.nehabia.org to review the benefits of BIA membership, view upcoming events, and join our network of industry and regulatory professionals.

Acknowledgement: The BIA board appreciates the support of NEHA's board of directors, staff, and members.

EH CALENDAR

UPCOMING NEHA CONFERENCES

July 13–16, 2020: NEHA 2020 Annual Educational Conference & Exhibition, New York City, NY. For more information, visit www.neha.org/aec.

July 12–15, 2021: NEHA 2021 Annual Educational Conference & Exhibition, Spokane, WA.

NEHA AFFILIATE AND REGIONAL LISTINGS

Georgia
May 27–29, 2020: Annual Education Conference, hosted by the Georgia Environmental Health Association, Lake Lanier Islands, GA. For more information, visit www.geha-online.org.

Kentucky
February 11–13, 2020: Annual Conference, hosted by the Kentucky Environmental Health Association, Erlanger, KY. For more information, visit www.kyeha.org/events.

Michigan
March 18–20, 2020: Annual Education Conference, hosted by the Michigan Environmental Health Association, Traverse City, MI. For more information, visit www.meha.net/AEC.

Missouri
April 7–10, 2020: Annual Education Conference, hosted by the Missouri Environmental Health Association, Springfield, MO. For more information, visit https://mehamo.org.

Nevada
April 28–29, 2020: NFSTF & NVEHA Joint Conference, hosted by the Nevada Food Safety Task Force (NFSTF) and the Nevada Environmental Health Association (NVEHA), Las Vegas, NV. For more information, visit www.nveha.org.

New Jersey
March 1–3, 2020: Educational Conference & Exhibition, hosted by the New Jersey Environmental Health Association, Atlantic City, NJ. For more information, visit www.njeha.org.

North Carolina
January 23–24, 2020: Public Health Leaders' Conference, hosted by the North Carolina Public Health Association, Raleigh, NC. For more information, visit https://ncpha.memberclicks.net.

Oregon
March 31–April 2, 2020: Annual Education Conference, hosted by the Oregon Environmental Health Association, Bend, OR. For more information, visit www.oregoneha.org/aec.htm.

Utah
May 6–8, 2020: Spring Conference, hosted by the Utah Environmental Health Association, Kanab, UT. For more information, visit www.ueha.org.

Virginia
April 24, 2020: Spring Onsite Workshop/Field Day, hosted by the Virginia Environmental Health Association, Charlottesville, VA. For more information, visit https://veha32.wildapricot.org.

Washington
April 27–29, 2020: 68th Annual Educational Conference, hosted by the Washington State Environmental Health Association, Tacoma, WA. For more information, visit www.wseha.org.

TOPICAL LISTINGS

Emergency Response
January 26–31, 2020: Environmental Health Training in Emergency Response Operations, held by the Federal Emergency Management Agency's Center for Domestic Preparedness, Anniston, AL. For more information, visit https://cdp.dhs.gov/find-training/course/PER-309.

Food Safety
March 9–12, 2020: Integrated Foodborne Outbreak Response and Management (InFORM) 2020 Conference, Atlanta, GA. For more information, visit www.aphl.org/conferences/InformConf/Pages/default.aspx.

Public Health
April 7–8, 2020: Iowa Governor's Conference of Public Health, Des Moines, IA. For more information, visit www.ieha.net/IGCPH.

Did You Know?

The U.S. Environmental Protection Agency has designated January as National Radon Action Month. Learn more about the national effort to take action against radon and how to plan your outreach events at www.epa.gov/radon/national-radon-action-month-information.

STUDENTS Don't Miss This Opportunity!

Applications for the 2020 National Environmental Health Association/American Academy of Sanitarians (NEHA/AAS) Scholarship Program are now available.

Undergraduate and graduate students enrolled in an accredited college or university with a dedicated curriculum in environmental health sciences are encouraged to apply.

Visit

www.neha.org/scholarship.

Application and qualification information are available online.

Contact

Jonna Ashley
with a request for information.

E-mail: jashley@neha.org

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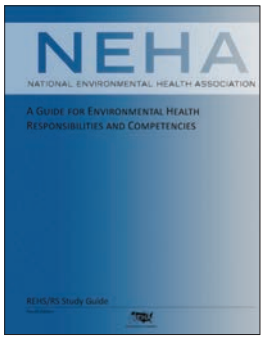
Resource Corner highlights different resources the National Environmental Health Association (NEHA) has available to meet your education and training needs. These timely resources provide you with information and knowledge to advance your professional development. Visit NEHA's online Bookstore for additional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

NEHA BOOKSTORE
www.neha.org/store

REHS/RS Study Guide (4th Edition)

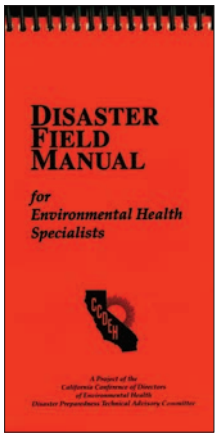
National Environmental Health Association (2014)



The Registered Environmental Health Specialist/Registered Sanitarian (REHS/RS) credential is the National Environmental Health Association's (NEHA) premier credential. This study guide provides a tool for individuals to prepare for the REHS/RS exam and has been revised and updated to reflect changes and advancements in technologies and theories in the environmental health and protection field. The study guide covers the following topic areas: general environmental health; statutes and regulations; food protection; potable water; wastewater; solid and hazardous waste; zoonoses, vectors, pests, and poisonous plants; radiation protection; occupational safety and health; air quality; environmental noise; housing sanitation; institutions and licensed establishments; swimming pools and recreational facilities; and disaster sanitation.
308 pages / Paperback
Member: $149 / Nonmember: $179

Disaster Field Manual for Environmental Health Specialists

California Association of Environmental Health Administrators (2012)



This manual serves as a useful field guide for environmental health professionals following a major disaster. It provides an excellent overview of key response and recovery options to be considered as prompt and informed decisions are made to protect the public's health and safety. Some of the topics covered as they relate to disasters include water, food, liquid waste/sewage, solid waste disposal, housing/mass care shelters, vector control, hazardous materials, medical waste, and responding to a radiological incident. The manual is made of water-resistant paper and is small enough to fit in your pocket, making it useful in the field. Study reference for NEHA's Registered Environmental Health Specialist/Registered Sanitarian credential exam.
224 pages / Spiral-bound hardback
Member: $37 / Nonmember: $45

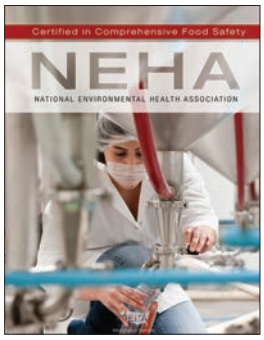
Certified Professional–Food Safety Manual (3rd Edition)

National Environmental Health Association (2014)

The Certified Professional–Food Safety (CP-FS) credential is well respected throughout the environmental health and food safety field. This manual has been developed by experts from across the various food safety disciplines to help candidates prepare for NEHA's CP-FS exam. This book contains science-based, in-depth information about causes and prevention of foodborne illness, HACCP plans and active managerial control, cleaning and sanitizing, conducting facility plan reviews, pest control, risk-based inspections, sampling food for laboratory analysis, food defense, responding to food emergencies and foodborne illness outbreaks, and legal aspects of food safety.
358 pages / Spiral-bound paperback
Member: $179 / Nonmember: $209

Certified in Comprehensive Food Safety Manual

National Environmental Health Association (2014)



The Food Safety Modernization Act has recast the food safety landscape, including the role of the food safety professional. To position this field for the future, NEHA is proud to offer the Certified in Comprehensive Food Safety (CCFS) credential. CCFS is a mid-level credential for food safety professionals that demonstrates expertise in how to ensure food is safe for consumers throughout the manufacturing and processing environment. It can be utilized by anyone wanting to continue a growth path in the food safety sector, whether in a regulatory/oversight role or in a food safety management or compliance position within the private sector. This manual has been carefully developed to help prepare candidates for the CCFS credential exam and deals with the information required to perform effectively as a CCFS.
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JEH QUIZ

FEATURED ARTICLE QUIZ #4

Water Quality Trading Mechanism Enhances Willingness to Upgrade Rural Household Septic Systems in Western Lake Erie Basin, Northwest Ohio

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 an easily accessible means to accumulate continuing-education (CE) hours 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 found at www.neha.org/publications/journal-environmental-health,
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   Denver, CO 80246.
   Be sure to include your name and member number!
4. One CE hour will be applied to your account with an effective date of January 1, 2020 (first day of issue).
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6. You're on your way to earning CE hours!

Quiz Registration

Name

NEHA Member Number

E-mail

→ Quiz deadline: April 1, 2020

1. It has been estimated that the septic system failure rate in Ohio is around
   a. 20%.
   b. 25%.
   c. 30%.
   d. 35%.

2. The Ohio Department of Health estimated that the onsite septic system effluent discharging into the Lake Erie watershed contain __ of total phosphorus.
   a. 302 tons/year
   b. 352 tons/year
   c. 402 tons/year
   d. 452 tons/year

3. In the study site in the Blanchard River Watershed, septic systems are the __ largest source of phosphorous.
   a. first
   b. second
   c. third
   d. fourth

4. In Ohio, the main causes of septic system malfunctioning include
   a. site limitations
   b. aging
   c. overloading
   d. soil limitations
   e. all the above

5. While __ of all systems installed in Ohio were traditional soil-based septic systems, __ of the soil in Ohio is considered not suitable for soil-based septic systems.
   a. 62%; 68%
   b. 68%; 72%
   c. 72%; 68%
   d. 78%; 62%

6. The estimated failure rate of septic systems in northwest Ohio is
   a. 24%.
   b. 29%.
   c. 34%.
   d. 39%.

7. Water quality trading allows point sources, such as factories and wastewater treatment plants, to meet their regulatory obligations to the National Pollutant Discharge Elimination System by adding pollutant reductions created by another source that has lower pollution control costs.
   a. True.
   b. False.

8. Of the households participating in the survey, __ did not do anything to maintain their septic systems in the past 5 years.
   a. 17%
   b. 39%
   c. 41%
   d. 66%

9. Overall, __ of the households showed some degree of interest in at least one of the three water quality trading models for septic system upgrades.
   a. 42.14%
   b. 43.48%
   c. 58.06%
   d. 56.52%

10. The perceived water quality in nearby streams was __ to upgrade willingness in all three study scenarios.
    a. positively related
    b. negatively related
    c. not related

11. The more concerned a household was about the local aquatic environment, the __ likely they would upgrade the septic system.
    a. less
    b. more

12. In the water quality treatment scenario, the odds of high-income households being willing to upgrade their septic systems were __ times higher than the low-income households.
    a. 2.92
    b. 3.59
    c. 3.92
    d. 4.32

JEH Quiz #2 Answers
October 2019

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

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Entries must be submitted by Friday, February 28, 2020, to
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For additional information and research submission guidelines, please visit www.aehap.org/aehap-src-scholarship-and-nsf-internships.html.

AEHAP gratefully acknowledges the volunteer efforts of AEHAP members who serve on the advisory committee for this competition.

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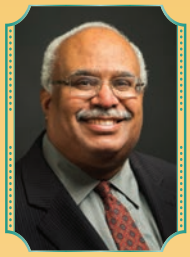

Keynote Address
Georges C. Benjamin, MD
Executive Director,
American Public Health Association

Closing Session
Reverend Gerald L. Durley, MS, MDiv, PhD
Pastor Emeritus, Providence Missionary Baptist Church of Atlanta, Georgia

Grand Session Kickoff
John Howard, MPH, MBA, LLM, JD, MD
Director,
National Institute for Occupational Safety and Health,
Centers for Disease Control and Prevention

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Full Conference Registration for Students Includes a 1-year NEHA Emerging Professional membership and one ticket to each of the * items below	$220	
Full Conference Registration for Retirees Includes one ticket to each of the * items below	$250	
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NEHA **NEWS**

Ready for Launch: Private Water Network—A Community of People Working Towards Promoting Safety in Private Drinking Water

By Reem Tariq, MSEH (rtariq@neha.org)

The National Environmental Health Association (NEHA) is pleased to announce the launch of the Private Water Network (PWN). PWN is a community of professionals and specialists working to protect the public's health from contaminants in private drinking water sources. Over 15 million U.S. households rely on private water systems for drinking water. These systems include private wells, cisterns, water storage tanks, and trucked water. The U.S. Environmental Protection Agency (U.S. EPA) is responsible for making sure that the public water supply within the U.S. is safe. U.S. EPA does not, however, monitor or treat private wells and unregulated drinking water systems. Owners of private wells are responsible for ensuring that their water is safe from contaminants.

Prior to the launch of PWN, there was no go-to resource for peer learning and information exchange for environmental health professionals and water safety specialists who serve communities with private drinking water systems. Through a partnership between the Centers for Disease Control and Prevention (CDC), NEHA, and National Network of Public Health Institutes (NNPHI), PWN was established to fill that void.

CDC's National Center for Environmental Health has historically had programs, such as the Private Well Initiative and the Environmental Health Specialist Network, that focused on addressing public health threats to drinking water. There were two additional capacity building projects that funded states to address the data issues with unregulated drinking water systems. A private well community of practice with about 150 members was formed to share research updates, surveillance data, and practices on private water. Participants of this community of practice included state and local health departments, nongovernmental organizations, and universities. The outcome from these projects led to the creation of the Safe Water for Community Health (Safe WATCH) program that funds health departments to address problems with drinking water systems in their communities by strengthening and improving their programs.

Based on the feedback from participants of the Safe WATCH program, CDC felt the need to establish a peer-to-peer network with a focus on private water. The intention was to build a stakeholder driven network with water safety specialists and environmental public health professionals working on private drinking water systems to drive network-related interactions based on participant needs. PWN was established to serve two purposes: 1) to gather, organize, and share all existing and relevant resources regarding private water and 2) to build an online resource to support future stakeholder goals.

Attendees of the "Private Water Network: What Is It and How You Can Be a Part of It" session at the National Environmental Health Association's 2019 Annual Educational Conference & Exhibition in Nashville, Tennessee. Photo courtesy of Reem Tariq.

Serving a membership of 6,500 environmental health professionals, NEHA was primed to build this resource. NNPHI was brought on to provide expertise on building a sustainable stakeholder driven network. NNPHI has a long track record of providing quality technical assistance in network building and online-community management. With CDC's and NNPHI's guidance, NEHA convened the participants of the Safe WATCH program to develop the mission of PWN. The mission of PWN is to "build a sustainable community for those working to support private water programs; to connect with their peers to share experiences, insights, and resources; to gain access to timely and relevant guidance for existing and emerging issues; and to build capacity to do the work more effectively and efficiently in order to protect the public's health from contaminants in private water sources."

PWN is a virtual community of practice with opportunities to interact face-to-face at NEHA's Annual Educational Conference & Exhibition (see photo above). Membership to PWN offers access to the virtual community platform that provides flexible communication options and easy-to-use knowledge management tools that facilitate collaboration and professional development. Features of the virtual community include a discussion forum, resources library, event calendar, member directory, and community-wide search option. Members of the network can engage on the virtual platform by uploading or downloading relevant materials, engaging in discussions, connecting with peers, and promoting relevant events. Furthermore, membership to PWN also offers access to exclusive webinars and newsletters on private water issues.

PWN's virtual platform is monitored by NEHA to provide a safe, secure, and productive virtual environment that is conducive for peer-to-peer learning and knowledge sharing. PWN is a resource for anyone working to promote safety and public health in relation to private wells and unregulated drinking water systems.

NEHA is looking to include more members from the following agencies and organizations:

- state, local, tribal, and territorial governmental public health agencies;

- other state agency departments (e.g., environmental health, wells, permitting, natural resources, agriculture, health, ecology, land, water conservation, transportation, geology, building codes, permits, flood plains, emergency management);
- federal agencies (e.g., U.S. EPA, Agency for Toxic Substances and Disease Registry, Federal Emergency Management Agency, Centers for Disease Control and Prevention, U.S. Geological Survey, Office of the Assistant Secretary for Preparedness and Response, Army Corps of Engineers);
- national organizations (e.g., National Association of County and City Health Officials, Water Quality Association, NSF International, National Groundwater Association, Association of State and Territorial Health Officials);
- certified laboratories; and
- academic and extension partners.

Membership to PWN is free. If you are interested in joining, you can sign up at www.privatewaternetwork.org. NEHA membership is not required to be a member of the network; however, you will need to create a MyNEHA account through www.neha.org. Over the next year, NEHA will work toward maintaining a sustainable network growth and increasing member engagement for PWN. NEHA hopes to expand PWN membership to include a member from every state and territory within the U.S.

If you work with private drinking water systems, NEHA encourages you to join PWN today! For any questions or concerns about PWN membership or participation, please contact pwn@neha.org.

NEHA Staff Profiles

As part of tradition, NEHA features new staff members in the *Journal* around the time of their 1-year anniversary. These profiles give you an opportunity to get to know the NEHA staff better and to learn more about the great programs and activities going on in your association. This month we are pleased to introduce you to two NEHA staff members. Contact information for all NEHA staff can be found on page 42.

Renee Clark

I joined NEHA in January 2019 as an accounting manager in the Finance department. My goal is to streamline processes, become paperless wherever possible, and most importantly, help NEHA grow in all aspects of environmental health.

I have an accounting degree from Louisiana State University and started my career in the flood prone area of Houston, scheduling, transporting, and marketing natural gas. I've been through several hurricanes and other natural disasters and have seen firsthand how they affect the environment. My job moved me to Denver several years ago where I continued to work in the natural gas industry. After a break from my career, I reentered the workforce for a nonprofit association where I gained experience with associations, memberships, and continuing education programs.

I have three children: one in Nashville, the other in Denver, and the youngest in college in Idaho. My husband and I enjoy beautiful Colorado with our two dogs and following college sports.

I love seeing the commitment NEHA has to environmental health issues that we see in the news every day. It's exciting and meaningful to be a part of an organization that is trying to make a difference.

Rosie DeVito

My career in public health began while pursuing a degree in biology from Le Moyne College in Syracuse, New York. I graduated in 2015 with a Bachelor of Science in biology and a minor in chemistry, and immediately went to graduate school for public health. I earned a Master of Public Health with a concentration in environmental health in 2017 from the University at Buffalo in Buffalo, New York. Since then, I have had the opportunity to take on various roles in the environmental and public health fields, including conducting research on air quality, food access, and lead poisoning.

Upon moving to Denver in 2017, I took on a program management and community organizing role in active living and urban planning, as well as public health program instruction for high school students. Most recently, I worked as a data specialist that served as a placeholder until I found the perfect career that would challenge me, fulfill my passions, and allow me to grow as a leader in environmental health. My first year at NEHA has shown me that it is possible to find that career!

As a project manager, I oversee NEHA's projects related to hurricane recovery in enhancing the environmental health workforce, children's environmental health and emergency preparedness, and disaster-related disease surveillance and prevention. These projects are in partnership with the Centers for Disease Control and Prevention, Puerto Rico, and the U.S. Virgin Islands. I enjoy exploring the intersection of multiple different fields and this job allows me to do that! What I love most about this position is that I have the opportunity to meet talented professionals in environmental health and travel to unique places. Additionally, knowing that I am contributing to making a positive impact on people's lives motivates me to work hard.

When I am not at work, you will probably find me hiking, camping, or just spending time in the mountains. I also love going to concerts, festivals, and exploring something new every weekend. The only thing I seem to be missing in Denver is a dog!

2020

ACCEPTING NOMINATIONS NOW

Walter S. Mangold Award

The Walter S. Mangold Award recognizes an individual for extraordinary achievement in environmental health. Since 1956, this award acknowledges the brightest and best in the profession. NEHA is currently accepting nominations for this award by an affiliate in good standing or by any five NEHA members, regardless of their affiliation.

The Mangold is NEHA's most prestigious award and while it recognizes an individual, it also honors an entire profession for its skill, knowledge, and commitment to public health.

Nomination deadline is March 15, 2020.

For application instructions, visit www.neha.org/about-neha/awards/walter-s-mangold-award.

2020 Joe Beck Educational Contribution Award

This award was established to recognize NEHA members, teams, or organizations for an outstanding educational contribution within the field of environmental health.

Named in honor of the late Professor Joe Beck, this award provides a pathway for the sharing of creative methods and tools to educate one another and the public about environmental health principles and practices. Don't miss this opportunity to submit a nomination to highlight the great work of your colleagues!

Nomination deadline is March 15, 2020.

For application instructions, visit www.neha.org/about-neha/awards/joe-beck-educational-contribution-award.

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Dad (aka Dr. Dyjack) and Nathan in the American Heartland. Photo courtesy of David Dyjack.

Dr. David Dyjack at the American University of Beirut in Lebanon. Photo courtesy of David Dyjack.

dictions in our professional lives are abundant. We are trained scientists and often play an enforcement role in that capacity. Many of us, however, joined this profession to protect and improve the lives of our communities. Historic health and economic disparities are at the root of much of our contemporary ills. How do we harmonize our passions with the challenges at hand? How do we ensure that we don't passively observe the fragmentation of our profession along the lines of the coasts and Heartland?

Most of us live in middle America and watch or participate in food being grown, resources being extracted, and can't afford fair trade coffee. Our members in Wichita, Kansas; Omaha, Nebraska; and Richmond, Kentucky, bear witness. I believe the National Environmental Health Association should lead through example and exert principled influence where it can to maintain balance in our vision of health for all. Let's think and act in a manner that ensures that the passions of the coastal champions can be harnessed to connect with and improve the working lives of our members and their communities in places like North Dakota, Iowa, and Mississippi.

Our country is large and diverse. Diversity, when properly and respectfully harnessed, makes us stronger and more resilient. This is true in ecosystems, workplaces, and economies. Let's endeavor to keep our professional community, in whatever form or function it appears, threaded together. And at the same time, let us increasingly recognize the importance of all people and places—whoever they are and wherever they may be.

American author F. Scott Fitzgerald once said that the test of a first-rate intelligence is the ability to hold two opposed ideas in mind at the same time and still retain the ability to function. Let's see what we got.

Dave

ddyjack@neha.org
Twitter: @DTDyjack

DirecTalk MUSINGS FROM THE 10TH FLOOR

David Dyjack, DrPH, CIH

Baltimore to Beirut

"Dad, be careful!" Nathan and I were rolling east on I-70 toward St. Louis in a large rental truck. Our son had been accepted into Johns Hopkins University and I volunteered to drive with him cross-country to gritty, glorious Baltimore. I inhaled deeply; my son's e-cigarette released its dose of nicotine and I savored the momentary alertness brought on by one of the most reviled drug-delivery instruments of the modern public health era.

Dr. Dyjack inhaling an e-cigarette? Indeed, and intermittently over 3 days. This experiment was conducted before the recent disclosures of illness and death from vaping. I am not glorifying e-cigarettes and am an older man whose appetite and biological propensity/brain chemistry for addictions are long gone. Knowledge is transferable. Experience is not. I desired the experience. If you find this incongruence with my public persona disturbing, please be comforted that I am doing my best to get Nathan to quit. I entertain opposing thoughts absent any sense of contradiction, which may be a strength or fatal character flaw.

To further illustrate my point, consider the following:

- I believe climate change is an existential crisis, yet I once worked for Exxon, an experience I savor.
- I spent 18 years in academia aware of my privileged place in the ivory tower and at the same time, worked to improve the health of immigrant communities.
- I did not become an overnight chief executive officer (CEO). I learned my craft through many years armed with a clipboard, respirator, Tyvek, and steel-toe boots. I possess abundant experience collecting samples, conducting environmental risk assessments, and reporting results to clients.
- I have lived much of my life in relatively wealthy coastal metro regions that possess immense disparity, while also being proximal to think tanks, such as those found on K Street in Washington, DC. At the same time, I have spent and continue to spend considerable time in the American Heartland and possess great affinity for the challenges of rural and frontier America.
- Poverty and health equity arguably should be priorities for our association and yet, I have been unable to map out a process that would meaningfully and sustainably advance progress in these areas of concern. I believe our association and its membership could act as professional sextants in these oceans of challenge even though they are not classic environmental health workforce issues.

Let's endeavor to keep our professional community, in whatever form or function it appears, threaded together.

The incongruencies that make up the fabric of our lives offer valuable insight. On some days I find myself in Washington, DC, where people speak swiftly with vocabularies reflective of elite education. These conversations often center around urban health issues. The next day I'm somewhere between Connecticut and California, where the people are equally intelligent and committed, but might lack the privilege and benefits of white-hot coastal economies. These conversations appropriately focus on the plight of rural America. It's almost as if these two groups live in separate universes. What role does our association play in threading these different experiences together?

This spring I led a Council on Education for Public Health site visit to the American University of Beirut in Lebanon. While I don't want to fall victim to false impressions left by a short visit with people on their best behavior, I was nonetheless left breathless by their atmosphere of inclusion. Regional politics, religious strife, and other factors that tend to drive Middle Eastern communities apart were absent by design. Everyone from all walks of life were welcome to study in relative safety and security.

Like a safe university campus ensconced in an unstable and militarized region, the contra-

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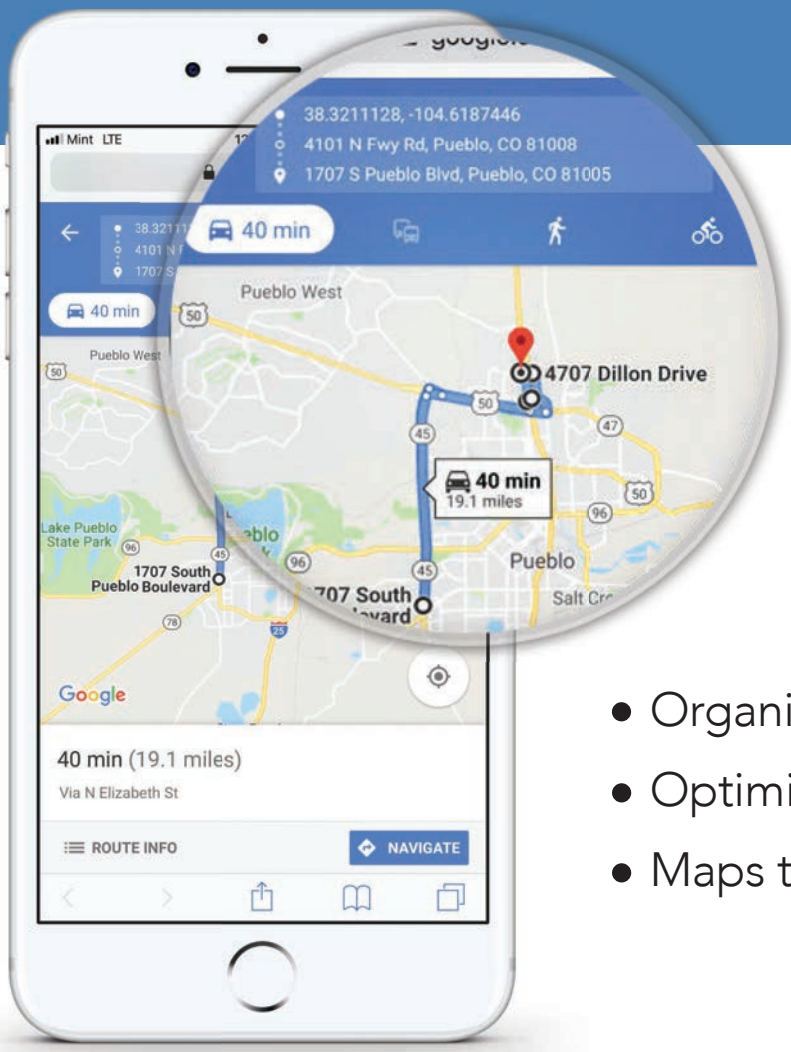

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