One Health and One Welfare

Joann M. Lindenmayer, Tufts University School of Medicine

Gretchen E. Kaufman, Washington State University, Tufts University

Until the lions have their own historians the history of the hunt will always glorify the hunter.

African Proverb

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Abstract

This chapter explores the connections between One Health and One Welfare and provides recommendations for how these two important, overlapping movements might proceed towards common goals in a spirit of mutual support. Both movements are rooted in the concept that humans, other animals and the environment are interconnected and interdependent. Furthermore, these relationships are inescapable, inviolable and arise out of common origins and shared experiences. A brief history of the One Health movement is presented, along with an analysis of the limitations of One Health as it is currently practiced. Particular emphasis is given to the human-centric nature of most One Health projects, their failure to adequately embrace socio-ecological complexity and the need to consider health and well-being of other animals and ecosystems in a more equitable manner. An argument is made for developing better tools to define and assess One Health and well-being. One Welfare is grounded in ethical concepts of welfare and well-being and is uniquely suited to provide much needed insight and approaches for the development of an ethical framework to guide One Health into the future.

Keywords

One Health; One Welfare; Ecosystem Health; Well-Being; One Health World; Post-Normal Science; One Health Ethics

Introduction

In this chapter, we will explore the connections between One Health and One Welfare and suggest how these two important and overlapping movements could benefit from each other and help us to work collaboratively towards common goals. Both concepts are based on the foundational idea that humans, other animals (wild and domestic) and the environment are interconnected and interdependent, and that these relationships are inescapable, inviolable and arise out of common origins and shared experiences.

The One Health concept requires us to recognize and appreciate the dynamic complexity of everything from minute ecosystems within cells to diverse populations that constitute macro-ecosystems. In doing so, we must move beyond the hundreds of years of training that has led us to think of health problems in simple reductionist terms of direct cause-and-effect relationships that can be studied and manipulated apart from the complex context in which they occur. One Health is not well served by this simplistic way of thinking, based on *normal science*, and would benefit from the more systemic approach offered by *post-normal science*, defined as a way of doing policy-related inquiry that is appropriate for complex cases where "facts are uncertain, values in dispute, stakes high and decisions urgent" that "does not pretend to be value free or ethically neutral" (Funtowicz and Ravetz, 1990, 1992). Our understanding of the world emerges not from isolated, linear lines of scientific inquiry but rather from multiple, sometimes conflicting perspectives, and varying historical, moral and ethical frameworks, *not all of which are based in science* (Bunch and Waltner-Toews, 2015).

Although One Health began with the recognition of interconnected, interdependent relationships, it has most often examined issues through a biased scientific lens of human health and human activities. Even as an ethical perspective of One Health is beginning to be explored, it is being applied mainly to people. But as Dr. Albert Schweitzer noted decades ago, "We need a boundless ethics that includes the animals also" (Schweitzer, 1998). We posit that a moral and ethical framework needs to be developed for One Health that considers more than human dimensions, applies as well to our relationship with other animals and the environment and assists us to reach beyond normal science. One Welfare, based on similar foundational ideas but also grounded in the ethical concepts of welfare and well-being, may serve as the basis for a much-needed ethical framework to guide One Health.

One Welfare begins with perspectives that are not all based in "normal" science, complementing One Health with an important value dimension. Taken together, One Health and One Welfare can give us a way to think about forging a healthier path away from the widespread destruction that *Homo sapiens* alone, of the more than 8 million known species on earth (Zimmer, 2011), has caused and that imperils not only our survival but that of all other living species. One Health and One Welfare together provide us with the opportunity to think about how we can "stitch a new garment. One that fits all of humanity and nature" (Sonya Renee Taylor, 2020). Accomplishing

this will require applying not only the science of health, among others, but doing so within an ethical framework.

We put forward that One Health and One Welfare together can establish a basic ethic of respect for other living and non-living elements of our planet, provide a foundation for the science of One Health and replace exploitation and annihilation with stewardship and responsibility for our planet and all its life forms.

Lessons from One Health – A Short History

The concept of One Health has its roots in ancient civilizations that made no distinction between healers of people and healers of animals and, although it has nearly completely fallen out of current practice and fashion, remnants of this idea persist among certain indigenous peoples (Callicott, 1982; Loppie, 2008; Dockery, 2010; Tignino, 2018; Jack, Gonet, Mease, and Nowak, 2020). Not until Hebrew prophets and Greek philosophers was the distinction drawn between man and other animals with respect to their morals, behaviour and mental processes (Schwabe, 1984), thereby setting humans apart from and superior to other animal species. In the 19th century, the physician-pathologist Dr. Rudolph Virchow studied spontaneously occurring diseases of domestic animals with the objective of applying what he learned to diseases in people, and wrote in 1856 that "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" (Klauder, 1958). His work, and that of others at the time, laid the groundwork for the study of comparative pathology among animals of all species, humans included, and he is credited with conceiving the concept of one medicine. Against this backdrop of a common scientific understanding of diseases, the microbiological revolution arrived in the mid-20th century. Coupled with the subsequent influence of biotechnology in the 21st century, physicians became increasingly specialized and collaborative efforts with veterinarians waned (Kahn, Monath, Bokma, Gibbs, and Aguirre, 2012).

One Medicine, a term formally defined and elaborated by veterinarian Dr. Calvin Schwabe, refocused attention on the common scientific origins of human and veterinary medicine (Schwabe, 1984). In the 21st century, two key advances propelled One Health to where it is today. The field of medicine expanded from treatment alone to include prevention, thereby paving the way for the evolution of One Medicine to One Health (United States Public Health Service, 1979; Etheridge, 1992). And in 2004, health experts from around the world met at the One World, One Health symposium to discuss movements of diseases among human, domestic animal and wildlife populations, leading to the publication of the Manhattan Principles (Cook, Karesh, and Osofsky, 2004). These gave greater weight to the value of biodiversity and extended One Health to encompass the environment and the health of people and other animals in ecosystems.

One Health is a concept that affirms the health interdependency of people, other animals and the environment. It is an approach to understanding and solving complex, shared health challenges and, as such, requires engagement by representatives of multiple disciplines and communities. Finally, it is the implementation of One Health in policies and programmes designed to improve the health of people, other animals and the environment. The most commonly applied definition of One Health states that it is "the integrative effort of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals, and the environment" (American Veterinary Medical Association, 2020b). A newer definition states that One Health is a "collaborative, multisectoral, and trans-disciplinary approach – working at local, regional, national, and global levels – to achieve optimal health and well-being outcomes, recognizing the interconnections between people, animals, plants and their shared environment" (One Health Commission, 2020c).

One Health as we know it today was launched into prominence with the heightened recognition of threats to people posed by the emergence of animal diseases such as Highly Pathogenic Avian Influenza, which has the capacity to become pandemic and kill vast numbers of people (and poultry). For that reason, an early focus of One Health was dominated by concerns primarily for human health and secondarily for animal health as advanced by physicians, veterinarians and population health professionals, and was adopted by many as a strategy for achieving effective and economically efficient joint health outcomes that would not have been possible had there been no collaboration. This relationship was codified in 2010 in a Tripartite Agreement signed by the Food and Agriculture Organization of the United Nations (FAO), World Health Organization (WHO), and the World Organization for Animal Health (OIE) (World Health Organization, 2010). The agreement promotes cross-sectoral collaboration to address and reduce risks from zoonoses and other public health threats existing and emerging at the human-other animal-ecosystems interface; similar collaborations were established in many other countries (Food and Agriculture Organization of the United Nations, 2020; Mbabu et al., 2014; Nigeria Centre for Disease Control, 2019; Pennsylvania State University, 2020). Because of these institutional arrangements at the highest levels, One Health in its most basic form has influenced investments, research funding and policy at international and national levels and is supported and recognized by many members of the international donor community (One Health European Joint Programme, 2020; United States Agency for International Development, 2018).

Visualizing One Health

Of four common graphic representations of One Health, including the generic One Health Venn Diagram (Figure 1.1), the One Health Triad (Centers for Disease Control and Prevention, 2020), the One Health Umbrella (Lerner and Berg, 2015), and a suggested new One Health World graphic (Figure 1.2), a survey of One Health experts found strong preferences for either the Venn Diagram or the Triad (One Health Commission, 2016). However, the Venn diagram/triad

images, while adequate in that they include the three domains of One Health (human health, other animal health, and environmental health), are flawed in a number of ways. While they emphasize that the area of overlap among human, animal and environmental health is the domain of One Health, they lead to troublesome interpretations. The first of these is that humans and other animals are considered separate at a time when, through advances in our understanding of genetics and the neurological basis of behaviours, we humans increasingly recognize solidarity with other living beings (Rock and Degeling, 2015). The second is that humans and other animals exist independently of the environment, which, whether that environment is natural and/or built, is never true. The third is that there is equivalence among human, other animal and environmental domains with respect to the degree to which they are valued and the extent to which they are represented in One Health research and application (Barrett and Bouley, 2015), an idea of equity which should be supported but belies our overwhelming focus on human health. The fourth is that disciplinary expertise in the traditional health sciences alone, as practiced by physicians, veterinarians and environmental health professionals, is sufficient for a full understanding and application of One Health.

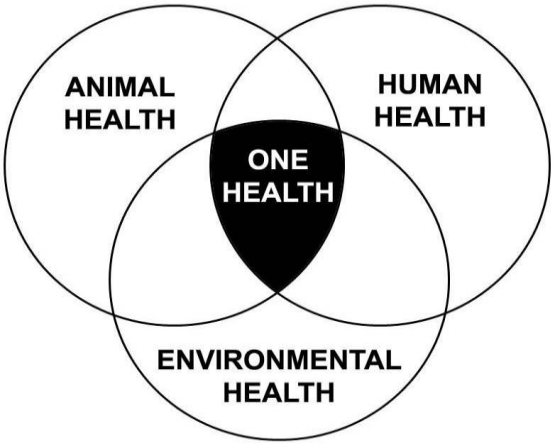

Figure 1.1: The One Health Venn diagram

Extending Health and Well-being to Animals and Ecosystems – Lessons Learned and Missed Opportunities from One Health

The practical meaning of the word ‘health’ has evolved over time. Long used to refer to the absence of disease, in 1946 the World Health Organization expanded its meaning and defined health as “a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity” (World Health Organization, 1946). This was extended in the 1970s to include disease prevention and health promotion (Etheridge, 1992; United States Public Health Service, 1979).

This broad interpretation of health is in widespread use for people today but the mental health and social well-being aspects of it have only recently been applied to other animals (Lerner and Berg, 2017) and rarely to the environment. Anthropocentrism, a view that informs our perspective of the world and our place in it, has, for centuries, led us to value human life over other forms of life (Waldau, 2002), and translated to health, and now One Health, it has favoured concern, funding, research and interventions that protect and promote human health over that of other living beings and ecosystems (Standley and Bogich, 2013). The separation of *Homo sapiens* from the rest of the natural world is a false separation that subverts the development of longer term, sustainable solutions to One Health challenges that would also benefit human health. As Rachel Carson, author of Silent Spring noted in an interview shortly before her death, "Man's attitude toward nature is today critically important simply because we have now acquired a fateful power to alter and destroy nature, and his war against nature is inevitably a war against himself" (Central Broadcasting Corporation, 1963).

A corollary to our near-overwhelming concern for human health is that even now, we deny, undervalue or dismiss the mental and social well-being consequences to animals of our treatment of them. Even among many veterinarians, if an animal is not sick or injured then it is not suffering or in distress, and it "fares well," even if it is deprived of space, environmental enrichment or opportunities for socializing with other members of its species. This is not only true for animals raised for food but also for animals kept for research and entertainment purposes, perhaps because for many of them, their lives are short and implementing changes to husbandry and housing would not translate to profits in sheer economic terms. That so much research, education and advocacy in the veterinary medical profession is subsidized by the corporate sector - agribusiness, pharmaceutical and feed companies, among others - raises inherent conflicts of interest as economics trumps a broader application of animal health and well-being (Dally, 2011; Dowers, Schoenfeld-Tacher, Hellyer, and Kogan, 2015). This influence also reinforces the idea that animals have value only insofar as they are useful to us.

Against this backdrop, however, the concordance of the human genome to that of chimpanzees (99%) and pigs (95%) suggests that we should view ourselves as slightly remodelled chimpanzee-like apes (Wildman, Uddin, Liu, Grossman, and Goodman, 2003), consider domesticated animals as closer relatives and treat our relationship with other animal species as part of a continuum across which pathogens can emerge and spread (Daszak, Cunningham, and Hyatt, 2000). Yet, it took the publication in 2012 of a text, *Zoobiquity: the Astonishing Connection between Human and Animal Health*, for many in the human medical community to recognize that the presentation of physical and mental health illnesses and conditions in animals bears striking resemblance to those same illnesses and conditions in people (Natterson-Horowitz and Bowers, 2013).

Finally, in one of the most exciting discoveries of the past few years, innovative research hints that even plants have the ability to acquire new behaviours that enhance foraging efficiency for light, form learned associations and communicate with other plants (Wong, 2020; Dicks, 2007; Gagliano, Vyazovskiy, Borbely, Grimonprez, and Depczynski, 2016). We have yet to fully explore what this means, if anything, with respect to health and well-being of plants or to broader ecosystems.

A search for the term "Environmental health" brings up the World Health Organization's (WHO) definition of environment, as it relates to health, as "all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviours" (World Health Organization, 2020a). Environmental health consists of preventing or controlling disease, injury and disability related to the interactions between people and their environment, but is not necessarily focused on the health of the environment itself. The environment, even in many One Health applications, is usually considered as a *context* for health issues involving humans or animals. Environmental health and "ecosystem health" are frequently used interchangeably and economic metrics are usually referred to as ecosystem services, a term that has many meanings but for public and policy audiences means "the benefits people obtain from ecosystems" (Millennium Ecosystem Assessment, 2005). Neither of these definitions fully represent what is meant by "environment" in One Health and this leads to confusion and misrepresentation because of the inherent human-centric bias. Rather than considering the three domains as separate but overlapping, in reality they constitute a hierarchical relationship or a continuum where humans are a subset of all animals, which are in turn a subset of the greater earth ecosystem (Figure 1.2). It is in this context that we should be treating the environment domain, discussing environmental or ecosystem health, and addressing environmental or ecosystem well-being and welfare.

Ecosystem health is a recognized discipline, largely based on foundational work by Costanza Norton and Haskell (1992) that strives to apply the idea of "health" to ecosystems. Considering the major impact humans have on ecosystems of all sizes, including the whole earth ecosystem, it is vital to be able to assess ecosystem health in order to assess our impact and devise more sustainable relationships with other living organisms and natural resources. There are many definitions that describe a healthy ecosystem in the literature, but most are similar to: "a healthy ecosystem…has the ability to maintain its structure (organization) and function (vigour) over time in the face of stress (resilience)" (Costanza and Mageau, 1999). Environmental or ecosystem health indicators have been developed and are continually being updated with the understanding that there cannot be a single rubric for evaluating health that applies to all ecosystems in all situations (Jorgensen, Xu, and Costanza, 2016).

Harkening back to the concept of One Health then, if we, as a matter of routine practice, apply a broad definition of health for people that includes well-being, it seems unreasonable and unjust

not to apply the same interpretation to the other two dimensions of One Health, that is, other animals and the environment. This is not to ignore the fact that doing so is likely to be complicated and difficult. But in the past few decades, our growing awareness that features once thought to be unique to human beings are shared by other species should impart to us a greater sense of solidarity and concern for the physical and mental health and social well-being of other species and the planet as a whole (Rock and Degeling, 2015). Perhaps, as has been suggested, to be effective and ethical, we should reframe One Health as a common or universal good shared across species (Degeling, Lederman, and Rock, 2016).

Focus on People and Zoonoses

As late as 2019, One Health focused largely on zoonotic disease, but a broader One Health agenda was beginning to be recognized that includes antimicrobial resistance, food safety, health services delivery, the human animal bond, climate change, destruction and depletion of natural resources including loss of biodiversity, disaster management, chronic diseases and other health challenges that are shared by people and animals (Takashima and Day, 2014; Xie, 2017). The recent appearance of the novel coronavirus and its worldwide toll on human morbidity and mortality ensures that interest in and commitment to the prevention and control of zoonotic diseases will displace other One Health problems for years to come. But in the rush to protect people, we cannot ignore the fact that the virus likely emerged precisely because of our species' careless disregard for wildlife and wild places. Evidence points to the virus's origin in horseshoe bat populations (Hu et al., 2017) and its transmission to people via an intermediary species in wet markets in China, where captured wildlife species are crowded together in cruel and unsanitary conditions, offered for sale, bought and consumed (Carpenter and Song, 2016). Historically, our response to zoonotic diseases has been to protect or treat affected people and interdict the pathogen at its proximal source - an animal, often by culling (Degeling et al., 2016; Lederman, 2016; Newsome, van Eeden, Lazenby, and Dickman, 2017), rather than addressing ways to improve the health of animal populations or altering the human behaviours that created the opportunity for pathogen spillover to occur from one species to another (Johnson et al., 2020). A few recent publications note that we ought to take better care of animals or, at least, leave them undisturbed in their natural environments for their sake and the sake of the environment, not just for ourselves. Osofsky's 'behavioural distancing,' of people from wildlife, building on the practice of social distancing among people in the time of COVID-19, is one such example (Osofsky, 2020).

Environment: The Missing Dimension

Because of the overwhelming attention and number of resources devoted to zoonotic diseases of direct significance to human health and their proximal causes - the animals that harbour and transmit them - the environmental component of One Health has usually been given limited consideration. We must also do a better job of evaluating the health of the environment in its

own right and not only as a source or context for human and animal health problems. This dimension is inherently complex and addressing it in relation to health reinforces the need to move beyond a search for proximal causes of disease and the simple cause-and-effect relationship of "normal science," to adopt a systems approach to the health of people, other animals and the environment. This approach is referred to by some as a "social ecological systems" approach and further as "health in social ecological systems" (Lu et al., 2015; Zinsstag, Schelling, Waltner-Toews, and Tanner, 2011). We can learn much from the ecological community to help us better define what constitutes a healthy ecosystem. This, in turn, will permit the development of tools and metrics that allow us to reasonably assess health in the environment which is, by its dynamic nature, always a moving target. To fairly consider the health of the environment will require defining better ecosystem health and well-being indicators (Lu et al., 2015; Prescott-Allen, 2001; Rapport, Costanza, and McMichael, 1998) and recruiting environmental experts in the service of One Health.

Reconciling Equity and Trade-Offs

We uphold the idea of "equity" as a fundamental ethical standard to be applied across the three domains of One Health: the health of all three domains should be balanced for any given situation or problem. The idea of achieving "equity" across this spectrum is challenging, not least of all because animals and the environment cannot represent themselves at the table. Attempting to account for equitable treatment or consideration requires subjective and objective, if not quantifiable, metrics and patterns of argument that help to illuminate and reconcile trade-offs that inevitably have to be made.

The last element of the One Health definition – "optimal health" - deserves discussion in this context. In biology, 'optimal' "denote[s] a condition or a result that is favourable or best for a particular living entity." (Biology Online Dictionary, 2020). In mathematical terms, an optimal solution is "a feasible solution where the objective function reaches its maximum (or minimum) value – for example, the most profit or the least cost," and "A globally optimal solution is one where there are no other feasible solutions with better objective function values" (Solvers, 2020). In the case of One Health, the biological living entity is an ecosystem and 'optimal' refers *simultaneously* to the health of people, other animals and the environment. It follows then that the health of each of these domains – humans, other animals and the environment – cannot be maximized independently of the other two. This means that there are trade-offs to be made between and among these domains so that the health of all three may be optimized simultaneously.

As a biological and mathematical process, optimization often takes into account an individual's or a community's preferences for one option over another. Since only people can express in words their preferences for one option over another, we must make the best guess, using new-found understanding of our fundamental connections with other species, about what we believe

other animals and even the environment would prefer. At the most basic level, however, individuals of all species seek to avoid pain and distress and mostly wish to live and not die. We can infer these choices in animals by observing their behaviours under stressful conditions and by measuring biological indicators such as oxytocin during relaxation or cortisol during stress. If we feel sufficient solidarity with animals, we may be able to project preferences upon them, although our best guesses will necessarily be imperfect. Similarly, we can project environmental preferences by striving to better assess, understand and appreciate what denotes health of an ecosystem and what factors contribute to an ecosystem's drive towards homeostasis or dynamic equilibrium.

Trade-offs may pit short-term versus long-term benefit or harm. In the case of the environment, harm is often long-term and not within the scope of short-term goals or needs defined by a particular problem. For example, climate change and pollution are the result of an accumulation of actions that may meet short-term needs, say of human development or agriculture, but which over time result in extreme harm to the environment that in turn affects the health and even the survival of all life. This trade-off is rarely considered when only short-term goals of a problem are assessed.

If we are to progress towards the actualization of One Health, we must also be able to measure the health of people, other animals, plant populations and ecosystems on various scales, or infer these states with some degree of certainty. But this is precisely where the most severe breakdown on the path to realizing One Health occurs.

Achieving One Health is an aspirational goal that is belied by our near overwhelming application of One Health to the health of human populations. Trade-offs that involve animals and environmental health often require acknowledging major gaps in our knowledge and understanding of individual or population health status and preferences of other species, but should *not* lead to discounting or ignoring these factors.

Public health has developed objective and subjective indicators and methods to measure physical and emotional health and well-being of human populations (Centers for Disease Control and Prevention, 2018, October 31). We understand relatively less about the physical and mental health and well-being of other animals, particularly those that live in the wild, because we have directed so few resources towards surveillance and understanding of these populations. We are least able to measure the health and well-being of the environment (Vucetich and Nelson, 2013). While the most comprehensive catalogue of ecosystem health indicators can be found in the CRC manual (Jorgensen, Xu, and Costanza, 2016), and an attempt to measure ecosystem well-being has been described by Prescott-Allen (2001) and expanded upon by others, public health institutions such as the United Nations, World Health Organization and the Centers for Disease Control and Prevention have developed environmental health indicators that exist only in the

context of how they impact the health of human populations. The same is true for ecosystem services, defined jointly in economic and ecological terms as "The outputs of ecosystems (whether natural, semi-natural or highly modified) that most directly affect the well-being of people…a fundamental characteristic is that they retain a connection to the underlying ecosystem functions, processes and structures that generate them" (Haines-Young and Potschin, 2013). This concept, similar to that of natural capital, is generally linear and unidirectional with respect to benefits to people. However, it does not yet adequately address situations where ecological benefits are indirect and, more importantly, when human activities are accompanied by side effects or consequences - externalities - that affect the well-being of non-human One Health stakeholders such as other animals, plants and environments. Progress in the science and application of ecosystem valuation is an important tool for assessing trade-offs but is still incomplete and must move towards a more social-ecological, integrated and non-linear process (Costanza et al., 2017). We hope that, as this science develops more fully, considerations beyond pure economic/monetary and societal benefit will be incorporated to ensure a measure of well-being of non-human components.

The complexity of ecosystems is difficult to comprehend without the benefit of mathematical models that solve problems by simultaneously accounting for multiple factors and processes, both quantitative and qualitative (Duboz et al., 2018), although models alone are insufficient towards this end. The same is true of One Health initiatives. The Network for the Evaluation of One Health (NEOH) has initiated efforts to address this complexity. NEOH's goal was to "develop standardized methodology for quantitative evaluation of One Health activities" and to apply that methodology so as to "enable future quantitative evaluations of One Health activities and to further the evidence base by developing and applying a science-based evaluation protocol in a community of experts" (Rüegg et al., 2018). Although frequently limited by a focus on the health of human populations and an emphasis on input by disciplinary experts and scientists, this effort represents the first and best attempt to date to measure the "One-Healthiness" of a One Health initiative.

Finally, assuming that we can, in specific circumstances, reach agreement on these matters, how can we even know when optimal health for all is achieved? Efforts to measure One Health will require considerably more work before what constitutes optimal health and well-being can be understood, measured, analysed and applied.

In summary, a scientific (and often economic) approach has been employed to demonstrate the benefits of a One Health approach to shared health challenges because scientific inquiry has dominated that approach and objective metrics are relatively easy to measure and understand (Roth et al., 2003; Schelling et al., 2007). However, the scientific approach without an underlying code of ethics as defined by community values means that One Health may elevate human health above all else, to the detriment of other animals, the environment, and longer term,

even to human populations themselves (Lynn et al., 2019). One Health has only begun to be inclusive of contributions of community representatives who can represent community values (Duboz et al., 2018). Consequently, there have been few attempts devoted to defining the ethics of One Health (Capps et al., 2015; Coghlan and Coghlan, 2018; Degeling et al., 2015; Lederman, 2016).

In this section, we have made the case that One Health, as practiced today, has serious limitations and we have also justified the need for an ethical underpinning of One Health by pointing out that the focus on science and metrics to the exclusion of an ethical framework may be undermining our success in achieving One Health.

Enter One Welfare

As discussed above, and as it is currently practiced, One Health has been beholden to research and academic interests focused almost exclusively on prevention and control of zoonoses, their impact on human health and the proximal risk factors to people for transmission of zoonotic disease - the animals. With few exceptions, disciplinary experts who are funded or tasked with implementing One Health operate in organizations that are not set up to support true interdisciplinary collaboration (Bunch and Waltner-Toews, 2015; Kahn et al., 2012; Ribeiro, van de Burgwal, and Regeer, 2019; Spencer et al., 2019) which, when done properly, is a thoughtful but long-term and challenging exercise that requires more than just getting a variety of disciplinary experts together (Mansilla, 2005; Mansilla, 2006; Mansilla, Duraisingh, Wolfe, and Haynes, 2009). With few exceptions, traditional "quantitative" scientists do not belong to professional networks that include social scientists who could raise important questions about the values and ethics of One Health (Lapinski, Funk, and Moccia, 2015; One Health Commission, 2020b; Wolf, 2015) and may not have the connections with community members who could impart local values to One Health plans and activities. For these reasons, quantitative disciplinary scientists rarely incorporate well-being, welfare and community values into their thinking and activities. In the absence of thoughtfully considered ethical guidelines and in spite of any well-meant intentions of One Health practitioners, efforts naturally tend to drift into familiar comfort zones that allow human health and well-being to dominate. Operationalizing One Health has moved forward without a well-defined moral or ethical framework that encompasses the well-being of all three domains, not just that of people. For this reason and others, a separate effort to incorporate an ethical framework is needed, along with a plan to integrate it with One Health (Pinillos et al., 2016).

Although the terms "well-being" and "welfare" are often cited as synonyms, the way in which they are applied to people makes clear the distinction between the two. Applied to people, the term "well-being" is defined as "the *state* of being happy, healthy, or prosperous" (Oxford University Press, 2020b). The term "welfare" on the other hand, is defined and used most often

to denote a "statutory procedure or social *effort* designed to promote the basic physical and material well-being of people in need" (Oxford University Press, 2020a). Well-being is a state of being, whereas welfare is an action taken towards others, underpinned by the conviction that we have an individual moral and a societal ethical responsibility to consider the desires and needs of others.

Welfare, as applied to animals, appears to be a hybrid of the meanings of both terms. According to the American Veterinary Medical Association,

> An animal is in a *good state of welfare* if (as indicated by scientific evidence) it is healthy, comfortable, well-nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear, and distress.
>
> (American Veterinary Medical Association, 2020a)

We may use animals for a variety of purposes, including companionship, food, fibre, recreation, work, education, exhibition and research conducted for the benefit of both humans and animals as long as we *provide them with good welfare*, meaning disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling and, when necessary, humane slaughter or euthanasia. As is abundantly clear, many if not most animals that are kept and maintained for human purposes, especially laboratory research, entertainment and food production cannot be said to have good welfare by this definition.

Nearly four decades of work has explored the concept of ecosystem health and devised tools and indicators to measure health of the environment (Costanza, Norton, and Haskell, 1992; Lu et al., 2015; Rapport, Costanza, and McMichael, 1998). In the context of ecosystem services which directly benefit human populations, it is clear that the inherent difficulty in devising metrics to measure the *well-being* of the environment has been a challenge and only rarely attempted. Some scientific publications and reports (Naiman and Dudgeon, 2011; Prescott-Allen, 2001) and essays (Tignino, 2018) have explored the ethical and legal rights of ecosystem elements such as rivers and mountains, as well as the well-being of entire national ecosystems. One such publication describes a new method of measuring both human and ecosystem well-being, and a methodology for combining the two. The Ecosystem Well-being Index (EWI) is a comprehensive measure of the quality of ecosystems, defined as their capacity to maintain themselves through cycles of growth, maturity, death and renewal; their productivity; and the chemical and physical integrity of soil, water and the atmosphere (Prescott-Allen, 2001).

In the Well-being of Nations, the author argues that to sustain their own well-being, people need to look after the well-being of the ecosystem: the system of land, water, air and living creatures that embraces and supports them. To that end, it becomes possible for people to adopt better ecosystem well-being as an achievable goal. Furthermore, although there are trade-offs between

the needs of people and the needs of the ecosystem, they must be limited because human and ecosystem wellbeing are *equally* important (Prescott-Allen, 2001).

Less than a century ago, medical research conducted on people lacked a foundation of ethical principles. This was corrected with universal acceptance of the Nuremberg code, a set of research ethics principles that prescribe conduct for human subjects research (Moreno, Schmidt, and Joffe, 2017). Forging ahead with One Health without an ethical set of principles as "humans have overrun the world," described by the historian Sir David Attenborough (The Guardian, 2020, January 15), risks destroying all that sustains human life and that of other species regardless of how tenuous and far-reaching is our relationship with each and every one.

In the spirit of the WHO definition of "health", we argue that, where One Health is concerned, a broad concept of well-being should apply to all three dimensions of humans, other animals (wild and domestic) and the environment/ecosystem. One Welfare can provide the individual moral and societal ethical construct to guide One Health actions and ensure well-being as part of achieving optimal health. It could serve as a scribe for human behaviour and policy-making, based on acknowledgement and respect for our interdependence with other living beings and our mutual dependence on the planet's natural resources.

One Welfare is an emerging concept or approach that "describes the interrelationships between animal welfare, human well-being and the physical and social environment" (Pinillos et al., 2016). It extends the idea of well-being, heretofore only applied to people, to animals, and is beginning to be addressed in scientific publications, but less so in treatises that explore the ethical underpinnings of One Health (Lysaght et al., 2017).

The need for an ethical framework is not a new idea. As Aldo Leopold envisioned, "All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts" (Leopold, 1949). Addressing the need for a land ethic decades ago Leopold noted, "Primacy of economics has undermined the notion of an ethic. A system of conservation based solely on economic self-interest is hopelessly lopsided" (Leopold, 1949). More recently, Goldberg and Patz asked, with respect to global health, "Might the recent proliferation of global health organizations in academia, government, and the private sector, tied to institutions driven by economic incentives, actually be impeding the development of a global health ethic?" (Goldberg and Patz, 2015). Until very recently, One Health has focused on quantifiable, scientific and economic metrics to the near exclusion, intended or not, of an ethical framework.

Illustrative Examples of One Health and Welfare Challenges and Successes

An example of a One Health challenge is the well-documented story of vultures and diclofenac on the Indian subcontinent. Populations of three Gyps vulture species declined mysteriously and rapidly, beginning in the 1990s and ending with their being classified as critically endangered in

2000. In 2004, renal failure secondary to diclofenac poisoning was identified as the cause of the decline in vulture populations. Diclofenac is an inexpensive non-steroidal anti-inflammatory agent used commonly to alleviate pain in people and animals. Out of concern for the welfare of their old, ailing cattle and bound by the Hindu practice of not killing or euthanizing cows, farmers in south Asia began applying diclofenac to alleviate the animals' suffering until they died a natural death. In this setting, without other means of disposal, bodies of dead animals are left out in the open to be scavenged naturally by carnivores and birds of prey, including Gyps vultures which have been called 'natural sanitary workers'. Where cattle were treated with diclofenac, vultures ingested doses of the drug that proved lethal, an unexpected and unintended consequence. As vultures disappeared, the primary role of scavenging and disposing of bodies was left to local carnivores, particularly free-roaming community dogs. With increased access to food sources in the absence of vultures, social interactions and competition among dogs increased at cattle carcass disposal sites, and the dog population exploded. In a country without effective rabies control, transmission of rabies increased among dogs, leading to a secondary increase in human rabies cases. Additional health risks, such as anthrax, brucellosis and runoff pollution from rotting carcasses have also been identified as a result of less efficient carcass disposal by dogs compared to vultures (Markandya et al., 2008).

Critical elements of this case include an initial welfare action, the catastrophic collapse of ecologically important species, the belated recognition of a critical connection between wild animals and carcass disposal, an increase in food sources supporting the expansion of dog populations, and increased transmission of rabies and other zoonotic diseases among dogs and, subsequently, to people. The solution to this problem was to ban the veterinary use of diclofenac and offer a more expensive alternative (meloxicam) that appears to be less toxic for vultures. However, the effectiveness of this solution has been limited because of the prohibitive cost of meloxicam and the ongoing preference for diclofenac by some farmers.

The lack of appreciation for different cultural practices, the need for a better understanding of the ecological dynamics of carcass disposal, and variable concern for a wild animal species illustrate the need for an integrated One Health One Welfare approach to future such challenges. Twenty years later, the vulture population is slowly recovering because of intense efforts at captive breeding and release, the creation of drug-free vulture feeding sites, and widespread educational efforts (Bindra, 2018; Green et al., 2004; Markandya et al., 2008; Oaks et al., 2004).

A second example of a One Health challenge is the common use of culling to kill animal populations for a variety of reasons and in a number of venues. Culling campaigns in the interest of human health have targeted free-roaming dogs to control rabies (Morters et al., 2013), badgers to control spread of bovine tuberculosis (Lederman, 2016), and poultry in backyard flocks and intensive production facilities to control avian influenza (Scoones and Forster, 2008). Culling campaigns in the interest of livestock production have targeted cows and sheep to stem

transmission of foot-and-mouth disease (Haydon, Kao, and Kitching, 2004) and pigs to stem transmission of African Swine Fever (Wang, Sun, and Qiu, 2018b). Widespread culling of free-roaming cats in Australia aims to eliminate an alleged threat to biodiversity (Aguirre, 2019).

In nearly all instances, the anticipated impact of culling on individual or aggregated human interests - health, livelihoods, livestock production and concerns for biodiversity - was elevated over interests of the animals and the environment. Where research into the outcomes of these campaigns was conducted, culling was determined to be ineffective, often counterproductive and not cost-effective (Lederman, 2016; Morters et al., 2013; Newsome et al., 2017). Furthermore, culling is typically met with strong and vocal opposition where it is viewed as being at odds with community values.

While the initial impulse to kill a pathogen's messenger – the animals – may be immediately satisfying, and culling may work in the short term, it raises difficult ethical issues and does little to arrest or control pathogen dynamics in the environment. More effective methods of control may be to address distal, structural factors that contribute upstream to a pathogen's emergence and maintenance in the environment (Wallace et al., 2015). As an example, some conservationists have advocated eliminating free-roaming cats from the environment *by any means necessary* (Marra and Santella, 2016) in the interests of biodiversity and survival of endangered wildlife species. This call has been met with intense resistance from community members and animal welfare advocates. Other structural methods to address the presence of free-roaming cats in the landscape are advocated by the National Association of Public Health Veterinarians, and these include educating cat owners to keep their pets indoors, strengthening community commitments to trap-neuter-[vaccinate]-release programmes, and advocating for greater public support for animal shelters (Lynn et al., 2019). Although these solutions are more complicated and likely involve a greater overall expenditure of public and private funds, they are likely in the end to yield better results and be met with greater acceptance.

Examples of One Health initiatives that simultaneously address the health of people, other animals and the environment do exist. The ethical foundations of these programmes are generally implied by their organization's mission statements. One example of the thoughtful scientific, economic and ethical application of One Health is Conservation through Public Health (Conservation through Public Health, 2019) founded by veterinarian Dr. Gladys Kalema-Zikusoka in Uganda. Out of concern for the survival of endangered mountain gorillas, CTPH promotes biodiversity conservation by supporting the coexistence of people, gorillas and livestock in and around Africa's protected areas. Recognizing that survival of this species was linked to the survival of poor local communities whose behaviours encroached upon the animals' habitats, competed with them for food, and served as points of origin and destination for diseases transmissible among human, wildlife and livestock species, CTPH organized Village Health and Conservation Teams (VHCTs) under the Ugandan Ministry of Health. VHCTs promote health,

conservation and community livelihoods by delivering integrated community-based public health services that promote good health-seeking behaviour, hygiene practices, infectious disease prevention and control, family planning, nutrition, and conservation education to individual households. VHCT networks are sustained through group income-generating projects, which are reinvested into Village Saving and Loan Associations that have a special focus on women as the primary influencers of household health.

Another example of a conservation, community and health-centred programme is Health in Harmony (HIH), founded by physician Dr. Kinari Webb (Health in Harmony, 2020). HIH supports communities that abut forest ecosystems in Borneo and Madagascar that are threatened by agricultural practices and extractive industries such as logging. The programme offers incentives to protect the forest and seeks alternative livelihoods and behaviours that lead to economic stability and more sustainable and healthy lifestyles. HIH has paired access to highly valued health care with rewards for forest conservation. For example, people accrue "green credits" if they reduce illegal logging in their communities and these in turn can be used for healthcare discounts at local medical clinics. People are also allowed to pay for services with sustainable non-monetary commodities such as seedlings, manure or handicrafts. Farmers have been provided with training in efficient and eco-friendly organic farming methods that have increased their crop production without requiring more land clearing or the use of chemical fertilizers. Other programmes help to support and bring dignity to marginalized members of the community, such as a Goats for Widows program, provide a source of income, nutrition, animal care and contact for widows who would not otherwise have a means of support. Programme recipients donate goat kids back to support other widows, thereby making this programme self-sustaining. HIH's programmes utilize "radical listening" to ensure that activities and training are focused directly on community needs, thereby utilizing local knowledge and cultural practices.

COVID-19 and a Global Pandemic of Our Own Making

The need for One Health and Welfare is no better illustrated than through the example of our current COVID-19 pandemic. At the time of writing this chapter, the facts surrounding its emergence and global impact are not yet completely understood, however, the story is not a new one and its lessons are clear. The spillover and likely mutation of this terrible virus, from an innocent wild species to one capable of causing a lethal human pandemic, was an inevitable event and long predicted by many scientists studying recent emerging diseases (Afelt, Frutos, and Devaux, 2018; Allen et al., 2017; Jones et al., 2008; Ross, Olveda, and Yuesheng, 2014; Wolfe, Daszak, Kilpatrick, and Burke, 2005). Despite these warnings, society has been unwilling or incapable of changing critical human activities that underlie the threat, or devoting sufficient resources to fully understand and prevent it. Now we are paying a price.

It has been shown that the links between "exploitation, as well as anthropogenic activities that have caused losses in wildlife habitat quality, have increased opportunities for animal–human

interactions and facilitated zoonotic disease transmission" (Johnson et al., 2020). Previous emerging disease events, arguably less lethal but no less preventable, have demonstrated how this happens and the roles that human activity played: HIV emerging from apes and producing the global AIDS epidemic, 38 million people living with HIV in 2020, and 690,000 deaths from AIDS in 2010, decreased from 1.7 million in 2004 (UNAIDS, 2020); H5N1 avian influenza emerging in intensive poultry markets in China, 445 deaths since 2003 (World Health Organization, 2020b); SARS-CoV emerging from a wet market in China with mixed live wildlife species, 775 deaths (Wang et al., 2006); Nipah virus emerging from bats through pigs to humans in Malaysia, Bangladesh and India, 373 deaths (Chattu, Kumar, Kumary, Kajal, and David, 2018); Ebola virus emerging from bats, through apes to humans, 13,308 deaths since 1976 (Centers for Disease Control and Prevention, 2019); MERS-CoV, another coronavirus originating in bats and jumping through camels to humans, 858 deaths (World Health Organization, 2020c). All of these emerging diseases originating in wildlife evolved to spread rapidly from human to human and arose in contexts where humans encroached on or manipulated natural environments. The impact of these pathogens was amplified by human travel and modern lifestyles, and all have threatened to become the events we see today.

Based on genetic analysis, it is currently believed that the COVID-19 virus, technically named SARS-CoV-2, originated naturally in bats (horseshoe bats, *Rhinolophus affinis*) and was either passed directly to humans or through other animals to humans in a heavily human-dominated situation. While the exact conditions for emergence may never be known, two possible scenarios are that it jumped in a rural village setting – perhaps several times – as communities cleared land, built farms and came in repeated contact with bats (Li et al., 2020; Wang et al., 2018a), or that it jumped from bats to another wild species such as pangolins (*Manis javanica*), a species that is traded illegally in China and crowded in captivity in close, unsanitary quarters for the purpose of sale (Andersen, Rambaut, Lipkin, Holmes, and Garry, 2020). The latter scenario is similar to the way SARS-CoV emerged nearly 20 years ago.

Both scenarios raise serious animal welfare issues. Unfettered human development and demands for housing, food and livelihoods lead to unprecedented environmental destruction and bring people and wildlife into unusually close levels of contact. It also induces stress in the animals, either because it disrupts their survival and species sustainability through habitat disruption, creates novel situations that expose them to diseases of people and domestic animals, or because they are trapped, traded, transported (often great distances in unimaginable conditions), sold and slaughtered. Some highly prized species have been traded so extensively that they are on the brink of extinction (pangolin, elephant, tiger and others (Traffic, 2020)). There is no worse example of bad welfare or lack of ethics than that seen in the practice of illegal wildlife trade. In fact, many animals handled in this way die in the process and never make it to markets where profit is generated (Baker et al., 2013; Goodall, 2020; Rosen and Smith, 2010). This is unacceptable under any circumstances and for any reasons.

In spite of the warning shot delivered by the well-documented first SARS-CoV emergence (Wang et al., 2006), nearly the very same scenario has played out yet again, producing SARS-CoV-2 and a rapidly developing global pandemic. This tragedy has been fed by human behaviours that devalue wildlife and other people, particularly those who are poor and powerless, as well as by our collective lack of readiness. Eminent scientists and humanitarians have made it clear that human societies themselves are endangered because of our careless exploitation of the natural environment (Goodall, 2020; Johnson et al., 2020; Kwong, 2020; Quammen, 2020; Vidal, 2020; Watts, 2020).

Allowing human greed and development to proceed unfettered and at the expense of other life on earth has instead increased the risk to our own health and threatens the sustainability of human populations. We have yet to fully experience the impact of this disaster. We need One Health and One Welfare now more than ever.

One Health and One Welfare as Partners

How can the One Health movement and the One Welfare movement support each other going forward? We have argued that One Health needs a robust ethical framework and its current stakeholders may not be well positioned to create such a framework. The One Welfare movement acknowledges that health is a significant component of good welfare and good/optimal health that includes well-being as a shared goal. Both concepts share a broad perspective that includes people, animals (domestic and wild) and the global environment and recognizes the essential interconnectedness among these domains. While there are some differences in focus and emphasis, we believe that neither One Health nor One Welfare should be subsumed by the other and that a lateral collaborative relationship would best serve both enterprises in these early stages. With sufficient foundational support, a merged "One Health and Welfare" concept should be possible in the future. The suggestions that follow might help this process move forward and result in a more equitable and sustainable One Health world.

Initially, an international conference involving a diverse group of One Health and One Welfare stakeholders could launch a dynamic and ongoing relationship focused on identifying overlapping interests and drafting ethical guidelines for One Health practice. Involving experts with broad backgrounds in ethics would help to create balance, identify common ground and draft a pathway to developing a *One Health Code of Ethics*. We suggest using the model of the process that led to the development of the Nuremberg Code as a starting point. After an initial gathering and securing commitments by participants to goals and objectives, working groups comprising a broad range of stakeholders, including the public, could be established to draft a strategic plan that includes benchmarks similar to the United Nations' Sustainable Development Goals (United Nations, 2020). It might also offer incentives to the One Health and One Welfare

communities that would serve to guide ethical human behaviours. The One Health Code of Ethics would be a "living" document with a mechanism for review and adjustment over time as it is applied, tested and reviewed in One Health programmes and in real time. This kind of high-profile meeting could be repeated at regular intervals.

We also suggest that one or more networks, similar to those that were created for One Health in Southeast Asia (SEAOHUN, 2011) and Africa (AFROHUN, 2018), but more inclusive of social scientists and community stakeholders, be created. These would make a broad range of social scientists available to work on existing or proposed One Health activities, thereby providing cultural, ethical and well-being/welfare input. This effort should be extended to public and private sector organizations and entities with significant One Health activities. It would bring welfare issues into focus in agencies that may never have considered them previously, raising the level of awareness and understanding of the need to consider welfare and well-being across the three domains of One Health.

A major theme of the One Health Commission is extending an ethic of respect for all living things through broad educational initiatives aimed at transforming public attitudes about humans' relationship with the natural world (One Health Commission, 2020a). Education needs to happen at all levels, especially among younger children where formative attitudes towards nature are developed that last a lifetime. One Health education promotes attitudes and behaviours that extend beyond typical public health themes of washing hands and eating right. Newly developed curricula incorporate concepts of interdependence and complexity, emphasize responsibility for personal and societal impacts on people and other living things, and reinforce positive human values of stewardship, respect, empathy and humility. This is encouraged through early hands-on environmental experiences, curriculum enhancements to existing programming and themes that focus on the most urgent issues such as climate change, water and air pollution, plastic pollution, habitat destruction, depletion of natural resources and loss of biodiversity. All of these initiatives could and should include elements of welfare and well-being. A One Health and One Welfare education working group could help to ensure that welfare ethics are being taught alongside existing and new One Health educational programming from K-12 through higher education, and build a stronger value-driven ethic for sustainability (One Health Commission, 2020a).

Educational efforts also need to include community-level engagement so that formal educational initiatives find an outlet to transform attitudes in families and communities for maximal impact. Ethical arguments can be very powerful in this context as outreach programmes influence social media and networks, utilize peer pressure and support local-based activities that raise the profile of One Health among members of the general public. The best example of this is the remarkable, global impact a single Swedish teenager and environmental activist, Greta Thunberg, has had on promoting the view that humanity is facing an existential crisis arising from climate change.

Complementing One Health activities with One Welfare perspectives may also lead to greater funding successes and help establish equity more securely among the three domains of One Health. Applying an ethical framework in combination with traditional cause-and-effect models could attract new funding partners that are likewise interested in welfare and well-being. At the same time, it could enlighten traditional funders of the need to embrace broader problem-solving approaches (post-normal science) and more inclusive and equitable rubrics that ensure balanced consideration for all three One Health domains.

Finally, as we consider new ethical frameworks and broader audiences for One Health and One Welfare, it seems like a good time to revise the visual representation of One Health and make its use universal. As discussed above, existing graphical representations of One Health, while useful as the movement has evolved within academic circles, are in need of reimagining so that they reflect more accurately the true relationships among constituents of the three One Health domains. A novel visualization of One Health, as pictured below, places humans in a more dependent and humble position with respect to the rest of the planet. We suggest that the concept and practice of One Health must arise from this understanding of our relationship with the planet.

A more accurate representation of One Health that sets humans squarely within the animal kingdom and both within the environment (Figure 1.2) helps us to rethink our relationships with both. It also leads us to consider different approaches to research on One Health, which have been dominated by epidemiological studies of the impact on people of diseases transmitted from other animals, often without reference to the environment, and to recognize that the environment not only contributes to our health but is eminently worthy of consideration in its own right. Our survival, and that of other living species, depends on it.

Figure 1.2: The One Health World (Art Credit Amy Kaufman, 2020)

Conclusions

One Health together with One Welfare provides us opportunities to extend Schweitzer's Reverence for Life (Schweitzer, 1936) beyond humans and other animals to the environment, incorporate new knowledge and understanding of health and well-being across the spectrum of life on earth, reassess our impact on health in the earth's ecosystems and give us novel tools to better protect and sustainably support good health and well-being in the broadest sense as we move forward in time.

One Health and One Welfare Structured Academic Controversy Model and a One Welfare Approach

Apply the questions below to one of the following scenarios:

1. The origin and evolution of the COVID-19 pandemic;
2. The wildfire disasters on the West Coast of the USA, Australia or the Amazon;
3. Consider a more locally relevant scenario in your area (e.g. earthquake, flood, disease emergency).

Background Information for Students

One Health and One Welfare Book Chapter

Animal Well-Being

1. Identify nonhuman animals, domestic and wild, which are likely to be impacted by the scenario.
2. Identify potential health, welfare and well-being impacts of the event on each of these species.
3. What stakeholder groups should be involved in developing potential actions/responses?
4. Propose potential actions/responses that could be considered in order to minimize the impact on health and well-being of these species.
5. What ethical principles underlie your potential actions/responses?

Environmental Well-Being

1. Identify key environmental components (renewable and non-renewable) that are likely to be impacted by the scenario (consider micro and macro-levels, including global levels where appropriate).
2. Identify potential environmental well-being impacts of the event on each of these components.
3. Propose potential actions/responses that could be considered in order to minimize the impact on environmental well-being of these components.

4. What stakeholder groups should be involved in developing potential actions/responses?
5. What ethical principles underlie your potential actions/responses?

Human Well-Being

1. Identify social, ethnic, racial, economic, cultural and/or religious groups that are likely to be impacted by the scenario.
2. Identify potential welfare and well-being impacts of the event on these groups.
3. What stakeholder groups should be involved in developing potential actions/responses?
4. Propose potential actions/responses that could be considered in order to minimize the impact on health and well-being of these groups.
5. What ethical principles underlie your potential actions/responses?

Synthesis

1. Consider how you might use an interdisciplinary process to *integrate* various actions/responses that you've listed above for the three domains.
2. List various trade-offs that might have to be made, how you might assign value and how you would resolve them.
3. Suggest a set of actions that would optimize One Health and One Welfare of the three domains collectively.
4. Identify a set of ethical principles to guide implementation of your recommended actions.

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