



Kaleidoscope Pro 5 User Guide



Online User Guide

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Tutorial Videos

Visit www.wildlifeacoustics.com/support/tutorial-videos to view tutorial videos for Kaleidoscope Pro.

Contacting Support

For technical queries contact the Wildlife Acoustics support team:

Email: support2021@wildlifeacoustics.com

North America (toll-free): 1-888-733-0200

Outside North America (toll charges may apply): +1 978-369-5225

Don't miss out on Important Updates

We continually add features to Kaleidoscope Pro. Stay up to date with the newest features and receive important technical support bulletins by signing up to our mailing list at:

<http://www.wildlifeacoustics.com/products#mailinglist>

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1 Getting Started

1.1 How to Use This User Guide

Welcome to Kaleidoscope. This user guide is designed to provide complete information about the software, including practical use-based walkthroughs. Here is a brief description of each section of the guide:

Getting Started

It is a good idea for all Kaleidoscope users to read through this chapter. The Overview provides a basic description of Kaleidoscope and provides step by step instructions for download, installation, and basic setup.

- [Overview and Introduction to Kaleidoscope Pro](#)
- [Compatibility and Optimization](#)
- [Data Management](#)
- [Included vs Licensed \(Pro\) Features](#)
- [Launching Kaleidoscope 5 for the First Time](#)

Typical Use Workflows

Use this chapter to follow step by step instructions for specific tasks which are commonly accomplished with Kaleidoscope. This chapter assumes that Kaleidoscope has been downloaded and installed, therefore it is a good idea to read through the Overview chapter first.

- [Batch File Processing and Conversion](#)
- [Bat Identification](#)
- [Auto ID for Bats](#)
- [Cluster Analysis for Sorting and Identification of Bats, Birds, and Other Animals](#)
- [Sound Pressure Level Analysis](#)
- [Cloud Storage Configuration](#)
- [Database Query Examples](#)

Metadata

Metadata is a significant part of the Kaleidoscope workflow. This chapter describes how metadata is collected, created, edited, managed, and output in various formats.

- [Overview](#)
- [MetaForm](#)
- [Project Form](#)
- [Metadata Panel and Results Window](#)
- [GUANO](#)

Reference Guide

This is a complete overview of all functions within Kaleidoscope. The order of the sections is loosely based on the graphic layout of the software. If the user needs detailed information about any specific function of Kaleidoscope, this is where that information will be found.

- [Batch Processing](#)
- [Control Panel](#)
- [Viewer](#)
- [Spectral Analysis Window](#)
- [Results Window](#)

Additional Resources

This is an appendix of information relevant to the functions of Kaleidoscope.

- [.CSV File Layouts](#)
- [File Types](#)
- [File Naming Conventions](#)
- [Metadata SCHEMA](#)
- [Bat Auto ID Theory](#)
- [Clustering Theory](#)
- [Wildlife Acoustics Managed Cloud Account](#)
- [Glossary](#)

1.2 Overview and Introduction to Kaleidoscope Lite and Kaleidoscope Pro

Kaleidoscope software can be downloaded for no charge. Without a Pro license, Kaleidoscope is known as Kaleidoscope Lite. Kaleidoscope Lite provides a suite of powerful tools for no charge.

Kaleidoscope Lite can be upgraded to Kaleidoscope Pro, which unlocks advanced features. Throughout this user guide, when a function is common to both Kaleidoscope Lite and Kaleidoscope Pro, the software will be referred to as "Kaleidoscope". When a function requires a Kaleidoscope Pro license, it will be noted as such and the software will be referred to as "Kaleidoscope Pro".

Kaleidoscope:

- Is an integrated set of software tools for efficient processing and analysis of full spectrum and zero crossing digital audio recordings.
- Supports a wide range of audio file formats created by Wildlife Acoustics recorders and other sources.
- Converts, edits, and creates full spectrum .wav audio files, zero-crossing files, .csv files, and additional data files.
- Can isolate detected signals within larger audio files based on specified parameters.
- Includes a sophisticated spectrogram/waveform Viewer and set of audio tools for quick audio/visual processing, manual verification, and labelling of data.
- In Bat Analysis Mode can attempt to identify and classify bat species.*
- Can isolate and group similar acoustic detections from within audio files. Basic Cluster Analysis can be further enhanced by building simple or advanced classifiers, for further organization and analysis of wildlife sounds within recordings.*
- Provides precise Sound Pressure Level measurements for specific frequency bands and weighted broadband curves.*
- Provides a range of Acoustic Index Analysis tools.*
- Provides database, Cloud-based processing, archiving, and file sharing.*
- *(Requires a Pro license)

Batch File Processing

In a single batch operation, Kaleidoscope can perform multiple tasks in parallel:

- Convert audio file formats.
- Extract metadata from files and batch processes to create .csv format files.
- Add field notes and other metadata to output files.
- Isolate detected signals within audio files based on specified parameters.
- Automatically identify and isolate noise files caused by false triggers in Bat Analysis Mode.
- Suggest most likely bat species in Bat Analysis Mode.*
- Apply cluster analysis to identify and group similar wildlife vocalizations.*
- Analyze full-spectrum recordings for sound pressure level characteristics.*
- Analyze full-spectrum recordings to measure multiple acoustic indices.*
- *(Requires Pro license)

Viewer/Metadata Panel

The Viewer provides audio and visual feedback of files for at-a-glance verification of data. The Metadata Panel is part of the Viewer and can be show or hidden. The Viewer and Metadata Panel can:

- View audio files as waveforms, full spectrum, and zero-crossing.
- Quickly review and manually verify automatic identifications.
- Add or edit metadata (e.g. field notes and manual classifications) to files.
- Listen to or save .wav files while applying band-pass filtering, speed, compressed mode, and amplitude adjustments.
- Take cursor measurements and view and log signal parameters.
- Analyze and export spectral data.

Cloud Storage

Kaleidoscope Pro introduces cloud-based data storage.

- Users can create or subscribe to a Wildlife Acoustics Managed Cloud Account.
- A Wildlife Acoustics Managed Cloud account provides convenient, fast, and safe storage and access for large amounts of data.
- Users can set up their own AWS account and S3 bucket, which can be accessed by Kaleidoscope Pro 5.
- Cloud accounts can be shared among multiple users for cross-collaboration. A Managed Cloud Account is highly secure and private, unless the user specifically allows data to be shared.

Cloud-Based Computing

Kaleidoscope Pro can take advantage of cloud-based computing for batch processes. This requires a Wildlife Acoustics Managed Cloud Account.

- When connected to a Wildlife Acoustics Managed Cloud Account, Kaleidoscope Pro has access to cloud-based computing for rapid handling of large-scale batch processing.
- Once the batch processed has been queued for cloud-based computing, the local computer can be taken off-line. When the cloud-based batch process is complete, the user will receive a notification email.

Database

Kaleidoscope Pro introduces searchable database functions. Kaleidoscope Pro can access a pre-configured database via a Managed Cloud Account. Kaleidoscope Pro can also access a user-managed PostgreSQL server and database.

- When batch processes are run or manual ID data is created, records of that data can be uploaded to the database.
- The database provides search functions to query records based on user-specified criteria.
- The database can reference full-spectrum and zero-crossing files that exist in a cloud account, on remote servers, and local drives.

1.3 Compatibility and Optimization

Kaleidoscope is software that is designed to run on most computers purchased within the last few years.

The latest update for Kaleidoscope is always available from <https://www.wildlifeacoustics.com/account/downloads/kaleidoscope>

Minimum Computer Requirements

The computer should have at least 8 GB RAM memory for minimum operation of Kaleidoscope. 16 GB or more is recommended, especially for higher function tasks such as cluster analysis.

- Windows - Minimum OS Win 7
When installing on Windows, choose Install for All Users when prompted.
- Mac – Minimum OS 10.8
After download move the Kaleidoscope app to the Applications folder
- Linux – Red Hat Enterprise Linux 7, x86_64 required
First download and install the wxWidgets libraries, then the Kaleidoscope executable.

On Linux platforms, the wxWidgets shared libraries are installed in `/usr/local/lib` and Kaleidoscope is installed in `/usr/local/bin`.

Be sure to add `/usr/local/lib` to `LD_LIBRARY_PATH`. To build, `cd wxWidgets-3.0.2; mkdir build-gtk; cd build-gtk; ./configure --with-gtk; make; make install`.

Also install the following files:

`openssl-1.0.2k`

`libcurl-7.53.1`

`libxml2-2.9.4`

`postgresql95`

- Linux – Ubuntu 18 amd64
Install the following prerequisites:
`libfftw3-single3`
`libxml2`
`libpq5`
`libcurl4`
`libgtk.0-0`
`libc6`
Install `Kaleidoscope.deb`
- Linux – Debian 9 amd64
Install the following prerequisites:
`libfftw3-single3`
`libxml2`
`libpq5`
`libcurl3`
`libgtk.0-0`
`libc6`
Install `Kaleidoscope.deb`

Note: There are competing frameworks for audio playback under Linux. Older distributions use OSS and newer distributions use ALSA. Kaleidoscope currently uses OSS which is not available by default on Debian and Ubuntu distributions. Therefore in order to get audio playback from Kaleidoscope, OSS is required. The link below describes how to run programs with OSS on Debian and Ubuntu distributions.

<https://help.ubuntu.com/community/alsa-oss>

CPU Optimization

Kaleidoscope can run multiple operations (threads) simultaneously during batch processing. This allows Kaleidoscope 5 to take full advantage of computers that implement multiple CPU cores. By default, Kaleidoscope will try to maximize efficiency by using a number of threads equal to the number of available cores, plus one. Memory usage will also grow proportionally with the number of concurrently processing threads.

The number of threads used by Kaleidoscope can be adjusted via the pull-down menu in the upper right corner of the Control Panel. This may be necessary on a machine with limited memory or CPU power available. It may also be desirable to lower the number of simultaneous threads if other tasks are running while Kaleidoscope is working in the background.

Drive Optimization

For general archiving, any type of data storage will work. The speed and efficiency of the drive that contains the input and output files will make a significant difference to the time it takes for Kaleidoscope to do batch processes. In general, the internal drive of the computer will provide the most reliable performance.

If an external storage medium is used, batch process performance may be adversely affected. For example, an SSD will always provide better performance than a USB thumb drive. If input files are initially stored on a slow external storage medium, copying the files to the internal drive of the computer before running the batch process may be required.

1.4 Data Management

Kaleidoscope is designed to process large amounts of data. Efficient management of data is an important part of the Kaleidoscope workflow.

Input Files

Acoustic recorders can create large amounts of data. Though Kaleidoscope can read directly from SD cards it is a good idea to copy the data to the computer's local drive. The internal drive of the computer will allow for much faster processing than if the data is read from an SD card. It is also a good idea to keep the original recordings stored in a safe place and use the copied data for processing in Kaleidoscope.

Output Files

Kaleidoscope can generate full-spectrum audio and zero-crossing output files. This happens when a batch process is run and WAV and or ZC files are checked in the OUTPUTS section under the Tab. Many operations in Kaleidoscope do not require creating audio or zero-crossing files on output. Creating these files takes time and takes up disk space. The user should be aware of whether the options for full spectrum audio (WAV and W4V) files and ZC (zero-crossing) files are checked or unchecked.



OUTPUTS

Output directory:
\\Home\Desktop\Results

Drive label (nickname) for database (optional):

Process all input channels Channel selection
None Create subdirectories
 Split to max duration, seconds

WAV (or W4V) files
 Split channels
None Compression
1 Time expansion factor

ZC files
8 Division Ratio
 8.3 file names
 11ba or instead of 778

Long Term Storage

Data can be safely stored on a variety of mediums. It is a good idea to physically label storage devices with at least the date the data was created.

It is possible to store data in the Cloud. Kaleidoscope Pro can upload data to a Cloud account. Uploading large amounts of data can be time consuming, so it is also possible for a user to send their storage medium directly to Wildlife Acoustics for fast upload. Contact support2020@wildlifeacoustics.com for further information.

For further information regarding how to upload data to a Wildlife Acoustics Managed Cloud Account via Amazon web services refer to the corresponding section of the Resources chapter in this user guide.

1.5 Included vs Licensed (Pro) Features

Kaleidoscope Lite includes a set of tools that are available for no charge. Kaleidoscope Pro provides additional features and capabilities which are licensed separately.

Throughout this user guide if a Kaleidoscope Pro license is required for a specific function, it will be noted.

Features Included with Kaleidoscope Lite

- Batch file format conversion.
- Isolation of detected signals within audio files, based on specified parameters.
- Filtering of Noise files caused by false triggers. (Bat Analysis Mode only)
- Extraction of metadata.
- Creation of manual IDs and notes.
- Addition and editing of field notes to output file metadata and meta.csv files.
- Viewer and Metadata Panel.
- Option to import MetaForms, which can then provide customized project forms and metadata output.

Features Enabled with Kaleidoscope Pro

- Automatic suggested species identification of bats for specific geographic areas.
- Cluster analysis.
- SPL analysis.
- Acoustic index analysis.
- Cloud storage and database functions.

Kaleidoscope Pro License Options

Wildlife Acoustics offers permanent licenses and yearly subscription licenses for Kaleidoscope Pro. For further information regarding license management refer to the Resources chapter in this user guide. Subscription licenses can be automatically added to a Wildlife Acoustics web account when purchased directly from Wildlife Acoustics. To do this, choose "Add to my cart" from within the Wildlife Acoustics web account.

Subscription licenses can also be provided as Subscription Credit Codes, which can then be manually added to a Wildlife Acoustics web account. For example if a Subscription license is purchased from the [WildlifeAcoustics.com Store](https://WildlifeAcoustics.com/Store), without logging in to an account, a Subscription Credit Code will be provided.

How to activate Kaleidoscope Pro on a Computer

- In order to activate Kaleidoscope Pro either a permanent license code or a subscription credit is required. The subscription credit must exist in a Wildlife Acoustics web account.
- Launch Kaleidoscope. Click on the **License** menu.
- If you are activating a subscription license choose **Activate annual subscription**.
 - A License Configuration window will open that asks for a Wildlife Acoustics log-in name and password. This window will also display the Installation ID number for the computer.
 - Enter the email address and password for the Wildlife Acoustics web account that has the subscription credit.
- If you are activating a permanent license choose **Install permanent or demo license**.
 - A License Configuration window will open that asks for an email address and License ID. This window will also display the Installation ID number for the computer.
 - Enter the email address and License ID from the Wildlife Acoustics sales invoice.
- Press the **Activate** button. If the computer is on line Kaleidoscope Pro will complete the license authorization process.
 - If the computer is not on line (or if there is some sort of firewall) Kaleidoscope will display a message describing that activation has failed.

- Write down the Installation ID number. Go on line from a computer that does have internet access. Log on to this address: <http://www.wildlifeacoustics.com/license-manager>
- On the License Manager web page enter the License ID from your invoice if you have a permanent or demo license. If you do not have a permanent or demo license leave this field blank.
- Enter your email address and Installation ID. Press **Activate**.
- The web page will provide a manual authorization number.
- Take the manual authorization number back to your off-line computer and enter it to the Kaleidoscope License Configuration window.
- Press the **Activate** button. Kaleidoscope Pro will now be authorized to run on the computer.
-

1.6 Launching Kaleidoscope For the First Time

The first time Kaleidoscope is launched, the application begins to create internal preferences. Kaleidoscope will open a series of windows for basic configuration of the software.

Software License Agreement

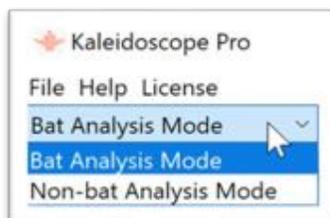
The first window to open is the **Software License Agreement**. This is a standard legal form that is required for use of a commercial software product. In order for Kaleidoscope to run, the user must press the **Agree** button. Once the user has accepted the agreement this window will not open again. To view a copy of the software license agreement after Kaleidoscope 5 has been initially configured, go to the Control Panel **License** menu and choose **Display licence agreement**.

Global Analysis Mode: Bats or Non-Bats

After the software license agreement, Kaleidoscope will display a window with the option to choose the analysis mode of the software. This window will not be displayed again unless Set Defaults is selected from the Control Panel File menu.

Kaleidoscope has specific settings and parameters that are appropriate to past and present conventions for recording of bats (e.g. time expansion and zero-crossing). These parameters are not suitable for the conventions used to analyze other types of audio recordings.

The analysis mode can also be changed at any time via the menu on the top left of the Control Panel.



Some of the Kaleidoscope features and settings are only available in one of these two modes. Controls for features that are not available for the selected mode are disabled and greyed out.

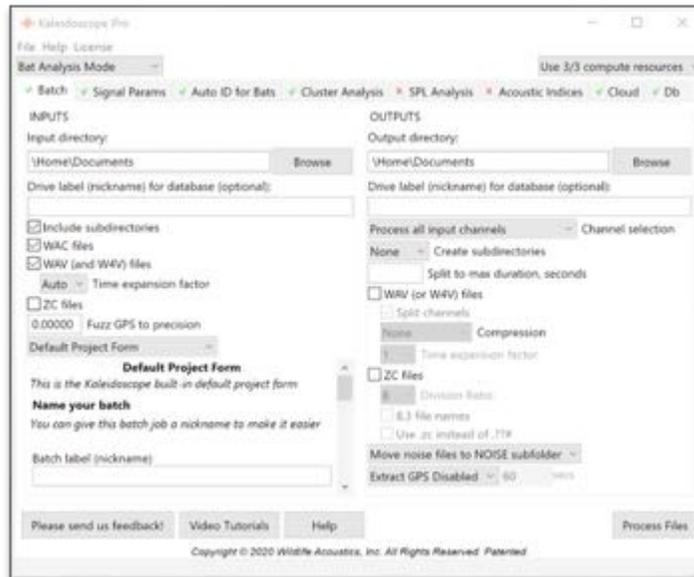
Upgrade to Pro

After selecting the initial analysis mode Kaleidoscope will open a window that mentions upgrading to the Pro version. There are two options:

- **Learn More** – Pressing this button will open a web browser to the Wildlife Acoustics website. The displayed page will describe the Pro features and provide options for upgrading to a Pro license. If the user does not want to upgrade or already has a Pro license, there is no need to select this option.
- **Dismiss** – Pressing this button will close the window and Kaleidoscope will now fully launch.

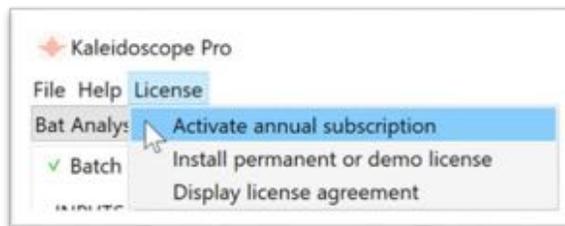
Control Panel

The Kaleidoscope Control Panel window will now open. The Control Panel is the central window for operation of Kaleidoscope. This where typical workflows with Kaleidoscope begin.



License Menu

To activate a Pro license, go to the Control Panel **License** menu and select **Activate Annual Subscription** or **Install permanent or demo license**.

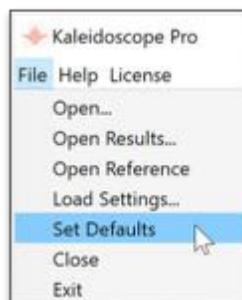


A **License Configuration** window will open asking for log-in information. Enter the required information and press the **Activate** button. Kaleidoscope Pro is now authorized to run on the computer. This will be verified by green checkmarks on the **Cluster Analysis** Tab, **SPL Analysis** Tab, **Cloud** Tab, and **Db** Tab in Non-bat Analysis mode, and by green check marks on the **Auto ID for Bats** Tab, **Cluster Analysis** Tab, **Cloud** Tab, and **Db** Tab in Bat Analysis Mode.



Set Defaults

Kaleidoscope can be reset to factory defaults. To do this go to the Control Panel File menu and select Set Defaults. When Set Defaults is chosen a window will appear to choose Bat Analysis Mode or Non-Bat Analysis Mode. After selecting a mode all parameters throughout the software will be reset to default values.



2 Typical Use Workflows

This chapter provides step by step instructions for typical workflows using Kaleidoscope. Kaleidoscope can be used for many different tasks and in some cases it's helpful to focus only on the functions required for a specific job. The purpose of the Typical Use Workflow descriptions is to walk the user through the primary tasks needed for each type of workflow situation. Some functions of Kaleidoscope require a Pro license. If a Pro license is required, that will be noted in the workflow description.

For additional information on any specific function of Kaleidoscope check the Reference Guide and Resources chapters in this user guide.

It is recommended to read through the Getting Started chapter in this user guide for basic familiarity with the software and for any required installation and setup assistance.

2.1 Batch File Processing and Conversion

During a batch process, input files can be analyzed and further processed for output. This workflow description will focus on the basic methods of batch processing, file conversion, and metadata extraction and editing.

Overview

Kaleidoscope is designed to process or convert one or more input files as a batch. Input files can be either full-spectrum or zero-crossing recordings.

Kaleidoscope can convert files from one format into another.

Kaleidoscope can split larger files into smaller file segments.

Metadata is extracted from the input files and used to create a meta.csv output file. Metadata can be edited and added to .csv files and wav/zc output files generated by the batch process.

The basic steps for batch file processing and conversion include:

- Select the input file directory.
- Select input file types to be included in the batch process.
- Select the output directory for converted audio files and data files.
- Select file types and options for output.
- Select any analysis options.
- Run the batch process.

Configure Input Options

Kaleidoscope is optimized to work with large numbers of files. Typically, full-spectrum and zero-crossing files are stored in directories on a hard drive or network storage device. The speed and efficiency of the drive that contains the input files will make a significant difference to the time it takes to complete the batch process. In general, the internal drive of the computer will provide reliable performance. If an external storage medium is used, batch process performance may be adversely affected. For example, an SSD will always provide better performance than a USB thumb drive. If input files are initially stored on a slow external storage medium, copying the files to the internal drive of the computer before running the batch process may be required.

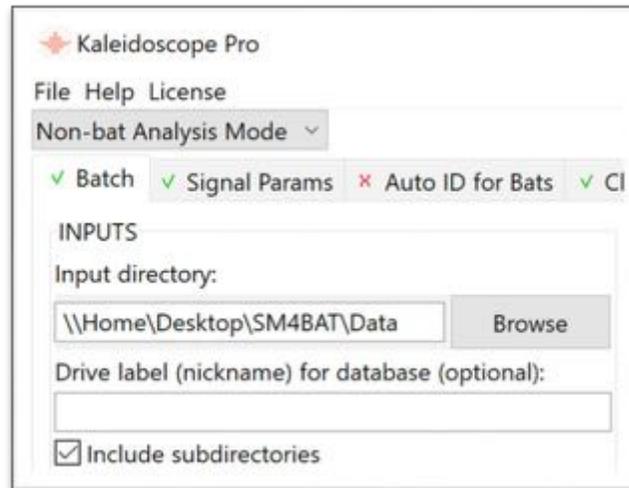
Select Input Files Directory

The first step of batch conversion or processing is to select the directory for the input files.

- Click the **Browse** button.

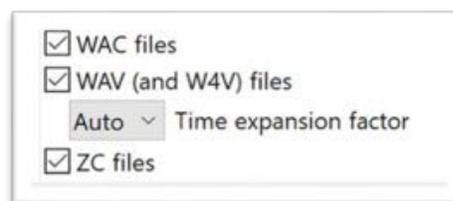
This will open a window that allows navigation to the folder that contains the files to be processed and converted. The browse function does not select any individual file. The browse function selects the directory or folder that contains the input files. When this directory is highlighted click **Select Folder** (Windows) or **Open** (Mac). The input directory path is now displayed to the left of the **Browse** button.

- In some cases, input files may be organized into subfolders within the main directory. Kaleidoscope can process subfolders and can preserve the directory structure on output. Check the box to **Include subdirectories** to enable this option. If this option is unchecked Kaleidoscope will not process any files in subdirectories.



Select Input File Types

- Four different file types can be selected for processing and/or conversion. If a file type is not selected in the **INPUTS** section, any files of that type will not be processed or converted. Check the boxes for the files to be processed.
 - WAC files** are compressed full-spectrum audio files. This file type can be created by the Wildlife Acoustics SM2 and SM3 recorders.
 - WAV files** are full-spectrum audio files.
 - W4V files** are compressed full-spectrum audio files. This file type can be created by the Wildlife Acoustics SM4 and SM4BAT FS recorders.
- WAV can initially be recorded with a time expansion factor. (Note: Wildlife Acoustics recorders do not record time-expanded files.) Kaleidoscope needs to know if any time expansion has been applied to the input files before any batch processing is applied. The time expansion factor for the input files can be configured manually or the parameter can be set to **Auto**.
Setting the **Time Expansion factor** to **Auto** will cause Kaleidoscope to check the metadata and sample rate to automatically set the time expansion factor for the batch process. A time expansion setting of **1** indicates that no time expansion has been applied to the original file. WAV files from all Wildlife Acoustics recorders are not time expanded and choosing 1 or AUTO is appropriate for these files.
- If any zero-crossing files are to be included in the batch process, check the **ZC files** box.



Additional Input Options

Input files may contain additional information known as metadata. Metadata could include information such as recorder hardware information and the time and GPS location of the recording. It is also possible to add metadata to a file during batch processing.

- If there is GPS location information in the input file it is possible to include that information in the processed output file. It is also possible to obscure the GPS information so the exact location of the recording is not preserved in the output file. **Fuzz GPS to Precision** is used to obfuscate GPS location information in the metadata from input to output. The value of the Fuzz is precision in degrees that the GPS location is rounded to. For example: A Fuzz value of 1.0 means if the original GPS location is 42.365842 N 71.964281 W, that will be rounded up on output to 42.0 N 72.0 W. If fuzz value is 0.25, that would round to 42.25 N 72.00 W.



- Kaleidoscope provides a form for adding or editing metadata within processed files. A **Default Project Form** is provided to add standardized information to output files. The Pro version of Kaleidoscope also allows selection of a custom project form to add metadata to the output files.

Configure Output Options

When Kaleidoscope runs a batch process it will create a variety of output files. Output files can include full-spectrum audio files, zero-crossing files, .csv files, and proprietary files that are used by Kaleidoscope for additional configuration and processing functions.

Select Output Directory

- Clicking the **Browse** button will open a window that allows navigation to the folder or directory that will contain the output files from the batch process. If the output folder does not yet exist, it can be created via the Browse window.
 - The output directory folder **Can not** be the same as the input directory folder. The output directory must be a separate folder.
- The output directory path is displayed to the left of the Browse button.

Channel Selection

If stereo (two channel) files are included in the INPUTS section, this menu determines whether just the left, just the right, or both channels will be processed to the outputs.

Specify Subdirectories

- If **Include Subdirectories** is checked in the INPUTS section, those subdirectories will be kept intact in the output directory. Subdirectories will only be created if Kaleidoscope generates full-spectrum audio or zero-crossing files on output.
- There is an additional option in the **OUTPUTS** section to **Create subdirectories** for the output files based on timestamps.
 - The **Daily** option creates subfolders based on the daily calendar time stamp from the original recording.
 - The **Nightly** option creates subfolders based on noon-to-noon time periods.

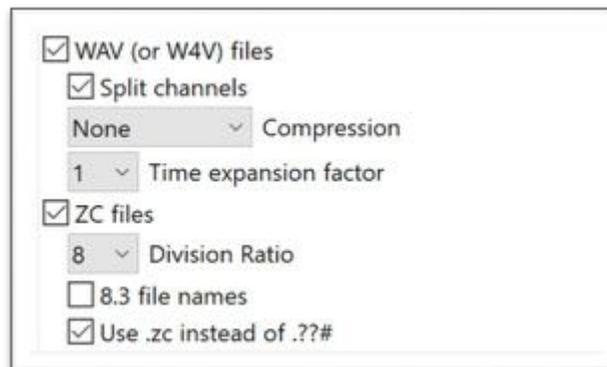
[Split to max duration, seconds](#)

- Split larger files into smaller file segments.

Split to max duration, seconds

Specify Output File Types

- Check **WAV (or W4V) files** to include these file types in the output batch. If no compression is applied the output files will be .wav format. If file compression is applied on output the output files will be .w4v format. It is not recommended to convert ZC input files to .WAV output files.
- If input files are dual channel they can be split to separate files based on channel by checking **Split Channels**.
- WAV files can be compressed to smaller file sizes to save storage space. If the **Compression** menu is set to **None**, no compression is applied. If a compression percentage is applied in the menu, output file size will be reduced by the specified amount. For example, a file compressed by 75% will be 25% of its original size. As a file is compressed it loses some data resolution. Smaller amounts of file compression will result in less loss of data. Higher amounts of compression will result in more loss of data.
- In Bat Analysis Mode only, WAV and W4V output files can be created with a time expansion factor. If the **Time Expansion factor** is set to **1**, no time expansion is applied to the output file.
- In Bat Analysis Mode only, check **ZC files** to create zero-crossing files on output.
 - There are additional options for zero-crossing files.
 - The **Division Ratio** of the file can be set to **4, 8, or 16**.
 - Zero-crossing files can be constrained to using the **8.3 file names** convention.
 - The original file name format for zero-crossing files uses the name extension .??#. There is an option to **Use .zc instead of .??#** for the file name extension.



Configure Signal Parameters

For basic batch processing in Bat Analysis Mode, it is possible to analyze input files and separate files of interest from files that are then designated as Noise. Signal parameters are also used for Auto ID for Bats and for Cluster Analysis. If none of these three functions are being used, the signal parameter settings make no difference to Batch processing. Signal parameters are configured under the **Signal Params** Tab in the Control Panel. For additional information regarding settings see the [Signal Params](#) Tab section in this user guide.

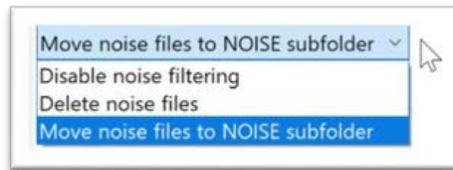
Configure Noise Extraction Options

Isolation of Noise Files

When running a batch process in Bat Analysis Mode, Kaleidoscope Pro can analyze input files based on the settings described under the Tab. Files that do not contain useable bat calls can be caused by false triggers. These files can be isolated as noise files. There are three options for files that have been designated as noise files.

- **Disable noise filtering**
 - No noise filtering is applied to input files.
- **Delete noise files**
 - If full-spectrum or zero-crossing files are created in the batch process, any files that are designated as noise are discarded from the output batch. This is not a recommend option for typical use.
- **Move noise files to NOISE folder**

If full-spectrum or zero-crossing files are created in the batch process, A NOISE folder is created in the output directory and any output files that are designated as Noise are placed in that location. If full spectrum or zero crossing files are not created in the batch process, a NOISE folder will not be created in the output directory.



When a batch process is run using Auto ID for Bats The results of the noise designation are written to the id.csv file which is created in the output directory.

Configure GPS Extraction Options

Extraction of GPS data

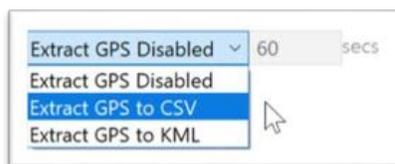
Kaleidoscope can extract GPS information from metadata in input files (as long as the data is present in the file).

The GPS information can then be written to a gps.csv or gps.kml file during a batch process.

Any GPS metadata in the input files will be passed through to full-spectrum or zero-crossing output files that are created in the batch process.

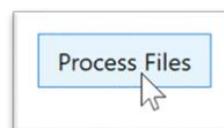
The precision of the GPS data in the output file is determined by the **Fuzz GPS to precision value** in the **INPUTS** section. The Fuzz function will lower the resolution of the GPS data written to output files, to obscure the exact location of the recording. There are three options for GPS data extraction:

- **Extract GPS Disabled** – No GPS data is extracted from inputs files.
- **Extract GPS to CSV** – GPS data found in the metadata of input files is extracted and used to create a gps.csv file in the output directory. Columns are created for **DATE**, **TIME**, **LAT**, **LONG**, and **NAME**, where **NAME** is the filename of the corresponding output file or blank for waypoints. If waypoints are available (e.g. in a .WAC file), the frequency of waypoint extraction can be specified in seconds.
- **Extract GPS to KML** - GPS data found in the metadata of input files is extracted and used to create a gps.kml file in the output directory. The KML file can be opened directly from Google Earth and will display a placemark corresponding to each output file. If waypoints are available (e.g. in a .WAC file), the frequency of waypoint extraction can be specified in seconds and are represented as a path in the KML file.



Run a Batch Process

Once input and output options have been configured press the **Process Files** button. A **Processing Files** window will open to show the status of the batch. Once the batch process has been completed the **Processing Files** window will close.

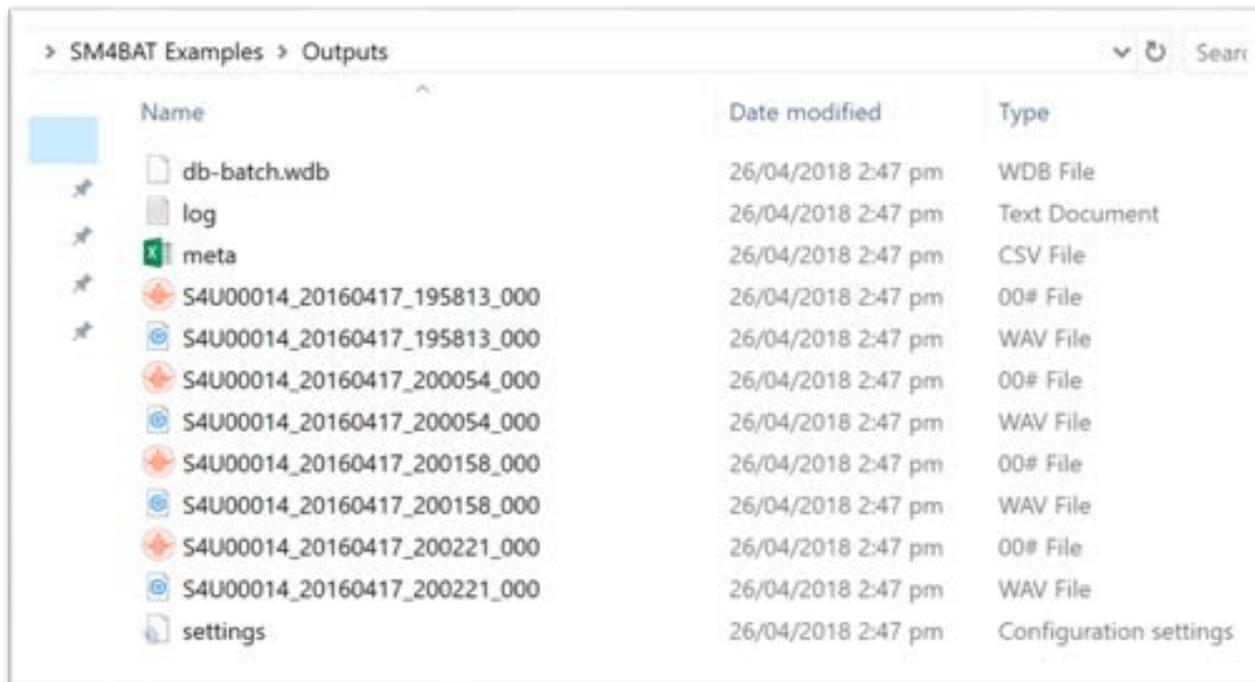


If the input and output directories are located in a Managed Cloud Account, the batch process can be run on the local computer or via Cloud-based computing. For further information regarding Cloud-based computing refer to the [Cloud](#) Tab section in this user guide.

Check the Output Files

Open the output directory folder. The output directory will now contain any WAV, W4V, or zero-crossing files specified by the batch process. The output directory will also include a **db-batch.wdb** file, a **settings.ini** file, a **log.txt** file, and a **meta.csv** file. The meta.csv file can be opened in a spreadsheet application.

If GPS extraction, Auto ID for Bats, Cluster Analysis, SPL Analysis, or Index analysis has been applied during the batch process, additional .csv files containing analysis data will also be created.



Name	Date modified	Type
db-batch.wdb	26/04/2018 2:47 pm	WDB File
log	26/04/2018 2:47 pm	Text Document
meta	26/04/2018 2:47 pm	CSV File
S4U00014_20160417_195813_000	26/04/2018 2:47 pm	00# File
S4U00014_20160417_195813_000	26/04/2018 2:47 pm	WAV File
S4U00014_20160417_200054_000	26/04/2018 2:47 pm	00# File
S4U00014_20160417_200054_000	26/04/2018 2:47 pm	WAV File
S4U00014_20160417_200158_000	26/04/2018 2:47 pm	00# File
S4U00014_20160417_200158_000	26/04/2018 2:47 pm	WAV File
S4U00014_20160417_200221_000	26/04/2018 2:47 pm	00# File
S4U00014_20160417_200221_000	26/04/2018 2:47 pm	WAV File
settings	26/04/2018 2:47 pm	Configuration settings

2.2 Bat Identification

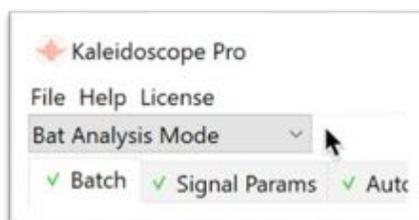
Kaleidoscope provides three basic techniques for sorting, isolation, and identification of bat calls in input files.

- Full-spectrum and zero-crossing files can be viewed and auditioned for manual identification. This does not require a Pro license.
- Kaleidoscope Pro can use an Auto ID function to attempt to identify specific bat species.
- Kaleidoscope Pro can use Cluster Analysis to isolate and group similar bat calls.

With all three techniques it is possible to add manual IDs to the output file metadata and to a separate .csv file.

For any type of identification of bats, the first step is to run a batch process. It is not required that any full-spectrum or zero-crossing output files are created during the batch process in order for Kaleidoscope to analyze input files. Creating full-spectrum or zero-crossing output files does allow additional metadata to be written to those files.

Bat calls are generally high-frequency, narrow-band, ultrasonic signals. Additionally, bat analysis mode enables a number of legacy protocols used by bat researchers over the decades before high-speed full-spectrum recording was possible. This includes support for zero crossing and time expansion. For broadband analysis, even in ultrasonic frequencies, non-bat analysis mode is preferred. When doing work with bat calls Kaleidoscope should be in Bat Analysis Mode.

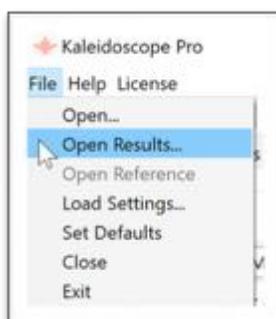


Run the Batch Process

- Select the input directory for the source files.
- Select the types of files to be analyzed.
- Select the output directory.

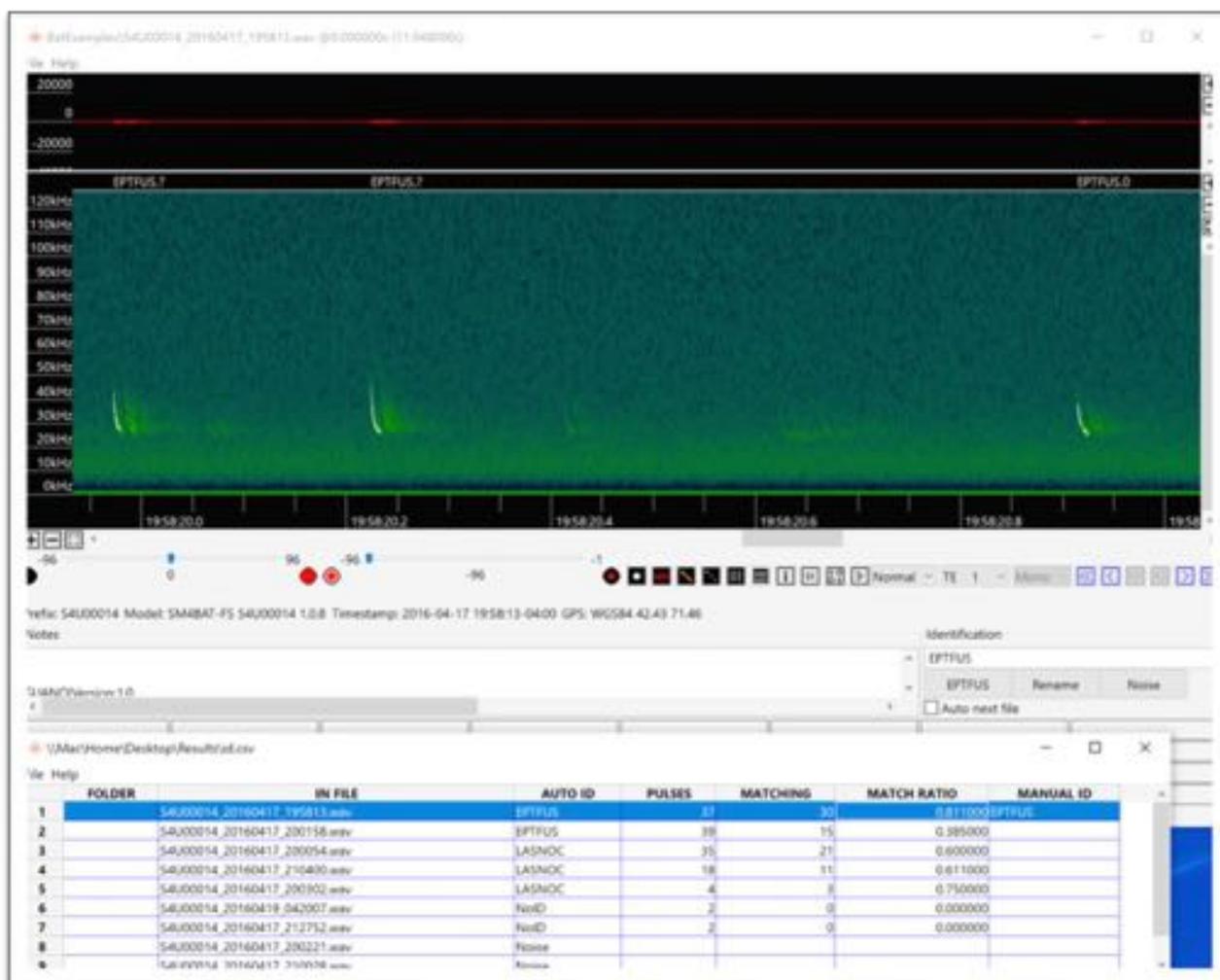
If the input and output directories are located in a Managed Cloud Account, the batch process can be run on the local computer or via Cloud-based computing. For further information regarding Cloud-based computing refer to the [Cloud](#) Tab section in this user guide.

- [Set any option for file segmentation.](#)
- Select any desired options for output file formats.
- Select any desired Noise and GPS options for the output batch.
- In Kaleidoscope the only additional options that will have any effect on bat identification are the signal parameters used for isolating files that are then designated as noise. Configure signal parameters under the Signal Params Tab in the Control Panel. For additional details on configuring settings refer to the [Signal Params](#) Tab section in this user guide.
- Press the **Process Files** button to begin the batch process. If the processing is being done on the local computer, the **Processing Files** window will open. When the Processing Files window closes the batch process is complete and the Viewer window and Results window will open automatically.
- If Kaleidoscope is quit or the Viewer or Results windows are closed, go to the Control Panel **File menu->Open Results...** Navigate to the output directory and select the **id.csv** file. The Viewer will open to display the first file listed in the batch. A Results window that lists all files in the batch will also open.



Add Manual IDs

- The first file of the batch will be loaded into the Viewer.
- Use the Viewer to visually confirm bat species. This requires basic expertise in identifying bats from their echolocation calls.
- The Metadata Panel at the bottom of the Viewer allows for input of manual IDs and notes.
- For additional information on how to use the Viewer and Metadata Panel refer to the Viewer section of the Reference Guide chapter in this manual.
- If output files have been created, manually designating a file as Noise will move that file to the NOISE folder in the output directory.
- After manual IDs have been added to the Results window, go to the Results window **File menu->Save**. This will update the id.csv file that has been created in the output directory.
- The edited id.csv file can also be opened in a spreadsheet application.



2.3 Auto ID for Bats

A Kaleidoscope Pro license is required to enable the Auto ID for Bats function.

When running a batch process, Kaleidoscope Pro can compare the recorded signals in input files to a [built-in reference library of known bat recordings](#).

Kaleidoscope Pro can make a determination as to the closest match between the input file and the reference files.

Auto-ID is intended for use in analyzing recordings of single bats in free flight in low clutter environments. Recordings of roost emergence, multiple or captive bats, bats in high clutter environments, or bat social calls are generally not suitable for Auto-ID. In addition, the Auto-ID feature does not include every possible bat for each of the covered regions. Therefore, if a bat that is not included is recorded, it may be identified as a species with a similar echolocation call type.

The best use of Auto ID is to do automatic sorting and classification first, and then follow up with manual verification of the files. Even if Kaleidoscope Pro makes false positive identifications it will have done a great deal of work sorting files to speed up the overall process of identification.

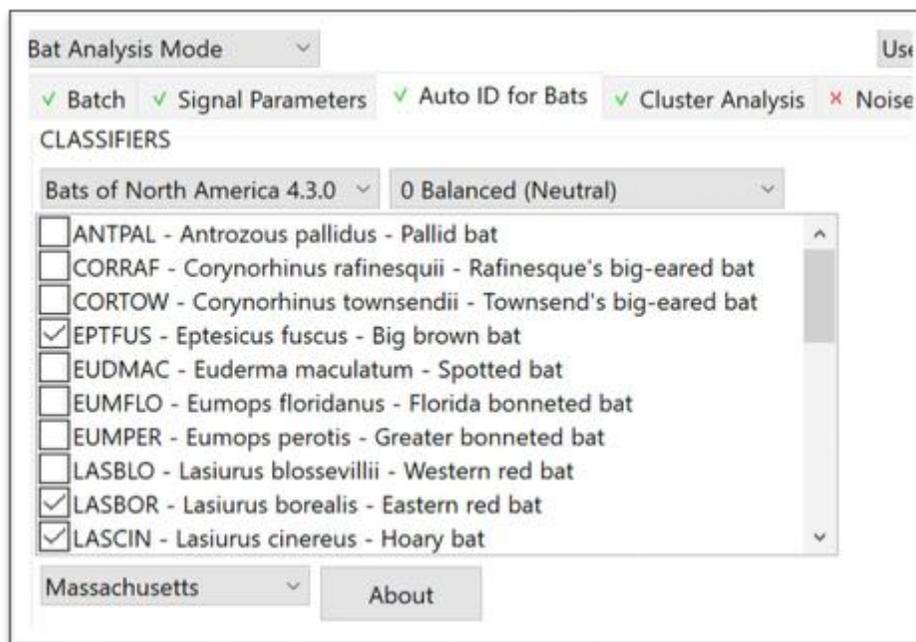
Because bats vary their echolocation calls in response to a wide variety of circumstances, no automated call identification can achieve 100% accuracy in species identification. **These automated identifications, though largely accurate, should not be relied on solely as a basis for scientific research or land management decisions. The automatic identification function is intended only as a suggestion to facilitate analysis, not to replace human expert vetting of calls.**

Configure Signal Parameters

Kaleidoscope Pro relies on settings under the **Signal Params** Tab to determine if a file contains the correct information to represent a bat call in the recording or if that recording is to be designated as noise. Signal parameters are critical to getting the best results with Auto ID. For additional information on settings refer to the [Signal Params](#) Tab section in this user guide.

Enable Auto ID for Bats

- Click on the **Auto ID for Bats** Tab in the Control Panel.
- Click on the **Disabled** menu and choose a classifier based on geographic area. This will display a list of bats commonly found in that area.
- Click on the **Select by region** menu and select a region within the geographic area. This will limit the classifiers to species typically found in the selected region. Listed species can be manually enabled or disabled to further refine the Auto ID process.
- There are three levels of sensitivity for the Auto ID function. Click on the menu to choose:
 - **-1 More Sensitive (Liberal)** – This will produce more identifications but at the risk of more false positives
 - **0 Balanced (Neutral)**
 - **+1 More Accurate (Conservative)** – This will produce less identifications and will tend to have more accurate identifications.



Run the Batch Process

- Select the input directory and the types of files to be analyzed.
- Select the batch output directory.
- Select any additional options for output file types.
- Select any noise and/or GPS extraction options for the output batch.

- Press the **Process Files** button to begin the batch process.

If the batch process is run on the local computer, A **Processing Files** window will open to show the status of the batch. Once the batch process has been completed the Processing Files window will close.

The Viewer and Results window will now open automatically.

If the input and output directories are located in a Managed Cloud Account, the batch process can be run on the local computer or via Cloud-based computing. For further information regarding Cloud-based computing refer to the [Cloud](#) Tab section in this user guide.

Use the Viewer to Manually Confirm IDs

- The first file of the batch will be loaded into the Viewer.
- Auto ID results for individual pulses will be displayed in the Viewer.
- Auto ID for the pulse sequence is also displayed.

Kaleidoscope Pro looks at individual pulses and sequences of pulses. Each pulse is compared to the reference data for the classifiers that have been selected under the **Auto ID for Bats** Tab. When individual pulses are identified they are labelled with a species type. The species type is followed by a number or a question mark. The number represents which pulse in the reference data most closely matches the pulse that has been analyzed. If there is a question mark after the species name, that indicates the pulse did not match any of the common reference data but is most likely to belong to that species.

If Kaleidoscope Pro was not able to find a reference match to a specific pulse, no auto-ID label will be applied.

Kaleidoscope Pro then looks at the overall sequence of pulses and makes a single species ID. Pulses that belong to the sequence ID are highlighted. If there are pulses that do not match the overall sequence ID, they will not be highlighted.
- The Metadata Panel at the bottom of the Viewer allows for addition of manual IDs.

Under the Identification section, type in any text and press the Return key to add a manual ID to the metadata.

The Auto ID of the pulse sequence will be listed in a button. Press the button to confirm the Auto ID as a manual ID.

Press **Rename** to rename the actual underlying zero-crossing or full spectrum file

Press the **Noise** button to designate the file as noise. If full-spectrum or zero-crossing files have been created during the batch process, manually designating a file as Noise will move that file to the NOISE folder in the output directory.

Check the **Auto next file** button to automatically advance to the next file after a manual ID has been assigned.

At the bottom of the Metadata Panel there are 32 buttons. These buttons can be used to assign manual IDs. Right click on a button and type to add text which can then be added as metadata when the customized button is pressed.

Go to the Viewer File menu and choose **Load Labels**. This will load the species IDs from the classifiers that have been specified under the **Auto ID for Bats** Tab as button labels.

For additional information on how to use the Viewer and Metadata Panel refer to the Reference Guide chapter in this user guide.
- From the Results window go to the File menu and choose **Save**. This will update the underlying id.csv file that was created in the output directory during the batch process. If full-spectrum or zero-crossing files were created during the batch process, their metadata will also be updated.

Check the id.csv and idsummary.csv Files

When an Auto ID for Bats batch process is run, specific files are created in the output directory that contain information regarding the Auto ID Analysis. These .csv files can be opened in a spreadsheet application.

Output Summary file (idsummary.csv)

- The idsummary.csv file is created when an Auto ID for Bats batch process is run.

- The idsummary.csv file contains an overall summary of the batch classification.
- For further information regarding the idsummary.csv layout refer to the Resources chapter in this user guide.

Output Identification file (id.csv)

- The id.csv file is created when an Auto ID for Bats batch process is run.
- The id.csv file has a data row for each analyzed file.
- The id.csv file can be updated with manual ID reviews.
- For additional information regarding the id.csv layout refer to the Resources chapter in this user guide.

2.4 Cluster Analysis and Classifiers

A Kaleidoscope Pro license is required to enable the Cluster Analysis function.

Cluster analysis is a process where audio files are examined and “signals of interest” are isolated. The clustering process then sorts similar detected signals based on a set of parameters. This allows large amounts of audio recordings to be searched for specific sounds.

There are two ways to use cluster analysis. Basic cluster analysis is a first step in which detected signals are compared to each other for similarity. In many cases, basic cluster analysis is all that is needed to complete the task at hand.

Basic cluster analysis can be enhanced by the building of simple or advanced classifiers. The purpose of the classifier is to be a custom filter which isolates and names specific sounds within audio files. Simple or advanced classifiers rely on the best possible results from the initial basic cluster analysis.

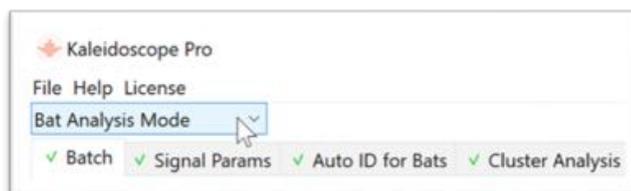
- When performing a cluster analysis batch process, Kaleidoscope Pro examines input files for signals of interest as described under the **Signal Params** Tab.
- Detected signals are analyzed for similarity and then grouped into clusters. This is basic clustering. Basic clustering is useful for general surveying of species, and variations of vocalizations within species.
- A “cluster” is a mathematical model of an acoustic pattern.
- Clusters can be manually labelled. A simple classifier can be created based on the results of a basic cluster analysis process. The simple classifier can then be used to analyze new recordings to find and label detected signals as defined by the classifier.
- It is possible to build advanced classifiers that are manually trained to further isolate specific vocalizations or sounds. An advanced classifier is designed to eliminate as many false positive identifications as possible. An advanced classifier is not useful for general species survey.
- Tips for tuning basic cluster analysis and classifiers are included at the [end of this section](#).

Basic cluster analysis works the same for any type of animal, including bats. Advanced classifiers are generally not useful for bat calls.

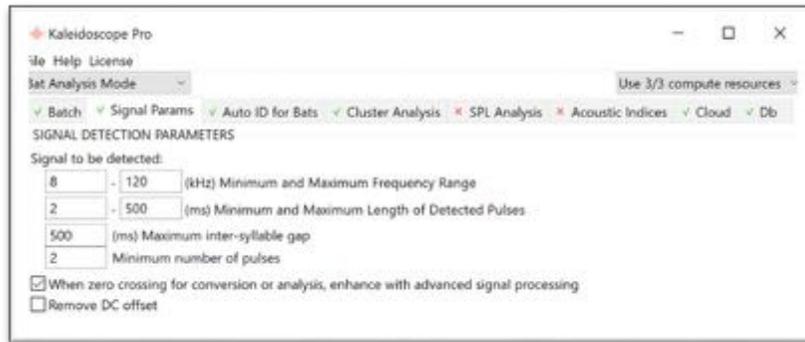
Because bat calls are generally in the ultrasonic range, there are separate signal parameters for bat analysis mode or non-bat analysis mode. Make sure Kaleidoscope Pro is in the correct mode for the frequency range of the files to be analyzed.

Cluster Analysis for Bats

- Select **Bat Analysis Mode** in the upper left of the Control Panel.

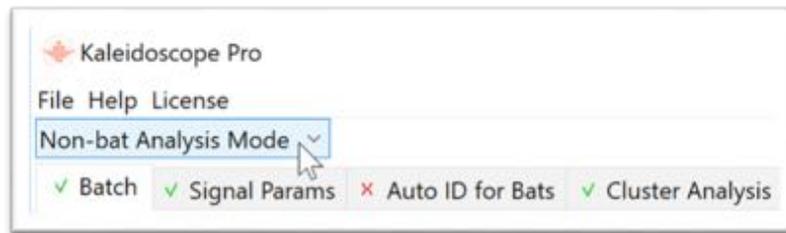


- In Bat Analysis Mode there are specific settings to be made under the **Signal Params** Tab. In general, the default settings are a good place to start. These settings are critical to getting good results from the cluster analysis. The signal parameters define if an input file contains a detected signal. Once a detected signal is identified, it is passed on to the cluster analysis function. If input signals are outside the ranges of the signal parameters, they will not be considered for cluster analysis. For additional information on settings refer to the [Signal Params](#) Tab section in this user guide.



Cluster Analysis for Birds and Other Animals

- Select **Non-bat Analysis Mode** in the upper left corner of the Control Panel window.



- In Non-bat Analysis Mode there are specific settings to be made under the **Signal Params** Tab. These settings are critical to getting good results from the cluster analysis. The signal parameters help define if an input file contains a detected signal. Once a detected signal is identified it is passed on to the cluster analysis function. If input signals are outside the ranges of the signal parameters, they will not be considered for cluster analysis. For additional information on settings refer to the [Signal Params](#) Tab section in this user guide.



Basic Cluster Analysis

The first time a cluster analysis batch process is run, Kaleidoscope Pro scans the input recordings and compares the audio content to the designated settings listed under the **Signal Params** Tab. Based on the audio content and signal parameters, detected signals are created.

A detected signal is defined by its position relative to the start of the audio file, and the duration of the detection. When the detection is displayed in the Viewer, additional audio "padding" is applied at the beginning and end of the detection (unless the detection is at the very beginning or very end of the audio file). The length of the padding is determined by the **Maximum inter-syllable gap** as described under the **Signal Params** Tab.

A single audio file may contain many separate vocalizations or specific acoustic patterns. Therefore, multiple signals or vocalizations can be detected within a single recording. These detected signals will be processed separately and listed separately in the Results window. Once a detected signal has passed through the parameters under the **Signal Params** Tab, it is passed to the Cluster Analysis module.

- The Cluster Analysis module first does a spectral analysis for each detected signal.
- The spectral models for all detected signals are compared to each other, and a single "cluster center" is created. This is the mathematical average of all the detected signals. This initial cluster center will represent the first cluster listed in the Results window.

- Detected signals are then compared to the initial cluster center.
- Detected signals which are close enough to the cluster center are assigned to the first cluster.
- The **TOP1DIST** column in the Results window shows how close the detection is to the cluster center. Initially, the detections are sorted within their clusters by distance from the cluster center (**TOP1DIST**). The shortest distance represents the detected signal most similar to the cluster center.
- Under the **Cluster Analysis** Tab the **Max distance from cluster center to include outputs in cluster.csv** specifies the distance from the cluster center at which detected signals will no longer be included. The default setting is 1, which will exclude outlier detections which exceed that distance from the cluster center.
- When the similarity of the detected signals to the cluster passes a threshold, the next cluster will be created. The next cluster is the most similar to the preceding cluster.
- Detected signals which are most similar to the next cluster are assigned to that cluster.
- A detected signal will only be present once in the Results window. A detected signal can not be assigned to more than one cluster.
- Clusters are initially named, starting with cluster.000, cluster.001, cluster.002 and so on.
- When numbering clusters, Kaleidoscope assigns the label cluster.0 to the cluster with the largest membership e.g. the most commonly occurring pattern in the data. The first cluster is the most similar to the overall average of all detected signals.
- A detected signal may have a similarity to more than one cluster. In the cluster.csv file (and also available for display in the Results window), there are columns for **TOP2MATCH** and **TOP3MATCH**, as well as their related **TOP2DIST**, and **TOP3DIST** columns. This allows a detected signal to be compared to more than one cluster for similarity.
- Clusters following the first cluster are based on similarity to the previous cluster. The second named cluster in the list is most similar to the first. The last cluster on the list is the least similar to the first.
- In this way the clusters are numbered spiraling outward (in hundreds of dimensions) in order of similarity to earlier clusters. For example, there may be several numbered clusters in a row that are similar to each other e.g. subtle variations of the same type of vocalization. But in multiple dimensions, the spiral might jump to a different vocalization/cluster and then back again.
- Some detected signals may contain a single syllable or phrase from a single species. Other detected signals may contain multiple syllables from the same species. Some detected signals may contain syllables or phrases from multiple species. The purpose of creating clusters is to sort similar detected signals, based on their acoustic patterns, into groups for easy manual identification.
- Cluster analysis requires enough input files to provide adequate information for creation of meaningful data clusters. If a batch process is run with too few input files, Kaleidoscope Pro may display a message that no clusters have been found.
- Cluster analysis requires a statistically significant number of similar detections in order to create a cluster. If an acoustic signature is rare in the input data, it may not be statistically significant enough to form a cluster. If this is the case, raising the **Max distance from cluster center to include outputs in cluster.csv** value may help include the rare detection in an existing cluster. A maximum setting of 2 will force all detected signals to be included in clusters.

Run a Basic Cluster Analysis Batch Process

- Under the **Batch** Tab, select the input directory for the files to be analyzed.
- Select an output directory.
- If full-spectrum audio files or zero-crossing files have been specified for the batch output, those files will be created in the output directory. It is important to know that creating full-spectrum or zero-crossing files in the batch process is **not** required in order to do cluster analysis. Unless there is some other need for converted output files, Make sure WAV and ZC files are unchecked in the Output section under the **Batch** Tab. This will save storage space and processing time.
- Check the correct mode is selected in the Control Panel for Bat Analysis or Non-bat Analysis.
- Click on the **Cluster Analysis** Tab in the Control Panel.
- Click on the **Disabled** menu and choose **Scan and cluster recordings to create cluster.kcs and cluster.csv**
- Press the **Process Files** button to begin the analysis.
- When the batch process is complete the Viewer and Results window will open.

When the batch process is complete, a cluster.csv file is created in the output directory listing all the detected signals and their cluster membership. The cluster.csv file is represented by the Results window, and can also be opened by other spreadsheet applications.

A cluster.kcs file is also created. This file is used by Kaleidoscope Pro, and is the “classifier”. The cluster.kcs file contains mathematical models of the clusters. The cluster.kcs file can be further customized and used as a simple or advanced classifier to sort new data.

Use the Viewer and Results Window to Examine Vocalizations and Clusters

- The Results window will display the detected vocalizations and their cluster membership.
- By default, the clusters will be listed in order, starting with the highest number of similar vocalizations. Subsequent clusters will be the most similar to the preceding cluster
- By default, the Results window will list the detected vocalizations in order of their distance to their cluster center. Distance to cluster center for each detected signal is displayed in the **TOP1DIST** column.
- The first vocalization from the first cluster will initially be initially displayed in the Viewer. This detected vocalization represents the most common acoustic pattern found in the input recordings (based on the current signal parameters and cluster analysis parameters).
- The  button will play the currently visible detected vocalization through the computer speakers.
- The  and  buttons in the Viewer change the view to the previous or next detected vocalization in the Results window. If the Results window is front-most, the up and down arrow keys on the computer keyboard will display the next or previous detected signal.
- The  and  buttons in the Viewer (or Shift-Up Arrow or Shift-Down Arrow keys in the Results window) will jump to the previous/next row in the results table based on the most recently sorted column. By default these buttons will jump to the next or previous cluster.
- Individual detections can be selected in the Results window and exported as WAV files. This is done from the Results window File menu.
- For additional information on how to use the Viewer and Metadata Panel refer to the [Viewer](#) section in this user guide.
- For additional information regarding the Results window refer to the [Results Window](#) section in this user guide.

At this point Kaleidoscope Pro has done a basic clustering of the detected vocalizations within the input files. If the goal is a simple scan of data for the purpose of presence/absence verification, this may be all that is required.

Create a Simple Classifier

A simple classifier uses clusters based on one set of data to sort another set of data. Clusters can be named. Detected signals in new data can be sorted and displayed within named clusters.

During the initial cluster analysis batch process, a cluster.kcs file was created in the output directory. The cluster.kcs file contains mathematical models of the clusters created from the detected signals found in the first batch of input files. The cluster.kcs file is a simple classifier. The cluster.kcs file can be used to sort and cluster detected vocalizations from a new batch of input files. The detected vocalizations from new input files will be sorted and grouped based on the same cluster models which were created in the first batch process.

In order for a simple classifier to work effectively, the results from the initial cluster analysis must be as reliable as possible. Some tuning of parameters may be required to get the best results from the initial cluster analysis. That tuning should be done before beginning to build a classifier.

The new input files are not affected by settings under the **Signal Params** Tab when using an existing cluster.kcs file. The classifier includes the signal parameters from the initial cluster analysis.

- Run a cluster analysis batch process to create the initial cluster.csv and cluster.kcs files.
 - The cluster.kcs file can be used immediately as a simple classifier to sort detected vocalizations from new input files based on the clusters created from the first batch of input files. If the cluster.kcs file is used as a simple classifier with no further editing, clusters will retain their original generic numbered labels.

If the input and output directories are located in a Managed Cloud Account, the batch process can be run on the local computer or via Cloud-based computing. For further information regarding Cloud-based computing refer to the [Cloud](#) Tab section in this user guide.

It is also possible to name clusters from the original batch process. When a new batch of recordings are analyzed using the simple classifier, the resulting clusters will be named accordingly.

- Via the Viewer, inspect and audition the detected vocalizations from the initial batch process. In the Results window select a vocalization. Go to the Results window File menu and choose **Edit Cluster Names...** Type in a name for the cluster and press OK. All detected vocalizations within the cluster are now labelled with the new cluster name.
- It is possible to label multiple clusters with different names. This might be desirable if a species makes a variety of calls which fall into different clusters. Also, if the basic cluster analysis effectively isolates different species into separate clusters, the clusters could be named as such and the classifier would be designed to identify and label multiple species.
- In the Results window go to the File menu and choose **Save**. This will update the underlying cluster.csv file and also the cluster.kcs file. The updated cluster.kcs file can now be used as a simple classifier which includes named clusters.
- The cluster.kcs file can be renamed as long as the .kcs suffix is intact.
- Go to the **Batch** Tab and select the input directory for the new files to be analyzed.
- Specify a new output directory.
- Under the **Cluster Analysis** Tab in the Control Panel, choose **Use existing .kcs to sort new recordings and create new cluster.csv**.
- Press the Browse button and navigate to the output directory used for the initial batch process. Select the cluster.kcs file.
- Press the **Process Files** button. Kaleidoscope Pro will analyze the new input files using the cluster.kcs file as a simple classifier.
- Detected vocalizations will be formed from the new input files and the detected vocalizations will be sorted into clusters as described by the simple classifier.
- When the batch process is complete the Viewer and Results window will open. The Results window will list the detected vocalizations within clusters.
- Vocalizations that match the named clusters in the simple classifier will be displayed with that cluster name.
- Named clusters will initially be listed in the Results window in alphabetical order.
- The unnamed (numbered) clusters will also appear in the results window.

Create an Advanced Classifier

Kaleidoscope Pro can use a simple classifier to look for one or more individual species within batches of files. In some cases detected signals may be of different species but similar enough that they are grouped into the same cluster. This is a false positive identification. An advanced classifier is more discriminating than a simple classifier. The advanced classifier can be used to separate the similar but different species into their own clusters. Detected vocalizations will then be labelled according to the cluster names embedded in the advanced classifier.

Advanced classifiers can be useful for non-bat species. Advanced classifiers are generally not useful for bat recordings.

Creating an advanced classifier which identifies multiple species requires significant work and is generally not efficient. If the goal is to have advanced classifiers for more than one species, better results may be obtained by building separate advanced classifiers for each species.

A batch of input files is used initially as training data. The advanced classifier is built using the detected signals from the training data files as references. Accurate detections are manually labelled. The advanced classifier is then used to analyze and label detected vocalizations within new batches of input files.

As with a simple classifier, the quality of the original cluster analysis batch process is critical to building an effective advanced classifier. It is worth taking the time to make sure the basic cluster analysis is doing as good a job as possible before building the advanced classifier.

- Under the **Batch** Tab, select the training data folder as the input directory.
- Assign an output directory.
- Under the **Cluster Analysis** Tab, select **Scan and cluster recordings to create cluster.kcs and cluster.csv files**.
- Run the batch process to create the first generation cluster.kcs and cluster.csv files.

If the input and output directories are located in a Managed Cloud Account, the batch process can be run on the local computer or via Cloud-based computing. For further information regarding Cloud-based computing refer to the [Cloud](#) Tab section in this user guide.

- From the **Results** window File menu choose **Copy Top1Match/Auto IDs to Manual IDs**. This will copy the cluster names to the **MANUAL ID** column. The purpose of this is to create clusters for all the detected signals that are not of interest. If these general clusters did not exist, Kaleidoscope Pro would try to put the detected vocalizations into the manually named clusters.
- Edit the results of the batch process with manual IDs.

The next steps in the process include manually labelling individual vocalizations for further discrimination. Rather than doing bulk labelling of cluster IDs, check and label individual detected signals with manual IDs. Some detected signals will contain an obvious vocalization from a single species. Other detected signals may have multiple vocalizations, variations of vocalizations, or vocalizations from entirely different species.

The goal is to train Kaleidoscope Pro to discriminate for vocalizations that have been verified via manual ID. Create manual ID button labels in the Metadata Panel of the Viewer.

Scan through the clusters and individual detected signals. Look for best examples of vocalizations for the species of interest. Label these detected signals accordingly.

When detected signals are found that contain a signal of interest but also contain signals that are not of interest, do not label these, otherwise they will confuse the classifier as to what is a desirable signal and what is not. Use a blank label button to remove the manual cluster ID. If a detected vocalization is left unlabelled, it will not be considered as training data for the advanced classifier.

For detected signals in a cluster that are similar but of different species (false positives), leave those detected signals with their original cluster names. This will train the advanced classifier that these incorrectly clustered signals do not belong in the newly named clusters. The purpose of leaving the original cluster name for detected signals that are not desirable in the newly named cluster is to train Kaleidoscope Pro to discriminate between detected signals that have some similarity but are not the same species.

The more manual ID labels that are applied, the more Kaleidoscope pro will have to work with to build the advanced classifier. For example, if the species of interest has multiple variations of their vocalization, make sure to manually label those variations, otherwise they will not be included in the final classification.

Kaleidoscope Pro will use the newly labelled detected signals to create new clusters which will have greater discrimination for the desired vocalizations.

- Choose Save As from the Results window File menu to update the initial cluster.csv file with the manual IDs. Rename the cluster.csv file to ClusterEdit.csv (or something equally recognizable). The purpose of this is so the file can later be identified and re-opened to review and possibly re-edit the manual IDs.
- Under the **Batch** Tab, keep the input directory set to the training files, but change the output directory to a new destination.
- Under the **Cluster Analysis** Tab choose **Re-scan recordings and edited cluster.csv to create new cluster.kcs with pairwise classifiers and cluster.csv**.
- Using the Browse button, locate the ClusterEdit.csv file that has been edited with the manual IDs.
- Run the cluster analysis batch process. The original files will be re-analyzed, using the ClusterEdit.csv file. Detected signals with manual IDs will be re-clustered while all other non-labelled detected signals are sorted into the general clusters. New clusters are created based the manually labelled detected signals.
- When the batch process is complete the Viewer and Results window will open. The Results window will list the manually named cluster first, and the general clusters after. This set of results can be checked for accuracy. Detected signals labelled with the species of interest will accurately represent that species.

A new cluster.kcs file is produced in the new output directory containing a representation of the clusters and pair-wise classifiers. This newly created cluster.kcs file can now be used as an advanced classifier to sort new input files.

- Under the **Batch** Tab, choose the input directory for the new files to be analyzed.
- Choose an output directory for the next set of results.
- Under the **Cluster Analysis** Tab choose **Use existing .kcs to sort new recordings and create new cluster.csv**.
- Use the Browse button to locate the cluster.kcs file that was created with the most recent batch process. This cluster.kcs file is the advanced classifier.
- Run a batch process to analyze the new recordings utilizing the cluster.kcs advanced classifier.

- The new batch of input files will be analyzed using the advanced classifier. Results will include the newly created labelled clusters. Detected signals that fit the manually labelled clusters will be sorted into the new labelled clusters, followed by the general unlabeled clusters (which can be ignored).

TIP: Under the **Cluster Analysis** Tab, the Max States parameter defines the target size of the Hidden Markov Model as a number of states. Experience shows that values between 8 and 16 are usually well suited for initial cluster analysis. The default setting is 12. This is a good starting point.

A larger number of states may be necessary in environments with a more diverse set of acoustic signals and may help tease apart more subtle differences between similar vocalization classes. However, too many states may result in noisy dimensions resulting in poor clustering.

If a smaller number of the training signals have been given a manual ID, there will be fewer specific variations of the training signal to compare with new input files. Therefore, lowering the number of Max states will loosen the requirements for new files with variations to be included in clusters as described in the advanced classifier.

If the results of the final cluster analysis for new files based on the advanced classifier is not finding enough examples of signal of interest, try lowering the max states to 8.

Tips for Tuning Basic Cluster Analysis

The key to effective use of cluster analysis is setting parameters which are most likely to achieve the task at hand. For example, the Default Settings of Kaleidoscope Pro include signal parameters and cluster analysis settings which are ideal for clustering songbirds. However, if the target of the cluster analysis was owls for example, different parameter may be more effective. Owls are generally more low frequency than songbirds.

When setting up to do a cluster analysis, first identify the goal. Is the goal a general survey of songbirds? Lower frequency sounds? Higher frequency sounds? Short sounds? Long sounds? If the goal is a general survey of mid-range species, start with the default settings.

If the goal is to isolate a species or specific acoustic pattern (such as a gunshot), Kaleidoscope Pro can then be tuned to have much better success isolating the desired detected signal.

Lastly, there are no obvious formulas or rules for setting these parameters. It is worth doing multiple cluster analysis batch processes while experimenting with different settings.

Signal Parameters

Start by finding the best example of the desired vocalization or sound. Look at this sound in the Viewer. The Viewer will display the frequency range, duration, and any syllables in the detected signal. This information can then be used to customize the settings under the **Signal Params** Tab.

Kaleidoscope Pro will ignore any signals outside the **Minimum and Maximum Frequency Range** parameters. For example, if the goal is to find owls that never call above 1000 hz, the maximum frequency could be set to 1000 Hz and no signals above that frequency would be considered for clustering. If a desired signal only occurs above 3 kHz for example, setting the minimum frequency to 3 kHz would exclude any audio content below that frequency from the detected signals in this batch process.

The default settings of 0.1 and 7.5 for the **Minimum and Maximum Length of Detection** are ideal for many birds, frogs, etc. But there are always exceptions. For example, if there was some sort of species that made a continuous call which lasted longer than the default 7.5 seconds, it would not be included in the detected signals if the default setting was used. If the call was as long as ten seconds for example, the maximum detection length would need to be at least ten seconds in order to consider the call as a detected signal. If a desired signal is very short, such as a gunshot, it might be useful to lower the minimum detection length. The lowest available setting is 0.01 ms.

The **Maximum inter-syllable gap** is used to determine where a detected signal ends. If there are multiple syllables in the vocalization they will often be obviously visible in the Viewer. The default setting of 0.35 seconds is generally enough to allow a complex phrase to be considered a single detected signal. Lowering this setting could then break up a complex set of syllables into individual syllables (or bat passes into individual calls) as separate detected signals.

Cluster Analysis Parameters

There are two parameters under the **Cluster Analysis** Tab which are the most-often customized.

Max distance from cluster center to include outputs in cluster.csv determines at what threshold outlier detections will be excluded from the cluster analysis batch process. The default value is 1. The maximum value is 2. When detected signals are viewed in the Results window, the **TOP1DIST** column shows the distance of the detection from the cluster center. With the default setting of 1, there will be no detected signals listed that exceed a **TOP1DIST** of 1. If the value is raised, this will allow detections further from the cluster center to be included in the output results. If there are many variations of a detected signal, increasing this value may help find those variations. Raising this value

will also allow outlier detections which may have little obvious resemblance to the cluster center. A maximum value of 2 will force all detected signals into clusters.

The FFT Window size is variable from 2.67 ms to 21.33 ms. A smaller FFT window size provides greater resolution of temporal events. A larger FFT size provides greater frequency resolution. This is a way to focus the spectral analysis depending on the signal content. If a desired detection is very short (gunshot) or has many quick syllables, a smaller FFT size may produce the best results. If a sound is slower and there are other signals in nearby frequency ranges, a larger FFT size will help separate different frequencies.

The **Max states** and **Max distance to cluster center for building clusters** are considered advanced features and are typically best left at their default values. For more information on these parameters refer to the [Cluster Analysis](#) Tab section in this user guide.

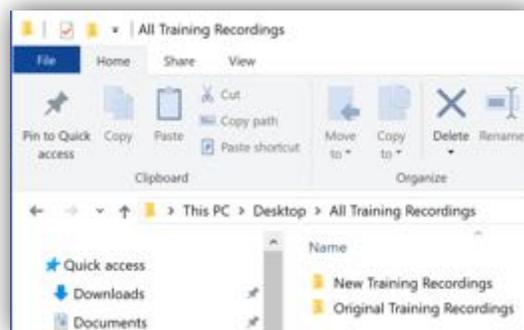
Tuning Advanced Classifier with New Training Recordings

If new training recordings become available, they can be used to further tune an advanced classifier. There are two ways to do this.

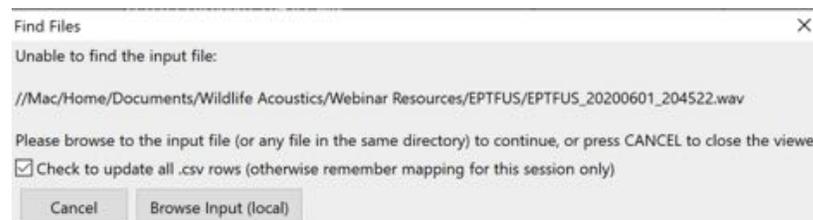
New training recordings can be added to the original training recordings and a new advanced classifier can be built from scratch. This means there will be a new basic cluster analysis, and then the process of manually labeling detections must be done again for all detected signals.

The second method is to use the existing manually edited cluster.csv file and add new manual IDs based on the new training data. This technique means the original detected signals do not need to be manually relabeled.

- Put the folder containing the new training recordings in the same general directory as the original training recordings. The original training recordings and new recordings must be in separate sub-folders.



- Navigate to the Output directory which was used for the original training recordings basic cluster analysis. From the File menu in the Control Panel, open the **settings.ini** file found in this directory. This will load the signal parameters and cluster analysis parameters from the original cluster analysis batch process.
- Go to the Control Panel File menu and choose Open Results. Open the ClusterEdit.csv file. This is the file which contains the original manual IDs which were used to make the original advanced classifier. If the training recordings have been moved since the original batch process, Kaleidoscope will present a window asking to relocate the audio files.



- Check the box to update all .csv rows. Press the Browse button and locate the listed file in the new location. The Results and Viewer windows will open. From the Results window File menu choose Save. This will update the ClusterEdit.csv file with the new location. Close the Results and Viewer windows.
- Set the input directory to the new training data directory Set the output directory to a new output folder.
- With the current settings, run a basic cluster analysis batch process on the new training data.

- Using the Viewer and Results window, add manual IDs to all the desired detected signals. Use the same manual ID labels that were added in the original training data batch process. Do not label any detected signals that are not the desired detections.
- Go to the Results window file menu and choose Save As. Name the new .csv file ClusterEdit2.
- The original ClusterEdit and the new ClusterEdit 2 .csv files must now be merged. This is done with a spreadsheet application such as Excel. Open the ClusterEdit.csv file in a spreadsheet application.
- The next step of this process will involve scanning both original and new training data in a single operation. Therefore the folder must be specified for all detections. In the spreadsheet application, type the name of the subfolder which contains the original training data. Copy and paste this to the FOLDER column for all vocalizations.
- Open the ClusterEdit 2.csv file in the spreadsheet application.
- Select and copy all columns and rows for the detected signals. Do not include the column names.
- In the ClusterEdit .csv document, select the first open row after the original detections.
- Paste. This will paste all the data from ClusterEdit2 into the ClusterEdit document.
- Type in the correct folder name for the first detection from the new detected signals. Copy and paste this to the FOLDER column for all following vocalizations.
- Go to the File menu of the Spreadsheet application and choose Save As. Name the new document TunedCSV or something similar.
- Under the **Batch** Tab, make sure **Include Subdirectories** is checked.
- Set the Input directory to the overall folder containing the new training recordings.
- If the new training recordings are a small set of data, set **Max distance from cluster center to include outputs in cluster.csv** to a value of 2. This will force all of the new training vocalizations into clusters in the batch process output.
- Under the **Cluster Analysis** Tab, select **Re-scan recordings and edited cluster.csv to create new cluster.kcs with pairwise classifiers and cluster.csv**.
- Make sure the newly edited cluster.csv file (TunedCSV for example) with original and new manual IDs is referenced in the field below.
- Process files
- This will create a new cluster.kcs file which is the new tuned advanced classifier.

Finding Rare Detections

- It is not uncommon that the goal of cluster analysis is to isolate a rare species. In some cases, the rare species may be present and calling often. That means the species may be rare, but the calls are plentiful. This is good news in terms of basic cluster analysis and building classifiers. One advantage of a classifier is that if a simple or advanced classifier is well-built, it can then find vocalizations in new recordings, even if there are very few examples.
- However, if there are very few examples of the vocalization to start with, that becomes much more challenging. Cluster analysis is a statistical process. It relies on statistical models and probability to build models of acoustic patterns. If there too few examples of a sound or vocalization, that may not be statistically significant enough to form a cluster. In that situation, cluster analysis may not be a useful solution. The basic signal detection will work as long as the vocalization or sound passes the signal parameters. If the **Max distance from cluster center to include outputs in cluster.csv** is set to a value of 2, all detected signals, including the rare detections will be included somewhere in the output results.

Analyze Recordings with No Cluster Analysis.

The fourth choice in the Cluster Analysis window is **Scan recordings and extract detections (no clustering)**.

In this mode Kaleidoscope Pro analyzes audio files and isolates general activity. No classification is done to the detected signals. The resulting data makes it easy to scan through detected signals and see only the portions of the input files which contain signals of interest.

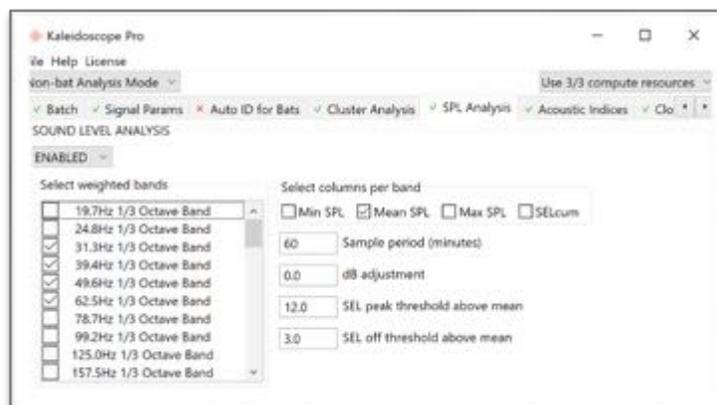
2.5 SPL Analysis

A Kaleidoscope Pro license is required to enable the SPL Analysis function.

Kaleidoscope Pro can analyze full-spectrum audio files for ambient sound pressure level characteristics. The results of the analysis are then written to .csv files which are typically opened in a spreadsheet application.

Configure SPL Analysis Parameters

- Kaleidoscope Pro will analyze sound pressure level characteristics based on the parameters configured under the **SPL Analysis** Tab. Kaleidoscope Pro provides a range of weighted frequency bands which can each be used to generate specific analysis. Multiple bands can be selected at the same time and separate results will be provided for each band.
- It is also possible to enable or disable specific measurements which will influence the .csv output results.
- SPL level analysis results can be viewed on a per-file-basis and can also be viewed based on time periods. Set the time periods to be represented via the **Sample period (samples)** parameter.
- For additional information regarding settings and output results refer to the [SPL Analysis](#) section of the Reference Guide chapter in this user guide.



Run a Batch Process

Under the **Batch** Tab, select the input directory for the files to be analyzed. SPL Analysis works on full-spectrum .wav and .w4v files.

Select an output directory for the analysis results. It is not required to convert input files to full-spectrum or zero-crossing files on output in order to do sound level analysis.

If the input and output directories are located in a Managed Cloud Account, the batch process can be run on the local computer or via Cloud-based computing. For further information regarding Cloud-based computing refer to the **Cloud** Tab section in this user guide.

Check Results

The results of the SPL analysis batch process will be provided in a spl.csv file and a splbyfile.csv file. These files are created in the output directory. These .csv files cannot be opened by Kaleidoscope Pro. Typically the .csv files are opened and viewed in a spreadsheet application. For additional information about the information contained in the .csv files refer to the Resources chapter in this user guide.

- **splbyfile.csv**
Contains data found in the batch conversion regarding spl for individual files.
- **spl.csv**
Contains data found in the batch conversion regarding spl on a per time segment basis, as described by the Sample Period parameter.

2.6 Cloud Storage Configuration

Kaleidoscope Pro introduces Cloud based storage for files. A Kaleidoscope Pro license is required for Cloud compatibility. Customers have the choice to subscribe to a Wildlife Acoustics Managed Account, or they can create their own Cloud account.

Large amounts of data can be uploaded to a Cloud account. Kaleidoscope Pro can then access the data in the Cloud for additional analysis and data searching. Data uploaded to a Cloud account can be shared by multiple users.

Set Up a Cloud Account

- In order for Kaleidoscope Pro to access a Managed Cloud Account the account must first have been created at www.WildlifeAcoustics.com.
- It is also possible to be invited to access an existing Wildlife Acoustics Managed Cloud Account. The invited user must be running Kaleidoscope Pro. Invitation of guests to a Managed Cloud Account is done by the account administrator via their Wildlife Acoustics web account.
- For further information regarding creating a Managed Cloud Account refer to the [Wildlife Acoustics Managed Cloud Account](#) section in the Resources chapter of this user guide.

Enable a Wildlife Acoustics Managed Cloud Account in Kaleidoscope Pro

Once a Managed Cloud Account has been created at the Wildlife Acoustics web site, Kaleidoscope Pro will then be able to access that account.

- Click on the **Cloud** Tab in the Control Panel.
- The Cloud window initially shows a menu with four choices:
 - **Disabled**
 - **Log in to Managed Cloud Account**
This requires an existing Wildlife Acoustics Managed Cloud Account.
 - **Log in to user managed AWS S3**
This requires an existing Amazon Cloud account.
 - **Set up user managed AWS3 account**
This is used to configure an existing Amazon Cloud account.
- Choose **Log in to Managed Cloud Account**.
- Enter your email address and Wildlife Acoustics account password.
- Press the **Log In** button. This will log Kaleidoscope Pro in to the Managed Cloud Account.

The screenshot shows a software interface for logging into a Managed Cloud Account. At the top, there are tabs for various analysis modes: 'Non-bat Analysis Mode', 'Batch', 'Signal Params', 'Auto ID for Bats', 'Cluster Analysis', 'SPL Analysis', 'Acoustic Indices', 'Cloud', and 'Db'. The 'Cloud' tab is selected. Below the tabs, there is a dropdown menu for 'Log in to Managed Cloud Account'. The main form contains the following fields and controls:

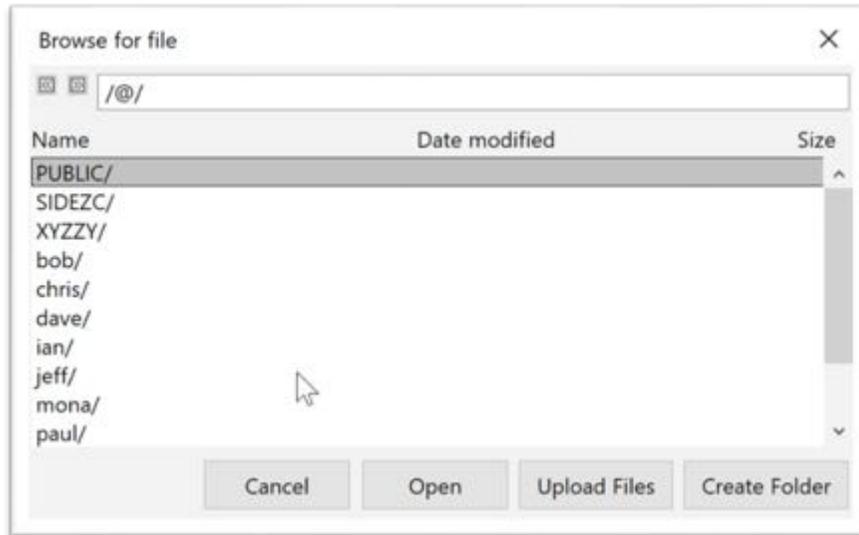
- Email Address:** A text input field containing 'null@wildlifeacoustics.com'.
- Password:** A password input field with masked characters (dots).
- Region:** A dropdown menu currently set to 'us-east-1'.
- Account:** A dropdown menu showing 'Dave World (24e05d28-5d56-5441-a20a-bac432aec123)'.
- Log In:** A button to submit the login information.
- Browse Files:** A button to open the Cloud directory.
- Browse to set Input Folder:** A button to set the input folder.
- Browse to set Output Folder:** A button to set the output folder.

At the top right of the dialog, it says 'Use 3/3 compute resources'.

View Cloud Storage Directories

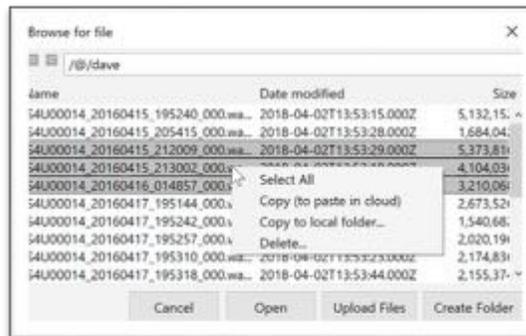
Once logged in to the Cloud account, Kaleidoscope Pro has access to the file directories within the account. Click the **Browse Files** button to open the Cloud directory.

The file browser will now open.



Manage Files in the Cloud Account

Navigate through directories to see individual files. Select one or more files and right-click for options to move files to different directories in the Cloud and to download files to the local computer.



Select Cloud Input and Output Directories for Batch Processing

Kaleidoscope Pro can run batch processes on files in the Cloud. Select the Cloud input and output directories for the batch process.



It is also possible to choose locations on the local computer for the input and output directories. This is done in the **Batch** Tab in the Control Panel. Using a location on the computer for the input or output directory will limit the speed of the batch process based on on-line connection speed.

Upload Data to the Cloud

There are several methods for uploading data to the Cloud.

- Data can be uploaded from an on-line computer. Open the Cloud file browser and click Upload Files. Files can be selected and uploaded to the current Cloud directory. Depending on the amount of data to be uploaded and the on-line connection speed, this may take a significant amount of time.
- Data can be sent directly to Amazon and Amazon will upload the data to a designated Cloud account. Refer to the Import/Export section in the Resources chapter in this user guide for instructions to send storage media to Amazon for uploading and downloading.

- Sending a physical drive to Amazon can take several weeks before the data is available on line. If the customer requires the fastest possible method to upload data to a Managed Cloud Account, please contact Wildlife Acoustics Technical Support to discuss additional options.

2.7 Database Query Examples

A Kaleidoscope Pro license is required to use the database query functions. The user must be logged in to a Wildlife Acoustics Managed Cloud Account in order to run a database query.

This section will show examples of database searches.

For complete instructions on how to create database information and how to use the individual query functions refer to the [Db](#) Tab section in this user guide.

Search for Batch Processes

This is a very simple query to look for a record of all batch processes run by the logged-in user.

- Type of query is set to **Batch**
- **Query.csv** and **query.json** files will be created in an untitled folder on the local desktop.
- Table Data Source is set to **My Records** which will limit the query to batch processes run by the logged-in user.
- The batches will be listed in the Results window starting with **Most Recent**.
- The Results window will show records starting with the first record that fits the query parameters.
- Number of listed results is limited to 1000.
- Time-zone listings are offset by 4 hours because this query is being run in the US East Coast which is four hours behind UTC.
- There are no other filters applied to this query.

The screenshot shows the 'Query database' section of the software interface. At the top, there are several status indicators: 'Non-bat Analysis Mode' (dropdown), 'Use 3/3 compute resources' (dropdown), and a row of checkmarks for 'Batch', 'Signal Params', 'Auto ID for Bats', 'Cluster Analysis', 'SPL Analysis', 'Acoustic Indices', 'Cloud', and 'Db'. Below this is a 'Log in to Managed Cloud Account' dropdown. The 'Upload to database' section contains two buttons: 'Upload local .wdb file to database' and 'Upload cloud .wdb file to database'. The 'Query database' section includes:

- 'Type of query:' dropdown set to 'Batch'.
- 'Choose destination for query results:' text input field containing '\\Home\Desktop\query.csv' and a 'Browse' button.
- 'Table Data Source:' dropdown set to 'My records'.
- 'Table Data Mode:' dropdown set to 'Most recent'.
- 'ALL OF' dropdown and '-- Select Database Field --' dropdown.
- 'Optional sort order:' dropdown set to 'Ascending'.
- 'Results to skip:' input field with '0'.
- 'Limit results to:' input field with '1000'.
- 'Adjust timezone (hours re UTC):' input field with '-4'.

Search for Bat Auto ID Results

This is a more complex query to look for Bat Auto ID results created by the logged in user. The query uses filters to limit the search to only EPTFUS and LASBOR species, and only for results that included six or more pulses.

- Type of query is set to **Bat AutoIDs (id.csv)**
- **Query.csv** and **query.json** files will be created in an untitled folder on the local desktop.
- Table Data Source is set to **My Records** which will limit the query to batch processes run by the logged-in user.
- The batches will be listed in the Results window starting with **Most Recent**.

- The ALL OF operator is selected to include all engaged filters.
- The first database field is set to Species Auto ID equals EPTFUS.
- The second database field is set to Species Auto ID equals LASBOR.
- The OR operator between the EPTFUS and LASBOR filters means the query will include all records that contain one or the other species.
- A third filter is set to search for six or more Auto ID Pulses.
- The AND operator for the Auto ID pulses means the query looks for all records with auto ID of EPTFUS or LASBOR species and have six or more pulses.
- The Results window will show records starting with the first record which fits the query parameters.
- Number of listed results is limited to 1000.
- Time-zone listings are offset by 4 hours because this batch process is being run in the US East Coast which is four hours behind UTC.

Non-bat Analysis Mode Use 3/3 compute resources

Batch
 Signal Params
 Auto ID for Bats
 Cluster Analysis
 SPL Analysis
 Acoustic Indices
 Cloud
 Db

Log in to Managed Cloud Account

Upload to database

Query database

Type of query: Choose destination for query results:

Bat AutoIDs (id.csv) \\Home\Desktop\query.csv

Table Data Source: Table Data Mode:

My records Most recent

Manual Review Source: Manual Review Mode:

My records Most recent

ALL OF Auto ID - Species Auto ID = EPTFUS
 OR Auto ID - Species Auto ID = LASBOR
 OR -- Select Database Field --
 AND Auto ID - Pulses >=
 OR -- Select Database Field --
 AND -- Select Database Field --

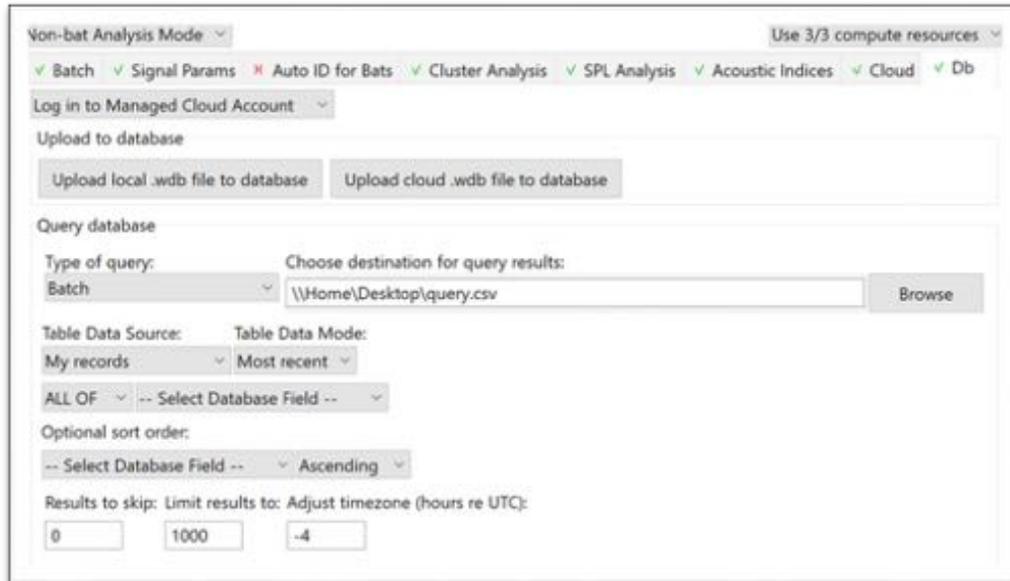
Optional sort order:

-- Select Database Field -- Ascending

Results to skip: Limit results to: Adjust timezone (hours re UTC):

Search for Cluster Analysis Results

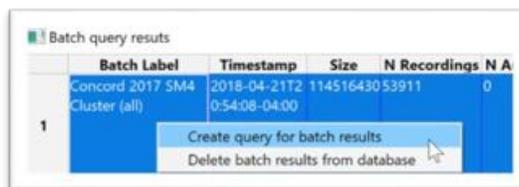
Each time a cluster analysis batch process is run a new set of clusters are created based on the input files. A cluster from one batch process may have nothing in common with a cluster found from a different batch process. Therefore, searches for cluster results should be done based on a single cluster analysis batch process. The first step is to search for batch processes. The following query is used to search for batch processes in all database records of My Organization.



The results of the query were 24 found batch processes. The first five listed batch processes are visible in the Results window.

	Batch Label	Timestamp	Size	N Recordings	N Auto IDs	N Clusters	Kaleidoscope Version	Input Directory	Output Directory	Inpu
1	Concord 2017 SMA4 Cluster (all)	2018-04-21T2 0:54:08-04:00	11451643053911		0	732464	5.0.alpha7	/@15a3d6aa-96ca-5c/@15a3d6aa-96ca-5c13-afa8-dfa63c9cb2c/c/an/Concord2017/5/an/Outputs/Concord2017/SMA4/Cluster		
2	Concord 2016 SMA4 Cluster (all)	2018-04-21T2 1:35:28-04:00	74266248	21026	0	503321	5.0.alpha7	/@15a3d6aa-96ca-5c/@15a3d6aa-96ca-5c13-afa8-dfa63c9cb2c/c/an/Concord2016/5/an/Outputs/Concord2016/SMA4/Cluster		
3	Concord 2016 SM4BAT Cluster (all)	2018-04-21T2 1:54:47-04:00	14739877	25706	0	50496	5.0.alpha7	/@15a3d6aa-96ca-5c/@15a3d6aa-96ca-5c13-afa8-dfa63c9cb2c/c/an/Concord2016/5/an/Outputs/Concord2016/SM4BAT/Cluster		
4	Concord 2017 SM4BAT Cluster (all)	2018-04-21T2 2:06:47-04:00	21635005	37962	0	75096	5.0.alpha7	/@15a3d6aa-96ca-5c/@15a3d6aa-96ca-5c13-afa8-dfa63c9cb2c/c/an/Concord2017/5/an/Outputs/Concord2017/SM4BAT/Cluster		
5	Concord 2017 SMA4 Cluster Owl	2018-04-22T0 7:11:58-04:00	17236239	53908	0	18150	5.0.alpha7	/@15a3d6aa-96ca-5c/@15a3d6aa-96ca-5c13-afa8-dfa63c9cb2c/c/an/Concord2017/5/an/Outputs/Concord2017/SMA4/ClusterOwl		

The first found batch process was run as a cluster analysis. To set up a search within this batch right-click on the batch. A menu appears with the option to create a second query based on this batch process, or to delete the batch from the database.



Choose Create query for batch results. A second query will be set up to look specifically at this batch.

- The Type of query is set to Clusters (cluster.csv).
- Table Data Source must be set to include the batch process which was actually run by someone else in the organization. Therefore, Table Data Source is set to My organization.
- Batch-fingerprint has been loaded as a condition. The fingerprint from the selected batch has been entered as a value. This will limit query results to the specified batch.
- Sort order has been set to look for ascending Top 1 Match and ascending Top 1 Distance.

- There were 732464 clusters found in the original batch process. This query is set to find the first thousand results from the batch process.
- Time zone offset is -4 to reflect east coast US time.

3 Metadata

Metadata is information about a file or batch process. Metadata is involved in a significant part of the Kaleidoscope workflow. Metadata is collected, created, and edited. Metadata is output to multiple destinations and formats. Metadata provides the information required for the final results of the file analysis.

3.1 Overview

In the context of Kaleidoscope, metadata is generated from three sources.

- Metadata is embedded in full spectrum and zero-crossing files by the recorder at the time of the recording. This can include date and time, GPS location, and other specific settings from the recording device. Full-spectrum and zero-crossing files may also contain additional metadata that was added after the files were initially created. Additional metadata may be embedded into files from previous Kaleidoscope processing or processing from other software applications.
- Metadata can be created manually via the Project Form under the **Batch** Tab. Metadata can also be created manually via the Metadata Panel in the Viewer.
- Kaleidoscope generates metadata during batch processes.

Metadata has four potential output destinations when working with Kaleidoscope.

- Metadata can be embedded into full-spectrum and zero crossing files.
- Metadata is written to .csv output files.
- Metadata can be uploaded to a Managed Cloud Account database (Requires Kaleidoscope Pro license).
- Metadata can be uploaded to a customer-provisioned PostgreSQL database server (Requires Kaleidoscope Pro license).

3.2 MetaForm

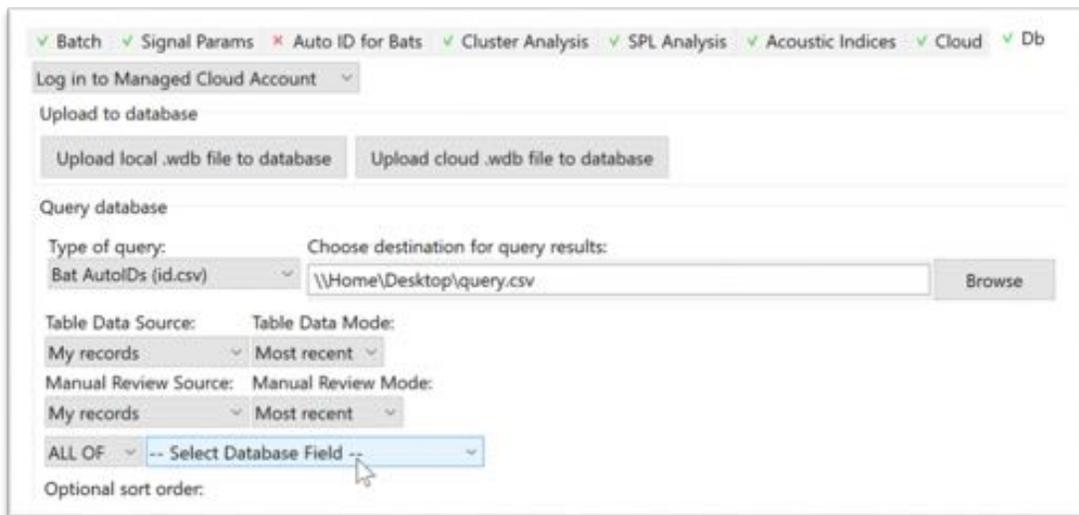
A MetaForm is a document that defines how metadata is managed within Kaleidoscope. Metadata output to .csv files and Managed Cloud Account databases is defined by a MetaForm. The MetaForm defines available data fields which can be written to full-spectrum audio and zero-crossing files in GUANO format.

There is a Default MetaForm embedded in Kaleidoscope. Kaleidoscope Pro also supports adding new or customized MetaForms.

The MetaForm defines:

- What metadata will be written to .csv and any full-spectrum or zero crossing output files.
- What options are available in the project form.
- What metadata is published to a Managed Cloud Account database.

- Which choices are available for searching the database in the **Select Database Field** under the Db Tab.

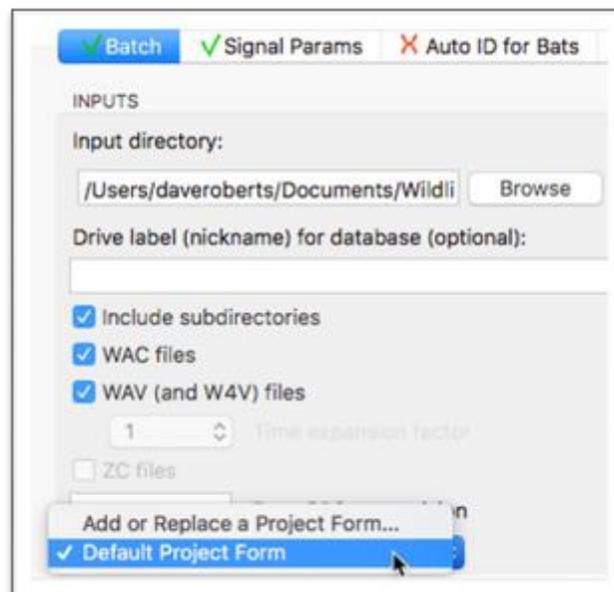


A list of the Select Database Field options for the Default MetaForm is provided in the [Resources](#) chapter in this user guide.

- The Default MetaForm is available to be used as a template to create a new customized MetaForm. The MetaForm is an XML formatted text document. A copy of the Default MetaForm, including instructions to customize or create a new MetaForm document can be downloaded from: <https://www.wildlifeacoustics.com/SCHEMA>
- A new MetaForm allows the user to specify .csv column outputs, embedded metadata in full-spectrum or zero crossing files, and user-defined database search fields.
- Kaleidoscope Pro provides the option to load additional MetaForms. This is done via the project form menu under the **Batch** Tab.
- New metaforms are stored to the following locations. Removing a metaform from this location will remove it as an option from within Kaleidoscope.
 - Mac: (User Library)>Application Support>kaleidoscope>forms
 - Windows: C:\(user name)\AppData\Local\kaleidoscope\forms

Mac: (User Library)>Application Support>kaleidoscope>forms

Windows: C:\(user name)\AppData\Local\kaleidoscope\forms

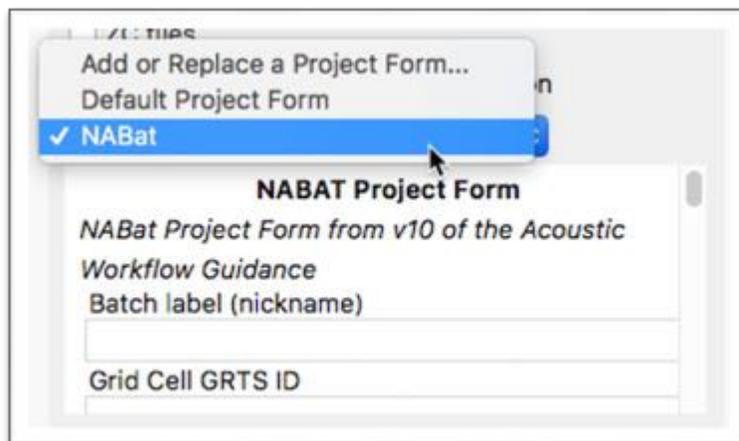


NABat MetaForm

The North American Bat Monitoring Program (NABat) has developed a standard for information collection. Wildlife Acoustics has developed a customized MetaForm that supports the suggested NABat data fields.

The NABat MetaForm can be downloaded and installed into Kaleidoscope Pro.

- Go to <https://www.wildlifeacoustics.com/SCHEMA/>
- Right-click on Kaleidoscope NABat MetaForm.
- Choose Download Linked File
- Download the NABat.xml file to the local computer.
- In Kaleidoscope Pro choose Add or Replace a Project Form...
- Navigate to the downloaded NABat.xml file and Open.
- Kaleidoscope Pro will now provide a choice of the Default Project Form or the NABat form.



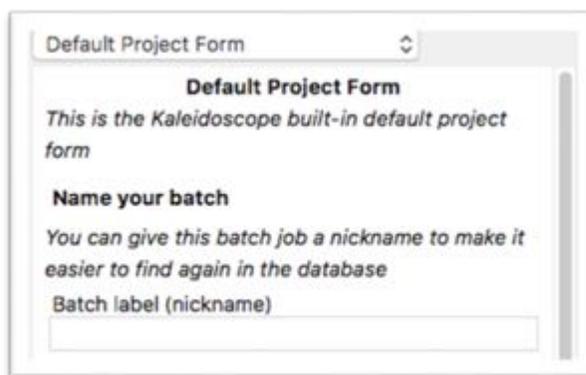
3.3 Project Form

The project form is found under the **Batch** Tab in the Control Panel. The project form allows the user to manually create metadata. The additional metadata can be embedded into output files when a batch process is run. The additional metadata is also written to .csv output files, as well as a db-batch.wdb file, which can be used to update a Managed Cloud Account database.

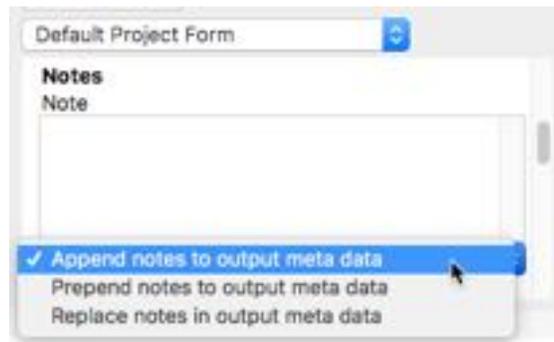
Kaleidoscope provides a Default Project Form. Customized project forms can be created and used instead of the Default Project Form. A Kaleidoscope Pro license is required in order to use a customized project form. For information regarding how to create a customized project form, see the previous section describing the MetaForm.

The Default Project Form includes text instructions, standardized options, and options to create field text notes.

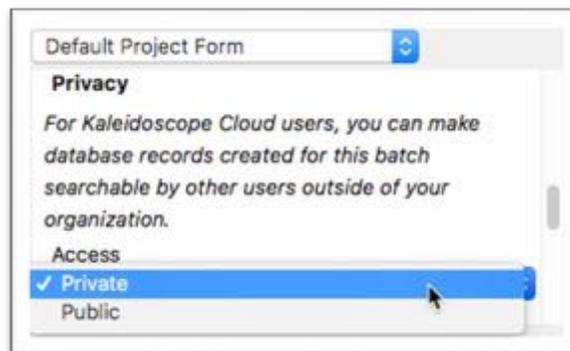
- The first option is for naming of the batch process. This information is used when Kaleidoscope Pro is accessing a database in a Managed Cloud Account. The database can be searched by batch label.



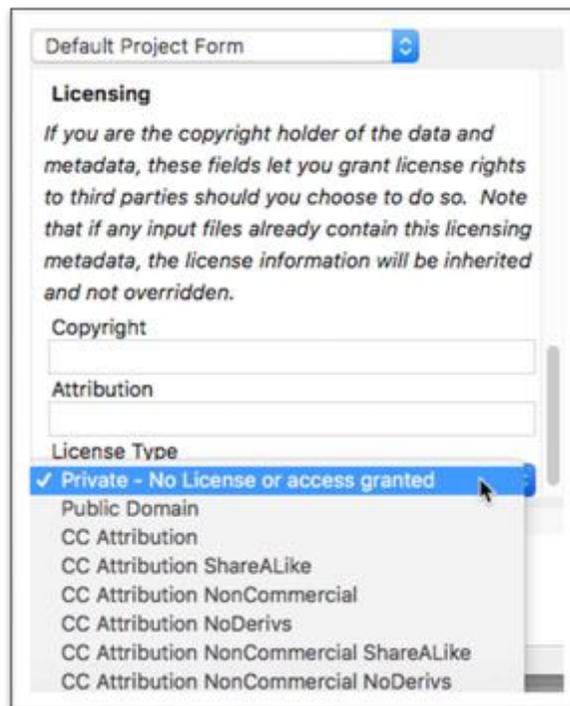
- The Default Project Form provides the option to write field notes. The field notes can be appended (placed after) or prepended (placed before) existing field notes. New field notes can replace previously existing field notes.



- Data created in a batch process can be uploaded to a Managed Cloud Account. The batch process data can be marked Private or Public, which determines whether the data will be searchable by users subscribed to other Managed Cloud Account organizations.



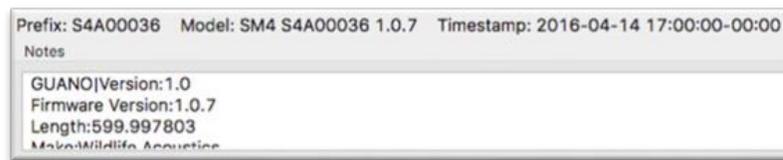
- Copyright information can be added to output files.



3.4 Metadata Panel and Results Window

Full-spectrum audio and zero-crossing files can be opened directly in the Viewer

When a file is opened in the Viewer, embedded metadata is displayed in the **Notes** field in the Metadata Panel. Scroll down in the Notes field to see current metadata.



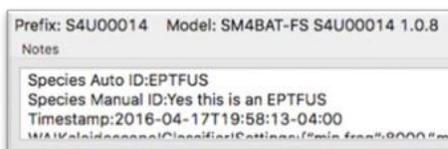
The Metadata Panel displays the raw metadata found in the file. This includes:

- Proprietary metadata created by Wildlife Acoustics recorders.
- Additional metadata added by Kaleidoscope or other software applications during previous processing.

If a file is opened directly in the Viewer, a manual ID can be added via the Metadata Panel. Type in the manual ID and press Return. The manual ID is written to the file.



- The next time the file is opened in the Viewer, the manual ID metadata will be visible in the Metadata Panel notes field.



When a batch process is run on the local computer the Viewer and Results window will open automatically when the batch process is complete. If the batch process is run using Cloud-based computing the Viewer and Results window can be opened in the output directory via the Browser under the **Cloud** Tab.

- For an Auto-ID batch double click on the id.csv file.
- For a cluster analysis batch double-click on the cluster.csv file.
- For a batch process run with or without Auto-ID or cluster analysis, also double-click on the meta.csv file.

Metadata will be visible in the Notes field of the Metadata Panel, as well as in the Results window.

- Metadata columns can be shown or hidden in the Results window. Go to the Results window File menu and choose **Edit Columns** to hide or show different metadata fields.
- If full-spectrum and zero-crossing output files have been created in an Auto-ID batch process, the Auto ID will be written to the output file and will be visible in the Notes field of the Metadata Panel, as well as in the Results window. The Auto ID is also written to the id.csv file and db-batch.wdb files that were created in the batch process. Add a manual ID and press Return to write the manual ID to the output file (if an output file was created in the batch process).

When a manual ID is created it is also written to the Results window. Select Save from the Results window File menu to update the underlying id.csv file. This will also create or update a db-review.wdb file that is used to update a Managed Cloud Account database.

- If a cluster analysis batch process is run, no cluster name is added to any full-spectrum or zero-crossing output files.
- Cluster names are visible in the Results window.
- Initial cluster names are present in the cluster.csv file and db-batch.wdb files created in the batch process. If a cluster is renamed in the Results window, press Save to update the underlying cluster.csv file. This will also create or update a db-review.wdb file which can be used to update a Managed Cloud Account database.

3.5 GUANO

There are multiple standards for metadata organization and formatting. GUANO is a de-facto standard that has been adapted by many organizations, including Wildlife Acoustics. The specifications for the GUANO standard are found here: <https://guano-md.org>

The specific GUANO formatting used by Kaleidoscope Pro can be viewed at www.WildlifeAcoustics.com/SCHEMA

GUANO has a list of well-known data fields that are generally readable by any software that supports the GUANO standard. For example, here is a GUANO formatted metadata that describes a sample rate setting of 24000:

```
Samplerate:2400.
```

GUANO also allows for additional data fields by what is called a "namespace". Namespace data fields provide a way for organizations and vendors to add metadata within the GUANO format. Field names contain a "namespace identifier" followed by the vertical bar character '|' followed by the rest of the name of the tag/key/name of the field. Then a ':' followed by the text value.

The GUANO standard includes the namespace "WA" for Wildlife Acoustics defined fields. A Wildlife Acoustics defined metadata field begins with "WA|" (note that is not "WAI", but "WA|" e.g. vertical bar vs. letter I). For example, here is a GUANO metadata that describes the version of Kaleidoscope used to process the file:

```
WA|Kaleidoscope|Version:5.0.0
```

GUANO data fields as read and generated by Kaleidoscope are described in the Resources chapter in this user guide.

- Kaleidoscope reads GUANO metadata from full-spectrum and zero-crossing input files.
- Kaleidoscope embeds GUANO metadata into full-spectrum and zero-crossing output files.
- Kaleidoscope extracts some fields from GUANO metadata to write to .csv output files and databases. The MetaForm defines which fields and subfields are extracted and written to which .csv file columns or database table fields.
- Manually created metadata and metadata from Kaleidoscope batch processes are converted to GUANO format for embedding in output files.

4 Reference Guide

This chapter is designed to provide a detailed explanation for each function within Kaleidoscope Pro. The Reference Guide can be used in combination with the Typical Use Workflows chapter to provide additional information about each workflow step. The order of information in the Reference Guide is loosely based on the order functions appear in the Kaleidoscope Pro software, starting with an explanation of batch processing.

4.1 Batch Processing

Kaleidoscope is designed to efficiently process, convert, and analyze large numbers of files in batches.

An input directory is selected for the source files. For some Kaleidoscope functions, the input directory can contain just a single file. For other functions, multiple input files may be required.

An output directory is selected as the location for output files to be created from the batch process. Output files include specific data files generated by Kaleidoscope. Kaleidoscope also provides the option to generate wav and zero crossing files during a batch process output, based on the files from the input directory.

Desired parameters are configured under the various tabs in the Control Panel. Kaleidoscope can then process the input files to provide output results.

If a batch process is run on files that are stored in a Managed Cloud Account, the user has the option to do the computing on a local computer or via Cloud-based computing. In order to use Cloud-based computing both the input directory and output directory must be located in the Managed Cloud Account.

Because the input and output files, and the actual computing is done on a remote computer, the Results window and Viewer will not open automatically on the computer once the Cloud batch process is complete. To open the results from the batch process, use the Cloud file browser to navigate to the output directory. Depending on the type of batch process, there will be a meta.csv file, id.csv file, cluster.csv file, gps.csv file, spl.csv file and splbyfile.csv file. Within the Cloud browser, double click on any one of these .csv files and the Viewer and Results window for the batch process will open.

Because the Batch Process was run in the Cloud, the results of the batch have now been automatically uploaded to the Cloud database. This means the user also has the choice to immediately go to the **Db** Tab and run a query on the batch process results.

For additional information on Cloud-based computing refer to the [Cloud](#) Tab section in this user guide.

Press the **Process Files** button to run the batch.

Output files will be created in the selected destination, including subfolders if that option has also been selected.

Output files will include (based on selected options):

- **settings.ini** Contains a record of all Kaleidoscope settings for the batch process. An existing settings.ini file can be re-loaded via the **File menu>Load Settings...** A settings.ini file can be renamed as long as the .ini name extension is retained.
- **log.txt** Provides a list of input and output files processed and error reporting done during the batch conversion. This document can be useful for diagnosis and troubleshooting.
- **meta.csv** Contains metadata associated with the full-spectrum and zero-crossing files.
- **db-batch.wdb** Contains results from the batch process. This file can be used to upload batch information to the database in a Wildlife Acoustics Managed Cloud Account. This file is not created if the batch process is run using Cloud-based computing.
- **db-review.wdb** Contains results from manual ID updates. This file can be used to update existing database records. This file is created when a Results window containing manually added IDs is saved. The db-review file will be created in the same directory that contains the underlying .csv file.
- **gps.csv** Provides any GPS data found in the batch conversion. This file is created if Extract GPS to CSV is enabled for the batch.
- **gps.kml** This file is created if Extract GPS to KML is enabled for the batch. The KML file can be opened directly from Google Earth and will display a placemark corresponding to each output file.
- **cluster.csv** Contains any cluster data found in the batch conversion. This file is only created if Cluster Analysis is enabled for the batch.
- **cluster.kcs** Contains a representation of the clusters that can be re-used to sort new data against the same clusters. This file is only created if Cluster Analysis is enabled for the batch.

- **id.csv** Contains detailed auto-ID data found in the batch process. This file is only created if Auto ID for Bats is enabled for the batch.
- **idsummary.csv** Contains a summary of auto-ID data found in the batch conversion. This file is only created if Auto ID for Bats is enabled for the batch. For further information regarding the idsummary.csv data format refer to .csv section of the Resources chapter in this user guide.
- **splbyfile.csv** Contains data found in the batch conversion regarding sound level for individual files. This file is only created if SPL Analysis is enabled for the batch.
- **spl.csv** Contains data found in the batch conversion regarding sound level on a per time segment basis. This file is only created if SPL Analysis is enabled for the batch.
-

The .csv file format is designed for easy import into spreadsheet software to create pivot tables. Pivot tables can be created to summarize species-specific activity by site, by day, by night, or by hour.

For further information regarding the .csv data layout for each file type refer to the .csv section of the Resources chapter in this user guide.

- **Full Spectrum audio files**
 - .WAV files are created if the option is checked under OUTPUTS and no file compression is specified.
 - .w4v files are created if the option is checked under OUTPUTS and a compression format is specified
- **Zero-crossing Files**
 - Zero-crossing files are automatically split to meet file format requirements (15 second maximum duration, 32KB maximum file size, 16K maximum dots).
 - .zc files are created if the ZC files option is checked under OUTPUTS, and Use .zc instead of .??# is also selected
 - .??# files are created if the ZC files option is checked under OUTPUTS, and Use .zc instead of .??# is not selected

Additional File Conversion Information

In Bat Analysis Mode there are a number of important conditions to keep in mind when converting files:

- Converting from .??# or .zc zero-crossing formats to .wav/.w4v full-spectrum formats is not possible to do accurately because zero-crossing formats do not contain any amplitude or harmonic content information from the original recorded signal. Instead, Kaleidoscope uses sophisticated digital signal processing techniques to synthesize a full-spectrum signal from the zero-crossing data that simulates the frequency modulated signal through time, but with no harmonic structure and with uniform amplitude information.
- Converting from .??# or .zc to .??# or .zc produces a copy of the original file and does not actually change the division ratio or split the recording into smaller pieces.

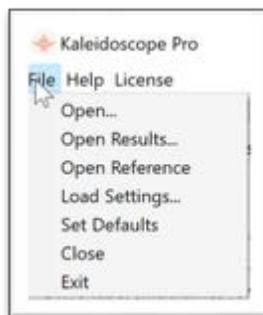
4.2 Control Panel

The Control Panel is the first window to open when Kaleidoscope is launched. The Control Panel includes a series of tabs which each contain controls and settings for specific functions within Kaleidoscope. Batch processes are configured and run from the Control Panel.

File Menu Commands

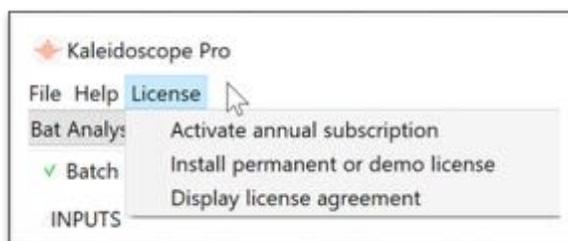
When the Control Panel window is front-most, these are the available File menu commands:

- **Open...** Open a full-spectrum or zero-crossing file into the Viewer.
- **Open Results...** Open a meta.csv, id.csv, or cluster.csv file to display the Viewer and linked Results window.
- **Open Reference** Open reference training data in the Viewer based on the selected classifiers under the **Auto ID for Bats** Tab.
- **Load Settings** Open a previously created setup.ini file to restore settings from a previous batch process.
- **Set Defaults** Set all Kaleidoscope parameters to default values.
- **Close** Close the Control Panel window. If no other windows are open this will also Exit (Windows) or Quit (Mac).
- **Exit** Windows only. This will Exit Kaleidoscope. On Mac the command to Quit Kaleidoscope is found under the main Kaleidoscope menu.



License Menu

The License menu provides the options to activate a subscription license or install a permanent license. There is also an option to display the Wildlife Acoustics software license agreement.



Bat Analysis Mode

Kaleidoscope operates in two basic modes – Bat Analysis Mode and Non-Bat Analysis Mode.

There are separate settings under the **Signal Params** Tab for each mode.

- Bat Analysis mode is designed for work with narrow-band ultrasonic sounds, specifically those made with sequences of pulses. This is the appropriate mode to use when working with recordings of bats.

Bat Analysis Mode must be selected in order to use the Auto ID for Bats function in Kaleidoscope Pro.

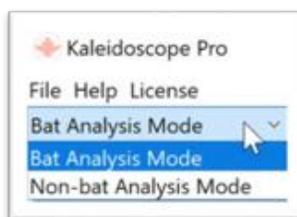
In Kaleidoscope Pro the **SPL Analysis** Tab is disabled in Bat Analysis Mode.

- Non-Bat Analysis mode is designed to work with lower frequency broad-band sounds. This is appropriate when working with birds or other animals that are not bats. Some non-bat animals do make ultrasonic sounds. The frequency range of Non-bat Analysis Mode can be adjusted under the **Signal Params** Tab.

Non-Bat Analysis Mode must be selected in order to use the SPL Analysis function in Kaleidoscope Pro.

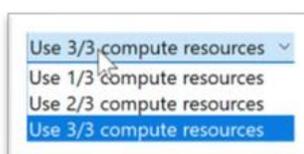
In Kaleidoscope Pro the **Auto ID for Bats** Tab is disabled in Non-Bat Analysis Mode.

In Non-Bat Analysis Mode output to ZC files and noise filtering are disabled under the **Batch** Tab.



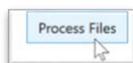
Compute Resources

Kaleidoscope is designed to take full advantage of multi-core CPUs. Kaleidoscope uses parallel processing during batch processing by dividing work into multiple threads. By default, Kaleidoscope will try to maximize utilization by using a number of threads equal to the number of available cores, plus one. Memory usage will also grow proportionally with the number of threads utilized. The number of threads used by Kaleidoscope can be adjusted via the menu in the upper right corner of the Control Panel. This may be necessary when running Kaleidoscope on a computer with limited available memory, or desirable if the computer is used to run other tasks while Kaleidoscope is running a batch process in the background.



Process Files Button

The Process Files button is in the lower right corner of the Control Panel. Press this button to begin a batch process.



4.3 Batch Tab

The following is a list of all parameters found under the Batch Tab:

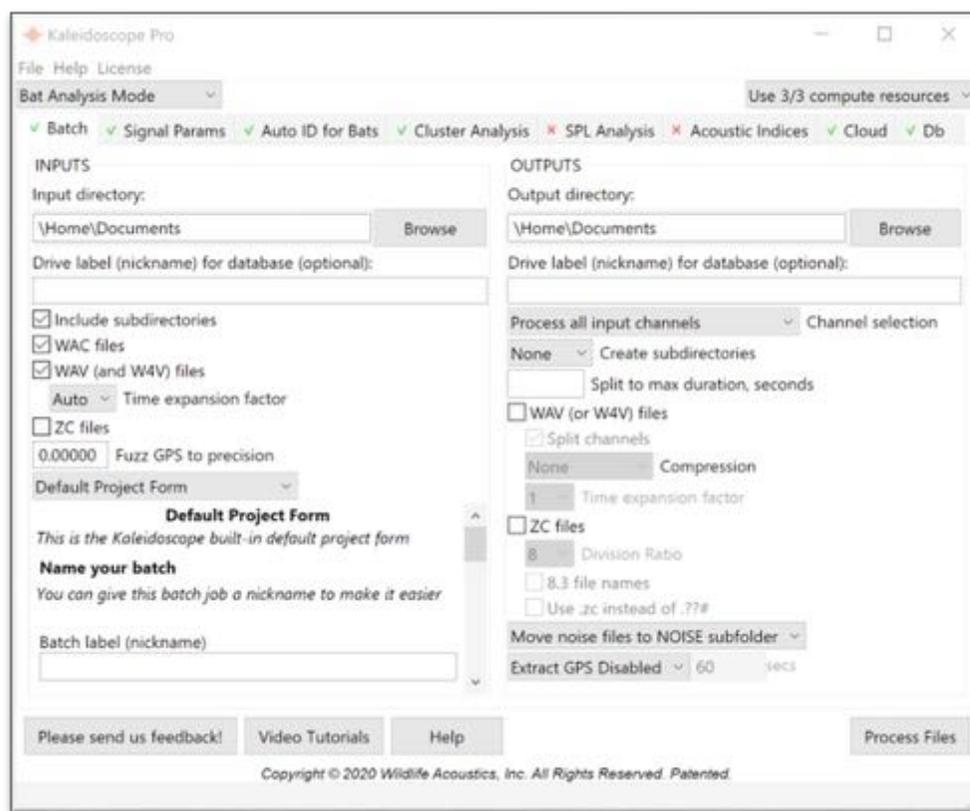
INPUTS

- Browse and select input file directory and types.
- Create nickname for source drive (optional)
- Include subdirectories from input directory
- Include WAC files
- Include WAV and W4V files
 - Select time expansion factor for WAV/W4V files (Bat Analysis Mode only)
- Include zero-crossing files (Bat Analysis Mode only)
- Fuzz GPS to precision
- Project form (This information will be added to the batch output as metadata).

OUTPUTS

- Browse and select output file directory
- Create nickname for source drive (optional)
- Channel selection
- Create subdirectories
- Split large files based on maximum duration in seconds
- Include WAV/W4V files
 - Split stereo files to separate mono files
 - Compress audio files
- Time expansion factor (Bat Analysis Mode only)
- Include zero-crossing files (Bat Analysis Mode only)

- Set division ratio
- Use ZC 8.3 file names
- Use .zc instead of .??#
- Noise filter options (Bat Analysis Mode only)
 - Disable Noise Filtering
 - Delete Noise Files
 - Move noise files to NOISE subfolder
- GPS extraction options
 - Extract GPS Disabled
 - Extract GPS to CSV
 - Extract GPS to KML



Choose Input Source and Formats

When Kaleidoscope does any sort of batch process it requires an input directory for source files and an output directory for batch process results. Under the **Batch** Tab in the Control Panel, configure the INPUTS parameters found on the left-hand side of the window.

- Click **Browse** to select the input directory. This is a local folder containing the input files to be processed. This operation selects a directory or folder, not an individual file. Depending on the operating system, individual files in a given directory may not be shown or will appear greyed out.
- There is an option to add a **Drive label (nickname)** for the input directory. This information is added to a Managed Cloud Account when a labeled batch process is uploaded to the database. This option requires a Kaleidoscope Pro license.
- Check **Include subdirectories** to process files recursively in all the subfolders below the specified Input directory. Otherwise only the files found in the top level of the Input directory will be process and any subfolders will be ignored.
- Check **WAC files** to process any available .wac format files.
- Check **WAV (and W4V) files** to process any available .wav/.w4v format files.
- In Bat Analysis Mode, the **Time expansion factor** used by the input files must be specified. A factor of 1 should be used for normal speed files. If the input .wav file was created by a time expansion capable bat detector, the time

expansion factor should be set to the same time expansion factor used to make the recording. The Auto setting can be used to automatically choose a time expansion factor of one for high-speed recordings (e.g. sample rates greater than 96 kHz) or ten for lower speed recordings (e.g. less than or equal to 96 kHz), unless an explicit time expansion factor can be found in the metadata.

- In Bat Analysis Mode, check **ZC files** to process any available .??# and/or .zc files.

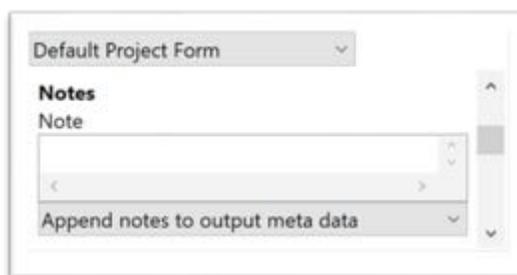
Additional Input Options

- **Fuzz GPS to Precision** is used to obfuscate GPS location information in the metadata from input to output. The value of the Fuzz is precision in degrees the GPS location is rounded to. For example: A Fuzz value of 1.0 means if the original GPS location is 42.365842 N 71.964281 W, it will be rounded up on output to 42.0 N 72.0 W. If fuzz value is 0.25, it would round to 42.25 N 72.00 W. This provides the option to obscure the exact location of the original recordings in output metadata.
- During batch file conversion, Kaleidoscope can add metadata to output files via a project form. Add comments and other textual information to the metadata in the output files by appending, prepending, or replacing any existing metadata in the project form. Kaleidoscope Pro provides a **Default Project Form** for field notes, as well as the option to import custom project forms. Under the **Batch** Tab of the Control Panel at the bottom of the INPUTS section on the left, select:
 - **Default Project Form** – This is the default Kaleidoscope project form.
 - **Add or Replace a Project Form** – Use this to import a custom project form. A Kaleidoscope Pro license is required to use custom project forms.
 - For additional information regarding custom metaforms see [this section](#).
- During batch file conversion, Kaleidoscope can replace, append, or prepend field notes to the metadata in output files. Within the Default Project Form, select from among **Append notes to output metadata**, **Prepend notes to output metadata**, or **Replace notes in output metadata**, and optionally type field notes into the text box below this choice. When the batch job is run, any notes provided will be added to any existing notes (depending on the choice specified) and written to the output files. The original input files are not modified during batch processing.

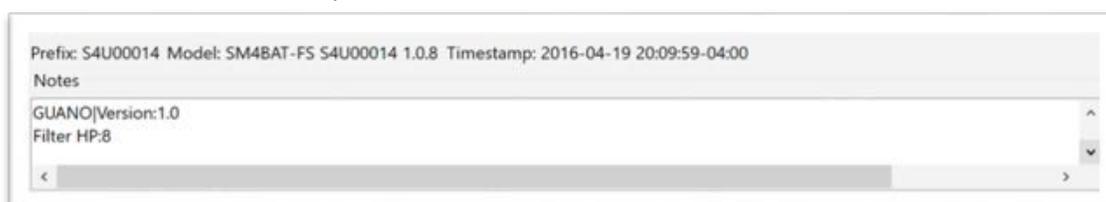
GUANO Metadata

- Arbitrary GUANO metadata may be added to output files in batch mode by adding the following line in the Default Project Form followed by one or more lines consisting of arbitrary GUANO key:value pairs:

```
GUANO|Version:1.0
some tag:some value
another tag:another value ...
```



- GUANO metadata can be reviewed in the Viewer via the Metadata Panel Notes field. GUANO metadata can be edited or added and saved back out. Press the Enter key or change a manual identification in order for the Metadata Panel to write out to the file and update the metadata.



Choose Output Destination and Formats

Under the **Batch** Tab in the Control Panel, configure the OUTPUTS parameters found on the right-hand side of the window:

- Click **Browse** to select the output directory for the output files. It is also possible to create an output directory from the browse window. **Note: This folder must not be located within the input directory.**
- If **Include subdirectories** is checked in the INPUTS section, output subfolders will be created mirroring the directory structure of the input data.
- There is an option to add a **Drive label (nickname)** for the output directory. This information is added to the Cloud when a labeled batch process is uploaded to the database. This option requires a Kaleidoscope Pro license.
- If stereo (two channel) files are included in the inputs, it is possible to use the **Channel Selection** menu to choose whether the left channel, right channel, or both channels will be processed to the outputs.
- Kaleidoscope can automatically sort output files into daily or nightly subfolders (if Kaleidoscope can determine the recording timestamp from the input filenames or metadata) by choosing **Daily** or **Nightly** for **Create subdirectories**. For no automatic sorting of output files, specify **None**.

When Daily is selected files are sorted by calendar date. When Nightly is selected files are sorted based on noon-to-noon time frames

- **Split to max duration, seconds** has two functions.
 - When doing an Auto-ID for Bats, or Acoustic Index Analysis batch process, Kaleidoscope Pro can split a large file into smaller segments for analysis. This does not require new audio files to be created on output. The separate segments will be listed in the Results window with offsets from the start of each file.
 - If WAV or ZC files are created on output for any batch process, this function will split larger files into smaller files based on the specified duration.
 - If this field is left blank Kaleidoscope will not split larger files into smaller files or segments.
- Check **WAV (or W4V) files** to convert input files to .wav/.w4v format files.
 - Check **Split channels** to separate each channel of a two-channel input file into individual single-channel output files and/or segments.
 - By default, uncompressed .wav files will be created. Kaleidoscope can also generate compressed .w4v files by specifying a **Compression** value. Supported output compression formats include: W4V-8 for 50% compression, W4V-7 for 56% compression, W4V-6 for 63% compression, W4V-5 for 68% compression, and W4V-4 for 75% compression. The compression percentage equals the amount of file size reduction. For example, 75% compression means the file is now 25% of its original size.
 - In Bat Analysis Mode only, a **Time expansion factor** can be specified. If time-compressed input files have been processed, this option can create output files that have been time-expanded. For normal speed files, use a factor of 1.
- In Bat Analysis Mode only, check **ZC files** to convert to .??# format files. The **Division Ratio** can be specified. Check **8.3 file names** to create output files with the legacy 8.3 filename convention (Note: The 8.3 filename convention can only be performed if the input files have a compatible timestamp). Otherwise Kaleidoscope will use the suffix .00#. If **Use .zc instead of .??#** is checked, Kaleidoscope will use the file suffix .zc

Additional Output Options

During batch file conversion in Bat Analysis Mode, Kaleidoscope can analyze each output file looking for detected signals (bats) and isolate files containing only uninteresting signals such as ambient background noise, rain and wind, or unwanted biological signals such as insects. These files are then labelled as Noise files.

Settings under the **Signal Params** Tab are used to specify whether a recording meets the criteria to be considered a signal of interest, or noise. As files are processed, Kaleidoscope decides if the file meets the criterion specified. If a file does not contain at least minimum number of pulses which have frequencies and durations in the ranges specified, then the file is considered to be noise.

Useful tip: weak signals may cause a discontinuity in a detected syllable resulting in two or more smaller file fragments. It may be useful to use smaller values for the minimum signal duration in order to consider these weaker signals as interesting. Setting the minimum duration to 0ms will allow even the smallest pulses to be counted as long as they meet the frequency range requirements. These settings are adjusted under the **Signal Params** Tab.

- There are three options for noise filtering:
 - **Disable noise filtering** – No noise filtering is applied.

- **Delete noise files** – Any files detected as noise are discarded from the output batch. This is not a recommended option for typical use.
- **Move noise files to NOISE folder** – A **NOISE** folder is created in the output directory and any output files designated as noise are placed in that location.

Kaleidoscope can extract GPS information from metadata in input files. The precision of the GPS data is determined by the Fuzz value in the INPUTS section.

- There are three options for GPS data extraction:
 - **Extract GPS Disabled** – No GPS data is extracted from inputs files.
 - **Extract GPS to CSV** – GPS data found in the metadata of input files is extracted and used to create a `gps.csv` file in the output directory. Columns are created for **DATE**, **TIME**, **LAT**, **LON**, and **NAME**, where **NAME** is the filename of the corresponding output file or blank for waypoints. If waypoints are available (e.g. in a `.WAC` file), the frequency of waypoint extraction can be specified in seconds.
 - **Extract GPS to KML** – GPS data found in the metadata of input files is extracted and used to create a `gps.km` file in the output directory. The KML file can be opened directly from Google Earth and will display a placemark corresponding to each output file. If waypoints are available (e.g. in a `.WAC` file), the frequency of waypoint extraction can be specified in seconds and are represented as a path in the KML file.

4.4 Signal Params Tab

“Signal Params” is short for Signal Parameters.

When Kaleidoscope Pro is used to analyze files for noise content (Bat-Analysis Mode only), Auto ID for Bats, or Cluster Analysis, signals are first examined for content.

The **Signal Params** Tab provides settings considered by Kaleidoscope Pro when using these functions in a batch process. Input files are examined for signals of interest based on the parameters in this window. Signals of interest which meet the specified criteria are then designated as detected signals and assigned for further analysis. There are separate signal parameters available depending on whether Kaleidoscope is in Bat Analysis Mode or Non-bat Analysis Mode.

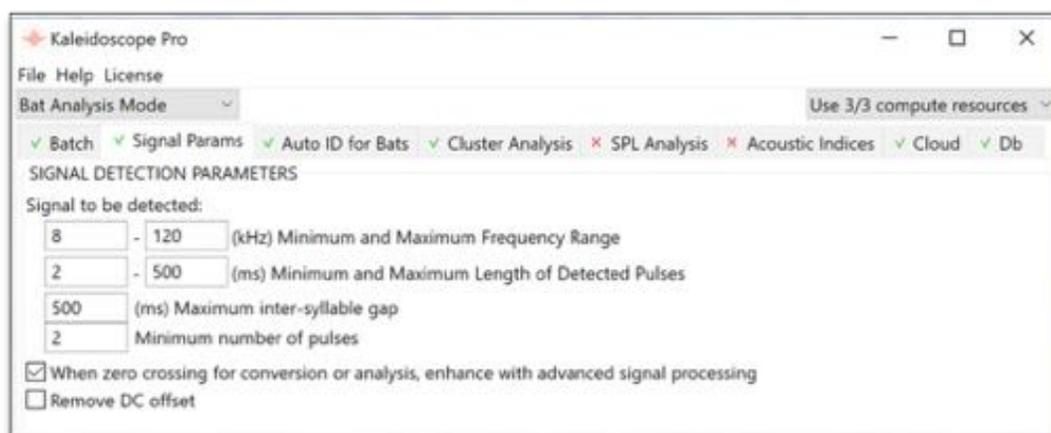
Accurate settings in the **Signal Params** Tab are critical for getting best results. Inaccurate settings can result in signals which would otherwise be of interest not be considered for further analysis.

The following is a list of all parameters found under the **Signal Params** Tab:

Bat Analysis Mode

Signal Detection Parameters

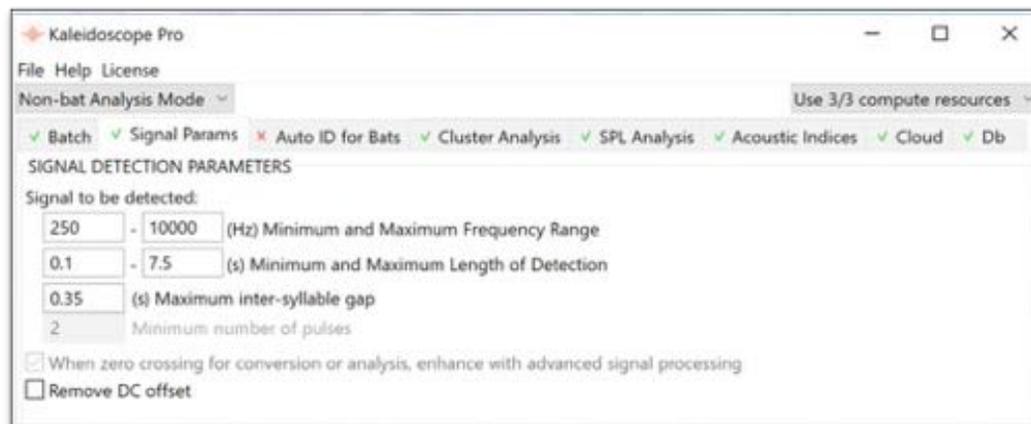
- Minimum and Maximum Frequency Range in kHz
- Minimum and Maximum Length of Detected Pulses in ms
- Maximum inter-syllable gap in ms
- Minimum number of pulses to be considered a phrase or pulse sequence.
- When zero-crossing for conversion or analysis, enhance with advanced signal processing
- Remove DC offset



Non-bat Analysis Mode

Signal Detection Parameters

- Minimum and Maximum Frequency Range in Hz
- Minimum and Maximum Length of Detection in seconds
- Maximum inter-syllable gap in seconds
- Remove DC offset



Signal to be detected: Bat Analysis Mode

A detected signal is a phrase comprised of one or more pulses, or syllables, occurring close together in time such that the maximum inter-syllable gap is not exceeded. The detected signal will be constrained to minimum and maximum frequencies and durations, and a minimum number of pulses.

If an input file does not have content which meets the signal parameters, that file is considered to be noise. The noise designation is listed in the meta.csv and id.csv output files. If .wav or zero-crossing files are being created in the batch process, output files designated as noise are moved to a NOISE folder in the output directory

- **Minimum and maximum frequencies**
Describes acceptable frequency range for detected signals.
- **Minimum and maximum durations**
Describes time duration range in milliseconds for pulses (syllables) which will be considered as detected signals.
- **Maximum inter-syllable gap**
Describes maximum allowable gap between found syllables.
If the maximum inter-syllable gap is set to less than the time between individual pulses, an individual pulse will be considered a signal of interest. If the maximum inter-syllable gap is longer than the space between pulses but still less than the space between a sequence of pulses, the entire sequence is considered to be a signal of interest. **This function applies for cluster analysis but is ignored for bat auto ID analysis.**
- **Minimum number of pulses**
Describes minimum number of call pulses to be considered a detected signal.
- **When zero-crossing for conversion or analysis, enhance with advanced signal processing.**
Converting from .wav/.w4v or .wac full-spectrum to .??# zero-crossing uses digital signal processing controlled by additional parameters found under the **Signal Params** Tab. Zero-crossing hardware technology has a disadvantage over full-spectrum recording technology of approximately 20dB in signal-to-noise ratio (SNR) because zero-crossing hardware must overcome noise in the entire frequency bandwidth of interest while FFT analysis of full-spectrum signals must only overcome noise in a narrow frequency bin.
Kaleidoscope implements patented advanced signal processing algorithms for extracting zero-crossing data from full-spectrum recordings. These algorithms are enabled (by default, recommended) by checking **When zero-crossing for conversion or analysis, enhance with advanced signal processing**. When turned off, the full-spectrum input is band-pass filtered according to the frequency range specified by the Signal of interest parameters and the resulting signal is converted to zero-crossing without further enhancement. When

turned on, Kaleidoscope further enhances the signal with noise reduction and echo cancellation techniques prior to zero-crossing, and also removes fragmented calls. The result is a cleaner filtered zero-crossing output which may detect weak signals that would have been missed or fragmented using conventional zero-crossing hardware. On the other hand, some weaker or fragmented pulses remaining may be discarded.

It is recommended to leave this feature turned on, especially when using the Auto ID for Bats function.

Signal to be detected: Non-bat Analysis Mode

A detected signal is a phrase comprising a sequence of syllables occurring close together in time such that the maximum inter-syllable gap is not exceeded. A syllable is the period between a detected onset above the background noise until the signal drops back towards the noise floor. A phrase is a series of syllables which occur within a vocalization. It is possible for multiple species to make a sound at the same time, so a detected signal could contain multiple syllables or phrases from multiple species. The detected signal will also be constrained to minimum and maximum frequencies and durations.

- **Minimum and maximum frequencies**

Describes acceptable frequency range for detected signals.

- **Minimum and maximum durations**

Describes time duration range in seconds for syllables to be considered for further analysis.

- **Maximum inter-syllable gap**

Describes maximum allowable gap between found syllables within a detected signal.

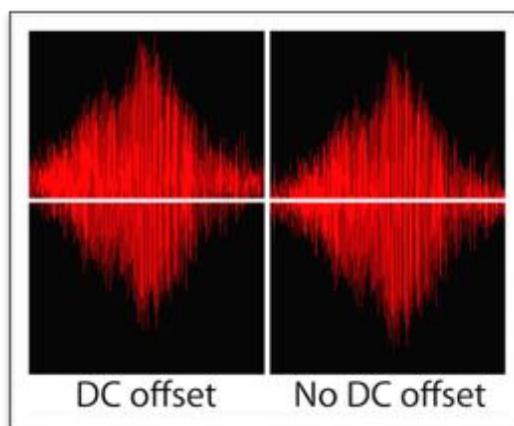
When recording full spectrum audio files with fixed durations, it is possible a single recording may contain multiple vocalizations, as well as other non-animal sounds. If the maximum inter-syllable gap time is exceeded, the next syllable is considered to be part of a new detected signal. This means a single input file may represent multiple detected signals.

Remove DC offset from input recordings

This parameter is available in both Bat Analysis and Non-bat Analysis modes.

An audio waveform has negative and positive amplitude. Ideally negative and positive aspects of the audio waveform are equally distributed. If the waveform is unevenly biased towards negative or positive, that is called a DC offset. Spectral analysis of recordings with DC offsets only affect power measurements of very low frequencies (e.g. the first few FFT bins) and generally should not affect analysis under normal conditions.

- When Remove DC offset is checked, full-spectrum audio files that are opened in the Viewer will have any DC offset removed.
- When Remove DC offset is checked, all full spectrum audio files created in a batch process will have any DC offset removed.



4.5 Auto ID for Bats Tab

Requires Kaleidoscope Pro license. Available only in Bat Analysis Mode.

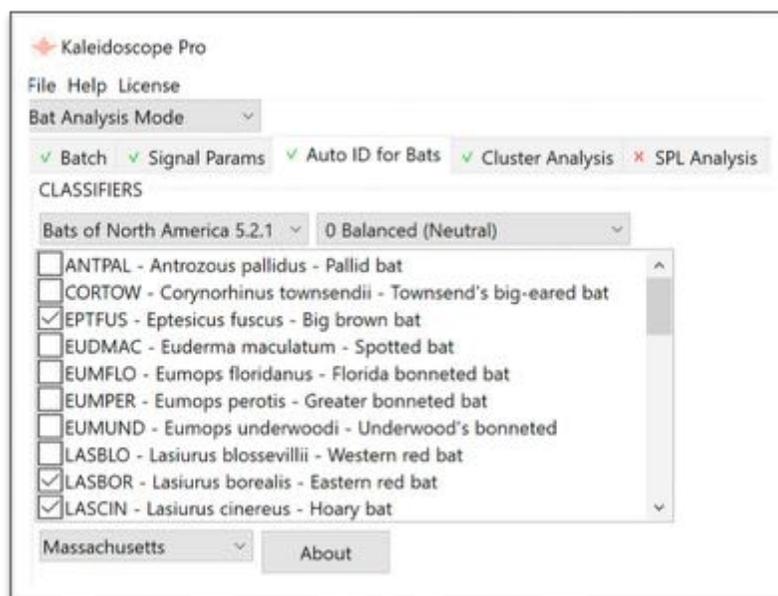
The following is a list of all parameters found under the Auto ID for Bats tab

Classifiers

- Bats of Europe
- Bats of North America
- Bats of South Africa
- Bats of the Neotropics

Balance

- -1 More Sensitive (liberal)
- 0 Balanced (neutral)
- +1 More Accurate (conservative)



Overview

- Kaleidoscope can analyze one or more files in an Auto-ID for Bats batch process. [Larger files can be split into smaller file segments for separate analysis.](#)
- During batch processing, Kaleidoscope Pro uses reference classifiers to attempt automatic species identification of input recordings.
- At this time, bat classifiers are offered for North America, South and Central America, Europe, and South Africa. Wildlife Acoustics continues to work to expand classification coverage to include additional bat species and geographic regions and to improve identification accuracy.
- Kaleidoscope Pro will make a determination as to the closest match between the input file and the reference files.
- Auto-ID is intended for use in analyzing recordings of single bats in free flight in low clutter environments. Recordings of roost emergence, multiple or captive bats, bats in high clutter environments, or bat social calls are generally not suitable for Auto-ID. In addition, the Auto-ID feature does not include every possible bat for each of the covered regions. Therefore, if a bat that is not included is recorded, it may be identified as a species with a similar echolocation call type.
- The best use of Auto ID is to do automatic sorting and classification first, and then follow up with manual verification of the files. Even if Kaleidoscope Pro makes false positive identifications it will have done a great deal of work sorting files to speed up the overall process of identification.
- Because bats vary their echolocation calls in response to a wide variety of circumstances, no automated call identification can achieve 100% accuracy in species identification. **These automated identifications, though largely accurate, should not be relied on solely as a basis for scientific research or land management decisions. The**

automatic identification function is intended only as a suggestion to facilitate analysis, not to replace human expert vetting of calls.

- In addition to the Auto-ID function, Kaleidoscope Pro also provides a basic clustering function which can be used to sort recorded vocalizations.
- Full-spectrum and zero-crossing files do not have to be created in the output directory in order to use the auto ID function. If full-spectrum or zero-crossing files are created in the batch process, those files can be updated with any new metadata added during the batch process, or manual IDs added during review.
- Additional information about auto ID classification theory can be found in the Resources chapter in this user guide.
- A complete list of bat species supported by the auto-ID function is found [here](#).

Configure Settings for Automatic Bat ID Classification

- Automatic identification of bats is a three-step process.
 - Input files are examined via the settings under the **Signal Params** Tab. If the input files pass the signal parameter filters, they are passed on to the auto-ID function. Therefore, the signal parameters must be set correctly for accurate detection of sequences of pulses. Refer to the [Signal Params](#) Tab section in this chapter for further information regarding signal parameter settings.
 - Files which pass the signal parameters are then passed to the auto analysis function. Auto analysis will be based on the classifiers selected under the **Auto ID for Bats** Tab.
 - When the batch process is run, files which have passed the signal parameter values are compared against the reference classifiers and then labelled accordingly.
- Click on the **Auto ID for Bats** Tab in the Control Panel.
- Choose the general geographic classifier.
- Select the **Region** within the geographic area.
 - Check or uncheck bat species which may be considered in the classification process. For best results include only the species expected to be found. If a species classifier is not checked, it will not be considered in the auto ID analysis.
- Adjust the sensitivity level for classification. A higher value will result in fewer but more accurate auto ID results.
 - **-1 More sensitive (Liberal)**
 - **0 Balanced (Neutral)**
 - **+1 More Accurate (Conservative)**

Run the Batch Process

Once the batch, signal parameters, and auto ID classifiers are configured, press the **Process Files** button.

- If both the input and output directories are in a Managed Cloud Account, Kaleidoscope Pro will provide the option to run the batch process via Cloud-based computing. For large amounts of data, Cloud-based computing will be much faster than using the local computer for the batch process. For further information regarding Cloud-based computing refer to the [Cloud](#) Tab section in this user guide.
- When the batch process is complete, an idsummary.csv and an id.csv file will be created in the output directory. The Results window represents the underlying id.csv file.
- If the batch process is run on the local computer a db-batch.wdb file will be created in the output directory. This file can be uploaded to a Managed Cloud Account to update the database. If the batch process was run using Cloud-based computing the results are automatically added to the Managed Cloud Account database and no db-batch.wdb file is created.
- If the batch process is run on the local computer the Viewer and Results window will open automatically when the batch process is complete.
- If the batch process is run using Cloud-based computing, an email will be sent notifying the user when the batch process is complete. It is also possible to check the status of the batch process via the user's Managed Cloud Account page at the Wildlife Acoustics web site.

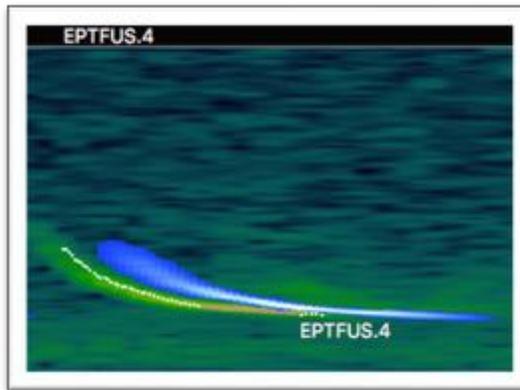
If the batch process is run using Cloud-based computing an id.csv file will be created in the output directory. The browser under the **Cloud** Tab can be used to navigate to the output directory. Locate and select the id.csv file and the Viewer and Results window will open.

If Cloud-based processing is used to run the batch process, the results will automatically be added to the Managed Cloud Account database. Once the batch process is complete, database searches can be run immediately via the Db Tab.

Check the Results

- The Viewer will display auto ID labels for individual pulses in the detected signal, based on the reference classifiers selected under the **Auto ID for Bats** Tab. Each reference classifier contains multiple variations of pulses from the same species. Reference classifier pulses are numbered based on commonality of the pulse. Lower numbered pulse classifiers are the most common. The reference pulse number will be listed above each pulse in the Viewer to indicate which reference pulse matches the detected pulse.

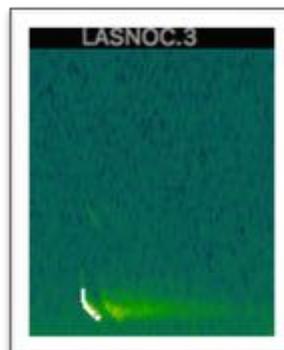
In the following graphic the reference classifier is displayed next to a detected pulse. The reference pulse is displayed in blue. The detected pulse is shown as both a full-spectrum and zero-crossing signal. The designation of the reference pulse is shown below. The designation of the detected pulse is shown above. The detected pulse designation is shown as highlighted because it matches the overall pulse sequence classification.



- If a pulse is identified but does not match one of the most common pulse classifiers, it may be labelled with a ? rather than a number.



- If a pulse matches a reference classifier that does not match the overall sequence classification, the pulse will be labeled but not highlighted. This can happen if there is more than one species of bat in a detected signal, for example.



- If a pulse does not match any of the selected classifiers, no classification label will be assigned.
- Once Kaleidoscope Pro has examined each pulse in the detected signal, a sequence-level classification is made. A detected signal may contain pulses from multiple species but can have only one sequence level classification. The sequence level classification is based on analysis of individual pulses and the overall sequence. If the pulses and sequences do not provide enough information that matches the reference classifier, the detected signal will be labelled as No ID. If the detected signal does not have recognizable pulses or sequences, it will be labelled as noise.
- If WAV or ZC files has been checked in the OUTPUTS section of the **Batch** Tab, those files will have been created in the output directory. A NOISE folder will also have been created in the output directory. Any output files analyzed and designated as noise will be placed in this folder.

Update with manual IDs

- The Viewer and Results window can be used to add manual IDs to the detected signals.
- After adding manual IDs, choose **Save** or **Save As...** from the Results window File menu.
- A db-review.wdb file will be created in the output directory. The db-review.wdb file can be uploaded to a Managed Cloud Account to update the database.
- The underlying id.csv file as well as the metadata in any full-spectrum or zero-crossing files which may have been created in the batch process will be updated.
- The id.csv file can be re-opened into the Results window. Go to the Control Panel and choose **File menu->Open results...**
- For further information regarding the Viewer and Results window refer to those sections in this chapter of the user guide.

Output Summary File (idsummary.csv)

- The idsummary.csv file is created when an Auto ID for Bats batch process is run.
- The idsummary.csv file contains an overall summary of the batch classification.
- For further information regarding the idsummary.csv layout see the Resources chapter in this user guide.

Output Identification File (id.csv)

- The id.csv file is created when an Auto ID for Bats batch process is run.
- The id.csv file has a data row for each output file.
- The id.csv file can be updated with manual ID reviews.
- For further information regarding the id.csv layout see the Resources chapter in this user guide.

db-batch.wdb File

- The db-batch.wdb file is created in the output directory if the batch process is run on the local computer.
- The db-batch.wdb file can be uploaded to a Managed Cloud Account to update the database. This is done via the **dB** Tab.

db-review.wdb File

- The db-review.wdb file is created in the output directory when manual ID results are saved in the Results window.
- The db-review.wdb file can be uploaded to a Managed Cloud Account to update the database. This is done via the **dB** Tab.
- Multiple users can examine the same files to add manual IDs. Each user can upload their own db-review.wdb file. The database can be queried to find multiple manual IDs for the same file based on different user reviews.

4.6 Cluster Analysis Tab

Requires Kaleidoscope Pro license. Available in Bat Analysis Mode and Non-Bat Analysis Mode.

The following is a list of all parameters found under the Cluster Analysis Tab:

Scan and cluster recordings to create cluster.kcs and cluster.csv files

- Max distance in ms from cluster center to include outputs cluster.csv file
- FFT window range
- Max States
- Max distance to cluster center for building clusters
- Max clusters

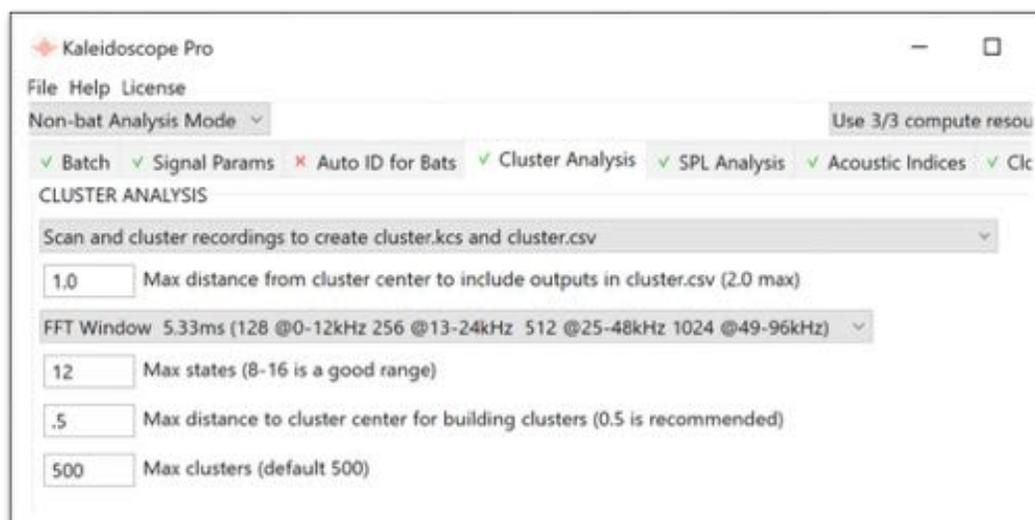
Re-scan recordings and edited cluster.csv to create new cluster.kcs with pairwise classifiers and cluster.csvs

- Browse and select .kcs file
- Max distance in seconds from cluster center to include outputs cluster.csv file
- FFT window range
- Max states
- Max distance to cluster center for building clusters
- Max clusters

Use existing .kcs file to sort new recordings and create new cluster.csv file

- Browse and select .kcs file
- Max distance in ms from cluster center to include outputs cluster.csv file

Scan recordings and extract detections (no clustering)



Overview

Cluster analysis is a powerful tool in Kaleidoscope Pro which is used to analyze, sort, and identify detected signals based on similar patterns. Clusters are classifications derived from files which have been analyzed to find similar acoustic, or zero-crossing patterns.

There are two general ways to use cluster analysis.

- Basic clustering analyzes files to find similar detected signals and group them into clusters. Basic clustering is useful for general surveying of species, including bats, and variations of vocalizations within species.
- Based on a basic cluster analysis, a classifier can be created. Classifiers can be simple or advanced. A classifier is used to sort and label new recordings. Classifiers are typically used to pick out specific vocalizations or acoustic patterns.

Basic cluster analysis for bats may be useful when there are no local reference files available for the Auto ID function. Cluster analysis for bats is also useful if the user does not want to use any Auto ID function, and would prefer to have Kaleidoscope Pro sort the data based on similar pulses and sequences of pulses, which can then be manually identified and labelled. A simple classifier built from local deployments may be useful for further analysis and identification of bat species. In general, advanced classifiers are not useful for bat recordings.

Basic cluster analysis is very useful for sorting and labelling birds, frogs and other acoustic patterns. Simple classifiers allow sorting and labelling based on previous training data. Advanced classifiers are used to further decrease false and negative identifications when looking for specifically labelled vocalizations and acoustic patterns.

It is important to understand that cluster analysis is a statistical probability function. The more information provided, the more refined the results will be. Smaller amounts of data will produce less reliable results.

- The Cluster Analysis function works in both Bat Analysis Mode and Non-bat Analysis Mode.
- Cluster Analysis and Auto ID for Bats cannot both be enabled at the same time.
- Input files are initially analyzed for signals of interest, based on settings made under the **Signal Params** Tab.
- A single input file may contain multiple detected signals; therefore the number of detected signals may be greater than the number of input files.
- The **Cluster Analysis** Tab provides parameters for creating clusters of similar detected signals.
- The detected signals are sorted into clusters based on similarity.
- The resulting clusters can be quickly reviewed and verified to efficiently survey species presence.

For more detailed information on cluster analysis theory, go [here](#).

For a step by step description of how to do basic cluster analysis, go [here](#).

For tips on how to build a simple classifier, go [here](#).

For tips on how to build an advanced classifier, go [here](#).

For tips on tuning cluster analysis, go [here](#).

For tips on adding new training data to an advanced classifier, go [here](#).

For tips on working with rare detections, go [here](#).

Bat Analysis Mode vs Non-Bat Analysis Mode

Cluster Analysis works in both Bat Analysis Mode and Non-Bat Analysis Mode. The difference between these modes is visible under the **Signal Params** Tab. Parameters under the **Cluster Analysis** Tab do not change between modes.

The first difference is frequency range.

In general, bats make sound in the ultrasonic range. In Bat Analysis Mode the **Signal Params** Tab provides options for lowest and highest frequencies in kHz. The default settings are 8 to 120 kHz. This means the signal parameters will not consider any frequencies below 8 kHz. Some non-bat animals make sounds at 8 kHz and above, while most birds for example, make sounds at lower frequencies than 8 kHz. This means if recordings of wildlife which include lower frequency signals are used for input data and Kaleidoscope Pro is set to Bat Analysis Mode, none of those lower frequency signals will be considered for clustering.

Likewise, the default frequency range for signal parameters in Non-Bat Analysis Mode is to 250 Hz to 10000 Hz (10 kHz). If the input signals are recordings of bats, and Kaleidoscope Pro is set to Non-Bat Analysis Mode, there is a good chance none of the bat recordings will be considered for clustering.

The second difference between Bat and Non-Bat Analysis Modes has to do with broad-band vs narrow-band detection.

Bat echolocation calls are typically narrow frequency band signals. Sounds made by birds and other animals may be much more wide-band signals.

A typical bat echolocation call is made with a series of pulses. Kaleidoscope Pro can look at both the individual pulses and the patterns of the pulses. In Bat Analysis Mode, clustering is based on the pulse sequences of bats as they are converted to zero-crossing to look at the underlying patterns in pulse shapes and sequences of pulses. The Maximum inter-syllable gap parameter can be set to a small number (like a few milliseconds) to cut off each pulse individually, in which case individual pulses will be clustered, or a larger number (such as the default of 2 – 500 ms) where a sequence of pulses results in a pattern: e.g. a "bat pass".

The distinction between using zero-crossing analysis for Bat Analysis Mode and full spectrum frequency-by-power envelope for Non-bat Analysis Mode is that bats are generally narrow-band (whistled) where the frequency content (other than the dominant frequency) is fairly redundant and hard to measure accurately: e.g. sensitive to variations of microphones, echoes, distance, placement, etc. But for bird/frog/other vocalizations, there is often a great deal of information encoded across the different frequencies at a given point of time representing harmonic structure, rapid transients, etc. Many birds like crows, geese, woodpeckers, etc., have more broad-band qualities to their vocalizations than narrow-band. Recordings are typically made in noisy environments. Zero-crossing analysis does not work in this type of environment. If animals with broad-band vocalizations including ultrasonic content are being studied, Non-bat Analysis Mode may provide better results even though the signal parameters are calibrated for ultrasound.

Basic Cluster Analysis

Select the clustering mode from the menu under the **Cluster Analysis** Tab in the Control Panel.

Scan and cluster recordings to create cluster.kcs and cluster.csv

- This is the first step in any cluster analysis work. Before simple or advanced classifiers can be built, a basic cluster analysis batch process is first run. In some cases, the basic analysis may be all that is needed in order to provide the desired results.
- In this mode, input recordings are analyzed for detected signals consisting of one or more syllables as described under the **Signal Params** Tab in the Control Panel. The Kaleidoscope Pro clustering algorithms are then used to sort the detected signals into clusters by similarity.
- Cluster analysis is done as part of a batch process.
 - If the cluster analysis is run on the local computer, the Viewer and Results window will open automatically when the batch process is complete.
 - If the cluster analysis is done using Cloud-based computing a notification email is sent to the user when the batch process is complete. The user can then use the browser under the **Cloud** Tab to navigate to the batch process output directory. The results of the cluster analysis batch process are contained in a cluster.csv file. From within the Cloud browser, double click on the cluster.csv file to open the Viewer and Results window.
- The Results window represents the underlying cluster.csv file which has been created by the batch process. If the batch process was run on the local computer, the cluster.csv file can be re-opened into the Results window at any time by going to the Control Panel File menu->Open Results. If the batch process was run using Cloud-based computing the Viewer and Results window can be re-opened at any time by using the Cloud browser and double-clicking on the cluster.csv file in the output directory.
- The highest number of similar detected signals will be assigned to cluster#0. Subsequent clusters are ordered to be most similar to those that come before.
- Clusters are created based on similarities between detected signals. Some detected signals are very similar. Some detected signals may be similar but less so. For example, a single detected signal may contain a single obvious signal of interest. Other detected signals may have less similar representation of the signal of interest. Individual detected signals can contain multiple examples of a single species making sound at the same time. It's also possible a single detected signal will contain vocalizations made by multiple species. Detected signals are numbered based on their distance to the cluster center. The cluster center represents the pattern which is most similar in the detected signals. A lower numbered detected signal (as displayed in the **TOP1DIST** column in the Results window) is closer to the cluster center as compared to a higher numbered detected signal.
- Detected signals with their cluster assignments are listed in the Results window. Clicking on a column header in the Results window will sort the data in that column. Click on **TOP1DIST** to sort detected signals within clusters by distance to cluster center. Click on the **TOP1MATCH** column to sort the clusters.
- Detected signals within clusters can be examined in the Viewer. Buttons in the Viewer (as well as key commands) can be used to cycle through detected signals within a cluster or to jump to the first or last detected signal of consecutive clusters. This makes it easy to quickly navigate between and audition different detected signals within clusters.

Re-scan recordings and edited cluster.csv to create new cluster.kcs with pairwise classifiers and cluster.csv

This step creates an advanced classifier which can be used to identify specific detected signals based on previous cluster analysis and manual review. It is important to understand that the advanced classifier is designed to isolate specific detected signals while reducing false positive identifications. Care should be taken in building the advanced classifier so it does not exclude detected signals which may otherwise be desired in the final results.

- The first step is to run a cluster analysis batch process on files which are used as training data. The results of the basic cluster analysis batch process are then manually edited to label specific detected signals. The goal is to isolate the best examples of a detected signal and its variations.
- After the basic cluster analysis batch process has been run, copy the generic cluster names to the **MANUAL ID** column in the Results window. Bring the Results window to the front and go to the Results window File menu and choose **Copy Top1Match/Auto ID to Manual ID**. This preserves all the clusters from the original cluster analysis.
- In the Metadata panel, create at least one button label which will be used to label the training recordings for the new advanced classifier.
- Start to review individual vocalization that represent the species or detected signal to be found with the advanced classifier.

- If the vocalization represents a good example of the desired signal of interest, press the custom-labeled button to confirm and add a manual ID to the vocalization in the Results window.
- If a vocalization contains the species of interest but also contains other species, press a blank button in the Metadata panel. This will remove the generic cluster name from the vocalization. A vocalization with no label in the **MANUAL ID** column will not be considered for training the advanced classifier. If a vocalization is manually labeled and does contain additional species, those additional species may be identified with the advanced classifier. If the species of interest vocalizations always contain other species, it may be unavoidable for some of these other species to be found by the advanced classifier.
- It is not uncommon to find false positives in a cluster. This can happen if Kaleidoscope Pro sees the detected signals as similar in some way, even though they are not the same species. Part of the power of the advanced classifier is it can be trained to exclude false positive identifications. When auditioning detected signals within a single cluster, if a false positive is found, leave the generic cluster name in the **MANUAL ID** column. This will train the advanced classifier to see the false positive as something other than the desired signal of interest.
- The same species may be found in different clusters in the initial cluster analysis batch process. This can happen if there are different vocalizations from that species, or if there are other differences in the recordings such as window or rain. If the same species in different clusters are given the same manual ID, this will cause similar vocalizations from the new recordings to be extracted and labeled.
- If the species of interest makes multiple distinctly different vocalizations, it may be more effective to use a different custom button label for the variations of the vocalizations.
- The advanced classifier will use the manually labeled vocalizations to isolate vocalizations from the new data. New vocalizations that match the manually labeled training data will be labeled with the custom name. Therefore the more vocalizations that are accurately labeled in the training data, the more effective the advanced classifier will be.
- Under the Results window file menu select Save. This will update the underlying cluster.csv file with the manual IDs
- Under the **Batch** Tab, keep the input directory assigned to the original training files.
- Under the **Signal Params** Tab keep the settings the same as they were for the initial cluster analysis.
- Select a new output directory.
- Under the **Cluster Analysis** Tab choose Re-scan recordings and edited cluster.csv to create new cluster.kcs with pairwise classifiers and cluster.csv
- Press the Browse button and locate the edited cluster.csv file from the initial cluster analysis batch process.
- Press the Process Files button.

Kaleidoscope Pro will re-analyze the training files, this time using the edited cluster.csv file as a classifier.

Detected signals with manual IDs in the edited input cluster.csv file are isolated and labeled. Clusters with the original generic cluster names are kept intact. This provides clusters for all the signals that are not of interest. Vocalizations with blank manual IDs are not considered as training data for any clusters. If there are two or more different manual ID labels in the cluster.csv file, additional pairwise classifiers will be constructed to improve discrimination between detected signals and therefore reduce false positive identifications.

- A new cluster.kcs file is produced in the current output directory. This file is the advanced classifier. The new cluster.kcs file contains representations of the manually identified vocalizations which are now used to sort new data.
- A new cluster.csv file is also created in the new outputs directory to show the performance of the new classifier. This file can be checked in the Viewer and Results window. The manual IDs can be compared to the training files to verify accuracy of the advanced classifier.
- To use the advanced classifier function, select the Cluster Analysis option **Use existing .kcs to sort new recordings and create new cluster.csv**
- Press the Browse button and select the trained cluster.kcs file as the advanced classifier.
- Under the **Batch** Tab select an input directory that contains new files to be analyzed.
- Create a new output directory.
- Press the Process Files button.
- If the batch process is run on the local computer the Viewer and Results window will open automatically when the batch process is complete.

If the batch process is run using Cloud-based computing an email will be sent to the user when the batch process is complete. Use the file browser under the **Cloud** Tab to navigate to the output directory. Double-click on the cluster.csv file to open the Viewer and Results window.

- Kaleidoscope Pro will analyze the new input files using the advanced classifier cluster.kcs file. The new results will isolate and label vocalizations based on the manual IDs from the training data. The new results will also include clusters based on the original generic clusters. These can be ignored.

Use existing .kcs to sort new recordings and create new cluster.csv

This function will use a simple classifier which has been created based on existing data. The simple classifier can be used to sort and label new data. The new data will contain clusters which are identified and labelled based on the information from the simple classifier. The new input files are not affected by settings under the **Signal Params** Tab when using an existing cluster.kcs file.

The first step is to do an initial cluster analysis. The initial cluster analysis will create clusters based on the settings within Kaleidoscope Pro and the input files from the batch process. The initial cluster analysis batch process will create a cluster.kcs file. For additional information regarding creating an initial cluster.kcs file, see the **Scan and cluster recordings to create cluster.kcs and cluster.csv** section above.

The cluster.kcs file contains information regarding the clusters found in the batch process. The cluster.kcs file can be used as a simple classifier.

- Under the **Batch** Tab set the input directory to the folder containing new files to be analyzed.
- Select a new output directory.
- Under the **Cluster Analysis** Tab choose **Use existing .kcs to sort new recordings and create new cluster.csv**
- Press the Browse button and locate the cluster.kcs file created during the initial batch process.
- Run the batch process.
- The new batch of input files will be analyzed and assigned to one of the cluster types created during the initial batch process.

Scan recordings and extract detections (no clustering)

- In this mode Kaleidoscope Pro analyzes files to detect signals. No classification or clustering is done to the detected signals, but the resulting data makes it easy to scan through files and see only the portions of the files which contain detected signals as described under the **Signal Params** Tab.

Cluster Parameters

Analysis of detected signals for clustering is based on identifying detected signals and then further examining those detected signals to sort into clusters. Detected signals are based on settings from the **Signal Params** Tab. Once signals have been detected, they are passed to the cluster analysis module. It is possible multiple detected signals may be found within a single input file. Therefore, there could be more detected signals than total number of input files. The parameters in the **Cluster Analysis** Tab then determine how detected signals are sorted into clusters.

In general, the default parameters for **FFT window** size, **Max states**, and **Max distance to cluster center for building clusters** are a good place to start. Changing these parameters may provide more desired results, depending on the content of the detected signals. Some experimentation with these parameter settings may be required to get optimum results.

The following parameters are found under the **Cluster Analysis** Tab:

- **Max distance from cluster center to include outputs in cluster.csv**
 Detected signals are analyzed for similar patterns. Some detected signals will be very similar to each other. Others will be less similar to each other. A cluster center is determined by the average pattern of the detected signals assigned to the cluster.
 Detected vocalizations are analyzed to determine their similarity or distance to the cluster center.
 Detected signals which are further away from the cluster center can be filtered out and excluded from the cluster analysis. Since the maximum possible distance to any cluster center is 2.0, a value of 2.0 will include all detected signals in the cluster analysis, even if the detected patterns are dissimilar.
 In an initial cluster analysis batch process this parameter may be set to 2 to include all detected signals. To limit the detected signals to be included in the initial analysis to only more common similar patterns, lower this setting.

A value of 1.4 (or about the square root of 2) is an orthogonal distance at which two vocalizations may be very different, and very few detected signals will be greater than this value. 1.0 is a good choice where detection distances smaller than 1.0 tend to be similar while larger distances are increasingly different.

When building a simple classifier, detected signals will be assigned to only the clusters identified in the classifier. If all detected signals are then included in the simple classifier cluster analysis, all the detected signals will be forced into one of the identified clusters. This could cause a higher number of false positive identifications. In this circumstance a setting of 1 will produce better final results.

- **FFT Window (non-bat analysis mode only)**

Kaleidoscope Pro provides four FFT window sizes to be used in cluster analysis. The size of the FFT window influences resolution of frequency vs time. A larger FFT window will have more resolution for frequency analysis, especially at lower frequencies. The trade-off is resolution of detail over time. In many cases lower frequency vocalization, such as those made by owls, also have less detail over time. For vocalizations that are slower and lower in frequency, a larger FFT window may provide more desirable results in the cluster analysis process.

By comparison, smaller FFT window sizes provide greater resolution of activity over time, especially at higher frequencies. If the FFT window is set to a smaller size, the cluster analysis process will be more accurate for fast transient, high-frequency vocalizations.

The default setting for the FFT window size is 5.33 ms. This default is based on an optimum balance of resolution for frequency and activity over time for most bird vocalizations.

This menu does not influence the FFT settings in the Viewer spectrogram. There are separate FFT display settings for the spectrogram under the Viewer File menu.

- **Max states**

Target size of the Hidden Markov Model is represented as a number of states. Experience shows values between 8 and 16 are usually good for most applications. A larger number of states may be necessary in environments with a more diverse set of acoustic signals and may help tease apart more subtle differences between similar vocalization classes. However, too many states may result in noisy dimensions resulting in poor cluster results.

The default setting is 12. When Kaleidoscope Pro is analyzing detected signals, more information will provide more reliable results. For smaller amounts of detected signals and manual IDs, a lower setting may provide more accurate cluster results. For larger amounts of data, a higher setting may provide more clusters with more discrimination between those clusters.

- **Max distance to cluster center for building clusters**

This controls how detected signals form clusters. When analyzing a detected signal, if the closest existing cluster is within the specified distance, then the detected signal is assigned to this cluster. Otherwise, a new cluster may be formed to include the detected signal. This is also the distance used to merge two clusters together. Experience shows a value of 0.5 works well. Higher values will cause fewer clusters to be formed from more detected signals and lower values will cause more clusters to be formed from fewer detected signals.

- **Max clusters**

Limits how many clusters are formed. The clusters with the highest number of similar detected signals are given priority while clusters with less similar detected signals are discarded to fit within this maximum.

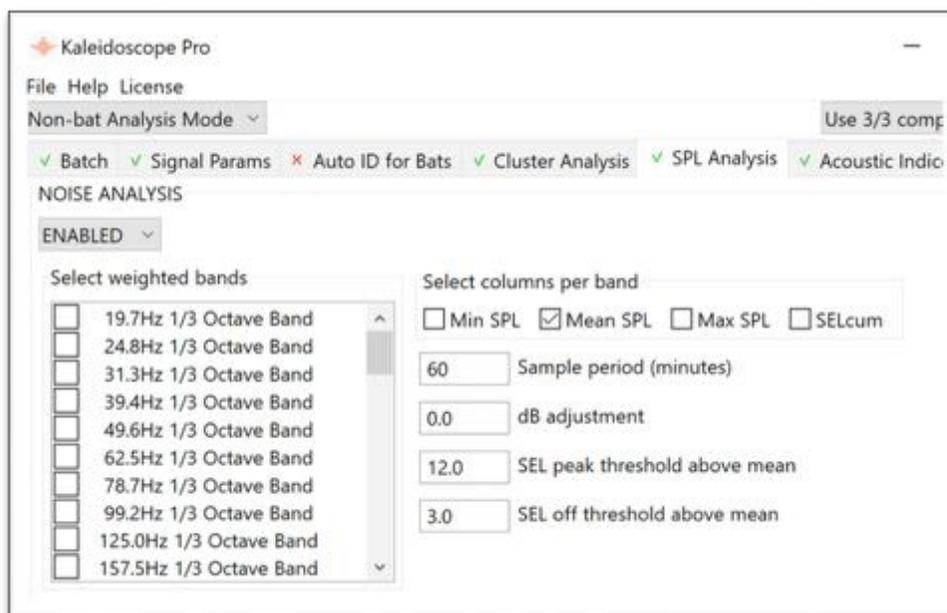
4.7 SPL Analysis Tab

Requires Kaleidoscope Pro license.

Available only in Non-bat Analysis Mode.

The following is a list of all parameters found under the SPL Analysis Tab:

- Selected weighted bands
- Select columns per band
 - Min SPL
 - Mean SPL
 - Max SPL
 - SELcum
- Sample Period (minutes)
- dB adjustment
- SEL peak threshold above mean
- SEL off threshold above mean



Overview

SPL is an acronym for Sound Pressure Level.

The SPL Analysis module is used to analyze full-spectrum audio recordings and generate a report of audio amplitude levels in accordance to various standards. Note: This function is not useful for analyzing ultrasonic recordings. SPL Analysis is available in Non-bat Analysis Mode only.

SPL results are relative to specific to reference points. Kaleidoscope Pro provides audio level analysis measurements in relation to full-scale RMS. In order to provide accurate sound pressure level results, the sensitivity of the recording microphone and other gain parameters set by the recording device are required. Without accurate microphone sensitivity and any other signal chain gain information, accurate SPL results are not possible.

- Under the **Batch** Tab set the input and output directories for the files to be analyzed and the destination of the batch process results.
- Check **WAC files** and or **WAV (and W4V) files** for the input files.

There is no need to create .wav or zero-crossing files in the output batch in order to do SPL analysis.

- In the Control Panel, click on the **SPL Analysis** Tab to access and configure the Noise Analysis module (see below).
- Press the **Process Files** button to start the batch process.
- Analysis is performed and results are written to a **spl.csv** file and **splbyfile.csv** file in the output directory.

SPL Module Requirements

- Triggered .wac files are not supported. Only continuous .wav/.w4v and non-triggered .wac files should be utilized.
- Most protocols require measurements in certain bands of frequencies. Recordings must be made at a sufficient sample rate in order to capture these frequencies. The audio file sample rate must be at least twice the highest frequency that is to be measured.

Supported Measurements

- The SPL Analysis Module supports many commonly used measurement references. Each measurement typically involves a weighted band of frequencies as listed below.
 - Third octave bands are supported with centers between 19.7Hz and 161,270Hz.
 - A Weighted
 - B Weighted
 - C Weighted
 - D Weighted
- NOAA combined marine mammal filters include:
 - Low-frequency cetacean
 - Mid-frequency cetacean
 - High-frequency cetacean
 - Pinniped Phocid
 - Pinniped Otterid
- Wide frequency band measurement references are also available
 - 10Hz - 10,000Hz
 - 10Hz -192,000Hz

Configure the SPL Analysis Module

The following configuration parameters and settings are specified under the **SPL Analysis** Tab in the Control Panel.

- **Enable SPL Analysis**
Choose ENABLED from the menu. Once enabled, a batch process can be run on suitable Input files through the SPL Analysis module. An spl.csv file and splbyfile.csv file will be generated in the output directory.
- **Select weighted bands**
Specify the desired frequency band measurements by checking one or more of the listed references.
- **Min SPL**
Check this box to include a Minimum Sound Pressure Level column in the output .cvs files for each selected measurement reference.
- **Mean SPL**
Check this box to include a Mean Sound Pressure Level column in the output .cvs files for each selected measurement reference.
- **Max SPL**
Check this box to include a Maximum Sound Pressure Level column in the output .cvs files for each selected measurement reference.
- **SELCum**
Check this box to include a Cumulative Sound Exposure Level column in the output .cvs files for each selected measurement reference.
- **Sample period (minutes)**
Select the sample period size in minutes. The spl.csv report will include a row for each sample period (one for each recorder channel). Minimum and maximum values correspond to the minimum and maximum value of any full one second period contained within the sample period.
- **dB adjustment**

The dB adjustment is added to each level measurement. This setting can be used to compensate for variables such as microphone sensitivity, gain changes in the recording chain, and to change the scale of the output measurements.

- **SEL peak threshold above mean**

When making cumulative Sound Exposure Level measurements, Kaleidoscope Pro looks through the sample period approximately one second at a time to find sound events to accumulate. A sound event must have a peak sound pressure level above the ambient background level set by this threshold.

- **SEL off threshold above mean**

When making cumulative Sound Exposure Level measurements, Kaleidoscope Pro adds up sound pressure levels on either side of the event peak until the Sound Pressure Level falls below this threshold above the ambient background level set by this threshold.

SPL Analysis File Output

The results of the SPL analysis batch process will be provided in an `spl.csv` file and an `splbyfile.csv` file. These files are created in the output directory. For additional information about the information contained in the `.csv` files refer to the [Resources](#) chapter in this user guide.

- **splbyfile.csv** Contains data found in the batch conversion regarding sound level for individual files.
- **spl.csv** Contains data found in the batch conversion regarding sound level on a per time segment basis, as described by the **Sample Period** parameter.

Microphone sensitivity and recorder gain compensation

In order to provide accurate spl analysis measurements Kaleidoscope Pro requires specific information about the microphone and recording device used to create the input files.

The Song Meter SM3 and SM4 recorders from Wildlife Acoustics have the ability to include additional metadata encapsulated in `.wav/.w4v` files. In particular, the user can specify the microphone sensitivities (e.g. in dBV/Pa) on the recorder itself.

It is also possible to add further adjustment to the mic sensitivity setting in the recorder to change the output scale as referenced by Kaleidoscope Pro.

This information is combined by the firmware with information about gain and full-scale voltages to produce a correction factor which is included in the recording file metadata. The correction factor is combined with the dB Adjustment from the SPL Analysis module to adjust the reported calculations.

The best practice would be to measure and specify the microphone sensitivities in the recorder settings before deployment. For acoustic microphones connected to a Wildlife Acoustics Song Meter SM3 or SM4 recorder, a standard microphone calibrator can be used to produce a 94dB SPL (1 Pa) 1kHz tone at the microphone while the SM3 or SM4 is in Microphone Calibrate mode. This will display the dBV of the 1Pa tone. The value displayed can be manually entered into the Microphone Sensitivity settings on the recorder. Then, Kaleidoscope Pro data would automatically be adjusted to dBV/Pa. To measure SPL relative to 20 micro-Pascals, the Kaleidoscope Pro dB Adjustment can be set to 94.0dB.

4.8 Acoustic Indices Tab

Requires Kaleidoscope Pro license.

Overview

In order to characterize massive eco-acoustic recording collections, a number of acoustic indexes have been developed over the years. These indexes can reduce individual recordings down into a set of measurements that can then be used to compare the changing soundscape from site to site or season to season. Many of these indexes were designed to correlate to bioacoustics activity.

Different acoustic index measurements that can be calculated on a large batch of recordings and output to an **acousticindex.csv** file. Acoustic Index metadata can be integrated into Kaleidoscope Pro's searchable database.

[When doing acoustic index analysis, it is possible to split large files into smaller segment.](#)

Acoustic Indices is available from the Kaleidoscope Pro Control Panel in "Non-bat Analysis Mode".

A global enable/disable menu turns on the index calculations. Indices are organized into groups sharing certain parameters such as FFT size, minimum and maximum frequencies, thresholds, etc. Individual indices can be enabled or disabled for inclusion in the outputs.

Many of these indices are available in the open source "Seewave" R package by Jerome Sueur, Thierry Aubin and Caroline Simmons. Others are available in the open source "SoundEcology" R package by Luis J. Villanueva-Rivera and Bryan C. Pijanowski. Many of the individual indexes were originally developed by others and cited below.

The Kaleidoscope Pro implementation of these indices is a new implementation designed to process large batches of files in parallel. The results produced in "Seewave" and "SoundEcology" are similar to those from Kaleidoscope Pro, but due to differences in the calculations the results may vary slightly, but not significantly.

When input files are processed with acoustic index analysis, an **acousticindex.csv** file is created in the output directory. The results of the selected acoustic index parameters are displayed for each input file or file segment.

Spectral Measurements Group

Spectral Measurements

These indices are compatible with the `specprop` function of the R `seewave` package by Jerome Sueur.

MEAN Enable
 SD Enable
 SEM Enable
 MEDIAN Enable
 MODE Enable
 Q25 Enable
 Q75 Enable
 IQR Enable
 SKEW Enable
 KURT Enable
 SFM Enable
 SH Enable

FFT Size: ▾

frequency minimum (Hz)

frequency maximum (Hz, 0 = nyquist)

The first group of measurements are more general spectral measurements than true eco-acoustics indexes. This group uses non-overlapping FFTs of a size specified. A Hanning window is used and the resulting amplitude spectrum is averaged across all the frames.

By default, the available spectrum from 0Hz to Nyquist is analyzed, but you can specify a narrower frequency band to measure by specifying the desired minimum and maximum frequencies.

MEAN The amplitude-weighted mean frequency (see Seewave).

SD The standard deviation of the amplitude-weighted mean frequency (see Seewave).

SEM The standard error of the amplitude-weighted mean frequency (see Seewave).

MEDIAN The median of the amplitude-weighted frequency (see Seewave).

MODE The mode of the amplitude-weighted frequency (see Seewave).

Q25 First quartile of the amplitude-weighted frequency (see Seewave).

- Q75** Third quartile percentile of the amplitude-weighted frequency (see Seewave).
- IQR** Inter-quartile range (see Seewave).
- SKEW** Skewness, a measure of asymmetry (see Seewave).
- KURT** Kurtosis, a measure of peakedness (see Seewave).
- SFM** Spectral flatness measure (see Seewave). SFM of a noisy signal will tend toward 1 while a pure tone will tend toward 0.
- SH** Shannon Spectral Entropy (see Seewave). SH of a noisy signal will tend toward 1 while a pure tone will tend toward 0.

Normalized Difference Soundscape Index (NDSI)

Normalized Difference Soundscape Index

This index is based on the work of Kasten, E.P., Gage, S.H., Fox, J. and Joo, W. (2012). compatible with the NDSI function of the R seewave package by Jerome Sueur

NDSI Enable

FFT Size:

Anthrophony frequency minimum (Hz)

Anthrophony frequency maximum (Hz)

Biophony frequency minimum (Hz)

Biophony frequency maximum (Hz)

The NDSI (implemented in Seewave and SoundEcology) is the ratio between biophony and anthrophony. The NDSI calculation uses a 50% overlapping Hamming window. **Anthrophony** is the power spectrum between 1kHz-2kHz, and biophony is the power spectrum between 2kHz and 8kHz. The upper bound of **biophony** is increased in many studies. With Kaleidoscope, you can specify the FFT size as well as the frequency ranges for biophony and anthrophony. NDSI is calculated as $(\text{biophony} - \text{anthrophony}) / (\text{biophony} + \text{anthrophony})$. Results are similar to the Seewave implementation.

Kasten, Eric P., Stuart H. Gage, Jordan Fox, and Wooyeong Joo. 2012. The Remote Environmental Assessment Laboratory's Acoustic Library: An Archive for Studying Soundscape Ecology. Ecological Informatics 12: 50-67. doi: [10.1016/j.ecoinf.2012.08.001](https://doi.org/10.1016/j.ecoinf.2012.08.001)

Acoustic Complexity Index (ACI)

Acoustic Complexity Index

This index is based on the work of Pieretti, N., A. Farina, and D. Marri (2011) compatible with the ACI function of the R seewave package by Laurent Lellouch et al.

ACI Enable

FFT Size:

frequency minimum (Hz)

frequency maximum (Hz, 0 = nyquist)

J (s), or zero for continuous

threshold dB fs or 0 for none

The ACI (implemented in Seewave and SoundEcology) measures the normalized absolute difference of amplitude between adjacent FFT windows in each bin over a period of J seconds. The total ACI is the sum of the ACIs across bins for each period J in the recording. This means that recordings of different sizes will affect the ACI proportionally. Kaleidoscope Pro lets you specify J of zero (the default) which then calculates ACI across the whole recording resulting in values that are not

dependent on recording length. The **FFT size, minimum frequency, maximum frequency and value J** may be specified. The **threshold** is relative to the peak signal bin in the recording. The FFTs are not overlapped and modified by the Hamming window. Results are close to those from Seewave.

Pieretti, N., A. Farina, and D. Morri. 2011. A new methodology to infer the singing activity of an avian community: The Acoustic Complexity Index (ACI). *Ecological Indicators* 11: 868-873. doi: [10.1016/j.ecolind.2010.11.005](https://doi.org/10.1016/j.ecolind.2010.11.005)

Acoustic Diversity Index (ADI) and Acoustic Evenness Index (AEI)

Acoustic Diversity/Evenness Indices

These indices are based on the work of Pijanowski, B.C., L.J. Villanueva-Rivera, S. Dumyahn, A. Farina, B. Krause, B. Napoletano, S. Gage, N. Pieretti (2011) compatible with the R soundecology package by L.J. Villanueva-Rivera.

ADI Enable AEI Enable

frequency minimum (Hz)

frequency maximum (Hz, 0 = nyquist)

frequency step (Hz)

threshold (dB fs)

The **ADI** and **AEI** (implemented in SoundEcology) are calculated by dividing the **frequency** range into 10 bins of 1kHz width each, and returning the Shannon index (for ADI, a measure of entropy) and Gini index (for AEI, a measure of flatness) of the occupancy of these bins with signal above some threshold. The **threshold** is relative to the peak signal bin in the recording. Kaleidoscope Pro lets you select an alternative **frequency step** width, maximum frequency and threshold. The DFT size is set to one tenth of the sample rate and uses non-overlapping Hanning windows. Results are close to those obtained by the SoundEcology implementation.

Pijanowski, B.C., L. J. Villanueva-Rivera, S. Dumyahn, A. Farina, B. Krause, B. Napoletano, S. Gage and N. Pieretti. 2011. *Soundscape Ecology: The Science of Sound in Landscapes*. *BioScience* 61: 203-216. doi:[10.1525/bio.2011.61.3.6](https://doi.org/10.1525/bio.2011.61.3.6).

Villanueva-Rivera, L. J., B. C. Pijanowski, J. Doucette, and B. Pekin. 2011. A primer of acoustic analysis for landscape ecologists. *Landscape Ecology* 26: 1233-1246. doi:[10.1007/s10980-011-9636-9](https://doi.org/10.1007/s10980-011-9636-9).

Bioacoustic Index (BIO)

Bioacoustic Index

This index is based on the work of Boelman NT, Asner GP, Hart PG, Martin RE (2007).

BI Enable

FFT Size:

frequency minimum (Hz)

frequency maximum (Hz, 0 = nyquist)

The Bioacoustic Index measures the area under the log amplitude spectrum curve in dB*kHz with the minimum dB level set to zero. Kaleidoscope lets you choose the **FFT size, minimum and maximum frequency**. The FFT uses non-overlapping Hamming windows.

Boelman NT, Asner GP, Hart PJ, Martin RE. 2007. Multi-trophic invasion resistance in Hawaii: bioacoustics, field surveys, and airborne remote sensing. *Ecological Applications* 17:2137-2144.

QUT Indexes Group

QUT indexes

These indices are based on the work of Michael Towsey, "The calculation of acoustic indices derived from long-duration recordings of the natural environment", QUT Ecoacoustics Research Group (2017).

BGN Enable SNR Enable ACT Enable EVN Enable

LFC Enable MFC Enable HFC Enable CENT Enable

FFT Size: 512 ▾

6 threshold (dB)

Several indexes were developed by Michael Towsey, QUT Ecoacoustics Research Group.

Michael Towsey 2018. The calculation of acoustic indices derived from long-duration recordings of the natural environment. Kaleidoscope Pro implements several of these indices. You can specify the threshold and FFT size. Non-overlapping Hanning windows are used.

Background Noise (BGN) Background noise estimate of the time domain signal, dB

Signal to Noise Ratio (SNR) Signal to noise ratio of the time domain signal, dB

Activity (ACT) The fraction of values in the noise-reduced decibel envelope exceeding threshold detected in the time domain series.

Events per Second (EVN) A measure of acoustic events per second exceeding threshold detected in the time domain series.

Low-frequency Cover (LFC) The fraction of noise-reduced spectrum cells that exceed the threshold in the 0-1kHz band.

Medium-frequency Cover (MFC) The fraction of noise-reduced spectrum cells that exceed the threshold in the 1-8kHz band.

High-frequency Cover (HFC) The fraction of noise-reduced spectrum cells that exceed the threshold in the 8-11.025kHz band.

Spectral Centroid (CENT) The average amplitude-weighted frequency relative to Nyquist computed individually on each frame ignoring frequencies below 500Hz.

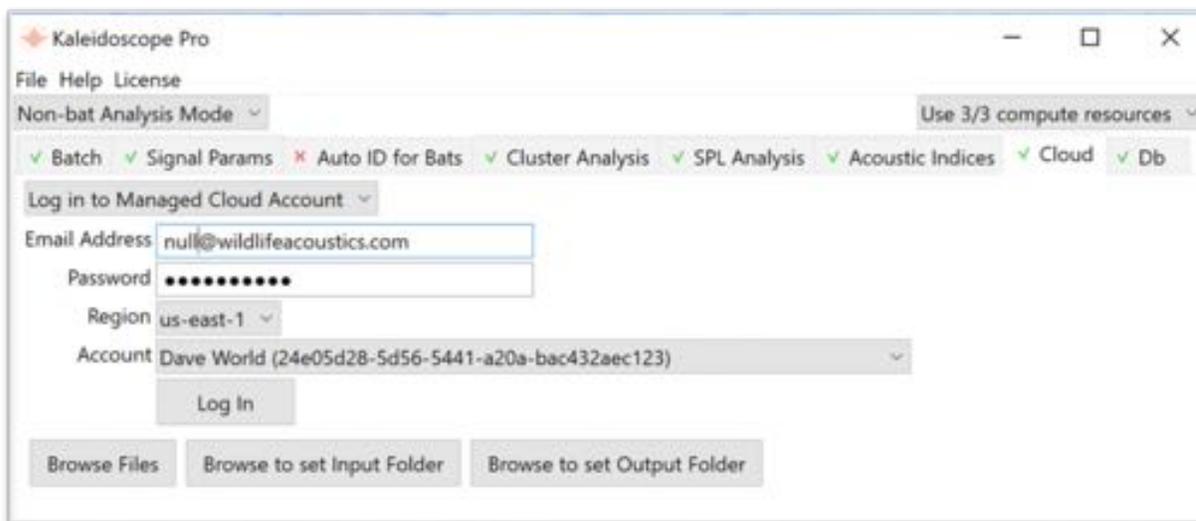
4.9 Cloud Tab

Requires Kaleidoscope Pro license.

Requires Wildlife Acoustics Managed Cloud Account or user-managed AWS S3 account.

The following is a list of all parameters found under the Cloud Tab:

- Log in to Managed Cloud Account
 - Email Address
 - Password
 - Region
 - Account
 - Log In
- Log in to user managed AWS S3
 - Enter password
- Set up user managed AWS S3
 - Password for encrypting credentials
 - Password (again)
 - AWS Key ID
 - AWS Key
 - AWS S3 Bucket Name
 - AWS Region
 - AWS S3 Storage Class
 - AWS S3 Server Side Encryption
 - Apply
- Browse Files
- Browse to set Input Folder
- Browse to set Output Folder



Cloud Overview

Kaleidoscope Pro introduces Cloud based storage and management. A Kaleidoscope Pro license is required for Cloud compatibility.

Large amounts of data can be uploaded, browsed, and managed within a Cloud account.

A Kaleidoscope Pro user has the choice to access an Amazon AWS S3 bucket, or they can create or join a Wildlife Acoustics Managed Cloud Account.

Managed Cloud Account services may incur additional fees. Consult the pricing page at www.WildlifeAcoustics.com for information regarding any additional costs.

Create a Cloud Account

- A Wildlife Acoustics Cloud Managed Account can be created at www.WildlifeAcoustics.com. Refer to the [Resources](#) chapter in this user guide for instructions on how to create and manage a Wildlife Acoustics Managed Cloud Account.
- Any Kaleidoscope Pro user can be invited to access an existing Managed Cloud Account.
- Customers can set up their own AWS S3 bucket account via Amazon Web Services. Kaleidoscope Pro can access a user-managed AWS S3 bucket. Details for creating an AWS S3 account are found here: <https://aws.amazon.com/s3/> For connecting to a user-managed AWS S3 bucket, create a bucket on Amazon AWS using an AWS account. It is possible to encrypt the AWS/S3 credentials with a password. The AWS Key ID, AWS Key, S3 bucket name, and region are required. The storage class and encryption options can also be specified.

Wildlife Acoustics Managed Cloud Account

Kaleidoscope Pro can access a standard AWS S3 Cloud account or a Wildlife Acoustics Managed Cloud Account. A Wildlife Acoustics Managed Cloud Account provides features not available with an AWS S3 account.

- **On-line processing**

If the input and output directories for a batch process are both located in a Managed Cloud Account, the user has the option of running the batch process within the Cloud. Processing on-line files with a local computer can take a great deal of time because of the upload and download requirements. Running the batch process in the Cloud means once the batch process is submitted, the local computer can be taken off-line. Cloud-based processing may be much faster than local processing. When the on-line processing is complete, an email is sent to the user notifying that the batch process results are available.
- **Database functions**

The Managed Cloud Account features a searchable database based on batch processes and manual reviews. The database can continually be updated via both local and Cloud-based processing. Database queries can be constrained to local searches or searches which include data from other users and organizations that also subscribe to a Wildlife Acoustics Managed Cloud Account. Searching data created by other users and organizations is dependent on access and file permissions granted by those users and organizations.
- **Cross collaboration**

Users of Kaleidoscope Pro can create a Cloud account or can be invited to join an existing Managed Cloud Account. A single user may be invited to join multiple Managed Cloud Accounts. Depending on privacy settings, database information from other Managed Cloud Accounts may be available for searching from Kaleidoscope Pro.

Access a Managed Cloud Account from Kaleidoscope Pro

- Click on the **Cloud** Tab in the Control Panel.
- The Cloud window initially shows a menu with four choices:
 - **Disabled**
 - **Log in to Managed Cloud Account**

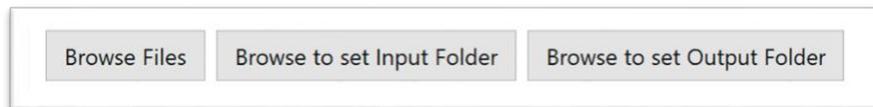
This requires an existing Wildlife Acoustics Managed Account.
 - **Log in to user managed AWS S3**

This requires an existing Amazon Web Services account and an S3 bucket.
 - **Set up user managed AWS3 account**

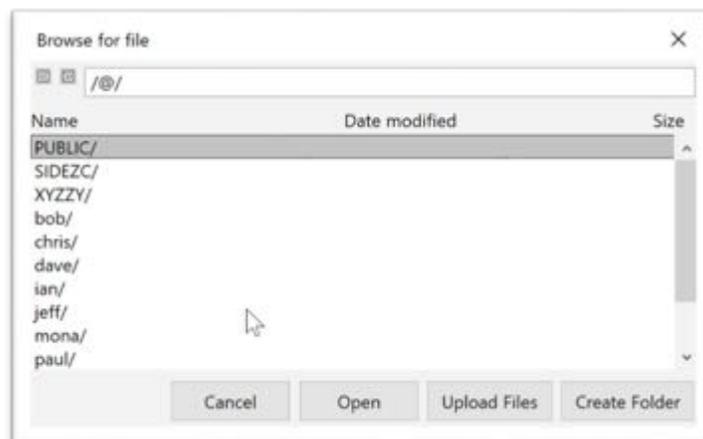
This is used to configure Kaleidoscope Pro to access an existing Amazon Web Service account and S3 bucket.
- Choose **Log in to Managed Cloud Account**.
- Enter your email address and Wildlife Acoustics account password.
- Press the **Log-in** button. This will log Kaleidoscope Pro in to the Wildlife Acoustics Managed Cloud Account.

View Cloud Storage Directories

- Once Kaleidoscope Pro is logged in to a Cloud account, three buttons are displayed:



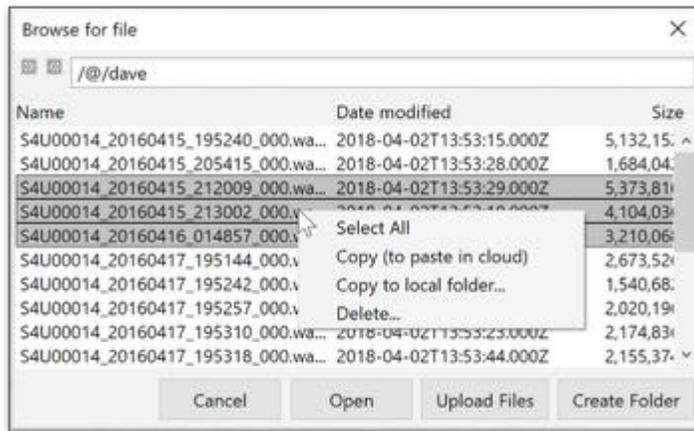
- Browse Files** – This will open a Browser window that displays the data in the Managed Cloud Account. New folders can be created. Files can be uploaded. Right-click on a file for options to select all, copy to a different Cloud location, copy to a local directory, or delete.
 - Browse to Set Input Folder** – Use this command to designate a Cloud input directory for Kaleidoscope Pro batch processing.
 - Browse to Set Output Folder** – Use this command to designate a Cloud output directory for Kaleidoscope Pro batch processing.
- Click the **Browse Files** button to open a browser that sees the Cloud directory.



Manage Files in the Cloud Account

Navigate through directories to see individual files. Select one or more files and right-click for options.

- Select All**
- Copy (to paste in cloud)**
First, select one or more files to be moved. Choose this command. Navigate to a different directory in the Cloud account and right-click to paste the copied files to the new location.
- Copy to local folder..**
First, select on or more files. Choose this command. A window will open which allows the user to select a local directory. Once the destination directory has been selected click Open (Mac) or Select Folder (Windows). Kaleidoscope Pro will copy the selected files from the Cloud to the local computer.
- Delete**
This will delete all selected files from the Cloud account.



PUBLIC/ Folder

Directories are created in a Cloud account using the name of the folder followed by /. For example:



A PUBLIC/ folder can be created. The PUBLIC/ folder is special because it allows files to be accessed from any other Managed Cloud Account (See the following UUID section for instructions and example), or even directly through the internet.

To download a file from a PUBLIC/ folder via the Internet, a web link to that file can be constructed like this:

<https://s3.amazonaws.com/us-east-1.s3.kaleidoscope.wildlifeacoustics.com/UUID/PUBLIC/...>

UUID is the Managed Cloud Account ID, and then from there add the path to the file, including the file name.

UUID

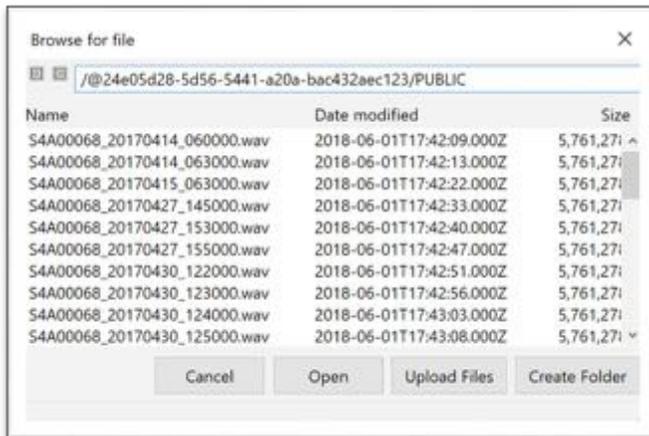
A Wildlife Acoustics Managed Cloud Account has a common name and a **UUID**. The UUID is the Cloud address for the account. The UUID for the Managed Cloud Account is visible in the users' WildlifeAcoustics.com web account.

Manage Cloud Accounts		
NAME	UUID	PAYMENT INFORMATION
Dave World	24e05d28-5d56-5441-a20a-bac432aec123	Ok
Wildlife Acoustics, Inc.	15a3d6aa-96ca-5c13-afa8-dfa63c9c8d2c	Ok

In order to differentiate local and cloud-based filenames, Managed Cloud Account based filenames are indicated as /@/... to indicate the currently logged in Managed Cloud Account, or, in order to access public folders in other accounts, /@<uuid>/PUBLIC/... where the <uuid> is the UUID assigned to a Managed Cloud Account.

The UUID can be used in the Managed Cloud Account file browser to access files belonging to different organizations. This provides read-only access to the PUBLIC folder in the remote account.

In the Cloud browser type /@ followed by the remote UUID, and then /PUBLIC. Press the Return key to enter the remote PUBLIC folder. The following graphic shows a browser address that points to the PUBLIC folder in a remote Managed Cloud Account.



Select Cloud Input and Output Directories for Batch Processing

Kaleidoscope Pro can run batch processes on files located in the Cloud. Select the Cloud input and output directories for the batch process.



It is also possible to choose locations on the local computer for the input and output directories. This is done in the **Batch** Tab in the Control Panel. This allows for local and Cloud-based input and output directories to be used in a batch process.

Upload Data to the Cloud

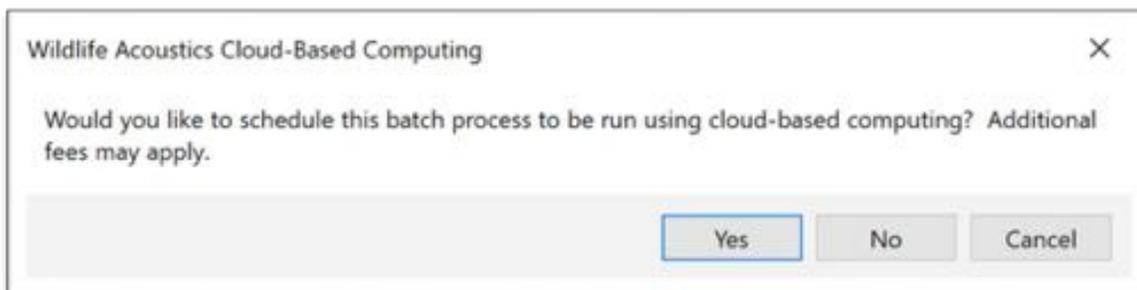
There are several methods for uploading data to the Cloud.

- Data can be uploaded from an on-line computer. Open the Cloud file browser and click Upload Files. Files can be selected and uploaded to the current Cloud directory. Depending on the amount of data to be uploaded and the on-line connection speed, this may take a significant amount of time.
- Uploading large amounts of data can be time consuming, so it is also possible for a user to send their storage medium directly to Wildlife Acoustics for fast upload. Contact support2020@wildlifeacoustics.com for further information.

Cloud-Based Computing

A Wildlife Acoustics Managed Account provides access to Cloud-based computing. Kaleidoscope Pro can run batch processes in the Cloud. In order to use Cloud-based computing, both input and output directories for the batch process must be located in a Managed Cloud Account.

If input and output directories are designated in the Managed Cloud Account and a batch process is initiated, Kaleidoscope Pro will display this message:



- Press **No** to run the batch process on the local computer. Depending internet connection speed and other variable such as output file conversion, this can take a significant amount of time.
- Press **Cancel** to stop a batch process which is currently running.
- Press **Yes** to run the batch process using Cloud-based computing. Before the batch process starts the following window will open:



Two email notifications will be sent to the specified address.

- When the batch process starts, an email notification will be sent.
- When the batch process is complete a second notification email will be sent.

When the notification email address is confirmed a window will appear that indicates the batch process has been assigned to the Cloud-based computing queue.



Once the batch process is queued, Kaleidoscope Pro can be quit and the local computer can be taken off line

When a batch process is run using Cloud-based computing, the results of the batch are automatically added to the Managed Cloud Account database.

Checking Results of the Cloud Batch Process

Because the input and output files, and the actual computing is done on a remote computer, the Results window and Viewer will not open automatically on your computer once the Cloud batch process is finished. To open the results from the batch process, use the Cloud file browser to navigate to the output directory. Depending on the type of batch process, there will be a meta.csv file, id.csv file, cluster.csv file, gps.csv file, spl.csv file and splbyfile.csv file. Within the Cloud browser, double click on any one of these .csv files and the Viewer and Results window for the batch process will open.

Because the Batch Process was run in the Cloud, the results of the batch have now been automatically uploaded to the Cloud database. This means the user also has the choice to immediately go to the **Db** Tab and run a query on the batch process results.

4.10 Db Tab

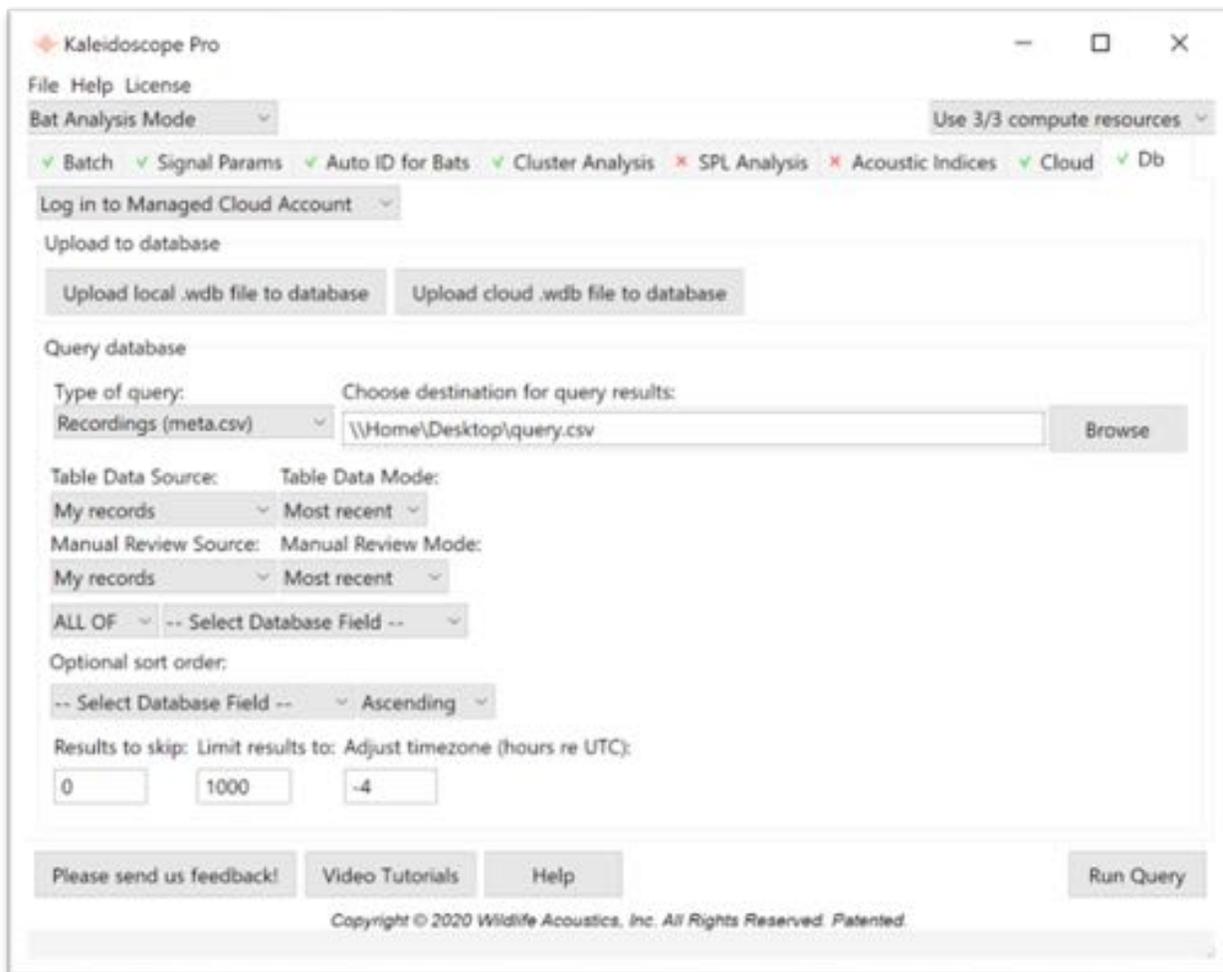
Requires Kaleidoscope Pro license.

Requires a Wildlife Acoustics Managed Cloud Account or customer created PostgreSQL server.

The following is a list of all parameters found under the Db Tab:

- Log in to Managed Cloud Account

- Upload to database
- Query database
- Log in to user managed PostgreSQL
 - PostgreSQL Connect String
 - Username
 - Database Password
 - Connect



Database Overview

Kaleidoscope Pro can create database information within a Wildlife Acoustics Managed Cloud account or user-managed PostgreSQL server. New information can continually be added to the database via batch processes and manual reviews of data.

The database is separate from the actual full-spectrum and zero-crossing files. The database can contain information about files stored in a Cloud account, local server, or both.

Database information from other users and even other organizations can be included in queries, depending on permission access of those separate Managed Cloud Accounts.

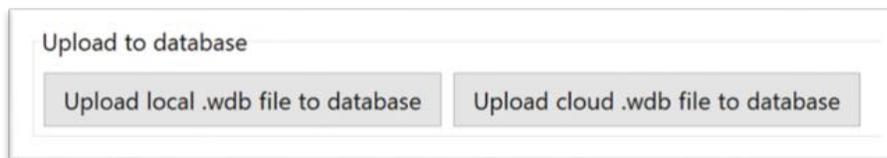
The database can be queried for specific information. The results of the database query will be displayed in a Results window and written to a query.csv file.

Create and Upload Records for the Database

Database information is created based on batch processes from Kaleidoscope Pro.

- When Kaleidoscope Pro runs a batch process on the local computer, a **db-batch.wdb** file is created. The db-batch.wdb file contains the results of the batch process and is used to generate database information.

- If the output directory for the batch process is on the local computer the db-batch.wdb is created in that location. The batch process results can be uploaded to the Cloud account. Press **Upload local .wdb file to database** button under the **Db** Tab. Locate and upload the locally created db-batch.wdb file.
- If the output directory for the batch process is located in a Cloud account, the db-batch.wdb file is created in that location. Press the **Upload cloud .wdb file to database** button under the **Db** Tab. The Cloud browser window will open. Locate and upload the db-batch.wdb file.
- If Cloud-based computing is used for the batch process, the results of the batch are automatically added to the Managed Cloud Account database. No db-batch.wdb file is created.



Manual IDs for bat species and cluster names can be updated and added to the database.

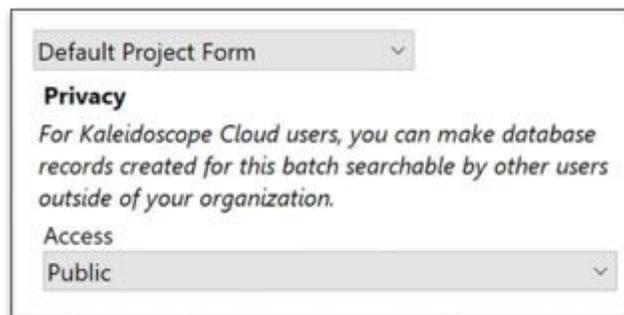
- If the batch process is run on a local computer the Results window and Viewer will open automatically at the end of an Auto ID for bats or Cluster Analysis batch process.
- For previously run batches, or batch processes run on-line, open the meta.csv, id.csv file or cluster.csv file via the File menu in the Control Panel (for local batch processes), or via the Browse button under the **Cloud** Tab (for batch processes run on-line). This will open the .csv file into the Results window and Viewer.
- Create manual IDs either directly in the Results window or via the Metadata Panel in the Viewer.
- Go to the Results window and choose Save. This will update the underlying .csv file and will also create a **db-review.wdb** file in the output directory.
- Upload the db-review.wdb file to the database via the **Db** Tab.
- The manual IDs are now added to the database.
- Manual IDs are linked to the user who uploaded the db-review.wdb file. This means multiple users can create separate manual IDs for the same files. The **Db** Tab includes options to search for manual ID results based on which user uploaded the information.

Any manual ID entry uploaded by a user overwrites any previous manual ID assigned by the same user to the same file/offset. Manual ID fields left blank will also delete any prior review made by the same user.

Public vs Private Database Records

When a batch process is run in Kaleidoscope Pro, metadata is added to the results of the batch that indicate whether the results are public or private. Selecting whether the batch data is public or private is done via the **Privacy** setting in the Default Project Form located under the **Batch** Tab.

The access setting does not affect users within a Wildlife Acoustics Managed Cloud Account. The access setting does apply if a user wants to search data in a Cloud account that belongs to a different organization.



- If Access is set to Public, any user logged in to the Wildlife Acoustics Cloud will be able to search the data generated from the batch process.
- If Access is set to Private users from other Managed Cloud Accounts will not be able to access the data from the batch process.

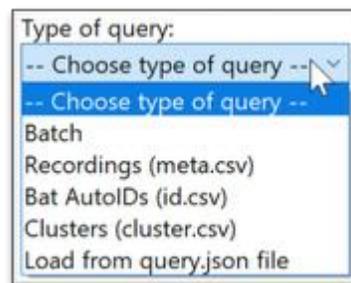
Query Parameters

The purpose of uploading database information to the Cloud account is so information can be searched for specific results. The database can contain information regarding files stored on the Cloud, as well as files that are not stored on the Cloud. The database contains separately searchable data tables. Data tables are based on .csv files created when a batch process is run and then uploaded to the database.

Choose the database table to be searched.

The **Type of query** is based on the selected database table. The following data tables can be searched:

- **Batch**
This will search for records of batch processes.
- **Recordings (meta.csv)**
This will search within records based on information generated by batch process file conversions.
- **Bat AutoIDs (id.csv)**
This will search within records based on information generated by Auto ID for Bats batch processes.
- **Clusters (cluster.csv)**
This will search within records based on information generated by Cluster Analysis batch processes.
- **Load from query.json file**
A query.json file is a file which contains search parameters. When a query is run a query.json file is generated. A query.json file can be re-used to run the same query at a later date.



Once the Type of query is selected additional search parameters are displayed.

Choose the destination for the query.csv file.

When a database query is completed, a Results window is displayed. A query.csv file that contains the results is also created. Choose the location for the query.csv file. This is also the location in which the query.json file will be created.

Output query results to .csv file:

Select Table Data Source.

The query can be directed to specific areas of the Wildlife Acoustics Cloud database.

- **My records**

This will restrict the query to database records which are specific to the logged-in user.

- **My organization**

This will include all database records for the Cloud account to which the logged-in user belongs.

- **Specific user**

This allows the records of a specific user to be searched. Enter the email address or nickname for a user who also has a Wildlife Acoustics Managed Cloud Account. If the specific user belongs to the same account as the logged in user, the specific user database information will be available for query. If the specific user belongs to a different account than the logged in user, the records in the specific user account must be marked as Public in order to be available for query.

Table Data Source:	User:
Specific user ▾	<input type="text"/>

- **Specific organization**

This allows the records of an organization account other than the logged in account to be queried. Enter the UUID address for the specific organization. UUID addresses are listed in the Managed Cloud Accounts page at the Wildlife Acoustics web site. In order for database results to be available in the specific organization account, they must be marked as public.

Table Data Source:	Organization:
Specific organization ▾	<input type="text"/>

- **All records**

This will search all available public records throughout the entire Wildlife Acoustics Cloud database.

Select Table Data Mode

The database can contain multiple records that reference the same files. For example, perhaps there have been multiple auto-ID batches on the same files with different parameters. This would result in multiple duplicate entries for each file. Select Table Data Mode determines whether to list all the duplicate entries or just the most recent one.

Table Data Mode:
List all ▾
Most recent
List all

Select a Manual Review Source

Manual IDs for bat species and cluster names can be added to the same files by multiple users. It is possible to specify the source of the manual IDs to be included in a query. The parameters for specifying the manual review source are the same as for selecting the Table Data Source.

Because batch process records do not include manual ID information, this parameter is not available if the Table Data Source is set to Batch.

Select Manual Review Mode

When manual ID results are included in a query, those results can be based on:

- **Most Recent**
This will include only the most recent manual ID results from the selected review source.
- **Most Frequent**
This will include the most frequently determined manual ID results from the selected review source.
- **List all**
This will include all manual ID results from the selected review source.

Manual Review Mode:
Most recent ▾
Most recent
Most frequent
List all

Create Search Filters

After selecting the Table Data Source, it is possible to create additional filters for the query. Multiple filters can be combined to narrow a search. If multiple filters are created, the query can be restricted to finding only results which meet all the filter criteria.

- **ALL OF** - Only results which meet all filter criteria are displayed.
- **ANY OF** - Results that meet at least one filter criteria are displayed.



- **Select Database Field**

The contents of this menu are based on which **Type of query** is selected. The Database Field is a specific area of the selected data table. This makes it possible to search only for specific information from within a table. The choices in this menu are a function of the meta form. There is a Default MetaForm embedded in Kaleidoscope. MetaForms can be customized to provide additional or different database fields. For a complete list of database fields supported by the Default MetaForm refer to the Metadata SCHEMA section in the Resources chapter in this user guide.

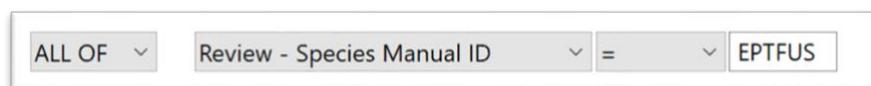
- **Query operator and text field**

Once a database field has been selected as a basic filter, an operator and text field are displayed.

The operator is used to limit results found in the selected database field, based on text entered into the text box.

- =
Result must be an exact match, including case sensitivity.
- >
Result must be a greater value. This is typically used for numeric values. If the text box contains text, this operator will look for results that start with the next letter in the alphabet based on the first letter in the text box.
- <
Result must be a lesser value.
- < =
Result must be the same or greater value.
- > =
Result must be the same or lesser value.
- < >
Result must not be the same value.
- **Like**
Result may contain variables but must be case sensitive. The variable is represented by the % symbol. For example, entering MYO% into the text box will limit the filter to looking at any text that starts with MYO but then has additional characters. In this example MYO% could return results for multiple species which are all part of the MYO family.
- **ilike** The same operator as like, but not case-sensitive.
- **not like**
The filter will exclude any case-sensitive data described in the text field with a variable.
- **not ilike**
The filter will exclude any non-case-sensitive data described in the text field with a variable.

The following graphic shows a filter for bat species manual IDs which are an exact match for EPTFUS:



If only one filter is applied, the **ALL OF/ANY OF** switch does not have any effect on the query.

If multiple filters are applied, the **ALL OF/ANY OF** switch describes how the filters will be applied.

Filters can be added with AND/OR conditions. For example, if the first database field is set to manual ID = EPTFUS and the second filter is set to manual ID = LASBOR, an OR operator will look for results which contain either EPTFUS or LASBOR manual IDs. Because a manual ID field cannot contain two different results at the same time, using an AND operator for this example would produce no query results. Therefore, care should be taken to use query parameters that will return useful results.

The Database Query Examples section of the Typical Use Workflows chapter in this user guide contains specific examples of how to create simple and complex searches.

Run a Query

- Configure query parameters.
- Press the Run Query button.
- Search results will be displayed in a Results window.
- A query.csv file and query.json file are also created in the user specified location.

Create a Database on a PostgreSQL Server

Kaleidoscope Pro can connect to a database on a user-managed PostgreSQL server.

Wildlife Acoustics assumes the user knows how create a PostgreSQL server. Wildlife Acoustics cannot offer further support beyond these instructions.

- Install PostgreSQL server version 9.6 or higher
- Create a new database and give it a name, for example "KaleidoscopePro".
- Create a role/user for the database with a password.
- In Kaleidoscope Pro:
 - Choose a MetaForm to use to define the database fields, or use the built-in default MetaForm. Run a dummy batch job on an empty input directory. This will create a db-batch.wdb file in the output directory which will contain no actual database records, but defines the structure of the database.
 - From the database Tab, select "Log in to user managed PostgreSQL"
 - Create a PostgreSQL Connect string, for example: host=hostname user=username sslmode=require dbname=KaleidoscopePro.
 - In order to create database tables, prepend this connect string with the word "CREATE" for example.
 - CREATEhost=hostname user=username sslmode=require dbname=KaleidoscopePro.
 - Enter the password and click "Connect" to connect to the database.
 - Choose "Upload local .wdb file to database" and upload the db-batch.wdb file created above.

The database is now initialized. Now remove the "CREATE" prefix in the connect string. Do this by changing "Log in to user managed PostgreSQL" to "DISABLED" and back, then delete the word "CREATE" and log in again.

Additional roles/users can be set up. For example read-only users with their own login/passwords can be configured - end users just need the correct connect string and password.

During database initialization, Kaleidoscope will create a number of PostgreSQL indexes for optimized searching and sorting. You may wish to manually add additional indexes as needed to improve performance for your particular data.

4.11 Viewer

The Viewer is a tool for inspecting full-spectrum audio and zero-crossing files. The Viewer displays one file at a time. Multiple Viewer windows can be open simultaneously. Open a file into the Viewer from the Control Panel via the **File menu->Open**.

If an Auto ID for Bats or Cluster analysis batch process is run on the local computer, the Viewer and Results window open automatically when the batch process is complete.

If the batch process is run using Cloud-based computing, a notification email is sent when the batch process is complete. Use the Browser under the **Cloud** Tab to navigate to the output directory for the batch process. From within the Browser double click on the id.csv file or cluster.csv file to open the Viewer and Results window.

Overview

- Full-spectrum audio files can be viewed as a waveform and as a spectrogram.
- Zero-crossing files can be viewed as dots within the spectrogram view.
- Full-spectrum audio files can be played back as an audio signal, including the ability to slow down ultrasonic recordings into the human-audible range.

- Full-spectrum audio files can be viewed with any DC offset removed. This option is enabled or disabled under the **Signal Params** Tab in the Control Panel. If a file is already opened in the Viewer, use the Reload command from the Viewer File menu to update the DC offset status.
- Band-pass filters, Time Expansion, and amplitude adjustments can be applied to .wav and .w4v audio files. Speed changes are not printed to the .wav file. Files can be played back with these adjustments. Files can be saved with these adjustments applied.
- Double click on the Time Ruler to toggle between a view showing time within the window or time based on the time-stamp of the file. Time within the file file is not displayed in Compressed view.
- The Viewer can be used to view and edit metadata and quickly review automatic identification and clustering results.
- The Viewer is capable of opening .wac, .wav/.w4v, and .??#/ .zc files.
- In Bat Analysis Mode the Viewer can synthesize and display zero-crossing data derived from a full-spectrum file.
- Two visual representations of full-spectrum files are provided. The upper view displays a waveform that shows amplitude in the vertical axis and time in the horizontal axis. The waveform view does not show signal frequency. The waveform view does not display zero-crossing files. The waveform can be displayed in linear or log scale (See Additional Controls below)
- The lower view is a spectrogram. The spectrogram displays time on the horizontal axis. Full-spectrum signals are displayed with frequency content on the vertical axis, and amplitude displayed as color shading. The spectrogram can also display zero-crossings data as a series of dots.
- Moving the mouse over either view shows a cursor and displays the time position in seconds and the amplitude value in either a linear or log (dB) scale.
- Clicking and dragging with the mouse will create a selection box. The boundaries and deltas of the selection box are displayed in the status bar at the bottom of the Viewer. The selection box can be cleared with a left click of the mouse.
- Right-click inside the selection box to open a pop-up menu with the option to **Zoom to fit**. This will expand the selection to fit the available window area.
- For zero-crossing files only, right-click in the selection box to choose **Turn off dots**. This will mark any selected zero-crossing dots to be hidden from view and analysis. The zero-crossing file is then updated with these changes. These hidden dots can be re-displayed using the **Show/Hide off dots** control via the **File menu->FFT Settings window**. To restore hidden dots so they are re-enabled, first select Show off dots from the FFT Settings window. Next select an area of the spectrogram that does not contain any dots. Then right-click and choose Turn off dots. Since no dots are selected, no dots are hidden, but the file is re-saved with the now visible dots.
- Up to two horizontal reference lines can be created with a right-click of the mouse. The reference lines can be cleared with a double right-click. Reference lines are useful for comparing upper and lower frequencies of multiple signals.
- Left- click and drag up or down on the spectrogram frequency ruler displayed on the left of the spectrogram plot to create a band-pass filter. Making a selection will update the waveform view with the filter applied. The band-pass filter will hide any signal outside the filter range. The band-pass filter can be cleared with a left-click on the frequency ruler.
- Kaleidoscope can convert full-spectrum data to zero-crossing data and will show zero-crossing dots superimposed on top of the color spectrogram plot. In Bat Analysis Mode, the dots represent literal zero-crossings from the signal using either a simple band-pass filter or more advanced signal processing as described in the Additional Conversion Options section of the Reference Guide chapter in this user guide. In Non-bat Analysis Mode, the dots are synthesized by tracing the peak signal of syllables through time as a visual aid to the underlying signal detection algorithms.
- If zero-crossing data is displayed with analysis, the body of the call is highlighted in purple. This represents the flattest part of the call with constant slope terminating with the characteristic frequency and beginning with the knee.
- For full-spectrum recordings, the color intensity corresponds to the amplitude of the signal at a given frequency and at a given point in time.
- In the upper right-hand corners of the waveform and spectrogram views are separate  and  buttons for zooming the view vertically. There is also a  button to vertically conform the view to fit the window. Clicking on this button will toggle between zoomed view and fit to window.

- In the bottom left hand corner of the window there are  and  buttons to zoom both the waveform and spectrogram views horizontally. There is a  button to zoom out and fit the entire file into the window. Clicking on this button will toggle between zoomed view and fit to window.
- Keyboard shortcuts can be used to change preset zoom levels.
- Click on the divider bar between the waveform and spectrogram views and drag up or down to show more or less of each view.
- The Viewer inherits many of its settings from the Control Panel at the time the Viewer is opened. This includes the output time expansion factor (used to determine the correct sample rate with the assumption that output files are being opened and not input files), as well as filtering and classification parameters. From the Viewer, reopen the Control Panel via the **File menu->Control Panel**. To reload Control Panel settings into the Viewer, use the **File menu->Reload**. This will apply the new settings to the Viewer window and reopen the currently displayed file.
- In Bat Analysis Mode, as a convenience, the Time Expansion factor is controlled via a pull-down menu. This is critical for Auto ID. Make sure the vertical frequency axis represents the true frequencies of the bats and is not divided down (or up) by time expansion.

Additional Controls

There are additional controls in the Viewer. From left to right:

- **Brightness slider**

The brightness slider indicated by  is used to decrease or increase spectrogram amplitude as represented by color on a dB scale from -96dB to +96dB. The brightness slider also adds or subtracts gain from the dB scale of the waveform view.

- **Contrast Slider**

The contrast slider indicated by  is used to decrease or increase the dynamic range represented by the spectrogram color gradient on a dB scale from -96dB to 0dB. The contrast slider has no effect on the waveform view.

- **Inverse video mode**

The  button toggles inverse video mode.

- **Waveform log/linear view**

The  button toggles between linear and log scales for the waveform view.

- **Full Spectrum view**

The  button toggles display of full-spectrum data on and off.

- **Zero-crossing view**

The  button is a three-way control which toggles display of zero-crossing dots. The three button states are: on with analysis, on without analysis, and off.

- **Normal/compressed time view**

The  button toggles between compressed time and normal time views. Activating the compressed time view removes blank space between pulses or syllables. This allows more pulses or syllables within vocalizations to be simultaneously displayed in the Viewer.

The compressed time view is based on Kaleidoscope's zero-crossing conversion. If no zero-crossing signals meeting the filter criteria are met, the compressed view will appear to be empty.

- **Linear/log frequency view**

The  button toggles between showing the frequency ruler in logrhythm or linear view.

- **Auto ID on/off**

The  button toggles between enabling and disabling display of auto bat ID or cluster analysis results.

If files have been processed with Auto ID for Bats, the pulse-by-pulse classification result will be shown at the top of the spectrogram plot indicating the species associated with the pulse classification. When all of the pulses in the file have been classified, a sequence-level analysis is performed.

The sequence-level classification is loaded into the identification button label in the Metadata Panel.

If a final sequence-level classification is determined, the pulses that match the sequence level classification will be highlighted.

Individual pulses that have been classified but do not match the sequence level classification will not be highlighted.

Pulses that cannot be matched with a reference classifier will not be labelled.

If files have been processed with Cluster Analysis, the detected signals are labelled with their cluster assignments.

- **Analyze view or selection**

The  button opens a Spectral Analysis window. Details of this window are described below.

- **Show/hide metadata**

The  button toggles between showing and hiding the Metadata Panel at the bottom of the Viewer. Details of the Metadata Panel are described below.

- **Play/stop**

The  button is used to play full-spectrum data as an audio signal via the computer speakers. If a region is selected, the region is played. Otherwise the area shown on the screen is played. If a band-pass filter is enabled, the filter is applied on playback. The brightness slider adjusts the volume of the playback. No sound is produced for zero-crossing recordings.

- **Playback speed**

Audio playback can be at **Normal** speed or fast or slow by factors of **8, 10, 16, or 20** times

- **Time expansion factor**

In Bat Analysis Mode, the time expansion factor can be used to specify if the file open in the Viewer is time expanded. The **TE Auto** choice will automatically determine the time expansion factor from metadata first, or the sample rate second.

- **Channel selector**

If a mono audio file is opened this menu is greyed out and reads **Mono**. If a stereo file is loaded this menu allows the **Left** or **Right** channel to be selected for viewing.

- **Go to previous file**

- **Go to next file**

The  and  buttons will change the view to the previous or next file in the folder respectively.

- **Go to previous folder**

- **Go to next folder**

The  and  buttons will change the view to the last file of the previous folder or the first file of the next folder respectively.

When the Viewer is linked to a Results window the previous/next file and folder buttons are used to go to the previous and next file or folder in the Results window (where folder corresponds to the most recently sorted row of the table).

- **Go to previous trigger** (Bat Analysis Mode only)

- **Go to next trigger** (Bat Analysis Mode only)

The title bar at the top of the Viewer displays the folder name containing the current file and the current file name. For .wac files the current trigger number out of how many triggers is also displayed. For example (1 of 3) indicates the first trigger out of three triggers in the file.

For .wac files, the  and  buttons will change the view to the previous trigger or the next trigger in the file.

Note: For large files, Kaleidoscope may break the file into smaller more manageable pieces to conserve memory. In this case, the file looks like it contains two or more triggers and it is possible to advance to the next part of the file with the next trigger button.

- **Play Notes** The  button is displayed if there are audio notes in the input file metadata. Pressing this button will play the audio note.

Keyboard Shortcuts

Click anywhere in the Viewer to bring the window to front and to enable the following keyboard shortcuts:

- **Down Arrow** Select next file.
- **Shift-Down Arrow** Select next folder.
- **Up Arrow** Select previous file.
- **Shift-Up Arrow** Select previous folder.
- **Left Arrow** Scroll back 1/10th screen width.
- **Right Arrow** Scroll forward 1/10th screen width.
- **Shift-Left Arrow** Scroll back one screen width.
- **Shift-Right Arrow** Scroll forward one screen width.
- **Space Bar** Play selection.
- **R** Reload file.
- **0** Accept Auto ID label.
- **1 - 8** Select the corresponding ID label on the top row of customizable buttons in the Metadata Panel.
- **+ or Z** Zoom in X axis.
- **- or Z** Zoom out X axis.
- **=** Zoom to fit X axis.
- **.** Toggle the zero-crossing dots display.
- **/** Toggle the compressed/expanded view.

Preset zoom levels can be triggered via keyboard shortcuts

- **Control-Z** followed by a number key **1,2,3,4,5,6,7,8,9, or 0** to activate a zoom level preset. This will set the X and Y zoom levels of the spectrogram as well as the Y axis starting frequency to one of 10 presets.
- **Shift-Control-Z** followed by a number key to set a preset to the current zoom level. For example, you can set your desired zoom and then do this to save the zoom level.
- **Control-Z Control-Z** followed by a number key to go back to the default preset value and zoom to that default zoom level.

Zoom levels are separate for bat mode and bird mode.

For non-bat mode, default Y axis is 0-12kHz; for bat mode, default Y axis is 0-128kHz.

- Default X zooms are as follows (non-bat, bat, for width of spectrogram):
 - 1 - 500ms 50ms
 - 2 - 1s - 100ms
 - 3 - 2s - 200ms
 - 4 - 4s - 400ms
 - 5 - 8s - 800ms *** This is the default zoom level on first launch ***
 - 6 - 16s - 1.6s
 - 7 - 32s - 3.2s
 - 8 - 1m4s - 6.4s
 - 9 - 2m8s - 12.8s
 - 0 - 4m16s - 25.6s

Viewer File Menu Commands

When the Viewer is open and is the front-most window the File menu offers the following choices:

- **Open** Manually open any audio file or zero-crossing file.
- **Toggle Reference** Hide or show reference files. The displayed files are based on the selected classifiers under the **Auto ID for Bats** Tab in the Control Panel.
- **Close** Close the Viewer.
- **Reload** The Viewer inherits many of its settings from the Control Panel at the time the Viewer is opened. This includes the output time expansion factor (used to determine the correct sample rate with the assumption

that output files are being opened as opposed to input files), as well as filtering and classification parameters. To reload these settings into the Viewer, choose **Reload**. This will apply the new settings to the Viewer and reopen the currently displayed file.

- **Load Labels**
At the bottom of the Metadata panel are 24 user-defined buttons used to assign manual identifications to the metadata. In Bat Analysis Mode, the button labels can be pre-loaded from the enabled Bat Auto ID classifiers by choosing **Load Labels**.
- **Save Screen...**
Take a screen shot of the Viewer.
- **Save WAV...**
Save the selected samples to a .wav/.w4v file. Any band-pass filtering, volume and Time Expansion adjustments are printed to the new WAV/w4v file. Speed changes are not included in the WAV file.
- **Control Panel...**
Opens the Control Panel.
- **Color Settings...**
Allows customization of color preferences.
 - There are two sets of colors that can be set, one for normal mode and one for inverse mode which is toggled with the  button. In normal mode, all text will be white so a darker color palette should be selected. In inverse mode, all text will be black so a lighter color palette should be selected.
 - For the spectrogram view, it is possible to choose the colors representing the maximum power (High) and minimum power (Low). If both colors are not greyscale, specify the direction of changing hue from the high to low color in either Red-Yellow-Green-Cyan-Blue-Magenta (RYGCBM) order or in Red-Magenta-Blue-Cyan-Green-Yellow (RMBCGY) order.
 - For the waveform view, choose the foreground and background colors.
 - For the zero-crossing dots, specify normal dots and dots corresponding to the analyzed body of the call.
 - For cluster reference plots can be configured in the same way as the spectrogram with a high color, low color, and hue direction.
- **FFT Settings...**
Used to change internal FFT parameters. These settings affect the visual display of information in the Viewer Spectrogram. These settings do not influence anything in regards to analysis batch processes.
 - **FFT Size** is the order of the Fast Fourier Transform (default 128).
 - **Window Size** is the step size and would be one half of the FFT Size (recommended) for a 50% overlap.
 - **Max Cache Size** is how much computer memory will be used to load samples and FFT data.
 - **Maximum number of samples** is shown. Large files that can't fit within the available memory will be broken into pieces. Navigate forward and backward through these pieces using the  and  buttons.
 - There is a menu to toggle between **Hide off dots** and **Show off dots**. For Zero-crossing files, there may be dots which have been marked as off dots which are excluded from the display and from analysis. By setting this control these dots can be turned back on again.
- **Exit**
Windows only. This will Exit Kaleidoscope. On Mac the command to Quit Kaleidoscope is found under the main Kaleidoscope menu.

Reference Call Display

- If one or more classifiers are enabled under the **Auto ID for Bats** Tab, it is possible to toggle on and off a visualization of the training data reference calls used for comparing with the input files. The reference calls provide visual display of acoustic signatures for the bat species currently selected under the **Auto ID for Bats** Tab in the Control Panel.

To display the training data reference calls:

- Choose the Viewer File menu->Toggle Reference
- Control-left-click (windows) or Command-left-click (Mac)

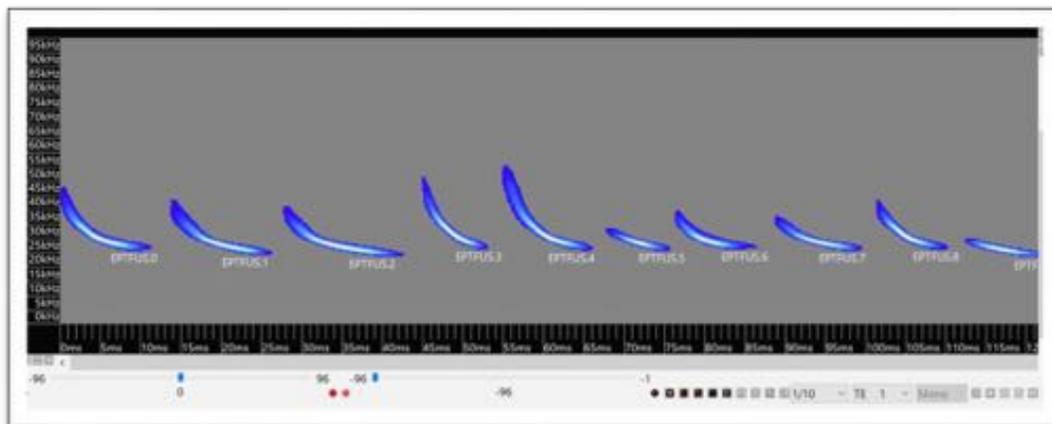
This will display the selected reference calls starting at the beginning of the file. To make the reference calls display at the current file location:

- Control-double-left-click (windows) or Command-double-left-click (Mac)

- When enabled, blueish shapes of calls are superimposed on top of the spectrogram using the current frequency and time scales. During training, similar calls from the training set are clustered together. The visualization represents a histogram of calls as if all of the cluster members were layered on top of each other. The yellow areas represent the path where most of the content of the call lines up, and the blue region around them represent the variation of calls represented.

To scroll the reference calls left or right:

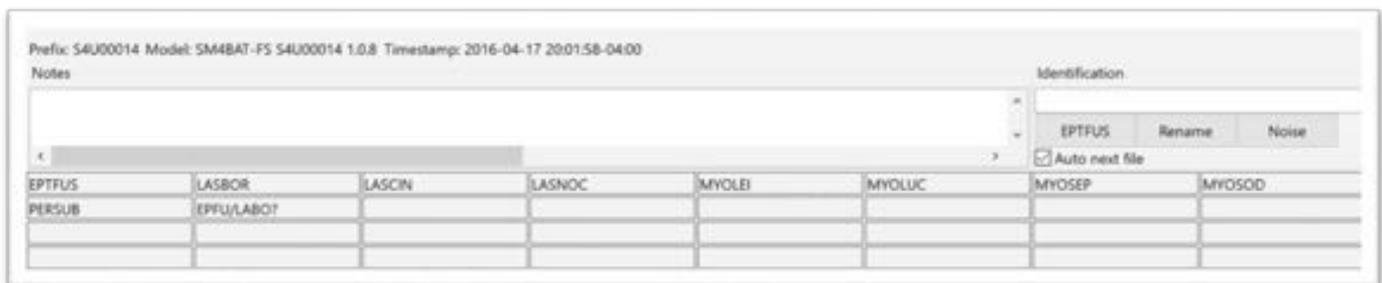
- Hold the Control key (Windows) or the Command key (Mac) while moving the mouse left or right across the spectrogram
 - Use the Left or Right Arrow keys on the computer keyboard.
- It is also possible to open a blank window to look at just the reference calls via the Control Panel **File menu->Open Reference**.



Metadata Panel

The  button toggles between showing and hiding the Metadata Panel at the bottom of the Viewer.

- The Metadata Panel displays metadata contained in the file including timestamps and GPS coordinates.
- Under **Notes** there is an editable field which contains field notes and GUANO format metadata if present. The GUANO metadata starts with GUANO|Version:1.0 followed by lines consisting of key/value pairs. The values can be edited and new fields can be added. The actual GUANO note field is displayed in the note rather than as part of the GUANO metadata.



Adding Manual IDs

Manual IDs can be created for files and individual vocalizations. Manual IDs are initially displayed in the Results window. When the Results window is saved, the manual IDs are written to the underlying .csv file.

If audio or zero-crossing output files have been created in the batch process, the metadata in the output file will also be updated with the manual ID.

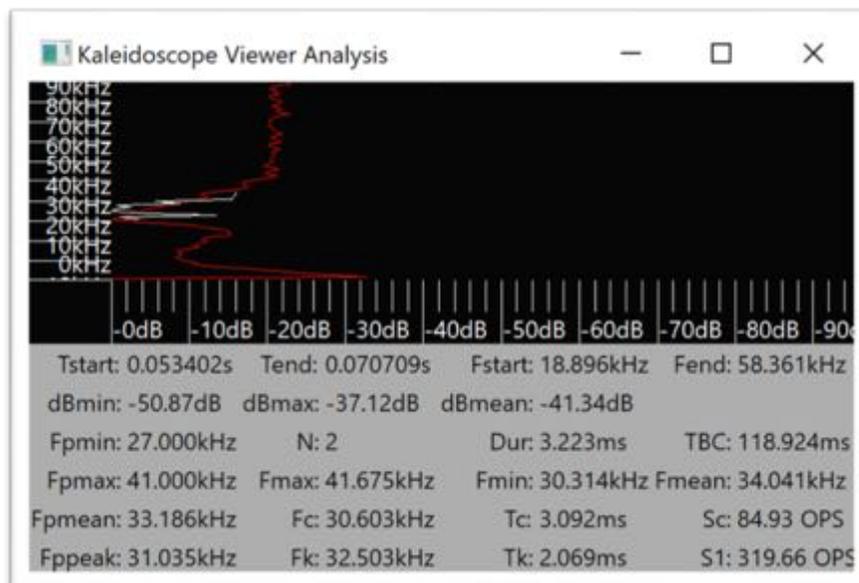
- Under **Identification** there is an editable field that is used to add manual identifications. Type in any manual ID and press the Return key to add the manual ID to the metadata.
- Below the Identification field there are three buttons:

- The first button is populated with the results of any available automatic identification. Clicking this button will add the auto ID result as a confirmed manual ID.
- The **Rename** button allows for manual renaming of the actual full-spectrum audio or zero-crossing file.
- The **Noise** button adds Noise as the manual ID and moves the output file to the NOISE folder in the Output directory (If output files have been created in the batch process).
- There is an option for **Auto next file**. When this box is checked adding a manual ID will then advance the selection to the next file. This allows manual IDs to be quickly added to consecutive files.
- At the bottom of the Metadata Panel are 24 user-defined buttons for assigning manual identifications to the metadata. In Bat Analysis Mode, the button labels can be pre-loaded from the Bat Auto ID classifiers from the Viewer **File menu->Load labels**.
- Button labels can be customized by right-clicking inside the button and typing in a new label.
- Click a button to enter the label name into the manual identification field. If Auto next file is enabled the next consecutive file in the Results window will then be loaded into the Viewer.
- The top eight label buttons can be triggered via the 1-8 keys on the top row of the computer keyboard.
- To assign multiple manual IDs, hold down the Control key (Windows) or Command key (Mac) while pressing one of the user-defined buttons (or the corresponding shortcut key). This will add the label to the Manual ID field, separating multiple entries with commas while also disabling the Auto next file button.
- Choose **Save** from the Results window. This will update the underlying .csv file and any output files created in the batch process.

4.12 Spectral Analysis Window

The  button opens the **Spectral Analysis** window. This window shows a spectral plot with frequency on the vertical axis and dB level on the horizontal axis. If a region of the spectrogram is selected within the window, the spectral plot shows data corresponding to the contents of the selection. Otherwise, the spectral plot shows data for the time period displayed on the spectrogram (or fragmented periods in compressed mode).

Right-click on the Spectral Analysis window to copy either the raw spectral data (minimum, mean, maximum and cumulative power density by FFT frequency bin in dBfs), full-spectrum, or zero-crossing measurements. The data can now be pasted into another application.



Graphic Display

- The frequency axis follows the displayed spectrogram frequency axis. Zoom in and out of the frequency axis by using the zoom and scroll controls on the spectrogram display. The dB axis is normalized with the selected peak at 0dB. Dynamic range follows the Viewer contrast control.

- A red line represents the power spectrum of the full-spectrum signal. A dotted black and white line represents a weighted zero-crossing histogram displaying how long the zero-crossing signal spends in a given frequency.

Statistics Display

The following statistics are calculated and displayed:

- **Tstart** Time offset to beginning of the selection being analyzed.
- **Tend** Time offset at the end of the selection being analyzed.
- **Fstart** Start frequency of the selection being analyzed.
- **Fend** End frequency of the selection being analyzed.
- **dBmin** Minimum power level of selection in dB relative to full-scale.
- **dBmax** Maximum power level of selection in dB relative to full-scale.
- **dBmean** Mean power level of selection in dB relative to full-scale.
- **Fpmin (full spectrum)** Estimate of minimum signal frequency. This is determined by following the peak frequency down to the noise floor.
- **Fpmax (full spectrum)** Estimate of the maximum signal frequency. This is determined by following the peak frequency up to the noise floor.
- **Fpmean (full spectrum)** This is the power-weighted mean frequency of the spectrum.
- **Fppeak (full spectrum)** This is the peak frequency of the spectrum.
- **N (zero-crossing)** This is the number of bat echolocation pulses included in the analysis.
- **Dur (zero-crossing)** Average duration of echolocation pulses.
- **TBC (zero-crossing)** Average time between calls from the start of one call to the start of the next.
- **Fmax (zero-crossing)** Average maximum frequency of echolocation pulses.
- **Fmin (zero-crossing)** Average minimum frequency of echolocation pulses.
- **Fmean (zero-crossing)** Time weighted average frequency of echolocation pulses.
- **Fc (zero-crossing)** Average characteristic frequency of echolocation pulses. This is the point in a call at the end of the body of the call defined as the flattest part (lowest absolute slope) of the call.
- **Tc (zero-crossing)** Average time offset from the beginning of the call to Fc.
- **Sc (zero-crossing)** Average characteristic slope (slope of the body of the call) of echolocation pulses in octaves per second.
- **Fk (zero-crossing)** Average knee frequency of echolocation pulses. This is at the beginning of the call body.
- **Tk (zero-crossing)** Average time offset from the beginning of the call to Fk.
- **S1 (zero-crossing)** Average initial slope of echolocation pulses in octaves per second.

4.13 Results Window

If an Auto ID for Bats or Cluster analysis batch process is run on the local computer, the Results window opens with the Viewer automatically when the batch process is complete.

If the batch process is run using Cloud-based computing, a notification email is sent when the batch process is complete. Use the Browser under the **Cloud** Tab to navigate to the output directory for the batch process. From within the Browser

It is also possible to open the Results window by going to the **Control Panel File menu->Open Results...** and choosing a .csv file.

Results Window Basics

- The Results window displays data from an underlying .csv file that has been created via a batch process.
- If the data in the Results window is edited, the underlying .csv file can be updated by going to the Results window **File menu->Save** or **Save As**.
- The displayed columns can be selected and re-ordered via the Results window **File menu->Edit columns...** Note: Most (but not all) columns are available for display.
- Rows can be sorted by clicking on column headers. Clicking on a column header again will reverse the sort order. Sort by multiple columns. For example, click on one column header to sort the data in that column, then click on a

second column header to sort the second column. In this case, all the matching second column rows will be together and sorted in the order of the first column.

- Clicking on a row causes the linked Viewer to open and display the corresponding file. In the case of cluster analysis, only a portion of the file is loaded according to the offset and duration columns (padded by the maximum inter-syllable gap on either side).
- The  and  buttons in the Viewer will advance the linked results window to the previous or next row and open the corresponding file. If a manual identification is updated or the file is renamed in the Viewer, the corresponding entry in the results table is also updated. In this way the files can be quickly reviewed and manual ID classifications added. When finished, choose the Results window **File menu->Save** or **File menu->Save as...** to update the underlying.csv file. The resulting .csv file can then be opened in spreadsheet software and pivot tables can be created to summarize results.

Results Window File Menu Commands

When the Results window is open and is the front-most window, the File menu offers the following choices:

For Bat Auto-ID

- **Change location** Change the source location of the currently selected file.
- **Save** Save edited data to the current underlying .csv file.
- **Save as...** Save edited data to a new version of the underlying .csv file.
- **Select all** Select all rows.
- **Select matching Top1Match/Auto ID...** Type in a Top1Match or auto-ID name and all detected signals with that name will be selected.
- **Select matching Manual ID...** Type in a manual ID name and all manual IDs with that name will be selected.
- **Copy selected files...** Selected files are copied to a new location.
- **Rename selected files prepending manual IDs...** When FS or ZC files are created on output as part of the auto-ID batch process, those files can be selected and any manual ID will be prepended to the output file name.
- **Bulk ID matching auto ID** Apply the same ID to all matching auto ID or cluster membership results.
- **Bulk ID selected rows** Apply the same ID to all results within selected rows.
- **Copy Top1Match/Auto IDs to Manual IDs** Copies all Top1Match or Auto IDs to **MANUAL ID** column.
- **Edit columns...** The displayed columns can be selected and re-ordered. Note: Most (but not all) columns are available for display.
- **Close** Close the Results window.
- **Exit** Windows only. This will Exit the program.

For Cluster Analysis

- **Change location** Change the source location of the currently selected file.
- **Save** Save edited data to the current underlying .csv file.
- **Save as...** Save edited data to a new version of the underlying .csv file.
- **Select all** Select all rows
- **Select matching Top1Match/Auto ID...** Type in a Top1Match or Auto-ID name and all detected signals with that name will be selected.
- **Select matching Manual ID...** Type in a manual ID name and all manual IDs with that name will be selected.
- **Save selected detections as WAVs...** Selected detections are copied as WAV files. The saved detections retain their original file names but add channel and offset information, including padding.
- **Bulk ID matching auto ID** Apply the same ID to all matching auto ID or cluster membership results.
- **Bulk ID selected rows** Apply the same ID to all results within selected rows.
- **Copy Top1Match/Auto IDs to Manual IDs** Copies all **TOP1MATCH** or **AUTO IDs** to **MANUAL ID** column.
- **Edit columns...** The displayed columns can be selected and re-ordered. Note: Most (but not all) columns are available for display.
- **Close** Close the Results window.
- **Exit** Windows only. This will Exit the program.

5 Resources

5.1 .csv File Layout

During batch processing Kaleidoscope creates .csv files depending on the selected batch options. The following are the .csv data format layouts.

meta.csv

The meta.csv file has a row for each detected signal and the following columns:

- **INDIR** Absolute path of the input directory.
- **FOLDER** Directory path from the input directory to the file containing the detected signal.
- **IN FILE** Filename of the file containing the detected signal.
- **DURATION** Duration of the detected signal in seconds.
- **DATE** Date stamp of the recording if available.
- **TIME** Time stamp of the recording if available.
- **HOUR** Hour (from time) of the recording if available.
- **DATE-12** Date stamp of the recording if available less 12 hours (for nightly folders).
- **TIME-12** Time stamp of the recording if available less 12 hours (for nightly folders).
- **HOUR-12** Hour (from time) of the recording if available less 12 hours (for nightly folders).
- **LATITUDE** GPS location of input file recording.
- **LONGITUDE** GPS location of input file recording.
- **MODEL** Recorder model.
- **SERIAL NO** Recorder serial number.
- **FIRMWARE** Recorder firmware version.
- **PREFIX** Recorder prefix (from the filename).
- **NOTES** Added field notes.
- **PULSES** Number of pulses detected in the file that were identified.
- **MATCHING** Number of pulses matching the auto classification result.
- **MATCH RATIO** The ratio of MATCHING over PULSES.
- **ORGID** Organization UUID of Managed Cloud Account who has run this batch process.
- **USERID** Nickname or email address of Managed Cloud Account who has run this batch process.
- **REVIEW ORIGID** If manual ID is present, this is the UUID of the organization corresponding to the manual ID.
- **REVIEW USERID** If manual ID present, this is the nickname or email address of the user who created the manual ID
- **INPATHMD5** Unique identification used internally by Kaleidoscope corresponding to the input file.

gps.csv

The gps.csv file has a row for each input file and the following columns:

- **DATE** Date stamp of the input file.
- **TIME** Time stamp of the input file.
- **LATITUDE** GPS location in output file.
- **LONGITUDE** GPS location in output file.
- **NAME** Filename of the corresponding output file or blank for waypoints.

cluster.csv

The cluster.csv file has a row for each detected signal and the following columns:

- **INDIR** Absolute path of the input directory.
- **FOLDER** Directory path from the input directory to the file containing the detected signal.

- **IN FILE** Filename of the file containing the detected signal.
- **CHANNEL** Channel number (0 = left, 1 = right) containing the detected signal.
- **OFFSET** Offset into the file in seconds to the start of the detected signal.
- **DURATION** Duration of the detected signal in seconds.
- **Fmin** Lowest frequency signal detected in any signal frame across the detected signal.
- **Fmean** Mean peak frequency signal detected across the detected signal.
- **Fmax** Highest frequency signal detected in any signal frame across the detected signal.
- **DATE** Date stamp of the vocalization if available.
- **TIME** Time stamp of the vocalization if available.
- **HOUR** Hour (from time) of the vocalization if available.
- **DATE-12** Date stamp of the vocalization if available less 12 hours (for nightly folders).
- **TIME-12** Time stamp of the vocalization if available less 12 hours (for nightly folders).
- **HOUR-12** Hour (from time) of the vocalization if available less 12 hours (for nightly folders).
- **TOP1MATCH, TOP2MATCH, TOP3MATCH**
Top 1st, 2nd, and 3rd cluster (or winning pair-wise label) from best to worse match.
- **TOP1DIST, TOP2DIST, TOP3DIST**
Distance to the cluster center corresponding with the 1st, 2nd and 3rd matches.
- **VOCALIZATIONS** Value of 1 for convenient pivot table counting.
- **MANUAL ID** User defined label that can be assigned subsequently.
- **USERID** Nickname or email address of Managed Cloud Account who has run this batch process.
- **REVIEW ORIGID** If manual ID is present, this is the UUID of the organization corresponding to the manual ID.
- **REVIEW USERID** If manual ID present, this is the nickname or email address of the user who created the manual ID
- **INPATHMD5** Unique identification used internally by Kaleidoscope corresponding to the input file.

When a cluster analysis batch process is complete, the Viewer is launched and linked with a results window containing a subset of the above columns. The displayed columns can be edited by using the **File menu->Edit columns...** on the results window. All of the **MANUAL ID** entries corresponding to a given **TOP1MATCH** in the selected row can be changed in bulk using the **File menu->Bulk ID...** on the results window.

When using the **Scan and cluster recordings...** mode, the cluster labels in the resulting cluster.csv and cluster.kcs files are named cluster.000, cluster.001, cluster.002, and so on. These labels can be changed to an arbitrary label in both the cluster.kcs and cluster.csv file via **File menu->Edit cluster name...** in the Results window. When the cluster.csv file is re-saved with **File menu->Save**, the labels in the cluster.kcs file will also be saved. This allows clusters to be named with a useful label such as a species name. A new data set can then be created using the same cluster.kcs file and the **TOPnMATCH** fields in the resulting cluster.csv will be set to the customized labels.

id.csv

The id.csv file has a row for each detected signal, and the following columns:

- **INDIR** Absolute path to input directory.
- **OUTDIR** Absolute path to output directory.
- **FOLDER** Directory path to the input file relative to the input root.
- **IN FILE** Input file name.
- **CHANNEL** Channel number from the input file (0=left, 1=right).
- **OFFSET** Offset in seconds into the input file where output begins.
- **DURATION** Duration in seconds of the output file.
- **OUT FILE FS** Name of the output file (full-spectrum).
- **OUT FILE ZC** Name of output file (zero-crossing).
- **DATE** Date in form YYYY-MM-DD of the recording.
- **TIME** Time in form of hh:mm:ss of the recording.
- **HOUR** Hour of the recording (0-23) for convenient pivot tables by hour.
- **DATE-12** Date 12 hours prior to date of recording (e.g. for night vs. day) in the form YYYY-MM- DD.

- **TIME-12** Time 12 hours prior to time of recording (e.g. for night vs. day) in the form hh:mm:ss.
- **HOURL-12** Hour 12 hours prior to time of recording (e.g. for night vs. day).
- **AUTO ID** Automatic classification result.
- **PULSES** Number of pulses detected in the file that were identified to species.
- **MATCHING** Number of pulses matching the auto classification result.
- **MATCH RATIO** The ratio of MATCHING over PULSES.
- **MARGIN** Classification margin - this is an uncalibrated confidence score and should not be subject to much interpretation other than that within a given species, higher values are more confident than lower values.
- **ALTERNATE 1** First alternate.
- **ALTERNATE 2** Second alternate.
In addition to the species identification, these fields list zero or more alternate species identifications separated by semicolons based on other pulse-level classifications detected in the file ranked from highest probability to lowest probability. This might suggest an alternate identification or multiple bats present.
- **N** Total number of pulses detected. This is used to derive average values for the following 12 parameters:
 - **Fc** Average characteristic frequency (kHz) - the body of the call is the portion of the call consisting of the flattest slope where the characteristic frequency is typically the frequency at the latest part of the call body.
 - **Sc** Average characteristic slope (Octaves per Second) - this is the slope of the body of the call. Positive values correspond to decreasing frequency while negative values correspond to increasing frequency.
 - **Dur** Average duration (ms) - this is the duration of the call.
 - **Fmax** Average maximum frequency (kHz) - the maximum frequency detected in the call.
 - **Fmin** Average minimum frequency (kHz) - the minimum frequency detected in the call.
 - **Fmean** Average mean frequency (kHz) - the time-weighted mean frequency of the call.
 - **TBC** Average time between calls (ms) - if N above is greater than one, this is the average period of the calls from the start of one call to the start of the next.
 - **Fk** Average frequency of the knee (kHz) - the frequency at the beginning of the call body.
 - **Tk** Average time to the knee (ms) - the time from the beginning of the call to the beginning of the call body.
 - **S1** Average initial slope (octaves per second) - the initial slope of the call.
 - **Tc** Average time to the characteristic (ms) - the time from the beginning of the call to the end of the call body.
 - **Qual** Average call quality (%) - a measure of the smoothness of the call where smaller values indicate a smoother call.
- **FILES** The number 1, indicating one file, as a convenience for pivot tables by file count.
- **MANUAL ID** Manual identification (this field populated during review with Viewer).
- **USERID** Nickname or email address of Managed Cloud Account who has run this batch process.
- **REVIEW ORIGID** If manual ID is present, this is the UUID of the organization corresponding to the manual ID.
- **REVIEW USERID** If manual ID present, this is the nickname or email address of the user who created the manual ID
- **INFILEMD5** Unique identification used internally by Kaleidoscope Pro corresponding to the input file.
- **OUTFILEMD5FS** Unique identification used internally by Kaleidoscope Pro corresponding to a full-spectrum output file.
- **OUTFILEMD5ZC** Unique identification used internally by Kaleidoscope Pro corresponding to a zero-crossing output file.

idsummary.csv

At a high level, this file is organized into rows representing output folders (from the input directory hierarchy) and columns representing species-specific data. More specifically, the first N columns represent the output directory structure hierarchy, where N is the maximum folder depth encountered. For example, if the input folder contained three subfolders A, B, and C, and each of these contained an additional three subfolders X,Y, and Z, there would be a total of 13 possible folder locations. This includes the root of the folder hierarchy, each of the three top level folders, and 9 additional subfolders including A/X, A/Y, A/Z, B/X, B/Y, B/Z, C/X, C/Y and C/Z. The maximum folder depth in this example is two, so the first column represents

the first level subdirectories and the second column represents the second level subdirectories. Asterisks are used to denote all the subfolders at a given level.

• Column 1	• Column 2	• Comments
• *	• *	• Represents overall totals
• A	• *	• Represents totals for folder A and all its subfolders
• A	• X	• Represents totals for files in A/X
• A	• Y	• Represents totals for files in A/Y
• A	• Z	• Represents totals for files in A/Z
• B	• *	• Represents totals for folder B and all its subfolders
• B	• X	• Represents totals for files in B/X
• B	• Y	• Represents totals for files in B/Y
• B	• Z	• Represents totals for files in B/Z
• C	• *	• Represents totals for folder C and all its subfolders
• C	• X	• Represents totals for files in C/X
• C	• Y	• Represents totals for files in C/Y
• C	• Z	• Represents totals for files in C/Z

Additional columns:

- **Classifier** General classifier used in the Auto ID for Bats analysis.
- **Species** For each species classifier enabled, there is an additional column indicating the number of files found matching the species.
- **NOID** Files the classifier chose not to classify.
- **NOISE** Files unlikely to be bats.
- **Presence P-Values** There is a set of columns for each species detected indicating the calculated presence P-values based on a Maximum Likelihood Estimator.

acousticindex.csv

The acousticindex.csv file has standard columns and then additional columns depending on what options are selected under the **Acoustic Indices** Tab.

Standard columns:

- **Folder** Directory path to the input file relative to the input root
- **In File** Input file name
- **Channel** Indicates the channel number in the recording.
- **Offset** Offset in seconds into the input file as defined by the Split to Max duration setting under the **Batch** Tab.
- **Duration** Duration of file or file segment as defined by the Split to Max duration setting under the **Batch** Tab.
- **Date** Date of file creation.
- **Time** Time of recording as displayed in hours, minutes, and seconds.
- **Hour** Hour of day of recording

Additional columns depending on options selected:

- **MEAN** The amplitude-weighted mean frequency (see Seewave).
- **SD** The standard deviation of the amplitude-weighted mean frequency (see Seewave).
- **SEM** The standard error of the amplitude-weighted mean frequency (see Seewave).
- **MEDIAN** The median of the amplitude-weighted frequency (see Seewave).

- **MODE** The mode of the amplitude-weighted frequency (see Seewave).
- **Q25** First quartile of the amplitude-weighted frequency (see Seewave).
- **Q75** Third quartile percentile of the amplitude-weighted frequency (see Seewave).
- **IQR** Inter-quartile range (see Seewave).
- **SKEW** Skewness, a measure of asymmetry (see Seewave).
- **KURT** Kurtosis, a measure of peakedness (see Seewave).
- **SFM** Spectral flatness measure (see Seewave). SFM of a noisy signal will tend toward 1 while a pure tone will tend toward 0.
- **SH** Shannon Spectral Entropy (see Seewave). SH of a noisy signal will tend toward 1 while a pure tone will tend toward 0.
- **NDSI** Normalized Difference Soundscape Index
- **ACI** Acoustic Complexity Index
- **ADI** Acoustic Diversity Index
- **AEI** Acoustic Evenness Index
- **BI** Bioacoustic Index
- **BGN** Background Noise
- **SNR** Signal to Noise Ratio
- **ACT** Activity
- **EVN** Events per Second
- **LFC** Low-frequency Cover
- **MFC** Medium-frequency Cover
- **HFC** High-frequency Cover
- **CENT** Spectral Centroid

splbyfile.csv

The splbyfile.csv file has a row for each audio sample and the following columns:

- **Folder** Directory path to the input file relative to the input root
- **File** Input file name
- **Channel** Indicates the channel number in the recording.
- **Offset (s)** Offset in seconds into the input file where output begins
- **Sample (s)** Indicates the actual number of seconds contributing to the sample period. This will correspond to the length of the file.
- **Correction (dB)** Indicates the combined correction factor applied to the full-scale recordings to produce the results. This includes the user-specified "dB Adjustment" value combined with any metadata adjustments from the recordings.
- **Min dB** Minimum Sound Pressure Level
- **Mean dB** Mean Sound Pressure Level
- **Max dB** Maximum Sound Pressure Level
- **SELcum dB** Cumulative Sound Exposure Level

spl.csv

The spl.csv file provides sound level analysis information based on per-hour time segments.

- **Prefix** Recorder prefix (from the filename). Kaleidoscope Pro assumes each recorder has a unique prefix.
- **Channel** Indicates the channel number in the recording.
- **Date** Indicates the date in YYYY-MM-DD format corresponding to the start of the sample period.
- **Time** Indicates the time in hh:mm:ss format corresponding to the start of the sample period.
- **Sample (s)** Indicates the actual number of seconds contributing to the sample period. This would usually be the same as the sample period as specified. But Kaleidoscope Pro will also process periods where there are gaps in the available recordings.

- **Correction (dB)** Indicates the combined correction factor applied to the full-scale recordings to produce the results. This includes the user-specified "dB Adjustment" value combined with any metadata adjustments from the recordings.

What follows will be a group of columns for each of the selected measurement bands. For each measurement band, there is a column for minimum, maximum, mean, and cumulative SEL as selected in the SPL Analysis options.

- **Min dB** Minimum Sound Pressure Level
- **Mean dB** Mean Sound Pressure Level
- **Max dB** Maximum Sound Pressure Level
- **SELCum dB** Cumulative Sound Exposure Level
-

query.csv

The query.csv file is created when a query is run from the **Db** Tab. The query.csv file contains the results from the database query. The format of the query.csv file is based on the type of query. For example, if the query type is Bat Auto IDs (id.csv), the format of the query.csv will be the same as an id.csv file. If the type of query is Recordings (meta.csv), the format of the query.csv file will be the same as a meta.csv file.

5.2 File Types

.wac - Wildlife Acoustics Compressed Format

The .wac or Wildlife Acoustics Audio Compression format is a legacy proprietary audio format produced by Song Meter and Echo Meter recorders. A .wac file may contain one or more channels (mono or stereo recordings), and these recordings may be either continuous or triggered. Triggered recordings are used for ultrasonic work (e.g. recording bats) where only periods of detected activity (a triggered event or bat pass) are recorded. A triggered .wac file may contain several triggered events as they are detected independently on each channel. In addition to acoustic data, .wac files may contain GPS track information when created by GPS-enabled recorders.

.wav - Waveform Audio File Format

The .wav format is a de-facto standard developed by IBM and Microsoft for representing multi-channel audio recordings. There are several flavors of .wav file formats which may utilize different forms of audio compression and metadata. Kaleidoscope supports only uncompressed 8-bit and 16-bit Pulse Code Modulation (PCM) .wav files. Wildlife Acoustics has also defined a proprietary (WAMD) extension to the .wav file format to store metadata and also supports the (GUANO) metadata format.

.w4v- Wildlife Acoustics Compressed WAV File Format

The .w4v format is identical to the .wav format except for a proprietary compressed encoding used to represent the audio samples. Kaleidoscope will open this type of file with either a .wav or .w4v file extension. The compression is a constant bit-rate where each 16-bit uncompressed sample is encoded as an n-bit code word plus some small amount of overhead. Typical code word sizes are 8-bit, 6-bit and 4-bit which are designated W4V-8, W4V-6 and W4V-4 respectively providing approximately 50%, 62% and 75% data compression respectively. While technically lossy, W4V-8 is very high quality and almost indistinguishable from uncompressed originals in the vast majority of acoustic and ultrasonic recordings made in the field. Compression is achieved by adaptively scaling the dynamic range, and the only artifact is raising the effective noise floor to no more than 42dB, 30dB or 18dB below the peak signal respectively.

Time Expanded File Format

In Bat Analysis Mode, the .wav/.w4v format described above may also represent time expanded recordings. Time expanded recordings are commonly used in ultrasonic work where the original recording is stretched through time by a constant factor effectively slowing it down such that ultrasonic signals are divided down into the audible range. This is accomplished by simply adjusting the sample rate of the recording. For example, if a recording is made at 384,000 samples per second, the sample rate in the file's metadata can be changed to 38,400 while keeping all the original audio samples. If we now play

back this file at 38,400 samples per second, it will take ten times longer to play and the frequencies will have been divided down by a factor of ten times. Such a file would be said to have a time expansion factor of 10.

With Kaleidoscope, it is possible to specify an explicit expansion factor for input files. It is also possible to use the Auto setting. The Auto setting assumes these are ultrasonic recordings and uses a time expansion factor of one for sample rates greater than 96,000. Otherwise, a time expansion factor of ten will be used, unless a different time expansion factor is explicitly defined in the source file metadata.

.??#, .zc - AnalookW Zero-crossing Sequence File Format

The .??# format is a proprietary format used in legacy zero-crossing bat detectors developed in the early 1990s by Chris Corben for Titley Electronics. This is not a recording in the conventional sense in that the original full-spectrum analog signal is not digitized and saved the way it is in a .wac or .wav/.w4v file. Instead, the time between a number (division ratio) of sequential zero-crossings is stored in the file. The original full-spectrum signal cannot be reconstructed from this small amount of data. However, with sufficient signal-to-noise ratio, the dominant frequency sweep through time produced by the echolocation calls of bats can be represented. More recently, the .zc file extension is also used to represent this type of file.

5.3 File Naming Conventions

The Wildlife Acoustics Song Meter line of recorders use specific file naming conventions.

Prefix_YYYYMMDD_hhmmss . extension

A Prefix may be optionally specified in the Song Meter configuration (typically to keep track of files from different Song Meters with different prefixes). If present, the prefix is prepended to the filename with an underscore character between the prefix and the year. The extension is either wav for a WAV file, wac for a WAC file, or 00# or zc for a Zero-crossing file.

On the Echo Meter EM3, the file name convention is slightly different to accommodate an additional optional tag character (represented by T below). This may be included if one of the tag buttons (e.g. A, B, C, or D) is pressed during recording, or the special N tag used to mark potential noise files. If no tag is present and the file is not a noise file, then the tag character is an underscore. The file name looks like this:

Prefix_T_YYYYMDD_hhmmss . extension

The output file name format will be in one of the following formats:

Prefix_YYYYMMDD_hhmmss_mmm . extension

Prefix_T_YYYYMMDD_hhmmss_mmm . extension

Prefix_C_YYYYMMDD_hhmmss_mmm . extension

If an Echo Meter tag is specified, the second form is used with T representing the tag.

If splitting channels from stereo to two mono channels, the third form is used with C representing the channel number (0 = left, 1 = right).

Otherwise the first form is used. In all these forms, an additional mmm is appended indicating the milliseconds offset.

When converting files which are not in the Song Meter filename format, the original filename is preserved and appended with:

_C_ssss_mmm. extension.

5.4 Metadata SCHEMA

This section provides specific metadata fields as defined in the Default MetaForm. It is possible to customize the Metaform to to extract different fields and sub-fields from the available metadata.

Standardized GUANO fields

The following table describes GUANO metadata fields, including fields used specifically by WildLife Acoustics.

Wildlife Acoustics GUANO Metadata Namespace

The GUANO Metadata (<https://guano-md.org>) specification reserves a namespace "WA" for use by Wildlife Acoustics, Inc. This document describes the custom fields defined by Wildlife Acoustics. Wildlife Acoustics reserves the right to modify the usage of these fields at any time.

Revision History

2020-07-05: Added acoustic indexes

2018-03-12: Added internal tags used in Kaleidoscope and standard tags

2017-11-22: Added WA|Kaleidoscope|Compression and WA|Song Meter|Prefix

2017-11-09: Initial disclosure.

Standardized GUANO fields

Field name	Data type	Description
GUANO Version	text	1.0
Filter HP	float	High-pass filter frequency in kHz
Filter LP	float	Low-pass filter frequency in kHz
Firmware Version	text	Recorder firmware version
Hardware Version	text	Recorder hardware version
Humidity	float	Relative humidity as a percentage
Length	float	Recording length in seconds
Loc Accuracy	float	Estimated Position Error in meters
Log Elevation	float	Elevation/altitude above mean sea level in meters
Loc Position	float float	WGS84 latitude and longitude
Make	text	Manufacturer of the recorder hardware
Model	text	Model name or number of the recording hardware
Note	text (multi-line)	Freeform textual note associated with the recording
Original Filename	text	Original filename before subsequent renaming during processing
Samplerate	integer	Recording sample rate, Hz
Serial	text	Serial number or unique identifier of recording hardware

Species Auto ID	text	Comma separated list of automatic classification species
Species Manual ID	text	Comma separated list of human-verified species
Tags	text	Comma separated list of arbitrary tags or labels
TE	integer	Time-expansion factor. If not specified, then 1 (no time-expansion a.k.a. direct-recording) is assumed.
Temperature Ext	float	External temperature in degrees Celsius outside the recorder's housing
Temperature Int	float	Internal temperature in degrees Celsius inside the recorder's housing
Timestamp	datetime	Date and time of the start of the recording (ISO 8601 with caveats)

Wildlife Acoustics GUANO Namespace

Field name	Data type	Description
WA Attribution	text	To share files, you can specify how you would like to be attributed by others who reference your data
WA Copyright	text	To share files, you can specify a copyright notice to be associated with your data
WA Kaleidoscope Auto ID	Text	Auto ID assignments generated by Kaleidoscope, like "Species Auto ID" This facilitates multiple programs to add auto id labels to the same files. The most recently used would overwrite the global "Species Auto ID", but the Kaleidoscope-specific ID is saved here. Presumably other programs will have other program-specific equivalents.
WA Kaleidoscope Channel	Integer	When splitting multi-channel (stereo) recordings into individual mono recordings, Kaleidoscope writes this metadata to the output file indicating which channel on the original recording represents the source of the data.
WA Kaleidoscope Classifier Settings	JSON-encoded Text	Classifier settings used to run the auto-id with the following JSON objects: <ul style="list-style-type: none"> • min freq - float minimum frequency, Hz • max freq - float maximum frequency, Hz • min dur - float minimum pulse duration, s • max dur - float maximum pulse duration, s • min calls - integer - minimum number of pulses • enhance - text - signal enhancement "on" or "off"

		<ul style="list-style-type: none"> • sensitivity - text - "liberal", "balanced" or "conservative" • species - array of strings - list of species codes selected
<p>WA Kaleidoscope Classifier Statistics</p>	<p>JSON-encoded Text</p>	<p>Auto ID classification results with the following JSON objects:</p> <ul style="list-style-type: none"> • id - text - Auto ID species code result • score - float - "margin" value • pulses - integer - number of pulses detected • matching - integer - number of pulses matching the Auto ID result • match ratio - float - ratio of matching/pulses • alternates - array of strings - alternate possible identifications • Fc - float - mean pulse characteristic frequency, kHz • Sc - float - mean pulse characteristic slope, OPS • Dur - float - mean pulse duration, ms • Fmax - float - mean pulse maximum frequency, kHz • Fmin - float - mean pulse minimum frequency, kHz • Fmean - float - mean pulse mean frequency, kHz • TBC - float - mean time between pulses, ms • Fk - float - mean pulse frequency of knee, kHz • Tk - float - mean pulse time of knee, ms • S1 - float - mean pulse initial slope, OPS • Tc - float - mean pulse time of characteristic, ms • Qual - float - mean pulse quality ratio
<p>WA Kaleidoscope Classifier Version</p>	<p>text</p>	<p>Name and version of the classifier</p>
<p>WA Kaleidoscope Cluster Settings</p>	<p>JSON-encoded text</p>	<p>Kaleidoscope cluster settings</p> <ul style="list-style-type: none"> • min freq - float - minimum frequency, Hz • max freq - float - maximum frequency, Hz • min dur - float - minimum duration, s • max dur - float - maximum duration, s • max gap - float - maximum gap, s • mode - text - clustering mode pass1, pass2, scan or scan-null • win - float - window, seconds • max states - integer - maximum number of states in model • max clusters - integer - maximum number of clusters to form • max dist merge - float - maximum distance used to merge clusters • max dist scan - float - maximum distance used to filter results

WA Kaleidoscope Cluster Statistics	JSON- encoded text	<p>Kaleidoscope cluster results</p> <ul style="list-style-type: none"> • offset - float - offset to detection, seconds • duration - float - duration of detection, seconds • fmin - float - minimum frequency of selected signal, Hz • fmean - float - mean frequency of selected signal, Hz • fmax - float - maximum frequency of selected signal, Hz • cluster - array of 3 strings indicating top 3 cluster names • distance - array of 3 floats indicating top 3 distances
WA Kaleidoscope Compression	text	Describes compression algorithm used in writing WAV files if any (e.g. "W4V-8")
WA Kaleidoscope Conversion	text	<p>Describes any conversion from input file to this file as one of:</p> <ul style="list-style-type: none"> • WAC to WAV • WAC to ZC • WAV to ZC • ZC to WAV
WA Kaleidoscope Fingerprint	text	A unique fingerprint corresponding to the raw data samples or zero crossing timings associated with a full spectrum or zero crossing audio file
WA Kaleidoscope GPS Fuzz	float	GPS Fuzz precision used to obfuscate location coordinates to the nearest grid center. For example, a value of 0.1 would round GPS latitude and longitude coordinates to the nearest 0.1 degree.
WA Kaleidoscope Acoustic Index Settings	JSON- encoded text	<p>Acoustic index module settings:</p> <ul style="list-style-type: none"> • NDSI <ul style="list-style-type: none"> ○ fft - integer - fft window size ○ anthro_min - float - minimum frequency for anthrophony (Hz) ○ anthro_max - float - maximum frequency for anthrophony (Hz) ○ bio_min - float - minimum frequency for biophony (Hz) ○ bio_max - float - maximum frequency for biophony (Hz) • ACI <ul style="list-style-type: none"> ○ fft - integer - fft window size ○ fmin - float - minimum frequency (Hz) ○ fmax - float - maximum frequency (Hz) ○ j - float - value of J (s) • ADI <ul style="list-style-type: none"> ○ fmax - float - maximum frequency (Hz) ○ fstep - float - step frequency (Hz)

		<ul style="list-style-type: none"> ○ thold - float - threshold (dB re peak signal) • AEI <ul style="list-style-type: none"> ○ fmax - float - maximum frequency (Hz) ○ fstep - float - step frequency (Hz) ○ thold - float - threshold (dB re peak signal) • BI <ul style="list-style-type: none"> ○ fft - integer - fft window size ○ fmin - float - minimum frequency (Hz) ○ fmax - float - maximum frequency (Hz) • SPEC <ul style="list-style-type: none"> ○ fft - integer - fft window size ○ fmin - float - minimum frequency (Hz) ○ fmax - float - maximum frequency (Hz) • QUT <ul style="list-style-type: none"> ○ fft - integer - fft window size ○ thold - float - threshold (dB re noise floor)
<p>WA Kaleidoscope Acoustic Index Statistics</p>	<p>JSON-encoded text</p>	<p>Acoustic index results (array by channel), floating point values of specific indexes</p> <ul style="list-style-type: none"> • MEAN • SD • SEM • MEDIAN • MODE • Q25 • Q75 • IQR • SKEW • KURT • SFM • SH • NDSI • ACI • ADI • AEI • BI • BGN • SNR • ACT • EVN • LFC • MFC • HFC • CENT
<p>WA Kaleidoscope SPL Settings</p>	<p>JSON-encoded text</p>	<p>SPL analysis module settings:</p> <ul style="list-style-type: none"> • period - the reporting sample period in seconds • adjust - decibel adjustment • SEL on - event onset threshold, dB

		<ul style="list-style-type: none"> SEL off - event offset threshold, dB
WA Kaleidoscope SPL Statistics	JSON-encoded text	<p>SPL analysis results (array by channel)</p> <ul style="list-style-type: none"> samples - audio sample in measurement, seconds correction - total correction factor, dB name of band (repeated for selected bands) <ul style="list-style-type: none"> min - minimum measurement, dB max - maximum measurement, dB mean - mean measurement, dB SELcum - cumulative Sound Exposure Level, dB*sec
WA Kaleidoscope Offset	float	Offset of result from input file in seconds
WA Kaleidoscope Version	text	Kaleidoscope software version
WA Kaleidoscope License	text	To share files, you can specify the type of licence under which you are willing to share your data. Choices include none (private), public domain, and various creative commons licenses.
WA Song Meter Audio settings	JSON-encoded text	<p>Song Meter settings (converted from WAMD metadata) including the following JSON objects in a per-channel array:</p> <ul style="list-style-type: none"> rate - integer - samplerate (samples per second) mic - text - microphone type e.g. "U1" gain - float - total gain in dB hpf - float - high-pass filter, Hz trig level - float - trigger level, dB trig window - float - trigger window, s trig max len - float - trigger maximum length, s trig min freq - float - trigger minimum frequency, Hz trig max freq - float - trigger maximum frequency, Hz trig min dur - float - trigger minimum duration, s trig max dur - float - trigger maximum duration, s
WA Song Meter Compression	text	The compression used by the Song Meter if any, converted from WAMD metadata, (e.g. "W4V-8")
WA Song Meter Prefix	text	The file prefix, if any, converted from WAMD metadata
Internal GUANO tags used in Kaleidoscope for database interfaces		
Field name	Data type	Description
WA *ACCESS	text	Set to 0 for private or 1 for public access to data

WA *BATCHFINGERPRINT	text	Unique fingerprint checksum for a given batch job
WA *BATCHLABEL	text	A user-defined label to identify a batch job
WA *BATCHRECORDSBYTES	integer	Size of batch database records (uncompressed .wdb (Wildlife Acoustics Database) file, in bytes.
WA *BATCHRECORDSRECORDINGS	integer	Number of recording records
WA *BATCHRECORDSAUTOIDS	integer	Number of autoid records
WA *BATCHRECORDSCLUSTERS	integer	Number of cluster records
WA *CHANNEL	integer	The input file channel used to create outputs
WA *DIVRATIO	integer	The zero crossing division ratio corresponding to a file
WA *DRIVELABEL	text	A user-defined label to identify a location (e.g. external disk drive) corresponding to a file
WA *FILE	text	The filename (with extension, but without directories)
WA *FINGERPRINT	text	A unique fingerprint corresponding to the raw data samples or zero crossing timings associated with a full spectrum or zero crossing audio file
WA *FOLDER	text	The folder path relative to the input directory to the input file
WA *INDIR	text	The absolute input directory path
WA *INDRIVELABEL	text	A user-defined label to identify a location (e.g. external disk drive) corresponding to an input file
WA *INFILE	text	The input filename (with extension, but without directories)
WA *INPATH	text	The absolute path name of the input file
WA *INPATHID	integer	A unique internal temporary id corresponding to an input file
WA *INPATHMD5	text	The MD5 hash of WA *INPATH used as a unique lookup key
WA *NCHANNELS	text	The number of audio channels in a file
WA *NOTEID	integer	A unique internal temporary id corresponding to a unique Note
WA *NOTEIDMD5	text	The MD5 hash of a Note used as a unique lookup key

WA *OFFSET	float	The offset in seconds into an audio file corresponding to a result
WA *ORGID	text	The unique Kaleidoscope Cloud account UUID corresponding to the source of a database entry
WA *OUTDIR	text	The absolute output directory path
WA *OUTDRIVELABEL	text	A user-defined label to identify a location (e.g. external disk drive) corresponding to an output file
WA *OUTFILE	text	The output filename (with extension, but without directories)
WA *OUTFILEFS	text	The full spectrum output filename (with extension, but without directories)
WA *OUTFILEZC	text	The zero crossing output filename (with extension, but without directories)
WA *OUTPATHFS	text	The absolute path name of the full spectrum output file
WA *OUTPATHZC	text	The absolute path name of the zero crossing output file
WA *OUTPATHIDFS	integer	A unique internal temporary id corresponding to a full spectrum output file
WA *OUTPATHIDZC	integer	A unique internal temporary id corresponding to a zero crossing output file
WA *OUTPATHMD5FS	text	The MD5 hash of WA *OUTPATHFS used as a unique lookup key
WA *OUTPATHMD5ZC	text	The MD5 hash of WA *OUTPATHZC used as a unique lookup key
WA *PATH	text	The absolute path name of the file
WA *PATHID	integer	A unique internal temporary id corresponding to the file
WA *PATHMD5	text	The MD5 hash of WA *PATH used as a unique lookup key
WA *PROFILEID	integer	A unique internal temporary id corresponding to a settings profile
WA *REVIEWORGID	text	The unique Kaleidoscope Cloud account UUID corresponding to the source of a review entry
WA *REVIEWUSERID	text	The user nickname (or email address if no nickname is specified) source of a review entry

WA *SETTINGS0	JSON-encoded text	The recorder settings for the left channel (channel 0) derived from "WA Song Meter Audio Settings"
WA *SETTINGS1	JSON-encoded text	The recorder settings for the right channel (channel 1) derived from "WA Song Meter Audio Settings"
WA *TIMESTAMP	datetime	Current timestamp for batches and reviews
WA *USERID	text	The user nickname (or email address if no nickname is specified) source of a database entry

Internal GUANO tags used in Kaleidoscope for database interfaces

Field name	Data type	Description
WA *ACCESS	text	Set to 0 for private or 1 for public access to data
WA *BATCHFINGERPRINT	text	Unique fingerprint checksum for a given batch job
WA *BATCHLABEL	text	A user-defined label to identify a batch job
WA *BATCHRECORDSBYTES	integer	Size of batch database records (uncompressed .wdb (Wildlife Acoustics Database) file, in bytes.
WA *BATCHRECORDSRECORDINGS	integer	Number of recording records
WA *BATCHRECORDSAUTOIDS	integer	Number of autoid records
WA *BATCHRECORDSCLUSTERS	integer	Number of cluster records
WA *CHANNEL	integer	The input file channel used to create outputs
WA *DIVRATIO	integer	The zero crossing division ratio corresponding to a file
WA *DRIVELABEL	text	A user-defined label to identify a location (e.g. external disk drive) corresponding to a file
WA *FILE	text	The filename (with extension, but without directories)
WA *FINGERPRINT	text	A unique fingerprint corresponding to the raw data samples or zero crossing timings associated with a full spectrum or zero crossing audio file
WA *FOLDER	text	The folder path relative to the input directory to the input file

WA *INDIR	text	The absolute input directory path
WA *INDRIVELABEL	text	A user-defined label to identify a location (e.g. external disk drive) corresponding to an input file
WA *INFILE	text	The input filename (with extension, but without directories)
WA *INPATH	text	The absolute path name of the input file
WA *INPATHID	integer	A unique internal temporary id corresponding to an input file
WA *INPATHMD5	text	The MD5 hash of WA *INPATH used as a unique lookup key
WA *NCHANNELS	text	The number of audio channels in a file
WA *NOTEID	integer	A unique internal temporary id corresponding to a unique Note
WA *NOTEIDMD5	text	The MD5 hash of a Note used as a unique lookup key
WA *OFFSET	float	The offset in seconds into an audio file corresponding to a result
WA *ORGID	text	The unique Kaleidoscope Cloud account UUID corresponding to the source of a database entry
WA *OUTDIR	text	The absolute output directory path
WA *OUTDRIVELABEL	text	A user-defined label to identify a location (e.g. external disk drive) corresponding to an output file
WA *OUTFILE	text	The output filename (with extension, but without directories)
WA *OUTFILEFS	text	The full spectrum output filename (with extension, but without directories)
WA *OUTFILEZC	text	The zero crossing output filename (with extension, but without directories)
WA *OUTPATHFS	text	The absolute path name of the full spectrum output file
WA *OUTPATHZC	text	The absolute path name of the zero crossing output file
WA *OUTPATHIDFS	integer	A unique internal temporary id corresponding to a full spectrum output file

WA *OUTPATHIDZC	integer	A unique internal temporary id corresponding to a zero crossing output file
WA *OUTPATHMD5FS	text	The MD5 hash of WA *OUTPATHFS used as a unique lookup key
WA *OUTPATHMD5ZC	text	The MD5 hash of WA *OUTPATHZC used as a unique lookup key
WA *PATH	text	The absolute path name of the file
WA *PATHID	integer	A unique internal temporary id corresponding to the file
WA *PATHMD5	text	The MD5 hash of WA *PATH used as a unique lookup key
WA *PROFILEID	integer	A unique internal temporary id corresponding to a settings profile
WA *REVIEWORGID	text	The unique Kaleidoscope Cloud account UUID corresponding to the source of a review entry
WA *REVIEWUSERID	text	The user nickname (or email address if no nickname is specified) source of a review entry
WA *SETTINGS0	JSON-encoded text	The recorder settings for the left channel (channel 0) derived from "WA Song Meter Audio Settings"
WA *SETTINGS1	JSON-encoded text	The recorder settings for the right channel (channel 1) derived from "WA Song Meter Audio Settings"
WA *TIMESTAMP	datetime	Current timestamp for batches and reviews
WA *USERID	text	The user nickname (or email address if no nickname is specified) source of a database entry

Database Fields

When searching a Managed Cloud Account database via the Db Tab, the Selectable Database Fields are defined by the MetaForm. The following is a list of Selectable Database Fields as defined by the Default MetaForm. It is also possible to customize the Metaform to create different fields.

Batch

Batch – Fingerprint
 Batch – Size (bytes)
 Batch – Recording Records
 Batch – Auto ID Records
 Batch – Cluster Records
 Batch – Batch Label

Batch – Timestamp
 Batch – Kaleidoscope Version
 Batch – Input Directory
 Batch – Output Directory
 Batch – Input Drive Label
 Batch – Output Drive Label

Batch – Classifier Version
 Batch – Classifier Settings
 Batch – Cluster Settings
 Batch – SPL Settings
 Batch - Note

Recordings (meta.csv)

Review – Timestamp	Rec – Filter LP (kHz)	Rec – Trig Window 1 (s)
Review – Species Manual ID	Rec – Firmware Version	Rec – Trig Max Len 1 (s)
Rec – Path	Rec – Hardware Version	Rec – Trig Min Freq 1 (Hz)
Rec – Drive Label	Rec – Make	Rec – Trig Max Freq 1 (Hz)
Rec – File	Rec – Model	Rec – Trig Min Dur 1 (s)
Rec – Fingerprint	Rec – Samplerate	Rec – Compression
Rec - Note	Rec – Serial	Batch – Fingerprint
Rec – Humidity (%)	Rec – TE	Batch – Size (bytes)
Rec – Length (s)	Rec – Prefix	Batch – Recording Records
Rec – Loc Accuracy (deg)	Rec – Mic0	Batch – Auto ID Records
Rec – Loc Elevation (m)	Rec – Mic1	Batch – Cluster Records
Rec – Latitude (deg)	Rec – Gain 0 (dB)	Batch – Batch Label
Rec – Longitude (deg)	Rec – HPF 0 (Hz)	Batch – Timestamp
Rec – GPS Fuzz (deg)	Rec – Trig Level 0 (dB)	Batch – Kaleidoscope Version
Rec – Original Filename	Rec – Trig Window 0 (s)	Batch – Input Directory
Rec – Temperature Ext (C)	Rec – Trig Max Len 0 (s)	Batch – Output Directory
Rec – Temperature Int (C)	Rec – Trig Min Freq 0 (Hz)	Batch – Input Drive Label
Rec – Timestamp	Rec – Trig Max Freq 0 (Hz)	Batch – Output Drive Label
Rec – SPL Statistics	Rec – Trig Min Dur 0 (s)	Batch – Classifier Version
Rec – Acoustic Index Statistics	Rec – Trig Max Dur 0 (s)	Batch – Classifier Settings
Rec – Copyright	Rec – Gain 1 (dB)	Batch – Cluster Settings
Rec – Attribution	Rec – HPF 1 (Hz)	Batch – SPL Settings
Rec – License Type	Rec – Trig Max Dur 1 (s)	Batch - Note
Rec – Filter HP (kHz)	Rec – Trig Level 1 (dB)	

Bat Auto IDs (id.csv)

Review – Timestamp	Auto ID – Fmin (kHz)	In Rec – Latitude (deg)
Review – Species Manual ID	Auto ID – Fmean (kHz)	In Rec – Longitude (deg)
Auto ID – Channel	Auto ID – TBC (ms)	In Rec – GPS Fuzz (deg)
Auto ID – Offset (s)	Auto ID – Fk (kHz)	In Rec – Original Filename
Auto ID – Duration (s)	Auto ID – Tk (ms)	In Rec – Temperature Ext (C)
Auto ID – Timestamp	Auto ID – S1 (OPS)	In Rec – Temperature Int (C)
Auto ID – Species Auto ID	Auto ID – Tc (s)	In Rec – Timestamp
Auto ID - Pulses	Auto ID – Qual (%)	In Rec – SPL Statistics
Auto ID - Matching	In Rec – Path	In Rec – Acoustic Index Statistics
Auto ID – Match Ratio	In Rec – Drive Label	
Auto ID - Margin	In Rec – File	In Rec – Copyright
Auto ID – Alternate 1	In Rec – Fingerprint	In Rec – Attribution
Auto ID – Alternate 2	In Rec – Note	In Rec – License Type
Auto ID – Fc (kHz)	In Rec – Humidity (%)	In Rec – Filter HP (kHz)
Auto ID – Sc (OPS)	In Rec – Length (s)	In Rec – Filter LP (kHz)
Auto ID – Dur (ms)	In Rec – Loc Accuracy (%)	In Rec – Firmware Version
Auto ID – Fmax (kHz)	In Rec – Loc Elevation (m)	In Rec – Hardware Version

In Rec – Make	In Rec – Trig Min Dur 1 (s)	Out ZC Rec – Loc Elevation (deg)
In Rec – Model	In Rec - Compression	Out ZC Rec – GPS Fuzz (deg)
In Rec – Samplerate	Out FS Rec – Path	Out ZC Rec – Original Filename
In Rec – Serial	Out FS Rec – Drive Label	Out ZC Rec – Temperature Ext (C)
In Rec – TE	Out FS Rec – File	Out ZC Rec – Temperature Int (C)
In Rec – Prefix	Out FS Rec – Fingerprint	Out ZC Rec – Timestamp
In Rec – Mic0	Out FS Rec – Note	Out ZC Rec – SPL Statistics
In Rec – Mic1	Out FS Rec – Humidity (%)	Out ZC Rec – Acoustic Index Statistics
In Rec – Gain 0 (dB)	Out FS Rec – Length (s)	Batch – Fingerprint
In Rec – HPF 0 (Hz)	Out FS Rec – Loc Accuracy (deg)	Batch – Size (bytes)
In Rec – Trig Level 0 (dB)	Out FS Rec – Loc Elevation (deg)	Batch – Recording Records
In Rec – Trig Window (s)	Out FS Rec – GPS Fuzz (deg)	Batch – Auto ID Records
In Rec – Trig Window 0 (s)	Out FS Rec – Original Filename	Batch – Cluster Records
In Rec – Trig Max Len 0 (s)	Out FS Rec – Temperature Ext (C)	Batch – Batch Label
In Rec – Trig Min Freq 0 (Hz)	Out FS Rec – Temperature Int (C)	Batch – Timestamp
In Rec – Trig Max Freq 0 (Hz)	Out FS Rec – Timestamp	Batch – Kaleidoscope Version
In Rec – Trig Min Dur 0 (s)	Out FS Rec – SPL Statistics	Batch – Input Directory
In Rec – Trig Max Dur 0 (s)	Out FS Rec – Acoustic Index Statistics	Batch – Output Directory
In Rec – Gain 1 (dB)	Out ZC Rec – Path	Batch – Input Drive Label
In Rec – HPF 1 (Hz)	Out ZC Rec – Drive Label	Batch – Output Drive Label
In Rec – Trig Max Dur 1 (s)	Out ZC Rec – File	Batch – Classifier Version
In Rec – Trig Level 1 (dB)	Out ZC Rec – Fingerprint	Batch – Classifier Settings
In Rec – Trig Window 1 (s)	Out ZC Rec – Note	Batch – Cluster Settings
In Rec – Trig Max Len 1 (s)	Out ZC Rec – Humidity (%)	Batch – SPL Settings
In Rec – Trig Min Freq 1 (Hz)	Out ZC Rec – Length (s)	Batch – Noise
In Rec – Trig Max Freq 1 (Hz)	Out ZC Rec – Loc Accuracy (deg)	

Clusters (cluster.csv)

Review - Timestamp	Rec – File	Rec – Attribution
Review – Species Manual ID	Rec – Fingerprint	Rec – License Type
Cluster – Channel	Rec - Note	Rec – Filter HP (kHz)
Cluster – Offset (s)	Rec – Humidity (%)	Rec – Filter LP (kHz)
Cluster – Duration (s)	Rec – Length (s)	Rec – Firmware Version
Cluster – Fmin (Hz)	Rec – Loc Accuracy (deg)	Rec – Hardware Version
Cluster – Fmean (Hz)	Rec – Loc Elevation (m)	Rec – Make
Cluster – Fmax (Hz)	Rec – Latitude (deg)	Rec – Model
Cluster - Timestamp	Rec – Longitude (deg)	Rec – Samplerate
Cluster – Top 1 Match	Rec – GPS Fuzz (deg)	Rec – Serial
Cluster – Top 1 Distance	Rec – Original Filename	Rec – TE
Cluster – Top 2 Match	Rec – Temperature Ext (C)	Rec – Prefix
Cluster – Top 2 Distance	Rec – Temperature Int (C)	Rec – Mic0
Cluster – Top 3 Match	Rec – Timestamp	Rec – Mic1
Cluster – Top 3 Distance	Rec – SPL Statistics	Rec – Gain 0 (dB)
Rec – Path	Rec – Acoustic Index Statistics	Rec – HPF 0 (Hz)
Rec – Drive Label	Rec – Copyright	Rec – Trig Level 0 (dB)

Rec – Trig Window 0 (s)	Rec – Trig Max Freq 1 (Hz)	Batch – Kaleidoscope Version
Rec – Trig Max Len 0 (s)	Rec – Trig Min Dur 1 (s)	Batch – Input Directory
Rec – Trig Min Freq 0 (Hz)	Rec – Trig Max Dur 1 (s)	Batch – Output Directory
Rec – Trig Min Dur 0 (s)	Rec – Compression	Batch – Input Drive Label
Rec – Trig Max Dur 0 (s)	Batch – Fingerprint	Batch – Output Drive Label
Rec – Gain 1 (dB)	Batch – Size (bytes)	Batch – Classifier Version
Rec – HPF 1 (Hz)	Batch – Recording Records	Batch – Classifier Settings
Rec – Trig Level 1 (dB)	Batch – Auto ID Records	Batch – Cluster Settings
Rec – Trig Window 1 (s)	Batch – Cluster Records	Batch – SPL Settings
Rec – Trig Max Len 1 (s)	Batch – Batch Label	Batch – Note
Rec – Trig Min Freq 1 (Hz)	Batch – Timestamp	

5.5 Explaining Maximum Likelihood Estimators (MLE) and P-values used in Kaleidoscope Pro Classifiers

The U.S. Fish Wildlife Service Indiana Bat Summer Survey Guidance:

<http://www.fws.gov/midwest/angered/mammals/inba/inbasummersurveyguidance.html> describes the use of approved software programs. As part of their software testing criteria:

"As species identifications are never perfect, all analysis programs must utilize a maximum-likelihood estimator approach to determine species presence at the site rather than relying on a single sequence. Post-hoc maximum-likelihood estimator p-values will be used to determine acceptance thresholds for final identification determination."

- The maximum-likelihood estimator used by Kaleidoscope Pro is based on a 2002 paper by Britzke, Murray, Heywood, and Robbins: Acoustic Identification.

http://www.fwspubs.org/doi/suppl/10.3996/082013-JFWM-057/suppl_file/082013-jfwm-057r1-s05.pdf

- The method described takes two inputs. First, there are the classification results e.g. how many detections of each bat did the classifier find. Second, there is the confusion matrix representing the known error rates across all the classifiers. For example, 70% of MYLU calls are correctly classified as MYLU while 3% of MYLU calls are misclassified as MYSO, etc. The maximum likelihood estimator determines what the most likely distribution of different species are that would result in the observed classifications given the classifier error rate. Then, to calculate P-values, a given species is clamped as absent and the most likely distribution is recalculated. The ratio of the clamped likelihood divided by the original likelihood is the P-value.
- In layman's terms, if we run an automated classifier on a data set, we will end up with a number of classifications for each species found in the data. From this, we want to determine the likelihood of presence or absence by calculating the P-value corresponding to the null hypothesis of absence. A low (near zero) p-value would therefore suggest presence.
- For example, suppose we have a classification result with 70 MYLU detections and 3 MYSO detections. Given the error rate between MYLU and MYSO, the 3 MYSO detections are easily explained away as false positives from actual MYLU calls, so the P-value for MYSO in this case would be expected to be very high (unlikely present). On the other hand, if we have 70 MYLU detections and 20 MYSO detections, it is harder to explain away all 20 MYSO detections as false positives from actual MYLU calls, so the P-value for MYSO in this case would be expected to be very low (likely present).

There are some important caveats:

- First, an important input to the calculation is the known confusion matrix of the classifier. Unfortunately, there is no such thing. The error rates of a bat classifier will vary from one site to the next, because the bats will produce different calls in different habitats with different levels of clutter. In a high clutter environment, for example, it might be expected to see a higher error rate than in a low clutter environment. It is also exceedingly difficult to measure the error rate without significant independently collected and verified data. For Kaleidoscope Pro, we split our data in half using one half to train our classifiers and the other half to measure the error rates. This is as good an estimate of the average confusion matrix that we can measure. But, it is not going to be the actual confusion matrix

for any particular deployment. Therefore, the P- value calculations can't be determined exactly. They are only estimates.

- Second, while the P-value is perhaps the best statistical tool we have to work with, it is not perfect. A high P-value is not proof of absence. It simply means there is not sufficient statistical evidence of presence. And a low P-value is not proof of presence, it simply means the null hypothesis of absence cannot be explained by the data. A low P-value might suggest that an alternate hypothesis is more likely. That could be presence. But it could also be that the classification error matrix was not a good fit for the data.
- MLE P-values are a convenient way to aggregate a lot of data and provide a useful statistic to estimate presence or absence of species. But, it is an imperfect statistic and should not be relied upon without some other means of verification of presence or likely absence.

5.6 Overview of the Clustering Algorithm Signal Detection and Feature Extraction

In non-bat analysis mode: A signal detector searches for candidate vocalizations and extracts the features used for clustering. A candidate vocalization is a phrase comprising a sequence of syllables occurring close together in time such that the maximum inter-syllable gap is not exceeded. Here, a syllable is the period between a detected onset above the background noise until the signal drops back towards the noise floor. The signal energy in the phrase is also expected to be constrained to minimum and maximum frequencies and durations. The algorithm estimates the ambient background spectrum through a rolling average of power levels going back in time by the maximum detected signal duration. The spectrum of each FFT frame in each syllable (the signal frames) are normalized and Discrete Cosine Transform (DCT) coefficients representing the spectrum are extracted. The variable-length sequence of these DCT coefficients of these signal frames forms the feature vector representing the candidate vocalization.

In bat-analysis mode, enhanced zero-crossing is performed and the sequence of dots representing frequency and time are extracted.

Hidden Markov Model

A Hidden Markov Model (HMM) is constructed from the vector of DCT coefficients for each signal frame. First, these vectors are clustered using K-Means to form initial estimates for HMM states. Then, the HMM is trained on the candidate vocalizations using the Viterbi algorithm. Note that there is deliberate randomness to the algorithm used to seed initial HMM states during the K-Means clustering. As such, the resulting HMM may vary between different runs resulting in slightly different clustering results.

Fisher Scores

The variable length feature vector representing each candidate vocalization is transformed into a highly dimensional fixed length feature vector by calculating the Fisher Score against the underlying HMM model parameters. The magnitude of the Fisher Scores are normalized to unit length and become the basis for comparing two vocalizations for similarity. The dot product of two Fisher Scores is related to the Euclidean distance between two Fisher Scores each normalized to unit length. A distance of zero would suggest the vocalizations are identical, while a distance equal to the square root of 2 (~1.41) suggests the vocalizations are orthogonal. The maximum possible Euclidean distance between two vocalizations is 2.0.

Clustering

Clusters are formed by moving vocalizations to existing clusters if they are within some minimum distance of the cluster. Otherwise, new clusters may be formed.

Pair-wise Classifiers

As an extra step which can be taken when vocalization classes are known (e.g. with human supervision), the multi-dimensional hyperplane maximizing the separation between two classes can be formed for each pair of classes. This will often outperform cluster membership alone in classification because it is both more discriminating (by finding separation between overlapping clusters) but also carves out more of the multi-dimensional space (e.g. a vocalization is on one side or the other side of the plane regardless of its distance to a cluster) to better fit new data that doesn't match closely to the training data.

5.7 Kaleidoscope Command Line Interface

Kaleidoscope Pro can be controlled via command lines and scripting. This is a specialized feature that is typically used to run server-based batch processes.

Installation

Windows

On Windows, the `kaleidoscope-cli.exe` executable is installed with DLLs in the application program directory. By default, this would be here:

```
C:\Program Files (x86)\Wildlife Acoustics\kaleidoscope\kaleidoscope-cli.exe
```

Linux

On all supported flavors of Linux (RHEL 7, Ubuntu 18, Debian 9), the `kaleidoscope-cli` executable is installed by default here:

```
/usr/local/bin/kaleidoscope-cli
```

License Activation

A Kaleidoscope Pro subscription or permanent license is required for use of Kaleidoscope CLI. The Kaleidoscope CLI program can share the same subscription or license as the graphical version installed on the same computer. You can activate the license from either the graphical version or from the command-line version.

To activate a subscription from the command line:

```
kaleidoscope-cli --subscribe --email subscription_email_address
```

You will be prompted for your Wildlife Acoustics account password. If the credentials are valid and a subscription is available, the activation will be completed.

To activate a permanent license from the command line:

```
kaleidoscope-cli --license license_id --email license_email_address
```

To check the current license and/or subscription status, use:

```
kaleidoscope-cli -license
```

Accepting Terms and Conditions

For each new version of Kaleidoscope, Wildlife Acoustics requires that the end-user accept the terms and conditions (see `license.html` found in the installation directory on Windows or `/usr/local/share/kaleidoscope` on Linux). This only needs to be done once after installing a new version, either from the graphical or command-line version of Kaleidoscope. To accept the license from the command line, use:

```
kaleidoscope-cli --accept-license
```

Note: it is a good idea to include `--accept-license` any time you use `kaleidoscope-cli` from a script to ensure that `kaleidoscope-cli` will run after new versions are installed.

Running a Batch Job

The Kaleidoscope command-line interface is typically used to run batch Kaleidoscope processing jobs, typically from a script. To run a batch job from a script, use the following arguments:

```
kaleidoscope-cli          [ --accept-license ]
--batch settings.ini
[ --form metaform.xml ]
[ --guano guano.txt ]
[ --file-list filelist.txt ]
[ --clusterfilter --clusterusecsv cluster.csv ]
```

```
[ --clusterusecsv cluster.csv ]
```

The following command line arguments are supported:

`--accept-license`

Optional. Acknowledge that you accept the Wildlife Acoustics, Inc. Terms and Conditions as provided in the `license.html` file distributed with the Kaleidoscope software. This is only required the first time Kaleidoscope is run after installing a new version. However, it is good practice to include this in scripts that use Kaleidoscope to ensure that the scripts will run after upgrades take place.

`--batch settings.ini`

Required. Run a batch job based on the settings defined in the `.ini` file indicated. It would be common for scripts to build a custom `.ini` file and invoke Kaleidoscope CLI with these settings. If a setting is not included in the `.ini` file, default values will be used. A more detailed list of `.ini` settings is included below.

`--form metaform.xml`

Optional. If you would like to use an alternative to the built-in default MetaForm, you can specify the MetaForm XML document to use here.

`--guano guano.txt`

Optional. To provide project form meta data to the batch job, you can create a GUANO-formatted text file. See www.wildlifacoustics.com/SCHEMA/ for details.

The first line in the file must be "GUANO|Version 1.0". Subsequent lines would be key/value pairs separated by colons.

`--file-list filelist.txt`

Optional. Normally, the input files are determined from the `.ini` file input directory. With this option, you can override the list of files to be processed. The `filelist.txt` file should have a list of files with absolute path names, one per line.

`--clusterfilter`

Optional. When scanning files for clustering using **Scan and cluster recordings to create cluster.kcs and cluster.csv**, it is sometimes desirable to include only a subset of detections as determined from prior clustering batches. When this option is specified, it must be used with the `--clusterusecsv` option to specify a previously generated `cluster.csv` file. Only detections that correspond to entries in the `cluster.csv` file containing a non-blank **MANUAL ID** column entry will be included in the new round of clustering.

`--clusterusecsv cluster.csv`

Optional (but required with `--clusterfilter` above) specifies the `cluster.csv` file to use for either the `--clusterfilter` option above or for a batch scan using "Re-scan recordings and edited cluster.csv to create new cluster.kcs with pairwise classifiers and cluster.csv". Note that if this option is not specified, the location of the `cluster.csv` to be used can be found in the `.ini` file instead.

Settings.INI Format

The settings.ini file is used by Kaleidoscope to save settings. INI files represent parameter values organized into groups. A group name is indicated by square braces e.g. "[global]" on a line by itself and is followed by one or more parameters with field names and values indicated with "name=value" pairs, one on each line. This file can also be opened and examined in a text editor.

GROUP	PARAMETER	REQUIRED	DEFAULT	VALUES
global	mode	yes		0 = Bat Analysis Mode 1 = Non-bat Analysis Mode
	threads	no	N cores + 1	Number of parallel threads to use
classifier	classifier	no		For bat auto-id, this is the base name of the Kaleidoscope classifier .zip file (without the .zip extension) for example "classifiers-Bats_of_North_America_4.3.0"
	roc	no	depends	0 = more sensitive 1 = balanced 2 = more accurate Default depends on classifier version loaded
	SPECIESCODE	no	0	0 = disabled 1 = enabled For each species code in the classifier
input	directory	yes		Absolute path of input directory
	drivelabel	no		Drive label for inputs
	subdirs	no	1	0 = do not scan subdirectories 1 = scan subdirectories
	gpsfuzz	no	0	0 = no fuzz Otherwise fuzz to precision specified
	metaform	yes	Default Project Form	
input/wac	enable	no	1	0 = do not scan WAC files 1 = scan WAC files
input/wav	enable	no	1	0 = do not scan WAV/W4V files 1 = scan WAV/W4V files
	te	no	0	0 = automatic time expansion 1 = time expansion factor 1 8 = time expansion factor 8 10 = time expansion factor 10 16 = time expansion factor 16 20 = time expansion factor 20
input/zc	Enable	no	0	0 = do not scan zero crossing files 1 = scan zero crossing files
output	directory	yes		Absolute path of output directory
	drivelabel	no		Drive label for outputs
	subdirs	no	0	0 = none 1 = create daily subdirectories in outputs 2 = create nightly subdirectories in outputs
	channelssel	yes	0	0 = process all input channels 1 = process only left input channel 2 = process only right channel
	max	no	0	0 = no maximum output file size >0 specify maximum file size in seconds, output files will be split into multiple files as necessary
	noise	No	2	0 = disable noise filtering

				1 = delete noise files 2 = move noise files to NOISE subfolder
output/wav	enable0	No	0	Bat-mode generate output wav files 0 = disabled 1 = enabled
	enable1	No	0	Non bat-mode generate output wav files 0 = disabled 1 = enabled
	compress	No	0	Compress output files using W4V format 0 = none 8 = W4V-8 7 = W4V-7 6 = W4V-6 5 = W4V-5 4 = W4V-4
	te	No	1	Output Time Expansion factor 1 = time expansion factor 1 8 = time expansion factor 8 10 = time expansion factor 10 16 = time expansion factor 16 20 = time expansion factor 20
	split	No	1	0 = do not split stereo channels into two files 1 = split stereo channels into two files
output/zc	enable	No	0	0 = do not create zero crossing output files 1 = create zero crossing output files
	divratio	No	8	Divratio (4, 8, 16, or 32) of output zc files
	83	No	0	0 = do not use old style 8.3 filenames 1 = use old style 8.3 filenames
	dotzc	No	0	0 = use .xx# file extension 1 = use .zc file extension
output/gps	format	No	0	0 = do not create gps.csv or gps.kml file 1 = create gps.csv file 2 = create gps.kml file
	waypoint	No	60	GPS track waypoint rate (seconds)
analysis	mincalls	No	2	Minimum number of calls for avoiding noise filter
	rawzc	No	1	0 = use only band-pass filter for zero crossing conversion 1 = use advanced signal enhancement for zero crossing conversion
	freqmin0	No	8	Bat mode minimum frequency (kHz)
	freqmax0	No	120	Bat mode maximum frequency (kHz)
	durmin0	No	2.0	Bat mode minimum pulse duration (ms)
	durmax0	No	500.0	Bat mode maximum pulse duration (ms)
	maxgap0	No	500.0	Bat mode maximum gap (ms)
	freqmin_1	No	250	Non-bat mode minimum frequency (Hz)
	freqmax_1	No	10000	Non-bat mode maximum frequency (Hz)
	dumin_1	No	0.1	Non-bat mode minimum detection duration (s)
	dumax_1	No	7.5	Non-bat mode maximum detection duration (s)
	maxgap_1	No	0.35	Non-bat mode maximum gap (s)
cluster	mode	No	0	Clustering mode

				0 = disabled 1 = simple clustering 2 = advanced clustering 3 = scan using existing cluster.kcs 4 = detect vocalizations without clustering
	read	No		Path to input cluster.kcs file when scanning using existing cluster.kcsn
	read2	No		Path to input cluster.csv file when building advanced classifiers (can be overridden with --clusterusecsv command line argument)
	window mode	No	1	0 = 2.67 ms 1 = 5.33 ms 2 = 10.67 ms 3 = 21.33 ms
	maxstates	No	12	Maximum number of states in model
SPL	enabled	No	0	SPL analysis 0 = disabled 1 = enabled
	period	No	60	Measurement period (minutes)
	min	No	0	0 = do not output minimum values 1 = output minimum values
	max	No	0	0 = do not output maximum values 1 = output maximum values
	mean	No	1	0 = do not output mean values 1 = output mean values
	selcum	No	0	0 = do not output SELcum values 1 = output SELcum values
	Adjdb	No	0	Additional dB adjustment value
	Selon	No	12	SELcum onset trigger level (dB)
	Seloff	No	3	SELcum offset trigger level (dB)
	BANDLABEL	No	0	Various band labels as they appear in the graphical interface with spaces changed to underscores and slashes changed to hyphens. 0 = disabled 1 = enabled
bioindex	enable	yes	0	0 = disabled 1 = enabled
Bioindex/ndsi	enable	no	0	0 = disabled 1 = enabled
	fftbits	no	10	6 = 64 7 = 128 8 = 256 9 = 512 10 = 1024 11 = 2048 12 = 4096
	anthromin	no	1000	Anthrophony frequency minimum
	anthromax	no	2000	Anthrophony frequency maximum
	binmin	no	2000	Biophony frequency minimum
	biomax	no	8000	Biophony frequency maximum
bioindex/aci	enable	no	0	0 = disabled 1 = enabled
	fftbits	no	9	6 = 64

				7 = 128 8 = 256 9 = 512 10 = 1024 11 = 2048 12 = 4096
	fmin	no	0	Frequency minimum
	fmax	no	0	Frequency maximum
	j	no	0	J (s), or zero for continuous
bioindex/adi	enable_adi	no	0	0 = disabled 1 = enabled
	enable_aei	no	0	0 = disabled 1 = enabled
	fmax	no	10000	Frequency maximum
	fstep	no	1000	Frequency step
	thold	no	-50	Threshold (dB fs)
bioindex/bio	enable	no	0	0 = disabled 1 = enabled
	fftbits	no	9	6 = 64 7 = 128 8 = 256 9 = 512 10 = 1024 11 = 2048 12 = 4096
	fmin	no	2000	Frequency minimum
	fmax	no	8000	Frequency maximum
bioindex/spec	enable_mean	no	0	0 = disabled 1 = enabled
	enable_sd	no	0	0 = disabled 1 = enabled
	enable_sem	no	0	0 = disabled 1 = enabled
	enable_median	no	0	0 = disabled 1 = enabled
	enable_mode	no	0	0 = disabled 1 = enabled
	enable_q25	no	0	0 = disabled 1 = enabled
	enable_q75	no	0	0 = disabled 1 = enabled
	enable_irq	no	0	0 = disabled 1 = enabled
	enable_skew	no	0	0 = disabled 1 = enabled
	enable_kurt	no	0	0 = disabled 1 = enabled
	enable_sfm	no	0	0 = disabled 1 = enabled

	enable_sh	no	0	0 = disabled 1 = enabled
	fftbits	no	9	6 = 64 7 = 128 8 = 256 9 = 512 10 = 1024 11 = 2048 12 = 4096
	fmin	no	0	Frequency minimum
	fmax	no	0	Frequency maximum
bioindex/qut	enable_bgn	no	0	0 = disabled 1 = enabled
	enable_snr	no	0	0 = disabled 1 = enabled
	enable_act	no	0	0 = disabled 1 = enabled
	enable_evn	no	0	0 = disabled 1 = enabled
	enable_lfc	no	0	0 = disabled 1 = enabled
	enable_mfc	no	0	0 = disabled 1 = enabled
	enable_hfc	no	0	0 = disabled 1 = enabled
	enable_cen	no	0	0 = disabled 1 = enabled
	fftbits	no	9	6 = 64 7 = 128 8 = 256 9 = 512 10 = 1024 11 = 2048 12 = 4096
	threshold	no	6	threshold (dB)

5.8 Kaleidoscope Pro License Management

The basic version of Kaleidoscope is available at no charge. Kaleidoscope can be upgraded to Kaleidoscope Pro by purchasing and activating an annual subscription license or permanent license. Kaleidoscope Pro provides additional features, including cluster analysis, auto ID for bats, SPL analysis, Cloud storage functions, and database functions.

This section will cover managing annual Kaleidoscope Pro subscription licenses. It will discuss how to apply the subscription credits you bought to your Wildlife Acoustics web account, how to use those credits to activate installations of Kaleidoscope Pro software, and how to manage subscription licenses for multiple users.

Subscription vs Permanent License

Annual subscriptions were introduced for Kaleidoscope Pro in late 2017. Annual subscriptions expire completely after one year of use, but are more easily managed, and present a lower up-front cost as compared to permanent licenses.

A Kaleidoscope Pro permanent license ID is represented by an 18 to 20 character code. The permanent license code can be viewed by going to the License menu in Kaleidoscope and choosing Install permanent or demo license. For assistance managing a permanent license, please contact Wildlife Acoustics Technical Support.

Administrator and Guest

Kaleidoscope Pro subscriptions can be managed by a single administrator for multiple users. The administrator is in charge of giving access to Kaleidoscope Pro subscriptions to other users and moving subscriptions between different computers and users. The administrator does not have to use Kaleidoscope Pro themselves – they could simply be a lab manager or IT technician, for example.

Throughout this section, “Administrator” will refer to the person who holds credits for Kaleidoscope Pro subscriptions on their account. “Guest” will refer to someone who has been given access to use the Administrator’s subscriptions. This section assumes that you, the reader, are the Administrator.

Redeem Kaleidoscope Pro Subscription Credits

If you haven't done so already, go to the WildlifeAcoustics.com website and create an account. Any subscriptions you use yourself or grant to other users will be managed from this account.

- Log into your account and navigate to Kaleidoscope Pro subscriptions.
- If you purchased Kaleidoscope Pro online while logged into your account, you will see that your account already has 1 or more available credits. Those subscription license credits are ready to be activated from within Kaleidoscope.
- If instead you received a sales invoice for Kaleidoscope Pro containing an 8-character subscription code, enter that code here and click Apply. You will now see that you have one or more available credits in your account.

The screenshot shows a web interface for managing subscriptions. On the left, under the heading "Subscriptions", it displays "AVAILABLE CREDITS" with a value of "0". To the right, there are two main sections. The first is "APPLY CREDITS TO ACCOUNT", which includes a text input field labeled "Subscription Credit Code from Invoice" and a button labeled "APPLY". The second section is "ADD NEW CREDITS TO SHOPPING CART", which includes a text input field labeled "Quantity" and a button labeled "BUY MORE".

Each credit represents one year’s worth of Kaleidoscope Pro use for a single user. A single user is entitled to activate a single license on two separate computers.

The subscription year does not start until the license is activated in the Kaleidoscope program itself.

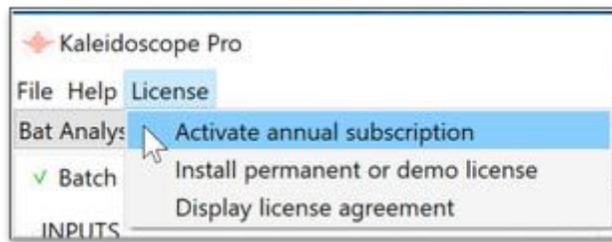
Activate a Subscription License

- Check your Wildlife Acoustics web account to make sure you have at least one available subscription credit.
- Download Kaleidoscope from the Wildlife Acoustics website and install the program.

At this point, Kaleidoscope will only allow you to use the free features, including the Viewer window and file converter, because the program has not been activated with a subscription license. Auto ID for Bats, Cluster Analysis, and SPL Analysis will each be marked with a red X.

The screenshot shows a settings window for "Bat Analysis Mode". At the top, there is a dropdown menu currently set to "Bat Analysis Mode". Below the dropdown, there are four feature indicators in a row: "Batch" with a green checkmark, "Signal Params" with a green checkmark, "Auto ID for Bats" with a red X, and "Cluster Analysis" with a red X.

- In Kaleidoscope, go to the License menu and choose **Activate subscription**.



- Enter the email address and password for the account you created at the Wildlife Acoustics web site.
- Press the **Activate** button. Kaleidoscope has now been upgraded to Kaleidoscope Pro

In Non-bat Analysis Mode, the **Cluster Analysis**, **SPL Analysis**, **Acoustic Indices**, **Cloud**, and **Db** tabs will be marked with a green check.



In Bat Analysis mode, the **Bat Auto-ID** and **Cluster Analysis** tabs will be marked with a green check.



Make a Subscription License Available for a Guest

This section will provide instructions for the Administrator to grant use of a Kaleidoscope Pro subscription license to a Guest user.

- Log into your account on the Wildlife Acoustics website and navigate to Kaleidoscope Pro subscriptions.
- Verify that you have one or more subscription license credits available.
- Enter the Guest user’s email address into the text box under Add a guest to share your subscription credits.
- If the Guest user already has a Wildlife Acoustics account, enter the email address used to create that account.
- Otherwise, the Guest user can create a Wildlife Acoustics web account later, using the email address you enter here.
- Press the ADD GUEST button



The Guest’s email address will appear in the Subscriber list. If the Guest does not yet have a Wildlife Acoustics account, it will be marked **Unregistered**.

If the guest has a Wildlife Acoustics web account but has not yet used the subscription license to activate Kaleidoscope Pro, it will be marked **Unsubscribed**.

Once the Guest user does have a Wildlife Acoustics web account, they can download and launch Kaleidoscope and activate the subscription license from the License menu using their own email address and password.

Move a Subscription License from One Computer to Another

On occasion, the same user may need to transfer a subscription license from one computer to another. For example, a user may discard an older computer and upgrade to a newer model. The subscription license on the old computer can be de-activated and transferred to the new computer.

- Log into your account on the Wildlife Acoustics website and navigate to Kaleidoscope Pro subscriptions.
- Click **Release** next to the email address of the user who wants to change which computer they will be using to run Kaleidoscope Pro.

SUBSCRIPTIONS					
SUBSCRIBER	STATUS	START DATE	EXP DATE	AUTO RENEW	
dave@wildlifeacoustics.com	subscribed (2)	2020-03-25	2021-03-26	<input checked="" type="checkbox"/>	Release
UPDATE					

That same user can now re-activate Kaleidoscope Pro on a new computer. Note that the release button will remove all activations that the user had. If they were using the software on 2 computers, they would now need to activate on both the new computer AND on the original one that they want to continue to use.

Move a Subscription License from one User to a Different User

A subscription license can be transferred from one user to another. The transfer can be between an Administrator and Guest user, or from one Guest user to another.

- Log into your account on the Wildlife Acoustics website and navigate to Kaleidoscope Pro subscriptions.
- Click Release next to the email address of the user whose subscription license you want to give to someone else.
- Under Transfer From Released Subscription Email Address, enter the original user's email address.

TRANSFER FROM RELEASED SUBSCRIPTION EMAIL ADDRESS

Enter email address of released subscription

- Under **Transfer to an unsubscribed or expired email address**, enter the email address of the person who will now be using Kaleidoscope Pro. The new user must already be a Guest under your account.
- Press the **Transfer** button.

TRANSFER TO AN UNSUBSCRIBED OR EXPIRED EMAIL ADDRESS

Enter email address of non-subscribed user

TRANSFER

You will now see in the subscriber list that the subscription license has moved from the original user to the new user. The email address for the original user is marked **unsubscribed**. The email address for the new user is marked **released**, which indicates the subscription license is available for activation.

The new user will now be able to activate the subscription license via the Kaleidoscope License menu.

Please see section 4 – Activate A Subscription in this document for further details.

5.9 Wildlife Acoustics Managed Cloud Account

Kaleidoscope Pro can make use of Cloud technology for data storage. A Wildlife Acoustics Managed Cloud Account will also provide on line processing and database functions.

A Managed Cloud Account is initially set up and managed via the WildlifeAcoustics.com web site.

Once the Managed Cloud Account is set up, one or more users can access the account via Kaleidoscope Pro. It is possible for a user to create multiple Managed Cloud Accounts. It is possible for a user to have access to multiple Managed Cloud Accounts.

Create a Managed Cloud Account

In order to create a Managed Cloud Account, the user must first create and log into a Wildlife Acoustics user account. Once logged into a user account, click on the Managed Cloud Account link on the left side of the web page. A new page will open. Enter the name of the organization that will administer the account.

CREATE A NEW MANAGED CLOUD ACCOUNT

Organization Name

Check the box to accept the terms of agreement and press the button to create an account.

I accept the [website, software and service terms of use](#)

CREATE ACCOUNT

The new Managed Cloud Account will now be listed in the user account.

Apply Payment for the Cloud Account

Notice that Payment Information the Dave World account is listed as "missing". The Managed Cloud Account will not be available within Kaleidoscope Pro unless there is payment information on file.

Manage Cloud Accounts		
NAME	UUID	PAYMENT INFORMATION
Dave World	24e05d28-5d56-5441-a20a-bac432aec123	OK
Wildlife Acoustics, Inc.	15a3d6aa-96ca-5c13-afa8-dfa63c9c8d2c	OK

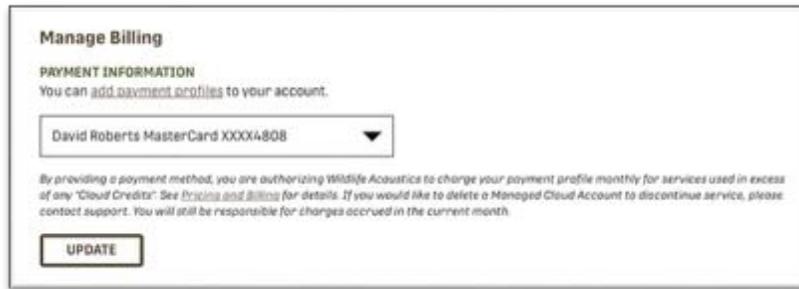
Click on the account name to go to the account management page. If there is no payment information on file for the user account click your account to go to the payment information page.

Cloud Account: Dave World

Account Id: 24e05d28-5d56-5441-a20a-bac432aec123

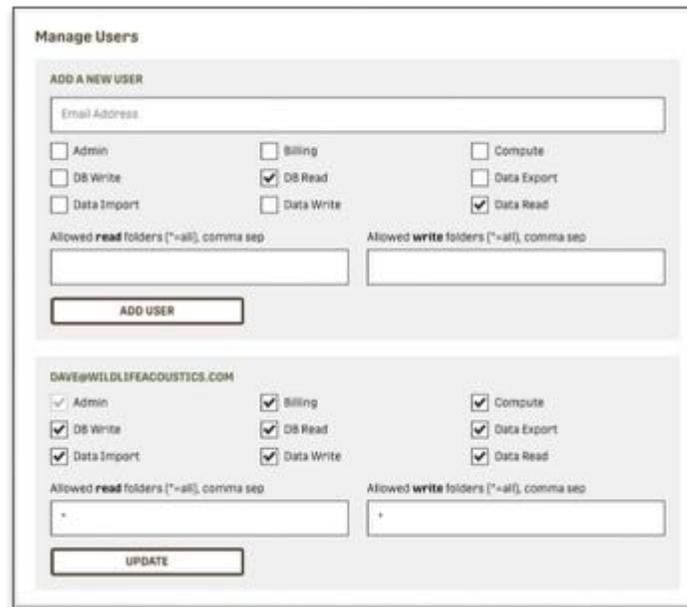
258 files 587,854,793 bytes

It is possible to have multiple credit cards on file for the user account. Once there is payment information on file for the user, select a payment method and press the Update button. This will apply the selected payment method to this Managed Cloud Account.



Manage Users

A Managed Cloud Account is initially administered by the user who created the account. By default, an administrator has access to all features of the Cloud account.



The administrator can invite other users to access the Managed Cloud Account. The administrator controls permissions for guests. A guest can be given administrator permissions. It is possible for a single Cloud account to have multiple administrators.

To add a guest type in the email and press the Add User button. If the guest already has a Wildlife Acoustics user account, the Cloud account will now be visible in their user account and they will be able to log in to the Cloud account from Kaleidoscope Pro. If the guest does not yet have a Wildlife Acoustics user account, they will receive an email inviting them to create an account so they can access that account on line and then through Kaleidoscope Pro.

When a user who does not have Admin permissions looks at the Cloud account, they will not see the options to invite other users or to change permissions. They will see the account ID, the size and number of files in the Cloud account, and a list of batch processes which have been run by that user in the Cloud account.

Compute Jobs						
JOB ID	BATCH LABEL	CREATED	STARTED	FINISHED	PROGRESS MESSAGE	% CANCELED
227		2020-07-23 14:30:19 dave@wildlifeacoustics.com	2020-07-23 14:31:32	2020-07-23 14:31:42 (00:00:10)	Batch size: 250 Files 0.54T On Inputs: 0 wav 250 wav 0 mp Outputs: 0 wav 15 scrubbed) 0 mp (0 scrubbed) 100: 100 classified 45 unknown: 0 noise	100

Compute Jobs

The Cloud management page shows a record of batch processes which have been run or are currently running. A user with Admin permissions will see all compute jobs that have been run on the Cloud account. A non-Admin user will only see jobs that user has run. The Compute Jobs section shows when the batch process was created. Once the batch process begins that information will be displayed, along with a progress status message. When the batch process is finished that information is then also displayed. This allows a user to keep track of the status of their Cloud-based computing, as well as allowing an administrator to review all jobs that have been run on the Cloud account.

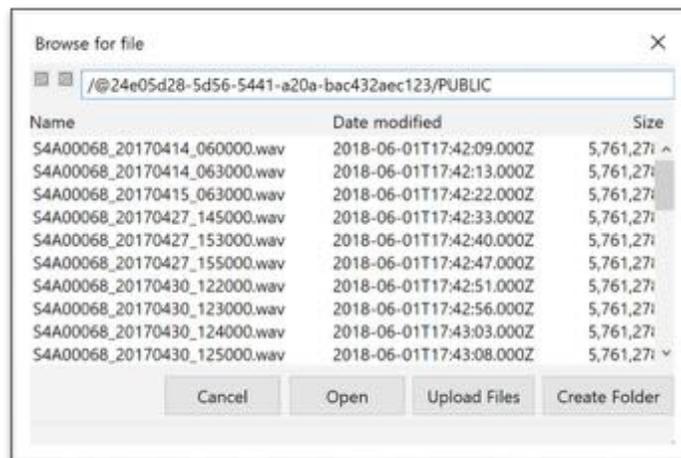
UUID

A Wildlife Acoustics Managed Cloud Account has a common name and a **UUID**. The UUID is the Cloud address for the account. The UUID for the Managed Cloud Account is visible in the users' WildlifeAcoustics.com web account.

Manage Cloud Accounts	
NAME	UUID
Dave World	24e05d28-5d56-5441-a20a-bac432aec123

The UUID can be used in the Managed Cloud Account file browser to see public folders of different organizations. This provides read-only access to the PUBLIC folder in the remote account.

In the Cloud browser type `/@` followed by the remote UUID, and then `/PUBLIC`. Press the Return key to enter the remote PUBLIC folder.



The UUID address can be entered into the **Table Data Source** field under the **Db** Tab in Kaleidoscope Pro for a **Specific Organization**. This allows a Kaleidoscope Pro user to include other organizations in database queries.

Batch Signal Params Auto ID for Bats Cluster Analysis SPL Analysis Acoustic Indices Cloud Db

Log in to Managed Cloud Account

Upload to database

Upload local .wdb file to database Upload cloud .wdb file to database

Query database

Type of query: Recordings (meta.csv) Choose destination for query results: \\Home\Desktop\query.csv Browse

Table Data Source: Specific organization Organization: 24e05d28-5d56-5441-a20a-bac432aec123 Table Data Mode: Most recent

Manual Review Source: My records Manual Review Mode: Most recent

ALL OF -- Select Database Field --

Optional sort order: -- Select Database Field -- Ascending

Results to skip: Limit results to: Adjust timezone (hours re UTC): 0 1000 -4

Please send us feedback! Video Tutorials Help Run Query

In order for a user to access database records in another organizations Cloud account, those records must have been marked as Public in the **Default Project Form** under the **Batch** Tab when the batch process was run.

Default Project Form

Privacy

For Kaleidoscope Cloud users, you can make database records created for this batch searchable by other users outside of your organization.

Access

Public

5.10 Bat Auto-ID Species Classifiers

Kaleidoscope Pro currently provides auto-ID bat species classifiers for these geographic areas:

- Europe
- North America (Including Canada)
- South Africa
- Neotropics

Following are lists of the bats species supported by each classifier. The species code as found in Kaleidoscope Pro is followed by the Latin name, and then common name.

Bats of Europe

BARBAR	Barbastella barbastellus	Western barbastelle
EPTISA	Eptesicus isabellinus	Meridional serotine
EPTNIL	Eptesicus nilssonii	Northern bat
EPTSER	Eptesicus serotinus	Common serotine
HYPYSAV	Hypsugo savii	Savi's pipistrelle
MINSCH	Miniopterus schreibersii	Common bent-wing bat
MYOALC	Myotis alcaethoe	Alcaethoe myotis
MYOBEC	Myotis bechsteinii	Bechstein's myotis
MYOBRA	Myotis brandtii	Brandt's myotis
MYOCAP	Myotis capaccinii	Long-fingered bat
MYODAS	Myotis dasycneme	Pond myotis
MYODAU	Myotis daubentonii	Daubenton's myotis
MYOEMA	Myotis emarginatus	Geoffroy's myotis
MYOESC	Myotis escalerae	Escalera's bat
MYOMYO	Myotis myotis	Mouse-eared myotis
MYOMYS	Myotis mystacinus	Whiskered myotis
MYONAT	Myotis nattereri	Natterer's myotis
NYCLAS	Nyctalus lasiopterus	Giant noctule
NYCLEI	Nyctalus leisleri	Lesser noctule
NYCNOC	Nyctalus noctula	Noctule
PIPKUH	Pipistrellus kuhlii	Kuhl's pipistrelle
PIP NAT	Pipistrellus nathusii	Nathusius' pipistrelle
PIPPIP	Pipistrellus pipistrellus	Common pipistrelle
PIPPYG	Pipistrellus pygmaeus	Soprano pipistrelle
PLEAUR	Plecotus auritus	Brown long-eared bat
PLEAUS	Plecotus austriacus	Grey long-eared bat
RHIEUR	Rhinolophus euryale	Mediterranean horseshoe bat
RHIFER	Rhinolophus ferrumequinum	Greater horseshoe bat
RHIHIP	Rhinolophus hipposideros	Lesser horseshoe bat
TADTEN	Tadarida teniotis	European free-tailed bat
VESMUR	Vespertilio murinus	Particoloured bat

Bats of North America

ANTPAL	Antrozous pallidus	Pallid bat
--------	--------------------	------------

CORTOW	<i>Corynorhinus townsendii</i>	Townsend's big-eared bat
EPTFUS	<i>Eptesicus fuscus</i>	Big brown bat
EUDMAC	<i>Euderma maculatum</i>	Spotted bat
EUMFLO	<i>Eumops floridanus</i>	Florida bonneted bat
EUMPER	<i>Eumops perotis</i>	Greater bonneted bat
EUMUND	<i>Eumops underwoodi</i>	Underwood's bonneted
LASBLO	<i>Lasiurus blossevillii</i>	Western red bat
LASBOR	<i>Lasiurus borealis</i>	Eastern red bat
LASCIN	<i>Lasiurus cinereus</i>	Hoary bat
LASEGA	<i>Lasiurus ega</i>	Southern yellow
LASINT	<i>Lasiurus intermedius</i>	Northern yellow bat
LASNOC	<i>Lasionycteris noctivagans</i>	Silver-haired bat
LASSEM	<i>Lasiurus seminolus</i>	Seminole bat
LASXAN	<i>Lasiurus xanthinus</i>	Western yellow bat
MACCAL	<i>Macrotus californicus</i>	California leaf-nosed bat
MOLMOL	<i>Molossus molossus</i>	Pallas's mastiff bat
MORMEG	<i>Mormoops megalophylla</i>	Ghost-faced
MYOAUS	<i>Myotis austroriparius</i>	Southeastern myotis
MYOCAL	<i>Myotis californicus</i>	California myotis
MYOCIL	<i>Myotis ciliolabrum</i>	Western Small-footed myotis
MYOEVO	<i>Myotis evotis</i>	Long-eared myotis
MYOGRI	<i>Myotis grisescens</i>	Gray myotis
MYOLEI	<i>Myotis leibii</i>	Eastern small-footed myotis
MYOLUC	<i>Myotis lucifugus</i>	Little brown myotis
MYOOC	<i>Myotis occultus</i>	Arizona myotis
MYOSEP	<i>Myotis septentrionalis</i>	Northern myotis
MYOSOD	<i>Myotis sodalis</i>	Indiana myotis
MYOTHY	<i>Myotis thysanodes</i>	Fringed myotis
MYOVEL	<i>Myotis velifer</i>	Cave myotis
MYOVOL	<i>Myotis volans</i>	Long-legged myotis
MYOYUM	<i>Myotis yumanensis</i>	Yuma myotis
NYCFEM	<i>Nyctinomops femorosaccus</i>	Pocketed free-tail
NYCHUM	<i>Nycticeius humeralis</i>	Evening bat
NYCMAC	<i>Nyctinomops macrotis</i>	Big free-tailed bat
PARHES	<i>Parastrellus hesperus</i>	Canyon bat
PERSUB	<i>Perimyotis subflavus</i>	Tricolored bat
TADBRA	<i>Tadarida brasiliensis</i>	Mexican free-tailed bat

Bats of South Africa

CHAPUM	<i>Chaerophon pumilus</i>	Little free-tailed
EPTHOT	<i>Eptesicus hottentotus</i>	Long-tailed house
LAEBOT	<i>Laephotis botswanae</i>	Botswanan long-eared
LAEWIN	<i>Laephotis wintoni</i>	De Winton's long-eared

MINNAT	<i>Miniopterus natalensis</i>	Natal long-fingered
MYOBOC	<i>Myotis bocagei</i>	Rufous mouse-eared
NEOCAP	<i>Neoromicia capensis</i>	Cape serotine
RHIBLA	<i>Rhinolophus blasii</i>	Blasius's horseshoe
RHICLI	<i>Rhinolophus clivosis</i>	Geoffroy's horseshoe
RHIDEN	<i>Rhinolophus denti</i>	Dent's horseshoe
RHIFUM	<i>Rhinolophus fumigatus</i>	Ruppell's horseshoe
RHIHIL	<i>Rhinolophus hildebrandtii</i>	Hildebrandt's horseshoe
RHILAN	<i>Rhinolophus landeri</i>	Lander's horseshoe
RHISIM	<i>Rhinolophus simulator</i>	Bushveld horseshoe
RHISMI	<i>Rhinolophus smithersi</i>	Smithers's horseshoe
RHISWI	<i>Rhinolophus swinnyi</i>	Swinny's horseshoe
SAUPET	<i>Sauromys petrophilus</i>	Roberts's flat-headed
SCODIN	<i>Scotophilus dinganii</i>	African yellow
SCONIG	<i>Scotophilus Nigrita</i>	Schreber's yellow
TADAEG	<i>Tadarida aegyptiaca</i>	Egyptian free-tailed

Bats of the Neotropics

ANTPAL	<i>Antrozous pallidus</i>	Pallid bat
BALIO	<i>Balantiopteryx io</i>	Thomas's sac-winged
BALPLI	<i>Balantiopteryx plicata</i>	Gray sac-winged
BAUDUB	<i>Bauerus dubiaquercus</i>	Van Gelder's
CENCEN	<i>Centronycteris centralis</i>	Thomas's shaggy
CENMAX	<i>Centronycteris maximiliani</i>	Shaggy Townsend's big-eared
CORTOW	<i>Corynorhinus townsendii</i>	
CYNMEX	<i>Cynomops mexicanus</i>	Mexican dog-faced
DICALB	<i>Diclidurus albus</i>	Northern ghost
EPTBRA	<i>Eptesicus brasiliensis</i>	Brazilian brown
EPTFUR	<i>Eptesicus furinalis</i>	Argentine brown
EPTFUS	<i>Eptesicus fuscus</i>	Big brown
EUDMAC	<i>Euderma maculatum</i>	Spotted
EUMGLA	<i>Eumops glaucinus</i>	Eumops floridanus
EUMPER	<i>Eumops perotis</i>	Western Mastiff Underwood's bonneted
EUMUND	<i>Eumops underwoodi</i>	
LASBLO	<i>Lasiurus blossevillii</i>	Desert red
LASCIN	<i>Lasiurus cinereus</i>	Hoary
LASEGA	<i>Lasiurus ega</i>	Southern yellow
LASINS	<i>Lasiurus insularis</i>	Cuban Yellow
LASINT	<i>Lasiurus intermedius</i>	Northern yellow
LASSEM	<i>Lasiurus seminolus</i>	Seminole
LASXAN	<i>Lasiurus xanthinus</i>	Western Bat
MACCAL	<i>Macrotus californicus</i>	California leaf-nosed
MOLMOL	<i>Molossus molossus</i>	Velvety free-tailed

MOLRUF	Molossus rufus	Black mastiff
MOLSIN	Molossus sinaloae	Sinaloan mastiff
MOLTEM	Molossops temminckii	Dwarf dog-faced
MORBLA	Mormoops blainvillei	Antillean ghost-faced
MORMEG	Mormoops megalophylla	Ghost-faced
MYOCAL	Myotis californicus	California myotis
MYOELE	Myotis elegans	Elegant myotis
MYOEVO	Myotis evotis	Long-eared myotis
MYOKEA	Myotis keaysi	Hairy-legged myotis
MYONIG	Myotis nigricans	Black myotis
MYOCC	Myotis occultus	Arizona myotis
MYORIP	Myotis riparius	Riparian myotis
MYOTHY	Myotis thysanodes	Fringed myotis
MYOVEL	Myotis velifer	Cave myotis
MYOVOL	Myotis volans	Long-legged myotis
MYOYUM	Myotis yumanensis	Yuma myotis
NOCLEP	Noctilio leporinus	Greater bulldog
	Nyctinomops	
NYCFEM	femorosaccus	Pocketed free-tail
NYCHUM	Nycticeius humeralis	Evening Bat
NYCLAT	Nyctinomops laticaudatus	Broad-eared
NYCMAC	Nyctinomops macrotis	Big free-tailed
PARHES	Parastrellus hesperus	Western pipistrelle
PERKAP	Peropteryx kappleri	Greater dog-like
PERMAC	Peropteryx macrotis	Lesser dog-like
PROCEN	Promops centralis	Promops Centralis
PTEDAV	Pteronotus davyi	Davy's naked-backed
PTEGYM	Pteronotus gymnonotus	Big naked-backed
PTEMAC	Pteronotus macleayii	Macleay's mustached
PTEPAR	Pteronotus parnellii	Parnell's mustached
PTEPER	Pteronotus personatus	Wagner's mustached
PTEQUA	Pteronotus quadridens	Sooty mustached
RHOAEN	Rhogeessa aeneus	Yucatan yellow
RHYNAS	Rhynchonycteris naso	Proboscis
SACBIL	Saccopteryx bilineata	Greater sac-winged
SACLEP	Saccopteryx leptura	Lesser sac-winged
TADBRA	Tadarida brasiliensis	Mexican free-tailed

5.11 Glossary

- Band-Pass Filter

In the Viewer there is a frequency ruler on the left side of the spectrum view. Frequency is represented from low to high. It is possible to click and drag on the frequency ruler to make a specific frequency range selection. This will apply a band pass filter to playback of the signal. The band-pass filter will only allow signals within the selected frequency range to be played.

- **Bat Pass**

A bat pass is typically a sequence of pulses.
- **Batch Process**

Kaleidoscope can convert and analyze multiple files with a single operation. This is known as a batch process. Kaleidoscope can run multiple batch process functions in parallel to take full advantage of multi-core CPUs.
- **Cluster**

A cluster describes a pattern based on the average of multiple similar patterns found in the data. Patterns which are most similar to the average are closest to the cluster center. As a detected signal is less similar, it is described as being further away from the cluster center.
- **CSV**

CSV stands for Comma Separated Values. .csv is a document format. The information in the document is arranged in a way that a spreadsheet application (such as Microsoft Excel) can open the document and display the information in columns and rows. Kaleidoscope creates different types of .csv documents to represent the results from batch processes. The intention is that results from Kaleidoscope batch processes are to be initially viewed in a spreadsheet.
- **Database**

When Kaleidoscope Pro is used to access a Managed Cloud Account, the results of batch processes can be used to create a database. The database is part of the Managed Cloud Account. Kaleidoscope Pro can create queries to search the database. Kaleidoscope Pro can also include other users and organizations in the query, dependent on file and database permissions.
- **Detected Signal**

The **Signal Params** Tab provides parameters for finding detected signals within audio files. A detected signal is information within an input file that has passed the conditions under the **Signal Params** Tab.
- **Fuzz GPS to Precision**

GPS location information can be embedded in full-spectrum and zero-crossing files at the time of recording. Kaleidoscope can pass the GPS information through to output. Kaleidoscope can also alter the GPS data to make the recording location less specific. Under the **Batch** Tab the Fuzz GPS to Precision parameter allows the user to specify the resolution of the GPS data that is provided on output.
- **File Compression**

Full spectrum files can be compressed to smaller file sizes within output batches. Compressed files can then be reopened to provide the original content. Compressing a full spectrum file can result in loss of signal fidelity. Higher compression percentages result in smaller files but with more loss of fidelity.

Kaleidoscope can also convert compressed input files to standard uncompressed .WAV files.

The type of file compression used is Wildlife Acoustics "W4V" compression which can provide extremely high fidelity with a 2:1 compression ratio, and some compromise in fidelity at higher compression ratios up to 4:1.
- **FFT**

FFT stands for Fast Fourier Transform. FFT is a mathematical technique used to analyze an audio recording. The results of the FFT analysis are used to create a spectrogram view of the audio signal. FFT information is also used internally by Kaleidoscope for analysis of signals during a batch process.
- **Full-Spectrum**

Full-spectrum describes an audio recording that includes both frequency and amplitude information. A full spectrum file can be examined in the Spectrogram within the Viewer. Time is represented on a left to right axis. Frequency is represented on a top to bottom axis. Amplitude is represented by color intensity of the displayed signal.
- **GUANO**

GUANO is a commonly used standard for metadata stored in full-spectrum and zero-crossing files. Kaleidoscope supports reading and writing of GUANO format metadata.
- **JSON**

JSON is an acronym for JavaScript Object Notation. JSON is a standard for storing information. JSON is used Kaleidoscope Pro can store and recall database query specifications via a JSON formatted file. When a

database query is run from within Kaleidoscope Pro, a query.json file is created. The query.json file can be reloaded under the **Db** Tab.

- KML

KML is an acronym for Keyhole Markup Language. **KML** is an international standard maintained by the Open Geospatial Consortium, Inc. **KML** is a file format used to display geographic data in an Earth browser such as Google Earth. Kaleidoscope can create a gps.kml output file based on GPS metadata extracted from full-spectrum and zero-crossing files.

- Managed Cloud Account

Kaleidoscope Pro can access a Cloud account for data storage. A Wildlife Acoustics Managed Cloud Account provides additional features including database searching and Cloud-based computing.

- Metadata

Metadata is additional information stored in a full spectrum or zero-crossing file or in a database. Metadata can include information generated when the recording was made. Metadata can include information added after the recording is made.

- Narrow-Band

An audio signal can be a pure tone or it can contain content at multiple frequencies. Narrow-band refers to a signal or parameter that describes a single frequency at any given time. A zero-crossing file can only represent one frequency at a time so a zero-crossing file represents narrow-band information.

- Noise

When an Auto ID for Bats batch process is run, input files are examined for signals of interest. If an input file does not meet the conditions specified under the **Signal Params** Tab, it is labelled as a noise file.

Kaleidoscope Pro can also examine full spectrum audio for measuring overall signal levels using various standard weightings such as A-weighted or third-octave bands. This is done by running a Noise Analysis batch process. The input file will be analyzed for content based on the settings under the **Noise Analysis** Tab.

- Pairwise Classifier

A pairwise classifier is a function within an advanced classifier that has been created for cluster analysis. A pairwise-classifier compares detected signals using manual identifications that discriminate between what is and what is not a signal of interest.

- Phrase

This term is typically used to describe bird vocalizations. A phrase is a series of syllables.

- Project Form

The project form is found under the **Batch** Tab. The project form is used to edit and embed metadata into output files. The project form is customizable to allow addition of custom metadata fields.

- Pulse

This term is typically used when describing bat vocalizations. A single pulse is also known as a bat call. Multiple pulses make up a pulse sequence. A detected signal could be comprised of a single pulse or a sequence of pulses.

- Pulse Sequence

A bat vocalization is often made up of a series of pulses. The series of pulses in a single bat pass is described as a pulse sequence.

- query.json

Kaleidoscope Pro can store and recall database query specifications via a JSON formatted file. When a database query is run from within Kaleidoscope Pro, a query.json file is created. The query.json file can be reloaded under the **Db** Tab for immediate recall or query settings. The loaded query settings can then be modified as needed.

- Sample Rate

In order to digitally record an audio signal, the original analog waveform is examined and described as a series of samples. The sample rate is how many samples are taken of the waveform per second. The sample rate must be double the highest frequency to be recorded. Therefore, in order to record a waveform of 20 kHz for example, a sample rate of at least 40 kHz would be required.

- Spectrogram

A spectrogram is a visual representation of the spectrum of frequencies of sound or other signal as they vary with time. A spectrogram displays broad-band frequency content and amplitude over time.

- SPL

Sound Pressure Level. Kaleidoscope Pro can examine full spectrum audio for measuring overall signal levels using various standard weightings such as A-weighted or third-octave bands. This is done by running an SPL Analysis batch process. The input file will be analyzed for content based on the settings under the **SPL Analysis** Tab.

- Signal of Interest

Signal of interest is used as a general term to describe something specific the user wants to find or analyze.

- Syllable

This term is typically used when describing non-bat vocalizations. Multiple syllables make up a phrase. A detected signal could include a single syllable or a phrase of syllables.

- Time Expansion

Time Expansion describes a legacy technique where ultrasonic information is first captured and then stored at a lower sample rate. No information is lost but the slowed down data can now be stored on older recording devices that do not support ultrasonic sample rates. A time expanded recording can then be restored to its original sample rate within Kaleidoscope Pro.

- Trigger

A recording device can be configured to go into record mode when it senses a signal. This is called a triggered recording. Typically bat recordings are made when the recorder is triggered by an ultrasonic signal. When the signal is no longer present for a specified time the recording device will stop recording. This means triggered recordings are more likely to be short and contain a specific vocalization.

When triggered recordings are made with current generation Wildlife Acoustics SM4 recorder, those recordings are created as separate WAV files. The older model Wildlife Acoustics SM2 and SM3 recorders can create individually triggered WAV files or they can create WAC files which contain multiple triggered recordings. WAC files are a proprietary Wildlife Acoustics format. These files can only be used within Kaleidoscope.

- Vocalization

This is a general term used to describe an utterance made by a single species.

- Waveform

An audio signal can be represented as amplitude over time. A waveform display does not include frequency information. The Viewer displays both Waveform and Spectrogram images of full spectrum recordings. A zero-crossing recording does not contain any amplitude information and therefore cannot be displayed as a waveform.

- Wideband

An audio signal can be a pure tone or it can contain content at multiple frequencies. A wideband signal or detection parameter can include signal multiple frequencies at the same time. An example of a wideband signal is a fundamental with harmonics. A full-spectrum recording is a wideband recording. A zero-crossing recording cannot contain wideband information.

- Zero-crossing

When doing ultrasonic recording, the file can contain full-spectrum data or it can contain only zero-crossing information. Zero-crossing information describes a present signal and its dominant frequency over time. A zero-crossing file does not contain any amplitude information and therefore does not contain any information about harmonics or broad-band signals.

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6. PRIVACY POLICY

WAI will publish its data security and privacy policy ("Privacy Policy") on its website at <https://www.wildlifeacoustics.com/privacy-policy>. In the event of a breach of data security, WAI will notify you to the extent expressly required to do so by applicable law.

7. COPYRIGHT POLICY

It is WAI's policy to respond to notices of alleged copyright infringement that comply with applicable international intellectual property law (including, in the United States, the Digital Millennium Copyright Act) and to terminate the accounts of repeat infringers. Notice - If you are a copyright owner or an agent thereof and believe that any Content infringes upon your copyrights, you may submit a notification pursuant to the Digital Millennium Copyright Act ("DMCA") by providing our Copyright Agent with the following information in writing (see 17 USC 512(c)(3) for further detail):

- A physical or electronic signature of a person authorized to act on behalf of the owner of an exclusive right that is allegedly infringed;
- Identification of the copyrighted work claimed to have been infringed, or, if multiple copyrighted works at a single online site are covered by a single notification, a representative list of such works at that site;
- Identification of the material that is claimed to be infringing or to be the subject of infringing activity and that is to be removed or access to which is to be disabled and information reasonably sufficient to permit the service provider to locate the material;
- Information reasonably sufficient to permit the service provider to contact you, such as an address, telephone number, and, if available, an electronic mail;
- A statement that you have a good faith belief that use of the material in the manner complained of is not authorized by the copyright owner, its agent, or the law; and
- A statement that the information in the notification is accurate, and under penalty of perjury, that you are authorized to act on behalf of the owner of an exclusive right that is allegedly infringed.

WAI's designated Copyright Agent to receive notifications of claimed infringement is Pete Mellor, email: copyright2018@wildlifeacoustics.com, fax: +1 (781) 207-5523. For clarity, only DMCA notices should go to the Copyright Agent; any other feedback, comments, requests for technical support, and other communications should be directed to WAI customer service at support2021@wildlifeacoustics.com. You acknowledge that if you fail to comply with all of the above requirements, your DMCA notice may not be valid.

Counter-Notice. If you believe that your Content that was removed (or to which access was disabled) is not infringing, or that you have the authorization from the copyright owner, the copyright owner's agent, or pursuant to the law, to post and use the material in your Content, you may send a counter-notice containing the following information to the Copyright Agent: Your physical or electronic signature; Identification of the Content that has been removed or to which access has been disabled and the location at which the Content appeared before it was removed or disabled;

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- Your name, address, telephone number, and e-mail address, a statement that you consent to the jurisdiction of the federal court in Boston, Massachusetts, and a statement that you will accept service of process from the person who provided notification of the alleged infringement.

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NOTWITHSTANDING ANYTHING TO THE CONTRARY IN THIS AGREEMENT, YOU ACKNOWLEDGE AND UNDERSTAND THAT WE MAY USE THIRD PARTIES TO PROVIDE COMPONENTS OF THE SERVICES, INCLUDING WITHOUT LIMITATION, THEIR SERVICES, EQUIPMENT, INFRASTRUCTURE, OR CONTENT. WAI IS NOT RESPONSIBLE FOR THE PERFORMANCE (OR NON-PERFORMANCE) OF THIRD- PARTY SERVICES, EQUIPMENT, INFRASTRUCTURE, OR CONTENT, WHETHER OR NOT THEY CONSTITUTE COMPONENTS OF WAI'S SERVICES OR SOFTWARE. WAI SHALL NOT BE BOUND BY ANY UNDERTAKING, REPRESENTATION OR WARRANTY MADE BY AN AGENT, OR EMPLOYEE OF WAI OR OF OUR UNDERLYING THIRD-PARTY PROVIDERS AND SUPPLIERS IN CONNECTION WITH THE INSTALLATION, MAINTENANCE, OR PROVISION OF THE SERVICES OR SOFTWARE, IF THAT UNDERTAKING, REPRESENTATION, OR WARRANTY IS INCONSISTENT WITH THE TERMS OF THIS AGREEMENT.

ALL REPRESENTATIONS, WARRANTIES, INDEMNIFICATIONS, AND LIMITATIONS OF LIABILITY CONTAINED IN THIS AGREEMENT SHALL SURVIVE THE TERMINATION OF THIS AGREEMENT; AND ANY OTHER OBLIGATIONS OF THE PARTIES HEREUNDER SHALL ALSO SURVIVE, IF THEY RELATE TO THE PERIOD BEFORE TERMINATION OR IF, BY THEIR TERMS, THEY WOULD BE EXPECTED TO SURVIVE SUCH TERMINATION.

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YOU AGREE THAT YOU SHALL BE RESPONSIBLE FOR AND SHALL DEFEND, INDEMNIFY, AND HOLD HARMLESS WAI AND ITS EMPLOYEES, AFFILIATES, SUPPLIERS, AGENTS AND CONTRACTORS AND SHALL REIMBURSE US FOR ANY DAMAGES, LOSSES OR EXPENSES (INCLUDING WITHOUT LIMITATION, REASONABLE ATTORNEYS' FEES AND COSTS) INCURRED BY US IN CONNECTION WITH ANY CLAIMS, SUITS, JUDGMENTS, AND CAUSES OF ACTION ARISING OUT OF (a) YOUR USE OF THE SERVICES OR SOFTWARE; (b) VIOLATION OR INFRINGEMENT OF CONTRACTUAL RIGHTS, PRIVACY, CONFIDENTIALITY, COPYRIGHT, PATENT, TRADEMARK, TRADE SECRET, OR OTHER INTELLECTUAL PROPERTY AND PROPRIETARY RIGHTS ARISING FROM YOUR USE OF THE SERVICE OR ANY UNAUTHORIZED APPARATUS OR SYSTEM; AND (c) YOUR BREACH OF ANY PROVISION OF THIS AGREEMENT.

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Entire Agreement. This Agreement and any other documents incorporated by reference constitute the entire agreement and understanding between you and WAI with respect to the subject matter of this Agreement, and replace any and all prior written or verbal agreements. If any portion of this Agreement is held to be unenforceable, the unenforceable portion shall be construed in accordance with applicable law as nearly as possible to reflect the original intentions of the parties, and the remainder of the provisions shall remain in full force and effect.

Modification and Waiver. Any modification, amendment, supplement, or other change to this Agreement must be in writing and signed by a duly authorized representative of WAI and You. All waivers must be in writing. The failure of WAI to insist upon strict performance of any provision of this Agreement, or to exercise any right provided for herein, shall not be deemed to be a waiver of the future performance or exercise of such provision or right, and no waiver of any provision or right shall affect the right of the waiving party to enforce any other provision or right herein.

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Retention of Rights. Nothing contained in this Agreement shall be construed to limit WAI's rights and remedies available at law or in equity. Upon termination of this Agreement for any reason, WAI and its suppliers reserve the right to delete all your data, files, electronic messages or other Customer information that is stored on WAI's or its suppliers' servers or systems. In the event you cancel the Services without downloading or porting your data to another server, we shall have no liability whatsoever as the result of the loss of any such data.

Remedies. The parties agree that any breach of this Agreement would cause irreparable injury for which no adequate remedy at law exists; therefore, the parties agree that equitable remedies, including without limitation, injunctive relief and specific performance, are appropriate remedies to redress any breach or threatened breach of this Agreement, in addition to other remedies available to the parties. All rights and remedies hereunder shall be cumulative, may be exercised singularly or concurrently, and shall not be deemed exclusive except as otherwise provided. If any legal action is brought to enforce any obligations hereunder, the prevailing party shall be entitled to receive its attorneys' fees, court costs, and other collection expenses, in addition to any other relief it may receive. You hereby waive any right or claim to which You may be entitled to immunity or exemption from liability.

Force Majeure. Neither party will be responsible for any failure to fulfill its obligations due to causes beyond its reasonable control, including without limitation, acts or omissions of government or military authority, acts of God, materials shortages, transportation delays, fires, floods, labor disturbances, riots, wars, or inability to obtain any export or import license or other approval of authorization of any government authority.

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Survival of Terms. The provisions of paragraphs 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14 (and any other provision which so indicates) as well as the introductory paragraphs shall survive termination of this Agreement.

Addendum A

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<http://xmlsoft.org>

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mbedtls version 2.4.0

<http://tls.mbed.org>

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md5c (RSA Data Security, Inc. MD5 Message-Digest Algorithm)

<http://www.ietf.org/rfc/rfc1321.txt>

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PostgreSQL version 9.6.6

<https://www.postgresql.org>

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