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INDOOR AIR QUALITY RISKS FOR RENTERS

Impact of a Personalized Report-Back Intervention

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ABOUT THE COVER

Lung cancer is the leading cause of cancer death in the U.S. Smoking and radon are the leading causes of lung cancer. Environmental risks are inversely related to income and socioeconomic status disparities are associated with a lack of action to reduce environmental risks. This month's cover article, "Personalized Report-Back to Renters on Radon and Tobacco Smoke Exposure," evaluates the impact, feasibility, and acceptability of a dual home screening and a personalized environmental report-back intervention to prompt action to reduce home exposure to radon and secondhand smoke in renters.

See page 8.

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PRESIDENT'S MESSAGE

Adam London,
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An Evolving Workforce

I am a sanitarian because of the powerful influence of two amazing women: my mother and grandmother. My mother has been a registered nurse since I was very young. She is retired now, but that changes very little. She is, and always will be, a nurse. It's not merely something she did for a paycheck; it became part the fabric of her identity. Caring for her patients, family, and everyone around her is central to who she is. This sense of vocation made a very powerful impact on me. I could see the joy of doing something that truly matters. I could also see the incredible force for good that this amazing professional woman projected onto the world around her. What higher calling could there be than serving other people? She has always inspired me to serve others.

Pursuing a career that could become a vocation was very important to me as I entered Ferris State University as a biology major. I did not really know what I wanted to be, but it needed to feed my love for science and the desire to make a difference in the world. At one point during my sophomore year, I became frustrated by the ambiguous career opportunities awaiting biology graduates. In a moment of doubt, I even considered transferring into the business school! It was my ever-wise grandmother who knocked some sense into me and said, "You need to get into that environmental health program like your uncle Bobby did!" She then proceeded—without my knowledge—to call faculty in Ferris State University's environmental health program and enlisted them to rescue me from my academic limbo. Within a week I was officially a student in the only accredited environmental health undergraduate program in Michigan at that time.

If environmental health is going to thrive, we need a diverse profession comprised of individuals empowered with the liberty to reach their full potential.

I will always owe a debt of gratitude to these two incredible women for steering me toward this noble profession. I know that many of you were inspired by strong women in your own lives. The environmental health profession has blessed all of us with innumerable opportunities, but it is not often an easy career path. As all of you know too well, environmental health is demanding and challenging work. It was especially difficult for me when I was a young, inexperienced sanitarian. Let's face it, a portion of the world loathes the fact that regulators even exist. I know that the young women in our profession have it harder yet. The additional challenges presented by sexism and harassment are intolerable and something we all need to recognize and reject. We have an obligation to ensure that our profession is safe for all to practice.

I am astounded by how far the demographics of our profession have changed during the past 20 years. In the late 1990s, when I finally graduated with that environmental health degree, the workforce I entered was predominately male. The membership, leadership, and attendance at statewide environmental health associations also appeared to be disproportionately endowed with Y chromosomes. While the rest of the public health workforce contained a majority of females, environmental health divisions lagged far behind. Making matters worse, a sticky floor seemed to slow their progression into leadership roles.

Something revolutionary has happened, however, during the course of the past two decades. The majority of sanitarians now in many health departments are female. Your NEHA board of directors is probably more diverse than it has ever been, and we have been led by extraordinary women presidents during my time on the board.

Times are changing, but we cannot let this progress fool us into thinking that sexism and harassment are extinct. The many revelations of sexual harassment within the entertainment industry should startle all of us. This issue should cause us to reflect upon our own industry and understand that the objectification of people is a problem everywhere. We can, and must, always strive to do better.

I hope you have already made it a priority to mentor at least one young professional. Preventing sexism and harassment in the environmental health workforce is more likely if we build strong networks of support for one another. This month I challenge you, regardless of your age or gender, to specifically reach out to the young women in our profession. We have all been blessed by amazing women in our families and at work—it's past time to pay it forward. Please don't assume that you know what their unique challenges are. Rather, reach out to them as colleagues and equals, and understand that they are the future standard bearers of our profession. Seek to understand and to build a culture of zero tolerance for sexism and harassment.

If environmental health is going to thrive, we need a diverse profession comprised of individuals empowered with the liberty to reach their full potential without fear of harassment. If we can successfully build this culture, we will have truly made the sort of difference that would make our mothers and grandmothers proud.

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Personalized Report-Back to Renters on Radon and Tobacco Smoke Exposure

Ellen J. Hahn, PhD, RN, FAAN
Kathy Rademacher
Amanda Wiggins, PhD
Mary Kay Rayens, PhD
University of Kentucky College of Nursing

Abstract **Combined exposure to tobacco smoke and radon increases lung cancer risk, and renters are disproportionately exposed to secondhand smoke (SHS). A quota sample of renters (*N* = 47) received free radon and airborne nicotine test kits in a primary care setting to explore the impact of a personalized environmental report-back intervention on home exposure. Half of the sampled renters reported smokers living in the home. Taking actions to reduce radon and SHS exposure were assessed at baseline, and at 3-, 9-, and 15-months postintervention; home testing occurred at baseline and at 15 months. Stage of action in home testing and in adopting a smoke-free (SF) home policy increased from baseline to 3 months; we observed no further changes in stage of action over time. Airborne nicotine declined from baseline to 15 months (p = .031; n = 9). More research is needed to evaluate interventions to motivate renters and landlords to test and mitigate for radon and adopt SF policies.**

Introduction

Lung cancer is the leading cause of cancer death in the U.S.; an estimated 222,500 new cases and 155,870 deaths were projected in 2017 (National Cancer Institute, n.d.). Smoking is the leading cause of lung cancer, followed by radon (U.S. Department of Health and Human Services [HHS], 2005) and secondhand smoke (SHS) exposure (HHS, 2006). Radon-related lung cancers are more likely in those with a smoking history (National Research Council, 1999).

Environmental risks are inversely related to income (Evans & Kantrowitz, 2002). Nearly one half of those living in multi-unit housing report that SHS enters their living space from elsewhere (Hewett, Sandell, Anderson, & Niebuhr, 2007). Further, socioeconomic status (SES) disparities are associated with lack of action to reduce environmental risks. A family of lower SES is less likely to adopt a smoke-free (SF) home than a family of higher SES (Norman, Ribisl, Howard-Pitney, & Howard, 1999; Wakefield et al., 2000), and a family of lower SES is more likely to live in a rental property.

Landlords often fear that SF policies will hurt their business, expecting higher vacancy, turnover, and tenant complaints (Cramer, Roberts, & Stevens, 2011; Hewett et al., 2007; Snyder, Vick, & King, 2016; Stein et al., 2016). Similarly, lower income individuals (Halpern & Warner, 1994; Hill, Butterfield, & Larsson, 2006; Wang, Ju, Stark, & Teresi, 1999) are least likely to initiate protective radon behaviors. Although radon test kits are relatively inexpensive and are often available for free, primary care providers do not routinely recommend radon testing.

Report-back is a cueing event that might motivate individuals to take action such as adopting a SF home (McBride, Emmons, & Lipkus, 2003; McBride et al., 2008). Report-back is effective in conveying exposure data (Altman et al., 2008), even with low-SES groups, and prompting action to reduce household exposures (Adams et al., 2011). When individuals are provided with evidence of high radon, they are more likely to mitigate (Duckworth, Frank-Stromborg, Oleckno, Duffy, & Burns, 2002; Riesenfeld et al., 2007; Wang et al., 1999).

This exploratory study evaluated the impact, feasibility, and acceptability of a dual home screening and personalized environmental report-back intervention (Hahn et al., 2014) to prompt action to reduce home exposure to radon and SHS in a sample of renters. We hypothesized that, over time, renters who received free in-person home test kits, report-back, and a brief problem-solving intervention would be more ready to take action to reduce radon and SHS exposure, and would have lower radon and SHS levels in their homes.

Methods

Design and Sample

This study was a prospective, quasi-experimental one-group design using quota sampling. Half of eligible renters had at least one smoker living in the home. Participants were eligible to participate if they were at least 21 years, had access to a telephone, had not tested their home for radon within two years, and did not own their home. We recruited participants in primary care clinics at an academic medical center from January–May 2013. Nearly all (97%) eligible renters participated. All 47 participants were assigned to receive the intervention; 23 reported at least one smoker lived in their home. Semistructured interviews were conducted to determine feasibility and acceptability of the intervention.

Intervention

The Freedom from Radon Exposure and Smoking in the Home (FRESH) intervention (Hahn et al., 2014) creates a teachable moment (Lawson & Flocke, 2009; McBride et al., 2003) for lung cancer risk reduction by motivating participants to 1) simultaneously test their homes for radon and SHS (cueing event) and 2) take action by participating in a personalized environmental report-back and brief problem-solving conversation via telephone.

First, we provided free home test kits in person at enrollment, including print and audiovisual instructions on how to deploy and return the kits. Next, if at least one home test value was high, we delivered the personalized intervention (Fiore et al., 2008; Rollnick, Mason, & Butler, 2010) based on stage of readiness to take action (Weinstein & Sandman, 2002) and on observed radon and airborne nicotine values. If radon values were high, we followed the U.S. Environmental Protection Agency (U.S. EPA) radon measurement protocol (U.S. EPA, 2010, 2012) and recommended their landlord contact a certified radon professional for further assessment and mitigation.

If renters provided permission for us to contact their landlord, we offered a voucher covering 30% of the radon mitigation cost, up to $600. If airborne nicotine levels were high, we suggested participants institute and enforce a SF-home policy. If tobacco smokers lived in or visited the home, we provided a brief intervention on quitting (Fiore et al., 2008) and referral to the telephone quit line (1-800-QUIT-NOW). We also provided information to share with their landlords to dispel perceived barriers to adopting a SF-property policy (American Nonsmokers' Rights Foundation, 2014; National Center for Healthy Housing, 2009). If both values were low, we mailed a results letter.

Procedure

Participants completed online or paper and pencil surveys at baseline, and at 3-, 9-, and 15-months postintervention; escalating payments ranged from $10–$40 for completing surveys. Renters were asked to deploy radon and SHS test kits in the home for 6 days at baseline and at 15 months postintervention, and were paid $20 for each pair of returned kits. Unless a participant withdrew, we invited them to complete follow-up surveys and end-of-study home testing even if they had missed prior surveys. All participants were invited to take part in semistructured telephone interviews at end of study.

Measures

Home radon and SHS levels were assessed using short-term radon test kits (Air Chek, Inc.) and passive airborne nicotine samplers (Hammond & Leaderer, 1987; Ogden & Maiolo, 1992). We used the U.S. EPA action level of ≥4.0 pCi/L to determine whether home radon was "high" or "low." Similarly, we used the cutoff of ≥ 0.1 µg/m^3 (Eisner, Katz, Yelin, Hammond, & Blanc, 2001; Sockrider, Hudmon, Addy, & Dolan Mullen, 2003) to denote "high" versus "low" air nicotine.

Stage of action between baseline and 3 months postintervention was assessed for home radon testing, home airborne nicotine testing, and adopting a SF-home policy. As the renter does not decide on radon mitigation, stage of action for this outcome was not considered. Stage of action is measured on a continuum of 1) unaware, 2) unengaged, 3) deciding, 4) acting, and 5) maintenance. Stages were assigned at baseline and at each follow-up based on responses to a series of survey items.

The first question was "Have you ever heard about testing your home for radon (testing your home for SHS/adopting a SF-home policy)?" Those who indicated "no" were assigned Stage 1 (unaware). The second question was "Which of the following best describes your thoughts about testing your home for radon (testing your home for SHS/adopting a SF-home policy)?" Response options included: "I've never thought about testing/adopting a SF-home policy," "I'm undecided about testing/adopting a SF-home policy," "I've decided I want to test/adopt a SF-home policy," and "I've decided I do not want to test/adopt a SF-home policy."

Participants who had never thought about home testing or were undecided were assigned Stage 2 (unengaged). Those who had decided for or against the outcome were assigned Stage 3 (deciding). At baseline, Stage 3 (deciding) was the highest available stage of action because radon and SHS testing had not yet occurred and none had tested their homes prior to the study. To measure stage of action for adopting a SF-home policy, we asked, "Have you ever adopted a SF-home policy?" At baseline, participants selecting "yes" were assigned Stage 4 (acting) for adopting a SF-home policy.

The same set of questions and response choices were asked at each follow-up and used to classify stage of action. At 3 months, those who had their homes tested after the baseline survey were considered Stage 4 (acting) for the corresponding outcome(s). These participants had tested their homes at least 6 months prior; therefore they were assigned Stage 5 (maintenance) at 9 and 15 months. For the SF-home policy outcome, participants who had established a SF-home policy at baseline were in Stage 4 (acting) and were assigned Stage 5 (maintenance) for each of the follow-up assessments, assuming the policy was maintained at each. For all others, the same set of criteria was used to define stage of action at each follow-up.

Demographics and personal characteristics were measured via baseline survey including age (in years); gender; race/ethnicity (White/non-Hispanic versus other based on racial/ethnic variability in the accessible population); education (high school or below, some college, college graduate); smoking status (current, former, never); and whether smokers lived in the home. We assessed feasibility and acceptability using a semistructured interview guide to measure motivation to take part in the study and experience with testing and the intervention. If test values were high, we asked whether participants shared the information with their landlord and how the landlord responded.

Data Analysis

Descriptive statistics, including means and standard deviations or frequency distributions, were used to summarize study variables. The Wilcoxon signed-rank test compared radon and airborne nicotine test results from baseline to 15 months. Repeated mea-

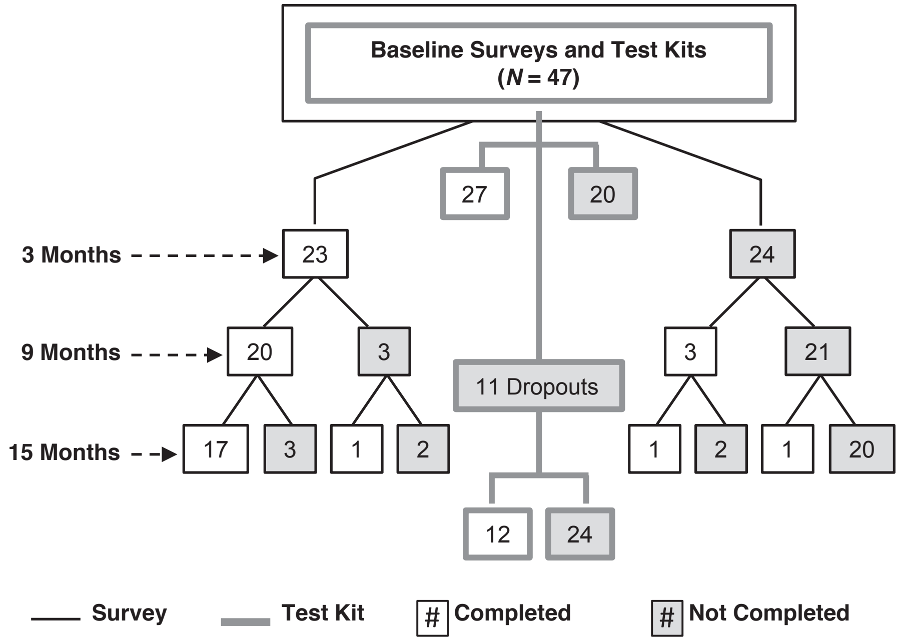
TABLE **1**

Demographic and Personal Characteristics of Participants (*N* = 47)

Characteristic	*n* (%)
Gender	
Male	18 (38.3)
Female	29 (61.7)
Race/ethnicity	
White/non-Hispanic	32 (68.1)
Other	15 (31.9)
Education	
High school or below	14 (29.8)
Some college	17 (36.2)
College graduate	16 (34.0)
Personal smoking status	
Current	17 (37.0)
Former	8 (17.4)
Never	21 (46.6)
Smoker(s) living in the home	
Yes	23 (48.9)
No	24 (51.1)

FIGURE **1**

CONSORT Diagram Detailing Participation in Each Survey and Home Testing (*N* = 47)



CONSORT = Consolidated Standards of Reporting Trials.

sures analysis of variance with Fisher's least significant difference method for pairwise post-hoc comparisons associated stage of action outcomes over time. All data analyses were conducted in SAS version 9.4 and α = .05 was used. We transcribed end-of-study interview data and coded for themes.

Results

The average age of participants was 42.5 years (SD = 14.7) and the majority were female (62%; Table 1). Most were White, non-Hispanic adults with an education level beyond high school who self-identified as never smokers. Consistent with quota sampling, 49% reported one or more smoker(s) living in the home.

The majority (57%) tested their homes for radon and airborne nicotine following the baseline survey (Figure 1). Of those who tested at baseline, over half (52%) had at least one elevated value. Six renters had low radon/high nicotine levels (22%); five had high radon/low nicotine (19%); and one had high radon/high nicotine (4%). Two participants with invalid radon results had high nicotine levels (7%); two others with invalid radon tests had low nicotine (7%). One renter had an unknown airborne nicotine value and had low radon (4%). Ten participants had low radon and low nicotine values (37%). Based on at least one elevated test, 14 renters qualified for the intervention; we delivered 12 interventions total.

Each stage of action outcomes (i.e., radon testing, airborne nicotine testing, and instituting a SF-home policy) exhibited an increase from baseline to 3 months postintervention, followed by a relatively stable value at each follow-up (Figure 2). For each outcome, the main effect of time was significant, with $F > 16.3$ and $p < .001$ in each of the three models. The post-hoc pairwise comparisons were nearly identical for the three models: for each stage of action outcome, the baseline stage was significantly lower than each of the three follow-up assessments ($p < .001$ for each comparison), while the three postintervention assessments did not differ from each other for any of the outcomes ($p > .07$ for each of these comparisons).

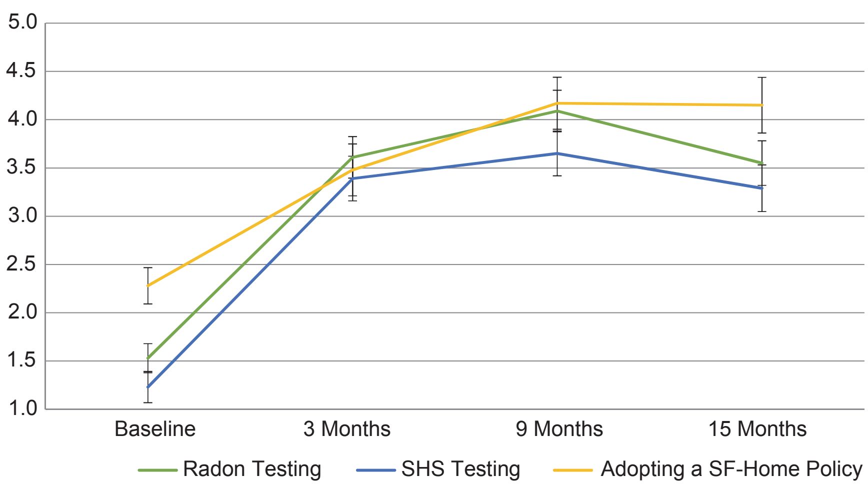
Among those who tested for radon at baseline and at 15 months, there was no difference in observed values between these two assessments ($p = .16$ for the signed-rank test, with 10 renters testing both times). Among those who tested for airborne nicotine at both time points, there was a significant decline in airborne nicotine ($p = .031$ for the signed-rank test; $n = 9$).

Participants also reported risk reduction outcomes at follow-up. One half of renters without a SF-home policy at baseline adopted a more restrictive or comprehensive SF-home policy by 3 months. From baseline to 3 months, one of the 17 smokers quit smoking. Six of the 21 participants who completed the 15-month survey said they wanted to mitigate for radon, but only two had high radon at baseline (the only test available at the 15-month survey). These two renters had talked to their landlord about their rental home's radon level, but their radon level remained high at 15 months.

Home testing completion and retention were challenges with this hard-to-reach

FIGURE **2**

Average Stage of Action Outcomes Over Time With Standard Error Bars (*N* = 47)



SHS = secondhand smoke; SF = smoke-free.

population (Figure 1). At baseline, 57% completed at least one radon and/or airborne nicotine test. Survey participation at 3 months was 49%. Between 3–9 months, three participants were lost to follow-up, and participation rates at 9 and 15 months were 52% and 49%, respectively, of those remaining in the study. By the 15-month survey, 11 participants were not invited to test their homes because they were either lost to follow-up ($n = 3$), had moved after baseline testing ($n = 6$), or had become homeowners ($n = 2$). Of the 36 who were invited to retest at 15 months, 10 completed radon and airborne nicotine testing (28%).

Renters shared at end of study ($n = 21$) that they liked the FRESH intervention. Renters liked home testing the most: kits were free and easy to deploy and they appreciated getting the results with corresponding health information. Some renters expected landlords to be unsupportive (e.g., would not fix high radon due to cost) and they expressed fear (e.g., having to move). Renters suggested that if we engaged the landlords earlier (i.e., before home testing), they might have perceived the landlord as more supportive. Renters advised that we ask landlords to distribute study recruitment fliers in future studies.

Discussion

As hypothesized, study participants were more ready to take action to test their homes for radon and SHS and institute a SF-home policy 3 months after the FRESH intervention. Half of those who did not have a SF-home policy at baseline adopted one 3 months after the intervention.

Similarly, airborne nicotine levels declined significantly by 15 months postintervention among those who tested at end of study. Providing environmental report-back and brief problem-solving skills in the primary care setting might reduce SHS exposure in this vulnerable population. SHS education and SF-home policies are not routinely recommended by primary care providers, however, as these recommendations are omitted from the Guide to Clinical Preventive Services (Agency for Healthcare Research and Quality, 2008).

Similarly, radon testing is missing from the Guide. Further, only the state of Maine requires landlords to test and disclose radon levels to their tenants (Larsson, 2014). Changes to state and federal policy and the clinical practice guideline, as well as further research to test environmental report-back interventions in primary care settings, are warranted.

Further, research engaging landlords might yield even more powerful results. Landlords with SF policies in multi-unit housing are less likely to report vacancies (11% versus 54%) and turnover (4% versus 50%; $p = .0001$) compared with their counterparts without these policies (Cramer et al., 2011; Hewett et al., 2007; Snyder et al., 2016; Stein et al., 2016). Studies on SF policy with landlords, however, have been cross-sectional and descriptive; few studies test environmental risk reduction interventions with landlords.

Our hypothesis that radon exposure would decline by end of study was not supported. Radon levels at 15 months after the intervention remained unchanged. Only two participants whose rental homes tested high for radon talked with their landlord, and none of the landlords redeemed the monetary voucher. Proper mitigation systems are expensive to install, and low-SES populations often cannot afford mitigation.

Mitigation costs range from $1,250–$1,750 for an average home on a basement, and up to $2,500–$3,000 for a home on a crawlspace. Costs are higher for multi-unit housing. Lack of knowledge and perceived risk from radon exposure are additional barriers to radon mitigation. One study with low-income rural residents reported low correlations between actual radon risk (as defined by a radon test result) and perceived risk, with only 20% of respondents correctly understanding their risk status (Hill et al., 2006). Engaging landlords to assist with renter recruitment and as research participants might increase likelihood of radon mitigation. Further, community resources and tax credits might help promote radon mitigation with property owners.

The FRESH intervention was feasible in that nearly 6 in 10 renters tested their homes for radon and SHS when provided with free home test kits in the primary care setting. Compared with a pilot study of homeowners in a pediatric clinic, home testing rates in this sample of renters were lower for radon (57% versus 76%) but higher for airborne nicotine (57% versus 48%) (Hahn et al., 2014). Homeowners in the earlier study were not paid to test their homes.

Interestingly, we noted lower participation when inviting renters to test again at 15 months. Only about one fourth of those who were sent free radon and airborne nicotine kits actually tested at 15 months. The low testing rate at end of study might have been related to the fact that nearly 4 in 10 who tested at baseline had low radon and low airborne nicotine results and might not have been motivated to test again. In fact, only 20% of those who were low/low at baseline retested at 15 months, compared with 43% of those with elevated tests. Albeit not significant, this finding indicates a trend toward lower likelihood of testing at end of study with low/low results at baseline.

Recruiting and retaining renters in research studies is a challenge, and the feasibility of delivering FRESH with renters might require different strategies. By their nature, renters are transient and their daily lives may be insecure and chaotic. Further, because they do not own their homes, renters have limited control over home exposure to environmental contaminants (Larsson, 2014). The fact that the majority tested their homes for radon and SHS at baseline is promising. Attrition rates were extraordinarily high, however, with only half completing follow-up surveys. Although there were relatively high exposure levels in this sample at baseline (26%, high radon; 35% high airborne nicotine), existing programs do not reach this vulnerable and hard-to-reach population. There is very little radon testing in rental property, but this exploratory study shows there is interest in testing among renters despite challenges with study retention.

Regardless of feasibility challenges, the FRESH intervention was acceptable to the renters and they liked testing and getting their data back. When individuals are provided with evidence of high radon, they are more likely to mitigate (Duckworth et al., 2002; Riesenfeld et al., 2007; Wang et al., 1999). Renters in our study, however, were skeptical that their landlords would fix the problem and some expressed fear in sharing results with their landlords. If landlords had access to affordable remediation resources for their rental property, they might be less concerned about vacancy and tenant turnover (Cramer et al., 2011; Hewett et al., 2007) and more likely to support healthy homes. Recruiting landlords, along with renters, and delivering FRESH with both groups might prompt action to reduce radon and SHS exposure.

The primary limitation of this exploratory study is the small sample size and lack of a control group. These preliminary findings, and in particular the elevated rate of radon and SHS exposure, underscore the need for increased attention to the environmental impact of radon and SHS on this vulnerable population. An additional limitation was that because participants had not previously tested for radon and SHS in their homes, the stage of action for testing was constrained to "deciding" or below, limiting the range of possible action levels at baseline. Finally, there was high attrition in this transient population.

Conclusion

Given that the combination of first and secondhand smoke and radon exposure increases lung cancer risk nearly tenfold (U.S. EPA, 2012), there is a critical need for effective interventions to reduce these environmental risks and prevent lung cancer among the most vulnerable (DeLancey, Thun, Jemal, & Ward, 2008; Ward et al., 2004), including renters who are disproportionately low income. FRESH is a feasible and acceptable personalized report-back intervention that shows promise in reducing inequities in environmentally induced diseases such as lung cancer. Unfortunately, the environmental risks that exist in the home, and particularly in rental property, are not readily acknowledged by those at risk and those who can provide solutions.

Changes to policy and clinical practice are needed to promote radon testing and mitigation, as well as SF environments to reduce lung cancer risk. Future research needs to develop and test strategies to inspire landlords, to consider environmental risk reduction as a way to promote healthy homes and attract future tenants (Cramer et al., 2011; Hewett et al., 2007).

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JEH QUIZ

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Personalized Report-Back to Renters on Radon and Tobacco Smoke Exposure

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) credits toward maintaining your NEHA credentials.

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JEH Quiz #4 Answers

January/February 2018

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

➔ Quiz deadline: August 1, 2018

1. Radon is the __ leading cause of lung cancer.
   a. first
   b. second
   c. third
   d. fourth

2. A family of higher socioeconomic status is less likely to adopt a smoke-free (SF) home than a family of lower socioeconomic status.
   a. True.
   b. False.

3. Landlords often expect that SF policies will result in
   a. lower tenant complaints.
   b. lower turnover.
   c. higher vacancy.
   d. lower vacancy.

4. Participants were eligible to participate in this study if they
   a. had access to a telephone.
   b. were at least 21 years.
   c. had not tested their home for radon within two years.
   d. did not own their home.
   e. all the above.

5. Participants who selected "yes" in response to "Have you adopted a SF-home policy?" were assigned as
   a. Stage 1.
   b. Stage 2.
   c. Stage 3.
   d. Stage 4.

6. The same set of questions and response choices were asked at each follow-up and used to classify stage of action.
   a. True.
   b. False.

7. Of the participants, __ reported one or more smoker(s) living in the home.
   a. 39%
   b. 49%
   c. 59%
   d. 69%

8. Home testing for radon and airborne nicotine following the baseline survey was completed by __ of the participants.
   a. 49%
   b. 52%
   c. 57%
   d. 62%

9. Among the participants who tested for airborne nicotine at baseline and at 15 months, there was __ in airborne nicotine.
   a. no change
   b. a significant decline
   c. a significant increase

10. __ of participants without a SF-home policy at baseline adopted a more restrictive or comprehensive SF-home policy by 3 months.
    a. One quarter
    b. One third
    c. One half
    d. Two thirds

11. Survey participation at 3 months was
    a. 45%.
    b. 49%.
    c. 52%.
    d. 55%.

12. The primary limitation of this study is
    a. the small sample size and lack of a control group.
    b. high attrition in this transient population.
    c. the limited range of possible action levels at baseline.
    d. none of the above.

Evaluation of Nitrate Concentrations and Potential Sources of Nitrate in Private Water Supply Wells in North Carolina

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Abstract **The goal of this study was to gain a better understanding of the link between groundwater nitrate concentrations and various land uses in North Carolina. Groundwater nitrate data from wells across North Carolina were summarized for each county. Land-use characteristics for each county including acreage and fraction of land in agriculture, population and population density, total number and density of septic systems, and the numbers and densities of various livestock (poultry, hogs, and cattle) were computed. Land-use characteristics for the 10 counties with the highest and lowest mean nitrate concentrations were compared to determine if significant differences in land-use characteristics accompanied differences in nitrate concentrations. Data indicated that counties with the highest average nitrate concentrations had more acreage and a higher fraction of their land in agriculture and higher numbers and densities of livestock. There were statistically significant correlations among average nitrate concentrations and acreage and fraction of land in agriculture and numbers and densities of livestock. Efforts to implement best management practices for reducing nitrate loss from agricultural fields is suggested especially in the Inner Coastal Plain of North Carolina where the highest mean concentrations of nitrate in groundwater were located.**

Introduction

Nitrogen and Environmental Health

Nitrogen is a crucial element for the development of proteins and other organic substances that directly influence plant and animal life. Insufficient concentrations of plant-available forms of nitrogen, such as nitrate, can limit crop yields and primary production in terrestrial and aquatic environments (Conley et al., 2009; Havlin, Beaton, Tisdale, & Nelson, 1999). Elevated nitrate concentrations in water resources, however, can be detrimental to public and environmental health. For example, research has suggested that prolonged consumption of high concentrations of nitrate in drinking water can increase the risk of cancer, methemoglobinemia (blue baby syndrome), and cumulative dysfunctions in organ systems (Ward et al., 2005).

The maximum contaminant level for nitrate-nitrogen (NO_3-N) in drinking water supplies across the U.S. (and North Carolina) is 10,000 µg/L (U.S. Environmental Protection Agency [U.S. EPA], 2009), but concentrations much lower can cause environmental health concerns. For example, concentrations of nitrate-nitrogen that exceed 1,000 µg/L can stimulate hypergrowth of algae in some surface waters, leading to eutrophication (Osmond et al., 2003). Some algae produce toxins such as microcystins that are hazardous to humans and animals, and thus are environmental health threats (North Carolina Department of Environmental Quality, 2015; Smith & Schindler, 2009). Algal blooms can impact drinking water supplies by clogging water filters and imparting undesirable tastes and odors (Dodds et al., 2009). When the algae eventually die and decompose, surface waters can become depleted of dissolved oxygen, leading to fish kills and water use impairment (Conley et al., 2009).

Major water resources in North Carolina including the Neuse River, Tar-Pamlico River, Falls Lake, and Jordan Lake are nutrient sensitive and watershed nutrient management rules have been or are being developed to reduce nitrogen loadings to these waters (North Carolina Department of Environmental Quality, n.d.). Identifying the main contributors of nitrate to water resources is important for policy development that will help protect public and environmental health.

Agricultural Nitrate Sources

There are many different sources of nitrate-nitrogen in the environment including fertilizer, animal waste, human waste, atmospheric deposition, and nitrogen fixation. Nitrogen fertilizer production and application to agriculture fields has increased fourfold since the 1960s (Havlin et al., 1999). The increased nitrogen applications not only led to an increase in crop yields and overall agricultural production but also raised concerns for environmental contamination resulting from nitrate that is not used by the crops (Havlin et al., 1999). Industrial livestock farms, also called confined animal feeding operations (CAFOs), produce animal wastes with elevated concentrations of nitrogen (>400,000 µg/L) that are often spray irrigated, or dried and applied onto crops (Goldberg, 1989; Huang, Yang, & Ling, 2014). Research has shown that nitrate concentrations in groundwater and surface waters near CAFOs and agricultural fields can exceed water-quality standards (Stone, Hunt, Humenik, & Johnson, 1998).

Agriculture is a major industry in North Carolina where farm receipts have totaled over 10 billion/year since 2010 (North Carolina Department of Agriculture and Consumer Services, 2016). There are more than 8 million hogs, 800 million poultry, 800,000 cattle, 1.9 million hectares (ha) of cropland, and 0.46 million ha of pasture in the state (North Carolina Department of Agriculture and Consumer Services, 2016). Commercial fertilizer (such as urea and ammonium nitrate) and manure are applied to approximately 72% and 10% of the cropland, respectively, in North Carolina (North Carolina Department of Agriculture and Consumer Services, 2016; Osmond et al., 2003).

Corn is one of the most commonly grown crops in North Carolina (>325,000 hectares) with nitrogen application rates typically exceeding 136 kg/ha (North Carolina Department of Agriculture and Consumer Services, 2016; North Carolina State Extension, 2017; Osmond et al. 2003). Crop uptake of nitrogen is relatively inefficient (~50%), leading to nitrogen loss via leaching, volatilization, and/or denitrification (Osmond & Kang, 2008). Therefore, groundwater quality can be influenced by nitrate leaching from agricultural lands receiving fertilizer and manure, especially in well drained, sandy regions of the state (Osmond et al., 2003; Stone et al., 1998).

Septic Systems and Nitrate

Septic systems, or onsite wastewater treatment systems (OWTS), are another potential source of nitrate in groundwater (Del Rosario, Humphrey, Mitra, & O'Driscoll, 2014; Humphrey, O'Driscoll, & Zarate, 2010; Humphrey et al., 2013). OWTS are commonly used for treating wastewater in rural areas of North Carolina and other states (U.S. EPA, 2002). OWTS include a septic tank, conveyance pipes, drainfield trenches, and aerated soil under the drainfield trenches (Humphrey et al., 2013). Septic tank effluent has concentrations of ammonium-nitrogen that often exceed 35,000 µg/L, and the ammonium can be quickly converted to nitrate-nitrogen in aerated soils beneath OWTS drainfield trenches via the nitrification process (Humphrey et al., 2013).

Nitrate concentrations exceeding the maximum contaminant level of 10,000 µg/L have been reported in groundwater near OWTS in numerous studies conducted in North Carolina (Del Rosario et al., 2014; Humphrey et al., 2010; Humphrey et al., 2013; Iverson, O'Driscoll, Humphrey, Manda, & Anderson-Evans, 2015). An estimated 50% of residents in North Carolina use OWTS (Pradhan, Hoover, Austin, & Devine, 2007), and thus OWTS might also be a significant source of nitrate in groundwater.

Atmospheric Deposition

Atmospheric deposition of nitrogen can occur via precipitation (wet deposition) or during movement and settling of aerosol particles by wind (dry deposition) (Gao, Kennish, & McGuirk Flynn, 2007). North Carolina receives on average 100–140 cm of rain in the Piedmont and Coastal Plain regions, and 94–229 cm in the mountains (State Climate Office of North Carolina, 2017). Regions downwind or close to industrialized areas or CAFOs are more likely to show an increased nitrogen load due to atmospheric deposition (Whitall & Paerl, 2001). Nitrogen in the atmosphere as N_2 gas can be fixed by some terrestrial and aquatic organisms to plant-available forms such as ammonium and converted to organic nitrogen (Havlin et al., 1999). Fixation can also occur via lightning strikes (Meyer, 2014). When the nitrogen-fixing plants and organisms die and decompose, the organic nitrogen in the cells can be mineralized, converted to ammonium and nitrate, and released into the environment (Havlin et al., 1999).

Groundwater Supplies and Nitrate

There are approximately 3 million people (31% of the population) who use groundwater for a water supply in North Carolina (North Carolina Department of Health and Human Services, 2016). The installation of private wells is permitted and regulated at the local level by county health departments. New wells must meet certain criteria for structural standards and setback distances, and are sampled and tested for contamination prior to initial use. The state of North Carolina performs water testing for contaminants such as nitrate for new and existing wells upon request. A database of sample results is kept on file by the state.

Study Goal and Objectives

The goal of this research was to gain a better understanding of potential links between land use and nitrate concentrations in well water across North Carolina. The research objectives included the following: 1) to determine if there are statistically significant correlations between the percentage of land in agriculture, livestock numbers and densities, septic systems, and average groundwater nitrate concentrations in North Carolina counties; 2) to determine the 10 counties in North Carolina with the highest and the 10 counties with the lowest average concentrations of nitrate in groundwater and summarize their associated land-use characteristics; and 3) to determine if there are statistically significant differences in livestock numbers, livestock densities, septic system numbers and densities, and land area in agriculture for the 10 counties with highest average nitrate concentrations in groundwater in comparison with the 10 counties with the lowest average nitrate concentration in groundwater. These analyses were performed to determine which land-use characteristics were strongly associated with relatively high mean concentrations of nitrate in groundwater.

Methods

Groundwater Nitrate Concentrations and Land-Use Characteristics Determination

Groundwater nitrate concentration data (1998–2010) from drinking water wells in North Carolina were obtained from the North Carolina State Laboratory of Public Health. More than 31,000 samples were analyzed during the time frame. The groundwater nitrate data from drinking water wells were organized in spreadsheets and the average nitrate concentration in groundwater samples was calculated for each county (North Carolina Department of Health and Human Services, 2016).

Agricultural land-use characteristics including the number of cattle, poultry, hogs, and cropland acreage were summarized for each county using published data from the North Carolina Department of Agriculture and Consumer Services (2016). The numbers of livestock and acreage in cropland were divided by the total land area for each county to determine the density of livestock and fraction of land in crop production.

The two latest U.S. Census Bureau reports (2000, 2010) did not include information with regards to use of septic systems. Septic system data from the 1990 U.S. Census Bureau and North Carolina Environmental Health Reports were analyzed to obtain a more current number of septic systems used in each county and in the state. The Environmental Health Division of the North Carolina Department of Health and Human Services collects yearly information regarding all onsite wastewater activities including the number of new septic system permits issued (North Carolina Department of Health and Human Services, 2018).

We used the number of operation permits (OPs) issued each year as the unit of measurement for new system installations in each county. The number of OPs issued each year was added to the number of septic systems reported in the 1990 U.S. Census to gain a more current estimate of the number of systems in each county and the state. The average number of people per dwelling as indicated by the 2010 Census was multiplied by the number of systems in each county and divided by the total population to determine the percentage of people using septic systems in each county. The average percentage of population using septic systems was calculated for all 100 North Carolina counties. The number and density of septic systems used in each county were calculated. Septic system density was calculated by dividing the total land area (ha) of a county by the total number of septic systems.

TABLE **1**

Correlations Between Total Number of Potential Sources of Nitrate and Average Nitrate Concentrations in Groundwater in North Carolina Counties

Total Number of Sources and Average Nitrate Concentrations	Correlation Coefficient	*p*-Value
Farmland (ha) and average nitrate	.456	<.001
Total livestock and average nitrate	.396	<.001
Poultry and average nitrate	.331	.001
Hogs and average nitrate	.322	.049
Total people and average nitrate	.300	.003
Cattle and average nitrate	.276	.007
Septic systems and average nitrate	.209	.038

ha = hectares.

TABLE **2**

Correlations Between Density of Potential Sources of Nitrate and Average Nitrate Concentrations in Groundwater in North Carolina Counties

Density of Source and Average Nitrate Concentration	Correlation Coefficient	*p*-Value
Fraction agriculture and average nitrate	.486	<.001
Hogs/ha and average nitrate	.391	<.001
Total livestock/ha and average nitrate	.382	<.001
Poultry/ha and average nitrate	.328	.001
People/ha and average nitrate	.306	.002
Cattle/ha and average nitrate	.290	.004
Septic systems/ha and average nitrate	.200	.047

ha = hectares.

Statistical Analyses

The average concentrations of nitrate in groundwater wells were compared to the numbers and densities of potential nitrate sources to determine if there were statistically significant correlations and to provide insight into the most significant sources of nitrate in groundwater. Nitrate and land-use data were organized by county, and all 100 counties in North Carolina were included in the correlation analyses. More specifically, the number of active septic systems in each county and the density of septic systems; the number and density of hogs, poultry, cattle, and all livestock; and the fraction of total land in agriculture were each compared to the average nitrate concentrations. Spearman correlation analyses were performed with Minitab 17 statistical software to determine which land-use factors were significantly correlated with nitrate concentrations. Summary tables were developed listing the correlation coefficients and *p*-values for the comparisons.

There are 100 counties in North Carolina. Characteristics of the 10 counties with the highest average nitrate concentrations (top 10%) were summarized and compared with the 10 counties with the lowest average nitrate concentrations (bottom 10%) to determine if significant differences in numbers and densities of livestock, septic systems, and cropland were observed. It was anticipated that differences in the major land-use characteristics (numbers and densities) that influence groundwater nitrate concentrations would be significant when comparing the

TABLE **3**

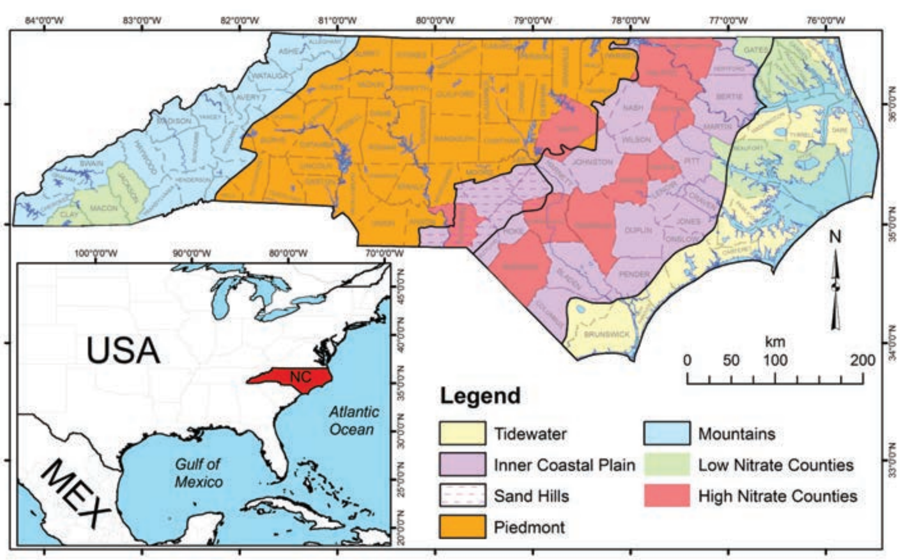
Characteristics of the 10 North Carolina Counties With the Highest Average Nitrate Concentrations in Groundwater

County	Total County Area (ha)	2010 Census Population	Average NO_3-N (µg/L)	Septic Systems	Cattle Estimates	Hog Estimates	Poultry Estimates	Total Livestock
Cumberland	170,494	319,431	3,003	48,233	2,900	95,000	2,645,000	2,742,900
Edgecombe	131,368	56,552	3,284	10,315	2,000	110,000	6,650,000	676,200
Greene	68,923	21,362	3,196	6,566	1,400	340,000	4,750,000	5,091,400
Halifax	189,409	54,691	3,214	13,101	9,500	45,000	0	54,500
Northampton	142,769	22,099	3,520	8,153	900	115,000	9,200,000	9,315,900
Richmond	124,372	46,639	3,397	14,374	1,800	50,000	34,910,000	34,961,800
Robeson	246,413	134,168	3,909	32,636	8,000	350,000	48,586,900	48,944,900
Sampson	245,377	63,431	3,134	22,979	26,000	1,750,000	47,185,000	48,961,000
Wake	222,057	900,993	4,504	64,106	3,500	0	9,200	12,700
Wayne	144,324	122,623	3,227	31,052	8,300	530,000	17,991,000	18,529,300
Average	168,551	174,199	3,439	25,151	6,430	338,500	17,192,710	17,537,640
SD	60,338	285,873	471	20,071	8,004	551,567	20,406,235	20,759,407

ha = hectares.

FIGURE **1**

Map of North Carolina Showing Counties With the Highest and Lowest Average Nitrate Concentrations



counties with the highest and lowest average nitrate concentrations. Comparisons were made using paired *t*-tests or Mann–Whitney tests (for data that did not follow a normal distribution) to determine if differences in numbers and densities of nitrate sources for the top 10 and bottom 10 counties were statistically significant ($p < .05$). These analyses were conducted to provide insight into the major factors associated with elevated concentrations of nitrate in groundwater.

Results

Correlations Between Average Nitrate Concentrations and Land-Use Characteristics

There were statistically significant ($p \leq .05$) correlations between the average nitrate concentrations in groundwater and various county land-use characteristics including farmland acreage ($p < .001$), total livestock ($p < .001$), human population ($p = .003$), number of poultry ($p = .001$), number of cattle ($p = .007$), number of septic systems ($p = .038$), and number of hogs ($p = .049$) (Table 1). The correlation coefficients were greatest for farmland acreage ($r = .456$), total livestock ($r = .396$), and poultry ($r = .331$) (Table 1). While there was a statistically significant correlation between the number of septic systems and average nitrate concentrations, the correlation coefficient was the smallest ($r = .209$) of the potential sources (Table 1).

There were statistically significant correlations between average nitrate concentrations and fraction of land in agriculture ($p < .001$),

TABLE **4**

Characteristics of the 10 North Carolina Counties With the Lowest Average Nitrate Concentrations in Groundwater

County	Total County Area (ha)	2010 Census Population	Average NO_3-N (µg/L)	Septic Systems	Cattle Estimates	Hog Estimates	Poultry Estimates	Total Livestock
Beaufort	248,485	47,759	517	19,206	1,200	50,000	0	51,200
Camden	79,287	9,980	500	3,391	100	0	0	100
Chowan	60,372	14,793	500	4,504	1,200	4,000	0	5,200
Clay	57,263	10,587	533	5,510	1,700	0	2,550,000	2,551,700
Gates	89,652	12,197	500	4,416	800	30,000	7,850,000	7,880,800
Hyde	368,972	5,810	500	3,819	ND	0	180,000	180,000
Jackson	128,000	40,271	526	17,006	1,600	0	4,200	5,800
Macon	115,563	33,922	520	20,937	2,400	0	1,200	3,600
Pasquotank	74,883	40,661	500	7,563	300	0	0	300
Perquimans	85,247	13,453	500	4,658	700	0	10,500,000	10,500,700
Average	130,772	22,943	510	9,101	1,111	8,400	2,108,540	2,117,940
SD	105,136	16,343	14	7,257	758	18,138	2,638,829	2,645,344

ha = hectares; ND = no data, if data were not reported for a county.

TABLE **5**

Characteristics and Densities of Potential Nitrate Sources for the 10 North Carolina Counties With the Highest Average Nitrate Concentrations in Groundwater

County	Fraction Agriculture	Systems/ha	People/ha	Hogs/ha	Poultry/ha	Cattle/ha	Livestock/ha
Cumberland	0.20	0.28	1.87	0.56	15.50	0.02	16.0
Edgecombe	0.39	0.08	0.43	0	50.60	0.01	51.5
Greene	0.59	0.10	0.31	4.93	68.90	0.02	73.9
Halifax	0.42	0.07	0.29	0.24	<0.01	0.05	0.3
Northampton	0.46	0.06	0.15	0.81	64.40	0.01	65.3
Richmond	0.15	0.12	0.37	0.40	280.70	0.01	281.1
Robeson	0.44	0.13	0.54	1.42	197.20	0.03	198.6
Sampson	0.48	0.09	0.26	7.13	192.30	0.11	199.5
Wake	0.15	0.29	4.06	0	0.04	0.02	0.1
Wayne	0.54	0.22	0.85	3.67	124.70	0.06	128.4
Average	0.38	0.14	0.91	1.92	99.40	0.03	101.5
SD	0.16	0.09	1.29	2.54	101.40	0.03	102.2

ha = hectares.

and densities of total livestock ($p < .001$), people ($p = .002$), poultry ($p = .001$), hogs ($p < .001$), cattle ($p = .004$), and septic systems ($p = .047$) (Table 2). The correlation coefficients (average nitrate concentration and density of potential sources) were greatest for fraction of land in agriculture ($r = .486$), hog density ($r = .391$), total livestock ($r = .382$), and poultry density ($r = .328$) (Table 2). Correlation coefficients were smallest for density of septic systems ($r = .200$) and density of cattle ($r = .290$) (Table 2).

TABLE **6**

Characteristics and Densities of Potential Nitrate Sources for the 10 North Carolina Counties With the Lowest Average Nitrate Concentrations in Groundwater

County	Fraction Agriculture	Systems/ha	People/ha	Hogs/ha	Poultry/ha	Cattle/ha	Livestock/ha
Beaufort	0.24	0.08	0.19	0.20	<0.01	0.01	0.21
Camden	0.25	0.04	0.13	<0.01	<0.01	<0.01	<0.01
Chowan	0.39	0.07	0.25	0.07	<0.01	0.02	0.09
Clay	0.08	0.10	0.18	<0.01	44.50	0.03	44.56
Gates	0.29	0.05	0.14	0.33	87.60	0.01	87.90
Hyde	0.12	0.01	0.02	<0.01	0.50	<0.01	0.50
Jackson	0.05	0.13	0.31	<0.01	0.03	0.01	0.05
Macon	0.08	0.18	0.29	<0.01	0.01	0.02	0.03
Pasquotank	0.39	0.10	0.54	<0.01	<0.01	<0.01	<0.01
Perquimans	0.38	0.05	0.16	<0.01	123.17	0.01	123.18
Average	0.23	0.08	0.22	0.06	25.60	0.01	25.70
SD	0.13	0.05	0.15	0.12	31.00	0.01	31.10

ha = hectares.

Counties With Highest and Lowest Average Nitrate Concentrations in Groundwater

The 10 counties with the highest average concentrations of nitrate in groundwater included Cumberland, Edgecombe, Greene, Halifax, Northampton, Richmond, Robeson, Sampson, Wake, and Wayne (Table 3). The overall average groundwater nitrate concentration for these 10 counties was 3,429 µg/L, with a range of 3,003–4,504 µg/L (Table 3). The top 10 counties are clustered in the inner Coastal Plain and Sand Hills region of the state (Figure 1).

The 10 counties with the lowest average nitrate concentrations in groundwater were Beaufort, Camden, Chowan, Clay, Gates, Hyde, Jackson, Macon, Pasquotank, and Perquimans (Table 4). The overall average nitrate concentration for these counties was 510 µg/L, with a range of 500–533 µg/L (Table 4). Seven of these counties are clustered in the Tidewater region of the state, and the other three are clustered in the mountains (Figure 1). The difference in nitrate concentrations between the top 10 and bottom 10 counties was statistically significant (p = .0001).

There were more people (174,199 versus 22,943), septic systems (25,151 versus 9,101), hogs (338,500 versus 8,400), poultry (17,192,710 versus 2,108,540), and cattle (6,430 versus 1,111) in the 10 counties with the highest average nitrate concentrations relative to the 10 counties with the lowest nitrate concentrations (Tables 3 and 4). There was also more land area on average for the top 10 counties (168,551 ha) relative to the bottom 10 counties (130,772 ha), so we also compared densities (numbers/area) of potential sources of nitrate including septic systems, livestock, and fraction of the overall county land that was in agriculture. Similar findings were observed when normalizing the data for land area.

More specifically, there was a higher average fraction of land in agriculture (0.38 versus 0.23) and higher densities of septic systems (0.14/ha versus 0.08/ha), people (0.91/ha versus 0.22/ha), hogs (1.92/ha versus 0.06/ha), poultry (99.4/ha versus 25.6/ha), and total livestock (101.5/ha versus 25.7/ha) in the 10 counties with the highest average nitrate concentration (Tables 5 and 6). There were statistically significant differences regarding the fractions of land in agriculture (p = .036), along with density of hogs (p = .0049), poultry (p = .0299), cattle (p = .0257), total livestock (p = .0211), and people (p = .0140) when comparing the top 10 with the bottom 10. While the mean density of septic systems was higher in the top 10 versus bottom 10, the differences were not statistically significant (p = .1041).

Discussion

Agriculture and Groundwater Nitrate Concentrations

There are many potential sources of nitrate in groundwater sampled from water supply wells across North Carolina. Most of the data indicate that agricultural sources such as fertilizers and total livestock (waste) might be the most important contributors of nitrate to groundwater in North Carolina. There was on average 15% more land in agriculture and 75 more livestock/ha in the 10 counties with the highest average nitrate concentrations relative to the 10 counties with the lowest average nitrate concentrations. There were statistically significant ($p \leq .05$) correlations between average nitrate concentrations and fraction of land in agriculture and total livestock densities; and the correlation coefficients were greatest for average nitrate concentration and fraction of land in agriculture, hog density, and total livestock density.

Four of the top 10 counties in North Carolina for hog production were in the top 10 for highest mean nitrate concentrations in groundwater. Those counties included Greene, Robeson, Sampson, and Wayne, which are all located in the Inner Coastal Plain of North Carolina. The total combined number of hogs produced each year by these counties was 2,970,000, which is nearly 40% of all hogs produced in the state (North Carolina Department of Agriculture and Consumer Services, 2016). Prior studies have shown that hog farms can be significant contributors of nitrogen to shallow groundwater (Stone et al., 1998) and surface waters (Mallin, McIver, Robuck, & Dickens, 2015).

The 10 counties with the highest mean concentrations of nitrate were all located in the Inner Coastal Plain or Sand Hills region, where the soils are characterized as permeable, well drained, and prone to nitrate leaching (Gilliam et al., 1996). Row crop and livestock production is extensive in the Inner Coastal Plain. Seven of the 10 counties with the lowest mean nitrate concentrations were in the Tidewater region of the state where row crop and livestock production are not as intensive as the Inner Coastal Plain and the soils have a high organic matter content, are poorly drained, and denitrification potential is high due to these conditions (Havlin et al., 1999).

Septic Systems and Groundwater Nitrate Concentrations

An estimated 4.87 million people in North Carolina were using septic systems in 2010, which was approximately 50% of the total population during that year. The percentage of population using septic systems varied greatly from county to county with a range of 10% to >90%. The last time the U.S. Census Bureau included information on septic system usage, 49% of the population in North Carolina used septic systems, so statewide, the percentage using septic systems has remained steady since 1990. While there were more septic systems and higher densities of septic systems in the 10 counties with the highest average nitrate concentrations, the differences were not statistically significant ($p > .05$). The correlations between average nitrate concentration and total number of septic systems and density of septic systems in North Carolina counties were significant, but they had the lowest correlation coefficients ($r < .021$) of the potential sources. Therefore, there was some evidence that septic systems were a contributing source of nitrate to groundwater, but the contributions were not as significant as agriculture.

Conclusions

The goal of this study was to gain a better understanding of how various land uses and nitrate sources might influence groundwater nitrate concentrations in North Carolina. Counties with extensive agricultural production located in geological settings where nitrate leaching potential is great, such as the Inner Coastal Plain, had the highest average concentrations of nitrate in groundwater. Counties with poorly drained, organic soils and less intensive agricultural and livestock production had the lowest average concentrations of nitrate in groundwater. Agriculture is a vital industry in North Carolina for the state's economy and for food production. Continued, substantial funding for the development and implementation of best management practices to reduce nitrogen loss from agricultural fields—especially in the Inner Coastal Plain of North Carolina—is needed to ensure a balance between the environment and economy.

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▸ INTERNATIONAL PERSPECTIVES

A Review of Nontuberculous Mycobacteria Presence in Raw and Pasteurized Bovine Milk

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Abstract **Nontuberculous mycobacteria (NTM), also known as environmental mycobacteria due to their ubiquitous nature, are opportunistic human pathogens of public health concern. They are the causative agent of lymphadenitis in children; pulmonary, skin, and soft tissue infections; and have been linked to Crohn's disease. Human-to-human transmission is rare and as such it is essential to identify potential environmental sources and routes of exposure. This review explores studies written in English investigating the presence of NTM in pasteurized and unpasteurized milk over the last 20 years. Globally, it was demonstrated that NTM have been detected from milk products in Argentina, Austria, Brazil, Chile, Cyprus, the Czech Republic, Denmark, Iran, Iraq, India, Ireland, Italy, Switzerland, Tanzania, Turkey, UK, and U.S. We explored the relationships among the specific NTM species identified, pasteurized and unpasteurized milk, and different detection methods. Both experimental studies and detection from commercial milk suggests the NTM can survive the pasteurization process. Further research is required to explore the potential role of milk as a possible route of exposure to NTM and to identify potential management and control strategies.**

Introduction

Nontuberculous mycobacteria (NTM) include all *Mycobacterium* species excluding *M. tuberculosis* complex and can also be referred to as environmental mycobacteria (Falkinham, 1996). Presently there are more than 120 recognized species of NTM and of those, 42 have been identified as opportunistic human pathogens of public health significance (Myneedu et al., 2013). NTM are ubiquitous in the environment and have been found in salt water, hard water, hot water systems, soils, dust, food, and plants (Ministry of Health, 2002). Human-to-human transmission of NTM is rare, so it is important to understand the environmental sources associated with human infection (Kankya et al., 2011).

Historically, the presence of *Mycobacterium* spp. in milk, specifically *M. bovis*, has received a lot of attention as a potential source of tuberculosis (Davies, 2006). In developed countries this route of exposure is now rare due to milk pasteurization processes and culling of infected herds (Centers for Disease Control and Prevention, 2005). This route of exposure is still an issue in developing countries and when raw milk is consumed (Müller et al., 2013). In developed countries, *Mycobacterium* spp. are once again receiving a lot of attention, however, because NTM are the focus of an increasing incidence of diseases caused by opportunistic pathogens (Mirsaeidi, Farshidpour, Allen, Ebrahimi, & Falkinham, 2014).

Increases in the incidence of NTM infections have been observed all around the world (Kendall & Winthrop, 2013; Panagiotou et al., 2014; Yoo et al., 2012). In Taiwan, from the years 2000–2008, the incidence of NTM disease increased from 2.7 to 10.2 cases per 100,000 (Lai et al., 2010) and in England, Wales, and Northern Ireland, the incidence of NTM infection increased from 0.9 per 100,000 population in 1995 to 2.9 per 100,000 in 2006 (Moore, Kruijshaar, Ormerod, Drobniewski, & Abubakar, 2010). The increase in incidence in NTM infection highlights the need to understand more about potential sources of infection. This review will explore the possible role of bovine milk as a potential source of NTM.

Methods

Original research articles investigating the presence of NTM in bovine milk samples published in English over the last 20 years were searched using Google scholar and Scopus (Table 1). The country the milk was sampled from, the detection method used, and the type of milk is also presented in Table 1. The reliability of different detection methods and the potential for NTM to survive the milk pasteurization process is also discussed.

TABLE **1**

Studies Detecting Nontuberculosis Mycobacteria (NTM) From Bovine Milk Products

Country	NTM	Milk Type	Detection Method	Reference
Argentina	*Mycobacterium avium* subspecies *paratuberculosis* (MAP)	Commercially available pasteurized milk	Culture	Paolicchi et al., 2003
Austria	MAP in individual cow samples but not in bulk tank milk	Milk samples from individual cows, raw and pasteurized bulk tank milk	qPCR	Khol et al., 2013
Brazil	*M. avium* complex (MAC)	Raw milk from bulk tanks and individual animals	PCR	Bezerra et al., 2015
	Raw milk: *M. nonchromogenicum*, *M. peregrinum*, *M. smegmatis*, *M. neoaurum*, *M. fortuitum*, *M. flavescens*, *M. kansasii*, and *M. scrofulaceum* Pasteurized milk: *M. chelonae* and *M. peregrinum*	Raw and pasteurized milk	Culture	Sgarioni et al., 2014
	M. gordonae, *M. fortuitum*, *M. intracellulare*, *M. flavescens*, *M. duvalii*, *M. haemophilum*, *M. immunogenum*, *M. lentiflavum*, *M. mucogenicum*, *M. novocastrense*, *M. parafortuitum*, *M. smegmatis*, *M. terrae*, and *M. vaccae*	Raw milk from individual and collective bulk tanks	Culture	Franco et al., 2013
	MAP	Pasteurized milk	Culture	Carvalho, Pietralonga, Schwarz, Faria, & Moreira, 2012
	M. simiae, *M. kansasii*, *M. flavescens*, *M. gordonae*, and *M. lentiflavum*	Water buffalo raw milk	Culture	Jordão Junior, Lopes, David, Farache Filho, & Leite, 2009
	Raw milk: *M. fortuitum*, *M. marinum*, and *M. gordonae* UHT milk: No NTM detected Pasteurized milk: *M. fortuitum*, *M. marinum*, *M. kansasii*, and *M. gordonae*	Raw milk, UHT, and pasteurized milk	Culture	Fujimura Leite et al., 2003
Chile	MAP	Bulk tank raw milk	qPCR	Kruze, Monti, Schulze, Mella, & Leiva, 2013
Cyprus	MAP	Raw milk from bulk tank and cheese originating from cow, sheep, goat, and mixed milks	Culture, qPCR, and combined phage PCR assay	Botsaris et al., 2010
	MAP and *M. fortuitum*	Bulk tank raw milk	Culture and PCR	Slana, Liapi, Moravkova, Kralova, & Pavlik, 2009
Czech Republic	MAP	Powdered infant milk	qPCR	Hruska, Slana, Kralik, & Pavlik, 2011
	MAP	Raw milk	Culture and PCR	Slana, Kralik, Kralova, & Pavlik, 2008
	MAP	Commercially pasteurized milk, locally pasteurized milk, and raw milk	Culture	Ayele, Svastova, Roubal, Bartos, & Pavlik, 2005
Denmark	MAP	Raw milk	Culture and PCR	Giese & Ahrens, 2000

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NTM and Unpasteurized Milk

Worldwide NTM have been detected in raw milk samples as demonstrated by Table 1. The most commonly isolated species are *Mycobacterium avium* complex (MAC) and specifically *M. avium* subspecies *paratuberculosis* (MAP), which has been detected using culture in raw milk samples from Cyprus, the Czech Republic, Denmark, India, Ireland, Italy, Tanzania, UK, and U.S. (Ayele, Svastova, Roubal, Bartos, & Pavlik, 2005; Botsaris et al., 2010; Grant, Ball, & Rowe, 2002; Mdegela et al., 2005; O'Reilly et al., 2004; Pillai & Jayarao, 2002; Shankar et al., 2010; Slana, Kralik, Kralova, & Pavlik, 2008; Taddei et al., 2008). MAP has also been detected using PCR in raw milk from Austria, Chile, Cyprus, the Czech Republic, TABLE **1** *continued from page 25*

Studies Detecting Nontuberculosis Mycobacteria (NTM) From Bovine Milk Products

Country	NTM	Milk Type	Detection Method	Reference
European Union countries	MAP	Powdered infant milk	PCR	Hruska, Bartos, Kralik, & Pavlik, 2005
India	MAP	Pasteurized and unpasteurized milk	Culture and PCR	Shankar et al., 2010
Iran	MAP	Raw milk from individual milk, bulk tanks, and collection center bulk milk	Culture and qPCR	Hanifian, & Khani, 2016
	MAP	Commercially available pasteurized milk	Culture and PCR	Anzabi & Hanifian, 2012
	MAP	Raw milk from healthy cows and cows with Johne's disease symptoms	Culture and PCR	Fathi, Sarkarati, Eslami, Rezavand, & Nourizadeh, 2011
Iraq	MAP	Powdered milk	qPCR	Hassan & Ali, 2012
Ireland	MAP	Pasteurized and bulk raw milk	Culture and IMS-PCR	O'Reilly et al., 2004
Italy	*M. porcinum* and MAP	Bulk raw milk	Culture	Taddei et al., 2008
Switzerland	MAP	Bulk tank raw milk	PCR	Corti & Stephan, 2002
Tanzania	*M. gordonae, M. phlei, M. fortuitum, M. smegmatis, M. flavescens,* and MAC	Raw milk	Culture	Mdegela et al., 2005
	M. terrae, M. fortuitum, M. flavescens, M. gordonae, and *M. smegmatis*	Raw milk	Culture	Kazwala et al., 1998
Turkey	*M. terrae*, *M. kansasii*, *M. haemophilum*, *M. agri*, and two unidentified environmental *Mycobacterium* species	Raw milk	Culture	Konuk, Korcan, Dülgerbaki, & Altindiş, 2007
United Kingdom	MAP	Bulk raw milk and commercially available pasteurized milk	Culture and PCR	Grant, Williams, Rowe, & Muir, 2005
	MAP	Commercially available pasteurized milk	PCR	Millar et al., 1996
U.S.	MAP	Commercially available pasteurized milk	Culture	Ellingson et al., 2005
	MAP	Milk samples from individual cows and raw bulk tank milk	Culture	Pillai & Jayarao, 2002

IMS-PCR = immunomagnetic separation-polymerase chain reaction; PCR = polymerase chain reaction; qPCR = quantitative polymerase chain reaction; UHT = ultra-high temperature processing.

Denmark, India, Ireland, Switzerland, and UK (Ayele et al., 2005; Botsaris et al., 2010; Corti & Stephan, 2002; Giese & Ahrens, 2000; Khol et al., 2013; Kruze, Monti, Schulze, Mella, & Leiva, 2013; O'Reilly et al., 2004; Shankar et al., 2010; Slana, Liapi, Moravkova, Kralova, & Pavlik, 2009).

Other NTM that have been detected in raw milk samples, as shown in Table 1, include *M. nonchromogenicum*, *M. peregrinum*, *M. smegmatis*, *M. neoaurum*, *M. fortuitum*, *M. kansasii*, *M. scrofulaceum*, *M. gordonae*, *M. flavescens*, *M. duvalii*, *M. haemophilum*, *M. immunogenum*, *M. lentiflavum*, *M. mucogenicum*, *M. novocastrense*, *M. parafortuitum*, *M. terrae*, *M. vaccae*, *M. simiae*, *M. porcinum*, *M. agri*, *M. phlei*, and *M. marinum* (Franco et al., 2013; Fujimura Leite et al., 2003; Jordão Junior, Lopes, David, Farache Filho, & Leite, 2009; Kazwala et al., 1998; Konuk, Korcan, Dülgerbaki, & Altindiş, 2007; Mdegela et al., 2005; Sgarioni et al., 2014; Slana et al., 2009; Taddei et al., 2008).

The presence of NTM in raw milk could be attributed to bovine hosts (Animal Health Australia, 2017; Diguimbaye-Djaibé et al., 2006; Pavlik, Matlova, Dvorska, Shitaye, & Parmova, 2005) or through cross-contamination with environmental sources (Eltholth, Marsh, Van Winden, & Guitian, 2009), or both. In South Africa it has been demonstrated that NTM are readily exchanged back and forth between water/soil and cattle/water buffalo through the mucous membranes of the animals (Gcebe, Rutten, Gey van Pittius, & Michel, 2013).

NTM and Pasteurized Milk

MAP has been the focus of the majority of research into the presence of NTM in pasteurized milk as shown in Table 1. MAP has been detected, using culture methods, in commercially available pasteurized milk from Brazil (Carvalho, Pietralonga, Schwarz, Faria, & Moreira, 2012), India, the Czech Republic, U.S., Argentina, and the UK (Ayele et al., 2005; Carvalho et al., 2012; Ellingson et al., 2005; Grant et al., 2002; Paolicchii et al., 2003; Shankar et al., 2010) and has also been detected using PCR in pasteurized milk from India, Iran, Ireland, and the UK (Anzabi & Hanifian, 2012; Grant et al., 2002; Millar et al., 1996; O'Reilly et al., 2004; Shankar et al., 2010). Other NTM that have been detected in pasteurized milk using culture include *M. chelonae, M. peregrinum, M. fortuitum, M. marinum, M. kansasii* and *M. gordonae* (Fujimura Leite et al., 2003; Sgarioni et al., 2014). The presence of NTM in pasteurized milk could be due to cross-contamination after the pasteurization processes or survival of the pasteurization process (Eisenberg et al., 2010; Van Brandt et al., 2011). Despite the presence of NTM in pasteurized milk samples from across the globe, there are currently no reported case studies of NTM infection that identify milk as a definitive source of infection.

NTM Potential to Survive Milk Pasteurization

The potential for NTM to survive the milk pasteurization process is supported by several experimental studies that have been focused specifically on the survival of MAP (Grant, Ball, & Rowe, 1998; Meylan et al., 1996; Peterz, Butot, Jagadeesan, Bakker, & Donaghy, 2016; Starikoff, Nishimoto, Ferreira, Balian, & Telles, 2016; Van Brandt et al., 2011). The effectiveness of the pasteurization process has been shown to be dependent on a range of variables, including pressure, time, and temperature (Grant, Williams, Rowe, & Muir, 2005). Donaghy and coauthors (2007) investigated the effect of pressure and time on the survival of MAP. It was found that pasteurization at 500 MPa resulted in a significantly ($p < .05$) greater reduction of MAP compared to 400 MPa. It was also demonstrated that a treatment time of 10 min significantly ($p < .05$) reduced MAP numbers compared with a treatment time of 5 min.

There are also conflicting observations from studies investigating the potential heat resistance of MAP (Lund, Gould, & Rampling, 2002; Rademaker, Vissers, & Te Giffel, 2007). Stabel and coauthors (1997) demonstrated that in a laboratory experiment MAP (at concentrations of 10^4 and 10^6 CFU/mL) was inactivated by heat treatment at temperatures of 72 °C and greater for at least 15 s. This finding was supported by Rademaker and coauthors (2007) who demonstrated that heat treatment at 72 °C for 15 s resulted in a greater than 7-fold reduction of MAP. These results differ, however, from other studies that demonstrated the survival of MAP at 72 °C for 15 s (Grant et al., 1998; Sung & Collins, 1998). Additionally, Van Brandt and coauthors (2011) demonstrated that in two out of six replicate experiments the HTST pasteurization conditions (71.7 °C, 15 s) were not sufficient to inactivate MAP in milk. It has been suggested that the discrepancy in these results might be due to the tendency of MAP cells to clump together and a possibility that there is a protective effect of certain milk components on MAP (Lindström, Paulsson, Nylander, Elofsson, & Linkmark-Månsson, 1994). This tendency could contribute to its heat resistance and potential survival of commercial milk pasteurization processes (Klijn, Herrewegh, & de Jong, 2001; Rowe, Grant, Dundee, & Ball, 2000). Research by Peterz and coauthors (2016) has demonstrated the efficiency of direct stream injection for inactivating MAP, which presents an alternative novel method to optimise the pasteurization process. The complete elimination of MAP by pasteurization, however, is still under debate.

NTM Detection Methods

Currently there is no standard method for NTM detection, although as demonstrated by Table 1, the main methods used are culture and PCR. The main variations in NTM culture methodology relate to the decontamination step and the culture medium used. A decontaminated process is not always included (Giese & Ahrens, 2000; Paolicchii et al., 2003); however, when it is, the most common method uses 0.75% hexadecylpyridinium chloride (HPC). This method has been successfully used when detecting NTM from cheese as well as raw and pasteurized milk (Anzabi & Hanifian, 2012; Botsaris et al., 2010; Carvalho et al., 2012; Faria et al., 2014; O'Reilly et al., 2004; Taddei et al., 2008). Other decontamination methods include using 5% oxalic acid, which has been used for the detection of NTM in raw and pasteurized milk (Fujimura Leite et al., 2003; Sgarioni et al., 2014). Also the Petroff's decontamination method has been used to detect NTM in raw buffalo milk (Jordão Junior et al., 2009); using SDS-NaOH (Konuk et al., 2007), or 4% sodium hydroxide neutralized with 14% potassium dihydrogen orthophosphate (Mdegela et al., 2005) has been used to detect NTM from raw cow's milk.

The most common media used is the Herrold's egg yolk medium (HEYM) (Anzabi & Hanifian, 2012; Botsaris et al., 2010; Carvalho et al., 2012; Faria et al., 2014; Grant et al., 2002; Pillai & Jayarao, 2002), although additions or alterations to this medium are also reported. Anzabi and Hanifian (2012) used HEYM with and without 2 µL/mL of mycobactin J and amphotericin B, nalidixic acid, and vancomycin for culture. Taddei and coauthors (2008) used HEYM containing 2 µg of mycobactin J/mL supplemented with chloramphenical (30 µg/L) or nalidixic acid (50 µg/L) and vancomycin (50 µg/L). Ayele and coauthors (2005) cultured milk on HEYM slants.

Ellingson and coauthors (2005) cultured milk on HEYM slants with mycobactin J and amphotericin B, nalidixic acid, and vancomycin. O'Reilly and coauthors (2004) cultured milk on HEYM containing 2 g of mycobactin J/mL and BACTEC 12B radiometric medium supplemented with 0.5 mL of Difco egg yolk emulsion, 2 g of mycobactin J/mL, and PANTA antibiotic supplement. Other culture mediums included Lowenstein Jensen media (Franco et al., 2013; Konuk et al., 2007), Lowenstein–Jensen medium with added pyruvate (Kazwala et al., 1998), and Lowenstein–Jensen and Stonebrink's media (Fujimura Leite et al., 2003; Jordão Junior et al., 2009; Sgarioni et al., 2014). The lack of standardization regarding culture medium makes it challenging to compare results from different studies. It also identifies that there is a lack of consensus regarding the best medium for NTM isolation.

There are numerous studies that compare different NTM detection methods (Damato & Collins, 1990; Kamala, Paramasivan, Herbert, Venkatesan, & Prabhakar, 1994; Thomson, Carter, Gilpin, Coulter, & Hargreaves, 2008). There are limited studies, however, that look specifically at NTM detection in milk and the studies that do focus on MAP. Dundee and coauthors (2001) compared four decontamination methods for the culture of MAP from milk and found pretreatment with 0.75% HPC for 5 hr to be the most efficient method, yielding the higher percentage recovery of MAP with the lowest limit of detection. Grant and coauthors (2003) compared nonradiometric mycobacteria growth indicator tubes and radiometric BACTEC 460TB culture systems as methods to identify MAP from milk and found there to be little difference between the two methods.

The biggest difficulty with the culture method of detection is that it is time consuming because of the organism's fastidious nature and slow growth (Mendoza, Lana, & Díaz-Rubio, 2009). Also, further identification methods are required to determine the specific *Mycobacterium* species (Franco et al., 2013). The main alternative method to culture detection is PCR (Table 1). Once again, MAP detection has received the most attention and multiple gene targets for MAP PCR have been identified including IS900, F57, ISMav2, hspX, and ISMap02 (Ellingson, Bolin, & Stabel, 1998; Möbius, Hotzel, Rassbach, & Köhler, 2008; Stabel & Bannantine, 2005). The most commonly used is IS900, which is found only in MAP genome; however, there have been reports of cross-reactions with other *Mycobacterium* species (Cousins et al., 1999). The main disadvantage with PCR is that it does not differentiate between viable organism and killed cells (Ricchi et al., 2014).

Conclusion

With aging populations, opportunistic pathogens are becoming a significant issue of public health concern. As the incidence of NTM infections increases, there is a greater need to identify the sources of infection. The presence of NTM in milk and the potential of NTM to survive the pasteurization process might present a possible risk to public health. This review demonstrates that NTM have been detected in raw and pasteurized milk sampled across the globe. Comparing these studies and factors influencing the presence of NTM, however, is difficult due to a number of variables. This difficulty includes the potential for herds to be infected with MAP, variances in sampling and detection methodologies, reliability and reproducibility of detection methods, and differences in the pasteurization operational procedures. In addition, although NTM are present in milk, there currently is no clinical evidence demonstrating that milk is a route of exposure; further research is required to determine the potential role milk might be playing as a source of NTM disease. If milk is identified as a source of infection, there is also a need for the development of appropriate management and control measures. Included in these measures will be ensuring the success of pasteurization methods for the elimination on NTM.

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DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES


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All-Inclusive or à la Carte? Many Routes to Adopt the Model Aquatic Health Code

Editor's Note: NEHA strives to provide up-to-date and relevant information on environmental health and to build partnerships in the profession. In pursuit of these goals, we feature 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.

Eugene Knight is the swimming pool program manager for New Mexico Environmental Health. Bob Vincent is an environmental administrator for Florida Environmental Health.

In 2014, the Centers for Disease Control and Prevention (CDC) released the first edition of the Model Aquatic Health Code (MAHC), a free, science-based resource to help states and localities make swimming and other water activities healthier and safer (Figure 1). MAHC guidelines address the design, construction, operation, maintenance, policies, and management of public aquatic facilities. States and localities can use it to create or update existing pool codes to reduce risk for drowning, waterborne illness outbreaks, and injuries from pool chemicals.

Every state and local jurisdiction is different, so a "one size fits all" approach will not work for everyone. The MAHC is a comprehensive guideline, but it can be easily adapted to fit the needs of various jurisdictions. Health departments interested in MAHC adoption can adopt the whole guidance or choose parts to fill the gaps in their state or local codes. New Mexico and Florida took different approaches to using the MAHC to strengthen aquatic safety and health.

All-Inclusive: How New Mexico Adopted the Entire MAHC

How Long Did MAHC Adoption Take?

In September 2013, the New Mexico Aquatics Program started reviewing the state aquatics code to update its Public Aquatics Program regulations. This time consuming process involved getting our aquatics team together multiple times for meetings and following the state procedural timelines for changing the regulations (Figure 2). Scheduling meetings with staff and interested inspectors was challenging for various reasons, including conflicting work schedules, time constraints, and distance from meetings. The newly adopted MAHC guidelines took effect in August 2016 after nearly three years of work.

What Was the Biggest Challenge to Adoption?

One of the most challenging aspects of the process was helping aquatic facilities understand that chapter 4 of the MAHC (Design & Construction) does not apply to existing facilities, except for the following items:

- diaper changing stations at all facilities that allow diaper age children in pool enclosure,
- automatic controllers within one year of adoption (we changed it to two years to give facilities time to budget for the change), and
- interlocks between automatic feeders and recirculation system.

The program anticipated that the biggest complaint would be requiring automatic controllers for disinfectant and pH control on all vessels, but this requirement was broadly accepted by most aquatic facilities. The diaper changing station requirement caused the most negative reaction mainly from homeowner associations and apartment complexes. Hotels and large aquatic facilities already had them in place.

What Advice Might Help Other Jurisdictions Considering Adopting the Entire MAHC?

Do your homework by comparing your jurisdiction's current policies with the MAHC to see if there are as many differences as you think and document those differences (see the sidebar for a link to the MAHC compari-

FIGURE **1**

Model Aquatic Health Code: Code Language

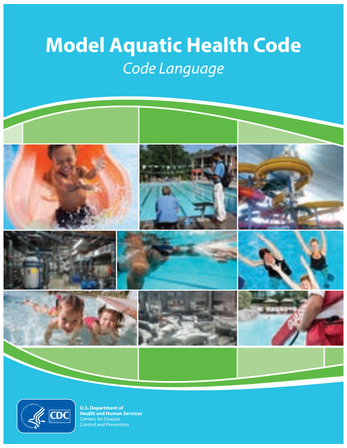


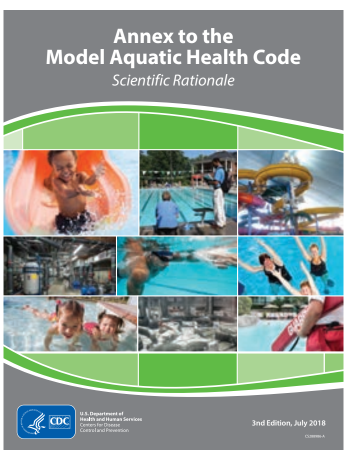
FIGURE **2**

New Mexico Model Aquatic Health Code Adoption Timeline

2013	September	New Mexico Environment Department (NMED) began revising outdated pool regulations.
2014	April	NMED decided to consider the MAHC for adoption.
	April–September	NMED compared revised draft swimming pool regulations with the MAHC drafts released for public comment.
	October	NMED determined that most of the proposals under consideration by the department were already in the MAHC, and the MAHC was more clear and easy to understand than the department's current guidelines.
	December	NMED decided to pursue official MAHC adoption.
2015	January–June	NMED worked with the Office of General Council to incorporate the MAHC as a major part of the swimming pool regulation for the Environmental Health Bureau.
	July	The Environmental Health Bureau developed a presentation for a public meeting and a website on how the new proposed regulations would affect existing pool facilities and new construction.
	August	Public meetings were planned and letters were mailed announcing the new proposed regulations and inviting all stakeholders to offer public comments.
	October–December	Proposed regulations were revised in response to the public comments collected at the meetings and revisions were posted on the Environmental Health Bureau's website.
2016	February	Proposed regulations were presented to the State Environmental Improvement Board for adoption as state swimming pool regulations.
	May	The State Environmental Improvement Board adopted the regulations incorporating MAHC guidance after hearing written and oral evidence in a public hearing.
	May–August	Staff training on new regulations and inspection forms was conducted. New regulations and inspection forms were posted on the Swimming Pool Programs web page. Numerous questions were answered regarding the new regulations.
	August	Newly adopted aquatic venue regulations took effect.

FIGURE **3**

Annex to the Model Aquatic Health Code: Scientific Rationale



son help website). When the New Mexico Aquatics Program compared the state pool code with the MAHC, the program thought there would be many differences between them, but they were surprisingly similar. Also, prepare a presentation for public meetings to show the differences between your current regulations and the MAHC. Our presentation was very useful for educating interested parties and answering many of their questions. It is essential to use the MAHC Annex (Figure 3) in conjunction with the Code to show the scientific reasoning behind how the Code is trying to improve public health. Lastly, do not become frustrated with changing your current regulations. Adoption is a long process that requires hard work and time to accomplish, but the improvements to public health will be worth the hard work and diligence it takes to get there.

A la Carte: How Florida Uses the MAHC to Help Fill Gaps

What Prompted You to Look to the MAHC for Help With Your State Code?

In April 2012, Florida state law changed, directing building code officials to begin issuing construction permits for pools. At this time, Florida's original pool code from 1923 had been revised only 16 times by the state health department. This system introduced many challenges for implementing the building and health departments' differing pool codes.

How Did You Begin to Update the Florida Code?

When the law changed in 2012, the pool building code's technical advisory committee appointed two state health department representatives. During the 2011–2014 and 2015–2018 code revision cycles, many health and safety revisions were included to better align the health department code with the building code. Issues still remain with the permitting process, which leaves contractors and pool owners responsible for corrections before opening. The program hopes to continue improving this process with future code revisions.

How Do You Maintain Consistency Among so Many Stakeholders?

With nearly 600 building department jurisdictions and 16 engineering offices in the state health department, the two departments strive to seek consistency daily with education opportunities, reporting templates, and checklists.

Where Have You Seen the MAHC at Work in Florida?

Outbreaks caused by *Cryptosporidium* are notoriously associated with spray pads (also known as interactive water play venues) due to children using the water features as both drinking fountains and bidets. This increased risk warranted the MAHC to recommend secondary disinfection systems (e.g., ultraviolet light or ozone) to be installed to inactivate *Cryptosporidium*, an extremely chlorine-tolerant parasite. Since this innovation was already in the MAHC, the state health department was able to convince stakeholders of the public health need, and this provision was accepted into the 2018 Florida Building Code. In addition, health department staff are encouraged to review the MAHC Annex (Figure 3) for useful understanding and analysis of the rationale.

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Quick Links

- Model Aquatic Health Code (MAHC) website: www.cdc.gov/mahc
- MAHC comparison help: www.cdc.gov/mahc/usingthemahc.html
- MAHC network, tools, and forms: www.cdc.gov/mahc/networks-tools-forms.html
- Policy statements and other stakeholder support for the MAHC: www.cdc.gov/mahc/policy.html
- Council for the Model Aquatic Health Code website: www.cmahc.org

Did You Know?

NEHA will host its Second Annual Lobby Day in Washington, DC, on May 1. The entire NEHA board of directors will be there to meet with Democrats and Republicans to discuss the importance of environmental health professionals, as well as why Congress should invest in building a credentialed environmental health workforce. Lobby days are critical to demonstrate to members of Congress that Americans from around the country care about environmental health. They are also a great way to make your voice heard loud and clear on Capitol Hill. Stay tuned to www.neha.org for more information about NEHA's Second Annual Lobby Day!

DIRECT FROM NCSL

Doug Farquhar, JD

2017 State Environmental Health Legislation

Editor's Note: **NEHA's Government Affairs program has a long and productive association with the National Conference of State Legislatures (NCSL). The organizations have worked together on numerous legislative and policy areas that directly impact the environmental health profession. One of the keys to the successes of this collaboration has been the recognition of the fact that often some of the most significant legislation and policy initiatives related to environmental public health occur in state legislatures. The states have, in a very real sense, been the innovators in developing new programs and practices. In recognition of this fact, we have asked NCSL to provide occasional overviews of state environmental public health legislative activity, covering topics that are of the most pressing public concern**

Doug Farquhar, director for NCSL's Environmental Health Program, has worked with NCSL since 1990. Mr. Farquhar directs development, management, and research for the Environmental Health Program.

Environmental health remains a concern within state legislatures. In 2017, 1,602 separate bills covering 2,879 environmental health topics were introduced at the state level, with 278 bills enacted (Table 1). Bills were introduced in every state and the District of Columbia, ranging from three bills in Wyoming to 255 bills in New York.

California enacted the most bills (32), followed by Virginia (20). Several states, including Alaska, Missouri, Ohio, South Dakota, and Wisconsin, did not enact any bills on environmental health. Massachusetts introduced 100 bills related to environmental health, but none were passed in 2017 and will carry over to 2018.

Toxics and chemicals were the foremost topics in 2017 (447 bills introduced). Food safety was the second foremost concern (380 bills introduced). Lead was the dominant chemical of concern in 2017 (248 bills introduced). Drinking water remained a top priority (284 bills introduced), along with bills addressing wastewater (134 bills introduced).

Other issues of legislative interest included pesticides (112 bills introduced), asthma (56 bills introduced), radon (49 bills introduced), body art (22 bills introduced), swimming pools (21 bills introduced) (Table 1).

North Dakota enacted three of the most consequential state laws on environmental health. In 2017, the legislature created a state Department of Environmental Quality (S 2327), transferring environmental responsibilities from the state's Department of Health to the new department. The legislature also enacted the Food Freedom Act (H 1433) exempting certain food manufactures from health or safety requirements. A third law requires mineral developers to test the water quality of private drinking water wells within half a mile of their operation (H 1409).

Toxics and Chemicals

Congress' revisions to the Toxic Substances Control Act through enactment of the Lautenberg Chemical Safety Act (LCSA) sought to limit state efforts in regulating chemicals. States remain as active in chemical safety, however, as they were prior to the enactment of LCSA. In 2015, prior to LCSA, states introduced 437 bills. In the first year of LCSA, states introduced 447 bills, many of which addressed lead hazards, a chemical states still have the authority to regulate. Of these 447 bills, 69 were enacted into law in 33 states.

One of the biggest issues in 2017 was sunscreen—whether a child can take sunscreen to school or camp without it being considered a prohibited drug. Another concern is whether oxybenzone (an ingredient in sunscreen) is harmful to marine life (an issue limited to the Hawaiian Legislature). The Food and Drug Administration considers sunscreen to be an over-the-counter drug product, meaning it is legal to purchase but it should not be applied to children without supervision. California passed a law in 2002 forgoing this warning, allowing students to use sunscreen in school. New York enacted a similar law in 2013, and Oregon and Texas

TABLE 1

2017 State Environmental Health Legislation

Topic	# of Bills Introduced	# of Bills Enacted
Asthma	56	13
Body art	22	3
Drinking water	284	56
Food safety	380	75
Indoor air quality	146	16
Pesticides	112	15
Swimming pools	21	3
Toxics and chemicals	447	69
Water/wastewater	134	28
Total bills	1,602	278

passed laws in 2015. In 2017, Alabama, Arizona, Florida, Georgia, Illinois, Louisiana, Massachusetts, Utah, and Washington passed laws regarding sunscreen products. Mississippi, Pennsylvania, and Rhode Island had bills introduced on the subject in 2017, but they were not enacted. The bill in Mississippi has died and the bills in Pennsylvania and Rhode Island were carried over to the 2018 session.

The Cleaning Product Right-to-Know Act was adopted in California (S 258). Florida enacted S 1018, requiring owners to report the release of certain pollutants within 24 hr to the state. In Maine, recent state law prohibits the sale and distribution of upholstered furniture with flame retardant chemicals (H 138). Rhode Island enacted similar provisions in 2017 (S 166 and H 5082).

Perfluorooctanoic acid (PFOA) also emerged as a concern in 2017. New York enacted S 5198 to reimburse several communities from PFOA contamination. Vermont enacted a law that holds individuals who release PFOAs into public water supplies to be strictly, jointly, and severably liable (S 10).

Lead

Of the 248 bills introduced regarding lead hazards, 34 were enacted or adopted into law. New Mexico adopted SJM 15 to study the risks of lead poisoning to the state. Pennsylvania established a task force on lead exposures and hazards to lead poisoning (SR 33).

Legislation to replace lead service lines was common. California S 427 requires communities to set a timeline to replace lead water service lines. Indiana H 1519 allows for utilities to be reimbursed for replacing private lead service lines. Minnesota S 1457 bans lead in plumbing and plumbing components. Wisconsin S 48 permits public utilities to use public funds to replace lines on private property. Appropriation bills in New York (A 3004, A 3007, and S 2007) and Pennsylvania (H 674) address lead service lines. The New York bills authorize $20 million to communities to replace lead service lines. The Pennsylvania bill allows for public water systems to pay for the replacement of lead service lines on private property.

Requirements for testing lead in school water systems were enacted in California (A 746), Colorado (H 1306), the District of Columbia (B 29), Maryland (H 270), and Virginia (S 1359). Arizona's budget bill provides funds for consultants to address lead in school water systems (H 2545). New Jersey provides reimbursements to schools to test lead in water (A 4284). Oregon's Healthy and Safety Schools Plan (S 1062) mandates schools to adopt a healthy safe school plan, ensuring compliance with the U.S. Environmental Protection Agency's (U.S. EPA) Lead Renovation, Repair, and Painting Rule. Rhode Island extended the special House commission on lead in drinking water in the state (H 6035).

California A 1316 requires screening for blood lead levels for high-risk children to be covered by insurers and changes the definition of lead poisoning to include lead in arterial or cord blood. In Florida, legislation requires healthcare providers to report individual cases of elevated blood lead levels (H 1041). Maryland H 133 requires the state to notify both a child's parents and the owner of the property where a child lives of the results of an elevated blood lead test. New Jersey requires state blood lead standards to be consistent with recommendations from the Centers for Disease Control and Prevention (S 1830).

Asbestos

Several states adopted legislation regarding claims to the asbestos bankruptcy trust including Iowa (S 376), Mississippi (H 1426), North Dakota (H 1197), and South Dakota (S 138). Virginia S 305 requires the state to provide basic worker safety procedures regarding the handling of asbestos. In Montana, the Libby Asbestos Cleanup Oversight Team was created to address the asbestos cleanup in the town of Libby. (S 315).

Mercury

States enacted five bills on Mercury: three in Maryland, one in Utah, and one in Washington. Maryland H 504 and S 713 prohibits the sale of electric switches, electric relays, and gas valve switches containing mercury. Utah H 33 extends the repeal date of its earlier Mercury Switch Removal Act.

Indoor Air Quality

State legislatures introduced 146 bills related to indoor air quality, enacting 18 of them. Indoor air quality covers efforts to eliminate contaminants in buildings including carbon monoxide, mold, and radon.

Delaware enacted S 107, which establishes an indoor environment information portal on the its Health and Social Services website. Virginia H 1869 makes a tenant financially responsible for the cost of exterminating insects and pests if the tenant fails to report their existence to the landlord.

Carbon Monoxide

In previous sessions, legislation requiring carbon monoxide detectors was common. In 2017, 35 bills in 15 states were introduced that relate to carbon monoxide. Only one bill was enacted—New Jersey's Rosa-Bonilla Family Act, which requires the state to provide educational materials on carbon monoxide poisoning in motor vehicles (A 3662).

Mold

Maryland enacted two laws related to mold, both dealing with mold remediation service providers (H 115 and S 183). These bills extend the date for firms providing mold remediation services to be licensed. Virginia enacted a law requiring landlords to pay relocations costs of tenants who have to move due to a mold situation not caused by the tenant (H 735).

Radon

Of the bills on radon, five bills were enacted in four states. Connecticut added radon to a list of contaminants that private well owners should test for (H 7222). Nebraska enacted the Radon Resistant New Construction Act (L 9) that requires active radon mitigation systems be installed in new construction by licensed contractors. Utah H 37 amends the state construction code to address passive radon installation. Illinois H 2719 amends the Radon Resistant Construction Act, removing the reference to the Radon Resistant Building Codes Task Force. Illinois also amended its radon licensing law, clarifying the circumstances in which a conviction would prohibit a person from receiving a license (H 1688).

Food Safety

Food safety was the second most common environmental health topic for state legislatures in 2017 with 380 bills introduced and 75 enacted into law, which is down from 560 bills introduced in 2016.

California A 564 provides for the Secretary of Food and Agriculture to inspect raw and unprocessed fruits, nuts, and vegetables, and to enforce standards of quality. The Illinois legislature now requires restaurant employees be trained in basic allergen principles (H 2510). Micromarkets in Indiana no longer require staffing (S 77). Nebraska updated its food code (L 134). New Hampshire revised its food code to allow its Department of Health and Human Services to inspect facilities (S 221). Maryland (H 771 and S 262), Utah (S 250), and Virginia (H 1625 and S 515) enacted laws regulating mobile food trucks.

Food Safety Modernization Act

Connecticut H 6333 and Louisiana S 256 establishes each state's agriculture department as the lead agency for enforcement of the Food Safety Modernization Act (FSMA). The Montana legislature provides for its agriculture department authority to inspect produce as part of FSMA (H 91). New Mexico H 305 authorizes its department similar powers to comply with FSMA, as does Oregon S 18 and South Carolina H 4003. Rhode Island provided FSMA authority to its Department of Environmental Management (H 6345 and S 720).

Georgia H 176 allows its Department of Agriculture to enter into agreements with the federal government to enforce provisions of FSMA. Texas H 3227 permits the agriculture department to enter into cooperative agreements, interagency agreements, grants, or memorandums of understanding with federal or state agencies for the administration, implementation, or enforcement of produce safety rules.

Cottage Foods and Food Freedom

In 2017, the Wyoming legislature expanded the state's Food Freedom Act. The North Dakota legislature enacted its own Food Freedom Act and the Maine legislature enacted legislation that allows local jurisdictions to opt-out of state food safety requirements (i.e., food sovereignty).

The Wyoming legislature amended its Food Freedom Act to include rabbit and fish; to clarify homemade products that are specifically exempt from state licensure, inspection, and labeling; and to permit state agencies to provide assistance, consultation, and inspection services to food producers utilizing the state's Food Freedom Law (H 129 and S 118). North Dakota H 1433 Food Freedom Law allows for producers of food (including animal products) to sell directly to consumers without a state food safety license.

Maine expanded the cottage food concept into food sovereignty by enacting S 242 and S 605. S 242 authorizes local governments to adopt their own food standards for foods grown, produced, or processed within the local jurisdiction, marking the first time that a state has given regulatory control to a municipal government over locally produced and sold food. Maine S 605 amended S 242 by providing that local governments must still comply with state and federal food safety laws. Florida expanded its cottage food law by increasing the annual sales limitation required to gain cottage food protections (H 1233). Illinois H 3063 allows for cottage food operations to produce homemade food and drink, with exceptions for potentially hazardous foods.

Farmers markets in Illinois must provide an effective means to maintain potentially hazardous food at or below a specific temperature (H 2820). Distillers can sell whiskey and distilled spirits at festivals in Kentucky (H 100).

Oklahoma now permits the sale of home-based foods at farmers markets and through direct delivery (S 508). Tennessee S 1187 exempts certain producers of small amounts of nonhazardous foods.

Food Donation

Liability relief for groups that donate excess food to charitable organizations gained interest in state legislatures in 2017. California enacted S 557 that allows unused returned food to be offered to a food bank or nonprofit charitable organization. The state also enacted the Good Samaritan Food Donation Act to exempt gleaners and persons who donate food. (A 1219).

Kentucky allows fit, wholesome food to be donated to nonprofit organizations and allows those organizations to recondition donated food (H 237). Montana now allows wild game and fish meat be served at not-for-profit events (H 166). Oregon permits the salvage of wildlife for consumption if the animal has been struck by a vehicle (S 372).

New York S 5664 establishes voluntary guidelines for the donation of excess, unused, and edible food from educational institutions to voluntary food assistance programs. Oklahoma permits schools to donate food to nonprofit organizations (H 1875). Texas addresses food donation and distribution of surplus food from public schools (S 725). Virginia provides a tax credit for food crop donations to food banks (H 1093), as does West Virginia (S 25).

Raw Milk

Legislatures in eight states introduced 14 bills regarding raw milk, but only one bill survived to enactment. Rhode Island S 247 sets forth standards and procedures for the handling and sale of raw milk.

Drinking Water

Events in Michigan, Ohio, and West Virginia prompted state legislatures to become more involved with their drinking water systems, both private and public.

Arizona established the Small Drinking Water Systems Fund to provide grants to owners of small systems to upgrade their water infrastructure (H 2094). California enacted several water and wastewater grant programs (A 277 and A 560). Maine made a one-time appropriation for the treatment of contaminated private drinking water wells (S 426).

The Indiana General Assembly reviewed the ability of its utilities to provide clean and safe drinking water (S 416). Louisiana enacted an ambitious program to improve public drinking water quality and to develop recommendations to the legislature concerning effective and responsible practices to improve and maintain the water quality (H 533). Texas required the notification of water quality test results in state-supported living centers (S 546).

Lead Service Lines

California adopted a lead service line replacement program in 2016; in 2017 the state enacted S 427 to establish a timeline for the replacement. The appropriation bills in New York (A 2007) and Pennsylvania (H 674) provide financing options to replace lead service lines.

Colorado enacted H 1306 that requires the testing of lead in public schools. The District of Columbia enacted a similar provision (B 29). Illinois S 1943 provides waivers from testing for lead in school buildings. Maryland also requires periodic testing for the presence of lead in schools (H 270). Minnesota H 2 establishes a program to test for lead in schools. New Jersey A 4284 provides reimbursement for schools testing for lead in water. Virginia S 1359 requires each school board to implement a plan to test potable water for lead.

Private Wells

Connecticut H 7222 allows local directors of health to require private drinking water well owners to test for water contaminants. The Maine legislature enacted H 321 to improve the testing and treatment of water in residential private drinking water wells.

North Dakota enacted a law that requires mineral developers to test private drinking water wells within half a mile of their operation. Owners who refuse to allow the developers to test are ineligible to bring suit against the developer for water contamination (H 1409).

Water/Wastewater

Sixteen states enacted 26 bills related to water quality and wastewater. Arizona enacted comprehensive legislation that provides for the regulation of dry wells and increases awareness of properly disposing solid waste (S 1183). Arkansas enacted a couple of bills related to wastewater—H 1550 amends the nonmunicipal domestic sewage treatment program, including the prohibition of new water connections to noncompliant nonmunicipal systems; and S 685 permits water utilities to terminate service if the customer fails to pay for wastewater services.

California enacted S 277 and A 339, both of which provide loans and grants to communities to upgrade wastewater systems. New Jersey had several bills on environmental infrastructure that allow for loans for wastewater maintenance and upgrades (A 10, A 3883, and A 3884). The state also enacted A 4350 that precludes the state agency from imposing certification requirements on installers of individual subsurface sewage disposal systems.

Hawaii has been struggling with homes that lack septic systems and enacted H 1244 to provide an income tax credit for homeowners who upgrade their cesspools or connect to a municipal wastewater system. New York amended its Septic System Replacement Fund to allow septic system installers to receive state reimbursement directly (A 7892). In Virginia, the state must eliminate the evaluation and design services by the health department for onsite sewage systems and private wells (H 558).

Tennessee S 999 requires public reports of annual audits of water and wastewater treatment authorities. Washington enacted a law that allows for water–sewer districts to contract for asset management services (S 5119).

One bill was enacted concerning graywater. Colorado enacted H 1008 that provides an exception for graywater use if done for purposes of scientific research.

Pesticides

In 2017, 117 bills were introduced relating to pesticides, with four being adopted and 12 being enacted. California adopted ACR 51 that establishes a Mosquito Awareness Week. New Jersey adopted SR 67 and AR 142 that urge Congress to fund efforts to combat Zika and to add Zika to the federal list of tropical diseases.

California enacted laws to make its fumigation enforcement program part of its pesticide regulation department (A 593) and to regulate the use of carbon monoxide to control burrowing rodents (A 1126).

Florida, Illinois, and Montana amended their fee rates for their pesticide registration programs (H 5401, H 3130, and H 126, respectively). Maine amended its definition of pesticides by removing the reference to U.S. EPA (S 209). North Dakota S 2027 provides for a pesticide program and user fees. Rhode Island enacted two bills that provide exemptions from pesticide registration requirements—S 733 and H 6158 exempt persons from registration and permit fees for the minor use of pesticides.

In Hawaii, H 186 studies the impact of pesticides on the coffee berry borer. Maryland H 830 requires pollinator habitation plans be established by state agencies. Rhode Island adopted H 6256 that continues its Pollinator Working Group within its Department of Environmental Management.

Asthma

Eight bills were enacted and five bills were adopted on asthma in 2017. Resolutions supporting asthma awareness were adopted in California, Michigan, and Pennsylvania (ACR 68, HR 108, and HR 254, respectively).

Arizona enacted H 2208 that relates to the emergency administration of epinephrine and inhalers in schools. The Illinois legislature enacted S 1846 that requires the public health department to promulgate rules and regulations to include asthma in the standard school health examination. In Nebraska, a physician or healthcare professions may issue medication to schools for cases of asthma or for anaphylaxis emergencies (L 487).

Texas enacted two laws on the use of epinephrine injectors in private schools and institutes of higher education (S 579 and S 1367). Utah also amended its Emergency Administration of Epinephrine Act (S 108).

Body Art

Only three bills were enacted on body art in 2017 out of a total of 23 introduced. Alabama enacted H 262 that relates to natural hair stylists, Arizona enacted a law relating to minimum standards for hairstylists (S 1130), and Utah modified its Acupuncture Licensing Act Requirements (S 73).

States that introduced but did not enact bills include Massachusetts, which sought to prohibit body piercing except by persons licensed by its public health department; New York, which looked into body art chemicals that could cause cancer; North Carolina, which sought to regulate mobile beauty salons; and Virginia, which attempted to license laser hair removal technicians.

Swimming Pools

State legislatures introduced 21 bills in nine states that address swimming pools, from lifeguard and instructor certification requirements to sanitation standards and construction code revisions. California enacted S 442 that requires pools and spas be equipped with drowning prevention features when a building permit is issued and requires home inspectors to examine pools and spas.

In Texas, the legislature enacted a law that requires public swimming pools or artificial swimming lagoons to be maintained in a sanitary condition (H 1468). Washington exempted inflatable equipment at temporary events from the regulation of water recreational facilities (H 1449).

Tracking, Surveillance, and Biomonitoring

Thirty-six bills were introduced in 2017, with four being enacted into law. Arkansas enacted H 1259 that modernizes the state's environmental laboratory certification program. California A 1438 amends the state's Environmental Laboratory Accreditation Act. The state also enacted the Cleaning Products Right-to-Know Act (S 258).

Florida H 1041 requires the surgeon general's program for early identification of persons at risk of having elevated blood lead levels. Montana, in response to its adoption of medical marijuana laws, established requirements for testing laboratories and the testing of samples collected during an inspection (S 333). New York had two bills that sought to develop a state environmental health tracking system; both bills remain pending (A 5450 and S 484).

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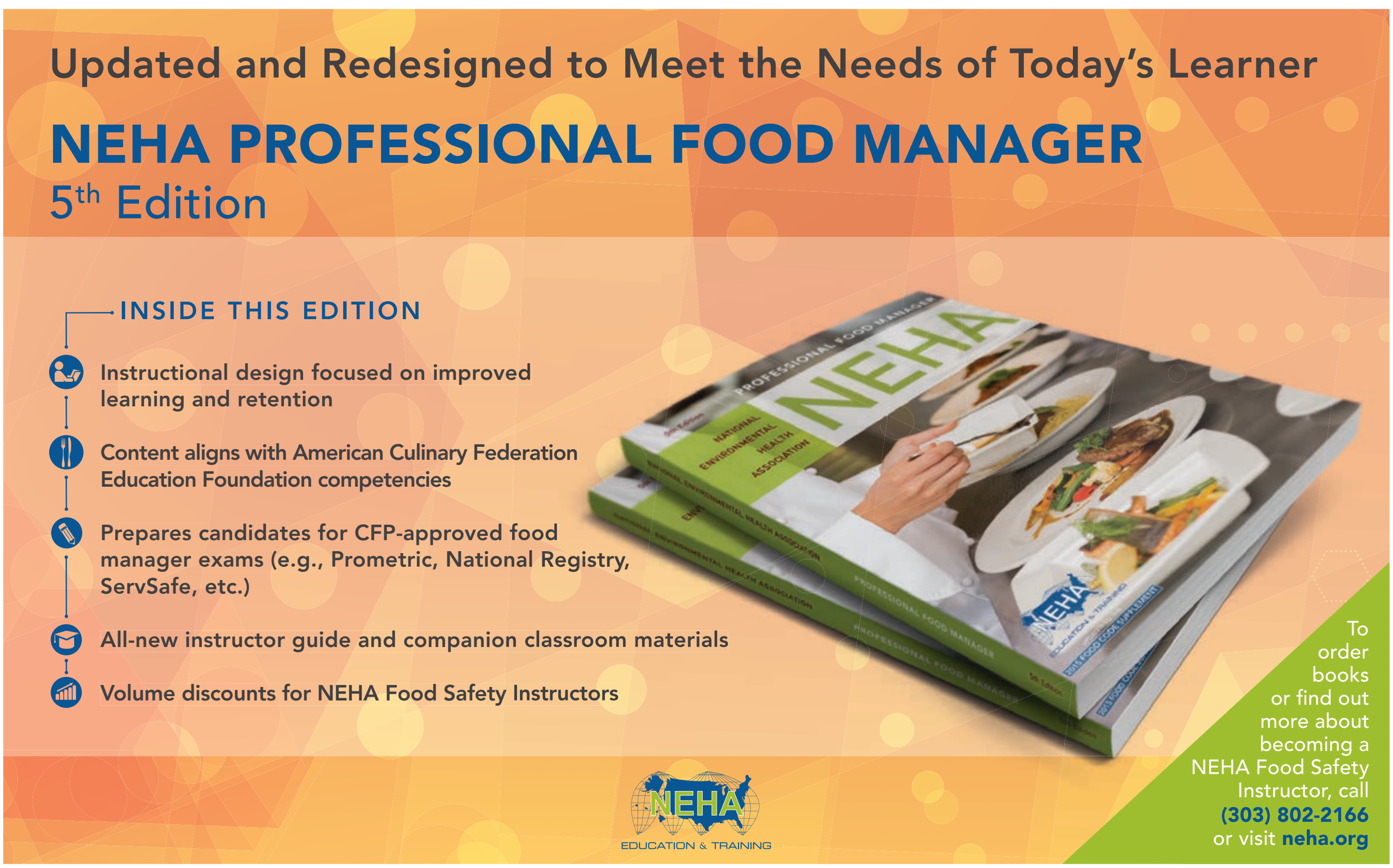
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PRIVATE DRINKING WATER SYSTEMS: CREATING A PUBLIC HEALTH NETWORK FOR PARTNERSHIPS, RESOURCES, AND TRAINING

Part 1: The Private Water Network

Editor's Note: The National Environmental Health Association is publishing a three-part series that describes the creation and execution of a public health network focused on private drinking water systems. This series will provide insights into the development process, mission, and goals of the network, as well as preview upcoming trainings and resources. This series is supported by the Centers for Disease Control and Prevention (CDC) Contract 200-2013-57475. The conclusions in this series are those of the author(s) and do not necessarily represent the official position of CDC.

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National Environmental Health Association

Introduction

In late 2017, the Centers for Disease Control and Prevention's Water, Food, and Environmental Health Services Branch (WFEHSB) partnered with the National Environmental Health Association (NEHA) to establish a network focused on private drinking water systems. WFEHSB and NEHA are creating the Private Water Network to support the estimated 50 state and 2,800 local environmental public health programs (National Association of County and City Health Officials, 2017) and the diverse partners working with them to ensure safe drinking water from federally unregulated drinking water systems (e.g., private wells, springs, trucked water). WFEHSB and NEHA are bringing together the varied skill sets, experience, and capacity needed to assure safe drinking water for approximately 34 million U.S. residents relying on private wells and for others depending on drinking water sources not protected by the Safe Drinking Water Act (National Ground Water Association, 2016). Initial members of the Private Water Network include representatives from state and local health departments, universities, federal agencies, and national associations. Members facilitating the network are working with stakeholders throughout the private drinking water spectrum to define the vision, mission, structure, and goals for an inclusive national network.

Private Water Network Topics

Early discussions with partners identified topic areas that will define the purpose of the Private Water Network and the types of support it should provide. Initial dialogue on priority areas for the network focused on the need to create opportunities for interdisciplinary and collaborative research. These opportunities include identification of funders and more targeted methods to report and share results.

Another theme in early conversations about the network focused on improving outreach and communication to partners. The network can help members improve outreach to first responders in disaster events, communicate effectively to culturally distinct communities (e.g., rural versus urban, affluent versus poor), and develop plain language for homeowner outreach and educational materials, including the reporting of laboratory results on water quality. Network members underscored the need to provide resources, strategies, and best treatment options for homeowners to prevent exposure to contaminants in well water. Additionally, some members thought providing a national-level perspective on policy issues and gaps for federally unregulated drinking water systems and sources would be useful.

Existing Water Networks

The Private Water Network will use existing network structures not only as resources and models for developing a national network but also as potential members and contributors. Existing water networks operate at national, regional, and local levels to organize information, collect data, and disseminate useful resources for environmental public health programs, practitioners, and partners. For example, the U.S. Geological Survey Office of Groundwater manages Groundwater Watch, a website with maps, graphs, and tables describing real-time and past groundwater conditions gathered from local databases and active well monitoring networks (U.S. Geological Survey, 2017).

State and university examples of water and groundwater networks include the Ohio Watershed Network managed by Ohio State University Extension. The network connects community members and natural resource professionals and provides educational programs for members (Ohio State University Extension, 2018). Likewise, the University of Arizona facilitates the Arizona Water Network, which connects researchers, students, government officials, businesses, and citizens (The University of Arizona, 2016). In Indiana, the Department of Environmental Management supports and contributes to the state groundwater monitoring network (Indiana Department of Environmental Management, 2018). The Indiana network collects and disseminates data on source water, watershed protection, and groundwater quality to communities, citizens, research organizations, and industry. Each of these networks has its own unique goals, mission, and infrastructure. Bringing people, ideas, and data together through a network can provide motivation for problem solving and change.

Purpose of Public Health and Environmental Science Networks

Public health and environmental science circles use networks to improve essential services delivery and to protect the health of global populations and U.S. citizens. These networks develop out of the need to combine disparate resources and knowledge so network members are more able to address critical public health issues. Reasons galvanizing development of these networks include the following:

- pooling resources and expertise to build a system of monitoring and surveillance (Mackenzie et al., 2014);
- developing standards of practice to improve the efficiency of public health implementation (Coish et al., 2018; Mackenzie et al., 2014);
- establishing and managing centralized databases (Schmeltz et al., 2011) that improve data accessibility and sharing (Mahler & Regan, 2012);
- fostering collaboration and mobilizing scarce public health expertise during outbreak response (Mackenzie et al., 2014); and
- sustaining a knowledge base and approach for solving environmental public health problems (Environmental Public Health Leadership Institute, 2013).

Public health networks have evolved to

- address key questions about exposures (e.g., mercury emissions, arsenic, particulate matter) (Hansen et al., 2012; Schmeltz et al., 2011);
- gather data through groundwater monitoring networks;
- contain structure, mission, and function (Centers for Disease Control and Prevention, 2015);
- establish and implement frameworks for information systems;
- establish reporting standards for information exchanges (Environmental Information Exchange Network, 2018); and
- organize training on learning management systems (Mackenzie et al., 2014).

The Private Water Network is seeking members to inform the development of the network's structure and mission.

Conclusion

Environmental health practitioners rely on partnerships, connections, and sharing of resources to improve programs and protect public health. The Private Water Network will make those connections easier to build, maintain, and grow. The network will be a forum to identify priorities and provide a collaborative workspace to create and disseminate resources. Furthermore, the network will have access to multiple types of internal communication channels such as online-facilitated discussions, teleconferences, virtual conferences, and webinars.

Facilitators supporting the network will have the capacity and reach to share messaging on best practices throughout the nation. Facilitators are committed to work with all partners to improve water quality for every community. To find out more about the Private Water Network and opportunities to participate, or to share your experiences or challenges with federally unregulated drinking water, visit www.neha.org/eh-topics/water-quality-0/private-drinking-water.

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CAREER OPPORTUNITIES

Did You Know?

You can download the Centers for Disease Control and Prevention's (CDC) new iPad app (https://itunes.apple.com/us/app/aquatic-inspector/id1348296177?mt=8) for a digital version of CDC's Model Aquatic Health Code inspection form. The app allows you to take photos, link to inspection reports, record data on site, and print/save/share inspection reports.

EH CALENDAR

UPCOMING NEHA CONFERENCES

June 25–28, 2018: NEHA 2018 Annual Educational Conference & Exhibition and HUD Healthy Homes Conference, presented by Green & Healthy Homes Initiative, Anaheim, CA. For more information, visit www.neha.org/aec.

July 8–11, 2019: NEHA 2019 Annual Educational Conference & Exhibition, Nashville, TN.

July 13–16, 2020: NEHA 2020 Annual Educational Conference & Exhibition, New York, NY.

NEHA AFFILIATE AND REGIONAL LISTINGS

Colorado
September 18–21, 2018: 63rd Annual Education Conference, hosted by the Colorado Environmental Health Association, Fort Collins, CO. For more information, visit www.cehaweb.com.

Florida
July 24–27, 2018: Annual Education Meeting, hosted by the Florida Environmental Health Association, Cape Canaveral, FL. For more information, visit www.feha.org.

Georgia
June 27–29, 2018: Annual Education Conference, hosted by the Georgia Environmental Health Association, Savannah, GA. For more information, visit www.geha-online.org.

Minnesota
May 10–11, 2018: Spring Conference, hosted by the Minnesota Environmental Health Association. For more information, visit www.mehaonline.org.

Montana
September 18–19, 2018: Fall Educational Conference, hosted by the Montana Environmental Health Association, Helena, MT. For more information, visit www.mehaweb.org.

Utah
May 2–4, 2018: Spring Conference, hosted by the Utah Environmental Health Association, Vernal, UT. For more information, visit www.ueha.org/events.html.

September 25–27, 2018: Fall Conference, hosted by the Utah Environmental Health Association, Vernal, UT. For more information, visit www.ueha.org/events.html.

Washington
May 7–9, 2018: 66th Annual Educational Conference—Environmental Public Health: Partnering, Protecting, & Planning, hosted by the Washington State Environmental Health Association, Olympia, WA. For more information, visit www.wseha.org.

Wisconsin
September 19–21, 2018: Educational Conference, hosted by the Wisconsin Environmental Health Association, Onalaska, WI. For more information, visit https://weha.net/events.

TOPICAL LISTINGS

Informatics
August 20–23, 2018: 2018 Public Health Informatics Conference, hosted by the National Association of County and City Health Officials and Centers for Disease Control and Prevention, Atlanta, GA. For more information, visit http://phiconference.org.

Vectors and Pest Control
September 11–14, 2018: 15th International Conference on Lyme Borreliosis and Other Tick-borne Diseases, hosted by the Centers for Disease Control and Prevention, National Institutes of Health, and National Environmental Health Association, Atlanta, GA. For more information, visit www.neha.org/international-conference-lyme-borreliosis-and-other-tick-borne-diseases.

Water Quality
May 9–11, 2018: Managing *Legionella* and Other Pathogens in Building Water Systems 2018 Conference, hosted by NSF International, Baltimore, MD. For more information, visit www.legionella2018.org.

Did You Know?

You can share your event with the environmental health community by posting it directly on NEHA's community calendar at www.neha.org/news-events/community-calendar. Posting is easy (and free) and is a great way to bring attention to your event. You can also find listings for upcoming conferences and webinars from NEHA and other organizations.

RESOURCE CORNER

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

NEHA BOOKSTORE
www.neha.org/store

Certified Professional–Food Safety Manual, 3rd Edition

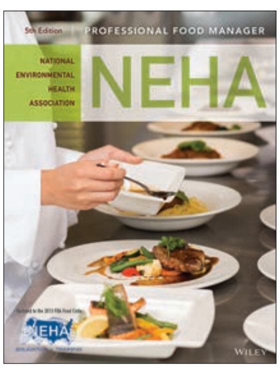
National Environmental Health Association (2014)

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 credential 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

Professional Food Manager (5th Edition)

National Environmental Health Association (2016)



The 5th edition of NEHA's *Professional Food Manager* provides culinary and hospitality professionals and students with the knowledge they need to ensure successful execution of best food safety practices in the workplace. Updated to the 2015 Supplement to the 2013 Food and Drug Administration *Food Code*, this book provides vital information on the principles of food safety management and how to use those principles to create a food safety culture. Additionally, it contains streamlined, validated content by NEHA subject matter experts to support the education of food managers and provides the knowledge needed for culinary and hospitality professionals to pass accredited food manager certification exams.

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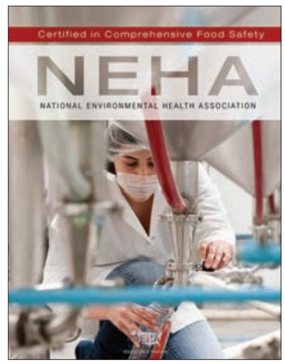
Certified in Comprehensive Food Safety Manual

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 offers the Certified in Comprehensive Food Safety (CCFS) credential. The CCFS is a midlevel credential for food safety professionals that demonstrates expertise in how to ensure safe food 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. The *CCFS 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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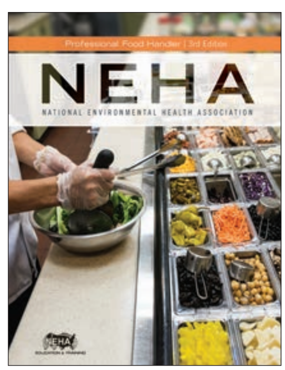
Member: $179 / Nonmember: $209

Professional Food Handler, 3rd Edition

National Environmental Health Association, Inc. (2013) and MindLeaders, Inc. (Portions) (2013)



NEHA's *Professional Food Handler* textbook provides food handlers access to essential knowledge and understanding of fundamental food safety practices that they need to carry out their work safely. Concise, brightly illustrated, and written at the eighth-grade level, this student textbook is an effective tool in the workplace. Based on the 2013 Food and Drug Administration *Food Code*, this book presents all the essential microbiological and technical food safety principles in ways that are easy to read, understand, and retain. In addition to containing fundamental food safety practices, the book also includes informative graphics that assist readers in retaining the information.

55 pages / Paperback
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http://health.baltimorecity.gov/programs/health-resources-topic

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Metro Public Health Department
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U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION

OFFICE OF LEAD HAZARD CONTROL AND HEALTHY HOMES
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NEHA 2018 AEC and HUD Healthy Homes Conference

Anaheim • California • June 25-28, 2018

REGISTRATION DEADLINE EXTENSION

The deadline for early registration pricing has been extended to **Monday, April 23.**

Session Agenda Now Online

View the full session agenda at **neha.org/aec/sessions**.

Preconference Offerings

See full details for the June 23–25 offerings at **neha.org/aec/preconference**.

Review Courses and Trainings
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Certified in Comprehensive Food Safety Credential Review Course
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Exams: Contact NEHA's Credentialing Department for details and costs at neha.org/professional-development/credentials. Only qualified applicants will be able to sit for an exam. A separate application is required for each credential exam and the application deadline is May 14, 2018.

Workshops
Survival Skills for Environmental Health Leaders • Sunday, June 24
Health Impact Assessment 101 • Sunday, June 24
Affiliate Leadership Workshop • Sunday, June 24

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Preconference Courses and Training Details
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SPECIAL AEC EVENTS

The AEC events are your opportunity to build your network, mingle with industry professionals, and just have fun!

Exhibition Grand Opening & Party
Monday, June 25 (6:00 – 8:00 PM)

Connect with exhibitors and other industry professionals who can take your career to the next level. Enjoy food, fun, socializing, and networking! A ticket to this event is included in full conference and Monday-only registrations.

Exhibit booths are still available! Don't miss this excellent opportunity to meet face-to-face with over 1,000 environmental health and healthy homes professionals. **Register for your booth today at neha.org/aec/exhibition.

UL Event—Angel Stadium
Tuesday, June 26 (6:00 – 9:00 PM)

Always one of the AEC's most popular events, Underwriters Laboratories, Inc. is hosting an exciting evening of fun at Angel Stadium, home of the Los Angeles Angels baseball team. (*Note*. Event is not a baseball game.) The event typically sells out, so be sure to purchase your ticket in advance!

Good Vibrations! Reception
Wednesday, June 27 (6:30 – 9:00 PM)

Join us for a fun-filled evening in the courtyard just outside the Marriott Anaheim Hotel. You'll enjoy festive music and dancing, and get a taste of the wonderful flavors representing various California regions. A ticket to this event is included in full conference registration.

Don't miss these exciting events!
Register today at neha.org/aec/register.

***Angel Stadium**, photo courtesy of Ballparks of Baseball.com. **Grand Plaza**, photo courtesy of visitanaheim.org.*

REGISTER NOW!

NEHA NEWS

A Tumultuous Time in Washington, DC

By Joanne Zurcher (jzurcher@neha.org)

Summer 2018 is right around the corner and NEHA's Government Affairs realizes that the 2018 midterm elections will be here before we know it. We want you to be prepared and informed as your elected leaders reach out to you this summer/fall and ask for your vote. It's been a frenetic time in Washington, DC, and NEHA has been hard at work to protect and promote the environmental health profession with our nation's governing and thought leaders. We thought it would be beneficial to our members to provide a synopsis of the past year and the activities we've undertaken (and are undertaking) on behalf of the profession

As with any new administration, there are bumps in the road as the transition from campaigning to governing begins. New positions need be quickly filled, and many must be confirmed by the U.S. Senate. There were many other challenges with the current administration as distractions to governing seemed to come hourly through Twitter.

A new Congress began in 2017 and for the first time in a decade, all three branches of government were controlled by one political party. The budget battles of 2016 continued as the 13 appropriations bills necessary to keep the federal government running were not passed. Instead, the federal government was operating under a continuing resolution (i.e., the previous year's funding is continued until a specific new date and at that time, Congress must pass the 13 bills). NEHA worked tirelessly to ensure that funding for the Centers for Disease Control and Prevention (CDC), especially the National Center for Environmental Health/Agency for Toxic Substances and Disease Registry, was kept off the political chopping block of federal funding.

NEHA worked to secure $1.1 billion for Zika funding in the previous Congress and began 2017 by trying to influence the release of funds from CDC as soon as possible to address the growing public health risks related to the disease. State and local environmental health departments were facing challenging times to increase vector control capabilities and stop Zika from spreading, and this funding was critical to support their efforts.

Good news came early in 2017 as our champion for environmental health in Congress, Representative Brenda Lawrence (D-Michigan), reintroduced HR 1909, the Environmental Health Workforce Act. The purpose of the bill is to ensure the requirement of a credentialed environmental health workforce in all states. Garnering support for this legislation has been a top priority for NEHA since we opened our Washington, DC, office.

NEHA then hosted its first ever Hill Day in Washington, DC, on February 13, 2017. NEHA's national officers came to Washington, DC, to meet with representatives and senators from both political parties to discuss the importance of environmental health, as well as highlight concrete solutions to pressing issues such as the passage of the Environmental Health Workforce Act. Information about the 2017 Hill Day was posted on NEHA's website at www.neha.org/node/58882.

Budget battles continued till May 2017, when the Fiscal Year (FY) 2017 Omnibus Appropriations bill was passed. Fortunately, CDC programs were not cut as originally proposed in the president's first budget. CDC received $7.16 billion in funding. Immediately following the passage of FY2017 appropriations, the budget battles for FY2018 began in earnest.

On July 10, 2017, Senator Deborah Stabenow (D-Michigan) welcomed everyone to the NEHA 2017 Annual Educational Conference & Exhibition in Grand Rapids, Michigan, through a video and Representative Lawrence gave an outstanding keynote address to our members.

Additionally, NEHA began working with over a dozen critical national public health partners to begin the conversation about the Pandemic and All-Hazards Preparedness Reauthorization Act. This legislation directs the Office of the Assistant Secretary of Preparedness and Response at the U.S. Department of Health and Human Services on what to do during a national crisis and who should be involved in the response. Environmental health is not mentioned in previous versions of the bill. As such, environmental health has not been funded during critical response times and has not been considered in the preparation for these incidences. NEHA has become a critical stakeholder on this issue and has met with the Assistant Secretary of Preparedness and Response on our work. As of this writing, the national public health partners now support the inclusion of environmental health in the legislation and NEHA has briefed the bipartisan group of senators working to draft this important legislation.

The devastating hurricane season in summer 2017 found environmental health on the cover of every newspaper again. The devastation and recovery efforts were nonstop due to the three massively destructive hurricanes that occurred—Hurricane Harvey in Texas, Hurricane Irma in Florida, and Hurricane Maria in Puerto Rico. NEHA immediately began assessing immediate and long-term needs from our members in Texas, Florida, and Puerto Rico. We then began work to ensure that federal funding was available to those areas. It took a lot longer than it should have, but $89.3 billion was finally appropriated. CDC received $200 million and we continue to work with CDC to get that money out to the most in-need areas.

Looking now to the present, FY2018 budget battles still continue and we don't have a budget. Congress, after two shutdowns and many continuing resolutions, did agree to raise the caps on both nondiscretionary funding (military funding) and discretionary funding (all other federal funding).

President Trump has released his budget for FY2019 and while many in Washington, DC, have not taken it very seriously, at least the process has begun for next year. Thus, before we finish the budget battles for 2018, we are already working on next year's budget.

NEHA **NEWS**

Finally, NEHA is hosting its Second Annual Lobby Day on Capitol Hill on May 1, 2018. The entire NEHA board of directors will be coming to Washington, DC, to meet with representatives and senators to discuss improving environmental health and protecting the profession that saves lives and money every single day. A summary of the event will be published in the July/August 2018 *Journal of Environmental Health*. Please visit NEHA's website at www.neha.org for more information about the event.

Whew, what a roller coaster this past year has been. NEHA's Government Affairs will continue to represent you in Washington, DC, to ensure that the environmental health profession always has a seat at the table, as well as stays off the proverbial chopping block. With midterm elections coming up, if you happen to talk to you congressional representatives, make sure you ask them, "What are you doing to support the environmental health profession?" I would love to hear what they say and ask that you contact me with their response at (202) 270-6193 or jzurcher@neha.org. It is truly my honor to work for you and our noble profession.

Did You Know?

If looking for foodborne outbreak environmental assessment training and resources, this video (www.youtube.com/watch?v=Ah8i0zuzw7I&feature=youtu.be) is a guide to navigating trainings and resources on environmental assessments conducted as part of foodborne illness outbreak investigations. The video summarizes trainings and tools from NEHA, the Centers for Disease Control and Prevention, and the Colorado Integrated Food Safety Center of Excellence. After watching the video, you will be able to identify the environmental assessment resources that meet your training needs and the needs of your environmental health team. More information can be found at www.neha.org/eh-topics/food-safety-0/environmental-assessments-and-training.

DirecTalk

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and largely self-sustaining communities with greenhouses and canneries. In the early 2000s, I visited one of the many hundreds of urban gardens in Havana, Cuba. These community gardens were created as a matter of desperation in the aftermath of reduced Soviet Union economic subsidies. Many of these gardens produce over two dozen different varieties of organic vegetables. Fresh, homegrown, and nutritious food at an affordable price.

There are many benefits to small farms and community gardens beyond healthy and nutritious food. A review of published literature suggests that they offer a focal point for community organizing, which can help address other concerns such as lead paint and safe walking routes to schools. Children can practice their math skills and learn where food comes from, such as I observed in post-Katrina New Orleans. In fact, the local school district introduced the idea of an edible schoolyard, a concept they imported from schools in San Francisco. Participating schools in New Orleans promoted healthy eating by encouraging children to grow their own crops on school property. After harvest, the children were taught how to prepare and cook meals with the vegetables. These were nutritionally rich meals to which children might not otherwise have access. School-based gardens represent an inexpensive activity that bring our children closer to nature and create opportunities for students to interact with each other in meaningful and physically productive manners.

Mexican shaving bush tree. Photo courtesy of Angela Dyjack.

Nayarit is not the only study in contrasts I've reflected on over the last few days. In recent history, America has supported policies that have incentivized large corporate farming over smaller family operations. Undoubtedly, economies of scale provided by large agribusiness have their advantages at the grocery store cash register. At the same time, small urban farms and community gardens provide a multitude of benefits to the places where we live and raise our families. Less greenhouse gases, less processed food, and more nutritious delights all realized in our local communities. That's a whale of a deal.

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DirecTalk MUSINGS FROM THE 10TH FLOOR

David Dyjack, DrPH, CIH

Going Local to Improve Diet and Health

Nayarit, Mexico, is a study in contrasts. On one hand, it is the Mexican state where reportedly much of the black tar heroin destined for the U.S. originates. On the other hand, it provides a glimpse of the possibilities when society rallies around solutions and is a testament to human determination. Take the North Pacific humpback whale that was once threatened with extinction—they now number in the tens of thousands. From my vantage point high above the Bay of Banderas, I can see dozens of graceful spouts of water vapor from humpback mothers and their calves. This example is indeed a successful testimony to what is possible when humans cooperate and collaborate.

If we can save the whales, I'm perplexed why we can't do the same for ourselves, starting with something we all have in common: eating. Reliable estimates suggest that around 70% of American adults are overweight or obese. The implication of this state of largesse is sobering. Roughly 18% of the U.S. gross domestic product is consumed by the healthcare industry, and a sizeable percentage of that total is related to treatments associated with metabolic diseases directly linked to poor nutrition. You are probably all too familiar with the health effects: cancer, high blood pressure, and diabetes, among others. Poor nutrition, arising from overconsumption of prepackaged and processed foods, is generally accepted as a major contributing factor to our poor national health status.

I'm struck by how important food is to our way of life. Roughly 50% of the world's assets, 50% of all employment, and 50% of consumer expenditures are related to the food system. These assets include greenhouse gas-producing transportation vehicles as our average mouthful of food travels an estimated 1,500 miles from farm to fork.

> *Small urban farms and community gardens provide a multitude of benefits.*

In the U.S., it is also generally recognized that farms are fewer in number now compared with the early 20th century. After peaking at 6.8 million in 1935, the number of U.S. farms fell sharply until leveling off in the early 1970s to around 2 million. Over the same time, farms have generally grown on average from 155 acres to around 240 acres each.

To be clear, larger farms are an essential part of our national food chain, and while efficient for the yield of a single crop, they are overall less efficient than their smaller counterparts. For every country where data are available, smaller farms are anywhere from 200–1,000% more productive per unit area. Smaller farms also tend to have crop mixtures that employ techniques requiring less herbicides, fertilizers, and pesticides. The result is a healthier and more diverse food crop, which is less inclined to deplete the soil of its nutrients.

At the intersection of small farms and human health lies an opportunity to improve the well-being of our communities. So, what do these issues have to do with our profession? If we really care about the environment and health, we should revitalize our efforts to support local agriculture with a focus on eating produce that's seasonal. Locally sourced food keeps money in the community, reduces greenhouse gases associated with transportation and storage, and is likely fresher and more nutritious than its counterpart that has been part of a distributed food production network originating in another part of the U.S. or the world.

A few years ago I spent a month as a practicing locavore, eating food grown within 100 miles of where I was living at the time. As part of the process, I took a 1-month subscription to a community supported agriculture co-op. The experience was life changing. I sampled a true free-range egg, whose yolk was a brilliant orange color, with a vibrant flavor to match. While the cost was more than what I was used to paying at the local grocery store, I found myself eating lower on the food chain as I benefitted from a cornucopia of fresh fruits and vegetables. I blogged my experience and had visitors from over 60 countries visit my site.

Even the Motor City is in on the action. As late as 2007, Detroit had lost almost one half of its population with as much as a third of the city's land comprised of empty lots and dilapidated buildings. Enterprising and committed entrepreneurs have created mini farms

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Last year Angie Clark did **700** routine inspections, **200** complaint inspections, **30** Court dates, logged **3,000** travel miles and quite possibly prevented dozens of illnesses.

She doesn't take chances. The communities she serves depend on her to do more inspections under an increasingly difficult workload and conditions. In the office or on the road, she demands the most from her tools and equipment.

That's why she is never without her tablet and **HealthSpace CS Pro.**

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ANGIE = A Nom-de-plume Genuine Inspector Environmentalist, and these results reflect actual activity by Inspectors using HealthSpace CS Pro.