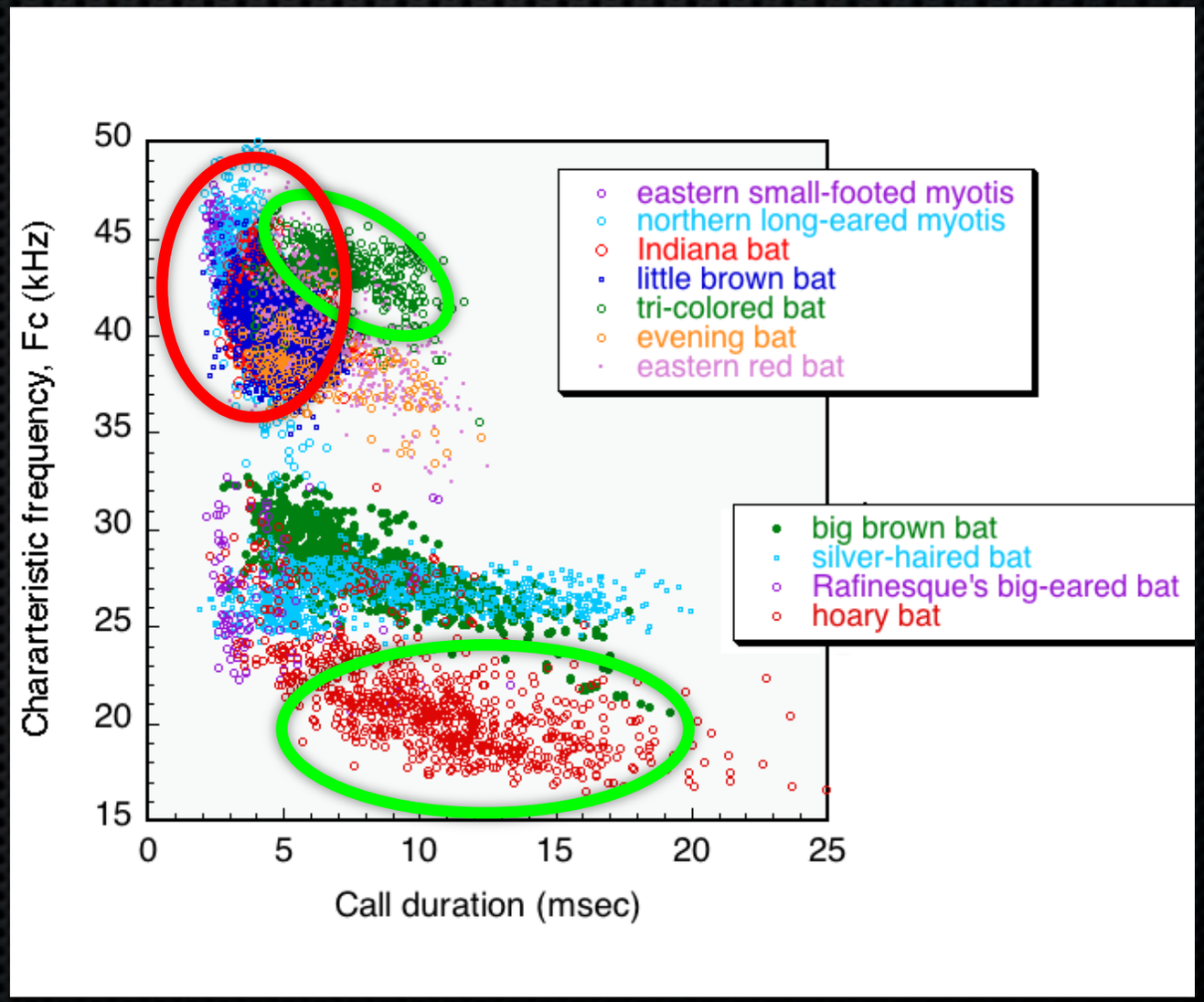
A Shout in the Dark . . .

The (Cold, Dark) Reality of Applying Acoustic Surveys to Determine Occupancy for Bats in the Myotis Species Guild

Acoustic Survey Assumptions

- Bats have Species-specific Echolocation Call Characters
- Bat Species are Equally Detectable
- All Bat Detectors are Created Equal
- Approved Auto-classifiers Return Accurate Results
- Version Control is Accurately Managed by all Users
- Surveyors Understand ID-outputs

Bats have Species-specific Call Characteristics



Barclay, R.M.R. 1999. Bats are not Birds – A Cautionary Note on Using Echolocation Calls to Identify Bats: A Comment. *Journal of Mammalogy*. 80(1): 290-296.

MYLU vs. MYSO

Myotis lucifugus

Myotis sodalis

LUSO Acoustic Repertoires

This is how we would like it to be:

MYSO

MYLU

This is more likely how it really is:

MYSO

MYLU

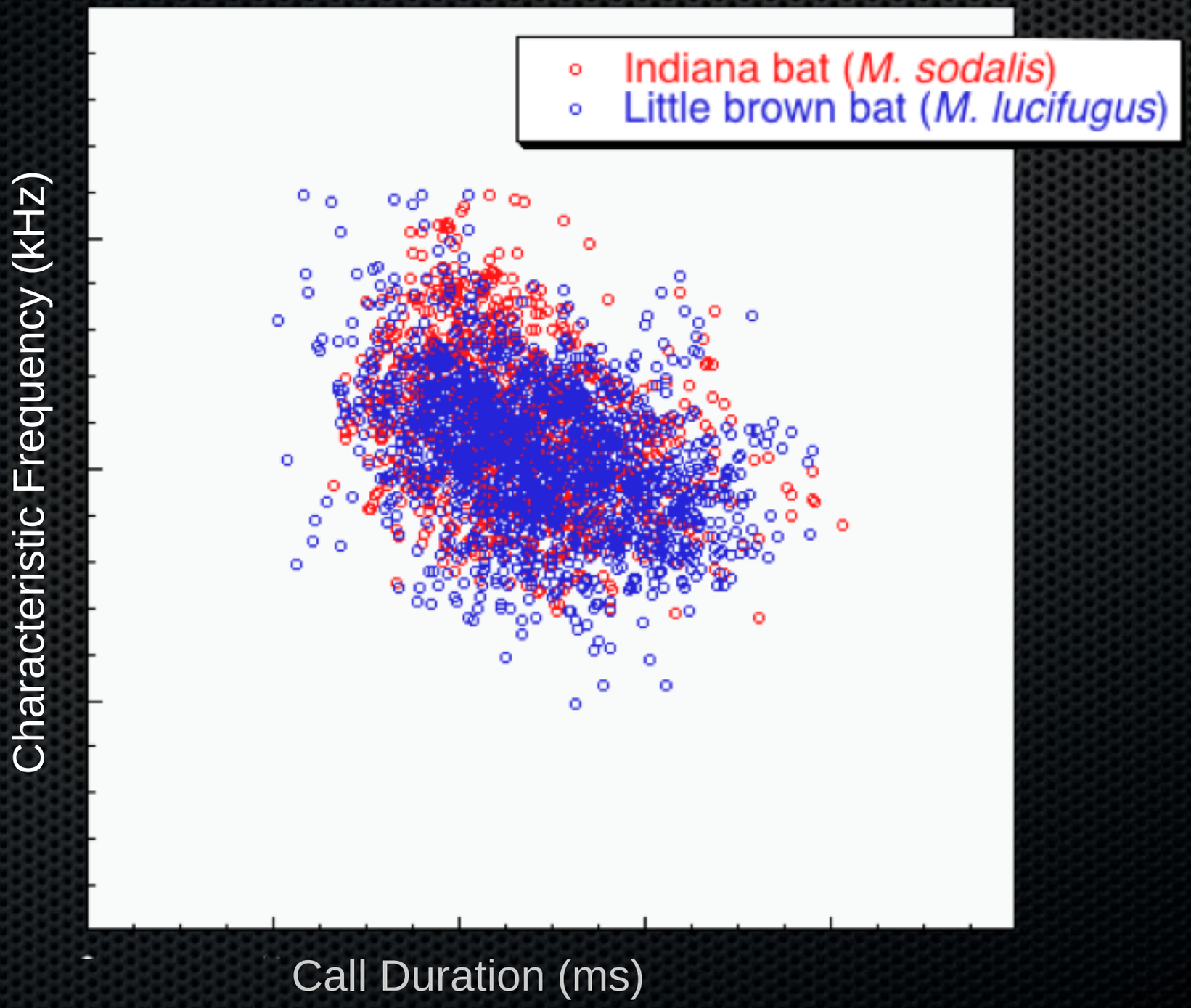
MYSO

MYLU

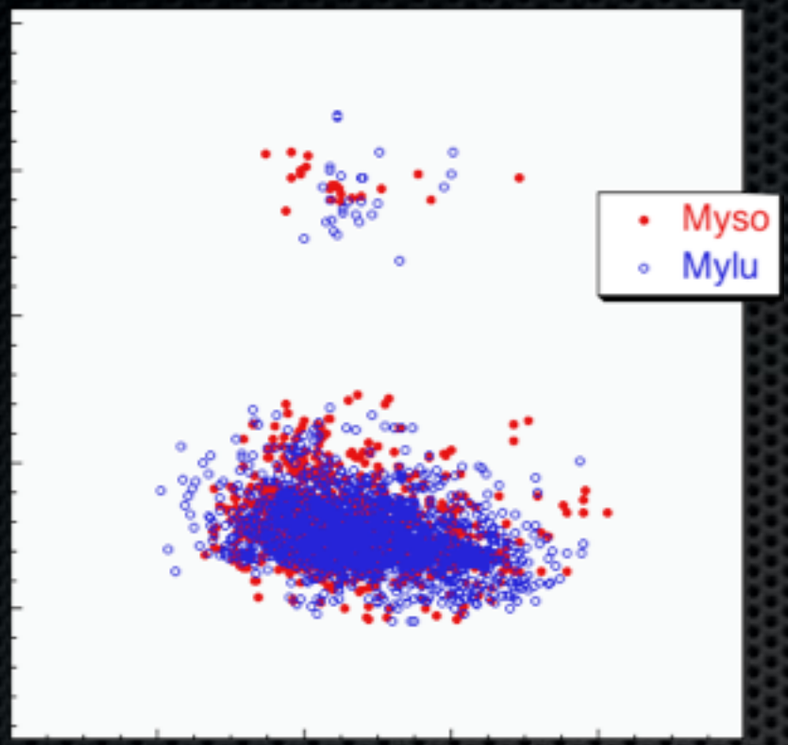
Other factors which might blur distinctions:

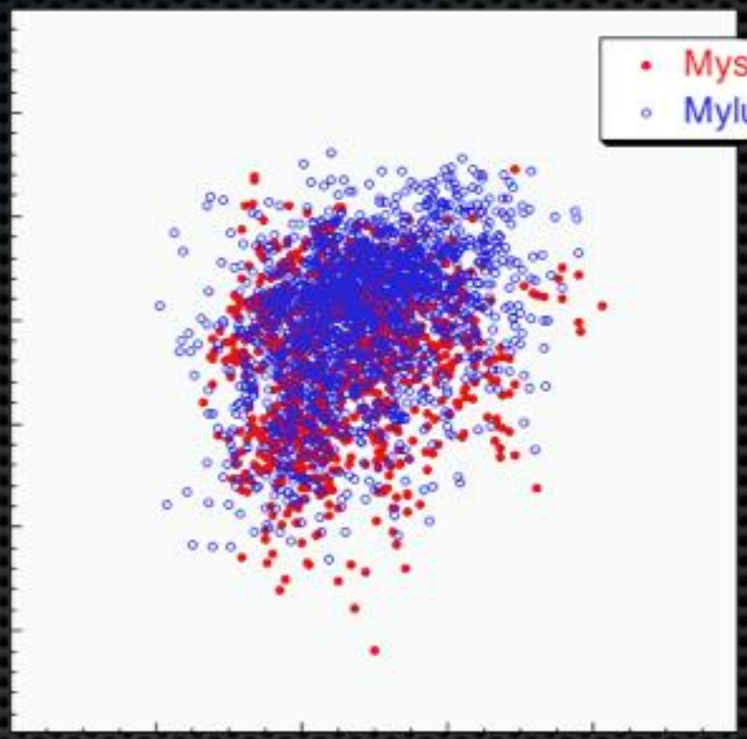
- presence or absence of other species
- seasonal variation in food resources
- geographic variation in food resources

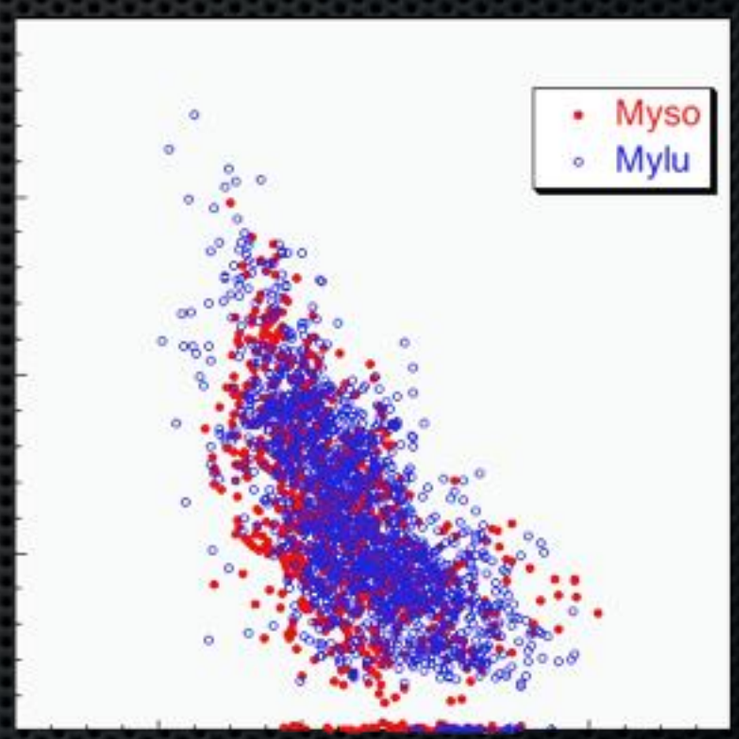
MYSO vs. MYLU: Fc vs. Dur

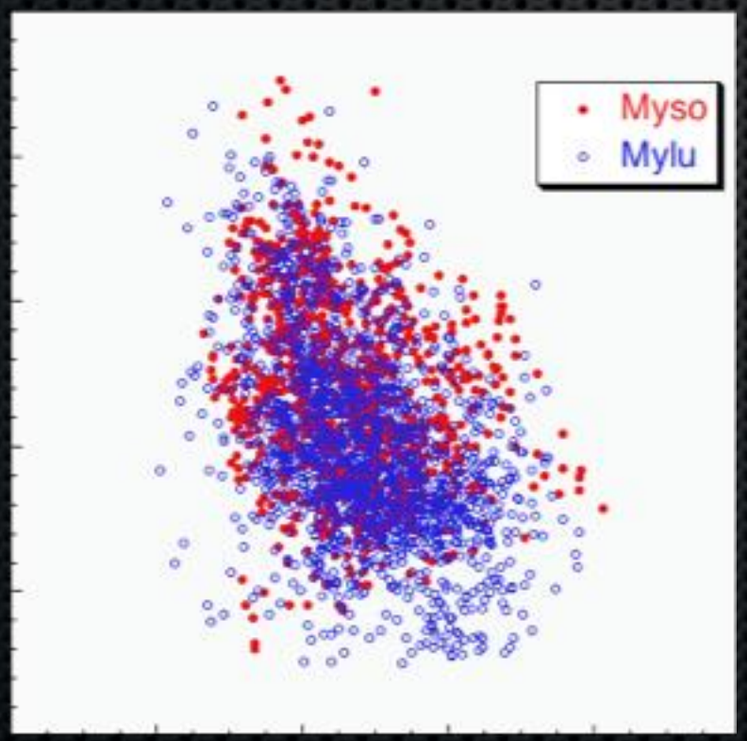


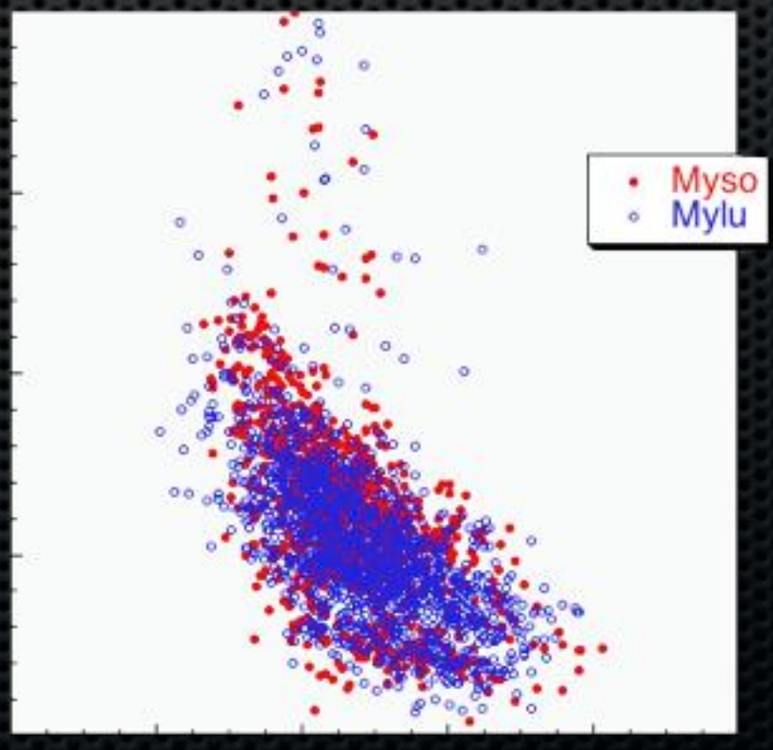
MYSO vs. MYLU: More . . .

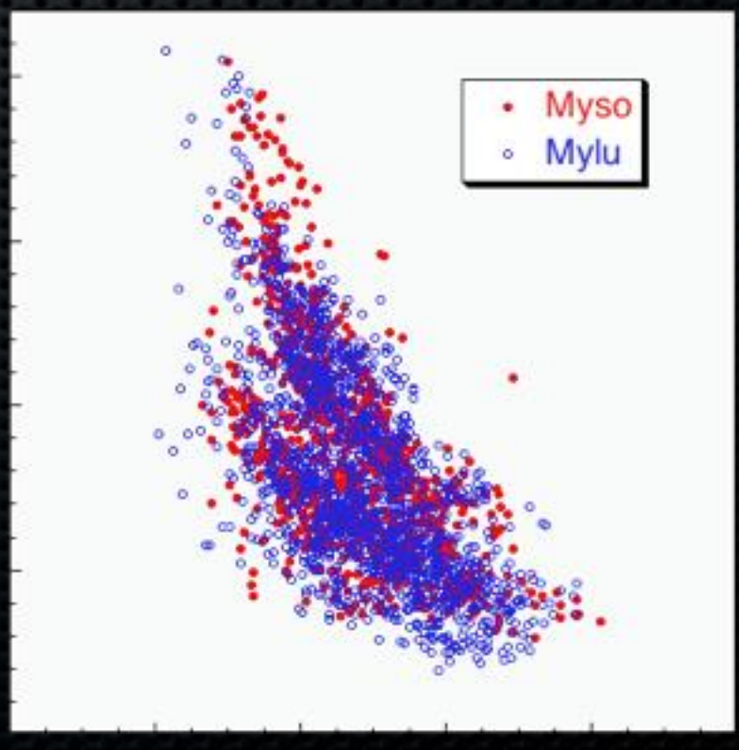


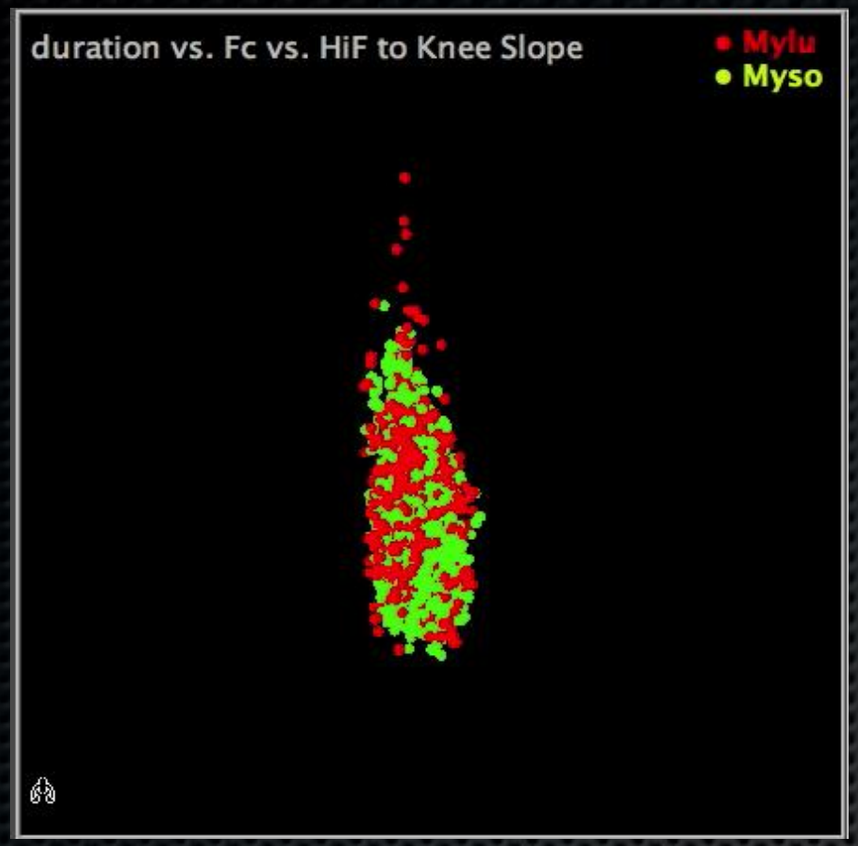


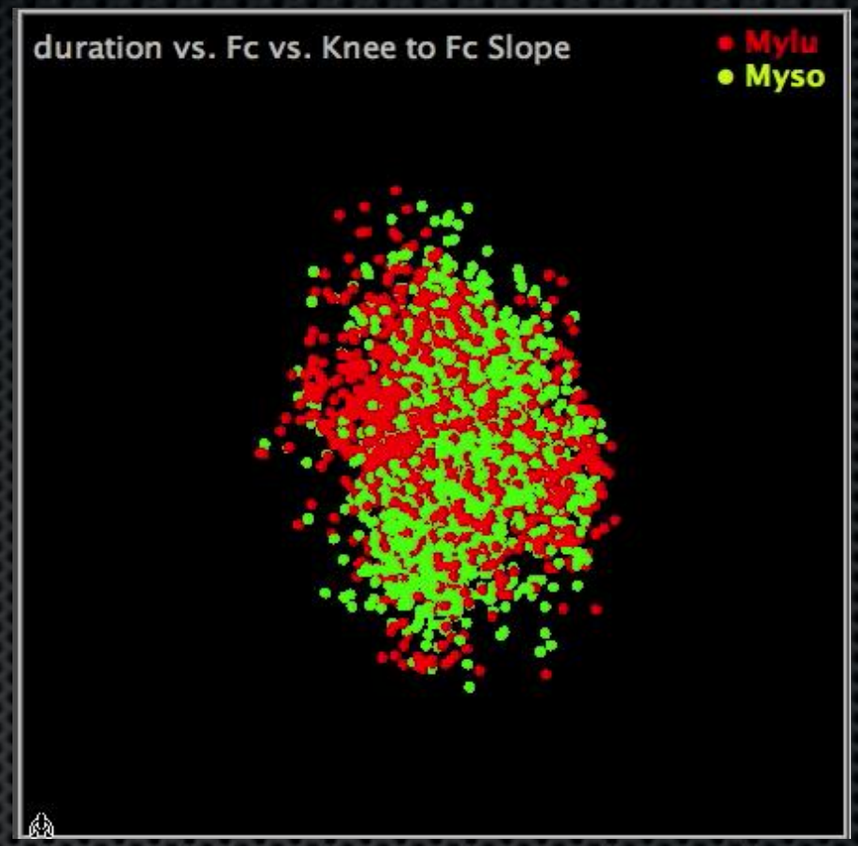


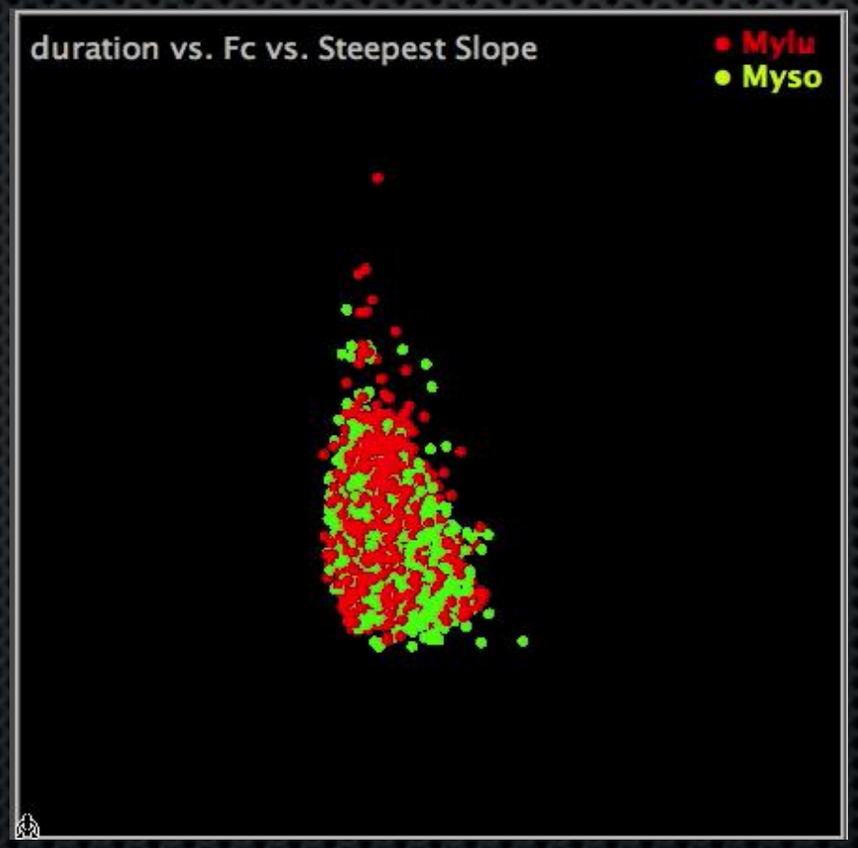


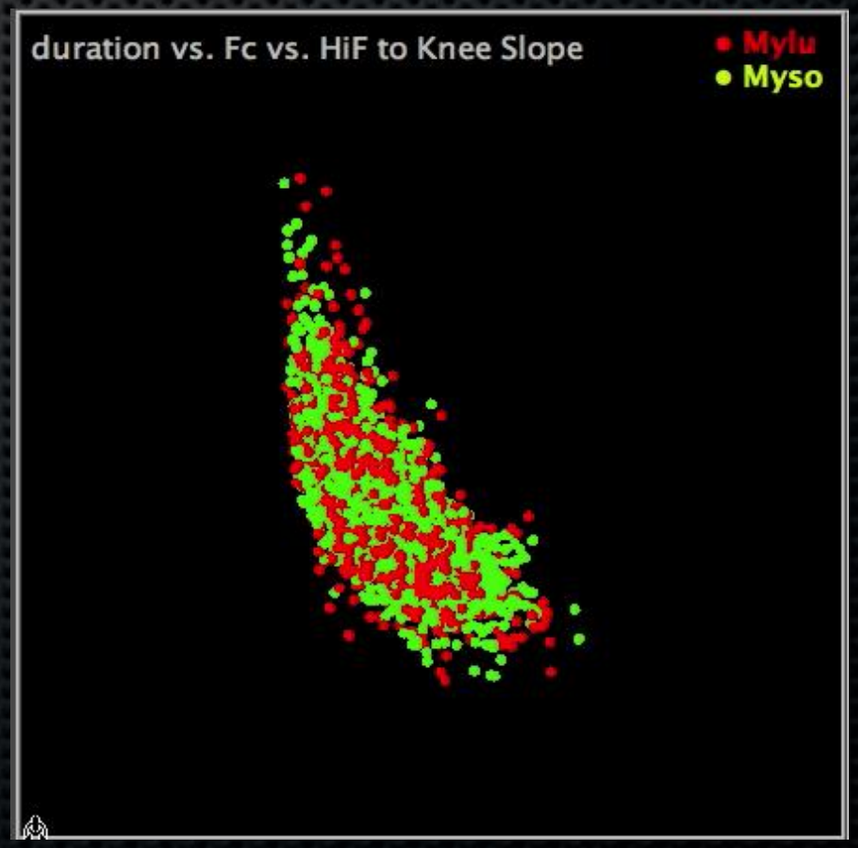




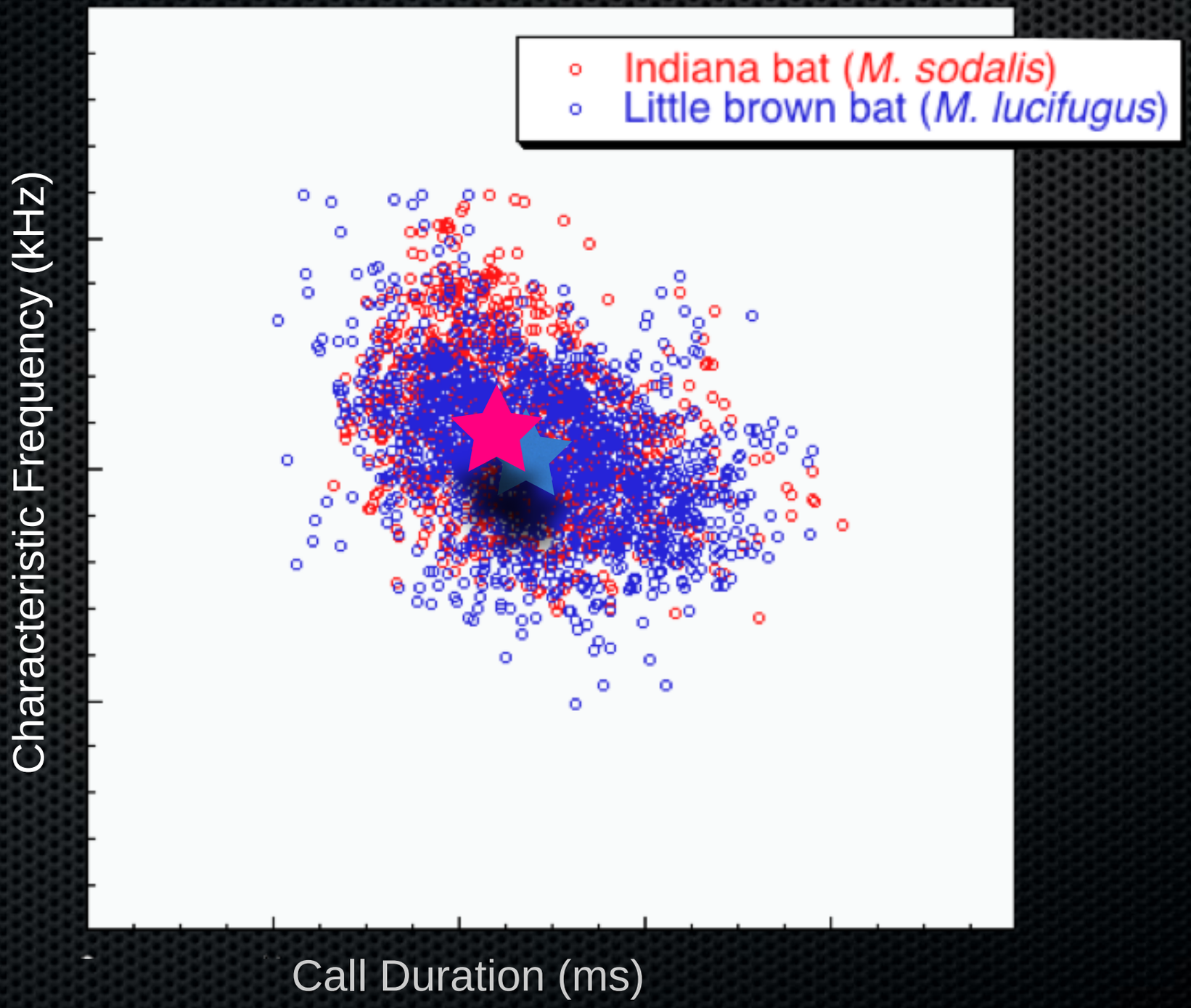

duration vs. Fc vs. HiF to Knee Slope
Mylu
Myso


duration vs. Fc vs. Knee to Fc Slope
Mylu
Myso

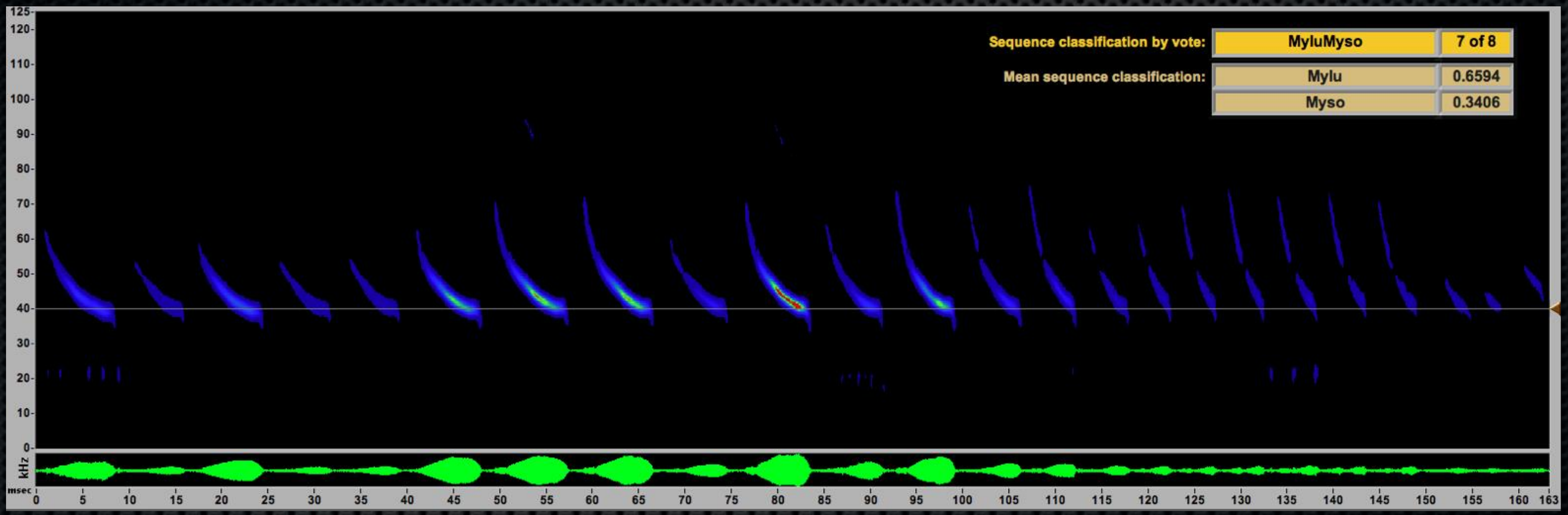

duration vs. Fc vs. Steepest Slope
Mylu
Myso


duration vs. Fc vs. HiF to Knee Slope
Mylu
Myso

Multi-variate Data-space



SonoBat Classifier Function



MYSE vs. MYLE

Myotis septentrionalis

Myotis leibii

All Bats are Equally Detectable

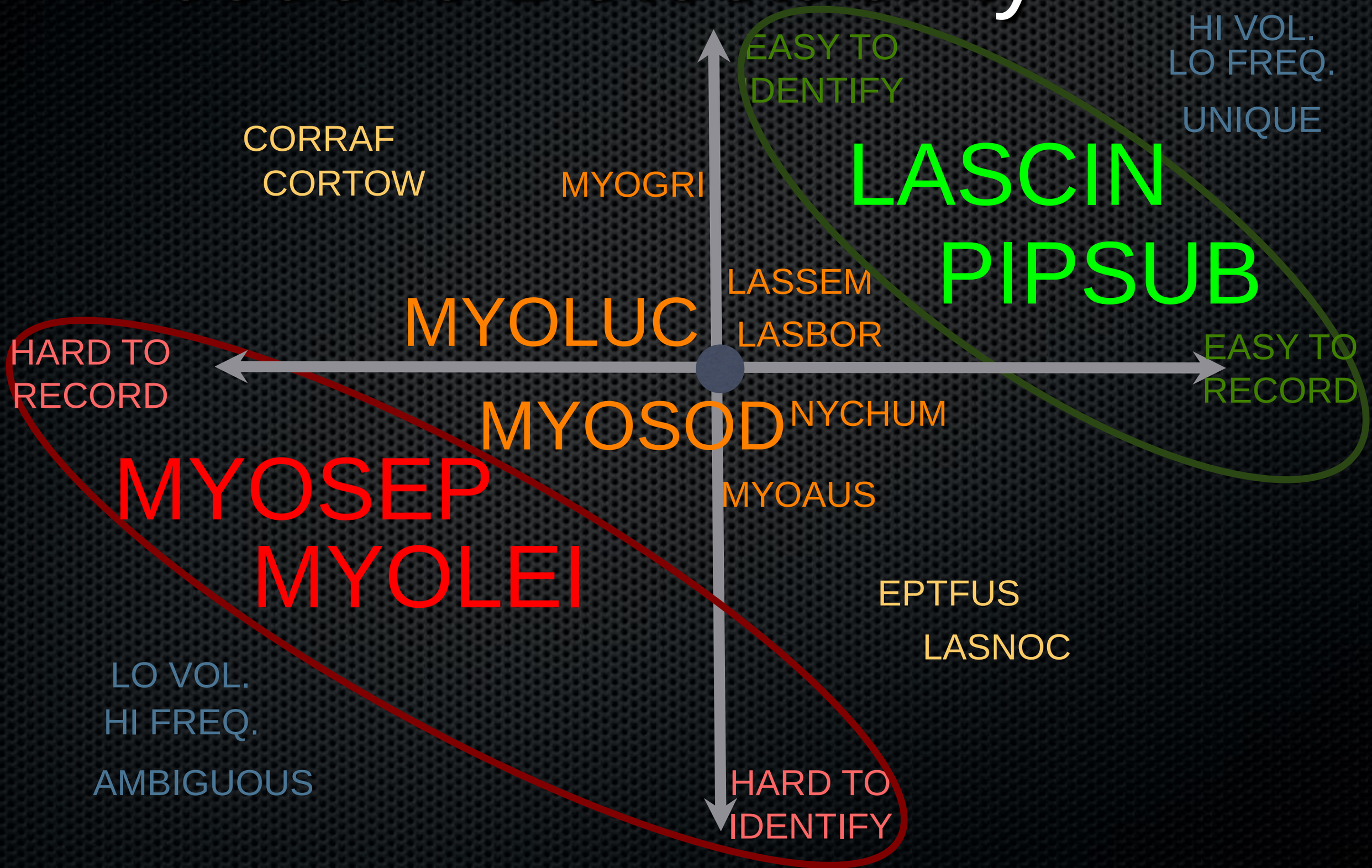
Griffin, D.R. 1971. The importance of atmospheric attenuation for the echolocation of bats (Chiroptera). *Animal Behaviour*, 19:55-61.

Behavior of Ultrasound in Air

Higher frequencies attenuate more rapidly than lower frequencies...

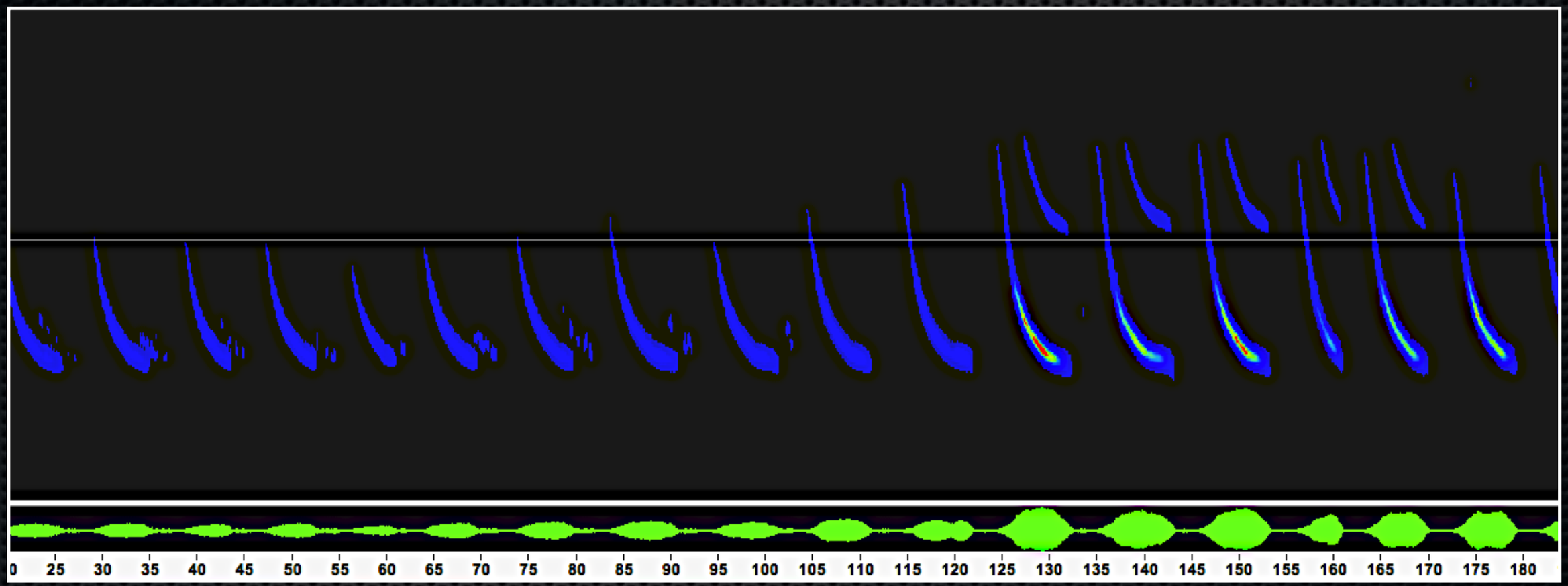
. . . and shorter wavelengths (higher frequencies) are more affected by air turbulence, convection, etc.

Acoustic Detectability

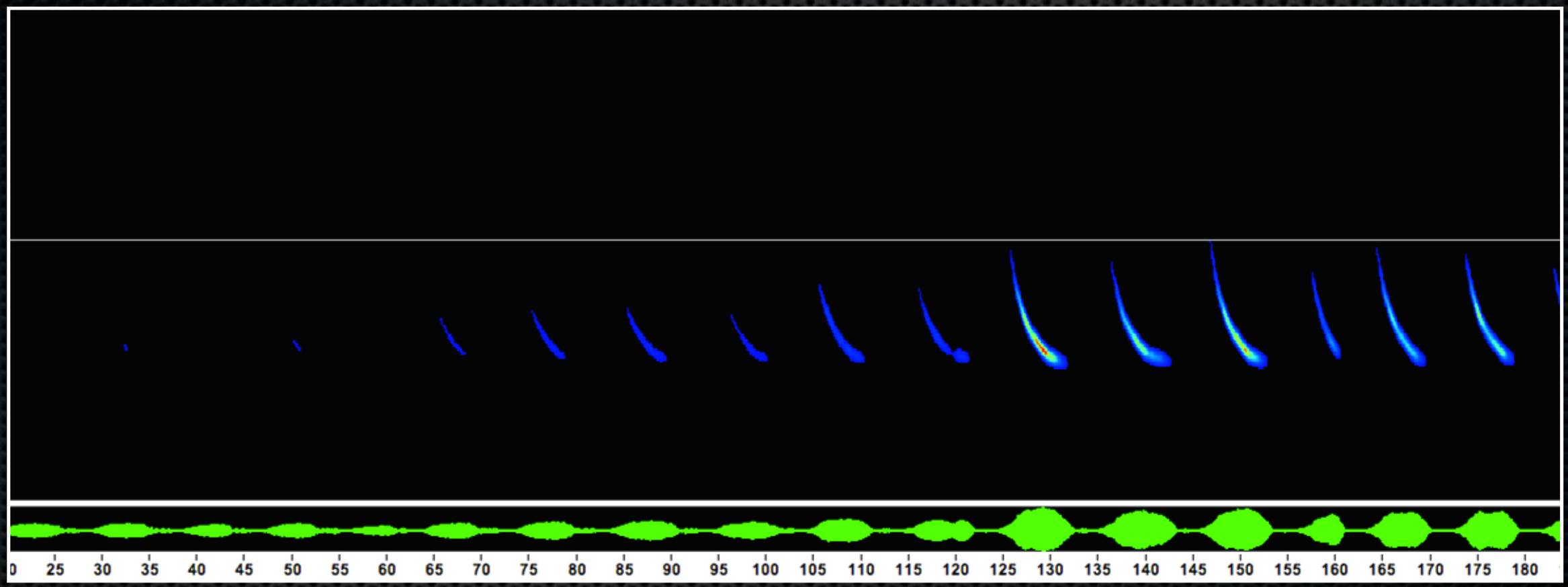


Distance obscures details . . .

Distance to Mic Effects . . .

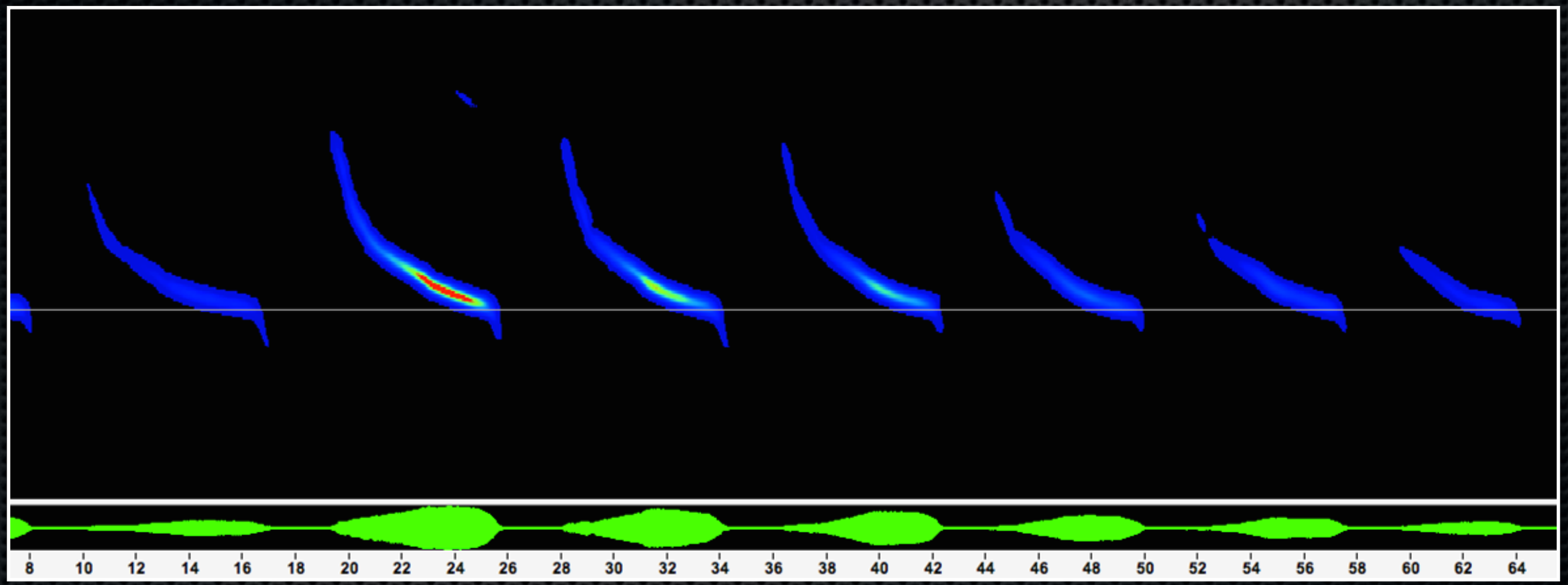


Distance to Mic Effects . . .

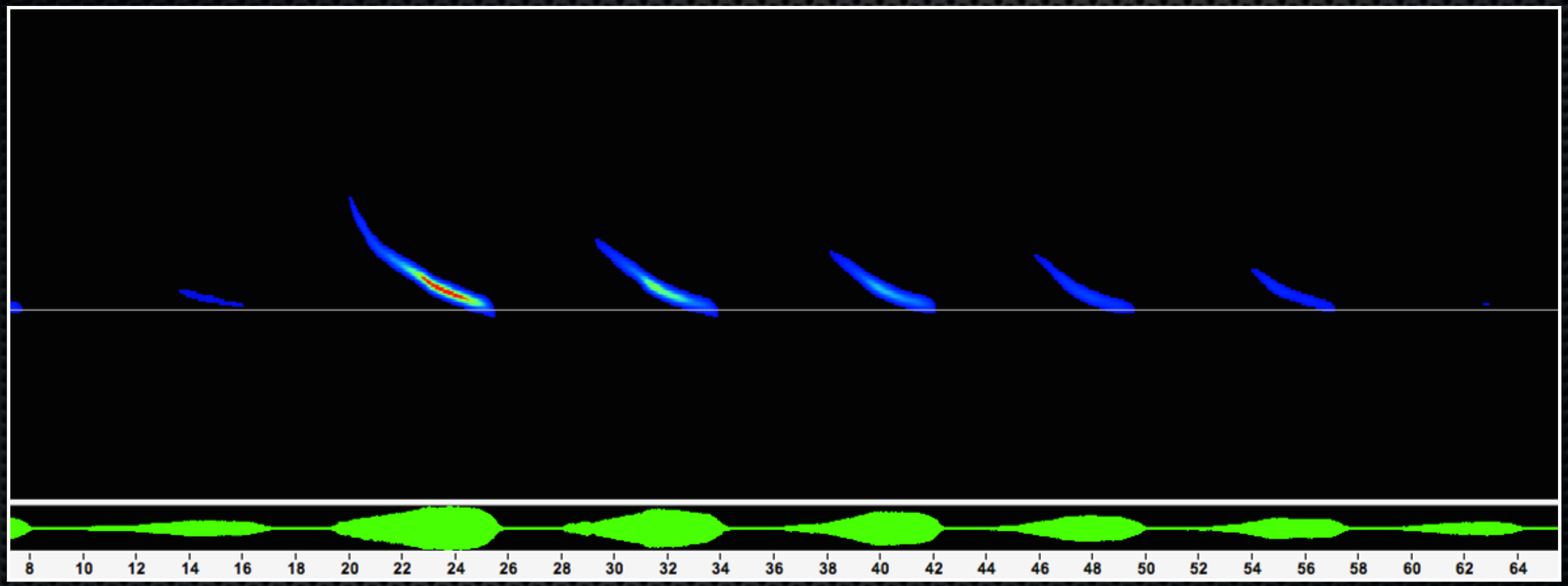


. . . attenuates highest frequencies.

Distance to Mic Effects . . .



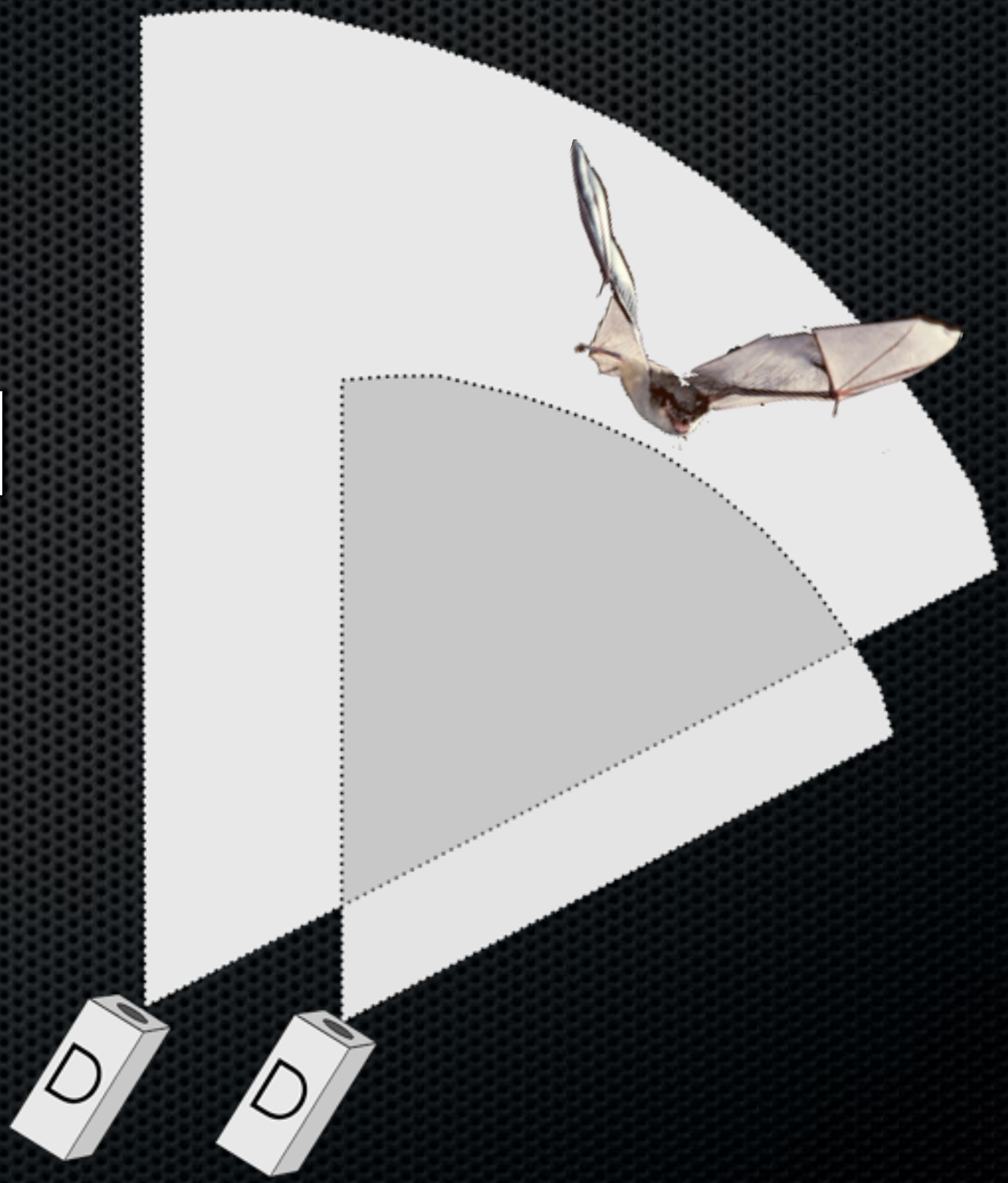
Distance to Mic Effects . . .



. . . attenuates lowest amplitudes.

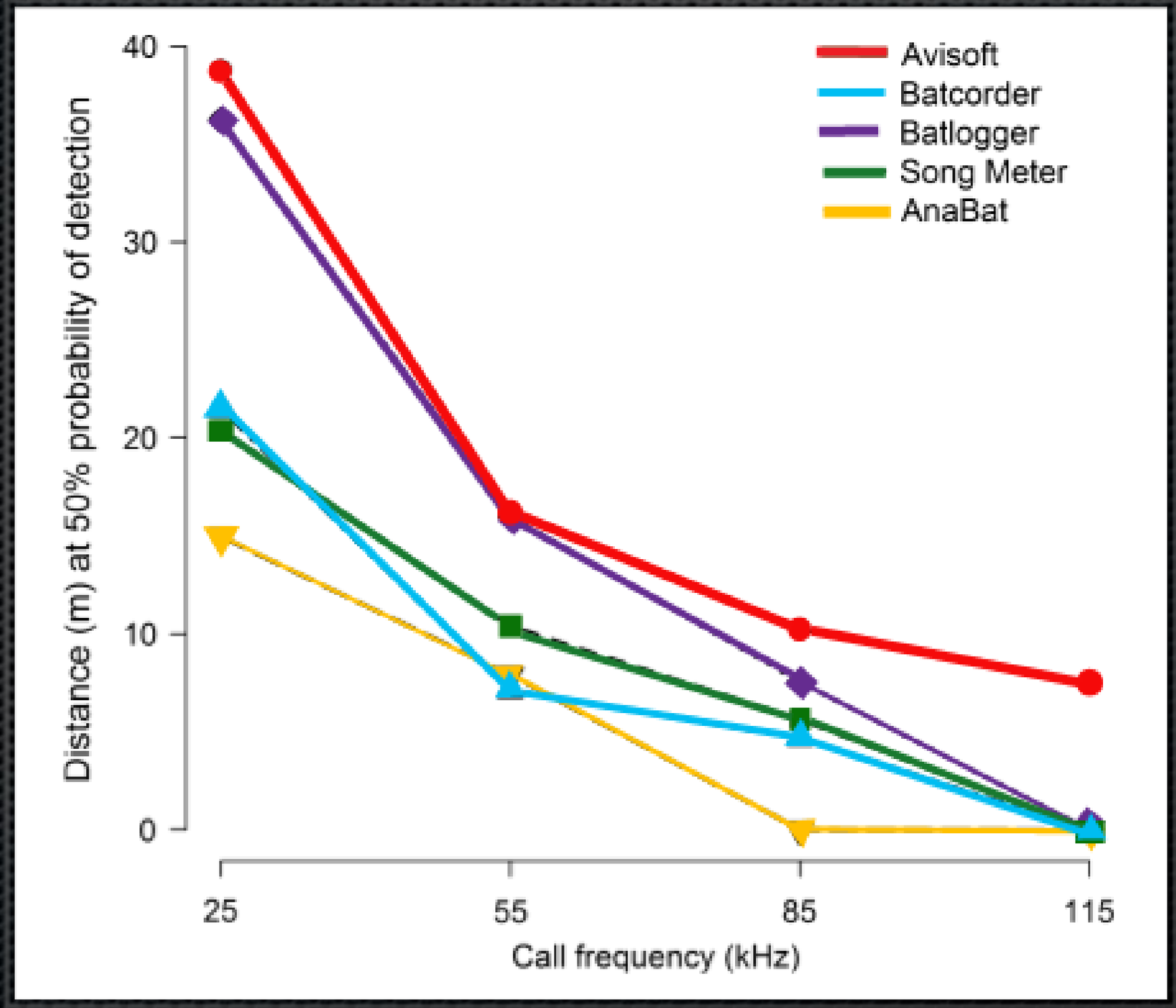
All Bat Detectors are Created Equal

Adams, A.M., M.K. Jantzen, R.M. Hamilton and M.B. Fenton. 2012. Do you hear what I hear? Implications of detector selection for acoustic monitoring of bats. *Methods in Ecology and Evolution*, 3: 992-998.



Differences in Detectors

- Frequency Response Varies Among Detectors
- Sensitivity is not Equal across All Frequencies
- Lab Results Cannot be Replicated in the Wild

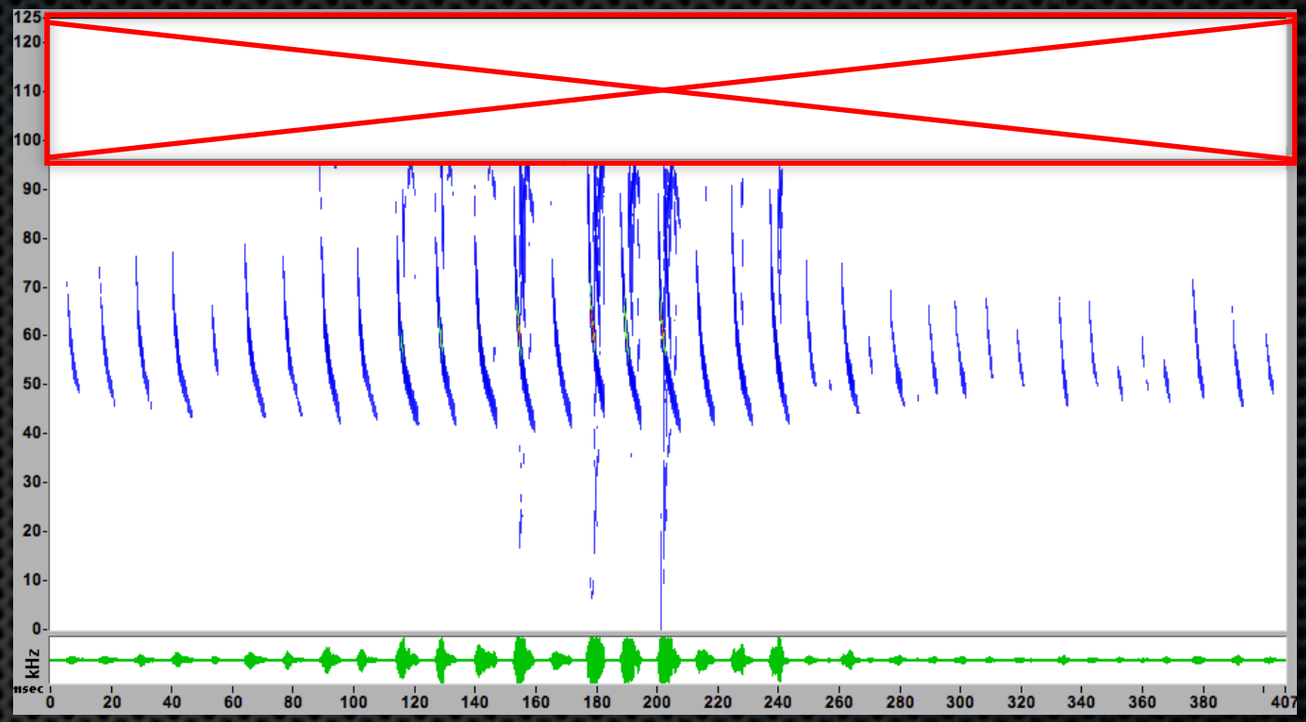


Detector Settings Matter

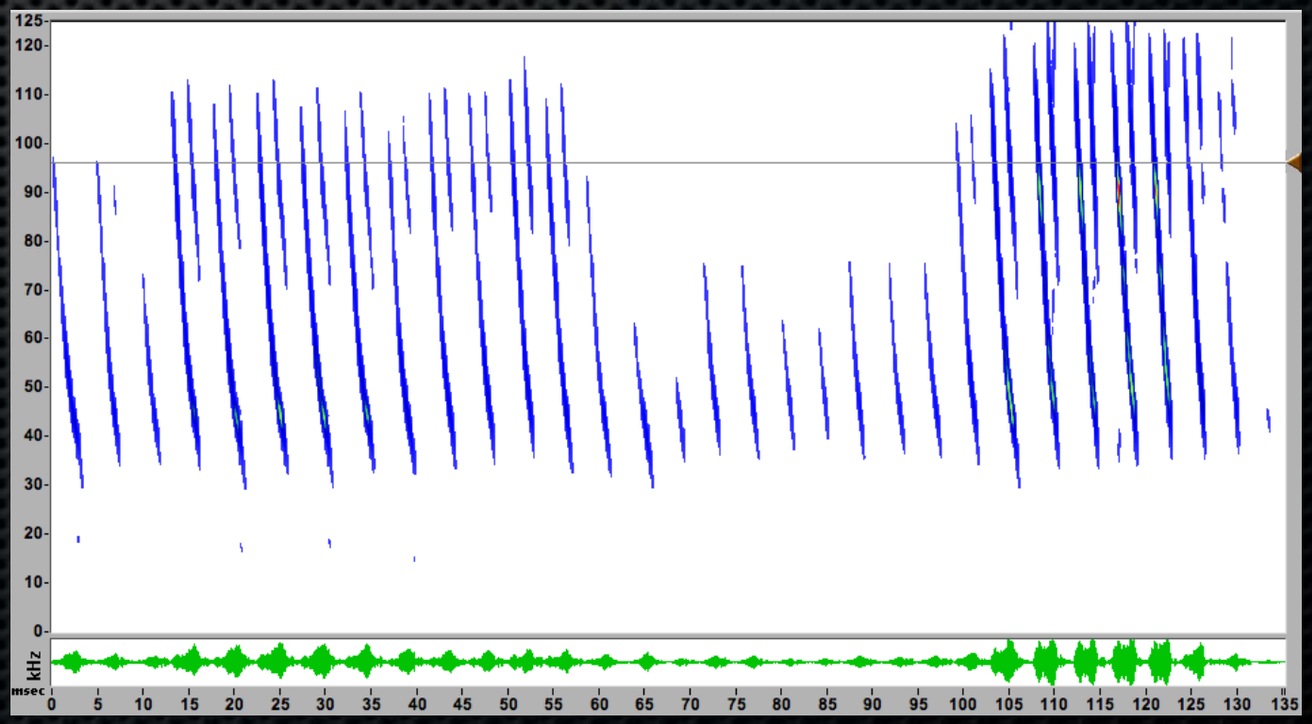
- Microphone Type
- Sampling Frequency
- Input Gain/Trigger Levels
- Signal Processing Methods

How SF Affects Recordings

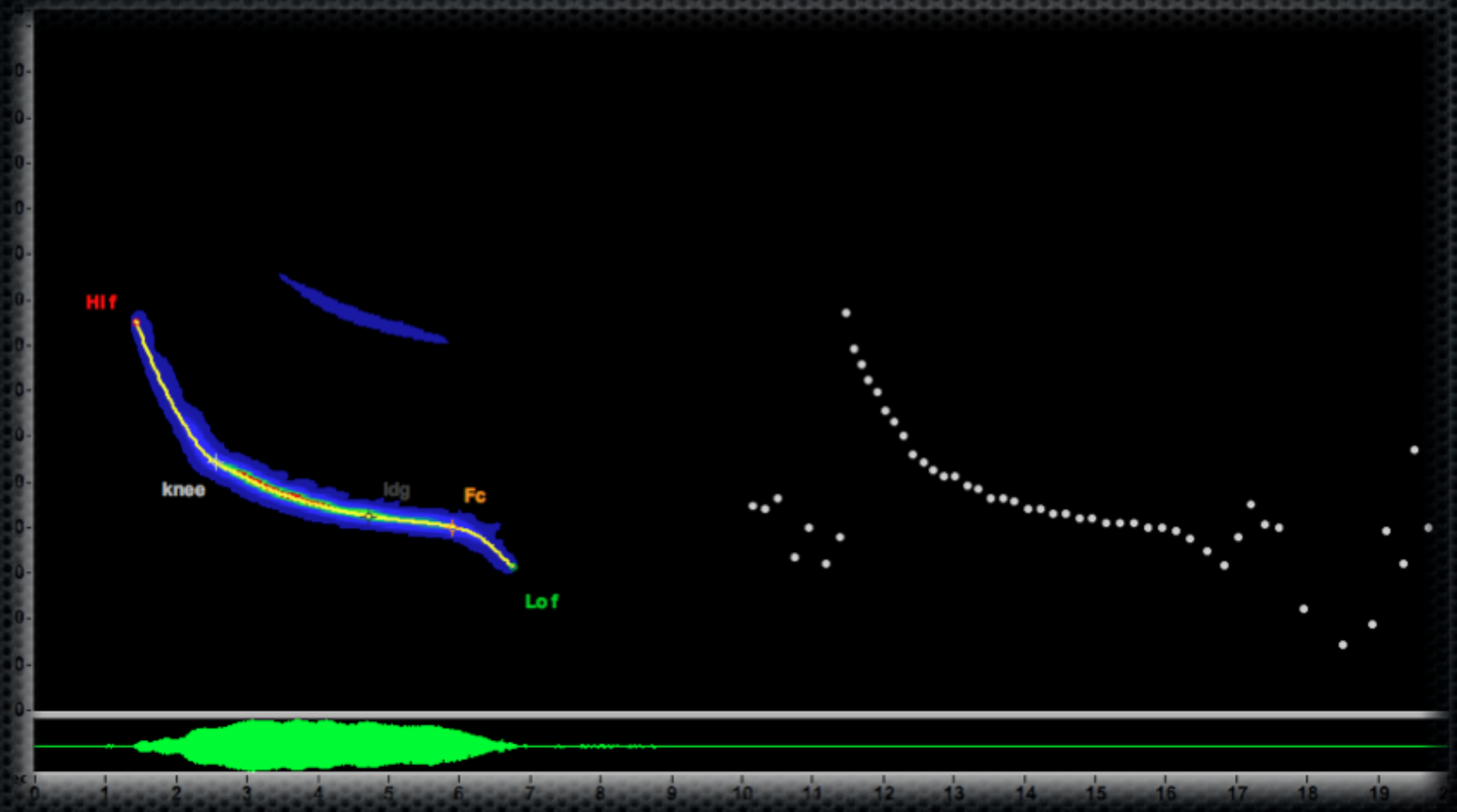
SF at 192kHz
Max F = 96kHz



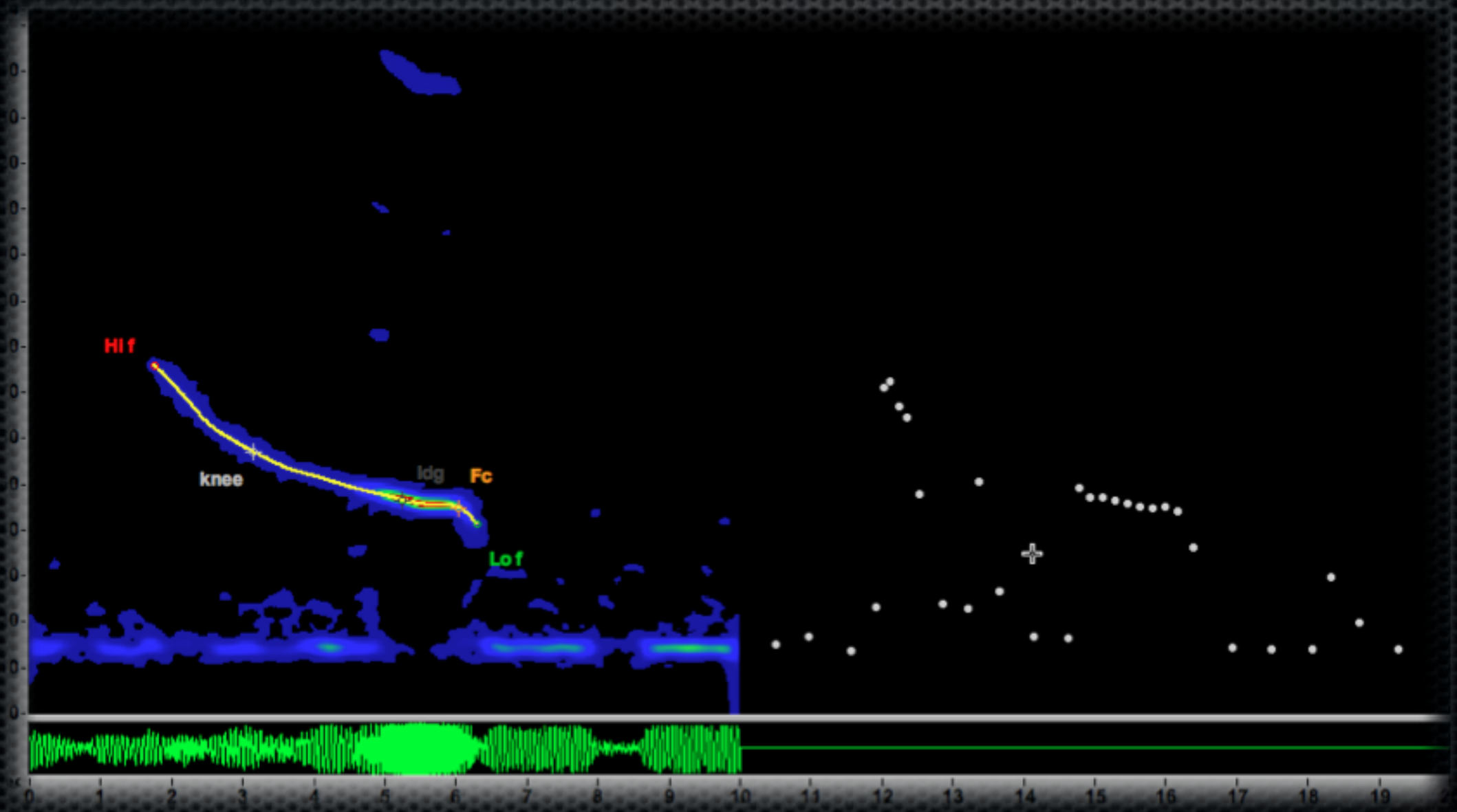
SF at 500kHz
Max F = 250kHz



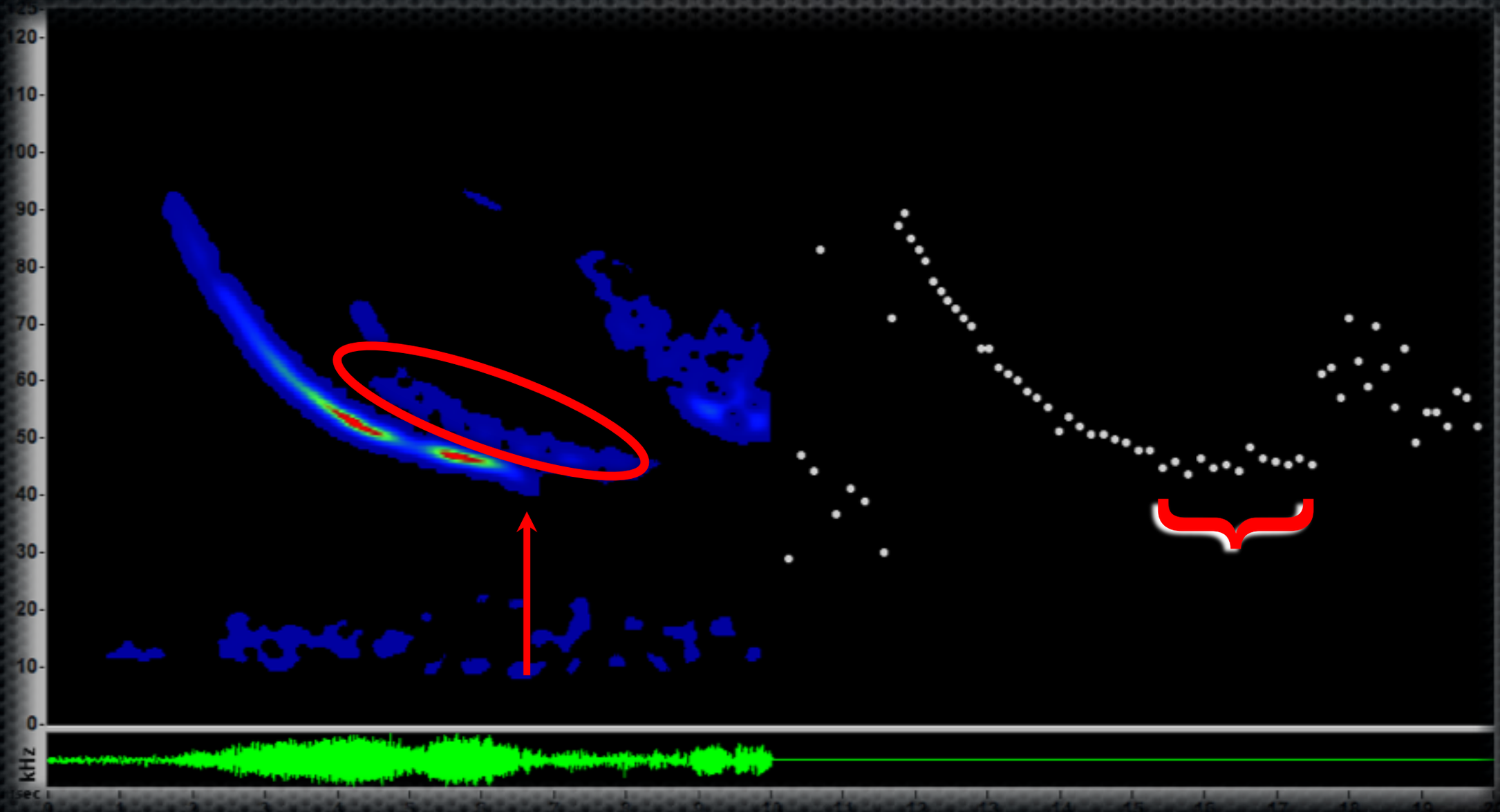
Signal Processing: FS vs. ZC



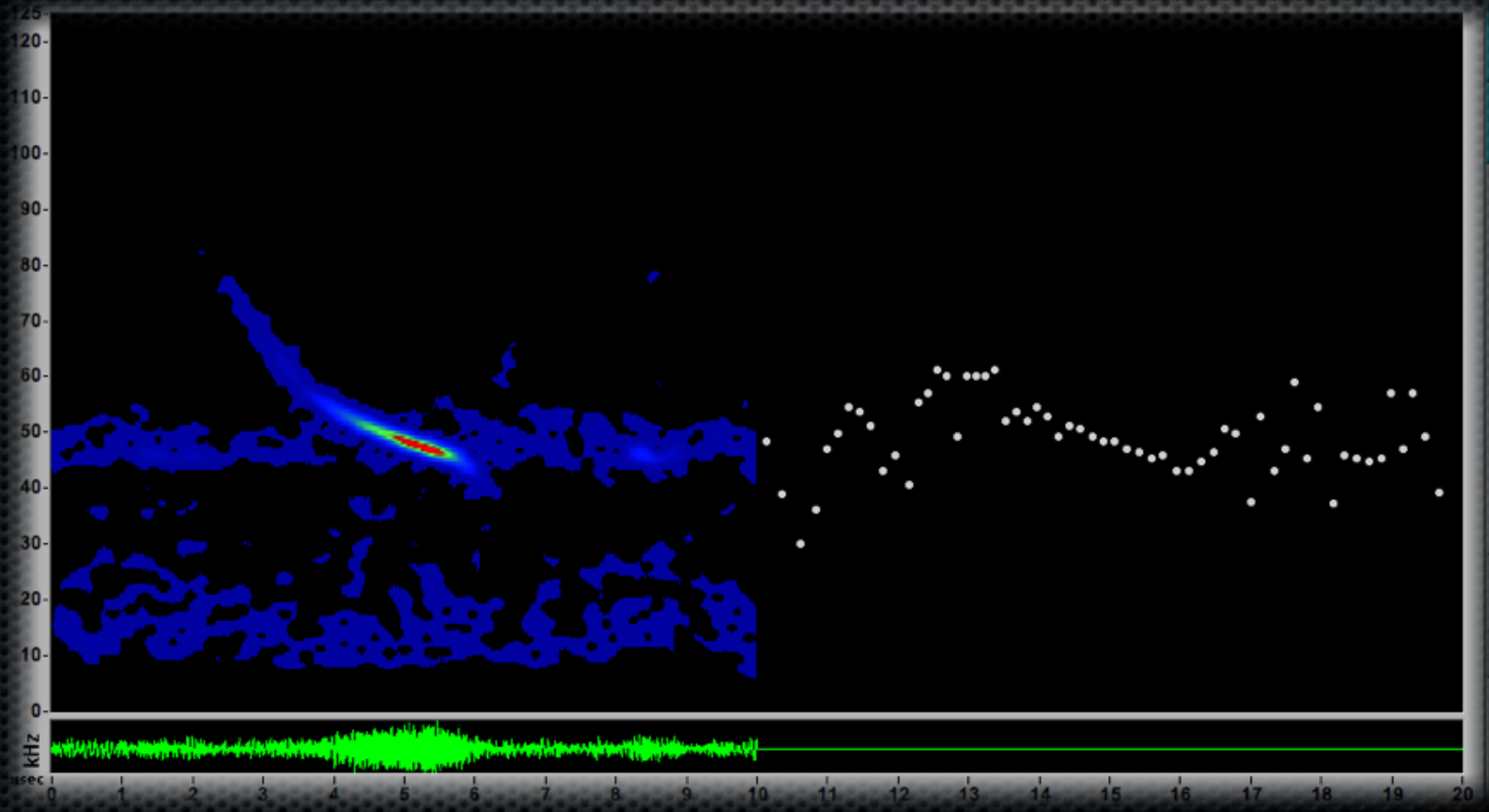
Effect of Insect Noise on ZC



Echoes from Clutter in ZC



Attenuation Due to Distance

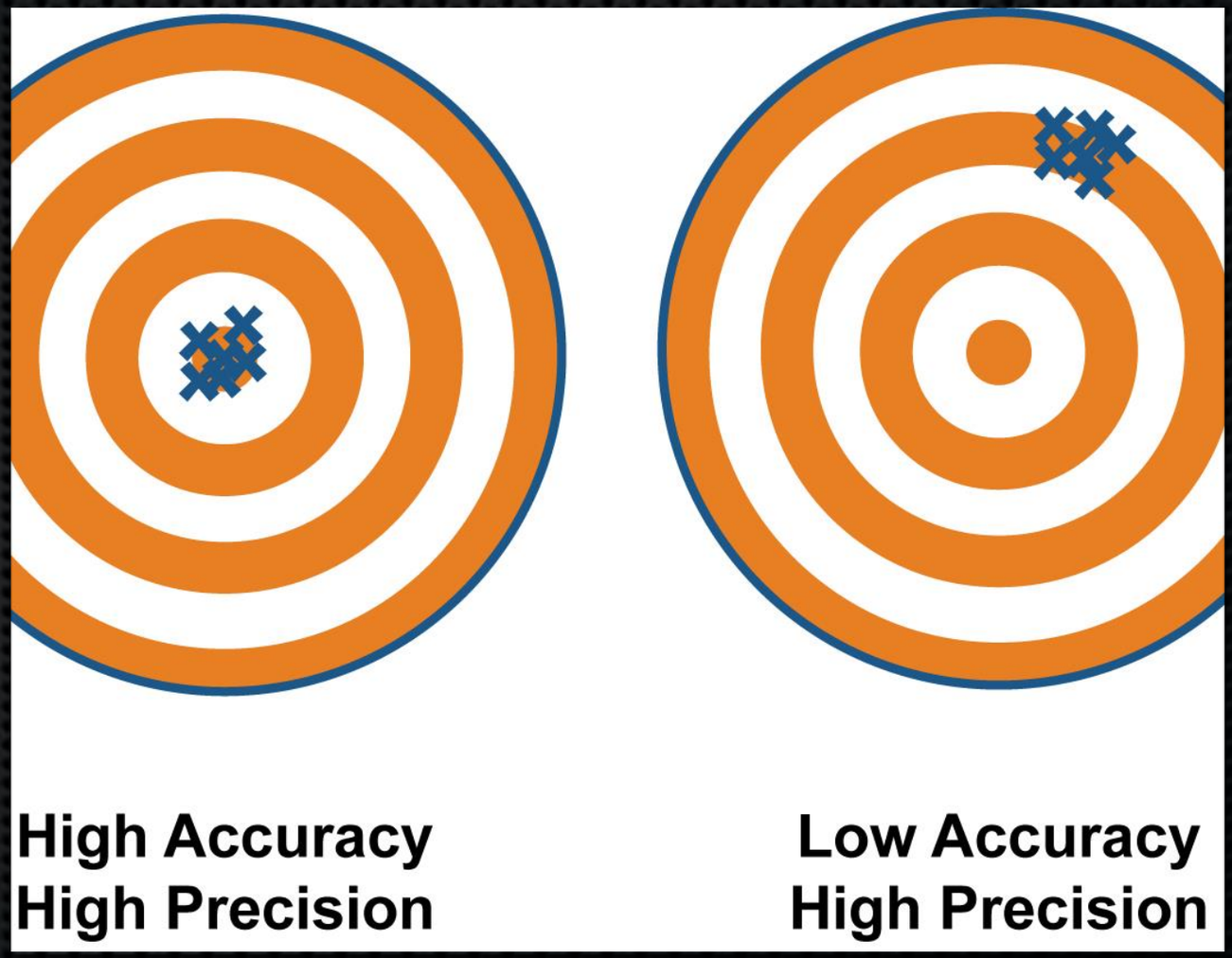


Approved Classifiers Are Accurate

PA-NWR: 2013

PA-ACE: 2014

MD-NWR: 2012-2013



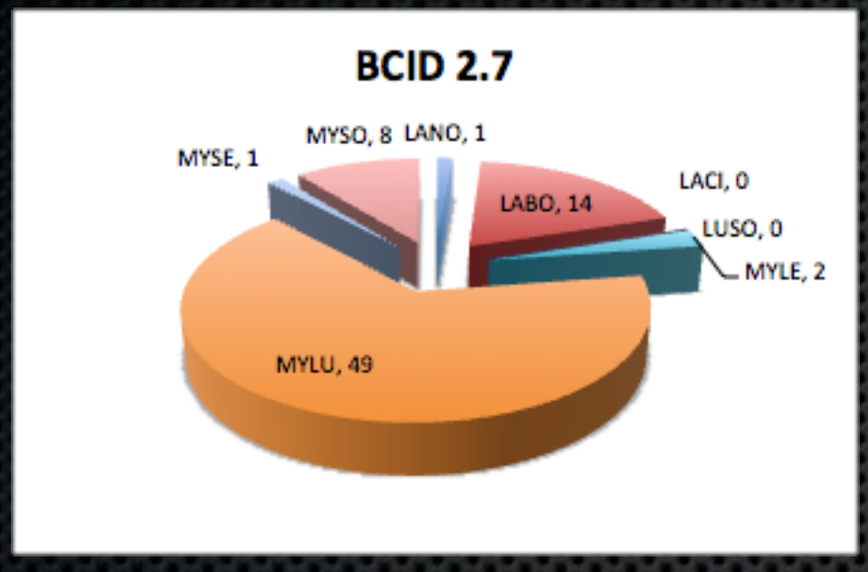
PA-NWR: 2014

Program	# Files Considered	# Species ID'd	+ P Value Species
BCID 2.7	76	6	LANO, LABO, MYLE, MYLU, & MYSO
EchoClass 3	90	5	LABO, MYLU, MYSE
KaPRO2.2.2	95	4	MYLU, MYSO
SonoBat 3	95	2	MYSO

Figures are calculated from a manually-vetted collection of MYOspp recordings.

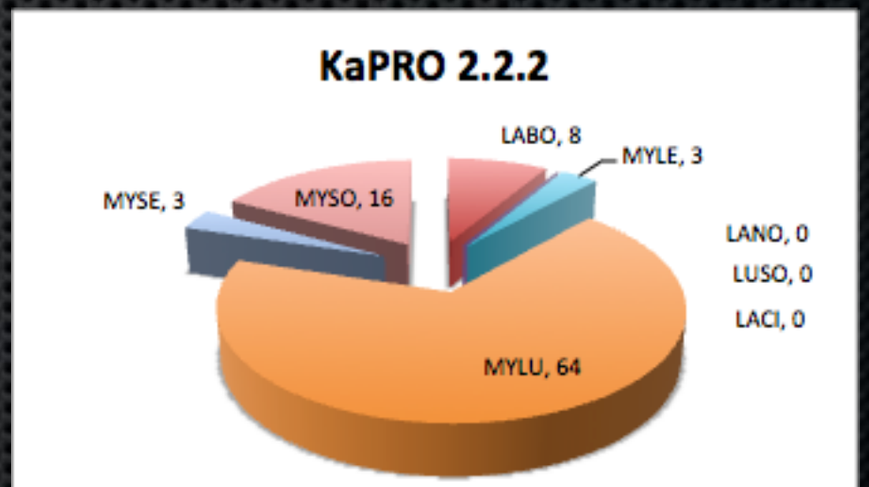
PA-NWR: 2014

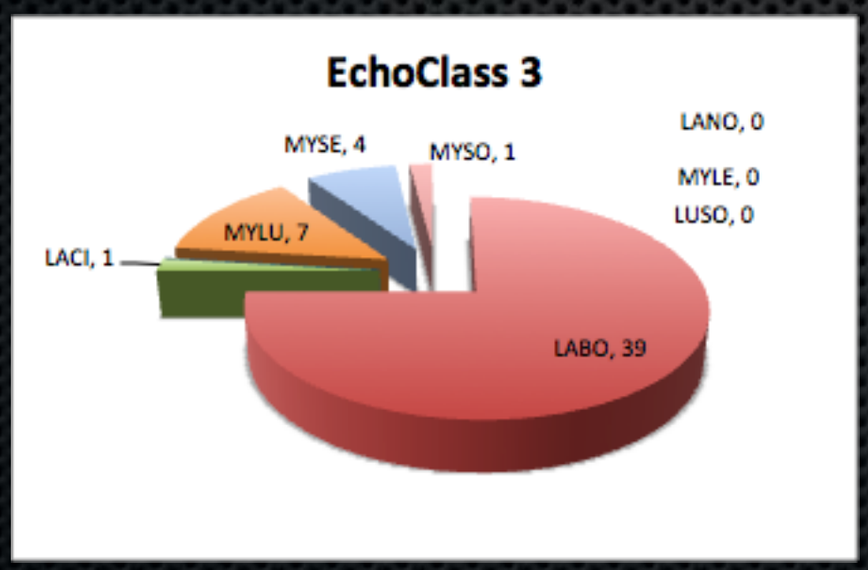
+P-value Species



LANO, LABO, MYLE, MYLU, & MYSO

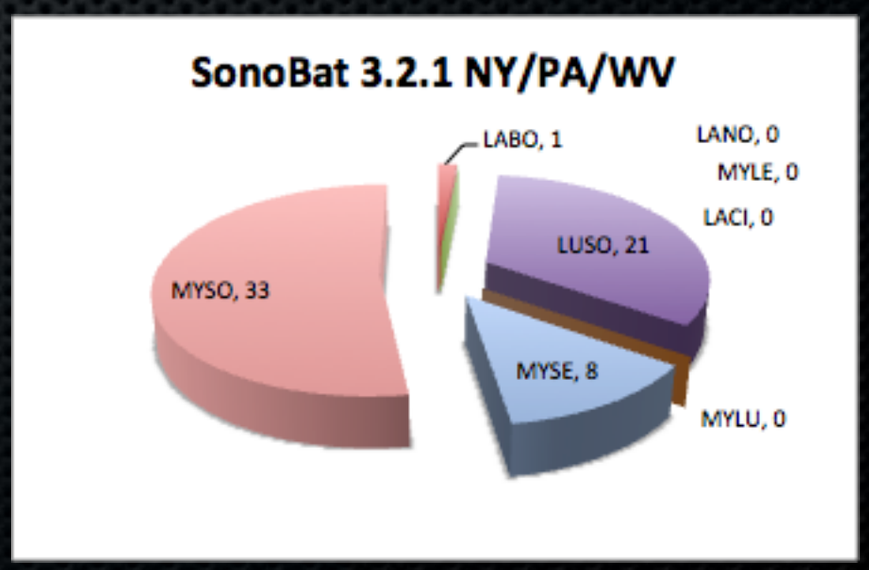
MYLU & MYSO





LABO, MYLU, & MYSE

MYSO



MD-NWR: 2012-2013

Program	# Files Considered	# Species ID'd	+ P Value Species
BCID 2.7	22	7	EPFU, MYLE, MYLU, MYSE, NYHU, PESU
EchoClass 3	22	6	LABO
KaPRO2.2.2	30	6	EPFU, LABO, MYLU, MYSE
SonoBat 3	34	2	none

Figures are calculated from a manually-vetted collection of MYOspp recordings.

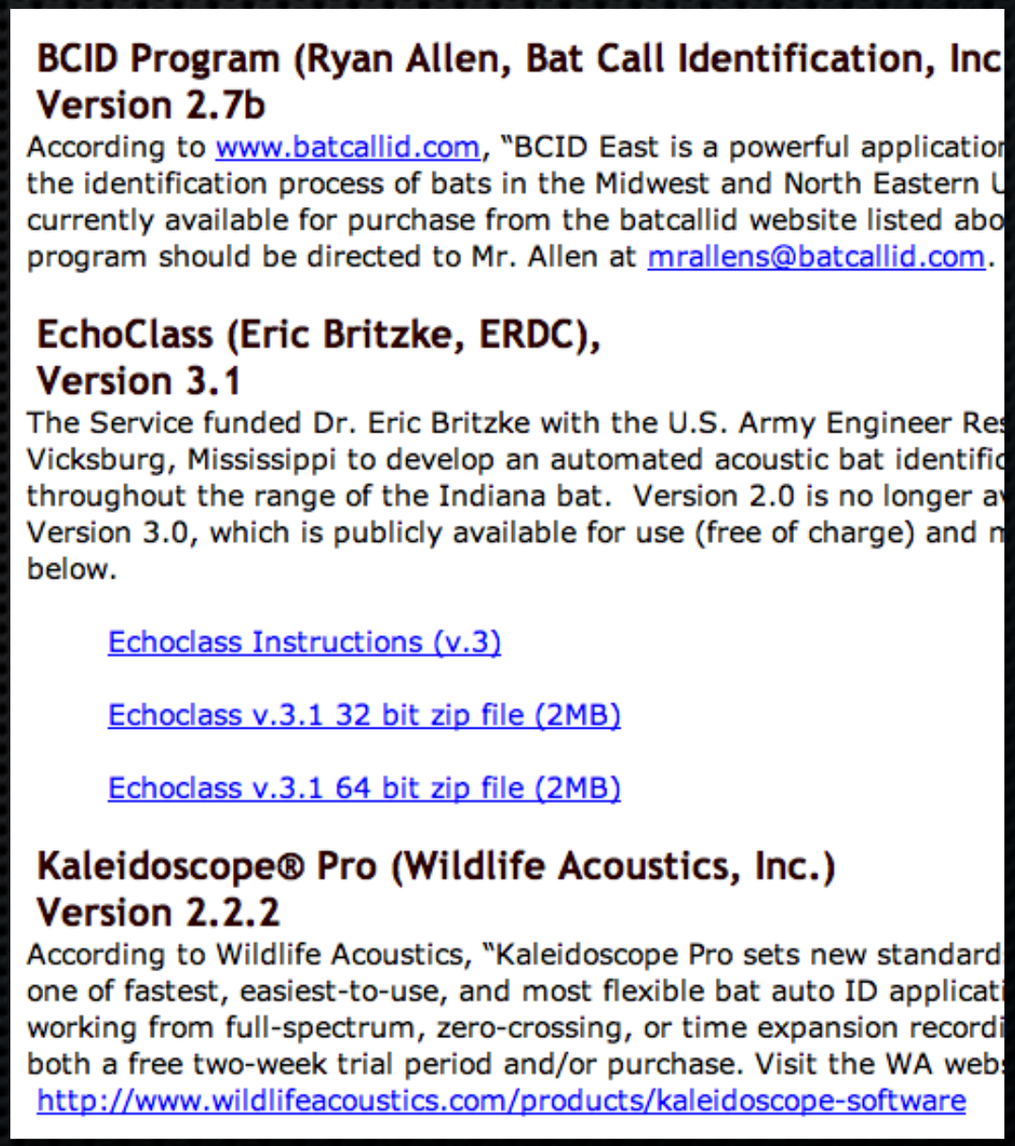
PA-ACE: 2014

A 17-location, 48-site, 109-night survey.

Program	# Files Considered	# Species ID'd	+ P Value Species
BCID 2.7	10,018	10	EPFU, LANO, LABO, LACI, MYLE, MYLU, MYSE, MYSO, NYHU, PESU
EchoClass 3	16,997	9	EPFU, LANO, LABO, LACI, MYLU, MYSE, MYSO, PESU
KaPRO2.2.2	16,997	10	EPFU, LANO, LABO, LACI, MYSE, MYSO, NYHU, & PESU

Version Control is Exact

Bat surveyors should bookmark this site and regularly check it to ensure that they are using an approved version(s) of each program. New software versions that represent significant changes to their classifiers will require additional testing by USGS before they are approved for use.



BCID Program (Ryan Allen, Bat Call Identification, Inc
Version 2.7b

According to www.batcallid.com, "BCID East is a powerful applicatio
the identification process of bats in the Midwest and North Eastern U
currently available for purchase from the batcallid website listed abo
program should be directed to Mr. Allen at mrallens@batcallid.com.

EchoClass (Eric Britzke, ERDC),
Version 3.1

The Service funded Dr. Eric Britzke with the U.S. Army Engineer Res
Vicksburg, Mississippi to develop an automated acoustic bat identific
throughout the range of the Indiana bat. Version 2.0 is no longer av
Version 3.0, which is publicly available for use (free of charge) and n
below.

Echoclass Instructions (v.3)

Echoclass v.3.1 32 bit zip file (2MB)

Echoclass v.3.1 64 bit zip file (2MB)

Kaleidoscope® Pro (Wildlife Acoustics, Inc.)
Version 2.2.2

According to Wildlife Acoustics, "Kaleidoscope Pro sets new standard
one of fastest, easiest-to-use, and most flexible bat auto ID applicati
working from full-spectrum, zero-crossing, or time expansion recordi
both a free two-week trial period and/or purchase. Visit the WA webs
http://www.wildlifeacoustics.com/products/kaleidoscope-software

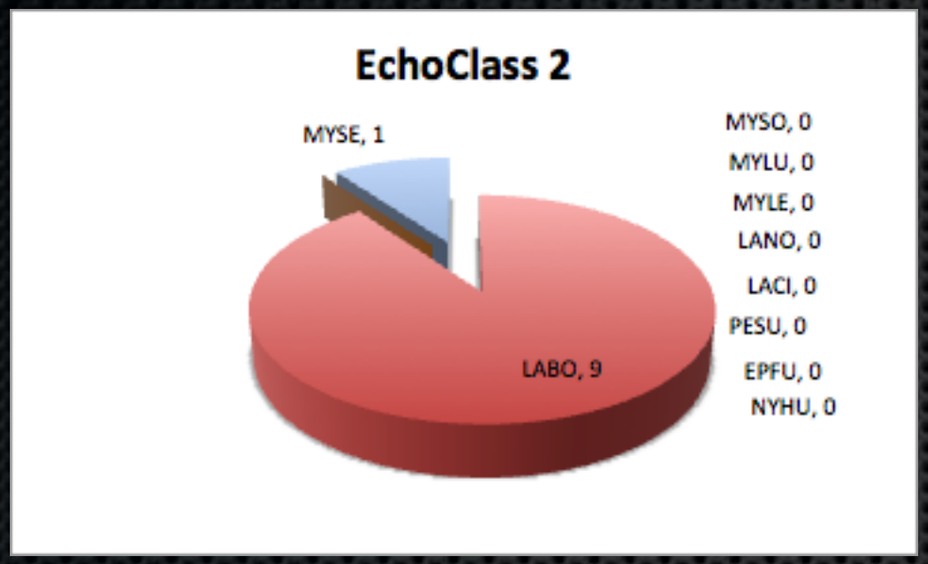
http://www.fws.gov/midwest/Endangered/mammals/inba/surveys/inbaAcousticSoftware.html

Version History

Program	Approved Version	Current Version
BCID	2.7b	2.7b
EchoClass	3.0	3.1
KaleidoscopePRO	2.2.2	3.1.1
SonoBat	*none*	3.2.2

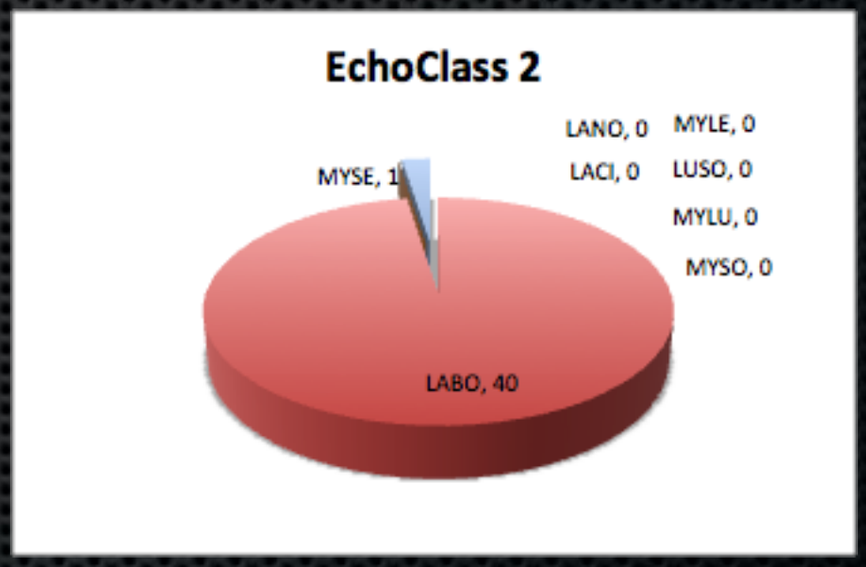
EchoClass v. 2 vs. 3.1

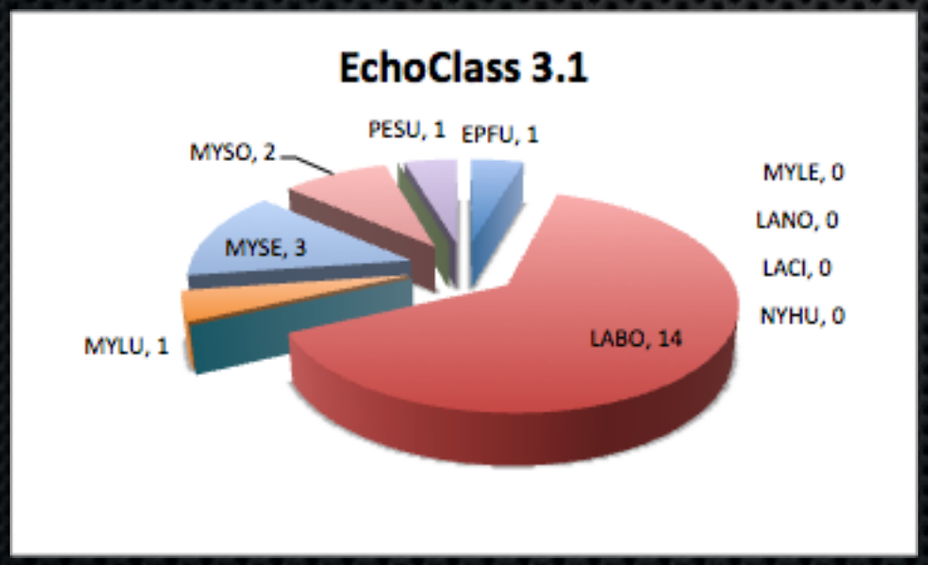
MD-NWR +P-value Species PA-NWR



LABO

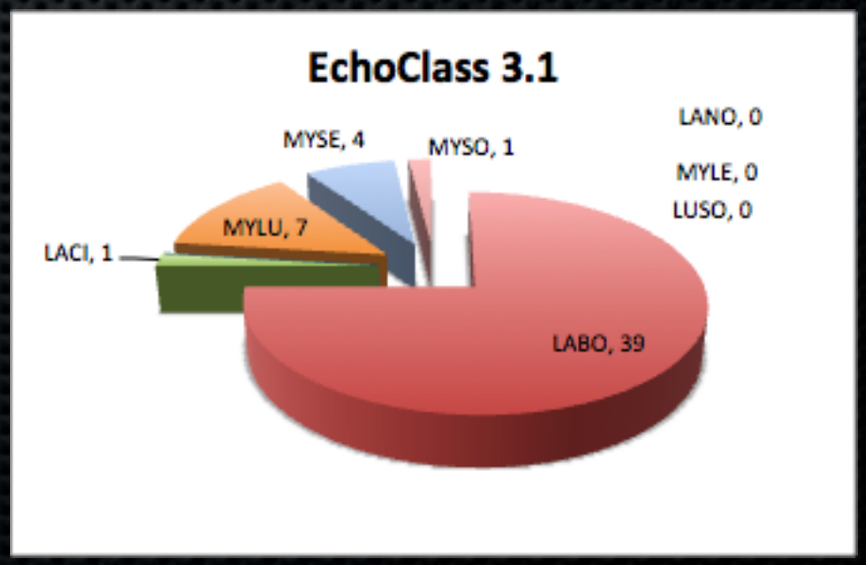
LABO



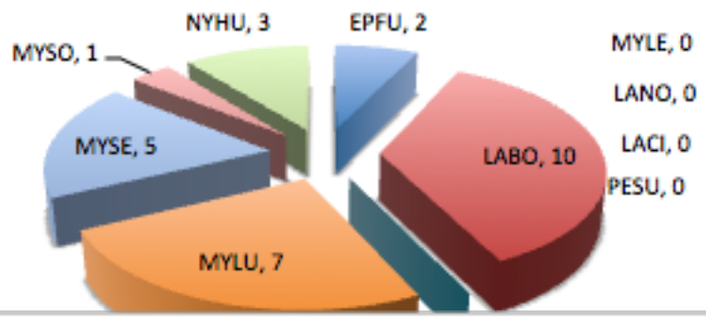
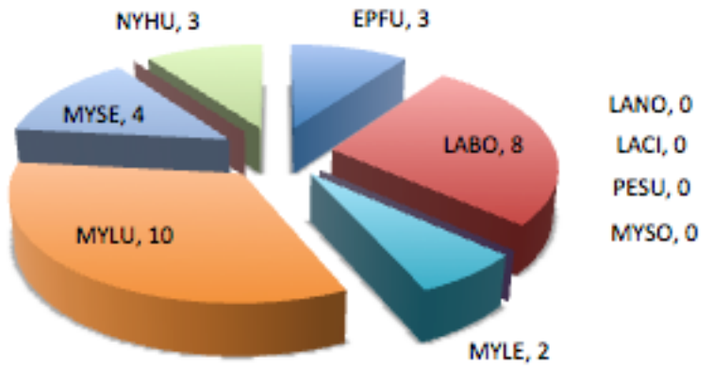


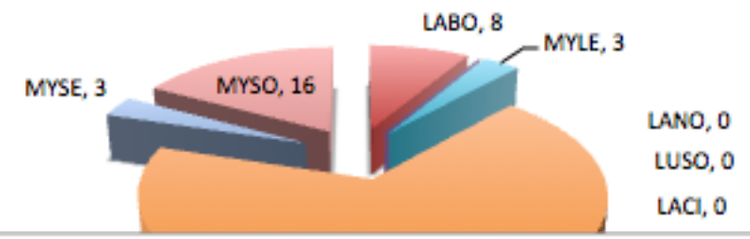
LABO

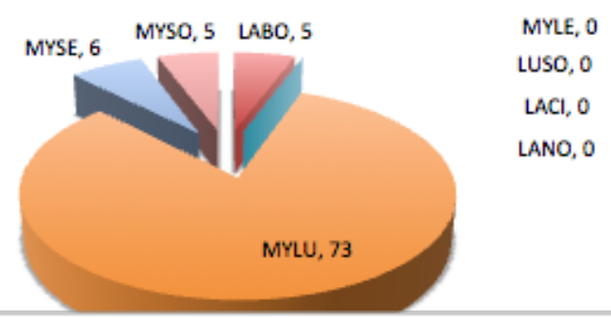
LABO, MYLU, & MYSE

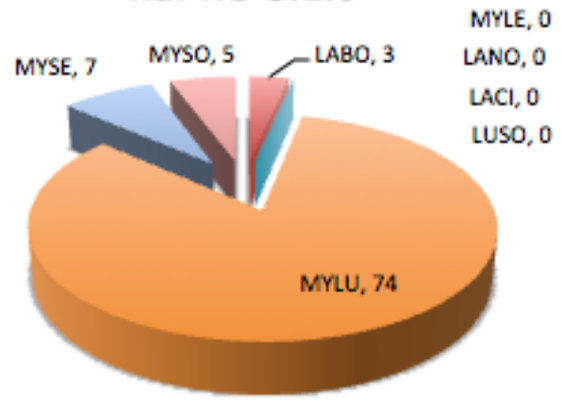


KaPRO Versions

MD-NWR	+P-value Species	PA-NWR
KaPRO 2.2.2 	LABO, MYLE, MYSE & MYSO	MYLU & MYSO
KaPRO 3.0.0 	LABO, MYLU & MYSE	MYLU
KaPRO 3.1.1 	EPTFUS, LABO, MYLU & MYSE	MYLU & MYSE

KaPRO 2.2.2 

KaPRO 3.0.0b 

KaPRO 3.1.0 

Surveyors Understand ID-outputs

Assigning Confidence
Reporting MLE Values
Nite-level, Site-level, & Project-level Results

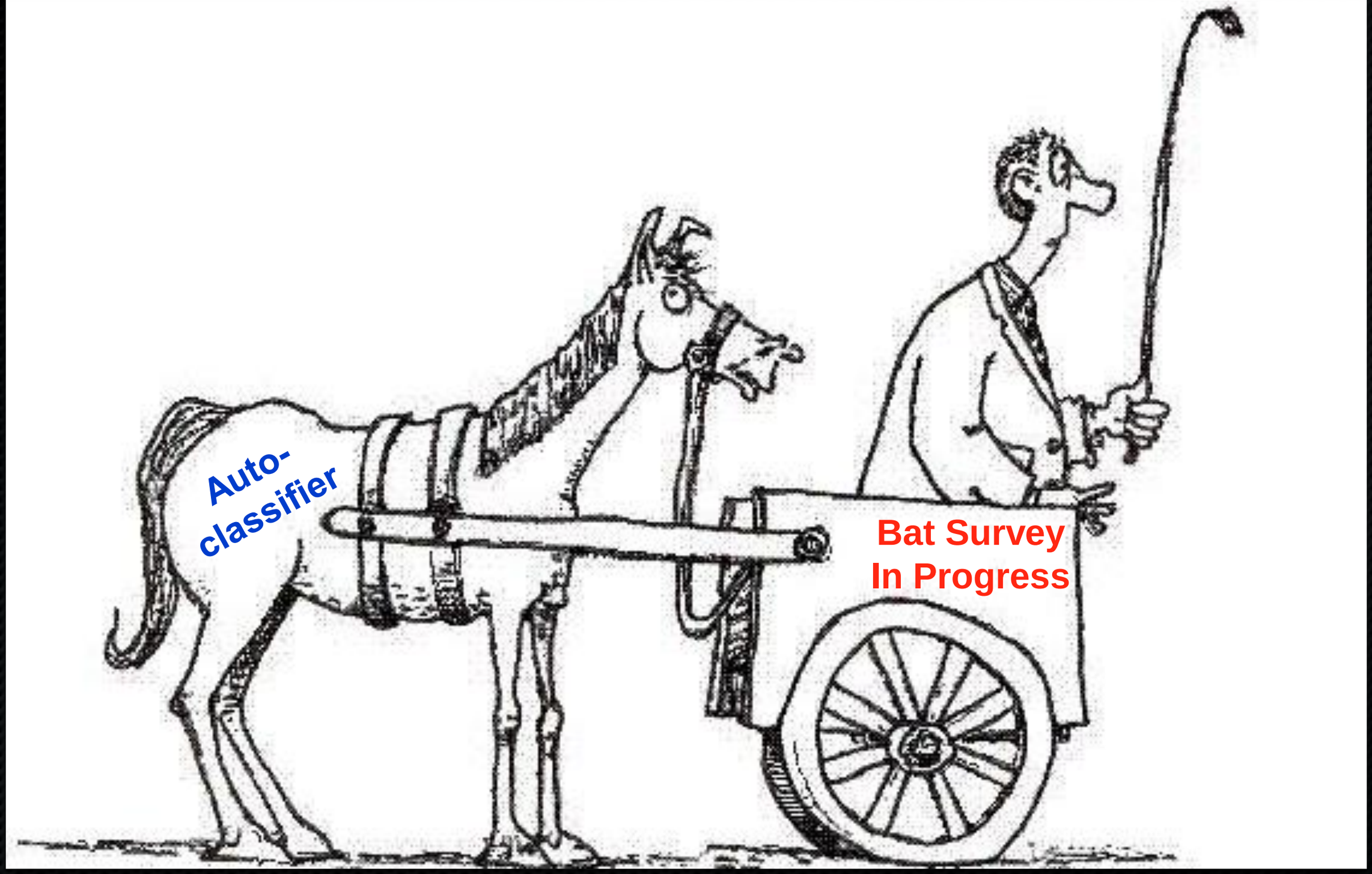
Assumptions vs. Reality

Assumption	Reality
Bats have Species-specific call characteristics	Some do, but MYsp, not so much
Bats are Equally Detectable	HiF, LoVol vs LoF, HiVol
Bat Detectors are Equal	Not by a long shot
Approved Classifiers are Precise and/or Accurate	Not on field data
Version Control is Manageable	Maybe someday . . .
Surveyors Understand Outputs	7 vs 277 vs 931 MYSE

Take Home Message . . .

- Acoustic Surveys are NOT Easy
- Anyone Willing to Trust Results from an Auto-classifier Must Accept a Certain Amount of Error
- How Much Depends on Bat Diversity and Over-lapping Repertoires

NEBWG - January 2011



USF&WS iBat Survey Protocol Comments

Mic.

Detector

Settings

Surveyor

Classifier

Analyst

USF&WS
Protocols