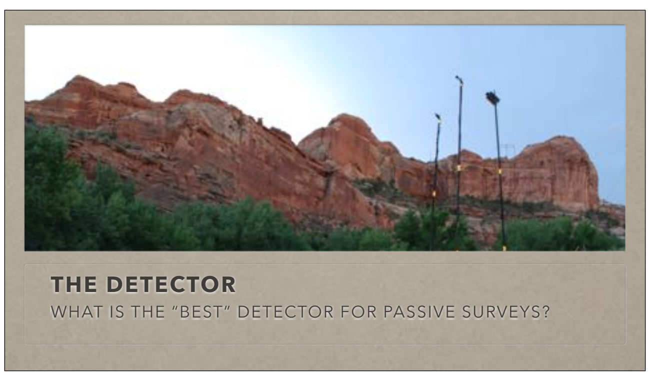
I have been teaching bat survey workshops since 1989 with Bat Conservation International and now with numerous colleagues.

And no bat survey method has undergone more specialization than the use of bat detectors and acoustic analysis software.

In designing these trainings, I've spend a LOT of time comparing different detectors, different deployments, different settings, and different software programs, to discover the most efficient combinations for surveys, especially for stationary point passive deployments.

But I also spend a LOT of time manually vetting and providing 2nd opinions on acoustic surveys for clients, so I see first hand what kind of data is collected from what types of detectors, deployed in which types of scenarios, with different settings.

So, today I've been asked bring you a synthesis of my most useful findings to conduct better acoustic surveys: ▶ Is it the detector? The deployment? Or the Settings?



Of course the answer is YES!

And, everyone wants to know: "what's the very best detector to use for passive surveys."

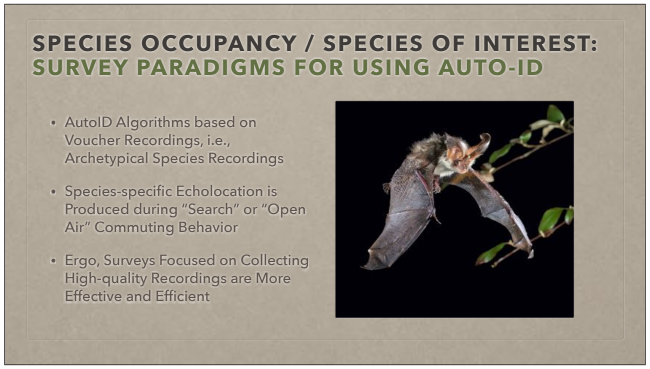
That's like trying to tell people what is the best of anything: the best vehicle, computer, headlamp, university, Thai restaurant . . . whatever.

The answer usually comes down to whatever doesn't piss you off the most.

And the good news is almost ANY bat detector can be use for bat surveys. And all manufacturers now produce bat detectors specifically designed for long-term, stationary point, passive surveys . . . and that record in full-spectrum.

The three main manufacturers are: ▶ Pettersson, Titley, and Wildlife Acoustics.

No matter what detector you choose, you need to become as familiar with it as you are with any other piece of electronic equipment: your camera, printer, drone, smart phone, whatever — this way you can get the most out of it and be the most efficient.



Most of us do acoustic surveys for bats to determine species occupancy OR probable presence for a species of interest.

And that means collecting GB's or TB's of data to feed thru an AutoID program, and then manually vet the output to report on results.

Because we have these AutoID programs, the temptation is to collect as MUCH data as possible so we don't "miss" anything because we can let the computer do all the "work." But in reality, that paradigm leaves us with an awful lot of work to do.

Remember, ▶ our AutoID programs are based on "voucher recordings" which are essentially the "archetypical" recordings for the species in the classifiers.

And archetypical recordings are those which have the ▶ "species specific" call characteristics. And these can best be measured during typical "search" phase or "open-air" commuting behaviors that bats perform.

Thus, instead of focusing our surveys on collecting "EVERYTHING," we need to shift our paradigm to ▶ collect only the HIGEST QUALITY recordings, because they will better match the classifiers AND have a better chance of being confidently and accurately identified.

If our AutoID programs are built on high-quality calls, our survey efforts should concentrate on recording high-quality calls.

These are: "fully formed" call pulses ▶ in long sequences that contain at least 8 individual, consecutive, high-quality call pulses per file.

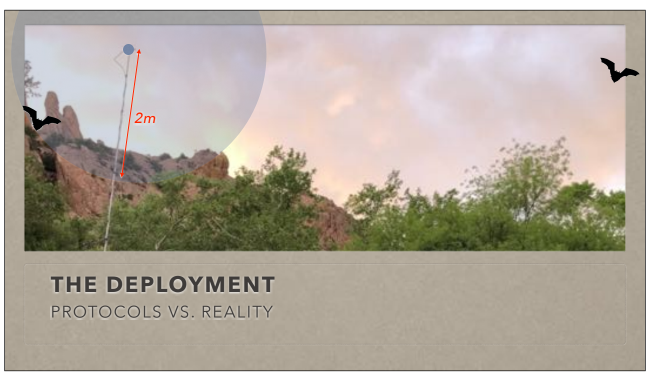
Also, those with ▶consistent inter-pulse intervals, indicating commuting behavior typical of "search phase" echolocation.

We want consistent call pulse shape ▶ or pulses illustrate a progression of shape changes indicating that there is just a single individual in the recording.

We don't want any interference with any part of the call pulses: no ▶ reflective or diffuse echoes, background noise, or sounds from other non-bat animals or anthropogenic noise that masks the true beginning or end of a call pulse.

That makes a crisp, clean ▶oscillogram with good signal to noise ratio.

The oscillogram shape and and the location of maximum power is often key to disambiguating between species in similar phonic groups.



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The best way to collect high-quality recordings is to start with the deployment.

We have a lot of protocols that provide guidelines describing the WHERE's and HOW's of setting up a bat detector.

Many of these guidelines simply co-opt the WHERE's and HOW's for setting nets and traps for CAPTURE surveys.

This is misleading for two reasons: We capture bats were they are concentrated at foraging or drinking sites AND where they fly low and are constricted to an area roughly the size of our ground-based nets. But bats flying together OR where they are constricted by clutter do not produce typical search-phase calls.

So the first HOW-TO deployment tip for collecting high-quality recordings is to reject the capture paradigm for detector placement. Put a microphone as high as possible in an unrestricted flyway.

I like to make my deployments 6-8 meters above ground level.

Detector-wise, this means is that you probably want your “go to” unit for passive surveys to have a ▶ cabled microphone, that is at least 10m long.

Moreover, ▶ if you can pick up a bat from 2-3 meters away, you want to be at <u>least</u> 1-2 meters away from the nearest “clutter” that might cause a bat to use a non-typical commuting-phase call-types as it is trying navigate around the clutter.

▶ Imagine a spherical volume around your mic with a radius of at least 2 meters that is devoid of all objects (except the microphone mast itself). ▶ If a bat is hugging the vegetation its echolocation call will be recorded, and it will be recorded well. This is because most bats that are “clutter” specialists have flight-styles and echolocation-styles suited for flying among edge habitats, and they will produce their most species-specific echolocation calls in these types of scenarios.

▶ This same microphone will <u>also</u> pick up calls from any open-air, high-flying bat that approaches the volume of detection of the microphone, also providing excellent quality recordings.

As for the WHERE's to deploy, there is a lot that the protocols get "right" and one very big thing that the protocols often get wrong.

To collect recordings from "open air" search-phase bats, we want to target places where bats are simply commuting thru un-cluttered habitats.

This includes ▶ clearings . . . caused by gaps in forests, meadows, or even anthropogenic structures such as parks, ball-fields, or even roof-tops.

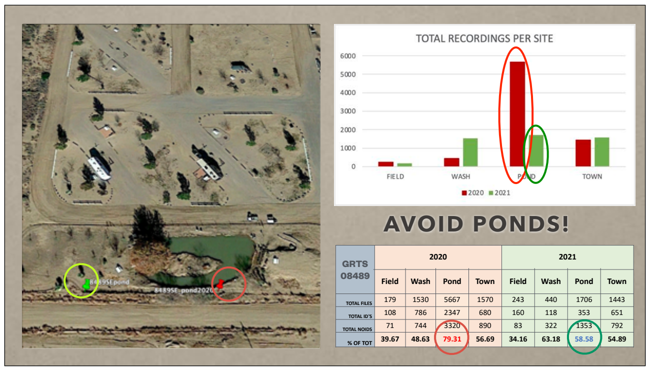
And ▶ travel corridors . . . it is much easier for a bat to follow a river corridor, an arroyo, a tree-line, or even a utility right-of-way rather than navigate thru a forested or other type of cluttered habitat . . . so, like a bat, key in on "linear landscape features" and put a detector in an open area adjacent to that.

And ▶ unobstructed flyways like paths, jeep trails, fire-breaks, even roads . . . especially those that unite different habitats or that lead from roosting habitat to foraging habitats … these are attractive bat travel corridors AND are areas where bats using "open air" commuting-type echolocation.

Almost every protocol out there also mentions ▶ ponds.

Ponds are the worst place to deploy. This turns your detector microphone into an Air Traffic Control tower that will collect recordings of bats all in different stages of approach, trying to share the same airspace, all at the same time.

This yields the worst possible recordings, the lowest potential for accurate species ID, and the greatest effort to manually vet, and makes it nearly impossible to report on species occurrence.



But we all do it. And I am just as guilty.

▶ In 2020 I put my NABat detector right at the edge of this pond in southeastern AZ. I collected over 5,000 recordings, almost 80% of which could not be ID'd to species.

The main problem with the recordings was that there were 2, 3, 4 and "more bats than I could count" in them. There was absolutely no way for me or the computer to confidently ID these files to species.

▶ In 2021, I moved the detector about 50m from the pond and my numbers of recordings dropped to a fraction of that in 2020 and my percentage of un-identifiable calls dropped as well.

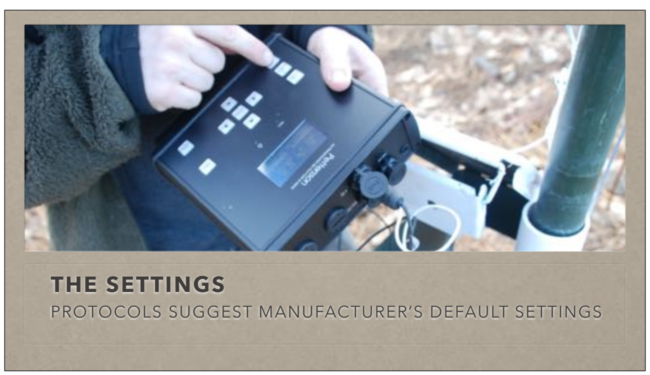
Deployment Matters.

These are actual examples of deployments we've done in field classes.

The photo on the left shows a mic 2m above ground, adjacent to, and under, vegetation, and in a cluttered flyway.
▶ The vast majority of recordings were poor quality, received NoID and were a booger to vet.

The photo on the right is ideal: 6m above ground level, 4m above the vegetation, along a dirt road serving as a linear landscape feature, and in a canyon that creates a travel corridor. ▶ Almost no noise is recorded and the majority of files are high-quality.

Deployment Rules are Easy: Deploy HIGH, in NO-clutter, and along OPEN flyways.



Settings are more complex . . . only because protocols encourage us to err on the side of being too liberal OR simply adopt the "Manufacturer's Default Settings."

Let's unpack this.

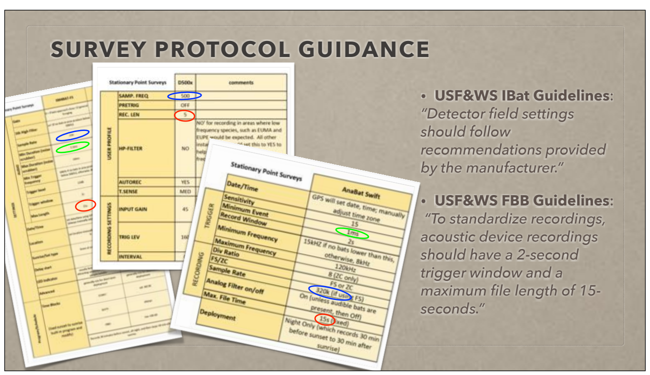
All manufacturers provide manuals about how to use their detectors, and break down the different options for their settings so users can program "triggered" recordings. A Triggered Recording means that if a sound meets or exceeds the entire complement of settings, then a recording will be initiated.

Some detectors have 3 different trigger settings . . . others have a dozen or more. And they don't all offer the same triggers or the same "units" for their settings.

No wonder it's confusing.

▶ So most manuals will contain recommended settings or offer "defaults" if you don't ever want to think about which buttons to push or take a deep dive into the physics of ultrasound.

Unfortunately, this paradigm has put us stationary point surveyors into a terrible spot.



Because manufacturer's settings and protocol guidance documents err on the side of collecting as much data as possible.

These are the suggested settings for SM4s, D500x's and Swifts from NABat. They essentially adopt wholesale the manufacturer's defaults . . . even though, some trigger options actually <u>are</u> consistent across manufacturers AND they also use the same units, yet they are contradicted in the recommendations!

▶ **Sample rate** for an SM4: 256kHz; for a D500x: 500kHz; and for a Swift: 320kHz

▶ **Minimum trigger duration** for an SM4 recording: 1.5ms and for a Swift: 1ms

▶ **Maximum File Length** for an SM4 and a Swift = 15s, but for a D500x = 5s

Now, differences in sample rates and in a half a ms for minimum trigger duration might not be a big deal, but 10 seconds . . . especially for file length . . . certainly is.

The trouble is, ferreting out the differences in the available settings from each detector and their impact on recording efforts is a BIG job, and nobody really wants to do it.

▶ So, the USF&WS Indiana bat survey protocols simply say "use the manufacturer's suggested guidelines — after all, why not? The people building the detectors know how they should be used, right?

▶ But then when it comes to Florida Bonneted bats, they say, "to standardize recordings, detectors should have a 2s trigger window and a maximum file length of 15s." Never mind that Pettersson doesn't even offer a "trigger window" setting NOR an option for a 15s maximum file length. So what? We can't use this detector for FBB surveys? We have to change our trigger window settings if we are doing NABat vs FBB surveys?

Another dirty little secret? There's no such thing as "standardizing" recordings from one detector to another . . . let alone from one model to another or from one manufacturer to another. I can have two microphones with elements 1-inch apart, running on two detectors from the same manufacturer, that are the same model, with the same firmware and the same settings and they do not record identical bat passes, nor the exact same number of bat passes throughout an entire monitoring session.

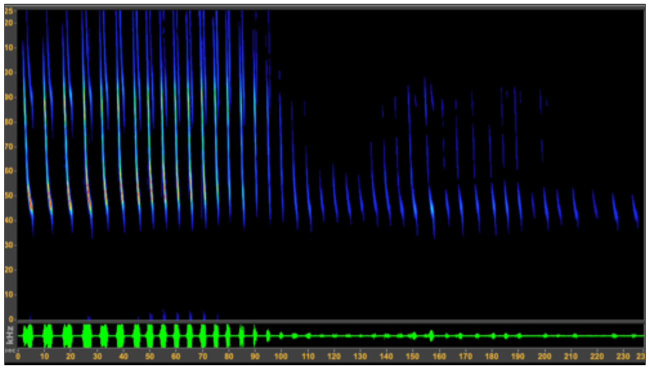
This is because you cannot control where in 3D space any bat, and its echolocation call, is going to intersect your stationary microphone's volume of detection. And on any given Sunday, any given bat may be just outside your mic's optimum volume of detection.

But still, ANY detector will work for acoustic surveys.

And there are four key settings that you need to understand and configure to collect high-quality recordings that will be most likely to be AutoID'd and that will drastically reduce your manual vetting burden.

▶ These are: Gain, Trigger Window, Maximum File Length, and Sensitivity.

Let's talk about each one individually, and how they are configured to work together.

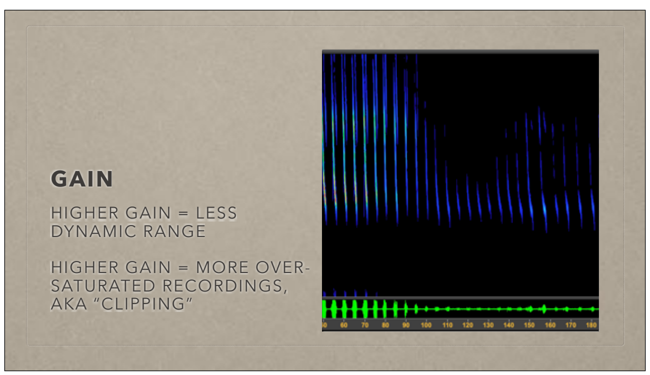


The gain setting on a detector allows users to “amplify” (e.g., strengthen, or make louder) a weak signal.

This sounds like a “good” thing, right? If you increase the gain on a detector, you should be able to detect quieter, higher frequency, and more distant bats, right? And detecting more bats increases the chances of detecting your species of interest, right?

As far as an adjustable gain setting is concerned, sound engineers do rely on this to record things like artists in studio sessions and actors that are talking and walking around movie sets. This allows them to control for variations in frequency and amplitude during a production so loud voices and quiet voices can be broadcast to an audience without being either too loud or too quiet for the audience members to appreciate: it’s the “Goldilocks approach” to making a good recording: adjust things so they are “just right.”

So designing detectors with adjustable gain settings sounds great, right?



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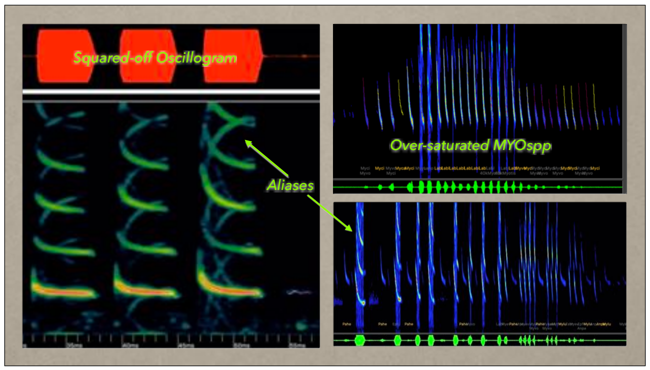
Well, no. We bat-workers aren’t competing for “Best in Sound Design” academy awards. We are trying to simply IDENTIFY bats.

And because we are mostly doing this with passive recordings. We are recording from a stationary position. We don’t use movable boom mics, nor do we have our fingers on the “gain” dial so we can adjust them as our subject moves.

Our gain settings need to be designed with more of a “Price is Right” approach: pick a value that is close without going over.

Any time you increase the gain for a passive deployment, ▶ you risk creating less dynamic range in the recording: this means that the loud sounds appear louder and the quiet sounds appear quieter. ▶ In fact, too much gain results in “clipping” what we call over-saturated recordings.

Oversaturated recordings do not provide accurate amplitude information.

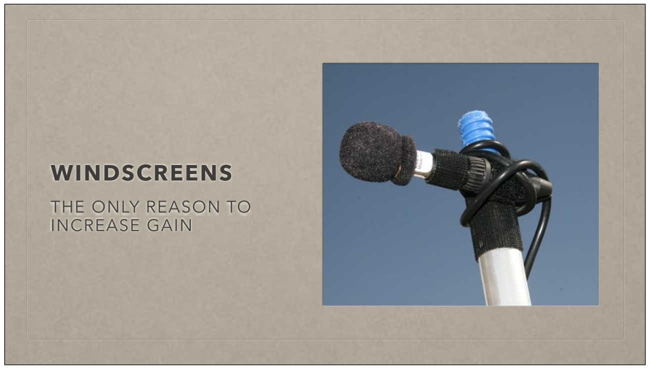


Remember, we can NEVER control how close the bat comes to our microphone. Increasing the gain will pick up quieter bats and more distant bats, but when it does, the recordings will be of poor quality because they will lack enough dynamic range to calculate metrics like HiF or LoF, FmaxE, and the power in the oscillogram will be difficult to discern. So your quiet/distant bats are hard to identify. Plus any close bats will be oversaturated.

These spectrograms are examples of recordings made with SongMeters using a 12dB gain setting.

- ▶ They are full of squared-off oscillograms; things that “look like” harmonics but are actually aliases from over-driving the the digital signal; and recordings from HiF bats that are consistently over-saturated . . . all of which interferes with accurate species ID.

So you are asking, why have an adjustable gain if you shouldn’t use it?

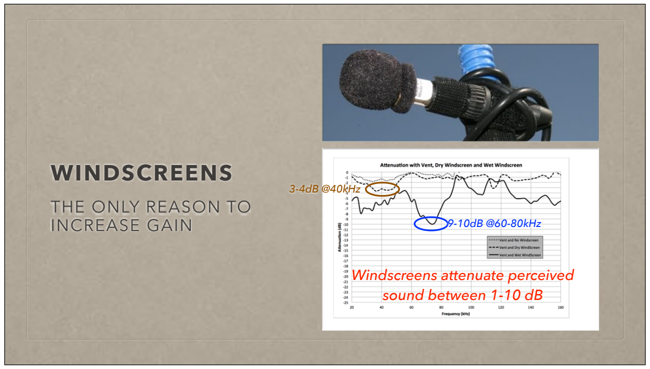


It's no coincidence that the only bat detectors with adjustable gains are the only detectors that offer a "windscreen." They are also the only detectors that began their lives as "acoustic" recorders, not "ultrasonic" recorders. Sound recording rules change for ultrasonic frequencies.

Wind screens are essential for making quality outdoor recordings of "audible" sound, like the Weather Channel meteorologists reporting during a hurricane. That is because the wind moving across a microphone element often creates a distracting "popping" sound or irregular bursts of noise that are undesirable especially on playback. You've probably noticed this when recording video outdoors on your smartphone, right? It doesn't have a windscreen. When you play back the video, the wind sound is really obvious and often very disruptive.

So, Wildlife Acoustics offers windscreens for their acoustic mics, and by extension, on their ultrasonic mics.

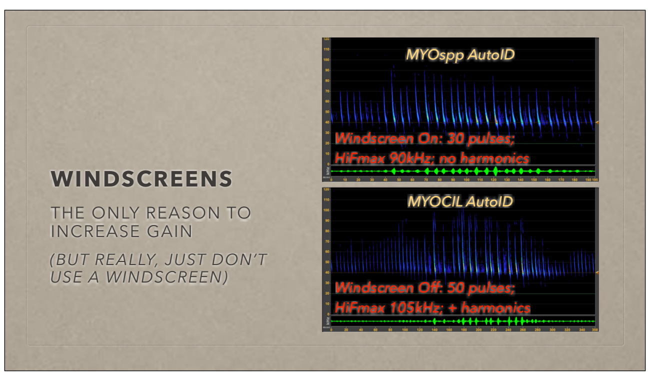
The thing is though any wind sound that might cause popping on a mic element is very low frequency, and isn't recorded by ultrasonic recorders that have built-in 1kHz "analog" filters or on detectors with settings that allow users to apply digital "low pass" filters to help attenuate sub 20kHz non-bat "noise."



This chart shows the affect of attenuation at different ultrasonic frequencies with the bare mic element (dotted line), a "dry" windscreen (the dashed line) and a wet windscreen (solid line).

The windscreen will attenuate sound between 1-10 dB at different frequencies depending on just how wet it gets (from humidity, dew, or rain). And if it freezes, the attenuation is almost complete (i.e., no sound can penetrate).

So only if you are using a windscreen should you increase the gain setting on your SongMeter detector to compensate.



Now, 1-10 dB doesn't SEEM like a lot, but even a slight bit of attenuation, especially attenuation at key frequencies can be bad.

Over the years, we've done several side-by-side deployments with SongMeter detectors running mics with and without windscreens, and consistently we have found that when the same bat pass is recorded, naked microphones provide better recordings for Auto ID and and for manual vetting efforts because they yield:

▶ more pulses upon which to base a decision
and broader bandwidth, including harmonics, on the pulses

▶ So, the take home is: Use a 0dB gain on your SongMeters and don't use a windscreen.

The next setting is the "Trigger Window" sometimes referred to as the "record window."

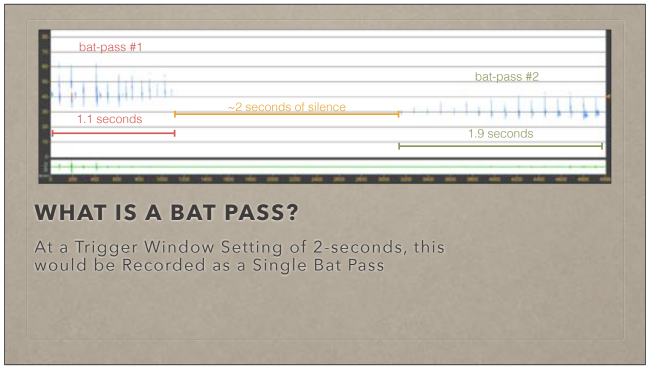
For bat recording, this is a window in time, of a specified length, which if exceeded results in ENDING a triggered recording.

The main purpose of the "trigger window" is to try to confine a single bat-pass to a single recording.

▶ The "default" trigger window (according to Wildlife Acoustics) is 3-seconds.

▶ The "recommended" trigger window (according to NABat) is 2-seconds.

Where do they get these numbers and what do they mean?

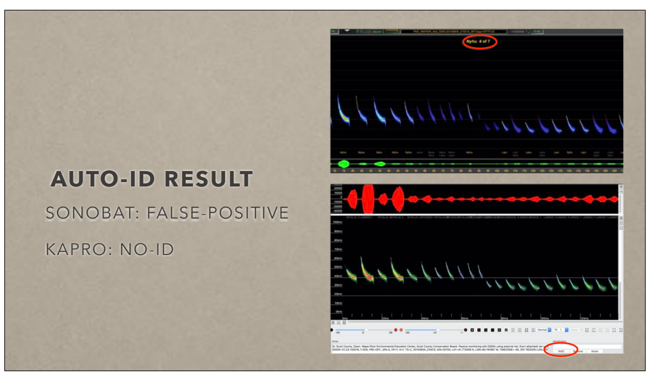


To figure this out, first we need to define a bat pass.

Take for instance this spectrograph of a 5 second, recording, displayed in "realtime" where the actual time between each call-pulse (the blue lines) is preserved. This clearly illustrates two distinct bat passes.

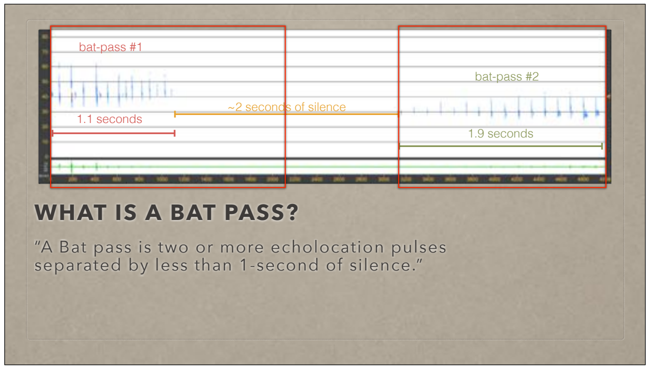
▶ Bat-pass #1, in the 40kHz phonic group, has 13 call pulses recorded over 1.1 seconds.
▶ Then there are 2 seconds silence . . .
▶ Before bat-pass #2, in the 30kHz phonic group, with 15 call pulses, is recorded over 1.9 seconds.

▶ If our "Trigger Window" setting is 2 (or more) seconds, then this 5-second recording would be saved as a single recording, with 2 bat passes.



This is a problem because:

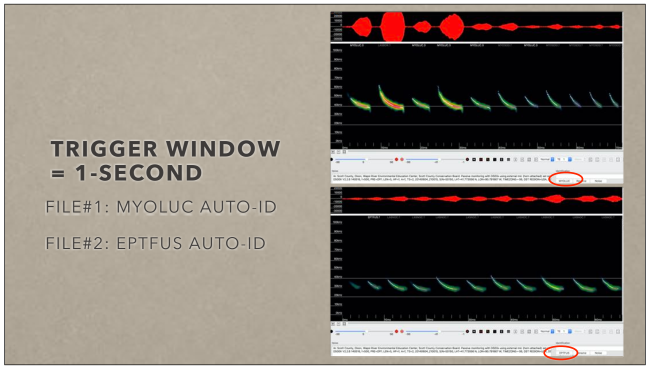
When our AutoID is run, the metrics from both the high-frequency bat pass and the low frequency bat pass are averaged, and in this instance, ▶ SonoBat provides a false-positive ID for NYCHUM and KaPRO cannot offer an AutoID.



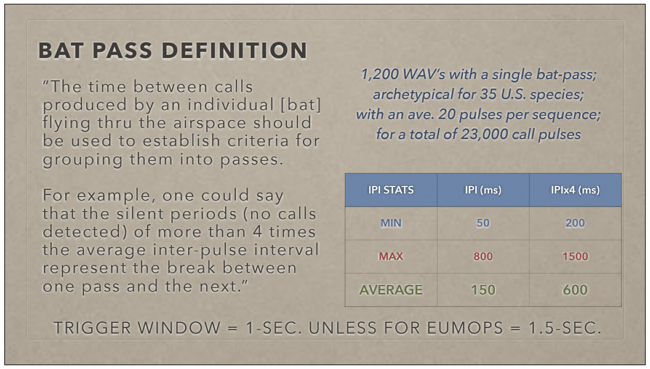
This is interesting, because Brock Fenton way back in 1980, promoted a working definition of a bat pass, namely: A bat pass is two or more echolocation pulses separated by less than 1-second of silence.

If we used this definition of a bat pass, and applied a 1-second Trigger window, then this single 5 second file would be recorded as two separate files:

▶ One 2-second file with the bat-pass from the high-frequency phonic group
And one 2-second file with the bat-pass from the low-frequency phonic group.



And, this being the case, our AutoID results would be more accurate, more likely correct, and our effort to manually vet would be far less involved, PLUS we could better correlate the number of recordings collected during our survey with the actual number of bat-passes that occurred.



So, if a 1-second trigger window is actually reasonable, why do "protocols" and "manufacturers" NOT use this?

A curious person would wonder just how close to reality the basic definition of a bat pass is: 2 or more pulses separated by less than 1 second of silence.

At the first echolocation symposium in Austin Texas in 2002, Brock Fenton elaborated on his definition of a bat pass for acoustic surveys: ▶ Basically saying: a bat pass ends when the period of silence exceeds 4-times the average inter-pulse interval of a sequence of bat calls.

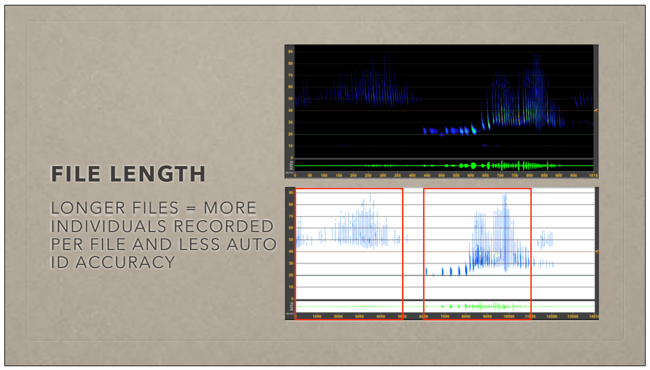
We decided to test this. ▶ We looked at over 1200 WAV files, manually identified as containing just a single bat-pass, and representing "archetypical" open-air, search-phase recordings, from 35 different U.S. bat species. Our WAV files included over 23,000 individual call pulses.

These files were "Parameterized" with a SonoBat batch output that calculated over 100 pulse and sequence metrics, including the inter-pulse interval between two consecutive pluses, allowing us to output the measures from consecutive pulses from each species.

▶ We collected metrics on the minimum, maximum and average IPIs, and then multiplied these IPI values by 4, as suggested by Brock. ▶ The minimum IPIx4 value was 200ms and the maximum was 1500ms with the average being slightly over 1/2 a second.

The only files with IPIx4 values exceeding 1 second came from a few of the bigger free-tailed bats.

▶ So, the take home message: Set a 1s “trigger window” as your default, unless surveying in *Eumops* country, then this can be increased to 1.5 seconds, but there is never a need to increase this to more than 1.5 seconds.



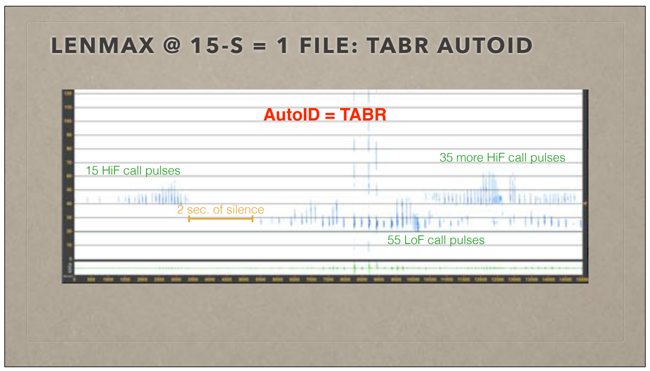
Besides Trigger Window, another setting is Maximum File Length.

These images are a compressed view (top) and realtime view (bottom) of the same-15 second long recording, from a SongMeter detector.

Remember, according to NABat for Swifts and SongMeters a 15-second maximum file length is recommended but if you are using a D500x, a Maximum File Length setting of 5-seconds is perfectly fine. Why? This makes no sense, especially if you are trying in any way to standardize recording efforts between detectors.

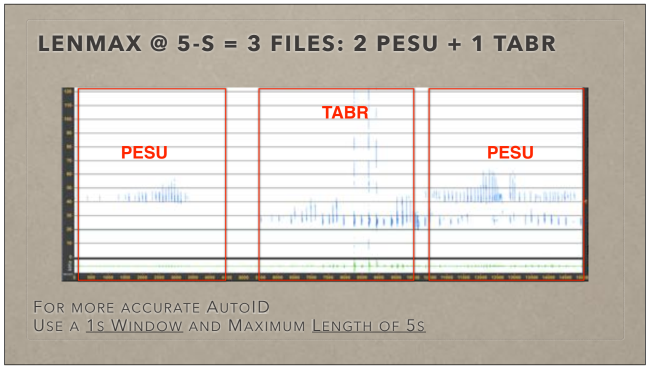
If we were to set the Swift and the SongMeter file lengths to match the D500x setting, then we would have gotten TWO recordings. ▶ One 5-second recording of the HiF individual, ▶ and one 5-second recording on the LoF individual.

▶ The only thing a longer file length gets you is the potential to have more bat passes from more individuals recorded in a single file, and we already showed that especially at the (recommended) trigger window settings, more bat passes in a file reduces AutoID accuracy, especially when they are from individuals in different phonic groups.



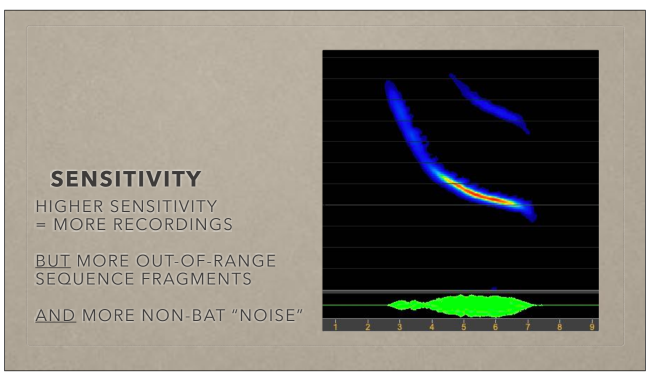
Here is another 15-second long recording (that also has a 3s trigger window setting). The “sequence level” AutoID was *Tadarida*, based on a majority of call pulses (N=45) that received a pulse-level AutoID for *Tadarida*.

But there are two other bat-passes in this recording, one at the beginning and one at the end from a HiF species, yet there are only 15 pulses in the first pass, all classified as tri-colored bats and 25 of the 35 pulses in the second pass also classified as tri-colored bats for a total of 40 which didn’t out-weigh the 45 LoF pulses that were classified as *Tadarida*.



If we had set a 5-second Maximum file length (along with a 1-second trigger window), this file would have been recorded in three separate files, one that just had PESU pulses, one that just had TABR pulses, and one that had both TABR and PESU, yet was AutoID'd as a PESU. This is important, not only because PESU is about to be listed and would have been missed due to the AutoID result on the 15-second file, but also because three shorter files is a more accurate representation of the relative bat activity during the survey.

So, for more accuracy, don't just use a 1s Trigger Window, but also use a Maximum Recording Length of 5-seconds.

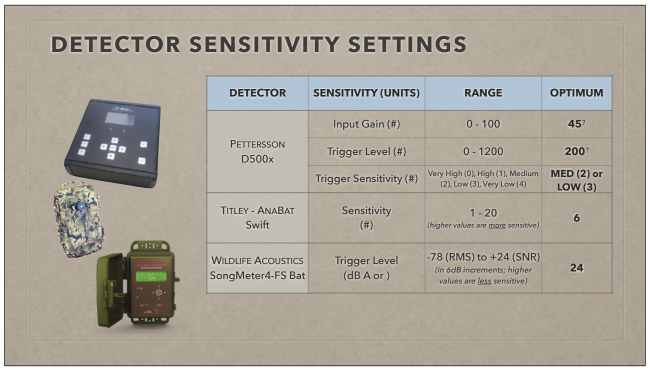


The final setting, and perhaps the most important, is the detector sensitivity.

As expected, the higher the sensitivity setting, the more recordings you will collect.

But at the considerable expense of also collecting more out-of-range sequence fragments and more non-bat noise.

And this makes more sensitive settings a very bad, wasteful, inefficient thing when it comes to running passive surveys.

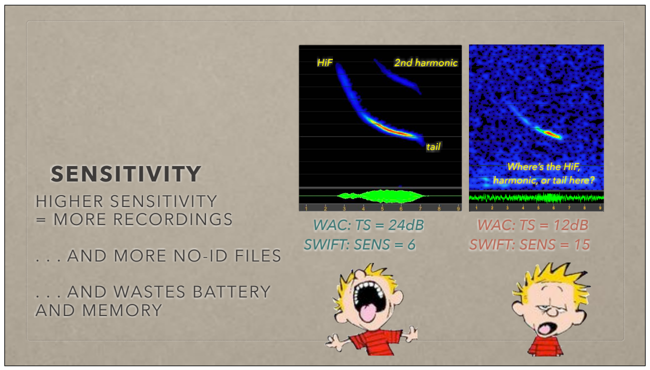


Another issue with detector sensitivity, is each manufacturer uses a different type of sensitivity setting and different units so attempts to "standardize" settings among detectors is really difficult.

The Pettersson detector is the most non-intuitive to set because its triggering is governed by a combination of 2 user-settings: the Input Gain and the Trigger Level; plus 1 profile setting: the Trigger Sensitivity. And each are measured in "random Pettersson units" that don't have any physical relationship to sound pressure levels. It would take me 30-more minutes to dive into how all that works, so today we are just going to focus on the Swift and SongMeter.

▶ The Swift also uses "random Titley/AnaBat units" but there's only one sensitivity setting with higher values being MORE sensitive. NABat recommends "15."

▶ The SongMeter also relies on a single sensitivity setting but with two options. Either an "absolute" or an "adaptive" trigger. The absolute trigger is a negative value corresponding to the RMS (root-mean-square) of the total energy in the file. The “adaptive” trigger corresponds to the rolling-average for the sound in the file relative to the SNR (signal to noise ratio). For bats, the adaptive trigger is more useful. And with this trigger setting, higher values are LESS sensitive.



The most important thing about the sensitivity setting is to shift the paradigm that a higher sensitivity will pick up quieter and/or more distant bats. This is true, but NOT effective for passive surveys.

We are always told that bats are LOUD, about 110dB, if we could hear them they would sound like a triggered smoke alarm. But what we neglect to appreciate is that bats do not use the same intensity of sound along the entire bandwidth of a frequency-modulated call pulse; in the case of the call pulse in this illustration, the entire pulse contains frequencies from 100kHz to 30kHz.

Only a PORTION of a that call pulse is loud, represented by the “hot spot” in the spectrogram. Here, the loudest portion of the call is roughly between 40-50kHz, the remainder of the frequency sweep, ▶ including the HiF of the pulse, the 2nd harmonic, and the tail at the end are all much quieter, possibly by 12dB or more. This pulse is well-rendered though, with all the quiet parts preserved, because the detector sensitivity was set to be very high and only triggered to record this call when the “frequencies with the maximum energy” were significantly above the background noise.

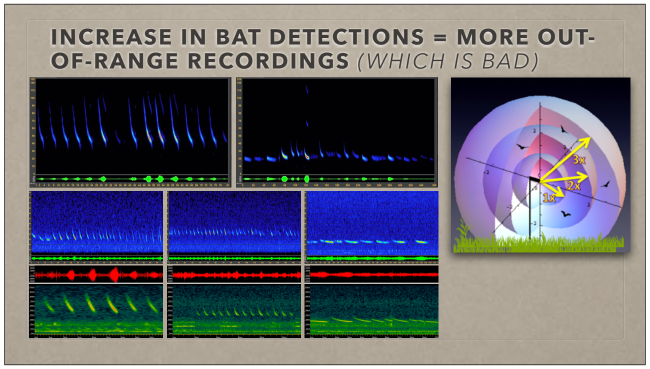
▶ The SongMeter setting was at a 24dB signal-to-noise ratio.
The SWIFT was set at “6” Titley-sensitivity-units

These are very conservative settings that only trigger when the bat is well within range of the optimum volume of detection for the detector. Not only are you picking up the frequency sweep of the bat call pulses that have the maximum energy, but you are also picking up more of the full bandwidth and lowest amplitude portions of the recording.

▶ A more liberal trigger sensitivity will still trigger on bat calls because the frequency sweep with the maximum energy meets the more liberal sensitivity setting, but the higher frequencies and quieter portions of the bat call pulse will dissolve into the background noise in the environment or not rise above the noise floor of the microphone.

And with liberal trigger settings, you record 10-100 times more these “out of range” files than you do at more conservative settings.

So let’s record the ▶ LOUD bats, not the distant quiet bats that won’t give us good recordings anyway. Because those distant, quiet bats will eventually come close enough to our microphone on any given Sunday, that they WILL be recorded.



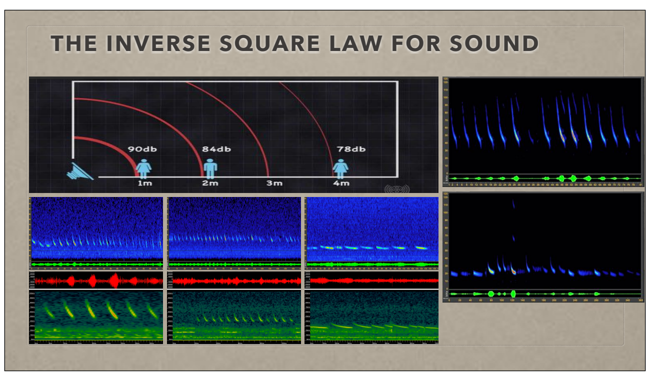
Sticking to liberal trigger level settings will give us vastly more poor recordings.

In this diagram, consider the 1x sphere to be the “optimum” volume of detection for a bat detector. When a bat is well within that volume, recordings will look like the spectrographs in the top row.

Yet, there will always bats approaching the microphone that are 2 or 3 radii out from the optimum volume at 1 radius. Consider how much larger the volumes of detection are at each additional radius out from optimum.

Bats in these areas will initiate recordings that look like the six spectrographs in the bottom two rows.

And with increasingly liberal settings, there will be many more of these out of range recordings and none will have enough bat-content to render confident AutoID decisions, nor will there be enough resolution to effectively manually vet.



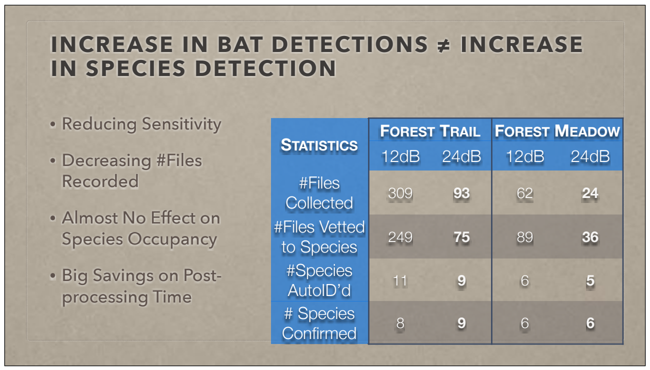
This is because of the Inverse square law, which essentially states that sound decreases exponentially with each doubling of the distance from the point source.

If you are a bat at 1 m away from the microphone and you have have an echolocation call with a maximum energy of 90dB, by the time you are 2-meters away, the apparent volume of that is 84dB (the sound level is attenuated by 6dB). This does not seem like much, but perceptively that sound level appears just half as loud as the 90dB sound, and when you are

4-m out the apparent volume drops to 78dB (with an attenuation of 12dB).

This means, that at very sensitive trigger levels, you are picking up hundreds of recordings that contain increasingly narrow bandwidths of frequencies in a call pulse that have enough intensity to rise above the noise floor of the mic or environment.

By now you are probably getting a bit nervous about programming detectors to be LESS sensitive. Maybe you still are afraid that you are going to miss those quiet, distant bats that USF&WS and NABat want you to be sure and document. How can you be sure that you're not missing your



Well, we tested this this at our workshops with some side-by-side deployments.

For **two** nights at two locations in KY we paired two identical SM detectors with identical settings except for the trigger levels.

One was at the recommended Trigger Level of 12dB and one was at a very conservative Trigger Level of 24dB.

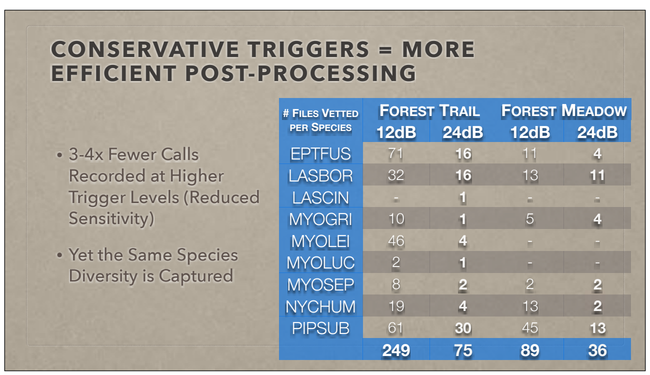
Then we ran everything thru an Auto-ID program and separated out the results by location and trigger level. The **12dB** detector at the forest trail collected over 300 recordings, and its twin with the higher setting of 24dB only collected about 100. At the clearing the 12dB detector collected 60 and the other only 24.

Then we manually vetted the entire collection, and at the trail were able to identify about **250** files to species on the 12dB detector and 75 files to species on the 24dB one. The meadow detectors had 90 and 36 respectively.

If we look at just the results of the **AutoID** outputs, we found at 11 species from the 12dB detector and 9 species from the 24dB one in the Forest.

But, after manually vetting the collection, the “liberal” detectors had no advantage, in fact they both had more false-positive ID’s. And, it is much easier to look at 75 and 35 files to determine species ID than it is to look at 250 of 90.

Remember, this was just a single survey night, and detectors only ran for 3 hours after sundown - multiply these numbers by full-night surveys running for multiple consecutive nights at multiple locations and the amount of manual vetting you have to do from detectors with liberal trigger settings becomes enormous, without much more gain in information.



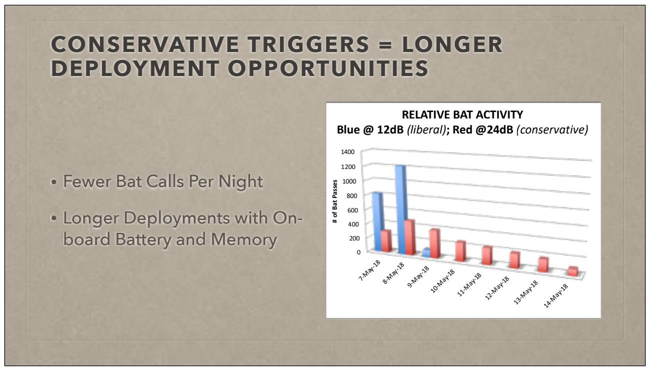
# Files Vetted per Species	Forest Trail 12dB	Forest Trail 24dB	Forest Meadow 12dB	Forest Meadow 24dB
EPTFUS	71	16	11	4
LASBOR	32	16	13	11
LASCIN	-	1	-	-
MYOGRI	10	1	5	4
MYOLEI	46	4	-	-
MYOLUC	2	1	-	-
MYOSEP	8	2	2	2
NYCHUM	19	4	13	2
PIPSUB	61	30	45	13
	249	75	89	36

The best part of this paired deployment is that at each location we documented the SAME species diversity.

This is the species break-down between the two detectors at the two locations.

You can see that we didn’t lose any species at the more conservative trigger levels, so if species presence is a goal, much can be gained by conservative triggers.

The only thing that's lost is significantly more data to have to pour thru to get at our species compositions at each site, which doesn't provide any additional insight.

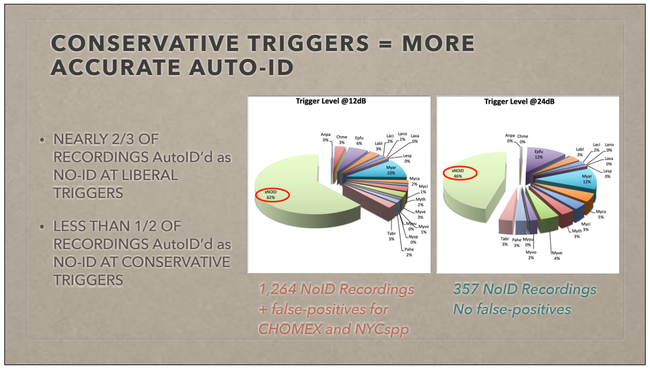


We tried a similar experiment at our AZ field class where we had a much higher species diversity and many more bats from "quiet" and "high frequency" phonic groups.

Here again we used two SongMeter detectors at two different trigger levels, with everything else being the same.

One of the most significant results was that the detector using the more conservative trigger level, functioned for 8 full nights, whereas the detector with the more liberal trigger level only recorded for less than 2.5 nights before the SD card was full.

Both detectors recorded over 2100 bat-passes (2,147 on the liberal; 2,117 on the conservative detector). But, at the increased trigger level, 4-times as many monitoring nights were achieved with on-board power and memory.

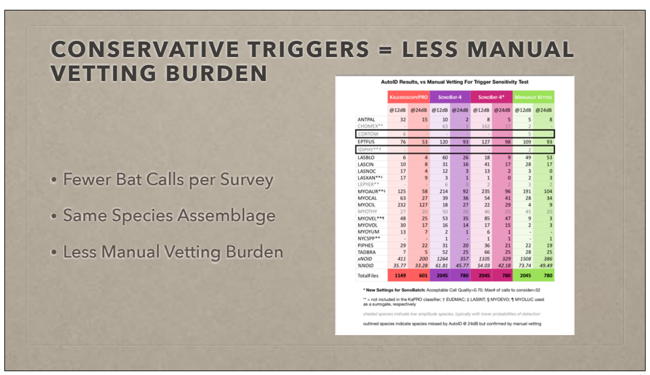


We compared the recordings from just the two nights when both detectors were operational.

The major benefit of of the conservative trigger setting was efficiency and accuracy of the AutoID.

▶ At the liberal trigger settings, nearly 2/3rds of the recordings received NoID from the computer classifier. And, after manual vetting, we identified false-positive classifications for two species of bats one of which wasn't present at the site and the other of which was not identified by AutoID.

▶ At the conservative trigger settings, less that 1/2 of the collection received NoID from the computer classifier. And, after manual vetting, we didn't identify any false-positive classifications for the species present.



Most importantly, when these auto-classification results were compared to the manually vetted results, there was almost no difference in occupancy results. The only exceptions were two species, *Corynorhinus townsendii* and *Idionycteris phyllotis* (outlined). Both were identified only in the 12dB collection, with the former identified by Kaleidoscope and the latter identified by manual vetting.

Both of these species produce low- bandwidth, low-amplitude echolocation calls that are difficult to record, as are other species in the table that are printed in a lighter shade of gray. One of these species, *Cheronycteris mexicana*, was identified by SonoBat at both trigger levels, but were determined to be false positives after manual vetting.

And remember, these comparisons were made only from the first two nights of monitoring when both detectors operated for the entire night.

The full complement of species, including these two “low bandwidth / low amplitude species” CORTOW and IDIPHY, that were missed by the 24dB detector on the first two nights WERE found in the files when the entire 8-night survey was analyzed from the 24dB detector.

Now consider, if our “liberal” detector were to have run for the entire 8-night survey, we would have likely recorded close to 10,000 recordings from it, with over 6,000 of those files being characterized as Noise or NoID. And with the conservative detector we only recorded 2,000 files in total - less than half of which were Noise/NoID.

For passive stationary point monitoring, efficiency is key.

We can achieve this by planning deployments carefully: targeting unobstructed flyways and staying away from ponds!

And by considering the settings we discussed today: 0dB gain on SongMeters; a 1-second trigger window on Swifts and SongMeters; a maximum file-length of 5-seconds on ALL detectors; and conservative trigger levels, 24dB SNR on SongMeters and a sensitivity of 6 on Swifts.

For AutoID and to make your manual vetting lives easier, JUST record the “good stuff” - and remember, even with “good stuff” settings, you will still get poor quality recordings from passive deployments. You will still get recordings that are over-saturated and clipped; you will still get recordings with multiple bats in a file; and you will still get recordings that are out-of-range fragments . . . but only a mere FRACTION of what you would get with traditional, manufacturer’s suggested settings.

For questions about any of the contents in this program, resources related to the images or information, and more details about acoustic surveys, contact J.D.Tyburec at Bat Survey Solutions.

To join us at a hands-on field workshop, see the Bat Survey Solutions Website.

Acoustic Survey Methods & NABat Project Training Courses
Monday - Saturday: 10-15 June, Portal (SWRS) AZ - $2,995 (on-site food and lodging included)

Monday - Saturday: TBA July, Tucson AZ (WWLR) - NABat-specific $500/day; $1,745 passive only; $1,995 full 5-day (food and lodging on your own)

Wednesday - Monday: 14-19 August, Baker (GRBA) NV - $2,995 (on-site food and lodging included)

Combined Field Survey Techniques Workshops
Thursday - Thursday: 30 May -6 June: Portal (SWRS) AZ - $3,595 (on-site food and lodging included)

Tuesday - Tuesday: 20-27 August: Baker (GRBA) NV - $3,595 (on-site food and lodging included)

Bats of Great Basin Natural History Workshop with Merlin Tuttle’s Bat Conservation
Thursday - Tuesday: 1-6 August: Baker (GRBA) NV - $6,995.00 (on-site food and lodging included)

Discover Bats and Texas Pecans - Sustainable Agriculture Workshop
Thursday - Sunday: 19-22 September: San Marcos TX - $645.00 (food included, lodging on your own)