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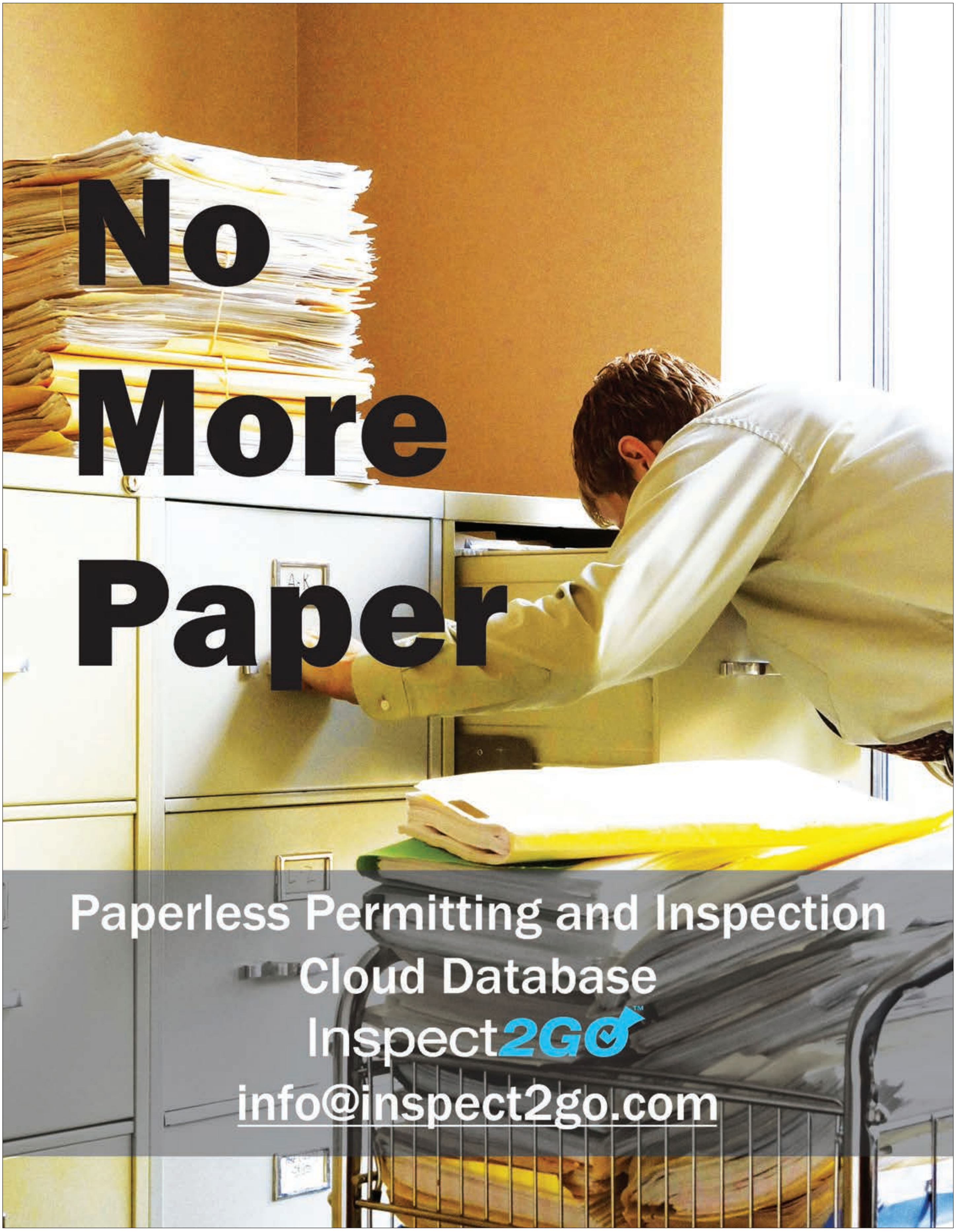

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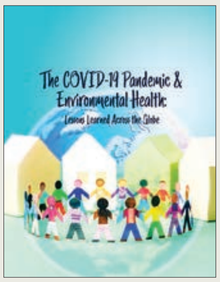

Environmental health is historically an overlooked and underrated discipline. The COVID-19 pandemic highlighted the value of environmental health and environmental health professionals (EHPs). This month's cover article, "The COVID-19 Pandemic and Environmental Health: Lessons Learned," explores two themes regarding the skills and activities of EHPs around the world during the pandemic. These themes were the local nature of environmental health and the development of new roles and the transferability of skills. The article also provides lessons for the future. To protect public health in the future, it is imperative that public health policies recognize the value of EHPs and the "value of local."

See page 20.

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PRESIDENT'S MESSAGE

Roy Kroeger, REHS

2021 Was Not the Year We Had Hoped

It looks like we have made it to the end of another challenging year. Over the last 12 months we have learned a lot about ourselves, our profession, innovation and technology, hardships, and heartaches. With the holiday season and the new year right around the corner, I wanted to take a few minutes to reflect on this past year and look forward to a brighter future in 2022.

The beginning of 2021 brought the environmental health profession and the public in general so much hope. A COVID-19 vaccine that could help bring the world back to normal had just been released and two additional vaccines would follow soon after. With a vaccine in place, the feeling was that we would see fewer people get sick and fewer people would lose their battle to the virus. We anticipated that the economy would return to normal and people could resume their lives. With all the despair and tragedy the world encountered in 2020, we imagined that people would gain a softer heart and show more kindness and compassion to their fellow man. People could take the time to slow down and find the real meaning in their lives.

I don't want to say that everything has gone wrong because improvements have been made. As I write this column, over 400 million doses of the vaccine have been administered to 64% of the population. Most communities have lifted most, if not all, restrictions. Sporting events have nearly returned to normal and some live concerts have returned since midsummer. People are even starting to travel again and I will be attending the American Public Health Association conference in person.

> *I believe that 2022 will indeed be a year of opportunities.*

With all the good that has happened, some dark clouds have remained throughout the year. Far too many people have chosen to not receive the vaccine for their own reasons. A new variant of the virus has slowed the progress in the battle. And the Delta variant has found a way to break through the vaccine protection in some people. Cases early in the year, and with the variant, have surpassed all of last year's numbers for illness and death, and they continue to climb.

The hope that people would contribute to a more compassionate society has also not come to fruition. The year has witnessed several violent protests and riots, some of which are still occurring. The very public health professionals that have endured so much to help people in their communities have become targets of hate and violence across the country. Many of them have decided to retire, while others were asked to resign. How can it be that part of our society has turned on the very profession that gave up so much to make everyone safer.

The virus is not the only thing that has prevented a return to routine. A large percentage of the world's population has decided not to reenter the workforce, at least not yet. The shortage of employees has in itself wreaked havoc on the global economy. Many consumer goods (not just sanitizer and toilet paper) are becoming scarce. Medicines, electronics, auto parts, clothes, and lumber are but a few. You may have even seen food shortages as you prepared for your holiday feasts this year.

I believe that 2022 will indeed be a year of opportunities. The National Environmental Health Association (NEHA) will undoubtedly be busy with the NEHA-FDA Retail Flex Funding Model Grant Program (I hope everyone got their applications in), student internships, and many other opportunities for our members. We are all looking forward to making the new year prosperous for many of our members. NEHA plans to hold its 2022 Annual Educational Conference (AEC) & Exhibition as an in-person event in Spokane, Washington—the first since 2019. There will also be a virtual component of the 2022 AEC for those who are unable to attend the in-person event. I am also hopeful for a better year because I have had concert tickets since the end of 2019 that I would like to use.

I would be amiss if I didn't recognize a few stalwarts of environmental health that we lost this past year. While this list is not inclusive and there may be some that I've overlooked, these individuals went above and beyond for the profession and the association.

- **Dennis Catanyag** (January 2021): Dennis Catanyag was fatally wounded while performing duties protecting and serving his community as a registered environmental health specialist for Sacramento County in California. He worked for Sacramento County for 15 years in the Environmental

Health Division conducting food protection, recreational health, and lead poisoning prevention inspections.

- **Brian Hess** (March 2021): Brian Hess was the program and operations manager within the Program and Partnership Development department at NEHA in the Denver office. He started in the position in May 2019 and worked to manage and improve internal processes including budgets and grant reporting, as well as served as a liaison for his department with other departments across the association.
- **Scott Meador** (May 2021) Scott Meador worked for the Tulsa Health Department for 15 years and coordinated its vector control program. He was dedicated to improving the quality of life for the resident of Tulsa County and the improvements he made in the mosquito control program benefited all. Meador was also an active member of the NEHA Vector Program Committee, contributing his time and expertise to develop a policy statement for NEHA on comprehensive mosquito control and to develop timely webinars on integrated mosquito and tick management.
- **Boyd T. Marsh** (September 2021): Boyd Marsh served as president of NEHA from 1981–1982 and was the recipient of the Walter F. Snyder Award in 1989. He was active in environmental health and worked for the city of Cleveland and retired as the health commissioner of Summit County, Ohio, in 2000. Marsh also taught environmental health as an adjunct professor at Cleveland State University, Bowling Green University, and the University of Akron.
- **George Nakamura** (September 2021): George Nakamura started his career with the California Department of Public Health in the Food and Drug Branch. He also worked in San Mateo County and finished his public service at Contra Costa County. He was a strong supporter of environmental health and an active NEHA member serving as a technical advisor and subject matter expert in food safety. He was a contractor for NEHA at the time of his passing.

I want to ask each and every one of you who reads this column to please consider making the world a better place over the next year. Please spend some time with your loved ones this holiday season; none of us know what tomorrow will bring. Have a Merry Christmas, Happy Hanukkah, Joyous Kwanzaa, Yuletide Greetings, Happy Holidays, Joyeux Noël, and Feliz Navidad!

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Retail Risk Assessment and Lethality of *Listeria monocytogenes* and *E. coli* O157 in Naturally Fermented Sauerkraut

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Nutrition, Dietetics, and Food Sciences Department
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Abstract **The interest in fermenting foods at retail and food service levels is increasing. Foodborne pathogens such as *E. coli* O157:H7 and *Listeria monocytogenes*, however, have been implicated in foodborne illness in several fermented and acidic foods. This study evaluated and validated the lethality of potentially acid-tolerant pathogens *E. coli* O157 and *L. monocytogenes* in sauerkraut that was made using traditional fermentation techniques. Fresh cabbage juice prepared with 2.5% salt was inoculated separately with a 5-strain mixture of *E. coli* O157 and a 5-strain mixture of *L. monocytogenes* and then was allowed to ferment at 25 °C. The pH decreased at a steady rate for the first 7 days and remained relatively stable thereafter. There was a significant decrease in *E. coli* O157 from Day 1 to Day 7 ($p < .05$) and a significant decrease in *L. monocytogenes* count from Day 2 to Day 7 ($p < .05$) with a 5-log reduction for both pathogens at Day 7 and no pathogens detected after Day 9. The data indicate that fermentation of cabbage at ambient temperature is lethal to the survival of *E. coli* O157 and *L. monocytogenes*. This study can be used to support the safety of sauerkraut fermentations in retail and food service operations.**

Introduction

Recent interest in traditional foods and probiotics has brought fermented sauerkraut back in vogue among both consumers and retail food service operators. As a fermented food, sauerkraut is designated as a special process under the Food and Drug Administration model *Food Code* (U.S. Department of Health and Human Services [HHS], 2017). Specifically, fermentation is considered a special process where a food additive (e.g., bacterial culture) is used to make a potentially hazardous (i.e., time/temperature control for safety [TCS]) food into a nonpotentially hazardous (non-TCS) food (HHS, 2017). As a *Food Code* special process, fermentation requires a documented and implemented hazard analysis critical control point (HACCP) food safety plan (HHS, 2017).

Intrinsic and Extrinsic Properties of Sauerkraut

The main ingredient in sauerkraut is cabbage, typically with an addition of 2–3% salt (Pérez-Díaz et al., 2013). More specifically, Bavarian- or German-style sauerkraut might use red or green head cabbage, onions, and caraway seeds. Chinese-style sauerkraut might be fermented from Chinese cabbage only, also known as baechu (Park, 2017). It has been noted that there are likely as many different sauerkraut recipes as there are sauerkraut makers.

The traditional sauerkraut fermentation comes from a natural proliferation of resident lactic acid bacteria (LAB). Numerous studies have identified a two-stage anaerobic lactic acid fermentation. Heterofermentative LAB such as *Leuconostoc mesenteroides* start growing quickly (within 24–48 hr), leading to the production of lactic acid primarily, with some acetic acid, alcohol, and carbon dioxide (CO_2) also produced (Steinkraus, 2002). The CO_2 bubbles are an effective sign that heterolactic fermentation is active. As more acid develops, the acid-tolerant homofermentative LAB, such as *Lactobacillus plantarum*, overtake the heterolactic fermenters to grow and produce additional lactic acid. *L. plantarum* usually will grow until all of the degradable carbohydrates are used up or when *L. plantarum* reaches a pH level where it can no longer grow (Steinkraus, 2002). The pH of cabbage is approximately 6–6.5 and the pH of most sauerkraut is between 3.4 and 3.7 (Plengvidhya et al., 2007), but can go as low as 3.2 with a final lactic acid concentration between 1.5 and 2.5% (Pérez-Díaz et al., 2013).

Sauerkraut Hazards

Foodborne pathogens of concern are present in the farm environment and can contaminate the raw cabbage via irrigation water, unhygienic human handling, and fertilizers that are made from animal feces (Niksic et al., 2005). Further unhygienic handling, cross-contamination, and improper processing can introduce and allow proliferation of pathogens in the retail food service or artisanal processing environment. Bacterial hazards from fresh vegetables include most of the common vegetative and spore-forming pathogens, except those of seafood origin (e.g., *Vibrio*). Salt and rapid acidification historically have been believed to account for the inhibition of spore-forming pathogens (Breidt & Fleming, 1998). Modeling *Clostridium botulinum* growth using a ComBase predictive model (www.combase.cc) demonstrates a lag time of 15–24 hr at 25 °C with a 5.5–6.0 pH and a 2% salt concentration. These conditions allow the faster-growing lactic acid fermentation culture to grow and produce lactic acid, which further increases the inhibition of spore-forming pathogens.

After sauerkraut fermentation is complete, commercial producers usually employ in-container pasteurization to destroy any potential vegetative pathogens and most organisms that contribute to food spoilage. Many retail food service operators and artisanal producers, however, do not pasteurize their final product. Pasteurization reduces the crisp texture of the cabbage and will kill off the desired live LAB culture. If the sauerkraut is not pasteurized, acid-tolerant vegetative pathogens (e.g., *E. coli* O157:H7 and *Listeria monocytogenes*) can remain. Various acidic foods such as apple cider, mayonnaise, yogurt (Hsin-Yi & Chou, 2001), and kimchi (Shin et al., 2016) have been implicated in the outbreaks of foodborne disease caused by *E. coli* O157:H7 or related Shiga toxin-producing *E. coli* strains. Additionally, *L. monocytogenes* has been associated with outbreaks in some acidic foods including fermented sausages and has shown the ability to survive in some acidic foods (Gandhi & Chikindas, 2007). *L. monocytogenes* has been found to survive in both the fermentation stage at room temperature as well as in the refrigeration stage in home-fermented refrigerator dill pickles for up to 91 days (Kim et al., 2005).

Sauerkraut Controls

There are three generally accepted bacterial pathogenic hazard control factors in sauerkraut fermentations: 1) salt, 2) competitive LAB cultures, and 3) the rapid production of lactic acid and other acids. The traditional sauerkraut fermentation process, like most vegetable fermentations, requires salt (Pérez-Díaz et al., 2013). The role of salt is to slow the growth of food spoilage microorganisms, allowing LAB to proliferate (Taormina, 2010). The second control factor is the presence of a competitive fermentation culture. Previous work in our laboratory on the survival of pathogens in low-salt cheddar cheese suggests that the fermentation cultures and their by-products contributed heavily toward the control of pathogen growth (Shrestha et al., 2011a, 2011b).

The last control factor is perhaps the most significant. The production of fermentation acids is rapid in most cases of lactic acid fermentation of sauerkraut (Beganovi et al., 2014; Plengvidhya et al., 2007). Lactic acid has shown to be highly inhibitory as both an organic acid and via its ionic effect on pH. As an organic acid, the protonated form enters the bacterial cell more freely to disassociate inside the cell, leading to toxicity (Breidt, 2005). It is ultimately the intracellular pH value that affects bacterial growth and survival. Acid-tolerant pathogenic bacteria have developed mechanisms to resist the intracellular pH change (Cotter & Hill, 2003). They usually succumb, however, under conditions of active metabolism when the concentration of organic acid reaches a critical point. The fermentation LAB generally are acid tolerant. Specifically, *L. mesenteroides* generally stops growth at a pH level of 4.0 and *L. plantarum* grows and survives at pH levels ≤3.5 (Breidt, 2005; McDonald et al., 1990).

This study was performed to support that the hazard controls of salt, LAB growth, and acid production in traditional sauerkraut fermentations preclude growth of all foodborne bacterial pathogens and demonstrate that the potentially acid-tolerant pathogens *E. coli* O157 and *L. monocytogenes* do not survive.

Methods

Sauerkraut Preparation

We obtained fresh green head cabbage from a local grocery store. We chopped the cabbage (unrinsed) and extracted the juice using a vegetable juicer. We added noniodized salt at 2.5% to the juice. The juice was used immediately and kept at room temperature (25 °C) for fermentation.

Inoculum Preparation

For *L. monocytogenes*, we obtained five strains (FSL J1-177, FSL C1-056, FSL N3-013, FSL R2-499, and FLS N1-227) from the culture collection of Dr. Jeff Broadbent at Utah State University. Similarly for *E. coli* O157, we obtained five strains of vegetable origins or related to vegetable outbreaks (H1730, EC4042, EC4045, EC4191, and EC4206) from the culture collection of Dr. Donald Schaffner at Rutgers University. Pure cultures were maintained as frozen stocks at -80 °C.

Cultures for each strain were prepared by transferring 0.1 ml of thawed frozen stock into 10 ml of fresh tryptic soy broth (TSB) and incubating at 37 °C for 24 hr. For *L. monocytogenes*, strains were plated into PALCAM agar and incubated at 37 °C for 48 hr. For *E. coli* O157, individual strains were plated into MacConkey Sorbitol agar and incubated at 37 °C for 24 hr. A working culture for each strain was then grown in TSB at 37 °C for 24 hr. The 5-strain mixture for each pathogen was prepared by combining 2-ml aliquots of each strain in a 15-ml conical centrifuge tube. Cells were pelleted by centrifugation (1,509 × g for 15 min) and resuspended in 10 ml of Butterfield PBS solution 3 times. Appropriate dilutions of washed cell suspensions were prepared in Butterfield PBS to achieve approximately 107 cells/g of sample.

Sample Inoculation and Incubation

We distributed the freshly prepared cabbage juice equally into control and treatment groups in plastic containers with airtight lids. The containers used were narrow-opening gallon-sized containers with a rubber seal added to each cap to make it airtight and exclude oxygen during fermentation. For each pathogen, a 5-strain mix was inoculated into the treatment group containers at 1ml/L of cabbage juice and distilled water was added into the control group containers. Both control and treatment group containers were incubated at 25 °C for 15 days.

Microbial Analysis

Control and treatment groups were first enumerated approximately 30 min after inoculation. After that, enumeration was performed each day for the first 7 days and at 2-day intervals between 7 and 14 days. Samples from the control and treatment groups were enumerated on PCA (Plate Count Agar) to determine total viable count (TVC), and on MRS (de Man, Rogosa, and Sharpe) broth in an anaerobic environment for enumerating LAB. For treatments along with TVC and LAB count, we used PALCAM agar to enumerate *L. monocytogenes* and MacConkey Sorbitol agar to enumerate *E. coli* O157.

pH Measurements

Cabbage juice samples (10 ml) were removed from control and treatment groups to determine the pH using a pH meter (Oakton pH testr 30, calibrated with Oakton pH 4.01 buffer) each day for the first 7 days and at 2-day intervals between 7 and 14 days.

Data Analysis

The bacterial population was interpreted as the log CFU value per ml of the juice. Data points are expressed as mean ± standard deviation. Analysis of variance (ANOVA) was analyzed using R; Duncan's new multiple range test was used to compare the significance of the differences in mean values at $\alpha = .05$. To compare mean values between the two pathogens studies, we used a Welch two sample t-test where $\alpha = .05$.

Results

pH

The pH for the control and treatment groups of sauerkraut inoculated with *L. monocytogenes* gradually decreased throughout the study period (Figure 1). The control and treatment groups both had a steady drop in pH for the first 7 days and had a relatively stable pH for the rest of the period—except at Day 15 for the control, which showed a higher drop in pH.

For the sauerkraut inoculated with *E. coli* O157, a similar trend of pH decline was observed (Figure 1). Similar to sauerkraut inoculated with *L. monocytogenes*, the pH stayed relatively stable after the 7-day period. Also, it was observed that in both treatment groups, the pH stayed slightly higher than the control groups. This finding might be attributed to some competitive growth of pathogens in the sauerkraut.

Total Viable Count and Lactic Acid Bacteria Count

Figure 2 shows the log growth of uninoculated controls for both total viable bacterial counts enumerated aerobically on PCA and LAB enumerated on MRS agar. TVC bacteria and LAB grew rapidly between Time 0 and Day 2. LAB for both control group fermentations were between 2 and 3 logs at Time 0 and peaked between 8 and 11 logs within 2–5 days. After that time, LAB counts dropped to approximately 4–5 logs at Day 15.

FIGURE **1**

pH of Cabbage Inoculated With *Listeria monocytogenes* and *E. coli* O157 Fermented at 25 °C

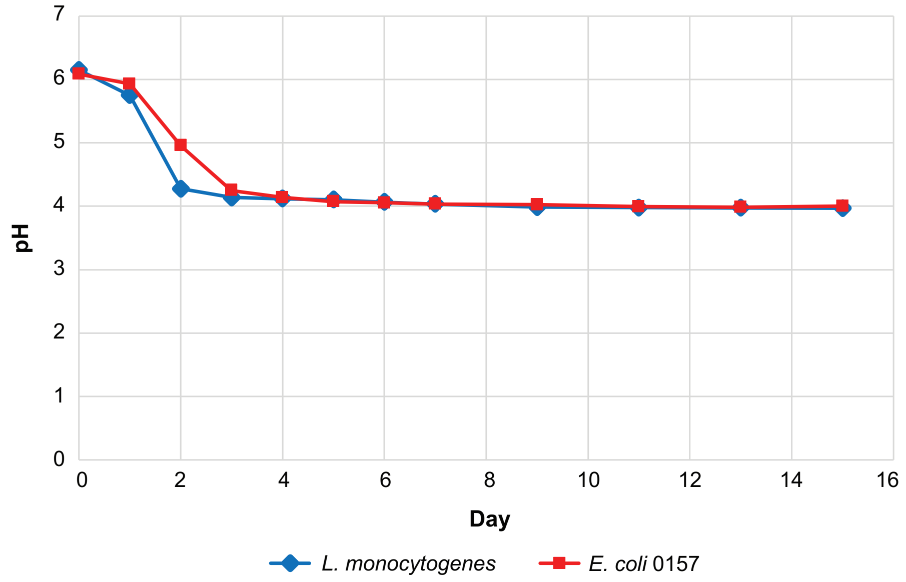
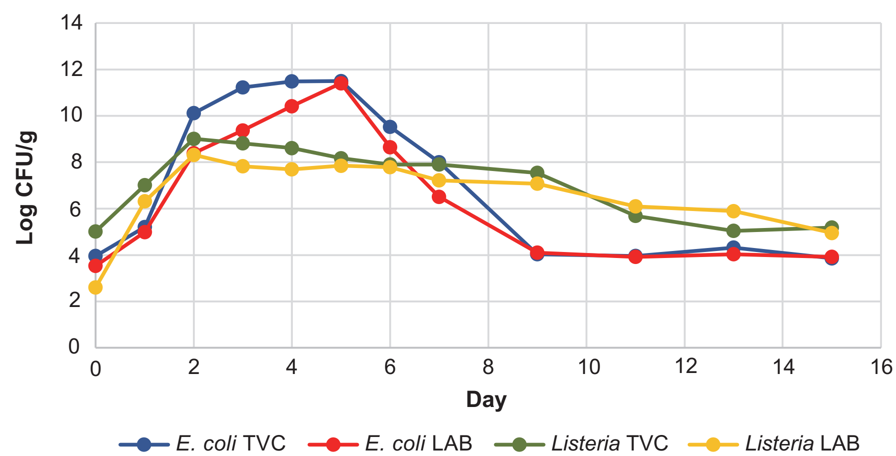


FIGURE **2**

Total Viable Count (TVC) and Lactic Acid Bacteria (LAB) Count in Cabbage Fermented at 25 °C



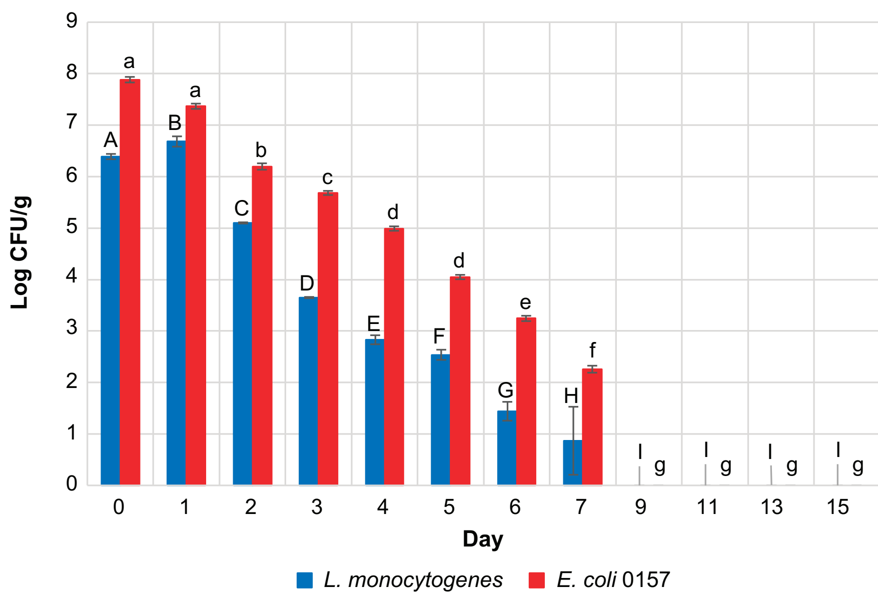
Note. Data are presented as the mean value of three replications representing natural biota growth without the addition of pathogens.

Lethality of *L. monocytogenes* and *E. coli* O157

The inoculum level of *L. monocytogenes* for the treatment group was 6.39 log CFU/g of sauerkraut (Figure 3). The *L. monocytogenes* count slightly increased on Day 1, following a significant decrease in the number of pathogens from Day 2 until Day 7 ($p < .05$).

FIGURE **3**

Lethality (Log CFU/g) of *Listeria monocytogenes* and *E. coli* O157 in Sauerkraut Fermented at 25 °C



Note. Data are presented as the mean value of three replications ± standard deviation.
[a–g] Data points for *E. coli* O157 followed by the same lowercase letter for each day are not significantly different ($p \geq .05$).
[A–I] Data points for *L. monocytogenes* followed by the same uppercase letter for each day are not significantly different ($p \geq .05$).

At 7 days, a 5-log reduction was observed in the treatment group and no pathogens were detected after Day 9.

In the sauerkraut inoculated with *E. coli* O157, the inoculum level was 7.88 log CFU/g of sauerkraut (Figure 3). There was a significant decrease in the *E. coli* O157 count from Day 1 until Day 7 ($p < .05$) and a 5-log reduction was observed at Day 7, with no detectable CFU/g after Day 9.

Discussion

The decreasing numbers of *L. monocytogenes* seen in the study are consistent with the study conducted by Niksic et al. (2005) that showed a gradual decrease in *L. monocytogenes* in sauerkraut fermented at 22 °C. Additionally, for the treatment group inoculated with *E. coli* O157, the rate of decrease in the number of pathogens over time was similar to studies by Arias et al. (2001) and Niksic et al. where a significant decrease in the count of *E. coli* O157 was observed in sauerkraut fermented at 22 °C.

The inoculum level for both the pathogens was significantly different ($p < .05$) from the start of the studies (Arias et al., 2001; Niksic et al., 2005) and the number of pathogens in the following days followed the same pattern until Day 6. On Day 7, the number of pathogens was not significantly different and no pathogens were detected from Day 9, which suggests that despite the number of pathogens inoculated, there is a lethal effect when the pH drops to a certain level. In both studies, the decrease in pH coincided with the decrease in pathogen count, indicating the natural fermentation process in the sauerkraut that increased the acidity of the product had a negative effect on the survival of the pathogens.

Conclusion

Our study suggests that naturally fermented sauerkraut does not permit growth or survival of *L. monocytogenes* and *E. coli* O157. Naturally present LAB in the sauerkraut create a competitive environment for the pathogens, and the acidity produced by those LAB produces a lethal effect on these pathogens. Moreover, our study supports the safety of sauerkraut during the natural fermentation process at ambient temperature. These data can be used to support a HACCP approach applied to the process by retail and food service operators.

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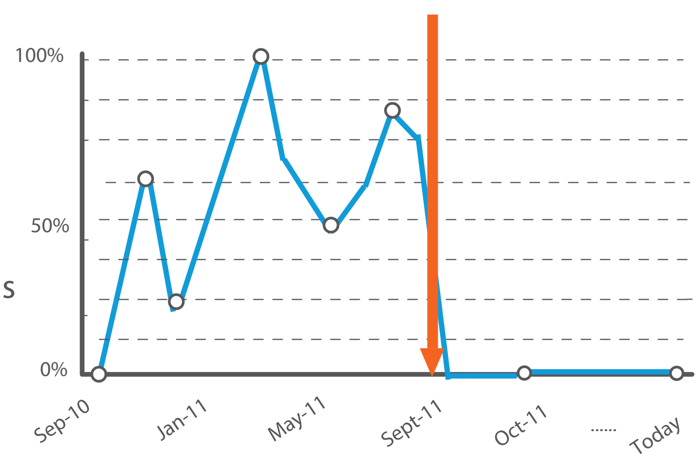

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SPECIAL REPORT

Vegetable Lactic Acid Fermentations Under the Food and Drug Administration Model *Food Code*: Risk Analysis and Safe Processing Guidance

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Abstract **Fermented foods have become a part of our cultural heritage and chefs and retailers seek to offer these tasty foods to their customers. Fermenting foods at the retail food service level, however, is considered a special process under the Food and Drug Administration model *Food Code* and requires a food safety plan. This special report was developed to assist both operators and regulators in preparing or reviewing a food safety plan for vegetable fermentation, including pickles, sauerkraut, kimchi, and fermented vegetable juices.**

Introduction

Fermentation was a valuable food preservation method for centuries, long before canning and refrigeration were invented. Fermentation not only preserves food but also makes some food more nutritious and more palatable (Steinkraus, 2002). A functional definition of fermented vegetables has been described as "low acid vegetables subject to the action of acid-producing microorganisms that will naturally achieve and maintain a pH of 4.6 or lower" (Pérez-Díaz et al., 2015). Restaurant marketing data from 2018 has shown more than a 20% uptick in interest for fermented foods driven by millennial customers and creative chefs (Prince, 2018).

The science of fermentation involves preserving foods via accumulation of lactic acid. The art of fermentation is to encourage desired fermentation flavors, while discouraging undesired fermentation flavors (e.g., spoilage). Most traditional vegetable fermentations are the result of naturally present lactic acid bacteria (LAB) that are usually a mixture of homolactic and heterolactic fermenters. Homolactic fermentation results in primarily lactic acid production. Heterolactic fermentation produces mostly lactic acid with minor amounts of acetic acid, carbon dioxide, and ethanol. Both lactic fermentations produce additional minor by-products that contribute to flavor and aroma.

Fermented foods or beverages are categorized in the Food and Drug Administration (FDA) model *Food Code* as a specialized process that would require a variance with submission of a food safety plan (U.S. Department of Health and Human Services [HHS], 2017). The purpose of this special report is to assist both operators and regulators in preparing or reviewing a vegetable fermentation food safety plan.

Generic Process Flow

A generic recipe starts with rinsing vegetables to remove visible soils. Vegetables can be left whole or chopped. Spices can be added. Salt is added to 2–12% by weight (varies by end product). A lactic acid bacterial culture is then added, or the natural LAB biota is encouraged to grow. Fermentation at ambient temperature converts vegetable sugars primarily into lactic acid. Once the acidity has reached pH ≤ 4.6, the fermentation vegetable is considered "acidified." It can be consumed immediately, left to ferment longer, or refrigerated to slow fermentation (and acid production). Spoilage, including flavor deterioration and potential mold growth, will determine the quality shelf life.

Fermented Cucumber Pickles

Rinse unwaxed, ripe, whole cucumbers (culled of any cut or bruised cucumbers) in water and cut the blossom tip off to prevent enzymatic rot. Place cucumbers in a large food-grade vessel with approximately 1 kg of pickling salt (i.e., pure granulated sodium chloride) to approximately 20 kg cucumbers. Use a salinometer to verify the salt percentage is ≥10%, which slows most pathogen growth while the salt-tolerant LAB fermentation starts. It is highly recommended to add brine from a recent successful pickle fermentation as inoculum to supplement the natural LAB on cucumbers. Submerge cucumbers 1–2 in. under brine with a food-grade weight. Cover the fermentation vessel (lactic acid fermentations are anaerobic) and add an airlock to permit fermentation gases from escaping. Leave cucumbers at ambient temperature to ferment.

After the first day, check and adjust the salt percentage of the brine to ≥10%. Within a few days, evidence of fermentation should be present (e.g., pH drop, cloudy brine, bubbles in airlock). Once an obvious active fermentation is achieved, add plain water to top off brine as brine water evaporates. Allow contents to ferment until the pH reaches ≤4.6 or a desired lower pH.

To achieve a palatable pickle, the salt must be diluted. Discard approximately 50% of the brine and replace it with water. Verify the new brine pH is ≤4.6 and the salt is at 4–5%. Note that dilution with water should not alter the pH. Continue to let contents ferment at ambient temperature, producing more lactic acid and flavors. Then repeat the water dilution step, leaving the brine at approximately 2% salt. An optional step is to add spices such as dill and garlic to this final stage of fermentation. Continue to ferment to the target acidity by monitoring pH. A finished pH of approximately 4.2 is considered half-sour pickles and a pH of approximately 3.3 is considered full sour pickles.

Fermented Cabbage: Sauerkraut and Kimchi

Start with head cabbage for sauerkraut and Napa (also known as Chinese) cabbage for kimchi. Remove the outer leaves and rinse the cabbage in water, then chop or shred it. Add 2–3% salt to vegetables by weight. Press salted cabbage tightly into a food-grade fermentation vessel to expel juice. Juice should cover the vegetable solids. Similar to cucumber pickles above, it is highly recommended to add brine from a recent successful sauerkraut or kimchi fermentation as inoculum to supplement the natural LAB on the cabbage. Submerge cabbage under juice with a food-grade weight. Cover the fermentation vessel and use an airlock to permit fermentation gases from escaping. Ferment sauerkraut at ambient temperature (≤25 °C) until the pH reaches ≤4.6. Most commercial sauerkrauts are said to have a finished pH of 3.2–3.8.

Kimchi fermentation (lactic acid production) is a temperature-dependent process. Kimchi can be fermented in three ways: a) at low temperature (2–5 °C) using psychrotrophic LAB for 1–2 weeks, b) at 15 °C for approximately 1 week, or c) at 25 °C for 1–3 days. Kimchi with optimum flavor is said to have a pH between 4.0 and 4.5, and be characterized by a sour, sweet, and carbonated taste that differs in flavor from sauerkraut.

Low-Salt Fermented Vegetable Juice

Rinse vegetables in water. Optionally, fruits and spices can be added. Chop or shred the ingredients as needed and process through a mechanical juicer. Palatable juice fermentations limit salt to 0–0.5%, or no more than the salt flavor desired for the end product. Because this fermentation has limited salt, a very active LAB starter culture must be used, such as *Lactobacillus plantarum*. Ferment juices at ambient temperature to a pH of ≤5 within 24 hr and then continue to ≤4.6 within 48–72 hr. If acidity does not occur quickly, there is less assurance that pathogens or acid-tolerant pathogens did not grow.

Biological and Chemical Hazards and Their Controls

Various acidic foods such as apple cider, mayonnaise, yogurt (Hsin-Yi & Chou, 2001), and kimchi (Shin et al., 2016) have been implicated in outbreaks of foodborne disease caused by *E. coli* O157:H7 or related Shiga-toxin producing *E. coli* strains. *Listeria monocytogenes* has shown the ability to survive in acidic foods (Gandhi & Chikindas, 2007) and has been associated with outbreaks in acidic foods, including fermented sausages.

Vegetables and vegetable juices are classified as time/temperature control for safety (TCS) foods due to the fact that they have a high water activity (a_w) and low acidity. Dry ingredients such as salt and spices are non-TCS foods. Water in fermentation brines will not change the pH, but it will increase the a_w.

Unlike dairy fermentations where milk or cream is pasteurized, vegetables or vegetable juices generally are not pasteurized. Therefore, both vegetative pathogens and spore-forming pathogens are a concern. All of the bacteria that cause foodborne illness would be considered hazards, except those associated with seafoods (e.g., *Vibrio*). Waterborne parasites are not considered hazards: pathogens such a *Cryptosporidium* and *Cyclospora* have been associated with foodborne illness from fresh vegetables but not from fermented vegetables. And finally, viruses and nematode parasites are not considered hazards likely to occur.

In general, there are three controls that increase food safety in lactic acid vegetable fermentations: 1) salt, 2) lactic acid (and other acids), and 3) competitive bacterial cultures. Salt reduces the a_w of the fermentation. Salt at ≥2% will select for growth of salt-tolerant LAB cultures and slow the growth of enteric pathogens. All pathogens are inhibited from growth at ≥10% salt except *Staphylococcus aureus*, which can grow but not produce toxin (HHS, 2021).

Lactic acid inhibits pathogens via pH reduction and organic acid effects. Once fermentation starts, neutral pH levels in the vegetables are reduced in days to weeks to a finishing pH of ≤4.6. This pH level effectively inhibits the dangerous spore-forming pathogen *Clostridium botulinum*. Fermentations that are at a pH of 4.2–4.6 must be refrigerated for safety based on the *Food Code* (Table B in section 1-201.10(B); HHS, 2017). Fermentations that have a pH level <4.2 done under an approved hazard analysis critical control point (HACCP) plan are considered non-TCS. Therefore, these fermented products may be stored or sold at any temperature until they become spoiled to the point of being considered an adulterated food.

Together, these three controls form an effective pathogen hurdle and in many cases a pathogen barrier, which is evidenced by the near complete lack of foodborne illnesses associated with properly fermented vegetables. The chemical hazards of fermented vegetables are the same as fresh vegetables, including pesticide or herbicide residues. Allergens are introduced as a function of the ingredients added. Rinsing produce in potable water will remove soils and water-soluble pesticides and herbicides.

Controlling Food Safety

Critical Control Points, Critical Limits, Monitoring, Corrective Actions, and Recordkeeping

Of all of the steps in Table 1, only step 5 is critical to prevent the potential for acid-resistant pathogens. In this step, the fermentation proceeds from pH near 6.5 to ≤4.6 or <4.2. The critical limit is pH ≤ 4.6 with refrigeration (≤41 °F) or pH < 4.2 (refrigeration not required). The pH should be monitored using a calibrated digital pH meter for ease of use and accuracy (as compared with paper test strips). The main corrective action if the pH is > 4.6 or 4.2 would be to continue fermentation and monitor pH levels. If the pH does not reach the target pH in the expected time, it is possible that the culture is contaminated or the fermentation temperature is too cold. In this case, a discard is recommended: Discard the batch and start a new batch with a new starter culture.

A record of the pH of fermented vegetables or vegetable juice must be kept to verify that a safe pH level has been reached. As an example, one can create a simple table (Table 2). For each batch, mark the start date (manufacture date) and starting pH, then mark each successive pH measurement until pH ≤ 4.6 or < 4.2. You could optionally continue to measure pH if your flavor target is pH < 4.2. Operators will also need to keep a separate pH meter calibration log or include calibration data in Table 2.

Good Fermentation Practices

LAB cultures: Starter cultures are either naturally sourced as part of the ingredient biota or commercially cultured. Traditional vegetable fermentation relies on the slow development of the natural biota. Failure to get a good fermentation started, however, can lead to excessive spoilage and the potential for pathogen growth.

- Option 1: It is highly recommended to enrich the LAB culture. Enrichment consists of simply fermenting a mini-batch (usually 5–10% of the size of the fermentation). Allow the enrichment to ferment at the same temperature as planned for the larger batch. Use the enriched culture to inoculate the main batch when the pH is close to 4.6.
- Option 2: LAB culture manufacturers offer vegetable fermentation strains that have been freeze-dried in most cases. It is also acceptable to use probiotic tablets or capsules. The capsules contain very high numbers of LAB cultures, as indicated on their labels. For example, *L. plantarum* is found as probiotic capsules. Freeze-dried cultures usually activate quickly within several hours once rehydrated and can be either used directly or enriched as described in option 1.
- Option 3: Use approximately 5% of a previous successful fermentation brine to inoculate a new batch. The previous batch should be fresh, have a pH level between 4 and 4.6, and still be active. Acidity levels below 4 will begin to kill off LAB cultures that are not highly acid tolerant.

LAB fermentation conditions: Vegetable LAB fermentations are most successful at 50–70 °F. Psychrotrophic fermentations can be successful at 4–10 °F. Fermenting at temperatures >70 °F usually results in spoilage or undesirable flavors. Salt at 2–12% will select for salt-tolerant LAB. In all cases, LAB fermentations are anaerobic. Oxygen offers no

TABLE **1**

Lactic Acid Fermented Vegetables: Hazard Analysis

Step	Description	Hazards Created, Eliminated, or Reduced	Control Measure	Critical Control Point
1	Receive vegetables	Vegetative and spore-forming bacterial pathogens present		
	Receive salt and/or spices	None for salt; spices may contain pathogenic strain spores and *Salmonella*	Consider adding spices (except salt) after an active fermentation has been established	
	Water	Potable water should be free of hazards		
2	Store	Vegetative and spore-forming bacterial pathogens present and may grow with temperature abuse	Refrigerate perishable ingredients	
3	Rinse	Biological and chemical hazards reduced	Rinsing reduces soils and water-soluble chemical hazards	
4	Chop or shred	Cross-contamination from food contact surfaces	Sanitation and hygiene	
5	Salting	Biological hazards reduced or growth slowed	Salt at ≥2% reduces the growth of some food pathogens. Salt at ≥10% greatly reduces the growth of all pathogens.	
6	Inoculation and acidification	Vegetative and spore-forming bacterial pathogens present and can grow unless inhibited by an active fermentation culture	Ensure using an active culture or natural biota. Ferment as rapidly as possible to achieve a pH ≤ 4.6 to prevent *Clostridium botulinum* growth.	Yes
7	Fermentation (aging)	Biological hazards reduced and possibly eliminated	Continued fermentation will produce more lactic acid, further reducing pathogen growth or survival	
8A	Option 1: Cold holding	Vegetative and spore-forming bacterial pathogen growth prevented	Refrigeration at ≤41 °F and pH ≤ 5 will prevent the growth of all bacterial pathogens including *Listeria monocytogenes* and psychrotrophic *C. botulinum*	Yes
8B	Option 2: Ambient holding	Vegetative and spore-forming bacterial pathogen growth prevented	Ferment to pH ≤ 4.2, resulting in a non-TCS fermented food. Cold hold for quality.	Yes
8C	Option 3: Thermal process for ambient storage	Vegetative bacterial pathogens destroyed by heat (e.g., pasteurization)	Fill jars with fermented food and brine ≥180 °F. Cap and invert for 3 min. Place jars right side up and allow to cool.	Yes

Note. TCS = time/temperature control for safety.

TABLE **2**

Example of a pH Log

Date	Batch # or Calibration	Time	pH Reading	Initials

benefit, so the presence of oxygen should be minimized by any acceptable means.

LAB culture health claims: Some live LAB fermentation cultures are considered probiotics. In order for operators to make probiotic claims, however, the culture must be a known probiotic culture and there should be at least 1,000,000 probiotic cells/g alive and active in the food. Operators are discouraged from marketing or labeling health claims such as eating or drinking will "cure" any specific ailments.

Good Retail Practices

Controls and preventive measures that do not meet the threshold of being classified as critical and are not directly related to fermentations—but nonetheless are needed to ensure safety—often are contained in good retail practices. Many are prescriptive in the *Food Code* itself:

1. Use only clean and sanitary equipment and utensils, and clean and sanitize following acceptable procedures (per *Food Code*).
2. Refrigerate all perishable ingredients at ≤41 °F (per *Food Code* regulations).
3. Fermented vegetables or vegetable juices with a pH ≤ 2.5 or that tastes especially acidic should not be offered to consumers.
4. Discard all fermented vegetables or juice that show signs of mold contamination.
5. Do not reuse for inoculum (under Adulterated Foods in *Food Code*).

Standard Operating Procedures

Standard operating procedures (SOPs) are written, step-by-step instructions to accomplish an important food safety objective. The following are recommended:

1. A detailed process instruction sheet to tell employees how to make the fermented vegetable or vegetable juice using the food safety measures outlined in this report. The SOP must describe how employees will measure and record safe levels of acidity on a pH log.
2. A detailed pH measurement and calibration SOP.
3. A detailed method or SOP of LAB culture enrichment.

Retail Sale of Fermented Vegetables and Packaging

Retail sale of fermented vegetables or vegetable juice is beyond the scope of this special report. Briefly, the concerns are maintaining a safe pH, minimizing gas buildup (e.g., carbon dioxide) inside containers, and minimizing any ethanol production usually associated with yeast fermentation. Operators seeking to package fermented vegetables or vegetable juice for retail sale must also address labeling that complies with the FDA model *Food Code*.

Questions and Answers

- I found this old ceramic pickle crock. Can I use it?
  Answer: Unfortunately, old ceramic vessels can contain glazes or paints that contain lead. The glaze/paint frequently cracks. It is recommended to use food-grade plastic, glass, or stainless steel containers. A food-grade plastic liner could be used inside the crock. The same advice goes for the weights used to submerge vegetables during fermentation: Rocks and bricks do not meet food-grade standards.
- Can I make diet or low-salt fermented vegetables or vegetable juice?
  Answer: Generally, no. The salt is required as part of the fermentation process. Without salt at the traditional level, pathogens or spoilage microorganisms can outcompete the lactic acid bacterial culture. Vegetable juice can be made low salt, but a very rapid fermentation acidity is required.
- I make fermented vegetables or vegetable juice using other ingredients (e.g., fruit). Can I still use this guidance?
  Answer: Yes. The safety of fermentation is due to the creation of lactic acid by LAB. In general, ingredients with more sugars equate to more lactic acid after fermentation.
- Can I use this report as my HACCP plan?
  Answer: Although this report contains some of the information needed for your HACCP plan, it is not adequate. Operators will need to create a HACCP plan that is more specific to their product, process, and facility. You would also need to have copies of any recipe used, a pH log, pH meter calibration log, and SOPs to complete the food safety plan.
- How can I sanitize utensils and ware so that the fermentation culture is not harmed by sanitizer chemicals?
  Answer: Section 4-703.11 of the FDA *Food Code* permits submerging previously cleaned wares and utensils in hot water (≥160 °F) for ≥30 s. This process will sanitize the wares and not leave any chemical residue (HHS, 2017).
- Once I get a good starter, can I keep reusing it, like a sourdough "mother" culture?
  Answer: No. Over time, LAB cultures are susceptible to bacteriophages (i.e., viruses that attack bacteria). Once in the culture, bacteriophages will replicate and eventually kill off one or more culture strains. A best practice is to keep culture reuse to one or two replications before returning to a known successful culture or a commercial source.
- Are some fermentation cultures sensitive to iodine in salt or chlorine in tap water?
  Answer: Most traditional recipes call for using pickling salt (noniodized salt). Fermentation cultures are not sensitive to the iodine, but it can cause cloudiness in fermentations. Some recipes also call for using dechlorinated (i.e., distilled or deionized) water. Lactic acid starter cultures are not very sensitive to the chlorine added to potable water and are exposed to the chloride ion (Cl-) as part of salt (NaCl).

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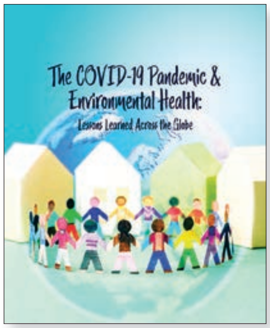

The COVID-19 Pandemic and Environmental Health: Lessons Learned

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Abstract **Environmental health is historically an overlooked and underrated discipline. The COVID-19 pandemic highlighted the value of environmental health and environmental health professionals (EHPs). EHPs have a unique set of skills and knowledge that were, or could have been, significant in controlling the pandemic. This skill set includes a thorough understanding of legislation and regulations; the ability to conduct human health risk assessment and implement effective risk-control measures; enforcement, communication, and education skills; and a significant understanding of their own local communities. The opportunities for applying the skills of EHPs vary across the world depending on several factors, including legislative and regulatory frameworks in each jurisdiction. Here we present our early evaluation of the unique skills and knowledge base of EHPs and lessons that can be learned from EHP engagement in public health protection. We also argue that local knowledge and engagement need to be recognized as valuable tools in emergency preparedness. In our increasingly globalized world, mechanisms to maintain and value local knowledge are needed, which could be achieved by embedding the "value of local" into policy to ensure that the importance and value of local knowledge are captured. We also advocate for raising awareness of the value of public health, and specifically, environmental health.**

Introduction

The World Health Organization (WHO, 2019) definition of environmental health is comprehensive:

> Environmental health addresses all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviors. It encompasses the assessment and control of those environmental factors that can potentially affect health. It is targeted toward preventing disease and creating health-supportive environments.

According to this definition, environmental health is critical to ensure the safety and health of populations. As a profession, however, environmental health has been overlooked and underrated (Brooks et al., 2019; Whiley et al., 2019).

In countries around the world, the COVID-19 pandemic highlighted that environmental health professionals (EHPs), as an army of workers, can be mobilized quickly and provide significant public health protection (Rodrigues et al., 2021; Ryan et al., 2020). EHPs were able to establish and implement public health measures rapidly and successfully due, in part, to the profession having significant local knowledge and networks, plus a range of key transferable skills. Examples of the application of environmental health and local knowledge are presented in this article. We explore the significance of these examples and we argue that the "value of local" should not be overlooked and should, in fact, be protected and enhanced through both policy creation and increased funding.

Our early evaluation presents the unique skills and knowledge base of EHPs as well as lessons that can be learned from EHP engagement in public health protection. This article provides an inventory for countries to assess their own utilization of the competent, multiskilled environmental workforce.

Methods

We followed methods described in an earlier article examining the role of EHPs during the pandemic (Rodrigues et al., 2021). In summary, to collate and assess the skills and activities of EHPs around the world, a community of practice (CoP) made up of environmental health academics and practitioners from the U.S., UK, Portugal, and Australia was formed. Recruitment to the CoP was undertaken using exponential nondiscriminative snowball sampling through our existing contacts (Etikan et al., 2016; Goodman, 1961). To identify this information, members of CoP consulted with other practitioners, professional associations, reports, gray and formal literature, and media articles published in their respective countries. Further details can be found in Rodrigues et al. (2021).

Results and Discussion

There were two dominant themes that arose from the CoP discussions:

1. The local nature of environmental health.
2. The development of new roles with the environmental health profession and the transferability of skills.

Lessons for the future were explored and are presented in this article.

The Local Nature of Environmental Health

The environmental health workforce represents a significant portion of the human capital that comprises the public health workforce. While global workforce numbers are unclear, the National Association of County and City Health Officials (NACCHO, 2019) routinely assesses workforce composition within the U.S. government. The nursing profession is the largest professional component (18%) of the U.S. public health workforce, while environmental health is the second largest (12%). In the authors' experience, this ratio approximates workforce distributions in many countries throughout the world. In Portugal, EHPs make up the largest portion of the human capital in the public health workforce (Ministério da Saúde, 2017). In England, EHPs make up the third-largest portion of the public health workforce (18%) (Centre for Workforce Intelligence, 2014). Much of the environmental health workforce is deployed locally; in fact, the profession uses the phrase "profoundly local" to describe and characterize its work and influence (Dyjack, 2017; Poprish & Tate, 2018).

Environmental health practice primarily is done at the local level. Regulatory responsibilities of EHPs include, for example, inspecting food premises, housing, tattooing and body piercing premises, public swimming pools and spas, and cooling tower and onsite wastewater systems (Frumkin, 2016; Yassi et al., 2001). This breadth means that EHPs have a comprehensive and intimate knowledge of the people and places within their own communities. It also means they have relationships with other levels of government including health, environmental protection, family services, and emergency services. During the pandemic, EHPs were in a strong position to provide advice based on knowledge of their local communities. Understanding community structure and community resources has been useful in the COVID-19 response and recovery, as the profession brings its community-based orientation to the larger public health discussion.

The importance of "local" can be illustrated by considering the role of contact tracing as a tool to understanding the route of transmission and break the chain of infection for outbreaks (Kretzschmar et al., 2021; MacIntyre, 2020). Lewis (2020) notes that while countries acknowledge this fact, countries, particularly those in the West, have struggled to implement effective systems. In contrast, countries such as Vietnam that have adopted a "boots-on-the-ground" approach have been much more successful in contact tracing.

The ineffectiveness of national track and trace systems is also highlighted by Briggs (2020), who states that in October 2020 the UK's national system was reaching only 54% of contacts within 24 hr. The impact of delays in contact tracing was modeled by Kretzschmar et al. (2020), who showed that even short delays (<24 hr) can have significant effects on disease spread. Local teams are far more successful at being able to reach contacts than the national systems. Lewis (2020) reports that this local success goes beyond simple databases with more accurate, local contact numbers but encompasses a range of factors including people's willingness to answer calls with a local telephone code; the ability and capacity of local teams to visit people at home (echoing the approaches in Vietnam and elsewhere); and having local people who understand their local populations and speak their language.

While it is easy to overlook this point, it was found in the UK that contact tracers who spoke with a local accent were able to elicit more comprehensive responses from interviewees compared with contact tracers who had nonlocal accents. Trust in local accents has been well described (Dahlbäck et al., 2007; Roessel et al., 2018); however, the need to establish community trust implicit in contact tracers was often overlooked. Malheiro et al. (2020) showed that local measures during the COVID-19 pandemic were "effective at reducing the number of high-risk cases." Above all, the advantage local track and trace teams have is their emphasis on what they can do to support local people and vice versa, the receptiveness of the local community to local EHPs.

The Development of New Roles and the Transferability of Skills

The unprecedented nature and impact of the COVID-19 pandemic meant that EHPs were required to undertake activities in some countries that they had never or seldom undertaken before, including infection control evaluation and enforcement; contact tracing; and other forms of education, engagement, and enforcement.

In the U.S., a national rapid needs assessment was undertaken, followed by monitoring of that assessment to track changes over time. A series of "just-in-time training" was designed and delivered in a nimble fashion to meet the needs articulated by the workforce (National Environmental Health Association [NEHA], 2020a). Subjects such as farmers markets safe operations, food labeling, and communication were addressed in short video formats. In the UK, the Chartered Institute of Environmental Health (2020) put in place a series of weekly online COVID-19 Conversations and short training sessions run by EHPs. These shared best practices explored solutions to common problems and provided guidance on issues that were being faced by EHPs responding to the pandemic in all areas of environmental health. In the UK, an Environmental Health Together register of EHPs was formed to collect details of EHPs who were willing to contribute toward measures to tackle the pandemic that were beyond their existing working requirements. This register could be used to match skill sets to specific needs and deploy resources into key areas as the need arose.

In Wales, EHPs were connected with care centers for older adults and worked with nursing staff at these centers to prevent infection from entering facilities and to implement quarantine procedures when suspected cases of COVID-19 occurred. EHPs were deployed to assist and enforce safety protocols when businesses were reopening following lockdowns; they also took part in controlling the migration of urban populations to vacation destinations, specifically recreational vehicle parks, and rural locations where health infrastructure was unable to cope with increased demand for healthcare.

In Portugal, EHPs worked in epidemiological investigations and contact tracing—tasks that in the past were limited to clinical staff. They are also involved in several other activities, depending on the region, such as assessing and monitoring sanitary conditions; supporting the development and implementation of contingency plans and assessing their effectiveness; providing training and support to care workers in facilities for older adults; and supporting the reopening of schools and other facilities. Other tasks included the authorization of events or activities and the selection of facilities used for vaccination sites.

Environmental health as a profession was able to manage these changes because the skill set of EHPs was transferable and applicable across a range of different situations. This ability was particularly important when looking to communicate key public health messages. According to Parvis (2001), communication—and especially public speaking—is something that is vital to the environmental health profession and should be encouraged. In England, for example, the cycle of lockdown and relaxation of restrictions led to confusion around the public health messages the government wanted to send and what people were allowed to do. In the UK, although television frequently featured clinicians, regular opportunities arose on local radio for EHPs to provide timely, accurate advice and raise the profile of environmental health at the same time. Broadcasters were keen to support their listeners and address uncertainty around the COVID-19 pandemic. The ability of EHPs to communicate effectively and provide expert advice was popular with local communities and media broadcasters alike.

The ability of EHPs to adapt to new roles and the field to produce professionals with a wide range of transferable skills has not happened by chance. To practice as an EHP, the workforce has considerable accreditation and continuing professional development requirements. These requirements, their execution, and their examinations differ across the world; however, all have the same exacting requirements and standards (e.g., www.neha.org/credentials, www.eh.org.au/workforce/course-accreditation-policy, www.cieh.org/professional-development/our-professional-standards).

The environmental health profession also has a strong culture of support within its ranks and strong national professional organizations. In countries from our CoP, these organizations include the National Environmental Health Association (U.S.), the Chartered Institute of Environmental Health (UK), the Royal Environmental Health Institute of Scotland, Environmental Health Australia, Environmental Health Professionals Australia, the Portuguese Society of Environmental Health, and the Portuguese Environmental Health Association (APSAi). These organizations are member supported, active, and engaged.

Almost all of these national bodies are also full members of the International Federation of Environmental Health (2020), which has developed and maintained an excellent online platform for "sharing of information and resources between EH professionals relating to the ongoing coronavirus (COVID-19) pandemic," with links to authoritative information and a platform for sharing experiences and resources.

Both at a national and international level, environmental health truly fulfills the definition outlined by the Australian Council of Professions (2003):

> A profession is a disciplined group of individuals who adhere to ethical standards and who hold themselves out as, and are accepted by the public as, possessing special knowledge and skills in a widely recognised body of learning derived from research, education and training at a high level and who are prepared to apply this knowledge and exercise these skills in the interest of others.

EHPs have an understanding of a variety of disciplines, including epidemiology, toxicology, microbiology, occupational health and safety, legislation and regulations, and policy development and implementation (Cromar et al., 2005). They also hold a host of other professional skills, including the capacity to communicate with a wide range of audiences (e.g., the community, other health professionals, academics); prioritization skills; analytical skills; the ability work within compliance frameworks; and risk assessment. Their knowledge and skills mean that EHPs can contribute to the full menu of nonclinical public health needs as they arise.

In view of this broad skill set, EHPs are involved in several activities including:

- Monitoring the health status of the population.
- General health protection.
- Fighting against means and agents of disease transmission (e.g., water surveillance).
- Specific health protection and the fight against pollution-related risk factors.
- Hygiene and promotion of urban and rural health (e.g., surveillance of sanitary conditions).
- Epidemiological surveillance and investigation.
- Risk-control systems (e.g., contingency plans, vector control, health promotion and protection).

The October 2020 survey (N = 765) of the U.S. environmental health workforce affirms the central role of environmental health and its contributions across the public health enterprise. EHPs in the U.S. reported being called on to engage in a broad menu of activities in which they partnered with law enforcement, epidemiologists, logisticians, public relations personnel, and other personnel in organization outside their tradition work areas (NEHA, 2020b).

Lessons for the Future

Raise Awareness of the Impact of Public Health (and Increase Funding)

While the focus of "health" is traditionally on hospitals, doctors, nurses, and emergency services, practitioners of public and environmental health have long recognized that clinical care is not the primary determinant of health. Callahan and Jennings (2002) noted that the "health of populations is a function more of good public health measures and socioeconomic conditions than of biomedical advances, a neglected truth by most outside the field." The COVID-19 pandemic disproportionally affected disadvantaged communities, even in countries with good national healthcare (Burström & Tao, 2020; Mikolai et al., 2020; Patel et al., 2020).

It is not possible to separate environmental health funding from public health funding in most countries, but as noted by Rodrigues et al. (2021), public health funding in most developed countries has decreased significantly over the past decades. In Portugal, for example, legislation decrees 1 EHP per 15,000 people (Diário da República, 2009), a ratio that is far from being achieved. Maani and Galea (2020) showed clearly that underfunding in public health in the U.S. made it "uniquely susceptible to the illness." In the UK, central government austerity measures have seen the national health service funding prioritized over local authority public health grants for over one decade, leading to a real-terms cut in funding to a point where an additional £1 billion (approximately US$1.4 billion [USD]) annual public health grant would be required to keep pace with population growth and inflation (Buck, 2020). In the UK, environmental health services can be delivered for an average of £7.82 (approximately $10 USD) per person served (Chartered Institute of Environmental Health, 2015).

Cost benefit analyses of environmental health work have demonstrated the savings that EHP activity provides for healthcare costs and the societal burden of factors EHPs seek to address. For example, in the UK, improvements to housing have an average 6-month repayment period when compared with savings to society. Improving warmth in vulnerable housing saves £4 ($5.50 USD) of healthcare treatment costs for every £1 ($1.35 USD) spent on heating and insulation. Home adaptations carried out by EHPs can generate £7.50 ($10 USD) of health and social care costs for every £1 ($1.35 USD) spent (Watson et al., 2019). It has been estimated that in the UK, an additional £1 billion ($1.4 billion USD) of public health funding is required to keep pace with population growth and inflation (Buck, 2020). We must advocate for better public health policies and a return to substantial funding of public and environmental health.

Quantifying the economic value—specifically, the return on investment—of environmental health is a valuable exercise and its replication across different areas of the profession and in different countries would help in advocating for a profession whose success is often defined by the absence of something rather than its presence. A safe, healthy environment typically is taken for granted by the general public; however, there does exist an army of EHPs who constantly work to ensure the health and safety of the public (Whiley et al., 2019).

Raise Awareness of the Value and Impact of Environmental Health

The profile of environmental health needs to be raised in the general community. Studies have consistently shown that people do not know what environmental health is or what EHPs do (Dhesi, 2019; Whiley et al., 2019). EHPs currently are in what could be described as a "teachable moment" (Ruby-Cisneros, 2020) and they need to rise to the challenge of communicating who they are, what they do, and what they can offer.

This need extends to university recruitment of more environmental health students to address the predicted workforce shortage in many countries (Hilliard & Boulton, 2012; Selvey et al., 2014).

Create National and International Registers of Environmental Health Professionals

As noted previously, in the UK, the Chartered Institute of Environmental Health has developed a register of EHPs to "enable local authorities to access the skills and experience they need in the fight against COVID-19." The International Federation of Environmental Health has established an online platform to share links, experiences, and resources. These initiatives are to be commended and could be used as a framework to create more national (and international) registers of EHPs that include specialized skills, mentoring, volunteering, and media relations opportunities.

Celebrate the "Value of Local"

The need for local knowledge and engagement is nothing new when dealing with outbreaks. Describing the work of John Snow in his groundbreaking investigation into the cholera outbreak in 1854, Johnson (2008) emphasized the fact that Snow's local connection was not only vital in obtaining information but also in giving meaning to his famous map: it transcended being simply marks on a page and became a reflection of a community's struggle and suffering.

Local knowledge and engagement must be recognized as a valuable tool in emergency preparedness. In our increasingly globalized world, mechanisms to maintain and value local knowledge are needed, which might be achieved by embedding the "value of local" in government policy to ensure that the importance and value of this local knowledge is captured. The COVID-19 pandemic reinforces why we need a strong environmental health workforce at the local government level. Their valuable work should not be minimized and should not be performed by outside consultants who do not hold strong links with the local community, which have been shown to be essential. We need local and national action to support and develop the environmental health profession via government policies, professional organization policies, and memoranda of understanding between universities.

Conclusion

EHPs possess a range of skills that were directly transferable that could be utilized to protect public health during the COVID-19 pandemic. Local knowledge and understanding of their communities are significant attributes of EHPs. To protect public health in the future, it is imperative that public health policies recognize the value of EHPs and the "value of local," and that funding is directed to ensure a strong environmental health workforce in the future.

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References on page 24

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DIRECT FROM AAS

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Environmental Health Professionals: Local Interprofessional Collaborations Require Global Thinking to Meet Shared Ethical Obligations

Editor's Note: In an effort to provide environmental health professionals with relevant information and tools to further the profession, their careers, and themselves, the National Environmental Health Association has teamed up with the American Academy of Sanitarians (AAS) to publish two columns a year in the *Journal*. AAS is an organization that "elevates the standards, improves the practice, advances the professional proficiency, and promotes the highest levels of ethical conduct among professional sanitarians in every field of environmental health." Membership with AAS is based upon meeting certain high standards and criteria, and AAS members represent a prestigious list of environmental health professionals from across the country.

Through the column, information from different AAS members who are subject matter expects with knowledge and experience in a multitude of environmental health topics will be presented to the *Journal's* readership. This column strengthens the ties between both associations in the shared purposes of furthering and enhancing the environmental health profession.

Professor Daniel Oerther is a leader bridging interdisciplinary environmental health practice, teaching, research, and policy. He is a diplomate with AAS, president-elect of the American Academy of Environmental Engineers and Scientists, deputy-chair of the Chartered Institute of Environmental Health, and a lifetime honorary fellow of the American Academy of Nursing.

We can trace the origins of today's modern practice of interdisciplinary environmental health to the Great Sanitary Awakening and the twin developments of 1) densely populated urban environments and 2) the emergence of specialized professional practice as sanitarians, engineers, nurses, and others protecting health and promoting wellness among individuals, families, communities, and the public (Oerther et al., 2021). In the UK, where the Chartered Institute of Environmental Health (2021) was founded in 1883, the definition of environmental health encompasses all of the external factors that affect human health and well-being—ranging from the air we breathe, the food we eat, and the water we drink to the wider impact of human-made hazards on the world around us. In the U.S., where the American Academy of Environmental Engineers and Scientists was founded in 1955, environmental engineers research, design, plan, or perform engineering duties in the prevention, control, and remediation of environmental hazards using various engineering disciplines, including waste treatment, site remediation, or pollution control (Occupational Information Network, 2021).

The work of environmental health professionals (EHPs)—from sanitarians, to engineers, to environmental health nursing—shares a common conceptual framework undergirding local practice, namely that the normal state of humanity is one of health and that the chief aim of practice is to prevent deviations from health as well as to promote wellness in the public by improving the local environment. This conceptual framework was well captured in Florence Nightingale's Environmental Theory (Fawcett, 2018). Today, while much of the work of EHPs remains intensely local (e.g., sanitary inspections of food service operations, vaccinations to prevent disease transmission, the design and installation of community water supplies), there is a growing need for EHPs to have a global world view. I believe that this global world view is essential for EHPs to contribute to effective policies and evidence-informed best practices that promote environmental health globally and across the breadth of professions (e.g., sanitarians, engineers, nurses, others).

One global world view that EHPs may wish to consider are the 17 Sustainable Development Goals (SDGs) from the United Nations (2015). The 17 SDGs were formally adopted by the United Nations General Assembly and began in force in 2015 to guide global efforts at sustainable development through 2030. Goal 6 (Clean Water and Sanitation) is clearly within the scope of practice of environmental health. In addition, I propose that sanitarians, engineers, nurses, and others have an important role to play in multiple goals. For example, Goal 3 (Good Health and Well-Being) and Goal 11 (Sustainable Cities and Communities) clearly benefit from the work of EHPs (Squires et al., 2019).

Throughout most of 2020 and ongoing even today, the world is dealing with the consequences of adapting to a new normal in the aftermath of the COVID-19 pandemic (Oerther & Klopper, 2021). As described by Rodrigues et al. (2021), the COVID-19 pandemic has shown where the practice of environmental health has strained under the demands placed on it during the pandemic. For example, in many local jurisdictions EHPs were redeployed to use their expertise assisting with test and trace as part of controlling the spread of transmission. While this example highlights the flexibility of EHPs to pivot their daily activities, it also brought to light a lack of redundancy and cross-coverage among EHPs. For example, vital surveillance or intervention activities such as inspections and enforcement may not have been performed with the typical due diligence normally afforded as resources were redeployed to deal with COVID-19.

Collectively, these four observations that EHPs share—an origin story, a common conceptual framework undergirding local practice, a global world view provided by the SDGs, and strained systems due to a lack of redundancy and cross-coverage—all point toward an urgent need to improve coordination among the practitioners that all share claim to the title of EHP.

In the practice of healthcare, it has long been recognized that physicians, nurses, pharmacists, social workers, and other members of the healthcare team benefit from coeducational training and continuing professional development that creates an esprit de corps at the clinical bedside. This approach is known as interprofessional education (IPE) (Buring et al., 2009; Oerther & Oerther, 2021). A parallel approach to IPE is lacking among the professions of environmental health.

In my opinion, this lack of a clear approach to interdisciplinary collaboration impedes the ability of environmental health to meet its ethical obligations to the public (Oerther, in press). Furthermore, in my opinion, one way to address this issue is to adopt an intentional approach to interdisciplinary collaboration as part of the ongoing efforts of the American Academy of Sanitarians (AAS) to refresh the definition of sanitarian and sanitary practice.

AAS needs input from the breadth of environmental health practitioners including members of the National Environmental Health Association (2021), the Environmental Section of the American Public Health Association (2021), the Alliance of Nurses for Healthy Environments (2021), and the American Academy of Environmental Engineers and Scientists (2021), among others. Input is needed from international practitioners as well, such as from the membership of the Chartered Institute of Environmental Health.

While I recognize that much of the current scope of practice within environmental health is strongly focused on the local level, I am equally aware that each profession shares strikingly similar statements of ethical obligation to patients, communities, and the public. My rhetorical question is, "What stops us from working together outside of the clinical setting as we collectively protect health by improving the local environment?" For example, sanitarians long have recognized that the suppliers of food could have as profound an impact on local outbreaks of foodborne illness as the kitchens where the food is prepared (Millstone & Lang, 2018). Therefore, evidence-informed protection of the food supply must include confidence in food safety from the farm gate to the dinner plate. This confidence is achieved through a combination of effective policies and professional practice including local inspections.

Would it similarly be useful to recognize that the morbidity and mortality increasingly associated with local heat waves are influenced strongly by weather patterns impacted by the collective actions of humanity (Chinowsky, 2021)? Would it be fair to propose that evidence-informed protection for captive and highly vulnerable populations—such as prisoners, school-age children, and residents of nursing homes—must include inspections that verify local access to air conditioning as well as effective policies linking local impacts to climate variability?

How do the practitioners that all share claim to the title of EHP work together effectively to deliver robust service to our local clients? I propose that we must think globally. We must recognize our shared ethical obligations. We must be intentional in our efforts to cultivate interprofessional collaboration. The public, local to global, needs us to step forward boldly and to practice to the full scope of our training, licenses, and credentials.

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Tools to Help You Write Clear Environmental Health Messages

Editor's Note: The National Environmental Health Association (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, NEHA features 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.

Traci Augustosky leads a team of writer-editors at the National Center for Environmental Health within CDC. Brandon Fastman is the editorial director at Powell Strategies, a firm that provides public health communication consulting.

Why Clear Communication?

Environmental health communicators must be able to disseminate scientifically accurate, evidence-based information in language that their audiences can easily understand and act on. This responsibility is doubly true in today's media environment where public health practitioners face competition from sources of misinformation that have access to the megaphones of social media platforms. To help public health communicators craft clear messages, the Centers for Disease Control and Prevention (CDC) created two key resources: the CDC Clear Communication Index and the Everyday Words for Public Health Communication (see sidebar).

The National Center for Environmental Health/Agency for Toxic Substances and Disease Registry (NCEH/ATSDR) augmented these resources with two more that are tailored to environmental health professionals. These resources are the Clear Writing Assessment and the Environmental Health Thesaurus (see sidebar). In this column, we will explain how these tools were developed and illustrate how they can be applied to strengthen environmental health communication.

What Is the Clear Writing Assessment?

The Clear Writing Assessment was designed to give public health practitioners practical feedback on written material that targets nonspecialist audiences (Figure 1). When applied effectively, it ensures that documents are focused and concise, easily understood, and clearly organized.

The assessment is divided into three groups of questions:

1. The first group ensures that the writer is considering the reading level of their audience.
2. The second group addresses formatting to help readers efficiently understand and internalize key messages.
3. The third and last group of questions addresses clarity on the word, sentence, and paragraph levels, ensuring that the language in a document is communicating information as efficiently as possible.

How to Apply the Clear Writing Assessment

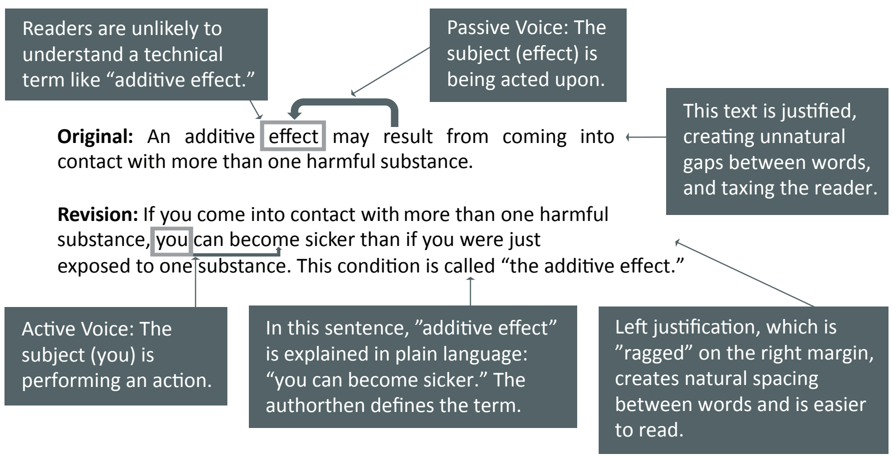
The assessment tool works best when paired with the CDC Clear Communication Index. Whereas the assessment focuses on plain language, the index focuses on health literacy. Combined, these tools will help you to create documents that effectively communicate with concepts and language that readers can readily digest and respond to.

The assessment asks objective yes or no questions based on an accompanying user guide that explains key principles of clear communication. Sample questions from each section are:

- If your document includes a necessary term your target audience might be unfamiliar with, did you explain the term in plain language?
- Did you use more space before and less space after each heading so it's clear how your content is chunked?

FIGURE 1

Annotated Clear Writing Example Illustrates How the Clear Writing Assessment and Environmental Health Thesaurus Can Improve Communication Messages



- Is the document written mostly in active voice (except for methods sections or other special circumstances described in the user guide)?

A score below 80 points means that a document needs further revision before it is ready for distribution to the public. For example, perhaps the author did not score a point for the use of active voice. Or they did not score a point for the question that asks, "Did you use pronouns like 'you' and 'we' to connect with the reader and make the tone more conversational?"

The following is a sample sentence that can be improved to address both of those omissions:

Original: It is uncertain whether the immune and developmental effects observed in rodents would manifest in humans. Some differences exist between how humans excrete PFAS compared to rodents.

Revised: We do not know if the immune and developmental effects seen in rodents exposed to PFAS would occur in humans. Humans and rodents differ to some extent in how they excrete PFAS.

Why Use a Plain Language Thesaurus?

When working in environmental health, we practitioners learn a vocabulary that is specific to our profession. We use terminology that is critical to our practice and that, over time, has become secondhand knowledge. It is easy to forget that words we often use are not accessible to the general public. This phenomenon is sometimes referred to as the "curse of knowledge" or the "curse of expertise" in social science literature (Newton, 1990).

Writing for the public requires that we describe concepts with language that is available to those without our specialized education or experience. To aid public health communicators in overcoming this challenge, NCEH/ATSDR created an Environmental Health Thesaurus. This online tool offers plain language alternatives for environmental health terms (e.g., biomarker, risk factor).

The following is an example of a sentence including scientific terminology that can be rephrased with everyday language.

Original: Ingesting bug repellent aerosols can lead to adverse health effects.

Revised: Some chemicals are sprayed into the air to kill bugs. Breathing in these chemicals can be harmful.

The improved sentence does away with the term "aerosols," which many people may not be able to define and instead describes it as "chemicals sprayed in the air."

Useful Links

- National Center for Environmental Health/Agency for Toxic Substances and Disease Registry Clear Writing Hub: www.cdc.gov/nceh/clearwriting/
- Centers for Disease Control and Prevention Clear Communication Index: www.cdc.gov/ccindex/index.html
- Everyday Words for Public Health Communication: www.cdc.gov/healthcommunication/everydaywords
- Clear Writing Assessment: www.cdc.gov/nceh/clearwriting/docs/Clear_Writing_Assessment-508.pdf
- Environmental Health Thesaurus: www.cdc.gov/nceh/clearwriting/thesaurus/index.html

Use These Free Tools

Writing for the public can challenge the communication habits we have developed as environmental health researchers and practitioners. Fortunately, there are concrete steps we can take to craft and revise documents according to clear communication principles. The heuristics developed by CDC and NCEH/ATSDR offer excellent guidance in following these principles. These tools are publicly available for anyone to use.

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DIRECT FROM U.S. EPA OFFICE OF RESEARCH AND DEVELOPMENT


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Office of Research and Development
U.S. Environmental Protection Agency

Environmental Health Challenges: Common Priorities Across Disciplines, Practical Tools, and Opportunities for the Future

Editor's Note: The National Environmental Health Association (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, NEHA has partnered with the Office of Research and Development (ORD) within the U.S. Environmental Protection Agency (U.S. EPA) to publish two columns a year in the *Journal*. ORD is the scientific research arm of U.S. EPA. ORD conducts research for U.S. EPA that provides the foundation for credible decision making to safeguard human health and ecosystems from environmental pollutants.

In these columns, authors from ORD will share insights and information about the research being conducted on pressing environmental health issues. The conclusions in these columns are those of the author(s) and do not necessarily represent the official position of U.S. EPA.

Megan Christian is a biologist and translational scientist with U.S. EPA's ORD within the Office of Science Advisor, Policy, and Engagement. Emily Trentacoste is a biologist and special assistant to senior leadership in U.S. EPA's ORD

Overview

Public health and healthcare professionals often view environmental health priorities through different lenses and at different scales. Differences include clinical, occupational, community, and ecological health perspectives, and whether the focus is on preventive actions, risk evaluation, or preparedness and response. Public health and healthcare practitioners are also often on the front lines of discovering and addressing public or individual health concerns related to environmental issues.

Identifying areas of mutual interest between public health and healthcare practitioners can foster improved understanding and coordination across sectors, as well as enhance our combined ability to identify and address environmental health challenges. This column will provide 1) an overview of environmental health challenges common to public health and healthcare practitioners, 2) identify a selection of tools and resources to address these challenges, 3) highlight the impact of COVID-19 in amplifying identified challenges, and 4) discuss opportunities for professional communities to address common priorities.

Environmental Public Health Challenges

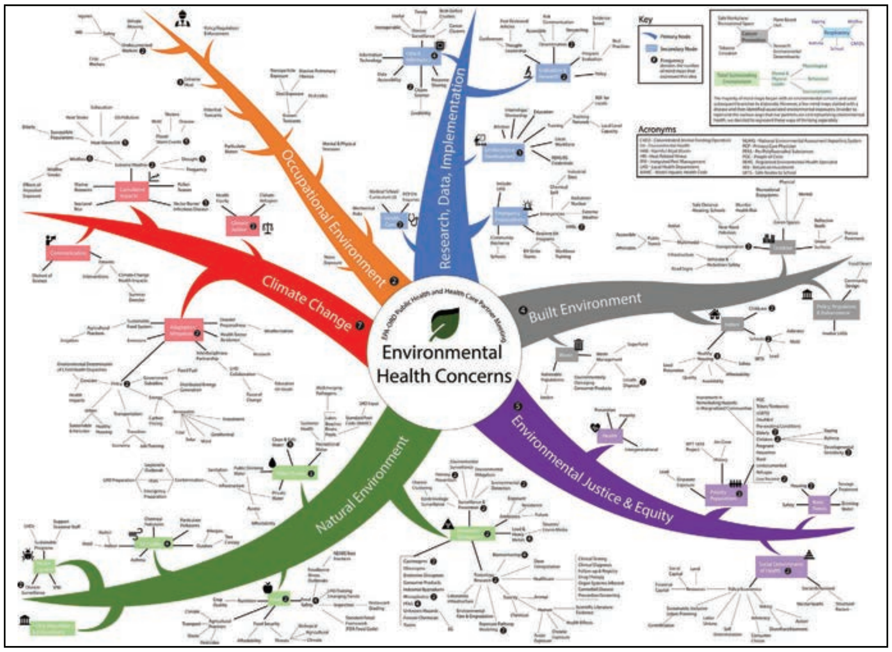
During summer 2020, the Office of Research and Development (ORD) within the U.S. Environmental Protection Agency (U.S. EPA, 2021a) convened a multiday, virtual workshop with public health, healthcare, and healthcare system practitioners to discuss environmental health priorities within their fields. The workshop provided a bridge across diverse healthcare sectors and allowed participants to understand how environmental and public health challenges are perceived from different professional perspectives and to learn how others are working to address these issues.

Through a mind mapping exercise and workshop discussions, six high-level environmental health concerns were identified as priority challenges to both public health and healthcare professionals (Figure 1). Although not exhaustive, the six areas represent high-level environmental health topics that can impact both public health and healthcare professionals:

- **Climate change** concerns include physical impacts on health (from extreme weather events, increased prevalence of vector-borne diseases, and decreased access to clean water), climate justice and disproportionate impacts, cumulative impacts, adaptation and mitigation, and communication.
- **Environmental justice and equity** address equitable access to basic needs (including clean water and air, food, safe housing and

FIGURE 1

Master Mind Map of Environmental Health Concerns for Public Health and Healthcare Practitioners



Source: U.S. Environmental Protection Agency, 2021a. A larger and zoomable version of this figure can be found at www.epa.gov/system/files/documents/2021-10/public-health-health-care-partner-workshop_master-mind-map.pdf.

environment, and healthcare) and consideration for disproportionately impacted communities (i.e., those who bear an unequal burden of risk, exposure, or impact), such as low income, minority, and tribal communities, and for vulnerable populations (i.e., those who are most susceptible to impacts from harmful environmental exposures), such as children and older adults.

- **Built environment** pertains to developed indoor and outdoor environments on which the public depends for daily life, including transportation systems, infrastructure, green spaces, urban development, office spaces, homes, schools, childcare facilities, public indoor spaces, and waste development and management. Public health concerns include indoor air quality, exposure to environmental contaminants, and community design.
- **Natural environment** refers to outdoor spaces, such as forests, parks, gardens, or even individual backyards, where public health concerns include air and water quality, presence of hazardous substances, vector-borne pest control, food safety and security, and environmental policy and enforcement.
- **Occupational environment** includes the potential for harmful workplace exposures (e.g., toxicants, extreme heat, loud noises, and particulate matter), mental and physical stressors related to specific work environments and fields, occupational training, access to personal protective equipment, and enforcement of policy and regulations.
- **Research, data, and implementation** refers to access to critical information, research, and data for environmental public health challenges and the ability to analyze data, translate results, and implement strategies and solutions to address challenges. Having adequate research, data, and implementation practices better support emergency response efforts, workforce development, and healthcare practices and communications.

Lead, children's health, mental health, and community design were identified by public health and healthcare practitioners as cross-cutting issues that are related to, or impacted by, factors across the six areas. Environmental justice and equity were also identified as cross-cutting issues in addition to being one of the six areas of concern.

Tools and Resources to Address Challenges

Actionable information and resources can assist public health and healthcare professionals in addressing environmental health concerns. Federal and state agencies play a role in developing and sharing information with partners, including tools and resources, that can be used to analyze and identify solutions to environmental health concerns. These tools range in their scale, intended uses, and target audiences. Table 1 highlights several U.S. EPA-ORD tools and resources that can aid practitioners from different disciplines in addressing the six common environmental health areas of concern. Some tools can be used directly by public health and healthcare practitioners, while others are intended for use by partners with whom these practitioners collaborate and consult. Additional US. EPA-ORD tools can be found on the ORD Science Models and Research Tools (SMaRT) Search website (U.S. EPA, 2021b). Figure 2 offers a case study of how two of these tools were applied to address an environmental health challenge.

Impacts of the COVID-19 Pandemic Public Health Crisis

Rather than decreasing in importance, environmental health priorities and challenges were heightened during the COVID-19 pandemic. People spent more time at home, increasing the importance of the home–built environment, and often more time in the natural environment and green spaces (Centers for Disease Control and Prevention, 2021). Environmental equity and justice issues—including access to clean and healthy housing, drinking water, food, internet, medical care, and green spaces—became more evident. Occupational health needs, especially for essential workers, were central. The COVID-19 pandemic also heightened the need to access research, data, and tools to quickly identify and implement solutions.

The intensification of environmental health challenges during the COVID-19 pandemic highlights the importance of continued cross-sector and cross-disciplinary discussions and collaborations on environmental health issues during nonemergency times. These interac-

TABLE **1**

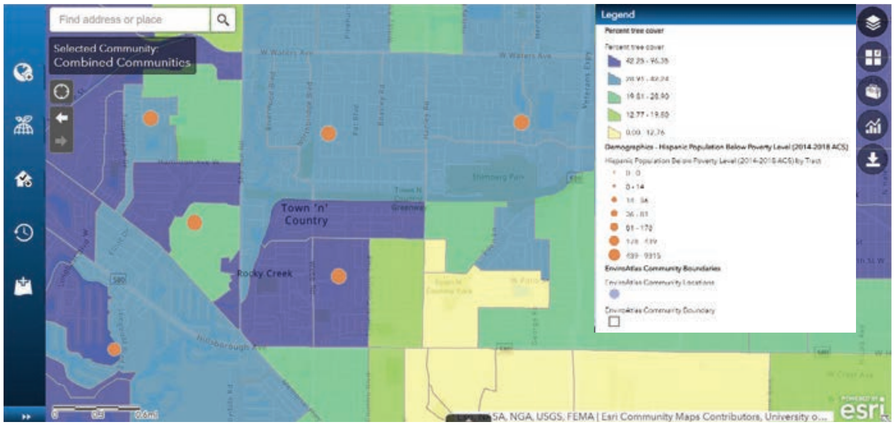
Tools and Resources From the Office of Research and Development (ORD) Within the U.S. Environmental Protection Agency (U.S. EPA) to Help Public Health Practitioners Address the Six Common Environmental Health Areas of Concern

Tool	Environmental Health Uses	Intended Users
Climate change		
Smoke-Ready Toolbox (U.S. EPA, 2021c)	Communicate risks of smoke exposures and provide actions people can take to protect their health	Public health officials, healthcare practitioners
Global Change Explorer (U.S. EPA, 2021d)	Explore various scenarios of future environmental change, including climate change, and access underlying spatial data for adaptation and resilience planning	Federal, state, and city regulatory/permitting authorities, decision makers, planners, natural resource managers, scientists, stakeholders interested in climate change impacts and adaptation, community organizations, environmental consultants
Environmental justice and equity		
EnviroAtlas (U.S. EPA, 2021e)	Consider place-based environmental, demographic, and socioeconomic information to assess health impacts and benefits from nature and stressors	Environmental and public health professionals, researchers, educators, government agencies, nongovernmental organizations
EJSCREEN [a] (U.S. EPA, 2021f)	Identify locations for consideration when developing programs, policies, and activities based on factors related to environmental justice, including minority and/or low-income populations and potential environmental quality issues	Communities, community planners, state and local health and environmental officials, grant writers, educational programs
Built environment		
Storm Water Management Model (U.S. EPA, 2021g)	Analyze and design stormwater runoff solutions, including evaluating gray and green infrastructure strategies, and estimate production of stormwater pollution	Engineers, planners, national/state/local stormwater management teams
Visualizing Ecosystem Land Management Assessments (U.S. EPA, 2021h)	Build in green infrastructure options for consideration in controlling fate and transport of water, nutrients, and toxics under present and future climate scenarios	Communities, land managers, policy makers, scientists, engineers
Natural environment		
EnviroAtlas Eco-Health Relationship Browser (U.S. EPA, 2021i)	Link and identify relationships between human health and ecosystem services	Environmental health researchers and decision makers, environmental educators, human health and ecosystem analysts
Cyanobacteria Assessment Network Application (U.S. EPA, 2021j)	Quickly assess changes in cyanobacteria levels in bodies of water to inform decisions regarding recreational and drinking water safety	Water quality managers, public health officials
Occupational environment		
Environmental Sampling and Analytical Methods Program (U.S. EPA, 2021k)	Access documents, information, and tools that support planning, reporting, and field and laboratory efforts during contamination incident site characterization, remediation, and release	Response community including response managers, field and laboratory personnel
Research, data, and implementation		
CompTox Chemicals Dashboard (U.S. EPA, 2021l)	Search chemistry, toxicity, and exposure information for >875,000 chemicals, including data and models, that can help inform chemical risk assessment and identify chemicals that need more testing	Federal/state governments, health agencies, industry decision makers for chemical risk assessment
Decision Support Tools for Waste Management (U.S. EPA, 2021m)	Access various tools to support planning, mitigation, response, and recovery of a large-scale environmental incident or natural disaster	State/local/tribal/territorial governments, federal decision makers on waste management
Wildfire Smoke and Your Patients' Health (U.S. EPA, 2021n)	Learn about health effects associated with wildfire smoke and actions patients can take before and during a wildfire to reduce exposure	Physicians, nurse practitioners, nurses, asthma educators, other medical professionals

[a] EJSCREEN was developed by the Office of Environmental Justice within U.S. EPA and has been used to inform U.S. EPA-ORD tools.

FIGURE **2**

Case Study Using the EnviroAtlas Eco-Health Relationship Browser



In 2015, the Florida Department of Health in Hillsborough County (2016) conducted a health impact assessment (HIA) to evaluate a proposed policy aimed at promoting public health in a predominately Hispanic/Latino community through improved access to parks and physical activity opportunities. The HIA used the EnviroAtlas Eco-Health Relationship Browser to identify potential health benefits the policy could address. The EnviroAtlas tool was then used to select study areas that would prioritize benefits for vulnerable and low-income populations. EnviroAtlas data on green space and tree cover were used to assess impact predictions and guide recommendations of the proposed policy.

tions build and foster trusted relationships and networks that can be leveraged when public health emergencies arise.

Future Opportunities

Continuing cross-sector and cross-disciplinary conversations on environmental health priorities will enable more information and stakeholders to be engaged when developing solutions to current and future challenges. Opportunities for collaboration include incorporating environmental health in training and workforce development; utilizing workshops, professional meetings, and other platforms to foster cross-disciplinary dialogue; and coordinating across sectors on risk communication.

Environmental health issues of mutual concern could also be used to inform outreach strategies, research directions, and issues for future targeted discussions and collaborations across disciplines. By working together, the environmental health community can develop more impactful and holistic actions to protect and improve our nation's environmental health.

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EH CALENDAR

UPCOMING NATIONAL ENVIRONMENTAL HEALTH ASSOCIATION (NEHA) CONFERENCE

June 28–July 1, 2022: NEHA 2022 Annual Educational Conference & Exhibition—Now a Hybrid Event, Spokane, WA, https://www.neha.org/aec

NEHA AFFILIATE AND REGIONAL LISTINGS

Iowa
May 3–4, 2022: Public Health Conference of Iowa, Iowa Environmental Health and Public Health Associations, Ames, IA, https://www.ieha.net/PHCI2022

Kentucky
February 2022 (Dates TBA): 2022 KYEHA Conference, Kentucky Environmental Health Association, Lexington, KY, http://kyeha.org/events

Michigan
March 22–24, 2022: 2022 Annual Education Conference, Michigan Environmental Health Association, Traverse City, MI, https://www.meha.net/AEC

North Carolina
April 27–29, 2022: NCPHA Fall Educational Conference (Rescheduled), North Carolina Public Health Association, Asheville, NC, https://ncpha.memberclicks.net

Ohio
April 14–15, 2022: Annual Educational Conference, Ohio Environmental Health Association, Dublin, OH, http://www.ohioeha.org

Utah
May 4–6, 2022: UEHA Spring Conference, Utah Environmental Health Association, Kanab, UT, http://www.ueha.org/events.html

Did You Know?

You can share your event with the environmental health community by posting it for free on NEHA's Community Calendar at www.neha.org/news-events/community-calendar. You can also find listings for upcoming events from NEHA and other organizations.

CAREER **OPPORTUNITIES**

Assistant Professor of Health Science (Environmental Health/Epidemiology)

California State University, Long Beach (CSULB)

Apply Now: https://bit.ly/3CFJWKO

Job Number: 501179

Work Type: Instructional Faculty—Tenured/Tenure-Track

Categories: Unit 3 - CFA - California Faculty Association, Tenured/Tenure-Track, Full Time, Faculty - Health Sciences

Position: Assistant Professor of Health Science (Environmental Health/Epidemiology)

Effective Date: August 17, 2022 (Fall Semester)

Salary Range: Commensurate with qualifications and experience

Required Qualifications

- MD, PhD, or DrPH in public health or a closely related field including, but not limited to, program tracks/concentrations related to environmental health, epidemiology, or a closely related discipline. [If doctoral degree is not in public health, must be formally trained in public health (e.g., MPH) or have at least 2 years of public health experience.] Degree at time of application or official notification of completion of the doctoral degree by August 1, 2022.
- Demonstrated potential for teaching courses in the health science major (e.g., environmental health, epidemiology, environmental and climate justice, and/or related courses).
- Demonstrated potential for conducting research, scholarly, and creative activities.
- Demonstrated commitment to working successfully with a diverse student population.

Preferred Qualifications

- Demonstrated potential or willingness to implement multiple teaching modalities (e.g., face-to-face, hybrid, online learning).
- Demonstrated potential or willingness to implement evidence-based teaching strategies that are effective for diverse learners.
- Demonstrated knowledge and experience to develop curriculum in the areas of environmental and climate justice.
- Demonstrated potential or willingness to engage in research focused on achieving health equity for underserved populations.
- Demonstrated potential or effectiveness in applying for external funding.
- Demonstrated potential or willingness to provide service to the department, college, and campus and/or in the community or profession.

Duties

- Provide high-quality instruction in the Department of Health Science that supports diverse student success. [Mode of instruction may include in-person, hybrid, online, and/or any combination thereof.]
- Develop a research agenda with high quality outcomes leading to academic publications and discipline-specific conferences that may benefit diverse populations.
- Maintain and apply for external funding to support research agenda.
- Participate in the development of undergraduate and graduate curriculum.
- Mentor and advise undergraduate and graduate students.
- Work collaboratively within the institution including the department, college, and university.
- Engage in activities that support diversity, equity, and inclusion on campus, in local and global communities, and in the profession.
- Participate in service to the department, college, university, community, and profession.

CSULB seeks to recruit faculty who enthusiastically support the university's strong commitment to the academic success of all of our students, including students of color, students with disabilities, students who are first generation to college, veterans, students with diverse socioeconomic backgrounds, and students of diverse sexual orientations and gender expressions. CSULB seeks to recruit and retain a diverse workforce as a reflection of our commitment to serve the people of California, to maintain the excellence of the university, and to offer our students a rich variety of expertise, perspectives, and ways of knowing and learning.

Information on the excellent benefits package available to CSULB faculty is located here: https://www2.calstate.edu/csu-system/careers/benefits/Documents/employee-benefits-summary.pdf

How to Apply—Required Documentation

- An equity and diversity statement about your teaching or other experiences, successes, and challenges in working with a diverse student population (maximum two pages, single-spaced). For further information and guidelines, please visit http://www.csulb.edu/EquityDiversityStatement.
- Letter of application addressing the required and preferred qualifications.
- CV.
- Three references (to be contacted for confidential letters of recommendation should you reach the **finalist stage**).
- **Finalists** should be prepared to submit an official transcript from institution awarding highest degree(s) including MPH, if applicable (e-transcript preferred, if available).

Employment Requirements

A background check (including a criminal records check and telephone reference check with most recent employer) must be completed satisfactorily before any candidate can be offered a position with CSU. Failure to satisfactorily complete the background check may affect the application status of applicants or continued employment of current CSU employees who apply for the position.

The person holding this position is considered a "mandated reporter" under the California Child Abuse and Neglect Reporting Act and is required to comply with the requirements set forth in CSU Executive Order 1083 Revised July 21, 2017, as a condition of employment.

CSULB is committed to creating a community in which a diverse population can learn, live, and work in an atmosphere of tolerance, civility, and respect for the rights and sensibilities of each individual, without regard to race or ethnicity (including color or ancestry), nationality, religion or religious creed, gender (or sex), gender identity (including transgender), gender expression, sexual orientation, marital status, disability (physical or mental), medical condition, genetic information, age, veteran, or military status. CSULB is an equal opportunity employer.

RESOURCE CORNER

Resource Corner highlights different resources the National Environmental Health Association (NEHA) has available to meet your education and training needs. These resources provide you with information and knowledge to advance your professional development. Visit the NEHA 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)

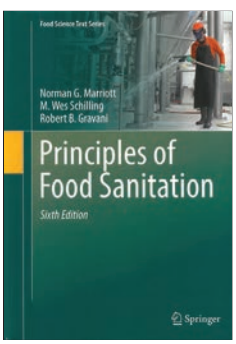
National Environmental Health Association (2014)

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 the National Environmental Health Association's (NEHA) CP-FS exam. This book contains science-based, in-depth information about causes and prevention of foodborne illness, HACCP plans and active managerial control, cleaning and sanitizing, conducting facility plan reviews, pest control, risk-based inspections, sampling food for laboratory analysis, food defense, responding to food emergencies and foodborne illness outbreaks, and legal aspects of food safety.

358 pages / Spiral-bound paperback
Member: $179 / Nonmember: $209

Principles of Food Sanitation (6th Edition)

Norman G. Marriott, M. Wes Schilling, and Robert B. Gravani (2018)

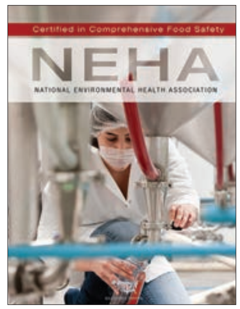


Now in its 6th edition, this highly acclaimed book provides sanitation information needed to ensure hygienic practices and safe food for food industry professionals and students. It addresses the principles related to contamination, cleaning compounds, sanitizers, and cleaning equipment. It also presents specific directions for applying these concepts to attain hygienic conditions in food processing or preparation operations. The new edition includes updated chapters on the fundamentals of food sanitation, as well as new information on contamination sources and hygiene, HACCP, waste handling disposal, biosecurity, allergens, quality assurance, pest control, and sanitation management principles. Study reference for NEHA's Registered Environmental Health Specialist/Registered Sanitarian and Certified Professional–Food Safety credential exams.

437 pages / Hardback
Member: $84 / Nonmember: $89

Certified in Comprehensive Food Safety Manual

National Environmental Health Association (2014)

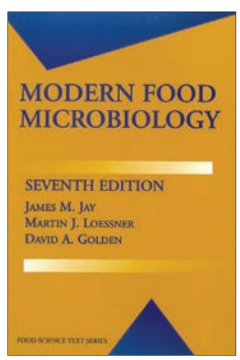


The Food Safety Modernization Act has recast the food safety landscape, including the role of the food safety professional. To position this field for the future, NEHA is proud to offer the Certified in Comprehensive Food Safety (CCFS) credential. CCFS is a mid-level credential for food safety professionals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

356 pages / Spiral-bound paperback
Member: $179 / Nonmember: $209

Modern Food Microbiology (7th Edition)

James M. Jay, Martin J. Loessner, and David A. Golden (2005)



This text explores the fundamental elements affecting the presence, activity, and control of microorganisms in food. It includes an overview of micro-organisms in food and what allows them to grow; specific microorganisms in fresh, fermented, and processed meats, poultry, seafood, dairy products, fruits, vegetables, and other products; methods for finding and measuring micro-organisms and their products in foods; methods for preserving foods; food safety and quality controls; and foodborne diseases. Other section topics include biosensors, biocontrol, bottled water, *Enterobacter sakazakii*, food sanitizers, milk, probiotics, proteobacteria, quorum sensing, and sigma factors. Study reference for NEHA's Certified Professional–Food Safety credential exam.

790 pages / Hardback
Member: $84 / Nonmember: $89

JEH QUIZ

FEATURED ARTICLE QUIZ #3

Retail Risk Assessment and Lethality of *Listeria monocytogenes* and *E. coli* O157 in Naturally Fermented Sauerkraut

Available to those with an active National Environmental Health Association (NEHA) membership, the *JEH* Quiz is offered six times per calendar year and is an easily accessible way to earn continuing education (CE) contact hours toward maintaining a NEHA credential. Each quiz is worth 1.0 CE.

Completing quizzes is now based on the honor system and should be self-reported by the credential holder. Quizzes published only during your current credential cycle are eligible for CE credit. Please keep a copy of each completed quiz for your records. CE credit will post to your account within three business days.

Paper or electronic quiz submissions will no longer be collected by NEHA staff.

INSTRUCTIONS TO SELF-REPORT A *JEH* QUIZ FOR CE CREDIT

1. Read the featured article and select the correct answer to each *JEH* Quiz question.
2. Log in to your MyNEHA account at https://neha.users.membersuite.com/home.
3. Click on Credentials located at the top of the page.
4. Select Report CEs from the drop-down menu.
5. Enter the date you finished the quiz in the Date Attended field.
6. Enter 1.0 in the Length of Course in Hours field.
7. In the Description field, enter the activity as "*JEH* Quiz #, Month Year" (e.g., *JEH* Quiz 3, December 2021).
8. Click the Create button.

JEH Quiz #1 Answers

July/August 2021

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

➔ Quiz effective date: December 1, 2021 | Quiz deadline: March 1, 2022

1. Foodborne pathogens such as __ have been implicated in foodborne illness in several fermented and acidic foods.
   a. *E. coli* O157:H7
   b. *Listeria monocytogenes*
   c. all the above
   d. none of the above

2. Fermentation is considered a special process where a food additive is used to make a potentially hazardous food into a nonpotentially hazardous food.
   a. True.
   b. False.

3. Foodborne pathogens of concern are present in the farm environment and can contaminate raw cabbage via
   a. water irrigation.
   b. unhygienic human handling.
   c. fertilizers that are made from animal feces.
   d. all the above.
   e. none of the above.

4. Historically, __ have been believed to account for the inhibition of spore-forming pathogens.
   a. salt
   b. extreme heat
   c. rapid acidification
   d. a and c
   e. all the above

5. *L. monocytogenes* has been found to survive in both the fermentation stage at room temperature as well as in the refrigeration stage in home-fermented refrigerator dill pickles for up to __ days.
   a. 51
   b. 71
   c. 91
   d. 121

6. The generally accepted bacterial pathogenic hazard control factor(s) in sauerkraut fermentations include:
   a. salt.
   b. competitive lactic acid bacteria (LAB) cultures.
   c. rapid production of lactic acid and other acids.
   d. b and c.
   e. all the above.

7. The control and treatment groups in this study both had a steady drop in pH for the first __ days.
   a. 5
   b. 7
   c. 9
   d. 11

8. For both control group fermentations, total viable count bacteria and LAB __ between Time 0 and Day 2.
   a. grew rapidly
   b. grew slowly
   c. did not grow

9. The inoculum level of *L. monocytogenes* for the treatment group was __ log CFU/g of sauerkraut.
   a. 4.39
   b. 5.39
   c. 6.39
   d. 7.88

10. At __ days, a 5-log reduction was observed in the *L. monocytogenes* treatment group and no pathogens were detected after Day __.
    a. 5; 7
    b. 5; 9
    c. 7; 9
    d 9; 15

11. In the sauerkraut inoculated with *E. coli* O157, there was __ in the *E. coli* O157 count from Day 1 until Day 7.
    a. no change
    b. a significant decrease
    c. a significant increase

12. This study suggests that naturally fermented sauerkraut __ growth or survival of *L. monocytogenes* and *E. coli* O157.
    a. does not permit
    b. does permit

SPECIAL LISTING

The National Environmental Health Association (NEHA) Board of Directors includes nationally elected officers and regional vice-presidents. Affiliate presidents (or appointed representatives) comprise the Affiliate Presidents Council. Technical advisors, the executive director, and all past presidents of the association are ex-officio council members. This list is current as of press time.

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Tribute to 2021 *JEH* Peer Reviewers

The *Journal of Environmental Health (JEH)* thanks and honors the individuals listed below whose contributions as peer reviewers are vital to our effort to advance, educate, and promote the science and profession of environmental health. We sincerely appreciate their hard work, devotion to the environmental health profession, and willingness to share their wealth of knowledge and expertise.

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IN MEMORIAM

Boyd T. Marsh

The National Environmental Health Association (NEHA) was saddened to learn that Boyd T. Marsh passed away September 1, 2021. Marsh served as president of NEHA from 1981–1982. This time period was tumultuous for NEHA due to financial difficulties and a decline in membership. From his "The President's Message" in the September/October 1981 *Journal of Environmental Health*, he stated, "We must strike out to establish a role and place for our association—an association where all of us can contribute our talents and where our association and profession can benefit from our collective contributions." Marsh certainly contributed his talents to moving NEHA into the future. His leadership and that of others during this time period helped to ensure that NEHA exists today.

In addition to his national impact, Marsh was a strong environmental health leader in his home state of Ohio. He began his career in 1966 as a staff sanitarian for the Summit County Health Department. He went on to serve as the director of environmental health for both the Summit County General Health District and the Cleveland Department of Public Health. He retired as health commissioner of the Summit County General Health District in 2000. Marsh also served as president of the Ohio Environmental Health Association (OEHA) in 1972. He was the first chairman of the Ohio Board of Sanitarian Registration and taught environmental health classes as an adjunct faculty member for Cleveland State University, Bowling Green State University, and the University of Akron.

Marsh was honored with the Walter F. Snyder Award in 1989 from NSF International and NEHA. He was described in the Snyder Award announcement as a person of "wisdom and accomplishment" whose contributions to environmental health "can be seen in the programs and publications which have grown from his wisdom." A copy of the award announcement can be viewed at https://bit.ly/31vLbyL. He was honored as Outstanding Sanitarian in 1979 and Outstanding Environmentalist in 1980 by OEHA. He was also named a diplomate of the American Academy of Sanitarians (AAS) in 1974.

Marsh shared his professional knowledge and personal experience with many Summit County organizations that helped individuals with intellectual and developmental disabilities. Marsh and his wife Paula created the Personal Advocacy Program for Summit and Portage County residents dealing with intellectual and developmental disabilities. In 1992, they were instrumental in legally challenging unfair local ordinances that created obstacles for individuals with developmental disabilities to live in residential neighborhoods.

The following quotes from colleagues and NEHA past presidents highlight his lasting contributions to NEHA and the environmental health profession, as well as the lives he touched.

"I had the good fortune to have served on the NEHA Board of Directors with Boyd and followed him as president. We served during a time when the future of the organization was in doubt. Boyd provided solid leadership and was always positive that we would succeed in paving a future for the organization. He would be proud of what the organization has become," Dr. Trenton Davis, NEHA past president.

"It was my good fortune to serve alongside Boyd on the NEHA board when I was president and when Boyd was getting ready to assume his term as president. I enjoyed his collegiality and friendship. Boyd was a professional of the first degree who was committed to serving the environmental health profession," Dr. Amer El-Ahraf, NEHA past president.

"I was fortunate to be the California Environmental Health Association (CEHA) president at the time of Boyd's NEHA presidential term. I remember Boyd as being a very professional and competent leader, role model, and advocate for the profession," Mel Knight, NEHA past president.

"I never had the pleasure of meeting Boyd personally but he did call to congratulation me when I became NEHA president. He had an extraordinary reputation here in Ohio as a great leader and an exemplary environmental health professional and community leader," Keith Krinn, NEHA past president.

"Boyd was one of my environmental health heroes and did a lot to help stabilize the finances of NEHA and move it forward. I have many fond memories of Boyd and his lovely wife Paula over the many years of our professional lives together," George A. Morris, NEHA past president.

"Boyd made a difference in environmental and public health here in Ohio. He was a legend to me as a young sanitarian and a real inspiration and good person to work with," Laura Studevant, NEHA past president.

"I had the huge privilege of being on the NEHA board with Boyd Marsh during his presidency. With his strong moral compass, Boyd led our association admirably. His careful and calculated leadership style kept our association on an even keel as we handled the environmental health challenges of the time. Further, as a seasoned practitioner in environmental health, Boyd possessed an excellent understanding of our profession and the issues we were confronted with," Dr. Leon Vinci, Health Promotion Consultants.

Obituary Source: Redmon Funeral Home, https://redmonfuneralhome.com/tribute/details/8318/Boyd-Marsh/obituary.html.

George Nakamura

NEHA was saddened to learn that George Nakamura passed away in September 2021. His career in environmental health and food safety spanned over four decades and he was highly respected and recognized as an expert in our field. He contributed his passion, leadership, and knowledge to numerous individuals, organizations, companies, and governmental agencies in California and across the country throughout his career. For those who knew him, his smile and laugh could brighten a room and were infectious.

IN MEMORIAM

Nakamura grew up in Watsonville, California. He earned his bachelor of science degree in public health from the University of California, Los Angeles (UCLA) School of Public Health. He went on to earn his master's in public administration from California State University, East Bay. Nakamura started his career in 1975 within San Mateo County Environmental Health as a consumer protection specialist. He started working at Contra Costa County in 1992 as a supervising environmental health specialist and retired as a program manager in 2006. His supervising experience encompassed nearly every environmental health program in Contra Costa and San Mateo Counties.

The passion Nakamura had for the profession was evidenced through his involvement in NEHA, CEHA, AAS, and numerous committees and advisory councils for organizations such as Underwriters Laboratories, NSF International, and the National Automatic Merchandising Association. He volunteered his time to NEHA as section cochair for food safety and protection (1997–2008) and technical advisor for workforce development, management, and leadership (2013–2016), as well as represented NEHA on the Council to Improve Foodborne Outbreak Response (CIFOR) and other committees over the years. Nakamura served as president of CEHA from 2007–2008. He was also active in his home community serving on the Sunnydale Planning Commission and the Mayor's Community Development Task Force.

Nakamura loved to share his knowledge and made countless presentations to diverse audiences. His presentations ranged from teaching food safety classes at a community college, presiding at a planning commission hearing, and addressing an audience of nearly 1,000 environmental health specialists to testifying in court on behalf of environmental health and private industry.

Nakamura was honored throughout his career with various awards and recognition—from being named Outstanding Sanitarian of the Year in 1975 by CEHA to being honored with the Davis Calvin Wagner Sanitarian Award in 2009 from AAS. He was also the recipient of the NEHA Past Presidents Award in 2006.

The following quotes from colleagues and friends showcase his contributions and dedication to environmental health and food safety, as well as the lasting impact he had on many individuals.

"I have many fond memories working with George. He was jolly, kind, knowledgeable, and well respected in our environmental health community. He will be missed," Harpreet Bains, Contra Costa County Environmental Health.

"I have worked closely with George for the past dozen years and count him as a tremendous mentor. George was a GIANT in this industry and was so energetic. The thing that I will always remember about George was his penchant for storytelling. My favorite story of George is when he was testifying at a trial as an expert legal witness. George was representing the defendant and was getting grilled by the prosecuting attorney. At one point the prosecutor asked George if he was a doctor. George responded, "No, but people certainly tell me that I'm a smooth operator." According to George, the courtroom erupted in laughter and he even had the judge chuckling. At the end of it, the defendant won the case and the 'Legend of the Smooth Operator' was born! The passing of George is shocking and tragic. He was energetic and passionate about food safety and the regulatory world, doted on his grandkids, and looked forward to getting free things at conferences and trade shows. I benefited from knowing George and am a better person because of it. And I know that there are hundreds more out there that have had similar experiences," Bryan Chapman, StateFoodSafety.

George Nakamura proudly displays the Davis Calvin Wagner Sanitarian Award that he was honored with in 2009 from the American Academy of Sanitarians.

"George was extremely knowledgeable and found joy in sharing his expertise with others. He loved and thrived on being a part of our environmental health family. Throughout the years, he was an ambassador for both NEHA and CEHA. He invited me and several other incoming professionals to get involved. For decades, he continued to encourage and mentor aspiring profes-

IN MEMORIAM

sionals. When we worked together, his morning greeting might include an individually wrapped candy or a tchotchke collected from a recent conference. He loved good food, especially our office potlucks with international flair. Long ago, I was able to share my mom's homemade tamales with George. For years he would ask if I had been to visit her lately and most importantly, did I bring any of her homemade tamales! Our conversations in recent years were about his grandsons. It was a treat to watch his face light up when he spoke about his family. He had the best sense of humor and was a true and treasured friend. George has a special place in my heart and I will miss him dearly," Alicia Collins, NEHA past president.

"I started working with George at Contra Costa County Environmental Health in 2001. He was always respectful, kind, and very funny. He joked often with the staff but he was a steadfast supporter of his team. He later became a NEHA mentor for me, providing me with introductions to his environmental health colleagues and friends and to the NEHA board and past presidents. I worked with him on a few NEHA projects over the years and always enjoyed our conversations and continuous banter. I will miss George!" Michele R. DiMaggio, NEHA Region 2 vice-president.

"George was a dear friend, a great colleague, and a star in our profession. I first met George as my student in environmental health at UCLA. His term paper on *Salmonella* in eggs was the best written paper submitted to me during my tenure and I gave him a well-deserved "A." I never tired of telling George about that over the years and equally, he was never tired of hearing it. He always rewarded me with his wonderful laugh. George was a person of good character and honorable service," Dr. Amer El-Ahraf, NEHA past president.

"George had a long history of service to CEHA and NEHA. He was one of my first contacts with the CEHA Northern Chapter in the early 1970s. Most recently he represented NEHA for several years on the CIFOR project and he was an active advocate for expanded industry outreach and participation," Mel Knight, NEHA past president.

"I met George at the very first AEC I attended in Alaska in 2004. Because of him I have made connections with other professionals at these conferences. And of course, he always liked the macadamia nut candies that I had," John Nakashima, Food Safety Services Hawaii, LLC.

"George and I were tightly connected through NEHA over the past 20 years. He welcomed me to my first NEHA conference in Atlanta in 2001. Since that time we worked side-by-side on developing the food safety sections for the NEHA conference, advising on the Food Safe Schools project, Epi-Ready, CIFOR, NSF, Conference for Food Protection, National Registry for Food Safety Professionals, and AAS. We shared a love of Disney and it was my joy to gift him Mickey ties (and on one occasion, socks). It was even more of a joy to see him wear them at subsequent meetings. George and NEHA were synonymous to me. I just joined the NEHA staff and was looking forward to letting George know where his mentoring and support landed me. Sadly, I won't have the joy of his reaction. He made an impact in many lives and was greatly loved," Michéle Samarya-Timm, NEHA staff.

"George provided me with mentoring and encouragement as I 'moved up the ranks,' both in the work environment and in CEHA and NEHA. I remember the times we competed against each another at the CEHA Northern Chapter softball tournaments in the early 1990s. I got to see firsthand just how competitive George was. Balance that competitive spirit with his passion for the environmental health profession and to me, that was George Nakamura," Ronald J. Torres.

NEHA extends its deepest sympathies to the families, friends, and colleagues of Boyd T. Marsh and George Nakamura. Each had a profound impact on our profession and the people around them. Both will be greatly missed.

Editor's Note: If you would like to share information about the passing of an environmental health professional to be mentioned in a future In Memoriam, please contact Kristen Ruby-Cisneros at kruby@neha.org. The *Journal* will publish the In Memoriam section twice a year in the June and December issues, or in other issues as determined appropriate.

NEHA **NEWS**

National Food Safety Education Month Wrap-Up

The National Environmental Health Association (NEHA) celebrated National Food Safety Education Month this past September with a 5-part webinar series on emerging food safety trends. The webinar series focused on providing insights, recommendations, and tools to assist attendees in keeping current with the rapidly changing landscape of retail food safety. A panel of subject matter experts from the new NEHA-FDA Retail Flexible Funding Model (RFFM) Grant Program kicked off the month by presenting on how the new NEHA-FDA RFFM Grant Program can offer support regarding education. Throughout the rest of the month, speakers presented on cannabis edibles from both industry and regulatory perspectives, food safety during third-party delivery, using emerging technology to supplement food safety programs, and enhancing virtual training with new technologies.

We are very grateful for our speakers who took time during September to share their knowledge and expertise. Recordings of each webinar are available on the Emerging Trends in Food Safety Webinar Series webpage at www.neha.org/eh-topic/neha-emerging-trends-food-safety-webinar-series.

Throughout the month we also celebrated food safety professionals whose work has had an outsized impact on those around them to express our gratitude for their essential work that protects the public from foodborne illness year-round. Please visit the Food Safety Heroes Blog at www.neha.org/food-safety-heroes.

The NEHA National Food Safety Education Month webpage serves as a repository for our past observances and resources, and can be found at www.neha.org/neha-celebrates-nfsem.

National Environmental Assessment Reporting System Request for Proposals

NEHA, in conjunction with the Centers for Disease Control and Prevention (CDC), will offer subawards between $2,500 and $4,000, depending on the number of applicants, to support state, tribal, local, or territorial governmental food safety programs to learn more about the National Environmental Assessment Reporting System (NEARS) program (www.cdc.gov/nceh/ehs/nears/index.htm). NEARS is a surveillance system that captures environmental assessment data from foodborne illness outbreak investigations in retail food services to improve food safety programs.

Who Is Eligible?

State, tribal, local, or territorial governmental food safety agencies not yet participating in NEARS. States not participating in NEARS will be given priority. Visit www.cdc.gov/nceh/ehs/nears/participants.htm to see the list of states and jurisdictions currently participating in NEARS.

What Types of Activities Can the Funding Support?

Funding will support food safety program initiatives to explore involvement in NEARS. Supported activities include:

- Staff time to learn about NEARS, such as
  - » Completing the Environmental Assessment Training Series (EATS) to conduct environmental assessments.
  - » Participating in a NEARS webinar training session.
- Attending a regional or national NEARS presentation.
- Purchase of environmental sampling or other investigation equipment to build capacity in foodborne outbreak investigations.
- Ability to use funds to encourage local programs within the state to participate.

Outputs Expected

- Complete the online Environmental Assessment Training Series (EATS).
- Complete the Introduction to NEARS webinar series hosted by CDC.
- Provide a 1-page final report
  - » Identify how the funding was able to help your program build capacity in conducting foodborne outbreak investigations (e.g., secured additional equipment, increased environmental assessment knowledge, provided training to staff, etc.).
  - » Identify if NEARS is a good fit for your program, if you would like to register your food safety program to participate in NEARS, and potential challenges to implementation.

How to Submit

The project period of performance is from February 1, 2022, through June 30, 2022. Applicants must submit their online application by **January 7, 2022**, by 5 p.m. EST. Awardees will be notified via email by January 28, 2022. To complete an application, visit https://bit.ly/3EltgsO.

2022 Joe Beck Educational Contribution Award

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

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

Nomination deadline is March 15, 2022.

To access the online application, visit www.neha.org/beck-award.

STUDENTS

Don't Miss This Opportunity!

Applications for the 2022 National Environmental Health Association/American Academy of Sanitarians (NEHA/AAS) Scholarship Program are now being accepted.

Students with a dedicated curriculum in environmental health sciences are invited to apply for the following:

- Dr. Sheila Davidson Pressley Undergraduate Scholarship
- Dr. Carolyn Hester Harvey Undergraduate Scholarship
- NEHA/AAS Graduate Scholarship

Nomination deadline is March 31, 2022.

For eligibility information and to apply, visit www.neha.org/scholarship.

DirecTalk
continued from page 54

each of us doing something small that draws positive attention to our contributions to the health, safety, and economic security of society. This endeavor will require sustained effort over many years. I am confident that this accomplishment is entirely within our grasp. We will need to be unpretentious, collaborative, and altruistic. What does a small thing look like?

It was almost 12:15 p.m. on September 22 as I drove up the New Jersey Turnpike enroute to the Yankee Conference in Connecticut. I exited at the James Cooper Travel Plaza so I could take a call with Dr. Gary Brown. As I secured a spot in the far reaches of the parking lot, a place where I could speak without the hum of the adjacent freeway, I noticed something bizarre. An insect with brilliant red wings flew by my windshield. It was unnatural. I've lived throughout the U.S. and have never seen anything like it. After Dr. Brown and I finished our call, I went to explore.

Imagine the sight of some old guy rummaging through the shrubberies at a New Jersey travel plaza, but hey, there I was. I located what I thought was the insect, camera in hand, and tried to capture a photo but the little beast was elusive. As I brushed the leaves and other dead foliage off my clothing, I touched something on my shoulder. It was the insect. I knocked it to the ground and took a photo with my phone camera.

Spotted lanternfly. Photo courtesy David Dyjack.

The moth-like creature turned out to be a spotted lanternfly. A new invasive species from southeast Asia that limits photosynthesis in target plants. It has the potential to destroy economically important crops and its distribution is increasingly rapidly. I reported the insect to the New Jersey Department of Agriculture, shared the news with my friends at the conference, and contributed to our knowledge of the distribution of this emerging pest. This story is an example of the intersection of entomology, economics, and social science. Seen in isolation, this story is meaningless. On the other hand, everyone reading this column is now aware of a new threat.

Each of us holds the potential to improve the lives of those around us through a myriad of tiny acts. Yes, the sterile and scorched-earth social environment around us can make those small acts seem meaningless. Together, let's build something beautiful.

Dave

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Did You Know?

You can stay in the loop every day with NEHA's social media. Find NEHA on
- Facebook: www.facebook.com/NEHA.org
- Twitter: https://twitter.com/nehaorg
- LinkedIn: www.linkedin.com/company/national-environmental-health-association

DirecTalk MUSINGS FROM THE 10TH FLOOR

David Dyjack, DrPH, CIH

Darwin's Paradox Reinterpreted

Palau occupies a special place in my heart. The tiny island nation (it is actually a nation comprised of 340 islands) lies in the western Pacific. It is at once a sovereign country and aligned with the U.S. through a Compact of Free Association. My relationship with the environmental health program there began in 2003 as I provided a 2-day training program in the conference room of the modest Penthouse Hotel in Koror, Palau's largest city and capital until 2006.

There are many memorable experiences to be had in the western Pacific. Local grocery stores carry Spam sushi, you can order a dinner of fruit bat, and you can enjoy some of the best whole fried fish on the globe, including right there at the Penthouse Hotel. I sampled a hearty chew of betel nut, but alas, did not experience the gentle stimulation for which it is famous.

Palau is world famous for its scuba diving, which holds special appeal to me. I spent one afternoon diving in the famous Blue Corner, an underwater feast for the eyes about 60 ft below the surface where dense, rich, and cold Pacific water upwells over a coral plateau. The cold, nutrient rich water from below blends with sterile, yet clear water of the shallows, which attracts plankton that in turn attract small fish and in the spirit of the food chain, attract pelagic predators. A string of superlatives fails to capture the breathtaking scene. A bigeye tuna—almost 7-ft long—roared out of the depths, took one close-up look at me, and then vaporized into the great abyss. I was mesmerized by disco clams, sea snakes, barracuda, black and white tip sharks, and a school of hammerheads. As the air level in my tank plummeted to 500 psi, my signal to return to the boat, I ascended to the surface and enroute encountered a battalion of spotted eagle rays. Pure bliss.

We are a professional ocean in a drop.

The rich, beautiful coral reefs of Palau are adjacent to expansive biological deserts of open ocean. How is it that the richest ecosystems on the planet are surrounded by the poorest? Naturalist Charles Darwin struggled with this observation during his epic 19th century voyages on the HMS Beagle. This conundrum is referred to as Darwin's Paradox. The solution lies in the intricate and symbiotic relationship between coral polyps and dinoflagellate algae. The coral polyps provide protection through their calcium carbonate exoskeleton and the algae provide nutrients through photosynthesis—a fecund marriage of epic proportions, one in which the partnership transforms a biological desert into an oasis.

The concept of adjacency, where rich and poor mingle, intellectually appeals to me. These conditions forge new relationships out of necessity and give rise to something bigger than themselves. I observe cities, large and small, to be hotbeds of innovation: brownfields reoccupancy, living walls, and white asphalt that reflects solar energy back into space, among other fascinating developments. A place where people, rich or poor and of various races, ethnicities, and religious beliefs, collide. Urban Blue Corners abound.

I see our profession as Blue Corners personified. Rumi, a 13th century Persian poet and Islamic scholar, suggested people are not a drop in the ocean but rather an ocean in a drop. We are a professional ocean in a drop. Our eclectic work is comprised of social, quantitative, and natural sciences. That's why it holds such appeal to us and offers such a fascinating career. That is, we possess knowledge, skills, and experiences that uniquely make our diverse professional lives fertile ground for new ideas in the public health enterprise. At the same time, we are directly adjacent to sterile, echo chambers of modern society's social and political discourse. I believe our intellectual coral reefs should be the ecological anchor for the health professions. Put another way, environmental health is a keystone profession that has a disproportionate impact on the environment around us.

The way forward means we will need to be more assertive in applying our observational skills to see and share solutions that involve the intersection of the public and private sectors. Small wins matter. You don't need to plan it, move into action as action attracts more action. The universe is blanketed in the notion that we need heroes. We don't need heroes. Our profession would benefit from

continued on page 53

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