BATscreen

for Windows XP / Vista / 7 / 8 / 8.1 / 10

USER MANUAL

bat bio acoustic technology

Version: 2.1.1

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CONTENT

1. Introduction

BATscreen is a powerful and easy to use tool for the analysis and classification of bat call files.

Files recorded with BATmode-Systems or other systems utilizing ultrasonic recording hardware of Avisoft Bioacoustics as well as files produced by the batcorder of ecoobs are displayed as spectrograms in the main window of the application. Multiple markers, zooming tools, power density spectra as well as adjustable audio playback enable the user to identify bat calls and assign them to different bat species.

Since long-term acoustic monitoring of bat activity on wind turbines produces a lot of data, the application focuses on a fast and intuitive visualization and classification of the recorded files. Evaluated bat data can be exported in ProBat compatible files, to allow a fast and easy calculation of shutdown times and cut-off wind speeds.

2. Hard- and Software Requirements

To run the software a Windows™ XP/Vista/7/8/8.1/10 PC with at least 8 GB RAM and about 50 MB free hard-disk space is required.

3. Supported Files

BATscreen supports ".wav" and ".raw" files, which are recorded with the BATmode-System or other recordings hardware of Avisoft Bioacoustics as well as with the batcorder of ecoobs. Since spectrogram calculation is memory extensive, file length is limited to 120s for a sampling rate of 300 000Hz.

4. Installation

To install the software, run the installation program either from the supplied USB flash drive (Setup_BATscreenXX_X.X.X.exe) or the website of bat bioacoustictechnology (www.bioacoustictechnology.de).

While BATscreen LITE is licensed as shareware, no license key is necessary. However, please be aware that BATscreen LITE only provides limited functionality. To use all features please purchase BATscreen PRO.

To install BATscreen PRO (either single or volume license) a license key is necessary in the installation procedure. Please be aware that the single license key is only valid for one pc system, for use by one person.

Free software updates that provide bug fixes and improved functionality are available from www.bioacoustictechnology.de.

5. Getting Started

The following procedure describes the basic visualization of recorded bat call files:

- Start BATscreen

- Select the file/folder that you want to visualize either by menu option FILE -> OPEN FILE or FILE -> OPEN FOLDER (see Figure 1).

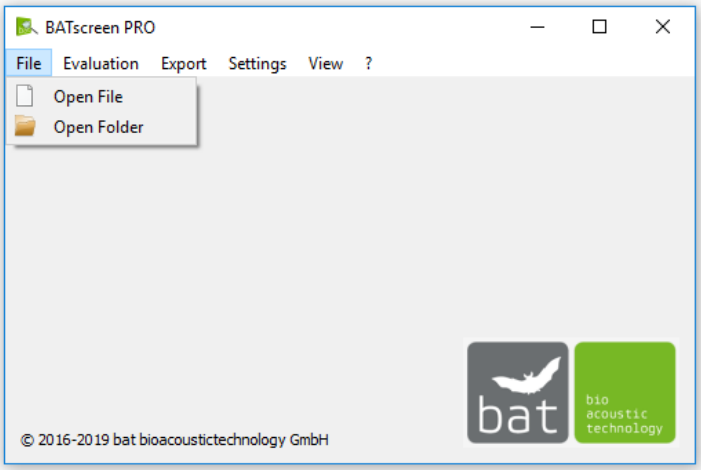

Figure 1: Start Window

Optionally, you can also use “drag & drop” to visualize a file/folder you choose in the explorer.

- After spectrogram calculation, the file or first file in a folder is visualized in the main window Area (see Figure 2). The upper plot shows the normalized amplitude envelope of the time signal, the lower left one the power density spectrum and the lower right plot the corresponding spectrogram. If a folder with multiple bat call files was selected, a list of all files is shown below the Main Window Area. You can open a file by double clicking on the desired list entry, using the arrow keys of the keyboard or the two arrows buttons right next to the file list.

- To zoom in, span a rectangular around the area you want to enlarge in the spectrogram by using the left mouse button. The depicted time and frequency period is marked in the upper x-axis and lower left y-axis plot, respectively.

- To zoom out, click on the right mouse button.

- To start the audio playback of the opened file, please use the audio control buttons in the upper left corner.

6. Main Window Area

The Main Window Area shows in the top line audio playback controls, cursor selection buttons and a file information section (see Figure 2). Below, you find the plot area. It consists of the main spectrogram plot as well as a corresponding x-axis plot above the spectrogram and a y-axis plot on the left of the spectrogram. Furthermore, you find two frequency markers within the spectrogram.

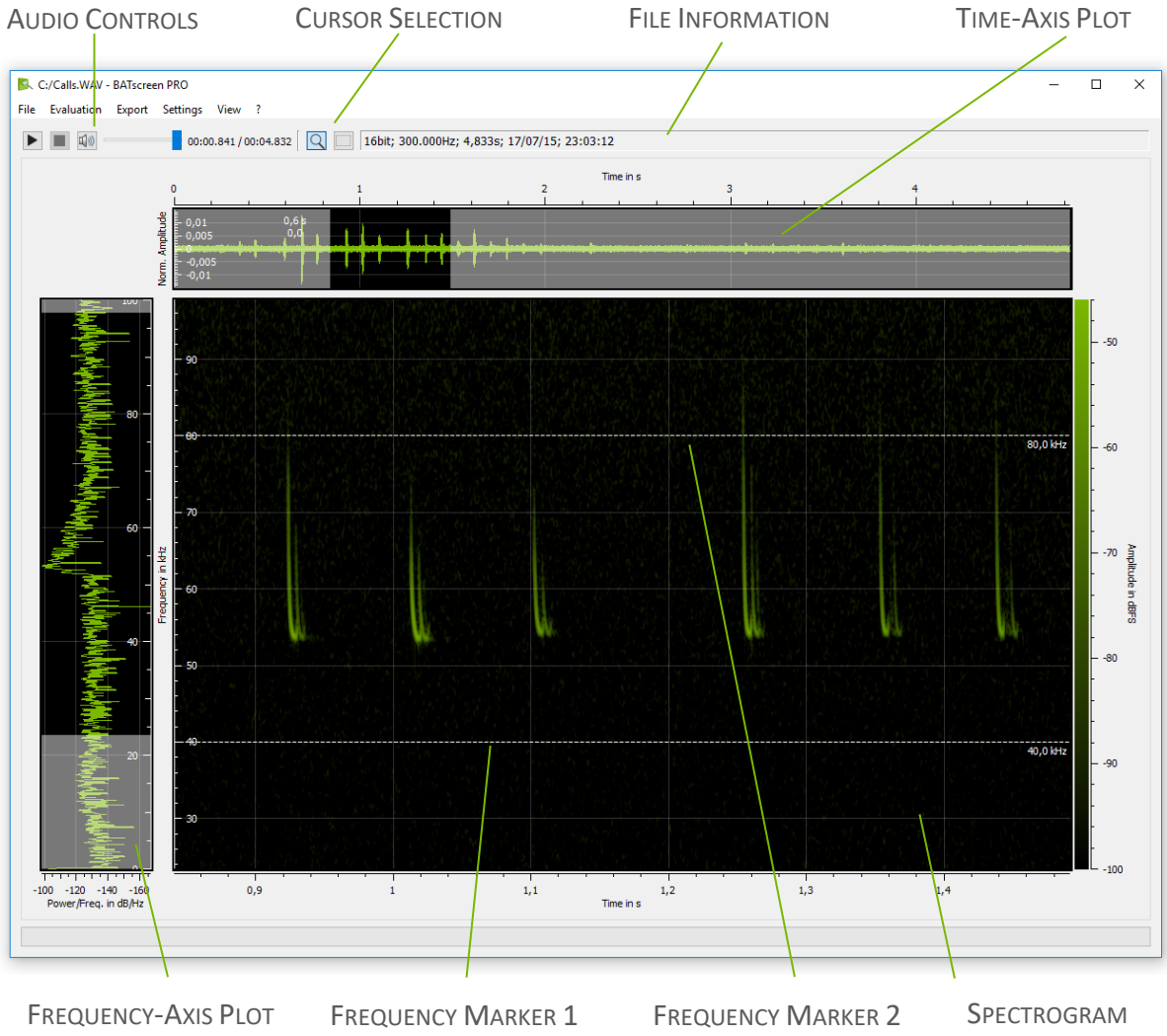

Figure 2: Main Window Area

Audio Controls

Press the ▶ button to play the current loaded file. Use ⏸ to pause and ■ to stop playback. The volume can be adjusted or muted by the slider or the 🔊 button, respectively.

To change the playback rate, set undersampling or configure a frequency mixer please use the menu SETTINGS -> AUDIO SETTINGS.

Cursor Selection

For a detailed inspection of the spectrogram, you can either use zooming or marking of interesting areas.

If the  button is selected, span a rectangular around the area you want to enlarge by using the left mouse button. To zoom out, click on the right mouse button.

If the  button is selected, span a rectangular around the area you want to mark by using the left mouse button. The time and frequency range as well as the start and stop point of the marked area are depicted next to the rectangular (see Figure 3). Use the mouse to adjust the rectangular by “drag & drop” mechanism. To delete the rectangular, press the right mouse button.

To use the marking option, when the zooming cursor is enabled, you can also span a rectangular by using the left mouse button and simultaneously pressing the <Shift>-key instead of selecting the marking cursor. To delete the rectangular, press the <Esc>-key.

To use the zooming option, when the marking cursor is enabled, you can also span a zooming rectangular by using the left mouse button and simultaneously pressing the <Shift>-key instead of selecting the zooming cursor. To zoom out, press the <Esc>-key.

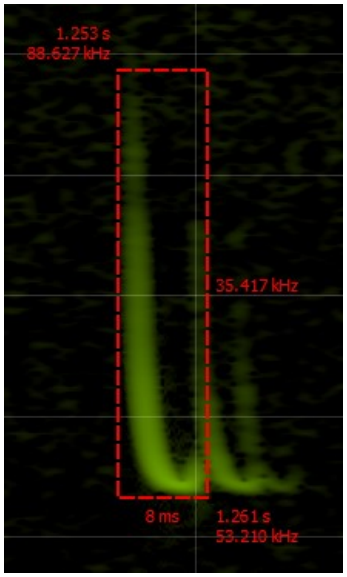

Figure 3: Marked rectangular in spectrogram

File Information

In the file information section, you find the resolution, the sample rate, the length, the recording date and the recording time of the current loaded file. Furthermore, the in the wav-header saved, manually assigned classifications as well as the user comment are shown.

Time-Axis-Plot

The Time-Axis Plot depicts various file information, which are plotted vs. the time axis.

To change the plot type use the menu SETTINGS -> AXIS PLOTS SETTINGS.

Frequency-Axis-Plot

The Frequency-Axis Plot depicts various file information, which are plotted vs. the frequency axis.

To change the plot type use the menu SETTINGS -> AXIS PLOTS SETTINGS.

Spectrogram

The spectrogram displays multiple short time signal spectra. Each spectrum is placed as vertical single line next to the previous one. By this, the vertical axis becomes the frequency scale and the amplitude information of the spectrum is converted to color, or intensity for the single line. By placing multiple short time spectra next to each other, the display horizontal axis becomes the “time axis”, and the three dimensions of the signal are all visible (Frequency, Amplitude, Time).

Frequency Markers

Three frequency markers as dotted horizontal lines allow marking specific discrete frequencies. The markers can be adjusted interactively by using the mouse and “drag & drop” mechanism or by setting the frequencies in the spectrogram settings dialog.

7. File Menu

To open a new file select OPEN FILE in the FILE menu. To open a new folder select OPEN FOLDER.

Optionally, you can also use “drag & drop” mechanism to visualize a file/folder you choose in the explorer.

If a folder was selected, a list of all supported files in the folder is shown below the Main Window Area (see Figure 4). You can open a file by double clicking on the desired list entry, using the <Left> and <Right> arrow keys of the keyboard or the two arrow buttons ▲ and ▼ on the right of the file list (supported files see Chapter 3). Subsequently, the header information of all files is loaded in the list. The progress bar right next to the list gives you feedback of how many files the header is already loaded.

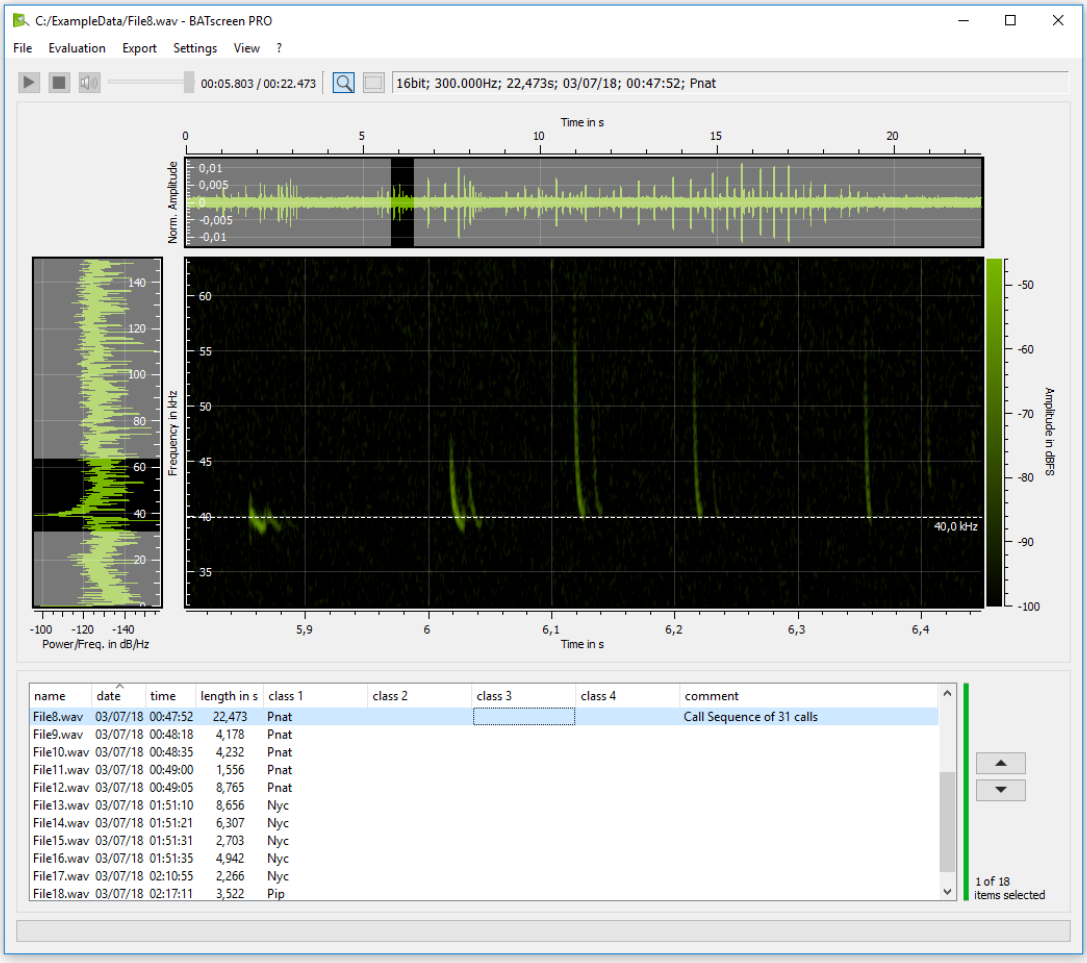

Figure 4: Open Folder Window

8. Evaluation Menu

Manual Folder Evaluation

To start the manual evaluation and classification of bat call files with your own classification model, select MANUAL FOLDER EVALUATION. Read Chapter 12 for further information about the manual evaluation and classification procedure.

Manual Review of RECORDER WEA Offline Analysis

Since version 4.2.28, which was released on the 10th December 2018, the Avisoft-RECORDER USGH software of Avisoft Bioacoustics includes the so-called *WEA Offline Analysis* configuration preset. This offline analysis preset was developed and defined in the research project RENEBAT III and enables a standardized automated post-recording step for the evaluation of bat call files recorded with the BATmode or any other hardware based on the UltraSoundGate of Avisoft Bioacoustics. It detects noise-triggered files and if possible assign bat calls to specific bat species. By this, the manual evaluation in BATscreen before importing the dataset into the PROBAT software can be shorted significantly.

For more information on the automated WEA Offline Analysis with the software Avisoft-RECORDER USGH, please read the manual of the Avisoft-RECORDER USGH software.

To start the manual review of data, which was already analyzed with the automated RECORDER WEA Offline Analysis, please press EVALUATION -> MANUAL REVIEW OF RECORDER WEA OFFLINE ANALYSIS.

Read Chapter 13 for further information about the WEA Offline Analysis with Avisoft-RECORDER USGH and the manual review with BATscreen PRO.

Activity Plots

In many cases, plots can help to detect correlations in large datasets. The ACTIVITY PLOTS feature of BATscreen allows correlating a dataset of bat call files to different parameters, like nighttime, month, temperature, wind speed or precipitation. Please read Chapter 14 for further information about the ACTIVITY PLOTS feature.

To start the ACTIVITY PLOTS feature the headers of all files in the evaluation folder has to be loaded to the list view. Please wait until the green progress bar right next to the list completes.

9. Export Menu

Export Time Axis Plot

To export the current time axis plot select EXPORT -> EXPORT TIME AXIS PLOT.

Supported export formats are:

- Vector graphics: pdf, svg and ps.
- Images: bmp, jpg, jpeg, pbm, pgm, png, ppm, xbm and xpm.

Export Frequency Axis Plot

To export the current time axis plot select EXPORT -> EXPORT FREQUENCY AXIS PLOT.

Supported export formats are:

- Vector graphics: pdf, svg and ps.
- Images: bmp, jpg, jpeg, pbm, pgm, png, ppm, xbm and xpm.

Export Spectrogram

To export the spectrogram select EXPORT -> EXPORT SPECTROGRAM PLOT.

Supported export formats are:

- Vector graphics: pdf, svg and ps.
- Images: bmp, jpg, jpeg, pbm, pgm, png, ppm, xbm and xpm.

Export CSV File

To export your current loaded files and examination as CSV (comma-separated values) file, click EXPORT -> EXPORT CSV FILE.

In the EXPORT CSV FILE dialog check all classes, which should be included in the exported CSV file. All files, which are assigned to at least one checked class, are included in the export file.

Set the TIME SETTINGS since this information is needed to calculate the OUTPUT OF CLASS EVENTS.

OUTPUT OF CLASS EVENTS

A class event is triggered when the recording start time of at least on recorded file is within a specific time interval (1min/5min/10min). No other files with recording start times within this time interval will trigger an additional class event. The time intervals can be either static or dynamic. Static time intervals are fixed intervals in relation to the time of day, e.g. from 12:05:00 – 12:09:59 (5min interval) or from 17:30:00 – 17:30:59 (1min interval). Dynamic time intervals start at the recording start time of the class event-triggering file. This means, if the recording start time of a class event-triggering file is at 20:22:45 the time interval for a 10 min dynamic interval is 20:22:45 – 20:32:44. To include an additional column, with for example the 1min class event, in the exported CSV-file, please enable the respective checkbox. Class events are calculated separately for each assigned class. If a file triggers a class event, the triggering class is included in the respective class event column. If several assigned classes of

a file triggers a class event, they are inserted in the column separated by commas. Table 1 depicts an example for an exported CSV file with static and dynamic 5min class events.

Table 1: Sample of CSV Export with different class events

FileName	Date	Time	Class1	Class2	5min class event (static)	5min class event (dynamic)
File1.wav	23.11.2017	16:25:30	Nyc	Pip	Nyc, Pip	Nyc, Pip
File2.wav	23.11.2017	16:28:38	Nyc			
File3.wav	23.11.2017	16:30:25	Nyc		Nyc	
File4.wav	23.11.2017	16:32:07	Nyc	Pip	Pip	Nyc, Pip
File5.wav	23.11.2017	16:32:34	Nyc			
File6.wav	23.11.2017	16:35:03	Nyc	Pip	Nyc, Pip	

To start the EXPORT CSV FILE functionality the headers of all files in the evaluation folder has to be loaded to the list view. Please wait until the green progress bar right next to the list completes.

A CSV file can be opened and edited with Microsoft Excel or other spreadsheets.

Export ProBat File

To export your current loaded files and examination as ProBat compatible file click EXPORT -> EXPORT PROBAT FILE. In the EXPORT PROBAT FILE dialog (see Figure 5), check all classes, which should be included in the export file. Since ProBat considers all included classes in the export file as bat calls, all noise and no call classes have to be unchecked. This is only necessary for the export of a ProBat file when you are using MANUAL FOLDER EVALUATION. When evaluating a folder with the MANUAL REVIEW OF RECORDER WEA OFFLINE ANALYSIS you do not have to check or uncheck the desired classes.

By selecting the appropriate time zone in which your data was recorded as well as if daylight saving was considered or not, all recording times of your files are adapted in the export file to UTC +02:00 (MESZ), the required time zone for ProBat.

For further information about the required data format of ProBat please read the documentation of ProBat (http://windbat.techfak.fau.de/tools/).

To start the EXPORT PROBAT FILE functionality the headers of all files in the evaluation folder has to be loaded to the list view. Please wait until the green progress bar right next to the list completes.

Since ProBat accepts only files, in which all data is recorded within one year, BATscreen will ask you to convert the timestamps of all data in the export file to one desired year, if multiple years are detected.

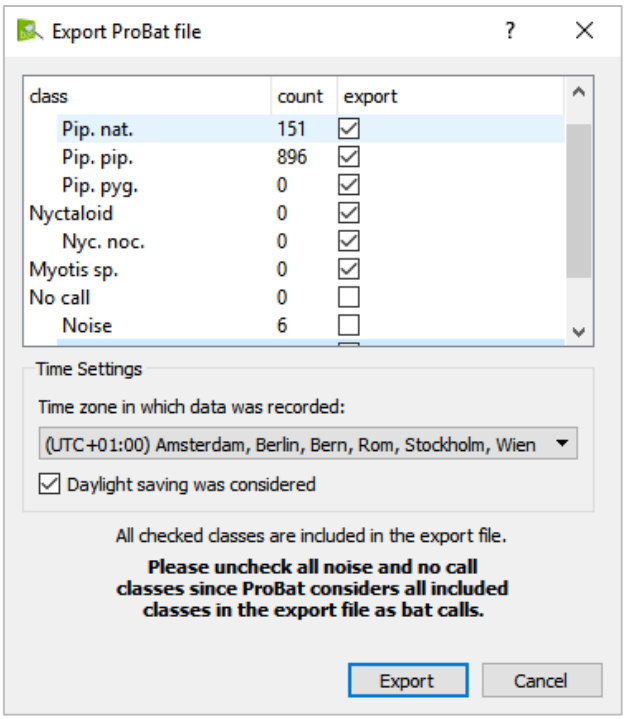

Figure 5: Export ProBat File Dialog

Copy Files to other Folder

To separate files assigned to different classes, it may be necessary to copy all files assigned to a specific class to another folder.

Click EXPORT -> COPY FILES TO OTHER FOLDER to select the new folder and open the COPY FILES TO OTHER FOLDER dialog. Files, which are assigned to at least one checked class, are copied to the selected new folder.

To start the COPY FILES TO OTHER FOLDER functionality the headers of all files in the evaluation folder has to be loaded to the list view. Please wait until the green progress bar right next to the list completes.

10. Settings Menu

Spectrogram Settings

The spectrogram settings allow adjusting the displayed spectrogram to get the most possible information about the sound signal.

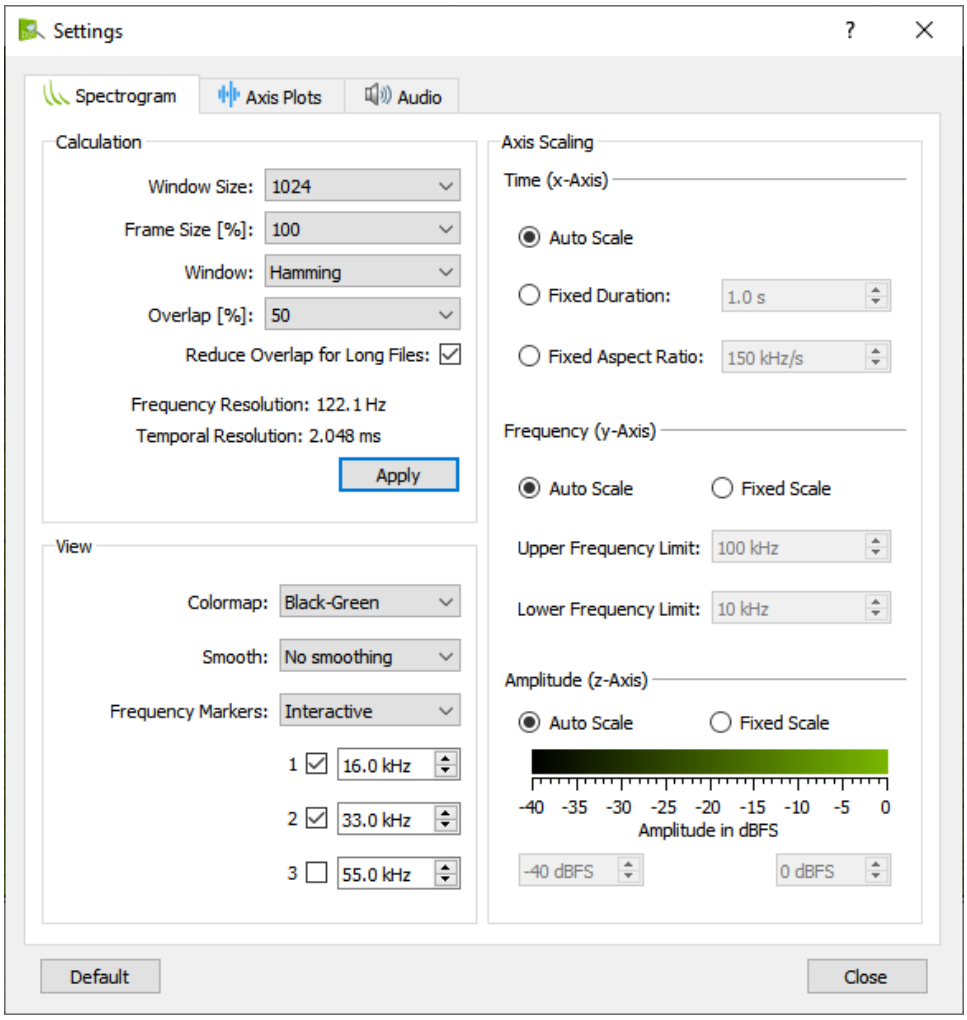

Figure 6: Spectrogram Settings

CALCULATION

The WINDOW SIZE determines the number of sample points used to calculate the short time spectra. Larger Window Sizes increase the frequency resolution of the spectrogram. However, temporal resolution is reduced, simultaneously.

The FRAME SIZE determines the percentage of the FFT length that is actually used for the spectrum computation (zero-padding). Low values will result in a higher time resolution. This is accompanied by lower frequency resolution. A frame size of 100% is recommended for normal applications.

The evaluation WINDOW determines the suppression of the unwanted spectrum distortion (so called “side lobes” that are associated with the analysis of stationary signals) and the analysis

bandwidth. The available window types are RECTANGLE, HAMMING, HANN, BLACKMAN, BARTLETT (triangle), FLATTOP and BLACKMAN-HARRIS. The FLATTOP or HAMMING windows provide the best results in most cases. The FLATTOP window provides a “flat top” band-pass filter characteristic that is ideal for taking precise magnitude measurements.

OVERLAP increases the temporal resolution of the spectrogram by overlapping the windows used for spectrum calculation. If you select a WINDOW SIZE of 1024 for example and an OVERLAP of 87.5%, the windows for the spectra calculation will overlap 896 sampling points. Since a larger OVERLAP goes along with a larger number of spectra that have to be computed, calculation time increases significantly.

REDUCE OVERLAP FOR LONG FILES automatically reduce the overlap for large files. By this, system memory usage is limited and memory exceptions are prevented. Unchecking this feature can cause program crashes.

The resulting FREQUENCY RESOLUTION as well as the TEMPORAL RESOLUTION, which equals the dimensions of a single spectrogram pixel, are depicted below the Calculation Settings.

Click APPLY to recalculate the spectrogram with your selected settings.

VIEW

To change the color map for spectrogram displaying, select your preferred color map in the dropdown menu COLOR MAP.

By enabling SMOOTHING the spectrogram will be smoothed with a Bilinear Interpolation between data points (pixels).

Frequency Markers can either be adjusted interactively using the mouse and “drag & drop” mechanism or by setting the frequencies directly in the respective spin boxes. To deactivate the interactive “drag & drop” mechanism select LOCKED in the drop-down menu. Use the check boxes to show or hide the respective frequency marker.

AXIS SCALING – TIME (X-AXIS)

Select AUTO SCALE to always show the complete length of the file in the spectrogram. If you prefer a fixed time scaling, choose FIXED DURATION and set the desired time duration the spectrogram should show. As bat calls are often classified by their shape or the steepness of the frequency sweep a fixed aspect ratio can be helpful to allow fast classifications. To use this feature, choose FIXED ASPECT RATIO and set your desired time-frequency ratio.

AXIS SCALING – FREQUENCY (Y-AXIS)

The scaling of the frequency axis (y-axis) can be set to either AUTO SCALE or FIXED SCALE. By enabling AUTO SCALE the minimum frequency is set to zero and the maximum frequency to half the sample rate of the opened file. When FIXED SCALE is enabled, you can define the minimum and maximum of the frequency axis with UPPER FREQUENCY LIMIT and LOWER FREQUENCY LIMIT, respectively.

Axis Scaling – Amplitude (Z-Axis)

The Amplitude Scaling allows adjusting the color map. By enabling Auto Scale the amplitude scaling is automatically adapted to the current file. By choosing Fixed Scale the amplitude scaling remains fixed to the defined limits, when loading a new file.

Default

The Default button sets all Spectrogram Settings to their defaults.

Axis Plots Settings

Besides the spectrogram in the TIME AXIS PLOT and FREQUENCY AXIS PLOT some additional information about the signal visible in the spectrogram (see Figure 2) can be displayed. The AXIS PLOTS SETTINGS allows adjusting these plots.

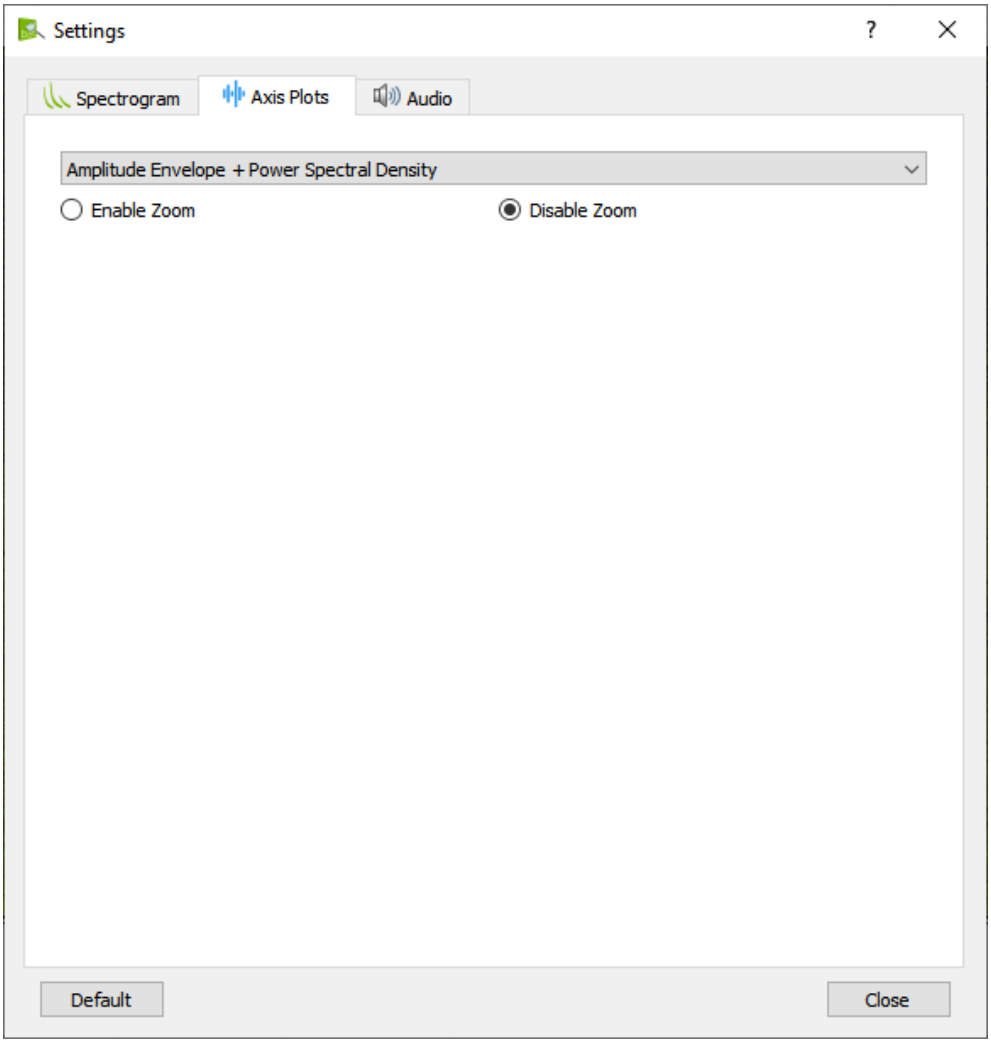

Figure 7: Axis Plots Settings

The drop-down menu allows choosing the information displayed in both plots.

AMPLITUDE AND RMS + POWER SPECTRAL DENSITY

By selecting AMPLITUDE AND RMS + POWER SPECTRAL DENSITY the time axis plot above the spectrogram displays the amplitude of the loaded audio file in dark green. Furthermore, in bright green a moving Root Mean Square (RMS) of the audio signal is superimposed to the amplitude plot (see Figure 8). The frequency plot left to the spectrogram shows a power spectral density estimate of the signal. Hereby, the power spectral density is calculated with

the evaluation WINDOW selected in the SPECTROGRAM SETTINGS and a fixed window length of 4.096 samples.

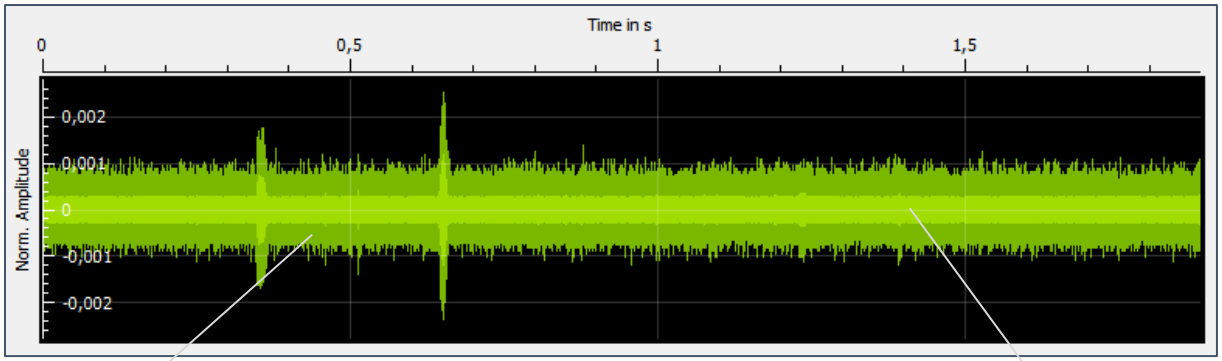

Figure 8: Amplitude and RMS Plot

SPECTRAL AMPLITUDES OF CURRENT CURSOR POSITION

The time axis plot above the spectrogram displays the intensity of a single frequency along the time axis defined by the cursor position in the spectrogram. The frequency axis plot left to the spectrogram shows the intensity of a single short time spectrum defined by the position of the cursor in the spectrogram.

MAXIMUM SPECTRAL AMPLITUDES

The time axis and frequency axis plots shows the maximum amplitudes in the spectrogram along the time or frequency axis, respectively.

ENABLE / DISABLE ZOOM

If ENABLE ZOOM is selected, both axis plots will follow the zooming in the spectrogram. If DISABLE ZOOM is selected, both axis plot will not zoom when the spectrogram is zoomed. However, on zooming in the spectrogram the zoomed area is marked in both axis plots.

DEFAULT

The DEFAULT button sets all AXIS PLOT SETTINGS to their defaults.

Audio Settings

The AUDIO SETTINGS provide a few options to playback audio signals and make also high ultrasonic frequency components audible. To start, stop and pause audio playback use the audio controls in the upper left corner of the Main Window (see Figure 2).

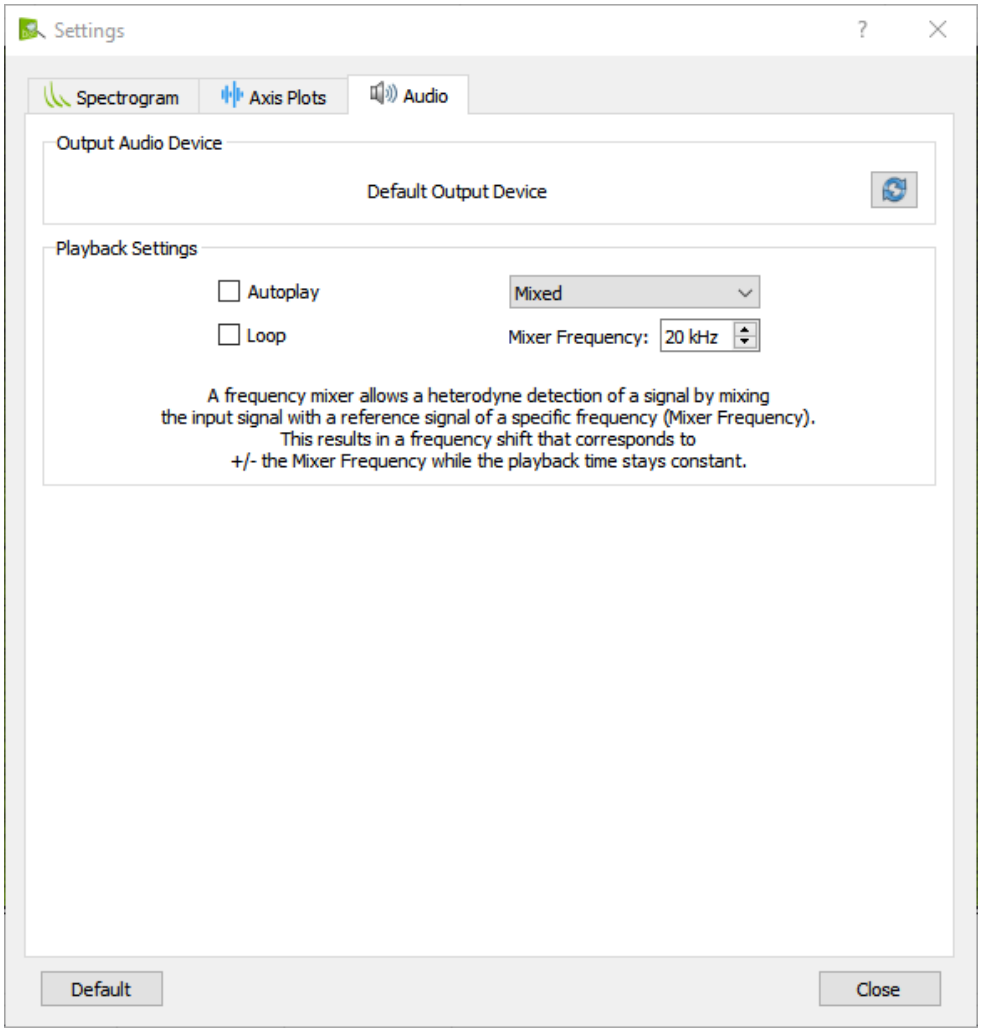

Figure 9: Audio Settings

OUTPUT AUDIO DEVICE

Depicts the detected default audio device on the system. Please, change the device in your operating system if the output device is not the desired on. To refresh the default audio device press the button.

AUTOPLAY

AUTOPLAY will automatically start audio playback after a new file is loaded or the spectrogram is zoomed.

LOOP

LOOP will loop audio playback.

PLAYBACK MODE

The playback mode drop-down menu provides several options for processing audio data to make also high frequency components audible.

ORIGNAL: The audio signal is played with its original sample and playback rate. High frequency components above the frequency threshold of the human ear will be inaudible.

UNDERSAMPLED: The audio signal will be undersampled for playback. Undersampling an audio signal results in a frequency shift to lower frequencies. By this, high frequency components become audible, while plackback time stays constant.

PITCHED: The audio signal will be played with a slower playback rate. This will slow-down the audio playback and high frequency components become audible.

MIXED: The audio signal is mixed with a reference signal of a specific frequency (mixer frequency) before it is played. This frequency mixing allows a so-called heterodyne detection of high frequency components as it results in a frequency shift of +/- the mixer Frequency. Playback time will stay constant.

DEFAULT

The DEFAULT button sets all AUDIO SETTINGS to their defaults.

11. View Menu

Time Axis Plot

Show or collapse Time Axis Plot above the spectrogram.

Frequency Axis Plot

Show or collapse Frequency Axis Plot left to the spectrogram.

Frequency Marker 1

Show or hide the Frequency Marker 1 in the spectrogram.

Frequency Marker 2

Show or hide the Frequency Marker 2 in the spectrogram.

Frequency Marker 3

Show or hide the Frequency Marker 3 in the spectrogram.

Grid

Show or hide the Grid in the spectrogram, the time axis plot and the spectrogram plot.

Theme

Change the color theme to dark or light. “Windows Theme” adopts the color theme from Windows.

12. Manual Folder Evaluation

BATscreen provides a fast and intuitive procedure to effectively and fast manually examine large numbers of recorded bat call files. After file classification is completed, data can be exported either in a CSV file format or in a ProBat compatible file to calculate shutdown times and cut-off wind speeds.

Select Evaluation Folder

To start the manual examination select MANUAL FOLDER EVALUATION in the EVALUATION menu and open the folder containing the files, which you want to examine.

Define class model

After this, a SET CLASS MODEL dialog opens (see Figure 10). Here, you have to define the classes/subclasses in which you want to group your recorded files. The simplest case is one class “Bat” and one “No call”.

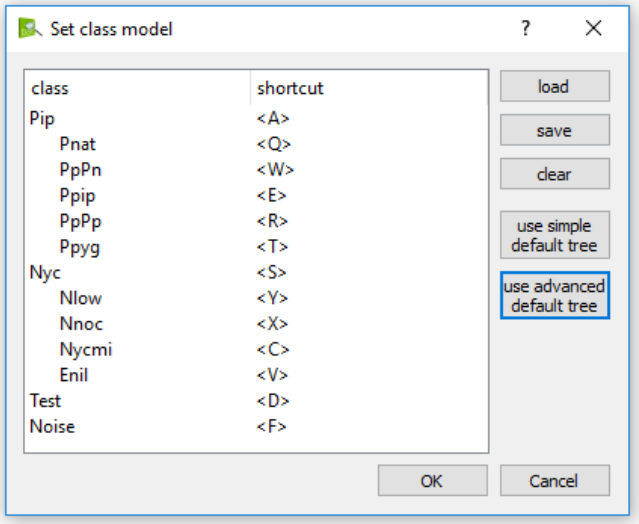

Figure 10: Set Class Model Dialog

By clicking USE SIMPLE DEFAULT TREE or USE ADVANCED DEFAULT TREE predefined class models are loaded. While the classes for the simple default tree are the already mentioned “Bat” and “No call”, the advanced default tree consist of numerous classes and subclasses as depicted in Figure 10.

To allow for a fast classification of files, one shortcut per class/subclass has to be defined. Later in the examination process, you can easily assign a file to a class by pressing the respective shortcut on the keyboard.

If you want to define your own class tree or adapt an existing one, use the right click menu to add, rename and delete classes/subclasses as well as change a dedicated shortcut.

To save your class tree or to load an already saved tree click SAVE or LOAD, respectively.

Assign files to your classes

After determining the class tree model, you can start to assign bat call files from the specified folder to your class tree model. Each file can be assigned to up to four classes (“class1”, “class2”, “class3” and “class4”).

Therefore, the first file in the specified folder is visualized in the Main Window Area. Below on the left, you can find your defined class tree model and on the right side a list of all sound files in the specified folder (see Figure 11).

The class tree model view lists all defined classes/subclasses, their corresponding shortcuts and the number of currently assigned files (“count”) in the specified folder. In red, you can find the number of unassigned files at the end of the list. Classes, which was not defined in the DEFINE CLASS MODEL step, but were already assigned to at least one file, when the MANUAL FOLDER EVALUATION is started, are depicted in blue. For editing the specified class tree model, utilize the right click menu. To save your current class tree model use the SAVE CLASS MODEL button right to the file list.

The file list shows all WAV or RAW files in the selected folder and gives information about filename, recording time, file length, class assignment and comment. To open an item double click it, use the <Left> and <Right > arrow keys of the keyboard or the buttons  and  . Use the right click menu to delete files. **Warning: By deleting files in the right click menu, they are deleted irrevocably from your hard disc drive!**

To assign the current opened file to one or more classes/subclasses click on the  buttons right next to the desired classes/subclasses entries in the class tree model. Alternatively, you can also press the associated shortcuts on the keyboard or use the right click menu in the file list. By selecting multiple files in the file list, it is also possible to assign multiple files, simultaneously. If you want to reassign (change) a class or delete assignment, use the right-click menu in the file list.

To edit the comment column of a file, double click in the comment column.

If you work with wav-files recorded by BATmode-Systems or hardware of Avisoft Bioacoustics, assignment and comment information are stored in the file headers. Consequently, assignment and comment information is preserved if you close the application or interrupt the classification process. In contrast, if raw-files recorded with a batcorder are used, assignment and comment information will be lost by closing the application or opening a new file or folder since the raw-file format of the batcorder does not support header information.

Export only selected files to a CSV- or ProBat-file

If you want to export only specific files in a folder, select them in the file list and use the right-click menu to export them. The exporting options are described in Chapter 9 (EXPORT CSV FILE and EXPORT PROBAT FILE).

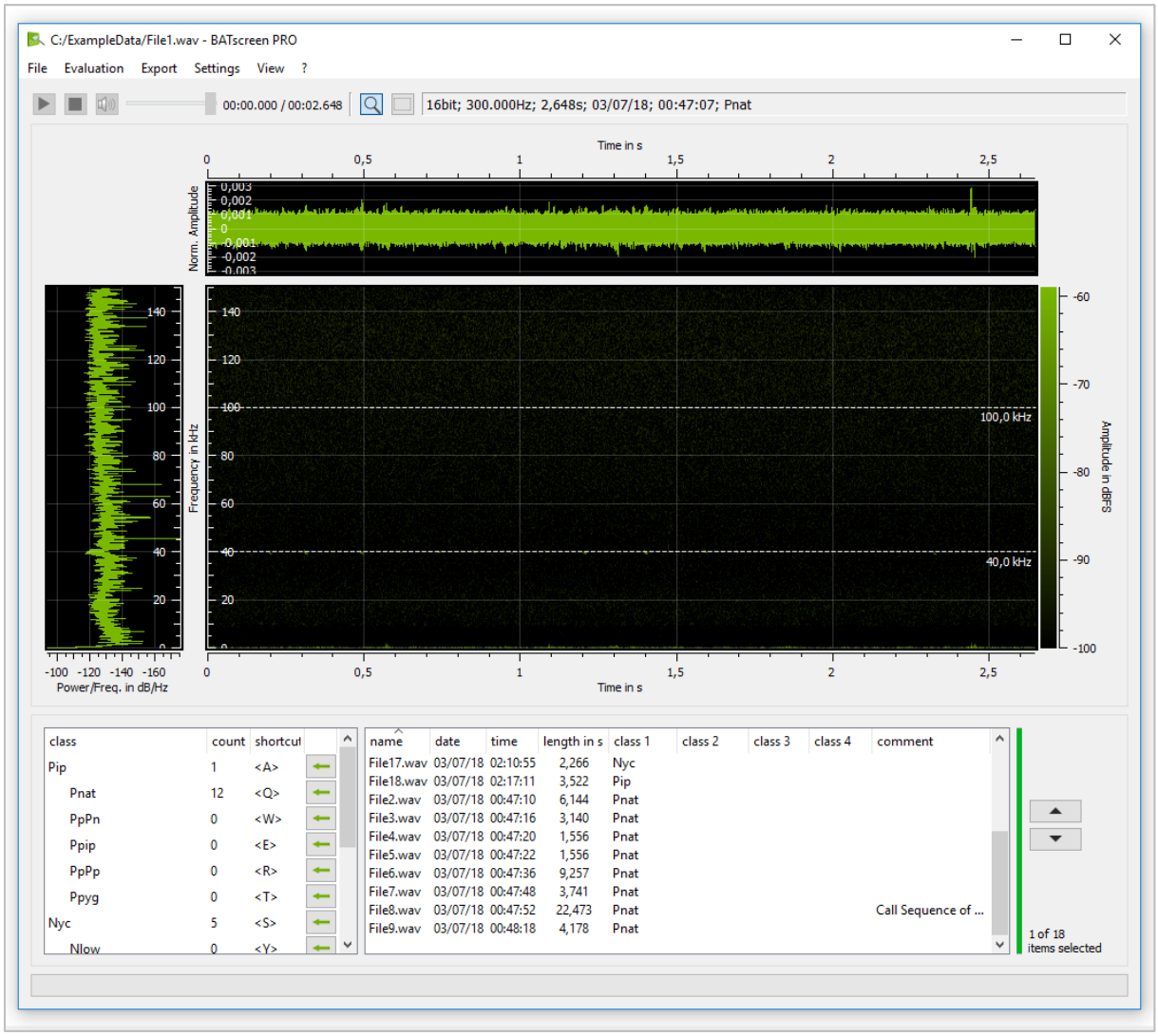

Figure 11: Manual Folder Evaluation Window

13. Manual Review of RECORDER WEA Offline Analysis

In general, the Avisoft-RECORDER USGH software of Avisoft Bioacoustics allows an automated call classification and evaluation as a post-recording step. The calls are visualized and measured with a spectrogram. The most important values are call duration, call interval, start frequency, end frequency, bandwidth, amplitude and slope of the individual calls. However, to achieve good classification results it is indispensable to identify a classification parameter set that enables a reliable class assignment and defines appropriate parameter ranges for each class.

In the research project RENEBAT III such a parameter set was developed and published in the resulting report[1]. To allow an easy use of this parameter set, it is included as configuration preset in the Avisoft-RECORDER USGH software from version 4.2.28 on, which was released on the 10th December 2018.

The results of the automated call classification are saved in text files. The MANUAL REVIEW OF RECORDER WEA OFFLINE ANALYSIS of BATscreen PRO allows to import these results, make a fast manual check of the automated classification results and export the data as CSV or ProBat compatible file.

Classification Parameter Set developed in RENEBAT III

The class model tree as well as the parameter boundaries for each class, which both were defined in RENEBAT III and published in the resulting report[1] (chapter 4.2, page 42 and following) are depicted in Table 2. The model uses only the two parameters “end frequency” and call “duration” to distinguish detected calls. Following the research report, the logic for file assignment is shown in Figure 12.

[1] Behr, O., Brinkmann, R., Hochradel, K., Mages, J., Korner-Nievergelt, F., Reinhard, H., Simon, R., Stiller, F., Weber, N., Nagy, M., (2018). „Bestimmung des Kollisionsrisikos von Fledermäusen an Onshore-Windenergieanlagen in der Planungspraxis“ - Endbericht des Forschungsvorhabens gefördert durch das Bundesministerium für Wirtschaft und Energie (Förderkennzeichen 0327638E). O. Behr et al. Erlangen / Freiburg / Ettiswil.

Table 2: Calls model tree and boundaries for the call parameters, end frequency and duration, defined in the resulting report[2] of RENEBAT III. min: minimum value, max: maximum value. End frequency is depicted in kHz and duration in ms.

class	end frequency min	end frequency max	duration min	duration max	possible species
Nyc	8.0	< 33.0	2.9	36.0	*Tadarida teniotis, Nyctalus lasiopterus, Nyctalus noctula, Nyctalus leisleri, Eptesicus serotinus, Vespertilio murinus, Eptesicus nilsonii*
Nlow	8.0	< 15.0	5.9	28.0	*T. teniotis, N. lasiopterus*
Nnoc	15.0	< 21.0	5.9	32.0	*N. noctula*
Nycmi	21.0	<26.5	5.0	30.0	*N. leisleri, E. serotinus, V. murinus (sometimes also high N. noctula or low E. nilsonii calls)*
Enil	26.5	<26.5	5.0	25.0	*E. nilssonii (sometimes also E. serotinus and N. leisleri) Pip*
Pip	33.0	65.0	1.4	20.0	*Pipistrellus nathusii, Pipistrellus pipistrellus, Pipistrellus pygmaeus (Pipistrellus kuhlii)*
Pnat	35.0	< 41.2	2.9	18.0	*P. nathusii (P. kuhlii)*
PpPn	41.2	< 42.5	2.9	18.0	*P. nathusii, P. pipistrellus*
Ppip	42.5	< 49.5	2.0	18.0	*P. pipistrellus*
PpPp	49.5	< 51.0	2.0	15.0	*P. pipistrellus, P. pygmaeus*
Ppyg	51.0	64.0	2.0	15.0	*P. pygmaeus*
Testsignal	-	-	36.0	3000.0	

[2] Behr, O., Brinkmann, R., Hochradel, K., Mages, J., Korner-Nievergelt, F., Reinhard, H., Simon, R., Stiller, F., Weber, N., Nagy, M., (2018). „Bestimmung des Kollisionsrisikos von Fledermäusen an Onshore-Windenergieanlagen in der Planungspraxis“ - Endbericht des Forschungsvorhabens gefördert durch das Bundesministerium für Wirtschaft und Energie (Förderkennzeichen 0327638E). O. Behr et al. Erlangen / Freiburg / Ettiswil.

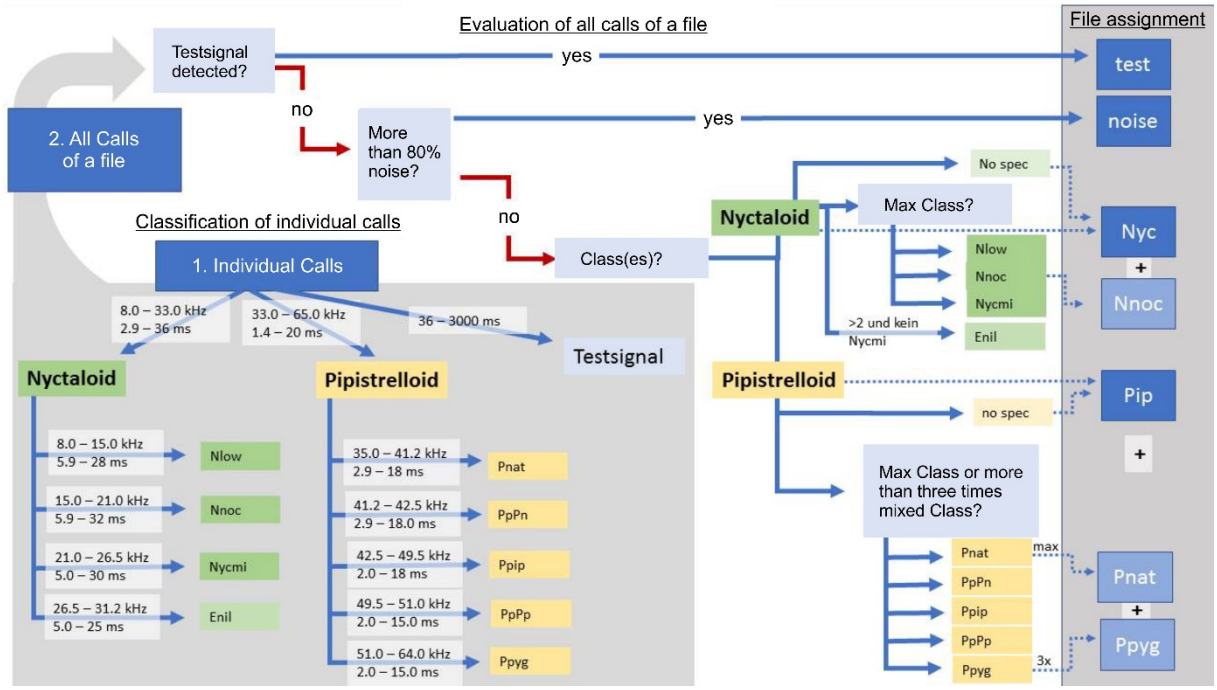

Figure 12: Logic of the automated evaluation of the recorded files following the resulting report[3] of RENEBAT III. The first step classifies all the individual calls of a file into species groups and types. The classification is based on the "end frequency" and "duration" of each call. If no call class can be determined, the recorded noise is assigned as noise. In the second step of the evaluation, the totality of the all individual calls of a file are considered and a defined logic is used to decide which species groups and/or species are contained in the file, or whether the file contains noise or a test signal. With dashed lines, the procedure for the case is shown that individual calls of the call classes Nnoc, Pnat and Ppyg are present. In this case, both species groups Nyctaloid and Pipistrelloid and additionally Nnoc, Pnat and Ppyg are assigned in the output file according to their number. If no species are detected, only the recognized species group and no spec are entered in the output file. "Max Class" refers to the most frequent call class within the respective species group.

[3] Behr, O., Brinkmann, R., Hochradel, K., Mages, J., Korner-Nievergelt, F., Reinhard, H., Simon, R., Stiller, F., Weber, N., Nagy, M., (2018). „Bestimmung des Kollisionsrisikos von Fledermäusen an Onshore-Windenergieanlagen in der Planungspraxis" - Endbericht des Forschungsvorhabens gefördert durch das Bundesministerium für Wirtschaft und Energie (Förderkennzeichen 0327638E). O. Behr et al. Erlangen / Freiburg / Ettiswil.

Automated WEA Offline Analysis in the Avisoft RECORDER USGH software

To evaluate a data set of WAV files recorded by a BATmode system with the automated WEA Offline Analysis install the latest Avisoft-RECORDER USGH software on your evaluation PC. The software can be downloaded from www.avisoft.com for free.

To start the software, connect your Avisoft UltraSoundGate USB dongle to your evaluation PC. The UltraSoundGate is included in the delivery scope of your BATmode system and contains the required software license for the Avisoft-RECORDER USGH software.

Subsequently, load the WEA OFFLINE ANALYSIS configuration presets by clicking OPTIONS -> CONFIGURATION MANAGEMENT -> PRESETS -> BAT CALLS -> WEA OFFLINE ANALYSIS (BMU PROJEKT) (see Figure 13). Confirm all opening configuration windows with OK.

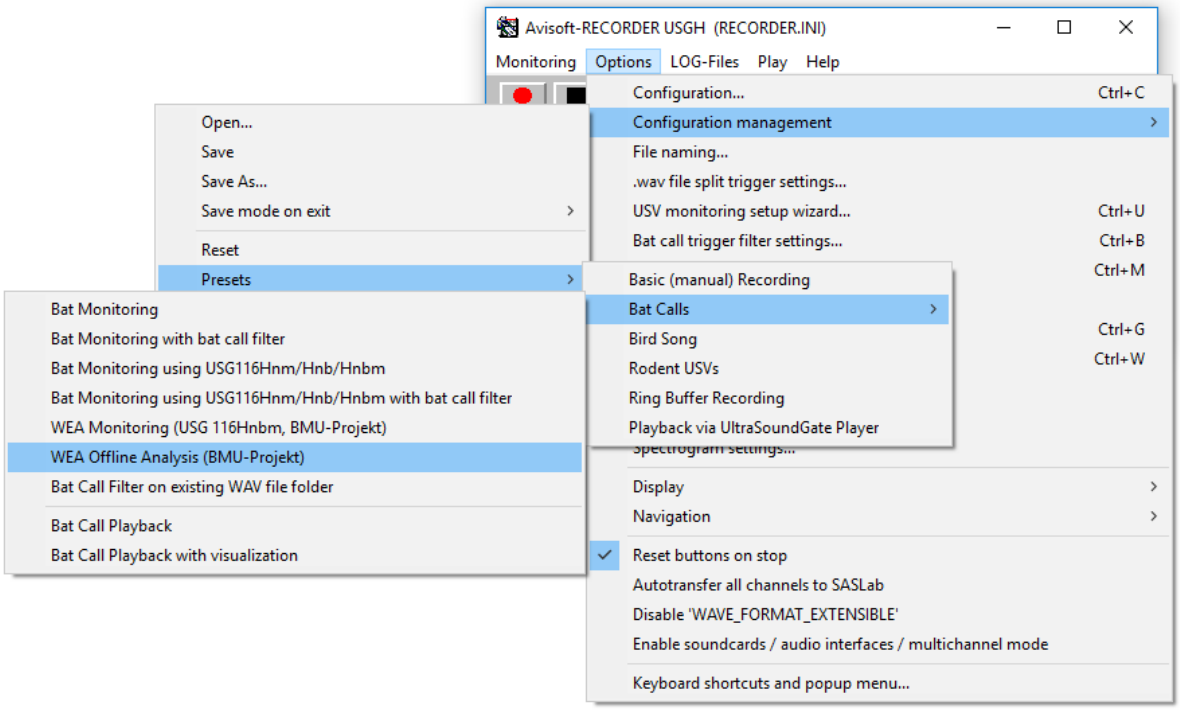

Figure 13: Load configuration presets for WEA Offline Analysis

To start the WEA Offline Analysis select the folder, which contains the recorded data set, in the Windows Explorer and “drag & drop” it on the start window of the Avisoft-RECORDER USG software. We recommend making a copy of your original data set first and removing all testsignal recordings from the copied data before starting the WEA Offline Analysis.

The results of the WEA Offline Analysis are stored in three text files “calls_ch1.txt”, “calls_ch1_files.txt” and “calls_ch1_stat.txt” in the selected folder. Hereby, the file “calls_ch1_files.txt” contains the results for each file line by line. The most important columns of the result file are described in Table 3.

Table 3: Most important columns of the result file "calls_ch1_files.txt"

Column	Name	Description
0	**timestamp**	*Recording time of the file*
1	**filename**	*Filename of the file*
2	**duration**	*Duration of the file in s*
3	**bat activity**	*Can contain "bat", "noise" or "test" and is a summary of the following results.*
4	**ProBat1**	*The first ProBat class[4] the file is assigned to.*
5	**#Probat1**	*Number of detected calls, which are assigned to the first ProBat class[4].*
6	**Probat2**	*The second ProBat class[4] the file is assigned to.*
7	**#ProBat2**	*Number of detected calls, which are assigned to the second ProBat class[4].*
8	**species1**	*The first class the file is assigned to following the logic depicted in Figure 12.*
9	**#species1**	*The number of detected calls, which are assigned to species 1.*
10	**species2**	*The second class the file is assigned to following the logic depicted in Figure 12.*
11	**#species2**	*The number of detected calls, which are assigned to species 2.*
12	**species3**	*The third class the file is assigned to following the logic depicted in Figure 12.*
13	**#species3**	*The number of detected calls, which are assigned to species 3.*

Manual Review of the RECORDER WEA Offline Analysis with BATscreen PRO

After the automated WEA Offline Analysis is performed with the Avisoft-RECORDER USGH software, the results have to be manually reviewed to delete remaining noise recordings and erroneous assigned bat calls in the resulting data set. This can be done with BATscreen PRO.

To start the MANUAL REVIEW OF RECORDER WEA OFFLINE ANALYSIS click EVALUATION -> MANUAL REVIEW OF RECORDER WEA OFFLINE ANALYSIS.

Select the folder, which has to be evaluated and contains the recorded WAV files as well as the resulting file "calls_ch1_files.txt" of the automated WEA Offline Analysis.

Subsequently, you have to choose the class model tree you want to use for the review of your WEA Offline Analysis (see Figure 14). The Simple Class Tree for ProBat Export contains only "Pip", "Pnat", "Nyc" and "No Call" and refers to the ProBat classes in the resulting "calls_ch1_files.txt" file ("Pipistrelloid" is replaced by "Pip" and "Nyctaloid" by "Nyc"). ProBat classes are a simple representation of the depicted class model tree in Table 2 since ProBat does not pay attention to a more detailed class tree. Furthermore, for the calculation of shutdown times ProBat interprets both "Nyctaloid" and "Pipistrelloid" as equal bat call files. Consequently, it is irrelevant for ProBat calculation, which one is assigned. In contrast, it is

[4] ProBat classes are a simple representation of the depicted class model tree in Table 2. ProBat classes can be "Nyctaloid", "Pipistrelloid" or "Pnat". An empty field represents a test or noise signal. However, for the calculation of shutdown times ProBat interprets both "Nyctaloid" and "Pipistrelloid" as equal bat call files. Consequently, it is irrelevant for ProBat calculation, which one is assigned. In contrast, it is important to assign "Pnat" just to files, which really contains "Pnat" calls, since ProBat uses different weighting factors for "Pnat" assigned files.

important to assign “Pnat” just to files, which really contains “Pnat” calls, since ProBat uses different weighting factors for “Pnat” assigned files. If you want to have an ADVANCED CLASS TREE with all classes defined in Table 2, select ADVANCED CLASS TREE. This class model tree can also be used for a ProBat evaluation since ProBat interprets “Pnat” as bat call with different weighting factor and all other classes just as equal bat call.

Please pay attention that all class assignments, which are already saved in the files headers, but not included in the selected class tree, will be discarded permanently, when opening the folder for the Manual Review of RECORDER WEA Offline Analysis.

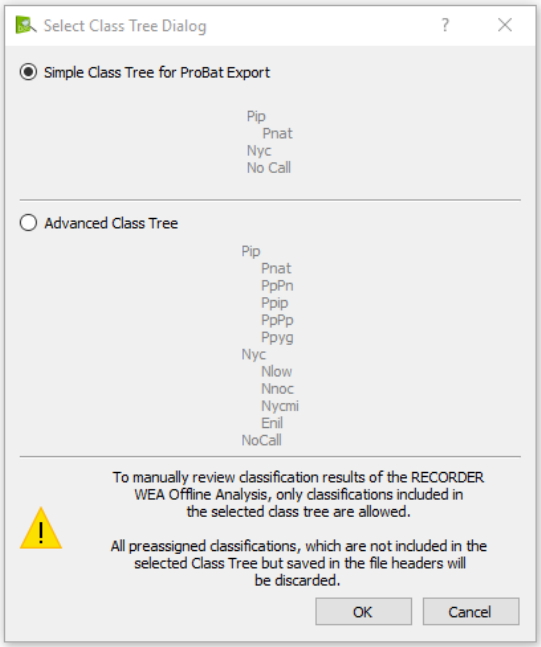

Figure 14: Select class tree for the review of a WEA Offline Analysis

After selecting the class tree, BATscreen opens the selected folder and visualizes the first file in the Main Window. Below on the left, you can find your selected class tree model and on the right side a list of all bat call files in the specified folder (see Figure 15).

The class tree model view lists all classes/subclasses of the selected class tree, their corresponding shortcuts and the number of currently assigned files (“count”) in the specified folder. In red, you can find the number of unassigned files at the end of the list. The class “Detected No Call” that is depicted in blue represents all files, which were assigned as either “test” or “noise” by the WEA Offline Analysis.

The file list on the left shows all WAV and RAW files in the selected folder and gives information about filename, recording time, file length, assignment proposal of the WEA Offline Analysis, class assignment and comment. Files that were detected as “test” or “noise” by the WEA Offline Analysis are disabled and marked in gray. To open an item double click it, use the <Left> and <Right > arrow keys of the keyboard or the buttons ▲ and ▼.

Use the right click menu to delete files. **Warning: By deleting files in the right click menu, they are deleted irrevocably from your hard disc drive!**

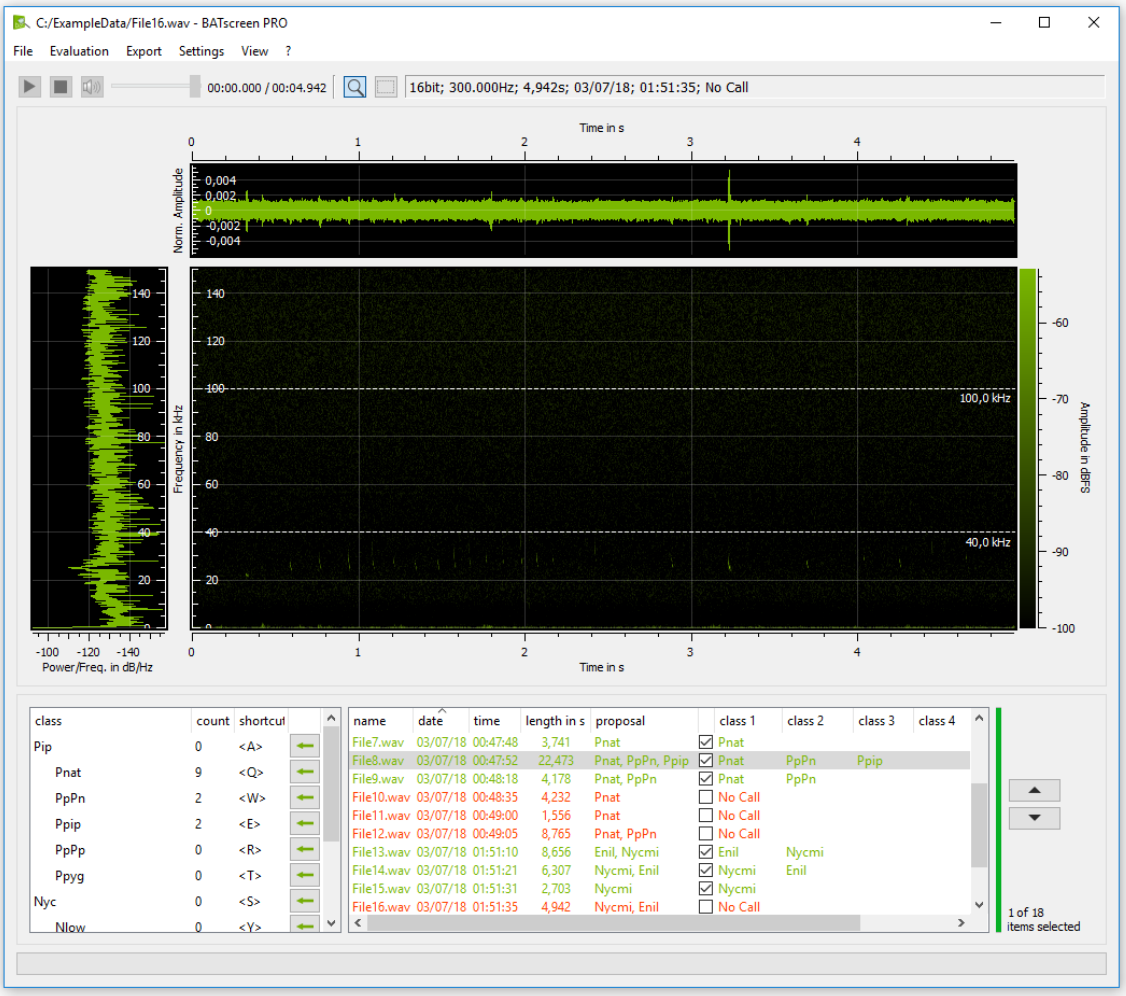

Figure 15: Window of Manual Review of WEA Offline Analysis

While reviewing a current opened file you can accept the proposal of the WEA Offline Analysis by checking the respective box left to the proposal in the file view list. Alternatively, you can also accept the proposal by using the <Space> key of your keyboard. An accepted file will be marked in green and the proposed classes are written to the file header of the file. If you want to decline a proposal just assign the file to different class(es) by clicking on the buttons right next to the desired classes/subclasses entries in the class tree model. Alternatively, you can also press the associated shortcut on the keyboard or use the right click menu in the file list. The file with the declined proposal will be marked orange. By selecting multiple files in the file list, it is also possible to assign multiple files, simultaneously. If you want to reassign (change) a class or delete assignment, use the right-click menu in the file list. By choosing RESET ALL FILES in the right click menu of the file list, you can delete the class assignments of all files and discard all accepted proposals.

Export the review result to a CSV- or ProBat-file

After finishing the review, you can export your result as CSV or ProBat compatible file by using the menu EXPORT. If you want to export only specific files in a folder, select them in the file list and use the right-click menu to export them. The exporting options are described in Chapter 9 (Export CSV File and Export ProBat File).

14. Activity Plots

In many cases, quality of recorded data can be easily estimated by plotting records over time, days, months or environmental parameters like temperature, wind speed or precipitation.

BATscreen PRO includes a fast and intuitive plotting tool to create a wide range of images for data evaluation and analysis. To start the plotting tool open a folder (see File Menu 7), run a manual folder evaluation (see Chapter 12) or review a RECORDER WEA Offline Analysis (see Chapter 13). Subsequently, when all headers in the file list are loaded (loading progress is depicted in the vertical progress bar right next to the file list), click EVALUATION -> ACTIVITY PLOTS to open the ACTIVITY PLOT window (see Figure 16).

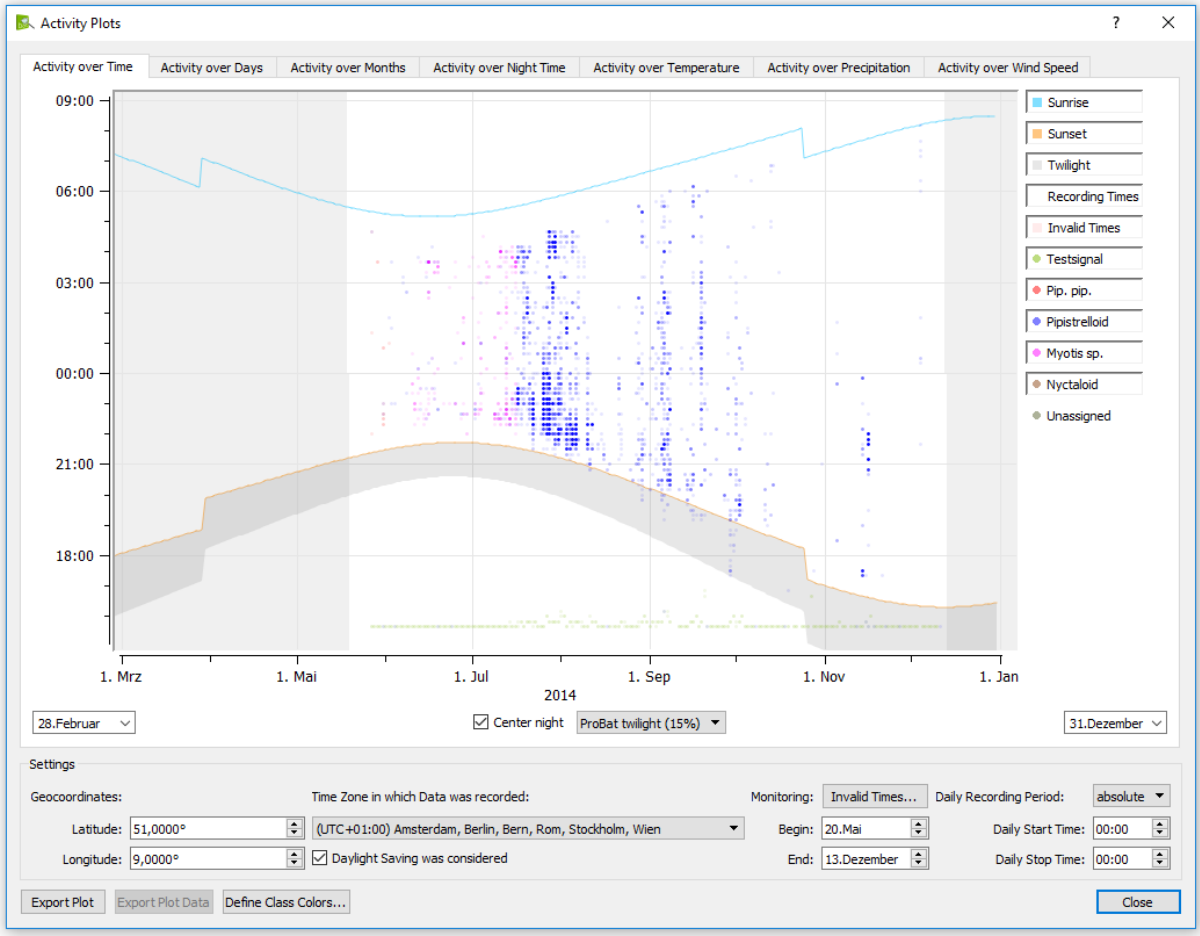

Figure 16: Activity over Time Plot

The ACTIVITY PLOT window shows in the upper part the plot selected in the Tab menu. Below you find the general SETTINGS box, which is applied for all plots.

To export created plots as pixel (*.bmp, *.jpg, *.jpeg, *.pbm, *.pgm, *.png, *.ppm, *xbm, *.xpm) or vector (*.pdf) graphic click EXPORT PLOT at the lower edge of the window.

With EXPORT PLOT DATA it is also possible to export the calculated plot data as CSV file (not for ACTIVITY OVER TIME plot). These data can be imported in other plotting tools like Microsoft Excel to create your own styled plots.

To change the color representation within the plots use the DEFINE CLASS COLORS… button. In the SET COLOR FOR CLASSES dialog (see Figure 17), the color representation of the assigned classes can be adapted by editing the respective RGB values.

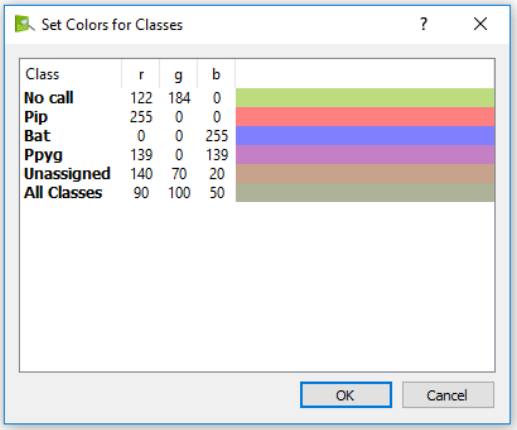

Figure 17: Set Colors for the class representation in the plots

Settings

The settings are necessary to calculate the plots.

Since in most cases settings are individual for each data evaluation, the settings are saved in the currently opened folder in the file “BATscreenSettings.ini”. On opening the ACTIVITY PLOTS window, the respective settings will load automatically.

The both GEOCOORDINATES, LATITUDE and LONGITUDE, allows to calculate sunrise and sunrise times at the location of data recording. Please insert the GEOCOORDINATES as decimal values. You can use Google Maps for example to determine the GEOCOORDINATES of your data recording location.

To enable a correct time representation please select the TIME ZONE in which your data was recorded. Furthermore, if your recording device considers DAYLIGHT SAVING, please check the respective box. The BATmode systems always use the time zone settings of the Windows operating system. Consequently, in most cases DAYLIGHT SAVING has to be enabled, when analyzing data recorded with a BATmode system.

In the MONITORING section the monitoring times of your data recording has to be specified. Insert the date you start and end the monitoring in the BEGIN and END field, respectively. If your monitoring data has several invalid periods, for example caused by downtimes of the recording device or bad values of the microphone sensitivity, use the INVALID TIMES… button to specify those periods.

The DAILY RECORDING PERIOD settings represents the daily times the recording began and stopped. Absolute values depict fixed points of time for each day. If using relative values, the start and stop times are defined as delay relative to sunrise and sunset. A positive delay means a point of time after sunrise or sunset. Consequently, negative delays refer to point of times prior to daily sunset or sunrise. If a BATmode system was utilized for data acquisition, these values were specified in the BATcontrol software.

Activity over Time

The ACTIVITY OVER TIME is used to show the number of records within 10-minute intervals with respect to daytime and day of the year (see Figure 16). Hereby, y-axis represents daytime and x-axis days of a year. For each ten minute-interval dots of various opacity depicts the number of records within the respective 10 minutes interval. For each file opacity increases 10%. Consequently, the opacity is 100% for 10 or more files within the respective 10 minutes interval. Different colors allow distinguishing assigned classes of records.

INVALID TIMES specified in the SETTINGS are depicted in red. All times outside the DAILY RECORDING PERIODS and the START and END date of the monitoring are disabled and marked light gray.

By selecting a desired TWILIGHT option, shadowed twilight times are added to the plot. Here, civil, nautical and astronomical twilight, depict the time period from sunrise or sunset until the geometric center of the sun reaches 6°, 12° or 18° below the horizon, respectively. In contrast, PROBAT TWILIGHT (15%) determines 15% of the night`s duration before sunset.

Checking CENTER NIGHT allows focusing the plot on night times.

By checking legend items, respective elements within the plot become visible or invisible.

The date edit fields at the lower left and right edge of the plot allows zooming the plot to specific start and stop dates.

If the < > buttons are visible on the left and right edge of the plot, your data contains files of multiple years. Use these buttons to switch between the years.

Activity over Days

The ACTIVITY OVER DAYS Plot shows data activity (left y-axis) over day in year (x-axis) (see Figure 18). The right y-axis depicts the valid monitoring hours for each day.

For the left y-axis you can choose between:

- ACTIVITY IN RECORDINGS PER HOUR: Number of Files normalized to the valid monitoring hours on this day.
- NUMBER OF FILES PER DAY
- NUMBER OF EVENTS WITH DYNAMIC 1 MINUTE TIME INTERVAL
- NUMBER OF EVENTS WITH DYNAMIC 5 MINUTE TIME INTERVAL
- NUMBER OF EVENTS WITH DYNAMIC 10 MINUTE TIME INTERVAL
- NUMBER OF EVENTS WITH STATIC 1 MINUTE TIME INTERVAL
- NUMBER OF EVENTS WITH STATIC 5 MINUTE TIME INTERVAL
- NUMBER OF EVENTS WITH STATIC 10 MINUTE TIME INTERVAL

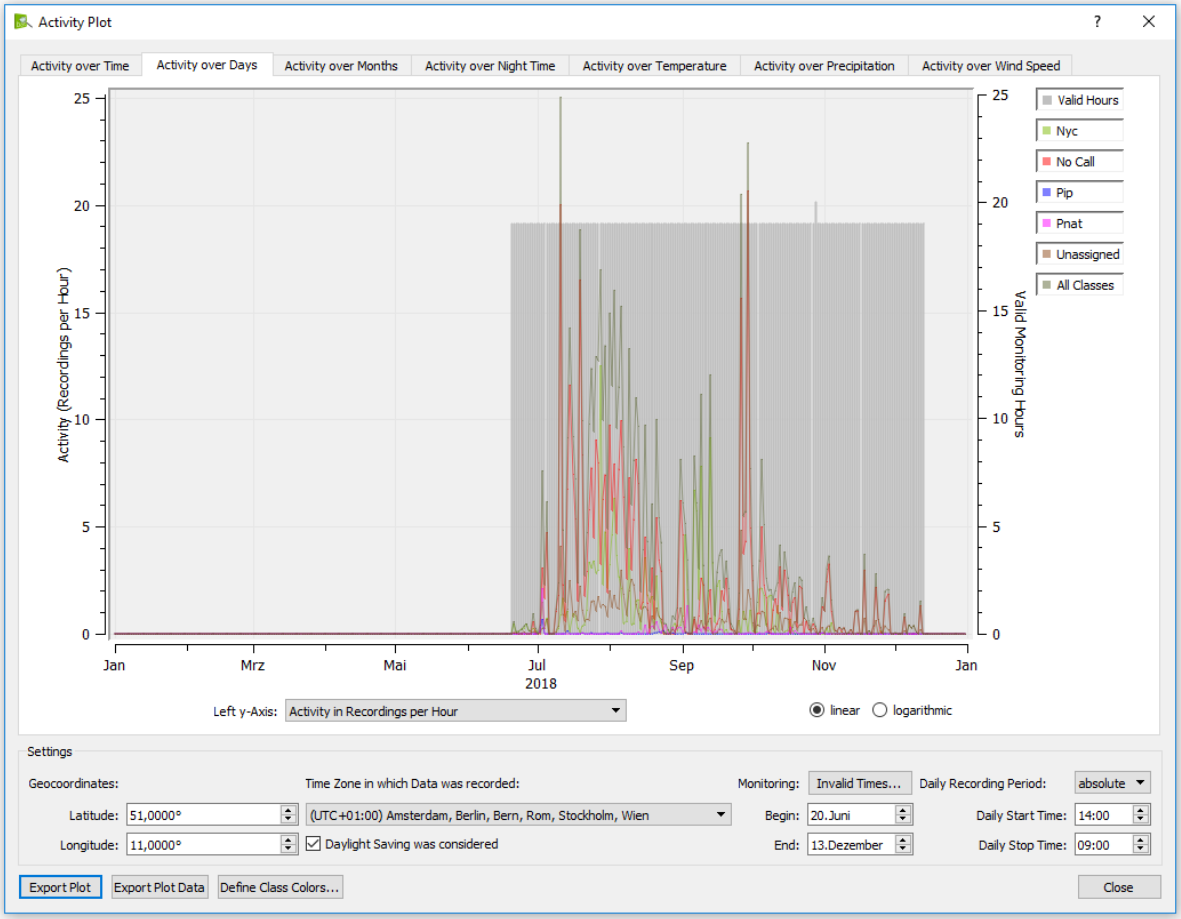

Figure 18: Activity over Days Plot

An event is triggered when the recording start time of at least on recorded file is within a specific time interval (1min/5min/10min). No other files with recording start times within this time interval will trigger an additional class event. The time intervals can be either static or dynamic. Static time intervals are fixed intervals in relation to the time of day, e.g. from 12:05:00 – 12:09:59 (5min interval) or from 17:30:00 – 17:30:59 (1min interval). Dynamic time intervals starts at the recording start time of the class event-triggering file. This means, if the recording start time of a class event-triggering file is at 20:22:45 the time interval for a 10 min dynamic interval is 20:22:45 – 20:32:44. Events are calculated separately for each class.

By checking legend items, respective elements within the plot become visible or invisible.

By selecting linear or logarithmic, you can change between a linear or logarithmic scaling of the left and right y-axis.

If the < > buttons are visible on the left and right edge of the plot, your data contains files of multiple years. Use these buttons to switch between the years.

Activity over Months

The ACTIVITY OVER MONTHS Plot shows the activity in recordings per hour (y-axis) over month (y-axis) (see Figure 19). Hereby, activity is defined as the number of recorded files within a certain month, normalized to the valid monitoring hours in this month. The right y-axis depicts valid monitoring hours for each month.

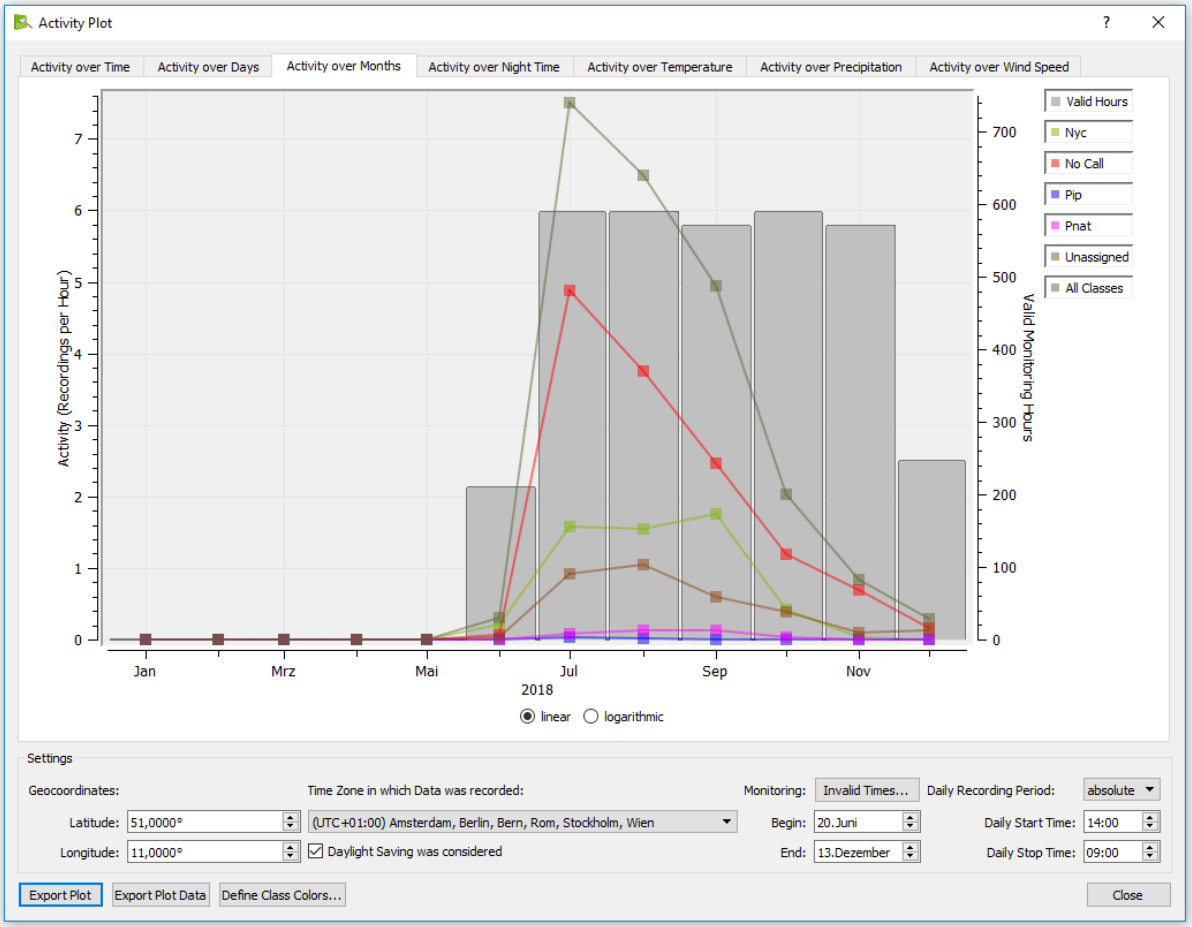

Figure 19: Activity over Months Plot

By checking legend items, respective elements within the plot become visible or invisible.

By selecting linear or logarithmic, you can change between a linear or logarithmic scaling of the left and right y-axis.

If the < > buttons are visible on the left and right edge of the plot, your data contains files of multiple years. Use these buttons to switch between the years.

Activity over Night Time

The ACTIVITY OVER NIGHTTIME Plot shows activity in recordings per hour (y-axis) over nighttime (x-axis) (see Figure 20). Hereby, activity is defined as the number of recorded files within a certain period of nighttime, normalized to the valid monitoring hours in this nighttime period. The right y-axis depicts valid monitoring hours for each nighttime period.

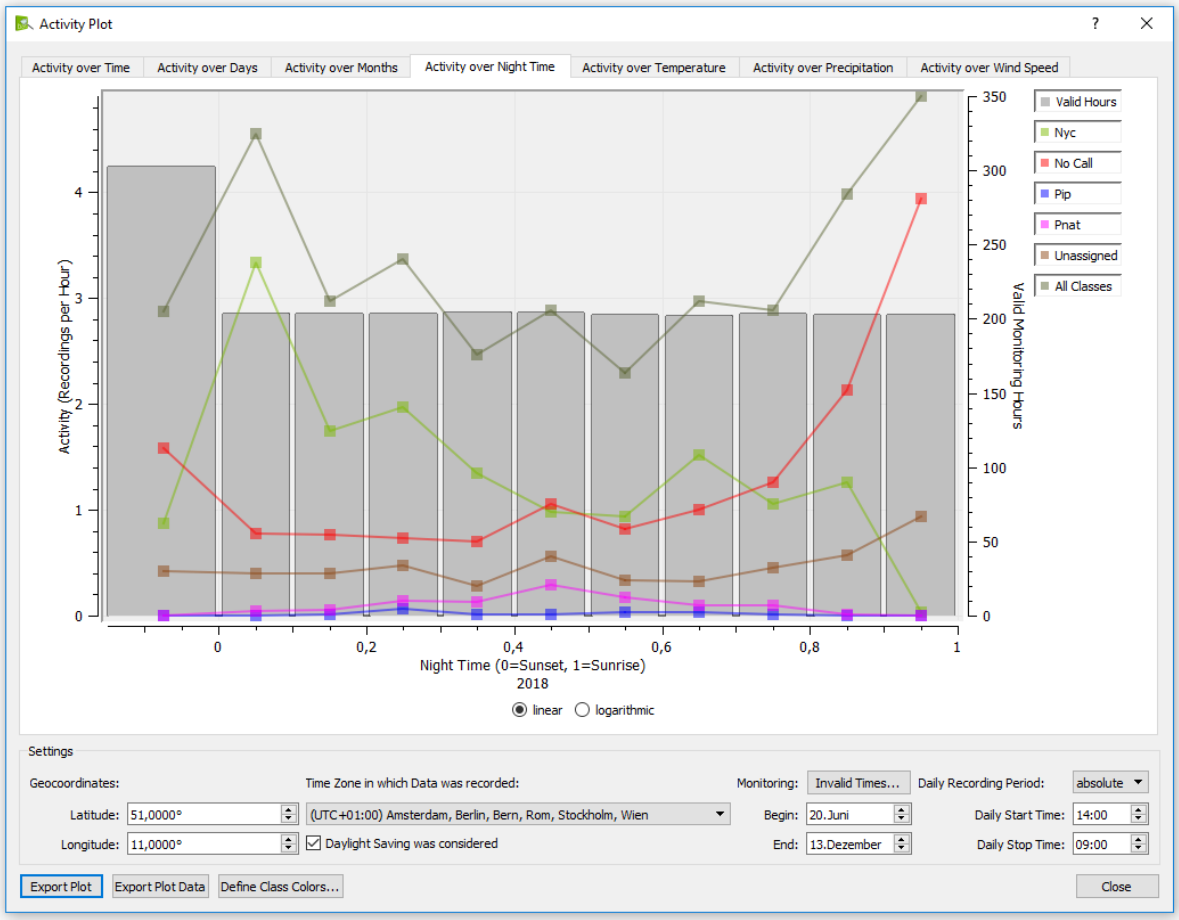

Figure 20: Activity over Nighttime Plot

A nighttime is defined in percentage of night. Consequently, a nighttime of zero represents sunset and a nighttime of one represents sunrise. For plotting, the night is divided in 10 nighttime periods each including 10% of the night duration. Additionally, the so called ProBat twilight nighttime interval is shown. This interval is defined as 15% of the night duration before sunset.

By checking legend items, respective elements within the plot become visible or invisible.

By selecting linear or logarithmic, you can change between a linear or logarithmic scaling of the left and right y-axis.

If the < > buttons are visible on the left and right edge of the plot, your data contains files of multiple years. Use these buttons to switch between the years.

Activity over Temperature

The ACTIVITY OVER TEMPERATURE Plot shows the activity in recordings per hour (y-axis) over temperature (y-axis) (see Figure 21). Hereby, activity is defined as the number of recorded files within a certain temperature interval, normalized to the valid monitoring hours in this temperature interval. The right y-axis depicts valid monitoring hours for each temperature interval.

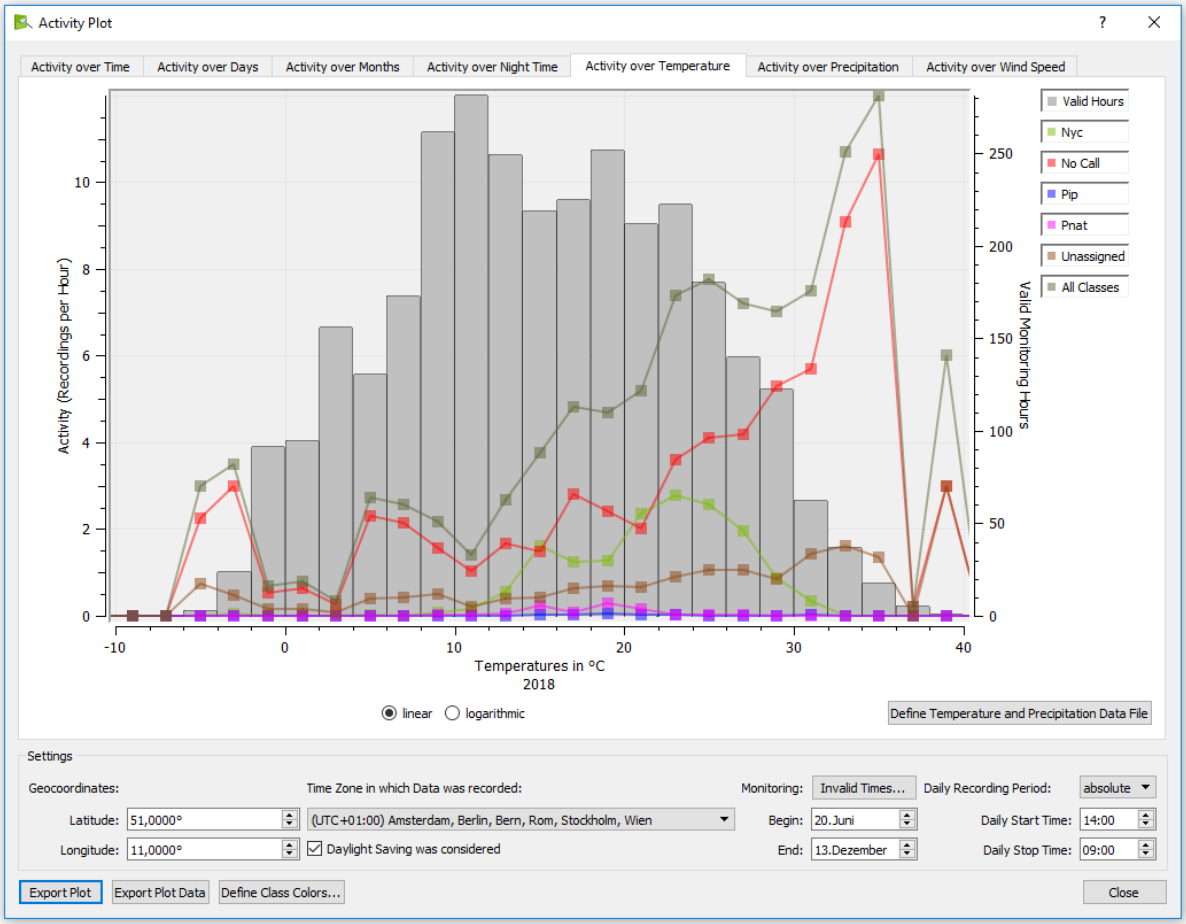

Figure 21: Activity over Temperature Plot

To create the ACTIVITY OVER TEMPERATURE plot, define the temperature data file by clicking DEFINE TEMPERATURE AND PRECIPITATION DATA FILE. The file has to contain temperature and precipitation data as mean values of 10 min intervals in three column, separated by tabulators:

- **Datetime**: Represents the beginning of the 10 min interval in the format “yyyy-MM-dd hh:mm:ss”.
- **Temperature** in °C
- **Precipitation** in mm/min

If a BATmode system is used for data acquisition use the file “conditionlog.txt”. This file stores all temperature and precipitation data acquired by the BATmode in the correct format.

By checking legend items, respective elements within the plot become visible or invisible.

By selecting linear or logarithmic you can change between a linear or logarithmic scaling of the left and right y-axis.

If the < > buttons are visible on the left and right edge of the plot, your date contains files of multiple years. Use these buttons to switch between the years.

Activity over Precipitation

The ACTIVITY OVER PRECIPITATION Plot shows the activity in recordings per hour (y-axis) over precipitation (y-axis) (see Figure 21). Hereby, activity is defined as the number of recorded files within a certain precipitation interval, normalized to the valid monitoring hours in this precipitation interval. The right y-axis depicts valid monitoring hours for each precipitation interval.

To create the ACTIVITY OVER PRECIPITATION plot, define the precipitation data file by clicking DEFINE TEMPERATURE AND PRECIPITATION DATA FILE. The file has to contain temperature and precipitation data as mean values of 10 min intervals in three column, separated by tabulators:

- **Datetime**: Represents the beginning of the 10 min interval in the format “yyyy-MM-dd hh:mm:ss”.
- **Temperature** in °C
- **Precipitation** in mm/min

If a BATmode system is used for data acquisition use the file “conditionlog.txt”. This file stores all temperature and precipitation data acquired by the BATmode in the correct format.

By checking legend items, respective elements within the plot become visible or invisible.

By selecting linear or logarithmic you can change between a linear or logarithmic scaling of the left and right y-axis.

If the < > buttons are visible on the left and right edge of the plot, your date contains files of multiple years. Use these buttons to switch between the years.

Activity over Wind Speed

The ACTIVITY OVER WIND SPEED Plot shows the activity in recordings per hour (y-axis) over wind speed (y-axis) (see Figure 22). Hereby, activity is defined as the number of recorded files within a certain wind speed interval, normalized to the valid monitoring hours in this wind speed interval. The right y-axis depicts valid monitoring hours for each wind speed interval.

To create the ACTIVITY OVER WIND SPEED plot, define the wind speed data file by clicking DEFINE WIND SPEED DATA FILE. Since wind speed data is in most cases acquired by wind turbines, data format may vary from turbine manufacturer to turbine manufacturer. To allow a wide variety of data formats you can specify the format in the SET FILE FORMAT dialog (see Figure 23), which opens when selecting a wind speed data file. In this dialog, the formats of the three columns **date**, **time** and **wind speed** have to be specified as well as the respective column separators. Furthermore, select the correct TIME/DATE DEFINITION and choose the time zone in which wind speed data was recorded as well as if daylight saving was considered or not. In the list view on the bottom edge of the dialog, a live preview of the first data values is shown. This helps to verify if data format settings are correct.

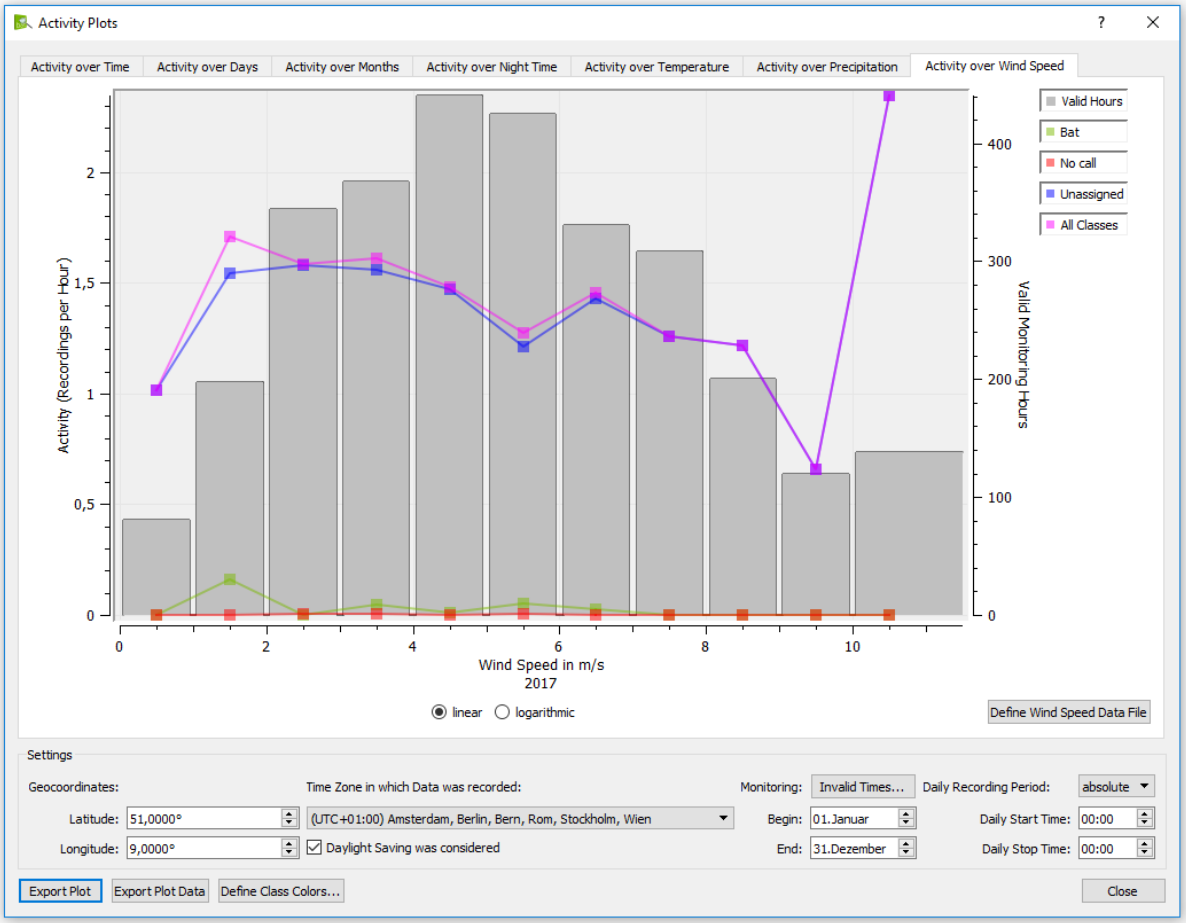

Figure 22: Activity over Wind Speed Plot

By checking legend items, respective elements within the plot become visible or invisible.

By selecting linear or logarithmic, you can change between a linear or logarithmic scaling of the left and right y-axis.

If the < > buttons are visible on the left and right edge of the plot, your data contains files of multiple years. Use these buttons to switch between the years.

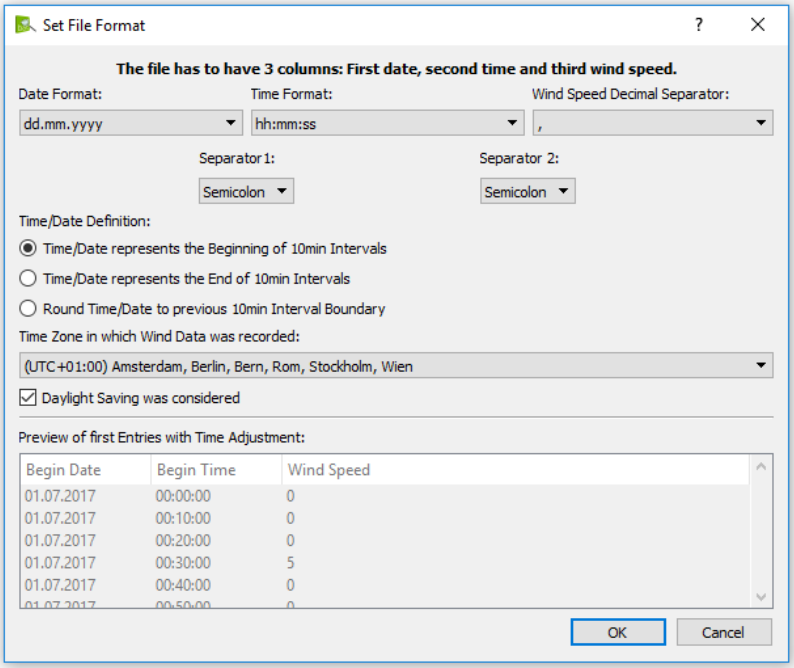

Figure 23: Set Wind Speed Data File Format

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