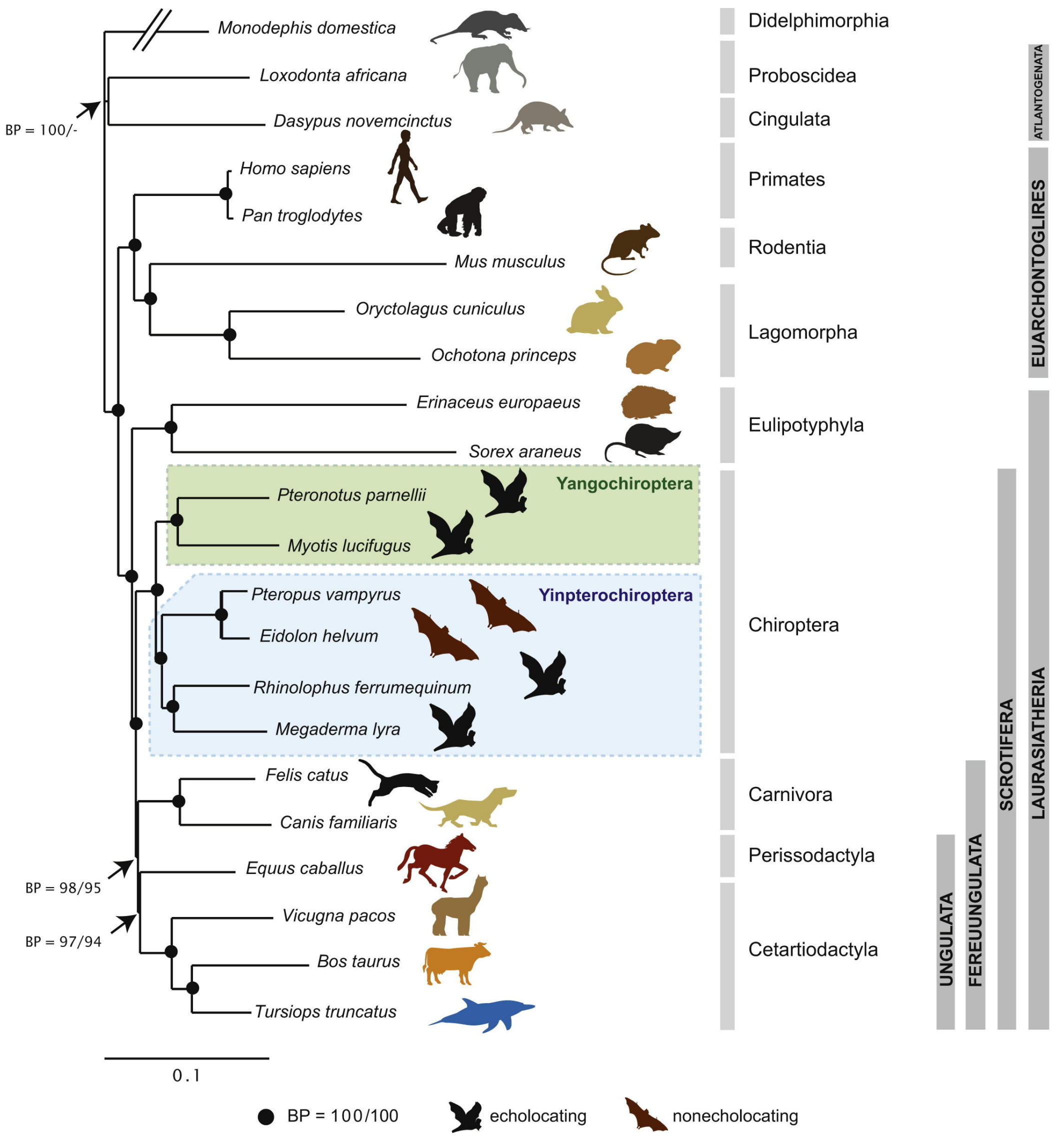
A Few Things About Bats

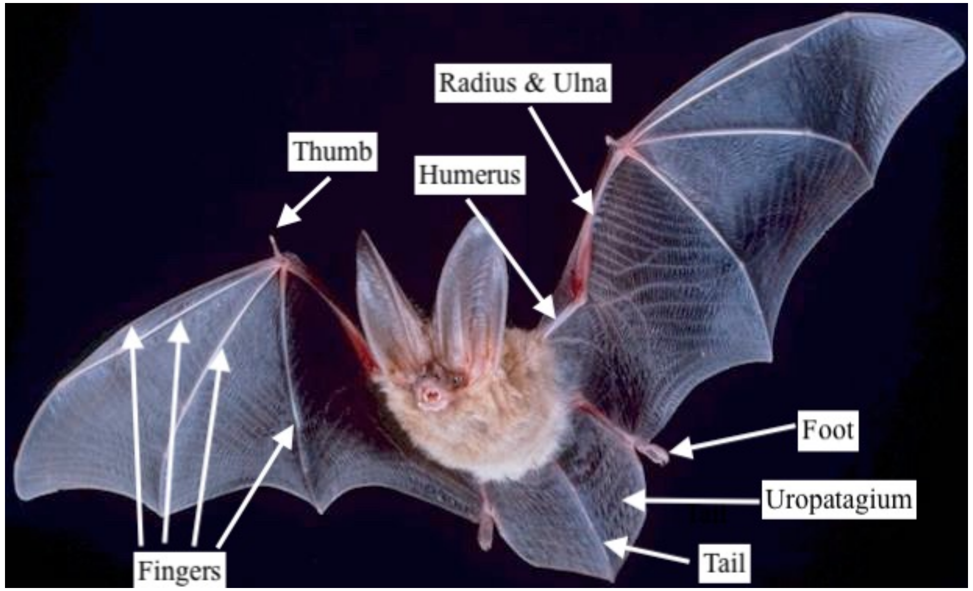
Position Within The Class Mammalia

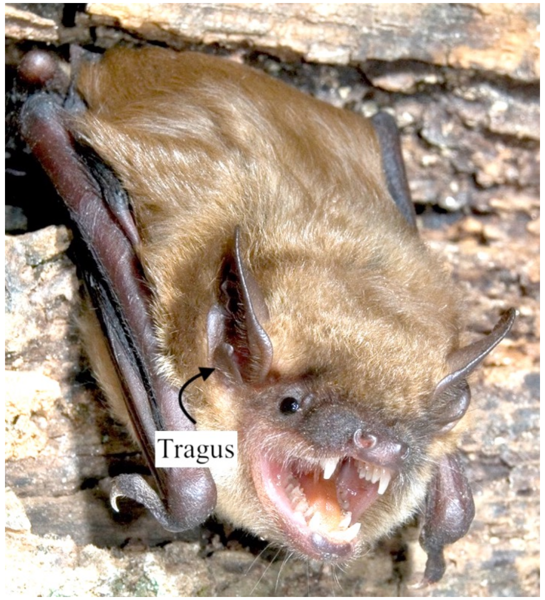
20% of all mammalian species are bats – more than 1,400 species

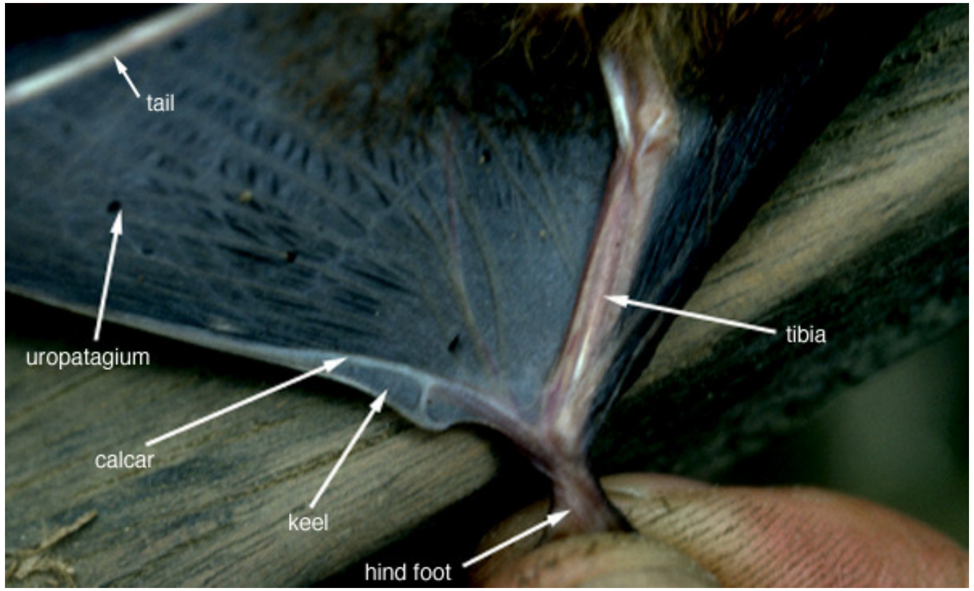


From: Tsagkoeorga *et al.* 2013. Phylogenetic analyses elucidate the evolutionary relationships of bats. *Current Biology* **23(22):** 2262-2267.

Bat Morphological Features Used In Identification







Genetic analysis is often necessary to distinguish some species, particularly myotis species

BC Bats Are All Insectivores

- They consume many insects that damage trees (e.g., spruce budworm, tent caterpillar, etc.) and agricultural crops (e.g., moths that have cutworms as the larval form; fruitflies, etc.)
  - As a pest control it is estimated that bats have a value of $22 billion to agricultural production in North America

- They also eat mosquitos, blackflies, etc.
  - Thereby decreasing the likelihood of some insect-vectored diseases

Bat Foraging Approaches

- Aerial Hawkers: capture prey on the wing using their wings and uropatagia to capture the insect

  Big Brown bat (*Eptesicus fuscus*); Silver-haired bat (*Lasionycteris noctivagans*); Eastern Red bat (*Lasiuris borealis*); Hoary bat (*Lasiurus cinereus*); California myotis (*Myotis californicus*); Long-legged myotis (*Myotis volans*); Dark-nosed Small-footed myotis (*Myotis melanorhinus*); Mexican Free-tailed bat (*Tadarida braziliensis*)

- Trawlers: fly close to a water surface and catch insects with their feet
  - These bats have long feet: Yuma myotis (*Myotis yumanensis*)
  - Some bats also catch small fish – but not BC bats
- Gleaners: capture prey on a surface such as leaf, branch or on the ground
  - These bats tend to rely on insect-generated noise and, thus, have large ears
  - E.g., Northern Long-eared bat (*Myotis septentrionalis*)

- Note
  - Some bats both hawk and trawl – e.g., Little Brown bat (*Myotis lucifugus*)
  - Others both hawk and glean– e.g., Long-eared myotis (*Myotis evotis*), Pallid bat (*Antrozus pallidus*); Townsend's Big-eared bat (*Cornyorhinus townsendii)*: Fringed myotis bat *(Myotis thysanodes*):

Bat Hibernaculae

- Most bat species congregate into tight colonies for their winter hibernaculae
  - Close packing of hibernating bats allows conserving of heat

Little Brown bat in hibernation

Photo from: US Geological Survey and can be found at: https://www.usgs.gov/centers/upper-midwest-environmental-sciences-center/science/continental-scale-study-acoustic

Maternity Colonies

- Most bat species form maternity colonies where they give birth, usually to one offspring, and raise their young
  - One of the reasons for maternity colonies is probably to keep the babies and juveniles warm
  - Another possible reason is that in some species providing milk to the young is a communal effort
- Interestingly, some bat species form mixed maternal colonies
  - For example, Little Brown bats and Yuma myotis bats
- A major exception to the formation of maternal colonies are lasiurines such as the Hoary bat and Eastern Red bats where females find individual roosts in foliage
    - They also usually give birth to two-four precocial offspring

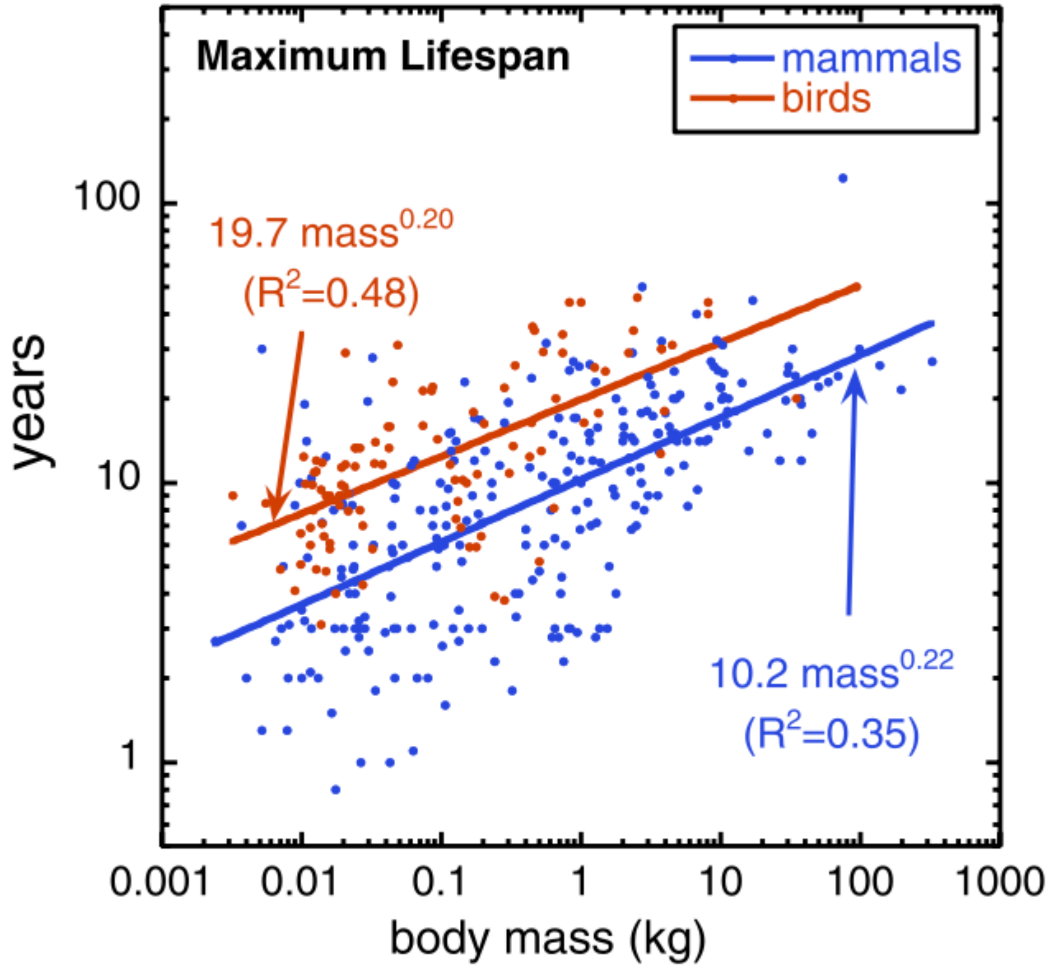
Little Brown Bat Maternity Colony

MATERNITY COLONY OF LITTLE BROWN MYOTIS IN ATTIC WITH PUP TUCKED UNDER ITS MOTHER'S WING ON THE LEFT.

Taken from: "Got Bats? BC Community Bat Project". See: https://www.bcbats.ca/attachments/bat_FAQ.pdf

Life Expectancy & Body Mass

B

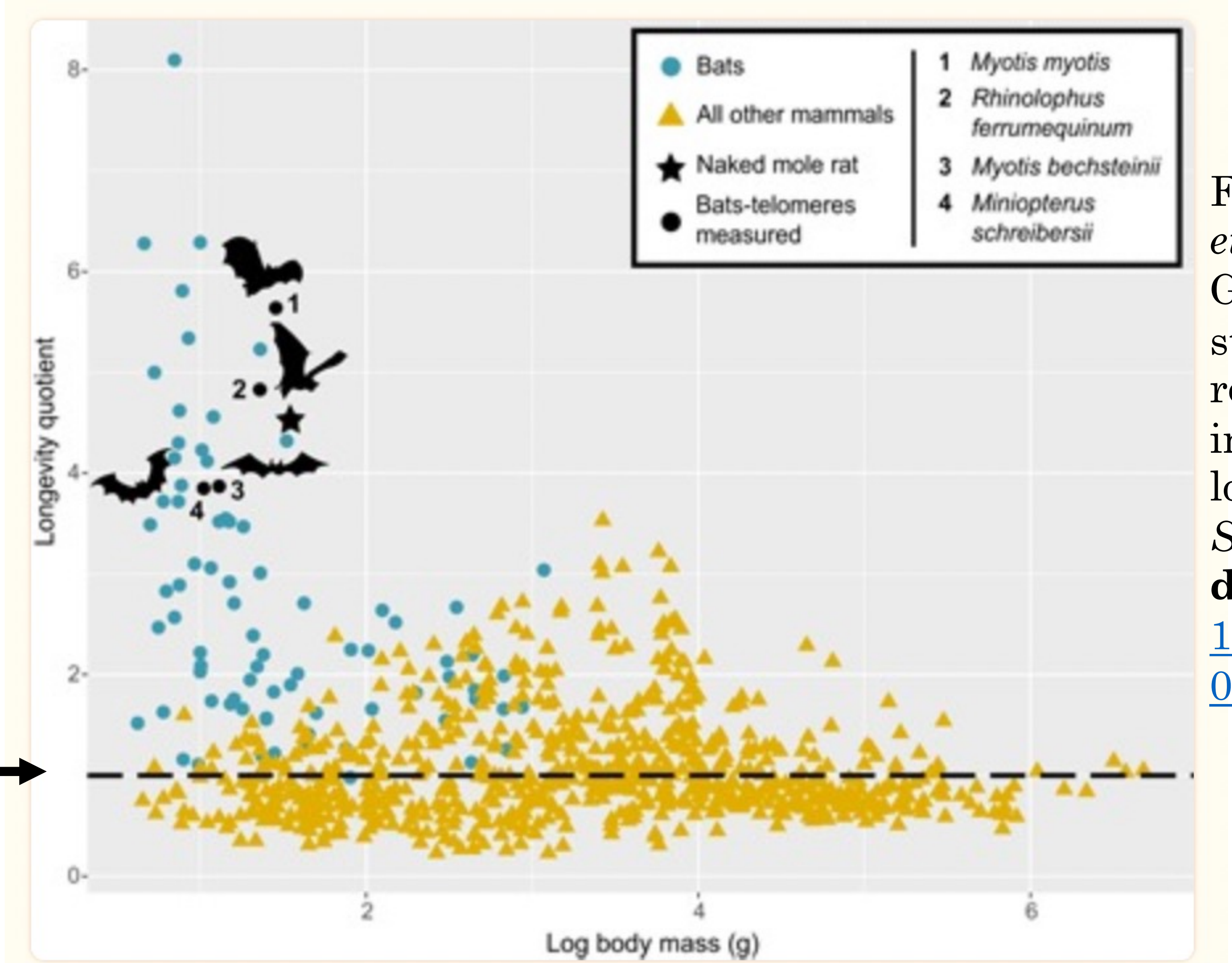


From: A.J. Hulbert *et al.* 2007. Life and death: Metabolic rate, membrane composition, and life span of animals. *Physiological Reviews* **87:** 1175-1213

Bats Are Extremely Long-Lived For Their Body Mass

Individuals from some bat species can live up to 30 to 40 years – some species live up to eight times what would be expected for their body mass

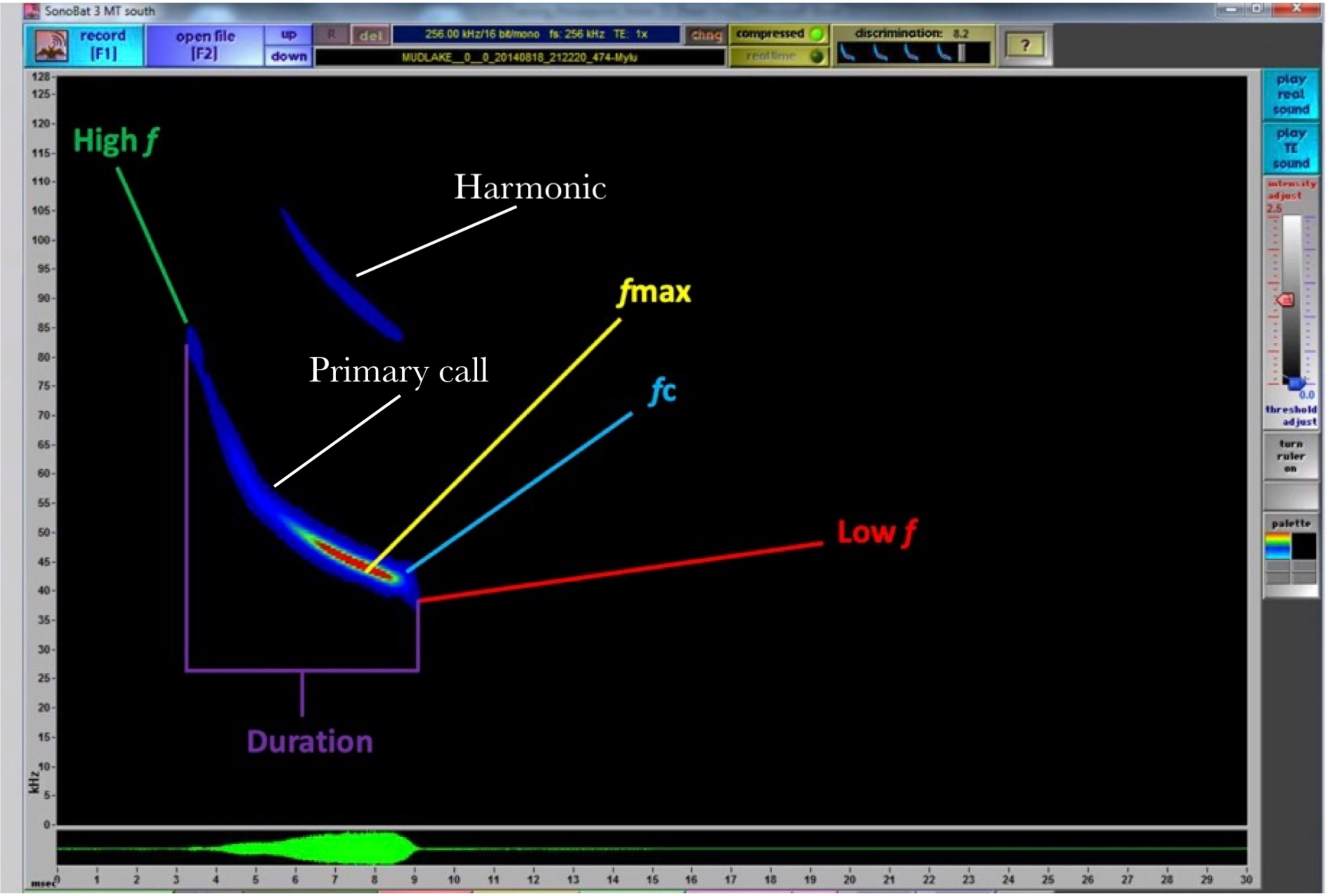
Expected lifespan according to body mass



From: N.M. Foley *et al.* 2018. Growing old, yet staying young: The role of teleomeres in bats' exceptional longevity. *Science Advances* **doi:** 10.1126/sciadv.aao0926

Bats Use Echolocation To Navigate In The Dark

Frequency



Time (milliseconds)

Features of a bat call: taken, with permission, from B. Maxwell *et al.* 2018. Bats of Montana: identification and natural history. *Report to Montana Department of Environmental Quality*. Montana Natural Heritage Program, Helena, Montana. 111 pp.

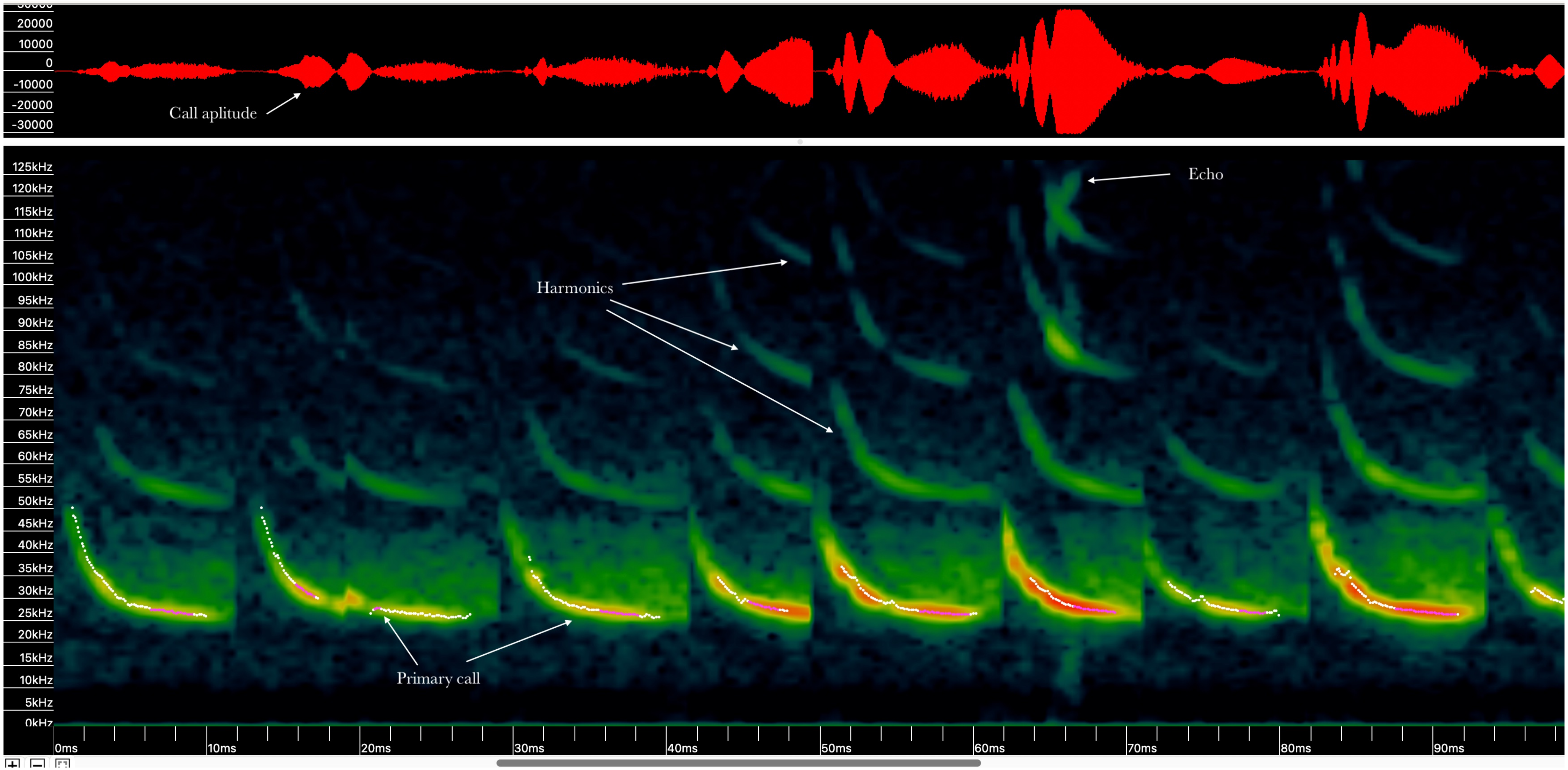
Why Have Frequency-Modulated Calls?

- The higher the frequency, the faster the energy dissipates
  - Comparing echo returns from high frequencies relative to low frequencies allows the bat to judge how far away an object is
  - Echos from the very high frequencies indicate the objects are very near
  - To record the highest frequencies, the bats must be near the acoustic meter
- Harmonic calls (higher frequencies) also play a very important role in judging distance to objects, whether it is a prey insect or obstacle

Echolocation Calls

- Many bat species have similar echolocation calls
  - In BC, there are four myotis specie that have characteristic frequencies (f_c*s*) around 40 kHz: *Myotis Volans* (Long-legged myotis), *Myotis lucifugus* (Little Brown myotis), *Myotis septentrionalis* (Northern [Long-eared] myotis) and *Myotis ciliolabrum*/*Myotis melanorhinus* (Western Small-footed myotis/ Dark-Nosed Small-footed Myotis). Furthermore, under certain uncluttered environments the California myotis (*Myotis californicus*) can be confused with the 40 kHz myotis species
- The echolocation calls can vary dependent upon the amount of clutter in the environment
  - Cluttered environments require higher frequency calls
  - Often quite tricky to distinguish one bat call from another

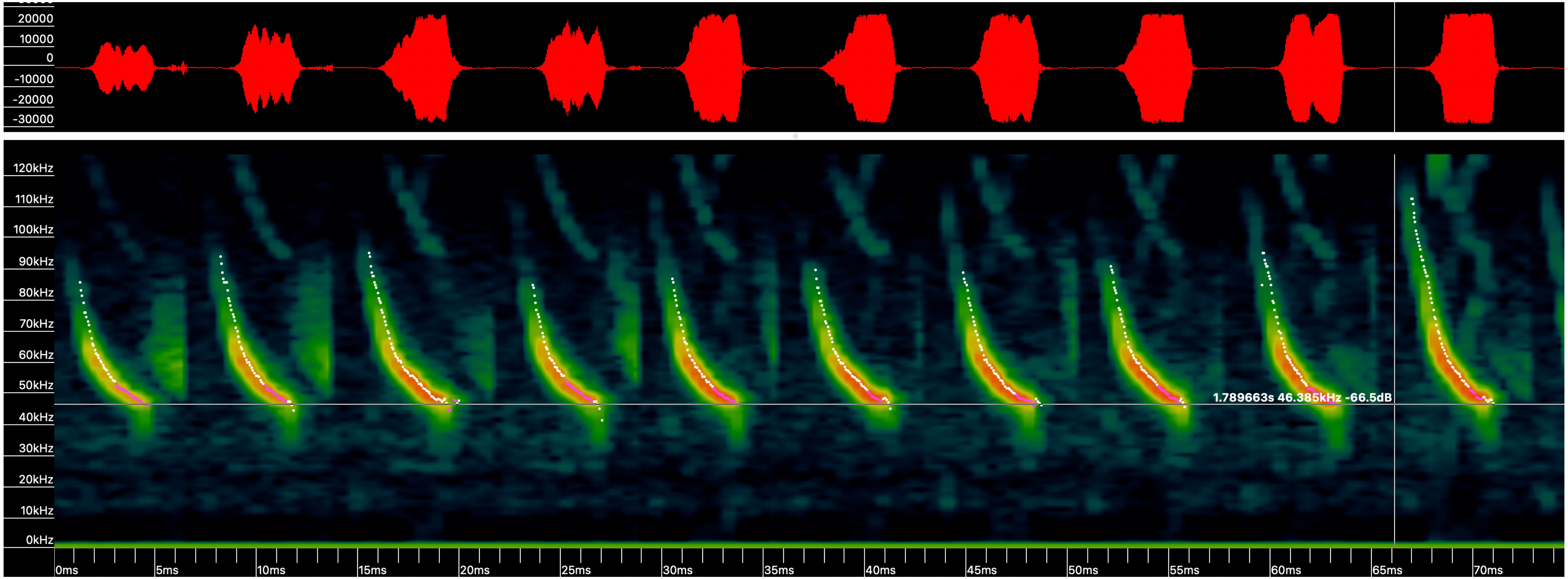
Example of an Echolocation Call Sequence



Compressed view: probably a Silver-haired bat

Two Ways To View Echolocation Calls

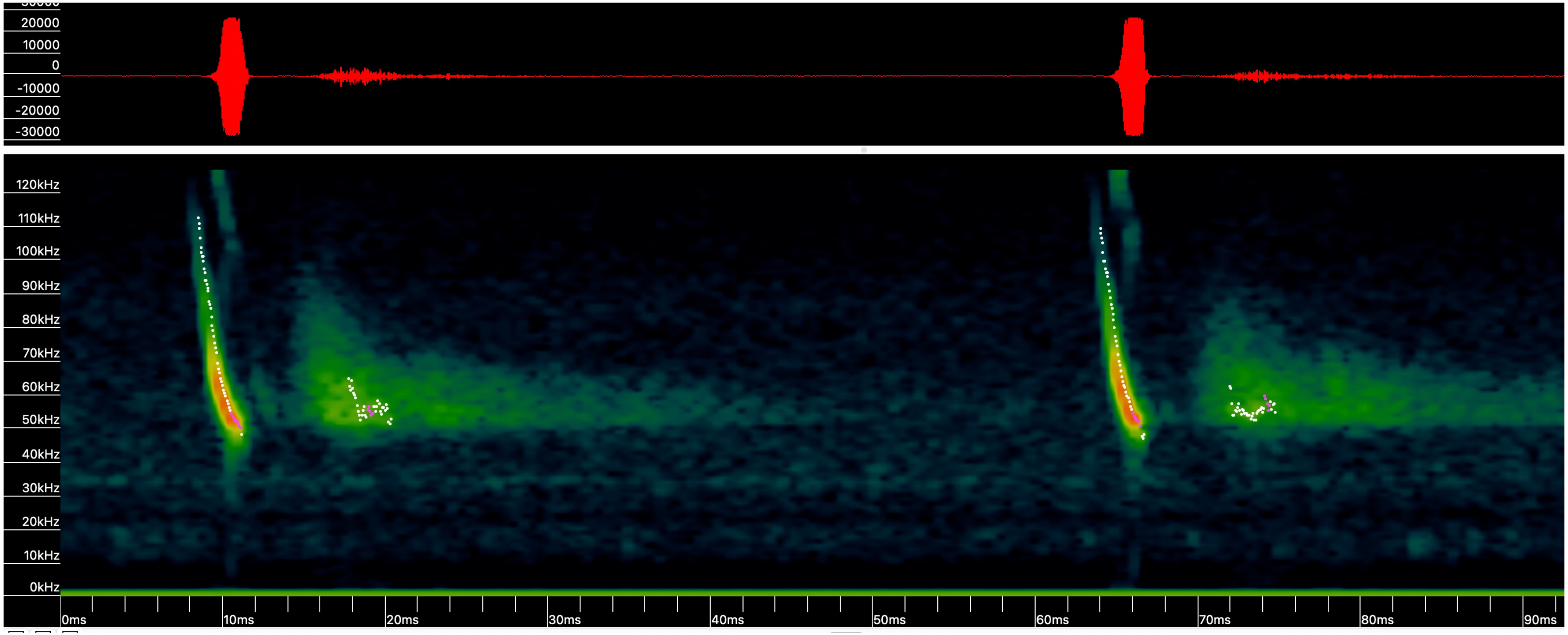
- 1) Compressed view where the inter-call interval is eliminated



This is likely a California myotis call: note f_c of 46 kHz and f_{High} of up to 114 kHz

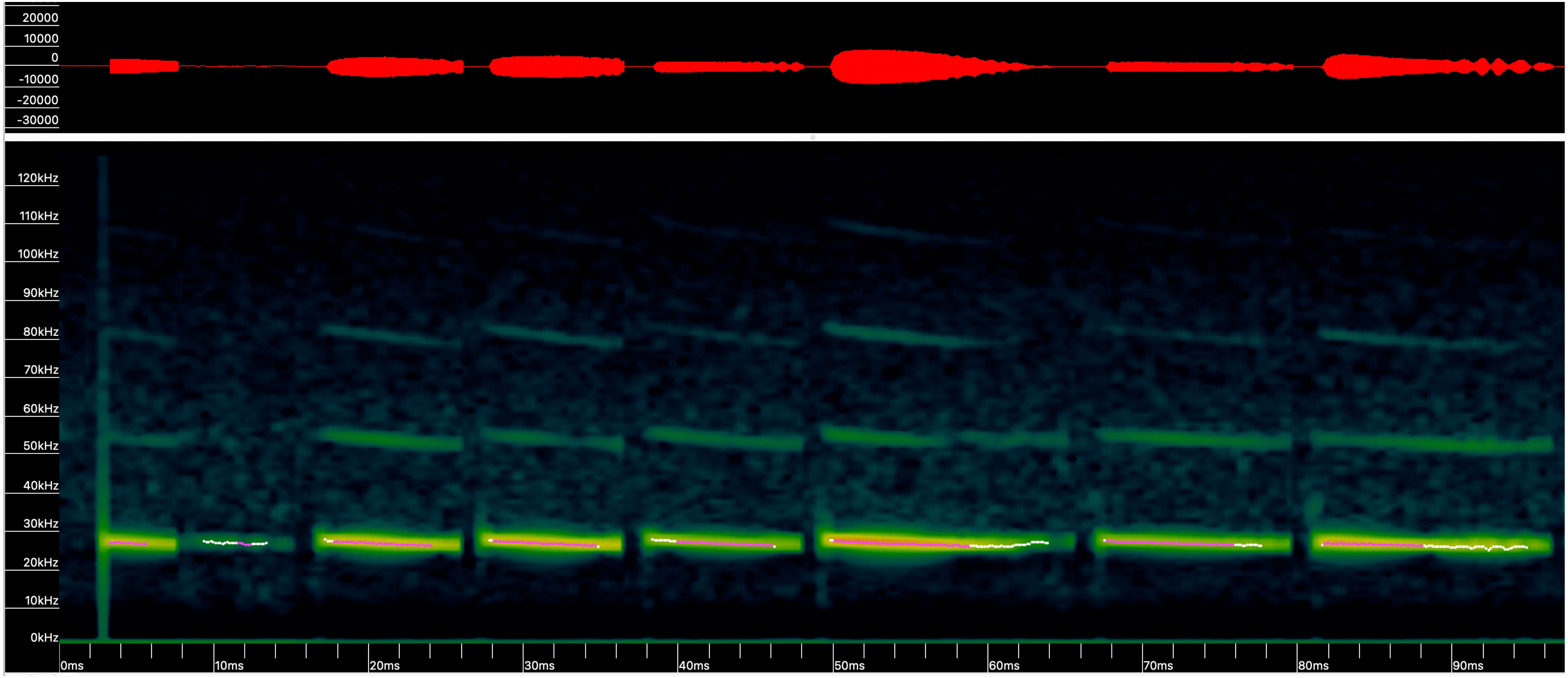
Two Ways To View Echolocation Calls

- 2) Expanded view where the inter-call interval is shown on the sonogram. The inter-call interval is also a criterion in determining the source of the echolocation call



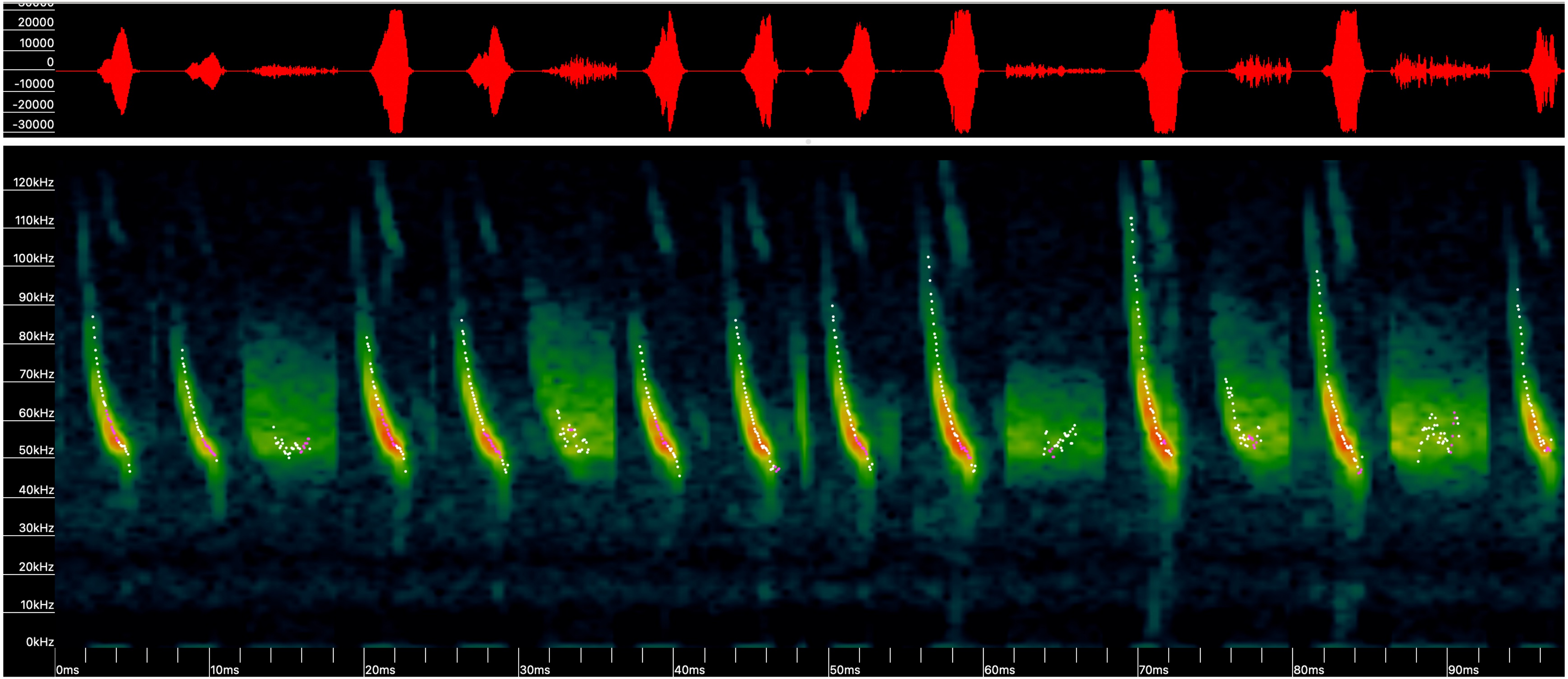
Same sonogram where the inter-call interval is shown. In this particular sonogram the inter-call duration varied from 60 to 80 msec

Some Bats Can Have FM As Well as Very Very Flat Calls



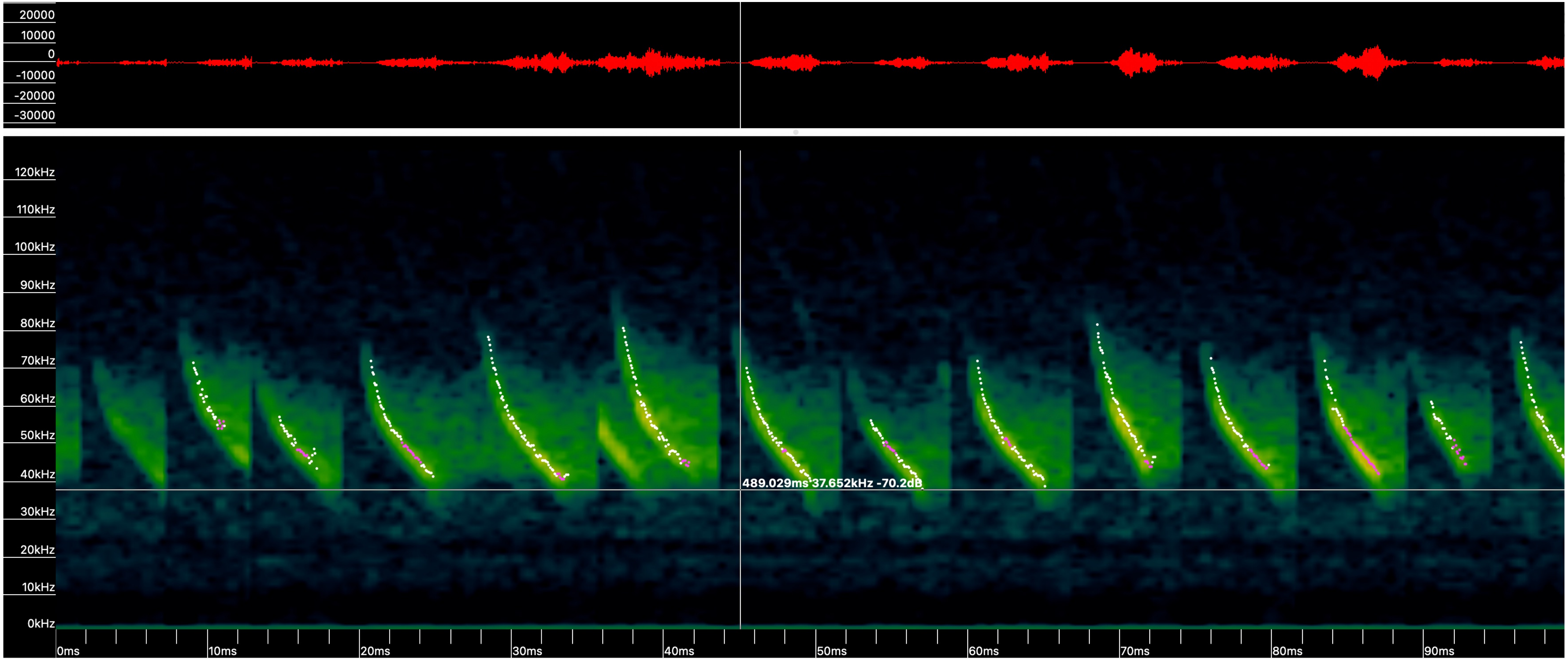
Compressed view: probably a Silver-haired bat

Some Bats Have Very Steep FM Calls



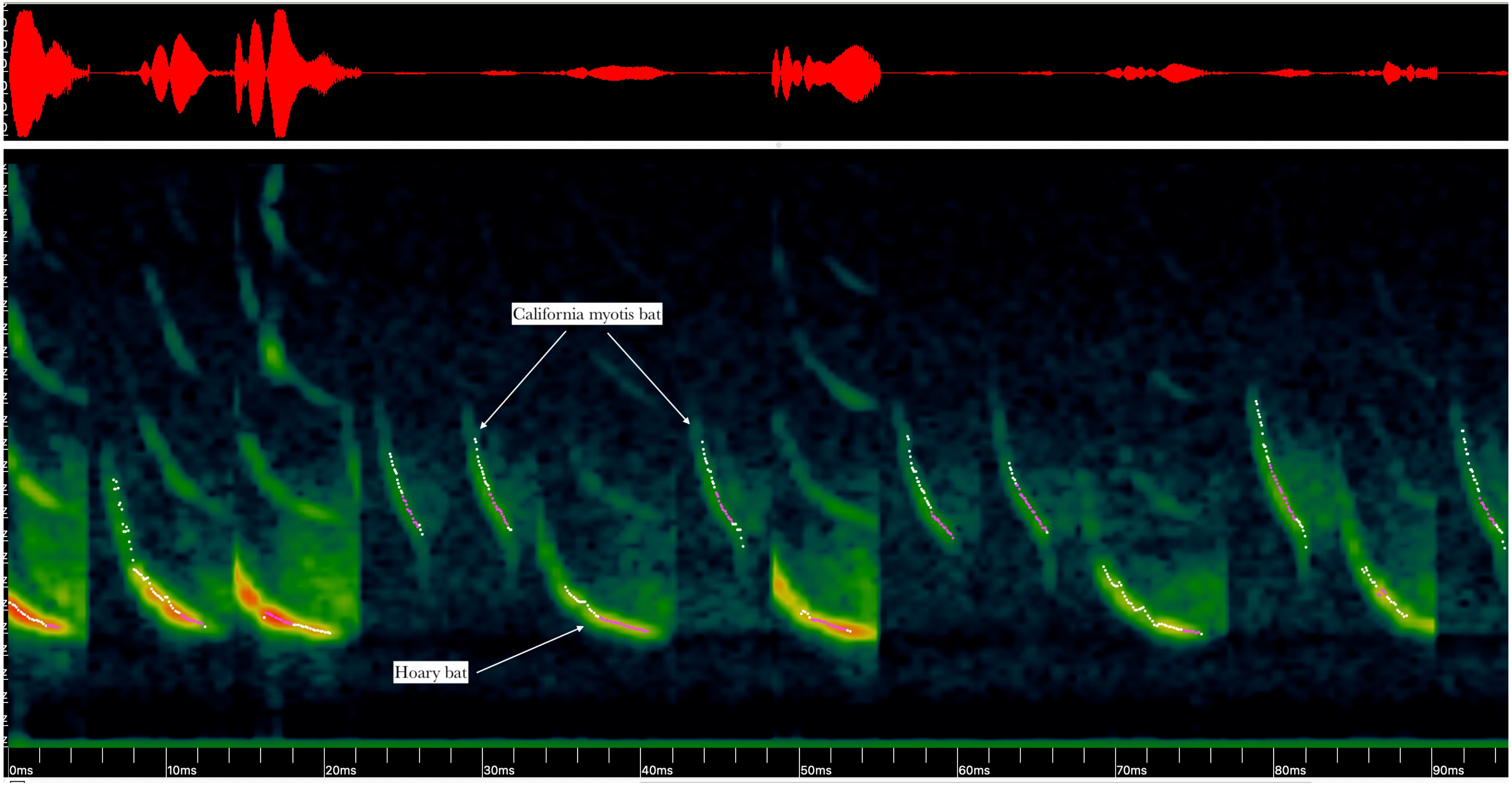
Compressed view: probably a California myotis

Lasiurine Bats Can Have an Oscillating f_c



Compressed view: probably an Eastern Red bat – has not been officially recognized as being on Vancouver Island

May Have More Than One Bat Echolocating



Compressed view: very confusing for bat analysis software to interpret

Which Softeware Analysis Program To Use?

- Fairly poor agreement in identifying bat echolocation calls amongst programs

TABLE 2. Percentage species-level agreement of identification of bat sequences by pairwise comparisons of software packages. Header columns indicate the programs being compared to calculate percentage agreement at both the lower and higher accuracy levels. Abbreviations and settings as in Table 1.

	Sono/Kal		Sono/BCID		Sono/Echo		Kal/BCID		Kal/Echo		BCID/Echo	
Species	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Single night												
E. fuscus	78	76	79	82	26	26	73	81	30	34	24	14
L. borealis	37	39	39	17	25	19	35	7	31	39	21	3
L. cinereus	83	86	39	42	54	58	32	42	47	39	42	62
L. noctivagans	28	23	14	19	10	7	33	68	19	21	19	31
M. lucifugus	65	76	71	88	16	16	59	91	12	17	16	19
N. humeralis	44	76	50	66	26	9	42	61	34	52	18	30
P. subflavus	86	87	86	95	60	62	75	85	65	70	46	59
Nebraska City												
E. fuscus	29	29	23	7	12	16	30	9	24	28	9	6
L. borealis	53	58	23	5	49	19	23	5	40	47	16	3
L. cinereus	74	92	25	45	64	76	26	26	62	60	68	76
L. noctivagans	10	10	9	10	13	10	42	55	32	32	37	46
N. humeralis	22	12	18	16	3	0	39	41	3	3	1	1
P. subflavus	88	92	84	98	14	18	82	97	16	16	15	21

From: C. Lemen *et al*. 2015. The problem of low agreement among automated identification programs for acoustical survey of bats. *Western North American Naturalist* **75:** 218-225

Kaleidoscope Vs Sonobat

- Wildlife Acoustics Echometer Pro uses Kaleidoscope software for identification – this is the software we have relied upon in the past two years and again this year for much of the survey
- We will also be using Sonobat for part of the survey where we are using AudioMoth or Chorus ultrasound detectors
  - Sonobat is highly recommended by Kyle Nelson, who has been advising us
  - Several studies comparing Sonobat to Kaleidoscope with expert vetting of the sonograms indicate that Sonobat is much more accurate than Kaleidoscope

Sonobat Vs Kaleidoscope Studies

Kaleidoscope Pro vs. SonoBat Expertly Vetted Missouri Dataset

Tyburec 2012

	KaPro		SonoBat	
	% correct	% classified	% correct	% classified
CORRAF	0.0	0.0	100.0	75.0
EPTFUS	77.7	52.4	98.2	89.5
LASNOC	53.1	38.8	98.1	79.1
LASBOR	61.4	52.5	88.1	51.8
LASCIN	97.0	67.1	96.7	80.8
MYOGRI	66.7	66.7	n/a**	n/a**
MYOLEI	66.7	50.0	100.0	91.7
MYOLUC	81.3	58.2	93.6	80.1
MYOSEP	21.1	15.4	94.4	65.4
MYOSOD	60.0	60.0	100.0	100.0
NYCHUM	65.9	62.2	97.6	80.7
PIPSUB	87.6	72.8	95.3	80.3
	60.8	49.7	96.5	79.1

Kaleidoscope Pro vs. SonoBat Expertly Vetted Western Dataset

Malloy 2014

	Kaleidoscope Pro 2.0.6		SonoBat 3.2	
	% correct	% classified	% correct	% classified
Myyu	51.5	39.2	98.4	79.5
Myca	62.5	4.9	98.2	68.9
Myci	94.0	48.6	99.6	83.9
Myvo	60.3	29.3	96.4	51.4
Mylu	54.2	36.5	98.5	67.2
Pahe	96.8	53.3	97.0	95.8
Labl	37.5	3.9	99.1	73.2
Myev	90.9	43.6	98.9	86.4
Anpa	55.7	23.5	96.0	57.9
Epfu	54.4	9.7	99.5	60.1
Lano	62.3	20.3	98.1	87.1
Myth	39.1	16.8	99.5	70.4
Tabr	64.7	4.0	98.2	91.6
Laci	86.2	22.0	99.7	86.3
Coto	81.0	23.3	100.0	81.6
Euma	80.0	2.8	100.0	78.0
Eupe	0.0	0.0	98.8	62.0
All	68.6	33.5	98.6	78.6

Taken from: https://batmanagement.com/blogs/acoustic-monitoring/top-recommendation-for-bat-call-analysis

Sonobat

- Developed and continually being upgraded by Joe Szewczak, Professor of Zoology, California Polytechnic State University, Humboldt
- Subscription monies used to purchase Sonobat are used to enhance the software
- At the Western Bat Working Group Conference recently held in Victoria, CERCA applied for the Bob Berry Award that is comprised of Sonobat software and a Pettersson D500x Bat Detector.
  - We were successful and are awaiting the Sonobat software (which is being upgraded) and the Pettersson bat detector

Importance Of Location

- In my front yard on Butterfield Road, Mill Bay, that has a small 1 metre wide pond, I get anywhere from 2 to 25 separate bat echolocation calls per night
- In a neighbour's yard, about 115 metres away, with the detector placed adjacent to a pond about 15 metres in diameter, I get anywhere from 450 to 1,500 echolocation calls per night

Location Matters

White Nose Syndrome

- Caused by the fungus *Pseudogymnoascus destructans*
- Grows on the skin of bats, not a problem as long as bats are awake and can remove the fungus, the problem arises when bats go into hibernation
  - Causes skin lesions and increases in metabolism depleting the fat stores of hibernating bats
- Fungus has been detected in bat-roosting caves in the interior of BC
  - So far no white nose disease detected in BC bats
  - Possibly due to the presence of 'probiotic' bacteria that have anti-fungal action such as a number of pseudomonas strains.
    - Reference: A. Forsythe *et al.* 2022. Microbial isolates with Anti-*Pseudogymnoascus destructans* activities from Western Canadian bat wings. *Scientific Reports* **12:** 9895. Paper can be found at: file:///Users/bernhardjuurlink/Downloads/s41598-022-14223-9.pdf