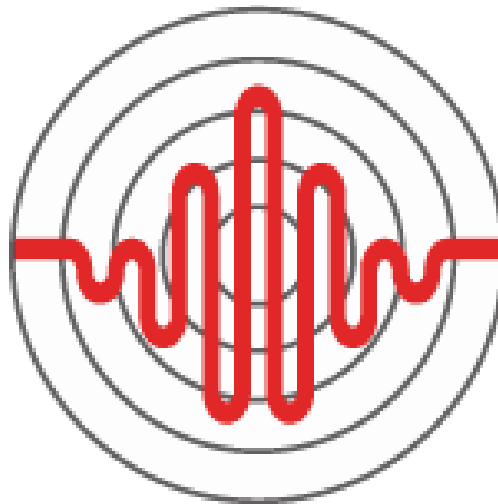


Kaleidoscope Pro 5 User Guide



Revised and Translated User Guides

This guide is regularly updated and improved. The latest update can be downloaded from www.wildlifeacoustics.com/download/kaleidoscope-software. Documentation is also available from the same webpage in Spanish, French, German, Chinese and Japanese translations.

Visit <http://www.wildlifeacoustics.com/products/kaleidoscope-pro/tutorial-videos> to view tutorial videos for Kaleidoscope Pro 5.

Contacting Support

For issues or questions not addressed in this guide, contact the Wildlife Acoustics Support Team:

- Email: support2019@wildlifeacoustics.com
 - North America (toll-free): 1-888-733-0200
 - Outside North America: US+1 978-369-5225 (Toll charges may apply.)
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1 Getting Started

1.1 How to Use This Manual

Welcome to Kaleidoscope 5. This manual is designed to provide complete information about the software, including practical use-based walkthroughs. Here is a brief description of each chapter of the manual.

Getting Started

It is a good idea for all users of Kaleidoscope 5 to read through this chapter. The Overview provides a basic description of Kaleidoscope 5 and provides step by step instructions for download, installation, and basic setup.

- Overview and Introduction to Kaleidoscope Pro 5
- 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 that are commonly done with Kaleidoscope 5. This chapter assumes that Kaleidoscope 5 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
- Noise Analysis
- Cloud Storage Configuration
- Database Query Examples

Metadata

Metadata is a significant part of the Kaleidoscope 5 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 5. 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 5, this is where that information will be found.

- Control Panel
- Viewer
- Metadata Panel
- Results Window
- Spectral Analysis Window
- Running a Batch Process

Additional Resources

This is an appendix of information relevant to the functions of Kaleidoscope 5.

- .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 5

Kaleidoscope 5 can be downloaded and run for no charge. Kaleidoscope 5 can be upgraded to Kaleidoscope Pro 5, which unlocks a suite of advanced features. Features that require a Pro license are noted as such.

Kaleidoscope 5:

- Is an integrated suite of software tools for efficient processing and analysis of bioacoustics, acoustic, and ultrasonic recordings.
- Supports a wide range of audio and zero-crossing file formats created by Wildlife Acoustics recorders and other sources.
- Converts and creates full spectrum audio files, zero-crossing files, .csv files, and additional data files.
- In Bat Analysis Mode can attempt to identify and classify bat species. (Requires Pro license)
- Can create clusters of data for further organization and analysis of wildlife sounds within recordings. (Requires Pro license)
- Includes a sophisticated spectrogram/waveform Viewer and set of audio tools for quick audio/visual processing, manual verification, and labelling of data.
- Introduces powerful new database, processing, archiving, and file sharing features via Cloud storage technology. (Requires Pro license)

Batch File Processing

In a single batch operation, Kaleidoscope Pro 5 can perform multiple tasks in parallel:

- Convert audio file formats.
- Add field notes and other metadata to output files.
- Extract metadata from files and batch processes to create .csv format files.
- Automatically identify and isolate noise files in Bat Analysis Mode.
- Automatically identify bat species in Bat Analysis Mode. (Requires Pro license)
- Apply cluster analysis to identify and group similar wildlife vocalizations. (Requires Pro license)
- Analyze full-spectrum recordings for noise characteristics. (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, and amplitude adjustments.
- Take cursor measurements and view and log signal parameters.
- Analyze and export spectral data.

Cloud Storage

Kaleidoscope Pro 5 introduces Cloud **Error! Bookmark not defined.** data storage.

- A Cloud account provides convenient, fast, and safe storage and access for large amounts of data.
- Users can subscribe to a Wildlife Acoustics Managed Cloud Account.
- 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 files to be shared.

Cloud-Based Computing

Kaleidoscope Pro 5 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 5 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 5 introduces searchable database functions. Kaleidoscope Pro 5 can access a pre-configured database via a Managed Cloud Account. Kaleidoscope Pro 5 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 either on remote servers, local drives, or both.

1.3 Compatibility and Optimization

Kaleidoscope 5 is software that is designed to run on most computers purchased within the last few years.

The latest update for Kaleidoscope 5 is always available from www.WildlifeAcoustics.com/download/kaleidoscope-software.

Minimum Computer Requirements

The computer should have at least 8 GB RAM memory for efficient operation.

- 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 5 app to the Applications folder
- Linux – Red Hat Enterprise Linux 7, x86_64 required
First download and install the wxWidgets libraries, then the Kaleidoscope 5 executable.
On Linux platforms, the wxWidgets shared libraries are installed in /usr/local/lib and Kaleidoscope 5 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

CPU Optimization

Kaleidoscope 5 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 5 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 5 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 5 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 5 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 5 is designed to process large amounts of data. Efficient management of data is an important part of the Kaleidoscope 5 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 5.

Output Files

Kaleidoscope 5 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 Batch tab. Many operations in Kaleidoscope 5 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:

Drive label (nickname) for database (optional):

☐ Create subdirectories
 ☐ Split to max duration, seconds

☒ WAV (or W4V) files
☒ Split channels
 ☐ Compression
 ☐ Time expansion factor

☒ ZC files
 ☐ Division Ratio
☐ 8.3 file names
☐ Use .zc instead of .??#

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 5 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 Amazon Web Services by creating a job on the Wildlife Acoustics website. Amazon will then upload the data to the Cloud account.

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 manual.

1.5 Included vs Licensed (Pro) Features

Kaleidoscope 5 includes a set of tools that are available for no charge. Kaleidoscope Pro 5 provides additional features and capabilities which are licensed separately.

Throughout this manual if a Kaleidoscope Pro 5 license is required for a specific function, that will be noted.

Features Included with Kaleidoscope 5

- Batch **Error! Bookmark not defined.** file format conversion.
- Filtering of Noise files (Bat Analysis Mode only).
- Extraction of metadata.
- Addition and editing of field notes to output file metadata and separate .csv files.
- Viewer and Metadata Panel.

Features Enabled with Kaleidoscope Pro 5

- Automatic identification of bats for specific geographic areas.
- Cluster analysis.
- Noise analysis.
- Cloud storage and database functions.

- The option to import MetaForms which can then provide customized project forms and metadata output.

Kaleidoscope Pro 5 License Options

Wildlife Acoustics offers permanent licenses and yearly subscription licenses for Kaleidoscope Pro 5. For further information regarding license management refer to the Resources chapter in this manual. Subscription licenses can be uploaded directly to a Wildlife Acoustics web account or can be provided as Subscription Credit Codes, which can then be added to a Wildlife Acoustics web account.

How to activate Kaleidoscope Pro 5 on a Computer

- In order to activate Kaleidoscope Pro 5 either a permanent license code or a subscription credit is required. The subscription credit must exist in a Wildlife Acoustics web account.
- Launch Kaleidoscope 5. 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 5 will complete the license authorization process. If the computer is not on line (or if there is some sort of firewall) Kaleidoscope 5 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: <https://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 5 License Configuration window.
 - Press the **Activate** button. Kaleidoscope Pro 5 will now be authorized to run on the computer.

1.6 Launching Kaleidoscope 5 For the First Time

The first time Kaleidoscope 5 is launched, the application begins to create internal preferences. Kaleidoscope 5 will open a series of windows for basic configuration of the software.

Software License Agreement

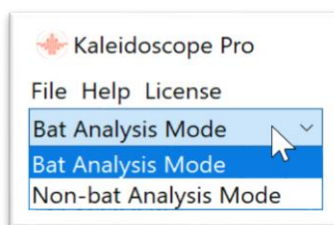
The first window to open is the **Software License Agreement**. This is a standard legal form that is required for use of a commercial software product. In order for Kaleidoscope 5 to run, the user must press the **Agree** button. Once the user has accepted the agreement this window will not open again. 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 5 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 5 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 5 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.

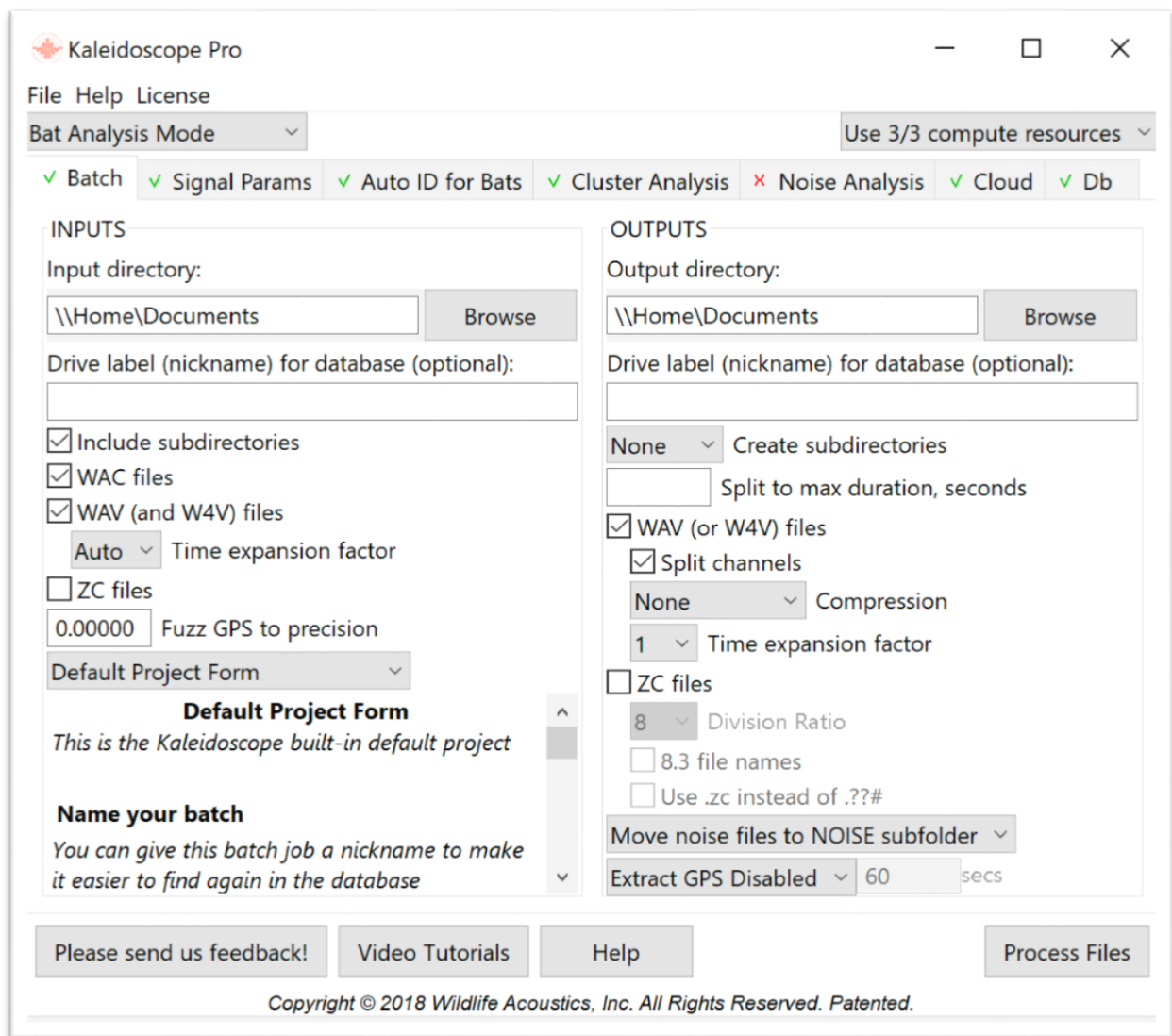
Upgrade to Pro

After selecting the initial analysis mode Kaleidoscope 5 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 5 will now fully launch.

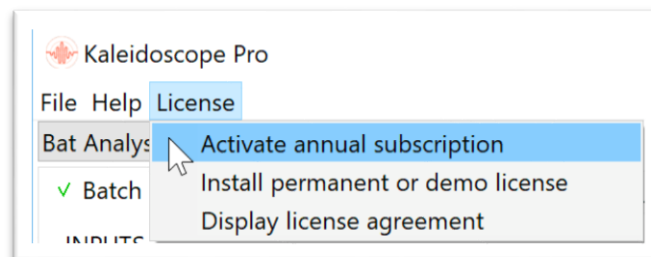
Control Panel

The Kaleidoscope 5 Control Panel window will now open. The Control Panel is the central window for operation of Kaleidoscope 5. This where typical workflows with Kaleidoscope 5 begin.

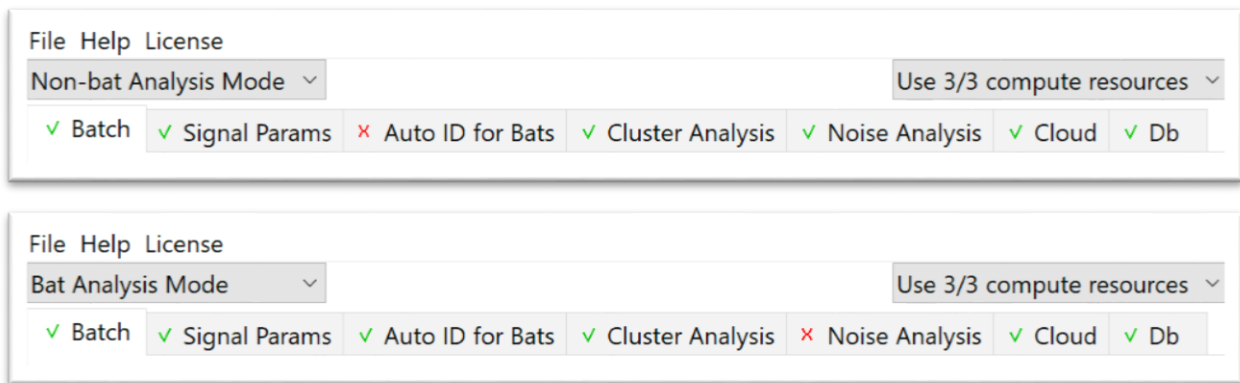


License Menu

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

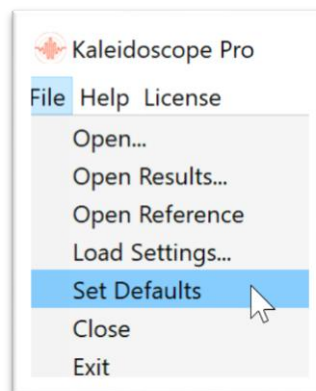


A **License Configuration** window will open asking for log-in information. Enter the required information and press the **Activate** button. Kaleidoscope Pro 5 is now authorized to run on the computer. This will be verified by green checkmarks on the Cluster Analysis tab, Noise Analysis tab, Cloud tab, 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 Pro 5 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 5. Kaleidoscope 5 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 5 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 5 check the Reference Guide and Resources chapters in this manual.

It is recommended to read through the Getting Started chapter in this manual 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 file conversion and metadata extraction and editing.

Overview

Kaleidoscope 5 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 5 can convert files from one format into another.

Different types of metadata information can be extracted from the original files and used to create .csv files. Metadata can be edited and added to the .csv file and to 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 files and data files.
- Select file types and parameters for output.
- Run the batch process.

Configure Input Options

Kaleidoscope 5 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.

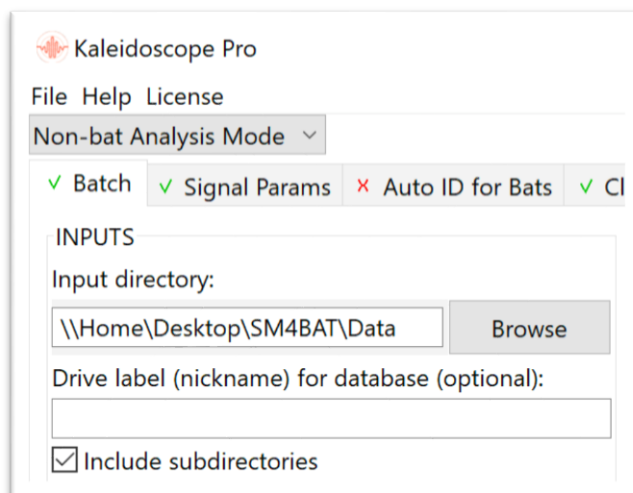
Select Input Files Directory

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

- Click the **Browse** button.

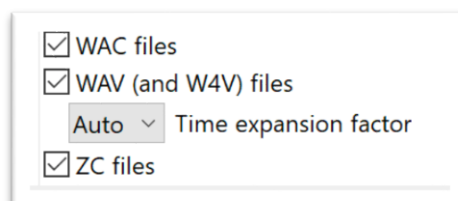
This will open a window that allows navigation to the folder that contains the files to be processed and converted. The browse function does not select any individual file. The browse function selects the directory or folder that contains the input files. When this directory is highlighted click **Select 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 5 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 5 will not process any files in subdirectories.



Select Input File Types

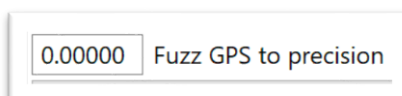
- Four different file types can be selected for processing and/or conversion. If a file type is not selected in the **INPUTS** section, any files of that type will not be processed or converted. Check the boxes for the files to be processed.
 - WAC files** are full-spectrum files created by older Wildlife Acoustics recorders.
 - WAV files** are full-spectrum audio files.
 - W4V files** are compressed full-spectrum audio files.
- WAV and W4V files can initially be recorded with a time expansion factor. Kaleidoscope 5 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 5 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 5 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 5 also allows selection of a custom project form to add metadata to the output files.

Configure Output File Options

When Kaleidoscope 5 runs a batch process it can 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 5 for additional configuration and processing functions.

Select Output Files Directory

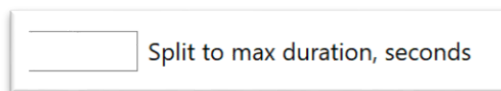
- Clicking the **Browse** button will open a window that allows navigation to the folder or directory that will contain the output files from the batch process. If the output folder does not yet exist, it can be created via the Browse window.
The output directory folder **must not** be created or selected anywhere inside the input directory folder.
The speed and efficiency of the storage medium that contains the output directory will make a significant difference to the time it takes to run 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.
- The output directory path is now displayed to the left of the Browse button.

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 5 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.

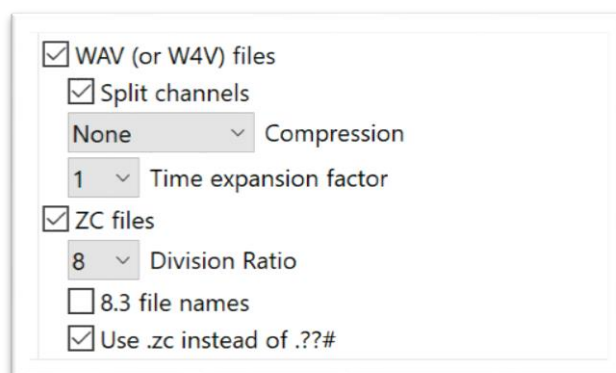
Specify Output File Length

Larger input files can be split into multiple smaller output files. There is an option to **Split to max duration, seconds**. If this field is left blank, larger files will not be split into smaller files. If a number is specified in this field, any input file more than this number of seconds in length will be split into smaller files.



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

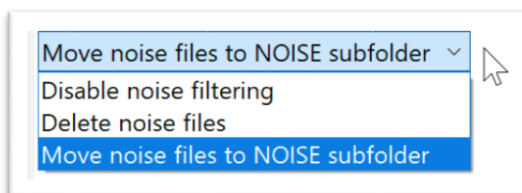
For basic batch processing in Bat Analysis Mode, it is possible to analyze input files and separate files of interest from files that are then designated as Noise. Signal parameters are also used for Auto ID for Bats and for Cluster Analysis. If none of these three functions are being used, the signal 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 of the Reference Guide chapter in this manual.

Configure Noise Extraction Options

Isolation of Noise Files

When running a batch process in Bat Analysis Mode, Kaleidoscope Pro 5 can analyze input files based on the settings described under the **Signal Params** tab. Files that do not contain signals that meet the signal parameter criteria 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.

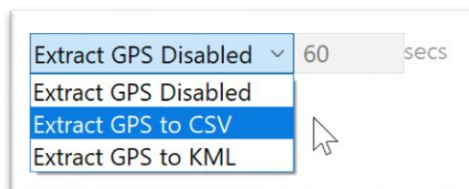
Configure GPS Extraction Options

Extraction of GPS data

Kaleidoscope 5 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 .csv files during a batch process. The GPS metadata can also be passed along to full-spectrum or zero-crossing output files that are created in the batch process.

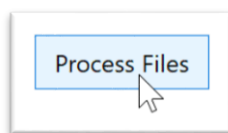
The precision of the GPS data in the output file is determined by the **Fuzz GPS to precision value** in the **INPUTS** section. The Fuzz function will lower the resolution of the GPS data written to output files, to obscure the exact location of the recording. There are three options for GPS data extraction:

- **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, 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.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 the Reference Guide chapter of this manual.

Check the Output Files

Open the output directory folder. The output directory will now contain any WAV, W4V, or zero-crossing files specified for 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, or Noise Analysis has been applied to 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

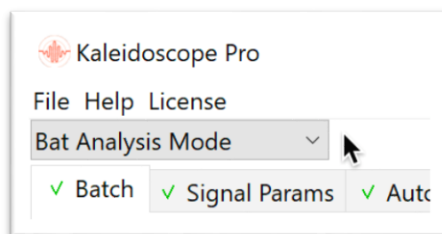
Kaleidoscope 5 provides three basic techniques for sorting, isolation, and identification of bat calls in input files.

- Full-spectrum and zero-crossing files can be viewed and auditioned for manual identification. This does not require a Pro license.
- Kaleidoscope Pro 5 can use an Auto ID function to attempt to identify specific bat species.
- Kaleidoscope Pro 5 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 5 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 5 should be in Bat Analysis Mode.



Run the Batch Process

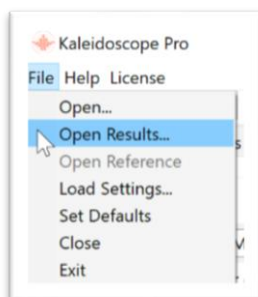
- Select the input directory for the source files.
- Select the types of files to be analyzed.
- Select the output directory.

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 the Reference Guide chapter of this manual.

- Select any desired options for output file formats.
- Select any desired Noise and GPS options for the output batch.
- In the non-Pro version of Kaleidoscope 5 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 Parameters section of the Reference Guide chapter in this manual.
- Press the **Process Files** button to begin the batch process. A **Processing Files** window will open. When the Processing Files window closes the batch process is complete.

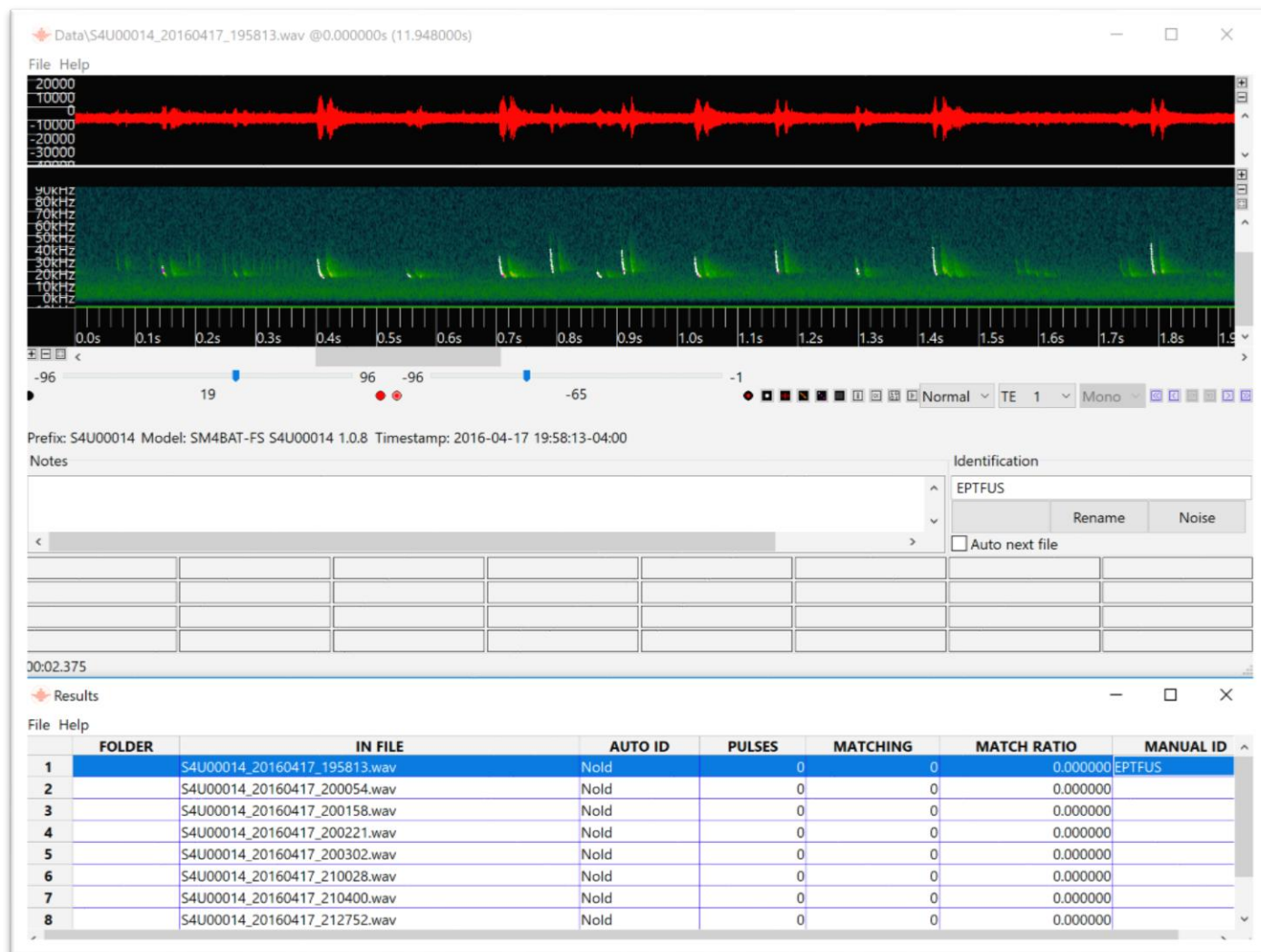
Check the Results

Go to the Control Panel **File menu->Open Results...** Navigate to the output directory and select the **meta.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 identify bat species.
- The Metadata Panel at the bottom of the Viewer allows for input of manual IDs.
- 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 now be opened in a spreadsheet application.



2.3 Auto ID for Bats

A Kaleidoscope Pro 5 license is required to enable the Auto ID for Bats function.

When running a batch process, Kaleidoscope Pro 5 can compare the recorded signals in input files to a built-in reference library of known bat recordings.

Kaleidoscope Pro 5 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 5 makes false positive identifications it will have done a great deal of work sorting files to speed up the overall process of identification.

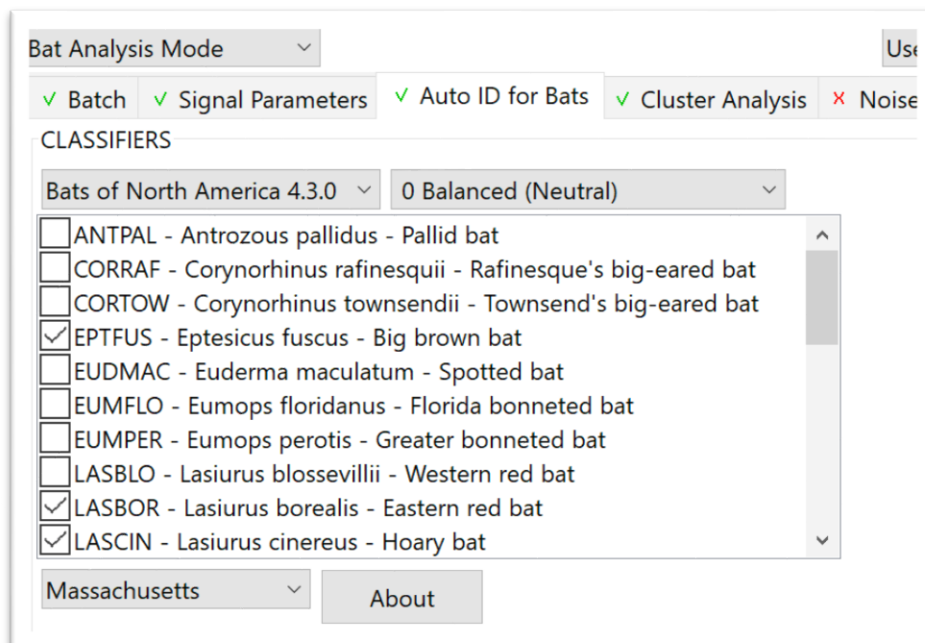
Because bats vary their echolocation calls in response to a wide variety of circumstances, no automated call identification can achieve 100% accuracy in species identification. **These automated identifications, though largely accurate, should not be relied on solely as a basis for scientific research 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 5 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 of the Reference Guide chapter in this manual.

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 the Reference Guide chapter of this manual.

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 5 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 5 was not able to find a reference match to a specific pulse, no auto-ID label will be applied.

Kaleidoscope Pro 5 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 manual.

- 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 manual.

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 manual.

2.4 Cluster Analysis for Sorting and Identification of Bats, Birds, and Other Animals

A Kaleidoscope Pro 5 license is required to enable the Cluster Analysis function.

There are three types of cluster analysis available in Kaleidoscope Pro 5 – basic clustering, simple classifiers, and advanced classifiers.

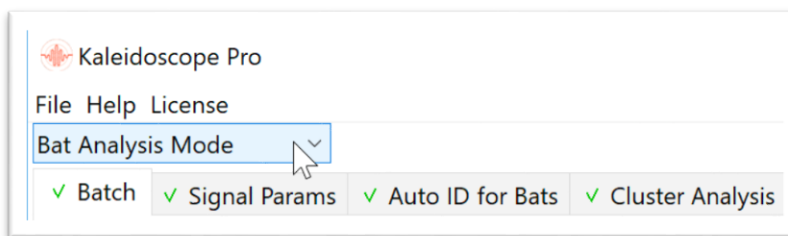
- When doing a batch process, Kaleidoscope Pro 5 can examine input files for signals of interest as described under the Signal Params tab. Detected signals can then be analyzed for similarity and then grouped into clusters of data. This is basic clustering. Basic clustering is useful for general surveying of species, and variations of vocalizations within species.
- Clusters can be manually reviewed and labelled. A simple classifier can be created from an initial data set which can then be used to cluster new recordings based on the labelled original recordings.
- It is possible to build advanced classifiers that are trained to isolate specific vocalizations. An advanced classifier is designed to eliminate as many false positive identifications as possible. An advanced classifier is not designed for general species survey.

Basic cluster analysis works the same for any type of animal, including bats. Simple and 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 5 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. 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 the Reference Guide chapter of this manual.

Bat Analysis Mode Use 3/3 comp

☒ Batch
 ☒ Signal Params
 ☒ Auto ID for Bats
 ☒ Cluster Analysis
 ☒ Noise Analysis
 ☒ C

SIGNAL DETECTION PARAMETERS

Signal to be detected:

- (kHz) Minimum and Maximum Frequency Range
 - (ms) Minimum and Maximum Length of Detected Pulses
 (ms) Maximum inter-syllable gap
 Minimum number of pulses

☒ When zero crossing for conversion or analysis, enhance with advanced signal processing

Cluster Analysis for Birds and Other Animals

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

Kaleidoscope Pro

File Help License

Non-bat Analysis Mode ▼

☒ Batch
 ☒ Signal Params
 ☒ Auto ID for Bats
 ☒ Cluster Analysis

- 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 of the Reference Guide chapter in this manual.

Non-bat Analysis Mode ▼

☒ Batch
 ☒ Signal Params
 ☒ Auto ID for Bats
 ☒ Cluster Analysis
 ☒ Noi

SIGNAL DETECTION PARAMETERS

Signal to be detected:

- (Hz) Minimum and Maximum Frequency Range
 - (s) Minimum and Maximum Length of Detection
 (s) Maximum inter-syllable gap

Basic Cluster Analysis

The first time a cluster analysis batch process is run, Kaleidoscope Pro 5 will look at all recordings and compare them to the designated settings under the Signal Params tab. A single audio file could contain many separate vocalizations. Therefore, multiple separate signals can be detected within a single recording. Once a signal has passed the parameters under the Signal Params tab, it is considered a detected signal and is passed to the cluster analysis module.

The Cluster Analysis module analyzes detected signals for similar patterns.

There are a series of parameters under the cluster analysis tab which may differ depending on the cluster mode. During this walkthrough one specific parameter will be changed. For the sake of this workflow example, leave the rest of these settings at their default values. For detailed information on the cluster analysis parameters, refer to the Cluster Analysis tab section of the Reference Guide chapter in this manual.

Based on the settings under the Cluster Analysis tab, Kaleidoscope Pro 5 will designate each detected signal as part of a cluster. Clusters are initially named, starting with cluster.000, cluster.001, cluster.002 and so on.

Detected signals are assigned to clusters based first on the highest number of most similar patterns.

Clusters following the lowest numbered cluster are based on similarity to the lowest numbered 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.

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 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 5 may display a message that no clusters have been found.






- 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, uncheck WAV and ZC files 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.
- **cluster.csv** and **cluster.kcs** files will have been created in the output directory.

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 5 clustering algorithms are used to sort the detected signals into clusters by similarity. A single input file may contain multiple detected signals, therefore the number of detected signals found may be greater than the number of input files.

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. A cluster.kcs file is also created. The cluster.kcs file contains a statistical representation of the clusters and can be used by Kaleidoscope Pro 5 to sort new data.

Initial cluster analysis can create up to 500 different clusters based on the contents of the input files. By creating simple or advanced classifiers, Kaleidoscope Pro 5 can further isolate and identify detected vocalizations based on specific cluster attributes.

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 of the highest number of similar vocalizations to the least similar.
- By default, the Results window will list the detected vocalizations in order of their distance to the cluster center. Distance to cluster center for each detected signal is displayed in the **Top1Match** column.
- The first vocalization from the first cluster will be displayed in the Viewer. This detected vocalization represents the best example of the most common cluster in the batch.
- 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 change the view to the last detected signal of the previous cluster or the first detected signal of the next cluster. By

examining a few of the first detected signals of each cluster it is possible to quickly verify the best examples of each cluster.

- 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.

At this point Kaleidoscope Pro 5 has done a basic clustering of the detected vocalizations within the input files.

Create a Simple Classifier

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. The new input files are not affected by settings under the Signal Params tab when using an existing cluster.kcs file.

- 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 number 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 the Reference Guide chapter of this manual.

It is also possible to name clusters from the original batch process. When a new batch of files is 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.
- 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.

Regardless of whether clusters have been named from the initial batch process, the cluster.kcs file can be used as a simple classifier to sort new input files.

- 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 5 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 based on 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.
- If clusters have been named based on the initial batch process, the new detected vocalizations will be labelled with the edited cluster names.

Create an Advanced Classifier

An advanced classifier is more discriminating than a simple classifier. Kaleidoscope Pro 5 can use an advanced 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. The advanced classifier can be used to separate the different but similar species into their own clusters. Detected vocalizations will then be labelled according to the cluster names embedded in the advanced classifier.

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

- 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 the Reference Guide chapter of this manual.

- 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.

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.

- Copy Top1Match cluster names to Manual ID column.

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 next steps in the process include manually labelling individual vocalizations for further discrimination.

- Edit the results of the batch process with manual IDs.

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 5 to discriminate for vocalizations that have been verified via manual ID.

Create manual ID button labels in the Metadata Panel of the Viewer. Create button labels for one or more species to be classified.

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. 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, name these false positive signals with either an accurate species name, or some other name than the desired species. This will train the advanced classifier that these incorrectly clustered signals do not belong in this cluster. The purpose of labelling detected signals that are not desirable in the cluster is to train Kaleidoscope Pro 5 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 5 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 5 will use the labelled detected signals as reference data to check against new input files.

- Choose Save from the Results window File menu to update the initial cluster.csv file with 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 edited cluster.csv file.
- The next batch process will compare the original training data with the edited cluster.csv file. Before this step, it may be required to make some adjustments under the Cluster Analysis tab.

The more overall information that is provided, the better the results of the Cluster Analysis process will be. Kaleidoscope Pro 5 looks at every manual ID in the edited cluster.csv file to compare with the input detected signals in the input files. If only one detected signal has been given a manual ID, that means a detected signal in a new input batch would have to be an exact match to the training signal with the manual ID. It is unlikely that a detected signal in a new batch of input files will be an exact match for a single detected signal from the training data.

More examples of detected signals with manual IDs will give Kaleidoscope Pro 5 a wider range of references to compare with new input files. Less detected signals with manual IDs will mean that Kaleidoscope Pro 5 will reject many detected signals in new files that do include the signal of interest but are not similar enough to the training data to be considered.

The **Max distance from cluster center to include outputs in cluster.csv** parameter determines which detected signals will be included in the cluster analysis. If this parameter is set to 2, all detected vocalizations will be included in the cluster analysis. Since the advanced classifier is looking for specific vocalizations a setting of 2 is likely to produce many false positive results. If a setting of 1.4 or less is used only detected signals that are closer to their cluster centers will be included in the cluster analysis scan. This will result in less false positive identifications.

Some experimentation may be required to get the best results from the advanced classifier.

- Run the cluster analysis batch process. The original files will be analyzed, along with the edited cluster.csv file. Detected signals with manual IDs will be re-clustered while all other non-labelled detected signals are discarded and ignored. In this way, new clusters can be learned which are associated with the manually labelled detected signals.
- When the batch process is complete the Viewer and Results window will open. The Results window will list only detected signals which have been identified using the edited cluster.csv file. These detected signals will be labelled based on the manual IDs created in the previous step. 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.
- Check the **Max distance from cluster center to include in cluster.csv** parameter under the Cluster Analysis tab.

The purpose of the advanced classifier is to discriminate for specific detected signals. It is not unlikely that new input files will include recordings of multiple species and other sounds. If the Max distance parameter is set to 2, all detected signals from the new input files will be included in the next step analysis results and labelled with one of the names included in the manual IDs. This means some of the detected signals in the next set of results will not be of the target species and therefore will be inaccurately labelled.

The solution is to lower the Max distance setting. This will allow Kaleidoscope Pro 5 to limit the detected signals to be included in the next cluster analysis. For this step start with a setting of 1 for the **Max distance from cluster center to include in cluster.csv**.

- 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 labelled detected signals.

Tune the Advanced Classifier

If the advanced classifier cluster.kcs file is still producing false positive identifications it can be further refined. Once the advanced classifier has been used to analyze a new set of input files, go through the clusters and create manual IDs using the same techniques as in the earlier step.

- Create manual IDs for obvious clear examples of signals of interest.
- Do not label detected signals that contain signals of interest but also contain un-wanted signals.

- Specifically label detected signals that have been incorrectly identified with accurate names.
- Choose Save from the Result window File menu to update the underlying cluster.csv file.
- Choose **Re-scan recordings and edited cluster.csv to create new cluster.kcs with pairwise classifiers and cluster.csv.** under the Cluster Analysis tab.
- Locate the newly created and edited cluster.csv file.
- Under the Batch tab select the original training data input directory.
- Select a new output directory.
- Run the batch process.
- A new cluster.kcs file is created. This is the tuned advanced classifier.
- The new cluster.kcs file can be used to analyze new input files via **Use existing .kcs to sort new recordings and create new cluster.csv** from under the Cluster Analysis tab.

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 5 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.

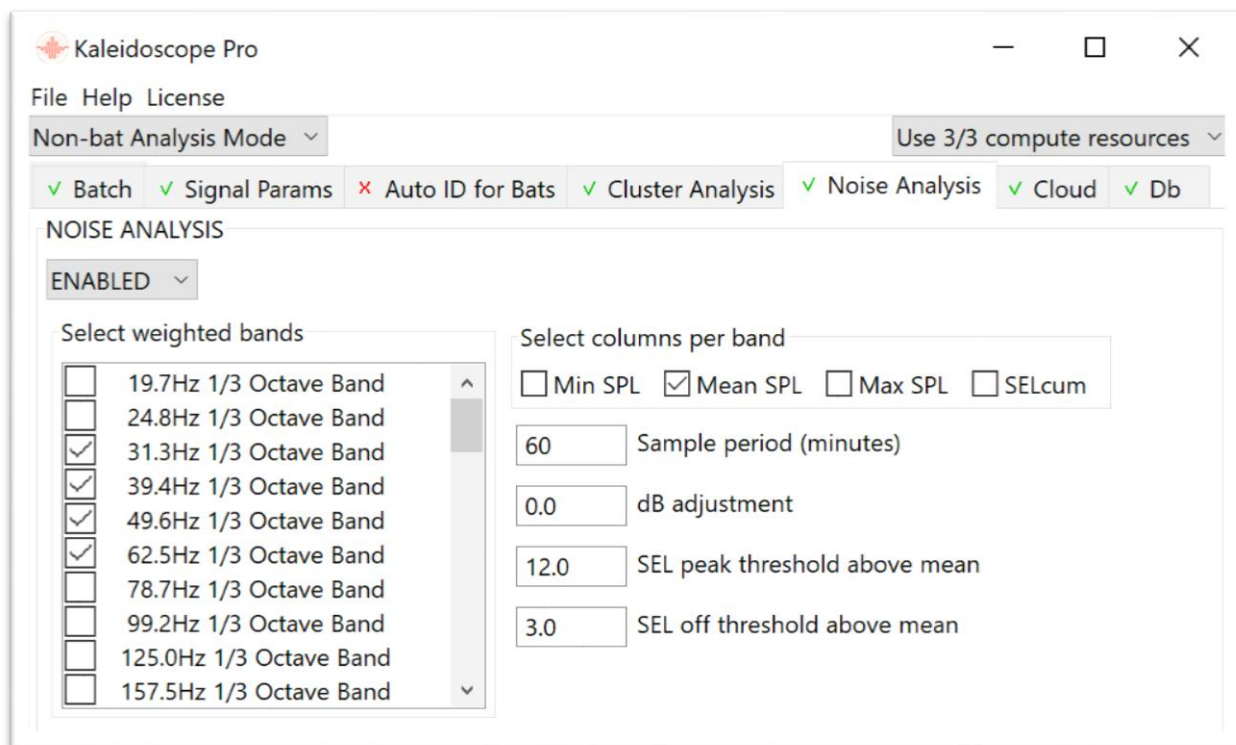
2.5 Noise Analysis

A Kaleidoscope Pro 5 license is required to enable the Noise Analysis function.

Kaleidoscope Pro 5 can analyze full-spectrum audio files for ambient noise level characteristics. The results of the analysis are then written to .csv files which are typically opened in a spreadsheet application.

Configure Noise Analysis Parameters

- Kaleidoscope Pro 5 will analyze noise level characteristics based on the parameters configured under the Noise Analysis tab. Kaleidoscope Pro 5 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.
- Noise 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 Noise Analysis section of the Reference Guide chapter in this manual.



Run a Batch Process

Under the Batch tab, select the input directory for the files to be analyzed. Noise 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 noise 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 the Reference Guide chapter of this manual.

Check Results

The results of the noise analysis batch process will be provided in a noise.csv file and a noisebyfile.csv file. These files are created in the output directory. These .csv files cannot be opened by Kaleidoscope Pro 5. 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 manual.

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

2.6 Cloud Storage Configuration

Kaleidoscope Pro 5 introduces Cloud based storage for files. A Kaleidoscope Pro 5 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 5 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 5 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 5. 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 manual.

Enable a Wildlife Acoustics Managed Cloud Account in Kaleidoscope Pro 5

Once a Managed Cloud Account has been created at the Wildlife Acoustics web site, Kaleidoscope Pro 5 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 5 in to the Managed Cloud Account.

✓ Batch ✓ Signal Params ✓ Auto ID for Bats ✓ Cluster Analysis ✗ Noise Analysis ✓ Cloud ✓ Db

Log in to Managed Cloud Account ▾

Email Address

Password

Region

Account

View Cloud Storage Directories

Once logged in to the Cloud account, Kaleidoscope Pro 5 has access to the file directories within the account. Click the **Browse Files** button to open the Cloud directory.

✓ Batch ✓ Signal Params ✓ Auto ID for Bats ✓ Cluster Analysis ✗ Noise Analysis ✓ Cloud

Log in to Managed Cloud Account ▾

Email Address

Password

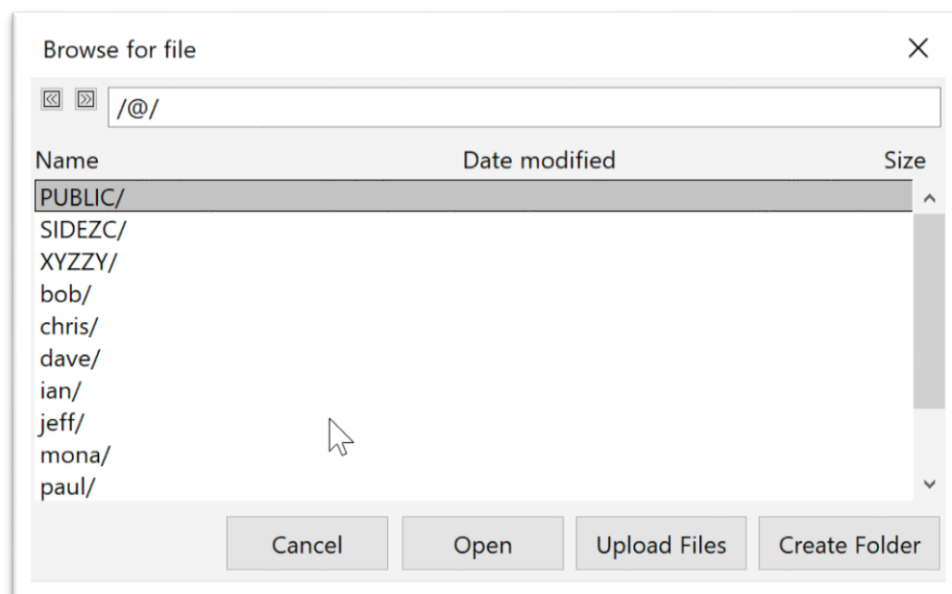
Region

Account

Log In

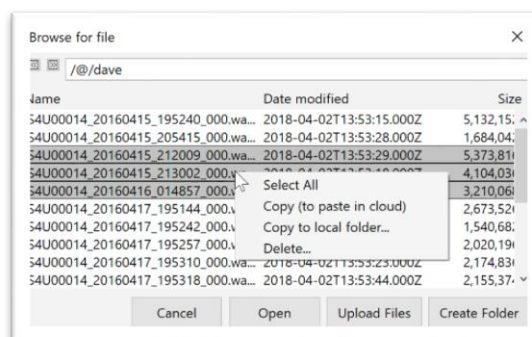
Browse Files Browse to set Input Folder Browse to set Output Folder

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

Browse to set Input Folder

Browse to set Output Folder

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 manual 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 5 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 section of the Reference Guide chapter in this manual.

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.

☒ Batch
 ☒ Signal Params
 ☒ Auto ID for Bats
 ☒ Cluster Analysis
 ☐ Noise Analysis
 ☒ Cloud
 ☒ Db

Log in to Managed Cloud Account

Upload to database

Query database

Type of query:
 Choose destination for query results:

Table Data Source:
 Table Data Mode:

Optional sort order:

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

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.

✓ Batch

✓ Signal Params

✗ Auto ID for Bats

✓ Cluster Analysis

✓ Noise Analysis

✓ 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:
Bat AutoIDs (id.csv)

Choose destination for query results:
\Home\Desktop\query.csv

Browse

Table Data Source: My records

Table Data Mode: Most recent

Manual Review Source: My records

Manual Review Mode: 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

>=

6

OR

-- Select Database Field --

AND

-- Select Database Field --

Optional sort order:
-- Select Database Field --

Ascending

Results to skip: 0

Limit results to: 1000

Adjust timezone (hours re UTC): -4

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Run Query

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.

☒ Batch
 ☒ Signal Params
 ☒ Auto ID for Bats
 ☒ Cluster Analysis
 ☒ Noise Analysis
 ☒ Cloud
 ☒ Db

Log in to Managed Cloud Account

Upload to database

Query database

Type of query: Choose destination for query results:

Table Data Source: Table Data Mode:

ALL OF

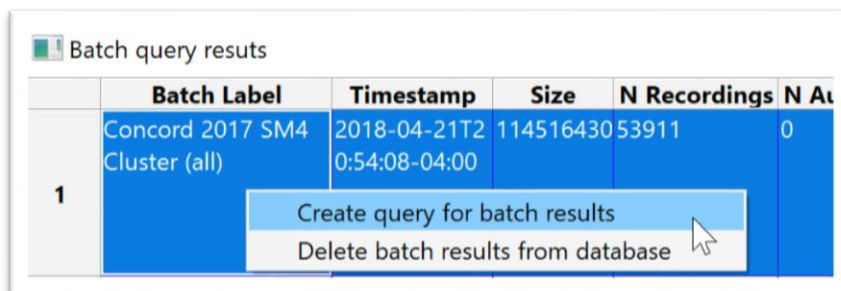
Optional sort order:

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

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

Batch query results										
	Batch Label	Timestamp	Size	N Recordings	N Auto IDs	N Clusters	Kaleidoscope Version	Input Directory	Output Directory	Input
1	Concord 2017 SM4 Cluster (all)	2018-04-21T2 0:54:08-04:00	114516430	53911	0	732464	5.0.0alpha7	/@15a3d6aa-96ca-5c/13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c/c/ian/Concord2017/SM4	/@15a3d6aa-96ca-5c/13-afa8-dfa63c9c8d2c/c/ian/Concord2017/SM4/Cluster	
2	Concord 2016 SM4 Cluster (all)	2018-04-21T2 1:35:28-04:00	74266248	21026	0	503321	5.0.0alpha7	/@15a3d6aa-96ca-5c/13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c/c/ian/Concord2016/SM4	/@15a3d6aa-96ca-5c/13-afa8-dfa63c9c8d2c/c/ian/Concord2016/SM4/Cluster	
3	Concord 2016 SM4BAT Cluster (all)	2018-04-21T2 1:54:47-04:00	14739877	25706	0	50496	5.0.0alpha7	/@15a3d6aa-96ca-5c/13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c/c/ian/Concord2016/SM4BAT	/@15a3d6aa-96ca-5c/13-afa8-dfa63c9c8d2c/c/ian/Concord2016/SM4BAT/Cluster	
4	Concord 2017 SM4BAT Cluster (all)	2018-04-21T2 2:06:47-04:00	21635005	37962	0	75096	5.0.0alpha7	/@15a3d6aa-96ca-5c/13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c/c/ian/Concord2017/SM4BAT	/@15a3d6aa-96ca-5c/13-afa8-dfa63c9c8d2c/c/ian/Concord2017/SM4BAT/Cluster	
5	Concord 2017 SM4 Cluster Owl	2018-04-22T0 7:11:58-04:00	17236239	53908	0	18150	5.0.0alpha7	/@15a3d6aa-96ca-5c/13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c/c/ian/Concord2017/SM4	/@15a3d6aa-96ca-5c/13-afa8-dfa63c9c8d2c/c/ian/Concord2017/SM4/CusterOwl	

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.

✓ Batch
✓ Signal Params
✓ Auto ID for Bats
✓ Cluster Analysis
✗ Noise Analysis
✓ 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: Clusters (cluster.csv)
Choose destination for query results: \\Mac\Home\Desktop\query.csv
Browse

Table Data Source: My organization
Table Data Mode: Most recent

Manual Review Source: My organization
Manual Review Mode: Most recent

ALL OF Batch - Fingerprint = uZCKuLt9
OR -- Select Database Field --
AND -- Select Database Field --

Optional sort order:
Cluster - Top 1 Match Ascending
Cluster - Top 1 Distance Ascending
-- Select Database Field -- Ascending

Results to skip: Limit results to: Adjust timezone (hours re UTC):
0 1000 -4

3 Metadata

Metadata is information about a file or batch process. Metadata is involved in a significant part of the Kaleidoscope 5 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 5, 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 5 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 5.

- 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 5 license).
- Metadata can be uploaded to a customer-provisioned PostgreSQL database server (Requires Kaleidoscope Pro 5 license).

3.2 MetaForm

A MetaForm is a document that defines how metadata is managed within Kaleidoscope 5. 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 5. Kaleidoscope Pro 5 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 manual.

- 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.

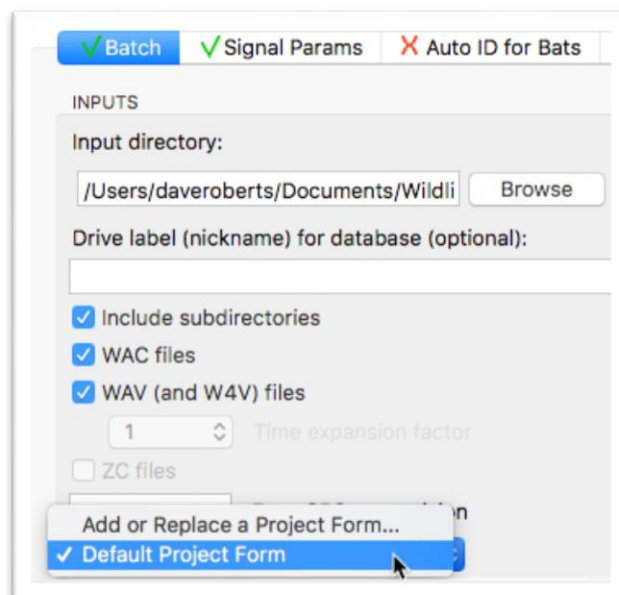
A copy of the Default MetaForm, including instructions to customize or create a new MetaForm document can be downloaded from: www.wildlifeacoustics.com/download/kaleidoscope-software.

DOWNLOAD KALEIDOSCOPE SOFTWARE

This one download of Kaleidoscope may be used for free tier, demo licenses and Kaleidoscope Pro licenses and subscriptions.

[Kaleidoscope Pro 5 User Guide](#)
[Kaleidoscope Release Notes](#)
[Kaleidoscope Meta Data Resources](#)

- 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 5 provides the option to load additional MetaForms. This is done via the project form menu under the batch tab.

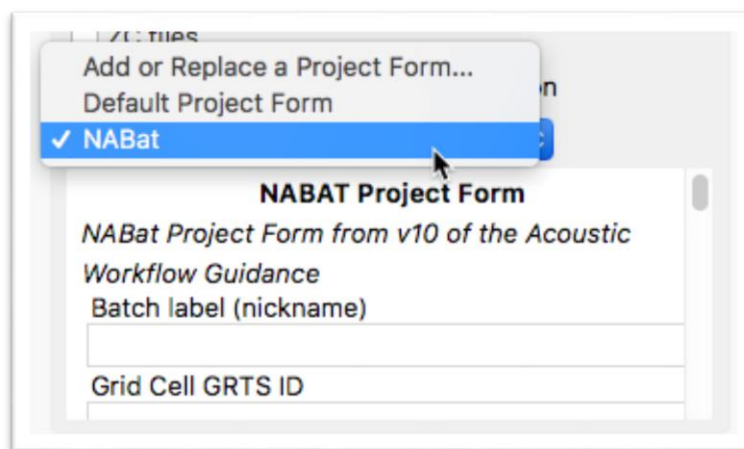


NABat MetaForm

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 5.

- Go to www.wildlifeacoustics.com/download/kaleidoscope-software.
- Click the link for Kaleidoscope Meta Data Resources
- Right-click on Kaleidoscope NABat MetaForm.
- Choose Download Linked File
- Download the NABat.xml file to the local computer.
- In Kaleidoscope Pro 5 choose Add or Replace a Project Form...
- Navigate to the downloaded NABat.xml file and Open.
- Kaleidoscope Pro 5 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 5 provides a Default Project Form. Customized project forms can be created and used instead of the Default Project Form. A Kaleidoscope Pro 5 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 5 is accessing a database in a Managed Cloud Account. The database can be searched by batch label.

The screenshot shows a window titled "Default Project Form". Inside, there is a section titled "Default Project Form" with the text: "This is the Kaleidoscope built-in default project form". Below this is a section titled "Name your batch" with the text: "You can give this batch job a nickname to make it easier to find again in the database". At the bottom of this section is a text input field labeled "Batch label (nickname)".

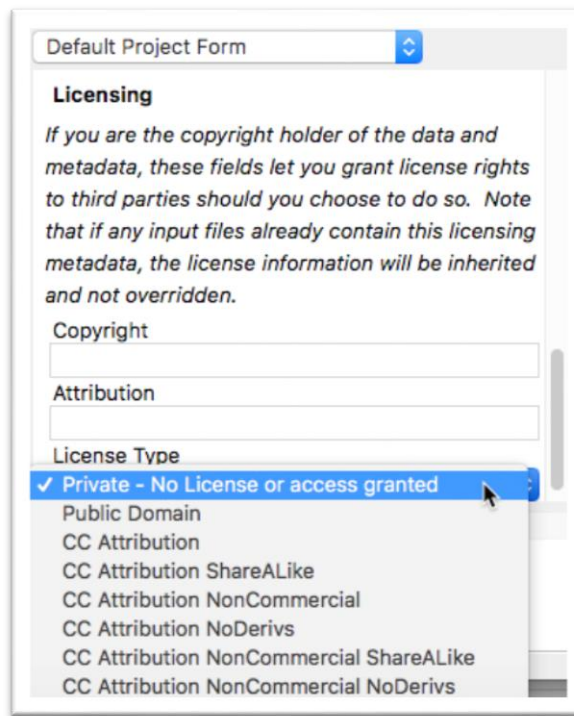
- The Default Project Form provides the option to write field notes. The field notes can be appended (placed after) or prepended (placed before) existing field notes. New field notes can replace previously existing field notes.

The screenshot shows a window titled "Default Project Form". Inside, there is a section titled "Notes" with a text input field labeled "Note". Below the input field is a dropdown menu with three options: "Append notes to output meta data" (which is selected and has a checkmark), "Prepend notes to output meta data", and "Replace notes in output meta data".

- 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.

The screenshot shows a window titled "Default Project Form". Inside, there is a section titled "Privacy" with the text: "For Kaleidoscope Cloud users, you can make database records created for this batch searchable by other users outside of your organization." Below this text is a section labeled "Access" with a dropdown menu. The dropdown menu has two options: "Private" (which is selected and has a checkmark) and "Public".

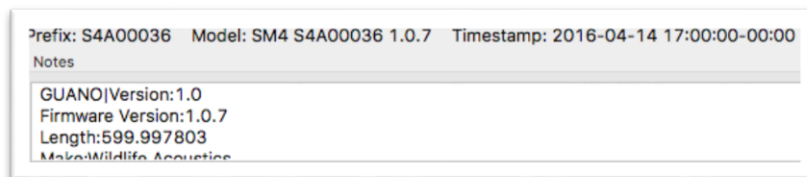
- Copyright information can be added to output files.



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.



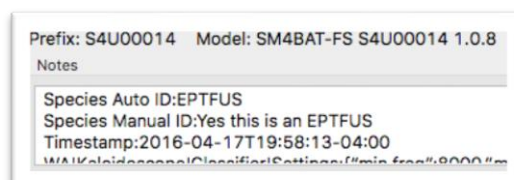
The Metadata Panel displays the raw metadata found in the file. This includes:

- Proprietary metadata created by Wildlife Acoustics recorders.
- Additional metadata added by Kaleidoscope 5 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/support/technical-faq/145-kaleidoscope-analysis-software/1117-metaforms

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 5 are described in the Resources chapter in this manual.

- Kaleidoscope 5 reads GUANO metadata from full-spectrum and zero-crossing input files.
- Kaleidoscope 5 embeds GUANO metadata into full-spectrum and zero-crossing output files.
- Kaleidoscope 5 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 5 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 5. 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 5 software, starting with the Control Panel.

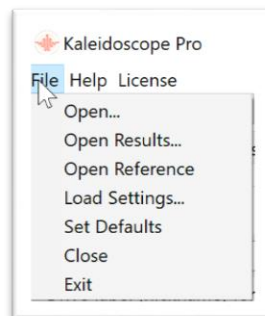
4.1 Control Panel

The Control Panel is the first window to open when Kaleidoscope 5 is launched. The Control Panel includes a series of tabs which each contain controls and settings for specific functions within Kaleidoscope 5. Batch processes are configured and run from the Control Panel.

File Menu Commands

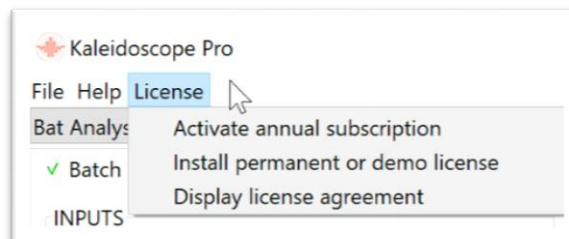
When the Control Panel window is front-most, these are the available File menu commands:

- **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 5 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 5. On Mac the command to Quit Kaleidoscope 5 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 5 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 5.

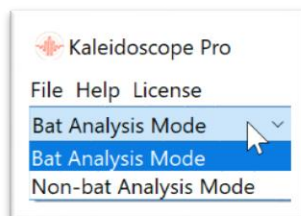
In Kaleidoscope Pro 5 the Noise Analysis tab is disabled in Bat Analysis Mode.

- 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 Noise Analysis function in Kaleidoscope Pro 5.

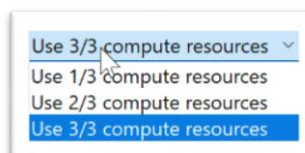
In Kaleidoscope Pro 5 the Auto ID for Bats tab is disabled in Non-Bat Analysis Mode.

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



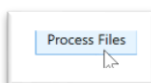
Compute Resources

Kaleidoscope 5 is designed to take full advantage of multi-core CPUs. Kaleidoscope 5 uses parallel processing during batch processing by dividing work into multiple threads. By default, Kaleidoscope 5 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 5 can be adjusted via the menu in the upper right corner of the Control Panel. This may be necessary when running Kaleidoscope 5 on a computer with limited available memory, or desirable if the computer is used to run other tasks while Kaleidoscope 5 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.



4.2 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)

- 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 5 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 5 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.

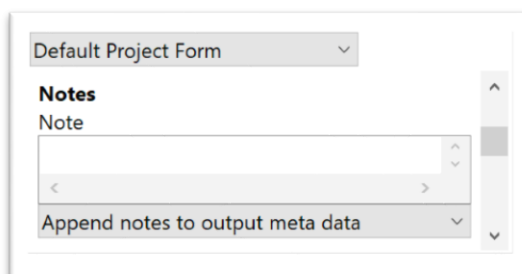
Additional Input Options

- **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 5 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 5 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 5 project form.
 - **Add or Replace a Project Form** – Use this to import a custom project form. A Kaleidoscope Pro 5 license is required to use custom project forms.
- During batch file conversion, Kaleidoscope 5 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.

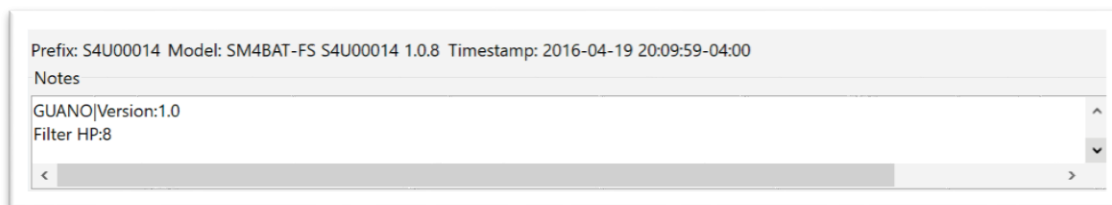
GUANO Metadata

- 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 5 license.
- Kaleidoscope 5 can automatically sort output files into daily or nightly subfolders (if Kaleidoscope 5 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
- Kaleidoscope 5 can break up long files into multiple shorter files. Specify a value for **Split to max duration** in seconds. If this field is left blank Kaleidoscope 5 will not split up larger files into smaller files.
- 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.
 - By default, uncompressed .wav files will be created. Kaleidoscope 5 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 5 will use the suffix .00#. If **Use .zc instead of .??#** is checked, Kaleidoscope 5 will use the file suffix .zc

Additional Output Options

During batch file conversion in Bat Analysis Mode, Kaleidoscope 5 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 5 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 Parameters 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 5 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.

4.3 Signal Params Tab

When Kaleidoscope Pro 5 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 5 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 5 is in Bat Analysis Mode or Non-bat Analysis Mode.

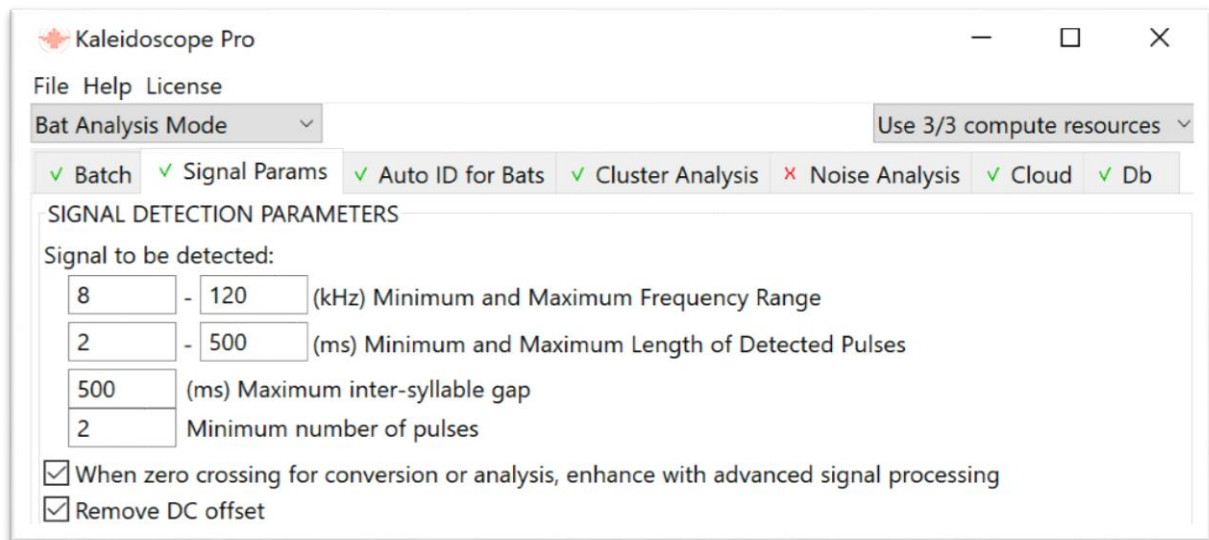
Accurate settings in the Signal Params tab are critical for getting best results. Inaccurate settings can result in signals which would otherwise be of interest not be considered for further analysis.

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

Bat Analysis Mode

Signal Detection Parameters

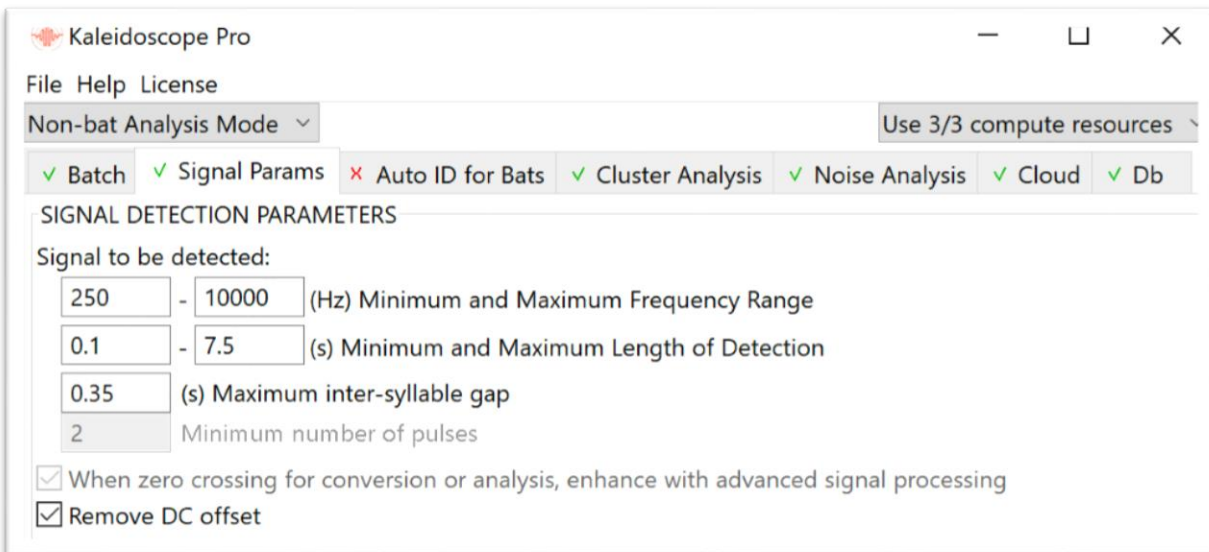
- Minimum and Maximum Frequency Range in kHz
- Minimum and Maximum Length of Detected Pulses in ms
- Maximum inter-syllable gap in ms
- Minimum number of pulses to be considered a phrase or pulse sequence.
- When zero-crossing for conversion or analysis, enhance with advanced signal processing
- Remove 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 Parameters 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 5 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 5 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.

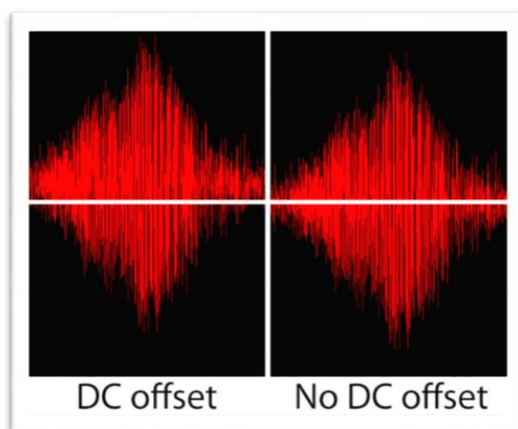
When recording full spectrum audio files with fixed durations, it is possible a single recording may contain multiple vocalizations, as well as other non-animal sounds. If the maximum inter-syllable gap time is exceeded, the next syllable is considered to be part of a new detected signal. This means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



4.4 Auto ID for Bats Tab

Requires Kaleidoscope Pro 5 license. Available only in Bat Analysis Mode.

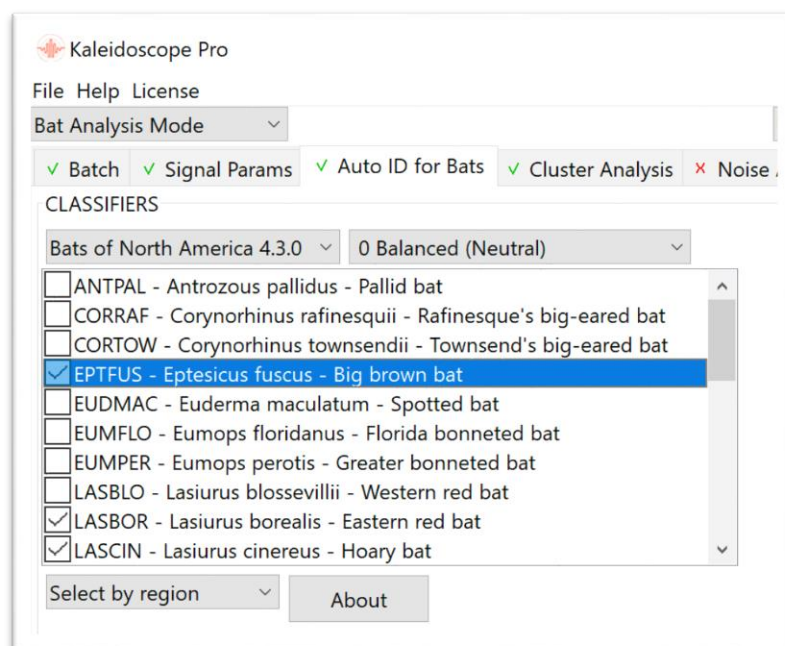
The following is a list of all parameters found under the Auto ID for Bats tab

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)



Automatic Identification of Bat Species Overview

- During batch processing, Kaleidoscope Pro 5 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 5 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 5 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 5 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 manual.

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 5 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 chapter of the manual.

- 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.

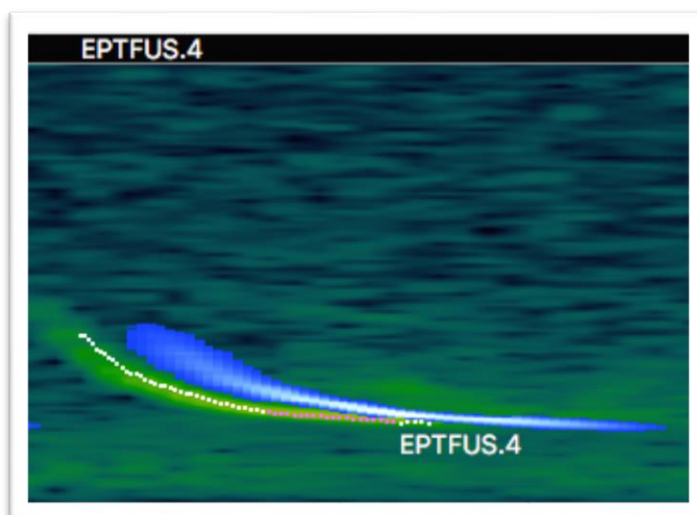
If the batch process is run using Cloud-based computing an id.csv file will be created in the output directory. The browser under the Cloud tab can be used to navigate to the output directory. Locate and select the id.csv file and the Viewer and Results window will open.

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.

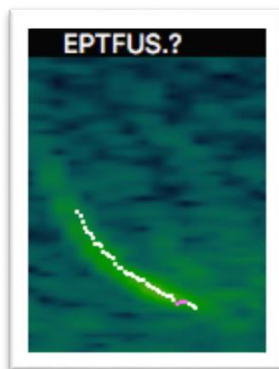
Check the Results

- 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.

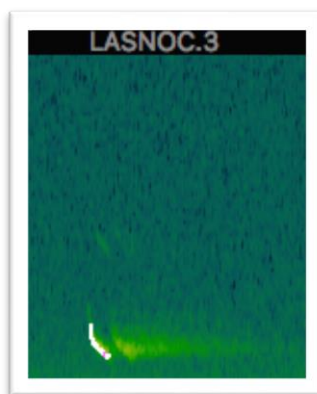
In the following graphic the reference classifier is displayed next to a detected pulse. The reference pulse is displayed in blue. The detected pulse is shown as both a full-spectrum and zero-crossing signal. The designation of the reference pulse is shown below. The designation of the detected pulse 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 5 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->Load results...**
- For further information regarding the Viewer and Results window refer to those sections in this chapter of the manual.

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 manual.

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 manual.

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.

4.5 Cluster Analysis Tab

Requires Kaleidoscope Pro 5 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

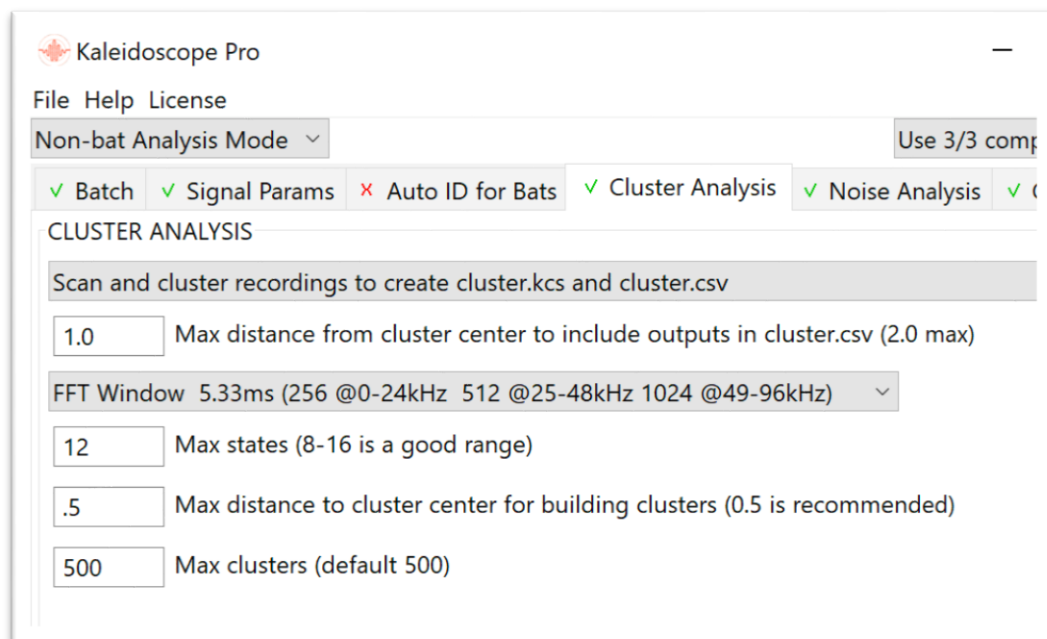
Re-scan recordings and edited cluster.csv to create new cluster.kcs with pairwise classifiers and cluster.csvs

- 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)



Cluster Analysis Overview

Cluster analysis is a powerful tool in Kaleidoscope Pro 5 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 three types of 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.
- Clusters can be manually reviewed and labelled. A simple classifier can be created which can then be used to cluster new recordings based on the labelled original recordings. Clusters in the simple classifier can be examined and manually named. The simple classifier is then used to sort new data and to create named clusters based on the original analysis.
- It is possible to build and tune advanced classifiers which are trained to isolate specific vocalizations. An advanced classifier is designed to eliminate as many false positive identifications as possible. An advanced classifier is not designed for general species survey.

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 Auto ID at all and would prefer to have Kaleidoscope Pro 5 sort the data based on similar pulses and sequences of pulses, which can then be manually identified and labelled. In general, simple and advanced classifiers are not useful for bat recordings.

Cluster analysis is very useful for sorting and labelling birds and other animals and can be used to separate and identify different animals within recordings. Cluster analysis can also be used to create simple and advanced classifiers, which can be used for direct isolation and identification of species.

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 refer to the Resources chapter in this manual.

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 5 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 250 Hz to 10000 Hz (10 kHz). If the input signals are recordings of bats, and Kaleidoscope Pro 5 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 5 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.

Clustering Modes

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 5 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.

Clusters can be named. All detected signals in a cluster can be relabelled with a single operation.

- Click on a cluster name in the Results window. Go to the Results window File menu->Edit Cluster Name.... Enter a name and click ok. All detected signals within the cluster have now been relabeled.
- Once the different clusters of interest have been named, go the Results window file menu and choose Save. This will update both the underlying cluster.csv file and the cluster.kcs file.
- When a cluster analysis batch process is run, a cluster.csv file is created in the output directory. The cluster.csv file lists all the detected signals and their cluster membership. Clusters can be renamed. Manual IDs can be added to individual detected signals. When the Results window is edited and saved, the cluster.csv file is updated with those changes. Depending on what data is desired from the cluster analysis, the cluster.csv file may now represent the final result.
- A cluster.kcs file is also created from the cluster analysis batch process. This file contains statistical information about the identified clusters. If the data in the Results window is edited and saved, the cluster.kcs file will also be updated. The updated cluster.kcs file can be re-used as a simple classifier to sort new input data. The cluster.kcs file can be further refined or trained to create an advanced classifier.

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 and identification. It is important to understand that the advanced classifier is designed to isolate specific detected signals and ignore all other signals. 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 will be 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.
- The same species may be sorted into 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, they will be reclustered together in this next step.
- After the basic cluster analysis batch process has been run, edit the resulting cluster.csv file with individual labels in the Manual ID column of the Results window. Manual IDs are added via the Metadata Panel in the Viewer.

The cluster name for the currently viewed detected signal is displayed in a button in the Metadata Panel. If the detected signal represents a good example of the desired signal of interest, press the button to confirm and add a manual ID to the detected signal. There may be variations of the signal of interest. If variations of the same detected signals are not labelled they may not be included in the advanced classifier and that could result in some detected signals not being properly identified. Only name the detected signals which contain pure examples of the signal of interest. If the detected signal contains multiple species, do not add a manual ID.

Detected signals not given a manual ID will be ignored and will not be part of the advanced classifier. By not labelling some detected signals, Kaleidoscope Pro 5 will not consider the unlabelled signal when creating the advanced classifier. For example, if a detected signal contains the signal of interest as well as other species, labelling that vocalization will train the advanced classifier to recognize both species as belonging to the same cluster. If only detected signals which contain a pure signal of interest are labelled, only those signals will be used to train the advanced classifier.

It is not uncommon to find false positives in a cluster. This can happen if Kaleidoscope Pro 5 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 it should be labelled as such. This will train the advanced classifier to see the false positive as something other than the desired signal of interest. Either correctly label the false positive or create a custom label button in the Metadata Panel called No Interest or similar. Use this to manually ID false positives within a cluster. If multiple clusters are to be included in the advanced classifier, use a unique no-interest label for each cluster.

- 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 5 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 re-clustered while all other detected signals are discarded and ignored. In this way, new clusters are created which are associated with the manually confirmed detected signals. 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 clusters 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 cluster 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 5 will analyze the new input files using the advanced classifier cluster.kcs file. Detected signals will be listed in the Results window using one of the manually confirmed cluster IDs.

If further refinement of the advanced classifier is required, the latest Results window can be edited with manual IDs. This file can be saved and the updated underlying cluster.csv file can be compared with the original data set to create a tuned second generation cluster.kcs advanced classifier.

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 5 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 5 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 5 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 5 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.

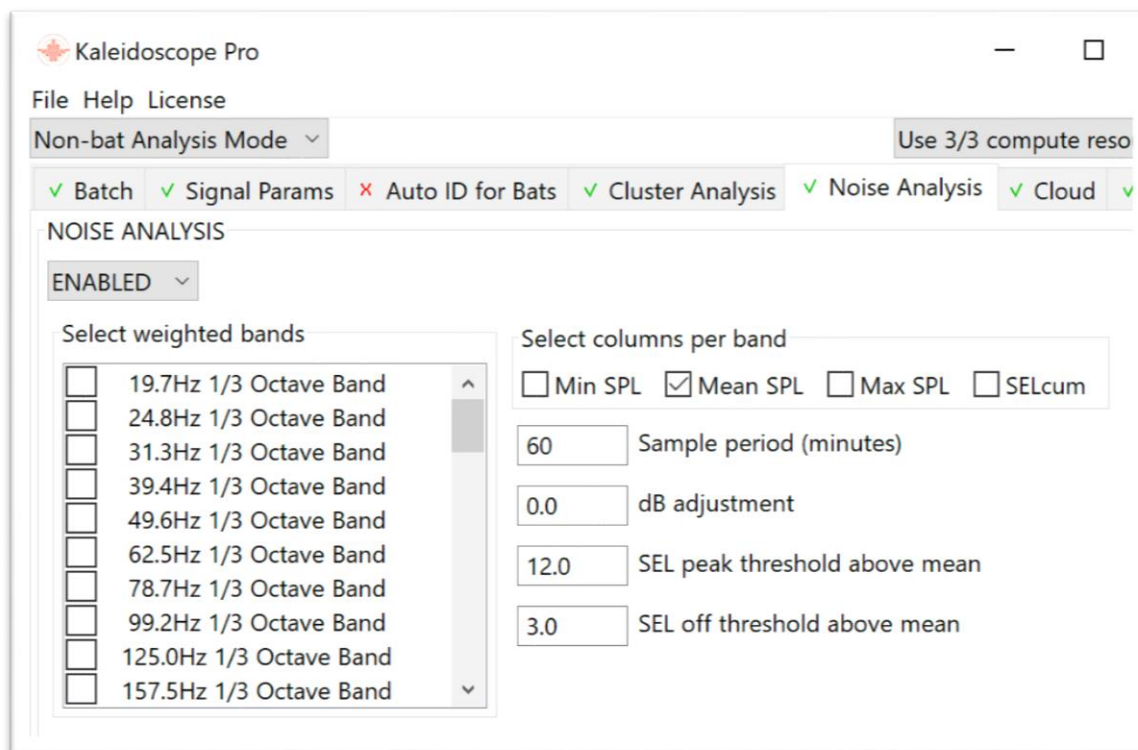
4.6 Noise Analysis Tab

Requires Kaleidoscope Pro 5 license.

Available only in Non-bat Analysis Mode.

The following is a list of all parameters found under the Noise 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



Noise Analysis Overview

The Noise 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. Noise Analysis is available in Non-bat Analysis Mode only.

Noise analysis level results are relative to specific reference points. Kaleidoscope Pro 5 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 noise analysis.

- In the Control Panel, click on the Noise 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 **noise.csv** file and **noisebyfile.csv** file in the output directory.

Noise 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 Noise 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 Noise Analysis Module

The following configuration parameters and settings are specified under the Noise Analysis tab in the Control Panel.

- **Enable Noise Analysis**
Choose ENABLED from the menu. Once enabled, a batch process can be run on suitable Input files through the Noise Analysis module. A noise.csv file and noisebyfile.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 .csv files for each selected measurement reference.
- **Mean SPL**
Check this box to include a Mean Sound Pressure Level column in the output .csv files for each selected measurement reference.
- **Max SPL**
Check this box to include a Maximum Sound Pressure Level column in the output .csv files for each selected measurement reference.
- **SELcum**
Check this box to include a Cumulative Sound Exposure Level column in the output .csv files for each selected measurement reference.
- **Sample period (minutes)**
Select the sample period size in minutes. The noise.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 5 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 5 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.

Noise Analysis File Output

The results of the noise analysis batch process will be provided in a noise.csv file and a noisebyfile.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 manual.

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

Microphone sensitivity and recorder gain compensation

In order to provide accurate noise analysis measurements Kaleidoscope Pro 5 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 Noise 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 5 data would automatically be adjusted to dBV/Pa. To measure SPL relative to 20 micro-Pascals, the Kaleidoscope Pro 5 dB Adjustment can be set to 94.0dB.

4.7 Cloud Tab

Requires Kaleidoscope Pro 5 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

The screenshot shows the Kaleidoscope Pro 5 application window. At the top, there is a menu bar with 'File', 'Help', and 'License'. Below the menu bar, there is a 'Bat Analysis Mode' dropdown menu and a 'Use 3/3 compute resources' dropdown menu. A row of status indicators shows: 'Batch' (green check), 'Signal Params' (green check), 'Auto ID for Bats' (green check), 'Cluster Analysis' (green check), 'Noise Analysis' (red X), 'Cloud' (green check), and 'Db' (green check). Below this is a 'Log in to Managed Cloud Account' dropdown menu. The login section includes fields for 'Email Address' (dave@wildlifeacoustics.com), 'Password' (masked with dots), 'Region' (us-east-1), and 'Account' (Wildlife Acoustics, Inc. (15a3d6aa-96ca-5c13-afa8-dfa63c9c8d2c)). A 'Log In' button is positioned below the account field. At the bottom of the login section are three buttons: 'Browse Files', 'Browse to set Input Folder', and 'Browse to set Output Folder'. The footer area contains four buttons: 'Please send us feedback!', 'Video Tutorials', 'Help', and 'Process Files'. Below these buttons is a copyright notice: 'Copyright © 2018 Wildlife Acoustics, Inc. All Rights Reserved. Patented.'

Cloud Overview

Kaleidoscope Pro 5 introduces Cloud based storage and management. A Kaleidoscope Pro 5 license is required for Cloud compatibility.

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

A Kaleidoscope Pro 5 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 manual for instructions on how to create and manage a Wildlife Acoustics Managed Cloud Account.
- Any Kaleidoscope Pro 5 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 5 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 5 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

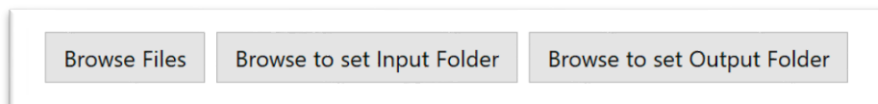
Users of Kaleidoscope Pro 5 can create a Cloud account or can be invited to join an existing Managed Cloud Account. A single user may be invited to join multiple Managed Cloud Accounts. Depending on privacy settings, database information from other Managed Cloud Accounts may be available for searching from Kaleidoscope Pro 5.

Access a Managed Cloud Account from Kaleidoscope Pro 5

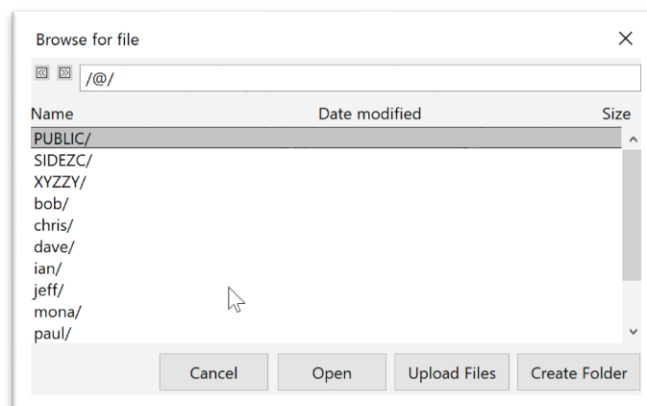
- Click on the Cloud tab in the Control Panel.
- The Cloud window initially shows a menu with four choices:
 - Disabled**
 - Log in to Managed Cloud Account**
This requires an existing Wildlife Acoustics Managed Account.
 - Log in to user managed AWS S3**
This requires an existing Amazon Web Services account and an S3 bucket.
 - Set up user managed AWS3 account**
This is used to configure Kaleidoscope Pro 5 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 5 in to the Wildlife Acoustics Managed Cloud Account.

View Cloud Storage Directories

- Once Kaleidoscope Pro 5 is logged in to a Cloud account, three buttons are displayed:



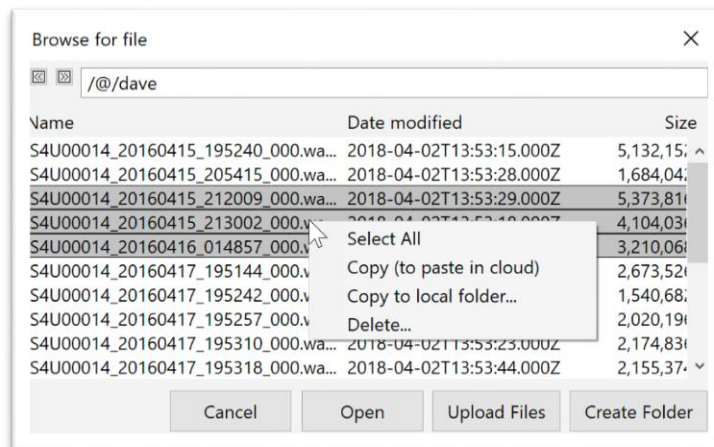
- Browse Files** – This will open a Browser window that displays the data in the Managed Cloud Account. New folders can be created. Files can be uploaded. Right-click on a file for options to select all, copy to a different Cloud location, copy to a local directory, or delete.
 - Browse to Set Input Folder** – Use this command to designate a Cloud input directory for Kaleidoscope Pro 5 batch processing.
 - Browse to Set Output Folder** – Use this command to designate a Cloud output directory for Kaleidoscope Pro 5 batch processing.
- Click the **Browse Files** button to open a browser that sees the Cloud directory.



Manage Files in the Cloud Account

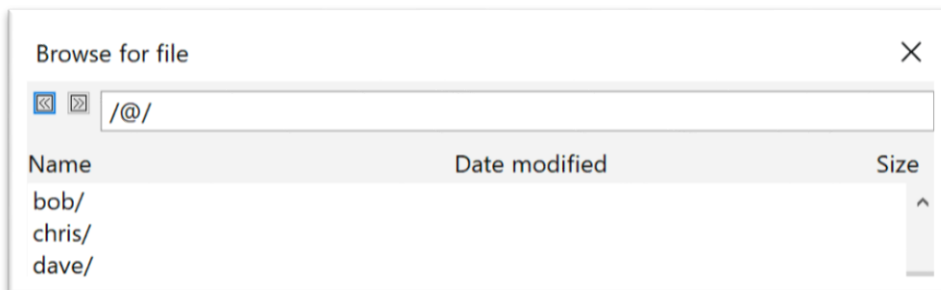
Navigate through directories to see individual files. Select one or more files and right-click for options.

- **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 one 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 5 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

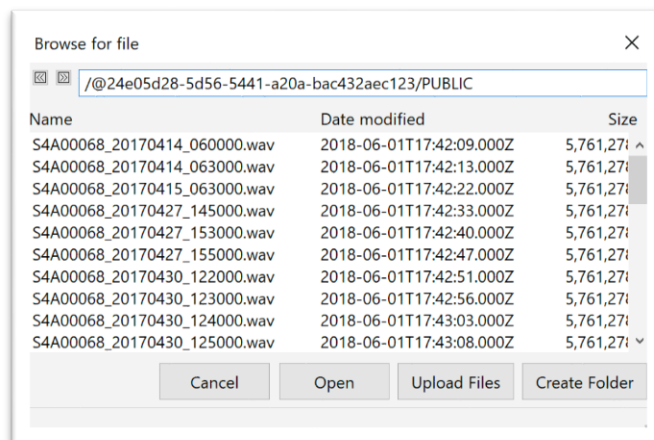
A Wildlife Acoustics Managed Cloud Account has a common name and a **UUID**. The UUID is the Cloud address for the account. The UUID for the Managed Cloud Account is visible in the users' WildlifeAcoustics.com web account.

MANAGED CLOUD ACCOUNTS	
NAME	UUID
Dave World	24e05d28-5d56-5441-a20a-bac432aec123

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.

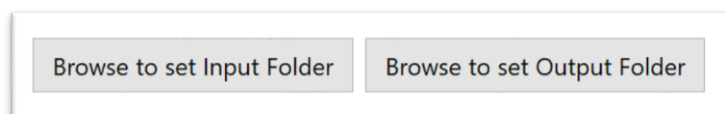
The UUID can be used in the Managed Cloud Account file browser to access files belonging to different organizations. This provides read-only access to the PUBLIC folder in the remote account.

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 5 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.

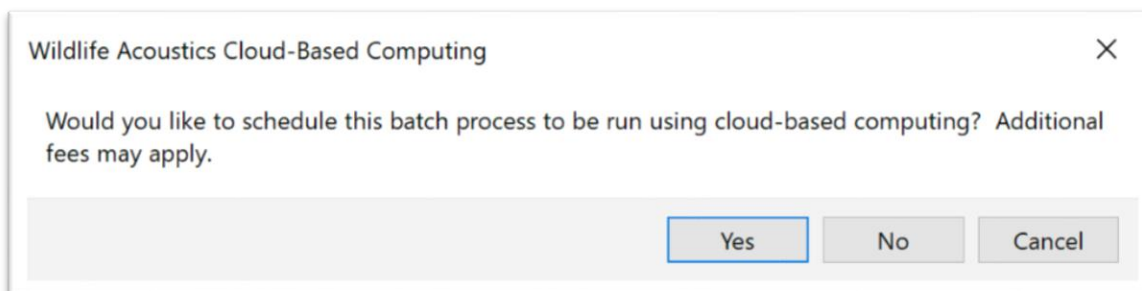
- Data can be uploaded from an on-line computer. Open the Cloud file browser and click Upload Files. Files can be selected and uploaded to the current Cloud directory. Depending on the amount of data to be uploaded and the on-line connection speed, this may take a significant amount of time.
- Data can 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 manual for instructions to send storage media to Amazon for uploading and downloading.

- Sending data to Amazon can take several weeks before that 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.

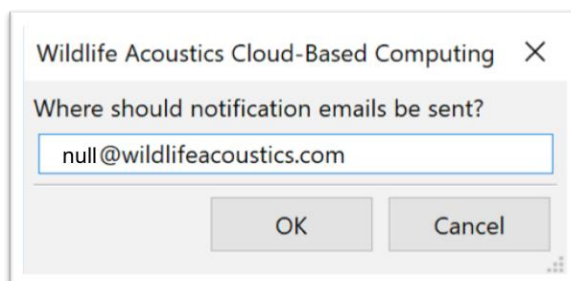
Cloud-Based Computing

A Wildlife Acoustics Managed Account provides access to Cloud-based computing. Kaleidoscope Pro 5 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 5 will display this message:



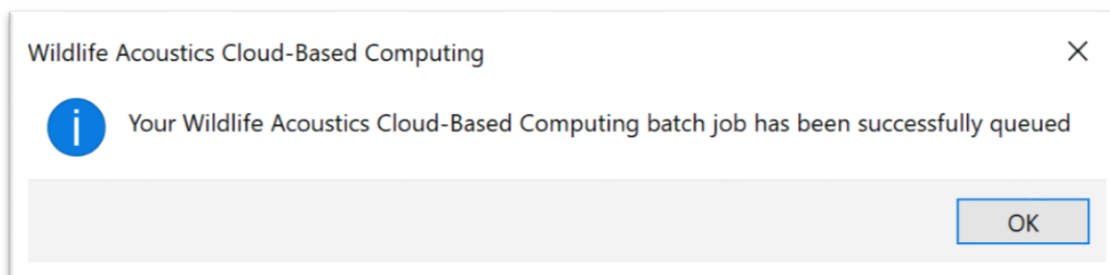
- Press **No** to run the batch process on the local computer. Depending internet connection speed and other variable such as output file conversion, this can take a significant amount of time.
- Press **Cancel** to stop a batch process which is currently running.
- Press **Yes** to run the batch process 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 5 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, noise.csv file and noisebyfile.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.

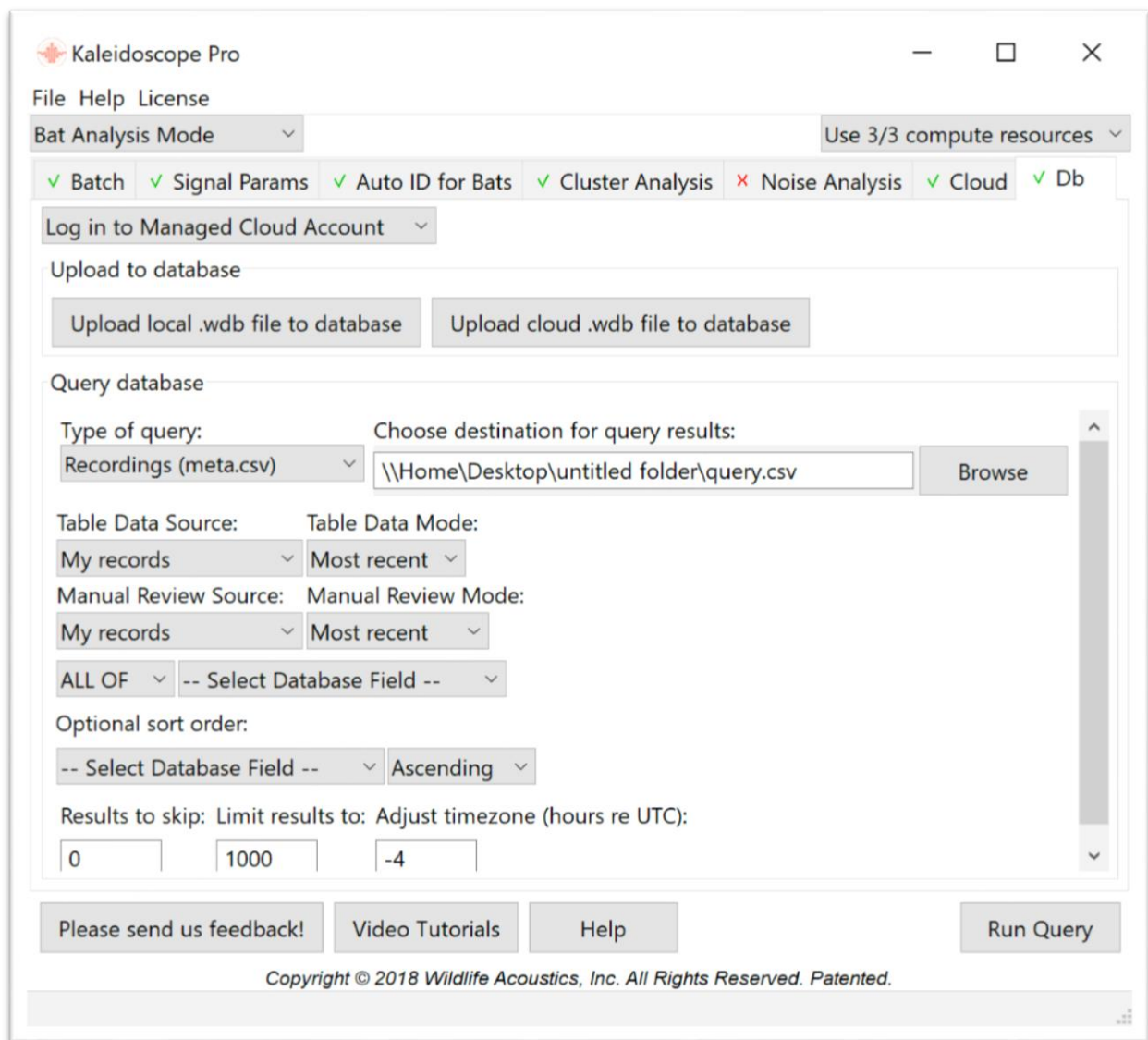
4.8 Db Tab

Requires Kaleidoscope Pro 5 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 5 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.

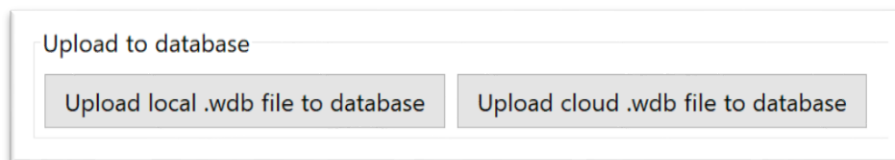
The database can be queried for specific information. The results of the database query will be displayed in a Results window and written to a query.csv file.

Create and Upload Records for the Database

Database information is created based on batch processes from Kaleidoscope Pro 5.

- When Kaleidoscope Pro 5 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.

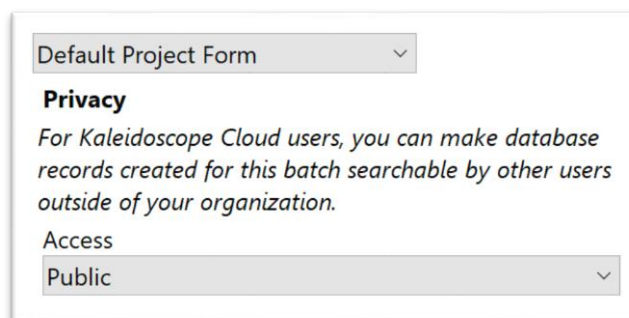
- If the batch process is run on a local computer the Results window and Viewer will open automatically at the end of an Auto ID for bats or Cluster Analysis batch process.
- For previously run batches, or batch processes run on-line, open the meta.csv, id.csv file or cluster.csv file via the File menu 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 5, 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

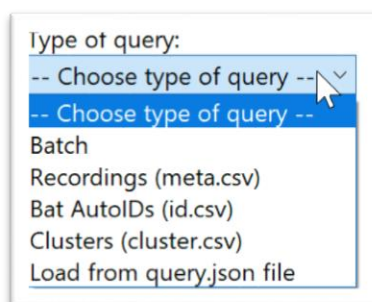
The purpose of uploading database information to the Cloud account is so information can be searched for specific results.

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.

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 ▼	

- **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 ▼	

- **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:

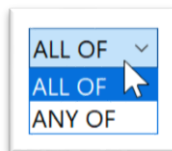
- **Most Recent**
This will include only the most recent manual ID results from the selected review source.
- **Most Frequent**
This will include the most frequently determined manual ID results from the selected review source.
- **List all**
This will include all manual ID results from the selected 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 5. 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 manual.

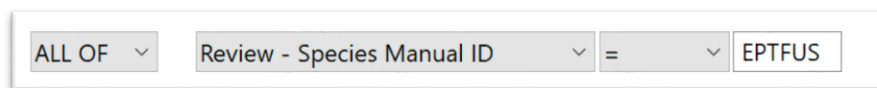
- **Query operator and text field**

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 manual 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 5 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 "KaleidoscopePro5".
- Create a role/user for the database with a password.
- In Kaleidoscope Pro 5:
 - 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=KaleidoscopePro5.
 - In order to create database tables, prepend this connect string with the word "CREATE" for example.
 - CREATEhost=hostname user=username sslmode=require dbname=KaleidoscopePro5.
 - 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.

4.9 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.

Viewer Overview

- Full-spectrum audio files can be viewed as a waveform and as a spectrogram.
- Zero-crossing files can be viewed as dots in a spectrogram.
- 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, speed, and amplitude adjustments can be applied to .wav and .w4v audio files. Files can be played back with these adjustments. Files can be saved with these adjustments applied.
- 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 5 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

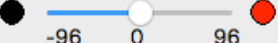
Additional Conversion Options section of the Reference Guide chapter in this manual. In Non-bat Analysis Mode, the dots are synthesized by tracing the peak signal of syllables through time as a visual aid to the underlying signal detection algorithms.

- 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.

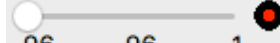
Additional Controls

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 5's zero-crossing conversion. If no zero-crossing signals meeting the filter criteria are met, the compressed view will appear to be empty.

- **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 5 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

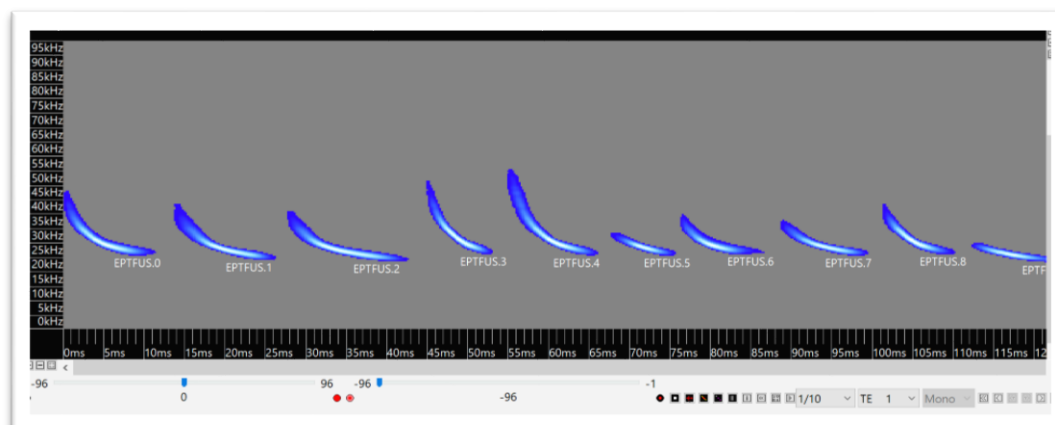
When the Viewer is open and is the front-most window the File menu offers the following choices:

- **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 speed adjustments are printed to the new WAV/w4v 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 5. On Mac the command to Quit Kaleidoscope 5 is found under the main Kaleidoscope 5 menu.

Reference Call Display

- If one or more classifiers are enabled under the Bat Auto ID tab, it is possible to toggle on and off a visualization of the training data reference calls used for comparing with the input files. Control-left-click (Windows) or Command-left-click (Mac) or choose the Viewer **File menu->Toggle Reference** to show or hide the reference call display. 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.
- When enabled, blueish shapes of calls are superimposed on top of the spectrogram using the current frequency and time scales. The reference calls can be scrolled left and right by holding the Control key (Windows) or the Command key (Mac) while moving the mouse left or right across the spectrogram, or by using the Left and Right Arrow keys on the computer keyboard. 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.
- It is also possible to open a blank window to look at just the reference calls via the Control Panel **File menu->Open Reference**.



4.10 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.

Prefix: S4U00014 Model: SM4BAT-FS S4U00014 1.0.8 Timestamp: 2016-04-17 20:01:58-04:00

Notes

Identification

EPTFUS Rename Noise

☒ Auto next file

EPTFUS	LASBOR	LASCIN	LASNOC	MYOLEI	MYOLUC	MYOSEP	MYOSOD
PERSUB	EPFU/LABO?						

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 the Control key down 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.

4.11 Results Window

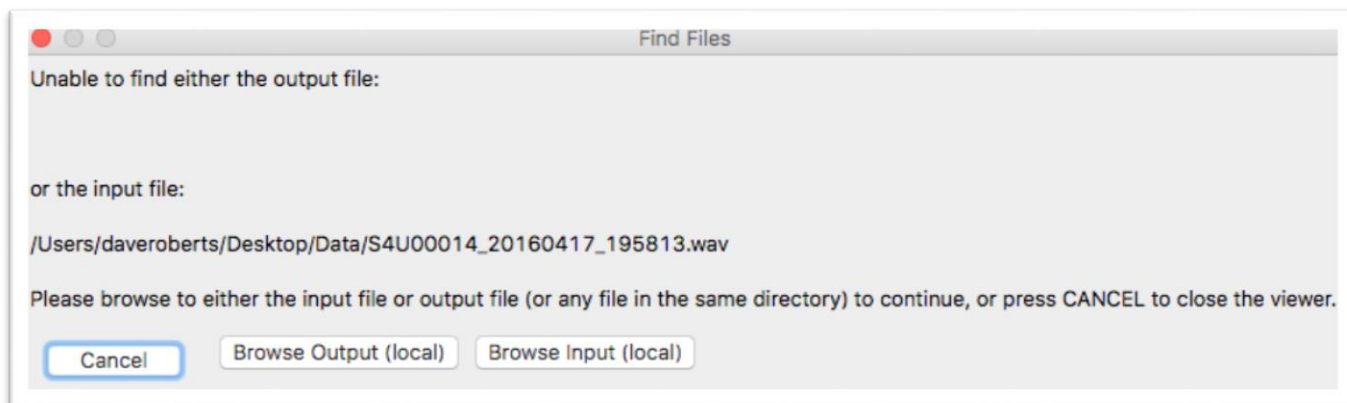
If an Auto ID for Bats or Cluster analysis batch process is run on the local computer, the Results window opens with the Viewer automatically when the batch process is complete.

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.

File Paths



When Kaleidoscope is used to run a batch process, .csv files are created that reference the location of the input files (and any output files that were created from the batch process). If the input or output files are then renamed or moved, Choosing Open Results from the Control Panel File menu will cause an error message to be displayed.



Use the Browse buttons to locate the input and output files in their new location. The file will now open and as long as the rest of the files from the batch are all in the new location, they will also be available within Kaleidoscope.

Kaleidoscope does not update the .csv file with the new file locations. In order for the .csv file to always find the input/output files in their new location, the .csv file must be manually edited to change the file path locations. Open the .csv file in a spreadsheet application. Edit the INDIR and/or OUTDIR columns for the first listed file to reflect the new location. Copy the location and paste it to the rest of the listed files. Save the .csv file. Now when the .csv file is opened from within Kaleidoscope it will find the input and outputs files with no error message.

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

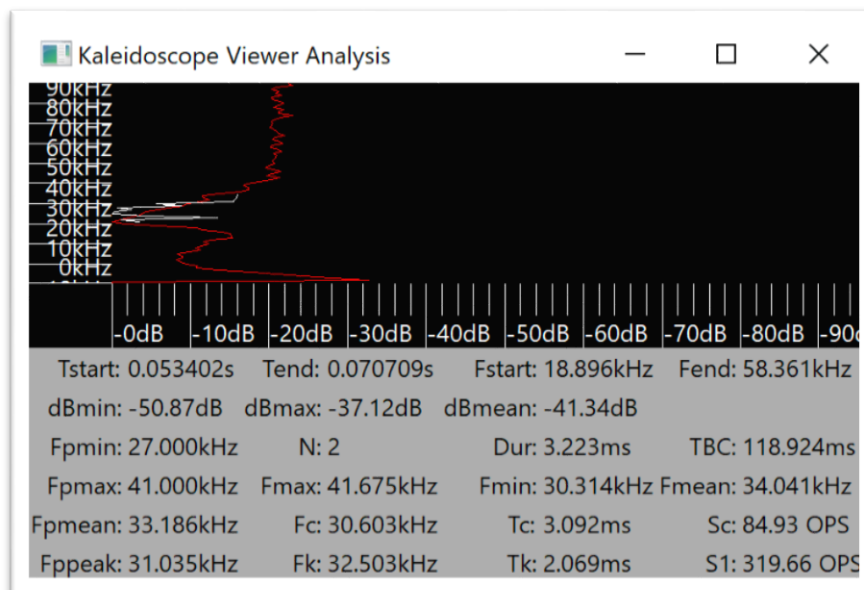
When the Results window is open and is the front-most window, the File menu offers the following choices:

- **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.
- **Copy selected files...** Selected files are copied to a new location.
- **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.

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 Batch Processing

Kaleidoscope 5 is designed to process, convert, and analyze large numbers of files in batches. An input directory is selected for the source files. An output directory is selected as the location for files to be created during the batch process. Desired parameters are configured under the various tabs in the Control Panel. Kaleidoscope 5 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, noise.csv file and noisebyfile.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 the Reference Guide of this manual.

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 5 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 manual.

- **noisebyfile.csv** Contains data found in the batch conversion regarding noise for individual files. This file is only created if Noise Analysis is enabled for the batch.
- **noise.csv** Contains data found in the batch conversion regarding noise on a per time segment basis. This file is only created if Noise 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 manual.

- **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 5 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.

5 Resources

5.1 .csv File Layout

During batch processing Kaleidoscope 5 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.
- **HOURL** 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).
- **HOURL-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 ORIGINID** 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 5 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 recording if available.
- **TIME** Time stamp of the recording if available.
- **HOURL** 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).
- **HOURL-12** Hour (from time) of the recording 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 ORIGINID** 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 5 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.
 - **HOUR-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 5 corresponding to the input file.
- **OUTFILEMD5FS** Unique identification used internally by Kaleidoscope Pro 5 corresponding to a full-spectrum output file.
- **OUTFILEMD5ZC** Unique identification used internally by Kaleidoscope Pro 5 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.

noisebyfile.csv

The noisebyfile.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

noise.csv

The noise.csv file provides noise analysis information based on per-hour time segments.

- **Prefix** Recorder prefix (from the filename). Kaleidoscope Pro 5 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 5 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 Noise 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 5 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 5 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 5, 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_YYYYMMDD_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_sssss_mmm. extension.

5.4 Metadata SCHEMA

This section provides specific metadata fields as defined in the Default MetaForm

Standardized GUANO fields

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

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	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	<p>Classifier settings used to run the auto-id with the following JSON objects:</p> <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" sensitivity - text - "liberal", "balanced" or "conservative" species - array of strings - list of species codes selected
WA Kaleidoscope Classifier Statistics	JSON-encoded Text	<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
WA Kaleidoscope Classifier Version	text	Name and version of the classifier
WA Kaleidoscope Cluster Settings	JSON-encoded text	Kaleidoscope cluster settings

WA Kaleidoscope Cluster Statistics	JSON-encoded text	Kaleidoscope cluster results
WA Kaleidoscope Compression	text	Describes compression algorithm used in writing WAV files if any (e.g. "W4V-8")
WA Kaleidoscope Conversion	text	Describes any conversion from input file to this file as one of: <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 Noise Settings	JSON-encoded text	Noise analysis module settings: <ul style="list-style-type: none"> • period - the reporting sample period in seconds • adjust - decibel adjustment • SEL on - event onset threshold, dB • SEL off - event offset threshold, dB
WA Kaleidoscope Noise Statistics	JSON-encoded text	Noise analysis results <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	Song Meter settings (converted from WAMD metadata) including the following JSON objects in a per-channel array:

		<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 5 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 *NOTEMD5	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.

Batch

Batch – Fingerprint	Batch – Timestamp	Batch – Classifier Version
Batch – Size (bytes)	Batch – Kaleidoscope Version	Batch – Classifier Settings
Batch – Recording Records	Batch – Input Directory	Batch – Cluster Settings
Batch – Auto ID Records	Batch – Output Directory	Batch – Noise Settings
Batch – Cluster Records	Batch – Input Drive Label	Batch - Note
Batch – Batch Label	Batch – Output Drive Label	

Recordings (meta.csv)

Review – Timestamp	Rec - Note	Rec – Longitude (deg)
Review – Species Manual ID	Rec – Humidity (%)	Rec – GPS Fuzz (deg)
Rec – Path	Rec – Length (s)	Rec – Original Filename
Rec – Drive Label	Rec – Loc Accuracy (deg)	Rec – Temperature Ext (C)
Rec – File	Rec – Loc Elevation (m)	Rec – Temperature Int (C)
Rec – Fingerprint	Rec – Latitude (deg)	Rec – Timestamp

Rec – Noise Statistics
 Rec – Copyright
 Rec – Attribution
 Rec – License Type
 Rec – Filter HP (kHz)
 Rec – Filter LP (kHz)
 Rec – Firmware Version
 Rec – Hardware Version
 Rec – Make
 Rec – Model
 Rec – Samplerate
 Rec – Serial
 Rec – TE
 Rec – Prefix
 Rec – Mic0
 Rec – Mic1
 Rec – Gain 0 (dB)
 Rec – HPF 0 (Hz)

Rec – Trig Level 0 (dB)
 Rec – Trig Window 0 (s)
 Rec – Trig Max Len 0 (s)
 Rec – Trig Min Freq 0 (Hz)
 Rec – Trig Max Freq 0 (Hz)
 Rec – Trig Min Dur 0 (s)
 Rec – Trig Max Dur 0 (s)
 Rec – Gain 1 (dB)
 Rec – HPF 1 (Hz)
 Rec – Trig Max Dur 1 (s)
 Rec – Trig Level 1 (dB)
 Rec – Trig Window 1 (s)
 Rec – Trig Max Len 1 (s)
 Rec – Trig Min Freq 1 (Hz)
 Rec – Trig Max Freq 1 (Hz)
 Rec – Trig Min Dur 1 (s)
 Rec – Compression
 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 – Noise Settings
 Batch – Not

Bat Auto IDs (id.csv)

Review – Timestamp
 Review – Species Manual ID
 Auto ID – Channel
 Auto ID – Offset (s)
 Auto ID – Duration (s)
 Auto ID – Timestamp
 Auto ID – Species Auto ID
 Auto ID - Pulses
 Auto ID - Matching
 Auto ID – Match Ratio
 Auto ID - Margin
 Auto ID – Alternate 1
 Auto ID – Alternate 2
 Auto ID – Fc (kHz)
 Auto ID – Sc (OPS)
 Auto ID – Dur (ms)
 Auto ID – Fmax (kHz)
 Auto ID – Fmin (kHz)
 Auto ID – Fmean (kHz)
 Auto ID – TBC (ms)
 Auto ID – Fk (kHz)
 Auto ID – Tk (ms)
 Auto ID – S1 (OPS)
 Auto ID – Tc (s)
 Auto ID – Qual (%)

In Rec – Path
 In Rec – Drive Label
 In Rec – File
 In Rec – Fingerprint
 In Rec – Note
 In Rec – Humidity (%)
 In Rec – Length (s)
 In Rec – Loc Accuracy (%)
 In Rec – Loc Elevation (m)
 In Rec – Latitude (deg)
 In Rec – Longitude (deg)
 In Rec – GPS Fuzz (deg)
 In Rec – Original Filename
 In Rec – Temperature Ext (C)
 In Rec – Temperature Int (C)
 In Rec – Timestamp
 In Rec – Noise Statistics
 In Rec – Copyright
 In Rec – Attribution
 In Rec – License Type
 In Rec – Filter HP (kHz)
 In Rec – Filter LP (kHz)
 In Rec – Firmware Version
 In Rec – Hardware Version
 In Rec – Make

In Rec – Model
 In Rec – Samplerate
 In Rec – Serial
 In Rec – TE
 In Rec – Prefix
 In Rec – Mic0
 In Rec – Mic1
 In Rec – Gain 0 (dB)
 In Rec – HPF 0 (Hz)
 In Rec – Trig Level 0 (dB)
 In Rec – Trig Window (s)
 In Rec – Trig Window 0 (s)
 In Rec – Trig Max Len 0 (s)
 In Rec – Trig Min Freq 0 (Hz)
 In Rec – Trig Max Freq 0 (Hz)
 In Rec – Trig Min Dur 0 (s)
 In Rec – Trig Max Dur 0 (s)
 In Rec – Gain 1 (dB)
 In Rec – HPF 1 (Hz)
 In Rec – Trig Max Dur 1 (s)
 In Rec – Trig Level 1 (dB)
 In Rec – Trig Window 1 (s)
 In Rec – Trig Max Len 1 (s)
 In Rec – Trig Min Freq 1 (Hz)
 In Rec – Trig Max Freq 1 (Hz)

In Rec – Trig Min Dur 1 (s)	Out ZC Rec – Drive Label	Batch – Cluster Records
In Rec - Compression	Out ZC Rec – File	Batch – Batch Label
Out FS Rec – Path	Out ZC Rec – Fingerprint	Batch – Timestamp
Out FS Rec – Drive Label	Out ZC Rec – Note	Batch – Kaleidoscope Version
Out FS Rec – File	Out ZC Rec – Humidity (%)	Batch – Input Directory
Out FS Rec – Fingerprint	Out ZC Rec – Length (s)	Batch – Output Directory
Out FS Rec – Note	Out ZC Rec – Loc Accuracy (deg)	Batch – Input Drive Label
Out FS Rec – Humidity (%)	Out ZC Rec – Loc Elevation (deg)	Batch – Output Drive Label
Out FS Rec – Length (s)	Out ZC Rec – GPS Fuzz (deg)	Batch – Classifier Version
Out FS Rec – Loc Accuracy (deg)	Out ZC Rec – Original Filename	Batch – Classifier Settings
Out FS Rec – Loc Elevation (deg)	Out ZC Rec – Temperature Ext (C)	Batch – Cluster Settings
Out FS Rec – GPS Fuzz (deg)	Out ZC Rec – Temperature Int (C)	Batch – Noise Settings
Out FS Rec – Original Filename	Out ZC Rec – Timestamp	Batch – Noise
Out FS Rec – Temperature Ext (C)	Out ZC Rec – Noise Statistics	
Out FS Rec – Temperature Int (C)	Batch – Fingerprint	
Out FS Rec – Timestamp	Batch – Size (bytes)	
Out FS Rec – Noise Statistics	Batch – Recording Records	
Out ZC Rec – Path	Batch – Auto ID Records	

Clusters (cluster.csv)

Review - Timestamp	Rec – Longitude (deg)	Rec – Trig Window 0 (s)
Review – Species Manual ID	Rec – GPS Fuzz (deg)	Rec – Trig Max Len 0 (s)
Cluster – Channel	Rec – Original Filename	Rec – Trig Min Freq 0 (Hz)
Cluster – Offset (s)	Rec – Temperature Ext (C)	Rec – Trig Min Dur 0 (s)
Cluster – Duration (s)	Rec – Temperature Int (C)	Rec – Trig Max Dur 0 (s)
Cluster – Fmin (Hz)	Rec – Timestamp	Rec – Gain 1 (dB)
Cluster – Fmean (Hz)	Rec – Noise Statistics	Rec – HPF 1 (Hz)
Cluster – Fmax (Hz)	Rec – Copyright	Rec – Trig Level 1 (dB)
Cluster - Timestamp	Rec – Attribution	Rec – Trig Window 1 (s)
Cluster – Top 1 Match	Rec – License Type	Rec – Trig Max Len 1 (s)
Cluster – Top 1 Distance	Rec – Filter HP (kHz)	Rec – Trig Min Freq 1 (Hz)
Cluster – Top 2 Match	Rec – Filter LP (kHz)	Rec – Trig Max Freq 1 (Hz)
Cluster – Top 2 Distance	Rec – Firmware Version	Rec – Trig Min Dur 1 (s)
Cluster – Top 3 Match	Rec – Hardware Version	Rec – Trig Max Dur 1 (s)
Cluster – Top 3 Distance	Rec – Make	Rec – Compression
Rec – Path	Rec – Model	Batch – Fingerprint
Rec – Drive Label	Rec – Samplerate	Batch – Size (bytes)
Rec – File	Rec – Serial	Batch – Recording Records
Rec – Fingerprint	Rec – TE	Batch – Auto ID Records
Rec - Note	Rec – Prefix	Batch – Cluster Records
Rec – Humidity (%)	Rec – Mic0	Batch – Batch Label
Rec – Length (s)	Rec – Mic1	Batch – Timestamp
Rec – Loc Accuracy (deg)	Rec – Gain 0 (dB)	Batch – Kaleidoscope Version
Rec – Loc Elevation (m)	Rec – HPF 0 (Hz)	Batch – Input Directory
Rec – Latitude (deg)	Rec – Trig Level 0 (dB)	Batch – Output Directory

Batch – Input Drive Label	Batch – Classifier Settings	Batch – Note
Batch – Output Drive Label	Batch – Cluster Settings	
Batch – Classifier Version	Batch – Noise Settings	

5.5 Explaining Maximum Likelihood Estimators (MLE) and P-values used in Kaleidoscope Pro 5 Classifiers

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

<http://www.fws.gov/midwest/endangered/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 5 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 5, 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.wildlifeacoustics.com/support/technical-faq/145-kaleidoscope-analysis-software/1117-metaforms 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.

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
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
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
	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)
	durmin_1	No	0.1	Non-bat mode minimum detection duration (s)
	durmax_1	No	7.5	Non-bat mode maximum detection duration (s)
	maxgap_1	No	0.35	Non-bat mode maximum gap (s)
noise	enabled	No	0	Noise 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 noise band labels as they appear in the graphical interface with spaces changed to underscores and slashes changed to hyphens. 0 = disabled 1 = enabled
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)

	windowmode	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
	maxclusters	No	500	Maximum number of clusters to generate
	maxdist	No	0.5	Maximum distance to cluster center when forming clusters
	maxdistscan	No	1.0	Maximum distance to cluster center for cluster.csv output results
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

5.8 Kaleidoscope Pro 5 License Management

The basic version of Kaleidoscope 5 is available at no charge. Kaleidoscope 5 can be upgraded to Kaleidoscope Pro 5 by purchasing and activating an annual subscription license or permanent license. Kaleidoscope Pro 5 provides additional features, including cluster analysis, auto ID for bats, noise 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. A single subscription can only be implemented by one user at a time. Multiple users can not access the same subscription license at the same time. The administrator does not have to use Kaleidoscope Pro themselves – they could simply be a lab manager or IT technician, for example.

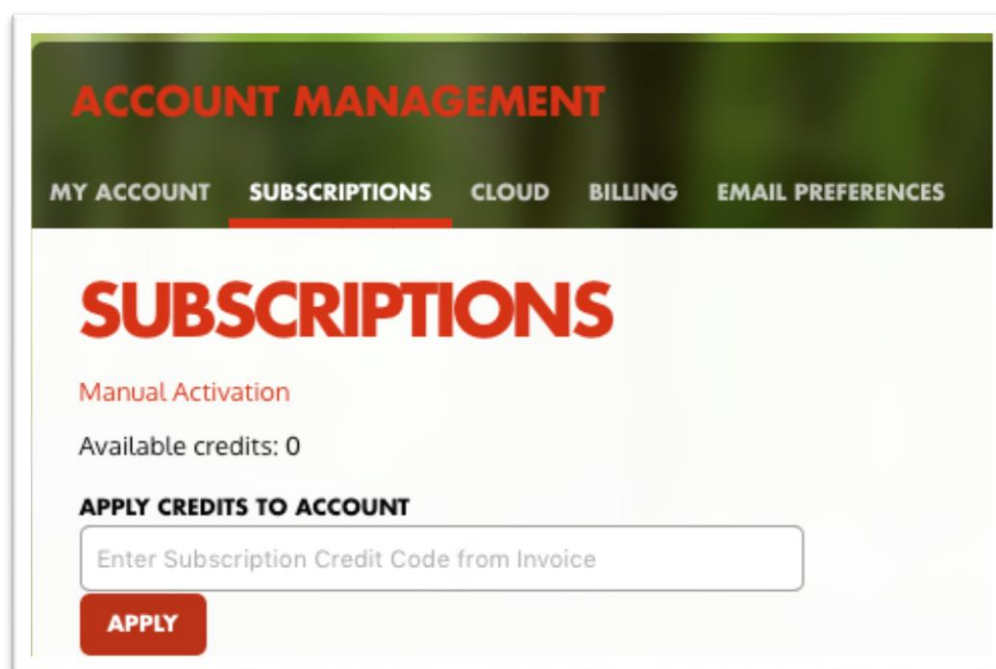
Throughout this section, "Administrator" will refer to the person who holds credits for Kaleidoscope Pro subscriptions on their account. "Guest" will refer to someone who has been given access to use the Administrator's subscriptions. This section assumes that you, the reader, are the Administrator.

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.



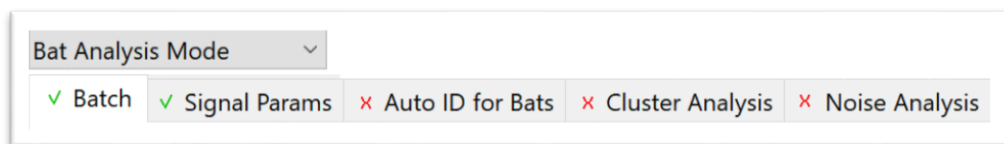
Each credit represents one year's worth of Kaleidoscope Pro use for a single user. A single user is entitled to activate a single license on two separate computers.

The subscription year does not start until the license is activated in the Kaleidoscope program itself.

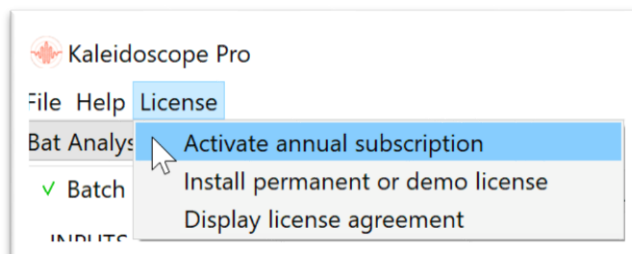
Activate a Subscription License

- 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 spectrogram viewer and file converter, because the program has not been activated with a subscription license. Auto ID for Bats, Cluster Analysis, and Noise Analysis will each be marked 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 and Noise Analysis tabs will be marked with a green check.

Non-bat Analysis Mode ▾

✓ Batch
 ✓ Signal Params
 ✗ Auto ID for Bats
 ✓ Cluster Analysis
 ✓ Noise Analysis

In Bat Analysis mode, the Bat Auto-ID and Cluster Analysis tabs will be marked with a green check.

Bat Analysis Mode ▾

✓ Batch
 ✓ Signal Params
 ✓ Auto ID for Bats
 ✓ Cluster Analysis
 ✗ Noise Analysis

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

ADD A GUEST TO SHARE YOUR SUBSCRIPTION CREDITS

Email address

ADD GUEST

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**.

wakaleidoscopeguest@gmail.com	unregistered	✓	DELETE
-------------------------------	--------------	---	---------------

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**.

Subscriber	Status	Start	Expires	Auto renew	
wakaleidoscopeguest@gmail.com	unsubscribed			✓	Hosted by wakaleidoscope@gmail.com

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.

Subscriber	Status	Start	Expires	Auto renew	
wakaleidoscope@gmail.com	subscribed(1)	24-Jan-2018	25-Jan-2019	<input checked="" type="checkbox"/>	RELEASE

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.

Subscriber	Status	Start	Expires	Auto renew	
wakaleidoscope@gmail.com	subscribed(1)	24-Jan-2018	25-Jan-2019	<input checked="" type="checkbox"/>	RELEASE

- Under Transfer from released subscription email address, enter the original user's email address.

TRANSFER FROM RELEASED SUBSCRIPTION EMAIL ADDRESS

- 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

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.

Subscriber	Status	Start	Expires	Auto renew
wakaleidoscope@gmail.com	unsubscribed			<input checked="" type="checkbox"/>
wakaleidoscopeguest@gmail.com	released	24-Jan-2018	25-Jan-2019	<input checked="" type="checkbox"/>

5.9 Wildlife Acoustics Managed Cloud Account

Kaleidoscope Pro 5 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 5.

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

The Managed Cloud Account will not be available within Kaleidoscope Pro 5 unless there is payment information on file.

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.

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 BILLING

Payment information:

MasterCard XXXX4808

By providing a payment method, you are authorizing Wildlife Acoustics to charge your payment profile monthly for services used in excess of any "Cloud Credits". See Pricing and Billing for details. If you would like to delete a Managed Cloud Account to discontinue service, please contact support2018@wildlifeacoustics.com. You will still be responsible for charges accrued in the current month. Required

UPDATE

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 5. 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 5.

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

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.

COMPUTE JOBS						
JOB ID	BATCH LABEL	CREATED	STARTED	FINISHED	PROGRESS MESSAGE	% CANCELED
140		2019-01-02 09:00:46 by dave@wildlifeacoustics.com	2019-01-02 09:01:44	2019-01-02 09:01:49 (00:00:04)		

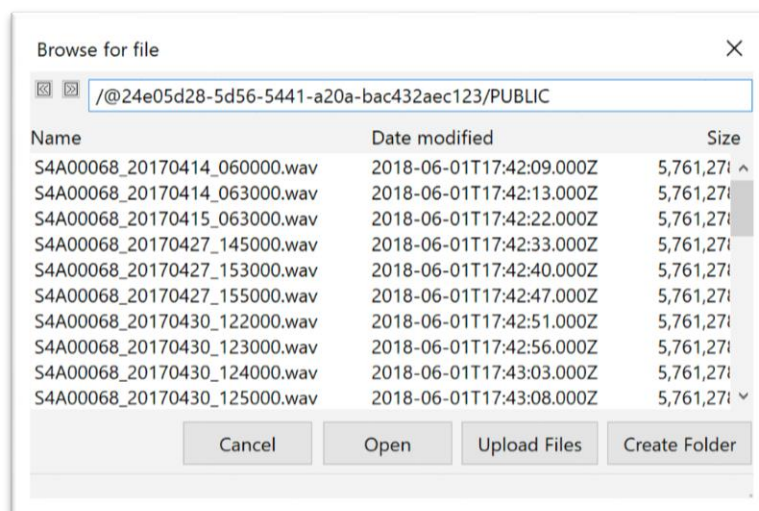
UUID

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.

CLOUD MANAGEMENT MANAGED CLOUD ACCOUNTS		
NAME	UUID	PAYMENT INFORMATION
Dave World	24e05d28-5d56-5441-a20a-bac432aec123	Ok

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 5 for a **Specific Organization**. This allows a Kaleidoscope Pro 5 user to include other organizations in database queries.

✓ Batch

✓ Signal Params

✗ Auto ID for Bats

✓ Cluster Analysis

✓ Noise Analysis

✓ 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:

Batch

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

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

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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

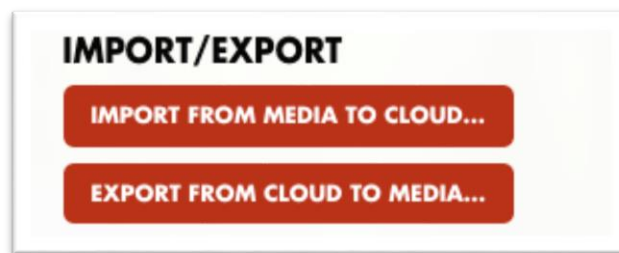
Public

Import/Export

A user with administrator permissions may send storage media to Amazon Web Services. Amazon will then upload the data to the Managed Cloud Account. This can be an efficient method for large amounts of data that would otherwise take an impractical amount of time for the user to upload themselves. Once the data is uploaded, Amazon will erase the storage media and send that media back to the user.

You may want to keep additional backup copies of the data in the event that it is lost or damaged during transit. Additionally, Wildlife Acoustics reserves the right to delete Managed Cloud Account data in the event of a breach of our terms and conditions.

To set up the transaction to send storage media with data to Amazon, click **Import From Media To Cloud...**



The user also has the option to send blank storage media to Amazon. Amazon will download user-specified data from the Managed Cloud Account to the storage media. Amazon will then send the storage media with copied data back to the user. To set up the transaction to send blank storage media to Amazon, click **Export From Cloud To Media...**

5.10 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 5 can convert and analyze multiple files with a single operation. This is known as a batch process. Kaleidoscope 5 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 5 creates different types of .csv documents to represent the results from batch processes. The intention is that results from Kaleidoscope 5 batch processes are to be initially viewed in a spreadsheet.
- **Database**
When Kaleidoscope Pro 5 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 5 can create queries to search the database. Kaleidoscope Pro 5 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 5 can pass the GPS information through to output. Kaleidoscope 5 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 5 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 5 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 5 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 5 can store and recall database query specifications via a JSON formatted file. When a database query is run from within Kaleidoscope Pro 5, 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 5 can create a gps.kml output file based on GPS metadata extracted from full-spectrum and zero-crossing files.

- Managed Cloud Account

Kaleidoscope Pro 5 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

There are two types of data that are referred to as noise within Kaleidoscope Pro 5. 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 5 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 5 can store and recall database query specifications via a JSON formatted file. When a database query is run from within Kaleidoscope Pro 5, 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.

- 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 5.

- 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 5.

- 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.

TERMS OF USE

Updated: June 6, 2018

This Terms of Use is a legal agreement ("Agreement") between you and, if applicable, your company ("You" or "your"), and Wildlife Acoustics, Inc., a Massachusetts corporation ("WAI", "we", "us", or "our"), governing your use of the software (the "Software") or services ("Services") provided by WAI, and if applicable, your use of any application with WAI products ("WAI Products"). This Agreement takes effect when you click an I Accept button or check box presented with these terms or, if earlier, when you use any Software or Service (the "Effective Date"). You represent to us that you are lawfully able to enter into contracts (e.g., you are not a minor). If you are entering into this Agreement for an entity, such as the company you work for, you represent to us that you have legal authority to bind that entity.

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You will ensure that all of users who access your content on the Services or otherwise use the Services under your account ("End Users") comply with your obligations under this Agreement. If you become aware of any violation of your obligations under this Agreement caused by an End User, you will immediately suspend access by such End User to WAI's Services, and any related Third Party Services.

This Agreement may be amended from time to time by WAI with notification to you, including updates to the Software or posting on WAI's website (available at <https://wildlifeacoustics.com/legal/>), and you agree that you are given the opportunity to review any amendments to this Agreement by notification via updating the Software or posting on WAI's website. You agree to be bound to any amendment to this Agreement if you continue to use the Software or Services after any such notification described above.

Unless this Agreement or applicable law specifies otherwise, changes will be effective immediately upon notice. If you find any changes unacceptable, you have the right to cancel your Service(s) and discontinue use of the Software. However, if you continue to receive Service(s) or use the Software after the end of the notice period (the Effective Date) of the change, you will be considered to have accepted the changes.

Our Services are very diverse and additional terms may apply. Additional terms will be available with the relevant Services, and those additional terms become part of your agreement with us if you use those Services.

1. CHARGES AND BILLING

You agree to pay all charges associated with the Services, including, but not limited to, monthly service charges, applicable federal, state, and local taxes and fees (however designated), and any fees or payment obligations imposed by governmental or quasi-governmental bodies for the sale, installation, use, or provision of the Services. We will give you at least thirty (30) days prior notice of any significant change to pricing or fees for the Services, unless such change is related to governmental or quasi-governmental taxes, fees, or assessments, in which case we may elect not to provide notice except where required by applicable law.

WAI price information is available by logging into your account at <http://www.wildlifeacoustics.com/> (or an alternative site if we notify you). If you have agreed to a minimum term arrangement, your price for Service(s) is as specified in the minimum term arrangement. All fees payable by you are exclusive of taxes and duties, including, without limitation, VAT, Service Tax, GST, excise taxes, sales and transactions taxes, and gross receipts tax ("Taxes"). We may charge and you will pay applicable Taxes that we are legally obligated or authorized to collect from you.

Unless you are subject to a prepaid subscription or minimum term arrangement, Services are provided to you on a month-to-month basis. You will generally be billed monthly for recurring service charges and fees. Your first bill may include pro-rated charges from the date you first begin receiving Services, as well as monthly recurring charges for the next month and charges for non-recurring services you have received.

PAYMENT AUTHORIZATION. BY PROVIDING A VALID CREDIT, DEBIT CARD, ACCOUNT FUNDS OR OTHER METHOD OF PAYMENT AS WE MAY ALLOW OR REQUIRE FROM TIME TO TIME ("PAYMENT METHOD"), YOU ARE EXPRESSLY AUTHORIZING ALL SERVICE CHARGES AND ORDERS TO THE PURCHASED PRODUCTS ("PURCHASED PRODUCTS") TO BE CHARGED TO SUCH PAYMENT METHOD.

IF THE PAYMENT CARD ASSOCIATED WITH USER'S ACCOUNT IS DECLINED OR FAILS FOR ANY REASON, WAI WILL SEND USER A NOTICE USING THE CONTACT INFORMATION ASSOCIATED WITH USER'S ACCOUNT. IF YOU HAVE PURCHASED OR OBTAINED SERVICES FOR A PERIOD OF MONTHS OR YEARS, CHANGES IN PRICES AND FEES SHALL BE EFFECTIVE WHEN THE SERVICES IN QUESTION COME UP FOR RENEWAL. YOU MAY VIEW WAI PRODUCT AND SERVICE PRICING OR REVIEW OR CHANGE YOUR AUTOMATIC RENEWAL SETTINGS AT ANY TIME BY LOGGING INTO THE USER'S ACCOUNT.

You may be billed fees, charges, and assessments related to late or non-payments if for any reason (a) WAI does not receive payment for the Services by the payment due date or (b) you pay less than the full amount due for the Services. Overdue amounts shall be subject to interest at the rate of 1.5% per month, or if less, the highest amount allowed by law plus reasonable costs of collection. All amounts payable by you under this Agreement will be paid to us without setoff or counterclaim, and without any deduction or withholding. If you fail to pay the full amount due for any or all of the Services then WAI, at its sole discretion in accordance with and subject to applicable law, may suspend or disconnect any or all the Services you receive and delete all accounts and data. WAI may, but has no obligation to, provide 30 days notice prior to deleting your data. Once data is deleted, it may not be recoverable. If you resume a Service after any suspension, we may require you to pay a reinstatement fee. If you reactivate any or all Services after disconnection, we may require you to pay a service activation fee. These fees are in addition to all past due charges and other fees. Continuation of the Services is subject to our credit policies, this Agreement and applicable law.

IN ADDITION, WAI MAY PARTICIPATE IN "RECURRING BILLING PROGRAMS" OR "ACCOUNT UPDATER SERVICES" SUPPORTED BY YOUR CREDIT CARD PROVIDER (AND ULTIMATELY DEPENDENT ON YOUR BANK'S PARTICIPATION). IF WE ARE UNABLE TO SUCCESSFULLY CHARGE YOUR EXISTING PAYMENT METHOD, YOUR CREDIT CARD PROVIDER (OR YOUR BANK) MAY NOTIFY US OF UPDATES TO YOUR CREDIT CARD NUMBER AND/OR EXPIRATION DATE, OR THEY MAY AUTOMATICALLY CHARGE YOUR NEW CREDIT CARD ON OUR BEHALF WITHOUT NOTIFICATION TO US. IN ACCORDANCE WITH RECURRING BILLING PROGRAM REQUIREMENTS, IN THE EVENT THAT WE ARE NOTIFIED OF AN UPDATE TO YOUR CREDIT CARD NUMBER AND/OR EXPIRATION DATE, WAI WILL AUTOMATICALLY UPDATE YOUR PAYMENT PROFILE ON YOUR BEHALF. WAI MAKES NO GUARANTEES THAT WE WILL REQUEST OR RECEIVE UPDATED CREDIT CARD INFORMATION. YOU ACKNOWLEDGE AND AGREE THAT IT IS YOUR SOLE RESPONSIBILITY TO MODIFY AND MAINTAIN YOUR ACCOUNT SETTINGS, INCLUDING BUT NOT LIMITED TO (I) CANCELLING PRODUCTS AND (II) ENSURING YOUR ASSOCIATED PAYMENT METHOD(S) ARE CURRENT AND VALID. FURTHER, YOU ACKNOWLEDGE AND AGREE THAT YOUR FAILURE TO DO SO, MAY RESULT IN THE INTERRUPTION OR LOSS OF SERVICES, AND WAI SHALL NOT BE LIABLE TO YOU OR ANY THIRD PARTY REGARDING THE SAME.

Expiration and Renewal of Services. It is your responsibility to keep your own records and to maintain your own reminders regarding when your Services are set to expire and to maintain current and accurate credit card information should any Services be placed on "auto-renew." As a convenience to you, and not as a binding commitment, we may notify you via an email message or via your Account when renewal fees are due. Should these fees go unpaid, your Services will expire or be cancelled. Payment must be made by credit card, debit card, account funds, or such other method as we may allow or require from time to time. If you select automatic renewal of the Services, we may attempt to renew the Services a reasonable time before expiration, provided your billing information is available and up to date. It is your responsibility to keep your billing information up to date and we are not required to, but may, contact you to update this information in the event that an attempted transaction is not processed successfully.

2. CHANGES TO SERVICES OR SOFTWARE

Subject to applicable law, we have the right to change our Services or Software at any time with or without notice. We also may rearrange, delete, add to, or otherwise change features or offerings contained in the Services or Software, including, but not limited to, functionality, hours of availability, file storage, data bases, import or export of files or data, and the upload or download of files. If we do give you notice, it may be provided on your monthly bill or other communication permitted under applicable law. If you find a change in the Services or Software unacceptable, you have the right to cancel your Service(s) and discontinue use of the Software. However, if you continue to receive Service(s) or use the Software after the change, this will constitute your acceptance of the change.

3. GRANT OF LICENSE AND PERMITTED USE

Subject to the terms and conditions of this Agreement and any other agreement between You and WAI that define the terms of the of the Software, which terms and conditions are incorporated herein by reference, WAI grants to You a limited, non-exclusive, non-transferable, non-sublicensable, revocable license, for use of the Software, to install, operate, and use the Software for the term of this Agreement or to distribute to an user ("User") that agrees to be bound by the terms of this Agreement as an integral part of, and solely in conjunction with, a product or software program distributed by WAI.

The order confirmation that was delivered with the Software or Services (of if none, the final sales quote) specifies the scope and duration of the license rights of the Software or Services that are permitted to You. Use of the Software or Services beyond the scope of the rights granted to You requires additional or modified license grants, and additional payment of applicable license and maintenance fees.

If you receive a copy of the Software or access to the Services, but have not purchased a license to use the Software or Services, You shall only have a limited non- transferable, non-exclusive license to install and use the Software or Services for your own internal use solely for purposes of evaluation for no more than fifteen (15) days (unless extended by WAI or an authorized vendor in writing). When the Software is used on an evaluation basis, it may not have the full functionality described in its accompanying documentation.

You acknowledge that the Software is protected by copyrights and other intellectual property and proprietary rights. WAI and its third-party licensors ("Licensors") reserve all such rights with respect to the Software, except for the license expressly granted to you in this Section 3. Except for such express license, no right, title, interest or license in or to the Software, whether by implication, estoppel or otherwise, is granted, assigned or transferred to you. You agree not to take any action that interferes, in any manner, with WAI or its Licensors' rights with respect to the Software.

You will be responsible for and deemed to have taken any action that you permit, assist or facilitate any person or entity to take related to this Agreement, the Software or the Services. You further agree that you are responsible for all activities that occur under your account, regardless of whether the activities are authorized by you or undertaken by you, your employees or a third party (including your contractors, agents or End Users), and (b) we and our affiliates are not responsible for unauthorized access to your account.

You may not use, or encourage, promote, facilitate or instruct others to use, the Services or any Third Party Services for any illegal, harmful, fraudulent, infringing or offensive use, or to transmit, store, display, distribute or otherwise make available content that is illegal, harmful, fraudulent, infringing or offensive..

You agree to use the Services (including the Web Site) only for purposes that are permitted by this Agreement and any applicable law, regulation or generally accepted practices or guidelines in the relevant jurisdictions (including any laws regarding the export of data or software to and from the United States or other relevant countries). You agree that you will not engage in any activity that interferes with or disrupts the Web Site (or the servers and networks which are connected to the Web Site).

You may not use the Services to violate the security or integrity of any network, computer or communications system, software application, or network or computing device (each, a "System"). Prohibited activities include:

- Accessing or using any System without permission, including attempting to probe, scan, or test the vulnerability of a System or to breach any security or authentication measures used by a System.
- Monitoring of data or traffic on a System without permission.
- Forging TCP-IP packet headers, e-mail headers, or any part of a message describing its origin or route. The legitimate use of aliases and anonymous remailers is not prohibited by this provision.

You may not make network connections to any users, hosts, or networks unless you have permission to communicate with them. Prohibited activities include:

- Monitoring or crawling of a System that impairs or disrupts the System being monitored or crawled.
- Inundating a target with communications requests so the target either cannot respond to legitimate traffic or responds so slowly that it becomes ineffective.
- Interfering with the proper functioning of any System, including any deliberate attempt to overload a system by mail bombing, news bombing, broadcast attacks, or flooding techniques.

- Operating network services like open proxies, open mail relays, or open recursive domain name servers.
- Using manual or electronic means to avoid any use limitations placed on a System, such as access and storage restrictions.

You will not distribute, publish, send, or facilitate the sending of unsolicited mass e-mail or other messages, promotions, advertising, or solicitations (like spam), including commercial advertising and informational announcements. You will not alter or obscure mail headers or assume a sender's identity without the sender's explicit permission. You will not collect replies to messages sent from another internet service provider if those messages violate this Agreement or the acceptable use policy of that provider.

We reserve the right, but do not assume the obligation, to investigate any violation of this Agreement or misuse of the Services or Web Site. We may:

- investigate violations of this Agreement or misuse of the Services or AWS Site; or
- remove, disable access to, or modify any content or resource that violates this Agreement or any other agreement we have with you for use of the Services or the AWS Site.

We may report any activity that we suspect violates any law or regulation to appropriate law enforcement officials, regulators, or other appropriate third parties. Our reporting may include disclosing appropriate customer information. We also may cooperate with appropriate law enforcement agencies, regulators, or other appropriate third parties to help with the investigation and prosecution of illegal conduct by providing network and systems information related to alleged violations of this Agreement.

4. CONTENT RIGHTS AND RESPONSIBILITIES

You understand that all information (such as data files, written text, computer software, music, audio files or other sounds, photographs, videos or other images) which you may have access to as part of, or through your use of, the Software or Services are the sole responsibility of the person from which such content originated. All such information is referred to below as the "Content".

You should be aware that Content presented to you as part of the Software or Services may be protected by intellectual property rights which are owned by the persons who provide that Content to WAI. You may not modify, rent, lease, loan, sell, distribute or create derivative works based on this Content (either in whole or in part) unless you have been specifically told that you may do so by WAI or by the owners of that Content, in a separate agreement.

If a Creative Commons or other license has been declared for any Content accessed through the Software or Services, you may use the content according to the terms and conditions of the applicable license. In using the Software or Services, you further agree (a) not to violate anyone's rights of privacy, (b) not to act in any way that might give rise to civil or criminal liability, (c) not to use or attempt to use another person's password, (d) not to collect or store personal data about anyone, (e) not to infringe any copyright, trademark, patent, or other proprietary rights of any person, (f) not to transmit or facilitate the transmission of unsolicited email ("spam"), (g) not to harass, threaten, or otherwise annoy anyone, and (h) not to act in any way that might be harmful to minors, including, without limitation, transmitting or facilitating the transmission of child pornography, which is prohibited by federal law and may be reported to the authorities should it be discovered by WAI.

You agree that you are solely responsible for (and that WAI has no responsibility to you or to any third party for) any Content that you create, transmit or display while using the Software or Services and for the consequences of your actions (including any loss or damage which you may suffer) by doing so.

WAI does not pre-screen the Content posted by users. WAI reserves the right (but shall have no obligation) to pre-screen, review, flag, filter, modify, refuse or remove any or all Content, without notice. However, WAI is under no affirmative obligation to monitor, review or remove any Content, is under no affirmative obligation to take any action in response to any Content (except as set forth in

Section 7), and assumes no responsibility or liability arising from the content of any such Content, nor for any error, defamation, libel, slander, omission, falsehood, obscenity, pornography, profanity, danger, threat or inaccuracy contained in any Content that could constitute or encourage conduct that would be considered a criminal offense, give rise to civil liability, or otherwise violate any law.

WAI will fully cooperate with any law enforcement authorities or court order requesting or directing WAI to disclose the identity of anyone posting any such information or materials. WAI reserves the right to deny in its sole discretion any user access to the Software or Services or any portion thereof without notice.

You confirm and warrant to WAI that you own or have all the rights, powers, licenses, consents, permissions and authority necessary to publish the Content you submit to the Web Site or Services and to grant the licenses in this Section 4 with respect to that Content. You further agree that Content you submit to the Software or Services will not contain third party copyrighted material, or material that is subject to other third party proprietary rights, unless you have permission from the rightful owner of the material or you are otherwise legally entitled to post the material and to grant WAI all of the license rights granted herein.

You retain copyright and any other rights you already hold in Content which you submit, post or display on or through, the Software or Services. Content may include proprietary content that is hosted by us or third party servers but intended only for your own internal use ("Proprietary Content"), shared content that you designate may be shared with users invited by you ("Shared Content"), and public content that is accessible to anyone by placing documents in a PUBLIC folder or posting it to a public webpage, such as comments to a blog or user posts on a discussion forum ("Public Content").

Public Content. By submitting, posting or displaying the Public Content you give WAI a perpetual, irrevocable, worldwide, royalty-free, and non-exclusive license to reproduce, adapt, modify, translate, publish, publicly perform, publicly display and distribute any Public Content which you submit, post or display on or through, the Software or Services. You also hereby grant each other user of the Software or Services a non- exclusive license to access your Public Content through the Software or Services, and to use, reproduce, distribute, display and perform the Content as permitted through the functionality of the Software or Services and under these Terms. You further grant to WAI and such users any license you may decide to grant (e.g., a Creative Commons license) as selected by You with the Services. You agree that this license includes a right for WAI to make such Public Content available to other companies, organizations or individuals with whom WAI has relationships, and to use such Public Content subject to the above license grants.

Shared Content. By submitting, posting or displaying your Shared Content, you hereby grant to WAI each designated user a non-exclusive license to access your Shared Content through the Software or Services, and to use, reproduce, distribute, display and perform the Content as permitted through the functionality of the Software or Services and under these Terms.

The above licenses will continue unless and until you remove your Content from the Services, in which case the licenses will terminate within a commercially reasonable period of time. Notwithstanding the foregoing, the license for legal archival/preservation purposes will continue indefinitely. Please note that removed Content may be cached in search engine indices after removal and that WAI has no control over such caching.

You understand that WAI and its service providers, in performing the required technical steps to provide the Software or Services to our users, may (a) transmit or distribute your Content over various public networks and in various media; and (b) make such changes to your Content as are necessary to conform and adapt that Content to the technical requirements of connecting networks, devices, services or media. You agree that this license shall permit WAI to take these actions.

You further agree that you will not submit to the Software or Services any Content or other material that is contrary to applicable local, national, and international laws and regulations or for any purpose not reasonably intended by WAI. By way of example, and

not as a limitation, you agree not to use the Software or Services: (i) to post or transmit any Content that is unlawful, infringing, libelous, defamatory, obscene, pornographic, abusive, offensive, threatening, abusive, harassing, tortuous, or defamatory; (ii) to attempt to misappropriate or use the identity of another user or person; or (iii) to upload, post or otherwise transmit any material that contains software viruses or any other computer code, files or programs designed to interrupt, destroy or limit the functionality of any website or computer or computer software or hardware or telecommunications equipment.

5. INTELLECTUAL PROPERTY RESTRICTIONS AND OTHER LIMITATIONS

WAI has and shall have sole and exclusive ownership of all right, title, and interest in and to the Software and Services and all portions and copies thereof. In addition, WAI shall have sole and exclusive ownership of any additional programs, updates, modifications, fixes, patches, upgrades, and revisions provided to You for the Software or provided online as part of its Services. No title is transferred by this Agreement or by the payment of any fee. If title to the Software or Services or any part thereof does not, by operation of law, vest in WAI, You hereby assign to WAI, or its designee all right, title and interest in and to the Software or Services.

The Services and Software, including, but not limited to, any software used to provide the Services, are protected by trademark, copyright, patent and/or other intellectual property laws and international treaty provisions. You are granted a revocable license to use such Services or Software in the form provided (without making any modification thereto) strictly in accordance with this Agreement. You acknowledge and understand that you are not granted any other license to use the Software or Services.

WAI does not claim any ownership of any data or content that you store, transmit or distribute using the Services. By using the Services to store, transmit, or distribute data or content, you (1) warrant that the material or content complies with the provisions of this Agreement, (2) consent to and authorize WAI, its agents, suppliers, and affiliates to use, reproduce, distribute, and display the content in order to provide the Services; and (3) warrant that you have the right to provide this authorization.

WAI and its suppliers reserve the right both during the term of this Agreement and upon its termination to delete your data, files, or other information that is stored on WAI's or its suppliers' servers or systems, in accordance with our storage policies.

Except as otherwise expressly provided in this Agreement, You shall not take any action nor allow anyone else to take any action that will: (i) reverse compile, disassemble, reverse engineer, or otherwise attempt to derive the source code from the binary code of the Software, in whole or in part; or (ii) adapt, alter, modify, translate, or create derivative works based on the Software or Services, in whole or in part.

You may make a reasonable number of copies of the licensed Software for non- production, backup purposes only. Except as expressly permitted herein or as otherwise agreed in writing, copying the Software for use in testing, development, disaster recovery, or training environments requires separate licenses subject to payment of Software maintenance and license fees.

You shall not utilize the Software or Services in conjunction with any Public Software in a manner which would require the Software to be disclosed or distributed in source code form or made available at no charge. Public Software means any software that contains, or is derived in any manner (in whole or in part) from, any software that is distributed as free software, open source software (e.g., Linux) or similar licensing or distribution models.

You may not (i) sell, assign, distribute, lease, market, rent, lend, sublicense, transfer, make available, publish, disclose, or otherwise grant rights to the Software or Services, in whole or in part, to any third party in any form; or (ii) electronically transfer the Software or Services, in whole or in part, from one computer to another over a network except as is necessary to load, operate and use the Software or Services.

You acknowledge and agree that you will not: (i) obscure, remove or alter any of the trademarks, trade names, logos, patent or copyright notices, or other proprietary notices, legends, symbols or labels in or on the Software or Services; (ii) add any other notices or markings to the Software or Services; or (iii) use the Software or Services in any manner to aid in the violation of any third-party intellectual property rights, including without limitation copyrights, trademarks, trade secrets, and patents, or the applicable laws of the jurisdictions in which you are using the Software, including without limitation libel, defamation, obscenity, and privacy-related torts.

You further acknowledge and agree that you will not: (a) attempt to circumvent or disable the Software or Services or any technology features or measures contained therein by any means or in any manner; (b) attempt to not reverse engineer, decompile, or disassemble the Software or Services or any portion thereof or otherwise obtain or attempt to obtain the source code for the Software or Services or any portion thereof.

The Software or Services licensed hereunder may include Open Source software (computer software that is distributed under a licensing arrangement, which provides that the computer code can be shared, viewed, and modified by the public). The restrictions of this Section 5 only apply to any such Open Source software when and to the extent that they do not conflict with any terms of the Open Source software's respective license(s).

6. PRIVACY POLICY

WAI will publish its data security and privacy policy ("Privacy Policy") on its website at <https://www.wildlifeacoustics.com/legal/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 support2018@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;

- A statement that you have a good faith belief that the Content was removed or disabled as a result of mistake or a misidentification of the Content; and
- 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.

If a counter-notice is received by the Copyright Agent, WAI may send a copy of the counter-notice to the original complaining party informing that person that it may replace the removed Content or cease disabling it in 10 business days. Unless the copyright owner files an action seeking a court order against the Content provider, member or user, the removed Content may be replaced, or access to it restored, in 10 to 14 business days or more after receipt of the counter-notice, at WAI's sole discretion.

8. SUPPORT; UPDATES; LICENSE VALIDATION; ACCURACY OF DATA

No product support for the Software or Services is provided unless a separate written support agreement is entered into by You and WAI or an authorized vendor. If the Software or Services is an upgrade or update to a previous version, You must possess a valid license to such previous version in order to use such upgrade or update. After You install such upgrade or update, You may continue to use any such previous version in accordance with its license agreement only if (a) the upgrade or update and all previous versions are installed on the same device, (b) the previous versions or copies thereof are not transferred to another party or device and (c) You acknowledge that any obligation WAI may have to support the previous version(s) may be terminated upon the availability of the upgrade or update. No other use of the previous version(s) is permitted after installation of an upgrade or update. Upgrades and updates may be licensed to You by WAI with additional or different terms.

The Software or Services may contain technological measures that are designed to prevent its unlicensed or illegal use. The Software or Services may require activation as explained during installation or in the Documentation. If any such applicable activation procedure(s) is not followed, then the Software or Services may only operate for a finite period of time or not operate at all. If activation is required, and not completed as explained during installation or in the Documentation, then the Software or Services will cease to function until activation has been completed, at which time functionality will be restored. If You have any problem with the activation process, You should contact WAI or an authorized vendor.

The Software or Services may contact WAI's servers to verify the User's license and send such information to WAI along with other information about the device, how and when the Software or Services is used (e.g, date, time and frequency of use). WAI may use this information to validate the User's license and to improve the Software or Services. WAI's use of such information is subject to its Privacy Policy which is posted on WAI's website at <https://wildlifeacoustics.com/legal/privacy-policy>. You agree to the terms of the Privacy Policy, which are expressly incorporated herein by reference.

WAI does not guarantee the accuracy, completeness, timeliness or results provided by the Software or Services. WAI shall have no liability for any error or omission, or for the use of, or the results obtained from the use of the Software. In addition, Users should not

rely on nor make decisions or comparisons based solely on the data or results provided by the Software, but should conduct additional independent verification and due diligence.

9. THIRD PARTY SOFTWARE AND SERVICES

Your use of WAI's Software or Services may allow you to download and use third-party software or link to third-party content, data or services (collectively, "Third-Party Services"). You also acknowledge that all Third-Party Services is the property of the applicable owners and may be protected by copyright and other intellectual property rights. Neither this Agreement nor your use of WAI's Software or Services gives you any rights to such Third Party Services except as expressly provided by the applicable service provider ("Service Provider").

You may not use any Third Party Services in any manner that has not been authorized by the applicable Service Provider. It is your responsibility to ensure that your use of the Software or Services to access, reproduce, display or otherwise use Third Party Services does not infringe any third-party intellectual property rights. You acknowledge that you may be required to enter into a separate agreement with a Service Provider for any Third Party Services, or comply with a Service Provider's terms or conditions of use in order to access or have the right to access any Third Party Services.

Specifically, WAI Services may provide you with a link or access to Amazon's online services. You agree that all your End Users will comply with all of the terms and conditions of the AWS Customer Agreement posted at <https://aws.amazon.com/agreement/> and any successor or related policy or terms as may be provided or amended from time to time.

No third-party products are covered by any warranty obligation of WAI and are not covered by any maintenance or service provision by WAI. If no such agreement is provided, such products are provided AS-IS. Users shall have recourse only to such Service Provider, not WAI, for all such warranty, service, or support obligations.

WAI's Software may be bundled with third party software, which use and distribution is subject to restrictions as provided in Addendum A hereto ("Third Party Licenses").

No third-party software or services are covered by any warranty obligation of WAI and are not covered by any maintenance or service provision by Licensor. If no such agreement is provided, such products are provided "AS-IS". You shall have recourse only to such manufacturer, not Licensor, for all such warranty, service, or support obligations.

10. TERM AND TERMINATION

Term of Services. The initial term of the Services purchased by you will be for the applicable time period specified when you order the Services (the "Initial Term"). Unless you cancel prior to the end of the Initial Term or as otherwise stated in a notice sent to you at least thirty (30) days prior to the expiration of your then-current term, the Services will automatically renew for successive periods of equal length as the Initial Term (each a "Renewal Period").

Termination by You. Unless you have signed a minimum term arrangement, you may terminate this Agreement for any reason at any time by notifying WAI in one of three ways: (1) send a written notice to WAI's postal address; (2) send an electronic notice to the email address specified on www.wildlifeacoustics.com; or (3) call WAI's customer service department during normal business hours. If you have a minimum term arrangement, you may terminate this Agreement by providing notice of non-renewal at least thirty (30) days prior to the end of the minimum term or any subsequent renewal term. Subject to applicable laws, all fees and charges for the Services and Software will accrue until this Agreement has terminated, the Services are disconnected, and all data is deleted. We will refund all prepaid monthly service fees charged for Services after the date of termination (less any outstanding amounts due WAI for the Services, affiliate services, or other applicable fees and charges). The foregoing refund does not apply to minimum term arrangements.

Termination by WAI. WAI reserves the right, subject to applicable law, to immediately and without notice terminate or suspend the Services and/or to remove from the Services any information or data transmitted by or to any authorized users if WAI reasonably believes: (1) payment for Services has not been paid when due; (2) your use of the Service does not conform with the requirements set forth in this Agreement or the terms of any Third Party Services, (3) your use of the Service interferes with WAI's ability to provide the Services to others, or (4) your use of the Service may violate any laws, regulations, or written and electronic instructions for use. WAI's action or inaction under this Section 10 shall not constitute review or approval of your or any other users' use of the Services or information transmitted by or to you or users.

Data Deletion. Upon termination of the Services for any reason, User Content, accounts, and other data will be deleted. You should always maintain back-up copies of all User Content and other data. WAI is not responsible for the loss of any User Content. It is essential that Users backup files offline, even if the Services or have applications for backup or archiving data.

Obligations after Termination. Termination of this Agreement shall not relieve either party of any obligation or liability accrued hereunder prior to such termination, nor affect or impair the rights of either party arising under this Agreement prior to such termination, except as expressly provided herein. Upon termination, you agree to cease using the Software and Services and delete or uninstall the Software and all copies thereof.

11. DISCLAIMER OF WARRANTY

EXCEPT AS EXPRESSLY PROVIDED BY WAI, THE SERVICES AND SOFTWARE ARE PROVIDED AS IS, WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED. NEITHER WAI NOR ITS AFFILIATES, SUPPLIERS, EMPLOYEES, AGENTS, OR CONTRACTORS WARRANT THAT THE SOFTWARE OR THE SERVICES WILL MEET YOUR REQUIREMENTS, PROVIDE UNINTERRUPTED USE, OR OPERATE AS REQUIRED, WITHOUT DELAY, OR WITHOUT ERROR. ALL REPRESENTATIONS AND WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OF PERFORMANCE, NONINFRINGEMENT, FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, ARE HEREBY DISCLAIMED AND EXCLUDED UNLESS OTHERWISE PROHIBITED OR RESTRICTED BY APPLICABLE LAW.

12. LIMITATION OF LIABILITY

NEITHER WAI NOR ITS AFFILIATES, SUPPLIERS, EMPLOYEES, AGENTS, OR CONTRACTORS SHALL HAVE ANY LIABILITY WHATSOEVER FOR ANY DAMAGE TO OR LOSS OF ANY HARDWARE, SOFTWARE, FILES, OR DATA RESULTING FROM A VIRUS, ANY OTHER HARMFUL FEATURE, OR FROM ANY ATTEMPT TO REMOVE IT.

YOU ACKNOWLEDGE AND UNDERSTAND THE IMPORTANCE OF BACKING UP ALL FILES TO ANOTHER STORAGE MECHANISM PRIOR TO SUCH ACTIVITIES. YOU UNDERSTAND AND ACCEPT THE RISKS IF YOU DECIDE NOT TO BACK UP FILES. NEITHER WAI NOR ITS AFFILIATES, SUPPLIERS, EMPLOYEES, AGENTS, OR CONTRACTORS SHALL HAVE ANY LIABILITY WHATSOEVER FOR ANY DAMAGE TO OR LOSS OF ANY SOFTWARE, FILES, OR DATA.

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(1) ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, TREBLE, PUNITIVE, EXEMPLARY, OR CONSEQUENTIAL LOSSES OR DAMAGES (INCLUDING, BUT NOT LIMITED TO, LOSS OF PROFITS, LOSS OF EARNINGS, LOSS OF BUSINESS OPPORTUNITIES, PERSONAL INJURIES, OR DEATH) THAT RESULT DIRECTLY OR INDIRECTLY FROM OR IN CONNECTION WITH (a) YOUR RELIANCE ON OR USE OF THE SERVICES OR SOFTWARE; OR (b) THE INSTALLATION,

MAINTENANCE, FAILURE, OR REMOVAL OF THE SOFTWARE OR SERVICES (INCLUDING, BUT NOT LIMITED TO, ANY MISTAKES, OMISSIONS, INTERRUPTIONS, FAILURES OR MALFUNCTIONS, DELETION OR CORRUPTION OF FILES, WORK STOPPAGE, ERRORS, DEFECTS, DELAYS IN OPERATION, DELAYS IN TRANSMISSION, OR FAILURE OF PERFORMANCE OF THE SERVICE, THE SOFTWARE, OR THE CUSTOMER DEVICES, OR ANY OTHER MISTAKES, OMISSIONS, LOSS OF CALL DETAIL, EMAIL, VOICEMAIL, OR OTHER INFORMATION OR DATA); OR

(2) ANY LOSSES, CLAIMS, DAMAGES, EXPENSES, LIABILITIES, LEGAL FEES, OR OTHER COSTS THAT RESULT DIRECTLY OR INDIRECTLY FROM OR IN CONNECTION WITH ANY ALLEGATION, CLAIM, SUIT, OR OTHER PROCEEDING BASED UPON A CONTENTION THAT THE USE OF THE SOFTWARE OR SERVICES BY YOU OR ANY OTHER PERSON OR ENTITY INFRINGES UPON THE CONTRACTUAL RIGHTS, PRIVACY, CONFIDENTIALITY, COPYRIGHT, PATENT, TRADEMARK, TRADE SECRET, OR OTHER INTELLECTUAL PROPERTY RIGHTS OF ANY THIRD PARTY.

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.

NOTWITHSTANDING ANYTHING TO THE CONTRARY HEREIN, IN NO EVENT SHALL WAI'S LIABILITY EXCEED THE AMOUNT OF FEES PAID UNDER THIS AGREEMENT DURING THE 12-MONTH PERIOD PRIOR TO THE EVENTS GIVING RISE TO A CLAIM OR, IF LESS, \$100 (WHETHER SUCH LIABILITY ARISES FROM BREACH OF WARRANTY, BREACH OF THIS AGREEMENT, OR OTHERWISE, AND WHETHER IN CONTRACT OR IN TORT, INCLUDING NEGLIGENCE AND STRICT LIABILITY). IN NO EVENT MAY ANY ACTION BE BROUGHT AGAINST WAI ARISING OUT OF THIS AGREEMENT MORE THAN ONE YEAR AFTER THE CLAIM OR CAUSE OF ACTION ARISES, DETERMINED WITHOUT REGARD TO WHEN YOU LEARNED OF THE ALLEGED DEFECT, INJURY, OR LOSS.

SOME JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF IMPLIED WARRANTIES OR LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE EXCLUSION OR LIMITATION MAY NOT APPLY TO YOU. THE PROVISIONS OF THIS SECTION 10 WILL SURVIVE ANY TERMINATION OF THIS AGREEMENT. THE FOREGOING LIMITATIONS, EXCLUSIONS AND DISCLAIMERS SHALL APPLY TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, EVEN IF ANY REMEDY FAILS ITS ESSENTIAL PURPOSE.

13. INDEMNIFICATION

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.

14. GENERAL

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.

WAI's Information and Trademarks. All Service information, documents, and materials on our websites are protected by copyright or trademark, other intellectual property laws, and international treaty provisions. All websites, corporate names, service marks, trademarks, trade names, logos, and domain names (collectively "Trademarks") of WAI and its affiliates are and shall remain the exclusive property of WAI. Nothing in this Agreement shall grant you the right or license to use any Trademarks.

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.

Notices. You agree that Wildlife Acoustics may provide you with notices, including those regarding changes to this Agreement. We will provide you notice of changes to this Agreement consistent with applicable law. If you find the change unacceptable, you have the

right to use of the Software or cancel the Services. However, if you continue to use the Software or Services after the change, we will consider this your acceptance of the change. WAI may deliver any required or desired notice to you in any of the following ways, as determined in our sole discretion: (1) by posting it on www.wildlifeacoustics.com or another website about which you have been notified, (2) by sending notice via first class U.S. postal mail or overnight mail to the postal address on WAI's account records; (3) by sending notice to the email address on WAI's account records, or (4) by hand delivery. You agree that any one of the foregoing will constitute sufficient notice and you waive any claims that these forms of notice are insufficient or ineffective. Because we may from time to time notify you about important information regarding the Services and this Agreement by these methods, you agree to regularly check your postal mail, email and all postings at www.wildlifeacoustics.com or on another website about which you have been notified or you bear the risk of failing to do so. Notices to WAI shall be addressed as follows: Wildlife Acoustics, Inc., 3 Mill and Main Place, Suite 210, Maynard, MA 01754-2657.

Language; Governing Law; Currency. This Agreement shall be signed by the parties in the English language. In the event of any translation, the English language version as signed by the parties shall be determinative. The validity, performance and construction of this Agreement shall be governed by the law of the Commonwealth of Massachusetts, USA applicable to contracts executed in and performed entirely within such Commonwealth, without reference to any choice of law principles of such Commonwealth. Any legal suit, action, or proceeding arising out of or relating to this Agreement shall be commenced in a federal or state court in Massachusetts, and each party hereto irrevocably submits to the non-exclusive jurisdiction and venue of any such court in any such suit, action, or proceeding. The application to this Agreement of the United Nations Convention on Contracts for the International Sale of Goods is hereby expressly excluded. All amounts of money payable hereunder shall be payable in U.S. dollars unless otherwise expressly stated or otherwise agreed.

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Assignment. This Agreement shall be binding upon and inure to the benefit of the parties hereto and their respective heirs, personal representatives and successors and assigns of the parties hereto. Notwithstanding the foregoing statement, this Agreement and the rights and obligations of the parties hereunder shall not be assignable by You without prior written consent of WAI. No agency, partnership, joint venture, or employment is created as a result of this Agreement and you do not have any authority of any kind to bind Wildlife Acoustics in any respect whatsoever.

Export Control. You shall not export or allow the export or re-export of the Software or any portions thereof without compliance with all export laws and regulations of the U.S. Department of Commerce and all other U.S. agencies and authorities, including without

limitation, the Export Administration Regulations of the U.S. Department of Commerce, Bureau of Export Administration, and, if applicable, relevant foreign laws and regulations

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

THIRD PARTY LICENSES

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libcurl version 7.53.1

<http://curl.haxx.se>

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libfftw version 3.3

<http://www.fftw.org>

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libxml2 version 2.9.4

<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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