



WILDLIFE
ACOUSTICS



Kaleidoscope

User Guide

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Online User Guide

Download this guide at wildlifeacoustics.com/resources/user-guides.

Tutorial Videos

Visit wildlifeacoustics.com/resources/video-tutorials/ to view tutorial videos for Kaleidoscope Pro.

Technical Support

For technical queries contact the Wildlife Acoustics support team:

wildlifeacoustics.com/support

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

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

Updates

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

wildlifeacoustics.com/products#mailinglist

TABLE OF CONTENTS

Table of Contents	iii
1 Getting Started	1
1.1 Welcome to Kaleidoscope	1
1.2 Kaleidoscope Lite vs. Kaleidoscope Pro	3
1.3 Compatibility and Optimization.....	4
1.4 Download and Install Kaleidoscope.....	7
1.5 Open Kaleidoscope for the First Time.....	8
1.6 Check or Activate a Kaleidoscope Pro License	9
2 Typical General Use Workflows	12
2.1 Set Defaults	12
2.2 Create and Restore Custom Settings.....	13
2.3 Use the Viewer	13
2.4 Batch Processing and File Conversion.....	30
2.5 Create a File Inventory List	33
2.6 Use Manual IDs	35
3 Typical Workflows for Bat Analysis	37
3.1 Optimize for Bat Analysis	37
3.2 Auto-ID for Bats.....	42
3.3 Cluster Analysis for Bats	49
4 Typical Workflows for Finding Sounds	51
4.1 Scan Recordings and Extract Detections (No Clustering).....	52
4.2 Optimize Signal Detection	54
4.3 Strategies for Finding Sounds	59
4.4 Cluster Analysis	63
4.5 Cluster Analysis Results	65
4.6 Simple Classifiers.....	70
4.7 Advanced Classifiers	72
5 Typical Workflows for Soundscape Analysis	75
5.1 SPL Analysis.....	75
5.2 Acoustic Index Analysis	79
6 Metadata Workflow	82
6.1 Metadata Management	82
6.2 Cloud-Based Storage	85
6.3 Cloud-Based Computing	89
6.4 Database Functions	91
7 Reference Guide	100
7.1 The Control Panel	101
7.2 Batch Tab	102
7.3 Signal Params Tab	106
7.4 Auto-ID for Bats Tab.....	108
7.5 Cluster Analysis Tab.....	110
7.6 SPL Analysis Tab	111
7.7 Acoustic Indices Tab	113
7.8 Cloud Tab	117
7.9 Db Tab.....	118
7.10 SMART Tab.....	119
7.11 The Viewer	121
7.12 Viewer Analysis Window	128
7.13 The Results Window.....	130
8 Additional Resources	134

8.1	Troubleshooting	134
8.2	CSV File Layouts.....	137
8.3	Audio File Formats.....	146
8.4	File Naming Conventions	147
8.5	Bat Auto-ID Species Classifiers.....	147
8.6	Maximum Likelihood Estimators (MLE) and P-values for Species Classifiers.....	151
8.7	Cluster Analysis Theory	152
8.8	Default Metadata SCHEMA	153
8.9	Managed Cloud Account Instructions	167
8.10	PostgreSQL Server Database	170
8.11	Command Line Interface	171
8.12	Glossary.....	178

1 Getting Started

1.1 Welcome to Kaleidoscope

This User Guide is designed for all users of Kaleidoscope software.

- Novice users will be guided step by step.
- Experienced users will find extensive instructions and descriptions of details.
- Links are provided throughout, for cross-reference and additional information.
- Notes, Tips, and Examples are included for additional clarification.

The User Guide is divided into four sections.

- **Getting Started**
 - A basic description of Kaleidoscope
 - How to download, install, and optimize the Kaleidoscope software application
 - How to activate a Kaleidoscope Pro license
 - How to troubleshoot common problems
- [Typical Use Workflows](#)
 - Here are the How-To Guides for Kaleidoscope. These sections provide step-by-step instructions and explanations for typical and practical uses of Kaleidoscope.
- [Reference Guide](#)
 - Provides a description of each function in Kaleidoscope
- [Additional Resources](#)
 - Provides background information for all aspects of Kaleidoscope
 - Includes a Troubleshooting section

What Is Kaleidoscope?

Kaleidoscope is an integrated set of software tools designed and optimized for typical bioacoustics analysis workflows.

Kaleidoscope Features:

- A Viewer for directly analyzing audio files
 - Batch processing for automated file analysis and management
 - Support for a wide range of audio file formats, created by Wildlife Acoustics recorders and other sources
 - File utilities including: format conversion, compression, file segmentation, and stereo to dual-mono splitting
 - detection and extraction of signals of interest from audio recordings, based on specified parameters
 - Automatic estimation of species identification for bat recordings*
 - Isolation and clustering of similar acoustic detections from within audio files*
 - Tools for building classifiers*
 - Tools for Sound Pressure Level measurement*
 - Tools for Acoustic Index analysis*
 - Support for cloud-based storage and computing*
 - Support for local or cloud-based database functions*
 - Wildlife Acoustics SMART system Alarm simulation*
- (*Requires a Kaleidoscope Pro license)

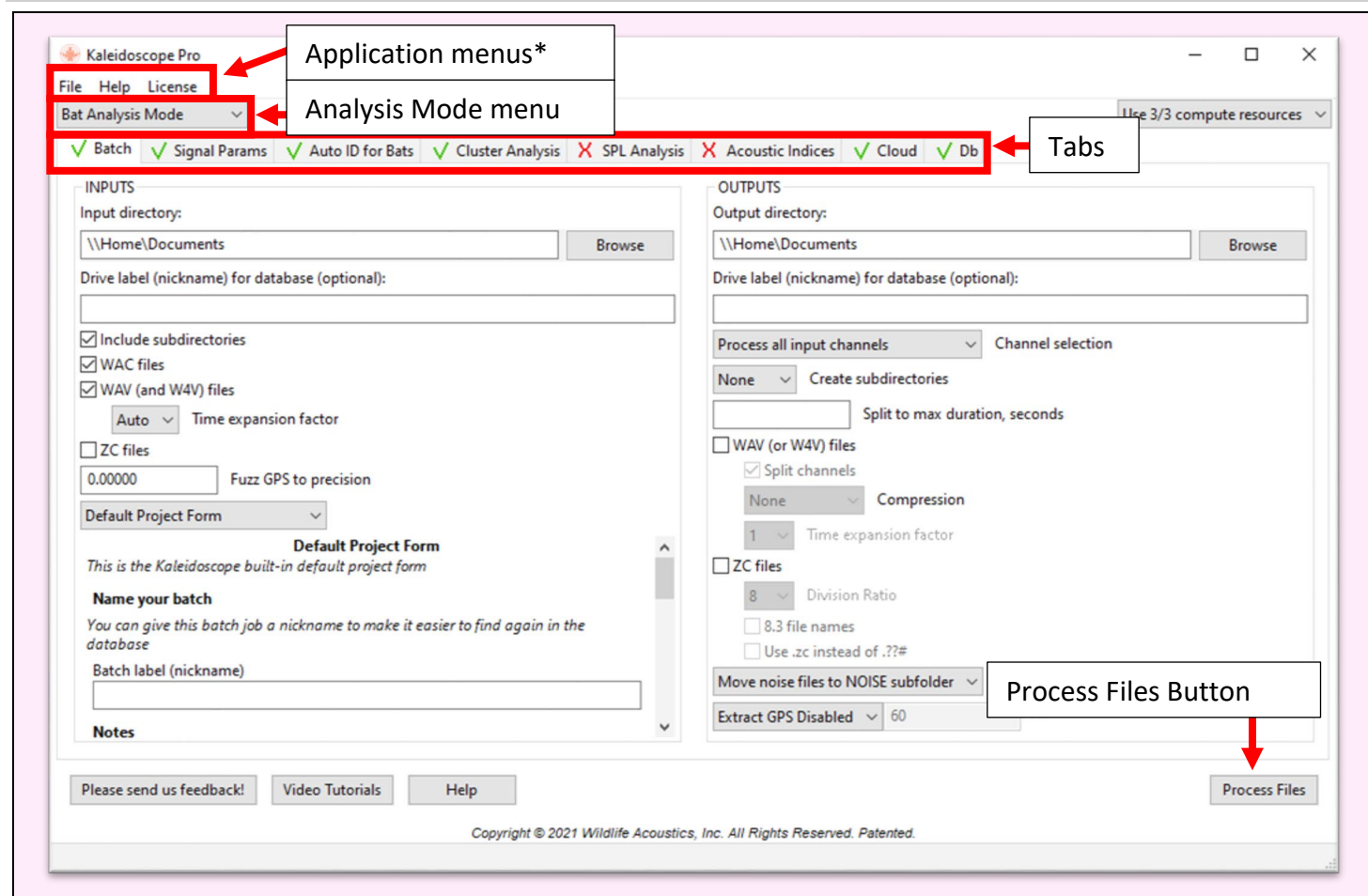
Human vs. Automated Analysis

Kaleidoscope provides functions for both human and machine-based (automated) analysis.

- Human-based analysis is typically done by examining audio files in the Viewer.
 - Manual IDs, Notes, etc. can be added throughout the analysis workflow.
- Automated machine-based analysis is done via batch processing.
 - Batch processing is configured in the Control Panel.
- It is common in a typical Kaleidoscope workflow to use a combination of human and machine-based analysis.

Tip: When using automated analysis it is always best practice for a human to interpret and verify the final results.

The Control Panel



* (Application menus as displayed under Windows OS. Under Mac OS, Application menus are displayed in the upper left corner of the Main menu Bar)

The Control Panel is displayed when Kaleidoscope is opened.

- The Control Panel License menu provides access to activate a Kaleidoscope Pro license.
- The Control Panel File menu provides access to open an audio file in the Viewer.
- Tabs provide access to automated analysis and file conversion functions.
- Cloud and database functions are configured from the Control Panel.
- SMART Alarm Simulations are configured from the Control Panel.

Batch Processing

Kaleidoscope can perform multiple automated tasks in parallel:

- Create file inventory lists
- Convert audio file formats
- Extract metadata from files and batch processes to create CSV format files
- Add Notes and other metadata to output files
- Automatically identify and isolate potential noise files in Bat Analysis Mode
- Suggest most likely bat species with Bat Auto-ID*
- Isolate detected signals within audio files based on specified parameters
- Apply cluster analysis to identify and group similar animal vocalizations*
- Create classifiers for automatic grouping and labelling of similar sounds*
- Analyze full-spectrum recordings for SPL measurements*

- Analyze full-spectrum recordings to measure multiple acoustic indices*
- Analyze bat recordings to simulate Alarms for the Wildlife Acoustics SMART system.
(*Requires Kaleidoscope Pro license)

The Viewer

The Viewer is used to open and directly analyze audio files. The Viewer includes:

- Variable speed audio playback of WAV files
- Visual display of audio files using oscillogram, spectrogram, and Zero-Crossing sonograms
- A Viewer Analysis window which provides tools and display for statistical measurements
- A Metadata Panel which is used to display and edit metadata information embedded in the audio file
- Quick review and manual verification of automated analysis results
- Keyboard shortcuts and multiple optimizations for fast vetting of large amounts of data
- Option to Save selection of an audio file as a new WAV file

Cloud Storage

Kaleidoscope Pro provides support for cloud-based file storage.

- Users can create or subscribe to a Wildlife Acoustics Managed Cloud Account.
- A Wildlife Acoustics Managed Cloud Account provides convenient, fast, and safe storage and access for unlimited amounts of data.
- Alternately, users can set up their own Amazon Web Services (AWS) account and Amazon Simple Storage Service (S3) bucket, which can be accessed by Kaleidoscope Pro 5.
- Cloud accounts can be shared among multiple Users for collaboration. The owner of the account has full administrative privileges, including allowing specific access to other Kaleidoscope Pro Users when appropriate.

Cloud Computing

Kaleidoscope Pro can take advantage of cloud-based computing.

- Access to a Wildlife Acoustics Managed Cloud Account is required for this function.
- When connected to a Wildlife Acoustics Managed Cloud Account, Kaleidoscope Pro has access to cloud-based computing for rapid handling of large-scale batch processing.
- Once the batch process has been queued for cloud-based computing, the local computer can be taken offline.

Database Support

Kaleidoscope Pro provides searchable database functions.

- Kaleidoscope Pro can access a preconfigured database via a Wildlife Acoustics Managed Cloud Account.
- Kaleidoscope Pro can access a user-managed PostgreSQL server and database.
- The database provides Smart Search functions to query metadata records based on user-specified criteria.
- The database can reference audio files which are not stored in the cloud.

1.2 Kaleidoscope Lite vs. Kaleidoscope Pro

When the Kaleidoscope software application is first downloaded and opened, it runs as Kaleidoscope Lite.

- Kaleidoscope Lite includes basic functions and tools which are made available for no charge.
- Kaleidoscope Lite can be upgraded to Kaleidoscope Pro, which will unlock and enable additional advanced features.

Throughout this User Guide, when a function is common to both Kaleidoscope Lite and Kaleidoscope Pro, the application will be referred to simply as Kaleidoscope. When a function requires a Kaleidoscope Pro license, it will be noted as such and the application will be referred to as Kaleidoscope Pro.

Features Included With Kaleidoscope Lite

- The Viewer and Metadata Panel
- Batch file format conversion
- Isolation and extraction of detected signals within audio files (Non-Bat Analysis Mode only)
- Filtering of Noise files for batches of recordings. (Bat Analysis Mode only)

- Extraction of metadata
- Creation of Manual IDs and Notes
- Addition and editing of Notes to output file metadata and meta.csv files
- Support for custom Project Forms

Features Enabled With Kaleidoscope Pro

- Auto-ID for Bats
- Cluster Analysis (including creation and use of classifiers)
- Sound Pressure Level analysis
- Acoustic Index analysis
- Integrated cloud support (Including storage and cloud-based computing)
- Integrated database support with Smart Search
- SMART system Alarm simulation

1.3 Compatibility and Optimization

Kaleidoscope must be installed on a compatible computer. The following sections describe compatibility information and instructions for overall optimization of the software.

Minimum Computer Requirements

Kaleidoscope is designed to run on current and recent-generation computers.

- **Storage Requirements:**
 - The Kaleidoscope application is installed to the internal drive of the computer and requires 100 MB of available storage space.
 - It is recommended that analysis of audio files by Kaleidoscope be done from the internal drive of the computer, or from a fast, locally connected external drive.
 - It is possible for Kaleidoscope to create new audio files as part of a batch process. If this function is used, there must be enough available storage space for the new files.
- **RAM:**
 - At least 8 GB of installed RAM (Random Access Memory) is required for minimum operation of Kaleidoscope.
 - 16 GB or more RAM is recommended, especially for higher function tasks such as cluster analysis.
 - Rebooting the computer and closing all nonessential applications will optimize the available RAM for use with Kaleidoscope.
- **Supported Windows OS:**
 - Minimum Win 7 is required.
 - Unless specifically noted on the Wildlife Acoustics downloads page, the latest version of Windows OS is always supported.
 - When installing under Windows, choose Install for All Users when prompted.
- **Supported Mac OS:**
 - Minimum OS 10.8 is required.
 - Unless specifically noted on the Wildlife Acoustics downloads page, the latest version of Mac OS is always supported.
 - After download, move the Kaleidoscope folder from the downloads directory to the Applications folder.

NOTE: During installation of Kaleidoscope under recent Mac OS versions, an error message will appear saying the application cannot be checked by Apple and therefore cannot be installed. If this happens, go to the **Apple menu** and open **System Preferences - Security & Privacy**. Text will be visible indicating Kaleidoscope was prevented from opening. Click the **Padlock Icon** in the lower-left of the window and enter the **Mac administrator password** when prompted. Under **Allow apps downloaded from** check the option for **App Store and identified developers**, then click **Open Anyway**.

- **Supported Linux OS:**
 - Red Hat Enterprise Linux 7, x86_64 required
 - First download and install: the wxWidgets libraries, then the Kaleidoscope executable
 - On Linux platforms, the wxWidgets shared libraries are installed in /usr/local/lib and Kaleidoscope is installed in /usr/local/bin

- 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
- Install the following files:
 - openssl-1.0.2k
 - libcurl-7.53.1
 - libxml2-2.9.4
 - postgresql95

Non-Supported Linux OS:

(Although Kaleidoscope will most likely work under the following Linux versions, Wildlife Acoustics cannot provide system level technical support for these platforms.)

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

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

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

CPU Optimization

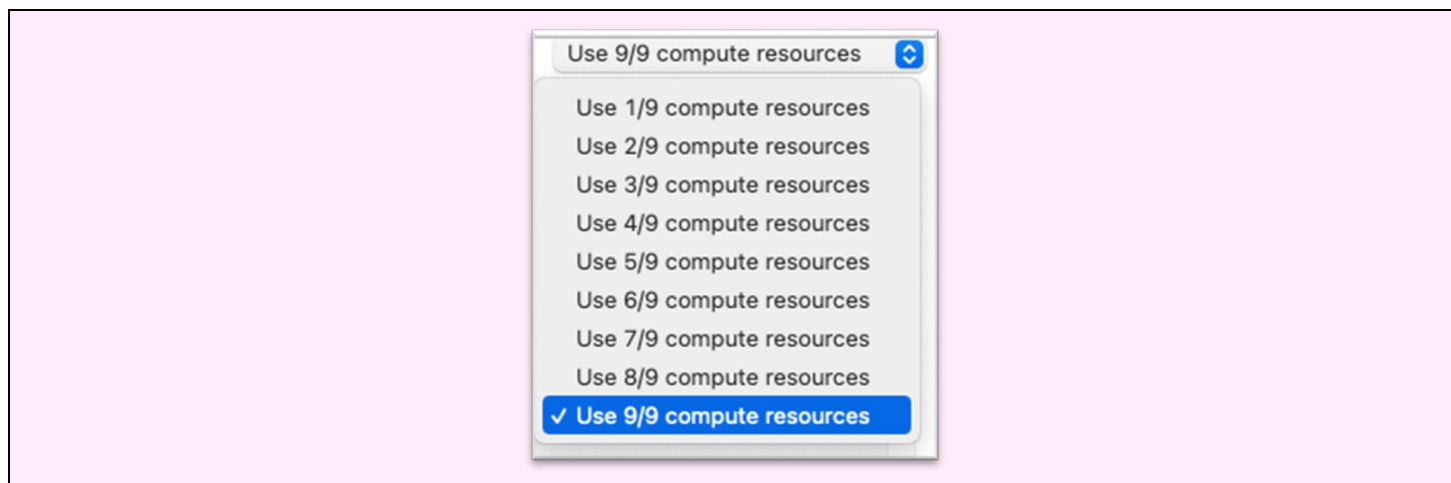
NOTE: For initial installation and use of Kaleidoscope, the user can skip this section. Kaleidoscope will install fully optimized for the computer. If Kaleidoscope crashes or puts up error messages as a result of batch processing, or if the user is curious about how Kaleidoscope works internally, refer back to this section.

- How Kaleidoscope uses multiple CPU Cores:

Kaleidoscope can run multiple simultaneous operations (also called “threads”) during batch processing. This allows the application to take full advantage of computers which implement multiple CPU cores. By default, Kaleidoscope will maximize efficiency by generating threads up to the number of available CPU cores, plus one. The computer operating system then assigns the threads to CPU cores based on their availability. Memory usage will also grow proportionally with the number of concurrently processing threads.

- What happens if the computer runs out of available RAM?
 - If the computer does not have enough RAM to complete the current analysis task, Kaleidoscope may stop processing and display an error message, or even crash or suddenly quit.
 - This type of error may happen intermittently, depending on available RAM, and the CPU requirements of the current batch processing.
 - If this happens it may be necessary to reduce the number of compute resources used by Kaleidoscope.

The number of simultaneous threads created by Kaleidoscope can be adjusted via the pull-down menu in the upper-right corner of the Control Panel. In the example below, the computer has eight cores. Therefore up to nine simultaneous threads can be used. The current highlighted selection shows Kaleidoscope is currently set to generate up to the maximum of nine threads at a time.



Tip: A lower number of compute resources also means longer processing time. Therefore, it may take some experimentation to find the optimal compute resources setting.

Audio File Compatibility

Kaleidoscope is designed to analyze digital audio recording files on input.

- File compatibility specifications are described under [Audio File Formats](#).
- Kaleidoscope is compatible with audio files created by all models of Wildlife Acoustics recorders.
- If audio files originate from sources other than Wildlife Acoustics recorders, they may or may not be directly compatible with Kaleidoscope.

Tip: If an audio file is not immediately compatible with Kaleidoscope, it may be possible to convert the file to a format that Kaleidoscope can open.

CSV File Compatibility

Kaleidoscope creates CSV files on output when a batch process is run.

- CSV (Comma Separated Value) is a common file format typically used to create spreadsheets.
- CSV files created by Kaleidoscope can be opened and edited in other applications which support the CSV file format.
- For reference information, see: [CSV File Layouts](#).

NOTE: If a CSV document created by Kaleidoscope is modified by an external spreadsheet application, Kaleidoscope may no longer be able to open the modified file. Therefore, make a backup copy of any CSV file created by Kaleidoscope before externally modifying the document.

File Storage and Management

In the bioacoustics analysis workflow, data is created in the form of audio recording files containing embedded metadata. Audio files can require potentially large amounts of storage space. Metadata represents the valuable results of analysis. Throughout the Kaleidoscope workflow, efficient management of both audio files and metadata is critical.

- In a typical workflow, audio files are often initially created and recorded to SD memory cards.
 - SD memory cards should not be regarded as a reliable long-term storage solution.
 - Best practice is to back up the recording files from SD memory cards as soon as possible.
- For long-term archiving of files, any type of reliable data storage medium can be used.

Tip: It is always best practice to make additional backup copies of valuable files.

NOTE: For fast access of multiple audio files or any sort of computer-based analysis, it is strongly recommended that audio files and Input and Output directories for batch processing are located on internal or directly connected hard drives. **In general, do not process files which are stored on a USB thumb drive, SD memory card, or over a network.**

- Kaleidoscope Pro provides cloud-based file storage functions.
 - For additional information, see: [Cloud-Based Storage](#).
- Kaleidoscope Pro provides database functions for metadata storage and management.
 - For additional information, see: [Database Functions](#).

1.4 Download and Install Kaleidoscope

The following sections describe how to download and install Kaleidoscope for the first time.

Create a Wildlife Acoustics User Web Account

In order to access file downloads at the Wildlife Acoustics web site, a Wildlife Acoustics User Web Account is required. A Wildlife Acoustics User Web Account is also required in order to activate a Kaleidoscope Pro license.

1. Go to: wildlifeacoustics.com/account/login.
2. Click on: Request Account.
3. Enter the user email address and check the box to accept terms of service.
4. Press the button to create a new account.

- A confirmation email will automatically and immediately be sent to the user email address.
 - If the confirmation email does not appear, check the user email spam folder.
 - The confirmation email will contain a link for the user to create a log-in password.
- Once the password is created, the user can log in to their Wildlife Acoustics User Web Account.

Download and Install Kaleidoscope

The latest update for Kaleidoscope software is always available as a no-charge download from: wildlifeacoustics.com/account/downloads.

When Kaleidoscope is first installed, it opens as Kaleidoscope Lite.

- If no license is activated, Kaleidoscope will continue to open as Kaleidoscope Lite.
- If a Kaleidoscope Pro license is activated, the advanced features will be unlocked, and the software will then open and run as Kaleidoscope Pro.

NOTE: There is no difference between Kaleidoscope Lite and Kaleidoscope Pro in terms of download and installation. Kaleidoscope Lite becomes Kaleidoscope Pro when a Kaleidoscope Pro license is activated.

- When downloading for Windows OS:
 - The Kaleidoscope installer is in the form of a .exe file.
 - Windows will typically ask if the installer should be run when the download is completed.
 - If the Kaleidoscope.exe installer is not run initially, it will be available in the designated downloads directory to run later.
 - When Kaleidoscope is installed, Windows will create a shortcut icon on the desktop.
- When downloading for Mac OS:
 - The Kaleidoscope application is in the form of a .zip file.
 - Typically, the user does not have to do anything, and the Mac OS will automatically "unzip" the Kaleidoscope application into the designated Downloads folder.
 - Double-click on the Kaleidoscope.zip file to unzip if required.
 - The Kaleidoscope.zip file unpacks to create a folder called Kaleidoscope. Inside that folder is the Kaleidoscope application and the Kaleidoscope User Guide pdf.
 - Drag the Kaleidoscope application icon to the Mac OS dock to create a shortcut.
 - Drag the entire Kaleidoscope folder from the Downloads folder to the Applications folder.

NOTE: If the computer is behind some sort of internet firewall, or if the computer is running anti-virus software, download and/or installation could be interrupted. If this happens, see [Download/Installation Help](#)

1.5 Open Kaleidoscope for the First Time

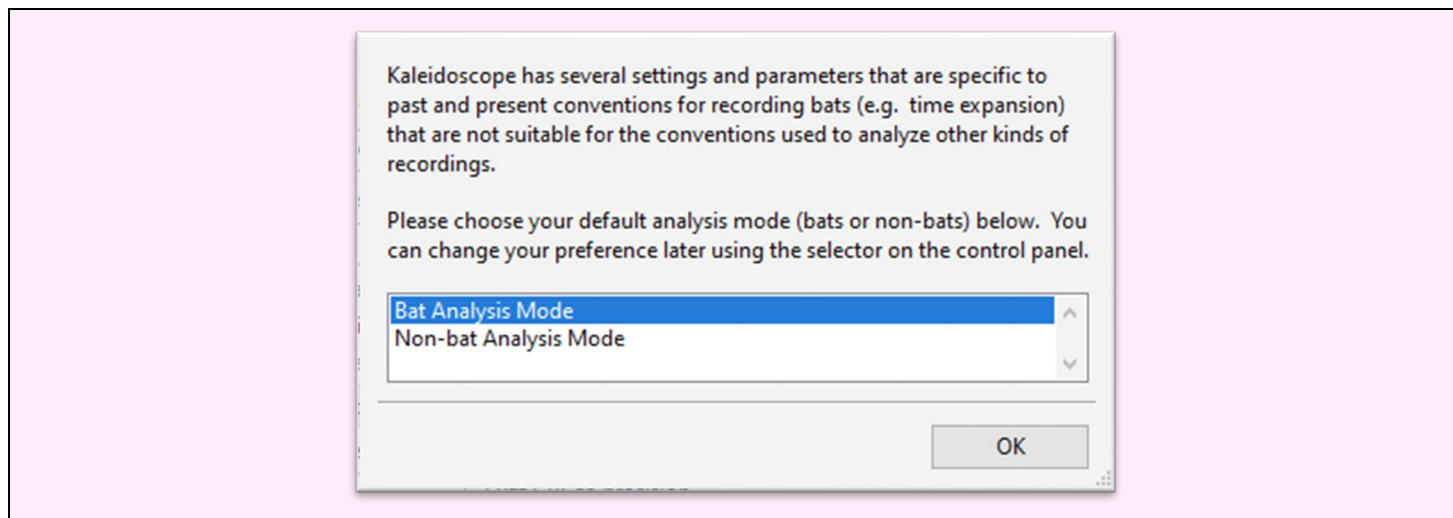
The first time Kaleidoscope is opened, a series of windows will appear. The Software License Agreement and Analysis Mode windows will not appear again automatically, once Kaleidoscope has been opened for the first time.

Software License Agreement Window

This is a standard legal form which is required for use of a commercial software product.

- In order for Kaleidoscope to run, the user must press the Agree button.
- To view the software license agreement at any time, go to the Control Panel File menu and choose Display License Agreement.

Analysis Mode



When Kaleidoscope is opened for the first time, a window is displayed with the option to choose the Analysis Mode.

This window will no longer appear automatically when Kaleidoscope opened subsequently.

- When working with recordings of bats, choose Bat Analysis Mode.
 - For additional information, see: [Optimize for Bat Analysis](#).
- When working with recordings of anything other than bats, it is typical to choose Non-Bat Analysis Mode.
- Some of the Kaleidoscope features and settings are only available in one or the other of these two modes.
 - Controls for features which are not available for the selected mode are disabled.
- The Analysis Mode window is displayed when [Set Defaults](#) is selected from the Control Panel File menu.
- The Analysis Mode can be changed at any time via the menu at the top left of the Control Panel.

Wildlife Acoustics Website Invitation

When Kaleidoscope Lite opens, a window appears to invite the user to visit the Wildlife Acoustics web site.

- Press Dismiss to close the invitation window.
- If a Kaleidoscope Pro license is activated, the invitation window will no longer appear.

Control Panel

The Kaleidoscope Control Panel window will now be displayed.

- The Control Panel will always be the first application window to appear when Kaleidoscope is opened.
- The Control Panel is used to access key functions of Kaleidoscope. For example:
 - To open an audio file in the Viewer, choose Open... from the Control Panel File menu.
 - To access the Online User Guide, go to the Control Panel Help menu.
 - To access Kaleidoscope Pro License functions, go to the Control Panel License menu.
- The Control Panel is used to configure automated batch processing and analysis.
- The Control Panel is used to access cloud and database functions.
- For reference information, see: [The Control Panel](#).

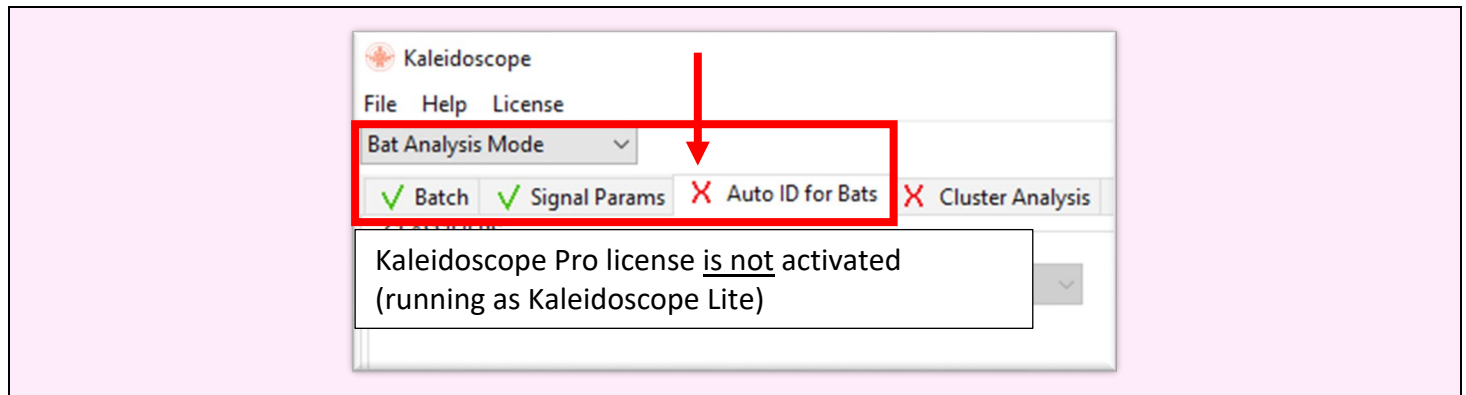
1.6 Check or Activate a Kaleidoscope Pro License

A software license must be activated in order to use the additional features enabled by Kaleidoscope Pro.

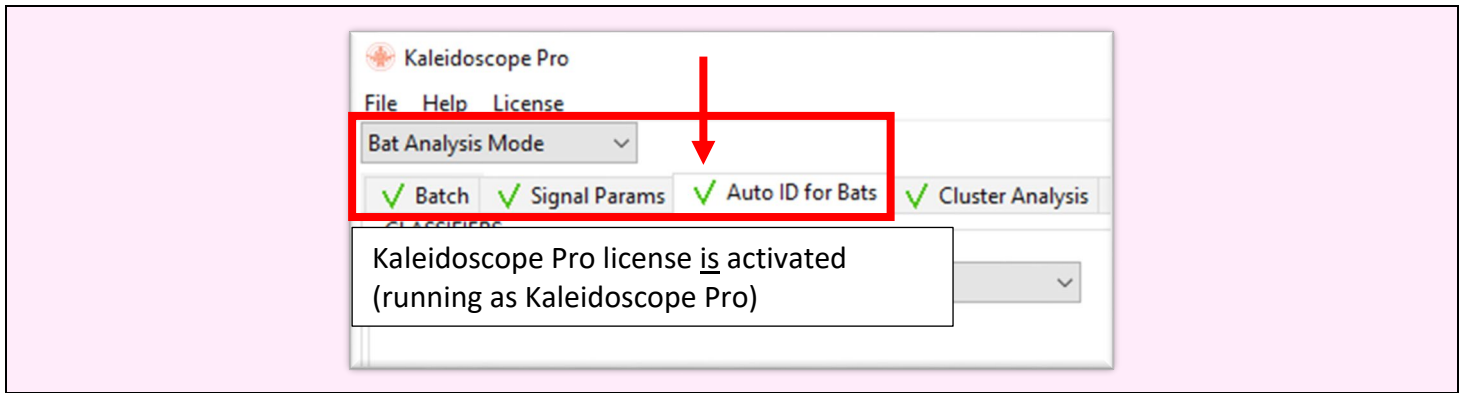
- When Kaleidoscope is first installed, no license is activated, and the software runs as Kaleidoscope Lite.
- A Kaleidoscope Pro annual software subscription license can be purchased from Wildlife Acoustics or an authorized reseller.
 - To activate a Kaleidoscope Pro subscription license, the license must be available in a Wildlife Acoustics User Web Account. For additional information, see [License Activation Help](#).
 - The available Kaleidoscope Pro license is activated via the Control Panel License menu.
 - Kaleidoscope Pro features also can be activated with a temporary trial license. Cloud and database functions are not available with a trial license.

Check if a Kaleidoscope Pro license is currently activated on a computer:

- Select Bat Analysis Mode from the menu in the upper left of the Control Panel.
 - If there is a red X in the Auto-ID for Bats tab, a Kaleidoscope Pro license is not currently activated.



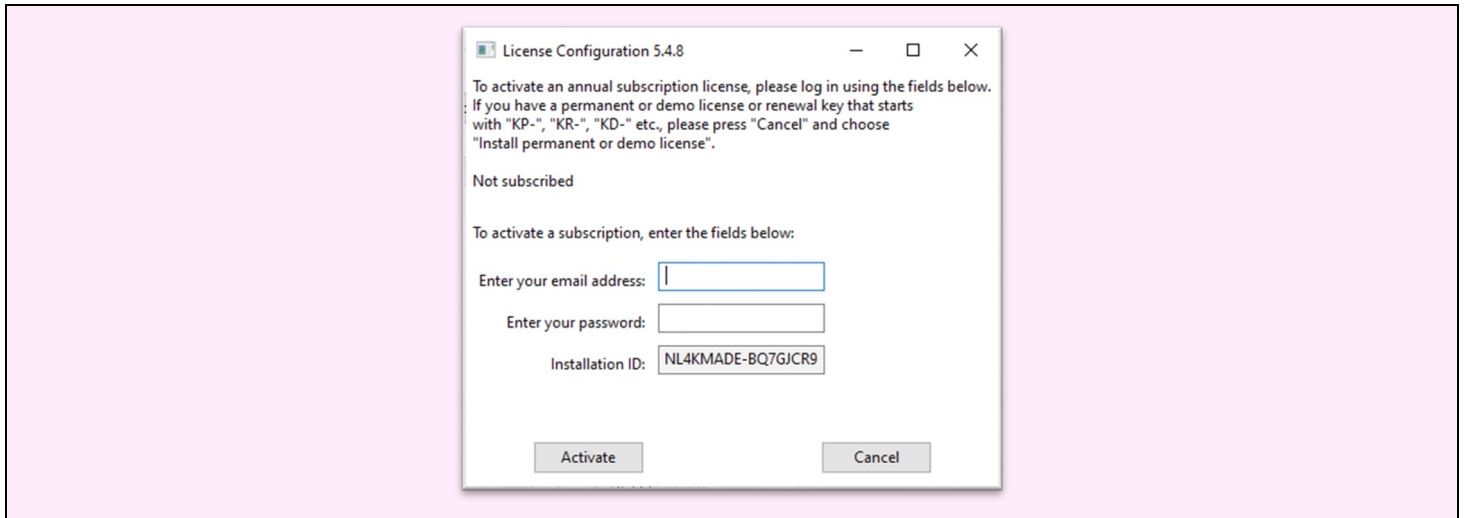
- If there is a green checkmark in the Auto-ID for Bats tab, Kaleidoscope Pro is currently activated on this computer.



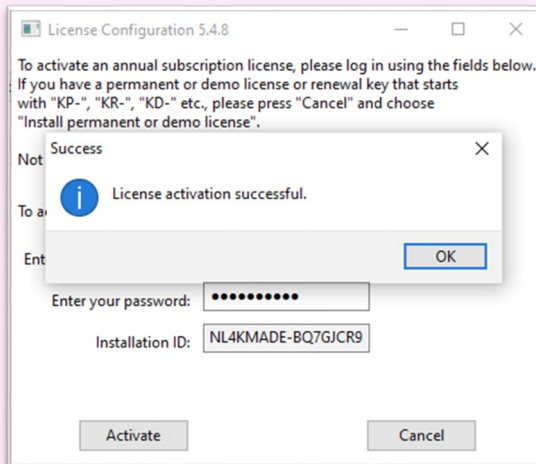
NOTE: The Auto-ID for Bats tab will always display a red X when Kaleidoscope is in Non-Bat Analysis Mode, regardless of whether a license is activated or not.

Activate a Kaleidoscope Pro Subscription License:

1. Open Kaleidoscope.
2. Click on the License menu and choose Activate Annual Subscription.
3. The License Configuration window will open.

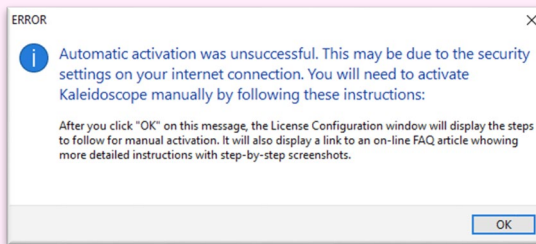


4. Enter the email address and password for the Wildlife Acoustics User Web Account which contains the available subscription license.
5. Press the Activate button.
 - o If the computer is connected to the Internet, Kaleidoscope Pro will complete the license authorization process and display a window to confirm activation.

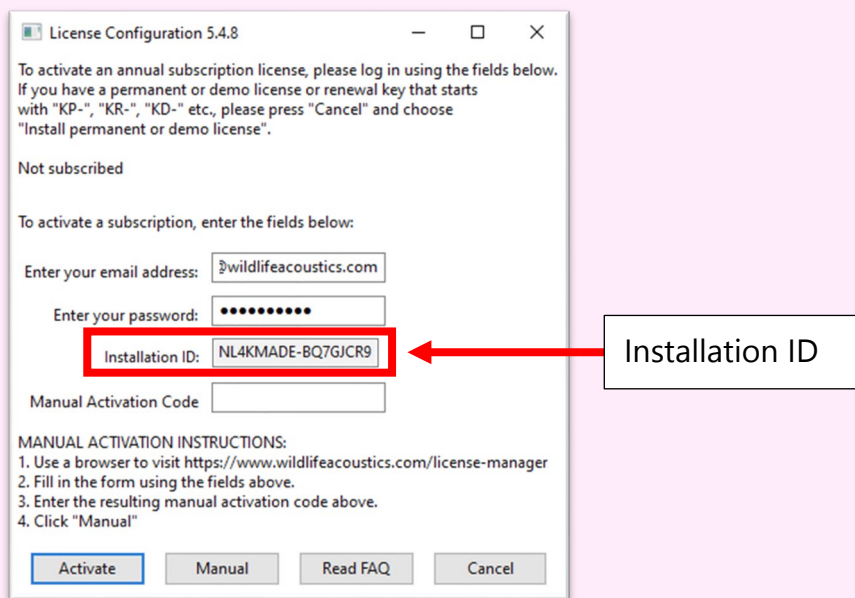


Manual License Activation

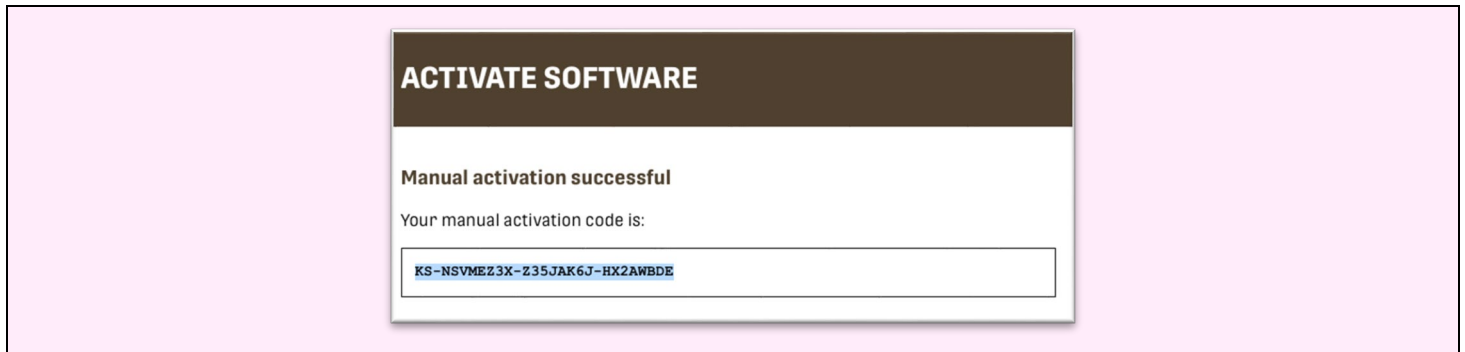
If the computer is not connected to the internet, or if the local network has a firewall, Kaleidoscope will display a message that the activation has failed. If this happens, follow the instructions for Manual License Activation.



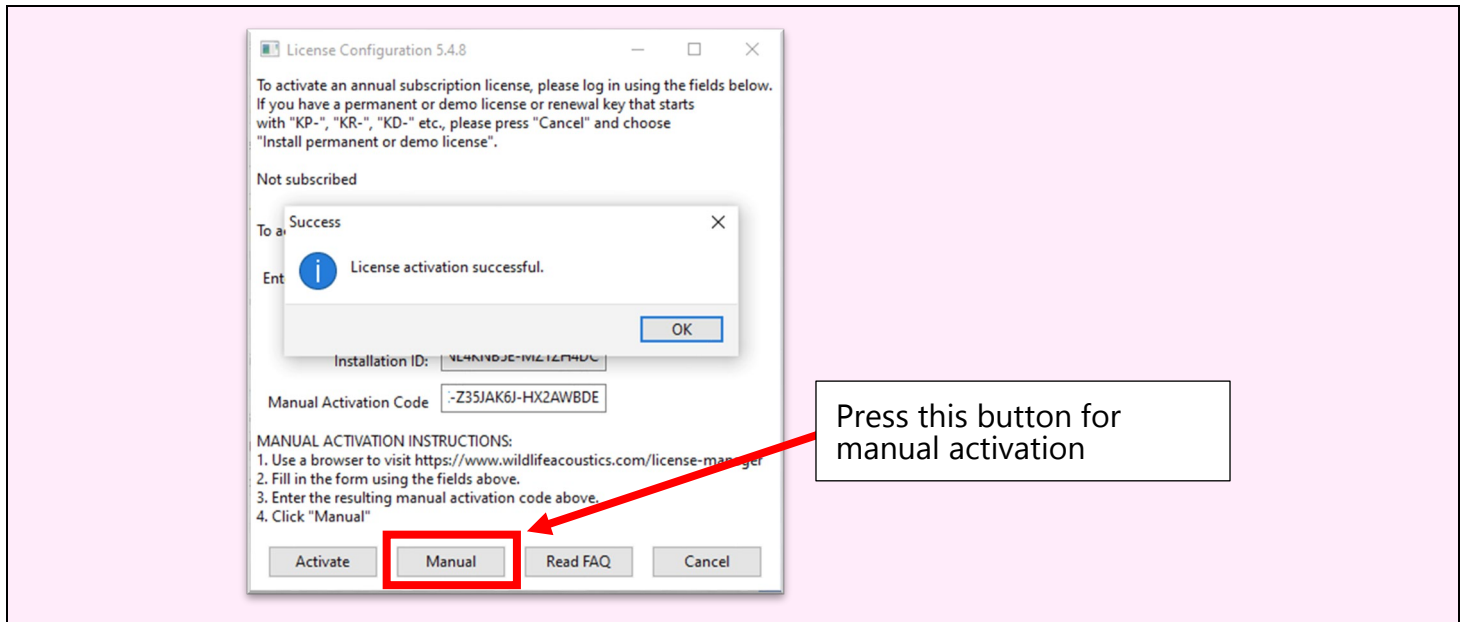
1. Press the OK button. A Manual Activation window will be displayed.
2. Make note of the Installation ID number displayed in the License Configuration window.



3. Access the Internet and log on to this address: [wildlifeacoustics.com/license-manager](https://www.wildlifeacoustics.com/license-manager).
4. On the License Manager web page choose the type of license to activate (Choose Subscription).
5. Follow the instructions to receive a Manual Activation Code.



6. In the Kaleidoscope License Configuration window, enter the Manual Activation Code in the field below the pre-filled account email and password fields.
7. Press the Manual button. Kaleidoscope will display a window to confirm the activation.



NOTE: The license management system for Kaleidoscope Pro is designed to be highly flexible to accommodate different admin/user situations. For additional assistance with Kaleidoscope Pro license management, please see the Wildlife Acoustics website [Frequently Asked Questions](#) or contact Wildlife Acoustics [Customer Support](#).

2 Typical General Use Workflows

Kaleidoscope includes multiple tools designed for use in the bioacoustics analysis workflow.

The following sections provide descriptions and step-by-step instructions for using Kaleidoscope to perform common tasks.

- Some functions require an activated Kaleidoscope Pro license.
 - If a Kaleidoscope Pro license is required to perform a specific function, it will be noted.
- The workflow examples herein assume Kaleidoscope software is currently installed and if a Kaleidoscope Pro license is required for a specific function, a license is currently activated.
 - For any installation and/or license activation questions, please refer to the [Getting Started](#) section in this User Guide.

2.1 Set Defaults

When Kaleidoscope is first installed and opened, it uses default settings, which include:

- Window sizes and positions
- All checkboxes
- All menu options.
- All Signal Parameter settings

- Viewer color and FFT settings
- Viewer zoom settings
- Custom Button Labels
- Results window column layout

NOTE: Restoring Kaleidoscope to default settings will delete any custom settings throughout the software. For instructions to Save and recall custom settings, see the next section.

To restore default settings at any time, choose Set Defaults from the Control Panel File menu.

- When Set Defaults is selected, the Analysis Mode menu opens.
- Select the Analysis Mode and Press OK.
 - Kaleidoscope reopens with default settings.

NOTE: Set Defaults restores both Bat Analysis Mode and Non-Bat Analysis Mode to Wildlife Acoustics assigned default settings, regardless of which mode is selected.

- Set Defaults does not affect a Kaleidoscope Pro license activation in any way.

Tip: The default settings are optimized for general survey work in both Bat Analysis and Non-Bat Analysis Modes. Default settings are designed to be the most likely parameters to produce immediately useful results.

2.2 Create and Restore Custom Settings

Multiple customized workspaces and workflow settings can be saved as named presets.

- Changes made to any settings are automatically saved when Kaleidoscope is exited or quit.
- When Kaleidoscope is opened, it will recall its last used settings.
- Settings can be saved within a file, and then recalled at any time.
 - A settings.ini file is created as an output result of any batch process.
 - The settings.ini file contains a record of all settings at the time a batch process was run.
 - A settings.ini file can be used as a Saved Settings Preset.
 - A settings.ini file can be renamed.
 - Multiple Saved Settings Presets can be created and recalled for specific workflow uses.

Tip: To create a preset of a current workspace without doing any specific analysis, run a simple batch process with no analysis functions enabled. This will quickly create a current settings.ini file, which can be used to recall the current workflow settings. All other output results from the batch process can then be discarded.

NOTE: No actual input recording files are required in order to run a batch process and create a settings.ini file.

- To restore Kaleidoscope to a previously saved state:
 1. Choose Load Settings... from the Control Panel File menu.
 2. Navigate to and select the saved (and possibly renamed) settings.ini file.
 - This will recall all the settings which were saved in the settings.ini file.

2.3 Use the Viewer

The Viewer is a window in Kaleidoscope that provides immediate information about the contents of a recording file.

- For additional reference information, see: [The Viewer](#).
- The Viewer provides audio playback, graphic representation, and statistical analysis based on selection within the audio file.
- The Viewer opens a single WAV, W4V, WAC, or Zero-Crossing audio file.

NOTE: For information regarding compatible file formats, see: [Audio File Formats](#).

- The Viewer includes a Metadata Panel for display and editing of file metadata.
- The Viewer can be used to process and export audio selections as WAV files.
- Viewer settings can be customized and saved.
 - For additional information, see: [Create and Restore Custom Settings](#).
- The Viewer can be used to manually examine and label results after an automated batch process analysis.

- The Viewer includes extensive optimizations and features designed specifically for analysis of bat recordings.
 - For additional information, see: [Optimize for Bat Analysis](#).

Open an Audio File

There are three ways to open an audio file in the Viewer:

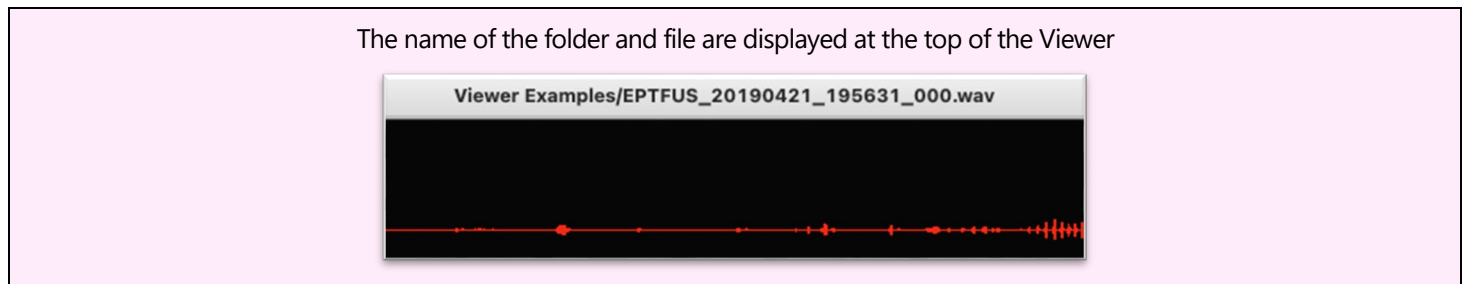
- Use the Control Panel File menu Open... command.
 - A new Viewer window is opened each time a file is selected and opened.
 - This allows for multiple Viewer windows to be opened and displayed simultaneously.
- Use the Viewer File menu Open... command.
 - This command will replace the file currently displayed in the Viewer with the newly selected file.
- Open the results of a batch process.
 - When a meta.csv, id.csv, or cluster.csv file is opened, the Viewer will also open to display associated files or detections within files.
 - To open the results of a batch process, choose Open Results... from the Control Panel File menu.
 - For further information, see:
 - [The meta.csv File](#)
 - [The id.csv Results Window](#)
 - [Cluster Analysis Results Window and Viewer](#)

To select and open an audio file from either the Control Panel or the Viewer:

1. Go to the Control Panel File menu or Viewer File menu and choose Open...
2. Find and select a compatible audio file.
3. Double-click or choose Open... to open the file in the Viewer.

NOTE: The Viewer will only open compatible format audio files. For more information, see: [Audio File Formats](#).

- The Viewer opens to display the selected file.



Replace Current File

A single Viewer window displays a single file at a time.

To replace the currently open file with a different file:

- Go to the Viewer File menu and choose Open...
- Navigate to and select a new file to open.

Open Files in Succession

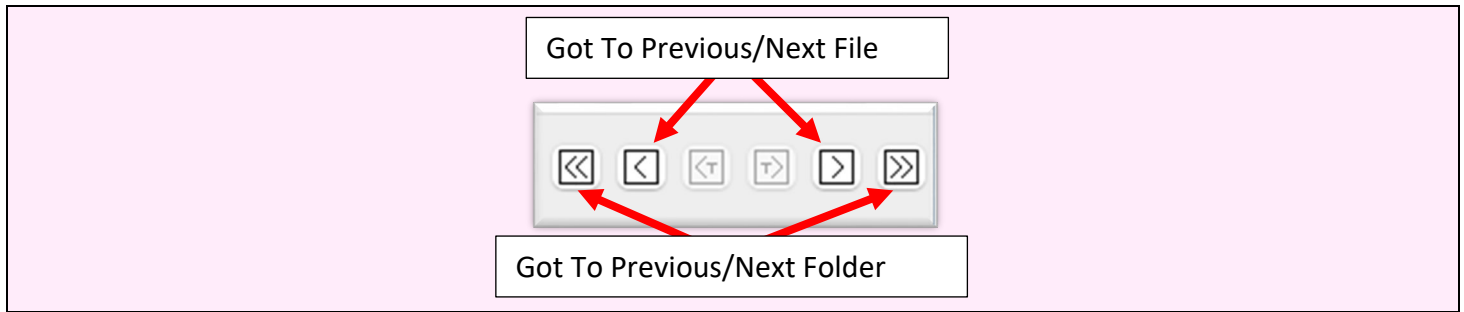
Multiple files can quickly be sequentially displayed in the Viewer.

To view files in succession:

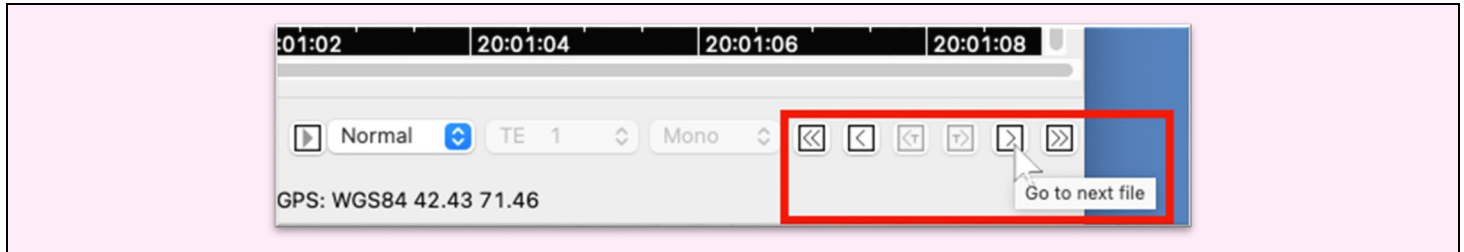
- Click on the right or left single-arrow buttons below the spectrogram. This will load the next/previous file into the Viewer.

To files in sequential folders:

- Click on the right or left double-arrow buttons below the spectrogram. This will load the next/previous file from the next or previous folder into the Viewer.



NOTE: When viewing the results of a cluster analysis, the single-arrow buttons select the next or previous detection as displayed in the list. The double-arrow buttons select the first detection in the next listed cluster, or last detection in the previously listed cluster.



Open Multiple Viewer Windows

Multiple Viewer windows can be opened to display separate files simultaneously.

- To do this, open each file, one at a time, from the Control Panel File menu.

Resize the Viewer

To resize the Viewer, grab and drag the bottom right corner of the window or use the standard Mac or Windows resize buttons in the upper portion of the window.

- Kaleidoscope remembers the size and window position of the Viewer. This means the Viewer will open in same position each time Kaleidoscope is opened.
- Kaleidoscope supports remembered window positions when using multiple computer monitors.

Segmentation of Long Files

Significant computer memory (RAM) is required to display a spectrogram. By default, Kaleidoscope limits how much RAM can be allocated for spectrogram display. As a result of the limited memory allocation, Kaleidoscope will display large files as separate segments.

- If the file has been segmented, the currently displayed segment and the total number of segments will be shown at the top of the Viewer, to the right of the file name.

Example: The following graphic shows this file has been broken into 11 segments by the Viewer. Segment number six within the file is currently being displayed.



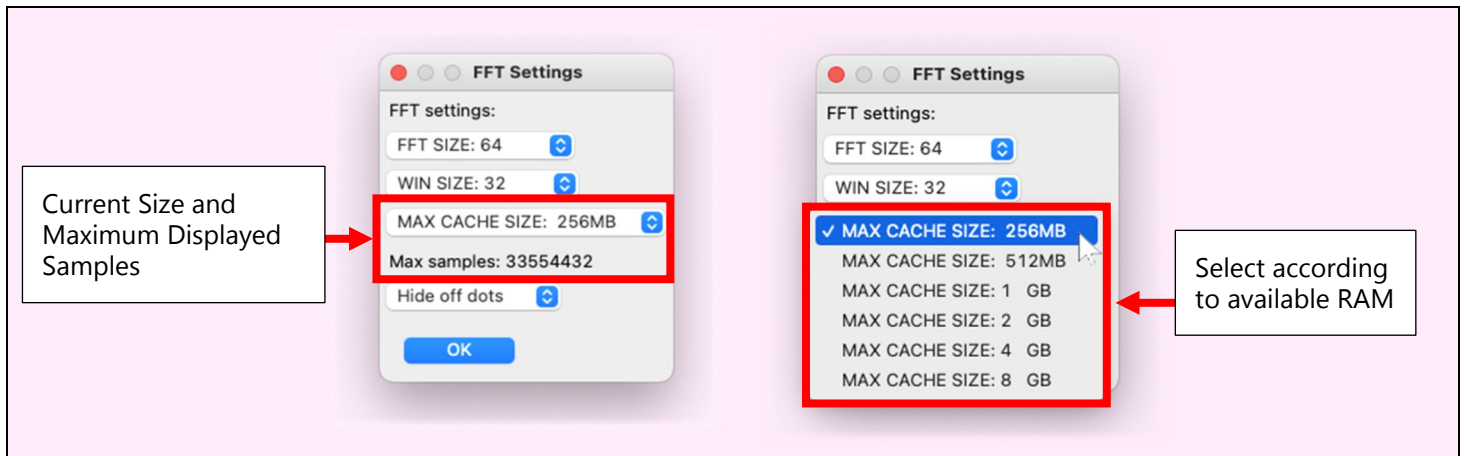
To toggle left or right between file segments, click the left or right Toggle buttons under the spectrogram.



- This will update the visible segment and also change the number at the top of the window to reflect the new current segment.

Adjust File Segmentation Length:

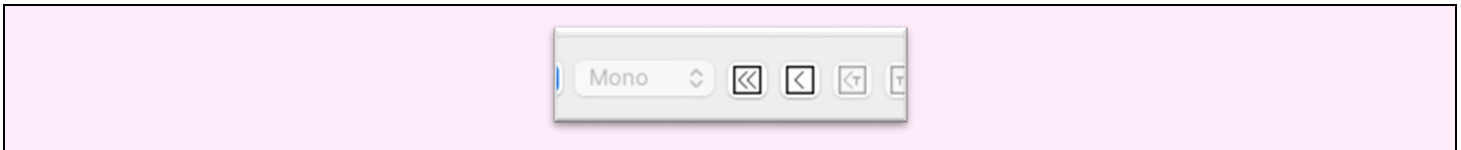
- Under the Viewer File menu choose FFT Settings...
- The Max Cache Size menu provides selection a of range of maximum allowable RAM to be used for the spectrogram display.
- The Max Samples display describes the maximum number of digital audio samples displayed with the selected Cache Size.
- A larger Max Cache Size requires more available computer RAM and displays longer segments of large files.
- A smaller Max Cache Size requires less available computer RAM and displays shorter segments of large files.



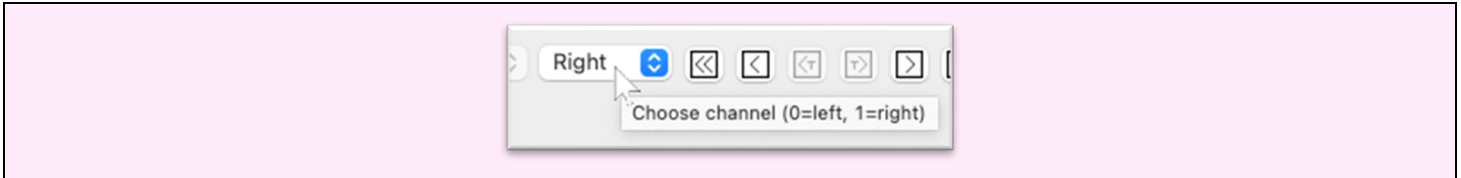
Mono and Stereo Files

The Viewer can open mono (single-channel), and stereo (two-channel) audio files.

- If a file is a single channel, Mono will be greyed out in the Channel Selection menu and non-selectable.



- If a file is stereo, Left or Right can be selected. This will change the display and playback to the selected channel.



NOTE: The left and right channels of a stereo file are displayed, played back, and analyzed independently, as if they were two separate, single-channel audio files.

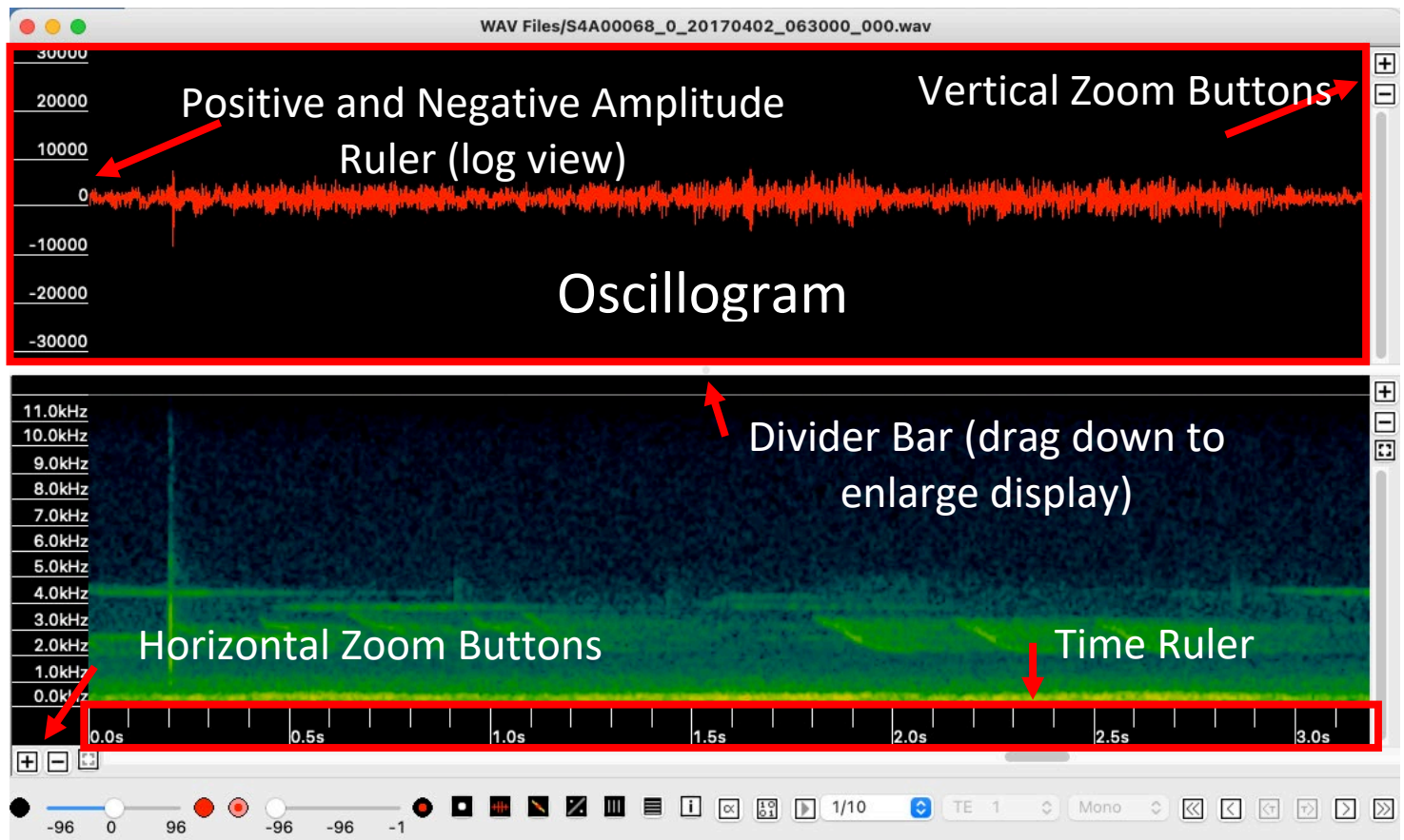
- When a stereo file is opened directly, the left channel will be displayed by default.
- When reviewing batch process results, the Viewer may display the left or right channel of a stereo file, depending on what is described and selected in the Results window.

Tip: When switching between left and right channel view, the zoom level and scroll position is maintained. This allows for quick comparison of the separate channels at the same location and zoom setting.

View Sonograms

When an audio file is opened in the Viewer, its contents are displayed as different types of sonograms. A sonogram is a visual representation of sound. Oscillograms and spectrograms are types of sonograms.

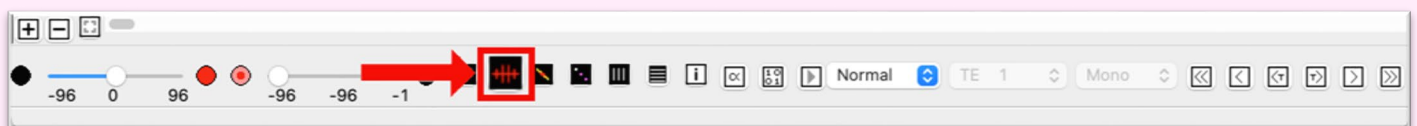
Oscillogram View



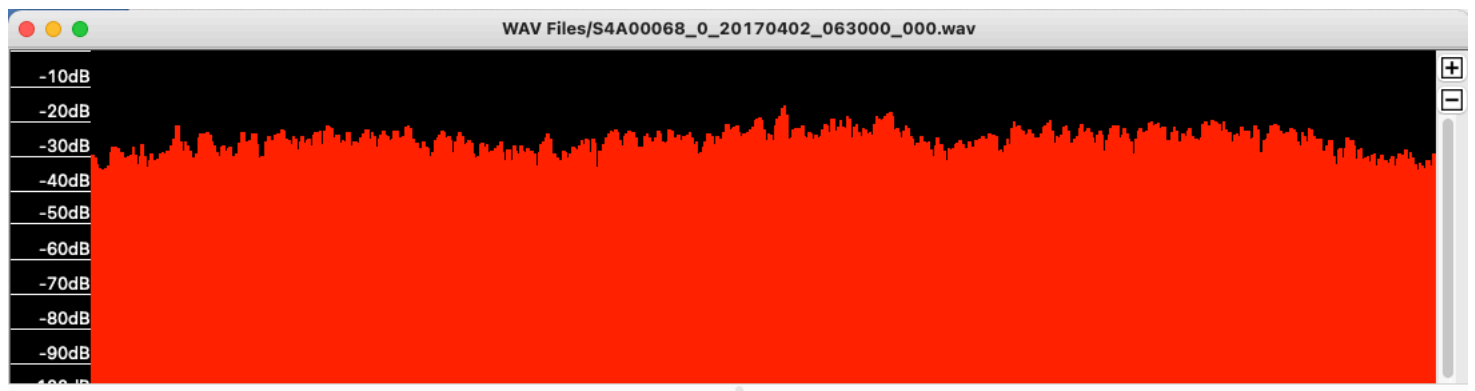
The upper section of the Viewer includes an oscillogram display.

- The oscillogram display is a representation of the audio waveform.
- When zoomed in closely in time, the actual audio waveform is visible.
- When zoomed out, the oscillogram is useful for seeing relative amplitude activity over time.
- Grab the bottom edge of the oscillogram window and drag up or down to resize the display. The window resizes when the mouse cursor is released.
- Horizontal zoom level and scroll location are linked with the spectrogram window below.
- Elapsed time is represented from left to right (horizontal axis).
- Amplitude is represented from top to bottom (vertical axis).
- Log view (default) displays both positive and negative amplitude of the waveform.
 - In log view, the ruler on the left and the mouse cursor display positive and negative amplitude values based on sample bit-depth.

The oscillogram can be toggled to display linear or log view by pressing the button below the spectrogram.



- Linear view displays an RMS average of amplitude of the waveform.
 - In linear view, the ruler on the left and the mouse cursor display amplitude in dB relative to 0 dB = full-scale.



- Zero-Crossing files do not contain the full-spectrum information required to create an oscillogram. Therefore, if a Zero-Crossing file is opened in the Viewer, the oscillogram display will be empty.

Spectrogram View

The spectrogram displays three aspects of a full-spectrum audio file.

- Elapsed time is displayed on the horizontal axis from left to right and is linked to the oscillogram view.
 - Elapsed time is displayed in the Time Ruler below the spectrogram and is measured in seconds.
- Frequency is represented in the vertical axis of the spectrogram.
 - The Frequency Ruler on the left displays frequency measurements from bottom (low frequency) to top (high frequency).
 - Frequency is described in units of hertz (Hz) or kilohertz (kHz).
 - Zoom buttons and the scroller on the right of the spectrogram adjust the visible frequency display.
- Amplitude is represented by color intensity.
 - Amplitude can be adjusted with the Brightness Slider below the spectrogram.
 - Contrast can be adjusted with the Contrast Slider below the spectrogram.
 - To customize Viewer color schemes, go to the Viewer File menu and choose Color Settings...

Zero-Crossing View

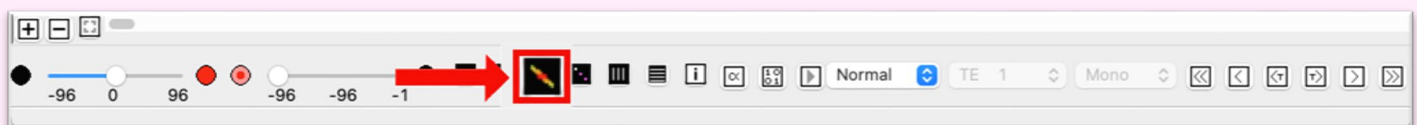
Zero-Crossing is a technology originally developed for recording ultrasonic bat calls.

- A field recorder can have the specific capability of recording bat calls as Zero-Crossing format files (.zc).
 - Kaleidoscope can open Zero-Crossing format files.
 - Zero-Crossing files do not contain full-spectrum content. Therefore, a Zero-Crossing file will not display a spectrogram or oscillogram.
- The Viewer uses the same portion of the display to show both Zero-Crossing and full-spectrum information.
- Kaleidoscope automatically converts full-spectrum (WAV) audio to Zero-Crossing format for display.
 - Kaleidoscope converts full-spectrum audio for both bat recordings and non-bat recordings to Zero-Crossing format display.
 - Zero-Crossing display for non-bat recordings can be useful in specific situations, but not in the same way it is used for bat recordings.

Tip: When Kaleidoscope creates a Zero-Crossing view for non-bat recordings, a narrow-band filter is used to look for the highest peaks of amplitude in the signal. This may be useful to see at a glance what Kaleidoscope considers primary activity in the audio. If the Zero-Crossing view is not being used, disabling Zero-Crossing view will provide a less cluttered view of the spectrogram

- Zero-Crossing information is displayed as a series of dots.

When a full-spectrum file is open, Zero-Crossing view can be enabled or disabled via this button below the display:



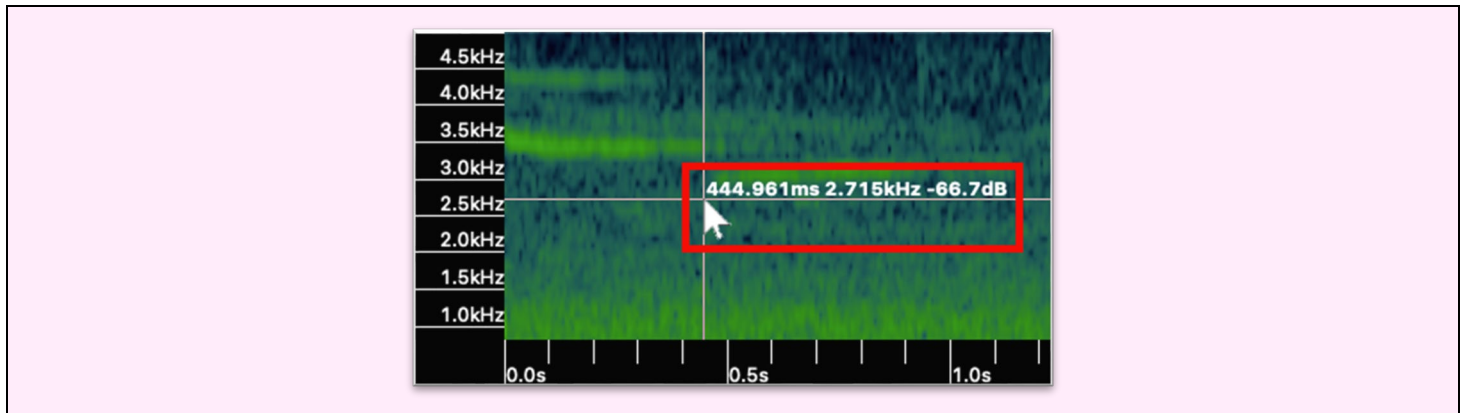
- Press the Zero-Crossing View button to toggle between three states:
 - Off
 - On with analysis highlight

- On with no analysis highlight
 - The analysis highlight is used to point to the flattest part of a bat call.
 - To change the Zero-Crossing color display and Dot size, go to the Viewer File menu and choose Color Settings...

Mouse Cursor Display

When positioned over the spectrogram or oscillogram views, the mouse cursor displays a crosshair. The crosshair is used to make measurements and selections.

- Information is displayed to the right of the crosshair, based on the mouse cursor position.



- The first number to the right of the mouse cursor displays either the elapsed time from the beginning of the file or the current real-time position. This is based on the [Time Ruler display mode](#).
- When over the spectrogram/Zero-Crossing view, the second number is the current frequency position, as referenced to the Frequency Ruler on the left.
- The last number to the right of the cursor (in spectrogram and oscillogram view) represents relative amplitude based on current cursor position.

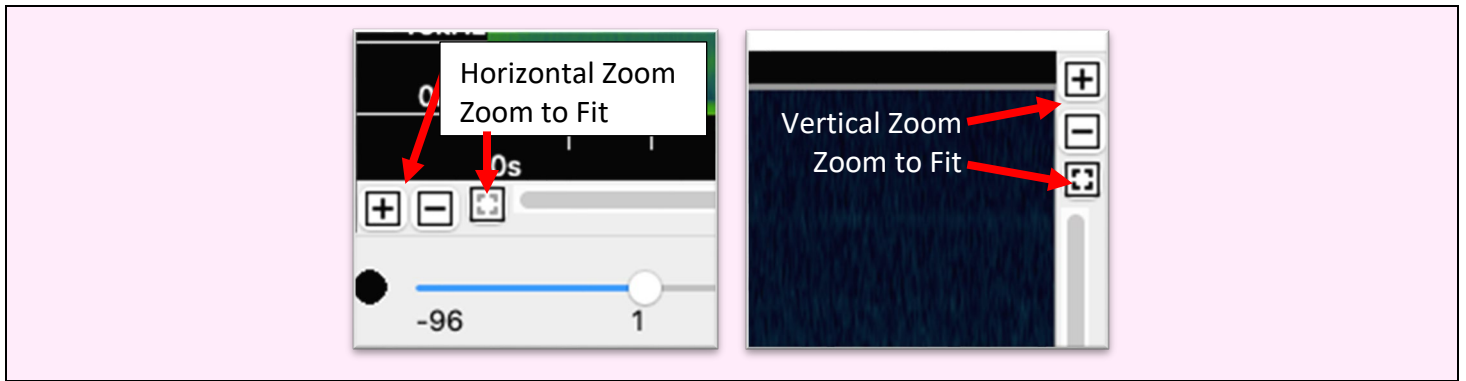
Tip: In the spectrogram and log display of the oscillogram, full-spectrum amplitude is based on full-scale = 0 dB. This means the loudest amplitude which can be described by the file is 0 dB. Any signal below the loudest describable signal is shown as a negative number.

Example: If the mouse cursor crosshair is over a signal which is displayed at -45 dB, and then the cursor is moved to a different place in the spectrogram and displays -65 dB, this indicates the frequency and time at the crosshair location with the -45 dB measurement has more amplitude (louder) than the frequency and time at the crosshair location which shows -65 dB (softer).

Zoom and Scroll

Navigation, zooming, and selection within the audio file is essential for effective use of the Viewer.

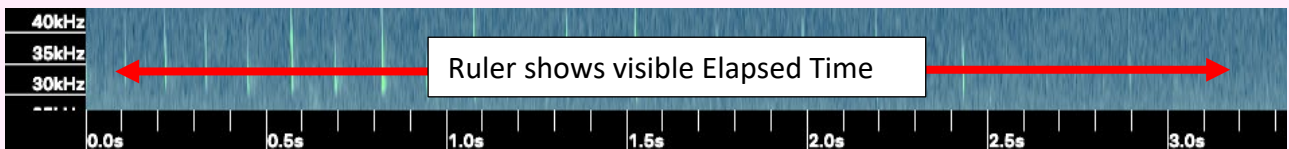
- The Viewer provides extensive and customizable shortcut keys for zooming and navigation.
- Elapsed/absolute time is displayed from left to right.
 - The horizontal zoom level and time position of the oscillogram and spectrogram views are linked.
 - Horizontal Zoom buttons are available in the bottom left corner of the spectrogram.
 - A third button provides horizontal Zoom-to-Fit.
- The oscillogram and spectrogram can be independently zoomed and scrolled on the vertical axis.
 - Vertical Zoom buttons are available separately in the upper right corners of the oscillogram and spectrogram views.
 - A third button provides vertical Zoom to Fit for the spectrogram view only.



- The vertical axis of the oscillogram describes relative amplitude within the audio file.
- The vertical axis of the spectrogram/Zero-Crossing view displays the available frequency range of the audio as described by the file sample rate.
- Double-click the Time Ruler at the bottom of the spectrogram to toggle the time display format.

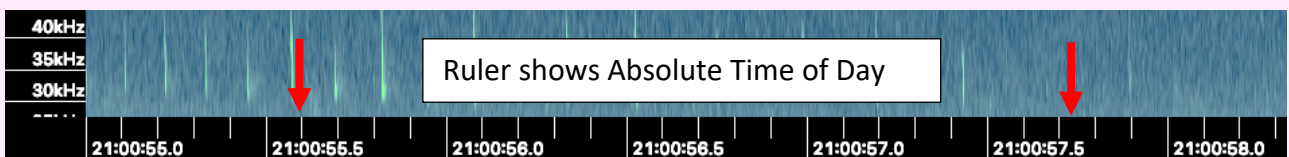
Example 1: Elapsed Time shows how much time is currently displayed in the window, in seconds and starting from zero.

- Changing the horizontal zoom level will display more or less elapsed time.
- The Elapsed Time Ruler does not change if the content of the file is scrolled left or right.



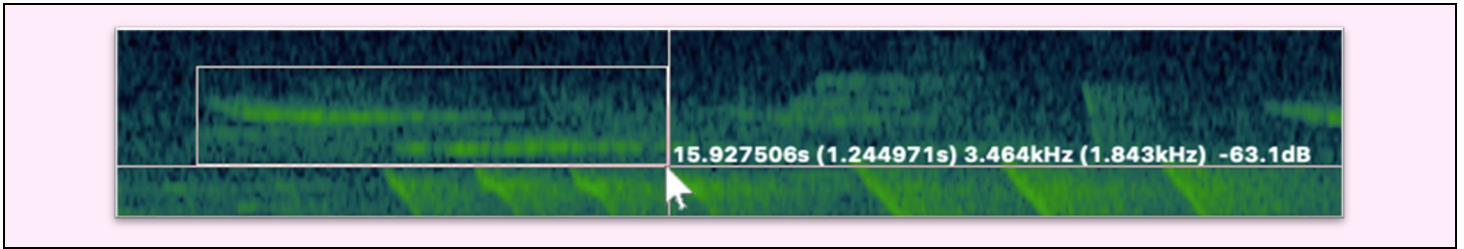
Example 2: Absolute Time of Day shows the actual time of recording at each point in the file.

- Absolute Time of Day is based on Timestamp metadata in the file.
- If there is no Timestamp metadata, the Absolute Time of Day Ruler is not available.
- The Absolute Time Ruler will move with the file if the file is scrolled left or right.



Make a Selection

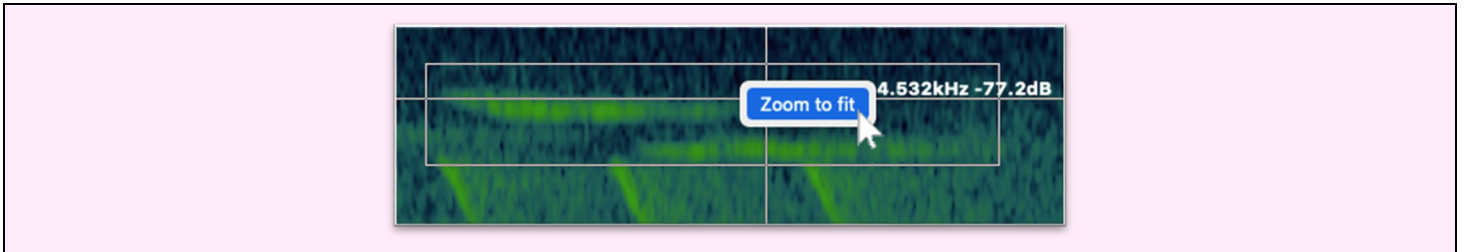
- The bottom left corner of the Viewer displays time from the left edge of the window to the beginning of the file, or selection information.
- When making a selection with the mouse cursor, the measurements change as the cursor moves. This allows selections to be made with precision.
- To make a selection, left-click and drag diagonally in either the oscillogram or spectrogram display. The mouse cursor crosshair displays:
 - Start time of the selection based on time from start of the file, or real-time depending on the Time Ruler display mode.
 - Length of time selection
 - Start frequency of selection
 - Bandwidth of frequency selection
 - Relative amplitude of current cursor location



- Left-click once to delete the selection.

Zoom to Selection

- Right-click inside a selection for the option to Zoom to fit. This will expand the selection to fill the window.



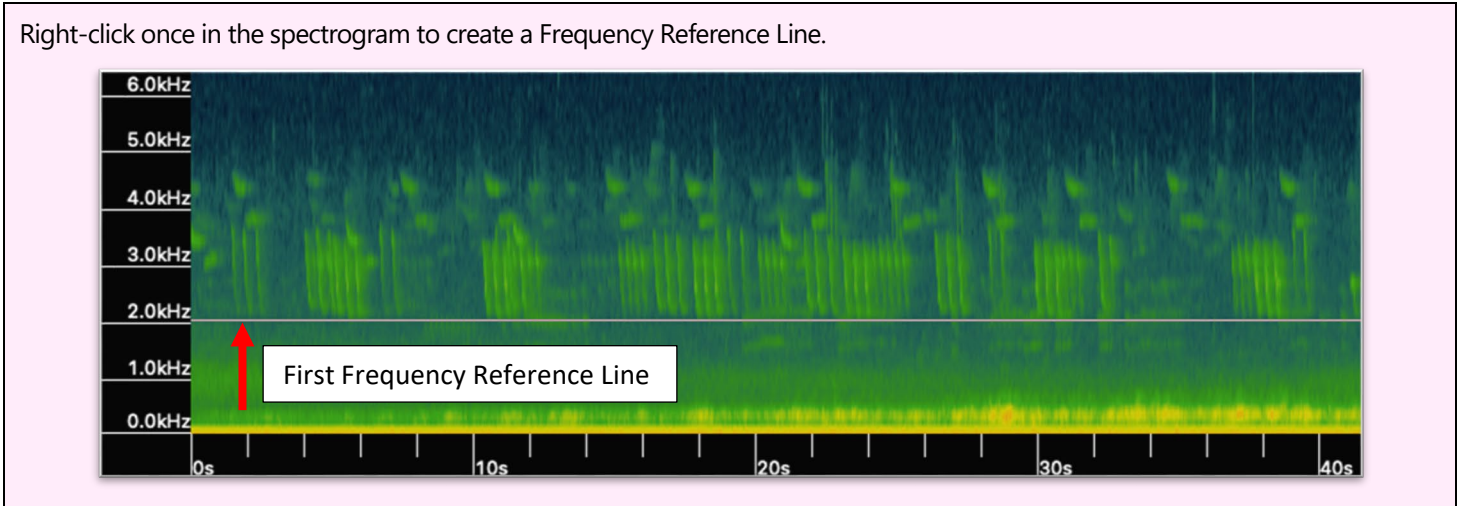
Frequency Reference Lines

One or two Frequency Reference Lines can be created in the spectrogram.

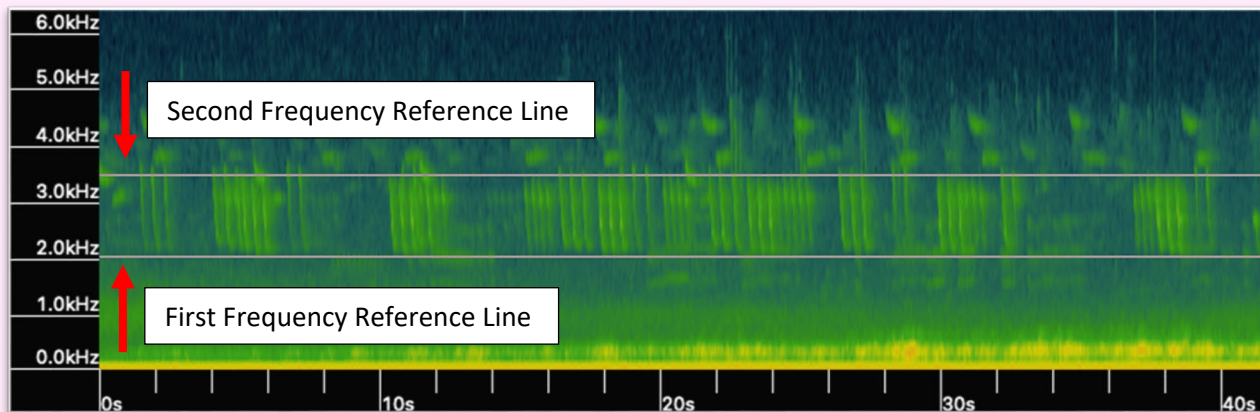
- A Frequency Reference Line is superimposed over the spectrogram.
- The Frequency Reference Line is used to compare activity in the file at a specific frequency point.

NOTE: In Bat Analysis Mode, a single Frequency Reference Line is used to engage and set the heterodyne frequency for audio playback. For additional information see [Heterodyne Playback](#).

- If the file is scrolled or if a new file or detection is displayed, the References Line will stay in place.



Right-click a second time to create a second Frequency Reference Line.



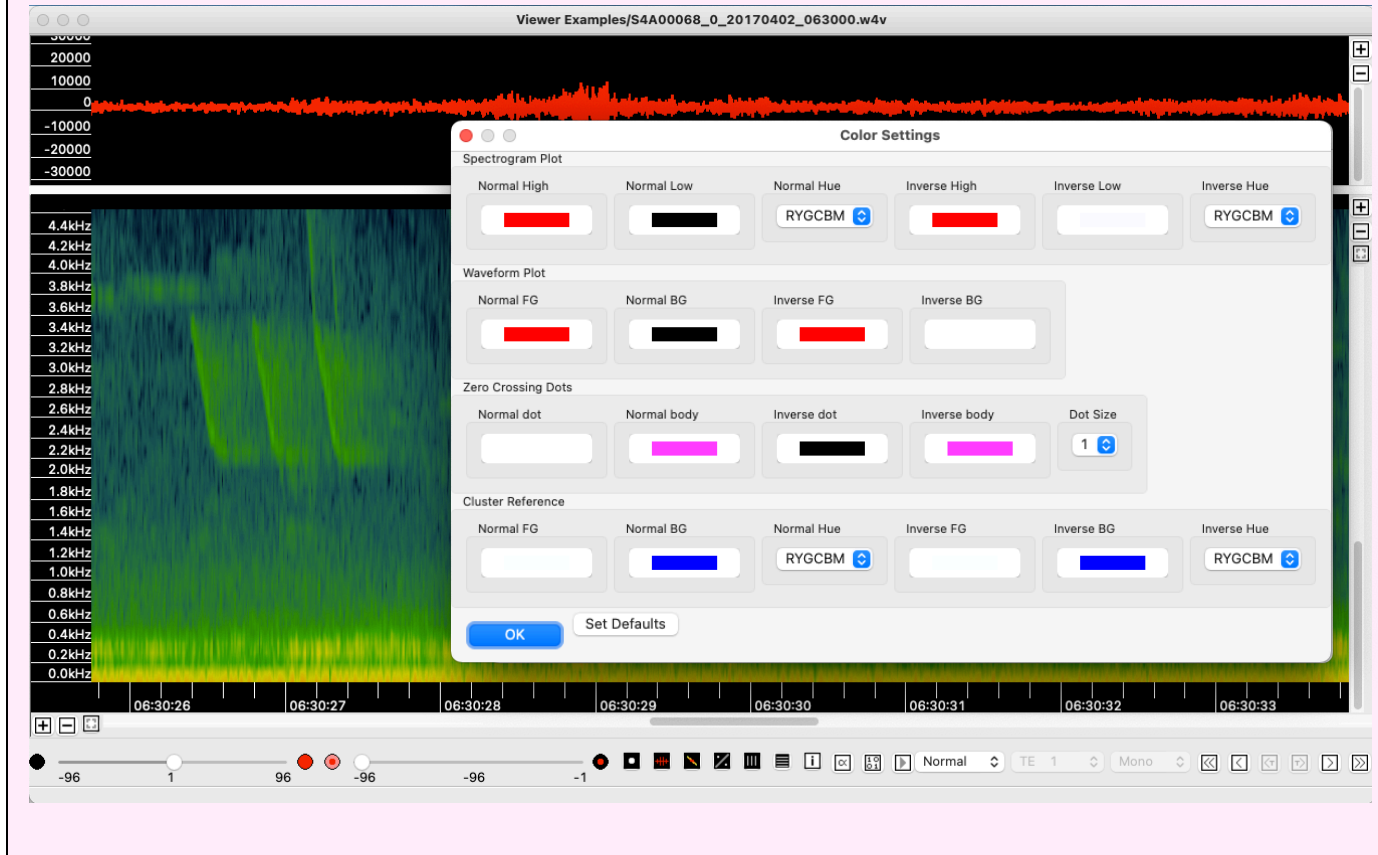
- Right-clicking a third time will remove the first Frequency Reference Line and create a new line.
 - A maximum of two Frequency Reference Lines can be displayed at one time.
- Double-right-click in the spectrogram to remove all Frequency Reference Lines.

Customize Color Settings

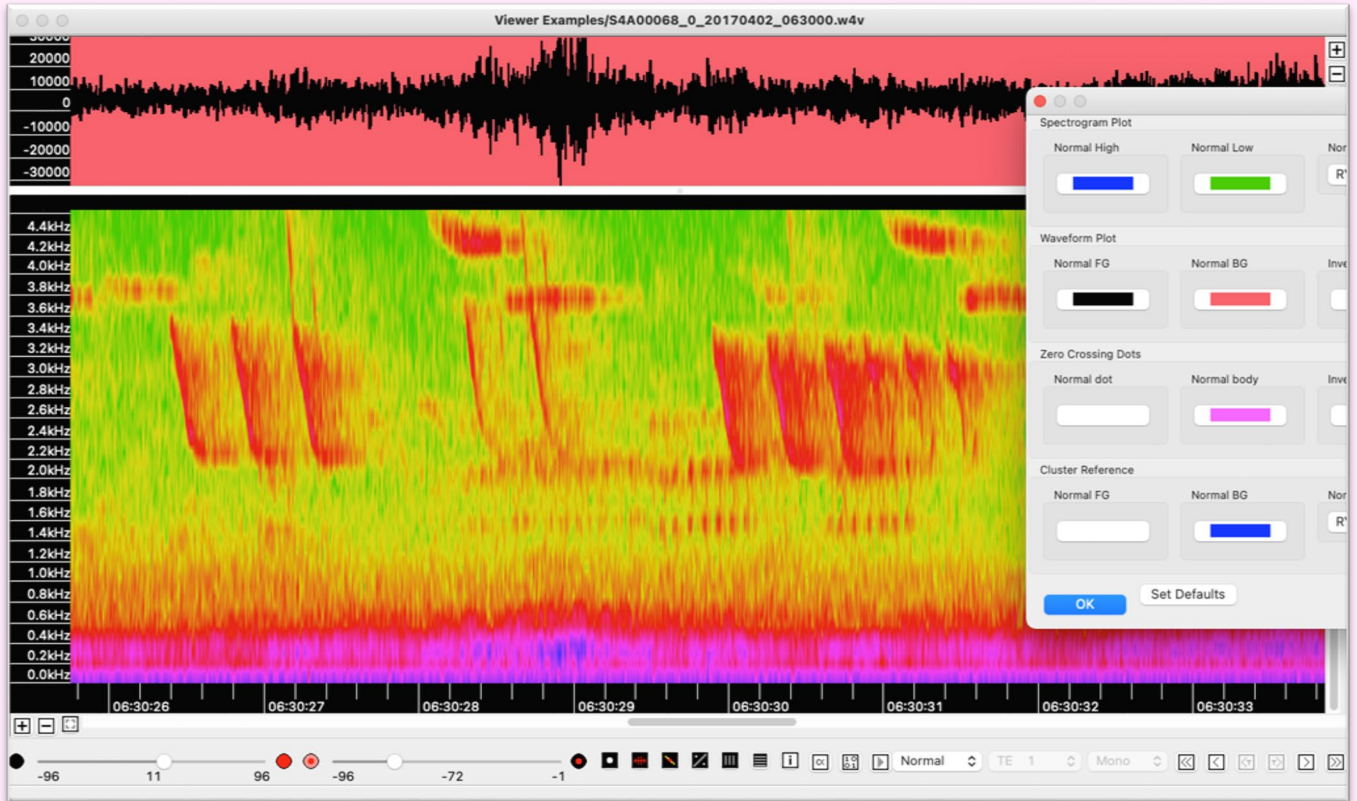
All colors used in the oscillogram and spectrogram displays can be customized.

- Two sets of preset display colors are available.
 - Toggle between color display sets with the Invert button.
- Under the Viewer File menu choose Color Settings.
 - 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 amplitude (High) and minimum amplitude (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 oscillogram 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.
 - Zero-Crossing detections can be configured in the same way as the spectrogram with a high color, low color, and hue direction.
- Viewer colors can be reset to defaults in the Color Settings window. This will not affect any other setting in Kaleidoscope.
- Custom color settings are remembered and can be saved as part of a settings.ini file.

Example 1: This graphic shows the Color Settings window with all Default Settings, including Brightness and Contrast Sliders.



Example 2: This graphic shows the same window with customized colors and adjusted Brightness and Contrast Sliders.

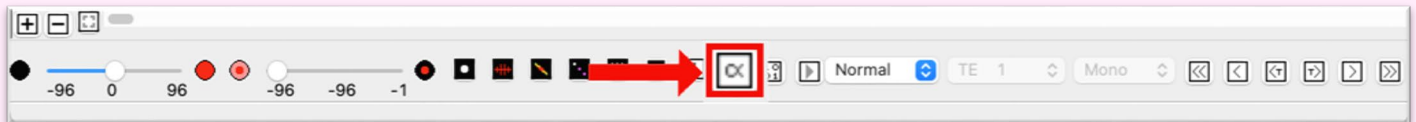


The Viewer Analysis Window

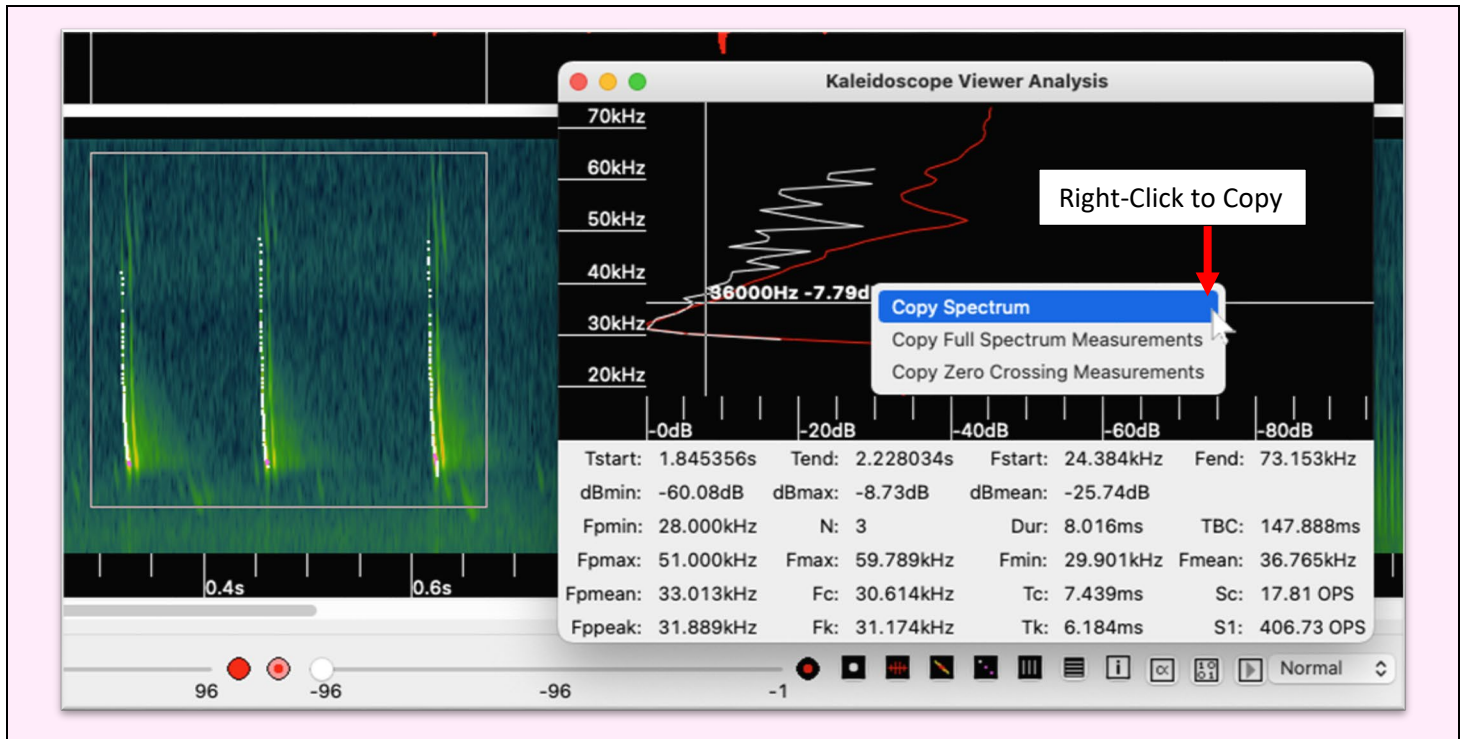
The Viewer Analysis window is a sub-window of the Viewer.

- For additional reference information, see: [The Viewer Analysis Window](#).

Hide or show the Viewer Analysis window using the button located below the spectrogram/Zero-Crossing display.



- The Viewer Analysis window represents information regarding a selection made in the spectrogram/Zero-Crossing view.
 - If no selection is made, the Viewer Analysis window will represent the currently visible portion of the spectrogram/Zero-Crossing view.
 - If a selection is changed or modified, the information in the Viewer Analysis window will update in real time.
- Both full-spectrum and Zero-Crossing statistical information can be represented.
- Graphic and numeric content can be exported by right-clicking in the upper portion of the Viewer Analysis window.



Play Sound

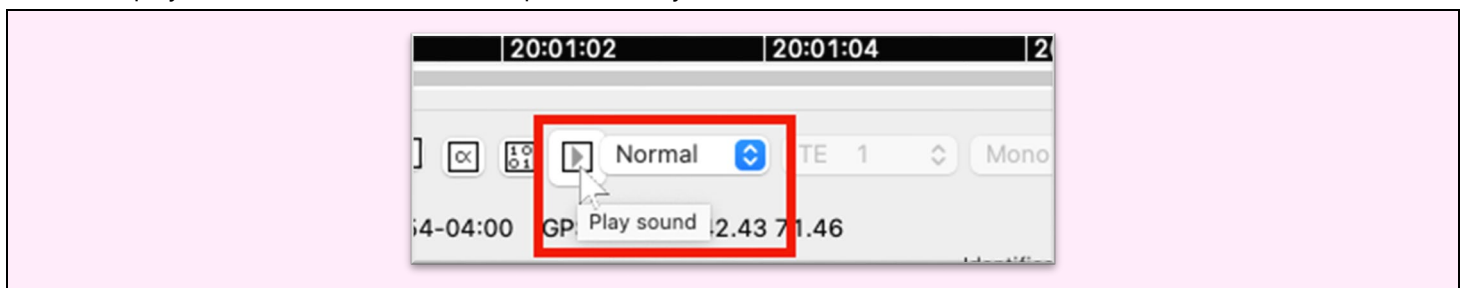
The Viewer can be used to play back a full-spectrum audio file. Zero-Crossing files do not produce audio output.

NOTE: The Viewer uses the computer audio system for playback. Therefore the computer must have a working audio playback system. This can include the built-in computer speakers or headphone jack, or an external audio interface. If the computer can play back simple sounds from its internal alerts, media, or web playback, it will be able to play back sound from the Kaleidoscope Viewer.

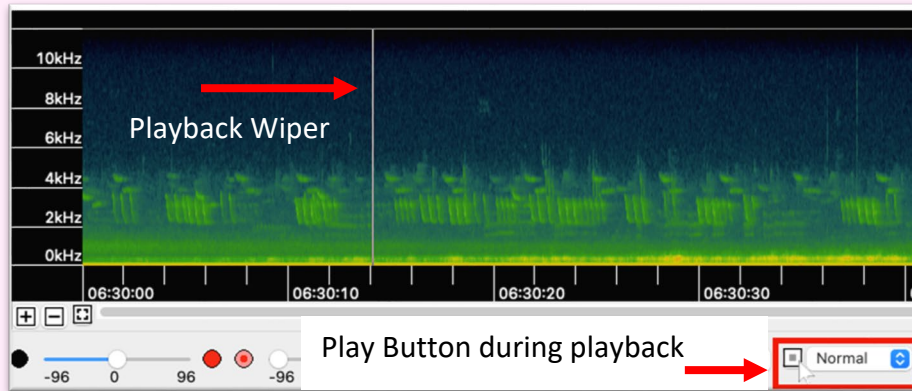
NOTE: When running Kaleidoscope under Linux OS, specific components must be installed for audio playback. See: [Minimum Computer Requirements](#).

Tip: If there is ever an audio playback problem with Kaleidoscope, the first thing to check is that the computer can play back audio from another application such as a web browser or media player.

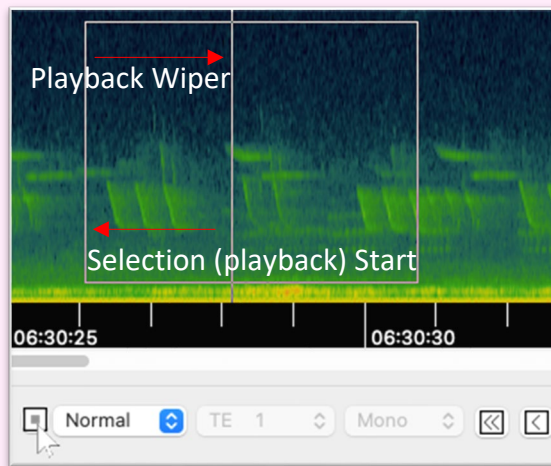
- The Viewer does not play back two-channel or stereo audio. If a file is a stereo (two-channel) file, the Viewer will display and play back a single channel at a time.
 - If the audio file contains a single channel of sound, Mono is displayed in the Channel Selection menu and is not selectable.
 - If the file is stereo, Left or Right can be selected for playback. This will also change the display to show the selected playback channel.
- To play back audio from the Viewer, press the Play button.



- When audio playback begins a Playback Wiper will scroll to show the current playback position.



- Playback starts from either the left edge of window or from the beginning of a selection.
 - To start playback from anywhere in the visible portion of the file, click and drag to create a selection box, then press the Play button.



Tip: Playback is based on either the visible portion of the spectrogram or a selection made within the spectrogram. If the Viewer does not appear to be playing back audio, make a new selection in the spectrogram to see if playback works in the new selection.

NOTE: It is possible for a selection to be made, and then for the view to be scrolled so the selection is no longer in the visible portion of the window. If this happens, playback will still start from the beginning of the (off screen) selection.

Heterodyne Playback

Heterodyne is a playback function used for ultrasonic recordings of bats. Heterodyne playback is available in Bat Analysis Mode only.

Heterodyne works by generating a tuning signal which is mixed with the bat call. The frequency of the heterodyne signal is the difference between the tuning signal and the bat call. This then generates a lower frequency audio signal which may be heard by human ears. The result is a real-time playback of audible bat calls without the need to slow the recording down.

- To engage heterodyne playback, right-click in the spectrogram/Zero-Crossing window to create a single frequency reference line. The frequency of the reference line is the frequency of the tuning signal.

NOTE: If there are two frequency reference lines visible, heterodyne playback will not work.

- Press the **Play** button to hear the heterodyne playback signal.

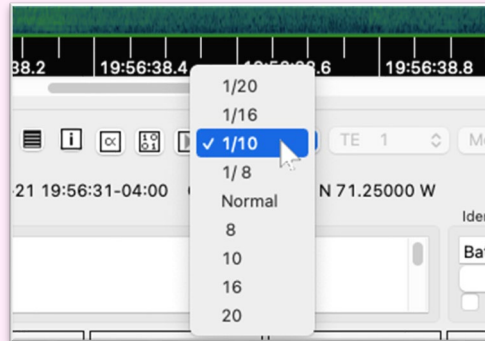
Change Playback Speed

The Speed menu is to the right of the Play button.

- Select a whole number to speed up playback by the selected amount.
- Select a fractional number to slow down playback speed by the selected amount.

The most typical use of this function is to slow down an ultrasonic recording so it will play back within the frequency range of human hearing.

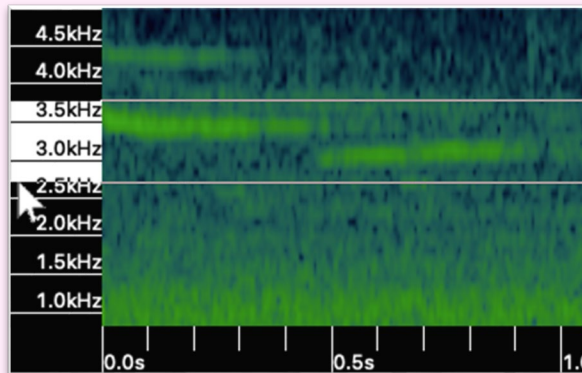
Example: A setting of 1/10 will slow the playback down to one-tenth its normal speed. This is typically used to audition bat calls and other ultrasonic sounds.



Use a Bandpass Filter

A bandpass filter is a tool used to isolate sound based on frequency range.

- A bandpass filter works by setting low frequency and high frequency cut-off points.
- Audio signal above and below the cutoff frequencies is muted.
- Only audio signal within the described frequency band is passed through.
- To create a bandpass filter, left-click and drag in the Frequency Ruler on the left of the spectrogram view.
 - As the mouse cursor is dragged over the Frequency Ruler, frequency reference lines will be displayed to the right.



- When the mouse button is released, the reference lines will no longer be displayed.
- To remove the filter, left-click once anywhere in the Frequency Ruler.

A bandpass filter can be used in the Viewer to isolate frequency ranges for playback. This is extremely powerful when a sound in one frequency range is relatively low in amplitude compared to sounds in surrounding frequencies.

- In such a case the lower amplitude sounds in one frequency range may be masked by sounds in other frequencies and therefore difficult or impossible to hear.
- If a bandpass filter is used to isolate a frequency range, the amplitude can be increased (with the Amplitude Slider) and only that frequency range will be audible and amplified.
- This can reveal sounds which would otherwise be inaudible.

Using a bandpass filter in the Viewer is a useful technique for human-based analysis. It can also be a powerful tool to determine the best minimum and maximum frequency settings to be used for automated batch processing.

Save WAV...

The Viewer can be used to export and Save a full-spectrum audio selection as a separate WAV file.

- Under the Viewer File menu, choose Save WAV...
- If a selection is made in either the oscillogram or spectrogram, that is the time range which will be saved.

- If no selection is made, the currently displayed time range will be saved.
- If any change has been made using the Gain Slider, Compressed View mode, or a bandpass filter, these changes will be part of the saved file.
- The sample rate of the Saved WAV file will be the same as the original file.
- A window will open verifying any changes made to the audio before the new file is created.
- The next window will allow naming of the new file and selection of the Save location.

Tip: When working with batch process results, it is possible to select and Save one or more files or detections in the Results window. The files/detections can then be saved as separate WAV files with a single operation. Changes made in the Viewer are not saved to WAV files exported from the Results window.

The Metadata Panel

The Metadata Panel is part of the Viewer.

Information embedded as metadata in the audio file can be viewed and edited in the Metadata Panel.

- For additional reference information, see [Metadata Panel](#).
- For additional reference information regarding the overall metadata workflow see: [Metadata Workflow](#).

The Metadata Panel is used for working with Manual IDs. For additional information, see [Use Manual IDs](#).

The top edge of the Metadata Panel displays the following information: (if the information exists in the file)

- **Prefix** - This is WA format information specific to Wildlife Acoustics field recorders.
- **Model** - This is standard text format information describing the model of recorder. (For Wildlife Acoustics recorders this also includes the recorder serial number).
- **Timestamp** - This is the start time and date of the recording. UTC offset may or may not be included. The degree of time precision is up to the model of recorder which creates the file.
- **GPS** - This is information based on location data provided by the recorder.

To show or hide the Metadata Panel press the button under the spectrogram.



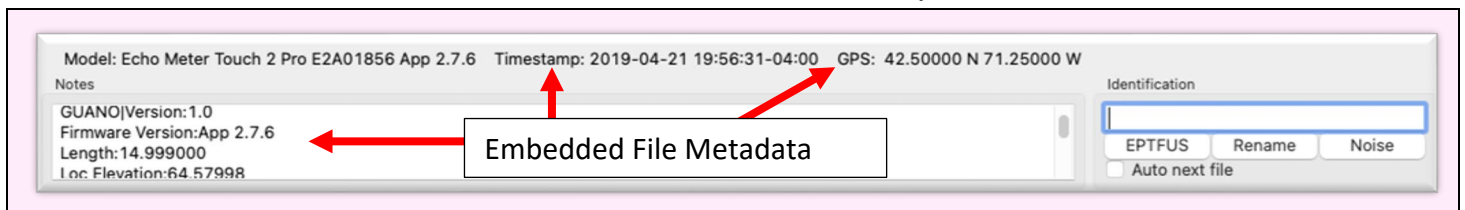
Tip: Hide the Metadata Panel when it is not currently in use to provide more space for the sonogram displays.

Metadata embedded in the currently displayed audio file can include:

- Standard WAV format metadata (sample rate and file length)
- Any GUANO format metadata. For additional information, see [Standardized GUANO Fields](#)
- Proprietary WA (Wildlife Acoustics) format metadata
- Additional metadata added by Kaleidoscope or other software applications during previous processing

The Notes window displays additional file metadata.

- The top portion of the Notes window is used to display any text Notes metadata.
- Scroll down in the Notes window to view additional metadata currently embedded in the audio file.



GUANO format metadata can be viewed, edited, and added under the following text:

- GUANO|Version:1.0
 - If this tag does not exist in the Notes window it must be added.
 - A GUANO format metadata field and value is described with a key and a value.

Example: Here is GPS location described in GUANO format:

```
Notes
-----
GUANO|Version:1.0
Loc Elevation:64.57998
Loc Position:42.50000 -71.25000
.....
```

Loc Position is the text that describes the metadata field (key).

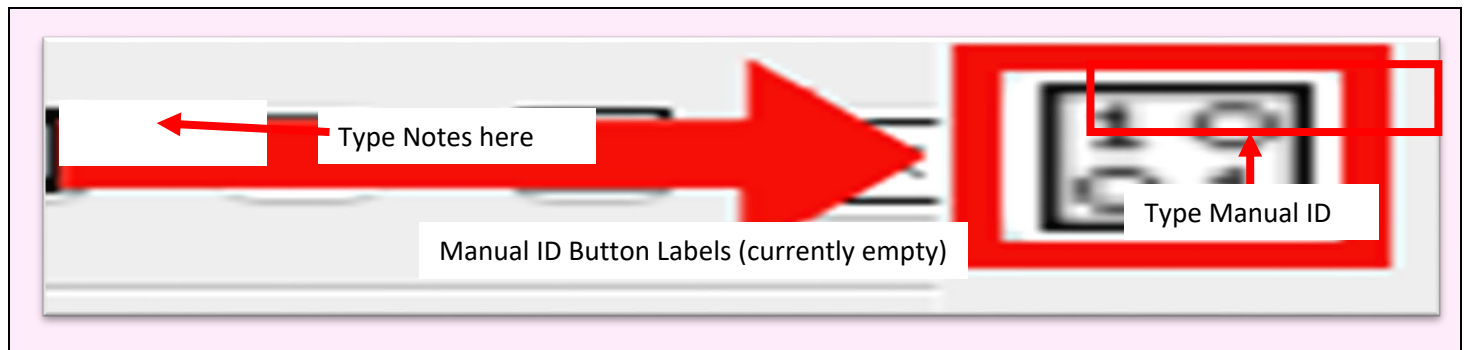
: is used as a separator between the key and value.

42.50000 -71.25000 is the value that is entered in the metadata field.

NOTE: Metadata must exist in the file in order to be displayed in the Metadata Panel. If specifically formatted metadata is not seen in this window, it does not exist in the audio file.

Notes can be added directly to individual audio files.

- Open an audio file in the Viewer.
- Type into the Notes field in the Metadata Panel.
- Press Return or close the file to save.



A Manual ID can be edited or added directly to the file.

- Manual ID is a standard metadata field. Manual ID can be any customized user text.
- Type the Manual ID into the Identification box to the right of the Notes field.
- Press Return or close the file to Save.

Tip: There is no functional difference between the Notes and Manual ID metadata fields. These are both text fields and can be used for interchangeable purposes. There are typical uses of these fields based on standard protocols. Any additional convention of how these fields are implemented is up to the user.

How FFT is Used to Create a Spectrogram

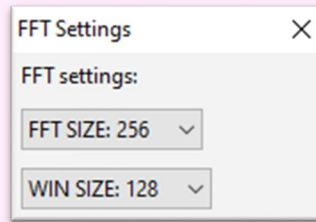
FFT technology is used to create a visual spectrogram from audio samples.

- Consecutive digital audio samples are grouped into an FFT Window.
- The number of digital audio samples within each group is described as the FFT Window Size.
- Each FFT Window is displayed as a visual slice of time in the Viewer.
- FFT analyzes energy (audio amplitude) in multiple frequency-range bins.
- Frequency bins display the relative acoustic energy as relative color intensity.
- This provides the visual content to represent audio activity over a frequency range.
- FFT Windows are displayed consecutively to build the overall spectrogram.
- The same audio can be viewed at different FFT sizes.
 - For examples, see: [FFT Window Size](#).

Adjust the Spectrogram FFT Size

The visual resolution of the spectrogram can be adjusted by changing the FFT Size.

- Choose FFT Settings... from the Viewer File menu.



- **FFT Size** is the number of samples in each FFT Window.
- **WIN Size** is the number of samples by which each FFT Window overlaps in the display.

NOTE: Overlap is done to improve visual clarity. Typically the Win Size is set to half the value of the FFT Size. This provides a 50% overlap of visual FFT frames.

Tip: The default FFT Size for the Viewer spectrogram is 256 with a Win size of 128. For general work, this is usually optimal.

- When the FFT and Win sizes are changed and the OK button is pressed, the Viewer will recalculate the view using the new settings.
- If the Viewer is being used to examine detections in a batch process, changing the FFT size will reload the entire file into the spectrogram. Re-select any detection to return to the detection view.
- The FFT resolution of the Viewer spectrogram can be adjusted in a similar way to adjusting the FFT resolution for signal extraction and cluster analysis.
 - Visual resolution can be biased towards frequency definition (Large FFT Window Size).
 - Visual Resolution can be biased towards temporal definition (Smaller FFT Window Size).

Tip: Adjust the FFT Size in the Viewer to find the optimal resolution to separate a target sound from a false positive sound. Use this information to adjust the FFT Window Size under the Cluster Analysis tab.

2.4 Batch Processing and File Conversion

Kaleidoscope uses batch processing to perform automated functions.

- A "batch" may consist of one or more recording files.

NOTE: It is not required that any audio files are actually in an Input Directory in order to run a batch process. For additional information, see [Create and Restore Custom Settings](#).

- Initial configuration for batch processing is done under the Batch tab in the Control Panel. For additional reference information, see: [Batch tab](#).
- Depending on the tasks, Kaleidoscope can perform multiple batch process functions simultaneously.
- The following batch process functions are available with both Kaleidoscope Lite and Kaleidoscope Pro:
 - Create new full-spectrum and/or Zero-Crossing files, based on input files
 - Convert audio file types from input to output
 - Split stereo input files into separate mono output files
 - Split longer input files into shorter output file segments
 - Add Project Form metadata to output audio files
 - Sort output files into daily or nightly subfolders
 - Create a meta.csv spreadsheet to list input files
 - Extract metadata from input files
 - Detect and extract Signals of Interest from audio files (Non-Bat Analysis Mode only)
 - Isolate Noise files on output (Bat Analysis Mode only)

NOTE: Kaleidoscope Lite has the following limitations: Maximum 100 files per batch process in Bat Analysis Mode, maximum 4 GB of files per batch process in Non-Bat Analysis Mode. Signal detection and extraction is available in Non-Bat Analysis Mode only. These limitations are removed when a Kaleidoscope Pro license is activated.

- The following batch process functions are available only with Kaleidoscope Pro:
 - Unlimited file processing
 - Auto-ID for Bats
 - Cluster analysis (Including building and using classifiers)

- Sound Pressure Level Analysis
- Acoustic Index Analysis
- Cloud-based computing

The following sections will describe each step and option for basic batch processing, including converting and creating output audio files.

Select an Input Directory

The Input Directory is the designated location for batch process input files.

Audio files (and subfolders containing audio files) which are to be included in the batch process must be located within the Input Directory.

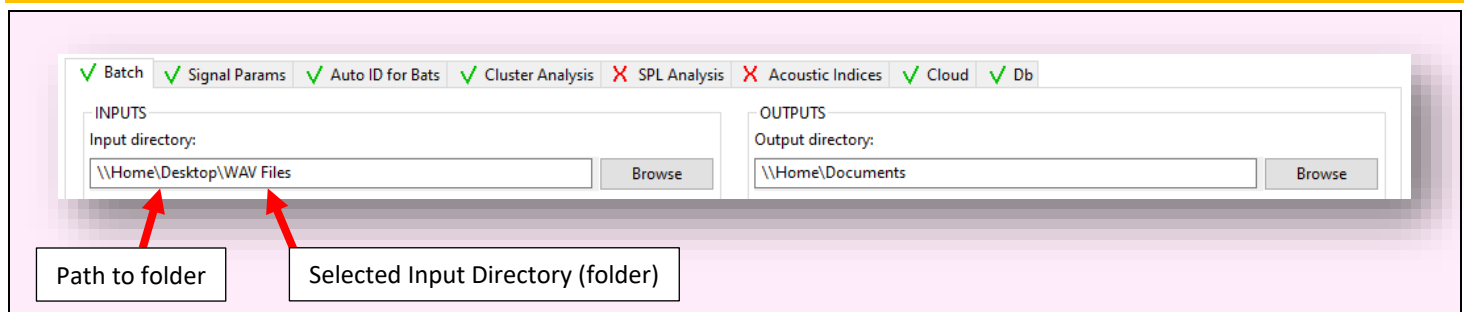
NOTE: Kaleidoscope is optimized to process many recording files as quickly as possible. Therefore it is highly recommended that the Input Directory is located on a locally connected or internal hard drive. If the Input Directory is located on an SD memory card, USB thumb drive, or cloud/network storage, this will result in slow performance and possible crashes and/or error messages.

To select an Input Directory:

1. Click on the Batch tab.
2. Click the Browse button to select the Input Directory.
3. Navigate to and select the directory/folder which contains the files to be processed.
4. When the directory is highlighted, click Select Folder (Windows) or Open (Mac).

The Input Directory path will now be displayed in the field to the left of the Browse button.

NOTE: The Browse function selects a directory (folder), not a file. Under Windows OS, the Browse button will show selectable folders, but will not display any audio files within those folders. Under Mac OS, the Browse button will display audio files within the current directory, but the file names will be greyed-out and non-selectable.



Configure Input Options

For reference information regarding input options, see: [Inputs](#).

NOTE: Kaleidoscope will not see audio files which are zipped. Any zipped files must be un-zipped before they can be opened or analyzed by Kaleidoscope.

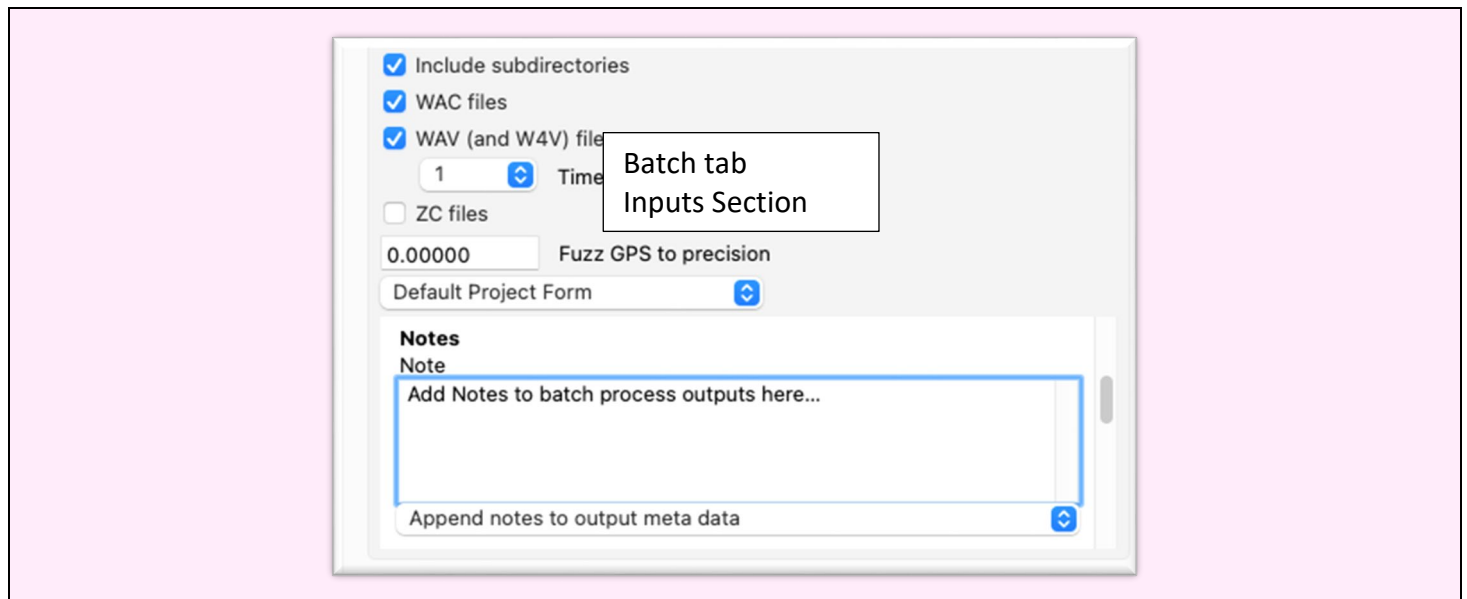
Add Notes

Notes is a standard metadata text field.

A typical use of Notes is to add information to the workflow, which is common to all to all files to the outputs of a batch process.

- Project Notes are added via the Project Form under the Batch tab.
- Project Notes are published to the default meta.csv file which is created by any batch process.
- Project Notes are added to any audio files which are created by the batch process.
- For additional information regarding the Project Form, see: [Use the Default Project Form](#).

NOTE: Project Notes must be added to the Project Form **before** the batch process is run.



Select an Output Directory

Designate an Output Directory for files created by the batch process:

1. Click the Browse button to select the Output Directory.
2. Navigate to the directory/folder which will be assigned for batch process output files. If the desired Output Directory folder does not yet exist, it can be created via the Browse window.
3. Click Select Folder (Windows) or Open (Mac) to assign the Output Directory.

The Output Directory path will now be displayed in the field to the left of the Browse button.

Configure Output Options

For reference information regarding output options, see: [Outputs](#).

Tip: If WAV and/or ZC files are checked under the output options, Kaleidoscope will create new audio files in the Output Directory. This can use significant storage space and will cause longer processing times. Many batch process functions do not require new audio files to be created on output. **Therefore be careful to NOT check WAV and/or ZC unless audio output files are specifically desired.**

NOTE: Zero-Crossing input files can be converted to WAV output files. However this process does not add any additional or useful information to the WAV file. Conversion of ZC to WAV format is not typical and is generally not recommended.

Configure Analysis Options

Additional analysis functions are selected and configured under the tabs in the Control Panel. Configuration options for each analysis function are described in the relevant sections of this User Guide.

Run a Batch Process

Follow these steps to run a simple batch process, with optional analysis and file conversion:

1. Select an Input Directory.
2. Configure input options.
3. Select the Output Directory.
4. Configure output options, including any file conversion
5. Configure and enable any additional analysis options.
6. Press the Process Files button.
 - A Processing Files window will open to show the status of the batch.
 - Once the batch process is completed the Processing Files window will close.
 - If the batch process includes Bat Auto-ID, or any cluster analysis function, the Viewer and Results window will open automatically when the processing is completed.

NOTE: 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 additional information, see: [Cloud-Based Computing](#).

Check the Results

To check the batch process results, navigate to the Output Directory folder.

- The Output Directory contains any new WAV, .w4v, or Zero-Crossing files which have been converted or created by the batch process.
 - If Kaleidoscope is in Bat Analysis Mode and audio files are created on output, a NOISE folder can be created. For additional information, see: [Analyze Noise Files](#).
- All batch processes create the following files in the designated Output Directory:
 - **meta.csv**
 - **settings.ini**
 - **log.text**
 - **db-batch.wdb** (not created when using cloud-based computing)
- The following files are created only by specific analysis functions:
 - **gps.csv**
 - **gps.kml**
 - **id.csv***
 - **idsummary.csv***
 - **cluster.csv**
 - **cluster.kcs***
 - **spl.csv***
 - **splbyfile.csv***
 - **acousticindex.csv***

(*Requires a Kaleidoscope Pro license)

To open (or re-open) the results of a batch process in the Viewer and Results window, go to the Control Panel File menu and choose **Open Results...**

- The following batch process results can be opened in the Kaleidoscope Viewer and Results window:
 - **meta.csv**
 - **id.csv**
 - **cluster.csv**
- The following batch process results files cannot be opened in Kaleidoscope. These files are intended to be opened in third-party CSV-compatible spreadsheet applications.
 - **idsummary.csv**
 - **spl.csv**
 - **splbyfile.csv**
 - **acousticindex.csv**

NOTE: Any existing settings and CSV files in the Output Directory will not be deleted or overwritten if multiple batch processes are run and the Output Directory is not changed. If previous settings and CSV output files with the same name are in the Output Directory, Kaleidoscope will add .bak# to the end of the older file names. If audio files from previous batch processes exist in the Output Directory, Kaleidoscope will replace any files with the same name.

2.5 Create a File Inventory List

Kaleidoscope can scan a directory and subfolders to create a list of the enclosed audio files.

- The inventory list is created as a standard meta.csv spreadsheet file.
 - For additional reference information, see: [meta.csv](#).
 - Additional metadata is extracted from the input files and included in the meta.csv file.
 - The specific metadata fields which are included in the meta.csv file can be customized. For additional information, see [Build a Custom Project Form](#).

The meta.csv File

When Kaleidoscope runs any type of batch process, a meta.csv file is always created in the Output Directory.

- The meta.csv file contains an inventory list of the files in the assigned Input Directory.
- A simple batch process with Default Settings can be used to quickly create a meta.csv file.
- The meta.csv file can be renamed.
- The meta.csv file can be opened and edited in any application which is compatible with the CSV file format.

Tip: If the meta.csv file is edited in an external application and its internal format is changed significantly, it may no longer be readable by Kaleidoscope. Therefore it is best practice to make a backup copy of the meta.csv file before any external editing is performed.

- Metadata can be extracted from input files and listed in the meta.csv file.
 - Output fields in the meta.csv file are based on the MetaForm and can be customized.
 - Project Notes can be added to the meta.csv file via the Project Form.
 - For additional information, see: [Metadata Workflow](#).

Review the File List

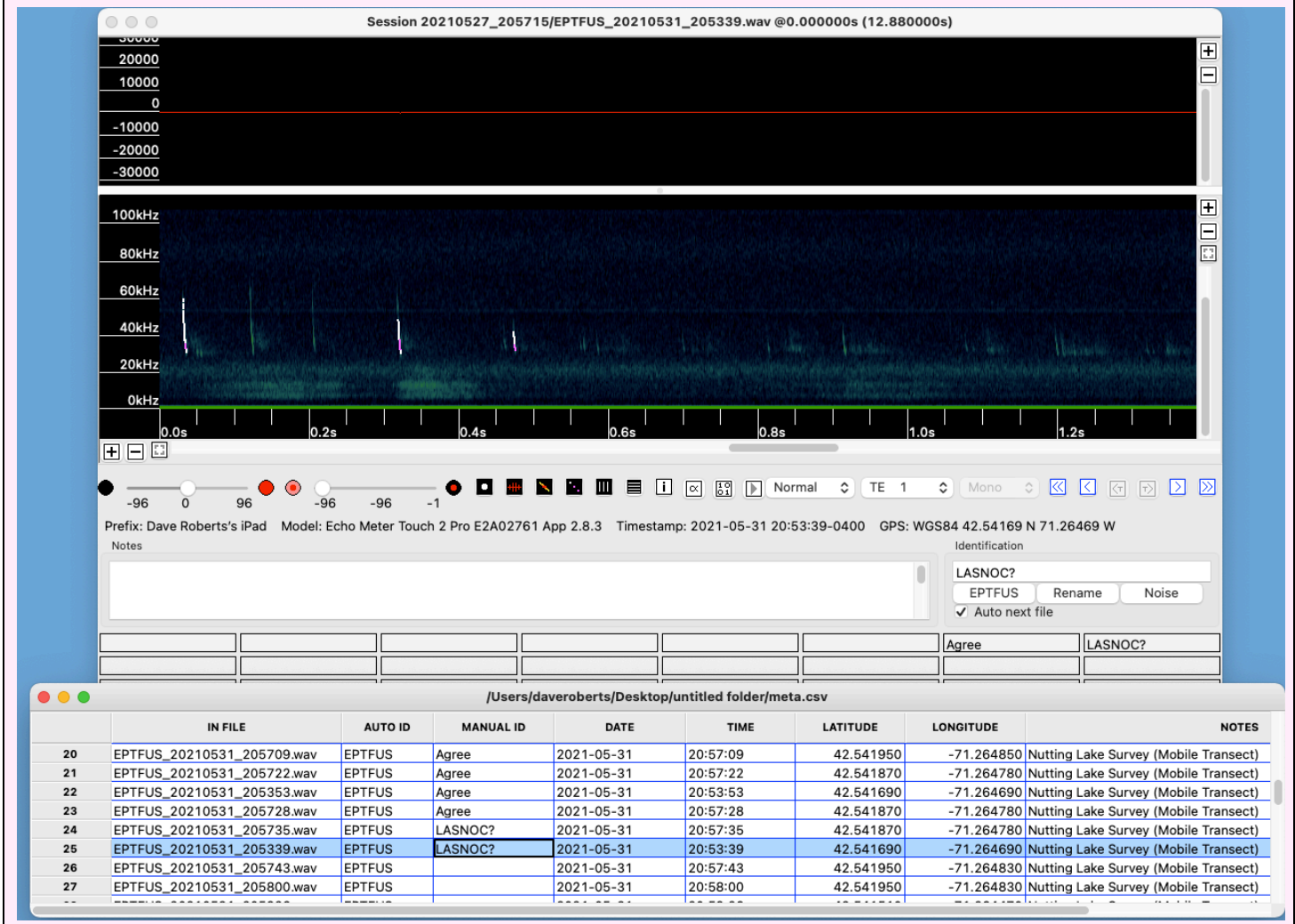
Kaleidoscope can open, view, and edit the meta.csv file.

- Under the Control Panel File menu, choose Load Results...
- Navigate to and select the meta.csv file.
- The Viewer and Results window will open.
 - The Viewer displays individual input files.
 - The Viewer can be used to add file-specific Manual IDs to the Results window and underlying meta.csv file.
- The Results Window and Viewer are linked.
 - Changing the visible or selected file in one window will update the other window.
- The Results Window represents the underlying meta.csv file.
 - Input files from the batch process are listed as rows.
 - Columns describe attributes of each file.
 - To change the column layout, choose Edit Columns... from the Results window File menu.
 - For additional reference information, see: [The Results Window](#).

Example:

Files have been recorded by an Echo Meter Touch 2 bat detector. Echo Meter Touch 2 has already analyzed the files for bat species identification. The files have been imported to the computer. A simple batch process was run to create a meta.csv file. The meta.csv file was opened from the Control Panel File menu>Open Results...

- The meta.csv file opens in the Results window.
- The Viewer opens to display the file which is currently highlighted in the Results window
 - EPTFUS_20210531_205339.wav is currently highlighted and displayed in the example below.
- The Results window displays the inventoried files as numbered rows.
- The columns in the Results window have been edited from their default settings.
- The Auto ID column displays analysis which has been performed by the Echo Meter Touch 2 bat detector.
- Notes were added to the Batch Process Project Form and are visible in the Notes column for all input files.
- Two button labels have been created in the Metadata Panel for "Accept" and "LASNOC?".
- Auto Next File is checked to speed review.
- Some individual Manual IDs have been added.



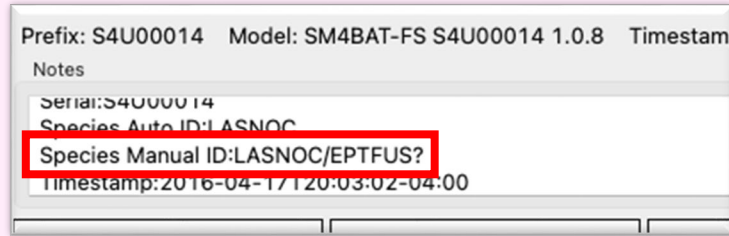
2.6 Use Manual IDs

Manual ID is a standard metadata text field.

A typical use of a Manual ID is to add information to the workflow, which is specific to a file or file segment.

Manual IDs are also part of the advanced classifier workflow. For additional information, see [Build an Advanced Classifier](#).

If there is an existing Manual ID in the file, it will be visible in the Metadata Panel



Manual IDs can be added directly to audio files.

- Open a file in the Viewer.
- Follow the instructions below to add a Manual ID.
- To add Manual IDs directly to multiple files, use the Arrow buttons to quickly toggle through multiple files in the same folder or adjacent folder. For additional information, see [Open Files in Succession](#).
- Press Return or close the file to save.
- Manual IDs can be added to batch process output results
 - Under the Control Panel File menu select Open Results...
 - Navigate to and select a meta.csv, id.csv, or cluster.csv file.
 - This will open the Results window and Viewer for the batch process.
 - Use the Viewer to add Manual IDs to the Results window Manual ID column.
 - Choose Save or Save As from the Results window File menu to update the underlying CSV file.

Example: A Manual ID has been added to the underlying id.csv file created by an Auto-ID for Bats batch process

	FOLDER	IN FILE	OUT FILE FS	OUT FILE ZC	AUTO ID	PULSES	MATCHING	MATCH RATIO	MANUAL ID
1		S4U00014_20160419_042007.wav			LASCIN	2	2	1.0000	0
2		S4U00014_20160417_200302.wav			LASNOC	4	3	0.7500	0 LASNOC/EPTFUS?
3		S4U00014_20160417_212752.wav			NoID	2	0	0.0000	0
4		S4U00014_20160417_210400.wav			NoID	18	0	0.0000	0
5		S4U00014_20160417_210028.wav			Noise				
6		S4U00014_20160419_050537.wav			Noise				

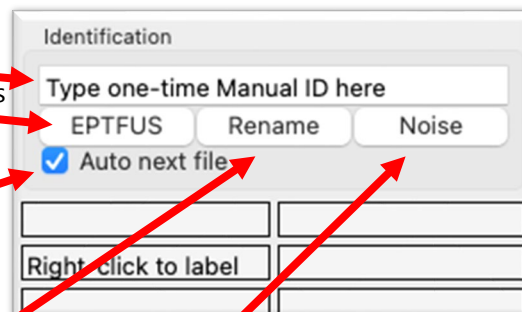
- Manual IDs will be added to any WAV or Zero-Crossing files created on output by the batch process.

NOTE: When using the Viewer to review the results of a batch process, Kaleidoscope WILL NOT ADD Manual IDs directly to the input audio files. If output files are created in the batch process, Kaleidoscope WILL ADD Manual IDs to the output audio files, as well as the Results window and underlying CSV file.

Use Button Labels

Manual IDs are added in the Metadata Panel via button.

- The Metadata Panel provides 32 buttons for custom labeling.
- Click any empty button to clear a current Manual ID.
- Type text into the Identification Field and press Return to add a one-time Manual ID.
- Click the Confirm button to accept an Auto-ID label or cluster name as the Manual ID.
 - If no Auto-ID or cluster name is found, the button will be empty and can be used to clear a Manual ID.
- Check the Auto Next File checkbox to automatically move to the next file or detection when a Manual ID is applied with a mouse click or keyboard shortcut.
- Click the Rename Button to rename a directly opened audio file, or an output audio file which was created by a batch process.



NOTE: When viewing batch process results which did not create output WAV or .zc files, the Rename button has no function.

- Press the Noise button to designate the file as Noise.
 - If full-spectrum or Zero-Crossing output files have been created during the batch process, manually designating a file as Noise will move the file to the NOISE folder in the Output Directory.
 - For additional information, see: [Analyze Noise Files](#).

Tip: Checking Auto Next File will greatly speed up review and labeling of multiple files.

- Right-click to highlight an unlabeled button.
- Type any text to create a Button Label.
- Press the Return key to exit the naming mode.
- Button Labels are remembered when the Viewer is closed, or Kaleidoscope is quit.
- Button Labels are saved in the settings.ini file created from any batch process.
- Button Labels can be triggered by keyboard shortcuts.
- Button Labels can be populated by the selected Species Classifier names which are selected under the Auto-ID for Bats tab.
- For additional information, see: [Load Species Labels](#).

3 Typical Workflows for Bat Analysis

Kaleidoscope provides a set of tools which are designed and optimized specifically for analysis of bat recordings. The following sections are specific to the workflow of Bat Analysis in Kaleidoscope.

3.1 Optimize for Bat Analysis

In many ways, the sounds made by bats are unique in the environment. Kaleidoscope includes optimizations designed specifically for bat calls.

NOTE: The terms "calls" and "pulses" are used interchangeably in this document.

Bat Analysis Mode

When working with recordings of bats, Kaleidoscope is typically set to Bat Analysis Mode.

NOTE: Full-spectrum bat recordings can be analyzed in Non-Bat Analysis Mode. This may be useful when using cluster analysis to look for feeding buzzes, for example.

- Bat Analysis Mode can be selected at any time via the menu in the upper left corner of the Control Panel.
- Bat Analysis Mode enables support for Zero-Crossing and Time-Expansion formats.
- Default Settings for Bat Analysis Mode are optimized for general work with bats which call within the 8 to 120 kHz frequency range.

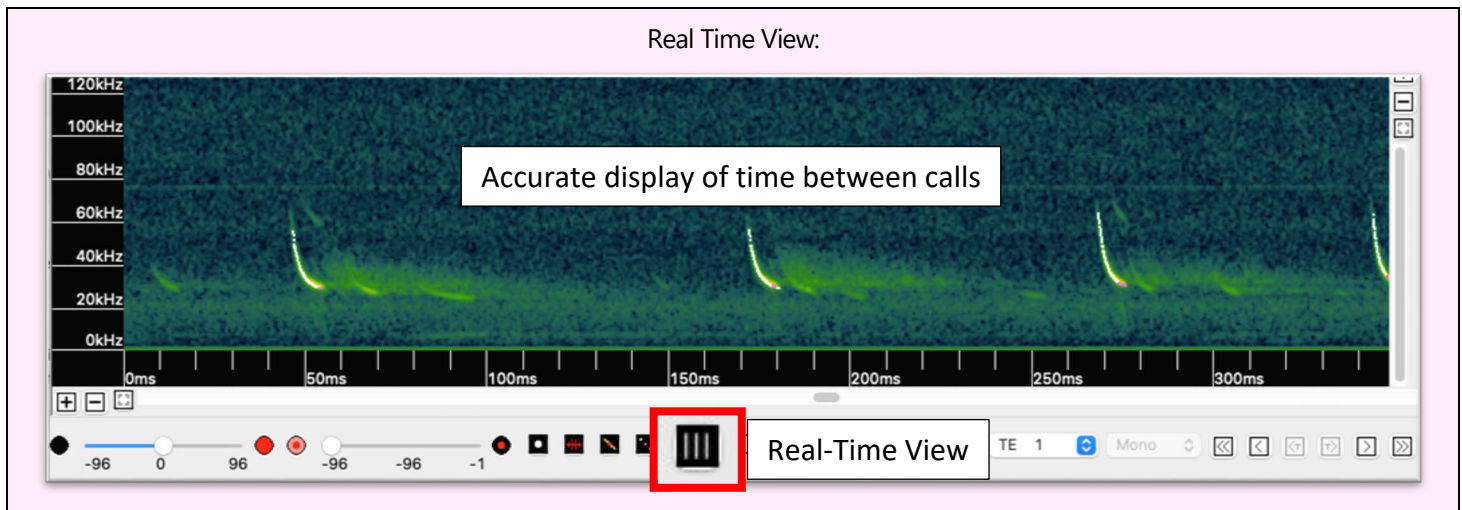
NOTE: Bat Analysis Mode is not specific to frequency range. Bat Analysis Mode can be used for analysis of all species of bats, regardless of their call frequency range.

Tip: Kaleidoscope can analyze all ultrasonic sounds in Bat Analysis Mode or Non-Bat Analysis Mode. For ultrasonic sounds that are not bat calls, such as rodents or insects, Kaleidoscope will typically provide best results in Non-bat Analysis Mode.

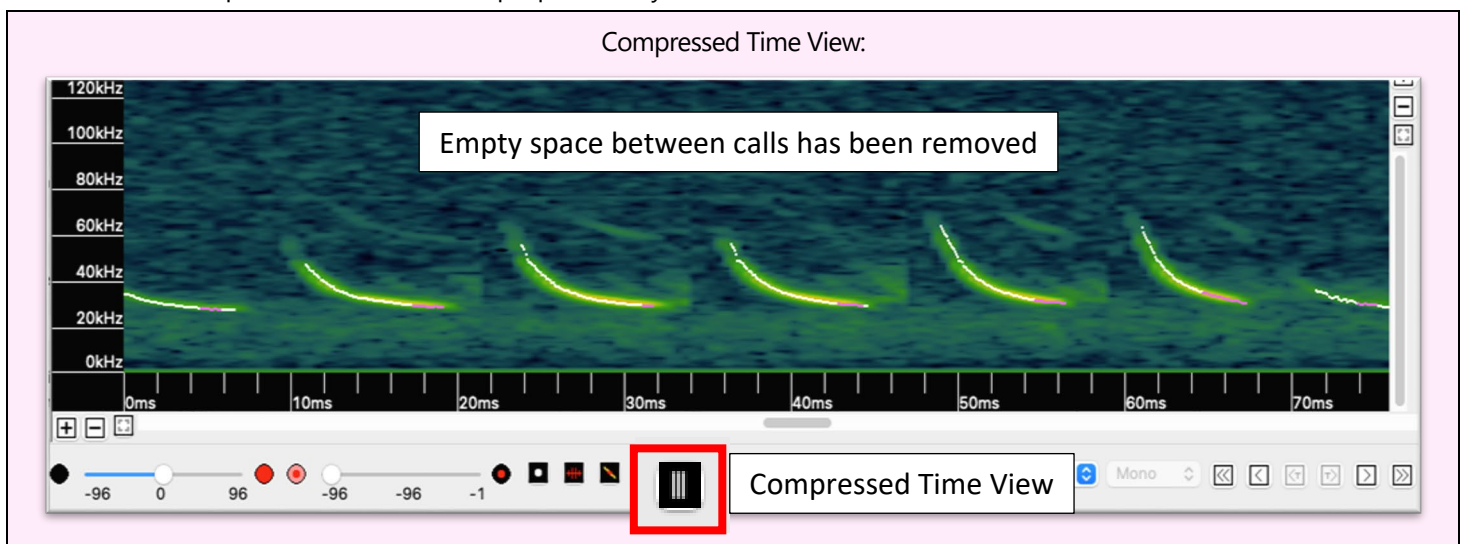
Compressed Time View

The Viewer can visually remove empty space between bat calls.

- Press the Compressed Time View button to toggle between Real-Time and Compressed-Time views.



- Real-Time View displays a proportionally accurate display of the timing of bat calls. This includes the space between the calls.
- The Time Ruler zooms with the horizontal display and shows a real-time reference of the call sequence timing.
- When zooming in closely to view a single call, scroll left or right to see other calls.
- In the Real-Time view, playback happens in real-time. If playback is slowed down via the Speed menu, the timing of the call sequence is slowed down proportionally.



- Compressed Time View allows more individual calls within a pass or call sequence to be simultaneously displayed at close zoom level in the Viewer.
- The Compressed Time View is based on calls which have been detected as usable for analysis.
 - Only calls which have been identified as usable detections will be displayed.

- If no bat calls have been identified as detections, the Compressed Time View will be empty.

NOTE: Compressed Time View removes time between calls. Therefore, the overall view no longer represents an accurate proportional timing of the call sequence. In Compressed View the Time Ruler does not provide an accurate timing reference for the call sequence.

NOTE: When calls are played back in Compressed Time View, they will be played back as displayed (with no space between calls). This will not be an accurate representation of the timing of the original call sequence.

NOTE: If a Wav file is saved in Compressed Time View mode, the WAV file will be saved with the space between calls removed, and will play back as such.

Load Species Labels

Bat species names can be loaded and saved to Button Labels in the Metadata Panel.

- Button Labels are used to add Manual IDs.
- This function requires a Kaleidoscope Pro license.
- Kaleidoscope Pro must be in Bat Analysis Mode.
- Auto-ID for Bats must be enabled, and at least one Species Classifier must be selected.
- Under the Viewer File menu, choose Load Labels.
 - This will load the names of the Species Classifiers which are currently selected under the Auto-ID for Bats tab as button labels in the Metadata Panel.
- For additional information regarding Button Labels and Manual IDs, see: [Use Manual IDs](#).

Zero-Crossing Format

Zero-Crossing is a format used to store recordings of bats. For additional reference information, see: [ZC Files](#).

- Kaleidoscope can open Zero-Crossing format files.
- Kaleidoscope can convert full-spectrum WAV files to Zero-Crossing format.
- When a WAV file is opened in the Viewer while in Bat Analysis Mode, Kaleidoscope will automatically create Zero-Crossing information based on the content of the file.

Analyze Noise Files

Kaleidoscope can use batch processing to analyze input files, which can then be identified and isolated as Noise files.

- This function is specifically designed to be used with recordings of bats.
 - Noise File Filtering is available only in Bat Analysis Mode.
 - Noise File Filtering is done as a function of a batch process.
- A Noise file is a full-spectrum audio or Zero-Crossing file which does not contain a usable recording of bat calls.
 - Recordings which do not contain any bat calls can be caused by false triggering or the field recorder.
 - Recordings may contain bat calls, but the calls may be of such poor quality as to not be useful for additional analysis.
- When running a batch process in Bat Analysis Mode, Kaleidoscope analyzes input files based on the settings described under the Signal Params tab. For additional reference information, see [Signal Params tab](#).
 - If the audio content of a file does not meet the described parameters, the file is considered unusable for bat analysis and is designated as Noise.

Tip: Kaleidoscope will only consider bat calls which are described in Zero-Crossing format, even if the call may otherwise be visible in full-spectrum view. Therefore it can be useful to check the Zero-Crossing view in order to understand what Kaleidoscope has used to determine the status of the file.

- If WAV or .zc files are created as a result of a batch process, output files designated as Noise can be deleted or moved to a designated NOISE folder.
- Auto-ID for Bats identifies input files designated as NOISE under the AUTO-ID column in the Results window and id.csv file.

Filter Noise Files

Kaleidoscope will not delete or separate files located in an Input Directory. In order to filter recording files which are designated as Noise, new files must be created as outputs from a batch process.

Tip: Noise file analysis is also done as part of the Auto-ID process. Therefore, when an Auto-ID batch process is run, if new audio files are not created on the output of a batch process, Kaleidoscope Pro will still analyze the input files to designate whether they are considered Noise files or not. This designation will be found under the AutoID column in the id.csv file. This will then allow for manual selection and deletion of input files which have been designated as Noise.

Run a simple batch process to filter Noise files created on output:

NOTE: A Kaleidoscope Pro license is not required for this basic function.

1. Make sure Kaleidoscope is in Bat Analysis Mode.
2. Assign the Input Directory with the input files to be analyzed and separated.
3. Make sure WAC, WAV (and W4V), and ZC are each enabled (checked) under the Inputs section of the Batch tab.
4. Assign an Output Directory.

NOTE: This batch process will create new audio files. Therefore there must be enough available storage space for the Output Directory to contain the new files.

5. Under the Outputs section, check the option to create WAV and/or Zero-Crossing files.
6. Select either:
 - **Delete noise files**
 - **Move noise files to NOISE folder**
7. Press the Process Files button to run the batch process.
8. Check The Results:

Input files which were not designated as Noise will be re-created in the Output Directory.

- If Move noise files to NOISE folder was selected, any input files which were designated as Noise based on the settings under the Signal Params tab, will be recreated in a NOISE folder in the Output Directory.
- If Delete noise files was selected, any input files which were analyzed and designated as Noise based on the settings under the Signal Params tab, will not be recreated in either the Output Directory or a NOISE folder.

Signal Parameters

The Signal Params tab provides settings which are used during automated processing of bat calls.

- **Minimum and Maximum Frequency Range (kHz)**
 - These settings describe the limits of the frequency range in which Kaleidoscope will look for bat calls.
 - The default range of 8-120 kHz includes many common species of bats.
 - To detect bats which call at higher frequencies, raise the Maximum Frequency Range.
 - To exclude low frequency noise in the recording, raise the Minimum Frequency Range to just below the lowest frequency of the target bat call.
 - If a bat call (or any other sound) is not within the described frequency range, it will not be considered for analysis by Kaleidoscope.

Tip: If there are two species of bat calling in the recording at different frequency ranges, the Minimum and Maximum frequency Range settings can be used to isolate the frequency range of one species or the other. This technique can be used effectively to isolate and analyze bats which call at known frequency ranges.

- **Minimum and Maximum Length of Detected Pulses (ms)**
 - These settings are used as a filter. If a sound is longer or shorter than the Minimum and Maximum Length range, it will not be considered for analysis.

Tip: Some species of bats make very short calls. Therefore, for short call pulses, lower the Minimum Length Setting to 1 ms.

- **Maximum Inter-Syllable Gap**
 - If the Maximum inter-Syllable Gap is set to less than the time between individual pulses, individual pulses will be detected and analyzed.
 - 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 detected and analyzed.

- **Minimum Number of Pulses**

- This setting is used as a filter. If Kaleidoscope detects less call pulses in a file or file segment than the specified value, the file or file segment is described as Noise.
- Pulse detection is based on signal-to-noise in the recording. In a full-spectrum recording, a very faint bat call may be visible, but fall below the detection threshold.
- To check what has been detected as a call pulse, display the Zero-Crossing View in the file or file segment. Detected pulses will be represented by Zero-Crossings.

Tip: If there are very few bat calls in a file or file segment, that could be because the bat was at a greater distance from the microphone. The further away the bat is from the microphone, the more the shape of the bat call can be distorted as the sound wave travels through the air. This can affect the accuracy of Auto-ID. Therefore, raising the Minimum Number of Pulses can be used to exclude poorer quality recordings and in return, increase the overall accuracy of Auto-ID.

- **CF Filter Max Frequency (Hz)**

A filter may be applied to ignore signals within a specified frequency range. This can be useful for eliminating non-bat sound from being detected as bats.

- This setting specifies the maximum cutoff frequency which is used for filtering.
- This setting is used in combination with CF Filter Max Bandwidth.

- **CF Filter Max Bandwidth (Hz)**

- This setting specifies the bandwidth of the filter, starting below the maximum cutoff frequency.

FFT Size

FFT Size is an option found under the Cluster Analysis tab.

- The FFT Window Size can be adjusted when running cluster analysis or using Scan Recordings to Extract Detections (No Clustering).
- In general, the default size of 5.33ms will produce optimal results.
 - A smaller FFT size may improve detection of very short bat pulses.
 - A larger FFT size may improve detection of longer, flatter calls.

Advanced Signal Processing

When Kaleidoscope works with Zero-Crossing format, it can apply Advanced Signal Processing.

- Used to enhance identification of Zero-Crossing detections when converting from full-spectrum audio.
- Used to enhance identification of Zero-Crossing detections when analyzing native Zero-Crossing files.
- Advanced Signal Processing removes noise and competing signals prior to converting full-spectrum recordings to Zero-Crossing format.
 - This provides the full SNR (Signal to Noise Ratio) available from the full-spectrum signal. This is approximately 20 dB greater than what is made from a native Zero-Crossing recorder.
- Advanced Signal Processing can be enabled or disabled under the Signal Params tab.
 - Advanced Signal Processing is enabled by default.
 - If Advanced Signal Processing is disabled, the time domain signal in a full spectrum recording is Zero-Cross analyzed with only a band-pass filter applied.

Tip: It is recommended to leave Advanced Signal Processing enabled, especially when using the Auto-ID for Bats function.

Bat Analysis Mode

Batch
 Signal Params
 Auto ID for Bats
 Cluster Analysis
 SPL Analysis
 Acoustic In

SIGNAL DETECTION PARAMETERS

Signal to be detected:

8 - 120 (kHz) Minimum and Maximum Frequency Range

2 - 500 (ms) Minimum and Maximum Length of Detected Pulses

500 (ms) Maximum inter-syllable gap

2 Minimum number of pulses

0 (kHz) CF Noise Filter Max Freq

0 (kHz) CF Noise Filter Max Bandwidth

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

Remove DC offset

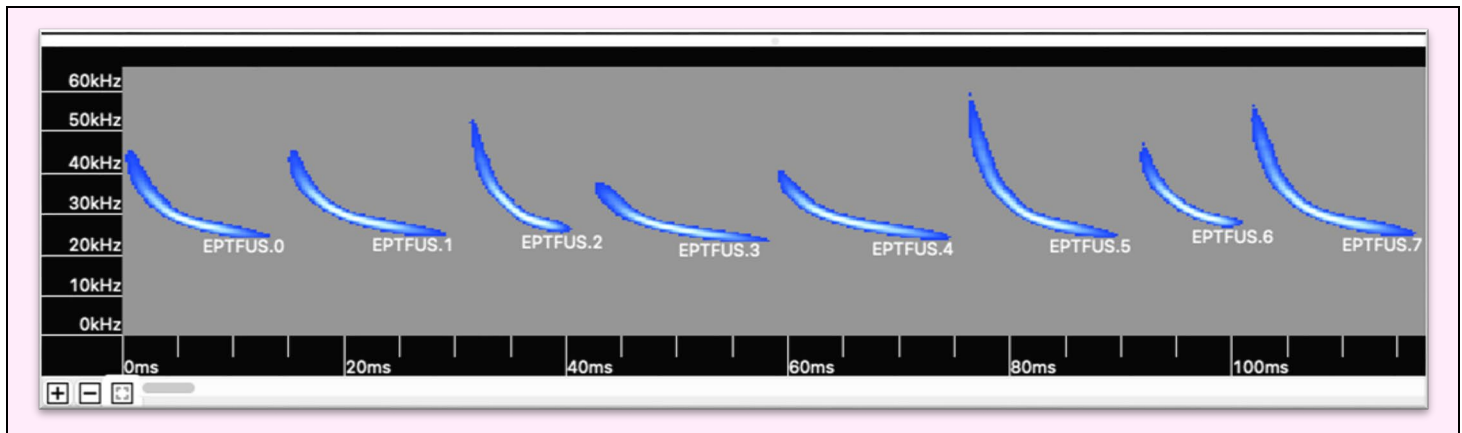
Display Reference Calls

The reference calls used in the Auto-ID for Bats Species Classifiers can be visually represented in the Viewer.

- The Reference Call display function requires a Kaleidoscope Pro license.
- Displayed reference calls are based on the enabled Species Classifiers under the Auto-ID for Bats tab.
 - Species classifiers which are enable will be displayed.
 - Manually check or uncheck species to display only the selected species.
- Each Species Classifier contains multiple variations of calls from the same species.

NOTE: A "reference call" is a statistical model of multiple similar calls.

- Species Classifier reference calls are numbered based on commonality of the pulse.
- Lower numbered references represent the more common examples of the call in the Species Classifier.
- Choose Open Reference from the Control Panel File menu to open the Viewer with only the Reference Calls displayed.



- Choose Toggle Reference from the Viewer File menu to display the reference calls starting from the beginning of a displayed file.
- For additional workflow information, see [Compare bats calls in a recording to a reference call](#).

3.2 Auto-ID for Bats

Kaleidoscope Pro can be used to analyze recordings of bat calls for the purpose of automatic species identification.

Automated identifications, though largely accurate, should not be relied on solely as a basis for scientific research or land management decisions.

It should be expected there will be false positive and false negatives identifications. Bats use echolocation for navigation and hunting. Therefore, they adapt their calls in real time to respond to their situation (e.g. hunting insects and avoiding collisions). Additionally,

individual species of bats can display extremely variable repertoires of call types, and some calls of some species are very difficult to differentiate from calls that can be produced by other species.

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

- A Kaleidoscope Pro license is required to enable the Auto-ID for Bats function.
- Auto-ID for Bats is available in Bat Analysis Mode only.
- For additional reference information, see: [Auto-ID for Bats tab](#).

About Classifiers and Accuracy

Verified recordings of bat calls are used as the foundation for Classifier Libraries in Kaleidoscope Pro.

- Classifier Libraries contain multiple individual Species Classifiers.
 - Species identification works by comparing recordings of bat calls to a known Species Classifier.

NOTE: Classifiers are generally built using recordings of individual 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.

- If no Species Classifier is available for a species or geographic region, Auto-ID for Bats will not provide useful results.
 - If no Species Classifier is available, cluster analysis for bats can be used for species isolation and identification. For additional information, see [Cluster Analysis for Bats](#).
- Classifier Libraries are updated as new reference recordings become available.

NOTE: A Classifier Library may not include every possible bat species found in a geographic region. Therefore, a bat which is not represented by an enabled Classifier Library may be mis-identified as a different species which is included in the currently enabled Species Classifiers.

- Individual Species Classifiers are tested for statistical accuracy.
 - Current statistical accuracy test results for Species Classifiers are available from Wildlife Acoustics.
 - Click to download the [Auto-ID Classifier Performance](#) document.

Auto-ID for Bats cannot guarantee 100% accuracy.

Tip: In some cases a recording may contain bat calls, but does not provide confident species identification. The recording may still be useful for providing confirmation of general bat presence.

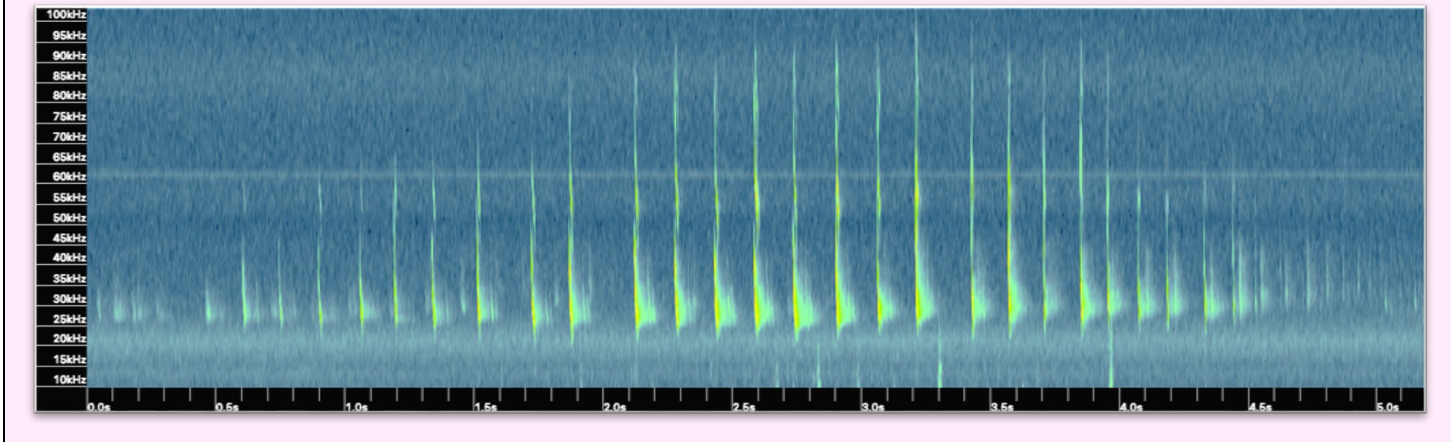
- ID accuracy is influenced by many variables. For example:
 - Clutter or echo can obscure the shape of the recorded bat call.
 - Background noise can obscure the bat call.
 - If multiple bats of similar or the same species are calling simultaneously, this can cause mis-identification.

NOTE: A common cause of mis-identification is when two different species found in the same region have similar calls. This is directly reflected in the Auto-ID Classifier Performance document.

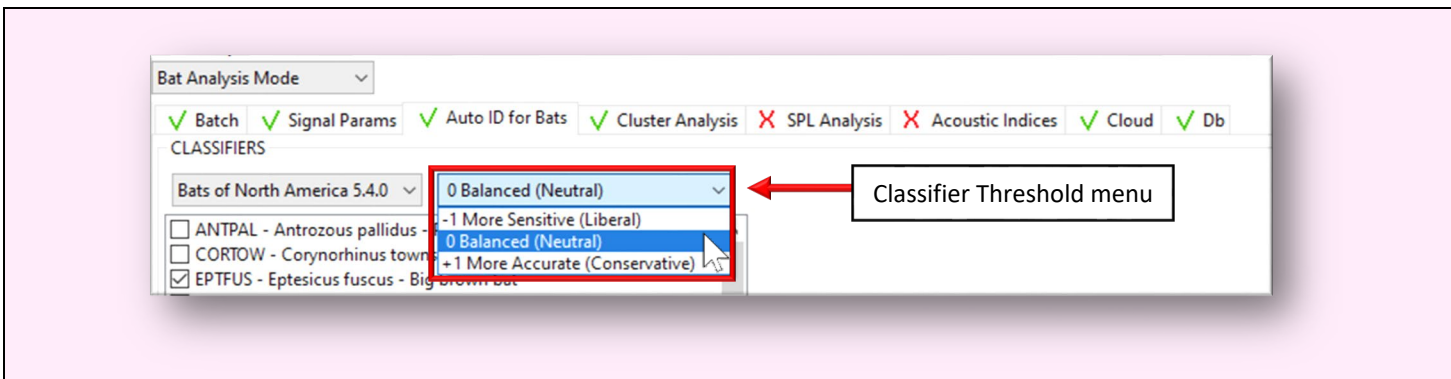
- The relative distance between the bat and the microphone can have a significant impact on ID accuracy.
 - This is because identification is based on call shape. The call shape which is recorded can be different than the call actually made by the bat, depending on the distance or other amplitude changes.
 - This can happen if different frequency components of the bat call are made at different amplitudes.

Example: This spectrogram displays a bat pass. In this recording the bat flies towards the microphone and then flies away. The shape of the bat call does not change as the bat is flying. As the bat approaches the microphone the call signals are louder. The spectrogram shows the diminished lower amplitude content when the bat is further away. The higher frequency component of

the call is lower in amplitude. Therefore, the recorded call shape changes at the bat call changes in distance and therefore, amplitude. This is a common cause of inaccurate Auto-ID estimation.



Classifier Threshold Menu



The Classifier Threshold menu adjusts the statistical weighting and confidence for species identification. This influences the results of an Auto-ID batch process.

- **-1 More Sensitive (Liberal)**
 - This setting will produce more identifications.
 - Some identifications may be less accurate.
- **0 Balanced (Neutral)**
- **+1 More Accurate (Conservative)**
 - This setting will produce less identifications.
 - Overall identifications may be more accurate.

The [Auto-ID Classifier Performance](#) document provides statistical accuracy estimation for each of the three balance settings.

How Auto-ID for Bats Works

Auto-ID for Bats is an automated batch process analysis.

1. Input files are separated into segments according to any Split to max duration setting.
2. Full-spectrum files are converted to Zero-Crossing format.
 - By default, full-spectrum to Zero-Crossing format conversion is enhanced with Advanced Signal Processing.
 - For additional information, see: [Advanced Signal Processing](#).

NOTE: Full-spectrum WAV recordings can contain visible bat calls which do not pass the signal parameters and are not converted to Zero-Crossing format. If a bat call is not detected and displayed as a result of Zero-Crossing conversion, it will not be considered in the Auto-ID process.

Tip: Use the Zero-Crossing view in the Viewer to understand what Kaleidoscope has detected in a full-spectrum file as potentially usable bat calls.

3. Files are analyzed for the presence of bat calls.

- Initial analysis is based on the settings under the Signal Params tab.
 - Files which do not meet the described signal parameters are designated as Noise files.
 - For additional information, see: [Analyze Noise Files](#).
4. Input file segments which meet the signal parameter settings are passed to the Auto-ID function.
 5. Statistical analysis is performed on the detected bat calls.
 - Statistical information includes the number of detected calls and average call characteristics.
 - Statistics are published to batch process output results.
 6. Identified bat calls are compared to enabled Species Classifiers within a Classifier Library.
 - If a detected call in the file matches any reference call in the enabled Species Classifiers, the individual call is identified with a species type.
 - If a detected call does not match calls in any enabled Species Classifier, the call is labeled No ID.
 7. Sequences of identified pulses are analyzed to create a file-level AUTO-ID designation.
 - The file-level identification is the designated Auto-ID label for the file.
 - A file can have only a single file-level AUTO-ID species designation.
 8. If multiple species are detected within a single file, Alternate IDs are created and listed in the id.csv and idsummary.csv output files.

Run Auto-ID for Bats

Follow these steps to run an Auto-ID for Bats batch process:

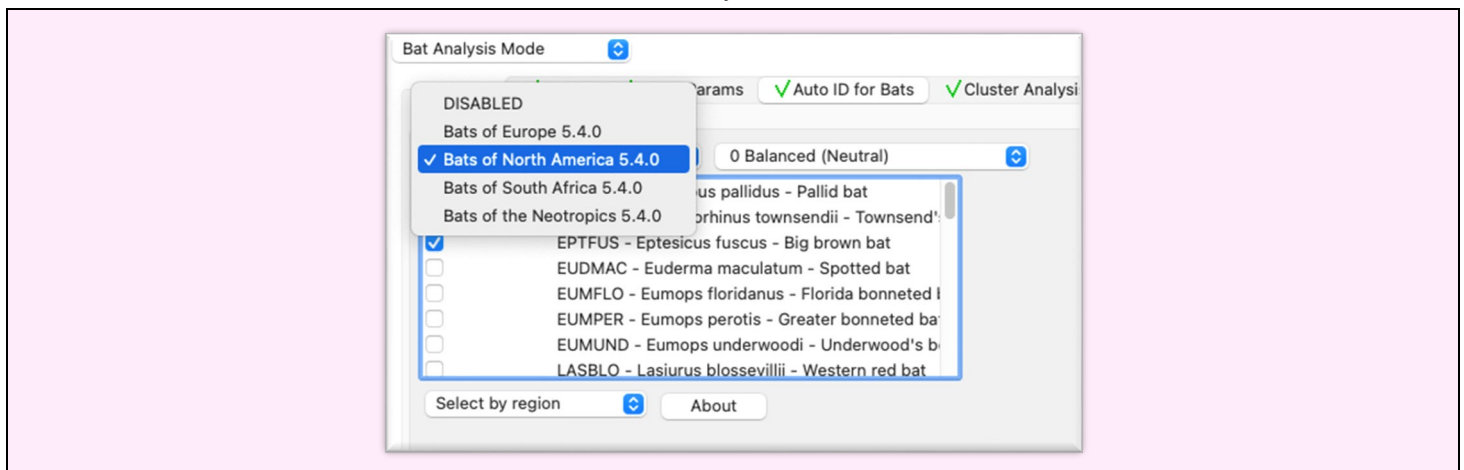
1. Confirm Kaleidoscope Pro is in Bat Analysis Mode.
2. Configure Input and Output Directories under the Batch tab.

NOTE: Although WAV and .zc files can be created on output, they are not required in order to run Auto-ID analysis on the designated input files.

3. Under the Signal Params tab, adjust any desired settings.

NOTE: For many applications, the default signal parameters are appropriate. For additional information regarding adjusting signal parameters see [Signal Params tab](#).

4. Under the Auto-ID for Bats tab, select the Classifier Library.



5. Select the Region within the Classifier Library.
 - For additional information, see [About Classifiers and Accuracy](#).
6. Adjust the Analysis Balance setting.
 - For additional information, see [Classifier Threshold menu](#).
7. Press the Process Files button.
 - The batch process will commence, and a progress bar will be displayed.
 - When the batch process is complete, the Viewer and Results window will open.

Check the Output Files

The following files are created in the Output Directory as a result of an Auto-ID for Bats batch process:

- **settings.ini**
 - This file is a snapshot of every setting in Kaleidoscope Pro at the time of the Auto-ID for Bats batch process.
 - The settings.ini file is additionally useful because it provides a record of any custom Button Labels in the Viewer.
- **idsummary.csv**
 - This file provides a summary of which species were detected in the analysis.
 - This file cannot be opened by Kaleidoscope. It can be opened by any third-party spreadsheet software which supports CSV file format.
 - The total number of files labeled with an Auto-ID tag are listed for each species.
 - Likelihood of presence probability is provided for each Species Classifier which was enabled in the batch process.
 - For additional reference information, see: [Maximum Likelihood Estimators \(MLE\) and P-values used in Kaleidoscope Pro Classifiers](#).
- **id.csv**
 - This file contains the analysis results for each file or file segment in the input batch.
 - The Results window represents the id.csv file.
 - The id.csv file can be opened by selecting Open Results... from the Control Panel File menu.

Tip: The id.csv file contains extensive statistical information regarding the content of the input files. With Default Settings, not all columns from this file are displayed in the Results window. For a complete list of available columns see: [id.csv](#)

- If WAV or ZC files are checked in the OUTPUTS section under the Batch tab, those files will be created in the Output Directory.
- If Noise Filtering is enabled under the Batch tab, A NOISE folder will be created in the Output Directory.
 - Any WAV or .zc file output files which have been analyzed and designated as noise will be placed in this folder.
 - For additional information, see: [Analyze Noise Files](#).

The id.csv Results Window

When the Auto-ID for Bats batch process is completed, the Viewer and Results window open automatically.

Tip: If other windows are open on the desktop, the Viewer or Results window could be hidden behind another window. Check to make sure this is not the case.

NOTE: The size and position of the Viewer and Results window are remembered when Kaleidoscope Pro is quit, and then re-opened. This includes positioning on multiple monitor screens.

The Viewer and Results window are linked. The Viewer displays the file or file segment row which is currently selected in the Results window.

Changing the currently selected or visible file or file segment in one window will update the other.

- For additional reference information, see: [The Results Window](#).
- The Results window represents the underlying id.csv file which was created by the auto-ID batch process analysis.
- The Results window lists the files or file segments from the batch process inputs as individual rows.
- Auto-ID analysis results are provided for each row.
- The Results window uses columns to display file attributes.
 - To show or hide columns, choose [Edit Columns...](#) from the Results window File menu.

The following is a list of columns displayed in the Results window using the default settings:

- **FOLDER**
 - This column describes the enclosing sub-folder or directory of the input file.
 - If the input file is in the top level of the assigned Input Directory, this field will be blank.

Tip: It is possible to analyze files from multiple deployments in a single batch process. The files from the different deployments can be kept in separate folders. The individual folders can be moved into a master folder which can be designated as the Input Directory. By default, Kaleidoscope is enabled to Include subdirectories when running a batch process. The Folder column will describe the sub-folder for each file, and also provide a way to sort a single set of results based on their separate enclosing sub-folders.

- **IN FILE**
 - This is the name of the input file.

NOTE: If a file has been segmented using the Split to max duration option, the same file name will be displayed for each segment.

- Choose Edit columns... from the Results window File menu to Show the Offset column.
- The Offset column will display the offset from the start of the file to the beginning of each segment.
- **OUT FILE FS** and **OUT FILE ZC**
 - These columns show the name of any WAV or .zc file created on output by the batch process.
 - If any file segmentation of the input file has been applied, the time offset of each segment will be added to the output file name.
 - If no WAV or .zc file has been created on output by the batch process, the field will be blank.
- **AUTO-ID**
 - This field shows the file-level automatic species identification.

Tip: Kaleidoscope Pro can detect multiple species in a single file. Only one species can be described at the file level. In addition to the Auto-ID column, edit the Results window column display to show the Alternate 1 and Alternate 2 columns. Any other possible file level species identifications will be displayed in these and their associated columns.

- **PULSES**

NOTE: The terms "calls" and "pulses" are used interchangeably throughout this document.

- This is the number of total pulses detected in the file or file segment.

Tip: A low number of detected pulses in a file may indicate a poor quality recording, which can result in lower confidence of automatic species identification. The Minimum number of pulses setting under the Signal Params tab can be raised to filter out files which contain lesser numbers of calls. This can increase overall accuracy of automatic species identification.

- The number of pulses is based on usable detections.

Tip: It is possible a full-spectrum file may show visible evidence of a bat call in the spectrogram view, but the bat call may not pass the signal detection settings and therefore may not be converted to Zero-Crossing format. To see which pulses are being detected in a full-spectrum file, enable the Zero-Crossing view in the Viewer.

- **MATCHING**
 - The number of detected pulses which match the AUTO-ID
- **MATCH RATIO**
 - The ratio of MATCHING over PULSES
- **MANUAL ID**
 - This column is for user-assigned Manual ID labels.

Path to underlying id.csv file

	FOLDER	IN FILE	OUT FILE FS	OUT FILE ZC	AUTO ID	PULSES	MATCHING	MATCH RATIO	MANUAL ID
1		S4U00014_20160417_195813.wav			EPTFUS	37	25	0.676000	
2		S4U00014_20160419_042007.wav			LASCIN	2	2	1.000000	
3		S4U00014_20160417_200054.wav			LASNOC	35	20	0.571000	
4		S4U00014_20160417_200302.wav				4	3	0.750000	
5		S4U00014_20160417_212752.wav				2	0	0.000000	
6		S4U00014_20160417_210400.wav			NoID	18	0	0.000000	

Default Column Layout

Tip: A great deal of statistical information is created during the Auto-ID analysis. This information can be found in additional columns which are not initially visible with the default settings. Use the [Edit Columns...](#) function to show or hide columns. For a complete list of the available columns, see: [id.csv](#)

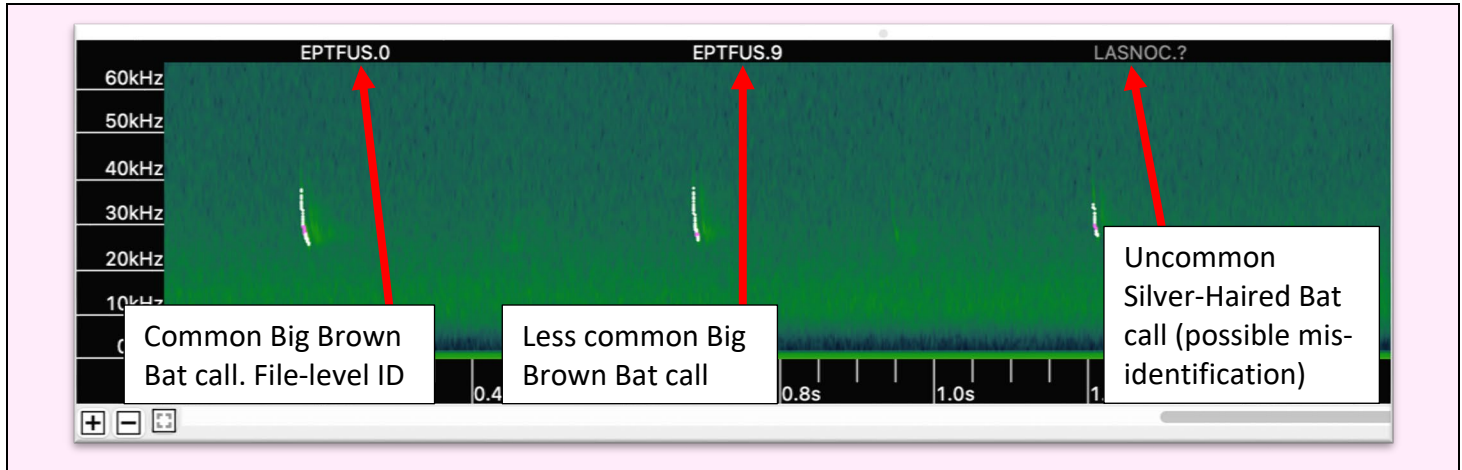
Use the Viewer

The Viewer is used to review and manually ID the results of the Auto-ID for Bats batch process.

- The Viewer displays individual Species Labels for detected calls in the upper part of the spectrogram.
 - The available Species Labels are based on the enabled Species Classifiers under the Auto-ID for Bats tab.
 - Species Labels displayed in bold white print reflect the file-level Auto-ID.
 - Species Labels displayed in grey represent identified calls which do not belong to the file-level Auto-ID.
 - Each Species Classifier contains multiple variations of calls from the same species.

NOTE: A "reference call" is a statistical model of multiple similar calls.

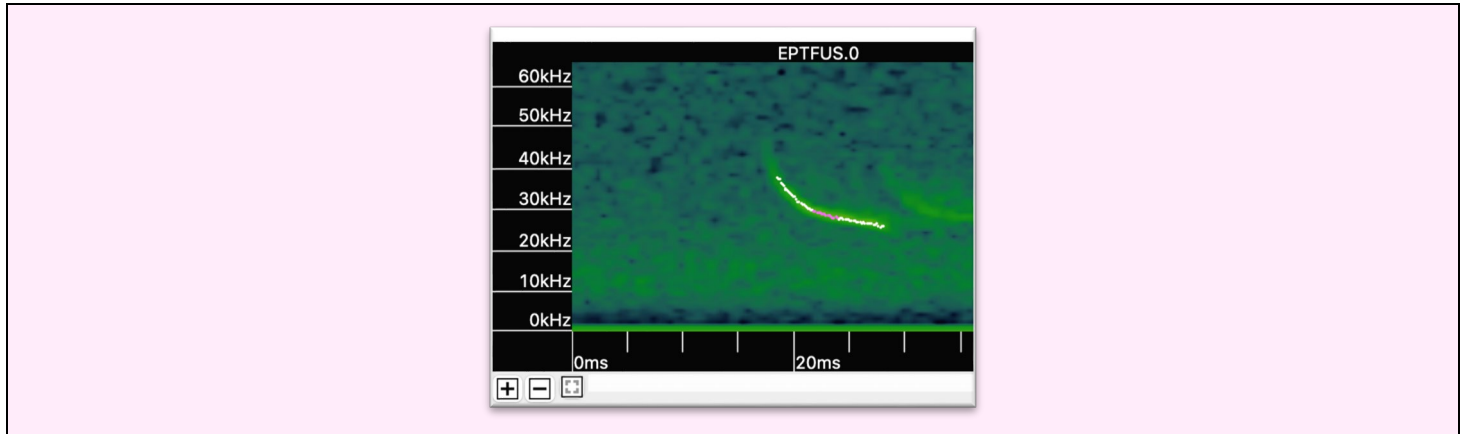
- Species Classifier reference calls are numbered based on commonality of the pulse.
 - Lower numbered references represent the more common examples of the call in the Species Classifier.
 - The reference number is listed with each call ID to indicate which reference call in the Species Classifier matches the detected call.
 - A question mark (?) indicates the reference call exists in the Species Classifier, but is not a common example.



- Calls in the input files can be compared to the reference calls used in the individual Species Classifiers.
- One or more calls can be statistically measured.
 - For additional information, see: [The Viewer Analysis Window](#).
- For complete information regarding adding Manual IDs to Auto-ID results see: [Use Manual IDs](#).

Compare bats calls in a recording to a reference call:

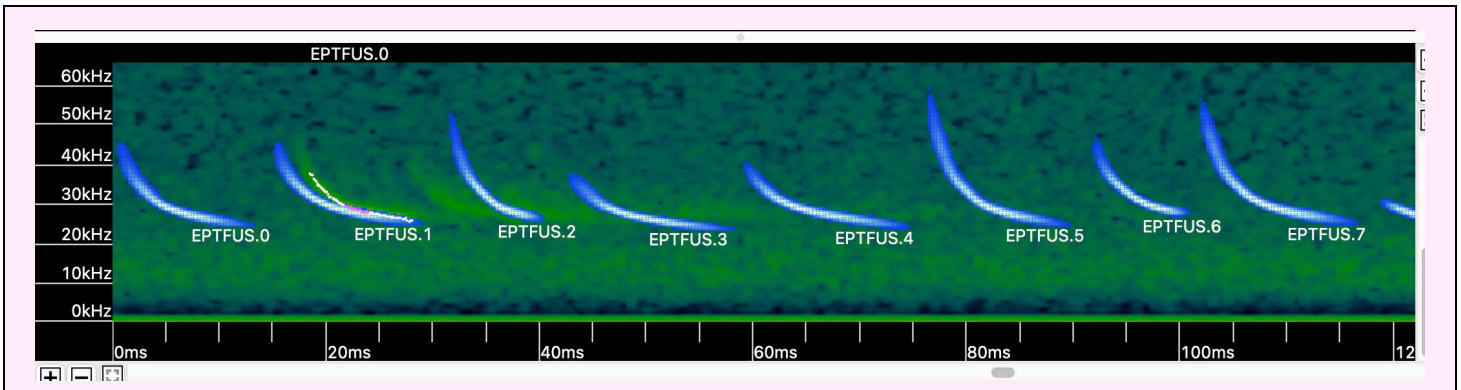
1. Zoom in to view a single recorded bat call.



NOTE: This graphic displays a recorded call with an Auto-ID label. Recorded calls can be compared to Reference Calls regardless of whether Auto-ID analysis has been done.

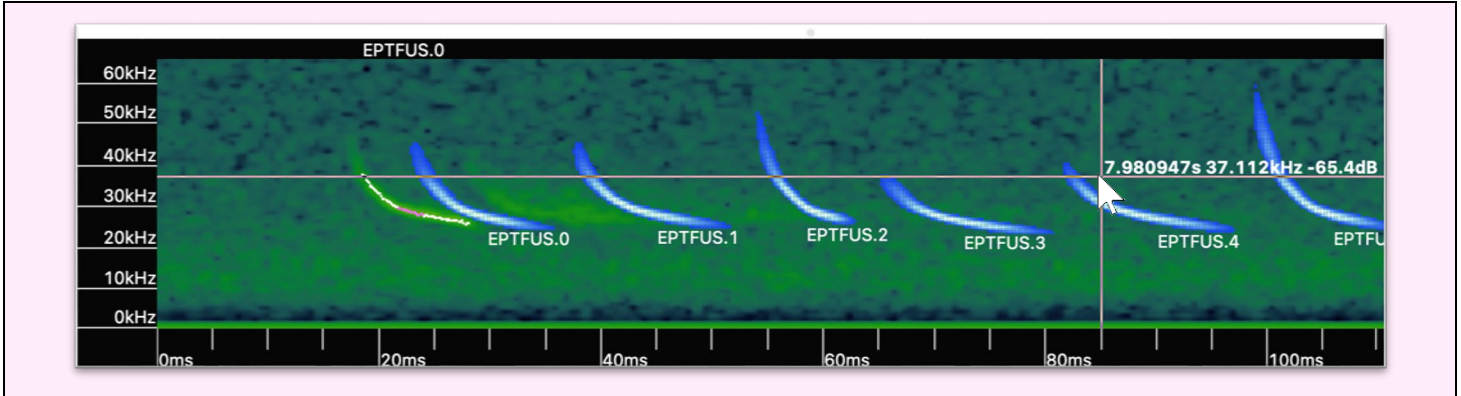
2. Display the reference calls, starting at the currently visible location:
 - On **Mac OS**, **Command-Double-Click** on the spectrogram.
 - On **Windows or Linux OS**, **Control-Double-Click** on the spectrogram .
 - **Command or Control-Single-Click** to make the Reference Calls go away.
 - The Reference Calls are displayed starting at the left edge of the visible spectrogram.

NOTE: Command or Control **Single-Click** will display the reference calls starting at the beginning of the file. This means if the window view is zoomed in and scrolled to the right, the reference calls may not be visible. If this happens, Command or Control **Double-Click** to display the reference calls at the current window display position.



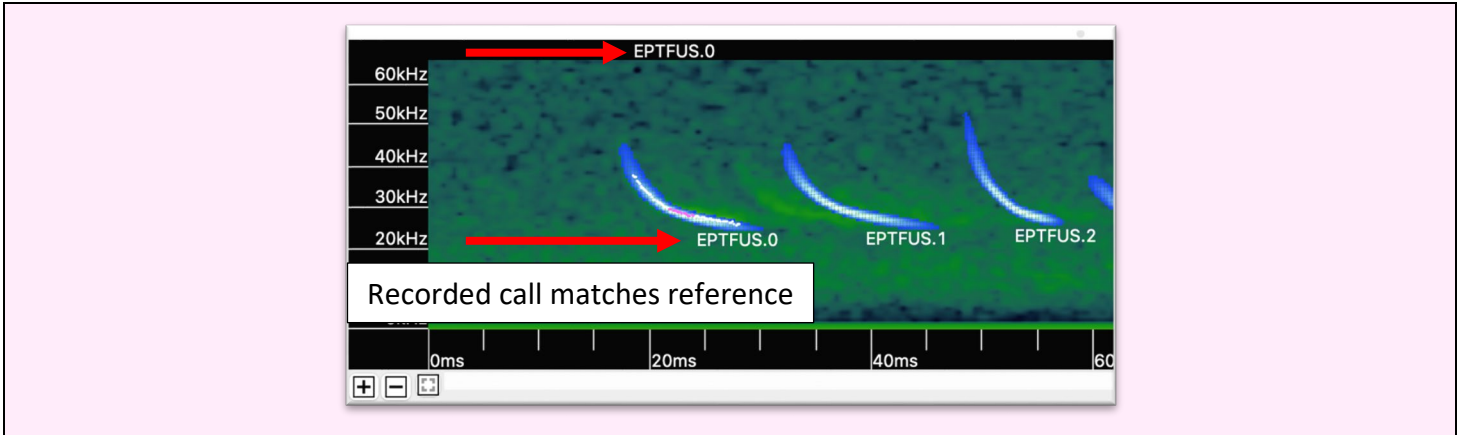
3. Slide the Reference Calls left or right:
 - On **Mac OS** hold down the **Command key** and glide (move) the mouse left or right over the spectrogram.
 - On **Windows OS** hold down the **Control key** and glide (move) the mouse left or right over the spectrogram.

NOTE: Do not hold down the left or right mouse buttons when sliding the reference calls left or right.



Tip: If the reference calls do not move, click once on the spectrogram to make it the front-most window, then try again.

4. Line the reference up with the recorded call for comparison:
 - This allows for direct comparison of the recorded call to the reference call.



3.3 Cluster Analysis for Bats

Cluster analysis can be used to detect and sort similar bat calls.

- A Kaleidoscope Pro license is required to enable the cluster analysis functions.
- Cluster analysis is set up and run the same way in Bat Analysis Mode as in Non-Bat Analysis Mode.
- For additional setup information, see: [Cluster Analysis](#).
- For additional reference information, see: [Optimize for Bat Analysis](#), [Cluster Analysis tab](#), and [Cluster Analysis Theory](#).

When to Use Cluster Analysis for Bats

Cluster analysis can find and group similar calls or call sequences in bat recordings.

Cluster Analysis is available in Bat analysis Mode and Non-bat Analysis Mode. The difference is that in Bat Analysis Mode, the cluster analysis function works with Zero-Crossing information. This means Cluster Analysis for Bats can be used with both full-spectrum and Zero-Crossing files.

NOTE: The Signal Detection parameters in Bat Analysis Mode are optimized for search-phase calls. When the goal is to detect and cluster other types of bat sounds, such as **feeding buzzes, or roost emergencies**, it may be more effective to run the cluster analysis in **Non-Bat Analysis Mode**.

The first step of cluster analysis is signal detection. The settings under the Signal Parameters tab determine what Kaleidoscope will attempt to detect in the input files. The default settings are optimized to look for sequences of pulses. A sequence of pulses, commonly referred to as a "pass", will probably be slightly different each time. This can result in multiple clusters which contain the same species of bat.

Additionally, if there are multiple bats calling at the same time in the recording, the overall "sequence" may include multiple species. This can result in clusters which represent two or more species.

It may be useful to analyze call sequences for the sake of separating overall activity in the recordings.

- If the **Inter-syllable gap** setting is lowered under the Signal Parameters tab, this can be used to separate detections into individual calls. Now there will be many more overall detections, and it will be less likely that a detection contains multiple species.
- The **Minimum and Maximum Frequency Range** settings under the Signal Parameters tab can be effectively used to filter out species of bats from cluster analysis results. Any bats calling above or below this range will not be detected and therefore not included in the cluster analysis results.

Cluster analysis relies on the statistical significance of audio patterns in the input recordings.

- This means large numbers of files can be searched for similar bat sounds with a single operation.
- This also means cluster analysis will be less effective or not work at all with smaller batches of files. In this case, use Scan recordings and extract detections as described in the next section.

Cluster Analysis for Bats may be useful when the Auto-ID Classifier Libraries included with Kaleidoscope do not support the species of bats, or types of bat calls in the input recordings.

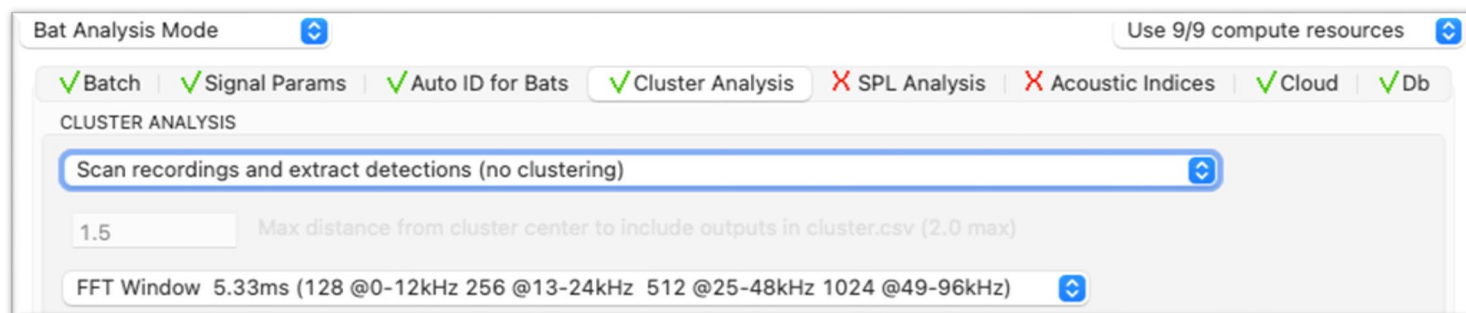
A Simple Classifier can be built for automatic clustering and labelling of bat vocalizations.

NOTE: The classifiers used in Kaleidoscope Pro Auto-ID for Bats are highly tuned and make use of thousands of vetted reference calls. It should **not** be expected that a Simple Classifier will perform as well as an auto-ID classifier.

- A classifier looks for similar patterns. The Simple Classifier "freezes" the cluster analysis process and allows for naming of the cluster patterns. Therefore, the basic cluster analysis results must be performing to expectation before a classifier can be built.
- For additional information, see: [Simple Classifiers](#).

Scan Recordings and Extract Detections (No Clustering)

Scan recordings and extract detections is available via the main menu under the Cluster Analysis tab.



- This function will detect individual bat calls or sequences of calls in one or more audio files.
- Scan recordings and extract detections is the first step of cluster analysis. However, because this function does not rely on statistical density and sorting of patterns, it can be used on a single file or multiple files with equally effective results.
- Detections are listed in the Results window.

- Detections are defined by the parent file, offset from start of file, and duration.
- The same segment of audio cannot be described by more than one detection. Every detection in the Results window describes a unique segment of an audio file.
- This function does not sort by pattern similarity.
- Scan recordings and extract detections can be used to test detection parameters on one or a small group of files, before running cluster analysis on a larger group of files.
- Scan recordings and extract detections relies on the settings under the Signal Params tab, along with the FFT Window Size to detect and isolate individual bat calls or sequences of calls.

Tip: It may be useful to sort detections based on minimum, maximum, and mean detection frequency. Use [Edit Columns](#) from the Results Window File menu to show these additional columns.

Example: This picture shows the Results window with an edited column layout:

	IN FILE	OFFSET	DURATION	Fmean	Fmin	Fmax	MANUAL ID
1	S4U00014_20160419_042007.wav	0.250150	0.257629	27150.707000	24345.312000	36394.836000	
2	S4U00014_20160417_200158.wav	10.165058	0.267340	28002.422000	26126.900000	32723.938000	
3	S4U00014_20160417_210400.wav	0.899252	0.278582	28178.309000	26909.762000	30254.943000	
4	S4U00014_20160417_200054.wav	0.000710	3.889357	28400.207000	25813.836000	34714.570000	
5	S4U00014_20160417_210400.wav	5.965654	1.128274	28472.363000	26749.227000	31701.559000	
6	S4U00014_20160417_200054.wav	9.714800	0.519944	28526.539000	25321.527000	39141.844000	
7	S4U00014_20160417_200054.wav	10.828991	1.002439	28865.010000	26405.244000	34510.031000	
8	S4U00014_20160417_200202.wav	1.852468	0.710242	29444.855000	27472.029000	34222.542000	

4 Typical Workflows for Finding Sounds

Kaleidoscope provides tools for finding and isolating specified audio patterns in recordings. This allows for a range of uses, from general species surveys to targeted searches of rare animal calls. The detection functions in Kaleidoscope are not limited to animal calls. Any sound with a distinct sonic pattern, such as a gunshot for example, can be detected and isolated by Kaleidoscope. Classifiers can be built which will automatically search for and label target sounds. The following sections describe tools and techniques used with Kaleidoscope for detecting and isolating sounds in audio recordings.

General Survey vs. Targeted Search

A typical goal of bioacoustics analysis is an open-ended search of audio recordings to "see what is there". This is a general survey.

It is also possible to search audio recordings for specific targeted sounds. This can include animal calls. This can also include non-animal sounds, such as gunshots.

Kaleidoscope can be tuned for general searches. Kaleidoscope can be tuned to find specific sounds in an environment. Therefore, depending on the project, it may be useful to run multiple analysis on the same set of recordings using different settings optimized for each task.

Multiple Deployment Sites

It is significant that the same species of animal may be found in multiple environments with very different background sounds. A simple example is the sound of an animal with or without the sound of a stream in the background.

When Kaleidoscope analyzes detections, it takes into account all aspects of the signal within the detection time and frequency range. Using the example of the animal call with or without the stream in the background, Kaleidoscope would analyze those two detections as different overall patterns. This can result in the same animal call being found in multiple clusters.

This is why a classifier will work best when it is made from a single set of deployment recordings, and then used to analyze new recordings from the same location.

NOTE: It is technically possible to run a single cluster analysis on recordings made in different locations. In some applications, that may be the best strategy. However, if the results of the analysis appear scattered and poorly sorted, it may be more effective to group the input recordings by location or similar location, and run separate cluster analysis based on deployment sites.

Closed Data Set vs. Continuous Incoming Recordings

What starts as an analysis of a closed or finite set of recordings may turn into an ongoing project at any time. Any work done on a closed data set will be useful if the project changes to include new recordings.

- Effective analysis can be carried out on a complete and finite set of recordings.

NOTE: It is typically not useful to attempt to build a classifier to analyze a closed set of recordings.

- It is also common that new recordings may be made over time for analysis in an ongoing project.

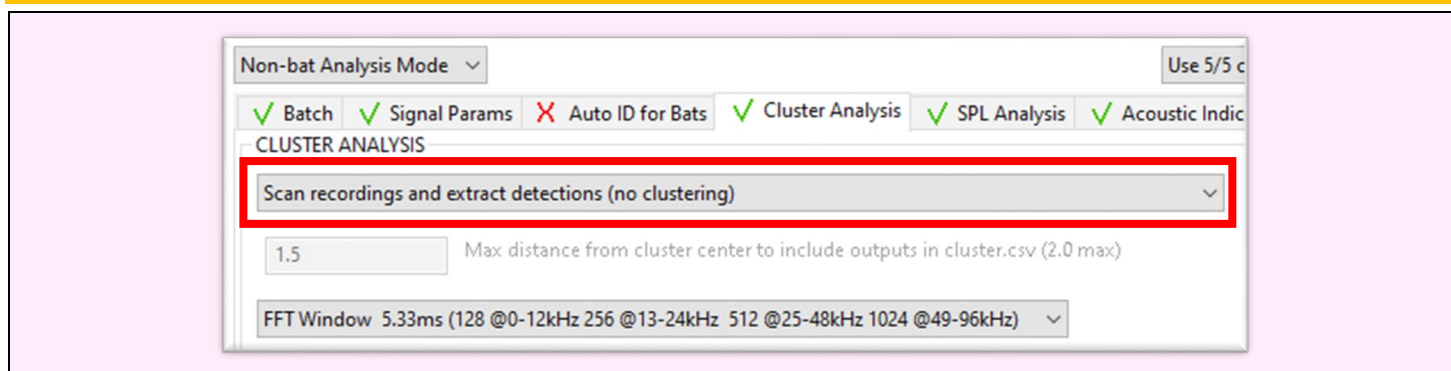
NOTE: When new recordings from the same deployment site are continually added to the project, that is the time to start considering building a Simple Classifier. Typically, the Simple Classifier is built once basic cluster analysis results are continually reliable for the new incoming recordings.

4.1 Scan Recordings and Extract Detections (No Clustering)

Kaleidoscope can analyze one or more audio files to detect and extract user-defined signals of interest.

- Scan Recordings and Extract Detections is an option found under the Cluster Analysis tab.

NOTE: Scan Recordings and Extract Detections is only available in Kaleidoscope Lite for Non-Bat Analysis Mode. A Kaleidoscope Pro license is required in order to use this function in Bat Analysis Mode.



- Scan Recordings and Extract Detections can be run as a batch process using a single audio file as an input.

Tip: This technique can be useful for testing signal detection parameters on a known target example in a recording file.

- One or more audio files can be analyzed in a single batch process to find and create detections.
 - A detection is typically an animal vocalization or some other specific sound such as a gunshot.
 - Signal detection parameters are defined under the Signal Params tab.
 - Default Settings in Non-Bat Analysis Mode are useful for general songbird-range surveys.
 - Signal detection parameters can be tuned.
 - Signal detection is further influenced by the FFT Window Size setting under the Cluster Analysis tab.
 - For additional information, see: [Optimize Signal Detection](#).

Tip: This technique can also be useful for testing detection parameters to see how well target sounds are being isolated and separated from non-target sounds.

- Detections are displayed in the Viewer and listed in the Results window.
 - The Results window represents an underlying cluster.csv file.
 - Detections can be sorted based on different criteria.
 - Manual IDs can be added to individual detections. For additional information, see: [Use Manual IDs](#).
- Detections can be exported as individual WAV files.

Tip: Signal Extraction does not require input files to be duplicated to output. Exporting individual detected signals as separate WAV files can be done after the batch process is completed.

Run Scan Recordings and Extract Detections

Follow these steps to run a signal detection and extraction batch process:

1. Set up a batch process.

- For additional information, see: [Batch Processing and File Conversion](#).
- 2. Adjust any settings under the Signal Params tab.
- 3. Select Scan Recordings and Extract Detections (No Clustering) from the menu under the Cluster Analysis tab.
- 4. Adjust the FFT Window Size.
- 5. Press the Process Files button.
 - The batch process will commence, and a progress bar will be displayed.
 - When the batch process is complete, the Viewer and Results window will open.

Check the Results

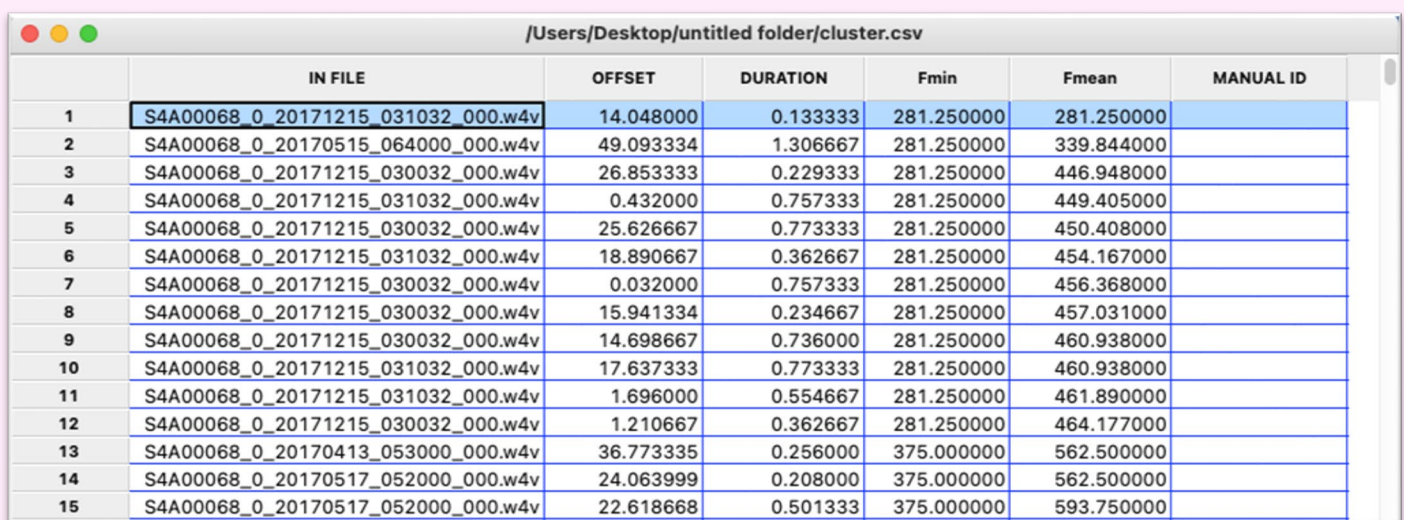
Extracted detections are listed as rows in the Results window.

- Each detection is described in a row by Input File, Offset, and Duration columns.
- The Results window represents an underlying cluster.csv file.
 - The cluster.csv file is created by the batch process and located in the Outputs Directory.
 - For additional information, see: [The Results Window](#).

The Viewer displays the currently selected detection.

- The Results window is linked to the Viewer.
 - Selecting a new detection in one window will update the other.
- The displayed length of the detection is expanded to include padding before and after the actual detection.
 - For additional information, see: [Detection Padding](#).
- To display the entire length of the file in the Viewer, go to the Viewer File menu and choose **Reload...**
 - To return the Viewer to displaying detections, select any other detection from the Viewer or Results window.
- Manual IDs can be added to detections.
 - For additional information, see: [Use Manual IDs](#).
- Detections can be manually sorted by column in the Results window.
 - Sorting by columns can be used to group similar detections.
 - Default Settings do not initially display all the available columns in the Results window.
 - Choose [Edit Columns](#) from the Results window File menu to show or hide columns.

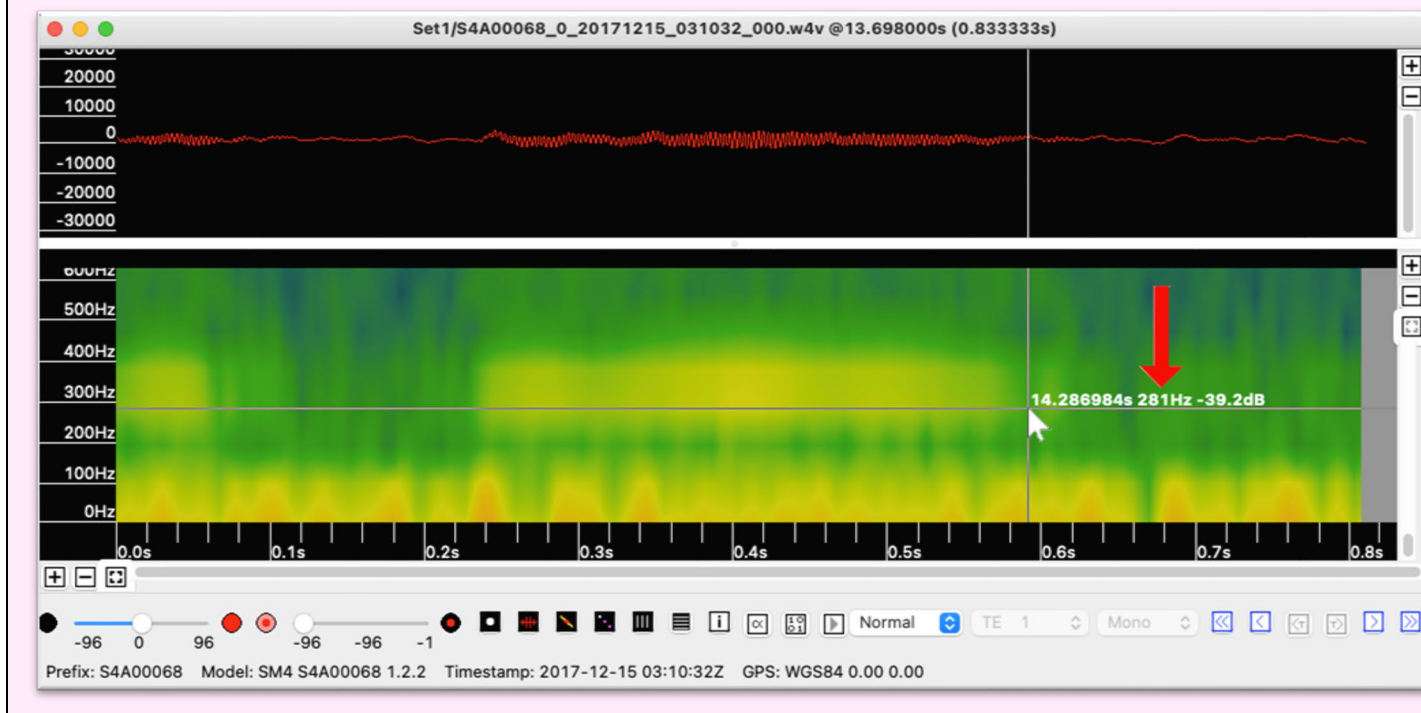
Example: The Results window is displayed for a Scan Recordings and Extract Detections (No Clustering) batch process. The default column layout has been customized. The Fmin and Fmean columns have been shown and other non-essential columns have been hidden. The sort order is based on Fmean from low to high. This sorts the detections based on average low frequency content.



	IN FILE	OFFSET	DURATION	Fmin	Fmean	MANUAL ID
1	S4A00068_0_20171215_031032_000.w4v	14.048000	0.133333	281.250000	281.250000	
2	S4A00068_0_20170515_064000_000.w4v	49.093334	1.306667	281.250000	339.844000	
3	S4A00068_0_20171215_030032_000.w4v	26.853333	0.229333	281.250000	446.948000	
4	S4A00068_0_20171215_031032_000.w4v	0.432000	0.757333	281.250000	449.405000	
5	S4A00068_0_20171215_030032_000.w4v	25.626667	0.773333	281.250000	450.408000	
6	S4A00068_0_20171215_031032_000.w4v	18.890667	0.362667	281.250000	454.167000	
7	S4A00068_0_20171215_030032_000.w4v	0.032000	0.757333	281.250000	456.368000	
8	S4A00068_0_20171215_030032_000.w4v	15.941334	0.234667	281.250000	457.031000	
9	S4A00068_0_20171215_030032_000.w4v	14.698667	0.736000	281.250000	460.938000	
10	S4A00068_0_20171215_031032_000.w4v	17.637333	0.773333	281.250000	460.938000	
11	S4A00068_0_20171215_031032_000.w4v	1.696000	0.554667	281.250000	461.890000	
12	S4A00068_0_20171215_030032_000.w4v	1.210667	0.362667	281.250000	464.177000	
13	S4A00068_0_20170413_053000_000.w4v	36.773335	0.256000	375.000000	562.500000	
14	S4A00068_0_20170517_052000_000.w4v	24.063999	0.208000	375.000000	562.500000	
15	S4A00068_0_20170517_052000_000.w4v	22.618668	0.501333	375.000000	593.750000	

The linked Viewer displays the detection which is selected in the Results window. In this example, by sorting by average low frequency, the detection which has been selected happens to have found an owl call. The mouse cursor crosshair is showing the

frequency in the spectrogram which matches the Mean Frequency in the Results window. In this example the owl was found by displaying the Fmean column and sorting the detections from average low to high frequency.



Save Detections as WAV Files

One or more detections can be selected and exported as individual WAV files.

- In the Results window, Shift-click, or Command-click to select one or more detections.
- Under the Results window File menu, choose Save Selected detections as WAVs...
- A window will open to allow selection of the Save location.
 - Separate WAV files will be created for each selected detection.
 - Each new file will have the original file name, with the addition of the channel and start time of the detection within the original file.

NOTE: Save detections as WAVs... is not available in Bat Analysis Mode.

4.2 Optimize Signal Detection

Signal detection is used to find and isolate (extract) target sounds in recording files.

- There are two goals when adjusting the parameters for signal detection:
 - Find and isolate as many as possible examples of the target sound(s)
 - Ignore sounds which do not meet the detection parameters, and therefore reduce non-target detections (which are sometimes referred to as "false positives")

How Signal Detection Works

- FFT is used to analyze the spectral content of an audio recording.
 - FFT Size can be adjusted to bias the analysis resolution.
 - FFT Size is adjusted under the Cluster Analysis tab.
 - For additional information, see: [FFT Window Size](#).
- The spectral content of the audio is analyzed for signals of interest, based on the signal detection parameters.
- Signals of interest are isolated in the audio file and described as detections.
 - Signal parameters define the frequency range and time range characteristics of the detected signal.
 - A single audio file can typically contain many detections.
 - A detection is described by its offset time from the start of the file and duration.

- Detections cannot overlap. The same segment of audio cannot appear in more than one detection when a recording is analyzed.
- What is detected in an audio recording can change depending on the signal detection parameters.
- The settings used to define a Signal of Interest are located under the Signal Params tab.

NOTE: Signal detection is not based on the absolute amplitude of a signal. In order for a signal to be detected, the signal must exist within the defined frequency range and duration, and the signal must be approximately 12 dB above the background noise (this is non-adjustable). The detection is based on signal-to-noise rather than absolute amplitude. Therefore, very low amplitude signals can be detected as long as they are at least 12 dB above the ambient background noise.

Tip: It is useful to understand that the detection parameters are not considering any pattern within the audio signal. The detection process only notices if there is an energy event (signal) in the recording which meets the defined parameters. The detection parameters can be understood as a "frame". It makes no difference what the pattern is. If the pattern fits inside the "frame" it will be isolated as a detection. Therefore, typically, the larger the "frame", the more overall detections may be found in a recording. Conversely, if the detection parameters are more tightly defined, fewer overall detections may be isolated. This technique can be used to isolate targets while excluding non-target sounds which are outside the detection ranges.

Signal Detection Parameters

Optimal signal detection parameters make a significant difference to the effectiveness of both finding desired target sounds, and rejecting undesirable sounds. This section describes how to effectively adjust signal parameter settings.

- Signal parameters are used to describe time and frequency boundaries for detection.
- When audio is analyzed, any signals which fit within the defined boundaries are isolated and described as detections.

Tip: The default settings are optimized to be most likely to provide immediate and usable results. This applies to Signal Parameters and FFT Window Size for both Bat Analysis and Non-Bat Analysis Modes. It may be helpful to Set Defaults in Kaleidoscope before starting any new work which makes use of these functions. Default settings provide a known baseline for customization and further optimization.

Signal Parameter settings are adjusted under the Signal Params tab.

- **Minimum Frequency Range**
 - This describes the lowest frequency of signal in the audio file which will be considered for analysis.
 - Any signal in the audio file below this frequency will not be considered or influence the analysis in any way.
- **Maximum Frequency Range**
 - This describes the highest frequency of signal in the audio file which will be considered for analysis.
 - Any signal in the audio file above this frequency will not be considered or influence the analysis in any way.

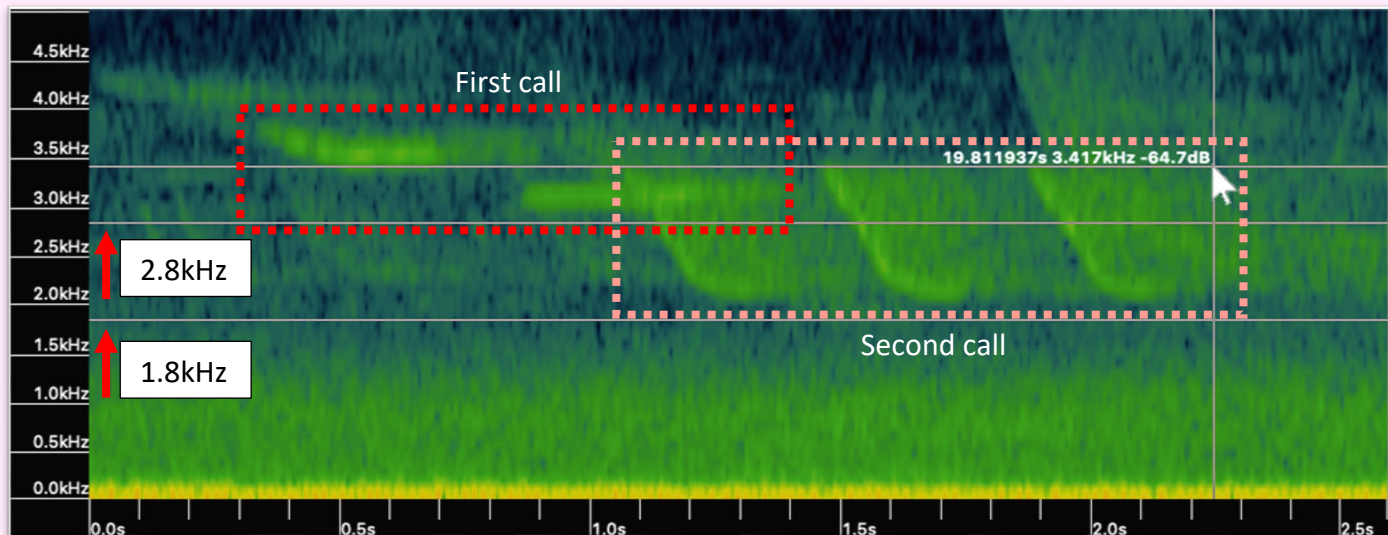
Tip: Isolating a frequency range for analysis is a typical first step for effective detection of specific target sounds or ranges of sounds.

Minimum and Maximum Frequency Range settings must include at least some part of the target sound(s).

- If the Minimum Frequency Range setting is above the lowest frequency of the target sound, the target sound is still included in the analysis, but any signal below the Minimum frequency is excluded from the analysis.
- If the Maximum frequency setting is below the highest frequency of the target sound, the target sound is still included in the analysis, but any signal above the Maximum frequency is excluded from the analysis.
- This allows possible exclusion of signals which overlap the higher or lower frequency ranges of the target signal.

Example: This spectrogram displays a detection which has been created using the default signal parameters.

- The detection includes two bird calls which overlap slightly in time and frequency range. The mouse cursor is positioned at the highest frequency of the second call (3.417kHz).
- If the Maximum Frequency Range is set to 3.417kHz, the analysis will include the bottom segment of the first call.
- If the Maximum Frequency Range is set to represent the middle reference line (2.8kHz), the second call will still be included in the analysis and the first call will be completely excluded.
- The lower reference line is set to 1.8 kHz. If the Minimum Frequency Range is set to this value, any signal below this frequency will not be considered for the analysis. By setting a narrow frequency range for the analysis, the second call will always be included, while nothing above or below the Minimum and Maximum Frequency Range settings will be detected or included for analysis.



Tip: Isolating the frequency range of the target sound is typically an early step when adjusting settings. Isolating the frequency range of the target excludes all signals in other frequency ranges and will often provide an immediate and dramatic difference in the quality of analysis results.

- **Minimum Length of Detection**
 - This value defines the minimum allowable duration of a detected signal which occurs within the Minimum and Maximum Frequency Range settings.
 - A detected signal must last at least as long as the Minimum Length of detection in order to be considered a Signal of Interest.
 - Raising the Minimum Length of detection will exclude any signals shorter than the specified value from the analysis.
- **Maximum Length of Detection**
 - This value defines the maximum allowable duration of a detected signal which occurs within the Minimum and Maximum Frequency Range settings.
 - A detected signal cannot exceed the Maximum Length of detection.
 - If a single sound or multiple overlapping shorter sounds within the Minimum and Maximum Frequency Ranges exceeds the overall Maximum Length of detection, the single or multiple overlapping sounds will not be included in the analysis.

Tip: Multiple signals can overlap to create a single longer overall detection. Therefore, it may be useful to experiment with longer Maximum Length of detection settings.

- **Maximum Inter-Syllable Gap**
 - This value defines the allowable elapsed time between signals before they are seen as separate detections.
 - Elapsed time between signals is defined as no present signal which exceeds the signal to noise ratio within the Minimum and Maximum Frequency Range settings.
 - If consecutive signals happen within the Maximum Inter-Syllable Gap time value, they will be considered to be part of the same detection.

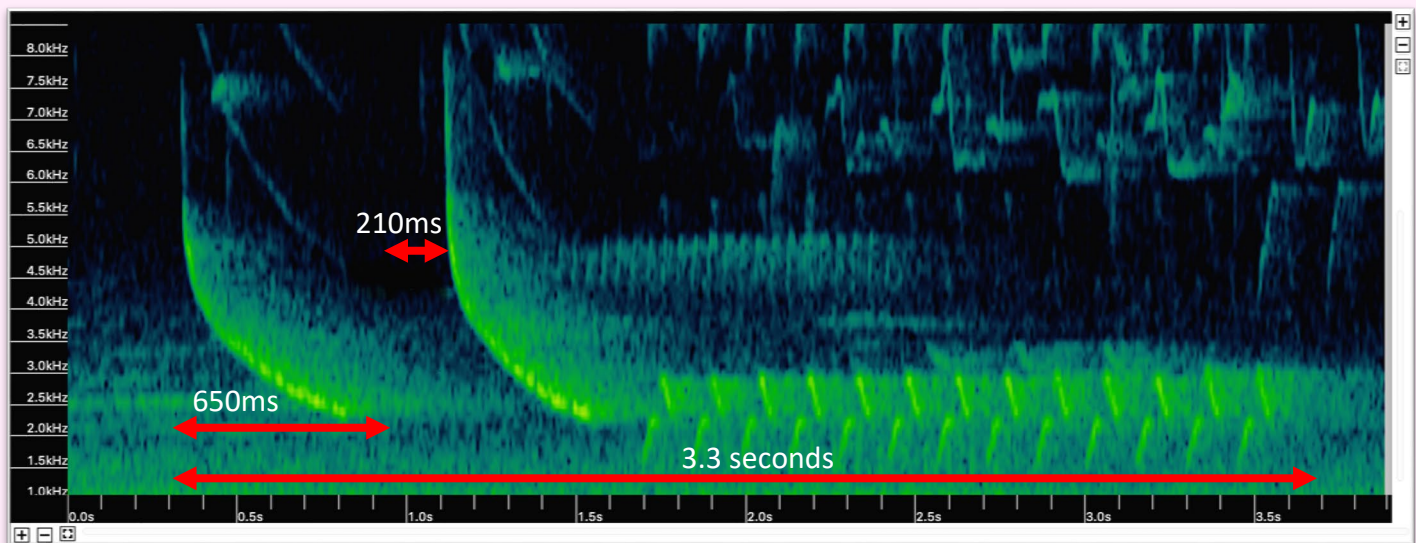
Tip: Lowering or raising the Maximum Inter-Syllable Gap time can be useful to separate or combine complex syllables, calls, and phrases.

- If consecutive signals are separated in time by greater than the Maximum Inter-Syllable Gap value, they will be considered to be separate detections.

Tip: In Bat Analysis Mode, lowering the Inter-Syllable Gap time can be used to separate individual bat calls within a sequence or pass.

Example: This spectrogram shows a bird call which begins with two distinct broadband syllables, followed by a series of faster, more narrow-band syllables. The overall phrase is **3.3 seconds** in duration. The first syllable is **650 ms** in duration. The gap between the first and second syllables is **210 ms** in duration.

- If the Inter-syllable Gap is less than **0.210 ms**, the first syllable will be detected separately from the following syllables.
- If the Minimum Length of detection is less than **0.65 ms**, the first syllable will then be discarded completely.
- If the Inter-syllable Gap is greater than **0.210 ms**, the first syllable will be considered to be part of the longer overall detection.
- If the Maximum Length of detection is less than **3.3 seconds**, the entire call will be discarded.



- **Minimum Number of Pulses**

- Minimum Number of Pulses is available in Bat Analysis Mode only.
- This parameter is used to define an acceptable number of detected bat calls (pulses) in order for the file or detection to be considered for analysis.
- If a file or detection has no detected pulses, or less than the specified Minimum Number of Pulses, it will be considered to be a Noise file.

Tip: A lower number of detected pulses in a file can indicate a poor quality recording of the calls which have been detected. Poor quality recordings of calls can adversely affect the accuracy of automatic species identification. Raising the Minimum Number of Pulses may increase the likelihood of better quality recordings, and therefore better quality species identification.

FFT Window Size

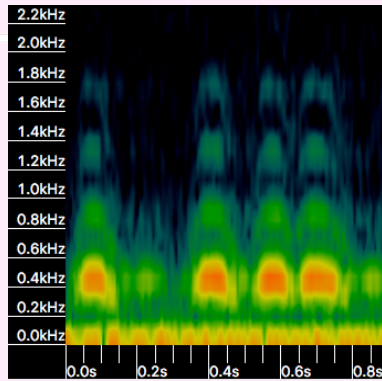
FFT Window Size is used to optimize isolation and separation of detections within audio files. FFT does not define signal detection parameters. FFT does influence how signals are seen by the detection parameters. Therefore, the FFT Size does influence both detection of sounds, and separation of similar sounds.

NOTE: FFT (Fast Fourier Transform) analysis is used to extract spectral information from audio. FFT works by analyzing groups of audio samples in what are called FFT Windows (also referred to as FFT frames).

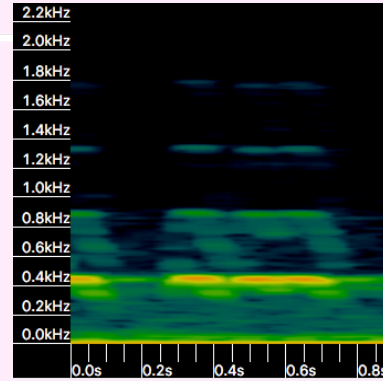
- FFT Window Size is adjusted under the Cluster Analysis tab.
 - The FFT Window Size menu is greyed out and unavailable when it is not in use.
- The FFT Window Size biases the spectral analysis.
 - A small FFT Window Size provides greater resolution of temporal activity – things which happen quickly.

- A large FFT Window Size provides greater resolution of frequency analysis.
- The FFT Window Size describes the number of audio samples included in each FFT frame.
 - The same number of samples represents a different length of time, depending on the sample rate of the audio file.
 - The FFT Window Size menu displays selections based on both time and number of samples in each frame, according to a range of sample rates.

Example: The same file is displayed with two different FFT Window Sizes. The file on the right with the larger FFT Window Size shows greater detail of frequency resolution. This provides clarity to longer narrow-band signals.

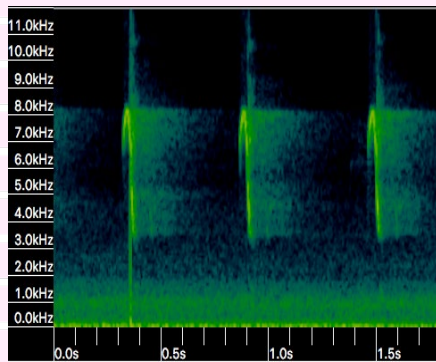


FFT Window Size 5.33 ms/256 (small)

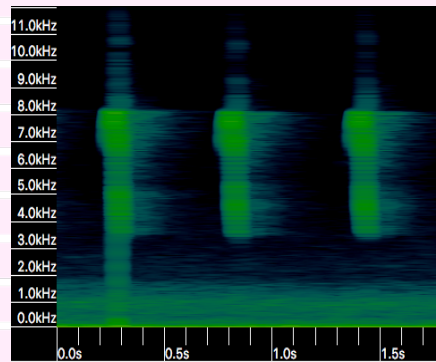


FFT Window Size 21.33 ms/1024 (large)

Example: The same file is displayed with two different FFT Window Sizes. The file on the left with the smaller Window size shows greater detail of activity over time. This provides clarity for shorter broadband signals



FFT Window Size 5.33 ms/256 (small)



FFT Window Size 21.33 ms/1024 (large)

Tune Signal Detection

Analysis output results are based on interaction of parameter settings and the actual content of the input audio files.

Tip: It can take significant time to analyze a large number of recordings. Therefore it may be helpful to use a single recording or small batch of recordings for initial testing. When settings are working well to isolate desired detections in a single file, those settings can then be used to analyze larger batches of files.

- Settings can be based initially on known information about the target sounds.
 - A single library recording or recording from any deployment site can be used to measure the parameters of target sounds.
 - Target sound examples can be from any source, as long as the example is similar to the actual sound in the deployment environment.
- The Viewer can be used to initially analyze target sound parameters.
 - The Viewer provides the frequency range, duration, and any gaps in the target call.
 - The Viewer displays background sounds, including environmental noise and other animal sounds.

Tip: The first step in isolating a sound or range of sounds can be adjustment of the Minimum and Maximum Frequency Range settings. Therefore, the upper and lower frequency range of the target sound would be the first thing to measure and test in an example recording.

- Use Scan Recordings and Extract Detections (No Clustering) to determine optimal signal detection parameters.
 - Run multiple batch processes on a single audio file and adjust one parameter each time.
 - The same input audio files can produce significantly different output results based on different analysis settings.
 - Use the Viewer to examine and compare the results from each adjustment.
 - When ideal settings for detection have been determined, the test results can be discarded.

Tip: When testing detection settings, the primary goal is to find as many targets as possible. The secondary goal is to then adjust the detection settings further to see if the number on non-target detections can be reduced. Do not adjust the parameters to ignore non-target detections at the expense of losing any target detections.

- Example recordings from the actual deployment site can be examined to analyze environmental background noise and any other sonic considerations.

Tip: It is useful to know if there are non-target sounds happening in the same frequency range as the targets. Use the Viewer to first check if there are competing sounds in the target frequency range. Use the Viewer to examine differences between sounds in the target frequency range which could be exploited to help separate the sounds. Maximum Detection Length, Inter-Syllable Gap, and FFT Window Size settings all interact with the actual audio content when separating signals.

- There is no substitute for experimentation.
 - There are many variables introduced by possible audio content and possible settings.
 - Adjusting one setting may influence the function of a different setting.
 - In many cases, experimentation is the only way to know how adjusting one or more settings will affect analysis.
 - Run multiple test batch processes and change a single setting each time to observe the effect of the specific adjustment.

4.3 Strategies for Finding Sounds

Kaleidoscope Pro can be used to find specifically targeted sounds in large batches of recordings. Cluster analysis can be used for this task. Cluster analysis is a two-step process:

1. The target sound must pass the signal detection parameters and exist as a detection.
 - Signal detection is absolute. A signal is either detected or it is not, and this can be tested.
 - If the target sound is not detected by the signal parameters, it will not be found in any further analysis.
 - Scan Recordings and Extract Detections can be used to test and emulate the first step of cluster analysis.
2. Target sounds are sorted by similarity.
 - Cluster analysis sorting is based on statistical significance.
 - If a target sound is plentiful in the input recordings, simple cluster analysis will easily find the target detections.

NOTE: If a target sound is uncommon in the recordings, it may be detected but then very difficult to find in the cluster analysis results. This is when additional techniques can be applied to enhance the cluster analysis results.

Bait Files

NOTE: In this context, the term "bait" is used to describe one or more known example recordings of a target sound. The known example recording is used to attract and find other target sounds in the deployment recordings, therefore it is being used as "bait".

- It is possible to start with a single example of a target sound, and use that as "bait" to find other similar target sounds, regardless of how scarce they may be in the recordings.
- This technique can also be used to improve cluster analysis results to the point that an effective classifier can be built.

Tip: It is possible to use the "bait" technique to search for multiple species at the same time. However, that will only be effective if the different species have similar detection parameters. If different species have significantly different detection parameters, they will need to be searched separately.

1. Create a Bait folder.

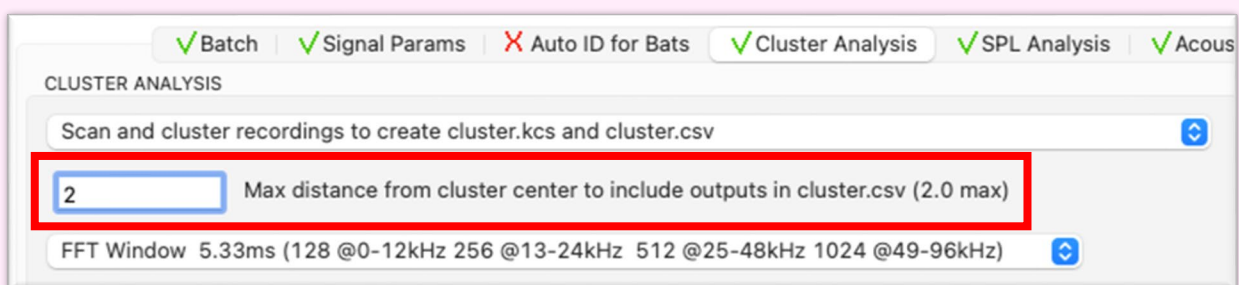
- Create a new folder on the computer desktop (or any location).
- Name the folder after the Target Sound. For example: "Spotted Owl Bait".

Tip: It is technically possible to use a single Bait folder for multiple target sounds or species calls. However, for the sake of organization, use multiple Bait folders with different names for different species or search targets.

2. Find one or more examples of the target sound.
 - The example(s) should be short wav files which describe only target sound with as little background interference as possible.

Tip: Use the Kaleidoscope Viewer to zoom in on a target sound in an audio file. Go to the Viewer File menu and choose Save Wav. Save the target sound to the Bait folder.

- This technique can be used starting with a single example of the target sound.
 - Initial examples can be from any source. This includes library recordings found on the internet, or examples from other deployment sites.
 - Examples found in recordings from the actual deployment site are the best possible examples.
 - Multiple examples of the same target sound can be added to the Bait folder.
 - Different sounds can be targeted and searched at the same time. For example, a single species may make a variety of different calls. In such a case, there would need to be a separate example of each variation of the species call.
 - It is possible to search for multiple species at the same time, as long as their calls can be detected with the same set of signal parameters.
 - If different target sounds are better found with different signal parameters, separate sets of analysis may be required.
3. Determine and test initial detection settings.
 - The goal with detection is to detect the target sound while excluding as much as possible that is not the target sound.
 - Frequency and timing settings can typically be determined from a single target example .
 - FFT settings can be determined by testing detection of the example while mixed in with one or more deployment recordings.
 4. Adjust the Max Distance from Cluster Center to Include Outputs in cluster.csv.
 - This setting is found under the Cluster Analysis tab.
 - The default setting is a value of 1, which will exclude rare detections from the output results.
 - Therefore, raise this setting to its maximum value of 2. This will force all detections into the cluster analysis results, regardless of their statistical significance.



5. Create a master Input Directory (folder) for the cluster analysis, next to the folder which contains the deployment recordings to be analyzed
 - Drag the folder with the deployment files into the master Input Directory.
 - Drag the Bait folder into the master Input Directory.
 - By default, Include Subdirectories is checked under the Batch tab, which means both the deployment recordings and the bait recordings will be included in the analysis.
6. Press the Process Files button to run a cluster analysis batch process.
7. In the Results window, click on the Folder column header to resort by Folder.
 - Scroll to the top of the Results window list.
 - Click again to reverse the sort order if needed.

- The Bait folder will be listed and the known and tested example recordings in the bait folder will be described as detections.
 - Note the cluster numbers of Bait detections.
 - Click on one of the bait detections to highlight the row.
8. Use Edit Columns to show the Mean Frequency column.
 9. Click on the Mean Frequency column header to sort.
 10. Click on Top1Match to then re-sort by cluster number.
 11. Scroll to find the highlighted bait detection in the noted cluster.
 12. Search for deployment targets in nearby detections.
 - The detections are sorted by average frequency within the cluster Therefore, other similar detections may be found adjacent to or nearby the bait detection.
 - It may also be useful to resort by TOP1DIST and then cluster number to repeat the same search for deployment targets.

NOTE: If there are similar target sounds in the deployment recordings, the bait technique can be effective at finding those sounds nearby. However, if the target sounds are scarce in the deployment recordings, their placement in clusters may appear scattered or random. This should not be considered a problem. The initial goal of using the bait technique is to find any examples of the target sound in the deployment recordings. If even one deployment example is found, that is proof of presence.

Tip: Recordings from sources other than the deployment site may be used initially for searching. However, non-deployment example recordings are not ideal for improving cluster analysis results and eventually building classifiers. As soon as any target detections are found in the deployment recordings, those detections should be added to the Bait folder. As deployment detections are added, non-deployment detections may be removed. Ultimately for best results, all the example recordings in the Bait folder will be taken from the actual deployment site.

Acoustic Niche Partitioning

This theory states each animal vocalization made a in given environment represents a unique sonic pattern.

- This is the foundation for isolating different species or different vocalizations made by the same species.
 - A vocalization can be measured to define what makes it unique in the environment.
 - Similar vocalizations can be compared to find and separate their specific differences.
- Defining the sonic characteristics of the target vocalization or sound is the first step to finding that sound in audio recordings.

Define the Target

In order to be found, the target must be defined.

- The additional benefit of a well-defined search is the exclusion of everything outside the defined search range.

At least one example of a target sound is required to make accurate measurements for detection.

- Any recording of a target sound can be used to make measurements of basic parameters.
 - If recordings from the project deployment site are available and contain known examples of the target, those are ideal examples.
 - Example recordings from other deployment sites or libraries can also be used to measure basic target parameters, but are less ideal.

Detection vs. Clustering

Signal detection and clustering are separate functions which happen in sequence.

- Signal detection and then clustering make up the overall cluster analysis process.
- Signal detection is an absolute function.
 - If there is a signal in the audio which meets the signal detection parameters, that signal will always be found by the detection process .
- Clustering is a relative or comparative function.
 - Detections are included and ordered in clusters based on similarity to the cluster model.

NOTE: Depending on the Max Distance from Cluster Center to Include Outputs in cluster.csv, an uncommon sound may have been accurately found as a detection, but may not be included in the output results at all.

- Setting the Max Distance from Cluster Center to Include Outputs in cluster.csv setting to a maximum value of 2 will force every detection to be included in a cluster.

Tip: Using Scan Recordings and Extract Detections (No Clustering) can be effective to find sounds in a single file or small number of files. This function will not sort detections but it will quickly find any sounds in the input files which do meet the signal detection parameters.

Examine Deployment Recordings

Examining actual deployment recordings will show what is in the recording besides the target.

- The challenge of finding a target sound is actually the challenge of picking out the target sound from a background of other sounds.
- Typically, there will be a great deal of audio content in any set of recordings which is not the target.
- Knowing the general non-target content of the input files provides valuable information about how to most efficiently search for the target and allows for informed tuning of the search.

Use Example Recordings

Example recordings can be included in inputs when running a basic cluster analysis batch process.

- The examples are known to be in the inputs. Therefore, they can be located by file name in the cluster analysis results.
 - Example recordings found in clusters can be used to quickly find any other similar detections.
- Recordings from the project deployment site can be manually searched to find examples of the target sound.
 - Examples from the project deployment site are ideal.
- Recordings from other deployment sites which include the target species can be used as examples.
- Libraries which include example recordings of different species vocalizations are available from many sources.
- For additional information, see: [Bait Files](#).

NOTE: Deployment recordings often contain a wide array of sounds besides any example of the target. Clusters created from one deployment site may not accurately represent the overall patterns found in the audio at a different deployment site.

Basic Cluster Analysis

Cluster analysis is often the most effective tool for finding specific sounds in large batches of recordings.

- Plentiful sounds have greater statistical density and are therefore easier to find.
- Sounds which are rare in the recordings have less statistical density and therefore present a greater challenge.

Classifiers

A simple or advanced classifier can be built for effective finding of target sounds in new recordings.

- A classifier does not rely on the statistical density of the target.
 - Therefore, when an effective classifier has been built, it can be used to find target sounds in new recordings, regardless of their scarcity.
- An effective classifier cannot be built until basic cluster analysis is working well.
 - Building a classifier is always a later step, if required at all.

Proving Absence

Proving a negative is not possible. The most practical goal is to look for the highest probability that a species or target sound is not present.

- To make sure no rare detections are lost in a cluster analysis, set the Max Distance from Cluster Center to Include Outputs in cluster.csv to a value of 2.

Reducing Non-Target Detections

Cluster analysis results can mix targets and non-targets together in clusters.

NOTE: A non-target detection is often referred to as a "false-positive" detection. This is not entirely accurate. If a detection is found in a cluster, it is there because it does have a similarity to the cluster center.

- Signal detection parameters are used to isolate the target as best as possible.
 - Non-target sounds may fit the same detection parameters as the target.
 - Further tightening of the detection parameters may result in fewer target detections being found.
- Increasing relative statistical density of target sounds is then used to further separate different but similar detections.

4.4 Cluster Analysis

Cluster analysis is used to detect and sort signals of interest in audio files.

NOTE: The terms: “signal of interest”, “target”, “detection”, “acoustic pattern”, “vocalization”, and even simply “sound”, can all be used interchangeably when describing the goals of cluster analysis.

- A Kaleidoscope Pro license is required to enable the cluster analysis functions.
- Cluster analysis is available in both Bat Analysis Mode and Non-Bat Analysis Mode. For additional information regarding using Bat Analysis Mode, see: [Cluster Analysis for Bats](#).
- Cluster analysis allows large amounts of audio recordings to be quickly inventoried for species content.
- Settings can be adjusted and tuned to target specific vocalizations, sounds, or ranges of sounds.
- Cluster analysis output provides detailed statistical information about one or more repeating audio patterns (such as animal vocalizations) from within a batch of audio recordings.
- Cluster analysis is used as the foundation for building a classifier.
- Cluster analysis is a statistical function.
 - For additional reference information, see: [Cluster Analysis tab](#) and [Cluster Analysis Theory](#).

General Survey vs. Targeted Search

Cluster analysis can be thought of as casting a net.

- A wide net can be used for a general survey of many different sounds currently present in a deployment environment.
- A narrow net can be created and used to find and isolate specific vocalizations and other targeted sounds.
- The Default Settings in Bat Analysis Mode are optimized for general analysis of bat calls within the frequency range of 8 kHz to 120 kHz.
- The Default Settings in Non-Bat Analysis Mode are optimized for general surveys of songbirds and other similar sounds within the frequency range of 250 Hz to 10,000 Hz.
- Cluster analysis settings can be optimized for targeted searches.
 - A targeted search can be a wide search range or a narrow search range.
 - The goal of a targeted search is to find specific audio patterns in the detected signals, and group those detections into clusters based on similarity and statistical density.
 - Focused targeting has the secondary benefit of fewer false-positive detections being found in clusters.
 - The FFT Window Size setting under the cluster analysis tab is used to bias analysis resolution.
 - Signal detection settings under the Signal Params tab are used to describe the search parameters.
 - For additional information, see: [Optimize Signal Detection](#).
- Depending on similarity, multiple species and/or different specific vocalizations can be effectively clustered simultaneously.
- If sounds within the same set of recordings have different enough sonic characteristics, it may be more effective to run separate cluster analysis using optimized settings for different target ranges.

Example: Some species of songbirds have relatively rapid calls typically in the frequency range between 1000 to 4000 Hz. The Default Settings are an appropriate starting point for analysis of these types of sounds. By comparison, some species of owls make slower calls at frequencies below 1000 Hz. In this case, changing the cluster analysis parameters to lower the maximum frequency and also raising the FFT Window Size to focus on frequency resolution may be more effective for finding owls.

How Cluster Analysis Works

The following is a brief description of what happens at each step of basic cluster analysis:

1. Input recordings are analyzed for spectral content.
2. Detections are created based on audio content and described settings.

NOTE: Signal detection is an absolute process. If a signal meets the described parameters, it will be detected regardless of statistical significance as compared to other detections.

3. Detected signals are individually analyzed for their spectral content.
 - Each detected signal has a unique spectral pattern.
4. The spectral patterns of all the detections are compared to each other.
 - A single spectral model is created.
 - This grand average is the Hidden Markov Model (HMM).
 - For additional reference information, see: [Cluster Analysis Theory](#).
5. The HMM is used to create the first cluster (Cluster.00).

NOTE: The statistical model described by the cluster is called the cluster center. Detections are described in similarity to the statistical model as distance from cluster center.

6. The spectral models of each of the detections are compared to the HMM.
 - None of the detections will be an exact match to the HMM, but one of the detections will be more similar than any of the others.
 - The detection which is the most similar to the HMM is the detection closest to the cluster center in Cluster.00.

Tip: The first detection in the first cluster is significant because it represents the most common pattern found in the input files, based on the content of the input files and the current cluster analysis settings. The first detection in the first cluster can be considered a reasonable starting point for understanding what is being found in the audio files with the current settings. If the most common detections found in the cluster analysis are grossly different from the intended target sound, this is an indication the current cluster analysis settings may need further refinement.

7. Detections are compared to the HMM until they reach a statistical threshold and the next cluster is created.
8. Detections are assigned to spiraling clusters based on statistical density and similarity.

NOTE: It is important to understand cluster analysis relies on statistical significance. If there are many similar detections found in a cluster analysis, they will form clear and obvious clusters. If there are fewer similar signals, detections may be scattered around and analysis becomes more challenging.

Run Cluster Analysis

Follow these steps run a basic cluster analysis batch process:

1. Under the Batch tab, select the Input Directory for the files to be analyzed.
2. Select an Output Directory.

NOTE: Do **NOT** check the output options to create WAV (or.zc) files on output.

3. Under the Signal Params tab, check and adjust any signal detection settings.

Select the Cluster Analysis tab.

4. Click on the Disabled menu and choose Scan and Cluster Recordings to Create cluster.kcs and cluster.csv.
5. Check and adjust the Max Distance from Cluster Center to Include Outputs in cluster.csv.
 - For additional information, see: [TOP1DIST Column](#).
6. Check and adjust the FFT Window Size.
 - For additional information, see: [FFT Window Size](#).
7. Press the Process Files button to start the analysis.
 - The batch process will commence and a progress bar will be displayed.
 - When the batch process is complete, the Viewer and Results window will open.

NOTE: If the computer has limited RAM, running a cluster analysis batch process could cause an error message or crash. Make sure all other applications are quit when running a cluster analysis batch process. If errors or crashing persist, lowering the Compute Resources may provide more stable results. For additional information, see: [CPU Optimization](#).

Cluster Analysis Output Files

When a cluster analysis batch process is run, the following files are created in the Output Directory:

- **db-batch.wdb**

- This file contains a record of the cluster analysis batch process in the form a file which can be uploaded to a database.
- **meta.csv**
 - The meta.csv file contains a record of the input files used in the batch process.
- **cluster.csv**
 - The cluster.csv file is displayed in the Results window along with the Viewer, to show the cluster analysis results.
 - To re-open the cluster.csv file, go to the Control Panel File menu and choose Open Results...
 - The cluster.csv file can be renamed.
 - This file contains the statistical results of the cluster analysis batch process.
 - The results include a list of detections and the clusters to which they are assigned.

NOTE: If the cluster analysis is run using a classifier (cluster.kcs file), the cluster.csv file will include named clusters. The named clusters are created when the classifier is built. Any detections which are similar to the named cluster models will be assigned to the named clusters.

- The cluster.csv file can be opened and edited in any application which supports the CSV file format.
- The cluster.csv file is used as part of the process when creating a classifier.
- For additional information regarding the cluster.csv file see: [cluster.csv](#).
- **cluster.kcs**
 - The cluster.kcs file contains the statistical models which were created by the cluster analysis.
 - If the cluster names are edited and saved, this updates the cluster.kcs file and this is considered to be a simple classifier.
 - The cluster.kcs file can be further refined to create an advanced classifier.
 - The cluster.kcs file can be renamed.

NOTE: A cluster.kcs file is not created when a cluster analysis batch process is run using a classifier.

- **settings.ini**
 - The settings.ini file from a cluster analysis batch process is specifically useful because it provides a record of all the settings used in the analysis.

4.5 Cluster Analysis Results

The following section describes how to review and understand the results of a cluster analysis batch process. This applies to both basic cluster analysis, and cluster analysis done using a classifier.

Results Window and Viewer

When a cluster analysis batch process is completed, the Results window and Viewer open.

- The Results window provides a list of detections found in the cluster analysis batch process.
 - For additional reference information, see: [The Results Window](#).
- The Results window and Viewer are linked.
 - A detection displayed or selected in one window is displayed or selected in the other.
 - Changing the current detection in one window will update the other window.

If the Viewer or Results window are closed, the cluster analysis results can be re-opened.

1. Choose Open Results... from the Control Panel File menu.
2. Navigate to the cluster.csv file which was created in the Output Directory by the cluster analysis batch process.
3. Select and open the cluster.csv file.
 - The Viewer and Results window will re-open.

Tip: If settings in the Control Panel are changed after a cluster analysis batch process has been run, there could be error messages or other problems when re-opening the cluster.csv file. If this happens, close the Viewer and Results windows. Under the Control Panel File menu, choose Load Settings... Navigate to and select the settings.ini file from the cluster analysis Output Directory. This will restore the required settings. Now re-open the cluster.csv file.

TOP1MATCH Column

Detections are represented as rows which are assigned to clusters.

The TOP1MATCH column lists the clusters as created by the cluster analysis.

NOTE: TOP2MATCH and TOP3MATCH columns display the next most likely clusters to which the detection could be assigned, based on similarity to the cluster pattern. TOP2MATCH and TOP3MATCH columns are initially hidden by the Default Settings.

- By default, the first listed cluster is named Cluster.00.
 - Cluster.00 represents the most common pattern found in the input recordings with the current cluster analysis settings.
- A new cluster is formed when there are enough detected signals which are similar enough to each other to form a cluster, but different enough from the previous cluster, that a new cluster is created.
 - Each successive cluster is based on similarity to the previous cluster.
 - As new cluster are created, they are less and less similar to Cluster.00.

NOTE: It is not uncommon for similar vocalizations to be found in different clusters. When this happens, it may be because even though the vocalization is similar, there are other influencing factors in the detection. The clusters model spiral out from the central model in similarity. Therefore, there could be two similar but slightly different clusters next to each other in the list. It is also possible that what looks like similar but slightly different clusters could be found separated in the list by other similar clusters.

Example: A frog call on dry land represents one general pattern. If the same frog call is made near a stream, the sound of the stream in the background changes the overall pattern within the detection. If there are enough detections of each the two separate patterns, two separate clusters could be formed.

Tip: If a target sound is found in higher numbered clusters (lower down the cluster list), this means based on the current analysis parameters, the target pattern is not as common as the patterns described by the lower numbered clusters (higher up the list). Tightening up analysis parameters to better focus on the target may create target clusters which are closer to or at the top of the cluster list.

- If a classifier was used, the named clusters will initially be at the top of the list and sorted alphabetically.

Understand Signal Detections

- Detections are listed as rows in the Results window.
 - A detection is a defined selection within a larger audio file.
 - Each detection is defined by its Input File, Offset, and Duration.

Tip: To display the entire file to which a detection belongs, choose Reload... from the Viewer File menu. To go back to viewing detections, select any other detection from within either the Viewer or Results window.

- Detections are created from input files, based on the signal parameters.

NOTE: Any detections which were found in the analysis but which exceed the Max Distance from Cluster Center to Include Outputs in cluster.csv setting will not be listed in the Results window

- Columns describe attributes of detections.
 - The Results window initially displays a limited list of columns.
 - To show or hide columns, go to the Results window File menu, and choose Edit Columns...
- Detections are sorted and assigned into clusters.
 - A cluster represents a statistical model of an audio spectral pattern. The statistical model is referred to as the cluster center.
- Multiple detections are often found within the same audio file.
 - The same input file name may appear in multiple rows to describe different detections.
 - Each detection which belongs to the same parent file will reference a different location and duration within the file.
- A detection can only appear once in the Results list.
 - Detections cannot overlap.
 - The same segment of time in an audio file cannot be described in more than one detection.

TOP1DIST Column

Detections are assigned to clusters based on their similarity to the cluster center.

- The cluster center is defined by the statistical model which represents the cluster.
- Each detection has a different statistical similarity to the cluster center.

- Similarity between a detection and the cluster center is described as a radial distance.
- By default, detections are sorted by distance (near to far) from the cluster center.
- The TOP1DIST column displays the distance from cluster center for each detection.
- A closer distance (lower numerical value) indicates the detection is more similar to the cluster center.

NOTE: The first detection (closest to the cluster center) in Cluster.00 represents the most common audio pattern found in the input files based on the current cluster analysis settings.

- As distance from cluster center increases, detections become less similar.
- The minimum distance to the cluster center is a radial degree value of zero. The cluster center is an average. Therefore, no detection will have an exact distance value of 0.
- The maximum value for distance from cluster center is 2.
- Any detection further from this cluster center will be assigned to a new cluster.
- Detections can be filtered from the output results based on distance from cluster center.
 - Max Distance from Cluster Center to Include Outputs in Cluster.csv is adjusted under the Cluster Analysis tab.
 - The default value is 1. This means any detections with a distance greater than a value of 1 will be excluded from the Results window.
 - The purpose of filtering is to exclude detections which are so different from the cluster center as to be of no interest.
 - The purpose of raising the Max distance from cluster to include outputs in cluster.csv setting is in case target sounds are rare and less likely to be found close to cluster centers.
 - Setting Max distance from cluster to include outputs in cluster.csv to a maximum value of 2 will force all detected signals to be included into clusters.

NOTE: A typical result of setting the Max distance from Cluster to include outputs in cluster.csv to a value of 2 will be detections found at furthest distances from cluster centers may appear to be random and exceptional.

Tip: When searching for relatively rare sounds, a Max distance from Cluster to include outputs in cluster.csv value of 1.5 may be an ideal starting point.

Use the Viewer

The Viewer is a powerful tool for understanding cluster analysis results.

- The Viewer is used to further analyze individual detections.
- The Viewer displays the detection which is currently selected in the Results window.
- Selecting a new detection in one window will change it in the other.

Tip: Use the arrow buttons or shortcut keys to quickly scan the first few detections at the top of each cluster. This will provide a general idea of the cluster pattern, and what other detections have been found which are similar to the pattern.

- To display the entire file to which the detection belongs, go to the Viewer File menu, and choose Reload...
 - To return to detection display mode, go to a different detection in the Viewer or select any detection in the Results window.
- A detection is a start and end point within a file.
 - The Viewer displays the described portion of the file and also adds padding at the beginning and end of the detection.
 - The padding is used to show the detection in context of what happens before and after.
 - The length of the padding is based on the Inter-Syllable Gap setting under the Signal Params tab.

NOTE: The Viewer is useful for understanding why similar vocalizations may be found in different clusters or far from cluster centers. The Viewer will display the target vocalization and will also show whatever else was happening in the background at that time and frequency range.

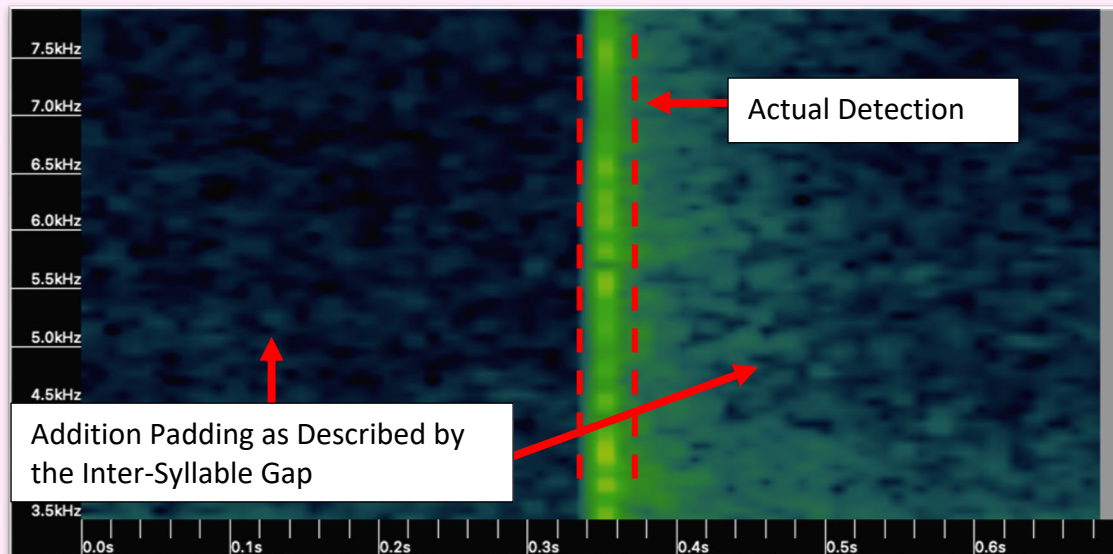
Detection Padding

When Kaleidoscope displays a detection in the Viewer, it expands the selection to include "padding" before and after the actual detection.

- Padding is extra time added to the display to provide visual context for the detection.

- The length of the additional padding before and after the detection is based on the Inter-Syllable Gap setting.
- Padding will be truncated if the detection is at the beginning or end of the recording file.

Example: The spectrogram is displaying a signal detection. In this example the detection is a recording of a gunshot. The Inter-Syllable gap was set to the default .35s. Therefore, the display includes .35 seconds of additional audio padding before and after the actual detection.



Kaleidoscope runs analysis functions in sequence.

- Full-spectrum audio is first run through FFT analysis.
 - FFT Analysis creates spectral information for the entire frequency range and time length of the file.
 - The FFT Window Size setting biases the spectral analysis towards frequency resolution or temporal resolution.
- Kaleidoscope searches the spectral content of the audio for Signals of Interest.
 - A signal is an event of audio energy which stands out from ambient background noise.
 - There is no specific threshold of amplitude used for signal detection.
 - A signal event is detected based on signal to noise ratio.
 - In order to be detected, the event must be roughly 12 dB louder than the background at the same frequency.
 - This allows for detections of signals with relatively low amplitude when the background noise is also low in amplitude.

NOTE: A signal may not be detected if there is significant background noise at the same frequency as the signal. However, a signal will not be masked by background noise which happens at a different frequency.

Example: A recording could have significant energy at low frequency. This is typical of wind noise. Another signal can exist simultaneously at higher frequency which is relatively low in amplitude. The low frequency ambient noise would not cause a problem with detection of the higher-frequency, lower-amplitude signal.

- FFT analysis happens before signal parameters are applied. Therefore, FFT Window Size will make a difference to the function of the Signal Parameters.
- FFT Window Size and Signal Parameters can be adjusted in any order for the sake of experimentation.

Tip: The bias of the FFT resolution will make a difference to what is found within the specified signal parameters. Therefore it may be useful to consider the character of the target sound, and therefore adjusting the FFT Window Size, before changing signal parameters. For slower, low frequency sounds, larger FFT Window Sizes may be useful. By comparison, when looking for faster, higher frequency sounds, smaller FFT Windows sizes may provide better results.

- Signals of Interest which fit into the defined Signal Parameters are then described as detections based on offset from start of the larger file, and duration.

- The detection is displayed in the Viewer with additional time shown before and after the actual detection. The amount of padding is determined by the Inter-Syllable Gap setting.

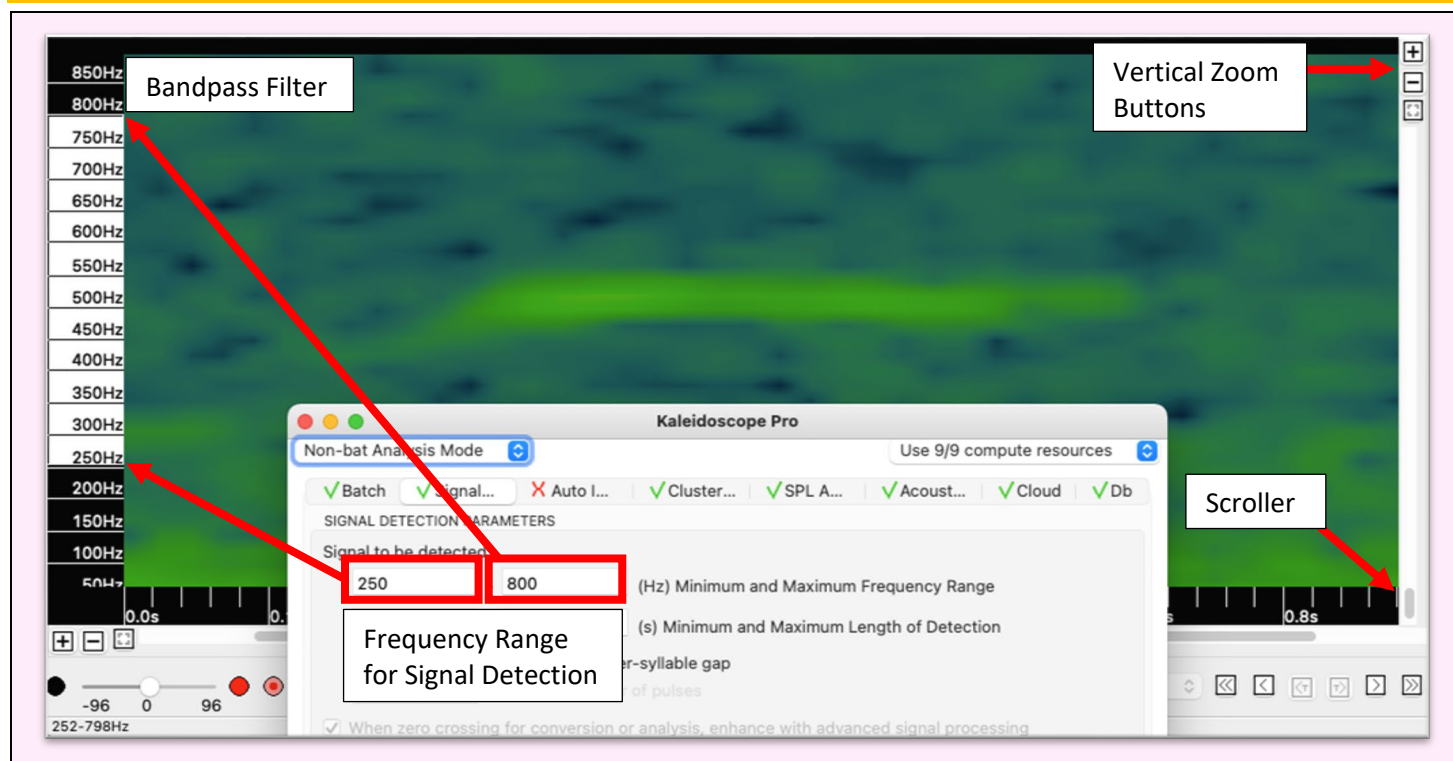
Isolate Detections

Tune the spectrogram to display and play back the same frequency range and resolution which was used in the cluster analysis process.

- This is helpful to understand how Kaleidoscope has defined a detection.
- The Viewer will initially display and play back the entire frequency range of audio contained in the file segment described by the detection.
 - Press the Vertical Zoom buttons and position the scroller in the spectrogram to display the same frequency range which is described under the Signal Params tab.
 - Click and drag in the Frequency Ruler to create a Bandpass Filter to isolate playback of the specified frequency range.
 - To adjust the spectrogram resolution, choose FFT Settings... under the Viewer File menu.

Now the human eye and ear will see and hear the same signal which Kaleidoscope detected and assigned to the cluster.

NOTE: The visual display will include extra padding, both before and after the detection, as defined by the Inter-Syllable Gap setting.



Save Detections as WAV Files

One or more detections can be selected and exported as individual WAV files.

1. In the Results window, Shift-click or Command-click to select one or more detections.
2. Under the Results window File menu, choose Save Selected detections as WAVs...
3. A window will open to allow selection of the Save location.
 - Separate WAV files will be created for each selected detection.
 - Each new file will have the original file name, with the addition of the channel and start time of the detection within the original file.

NOTE: Save detections as WAVs... is not available in Bat Analysis Mode.

Improve Cluster Analysis Results

There are two basic techniques which can be applied to improve clarity in cluster analysis results:

1. Improve detection parameters.
 - Even though signal parameters and FFT size may have been determined previously, it is never a bad idea to spot-check known deployment examples of the target sound.
 - Signal detection is absolute. An audio signal in a recording will either pass the current detection parameters or it will not. Use the Scan Recordings and Extract Detections function at any time to test whether a known target sound in a recording is being detected.
 - Typically, the only reason a known target signal will not be detected is if it is obscured by background sound at the same frequency. If this happens, look for any portion of the target sound which may not be masked by background noise. Otherwise, if the target signal does not stand out enough from the background, it may not be detectable at all.

NOTE: Once detection parameters are optimized, the only way to improve basic cluster analysis results is to increase the statistical density of the target.

2. Improve cluster sorting.
 - Cluster sorting happens after detection and is based on the statistical density of similar audio patterns within the detections.
 - If a target sound is scarce in a batch of recordings this presents a statistical challenge.
 - A target sound may be detected, but because of its lack of statistical significance it may be difficult to find in the cluster analysis results.
 - Once an effective classifier has been built, any target sounds in the input recordings will be found and labeled, regardless of their statistical density.

Tip: A classifier cannot be built until basic cluster analysis is working well. Therefore do not start the overall process of trying to find a scarce target by attempting to build a classifier.

- To improve the statistical density of target sounds, use the [Bait Files](#) technique.
 - The Bait folder is used to train the cluster analysis by increasing the statistical density of the target sound.
 - With continued analysis, more examples can be added to the Bait folder, which will continue to increase the statistical density of the target sound.
 - Over time, the increased statistical significance of the bait examples will cause the represented audio pattern to become more common in the analysis, and therefore more clearly defined in clusters.

4.6 Simple Classifiers

A simple classifier is a tool used for targeted detection and labelling of specific sounds or vocalizations.

- Building and using simple classifiers is a function of cluster analysis.
- A Kaleidoscope Pro license is required to work with simple classifiers.
- Simple classifiers are supported in Bat Analysis Mode and Non-Bat Analysis Mode.
- A simple classifier is a file (cluster.kcs) which is created as a result of a cluster analysis batch process.
 - A simple classifier contains statistical models of audio patterns.
 - A statistical model defines a cluster.
 - The statistical models are created based on training files, using basic cluster analysis
 - The statistical models (clusters) in the simple classifier can be named.
- A simple classifier is then used to sort and label detections found in new recording files.
 - The simple classifier uses the settings from the original cluster analysis to detect signals of interest in the new recordings.
 - Detections are compared to the named cluster in the simple classifier and sorted accordingly.

When to Build a Simple Classifier

Understanding when to build a simple classifier will provide the most efficient results.

A simple classifier is not useful if no new recordings are expected.

- A simple classifier is built using one set of recording files and then used to analyze other recording files.
- The first step in building a simple classifier is basic cluster analysis of existing recordings.

Tip: Basic cluster analysis of a current set of recordings is the foundation for building a simple classifier. If new recordings do come in at a later time, the initial cluster analysis can then be used to immediately provide a simple classifier.

Use a simple classifier to quickly sort and label detections in new recordings.

- The clusters created from the training recordings are used to detect and sort similar sounds found in new recordings.
- Clusters in the cluster.kcs simple classifier file are named, and the similar detections found in the new recordings are sorted into accurately named clusters.

A simple classifier can be used to find a rare sound.

- A simple classifier uses clusters to detect and match similar sounds in new recordings.
- A cluster is based on a statistical average of multiple examples of a similar pattern.
 - A single example of a pattern is not enough information to form a cluster.
 - A robust cluster is built from as many examples of the target as possible.
- Once a robust cluster has been formed, it can then detect and isolate even a single example of the target pattern in a new audio file.

NOTE: Once an effective simple classifier is built, it makes no difference how many examples of the target are in the new recordings, or even how many recordings are in the input batch. If the target is in the new recordings, the simple classifier will find it.

Do not attempt to build a simple classifier until first getting the best possible basic cluster analysis results.

- The results from basic cluster analysis of training recordings directly influences the quality and function of the simple classifier.
- If basic cluster analysis of currently available recordings is not producing useful cluster analysis results, it may be prudent to wait until additional recordings are available before attempting to build a simple classifier.
- Ideally a simple classifier will be built using training recordings from the project deployment site.
 - An effective simple classifier cannot be built from library recordings alone.
 - A simple classifier can be built from remote deployment recordings, although this may not be ideal.
- For additional information, see: [Optimize Signal Detection](#).

A simple classifier can be improved over time.

- As more recordings are added to the basic cluster analysis, statistical significance of similar sounds will increase and analysis results will continue to improve.
- As new recordings become available, they can be added to the previously used training recordings.
 - A new cluster analysis is run on the combined new and old recordings.
 - This creates a new cluster.kcs simple classifier file.
 - The clusters will then need to be renamed and saved to complete the next-generation simple classifier.

Build a Simple Classifier

Follow these steps to build a simple classifier:

1. Run a basic cluster analysis batch process on training recordings:
 - Example recordings can be used in this step.
 - For additional information, see: [Use Example Recordings](#).
 - When the basic cluster analysis batch process is completed, the Viewer and Results windows will open.
2. Name clusters:
 - Select any detection in the Results window.
 - Under the Results window File menu, choose Edit Cluster Name...
 - Type in any text and press OK.
 - The TOP1MATCH column for all assigned detections will display the new cluster name.

Tip: Not all the clusters need to be renamed. Only rename the clusters which represent the desired sounds or vocalizations to be isolated and named by the classifier.

- Multiple clusters can be individually named.
- A single simple classifier can represent multiple species as separately named clusters.
- Different calls made by the same species can be isolated and labeled into separate clusters.
- Multiple clusters can have the same name.

Tip: Different calls made by the same species or variations of similar calls with different background sounds can get sorted into different clusters. Applying the same name to different clusters allows variations of a vocalization or target sound to be grouped together under the same name.

3. To update the underlying cluster.csv and cluster.kcs files at any time, choose Save or Save As from the Results window File menu.
 - This will update both the underlying cluster.csv file and also the cluster.kcs file.
 - The edited cluster.kcs file is the simple classifier with the newly created and saved cluster names.

Use a Simple Classifier

Follow these steps to use a simple classifier to sort and label new audio recordings.

1. Under the Batch tab, select the Input Directory for the new files which will be analyzed.
2. Select an Output Directory.

NOTE: When using a simple or advanced classifier, the signal detection parameters are included in the cluster.kcs file. Therefore, when sorting new recordings with a classifier, the settings under the Signal Params tab are not in use and therefore have no effect on the analysis.

3. Under the cluster analysis tab, choose Use existing .kcs to sort new recordings and create new cluster.csv.
4. Press the Browse button to navigate to and select the edited cluster.kcs file (the simple classifier).

Tip: When creating a simple classifier, it is best practice to re-name the cluster.kcs file so it will be easily and correctly identified.

5. Check and adjust the Max Distance from Cluster Center to Include Outputs in cluster.csv.

Tip: If the target sounds in the new recordings are scarce and tend to be found in varied background noise, raising the Max Distance from Cluster Center to Include Outputs in cluster.csv. value may increase the likelihood of finding more outlier detections.

6. Press the Process Files button to begin the analysis.
 - The new recordings will be analyzed and compared to the simple classifier.
 - When the analysis is complete the Viewer and Results window open.

Review Simple Classifier Results

- Detections found in the new recordings which match the simple classifier clusters will be sorted into named clusters.
- Named clusters are initially listed in alphabetical order.
- Clusters which were not named when building the simple classifier will still be present in the results.
- Detections in the new recordings which are similar to the unnamed clusters will be assigned to those clusters.
- For additional information, see: [Cluster Analysis Results](#).

NOTE: Unlike basic cluster analysis, cluster analysis done using a cluster.kcs simple classifier file does not create a new cluster.kcs file on output.

4.7 Advanced Classifiers

An advanced classifier is a specialized tool which is used to further isolate target detections.

- Building and using an advanced classifier is a function of cluster analysis.
- A Kaleidoscope Pro license is required to work with advanced classifiers.
- Advanced classifiers typically work best in Non-Bat Analysis Mode only.

NOTE: Although it is possible to build an advanced classifier in Bat Analysis Mode, this is generally not recommended. A simple classifier can work well in Bat Analysis Mode. An advanced classifier built and used in Bat Analysis Mode is unlikely to produce useful results.

When to Build an Advanced Classifier

An advanced classifier is typically only useful in specialized circumstances.

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

- An advanced classifier further isolates target detections as compared to using a simple classifier.

- If a target sound is rare and is also similar to other more common sounds, the more common and similar sounds may be found in the same clusters as the target detections.
- If two similar but different sounds are confused and found together in the same cluster, this is sometimes described as a "false positive" identification.
- An advanced classifier can be used to separate the target from the more common similar sound.

Tip: As more examples of the target sound are found in new recordings, the new target recordings can be added to the original training recordings. This will increase statistical density of the target in the input files. A new cluster analysis batch process can be run with the additional target recordings included. A new and more robust classifier can then be built. Over time the need for an advanced classifier may decrease, and a simple classifier may be all that is required for good results.

An advanced classifier works by isolating manually labelled target detections found in a basic cluster analysis.

- A batch of input files is used initially as training data.
- The advanced classifier is built using the detected signals from the training data files as references.
- Accurate detections are labeled with a custom Manual ID.
- Non-target detections are given generic Manual IDs for the purpose of isolating the non-target detections in new recordings.
- The labeled detections are used in a second-stage analysis to further isolate targets from other similar sounds.
- The second-stage analysis produces a new cluster.kcs file which is the advanced classifier.

Example: A set of recordings is made around the dawn hours. The recordings contain many Mourning Dove calls. The recordings contain some Owl calls, but very few. The Mourning Dove and Owl calls are similar and occur at slightly different frequencies. In this example a simple classifier will not find any owls if the detection frequency range is based around just the Owl. This is because there are not enough Owl calls to create a cluster.

The detection frequency range is expanded to include both the Owls and the more plentiful Mourning Doves. The Owl calls are similar to the Mourning Dove calls. Therefore, the Owl calls are found in the same clusters as Mourning Dove calls. The Owls are actually false positive detections in the Mourning Dove clusters. They are scattered at greater distances from the cluster centers than the Mourning Doves and are still difficult to locate. The Owl calls have been found but they are obscured by the Mourning Dove calls.

The Owl calls can be manually labeled. The manual labels will then work to separate the Owl calls from the Mourning Dove calls. An advanced classifier can be built using the original training recordings, settings, and manual labels. The advanced classifier can then be used to analyze new recordings. If there are Owl and Mourning Dove calls in the new recordings, the advanced classifier will find and separate both, and then specifically label the Owl calls.

Build an Advanced Classifier

Follow these steps to build an advanced classifier:

1. Run a basic cluster analysis batch process on training recordings:

Tip: The typical use of an advanced classifier is to find rare detections. Therefore, raising the Max Distance setting may help find more targets.

- When the basic cluster analysis batch process is completed, the Viewer and Results windows will open.
 - Manual review of detections is done in the Viewer.
 - Manual IDs are assigned from the Viewer to the current detection in the Results window.
2. Choose Copy Top1Match/Auto-IDs to Manual IDs from the Results window File menu.
 - A window will open to confirm the operation .
 - Generic cluster names will be copied from the Top1Match column to the Manual ID column for all detections.
 - This will overwrite any previous Manual IDs which may have been created.
 3. In the Viewer Metadata Panel, create a single button label for the target sound.

Tip: It is possible to use multiple labeled buttons to add different Manual IDs to detections. However, this is not a recommended technique when first attempting to build a working advanced classifier. A single target Manual ID label is more likely to be initially effective.

4. Review the clusters to locate the target detections.

NOTE: This is the point where the quality of the basic cluster analysis is critical. Ideally, the target detections have been found as clearly as possible using tuned settings.

- Some clusters may contain no target detections at all.
- Target detections may be found in multiple clusters.
- The goal is to find and label each of the individual examples of the target detection.

NOTE: Manual labeling of individual detections is a time-consuming process. If there are so many examples of the target being found in the cluster analysis that labeling everyone would be an overwhelming job, it may be possible there are enough examples of the target that an advanced classifier is not required.

Tip: If many examples of the target sound are being found, but they appear to be scattered all over the current clusters, it may be an indication the basic cluster analysis could be tuned more accurately. Always be as sure as possible the basic cluster analysis is working as well as possible before building an advanced classifier.

5. Apply Manual ID labels to individual detections.

There are three possible states for the Manual ID field for each detection in the Results window.

- **The generic cluster names which have been copied from the TOP1MATCH column can be left in place.**
 - This is appropriate when the detection does not contain any trace of the target sound.
 - Detections labeled with generic cluster names will be used to train the advanced classifier.
 - When analyzing new recordings, any new detections which resemble the generically labeled training detections will be separated from the new target detections and assigned to generically named clusters.
- **The Manual ID field can be blank.**
 - To delete the generic cluster name or any other text from the Manual ID column, click on any blank button label in the Metadata Panel.
 - To restore the generic cluster name to the Manual ID field, click the button which displays the current generic cluster name.
 - A detection with no label in the MANUAL ID column will not be considered for training the advanced classifier.
- **The Manual ID field can contain a Custom Label.**
 - A Custom Label is used to identify only the desired detections from within one or more clusters.
 - Custom-Labeled detections are used to train the advanced classifier.
 - The advanced classifier will isolate new detections which closely match the custom-labeled training detections.

NOTE: If a detection contains the target and also contains other specific sounds, using the detection as training data can teach the advanced classifier to include the other sounds with the target.

- If the detections always contain the target along with other similar sounds, or if there few available target detections, it may be unavoidable for the similar sounds to be found together by the advanced classifier.
- The target sound may be by detections found in multiple clusters.
- All target detections in the cluster analysis must be accurately labeled.

NOTE: If a detection represents the target sound but is left with the generic cluster name for its Manual ID, the detection will be used to train the advanced classifier that this example does not represent the target.

6. Choose Save... or Save As... from the Results window File menu to update the underlying cluster.csv file with the Manual IDs.
7. Under the Cluster Analysis tab choose Re-scan recordings and edited cluster.csv to create new cluster.kcs with pairwise classifiers and cluster.csv.
8. Use the Browse button to locate the cluster.csv file which has been edited with the Manual IDs.
9. Press the Process Files button.
 - The original files will be re-analyzed, using the manually edited cluster.csv file as a reference.
 - Detected signals with Manual IDs will be re-clustered.
 - New clusters are created based the manually labeled detected signals.
- When the batch process is complete the Viewer and Results window will open.
 - This set of results can be double-checked for accuracy.
 - The second stage cluster analysis creates a new cluster.kcs file in the Output Directory.
 - The new cluster.kcs file is the advanced classifier.

Use an Advanced Classifier

Follow these steps to use an advanced classifier to sort and label detections in new audio recordings.

1. Under the Batch tab, select the Input Directory for the new recording files to be analyzed.
2. Select an Output Directory.

NOTE: When using an advanced classifier, the signal detection parameters are included in the cluster.kcs file. Therefore, when sorting new recordings with an advanced classifier, the settings under the Signal Params tab are not in use and therefore have no effect on the analysis.

3. Under the cluster analysis tab, choose Use existing .kcs to sort new recordings and create new cluster.csv.
4. Press the Browse button to navigate to and select the edited cluster.kcs file (the advanced classifier).

Tip: When creating a simple classifier, it is best practice to re-name the cluster.kcs file so it will be easily and correctly identified.

5. Check and adjust the Max Distance from Cluster Center to Include Outputs in cluster.csv.

Tip: If the target sounds in the new recordings are scarce and tend to be found in varied background noise, raising the Max Distance from Cluster Center to Include Outputs in cluster.csv. value may increase the likelihood of finding more outlier detections.

6. Press the Process Files button.
 - The new batch of input recordings will be analyzed using the advanced classifier.
 - When the analysis is complete the Viewer and Results window open.
 - Results will include the newly created labeled clusters.
 - Detections which are similar to the custom-labeled clusters will be sorted by the custom-label name.
 - Detections which are similar to the generic-labeled clusters will be separated and sorted by generic-label name. These detections can be ignored.

Review Advanced Classifier Results

- Clusters are initially listed in alphabetical order.
- Detections found in the new recordings which match the named clusters will be sorted based on similarity.
- Detections in the new recordings which are similar to the unnamed clusters will be assigned accordingly.
- For additional information, see: [Cluster Analysis Results](#).

NOTE: Unlike basic cluster analysis, cluster analysis done using an advanced classifier file does not create a new cluster.kcs file on output.

5 Typical Workflows for Soundscape Analysis

Soundscape analysis is different than species surveys or targeted searches. Soundscape analysis provides statistical information about an environment over time. Soundscape analysis can include information about animal activity. Soundscape analysis can also be used to measure anthropomorphic or other non-animal sounds in the environment. In some cases it may be useful to do a combination of both soundscape analysis as well as specifically targeted analysis of animal calls. This can provide a complete picture of the behaviour of the animal and what is going on around the animal, for example.

Soundscape analysis is a growing field. There are many ways to measure the environment. Kaleidoscope provides Sound Pressure Level (SPL) analysis tools, as well as support for a selection of Acoustic Index analysis tools. The following sections describe these tools and how they can be used.

5.1 SPL Analysis

SPL Analysis is used to measure relative amplitude of sound over time.

- A Kaleidoscope Pro license is required to enable the SPL Analysis function.
- SPL Analysis is available in Non-Bat Analysis Mode only.
- For additional reference information, see: [SPL Analysis tab](#).
- Separate 1/3 octave (narrow) frequency bands from 19.7 Hz to 16,1269.9 Hz can be selected and analyzed.
- Standard weighted broadband ranges can be selected and analyzed.
- Multiple weighted bands can be selected simultaneously for analysis.

- Output measurements are provided for minimum, mean (average), maximum, and accumulated sound exposure level (SELcum).
- Output measurements are based on file length or specified time segments.
- SPL Analysis results are provided in two CSV files:
 - [spl.csv](#)
 - [splbyfile.csv](#)

Understanding Decibels (dB)

Audio amplitude measurements are typically described in Decibels.

- Sound Pressure Level (SPL) describes the absolute energy level of an audio signal.
- Relative amplitude of sound is typically expressed in Decibels (dB).
 - Relative amplitude level of sound is also referred to as volume or loudness.
- The Decibel scale describes relative difference in audio amplitude.
- dB can be described in positive or negative numbers, relative to 0.
- dB can be used to describe absolute sound pressure level (SPL).
 - SPL is actual acoustic energy.
 - Absolute acoustic energy can be measured in Pascals.
 - A common standard is to reference 0 dB = 20 micro-Pascals.
 - 0 dB then represents what humans typically experience as silence.
 - Using this reference, 120 dB SPL would be a painfully loud sound to a human ear.

NOTE: It is important to understand that Pascals are an absolute measurement of pressure. Decibels (dB) is a relative measurement scale which may or may not be referenced to Pascals.

When sound is recorded in a digital audio file, there is an absolute maximum value of amplitude which can be expressed in the file.

- The maximum amplitude which can be represented in the file is described as full-scale
 - It is common practice for amplitude within a digital audio file to be described in dB relative to full-scale
 - This can be described as 0 dB = FS (full-scale). 0 dB represents the loudest amplitude which can be described in the audio file.
 - All signal below maximum amplitude is then described in negative numbers

Example: Signal which is 5 relative Decibels below the maximum amplitude which can be represented in the file is seen as -5 dB. A signal which is much quieter in the recording would be further below the full-scale ceiling. Therefore a -65 dB signal is quieter than a -25 dB signal.

- Full-scale (maximum amplitude) within an audio file can be referenced to an absolute SPL measurement
 - The maximum SPL which can be represented in an audio file is a function of the microphone and recording signal path

Example: It is typical to calibrate a recording system by applying a test signal with known amplitude and frequency at the microphone input. A common example is a 1 kHz test tone at 1 Pascal SPL is used to describe 0 dB as full-scale at the microphone input. Any change in the recording signal path is then calculated and compensated, and then referenced to the microphone input calibration. This reference and compensation allows for measurement of absolute SPL in the audio file.

NOTE: Without a known SPL reference for the recording path from microphone to file, it is not possible to know absolute SPL within a WAV file.

Tip: It is always possible to measure relative amplitude difference (in dB) within a WAV file.

Select Weighted Bands

Select the frequency bands to analyze.

- Acoustic energy is frequency-specific
- SPL measurements can be specific to narrow or broad frequency ranges.

- When SPL is measured over a frequency range, the measurement is an average of the energy across the described frequency range
- A broadband frequency range can be weighted to simulate the hearing response of different types of animals
- One or more Weighted Bands can be selected for a single SPL Analysis batch process

Example: A-weighting is a broadband measurement from 20Hz to 20kHz with a specific frequency curve designed to mimic the response of human hearing.

- Kaleidoscope can simultaneously analyze relative sound pressure levels of audio within both narrow 1/3 octave frequency bands and standard weighted broadband ranges

Select Columns Per Band

A separate set of measurement columns are created in the spl.csv and splbyfile.csv files for each enabled Weighted Band.

- Checking a column includes that measurement for all enabled Weighted Bands:
- **Min SPL**
 - Minimum Sound Pressure Level
- **Mean SPL**
 - Mean (Average) Sound Pressure Level
- **Max SPL**
 - Maximum Sound Pressure Level
- **SELCum**
 - Accumulated Sound Exposure Level

Sample Period (Minutes)

The Sample Period describes the time intervals which will be analyzed and described in the spl.csv file.

- The Sample Period is not based on the lengths of the input files
- If the audio recordings are not continuous, the Sample Period will average the measurements for each time segment

NOTE: The Sample Period relies on finding accurate Timestamp metadata in the audio files. All audio files made by Wildlife Acoustics recorders have Timestamp information. Recorders made by other manufacturers may or may not embed Timestamp metadata into their audio files. If the input audio files do not have readable Timestamp metadata, the spl.csv file will be empty.

dB Adjustment

The dB Adjustment field under the SPL Analysis tab is used to provide a global offset to all output results. This is used for two general purposes.

- dB Adjustment can be used to change the 0 reference point of the Decibel scale.
 - By default, 0 dB = full-scale (maximum amplitude which can be represented in the file).
 - This means all SPL measurements will be below full-scale and will therefore be negative numbers.
- Enter 94 to the dB adjustment field to change the dB offset so that output measurements will generally be positive numbers (any negative number would be below the threshold of human hearing).
 - 94 dB is the difference in decibels between 20 micro-Pascals and 1 Pascal.

Tip: When the overall system is calibrated so that 0 dB = 1PA, enter 94 to the dB Adjustment field to change the dB scale so 0 dB equals 20 micro Pascals. 20 micro Pascals is the generally accepted standard for "silence" at the human ear.

- dB Adjustment can be used to compensate for amplitude changes in the recording signal path.
 - A positive number is used to compensate for attenuation in the recording signal path.

Example: If a microphone has a sensitivity measurement of -34 dB, a positive value of 34 is added to compensate.

- A negative number is used to compensate for amplification within the recording signal path.

Example: If a preamplifier adds 24 dB of gain, -24 would be entered to the dB Adjustment field for compensation.

- In order to have an absolute dB measurement of SPL, there must be a known calibration reference level, and any changes in the recording signal path must be compensated accordingly.

- Microphones absorb acoustic energy.
- Recorders often have pre-amplifiers and other circuitry which can affect the amplitude of the signal passing through.

Example: The Wildlife Acoustics Song Meter SM4 recorder has an internal pre-amplifier, a second gain adjustment, and there is additional change to amplitude when the analog signal is converted to digital information. These specific changes in the signal path amplitude are embedded as proprietary metadata in the recording file. Kaleidoscope Pro sees the amplitude adjustment metadata and automatically compensates in its SPL analysis.

- Microphones can vary in sensitivity.
 - The sensitivity of the actual microphone which makes the recording needs to be known in order to be absolutely sure of how much signal the microphone is absorbing.

Example: In the case of the built-in microphone on the SM4, a test tone can be applied and a front panel display will show the exact microphone sensitivity. This measurement can be entered on the front panel of the SM4 before recordings are made. Recordings will then contain complete signal path amplitude information (including the microphone sensitivity), and Kaleidoscope Pro will compensate accordingly in its SPL analysis. No further dB adjustment is then required, and the dB measurements made by Kaleidoscope Pro will have an absolute reference to known SPL at the place where sound entered the microphone.

- If any change of amplitude in the recording signal chain is not embedded in the file metadata, it can be compensated manually.
 - In order to compensate for signal path changes, the changes must be known.

Example: If an SM4 was used for recording, but the microphone sensitivity had not been measured and entered on the front panel, that piece of information would be missing from the file metadata. If the microphone was measured later, the sensitivity could be added back via the dB adjustment field. If a calibrated 1 kHz signal at 1 Pascal is applied to the built-in microphone of the SM4, typical sensitivity is around -34 dB. Therefore a value of 34 would be added to the dB adjustment field to make that specific compensation.

- Signal chain compensation and dB scale offset can be done at the same time.

Example: In the case of the SM4 which did not have microphone sensitivity embedded in the file metadata, 34 dB is required to compensate for the microphone. If the results are also to be offset so 0 dB = 20 micro Pascals (silence), this requires a 94 dB offset. Therefore the total amount to enter to the dB adjustment field for this example is 128 (34 + 94).

SEL Threshold Settings

Accumulated Sound Exposure Level is based on measuring transient sounds.

- **SEL peak threshold above mean**
 - This sets the relative amplitude of the transient required to make the measurement.
- **SEL off threshold above mean**
 - This sets the relative amplitude at which the transient is no longer included in the measurement.

Run SPL Analysis

Follow these steps to run an SPL Analysis batch process:

1. Set up a batch process.
2. Select ENABLED from the Global menu under the SPL Analysis tab.
3. Select one or more Weighted Bands to analyze.
4. Select the Columns per band.
5. Set the Sample period.
6. Set the dB adjustment.
7. Set the SEL peak threshold above mean (if in use).
8. Set the SEL off threshold above mean (if in use).
9. Press the Process Files button.

A window will appear to show the progress of the batch process.

NOTE: Kaleidoscope cannot open the results of SPL Analysis in the Viewer or Results window. Therefore these windows will not open when the SPL Analysis batch process is completed.

Check the Results

The results of the SPL analysis batch process are provided in an spl.csv file and an splbyfile.csv file.

- The spl.csv file and splbyfile.csv files are created in the Output Directory.
 - Kaleidoscope cannot open an spl.csv file or splbyfile.csv file.
 - Typically, these CSV files are opened and viewed in a spreadsheet application.
- **splbyfile.csv**
 - The splbyfile.csv file contains measurements specific to each file in the Input Directory.
 - Each input file or file segment is listed and measured separately.
 - To make measurements of segments of files, set the segment length in the Split to max duration, seconds field under the Batch tab.
 - Each listing will display the offset of the analysis segment from the start of the file.
 - When stereo files are input for SPL Analysis, each channel is analyzed and listed independently.
- **spl.csv**
 - The spl.csv file contains measurements specific to time segments based on the files in the Input Directory.
 - Measurements are based on averages of the input files within each Sample Period.

5.2 Acoustic Index Analysis

Kaleidoscope Pro can be used to apply Acoustic Index Analysis to audio recordings.

- A Kaleidoscope Pro license is required to enable the Acoustic Index Analysis.
- Acoustic Index is available in Non-Bat Analysis Mode only.
- For additional reference information, see: [Acoustic Indices tab](#).

Overview

Acoustic Indices are typically used to measure environmental change over time.

- Files are analyzed to create statistical measurements.
- The measurements are used to compare changes in soundscapes over time, from one or more geographic locations.
- Kaleidoscope Pro includes a selection of relevant acoustic index analysis tools.
 - Many acoustic indices have been developed over time and are used for different functions.
 - Many of the acoustic indices included with Kaleidoscope Pro are designed to correlate to bioacoustics activity.
 - Some included indices are available in the open source Seewave R package by Jerome Sueur, Thierry Aubin and Caroline Simmons.
 - Some included indices are available in the open source SoundEcology R package by Luis J. Villanueva-Rivera and Bryan C. Pijanowski.
 - Additional indices were developed by others and cited appropriately.
 - The Kaleidoscope Pro implementation of these indices is designed to process large batches of files quickly and efficiently.
 - The results produced in Seewave and SoundEcology are similar to those from Kaleidoscope Pro. Due to differences in the calculations, the results may vary slightly, but not significantly.
- Multiple acoustic index measurements can be calculated simultaneously on a large batch of recordings.
- Acoustic index metadata can be integrated into a searchable database.
- Large files can be segmented to increase analysis granularity.
 - For additional information, see: [Split To Max Duration](#).
- Acoustic Index Analysis results are provided in an acousticindex.csv file.
 - For reference information, see: [acousticindex.csv](#).

NOTE: Wildlife Acoustics does not represent or explain the use of included acoustic indices. The best explanations of each acoustic index will come from the authors and users of these Indices. Therefore cites and additional references are included so the user may do further research on the specific functions and use of each included acoustic index.

Run Acoustic Index Analysis

Acoustic Indices are organized into groups which share similar parameters.

- Individual Indices can be enabled or disabled.
- Multiple Indices can be simultaneously enabled.
- For additional reference information, see: [Acoustic Indices tab](#).

Follow these steps to run an acoustic index analysis batch process:

1. Set up a batch process.
2. Choose Enabled from the Global menu under the Acoustic Indices tab.
3. Enable one or more Acoustic Indices.
4. Adjust any relevant settings.
5. Press the Process Files button.

A window will appear to show the progress of the batch process.

NOTE: Kaleidoscope cannot open the results of acoustic index analysis in the Viewer or Results window. Therefore these windows will not open when the acoustic index analysis batch process is completed.

Check the Results

When the batch process is complete an acousticindex.csv file is created in the Output Directory.

- The acousticindex.csv file cannot be opened by Kaleidoscope Pro.
- Typically the acousticindex.csv file is opened and viewed in a spreadsheet application.
- The analysis results for each selected acoustic index parameter are provided for each input file or file segment.

NOTE: The following example is a highly simplified use of a specific acoustic index. The purpose of the example is to show the workflow. The example is not meant to represent the specific acoustic index other than for demonstration.

Example 1: A batch of files has been analyzed using the default settings for the Acoustic Evenness Index. The acousticindex.csv file has been opened in a spreadsheet. A ribbon chart has been created from the spreadsheet. Each ribbon represents the analysis results from 5AM to 7AM over five days. Notice the first day, which is represented by the blue ribbon, shows little activity from

5AM to 7AM. Notice the fourth day, which is represented by the yellow ribbon, shows significant activity around 6AM and 6:50 AM.

Acoustic Diversity/Evenness Indices

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

ADI Enable AEI Enable

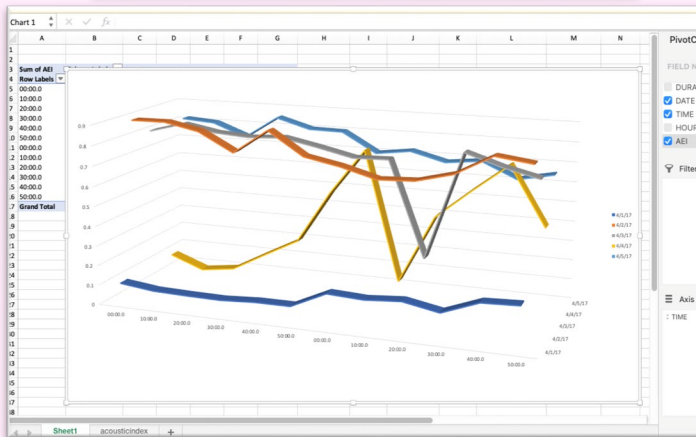
frequency minimum (Hz)

frequency maximum (Hz, 0 = nyquist)

frequency step (Hz)

threshold (dB fs)

1	A	B	C	D	E	F	G	H	I
2	FOLDER	IN FILE	CHANNEL	OFFSET	DURATION	DATE	TIME	HOUR	AEI
3		S4A00068_0	0	0	60	4/1/17	30:00.0		0.075496
4		S4A00068_0	0	0	60	4/1/17	20:00.0		0.077726
5		S4A00068_0	0	0	60	4/1/17	00:00.0		0.102942
6		S4A00068_0	0	0	60	4/1/17	10:00.0		0.159777
7		S4A00068_0	0	0	60	4/1/17	00:00.0		0.169136
8		S4A00068_0	0	0	60	4/1/17	50:00.0		0.086349
9		S4A00068_0	0	0	60	4/1/17	20:00.0		0.17316
10		S4A00068_0	0	0	60	4/1/17	10:00.0		0.082376
11		S4A00068_0	0	0	60	4/1/17	40:00.0		0.08571
12		S4A00068_0	0	0	60	4/1/17	30:00.0		0.139288
13		S4A00068_0	0	0	60	4/1/17	50:00.0		0.215409
14		S4A00068_0	0	0	60	4/1/17	40:00.0		0.208063
15		S4A00068_0	0	0	60	4/3/17	10:00.0		0.852972
16		S4A00068_0	0	0	60	4/3/17	00:00.0		0.808393
17		S4A00068_0	0	0	60	4/3/17	30:00.0		0.809101
18		S4A00068_0	0	0	60	4/3/17	20:00.0		0.821321
19		S4A00068_0	0	0	60	4/3/17	40:00.0		0.818629
20		S4A00068_0	0	0	60	4/3/17	50:00.0		0.782945
21		S4A00068_0	0	0	60	4/3/17	00:00.0		0.743186
22		S4A00068_0	0	0	60	4/3/17	10:00.0		0.747479
23		S4A00068_0	0	0	60	4/3/17	20:00.0		0.2752
24		S4A00068_0	0	0	60	4/3/17	50:00.0		0.707273
25		S4A00068_0	0	0	60	4/3/17	30:00.0		0.806911
26		S4A00068_0	0	0	60	4/3/17	40:00.0		0.749474
27		S4A00068_0	0	0	60	4/5/17	00:00.0		0.814332
28		S4A00068_0	0	0	60	4/5/17	10:00.0		0.802028
29		S4A00068_0	0	0	60	4/5/17	20:00.0		0.737247
30		S4A00068_0	0	0	60	4/5/17	30:00.0		0.849742
31		S4A00068_0	0	0	60	4/5/17	40:00.0		0.800103
32		S4A00068_0	0	0	60	4/5/17	00:00.0		0.697964
33		S4A00068_0	0	0	60	4/5/17	10:00.0		0.721146
34		S4A00068_0	0	0	60	4/5/17	50:00.0		0.797025
35		S4A00068_0	0	0	60	4/5/17	20:00.0		0.67591
36		S4A00068_0	0	0	60	4/5/17	30:00.0		0.696157
37		S4A00068_0	0	0	60	4/5/17	40:00.0		0.617028
38		S4A00068_0	0	0	60	4/5/17	50:00.0		0.652748



Example 2: The same recordings have been analyzed through the same Acoustic Evenness Index, but the minimum frequency has been raised to 500Hz. This eliminates all signals below 500 Hz from being included in the analysis.

The spreadsheet on the right shows the different AEI Values for the same audio files.

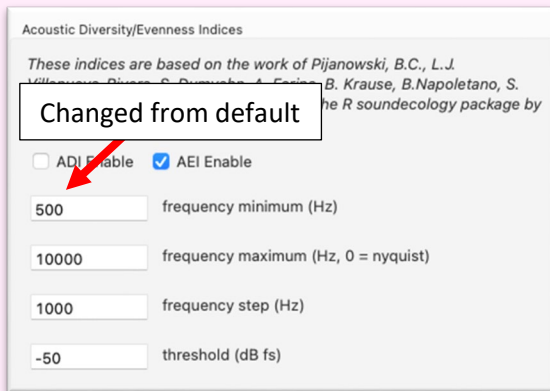
Note the ribbon chart and the blue and yellow ribbons which represent the first and fourth days. By going back and examining the actual recording files, it turns out there was steady rain and little animal activity on the first and fourth days. At around 6AM

and 6:50AM, loud atmospheric thunder occurred. The low frequency thunder was included in the first analysis, and that is reflected in the analysis results.

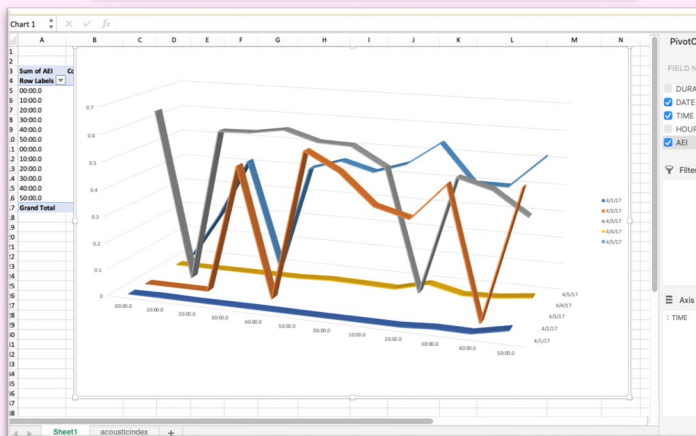
By excluding the frequency range which contained the thunder in the second analysis, the rest of the recording on the first and fourth days contained little more than steady rain sounds. This is reflected in the second analysis of the first and fourth days.

As the ribbon chart shows, removing low frequency content made a significant difference to the analysis across all days. By removing constant low frequency acoustic energy on days without rain, the Index was more sensitive to animal activity taking place at higher frequencies.

This example points out the results of Acoustic Index analysis are directly influenced by the content of the audio files and the settings used for the analysis.



A	B	C	D	E	F	G	H	I
FOLDER	IN FILE	CHANNEL	OFFSET	DURATION	DATE	TIME	HOUR	AEI
2	S4A00068_0	0	0	60	4/1/17	20:00.0		0.000532
3	S4A00068_0	0	0	60	4/1/17	50:00.0		0.00104
4	S4A00068_0	0	0	60	4/1/17	10:00.0		0.002553
5	S4A00068_0	0	0	60	4/1/17	10:00.0		0.001242
6	S4A00068_0	0	0	60	4/1/17	00:00.0		0.00061
7	S4A00068_0	0	0	60	4/1/17	30:00.0		0.001079
8	S4A00068_0	0	0	60	4/1/17	40:00.0		0.001822
9	S4A00068_0	0	0	60	4/1/17	00:00.0		0.000703
10	S4A00068_0	0	0	60	4/1/17	20:00.0		0.001266
11	S4A00068_0	0	0	60	4/1/17	40:00.0		0.008573
12	S4A00068_0	0	0	60	4/1/17	30:00.0		0.009545
13	S4A00068_0	0	0	60	4/3/17	00:00.0		0.639179
14	S4A00068_0	0	0	60	4/3/17	50:00.0		0.03589
15	S4A00068_0	0	0	60	4/3/17	50:00.0		0.564795
16	S4A00068_0	0	0	60	4/3/17	30:00.0		0.582093
17	S4A00068_0	0	0	60	4/3/17	20:00.0		0.579099
18	S4A00068_0	0	0	60	4/3/17	40:00.0		0.601378
19	S4A00068_0	0	0	60	4/3/17	10:00.0		0
20	S4A00068_0	0	0	60	4/3/17	20:00.0		0.041059
21	S4A00068_0	0	0	60	4/3/17	00:00.0		0.560081
22	S4A00068_0	0	0	60	4/3/17	10:00.0		0.489136
23	S4A00068_0	0	0	60	4/5/17	20:00.0		0.412403
24	S4A00068_0	0	0	60	4/3/17	40:00.0		0.441091
25	S4A00068_0	0	0	60	4/5/17	10:00.0		0.183931
26	S4A00068_0	0	0	60	4/3/17	30:00.0		0.475914
27	S4A00068_0	0	0	60	4/3/17	50:00.0		0.356601
28	S4A00068_0	0	0	60	4/5/17	00:00.0		0
29	S4A00068_0	0	0	60	4/5/17	50:00.0		0.443211
30	S4A00068_0	0	0	60	4/5/17	30:00.0		0.396157
31	S4A00068_0	0	0	60	4/5/17	30:00.0		0
32	S4A00068_0	0	0	60	4/5/17	20:00.0		0.538281
33	S4A00068_0	0	0	60	4/5/17	00:00.0		0.409576
34	S4A00068_0	0	0	60	4/5/17	40:00.0		0.395236
35	S4A00068_0	0	0	60	4/5/17	50:00.0		0.513406
36	S4A00068_0	0	0	60	4/5/17	40:00.0		0.403516
37	S4A00068_0	0	0	60	4/5/17	10:00.0		0.450083



6 Metadata Workflow

The simple definition of metadata is: "information about information". In the context of the Kaleidoscope workflow, metadata is information about audio recordings.

- Metadata can be embedded into an audio file, along with the actual audio content.
- Metadata typically exists in the form of text and numbers.
- Metadata can be stored in common CSV format spreadsheet files.
- Metadata can be uploaded into a searchable database.

In short, metadata is created and used at the beginning and end of the bioacoustics analysis workflow. Metadata represents the raw information and the final results. A central function of Kaleidoscope is to provide metadata workflow tools. The following sections describe the metadata workflow in Kaleidoscope.

6.1 Metadata Management

Understanding and managing metadata is critical for achieving useful and efficient results from the Kaleidoscope workflow.

What is Metadata?

Metadata relies on specific formatting.

- Kaleidoscope supports standard text, GUANO format, and proprietary Wildlife Acoustics metadata formats.
- Kaleidoscope will read GUANO format metadata created by any recorder.
 - All recorders made by Wildlife Acoustics embed GUANO and WA format metadata into the files they create.
 - Recorders not made by Wildlife Acoustics may or may not embed GUANO format metadata into their files.
 - For additional information, see: [Standardized GUANO Fields](#).
- Kaleidoscope will not recognize other proprietary metadata formats.

How is Metadata Created?

In the Kaleidoscope workflow, metadata is generated from three sources:

- The Recorder
 - Metadata is embedded into full-spectrum and Zero-Crossing audio files by the field recorder.
 - Metadata is created and embedded into the file at the moment the file is created.
 - This can include date and time, GPS location, and other specific settings.
 - The metadata which is embedded in the audio file is a function of the specific model of recorder.
- Human Input
 - Metadata can be created manually by human input.
 - Notes and Manual IDs are standard metadata fields in the Kaleidoscope workflow.
 - The Project Form under the Batch tab allows for creation of Notes in batch process outputs.
 - Notes and Manual IDs can be added to audio files opened directly in the Viewer.
 - The Viewer can be used to add Manual IDs to batch process outputs.
- Automated Analysis
 - Kaleidoscope generates metadata as a result of batch processing.
 - Metadata is output to CSV files.
 - If audio files are created on output, batch process metadata will be embedded into the new audio files.
 - If batch processing is done using cloud-based computing, metadata is automatically added to the cloud database.
 - If batch processing is done on the local computer, a db-batch.wdb file is created, which is used to upload the metadata from the batch process to a local or cloud database.

Where Does Metadata Go?

Metadata has three potential output destinations in the Kaleidoscope workflow.

- Metadata can be embedded into full-spectrum and Zero-Crossing files.
- Metadata is written to CSV output files.
- Metadata can be uploaded to a database. (Requires Kaleidoscope Pro)

What is the MetaForm?

Kaleidoscope makes use of an internal document called a MetaForm.

- 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.
- The Default MetaForm is available to be used as a template to create a new customized MetaForm. The MetaForm is a .xml formatted text document.
- A copy of the Default MetaForm, including instructions to customize or create a new MetaForm document can be downloaded from: wildlifeacoustics.com/SCHEMA.
- A custom MetaForm allows a user to specify CSV column outputs, embedded metadata in full-spectrum or Zero-Crossing files, and user-defined database search fields.

- Kaleidoscope Pro provides the option to load additional MetaForms. This is done via the project form menu under the Batch tab.
- New MetaForms are stored to the following locations. Removing a MetaForm from this location will remove it as an option from within Kaleidoscope.
 - Mac: (User Library)>Application Support>kaleidoscope>forms
 - Windows: C:\(user name)\AppData\Local\kaleidoscope\forms

Use the Default Project Form

The Default Project Form is found under the Batch tab in the Control Panel.

- The Project Form is used to manually create and add metadata during a batch process.
- The Project Form adds common information to batch process outputs.

The Default Project Form includes text instructions and options to create text Notes.

- **Batch Label (nickname)**
 - Create a name for the batch process.
 - This information is added to a database and used for searching by specific batch process. (Requires Kaleidoscope Pro).
- **Notes**
 - Notes is a standard metadata field. Any text can be added to this field.
 - Specific formatting can be used to create and populate additional metadata fields.
 - Notes text can be appended (placed after) or prepended (placed before) existing Notes
 - New Notes can replace previously existing Notes.
- **Privacy Access**
 - This menu selection is used for Wildlife Acoustics Managed Cloud Account database functions. (Requires Kaleidoscope Pro)
 - Batch process output results can be uploaded to a Wildlife Acoustics Managed Cloud Account database.
 - The batch process data can be marked Private or Public.
 - This choice determines whether the data will be searchable by Users who are not specifically invited to the Wildlife Acoustics Managed Cloud Account.
- **Copyright, Attribution, and License Type**
 - This additional metadata can all be added to output files.

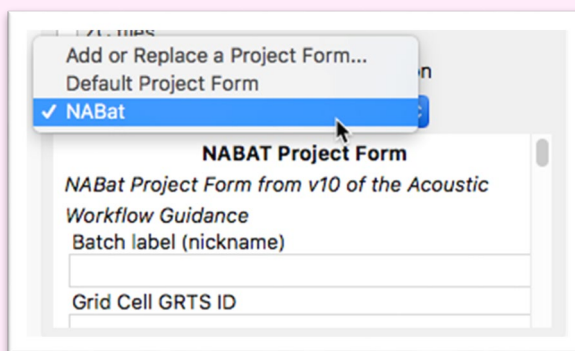
Install the NABat Project Form

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

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

1. Go to wildlifeacoustics.com/SCHEMA.
2. Right-click on Kaleidoscope NABat MetaForm.
3. Choose Download Linked File.
4. Download the NABat.xml file.
5. Under the Batch tab in the Kaleidoscope Control Panel, choose Add or Replace a Project Form...
6. Navigate to and select the NABat.xml file.

Kaleidoscope will now provide choices for the Default Project Form or the NABat Project Form.



Build a Custom Project Form

It is possible to build a custom Project Form.

- A Project Form is a function of a MetaForm.
- The MetaForm is an .xml text file and can be created or edited.
- Wildlife Acoustics provides a copy of the default MetaForm:
 - Go to wildlifeacoustics.com/SCHEMA/.
 - Right-click on Kaleidoscope Default MetaForm.
 - Choose Download Linked File.
 - This document can be used as a foundation to build a custom Project Form.
- Wildlife Acoustics provides a detailed description of how the MetaForm works:
 - Go to wildlifeacoustics.com/SCHEMA/.
 - Right-click on MetaForm SCHEMA.
 - Choose Download Linked File.
 - This document provides information and instructions for customizing the MetaForm and included Project Form.
- A customized Project Form can include user-created data fields.
 - A custom Project Form can work with existing metadata fields.
 - Custom metadata fields can be created to be added to batch process outputs.

For additional assistance with customized Project Forms, please contact Wildlife Acoustics Technical Support.

6.2 Cloud-Based Storage

Kaleidoscope Pro provides an interface for cloud-based file storage.

- A Kaleidoscope Pro license is required to enable cloud-based storage functions.
 - Cloud functions are not available with a Kaleidoscope Pro demo or training license.
- Cloud-based file management is configured and accessed under the Cloud tab in the Control Panel.
 - For additional reference information, see: [Cloud tab](#).
- Cloud-based file storage is not specific to Bat Analysis Mode or Non-Bat Analysis Mode.

Kaleidoscope Pro provides two options for cloud-based file storage.

1. Kaleidoscope Pro can access a privately owned Amazon AWS S3 bucket account.
 - For additional information, see: [Amazon Cloud Storage](#).

NOTE: A privately owned Amazon cloud account will not provide on-line computing or pre-configured database functions.

2. Kaleidoscope Pro can access one or more Wildlife Acoustics Managed Cloud Accounts.
 - Any owner of a Kaleidoscope Pro license can create a Managed Cloud Account.
 - Access and permissions to use a Managed Cloud Account are controlled by one or more Administrators of the account.
 - Any owner of a Kaleidoscope Pro license can access other Managed Cloud Accounts, based on permissions granted by the Managed Cloud Account Administrator.

- For additional reference information, see: [Managed Cloud Account Instructions](#).

Connect to a Cloud Account

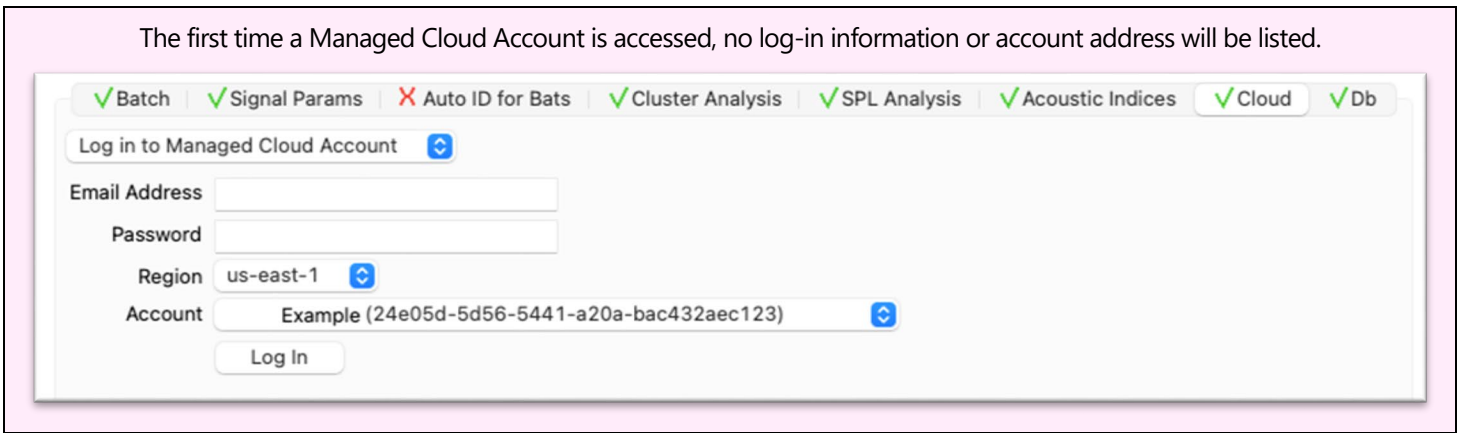
NOTE: The following instructions refer to a Wildlife Acoustics Managed Cloud Account. The same instructions and functions apply when using a privately owned Amazon SW3 bucket account for the purpose of file storage and management.

1. Click on the Cloud tab in the Control Panel.



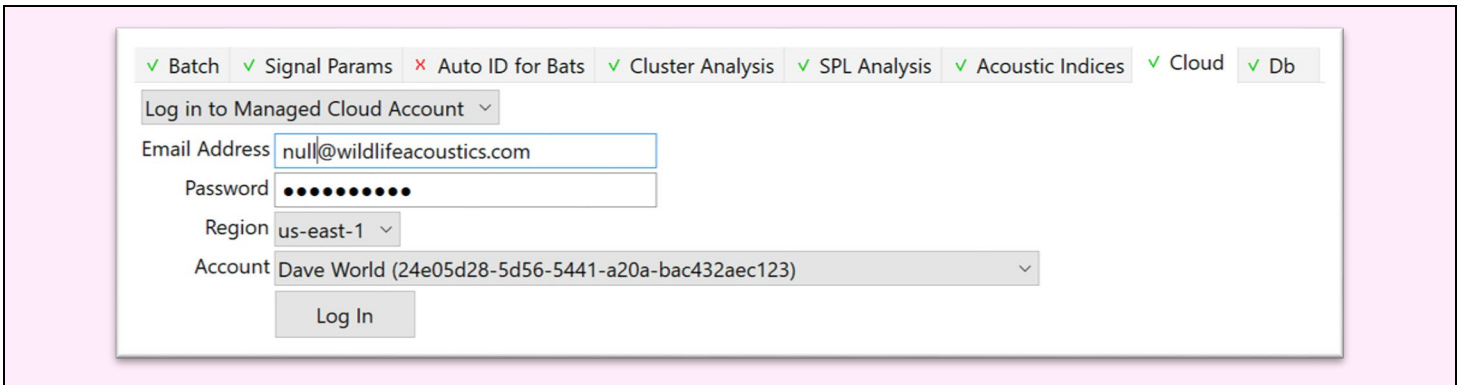
2. Choose Log in to Managed Cloud Account.

NOTE: Screen shots represent both Mac and Windows interface views. The account names and UII addresses are for display and example only.



- If the Kaleidoscope Pro User has created a Managed Cloud Account, the account will automatically be listed.
- If the Kaleidoscope Pro User is a guest of other Managed Cloud Accounts, those accounts will be listed and available for selection.
- Kaleidoscope Pro will connect to one cloud account at a time.

3. Enter the email address and password for the Wildlife Acoustics User Web Account.



4. Press the Log-In button.

This will log Kaleidoscope Pro in to the selected Wildlife Acoustics Managed Cloud Account.

NOTE: After the first time a Managed cloud account is accessed, the User Name and Account address are remembered. The log-in password is not stored and will be required each time a Kaleidoscope Pro is opened, and a Managed Cloud Account is then accessed.

View Cloud Storage Directories

Click the Browse Files button to open the Cloud File Browser window.

NOTE: Initially the Cloud File Browser window will be empty.

Upload Files

There are two available methods for uploading files to a cloud account.

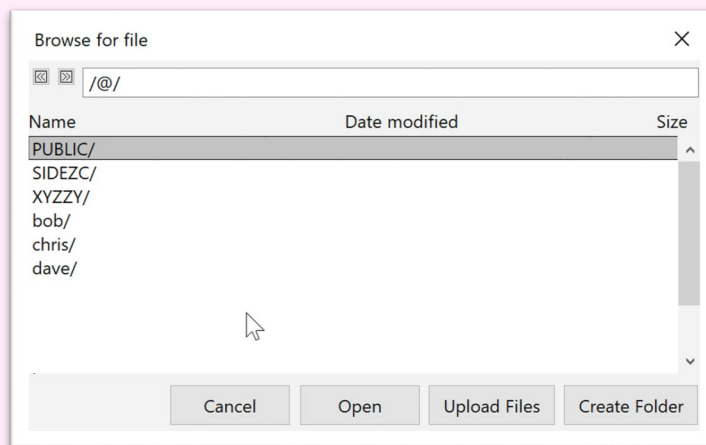
- Files can be uploaded from an on-line computer.
 - Open the Cloud file browser and click Upload Files.
 - Files can be selected and uploaded to the current cloud directory.
 - Depending on the amount of data to be uploaded and the on-line connection speed, this can take a significant amount of time.
- For large file uploads, Wildlife Acoustics can provide direct assistance.
 - Please contact Wildlife Acoustics Technical Support for further information.

Create Folders and Manage Files

Folders and sub-folders can be created in the Managed Cloud Account.

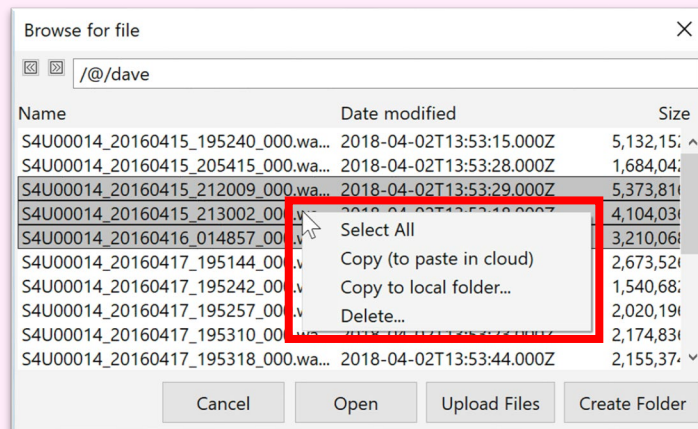
- Click the Create Folder button to make a new folder inside the currently displayed directory.
- A PUBLIC/ folder can be created.
 - Permissions and access to any folder is controlled by the Administrator of the Managed Cloud Account.
 - The PUBLIC/ folder can be accessed from other Wildlife Acoustics Managed Cloud Accounts.
 - The PUBLIC/ folder can be accessed directly through the Internet.

Example: 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.



- Navigate through directories to view individual files.

Select one or more files and right-click for options.



- **Select All**
 - Select all files in the directory.
- **Copy (to paste in cloud)**
 - Select one or more files to be copied.
 - Right-click and choose Copy (to paste in cloud).
 - Navigate to a different directory in the cloud account.
 - Right-click again to Paste the copied files to the new location .
- **Copy to local folder...**
 - Select one or more files to be copied.
 - Right-click and choose Copy to local folder...
 - Navigate to a local directory on the computer internal or external drive.
 - Once the destination directory is selected click Open (Mac) or Select Folder (Windows).
 - Kaleidoscope Pro will copy the selected files from the cloud to the local directory.
- **Delete...**
 - This will delete all selected files from the cloud account.

UUID

A Wildlife Acoustics Managed Cloud Account has a common name and a **UUID**.

- The UUID is the Internet address for the cloud account.

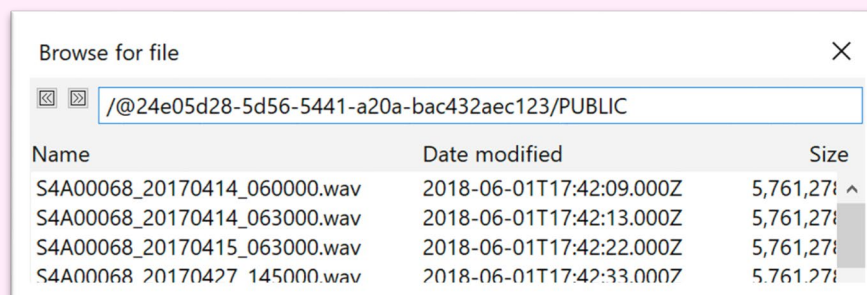
The UUID for the Managed Cloud Account is visible in a Wildlife Acoustics Web Account.

Manage Cloud Accounts		
NAME	UUID	PAYMENT INFORMATION
Dave World	24e05d28-5d56-5441-a20a-bac43	Ok
Wildlife Acoustics, Inc.	15a3d6aa-96ca-5c13-afa8-dfa63c9	Ok

NOTE: 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 to access different Managed Cloud Accounts.
 - This provides read-only access to the files in the PUBLIC folder in the remote account.
1. In the cloud File Browser window type: /@ followed by the remote UUID and then /PUBLIC.
 2. Press the Return key to enter the remote PUBLIC folder.

Example: This File Browser window displays a browser address which points to the PUBLIC folder in a remote Managed Cloud Account.



6.3 Cloud-Based Computing

Kaleidoscope Pro can make use of cloud-based computing to run remote batch processes.

- A Kaleidoscope Pro license is required to enable cloud-based computing functions.
 - Cloud functions are not available with a Kaleidoscope Pro demo or training license.
- Cloud-based computing requires a Wildlife Acoustics Manage Cloud Account.
 - Cloud-based computing works by having Kaleidoscope Pro running on-line, within a Managed Cloud Account.
- Cloud-based computing is not specific to Bat Analysis Mode or Non-Bat Analysis Mode.

Batch Processing

Kaleidoscope Pro can run a batch process on files which are located in a Managed Cloud Account.

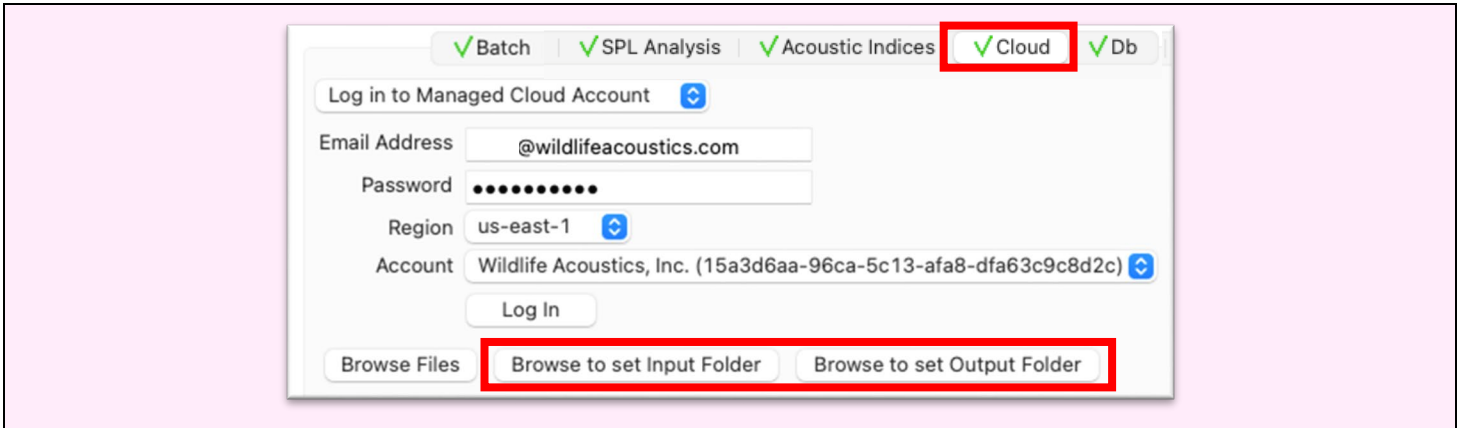
NOTE: It is possible to analyze files in a cloud account from a local computer. However this is inefficient because each file must be downloaded for the analysis. cloud-based computing is the most efficient way to analyze files in a Managed Cloud Account.

- Cloud-based computing is typically much faster as compared to running a similar batch process on a desktop or laptop computer.
- Cloud-based computing does not require the local computer stays on line during the batch process.
- When a batch process is run using cloud-based computing, the results are available to any User who can access the Managed Cloud Account.
- When a batch process is run using cloud-based computing, the results are automatically added to the Managed Cloud Account database.

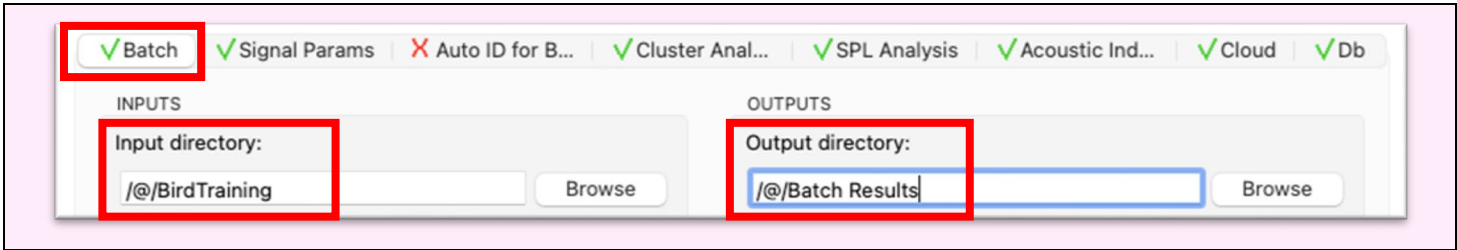
When the batch processed is commenced, Kaleidoscope displays a message asking if the processing is to be done on the local computer or using cloud-based computing.

1. Log in to a Wildlife Acoustics Managed Cloud Account.
2. Select the cloud Input and Output Directories for the batch process.

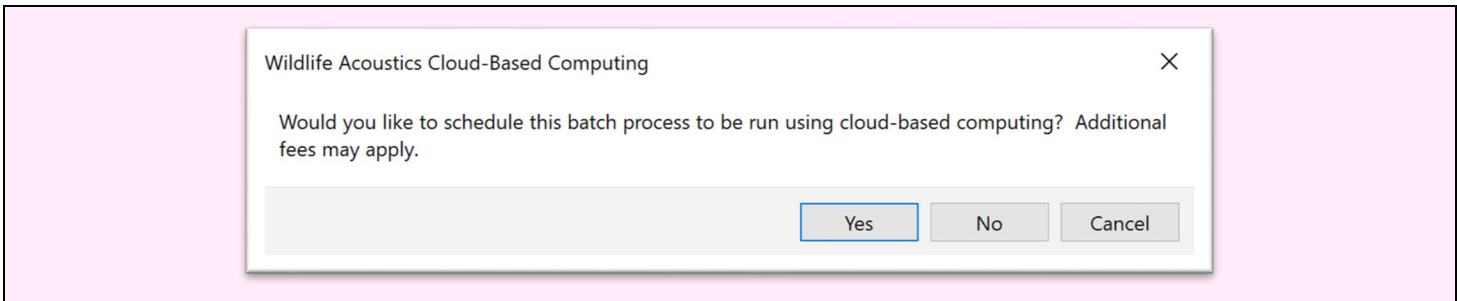
NOTE: Both the Input Directory and the Output Directory must be located in the Managed Cloud Account in order for cloud-based computing to be available.



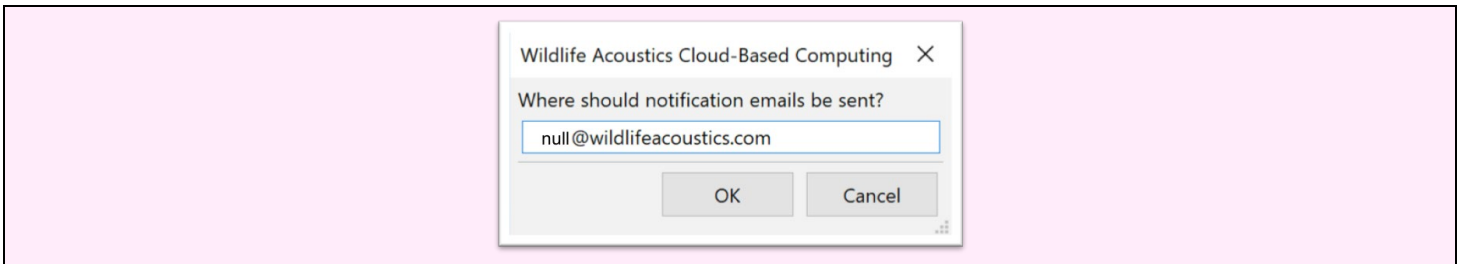
- The assigned Input and Output Directories will be added to the Batch tab.



3. Configure additional batch process functions.
4. Press the Process Files button.
 - The following window will open:

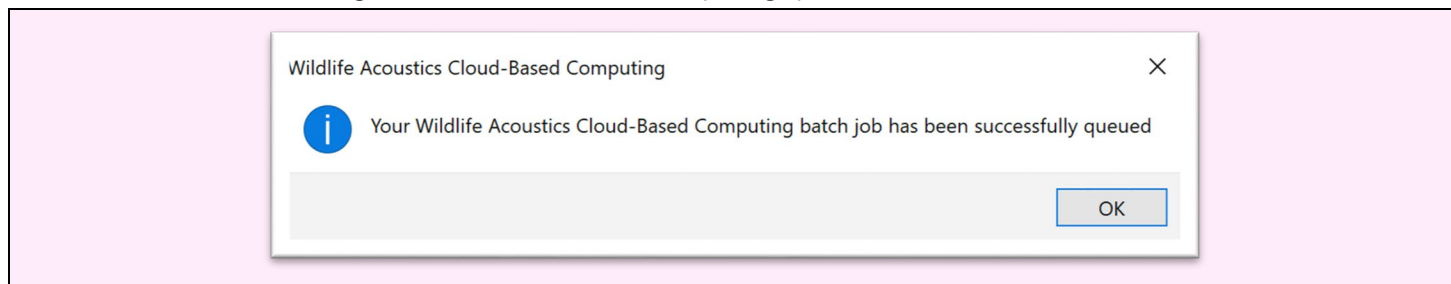


- Press **No** to run the batch process on the local computer.
 - Depending internet connection speed and other variable such as output file conversion, this can take a significant amount of time.
- Press **Cancel** to return to Kaleidoscope Pro.
- Press **Yes** to run the batch process using cloud-based computing.
 - 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 which indicates the batch process has been assigned to the cloud-based computing queue.



- Once the batch process is queued, Kaleidoscope Pro can be quit and the local computer can be taken offline.

Checking Results of the Cloud Batch Process

When the batch process is complete, results will be created in the assigned Managed Cloud Account Output Directory.

1. Log in to the Managed Cloud Account.
2. Navigate to the assigned Output Directory.
3. Double-click on the meta.csv, id.csv, or cluster.csv file to open the Results window and Viewer for the batch process.

6.4 Database Functions

Kaleidoscope Pro provides an interface for a searchable database.

- A Kaleidoscope Pro license is required to enable database functions.
 - Database functions are not available with a Kaleidoscope Pro demo or training license.
- Database functions are not specific to Bat Analysis Mode or Non-Bat Analysis Mode.
- Connection to a database server is configured under the Db tab in the Control Panel.
 - For additional reference information, see: [Db tab](#).

Database Contents

Metadata created by batch processes and Manual ID review is used to create searchable Database tables.

This includes:

- Records of all batch processes
 - Analysis settings used for each batch process
 - Information added to the Project Form for each batch process
- Analysis results from all batch processes
- References to all input and output full-spectrum or Zero-Crossing files analyzed or created by batch processing
 - Referenced input and output files can exist in any location
 - Drive Location for input and output files can be specified under the Batch tab (This provides database paths to files stored on external hard drives.)
 - Standard, GUANO, and WA format metadata from input files
- Manual IDs
 - Manual IDs are created separately from batch processes.
 - Manual IDs are added to the Results window and saved to the underlying CSV file.
 - When the underlying CSV file is saved with the Manual IDs, a db-review.wdb file is created or updated.
 - The db-review.wdb file is used to upload the Manual IDs to the database.
 - Manual ID records are associated with the Kaleidoscope Pro User name.
 - Manual IDs for the same results can be created by different Users and uploaded to the same database.
 - Manual ID records can be searched and identified by Manual Review Source.

Upload to database

Upload local .wdb file to database Upload cloud .wdb file to database

Query database

Type of query: Recordings (meta.csv) Choose destination for query results: \\Home\Desktop\query.csv Browse

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

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

ALL OF -- Select Database Field --

Optional sort order: -- Select Database Field -- Ascending

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

Please send us feedback! Video Tutorials Help Run Query

Upload to the Database

Database information created by local batch processes can be uploaded to the database.

- When a batch process is run using cloud-Based Computing, the results are automatically added to the Managed Cloud Account database.
 - When a batch process is run on a local computer, the results are not automatically added to a database.
 - When a batch process is run on either a local computer or with cloud-Based Computing, a db-batch.wdb file is created in the Output Directory.
 - The db-batch.wdb file contains the results of the batch process.
 - Local batch process results can be uploaded to the database.
 - Press Upload local .wdb file to Database button under the Db tab.
 - Locate and upload the locally created db-batch.wdb file.
 - Results created using cloud-Based Computing in one Managed Cloud Account can be uploaded into a database in a different Managed Cloud Account.
1. Run a batch process.
 - A db-batch.wdb file will be created in the Output Directory.
 2. Press the Upload cloud .wdb file to Database button under the Db tab.
 - The cloud File Browser window will open.
 3. Locate and upload the db-batch.wdb file.

Updated Manual IDs and cluster names can be added to the database.

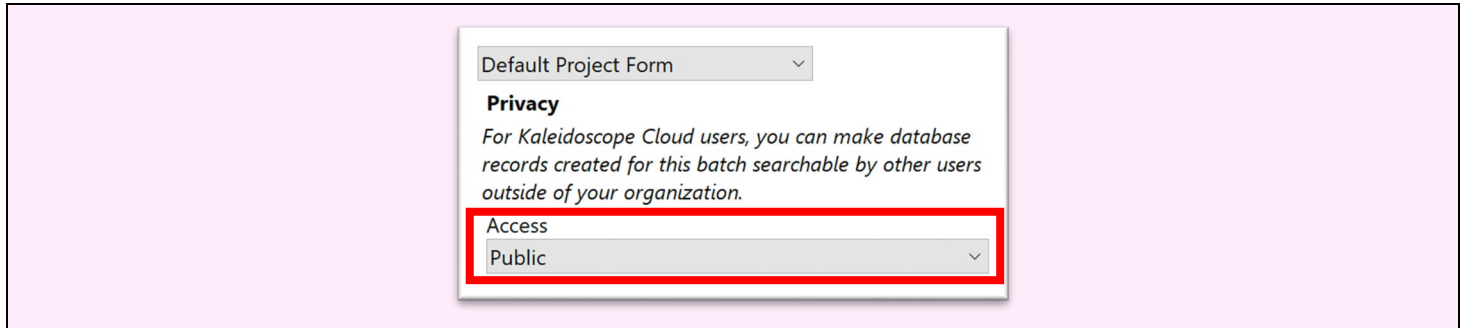
1. Open the results for a cluster.csv, id.csv, or meta.csv file.
2. Create Manual IDs or edit cluster names.
3. Choose Save or Save As from the Results window File menu.
 - This will update the underlying CSV file and will also create a db-review.wdb file in the Output Directory.
4. Press the Upload cloud .wdb file to Database button under the Db tab.
 - The cloud File Browser window will open.
5. Locate and upload the db-review.wdb file.
 - The Manual IDs or cluster names are added to the database.

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

Public vs. Private Database Records

When a batch process is run in Kaleidoscope Pro, metadata is added to the results of the batch which indicate whether the results are Public or Private.

- Selecting whether the batch data is Public or Private is done via the Privacy Access setting in the Default Project Form located under the Batch tab.



- The access setting applies if a User wants to search data in a cloud account which belongs to a different organization.
- The access setting does not affect Users within a Wildlife Acoustics Managed Cloud Account.
- 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 Database

Use these options to build, save, and run a database query.

Type Of Query:

- **Batch**
 - This will search for records of uploaded batch processes .
- **Recordings (meta.csv)**
 - This will search within records based on information generated by a meta.csv file.
- **Bat AutoIDs (id.csv)**
 - This will search within records based on information generated by an id.csv file.
- **Clusters (cluster.csv)**
 - This will search within records based on information generated by a cluster.csv file.
- **Load from query.json file**
 - A query.json file is a file which contains the parameters of a search .
 - When a database 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 Destination For Query Results:

- Press the **Browse** button to choose a local destination.
 - When a database query is run, two files are created in this location.
- The **query.csv** file contains results of the query.
- The **query.json** file contains the parameters of the query.

Table Data Source:

The query can be directed to specific areas of a 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 queried.
 - Enter the email address for another User who also has a Wildlife Acoustics Managed Cloud Account.
 - If the Specific User belongs to the same Managed Cloud Account, the database information of the Specific User will be available to query.
 - If the Specific User belongs to a different Managed Cloud Account, the records in the Specific User account must be marked as **Public** to be available for query.
- **Specific organization**
 - This allows the records of a different Managed Cloud Account to be queried.
 - Enter the UUID address for the Specific Organization.
 - UUID addresses are listed on the Managed Cloud Accounts page in a Wildlife Acoustics Web Account.
 - In order for database results to be available in the Specific Organization account, the results must be marked as Public.
- **All records**
 - This will search all /PUBLIC folders, and all records marked as Public, which are found throughout the entire Wildlife Acoustics Cloud database.

Table Data Mode:

The database can contain multiple records which reference the same files.

Most Recent**List All**

Select table Data Mode determines whether to list all the duplicate entries or just the most recent one.

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.

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.

Batch process records do not include Manual ID information. Therefore, this parameter is not available if the table Data Source is set to Batch.

- **My records**
- **My organization**
- **Specific user**
- **Specific organization**
- **All records**

Manual Review Mode:

Manual ID results can searched by mode.

- **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.

Search Filters

Multiple Search Filters can be created for the selected table Data Source.

- **ALL OF**
 - Only results which meet all filter criteria are displayed.
- **ANY OF**
 - Results which meet at least one filter criteria are displayed.
- **Select Database Field**
 - The contents of this menu are based on the Type of query.
 - The Database Field selects the information to be searched within the selected Data table.
 - The choices in this menu are a function of the MetaForm.
 - MetaForms can be customized to provide additional or different Database Fields.
 - For a complete list of Database Fields supported by the Default MetaForm see: [Default Metadata SCHEMA](#).
- **Query operator and text field**

Once a Database Field is 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.

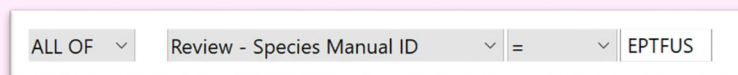
NOTE: This operator is typically used for numeric values. If the text box contains text, this operator will look for results which start with the next letter in the alphabet based, on the first letter in the text box.

- 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.
- Result may contain variables but must be case sensitive. The variable is represented by the % symbol.

Example: Entering MYO% into the Text Box will limit the filter to looking at any text which 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.

- The same operator as like, but not case-sensitive
- The filter will exclude any case-sensitive data described in the text field with a variable
- The filter will exclude any non-case-sensitive data described in the text field with a variable.

Example: Filter for all 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.

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.

A Manual ID field cannot contain two different results at the same time. Therefore, using an AND operator for this example would produce no query results.

Optional Sort Order:

- Results to Skip:
- Limit Results To:
- Adjust timezone (hours re UTC)

Run 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 specified location.

Example: Search For batch processes

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

The screenshot shows the software's configuration window. At the top, it indicates 'Non-bat Analysis Mode' and 'Use 3/3 compute resources'. A row of analysis options includes 'Batch' (checked), 'Signal Params' (checked), 'Auto ID for Bats' (unchecked), 'Cluster Analysis' (checked), 'SPL Analysis' (checked), 'Acoustic Indices' (checked), 'Cloud' (checked), and 'Db' (checked). Below this is a 'Log in to Managed Cloud Account' dropdown. The 'Upload to database' section contains two buttons: 'Upload local .wdb file to database' and 'Upload cloud .wdb file to database'. The 'Query database' section includes a 'Type of query' dropdown set to 'Batch', a 'Choose destination for query results' text box containing '\\Home\Desktop\query.csv' with a 'Browse' button, 'Table Data Source' set to 'My records', and 'Table Data Mode' set to 'Most recent'. There are also dropdowns for 'ALL OF' and '-- Select Database Field --'. The 'Optional sort order' section has a dropdown for '-- Select Database Field --' and another set to 'Ascending'. At the bottom, 'Results to skip' is set to 0, 'Limit results to' is set to 1000, and 'Adjust timezone (hours re UTC)' is set to -4.

Example: 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 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.

Non-bat Analysis Mode Use 3/3 compute resources

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

Log in to Managed Cloud Account

Upload to database

Query database

Type of query: Bat AutoIDs (id.csv) Choose destination for query results: \\Home\Desktop\query.csv

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

Example: Search For cluster analysis Results

- The first step is to search for batch processes.
 - 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 following query is used to search for batch processes in all database records.

Non-bat Analysis Mode Use 3/3 compute resources

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

Log in to Managed Cloud Account

Upload to database

Query database

Type of query: Choose destination for query results:

Batch \\Home\Desktop\query.csv

Table Data Source: Table Data Mode:

My records 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):

The results of the query were 24 found batch processes. The found batch processes are displayed in the Results window.

	Batch Label	Timestamp	Size	N Recordings	N Auto IDs	N Clusters	Kaleidoscope Version	Input Directory	Output Directory	Input
1	Concord 2017 SM4 Cluster (all)	2018-04-21T20:54:08-04:00	114516430	53911	0	732464	5.0.0alpha7	\\15a3d6aa-96ca-5c13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c\i\c\ian\Concord2017\San\Outputs\Concord2017\SM4	\\15a3d6aa-96ca-5c13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c\i\c\ian\Concord2017\San\Outputs\Concord2017\SM4\Cluster	
2	Concord 2016 SM4 Cluster (all)	2018-04-21T21:35:28-04:00	74266248	21026	0	503321	5.0.0alpha7	\\15a3d6aa-96ca-5c13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c\i\c\ian\Concord2016\San\Outputs\Concord2016\SM4	\\15a3d6aa-96ca-5c13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c\i\c\ian\Concord2016\San\Outputs\Concord2016\SM4\Cluster	
3	Concord 2016 SM4BAT Cluster (all)	2018-04-21T21:54:47-04:00	14739877	25706	0	50496	5.0.0alpha7	\\15a3d6aa-96ca-5c13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c\i\c\ian\Concord2016\San\Outputs\Concord2016\SM4BAT	\\15a3d6aa-96ca-5c13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c\i\c\ian\Concord2016\San\Outputs\Concord2016\SM4BAT\Cluster	
4	Concord 2017 SM4BAT Cluster (all)	2018-04-21T22:06:47-04:00	21635005	37962	0	75096	5.0.0alpha7	\\15a3d6aa-96ca-5c13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c\i\c\ian\Concord2017\San\Outputs\Concord2017\SM4BAT	\\15a3d6aa-96ca-5c13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c\i\c\ian\Concord2017\San\Outputs\Concord2017\SM4BAT\Cluster	
5	Concord 2017 SM4 Cluster Owl	2018-04-22T07:11:58-04:00	17236239	53908	0	18150	5.0.0alpha7	\\15a3d6aa-96ca-5c13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c\i\c\ian\Concord2017\San\Outputs\Concord2017\SM4	\\15a3d6aa-96ca-5c13-afa8-dfa63c9c8d23-afa8-dfa63c9c8d2c\i\c\ian\Concord2017\San\Outputs\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.

	Batch Label	Timestamp	Size	N Recordings	N At
1	Concord 2017 SM4 Cluster (all)	2018-04-21T2 0:54:08-04:00	114516430	53911	0

- 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 is loaded as a condition.
 - The fingerprint from the selected batch is entered as a value.
 - This will limit query results to the specified batch.
- Sort order is 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 1000 results from the batch process.
- Time zone offset is -4 to reflect east coast US time.

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

7 Reference Guide

The Reference Guide provides a detailed explanation for each function within Kaleidoscope.

- The Reference Guide is designed to be used in combination with the [Typical Use Workflows](#) sections to provide additional information about each workflow step.
- The order of information in the Reference Guide is loosely based on the order in which functions appear in the software.
- The Control Panel, Viewer, and Results windows in Kaleidoscope make use of standard application menus.
 - Application menus contain the same choices and functions, regardless of the computer OS version.
 - Windows and Linux OS display application menus in the upper-left corner of the application window.
 - Mac OS displays application menus in the upper-left menu Bar of the computer desktop.

7.1 The Control Panel

The Control Panel is always the first window to open when Kaleidoscope is opened.

- Control Panel menus provide access to key functions within Kaleidoscope.
 - Activate a Kaleidoscope Pro license from the Control Panel License menu.
 - Open an audio file in the Viewer via the Control Panel File menu.
 - Restore Default Settings via the Control Panel File menu.
 - Access the Kaleidoscope User Guide via the Help menu.
- The Control Panel displays a series of tabs from left to right.
 - Tabs are labeled according to functions within Kaleidoscope
 - Clicking on a tab displays the functions described by the tab label.
 - Each tab displays a green checkmark or red X depending on if the function is currently available.
- The Control Panel is used to configure batch process functions, including automated analysis.
- The Control Panel provides access to cloud and database functions.

Control Panel File Menu

- **Open...**
 - Open a full-spectrum or Zero-Crossing file into the Viewer.
 - For workflow information, see: [Open File](#).
- **Open Results...**
 - Open a meta.csv, id.csv, or cluster.csv file.
 - This will cause the Viewer and linked Results window to open.
- **Open Reference** (Requires Kaleidoscope Pro license)
 - Open Reference is available in Bat Analysis Mode only.
 - This command opens the Viewer.
 - Species Classifier reference calls currently enabled under the Auto-ID for Bats tab are displayed.
 - For workflow information, see: [Auto-ID for Bats](#).
- **Load Settings...**
 - Open a previously created settings.ini file.
 - A settings.ini file is created in the Output Directory by any batch process.
 - The settings.ini file will restore all settings which were in use at the time the batch process was run.
 - For workflow information, see: [Create and Restore Custom Settings](#).
- **Set Defaults**
 - Set all Kaleidoscope parameters to default values.
 - The Analysis Mode selection window will open.
 - Settings are set to default in both Bat Analysis and Non-Bat Analysis Modes.
 - For workflow information, see: [Set Defaults](#).
- **Close**
 - Close the Control Panel.
 - If no other windows are open this will also Exit (Windows) or Quit (Mac).
- **Exit**
 - Windows OS only
 - This will Exit Kaleidoscope.
 - Under Mac OS the command to Quit Kaleidoscope is found under the Kaleidoscope application menu.

License Menu

The License menu is used to activate a Kaleidoscope Pro license.

- **Activate annual subscription**
 - Enter the User email address and WildlifeAcoustics.com log-in password to activate an available license.
 - If the computer is off-line or there is a firewall, a window will open with instructions for manual activation.
- **Install Permanent or Demo License**
 - Enter any email address and a permanent or demo license code to activate Kaleidoscope Pro.
 - If the computer is off-line or there is a firewall, a window will open with instructions for manual activation.
- **Display License Agreement**
 - This displays the Kaleidoscope Pro software license agreement.
- For workflow information, see: [Activate a Kaleidoscope Pro License](#).

Help Menu

- Under the Help menu select Help Topics to open the Kaleidoscope User Guide.
- Type text into the Search field to search the Kaleidoscope User Guide.

Analysis Mode Menu

Use this menu to change the Analysis Mode.

- Select Bat Analysis Mode when working with recordings which contain bat calls.
- Select Non-Bat Analysis Mode when working with recordings which do not contain bat calls.
- The analysis mode can be changed at any time.

- SPL analysis and Acoustic Index analysis functions are disabled in Bat Analysis Mode.
- Auto-ID for Bats is disabled in Non-Bat Analysis Mode.
- For additional information, see: [Optimize For Bat Analysis](#).

Compute Resources Menu

Use this menu to limit Kaleidoscope's use of available computer resources.

- The maximum Compute Resources is the number of CPU Cores detected in the computer, plus one.
- Lowering the Compute Resources setting restricts the number of processing threads Kaleidoscope will hand off to the computer simultaneously.
- For additional information, see: [CPU Optimization](#).

Process Files Button

The Process Files button is located in the bottom right corner of the Control Panel.

- Press the Process Files button to commence a batch process

Tabs

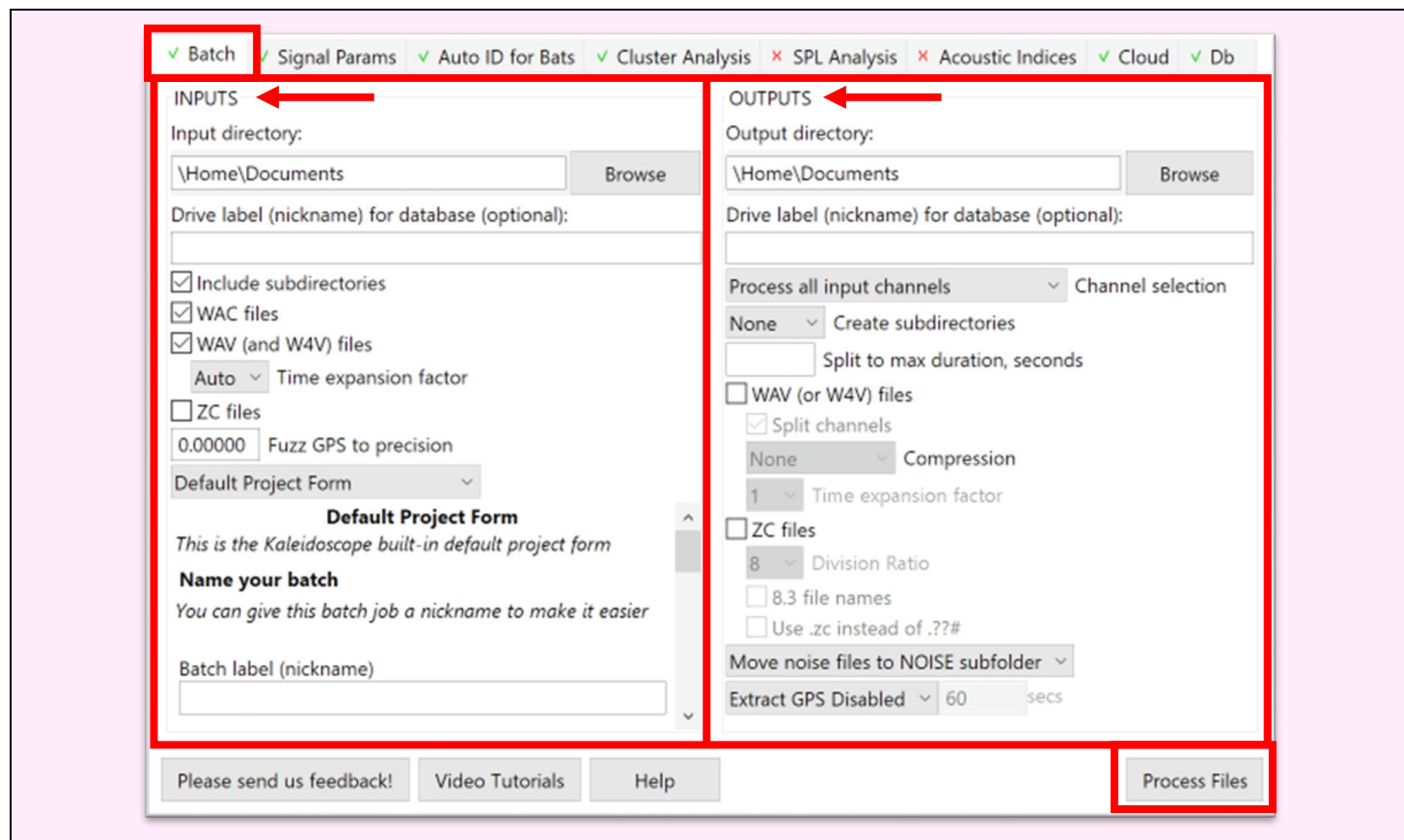
The Control Panel displays a series of tabs.

- Click on a tab to display a set of functions.
- Tabs can have green or red check-marks, indicating if the contents of the tab are currently available for use.
- The Batch tab is always selected when Kaleidoscope is first opened.

7.2 Batch Tab

The options under the Batch tab are used to configure inputs and outputs for an automated batch process.

- The Batch tab is always selected when the Control Panel is first opened.
- For workflow information, see: [Batch Processing and File Conversion](#).
- The Batch tab display is divided in half.
 - The left side shows options related to setting up the input configuration for a batch process.
 - The right side shows options related to configuring output results for a batch process.



Inputs

- Click the **Browse** button to select the Input Directory.
 - The Input Directory is a local folder containing the input files to be processed.
 - The Input Directory and enclosing file path will be displayed once selected.

NOTE: This operation selects a directory or folder, not an individual file. On Mac OS, any audio files in the folder will be greyed out. Under Windows OS, audio files will not be visible at all.

- **Drive label (nickname) for Database (optional):**
 - This is a text field which can be used to create and add information to batch process outputs.
 - A hard drive which is used to store input files for the batch process can be labeled accordingly.
 - This information can be added to a searchable database.
 - For workflow information, see: [Database Functions](#).
- **Include subdirectories**
 - Check this box to process files recursively in all the subfolders below the specified Input directory.
 - If the box is unchecked, only audio files found in the top level of the Input directory will be processed, and any subfolders and enclosed files will be ignored.

NOTE: Kaleidoscope will not see aliases/shortcuts to remote sub-folders or files. The actual audio files must be located in the Input Directory in order to be accessed by Kaleidoscope.

- **WAC files**
 - Check this box to process any .wac format audio files in the Input Directory.
 - If the box is unchecked, any .wac files in the Input Directory will not be included in the batch process.
- **WAV (and W4V) files**
 - Check this box to process any WAV and .w4v format audio files in the Input Directory.
 - If the box is unchecked, any WAV/.w4v files in the Input Directory will not be included in the batch process.
- **Time expansion factor**
 - Time Expansion is a legacy technique used to record ultrasonic bats calls using WAV format files.
 - This option is available in Bat Analysis Mode only.

- A Time expansion 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 will automatically choose the time expansion factor if Time Expansion Factor can be found in the file metadata.
- If no Time Expansion Factor metadata is found in the file, the Auto setting will choose a value of 1 for high-speed recordings (sample rates greater than 96 kHz) or a value of 10 for lower speed recordings (less than or equal to 96 kHz sample rate).
- **ZC files**
 - This option is available in Bat Analysis Mode only.
 - Check this box to process any .??# and/or .zc format files in the Input Directory.
 - If the box is unchecked, any .??# and/or .zc files in the Input Directory will not be included in the batch process.
- **Fuzz GPS to precision**
 - This option is used to obfuscate GPS location information in the metadata from input to output.
 - The default value of 0.00000 will leave any GPS metadata information untouched from input to output.
 - The value of the Fuzz is precision in degrees to which the GPS location is rounded.

Example: A Fuzz value of 1.0 means if the original GPS location is 42.365842 N 71.964281 W, it will be rounded on output to 42.0 N 72.0 W.

If fuzz value is 0.25, it will round to 42.25 N 72.00 W.

- **Default Project Form**
 - The Default Project Form is used to add common data to batch process output results
 - Add comments and other textual information to output results by appending, prepending, or replacing to any existing metadata.
- **Add or Replace a Project Form**
 - New custom-built Project Forms can be added as choices to this menu..
 - A custom Project Form is a function of a customized MetaForm .xml file.
 - Choose Add or Replace a Project Form to locate and load a MetaForm .xml file.
 - For workflow information, see: [Metadata Workflow](#).

Outputs

- Click the Browse button to select the Output Directory.
 - The Output Directory is a local folder which is used as a destination create the batch process output results.
 - The Output Directory and enclosing file path will be displayed once selected.

NOTE: The Output Directory **Can Not** be located within the Input Directory.

- **Drive label (nickname) for Database (optional):**
 - This is a text field which can be used to created and add information to batch process outputs.
 - A hard drive which is used to store output files created by the batch process can be labeled accordingly.
 - This information can be added to a searchable database.
- **Channel selection**
 - This menu designates whether the left channel, right channel, or both channels of a stereo (two-channel) audio file will be processed to the outputs.
 - Left and right channels are also referred to as channels 1 and 2.
 - **Process all input channels**
 - **Process only left input channel (0)**
 - **Process only right input channel (1)**
 - For additional workflow information, see: [Mono and Stereo Files](#).
- **Create subdirectories.**
 - When output audio files are created by a batch process, the files can be sorted into Daily or Nightly subfolders.
 - This function requires timestamp information in the input filenames or metadata.

- **None**
 - No additional sorting of files
 - **Daily**
 - Files are sorted by calendar date.
 - **Nightly**
 - Files are sorted based on noon-to-noon time frames.
- **Split to max duration, seconds**

This menu provides two functions:

 - When doing an Auto-ID for Bats, or Acoustic Index Analysis batch process, Kaleidoscope Pro can split a large file into smaller segments for analysis. This does not require new audio files to be created on output. The separate segments will be listed in the Results window with offsets from the start of each file.
 - If WAV or ZC files are created on output for any batch process, this function will split larger files into smaller files based on the specified duration.
 - If this field is left blank Kaleidoscope will not split larger files into smaller files or segments.
- **WAV (or W4V) files**
 - Check this box to convert input files to WAV/.w4v format output files.
- **Split channels**
 - Check this box to separate stereo (two-channel) input files into individual mono (single-channel) output files.
- **Compression**
 - The default value of **None** causes uncompressed WAV files to be created on output.
 - 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.

Example: 75% compression means the file is now 25% of its original size.

NOTE: Compressing a file causes some data loss. A compression value of W4V-8 will most likely not compromise the file for general bioacoustics analysis work. For greater compression values, it is best practice to do test conversions of files to make sure the compressed files will still be usable.

- **Time expansion factor**
 - This option is available in Bat Analysis Mode only.
 - If time-compressed input files have been included in batch process, this option will create output files which have been time-expanded.
 - For normal speed files, or to expand time-compressed input files, use a value of 1.
 - To keep time compressed input files in time compressed format when recreated on output, select the same time expansion factor value which was used for time compression of the input file.
- **ZC files**
 - Zero-Crossing options are available only in Bat Analysis Mode.
 - Check this box to convert full-spectrum input files to Zero-Crossing output files.
 - **Division Ratio**
 - Set the Zero-Crossing division ratio to 4, 8, or 16.

NOTE: When Zero-Crossing files are included in batch process inputs, checking ZC on output produces a copy of the original file and does not change the division ratio or split the recording into smaller pieces.

- **8.3 file names**
 - Check this box to create output files using the legacy 8.3 filename convention .

NOTE: The 8.3 filename convention can only be used if the input files have a compatible timestamp.

- **Use .zc instead of .??#**
 - Check this box to change the file name extension.

NOTE: When Kaleidoscope converts WAV files to Zero-Crossing files it can use enhanced DSP processing. This function is enabled (checked) by default and can be disabled (unchecked) under the Signal Params tab.

- **Noise Filtering**

- Noise filtering options are available in Bat Analysis Mode only.
- Noise filtering is used to isolate output audio files which do not contain useful recordings of bats.
 - **Disable noise filtering**
- No noise filtering function is applied.
 - **Delete noise files**
- Any input audio files which are designated as noise are not recreated in batch process outputs.
 - **Move noise files to NOISE folder**
- A **NOISE** folder is created in the batch process Output Directory.
- Any output files designated as noise are created in that location.
- For workflow information, see: [Analyze Noise Files](#).
- **GPS Extraction**
 - Existing GPS information can be extracted from metadata in input files.
 - The precision of the extracted GPS values is determined by the Fuzz value in the INPUTS section.
 - **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.
 - The gps.csv file can be opened by any application which supports the CSV file format.
 - **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 gps.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 gps.kml file.

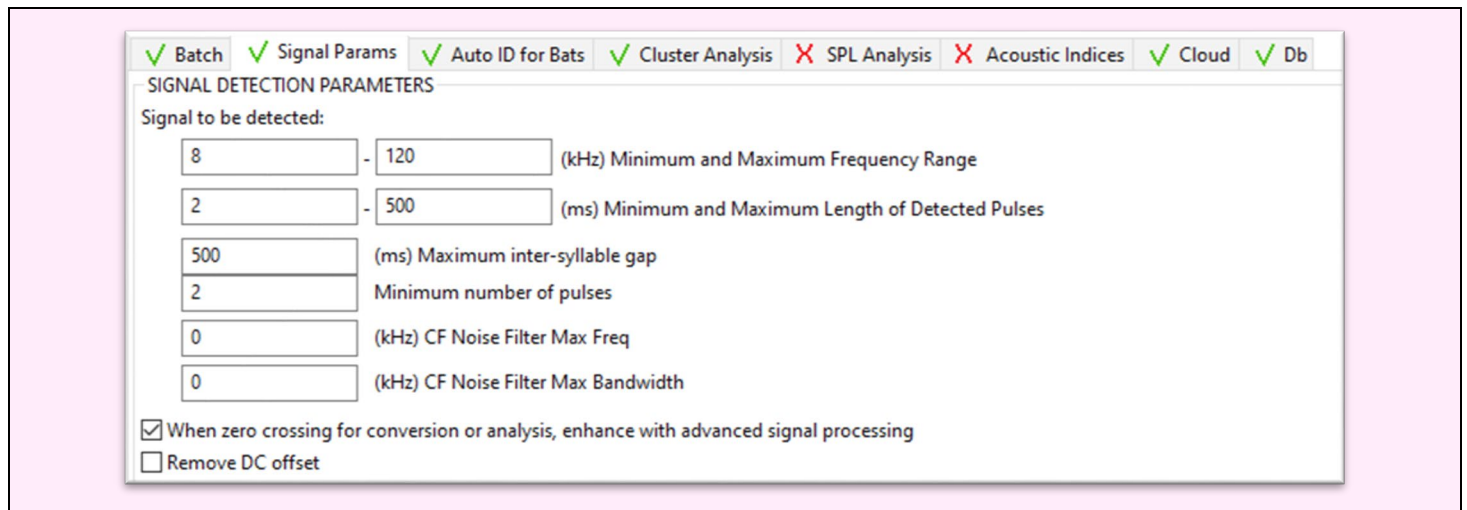
7.3 Signal Params Tab

Signal Params is an abbreviation of Signal Parameters.

The options under the Signal Params tab are used to configure signal detection parameters.

Signal detection is used for:

- **Noise File Analysis (Bat Analysis Mode only)**
 - For workflow information, see: [Analyze Noise Files](#).
- **Auto-ID for Bats (Bat Analysis Mode only)**
 - For workflow information, see [Auto-ID For Bats](#).
- **Extracting Signals of Interest (No Clustering)**
 - For workflow information, see: [Scan Recordings and Extract Detections \(No Clustering\)](#).
- **Basic Cluster Analysis**
 - For workflow information, see: [Cluster Analysis](#).



Signal Detection Parameters

- **Minimum Frequency Range**
 - This describes the lowest frequency of signal in the audio file which will be considered for analysis.
 - Any signal in the audio file below this frequency will not be considered or influence the analysis in any way.
- **Maximum Frequency Range**
 - This describes the highest frequency of signal in the audio file which will be considered for analysis.
 - Any signal in the audio file above this frequency will not be considered or influence the analysis in any way.
- **Minimum Length of detection (Non-Bat Analysis Mode)**
 - A signal must be at least this value in order to be considered as a detection.
- **Minimum Length of Pulse (Bat Analysis Mode)**
 - Individual bat calls must be at least this value in order to be considered as detections.
- **Maximum Length of detection (Non-Bat Analysis Mode)**
 - Any continuous signal which exceeds this value will not be considered as a detection.
- **Maximum Length of Pulse (Bat Analysis Mode)**
 - Any continuous signal which exceeds this value will not be considered as a detection.
- **Maximum Inter-Syllable Gap**
 - This function is used during cluster analysis.
 - This value defines the allowable elapsed time between signals before they are seen as separate detections.
 - This value defines the amount of padding placed before and after detections when displayed in the Viewer.
 - For workflow information in Bat Analysis Mode see: [Maximum Inter-Syllable Gap](#).
- **Minimum number of pulses (Bat Analysis Mode)**
 - This specifies the minimum number of call pulses to be considered a detected signal.
- **CF Filter Max Frequency (Hz) (Bat Analysis Mode)**

A filter may be applied to ignore signals within a specified frequency range. This can be useful for eliminating non-bat sound from being detected as bats.

- This setting specifies the maximum cutoff frequency which is used for filtering.
- This setting is used in combination with CF Filter Max Bandwidth.
- **CF Filter Max Bandwidth (Hz) (Bat Analysis Mode)**
 - This setting specifies the bandwidth of the filter, starting below the maximum cutoff frequency.

Advanced Signal Processing

- **When Zero-Crossing for conversion or analysis, enhance with advanced signal processing.**
 - Enabled by default
 - This function is used in Bat Analysis Mode only
 - This function is used when converting full-spectrum input files to Zero-Crossing format.
 - This function is used when viewing and analyzing Zero-Crossing files.

- For workflow information, see: [Advanced Signal Processing](#).

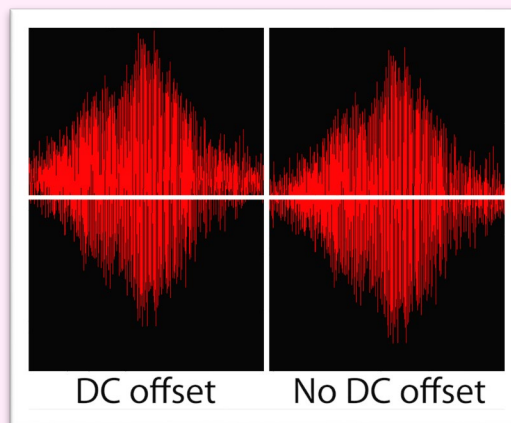
Remove DC Offset

When a WAV file is created, it is possible that the average positive and negative component of the waveform can be recorded off-center from the zero-amplitude point. This is called DC offset.

Kaleidoscope can remove any DC Offset from a WAV file.

- **Remove DC Offset**
 - Enabled by default
 - Remove DC Offset is available in both Bat Analysis and Non-Bat Analysis Modes.
 - Remove DC Offset is not checked as part of the Default Settings.
 - When Remove DC offset is checked, WAV files opened in the Viewer will have any DC offset removed.
 - When Remove DC offset is checked, all new WAV files created in any batch process will have any DC offset removed.
- Check Remove DC Offset under the Signal Parameters tab in the Control Panel.
- Reload or re-open a file in the Viewer and any DC offset in the oscillogram will be removed.

Example:

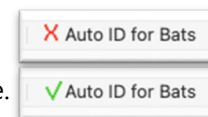


7.4 Auto-ID for Bats Tab

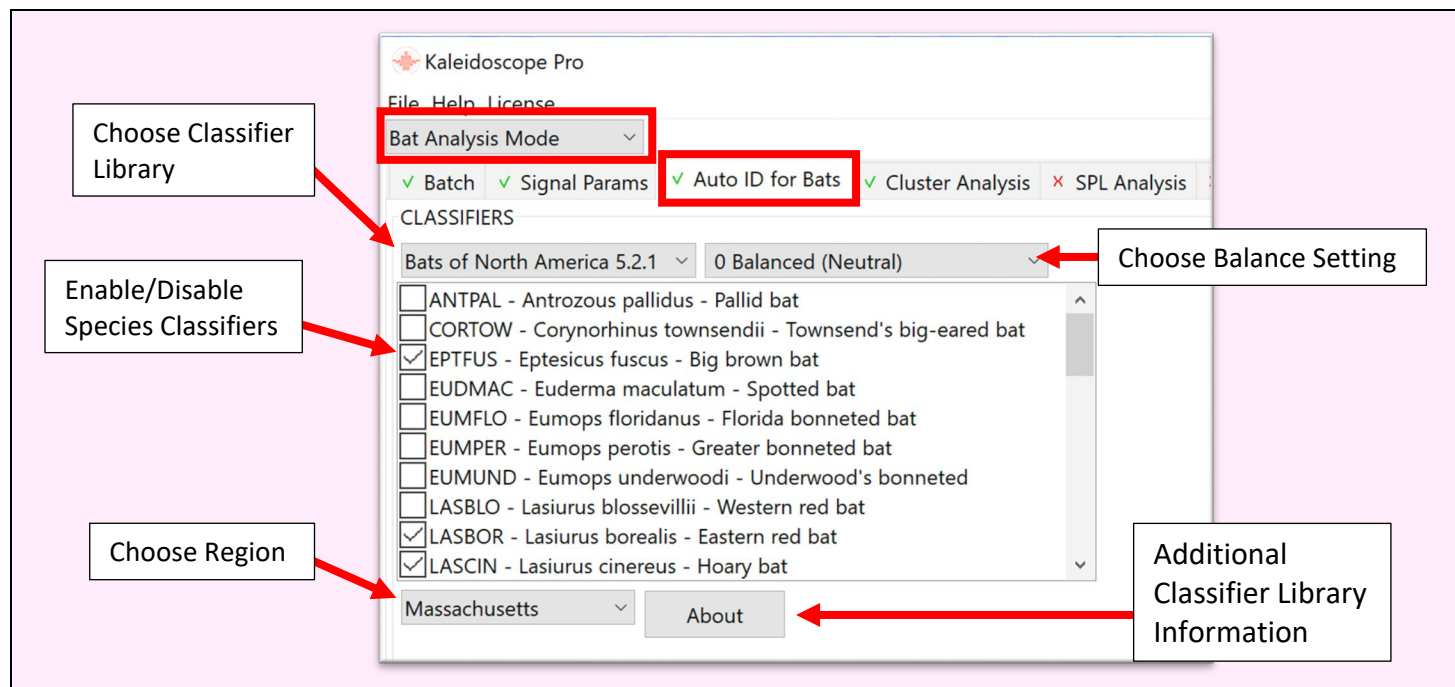
Auto-ID for Bats is used to automatically analyze bat recordings and provide species identification estimations.

NOTE: 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.

- A Kaleidoscope Pro license is required for Auto-ID for Bats.
- Auto-ID for Bats is available in Bat Analysis Mode only.
- A Red X on the Auto-ID for Bats tab indicates the function is disabled.
- A Green Check on the Auto-ID for Bats tab indicates the function is available.
- For workflow information, see: [Auto-ID for Bats](#).



NOTE: If Kaleidoscope is in Bat Analysis Mode and there is a Red X on the Auto-ID for Bats tab, this indicates a Kaleidoscope Pro license is not currently activated and the software is running as Kaleidoscope Lite.



Classifiers

Initially Auto-ID for Bats is Disabled.

- Enable Auto-ID for Bats by selecting a Classifier Library from the menu.
 - **Bats of Europe**
 - **Bats of North America**
 - **Bats of South Africa**
 - **Bats of the Neotropics**

NOTE: Wildlife Acoustics continues to work to expand classification coverage to include additional bat species and geographic regions and to improve identification accuracy. Classifier updates are made available via Kaleidoscope Pro version updates.

Select by Region

Initially, all available Species Classifiers for the selected Classifier Library will be listed and checked.

- **Select by Region** will check only a subset of listed Species Classifiers.
 - Regions subsets are based on recommendations made by Bat Conservation International.
 - Individual species within a Species Classifier can be enabled or disabled.

Tip: A species can only be identified if the Species Classifier is enabled. Disable individual species to filter unlikely identifications. Enable individual Species Classifiers to identify species which are not enabled in the initial Region preset.

Classifier Threshold Menu

Classifier Threshold changes the statistical weighting and confidence for species identification.

- **-1 More Sensitive (Liberal)**
 - This setting will produce more identifications with a risk of less accuracy.
- **0 Balanced (Neutral)**
- **+1 More Accurate (Conservative)**
 - This setting will produce less identifications which will tend to be more accurate.
- For statistical information regarding Species Classifiers using all three threshold settings, download: [Auto-ID Classifier Performance](#).

About Screen

Relevant information regarding the selected Classifier Library is described.

NOTE: Information regarding Classifier compatibility with USFW regulations is provided for the Bats of North America Classifier Library.

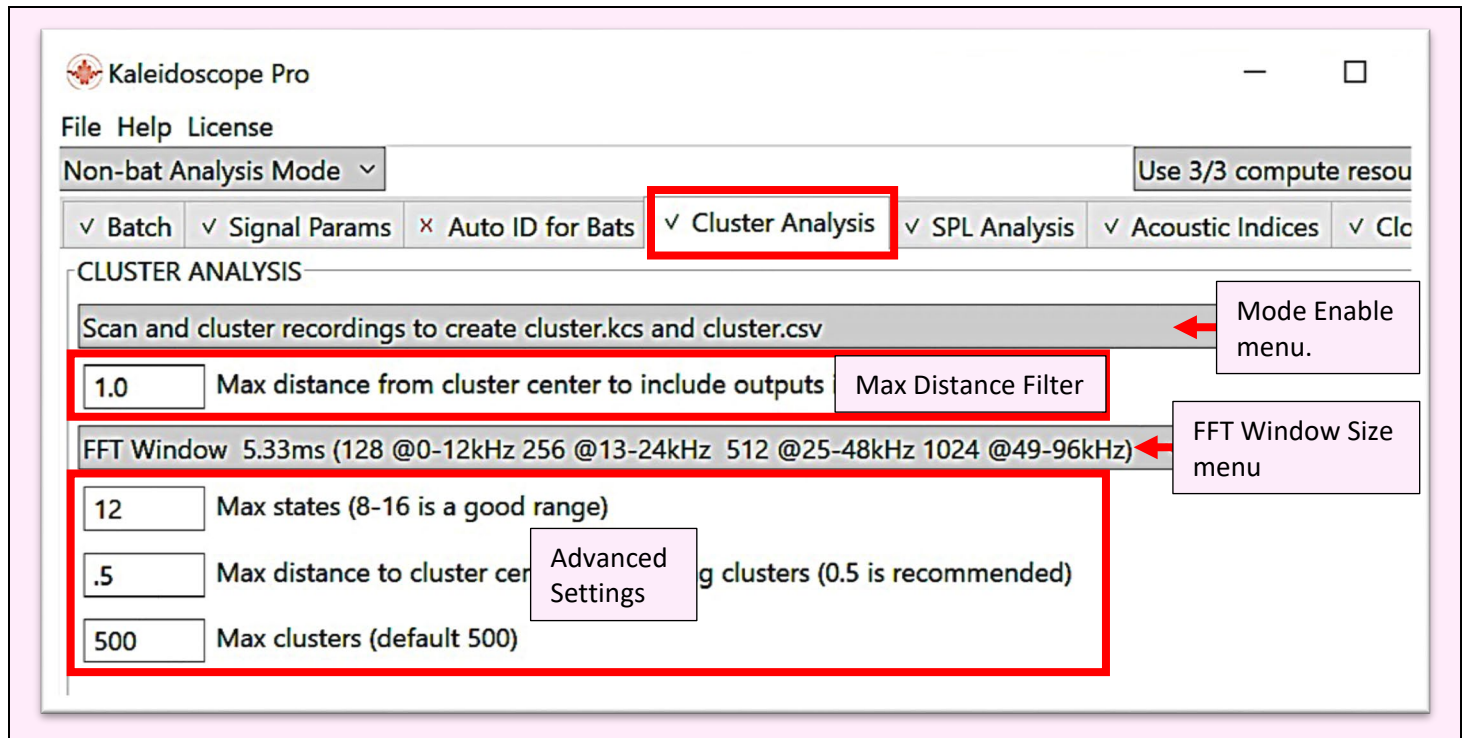
7.5 Cluster Analysis Tab

Cluster Analysis is used to automatically analyze audio for Signals of Interest, and then group the detected signals into clusters based on statistical similarity.

- Cluster Analysis functions require an activated Kaleidoscope Pro license.

NOTE: Kaleidoscope Lite enables Scan Recordings and Extract Detections (No Clustering) in Non-Bat Analysis Mode.

- Cluster Analysis is available in both Bat Analysis Mode and Non-Bat Analysis Mode.
- Cluster Analysis and Auto-ID for Bats cannot be simultaneously enabled.



Enable Cluster Analysis Mode

The cluster analysis Mode menu provides five choices:

Disabled

- No cluster analysis functions will be performed.

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

- Used to run a basic cluster analysis batch process
- The first step in any cluster analysis work
- May be all that is required to provide the desired final results
- Is the foundation for building classifiers
- For workflow information, see: [Cluster Analysis](#).

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

- This function is used to create an advanced classifier.
- The advanced classifier is a tuned cluster.kcs file.
- The cluster.kcs file is created in the batch process Output Directory.
- For workflow information, see: [Advanced Classifiers](#).

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

- This function is used to implement a simple or advanced classifier.
- When this function is enabled, a new field is displayed along with a Browse button.

- Use the Browse button to navigate to and select the cluster.kcs file to be used as the classifier.
- The cluster.kcs file and its enclosing file path will be displayed in the field.
- For workflow information, see: [Simple Classifiers](#).

Scan Recordings and Extract Detections (No Clustering)

- This function is used to Detect and Extract Signals of Interest from full-spectrum audio files.
- This mode is available in Kaleidoscope Lite in Non-Bat Analysis Mode only.
- For workflow information, see: [Scan Recordings and Extract Detections](#).

Max Distance

Max Distance from Cluster Center to Include Outputs in cluster.csv functions as a filter.

- Detected signals which exceed the specified value are excluded from cluster analysis results.
- This function is not used for Scan Recordings and Extract Detections (No Clustering).
- For workflow information, see: [Distance From Cluster Center](#).

FFT Window Size

FFT Window Size is used to bias spectral analysis of input audio files.

- This menu does not influence the FFT settings in the Viewer spectrogram.
- For workflow information, see: [Optimize FFT Size](#).

Advanced Settings

- **Max states**

This setting changes the target size of the Hidden Markov Model as represented by a number of states.

- Generally, values between 8 and 16 are optimal for most applications.
 - The default value 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.
 - Too many states can result in noisy dimensions resulting in poor cluster analysis results.
 - For fewer detected signals and Manual IDs, a lower setting may provide more accurate cluster analysis 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 setting 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.
- Generally, a value of 0.5 will provide optimal results.
 - Higher values will cause fewer clusters to be formed from more detected signals.
 - Lower values will cause more clusters to be formed from fewer detected signals.
- **Max Clusters**

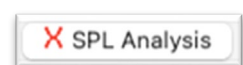
This setting limits the maximum number of clusters which can be formed.

- Clusters with the highest number of similar detected signals are given priority.
- Clusters with less similar detected signals are discarded to fit within this maximum value.

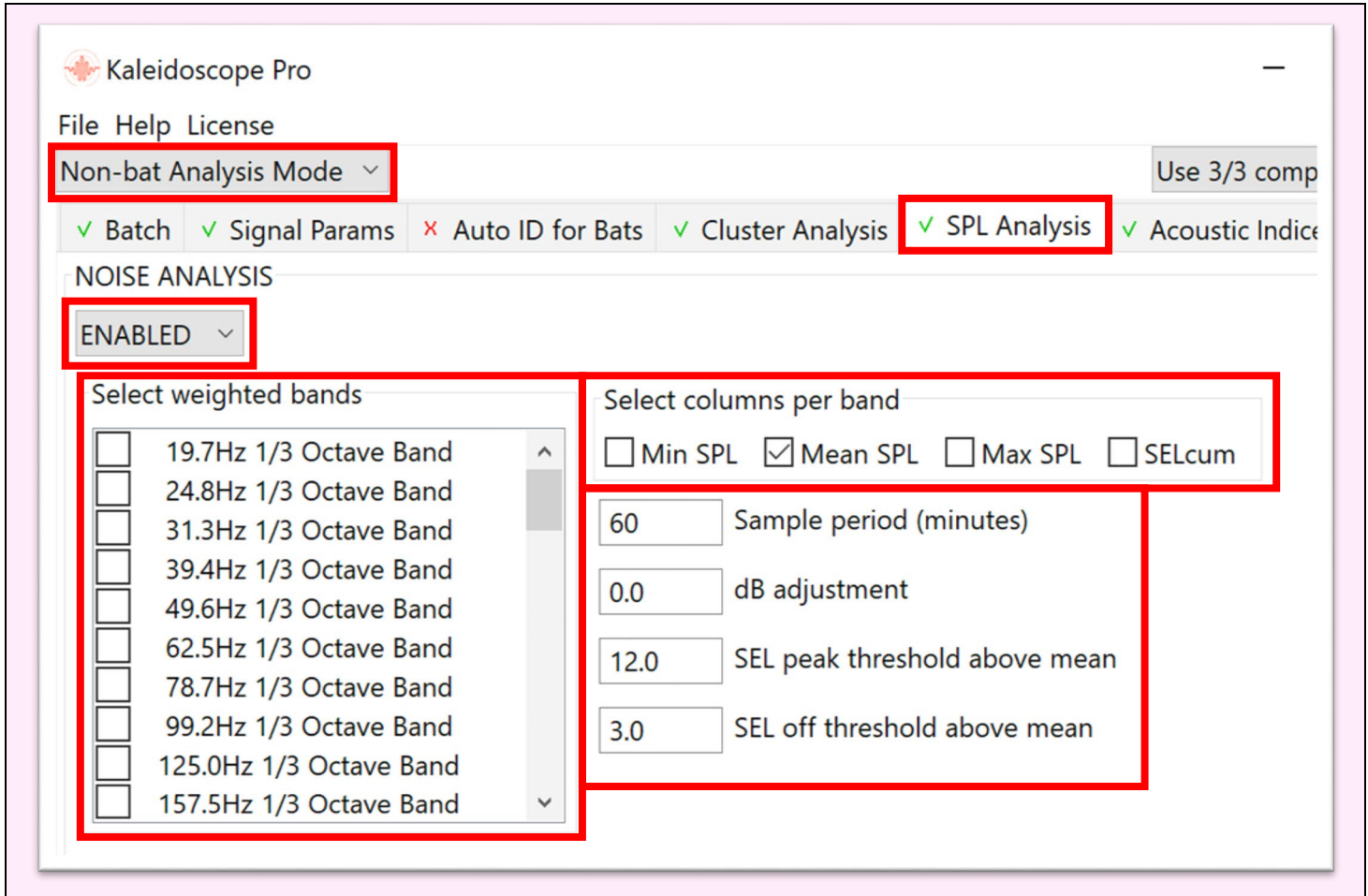
7.6 SPL Analysis Tab

SPL Analysis is used to automatically analyze recordings to provide a range of Sound Pressure Level measurements.

- A Kaleidoscope Pro license is required for SPL Analysis.
- SPL Analysis is available in Non-Bat Analysis Mode only.
- A red X on the SPL Analysis tab indicates the functions are disabled.



- A green check on the SPL Analysis tab indicates the functions are available for use.
- For workflow information, see: [SPL Analysis](#).

Kaleidoscope Pro

File Help License

Non-bat Analysis Mode Use 3/3 comp

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

NOISE ANALYSIS

ENABLED

Select weighted bands

- 19.7Hz 1/3 Octave Band
- 24.8Hz 1/3 Octave Band
- 31.3Hz 1/3 Octave Band
- 39.4Hz 1/3 Octave Band
- 49.6Hz 1/3 Octave Band
- 62.5Hz 1/3 Octave Band
- 78.7Hz 1/3 Octave Band
- 99.2Hz 1/3 Octave Band
- 125.0Hz 1/3 Octave Band
- 157.5Hz 1/3 Octave Band

Select columns per band

Min SPL
 Mean SPL
 Max SPL
 SELcum

60 Sample period (minutes)

0.0 dB adjustment

12.0 SEL peak threshold above mean

3.0 SEL off threshold above mean

- **Enabled/Disabled**

Select to enable or disable SPL Analysis.

Select Weighted Bands

Specify the desired measurements by checking one or more Weighted Bands.

- 1/3 Octave Bands provide individual narrow-band measurement.
 - **40 separate frequency centers are available between 19.7 Hz and 161,270 Hz.**
- Standard broadband measurements include:
 - **A Weighted**
 - **B Weighted**
 - **C Weighted**
 - **D Weighted**
- NOAA Marine Mammal filters include:
 - **Low-frequency cetacean**
 - **Mid-frequency cetacean**
 - **High-frequency cetacean**
 - **Pinniped Phocid**
 - **Pinniped Otterid**
- Flat frequency band measurement references include:
 - **10Hz - 10,000Hz**
 - **10Hz -192,000Hz**

Select Columns per Band

- **Min SPL**
 - Check to include a Minimum Sound Pressure Level column in the output CSV files for each selected measurement reference.
- **Mean SPL**
 - Check to include a Mean Sound Pressure Level column in the output CSV files for each selected measurement reference.
- **Max SPL**
 - Check to include a Maximum Sound Pressure Level column in the output CSV files for each selected measurement reference.
- **SELcum**
 - Check to include a Cumulative Sound Exposure Level column in the output CSV files for each selected measurement reference.

Analysis Options

- **Sample period (minutes)**
 - Select the sample period size in minutes.
 - The spl.csv report will include a row for each sample period (one for each recorder channel).
 - Minimum and maximum values correspond to the minimum and maximum value of any full one second period contained within the sample period.
- **dB adjustment**
 - The dB adjustment is global to all level measurements.
 - dB adjustment can be used to change the relative dB scale.
 - dB adjustment can be used to compensate for variables such as microphone sensitivity and gain changes in the recording chain.
 - For workflow information, see: [dB Adjustment](#).
- **SEL peak threshold above mean**

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

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

7.7 Acoustic Indices Tab

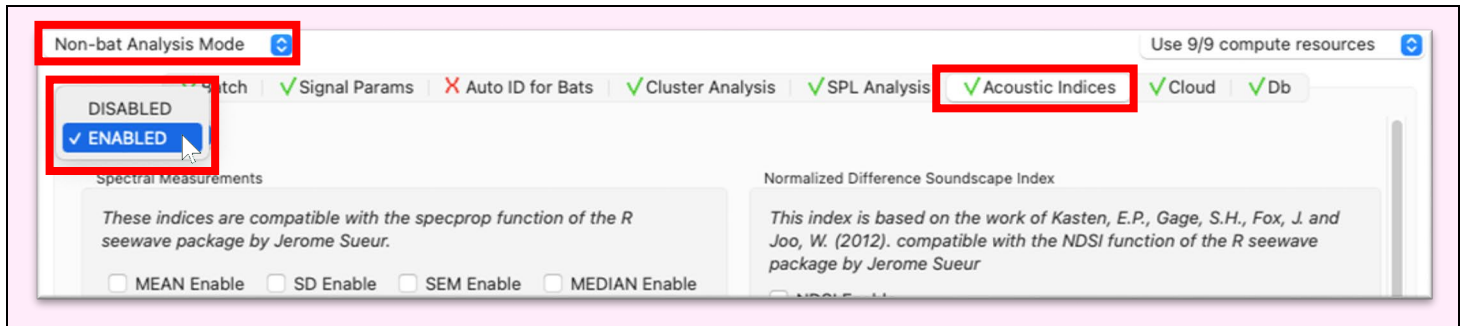
Acoustic Index Analysis is typically used to measure environmental change over time.

A Kaleidoscope Pro license is required for Acoustic Index Analysis.

- Acoustic Index analysis is available in Non-Bat Analysis Mode only.
- A red X on the Acoustic Indices tab indicates the functions are disabled.
- A green Check on the Acoustic Indices tab indicates the functions are available for use.
- For workflow information, see: [Acoustic Index Analysis](#).

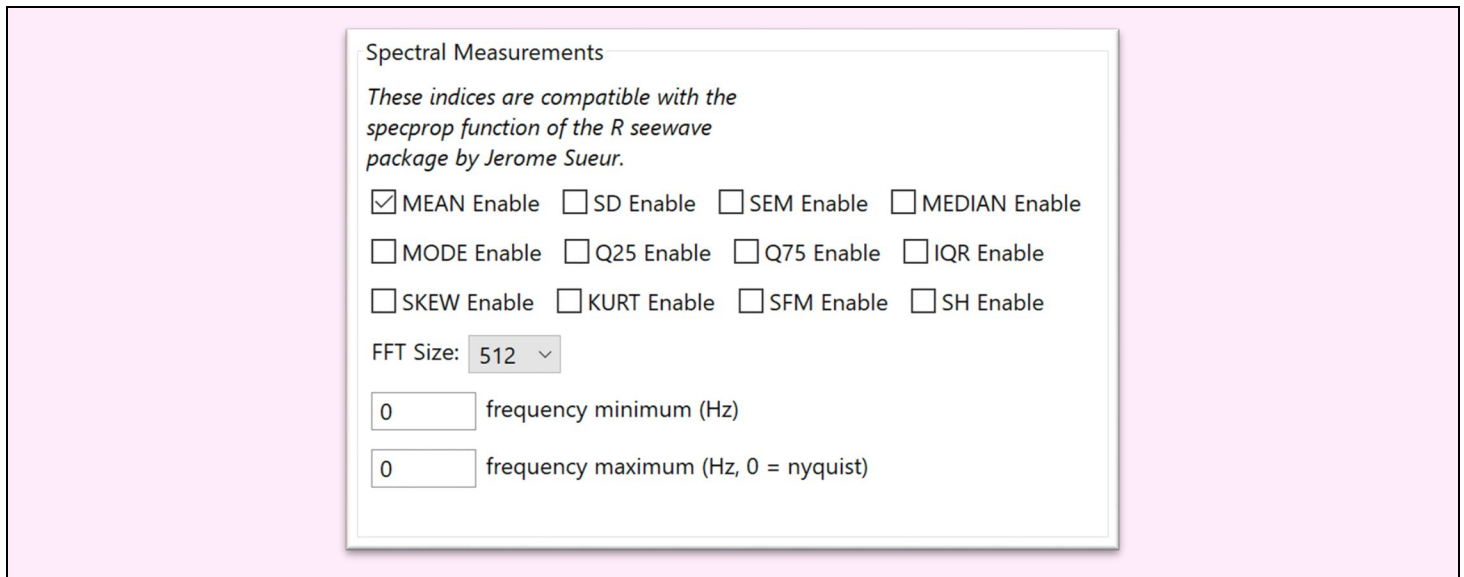


Enable Acoustic Index Analysis



- Click on the Acoustic Indices tab.
 - Click on the global Disabled/Enabled menu to Enable Acoustic Index analysis functions.
 - One or more individual Acoustic Indices can now be enabled.

Spectral Measurements Group



- The first group of measurements are more general spectral measurements than true eco-acoustics indexes. This group uses non-overlapping FFTs of a size specified. A Hanning window is used and the resulting amplitude spectrum is averaged across all the frames.
- By default, the available spectrum from 0Hz to Nyquist is analyzed. Specify a narrower frequency band to measure by adjusting the desired minimum and maximum frequencies.

MEAN The amplitude-weighted mean frequency (see Seewave)

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

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

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

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

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

Q75 Third quartile percentile of the amplitude-weighted frequency (see Seewave)

IQR Inter-quartile range (see Seewave)

SKEW Skewness, a measure of asymmetry (see Seewave)

KURT Kurtosis, a measure of peakedness (see Seewave)

SFM Spectral flatness measure (see Seewave). SFM of a noisy signal will tend toward 1 while a pure tone will tend toward .0

SH Shannon Spectral Entropy (see Seewave). SH of a noisy signal will tend toward 1 while a pure tone will tend toward 0.

Normalized Difference Soundscape Index (NDSI)

Normalized Difference Soundscape Index

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

NDSI Enable

FFT Size: 1024 ▾

Anthrophony frequency minimum (Hz)

Anthrophony frequency maximum (Hz)

Biophony frequency minimum (Hz)

Biophony frequency maximum (Hz)

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

Kasten, Eric P., Stuart H. Gage, Jordan Fox, and Wooyeong Joo. 2012. The Remote Environmental Assessment Laboratory's Acoustic Library: An Archive for Studying Soundscape Ecology. *Ecological Informatics* 12: 50-67. doi:

[10.1016/j.ecoinf.2012.08.001](https://doi.org/10.1016/j.ecoinf.2012.08.001)

Acoustic Complexity Index (ACI)

Acoustic Complexity Index

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

ACI Enable

FFT Size: 512 ▾

frequency minimum (Hz)

frequency maximum (Hz, 0 = nyquist)

J (s), or zero for continuous

threshold dB fs or 0 for none

- The ACI (implemented in Seewave and SoundEcology) measures the normalized absolute difference of amplitude between adjacent FFT windows in each bin over a period of J seconds. The total ACI is the sum of the ACIs across bins for each period J in the recording. This means recordings of different sizes will affect the ACI proportionally. Kaleidoscope Pro lets you specify J of zero (the default) which then calculates ACI across the whole recording resulting in values which are not dependent on recording length. The FFT size, minimum frequency, maximum frequency and value J may be specified. The threshold is relative to the peak signal bin in the recording. The FFTs are not overlapped and modified by the Hamming window. Results are close to those from Seewave.

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

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

Acoustic Diversity/Evenness Indices

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

ADI Enable AEI Enable

frequency minimum (Hz)

frequency maximum (Hz, 0 = nyquist)

frequency step (Hz)

threshold (dB fs)

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

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

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

Bioacoustic Index (BIO)

Bioacoustic Index

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

BI Enable

FFT Size: ▾

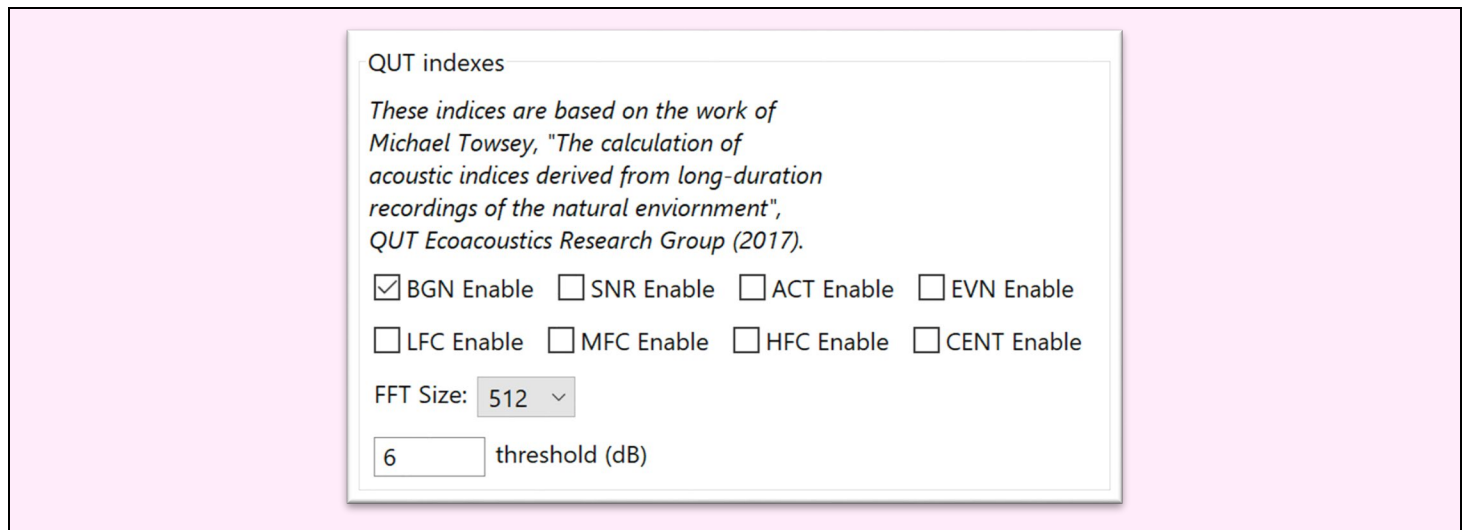
frequency minimum (Hz)

frequency maximum (Hz, 0 = nyquist)

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

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

QUT Indexes Group



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

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

Michael Towsey 2018

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

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

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

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

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

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

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

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

7.8 Cloud Tab

The Cloud tab provides access to cloud-based storage and cloud-based computing functions.

- A Kaleidoscope Pro license is required for cloud functions.
 - Cloud functions are not available with a Kaleidoscope Pro demo or training license.
- A red X on the Cloud tab indicates the functions are disabled.
- A green check on the Cloud tab indicates the functions are available for use.



Log in to a Cloud Account

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.
 - For workflow information, see: [Managed Cloud Account Instructions.](#)
- **Log in to user managed AWS S3**
 - This requires an existing Amazon Web Services account and an S3 bucket.

- For information regarding configuration of an Amazon SW3 cloud account see: <https://aws.amazon.com/s3/>.
- This is used to configure Kaleidoscope Pro to access an existing Amazon Web Service account and S3 bucket.

Cloud-Based Storage

For workflow information, see: [Cloud-Based Storage](#).

Cloud-Based Computing

For workflow information, see: [Cloud-Based Computing](#).

7.9 Db Tab

Db is shorthand for database.

The Db tab provides an interface for a searchable database.

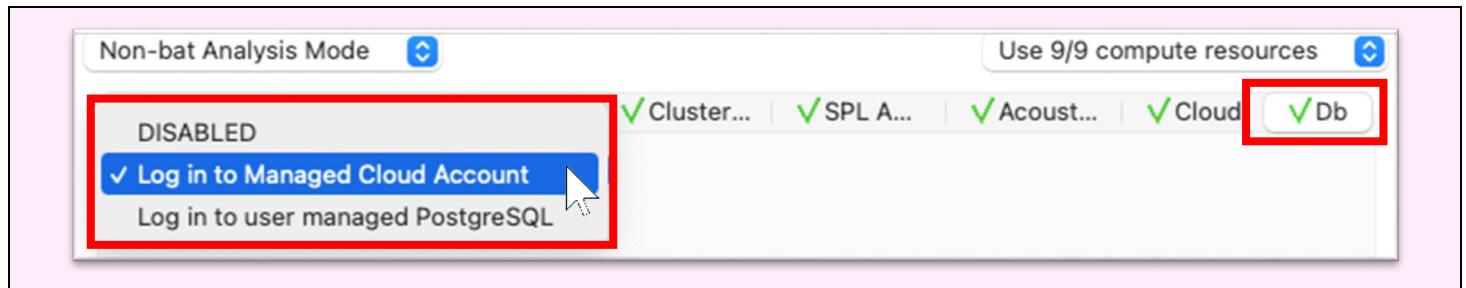
- A Kaleidoscope Pro license is required for database functions.
 - Database functions are not available with a Kaleidoscope Pro demo or training license.
- Database functions are not specific to Bat Analysis Mode or Non-Bat Analysis Mode.
- A red X on the Db tab indicates database functions are disabled.
- A green check on the Db tab indicates database functions are available.



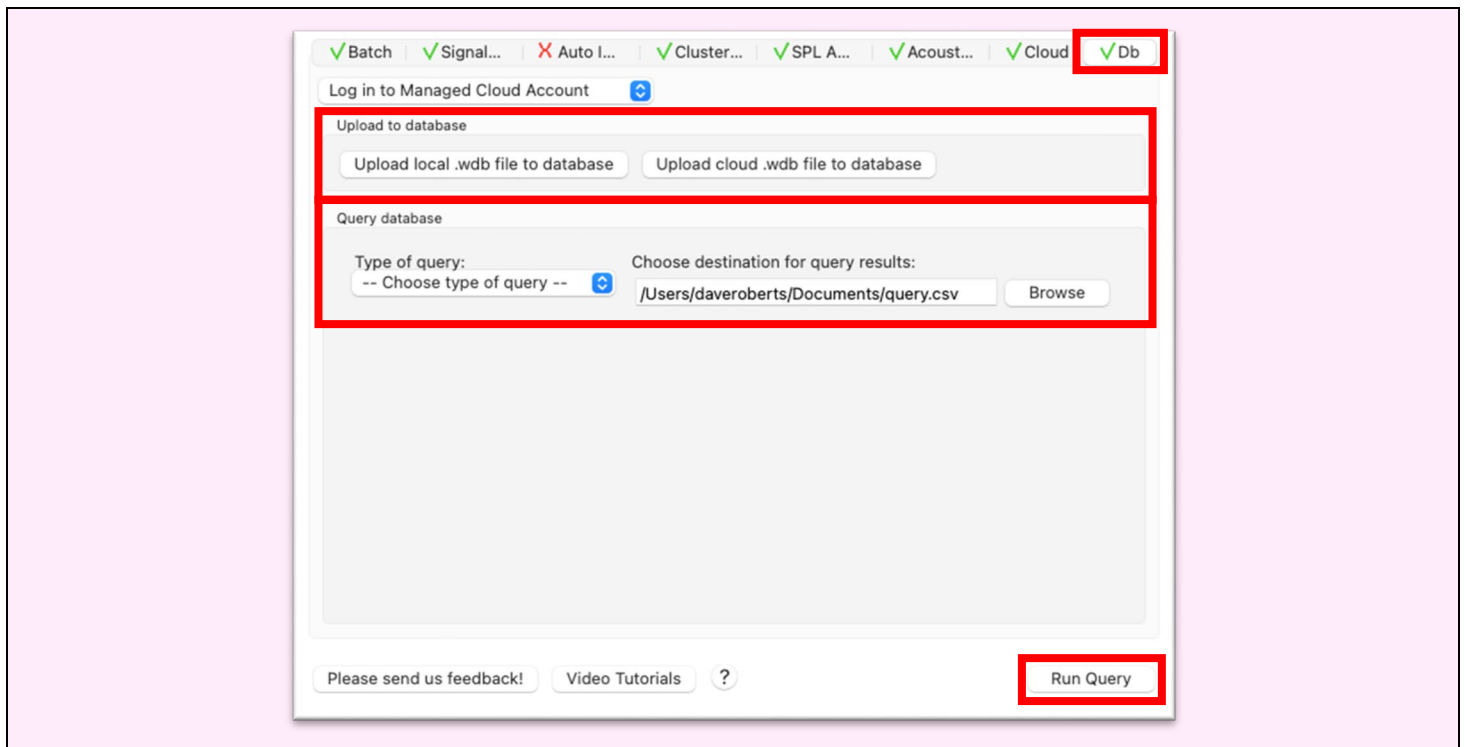
Connect to a Database Server

Kaleidoscope Pro connects to a server to access a database.

- When Kaleidoscope is first opened, it does not automatically connect to a database server.
- Two Database server-type choices are provided:
 - Any Wildlife Acoustics Managed Cloud Account is pre-configured and can be used as a database server.
 - See: [Managed Cloud Account Instructions](#).
 - Kaleidoscope Pro can create and access a database on a user-created PostgreSQL server.
 - See: [PostgreSQL Server Database Instructions](#).



1. Click the Log In menu to choose the database server type.
2. Fill in the appropriate fields and log In or Connect to the database server.
 - The Database Interface will open.



Upload to Database

These functions are used to add information to the database:

- **Upload local .wdb file to database**
- **Upload cloud .wdb file to database**

Query Database

The following fields provide database search tools:

- **Type of query:**
- **Choose Destination for query results:**
- **Browse**

Run a Query

Press the Run Query button to initiate a database search.

For database workflow information, see: [Database Functions](#).

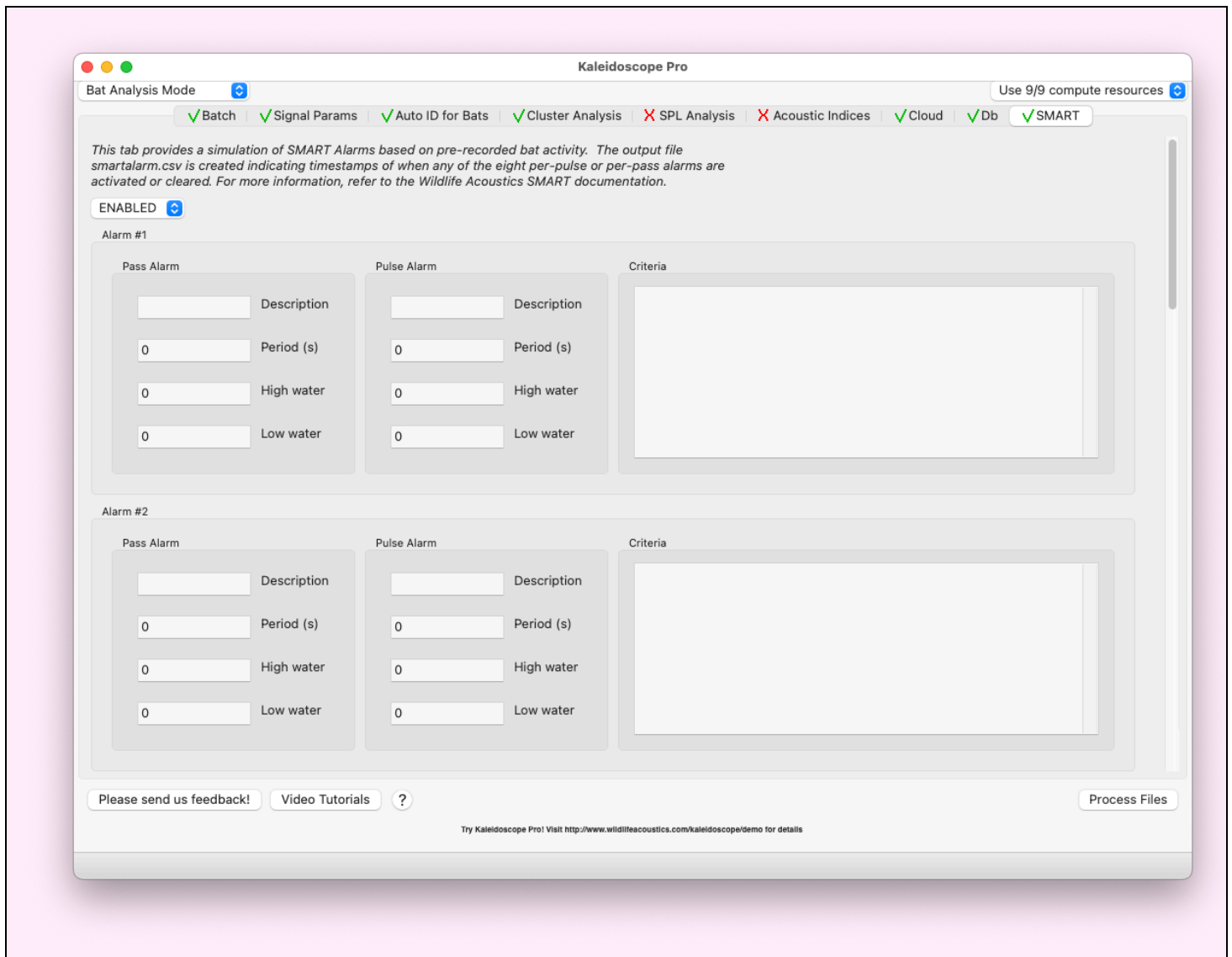
7.10 SMART Tab

Wildlife Acoustics' Song Meter with Analysis and Remote Transfer (SMART) System is an innovative solution for reducing bat fatalities and associated curtailment costs at wind farms. SMART can be integrated with SCADA or other control systems to minimize turbine downtime, eliminating the need for blanket curtailment and increasing annual energy production. The SMART System consists of one controller and up to three microphones which enable extensive monitoring and analysis capabilities. One of the functions of a SMART system is the ability to generate Alarms based on specific conditions. Alarms are then used by a SCADA system, typically for curtailment of wind turbines.

Kaleidoscope Pro includes a simulator to generate Alarms from bat recordings. A batch process is run on input files and a smartalarm.csv file is generated on output. The smartalarm.csv file provides the results of the Alarm criteria as applied to the input recordings. This simulates what the SMART system will do in real-time. This allows for testing of Alarm criteria outside of the actual SMART system.

- A Kaleidoscope Pro license is required for SMART Alarm simulation.
- SMART Alarm simulation is available in Non-Bat Analysis Mode only.
- A red X on the SMART tab indicates database functions are disabled.
- A green check on the SMART tab indicates database functions are available.





Alarms

An Alarm is a set of criteria based on Pass and/or Pulse filter settings.

- Alarm Criteria can be created to fine tune the alarm conditions.
- The SMART system listens for bats in real-time and creates Alarms according to the specified criteria.
- When an Alarm is triggered, the corresponding Modbus register in the SMART system is updated to reflect the current condition.
- An external SCADA system can poll the SMART Modbus registers to acquire the current status of all alarms.
- The external SCADA system can then use the Alarm status as an input for its curtailment logic.
- Up to 8 Alarms can be created to run simultaneously and in parallel.

Pass Settings

The "Pass" alarm operates on a trigger-by-trigger bat pass basis using the average call parameters across the pass. The "Pass" alarm is equivalent to looking at the results.csv file as each trigger is detected and analyzed.

Pass Period (s)

- This sets the length of the Pass Period in seconds.
- The Pass Period is a rolling and continuous window of time.
- SMART keeps track of the number of bat passes which meet the alarm requirements within the Pass Period.

Pass High Water

- If the number of bat passes within the Pass Period exceeds the specified Pass High Water number, the corresponding pass alarm condition is raised.

Pass Low Water

- The alarm condition persists until the number of bat passes per Pass Period drops below the specified Pass Low Water number.

Pulse Settings

The "Pulse" alarm operates on individual pulses as they are detected while building up a pass. The "Pulse" alarm looks at one pulse at a time to target specific patterns.

Pulse Period (s)

- This sets the length of the Pulse Period in seconds
- The Pulse Period is a rolling and continuous window of time
- SMART keeps track of the number of bat pulses which meet the alarm requirements within the Pulse Period

Pulse High Water

- If the number of bat pulses within the Pulse Period exceeds the specified Pulse High Water number, the corresponding pulse alarm condition is raised

Pulse Low Water

- The alarm condition persists until the number of bat pulses per Pulse Period drops below the specified Pulse Low Water number

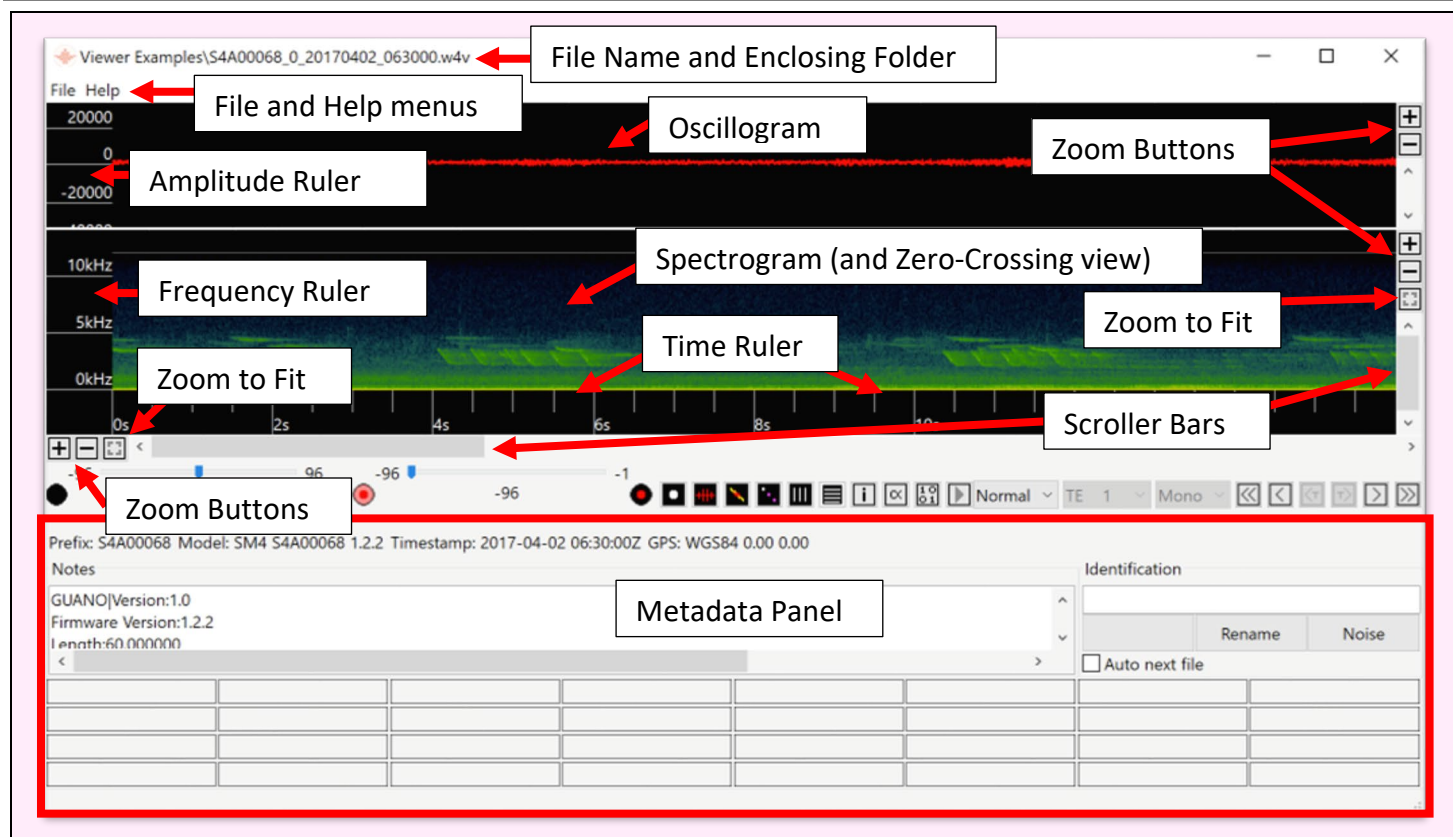
Alarm Criteria

- Alarm Criteria are additional conditions used to further refine each alarm
- Each Alarm has separate Alarm Criteria
- For examples of Alarm Criteria, please see the SMART User Guide.

7.11 The Viewer

The Viewer opens as a separate window in Kaleidoscope.

- The Viewer is a tool for inspecting full-spectrum and Zero-Crossing audio files.
- To open an audio recording file in the Viewer, go to the Control Panel File menu and choose Open...
 - Navigate to and select the file to be opened.
 - For file compatibility information, see: [Audio File Formats](#).
- 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.



File Menu Choices

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

- **Open**
 - Directly open a compatible full-spectrum or Zero-Crossing recording file.
 - This will replace the currently open file with the newly selected file.
 - For file compatibility information, see: [Audio File Formats](#).
- **Toggle Reference**
 - This function requires a Kaleidoscope Pro License.
 - This function is available only in Bat Analysis Mode.
 - Choose to hide or show bat Species Classifier reference calls in the spectrogram.
 - The displayed reference calls represent the currently selected Species Classifiers under the Auto-ID for Bats tab.
 - Reference calls will be superimposed over the underlying full-spectrum or Zero-Crossing file.
 - Auto-ID for Bats must be enabled and at least one Species Classifier must be selected.
 - For additional workflow information, see: [Display Reference Calls](#).
- **Close**
 - Close the Viewer.
- **Reload**

This menu choice has two functions:

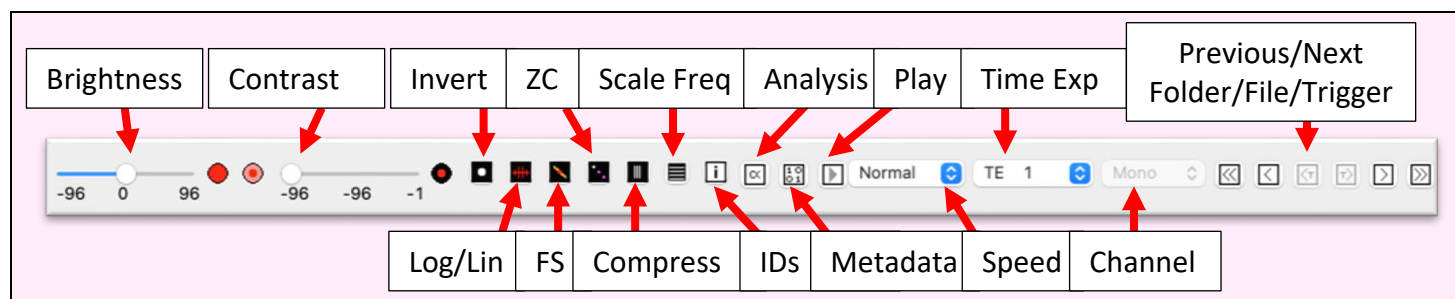
- When a detection from a cluster analysis or Signal Extraction batch process is displayed, Reload will display the entire file.
- Select any other detection to go back to detection view .

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, as well as filtering and classification parameters.
- To reload these settings into the Viewer, choose Reload.
- This will apply the relevant Control Panel settings to the Viewer, and then reopen the currently displayed file.

- **Load Labels**
 - This will load bat Species Labels into the buttons in the Metadata Panel.
 - For workflow information, see: [Load Species Labels](#).
- **Save Screen...**
 - Take a screen shot of the spectrogram.
- **Save WAV...**
 - This option creates a new WAV audio file based on either the visible portion of a full-spectrum file or a selection within a full-spectrum file.
 - Any bandpass filtering, volume and Time Expansion adjustments are printed to the new WAV file .
 - Speed changes are not included in the WAV file.
- **Control Panel...**
 - This opens the Kaleidoscope Control Panel.
- **Color Settings...**
 - This allows customization of color preferences and Zero-Crossing dot size.
 - For workflow information, see: [Customize Color Settings](#).
- **FFT Settings...**
 - 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 .
 - 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. Dot size can be customized from the Color Settings... window.
- **Exit**
 - Windows OS only. This will Exit Kaleidoscope .
 - On Mac OS the command to Quit Kaleidoscope is found under the main Kaleidoscope menu.

Buttons and Sliders



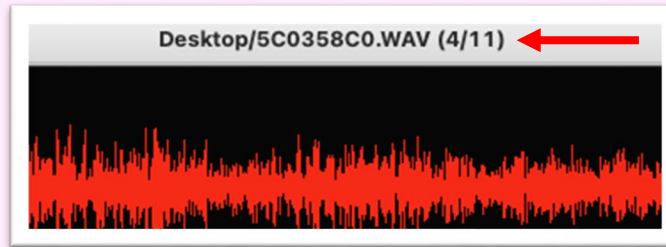
- **Brightness Slider**
 - The Brightness Slider is an audio volume control for full-spectrum audio files.
 - The Brightness Slider increases or decreases visible amplitude in the oscillogram and spectrogram views.
- **Contrast Slider**
 - The Contrast Slider is used to reduce visible background noise in the spectrogram.
 - The contrast slider decreases or increases the dynamic range represented by the spectrogram color gradient from -96 dB to 0 dB.
 - The Contrast Slider has no effect on the oscillogram.
- **Inverse Video Mode**
 - Toggles between inverted or non-inverted colors in the spectrogram view.
 - A typical use is to create a white background in the spectrogram for print to paper.
 - For workflow information, see: [Customize Color Settings](#).
- **Oscillogram Log/Linear View**

- Toggles between linear and log scales for the oscillogram
- **Full-spectrum View**
 - Toggles the full-spectrum display on and off
- **Zero-Crossing View**
 - Toggles through three states:
 - On with Call Body analysis
 - On without Call Body analysis
 - Off
- **Real-Time/Compressed Time View**
 - Toggles between Compressed-Time and Real-Time views
 - For workflow information, see: [Compressed Time View](#).
- **Linear/Log Frequency View**
 - Toggles the spectrogram Frequency Ruler between log or linear display modes
- **Auto-ID On/Off**
 - Toggles between enabling and disabling display of Bat Auto-ID or cluster analysis results
- **Analyze View or Selection**
 - Toggles between showing and hiding the Viewer Analysis window
- **Show/Hide Metadata Panel**
 - Toggles between showing and hiding the Metadata Panel
- **Play/Stop**
 - The Play button starts or stops playback of full-spectrum audio through the computer speakers.
 - If a selection is made in the oscillogram or spectrogram, playback starts from the beginning of the selection.
 - If no selection is made, playback starts from the left edge of the window.
 - If a Bandpass 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**
 - Select the playback speed for a full-spectrum file.
 - Audio playback can be at Normal speed or fast or slow by factors of +/- 8, 10, 16, or 20.
- **Time Expansion Factor**
 - This setting is used in Bat Analysis Mode if the currently open file is in Time Expanded format.
 - The TE Auto choice will automatically determine the time expansion factor from metadata first, or the sample rate second.
 - For additional information, see: [Time Expanded Format](#).
- **Channel Selector**
 - When a single-channel (mono) audio file is opened, this menu is greyed out and displays Mono.
 - When a two-channel (stereo) file is opened, this menu allows the Left or Right channel to be selected for viewing.
 - For workflow information, see: [Mono vs. Stereo Files](#).
- **Go to Previous File/Detection**
- **Go to Next File/Detection**
 - Use these buttons to select the previous or next file in the folder.
 - When the Viewer is linked to a cluster analysis Results window, the Previous/Next file/detection buttons are used to go to the last detection in the previous cluster or the first file in the next cluster.
- **Go to Previous Folder/Cluster**
- **Go to Next Folder/Cluster**
 - Use these buttons to select the last file of the previous folder or the first file of the next folder.
 - When the Viewer is linked to a cluster analysis Results window, the Previous/Next folder/cluster buttons are used to go to the last detection in the previous cluster, or the first detection in the next cluster.

- **Go to Previous Trigger/Segment**
- **Go to Next Trigger/Segment**
 - Use these buttons to move left or right through segments of long files
 - In Bat Analysis Mode use these buttons to move left or right through triggers in a .wac file

NOTE: When a segmented WAV file or .wac file is open, the number of segments or triggers and currently visible segment or trigger is listed next to the file name in the top bar of the Viewer.

Example: The Viewer is currently set to display the fourth of eleven segments in this file.



- **Play Notes**
 - This button is displayed if there are Audio Notes in the input file metadata.
 - Press the button to play back the Audio Note.

Oscillogram

A full-spectrum audio file is displayed in the upper portion of the Viewer as an oscillogram (also known as a waveform).

- Elapsed time is displayed in the horizontal axis.
- Amplitude of the oscillogram is displayed in the vertical axis.
- Amplitude can be displayed in linear or log mode.
 - Press this button to toggle between view modes:
 - In Linear View mode, amplitude is displayed as positive and negative numbers.
 - Maximum values are -32768 and +32767 and represent the describable dynamic range of a 16 bit audio sample.
 - In Log View mode, values are described in relative dB with 0 dB = full-scale (maximum amplitude).
- Any DC offset can be removed from the oscillogram.
 - For workflow information, see: [Remove DC Offset](#).

Spectrogram

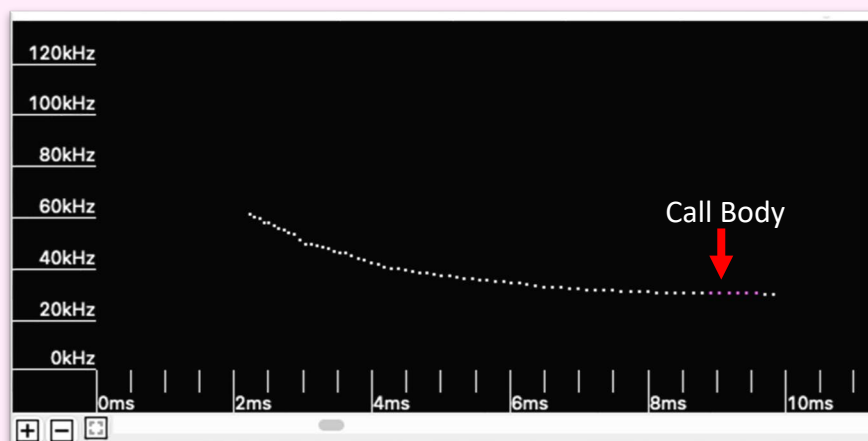
A full-spectrum audio file is displayed in the lower portion of the Viewer as a spectrogram.

- Elapsed time is displayed in the horizontal axis.
- Frequency is displayed in the vertical axis.
- Signal amplitude is represented by relative color intensity.

Zero-Crossing View

The lower portion of the Viewer can display Zero-Crossing information.

Zero-Crossing View:



- Zero-Crossing format is originally designed for bat analysis.
- Zero-Crossing is used and can be displayed for cluster analysis.
- A Zero-Crossing file can be opened and displayed in the Viewer.
 - When a Zero-Crossing file is open in the Viewer, the spectrogram and oscillogram displays are empty.
- In Bat Analysis Mode the Viewer will automatically create and display Zero-Crossing information derived from a full-spectrum file.
 - When Zero-Crossing data is displayed with analysis, the Call Body can be analyzed and displayed with color coding.
 - The Call Body represents the flattest part of the call with constant slope beginning with the knee and terminating with the Characteristic Frequency.
- Right-Click in the display 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 which 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.
- Change Dot size from the Viewer File menu>Color Settings...

Keyboard Shortcuts

Click once on the spectrogram 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 top-row button in the Metadata Panel
- **+ and Z** Zoom in to X axis
- **- and Z** Zoom out to X axis

- = Zoom to fit X axis
- . Toggle the Zero-Crossing Dots display
- / Toggle between Compressed and Expanded view

Preset zoom levels can be triggered via keyboard shortcuts.

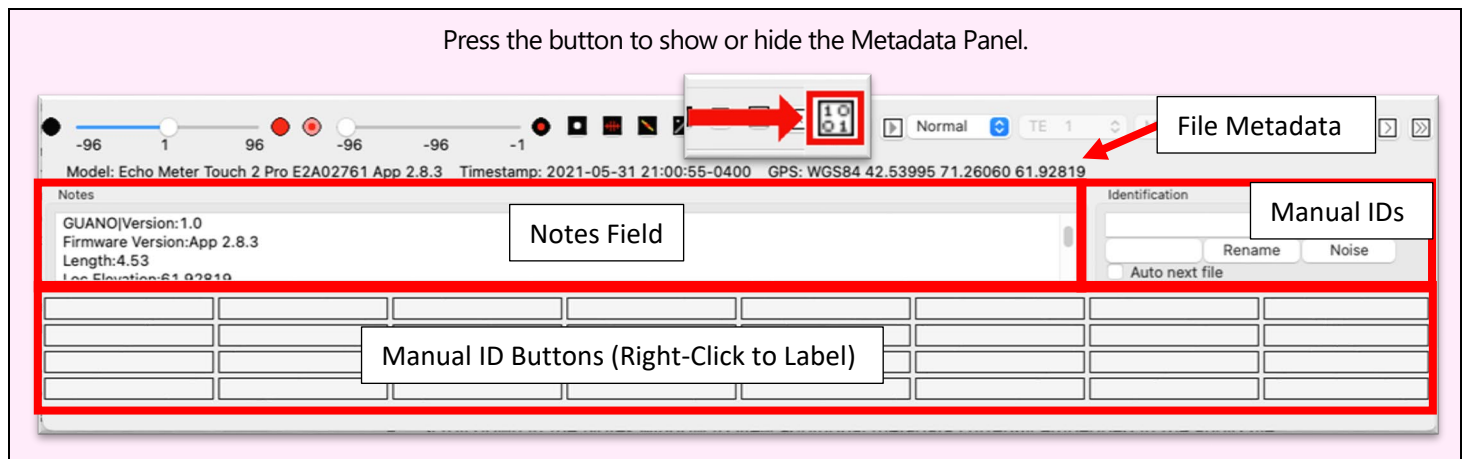
- **Control-Z** followed by a number key 1-9, or 0 to activate a zoom level preset.
 - This will set the X and Y zoom levels of the spectrogram as well as the Y axis starting frequency to one of 10 presets.
- **Shift-Control-Z** followed by a number key to set a preset to the current zoom level.
 - Set the desired zoom level and then do this to Save the zoom level.
- **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 non-bat 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 open ***
 - 6 - 16s - 1.6s
 - 7 - 32s - 3.2s
 - 8 - 1m4s - 6.4s
 - 9 - 2m8s - 12.8s
 - 0 - 4m16s - 25.6s

Metadata Panel

The lower portion of the Viewer includes the Metadata Panel.



- The Metadata Panel displays metadata contained in the file including timestamps and GPS coordinates.
- Under **Notes** there is an editable field which contains Notes and additional metadata when present.
 - GUANO format 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.
- Under **Identification** there is an editable field which 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 full-spectrum audio or Zero-Crossing output file. (This button has no function if no output audio files were created in a batch process).
 - The **Noise** button adds "Noise" as the Manual ID label 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 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 .
 - Button labels can be pre-loaded from the Bat Auto-ID Species Classifiers.
 - For workflow information, see: [Load Species Labels](#).
- Button Labels can be customized by right-clicking inside the button and typing in a new label.
- Click a button to enter the label name into the manual identification field.
 - If Auto Next File is enabled the next consecutive file in the Results window will then be loaded into the Viewer.
- The top eight label buttons can be triggered via the 1-8 keys on the top row of the computer keyboard.
- To assign multiple Manual IDs, hold down the Control key (Windows) or Command key (Mac) while pressing one of the user-defined buttons (or the corresponding shortcut key).
 - This will add the label to the Manual ID field, separating multiple entries with commas while also disabling the Auto Next File button.
- Choose Save from the Results window File menu..
 - This will update the underlying CSV file and any output files created in the batch process.

7.12 Viewer Analysis Window

The Viewer Analysis window is a sub-window of the Viewer.

The screenshot shows the Kaleidoscope Viewer Analysis window. It features a spectrogram on the left and a table of measurements on the right. A red box highlights the measurement table, and a red arrow points to a button in the bottom toolbar.

Tstart: 1.845356s	Tend: 2.228034s	Fstart: 24.384kHz	Fend: 73.153kHz
dBmin: -60.08dB	dBmax: -8.73dB	dBmean: -25.74dB	
Fpmin: 28.000kHz	N: 3	Dur: 8.016ms	TBC: 147.888ms
Fpmax: 51.000kHz	Fmax: 59.789kHz	Fmin: 29.901kHz	Fmean: 36.765kHz
Fpmean: 33.013kHz	Fc: 30.614kHz	Tc: 7.439ms	Sc: 17.81 OPS
Fppeak: 31.889kHz	Fk: 31.174kHz	Tk: 6.184ms	S1: 406.73 OPS

Press the button to Show or Hide the Viewer Analysis window.

- The Viewer Analysis window provides detailed statistical information about the contents of a full-spectrum or Zero-Crossing file.
 - Zero-Crossing measurements are typically used for bat analysis.
 - Full-spectrum measurements can be useful for both bat and non-bat analysis.

NOTE: In Bat Analysis Mode, full-spectrum audio is automatically analyzed to create and display Zero-Crossing content.

- Analysis is based on a selection, or if no selection is made, the entire visible portion of the file.
 - Measurements update in real-time as the selection is changed.
 - The frequency axis of the Viewer Analysis window 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 0 dB.
- Dynamic range follows the Contrast Slider.
- A red line represents the amplitude spectrum of the full-spectrum signal.
- A dotted white line represents a weighted Zero-Crossing histogram which displays how long the Zero-Crossing signal spends in a given frequency.
- Right-Click in the upper portion of the Viewer Analysis window to export graphic and numeric content.

Selection Statistics

The following statistics are based on the overall selection:

- **Tstart**
 - Offset of Selection Start Time from the beginning of the file
- **Tend**
 - Offset of Selection End Time from the beginning of the file
- **Fstart**
 - Start Frequency (low) of the selection
- **Fend**
 - End Frequency (high) of the selection

Full-Spectrum Statistics

The following statistics are based on full-spectrum content:

NOTE: A Zero-Crossing file does not contain full-spectrum information. These fields will be empty when opening a Zero-Crossing file.

- **dBmin**
 - Minimum Amplitude of selection in dB relative to full-scale
- **dBmax**
 - Maximum Amplitude of selection in dB relative to full-scale
- **dBmean**
 - Mean (Average) Amplitude of selection in dB relative to full-scale
- **Fpmean**
 - Amplitude-Weighted Mean (average) Frequency of the energy (amplitude) within the selection
- **Fppeak**
 - Frequency which has the highest (Peak) energy within the selection

Zero-Crossing Statistics

The following statistics are based on Zero-Crossing content:

NOTE: If there is no Zero-Crossing content in the audio, the Zero-Crossing measurements will be empty.

- **Fpmin**
 - Estimate of Minimum Signal Frequency
 - The estimate is determined by following signal amplitude starting from the Peak Frequency up until the noise floor.
- **Fpmax**
 - Estimate of the Maximum Signal Frequency
 - The estimate is determined by following signal amplitude starting from the Peak Frequency down until the noise floor.
- **Qual**
 - Average call quality (%). A measure of the smoothness of the call where smaller values indicate a smoother call.
- **N**
 - Number of Detected Call Pulses within the selection

- **Dur**
 - Average Duration of Call Pulses within the selection
- **TBC**
 - Average Time Between Calls, from the start of one call pulse to the start of the next call

NOTE: This statistic is not useful in Compressed-View Mode.

- **Fmax**
 - Average Maximum Frequency of call pulses
- **Fmin**
 - Average Minimum Frequency of call pulses
- **Fmean**
 - Time-Weighted Average Frequency of call pulses
- **Fc**
 - Average Characteristic Frequency of call pulses
 - This is the point at the end of the body of the call pulse which is defined as the flattest part (lowest absolute slope) of the call.
- **Tc**
 - Average Time Offset from the beginning of the call pulse to Fc
- **Sc**
 - Average Characteristic Slope (slope of the body of the call) of call pulses in octaves per second
- **Fk**
 - Average Knee Frequency of calls
 - This is at the beginning of the call body.
- **Tk**
 - Average Time Offset from the beginning of the call to Fk
- **S1**
 - Average Initial Slope of calls in octaves per second

7.13 The Results Window

The Results window displays the statistical results of a batch process.

- The Results window displays data from an underlying CSV file, which is created as a result of a batch process.
 - The following CSV files can be represented by the Results window:
 - **meta.csv**
 - **id.csv**
 - **cluster.csv**
 - To open or re-open one of these files, select Open Results... from the Control Panel File menu.
- The Results opens automatically at the completion of a cluster analysis or Auto-ID for Bats batch process
- The Results window is linked with the Viewer.

Results Window File Menu Commands

The Result window File menu displays different choices, depending on which type of CSV file is open.

meta.csv and id.csv File menu 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.
- **Select all**
 - Select all rows.
- **Select matching Top1Match/Auto-ID...**

- Type in a Top1Match or auto-ID name and all detected signals with that name will be selected.
- **Select matching Manual ID...**
 - Type in a Manual ID name and all Manual IDs with that name will be selected.
- **Copy selected files...**
 - Selected files are copied to a new location.
- **Rename selected files prepending Manual IDs...**
 - When FS or ZC files are created on output as part of the auto-ID batch process, those files can be selected and any Manual ID will be prepended to the output file name.
- **Bulk ID matching auto-ID**
 - Apply the same ID to all matching auto-ID or cluster membership results.
- **Bulk ID selected rows**
 - Apply the same ID to all results within selected rows.
- **Copy Top1Match/Auto-IDs to Manual IDs**
 - Copies all Top1Match or Auto-IDs to MANUAL ID column.
- **Edit columns...**
 - The displayed columns can be selected and re-ordered.

NOTE: Most (but not all) columns are available for display.

- **Close**
 - Close the Results window.
- **Exit**
 - Windows only. This will Exit the program.

cluster.csv File menu choice:

- **Change location**
 - Change the source location of the currently selected file.
- **Save**
 - Save edited data to the current underlying CSV file.
- **Save as...**
 - Save edited data to a new version of the underlying CSV file.
- **Select all**
 - Select all rows.
- **Select matching Top1Match/Auto-ID...**
 - Type in a Top1Match or Auto-ID name and all detected signals with that name will be selected.
- **Select matching Manual ID...**
 - Type in a Manual ID name and all Manual IDs with that name will be selected.
- **Save selected detections as WAVs...**
 - Selected detections are copied as WAV files.
 - The saved detections retain their original file names with additional channel and offset information.
- **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.
- **Close**
 - Close the Results window.
- **Exit**
 - Windows only. This will Exit the program.

Results Window Rows

The rows in the Results window describe detections, Files, or File Segments

- The rows in the meta.csv file represent the files in the Input Directory which were included in the batch process.
- The rows in the id.csv file represent entire files or file segments.
 - File segments can be based on .wac trigger.
 - File segments can be based on detections within larger files.
 - File segments can be a result of using the Split to max duration function under the Batch tab.
 - File segments are described with time offsets from the start of the parent file.
- The rows in the cluster.csv file represent detected signals within the input files.
 - Detected signals are described by time offset and duration within the parent file.

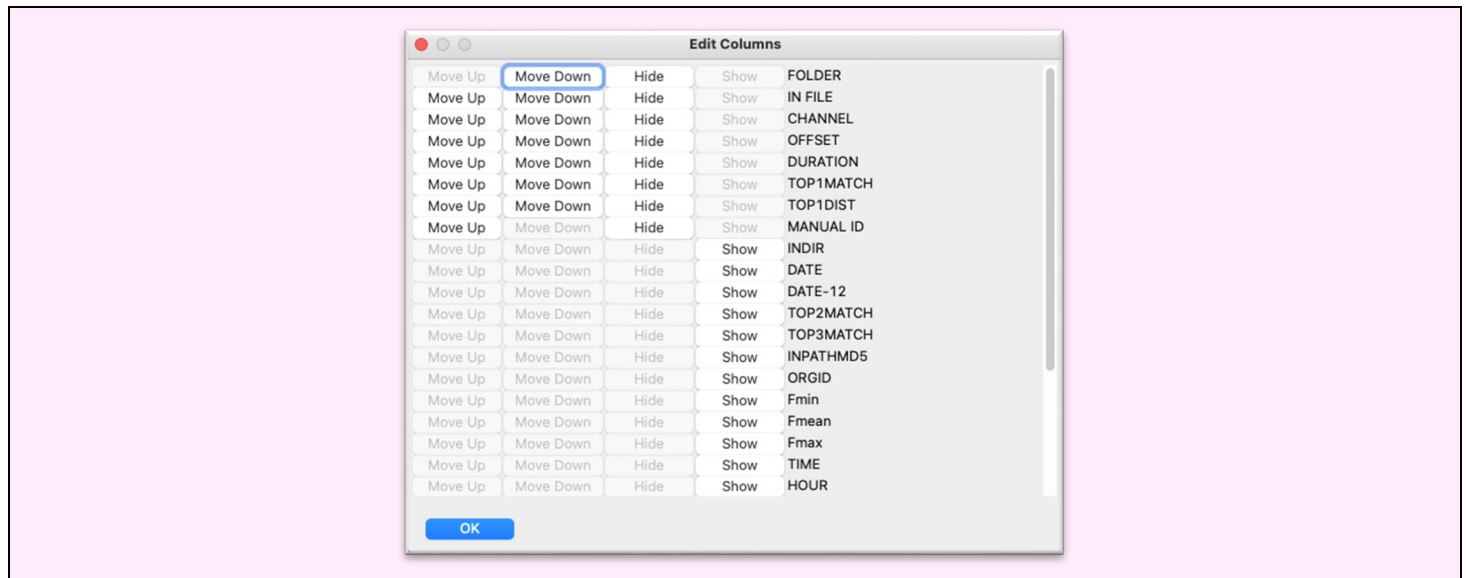
Results Window Columns

The columns in the Results window display labelled attributes for the listed rows.

- The available columns are based on the type of underlying.csv file.
- Default Results window columns:
 - **meta.csv**
 - Folder
 - In File
 - Auto-ID
 - Pulses
 - Matching
 - Match Ratio
 - Manual ID
 - **id.csv**
 - Folder
 - In File
 - Out File FS
 - Out File ZC
 - Auto-ID
 - Pulses
 - Matching
 - Match Ratio
 - Manual ID
 - **cluster.csv**
 - Folder
 - In File
 - Channel
 - Offset
 - Duration
 - Top1Match
 - Top1Dist
 - Manual ID

The column layout can be edited:

- Select Edit Columns... from the Results window File menu.



- Show or Hide columns
- Move columns Up or Down to change the display order
- The column layout is remembered when Kaleidoscope is quit.
- The column layout is saved with any batch process in the settings.ini file.
- Rows can be sorted by columns.
 - Click on a column header to sort the rows based on the contents of the column.

- Clicking again on the column header to reverse the sort order.
- Sort multiple columns in order to create custom data displays.
- The contents of the Results window can be edited.
 - The Top1Match column cluster names can be edited. See: [Simple Classifiers](#).
 - The Manual ID column can be edited. See: [Advanced Classifiers](#).
 - To Save any edits to the Results window, choose Save or Save As from the Results window File menu.
 - This will update the underlying CSV file.

8 Additional Resources

8.1 Troubleshooting

The following section addresses typical problems which can occur when using Kaleidoscope.

Set Defaults

For many simple problems, resetting Kaleidoscope to Default Settings can be a quick solution. See: [Set Defaults](#).

Download/Installation Help

The current version of Kaleidoscope software can always be downloaded for no charge.

- To access downloads go to wildlifeacoustics.com/account/downloads.
 - A Wildlife Acoustics Web Account is required to access downloads.
 - If there is a problem with creating an account or accessing a download, this is usually because of a network firewall or some other Internet access problem.
- If the computer is behind an institutional firewall or is otherwise locked, an authorized system administrator may be required to download and install Kaleidoscope.

Error Message at Open

If Kaleidoscope has some sort of problem as it attempts to open, this may be an indication of a problem with Kaleidoscope interacting with the computer operating system.

If an error message appears as Kaleidoscope tries to open:

1. Take a screen shot to send to Wildlife Acoustics Technical Support.
2. Restart the computer.
3. Check to make sure the current version of Kaleidoscope is installed.
4. Try to open Kaleidoscope again.
5. If the problem persists please contact [Wildlife Acoustics Technical Support](#) for assistance.

License Activation Help

There are two common reasons why a Kaleidoscope Pro license activation can fail.

- If the computer cannot communicate with the Wildlife Acoustics server, a message will be displayed instructing the user to complete a manual activation.
 - If this happens, see: [Manual License Activation](#).
- If a license cannot be found to activate, a message will indicate there is no license available.
 - The quickest solution for this is to contact Wildlife Acoustics Technical Support for assistance.

File-Related Error Messages

Kaleidoscope may display an error message, or in extreme cases crash, if it tries to open or process a non-compatible or corrupted recording file.

- Check supported file formats here: [Audio File Formats](#).

If a problematic recording file is isolated:

- Make sure the file is on a local drive.
 - It may be informative to copy the file to a different drive. Try to open the file from the new drive location. This will suggest if the problem is specific to the file or its previous location.
- Check to see if the file can be opened in any other application.
- Check an individual File by choosing Open from the Control Panel File menu and navigating to and selecting the file.

Tip: If the file is in an unsupported format, it is often an easy task to convert one or more files to a compatible format.

File Display Problems

If a recording file appears to open in the Viewer, but there are display problems:

- Check the analysis mode.
 - The Viewer has separate optimized settings for Bat-analysis mode and Non-Bat Analysis Mode.
 - When opening a bat recording, make sure Kaleidoscope is in Bat Analysis Mode.
 - When opening a non-bat recording, make sure Kaleidoscope is in Non-Bat Analysis Mode.

If a file is opened in the wrong analysis mode:

1. Navigate back to the Control Panel window.
2. Select the correct analysis mode from the menu in the upper left corner of the Control Panel.
3. Go to the Viewer File menu and choose Reload.
 - The file will reload in the correct display mode.

NOTE: WAV and W4V files do not contain native Zero-Crossing information. When Kaleidoscope is in Bat Analysis Mode, the Viewer will automatically attempt to extract and display zero crossing information from a WAV/W4V file. If no signal is found which can be used to create Zero-Crossing information, the Zero-Crossing view will be empty.

- Verify the Viewer settings.
 - Check Zoom levels.
 - Check Brightness and Contrast Sliders.
 - Check Compressed View Mode.
 - Check the Full-Spectrum and Zero-Crossing View buttons.
- Verify the recording file metadata.
 - Check the Notes window in the Metadata Panel to verify the File Length.
 - Look for any additional metadata which may indicate anything unusual.

NOTE: Zero-Crossing files do not contain full-spectrum audio content and therefore will not create oscillogram and spectrogram displays.

- Display is distorted.
 - Check FFT and Color settings.
- Reset to Default Settings.
 - This will reset all Viewer settings.
 - If there is still a display problem, check other files.
- If display problems persist, please contact Wildlife Acoustics Technical Support for assistance.

Audio Playback Problems

A full-spectrum audio file may open in the Viewer and then have audio playback problems.

- Zero-Crossing files do not play back sound.
- The Viewer uses the computer audio output for playback.
 - Check that audio plays back from other computer applications.
 - For Linux users, make sure all required components are installed.
 - If possible test the WAV file with a different audio playback application.
- Draw a selection box around a specific audio target.
- Check to see if the Playback Wiper moves through the selection box when the Play button is pressed.
- Check The following Viewer settings:
 - Brightness Slider
 - Bandpass filter (if any)
 - Compressed View Mode
 - Playback Speed (for ultrasonic recordings make sure speed has been slowed down to audible range)
 - Time Expansion Factor
- Restart the computer, open Kaleidoscope, Reset to Default Settings.
 - If still no playback at this point please contact Wildlife Acoustics Technical Support for assistance.

A file may play back but be quiet or loudly distorted..

- Check the computer playback volume is turned up.
- Check the Viewer Brightness Slider.

Tip: It is typical for a recording to contain low frequency ambient sound at high energy. If a higher frequency sound is then amplified with the Brightness Slider, this will also amplify the low frequency noise and can cause playback distortion. To solve this, use a Bandpass Filter to isolate lower amplitude frequency ranges from the louder ambient noise. For further information, see: [Bandpass Filter](#).

File Conversion Problems

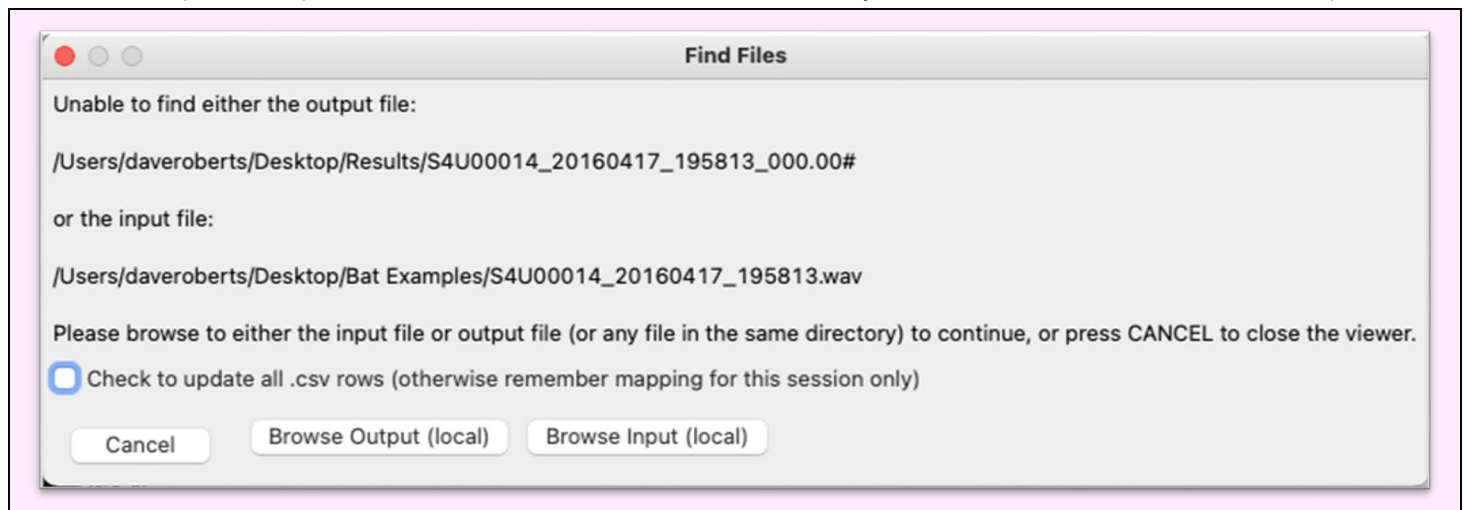
When creating or converting audio files as outputs of a batch process, an Error Message may appear or a crash may occur.

- Make sure Input and Output Directories are on local drives.
- If an Error Message appears, take a screen shot to send to Wildlife Acoustics Technical Support.
 - The Error Message may describe the specific problem with the file.
- Test conversion with a single file.
 - If conversion with a single file is problematic, check that the input file can be opened by Kaleidoscope.

Find Files Window

When a meta.csv, id.csv, or cluster.csv file is opened via Open Results..., a Find Files window may appear.

- If an input or output file is not found in the location referenced by the CSV file, a Find Files window will open.

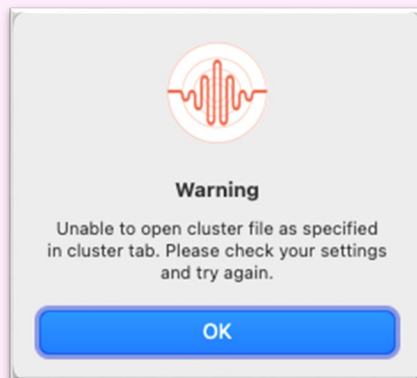


- **Check to update all.csv rows**
 - Check this box before locating missing input or output files.
 - Once the files have been relocated, choose Save or Save As from the Results window File menu.
- **Cancel**
 - This will close the Viewer but not the Results window.
 - If another File or detection is selected in the Results window and is also missing, the Find Files window will reopen.
- **Browse Output**
 - Locate the specified output file in its new location.
 - This is only displayed if audio files were created on output and cannot be found.
- **Browse Input**
 - Locate the specified input file in its new location.

Error when Opening Cluster Analysis Results

Open a cluster.csv file from the Control Panel File menu by selecting Open Results...

- The following Error Message May appear.
- This error may be followed by additional Error Messages.



1. Close the Viewer and Results window (if open).
2. Choose Load Settings... from the Control Panel File menu.
3. Navigate to and open the settings.ini file which was created when the cluster analysis batch process was run.
4. Open the cluster.csv file.

Keyboard Shortcuts Don't Work

If Keyboard Shortcut Commands do not work:

- Kaleidoscope Keyboard Commands only work when Kaleidoscope is the front-most application.
 - Click on the Control Panel to activate the Control Panel Keyboard Commands.
 - Click on the spectrogram in the Viewer window to activate the Viewer Keyboard commands.
- The numbers above the letters on a computer keyboard are not the same Keyboard Commands as the numbers on a separate keypad or on the right side of an extended keyboard.
- Check for any operating system utility which may be changing the computer keyboard functions.
- Check that Keyboard Commands work in other applications.

8.2 CSV File Layouts

During batch processing Kaleidoscope creates CSV files depending on the selected batch options.

meta.csv

The meta.csv file is always created by any batch process.

- The meta.csv file is a catalog of the input recording files which were processed in the batch.
- If metadata information does not exist in the input file, the corresponding fields in the meta.csv file will empty.
- The columns in the meta.csv file are described in the MetaForm and can be customized.
 - For workflow information, see: [Metadata Management](#).

The following are the columns listed in the meta.csv file using the default MetaForm:

- **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**
 - Datestamp of the recording if available
- **TIME**
 - Timestamp of the recording if available
- **HOURL**
 - Hour (from time) of the recording if available

- **DATE-12**
 - Datestamp of the recording if available less 12 hours (for nightly folders)
- **TIME-12**
 - Timestamp of the recording if available less 12 hours (for nightly folders)
- **HOUR-12**
 - Hour (from time) of the recording if available less 12 hours (for nightly folders)
- **LATITUDE**
 - GPS location of input file recording
- **LONGITUDE**
 - GPS location of input file recording
- **MODEL**
 - Recorder model
- **SERIAL NO**
 - Recorder serial number
- **FIRMWARE**
 - Recorder firmware version
- **PREFIX**
 - Recorder prefix (from the filename)
- **NOTES**
 - Manually Created Notes
- **PULSES**
 - Number of pulses detected in the file which were identified
- **MATCHING**
 - Number of pulses matching the auto classification result
- **MATCH RATIO**
 - The ratio of MATCHING over PULSES
- **ORGID**
 - Organization UUID of Managed Cloud Account who has run this batch process
- **USERID**
 - Nickname or email address of Managed Cloud Account who has run this batch process
- **REVIEW ORIGID**
 - If Manual ID is present, this is the UUID of the organization corresponding to the Manual ID
- **REVIEW USERID**
 - If Manual ID present, this is the nickname or email address of the User who created the Manual ID
- **INPATHMD5**
 - Unique identification used internally by Kaleidoscope corresponding to the input file

gps.csv

The gps.csv file contains GPS information extracted from input files during a batch process.

- The gps.csv file is only created if the option is checked under the Batch tab.
- In order for GPS information to be extracted, the information must exist as metadata in the input files.
- The location coordinates in the gps.csv file are affected by any rounding done by the Fuzz function under the Batch tab.

The following are the columns found in the gps.csv file:

- **DATE**
 - Datestamp of the input file
- **TIME**
 - Timestamp 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 is created by a cluster analysis batch process or Extract detections batch process. The cluster.csv file contains a list of the detections found in the batch process.

The following are the columns found in the cluster.csv file:

- **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**
 - Datestamp of the vocalization if available
- **TIME**
 - Timestamp of the vocalization if available
- **HOUR**
 - Hour (from time) of the vocalization if available
- **DATE-12**
 - Datestamp of the vocalization if available less 12 hours (for nightly folders)
- **TIME-12**
 - Timestamp of the vocalization if available less 12 hours (for nightly folders)
- **HOUR-12**
 - Hour (from time) of the vocalization if available less 12 hours (for nightly folders)
- **TOP1MATCH, TOP2MATCH, TOP3MATCH**
 - Top 1st, 2nd, and 3rd cluster (or winning pair-wise label) from best to worse match
- **TOP1DIST, TOP2DIST, TOP3DIST**
 - Distance from 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
- **USERID**
 - Nickname or email address of Managed Cloud Account who has run this batch process
- **REVIEW ORIGID**

- If Manual ID is present, this is the UUID of the organization corresponding to the Manual ID
- **REVIEW USERID**
 - If Manual ID present, this is the nickname or email address of the User who created the Manual ID
- **INPATHMD5**
 - Unique identification used internally by Kaleidoscope corresponding to the input file

id.csv

The id.csv file is created by an Auto-ID for Bats batch process.

- The id.csv file contains a list of all input files and their Auto-ID analysis results.
- The id.csv file can be opened directly by Kaleidoscope.
 - Under the Control Panel File menu, choose Open Results...
 - Navigate to and select the id.csv file.
- The id.csv file will open the Viewer and Results window for the Auto-ID for Bats batch process.

NOTE: Auto-ID for Bats analysis results are based on Zero-Crossing measurements. Therefore there are no full-spectrum measurements listed in the id.csv file.

Tip: If full-spectrum measurements are desired, they can be described via the Viewer Analysis window. Full-spectrum measurements are based on selection content, not detected bat calls.

Columns included in the id.csv file:

- **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 which 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)
 - Duration of the call
- **Fmax**
 - Average maximum frequency (kHz)
 - Maximum frequency detected in the call
- **Fmin**
 - Average minimum frequency (kHz)
 - Minimum frequency detected in the call
- **Fmean**
 - Average mean frequency (kHz)
 - 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)
 - Frequency at the beginning of the call body
- **Tk**
 - Average time to the knee (ms)
 - Time from the beginning of the call to the beginning of the call body
- **S1**
 - Average initial slope (octaves per second)

- Initial slope of the call
- **Tc**
 - Average time to the characteristic (ms)
 - 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
- **USERID**
 - Nickname or email address of Managed Cloud Account who has run this batch process
- **REVIEW ORIGID**
 - If Manual ID is present, this is the UUID of the organization corresponding to the Manual ID.
- **REVIEW USERID**
 - If Manual ID present, this is the nickname or email address of the User who created the Manual ID.
- **INFILEMD5**
 - Unique identification used internally by Kaleidoscope Pro corresponding to the input file
- **OUTFILEMD5FS**
 - Unique identification used internally by Kaleidoscope Pro corresponding to a full-spectrum output file
- **OUTFILEMD5ZC**
 - Unique identification used internally by Kaleidoscope Pro corresponding to a Zero-Crossing output file

idsummary.csv

The idsummary.csv file provides a summary of which species were detected in the analysis.

- This file cannot be opened by Kaleidoscope.
- The total number of files labeled with an Auto-ID tag are listed for each species.
- Likelihood of presence probability is provided for each Species Classifier which was enabled in the batch process.
 - For additional reference information, see: Maximum Likelihood Estimators (MLE) and P-values used in Kaleidoscope Pro Classifiers.

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.

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

acousticindex.csv

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

Standard columns:

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

Additional columns depending on options selected:

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

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

spl.csv

The spl.csv file is created by an SPL Analysis batch process.

- The spl.csv file provides sound level analysis information based on specified length time segments.
- This file cannot be opened in Kaleidoscope.

Columns included in the spl.csv file:

- **Prefix**
 - Recorder prefix (from the filename)
 - Kaleidoscope Pro assumes each recorder has a unique prefix.
- **Channel**
 - Indicates the channel number in the recording
- **Date**
 - Indicates the date in YYYY-MM-DD format corresponding to the start of the sample period
- **Time**
 - Indicates the time in hh:mm:ss format corresponding to the start of the sample period
- **Sample (s)**
 - Indicates the actual number of seconds contributing to the sample period
 - This would usually be the same as the sample period as specified.
 - Kaleidoscope Pro will also process periods where there are gaps in the available recordings.
- **Correction (dB)**
 - Indicates the combined correction factor applied to the full-scale recordings to produce the results
 - This includes the user-specified dB Adjustment value combined with any metadata adjustments from the recordings.

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

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

splbyfile.csv

The splbyfile.csv file is created by an SPL Analysis batch process.

- The splbyfile.csv file provides sound level analysis information on a per-file basis.
- This file cannot be opened in Kaleidoscope.

Columns included in the splbyfile.csv file:

- **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 (seconds)**
 - Offset in seconds into the input file where output begins
 - This is based on the Split to Max Duration setting under the Batch tab.
- **Sample (seconds)**
 - Indicates the actual number of seconds contributing to the sample period
 - This equals the file length or the Split to Max Duration setting (if the value is other than zero).

- **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 (Average) 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 search is run from the Db tab. The query.csv file contains the results from a database query. The format of the query.csv file is based on the type of query search.

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.

8.3 Audio File Formats

The following audio file types are supported by Kaleidoscope:

WAV - Waveform Audio Format

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

.w4v- Wildlife Acoustics Compressed WAV Format

The .w4v format is identical to the WAV format except for a proprietary compressed encoding used to represent the audio samples. Kaleidoscope will open this type of file with either a WAV or .w4v file extension. The compression is a constant bit-rate where each 16-bit uncompressed sample is encoded as an n-bit code word plus some small amount of overhead. Typical code word sizes are 8-bit, 6-bit and 4-bit which are designated W4V-8, W4V-6 and W4V-4 respectively providing approximately 50%, 62% and 75% data compression respectively. While technically lossy, W4V-8 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 artefact is raising the effective noise floor to no more than 42 dB, 30 dB or 18 dB below the peak signal respectively.

.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.

NOTE: .wac format files are not appropriate to use for SPL Analysis in Kaleidoscope. This is because the SPL Analysis function is based on fixed time ranges, not variable length triggered ranges.

Time-Expanded 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.

Example: If a recording is made at 384,000 samples per second, the sample rate in the file metadata can be changed to 38,400 while keeping all the original audio samples. If we now play back this file at 38,400 samples per second, it will take ten times longer to play and the frequencies will have been divided down by a factor of ten times. Such a file would be said to have a time expansion factor of 10.

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

?.?# , .zc - Analoow Zero-Crossing Sequence 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 .wav 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.

8.4 File Naming Conventions

The Wildlife Acoustics Song Meter line of recorders use specific file naming conventions. These naming conventions are directly supported by Kaleidoscope.

Prefix_YYYYMMDD_hhmmss . extension

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

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

Prefix_T_YYYYMDD_hhmmss . extension

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

Prefix_YYYYMMDD_hhmmss_mmm . extension

Prefix_T_YYYYMMDD_hhmmss_mmm . extension

Prefix_C_YYYYMMDD_hhmmss_mmm . extension

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

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

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

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

_C_sssss_mmm . extension.

8.5 Bat Auto-ID Species Classifiers

Kaleidoscope Pro currently provides auto-ID bat Species Classifiers for these geographic areas:

- Europe
- North America (Including Canada)

- South Africa
- Neotropics

Following are lists of the bats species supported by each Classifier Library. The species code as found in Kaleidoscope Pro is followed by the Latin name, and then common name.

Bats of Europe

BARBAR	<i>Barbastella barbastellus</i>	Western barbastelle
EPTISA	<i>Eptesicus isabellinus</i>	Meridional serotine
EPTNIL	<i>Eptesicus nilssonii</i>	Northern bat
EPTSER	<i>Eptesicus serotinus</i>	Common serotine
HYPYSAV	<i>Hypsugo savii</i>	Savi's pipistrelle
MINSCH	<i>Miniopterus schreibersii</i>	Common bent-wing bat
MYOALC	<i>Myotis alcathoe</i>	Alcathoe myotis
MYOBEC	<i>Myotis bechsteinii</i>	Bechstein's myotis
MYOBRA	<i>Myotis brandtii</i>	Brandt's myotis
MYOCAP	<i>Myotis capaccinii</i>	Long-fingered bat
MYODAS	<i>Myotis dasycneme</i>	Pond myotis
MYODAU	<i>Myotis daubentonii</i>	Daubenton's myotis
MYOEMA	<i>Myotis emarginatus</i>	Geoffroy's myotis
MYOESC	<i>Myotis escalerae</i>	Escalera's bat
MYOMYO	<i>Myotis myotis</i>	Mouse-eared myotis
MYOMYS	<i>Myotis mystacinus</i>	Whiskered myotis
MYONAT	<i>Myotis nattereri</i>	Natterer's myotis
NYCLAS	<i>Nyctalus lasiopterus</i>	Giant noctule
NYCLEI	<i>Nyctalus leisleri</i>	Lesser noctule
NYCNOC	<i>Nyctalus noctula</i>	Noctule
PIPKUH	<i>Pipistrellus kuhlii</i>	Kuhl's pipistrelle
PIP NAT	<i>Pipistrellus nathusii</i>	Nathusius' pipistrelle
PIPPIP	<i>Pipistrellus pipistrellus</i>	Common pipistrelle
PIPPYG	<i>Pipistrellus pygmaeus</i>	Soprano pipistrelle
PLEAUR	<i>Plecotus auritus</i>	Brown long-eared bat
PLEAUS	<i>Plecotus austriacus</i>	Grey long-eared bat
RHIEUR	<i>Rhinolophus euryale</i> <i>Rhinolophus</i>	Mediterranean horseshoe bat
RHIFER	<i>ferrumequinum</i>	Greater horseshoe bat
RHIHIP	<i>Rhinolophus hipposideros</i>	Lesser horseshoe bat
TADTEN	<i>Tadarida teniotis</i>	European free-tailed bat
VESMUR	<i>Vespertilio murinus</i>	Particolored bat

Bats of North America

ANTPAL	<i>Antrozous pallidus</i>	Pallid bat
CORTOW	<i>Corynorhinus townsendii</i>	Townsend's big-eared bat
EPTFUS	<i>Eptesicus fuscus</i>	Big brown bat
EUDMAC	<i>Euderma maculatum</i>	Spotted bat
EUMFLO	<i>Eumops floridanus</i>	Florida bonneted bat

EUMPER	<i>Eumops perotis</i>	Greater bonneted bat
EUMUND	<i>Eumops underwoodi</i>	Underwood's bonneted
LASBLO	<i>Lasiurus blossevillii</i>	Western red bat
LASBOR	<i>Lasiurus borealis</i>	Eastern red bat
LASCIN	<i>Lasiurus cinereus</i>	Hoary bat
LASEGA	<i>Lasiurus ega</i>	Southern yellow
LASINT	<i>Lasiurus intermedius</i>	Northern yellow bat
LASNOC	<i>Lasionycteris noctivagans</i>	Silver-haired bat
LASSEM	<i>Lasiurus seminolus</i>	Seminole bat
LASXAN	<i>Lasiurus xanthinus</i>	Western yellow bat
MACCAL	<i>Macrotus californicus</i>	California leaf-nosed bat
MOLMOL	<i>Molossus molossus</i>	Pallas's mastiff bat
MORMEG	<i>Mormoops megalophylla</i>	Ghost-faced
MYOAUS	<i>Myotis austroriparius</i>	Southeastern myotis
MYOCAL	<i>Myotis californicus</i>	California myotis
MYOCIL	<i>Myotis ciliolabrum</i>	Western Small-footed myotis
MYOEVO	<i>Myotis evotis</i>	Long-eared myotis
MYOGRI	<i>Myotis grisescens</i>	Gray myotis
MYOLEI	<i>Myotis leibii</i>	Eastern small-footed myotis
MYOLUC	<i>Myotis lucifugus</i>	Little brown myotis
MYOOC	<i>Myotis occultus</i>	Arizona myotis
MYOSEP	<i>Myotis septentrionalis</i>	Northern myotis
MYOSOD	<i>Myotis sodalis</i>	Indiana myotis
MYOTHY	<i>Myotis thysanodes</i>	Fringed myotis
MYOVEL	<i>Myotis velifer</i>	Cave myotis
MYOVOL	<i>Myotis volans</i>	Long-legged myotis
MYOYUM	<i>Myotis yumanensis</i>	Yuma myotis
NYCFEM	<i>Nyctinomops femorosaccus</i>	Pocketed free-tail
NYCHUM	<i>Nycticeius humeralis</i>	Evening bat
NYCMAC	<i>Nyctinomops macrotis</i>	Big free-tailed bat
PARHES	<i>Parastrellus hesperus</i>	Canyon bat
PERSUB	<i>Perimyotis subflavus</i>	Tricolored bat
TADBRA	<i>Tadarida brasiliensis</i>	Mexican free-tailed bat

Bats of South Africa

CHAPUM	<i>Chaerophon pumilus</i>	Little free-tailed
EPTHOT	<i>Eptesicus hottentotus</i>	Long-tailed house
LAEBOT	<i>Laephotis botswanae</i>	Botswanan long-eared
LAEWIN	<i>Laephotis wintoni</i>	De Winton's long-eared
MINNAT	<i>Miniopterus natalensis</i>	Natal long-fingered
MYOBOC	<i>Myotis bocagei</i>	Rufous mouse-eared
NEOCAP	<i>Neoromicia capensis</i>	Cape serotine
RHIBLA	<i>Rhinolophus blasii</i>	Blasius's horseshoe

RHICLI	<i>Rhinolophus clivosis</i>	Geoffroy's horseshoe
RHIDEN	<i>Rhinolophus denti</i>	Dent's horseshoe
RHIFUM	<i>Rhinolophus fumigatus</i>	Ruppell's horseshoe
	<i>Rhinolophus</i>	
RHIHIL	<i>hildebrandtii</i>	Hildebrandt's horseshoe
RHILAN	<i>Rhinolophus landeri</i>	Lander's horseshoe
RHISIM	<i>Rhinolophus simulator</i>	Bushveld horseshoe
RHISMI	<i>Rhinolophus smithersi</i>	Smithers's horseshoe
RHISWI	<i>Rhinolophus swinnyi</i>	Swinny's horseshoe
SAUPET	<i>Sauromys petrophilus</i>	Roberts's flat-headed
SCODIN	<i>Scotophilus dinganii</i>	African yellow
SCONIG	<i>Scotophilus Nigrita</i>	Schreber's yellow
TADAEG	<i>Tadarida aegyptiaca</i>	Egyptian free-tailed

Bats of the Neotropics

ANTPAL	<i>Antrozous pallidus</i>	Pallid bat
BALIO	<i>Balantiopteryx io</i>	Thomas's sac-winged
BALPLI	<i>Balantiopteryx plicata</i>	Gray sac-winged
BAUDUB	<i>Bauerus dubiaquercus</i>	Van Gelder's
CENCEN	<i>Centronycteris centralis</i>	Thomas's shaggy
CENMAX	<i>Centronycteris maximiliani</i>	Shaggy Townsend's big- eared
CORTOW	<i>Corynorhinus townsendii</i>	
CYNMEX	<i>Cynomops mexicanus</i>	Mexican dog-faced
DICALB	<i>Diclidurus albus</i>	Northern ghost
EPTBRA	<i>Eptesicus brasiliensis</i>	Brazilian brown
EPTFUR	<i>Eptesicus furinalis</i>	Argentine brown
EPTFUS	<i>Eptesicus fuscus</i>	Big brown
EUDMAC	<i>Euderma maculatum</i>	Spotted
EUMGLA	<i>Eumops glaucinus</i>	Eumops floridanus
EUMPER	<i>Eumops perotis</i>	Western Mastiff Underwood's bonneted
EUMUND	<i>Eumops underwoodi</i>	
LASBLO	<i>Lasiurus blossevillii</i>	Desert red
LASCIN	<i>Lasiurus cinereus</i>	Hoary
LASEGA	<i>Lasiurus ega</i>	Southern yellow
LASINS	<i>Lasiurus insularis</i>	Cuban Yellow
LASINT	<i>Lasiurus intermedius</i>	Northern yellow
LASSEM	<i>Lasiurus seminolus</i>	Seminole
LASXAN	<i>Lasiurus xanthinus</i>	Western Bat
MACCAL	<i>Macrotus californicus</i>	California leaf-nosed
MOLMOL	<i>Molossus molossus</i>	Velvety free-tailed
MOLRUF	<i>Molossus rufus</i>	Black mastiff
MOLSIN	<i>Molossus sinaloae</i>	Sinaloan mastiff
MOLTEM	<i>Molossops temminckii</i>	Dwarf dog-faced
MORBLA	<i>Mormoops blainvillei</i>	Antillean ghost-faced

MORMEG	<i>Mormoops megalophylla</i>	Ghost-faced
MYOCAL	<i>Myotis californicus</i>	California myotis
MYOELE	<i>Myotis elegans</i>	Elegant myotis
MYOEVO	<i>Myotis evotis</i>	Long-eared myotis
MYOKEA	<i>Myotis keaysi</i>	Hairy-legged myotis
MYONIG	<i>Myotis nigricans</i>	Black myotis
MYOOC	<i>Myotis occultus</i>	Arizona myotis
MYORIP	<i>Myotis riparius</i>	Riparian myotis
MYOTHY	<i>Myotis thysanodes</i>	Fringed myotis
MYOVEL	<i>Myotis velifer</i>	Cave myotis
MYOVOL	<i>Myotis volans</i>	Long-legged myotis
MYOYUM	<i>Myotis yumanensis</i>	Yuma myotis
NOCLEP	<i>Noctilio leporinus</i>	Greater bulldog
	<i>Nyctinomops</i>	
NYCFEM	<i>femorosaccus</i>	Pocketed free-tail
NYCHUM	<i>Nycticeius humeralis</i>	Evening Bat
NYCLAT	<i>Nyctinomops laticaudatus</i>	Broad-eared
NYCMAC	<i>Nyctinomops macrotis</i>	Big free-tailed
PARHES	<i>Parastrellus hesperus</i>	Western pipistrelle
PERKAP	<i>Peropteryx kappleri</i>	Greater dog-like
PERMAC	<i>Peropteryx macrotis</i>	Lesser dog-like
PROCEN	<i>Promops centralis</i>	Promops Centralis
PTEDAV	<i>Pteronotus davyi</i>	Davy's naked-backed
PTEGYM	<i>Pteronotus gymnotus</i>	Big naked-backed
PTEMAC	<i>Pteronotus macleayii</i>	Macleay's mustached
PTEPAR	<i>Pteronotus parnellii</i>	Parnell's mustached
PTEPER	<i>Pteronotus personatus</i>	Wagner's mustached
PTEQUA	<i>Pteronotus quadridens</i>	Sooty mustached
RHOAEN	<i>Rhogeessa aeneus</i>	Yucatan yellow
RHYNAS	<i>Rhynchonycteris naso</i>	Proboscis
SACBIL	<i>Saccopteryx bilineata</i>	Greater sac-winged
SACLEP	<i>Saccopteryx leptura</i>	Lesser sac-winged
TADBRA	<i>Tadarida brasiliensis</i>	Mexican free-tailed

8.6 Maximum Likelihood Estimators (MLE) and P-values for Species Classifiers

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

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

<http://www.fws.gov/midwest/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 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 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 low (likely present).

There are some important caveats:

- First, an important input to the calculation is the known confusion matrix of the classifier. Unfortunately, there is no such thing. The error rates of a bat classifier will vary from one site to the next, because the bats will produce different calls in different habitats with different levels of clutter. In a high clutter environment, for example, it might be expected to see a higher error rate than in a low clutter environment. It is also exceedingly difficult to measure the error rate without significant independently collected and verified data. For Kaleidoscope Pro, we split our data in half using one half to train our classifiers and the other half to measure the error rates. This is as good an estimate of the average confusion matrix that we can measure. But, it is not going to be the actual confusion matrix for any particular deployment. Therefore, the P- value calculations can't be determined exactly. They are only estimates.
- Second, while the P-value is perhaps the best statistical tool we have to work with, it is not perfect. A high P-value is not proof of absence. It simply means there is not sufficient statistical evidence of presence. And a low P-value is not proof of presence, it simply means the null hypothesis of absence cannot be explained by the data. A low P-value might suggest an alternate hypothesis is more likely. That could be presence. But it could also be 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.

8.7 Cluster Analysis Theory

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 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 which doesn't match closely to the training data.

8.8 Default Metadata SCHEMA

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

Standardized GUANO Fields

There are multiple standards for metadata organization and formatting. GUANO is a de-facto standard which has been adapted by many organizations, including Wildlife Acoustics.

- The specifications for the GUANO standard are found here: https://github.com/riggsd/guano-spec/blob/master/guano_specification.md.
- The specific GUANO formatting used by Kaleidoscope Pro can be viewed at wildlifeacoustics.com/SCHEMA.
- Kaleidoscope reads GUANO metadata from full-spectrum and Zero-Crossing input files.
- Kaleidoscope embeds GUANO metadata into full-spectrum and Zero-Crossing output files.
- Kaleidoscope extracts specified fields from GUANO metadata to write to CSV output files and databases. The MetaForm defines which fields and subfields are extracted and written to which CSV file columns or Database table fields.
- Manually created metadata and metadata from Kaleidoscope batch processes are converted to GUANO format for embedding in output files.

GUANO has a list of well-known data fields which are generally readable by any software that supports the GUANO standard.

Example: Here is GUANO formatted metadata which describes a sample rate setting of 24000:

```
Samplerate:24000
```

- 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).

Example: Here is GUANO metadata which describes the version of Kaleidoscope used to process the file:

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

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

Wildlife Acoustics GUANO Metadata Namespace

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

Revision History

2020-07-05: Added acoustic indexes

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

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

2017-11-09: Initial disclosure.

Standardized GUANO Fields

Field Name	Data Type	Description
GUANO Version	text	1.0
Filter HP	float	High-pass filter frequency in kHz
Filter LP	float	Low-pass filter frequency in kHz
Firmware Version	text	Recorder firmware version
Hardware Version	text	Recorder hardware version
Humidity	float	Relative humidity as a percentage
Length	float	Recording length in seconds
Loc Accuracy	float	Estimated Position Error in meters
Log Elevation	float	Elevation/altitude above mean sea level in meters
Loc Position	float	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
Sample rate	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	<p>Kaleidoscope Cluster settings</p> <ul style="list-style-type: none"> • min freq - float - minimum frequency, Hz • max freq - float - maximum frequency, Hz • min dur - float - minimum duration, s • max dur - float - maximum duration, s • max gap - float - maximum gap, s

		<ul style="list-style-type: none"> • mode - text - Clustering mode pass1, pass2, scan or scan-null • win - float - window, seconds • max states - integer - maximum number of states in model • max Clusters - integer - maximum number of Clusters to form • max dist merge - float - maximum distance used to merge Clusters • max dist scan - float - maximum distance used to filter results
WA Kaleidoscope Cluster Statistics	JSON-encoded text	<p>Kaleidoscope Cluster results</p> <ul style="list-style-type: none"> • offset - float - offset to detection, seconds • duration - float - duration of detection, seconds • fmin - float - minimum frequency of detected signal, Hz • fmean - float - mean frequency of detected signal, Hz • fmax - float - maximum frequency of detected signal, Hz • Cluster - array of 3 strings indicating top 3 Cluster names • distance - array of 3 floats indicating top 3 distances
WA Kaleidoscope Compression	text	Describes compression algorithm used in writing WAV files if any (e.g. "W4V-8")
WA Kaleidoscope Conversion	text	<p>Describes any conversion from input file to this file as one of:</p> <ul style="list-style-type: none"> • WAC to WAV • WAC to ZC • WAV to ZC • ZC to WAV
WA Kaleidoscope Fingerprint	text	A unique fingerprint corresponding to the raw data samples or Zero-Crossing timings associated with a full-spectrum or Zero-Crossing audio file
WA Kaleidoscope GPS Fuzz	float	GPS Fuzz precision used to obfuscate location coordinates to the nearest grid center. For example, a value of 0.1 would round GPS latitude and longitude coordinates to the nearest 0.1 degree.
WA Kaleidoscope Acoustic Index Settings	JSON-encoded text	<p>Acoustic index module settings:</p> <ul style="list-style-type: none"> • NDSI <ul style="list-style-type: none"> ○ fft - integer - FFT Window Size ○ anthro_min - float - minimum frequency for anthrophony (Hz)

		<ul style="list-style-type: none"> ○ anthro_max - float - maximum frequency for anthrophony (Hz) ○ bio_min - float - minimum frequency for biophony (Hz) ○ bio_max - float - maximum frequency for biophony (Hz) ● ACI <ul style="list-style-type: none"> ○ fft - integer - FFT Window Size ○ fmin - float - minimum frequency (Hz) ○ fmax - float - maximum frequency (Hz) ○ j - float - value of J (s) ● ADI <ul style="list-style-type: none"> ○ fmax - float - maximum frequency (Hz) ○ fstep - float - step frequency (Hz) ○ thold - float - threshold (dB re peak signal) ● AEI <ul style="list-style-type: none"> ○ fmax - float - maximum frequency (Hz) ○ fstep - float - step frequency (Hz) ○ thold - float - threshold (dB re peak signal) ● BI <ul style="list-style-type: none"> ○ fft - integer - FFT Window Size ○ fmin - float - minimum frequency (Hz) ○ fmax - float - maximum frequency (Hz) ● SPEC <ul style="list-style-type: none"> ○ fft - integer - FFT Window Size ○ fmin - float - minimum frequency (Hz) ○ fmax - float - maximum frequency (Hz) ● QUT <ul style="list-style-type: none"> ○ fft - integer - FFT Window Size ○ thold - float - threshold (dB re noise floor)
<p>WA Kaleidoscope Acoustic Index Statistics</p>	<p>JSON-encoded text</p>	<p>Acoustic index results (array by channel), floating point values of specific indexes</p> <ul style="list-style-type: none"> ● MEAN ● SD ● SEM ● MEDIAN ● MODE ● Q25 ● Q75 ● IQR ● SKEW ● KURT ● SFM ● SH ● NDSI ● ACI ● ADI ● AEI ● BI ● BGN ● SNR ● ACT

		<ul style="list-style-type: none"> • EVN • LFC • MFC • HFC • CENT
WA Kaleidoscope SPL Settings	JSON-encoded text	<p>SPL analysis module settings:</p> <ul style="list-style-type: none"> • period - the reporting sample period in seconds • adjust - decibel adjustment • SEL on - event onset threshold, dB • SEL off - event offset threshold, dB
WA Kaleidoscope SPL Statistics	JSON-encoded text	<p>SPL analysis results (array by channel)</p> <ul style="list-style-type: none"> • samples - audio sample in measurement, seconds • correction - total correction factor, dB • name of band (repeated for selected bands) <ul style="list-style-type: none"> ○ min - minimum measurement, dB ○ max - maximum measurement, dB ○ mean - mean measurement, dB ○ SELcum - cumulative Sound Exposure Level, dB*sec
WA Kaleidoscope Offset	float	Offset of result from input file in seconds
WA Kaleidoscope Version	text	Kaleidoscope software version
WA Kaleidoscope License	text	To share files, you can specify the type of license under which you are willing to share your data. Choices include none (private), public domain, and various creative commons licenses.
WA Song Meter Audio settings	JSON-encoded text	<p>Song Meter settings (converted from WAMD metadata) including the following JSON objects in a per-channel array:</p> <ul style="list-style-type: none"> • rate - integer - samplerate (samples per second) • mic - text - microphone type e.g. "U1" • gain - float - total gain in dB • hpf - float - high-pass filter, Hz • trig level - float - trigger level, dB • trig window - float - trigger window, s • trig max len - float - trigger maximum length, s • trig min freq - float - trigger minimum frequency, Hz • trig max freq - float - trigger maximum frequency, Hz • trig min dur - float - trigger minimum duration, s • trig max dur - float - trigger maximum duration, s

WA Song Meter Compression	text	The compression used by the Song Meter if any, converted from WAMD metadata, (e.g. "W4V-8")
WA Song Meter Prefix	text	The file prefix, if any, converted from WAMD metadata

Internal GUANO Tags Used in Kaleidoscope for Database Interfaces

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

WA *INPATHID	integer	A unique internal temporary id corresponding to an input file
WA *INPATHMD5	text	The MD5 hash of WA *INPATH used as a unique lookup key
WA *NCHANNELS	text	The number of audio channels in a file
WA *NOTEID	integer	A unique internal temporary id corresponding to a unique Note
WA *NOTEIDMD5	text	The MD5 hash of a Note used as a unique lookup key
WA *OFFSET	float	The offset in seconds into an audio file corresponding to a result
WA *ORGID	text	The unique Kaleidoscope cloud account UUID corresponding to the source of a Database entry
WA *OUTDIR	text	The absolute Output Directory path
WA *OUTDRIVELABEL	text	A user-defined label to identify a location (e.g. external disk drive) corresponding to an output file
WA *OUTFILE	text	The output filename (with extension, but without directories)
WA *OUTFILEFS	text	The full-spectrum output filename (with extension, but without directories)
WA *OUTFILEZC	text	The Zero-Crossing output filename (with extension, but without directories)
WA *OUTPATHFS	text	The absolute path name of the full-spectrum output file
WA *OUTPATHZC	text	The absolute path name of the Zero-Crossing output file
WA *OUTPATHIDFS	integer	A unique internal temporary id corresponding to a full-spectrum output file
WA *OUTPATHIDZC	integer	A unique internal temporary id corresponding to a Zero-Crossing output file
WA *OUTPATHMD5FS	text	The MD5 hash of WA *OUTPATHFS used as a unique lookup key
WA *OUTPATHMD5ZC	text	The MD5 hash of WA *OUTPATHZC used as a unique lookup key
WA *PATH	text	The absolute path name of the file
WA *PATHID	integer	A unique internal temporary id corresponding to the file

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

Internal GUANO Tags Used in Kaleidoscope for Database Interfaces

Field Name	Data Type	Description
WA *ACCESS	text	Set to 0 for private or 1 for public access to data
WA *BATCHFINGERPRINT	text	Unique fingerprint checksum for a given batch job
WA *BATCHLABEL	text	A user-defined label to identify a batch job
WA *BATCHRECORDSBYTES	integer	Size of batch Database records (uncompressed .wdb (Wildlife Acoustics Database) file, in bytes.
WA *BATCHRECORDSRECORDINGS	integer	Number of recording records
WA *BATCHRECORDSAUTOIDS	integer	Number of autoid records
WA *BATCHRECORDSCLUSTERS	integer	Number of Cluster records
WA *CHANNEL	integer	The input file channel used to create outputs
WA *DIVRATIO	integer	The Zero-Crossing division ratio corresponding to a file
WA *DRIVELABEL	text	A user-defined label to identify a location (e.g. external disk drive) corresponding to a file

WA *FILE	text	The filename (with extension, but without directories)
WA *FINGERPRINT	text	A unique fingerprint corresponding to the raw data samples or Zero-Crossing timings associated with a full-spectrum or Zero-Crossing audio file
WA *FOLDER	text	The folder path relative to the Input Directory to the input file
WA *INDIR	text	The absolute Input Directory path
WA *INDRIVELABEL	text	A user-defined label to identify a location (e.g. external disk drive) corresponding to an input file
WA *INFILE	text	The input filename (with extension, but without directories)
WA *INPATH	text	The absolute path name of the input file
WA *INPATHID	integer	A unique internal temporary id corresponding to an input file
WA *INPATHMD5	text	The MD5 hash of WA *INPATH used as a unique lookup key
WA *NCHANNELS	text	The number of audio channels in a file
WA *NOTEID	integer	A unique internal temporary id corresponding to a unique Note
WA *NOTEIDMD5	text	The MD5 hash of a Note used as a unique lookup key
WA *OFFSET	float	The offset in seconds into an audio file corresponding to a result
WA *ORGID	text	The unique Kaleidoscope cloud account UUID corresponding to the source of a Database entry
WA *OUTDIR	text	The absolute Output Directory path
WA *OUTDRIVELABEL	text	A user-defined label to identify a location (e.g. external disk drive) corresponding to an output file
WA *OUTFILE	text	The output filename (with extension, but without directories)
WA *OUTFILEFS	text	The full-spectrum output filename (with extension, but without directories)
WA *OUTFILEZC	text	The Zero-Crossing output filename (with extension, but without directories)

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

Database Fields

When searching a Managed Cloud Account Database via the Db tab, the selectable Database Fields are defined by the MetaForm.

- The following is a list of selectable Database Fields as defined by the Default MetaForm

- It is possible to customize the MetaForm to edit or create different Database Fields
- For workflow information, see: [Metadata Management](#)

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 – SPL Settings
Batch – Cluster Records	Batch – Input Drive Label	Batch - Note
Batch – Batch Label	Batch – Output Drive Label	

Recordings (meta.csv)

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

Bat Auto-IDs (id.csv)

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

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

Clusters (cluster.csv)

Review - Timestamp	Cluster - Timestamp	Rec – Drive Label
Review – Species Manual ID	Cluster – Top 1 Match	Rec – File
Cluster – Channel	Cluster – Top 1 Distance	Rec – Fingerprint
Cluster – Offset (s)	Cluster – Top 2 Match	Rec - Note
Cluster – Duration (s)	Cluster – Top 2 Distance	Rec – Humidity (%)
Cluster – Fmin (Hz)	Cluster – Top 3 Match	Rec – Length (s)
Cluster – Fmean (Hz)	Cluster – Top 3 Distance	Rec – Loc Accuracy (deg)
Cluster – Fmax (Hz)	Rec – Path	Rec – Loc Elevation (m)

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

8.9 Managed Cloud Account Instructions

- Wildlife Acoustics offers pre-configured Managed Cloud Accounts for Kaleidoscope Pro Users.
 - A Wildlife Acoustics Managed Cloud Account provides cloud-based storage, cloud-based computing, and Database functions.
 - A Managed Cloud Account is initially set up and managed via a User Web Account at wildlifeacoustics.com.

NOTE: There is no initial charge or cost to create a Managed Cloud Account. There must be current credit card information on file in order to create a Managed Cloud Account. For complete details, please see: [Kaleidoscope Pro Cost Scenarios](#).

- Once the Managed Cloud Account is set up, one or more Users can access the account via Kaleidoscope Pro.
 - It is possible for a User to create multiple Managed Cloud Accounts.
 - It is possible for a User to have access to multiple Managed Cloud Accounts.

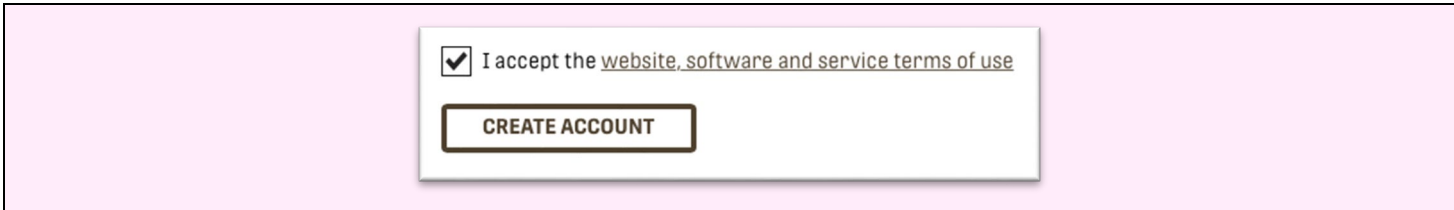
Create a Managed Cloud Account

Once logged into a Web Account, click on the Cloud tab on the left.

- A new page will open .
- Enter the Organization Name.

CREATE A NEW MANAGED CLOUD ACCOUNT

- Check the box to accept the terms of agreement and press the button to Create Account.

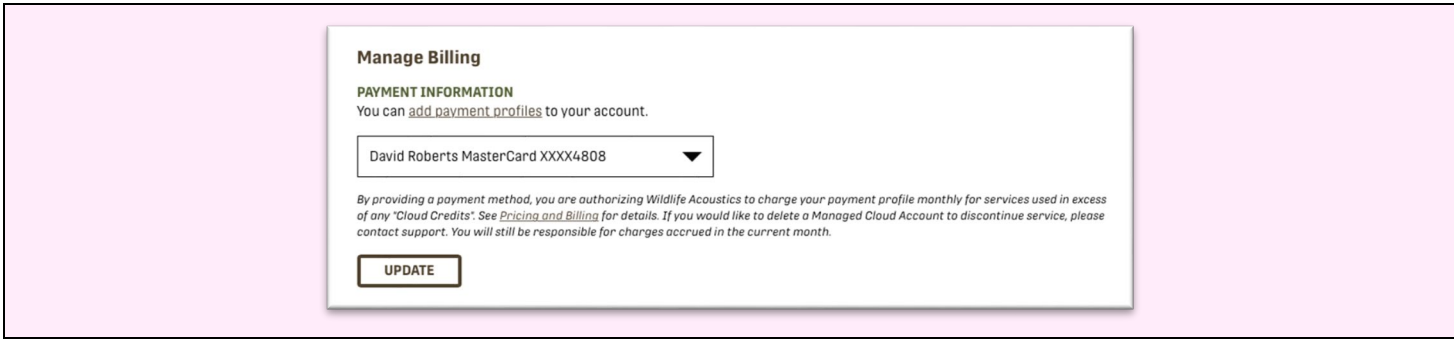


- The new Managed Cloud Account will now be listed in the User Web Account

Apply Payment for the Cloud Account

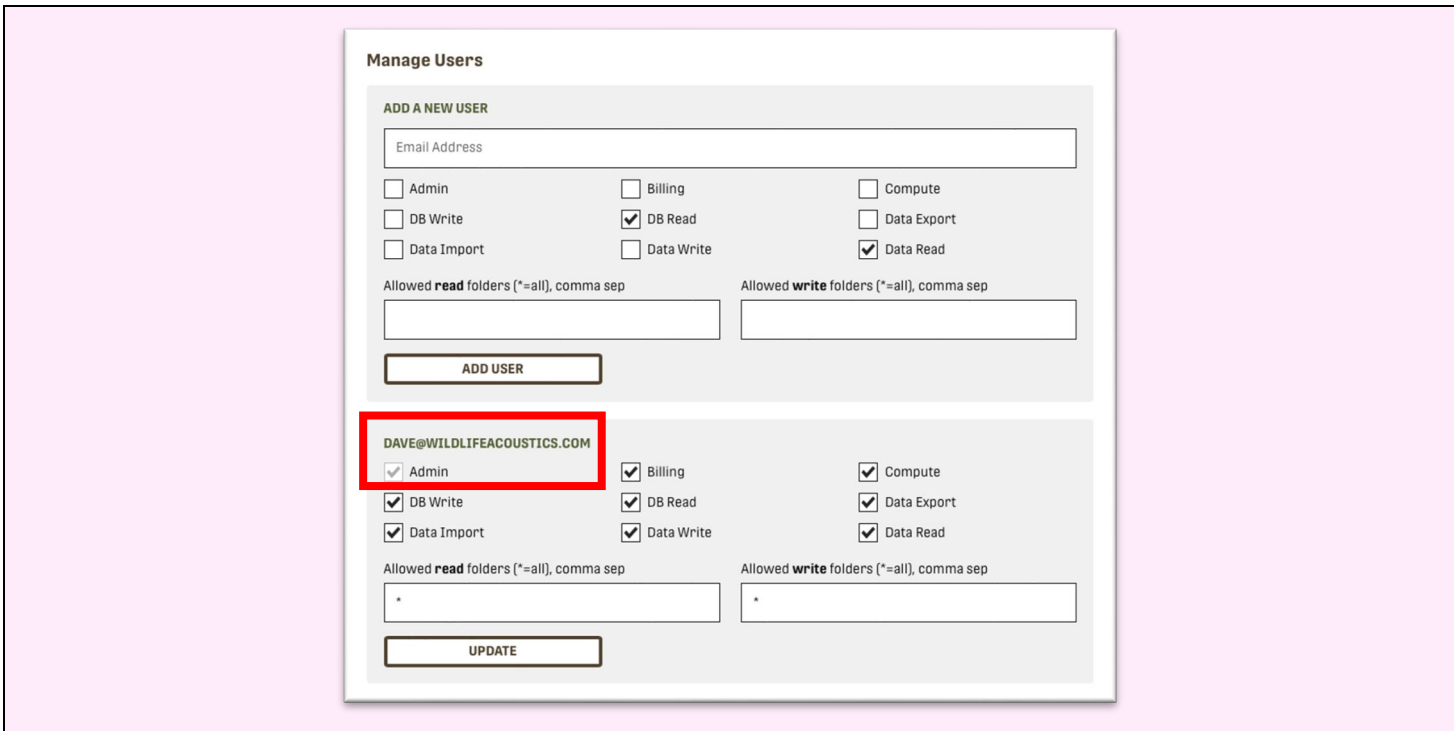
The Managed Cloud Account will not be available within Kaleidoscope Pro unless there is payment information on file.

- Click on the Bill/Ship Profiles tab on the left.
 - Click Add a New Payment Method.
 - It is possible to have multiple credit cards on file for the User Web Account.
 - Once there is payment information on file, select a payment method and press the Update button.
 - This will apply the selected payment method to this Managed Cloud Account.



Manage Users

A Wildlife Acoustics Managed Cloud Account is initially administered by the User who creates the account.



- By default, an Administrator has access to all features of the Managed Cloud Account.
- It is possible for a single Managed Cloud Account to have multiple Administrators.
- The Administrator can invite Guest Users to access the Managed Cloud Account.
 - The Administrator controls permissions for Guest Users.

- A Guest User can be granted Administrator permissions.
- To add a Guest User, type in the email and press the Add User button.
 - If the Guest User already has a Wildlife Acoustics Web Account, the Managed Cloud Account will now be visible in their Web Account.
 - The Guest User will be able to log in to the Managed Cloud Account from Kaleidoscope Pro.
- If the Guest User does not yet have a Wildlife Acoustics Web Account, they will receive an email inviting them to create an account so they can access that account on line and then through Kaleidoscope Pro.
- When a User who does not have Admin permissions accesses the Managed Cloud Account, they will not see the options to invite other Users or to change permissions .
- The Guest User 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.

Compute Jobs							
JOB ID	BATCH LABEL	CREATED	STARTED	FINISHED	PROGRESS MESSAGE	%	CANCELED
227		2020-07-23 14:30:19 dave@wildlifeacoustics.com	2020-07-23 14:31:32	2020-07-23 14:31:42 (00:00:10)	Batch size: 250 files 0.547 GB Inputs: 0 wav 250 wav 0 zc Outputs: 0 wav (0 scrubbed) 0 zc (0 scrubbed) Ids: 185 classified 65 unknown 0 noise	100	

- A User with Admin permissions will see all compute jobs which have been run on the Managed Cloud Account.
 - A non-Admin User will only see jobs that User has run.
 - 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 which have been run on the cloud account.
- 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.

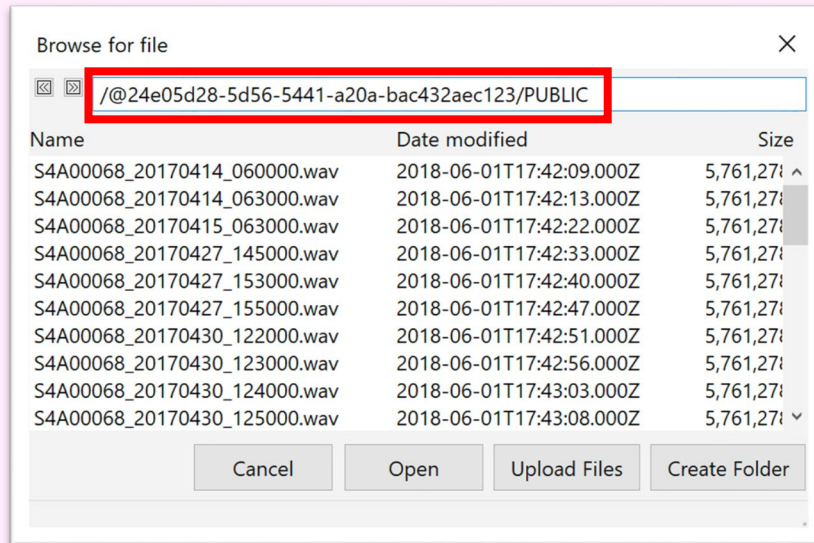
UUID

A Wildlife Acoustics Managed Cloud Account has a common name and a UUID.

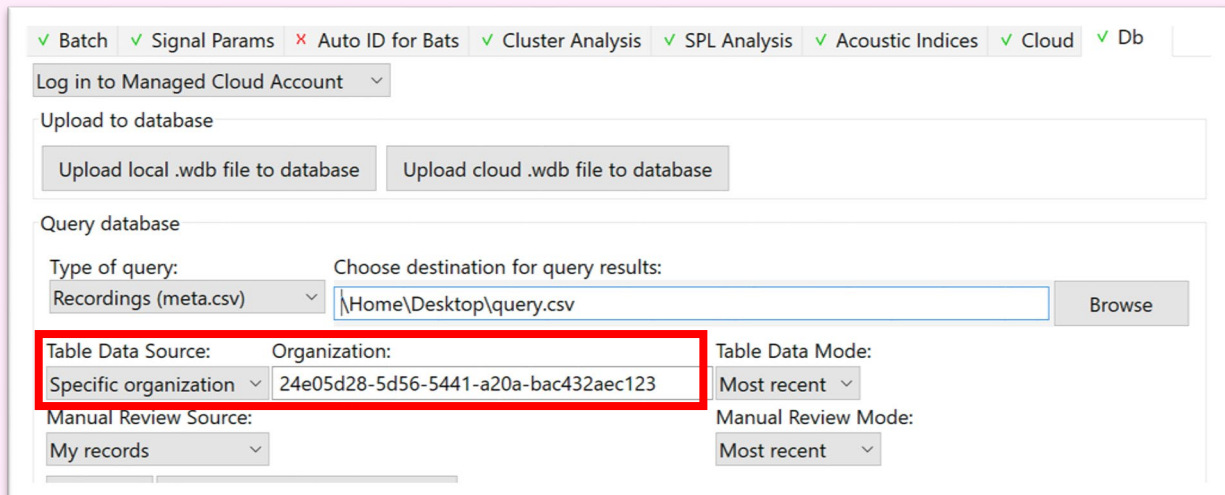
- The UUID is the Internet address for the cloud account.
- The UUID for the Managed Cloud Account is visible in the Users' WildlifeAcoustics.com web account.

Manage Cloud Accounts	
NAME	UUID
Dave World	24e05d28-5d56-5441-a20a-bac432aec123

- The UUID can be used in the Managed Cloud Account file browser to see public folders of different organizations.
 - This provides read-only access to the PUBLIC folder in the remote account.
 - In the cloud File Browser, type `/@` followed by the remote **UUID**, and then `/PUBLIC`.
 - Press the Return key to enter the remote PUBLIC folder.



- The UUID address can be entered into the table Data Source field under the Db **tab** in Kaleidoscope Pro for a Specific Organization.
 - This allows a Kaleidoscope Pro User to include other organizations in database queries.



8.10 PostgreSQL Server Database

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

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

- Install PostgreSQL server version 9.6 or higher .
- Create a new database and give it a name.

Example: "KaleidoscopePro".

- Create a role/user for the database with a password.
- In Kaleidoscope Pro:
 - Choose a MetaForm to use to define the Database Fields, or use the built-in default MetaForm
 - Run a dummy batch job on an empty Input Directory. This will create a db-batch.wdb file in the Output Directory which will contain no actual database records, but defines the structure of the database.
 - From the DB tab, select "Log in to user managed PostgreSQL".
 - Create a PostgreSQL Connect string.

Example: host=hostname user=username sslmode=require dbname=KaleidoscopePro

- In order to create Database tables, prepend this connect string with the word "CREATE".
- For example: CREATEhost=hostname user=username sslmode=require dbname=KaleidoscopePro.
- Enter the password and click "Connect" to connect to the Database.
- Choose "Upload local .wdb file to Database" and upload the db-batch.wdb file created above.

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

Additional roles/users can be set up.

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.

8.11 Command Line Interface

Kaleidoscope Pro can be controlled via command lines and scripting. This is a specialized feature which 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 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 `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 which 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 wildlifacoustics.com/SCHEMA for details.

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

`--file-list filelist.txt`

Optional. Normally, the input files are determined from the `.ini` file Input Directory. With this option, you can override the list of files to be processed. The `filelist.txt` file should have a list of files with absolute path names, one per line.

`--Clusterfilter`

Optional. When scanning files for Clustering using Scan and Cluster recordings to create `Cluster.kcs` and `cluster.csv`, it is sometimes desirable to include only a subset of detections as determined from prior Clustering batches. When this option is specified, it must be used with the `--Clusterusecsv` option to specify a previously generated `cluster.csv` file. Only detections which correspond to entries in the `cluster.csv` file containing a non-blank MANUAL ID column entry will be included in the new round of Clustering.

--Clusterusecsv cluster.csv

Optional (but required with --Clusterfilter above) specifies the cluster.csv file to use for either the --Clusterfilter option above or for a batch scan using "Re-scan recordings and edited cluster.csv to create new Cluster.kcs with pairwise classifiers and cluster.csv". Note that if this option is not specified, the location of the cluster.csv to be used can be found in the .ini file instead.

Settings.INI Format

The settings.ini file is used by Kaleidoscope to Save settings. INI files represent parameter values organized into groups. A group name is indicated by square braces e.g. "[global]" on a line by itself and is followed by one or more parameters with field names and values indicated with "name=value" pairs, one on each line. This file can also be opened and examined in a text editor.

GROUP	PARAMETER	REQUIRED	DEFAULT	VALUES
global	mode	yes		0 = Bat Analysis Mode 1 = Non-Bat Analysis Mode
	threads	no	N cores + 1	Number of parallel threads to use
classifier	classifier	no		For bat auto-id, this is the base name of the Kaleidoscope classifier .zip file (without the .zip extension) for example "classifiers-Bats_of_North_America_4.3.0"
	roc	no	depends	0 = more sensitive 1 = balanced 2 = more accurate Default depends on classifier version loaded
	SPECIESCODE	no	0	0 = disabled 1 = enabled For each species code in the classifier
input	directory	yes		Absolute path of Input Directory
	drivelabel	no		Drive label for inputs
	subdirs	no	1	0 = do not scan subdirectories 1 = scan subdirectories
	gpsfuzz	no	0	0 = no fuzz Otherwise fuzz to precision specified
	MetaForm	yes	Default Project Form	
input/wac	enable	no	1	0 = do not scan WAC files 1 = scan WAC files
input/wav	enable	no	1	0 = do not scan WAV/W4V files 1 = scan WAV/W4V files
	te	no	0	0 = automatic time expansion 1 = time expansion factor 1 8 = time expansion factor 8 10 = time expansion factor 10 16 = time expansion factor 16 20 = time expansion factor 20
input/zc	Enable	no	0	0 = do not scan Zero-Crossing files 1 = scan Zero-Crossing files
output	directory	yes		Absolute path of Output Directory
	drivelabel	no		Drive label for outputs
	subdirs	no	0	0 = none 1 = create daily subdirectories in outputs 2 = create nightly subdirectories in outputs
	channelssel	yes	0	0 = process all input channels 1 = process only left input channel 2 = process only right channel
	max	no	0	0 = no maximum output file size >0 specify maximum file size in seconds, output files will be split into multiple files as necessary
	noise	No	2	0 = disable noise filtering

				1 = delete noise files 2 = move noise files to NOISE subfolder
output/wav	enable0	No	0	Bat Analysis 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 bandpass 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)
Cluster	mode	No	0	Clustering mode

				0 = disabled 1 = simple Clustering 2 = advanced Clustering 3 = scan using existing Cluster.kcs 4 = detect vocalizations without Clustering
	read	No		Path to input cluster.kcs file when scanning using existing cluster.kcsn
	read2	No		Path to input cluster.csv file when building Advanced Classifiers (can be overridden with --Clusterusecsv command line argument)
	window mode	No	1	0 = 2.67 ms 1 = 5.33 ms 2 = 10.67 ms 3 = 21.33 ms
	maxstates	No	12	Maximum number of states in model
SPL	enabled	No	0	SPL analysis 0 = disabled 1 = enabled
	period	No	60	Measurement period (minutes)
	min	No	0	0 = do not output minimum values 1 = output minimum values
	max	No	0	0 = do not output maximum values 1 = output maximum values
	mean	No	1	0 = do not output mean values 1 = output mean values
	selcum	No	0	0 = do not output SELcum values 1 = output SELcum values
	AdjdB	No	0	Additional dB adjustment value
	Selon	No	12	SELcum onset trigger level (dB)
	Seloff	No	3	SELcum offset trigger level (dB)
	BANDLABEL	No	0	Various band labels as they appear in the graphical interface with spaces changed to underscores and slashes changed to hyphens. 0 = disabled 1 = enabled
bioindex	enable	yes	0	0 = disabled 1 = enabled
Bioindex/ndsi	enable	no	0	0 = disabled 1 = enabled
	fftbits	no	10	6 = 64 7 = 128 8 = 256 9 = 512 10 = 1024 11 = 2048 12 = 4096
	anthromin	no	1000	Anthrophony frequency minimum
	anthromax	no	2000	Anthrophony frequency maximum
	binmin	no	2000	Biophony frequency minimum
	biomax	no	8000	Biophony frequency maximum
bioindex/aci	enable	no	0	0 = disabled 1 = enabled
	fftbits	no	9	6 = 64

				7 = 128 8 = 256 9 = 512 10 = 1024 11 = 2048 12 = 4096
	fmin	no	0	Frequency minimum
	fmax	no	0	Frequency maximum
	j	no	0	J (s), or zero for continuous
bioindex/adi	enable adi	no	0	0 = disabled 1 = enabled
	enable aei	no	0	0 = disabled 1 = enabled
	fmax	no	10000	Frequency maximum
	fstep	no	1000	Frequency step
	thold	no	-50	Threshold (dB fs)
bioindex/bio	enable	no	0	0 = disabled 1 = enabled
	fftbits	no	9	6 = 64 7 = 128 8 = 256 9 = 512 10 = 1024 11 = 2048 12 = 4096
	fmin	no	2000	Frequency minimum
	fmax	no	8000	Frequency maximum
bioindex/spec	enable_mean	no	0	0 = disabled 1 = enabled
	enable_sd	no	0	0 = disabled 1 = enabled
	enable_sem	no	0	0 = disabled 1 = enabled
	enable_median	no	0	0 = disabled 1 = enabled
	enable_mode	no	0	0 = disabled 1 = enabled
	enable_q25	no	0	0 = disabled 1 = enabled
	enable_q75	no	0	0 = disabled 1 = enabled
	enable_irq	no	0	0 = disabled 1 = enabled
	enable_skew	no	0	0 = disabled 1 = enabled
	enable_kurt	no	0	0 = disabled 1 = enabled
	enable_sfm	no	0	0 = disabled 1 = enabled

	enable_sh	no	0	0 = disabled 1 = enabled
	fftbits	no	9	6 = 64 7 = 128 8 = 256 9 = 512 10 = 1024 11 = 2048 12 = 4096
	fmin	no	0	Frequency minimum
	fmax	no	0	Frequency maximum
bioindex/qut	enable_bgn	no	0	0 = disabled 1 = enabled
	enable_snr	no	0	0 = disabled 1 = enabled
	enable_act	no	0	0 = disabled 1 = enabled
	enable_evn	no	0	0 = disabled 1 = enabled
	enable_lfc	no	0	0 = disabled 1 = enabled
	enable_mfc	no	0	0 = disabled 1 = enabled
	enable_hfc	no	0	0 = disabled 1 = enabled
	enable_cent	no	0	0 = disabled 1 = enabled
	fftbits	no	9	6 = 64 7 = 128 8 = 256 9 = 512 10 = 1024 11 = 2048 12 = 4096
	threshold	no	6	threshold (dB)

8.12 Glossary

- **Bandpass 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 bandpass filter to playback of the signal. The bandpass filter will only allow signals within the selected frequency range to be played.

- **Bat Pass**

A bat pass is typically a sequence of call pulses.

- **Batch Process**

Kaleidoscope can convert and analyze multiple files with a single operation. This is known as a batch process. Kaleidoscope can run multiple batch process functions in parallel to take full advantage of multi-core CPUs.

- **Cluster**

A Cluster describes a pattern based on the average of multiple similar patterns found in the data. Patterns which are most similar to the average are closest to the cluster center. As a detected signal is less similar, it is described as being further away from the cluster center.
- **CSV**

CSV stands for Comma Separated Values. CSV is a document format. The information in the document is arranged in a way that a spreadsheet application (such as Microsoft Excel) can open the document and display the information in columns and rows. Kaleidoscope creates different types of CSV documents to represent the results from batch processes. The intention is that results from Kaleidoscope batch processes are to be initially viewed in a spreadsheet.
- **Database**

When Kaleidoscope Pro is used to access a Managed Cloud Account, the results of batch processes can be used to create a database. The database is part of the Managed Cloud Account. Kaleidoscope Pro can create queries to search the database. Kaleidoscope Pro can also include other users and organizations in the query, dependent on file and database permissions.
- **Detected Signal**

The Signal Params tab provides parameters for finding detected signals within audio files. A detected signal is information within an input file which has passed the conditions under the Signal Params tab.
- **Fuzz GPS to Precision**

GPS location information can be embedded in full-spectrum and Zero-Crossing files at the time of recording. Kaleidoscope can pass the GPS information through to output. Kaleidoscope can also alter the GPS data to make the recording location less specific. Under the Batch tab the Fuzz GPS to Precision parameter allows the user to specify the resolution of the GPS data which is provided on output.
- **File Compression**

Full-spectrum files can be compressed to smaller file sizes within output batches. Compressed files can then be reopened to provide the original content. Compressing a full-spectrum file can result in loss of signal fidelity. Higher compression percentages result in smaller files but with more loss of fidelity.

Kaleidoscope can also convert compressed input files to standard uncompressed WAV files.

The type of file compression used is Wildlife Acoustics "W4V" compression which can provide extremely high fidelity with a 2:1 compression ratio, and some compromise in fidelity at higher compression ratios up to 4:1.
- **FFT**

FFT stands for Fast Fourier Transform. FFT is a mathematical technique used to analyze an audio recording. The results of the FFT analysis are used to create a spectrogram view of the audio signal. FFT information is also used internally by Kaleidoscope for analysis of signals during a batch process.
- **Full-Spectrum**

Full-spectrum describes an audio recording that includes both frequency and amplitude information. A full-spectrum file can be examined in the spectrogram within the Viewer. Time is represented on a left to right axis. Frequency is represented on a top to bottom axis. Amplitude is represented by color intensity of the displayed signal.
- **GUANO**

GUANO is a commonly used standard for metadata stored in full-spectrum and Zero-Crossing files. Kaleidoscope supports reading and writing of GUANO format metadata.
- **JSON**

JSON is an acronym for JavaScript Object Notation. JSON is a standard for storing information. JSON is used Kaleidoscope Pro can store and recall database query specifications via a JSON formatted file. When a database query is run from within Kaleidoscope Pro, a query.json file is created. The query.json file can be reloaded under the Db tab.
- **KML**

KML is an acronym for Keyhole Markup Language. **KML** is an international standard maintained by the Open Geospatial Consortium, Inc. **KML** is a file format used to display geographic data in an Earth browser such as Google Earth. Kaleidoscope can create a gps.kml output file based on GPS metadata extracted from full-spectrum and Zero-Crossing files.

- **Managed Cloud Account**

Kaleidoscope Pro can access a cloud account for data storage. A Wildlife Acoustics Managed Cloud Account provides additional features including database searching and cloud-based computing.
- **Metadata**

Metadata is additional information stored in a full-spectrum or Zero-Crossing file or in a database. Metadata can include information generated when the recording was made. Metadata can include information added after the recording is made.
- **Narrow-Band**

An audio signal can be a pure tone or it can contain content at multiple frequencies. Narrow-band refers to a signal or parameter which describes a single frequency at any given time. A Zero-Crossing file can only represent one frequency at a time so a Zero-Crossing file represents narrow-band information.
- **Noise**

When an Auto-ID for Bats batch process is run, input files are examined for Signals of Interest. If an input file does not meet the conditions specified under the Signal Params tab, it is labelled as a noise file.

Kaleidoscope Pro can also examine full-spectrum audio for measuring overall signal levels using various standard weightings such as A-weighted or third-octave bands. This is done by running a Noise Analysis batch process. The input file will be analyzed for content based on the settings under the Noise Analysis tab.
- **Pairwise Classifier**

A pairwise classifier is a function within an Advanced Classifier which has been created for cluster analysis. A pairwise-classifier compares detected signals using manual identifications that discriminate between what is and what is not a Signal of Interest.
- **Phrase**

This term is typically used to describe bird vocalizations. A phrase is a series of syllables.
- **Project Form**

The project form is found under the Batch tab. The project form is used to edit and embed metadata into output files. The project form is customizable to allow addition of custom metadata fields.
- **Pulse**

This term is typically used when describing bat vocalizations. A single pulse is also known as a bat call. Multiple pulses make up a pulse sequence. A detected signal could be comprised of a single pulse or a sequence of pulses.
- **Pulse Sequence**

A bat vocalization is often made up of a series of pulses. The series of pulses in a single bat pass is described as a pulse sequence.
- **query.json**

Kaleidoscope Pro can store and recall database query specifications via a JSON formatted file. When a database query is run from within Kaleidoscope Pro, a query.json file is created. The query.json file can be reloaded under the Db tab for immediate recall or query settings. The loaded query settings can then be modified as needed.
- **Sample Rate**

In order to digitally record an audio signal, the original analog oscillogram is examined and described as a series of samples. The sample rate is how many samples are taken of the oscillogram per second. The sample rate must be double the highest frequency to be recorded. Therefore, in order to record an oscillogram of 20 kHz for example, a sample rate of at least 40 kHz would be required.
- **Spectrogram**

A spectrogram is a visual representation of the spectrum of frequencies of sound or other signal as they vary with time. A spectrogram displays broad-band frequency content and amplitude over time.
- **SPL**

Sound Pressure Level. Kaleidoscope Pro can examine full-spectrum audio for measuring overall signal levels using various standard weightings such as A-weighted or third-octave bands. This is done by running an SPL Analysis batch process. The input file will be analyzed for content based on the settings under the SPL Analysis tab.

- **Signal of Interest**

Signal of Interest is used as a general term to describe something specific the user wants to find or analyze.
- **Syllable**

This term is typically used when describing non-bat vocalizations. Multiple syllables make up a phrase. A detected signal could include a single syllable or a phrase of syllables.
- **Time Expansion**

Time Expansion describes a legacy technique where ultrasonic information is first captured and then stored at a lower sample rate. No information is lost but the slowed down data can now be stored on older recording devices that do not support ultrasonic sample rates. A time expanded recording can then be restored to its original sample rate within Kaleidoscope Pro.
- **Trigger**

A recording device can be configured to go into record mode when it senses a signal. This is called a triggered recording. Typically bat recordings are made when the recorder is triggered by an ultrasonic signal. When the signal is no longer present for a specified time the recording device will stop recording. This means triggered recordings are more likely to be short and contain a specific vocalization.

When triggered recordings are made with current generation Wildlife Acoustics SM4 recorder, those recordings are created as separate WAV files. The older model Wildlife Acoustics SM2 and SM3 recorders can create individually triggered WAV files or they can create WAC files which contain multiple triggered recordings. WAC files are a proprietary Wildlife Acoustics format. These files can only be used within Kaleidoscope.
- **Vocalization**

This is a general term used to describe an utterance made by a single species.
- **Oscillogram**

An audio signal can be represented as amplitude over time. An oscillogram display does not include frequency information. The Viewer displays both oscillogram and spectrogram images of full-spectrum recordings. A Zero-Crossing recording does not contain any amplitude information and therefore cannot be displayed as an oscillogram.
- **Wideband**

An audio signal can be a pure tone or it can contain content at multiple frequencies. A wideband signal or detection parameter can include signal multiple frequencies at the same time. An example of a wideband signal is a fundamental with harmonics. A full-spectrum recording is a wideband recording. A Zero-Crossing recording cannot contain wideband information.
- **Zero-Crossing**

When doing ultrasonic recording, the file can contain full-spectrum data or it can contain only Zero-Crossing information. Zero-Crossing information describes a present signal and its dominant frequency over time. A Zero-Crossing file does not contain any amplitude information and therefore does not contain any information about harmonics or broad-band signals.

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Updated: June 6, 2018

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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.

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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/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. 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.

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YOU AGREE THAT YOU SHALL BE RESPONSIBLE FOR AND SHALL DEFEND, INDEMNIFY, AND HOLD HARMLESS WAI AND ITS EMPLOYEES, AFFILIATES, SUPPLIERS, AGENTS AND CONTRACTORS AND SHALL REIMBURSE US FOR ANY DAMAGES, LOSSES OR EXPENSES (INCLUDING WITHOUT LIMITATION, REASONABLE ATTORNEYS' FEES AND COSTS) INCURRED BY US IN CONNECTION WITH ANY CLAIMS, SUITS, JUDGMENTS, AND CAUSES OF ACTION ARISING OUT OF (a) YOUR USE OF THE SERVICES OR SOFTWARE; (b) VIOLATION OR INFRINGEMENT OF CONTRACTUAL RIGHTS, PRIVACY, CONFIDENTIALITY, COPYRIGHT, PATENT, TRADEMARK, TRADE SECRET, OR OTHER INTELLECTUAL PROPERTY AND PROPRIETARY RIGHTS ARISING FROM YOUR USE OF THE SERVICE OR ANY UNAUTHORIZED APPARATUS OR SYSTEM; AND (c) YOUR BREACH OF ANY PROVISION OF THIS AGREEMENT.

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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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Survival of Terms. The provisions of paragraphs 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14 (and any other provision which so indicates) as well as the introductory paragraphs shall survive termination of this Agreement.

Addendum A

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md5c (RSA Data Security, Inc. MD5 Message-Digest Algorithm)

<http://www.ietf.org/rfc/rfc1321.txt>

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Wildlife Acoustics, Inc.

3 Mill and Main Place, Suite 110

Maynard, MA 01754 USA

(978) 369-5225 or toll-free in the U.S. (888) 733-0200

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