Echolocation Call Characteristics of Montana Bats

Table 6. Frequency characteristics and diagnostic criteria for bat species found in Montana. Mean frequencies are shown in bold for each feature and the range of measurements is displayed below in each box. Call sequences analyzed to produce this table are from Humbolt State University Bat Lab and the Montana Bat Call Reference library.

	species	f_c	low f	high f	f_{max}	dur	Upper slope	Lower slope	Total slope	Diagnostic[2] and Special characteristics	Hand-Class Priorities[3]	MTNHP Notes[3]	Search Phase call intervals[3]
50	***Myotis yumanensis*** Yuma Myotis	**49.2** 44.8-54.8	**45.6** 42.4-48.4	**90.0** 64.0-116.0	**55.2** 46.0-78.8	**5.5** 3.3-7.9	**16.6** 5.4-27.4	**4.4** 1.6-9.4	**8.1** 2.2-17.9	**Pronounced knee, dur >6 ms, upprSlp <16, lwrSlp <3, f_c >47 kHz diagnostic within known range** (95% CI for MYVO)**. Sometimes insert longer duration calls within sequence of short duration calls.** Power focused around fc; gradually builds up to peak and attenuates rapidly. Typically exhibit only a hint of a tail. Limited geographic range in MT (west of Continental Divide).	f_c > 50 kHz dur > 6 ms	Date range: Year round	90-175 ms
50	***Myotis californicus*** California Myotis	**49.1** 44.9-52.9	**45.3** 40.7-48.7	**99.6** 78.4-122.4	**52.8** 45.0-65.2	**3.8** 2.0-5.6	**28.0** 14.0-42	**7.4** 2.4-12.6	**15.1** 3.9-26.9	**FM sweep a smooth curve** (i.e., no inflection), beginning steeply and then increasing in curvature*. **Often a well-defined downward tail. Sometimes a lower inflection; with the appearance of a "ledge" or "shelf" or "secondary change in slope" before f_c. Peak power of call typically persists for at least 1 ms on non–saturated calls. f_c >48 kHz diagnostic** (95% CI for MYCI). Limited geographic range (western MT). *some calls may have an inflection, but the smoothly curved variant is diagnostic.	f_c > 50 kHz dur < 5 ms	*D calls should have:* f_c > 48 kHz uppr slp >20 total slp > 10 dur < 4 ms tail > 3 kHz Date range: Year round	75-125 ms (occ. >175 ms)
40	***Myotis ciliolabrum***	**44.3**	**40.6**	**95.1**	**49.1**	**3.2**	**33.5**	**9.6**	**16.9**	**FM sweep a smooth curve** (i.e., no inflection), beginning steeply and then increasing in curvature*. **Often a well-defined downward tail. Peak power of call typically persists for at least 1 ms on**	f_c > 42 kHz dur < 5 ms Kaleido Accurate	*D calls should have*: f_c > 42 kHz uppr slp >25 total slp > 12 tail > 3 kHz Date range: Year	75-125 ms

	species	f_c	low f	high f	f_{max}	dur	Upper slope	Lower slope	Total slope	Diagnostic[2] and Special characteristics	Hand-Class Priorities [3]	MTNHP Notes[3]	Search Phase call intervals[3]
	Western Small-footed Myotis	39.7-47.7	37.4-43.4	76.9-112.9	42.9-54.9	1.8-4.6	20.5-46.5	4.4-14.4	7.1-27.1	**non–saturated calls, f_c <45 kHz diagnostic if within MYCA geographic range** (95% CI for MYCA). *some calls may have an inflection, but the smoothly curved variant is diagnostic.		round	
	Myotis septentrionalis	**43.2**	**37.0**	**104.0**	**51.3**	**3.9**	**24.2**	**11.7**	**18.6**	**Calls may have up to 100 kHz of bandwidth.** Shaped like MYEV or MYTH but distinguished by f_c. FM sweep may be nearly linear making f_c difficult to recognize. Quiet but consistent calls. Examine sequence in real time and confirm consistent search phase call intervals across the sequence to rule out approach phase calls from other Myotis spp. **Distribution in Montana very limited - capture and genetic analysis needed to confirm ID.**	fc > 40 kHz	Look for Fc >40 kHz and ensure they aren't approach-phase calls from other Myotis by confirming consistent search phase call intervals across the sequence.	unknown
	Northern Long-eared Myotis	36.8-50.8	27.0-47.0	86.0-124.0	30.7-72.7	2.3-5.3	11.8-35.8	3.1-20.3	9.4-29.4				
	Myotis volans	**41.6**	**36.9**	**89.6**	**48.0**	**4.8**	**15.1**	**7.7**	**12.0**	**May exhibit an upward sweep into the call; uncommon, but diagnostic when present on steep calls.** May have subtle lower slope or backward bend at higher frequencies. End of call may exhibit a rounded, lazy drop. Generally has shorter, steeper calls than MYLU in uncluttered areas. Note that alias harmonics may resemble upsweeps if sonogram is truncated (e.g. 96 kHz maximum for SM2s with FS = 192 kHz).	f_c > 35 kHz	Date range: Year round	80-160 ms?
	Long-legged Myotis	36.4-46.4	31.1-43.1	66.4-112.4	39.0-60.0	2.4-7.0	6.9-22.9	1.1-14.3	4.0-22.0				
	Myotis lucifugus	**40.8**	**38.1**	**74.5**	**44.5**	**6.0**	**13.1**	**3.9**	**6.2**	Can make the longest duration and lowest slope calls of all Myotis. **Dur >7 ms** (95% CI for MYVO) **and lwrSlp <3 diagnostic among 40 kHz Myotis; f_c <44 kHz diagnostic**	dur > 6 ms	Date range: Year round	100-200 ms

	species	f_c	low f	high f	f_{max}	dur	Upper slope	Lower slope	Total slope	Diagnostic[2] and Special characteristics	Hand-Class Priorities[3]	MTNHP Notes[3]	Search Phase call intervals[3]
	Little Brown Bat	37.2-43.2	33.9-41.9	51.5-97.5	36.0-53.5	3.2-8.6	2.7-26.9	0.8-9.1	1.6-13.8	**west of Continental Divide** (95% CI for MYYU). Calls may have abrupt upturn at end (unlike smooth LABO upturn). Sometimes with multiple power centers making calls look clumpy.			
	Lasiurus borealis Eastern Red Bat	**40.4** 31.6-47.6	**40.2** 33.8-45.8	**67.6** 40.4-94.4	**43.8** 34.2-54.2	**6.8** 3.2-11.4	**10.0** 0.1-22	**2.0** 0.0-4.4	**4.4** 0.1-9.8	**U-shaped calls; up-turn at end of call; may exhibit variable f_c across sequence.** Power smoothly centered in call. Typically 32-40 kHz calls with dur >10 ms are LABO, but look at shape. fc > 30 kHz in sequences with characteristic variation in frequencies (as opposed to LACI <30 kHz). Limited geographic range in MT (eastern plains).	Kaleido Accurate, dur > 9-11 ms	Date range: June 14 - Oct 26	100-250 ms (occ. >300 ms)
30	***Myotis evotis*** Long-eared Myotis	**34.3** 31.7-37.7	**28.1** 23.9-33.9	**78.5** 49.5-107.5	**39.1** 31.0-46.9	**3.7** 2.1-5.3	**20.5** 6.1-35.5	**8.7** 2.3-15.3	**13.5** 4.9-24.5	Calls may have up to 100 kHz of bandwidth. Shaped like MYTH and MYSE but distinguished by **f_c = 32-36** (upper range boundary for MYTH, 95% CIs for MYVO and MYSE). FM sweep may be nearly linear making f_c difficult to recognize. **Harmonics converge toward primary call component.**	f_c = 33-36 kHz dur < 3-4 ms; Sonobat= EPFU and dur <5 ms	Date range: Year round	90-200 ms
	Eptesicus fuscus Big Brown Bat	**28.2** 25.8-31.8	**27.2** 24.8-30.8	**56.6** 43.4-69.4	**31.9** 25.0-40.1	**7.8** 2.8-12.2	**8.5** 2.5-15.5	**2.1** 0.3-4.3	**4.0** 0.6-7.6	Variable; calls with high f below 60 kHz can be confused with LANO. **Calls with high f >65 kHz distinguish from LANO** (range boundary for LANO)**, duration >12 ms to distinguish from ANPA where species coexist** (range boundary for ANPA). May produce nearly flat calls (with fc as low as 23 kHz) but never 100% flat at any point in call. Parallel harmonics. Some calls may have inflection.	f_c = 28-32 kHz dur > 6 ms	Look at longer calls if in ANPA geographic range, but note that long calls (>10ms) may have call/sec < 6 Date range: Year round	100-150 ms (150-250 ms for long, low calls)

	species	f_c	low f	high f	f_{max}	dur	Upper slope	Lower slope	Total slope	Diagnostic[2] and Special characteristics	Hand-Class Priorities[3]	MTNHP Notes[3]	Search Phase call intervals[3]
	Antrozous pallidus	**28.0**	**26.2**	**54.5**	**31.0**	**6.8**	**8.1**	**2.7**	**4.3**	Often simple curved FM sweep, sometimes with knee in center. **Distinguish from short, steep EPFU calls by looking for call intervals >180 ms for ≥1 second (<6 calls/sec)**. Note that MYTH & MYEV can also be <6 calls/sec. No Myotis-like tail, but calls may end in a foot-like arch or "dog paw". Parallel harmonics. **Presence of social calls diagnostic** (see ref. calls). Limited geographic range (southeastern MT).	dur < 10 ms calls/sec < 6 f_c < 35 kHz	*Probables:* Sequences of short, steep calls with >200 ms intervals *Defintives:* Social calls, must view "unfiltered" to see these Date range: Apr 1 - Sept 23	150-300 ms?
	Pallid Bat	26.0-30.0	23.8-29.8	41.5-67.5	25.0-37.0	3.8-10.0	3.0-15.9	0.6-5.1	2.1-7.9				
	Lasionycteris noctivagans	**26.5**	**25.4**	**41.5**	**28.8**	**9.2**	**5.2**	**1.3**	**2.5**	Some call variants can be confused with EPFU. **Flat calls with f_c ≥26 kHz diagnostic.** Shorter calls reverse J–shaped; often with a **distinct inflection**. **Short search phase calls (<7 ms) with harmonics do not exceed 55kHz.** Parallel harmonics. Flat LACI calls are lower in f_c, but shorter LACI approach calls may overlap short LANO calls (examine entire sequence and call interval). Low slope calls with f_c = 25–26 kHz may be distinguished from LACI by the presence of an inflection. EPFU typically has more FM, with smooth curvature (no inflection), but may produce nearly flat calls (with fc as low as 23 kHz).	f_c < 28 kHz	Date range: Year round	200-500 ms (100-200 ms for short, steep calls)
20	Silver-haired Bat	25.5-27.5	22.6-28.6	26.0-58.5	24.0-33.2	2.3-16.8	0.0-12.6	0.0-3.7	0.0-6.7				
	Myotis thysanodes	**24.5**	**19.8**	**72.4**	**30.7**	**3.9**	**19.0**	**9.2**	**13.9**	Calls may have up to 100 kHz of bandwidth. Shaped like MYEV but distinguished by f_c. FM sweep may be nearly linear making f_c difficult to recognize. Want to have presence of harmonics to distinguish from COTO if high f <50 kHz. **Continuous steep shape and**	f_c < 24 kHz, dur 3-5 ms, and/or Kaleido Accurate	Date range: Mar 28 - Oct 31	100-160 ms

	species	f_c	low f	high f	f_{max}	dur	Upper slope	Lower slope	Total slope	Diagnostic[2] and Special characteristics	Hand-Class Priorities[3]	MTNHP Notes[3]	Search Phase call intervals[3]
	Fringed Myotis	21.5-27.5	14.2-24.2	41.6-103.6	24.0-39.3	1.9-5.9	7.1-33.0	3.1-16.8	4.9-24.1	**f_c down into the 20s is diagnostic: totalSlp >15, f_c <28 kHz, and low f <24 kHz diagnostic or totalSlp >10, f_c <28 kHz, and low f <24 kHz diagnostic if harmonics converge toward primary call component.**			
	Corynorhinus townsendii	**23.4**	**21.4**	**42.5**	**31.1**	**4.6**	**7.1**	**4.9**	**5.0**	Low intensity, difficult to record; harmonics may be present. Call-shape **simple linear FM sweep** (sometimes with upsweep or flat at onset - no knee or upward facing curvature toward end of call unless a connected squiggle). **Squiggle calls diagnostic (5-7 ms period); rare, likely social and used near roosts.** f_{max} may alternate between primary call component and second harmonic. For search phase calls, COTO will have high f <50 kHz, f_c <32 kHz, and $f$max <41kHz (upper range boundaries). *Examine entire call sequence and look for upward facing curvature on any call; if found, likely not COTO. LACI and LANO approach calls and some linear MYTH fragments can mimic COTO.	f_c < 35 kHz	Date range: Year round	70-120 ms (occ. >150 ms)
	Townsend's Big-eared Bat	18.6-28.6	17.0-24.6	37.5-47.5	24.9-36.9	1.7-8.0	0.2-18.9	1.5-8.3	2.0-8.0				
	Lasiurus cinereus	**20.1**	**19.7**	**26.0**	**20.8**	**11.0**	**2.2**	**0.4**	**0.7**	**Pronounced or subtle U–shape or very flat calls (<20 kHz). Low f & f_c may vary across sequence;** power builds toward center then gradually declines. Short calls can be confused with LANO or EPFU. f_c < 30 kHz in sequences with characteristic variation in frequencies (as opposed to LABO >30 kHz).	f_c < 20 kHz and/or Kaleido Accurate	Date range: Mar 22 - Nov 15	250-400 ms (occ. >500 ms)
	Hoary Bat	16.0-23.9	16.3-24.3	17.0-36.0	17.0-25.2	4.0-19.0	0.1-6.0	0.0-1.2	0.0-2.1				

	species	f_c	low f	high f	f_{max}	dur	Upper slope	Lower slope	Total slope	Diagnostic[2] and Special characteristics	Hand-Class Priorities[3]	MTNHP Notes[3]	Search Phase call intervals[3]
10	***Euderma maculatum*** Spotted Bat	**10** 8.6-12.0	**9.6** 8.2-10.4	**14.5** 12.0-17.5	**12.5** 10.0-15.5	**3.2** 1.6-6.0	**2.2** 0.1-5.2	**1.5** 0.1-3.1	**1.7** 0.9-2.7	**Simple linear FM sweep,** sometimes with a mild inflection. Short calls at low frequency. Harmonics often present, with second harmonic persisting beyond primary call component. **f_c = 7-10 kHz and dur = 3-8 ms diagnostic.**		Process separately in Kaleidoscope, view "unfiltered" Date range: Mar 10 - Nov 12	200-500 ms

[1] data from Humbolt State University Bat Lab (Eastern and Western US Bats 2011); numbers represent means and approximate 95% confidence intervals - if the 95% CI exceeded the observed range of a characteristic, the range boundary was used.
[2] diagnostic characteristics for determination of species identification are bolded in text.
[3] filters and notes represent work in progress or draft guidelines to speed hand review of call sequences; seasonal range dates are from either definitively identified calls or captures in the Montana Point Observation Database as of February 2017.

Important Characteristic/Sonogram Terminology[1]

Primary call: the component of an echolocation sound emitted by a bat with the lowest frequency, also called the fundamental; typically the most powerful and sometimes the only part of the call visible on a sonogram

Harmonic: multiple, typically subtle components of the call, existing at higher frequencies but roughly parallel to the primary call component; presence may indicate higher call quality unless a call is oversaturated

The characteristics below refer to attributes of the primary call. In rare cases, a harmonic may be the most powerful component of a call; these characteristics and their corresponding values in this key are not applicable to those measured from a harmonic component.

low *f*: lowest frequency (kHz)

high *f*: highest frequency (kHz)

f_c: characteristic frequency, the frequency of the call at its lowest slope (kHz)

f_{max}: the frequency where the power is greatest (kHz)

dur: duration (ms) from the start to the end of a call

Upper slope: the slope of the call (kHz/ms) between the high *f* and the knee; abbreviated: upprSlp

Lower slope: the slope of the call (kHz/ms) between the knee and the f_c; abbreviated: lwrSlp

Total slope: the slope of the call (kHz/ms) between the high *f* and the low *f*; abbreviated: totalSlp

Other terms used to describe calls:

FM: frequency modulation, change in frequency over time; most calls start at a high frequency and sweep down to a lower frequency

power: amplitude or sound energy (i.e. volume)

oversaturation: powerful calls may exceed the microphone/recorder capability and produce anomalies in the sonogram such as full spectrum "noise" (clipping) or alias harmonics (upside-down harmonics resulting from truncation of the upper portions of calls due to sampling frequency limitations); peak power duration cannot be accurately estimated

inflection or knee: pronounced change in slope; some calls may not have an obvious knee if very steep or smoothly curved

flat: a call or portion of a call with very low or no slope (horizontal), i.e. constant frequency (CF)

sequence: a series of bat calls, produced as a bat flies past the detector

calls/sec: the number of calls per second for a given period; note that Sonobat's calculation of this characteristic may be incorrect due to multiple bats in a recording, low intensity calls, and dead air space in a sequence – ms between calls should be examined and calls should be looked at in real time to accurately estimate this characteristic if needed

Note that all frequencies should be interpreted as apparent or observed frequencies. These values may vary from the frequency emitted by the bat due to distance to detector (decreasing call power or volume). Call volume may have a noticeable effect on all frequencies recorded depending on the location of the power in the call (>5 kHz).

Call Types[2]

The values for the characteristics listed in this key are based on search phase calls. Therefore, it is important to make sure that search phase calls are examined and analyzed during hand classification.

Search phase calls: used for general navigation and searching in uncluttered areas, generally consistent call characteristics, approximately 3-12 calls per second; bats may be able to detect objects >10 meters away with these calls[3]

Approach phase calls: used when approaching either prey or a landing site or in cluttered airspace, such as when flying around vegetation; these calls are typically steeper and shorter than search calls and frequencies may shift up significantly, often 10-25 calls per second

Feeding buzz: also called terminal phase calls, used for close proximity object location during prey pursuit/capture, may exceed 100 calls per second[4]; very steep and short calls that can mimic other species if interpreted as search calls, but can be much lower in volume/power; not useful for species ID

Social calls: used to communicate with other bats, often lower in frequency than search phase calls for a species and may contain complex frequency modulation patterns; may be very helpful for identifying some species (e.g. ANPA) but are irregularly recorded

How to Use the Key for Montana Bats[1]

Tip: Put bat detector in an open, uncluttered environment so that it is more likely to detect bats using search phase calls.

1. Load auto-identification analysis results into a database in order to expedite hand review of calls by sorting calls to species or species groups and/or sorting on call characteristics.
2. Look at search phase calls (not approach calls, feeding buzzes, or social calls) within a sequence.
3. Choose noise free calls with harmonics so that you are more likely to see the whole call instead of just a portion. Note that some calls may be oversaturated if the bat closely approached the microphone and these should be avoided if possible.
4. Look at the entire sequence in both compressed and real time views. This will help you see the whole picture (Are there multiple bats? Are there feeding buzzes or other non-search phase calls?). This is particularly important for differentiating EPFU vs. ANPA, MYLU vs. LABO, and for COTO in general since many other species may have calls that mimic COTO.

5. Look at the standard view for multiple calls within a sequence. BE AWARE that Sonobat sometimes identifies incorrect characteristics, analyzes strong harmonics instead of the primary call, and occasionally includes noise along with the primary call of interest.

[1] Adapted from Humbolt State University Bat Lab. 2011. Eastern and Western US Bat Keys.

[2] Reviewed in Fenton, M. B. 2013. Questions, ideas and tools: lessons from bat echolocation. Animal Behaviour 85, 869-879. Originally described in Griffin, D. R., et al. 1960. The echolocation of flying insects by bats. Animal Behaviour 8, 141-154.

[3] Fenton, M. B. 2004. Bat Natural History and Echolocation. *In* Brigham, R. M.,et al., eds. Bat Echolocation Research: tools, techniques, and analysis. Bat Conservation International, Austin, TX.

[4] Elemans, C., et al. 2011. Superfast Muscles Set Maximum Call Rate in Echolocating Bats. Science 333, 1885-1888.

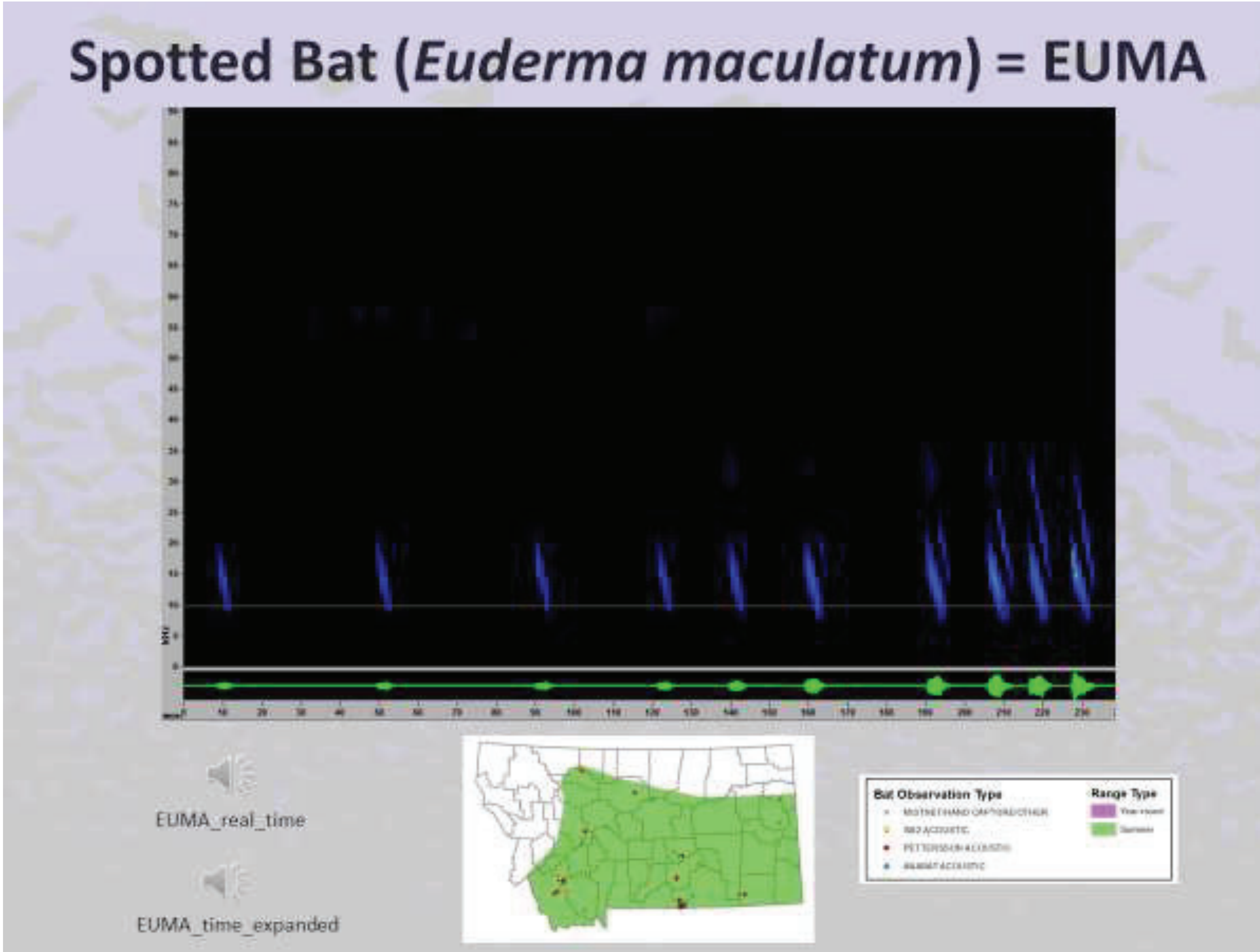


Figure 30. Example calls for the Spotted Bat (Euderma maculatum, EUMA)

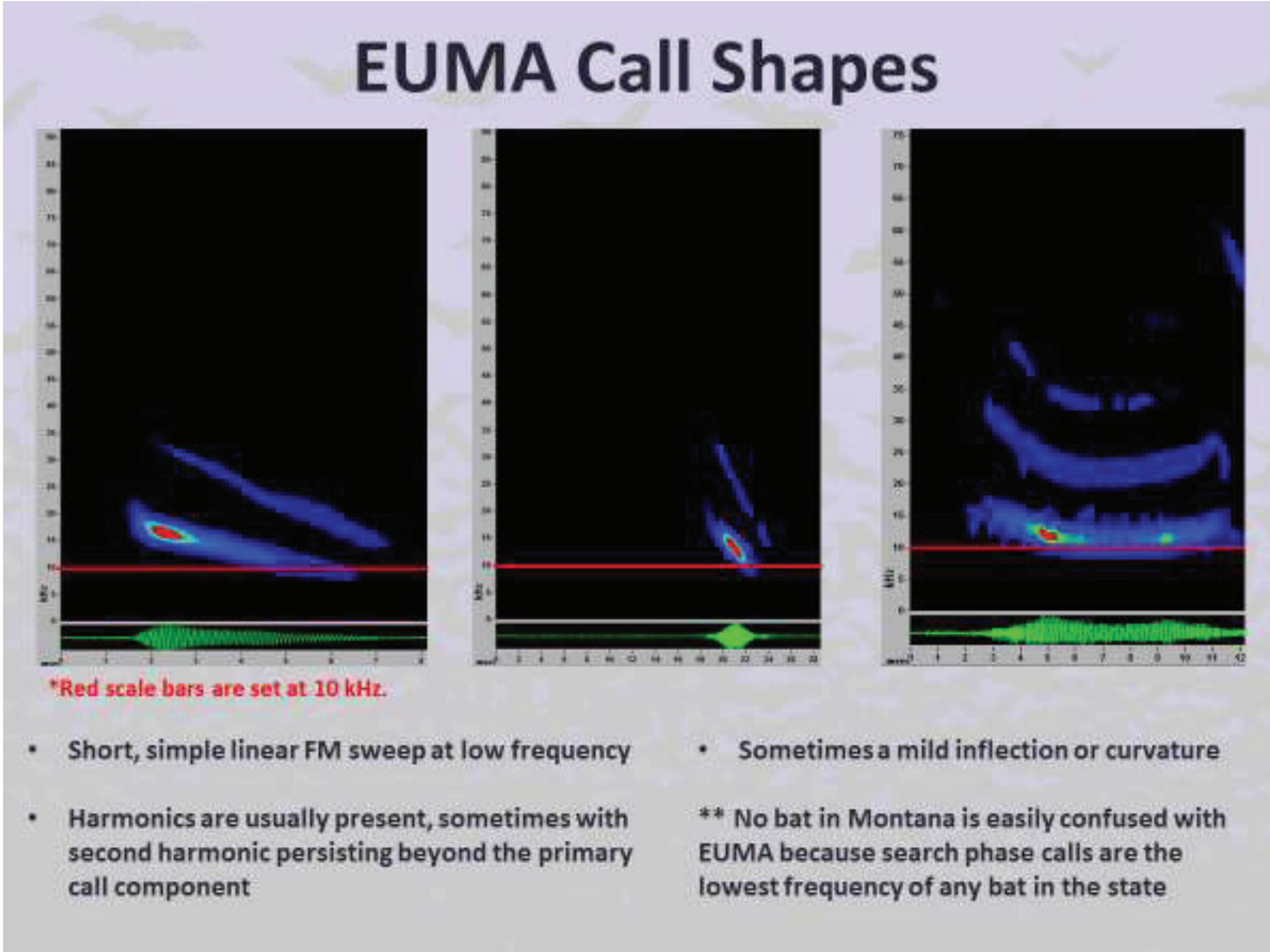


Figure 31. Call shapes of the Spotted Bat (Euderma maculatum, EUMA)

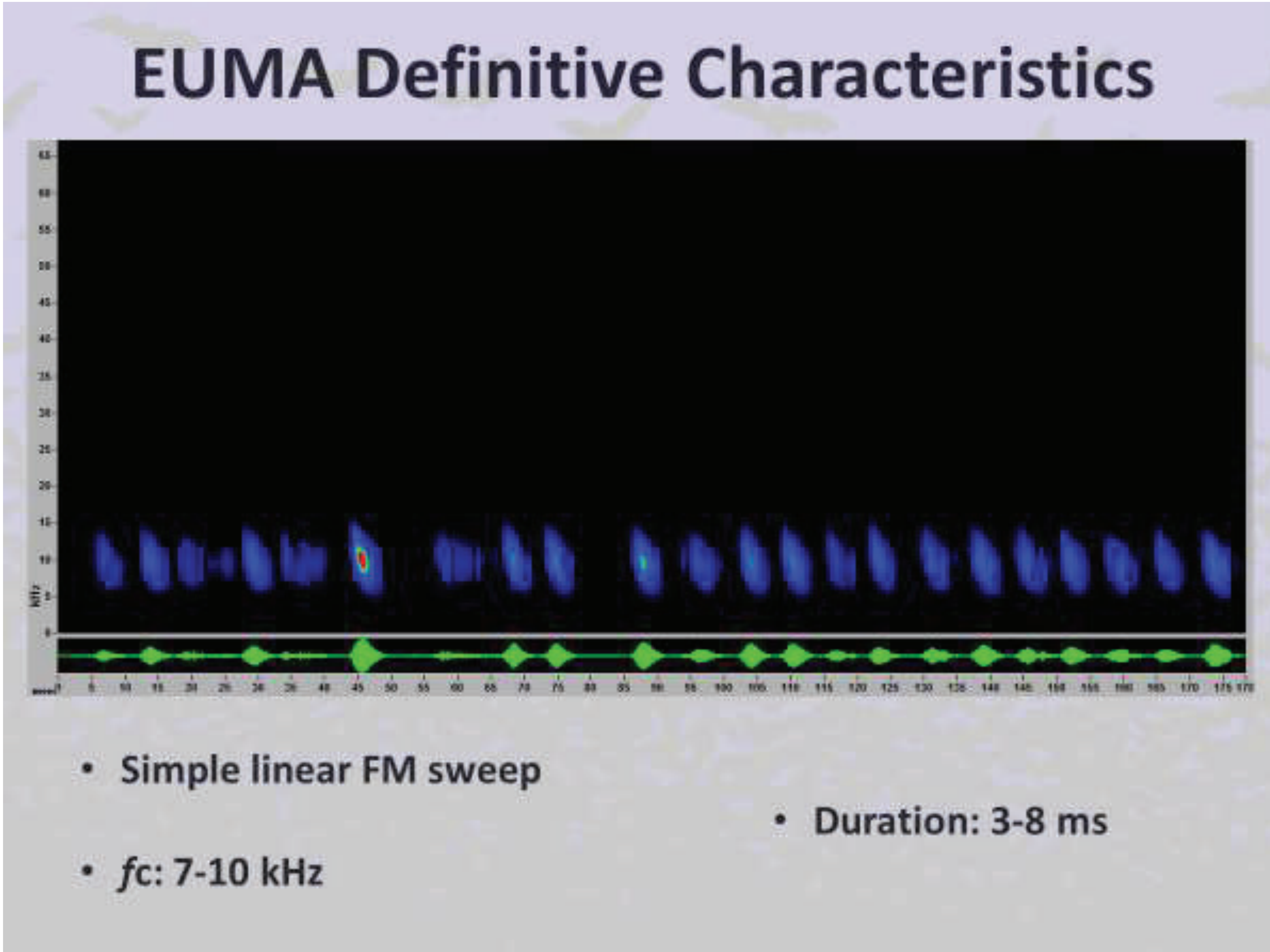


Figure 32. Difinative characteristics for the Spotted Bat (Euderma maculatum, EUMA)

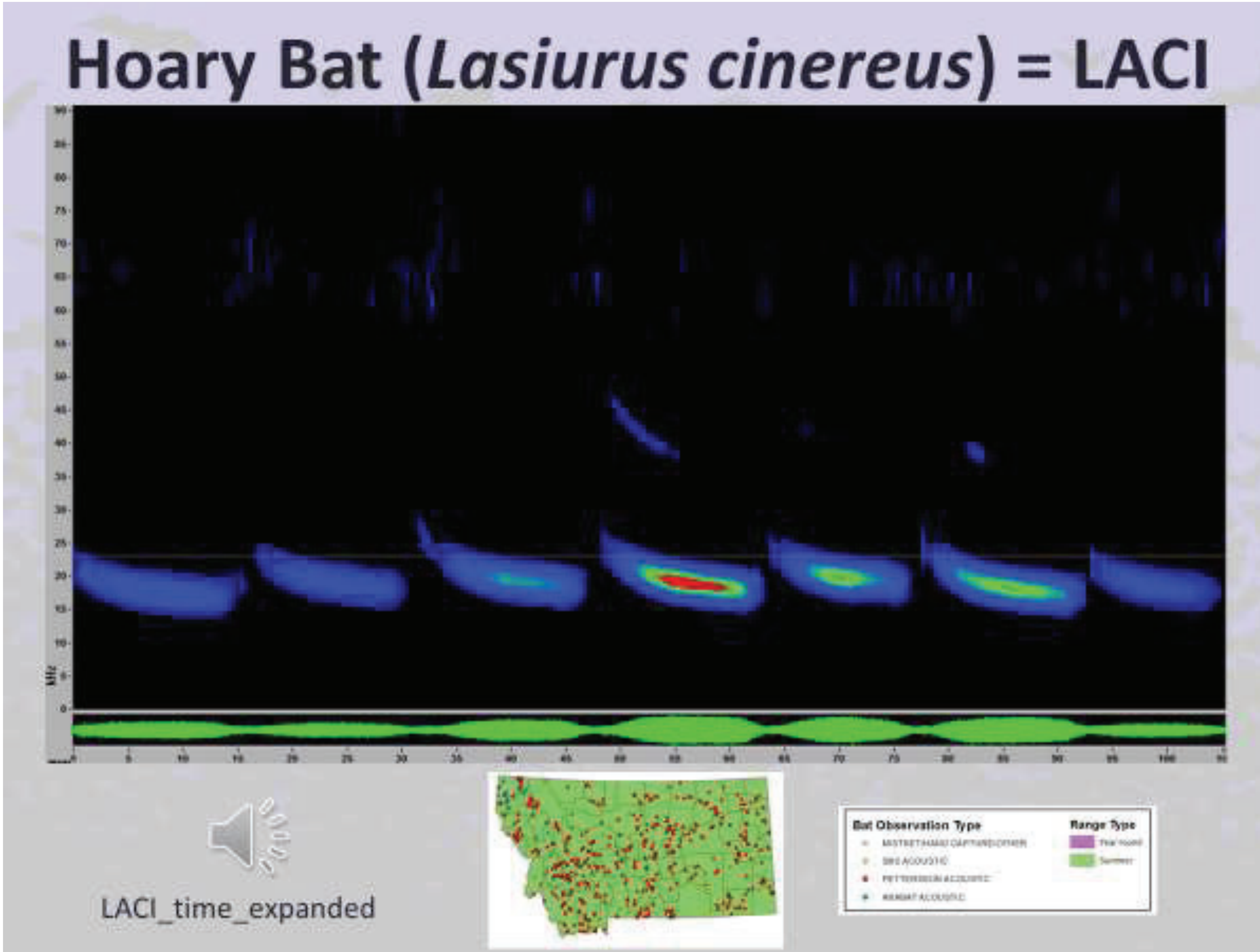


Figure 33. Example calls for the Hoary Bat (Lasiurus cinereus, LACI)

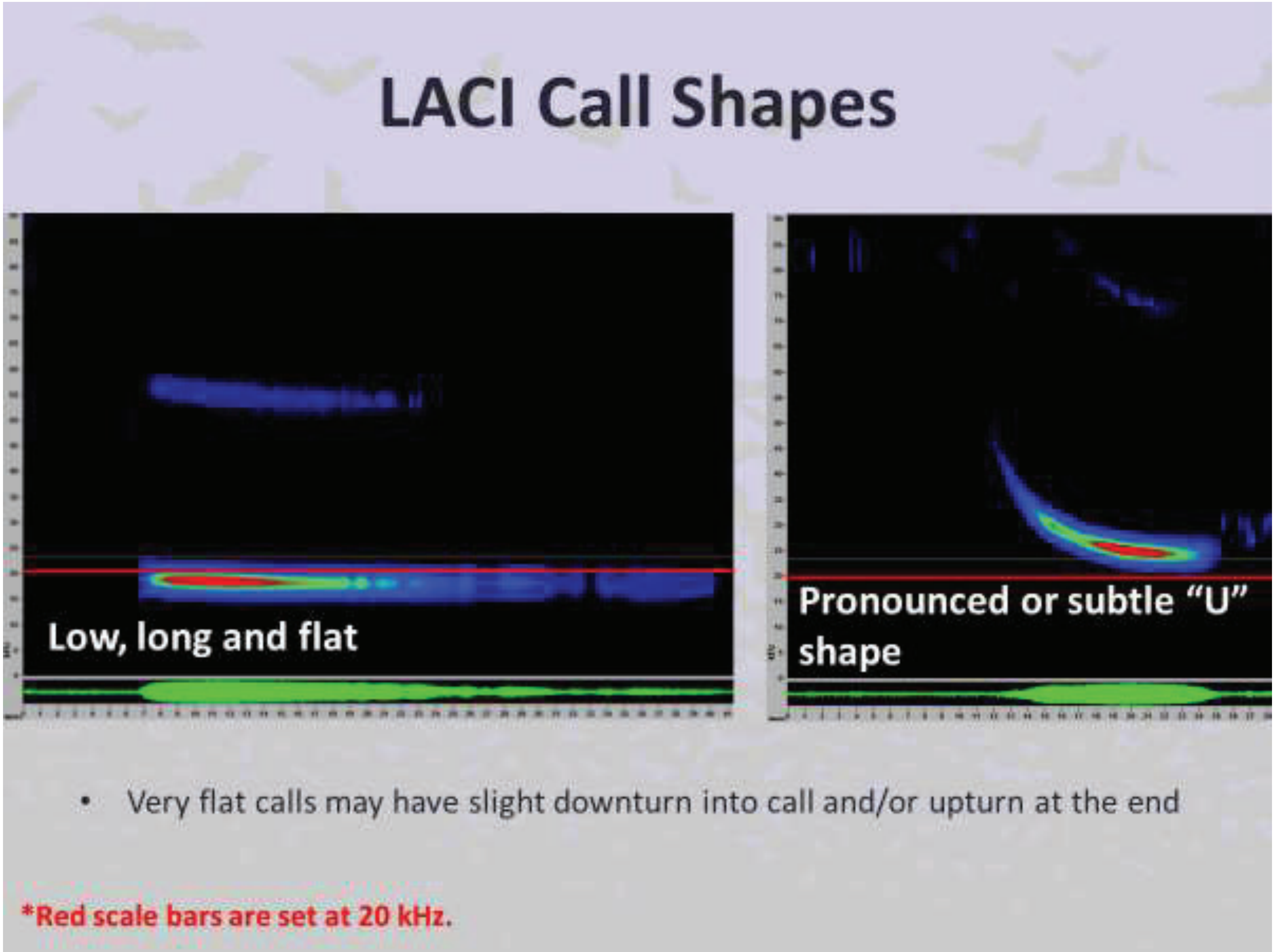


Figure 34. Call shapes of the Hoary Bat (Lasiurus cinereus, LACI)

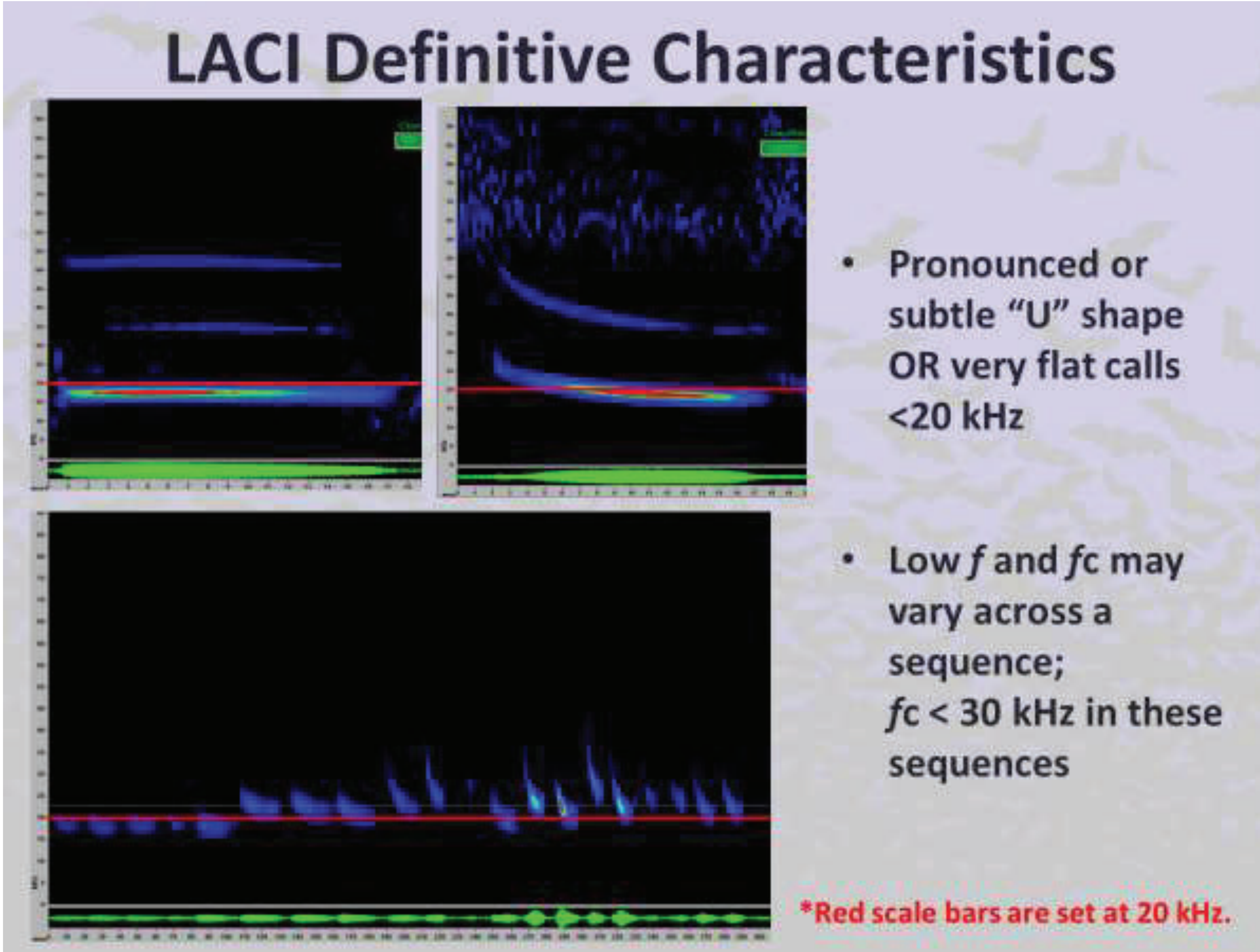


Figure 35. Definitive call characteristics for the Hoary Bat (Lasiurus cinereus, LACI)

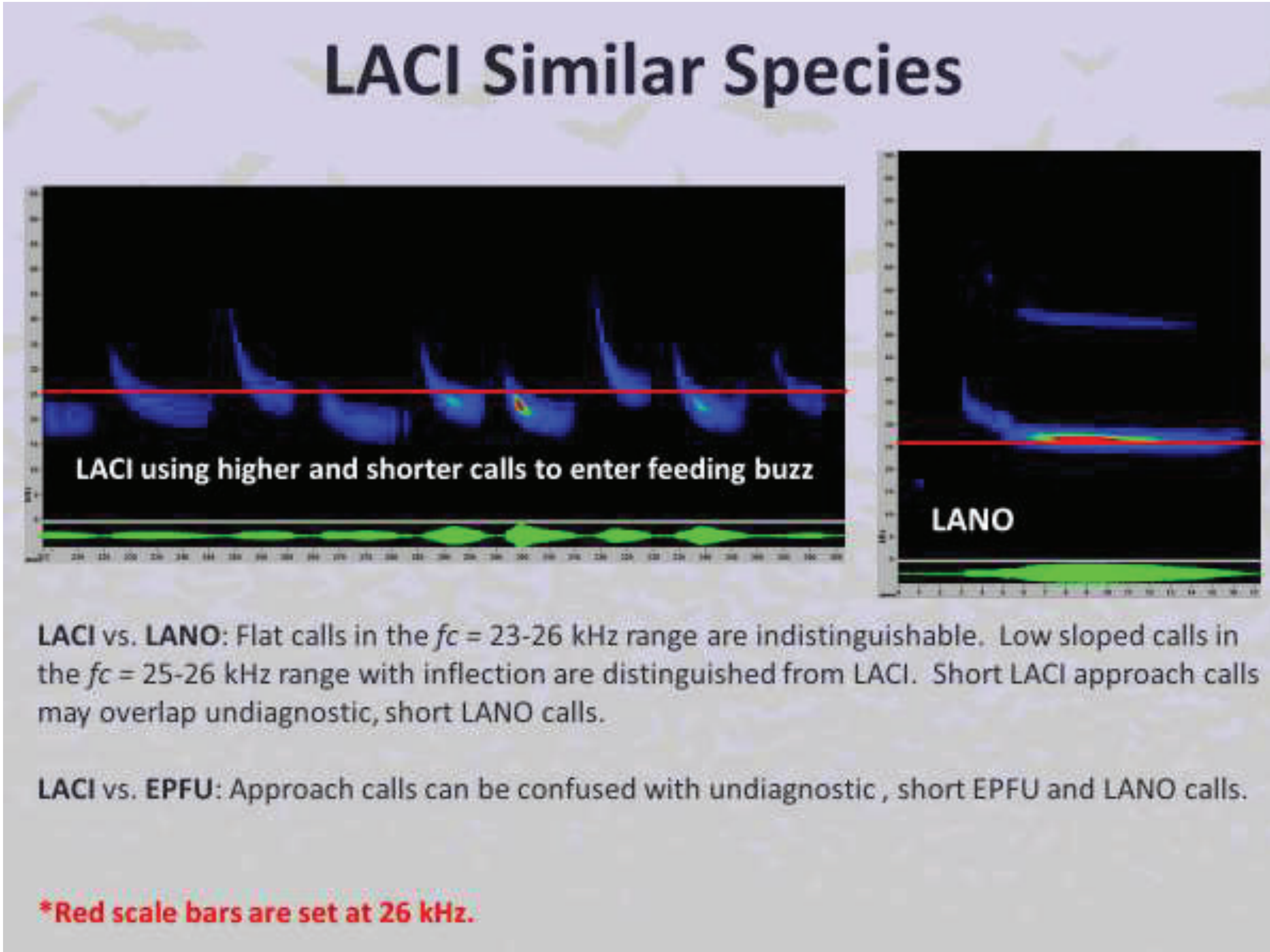


Figure 36. Call sequences produced by other species that may be confused with the Hoary Bat (Lasiurus cinereus, LACI)

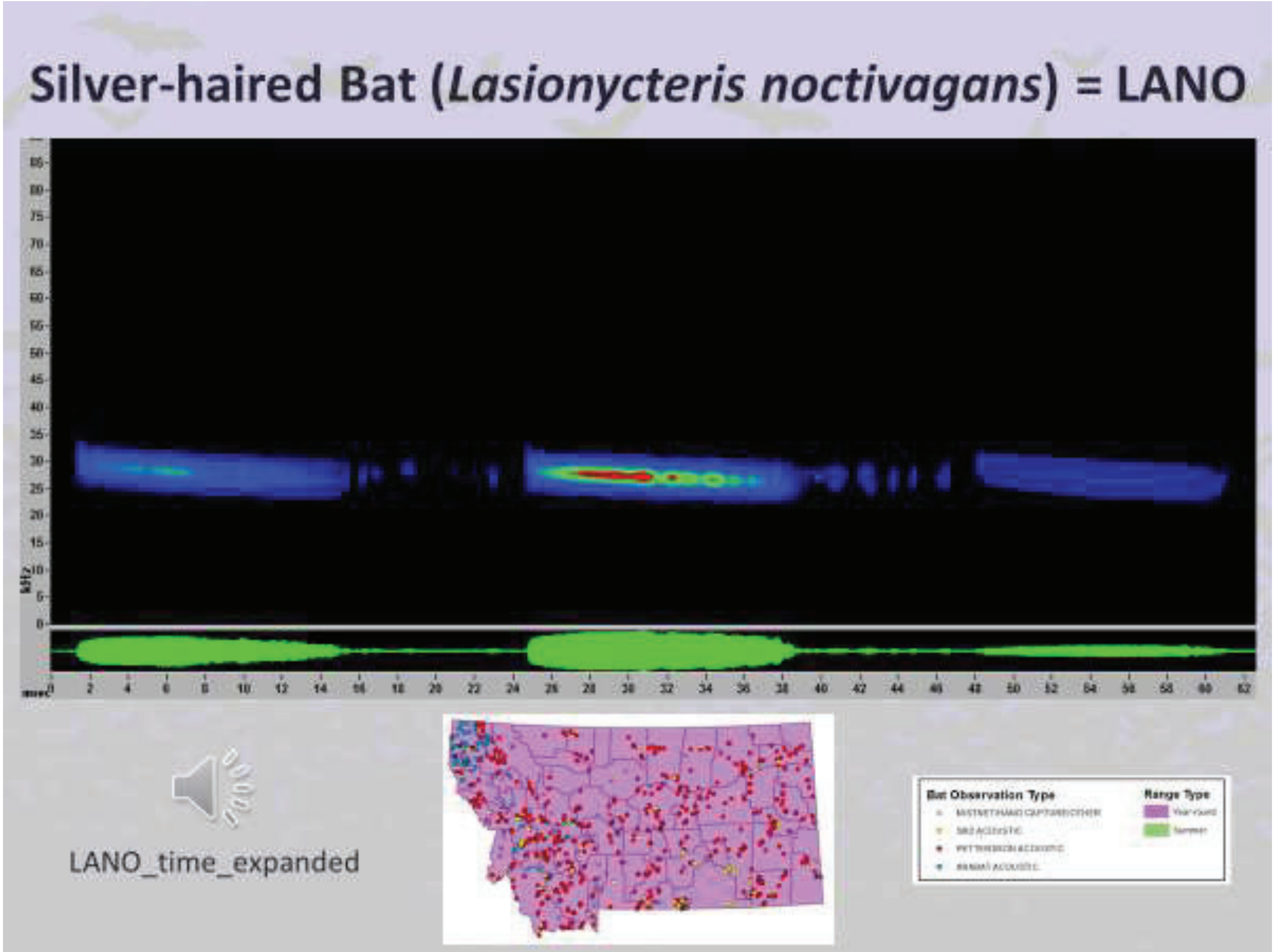


Figure 37. Example call sequence for the Silver-haired Bat (Lasionycteris noctivagans, LANO)

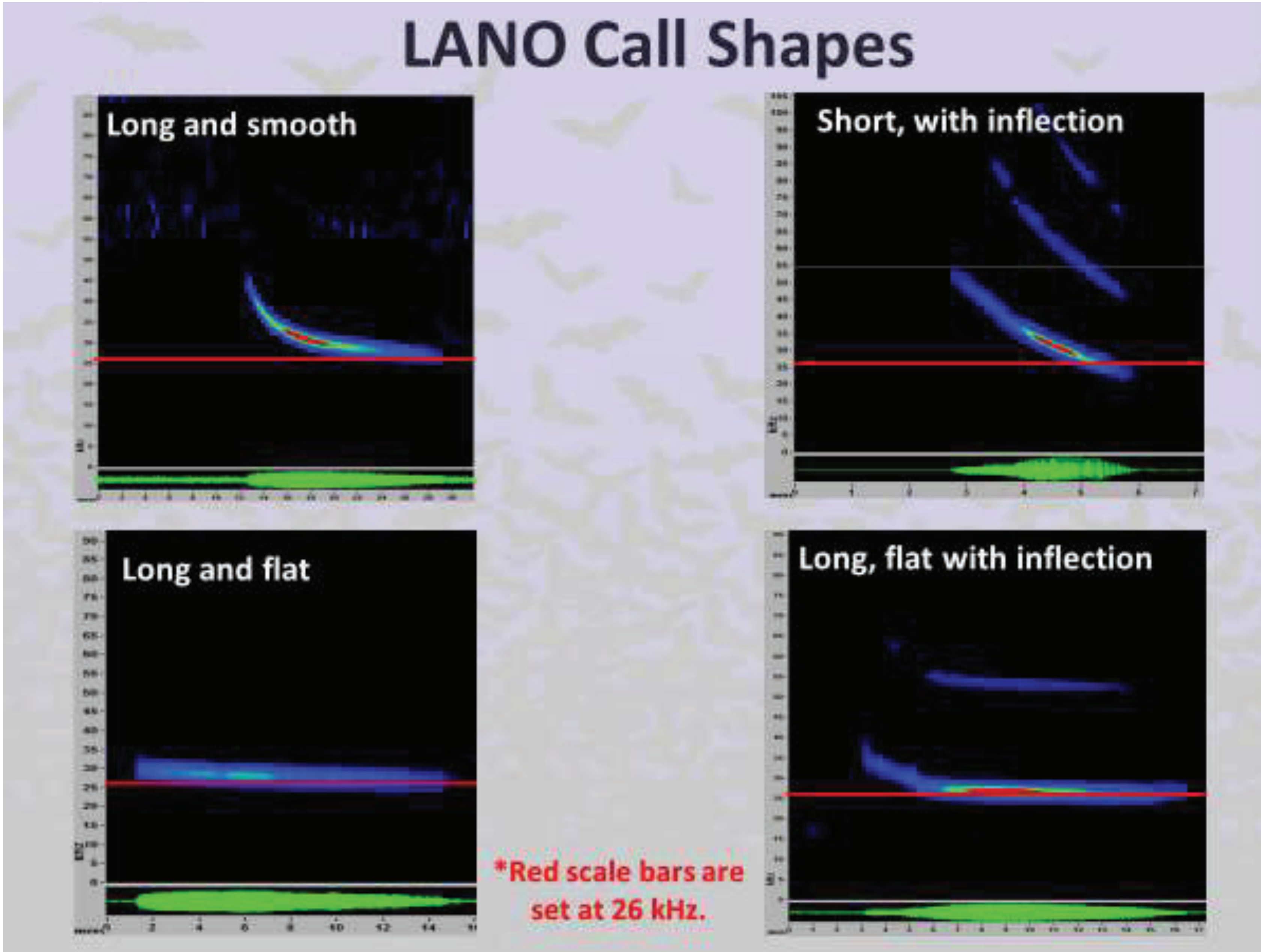


Figure 38. Call shapes of the Silver-haired Bat (Lasionycteris noctivagans, LANO)

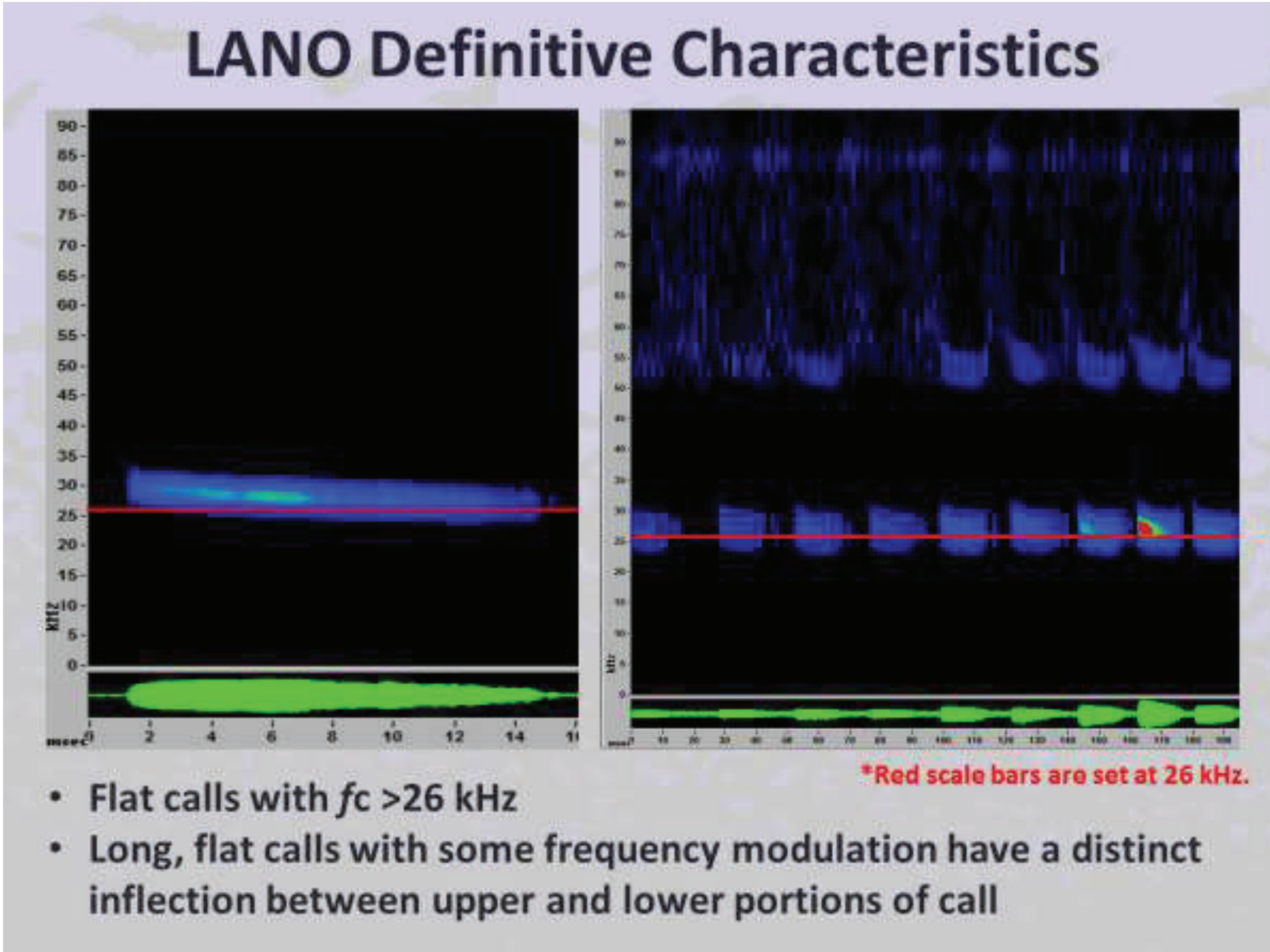


Figure 39. Definitive characteristics of call sequence for the Silver-haired Bat (Lasionycteris noctivagans, LANO)

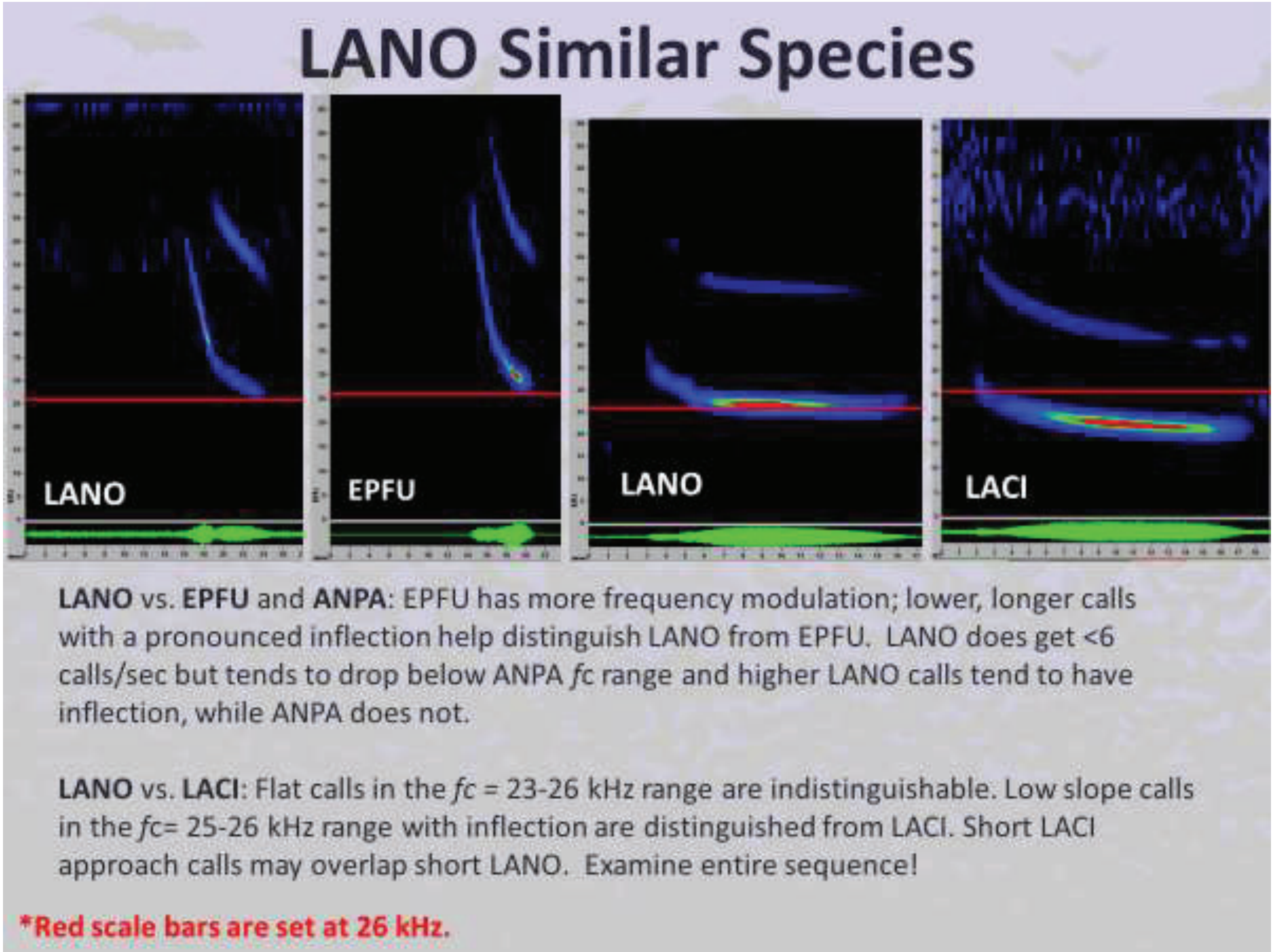


Figure 40. Calls sequences produced by other species that may be confused with the Silver-haired Bat (Lasionycteris noctivagans, LANO)

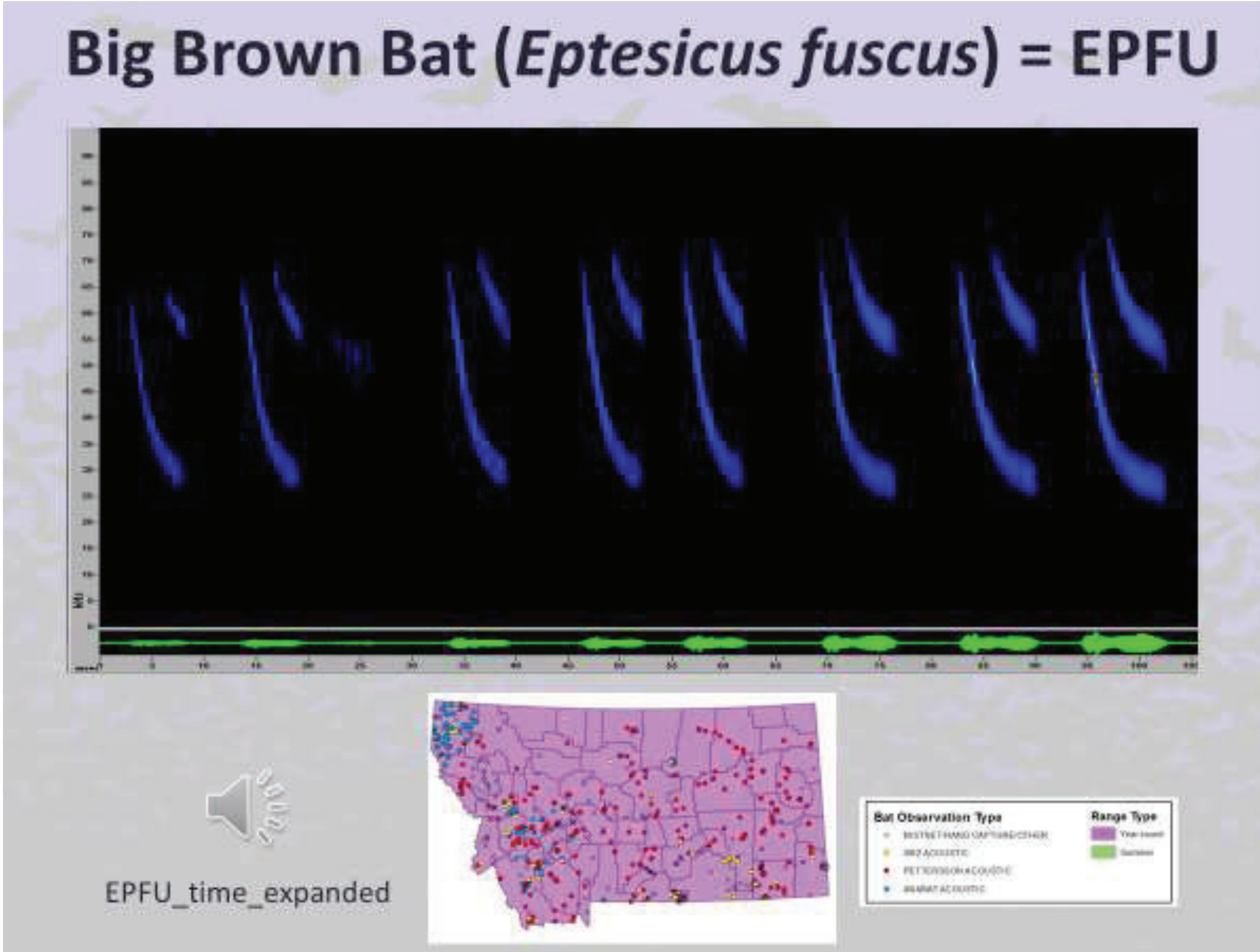


Figure 41. Example call sequence for the Big Brown Bat (Eptesicus fuscus, EPFU)

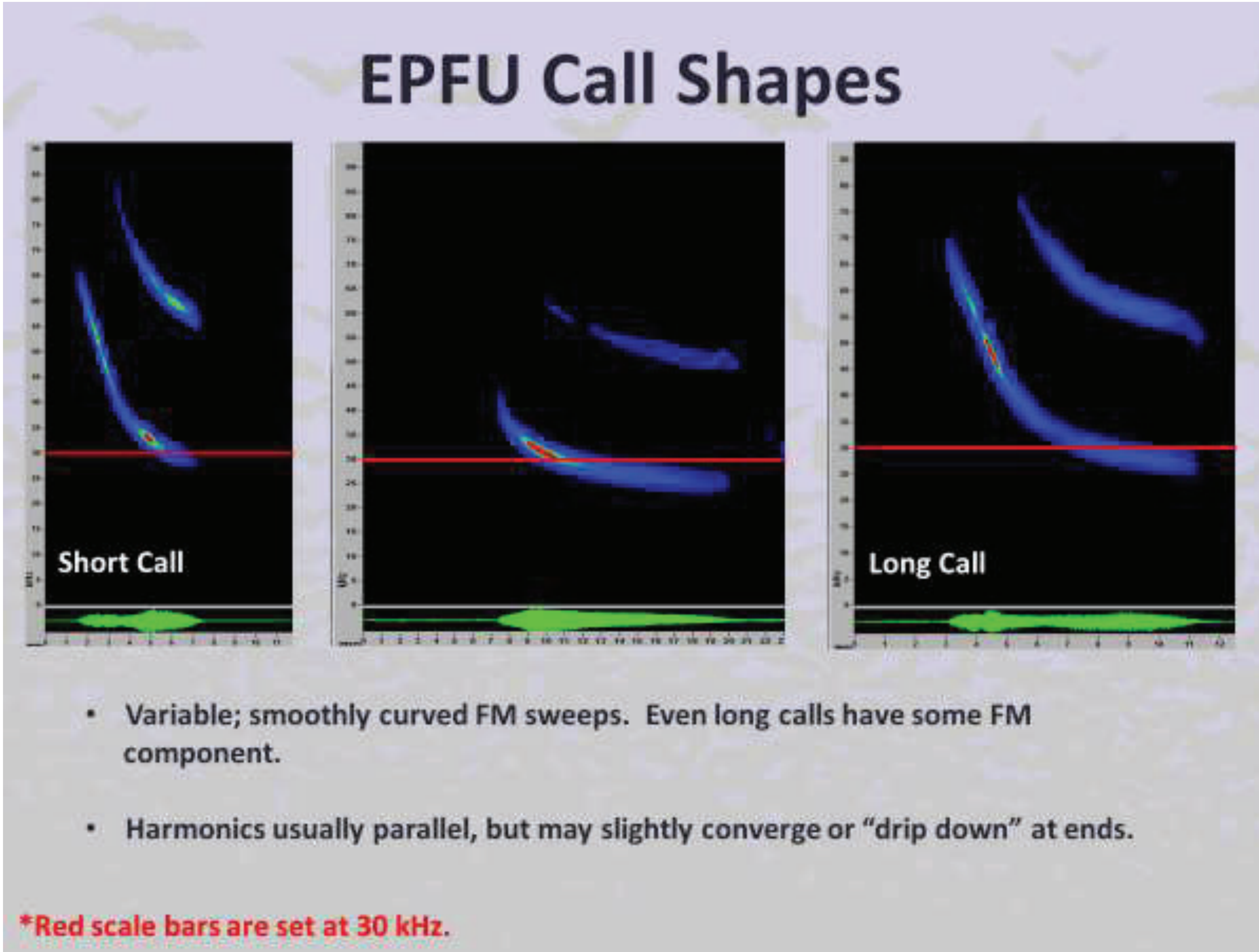


Figure 42. Call shapes of the Big Brown Bat (Eptesicus fuscus, EPFU)

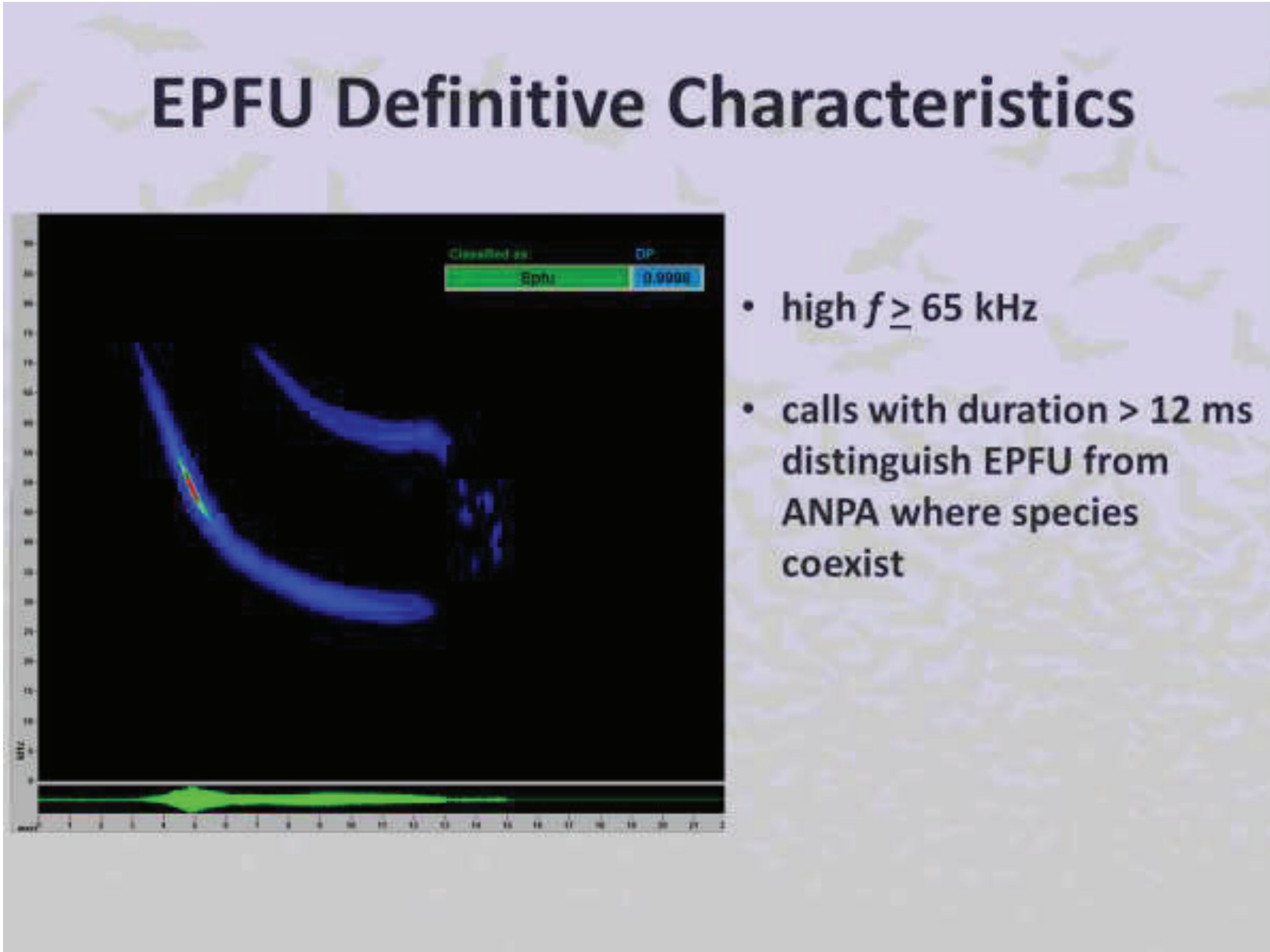


Figure 43. Definitive characteristics of call sequence for the Big Brown Bat (Eptesicus fuscus, EPFU)

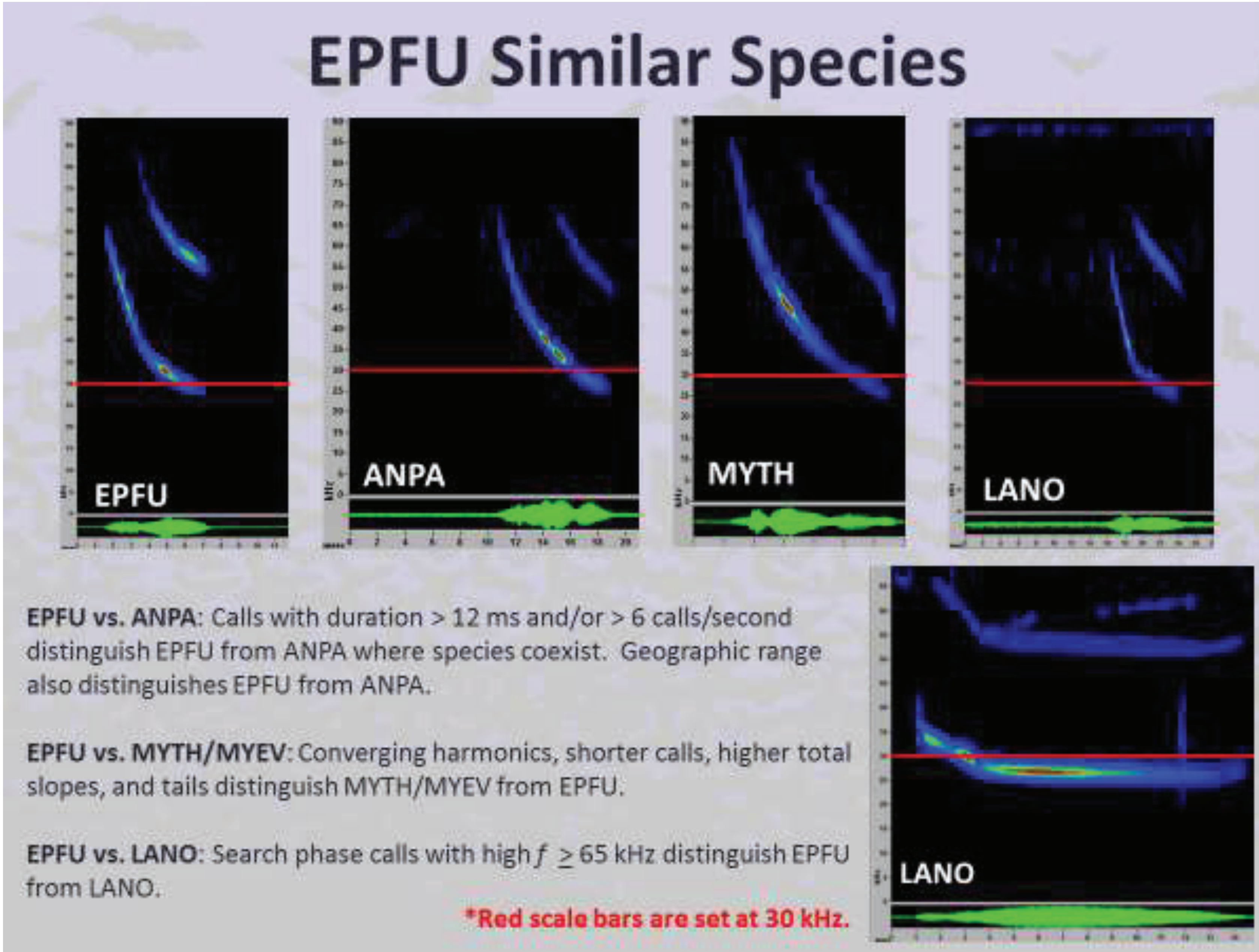


Figure 44. Calls sequences produced by other species that may be confused with the Big Brown Bat (Eptesicus fuscus, EPFU)

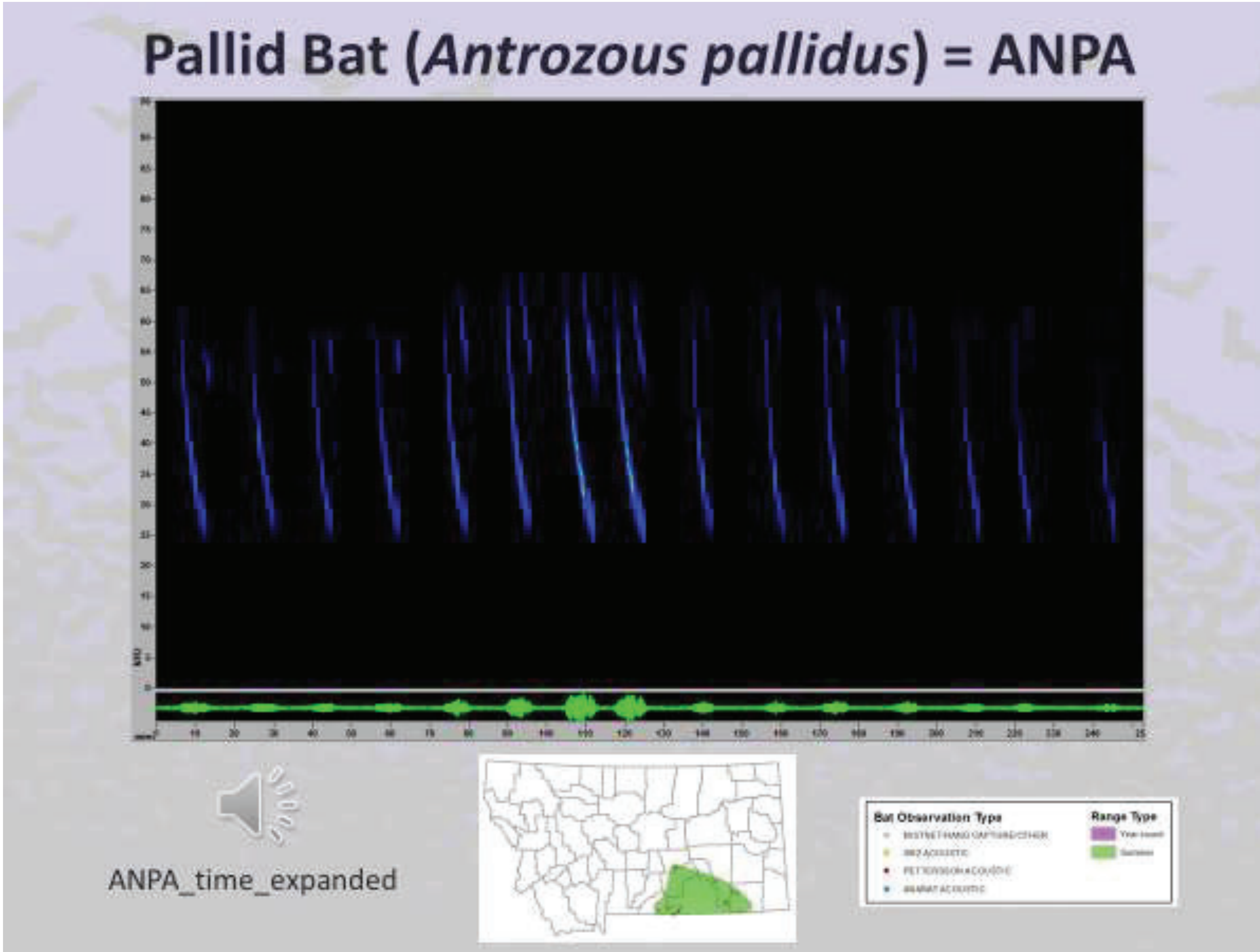


Figure 45. Example call sequence for the Pallid Bat (Antrozous pallidus, ANPA)

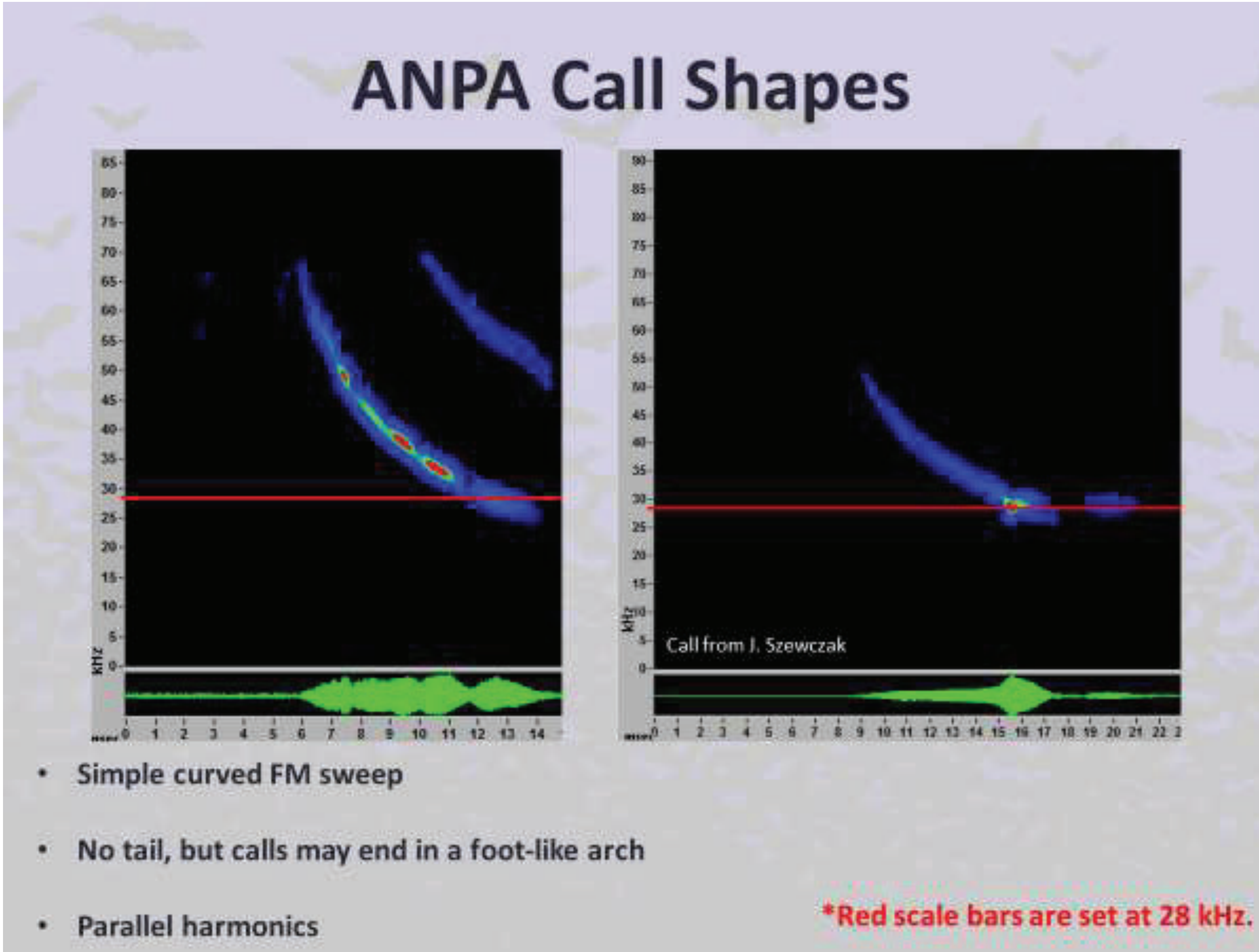


Figure 46. Call shapes of the Pallid Bat (Antrozous pallidus, ANPA)

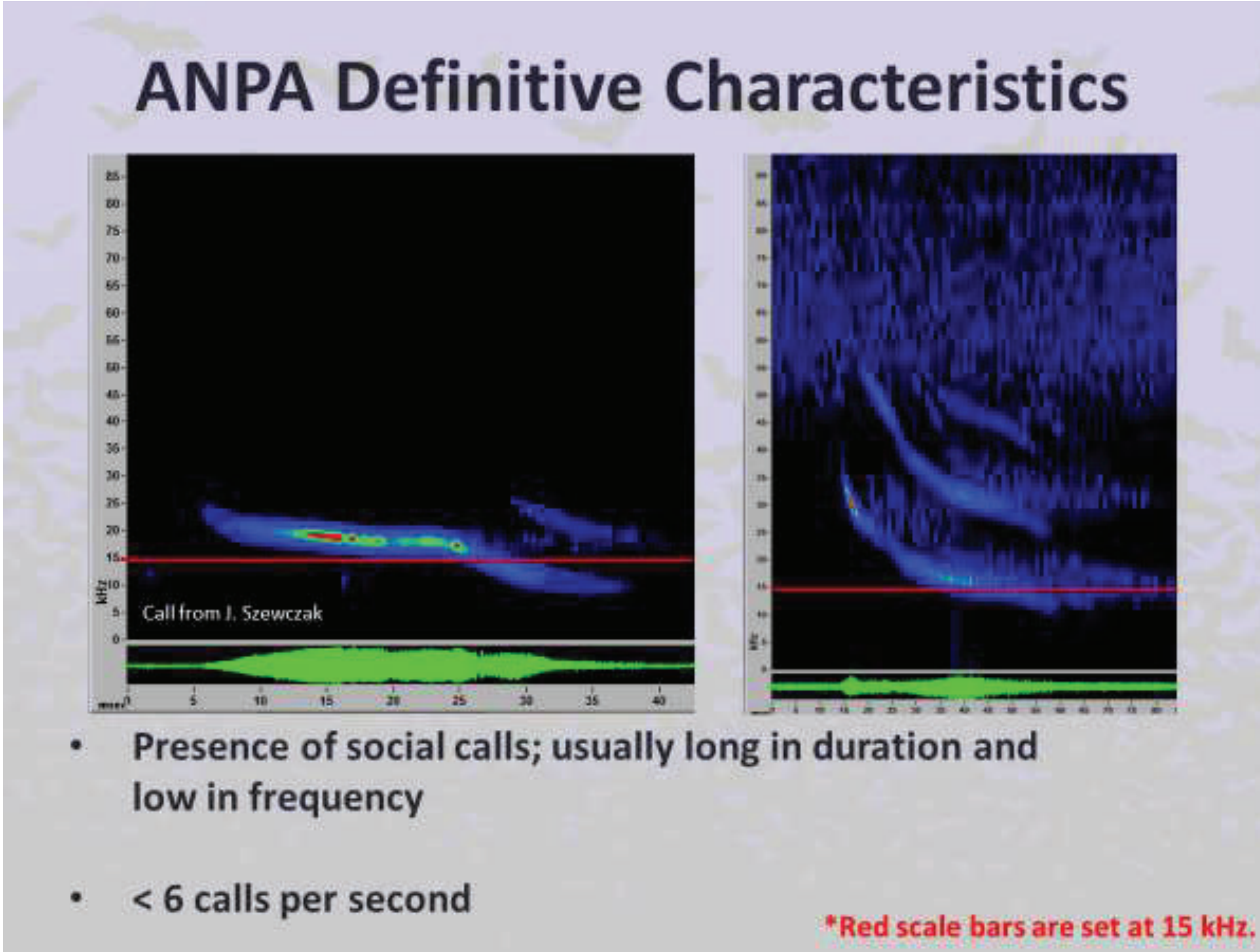


Figure 47.Definitive characteristics of call sequence for the Pallid Bat (Antrozous pallidus, ANPA)

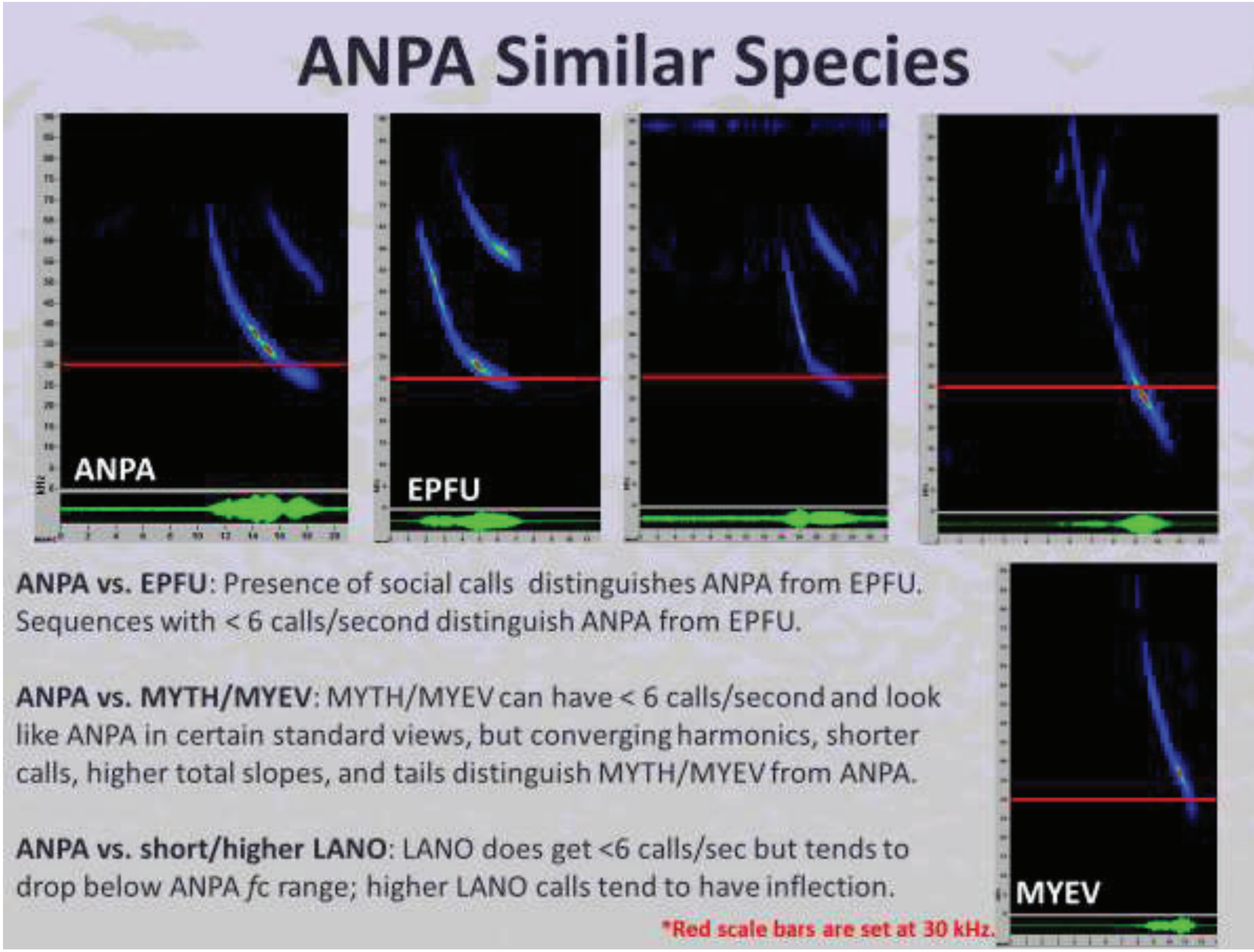


Figure 48. Calls sequences produced by other species that may be confused with the Pallid Bat (Antrozous pallidus, ANPA)

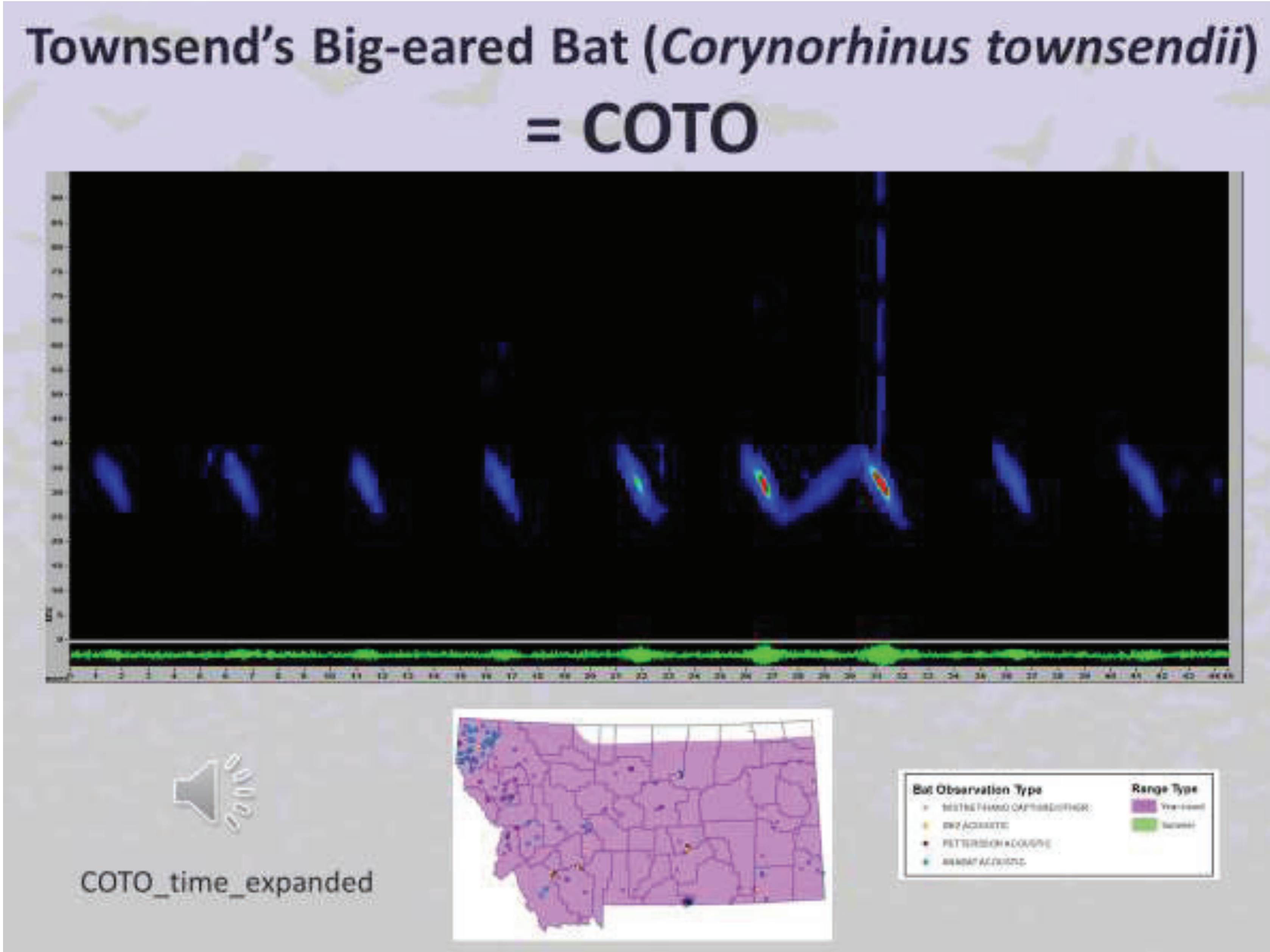


Figure 49. Example call sequence for the Townsend's Big-eared Bat (Corynorhinus townsendii, COTO)

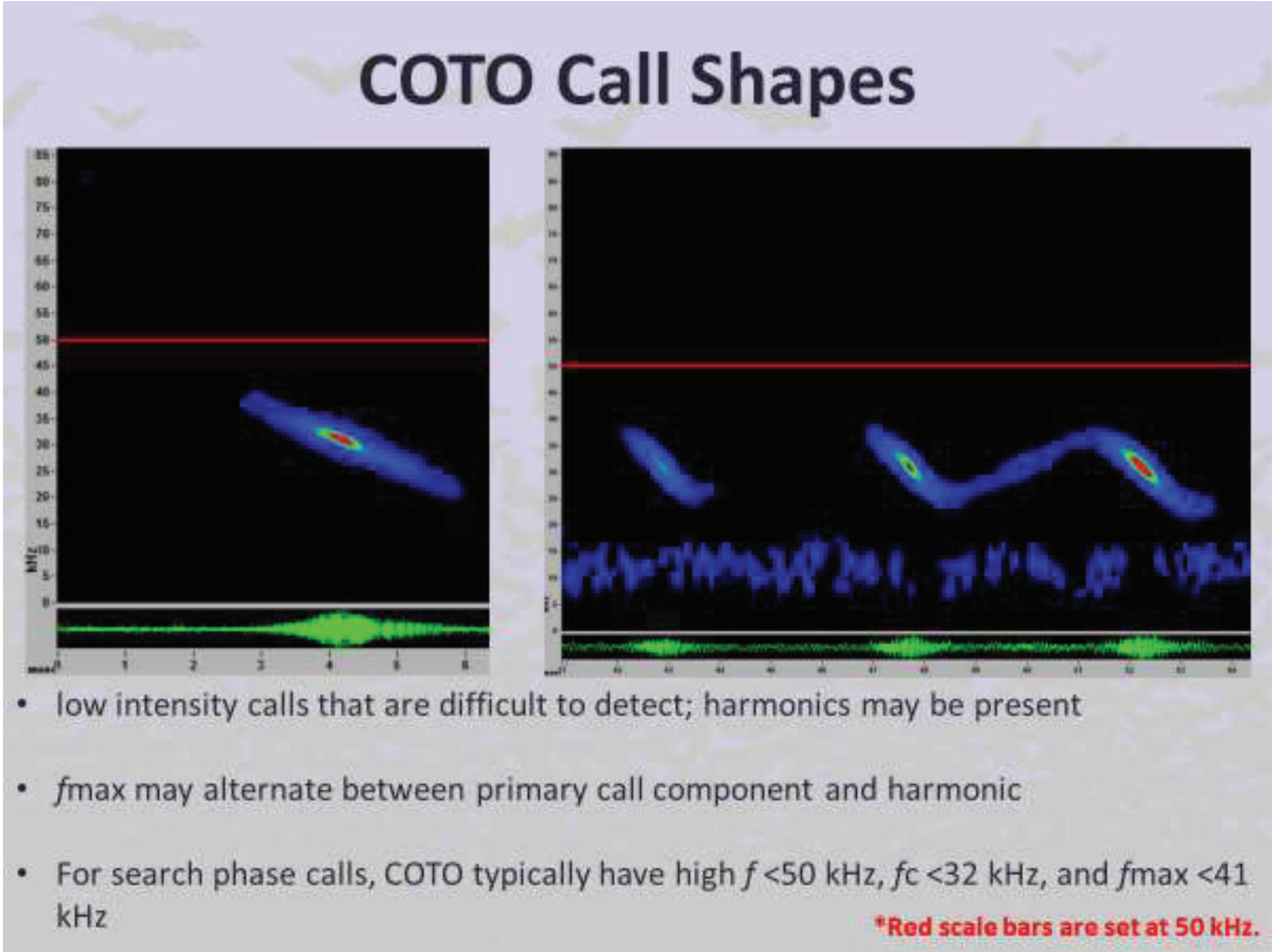


Figure 50. Call shapes of the Townsend's Big-eared Bat (Corynorhinus townsendii, COTO)

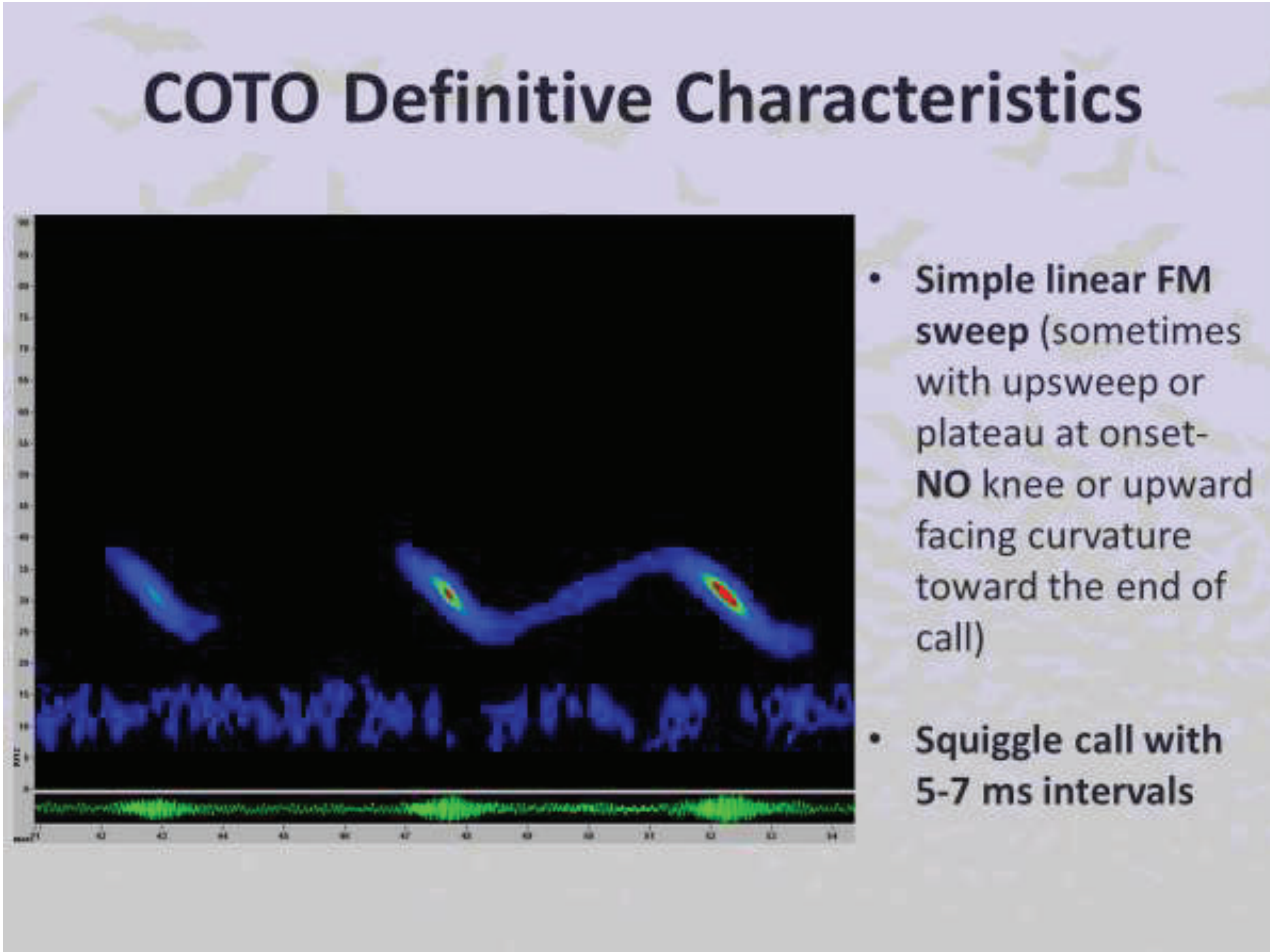


Figure 51. Definitive characteristics of call sequence for the Townsend's Big-eared Bat (Corynorhinus townsendii, COTO)

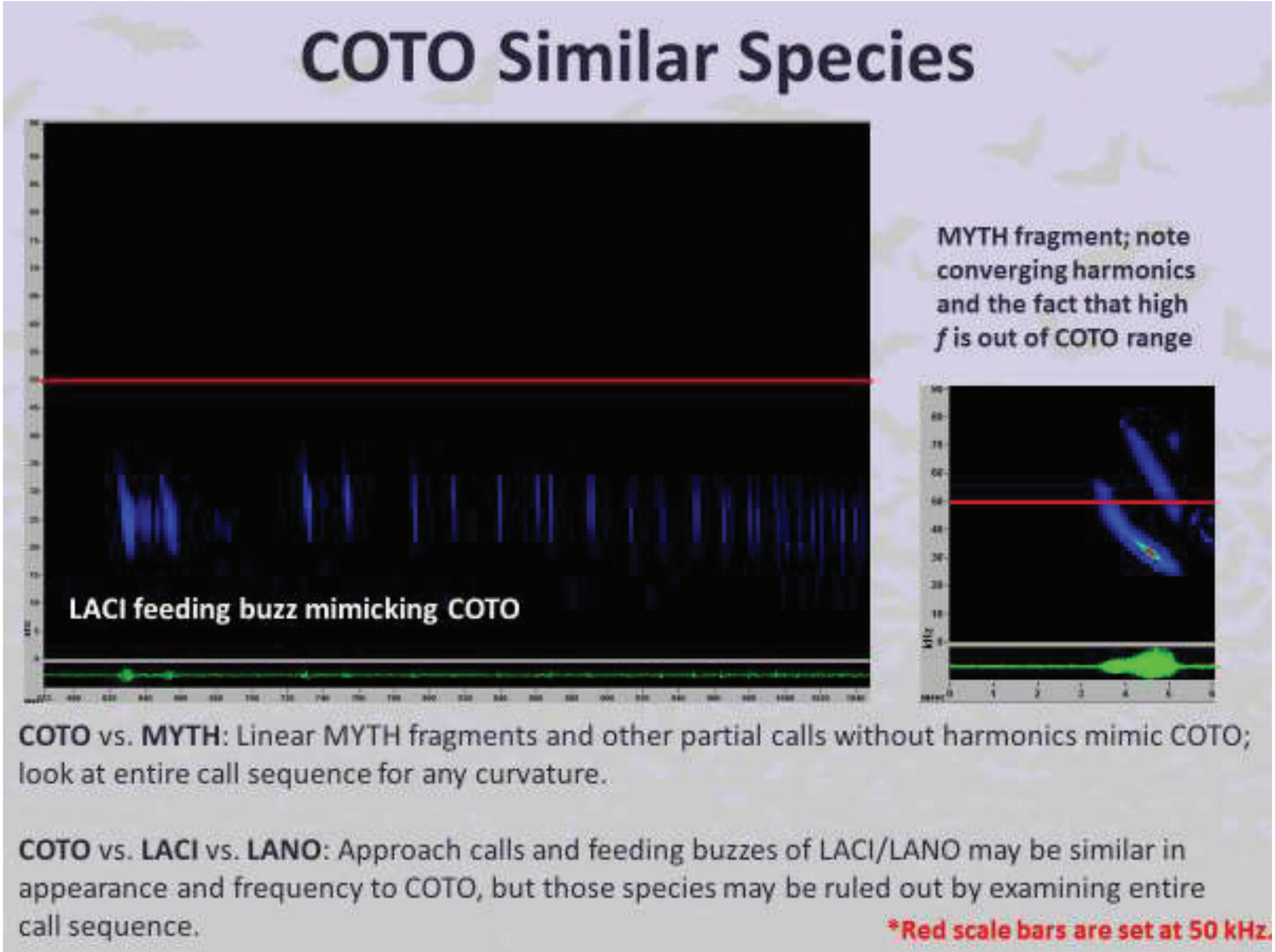


Figure 52. Calls sequences produced by other species that may be confused with the Townsend's Big-eared Bat (Corynorhinus townsendii, COTO)

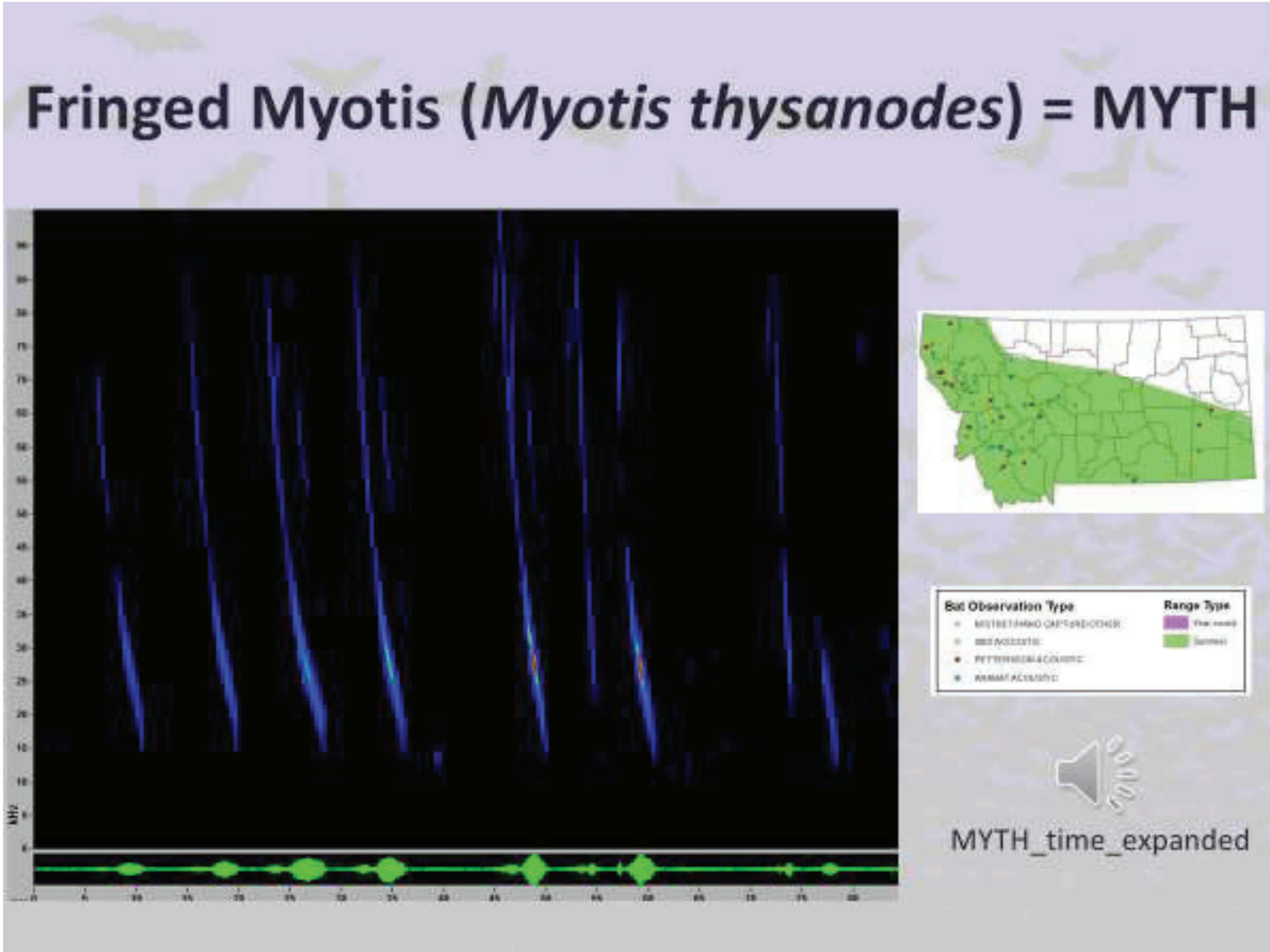


Figure 53. Example call sequence for the Fringed Myotis (Myotis thysanodes, MYTH)

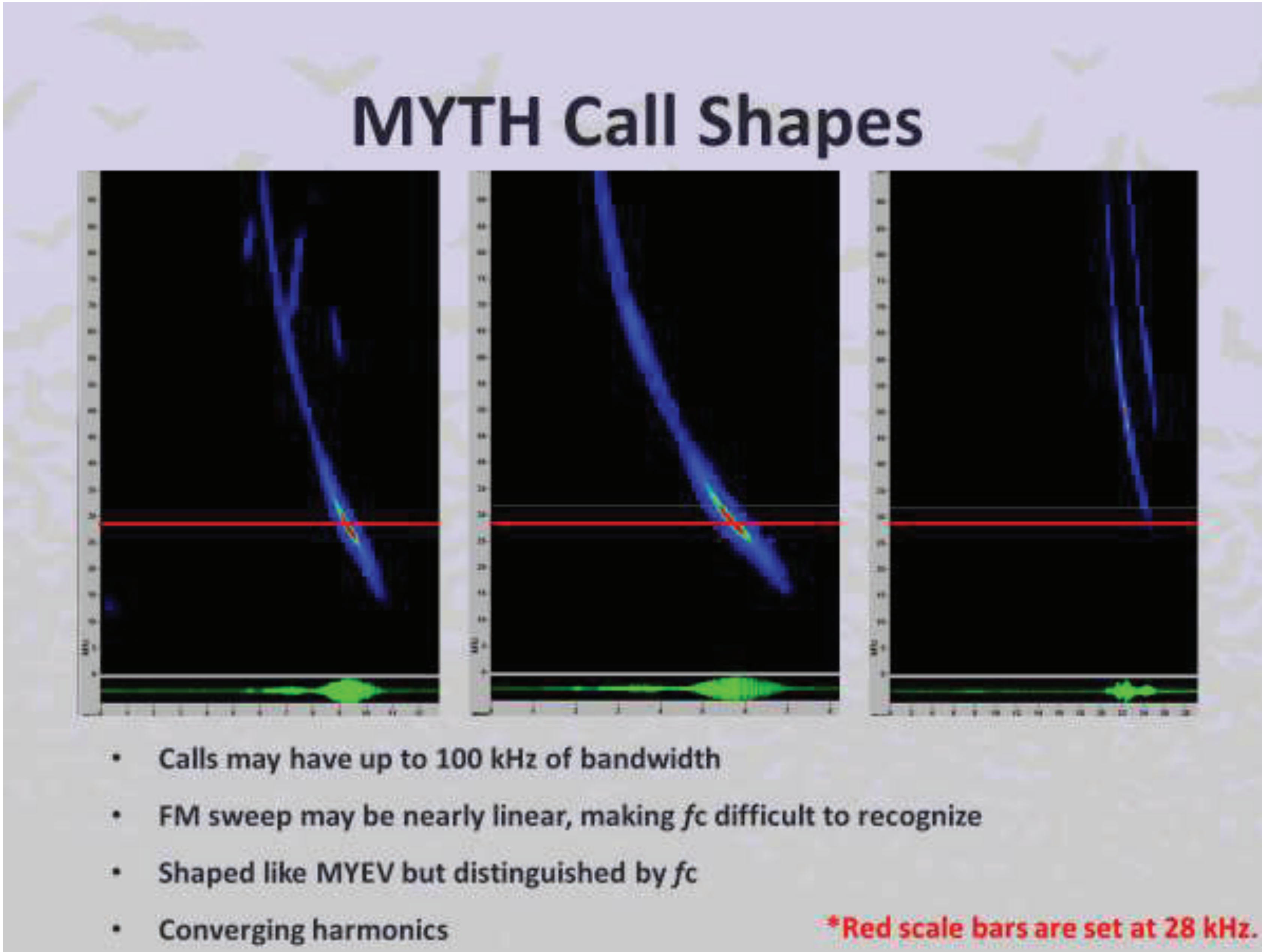


Figure 54. Call shapes of the Fringed Myotis (Myotis thysanodes, MYTH)

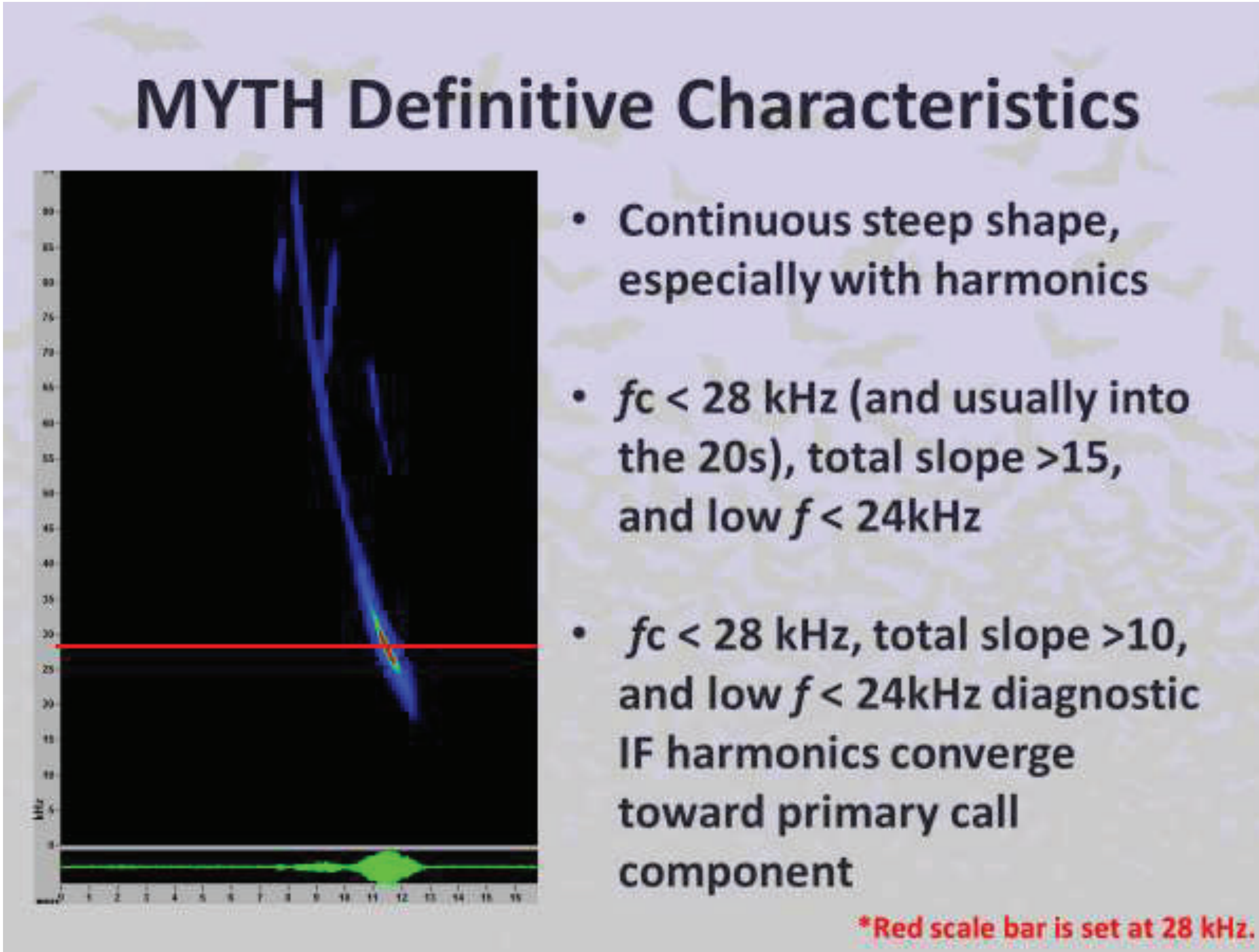


Figure 55. Definitive characteristics of call sequence for the Fringed Myotis (Myotis thysanodes, MYTH)

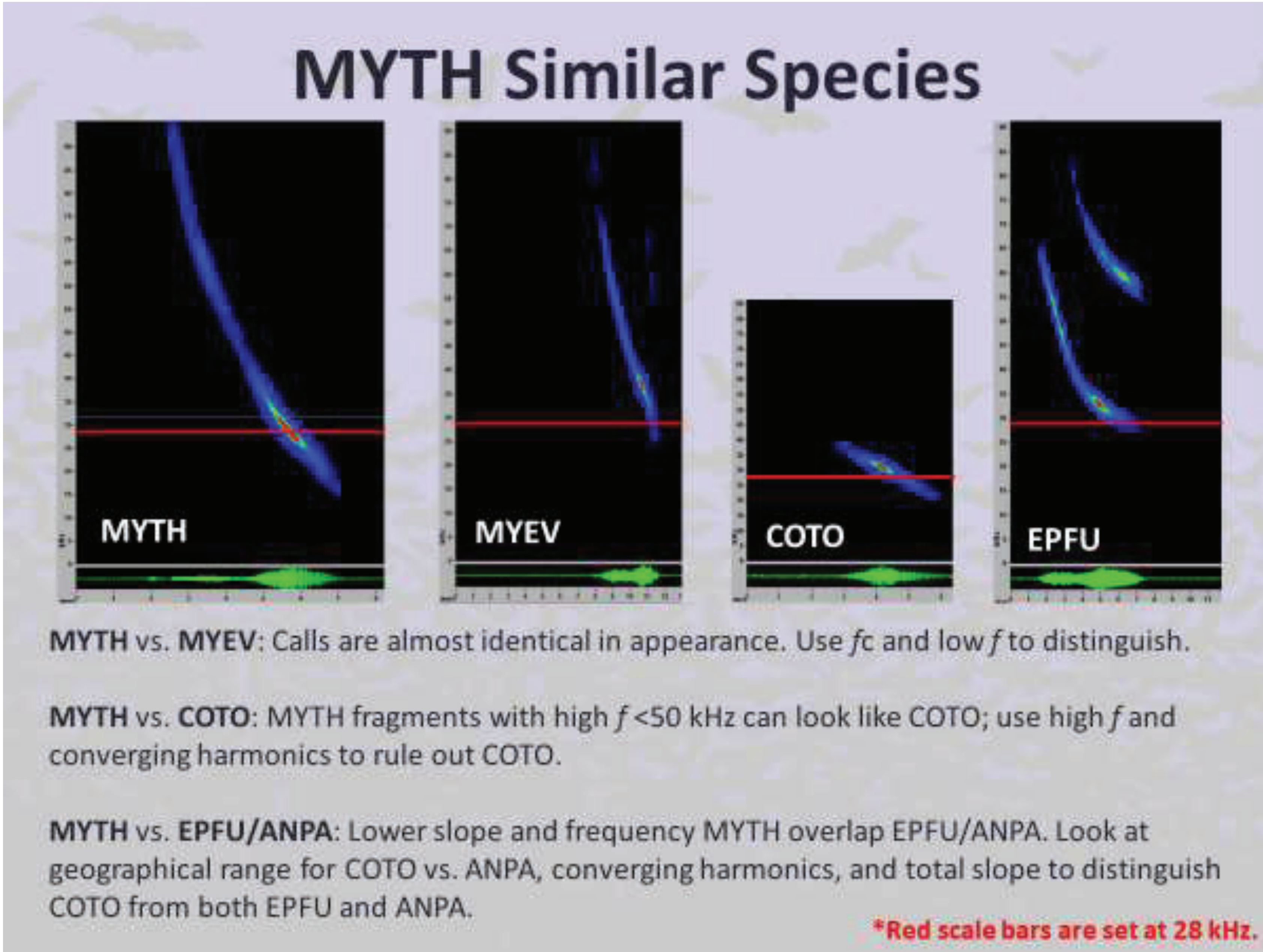


Figure 56. Calls sequences produced by other species that may be confused with the Fringed Myotis (Myotis thysanodes, MYTH)

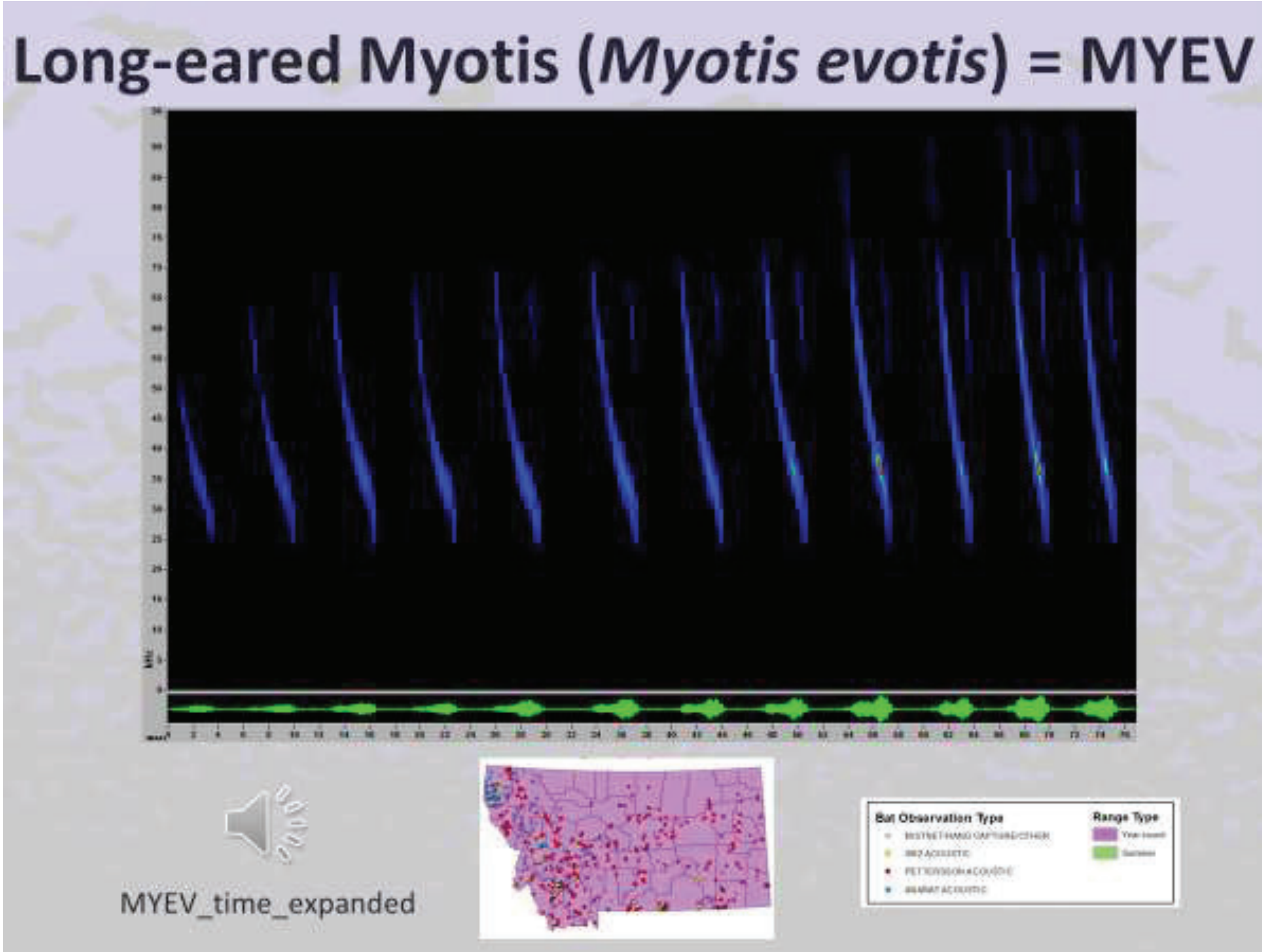


Figure 57. Example call sequence for the Long-eared Myotis (Myotis evotis, MYEV).

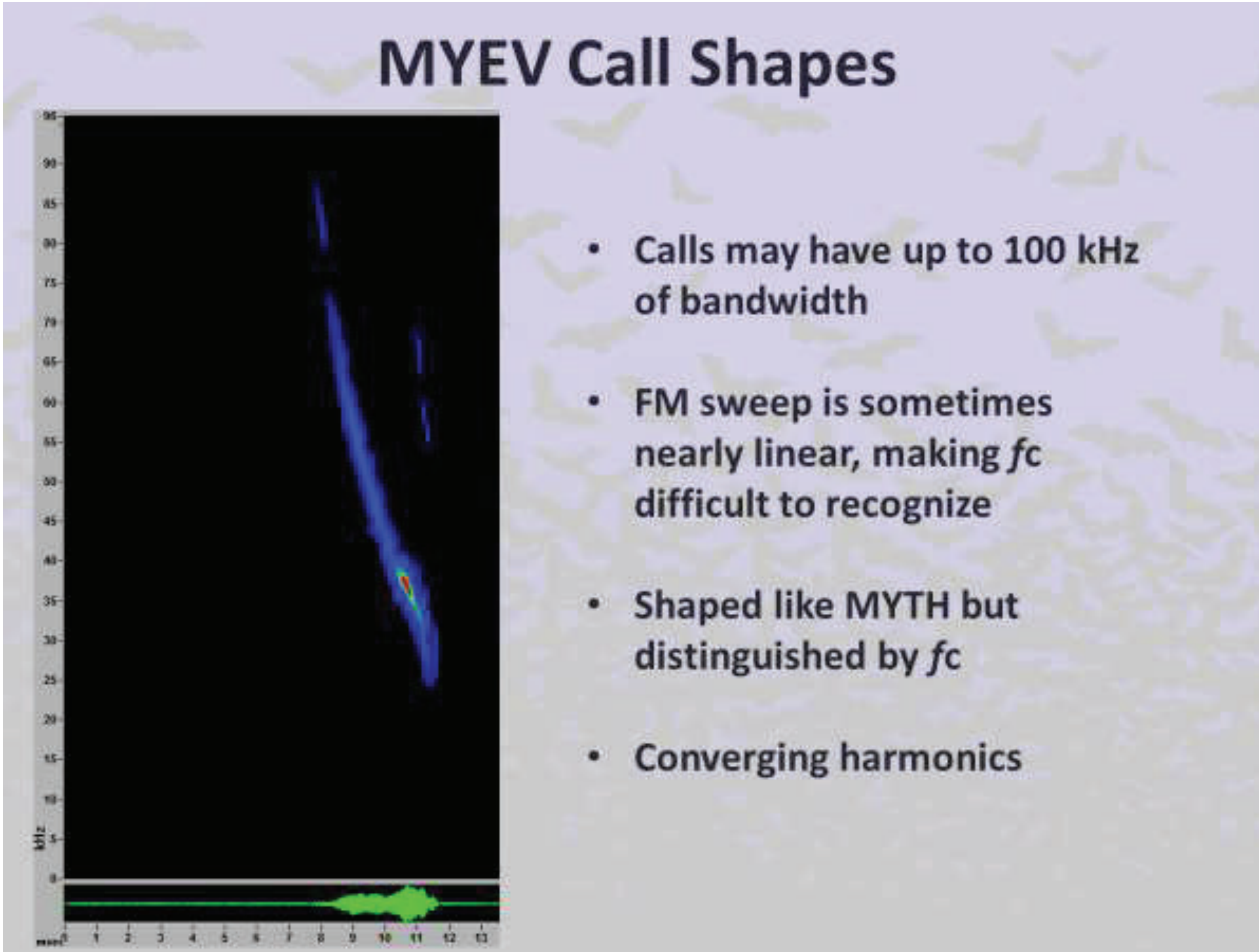
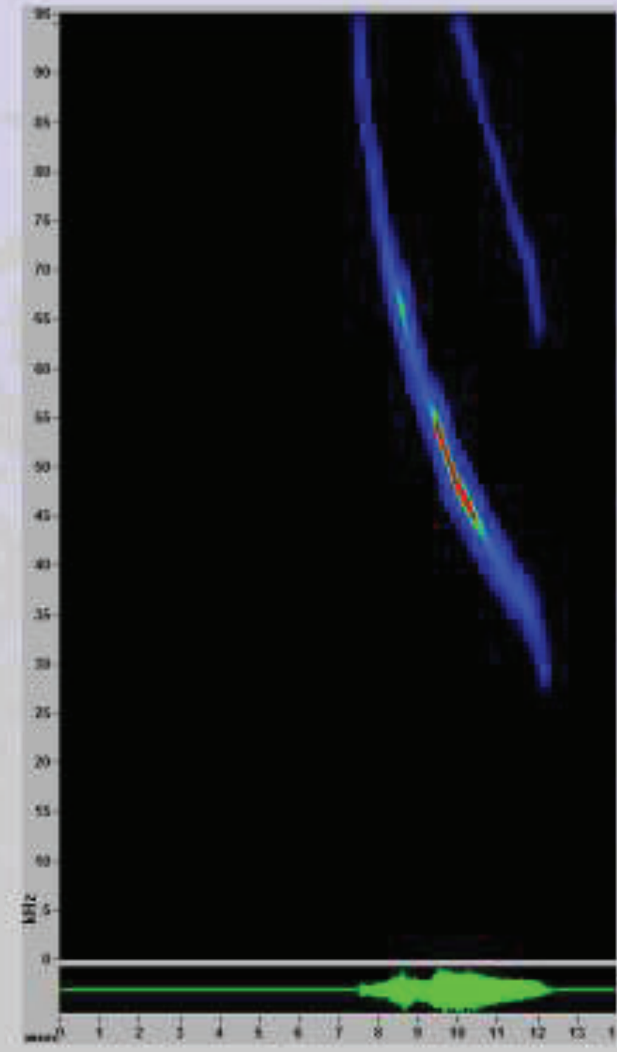


Figure 58. Call shapes of the Long-eared Myotis (Myotis evotis, MYEV)

MYEV Definitive Characteristics



- Converging harmonics
- *f*c: 32-36 kHz

Figure 59. Definitive characteristics of call sequence for the Long-eared Myotis (Myotis evotis, MYEV)

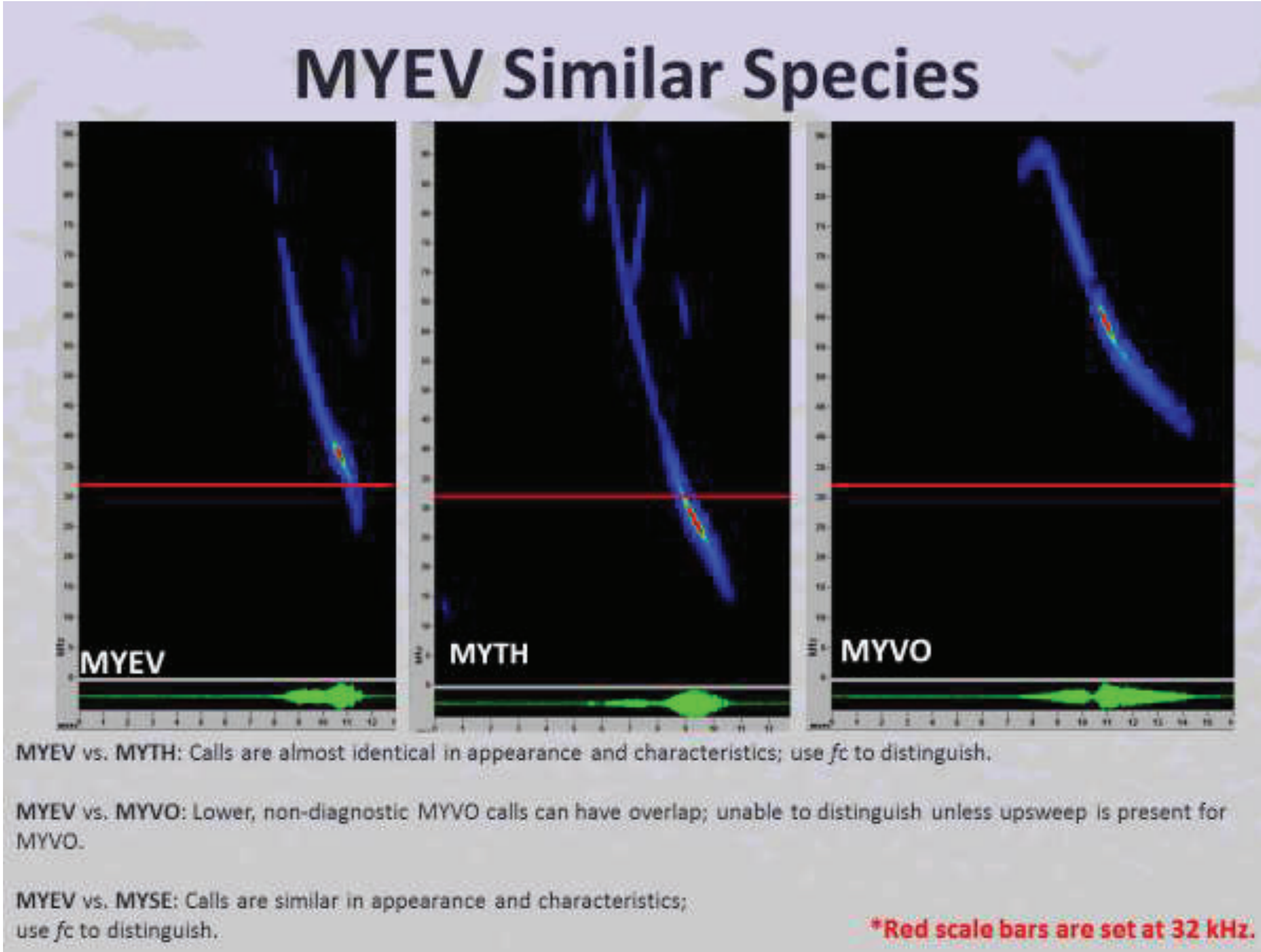


Figure 60. Calls sequences produced by other species that may be confused with the Long-eared Myotis (Myotis evotis, MYEV)

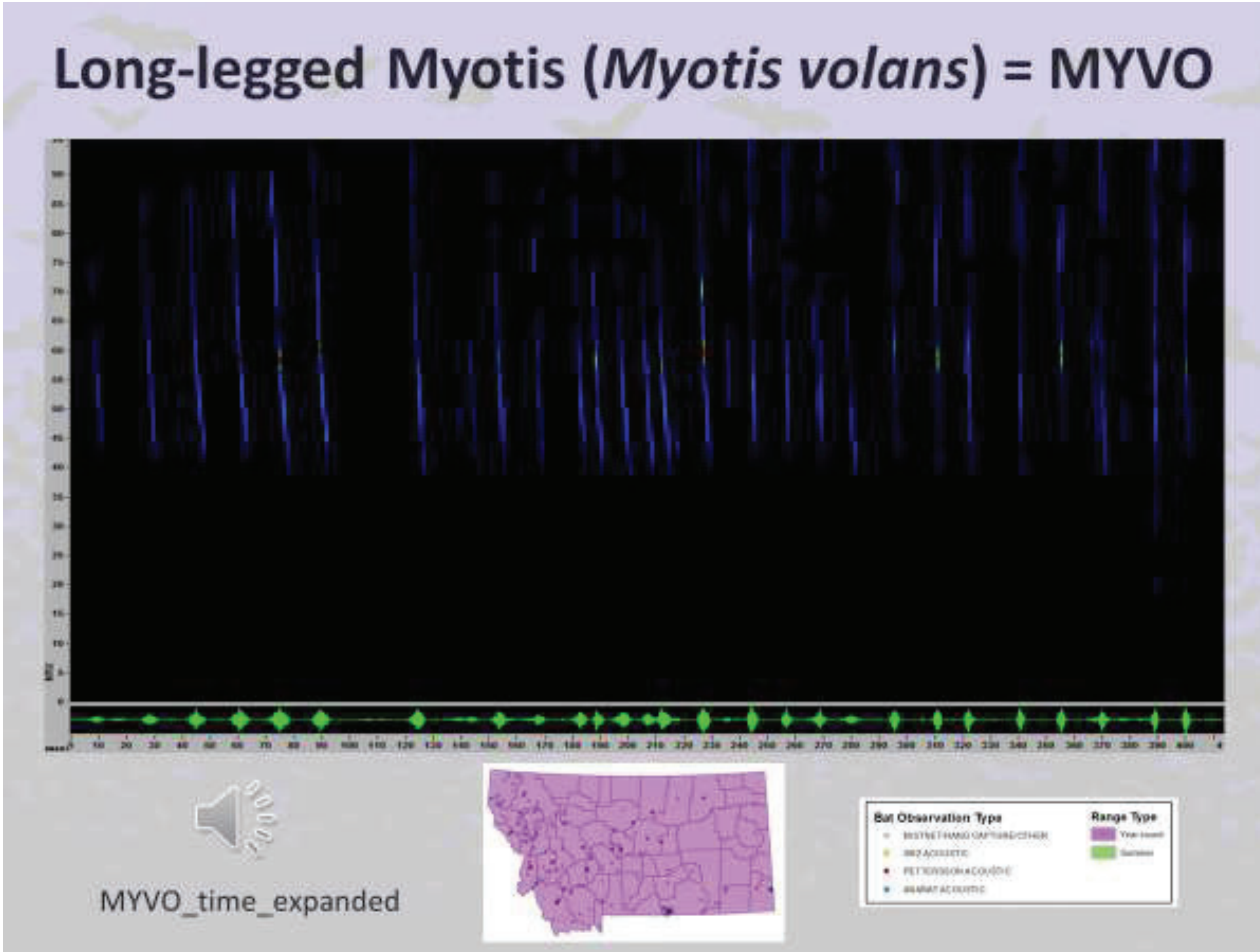


Figure 61. Example call sequence for the Long-legged Myotis (Myotis volans, MYVO)

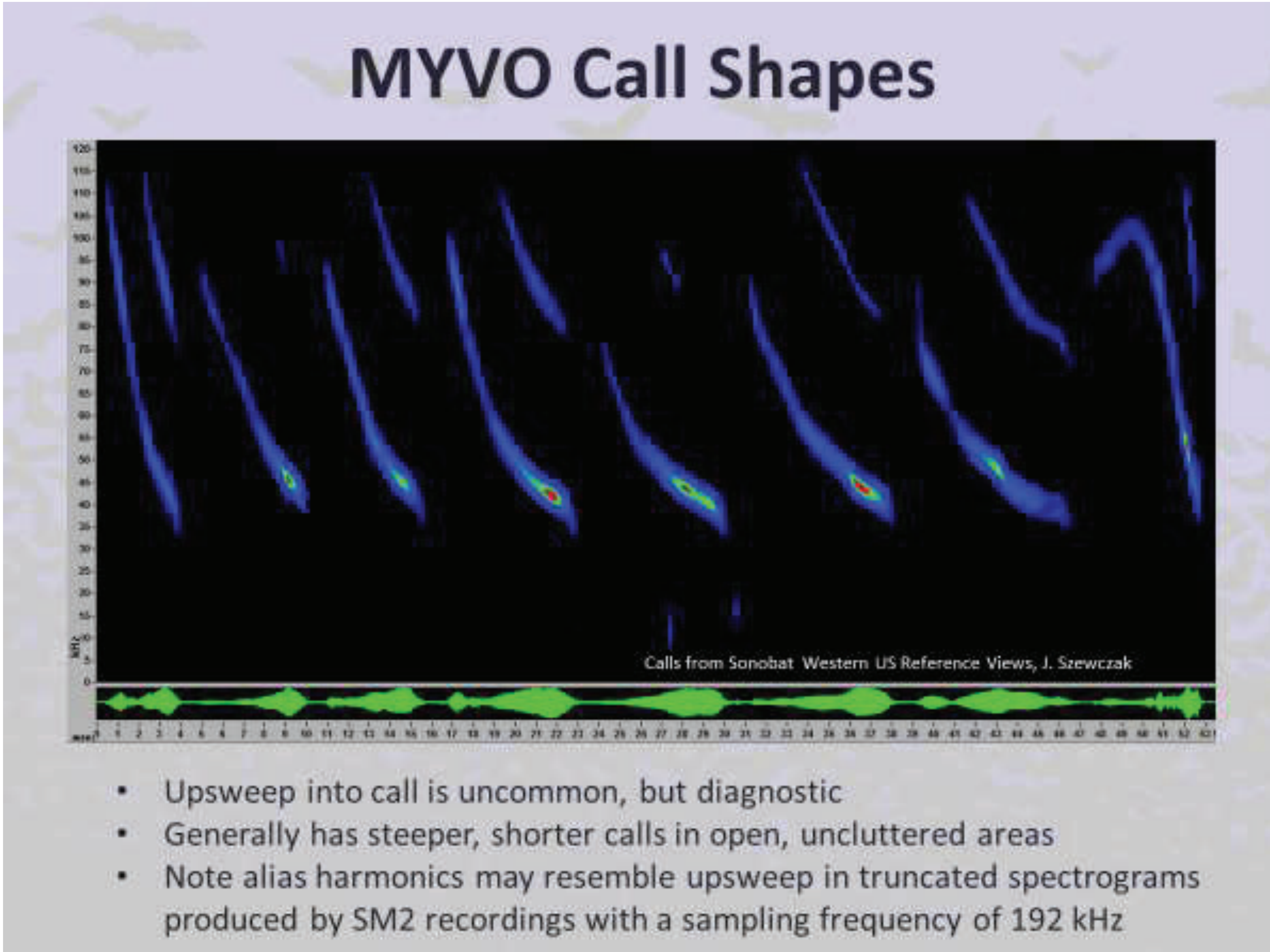


Figure 62. Call shapes of the Long-legged Myotis (Myotis volans, MYVO)

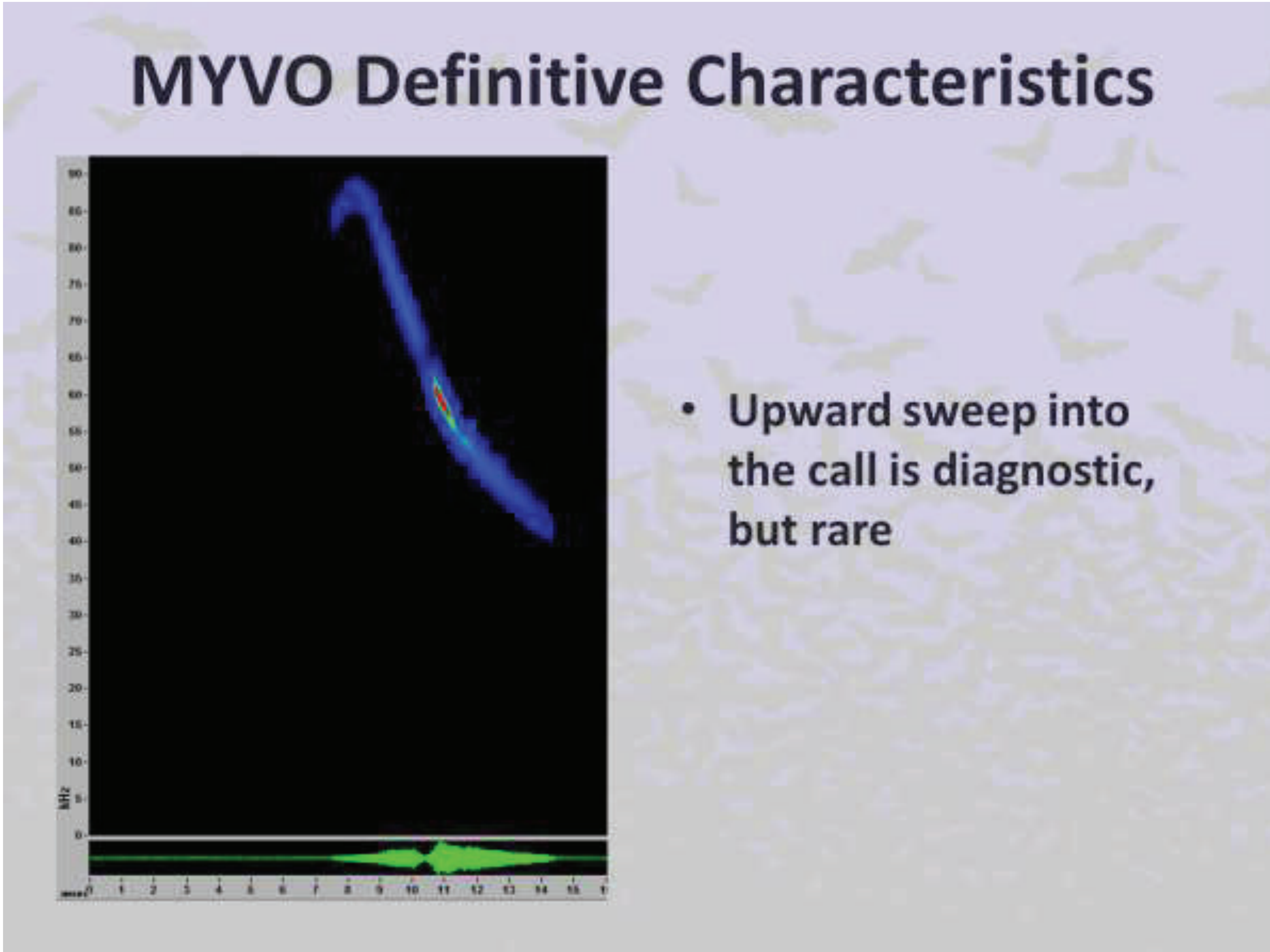


Figure 63. Definitive characteristics of call sequence for the Long-legged Myotis (Myotis volans, MYVO)

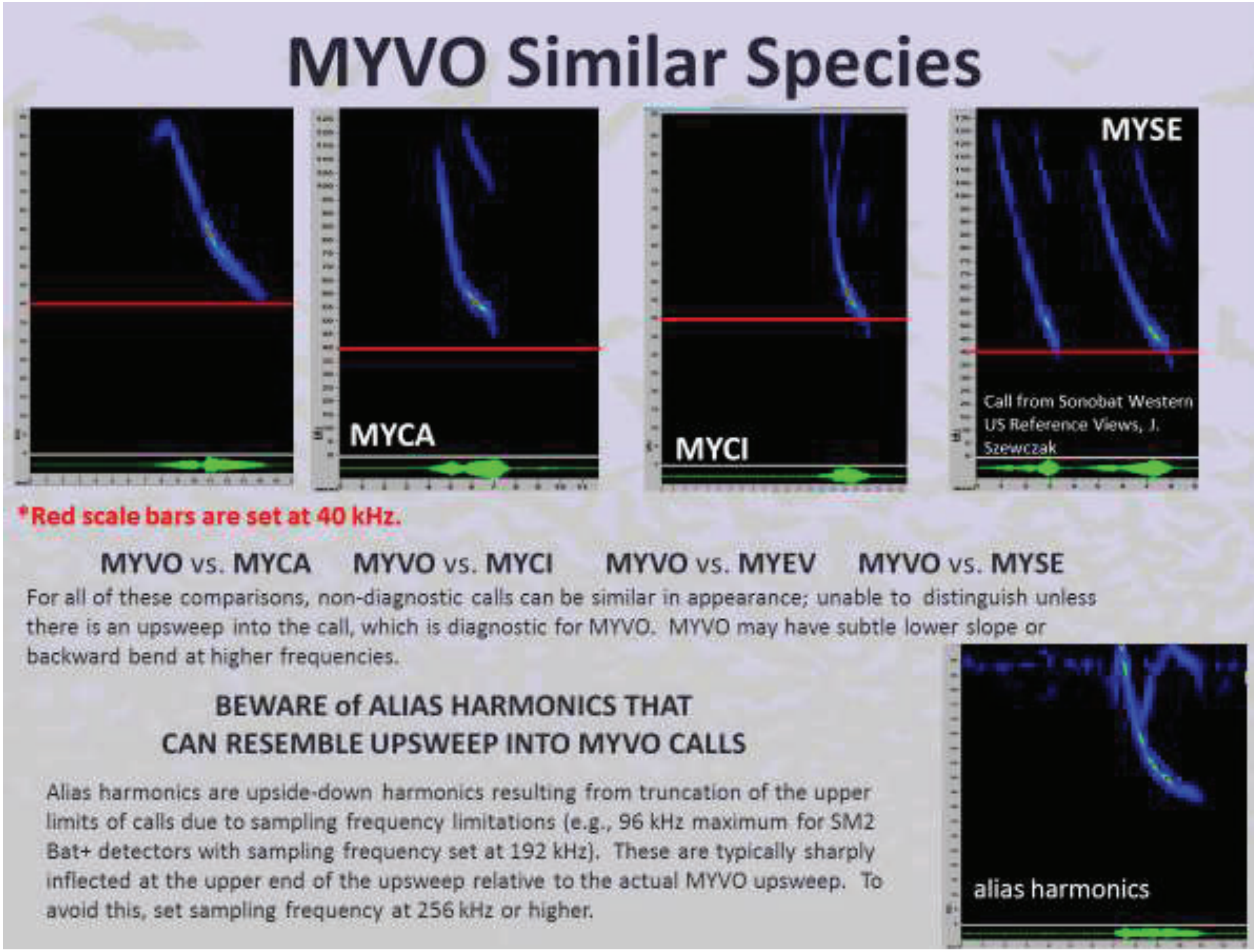


Figure 64. Calls sequences produced by other species that may be confused with the Long-legged Myotis (Myotis volans, MYVO)

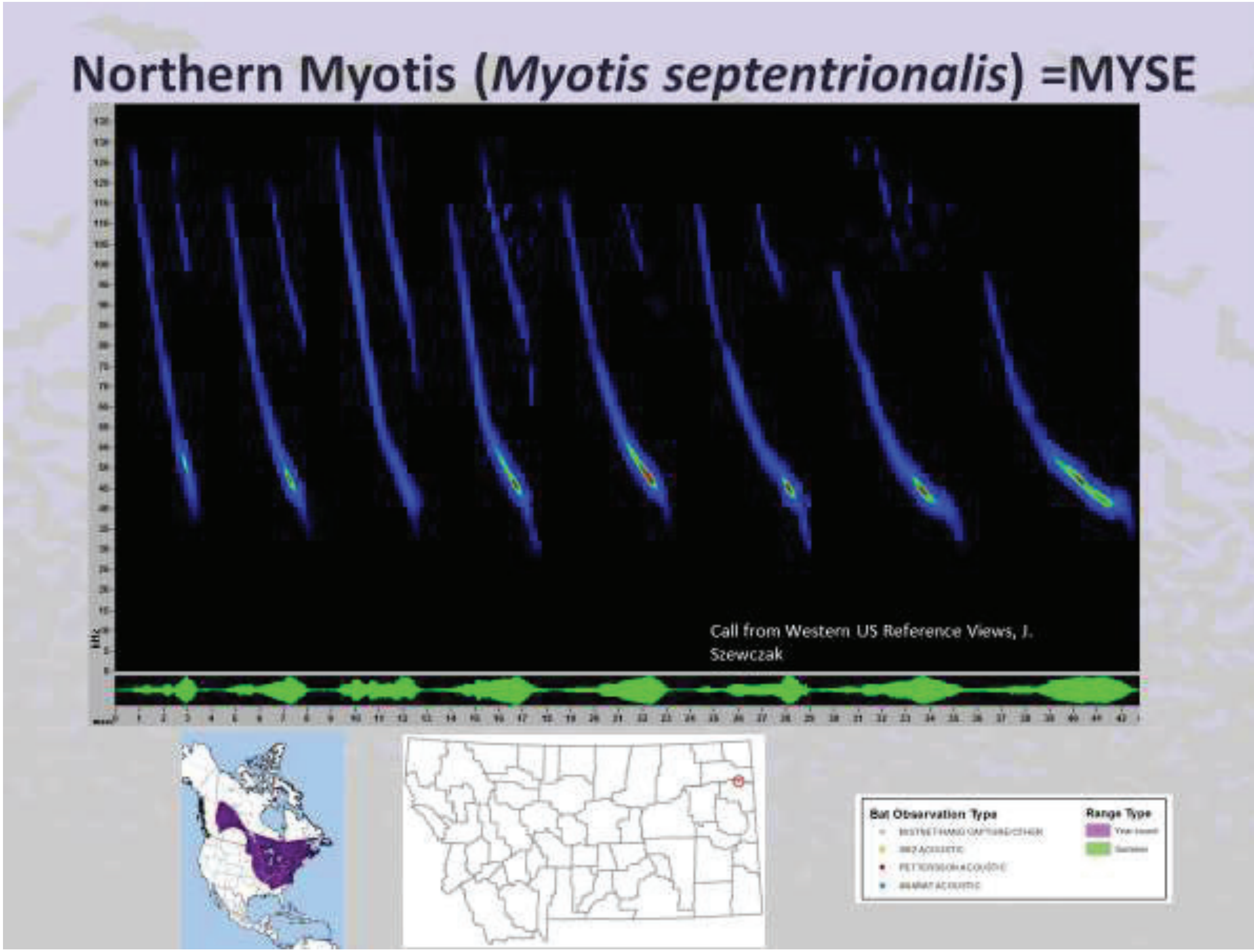


Figure 65. Example call sequence for the Northern Myotis (Myotis septentrionalis, MYSE)

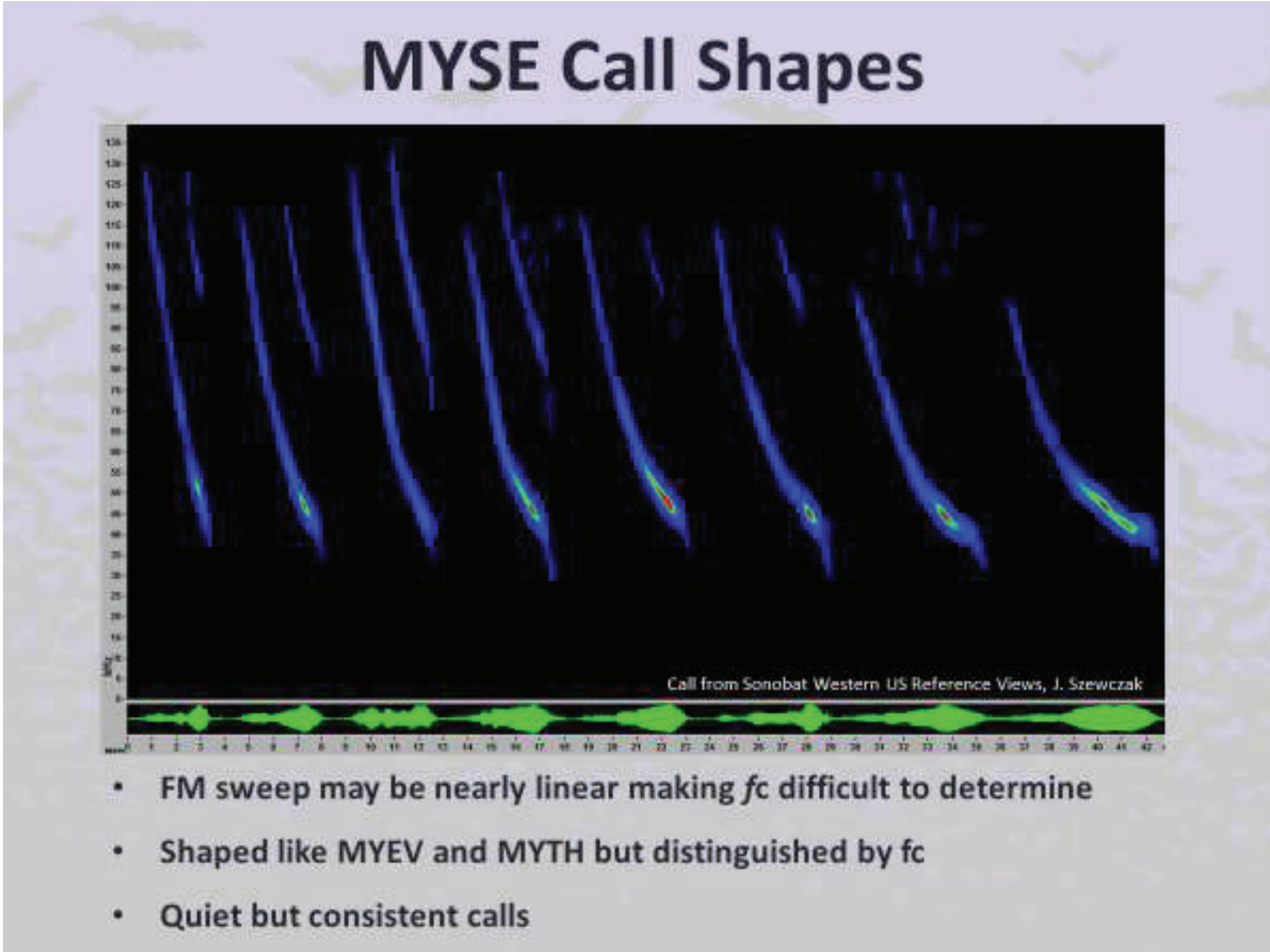


Figure 66. Call shapes of the Northern Myotis (Myotis septentrionalis, MYSE)

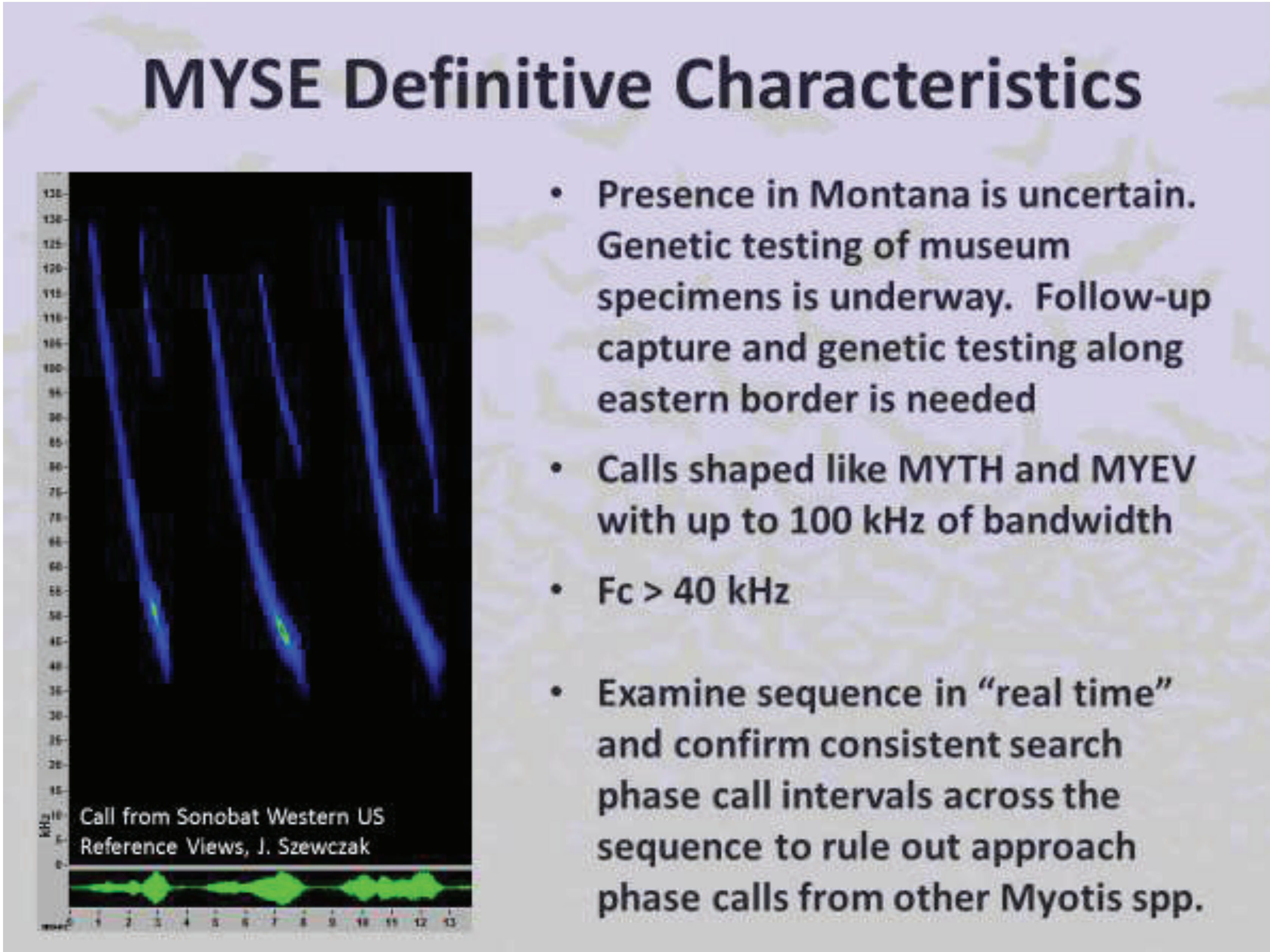


Figure 67. Definitive characteristics of call sequence for the Northern Myotis (Myotis septentrionalis, MYSE)

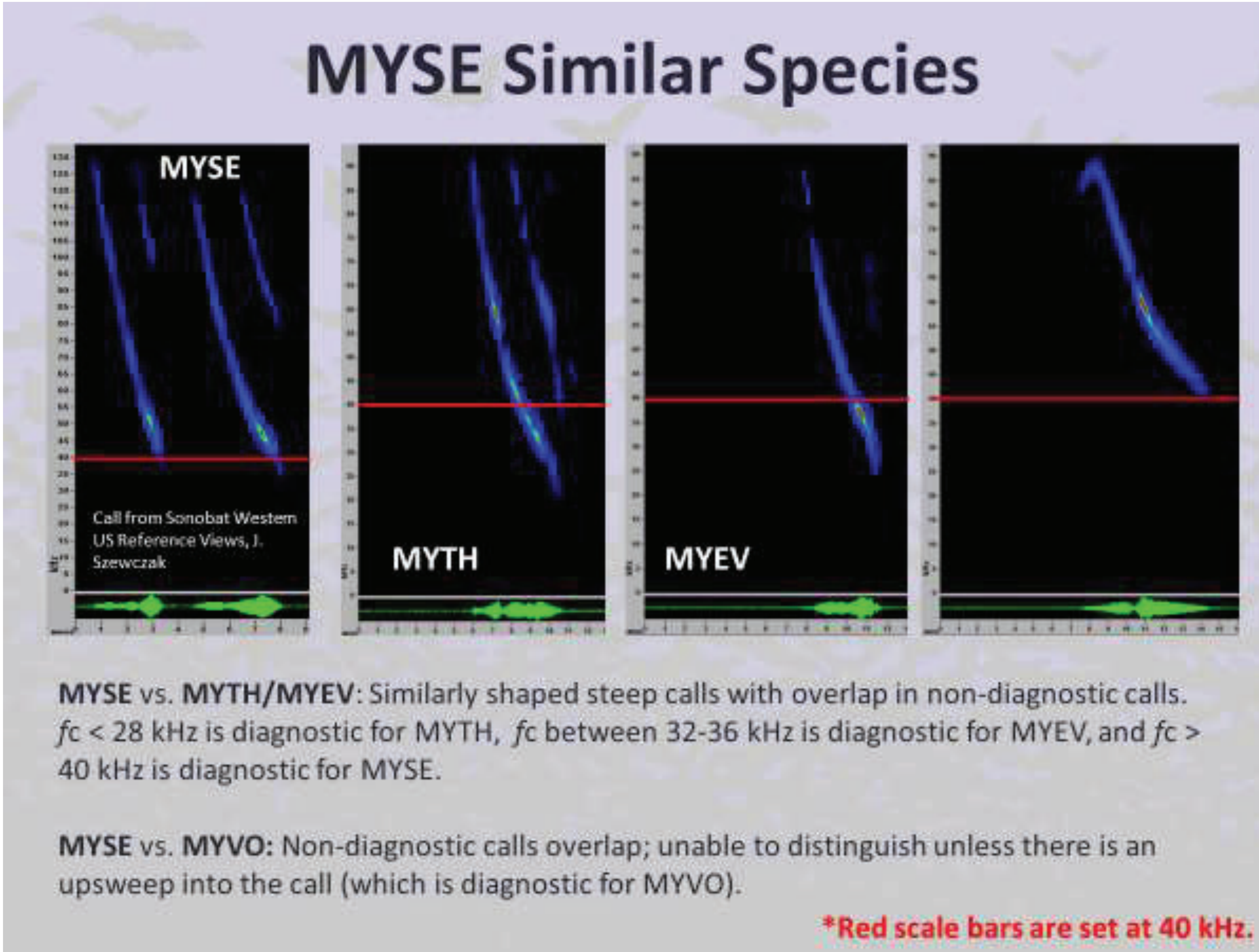


Figure 68. Calls sequences produced by other species that may be confused with the Northern Myotis (Myotis septentrionalis, MYSE)

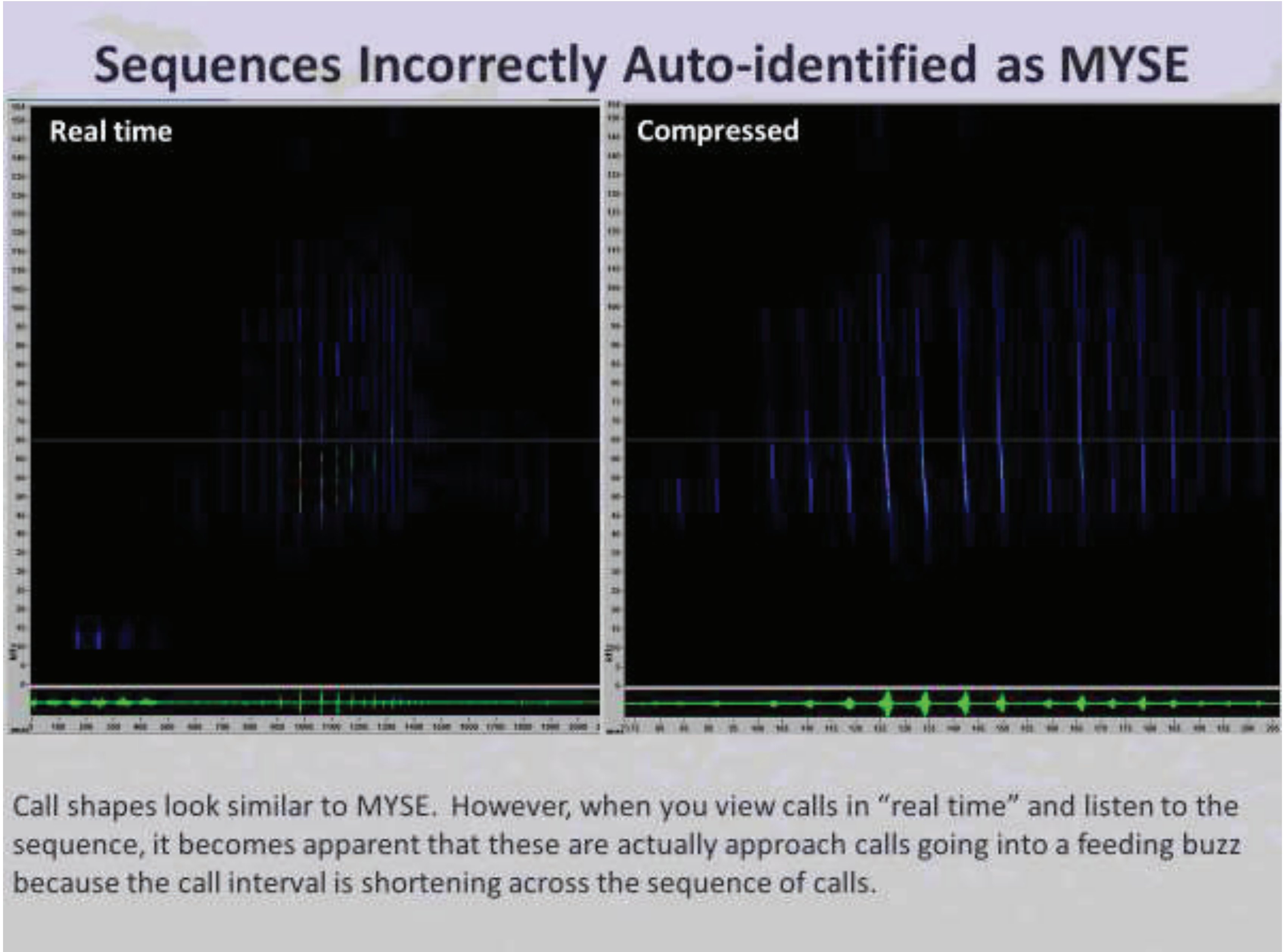


Figure 69. Example of the similarity between a feeding buzz produced by a Myotis bat and the call sequence of a Northern Myotis

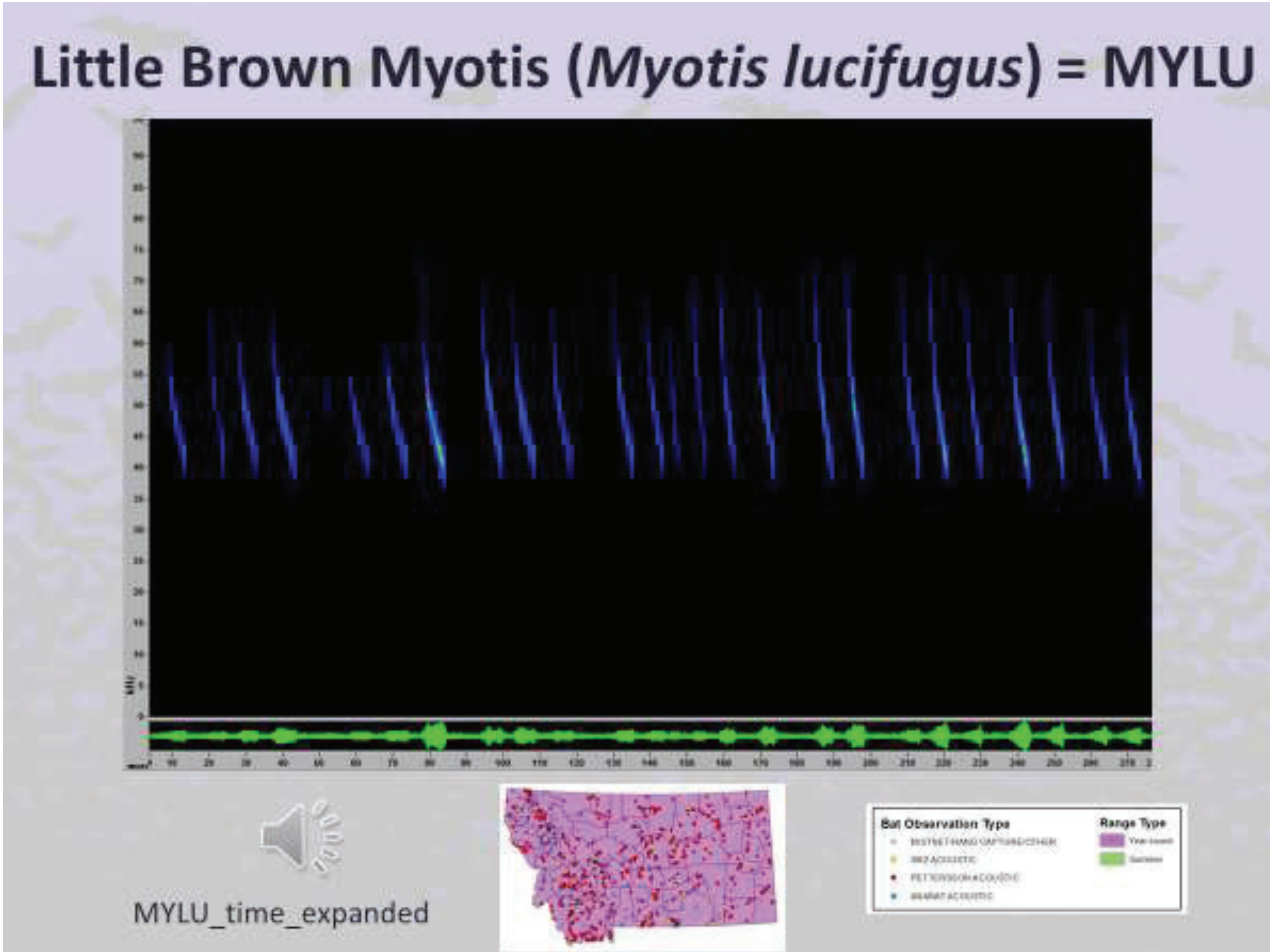


Figure 70. Example call sequence for the Little Brown Myotis (Myotis lucifigus, MYLU)

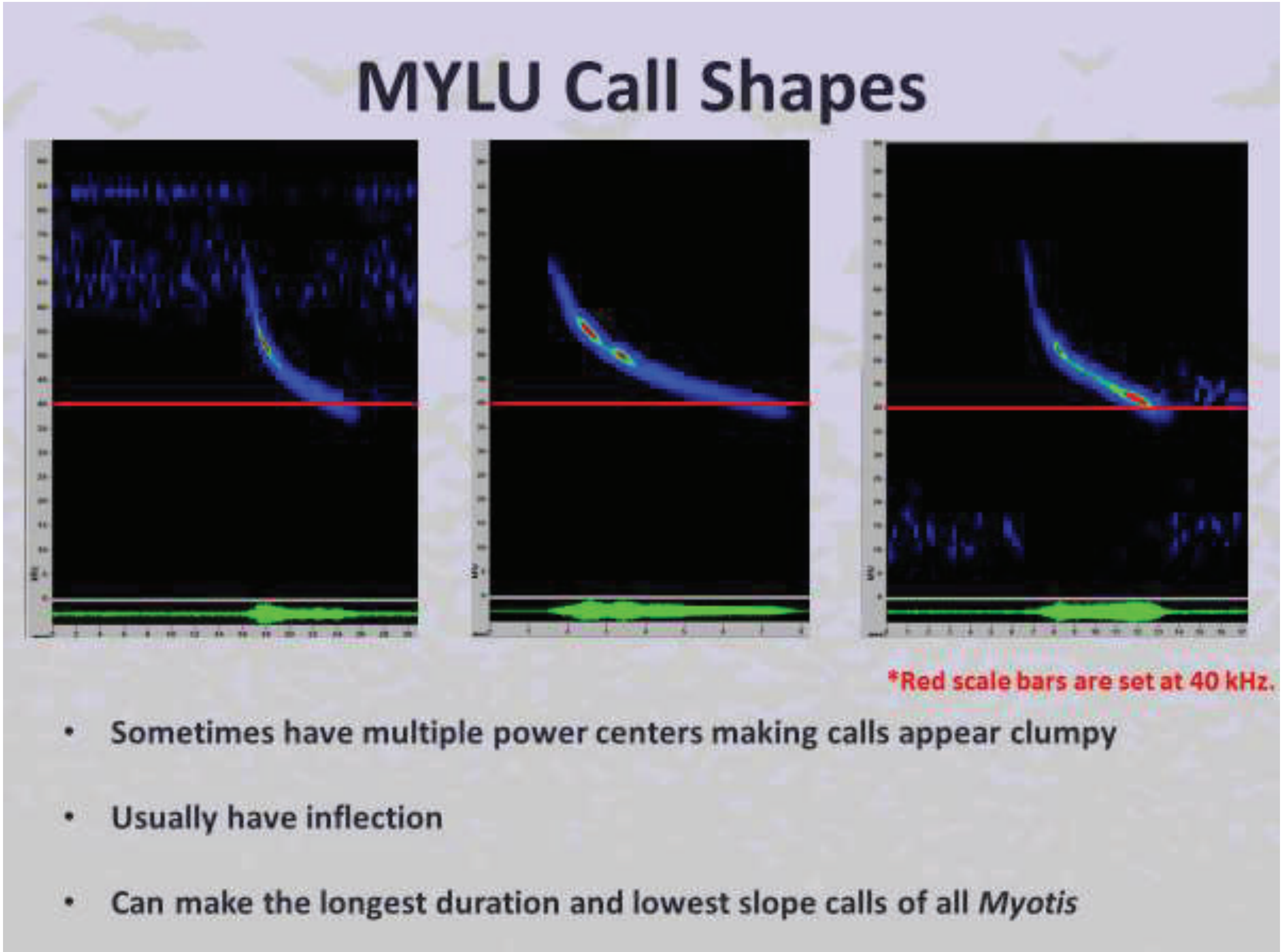


Figure 71. Call shapes of the Little Brown Myotis (Myotis lucifigus, MYLU)

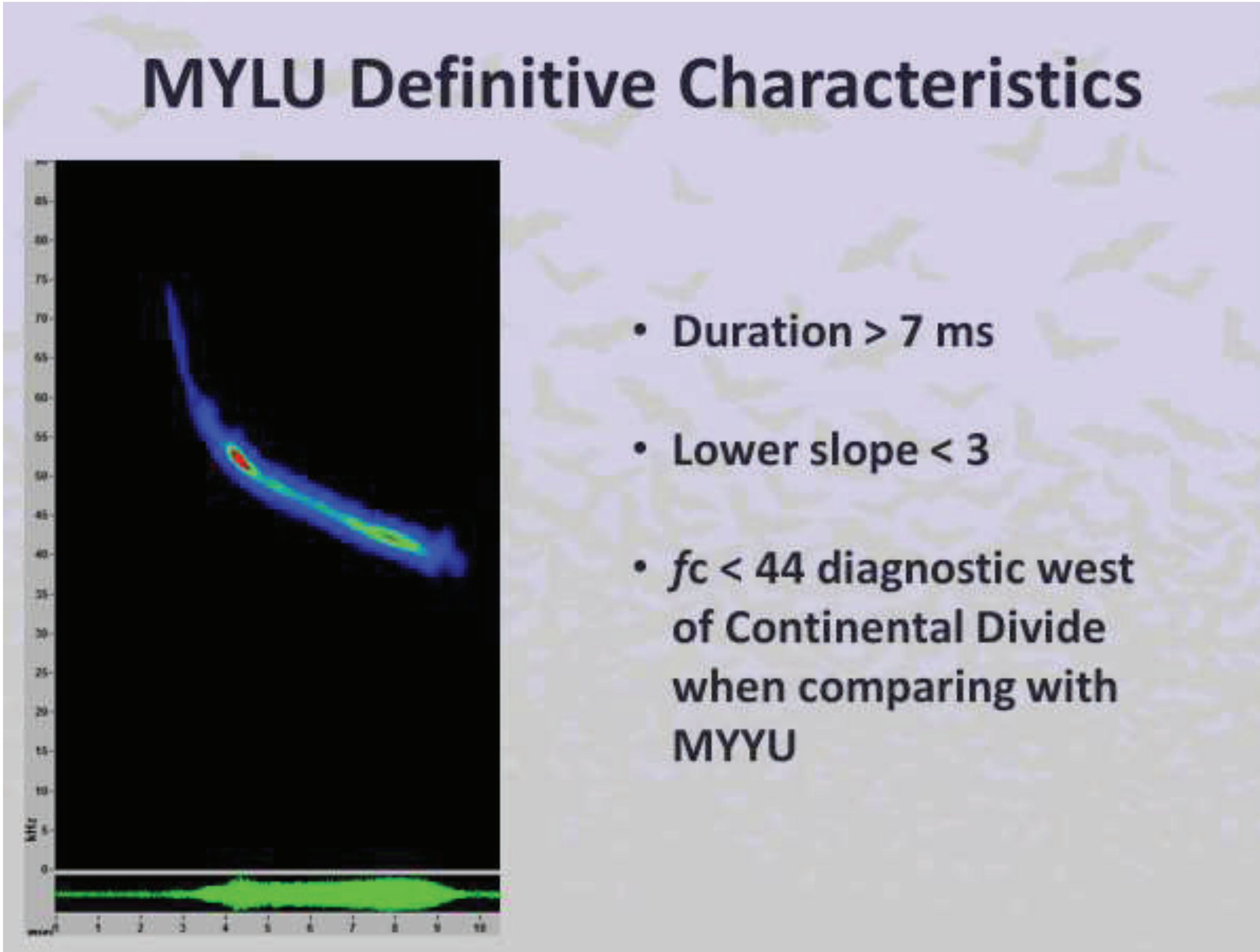


Figure 72. Definitive characteristics of call sequence for the Little Brown Myotis (Myotis lucifigus, MYLU)

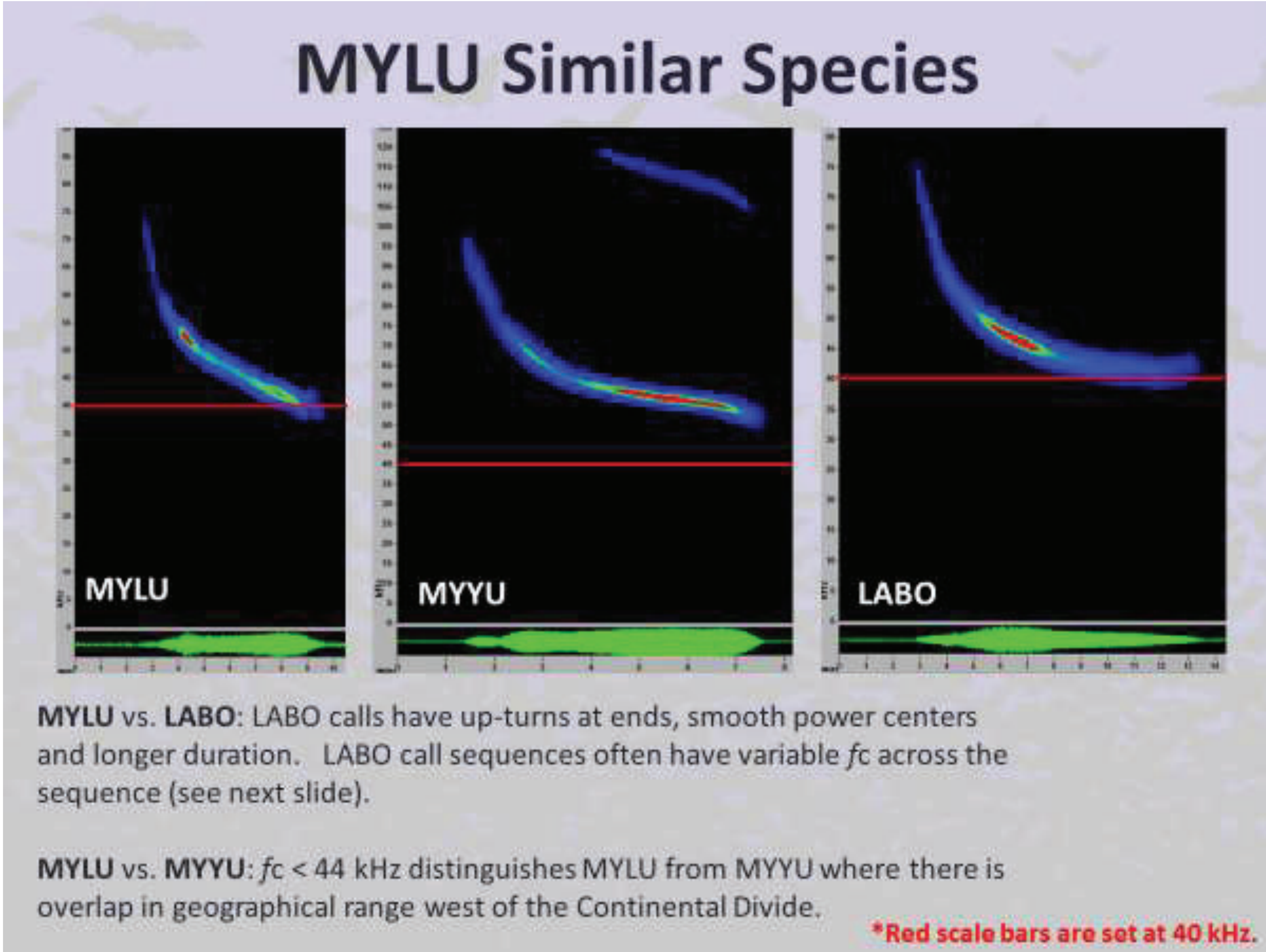


Figure 73. Calls sequences produced by other species that may be confused with the Little Brown Myotis (Myotis lucifigus, MYLU)

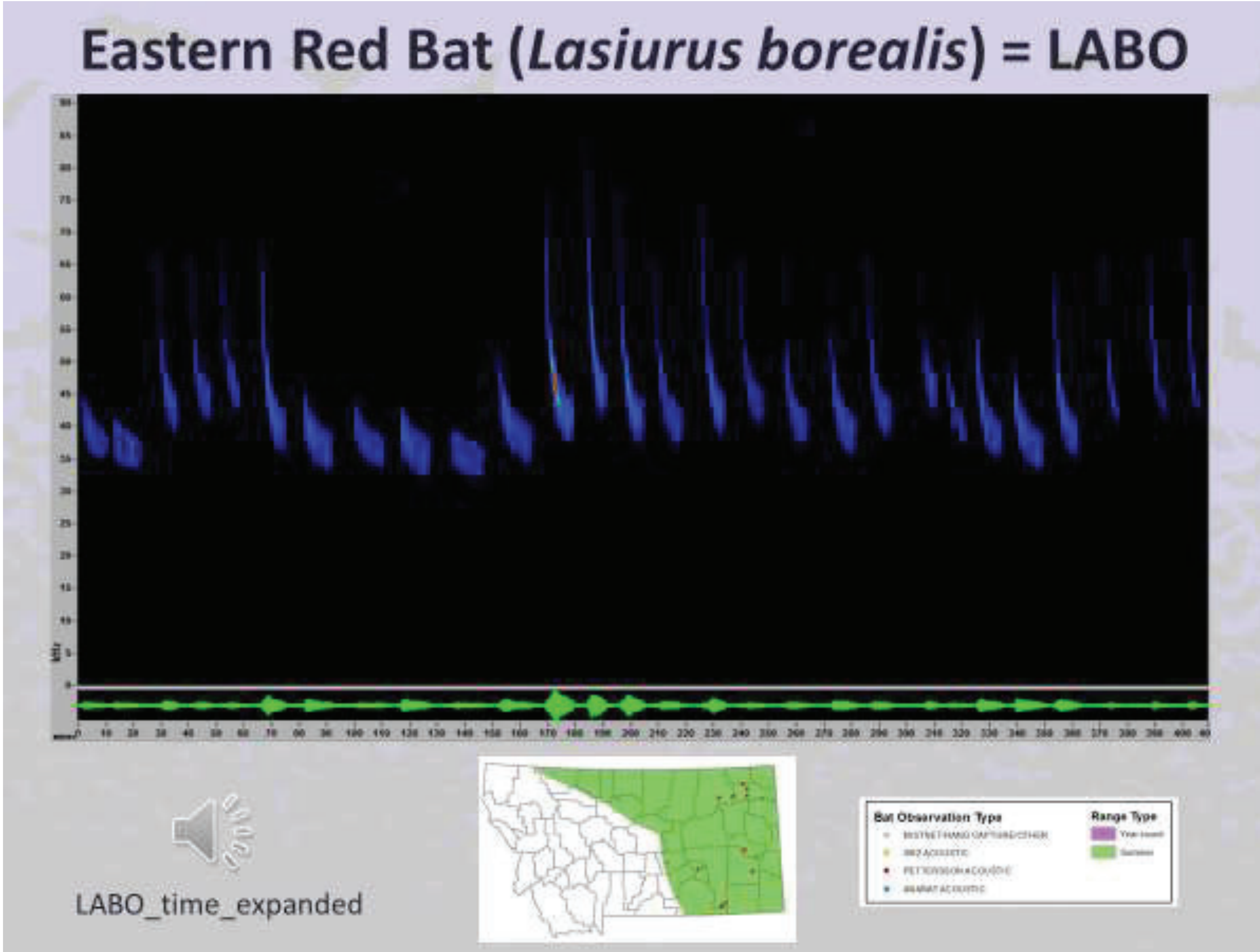


Figure 74. Example call sequence for the Eastern Red Bat (Lasiurus borealis, LABO)

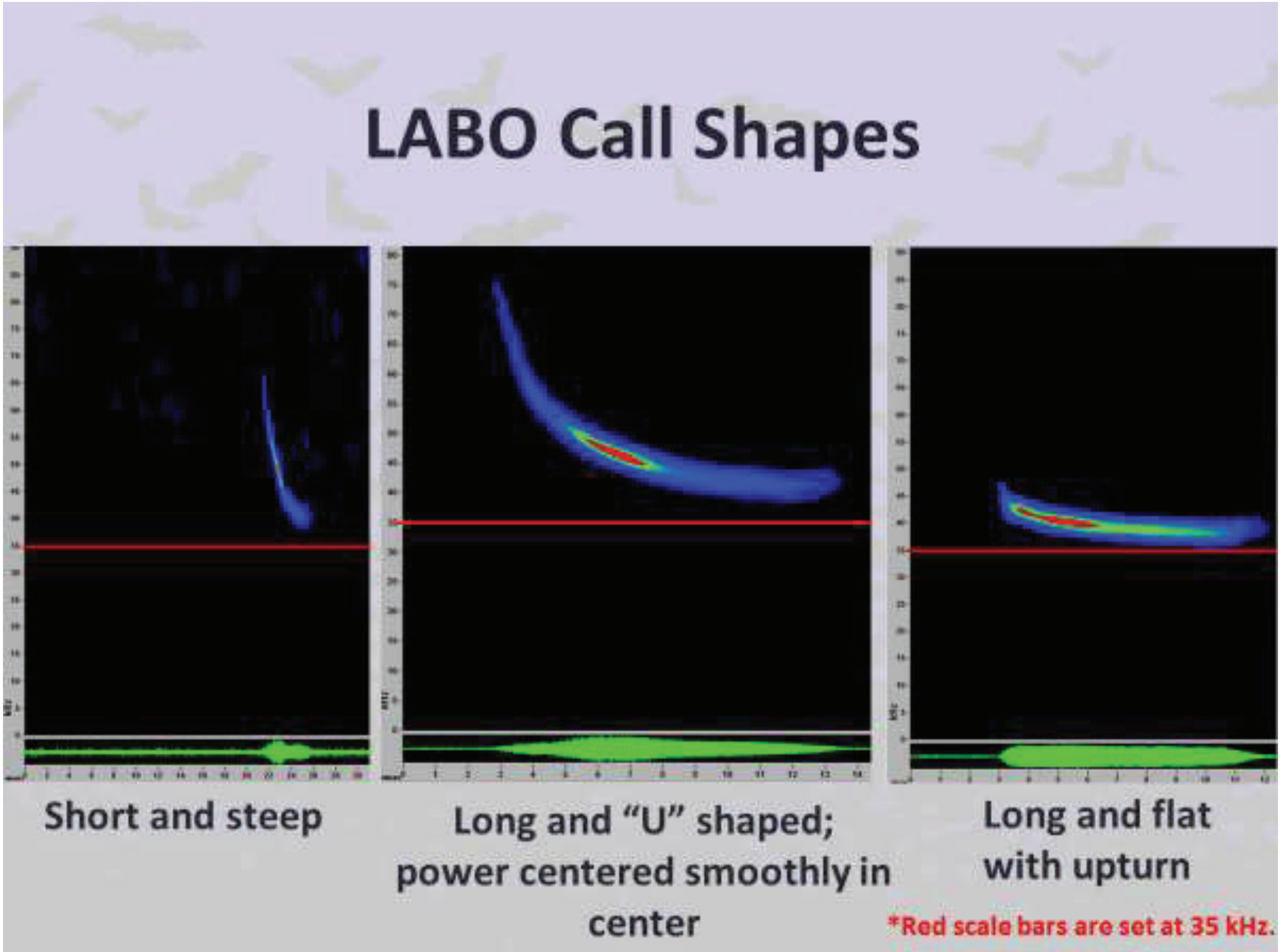


Figure 75. Call shapes of the Eastern Red Bat (Lasiurus borealis, LABO)

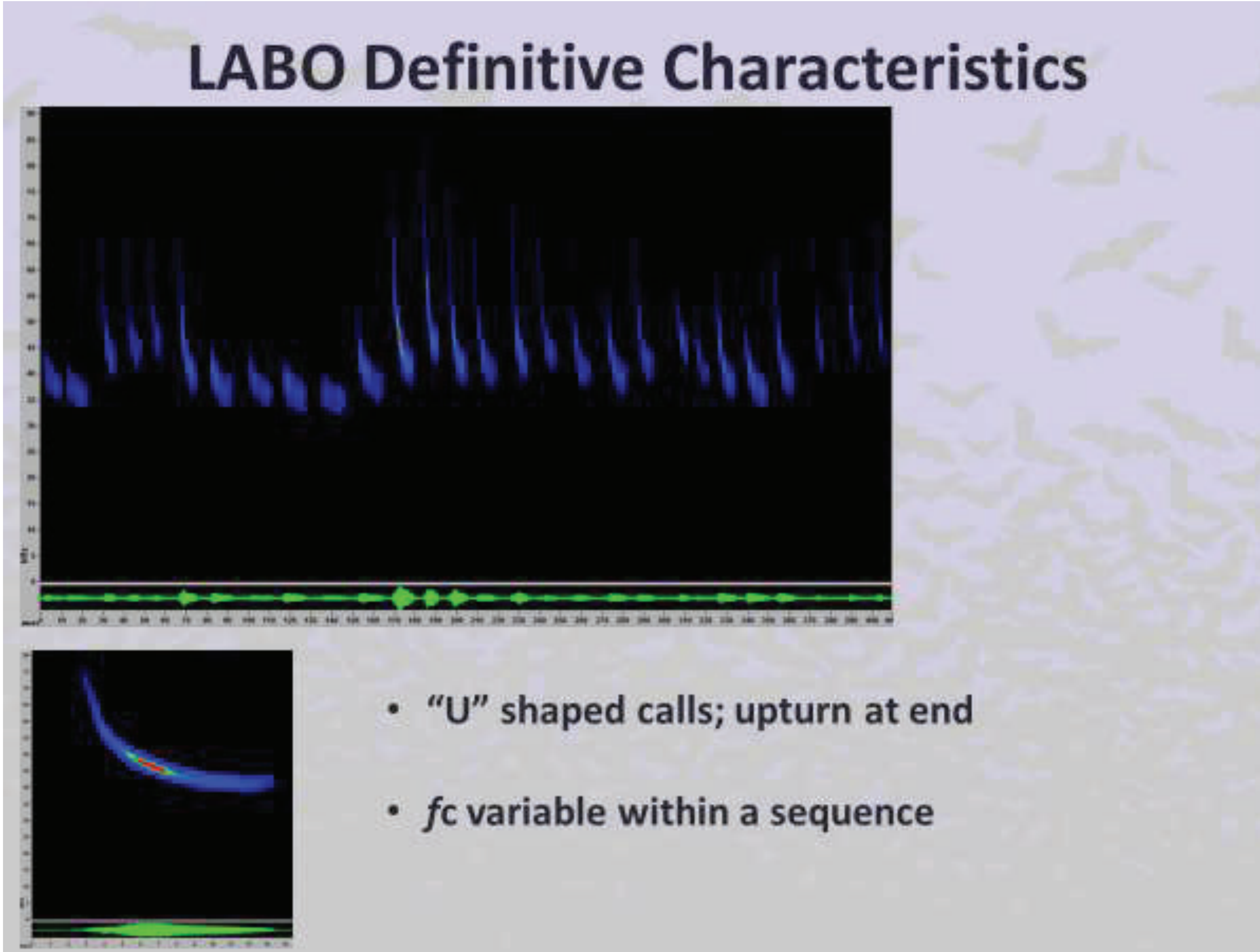
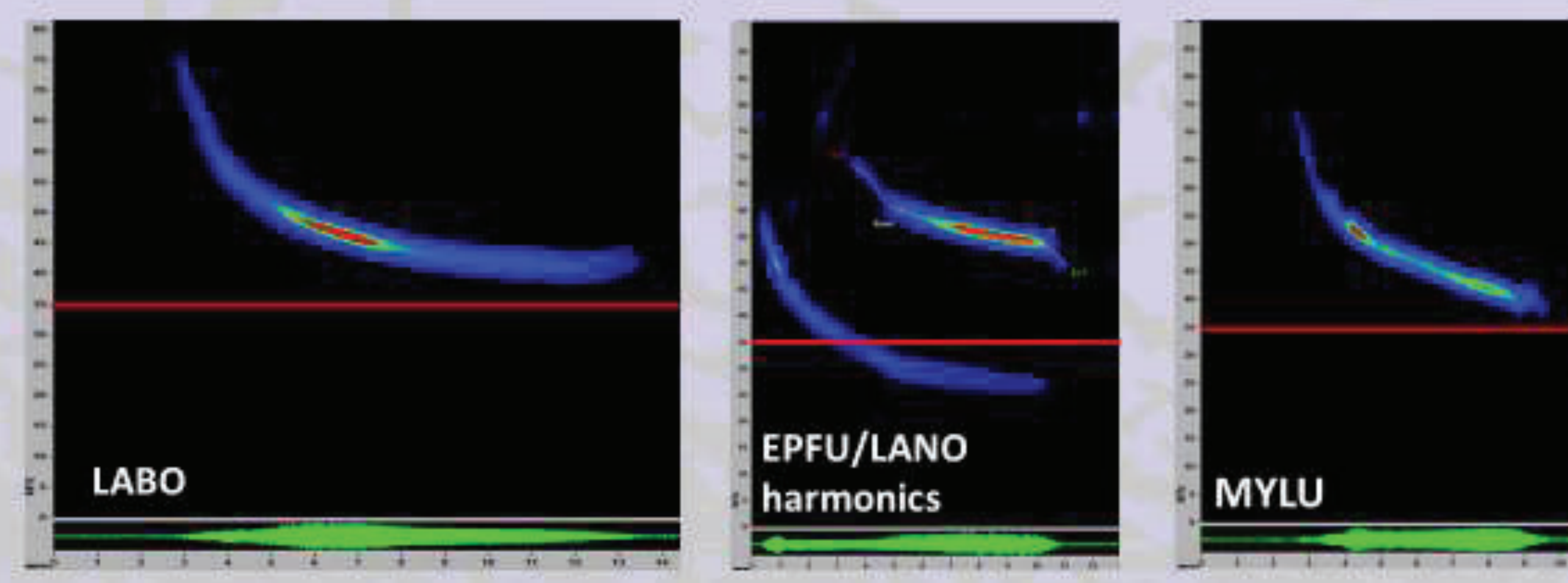


Figure 76. Definitive characteristics of call sequence for the Eastern Red Bat (Lasiurus borealis, LABO)

LABO Similar Species



LABO vs. **MYLU**: MYLU calls infrequently exceed 10 ms, are not upturned at the end; instead, have a steadily decreasing frequency or a steady *fc* across a sequence. **NOTE:** Sonobat sometimes classifies EPFU/LANO harmonics as MYLU or LABO.

LABO vs. **LANO**: LANO can have a similar shape to LABO, but are much lower in *fc*.

***Red scale bars are set at 35 kHz.**

Figure 77. Calls sequences produced by other species that may be confused with the Eastern Red Bat (Lasiurus borealis, LABO)

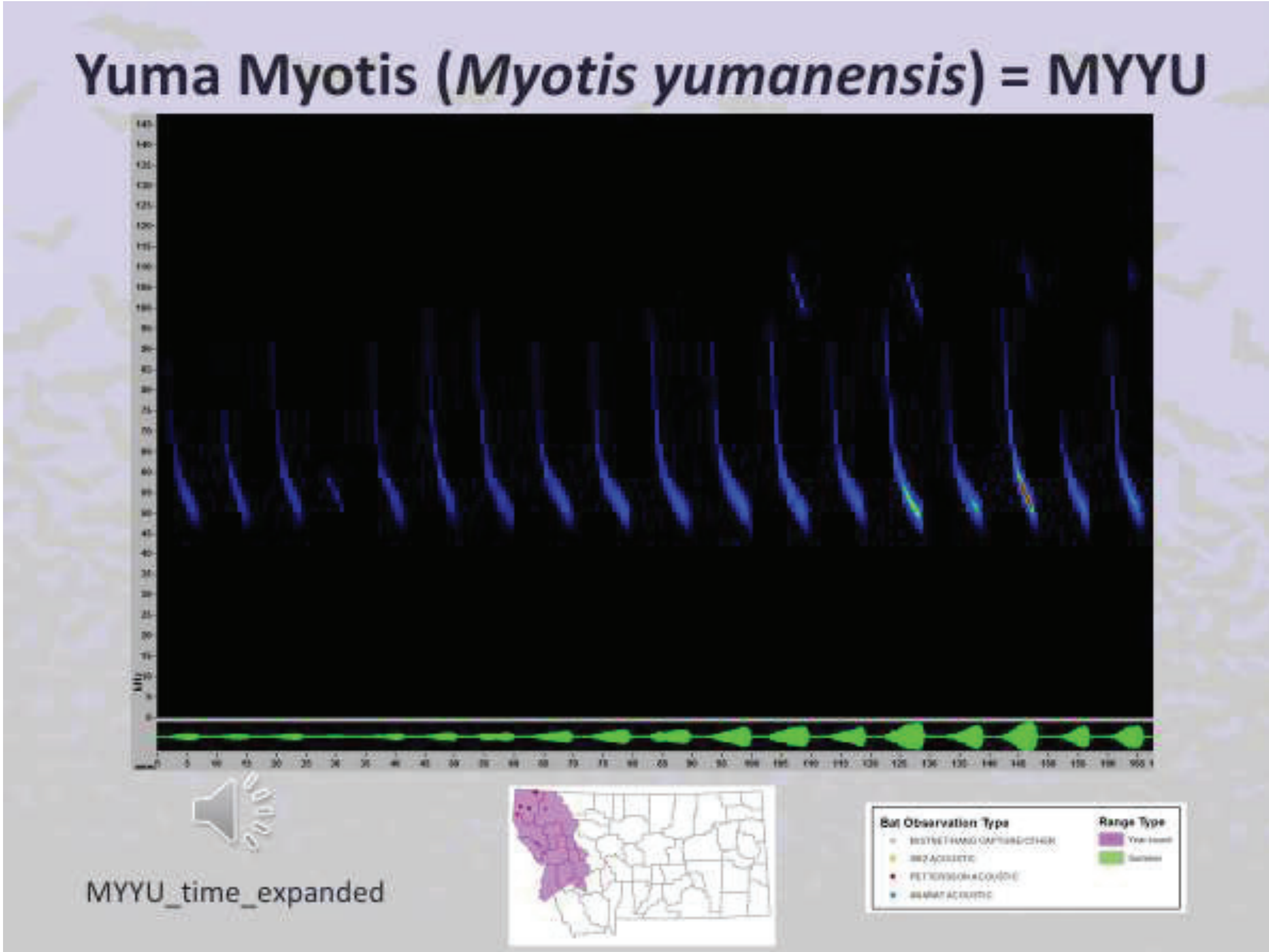


Figure 78. Example call sequence for the Yuma Myotis (Myotis yumanensis, MYYU)

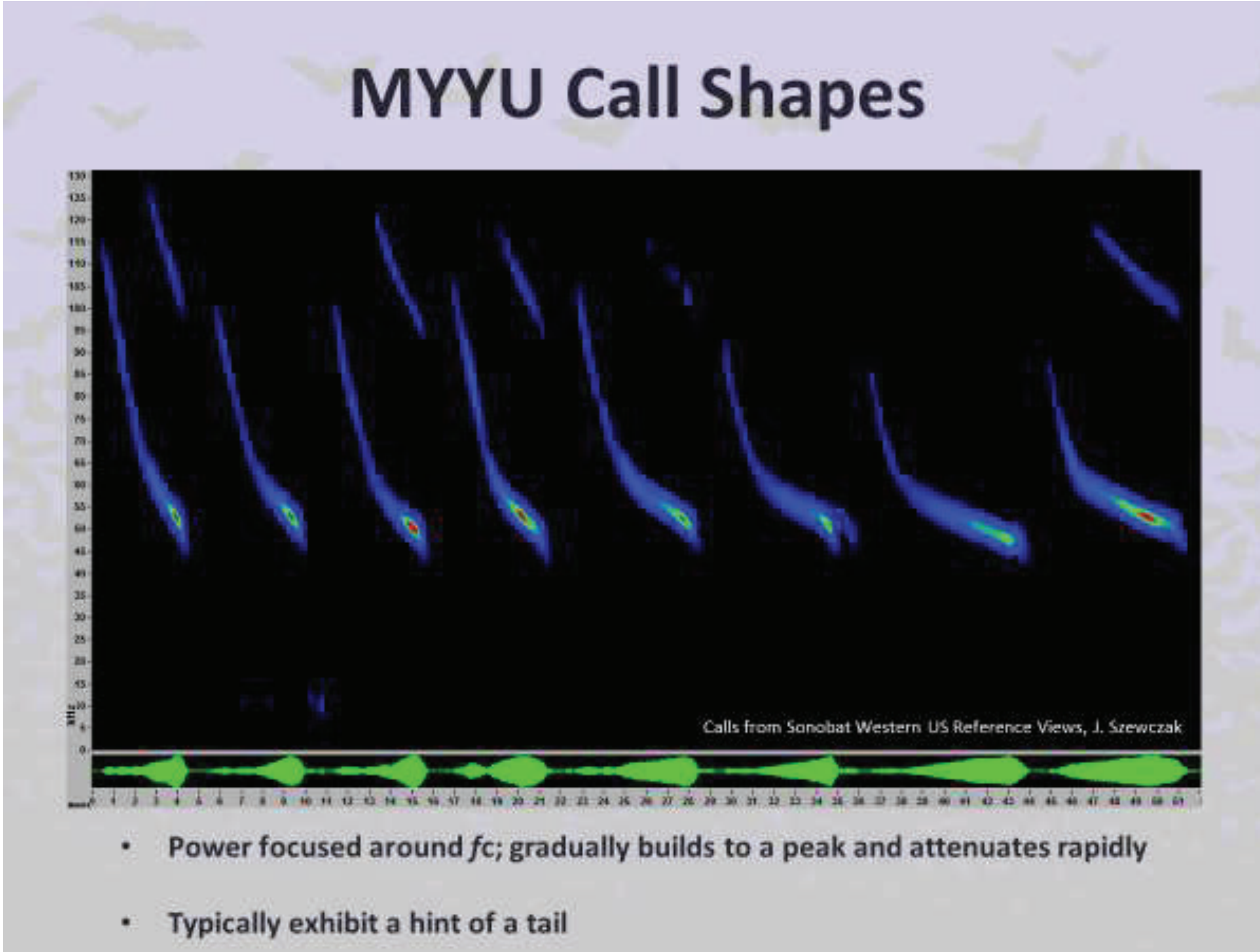


Figure 79. Call shapes of the Yuma Myotis (Myotis yumanensis, MYYU)

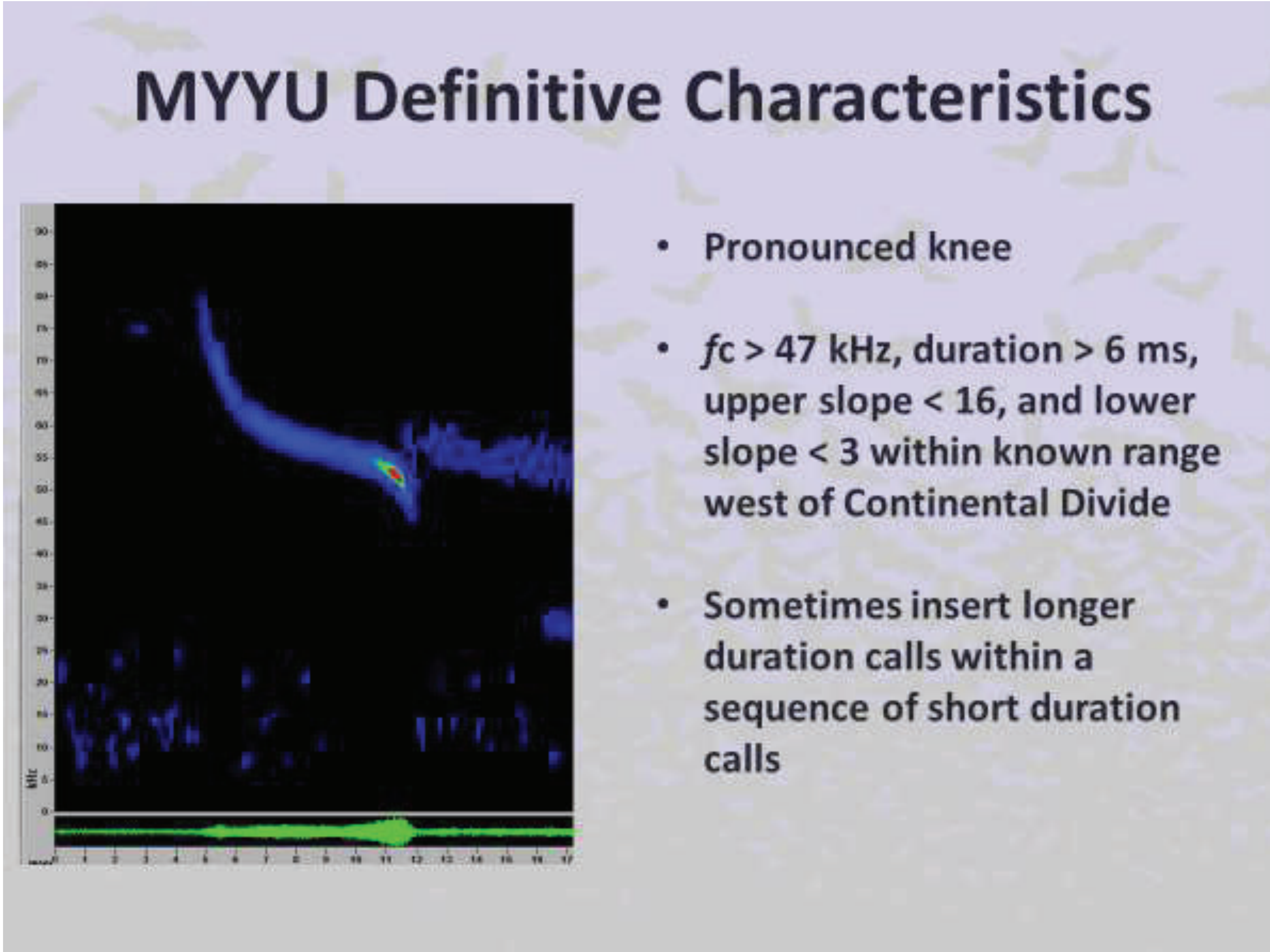


Figure 80. Definitive characteristics of call sequence for the Yuma Myotis (Myotis yumanensis, MYYU)

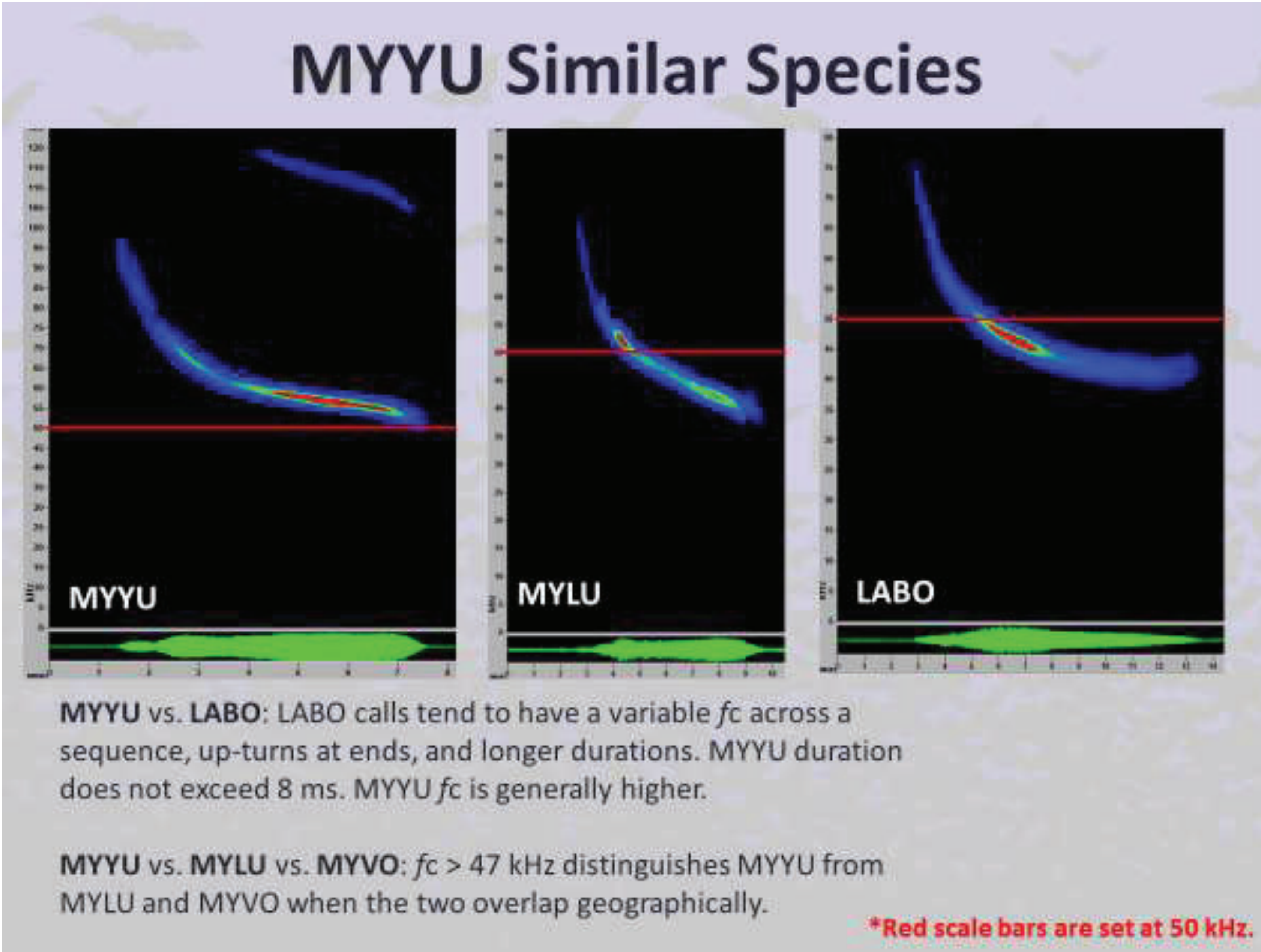


Figure 81. Calls sequences produced by other species that may be confused with the Yuma Myotis (Myotis yumanensis, MYYU)

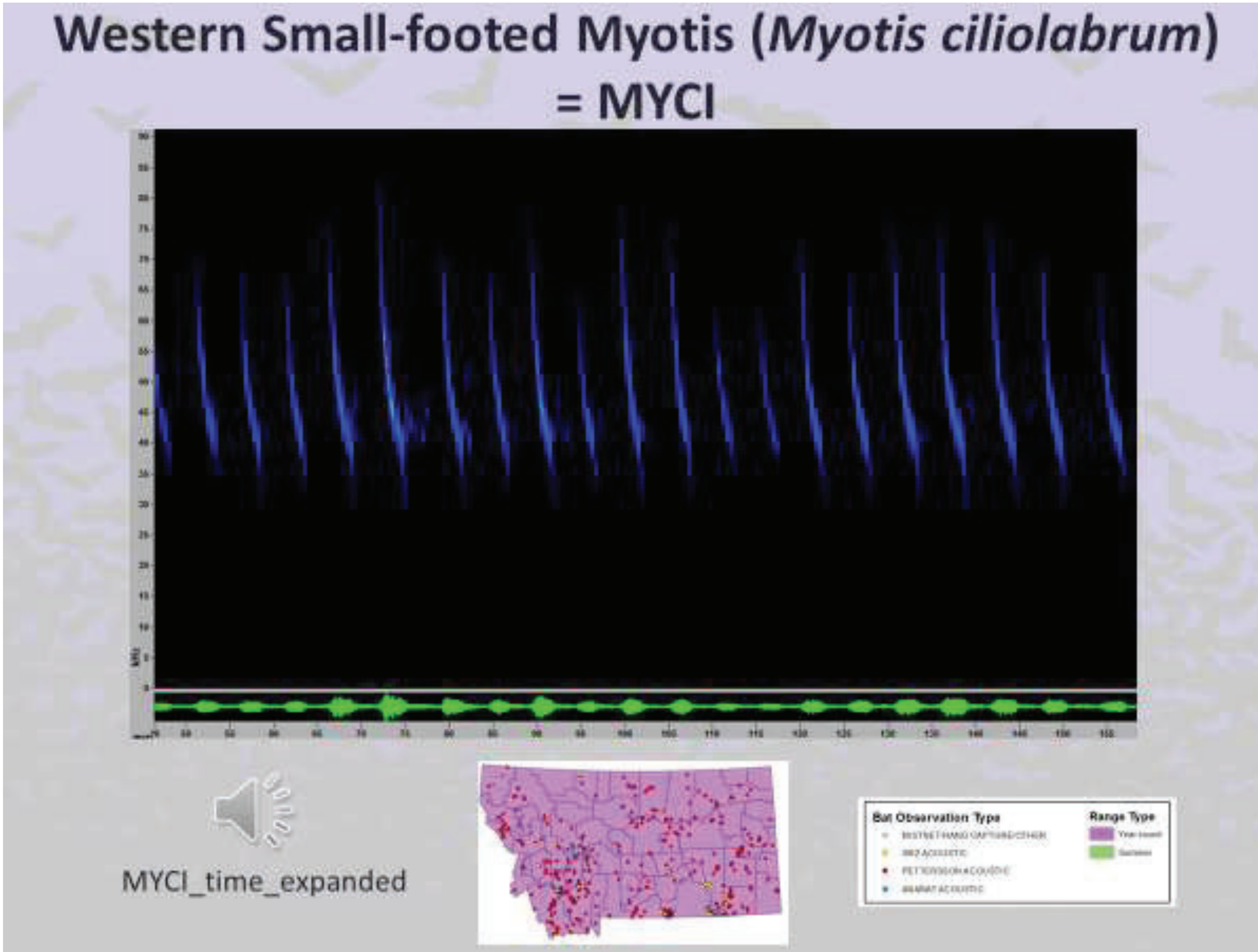


Figure 82. Example call sequence for the Western Small-footed Myotis (Myotis ciliolabrum, MYCI)

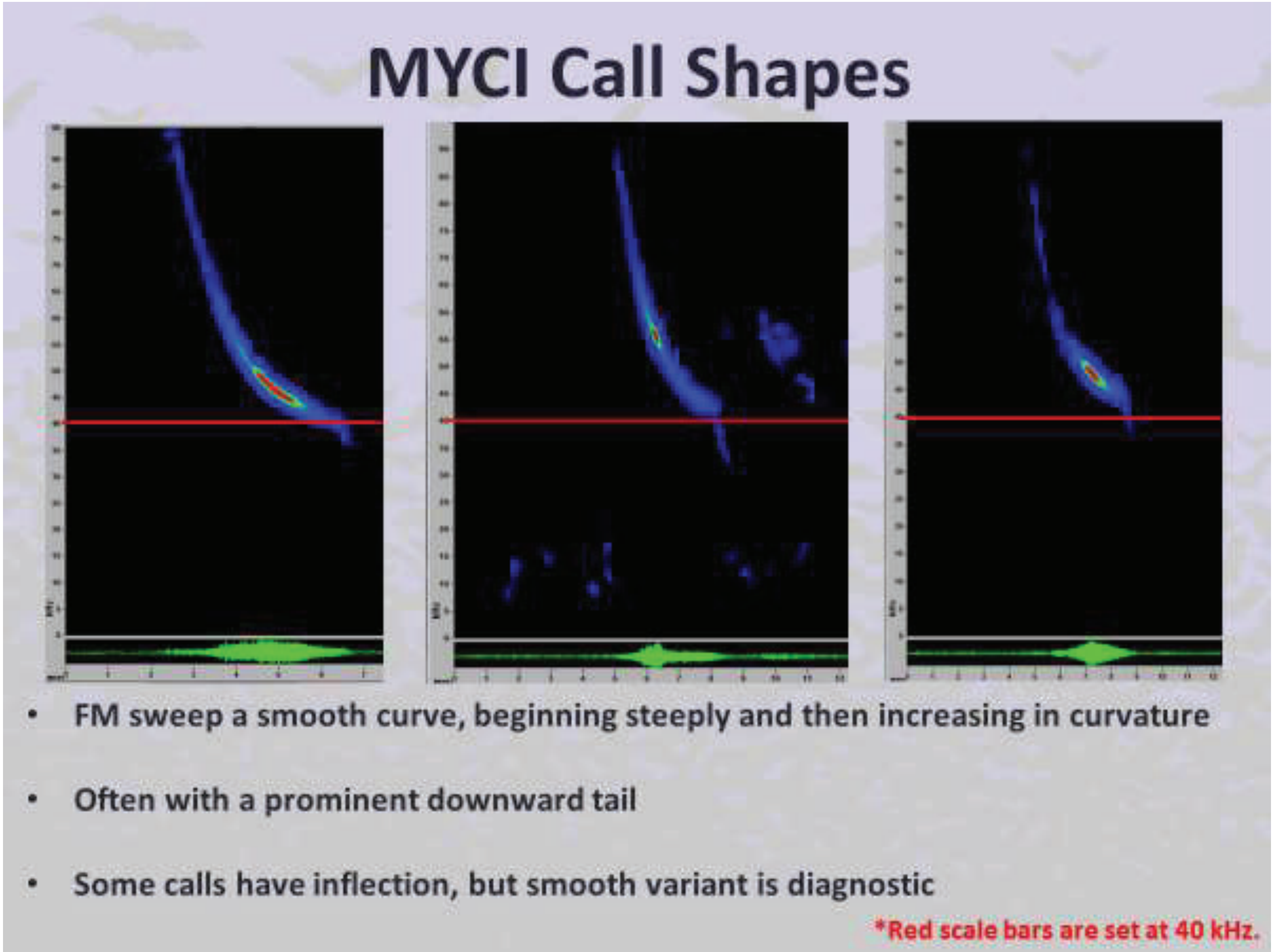


Figure 83. Call shapes of the Western Small-footed Myotis (Myotis ciliolabrum, MYCI)

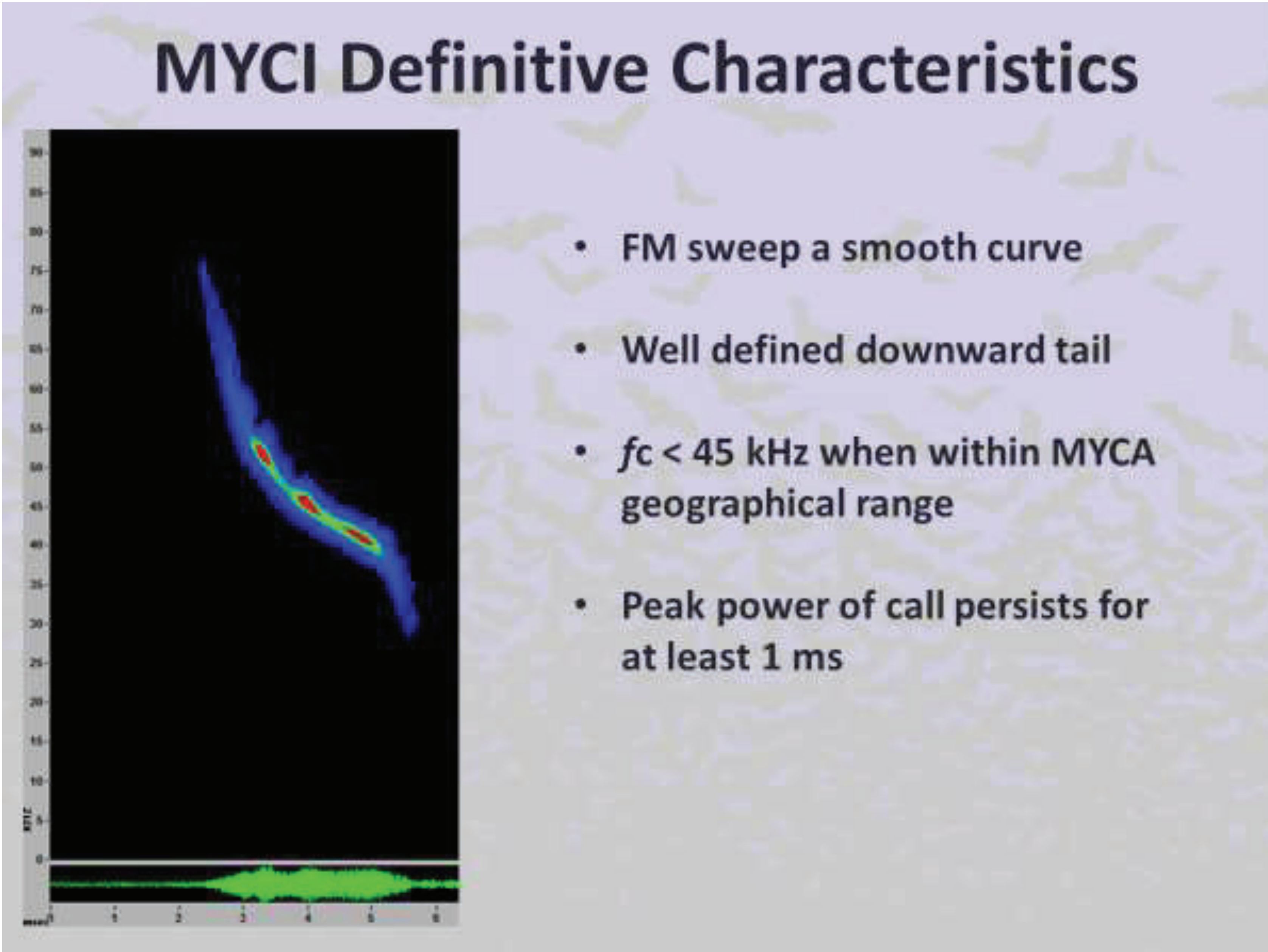


Figure 84. Definitive characteristics of call sequence for the Western Small-footed Myotis (Myotis ciliolabrum, MYCI)

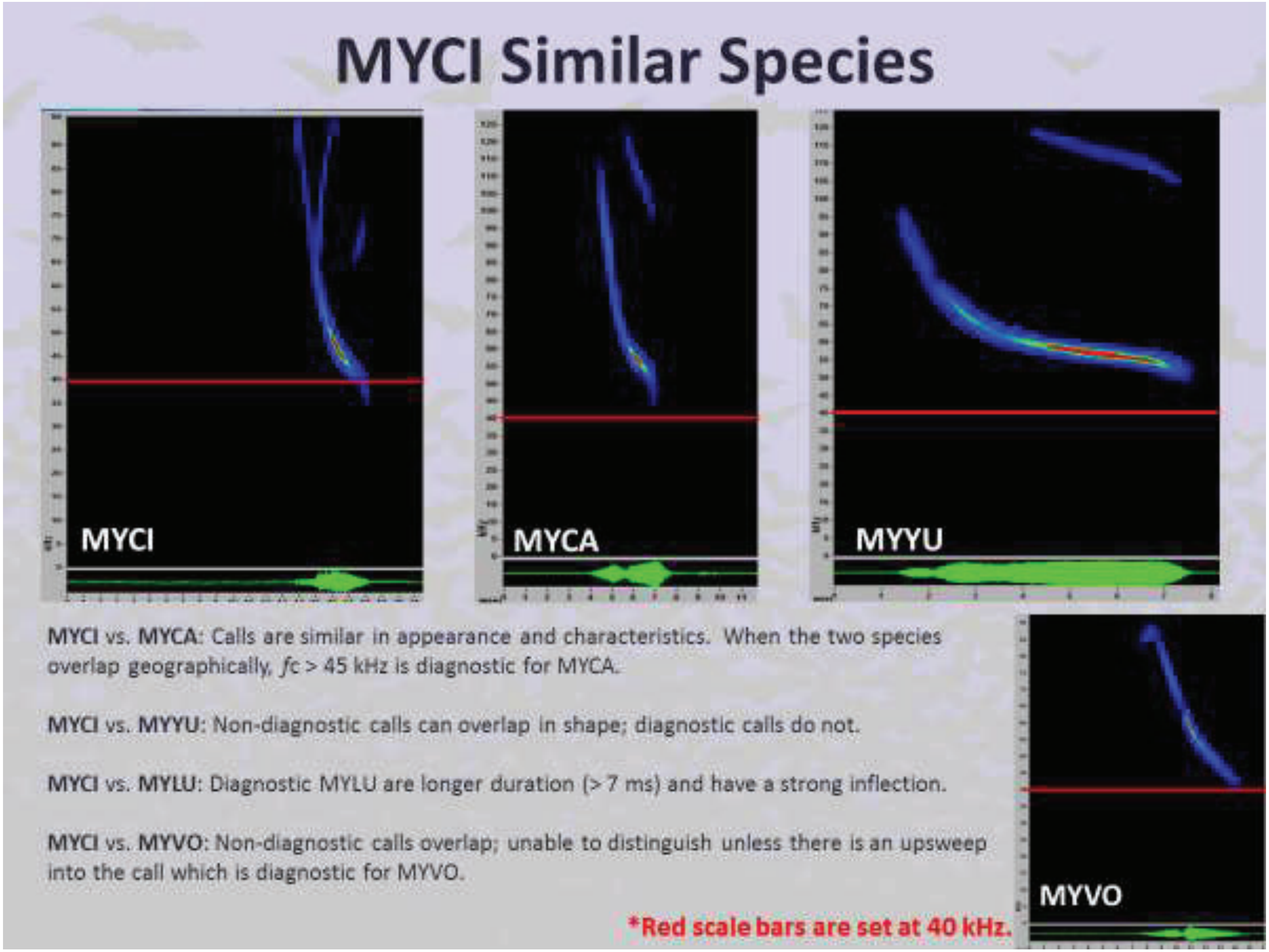


Figure 85. Calls sequences produced by other species that may be confused with the Western Small-footed Myotis (Myotis ciliolabrum, MYCI)

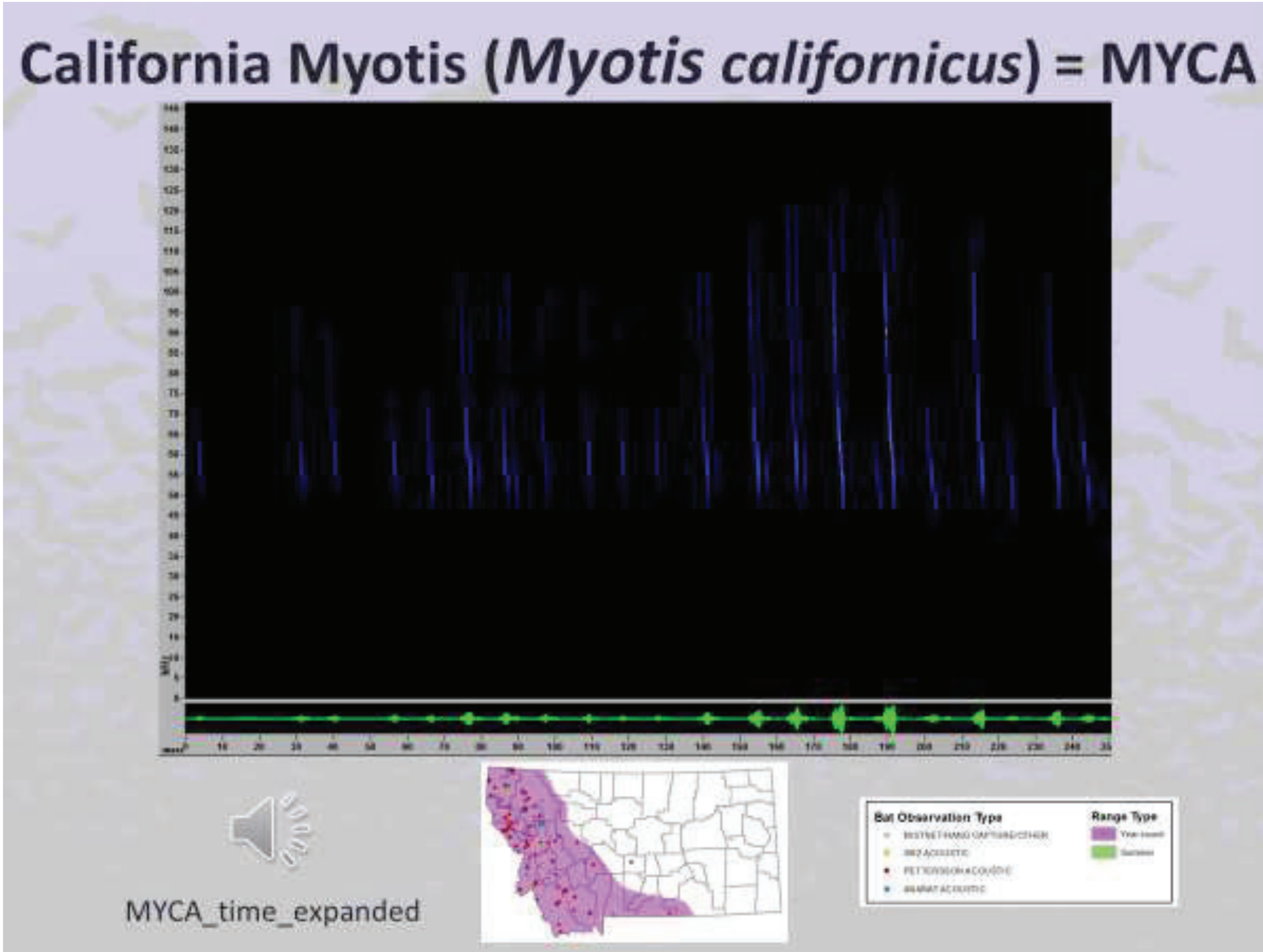


Figure 86. Example call sequence for the California Myotis (Myotis californicus, MYCA)

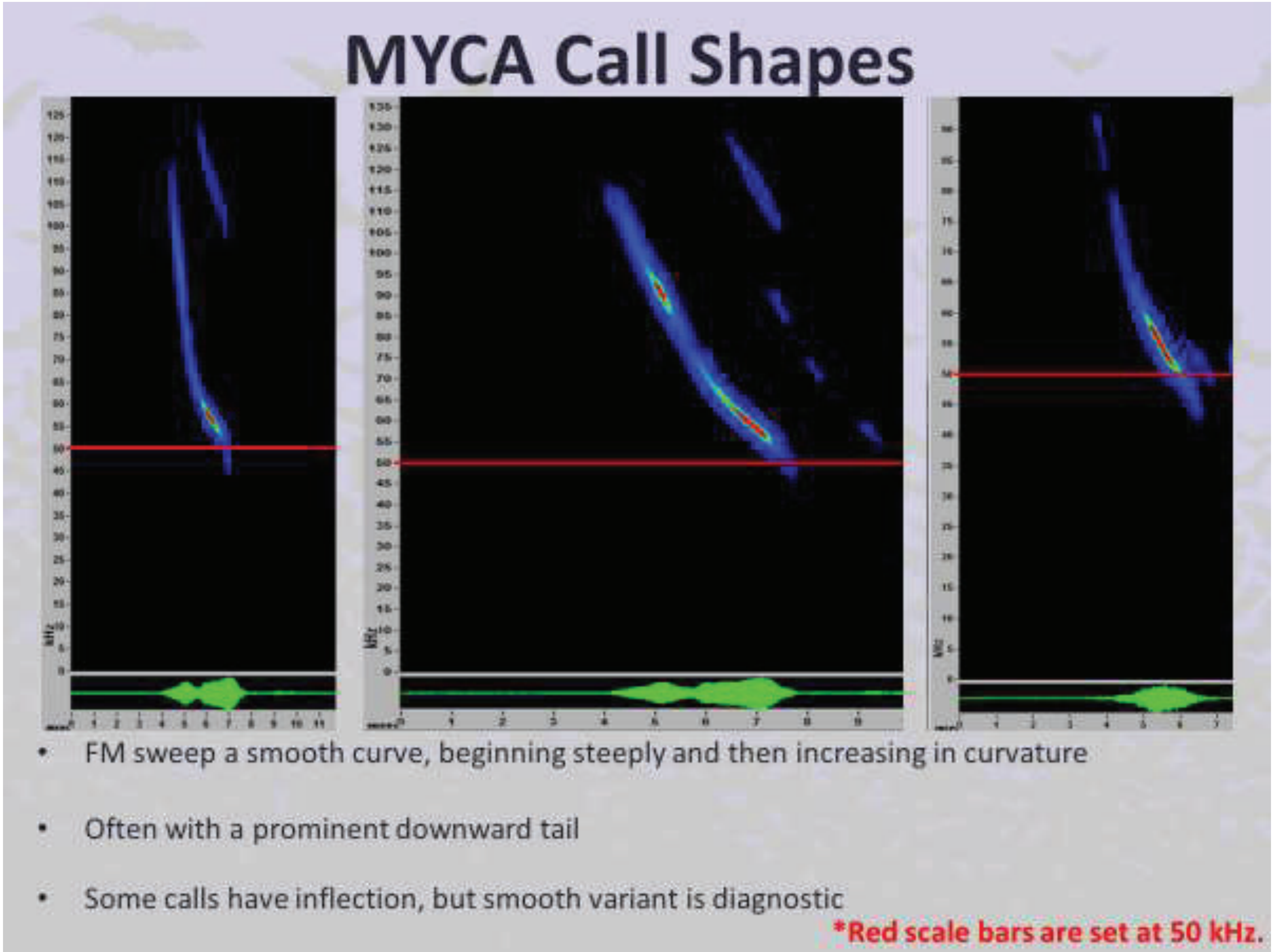


Figure 87. Call shapes of the California Myotis (Myotis californicus, MYCA)

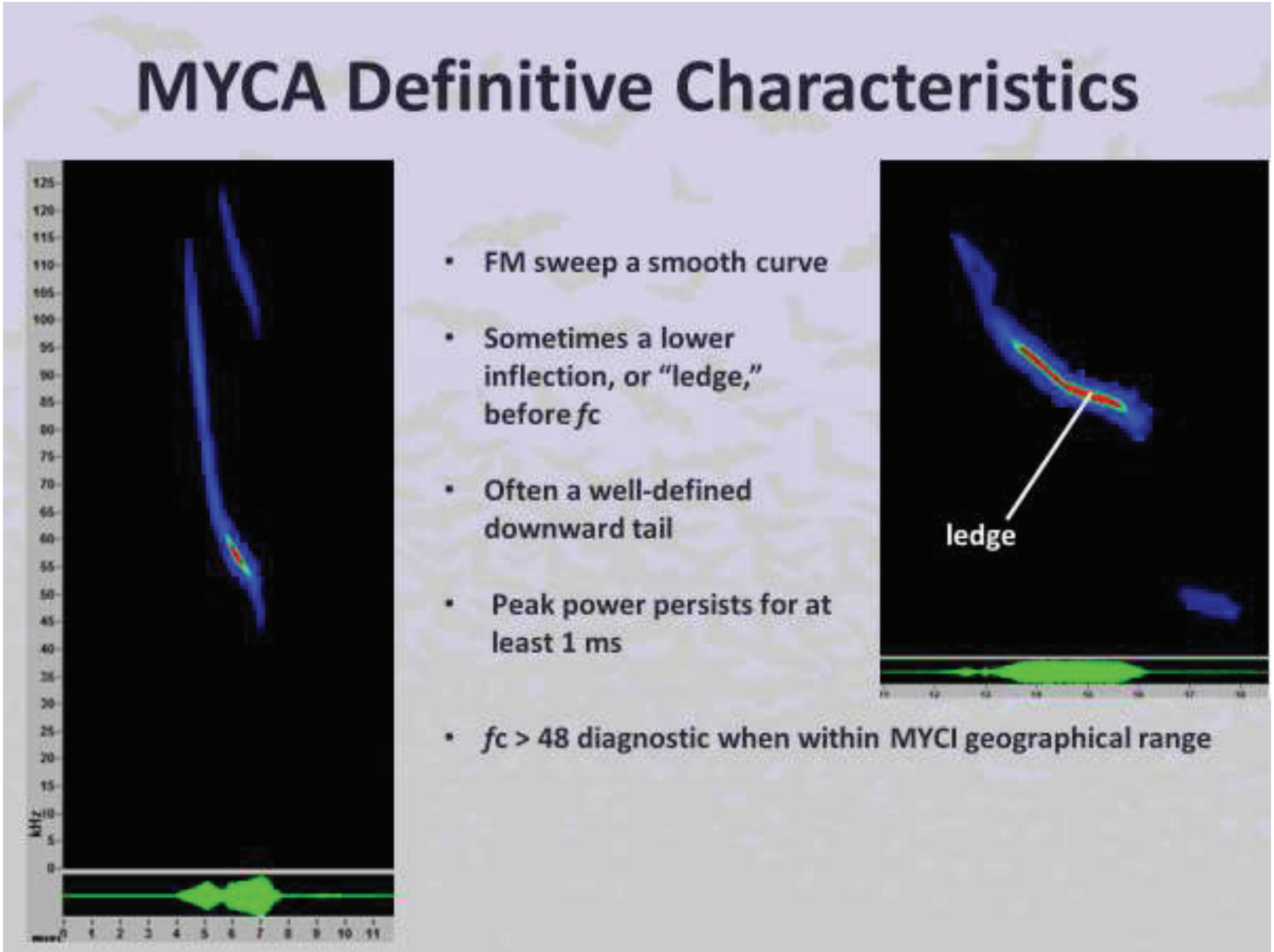


Figure 88. Definitive characteristics of call sequence for the California Myotis (Myotis californicus, MYCA)

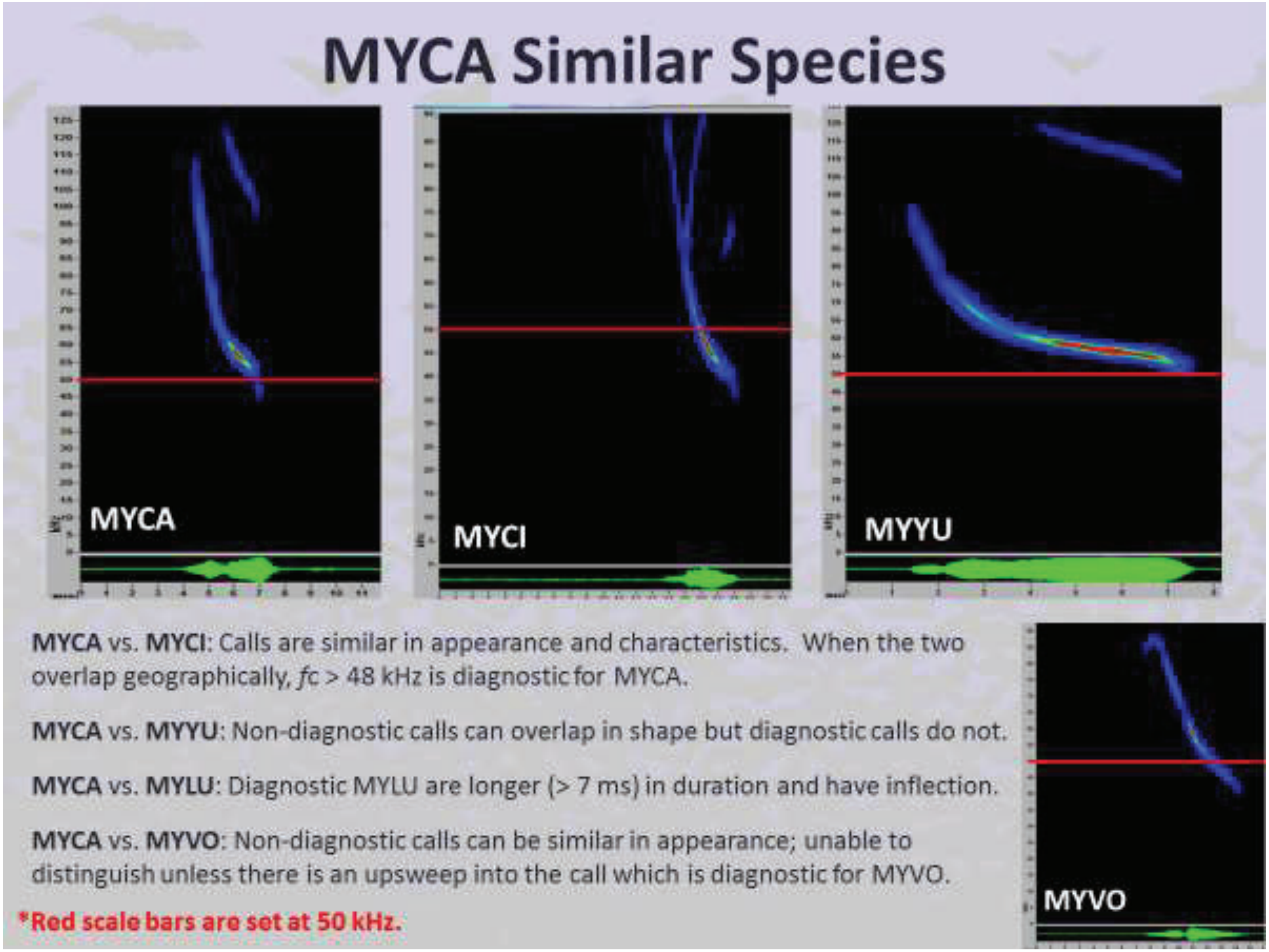


Figure 89. Calls sequences produced by other species that may be confused with the California Myotis (Myotis californicus, MYCA)