ROYAL BC MUSEUM HANDBOOK

BATS
OF BRITISH COLUMBIA

SECOND EDITION

ADVANCE UNCORRECTED GALLEY

CORI L. LAUSEN, DAVID W. NAGORSEN,
R. MARK BRIGHAM AND JARED HOBBS

Bats of British Columbia

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Royal BC Museum Handbook

BATS

OF BRITISH COLUMBIA

Second Edition

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Identifying BC's Bats

Many bat species in BC are difficult to differentiate from one another, and sometimes a combination of tools may be needed. Before we dive into the more technical approaches to identifying bats, we stress that many of the bat species in BC can be identified using the photographs in the species account, and this does not require touching bats. When you are trying to identify a roosting or downed bat, there are several strategic parts of the body that you should photograph or observe: the front of the head, the side of the head, and the tail. Additional photographs of the bat's back and underbelly, if visible, may assist in identification using fur colour or other defining traits. (See In-Hand Differentiation, page 92.)

Some species, however, are difficult to identify without close inspection. This is particularly true of the myotis species. Even when a bat can be closely examined in the hand, final species determination may require analysis of echolocation calls, genetics (DNA), examination of dentition, or even consideration of skeletal structure. Mist-net or harp trap capture to observe a bat directly in the hand remains one of the best ways to differentiate species, but even that may involve some uncertainty. Genetic tools for differentiating bat species are becoming more common as more techniques have become available, including greater ability to examine more areas of the genome. In some cases, entire genomes are being sequenced. The greater the extent of the genome that can be examined, the more likely it is that a reliable species differentiation can be made. To date, a number of species have been difficult to resolve using genetic techniques based on the small sections of the genome that are typically sequenced. For example, researchers have shown that CALIFORNIAN MYOTIS cannot be differentiated from WESTERN SMALL-FOOTED MYOTIS using common genetic markers of the mitochondrial genome; Wildlife Genetics International (David Paetkau) in BC has confirmed this to also be the case for CALIFORNIAN MYOTIS versus DARK-NOSED SMALL-FOOTED MYOTIS and for LONG-EARED MYOTIS versus some LITTLE BROWN MYOTIS in the province.

All handling of bats must be done by people with pre-exposure rabies vaccinations who have been trained in this field. Training procedures will provide specific details not included in this book, but here we describe the various measurements and traits most commonly used in species identification. This chapter explains how to differentiate bats using two main methods: in-hand examination and acoustic analysis.

In-hand examination uses morphology and measurements. This process requires measuring tools, such as vernier calipers, plastic rulers and precise

weigh scales. Body traits and size can be used to differentiate most species of BC bats. Skull and dentition keys, which may also be helpful in differentiating species, are available in Appendix 2.

Acoustic analysis uses acoustic signatures of free-flying bat echolocation. This requires a bat detector. Bat detectors can be active (the user actively holds the device while recording bats), passive (the user may leave the device unattended to remotely record bats at scheduled intervals), or both. Some bat detectors, generally those used for active recordings, have a display screen either built in or viewable on an attached mobile device that allows users to visualize bat calls as spectrograms (representations of frequencies produced over time), and most detectors will record sound files for subsequent analysis. Recordings can be analyzed later using computer software. This chapter explains key features of bat echolocation pulses, how to interpret the recordings, how some species of bats can be identified using acoustics, and limitations of using acoustics to determine species presence.

In-Hand Differentiation

When a bat is first examined, obvious features, such as colour and relative ear length, may allow immediate identification. For example, a SPOTTED BAT (see species account, page 169) is uniquely black with three white spots on its back and pinkish ears nearly the same length as the rest of its body. Other easily identifiable species in BC include PALLID BAT, EASTERN RED BAT, HOARY BAT and TOWNSEND'S BIG-EARED BAT. However, other BC species are less obvious, such as the eight species of myotis—all small bats in varying shades of brown. Measuring limb bones and ears and determining the relative steepness of the forehead of the skull (morphometrics), looking for the presence or absence of certain traits or features (diagnostic characters), and in some cases testing bats' ultrasonic signals (e.g., frequencies of sound produced) will assist in differentiation. For example, body features used for differentiation of myotis species include the presence or absence of a keeled calcar (see page 17), the shape of the tragus, and the presence or absence of obvious hairs along the edge of the tail membrane or in the armpit area under the wings (see image on page 264).

If you are photographing an unknown bat for later identification, we recommend taking the following photos:

1. Front head shot to show shape of nose and any facial mask that might be evident around the eyes
2. Side profile of head showing the ear and tragus clearly
3. Entire tail area, including at least one hind foot so that the calcar and edge of the tail membrane can be examined (ideally the tail membrane would be stretched out to more clearly see features)

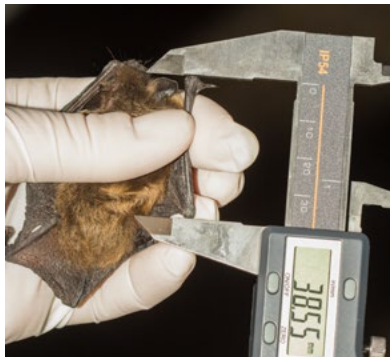
These photos, together with a forearm measurement (from elbow to wrist), will provide key information used to identify bats, but further photos (such as of the underside of the wing, or of dorsal fur) and measurements of ear length may help in some cases. These diagnostic traits are illustrated in the accounts for each species.

Because genetic tools are increasingly available and affordable, species of bats can also be identified from small pieces of tissue or from guano pellets (see Studying Bats, page 73).

Morphometrics

Forearm length

This is the most standard measurement taken for bats. Accurate forearm measurement requires the use of vernier calipers, with tips that have been ground off to remove sharp points. Measure the length of the ulna bone, aligning the calipers from the wrist to the elbow. Typically, the right forearm is measured.



Ear and tragus length

These are measured using a small ruler with the zero measure at the edge. Place the ruler gently into the ear, approaching from the outside (distal), and nestle the base of the ruler *into* the base of the ear. The base of the ear, which generally aligns with the base of the tragus, may be difficult to see, and you may need to move the head and fur. Gently lay the ear against the ruler. As this is a difficult measurement to make consistently, three independent measures are generally made and averaged.

Tragus length is also challenging to measure. Apply the ruler in the same way as described above, but carefully align the ruler alongside the tragus, again from the base, manipulating the head and fur to be able to see clearly. Ear and tragus measurement can be useful for differentiating "long-eared" bat species (such as LONG-EARED MYOTIS, FRINGED MYOTIS and NORTHERN

MYOTIS) from species with short ears (such as LONG-LEGGED MYOTIS and BIG BROWN BAT). For detailed information about ear length, see measurements in individual species accounts.

Foot length

Isolate the hind foot. The best way to do this is by holding the bat in such a way that it stands on a ruler and allowing the bat to bend its leg as though it were going to crawl on the ground. Measure from the heel to the tip of the longest digit, including the length of the claws. This measurement can be useful for differentiating several of the myotis species, as some have a small hind foot (e.g., CALIFORNIAN, LITTLE BROWN and YUMA MYOTIS) while others have a large hind foot (LONG-LEGGED MYOTIS, LONG-EARED MYOTIS and FRINGED MYOTIS). For more information, see foot measurements in species accounts.

Tibia length

The tibia can be measured using a ruler or calipers. As with the foot length measure, this is often best accomplished by allowing the bat to bend its leg while standing on a surface, such as your finger or a table. Use the calipers or ruler to measure the tibia—the main leg bone between the ankle and the knee. This measurement can be useful for identifying LONG-LEGGED MYOTIS.

Snout length and width

The snout can be measured using a ruler. Approaching from the top, measure both the width and the length. The base of the snout is where the hairline ends, and you may need to move the fur until the line can be seen. Length is the measure from hairline to the tip of the nose at the nostrils. The width of the snout is also measured at the hairline. The relative width to length of the snout can be useful for differentiating CALIFORNIAN MYOTIS from DARK-NOSED SMALL-FOOTED

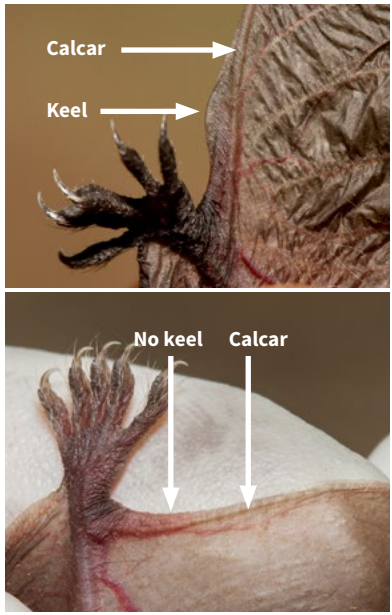
MYOTIS, and the width of the snout can be useful for differentiating FRINGED MYOTIS from LONG-EARED MYOTIS.

Thumb length
Align a ruler at the base of the thumb and measure to the tip of the claw. While all of the thumb measurements in this book include the claw, sometimes two measurements are made, one with and one without the claw, to account for the fact that some individuals have far greater curvature of the claw than others. It is therefore important to record whether a thumb measurement includes the claw. This measurement can be useful for differentiating CALIFORNIAN MYOTIS from DARK-NOSED SMALL-FOOTED MYOTIS.

Diagnostic External Features

We can use the presence of certain features in combination with morphometrics to confidently arrive at an identification. Below are some of the typical features that are inspected when differentiating bats. Many of these features are referred to in the species accounts and in Appendix 3.

Tail membrane
Keeled calcar: Look for presence or absence of a flap of tissue on the outside of the calcar (the cartilaginous spur off the ankle (see image on page 17). This small flap is called a keel, and is important in differentiating many species, especially various myotis species. However, some species have only partial keels, and some individuals may have an indistinct keel on one side of the body and not on the other; partial keels are often found on LONG-EARED MYOTIS. For other species, such as CALIFORNIAN MYOTIS, DARK-NOSED SMALL-FOOTED MYOTIS and LONG-LEGGED MYOTIS, the keel is obvious and distinct, and is important in differentiating them from myotis that do not have keeled calcars, such as LITTLE BROWN MYOTIS and YUMA MYOTIS.



A calcar with a keel (top) and without a keel (bottom).

Fringe of hair: A comb of stiff hairs along the outer edge of the tail membrane is a trait pronounced in FRINGED MYOTIS. However, LONG-EARED MYOTIS can also have a subtle fringe of sparsely spaced hairs, especially in young individuals.

FRINGED MYOTIS

Dorsal surface hairy: Most bats have little hair on the dorsal (top) surface of the tail membrane; however, SILVER-HAIRED BAT is usually partially furred there, and HOARY and EASTERN RED BAT have fully furred tail membranes (see image on page 21).

Vertebrae extend beyond membrane edge: The tip of the tail extends several vertebrae past the end of the tail membrane in DARK-NOSED SMALL-FOOTED MYOTIS, but not in the similar CALIFORNIAN MYOTIS (see image on page 208). BRAZILIAN FREE-TAILED BAT has a tail that extends well beyond the edge of the tail membrane.

DARK-NOSED SMALL-FOOTED MYOTIS

Wing membrane

On most bats, the underside of the wing membrane has sparse hair, with the bulk of the fur ending at the edge of the body. But on LONG-LEGGED MYOTIS, the hair is rather thick, extending all the way out to an imaginary line between the elbow and the ankle. This species is often said to have "hairy armpits" (see image on page 264).

Shape of ear and tragus

The shape of the ear and tragus can be important for differentiating some species. For example, NORTHERN MYOTIS has a pin-point sharp tragus that is straight. This is used to differentiate it from the similar LITTLE BROWN MYOTIS, whose tragus is blunt and sometimes curved or even notched (see images in species accounts). CANYON BATS have a unique paddle-shaped tragus. Some

bats, like LONG-LEGGED MYOTIS, have round-tipped ears, whereas others, like CALIFORNIAN MYOTIS, have more pointed ear shapes.

To measure the length of the tragus, a plastic ruler is gently set into the base of the ear.

Head

While skulls of the various species differ (see Appendix 2), this is not always obvious on a live bat. One rather subjective feature that can be assessed is the slope of the forehead. By feeling the forehead with the tip of your finger, you can develop a sense of "steep" versus "shallow," traits that can help differentiate YUMA MYOTIS (steep) from LITTLE BROWN MYOTIS (shallow). Coloration of the skin and fur on the head can also help with species identification—for example, DARK-NOSED SMALL-FOOTED MYOTIS appears to have a dark "mask" over the eyes, whereas the similar CALIFORNIAN MYOTIS usually does not. Likewise, LONG-EARED MYOTIS typically has a dark mask over the eyes, whereas NORTHERN MYOTIS, another myotis with relatively long ears, does not.

Morphological Key to BC Bats

The following key is based largely on external features. Diagnostic characteristics are arranged into descriptive pairs, or couplets; each couplet offers the user two mutually exclusive choices (labelled *a* or *b*). To identify a bat, begin with couplet number 1 and select a or b. This will either give you a species name or direct you to another couplet in the key. By working through the various steps in the key, you will arrive at an identification. We have tried to avoid subjective traits (e.g., "slightly darker than" or "slightly larger than") and instead emphasize presence or absence of features or absolute size measurements; however, in some cases, these relative traits are helpful, and they may be provided in addition to other, less subjective traits. To simplify the key, the diagnostic criteria in a couplet (decision between two options at each branch of the key) are limited to a few characteristics. Once you have made an identification, consult the description in the appropriate species account to see if it is consistent with the determination from the key.

Many identification keys incorporate locality information (e.g., "found only in the Okanagan Valley"), but we deliberately avoided geography in the keys, given that species ranges are not completely known and may shift over time. We also advise you to take photographs to allow subsequent confirmation of your species identification. Note that due to the extreme difficulty in telling

YUMA MYOTIS apart from LITTLE BROWN MYOTIS based solely on external features and measurements, we recommend the use of a bat detector to aid in differentiating these species. A biologist might also consider confirming species identification by using genetic samples (e.g., from a biopsy punch or wing or cheek swab) supplementing the use of acoustics and morphometrics.

Each couplet includes the number of the previous determining couplet. If you arrive at an unlikely or incorrect identification, use these numbers to navigate backward through the key.

1	**1a**	More than one-third of the tail extends beyond the outer edge of the interfemoral membrane (see image on right): Go to **2**	
	1b	Tail enclosed in the interfemoral membrane (e.g., see images on p. 96 and p. 208): Go to **3**	

BRAZILIAN FREE-TAILED BAT. PHOTO: MICHAEL DURHAM/MINDEN PICTURES (BAT CONSERVATION INTERNATIONAL)

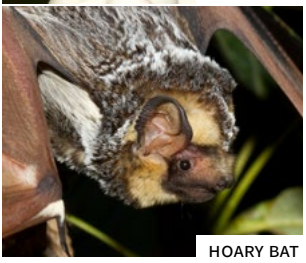
2 (t.1)	**2a**	Ears joined at the base, forearm length 58–64 mm: BIG FREE-TAILED BAT (p. 291)	
	2b	Ears not joined at the base, forearm length 36–46 mm: BRAZILIAN FREE-TAILED BAT (p. 285)	

BIG FREE-TAILED BAT. PHOTO: MICHAEL DURHAM/MINDEN PICTURES (BAT CONSERVATION INTERNATIONAL)

BRAZILIAN FREE-TAILED BAT. PHOTO: MICHAEL DURHAM/MINDEN PICTURES (BAT CONSERVATION INTERNATIONAL)

3 (t1)	**3a**	Ear length greater than 28 mm: Go to **4**
	3b	Ear length less than 28 mm: Go to **6**
4 (t3)	**4a**	Fur on back black with three prominent white spots on rump and shoulders: SPOTTED BAT (p. 169)
	4b	Fur on back not black and lacking white spots: Go to **5**
5 (t4)	**5a**	Nose with two prominent bumps (see p. 148 in TOWNSEND'S BIG-EARED BAT species account), forearm length 40–50 mm: TOWNSEND'S BIG-EARED BAT (p. 147)
	5b	Nose lacking two prominent bumps, forearm length 48–58 mm: PALLID BAT (p. 135)
6 (t3)	**6a**	Fur orange or reddish orange in colour: EASTERN RED BAT (p. 179)
	6b	Fur not orange or reddish orange: Go to **7**
7 (t6)	**7a**	Fur on back with frosted or silver tipped hairs, at least part of the dorsal surface of the tail membrane thickly furred: Go to **8**
	7b	Fur on back without frosted or silver-tipped hairs, dorsal surface of tail membrane has few hairs: Go to **9**
8 (t7)	**8a**	Upper surface of tail membrane completely covered with fur, yellowish-brown fur around head, forearm length 50–57 mm: HOARY BAT (p. 187)


HOARY BAT


HOARY BAT

	8b	Upper surface of tail membrane furred only at its base, forearm length 38–45 mm: SILVER-HAIRED BAT (p. 197)	 SILVER-HAIRED BAT
9 (t7)	**9a**	Tragus is paddle shaped, and there is a dark mask over the eyes: CANYON BAT (p. 295)	 **CANYON BAT.** PHOTO: JOSE MARTINEZ
	9b	Tragus is not paddle shaped: Go to **10**	
10 (t9)	**10a**	Distinct fringe of hairs on outer edge of tail membrane (see image on p. 96), forearm length greater than 38 mm: FRINGED MYOTIS (p. 255)	
	10b	Lacking a distinct fringe of hairs on outer edge of tail membrane: Go to **11**	
11 (t10)	**11a**	Prominent keel on each calcar (see image p. 95): Go to **15**	
	11b	Indistinct or no keel on each calcar: Go to **12**	
12 (t11)	**12a**	Forearm length to ear length ratio less than 2.6, ear length equal to or greater than 14.5 mm (see image on p. 93 for comparison): Go to **13**	
	12b	Forearm length to ear length ratio greater than 2.5, ear length less than 15 mm: Go to **14**	

13 (t12) **13a** Ears darker than fur and when fur is parted at shoulder, dark bases are evident (dark shoulder patches); tragus rounded at tip, ears greater than 15 mm and typically greater than 17.5 mm: LONG-EARED MYOTIS (p. 217)


LONG-EARED MYOTIS

13b Tragus is sharp, ears about the same colour of brown as the fur, ear length less than or equal to 17.5 mm but typically less than 16 mm; when fur is parted at shoulder, darker "shoulder patches" are not evident: NORTHERN MYOTIS (p. 247)


NORTHERN MYOTIS

14 (t12) **14a** Forehead feels relatively steep, fur looks short and dull brown, forearm equal to or less than 36 mm: likely YUMA MYOTIS (p. 271)

14b Forehead feels shallow, fur looks glossy brown and hairs are relatively long, forearm greater than 35 mm: likely LITTLE BROWN MYOTIS (p. 227)

Morphology may not differentiate these two species. The use of an acoustic bag test is recommended (see YUMA and LITTLE BROWN MYOTIS species accounts). For biologists, a skin sample for genetic testing may also be useful (see Studying Bats, p. 73).

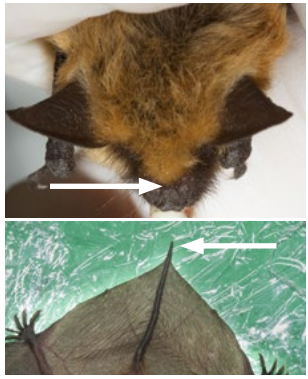
15 (t11) **15a** Underwing furred outward to a line extending from knee to elbow ("hairy armpits"; see image on p. 264): LONG-LEGGED MYOTIS (p. 263)

15b Underwing not furred outward to a line extending from knee to elbow: Go to **16**

16 (t15) **16a** Forearm length greater than 40 mm, snout has slight glandular swellings visible on each side: BIG BROWN BAT (p. 159)


BIG BROWN BAT

16b Forearm length less than 36 mm: Go to **17**

17 (t16)	**17a**	Fur on back pale blonde to yellow, contrasting sharply with blackish ears, face, and wings; slight dark mask across eyes; long thumbs (greater than 4 mm); several tail vertebrae extend past edge of tail; length of bare area on snout rectangular in shape, approximately 1.5 times width across nostrils: DARK-NOSED SMALL-FOOTED MYOTIS (p. 239)	
	17b	Fur on back chestnut to brown, does not contrast sharply in colour with ears, face and wings; thumb short (less than 5 mm); tail ends flush at edge of tail membrane (see image p. 208); bare area on snout square in shape, approximately equal length to width across nostrils: CALIFORNIAN MYOTIS (p. 207)	

References

British Columbia Ministry of Environment, Lands and Parks (1998), Kunz and Parsons (2009), Lausen (2005), Rodriguez and Ammerman (2004).