CANADIAN WILDLIFE HEALTH COOPERATIVE

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The Canadian Wildlife Health Cooperative National Bat Health Report – 2021

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Executive summary

It has become increasingly important in Canada to understand and manage bat populations through a holistic bat health approach. Bats are widely distributed throughout most of Canada, and dead and diseased individuals function as proxies for population and ecosystem health. The goal of this report is to synthesize the scanning and targeted surveillance data maintained in the Canadian Wildlife Health Cooperative (CWHC) Wildlife Health Information Platform (WHIP) database and the British Columbia Animal Health Centre database for bat species received by the CWHC nationally over the past five years to provide situational awareness about the causes of mortality affecting Canadian bats. This report does not take into account data from outside organisations. As such, we acknowledge that there may be other issues impacting the health of bats that are not identified through the CWHC's scanning surveillance program.

The four main issues for bats identified through the CWHC's wildlife health surveillance program are human-induced trauma, predation by companion animals, rabies, and white-nose syndrome, indicating that anthropogenic sources of trauma and infectious diseases are the main threats for the health of Canadian bat populations detected through this analysis. Rabies is a significant zoonotic disease and there is overlap in some instances where bats with human- or pet-induced trauma as a cause of death also test positive for rabies.

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Interestingly, while wind farm development is well-documented in the peer reviewed literature as a significant cause of traumatic injuries and death in several bat species, the 5 year review of the CWHC's bat surveillance data revealed little in terms of this threat to the health of Canadian bat populations. We believe that this significant data gap requires further investigation to better understand the severity of this potential threat in the Canadian context, particularly with the current increase in wind energy development across the country. Therefore, we strongly recommend promoting partnerships with various stakeholder groups to access and analyse the available bat mortality data from wind farms to assess the magnitude and species diversity of bat mortality at Canadian wind energy sites and determine the potential impact of this industry on bat health at a national scale.

Additional known threats to bat health that were not identified in this review include pesticides and other causes of toxicity, overheating events in bat houses, and trauma and stress associated with colony exclusion events from anthropogenic structures.

Introduction

Approximately 17 bat species have been identified in Canada (Adams 2003; Lausen 2019; Naughton 2012). Three of these species, little brown myotis (*Myotis lucifugus*), northern myotis (*M. septentrionalis*), and tri-colored bat (*Perimyotis subflavus*), are federally listed as endangered under the Species At Risk Act (SARA) due to impact of the disease white-nose syndrome caused by the fungus *Pseudogymnoascus destructans* (*Pd*) (Environment and Climate Change Canada 2018). Pallid bat (*Antrozous pallidus*) and spotted bat (*Euderma maculatum*) are federally listed as threatened and special concern, respectively (Environment and Climate Change Canada 2017). The three migratory species, hoary bat (*Lasiurus cinereus*), eastern red bat (*L. borealis*), and silver-haired bat (*Lasionycteris noctivagans*), are currently under review for status assessment (COSEWIC 2021). Additional species are listed under various provincial and territorial endangered species acts. The Canadian Wildlife Health Cooperative (CWHC) conducts targeted and scanning surveillance for bat health and coordinates the national targeted surveillance program for white-nose syndrome. Diagnostic data, including health data on thousands of bats, from CWHC centres across Canada are entered into and maintained in the CWHC Wildlife Health Information Platform (WHIP) database and the British Columbia Animal Health Centre database.

Methods

Scanning surveillance for bat health is conducted opportunistically at all CWHC centres, primarily through necropsy examination of bats found dead and submitted to a CWHC regional centre. Bat carcasses are submitted from a variety of sources, including but not limited to federal, provincial and territorial government department employees, zoo staff, wildlife rehabilitators, veterinarians, university researchers and students, and the general public. Cases are triaged and diagnostic data are entered in the CWHC's WHIP database with mandatory and discretionary fields for each incident. Additionally, targeted surveillance for WNS is conducted in a harmonized manner at all CWHC centres following the

Canadian bat WNS necropsy protocol, including an internationally agreed upon case definition for reporting incidents of bat white-nose syndrome (WNS) at the individual specimen level.

The CWHC WHIP database and the British Columbia Animal Health Centre database were searched for any chiroptera (the taxonomical order of the bats) with earliest date (*i.e.*, date found, date received, date of death, or necropsy date) from April 1 2016 to March 31 2021, to cover a span of five years which is representative of the tenure for the current Environment and Climate Change Canada contribution agreement funding held by the CWHC for the WNS scientific coordinator's position.

Incidents were reviewed and categorized by cause of death. Fields reviewed included: etiology, history, interpretation, diagnosis text, rabies test status, and bat white nose syndrome test status. Species, sex, and age were quantified only for the purpose of noting potential data bias. Data came from across Canada with the exception of Nunavut (figure 1), but were not categorized by geographic location for the analysis purposes of this report. Regardless of etiology recorded in the database, all specimens in an incident that tested positive for rabies or WNS were designated as such for the cause of death (for example: a bat killed by a cat or human, testing positive for rabies, was reclassified with a final diagnosis of rabies as the cause of death even if the incident previously had trauma as the etiology of the incident).

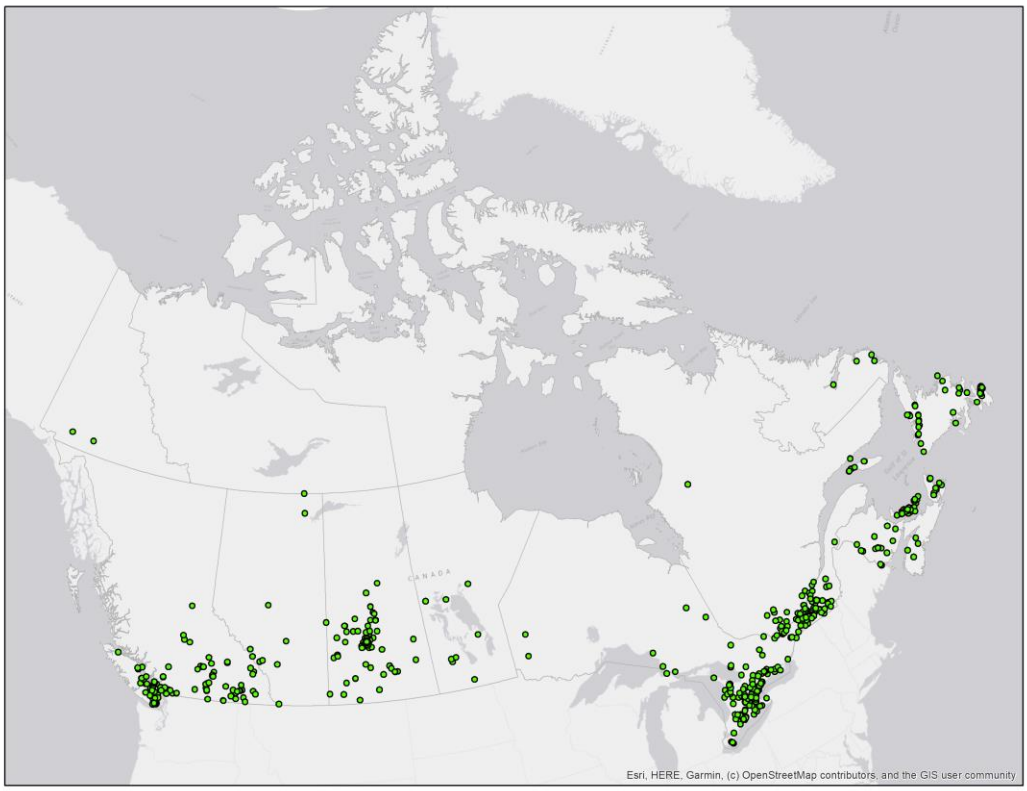

Figure 1: Map of Canada illustrating known locations of bat mortality incidents with specimen submissions to CWHC centres.

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Results

The diagnostic data obtained from the CWHC WHIP database and the British Columbia Animal Health Centre database included 1489 incidents involving chiroptera of which 1074 incidents had a final diagnosis which also included a category of "cause of death undetermined". Only incidents with a final diagnosis were considered. Sex was recorded as: 377 females, 381 males, and 316 unknown. Age was specified as: 366 adults, 85 juveniles, 7 neonates, 279 unknown, and 337 no value. Therefore, the submitted specimens had a relatively equal sex ratio and all age categories were represented with predominately adult specimens in those instances where the age could be determined. For the purpose of further reporting, the species were grouped as presented in Table 1. Specimens identified as 'Chiroptera' can be any bat species, and this designation might have been used for specimens with significant post mortem decomposition that precluded an accurate species identification. Specimens identified as '*Myotis* sp.' from Atlantic Canada were grouped with the endangered little brown myotis and northern myotis as these are the only two *Myotis* species with ranges in this region. However, *Myotis* sp. specimens identified in all other parts of Canada were grouped under 'other hibernators' as these specimens could represent little brown myotis, northern myotis, or any other *Myotis* species.

Table 1: Number of bat species and groupings

Species grouping (N =1074)	Species (N = 1074)
Chiroptera (73)	Unidentified bat species (73)
Big brown bat (585)	Big brown bat (585)
Endangered *Myotis* (255)	Little brown myotis (209) Northern myotis (11) *Myotis* sp. (35)
Migratory bats (47)	Eastern red bat (1) Hoary bat (17) Silver-haired bat (29)
Other hibernators (114)	California myotis (25) Eastern small-footed myotis (7) Fringed myotis (1) Keen's myotis (5) Other *Myotis* sp. (22) Townsend's big-eared bat (7) Western long-eared myotis (11) Western small-footed myotis (2) Yuma myotis (34)

Big brown bat (*Eptesicus fuscus)* and endangered *Myotis* species were the most commonly identified species groups, with 585 and 255 specimens respectively.

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Causes of death per species group are presented in Table 2. Trauma was by far the most commonly diagnosed cause of death, with all trauma categories combined representing 26.4% of all incidents of mortality (283/1074) (Table 2). The majority of traumatic incidents, when the specific cause could be identified, were categorized as human-induced trauma and predation by pets. Specifically, the two most common causes of trauma were predation by cats (68/283) and trauma caused by intentional trapping of bats in homes (27/283). Out of these 27 trapping cases, big brown bats were most commonly affected (20 out of 27 intentionally trapped bats in homes), likely because this is the bat species most commonly found in human residences across Canada year round, which likely also contributed to big brown bats being the most common species submitted for post mortem examination (585/1074 or 54.5%) (Tables 2 and 3).

Significant infectious diseases of bats are bat rabies and white-nose syndrome. Rabies was diagnosed in 117/1074 bats (10.9%). Rabies was most prevalent in big brown bats (100/585 or 17.1%), consecutively followed by migratory bats (5/47 or 10.6%), other hibernators (7/114 or 6.1%), endangered *Myotis* species (4/255 or 1.6%), and the chiroptera group (1/73 or 1.4%). White-nose syndrome was diagnosed in 53/1074 bats (4.9%) and was most prevalent in endangered *Myotis* species (50/225 or 19.6%), consecutively followed by other hibernators (1/114 or 0.9%) and big brown bats (2/585 or 0.3%).

Other notable results include: 15 big brown bats and 1 endangered *Myotis* species were euthanised and sent for rabies testing after potential contact with humans or pets but tested negative for rabies which is 1.5% of all incidents (16/1074); the cause of a single migratory bat's death was wind farm trauma; the cause of death in 9 big brown bats was bycatch in glue traps, representing 23.1% (9/39) of all trapping incidents; 10.1% of incidents (109/1074) had emaciation-starvation as the cause of death, including specimens from all species groupings; 14.1% (151/1074) had trauma (undetermined cause) as the cause of death, including species from all species groupings; and the cause of death was undetermined in 40.8% of incidents (438/1074), including species from all species groupings.

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Table 2: Identified causes of death per species grouping

Cause of Death	Big brown bat	Chiroptera	Endangered *Myotis*	Migratory bats	Other hibernators	Grand Total
Emaciation-starvation	46	10	26	4	23	109
Emaciation (trapped in building)	3		1		5	9
Euthanasia (for rabies testing - negative)	15		1			16
Other infections	18	6	5	1	8	38
Miscellaneous	7	1	1	1		8
Rabies	100	1	4	5	7	117
Trauma	152	26	45	22	38	283
Undetermined	242	28	122	14	32	438
WNS	2		50		1	53
Grand Total	585	73	255	47	114	1074

Table 3: Identified causes of trauma per species grouping

Trauma	Big brown bat	Chiroptera	Endangered *Myotis*	Migratory bats	Other hibernators	Grand Total
Trauma (undetermined cause)	71	22	22	17	19	151
Drowning	3		1			4
Intentional trapping	20	3	3	1		27
Bycatch mouse trap	3					3
Bycatch glue trap	9					9
Predation (cat)	29	1	17	2	19	68
Predation (dog)	5					5
Predation (undetermined cause)	7		2			9
Predation (wildlife)	5			1		6
Wind turbine				1		1
Grand Total	152	26	45	22	38	283

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Discussion

There are biases associated with data collected for by the CWHC because wildlife mortality is most commonly detected and investigated in areas of human activity (as the map in figure 1 illustrates); targeted surveillance programs increase submission of specimens for particular diseases (i.e., WNS); zoonotic disease surveillance is prioritized to protect human health which increases the detection of certain diseases (i.e., rabies); and the majority of animals submitted for diagnostic investigation are selected because they are showing signs of illness or have been found dead.

With these caveats in mind, from April 2016 to March 2021, 10.9% of the bats in the CWHC's WHIP and British Columbia Animal Health Centre database tested positive for rabies. The highest rate of detection was in big brown bats (17.1%) followed by migratory bats (10.6%), while the rate of detection in endangered *Myotis* spp. was 1.6%. The prevalence of rabies in healthy bat populations is estimated to be approximately 1% (Fenton et al 2020; Klug et al, 2011). However, in biased samples of bats found dead or with signs of illness the proportion testing positive for rabies is often higher, for example ranging from 5.0% to 6.7% (Pybus 1986; Patyk *et al*. 2012). In Western Canada, Pybus (1986) documented that big brown bats accounted for approximately 55% of bat rabies cases, migratory bat species such as the silver-haired bat had a rate of rabies detection of approximately 7.3%, and rabies was rarely identified in little brown myotis (<1%). This demonstrates that the surveillance data for rabies in the CWHC's WHIP and BC Animal Health Centre are consistent with that found in the literature in bats found sick or dead, and should serve as a reminder that extra caution is reasonable when handling bats in Canada to prevent human contact and potential exposure to a zoonotic disease. Therefore, for the protection of human health, we developed appropriate and consistent messaging about bat rabies for the public and nuisance wildlife control operators, including a bats and rabies infographic and Bats in Buildings beneficial management practices which were adopted and adapted for communication and outreach purposes by several provinces and international groups. There were 16 incidents in our data where bats were euthanized for rabies testing that had negative results. While prevention of human exposure to bat rabies is extremely important, we do want to emphasize that unnecessary euthanasia of bats of any species, but particularly endangered species, should be avoided. Therefore, those responsible for human health and wildlife management should ensure that there are proper risk assessments of potential human exposure to a bat based on credible, scientific criteria prior to euthanizing bats for rabies testing. Otherwise, apparently healthy bats found in human dwellings when there is absolutely no history or risk of the bat having come in contact with humans or pets should not be euthanized for rabies testing.

White-nose syndrome remains a major threat to bats in Canada and the United States. The CWHC leads the targeted WNS surveillance program in Canada so it is not surprising that we have a significant number of incidents of WNS in the WHIP database, with recent submissions of positive specimens from the eastern and western leading edges of this emerging disease. We continuously work with national and international partners to ensure accurate and consistent case definitions are used to provide data for our federal, provincial, and territorial partners with authority for response and management of the

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disease. By providing regional wildlife managers with tools and information about early detection of WNS (including spread maps and provincial summaries), resources for population monitoring and management, information about funding opportunities, and mitigation strategies to minimize risk of spread (i.e., bats astray brochure, decontamination protocols) or impact of WNS (i.e.,regulatory considerations for treatment of WNS), we have contributed in a meaningful way to management, response, and conservation actions that stimulate population recovery as identified in the federal recovery strategy for the little brown myotis, northern myotis, and tri-colored bat in Canada. Detection of WNS and *Pd* is becoming increasingly difficult as the fungus spreads into less densely populated areas in the north and west and this is further exacerbated by the lack of knowledge about the hibernation strategies of bats in these areas. Many of the detection and surveillance strategies employed when WNS emerged in the east, as well as the guidance developed for a response (e.g., hibernacula surveys), are less suitable for detection of WNS and *Pd* as the fungus spreads to the west and north. To address this need, we will convene a small working group with the appropriate expertise to develop *Pd* surveillance guidance. As a key strategy to enhance WNS surveillance in less densely populated and remote areas, federal, provincial, and territorial wildlife departments could also benefit from citizen science by working with the public and media to increase public reporting of dead bats and facilitate submission of these specimens for diagnostic examination. To help our government partners achieve this, we are collaborating with our US counterparts to update consistent public and media messaging about WNS and describe how public outreach can help with surveillance and detection.

The number of incidents with human induced trauma as the cause of death (primarily deliberate killing of bats inside human dwellings, but also accidental injury during home captures and death from bycatch in traps) and predation by pets (primarily cats but also dogs) was striking. Human persecution of bats, due to general ignorance and fear of bats, remains a serious issue to bat health. While outreach material on how to remove a single bat from a building is already available on our CWHC website, these data suggest there is further need to increase public outreach to address this threat. The general public should be engaged to reduce their fear of bats, promote the value of bats, and educate them on the appropriate removal strategies for bats in instances where there is no human or domestic animal contact with the bat. The CWHC is an active partner on the organizing committee of Bat Week, an annual outreach event that promotes the value of bats to people in North and South America. Additionally, the Bats in Buildings beneficial management practices we developed provide approaches that encourage outcomes that promote the health and welfare of bats in such circumstances. If situations arise where the euthanasia of a bat is absolutely necessary, it should be performed by a trained professional.

Many studies show that predation by feral cats and (to a lesser degree) house cats has a severe impact on wildlife populations, primarily on birds and small mammals (Ancillotto et al 2013) and is considered the single greatest cause of anthropogenic mortality for birds and mammals in the US (Loss et al. 2013). Our data show that contact between bats and domestic cats is common and results in mortality or significant traumatic injuries to bats. Predation by cats was observed in all species groups and was most

prevalent at 16.7% in other hibernators (most notably Yuma myotis, *Myotis yumanensis*), in 6.7% of endangered migratory bats (most notably little brown myotis), and in 5.0% of big brown bats. Yuma myotis, little brown myotis, and big brown bat are species often associated with roosting inside human dwellings (Naughton 2012; Evelyn *et al*. 2004; Fenton and Barclay 1980; Lausen and Barclay 2006) which puts these species at higher risk of contact with domestic pets and injuries from their predatory behaviours. Incidence of cat predation (n = 68) was highest in the months of July (15/68), August (11/68), and September (11/68). While it could be expected that juvenile bats are more susceptible to cat predation than adults, and the timing from July to September is consistent with newly volant bat pups, only 3 of the affected bats were classified as immature, suggesting that cat predation likely is a health issue for bats regardless of their age. While none of these bats tested positive for rabies, there is a real risk that domestic cats (or dogs) could come in contact with a rabid bat and public outreach continues to be important to minimize the risks to human and pet health associated with such situations. Additionally, while the history of only a few incidents of cat predation in our data indicated that they outside, predation of bats from outdoor cats likely remains undetected and possibly could be a much bigger wildlife health issue than our data are able to demonstrate. Continued public outreach about the threat of cats to native wildlife remains important for the protection of native species. Therefore, the CWHC recently developed a fact sheet about wildlife and cats.

Bycatch in glue traps represented 23% or almost a quarter of all incidents where trapping was determined to be the cause of death. Since these traps are in wide use and it is likely that most bycatch is simply discarded because the cause of death or injury would be obvious, we believe glue traps could represent a real threat to non-target bat species, including endangered bat species, roosting in anthropogenic structures. Since death associated with glue traps is not immediate and bycatch is relatively common with them due to their non-targeted mechanism of action, their use is increasingly being discouraged by organizations such as the Humane Society. We strongly support such action and recommend not using them in areas where bats may be present. This includes the use of hanging glue traps for insect control which can also accidentally entrap bats. In the meantime, to minimize or eliminate the impact of glue traps, increased public outreach is needed to educate people and raise awareness about the inhumane consequences of using them both on target and non-target species.

Our datasets contain very few incidents of mortality associated with wind farms (only one hoary bat for the specific time interval chosen for this review). Academic and governmental research has documented the scope and severity of this threat to various bat species, particularly the fact that since 2000 collision with wind turbines have contributed to substantial mortality of several species of bats (Frick et al 2017; Zimmerling and Francis 2016; O'Shea et al 2016 and many others), and minimizing this threat to bats remains high on the agenda of many Canadian governmental wildlife agencies (C. Davy, personal communication March 29 2021; R. Zimmerling, personal communications, March 4 2021). Other datasets (*e.g.*, environmental assessment data from the wind farm industry or biological consulting firms) could and should be analysed to more accurately define the impact of wind turbines on bat populations as well as to determine options to mitigate or prevent mortality from this threat, especially

since the demand for wind energy is increasing in Canada due to its promotion as a carbon reduction strategy. We recommend collaborating with various stakeholder groups to gain access to, review and analyse any available bat mortality datasets from wind farms nationally to determine the magnitude and species diversity of bat mortality caused by wind energy as well as the other factors possibly associated with this threat to bats (*e.g.*, seasonality, wind conditions, structure, etc.). This exercise will lead to a better understanding of this industry's potential impact on bat health nationally and enable those responsible for response and management to develop beneficial management practices and other threat reduction strategies. Currently, guidelines to reduce bat mortality related to the Canadian wind farm industry are a priority and have been developed by some provincial and territorial governments (e.g., British Columbia, Ontario), and the federal government (i.e., wind energy is listed as a major source of bat mortality in the SAR bat recovery strategy). The CWHC national bat health program will support our federal, provincial, and territorial government partners by coordinating data acquisition and engaging bat health practitioners with the appropriate expertise to address this important issue.

Bat species diversity in our dataset is heavily biased towards those bat species that live in close association with people; in particular big brown bats and little brown myotis are over-represented. Important species that we have no data on over the past five years are the tri-colored bat, pallid bat, and spotted bat. Like little brown myotis and northern myotis, the tri-colored bat is federally listed as endangered due to the devastating effects of WNS and pallid bat and spotted bat are federally listed as threatened and special concern, respectively, which makes understanding any threats to their health essential to their recovery. However, unlike the two endangered *Myotis* species, the tri-colored bat, the pallid bat, and the spotted bat's range in Canada is much smaller and generally limited to more natural areas away from human settlements (Naughton 2012). These factors in combination with potential lower population sizes compared with the endangered *Myotis* species likely contribute to the lack of health data for these species in our dataset over the past five years. We will continue to work with federal, provincial, and territorial wildlife departments to strongly encourage submission of all bat specimens found sick or dead to a CWHC regional centre for accurate species identification and post mortem examination to determine the cause of their death or health problem.

The cause of death was undetermined in 438 incidents or 40.8% of all incidents reviewed for this report. Canadian bats are small and as a result, they rapidly decompose after death, precluding an accurate post mortem examination and diagnosis in many instances. In these cases, speculation about the cause of death could lead to misdiagnosis and erroneous conclusions about bat health. While the CWHC recommends freezing and submission of specimens in a timely manner to ensure their optimal preservation, we understand that often this is not possible in incidents of wildlife mortality.

Habitat degradation is a known threat to wildlife (Tilman et al. 1994), and habitat fragmentation can have a varying effect on different bat species (Segers & Broders 2014). Indicators of habitat degradation related to bat health could include body condition and exposure to pesticides and toxins. Emaciation-starvation was the cause of death identified in 10.1% of the incidents examined. In wildlife populations,

juvenile, yearling, and older aged animals are those cohorts most susceptible to emaciation-starvation, and research has shown that this is likely true of bats. For example, one study on three species of *Myotis* examined in the fall found that adults deposit more fat than juveniles and females deposit more fat than males of the same age class (Ewing et al. 1970). However, the data in our dataset did not suggest sex or age group to be correlated with emaciation-starvation as a cause of death. Additionally, there is a seasonality associated with starvation in bats as it is recognized as a major cause of mortality in hibernating bats at the end of the winter, and juvenile bats are more susceptible to death from starvation during the over-wintering period (Ransome 1967). The incidents of emaciation-starvation in our dataset may simply represent the normal background level of mortality associated with this cause of death in Canadian bat populations. However, it is important to monitor for an increasing trend in emaciation-starvation as this could be an indicator of decreased prey availability which can be directly related to habitat degradation. Currently, the scanning surveillance program for bat health does not screen submitted specimens for pesticides and other toxins due to the high cost associated with the diagnostic tests for these compounds. We do recognize their relationship to habitat quality and the importance of determining their effects on bat health. Therefore, the CWHC, British Columbia region has recently initiated collaboration with researchers studying the impact of agricultural pesticides on bat health. The CWHC also understands the value of monitoring population trends for response and management purposes, which also relates to habitat quality and provides important data on the declines and potential recovery of those bat species most severely impacted by WNS. Therefore, the CWHC actively promotes and participates in the North American Bat Monitoring Program (NABat) as recommended by the Recovery Strategy (Environment and Climate Change Canada 2018). We accomplish this as a Canadian member of the NABat steering committee as well as through participation on multiple sub-committees that develop up-to-date scientific strategies for acoustic monitoring and colony counts, and encourage the formation and facilitation of bat monitoring hubs. Most recently the CWHC, Atlantic Region formed an official NABat monitoring hub in Atlantic Canada that facilitates monitoring of regional bat populations using NABat written and audio visual bat monitoring training materials that were developed with funding from the Habitat Stewardship Program-Species at Risk (HSP-SAR) program and offered as online training workshops to interested participants of many governmental and non-governmental organizations throughout the region.

Bats' potential susceptibility to SARS-CoV-2 (Cook et al 2021) is an emerging concern that was identified at the end of the period covered by this review. The CWHC developed guidance for wildlife management and permitting agencies on responding to the unknown but potential risks around handling bats during a global pandemic. In the future, this potential threat could be assessed by identifying resources to facilitate a targeted surveillance program for SARS-CoV-2 in bats. Additional known anthropogenic threats that are not currently assessed through the CWHC scanning surveillance program include: hyperthermia associated with bat boxes and improper exclusion of bat colonies from their roosts in anthropogenic structures despite the availability of Beneficial Management Practices to prevent this problem. Fortunately, these threats are either currently being studied in Canada with a view to developing prevention and mitigation strategies or have already been addressed through appropriate

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training and communication and outreach materials. One example is that of a national study to examine the possibility of overheating events associated with bat houses. Another example is that of beneficial management practices to manage bats in buildings that are promoted by multiple jurisdictions. Training material on this was developed by the CWHC Atlantic Region with funding from the HSP-SAR program and is offered on the CWHC website for nuisance wildlife control operators and pest control operators to encourage increased stewardship for bats in their professional activities.

Conclusion

The primary health threats to bats identified through this examination of the most recent 5 years of data from the CWHC's WHIP and BC Animal Health Centre database were: anthropogenic trauma (including predation by pets, mainly cats), rabies, and WNS. The continuation of the CWHC's WNS targeted surveillance program is important as this disease continues to move west and north in Canada. This program gives those responsible for the health of bats accurate information on which to base their response and management strategies. Opportunistic and targeted surveillance for rabies in bats will always be important to protect the health of humans and domestic animals as well as to better understand the epidemiology of this disease as it relates to the health of Canadian bat populations. Continued outreach and promotion of the value of bats is necessary to help reduce the impact of anthropogenic trauma on bat health so the CWHC will continue its efforts to develop and communicate appropriate messages to mitigate this threat.

Significant health threats to bats that are known, but were not identified with our dataset included: wind farm trauma, pesticide toxicity and other toxins, overheating events at bat boxes, and trauma or stress during colony exclusions. The CWHC's bat health program currently encourages, facilitates, and supports research, response and management actions to address these threats.

The CWHC has coordinated Canada's national WNS response program since 2012, focusing heavily on this threat to bats. While the regions where WNS is endemic are concentrated on response efforts and recovery of affected bat species, regions on the leading edge of WNS continue monitoring for the emergence of *Pd* and WNS and assessing bat populations pre-emergence of WNS. Although the impact of WNS can be mitigated to a certain extent, once it emerges, its negative impact on bat health cannot currently be avoided. Therefore, understanding other pressures on bat populations is more important now than ever so these threats do not compound the effects of WNS, and so appropriate strategies can be developed to mitigate and prevent them for the overall protection of bat health in Canada. The CWHC will continue to work towards this goal with our federal, provincial, and territorial partners as well as other interested partners to ensure our bat health program provides evidence-based knowledge on which to base timely response and management initiatives to protect and recover bat populations across our country.

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