Birding by sound: developing competence, confidence and commitment in bioacoustic surveying

Introduction

Bioacoustics is the scientific study of sound in living organisms. Birds are particularly well-suited to bioacoustic monitoring because vocalisations play a central role in their behaviour, e.g. territory defence, mate attraction, contact calls and nocturnal migration.

In bird surveying, the commonest bioacoustic method is passive acoustic monitoring (PAM) which deploys autonomous recording devices to capture sounds over extended periods without a human presence. It can detect species presence and absence, monitor behavioural patterns, and contribute to assessments of habitat and ecosystem condition.

Bioacoustics and PAM are important tools, helping overcome constraints of traditional fieldwork such as cost, availability of experienced surveyors, surveying at night, poor weather and remote or inaccessible locations (Sugai *et al*. 2019). However, skilled birders remain far better at interpreting behaviour, assessing habitat use, and detecting unusual or unexpected species. What is emerging instead is a hybrid human-machine surveying model combining automated recording and detection with human expertise.

To help SOC members engage with this future, we received a small club grant in 2025 to develop and deliver a PAM training programme via two workshops. In this article, we share key aspects from this programme, and provide a brief overview of some pioneering bioacoustic work in Scotland.

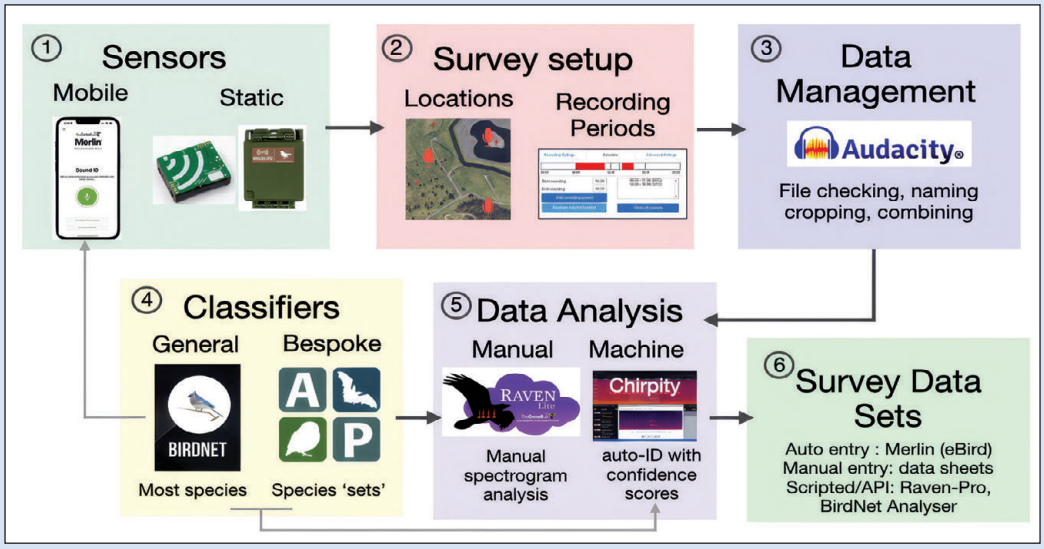

Figure 1. The bioacoustic survey workflow, from sensor selection and survey setup through data management, classification and analysis to the production of survey-ready datasets.

The bioacoustic survey ecosystem

Bioacoustic surveying can be thought of as a step-by-step workflow, with each stage supported by specific hardware and software tools as illustrated in Figure 1. Each stage is introduced, together with practical advice drawn from our training programme and field experience. As bioacoustic methods become more widely adopted, SOC members may become involved in one or several stages of this process, from deploying sensors in the field to reviewing spectrograms at home.

Sensors

The recent uptake of PAM has been driven by the availability of two relatively low-cost acoustic sensors: the AudioMoth and the Song Meter Micro 2. Both are entry-level sensors capable of recording high-quality bird vocalisations. The Song Meter Micro 2 can be programmed via a mobile phone using Bluetooth; the AudioMoth requires a computer connection but can be set to record ultrasound, e.g. to monitor bats. Choice of device often comes down to ease of use, durability, and objective.

Plate 193. The Song Meter Micro 2 provides a good entry level acoustic sensor which can be programmed using a mobile phone via Bluetooth. © *Mike Thornton*

Plate 194. The Audiomoth acoustic sensor can be set to detect ultrasound more than 20 kilohertz to record echolocating bats. © *Mike Thornton*

The recording schedule selected depends on survey aims and target species. For most crepuscular and nocturnal birds, e.g. Nightjar, Woodcock and owls, recommended recording coincides with peaks in vocal activity from around 45–60 minutes before to 60–90 minutes after sunrise, and from 45–60 minutes before to 45–60 minutes after sunset. Recordings can be continuous or cyclical (e.g. five minutes on, five off) to extend battery life and allow longer deployment.

Classifiers and automated detection

At the heart of most modern bioacoustic systems is a classifier. This is an AI model trained to analyse audio recordings and predict which species are vocalising. General classifiers e.g. BirdNET (which is similar to the Merlin app) are trained on recordings from thousands of species worldwide (Kahl, *et al.* 2021). This broad coverage is impressive, but can lead to errors where species have similar songs or calls. Confusions between Chaffinch and Chiffchaff, between Greylag and White-fronted Geese, and false positives involving Hawfinch, are well-known examples.

To improve accuracy, organisations like the BTO are developing more targeted classifiers focused on particular species groups (e.g. nocturnal migrants) or specific geographic regions, while researchers are developing statistical approaches that assign confidence scores to automated identifications. Despite rapid advances, automated detection is unlikely ever to be error-free. Bird vocalisations, like human language, are varied and complex, thus human verification will remain essential to most workflows.

Analysis tools and manual review

Manual inspection of recordings is crucial to ensure data quality. Several well-established software tools are commonly used here: 'Audacity' is a widely used free software package for editing sound files; 'Raven' is widely regarded as the gold standard for bird spectrogram analysis, particularly valuable when investigating rare species, ambiguous calls, or potential false positives generated by automated classifiers; 'Chirpity' provides an accessible interface to BirdNET auto-identification. Importantly, it allows users to focus on low-confidence detections requiring manual verification. 'Kaleidoscope' sits between automated detection and manual analysis. In practice, the emerging cadre of 'sound ornithologists' use a combination of tools: automated classifiers to scan large volumes of data efficiently, and manual software to verify uncertain records.

Bioacoustic surveying in Scotland: current practice and future potential

PAM is particularly well suited to surveying cryptic, crepuscular and nocturnal birds. During COVID-19, reduced anthropogenic noise led to increased interest in nocturnal migration monitoring ('noc-mig'), with recorders deployed overnight to capture flight calls of migrating birds. This resulted in notable discoveries, e.g. identification of multiple west–east overland flyways used by Common Scoter.

In Scotland, PAM has also been trialled for several rare or declining species. Capercaillie leks have been monitored to assess occupancy and relative abundance between sites. SOC-funded studies have used PAM to survey Nightjars in the Scottish Borders, Aberdeenshire and Argyll, substantially improving coverage compared with historical survey effort. Other projects employ PAM to detect Tawny Owls in Glasgow, Corncrakes on Skye, Long-eared Owls in East Lothian, breeding waders in the Cairngorms and to measure the population size and breeding success of Storm Petrels. Additional species for which PAM could usefully complement conventional field methods include Water Rail, Spotted Crake, Black Grouse and Woodcock.

Broader applications and emerging directions

Demand for bird survey data in Scotland has never been greater. Alongside established national atlases and long-term monitoring programmes, surveys are now routinely required for planning and environmental assessment associated with wind farms, housing and other infrastructure. More recently, bird data are being incorporated into indices that support emerging Nature and Biodiversity Credit schemes. There are neither enough skilled surveyors nor sufficient budgets to meet this demand using traditional methods alone. Bioacoustic surveying offers a credible way to extend survey coverage within existing constraints of time, finance and human capacity.

Two broad strategies are currently being pursued. The first focuses on integrating PAM with established UK bird survey methods. The BTO leads work here. The second is more innovative, designing new biodiversity metrics that draw directly on advances in environmental sensing, including bioacoustics, to quantify changes in ecosystems. In Scotland, this approach is being explored through partnerships developing the proposed Scottish Ecosystem Recovery Code.

In parallel, significant effort is being invested in automating bioacoustic workflows. Sensor deployments currently require battery changes, SD card swaps and manual data upload. For example, the Soprano project at Edinburgh University is developing on-sensor classifiers (often referred to as *edge AI*) that analyse recordings *in situ* and transmit summarised data via local radio networks to satellite internet (e.g. Starlink). This reduces power demand, opening the door to near real-time, multi-site monitoring at relatively modest cost.

Lastly, guidance and protocols are being developed for bioacoustic surveying covering aspects such as sensor placement, numbers, and recording protocol (Metcalf *et al*. 2023).

Conclusion: competence, confidence and participation

Bioacoustic surveying powerfully extends what skilled bird surveyors can achieve. Crucially, it still depends on human competence in deploying sensors, interpreting outputs, and making informed judgements about uncertain records.

Bioacoustics offers an opportunity to engage with the future of bird surveying while building on existing skills and experience. It also provides an accessible entry point into technologies now transforming science and society. For those intending a career in field ornithology or the environmental sector, bioacoustics offers opportunities to develop skills and expertise increasingly essential in the workplace.

For members wishing to try their hand (or their ear) at bioacoustic surveying, the SOC library has AudioMoths available for loan. PAM rewards curiosity, care, collaboration and vision, and we can expect a flourishing of Scottish bird surveys - whether led by local members, established organisations or new start ups - in the years ahead. The challenge will be to combine technological innovation with the judgement and enthusiasm that have always underpinned good ornithology.

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SOC Motus project sees first birds tagged and detected

The Club's Motus project (see *Scottish Birds* 44: 154–56) is gathering pace as it looks to establish this exciting wildlife tracking system in Scotland. Based in Fife, the project has seen the installation of Motus receivers at Cellardyke, Crail and St Andrews. While these are the first three Motus receivers in Scotland, they form part of a global network of receivers which detect birds (and even bats and large insects) fitted with Motus tags.

The project is specifically looking at Rock Pipits in the East Neuk of Fife, where Mike Martin and the Tay Ringing Group have been studying the population through a colour-ringing scheme. Ringing recoveries have shown that the wintering population of Rock Pipits in Fife comprises resident birds, individuals which breed on the Isle of May, Norwegian birds of the Fennoscandian race *Anthus petrosus littoralis*

Plate 195. Mike Martin, Chris Broom and Rachael Wilbourn standing next to the receiver after it was installed at Crail, Fife, June 2024. © *Richard Wellstead*