

# Disease risks associated with translocation of wildlife – information for veterinarians and wildlife rehabilitators in Ontario

## **Prepared/Reviewed by:**

Jolene Giacinti<sup>1</sup>, BHSc, DVM  
Christina McKenzie<sup>1</sup>, BSc, DVM, DVSc  
David McRuer<sup>2</sup>, MSc, DVM, DACVMP  
Diana Sinclair<sup>1</sup>, DVM, PhD  
Brian Stevens<sup>1</sup>, DVM, DVSc, DACVP  
Jeff Bowman<sup>3</sup>, BSc, MSc, PhD  
Tamara Gomer<sup>3</sup>, BSc, MES  
Chris Heydon<sup>3</sup>, BES  
Larissa Nituch<sup>3</sup>, MSc  
Claire Jardine<sup>1</sup>, DVM, MSc, PhD

<sup>1</sup>Canadian Wildlife Health Cooperative, Department of Pathobiology, University of Guelph, Guelph, ON

<sup>2</sup>Parks Canada, Atlantic Veterinary College, University of Prince Edward Island, Charlottetown, PEI

<sup>3</sup>Ontario Ministry of Natural Resources and Forestry, Peterborough, ON

Updated January 2021

## Contents

Introduction .....	3
Objective .....	3
Methods .....	4
Emerging and Unknown Pathogens .....	5
CWHC Submissions .....	5
Aves.....	6
1.    Avian Influenza (AI) .....	6
2.    Avian Mycoplasmosis (finch conjunctivitis, infectious sinusitis).....	7
3.    Avian Pox (bird pox, fowl pox, avian diphtheria).....	9
4.    Avian Salmonellosis (songbird salmonellosis).....	10
5.    Botulism .....	12
6.    Gapeworm (syngamiasis).....	13
7.    Newcastle Disease (APMV-1).....	14
8.    Aquatic Bird Bornavirus (ABBV-1).....	15
9.    Trichomonosis (canker in doves and pigeons, frounce in raptors).....	17
10.   West Nile Virus (WNV) .....	18
Herptiles .....	20
1.    Chytridiomycosis (Bd, chytrid disease).....	20
2.    Ophidiomycosis (Snake fungal disease).....	21
3.    Ranavirus .....	22
Mammals .....	24
1.    Distemper (CDV).....	24
2. <i>Echinococcus multilocularis</i> (alveolar echinococcosis).....	25
3.    Giardiasis.....	26
4.    Leptospirosis.....	27
5.    Parvovirus .....	29
6.    Poxvirus (rabbit/shope fibroma, squirrel pox).....	30
7.    Rabies .....	32
8.    Raccoon Roundworm .....	33
9.    Sarcoptic Mange.....	35
10.   Tularemia (rabbit fever, hare plague).....	36
11.   White Nose Syndrome (WNS).....	37
References .....	39

## Introduction

When an animal is translocated it is not only the individual animal that is being moved, but also its entire microbiome, including disease agents. After an animal has been released it is almost impossible to recover the animal or the pathogens it was carrying.

Risk associated with animal translocation can be defined as “the likelihood of the occurrence and the likely magnitude of the consequences of an adverse event to animal or human health” (Murray, 2004).

A powerful tool in Ontario for limiting the risk of disease translocation from animals taken into rehabilitation centres are the limitations placed on the range between the site of capture and the site of release by the Ontario Ministry of Natural Resources and Forestry’s (MNRF) Wildlife Custodian Authorization Standard Conditions. These requirements help to ensure that disease is not spread to new and possibly naïve species and locations through human interference, which could have long-lasting and devastating effects.

Another important component of minimizing the risk of disease translocation is the application of effective quarantine, health screening and pre-release treatments. An outline of suggested protocols for a wide variety of species is available in Woodford (2000).

The types of hazards associated with disease and the translocation of animals are typically defined as follows (Sainsbury & Vaughan-Higgins, 2012):

- i) Carrier hazard – stress induced depression of immunity in sub-clinically infected animals, leading to clinical disease and/or increased pathogen shedding.
- ii) Source hazards – pathogen present at the source (i.e. rehabilitated animal) but not at the release environment.
- iii) Destination and population hazard – pathogen present at the release environment but not at the source (i.e. rehabilitated animal).
- iv) Transport hazard – translocated animal contracts pathogen during transit. In a rehabilitation context, this risk may be thought of as the risk of exposure to the pathogen within the rehabilitation facility.

The relative importance of each of these hazards can be difficult to determine due to the fundamental difficulty of wildlife disease risk assessment: the general paucity of information on the type, prevalence, range and pathogenicity of disease agents in wild animals (Sainsbury & Vaughan-Higgins, 2012). In many cases there is insufficient information available to make a fully informed decision, in which case there is a great benefit in taking a precautionary approach.

In Ontario, legislation provides for the creation of wildlife disease and surveillance zones within which certain measures, requirements or restrictions may be imposed and may impact the work of wildlife rehabilitators. Rehabilitators should ensure they are acting in accordance with these wildlife disease control and response measures, as well as any other applicable legislation and associated regulations (e.g., Endangered Species Act).

## Objective

This report was written to help wildlife rehabilitators and veterinarians in Ontario assess the risk of disease as it pertains to the rehabilitation and release of wild-caught animals and provide basic information for making risk associated decisions. This report did not attempt a comprehensive and all-inclusive review of every relevant disease, rather it is intended as an analysis of key diseases of interest, to highlight important components of a risk analysis framework that can be expanded and adapted. This information is meant to be supplementary to the wildlife rehabilitation policy and program enabled by the *Fish and Wildlife Conservation Act, 1997*. The reader is referred to these important policy statements and conditions of authorization, the Guidelines for Reintroductions and Other Conservation Translocations created by the International Union for Conservation of Nature (IUCN/SSC, 2013), as well as the Minimum Standards for Wildlife Rehabilitation

published by the National Wildlife Rehabilitators Association and the International Wildlife Rehabilitation Council (Miller, 2012).

## Methods

Pathogens to be assessed were identified as those known to be diseases of concern in species frequently seen in rehabilitation centres through communication with wildlife custodians in Ontario, wildlife health experts and the necropsy reports of the Ontario-Nunavut branch of the Canadian Wildlife Health Cooperative (CWHC) from 2012-2017. Diseases to be assessed are listed in table 1, but the possible presence of unknown or undetected pathogens should also be considered when translocating wildlife. The risk assessment components were adapted from the following documents: (Dalziel, Sainsbury, McInnes, Jakob-Hoff, & Ewen, 2017; Sainsbury & Vaughan-Higgins, 2012; Woodford, 2000).

Table 1. Diseases/Pathogens included in assessment

<b>Animal Group</b>	<b>Disease</b>
Aves	
	1. Avian Influenza
	2. Avian Mycoplasmosis
	3. Avian Pox
	4. Avian Salmonellosis
	5. Botulism
	6. Gapeworm
	7. Newcastle Disease
	8. Aquatic Bird Bornavirus
	9. Trichomonosis
	10. West Nile Virus
Herptiles	
	1. Chytridiomycosis
	2. Ophidiomycosis
	3. Ranavirus
Mammals	
	1. Distemper
	2. <i>Echinococcus multilocularis</i>
	3. Giardiasis
	4. Leptospirosis
	5. Parvovirus
	6. Poxvirus
	7. Rabies
	8. Raccoon Roundworm
	9. Sarcoptic Mange
	10. Tularemia
	11. White Nose Syndrome

The risks for each of the diseases listed above were considered in light of the available information on the following factors in Ontario: the nature of the etiologic agent, host range, geographic range of the agent, the prevalence of the agent, mode of transmission and presence of potential vectors or intermediate/secondary hosts, pathogenicity of the agent, and if the agent is zoonotic.

This document is intended to be ‘evergreen’ and will be edited/updated as appropriate as new information becomes available.

## Emerging and Unknown Pathogens

The host, agent, and environment dynamic within rehabilitation centres creates an opportunity for novel disease transmission pathways. Wildlife in rehabilitation settings are disproportionately diseased and immunosuppressed compared to their wild counterparts therefore, this population of animals is more susceptible to acquiring and shedding pathogens. Furthermore, these animals are entering an environment where they may have close and extended contact with species and individual animals that they would otherwise not encounter. There are a number of emerging diseases that, if introduced, are of serious concern to wild populations in Ontario (e.g., chronic wasting disease and *Batrachochytrium salamandrivorans* or BSal). The potential for both emerging and unknown pathogens to be transmitted in a rehabilitation setting requires serious consideration. Many of the hazards associated with emerging and unknown pathogen transmission in a rehabilitation context can be mitigated by following best practice.

For information regarding current wildlife disease surveillance and response initiatives undertaken by the CWHC, please refer to our website: <http://www.cwhc-rcsf.ca/>

## CWHC Submissions

The CWHC carries out regular surveillance activities to expand our knowledge about the pathogens that occur in wild populations. Wildlife rehabilitation facilities offer excellent opportunities to sample for emerging and unknown pathogens. Therefore, wildlife rehabilitators are important partners for wildlife health surveillance initiatives.

Contact the CWHC regional centre in your area to report sick or dead wildlife. The regional staff can advise you on the next steps or discuss options for carcass submission. Carcass submission allow us to investigate cause of death, screen for diseases and parasites, and gather information pertaining to the health of wild populations.

### **CWHC Ontario/Nunavut Region**

Pathobiology

University of Guelph

Guelph, ON N1G 2W1

Phone: 866.673.4781

Email: [on-nu@cwhc-rcsf.ca](mailto:on-nu@cwhc-rcsf.ca)

<http://www.cwhc-rcsf.ca/contact.php>

# Aves

## 1. Avian Influenza (AI)

- a. Classification: Virus, RNA
- b. Etiologic agent: Influenza A virus
- c. Known species affected: Migratory waterfowl, particularly mallards of the order Anseriformes (ducks, geese, swans), are the principal reservoir but all species of birds can be infected. Other avian species of note include shorebirds and raptors. Less commonly, mammals can be infected. (CWHC, 2019; Friend, Franson, & Ciganovich, 1999)
- d. Range: Has been identified in Ontario, but the exact range is unknown. The range of AI can be expected to follow waterfowl migratory flyways however, infection is not exclusive to these areas (Friend et al., 1999).
- e. Prevalence: The apparent prevalence of AI viral infection was 25% in a study that sampled ducks from Eastern Canada, the Prairie Provinces and BC. In Eastern Canada, the prevalence in ducks was 29.4% (Papp et al., 2017). The prevalence of AI is expected to vary by year and between flyways. The CWHC carries out regular surveillance activities for the detection of this pathogen; updates are available at:
  - i. [http://www.cwhc-rcsf.ca/disease\\_surveillance.php](http://www.cwhc-rcsf.ca/disease_surveillance.php)
- f. Transmission: Fecal-oral transmission via contaminated equipment or water and direct contact with respiratory secretions are the primary methods of transmission. The virus can remain infectious in water for extended periods depending on water temperatures. Migratory birds play an important role in the spread of AI. (CWHC, 2019; Friend et al., 1999)
- g. Pathogenicity: Avian influenza A viruses are classified into two categories: low pathogenic avian influenza (LPAI) A viruses, and highly pathogenic avian influenza (HPAI) A viruses. The categories refer to the virus's ability to cause mortality and disease in domestic chickens rather than wild species. Generally, wild birds that carry AI virus will not demonstrate overt signs of disease however morbidity and mortality can be observed depending on several factors including host species and virus subtype.
- h. Zoonotic potential: Certain virus subtypes are zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of Avian influenza virus can act as a source of infection for wildlife, domestic animals and humans in the rehabilitation and/or release environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of viral transmission to naïve individuals and/or populations is best achieved by:
    1. Not mixing individuals from different source environments within the rehabilitation facility; and
    2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
    3. Migratory species may encompass a larger geographical range than would be the case for non-migratory species. It is reasonable to apply flexibility to the release distance from point of capture for migratory species to ensure the release area is consistent with the species range at the time of year the species is released.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    1. **Any bird demonstrating clinical signs consistent with AI, and all in-contact birds, should be placed in isolation.**

2. **Anti-viral medication should not be used for the prevention or treatment of viral infections in wildlife patients due to public health risks associated with the development of drug resistance. Refer to the policy statement from The National Wildlife Rehabilitators Association Veterinary Committee for more information.**
  - a. **Source:**  
[https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy\\_Statements/vetcomuseoftamiflu.pdf](https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy_Statements/vetcomuseoftamiflu.pdf)
3. **Diagnostic testing for AI in asymptomatic birds is carried out for the purpose of disease surveillance and is not considered necessary in a rehabilitation setting.**
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of viral transmission within the rehabilitation facility.
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
    1. **Additional precautions should be considered by staff to prevent exposure to potential zoonotic diseases that may be present in wildlife species, namely the use of personal protective equipment including gloves and masks, during handling, feeding or cleaning activities.**
    2. **Avian influenza poses a risk to the poultry industry and it is recommended that any individuals who come into contact with domestic birds take care to follow proper biosecurity protocols to prevent transmission.**
  - v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
    1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
    2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
  - vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.
  - vii. **HPAI and certain strains of LPAI are reportable under the *Health of Animals Act*. However, to determine the form, further testing is required, and all cases must be reported to the Canadian Food Inspection Agency**
    1. **Source:** <http://www.inspection.gc.ca/animals/terrestrial-animals/diseases/reportable/ai/eng/1323990856863/1323991018946>

## 2. Avian Mycoplasmosis (finch conjunctivitis, infectious sinusitis)

- a. **Classification:** Bacteria
- b. **Etiologic agent:** *Mycoplasma gallisepticum* is the only mycoplasma species known to be important in wild birds (Friend et al., 1999).
- c. **Known species affected:** Passerines: American goldfinch, purple finch, house finches, northern cardinal, downy woodpecker, blue jay, evening grosbeak, pine grosbeak and many more (Hartup, Dhondt, Sydenstricker, Hochachka, & Kollias, 2001). Capable of infecting corvids, gamebirds including pheasants, quail, partridge and waterfowl (CWHC, 2019; Friend et al., 1999).

- d. Range: *M. gallisepticum* has been identified in Ontario, but the exact range is unknown. The range of mycoplasma generally follows the range of the eastern house finch (Friend et al., 1999). It appears to be an emerging infectious disease (Friend et al., 1999). The CWHC carries out regular surveillance activities for the detection of this pathogen; updates are available at:
  - i. [http://www.cwhc-rcsf.ca/disease\\_surveillance.php](http://www.cwhc-rcsf.ca/disease_surveillance.php)
- e. Prevalence: The prevalence of *M. gallisepticum* in Ontario is unknown and expected to vary by year, region and during epidemic periods.
- f. Transmission: *M. gallisepticum* is highly transmissible. Direct contact, airborne and contaminated environments are all possible routes of transmission (Friend et al., 1999). Additionally, it can be spread at bird feeders and to raptors fed infected carcasses.
- g. Pathogenicity: The pathogenicity of *M. gallisepticum* varies based on species and has been reported to be increasing in virulence. Avian mycoplasmosis can cause a reduction in abundance of up to 40% in wild bird populations. (CWHC, 2019)
- h. Zoonotic potential: Not known to be zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of *M. gallisepticum* can act as a source of infection for wildlife and potentially domestic animals in the rehabilitation and/or release environment.
  - ii. If *M. gallisepticum* is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of bacterial transmission to naïve individuals and/or populations is best achieved by:
    - 1. Not mixing individuals from different source environments within the rehabilitation facility; and
    - 2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
    - 3. Migratory species may encompass a larger geographical range than would be the case for non-migratory species. It is reasonable to apply flexibility to the release distance from point of capture for migratory species to ensure the release area is consistent with the species range at the time of year the species is released.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    - 1. **Any bird demonstrating clinical signs consistent with avian mycoplasmosis, and all in-contact birds, should be placed in isolation.**
    - 2. **Treatment with antibiotics is controversial in birds infected with *M. gallisepticum*. At present, antibiotic use is not recommended to treat *M. gallisepticum* due to the potential for development of asymptomatic carriers and drug-resistant organisms which have the potential to threaten the health of wild individuals and/or populations at the release environment.**
    - 3. **Diagnostic testing in asymptomatic birds is carried out for the purpose of disease surveillance and is not considered necessary in a rehabilitation setting.**
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of bacterial transmission within the rehabilitation facility.
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
    - 1. **Use dedicated handling equipment for infected individuals to limit the mechanical spread of this pathogen.**



- v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
  - 1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  - 2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

### 3. Avian Pox (bird pox, fowl pox, avian diphtheria)

- a. Classification: Virus, DNA
- b. Etiologic agent: Avipox virus. Different species adapted strains are present.
- c. Known species affected: Commonly affected birds include turkeys, finches and doves but most bird species are susceptible; Avipox virus has been reported in >230 species of birds (Bolte, Meurer, & Kaleta, 1999).
- d. Range: Avipox virus has been identified in Ontario, but the exact range is unknown.
- e. Prevalence: The prevalence in Ontario is currently unknown but appears to vary with season.
- f. Transmission: Vector-borne (e.g. mosquitoes), direct contact, and contamination of the environment are all possible transmission pathways for this virus (Friend et al., 1999). The avipox virus resists drying (Friend et al., 1999).
- g. Pathogenicity: The pathogenicity of Avian pox varies based on virulence of the virus, susceptibility of the host and distribution of the lesions (Bolte et al., 1999). Avian pox can be cutaneous or diphtheric; the diphtheric form is generally more pathogenic (Bolte et al., 1999). Both forms can occur at the same time (Bolte et al., 1999).
- h. Zoonotic potential: Not known to be zoonotic
- i. Translocation concern:
  - i. Asymptomatic carriers of Avipox virus can act as a source of infection for wildlife in the rehabilitation and release environment.
    - 1. **The release of infected birds provides a source of virus for vectors.**
  - ii. If Avipox virus is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of viral transmission to naïve individuals and/or populations is best achieved by:
    - 1. Not mixing individuals from different source environments within the rehabilitation facility; and
    - 2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
    - 3. Migratory species may encompass a larger geographical range than would be the case for non-migratory species. It is reasonable to apply flexibility to the release distance from point of capture for migratory species to ensure the release area is consistent with the species range at the time of year the species is released.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    - 1. **Any bird demonstrating clinical signs consistent with avian pox, and all in-contact birds, should be placed in isolation.**

2. **Consult a veterinarian for diagnostic and potential treatment options if deemed appropriate. Euthanasia may be considered if lesions interfere with normal biological function.**
3. **Anti-viral medication should not be used for the prevention or treatment of viral infections in wildlife patients due to public health risks associated with the development of drug resistance. Refer to the policy statement from The National Wildlife Rehabilitators Association Veterinary Committee for more information.**
  - a. **Source:**  
[https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy\\_Statements/vetcomuseoftamiflu.pdf](https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy_Statements/vetcomuseoftamiflu.pdf)
4. **Diagnostic testing in symptomatic and asymptomatic birds is carried out for the purpose of disease surveillance and is not considered necessary in a rehabilitation setting.**
- iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of viral transmission within the rehabilitation facility.
  1. **Consider vector control measures, including minimizing vector breeding and resting sites in and around outdoor enclosures.**
- iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
  1. **Use dedicated handling equipment for infected individuals to limit the mechanical spread of this pathogen.**
- v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
  1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

#### 4. Avian Salmonellosis (songbird salmonellosis)

- a. **Classification:** Bacteria, rod, gram-negative
- b. **Etiologic agent:** The most commonly isolated type is *Salmonella enterica* serovar Typhimurium (commonly abbreviated to *Salmonella typhimurium*), but there are 2300 different strains of salmonellae (Friend et al., 1999).
- c. **Known species affected:** Many types of songbirds including greenfinches, purple finches, common redpoll, house sparrows, tree sparrows, cowbirds and pine siskins (Daoust et al., 2000; Terio, McAloose, & St. Leger, 2018; Tizard, 2004; Wilson et al., 2016). Scavenging and carrion eating birds (vultures, crows and gulls) can become infected secondarily (Tizard, 2004). All bird species should be considered susceptible (Friend et al., 1999).
- d. **Range:** *Salmonella typhimurium* has been identified in Ontario, but the exact range is unknown. Presumed to be present throughout Ontario (Tizard, 2004).
- e. **Prevalence:** In Ontario, *Salmonella typhimurium* has been reported in 15% of healthy house sparrows and 90% of sick and dead sparrows (Tizard, 2004).

- f. Transmission: Fecal-oral and contaminated prey/feed are common routes of transmission for this pathogen (Tizard, 2004). Epidemics are often associated with bird feeders and high concentrations of birds (Tizard, 2004).
- g. Pathogenicity: *Salmonella typhimurium* results in a subclinical infection in most species. However, it can cause acute, lethal disease in small passerines and young pigeons (Tizard, 2004).
- h. Zoonotic potential: Zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of *S. typhimurium* can act as a source of infection for wildlife, domestic animals and humans in the rehabilitation and release environment.
  - ii. If *S. typhimurium* is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of bacterial transmission to naïve individuals and/or populations is best achieved by:
    - 1. Not mixing individuals from different source environments within the rehabilitation facility; and
    - 2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
    - 3. Migratory species may encompass a larger geographical range than would be the case for non-migratory species. It is reasonable to apply flexibility to the release distance from point of capture for migratory species to ensure the release area is consistent with the species range at the time of year the species is released.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    - 1. **Diagnostic testing in asymptomatic birds is carried out for the purpose of disease surveillance and is not considered necessary in a rehabilitation setting.**
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of bacterial transmission within the rehabilitation facility.
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
    - 1. **Additional precautions should be considered by staff to prevent exposure to potential zoonotic diseases that may be present in wildlife species, namely the use of personal protective equipment including gloves and masks, during handling, feeding or cleaning activities.**
  - v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
    - 1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
    - 2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
  - vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

## 5. Botulism

- a. Classification: Toxin
- b. Etiologic agent: Toxin of *Clostridium botulinum*. There are 7 different toxins labelled A through G; types C and E are the most important in wild birds (Friend et al., 1999).
- c. Known species affected: All bird species are susceptible to varying degrees. Mammals can also be affected by the toxin. Feeding habits often determine which species are at greatest risk; filter feeding and dabbling waterfowl and mammals and birds that scavenge dead fish are at the greatest risk. (Friend et al., 1999)
- d. Range: *Clostridium botulinum* is present in Ontario, but the exact range is unknown. This pathogen is usually associated with aquatic habitats (Friend et al., 1999).
- e. Prevalence: The prevalence of botulism is expected to vary by year, region and during epidemic periods. Outbreaks of botulism are most common when water levels are low and temperatures are high (i.e. July through September) (Friend et al., 1999).
- f. Transmission: *C. botulinum* occurs naturally in certain environments (soil, aquatic sediment). Typical routes of exposure are through consumption of food items infected with the toxin or with the *C. botulinum* bacteria under conditions where the toxin is being produced (e.g. decomposition or other protein source, anaerobic, warm temperature). Bacterial spores can remain viable for extended periods of time in the environment (Friend et al., 1999).
- g. Pathogenicity: The severity of clinical signs varies with species, type of toxin and level of toxin exposure. Botulism is a common cause of large-scale mortality events. Waterfowl and shorebirds are most susceptible and vultures and scavengers appear to be more resistant (Friend et al., 1999).
- h. Zoonotic potential: Not considered zoonotic however, the toxin itself can affect humans
- i. Translocation concern:
  - i. If botulism toxin is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of toxin exposure in naïve individuals and/or populations is best achieved by:
    1. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
    2. Migratory species may encompass a larger geographical range than would be the case for non-migratory species. It is reasonable to apply flexibility to the release distance from point of capture for migratory species to ensure the release area is consistent with the species range at the time of year the species is released.
    3. **It is not advisable to release an animal into an environment that is experiencing an outbreak of botulism.**
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    1. **If a bird is showing clinical signs consistent with botulism, consult a veterinarian for diagnostic and potential treatment options.**
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of bacterial transmission within the rehabilitation facility.
    1. **Monitor water sources closely for organic material and clean regularly.**
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
  - v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can

lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.

1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

## 6. Gapeworm (*syngamiasis*)

- a. Classification: Endoparasite, nematode
- b. Etiologic agent: *Syngamus trachea*
- c. Known species affected: turkeys, pheasants, perching birds, waterfowl, herons, storks, cranes, pelicans and woodpeckers (Fernando & Barta, 2009).
- d. Range: *Syngamus trachea* has been identified in Ontario, but the exact range is unknown. *Syngamus trachea* likely infects birds globally in tropical, temperate and cold climates, including Ontario (Fernando & Barta, 2009).
- e. Prevalence: The prevalence of *Syngamus trachea* infection varies widely by host and by age-class (e.g. can range from 1-99%; Fernando & Barta, 2009).
- f. Transmission: Fecal-oral transmission of this parasite is most common with the peak of transmission occurring in the late summer (Fernando & Barta, 2009). Consumption of earthworms, snails, slugs is an additional form of parasite transmission. Higher transmission rates can be expected in captivity.
- g. Pathogenicity: Low. Subclinical infections are common, clinical infections in wild birds are rare (Fernando & Barta, 2009).
- h. Zoonotic potential: Not known to be zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of *Syngamus trachea* can act as a source of infection for wildlife and domestic animals in the rehabilitation and release environment
  - ii. If *Syngamus trachea* is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of parasite transmission to naïve individuals and/or populations is best achieved by:
    1. Not mixing individuals from different source environments within the rehabilitation facility; and
    2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
    3. Migratory species may encompass a larger geographical range than would be the case for non-migratory species. It is reasonable to apply flexibility to the release distance from point of capture for migratory species to ensure the release area is consistent with the species range at the time of year the species is released.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    1. **If a bird is showing clinical signs consistent with syngamiasis, consult a veterinarian for diagnostic and potential treatment options.**
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of parasite transmission within the rehabilitation facility.

- iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
- v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
  - 1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  - 2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

## 7. Newcastle Disease (APMV-1)

- a. Classification: Virus, RNA
- b. Etiologic agent: Avian avulavirus serotype 1 (previously Avian paramyxovirus-1)
- c. Known species affected: Double-crested cormorants, white pelicans, pigeons, ring-billed gulls, California gulls, doves (Friend et al., 1999).
- d. Range: APMV-1 has been identified in Ontario, but the exact range is unknown.
- e. Prevalence: The prevalence of APMV-1 in Ontario is unknown, although there have been ongoing outbreaks in southern Ontario since 1992 (Glaser et al., 1999; Heckert, 1993).
- f. Transmission: Airborne exposure, direct contact and exposure to contaminated environments are all possible routes of transmission. Newcastle disease appears to be an emerging infectious disease (Friend et al., 1999).
- g. Pathogenicity: Varies based on species and strain.
- h. Zoonotic potential: Zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of APMV-1 can act as a source of infection for wildlife and domestic poultry (including backyard poultry) in the rehabilitation and release environment.
  - ii. If APMV-1 is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of viral transmission to naïve individuals and/or populations is best achieved by:
    - 1. Not mixing individuals from different source environments within the rehabilitation facility; and
    - 2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
    - 3. Migratory species may encompass a larger geographical range than would be the case for non-migratory species. It is reasonable to apply flexibility to the release distance from point of capture for migratory species to ensure the release area is consistent with the species range at the time of year the species is released.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    - 1. **Any bird demonstrating clinical signs consistent with Newcastle disease, and all in-contact birds, should be placed in isolation. Consult a veterinarian immediately.**

2. **A bird with Newcastle disease should not be released.**
3. **Anti-viral medication should not be used for the prevention or treatment of viral infections in wildlife patients due to public health risks associated with the development of drug resistance. Refer to the policy statement from The National Wildlife Rehabilitators Association Veterinary Committee for more information.**
  - a. **Source:**  
[https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy\\_Statements/vetcomuseoftamiflu.pdf](https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy_Statements/vetcomuseoftamiflu.pdf)
- iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of viral transmission within the rehabilitation facility.
- iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
  1. **APMV-1 poses a risk to the poultry industry and it is recommended that any individuals who come into contact with domestic birds take care to follow proper biosecurity protocols to prevent transmission.**
- v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
  1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.
- vii. **The velogenic (highly virulent) form of APMV-1 is reportable under the *Health of Animals Act*. However, to determine the form further testing is required and all suspected cases must be reported to the Canadian Food Inspection Agency for immediate investigation**
  1. **Source:** <http://www.inspection.gc.ca/animals/terrestrial-animals/diseases/reportable/nd/fact-sheet/eng/1330202454619/1330202602677>

## 8. Aquatic Bird Bornavirus (ABBV-1)

- a. Classification: Virus, RNA
- b. Etiologic agent: Aquatic bird bornavirus 1 (ABBV-1)
- c. Known species affected: Canada geese, trumpeter swans, mute swans (Delnatte et al., 2013).
- d. Range: ABBV-1 is known to be present in Ontario in association with waterfowl. The distribution more broadly in Ontario is not well known and thought to be underrecognized (Delnatte et al., 2014).
- e. Prevalence: In asymptomatic waterfowl prevalence varies from 5-50% based on species, location, and sampling modality (Delnatte et al., 2013).
- f. Transmission: The transmission of ABBV-1 is thought to be horizontal (fecal-oral route) and vertical, but the exact mechanism requires further research.
- g. Pathogenicity: Found in asymptomatic and symptomatic waterfowl (Delnatte et al., 2013).
- h. Zoonotic potential: Not known to be zoonotic
- i. Translocation concern:

- i. Symptomatic and asymptomatic carriers of ABBV-1 can act as a source of infection for wildlife in the rehabilitation and release environment.
- ii. If ABBV-1 is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of viral transmission to naïve individuals and/or populations is best achieved by:
    - 1. Not mixing individuals from different source environments within the rehabilitation facility; and
    - 2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
    - 3. Migratory species may encompass a larger geographical range than would be the case for non-migratory species. It is reasonable to apply flexibility to the release distance from point of capture for migratory species to ensure the release area is consistent with the species range at the time of year the species is released.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    - 1. **If a bird is exhibiting clinical signs consistent with aquatic bird bornavirus, consult a veterinarian for diagnostic options.**
    - 2. **Since transmission routes are not fully understood, it is recommended that any bird demonstrating clinical signs consistent with aquatic bird bornavirus, and all in-contact birds, be placed in isolation.**
    - 3. **Anti-viral medication should not be used for the prevention or treatment of viral infections in wildlife patients due to public health risks associated with the development of drug resistance. Refer to the policy statement from The National Wildlife Rehabilitators Association Veterinary Committee for more information.**
      - a. **Source:**

[https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy\\_Statements/vetcomuseoftamiflu.pdf](https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy_Statements/vetcomuseoftamiflu.pdf)
    - 4. **Diagnostic testing in asymptomatic birds is carried out for the purpose of disease surveillance and is not considered necessary in a rehabilitation setting.**
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of viral transmission within the rehabilitation facility.
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
  - v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
    - 1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
    - 2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
  - vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.



## 9. Trichomonosis (canker in doves and pigeons, frounce in raptors)

- a. Classification: Endoparasite, protozoa
- b. Etiologic agent: *Trichomonas gallinae*
- c. Known species affected: Mourning doves, band-tailed pigeons, domestic pigeons, finches, falcons, hawks, and owls (Friend et al., 1999), as well as other raptor species (CWHC, 2019).
- d. Range: *Trichomonas gallinae* has been identified in Ontario, but the exact range is unknown. The range can be expected to follow the range of domestic pigeons and mourning doves (Friend et al., 1999). The CWHC carries out regular surveillance activities for the detection of this pathogen; updates are available at:
  - i. [http://www.cwhc-rcsf.ca/disease\\_surveillance.php](http://www.cwhc-rcsf.ca/disease_surveillance.php)
- e. Prevalence: 80-90% of adult pigeons are infected with *Trichomonas gallinae* but show no clinical signs (Friend et al., 1999).
- f. Transmission: Contaminated food and water (especially when adults regurgitate for nestlings) are possible routes of transmission for this parasite. *Trichomonas gallinae* can also be spread by saliva and feces but the parasite does not survive long periods in the environment (Forzán, Vanderstichel, Melekhovets, & McBurney, 2010). Trichomonosis can be spread at bird feeders.
- g. Pathogenicity: Trichomonosis can cause significant mortality in small passerines (Forzán et al., 2010).
- h. Zoonotic potential: Not known to be zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of *Trichomonas gallinae* can act as a source of infection for wildlife in the rehabilitation and release environment.
  - ii. If *Trichomonas gallinae* is present in the release environment there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of parasite transmission to naïve individuals and/or populations is best achieved by:
    1. Not mixing individuals from different source environments within the rehabilitation facility; and
    2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
    3. Migratory species may encompass a larger geographical range than would be the case for non-migratory species. It is reasonable to apply flexibility to the release distance from point of capture for migratory species to ensure the release area is consistent with the species range at the time of year the species is released.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    1. **Consider routine screening for this pathogen.**
    2. **Consult a veterinarian for diagnostic and potential treatment options if deemed appropriate.**
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of parasite transmission within the rehabilitation facility.
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
  - v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.

1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

## 10. West Nile Virus (WNV)

- a. Classification: Virus, RNA
- b. Etiologic agent: West Nile Virus
- c. Known species affected: Extremely broad host range. Wild birds are typically the host species but the virus can also infect amphibians, people and other mammals (particularly horses). (McLean & Ubico, 2007)
- d. Range: WNV is present throughout Southern Ontario where mosquitos are found. The range of WNV is likely to expand alongside the range of the mosquito, due to changing climactic and ecological conditions. The CWHC and Ontario Public Health Agency carry out regular surveillance activities for the detection of this pathogen; updates are available at:
  - i. <http://www.cwhc-rcsf.ca/wnv.php>
  - ii. <http://oahpp.maps.arcgis.com/apps/webappviewer/index.html?id=c30ad8593f404f06a0faeb57346b5ee0>
- e. Prevalence: In Ontario, 22% of WNV cases between 2017-2018 were birds of prey (Stephen & Zimmer, 2018); 11.5% of dead American crows tested positive between 2001-2004 (McLean & Ubico, 2007).
- f. Transmission: Transmission of WNV is primarily by mosquitoes (McLean & Ubico, 2007).
- g. Pathogenicity: The pathogenicity of WNV varies based on species (McLean & Ubico, 2007). Crows and house sparrows develop very high viremias (McLean & Ubico, 2007).
- h. Zoonotic potential: Zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of WNV can act as a source of infection for wildlife and humans in the rehabilitation and release environment
  - ii. If WNV is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of viral transmission to naïve individuals and/or populations is best achieved by:
    1. Not mixing individuals from different source environments within the rehabilitation facility; and
    2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
    3. Migratory species may encompass a larger geographical range than would be the case for non-migratory species. It is reasonable to apply flexibility to the release distance from point of capture for migratory species to ensure the release area is consistent with the species range at the time of year the species is released.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    1. **Consult a veterinarian for diagnostic and potential treatment options if deemed appropriate.**
    2. **Anti-viral medication should not be used for the prevention or treatment of viral infections in wildlife patients due to public health risks associated with**

**the development of drug resistance. Refer to the policy statement from The National Wildlife Rehabilitators Association Veterinary Committee for more information.**

**a. Source:**

[https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy\\_Statements/vetcomuseoftamiflu.pdf](https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy_Statements/vetcomuseoftamiflu.pdf)

- iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of viral transmission within the rehabilitation facility.
  1. **Consider vector control measures, including minimizing vector breeding and resting sites in and around outdoor enclosures.**
- iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
  1. **Additional precautions should be considered by staff to prevent exposure to potential zoonotic diseases that may be present in wildlife species namely the use of personal protective equipment including gloves and masks, during handling, feeding or cleaning activities.**
- v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
  1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.
- vii. **West Nile Virus is an immediately notifiable disease under the *Health of Animals Act*. Only laboratories are required to contact the Canadian Food Inspection Agency**
  1. **Source: <http://www.inspection.gc.ca/animals/terrestrial-animals/diseases/immediately-notifiable/west-nile-virus/eng/1305840783267/1305840912854>**

# Herptiles

## 1. Chytridiomycosis (Bd, chytrid disease)

- a. Classification: Fungus
- b. Etiologic agent: *Batrachochytrium dendrobatidis*
- c. Known species affected: Affects over 520 amphibian species worldwide (Berger et al., 2016). In Canada it has been reported in spotted salamander, American toad, gray treefrog, eastern newt, western chorus frog, American bullfrog, green frog, pickerel frog, northern leopard frog, mink frog, and wood frog (Ouellet, Mikaelian, Pauli, Rodrigue, & Green, 2005).
- d. Range: *B. dendrobatidis* has been documented in five provinces, including Ontario (Ouellet et al., 2005) and has since been reported in the Northwest Territories (D'Aoust-Messier, Echaubard, Billy, & Lesbarrères, 2015; Schock et al., 2010).
- e. Prevalence: The prevalence of *B. dendrobatidis* in Ontario is unknown but the pathogen is considered enzootic in this region.
- f. Transmission: Environmental/water contamination and direct contact are considered the primary modes of transmission. Anthropogenic spread of this pathogen has been increasingly recognized as an important method of transmission.
- g. Pathogenicity: The pathogenicity of *B. dendrobatidis* varies based on strain and host species. Some populations only experience sporadic deaths, while others have gone extinct (Berger et al., 2016). No population declines in Ontario have been linked to *B. dendrobatidis* at this time.
- h. Zoonotic potential: Not known to be zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of *B. dendrobatidis* can act as a source of infection for wildlife in the rehabilitation and release environment.
  - ii. If *B. dendrobatidis* is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of fungal transmission to naïve individuals and/or populations is best achieved by:
    1. Not mixing individuals from different source environments within the rehabilitation facility; and
    2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
    3. **Source environment is species dependent and in the context of some herptiles, may be very geographically restricted and/or isolated.**
    4. **Consider a period of quarantine for all newly acquired herptiles.**
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of fungal transmission within the rehabilitation facility.
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
  - v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.

1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

## 2. Ophidiomycosis (Snake fungal disease)

- a. Classification: Fungus
- b. Etiologic agent: *Ophidiomyces ophidiicola*
- c. Known species affected: Includes, Eastern foxsnake, Massasauga rattlesnake, queen snake (Lorch et al., 2016). The number and distribution of susceptible species in Canada likely exceeds this list (CWHC, 2017c).
- d. Range: Has been identified throughout Southern Ontario, but the exact range is unknown.
- e. Prevalence: An exact value is not available for Ontario, but snakes are frequently found with lesions consistent with snake fungal disease.
- f. Transmission: Unknown; the fungus is likely an environmental saprobe (Allender et al., 2015).
- g. Pathogenicity: Variable based on species and population. In experimentally infected snakes, mortality rates of 40% have been reported (Allender et al., 2015), while in some free-ranging populations recovery rates of 50% have been reported after severe infection (Lind et al., 2018).
- h. Zoonotic potential: Not known to be zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of *O. ophidiicola* can act as a source of infection for wildlife in the rehabilitation and release environment.
  - ii. If *O. ophidiicola* is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of fungal transmission to naïve individuals and/or populations is best achieved by:
    1. Not mixing individuals from different source environments within the rehabilitation facility; and
    2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
    3. **Source environment is species dependent and in the context of some herptiles, may be very geographically restricted and/or isolated.**
    4. **Consider a period of quarantine for all newly acquired herptiles.**
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of fungal transmission within the rehabilitation facility.
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
  - v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.

1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

### 3. Ranavirus

- a. Classification: Virus, DNA
- b. Etiologic agent: Frog Virus 3, Frog Virus 3-like viruses
- c. Known species affected: Affects at least 175 species of ectothermic vertebrates (Gray & Chinchar, 2015). It has been found in Ontario species such as the spring peeper, green frog, northern leopard frog, eastern newt (Gray & Chinchar, 2015), common snapping turtle, wood turtles and painted turtles.
- d. Range: Frog Virus 3 has been identified in Ontario, but the exact range is unknown. (Schock et al., 2010).
- e. Prevalence: Unknown
- f. Transmission: Can be transmitted through the water, via direct contact and by predation or scavenging (Gray & Chinchar, 2015).
- g. Pathogenicity: The pathogenicity of Frog Virus 3 is variable based on species and age group. Most mass mortalities are associated with juvenile amphibians (Gray & Chinchar, 2015). Mortality in turtles has also been reported.
- h. Zoonotic potential: Not known to be zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of Frog Virus 3 or Frog Virus 3-like viruses, can act as a source of infection for wildlife in the rehabilitation and release environment.
  - ii. If Frog Virus 3 or Frog Virus 3-like viruses are present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of viral transmission to naïve individuals and/or populations is best achieved by:
    1. Not mixing individuals from different source environments within the rehabilitation facility; and
    2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
    3. **Source environment is species dependent and in the context of some herptiles, may be very geographically restricted and/or isolated.**
    4. **Consider a period of quarantine for all newly acquired herptiles.**
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    1. **Anti-viral medication should not be used for the prevention or treatment of viral infections in wildlife patients due to public health risks associated with the development of drug resistance. Refer to the policy statement from The National Wildlife Rehabilitators Association Veterinary Committee for more information.**
      - a. **Source:**  
[https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy\\_Statements/vetcomuseoftamiflu.pdf](https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy_Statements/vetcomuseoftamiflu.pdf)

- iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of viral transmission within the rehabilitation facility.
- iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
- v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
  - 1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  - 2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

# Mammals

## 1. Distemper (CDV)

- a. Classification: Virus, RNA
- b. Etiologic agent: Canine Distemper Virus
- c. Known species affected: Raccoons, striped skunks, red fox, coyotes, badgers, other carnivores (Terio et al., 2018). Broad and expanding host range.
- d. Range: Present throughout southern Ontario (Jardine et al., 2018; Giacinti et al., 2021).
- e. Prevalence: Considered endemic in Ontario wild carnivore populations. Expected to vary by year, region and during epidemic periods (Giacinti et al., 2021).
- f. Transmission: Can be transmitted through body fluids and aerosolization. CDV is highly contagious.
- g. Pathogenicity: Young animals are most susceptible. The severity of disease varies greatly (Terio et al., 2018) from subclinical infection to severe multisystemic disease (including neurological signs).
- h. Zoonotic potential: Not known to be zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of CDV can act as a source of infection for wildlife and domestic dogs in the rehabilitation and release environment
    1. **Viral introduction in a rehabilitation facility can lead to a disease outbreak with the potential for significant fatalities.**
  - ii. If CDV is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of viral transmission to naïve individuals and/or populations is best achieved by:
    1. Not mixing individuals from different source environments within the rehabilitation facility; and
    2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    1. **Consult a veterinarian immediately if an animal is demonstrating signs consistent with CDV. CDV cannot be distinguished from rabies based on clinical signs.**
    2. **Any animal demonstrating clinical signs consistent with CDV, and all in-contact animals, should be placed in isolation.**
    3. **An animal with clinical CDV should not be released.**
    4. **Diagnostic testing in asymptomatic animals is carried out for the purpose of disease surveillance and is not considered necessary in a rehabilitation setting.**
    5. **Vaccinations are available for certain commonly affected species. Consult a veterinarian to develop an appropriate routine vaccination protocol.**
    6. **Anti-viral medication should not be used for the prevention or treatment of viral infections in wildlife patients due to public health risks associated with the development of drug resistance. Refer to the policy statement from The National Wildlife Rehabilitators Association Veterinary Committee for more information.**



**a. Source:**

[https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy\\_Statements/vetcomuseoftamiflu.pdf](https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy_Statements/vetcomuseoftamiflu.pdf)

- iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of viral transmission within the rehabilitation facility.
- iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
  1. **CDV can pose a risk to domestic dogs and farmed mink. It is recommended that any individuals who come into contact with domestic animals or farmed mink take care to follow proper biosecurity protocols to prevent transmission.**
- v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
  1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

## 2. *Echinococcus multilocularis* (alveolar echinococcosis)

- a. Classification: Endoparasite, tapeworm
- b. Etiologic agent: *Echinococcus multilocularis*
- c. Known species affected: Wild canids (e.g. coyotes, foxes) are most commonly the definitive host which include animals that develop the adult tapeworm in the intestine after ingestion of the larval stage of the parasite. In North America, small rodent species can act as intermediate hosts. Intermediate hosts ingest the tapeworm eggs which develop into the larval stage of the parasite. Domestic dogs can act as definitive and intermediate hosts. (Samuel et al., 2008). *Echinococcus multilocularis* has been documented in domestic dogs, eastern chipmunks, foxes and coyotes in Ontario.
- d. Range: Has been identified in Ontario, but the exact range is unknown (Kotwa et al., 2019).
- e. Prevalence: Recent reports of 23% in Ontario wild canids (Kotwa et al., 2019).
- f. Transmission: Can be transmitted through the ingestion of an intermediate host that is infected with the larval stage or through the direct ingestion of tapeworm eggs which are shed in the feces of definitive hosts (Samuel et al., 2008).
- g. Pathogenicity: Wild canids, as the definitive hosts of the parasite, are generally asymptomatic except in the case of very heavy parasite burdens. Intermediate hosts are asymptomatic after initial infection. However, clinical disease results when the larvae form cysts in the target organ, usually the liver, of the intermediate host. Typically, *E. multilocularis* cysts grow slowly (Ministry of Health and Long-Term Care, 2018).
- h. Zoonotic potential: Zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of *E. multilocularis* can act as a source of infection for wildlife, domestic animals and humans in the rehabilitation and release environment

- ii. If *E. multilocularis* is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of parasite transmission to naïve individuals and/or populations is best achieved by:
    - 1. Not mixing individuals from different source environments within the rehabilitation facility; and
    - 2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    - 1. **Consult a veterinarian to develop an appropriate routine deworming protocol for commonly affected species.**
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of parasite transmission within the rehabilitation facility.
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
    - 1. **Additional precautions should be considered by staff to prevent exposure to potential zoonotic diseases that may be present in wildlife species, namely the use of personal protective equipment including gloves and masks, during handling, feeding or cleaning activities.**
  - v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
    - 1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
    - 2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
  - vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.
  - vii. ***Echinococcus multilocularis* is reportable under the Health Protection and Promotion Act.**
    - 1. **Source: <https://www.ontario.ca/laws/regulation/900557>**

### 3. Giardiasis

- a. Classification: Protozoa
- b. Etiologic agent: *Giardia spp.* Six species of giardia are recognized, and each is associated with a specific set of hosts. *Giardia duodenalis* is an important zoonotic pathogen and is commonly encountered in wild mammals.
- c. Known species affected: Most wild mammals can be infected with giardia. Beavers and other water-dwelling rodents are thought to play an important role in waterborne transmission of giardia (Tsui et al., 2018).
- d. Range: Present throughout Ontario.
- e. Prevalence: Unknown

- f. Transmission: Direct fecal-oral transmission of giardia cysts. Indirect transmission through ingestion of contaminated water or food. Giardia cysts can persist in the environment for extended periods of time (Samuel et al., 2008).
- g. Pathogenicity: Giardia infections can remain asymptomatic. Clinical signs are most likely to occur in young animals (Samuel et al., 2008).
- h. Zoonotic potential: *Giardia duodenalis* is zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of *Giardia spp.* can act as a source of infection for wildlife, domestic animals and humans in the rehabilitation and release environment
  - ii. If *Giardia spp.* are present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of parasite transmission to naïve individuals and/or populations is best achieved by:
    - 1. Not mixing individuals from different source environments within the rehabilitation facility; and
    - 2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    - 1. **Consider routine screening for this pathogen in commonly affected species.**
    - 2. **Consult a veterinarian for potential treatment options if deemed appropriate.**
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of parasite transmission within the rehabilitation facility.
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
    - 1. **Additional precautions should be considered by staff to prevent exposure to potential zoonotic diseases that may be present in wildlife species, namely the use of personal protective equipment including gloves and masks, during handling, feeding or cleaning activities.**
  - v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
    - 1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
    - 2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
  - vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

#### 4. Leptospirosis

- a. Classification: Bacteria
- b. Etiologic agent: *Leptospira spp.*
- c. Known species affected: Almost all mammals including the following commonly rehabbed species: raccoons, striped skunks, red fox, beavers, opossums, rabbits, coyotes, and deer.
- d. Range: *Leptospira spp.* are present in Ontario wildlife, but the exact range is unknown.

- e. Prevalence: 42% of skunks, 33% of raccoons, 9% of beavers, 8% of foxes and 6% of opossums tested in Ontario were reported to be seropositive (Shearer et al., 2014).
- f. Transmission: Shed in urine (Shearer et al., 2014). Indirect transmission through ingestion of contaminated water or food.
- g. Pathogenicity: Wild species are generally transiently infected or reservoir hosts (Shearer et al., 2014).
- h. Zoonotic potential: Zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of *Leptospira spp.* can act as a source of infection for wildlife, domestic animals and humans in the rehabilitation and release environment.
  - ii. If *Leptospira spp.* are present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of bacterial transmission to naïve individuals and/or populations is best achieved by:
    - 1. Not mixing individuals from different source environments within the rehabilitation facility; and
    - 2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    - 1. **Diagnostic testing in asymptomatic animals is carried out for the purpose of disease surveillance and is not considered necessary in a rehabilitation setting.**
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of bacterial transmission within the rehabilitation facility.
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
    - 1. **Additional precautions should be considered by staff to prevent exposure to potential zoonotic diseases that may be present in wildlife species, namely the use of personal protective equipment including gloves and masks, during handling, feeding or cleaning activities.**
    - 2. **Leptospirosis can pose a risk to domestic animals. Bovines are particularly susceptible to disease (Shearer et al. 2014). It is recommended that any individuals who come into contact with domestic animals take care to follow proper biosecurity protocols to prevent transmission.**
  - v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
    - 1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
    - 2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
  - vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

## 5. Parvovirus

- a. Classification: Virus, RNA
- b. Etiologic agent: Viruses belonging to the family *Parvoviridae*. This family of viruses is made up of a number of distinct genera and species. Infections in free-ranging wildlife are currently known to be caused by numerous viral strains classified under carnivore protoparvovirus 1 (CPPV-1) informally referred to as the feline parvovirus subgroup (e.g., feline parvovirus, canine parvovirus including variants, mink enteritis virus, and raccoon parvovirus) and carnivore amdoparvovirus 1 (Aleutian mink disease virus, AMDV; Steinel et al., 2001; Williams and Barker, 2001).
- c. Known species affected: Of the species commonly encountered at rehabilitation centres, CPPV-1 is most likely to be encountered in canids, felids, mustelids, and raccoons. AMDV primarily infects mink and ferrets although other species such as raccoons, may act as subclinical carriers. (Steinel et al., 2001; Williams and Barker, 2001).
- d. Range: CPPV-1 strains have been detected throughout Ontario (unpublished data from the CWHC). AMDV has been detected in Ontario wild mink populations particularly in association with proximity to mink farms (Nituch et al., 2011).
- e. Prevalence: CPPV-1 is considered endemic in Ontario wild carnivore populations (unpublished data from the CWHC). A survey of Ontario free-ranging mink populations found an AMDV seroprevalence of 29% in surveyed animals however, this was significantly higher in areas close to mink farms (Nituch et al., 2011).
- f. Transmission: The primary mode of CPPV-1 and AMDV transmission is fecal-oral, although the virus may also be shed in other secretions including urine and saliva. Parvoviruses remain infectious in the environment for long periods therefore direct contact with an infected animal is not necessary for virus transmission.
- g. Pathogenicity: CPPV-1: The virus targets dividing cells and therefore presents differently in adult (typically gastroenteritis associated with lethargy, depression and foul-smelling diarrhea that may be hemorrhagic) and fetal/neonatal animals (less well described in wild animals). AMDV: Several strains of AMDV have been identified ranging from nonvirulent to highly virulent (Nituch, 2012). Highly virulent strains cause significant disease in all mink whereas only mink with the Aleutian coat colour seem to develop disease from low-virulence strains (Nituch, 2012). Clinical disease presentation differs between adult mink and kits.
- h. Zoonotic potential: Not known to be zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of parvovirus can act as a source of infection for wildlife, domestic dogs, cats, ferrets and farmed mink in the rehabilitation and release environment.
    1. **Viral introduction in a rehabilitation facility can lead to a disease outbreak with the potential for significant fatalities.**
  - ii. If parvovirus is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of viral transmission to naïve individuals and/or populations is best achieved by:
    1. Not mixing individuals from different source environments within the rehabilitation facility; and

2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
- ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
  1. **Any animal demonstrating clinical signs consistent with parvovirus, and all in-contact animals, should be placed in isolation. Consult a veterinarian for diagnostic and potential treatment options.**
  2. **Diagnostic testing in asymptomatic animals is carried out for the purpose of disease surveillance and is not considered necessary in a rehabilitation setting.**
  3. **Vaccinations are available for certain commonly affected species. Consult a veterinarian to develop an appropriate routine vaccination protocol.**
  4. **Anti-viral medication should not be used for the prevention or treatment of viral infections in wildlife patients due to public health risks associated with the development of drug resistance. Refer to the policy statement from The National Wildlife Rehabilitators Association Veterinary Committee for more information.**
    - a. **Source:**  
[https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy\\_Statements/vetcomuseoftamiflu.pdf](https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy_Statements/vetcomuseoftamiflu.pdf)
- iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of viral transmission within the rehabilitation facility.
- iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
  1. **Parvoviruses can pose a risk to domestic and farmed animals (e.g., cats, dogs, ferrets, mink). It is recommended that any individuals who come into contact with domestic animals or farmed mink take care to follow proper biosecurity protocols to prevent transmission.**
- v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
  1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

## 6. Poxvirus (rabbit/shope fibroma, squirrel pox)

- a. Classification: Virus, DNA
- b. Etiologic agent: Poxviruses are comprised of multiple different genera and species of virus. Each species of poxvirus is adapted to a particular host and often named for that host or the associated disease. Some of the most commonly encountered in rehabilitation centres include: rabbit fibroma virus and squirrel fibroma virus. (Williams & Barker, 2001) Squirrelpox virus, a European variant that causes a fatal disease in European red squirrels, was identified for the first time in a North American red squirrel in Yukon in 2008 (Himsworth et al., 2009).

- c. Known species affected: Of the species commonly encountered at rehabilitation centres, rabbits and gray squirrels are the most likely to be infected with poxvirus. However, there are host-adapted strains of poxvirus that infect numerous genera of wild mammals. (Williams & Barker, 2001)
- d. Range: The range is currently unknown in Ontario. Squirrel fibroma virus may be endemic in the grey squirrel populations of eastern North America (Himsworth et al., 2009).
- e. Prevalence: Unknown in Ontario and uncommonly reported in the literature. Generally, reports of poxvirus are incidental and secondary to a primary cause of death.
- f. Transmission: Vector borne transmission, namely through mosquitoes and fleas, is considered the primary mode of transmission. Transmission from mother to suckling young can also occur (Williams & Barker, 2001).
- g. Pathogenicity: Generally, poxvirus causes focal lesions that do not impact the overall health of an adult animal. However, a large fibroma burden or fibromas around the eyes or mouth can impact the animal's ability to carry out critical functions (e.g. eating, movement) which can eventually lead to emaciation and death. Very young animals are more susceptible to poxvirus infections and fatalities can occur (Williams & Barker, 2001).
- h. Zoonotic potential: Not known to be zoonotic
- i. Translocation concern:
  - i. Asymptomatic carriers of Poxvirus can act as a source of infection for wildlife in the rehabilitation and release environment.
    - 1. **The release of infected animals with lesions, provides a source of virus for vectors.**
  - ii. If poxvirus is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of viral transmission to naïve individuals and/or populations is best achieved by:
    - 1. Not mixing individuals from different source environments within the rehabilitation facility; and
    - 2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    - 1. **Consult a veterinarian for diagnostic and potential treatment options if deemed appropriate. Euthanasia may be considered if lesions interfere with normal biological function.**
    - 2. **Diagnostic testing in symptomatic and asymptomatic mammals is carried out for the purpose of disease surveillance and is not considered necessary in a rehabilitation setting.**
    - 3. **Anti-viral medication should not be used for the prevention or treatment of viral infections in wildlife patients due to public health risks associated with the development of drug resistance. Refer to the policy statement from The National Wildlife Rehabilitators Association Veterinary Committee for more information.**
      - a. **Source:**  
[https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy\\_Statements/vetcomuseoftamiflu.pdf](https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Policy_Statements/vetcomuseoftamiflu.pdf)
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of viral transmission within the rehabilitation facility.

1. **Consider vector control measures, including minimizing vector breeding and resting sites in and around outdoor enclosures.**
- iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
- v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
  1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

## 7. Rabies

- a. Classification: Virus, RNA
- b. Etiologic agent: Rabies virus, several strains present in Canada including: mid-Atlantic raccoon, Arctic fox, and a variety of bat strains (Ontario Ministry of Natural Resources and Forestry, 2019).
- c. Known species affected: All mammals. The following species are commonly affected: all bat species, raccoons, striped skunks, red fox.
- d. Range: Cases of raccoon, fox and bat rabies have been confirmed in Ontario.
- e. Prevalence: In 2020, approximately 2570 samples were submitted to the Canadian Food Inspection Agency for rabies testing. Of these, 101 were positive: 4 raccoons, 15 skunks, 74 bats, 1 arctic fox, 1 red fox and domestic species including 2 bovines, 3 dogs, and 1 cat (Canadian Food Inspection Agency, 2020). The CWHC, MNRF and Canadian Food Inspection Agency carry out regular surveillance activities for the detection of this pathogen; updates are available at:
  - i. <http://www.inspection.gc.ca/animals/terrestrial-animals/diseases/reportable/rabies/rabies-in-canada/eng/1356156989919/1356157139999>
  - ii. <https://www.ontario.ca/page/rabies-wildlife>
  - iii. <http://www.omafra.gov.on.ca/english/food/inspection/ahw/rabieszone.htm>
- f. Transmission: Contact of infected saliva with mucous membranes or broken skin (Fisher et al., 2018).
- g. Pathogenicity: Invariably fatal (Fisher et al., 2018).
- h. Zoonotic potential: Zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of Rabies virus can act as a source of infection for wildlife in the rehabilitation and release environment.
  - ii. If Rabies virus is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of viral transmission to naïve individuals and/or populations is best achieved by:
    1. Not moving animals from current outbreak areas to rehabilitation facilities outside the control zone;



2. Not mixing individuals from different source environments within the rehabilitation facility as stipulated by the MNRF conditions of authorization; and
3. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
- ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
  1. **Consult a veterinarian immediately and use extreme caution if an animal is demonstrating signs consistent with rabies.**
  2. **Any animal suspected of having rabies should be euthanized and sent for confirmatory testing. Contact the appropriate regulatory agency for assistance.**
  3. **Vaccinations are available for certain commonly affected species. Consult a veterinarian to develop an appropriate routine vaccination protocol.**
- iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of viral transmission within the rehabilitation facility.
- iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
  1. **Additional precautions should be considered by staff to prevent exposure to potential zoonotic diseases that may be present in wildlife species, namely the use of personal protective equipment including gloves and masks, during handling, feeding or cleaning activities.**
  2. **It is recommended that staff and other personnel who handle wild animals be rabies vaccinated and have titres regularly checked; please consult your doctor for more information regarding the rabies vaccination series.**
- v. **Contact your local authority to assist with the euthanasia and submission of any rabies suspect.**
- vi. **Depending on contact history, carcasses should be submitted to the appropriate agency for confirmatory testing. The OMNRF rabies information line (1-888-574-6656) can be contacted for more information about the process of submitting a carcass for investigation.**
  1. <https://www.ontario.ca/page/rabies>
- vii. **Rabies is reportable under the *Health of Animals Act*.**
  1. **Source: <http://www.inspection.gc.ca/animals/terrestrial-animals/diseases/reportable/rabies/eng/1356138388304/1356152541083>**

## 8. Raccoon Roundworm

- a. Classification: Endoparasite, roundworm
- b. Etiologic agent: *Baylisascaris procyonis*
- c. Known species affected: Raccoons are the definitive host which means adult worms develop in this species. In North America, many mammal and avian species can act as intermediate hosts which means that they can be infected with the larval stage of this parasite (Samuel et al., 2008). Species commonly affected with the larval form of the roundworm include: mice, rats, squirrels, rabbits and birds.
- d. Range: The presence of this parasite is a possibility wherever raccoons are found.
- e. Prevalence: Recent reports of 38% in Ontario raccoons (Jardine et al., 2014). Considered endemic in Ontario (CCWHC, 2011).
- f. Transmission: Can be transmitted through the ingestion of an intermediate host that is infected with the roundworm larvae or through the direct ingestion of roundworm eggs which are shed in

the feces of definitive hosts. The eggs of the *Baylisascaris* parasite are resilient and remain infectious for an extended period of time (CDC, 2018).

- g. Pathogenicity: Raccoons, as the definitive host of the parasite, are generally asymptomatic except in the case of very heavy parasite burdens causing intestinal obstruction. In intermediate hosts, the severity of clinical signs can range from asymptomatic to severe based on the number of eggs that are ingested and the location and extent of larval migration in the body (Samuel et al., 2008).
- h. Zoonotic potential: Zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of *B. procyonis* can act as a source of infection for wildlife, domestic animals and humans in the rehabilitation and release environment
  - ii. If *B. procyonis* is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of parasite transmission to naïve individuals and/or populations is best achieved by:
    - 1. Not mixing individuals from different source environments within the rehabilitation facility; and
    - 2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    - 1. **Consider routine screening for this pathogen.**
    - 2. **Consult a veterinarian to develop an appropriate deworming protocol to minimize environmental contamination with eggs and parasite transmission.**
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of parasite transmission within the rehabilitation facility.
    - 1. **Baylisascaris eggs are difficult to kill.**
    - 2. **All raccoon waste material should be promptly removed and disposed of.**
    - 3. **Housing, and other enclosure surfaces, should be made of materials that can be flamed or cleaned with boiling water (CDC, 2018). Ensure that appropriate safety protocols have been developed, in consultation with local authorities, prior to utilizing flame for disinfection.**
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
    - 1. **Additional precautions should be considered by staff to prevent exposure to potential zoonotic diseases that may be present in wildlife species, namely the use of personal protective equipment including gloves and masks, during handling, feeding or cleaning activities.**
  - v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
    - 1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
    - 2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).

- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

## 9. Sarcoptic Mange

- a. Classification: Ectoparasite, mite
- b. Etiologic agent: *Sarcoptes scabiei*, there are different variants of this mite which are adapted to particular families of mammals (e.g. *S. scabiei* var. *canis* is adapted to members of the Canidae family). Not to be confused with several other categories of mange including: notoedric mange (*Notoedres centrifera*), demodectic mange (*Demodex spp.*), and psoroptic mange (*Psoroptes cuniculi*) (CWHC, 2019).
- c. Known species affected: Occurs predominantly in red foxes, coyotes, wolves and other wild canids in North America. However, mange has been reported in over 100 wild mammal species in North America including porcupines, rabbits, squirrels and raccoons (CWHC, 2019).
- d. Range: Has been documented throughout Ontario. More likely to be encountered in areas where host species are present at high-density (CWHC, 2019).
- e. Prevalence: Unknown. Considered endemic in Ontario (CWHC, 2019).
- f. Transmission: Transmission of *Sarcoptes scabiei* is through direct contact with infected animals or environments (e.g. denning site). In appropriate environmental conditions, mites can survive off the host for up to several weeks (CWHC, 2019).
- g. Pathogenicity: Variants of this mite tend to cause the most severe forms of the disease in the species to which they are adapted but can cause less-severe, short-lived infections in other species. Sarcoptic mange has the potential to cause high mortality (80-90%) if introduced to a naïve population (CWHC, 2019).
- h. Zoonotic potential: Zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of *Sarcoptes scabiei* can act as a source of infection for wildlife, domestic animals and humans in the rehabilitation and release environment.
  - ii. If *Sarcoptes scabiei* is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of parasite transmission to naïve individuals and/or populations is best achieved by:
    - 1. Not mixing individuals from different source environments within the rehabilitation facility; and
    - 2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    - 1. **Any animal demonstrating clinical signs consistent with mange, and all in-contact animals, should be placed in isolation. Consult a veterinarian for diagnostic and potential treatment options.**
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of parasite transmission within the rehabilitation facility.
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
    - 1. **Additional precautions should be considered by staff to prevent exposure to potential zoonotic diseases that may be present in wildlife species, namely the**

**use of personal protective equipment including gloves, masks, and long sleeve clothing or surgical gown during handling, feeding or cleaning activities.**

- v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
  - 1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  - 2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

#### 10. Tularemia (rabbit fever, hare plague)

- a. Classification: Bacteria, gram-negative
- b. Etiologic agent: *Francisella tularensis*
- c. Known species affected: Rodents and lagomorphs. In North America, *Francisella tularensis* has been diagnosed most commonly in hares, cottontail rabbits, beavers, and muskrats. Infections have been reported in over 200 species worldwide including mammals, birds, amphibians and invertebrates (CWHC, 2019; Wobeser et al., 2009).
- d. Range: *Francisella tularensis* is present in Ontario wildlife, but the exact range is unknown.
- e. Prevalence: Unknown. Sporadically reported and identified in Ontario. Likely to be underreported and underdiagnosed. Outbreaks in Ontario have historically been reported in beavers and muskrats (CWHC, 2019; Wobeser et al., 2009).
- f. Transmission: Vector borne (notably ticks, mosquitos, fleas, and flies) transmission, direct contact with or ingestion of blood and/or tissues infected with the bacteria, ingestion of contaminated water, inhalation of aerosolized bacteria. *Francisella tularensis* is highly infectious and can survive in the environment for an extended period of time (CWHC, 2019).
- g. Pathogenicity: Susceptibility to disease varies by species. Ranges from fatal to subclinical infections. In general, rodents and insectivores are highly susceptible to infection and have a severe clinical response. Whereas, carnivores are thought to be more resistant to infection and more likely to be subclinical carriers (CWHC, 2019).
- h. Zoonotic potential: Zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of *F. tularensis* can act as a source of infection for wildlife, domestic animals and humans in the rehabilitation and release environment
  - ii. If *F. tularensis* is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of bacterial transmission to naïve individuals and/or populations is best achieved by:
    - 1. Not mixing individuals from different source environments within the rehabilitation facility; and
    - 2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.

1. **Any animal demonstrating clinical signs consistent with tularemia, and all in-contact animals, should be placed in isolation.**
2. **Diagnostic testing in asymptomatic animals is carried out for the purpose of disease surveillance and is not considered necessary in a rehabilitation setting.**
- iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of bacterial transmission within the rehabilitation facility.
  1. **Consider vector control measures, including minimizing vector breeding and resting sites in and around outdoor enclosures.**
- iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
  1. **Additional precautions should be considered by staff to prevent exposure to potential zoonotic diseases that may be present in wildlife species, namely the use of personal protective equipment including gloves and masks, during handling, feeding or cleaning activities.**
  2. **Use caution if performing a necropsy on commonly affected species.**
- v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
  1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
  2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
- vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.
- vii. ***F. tularensis* is reportable under the Health Protection and Promotion Act.**
  1. **Source: <https://www.ontario.ca/laws/regulation/900557>**

## 11. White Nose Syndrome (WNS)

- a. **Classification:** Fungus
- b. **Etiologic agent:** *Pseudogymnoascus destructans*. Little is known about the diversity of the fungus and whether multiple strains may exist.
- c. **Known species affected:** Has been identified in four species of bats in Canada: little brown bat, northern long-eared bat, tri-coloured bat, and big brown bat (CWHC, 2017b).
- d. **Range:** WNS has been found in 6 eastern and central Canadian provinces, including Ontario. The range of WNS is expanding. The CWHC carries out regular surveillance activities for the detection of this pathogen; updates are available at:
  - i. <http://www.cwhc-rcsf.ca/wns.php>
- e. **Prevalence:** Unknown.
- f. **Transmission:** Direct contact, inhalation, and ingestion are thought to be the primary modes of bat to bat transmission however, much about this pathogen is unknown and more research is needed. Fomite transmission, including clothes, shoes and other materials, has been implicated in pathogen translocation as the fungus can survive for long periods of time on a range of different surfaces (CWHC, 2017c).
- g. **Pathogenicity:** Disrupts normal torpor behavior and damages the wings, which play an important physiologic function, leading to starvation, dehydration and likely death. Almost all mortalities

occur during the winter. More than 6 million bats have reportedly been killed in North America by WNS. A recent report suggests that some bats in rehabilitation centres have recovered from infection with supportive care and temperature regulation however, surviving individuals may be negatively impacted in the long term (Meierhofer et al., 2018; Meteyer et al., 2011).

- h. Zoonotic potential: Not known to be zoonotic
- i. Translocation concern:
  - i. Symptomatic and asymptomatic carriers of *P. destructans* can act as a source of infection for wildlife in the rehabilitation and release environment.
  - ii. If *P. destructans* is present in the release environment, there is the potential for infection and disease in animals released into this environment.
- j. Mitigation strategies for disease related risk:
  - i. Mitigation of fungal transmission to naïve individuals and/or populations is best achieved by:
    - 1. Not mixing individuals from different source environments within the rehabilitation facility; and
    - 2. Releasing animals in close proximity to the point of capture as stipulated by the MNRF conditions of authorization.
  - ii. It is not advisable to release an animal that after careful examination is demonstrating any clinical evidence of disease.
    - 1. **Any bat demonstrating clinical signs consistent with WNS, and all in-contact bats, should be placed in isolation.**
  - iii. Appropriate disinfection and disposal protocols are required for housing and other enclosure items, animal waste products and bedding in order to further minimize the risk of fungal transmission within the rehabilitation facility.
    - 1. **A decontamination protocol has been developed by the CWHC and partners**
      - b. **Source: [http://www.cwhc-rcsf.ca/docs/WNS\\_Decontamination\\_Protocol-Mar2017.pdf](http://www.cwhc-rcsf.ca/docs/WNS_Decontamination_Protocol-Mar2017.pdf)**
  - iv. Personnel should adhere to strict disinfection protocols for hands, shoes, clothing and other handling equipment prior to, after, and between handling of different animals.
  - v. It is recommended that an appropriate disposal service be utilized to incinerate wild animals that are euthanized or die at rehabilitation centres (except when submitted to the CWHC or other government facility for investigation); improper carcass disposal can lead to environmental contamination and creates a potential pathway for disease transmission when pathogens are knowingly or unknowingly present.
    - 1. At minimum, carcasses must be disposed of in accordance with the applicable municipal, provincial and federal regulations.
    - 2. Burial can be performed, where legal, if incineration is not feasible. Burial should be performed at a depth that will prevent scavenging (Miller, 2012).
  - vi. Refer to the section entitled “CWHC Submissions” for more information about the process of submitting a carcass for investigation.

## References

- Allender, M. C., Baker, S., Wylie, D., Loper, D., Dreslik, M. J., Phillips, C. A., Maddox, C., Driskell, E. A. (2015). Development of snake fungal disease after experimental challenge with *Ophidiomyces ophiodiicola* in cottonmouths (*Agkistrodon piscivorus*). *PLOS ONE*, *10*(10), e0140193.
- Berger, L., Roberts, A. A., Voyles, J., Longcore, J. E., Murray, K. A., & Skerratt, L. F. (2016). History and recent progress on chytridiomycosis in amphibians. *Fungal Ecology*, *19*, 89–99.
- Bolte, A. L., Meurer, J., & Kaleta, E. F. (1999). Avian host spectrum of avipoxviruses. *Avian Pathology*, *28*(5), 415–432.
- Canadian Food Inspection Agency. (2020). Rabies in Canada. Retrieved from <https://www.inspection.gc.ca/animal-health/terrestrial-animals/diseases/reportable/rabies/rabies-cases-in-canada-2020/eng/1584479348956/1584479349378>.
- CCWHC. (2011). Annual Report 2010-2011. Retrieved from [http://www.cwhc-rcsf.ca/docs/annual\\_reports/2010\\_2011\\_CCWHC\\_Annual\\_Report\\_EN.pdf](http://www.cwhc-rcsf.ca/docs/annual_reports/2010_2011_CCWHC_Annual_Report_EN.pdf).
- CDC. (2018). Baylisascaris infection. Retrieved from <https://www.cdc.gov/parasites/baylisascaris/>.
- CWHC. (2017a). Canadian national white-nose syndrome decontamination protocol for entering bat hibernacula. Retrieved from [http://www.cwhc-rcsf.ca/docs/WNS\\_Decontamination\\_Protocol-Mar2017.pdf](http://www.cwhc-rcsf.ca/docs/WNS_Decontamination_Protocol-Mar2017.pdf).
- CWHC. (2017b). Regulatory considerations for control of wildlife diseases: Bat white-nose syndrome treatment regulations overview. Retrieved from [http://www.cwhc-rcsf.ca/docs/technical\\_reports/Regulatory\\_considerations\\_for\\_control\\_of\\_wildlife\\_diseases.pdf](http://www.cwhc-rcsf.ca/docs/technical_reports/Regulatory_considerations_for_control_of_wildlife_diseases.pdf).
- CWHC. (2017c). Snake fungal disease in Canada rapid threat assessment. Retrieved from [http://www.cwhc-rcsf.ca/docs/technical\\_reports/CWHC\\_Snake\\_Fungal\\_Disease\\_Threat\\_Assessment.pdf](http://www.cwhc-rcsf.ca/docs/technical_reports/CWHC_Snake_Fungal_Disease_Threat_Assessment.pdf).
- CWHC. (2019). CWHC-RCSF - Canadian Wildlife Health Cooperative / Réseau canadien pour la santé de la faune. Retrieved from [http://www.cwhc-rcsf.ca/fact\\_sheets.php](http://www.cwhc-rcsf.ca/fact_sheets.php).
- D'Aoust-Messier, A., Echaubard, P., Billy, V., & Lesbarrères, D. (2015). Amphibian pathogens at northern latitudes: Presence of chytrid fungus and ranavirus in northeastern Canada. *Diseases of Aquatic Organisms*, *113*(2), 149–155.
- Dalziel, A. E., Sainsbury, A. W., McInnes, K., Jakob-Hoff, R., & Ewen, J. G. (2017). A comparison of disease risk analysis tools for conservation translocations. *EcoHealth*, *14*(Suppl 1), 30–41.
- Daoust, P. Y., Busby, D. G., Ferns, L., Goltz, J., McBurney, S., Poppe, C., & Whitney, H. (2000). Salmonellosis in songbirds in the Canadian atlantic provinces during winter-summer 1997-98. *The Canadian Veterinary Journal = La Revue Veterinaire Canadienne*, *41*(1), 54–59.
- Delnatte, P., Nagy, É., Ojkic, D., Leishman, D., Crawshaw, G., Elias, K., & Smith, D. A. (2014). Avian bornavirus in free-ranging waterfowl: Prevalence of antibodies and cloacal shedding of viral RNA. *Journal of Wildlife Diseases*, *50*(3), 512–523.
- Delnatte, P., Ojkic, D., DeLay, J., Campbell, D., Crawshaw, G., & Smith, D. A. (2013). Pathology and diagnosis of avian bornavirus infection in wild Canada geese (*Branta canadensis*), trumpeter swans (*Cygnus buccinator*) and mute swans (*Cygnus olor*) in Canada: A retrospective study. *Avian Pathology*, *42*(2), 114–128.
- Fernando, M. A., & Barta, J. R. (2009). Tracheal worms. In *Parasitic Diseases of Wild Birds* (pp. 343–354). Oxford, UK: Wiley-Blackwell.
- Fisher, C. R., Streicker, D. G., & Schnell, M. J. (2018). The spread and evolution of rabies virus: Conquering new frontiers. *Nature Reviews Microbiology*, *16*(4), 241–255.
- Forzán, M. J., Vanderstichel, R., Melekhovets, Y. F., & McBurney, S. (2010). Trichomoniasis in finches from the Canadian maritime provinces--An emerging disease. *The Canadian Veterinary Journal = La Revue Veterinaire Canadienne*, *51*(4), 391–396.

- Friend, M., Franson, J. C., & Ciganovich, E. A. (1999). *Field manual of wildlife diseases: General field procedures and diseases of birds*. U.S. Dept. of the Interior, U.S. Geological Survey.
- Giacinti, J. A., Pearl, D. L., Ojkic, D., & Jardine, C. M. (2021). Comparison of two surveillance components for investigating the epidemiology of canine distemper virus in raccoons (*procyon lotor*). *Journal of Wildlife Diseases*, 57(1), 104-115.
- Glaser, L. C., Barker, I. K., Weseloh, D. V. C., Ludwig, J., Windingstad, R. M., Key, D. W., & Bollinger, T. K. (1999). The 1992 epizootic of newcastle disease in double-crested cormorants in North America. *Journal of Wildlife Diseases*, 35(2), 319-330.
- Gray, M. J., & Chinchar, V. G. (2015). Ranaviruses: Lethal pathogens of ectothermic vertebrates. *Choice Reviews Online*, 53(03), 53-1272-53-1272.
- Hartup, B. K., Dhondt, A. A., Sydenstricker, K. V., Hochachka, W. M., & Kollias, G. V. (2001). Host range and dynamics of mycoplasmal conjunctivitis among birds in North America. *Journal of Wildlife Diseases*, 37(1), 72-81.
- Heckert, R. A. (1993). Ontario. Newcastle disease in cormorants. *The Canadian Veterinary Journal = La Revue Veterinaire Canadienne*, 34(3), 184.
- Himsworth, C. G., Musil, K. M., Bryan, L., & Hill, J. E. (2009). Poxvirus infection in an American red squirrel (*Tamiasciurus hudsonicus*) from northwestern Canada. *Journal of Wildlife Diseases*, 45(4), 1143-1149.
- IUCN/SSC. (2013). *Guidelines for reintroductions and other conservation translocations*. Retrieved from <https://www.iucn.org/content/guidelines-reintroductions-and-other-conservation-translocations>.
- Jardine, C. M., Buchanan, T., Ojkic, D., Campbell, G. D., & Bowman, J. (2018). Frequency of virus coinfection in raccoons (*procyon lotor*) and striped skunks (*mephitis mephitis*) during a concurrent rabies and canine distemper outbreak. *Journal of Wildlife Diseases Wildlife Disease Association*, 54(3), 622-625.
- Jardine, C. M., Pearl, D. L., Puskas, K., Campbell, D. G., Shirose, L., & Peregrine, A. S. (2014). The impact of land use, season, age, and sex on the prevalence and intensity of *Baylisascaris procyonis* infections in raccoons (*Procyon lotor*) from Ontario, Canada. *Journal of Wildlife Diseases*, 50(4), 784-791.
- Kotwa, J. D., Isaksson, M., Jardine, C. M., Campbell, G. D., Berke, O., Pearl, D. L., Mercer, N. J., Osterman-Lind, E., & Peregrine, A. S. (2019). Echinococcus multilocularis infection, Southern Ontario, Canada. *Emerging Infectious Diseases*, 25(2), 265-272.
- Lind, C. M., McCoy, C. M., & Farrell, T. M. (2018). Tracking outcomes of snake fungal disease in free-ranging pygmy rattlesnakes (*Sistrurus miliarius*). *Journal of Wildlife Diseases*, 54(2), 352-356.
- Lorch, J. M., Knowles, S., Lankton, J. S., Michell, K., Edwards, J. L., Kapfer, J. M., Staffen, R. A., Wild, E. R., Schmidt, K. Z., Ballmann, A. E., Blodgett, D., Farrell, T. M., Glorioso, B. M., Last, L. A., Price, S. J., Schuler, K. L., Smith, C. E., Wellehan, J. F. X., & Blehert, D. S. (2016). Snake fungal disease: an emerging threat to wild snakes. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 371(1709), 20150457.
- McLean, R. G., & Ubico, S. R. (2007). Arboviruses in birds. In *Infectious Diseases of Wild Birds*. Oxford, UK: Wiley-Blackwell.
- Meierhofer, M. B., Johnson, J. S., Field, K. A., Lumadue, S. S., Kurta, A., Kath, J. A., & Reeder, D. M. (2018). Bats recovering from white-nose syndrome elevate metabolic rate during wing healing in Spring. *Journal of Wildlife Diseases*, 54(3), 480-490.
- Meteyer, C. U., Valent, M., Kashmer, J., Buckles, E. L., Lorch, J. M., Blehert, D. S., Lollar, A., Berndt, D., Wheeler, E., White, C. L., & Ballmann, A. E. (2011). Recovery of little brown bats (*Myotis lucifugus*) from natural infection with *geomyces destructans*, white-nose syndrome. *Journal of Wildlife Diseases*, 47(3), 618-626.
- Miller, E. A., (2012). *Minimum Standards for Wildlife Rehabilitation, 4th edition*. Retrieved from <https://cdn.ymaws.com/www.nwrawildlife.org/resource/resmgr/Standards-4th-Ed-2012-final.pdf>.
- Ministry of Health and Long-Term Care. (2018). Management of echinococcus multilocularis infections in animals guideline. Retrieved from [http://health.gov.on.ca/en/pro/programs/publichealth/oph\\_standards/docs/protocols\\_guidelines/Management\\_of\\_EM\\_Infections\\_in\\_Animals\\_2018.pdf](http://health.gov.on.ca/en/pro/programs/publichealth/oph_standards/docs/protocols_guidelines/Management_of_EM_Infections_in_Animals_2018.pdf).



- Murray, N. (2004). *Handbook on import risk analysis for animals and animal products*. Office international des épizooties. Retrieved from <https://www.oie.int/doc/ged/D11250.PDF>.
- Nituch, L. A., Bowman, J., Wilson, P., & Schulte-Hostedde, A. I. (2012). Molecular epidemiology of Aleutian disease virus in free-ranging domestic, hybrid, and wild mink. *Evolutionary Applications*, 5(4), 330-340.
- Nituch, L. A., Bowman, J., Beauclerc, K. B., & Schulte-Hostedde, A. I. (2011). Mink farms predict aleutian disease exposure in wild american mink. *PloS One*, 6(7), e21693.
- Ontario Ministry of Natural Resources and Forestry. (2019). Rabies in wildlife. Retrieved from <https://www.ontario.ca/page/rabies-wildlife#section-5>.
- Ouellet, M., Mikaelian, I., Pauli, B. D., Rodrigue, J., & Green, D. M. (2005). Historical evidence of widespread chytrid infection in North American amphibian populations. *Conservation Biology*, 19(5), 1431–1440.
- Papp, Z., Clark, R. G., Parmley, E. J., Leighton, F. A., Waldner, C., & Soos, C. (2017). The ecology of avian influenza viruses in wild dabbling ducks (*Anas* spp.) in Canada. *PloS One*, 12(5), e0176297.
- Sainsbury, A. W., & Vaughan-Higgins, R. J. (2012). Analyzing disease risks associated with translocations. *Conservation Biology*, 26(3), 442–452.
- Samuel, W. M., Pybus, M. J., & Kocan, A. A. (2008). *Parasitic Diseases of Wild Mammals*. John Wiley & Sons.
- Schock, D. M., Ruthig, G. R., Collins, J. P., Kutz, S. J., Carrière, S., Gau, R. J., Veitch, A. M., Larter, N. C., Tate, D. P., Guthrie, G., Allaire, D. G., & Popko, R. A. (2010). Amphibian chytrid fungus and ranaviruses in the Northwest Territories, Canada. *Diseases of Aquatic Organisms*, 92(2–3), 231–240.
- Shearer, K. E., Harte, M. J., Ojkic, D., Delay, J., & Campbell, D. (2014). Detection of leptospira spp. in wildlife reservoir hosts in Ontario through comparison of immunohistochemical and polymerase chain reaction genotyping methods. *The Canadian Veterinary Journal = La Revue Veterinaire Canadienne*, 55(3), 240–248.
- Steinel, A., Parrish, C. R., Bloom, M. E., & Truyen, U. (2001). Parvovirus infections in wild carnivores. *Journal of Wildlife Diseases*, 37(3), 594-607.
- Stephen, C., & Zimmer, P. (2018). State of wildlife health: CWHC annual report 2017/2018. Retrieved from <http://2017-2018.cwhc-rcsf.ca/>.
- Terio, K. A., McAloose, D., & St. Leger, J. (2018). *Pathology of Wildlife and Zoo Animals*.
- Tizard, I. (2004). Salmonellosis in wild birds. *Seminars in Avian and Exotic Pet Medicine*, 13(2), 50–66.
- Tsui, C. K.-M., Miller, R., Uyaguari-Diaz, M., Tang, P., Chauve, C., Hsiao, W., Isaac-Renton, J., & Prystajec, N. (2018). Beaver fever: Whole-genome characterization of waterborne outbreak and sporadic isolates to study the zoonotic transmission of giardiasis. *MSphere*, 3(2).
- Williams, E. S., & Barker, I. K. (Eds.). (2001). *Infectious Diseases of Wild Mammals*. Ames, Iowa, USA: Iowa State University Press.
- Wilson, M. R., Fedewa, G., Stenglein, M. D., Olejnik, J., Rennick, L. J., Nambulli, S., Feldmann, F., Duprex, W. P., Connor, J. H., Mühlberger, E., & DeRisi, J. L. (2016). Multiplexed metagenomic deep sequencing to analyze the composition of high-priority pathogen reagents. *MSystems*, 1(4), e00058-16.
- Wobeser, G., Campbell, G. D., Dallaire, A., & McBurney, S. (2009). Tularemia, plague, yersiniosis, and tyzzer's disease in wild rodents and lagomorphs in Canada: A review. *The Canadian Veterinary Journal = La Revue Veterinaire Canadienne*, 50(12), 1251–1256.
- Woodford, M. H. (2000). *Quarantine and Health Screening Protocols for Wildlife prior to Translocation and Release into the Wild*. Retrieved from <https://digitalcommons.unl.edu/zoonoticpub/32/>.