Listening to the Whispers of the Wings

by Sunny (Yi-Chin) Tseng

Birds sing—it is one of the reasons people are fascinated by them. Surprisingly, it was not until 1929 that the first recordings of wild birds were made. Since 1929, field audio recording of birds has become important for science, conservation and a fun hobby for enthusiastic birders. Permanent records of bird sounds not only inform new scientific discoveries, but also provide an opportunity for people to learn birds from their sounds. This article will cover the history of avian field recording, the tools that are used in the present to record bird sounds, and the citizen science platforms that are accessible for all to learn and share about worldwide bird sounds.

History of Avian Field Recording

It is impossible to discuss the history of wild bird recording without mentioning Arthur Allen, Peter P. Kellogg and Albert R. Brand from the Cornell Lab of Ornithology. During the first half of the 20th century, the team developed techniques and key technologies for recording birds that are still used today. In 1929, Allen and Kellogg made the very first recordings of wild birds using the new technology of motion-picture film with synchronized sound. The digital version of the first bird sound recording, that of a Song Sparrow (*Melospiza melodia*), can be found in the Cornell Macaulay Library (see p. 89). Within two years, they successfully recorded more than 40 species of birds in North America. In 1931, the team used a World War I parabola mould to design and build a parabolic reflector for field recordings (Image 1). The parabolic design and the concept of directional recording are still being used today.

Image 1. The early parabolic recording equipment (Cornell Lab of Ornithology).

Microphones for Field Recording

The microphone is the key component in a recording system—it senses the vibration of air and transforms it into electrical signals. Microphones for recording birds should be 'directional', that is, microphones that are sensitive to sounds coming from one direction. Two kinds of directional microphones are commonly used for bird sounds: the parabolic microphone and the shotgun microphone.

A parabolic microphone consists of a microphone placed at the focal point of a dish with a

parabolic curve (Image 2). Given the reflective property of a parabola, parabolic microphones can amplify sounds from a far distance, making them suitable to record species from high-canopy or birds with soft vocalizations. The diameter of the parabola influences the dominant frequency it collects. The lower the frequency (longer wavelength), the bigger the parabola needs to be. Common commercial parabolic microphones for field recording (e.g., Telinga Microphones) have a diameter of 55 cm, targeting sounds with frequency 500 Hz to 10 kHz (Wildtronics, 2022)—the frequency range of most songbirds.

A shotgun microphone doesn't amplify sounds like a parabolic microphone; instead, it selectively captures the sounds coming from the same direction. Shotgun microphones have a long interference tube containing a series of slots (Image 3) which make off-axis sounds cancel out each other, and only the on-axis sounds can reach the microphone capsule. The longer the interference tube, the more directional that microphone is. Sennheiser shotgun microphones are most commonly used, e.g., Sennheiser ME 66, ME 67 and MKH series. Recently, Røde shotgun microphones are gaining

Image 2. The dish can be made of various materials. The most advanced disk is made of foldable plastic which is light and easier to carry in the field (the disk on the left held by Ken Hall). An older version of the dish was made of glass fibre (the disk on the right held by Sunny Tseng). *Photo: Peter Ward*

in popularity given their lower price range.

The choice between parabolic microphone or shotgun microphone depends on the species that one is trying to record. Parabolic microphones provide outstanding directionality. It's often recognized that parabolic microphones can produce a cleaner recording than shotgun microphones under the same circumstances. However, as a shotgun microphone is less directional than a parabolic microphone, it is faster to aim. Additionally, a shotgun is easier to carry in the field and can be especially useful for recording a group of birds, birds in flight or birds on the move.

Passive Acoustic Monitoring

Passive acoustic monitoring involves setting up recorders in the field to remotely monitor the bird sound activity. Unlike in an active search that emphasizes the quality of recordings, the system used in passive acoustic monitoring prioritizes compactness, durability and most importantly, programmability. Recording systems that can be programmed to record sounds at a given time and interval are called 'autonomous recording units'. The most commonly used autonomous recording units are Song Meter SM4 from Wildlife Acoustics, Swift from Cornell Lab of Ornithology and AudioMoth from Open Acoustic Devices (Image 4).

Passive acoustic monitoring is mostly used in avian surveys, conventionally done with people conducting point counts. Passive acoustic monitoring with autonomous recording units provides several advantages over conventional point count surveys, such as providing permanent records, reducing observer bias and potentially

Image 3. Shotgun microphones with interference tube. *Photo: Sunny Tseng*

Image 4. Autonomous recording unit AudioMoth. A single autonomous unit includes microphone and data logger that can be left in the field for days or months. Usually, the AudioMoth is deployed with plastic bags to prevent water damage. *Photo: Sunny Tseng*

increasing the spatiotemporal scale of the scientific study (Shonfield & Bayne, 2017). Several studies have used richness as the metric to compare the performance of passive acoustic monitoring and point counts and these studies have suggested that both methods together can be more effective in assessing biodiversity than either method alone (Celis-Murillo et al., 2009).

Citizen Science to Share Bird Sounds

The idea of citizen science was developed in the mid-1990s, fostering the relationship between citizens and science. There are two worldwide citizen science platforms that encourage people to share their bird sound recordings: Xeno-Canto and Macaulay Library. Shared recordings can be accessed for scientific research or for educational purposes.

Xeno-Canto (***www.xeno-canto.org***), which translates to "strange sounds", is a website for sharing bird sounds all around the world. It was initiated in 2005, aiming to improve accessibility of bird sounds, and can be used for enjoyment, education, conservation and science. Xeno-Canto has a collection of around 700,000 recordings representing 10,516 bird species. More than 9,000 recordists participate around the world (numbers

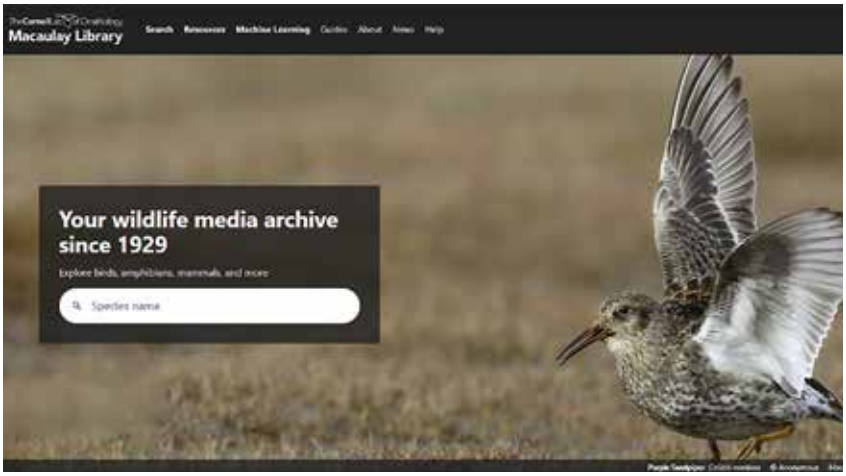

Image 5. Home page of Macaulay Library.

accessed 24 October 2022). Most importantly, Xeno-Canto keeps this dataset as open source. It is free for anyone to share, download and comment on other people's sound collections.

Macaulay Library (***https://www.macaulaylibrary.org/***), hosted by the Cornell Lab of Ornithology, is a scientific archive for research, education and conservation (Image 5). It was initiated in 1929, making it one of the oldest archives for bird sounds. Macaulay Library has a collection of 40 million media files (photo, audio and video) representing 10,056 bird species. There are more than 80,000 contributors (numbers accessed on 24 October 2022). Contributors can upload their recording while submitting an eBird checklist. Birds Canada coordinates oversight of eBird checklists throughout Canada for the Macaulay Library, Cornell Lab of Ornithology.

Learning and Identifying Birds by their Sounds

There are several "free" cell phone apps developed to help people learn birds by ear or enhance field surveys. These apps include Merlin (Image 6) and BirdNET. BirdNET is a sound identification app developed by the Cornell Lab of Ornithology. Soon after, a similar artificial-intelligence algorithm was integrated into Merlin 'Sound ID' feature. BirdNET features more than 3,000 of the most common species worldwide while Merlin supports 685 species of birds in the US, Canada and Europe. Both apps work by recording bird sounds using phone and the sounds are processed by artificial intelligence algorithms. The bird species is named immediately when the app records the bird sound. In addition to the name of the bird species, the app shows a spectrogram of the sound. The app

can even simultaneously detect/identify species singing and will list all species heard. For enhanced recording and identification, you can connect a shotgun microphone to your cell phone. To date, the app sound recording identification is not 100% accurate, but birders estimate it is better than 90% accurate depending on the extent of recordings that are available for that geographic area. The sound apps identify species, but not the number of birds making the sound, so field observers are still essential.

Image 6. Merlin app for sound identification. Merlin also provides a sound library for each of the species so that users can double-check the prediction output.

Conclusions

Technology advancements have made field bird sound recording affordable for the public. Professional microphones such as parabolic microphones and shotgun microphones provide high quality sound recordings. Autonomous recording units enable passive acoustic monitoring. One can further share their bird sounds in citizen science platforms such as Xeno-Canto and Macaulay Library through eBird checklists. Finally, there are apps such as BirdNET and Merlin to help birders identify bird sound in the field. It is a pure pleasure to do bird sound recordings and it is even more delightful to share these beautiful sounds with the world.

"There is a danger when picking up recorders," warns Donald Kroodsma, a well-known field recordist. "You can get hooked for life."

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