Hazard Risk Analysis

Diseases

Diseases

This section introduces a number of types of diseases including those that affect animals, humans, and plants. It also includes plant infestations. There is one risk analysis for diseases that have a natural cause and for those caused by people (human-caused). Diseases have other causes as well such as those caused by water, food, insects and animals. Water-borne diseases are covered under *Contamination and Pollution*.

Resources are available to assist you in completing this analysis in the Risk Analysis Resources section.

Diseases – Animals - Natural or Human-caused

Definition

Animal diseases or sicknesses can be spread from animals to animals and from animals to humans. They are classified by a number of criteria into several groupings: non-infectious diseases, infectious diseases, and diseases caused by parasites.

It is impossible to review every single disease capable of leading to an epidemic or disease outbreak in animals. The risk indicators for those diseases that affect animals are presented from a very general perspective. Experts should always be contacted in determining the risk of any specific diseases. There have been outbreaks of BSE (Mad Cow), Avian Flu and other animal

diseases in recent years in Canada. Diseases are considered from the perspective of those that are transmitted by air and water; by humans; and by other animals.

Discussion

In addition to animals contracting or dying from disease, animal diseases pose a serious threat to human health because of our dependence on a range of animal species for food and the risk of infection from a virus or disease carried by an animal host. The infection of a herd of animals being raised for food can have negative economic impact for farmers, as in the case of foot and mouth disease, in which animals exposed or suspected of exposure are slaughtered and destroyed, in order to limit risk of spreading the disease. The Canadian Food Inspection Agency tracks the number of herds or flocks on farms with federally reportable diseases on an annual basis.

Infectious diseases affecting livestock are caused by bacteria, fungi, viruses, and protozoa, otherwise known as microorganisms. For example, these microorganisms include foot and mouth disease, lumpjaw, rabies, gastroenteritis, anthrax, bovine tuberculosis, brucellosis, and swine fever. Of these diseases, viral infections such as anthrax, which cause rapid death in a number of commercially raised animals, and brucellosis which causes spontaneous abortion in infected animals, can have serious economic impact on farmers. In addition, while they rarely infect humans, there is a slight risk that farm workers, or those who handle the dead bodies of infected animals, could contract the disease.

Foot and mouth disease (FMD) is the most contagious animal disease known, it is extremely virulent and capable of surviving in the open for hundreds of days. There may be increased risk for disease transmission in communities where livestock are raised in close proximity or share pastures, which slaughter and process animals, where it is common for families to handle or come into contact with animals. Canada has been fortunate to remain free of FMD since the 1950's, despite the huge increase in global travel and the evolution of the virus over the years. Despite Canada's FMD-free status, and the relatively low risk of an outbreak, FMD remains a critically important disease for Canada's federal, provincial, and livestock industry sectors. It is estimated that an FMD outbreak in Canada would cost approximately $65 billion in losses and affect not just the livestock industry but also Canada's grain industry, veterinary sector, and tourism industry.

It Happened Here…

In 2020, there were 14 cases of Chronic Wasting Disease (CWD) in Alberta and Saskatchewan identified in elk, white-tailed deer and other deer. CWD is a progressive, fatal nervous system disease that affects these animals, which are all part of the deer family known as cervids. It is a transmissible spongiform encephalopathy, or prion disease. It is contagious amongst cervids, like scrapie in sheep. There has been no known transmission of CWD to humans.

In 2020, there were four cases of Equine Infectious Anemia (EIA) – two in Alberta, one in Saskatchewan and one the Yukon. EIA is an infectious and potentially fatal viral disease affecting the immune system of members of the Equidae family, including horses, donkeys, mules, and zebras. Most EIA-infected horses show no clinical signs of disease; however, they remain carriers of the virus for life and can be a source of infection for susceptible animals.

Since 2015, until 2019, Nova Scotia, New Brunswick and Quebec have seen periodic outbreaks of infectious pancreatic necrosis (IPN) in Brook and Rainbow trout. The disease can cause significant death rates in fry and fingerlings from 1 to 4 months of age. Atlantic salmon smolts transferred to seawater are also at risk of death, with rates increasing in infected animals 7 to 12 weeks after their transfer. Currently no treatments are available for IPN. Finfish may contract the virus through contact with discharged bodily wastes or mucus secretions from infected finfish. It can also spread through water contaminated with the virus. People can spread the virus to other

finfish by moving infected live or dead finfish, by using contaminated equipment, vehicles and vessels, or by using or moving contaminated water. It is not dangerous to humans.

In February 2004, The Canadian Food Inspection Agency (CFIA) quarantined farms and ordered approximately 20 million birds destroyed in Abbotsford, BC and the surrounding rural communities from the Fraser Valley all the way to Hope BC. The CFIA also put restrictions on the movement of birds and poultry products in the area, but the disease spread to other nearby farms.

In 2003 the BSE (Mad Cow) scare arrived in Canada as officials confirmed infected cattle in Alberta had gone through the slaughter house—affecting Manola, Barrhead County, Alberta (county population 5,845). The U.S. and 40 other countries immediately put a ban on Canadian beef. This resulted in all of Alberta`s municipal districts declaring economic disasters in 2004.

In 1997 Infectious Salmon Anemia (ISA) which is caused by the ISA Virus broke out in the Bay of Fundy, affecting Blacks Harbour, New Brunswick (population 952). It caused anemia and respiratory problems in the Atlantic salmon. Thousands of infected salmon had to be removed from the salmon farms resulting in economic losses. There were no cases of human infection because the virus stops producing at 25 degrees Celsius.

Animal Diseases - Transmitted through Air and/or Water - Natural or Human-caused

Hazard Rating	High Risk ☐	Low Risk ☐	Need More Info ☐	Not Applicable ☐

Yes	No	Need More	Not	FACTORS
☐	☐	☐	☐	Animal feces can infect water sources. Are the animal farms in your community in close proximity to a drinking water source?
☐	☐	☐	☐	Farms that do not sanitize water lines frequently (once a week) are more likely to encounter animal health problems from pathogen build-up (pathogens are anything that may cause disease, for example, bacteria, virus, or fungi). Do farms in your community sanitize water lines less than once per week?
☐	☐	☐	☐	There is an increased risk of air-borne transmission of disease in areas of high humidity. Does your community experience high humidity?

Animal Diseases - Transmitted from Animal to Animal - Natural or Human-caused

Hazard Rating	High Risk ☐	Low Risk ☐	Need More Info ☐	Not Applicable ☐

Yes	No	Need More	Not	FACTORS
☐	☐	☐	☐	Failing to quarantine animals new to a farm for at least 2 weeks increases the risk of infection on the farm. Do the farms in and around your community quarantine (separate and restrict movement) new animals for less than 2 weeks?
☐	☐	☐	☐	Vaccination decreases risk of disease. Do farms in your community abstain from vaccinating the livestock? (Answer yes if livestock are not vaccinated)
☐	☐	☐	☐	Livestock exhibitions such as fairs and agricultural shows increase the risk of disease. Does your community host exhibitions and/or contain farms whose animals participate in exhibitions?
☐	☐	☐	☐	As the proximity to other poultry farms increases so does the risk of disease transmissions between poultry farms. Does your community have multiple poultry farms in close proximity?
☐	☐	☐	☐	A high density of small and/or backyard poultry farms in close proximity to commercial poultry farms increases the risk for the commercial farms. Does your community have a large number of small poultry farms in close proximity to a commercial poultry farm?
☐	☐	☐	☐	Free range poultry flocks (where animals can roam freely outdoors) are considered to be at more risk to the introduction of infection. Does your community have free range poultry flocks?
☐	☐	☐	☐	The presence of wild birds on breeder farms increases the risk of disease. Do the breeder farms in your community (if any) have large number of wild birds on their premises?
☐	☐	☐	☐	Older chickens are more susceptible to infection. Does your community often have old chickens on its farms?
☐	☐	☐	☐	If farms share pastures it increases the risk of disease spread between animals from different farms. Do any farms in your community share pastures?
☐	☐	☐	☐	Some viruses (e.g. avian influenza) can be transmitted from affected poultry to pigs, also increasing the risk for humans. Does your community have poultry and pig farms or raise poultry and pigs in close proximity?
☐	☐	☐	☐	Some diseases are spread from fish to other fish or by transfer of contaminated water from one body or water to another via boats or equipment. Has your commmunity experienced outbreaks of transmittable fish diseases in nearby aquatic sites?

Animal Diseases - Transmitted through Humans - Natural or Human-caused

Hazard Rating	High Risk ☐	Low Risk ☐	Need More Info ☐	Not Applicable ☐

Yes	No	Need More	Not	FACTORS
☐	☐	☐	☐	Movement of people and vehicles between farms (i.e., workers, service companies, etc.) increase the risk of spreading disease. Is there a lot of sharing of staff, vehicles, or equipment between the farms in and around your community?
☐	☐	☐	☐	Visitors can bring disease onto the farm if they do not have to put on special boots and coveralls. Do the farms in your community allow visitors without special protective gear?
☐	☐	☐	☐	Just as animals can pass disease to humans, humans can pass disease to animals when living in close proximity. Is the human population living in close proximity to the animal population in your community?
☐	☐	☐	☐	Does your community have traditions or events which involve contact with animals such as parades, fairs or rodeos?

Human Diseases - Natural or Human-caused

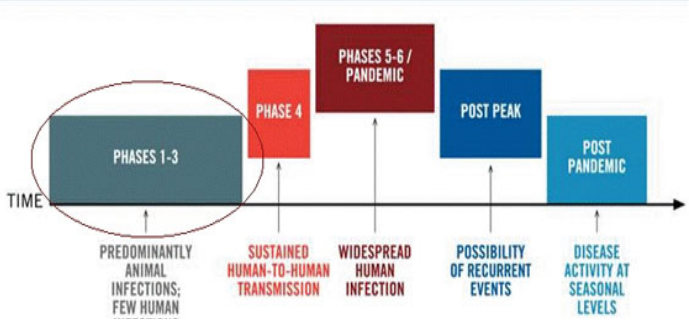
Definition

Human diseases of concern are diseases and epidemics which affect people, cause death, have serious economic implications and form the basis for a mass casualty emergency response. It is impossible to review every single disease capable of leading to an epidemic or pandemic. The risk indicators for those diseases that affect people are presented from a very general perspective. Experts should always be contacted in determining the likelihood of any specific diseases. The following diseases are those that affect people. Diseases that have affected humans in Canada in the last several years have ranged from SARS (Severe Acute Respiratory Syndrome) coronavirus, H1N1 (influenza virus), and West Nile Disease to outbreaks of listeriosis and E. Coli (bacterium). Vector-borne and zoonotic diseases are caused by viruses, bacteria or parasites that are transmitted to humans from animals or insects. Some diseases that originate in animals must be transmitted through a “vector” (e.g., mosquito, tick) in order to infect a human. Diseases are considered from the perspective of those that are transmitted by: air and water, animals (including insects), humans, and food.

Discussion

Infectious diseases which affect humans, causing sickness or death, are often of great concern. and require rapid and intensive response to treat the ill and help prevent further transmissions. Of major concern is a pandemic. A pandemic as currently defined by the World Health Organization (WHO) is an outbreak of an infectious disease that affects people or animals that is declared at Phases 5 and 6 (the highest phases as illustrated in Figure 1, and where there is widespread human infection).

Figure 1
World Health Organization Phases of a Pandemic



Starting in 2020, Canada and the rest of the world was impacted by COVID-19, a global pandemic. Other diseases that may possibly attain pandemic proportions include Influenza, Lassa fever, Rift Valley fever, Marburg virus, Ebola virus and Bolivian haemorrhagic fever. For some diseases, there are no vaccines or cures. Recent emergence or re-emergence of these diseases into the human population have 'burned out' in geographically confined areas or had limited effect on humans. However, disease strains evolve over time and some can combine, presenting the potential threat of an outbreak or pandemic in the future. There are other diseases such as West Nile Virus which has affected hundreds of people in Canada but numbers in 2010 had declined considerably (see Risk Analysis Resources West Nile Virus).

HIV - the virus that causes AIDS - can be considered a global pandemic but it is currently most extensive in southern and eastern Africa. It is restricted to a small proportion of the population in other countries, and is only spreading slowly in those countries. If there was to be a true destruction-of-life pandemic it would be likely to be similar to HIV, i.e. a constantly evolving disease.

Antibiotic-resistant superbugs may also revive diseases previously regarded as “conquered.” Tuberculosis (TB) was of pandemic proportions a Century ago and was largely ‘conquered’ but is re-emerging as a potential concern due to an increase in antibiotic-resistant cases.

In February 2004, avian influenza virus was detected in pigs in Vietnam, increasing fears of the emergence of new variant strains. It is feared that if the avian influenza virus combines with a human influenza virus, the new influenza 'sub-type' created could be both highly contagious and highly lethal in humans. Such a subtype could cause a global influenza pandemic, similar to the Spanish Flu (1918-1920), or the lower mortality pandemics the Asian Flu (1956-1958) and the Hong Kong Flu (1968-1969). In November 2004 the director for the western region of the World Health Organization said that an influenza pandemic was inevitable and called for urgent plans to combat the virus. The most recent 2009 H1N1 outbreak was a result of a combination of human, avian, and swine viruses.

The severity of each influenza season varies, with between 2,000 and 8,000 people die of influenza annually in Canada.

Each year, 1 in 8 people (4 million Canadians) get sick from contaminated food resulting in over 11,500 hospitalizations and 240 deaths due to food-related illnesses.

It Happened Here…

While the first case of a neurological disease, with symptoms similar to prion diseases, was diagnosed in 2015, there have been increasing numbers of persons affected by what is believed by some scientists to have environmental causes, or to be an entirely new disease, as to date no links to prion disease have been identified. The disease has only occurred in New Brunswick, and in 2019, 11 cases were discovered, with 24 more cases discovered in 2020 and another six in 2021 by March 2021. Five people have died.

On January 25, 2020 the first Canadian COVID-19 case was reported in Toronto. The day of his Jan. 22 flight from Beijing, major Canadian airports in Montreal, Toronto and Vancouver had introduced new screening measures for passengers returning from China with flu-like symptoms. The man didn't have any symptoms when he arrived, but the next day, he became so sick that he required a trip to the hospital. It wasn't until Feb. 20, that Canada reported its first case related to travel outside mainland China—a traveller from Iran. By Feb. 26, Canada had 12 confirmed cases. By April 12, 2021 there were 1.07 million cases diagnosed cases and 23,356 deaths.

In 2019 anthrax killed seven animals (not cattle) in Saskatchewan (the species was not named but categorized as ruminants – which includes sheep, goats and other animals. In 2018, 13 bison on a farm in Fort St. John, BC died of anthrax.

In 2017, follow-up on investigations by the United States CDC and public health officials in Canada indicated that pet rats had been exchanged between the United States and Canada. Three positive human cases for the Hemorrhagic Fever Renal Syndrome (HFRS) group of hantaviruses, which includes Seoul, Hantaan, Puumala and Dobrava viruses, were identified by serology in Canada. No serious illness was reported in these individuals.

In February 2015 there was a human infection with avian influenza A (H7N9). Two individuals flew from Hong Kong, SAR China to British Columbia, Canada after travelling together through China. During their travels, they were exposed to live poultry, although they had no direct contact with poultry. Both survived following treatment in Canada.

In 2009 the H_1N_1 pandemic proved to be far less fatal than previously thought, nevertheless, thousands did become ill and 66 persons died as a result of the infection.

On Aug. 23, 2008, a Toronto Maple Leaf Foods plant was confirmed as being involved in the outbreak of the food-borne illness, caused by the bacterium Listeria monocytogenes. A day later, Maple Leaf recalled all 220 packaged meats from the plant, which has been shut down. The company estimated the recall will directly cost it at least $20 million, with further costs expected due to lost sales and advertising to rebuild its image. Twelve people died.

On April 16, 2003 researchers around the world established a hitherto unknown virus as the cause of SARS. The new coronavirus was named by WHO and member laboratories as "SARS-CoV Virus." In Canada there were 251 probable cases (247 cases in Ontario, 4 cases in British Columbia), with 44 deaths (43 probable, 1 suspect). In addition, there were 187 suspect cases (128 in Ontario, 46 in B.C., 6 in Alberta, 4 in PEI, 2 in New Brunswick and 1 in Saskatchewan). The case fatality rate in Canada was estimated at approximately 17.1% of probable cases (10.0% of probable and suspect cases). Most of the case fatalities occurred in patients with underlying illness, and nearly all were elderly patients with the average age being 71 years. There have been no new cases of SARS in Canada since June 12, 2003. There was a total of 136 probable cases and 27 deaths in the first Ontario cluster and 111 probable cases with 17 deaths in the second Ontario cluster in 2003.

Between Oct 1999 and March 2000 170 band members were evacuated from their homes as an unknown toxic mold invaded the community of Little Saskatchewan India Reserve, Manitoba (population 654). The invasion was severe that several homes had to be destroyed.

In 1992 a Campylobacter bacterium outbreak occurred, affecting Kaslo, British Columbia (population 1072). Birds are the suspected source of this waterborne disease outbreak but this remains unconfirmed. After the outbreak the community spent millions of dollars upgrading its water treatment system.

In June 1983 an encephalitis outbreak swept across Manitoba affecting large and small communities alike, including Winnipegosis, Manitoba (population 630). The disease is thought to have been spread by infected mosquitoes carried northward by warm winds.

In 1953 there was a polio epidemic across Canada. In total 481 died and more 8000 Canadians were affected. The community of Cavendish, Prince Edward Island (population 272) was among the many affected communities.

Human Diseases Transmitted through Air and Water Natural or Human-caused

Hazard Rating	High Risk ☐	Low Risk ☐	Need More Info ☐	Not Applicable ☐

Yes	No	Need More	Not	FACTORS
☐	☐	☐	☐	Is your community listed under a “Do Not Consume Water” or “Boil Water Advisory?”(Check Risk Analysis Resources – Water Advisories)
☐	☐	☐	☐	Does your community fail to regularly test your water system for adequate chlorination levels and for a bacterial and virus count?
☐	☐	☐	☐	Cattle feces can contaminate drinking water and produce E. coli. Does your community farm cattle in close proximity to the drinking water source?
☐	☐	☐	☐	Rodents searching for higher grounds (i.e., during flooding) can contaminate water, mud and damp vegetation. Waterborne diseases can be transmitted when skin membranes come into contact these contaminated substances. Does your community experience flooding? (Refer to section on Floods)
☐	☐	☐	☐	There is an increased risk of air-borne transmission of disease in areas of high humidity. Does your community experience high humidity?
☐	☐	☐	☐	Campylobacteriosis is an infection caused by the Campylobacter bacteria and can result in serious illness requiring hospitalization and, in some cases life-long illness. Several thousand Canadians are infected every year. It can be found in untreated drinking water. It can also be spread in untreated lakes, rivers and creeks contaminated by sewage or manure. Do community residents drink, or swim in untreated water?

Human Diseases Transmitted through Animals (Including Insects) - Natural or Human-caused

Hazard Rating	High Risk ☐	Low Risk ☐	Need More Info ☐	Not Applicable ☐

Yes	No	Need More	Not	FACTORS
☐	☐	☐	☐	Many human influenza pandemics in humans came from viruses that originated in birds. Do residents live in close proximity to birds i.e., poultry farms, “pets” and/or used for personal egg supply?
☐	☐	☐	☐	Pigs can contract viruses from humans and birds as well as pass them off to humans and birds. Do residents live in close proximity to pigs i.e., hog farms?
☐	☐	☐	☐	Mosquitoes can easily transmit some diseases. Scientists are predicting that with changes in climate, such as increased precipitation or warmer temperatures further North, there will be increased ranges of insect-borne and tick-borne diseases. Does your community experience a large number of mosquitoes in the spring and summer months? Is your community experiencing increased precipitation or warmer temperatures and increasing number of mosquitoes? Do you have stagnant pools of water, or marshland, where mosquitoes are known to lay their eggs?
☐	☐	☐	☐	People are more vulnerable to mosquitoes, ticks and other animal borne diseases (i.e., West Nile Virus, Lyme Disease) if hiking or sleeping outside. Are camping and/or other outdoor activities that require spending the night outdoors popular in your community and is your community known for experiencing mosquitoes and ticks?
☐	☐	☐	☐	Wild and domestic animals can pass infectious diseases to humans (e.g., Anthrax). This bacteria can be found naturally in soil and it can infect farm animals such as cattle, sheep and pigs and deer and bison. Although uncommon, a person can become infected with anthrax by contact with infected animals or exposure to contaminated animal products. Does your community have grazing grasses with soil that contains anthrax?
☐	☐	☐	☐	Campylobacteriosis is an infection caused by the Campylobacter bacteria and can result in serious illness requiring hospitalization and, in some cases life-long illness. Several thousand Canadians are infected every year. It can be spread through dogs and cats (through their feces) and livestock as well as through contagious people. Have there been previous Camplobacteriosis outbreaks in the past in your community?

Human Diseases Transmitted from Human to Human - Natural or Human-caused

Hazard Rating	High Risk ☐	Low Risk ☐	Need More Info ☐	Not Applicable ☐

Yes	No	Need More	Not	FACTORS
☐	☐	☐	☐	The more interactions between people, the larger the risk of spreading disease within a community. Does your community have many cultural or other type of gatherings?
☐	☐	☐	☐	The more interactions between different communities, the larger the risk of spreading disease between communities. Does your community frequently interact with other communities or people (i.e., is tourism popular, do a lot of people holiday out of country or work in another town)?
☐	☐	☐	☐	During pandemics everyone is at an increased risk. Do most people in your community fail to abide by the rules and guidelines established by the Medical Health Officer?
☐	☐	☐	☐	Vaccines are important in fighting of diseases such as influenza. Does your community have a large number of people who go unvaccinated?
☐	☐	☐	☐	Health care workers are likely to be at a higher risk due to their exposure in the workplace. Does your community have a high proportion of individuals employed in the health care field?
☐	☐	☐	☐	Children 5-15 years old are most at risk to many infections. Is a high proportion of your community 5-15 years old?
☐	☐	☐	☐	Underweight and overweight children are more susceptible to disease. Are underweight and overweight children a concern in your community?
☐	☐	☐	☐	Crowded housing and poor nutrition increase the risk of TB (Tuberculosis). Does your community have high rates of crowded housing and/or poor nutrition?
☐	☐	☐	☐	Would a significant percentage of your community be considered to have complicating medical conditions such as diabetes, obesity, alcohol and drug dependencies, and/or smoking?

Human Diseases - Food Transmitted - Natural or Human-caused

Hazard Rating	High Risk ☐	Low Risk ☐	Need More Info ☐	Not Applicable ☐

Yes	No	Need More	Not	FACTORS
☐	☐	☐	☐	Food can become contaminated with *Salmonella* and other bacteria during the slaughter and processing of an animal, when food is handled by a person infected with *Salmonella*, or by cross-contamination from other animals. Does your community have a slaughter house in or near to the community? Does your community have traditions involving slaughter and processing of an animal?
☐	☐	☐	☐	Regulations help prevent contamination of potable water and irrigated land with sewage. Is there a lack of regulations to ensure that potable and irrigation water is not contaminated with sewage?
☐	☐	☐	☐	Food is often contaminated as a result of unsanitary food handling practices. Does your community frequently have events when home cooked meals are served?
☐	☐	☐	☐	Eating raw meat or drinking unpasteurized milk and cheeses can increase the risk of disease transmission. Do residents in your community frequently eat or drink raw meat or drink unpasteurized milk and raw milk cheeses?
☐	☐	☐	☐	Outbreaks of botulism have also occurred in Canada's Inuit populations when people have eaten improperly prepared raw or parboiled meats from marine mammals? Does your community eat raw or parboiled marine mammal meat?
☐	☐	☐	☐	Vegetables and fruits can become contaminated from improperly composted manure, contaminated water, and poor hygienic practices of farm workers. Is there a lack of farming standards regarding the use of manure or contaminated water in any agricultural areas in your community? Is the practice of hiring farm workers poorly administered?
☐	☐	☐	☐	Are residents and visitors unaware of when and where areas are closed for shellfish harvesting?
☐	☐	☐	☐	Do community residents and visitors frequently disregard the rules regarding open shellfish harvesting?
☐	☐	☐	☐	Infections can be transmitted from food arriving from various sources such as farms and food processing plants. Does your community's restuarants or sellers of food products have limited or untimely access to Food Recall Notices sent out by Agriculture and Agri-Food Canada?

Plant Diseases and Infestations – Natural or Human-caused

Definition

Plant diseases are any series of harmful physiological processes caused by irritation of the plant by some invading agent (the cause). These invading agents are typically referred to as plant pathogens and include viruses, bacteria, fungi, and algae. Plant diseases can also be classified as a pandemic.

It is impossible to review every single disease capable of leading to a disease outbreak in plants. The risk indicators for those diseases that affect plants are presented from a very general perspective. Experts should always be contacted in determining the risk of any specific diseases. There have been outbreaks of Blackleg Disease in rapeseed, Mountain Pine Beetle infestations in Western Canada and Potato Disease in the Maritimes. The following presents risk factors for plants under human control and those in general.

Discussion

Increasingly our crops are becoming more vulnerable to plant diseases and infestations. The risk of disease is increased when only one crop is produced in an area – for example, if only wheat is grown in a particular area and the wheat becomes diseased there are no other crops between plots of wheat and thus there is a greater likelihood that the disease will spread more quickly. The risk of crop loss due to disease continues to pose a major problem to agricultural producers.

The major plant diseases affecting Canada crops are: ergot (a fungus affecting cereals and grasses), rust (a fungus affecting cereals), associated diseases affecting corn, blackleg (a fungus) and clubroot in canola fields, and root rot in soybeans, and fruit rot. By 2019, over 3,000 fields in Alberta have been infected with clubroot (a plant disease that can affect broccoli, brussels sprouts, cabbage, cauliflower, Chinese cabbage, kale, kohlrabi, radish, rutabaga, turnip, canola, rapeseed and mustard. In 2019, diseases of ornamental nursery and landscape crops in south coastal British Columbia were identified and cool, wet weather in spring led to high levels of botrytis and downy mildew on many crops in Canada. No new diseases or causal agents were identified.

It Happened Here…

In 2019, rapid apple decline was an emerging viral disease that has devastated apple orchards in several regions in Canada, including the Okanagan valley in British Columbia. Nineteen viruses and one viroid were detected. Although no single virus showed a clear association with the disease, it is possible that several viruses contributed together to the disease severity.

In July 2010, an outbreak of Downy Mildew was confirmed throughout Southern Ontario: including several fields of cucumbers in Norfolk, Elgin and Chatham/Kent Counties.

In 1993, the PVYN Potato virus swept through Prince Edward Island and New Brunswick, affecting Rogersville, New Brunswick (population 1,165). Potato crops were affected and financial losses were experienced by farmers.

Plant Diseases – Human-controlled

Hazard Rating	High Risk ☐	Low Risk ☐	Need More Info ☐	Not Applicable ☐

Yes	No	Need More	Not	FACTORS
☐	☐	☐	☐	Dense agricultural crops are more susceptible to invasion. Are agricultural crops grown in your community?
☐	☐	☐	☐	Areas where monoculture is practiced (growing of one crop type) are at greater risk to disease. Is your community's agriculture based solely on one (or two) crops?
☐	☐	☐	☐	The migration of seasonal workers may facilitate the movement of plant pathogens. Does your community receive an influx of seasonal workers at some point during the year?
☐	☐	☐	☐	Overuse of pesticides can result in resistant pathogens which cause disease. Are large amounts of pesticide used in your community?
☐	☐	☐	☐	Forestry enables the spread of infections by unintentionally transporting pests or diseases on timber-harvesting vehicles to unaffected areas (the strongest influence on the rate of spread of some diseases). Is there active timber-harvesting in and/or around your community?
☐	☐	☐	☐	Tree nurseries are one of the main pathways exotic plant diseases are introduced. Does your community have tree nurseries?
☐	☐	☐	☐	Epidemics can occur if plants are introduced to an area that contains a disease i.e., soil-borne fungus. This can occur when a new crop that is susceptible to infection is planted in an infested field. Has your community started planting new crops and/or is planning to do so?
☐	☐	☐	☐	Recent emerging plant diseases have been assisted by trade of infected material among countries. Does your community receive overseas plants and/or plant material?
☐	☐	☐	☐	Soil-less production is an increasing trend in horticulture that has potential for new diseases. Does your community have soil-less horticulture production?

Plant Diseases - General – Natural or Human-caused

Hazard Rating	High Risk ☐	Low Risk ☐	Need More Info ☐	Not Applicable ☐

Yes	No	Need More	Not	FACTORS
☐	☐	☐	☐	Following an outbreak both the host (the infected plant) and pathogen (the basis of the infection) rarely disappear completely resulting in the possibility of a subsequent outbreak. Has your community experienced a plant disease outbreak in the past?
☐	☐	☐	☐	Wetter areas are more susceptible to fungal infections. Is your community located in a wet area (i.e., experiences a lot of rain and/or humidity)?
☐	☐	☐	☐	Epidemics can occur if plants are introduced to an area that contains a pathogen i.e., soil-borne fungus. This can occur when a new crop that is susceptible to infection is planted in an infested field. Has your community started planting new crops and/or planning to do so?
☐	☐	☐	☐	The Appalachians have what is considered a disease-inducing climate. Is your community located in the Appalachians in the East Coast?
☐	☐	☐	☐	Following a pest infestation, trees are more susceptible to disease outbreaks. Has your community recently experienced a pest infestation?

Pest Infestations

Definition

Pest infestations are classified by the feeding habits of the pest: bark, foliage feeding or root feeding.

Discussion

In Canada, pests such as the spruce budworm or the mountain pine beetle have been known to damage marketable timber and affect the health of forests for other cultural or traditional uses. These infestations can cause millions of dollars worth of damage to forests and tree farms and cause secondary economic impacts in subsidiary industries. The current top ten concerns in Canada regarding pest infestations of trees, according to Natural Resources Canada, are the: Asian longhorn beetle (Ontario), birch leafminer (Alberta and Quebec), brown spruce longhorn beetle (Nova Scotia), emerald ash borer (Ontario), forest tent caterpillar (large outbreaks in Alberta, Ontario and Quebec), mountain pine beetle (British Columbia and Alberta), spruce budworm (Quebec and the northern boreal forest from Alberta to the Yukon), and western spruce budworm (British Columbia).

Additional concern includes the large variety of pests which may feed on agricultural crops including potatoes, grain, fruit and other produce. For example, Agriculture Canada reports that infestations of grasshoppers can result in crop losses of up to 50%.

It Happened Here…

In August 2019, the Asian giant hornet was first spotted in B.C. and in December 2020, it was discovered in Washington State. Warnings have now been issued in B.C. and Washington that the Vespa mandarinia species may become active in 2021 as queens emerge from hibernation to build nests and form colonies. The hornets are not usually interested in humans (although people can die from being stung) or animals, but they kill and eat honeybees which is a significant concern for struggling bee populations that play a vital role in agricultural success in Canada. The Asian giant hornet can kill 40 honeybees a minute by ripping their heads off and use their bodies to feed its young.

In 2015, large outbreaks of forest tent caterpillars defoliated 4.8 million nectars of forest, mainly in Ontario and Quebec. Infestations happen in cycles of every 10-12 years and can last up to 3 to 6 years. The end of an outbreak is associated with an increase in disease (typically viruses) in the population. There seems to be a synchronization among outbreaks in different areas within Ontario and Quebec.

In 2009 Agriculture and Agri-Food Canada reported that Culicoides, “a biting fly that makes its home and takes its meals in livestock facilities can spread viral diseases among cattle, including the devastating bluetongue disease. Apart from the Okanagan Valley in British Columbia, Canada is free of this disease. However, the potential for outbreaks elsewhere has caused severe restrictions on animal movement and loss of international trade.”

Agriculture and Agri-Food Canada reported that in 2006, a wheat midge infestation caused an estimated $40 million in yield and grade losses in Saskatchewan and Manitoba, while the pest can cause up to $100 million in losses in a year of high infestation. Currently pesticide application is the only defence against wheat midge.

Starting in the early 1990s, an ongoing outbreak of mountain pine beetle in British Columbia has affected more than 18 million hectares of forest. The beetle has migrated well beyond its historic range into northern British Columbia and eastward into the boreal forests of north-central Alberta. the beetle has attacked 50% of the total volume of commercial lodgepole pine in British Columbia. By 2017, the total cumulative loss of pine that could have been sold was estimated at 752 million cubic metres (58% of sellable pine volume).

Pest Infestations

Hazard Rating	High Risk ☐	Low Risk ☐	Need More Info ☐	Not Applicable ☐

Yes	No	Need More	Not	FACTORS
☐	☐	☐	☐	Following an infestation the pest often does not disappear completely resulting in the possibility of a subsequent outbreak. Has your community experienced a pest infestation outbreak in the past?
☐	☐	☐	☐	Increased moisture in certain dry regions of Eastern Canada has increased the likelihood of pest infestations. Is your community located in Eastern Canada and has it experienced increased moisture?
☐	☐	☐	☐	Longer growing seasons without frost or very warm winters increases the likelihood of pest infestations. Has your community experienced warmer winters or longer periods without frost?
☐	☐	☐	☐	Boreal forests have experienced increased invasions of tree-damaging pests. Is your community located in a boreal forest area?
☐	☐	☐	☐	Is your community in an area which is listed by Natural Resources Canada or TreeCanada as being suseptible to pest infestation in the coming years?

Risk Analysis Resources

Animal Diseases

The Canadian Food Inspection Agency tracks and inspects for Terrestrial animal diseases including reportable and immediately notifiable diseases, annually notifiable diseases and other monitored diseases.

Keywords: Agriculture and Agri-Food Canada, plant diseases, pests

The Canadian Food Inspection Agency also tracks Aquatic animal diseases including diseases of fin fish such as salmon and trout.

Keywords: Canadian Food Inspection, aquatic animal disease

The Canadian Wildlife Health Cooperative provides a lot of information on invasive pigs, avian influenza, bat health, chronic wasting disease and other animal diseases.

Keywords: Canadian Wildlife Health Cooperative, animal diseases, plastics

Human Diseases, Epidemics and Pandemics

The Public Health Agency of Canada includes a lot of information on its website regarding potential epidemics and pandemics. It also publishes a weekly Canadian Communicable Disease Report.

Keywords: Communicable Disease, Canada

Health Canada has a lot of information on diseases and disease prevention.

Keywords: Disease Prevention, Canada

In British Columbia, the BC Centre for Disease Control (BCCDC), provides: health surveillance, investigation and education to address foodborne, waterborne and vector-borne (infections transmitted by species such as mosquitoes, ticks and blackflies) diseases. As well the BCCDC works closely with health professionals in communities and regional health authorities to provide a coordinated response to illnesses and outbreaks.

Keywords: BC Centre for Disease Control

For First Nations in British Columbia, the First Nations Health Authority has information on communicable diseases.

Keywords: First Nations Health Authority, Communicable Disease

The World Health Organization provides a detailed overview of the various stages of a pandemic.

Keywords: WHO, stages of pandemic

Specific Diseases

The Public Health Agency of Canada tracks COVID-19 cases daily and provides updated information on the risk, the variants, travel restrictions and treatments. It also provides links to ongoing information on COVID-19 as provided by each province and territory.

Keywords: Public Health Agency of Canada, COVID-19

The World Health Organization has a website devoted to the COVID-19 pandemic.

Keywords: WHO, COVID-19

Infection Prevention and Control Canada has a large source of publications regarding COVID-19 *Coronavirus (COVID-19). Additional reading* and includes links to research and published papers.

Keywords: Infection Prevention and Control Canada, COVID-19, Additional Readings

Canada also tracks the current and past cases of West Nile Disease and provides information on ongoing surveillance.

Water Advisories

For all of Canada check for up-to-date listings for First Nations communities where there is a "Do Not Consume" or "Boil water" advisory.

In British Columbia, First Nations community members can obtain the most up-to-date information on drinking water in their community through Chief and Council, or their local First Nations Health Authority from http://www.fnha.ca/what-we-do/environmental-health. As well, there is information on how to maintain and inspect private wells.

Plant Diseases

The Canadian Phytopathological Society promotes research and education in plant pathology, public awareness of the importance of plant diseases, and discussion of all aspects of plant pathology in Canada and internationally. The Canadian Plant Disease Survey is a periodical of information and record on the occurrence and severity of plant diseases in Canada and on the analysis of losses from disease.

Keywords: Canadian Plant Disease Survey

Agriculture and Agri-Food Canada has a lot of information on plant diseases and pests.

Keywords: Agriculture and Agri-Food Canada, plant diseases, pests

References

Agriculture and Agri-Food Canada. (2021). *Crop news*.

Anderson, R. M., & May, R. M. (1985). Vaccination and herd-immunity to infectious-diseases. *Nature, 318*(6044), 323-329.

B.C. Ministry of Agriculture and Food. (1984). *Major insect and allied pests of vegetables in British Columbia*. Queen's Printer.

Breen, K. (2019, August 31). *Anthrax killed 7 animals in Saskatchewan. Here's what you need to know about the disease*. Global News.

Broadway, Michael. (2008). BSE Devastating impact on rural Alberta: A preliminary analysis. *Prairie Forum, 35(*1), 123-143.

Broca, T. (2020, April 8). *COVID-19: A Canadian timeline*. Canadian Healthcare Network.

Burkle, F.F. (2010). Future humanitarian crises: Challenges for practice, policy, and public health. *Prehospital and Disaster Medicine*, *25*(3), 191-198.

Canadian Animal Health Surveillance System (CAHSS) equine diseases dashboard. (2021). *Equine diseases*.

Canadian Food Inspection Agency. (2020). *Facts about infectious pancreatic necrosis*.

Canadian Food Inspection Agency. (2021a). *Canadian Food Inspection Agency*.

Canadian Food Inspection Agency. (2021b). *Causes of food poisoning*.

Canadian Food Inspection Agency. (2021c). *Chronic wasting disease of deer and elk.*

Canadian Wildlife Health Cooperative. (n.d.). *Surveillance and response*.

Cross, P. C., Johnson, P. L. F., Lloyd-Smith, J. O., & Getz, W. M. (2007). Utility of R-0 as a predictor of disease invasion in structured populations. *Journal of the Royal Society Interface, 4*(13), 315-324. doi:10.1098/rsif.2006.0185

Dehnen-Schmutz, K., Holdenrieder, O., Jeger, M. J., & Pautasso, M. (2010). Structural change in the international horticultural industry: Some implications for plant health. *Scientia Horticulturae, 125*(1), 1-15. https://doi.org/10.1016/j.scienta.2010.02.017

Dusan, F., Toribio, J., & East, I. J. (2010). Assessment of the risks of communicable disease transmission through the movement of poultry exhibited at agricultural shows in New South Wales. *Australian Veterinary Journal, 88*(9), 333-341. doi:10.1111/j.1751-0813.2010.00613.x

East, I., Kite, V., Daniels, P., & Garner, G. (2006). A cross-sectional survey of Australian chicken farms to identify risk factors associated with seropositivity to Newcastle-disease virus. *Preventive Veterinary Medicine,* 77(3-4), 199-214. doi:10.1016/j.prevetmed.2006.07.004

Gilles, M. (2018). Modernizing Canada's foot and mouth disease response plan. *The Canadian Veterinary Journal, 59*(8), 899-902.

Government of Canada. (2018). *Campylobacteriosis (Campylobacter)*.

Gubbins, S., Gilligan, C. A., & Kleczkowski, A. (2000). Population dynamics of plant–parasite interactions: Thresholds for invasion. *Theoretical Population Biology, 57*(3), 219-233. https://doi.org/10.1006/tpbi.1999.1441

Hampton, T. (2004). Clues to deadly 1918 flu revealed. *JAMA, 29*(13), 1553. doi:10.1001/jama.291.13.1553

Hao, W, Xiao, H., & Sanfacon, H. (2020, December 10). *Identification of plant viruses in orchards affected by rapid apple decline disease in the Okanagan and Similkameen valleys* [Presentation]. BC regional meeting of the Canadian Phytopathological Society, Summerland Research and Development Centre, B.C.

Health Canada. (2016). *Food-related illnesses, hospitalizations and deaths in Canada* [Infographic].

Holdenrieder, O., Pautasso, M., Weisberg, P. J., & Lonsdale, D. (2004). Tree diseases and landscape processes: The challenge of landscape pathology. *Trends in Ecology & Evolution, 19*(8), 446-452. https://doi.org/10.1016/j.tree.2004.06.003

How Maple Leaf Foods is handling the listeria outbreak. (2008, August 28). CBC News.

Huber, L., & Gillespie, T. J. (1992). Modeling leaf wetness in relation to plant-disease epidemiology. *Annual Review of Phytopathology, 30, 553-577.* https://doi.org/10.1146/annurev.py.30.090192.003005

Infection Prevention and Control Canada. (n.d.). *SARS-CoV (severe acute respiratory syndrome).*

Margosian, M. L., Garrett, K. A., Hutchinson, J. M. S., & With, K. A. (2009). Connectivity of the American agricultural landscape: Assessing the national risk of crop pest and disease spread. *Bioscience, 59*(2), 141-151. https://doi.org/10.1525/bio.2009.59.2.7

Natural Resources Canada. (2020). *Top forest insects and diseases in Canada.*

Neustoer, B. (2020, May 4). *Murder hornets may spread east from B.C. if not eradicated, entomologist says.* CTV News.

Pautasso, M., Xu, X., Jeger, M. J., Harwood, T. D., Moslonka-Lefebvre, M., & Pellis, L. (2010). Disease spread in small-size directed trade networks: The role of hierarchical categories. *Journal of Applied Ecology, 47*(6), 1300-1309. https://doi.org/10.1111/j.1365-2664.2010.01884.x

Pons, W., Young, I., Truong, J., Jones-Bitton, A., McEwen, S., Pintar, K., & Papadopoulos, A. (2015). A systematic review of waterborne disease outbreaks associated with small non-community drinking water systems in Canada and the United States. *PLOS ONE, 10*(10), e0141646. doi:10.1371/journal.pone.0141646

Popplewell, B. (2010 October 30). The Indian Reserve Little Saskatchewan, Man., the 14th worst place to live in Canada. *Toronto Sta*r.

Public Health Agency of Canada. (2020). *West Nile virus and other mosquito-borne diseases national surveillance report.*

Public Health Agency of Canada. (2020.). *Flu (influenza): Symptoms and treatment*.

Public Health Ontario. (2019). *Vector-borne and zoonotic diseases*.

Public Safety Canada. (n.d.). *Canadian disaster database*.

Sutherland, M. (2021, March 18). *Environment a chief suspect in mystery neurological disease found only in N.B*. CBC News.

TreeCanada. (n.d.). *Tree killers*.

Webb, C. R. (2005). Farm animal networks: Unraveling the contact structure of the British sheep population. *Preventive Veterinary Medicine, 68*(1), 3-17. doi: 10.1016/j.prevetmed.2005.01.003

World Health Organization. (2021). *Disease outbreak news*.

World Health Organization. (n.d.). *Emergencies, preparedness, response*.