BMP Series

Best Management Practices Guidelines for Bats in British Columbia

CHAPTER 3: CAVING, ROCK CLIMBING, GEOCACHING AND OTHER ACTIVITIES AROUND CAVE AND CREVICE HABITAT



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Ministry of Environment

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Executive Summary

The British Columbia (B.C.) Ministry of Environment has developed this document to provide helpful guidance to land managers, cavers, rock climbers, researchers, consultants, recreational and other resource developers on how to minimize impacts to bats as a result of activities around cave and crevice habitat in British Columbia. Use of these guidelines demonstrates due diligence towards the protection of bats and their habitats in locations where recreational developments of cave and cliff features occur in the province.

"Best Management Practices Guidelines for Bats in British Columbia: Caving, Rock Climbing, Geocaching and Other Activities Around Cave and Crevice Habitat" is one chapter of a larger strategy identifying a number of resource sectors in the province of British Columbia most likely to impact bats and their habitats. The Introductory Chapter for the strategy reviews bat species, distribution and ecology in British Columbia and this chapter should be reviewed in conjunction with industry/activity specific Best Management Practices guidance in later individual chapters.

Each industry/activity specific chapter follows a similar structure. Section 1 highlights particular aspects of bat ecology, behaviour and distribution that may be impacted or may benefit from a specific industry/activity, for example mining, development of wind power, or caving. Section 2 describes the activities associated with a specific industry or activities that are most likely to impact bats and their habitats. Section 3 outlines Best Management Practices. Section 4 lists monitoring and reporting priorities. Section 5 outlines knowledge gaps and information needs to improve adaptive management for bats in specific industry/activities.

Some of the issues discussed in this document are subject to ongoing research (e.g., the effectiveness of bat gating for different bat species, and the management of White-nose Syndrome). All activities related to assessing the quality of bat habitat or the impact of activities on bats should engage an experienced bat biologist qualified to conduct bat surveys.

Twelve of the 16 bat species in British Columbia have roosting preferences that include caves, crevices, and other cracks or surface openings within caves, in rocks, in rock outcrops, and on exposed cliff faces. While most bat species in British Columbia use caves for winter hibernation, some will also use caves and crevices during the summer as maternity or night roosts, and in autumn for swarming as part of their breeding behaviour. Activities in and around cave and crevice habitat, from recreationalists or resource developers, have the potential to negatively affect bats and/or bat habitat. This chapter outlines the issues associated with cave and crevice bat habitat, and best management practices for cavers, climbers, geocachers, recreational developers and other industries to implement to minimize impacts on bats.

Acknowledgements

This chapter of British Columbia's Best Management Practices Guidelines for Bats was written by written by Dr. Vanessa Craig (EcoLogic Research) and Susan Holroyd (Holroyd Consulting). The document is based on the Bat Conservation Strategy for British Columbia and Alberta (Craig and Holroyd 2004). Input and review was provided by Dr. Purnima Govindarajulu (B.C. Ministry of Environment), Juliet Craig (Silverwing Consulting), Martin Davis (Canadian Cave Conservancy) Dr. Cori Lausen (Wildlife Conservation Society Canada), Mike Sarell (Ophiucon Consulting) Kirk Safford (B.C. Ministry of Environment), Russ Turner (Skaha Rock Adventures), Rob Countess (Vancouver Island Nature Exploration), Jerry Fochler (Inroads Mountain Sports), Charles (Chas) Yonge (Canmore Caverns Ltd.), Paul Griffiths (Cave Management Services/KarstCare), Kathleen Graham (Alberta Speleological Society), and Dr. Helen Schwantje (B.C. Wildlife Health Program). Thanks to everyone who provided photos free of cost. Thanks to Al Hicks, Ted Down, Dave Fraser and Brenda Hartley for facilitating the review and approval process. Funding was provided by the B.C. Ministry of Environment and the Habitat Conservation Trust Foundation.

Front page photos (left to right): Hibernating Townsend Big-eared bat. Photo: Vanessa Craig; Keen's Myotis crevice roost. Photo: Doug Burles; Pallid Bat. Photo: Daniela Rambaldini

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Section 1: Introduction

1.1 Purpose/Scope

Caves and crevices provide important habitat for bats throughout the year and represent a critical habitat type that may be limited on the landscape. Recreational activities such as caving, rock climbing, geocaching, and associated activities such as road and trail development all have the potential to negatively affect these bat habitats.

Industrial activities such as forestry, mining, and hydroelectric power development in the vicinity of caves have the potential to change important characteristics of cave and crevice habitat. Effects on bats and their habitats from activities associated with these resource sectors are explored in detail in separate chapters as part of the Best Management Practices for Bats in British Columbia; impacts from these activities are not the focus of this current chapter. However, proponents of other industries that find their activities may affect identified bat cave and crevice habitat may find this chapter useful.

Bats exiting a cave roost. Photo: Juliet Craig.

This chapter explores three issues with disturbance around cave and crevice habitat, and how they may affect bat populations and their habitats. It also contains recommendations for best management practices that when implemented could minimize negative effects to bats in cave and crevice habitats. The three issues with disturbance are:

1. Disturbance at roost sites during caving/rock climbing/hiking or from other activities (including industrial or other land management activities);
2. Modification of the roost condition from alteration of the above-ground or below-ground environment; and
3. Spread of *Pseudogymnoascus (*prev. *Geomyces) destructans* between caves. This fungus causes "White-nose Syndrome" (WNS) in infected bats, and has been connected to millions of bat deaths in North America. White-nose Syndrome is now recognized as a significant wildlife

crisis in the USA and Canada, which threatens to cause the extirpation and/or extinction of a number of hibernating bat species (Blehert et al. 2009). The death toll is expected to continue to rise as the disease spreads across the continent (USDA Forest Service 2012). Currently, there is no known treatment.

1.2 How to Use This Document

This document, Best Management Practices Guidelines for Bat Conservation Chapter 3: Caving, Rock Climbing, Geocaching and Other Activities Around Cave and Crevice Habitat, is one chapter of a larger strategy identifying a number of resource sectors in the province of British Columbia most likely to impact bats and their habitats. Chapter 1 of the larger strategy document provides an introduction to the bats of British Columbia with in-depth information on bat ecology to set the context for the following resource sector specific chapters. Chapter 1 should be read in conjunction with each of these chapters. Chapter 2 "Best Management Practices Guidelines for Bat Conservation in Mines" provides information on mine management especially mine openings and mine closures as they pertain to bats and bat habitat and may be of relevance to recreationists that use mines. Chapter 3, the current document, provides information on the potential impacts of recreational and other activities that may occur in and around cave and crevice habitat on bat populations in British Columbia, and best management practices to mitigate these impacts. Section 1 lists the objectives, briefly provides information about the species of bats using cave and crevice habitats in British Columbia and their ecology as it relates to these habitats, and explains why cave and crevice habitats are important for bats. It also includes information about the threat of White-nose Syndrome to bat populations and a brief review of the current state of knowledge on this spreading health crisis for bats across North America. Section 2 identifies human activities around cave and crevice habitat that may impact bats and their habitats and the Best Management Practices guidelines are presented in Section 3. These BMPs represent the best recommendations for minimizing impacts to bats and their habitats, based on currently available information. Information from future research or practical experience may result in the modification of BMPs to better meet the objective of minimizing negative impacts to bat populations and bat habitat. Section 4 provides a discussion of monitoring and reporting needs and methodologies. Section 5 discusses the information needs required to improve adaptive management of recreational and resource development activities around cave and crevice habitats to minimize impacts to bat populations and bat habitat. The glossary in Section 6 provides definitions of technical terms used in the document. Section 7 lists the literature cited in the document.

Some of the issues discussed in this document are subject to ongoing research (e.g., the effectiveness of bat gating for different bat species, and the management of White-nose Syndrome). All activities related to assessing the quality of bat habitat or the impact of activities on bats should involve a qualified, experienced bat biologist, as bats have unique adaptations and behaviours that require specialized knowledge and training. Qualified bat biologists should be up-to-date with current information and be experienced in bat handling and survey methodologies.

Hyperlinks (underlined in blue) connect to information within the document, or to information available on the World Wide Web (www). Links to the www will open in a separate window.

1.3 Objectives

The objectives of this document are to:

1. Describe the ecology and distribution of bats using cave and crevice habitat in British Columbia;
2. Explain how the use of the cave and crevice resources and how other activities that may occur near these resources in British Columbia may impact bat populations and their habitats;
3. Describe Best Management Practices (BMPs) to minimize impacts on cave and crevice habitat caused by human use and also measures to prevent the inadvertent introduction and transmission of White-nose Syndrome; and
4. List areas of research and inventory necessary to improve cave and crevice management and assess effectiveness of BMPs.

1.4 Bat Use of Caves and Crevices in British Columbia

Twelve of the 16 bat species in British Columbia (Table 1) have roosting preferences that include caves, rock crevices and other geological formations or features (see Chapter 1 for additional information about roosting preferences). All of the hibernating bat species in British Columbia use caves, rock features or mines to some extent for hibernating. A cave is defined as a natural cavity in the earth that connects with the surface, contains a zone of at least partial darkness, and is large enough to admit a human. For the purposes of cave management, this term also includes any natural extensions, such as crevices, sinkholes, pits, shafts or any other openings that contribute to the functioning of the cave system (adapted from Resources Information Standards Committee 2003). A crevice is defined as a narrow crack or opening, or a fissure or a cleft, not large enough to admit a human. In addition to using caves, bats may roost in crevices and other cracks or

Table 1. List of bat species in British Columbia, and whether they use rock habitat in summer (maternity or night roosts) or winter (hibernacula). Little is known about bat hibernacula in the province, so information is extrapolated from elsewhere in their range.

Common name ***Scientific name***	**Habitat use in:**	
	Summer	**Winter**
Little Brown Myotis *Myotis lucifugus*	Rock crevices, cliffs, caves, other*	Caves, other*
Yuma Myotis *Myotis yumanensis*	Rock crevices, caves, other*	Other*, caves?
Long-legged Myotis *Myotis volans*	Cliffs, rock crevices, other*, caves	Other*, caves
Western Small-footed Myotis *Myotis ciliolabrum*	Cliffs, rock crevices, talus slopes, boulders, caves, other*	Other*, crevices, caves
Californian Myotis *Myotis californicus*	Rock outcrops & crevices, caves, other*	Other*, caves
Fringed Myotis *Myotis thysanodes*	Caves, cliffs, rock crevices, other*	Caves, other*
Long-eared Myotis *Myotis evotis*	Cliffs, talus slopes, rock outcrops, crevices, caves, other*	Other*, caves?
Keen's Myotis *Myotis keenii*	Cliffs, rock crevices, caves, rock outcrops, boulders, other*	Caves, other*, rock crevices?
Northern Myotis *Myotis septentrionalis*	Other*, caves	Caves?, other*
Townsend's Big-eared Bat *Corynorhinus townsendii*	Cliffs, caves, other*	Other*, caves
Eastern Red Bat *Lasiurus borealis*	Other*	Migrates
Hoary Bat *Lasiurus cinereus*	Other*	Migrates
Silver-haired Bat *Lasionycteris noctivagans*	Other*	Other*
Big Brown Bat *Eptesicus fuscus*	Cliffs, rock crevices, other*	Other*, caves, rock crevices?
Pallid Bat *Antrozous pallidus*	Cliffs, rock outcrops, crevices, caves, other*	Rock crevices? Caves? Other*
Spotted Bat *Euderma maculatum*	Cliffs	Cliffs, caves?, other*

*Other includes any other roost type not covered in this chapter. Examples of other roost types are live or dead trees, mines, buildings, or bridges (See Chapter 1, Table 5 for a full summary of types of roosts used by the bats of British Columbia).

surface openings within caves, in rocks, in rock outcrops, and on exposed cliff faces (Nagorsen and Brigham 1993; Nagorsen et al. 1993; Lewis 1995).

Rock-type roosts for bats (such as caves, crevices, and outcrops as well as mines) are relatively permanent. These permanent-type roosts are less available on the landscape compared to roosts in decaying trees or under loose bark, which are more abundant but ephemeral. Bats using these more permanent roosts tend to use them repeatedly over many years and show strong site fidelity, unlike bat species using ephemeral roosts such as trees (Lewis 1995). The higher fidelity to these more permanent, but less abundant, roosts can make the bats using them vulnerable to local extirpation. If the roost is destroyed or made ineffective as a result of human intervention such as obstruction of a cave entrance, modification of the interior environment, or disturbance at the roost site, an alternate equivalent roost site may not be available.

Caves

Caves in British Columbia are generally considered too cool to provide suitable habitat for bat maternity colonies. However, in areas of the province with hot summer conditions such as the central dry interior, the southern Rocky Mountain Trench, eastern Vancouver Island and lower mainland British Columbia, cave-preferring species such as Townsend's Big-eared Bat may use caves as sites for daytime summer nursery colonies (Schaeffer et al. 2002; Craig 2003; Hill et al. 2005, 2006). In addition, Keen's Myotis in Haida Gwaii exploited a geothermally heated cave/crevice shelter as a maternity roost (Burles 2000); similarly, a large Little Brown Myotis colony was found using a geothermally heated maternity roost near the Grayling River in northern British Columbia which consisted of a 30 metre deep pit with a cavern at the base (M. Davis, pers. comm).

Caves may also be used in summer for night-roosting. Night roosts are used by bats after their first foraging session of the night. The bats gather communally to stay warm while digesting their food before foraging again. Although little is known of night-roosting habits of bats, work in the West Kootenay found several species, including Townsend's Big-eared Bats, and Fringed, Long-eared, Californian and Long-legged Myotis using caves as night roosts (Hill et al. 2005). Western Small-footed, Long-eared, Fringed, Long-legged, Keen's, and Northern Myotis, and potentially Pallid bats also use caves as night roosts (Nagorsen and Brigham 1993); as do Little Brown Myotis and Yuma Myotis (M. Davis, pers. comm.).

In late summer and early autumn, caves become important for 'swarming' behaviour which involves the congregation of males and females for pre-hibernation mating and courtship (Randall 2011). These swarming sites may also serve as hibernacula (Barclay et al. 1979; Fenton and Barclay 1980).

All known hibernacula of bats in British Columbia are in caves or mines (Bryant 1987; Nagorsen et al. 1993). During hibernation a bat's body temperature drops to 1 to 2 ^{0}C above ambient (Webb et al. 1996). The temperature at which bats are most energy-efficient during hibernation is 1 to 2 ^{0}C (Webb et al. 1996). Below this temperature bats take action to avoid freezing (rousing to warm body temperature, perhaps move to a different location), and above this temperature their metabolism is higher, resulting in

Cave used by Western Small-footed Myotis. Photo: Dr. Cori Lausen.

greater energy expenditure. Ideally the temperature in a hibernaculum should remain fairly stable (remain above freezing, but below ~9 ^{0}C; Nagorsen and Brigham 1993; Hill et al. 2006), and have a high relative humidity (75-100% measured in West Kootenay, Hill et al. 2006 and Vancouver Island, Davis et al. 2000), which prevents dehydration. Webb et al. (1996), in a review of hibernaculum temperatures, reported that worldwide the modal temperature of hibernating Vespertilionidae (the family in which all Canadian bat species belong) was 6 ^{0}C (temperatures ranged from -10 ^{0}C to 21^{0}C). A study of bat use of Vancouver Island karst habitat indicated that several bat species hibernated in high-elevation caves with stable low temperatures (2.6 ^{0}C to 3.9 ^{0}C) and 100% relative humidity (Davis et al. 2000). Deeper and more complex caves offered the most stable microclimates (Davis et al. 2000).

Townsend's Big-eared Bat hibernaculum in central British Columbia. Photo: Anna Roberts.

Crevices

Almost all bat species in British Columbia will use rock- or crevice-type summer roosts (Nagorsen and Brigham 1993; Smith 1993; Table 1 and Chapter 1), with the exception of species considered tree-dependent: Eastern Red Bat, Hoary Bat, and Silver-haired Bat). Pallid Bat, Spotted Bat and

Western Small-footed Myotis, all classified as species at risk in British Columbia, exhibit an almost exclusive preference for rock and crevice summer day roosts. Spotted Bat roosts are known only from steep cliffs in the British Columbian dry southern interior (Nagorsen and Brigham 1993; Holroyd et al. 1994; Sarell and Haney 2000) and Pallid Bats in the Okanagan are associated with crevices in rocky outcrops (Chapman et al. 1994; Sarell and Haney 2000; Rambaldini 2003, 2006). Of the few summer roosts known for the Western Small-footed Myotis in British Columbia, rock-type roosts seem to be preferred (Garcia et al. 1995; Holloway and Barclay 2001).

Low rock outcrops and other geological formations or features, such as 'hoo-doos' and crevices created by erosion of streambank sediments along steep-sided rivers (such as the Fraser and Columbia Rivers in British Columbia) also provide important summer roosting habitat for many bat species (Holloway 1998; Chruszcz 1999; Holloway and Barclay 2000; Lausen 2001; Chruszcz and Barclay 2002; Lausen and Barclay 2002; Lausen 2003; Lausen and Barclay 2003, 2006; Rambaldini 2006). Species known to use these 'erosion'-type crevices (narrow crevices in sediment formed by movement of air or water) include the Western Small-footed Myotis, Long-legged Myotis, Big Brown Bat, and Long-eared Myotis (Holloway 1998; Chruszcz 1999; Holloway and Barclay 2000; Lausen 2001; Chruszcz and Barclay 2002; Lausen and Barclay 2002; Lausen 2003; Lausen and Barclay 2003).

South-facing exposed rock outcrops such as those at the top of this hillside provide suitable summer roosting habitat for bats. Photo: Vanessa Craig.

Exposed crevices are not generally considered suitable for hibernation because they may not offer a stable microclimate depending on the depth (temperature and relative humidity; Thomas and Cloutier 1992); bats will use crevices inside mines and caves which makes them difficult to find during winter visual inspections. There are few records of bats hibernating in crevices in British Columbia, but recent work has confirmed that it does occur; crevice hibernacula have been confirmed using radio-telemetry for California Myotis and Silver-haired Bats (C. Lausen, pers. comm.). Early winter use of crevices by Yuma Myotis has also been observed in British Columbia (C. Lausen, pers. comm.). In addition, Fenton et al. (2002) suggested that Keen's Myotis and Little Brown Myotis on Haida Gwaii might be capable of hibernating in rock crevices. Work in Alberta indicated that crevices created by soil erosion along the Red Deer River provided critical winter hibernation habitat for Big Brown Bat (Lausen and Barclay 2006). This tendency by bats to hibernate in crevice habitat needs to be further explored in British Columbia where similar habitat exists.

Crevice roosts used by Keen's Myotis on Haida Gwaii. Photo: Doug Burles.

1.5 White-nose Syndrome

White-nose Syndrome is an emerging threat to bats in North America. People who recreate, or work, in and around caves should be aware of this threat, and take steps to minimize the chance of spread. Note that White-nose Syndrome does not pose a threat to humans.

In 2006, U.S. researchers reported an outbreak of an unidentified disease that has since killed millions of hibernating bats in both mines and caves, including the endangered Indiana Bat (*Myotis sodalis*; USDA Forest Service 2012). The researchers called the infection 'White-nose Syndrome' (WNS) after the characteristic white nose of infected bats, caused by the recently discovered fungus *Pseudogymnoascus (*prev. *Geomyces) destructans* (Gargas et al. 2009; Minnis and Lindner 2013). Bats also develop fungus on the wing and tail membranes. White-nose Syndrome is now recognized as a significant wildlife crisis in the USA and Canada, which threatens to cause the extirpation and/or extinction of a number of hibernating bat species (Blehert et al. 2009). The death toll is expected to continue to rise as the disease spreads across the continent (USDA Forest Service 2012).

Indiana Bats (*Myotis sodalis*) showing typical "white nose" as a result of fungal infection by *Pseudogymnoascus* (prev. *Geomyces*) *destructans*. Photo: Al Hicks.

In winter 2009–2010, the disease was first discovered in Canada, in both Ontario (Ontario MNR 2013) and Quebec (Quebec MNRF 2010). In response to mass mortalities of three species of bats in eastern Canada, the Committee on the Status of Endangered Wildlife Species in Canada (COSEWIC) conducted emergency assessments of the Little Brown Myotis (*Myotis lucifugus*), Northern Myotis (*Myotis septentrionalis*) and Tricoloured Myotis (*Perimyotis subflavus*), and assessed all three as Endangered (COSEWIC 2012). The federal environment minister made the decision to accept this listing for inclusion of these species under the *Species At Risk Act* on the 17th of December 2014 (Environment Canada 2014). Biologists project that WNS may reach the west coast of North America by 2017–2020 (Kunz 2009); modelling exercises have predicted WNS arriving at the Olympic Peninsula, Washington State, U.S.A. by 2027 (Ihlo 2013).

People moving between caves either for work or recreation may unknowingly spread *Pseudogymnoascus destructans*, the fungus associated with WNS. Cavers and geocachers travel around the world visiting caves. To date, WNS is not known to be in British Columbia, but transfer of fungal conidia via human clothing/equipment is a possible mechanism of spread; as such, human activities in caves are a potential threat to bat populations in the west.

More information on White-nose Syndrome can be found in Chapter 1 and on the BC Wildlife Health website (BC MOE Wildlife Health http://www.env.gov.bc.ca/wld/wldhealth/), including information on precautionary steps to take and decontamination procedures to reduce the risk of spreading WNS in British Columbia (BC MOE Wildlife Health 2013). Decontamination procedures for cavers can also be found on the BatCaver website and on the Canadian Wildlife Health Cooperative website Research updates and disease spread maps can be found on the USFWS White-nose Syndrome website. Research is ongoing and active for this issue; please consult the latest decontamination procedures available.

Section 2: Activities Inside and/or Near Cave and Crevice Habitat

Disturbance of bats at roost sites repeatedly and/or at critical times can cause roost abandonment and ultimately, declines in populations.

Disturbance at cave and crevice roost sites can occur through many types of human activity including: caving, rock climbing, hiking, and other activities, as well as during development of areas for recreation. The focus of this Chapter is on recreational activities; see BMPs in other chapters that focus on specific industrial activities such as forest harvesting, mining, hydroelectric power and wind development. For projects developed within the Ministry of Forests Lands and Natural Resource Operations framework, potential effects on "valued components" including bats and bat habitat must be identified and managed (Environmental Assessment Office 2013*a, b*). The potential for cumulative effects of multiple activities also needs to be considered (B.C. Ministry of Environment 2014*a*).

Recreational caving, climbing, and geocaching are popular activities in British Columbia. Visitors to caves may be part of a guided tour operation, may cave independently, may be associated with a provincial caving association (such as the British Columbia Speleological Federation, B.C.S.F. or the Alberta Speleological Society A.S.S.) or they may simply be part of the general public that occasionally explores a cave. Cavers or geocachers that, even inadvertently, disturb a hibernating bat may reduce the bat's chance of survival. In addition, recreationalists who enter caves are a potential way by which disease can spread between bat populations. Rock climbing and hiking may also result in disturbance to bats. Rock climbers could potentially disturb crevice-roosting bats; this may be particularly important for species at risk that regularly use crevice roosts, such as Spotted or Pallid Bats. Hikers may also be a source of disturbance for bats roosting in boulder fields, talus slopes or low cliffs.

Rocky knoll with a cave used by Keen's Myotis (arrow). Bats may also roost in nearby rock crevices and in the large veteran trees in the nearby forest. Photo: Vanessa Craig.

Recreational development of an area around a significant bat roost (see definition in glossary) associated with cave/karst habitat, such as development of trails, may degrade habitat for bats during both construction and post-construction phases. Negative impacts on bats and bat habitats can result from human presence that results in increased noise, dust, or light, introduction of garbage, habitat modification in and around roosts during their season of use, or vandalism, harassment or killing of bats at the roost site. Even small-scale habitat modification can result in habitat degradation for bats if it occurs in a sensitive habitat area or in an area used by bats, especially if the activity occurs during the period when bats occupy the site.

Habitat surrounding a roost can influence accessibility for bats, microclimate, and predation risk (Kalcounis and Brigham 1998; Jung et al. 1999). Land management activities around cave and crevice habitat can degrade habitat for bats by changing the microclimate of the habitat. Removing trees changes the temperature, wind speed and humidity in the surrounding area (Chen et al. 1995), and can change the roost conditions of caves (Hill and Smith 1984; but see Davis et al. 2000) or other roost types. Removing vegetation in front of cave entrances or above cave systems, especially in karst settings, can change water erosion patterns and the infiltration regime, and could significantly influence internal cave conditions (Nieland 2000).

Light, noise, and dust from activities such as trail building, road building, blasting, forest harvesting, prescribed burning and construction can disturb bats in nearby cliff and crevice habitat. Development of trails and paths must be done sensitively to ensure minimal disturbance to bats at their roost. Modifications of the surrounding habitat can affect temperature (for summer roosts and hibernacula), relative humidity (hibernacula) and accessibility, safety, light conditions, and size thereby affecting suitability of these habitats for continued bat use.

Occasionally, land management of cave and karst habitat includes gating of features to control human access. Many bat species will continue to use a feature if it's properly gated (see Appendix 1 this Chapter). Modification of a cave entrance by improper gating or other physical obstruction can exclude bats, or result in disruptions in airflow that can cause temperature changes. The latter effect has been implicated in population declines in the endangered Indiana bat in the US (U.S. Fish and Wildlife Service 2009).

Section 3: Best Management Practices Guidelines

3.1 BMPs for Recreational Activities (Cavers, Rock Climbers, Geocachers, and Hikers)

3.1.1 All Recreational Activities

1. Be aware that many caves, crevices and mines are used by hibernating bats. A hibernating bat that is disturbed uses a large amount of energy to rouse itself; this could mean that the bat does not have sufficient energy reserves to survive the winter. Crevices and cliffs are often used by groups of bats in the summer and these could be maternity colonies. Pregnant females and non-volant pups are especially vulnerable to disturbance.
2. Before visiting a cave, check the latest rules and regulations regarding cave entrance with British Columbia Parks or British Columbia Ministry of Environment or other relevant online sources (e.g., National Parks websites). There may be information posted that is specific to the site you are interested in visiting.
3. Research a cave/cliff area to become aware of the presence of bats and the seasons of use. Information options include government websites, the wider caving/rock climbing/hiking community (word of mouth) and the BatCaver website (http://programs.wcs.org/batcaver/Home.aspx) developed with the Wildlife Conservation Society Canada. Identify the likely season of use based on dates when bats are known to be present. Hibernacula are typically in use (for hibernation and possibly swarming) between October and April; maternity roosts between May and August (these dates can vary depending on region, year and climatic conditions). If bats are known to occupy the cave or cliff habitat, do not enter or climb in the immediate area until the season of use is over. For example, if a caver reported seeing a group of bats occupying a site in July (especially if pups are present); the site is likely a maternity or nursery roost and the site should be avoided between May and August (continued use of a site may be appropriate after consultation with a bat expert to determine the nature of bat use at a site).
4. Cavers and geocachers, and anyone who enters caves or any underground habitat recreationally, can potentially transmit White-nose Syndrome spores to caves in British Columbia on their clothes,

boots etc. In B.C. and other WNS free areas, it is best to avoid using equipment that has been used underground (e.g., boots, caving gear, camera equipment, backpacks etc.) in any province or U.S. state where the fungus *Pseudogymnoascus destructans* is known to occur, or anywhere in Europe or Asia. However, if avoidance is not possible follow the latest protocol for White-nose Syndrome spread prevention and decontamination; go to the BC Wildlife Health and the Canadian Wildlife Health Cooperative (CWHC) websites for the latest information.

5. The need for decontamination procedures for caves with tourist visitors is recognized. Currently there are no recommended protocols in British Columbia or Canada, although research is currently underway. Mammoth Cave National Park, Kentucky has implemented a two stage dry carpet and chemical decontamination walk-on pad system to prevent transmission of *Pseudogymnoascus destructans* (Richkard Toomey, personal communication 2016). The BC Wildlife Health and the Canadian Wildlife Health Cooperative (CWHC) websites will post the latest information on these decontamination protocols as soon as they become available.
6. Do not disturb bats observed in the cave/crevice habitat. If roosting bats are seen, leave the area as soon as possible to minimize disturbance.
7. Report any roosting bats to the British Columbia Ministry of Environment (Section 4); or communicate this information through the local B.C. Community Bat Program (www.bcbats.ca). Important details to report include: how many bats were observed, their activity, where they were located, whether any pups were observed (in summer), whether any apparently dead bats were observed on the ground, and whether any bats had a white residue on their nose. Do not approach the bats or colony to obtain this information.
8. If any sick or dead bats are observed (possible White-nose Syndrome):
    a. Take pictures of the bats;
    b. Record an accurate location (e.g., GPS location or mark on a topographic map), date, and time;
    c. Place a carcass in a Ziploc bag if possible (see step e for subsequent action).
    d. Leave the cave immediately and only enter another cave after thorough decontamination of equipment and clothing has been conducted; if WNS is suspected due to visible white fungal spores on dead bats, equipment and clothing should not be worn into other underground environments even if decontamination has been conducted; and

e. Immediately contact the Ministry of Environment, Parks Office (if bats are found in a Park), or a local B.C. Community Bat Program for further information (http://www.bcbats.ca/) (Section 4).

3.1.2 Caving

1. Follow the guidelines in 3.1a.
2. Abide by a caver's Code of Conduct to minimize harm to the cave environment, such as that outlined by the British Columbia Speleological Federation (B.C.S.F.; Appendix 2).
3. Consult with other cavers to learn about sensitive features and wildlife that use the cave. Do not enter a cave during its period of use by bats. Hibernacula can be in use by bats (for hibernation and/or swarming) between 1 October and 1 April; maternity roosts of bats are typically in use between 1 April and 1 October.
4. Good caving practice (as per the Caver's Code of Conduct) requires making an effort to have minimum impact on the cave environment by:
   a. Not damaging sensitive features.
   b. Not littering or polluting the cave environment or the surrounding surface area.
   c. Staying on the established route.
   d. Not smoking or building a fire in the cave or at the cave entrance.
   e. Avoiding altering the cave by using bolts whenever possible and avoid bolting near bats at all times (this situation should only arise if cavers inadvertently come across bats in a cave).
   f. Avoiding altering the natural air and water flows of the cave.

3.1.3 Rock Climbing and Bouldering

1. Follow the guidelines in 3.1a.
2. Follow mindful climbing and recreating which limits damage to rocks and the environment. Some of the climbing approaches that include this mindset include "minimal impact" and "leave no trace" principles, and the "clean climbing" philosophy.
3. Use established routes instead of developing new ones.
4. During route development, consider the information in B.C. Parks' Best Practices Guide for route development (B.C. Parks 2012), whether or not you are climbing in a park. The Stewardship Centre for British Columbia also offers "Species at Risk Voluntary Stewardship Practices for: Climbing" (http://stewardshipcentrebc.ca/PDF_docs/sar/StewardshipPracticesforClimbingPilot12-2013.pdf).
5. Before climbing, check the latest rules and regulations on climbing in the area with British Columbia Parks, National Parks or the British

Columbia Ministry of Environment. There may be rules posted specific to the site you are interested in visiting.

6. In addition to government websites, consult online climbing route logs or with fellow climbers to determine if there is any record of bats or other wildlife (e.g., raptor nests) known at the site. Examples of climbing websites include SummitPost or rockclimbing. If bats or other wildlife are known to occupy the cliff face during the season you intend to climb, select a different climbing site or route.
7. Do not chip rocks as this might disturb bats roosting in crevices and cracks in the rocks.
8. Avoid cliff edges, cracks, or ledges that are prone to erosion.
9. Do not change the nature of an established climb by adding or moving bolts.
10. Limit route cleaning (removal of organic material such as vegetation or soil, or loose rocks).
11. Climb in small groups to minimize damage to cliff and crevice habitat.
12. Encourage fellow climbers to voluntarily avoid areas known to be used by bats (such as postings on discussion groups and informal discussion with climbing partners), and to always follow climbing procedures that minimize impact to habitat.

3.1.4 Geocaching

1. Follow the guidelines in 3.1a.
2. When establishing a new cache location, avoid caves or mines (recommended), or place the cache within the first few metres of the entrance where bats are unlikely to roost.
3. When choosing a geocache for a search, select one that is not in a cave or mine, particularly during the bat hibernation season (1 October to 1 April).
4. Encourage fellow geocachers to voluntarily avoid caves and inform them about the threat of White-nose Syndrome.
5. If you encounter a bat in a cave or mine while looking for a geocache, leave the area immediately.

3.1.5 Hiking

1. Follow the guidelines in 3.1a.
2. Endeavour to have minimum impact on the area.
3. Follow established routes.
4. Limit route cleaning (removal of organic material such as vegetation or soil, or loose rocks).
5. Avoid entering caves or slab crevices.

6. Do not smoke or build a fire in or at the entrance to caves at any time of year. Do not smoke or build a fire at the base of cliff faces between April and October.

3.2 BMPs for Land Management Around Caves, Crevice, Cliff and Karst Habitat

Cave, crevice, cliff, and karst habitat can all provide important habitat for bats. Land management around these habitat types that might affect the above-ground landscape or underground structures should include assessment of impacts to bats and bat habitat.

The BMPs in this chapter provide a decision matrix (Figure 1) and general guidance for land management around caves, crevice, cliff and karst habitat. Where activities are associated with land development such as forest harvesting, mining, agriculture, wind development, or hydroelectric development, consult the applicable BMP chapter for additional specific guidelines. In all cases an experienced bat biologist should be consulted to provide site specific and project specific advice.

1. First determine if there are karst/cave/crevice habitat and/or significant bat roosts within 1 km of the project area. To collect background information consult detailed maps from government agencies including habitat-suitability models where available, and/or local and regional biologists and land owerns/managers (contact information in Chapter 1: Introduction to the Bats of British Columbia, Section 7 – Additional Information).
2. Where cave/karst/crevice/ cliff habitat occurs in the project area, either assume that the habitat is potentially used by bats and implement the BMPs in 3.2c as a precautionary measure, or assess the habitat to determine its suitability for bats using the protocols in section 3.2a. If the habitat assessment:
   a. Indicates that the habitat is potentially suitable for bats, or its suitability cannot be accurately assessed, either assume that the habitat is used by bats and implement the BMPs in 3.2c as a precautionary measure (recommended).
   b. Indicates that the cave/karst/crevice/cliff habitat is not suitable for bats, implementing the BMPs on activity around bat habitat is not necessary; however, activities should still follow the relevant BMPs outlined in British Columbia Ministry of Forests (2003) for activities around karst habitat.
3. If habitat is assessed as suitable, then conduct an assessment of bat use of the habitat feature following the protocol in 3.2b. If the survey of the potential habitat:
   a. Indicates that bats do use the feature, follow the BMPs in 3.2c.

b. Indicates that bats do not use the feature, implementing these BMPs is not necessary. However, proponents should follow relevant BMPs developed for activities around karst habitat (British Columbia Ministry of Forests 2003).

3.2.1 Assessing suitability of habitat

Assessment of potential habitat suitability for bats should be conducted by an experienced bat biologist. Bats use rock/crevice/cave habitat to fulfill different requirements at different times of year (Table 2). Since there is little B.C. specific information, underground roosting habitat for bats is generally characterized based on what is known about bats outside of British Columbia. Habitat actually used by bats in British Columbia might vary; more research on use of underground habitats by bats in British Columbia is required. The following provides general guideline for identifying bat roost features (based on Pierson et al. 1999; U.S. Fish and Wildlife Service 2009; Sherwin et al. 2009):

1. Cave/mine portal openings are typically minimum 30 centimetres in diameter.
2. For winter hibernation sites, cave/mine passages continue for 30 metres or more.
3. Summer roosting sites, especially for Townsend's Big-eared Bat, can be quite shallow (<10 metres deep).
4. There is typically some amount of air flow in or out of the entrance; this may vary by day or season, and may not always be detectable. Too much airflow can make a site unsuitable.
5. Cave/mine that are flooded or prone to flooding are not as likely to be used by bats however caves with some flooding (but still allows access) or with entrances that are flooded over the winter period (after occupation by hibernating bats) may be used by bats (M. Davis, pers. comm.).
6. Vertical passages may be used by bats. These are typically at least 60 centimetres in diameter; some air flow is acceptable.
7. Foliage and other vegetation in front of a cave/mine opening will not stop use by bats. Bats can navigate through foliage. However, the more clutter that obscures the opening and the smaller the opening, the fewer the species that are likely to use it.
8. Bats can access roosts via old buildings in front of entrances, such as a fan house at a mine. Buildings themselves may provide bat roosting habitat.
9. Above-ground rock/crevice/cliff roosting habitat for bats typically is south or southwest facing to maximize solar heating. The surface has crevices or cracks suitable for one or more bats to use as habitat (Table 2).

Table 2. Important cave/crevice/rock roosting habitat features for bats, their season of use, and types of surveys.

Season	Roost Type	Description	Surveys	Reference
Summer	Rock Complex – maternity roost, night roost	South/southwest facing; suitable crevices for roosting bats; uncluttered by vegetation for accessibility; situated to receive solar heating; karst features	Survey for evidence of bat use (exit surveys; radiotelemetry; acoustic surveys; internal surveys)	Holloway and Barclay 2001; Chatwin 2004
Summer	Cliff – maternity roost, night roost	Suitable crevices for roosting bats (i.e., offers protection and suitable thermal regime); may be high/steep; close to foraging/drinking habitat	Survey for evidence of bat use (exit surveys; radiotelemetry; acoustic surveys)	Sarell 2004*a*
Summer	Caves – maternity roost, night roost	Maternity roosts of some species may be in caves (e.g., Townsend's Big-eared Bat); suitable thermal regime; close to foraging/drinking habitat Many species may use caves as a night roost (e.g., Townsend's Big-eared Bats, Fringed, Western Long-eared, Californian and Long-legged Myotis); close to core foraging/drinking habitat	Surveys for evidence of bat use (internal - guano, insect fragments, dead bats, urine; external – acoustic surveys, radiotelemetry)	Craig 2003; Hill et al. 2005; Knight and Jones 2009
Summer	Caves - hibernaculum	Typically higher elevation with stable cool temperatures and stable high humidity.	Internal surveys for evidence of winter bat use (guano, insect fragments, urine staining, dead bats).	
Autumn/ Winter	Caves – swarming site, hibernaculum	Typically higher elevation with stable cool temperatures and stable high humidity. Requirements vary by species; e.g., Keen's Myotis use caves >100 metres in length and above 500 metres above sea level with temperatures between 2.4 and 4C with 100% humidity; Townsend's Big-eared Bats may use more open and shorter caves	Autumn - external surveys for evidence of swarming (acoustic surveys, exit surveys, radio-telemetry) Winter - Internal surveys (with caution not to disturb bats) for evidence of bat presence (e.g., guano, insect fragments, urine staining, although these signs may be limited in a hibernaculum; live or dead bats).	Chatwin 2004; Nagorsen et al. 1993

3.2.2 Surveys for bat use

Surveys can identify whether bats use a feature, the season of use, as well as information on the community of bats (species, gender, age etc.). Because bats may use a feature in one season and not others, or in some years and not others, surveys to determine with certainty that bats do not use a feature must be rigorous. Surveys should be sufficient to identify the presence of a significant bat roost associated with cave/cliff/rock crevice habitat in the project area. **To conclude that bats do not use the feature, surveys should occur repeatedly using different techniques and occur in different seasons throughout the year, and ideally occur over more than one year**. Two years of non-detection of bat acoustic activity is required before assessing a site as "not in use by bats" (Altenbach et al. 2000). All surveys should involve an experienced bat biologist in study design, data collection, and data analysis.

Note that the B.C. RISC standards for bat inventories (1998) are the minimum required as some of the methods in those standards are dated. <u>Surveyors should follow the protocols in the RISC guidelines, supplemented by the advanced methods outlined in this document</u>.

Surveys in the late spring and summer are needed to detect maternity roosts and surveys in the fall and winter are needed to detect hibernation and swarming sites. Techniques used in both seasonal surveys are similar and can include: a) acoustic surveys and visual surveys such as exit counts; b) mist-netting or harp-trapping bats; c) radio-telemetry of bats; and d) internal surveys of the feature.

Late spring/summer surveys

Surveyors should use techniques that minimize disturbance to bats.

1. **Acoustic surveys and visual surveys** such as roost exit counts are the least intrusive methods of surveying bat use of a feature. They can be used in combination with netting to determine bat use of a feature.
    - Preliminary surveys will focus on a particular rock feature with a goal of identifying presence/absence of bat use of the feature. For repeated surveying of a feature to determine bat usage, acoustic surveys are likely the most cost-effective and efficient because they can record data automatically and can be left to collect data over a long period of time. To determine the number or species of bats using a feature, exit counts, netting, and/or internal surveys are required.
    - Detectors can be placed at or inside the entrance to caves or other rock/crevice features, or pointing upwards at a cliff face. Placing one detector outside will provide information on bat activity in the vicinity of the feature and another detector inside will show if the particular feature is used for roosting.
    - Bat detectors should be capable of recording continuously and autonomously from 30 minutes before sunset to 30 minutes after sunrise on multiple nights. The recorders should also be capable of recording sufficient information about bat calls for the calls to

be identified to species, or to species groups where species cannot be distinguished based on acoustic characteristics alone.

- Acoustic data should be collected over the entire season to understand when a feature starts being used and when the bats leave that feature. Maternity colonies are formed approximately from May to August in B.C. but there are regional variations in the seasonal use.
- Weather-proof bat detectors as appropriate. If waterproofing is required, detector microphones should have a rain hat system or sound reflector, where appropriate for the brand of detector used (Kunz et al. 2007*a*). Note that the waterproofing system may influence the data recorded (e.g., Britzke et al. 2010); all reporting should include a clear description of any weatherproofing used.
- Acoustic data should be analysed to determine whether there is evidence of bat use of the feature, the season and timing of use, and the bat species or species group.
- In some cases where visual and acoustic data cannot resolve species identification, DNA analysis of guano collected at the site might provide accurate species identification.
- If the acoustic data indicate that bats are potentially using the feature, a visual survey/roost exit count can confirm use and provide information on how many bats are using the feature, which can determine whether the roost is considered significant. If small numbers of bats use the roost, then netting to identify species may be required to determine whether the roost is significant.
- Where exit/visual surveys of bats are used to confirm the numbers of bats using a roost (the number present may be small, many winter roosts in B.C. house less than five bats), the feature should be surveyed at least twice during the season of suspected use. The second night is not required if information sufficient to confirm whether the feature is used by bats and/or whether the feature is a significant roost is collected during the first night.

2. **Netting surveys.** Netting at one or more entrances of a cave or rock feature in summer allows data collection on the bat species using the roost, as well as gender, body condition, and age information. It can be used to supplement acoustic data and exit surveys. At some roosts, netting might be required to determine whether the roost meets the criteria for a significant bat roost. Netting at the cave/crevice entrance can provide information sufficient that an internal survey does not need to be conducted. Mist-netting can also be used more widely to understand the composition of the resident bat community

in the area, and can be used in conjunction with radio-telemetry to find a suspected roost or better understand bat use of the area.

- Mist-nets or harp traps can be used to capture bats. Harp traps are useful when the bats are funnelled through a small area; mist-nets can be used in larger openings.
- All personnel handling bats should have pre-exposure rabies vaccinations before mist-netting. A *Wildlife Act* permit is required to capture bats.
- Place nets or harp traps to cover most or all of the exits to the feature.
- Plan to sample at least twice at a feature during the suspected season of use for at least 1 year and preferably 2 years. Bat activity can be sporadic and netting may not be successful every time even if bats are using the feature.
- Netting alone is not sufficient to rule out bat use of a feature. Acoustic data should be collected to confirm that bats do not use the feature.
- Netting also offers an opportunity to collect reference calls of captured bats to aid in identification of bat echolocation calls collected during acoustic surveys. Release bats on a zip-line (Szewczak 2000) or a free-flying tether ("bat-kiting"; C. Lausen, pers. comm.) to record echolocation calls of free-flying bats using autonomous recording units; spot-light or light-tags (glued to bat) can be used to follow the bat after release and facilitate directing the microphone towards the bat to obtain better quality recordings.
- Identify species following a standard key to identifying bats in the field, such as Nagorsen and Brigham (1993).
- If a positive identification is required, all cryptic species or those impossible to identify in the hand, such as some of the Myotis species, require genetic analysis. For these species a tissue sample must be obtained to enable analysis (see protocol below).
- **Genetic Protocol**. Genetic samples are most easily obtained by obtaining a 3 mm wing punch from each wing and placing them into a vial of 90% ethanol or desiccant. All tissue samples should be placed in a freezer for long-term storage until they can be deposited in a repository and/or submitted for genetic analysis. Specimen labels should at minimum contain the name and/or company of the collector, the date, a GPS location, gender, and the likely species. If more than one sample has this same information, assign a unique number to each sample. The following guidance is summarized from the American Museum of Natural History protocol:

  - Take the samples close to the body, between the leg and the 5th digit in the wing, avoiding large blood vessels.
  - Sterilize the punch and forceps with a lighter before use and between each bat (or use a new biopsy punch for each bat). Let cool before using, then swab with alcohol prior to use. When not using the instruments, ensure they remain sterile by not touching the parts that will contact the tissue sample like the cutting edge of the punch or tip of the forceps.
  - Stretch the wing over a flat, hard or firm surface (such as a sterile cutting board) and press firmly with the punch.
  - Use forceps to move the tissue that has been punched out to the vial.
  - Obtain a wing punch from the other wing and place it in the same vial. Obtaining two samples provides some redundancy. Ensure that both tissue samples are covered with preservative, either ethanol or desiccant.
  - Label the vial.
  - Disinfect all equipment, including the surface used to obtain the wing punch, before collecting samples from a different bat.
- Decontamination protocols are needed to safeguard (see here) against the spread of the fungal pathogen *Pseudogymnoascus (*prev. *Geomyces) destructans*, which causes White-nose Syndrome.

3. **Radio-telemetry** can be useful for determining the specific location of a summer day roost (Lacki et al. 2007) or night roost. Radio-tags that fit bats generally have a lifespan of two to three weeks due to small battery size. Tags also tend to fall off as the glue wears off the bat. Due to the investment required for this technology, and the impact on the individual bat, it is recommended that radio-tag locations be acquired each day for the short lifetime of the tag. If the bat cannot be located during daytime searches, evening searches may be necessary.

4. **Internal assessments** of caves can provide definitive evidence of bat use e.g., presence of bats; guano; urine staining; moth wings or insect parts; live or dead bats; or the presence of orange lichen around rock crevices, (M. Sarell, pers. comm.). All internal assessments should follow the protocol in RISC (1998). Surveyors should use the latest White-nose Syndrome protocols available here. Once there is evidence that White-nose Syndrome is found in western provinces or states in the U.S.A., internal surveys may be discouraged to help control the spread of the pathogen. Where possible, assessments of bat use should be performed by experienced

bat biologists who are also familiar with caving techniques. Even for experienced bat biologists it can be difficult to see bats, which may be crammed into small crevices. Internal surveys should only be conducted if it's possible to do so safely, and all necessary safety precautions should be taken. Note that lack of evidence of bat use during a summer survey does not rule out the potential use of a site by bats as a hibernaculum.

Autumn/Winter/Early Spring Surveys

In the autumn/winter/early spring seasons, surveying will focus primarily on cave habitat. Surveying can include the use of passive acoustic detection systems; visual observations (in autumn); radio-telemetry (autumn); and internal surveys (winter). It is generally not cost effective to do capture surveys or visual surveys at portals in winter because bat emergence numbers can be low, even in hibernacula with a substantial number of bats (C. Lausen, pers. comm.).

1. **Acoustic detectors and visual surveys** at the entrance to a cave that record a high amount of bat activity ("swarming") in autumn might indicate the cave is a hibernaculum (Barclay et al. 1979; Fenton and Barclay 1980). In winter bats may be active at hibernation sites when temperatures are warmer than -8 ^{0}C (Lausen and Barclay 2006), and may occasionally emerge to forage; this activity can be recorded by a detector placed at the cave entrance.
    - Place 1 detector at a cave entrance to remotely and continuously monitor bat activity at the site from ½ hour before sunset to ½ hour after sunrise between autumn and spring.
    - If the cave entrance is large enough to permit entry, place a second detector at least 10 m into the cave, which will provide information about whether bats are entering/exiting the feature. Bats usually fly alone in winter; therefore, using two detectors (one inside, one outside) can provide some insight into whether bats are either hibernating in the cave or entering for only for a short period during the night (e.g., to forage on hibernating insects in the cave; C. Lausen, pers. comm.).
2. **Netting** in the project area in the autumn can be used to capture bats for radio-telemetry, in addition to allowing data collection on the bat species in the area. Mist-nets and harp traps can be used at the entrances of suspected swarming sites to identify species. See above under spring/summer surveys for considerations.
3. **Radio-telemetry** can be useful in autumn for determining location of a swarming site, which might also be a hibernaculum.

4. **Internal surveys** of caves can provide conclusive evidence of bat use of the feature as a hibernaculum.
   - See considerations under spring/summer surveys, above.
   - The amount of time spent within caves should be minimized to limit disturbance to hibernating bats.
   - All internal assessments should follow the protocol in RISC (1998).
   - Surveyors should use the latest White-nose Syndrome protocols available here; however, if any evidence of White-nose Syndrome is found in western provinces or states in the U.S.A., internal surveys are discouraged.
   - Winter surveys of caves should be conducted a maximum of one time per year, during the period of highest potential use (typically January-February; RISC 1998).
   - If extensive mapping of the hibernacula is required, it should occur in summer when bats are absent (Kunz et al. 1996).

3.2.3 Minimizing Effects of Land Management Activities on Cave and Crevice Bat Habitat

Where activities will occur in areas with potential or known cave/karst/cliff/crevice bat habitat or around a significant bat roost, implement the following:

1. Delineate a "roost complex polygon", by including the entire area that comprises each roost feature:
   - For cave habitat: map the complete extent of underground wintering habitat. Use entrances and information on the extent of the rock habitat if internal surveys are not possible.
   - For cliff/crevice habitat identify the extent of the rock roosting habitat used if possible. In some cases, extent of the roost area may need to be inferred from known average roost area sizes for a particular species if no data are available (see Appendix 1, Chapter 1 for review and summary).
2. Establish a 100 metre core area around the perimeter of the roost complex polygon. Within the core area, no medium- or high-impact (Figure 2, Table 3) activities should occur during the period when bats occupy the feature (Figure 3). Low-impact activities should be evaluated on a case-by-case basis by an experienced bat biologist and should be permitted to occur only where there is no disturbance to the bats using the feature. No activities that will alter the microclimate or other important characteristics of the roost should occur within the core area. Important considerations in core areas include:

- Maintaining the water flow, shading, and air flow to maintain the important microclimate conditions of the roost (e.g., temperature, humidity; B.C. Ministry of Forests 2003).
- Ensuring that activities do not result in entrances being blocked or impede access to the feature.
- Where gating is considered for caves, consider the species of bat to determine whether to gate (Appendix 1 this Chapter) and use bat-friendly designs and protocols designed and recommended by Bat Conservation International (also see information in Chapter 2: Best Management Practices for Bats – Mine Developments and Inactive Mine Habitats).
- Ensuring that activities do not disturb bats using the feature (seasonal restrictions).

3. Establish a 1-kilometre-radius "special management zone" around the 100-metre core area (Figure 2). This limits disturbance around the roost complex and provides important foraging habitat for adults and newly volant young close to their roost (e.g., Lacki et al. 2007), and for hibernating bats that periodically become active in winter (C. Lausen, pers. comm. See Appendix 1 in Chapter 1 for information on movement patterns). Activities within the special management zone must not negatively affect the characteristics of the feature or the bats that use the roost (Table 3).

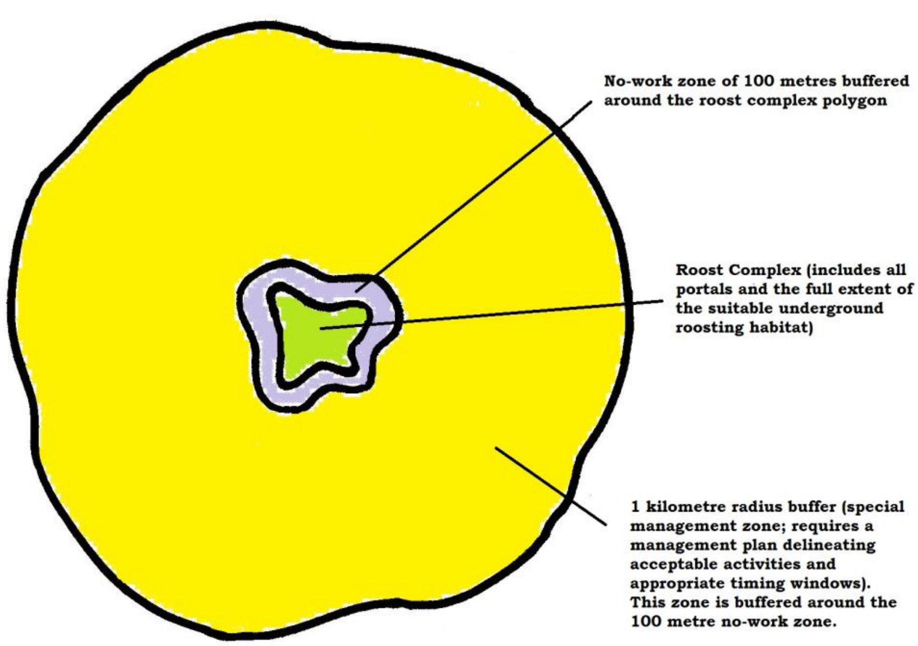

Figure 1. Establish a 100-m-wide "core area" and 1-km-wide "special management zone" around identified underground roost complexes. The roost complex polygon should include all portals and the full extent of the suitable underground roosting habitat.

Table 3. Three levels of impact (low, medium and high) to bats and their habitats as a result of human activities; to use in planning acceptable activities within the management zones around significant bat roosts (adapted from Alberta Sustainable Resource Development 2011).

Level of Disturbance	Examples	Acceptability

Low impact disturbances are often infrequent; habitat is not being modified by the activities; and the duration of the activity is relatively short (i.e., hours).	• Land surveying
	• Recreational trail users (hiking) especially where trails traverse areas of winter use such as talus slopes, or rock outcrops
		• Extra caution should be used immediately adjacent to the roost.
		• Acceptable in the 1-kilometre special management zone all year, and within the 100 metre core area within timing windows.
		  o Maternity sites – avoid activities between May to August.
		  o Hibernation sites – avoid activities between October and April.
		  o May be acceptable in the 100 metre core area during the period of bat use; evaluate activity on a case-by-case basis by an experienced bat biologist.

Medium impact disturbances are usually high in frequency, may use vehicles and other equipment, and may involve small habitat modifications and the duration is relatively long (i.e., days).	• Seismic drilling
	• Recreational trail construction
		• Not acceptable in the 100 metre core area during the occupied period.
		• May be acceptable in the 100 metre core area when bats are not occupying the site and where the activity does not degrade the habitat (upon review by an experienced bat biologist).
		• Acceptable in the 1 kilometre special management zone within the suggested timing windows
		  o Maternity sites – avoid activities between May and August.
		  o Hibernation sites – avoid activities between October and April.

High impact activities generally involve disturbances that are high in frequency, involve vehicles and machinery, permanently modify the habitat by altering vegetation, soils, geomorphology and perhaps hydrology, and the impact is long term (i.e., more than 10 years).	• Construction
	• Blasting
	• Burning
	• Forest harvesting
	• Use of heavy equipment
	• Land clearing
	• Excavation
	• Road building
	• Recreational trail users (snowmobiling)
		• Not acceptable in the 100 metre core area at any time (Sarell 2004*a*, 2004*b*; Chatwin 2004)
		• Possibly acceptable in the 1 kilometre special management zone (with review by an experienced bat biologist); activities should occur within the suggested timing windows:
		  o Maternity sites – avoid activities between May to August.
		  o Hibernation sites – avoid activities between October and April
		• **Specifically for blasting activities**: either ensure sound concussion of less than 150 decibels and that shock wave is less than 1.5 p.s.i. and the peak particle velocity is less than 15 mm/second (MFLNRO 2014) or **maintain a setback of 2 kilometres** from occupied significant roost sites (Delaney 2002; M. Davis, pers. comm.). Blasting may occur during periods when bats are not occupying the roost, however, ensure that the roost habitat is not degraded in any way.

- Maintain important habitat features within the special management zone.
- When recreational trails are built, meander the trail as necessary to avoid tree cutting.

4. Within the entire 1.1 kilometre-radius core and special management area around the roost complex, identify important roosting, drinking and foraging areas and important areas of connectivity. Establish work plans that maintain the integrity of the habitat, ensure connectivity between roosting and foraging or drinking habitat, and ensure these habitats remain suitable for bats.

3.2.4 Mitigation

Mitigation is defined as the measures implemented to control, reduce or eliminate a potential adverse impact of a project, including restorative measures (Environmental Assessment Office 2003). Implementation of mitigation measures should follow the mitigation hierarchy procedures of the B.C. Ministry of Environment (B.C. Ministry of Environment 2012; B.C. Ministry of Environment 2014*b*). Updates and additional information on the mitigation policy are available on the Ministry of Environment mitigation policy website. Mitigation of the effects of resource development on bats and their habitats should be planned before modifying the habitat.

Because of the specific habitat conditions provided by cave and cliff habitat, it is difficult to provide substitute roosting habitat. Protection and conservation of suitable cave habitat as hibernacula is the most effective strategy.

When altering forest habitat around cave or crevice habitat, mitigation may involve site planning to retain or recruit tree-roost habitat; offering alternate habitat (such as artificial structures) to off-set the loss of summer roosting

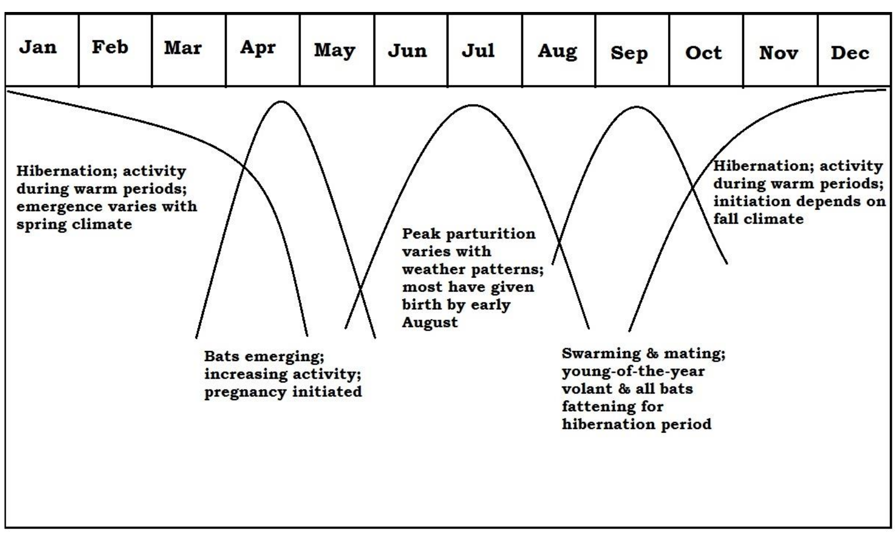

Figure 2. General seasonal patterns of activities of bats in British Columbia.

habitat; planning to retain or re-build ponds and wetland areas that represent important drinking/foraging habitat for bats; and/or replanting areas where forest clearing has disrupted connectivity corridors between roosting and drinking/foraging habitats.

For activities around significant bat roosts, mitigation may involve consultation with local Ministry of Environment Wildlife Specialists and an experienced bat biologist, to evaluate and prioritize sites to determine the most appropriate conservation action. Gating may be required in areas where human access is an issue; education and/or signage may also be an appropriate action at important hibernation sites.

Construction of bat-friendly gates in portals of known roosts is often used to control access because of safety and liability considerations, and also to reduced disturbance to bats. However, gates are not always the optimum strategy for the bats because installations can disrupt airflow and, if improperly installed, can prevent access for some bat species. There are numerous design options for bat-gating. The appropriate gate design is often site-specific because of the variation in size and type of opening and geomorphology of an area. Any bat-gate installation should involve an experienced bat biologist as well as an experienced bat-gate specialist. There are numerous sources of information on the variety of bat-gate designs available and one of the best resources the Bat Conservation International website.

Section 4: Monitoring and Reporting

Land managers, cavers, climbers, hikers, and geocachers have the opportunity to contribute to knowledge about bat species in British Columbia by reporting bat sightings to the British Columbia Ministry of Environment

1. A Wildlife Act Permit is required if trapping or other methods that involve touching the bats are used in the project. Under the permit conditions, data and reports must be submitted to the Wildlife Species Inventory database. Although a Wildlife Act Permit is not required for acoustic monitoring, counts of emerging bats or other visual surveys, it is strongly suggested that the data and reports be submitted to the Wildlife Species Inventory database. It may also be beneficial to report to the BatCaver program (www.BatCaver.org) if bats are suspected of using a mine site and follow-up activities are needed.
2. Important things to report include: how many bats were observed, their activity, where they were located, whether any pups were observed (in summer). With the potential emergence of WNS, additional information on whether any apparently dead bats were observed on the ground, and whether any bats had a white residue on their nose can be noted. Do not approach the bats or colony to obtain this information.
3. If bats are observed incidentally during a caving expedition, please report this information to the Incidental Wildlife Observation database. In these cases, the species identity of the bat will probably be unknown and so the observation can just be entered as "bats". This will enable further follow-up investigation with bat surveys.
4. For bat surveys:
    - Report the protocol used in surveying bat habitat and how survey sites were chosen.
    - Report the location (UTMs) of any bat habitat discovered (e.g., caves, cliff habitat etc.).
    - Report the location (UTMs) of any caves surveyed, and whether or not bats were discovered. Useful information to include in any report include site position, microtopography, elevation, aspect, ecological features such as proximity to water and foraging habitat, entrance location, entrance configuration, accessibility and cover, microclimate (temperature, relative humidity), airflow

patterns, cave passage geometry and complexity, presence of cave water, and presence of insects.

- Report the presence of bats (numbers of bats, locations, indicators of species ID) or signs of bat use (e.g., guano, insect parts, dead bats) of surveyed caves. Include the dates sites were surveyed and any information gathered at the location (e.g., temperature, bat activity, location of bats inside the cave system).
- Clearly identify the sampling design, including: the type of sampling protocol used (e.g., bat detectors, net nights, cave searches). For acoustic detectors report any modifications to the units (e.g., weatherproofing); number and placement of detectors; detector settings; dates sampled; considerations in establishing sampling locations; and considerations in determining the number of detectors used. For netting, report number of net-nights, dates and hours nets were open; information on weather; considerations in establishing sampling locations; and considerations in determining the number of net-nights.
- For acoustic surveys: Summarize activity by species to identify the total, average and median number of bat passes/detector night. To facilitate comparison across studies, present activity data as average number of bat passes/hour expressed per species or species group. Provide information on how activity by species or species group varies across seasons.
- For netting: report species; gender; life stage (juvenile or adult); sexual condition (reproductive or not); weight; and size measurements.

5. Report the results of any land management activities on occupied bat habitat (e.g., forest harvesting, blasting, gating) to the British Columbia Ministry of Environment.
    - When land management occurs around occupied caves/cliff/karst/crevice habitat, survey the habitat after the activity to determine whether bat occupancy was affected (e.g., species presence, number of species, season of use, number of individuals).
    - After installing a gate to exclude people from a cave or other habitat, monitor the gated habitat to determine if bat use of the feature was affected. Track and report gated feature usage, number of bats by species, trends in usage, and effects on the feature's microclimate as a result of gating (Grandison 2000).

Section 5: Information Needs to Improve Adaptive Management

Land managers, cavers, rock climbers, geocachers and hikers have the opportunity to contribute to knowledge about how and where the bat species of British Columbia use cave and crevice habitat.

Specific knowledge gaps that these groups can contribute to include:

1. The location of caves used by bats, and the timing of use by geographic region.
2. Information on the size of bat populations using each cave system, or cliff and crevice areas.
3. The characteristics of caves, crevices, cliff faces or other geological features that are important to bats, including site position, microtopography, elevation, aspect, ecological features such as proximity to water and foraging habitat, entrance location, entrance configuration, accessibility and cover, microclimate (temperature, relative humidity), airflow patterns, cave passage geometry and complexity, and presence of cave water.
4. Information on how surface and subsurface activities, such as mining, forestry, urban development, and oil and gas development affect the microenvironment of important geological features.
5. The best bat-compatible gating systems; most effective design, effect on cave microclimates, species-specific response to bat gates.
6. Information on night-roosts used by bats: location, type, number of bats using the feature.
7. Whether human disturbance is causing significant impacts to roosting bats in British Columbia. What is the extent of impacts on crevice-dwelling bat species from recreational climbing, and impacts on cave-dwelling bat species from caving?
8. The acceptance of bat-compatible gates and seasonal closures by recreational user groups. How effective are entrance signs and other education efforts on caving practices in self-guiding caves?
9. The human-use trends for individual caves that are past, current, or potential bat habitats. This information will help inform appropriate management strategies and practices. Supporting information may be obtained from entry registers, caving publications, personal accounts, and through surveillance devices.

Section 6: Glossary

Acoustic Survey/Echolocation Survey: A method of detecting bats using an ultrasonic bat detector. Detectors may be hand-held ('active surveys') or connected to an electronic system ('passive surveys') for long periods of recording independent of human observation.

Adit: A horizontal mine passage driven from the surface (Thomson 2002).

Bat Detector: Any device used to render the ultrasonic calls of a bat audible to the human ear (Resources Inventory Standards Committee 1998).

Bachelor roost: A roost used by one or more males during the day.

Best management practices: Methods, measures, or practices designed to prevent or reduce the resulting effects of human-related activities or industry. Usually, BMPs are applied as a system of practices rather than a single practice (Dunster and Dunster 1996).

Blind: A mine passage without lateral workings (Thomson 2002).

Cave: A natural cavity in the earth that connects with the surface, contains a zone of at least partial darkness, and is large enough to admit a human. For the purposes of cave management, this term also includes any natural extensions, such as crevices, sinkholes, pits, or any other openings that contribute to the functioning of the cave system (adapted from Resources Information Standards Committee 2003).

Crevice: A narrow crack or opening, or a fissure or a cleft, not large enough to admit a human. In addition to using caves, bats may roost in crevices and other cracks or surface openings within caves, in rocks, in rock outcrops, and on exposed cliff faces (Nagorsen and Brigham 1993; Nagorsen et al. 1993; Lewis 1995).

Curtailment: Limiting the supply of electricity during conditions when it would normally be supplied. Accomplished by cutting-out the generator from the grid and/or feathering the turbine blades (from Arnett et al. 2013).

Cut-in speed: The wind speed at which the turbines produce electricity. Some turbine blades will continue to spin even when no electricity is produced (adapted from Arnett et al. 2013).

Day roost: A roost where bats rest during the day in spring/summer/autumn. Day-roost types include maternity roosts, bachelor roosts, and mixed male/non-reproductive female/yearling groups. Use of a specific day roost may be seasonal or variable within a season.

Echolocation: An orientation system based on generating sounds and listening to their returning echoes to locate obstacles and prey (Nagorsen and Brigham 1993).

Ephemeral roost: A bat roost in a feature where the characteristics important to bats (e.g., microclimate) may change quickly and/or unpredictably. For example, an area under sloughing tree bark.

Feathering of the blades: Adjusting the angle of the rotor blade parallel to the wind, or turning the whole unity out of the wind to slow or stop blade rotation (from Arnett et al. 2013).

Fertilization: The impregnation of the egg by the male sperm cell (Nagorsen and Brigham 1993).

Flyway: Any corridor used by bats commuting between roost and foraging areas. Flyways make excellent sites for capturing bats in mist-nets and harp-traps. Often delimited by physical structures such as vegetation or buildings (Resources Inventory Standards Committee 1998).

Forage: To hunt for food.

Gestation Period: The length of the pregnancy; the time from fertilization until the birth of the foetus (Nagorsen and Brigham 1993).

Gleaner: A bat that can capture prey on the leaves and twigs of vegetation or on the ground (Nagorsen and Brigham 1993).

Goal: Goals provide general purpose and direction. They are the end result of ultimate accomplishment toward which an effort is directed. They generally should reflect perceived present and future need. They must be capable of being effectively pursued (B.C. Ministry of Forests 2008). An ideal; a desired endpoint; frequently defined in abstract terms. Goals are qualitative and are achieved by means of objectives (Dunster and Dunster 1996).

Guidelines: A set of recommended or suggested methods or actions that should be followed in most circumstances to assist administrative and planning decisions, and their implementation in the field. Guidelines may consist of policy statements, procedures, or checklists. They are provided as a broad framework of recommended actions to be taken and, therefore, provide some flexibility for decision-making. Note that guidelines cannot, by definition, be mandatory; such actions are prescribed by regulations or rules (Dunster and Dunster 1996).

Harp-trap: A specialized trap designed exclusively for capturing bats (Resources Inventory Standards Committee 1998).

Hibernaculum: A site where one or more bats hibernate in winter (pl. Hibernacula). A specific hibernaculum may be used by bats only part of the winter, and may not be used every winter.

Hibernation: A state of lethargy characterized by a reduction in body temperature and metabolic rate (Nagorsen and Brigham 1993).

Impact assessment: A study of the potential future effects of resource development on other resources and on social, economic and/or environmental conditions (B.C. Ministry of Forests 2008).

Inventory: A single enumeration of an ecological system; generally carried either as a basis for estimating potential yield or to establish a benchmark. An inventory may act as one point in time in a monitoring program. Ecological inventories may be more comprehensive and spatially/temporally discrete than monitoring activities (Quayle 2003).

Lactation: The period of milk production by female mammals nursing young (Resources Inventory Standards Committee 1998).

Landscape Unit: An area of land and water used for long-term planning of resource management activities. It is important for designing strategies and patterns for landscape-level biodiversity and for managing other forest resources. A landscape unit may be used by the deputy minister to establish objectives for any purpose permitted under section 2 of the Forest Practices Code of British Columbia Act (Ministry of Forests and Ministry of Environment Lands and Parks 1999).

Maternity colony: An aggregation of females in spring, summer, or autumn. The colony may include pregnant females (may not be visibly pregnant early in the season), lactating females with or without young-of-year, or post-reproductive females. A maternity colony may consist of a group of females within a single maternity roost (e.g., building, cave), or a group of females roosting singly or in small groups in close proximity and maintaining a long-term social relationship, adhering to the fission-fusion model (Metheny et al. 2007; Kerth et al. 2011; e.g., in crevices within a cliff or boulder field, in a forest stand under sloughing bark of trees). A roost used by such a colony is called a maternity roost.

Maternity roost: a roost used outside of the winter period by adult females that are capable of reproduction.

Mitigation: Measures implemented to control, reduce or eliminate a potential adverse impact of a project, including restorative measures (Environmental Assessment Office 2003).

Monitoring: Repeated, systematic measurements done with a specific purpose in mind. Monitoring is focused on measurements over time in order to detect the change toward, or away from, a stated standard or objective. Monitoring is part of the cycle of assessment and evaluation that is linked to management activities (Quayle 2003).

Nearshore wind development: one built on land within 3 km of a coastline, or in the ocean <10 km from land (see offshore and onshore developments).

Nocturnal: Active at night.

Night roost: A roost where bats rest at night between foraging bouts. Bats may roost singly or congregate.

Nursery colony: A type of maternity colony containing mainly nursing adults with young (summer), or an aggregation of mainly volant pups (late summer/early autumn). A roost used by such a colony is called a nursery roost (C. Lausen, pers. comm.).

Nursery roost: A roost where females congregate to give birth and raise their young (adapted from Knight and Jones 2009). A nursery roost is a type of maternity roost.

Objective: A quantifiable, measurable and defined target, capable of attainment within a defined period of time. Objectives are the means by which goals are achieved and should include four main components: 1. They must state the desired outcome (i.e., what is to be accomplished); 2. They must indicate the time period within which the expected outcome is to be achieved; 3. They must include measurement factors, such as quantity, quality, or cost, so that the fulfilment of the objective can be verified; 4. They must indicate who is responsible for achieving the indicated result. Desirable (but not absolutely essential) elements of objectives are a description of how they will be achieved and an indication of who will determine whether the results have been achieved. Objectives are typically narrower and shorter in range than goals, and serve as milestones toward goal achievement (Dunster and Dunster 1996).

Offshore wind development: one built in the ocean ≥10 km from land (see onshore and nearshore developments).

Onshore wind development: one built on land >3 km from a coastline (see nearshore and offshore developments).

Ovulation: Maturation and release of the egg before fertilization.

Parturition: Birth.

Permanent roost: A roost that is available for bat use over many years and has suitable characteristics (e.g., microclimate, access) that remain stable over time. Examples of permanent roosts include caves, cliffs, mines, bridges, buildings, and large hollow trees of a slow-decaying species such as western redcedar (*Thuja plicata*).

Portal: The entrance to an adit or tunnel (Thomson 2002).

Pup: A bat born during the current year.

Rehabilitation: The restoration of ecosystem functions and processes in a degraded system or habitat (Dunster and Dunster 1996).

Reporting: The process of effectively communicating the results of monitoring and their potential implications to a target audience (Quayle 2003).

Resident bat species: Species that move relatively short distances between summer and winter habitat, compared to migratory species which travel long distances (>1000 km).

Roost: A daytime retreat or night-time resting place.

Shaft: A vertical mine opening from the surface (Thomson 2002) may also apply to cave systems.

Significant bat roost:

- Any hibernaculum or swarming site;
- A roost used by a nursery colony of a Red- or Blue-listed species (any number of individuals), or a nursery roost used by more than six females of other species (can include mixed species groups);
- a roost used by a maternity colony of Red- or Blue-listed species (any number of bats), or a maternity roost used by more than four females of other species (can include mixed species groups);
- Any permanent-type day roost used by a male or a non-reproductive female of a Red- or Blue-listed species, or >10 males/non-

reproductive females/juveniles of other species (can include mixed species groups);

- Any night roost used by a Red- or Blue-listed species or >10 bats of other species (can include mixed species groups);
- Any regularly-used roost of a species listed under Schedule 1 of SARA (any number of individuals); or,
- Any other roost deemed significant by an experienced bat biologist.

Standard: Quantifiable and measurable thresholds that are typically defined in law or regulation, and are mandatory. A statement that outlines how well something should be done, rather than how it should be done. A standard does not necessarily imply fairness or equity, nor an absolute knowledge of cause-and-effect linkages. Standards are typically established using a combination of best available scientific knowledge, tempered by cautious use of an established safety (caution) factor (Dunster and Dunster 1996).

Stewardship: Caring for the land and associated resources so that healthy ecosystems can be passed on to future generations (Dunster and Dunster 1996).

Swarming: Behaviour associated with nocturnal flights that are made through potential hibernacula by aggregations of bats in late summer or autumn (Nagorsen and Brigham 1993).

Torpor: A short-term (daily) state of inactivity achieved by lowering the body temperature and reducing the metabolic rate in order to conserve energy (Nagorsen and Brigham 1993).

Tunnel: A horizontal mine passage that is open at both ends (Thomson 2002).

Volant: Capable of flying.

Winze: A mine opening sunk downward from inside to connect lower levels or explore areas beneath a level (Thomson 2002).

Yearling: A bat born in the previous reproductive year.

Young-of-year: A bat born during the current reproductive year.

Section 7: Additional Information

7.1 Links to additional information

- B.C. BAT Fact Sheet on White-nose Syndrome
- Information on leave no trace climbing principles of climbing available here and here
- Regions of British Columbia
- The Karst Inventory Standards and Vulnerability Assessment Procedures for British Columbia
- Karst Management Handbook for British Columbia
- Interim Wildlife Guidelines for Commercial Backcountry Recreation in British Columbia
- Wildlife Guidelines for Backcountry Tourism/Commercial Recreation
- Copies of all official legislation for the province of British Columbia is available online
- Ministry of Environment Guidelines and Best Management Practices for environmental stewardship
- The British Columbia Speleological Federation has information on caving codes of conduct

7.2 Additional information on bats

- The British Columbia Species and Ecosystems Explorer has information on all the species of bats in the province
- Bat Conservation International has information about bat species, bat gating, and bat houses
- For the latest information on White-nose Syndrome, see the Canadian Wildlife Health Cooperative as well as British Columbia Ministry of Environment's Wildlife Health website. The US Fish and Wildlife Service also provides the latest information on the spread of White-nose Syndrome across North America as well as up-to-date information on White-nose Syndrome research.

- The Wildlife Conservation Society of Canada has launched a program to help cavers understand and help with bat conservation. BatCaver.org can be found at http://programs.wcs.org/batcaver/Home.aspx

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Appendix 1: Bat Acceptance of Gates

Acceptance of full gates by cave and mine dependent bats (adapted from Currie 2000).

Species	Summer Roosts	Winter Roosts
Pallid Bat (*Antrozous pallidus*)	Yes	Unknown (probably will)
Townsend's Big-eared Bat (*Corynorhinus townsendii*)	Yes	Yes
Big Brown Bat (*Eptesicus fuscus*)	Unknown (probably will)	Yes
Silver-haired Bat (*Lasionycteris noctivagans*)	N/A*	Yes (Southern Okanagan British Columbia record)
Californian Myotis (*Myotis californicus*)	Yes	Yes
Western Small-footed Myotis (*Myotis ciliolabrum*)	Yes	Yes
Long-eared Myotis (*Myotis evotis*)	Unknown	Unknown
Little Brown Bat (*Myotis lucifugus*)	Unknown (probably will)	Yes
Northern Myotis (*Myotis septentrionalis*)	N/A*	Yes
Fringed Myotis (*Myotis thysanodes*)	Yes	Unknown (probably will)
Long-legged Myotis (*Myotis volans*)	Unknown (probably will)	Unknown (probably will)
Yuma Myotis (*Myotis yumanensis*)	Yes	Unknown
Keen's Myotis *(Myotis keenii)*	Unknown	Unknown
Spotted Bat *(Euderma maculatum)*	Unknown	Unknown
Western Red Bat *(Lasiurus borealis)*	N/A	N/A
Hoary Bat *(Lasiurus cinereus)*	N/A	N/A

*Species not believed to use caves or mines as maternity roosts to a great extent, although males and non-reproductive females may use these sites during the summer.

Appendix 2: Caver Code of Conduct (British Columbia Speleological Association)

http://www.cancaver.ca/bcsf/cavethic.htm

Caving Safety: Individual Responsibilities

Before entering the cave:

- Let someone at home know of your itinerary and approximate schedule.
- Select appropriate personal equipment and supplies including headlamp, head protection, protective clothing (including gloves and kneepads), footwear, food and basic emergency supplies.
- Know how to properly use your personal equipment.
- Check your equipment and ensure that it is in good working condition.
- Check the weather and project the (hydrological) response of the cave to adverse weather conditions.
- Don't go underground under the influence of alcohol, drugs, or medication that could impair your judgement or performance.
- Inform the trip leader of any personal physical or mental limitations.
- Never plan to cave alone (groups of 3 are good; groups of 4 are preferable).

Inside the cave:

- ***Accept the trip leader's decisions.***
- Identify, recognize, and evaluate inherent caving hazards (e.g. flooding, hypothermia, fatigue, rockfalls etc.)
- Don't exceed your abilities and limitations.
- Stay together (minimum 2 persons for side passages).
- Don't linger at entrances or other potentially unstable zones, or vertical exposed areas (e.g. pitches, overhanging ice).
- Avoid jumping, sliding, or making (unnecessarily) rapid manoeuvres.
- Don't attempt something untried without a backup plan (e.g. backing out of a tight passage).
- Don't share your equipment.
- Never throw anything into pitches.
- Avoid unnecessary chatter while moving (this distracts other participants who may value silence more than you).

- Know the agreed-upon communication protocol (used when voice communications are impractical or impossible).

Caving Safety: Trip Leader's Responsibility

Before entering the cave:

- Let someone on the surface know of your plans.
- Know how to activate an outside cave rescue operation.
- Ensure that all collective and personal equipment is matched to the cave's difficulty (and in good working order).
- Ensure that basic emergency equipment and supplies are taken (e.g. first-aid kit, pulleys, heat source, extra rope, etc.)
- Plan the underground activity according to age, experience, skills, and physical condition.
- Have a back-up plan.

Inside the cave:

- Distribute experienced cavers to the front and back of group (and use the "buddy system" within the group).
- Progress through the cave as fast as the slowest person.
- Don't ask someone to perform something beyond their capability.
- Use fall protection for all vertical exposures.
- Recognize the symptoms of fatigue and hypothermia.
- Don't hesitate to call a halt to a "bad" trip.

Minimum Impact Caving

- Consult with prior visitors about sensitive features. (This may also reduce the need for redundant visits.)
- Limit the size of the party to the minimum required for a safe visit. (Four is a reasonable lower limit.)
- Use a good source of light. (Avoid using acetylene-based headlamps in confined delicate areas.)
- Use suitable protective clothing.
- Don't smoke or make fires (even at the entrance).
- Stay on the established "minimum impact" route if already established, and avoid touching anything.
- Never break or soil speleothems (including flowstone and moonmilk).
- Don't "push" delicate passages.
- Don't overuse sensitive caves or sensitive interior passages.
- Never mark surfaces.
- Don't discard anything. (Remove all modern discarded objects, even if you were not responsible for putting them there!)
- Don't urinate or defecate inside the cave. (Carry out all human waste in the case of bivouac).

- Don't disturb hibernating bats or other sensitive organisms.
- Avoid altering natural air or water flows.
- Improve personal technique and abilities rather than permanently modifying the cave.
    - Use bolts only as a last resort where natural or non-marking anchors (cams, chocks, etc.) cannot be used.
    - Place bolts or other permanent fixtures only after thoughtful consultation with the broader caving community, particularly other persons familiar with the cave.
    - Use only high-quality bolts, and tag all bolts with the date of installation
- Avoid the use of explosives.
- Avoid unique or unusual sediment accumulations.