The Association of Fish and Wildlife Agencies and the One Health Approach: Providing the Foundation for a Leadership Role

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Executive Summary

In North America, active management of wildlife populations extend back as far as 25,000 years, originally by Indigenous cultures and later by colonizing Europeans. The earlier patterns of European exploitation disrupted or destroyed many Indigenous societies and ushered in a period of major depletions and extinctions of wildlife and other living resources. By the late 19th century, however, a reactionary and highly successful system of wildlife conservation had developed. Central to this effort was a rising class of recreational hunters who advocated for, and eventually helped fund, a regulated, user-based system of wildlife conservation, recognized today as the North American Model of Wildlife Conservation. This Model very much emphasized human custodianship over nature.

Today, while the fate of North American wildlife is again at a crossroads, overexploitation is no longer a primary threat. Instead, habitat alteration and destruction, largely caused by direct human intervention, as well as changing climate influences and disease, have emerged as primary threats to terrestrial biodiversity. At the same time, as humans have continued to occupy and manipulate greater expanses of wildlife habitat, the risk of infection from zoonotic diseases has greatly increased, as illustrated by the recent outbreaks of COVID-19, SARS, and Monkeypox, for example. These highly disruptive diseases have proven significant motivators for the emergence of a new and more inclusive view of nature's future, one that includes human beings as an integral and interdependent component. This new vision, now embraced by growing numbers of international institutions and conventions, is termed 'One Health'.

The One Health philosophy is founded on the principle that human health is dependent upon animal health (both wild and domestic) and ecosystem health, and that all components must be addressed in a cohesive, comprehensive manner to support and improve global health security. While leaders in the human health and domestic livestock arenas have emerged, there is a need for greater representation from the fish, wildlife, and habitat sectors in North America and, most especially, globally. This circumstance provides a unique opportunity for the Association of Fish and Wildlife Agencies (AFWA) to position itself as a leader in this space to safeguard both wildlife and human health via the One Health approach; but also, importantly, through such engagement, to bring fish and wildlife management issues to the forefront of policy makers' agendas and, at the same time, capture a wider community of interest in the issues and realities facing wildlife and wildlife agencies. This all comes at a propitious time, considering that there has been increased engagement by the public in outdoor recreation (both consumptive and non-consumptive) because of the social circumstances spurred by the recent Covid-19 pandemic.

In this paper we provide a comprehensive overview of the One Health approach and provide context for AFWA's engagement with this concept, particularly as a leader in the space. In doing so, we refer to institutional underpinnings such as the North American Model of Wildlife Conservation, while referencing not only the efforts AFWA and its member organizations have already ventured in the One Health and animal health arenas, but also the connectivity between One Health and AFWA's deliberations and actions towards social relevancy.

Please note that this document is limited by its scope. It is based upon an outline agreed to, and with input from AFWA leadership. One Health, however, is an idea whose time has come; and, worldwide, there is an explosion of interest and uptake surrounding this concept. As a result, there is much more that could be articulated regarding the history of One Health, it's current state of play in the international sphere, and synergies between One Health and AFWA's mission and core mandate. Likewise, much more could be said about new partnership opportunities for AFWA, and of challenges, at least in the short term, should AFWA take truly affirmative action in the One Health space. Nevertheless, this is a lengthy document, designed primarily to stimulate thought and discussion within AFWA's membership. In consideration of this, the end of each section contains a box summarizing the main points. For those requiring a quick read of the document, these summaries offer accessible insight to its primary points.

Setting the Stage: Wildlife Management and Conservation in the United States and Canada

Humans successfully colonized North America sometime between 25,000–13,100 years ago (Gugliotta, 2013). Despite a relatively open landscape, ripe with extremely dangerous predator and herbivore megafauna including dire wolf, Siberian tiger, giant sloth and beaver (the latter of which grew over 8 ft in length), humans were able to adapt to the environment over time (Geist & Mahoney, 2019).

Approximately 13,100 years ago, early humans became so skilled at hunting mastodon and mammoth through the use of poison-tipped spears and atlatls, that they likely contributed to their extinction (Geist & Mahoney, 2019; Ansell, 2021). Shortly thereafter, humans shifted their hunting activities to primarily target bison, and influenced that species' evolution from a larger and aggressive species, more likely to confront predators, to the somewhat smaller and more escape-prone form we recognize today (Geist & Mahoney, 2019). It took, seemingly, just a few thousand years for North America's original human inhabitants to radically reduce and alter the continent's biodiversity.

For the next thousand years or so, humans would sustain themselves through the harvest and use of many species familiar to us today, such as the moose and white-tailed deer. Already highly skilled hunters, Indigenous Peoples also developed great skill in establishing deliberate fire regimes to prevent uncontrolled wildfire, to improve their ease of travel across landscapes and to favour the growth of edible plants and the populations of preferred prey species (Geist & Mahoney, 2019). Thus, active management of North America's wildlife populations has a very long history indeed, predating that of later European cultures by thousands of years.

Beginning approximately 10,000 years ago, humans developed and increasingly relied upon agricultural food production, which facilitated greater population growth and densities (Koch et al., 2019). This ecological shift occurred globally and included established North American cultures. While various estimates have been developed, prior to European colonization, Indigenous Peoples living in what is today the United States (US) and Canada probably numbered between 2.8–5.7 million, though estimates vary (Koch et al., 2019). Such a population necessitated considerable exploitation of natural resources and land, likely contributing to depletion of some wildlife populations, and in some regions more than others. Certainly, the very first Europeans to travel to North America in the 1500s noted few animals, but plenty of hides used for warmth and clothes by the inhabitants they encountered (Geist & Mahoney, 2019; Koch et al., 2019). This scenario of wildlife scarcity is very different from what other Europeans observed only 200 years later.

During the 16th and 17th century, widening contact with Europeans brought disease (most notably smallpox), deliberately in some cases, which decimated Indigenous Peoples, reducing their populations by 90%, in what is known and preserved in Indigenous oral history as the "Great Dying". This reduction in human populations was so severe that it resulted in dramatic landscape changes and a significant increase in vegetation, which may have reduced the amount of atmospheric carbon dioxide globally by 3.5ppm (Koch et al., 2019). It is not surprising, therefore, that following the Great Dying, wildlife in North America experienced a population resurgence, resulting in the Eden described by European colonists in the 18th century.

Following European colonization, wildlife and other living natural resources were excessively exploited for food, fur, and other products. During the 18th and 19th centuries, old-growth timber was harvested without limitation and market hunters made a living by hunting and selling animal hides, meat, and other products (e.g., bowhead whale for their baleen, elk for their teeth in the enamel market, and a variety of birds for their feathers in the millinery trade) (Sandlos, 2019; National Oceanic

and Atmospheric Administration, 2022). This resulted in the decimation of virtually all game species, and the extirpation of numerous others (great auk and passenger pigeon), including some well-recognized subspecies of large mammals (Merriam's elk and Audubon bighorn) (Mahoney & Jackson, 2013; Di Minin et al., 2021).

With the industrial revolution, the advent of railways in North America, and with urban markets expanding and people travelling further westward into the continent, pressures on wildlife increased even further. During this period, the annual bison harvest, for example, increased from 1 million in 1833 to approximately 5 million in the 1860s (Brown, 2010; Organ et al., 2010). This European exploitation of wildlife, and bison in particular, was not only driven by human commerce, but also by an extended war over land rights and ownership between European colonists and the continent's Indigenous Peoples. As part of the US army strategy, the killing of bison was encouraged, with the goal being the elimination of a critical food source for numerous Indigenous tribes and communities (Phippen, 2016; Geist & Mahoney, 2019). Once numbering between 30-60 million, by 1886 it was estimated that only 540 bison remained in the US (Brown 2010).

These were the culminating days of a devastating wildlife slaughter in North America, conducted at virtually a continental scale, and one that would eventually set in motion a social upheaval that would lead to the modern wildlife management systems we know today. For, by the mid-to-late 19th century, the striking scarcity of once-abundant wildlife could no longer be ignored. Broad agitation on behalf of wildlife slowly took root and a new class of "sport hunters" emerged and lobbied against market hunting and for the conservation of game species, in particular. They soon became organized and in 1887 two prominent leaders of the rising conservation movement, George Bird Grinnell and Theodore Roosevelt, helped found the Boone and Crocket Club, an organization tasked to promote hunting, exploration and natural history, as well as, crucially, to preserve big game animals by influencing conservation policy (Reiger, 2005).

The Boone and Crocket Club was successful in spearheading many important conservation efforts, including influencing the Lacey Act of 1900, making it illegal to transfer illegally hunted wildlife across state borders; the Migratory Bird Treaty of 1916, preventing the overharvest of migratory birds; and the formulation of the first national forests in North America (Organ et al., 2010). But the sport hunters and their early flagship, the Boone and Crockett Club, were not alone. Many efforts and varying philosophical ideals were mobilized to safeguard wildlife and protect wild areas. These well-intentioned early efforts, which were often inspired by transported European values, were to make some tragic mistakes along the way. For example, the establishment of parks and protected areas, led, yet again, to many Indigenous Peoples being forced off their ancestral lands and excluded from stewardship and economic opportunities (Krakoff, 2020). Furthermore, the overzealous focus on recovering huntable game species at the time sometimes inadvertently resulted in harming entire ecosystems, as unlimited hunting of predators was widespread and encouraged by bounties, resulting in overgrazing by herbivores, leading to starvation and landscape disfigurement (Carmony, 2014; Sandlos, 2019).

This mixture of success and failures in early conservation efforts took place against the ongoing tide of broader social change. Indeed by 1860, 80 % of the US population was already living in urban centers while a mere 5% were located there only forty years before (Organ et al., 2010). Various demographic and cultural value shifts resulted and had significant roles to play in conservation and wildlife management efforts. By 1955, sport hunters represented only ~10% of the American population (US Department of the Interior & US Fish and Wildlife Service, 1955). Around the same time, the importance of 'nongame' species was increasing in the public eye, and hunting began to attract criticism, despite its important role in helping establish and maintain conservation in North America. Further, the

study of biology and ecology were gaining acceptance and conservation efforts started to consider the health of entire ecosystems, including the role of predators and the effects of habitat fragmentation on animal populations. In 1967, the first list of endangered species with federal protection was published in the US and, in 1975, the first conference for the management of nongame species was held (Mahoney & Jackson, 2013; Mahoney et al., 2015). Recreational hunters and anglers, however, continued to play, through various specific taxes and fees, a dominant role as the primary source of dedicated funding for conservation (Arnett and Southwick 2015).

Through the various efforts to preserve wildlife and wild areas, eventually, a recognizable system of conservation policies, laws and institutions gradually emerged in Canada and the US. Now referred to as the North American Model of Wildlife Conservation (NAM), the system was, in fact, developed over the late 19th and early 20th centuries. In 1995, Geist outlined and gave explicit description to the NAM by articulating the 7 principles underpinning the broad process of conservation that still largely applies in North America today (Geist, 1995). While the wording of these tenets varies slightly when described in publications (e.g., Mahoney, 2004), they are essentially as follows:

1. Maintaining wildlife as a public trust resource, entrusted to the state to manage.
2. Prohibiting deleterious commerce in dead wildlife products.
3. Regulating and defining appropriate wildlife use by law.
4. Ensuring wildlife can only be killed for legitimate purpose.
5. Recognizing and managing wildlife as an international resource.
6. Utilizing and safeguarding science as the appropriate basis for wildlife policy.
7. Protecting the democratic allocation of public opportunity to harvest wildlife.

Though modifications have gradually been applied over time, the NAM is still the guiding wildlife management philosophy and practise in use in the US and Canada today and it has proven a highly successful model, certainly for game species and their habitats. Indeed, the NAM can be credited with some incredible species recoveries (Hewitt, 2015; Hughes & Lee, 2015; Hurley et al., 2015; Mahoney & Jackson, 2013).

The NAM has also enabled and facilitated a management and conservation approach that has historically been supported by a reliable funding mechanism and has produced direct, meaningful societal contributions, both to food security and the economy (Arnett and Southwick, 2015; Tufts et al., 2015; Conservation Visions, 2019). For this reason, the NAM may also be used as a prescriptive model to guide management and conservation efforts in other regions.

Of course, the NAM is not without its challenges. The conservation perspective applied largely to terrestrial ecosystems in the model's formative years was similar, in some ways, to that of commercial fisheries now: to maximize the yield of animals that can be sustainably harvested, ensuring a maximum harvest in perpetuity (Sandlos, 2019). While the model has adapted to consider entire ecosystems, it is still largely rooted in a utilitarian ideology, which may not require balanced conservation efforts for lesser-known or less-valued species. In the US and Canada, for example, there are currently 592 animal species that are endangered, critically endangered, or extinct in the wild, and virtually none of these are game animals; instead, they are species such as rice's whale, kemp's ridley and hawksbill sea turtles, the ivory-billed woodpecker, the salt-marsh harvest mouse, the Wyoming toad, and the yellow-breasted Bunting (IUCN, 2022). From a biodiversity perspective, these circumstances can only be viewed as failings, of the NAM itself, or the narrower vision with which it has been applied.

Furthermore, the NAM has historically failed to consider and integrate the needs, culture, and knowledge of Indigenous Peoples (Sandlos, 2019; Mahoney, Geist and Krausman, 2019; Krakoff, 2020; Hessami et al., 2021).

The Migratory Birds Convention Act of 1917, for example, originally prohibited the hunting of waterfowl until September 1, by which time, migratory birds in Northern Canada had already migrated south, leaving northern residents unable to legally harvest migratory birds (Sandlos, 2019).

Just as the NAM has adapted and evolved over time, it must continue, through reflection and foresight, to do so now, if we are to ensure the continued success of conservation in North America for both nature and people.

In Brief: Wildlife Management and Conservation in the United States and Canada

From a historical perspective, conservation in North America has transitioned from the earliest engagements, impact and management by Indigenous Peoples through the complex and difficult history of colonial conquest and an intense overharvesting of wild resources to a model of conservation largely built on the utilitarian values of sustainable harvest for the recreational user. While the vital connections between people and their natural environment were certainly a part of this evolution in context and approach, it is also true that in large measure our North American approach, post colonialization, placed people in a position of authority and responsibility over nature, rather than emphasizing our fundamental integration with, and reliance upon, the natural world. The latter was certainly a more prominent aspect of Indigenous thought.

Society and the Environment: Some Challenges and Implications for North American Conservation

During the inception of the NAM in the late 1800s and early 1900s, overharvest was perhaps the greatest threat to terrestrial biodiversity (Mahoney & Jackson, 2013). Today, terrestrial wildlife face very different challenges. We are living in a time of exponential human population growth, resulting in unprecedented climate change and habitat destruction. Since 1967, the world population has more than doubled. To meet the demands of a growing human population, we have lost 800,000 km^2 of forested land and gained 1,000,000 km^2 of agricultural land since 1960 (Winkler et al. 2021). Currently, 49% of the ice-free land surface on Earth is devoted to agriculture alone (IPCC 2019).

Unsurprisingly, the greatest threat to terrestrial biodiversity is now habitat change (IPBES 2019). Therefore, while the NAM has succeeded by actively managing game species, largely eliminating overharvest as a threat to terrestrial biodiversity in North America, biodiversity on this continent and elsewhere is now threatened with other daunting challenges.

Just as the last 70 years has brought immense ecological change, societal change has also occurred. Conservation policy and decisions are now influenced and scrutinized by an international community. The US and Canada are both members of legally binding international treaties such as the Convention on Biological Diversity (CBD), and are influenced by other international conservation entities such as the International Union for Conservation of Nature (IUCN) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Fish and wildlife management and conservation policy increasingly needs to serve and engage not only the country within which they operate, but also an international public comprised of many different cultures and values.

Complicating this increase in population growth are factors such as urbanization and technological development which have pushed humans further away from nature, creating an unprecedented human-nature divide and a gradual loss in direct natural harvesting by a majority of people. For example, there are now *relatively* far fewer recreational hunters in the US than previously. In 1955, there were 11.8 million, representing approximately 10% of the US population at that time (US Department of the Interior & US Fish and Wildlife Service, 1955). Since then, however, the hunting participation *rate* has steadily declined and, in 2016, the national survey reported 11.5 million hunters – but these now represent only 3.6% of the US population (US Fish and Wildlife Service, 1999; US Department of the Interior et al., 2018).

Furthermore, while hunting participation has already decreased, both hunting and angling participation will almost certainly decrease further in the future. The proportion of hunters and anglers aged over 45 years increased by 24.3% to 59.6% for hunting, and by 30.0% to 58.5% for angling, from 1991 to 2016 (US Department of the Interior et al., 1993; US Department of the Interior et al., 2018). These data demonstrate that not only are fewer young people participating in recreational hunting and fishing, but they also warn of a further and almost certainly rapid reduction in participation in the foreseeable future, due to the existing community effectively ageing out. Trends are likely similar for Canada, which indicates important structural weakness in the existing North American conservation approach.

Concomitant with a reduction in recreational hunting and angling participation there is also a direct reduction in conservation funding generated through excise taxes, hunting and angling license fees and donations, which are the predominant contributors to wildlife agency capacity in many US states. Even as additional sources of funding are pursued and considered likely (e.g., Recovering America's Wildlife Act), a significant loss of hunting and angling conservation dollars would still pose a daunting challenge.

Another consequence of the reduction in hunting and angling participation is that it will likely lead to a further loss of knowledge among the general public of how fish and wildlife conservation actually work in North America. It is true to say that the linkages between conservation and recreational hunting and angling are not well-known by the public. In fact, many people believe that hunting and conservation are contradictory and may even stop funding conservation organizations when they learn of their connections to hunting (Mahoney and Cobb, 2010). Hunters and anglers may not be experts in conservation policy and practise, but, as a group, they generally are somewhat informed. Losing this constituency is therefore problematic. Indeed, the generally poor public understanding of conservation has significant implications for the NAM and is one that can only be overcome through increased public education and awareness.

But many other aspects of our human-animal interactions have consequences for how we perceive and value wildlife and, therefore how society may perceive what best conservation practices are. Significant among these are zoonotic diseases and their implications for human health. As a consequence of our increasingly globalized world, rapid population growth, and human-induced landscape intrusions and alterations, there has been a growing number of zoonotic disease epidemics and pandemics of increasing concern, including avian influenza, Lyme disease, chronic wasting disease, West Nile Virus (Mahoney and Cobb, 2010), and the more recent, high-profile and globally disruptive COVID-19 and, now, monkeypox, outbreaks, to name just some. These wildlife-harboured diseases have led to calls by some international and more animal protectionist leaning organizations for an end to all wildlife harvesting and consumption.

Of course, there are other threats posed by wildlife to human health and livelihoods, besides potential diseases. Such negative human-wildlife interactions and conflict include animal-vehicle collisions, predator attacks on humans, and private property destruction due to abundant or overabundant species. These factors

can also translate into negative perceptions of wildlife and, thereby, have implications for conservation in general, for sustainable-use activities like recreational hunting and for wildlife itself. These threats and negative interactions with wildlife can threaten the very willingness of society to engage in conservation efforts at all.

The social realities of conservation today also involve private property rights and a growing debate over how far these extend towards wildlife. A great percentage of North America's wildlife spends some, much or even all of its time on private lands, which, in fact, make up the majority of all landscapes in the United States. This has sometimes resulted in property owners creating their own conservation strategies in accordance with their own wildlife values and land-use needs. This has also enabled various forms or tendencies towards wildlife commercialization, private ownership, and genetic engineering of wildlife via game farms, hunting leases, and artificial selection to increase antler size (Mahoney et al., 2015).

The privatization of wildlife threatens various tenets of the NAM and, in certain cases, may result in the *de facto* domestication of wild species and shifting management responsibility of the species from wildlife agencies to the agricultural sector (Brennan et al., 2019). While such wildlife privatization is often a highly contentious issue, to conserve species in an increasingly privately owned world means that effectively addressing private land conservation, as well as private property rights, will be essential.

While the NAM has enjoyed successes, society has changed, and the model must change with it in order to remain relevant and effective. In the 21st century, the goal of fish and wildlife management cannot be solely to preserve fish and wildlife for our continued ability to utilize it, nor for its inherent beauty; rather, fish and wildlife conservation must be articulated as a requirement for humanity's health and wellbeing. The NAM must address key challenges stemming from the harsh realities of exponential human population growth and development, such as habitat loss, zoonotic diseases, an increasing human-nature divide, and decreasing funds for conservation. For effective management and conservation moving forwards, conservation entities will need to work together with public health professionals, ecologists, private landowners, and the public to protect both game and non-game alike, as well as the ecosystems in which they reside.

In Brief: Some Challenges and Implications for North American Conservation

Wildlife in North America currently faces very different challenges than it did when the North American Model of Wildlife Conservation (NAM) was developed. From an ecological perspective, there are twice as many people as there were only 55 years ago, vastly increasing our demands for agriculture and other uses of wild land. Habitat change, therefore, currently puts far more pressure on terrestrial wildlife populations than overharvest. Further, humans have changed their relationship with nature, and their values towards wildlife, such that hunting is not attractive to, nor seen as an incentive for wildlife conservation for, the vast majority of people; and may not be a reliable source of funding for conservation in the future. At the same time, issues of wildlife disease and human wildlife conflict, as well as increasing demands for private property benefits to encompass some form of commercial exchange in wildlife are vital issues that have assumed high prominence in public debates over wildlife's future status. To ensure wildlife conservation in perpetuity, the NAM will need to adapt.

Introducing the One Health Approach

One Health is not a new concept, although the recent enthusiasm for the idea might suggest that it is. In reality, though, the notion has no clear first origin in human thought; but, certainly, its foundational elements of human, animal and environmental interdependence have intruded and occupied a lingering relevance over the course of time. From the spiritual beliefs of Indigenous cultures to the writings of Hippocrates and Aristotle and on through the works of various 18th and 19th centuries' specialists in human and veterinary health, we can easily see this critical awareness of our human vulnerability being described in a wider environmental context. This connection was to be much more forcibly articulated in broader scientific terms in the 21st century as the focus on both ecological and environmental factors became key elements of human health discussions (Evans and Leighton, 2014).

Zoonotic diseases have certainly been the primary catalyst for much of this thinking, as the world has come to realize that the majority of such diseases originate in animals, and most often in the wild. But recognizing that human-induced changes to landscapes and land use, urbanization, climate alterations and increased international travel and trade, are clearly the main drivers of the emergence and transmission of these diseases has forced global authorities to seek broader understandings to facilitate improved risk assessments and responses (Taylor et al. 2001). These broader understandings, have in turn, required multi-disciplinary approaches that embrace knowledge once considered far outside the medical and health disciplines.

It is important to recognize that North American scientists have contributed significantly to this wider ecological and health-relevant research, including Robert MacArthur whose contributions to landscape and community ecology are legendary (Fretwell, 1975), Aldo Leopold whose writings on land use and wildlife management (Leopold, 1933) and timeless philosophical writings in Sand County Almanac (1949) so clearly identified human-nature interdependence, and Valerius Geist, who in 1978 published a major work, *Life Strategies, Human Evolution, Environmental Design: Toward a Biological Theory of Health*, which focused directly on human biology and health from an environmental perspective. Thus, while the One Health approach may have seemed distant from the North American world of applied ecology and wildlife management, this is certainly no longer the case; and, in fact, it never was.

The term 'One Health' first came to common usage in the 2003-2004, and was associated with major outbreaks of severe acute respiratory disease (SARS) and the avian influenza H5N1. The irrefutable evidence provided through study of these viral outbreaks indicated that these diseases were arising at the interface of human and animal ecosystems, leading to the founding of a One World One Health concept at a conference convened by the Wildlife Conservation Society at Rockefeller University in 2004. A series of strategic goals known as the 'Manhattan Principles' derived at this meeting clearly linked human and animal health and the threats these zoonotic diseases posed to not only human health but also to food supplies and economies. By 2008, UN agencies and the World Bank had drafted a strategy framework based on these interconnections, making it clear that these could only be effectively addressed in a coordinated manner (Woldehanna and Zimicki, 2015). Eventually the One World One Health terminology would be foreshortened to One Health.

Still, today, there is no universally agreed upon definition of One Health. However, the many definitions that do exist share much in common. Two that will cover the topic sufficiently are those provided by the US Centers for Disease Control and the One Health Commission; and the One Health Institute of University of California at Davis, respectively.

The first is: 'One Health is defined as a collaborative, multisectoral, and transdisciplinary approach – working at the local, regional, national and global levels – with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants and their shared environment'. The second and much simpler states: 'One Health is an approach to ensure the well-being of people, animals and the environment through collaborative problem solving – locally, nationally and globally' (Mackenzie and Jeggo, 2019).

What all definitions of One Health basically articulate is that the health of the planet and all natural systems and life forms are co-dependent and interconnected, emphasizing that this includes the health of humanity and our systems of economic and social support. In one sense, the simple logic of these definitions may serve to mask the importance and strategic benefits of adopting a One Health approach. However, effective and adaptive change is not always based upon complexity. Sometimes subtle to moderate changes in emphasis or approach can lead to very effective outcomes. Our efforts for wildlife conservation in North America have demonstrated this on many occasions. The synthetic nature of One Health and its conceptualization of a coordinated and multidisciplinary approach to landscape, animal and human health is of direct benefit to such efforts in that it links biodiversity recovery, applied wildlife management, and environmental restoration to the urgent issues arising from human population increases and associated resource demands. Such demands and their outcomes for wildlife lie at the heart of our conservation challenges on this continent, and elsewhere, and we have long recognized that, despite our best efforts to restore, manage and conserve wildlife, many economic and social forces lie outside our capacity and expertise.

Embracing a One Health approach and its reliance on shared expertise and knowledge, as well as institutional connectedness, could greatly increase the wildlife community's leverage in these wider areas of ecological relevance and intrusion, something long hoped for. At the same time, meaningfully contributing the unique knowledge wildlife agencies have developed over more than a century of legal responsibility for wildlife conservation would be of great value to the One Health movement. Further, having such knowledge integrated within human health discussions could only increase the relevance and profile of wildlife management in wider social discussions.

There is, further, the issue of wildlife management's own burden of social responsibility. One Health looks at cause and effect across the central issues of human and animal populations and ecosystems and how these dynamics influence such urgent issues of human food security and emotional well-being, economic prosperity, and security. While the One Health concept may be challenging for many existing institutions, including those focused on sustainable wildlife management, can there be any question that responsibility for wildlife and human health must be accepted and shared by all of us?

In Brief: Introducing the One Health Approach

The philosophy behind One Health extends back to Indigenous cultural beliefs and was carried forward by many influential thinkers from classical to modern times. Emphasis was originally placed on relevant environmental issues contributing to the origin and spread of pandemic diseases but the 20th century saw a major expansion in thinking that brought greater emphasis on wider ecological issues. North American wildlife scholars played key roles in helping provide this ecological context. The actual term 'One Health' is a shortened version of 'One World One Health', both terms originating in the first decade of the 21st century and following critical discussions of the SARS and H5N1 viral outbreaks of that time. Embracing the One Health approach and bringing wildlife management expertise into wider interdisciplinary discussions could be of significant advantage to biodiversity conservation, in general, while also increasing the profile and social relevance of wildlife agencies themselves.

One Health and the North American Model of Conservation

The NAM was developed to conserve wild animals. In the formative years of the NAM, the biggest threat to wildlife was the overharvesting of species. Perhaps ironically, recreational hunting became the foundation of the NAM, the means through which wildlife was conserved (Mahoney & Jackson, 2013). To enable wildlife conservation, recreational hunting acted as both the funding source for conservation and the incentive for the public to care about wildlife conservation (Arnett & Southwick, 2015). Importantly, the NAM was founded upon a utilitarian approach towards wildlife, with the ultimate goal of conserving wildlife itself, but not per se the wild places in which they inhabit, though this was a component of conservation *writ large*.

Thus, historically, the NAM has embodied certain preservationist philosophies, as seen through the creation of national parks and forests (Mahoney et al., 2015); however, conserving wild areas is not a fundamental, stated goal of the NAM, but is an understood necessity for conserving wildlife, nevertheless — there can be no wildlife without wild places. The respective weight of use versus protection is evident within the model's 7 tenets, as none of these directly speak to the importance of maintaining wild spaces, habitats, or ecosystems to wildlife conservation.

One Health has a very different goal than the NAM. At its core, the goal of One Health is anthropocentric: to improve and preserve human health. The One Health approach aims to improve human health through two general approaches. First, by ensuring the health of wild and domestic animals, because zoonotic diseases in animals can jeopardize human health. Second, by ensuring the health of wild ecosystems, not just because they are essential for animal health, but because they provide mental and physical health benefits to humans and contribute to the public's overall well-being via the many ecosystem services they provide. Such ecosystem services include, but are not limited to, food security, regulation of air and water quality, and the regulation of climate, hazards and extreme events (IPBES, 2019). Therefore, unlike the NAM, One Health explicitly emphasizes the importance of animal health and ecosystem health to its goal of achieving human health, even though both of these factors are just as critical to the goal of the NAM, the conservation of wildlife.

Despite the different goals of the NAM and One Health, there is considerable overlap between the two, in that both depend on the same fundamental principles: healthy domestic and wild animals and healthy ecosystems. Disease among domestic animals frequently transfers to wild species, humans can be reluctant to hunt animals with diseases transmissible to humans (for example Chronic Wasting Disease), and wild animals cannot exist without healthy ecosystems (Jori et al., 2021). Further overlap occurs as, fundamentally, the NAM is also dependent upon human health, without which there could be no recreational hunting, and no wildlife conservation.

If wildlife conservation were to take on a One Health approach, perhaps it would require, among other things, revising the NAM to include two new fundamental tenets: ensuring the health of wild and domestic animals, and maintaining healthy ecosystems to ensure animal and human health. While both were always implicit requirements, taking on a One Health approach would enable these tenets to be made explicit. In doing so, a greater focus could be placed upon these two tenets — to the benefit of wildlife conservation and people. Doing this would require partnerships within the human health and agricultural sphere to prevent zoonotic epidemics at the human-animal interface and at the wild-animal–domestic-animal interface. It would also require conservation efforts to focus on ecosystem health and the conservation of ecosystems themselves, in addition to animals.

Similarly, international wildlife conservation policy may recognize that conservation policy anywhere can impact conservation outcomes everywhere, again emphasizing

the interdependence of systems, of thought processes, of policy development, and of nature itself. The emergence and spread of zoonotic diseases may create epidemics and pandemics among animals and humans, and habitat change in far-away places can impact climate, air and water quality locally, increasing the frequency and intensity of calamities, such as wild-fires — all of which impact wild animal conservation. It is clear that integrating a One Health approach is not only necessary for human health, but also for wildlife conservation as well.

In Brief: One Health and the North American Model of Conservation

One Health and the North American Model of Wildlife Conservation (NAM) share different goals, but are ultimately linked in the mechanisms through which they aim to accomplish their goals. Both human health and wildlife conservation depend upon the health of wild and domestic animals, and the prevalence of healthy ecosystems. Integrating the One Health approach into the NAM would involve a recognition of the interdependence between human health, animal health, ecosystem health and wildlife conservation, and would require the NAM to explicitly broaden its focus to strengthen these interrelated entities.

Leadership in the One Health space

Worldwide, One Health has been encouraged and modelled primarily by international health agencies. Leading the charge have been the World Health Organization (WHO), World Organisation for Animal Health (WOAH; initially founded as the Office International des Epizooties [OIE]), and the Food and Agriculture Organization of the United Nations (FAO). Together, in 2010, these agencies formed a tripartite to address health risks stemming from the human-animal-ecosystem interface (FAO, OIE, & WHO, 2010). Since 2011, they have provided guidance to support countries in taking a multisectoral, One Health approach to address zoonotic diseases (World Health Organization, 2019).

In 2019, the Tripartite developed the *Tripartite Zoonoses Guide*, a global effort of more than 100 experts worldwide, that provides guidance and best practices for addressing zoonotic diseases. The guide assists with disease surveillance, risk assessment, communication, response and more (WHO, 2020). To compliment the guide, three operational tools (OTs) have since been developed: the *Multisectoral Coordination Mechanism OT*, the *Joint Risk Assessment OT*, and the *Surveillance and Information Sharing OT*. These tools are designed to support national capacity for preparedness and response to emerging zoonotic diseases, and ultimately link to existing international policies and frameworks with regional health approaches (Multisectoral coordination mechanisms operational tool, 2022).

In November 2020, the Tripartite met with the United Nations Environment Programme (UNEP) during the Paris Peace Forum to address the inherent links between human health, animal health, and environmental health (World Health Organization, 2021). The discussion focused on these interconnections, as well as the related vulnerabilities in our current approach to health, as demonstrated by the COVID-19 pandemic. The discussion ultimately led to the creation of a multidisciplinary One Health High-Level Expert Panel (OHHLEP) (WHO, 2021). Supported by the governments of Germany and France, OHHLEP consists of 26 diverse experts, chosen by the Tripartite and UNEP, who are tasked to "collate, analyze, disseminate, and highlight" relevant scientific data to inform the public and guide formal decision-making processes regarding public health crises (Government of France, 2021).

In 2022, the Tripartite partnership for One Health formally became the Quadripartite as it signed a Memorandum of Understanding with UNEP. The Memorandum of Understanding notes that UNEP "sets the environmental agenda and promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations (UN) system and serves as an authoritative advocate for the global environment" (WHO & UNEP, 2022). The newly expanded alliance will focus its work on creating a One Health Joint Plan of Action, which will include 6 action items:

> *"enhancing countries' capacity to strengthen health systems under a One Health approach; reducing the risks from emerging or resurfacing zoonotic epidemics and pandemics; controlling and eliminating endemic zoonotic, neglected tropical or vector-borne diseases; strengthening the assessment, management and communication of food safety risks; curbing the silent pandemic of antimicrobial resistance (AMR); and better integrating the environment into the One Health approach"* (WHO & UNEP, 2022).

OHHLEP is providing support and advice to develop the Joint Plan of Action.

In 2021, the IUCN, the world's largest and most diverse environmental network, collaborated with WHO, and the Friends of Ecosystem-based Adaptation (FEBA), a global collaborative network of more than 90 agencies and organizations working on ecosystem-based adaptation, to establish a new expert working group (EWG) on Biodiversity, Climate, One Health, and Nature-based Solutions (IUCN, 2008; IUCN 2021; FEBA, 2021).

The EWG will develop guidance and tools to support the operationalization of One Health approaches and Nature-based Solutions by:

1. Identifying co-benefits and trade-offs for human and ecosystem health;
2. Strengthening social and ecological resilience; and
3. Supporting a healthy, green and just recovery from COVID-19 (IUCN, 2021).

In pursuit of its goals, the EWG will examine the relationships between biodiversity, ecosystem degradation, climate change and infectious disease emergence; promote the linkages between human health and biodiversity; support a transition towards sustainable and healthy food systems; evaluate climate change as a cross-cutting driver and amplifier of ecosystem degradation, biodiversity loss, and human health; and take actions to operationalize the One Health approach (IUCN, 2021).

Existing One Health initiatives at the US federal level include the One Health Office established by the Centers for Disease Control and Prevention (CDC), and the One Health Coordination Center established by the United States Department of Agriculture's (USDA) Animal and Plant Health Inspection Service.

The CDC's One Health Office works within the United States and in other countries, partnering with state, local, tribal, and territorial governments, as well as with industry, professional organizations, academia, and nongovernmental organizations to:

- Coordinate partners to address One Health challenges
- Prepare for and respond to outbreaks and public health emergencies, such as Ebola, Zika, and COVID-19
- Build One Health capacity and strengthen global health security through training and tool development
- Strengthen surveillance and information sharing across public health, agriculture, wildlife, and other sectors
- Educate people on ways to prevent diseases they can get from pets, wildlife, and farm animals
- Develop guidance for veterinarians, public health officials, wildlife professionals, animal

health officials, and many others (*One Health, CDC's One Health Office: What We Do*, 2022).

CDC's One Health experts are also working globally to implement a One Health Zoonotic Disease Prioritization process that builds collaboration across disciplines and sectors to focus limited resources on preventing, detecting, and responding to zoonotic diseases of greatest national concern (*One Health, CDC's One Health Office: What We Do*, 2022).

The CDC works closely with the USDA, the Department of the Interior (DOI), and other federal agencies, such as the United Stated Geological Survey (USGS), to exchange information and coordinate One Health activities across the US government (USGS, 2021). USGS has been promoting and prioritizing a One Health approach since prior to 2015 and its National Wildlife Health Center has fully embraced the concept in its planning and operations as it conducts surveillance and research to respond to zoonotic diseases (USGS, 2015; USGS 2021).

Importantly, the CDC, USDA, and DOI are currently working together and with other federal partners to create both a One Health framework and coordination mechanism at the federal level, in response to the 2021 Omnibus Appropriations Bill (*One Health, Federal One Health Coordination*, 2022). The United States Fish and Wildlife Service (USFWS) is a partner in this effort. USFWS's One Health Approach mandates that it works closely with experts in public, animal, and ecosystem health to develop comprehensive plans and appropriate responses to disease events (Kauffman, 2022). It's Zoonotic Disease Initiative, launched in April 2022, is a first-of-its-kind grant program, focused on wildlife disease prevention and preparedness, that has been authorized under the American Rescue Plan (2021, H.R. 1319, Section 6003.3) to provide $9 million in available funding to US states, Tribes, and territories to "strengthen early detection, rapid response, and science-based management research to address wildlife disease outbreaks before they cross the barrier from animals to humans and become pandemics" (U.S. Fish & Wildlife Service, 2022).

The US also hosts groups that are focused on the global implementation of One Health at various levels of engagement. The One Health Commission, for example, is a globally focused non-profit organization, chartered in 2009 in Washington D.C., that is dedicated to implementing One Health and One Health actions around the world. Its mission is to "connect, create, educate, and support networks to improve shared health outcomes and well-being of people, animals, and plants and to promote ecosystem resilience through a collaborative, local to global One Health approach" (One Health Commission, 2011). Its First (2014) and Second (2016) International "Who's Who in One Health" online webinars drew over 1,500 participants from more than 35 countries (One Health Commission, 2020). It manages a Global One Health Community Listserv of nearly 10,000 international participants and distributes a monthly global One Health Happenings newsletter (One Health Commission, 2020).

In Canada, veterinary science experts from the Canadian Food Inspection Agency's Animal Health Risk Analysis and Intelligence Section are engaging with experts across the country in public health, animal health, and ecosystem health to pilot a collaborative approach to rapid qualitative risk assessments (RQRA) (Calvin and Osborn 2021).

Additionally, Canada has formed the Community for Emerging and Zoonotic Diseases (CEZD), a virtual network that includes representatives in Canada and the United States from federal, provincial, and municipal governments, academia, and the private sector who have expertise in public, animal, and environmental health (Government of Canada, 2021). CEZD relies on "multidisciplinary perspectives to generate anticipatory intelligence to provide early warning for emerging and zoonotic diseases" (Government of Canada, 2021). It is tasked to assist governments, industry, and others across Canada to identify and plan for potential disease threats that can harm people, animal health, the environment, and the economy and uses an automated information mining

tool, KIWI[1], to collect and filter relevant data which is used to build knowledge and preparedness (Government of Canada, 2021).

Canada is also home to the Global 1 Health Network (G1HN), an interdisciplinary research-to-action network whose mission is to strengthen Canadian leadership "in improving the global governance of infectious diseases and antimicrobial resistance (*Mission Statement*, 2020). G1HN is collaborating with the Public Health Agency of Canada to implement a novel infectious disease surveillance system using social media data to develop an algorithm to detect the introduction and spread of infectious diseases in Canada, "especially COVID-19-like infections" (*Organization*, 2020).

In Brief: Leadership in the One Health space

Many influential national and international organizations have embodied a One Health approach and have taken a leadership role. Additionally, new institutions have emerged with One Health as their sole focus. Importantly, most of the leaders in One Health are involved in either human health, animal health, or agriculture, and there is a definitive gap in leadership in the wild-animal and ecosystem space. International leaders include the World Health Organization, World Organization for Animal Health, the Food and Agriculture Organization of the United Nations, the United Nations Environment Programme, the One Health Commission, and the Global 1 Health Network. In the US, leaders include the Center for Disease Control and Prevention and the United States Department of Agriculture. In Canada, leadership includes, the Canadian Food Inspection Agency's Animal Health Risk Analysis and Intelligence Section and the Community for Emerging and Zoonotic Diseases.

Evolution of the One Health Approach

Internationally and in North America, the One Health approach has gained significant ground over the past few decades. Since the onset of the COVID-19 pandemic, its profile as both a philosophy and a framework has exploded. But questions naturally arise concerning how much real progress has been made towards developing integrated frameworks and whether we have evidence for the effectiveness of a One Health approach.

As noted earlier, the concept of One Health is not new. As a current of thinking, it is perhaps as old as humanity; and, even as an expression in language, it can be traced back at least two hundred years, first as One Medicine, then One World One Health, and, eventually, One Health. Initially, One Health focused primarily on emerging and endemic zoonoses, antimicrobial resistance (AMR), and food safety, but has since expanded its scope to include other disciplines and domains, including environmental and ecosystem health, social sciences, human dimensions, ecology, wildlife, land use, and biodiversity (Mackenzie & Jeggo, 2019).

While the veterinary community has been quick to embrace a One Health approach, the medical community has been slower to engage, despite endorsement from leading bodies such as the American Medical Association, Public Health England, and the World Health Organization (WHO) (Hanisch et al., 2012; Mackenzie & Jeggo, 2019). In comparison to medical institutions, the wildlife management and conservation community is further behind in terms of

[1] KIWI stands for Knowledge Integration using Web Based Intelligence. It was developed by the Canadian Network for Public Health Intelligence (CNPHI) with the National Microbiology Laboratory of the Public Health Agency of Canada (Government of Canada, 2021).

awareness and engagement with One Health. Thus, it is also lagging in terms of One Health-oriented action. This is unsurprising given that, in the past, discussions of animal health in One Health forums, and consideration of animal health in One Health approaches and action plans, have been disproportionately focused on domestic animals, and primarily livestock (Marselle et al., 2021).

There is, as previously emphasized, no single, internationally agreed upon definition of One Health. In 2021, however, OHHLEP introduced a new operational definition aimed at developing a common language and understanding, but, more importantly, for moving the One Health approach from theory to practice, across sectors and disciplines, via application of "the 4 Cs" – communication, coordination, collaboration, and capacity building (Adisasmito et al., 2022).

The One Health definition developed by OHHLEP states:

> *"One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals, and ecosystems.*
>
> *It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent.*
>
> *The approach mobilizes multiple sectors, disciplines, and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development"* (Adisasmito et al., 2022).

OHHLEP also lists the fundamental principles of an effective One Health approach. These include:

> "*equity between sectors and disciplines; sociopolitical and multicultural parity (the doctrine that all people are equal and deserve equal rights and opportunities) and inclusion and engagement of communities and marginalized voices; socioecological equilibrium that seeks a harmonious balance between human-animal-environment interaction and acknowledging the importance of biodiversity, access to sufficient natural space and resources, and the intrinsic value of all living things within an ecosystem; stewardship and the responsibility of humans to change behavior and adopt sustainable solutions that recognize the importance of animal welfare and the integrity of the whole system, thus securing the wellbeing of current and future generations; and transdisciplinarity and multisectoral collaboration, which includes all relevant disciplines, both modern and traditional forms of knowledge and a broad array of perspectives*" (Adisasmito et al., 2022).

According to OHHELP, the expanded definition, which has been strongly endorsed by the Quadripartite, should be thought of as an "overarching set of guiding principles that can be further tailored to specific stakeholders" (WHO, 2021; Adisasmito et al., 2022). Importantly, the new OHHLEP One Health definition specifically includes "wild animals." Moreover, OHHLEP's One Health approach extends its focus to encompass and address the full range of relevant issues from prevention, health improvement, and health promotion to detection, preparedness, response, and recovery from health crises (Adisasmito et al., 2022).

While it is too early to judge the degree to which the application of One Health principles will broadly impact planetary health, it may be stated with certainty that the approach is contributing to positive health outcomes across the board — for humans, for domestic and wild animals, and for the environment. There are already many examples of One Health successes.

In Australia, Hendra virus, a rare zoonotic paramyxovirus that is transmitted from flying foxes (*Pteropus* bats) to horses, emerged suddenly in 1994. The outbreak first appeared in a racing stable, presenting as an acute equine respiratory disease, which resulted in the deaths of 13 of 20 infected horses within 16 days (Field & McCall, 2012). Two humans were infected through close contact with the sick horses, and

one human died from the illness (Field & McCall, 2012). Since 1994, Hendra virus infections have occurred in 7 humans (4 of whom died), each with a strong epidemiological link to horses (Hendra virus infection, 2020). In response to this threat to human and domestic horse populations, Australian authorities had considered eradicating flying fox populations, despite their crucial environmental role in pollination and seed dispersal (Middleton et al., 2014). Instead, the decision was made to embrace a One Health approach. A coordinated multi-agency threat-abatement team was formed. This team worked not just at the policy and operational level, but also collaborated with industry, local communities, and media (Field & McCall, 2012). Collaborative efforts focused on disrupting viral transmission from flying foxes to horses and resulted in the development of a vaccine for horses, which effectively prevented infection in horses, and consequently, in humans as well (Borrell, 2018).

Rwanda is one of the most densely populated countries in the world and exhibits elevated food insecurity, soil erosion, and forest degradation (Nyatanyi et al., 2017). Because of this, public health threats can quickly endanger large groups of people. Since many of the country's residents are pastoralists who practice a nomadic lifestyle, large numbers of people are at risk of contracting animal pathogens, such as foot and mouth disease and bovine pleural pneumonia, both of which have become endemic (Tekleghiorghis et al., 2016). Through these experiences, authorities learned that the eradication of hunger, improvement in public health, and environmental sustainability are interdependent, and require shared responsibility, community engagement, and collaboration across government agencies and policies — all ideas encompassed by One Health (Nyatanyi et al., 2017). In 2015, the Government of Rwanda developed and approved a One Health Strategic Plan, which is "problem-focused," rather than "discipline-focused" (Nyatanyi et al., 2017). The success of this approach has recently become most pronounced as Rwanda, a low- to middle-income country with scant resources and budget, has been deemed to have fared better against COVID-19 than many of its neighbours in the global north (Henley et al., 2021).

In the U.S., in 2014-15, a Eurasian strain of highly pathogenic avian influenza (HPAI), an extremely contagious virus that infects birds, entered human food systems, likely via contact between wild waterfowl and livestock. More than 200 Midwest poultry farms reported infected turkeys and chickens, making it the largest HPAI outbreak to date (USDA, 2017). The initial reaction was to simply cull the wild birds and destroy all wetland habitat around the poultry farms, a solution that may have solved the commercial food problem but would have been devastating for wildlife and ecosystems. Instead, the crisis management committee, which included the CDC, DOI, and USDA, brought in additional stakeholders, including hunters, to work on the problem. The final strategy for crisis resolution combined all inputs and proved far more balanced: massive wildlife culls were avoided, as was widespread habitat destruction, and new ideas for monitoring, such as tracking wild birds' proximity to poultry farms with radar, were introduced and implemented to protect human health (Sleeman et al., 2017).

In Canada, national, provincial, local, and nongovernmental organizations have collaborated to implement a One Health approach in response to the emergence of West Nile Virus in North America, first documented in the Western Hemisphere in August 1999 (Nash et al., 2001; Papadopoulos & Wilmer, 2011). By 2000, Health Canada, working with partners across the human-animal interface, had established the West Nile Virus National Steering Committee to develop guidelines and mandates for surveillance and response. In 2003, Health Canada launched the collaborative *Prepared and Prevention Plan*. Engaged stakeholders included the Public Health Agency of Canada, Parks Canada, the federal Ministry of Health, Canadian Cooperative Wildlife Health Centre, Health Canada's First Nations and Inuit Branch, Canadian Blood Services, and Héma-Québec (Papadopoulos & Wilmer, 2011). While West Nile Virus remains an issue of concern, the One Health approach has led to long-term

control of this infectious disease within Canadian borders (Todoric et al., 2022).

These examples are encouraging; but, of course, further research and engagement is needed before we can provide more comprehensive analyses. Meanwhile, the topic of One Health is becoming increasingly prevalent in the news, on websites, and in social media. This is providing the One Health community with opportunities to meaningfully expand and to promote One Health messaging. Here is just a small sample of recent news stories:

1. Rutgers University Hosts Regional One Health Consortium Conference
2. World Bank Board Approves New Fund for Pandemic Prevention, Preparedness and Response (PPR)
3. American Public Health Association Advancing a One Health Approach to Promote Health at the Human-Animal-Environment Interface
4. Quadripartite Memorandum of Understanding (MoU) signed for a new era of One Health collaboration
5. One Health is critical to addressing zoonotic public health threats and environmental issues
6. UN Environment Programme joins alliance to implement One Health approach
7. On World NTD Day, WHO releases key document to guide a paradigm shift towards One Health
8. Editorial underscores the 'One Health' policy for surveilling emergent infectious diseases
9. World Economic Forum - What is the One Health approach - and how can it help pre-empt future pandemics?
10. The Conversation - One Health: why we need to combine disease surveillance and climate modelling to preempt future pandemics
11. Krishak Jagat - Reducing zoonotic diseases thanks to 'One Health' approach
12. University of Toronto expert Kerry Bowman on monkeypox and the danger posed by zoonotic diseases
13. Opinion: The new normal — preparing for the next zoonotic pandemic
14. Financial Express - Zoonotic diseases are rising across the world. Is this a cause of concern?

In Brief: Evolution of the One Health Approach

One Health is not a new concept but has gained significant popularity over the past two decades, especially due to recent zoonotic epidemics and pandemics. One Health was initially focused largely on zoonoses, antimicrobial resistance and food safety, but has expanded its scope to include the health of wildlife and ecosystems, as well as human well-being and overall quality of life. Today, there are significant national, and international institutions focused on building collaboration amongst diverse research areas to foster a One Health approach. There are examples where the One Health approach has provided effective and beneficial response to zoonotic disease outbreaks and where better outcomes for the environment, wildlife and people have been realized.

One Health in Policy and Legislation

As the world endures the third year of the COVID-19 pandemic, there is increased awareness and broad recognition of the importance of One Health as a long-term, viable, and sustainable approach. It is firmly anchored now in the global agenda, from G7 and G20 economic policy discussions to the UN Food Systems Summit (World Health Organization & UN Environment Programme, 2022).

The G7, which consists of Canada, France, Germany, Italy, Japan, the United Kingdom, the US, and the European Union, is an informal grouping of the world's seven largest, "most advanced" economies (*Canada and the G7*, 2022). During the 2021 G7 Summit at Cornwall, England, global leaders recognized the importance of the animal-human-environmental health interface to humanity's survival (The White House, 2021). This means that One Health is now recognized by the G7 as critical to everyone's health. This is recognition, for the first time, at the highest political levels, in what are commonly referred to as developed countries.

The G20 is a strategic multilateral platform connecting the world's major developed and emerging economies. It works on major issues related to the global economy, e.g., climate change mitigation, sustainable development, and international financial stability (G20 Presidency of Indonesia, 2021). Its members, which include Argentina, Australia, Brazil, Canada, China, the European Union, Germany, France, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, the United Kingdom, and the US, represent all inhabited continents, 80% of the world's GDP, 75% of global trade, and 60% of the world's population (*Canada and the G20*, 2022). In October 2021, at the G20 Summit in Rome, Italy, the group's finance and health ministers issued a communiqué strongly endorsing the One Health approach and committing to the establishment of a new G20 Task Force to promote and assist with its adoption (G-20 Joint Finance and Health Ministers, 2021).

In contrast to the G7, which generally engages in political and security-related issues, the G20 focuses almost exclusively on global economics (Alexander et al., 2016). While there is some overlap in terms of agendas, it is important and highly significant that One Health has been included and promoted across both governance landscapes.

The 2021 UN Food Systems Summit, held in New York on September 23, 2021, set the stage for global food systems transformation to achieve the Sustainable Development Goals by 2030 (IISD, 2021). During the conference, a One Health Commitment was registered to support a Global One Health Coalition. This is aimed at building engagement across sectors, disciplines, and all levels of society and is expected to shape agrifood systems around the world (World Health Organization & UN Environment Programme, 2022).

One Health is also being integrated into policies and recommendations by leading multilateral treaties, including the CBD and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

CBD, which entered into force in 1993 with 150 Parties, has 3 main objectives: the conservation of biological diversity, the sustainable use of the components of biodiversity, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources (CBD, 2012). Working through its Subsidiary Body for Scientific and Technological Advice (SBSTTA) and, related, Open-Ended Working Group (OEWG), CBD is responsible for the development of the post-2020 global biodiversity framework (GBF). The GBF not only builds on the Strategic Plan for Biodiversity 2011–2020, but "sets out an ambitious plan to implement broad-based action to bring about a transformation in society's relationship with biodiversity, ensuring that by 2050 the shared vision of 'living in harmony with nature' is fulfilled" (CBD, 2021). The GBF will define the targets and pathways for the conservation and

sustainable use of biodiversity for decades to come and is immediately relevant to North America's conservation strategies at the national/federal and state/provincial levels.

Adoption of the GBF is considered important beyond CBD, for all biodiversity-related conventions. During the 4th Meeting of the Open-ended Working Group on the GBF, the United Kingdom reiterated the need to have a standalone "Target 23" on health, "calling for the implementation of a biodiversity-inclusive One Health approach" (IISD, 2022). One Health is also referenced in the document's Section B.bis (Principles and Approaches). While a final draft of the GBF is still being negotiated and refined, it is expected to be adopted during the second part of the 15th Conference of the Parties of the CBD, scheduled for 5–17 December 2022 in Montreal, Canada.

CITES, which came into force internationally in 1975, boasts 183 State Parties (plus the European Union) and is tasked with regulating international trade in about 38,000 species of animals and plants, and their parts and derivatives. It works with national management authorities and aims to ensure the legality, traceability, and sustainability of international trade in wildlife (Higuero, 2022). In 2015, CITES signed an agreement with WOAH to increase their collaborative efforts to ensure the "efficient implementation of surveillance and disease control measures needed to protect animal and human health worldwide" (OIE & CITES, 2021).

In May 2022, during the 89th General Session of the World Organisation for Animal Health, CITES formally recognized the importance of fully engaging with all its partners to support national authorities and reduce global health risks associated with zoonotic diseases. CITES is also considering a new Resolution on actions to advance the One Health approach in relation to international trade (Higuero, 2022). This is certain to be an important topic of discussion at the upcoming 19th Meeting of the Conference Parties, planned for 14–25 November 2022, in Panama.

In the US, efforts to legislatively address One Health began prior to the onset of the COVID-19 pandemic. In 2017, the CDC, USDA, and DOI organized a One Health Zoonotic Disease Prioritization Workshop to advance efforts to address zoonotic disease challenges in the US. Following this workshop, the House Appropriations Committee Report that accompanied the 2021 Omnibus Appropriations Bill directed CDC to create a national One Health framework to combat the threat of zoonotic diseases and advance emergency preparedness in the United States. The bill also directs the development of a federal One Health coordination mechanism to strengthen One Health collaboration related to prevention, detection, control, and response for zoonotic diseases and related One Health work across the federal government.

In June 2021, New Jersey became the first US state, and the first regional jurisdiction in the US and Canada, to legislate a One Health initiative. It established a One Health Task Force, which is tasked to prevent, monitor, and control zoonotic and environmental public health threats, as well as to promote communication between state agencies and scientists who study human health, animal health, and the earth sciences (Rutgers University, 2022). A number of jurisdictions in the US and Canada have also legislatively recognized One Health. Please see Appendix for a review of One Health related legislation is all US states and Canadian provinces and territories.

In Brief: One Health in Policy and Legislation

One Health is now firmly rooted within the international agenda. The importance of a One Health approach has been recognized by the G7 while other international entities are currently working towards formal agreements pertaining to One Health. In 2021, the G20 committed to the establishment of a G20 Task Force to facilitate One Health adoption and promotion; during the United Nations Food Systems Summit, a One Health Commitment was registered to support a Global One Health Coalition. One Health is also working its way into legally binding international treaties: the Convention on Biological Diversity is calling for a biodiversity-inclusive One Health approach in its post-2020 Global Biodiversity Framework, and the Convention on International Trade in Endangered Species of Wild Fauna and Flora is considering a new Resolution on One Health in relation to international trade. In the US, the Centers for Disease Control and Prevention has drafted a federal bill mandating a One Health framework, and other One Health legislation already exists in several states.

Why Does AFWA Need to Embrace a One Health Approach?

Human activities have significantly altered 75% of Earth's terrestrial environments and 66% of its marine environments (IPBES, 2019). Loss of biodiversity, habitat fragmentation, pollution, and environmental degradation now threaten the range of ecosystem services on which all human, animal, and plant life depend. These changes are driving the emergence, and re-emergence, of infectious diseases, influencing health outcomes for humans, animals, and the environment. Health risks are also steadily increasing because of globalization in trade and transport, and significantly, also, due to climate change, all of which provide enhanced opportunities for pathogens to "colonize new territories and evolve into new forms" (WOAH, 2022).

Infectious diseases threaten fish and wildlife populations and, thereby, directly impact the work of AFWA and its members. Increased levels of disease in North America's fish and wildlife, the introduction of new diseases, and disease spillover threaten to entirely undermine AFWA's mission if they are not adequately addressed and controlled.

As a zoonotic virus, COVID-19 joins a growing list of other zoonotic diseases. The UN estimates that approximately 75% of new diseases in humans come from other animals (UNEP, 2020). While the pandemic phase of COVID-19 appears to be ending, the recent monkeypox outbreak serves as a stark reminder that the threat of zoonotic diseases to humans is persistent in the long-term (Charumilind et al., 2022).

According to the CDC, more than 41,000 cases of monkeypox have been reported across the world, as of August 19, 2022 (2022 Monkeypox Outbreak Global Map, 2022). In July 2022, WHO declared the monkeypox outbreak a global health emergency. It is notable that this terminology is currently in use for only 2 other diseases: COVID-19 and Polio. It is also significant that of the 94 total countries reporting cases since May 2022, 87 of these have not historically reported monkeypox (*2022 Monkeypox Outbreak Global Map*, 2022). This is the first time that many monkeypox cases and clusters have been reported concurrently in non-endemic and endemic countries in disparate geographical areas (Monkeypox Outbreak, 2022).

Relevantly, the recent pandemic, coupled with increased public fear concerning the possibility of future large-scale health crises, has not just provided perspective with regard to the importance of the linkages between human, animal, and environmental health; it has also sparked an unprecedented surge in outdoor recreation, thus significantly, and rapidly, increasing the number of

people engaged in areas of interest to AFWA and its members.

AFWA serves as the collective voice of North America's fish and wildlife agencies. Operating with a vision to provide "leadership for a sustainable, publicly supported future for fish and wildlife," the organization's mission is "to advocate for the roles, responsibilities, and authorities" of its member agencies to manage those resources as "public trust resources" for current and future generations (AFWA, 2020).

Because most emerging zoonotic diseases begin in wildlife populations, any attempt to address their root causes must take wildlife and their habitat into account; if wildlife are healthy, diseases are less likely to develop among them and spread to humans. Wildlife management, which encompasses habitat management to a large degree, and healthy ecosystems that support healthy fish and wildlife populations are, therefore, vital components of public health. This is an important point, given that AFWA's members are responsible — often primarily — for the management and maintenance of much of America's wild lands and waters.

The COVID-19 pandemic illustrated and reinforced the linkages between wildlife management, wildlife health, and public health and this has emerged as an important consideration for AFWA's future work. From a practical standpoint, especially given the current socioecological context, it is not possible for AFWA to enact its mission and maintain its current vision, without incorporating One Health into strategic planning and operations. Implementing a collaborative, One Health approach, which clearly focuses on actions, responses, and consequences at the human-animal-ecosystem interface, is essential to ensure success in AFWA's activities across the board (Mackenzie & Jeggo, 2019; IAEA, 2021).

One Health is not a new concept for wildlife management, nor for AFWA, though it is a relatively new term in common language. In fact, in many ways AFWA's mission, vision and values are inherently related to the concept of One Health, whether or not this is explicitly stated. This is not surprising, considering the organization's technical expertise in the form of state, provincial, and territorial fish and wildlife health practitioners.

Broadly, AFWA's workplan has historically encouraged and supported a holistic conservation approach. As a result, the organization has already incorporated important aspects of One Health thinking into its planning and practices in a very organic way. It has already, for example, a well-established Fish & Wildlife Health Committee, which provides expert fish and wildlife health advice to AFWA members and officers, evaluates the potential impacts of state and federal–animal-health legislation on fish and wildlife resources, and maintains a close relationship with appropriate USDA officials "to assure that the interests of fish and wildlife management are taken into account in any emergency animal disease control program" (*Fish & Wildlife Health Committee*, 2020).

In 2007, AFWA took major steps to create a National Fish and Wildlife Health Initiative, with the goal of helping US states build capacity for management of healthy wildlife and fish resources (Hanisch et al., 2012). This Initiative enabled the development of programs to effectively respond to health issues involving free-ranging wildlife. This coincided with the establishment of the National Fish and Wildlife Health Steering Committee, formed under the auspices of the Association's Fish & Wildlife Health Committee to oversee implementation of a National Fish and Wildlife Health Action Plan, as was called for by the National Fish and Wildlife Health Initiative (AFWA, 2008).

In 2008, AFWA published the National Fish & Wildlife Health Initiative Toolkit (AFWA, 2008). The effort, led by the Fish & Wildlife Health Committee, reiterated the mission, goals, and objectives of the National Fish and Wildlife Health Initiative, but also provided a strategy for implementation (AFWA, 2008). While the publication does not explicitly reference One Health, One Health principles are evident in its "Guiding Principles," i.e., "Foster collaboration, coordination, and communication among fish and wildlife health

jurisdictions, as well as with domestic animal health and public health agencies at the state and national level;" and "Recognize, articulate, and integrate the abilities and authorities of cooperating state, tribal, territorial, and federal agencies and other partners" (AFWA, 2008).

Other One Health-related resources produced by AFWA include *AFWA Best Management Practices for Prevention, Surveillance, and Management of Chronic Wasting Disease* (2018), *Statement on Chronic Wasting Disease Etiology* (2019), *Rabbit Hemorrhagic Disease: Guidance for Hunting and Outdoor Recreation* (2020), *Voluntary Interim Guidance for Bat-related Activities in Response to COVID-19* (2020), *Guidance on SARS-CoV-2 and Free-Ranging White-Tailed Deer* (2022), and *Guidance for State Wildlife Agencies to Reduce the Risk of Highly Pathogenic Avian Influenza Transmission in Wildlife Rehabilitation Facilities* (2022).

In 2018, AFWA hosted the first AFWA Fish and Wildlife Health Forum at USGS Headquarters in Reston, Virginia. Attended by more than 100 participants, representing state and federal agencies, non-governmental organizations, academia, and industry, the forum produced a significant listing of potential action items and recommendations for AFWA, its members, and partners (AFWA, 2018). Notably, at the top of the list of Key Recommendations, is a desire to revitalize the National Fish and Wildlife Health Initiative, a priority that remains outstanding and which could benefit significantly from a One Health approach (AFWA, 2018). More recently, in 2021, AFWA called together a first-ever consortium of human health, environmental health, and wildlife health experts to begin a discussion of how to collaborate more effectively in the One Health space. This meeting led to a new communication paradigm for these various entities, which has resulted in regular meetings and increased knowledge-sharing that continues to expand over time.

Presently, AFWA's Strategic Plan (2020 to 2025) includes 6 overarching goals, each with a set of objectives (*Strategic Plan Final*, 2020). Fully embracing, and articulating, a One Health approach in the context of each of these action items and deliverables will help ensure their success. This means working not just across state, provincial and national boundaries to address shared priorities and complex problems, but also across disciplines (which has, in the past, occurred less frequently) so that *all* available expertise and resources may be identified and mobilized to support strategic goals.

For example, Goal 1, "Advocate for funding, laws, regulations, and policies that fulfill the missions and capabilities of our members," requires that AFWA build trust and credibility with lawmakers; advocate for member agencies; create awareness among lawmakers; strengthen relationships with its own members and with federal agency partners; and "amplify member voices through robust relationships with conservation non-governmental organizations, private landowners, coalitions, hunting and fishing industries, and other new partners" (*Strategic Plan Final*, 2020). A One Health approach to achieving this goal will facilitate knowledge sharing and collaboration with diverse stakeholders. It will encourage new partnerships between AFWA and other regional, national, and international One Health proponents, with the potential to also access new funding and support mechanisms. It will also enable better coordination of on-the-ground efforts and advocacy work, highlighting efficiencies and redundancies, and allowing for the most productive use of funding and human resources. Ultimately, taking a One Health approach to realizing this goal will increase AFWA's overall capacity for work, thus contributing simultaneously to Goal 5, "Provide communication, training, and capacity-building to support member fish and wildlife agencies" and to the second half of Goal 6, "Improve fiscal and operational excellence of the Association" (*Strategic Plan Final*, 2020).

Similarly, Goals 2 through 6 emphasize increased diversity and inclusivity; increased awareness of the value of wildlife and safety of nature-based recreation; increased engagement with stakeholders, including non-traditional stakeholders; increased application of conservation science in decision-making; and increased coordination among members. They encourage new

partnerships and emphasize engagement with members, law enforcement, networks of scientific experts, Indigenous Peoples and others, as well as educational outreach efforts (*Strategic Plan Final*, 2020).

Objectives 3.4, to "advance our role in promoting science and research into fish and wildlife health and emerging threats", 3.7, to "address ongoing and developing international fish and wildlife issues on sustainable use, trade, exotic species importation, and other issues impacting members", and 6.1, to "be resilient, efficient, and adaptive in the delivery of programs and services" especially highlight the linkages between AFWA's current Strategic Plan and One Health (*Strategic Plan Final*, 2020).

As previously noted, some of AFWA's members have already taken strides to embrace and integrate One Health into their own policies and planning (also see following section). While New Jersey is the first US state to legislate a One Health Task Force, the Missouri Department of Conservation may be the first North American state, provincial, or territorial wildlife agency to embrace the philosophy and to integrate it with strategic planning and research initiatives (Missouri Department of Conservation, 2021).

Even prior to the onset of the COVID-19 pandemic, officials in Missouri made considerable progress in "removing administrative barriers through the formation of an interagency team to foster collaboration across the Departments of Agriculture, Natural Resources, Health and Senior Services, and Conservation" (EPA, 2022). Other states and the United States Environmental Protection Agency are looking at Missouri as a model for One Health planning and action (EPA, 2022).

While AFWA is a leader in wild-animal health and facilitates collaboration between conservation agencies and veterinarians, this is largely the extent of existing collaboration. This approach has inherent limitations and certainly does not, in itself, constitute a One Health approach. Yes, wild-animal health is dependent upon human and domestic-animal health because zoonotic diseases can spread amongst all three populations, each acting as reservoirs and sources for disease (Jori et al., 2021). But further, both human and animal health are dependent upon healthy ecosystems due to the services well-functioning natural systems provide, such as the regulation of extreme events (such as fires and floods), and the provisions of quality forage, and clean air and water (IPBES, 2019). Therefore, to improve the health of wild animals, and to advance conservation generally, it is in AFWA's interest to also improve human, domestic-animal, and ecosystem health, and vice versa for the human health community.

Embracing a One Health approach would mean linking AFWA's work in wild-animal health to all these realms. This collaboration would help ensure the health of animals and humans through maintained or improved ecosystem services and would also help limit the spread of zoonotic disease, not just among wildlife, but also between domestic animals, wild animals and humans.

In Brief: Why Does AFWA Need to Embrace a One Health Approach?

At the center of wildlife conservation in North America, AFWA has a direct responsibility and plays a critical role in monitoring and helping prevent disease spread in wild animals. Further, AFWA already collaborates with other agencies and animal-health specialists in matters pertaining to wild-animal health. However, wild-animal, domestic-animal, human and ecosystem health are all interdependent and broader and deeper collaborations involving AFWA are required to safeguard all of these. Certainly, zoonotic diseases can spread between humans and wild and domestic animals, and healthy ecosystems are critical for the health of animals and humans. AFWA's members also have responsibilities to connect the public to healthy ecosystems through outdoor recreation opportunities. Improving human and domestic animal health, as well as ecosystem services, are essential to safeguarding not only wild-animal health and conservation, but also these recreational opportunities. Wildlife faces daunting 21st century challenges, including unprecedented habitat destruction, pollution and disease. All of these issues are relevant to One Health and AFWA's own Strategic Plan and Relevancy Roadmap speak to such issues, though not explicitly in One Health terms.

Making the Case for AFWA as a Leader in the One Health Space

Engaging is not the same as leading. Part of AFWA's vision is to provide leadership (*Strategic Plan Final*, 2020). It already represents a leading force in both North American land and water management and fish and wildlife management and conservation, especially in the US, where AFWA is able to have the greatest legislative impact[2]. Extending this leadership into the One Health space is an appropriate and necessary expansion of AFWA's expertise and influence to achieve optimal outcomes, for itself and for wildlife conservation.

As noted earlier, the pandemic and the post-pandemic social landscape have ignited an exceptional increase in the number of outdoor recreationalists. More members of the public are choosing to spend time outside, to avail of recreational opportunities in nature, and to engage in the use of nature, whether that use is consumptive or non-consumptive. There is now, perhaps, the greatest intersection between AFWA's priorities with American and Canadian public interests in decades.

Jason Sumners, the Science Branch Chief for the Missouri Department of Conservation, noted the following when discussing Missouri's ground-breaking One Health framework, "As more people went outside, there was a collective shift in focus toward understanding the human/animal interface. [This created] an opportunity to harness the renewed interest in the outdoors while keeping people, animals, and the environment healthy" (EPA, 2022). This opportunity remains. In fact, "a wealth of data shows that hunting, fishing, and outdoor recreation are more valued now than ever" (*Strategic Plan Final*, 2020; Mahoney, 2021). AFWA can maximize this opportunity, and help sustain it, by extending its engagements with, and services to, broader constituencies through One Health leadership. Increased engagement in a new leadership capacity will also show AFWA's capacity to adapt to the changing demography and values of its diverse member jurisdictions, which is essential to maintaining AFWA's relevancy, resiliency and continued success (AFWA, 2019). It will also open doors for new partners, and enable AFWA to effectively leverage its knowledge and

[2] This is due to differing governance structures between Canada and the US.

resources to contribute to national health and wellness, which encompasses human residents, domestic pets and livestock and wild animal and landscape resources. This broader and more inclusive domain of policy and knowledge application can only bring positive outcomes for AFWA members, locally, regionally, nationally, and in the international space.

As noted by Sara Parker Pauley, Director of the Missouri Department of Conservation, "One Health can be a uniting purpose for diverse constituent groups and organizations. Unlocking partnerships using the One Health lens is facilitating engagement and understanding of the importance of healthy ecosystems to human health" (EPA, 2022). Leadership in the One Health space will provide opportunities to find common ground with diverse groups, even those which may have seemed inaccessible or unreceptive to collaboration in the past. Such opportunities are not always available but recognizing them when they do arise is an important component of adaptive leadership.

While highly credible and authoritative leaders in One Health have already emerged, both internationally and in North America, vacancies remain. Most significantly, it is well recognized that there has been insufficient engagement by leaders who represent sectors and disciplines that focus on wild animals (Destoumieux-Garzón et al., 2018). As reported by Keith Sumpton, a veterinarian and leader of the Animal Health Program at the FAO, this must change: "The One Health approach needs to engage and receive the contributions of natural resource management professionals working in ecosystems, biodiversity, and wildlife management" (Lipton, 2020). This is an obvious space for AFWA, within which it may reach its full potential to best support the missions and mandates of its state, provincial, and territorial wildlife agency members.

Though it is widely recognized in academic and medical circles that a One Health approach may facilitate addressing complex, multi-disciplinary issues such as zoonotic diseases and anti-microbial resistance, its usefulness in addressing biodiversity loss and assisting solutions for wildlife conservation problems, and promoting overall human health and well-being, has received less attention. It has been proven, however, that actions prescribed within the context of a One Health approach typically also have direct benefits for species and land conservation (Romanelli et al., 2014). Humans and domestic animals, for example, have a greater likelihood of encountering wildlife when more than 35% of original forest cover is lost, which increases the likelihood of disease transmission; landscape conservation, therefore, is necessitated by One Health (WHO, 2022). There is a clear need for a leader in the fish and wildlife sector to focus One Health's usefulness in addressing biodiversity loss and landscape management, thereby assisting in developing solutions for wildlife conservation within a wider knowledge and social context (Sleeman et al, 2019). Increased engagement with One Health as a leader in the space is therefore likely to also increase the effectiveness of AFWA members' conservation efforts, a top priority for all individual agencies.

Relatedly, in the past, human and agricultural health initiatives did not typically consider fish and wildlife health or environmental health, and this has resulted in unintended, negative consequences for both (USGS, 2019; Sleeman et al., 2019). Now and in the future, it is essential that leaders in the wildlife management and conservation community increase their engagement with public health and spatial planning processes to ensure that the health of wild animals and their habitats is appropriately considered (Cooke et al., 2019; Heiland et al., 2019). One Health will provide a platform for AFWA and its members to engage with more diverse stakeholders on these issues at regional, national, and international levels.

Successful One Health frameworks in North America and around the world rely most heavily on collaboration between multiple sectors and disciplines working at the local, regional, national, and global level, with a goal of achieving optimal health outcomes for people, animals, plants, and our shared environment. Collaboration is one of AFWA's core values, and it has already harnessed the capacity to be recognized as a leading fish and

wildlife convener and a skilled communicator (*Strategic Plan Final*, 2020). Furthermore, its governance reach extends into every jurisdiction in Canada and the United States. AFWA can leverage these capacities, not just to link with other progressive efforts to support the fish and wildlife sector, but to publicly position itself as a leader in the One Health space, to increase its profile and relevancy in the domestic and international spheres, and to bring the unique perspectives of its members to bear on decision and policy making.

For example, current One Health frameworks often fail to adequately consider fish and wildlife as a consumptive resource. While it has been demonstrated that food production will need to increase by 70% to feed the world by 2050, and while annual meat production must increase by more than 200 million tonnes, One Health thinking has not yet evolved to encompass either the contribution to food security by wild animal harvests or the implications of reduced or eliminated harvests, due to zoonotic disease or related environmental degradation (Food and Agriculture Organization, 2009). As a leader in One Health, AFWA can ensure that this, and other sustainable use perspectives, central to its mission, are integrated in future thinking and planning.

Leadership in One Health offers an opportunity for AFWA to better engage with international and domestic governments and institutions on fish and wildlife issues, as well as to showcase and enhance its leadership in developing fish and wildlife conservation science and policymaking (*Strategic Plan Final*, 2020). There is also a need to develop and, in some cases, modify existing biodiversity conservation policy to ensure that human and domestic animal health and wellbeing are integral to those policies (Korn et al., 2019). Distinct regulatory silos for response to infectious disease in animals and humans no longer make sense. Regulation of wildlife must deal with infectious diseases and the risks they pose. This represents another opportunity for AFWA to engage broadly on its members behalf with legislative reviews and other processes, to work with diverse stakeholders in the One Health space to maintain balance between wildlife management and human health, and to ensure that members' interests are always well-represented. It is also an opportunity for AFWA to increase the relevance of healthy ecosystems to the public, thus engaging greater support for their maintenance and conservation.

Finally, becoming a leader in the One Health space will enable AFWA and its members to better cope with the public-relations problems that go hand-in-hand with managing fish and wildlife populations in a society preoccupied by the threat of infectious disease. Increasing occurrences of negative human-wildlife interactions, including wildlife disease, can become indirect threats to wildlife conservation when they generate media attention and have socially amplified risks (Buttke et al., 2015). This can negatively impact social support for AFWA's mission and its members' mandates. Because funding for wildlife conservation is dependant on social support, any perceived diminution of wildlife's net benefit to society will also have clear operational and budgetary implications. A wildlife agency's capacity to detect, respond to, and communicate about zoonoses can contribute, significantly, to a sense of societal efficacy (Buttke et al, 2015). According to a national study of agency competencies needed to manage wildlife disease, coordination and collaboration are key factors. One Health promotes both, alongside communication, which is also essential to achieve these goals (Siemer et al., 2012).

AFWA has the capacity and potential to create meaningful change, an ability that may have been underestimated in the past (*Strategic Plan Final*, 2020). One Health represents a chance for AFWA to do more: to engage and collaborate with diverse organizations and individuals, including Indigenous, local, and rural people who often live, work, and recreate in the closest proximity to nature; to contribute to new research and policy development; and, ultimately, to be a more effective advocate for its members, their constituents, and the fish and wildlife resources at the heart of AFWA's mission.

If AFWA chooses not to engage with One Health in a leadership capacity, there is a risk that the interests of the fish and wildlife sector and, more specifically, the North American fish and wildlife sector will not be adequately represented on either international or domestic stages. This means inadequate consideration of North American fish and wildlife in decision and policymaking, which is likely to produce suboptimal or negative outcomes for North American wildlife management, sustainable use, and biodiversity conservation. Furthermore, it is now abundantly clear from discussions across the globe that wildlife and ecosystem management must be brought into One Health strategies and, that in all jurisdictions, *some* entity must and will take the lead. In the North American context, we might ask, if not AFWA, then who? Not taking a leadership role in this directional change in conservation would have clear implications for AFWA relevancy.

Perhaps even more importantly, the application of One Health, generally, will also be less effective without the benefit of AFWA's knowledge, capacities, and integrated perspective. Ultimately, if AFWA does not become a leader in the One Health space, there is an increased likelihood of health risks for humans, animals, and the environment, especially within the North American context, which could result in escalated biodiversity loss, as well as a loss or significant reduction in ecosystem services. These outcomes would represent a failure for the North American Model and for 21st Century conservation.

In Brief: Making the Case for AFWA as a Leader in the One Health Space

Healthy wildlife and ecosystems are essential for human health and are thus a critical aspect of the One Health approach. While One Health has obtained international recognition, and leaders in One Health have emerged from the medical, veterinary and agricultural industries, there is a striking absence in leadership from the wild-animal and ecosystem sector. Without AFWA leadership in this space, wild animals and ecosystems will not be adequately represented in future One Health legislation and discussions. This will not only hamper the effectiveness of One Health to improve human and animal health, but it will also be detrimental to wildlife conservation. Taking on a leadership role in One Health will allow AFWA to form new partnerships, possibly enable access to new funding for the agency, better represent the needs of its members in policy discussions and better advocate for fish and wildlife conservation. It is clear that some AFWA member organizations are already taking leadership positions within their jurisdictions for the One Health space, seizing relevancy opportunity within a social environment expressing greater engagement in outdoor recreation. This greater participation in outdoor recreational activities, including hunting and angling, has been driven, significantly or in part, by circumstances arising from the COVID pandemic.

Bridging Science and Policy

Bridging the gap between science and policy is essential to evidence-informed policymaking and, therefore, good governance in the fish and wildlife sector (Choi et al., 2016). AFWA and its members rely on sound public policy and effective legislation to ensure the success of long-term management and conservation efforts. Goal 3 of the *Strategic Plan (2021-2025)*, to "provide leadership in developing fish and wildlife conservation science and its application in decision and policymaking," reflects this important connection (*Strategic Plan Final*, 2020).

Although knowledge of biodiversity is increasing, thanks in large part to focused research efforts, fish and wildlife management conservation is often still given a relatively low priority compared to other, more anthropocentric policy challenges. There exists a strong

general perception that biodiversity research and knowledge is under used in decision making and policy implementation (Spierenberg 2012). Certainly, more effective dialogue is needed between biodiversity-science practitioners and policymakers to underpin the sustainable use and conservation of biodiversity and to secure the public and financial support required to achieve these goals. (Young et al., 2014).

While many past initiatives have aimed to improve communication between conservation science and government policy development, these have mostly conformed to a linear model of communication, through which neutral scientific facts are transmitted directly to policy advisors to solve problems (Nutley et al., 2013). This model has proven insufficient, "as decision-making is complex, iterative, and often selective in the information used" (Young et al., 2014). In addition, many conservation-related issues require interdisciplinary knowledge to develop effective policy and, ultimately, legislation. Also, more effective policy and decision making regarding natural assets must involve a broader range of stakeholders, including a better educated, motivated and engaged public.

One Health provides a platform to facilitate and energize AFWA's broader engagements with policymakers and diverse stakeholders, especially through new collaboration across sectors. It also promotes and encourages public engagement and offers opportunities to bolster education and awareness campaigns. The public is highly sensitive to disease and health concerns, and is understandably eager to have solid information on how to react to such issues. This opens a new window for delivering information on the importance of landscape and wildlife conservation and sustainable management. Taking advantage of this opportunity will improve the perception of AFWA and its members' societal role in policy formation surrounding issues seen as high priorities by the public and by decision-making authorities. Increasingly, research needs to be demand-driven to be relevant for policymakers. Identifying the right partners, times, and places, and delivering knowledge products that reflect, certainly in part, wider societal contexts will increase the possibility of narrowing gaps between policymakers and scientists in general (Choi et al, 2016). Recognizing and acknowledging the politics embedded in decision-making processes, empowering civil society to hold government agencies accountable in creating transformative coalitions for change, and maintaining scientists' roles as independent knowledge brokers also play important roles in bridging science and policy (Thuy, 2021).

Working within a One Health framework, AFWA will gain valuable insight, not just through collaborative activities, but also through coordination, to identify and influence One Health research priorities for the cross-cutting issues that are most likely to have a positive impact on fish and wildlife management and governance. This will also help avoid duplication of research efforts within the North American fish and wildlife community and guide the most efficient use of funds, staffing, and other resources. Ultimately, embracing a One Health approach and framework will help AFWA bridge the gap between science and policy, thus increasing the capacity of AFWA and its members to enact their missions.

In Brief: Bridging Science and Policy

AFWA and its members rely on science-based policy to enable effective wildlife conservation. In light of this, it is critically important to ensure that the best scientific information is made available to policy makers and understood by them. In policy discussions, anthropocentric issues often take precedence over wildlife-related issues. One Health exemplifies this, as a movement gaining international attention, with the ultimate goal of improving human health. However, because the One Health approach strives to improve human health by also improving the health of animals and ecosystems, it offers a unique opportunity to bring wildlife-related issues to the forefront of the agenda of decision makers. By AFWA engaging with One Health, wildlife-related issues can be raised and positioned to be essential to human health. Better and more effective dialogue is needed between wildlife-conservation scientists and policy makers, in general, and through One Health, AFWA can help bridge this gap in a highly relevant social space.

Logistical Considerations and Barriers to implementation

It is clear that the One Health philosophy is needed in North America and worldwide, to inform political and legislative action plans, and across disciplines, to preserve human, animal, and environmental health. There are, however, common logistical considerations and barriers to implementation and success that must be addressed. A recent scoping review and evaluation of 23 well-established One Health initiatives has identified a number of challenges that generally impede the success of One Health implementation (Delesalle et al., 2022) and many are relevant to AFWA's potential role in this space. Indeed, many bear striking similarity to issues raised in AFWA's own Relevancy Roadmap (AFWA 2019).

These include:

- Top-down management
- Poor communication and coordination among stakeholders
- Low community engagement
- Insufficient political engagement
- Failure to adapt to changing behaviors
- Lack of consideration for traditional practices and local knowledge
- Lack of structural resources or capacity, i.e., staff, budget, etc.
- Gaps in awareness, education, and training regarding zoonotic disease threat, requirement, and law

An additional barrier, but also a need, for One Health implementation, is the historically insufficient consideration of human wildlife use, most especially in developed countries, as a vital component of human food security and health, in general. This may be viewed as just one component of a more general need within One Health frameworks to more thoughtfully consider the human dimensions of fish and wildlife management and conservation. A lack of consideration of the "vulnerability, variability, and susceptibility" of human societies and the many ways in which humans interact with, and benefit from, wild animals and ecosystems certainly present obstacles to One Health success (Destoumieux-Garzón et al., 2018). Such vacancies, of course, also speak to the need for agencies who can deliver these ideas to the One Health agenda.

The success of One Health also requires the breakdown of interdisciplinary barriers that separate human and veterinary medicine from ecological and environmental sciences (Destoumieux-Garzón et al., 2018). More integrative approaches than currently exist must be developed and promoted to ensure optimal results for

human, animal (both wild and domestic), and environmental health.

While there are likely many internal efficiencies that may be identified, it is also reasonable to assume that there may be some new and/or increased costs associated with AFWA implementing a One Health framework and taking on a leadership role. Importantly, however, compared to "silo approaches," One Health is reported to increase the productivity and cost effectiveness of field interventions, surveillance, and health policies, particularly for zoonoses (Delesalle et al., 2022).

In Brief: Logistical Considerations and Barriers to implementation

There are several challenges and some likely limitations to AFWA implementing a One Health approach. For example, to ensure success, it is important to ensure effective communication among stakeholders, to avoid or reduce top-down management approaches, and to develop more strategic and effective political engagement. It is also vital to break down barriers and build effective, long-term, multi-lateral engagement between wildlife conservation and other disciplines, including medicine, agriculture and human health. Although such efforts would entail costs, certainly in the earlier stages of implementation, effective integration of One Health has been demonstrated to increase the productivity and cost efficiencies of efforts aimed at managing zoonoses. Presumably such efficiencies would extend to the wider sphere of issues (wildlife conservation in this instance) that would be engaged in One Health approaches. It is worth noting that AFWA, through its Relevancy Roadmap efforts, is already making strides to address many obstacles that have been identified for engaging in One Health delivery.

Partnerships Critical to Success

There are numerous One Health institutions in the United States, at both a federal and state level, that represent partnership opportunities for AFWA (Appendix Table 3). Indeed, some of these may already be engaged, in some capacity. A few of these partnership opportunities stand out as having greater potential to improve wildlife and habitat conservation as well as human health.

In the US, on a federal-level, one excellent partnership opportunity is with the One Health Office, established by the CDC. This is the first formal office dedicated to One Health within a federal agency. It is focused on strengthening global health capacity and preventing zoonoses through building One Health partnerships. Focus areas include "global health security and capacity building", and "strategic One Health partnerships" (One Health, CDC's One Health Office: What We Do, 2022). From a One Health perspective, strengthening global health capacity and preventing zoonoses are dependent upon the health of wild animals and ecosystems, positively positioning AFWA at the forefront of One Health Office's agenda.

Another excellent federal-level partnership is with the USDA, particularly with respect to their One Health Coordination Center. This coordination center was created to prevent the spread of zoonotic diseases from animals to humans. One of the Key Activity Areas of the One Health Coordination Center is "building partnerships that bring together the strengths of multiple disciplines to find solutions that address complex problems at the animal-human-environmental interface" (One Health Coordination Center, 2012). Contact between wild animals with livestock facilitates the spread of disease between domestic and wild animals, which is detrimental to both. Further, wild animals can act as a reservoir for disease, preventing its eradication in domestic animals (Jori et al., 2021). Therefore, AFWA provides a critical link between wild animals and ecosystems with agriculture and livestock disease, a key focus of the USDA. These two federal

partnerships would provide a strong link between human health via the CDC, the health of food systems and domestic animal health via the USDA, and the health of wild animals and ecosystems via AFWA itself.

There are also opportunities for partnerships with environmental agencies in the US. Such partnerships will ensure that AFWA collaborates more broadly with the widest range of key players. Potential partners at the federal level include the U.S. Environmental Protection Agency (EPA), The Environmental Council of the States (ECOS), and The Council on Environment Quality, within the Executive Office of the President (CEQ).

Similarly, partnerships with environmentally focused non-government organizations (NGO) may also provide significant opportunities for collaborative engagement and knowledge-sharing. NGO partner prospects may include the Sierra Club, National Wildlife Federation, Ducks Unlimited, and The Wildlife Society.

Partnerships in Canada may include the Public Health Agency of Canada, which is itself a partner of the Global 1 Health Network and would link human health with wildlife and habitat health (Mission Statement, 2020). On the Canadian domestic animal health front, the Canadian Food Inspection Agency's Animal Health Risk Analysis and Intelligence Section may provide an excellent partnership opportunity as well (Government of Canada, 2021). They are currently collaborating with experts in animal, ecosystem and human health in a One Health approach to prevent zoonotic diseases in humans and would provide a linkage for domestic animal health and wildlife and habitat health.

Internationally, partnerships with WHO and WOAH, would link One Health approaches between institutions focused on human health and domestic animal health with the health of wildlife and ecosystems. These two organizations are already leaders in the One Health space, and are also highly influential international

organizations (WHO, 2020). Partnerships with these institutions would bring international recognition and attention to the importance of wildlife and habitat management in the One Health approach, an area which is currently lacking at all levels in One Health.

As the One Health agenda expands and implementation strategies mature, new partnership connections will undoubtedly arise. In this regard, AFWA should consider that engaging significantly in the One Health agenda at this crucial and formative time would provide opportunity to influence the very nature and range of partnerships and collaborations moving forward.

In Brief: Partnerships Critical to Success

There are a great number of existing and emerging partnership opportunities for AFWA in the One Health space. AFWA, being itself a leader in fish, wildlife and habitat management, needs to partner with organizations from the agriculture and human health sectors, as well as the broader environmental community, to facilitate a One Health approach, acting as the final piece in the human-animal-environment interface. In the US, on a federal level, important partnerships would involve the CDC and the USDA, which represent leaders in human and livestock health, and both agencies have integrated a One Health approach. Other significant partnerships should involve broadly environmental agencies and might include the EPA, ECOS, and CEQ. Additionally, there are numerous opportunities for meaningful partnerships with environmentally focused NGOs in the US. In Canada, important partnerships could involve the Public Health Agency of Canada and the Canadian Food Inspection Agency's Animal Health Risk Analysis and Intelligence Section, which have also incorporated One Health approaches. Lastly, on an international level, key partnerships may involve the World Health Organization and the World Organization for Animal Health, authorities on human health and animal health, respectively. These partnerships would bridge the gaps between disparate sectors and enable an effective One Health approach. AFWA engaging at this relatively early stage of One Health's maturation could provide opportunities that might not exist, equally, at a later point in time.

What does AFWA leadership in One Health look like? Recommendations.

While government departments and agencies have considerably increased their engagement with One Health approaches, and most specifically in relation to infectious disease management, under current regulatory schemes many challenges remain. For example, even with respect to zoonoses, wildlife health concerns are not prioritized, risk assessments do not explicitly consider the impacts of human action on wildlife health, and there is insufficient collaboration between governments sectors (Farnese, 2014).

New leadership in One Health from the fish and wildlife sector is needed to fill these gaps and AFWA is well positioned to take on this role and address these issues, given its prioritization of conservation science, sustainable wildlife management, wildlife advocacy, leadership in wildlife policy development, collaborative conservation efforts, responsibilities for outdoor recreation in public spaces and beyond, and public education and awareness (*Strategic Plan*, 2020). Of course, these priorities are also reflected across AFWA's membership, underscoring AFWA's existing capacity to both convene and coordinate meaningful One Health effort across regional and national geographic, ecosystem and political landscapes, should it decide to do so.

For AFWA, leadership in the One Health space means representing the North American wildlife and habitat management sector, and the underlying principles applied under the NAM, in international and domestic engagements where no such institutional leader has yet emerged. It also means seeking out new ways to engage other One Health initiatives. Doing so will necessarily involve collaborating at home and abroad at multiple levels, across multiple sectors and disciplines, and with diverse stakeholders. It will also require motivating and helping coordinate AFWA members' efforts towards accomplishing common goals in wider arenas; building and mobilizing knowledge and promoting new research and new ideas; capturing traditional and Indigenous knowledge while also advocating for novel solutions to old problems, as well as identifying emerging ones; and working within modern social and cultural processes, without compromising valued traditions. This is a tall order; but as previous sections of this paper have underscored, AFWA has, in some ways, been preparing itself for this leadership opportunity for some time.

It is with this perspective in mind that we recommend AFWA consider the following as possible next steps toward becoming a leader in the One Health space, while noting that the list is not exhaustive and that a progressive campaign of gradual advance would likely be the most practical way forward:

1. Establish a One Health Expert Working Group within AFWA to develop a more detailed strategy including best next best steps for AFWA in the One Health space.
2. Identify ways to collaborate more effectively with government agencies in the United States and Canada, especially with those representing public and environmental health, at regional and national levels.
3. Engage with the North American One Health community as a leader in the fish and wildlife sector. Consider how this intersects with the mandate of AFWA's Fish and Wildlife Health Committee and the Fish and Wildlife Health Initiative.
4. Engage with the international One Health community as a leader in the fish and wildlife sector, as well as a representative of North American interests. Consider how this intersects with AFWA's International Relations Committee, especially in terms of engagements with CBD, CITES, and IUCN.
5. Increase the effectiveness of wildlife management advocacy efforts through collaboration with cross-sector and cross-discipline One Health initiatives, as well as

through increased engagement with policymakers via the One Health platform.

6. Collaborate strategically with existing health risk assessment processes to ensure the impacts of human action of wildlife health are considered.
7. Coordinate and collaborate among appropriate entities to develop new approaches to reduce hazards to human and animal health, including matters of relevance to landscape management.
8. Become more engaged with state, federal, and tribal officials, and alongside NGO partners, in collaborative efforts for the development of protocols for response to, monitoring of and recovery from, zoonotic disease, as well as for development of better diagnostic tests for zoonotic, vector-borne, and environmental diseases in wildlife (Mawdsley & Humpert, 2019).
9. Encourage AFWA members and/or AFWA regional fish and wildlife associations to develop their own One Health frameworks (as Missouri has done so successfully); and coordinate and offer support to these efforts in order to achieve workable consistency and to help remove barriers to success.
10. Coordinate AFWA members' engagement on One Health, as well as assist members in communicating with each other and with regional and federal entities on One Health challenges and progress.
11. Develop public education and awareness initiatives within a One Health framework to educate the public on the interconnectedness and interdependence of animals, humans, and the environment, and to create better general understanding of how human actions and policies could affect animal and environmental health and the role wildlife agencies play in this regard.
12. Engage specifically with sectoral publics, protectionist as well as the use-oriented hunter and angler communities, to demonstrate the inclusivity of One Health approaches.
13. Recognize that when the public demands good, multisectoral health governance, policymakers will need to make One Health a legislative priority (IAEA, 2021). AFWA should pro-actively develop ideas for consideration in this new legislative environment.
14. Help people understand how their own actions affect the environment, animals, and people around them and how climatic changes can increase human risk and exposure to potential disease and other environment related health impacts (IAEA, 2021).
15. Participate in collaborative efforts to inform and educate political leaders, policymakers, and the public sector through accurate media publications.
16. Participate in collaborative communications efforts in journals, at conferences, and via allied health networks.
17. Engage with development of the One Health Joint Plan of Action, potentially also coordinating engagement by its members (WHO & UNEP, 2022).
18. Engage and collaborate with the One Health Commission.
19. Leverage AFWA's convening power to facilitate collaboration between state, provincial, and territorial agency members and NGO and industry players, moving towards a North American Wildlife and One Health Strategy.
20. Increase engagement with already existing collaborative efforts that have relevance for One Health, or may be improved by considering One Health perspectives, like The Responsible Recreation Campaign, of which AFWA is a founding partner (*Strategic Plan Final*, 2020).
21. Consider extending current transborder collaborations for conservation delivery between the United States and Canada to better encompass One Health initiatives.

22. Identify ways to better contribute to fish and wildlife disease surveillance, including cross-species disease surveillance, and monitoring through research and fieldwork, coordinating with members and regional fish and wildlife associations, and encouraging engagement by recreational hunters and anglers in monitoring and reporting processes. If a hunter, for example, witnesses an unusual animal event while afield, they should know to inform authorities since this may indicate an animal disease outbreak.
23. Reinforce existing working relationships among scientists, diagnosticians, animal and public health specialists, epidemiologists, biologists, ecologists, land managers, legislators, and stakeholders to meet current and future disease challenges within a One Health framework (Mawdsley & Humpert, 2019).
24. Establish a program of One Health training sessions (at NCTC) and expand participation in the community of practice (started by EPA) for employees of state, provincial, territorial, and tribal wildlife agencies.

In Brief: What does AFWA leadership in One Health look like?

As a leader in One Health, AFWA would fill a critical gap in the current One Health space by providing additional knowledge and greater emphasis to the incorporation of wild-animal and ecosystem health alongside human health considerations in planning, decision-making, and problem-solving processes. To more fully consider its role and develop a best-next-steps strategy, AFWA should appoint an Expert Working Group to develop its preferred approach. Being a leader in One Health will require AFWA to form long-term and effective partnerships with human health, environmental, and agricultural agencies but also consider partnerships with economic and social policy institutions, thinktanks and corporations. Partnerships should take place at the international, national, state, provincial, territorial and tribal levels. AFWA can also act as a leader by educating the public and encouraging its member organizations to take on a One Health approach and form their own partnerships within the states, provinces and territories to implement One Health practices, incorporating wildlife and ecosystem considerations at the ground level.

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Appendix

In each state in the United States and each province and territory in Canada (63 total jurisdictions), we searched for any legislation pertaining to One Health (Table 1), any reports and articles pertaining to the implementation of One Health in the Jurisdiction (Table 2), and any institutions specifically focused on One Health within the jurisdiction (Table 3).

To do this, we performed a structured online search. Where "Jurisdiction" indicates the province, state or territory of focus, for each jurisdiction, we first searched in google "Jurisdiction One Health", "Jurisdiction One Health approach", and "Jurisdiction One Health initiative". Then, within each jurisdiction's legislature website, we searched "One Health", "One Health approach", and "One Health initiative". Finally, we searched again on google "Jurisdiction One Health legislation", "Jurisdiction One Health approach legislation" and "Jurisdiction One Health initiative legislation". When given the option on the jurisdiction's legislature website, we narrowed the search to include the years 2012–2022.

Please note, reports and articles were only selected if they pertained to the implementation of One Health in the jurisdiction; therefore, general informative documentation about One Health were not included. Likewise, institutions were only selected if they were directly focused on One Health within the jurisdiction; therefore, institutions that simply stated their support for One Health, and/or indicated that they take a "One Health Approach" to reach their goals were also not included.

Table 1. Jurisdictional legislation pertaining to One Health in Canada and the United States.

Jurisdiction	Legislative Document	Link to Web Document	Link to File	Year
California	SCR. 58. Senate Concurrent Resolution Relative to One Health Day.	California SCR. 58	California SCR. 58	2021
	AB. 2684. An act to amend Sections 1206.5, 2242.2, 2571, 2701, 2706, 2708, 2717, 2746.51, 2746.53, 2786, 2786.2, 2786.3, 2786.5, 2815, 2815.5, 2836.3, 2837.104, 3703, 4024, 4040, 4060, 4061, 4170, and 4174 of, and to add Sections 2785.6 and 2786.4 2785.6, 2786.4, and 2837.103.5 to, the Business and Professions Code, relating to healing arts.	California AB. 2684	California AB. 2684	2022
	SB. 1029. An act to add Division 118 (commencing with Section 150500) to the Health and Safety Code, relating to public health.SB 1029, as amended, Hurtado. One Health Program: zoonotic diseases.	California SB. 1029	California SB. 1029	2022
Hawaii	HB. 1891. A bill for an act relating to health	Hawaii HB.1891	Hawaii HB.1891	2020
	HB. 1987. A bill for an act relating to invasive species	Hawaii HB. 1987	Hawaii HB. 1987	2022
New Jersey	No 1992. An Act establishing the "New Jersey One Health Task Force," and supplementing Title 26 of the Revised Statutes.	New Jersey No 1992	New Jersey No 1992	2021
	Resolution 1. New Jersey One Health Program	New Jersey Resolution 1	New Jersey Resolution 1	2021
Ohio	HB. 580. Fiscal Note & Local Impact Statement	Ohio HB 580	Ohio HB 580	2016
Pennsylvania	No 481. Senate Resolution	Pennsylvania No 481	Pennsylvania No 481	2018

Table 2. Reports and articles pertaining to the implementation of One Health in jurisdictions within Canada and the United States.

Jurisdiction	Report/Article	Link to Web Document	Link to File	Year	Author
Arizona	Arizona One Health Toolkit	Arizona One Health Toolkit	Arizona One Health Toolkit	2019	Arizona Department of Health Services
British Columbia	A Comparative Analysis of One Health Policies in Asia: Opportunities for Application in British Columbia	A Comparative Analysis of One Health Policies in Asia: Opportunities for Application in British Columbia	A Comparative Analysis of One Health Policies in Asia: Opportunities for Application in British Columbia	2022	University of British Columbia
Colorado	One Health Institute Pilot Grants Review	One Health Institute Pilot Grants Review	One Health Institute Pilot Grants Review	2020	One Health Institute
Delaware	Delaware Partnership for One Health	Delaware Partnership for One Health	Delaware Partnership for One Health	2021	Douglas D Riley
Manitoba	A One Health approach to rabies management in Manitoba, Canada	A One Health approach to rabies management in Manitoba, Canada	A One Health approach to rabies management in Manitoba, Canada	2019	Shauna Richards et al.
Minnesota	Lyme Disease, Wildlife Management and Public Health	Lyme Disease, Wildlife Management and Public Health	Lyme Disease, Wildlife Management and Public Health	2013	Michael W. Fox
Missouri	Showing the Way for One Health Collaboration	Showing the Way for One Health Collaboration	Showing the Way for One Health Collaboration	2022	United States Environmental Protection Agency
	Promoting One Health: The University of Missouri Research Center for Human/Animal Interaction	Promoting One Health: The University of Missouri Research Center for Human/Animal Interaction	Promoting One Health: The University of Missouri Research Center for Human/Animal Interaction	2013	Rebecca A. Johnson
Montana	Animal and Human Health Prevention Opportunities	Animal and Human Health Prevention Opportunities	Animal and Human Health Prevention Opportunities	2021	Montana Department of Livestock & Montana Departmen

					t of Public Health and Human Services
Ontario	Climate Ready: Adaptation Strategy and Action Plan 2011-2014	Climate Ready: Adaptation Strategy and Action Plan 2011-2014	Climate Ready: Adaptation Strategy and Action Plan 2011-2014	2011	Governme nt of Ontario
	One Health and EcoHealth in Ontario - a Qualitative Study Exploring How Holistic an Integrative Approaches are Shaping Public Health Practices	One Health and EcoHealth in Ontario - a Qualitative Study Exploring How Holistic an Integrative Approaches are Shaping Public Health Practices	One Health and EcoHealth in Ontario - a Qualitative Study Exploring How Holistic an Integrative Approaches are Shaping Public Health Practices	2012	Zee Leung et al.
Tennessee	State of Tennessee 2021-2022 Budget	State of Tennessee 2021-2022 Budget	State of Tennessee 2021-2022 Budget	2022	State of Tennessee
Wyoming	Implementing a One Health Approach to Rabies in Wyoming	Implementing a One Health Approach to Rabies in Wyoming	Implementing a One Health Approach to Rabies in Wyoming	2021	Elizabeth Walker
Yukon	One Health Recommendations for Yukon ENGO sector	One Health Recommendations for Yukon ENGO sector	One Health Recommendations for Yukon ENGO sector	2020	Katarzyna Nowak

Table 3. Jurisdictional One Health institutions within Canada and the United States.

Jurisdiction	Institution	Parent Organization	Link to Website
Alaska	Center for One Health Research	University of Alaska Fairbanks	Center for One Health Research
Alberta	One Health Alberta	Alberta Veterinary Medical Association	One Health Alberta
Colorado	One Health	University of Connecticut	One Health
Delaware	One Health Delaware	Delaware Humane Society	One Health Delaware
Florida	One Health Center of Excellence	University of Florida	One Health Center of Excellence
Georgia	Division of One Health	University of Georgia	Division of One Health
Idaho	One Health Committee	Idaho Veterinary Medicine Association	One Health Committee
Illinois	Center for One Health Illinois	College of Veterinary Medicine	Center for One Health Illinois
Louisiana	Louisiana One Health In Action	N/A	Louisiana One Health In Action
Maine	Initiative for One Health and the Environment	University of Maine	Initiative for One Health and the Environment
Manitoba	One Health Program	Winnipeg Humane Society	One Health Program
	One Health Steering Committee	Government of Manitoba	One Health Steering Committee
Michigan	One Health Initiative	Wayne State University	One Health Initiative
	Institute for Global Health	Michigan State University	Institute for Global Health
Minnesota	One Health Workforce	University of Minnesota	One Health Workforce
	Minnesota One Health Antibiotic Stewardship Collaborative	Minnesota Department of Health	Minnesota One Health Antibiotic Stewardship Collaborative
Mississippi	The One World – One Health & Public Health Club	Mississippi State University	The One World – One Health & Public Health Club
Missouri	Research Center for Human-Animal Interaction	University of Missouri	Research Center for Human-Animal Interaction
Nebraska	Nebraska One Health	University of Nebraska-Lincoln	Nebraska One Health
New Mexico	USAID One Health Workforce	New Mexico University	USAID One Health Workforce
North Carolina	North Carolina One Health Collaborative	N/A	North Carolina One Health Collaborative
Ohio	Global One Health Initiative	The Ohio State University	Global One Health Initiative

Oklahoma	Oklahoma Pandemic Center for Innovation and Excellence	Government of Oklahoma	Oklahoma Pandemic Center for Innovation and Excellence
Ontario	One Health Institute	University of Geulph	One Health Institute
Pennsylvania	Penn One Health	University of Pennsylvania	Penn One Health
	Pennsylvania One Health Task Force	Government of Pennsylvania	Pennsylvania One Health Task Force
Quebec	One Health Initiative	Université de Montréal	One Health Initiative
South Dakota	South Dakota One Health	South Dakota Area Health Education Center	South Dakota One Health
Tennessee	Tennessee One Health Initiative	Government of Tennessee	Tennessee One Health Initiative
	One Health Initiative	University of Tennessee	One Health Initiative
Texas	One Health	Texas Tech University	One Health
	UTMB One Health	The University of Texas Medical Branch	UTMB One Health
	Global One Health	Texas A&M University	Global One Health
Utah	One Health	Government of Utah	One Health
Washington	One Health Collaborative	Government of Washington	One Health Collaborative
	WSU One Health Diagnostics	Washington State University	WSU One Health Diagnostics
	One Health Clinic	Washington State University	One Health Clinic
	Washington Center for One Health Research	University of Washington	Washington Center for One Health Research
Wisconsin	One Health Consortium	University of Wisconsin Madison, the Universidad Nacional de Colombia and the Corporación Ruta N Medellin	One Health Consortium
	Global Health Institute	University of Wisconsin-Madison	Global Health Institute