



Extension FactSheet

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Livestock and Streams

Pathogenic Effects from Livestock Grazing Riparian Areas

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Due to the threat of contamination of drinking water by pathogenic microorganisms, livestock manure in streams is an important human health concern (Strand and Merritt, 1999). Pathogens include bacteria, protozoa, viruses, and helminthes (worms) that have the potential to cause human illness.

Characterization of Waterborne Pathogens

Waterborne pathogens of greatest concern have the following characteristics:

- The organisms are shed into the environment in high number, or they are highly infectious to humans or animals at low doses.



Through the Microscope: An Internet Gallery of Health Science Images: E. Coli bacteria



*Courtesy of Dr. Stan Erlandsen, University of Minnesota
Image of protozoan: Giardia*

- The organism can survive and remain infectious in the environment for long periods, or is highly resistant to water treatment.
- Some types of bacterial pathogens can multiply outside of a host under favorable environmental conditions. (Rosen, NRAES-147)

Types of Waterborne Pathogens

Pell (1997) in a review of 60 peer-reviewed scientific papers summarized major pathogens and health effects associated with dairy wastes. Humans and animals are susceptible to infection with many organisms, including the protozoa Giardia and Cryptosporidium; bacteria species including salmonella, Escherichia coli O157:



Photo courtesy of USDA Natural Resources Conservation Service. Runoff from this livestock facility may enter a nearby stream and degrade water quality.

H7, brucella, Chlamydia, leptospira, listeria, rickettsia, and versinia.

E. coli O157:H7 is of concern because many outbreaks have been traced to ground beef and raw milk. *E. coli* O157:H7 can lead to kidney failure and death in some individuals. Pell (1997) said, “Aside from the problem of disease transmission among animals, more than 150 pathogens can cause zoonotic infections (from animals to humans).

Fecal coliform bacteria are a group of bacteria that reside in the intestinal tract of warm-blooded animals and are used as indicators of water pollution related to waterborne disease (EPA, 1976). Cattle have been shown to produce 5.4 billion fecal coliform and 31 billion fecal streptococcus bacteria in their feces per day. Since cattle spend a significant portion of their time in or near streams, lakes, and wetland areas and average 12 defecations per day, they can contribute significant numbers of these organisms to surface waters (Howard et al., 1983).

Survival of Pathogens in Water

The survival of pathogens in water is variable. Once a pathogen leaves the host environment, it must adjust to external conditions that are different and stressful. The survival of most pathogens is highly variable depending upon the receiving water, particularly turbidity, temperature, oxygen levels, presence of nutrients and pesticides, pH, organic matter, and solar radiation (Moore et al., 1988).

Large concentrations of pathogens can occur in runoff from pastures that do not receive stored manure, due to manure deposited by wildlife and cattle (Edwards et al., 1993). Nutrient enrichment can lead to increased production of microbes that can reduce dissolved oxygen concentrations (Harris et al., 1994) in streams and reduce habitat for aquatic fish and invertebrates.

Milwaukee water supply contaminated with *Cryptosporidium*

An outbreak of *Cryptosporidiosis* in Milwaukee in 1993 is the largest waterborne disease outbreak reported in the United States. An estimated 403,000 people were reported ill. Four deaths were directly linked to *Cryptosporidiosis* and 107 deaths listed the outbreak as a contributing cause of death. Estimated cost is over \$100 million dollars.

What caused this outbreak? High tributary flows into Lake Michigan because of rain and snow runoff may have transported oocysts great distances into the lake from its watershed, and from there to the water plant intake. Although the water treatment plant was meeting all applicable water quality standards, the facility needed significant upgrades to reduce the risk of *Cryptosporidium* in treated water. (Mackenzie et al., 1994).

Where did the *Cryptosporidium* come from? A joint Department of Natural Resources–State Laboratory of Hygiene study was unable to pinpoint a source of the crypto that sickened Milwaukee. Unusually high spring runoff conditions in the agricultural (dairy) lands that are a part of the watershed providing Milwaukee’s drinking water are thought to be at least one possible source of the 1993 outbreak. Wildlife such as deer, as well as *cryptosporidia* of human origin may also be suspected.

(From Kent Hoblet, DVM, The Ohio State University.)

Tiedemann et al. (1987, 1989) found significant increases in fecal coliform (bacteria) with increased intensity of grazing in Oregon. Gary et al. (1983) report that bacteria densities were significantly higher along a pasture when 150 cattle were grazed compared to when 0 or 40 cattle were grazed in a Colorado stream. Bacteria from livestock can enter streams in runoff or are deposited directly when animals have access to the stream (Sherer et al., 1988).

Microorganisms often become adsorbed to organic matter and soil particles which settle out and accumulate at the bottom of rivers and lakes. Sediments at the bottom of streams have been found to harbor significantly higher concentrations of bacteria than the overlying water. Bacteria have demonstrated significantly longer survival in sediment-laden waters than in those without sediment (Sherer et al., 1992). Sherer et al. (1988) artificially re-suspended stream sediments in a watershed with active grazing. They found significantly higher bacteria counts related to the cattle’s access to the stream.

Pathogenic bacteria generally are not well suited to aquatic systems, and survival studies indicate that native bacteria out-compete them for nutrients (Korhonen and Martikainen, 1991). In laboratory studies of lake water, *E. coli* can survive for prolonged periods (as long as 260 days) when kept at 39 degrees Fahrenheit (Flint, 1987),



Photo courtesy of Jim Hoorman. Testing an Ohio stream for water quality.

when no other bacteria is present. Low temperatures, which slow metabolism, generally prolong the survival of pathogens.

Factors That Limit Pathogen Survival

Most bacterial pathogens are sensitive to temperatures exceeding 140 degrees Fahrenheit. Bacterial pathogens can produce resistant endospores or thick-walled cells and only be killed by high temperatures in excess of 212 degrees Fahrenheit. Higher temperatures also kill protozoa cysts. Freeze-thaw cycles also cause pathogen mortality.

The normal pH range for most water bodies is close to 7 (neutral) and would not affect bacteria survival. Only at extreme pH (< 4.5 or > 8.2) can cell die-off be expected.

Nutrient enrichment of water may play an important role in survival. Lim and Flint (1989) demonstrated the importance of nitrogen in the survival of *E. coli*. The nitrogen allowed the cells to survive the competition from native bacteria. The additional nitrogen appears to be important in allowing cells to go through a period of progressive cell dormancy that prolongs viability.

The effect of ultraviolet radiation on bacterial and protozoan mortality has long been known. *E. coli* and *Enterococcus faecalis* were significantly reduced when exposed to visible light in both freshwater and marine systems (Barcina et al., 1990). Habitat competition by other soil microorganisms decreases populations of human and animal pathogens, such as *E. coli*, giardia, and cryptosporidium, that may be transported into streams from manure or septic systems (Stehman et al., 1996).

Several potential sources of pathogens are in the environment. Complex pathways for their distribution are common. Only three waterborne disease outbreaks have been associated with agriculture. The vast majority are

The Walkerton Outbreak: *E. coli*

At Walkerton, Ontario, Canada (May 2000), studies indicate that contaminated drinking water resulted in over 1,300 reported cases of diarrhea, 65 patients hospitalized, and at least 6 deaths. The estimated cost of this outbreak is over \$155 million dollars.

What caused this outbreak? Tests from 174 people confirmed the presence of *E. coli* in 167, and 116 were infected with another bacteria commonly found in cattle and chickens, *Campylobacter* spp. All evidence points to the faulty municipal water supply as being the source of infection. Analysis of data indicated that people living in homes connected to Walkerton's municipal water supply were 11.7 times more likely to develop illness than those who did not have city water.

Where did the *Campylobacter* and *E. Coli* come from? Walkerton is a small farming community in north central Ontario with numerous small livestock farms. Most are pasture operations with 40–60 cow/calf pairs. The outbreak in Walkerton followed 4 days of torrential rains. One city well was in a flooded hay field where manure had been applied from a beef farm. This well had a history of positive total coliform bacteria tests and a cracked well casing. The city had been advised twenty years ago not to locate the well in this location.

Two other wells also supply the town with water and are located in swampy areas with farm fields surrounding them. *E. coli* was found in the environment around these wells. All credible evidence indicates that if properly sited, constructed, and maintained, wells provide safe drinking water. In this instance, improperly sited wells flooded and supplied contaminated water to the city. In addition, the water was improperly chlorinated by the city water department.

(From Kent Hoblet, DVM, The Ohio State University.)

associated with drinking water facilities or inadequacies or failures at these facilities. The potential does exist for contamination of water with pathogens from agriculture. Agriculture continues to be recognized as a major cause of not attaining water quality standards based on indicator bacteria standards (USEPA, 1996). This warrants a proactive approach for reducing this source in watersheds.

Summary of Pathogens Effects

Most waterborne outbreaks associated with drinking water are the result of either poor construction of wells or major rainfall events that result in increased contamination and water turbidity.

- Bacteria from livestock can enter streams in runoff or are deposited directly when animals have access to the stream.

- Sediments in the bottom of streams harbor significantly higher concentrations of bacteria than the overlying water.
- Bacteria densities in a stream increase with increased grazing pressure.
- Some microorganisms are encouraged to grow by excess nutrients in the water, especially nitrogen.
- Low temperatures in surface water, which slow metabolism, generally prolong the survival of pathogens.
- Ultraviolet light inhibits the survival of bacterial and protozoan pathogens.
- Habitat competition decreases populations of certain pathogens transported into streams.

For more information on the effects of livestock grazing riparian areas see the following fact sheets:

- Understanding the Benefits of Healthy Riparian Areas, LS-1-05
- Negative Effects of Livestock Grazing Riparian Areas, LS-2-05
- The Effects of Grazing Management on Riparian Areas, LS-3-05
- Best Management Practices to Control the Effects of Livestock Grazing Riparian Areas, LS-4-05

This fact sheet was adapted from Generic Environmental Impact Statement on Animal Agriculture: A Summary of Literature Related to the Effects of Animal Agriculture on Water Resources (G), 1999, Univ. of Minnesota.

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