

Chapter 11

A One Health Approach to Wildlife and Food Safety

Amanda Arens, Cheryl Scott, and Bennie Osburn

Abstract Global health problems including the assurance of safe and secure food are becoming more numerous and complex and require sensitive and transdisciplinary problem solving efforts. One Health provides the framework to approach food safety risks from the whole ecosystem of the food system by using a Web of Causation approach instead of an ‘us vs. them’ approach. This whole ecosystem, One Health approach focuses on prevention through the integration of wildlife, environmental, human, and domestic health sectors improving our ability to prevent rather than react to disease events. A true One Health viewpoint understands that all life is connected to its habitat, and the health of the whole sits squarely on a robust and sustainable environment. Safe food and water, thus ecological health, can be ensured using an evidence-based, transdisciplinary, collaborative based approach to the solution of food production and public health.

Keywords Agriculture • Climate change • Conservation • Ecosystem • Environmental health • Food safety • Global health • One Health • Public health • Wildlife

Introduction

There seems to be little doubt, the planet is changing. Climatic alterations, human population expansion, habitat alterations, ecosystem shifts, and hunger are profound. Global health problems including the assurance of safe and secure food are becoming even more numerous and complex, and require sensitive and transdisciplinary problem solving efforts. The globalization of our world now means that what is happening in one village in remote Africa or Asia will have repercussions

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that affect the health and welfare of all communities across the globe. Expansive and rapid movement of people, pathogens, animal products, and produce around the world lends urgency to the common goal of health.

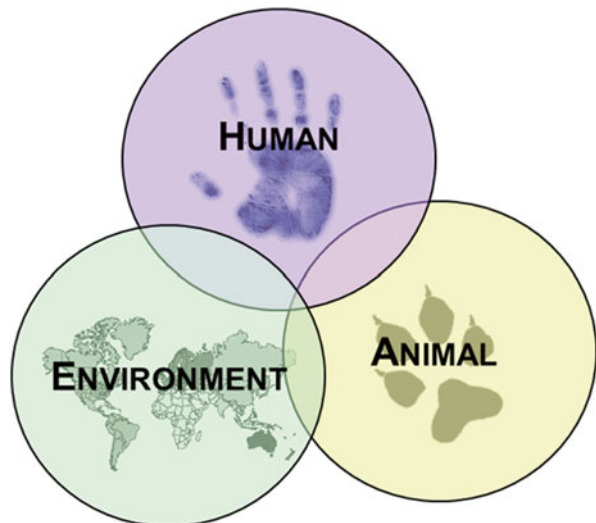
Food is only as safe and nutrient dense as the environment from which it comes. Food that is grown or processed in a contaminated environment becomes a food safety risk; food that is grown in nutrient-poor soil is less nutritious than food grown in a nutritionally richer environment; food from sick animals or animals carrying zoonotic pathogens becomes a food safety risk. Thus, healthy animals and a healthy environment are required to ensure a safe food supply.

The interdependency of human, animal, and environmental or ecosystem health in many aspects including food safety necessitates that problems in any of these sectors cannot be addressed in isolation, but rather need to be addressed by a larger, more systems-based approach in which all sectors are considered as part of the solution. One such approach that has come to the forefront is that of One Health—“the collaborative effort of multiple health science professions, together with their related disciplines and institutions – working locally, nationally, and globally – to attain optimal health for people, domestic animals, wildlife, plants, and our environment” (King et al. 2008). A One Health approach to food safety aims to have a safe food supply while at the same time ensuring the health and welfare of animals intended for food and preserving the health of the ecosystem in which the food lives or is grown.

One Health and Food Safety

One Health is an expanding area of professional global health advocacy arising from the recognition of the growing interconnections and overlap—economic, cultural, and physical—at the interface of human, animal, and ecosystem health (Fig. 11.1).

Fig. 11.1 One Health triad: Interconnection of humans, animals, and the environment



Although One Health is becoming an increasingly mainstream field of study today, the origins of One Health go back at least two centuries. In the nineteenth century, Rudolf Virchow, a German physician and pathologist, formally recognized the connection between human and animal health, stating, “Between animal and human medicine there is no dividing line, nor should there be. The object is different, but the experience obtained constitutes the basis of all medicine” (Kahn et al. 2007). Subsequently, the medical and veterinary professions noted the impact of animal diseases and ecological change on public health. Calvin Schwabe introduced the “One Medicine” concept in *Veterinary Medicine and Human Health* (Schwabe 1984) long after interest in the field had waned in the early 1900s. In recent years, the One Health concept has steadily gained recognition within the human and animal health sciences. In July 2008, the American Veterinary Medical Association (AVMA) released the report, *Executive Summary of the AVMA One Health Initiative Task Force*. In collaboration with the American Medical Association, the initiative provides groundbreaking recommendations and strategic action to support and expand the One Health concept across both veterinary and human health professions.

One Health seeks to shift the paradigm from the current “individual” and “disease-centered” approach that focuses on treatment to a “system-” or “community-based” approach that focuses on prevention. One Health is a creative way to view human, animal, and ecosystem health as a cooperative endeavor between health practitioners and environmental scientists in a collaborative and synergistic effort (Fig. 11.2). One Health provides the framework to address food safety issues in a transdisciplinary way in which solutions come from both within and beyond the various disciplines creating new perspectives to address these global, complex issues.

Safe Food, Wildlife Preservation, and Ecosystem Conservation through One Health

As our world population grows from 7 billion today to 9.1 billion by 2050 (United Nations) food security, food safety, and adequate nutrition will become increasingly more important. Everyone wants to trust that the food we eat and feed our families will not make us sick. In the USA, foodborne illness affects 48 million people, causes 128,000 hospitalizations, and results in over 3000 deaths annually (CDC 2011). While there are no current statistics of the global impact of foodborne diseases specifically, food and waterborne diseases together are estimated to kill 2.2 million people worldwide (WHO 2010). Foodborne illnesses arise from contamination from a number of pathogens including bacteria, viruses, parasites, and prions but can also be due to toxins, chemicals, metals, and allergens that are transmitted via food or water.

These microbial foodborne pathogens are part of the ecosystem where they live, survive, and find new hosts. These pathogens adapt to local conditions whether in

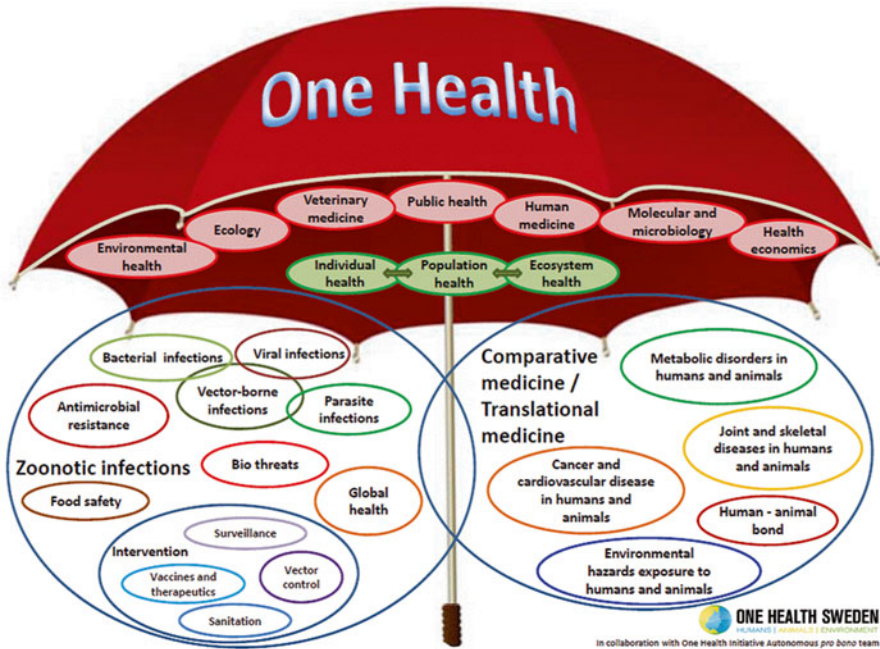


Fig. 11.2 One Health Umbrella—Broader vision of One Health demonstrating the relationships and interconnectedness of a variety of disciplines. Working together, these disciplines comprise a one health approach to solve global issues. “One Health Umbrella” graphic was developed under the auspices of One Health leader Dr. Olsen and the *One Health Sweden* team [two physicians and two veterinarians] in collaboration with the One Health Initiative Autonomous *pro bono* team [two physicians, two veterinarians, one PhD health research scientist] in December 2013

animals, plants, soil, or water. In some instances, these pathogens may replicate in the environment or find effective ways to propagate in more favorable conditions in animal or human hosts. The current hypothesis is that most of these pathogens are carried and multiply within the intestinal tracts of their animal hosts before they are eventually passed into the environment in the feces. Feces are often the rich and protective condition which allows the pathogens to remain viable and infective.

In the past few decades, 75 % of new human infections of all kinds are of zoonotic origin, meaning they can be spread from animals to people, and approximately 30 % of all globally emerging infections over the past 60 years have included pathogens that are commonly transmitted through food (Jones et al. 2008). Examples of zoonotic diseases that started as a foodborne disease and then became transmissible by human-to-human contact include HIV, Ebola, and SARS; examples of zoonotic pathogens that continue to be spread through food include *Salmonella*, *E. coli* O157:H7, *Listeria monocytogenes*, *Campylobacter*, and *Cryptosporidium*.

While foodborne illnesses have historically been associated with undercooked meat, the vehicles for human contamination have changed in the past decade. Between 1998 and 2008, 46 % of foodborne illnesses were associated with fresh

produce, 22 % were associated with meat and poultry, 20 % were associated with dairy and eggs, and 6.1 % of illnesses were associated with fish and shellfish (Painter et al. 2013). Even though most cases of produce-associated illnesses are often attributed to contamination with *Norovirus*, a human pathogen, enteric zoonotic foodborne pathogens such as pathogenic *E. coli*, *Salmonella*, and *Campylobacter* cause a significant amount of produce-associated foodborne outbreaks. Raw produce is at risk because there is often no kill step to reduce or eliminate the pathogen(s) that may contaminate the products at any point along the food production continuum. Further, many fresh-cut fruits and vegetables are not amenable to treatments to kill pathogens and some are field-packed and thus not subject to a processing step (Jay-Russell 2013). Thus, contamination at any place along the production chain can cause foodborne illness. The change in dietary preferences in Western cultures to consume more raw agricultural products, thus failing to have this final kill step, whereby produce could be sterilized, is one of the reasons for the increase in produce-associated outbreaks. With this increase in occurrence of outbreaks in fresh produce, people have looked for the cause or source of contamination of these specific commodities.

There are 25 animal-derived foodborne pathogens which have been implicated as the causative agent of disease in people. Of these 25 pathogens, nine are considered of greatest importance by the Centers for Disease Control and Prevention. Of these nine highly important pathogens, eight may be of domestic and wild animal origin and include *Salmonella*, *Campylobacter*, *Cryptosporidium*, *E. coli* O157:H7, *Clostridium*, *Listeria*, *Toxoplasma*, and *Yersinia*. Routes of contamination of these pathogens onto fresh produce can be direct fecal contamination; through water, soil amendments such as manure or compost, or wind; or as secondary contamination from unclean equipment, clothes, or workers.

The current approach to a foodborne outbreak is to focus on the human illness and “trace back” the outbreak to find a “root cause.” Once a plausible cause has been identified, recommendations are made, often solely focused on food safety to prevent the same type of contamination from occurring again. Wildlife may pose a risk to food safety as a probable source of contamination (California Department of Public Health 2007; Jay-Russell 2013; Rice 2014). However, there is often a lack of conclusive evidence implicating wildlife in foodborne illness outbreaks because they typically are not present at the time the traceback investigation is performed. An example of this is the 2006 outbreak of *E. coli* O157:H7 in California’s Salinas Valley in bagged spinach. This was the first major outbreak involving fresh produce and sickened almost 200 people across 26 states and led to 3 deaths (CDC 2006). The “root cause” of the outbreak was not conclusively determined; however wildlife, especially feral swine, and grazing cattle were both implicated based on epidemiological and laboratory findings during the outbreak investigation (Jay et al. 2007, California Department of Public Health 2007). The leafy greens industry rapidly responded to this outbreak by creating the Leafy Greens Marketing Agreement (LGMA).

Because many of the known foodborne pathogens are zoonotic and may be found in wildlife and environmental reservoirs, addressing these sources is certainly a

critical piece to the development of control measures aimed at the environmental level to reduce the incidence of human exposure. However, mitigation of wildlife contamination is a challenge. There are no economically feasible mechanisms to prevent direct contact. For example, barriers can be used to prevent access from some animals, but they are not all exclusive; poisons are toxic for many animals, not just the target animals, and have downstream effects such as decimating raptor populations; and habitat removal is detrimental to the environment and overall ecology. We know that intact ecosystems contribute to agricultural productivity by providing soil fertility, improved water quality, recharging of groundwater, and pollination of plants. So, how do we maintain the ecosystem and keep our food safe?

A One Health approach focuses on prevention. One Health shifts the “focus upstream to ecological, animal and environmental sources and influences responsible for these illnesses and helps identify the most effective points for the initiation of food safety actions” (King 2012). Coordination of wildlife, environmental, human, and domestic health sectors improves our ability to prevent disease events rather than simply reacting to them. Prevention is always preferable to control because it actively avoids the impacts of disease.

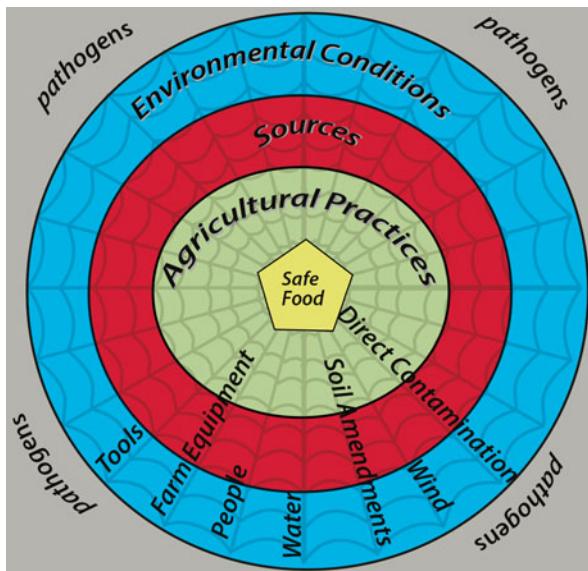
Balanced Solutions to the Food Safety and Wildlife Interface through One Health

Food safety has historically been recognized as, and measured by, the impact on people and the risk to human health (Rabinowitz et al. 2008). Animals and wildlife have been viewed as a direct threat to food safety. However, this “Us vs. Them” approach has led to policies for avoidance and vector/reservoir population control. Ultimately, risks are mitigated with barriers (Rabinowitz et al. 2008). This “Us vs. Them” approach focusing solely on the animals ignores other sources or routes of contamination.

Instead of a root cause approach, a more One Health approach is to view the whole ecosystem of the food system and analyze the Web of Causation (Fig. 11.3). Because of the intricate relationships between people, animals, and the environment, there is an intricate array of relationships similar to a spider’s web that includes the commodity, agricultural practices, sources of contamination (e.g., domestic and wild animals, people, water, and soil), environmental conditions including weather, and routes of contamination (e.g., tools, farm equipment, people, water, soil amendments, wind, and direct contamination).

The Web of Causation is the first step in addressing food safety at the preharvest level where it provides a whole ecosystem perspective to use when faced with determining potential routes for pathogens to reach commodities. In this open environment, all the factors associated with the Web of Causation must be considered when assessing potential routes or pathways of contamination. In contrast, post-harvest processing and manufacturing of food products occur in a much more rigid and confined environment that can be controlled. Thus, preharvest food safety poses a

Fig. 11.3 Web of Causation for contamination of safe food by pathogens demonstrating that there is often no one point source, but rather a series of events throughout the ecosystem that are interconnected like the strands on a spider’s web



more complex and greater challenge than post-harvest food safety and thus needs a more complex and dynamic approach to addressing food safety challenges.

The Web of Causation provides the opportunity to move beyond “Us vs. Them” and develop preventive strategies that are in the best interest of people, animals, and the environment. Thus, the Web of Causation is a One Health approach to food safety where the vision of One Health is to “optimize human-environmental interactions while minimizing health hazards to humans and animals and preserving a balanced ecosystem” (Zinstaag et al. 2009).

One example of a transdisciplinary, One Health approach is the concept of co-management which offers a comprehensive solution to the problem. “Co-Management is an approach to conserving soil, water, air, wildlife, and other natural resources while simultaneously minimizing microbial hazards associated with food production” (Leafy Green Marketing Association). The expectation of co-management is that safe food now becomes a collaborative priority for all stakeholders including landowners, farmers, conservation groups, buyers, industry, public health, ecosystem scientists, and wildlife agencies (see also Chap. 9).

A true One Health viewpoint understands that all life is connected to its habitat, and the health of the whole sits squarely on a robust and sustainable environment. Safe food and water, and thus ecological health, can be ensured using an evidence-based, transdisciplinary, collaborative based approach to the solution of food production and public health. It seems incumbent upon this generation of scientists and problem solvers to attempt to leave the world to our children in a more logical, balanced, and sustainable direction.

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