# Continuation of the recordings at the research station Jungfraujoch on the activity and migration behaviour of bats

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## 1. Project description

In 2011 (May, Aug, Sept, Oct), using a batlogger, we detected for the first time that bats fly over the Jungfraujoch. A crossing of such high altitudes in the alpine region in connection with seasonal migration was unknown until then (Zingg & Bontadina 2016). Batloggers (www.batlogger.com) are data loggers, which record ultrasound vocalisations (10-150 kHz) of bats in real-time, and store them in a digitised form for later processing on a SD / SDHC memory card. A temperature sensor (range -5°C to +40°C) is integrated in the microphone. With each sound sequence, air temperature, date, time, location etc. are registered on a meta data file. With a batlogger and its microphone, only a small area can be scanned for bats calling in flight. The detection distance (between microphone and bat) ranges from a few metres to almost a hundred metres, depending on the bat species and the range of its calls. For most combinations of bat species passing through, flight direction, wind direction, etc. in relation to the microphone, the effective detection distance should be less than 50 m in most cases.

In 2011 and 2012, a batlogger with autonomous power supply was operated unsystematically not far from the lowest point (3464 m.a.s.l.) on the north-south transition, the so-called plateau (A in Fig. 1), during single nights with air temperatures above zero degrees Celsius (compare Activity Report 2012; https://www.hfsjg.ch/).

In 2018, we operated two to three batloggers simultaneously for two to three nights at the end of April, May, June and July, mostly on the plateau and the research station, and once each on the Sphinx and the Mönchsjoch (Activity Report 2018). In order to reduce the presence and time required at the Jungfraujoch and at the same time to enable continuous monitoring, we installed and operated a batlogger C outside the research station (C in Fig. 1) for the first time from June to the end of October 2019, with electricity supplied from the grid (Activity Report 2019).

Due to restrictions caused by the SARS-CoV-2 pandemic, the batlogger C could not be installed and commissioned at the research station this year until 8 May 2020. We ended the mission for this year on 29 October.

The research station site in a rocky flank, exposed to the south (C in Fig. 1), used in 2019 and 2020, is 370 m ESE of the lowest point of the Jungfraujoch. The data collected at this site C are therefore likely to be different from those collected on the plateau (site A). Additional monitoring on the plateau (A) would be desirable as a supplement to the research station site (C).

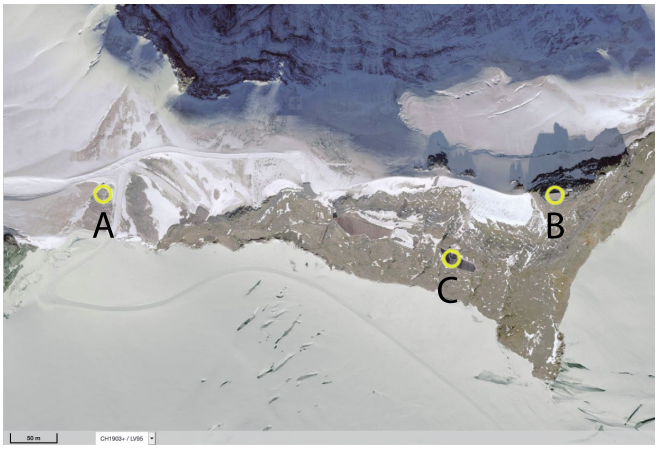


*Figure 1. Batlogger locations: A – Plateau, B – Sphinx, C – Research station (Areal photo from https://map.geo.admin.ch).*

## 2. Goals

The Jungfraujoch is an extreme location for most creatures. Therefore, we are interested in which bat species visit the Jungfraujoch or cross it as part of their seasonal migration and when in the year and under which weather conditions these specific visits or crossings happen. Weather patterns vary from year to year and are also influenced by ongoing climate change. Consequently, the presence and activity patterns of the different bat species on the Jungfraujoch are likely to vary from year to year

or show medium-term trends. This requires continuous monitoring over the years in order to identify correlations and long-term trends.

**3. Main results 2020**

From 8 May to 29 October (175 operating nights) a total of 27'250 events were triggered. 99% of the recorded events (sound sequences) were related to wind noise, falling ice and water. Among these 246 sequences concerned the echolocation calls of bats (hereafter simplified as bat call sequences). The distribution of these bat call sequences during the nights and over the months of May to October is shown in Figure 2. The abundances in May (45), August (78) and September (89) are likely to be largely the result of seasonal migration of various bat species.

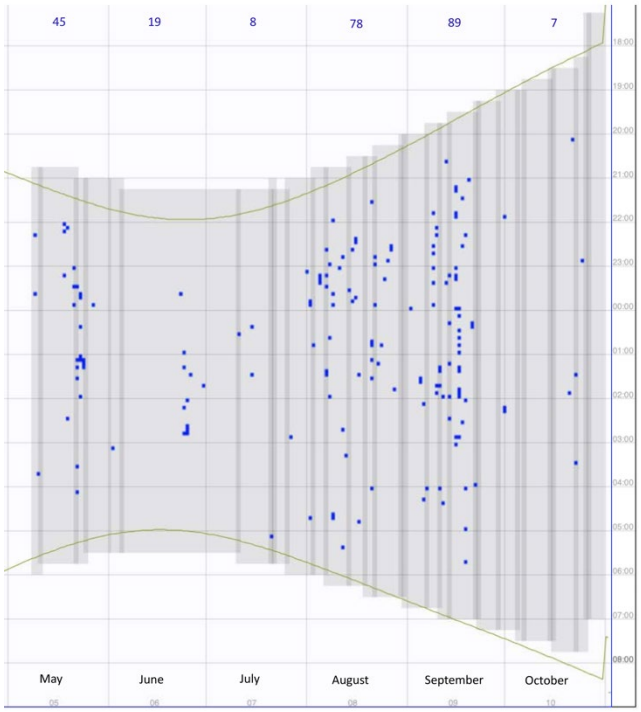


*Figure 2. Temporal distribution of bat call sequences recorded by the batlogger C at the research station during the nights from 8 May to 29 October 2020. Horizontal axis: months May to October; vertical axis: nighttime between sunset (upper green line) and sunrise (lower green line). The grey vertical shading shows the nocturnal operating time of the batlogger (overlaps of the grey shading have no meaning). Numbers at the top of the image: Monthly sum of sequences with bat echolocation calls. A blue dot represents all sequences with bat echolocation calls within a 5-minute interval.*

The extent to which the bats recorded in June and July were migrating individuals and/or this behaviour belongs to dispersal (roaming) cannot be said with certainty in individual cases. The cold periods towards the end of September and during October with air temperatures well below 0°C (see Fig. 3) brought bat migration over the Jungfraujoch almost to a standstill. Throughout the observation period, temperature often seems to have had an influence on the occurrence of bats at the research station (see Fig. 3). When the air temperature was below 0°C (black dots below the horizontal axis in Fig. 3), most of the bat call sequences were zero (the red dots are on the horizontal 0-line). The quantitative data are shown in Table 1.

| Median night temperature | > 0°C | = 0°C | < 0°C |
|---|---|---|---|
| Number of bat call sequences | 162 (66%) | 37 (15%) | 47 (19%) |

*Table 1. Distribution of bat call sequences in three temperature classes.*

The highest number of bat call sequences was recorded when the median air temperatures at night was above 0°C. Comparing the number of bat call sequences per night and the median night air temperature of all the 175 nights the batlogger was in operation, shows a weak but significant correlation between the number of bat call sequences and air temperature (Kendall's rank correlation coefficient $\tau = 0.35$, p=4.40 E-12; n=175).

Even at air temperatures above 0°C, no bat calls were recorded in some nights. Besides air temperature, other weather factors (e.g. wind direction, wind strength) as well as endogenous biological factors control the mobility behaviour of the different bat species.

Ten bat species and one unidentified call (rodent?) could be detected acoustically from May to October 2020. The following records are noteworthy: On 21 July (23:03 h; +3°C), a social sound of a small mammal was recorded in the ultrasonic range 20-55 kHz (see Fig. 4).

On 15 Sept. (21:14 h, +4°C), the batlogger recorded a sequence with two calls of a European Free-tailed bat *(Tadarida teniotis*). This bat species is one of the largest in Europe and has its main distribution in the Mediterranean region. Regular occurrences in Switzerland are only known from Ticino, Valais and the Geneva Basin. The registration on 15 Sept. on the Jungfraujoch is probably the highest record of this species in Europe. This individual probably made a trip (so-called dispersal) from the Valais to the Jungfraujoch, as seasonal migrations are unknown for this species.

The two last recorded overflights of the whole observation period were remarkable, too: These were two Nathusiu's or Kuhl's Pipistrelle bats *(P. nathusii or kuhlii)* on 24.10.2020 at 22:54 h and an air temperature of minus 5°C! The two small (5 - 10 g body weight) migrating bats still had to fly from the Jungfraujoch more than 20 km over the Aletsch Glacier towards the south!

**4. Importance of the High Altitude Research Station Jungfraujoch for biological research**

In terms of altitude and weather conditions, the Jungfraujoch in Switzerland is a border zone for many living creatures. The infrastructure of the research station makes it possible to carry out studies on living organisms in this border zone that would otherwise not be possible. Studies on organisms in extreme areas provide information about their plasticity and temporary adaptability. Long-term monitoring at such extreme places contributes valuable information on seasonal variations and the consequences of climate change.

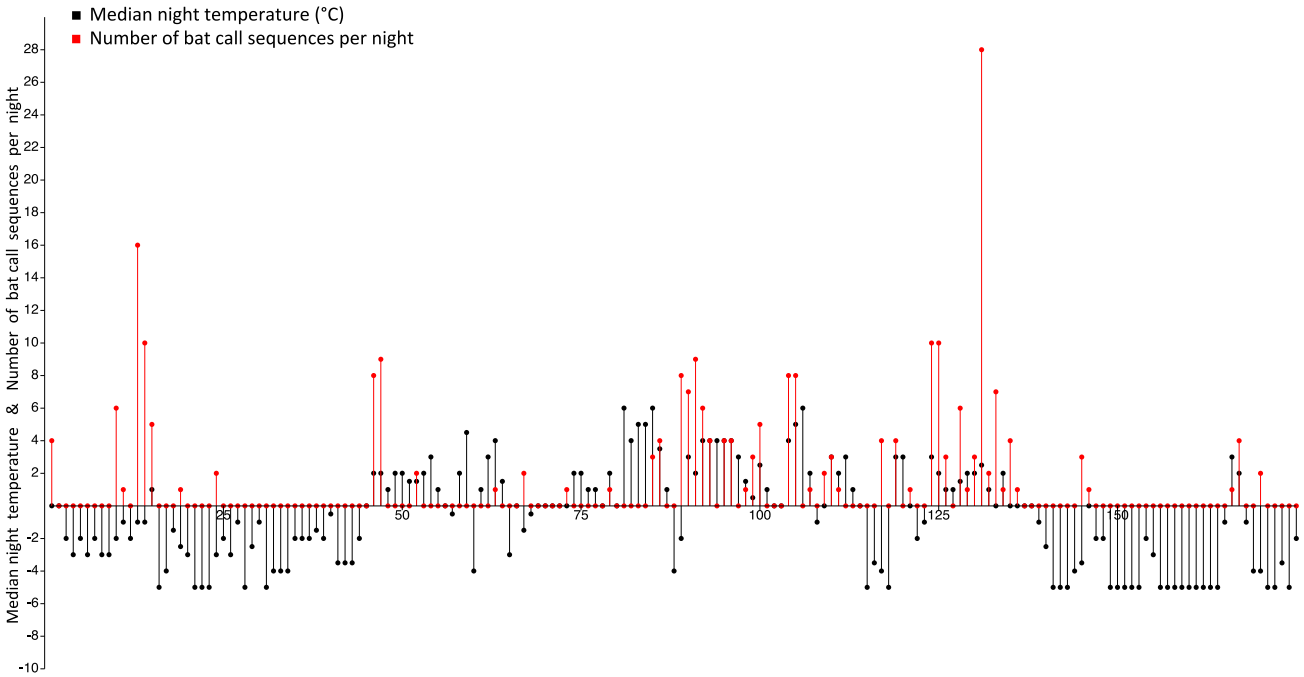


*Figure 3. Distribution of bat call sequences (red dots) from 8 May to 29 October 2020 (horizontal time axis) and median night temperature (black dots). On the vertical axis, the same scale is used for temperature (°C) and number of bat call sequences. The vertical lines from the dots to the time axis serve as a visual interpretation aid.*

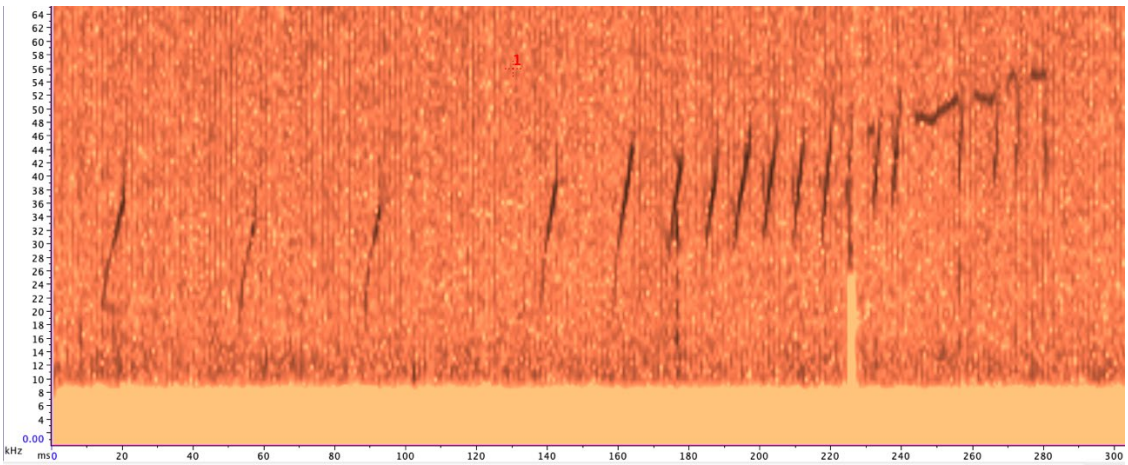


*Figure 4. Frequency spectrogram of a vocalisation, most probably of a rodent; 21 July 2020 (23:03 h; +3°C air temperature). Vertical axis: Sound frequency in kHz. Horizontal axes: Time in Milliseconds.*

**References**

Zingg, P.E., Bontadina, F. 2016. Migrating bats cross top of Europe. PeerJ Preprints 4:e2557v1. https://doi.org/10.7287/peerj.preprints.2557v1

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