Bat3Data®, automated detection of bat flight paths

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Abstract

Infrastructures have a significant impact on bats, by in disrupting their flight paths of bats. Traditional methods of monitoring bat movements are rather limited and often prone to error. Using acoustics, GIS and 3D simulation engines, the Bat3Data® system enables the field ecologist in differentiating species and tracking their flight paths in 3D.

This helps in gauging efficiencies of gantries, bat bridges and underpasses in helping bats cross highways and railway lines. Thus, Bat3Data® can help improve efficiency of remediation of ecological corridors cut by infrastructures.

«Detection of bat flight paths by triangulation of their ultrasonic call signals for use in the environmental impact assessment»

During the process of Environmental Impact Assessment (EIA), bat species have become a focus of surveys because of their European Protected Species status and their ecological importance. As a result of advances in survey techniques and detection technology, the detection of bats and their identification to species level is now commonplace. Ultrasonic bat detectors can transfer the sounds made by bats into an audible signal which can be recorded for further analysis. However, there are limitations to the data which can be collected. Classical ultrasound detectors give a record at one point, and do not allow the experts to register the movement of bats across a site, along a hedgerow or within tunnels. Bat ecologists in the field with traditional detectors can make reasoned inferences, but there is often no solid evidence backing up such inferences of bat movements on sites.

There is a need for sound, measurable evidence of bat movements in order to analyze bats behavior related to the project. Projects which may have an impact on bat flight lines, and which are deemed to have in impact on the conservation status of a species, may require expensive project realignments, bypasses or specific mitigation measures. It is therefore important that the evidence upon which such decisions are made are as robust as possible.

Egis, a French engineering company, in collaboration with *Cyberio (a French start-up)*, has developed a system that can record bat calls and pinpoint their location. The information can be treated, analyzed and used to inform the environmental impact assessment process, identify risks, plan mitigation measures *etc.* The technology can be used on a wide range of projects including linear transport infrastructure developments.

Bat3Data$^®$ technology and principles

Four ultrasonic microphones are set up at the imaginary vertices of a regular tetrahedron with sides of 1m in a WXYZ formation on a horizontal plane. With; (W = 0°, X = 120°, Y = 240°) on the horizontal and Z at the vertical, much like the arrangement of hydrogen atoms in a molecule of ammonium NH_4^+.

The coordinates of the microphones in relation to "north" are noted for later use in Geographical Information System (GIS) modeling. The microphones are connected to a sound card with its own power supply. The antenna system is then connected to a PC, laptop or tablet via an Ethernet cable. When a bat flies past the antenna cluster and emits ultrasonic calls, the installed software (EcoRecorder) is able to automatically record the sound files obtained from the four antennas. The time and date is stored. After the recording phase of the survey, the sound file data are "scrubbed" to remove any unwanted, non-bat sounds. The stored sound files can then be processed to triangulate the position of each individual bat call within a sound file using a mathematical algorithm.

Each triangulated bat call can then be entered into a 3D GIS database. The orientation of each microphone is added and a map layer inserted. The points can therefore be seen in 3D in relation to a project. This data can be used by ecologists to interpret the significance of the site as bat habitat and identify any potential environmental risks associated with a future project. The ecologist can recommend mitigation or avoidance measures related to these firm findings.

As flight paths are recorded into a computer database, there is arguably less subjectivity than field observations made by an ecologist under nighttime conditions.

What are the results from the field trials?

The technology was tested in the Forêt de Cîteaux in Burgundy, France (as well as on the A65 motorway in the Aquitaine Region and on a railway near Mâcon. In Burgundy, the technology was installed one evening in the centre of a 20 m wide forest ride (longitudinal clearing which followed a buried high pressure gas pipeline). The range of the detection was related to the sensitivity of the microphones and the energy of the bat calls. The system can detect and plot *Myotis* and *Pipistrellus spp.* up to a range of 20-40 meters, *Noctula*, *Eptesicus*, up to 100 meters and *Rhinolophus* and *Plecotus spp.* up to 5 meters.

The equipment can also be installed at intervals within a survey area to increase the range of detection, for example along a hedgerow or woodland edge. Geolocalised sound files were generated and stored for later insertion within a 3D GIS package.

Which projects can benefit?

The technology can be used for any project where it is necessary to understand bat movement around a site, including linear road and rail infrastructure, isolated projects such as industrial sites of production, sites where a flight path is at risk and at potential "hop overs" (for example where a road or railway is planned to cut through woodland).

The technology can theoretically be scaled up to a regional scale by the installation of a series of high sensitivity microphones across a landscape, linked into a network. This is a medium-term ambition of this project. It may allow the identification of bat migration routes across a landscape, something that is currently only possible with radio-tracking with low volumes of bats observed at high cost. Bat3Data$^©$ is aiming to improve on this. The technology may be able to enhance the identification of region-wide ecological networks.

Application of Bat3Data®to the EIA process

The methodology is well suited to the EIA process of identifying risks, then providing ways to avoid or reduce impacts or compensate for significant residual impacts.

Firstly the technology can identify risks during baseline assessment. After a desk study, Bat3Data® can be installed to identify existing bat flight paths or to identify flight lines along a forest ride. The height and direction can be measured. This information, used alongside the details of a future project can lead to the creation of risk maps, showing where (and if at all) bats are affected by a project.

If potential impacts are identified, the developer/consultant will be in a position to implement modifications to the design to avoid the impacts including the consideration of alternative routes / sites. If the potential impacts are significant and unavoidable, the data obtained from Bat3Data® can justify the employment of often expensive mitigation measures such as the construction of a bat bridge or "Hop-Over". If, after the EIA process, it is determined that compensation is required, the technology can be used to monitor the condition and eligibility of potential donor sites.

Bat3Data© used in surveys for European Protected Species derogation licences

All bats are strictly protected under *Annex IV* of *Council Directive 92/43/EEC 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora* (EC Habitats Directive), meaning they are European Protected Species. This means that a derogation license would be required by a developer to allow their development to proceed if a significant impact on the conservation of bats is detected. Derogation licence conditions can demand specific impact mitigation or compensation requirements of the developer to ensure that the conservation status of bats is maintained. Bat3Data® can be used within this context to identify the importance of certain flight paths and can then allow the developer, in conjunction with an ecologist, to propose specific, focused mitigation measures to reduce impacts based on sound data. The visual outputs from this technology, in 3D, showing flight paths, can assist with the fine tuning of the placement of mitigation measures. Indeed, the technology can be used before and after the installation of a project to assess the conservation status of bats following installation of a bat bridge or any other mitigation features. As this data enables bats to be identified to species level, Bat3Data® performs better in this respect than infra-red camera technology because the flight is precisely identified and recorded. The technology can also be used within the EIA process to justify, in certain situations, when a license might not be required.

Conclusion

Bat3Data© is a bat detection technology that allows for the collection of species level data on the movement of bats by triangulating and recording echolocation calls in 3D. Species can be identified and displayed within a 3D GIS database/photomontage. The resulting data are suitable for use in Public Enquiry, EIA and EPS license applications.

The data obtained can inform the EIA process by highlighting risk to bats potentially impacted by a project.

The survey technique reduces the subjectivity which is associated with the current standard of bat surveys.

The technology is applicable to many different types of project; infrastructure, industrial, and energy.