

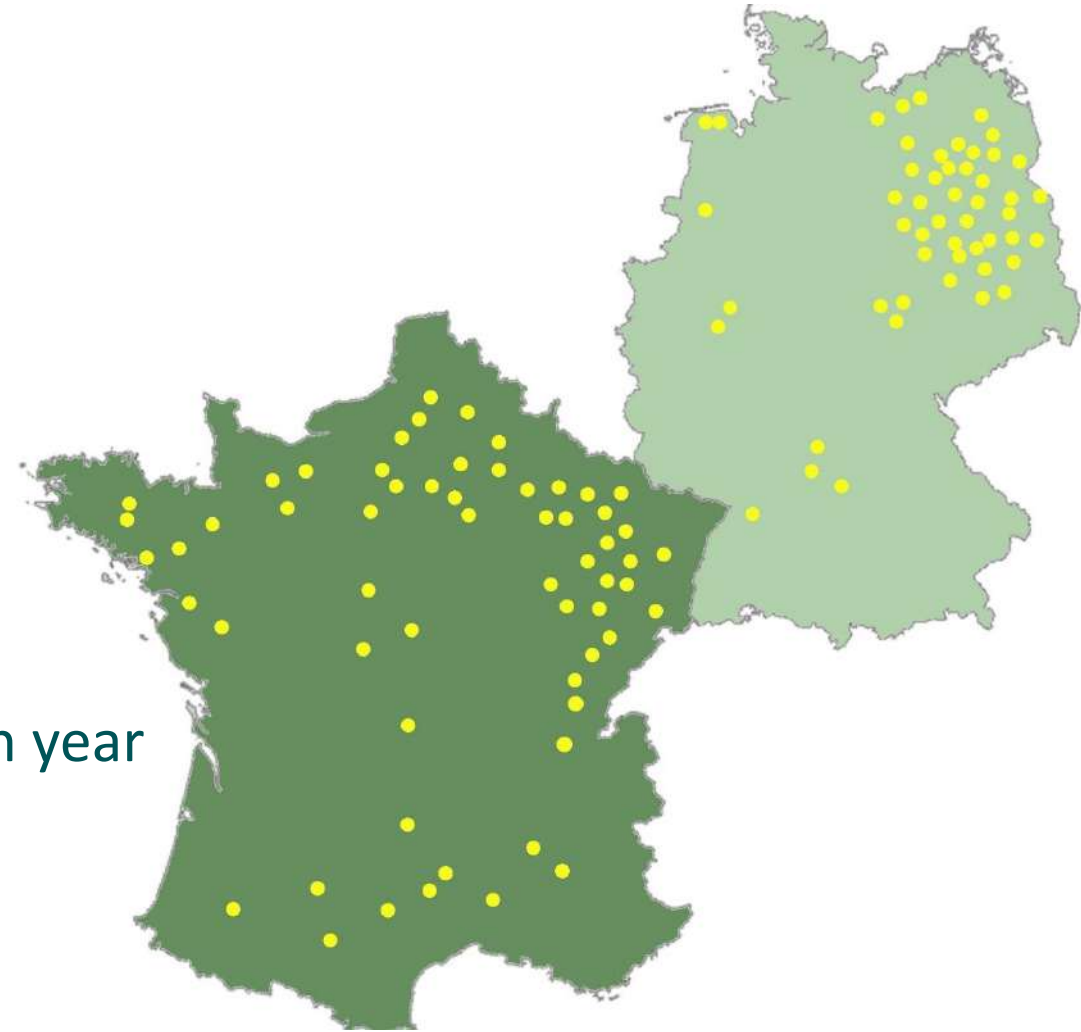
Who does the night belong to?

Bats and wind energy - a green-green dilemma with solutions

RGI webinar - Bats and Wind Energy - Protecting bats around onshore wind farms

Who we are?

- KS Umweltgutachten GmbH
- KJM conseil SAS
 - 50 employees
 - 25 years of experience
 - About 100 nacelle activity monitoring each year



What are the consequences of wind turbines for bats?

- Wind power generation has grown exponentially over the past two decades
- Annual impact rates on individual wind turbines: Ø 14 bats (up to 70)
(Brinkmann et al., 2011; Mantoiu et al., 2020; Rydell et al., 2010; Voigt et al., 2022)
- 75% of the wind turbines in Germany (approx. 30,000 in total) operate without restrictions to protect bats (Fritze et al., 2019; KNE, 2020)
- **Species with highest collision risk in Europe**
 - **Common Pipistrelle** (*Pipistrellus pipistrellus*) → estimated more than 50% of carcasses
(Richardson et al., 2021)
 - **Greater noctule** (*Nyctalus noctula*) → an estimated 32% of carcasses
(Voigt, 2020)
- **Ecosystem consequences of bat loss are unclear**
- **Ecosystem services provided by bats are still not well understood in Europe**
(Ghanem & Voigt, 2012; Heim et al., 2016; Russo et al., 2023)



Nyctalus noctula

- UNEP/EUROBATS agreement ratified by 37 countries
- EUROBATS Guidelines in wind energy planning are still not followed as intended (Barre et al., 2022)
- Several countries use Cut-In regulations for (bird or) bat protection
 - Usually wind depending Cut-Ins
 - Cut-In 4-7 m/s
- Lack of standardization and methodological requirements



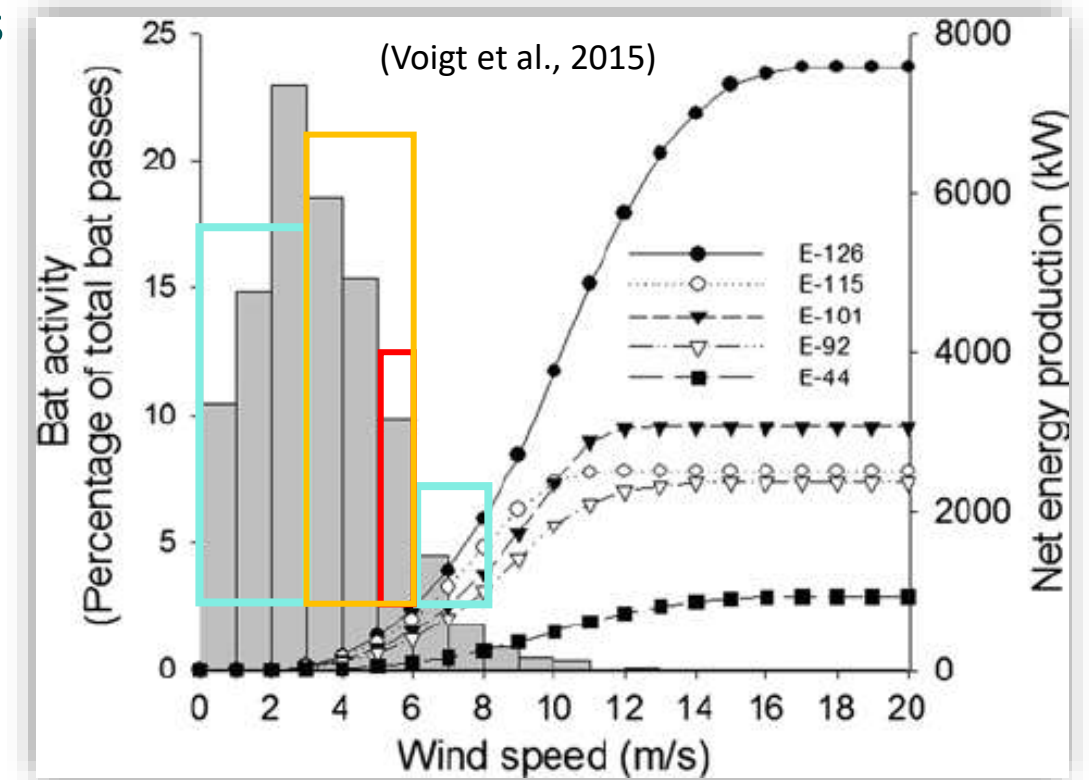
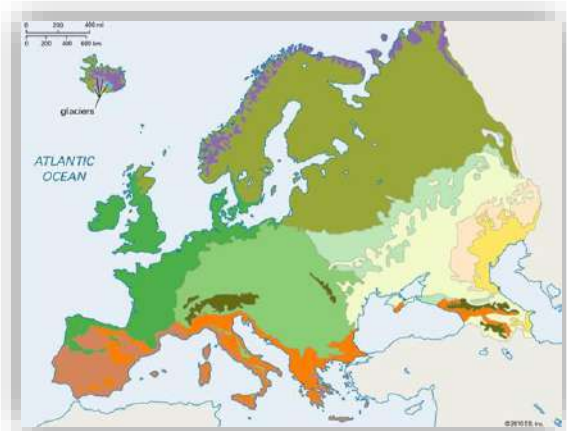
- Risk assessment via data collection (pre- or post construction)
 - Ground studies
 - Carcass search
 - Acoustic monitoring of bat activity at higher levels

- Risk assessment via data collection (pre- or post construction)
 - Ground studies
 - Carcass search
 - Acoustic monitoring of bat activity at higher levels
- Reduction of the mortality risk
 - Feathering of turbine blades instead of idling may reduce fatality rates
 - Deterrent tools
 - Operational adjustments of wind turbines

- Monitoring at height is of crucial importance for assessing collision risk
(Baerwald et al., 2009)
 - Clear link between activity and collision risk
(Baerwald et al., 2011)
 - Curtailment is still the most effective way to reduce bat mortality
 - Blanket curtailment
 - Wind speed based curtailment
 - Live activity induced curtailment (e.g., TIMR)
 - multivariate algorithms to calculate curtailment
- potentially high yield losses depending on used Cut-in speeds

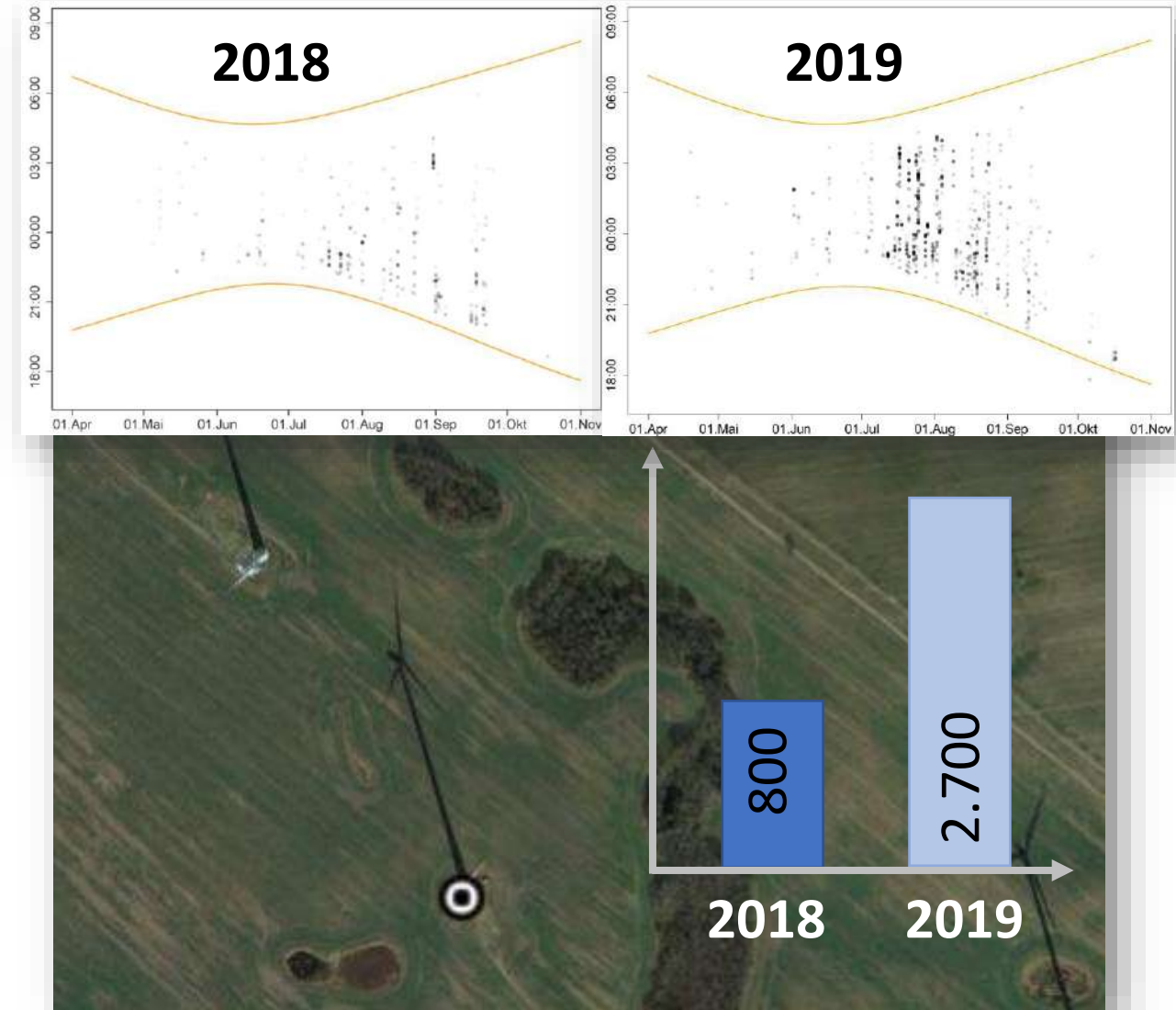
Collision risk

- Maximum collision rate is between 3 and 6 m/s
- The highest risk between 5 and 6 m/s
- Below 3 m/s the rotors (often) do not move
- Above 6 m/s usually a lower activity



Nacelle activity monitoring

- Seasonal differences
- Mutli-year monitoring recommended



Protection of a percentage of the bat activity



90% as activity threshold → 10% vulnerable

| | A | B | C |
|------------------------------------|-----|-----|------|
| # bat recordings on nacelle height | 556 | 993 | 4409 |
| 10 % of the activity unprotected | 56 | 99 | 441 |

Objective of RENEBAT I, II, III (2007-2016):

- **Standardize** recording methods and recording parameters (**Calibration**)
- Enable **comparability** and **equal treatment**
- **Ensure bat protection** through curtailment
- At the same time, **minimize energy loss** caused by curtailment



<https://www.probat.org>

RENEBAT I, II, III (2007-2016)

- Bat activity
- Carcass search
- Bats use of space
- Detector range test
- Wind turbine characteristics

BATmode/Avisoft 37 dB

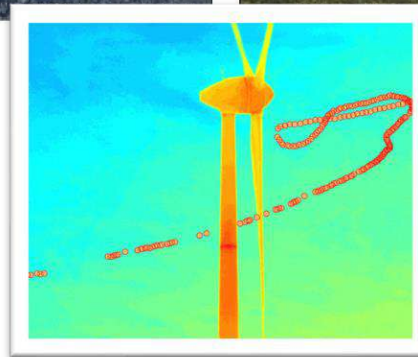
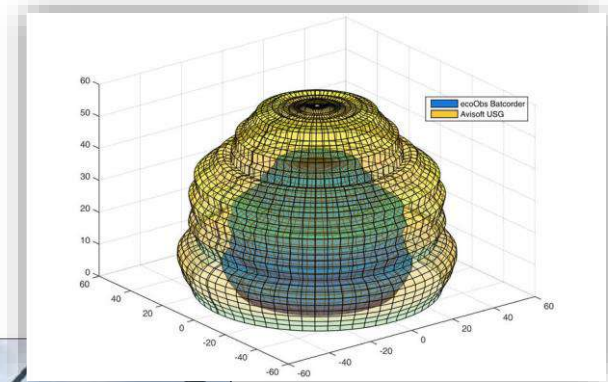
Avisoft 50 dB

ecoObs BC -27 dB

ecoObs BC -30 dB

ecoObs BC -36 dB

Anabat SD1



Welcome to ProBat 7

Dear ProBat users,

Welcome to the completely reprogrammed online version of ProBat 7!

Before describing the innovations, first of all a very big thank you to all data donors*, without whom the further development of the app in its current form would not have been possible!

The new ProBat Version 7.0 is now based on the R software. The continuation of the previous MS Access-based version ended on November 30th, 2020. We will miss their retro design!

ProBat can now be operated in any Internet browser - the installation of the software on your own computer is therefore no longer necessary. We have created tool tips for almost all inputs and outputs to make operation easier and to answer questions. Even if the ProBat interface now looks completely different (and we hope it is clearer) and we have integrated many new tools and illustrations, the calculation of the operating algorithms changes only minimally with the version change - apart from a few exceptions mentioned below.

In particular, data sets from the south and north have helped us to integrate standard phenologies (distributions of bat activity over the year) for two new natural regions "Southwest German Central Uplands" and "Coast" in the new ProBat version, as well as the existing phenologies to provide more stable statistical feet. Overall, the data now also show a somewhat greater concentration of bat activity in the summer months. This results in minor changes in the calculations for the regions already integrated in ProBat 6: The average cut-in wind speed usually drops somewhat, with somewhat lower cut-in wind speeds being calculated in spring and autumn in particular - in summer, on the other hand, the values increase slightly.

Even if we now have more than 200 plant years from our donors, we still need more data for the development. We are therefore always looking for new donors who provide data anonymously from ProBat. If you are interested, please contact us via probat@oekofor.de and send us. So far, our data for the coastal region in Mecklenburg-Western Pomerania and from the southern part of this federal state in the "coast" region). We also need more data from the coastal region in Mecklenburg-Western Pomerania and from the southern federal states. In addition, datasets from other regions of Germany are always helpful.

Another innovation in the processing and calculation of the data is the automatic inclusion or exclusion of the twilight interval. Other exciting functions, such as checking the wind turbine shutdown, will follow.

Even though we have tested the software many times, there will certainly still be one or two bugs to fix, especially in the early days. Feel free to contact us with information about such bugs or other information about the new version (probat@oekofor.de). Thank you very much for your support and we appreciate your feedback on ProBat 7.0!

Your ProBat team

operation of the app

The individual processing steps can be called up in the sidebar on the left in tabs. The arrangement of the tabs from top to bottom corresponds to the order that we recommend for processing a project. Help documents for all processing steps are stored in pop-up windows behind a question mark symbol in the tabs. In addition, the current versions of the [operating instructions](#) and the accompanying document on the [ProBat data requirements](#) are linked here for download. The user manual was not updated in the course of the update to version 7.1. Help on the new functions can be found in the pop-up help documents (question mark symbols). Likewise, the documents include [Part 1: Questions and Answers](#) and [Part 2: Reduction of the risk of collision of the working aid bat protection and wind power of the Bavarian Wind Energy Decree](#) still relevant information, which was not updated specifically for ProBat 7.

The app is designed for processing one wind farm at a time. The data and processing status can be saved and downloaded as a file by clicking on the save button (floppy disk symbol, top right in the header). The save can be restored by uploading this file after clicking on the load button (upload symbol, top right in the header).

Please note: After 10 minutes of inactivity in the browser window, the connection will be cut. Therefore, please ensure that you regularly save your project.

Note on data security

In ProBat 7 no data is stored online in the long term. Your data is only on the server while you are interacting with the app. After you disconnect from the server, all uploaded data will be completely deleted. Accordingly, the only long-term storage is on your own PC when you download a save file. In addition, no one but you has access to your data while using the app.

The ProBat app is hosted via shinyapps.io on Amazon Web Services (AWS) servers in the USA (us-east-1). Your connection to the server is encrypted via SSL.

You can find a complete declaration on data protection in the sidebar on the left under the **Data protection declaration** tab.

Support

If you have technical problems, please contact technical support at probat@oekofor.de. We can best help you if you send us a screenshot of the problem and a project save. In most cases, anonymized storage is sufficient. We guarantee that your data will be treated confidentially and will, of course, be deleted as soon as the problem has been solved.

The screenshot displays the ProBat v7.1c application interface. On the left is a dark sidebar with navigation options: Introduction, project management, bat activity data, weather data, it proves, Checking the activity distribution, Cut in calculation, imprint, Data protection, and Updates. The main area is divided into sections for 'Editor: in', 'competent person', 'new responsible person', 'associated institution', and 'wind farm'. A central white popup window titled 'Location map with natural areas' contains the following text:

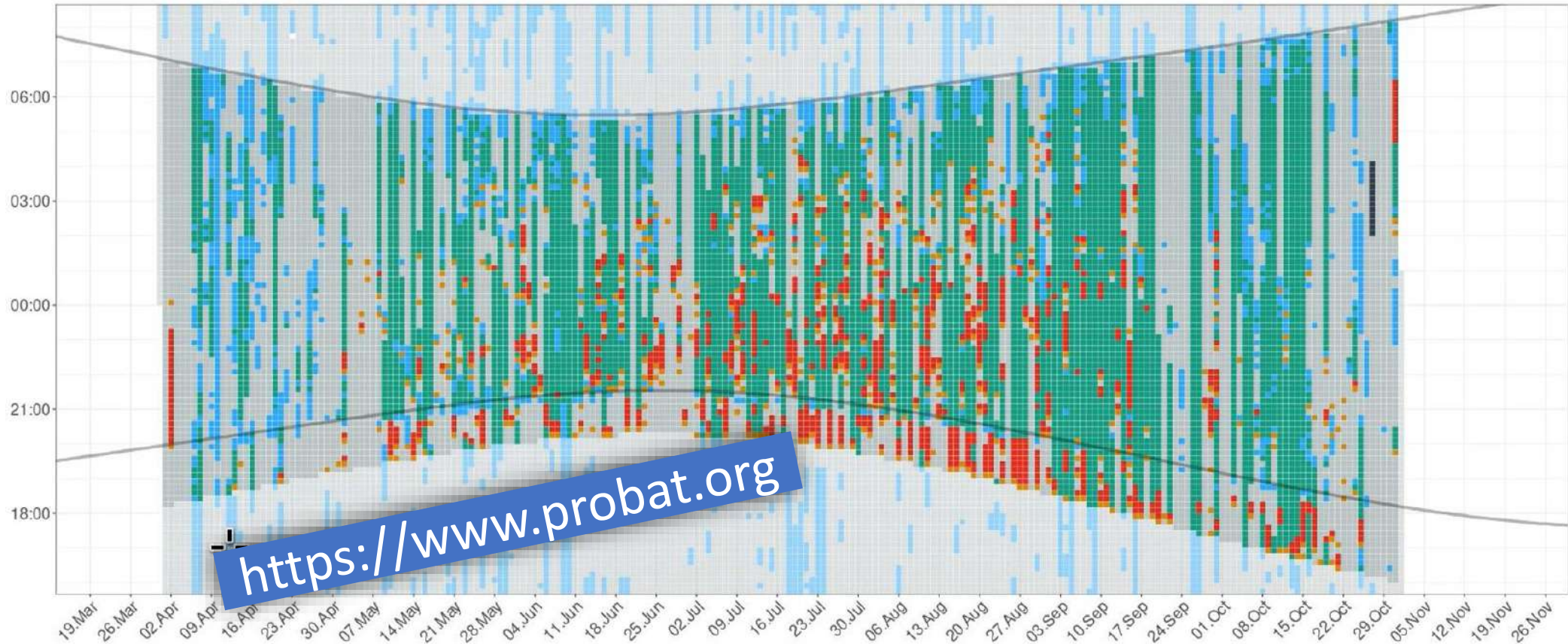
In this box, the natural spatial main units (according to BfN 2008) are presented, for which, with the exception of the Alpine foothills and the Alps, activity models are stored in Probat. By clicking on the layer symbol in the upper right corner, a selection field for different base maps appears.

As soon as an entry for a wind turbine is created in the table on the left, it is shown with a marker on the map. A click on this marker causes a small popup with the wind turbine number to appear. At the same time, it is calculated for each wind turbine to which natural space it can be assigned according to its coordinates. The mapping is displayed in a table below the map.

Note: For locations in the natural areas of the Alps and the foothills of the Alps, the activity models of the nearest natural areas can be used. The app carries out this assignment automatically. In the "Checking the activity distribution" tab, it can later be checked whether the activity distribution over the course of the year, which is assigned via the natural areas, largely agrees with the activity distribution determined at the location.

The popup has an 'Okay' button. Below the popup is a table with columns for 'wind farm name', 'wind farm number', 'WEA number', 'Rotor diameter', 'latitude', and 'timestamp position'. The table is currently empty, showing 'No entries available'. At the bottom of the table are buttons for '+ Add wind turbine', 'Delete Entry', and 'to edit an entry'. On the right side of the interface is a map of Europe with a legend for 'natural space' including categories like Alps, Alpine foothills, coast, Northeast German lowlands, Northwest German lowlands, Eastern Central Mountains, Southwest German low mountain range, and Western Central Mountains. A 'Reload map' button is located at the bottom left of the map area.

<https://www.probat.org>



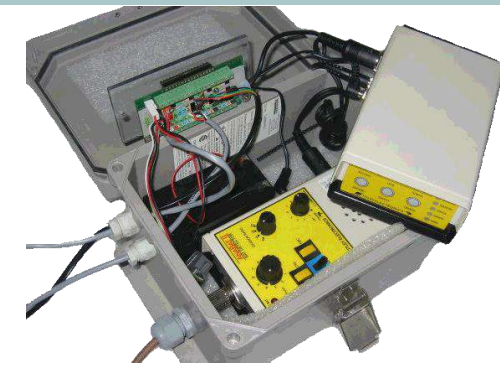
- | | | |
|-------------------------------------|----------------------------|------------------|
| Functional curtailment | Non-functional curtailment | Normal operation |
| the shutdown must be initiated | non-functional machine | Lack of data |
| Authorized operation, unknown state | | |

- **Statistical models**
 - Phenology of the bat acoustic activity
 - Natural habitat
 - Nighttime
 - Season
 - Wind speed
 - Bat activity levels at the monitored wind turbine
- This data is used to determine and reduce the site-specific collision risk

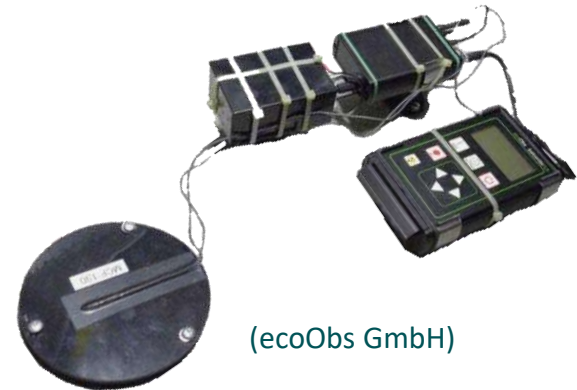


Prerequisites for correct data collection

- **Data collection parameters**
 - Calibration and adjustment of recorder settings



(Avisoft Bioacoustics eK)



(ecoObs GmbH)

- BATmode/Avisoft 37 dB
- Avisoft 50 dB
- ecoObs BC -27 dB
- ecoObs BC -30 dB
- ecoObs BC -36 dB
- Anabat SD1



(bat bioacoustictechnology GmbH)



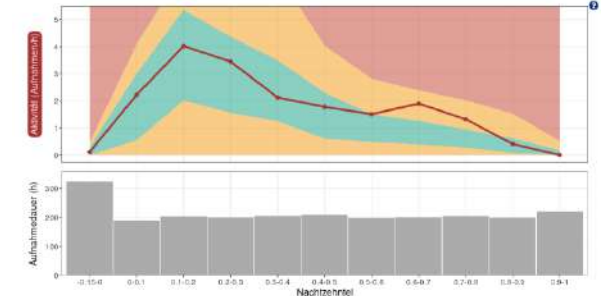
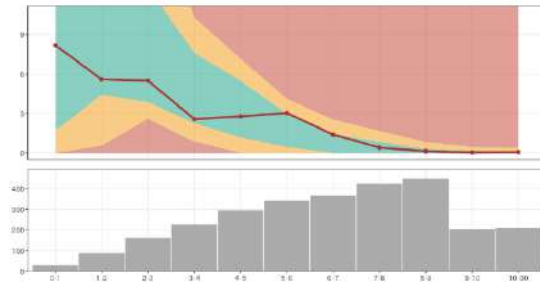
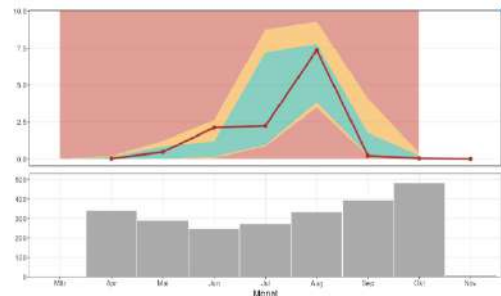
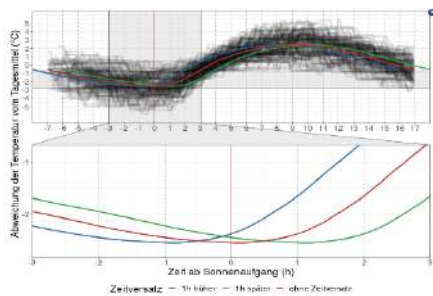
- **Data collection parameters**
 - Calibration and adjustment of recorder settings
 - Correct microphone installation



- **Data control and correction**

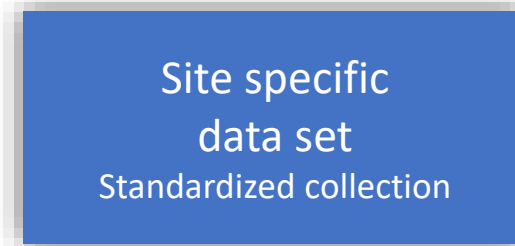
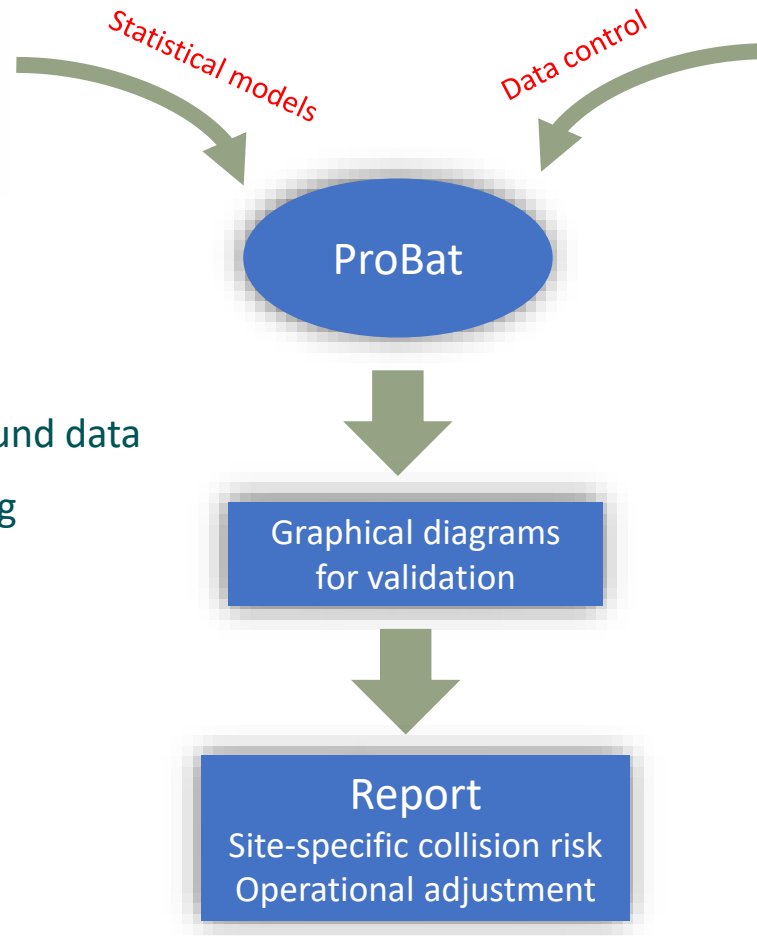
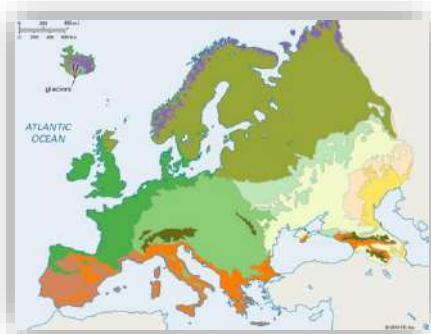
- Calibration and adjustment of recording device
- Correct times of recordings (summer and winter time)
- Measurement of current microphone sensitivity (daily)

**RENEBAT
DATABASE**
65 000 nights from 3 studies



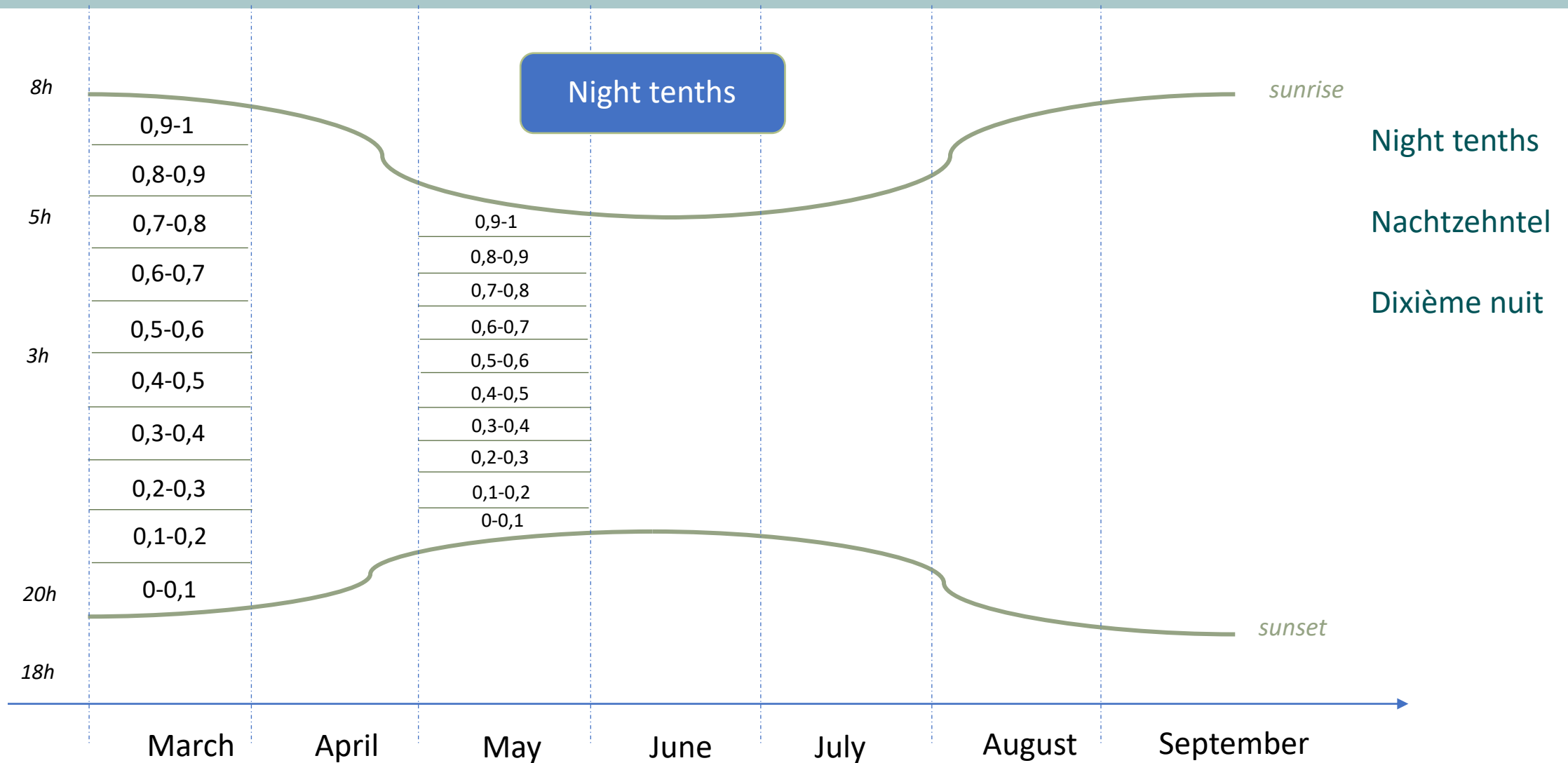


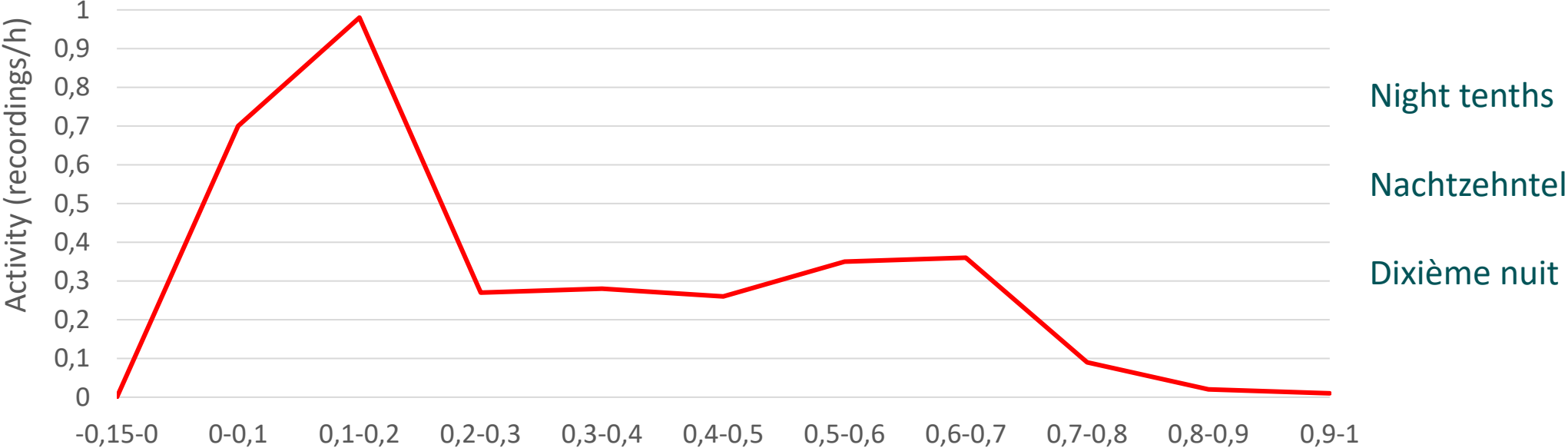
- Phenology of bat activity
- Mortality
- Different biomes in background data
- Standardization of measuring parameters

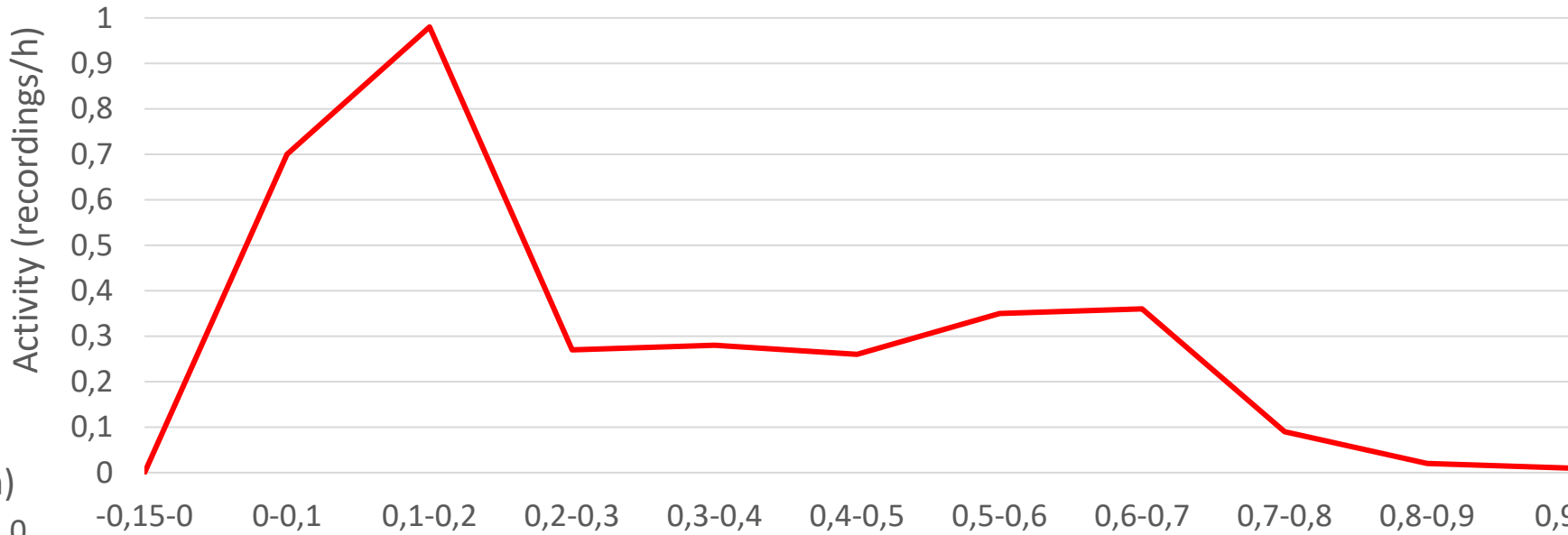


- Phenology
- Geography
- Characteristics of wind turbines
- Weather data
- Activity









Night tenths

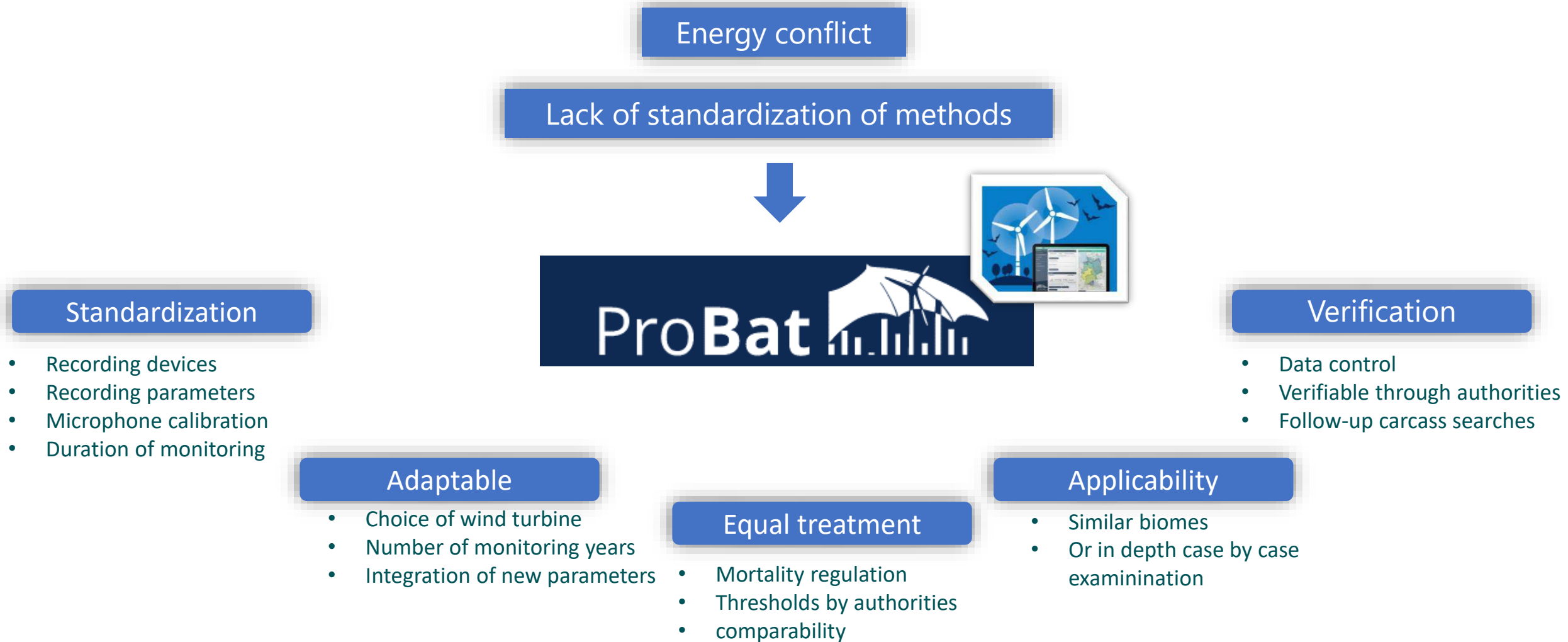
Nachtzehntel

Dixième nuit

Activity (recordings/h)

8 6 4 2 0

| | -0,15-0 | 0-0,1 | 0,1-0,2 | 0,2-0,3 | 0,3-0,4 | 0,4-0,5 | 0,5-0,6 | 0,6-0,7 | 0,7-0,8 | 0,8-0,9 | 0,9-1 |
|-----------|---------|-------|---------|---------|---------|---------|---------|---------|---------|---------|-------|
| April | | 1,9 | 3 | 2,5 | 2,4 | 2,5 | 1,6 | 1,7 | 1,3 | 1,3 | 0,7 |
| May | | 3,6 | 4,1 | 3,8 | 3,8 | 3,8 | 3,5 | 3,6 | 2,8 | 2,6 | 1,1 |
| June | | 4,1 | 4,6 | 4,2 | 4,2 | 4,1 | 3,8 | 3,9 | 3,4 | 3,1 | 1,2 |
| July | | 4,3 | 4,8 | 4,4 | 4,2 | 4,2 | 3,9 | 4 | 3,7 | 3,7 | 1,4 |
| August | | 4,4 | 5 | 4,7 | 4,6 | 4,4 | 4 | 4 | 3,7 | 3,6 | 1,4 |
| September | 1,5 | 4,2 | 4,8 | 4,5 | 4,5 | 4,4 | 4,1 | 4,1 | 3,7 | 3,7 | 1,5 |
| October | 0,9 | 3,2 | 3,8 | 3,4 | 3,2 | 3 | 2,3 | 2,5 | 1,6 | 1,6 | 0,9 |



Thank you for your attention!

K

S

Büro für
Freilandbiologie und
Umweltgutachten



- Baerwald, E. F., & Barclay, R. M. R., (2009). Geographic Variation in Activity and Fatality of Migratory Bats at Wind Energy Facilities, *Journal of Mammalogy* , 90(6), 1341–1349.
- Baerwald, E. F., & Barclay, R.M.R. (2011), Patterns of activity and fatality of migratory bats at a wind energy facility in Alberta, Canada. *The Journal of Wildlife Management*, 75: 1103-1114.
- BfN. (2018). National Implementation Report to EUROBATS. [https://www.eurobats.org/sites/default/files/documents/pdf/ Meeting_of_Parties/Inf.MoP8_.21_NIR_Germany.pdf](https://www.eurobats.org/sites/default/files/documents/pdf/Meeting_of_Parties/Inf.MoP8_.21_NIR_Germany.pdf)
- Barré, K., Froidevaux, J. S. P., Leroux, C., Mariton, L., Fritze, M., Kerbirou, C., Le Viol, I., Bas, Y., & Roemer, C. (2022). Over a decade of failure to implement UNEP/EUROBATS guidelines in wind energy planning: A call for action. *Conservation Science and Practice*, 4(11), e12805.
- Brinkmann, R., Behr, O., Niermann, I., & Reich, M. (2011). Entwicklung von Methoden zur Untersuchung und Reduktion des Kollisionsrisikos von Fledermäusen an Onshore-Windenergieanlagen. Cuvillier Verlag.
- Fritze, M., Lehnert, L. S., Heim, O., Lindecke, O., Roeleke, M., & Voigt, C. C. (2019). Fledermausschutz im Schatten der Windenergie. *Naturschutz und Landschaftsplanung*, 51(1), 20–27.
- Ghanem, S. J., & Voigt, C. C. (2012) Increasing awareness of ecosystem services provided by bats. *Adv Study Behav* 44:279–302.
- Heim, O., Schröder, A., Eccard, J., Jung, K., & Voigt, C. C. (2016) . Seasonal activity patterns of European bats above intensively used farmland, *Agriculture, Ecosystems & Environment*, 233, 130-139.
- KNE. (2020). Anfrage Nr. 279 zur Anzahl an Windenergieanlagen (onshore) in Deutschland mit Abschaltungen zum Fledermausschutz. <https://www.naturschutz-energiewende.de/fragenundantworten/279-anzahl-windenergieanlagenabschaltungen-fledermausschutz-deutschlan>
- Mantoiu, D. S., Kravchenko, K., Lehnert, L. S., Vlaschenko, A., Moldovan, O. T., Mirea, I. C., Stanciu, R. C., Zaharia, R., Popescu-Mirceni, R., Nistorescu, M. C., Voigt, C. C., & Voigt, C. C. (2020). Wildlife and infrastructure: Impact of wind turbines on bats in the Black Sea coast region. *European Journal of Wildlife Research*, 66(3), 1–13.
- Richardson, S. M., Lintott, P. R., Hosken, D. J. et al. (2021). Peaks in bat activity at turbines and the implications for mitigating the impact of wind energy developments on bats. *Sci Rep* 11, 3636.
- Russo, D., Coleman, J. L., Ancillotto, L., Korine, C. (2022). Ecosystem Services by Bats in Urban Areas. In: Moretto, L., Coleman, J.L., Davy, C.M., Fenton, M.B., Korine, C., Patriquin, K.J. (eds) *Urban Bats. Fascinating Life Sciences*. Springer, Cham. https://doi.org/10.1007/978-3-031-13173-8_12.
- Rydell, J., Bach, L., Dubourg-Savage, M. J., Green, M., Rodrigues, L., & Hedenström, A. (2010). Bat mortality at wind turbines in northwestern Europe. *Acta Chiropterologica*, 12(2), 261–274.
- Voigt, C. C., Lehnert, L. S., Petersons, G., Adorf, F., & Bach, L. (2015). Wildlife and renewable energy: German politics cross migratory bats. *European Journal of Wildlife Research*, 61, 213-219.
- Voigt, C. C., Scholl, J. M., Bauer, J., Teige, T., Yovel, Y., KramerSchadt, S., & Gras, P. (2020). Movement responses of common noctule bats to the illuminated urban landscape. *Landscape Ecology*, 35(1), 189–201.
- Voigt, C. C., Kaiser, K., Look, S., Scharnweber, K., & Scholz, C. (2022). Wind turbines without curtailment produce large numbers of bat fatalities throughout their lifetime: A call against ignorance and neglect. *Global Ecology and Conservation*, e02149.
- <https://www.probat.org>

- Central Europe
 - Measured activity patterns must be compared with ProBat assumptions
 - Has already been successfully used in France, Austria, Netherlands...
- Southern and Northern Europe
 - In depth case by case examination
 - Eventually adaptation might be necessary
- Data sets from other species (e.g. the bulldog bat *Tadarida teniotis* show similar behavior to that from other species
- The data sets and algorithms are available and possibly need some supplements



Cut-In Windgeschwindigkeiten (m/s)
WEA 1 - 2015

Geschätzte jährl. Schlagopferzahl ohne Abschaltung = 11.0
Pauschale Cut-In-Windgeschwindigkeit = 6.1 m/s

| Nachtzehntel | Monat | | | | | | | |
|--------------|-------|-----|-----|-----|-----|-----|-----|-----|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| -0.15-0 | 3.2 | 4.1 | 4.5 | 5.0 | 5.0 | 4.8 | 4.0 | 1.5 |
| 0-0.1 | 4.8 | 5.7 | 6.2 | 6.4 | 6.5 | 6.3 | 5.6 | 4.0 |
| 0.1-0.2 | 5.3 | 6.1 | 6.6 | 6.9 | 7.0 | 6.7 | 6.0 | 4.3 |
| 0.2-0.3 | 5.0 | 5.9 | 6.3 | 6.5 | 6.7 | 6.5 | 5.7 | 4.0 |
| 0.3-0.4 | 4.9 | 5.8 | 6.3 | 6.4 | 6.7 | 6.5 | 5.5 | 3.9 |
| 0.4-0.5 | 5.0 | 5.9 | 6.2 | 6.3 | 6.5 | 6.5 | 5.4 | 3.8 |
| 0.5-0.6 | 4.7 | 5.5 | 5.9 | 6.1 | 6.2 | 6.2 | 5.1 | 3.4 |
| 0.6-0.7 | 4.7 | 5.6 | 5.9 | 6.2 | 6.2 | 6.2 | 5.1 | 3.5 |
| 0.7-0.8 | 4.2 | 5.1 | 5.5 | 5.8 | 5.8 | 5.7 | 4.7 | 3.0 |
| 0.8-0.9 | 4.1 | 5.0 | 5.3 | 5.8 | 5.8 | 5.8 | 4.8 | 3.0 |
| 0.9-1 | 2.5 | 3.8 | 4.0 | 4.4 | 4.4 | 4.4 | 3.6 | 1.2 |