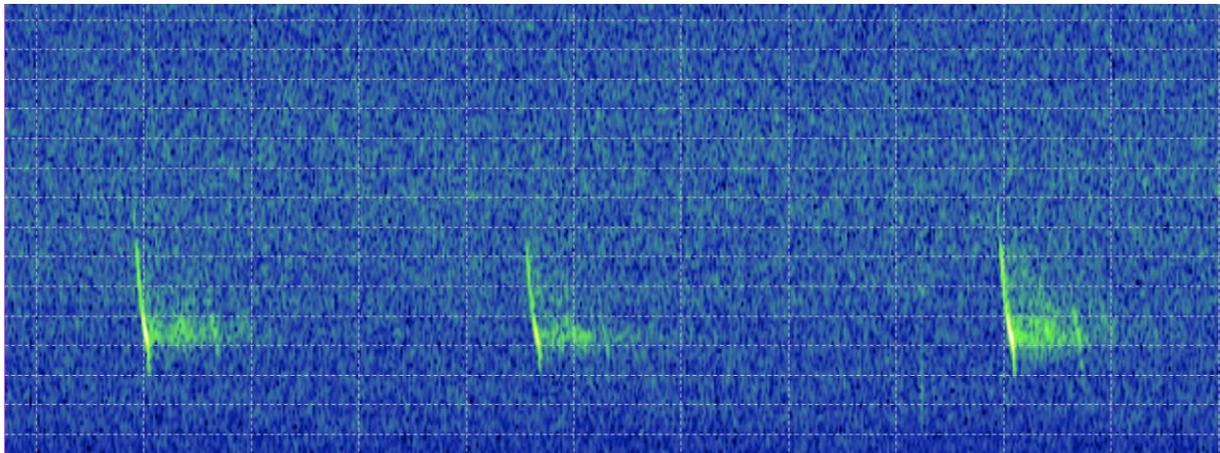




SBBG – Swiss Bat Bioacoustics Group

Guidelines for the recording, analysis and validation of bat calls in Switzerland

Version 1.3e, February 2021



Ce document aussi existe en français

Dieses Dokument existiert auch auf Deutsch

Summary

Over the past years, bioacoustics has become a central element of basic and applied bat research. Despite numerous advantages, method-dependent restrictions of this approach must not be ignored. Certain criteria need to be fulfilled to produce evidence-based data. Crucial is the traceability of species identifications. This is especially true if the data are to be integrated in the national databases of bat conservation Switzerland KOF/CCO and the Swiss center for the cartography of fauna CSCF. We define requirements on how bat species records obtained using bioacoustic methods must be validated in a standardized and reproducible manner to make them useable for scientific projects and for integration into national databases. This document illustrates basic aspects of bioacoustic data acquisition and introduces a system in which species – broken down by region and in relation to their abundance and difficulty of acoustic identification – are grouped into three categories. Depending on the category, different criteria must be met to classify an acoustic species record as certain and validated. While records of common and easily identifiable species do not require additional validation, records of uncommon species and/or species that are hard to identify must be confirmed by accredited experts.

Publisher:

Swiss Bat Bioacoustics Group (SBBG). The SBBG is a union of bat bioacoustics experts in Switzerland. The SBBG is financially supported by the Swiss Federal Office for the Environment FOEV and aims at advancing research and conservation of native bat species with bioacoustic methods.

Members of the SBBG (at the time of publication of the document)

Elias Bader, MSc Biology
Thierry Bohnenstengel, MSc Biology
Dr. Fabio Bontadina
Annie Frey-Ehrenbold, MSc Biology
René Gerber
Silvio Hoch
Dr. Jens Koblitz
Dr. Hubert Krättli
Marzia Mattei, Dipl. Zool.
Dr. Martin K. Obrist
Emmanuel Rey, Dipl. Biol.
Dr. Thomas Sattler
Grégoire Schaub BSc Biology
Dr. Daniela Schmieder
Cyril Schönbächler
Dr. Karl Zbinden
Dr. Peter E. Zingg

Version 1.3e, February 2021

Citation:

Bader, E., F. Bontadina, A. Frey-Ehrenbold; C. Schönbächler, P. E. Zingg & M. K. Obrist (2017). Guidelines for the recording, analysis and validation of bat calls in Switzerland. Report of the Swiss Bat Bioacoustics Group SBBG, Version 1.3e, February 2021. 21 pages.

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Kindly supported by the Swiss Federal Office of the Environment FOEV

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1. Introduction

Bat research is still confronted with numerous challenges.

Nocturnal and flying lifestyle, small body size and the ability to detect and avoid even the finest mesh complicate the study of bats in the field. With the increased use of bioacoustics, however, a new era in field biology has been launched. Now it is possible to study bats without needing to catch them, which means less stress for both animal and scientist. At the same time, the amount of data collected with the same effort can be increased significantly.

The big advantages and opportunities of bioacoustics are:

- Non-invasive
- Inquiries in areas and habitats not accessible with traditional methods
- Automated data collection
- Simultaneous data collection at different locations
- Collection of large datasets

At the same time, however, there are certain disadvantages:

- Partially uncertain species identification due to similarity between calls of different species
- Impossible to distinguish individuals (activity \neq abundance)
- Varying directivity and sensitivity of different recording devices impede inter-comparability of data
- Physical limits: detection distance depends on air temperature and humidity, as well as on species-specific call characteristics. A consequence is varying detection probability.
- Analysis of large data sets is very time consuming

Despite these limitations, bioacoustics is a powerful tool to investigate bats and their behavior in the field. The following guidelines are proposed to help collect bioacoustic data in a way that makes species identifications reproducible. This is a crucial prerequisite to allow for validation and confirmation of calls of species that are uncommon and/or hard to identify. Correspondence of identifications with these guidelines is a precondition for the inclusion of data in the databases of bat conservation Switzerland (KOF/CCO), the Swiss Center for the Cartography of Fauna (CSCF) and the Cantons. Federation and Cantons are asked to require the application of the guidelines in the context of environmental risk and mitigation assessments (e.g. wind farm projects) and in the implementation of bat conservation.

The guidelines presented herewith are addressed to those involved in bat research and conservation, as well as decision makers in administration whom at least possess some basic knowledge on bat ecology and bioacoustics. Beginners are recommended to first read some general bat literature or to participate in training as a regional bat conservation volunteer, offered regularly in various cantons.

2. Requirements on devices, sampling sites and recording techniques

Automated and manual recordings

Before fieldwork

- Create protocol sheet
- Check settings of every device (Hardware & Software). Within a project, only devices of the same build and with the same settings shall be used. This ensures the inter-comparability of data.
- Check that batteries are charged and that enough data storage capacity is available.
- Check sensitivity of the microphones. We recommend a comparison recording before the project starts.

In the field

- If possible, select quiet locations with no or little background noise (no broadband signals – audible or ultrasound). Special attention is required when it comes to running water (wells, cataracts, rain etc.)
- Avoid on transect recordings: Noise of motors, wheels, keys etc. Ideally only point transects.
- Place microphones in a way such that echoes are minimized. This can be achieved by sufficient distance (ideally > 10m) to hard, smooth surfaces (including water).
- Avoid damage to crops at installation and removal of devices.

Additional requirements for automated recordings

- Place the microphone at least 1.5 m (ideally 2 m) above the ground and position it so that water cannot enter.
- Theft can be avoided by placing devices inconspicuously/masked and by adapting the color of the setup to its surroundings.
- Label each device with information on the project and contact details.
- Inform land owners beforehand and obtain permits, where necessary.
- Regularly check the sensitivity of the microphones during the season.
- Only collect the data you need, as collection is easy but analysis is laborious.

3. Data analysis

a) General

Currently, there are various software packages for automated recognition and classification of recorded bat calls. This could mislead novices into relying completely on the software output. To date, however, no such software works free of errors. In fact, the assessment of several experienced identifiers is often needed to identify a species reliably and in certain cases, identification is not even possible.

The assignment of a call to a species by software can only be as good as the calls that were used to train the software. It is therefore of imminent importance that a person using such software can identify species manually and knows enough about ecology and call types to critically double check the software output.

Species identification of bats by calls is an issue of experience, in which even after years of practice progress can still be made. Beginners are highly recommended to take a course on the topic, which can help to prevent strategical and qualitative errors from the beginning. Such courses are offered by the Swiss Bat Bioacoustics Group SBBG (www.sbbg.ch). Still, even for experts, there happen to be situations where calls and call sequences cannot clearly be attributed to a bat species. Another important point to be considered with automated recordings is the fact that with such recordings, the amount of collected data easily reaches gigabytes or even terabytes. Well-structured sampling and good organization of data is essential from the beginning. The temporal effort needed for the analysis of such data can easily outnumber the sampling effort. This should be considered already in the planning phase of a project.

There are different ways to recognize and process bat calls on the computer. Some of these need a special pre-treatment of the collected data. Differences can already show up in the recording process. Quantitative results produced with different recording techniques can never, qualitative only with restrictions be compared among each other.

- **Real time high frequency recordings:** This is the most common system of automated data collection (e.g. Batlogger, Batcorder, SM4, etc.). Bat calls are recorded in real time, stored on an SD card and can then be analyzed with corresponding software. As the signals are recorded digitally and with a high resolution, this method is especially useful for the verification and subsequent validation of species that are rare and/or hard to identify (categories 1 and 2 of the validation table in appendix 1).
- **Time expansion with simultaneous recording:** Time expansion devices (e.g. D240X) were designed primarily for the direct listening and interpretation of bat calls in the field. In combination with a recording device, however, they allow the collection of time-expanded recordings and thus offer an opportunity to collect data for later validation of species belonging to the categories 1 and 2.
- **Time expansion without simultaneous recording:** The devices used for this approach are usually the same as mentioned before (e.g. Petterson D240X), but run without a recording device. Species identification with this method is solely based on the observer's experience and instantaneous perception in the moment the observation takes place. A validation or revision later on is not possible. Species records collected this way are only useable for species that need no validation (category 0 and, with restrictions, category 1 in appendix 1).
- **Heterodyne detectors:** Like the devices mentioned before, heterodyne detectors only allow for direct identification in the field. Signal quality and sound depend greatly on the settings of the device. Consequently, even with recordings, the records cannot be

validated. Species records collected with this method, therefore, are only valid for species that need no validation (category 0 and, with restrictions, category 1).

- **Zero crossing:** This technique is used in devices from Anabat and all frequency dividers. They allow for the taping of large data sets at low power consumption and low data volume. The signal transformation carried out in this process comes with a loss of information, as calls are recorded in a much lower frequency resolution. This is disadvantageous for species identification; for several genera and species, respectively, identification to species level is often not possible with such recordings.

b) Automated species identification

For the (partially) automated species identification, real time recordings as produced by e.g. Batlogger or Batcorder are most suitable and often even indispensable. Commonly used software for the automated species identification of bat calls are inter alia: BatScope¹, BatIdent², SonoChiro³ und Kaleidoscope⁴. Additional software is launched regularly. Even though these programs are not yet able to produce reliable results, they are provide great assistance for culling, organizing and filtering recorded sequences, especially if they have direct access to the sequence database. By culling the sequences with no bat calls or that contain only common pipistrelles, the amount of data that needs manual revision can be reduced greatly.

c) Manual species identification

With the current state of the technique, we recommend as well that automatically identified sequences – especially sequences of uncommon species – be double checked manually before they are passed on for validation. This has a positive impact on the costs to be spent for validation, as the number of sequences that are not identifiable or do not even contain bat calls, but are erroneously attributed to a species by software can be drastically reduced.

Neither with a manual approach by an experienced identifier can each call or sequence be attributed to a species. For some, this is only possible to the level of sonotypes, i.e., a group of species with similar call characteristics. To avoid misidentifications, calls and sequences, respectively, are only identified down to the lowest taxonomic/acoustic level at which a doubtless identification is still possible.

When in doubt, it is better to leave a call or sequence with a correct sonotype rather than an incorrect species identification.

To stay conservative is one of the most fundamental rules in bat bioacoustics. To date, species of the following groups either cannot be separated or are hardly possible to separate acoustically. Identification to species level therefore needs a sound explanatory statement to avoid a downgrade to sonotype level in the validation process:

- Species of the genus *Plecotus*
- *Myotis capaccinii* and *M. daubentonii*. Due to the rareness of *M. capaccinii* and its northern distribution limit in Southern Switzerland, as well as the commonness and wide distribution of *M. daubentonii*, it is legitimate to attribute calls to *M. daubentonii* but not to *M. capaccinii*.
- *Myotis blythii* and *M. myotis*.
- *Myotis brandtii* and *M. mystacinus*

¹ <http://www.batscope.ch>

² <http://www.ecoobs.de/cnt-batIdent.html>

³ <http://www.biotope.fr/fr/innovation/sonochiro>

⁴ <https://www.wildlifeacoustics.com/products/kaleidoscope-software-ultrasonic>

- *Myotis nattereri* and *M. crypticus* (to date, also the exact distributions of the two species in Switzerland are unknown)

Manual species identification works best with a hierarchical approach:

- First, it is diagnosed whether a call is constant frequent (CF), frequency modulated-quasi constant frequent (FM-QCF) or frequency modulated (FM). This usually helps to significantly reduce the number of species to be considered.
- Then, a set of call characteristics helpful for species identification is extracted. These characteristics may include: maximum frequency, peak frequency, minimum frequency, bandwidth, call duration and inter-call-interval. Which characteristics are needed depends on the species, or sonotype, respectively.
- Additionally, for species of the genus *Myotis*, the position and specification of the ‘Myotis kink’ may be helpful. Due to the large variability of bat calls, it is usually not acceptable to identify a species by only a single call. Often, several calls (>5) or even sequences are needed for reliable identification. In Switzerland, the Lesser and Greater Horseshoe Bat (*Rhinolophus* sp.) are exceptions, as only a few calls can be diagnostic.

If a combined approach of automated and manual identification is chosen, then data can be identified by the software before or after the procedure mentioned above. Since an initial automated identification reduces workload for the aforementioned reasons, it is usually the preferred course of action for large datasets. However, an initial manual identification reduces the risk of biases.

d) References for species identification

The references below (books & tables) can be helpful for the manual, as well as the automated species identification:

Barataud, M., 2015. Acoustic Ecology of European Bats. Biotope Editions, Paris F. (available in french and english)

Middleton, N., Froud, A. and French, K., 2014. Social Calls of the Bats of Britain and Ireland. Pelagic Publishing.

Pfalzer, G., 2002. Inter- and intraspecific variability of social calls from native bat species (Chiroptera: Vespertilionidae). Thesis, 95 pp. [Access](#)

Russ, J., 2012. British bat calls. A guide to species identification. Pelagic Publishing, Exeter UK

Skiba, R., 2009. Europäische Fledermäuse - Kennzeichen, Echoortung und Detektoranwendung. 2. Auflage, Die neue Brehm-Bücherei, Bd.64

- Tables with species-specific call parameters can be found at:

Hammer, M. and A. Zahn, 2009. Kriterien für die Wertung von Artnachweisen basierend auf Lautaufnahmen. Report, 16. pp. [Link](#)

Limits of echolocation calls of european bats. 2009. [Link](#) (german, french, english and dutch)

Haquart, A. 2009. Fiches acoustiques de Chiroptères de France et du Var. 29 Seiten.

Access (french)

BatEcho. Reference calls and measurements. Open access software. [Link](#)

<http://ecologieacoustique.fr>

e) **Software for the analysis of bat calls**

For the manual, as well as the automated species identification, software can be useful for visualizing and measuring recorded sequences and, therewith, for identification. Below is a list of recommended and commonly used software.

BatScope⁵,
BatIdent⁶
Raven (Lite: free; Pro: licensed)⁷
BatSound (licensed)⁸
Audacity (free)⁹
SonoChiro (licensed)¹⁰
Kaleidoscope (licensed)¹¹

Caution: Some call parameters like maximum and minimum frequency may depend strongly on the device settings, microphone sensitivity, relative humidity and the position of the bat in relation to the microphone. Also, software may cause differences in output.

To avoid problems caused by device-specific differences, only devices of the same make and with identical settings should be used within a project, and recordings should be made only under suitable weather conditions. The sensitivity of microphones must be checked regularly. Additionally, it is recommended to stick with one or few programs in order to get an experience- based feeling for the respective output. Finally, one's own data should only be compared with reference literature data that was collected in a comparable way.

4. Data validation

- a) **Prerequisites:** The diversity of the different bat species' calls encompasses easily/certainly identifiable calls, calls that are questionable and calls that simply cannot be attributed to a species. None of the software available at present can identify all bat calls free of error. Consequently, calls of different species must be handled differently in the validation process. Those who analyze acoustic bat data must be familiar with the calls of the different species and be able to identify them manually, too.
- b) **Conceptual basics:** The calls of certain bat species are difficult to identify. Furthermore, for many species, distribution in Switzerland is only partially known. Even on a cantonal level, there exist only scattered records for many species. Consequentially, validation of bat calls is conducted depending on difficulty of identification and known distribution in the cantons. Three categories are defined for validation, as shown in table 1.

⁵ <http://www.batscope.ch>

⁶ <http://www.ecoobs.de/cnt-batIdent.html>

⁷ https://store.birds.cornell.edu/Raven_s/20.htm

⁸ <http://www.batsound.com/?p=15>

⁹ <http://www.audacityteam.org>

¹⁰ <http://www.leclub-biotope.com/fr/content/22-sonochiro>

¹¹ <https://www.wildlifeacoustics.com/products/kaleidoscope-software>

| Kat. | validation | justification |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 0 | No validation necessary | These species are easy to identify and common and well known in the canton. |
| 1 | Validation by two experts, if at least one of the following criteria applies <ul style="list-style-type: none"> - first record for the Canton - no record past 2000 (in red) in the square itself and its adjacent squares (5x5 km resolution, see lepus.unine.ch) | Records of these species are uncommon and/or the species is difficult to identify. |
| 2 | Validation by two experts mandatory | These species are rare or were not recorded yet in the respective canton and/or their identification on species level is very difficult. |

Table 1: Categories for the validation of acoustic bat records

- c) **Validation procedure:** first, it is determined to which category the identified species belongs.
- If the species belongs to **category 0**, then no further validation is necessary. It is a species that is common and widely distributed, whose identification usually does not involve any problems.
 - Species of **category 1** require a more detailed inspection. They are either difficult to identify, little known, or their distribution across Switzerland is very patchy. For such species, a validation is necessary if at least one of the following criteria applies:
 - The species was never recorded in the respective Canton and time period. This information can be obtained from table in the Appendix 1.
 - The closest record from the species since 2000 lays outside the respective 25 km² square itself and its adjacent squares. This information can be obtained from the CSCF website, lepus.unine.ch, on which the known distribution of each species (red squares for records past 2000) can be visualized with a 5x5 km resolution
 - Records that fall into **category 2** must be validated in every case. They concern species that are rare to very rare and often hard to identify, as well as species whose records are limited to geographically restricted areas.

Calls of uncommon species and species that are hard to identify must always be **validated** by two bat bioacoustics experts accredited in Switzerland. If the calls were already identified at first hand by an SBBG member, then validation by one more expert is sufficient. If the experts do not agree on an

identification, then the corresponding sequence must be downgraded to genus or sonotype level, i.e., the largest common denominator. The corresponding procedure is shown in figure 1.

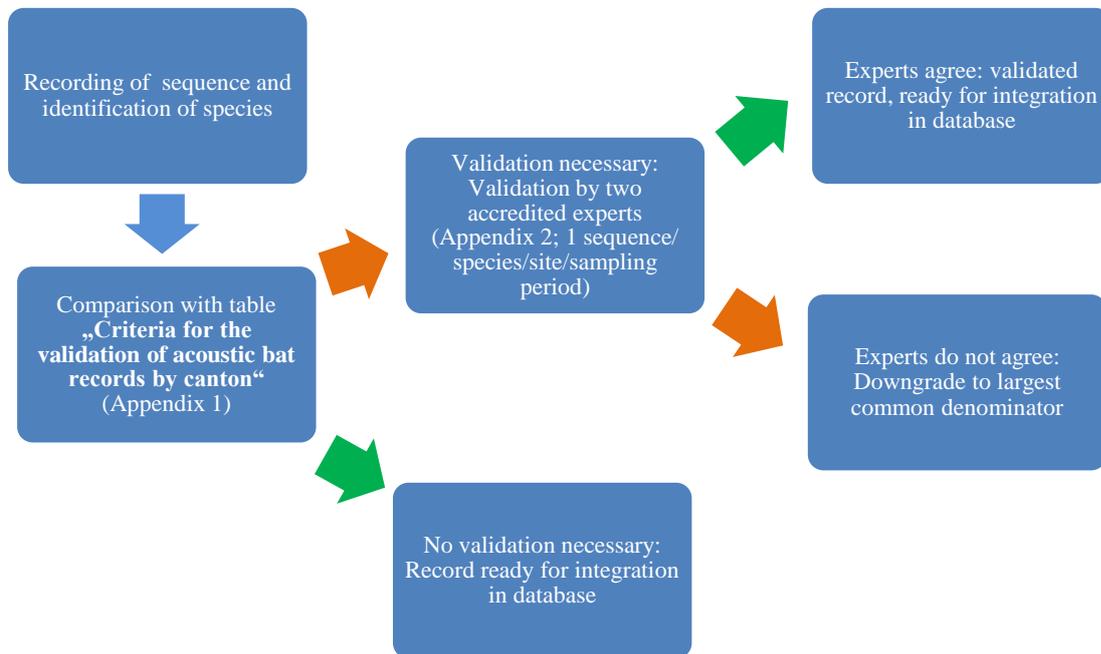


Figure 1: Procedure for the validation of bat call sequences

If a larger number of sequences from one site are assigned to a species with validation needed, then it is not necessary to have all these sequences validated. We recommend in such cases that at least one representative sequence per sampling period (time span of field work, but no longer than 1 month) and site (or km²) be submitted for validation. If the submitted sequence does not suffice for species identification, a submission of further sequences may be requested; for sequences that contain only a few calls or difficult species, several sequences should be submitted at the beginning.

The SBBG provides a list broken down to species and canton (see Appendix 1) which contains the **criteria** for a validated species record. Further, the SBBG runs a list of validation experts (Appendix 2) and ensures their qualifications. Both lists are periodically updated.

- d) Application:** We recommend a data validation for every serious bioacoustics project in Switzerland according to the aforementioned standards. A correct validation is especially important for data collected in an official context, e.g. mandates from the government, environmental impact assessments, and records that are to be included in the cantonal and national databases (for declaration see below). Data validation is always part of the project and correct application of the guidelines is the duty of the project leaders. As validation of bioacoustics data may represent a considerable workload, requirements in terms of time and money must already be considered in the planning and fundraising phase of a project.

- e) **Declaration:** If the aforementioned procedure for the validation of bioacoustic data is met, then we recommend it be declared with the following statement:

The validation of the bioacoustic data was effected with respect to the guidelines of the Swiss Bat Bioacoustic Group (SBBG 2017).



5. Use of acoustic data for research and conservation

To make acoustic data accessible for bat research and conservation, we highly recommend all bioacoustic data be validated, if necessary, and transmitted to the cantonal and national databases. The cantons shall foresee a budget for this task in the framework of their bat conservation mandates. Cantonal and national administrations are requested to compulsorily and explicitly presuppose the following two aspects:

- The validation of bioacoustics bat records following the SBBG guidelines, as well as
- The provision of acoustic bat records to the respective cantonal and national databases for use in conservation and research.

To make acoustic data capable of being integrated into the cantonal and national databases, at least the subsequent set of information must be provided with each species identification:

- Exact date
- Sampling site (ZIP code, municipality, local name)
- Coordinates (Swiss Grid System LV95), as accurate as possible
- Accuracy of coordinates
- Identifier (name and address)
- Validators, if validation necessary

This information can be compiled in an excel sheet as shown in Appendix 3. Only data that fulfill the validation standards – i.e., that was validated by experts if necessary – is passed on.

Such data is transmitted to the coordination centers KOF/CCO. The coordination centers take care of the integration into the database and the information of the cantons.

For further information on data transfer, please see Appendix 3.

6. Relevant literature on bat bioacoustics

An up-to-date list with relevant literature on bioacoustics can be found on our website, www.sbbg.ch.

7. Appendix

Appendix 1: Table of criteria for the validation of acoustic bat records per canton

Appendix 2: List of experts for the validation of bat calls in Switzerland

Appendix 3: Requirements and data array for the transmission of validated bioacoustic data to the databases

| Species | Difficulty of acoustic identification | AG | AR | AI | BE | BL | BS | FR | GE | GL | GR | JU | LU | NE | NW | OW | SG | SH | SO | SZ | TG | TI | UR | VD | VS | ZG | ZH | FL | Confusions possible with the following species: |
|-----------------------------------|---------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Rhinolophus ferrumequinum</i> | A | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - |
| <i>Rhinolophus hipposideros</i> | A | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - |
| <i>Barbastella barbastellus</i> | A | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>Plecotus</i> sp., <i>M. myotis</i> / <i>blythii</i> |
| <i>Plecotus auritus</i> | C | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | <i>Plecotus</i> sp. (hardly distinguishable), <i>B. barbastellus</i> , <i>V. murinus</i> , <i>E. serotinus</i> |
| <i>Plecotus austriacus</i> | C | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>Plecotus</i> sp. (hardly distinguishable), <i>B. barbastellus</i> , <i>V. murinus</i> , <i>E. serotinus</i> |
| <i>Plecotus macbullaris</i> | C | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>Plecotus</i> sp. (hardly distinguishable), <i>B. barbastellus</i> , <i>V. murinus</i> , <i>E. serotinus</i> |
| <i>Myotis alcaethoe</i> | C | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>P. pipistrellus</i> , <i>M. emarginatus</i> , <i>M. mystacinus/brandtii</i> , <i>Myotis</i> sp. |
| <i>Myotis bechsteinii</i> | C | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>M. daubentonii</i> , <i>M. emarginatus</i> , <i>M. myotis</i> / <i>blythii</i> , <i>M. mystacinus/brandtii</i> , <i>M. nattereri/crypticus</i> |
| <i>Myotis blythii</i> | C | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>M. myotis</i> (hardly distinguishable), <i>Myotis</i> sp. |
| <i>Myotis brandtii</i> | C | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>M. mystacinus</i> (hardly distinguishable) <i>M. alcaethoe</i> , <i>M. bechsteinii</i> , <i>M. daubentonii</i> , <i>M. emarginatus</i> |
| <i>Myotis capaccinii</i> | C | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>M. daubentonii</i> , <i>M. mystacinus/brandtii</i> , <i>M. bechsteinii</i> |
| <i>Myotis daubentonii</i> | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | <i>M. capaccinii</i> , <i>M. mystacinus/brandtii</i> , <i>M. bechsteinii</i> , <i>M. myotis</i> |
| <i>Myotis emarginatus</i> | C | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>M. alcaethoe</i> , <i>M. bechsteinii</i> , <i>M. mystacinus/brandtii</i> , <i>M. nattereri/crypticus</i> |
| <i>Myotis myotis</i> | C | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | <i>E. serotinus</i> , <i>M. blythii</i> (hardly distinguishable), <i>M. bechsteinii</i> , <i>M. daubentonii</i> , <i>M. nattereri/crypticus</i> |
| <i>Myotis mystacinus</i> | C | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | <i>M. brandtii</i> (hardly distinguishable), <i>M. alcaethoe</i> , <i>M. bechsteinii</i> , <i>M. daubentonii</i> , <i>M. emarginatus</i> |
| <i>Myotis nattereri/crypticus</i> | C | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | <i>M. bechsteinii</i> , <i>M. emarginatus</i> , <i>M. myotis</i> , <i>M. blythii</i> |
| <i>Eptesicus nilssonii</i> | B | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>E. serotinus</i> , <i>H. savii</i> , <i>N. leisleri</i> , <i>V. murinus</i> |
| <i>Eptesicus serotinus</i> | B | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>E. nilssonii</i> , <i>N. leisleri</i> , <i>N. noctula</i> , <i>V. murinus</i> , <i>M. myotis</i> |
| <i>Nyctalus lasiopterus</i> | B | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>N. noctula</i> , <i>N. leisleri</i> (social calls), <i>T. teniotis</i> |
| <i>Nyctalus leisleri</i> | B | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | <i>E. serotinus</i> , <i>E. nilssonii</i> , <i>N. noctula</i> , <i>V. murinus</i> |
| <i>Nyctalus noctula</i> | B | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | <i>E. serotinus</i> , <i>N. leisleri</i> , <i>V. murinus</i> , various social calls |
| <i>Vespertilio murinus</i> | C | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | <i>E. serotinus</i> , <i>E. nilssonii</i> , <i>N. leisleri</i> , <i>N. noctula</i> |
| <i>Tadarida teniotis</i> | A | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>N. noctula</i> , <i>N. leisleri</i> (social calls) |

| Species | Difficulty of acoustic identification | AG | AR | AI | BE | BL | BS | FR | GE | GL | GR | JU | LU | NE | NW | OW | SG | SH | SO | SZ | TG | TI | UR | VD | VS | ZG | ZH | FL | Confusions possible with the following species: |
|----------------------------------|---------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---------------------------------------------------------------------------------------|
| <i>Hypsugo savii</i> | A | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 1 | 2 | 2 | 2 | <i>E. nilssonii</i> , <i>P. kuhlii</i> , <i>P. nathusii</i> |
| <i>Pipistrellus kuhlii</i> | B (with social calls: A) | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | <i>H. savii</i> , <i>P. nathusii</i> , <i>P. pipistrellus</i> |
| <i>Pipistrellus nathusii</i> | B (with social calls: A) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | <i>P. kuhlii</i> , <i>P. pipistrellus</i> |
| <i>Pipistrellus pipistrellus</i> | A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | <i>M. alcathoe</i> , <i>M. schreibersii</i> , <i>P. pygmaeus</i> , <i>P. nathusii</i> |
| <i>Pipistrellus pygmaeus</i> | A | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | <i>M. schreibersii</i> , <i>P. pipistrellus</i> |
| <i>Miniopterus schreibersii</i> | C | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | <i>P. pipistrellus</i> , <i>P. pygmaeus</i> |

| Difficulty of identification | |
|------------------------------|-------------------------------------------------------------------------------------------------------|
| A | easy - can usually be identified with little experience |
| B | intermediate - identification can be challenging but is usually possible with few years of experience |
| C | difficult - identification usually only possible with several years of experience |

| | |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0 | no validation needed |
| 1 | Expert validation needed if first record in canton or first record in respective or adjacent 5x5 km square (past 2000); see https://lepus.unine.ch |
| 2 | Validation by two experts mandatory |
| . | Species already recorded in the canton |

Version 1.3e: February 2021

Data sources

Included are all data from the KOF/CCO/CSCF database since 2000.

Appendix 2: List of experts for the validation of bat calls in Switzerland

The experts mentioned below are accredited by the SBBG to validate bat calls in Switzerland. To become listed as an expert, please contact info@sbbg.ch.

| Name | Vorname |
|---------------|----------------|
| Bader | Elias |
| Bohnenstengel | Thierry |
| Bontadina | Fabio |
| Frey | Annie |
| Gerber | René |
| Krättli | Hubert |
| Märki | Kathi |
| Mattei-Roesli | Marzia |
| Obrist | Martin |
| Rey | Emmanuel |
| Schmieder | Daniela |
| Schönbächler | Cyril |
| Zbinden | Karl |
| Zingg | Peter |

Appendix 3: Requirements for the integration of bioacoustic data into cantonal and national databases

Aims

- 1) Propose a solution on how to achieve that all useful bioacoustic data collected in Switzerland is provided for the fauna databases: cantonal and national (InfoSpecies)
- 2) Outline the workflow from validated bioacoustic data (according to SBBG standard) to confirmed records in the relevant database(s)

What bioacoustic data to enter the databases?

1. Data must be validated according to the most recent guidelines (Guidelines for collection, analysis and validation of bat calls in Switzerland, SBBG 2017).
2. Reduction of data according to the ONE rule: 1 record = 1 species/1 date/1 location/1 observer
 - the date is accepted as the date of the evening (not two dates necessary in one night)
 - the density might be reduced to a single record per month (voluntary) – but also single nights are ok
 - location is always the location of the recording unit
 - accuracy of the location is 50m (code 5) or 10m (code 6) (InfoSpecies / gbif.ch)
 - a single best sound file must be identified and its name included in the record (the file is stored but initially not submitted)

How and when to submit bioacoustic data?

1. Data submission by using the template Excel sheet (see below)
2. The provider of the data records is responsible to archive the original data (wav / raw files)
3. The original data files are provided by the data owner, if required (e.g. for additional validation, for a study)
4. The records should be submitted by the end of the year
 - in the eastern Part of Switzerland: to KOF, fledermaus@zoo.ch
Once the data is integrated in the database, the cantonal responsible (KFB) is notified by KOF
 - in the western Part of Switzerland (Suisse Romande): to the data centre of the CCO, thierry.bohnstengel@unine.ch
5. In the case of students / volunteers the CSCF might offer support for the task of data validation / extraction of the relevant data sets or archiving of the raw data, contact: thierry.bohnstengel@unine.ch

Tasks and responsibilities of the partners

Users

- Documentation of recording
- Selection of relevant files for species identification (particular representative sound files)
- Extraction of sequences by the ONE rule
- Saving and storage of source sequences
- Inducement of validation process as explained in this document

Experts

- Identification of key sequences for species ID (single representative sequences as sound files)
- Extraction of sequences by ONE rule
- Saving and storage of source files
- Validation of sequences according to SBBG standard
- Documentation of validation
- Transmission of excel file to CSCF/CCO or KOF

CSCF/KOF

- Confirmation of receipt of data to source (expert)
- Integration of records into the CSCF/swissbats database
- Reporting to expert on how many records were integrated
- Reporting the number of records included in database to SBBG annually
- Occasional help for students/volunteers in extraction of data / archiving of original sequences

Why should I submit bioacoustic data?

It is one of the key aims of the SBBG to make the bioacoustics data accessible for bat conservation and research

These data contribute to the knowledge of species distributions and basic data for conservation. They allow that the species can be considered in the different fields affecting biodiversity (agriculture, forest management, urbanization, landscape and infrastructure planning).

The suggested procedure benefits all partners: Swiss Bat Conservation CCO/KOF, CSCF, Cantons and BAFU.

In special cases (e.g. students / volunteers) the CSCF can help in the preparation of the data

It should become a standard requirement in cantonal and federal projects (e.g. requested in the current proposal of Vollzugshilfe UVP Windenergie und Fledermäuse)

It allows to monitor the achievements of myself / of the SBBG group / of bat bioacoustics in Switzerland

There is an Excel screenshot as template for the data entry:

Matrix Info fauna / CCO zur Erfassung von Beobachtungen und Belegsdaten

Schema V0.1, 2017-04-11 TB / Adaption 2017-04-12 FB

SBBG-2-CSCF_2017a.xlsx

Pflichtangabe

fakultativ

| Spaltenname | Erklärung | Levels | Bsp |
|-----------------------|--------------------------------------------------------------------------------------------------|----------------------------------|---------------------------|
| SCIENTIFICNAME * | Wissenschaftlicher Name: Gattung, Art, Unterart | --> Tab /SPE | Barbastella barbastellus |
| DAY * | Datum: Tag der Aufnahme/ Beobachtung | 1 - 31 | 12 |
| MONTH * | Datum: Monat der Aufnahme/ Beobachtung | 1 - 12 | 8 |
| YEAR * | Datum: Jahr der Aufnahme/ Beobachtung | 2000 - 2050 | 2015 |
| ORIGINALLOCALITY * | Vollständige Ortsangabe: Falls ab Etiketle: Ergänzte und interpretierte Elemente in | swisstopo names | Cudrefin, Champs montants |
| CANTON * | Kanton: Verwaltungseinheit (Kanton, Departement, Bundesland) | Swiss cantons, 2 chars | VD |
| SWISSCOORDINATE_X * | CH1903(+): Ostwert | | 566500 |
| SWISSCOORDINATE_Y * | CH1903(+): Nordwert | | 199500 |
| COORDMAXDEVIATION * | Punktradius: Maximale Unschärfe in Meter | 10 or 50 | 10 |
| COLLECTOR-OBSERVER * | Sammler, Beobachter: Nachname Vorname <u>ausgeschrieben</u> . Mehrere Namen mit Komma | Recording person | Hirsch Harry |
| FIELDMETHOD (*) | Methode der Beprobung (Liste) | --> Tab /FMT | PECO |
| DETERMINATOR | Bestimmer: Nachname Vorname <u>ausgeschrieben</u> , bei Sammlungsbelegen <u>gefolgt vom Jahr</u> | Validating expert | Bossy Betty |
| EVIDENCETYPE (*) | Art des Nachweises oder die Validation erlaubendes Kriterium (Liste) | --> Tab /EVT | |
| NAMEACCORDINGTO* | Bibliographische Referenz oder automatische software referenz | Barataud 2012 / Software version | Batscope 3.2 |
| FIELDID | Vom Sammler zugeordnete Kennnummer | Individual recording ID | PZ-1201 |
| SCIENTIFICPUBLICATION | Bibliographische Referenz | Filename of reference call | MBR-200340459.wav |

HINWEIS:

Alle Nachweise werden dem im Blatt METADATA eingetragenen Urheber und Dateneigentümer zugeordnet.

Im Falle mehrerer Projekte sind separate Dateien zu übermitteln.