

Master of Public Health

Applied Practice Experience

***COMMUNICATING ABOUT ZOO NOTIC PARASITES IN
PURSUIT OF PUBLIC HEALTH: TRANSMISSION AND
PREVENTION AT THE HUMAN-WILDLIFE INTERFACE***

by

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submitted in partial fulfillment of the requirements for the degree

MASTER OF PUBLIC HEALTH

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June, 2023 – August, 2023

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2025

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Chapter 1: Portfolio Products

Background:

As human populations expand, urbanization creeps across the landscape, and the climate shifts, the opportunity for human-animal contact increases. This contact sometimes results in “spillover” events, which occur when a pathogen jumps from an animal host to a human one. Currently, 75% of emerging infectious diseases worldwide are zoonotic in origin (Mackenstedt et al., 2015, p. 72). While most of these diseases are of viral or bacterial etiology, zoonotic parasites also contribute to this overall statistic and are often under- or misdiagnosed.

Because of North America’s diverse geography and multitude of wildlife species, it is also home to a wide variety of zoonotic parasites. The ubiquity of wildlife, including in urban areas, represents a myriad of potential points of human exposure to these parasites. According to a report from the U.S. Fish and Wildlife Service, over 14.4 million Americans hunted wildlife in 2022 (U.S. Fish & Wildlife Service, 2024), thus directly interacting with wildlife. However, indirect contact with wildlife also plays an important role; in 2023, 175.8 million Americans participated in outdoor recreation (Outdoor Foundation & Outdoor Industry Association, 2024). Wildlife biologists, veterinarians, and rehabilitators represent other populations at risk of exposure to wildlife and the parasites they carry.

Mechanisms of Zoonotic Parasite Transmission at the Human-Wildlife Interface

Parasitic life cycles are notoriously complex, sometimes requiring multiple hosts and environmental factors to complete. However, we can classify zoonotic parasites in wildlife into two broad categories: fecal-borne and meat-borne. Not all parasites fit neatly into these two categories, but they provide a framework that informs preventive recommendations.

“Fecal-borne” parasites generally describe pathogens that reside in the gastrointestinal tract and shed eggs, oocysts, or immature larvae in their host’s feces. Fecal-borne parasites substantially contaminate the environment, with some species surviving in soil, in water, or on surfaces (e.g., tree bark) for months or even years (Centers for Disease Control [CDC], 2024). The implications of these parasites are far-reaching; human infection does not require direct contact with wildlife and often occurs unwittingly.

“Meat-borne” parasites are those that form cysts in the muscles of their hosts. Parasitic cysts (e.g., *Trichinella spp.*) are hardy and capable of surviving many methods of meat processing, including salting, drying, smoking, microwaving, and sometimes freezing (CDC, 2024). Meat-borne parasites infect people who ingest undercooked or raw wild game.

One under-recognized source of exposure to zoonotic parasites is through urban wildlife. Urbanization creates an environment detrimental to many wildlife species, but other animals, such as foxes and raccoons, have remarkably adapted to an urban lifestyle and serve as a potential source of zoonotic infection (Mackenstedt et al., 2015, p. 72), usually through

environmental contamination. One unique aspect of this type of interaction is that the individuals involved may have little to no experience with wildlife or the environment and thus may not be aware of the risks posed by direct or indirect contact with wildlife.

Altogether, these concepts lay the foundation for both products created through the course of this project.

Best Practice Guidelines for Preventing Zoonotic Parasite Transmission from Wildlife to Humans

The majority of information regarding zoonotic parasites in wildlife is geared towards an academic audience. While valuable, such resources are not easily accessible to those outside of academia. The goal of this project—culminating in two written products—was to provide accessible resources that discuss the most common and/or important zoonotic parasites in North American wildlife and outline general practices for preventing human infection. The products are designed for anyone interacting closely with wildlife, including hunters, trappers, hikers, wildlife biologists, veterinarians, or anyone spending significant time outdoors.

Over the course of this project, I created an evidence-based, best-practice manual focusing on zoonotic endoparasites in wildlife. I worked with Dr. Brian Herrin, my preceptor and a board-certified parasitologist, to select significant zoonotic parasites and identify what components to include in each parasitic section. The manual outlines general information regarding each selected parasite, illustrated by pictorial life cycles that emphasize the specific mechanisms of transmission and subsequently inform preventive practices.

I further condensed these concepts into my second project, a commentary article that will be submitted for publication in the *Wildlife Professional*, a magazine geared towards individuals with wildlife experience. This article focuses on the two main mechanisms of zoonotic parasitic transmission—fecal-borne and meat-borne—and communicates preventive practices.

Overall, these projects emphasize several core methods of prevention:

- **Hand Hygiene:** Washing your hands with soap and water is the most effective method for removing parasite eggs, cysts, or larvae from your hands.
- **Environmental Awareness:** Environmental contamination is one of the most common ways people are exposed to zoonotic parasites. Avoid areas that may contain a high parasitic load (e.g., raccoon latrines) and practice hand hygiene after spending time outdoors.
- **Temperature Control:** Cooking wild game to appropriate internal temperatures renders it safe to consume. Drying, salting, smoking, and freezing are unreliable methods of killing parasitic cysts. Use a meat thermometer to verify appropriate internal temperatures.
- **Parasites in Pets:** Some species of parasites from wildlife can infect dogs and cats. Regular deworming, under the supervision of your veterinarian, can decrease

the environmental parasite load. Removing their feces from the environment also aids in breaking the cycle of transmission.

Finally, preventing the transmission of zoonotic parasitic diseases from wildlife requires a One Health approach. There is no single universal definition of One Health, but the term encapsulates the idea that the health of people, animals, and the environment are intertwined. This project emphasizes the importance of environmental factors, wildlife behavior, and human actions in the transmission of zoonotic disease, but mainly focuses on how these factors affect human health. However, it is important to not only consider animal and environmental health in these situations, but to also consider the cultural and societal importance of practices such as hunting, hiking, and conservation.

With that in mind, the goal of this project is not to demonize wildlife and portray them solely as reservoirs for disease. In the same vein, I am not discouraging individuals from hunting, hiking, studying, or otherwise exploring the environment. Rather, the core of this project is to lay the context and subsequently provide the tools for preventing disease transmission from wildlife. It is intended to render outdoor activities as safe as possible and allow individuals to take reasonable steps towards protecting their own health. The following portfolio products embody this goal and provide accessible resources to the general public.

Table 1.1 Summary of Portfolio Products

Portfolio Product		Description
1	Contributions for an evidence-based, best-practice manual on zoonotic endoparasites in wildlife.	Creation of the written and visual input for a manual covering zoonotic endo-parasites in North American wildlife, including basic information, specific parasitic life cycles, symptoms of human infection, and methods of prevention. This manual is designed for a broader, non-academic or layperson audience that works closely with wildlife.
2	Commentary article (written to provide guidance to the general public, specifically those that interact with wildlife) on zoonotic parasites in wildlife submitted for publication in the <i>Wildlife Professional</i> .	Article for the <i>Wildlife Professional</i> on zoonotic endo-parasites in wildlife with an emphasis on preventive practices (solely authored by Elizabeth Buller). Similar to the wildlife manual, this article is written for the portion of the public working with wildlife, including varying types of wildlife professionals.

The above products strive to fulfill several MPH competencies. As described in Table 1.2 below, five competencies were addressed in the creation of the portfolio products.

Table 1.2 Portfolio Products and Competency Addressed

Portfolio Product		Number and Competency Addressed	
1	Contributions for an evidence-based, best-practice manual on zoonotic endoparasites in wildlife.	7	Assess population needs, assets, and capacities that affect communities' health
		16	Apply principles of leadership, governance, and management, which include creating a vision, empowering others, fostering collaboration, and guiding decision making
		18	Select communication strategies for different audiences and sectors
		21	Integrate perspectives from other sectors and/or professionals to promote and advance public health
		22	Apply systems thinking tools to a public health issue
2	Commentary article (written to provide guidance to the general public, specifically those that interact with wildlife) on zoonotic parasites in wildlife submitted for publication in the <i>Wildlife Professional</i> .	16	Apply principles of leadership, governance, and management, which include creating a vision, empowering others, fostering collaboration, and guiding decision making
		18	Select communication strategies for different audiences and sectors
		21	Integrate perspectives from other sectors and/or professionals to promote and advance public health
		22	Apply systems thinking tools to a public health issue

Chapter 2: Competencies

Throughout the APE project, I emphasized 5 of the overall 22 MPH Foundational Competencies. As expressed in Table 2.1, these competencies were achieved through creation of specific projects.

Table 2.1 Summary of MPH Foundational Competencies

Number and Competency		Description
7	Assess population needs, assets and capacities that affect communities' health.	This project assessed the prevalence and importance of zoonotic endoparasites in North American wildlife, identifying key mechanisms of transmission and methods of prevention relevant to individuals handling wildlife. The available literature was reviewed and information regarding each parasite was evaluated, condensed, and translated into a format accessible to the target audience, resulting in the wildlife manual.
16	Apply principles of leadership, governance, and management, which include creating a vision, empowering others, fostering collaboration, and guiding decision making.	Throughout this project, I leaned into my expertise regarding zoonotic parasites not only as a Public Health student, but also as a veterinary professional. One crucial responsibility I possess as a leader in my field is public (and client) education, with the purpose of empowering individuals to control their own health through preventive care. Both the parasite manual and the wildlife magazine article are designed to educate the audience and then provide them with applicable methods of protecting themselves. Rather than simply providing a list of recommended preventive methods to a largely non-medical audience, these materials first provide contextual information, such as parasitic life cycles, impact of disease, and transmission methods, to build foundational knowledge, all of which later inform the audience's decisions. By doing so, the reasoning for these practices is no longer solely based on "expert" recommendations but also based on the audience's personal

		understanding of the public health impact of zoonotic parasites, honing individual critical thinking skills and increasing adherence to the recommended preventive practices.
18	Select communication strategies for different audiences and sectors.	The project culminated in two products designed for the target audience. The wildlife manual is the more exhaustive of the two and focused on the most important (defined as either the most common or those causing severe disease) zoonotic parasites in North American wildlife. I designed this manual for anyone interacting closely with wildlife: hunters, trappers, wildlife enthusiasts or biologists, or anyone spending significant time in the great outdoors. The manual uses a combination of prose, bullet points, and visual resources (e.g., life cycles) to communicate vital concepts. The wildlife magazine article is a succinct version of the manual and thus is written in a more casual style, but it is geared towards wildlife professionals. It begins with a narrative story to engage the reader, then focuses on general methods of parasitic transmission and prevention.
21	Integrate perspectives from other sectors and/or professionals to promote and advance public health.	During this project, I worked with individuals in the veterinary, public health, and wildlife fields. I worked closely with Dr. Brian Herrin, a board-certified parasitologist, to select relevant parasitic species and ensure that my products were scientifically sound. I also met with Geriann Albers, the Furbearer Biologist for the Indiana Department of Natural Resources, to review and receive feedback on sections of the manual based on her experience with the target audience. Throughout all of this, I worked closely with the veterinary and public health fields, both through my work with Dr. Herrin and my career as a veterinary student (now veterinarian).

22	Apply systems thinking tools to a public health issue.	I applied systems thinking to this project by examining the complex interactions between humans, wildlife, and the environment, focusing on how these interactions result in human disease. Analyzing these factors illuminated numerous points of intervention. In the case of the wildlife manual, by initially establishing baseline information regarding parasitic life cycles, specific animal behaviors, and methods of transmission, the manual sets the context for preventive practices, emphasizing the importance of understanding the roles played by the parasite, the wildlife involved, the environment, and the individuals themselves.
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As described above, Table 2.1 features the 5 Foundational Competencies fulfilled throughout the APE Project. Table 2.2, as featured below, summarizes the 22 of the Foundational Competencies achieved throughout the coursework. Finally, Table 2.3 lists the competencies for the “Infectious Diseases and Zoonoses” emphasis area and illustrates how I pursued these concepts during my APE.

Table 2.2 MPH Foundational Competencies Course Mapping

22 Public Health Foundational Competencies Course Mapping	MPH 701	MPH 720	MPH 754	MPH 802	MPH 818
Evidence-based Approaches to Public Health					
1. Apply epidemiological methods to the breadth of settings and situations in public health practice	x		x		
2. Select quantitative and qualitative data collection methods appropriate for a given public health context	x	x	x		
3. Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate	x	x	x		
4. Interpret results of data analysis for public health research, policy or practice	x		x		
Public Health and Health Care Systems					
5. Compare the organization, structure and function of health care, public health and regulatory systems across national and international settings		x			

22 Public Health Foundational Competencies Course Mapping	MPH 701	MPH 720	MPH 754	MPH 802	MPH 818
6. Discuss the means by which structural bias, social inequities and racism undermine health and create challenges to achieving health equity at organizational, community and societal levels					X
Planning and Management to Promote Health					
7. Assess population needs, assets and capacities that affect communities' health		X		X	
8. Apply awareness of cultural values and practices to the design or implementation of public health policies or programs					X
9. Design a population-based policy, program, project or intervention			X		
10. Explain basic principles and tools of budget and resource management		X	X		
11. Select methods to evaluate public health programs	X	X	X		
Policy in Public Health					
12. Discuss multiple dimensions of the policy-making process, including the roles of ethics and evidence		X	X	X	
13. Propose strategies to identify stakeholders and build coalitions and partnerships for influencing public health outcomes		X		X	
14. Advocate for political, social or economic policies and programs that will improve health in diverse populations				X	
15. Evaluate policies for their impact on public health and health equity			X	X	
Leadership					
16. Apply principles of leadership, governance and management, which include creating a vision, empowering others, fostering collaboration and guiding decision making		X			X
17. Apply negotiation and mediation skills to address organizational or community challenges		X			
Communication					
18. Select communication strategies for different audiences and sectors	DMP 815				
19. Communicate audience-appropriate public health content, both in writing and through oral presentation	DMP 815				

22 Public Health Foundational Competencies Course Mapping	MPH 701	MPH 720	MPH 754	MPH 802	MPH 818
20. Describe the importance of cultural competence in communicating public health content		x			x
Interprofessional Practice					
21. Perform effectively on interprofessional teams		x			x
Systems Thinking					
22. Apply systems thinking tools to a public health issue	x	x	x	x	

Table 2.3 Summary of MPH Emphasis Area Competencies*

MPH Emphasis Area: Infectious Diseases and Zoonoses		
Number and Competency		Description
1	Pathogens/pathogenic mechanisms Evaluate modes of disease causation of infectious agents.	This project identified the two main methods of zoonotic parasitic transmission from wildlife: meat-borne and food-borne. The project emphasized both methods throughout each product. The wildlife manual includes greater detail, describing the life cycles and points of transmission for each endoparasite, whereas the commentary article focuses on the broader groups of fecal-borne and meat-borne parasites.
2	Host response to pathogens/immunology Investigate the host response to infection.	I thoroughly researched each parasitic disease and the resulting clinical signs seen in people, condensing this information into bullet points within the wildlife manual. The manual also discusses the possibility of subclinical or asymptomatic parasitic infections and the risks those pose. These aspects emphasize the variability of host response to parasitic infection.
3	Environmental/ecological influences Examine the influence of environmental and ecological forces on infectious diseases.	Both products highlight how environmental and ecological factors play a major role in zoonotic parasitic transmission from wildlife. This competency is reflected in several ways: by acknowledging the presence of wildlife

		(e.g., raccoons) in urban settings, evaluating the scope of environmental contamination by fecal-borne parasites, and analyzing the complex parasitic life cycles within various hosts.
4	Disease surveillance Analyze disease risk factors and select appropriate surveillance.	This project analyzed several risk factors associated with zoonotic parasitic infection from wildlife. This included the risks posed by both direct and indirect contact with wildlife, environmental contamination, and the handling and consumption of wild game. While surveillance methods were not directly discussed within the project products, the research conducted prior to creation of the products emphasized the importance of accurate disease surveillance. Due to the vague nature of human symptoms and long-term health effects of some parasitic diseases, it is likely that many human infections go undiagnosed or misdiagnosed. Increasing awareness of the signs and symptoms of human parasitic infections and how they occur may lead to higher rates of diagnosis.
5	Disease vectors Investigate the role of vectors, toxic plants, and other toxins in infectious diseases.	The products demonstrate the vital role that wildlife species play as vectors of parasitic disease. The project overall emphasizes the dynamic nature of wildlife as vectors; the geographic presence and environmental behavior of specific animal hosts often dictates the risk of parasitic exposure to humans. While this project did not directly address the roles of toxic plants and toxins in infectious disease, these topics were thoroughly covered in the required IDZ coursework.

*All five competencies were emphasized in the required IDZ coursework.

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