

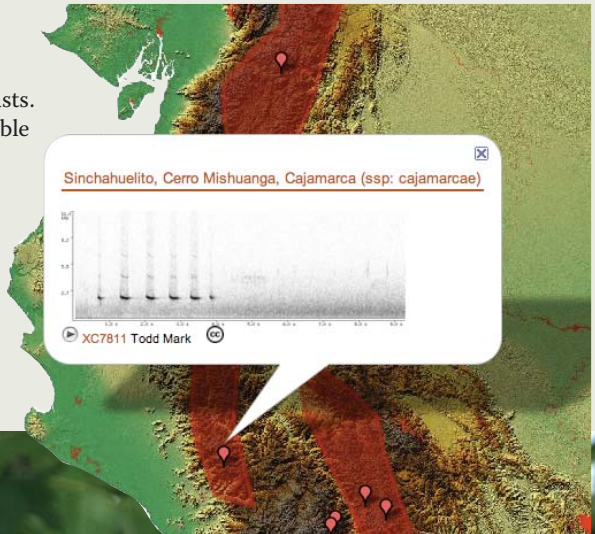
# Xeno-canto: a 21st-century way to appreciate Neotropical bird song

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In today's digital age, information on birds and their lives has never been more widely available. Bird songs and calls can be recorded and shared with ease, as a sizeable community of enthusiasts is now proving. To kick off a new series entitled 'Better Neotropical Birding', designed to help you get the most out of birding, the founders of the website [www.xeno-canto.org](http://www.xeno-canto.org) walk us through doors that are opened by combining new technology and digital sound recordings.

The internet has opened up many new possibilities to create rich and dynamic information sources, run at low cost and supplied with data by communities of enthusiasts. Formerly inaccessible databases are now available for everyone to use, as is a wealth of free and

Figure 1. Superimposed upon a Shuttle Radar Topography Mission (SRTM) elevation map, this figure shows the location of a recording of Rufous Antpitta *Grallaria rufula cajamarcae* made by Todd Mark, together with its sonogram and other data. The species' distribution is shown in red, and the markers pinpoint the location of other recordings held on xeno-canto



Moustached Woodcreeper *Xiphocolaptes falcirostris*, Olho D'Água do Urucu, Brazil (recording number XC13538 in the xeno-canto collection; Ciro Albano). A Vulnerable species, this pair performed a courtship display after playback of their songs in *caatinga* trees

open-source software plus web-services such as mapping applications. Examples of hugely successful birding websites harvesting this new technology are [www.eBird.org](http://www.eBird.org) and its Dutch counterpart [www.waarneming.nl](http://www.waarneming.nl), both community websites documenting bird and other nature observations.

Xeno-canto ([www.xeno-canto.org](http://www.xeno-canto.org)), which roughly means ‘unknown song’, fits squarely into this concept. Many *Neotropical Birding* readers may know that xeno-canto is a large, web-based collection of Neotropical bird vocalisations. Indeed, xeno-canto has quickly established itself as one of the largest resources of bird songs anywhere. Here are some statistics (correct at the time of writing, but probably out of date by the time you read this): in the three years of its existence, more than 170 recordists have joined forces and accumulated more than 18,000 cuts of 3,100 species from Latin America. Species coverage in any mainland region averages around 90%. To mention just a few groups, there are recordings of all *Synallaxis* spinetails, 350 species of tyrant flycatcher and 200 antbirds.

Xeno-canto is not just large numbers, however. There are plenty of odd, good and rare recordings too. Odd? Check out Chris Benesh’s hilarious Snowy Egret *Egretta thula*. Good? Just listen to some in the ‘Hall of Fame’, such as Fábio Olmos’ Cinnamon-throated Hermit *Phaethornis nattereri* or Todd Mark’s Striolated Puffbird *Nystalus striolatus*. And rare? How about Araripe Manakin *Antilophia bokermanni* (Critically Endangered), Recurve-billed Bushbird

*Clytoctantes alixii* (an Endangered species for which there are 14 recordings!), four *Neomorphus* ground cuckoos (one Vulnerable), Yellow-browed Toucanet *Alaucorhynchus huallagae* (Endangered), Greater Scythebill *Campylorhynchus pucherani* (Near Threatened), Stresemann’s Bristlefront *Merulaxis stresemanni* (Critically Endangered), plus a trio of sought-after antpittas: Great *Grallaria excelsa* (Vulnerable), Jocotoco *G. ridgelyi* (Endangered) and Scallop-breasted *Grallaricula loricata* (Near Threatened).

Very impressive, we hope you agree; and all free for download. However, this article is not really about the collection itself. Instead, we want to share with you the various ways the recordings are made accessible to the sound-oriented birder, and show how xeno-canto has become a playground for novel ideas on classifying and organising data on bird song, biogeography, and life history.

## Identifying bird songs

Originally, xeno-canto was developed to identify unknown bird songs from the Neotropics. This is a relevant problem: vocalisations are a common tool for avifaunal inventories in the region. However, it takes much effort to acquire a comprehensive knowledge of an avifauna’s repertoire. Only a few professional ornithologists and bird guides have ever reached this nirvana. For the travelling birder or the otherwise employed, there is little hope of achieving such proficiency.

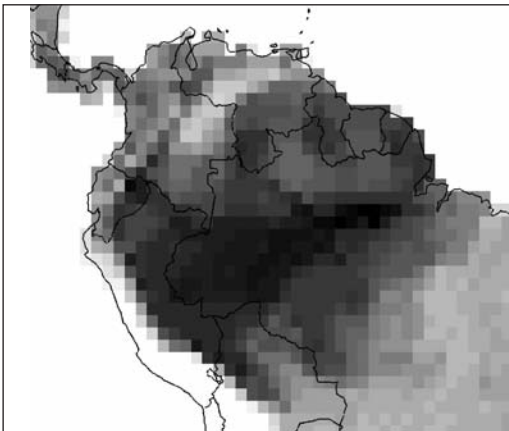


Figure 2. The cumulative distribution of all woodcreepers (Dendrocolaptidae). The family hotspot (the darkest area) can be seen clearly just south of the Amazon on the border between the Brazilian states of Amazonas and Pará

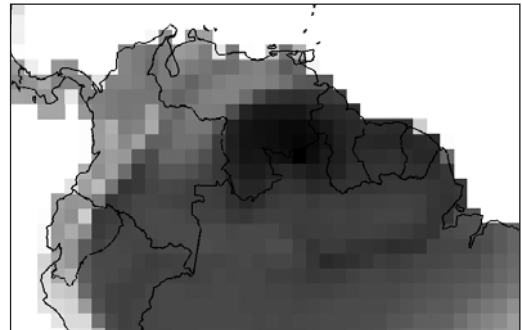


Figure 3. A sample cumulative range map for a focal location in south Venezuela. The map shows the cumulative range of all species occurring in the grid square shown in darkest grey. The map shows that most of the species occurring in this square also occur in east Venezuela or in a loop through the mouth of the Amazon back onto the floodplain. The species at the focal location occur in their lowest cumulative numbers along the Pacific coast, in the areas coloured off-white

Should we despair? Not completely. Some great institutional collections, such as that of the Macaulay Library at Cornell, are finding their way onto the internet. And, of course, there are many great cassettes, CDs, CD-ROMs and DVDs that, between them, contain a large proportion of the bird sounds of the Neotropics. For countries such as Ecuador there are fantastic publications that provide almost complete renditions of the national avifauna<sup>4</sup>.

Nevertheless, buying loads of recordings doesn't necessarily help. Granted, such collections are very useful to confirm tentative identifications or to use, judiciously, for playback. If, however, you are really clueless (like the authors, who tried forlornly to identify hours of dawn chorus from the Peruvian Amazon), their use is limited. The collections rarely offer any facility to search for unidentified voices. A large private collection of vocalisations certainly increases the odds of encountering the right whistle or squeak, but at a cost: you need much more time to track it down.

This led us to wonder whether it might be possible to devise 'field marks' for sounds and to combine these with data noted by recordists (such as altitude, habitat and location) in order to narrow down the options. What about fast ways of searching through large collections of sounds to quickly compare a few that match shared criteria? And what about reaching out to other recordists facing the same problem?

The web seemed to provide the way forward. Our starting point was to seek permission to use the incredible ecological and distributional databases contained in the seminal publication *Neotropical birds: ecology and conservation*<sup>5</sup> as the information backbone of the new website.

Our next idea was to devise a qualitative 'scoring system' for particular characteristics of the vocalisation such as length, volume, pitch, number of notes, speed and variability. For each characteristic, we developed some user-friendly categories to describe it: pitch might be 'even' or 'rising', for example, and volume might be 'increasing' or 'decreasing'.

This approach can be easily used on the xeno-canto website. Users can rapidly narrow down a search by selecting only those cuts that meet specified criteria. For instance, one might request details of all cuts 'recorded in Peruvian flooded tropical rainforest, that are 3–6 seconds long and decrease in volume'. Listening to the subset of recordings that meets these criteria or quickly checking the accompanying sonograms guides the user to promising recordings, one of

which hopefully matches the call or song being sought.

This system is far from perfect, of course. In fact, it doesn't work at all for bird groups such as parrots (how does one describe a macaw's calls?) and wildfowl. But for famously hard groups within the suboscines, such as woodcreepers and antbirds, it really works quite well.

## Community search: using background species

The initial format of the website was enough to convince Sjoerd Mayer, the well-known Dutch sound recordist, to contribute all recordings from the seminal CD-ROM of Bolivian bird sounds<sup>3</sup>. Sjoerd's accompanying notes on each recording also listed all species audible in the background.

This led us to develop another strategy for identifying an unknown vocalisation. Birders, we thought, might start their quest with a known species in a particular area, further refine the search with details of altitude and habitat, then check whether the unknown song could be heard in the background of recordings in the xeno-canto collection.

We thought it would be a major asset to include this feature in xeno-canto. At present, 'background species' are identified in more than 5,000 recordings. By combining these data and the *Neotropical birds* dataset we created a process that we call a 'community search'. The 'communities' are groups of birds that have been recorded together. In essence, the user tries to solve a bird song riddle by asking: "I don't know what I heard, but I do know that species A, B and C occurred at the same spot. So let me figure out which species are commonly heard together with A, B and C." We are keen to receive feedback on the effectiveness of this approach, so please try it and let us know how you get on.

## Biogeography

Over time, we have been able to combine more data sources and tools with the recordings. We have incorporated the InfoNatura distributional maps produced by NatureServe (a conservation and educational resource on animals and ecosystems of Latin America and the Caribbean; see [www.natureserve.org/infonatura](http://www.natureserve.org/infonatura)). Notwithstanding small mismatches in taxonomy, these can be displayed on xeno-canto with Google Maps. Markers for each recording superimposed on the species' range enable the user to get a



This Crescent-chested Puffbird *Malacoptila striata*, a striking Atlantic Forest endemic, was singing behind the lodge near the swimming pool at the Reserva Ecológica de Guapi Assu, Brazil (XC3443; Nick Athanas/Tropical Birding)



Many-colored Chaco Finch *Saltatricola multicolor*, Tunal, Argentina (XC8999; Nick Athanas/Tropical Birding). A distinctive, monotypic species of Chaco woodland of Argentina and Paraguay



Red-banded Fruiteater *Pipreola whiteyi*, Sierra de Lema, Venezuela (XC3525; Nick Athanas/Tropical Birding). An aberrant fruiteater from the *tepui* table mountains in Venezuela and Guyana. Despite its unique plumage, its vocalisations are similar to those of many other congeners



Striped Manakin *Machaeropterus regulus*, Reserva Ecológica de Guapi Assu, Brazil (XC7923; Nick Athanas/Tropical Birding). This is the nominate subspecies ('Eastern Striped Manakin') which is sometimes allocated full species status



Above: Bronzy Jacamar *Galbula leucogastra*, Reserva Ecológica da Campina, Brazil (XC7119; Nick Athanas/Tropical Birding). A beautiful jacamar of central Amazonia, found from the Guianas to Mato Grosso, Brazil, but mostly absent from western Amazonia

Top right: Rufous-crowned Tody-Tyrant *Poecilotriccus ruficeps*, Tandayapa, Ecuador (XC5064; Nick Athanas/Tropical Birding). This is the subspecies *rufigenis*, which lacks the dark malar typical of the other subspecies and is endemic to the Chocó region

Right: Great Xenops *Megaxenops parnaguae*, Tianguá, Brazil (XC14932; Ciro Albano). A striking bird from north-east of Brazil. Whilst resembling other xenops in bill shape, this species' behaviour suggests it is more closely related to foliage-gleaners



One of the few photographs of White-crested Guan *Penelope pileata*, Serra dos Carajás, Brazil (XC7107; Nick Athanas/Tropical Birding). A large, handsome cracid from the eastern reaches of the Amazon basin. Carajás is one of the few easily accessible sites to see it

detailed geographical overview of xeno-canto holdings of a species (Fig. 1), including its subpopulations or subspecies. Perusing the information in the text windows of the markers means that it has never been easier for birders to appreciate geographical variation in bird vocalisations. To add further layers of detail, several different maps may be used as a background, including the familiar satellite maps offered by Google Maps and the spectacular Shuttle Radar Topography Mission (SRTM) elevation map (for which see Fig. 1).

This leads us to a 'neat extra': xeno-canto member Chris Parrish helped us reshape species' ranges onto a one-by-one degree map of Latin America. The most obvious reason to do this is to make it possible to generate checklists of all species (and their recordings) for any particular location in the Neotropics with a single click. But it also enables some less obvious activities. For example, it is easy to create maps depicting the geographical variation in the numbers of species within a particular group (e.g. woodcreepers [Dendrocolaptidae]; see Fig. 2). Another useful feature is to map the combined distribution (sometimes referred to as "assemblage dispersion fields"<sup>2</sup>) of species that occur at a particular location. Such a map enables you to determine the relative similarity between the avifauna of the particular location and all other locations in the Neotropics: Fig. 3 shows such a map for one of our favourite areas, the *tepuis*.

Maps like these may warrant their own website, and we hope that NGOs such as InfoNatura will publish distributional data of other taxonomic groups to enable us to extend this feature.

## Sonograms

Sounds are great, but a listener can only hear one at a time, which makes them less than ideal for direct comparison. One solution is to represent sounds visually as sonograms and then compare sets of sonograms much as one would compare plates in a field guide. *Birds of the high Andes*<sup>1</sup> used this principle for *Scytalopus* tapaculos. Nowadays, creating sonograms is very easy, and xeno-canto displays them for all recordings. Sonograms enable visual comparison of sounds produced by related species or by the same species in different locations, and can be assembled in rudimentary visual sound-guides or 'sonogram checklists'. Birders can produce such sonogram checklists according to desired

categories (for example, region, habitat, or GPS coordinate). Simply print, staple and take them into the field.

## Sharing the mike

One of the more ambitious plans we had when we launched xeno-canto was to proactively acquire recordings. Ideally, we would like to run a number of sets of recording equipment in fixed locations, strategically located across the Neotropics, to document bird song over long periods of time. After all, little is known about how song dynamics change across the year in many parts of Latin America.

Two sets of recording equipment are currently in action. One is with Paul Smith of Fauna Paraguay, the second with Pedro Regalado in Cuba. In his forthcoming field guide to the birds of Paraguay, Paul aims to cross refer descriptions of species' vocalisations to specific recordings on xeno-canto. We will create a page dedicated to recordings of species occurring in Paraguay. Over time, we expect this page to be dominated by recordings actually made in Paraguay, such as Paul's. This exciting set-up could be copied for other regions, national parks, lodges etc.

## The future

The horizons for our future plans are broad. Xeno-canto has just expanded into Africa and Asia. We will not be able to provide the same services in these regions as for the Neotropics, as there are no Asian or African equivalents of the datasets offered by *Neotropical birds*, although the community spirit and sound-searching facility will be similar. We are also investigating extending xeno-canto to other taxa (e.g. mammals, frogs and insects). Automated recognition is another interesting area that we would like to explore, but remains difficult at present.

Such new areas will require a lot of work. Xeno-canto is a labour of love run by just two people (the authors) in their spare time. We enjoy running xeno-canto because of its community ethos: many people have already helped us develop the system. Xeno-canto will continue to need assistance. If you like what you see and hear, please join us! The site is trilingual (English, Spanish, Portuguese) so translators are always needed. If you are an IT genius and can think of improvements or additions, please talk to us. And, of course, do spend time in the field

recording or behind your desk digitising those old tapes! Today the web is replete with photos and the Internet Bird Collection ([www.hbw.com/ibc](http://www.hbw.com/ibc)) is making good progress with video footage, but sound recordings remain hard to find.

Attractively priced, high-quality digital recording equipment will soon be widely available, and eager recordists will be looking for ways to put their new kit to use. Xeno-canto will be there, a friendly community of people trying to make sense of all Neotropical bird sounds. Please keep us in mind!

#### ACKNOWLEDGEMENTS

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