

Bird Sounds Global: automated species recognition with machine learning

Sebastian Andrejeff & Petteri Lehtikoinen

A fascinating insight into how to harness your expertise to advance automated bird-sound identification, understanding of global biodiversity and enhance your own sound-recognition skills.



1 Birds identified from soundscapes at the Reserva Natural Los Yátaros in Gachantivá, Boyacá, Colombia, a LIFEPLAN sampling site, include the near-endemic Scrub Tanager *Stelgidopteryx serripennis* ('Montezuma Road', Risaralda, Colombia, November 2018; James Lowen: [jameslowen.com](https://www.jameslowen.com)).

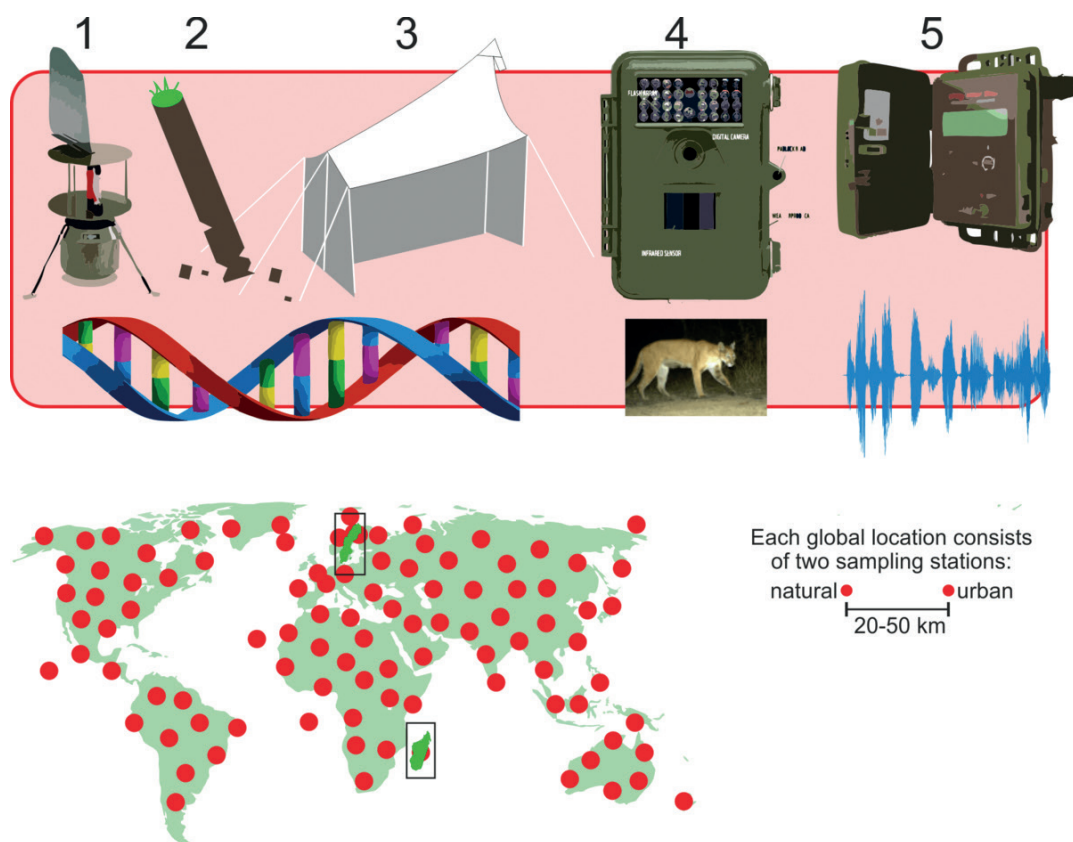
Bird Sounds Global (BSG) is part of the LIFEPLAN research programme (www2.helsinki.fi/en/projects/lifeplan), which aims to improve understanding of the global biodiversity and its driving factors. LIFEPLAN is a network of data collection through remote sensing, and it monitors a wide range of taxa with different sampling methods. It produces thousands of years of audio data from across the planet. Understandably, these data cannot be listened through by human experts. Therefore, automated species identification is required, and this represents the main goal of BSG.

Another important element of BSG involves enabling public participation in the research. BSG is about developing automated bird-sound identification by combining machine learning and citizen science. In BSG you can produce sound features alongside labelled training and testing material of the birds of the world. These are important steps for developing methods that will

eventually be used to recognize sounds produced by all the world's birds, mammals and amphibians. With such methods, machine learning and automated data collection can be used not only to understand current biodiversity and its drivers but also to predict future biodiversity.

The end products of BSG are an expert-validated sound-feature library for birds of the world and locally refined species-identification models for bird vocalizations. The end products will be openly available to everyone for further use. Open-access recognition models provide opportunities for other applications and their further development, such as the current state-of-the-art software applications, Merlin & BirdNET, developed by the Cornell Lab of Ornithology (<http://birdnet.cornell.edu/>).

Both Merlin and BirdNET are working well for targeted recordings, but since the LIFEPLAN project is producing audio data on *soundscapes* (i.e., passive recordings of all noises in the



2 The overall sampling scheme of the LIFEPLAN project, targeting a wide range of taxa. Fungi and bacteria are monitored with cyclone samplers (1) and soil samples (2), insects with Malaise traps (3), mammals and other vertebrates with camera traps (4) and birds, amphibians and bats with sound recorders (5).



3 AudioMoth device at the LIFEPLAN recording site of Reserva Natural Los Yátaros in Gachantivá, Boyacá, Colombia (Orlando Acevedo-Charry).

environment at a locality, rather than recording a single species), further method development is needed. Fine-tuning the models with data annotated by ornithological experts is a crucial and important part of this development. Essentially this means birders identifying bird vocalizations within an ambient recording... which is where *Neotropical Birding* readers come in!

A recap on passive acoustic monitoring

First though, a recap on passive acoustic monitoring (PAM), an increasingly important technique that was treated to a feature in this magazine last year (Metcalf 2022). Among other advantages, PAM offers a powerful tool to survey species that are hard to observe otherwise, including families such as antpittas, tinamous and tapaculos; provide important information on nocturnal groups such as owls and nightjars; and can, particularly over the long term, offer information about species' population sizes and trajectories. Critically, all this can happen without ornithologists needing to be in the field.

LIFEPLAN in the Neotropics

LIFEPLAN sampling sites in the Neotropical region include 11 localities spread across Antigua and Barbuda, Argentina, Brazil, Colombia, Peru and Mexico (Fig. 2). One of the recording sites is located in the Reserva Natural Los Yátaros in Gachantivá, Boyacá, Colombia (Fig. 3). Over 100 species have been recorded there. Of particular interest for PAM are the near-endemics Moustached Brushfinch *Atlapetes albofrenatus* and Scrub Tanager *Stilpnia vitriolina*. Other

interesting species recorded at the site include Black Inca *Coeligena prunellei* (Vulnerable), Spillmann's Tapaculo *Scytalopus spillmanni* and White-capped Dipper *Cinclus leucocephalus*.

Another Neotropical recording site is in Tucumán, Argentina. It is located in the foothills of a subtropical montane forest, where breeding is markedly seasonal. In winter, during the non-breeding season, the species are much less vocal, but PAM can be very useful in capturing and identifying the contact voices of small passerines that move in mixed flocks through the different strata of the forest.

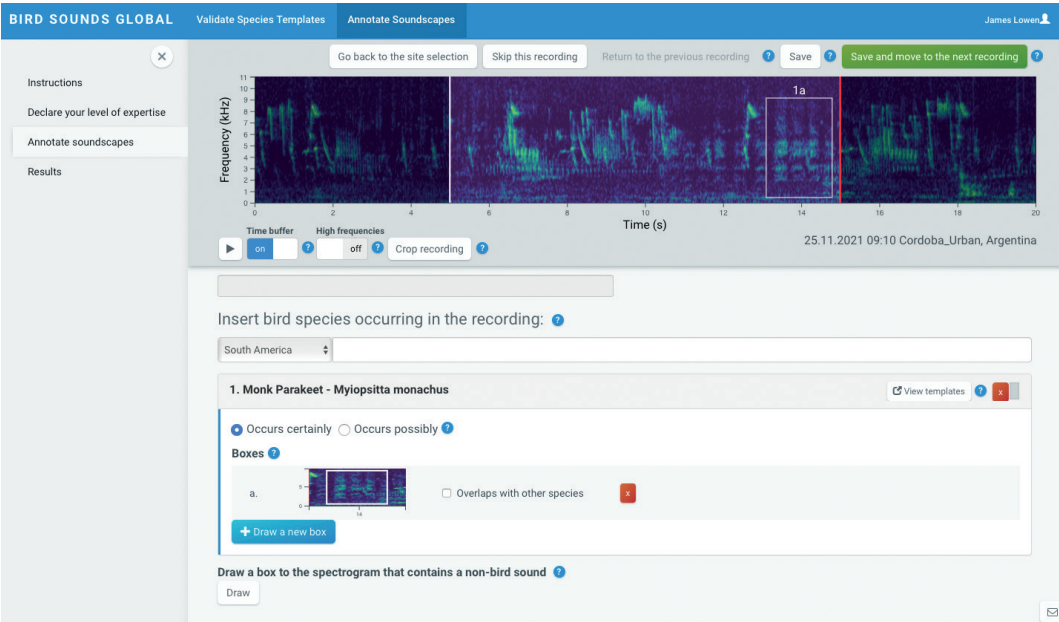
PAM is helping in other ways too. Many of the species here perform some form of migration, whether altitudinal, intra-Neotropical, trans-hemisphere or partial. For example, in winter, cold fronts regularly reduce temperatures for several days. During these cold periods many birds descend from the highest parts of the mountain range towards the foothills where the LIFEPLAN site is located. Acoustic monitoring can be used to detect these short-term changes in bird activity and link them with climatic information, which helps understand the dynamics and possible drivers of these elevational movements. Moreover, PAM is recording some species that are becoming more and more frequent in the province. Considering the amount of effort that is required for in-person surveys, gathering such data would be impossible without PAM.

How you can annotate soundscapes from the Neotropical sites

Regions with LIFEPLAN sampling sites in the Neotropics will be well known to many *Neotropical Birding* readers. So how can you help?

You can contribute your expertise in five easy steps. First, visit bsg.laji.fi/identification/ instructions to sign up or log in. Second, declare your level of expertise by answering a couple of questions. Then you can 'annotate' the soundscapes via the 'Annotate Soundscapes' portal (Fig. 4; this will soon be made available in Spanish). You are invited to identify and label the species that vocalize on a 10-second audio recording. You are not necessarily expected to identify all the vocalizations. In case of unrecognized vocalizations, simply check the box marked 'recording contains bird vocalisations I cannot identify.'

Labelling is done by drawing boxes on the spectrogram. Labels are used for training



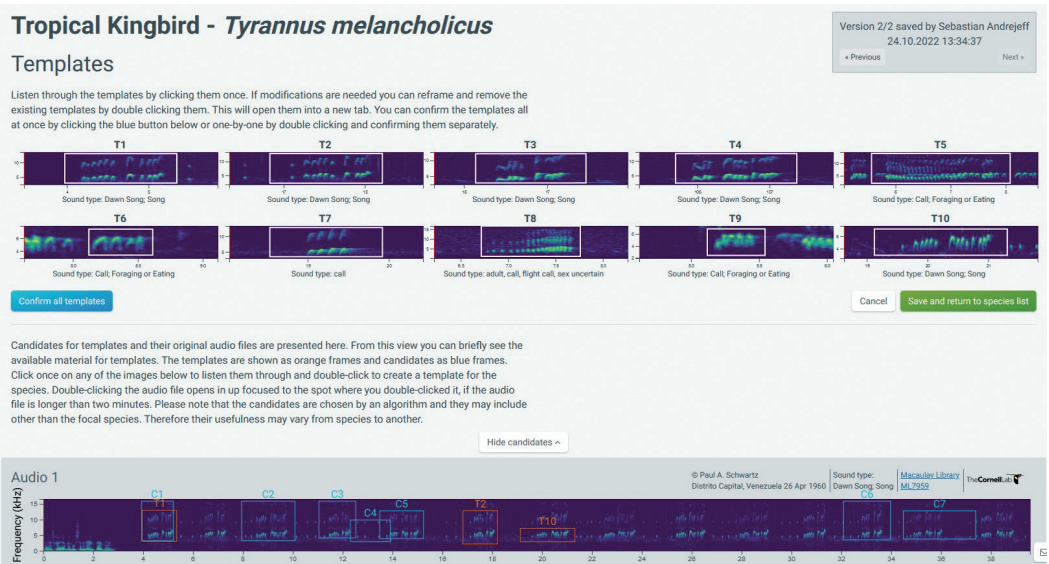
4 Example of an annotated soundscape from Córdoba, Argentina.

and testing the identification models. It is recommended to label all the sounds when it is easy, but the first priority is to insert all bird species that you can identify in the recording. If there are many species vocalizing in the recording, it is better to label only those sounds which are clear and not get stuck with labelling all distant or overlapping sounds. As a rule of thumb, for method-developing purposes it is best to produce

annotations time-efficiently, i.e., focus on what you can easily do.

Validating species templates

In addition to annotating soundscapes, BSG hosts a section for creating and validating sound templates for the world's bird species (Fig. 5; see bsg.laji.fi/validation/instructions). This project was launched in November 2021 and sound



5 Tropical Kingbird *Tyrannus melancholicus* and its sound templates including calls and phrases of song.



Birds identified from soundscapes at a LIFEPLAN sampling site in Tucumán, Argentina, include: **6** Turquoise-fronted Parrot *Amazona aestiva* (Formosa, Argentina, February 2009); **7** Brown-capped Redstart *Myioborus bruniceps* (Salta, Argentina, August 2009); **8** Common Chlorospingus *Chlorospingus flavopectus* (Jujuy, Argentina, August 2009); and **9** Black-backed Grosbeak *Pheucticus aureoventris* (Tucumán, Argentina, February 2007). Photos **6–9**: James Lowen (✓ jameslowen.com).

templates have already been completed for over 1,300 species. The results vary regionally; over 60% of European species templates have two or more validations, but in South America fully validated templates comprise only 18% of the species.

You can contribute through two types of tasks. The first expert to work with a particular species can build up 10 sound templates which represent the vocalizations of the focal species. The second expert is expected to check and validate that the 10 templates prepared by the first expert all include the focal species and have been correctly framed. Ideally, all the templates should include the most typical vocalization for the species, so that they include different vocalization types and/or



different variations of these types. The audio used to create these templates are from Xeno-Canto and the Macaulay Library.

The global data collected in this first phase of BSG is now being put to good use, namely training a global base model for bird-sound recognition. Training data produced from annotating soundscapes will be used for adapting this base model for a specific location. Our pilot work has showed these annotated local soundscapes to be important for fine-tuning location-specific models, and thereby identifying the local bird species with higher accuracy (Lauha *et al.* 2022).

HOW TO HELP BIRD SOUNDS GLOBAL

To contribute to automated bird sound recognition with Bird Sounds Global, visit  bsg.laji.fi

End products

LIFEPLAN is a non-profit research project that aims to produce end products which could be freely used in other research. BSG will produce an open-access database of fully annotated sound features for the global avifauna. Application possibilities are ample, such as further development of automatic bird-sound recognition, environmental education or recognizing which features in vocalizations are pleasant for human ears (a characteristic that might render these bird species more vulnerable to capture and trafficking).

Another end product of the BSG will be an open-access global bird-sound recognition model and multiple locally fine-tuned models for the LIFEPLAN sites. Since autumn 2022, we have invited non-LIFEPLAN locations to contribute their PAM data to BSG. In the portal, teams can easily annotate their own recordings and, in return, receive a recognition model fine-tuned for their data. This will also mean that there is more annotated data for the global model, which will improve its performance and reliability.

How can you contribute and strengthen understanding of global biodiversity?

With BSG you can harness your expertise to advance automated bird-sound identification and understanding of global biodiversity! The number of annotated soundscapes in the Neotropics is currently very low as is the number of completed species' sound templates. This means that even with a small contribution you will significantly advance automated sound recognition in the region. In turn, this will increase not only possible applications for research, monitoring and protection of the Neotropical birds but also applications for birdwatchers and other naturalists. These include the next generation of smartphone apps, which can identify the vocalizing birds in the field.

Another good reason to contribute to the BSG is to enhance your own sound-recognition skills. Focusing completely on the sounds with the help of the audiovisual spectrograms is highly educational even for the most hard-core birders. Exploring the soundscapes is also purely fun – and you never know what you might encounter in the next recording!

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SEBASTIAN ANDREJEFF & PETTERI LEHIKONEN

The LIFEPLAN project, Department of Biosciences, University of Helsinki, Finland

✉ sebastian.andrejeff@helsinki.fi

✉ petteri.lehikoinen@helsinki.fi

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The iGoTerra team have made available checklists for countries in the NBC region, which are downloadable via NBC's website:  neotropicalbirdclub.org/igoterra-checklists/

