BIRD RECORDING: DAVID TIPLING/BIRDPHOTO.CO.UK

ORNITHOLOGICAL MASTERCLASS

24 CITIZEN SCIENCE

At this time of year many dedicated BTO volunteers are out collecting data, but how do scientists capitalise on their efforts to influence conservation actions. **Cat Morrison** explains.

◀ Globally, citizen scientists collect huge amounts of valuable data.

It's just after 5am and I am driving to our ringing Constant Effort Site. The sun is starting to come up but there is still a chill in the air, the birds are singing their first songs of the day, and the world still feels quiet and calm. I am anticipating what species we may catch and thinking about the incredible journeys they may have taken to return to our site. This is one of my favourite places to be, a chance to be with just a handful of fellow ringers, in the natural world, while also helping to collect valuable information about the lives of the birds we are handling.

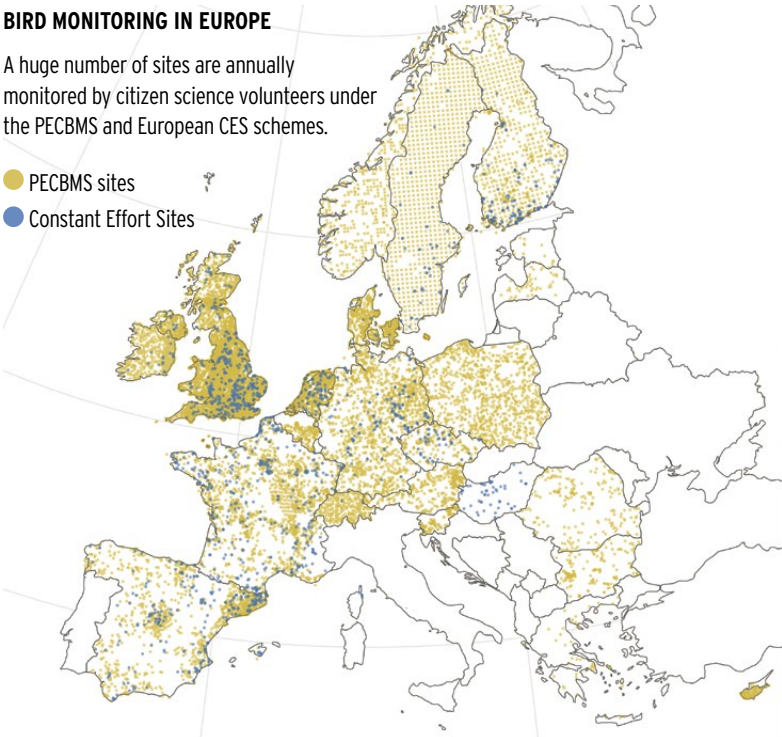
While spending time alone in nature can be a huge draw for many citizen scientists, when we take part in these surveys we inevitably also become hugely connected. Our individual contributions feed into a much larger network, providing unique insights into the fortunes of many species. The figure below shows the ~16,000 sites which bring together data from national monitoring schemes (including the Breeding Bird Survey, BBS) across 29 European countries to form the Pan-European Common Bird Monitoring Scheme (PECBMS). On average, PECBMS sites are active for 10 years, which means that, to date, the total length of transects walked by volunteers would travel round the world four times. This figure also shows the ~1,500 European Constant Effort Site (CES) ringing sites which allow us to monitor demographic rates across 13 European countries.

Demographic rates

Demographic rates are the vital rates that govern how populations change over time. For example, the number of births or deaths in a population or the frequency of individuals moving into or out of that population (i.e. immigration and emigration). The impact of demographic rates on populations is examined in more detail in a previous Masterclass (*BTO News* 341).

BIRD MONITORING IN EUROPE

A huge number of sites are annually monitored by citizen science volunteers under the PECBMS and European CES schemes.



Science from citizen science data

▲ Nightingales are now found only in small numbers in the south and east of England.

As our natural world changes, it is imperative that we can make evidenced-based decisions on how best to protect species, and one of our greatest assets in this task is people power. BTO is clearly at the forefront of harnessing this for monitoring birds (and an ever-expanding range of other taxa too) via its many schemes and surveys, but there is a range of citizen science projects running nationally and internationally, shedding light on everything from penguin colonies in Antarctica to the classification of distant galaxies. As a conservation ecologist, I feel incredibly luckily to be working with citizen science data. My research brings together data that span vast geographical gradients and timescales, allowing me to ask questions about how populations have changed, and how these changes vary through space and time. This ability to compare and contrast the status of populations and their demographic rates between sites and years, is an incredibly powerful tool in helping us unravel the processes that are driving population declines.

GOING BEYOND THE BROAD PATTERNS

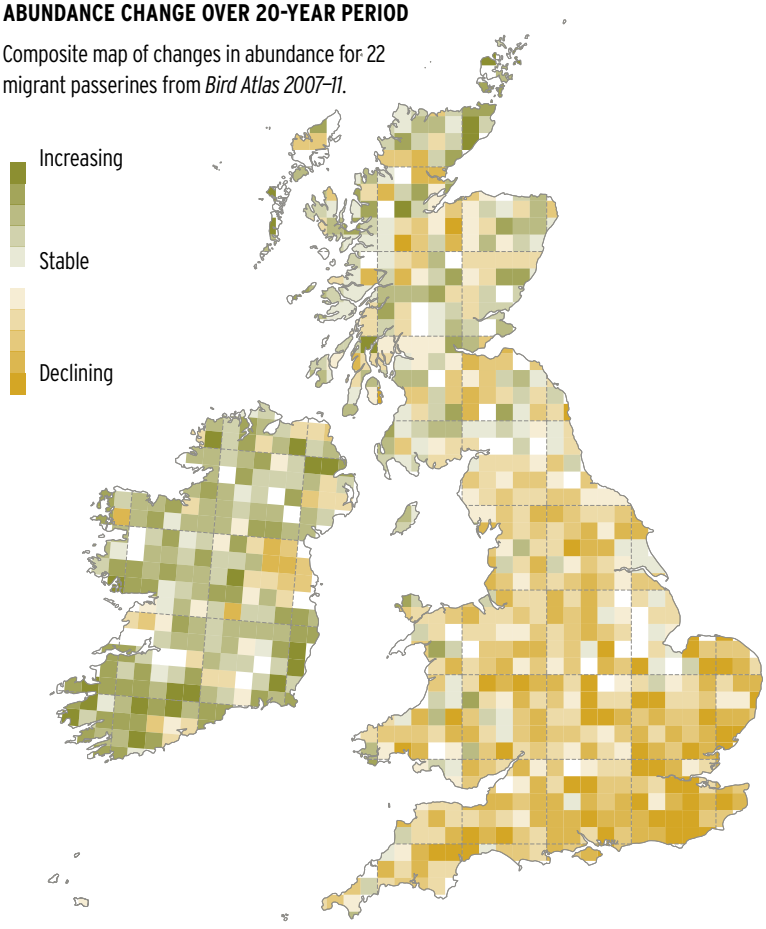
An important use of the BTO's large-scale monitoring surveys is their role in the production of large-scale indicators – trends in our bird populations for different groups of species (*BTO News* 335). For example, such indicators have been key in highlighting the huge decline of farmland birds since the 1970s. While such indices often are extremely useful in helping us to identify which species are most threatened, they provide little direction to the conservation policies or actions needed to halt and reverse declines. To address these questions, we need to dive deeper into the data.

Since the 1980s, declines in our migrant species, particularly those that travel to the Humid Zone of Africa, have been greater than those seen in species that overwinter within Europe. This pattern led us to look to Africa for causes of decline, and potential routes to recovery. However, regional analysis of the BBS and *Bird Atlas 2007–11* data also highlighted the potential role that breeding grounds play in reversing these declines: a number of species that are currently declining in England are remaining stable or increasing within Scotland. This suggests that if we get the conditions correct on European breeding grounds, we can buffer populations against drivers of declines occurring outside the breeding grounds. Further investigation of demographic rates using data from BTO's Constant Effort Site and Nest Record Schemes showed that, for certain species, productivity was also greater in Scotland than in England, while there were no regional differences in survival rates. This suggests that actions aimed at increasing productivity could be an effective route to recovery for many migrant species. These patterns could not have been detected without comparisons across citizen science data collected at thousands of sites across multiple years.

▲ Willow Warbler numbers are increasing in Scotland, but falling in England.

ABUNDANCE CHANGE OVER 20-YEAR PERIOD

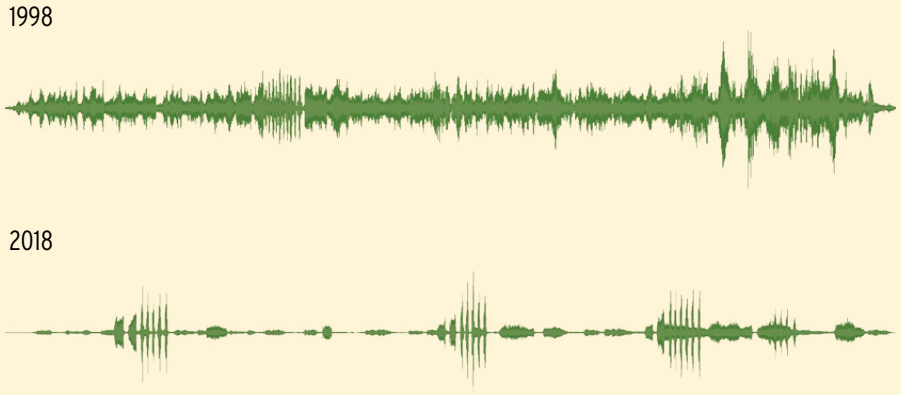
Composite map of changes in abundance for 22 migrant passerines from *Bird Atlas 2007–11*.



Soundscapes

When we are out and about in the natural world we predominantly hear, rather than see, birds – and this is also true when we are participating in monitoring surveys. It is therefore likely that a key mechanism by which we will experience the declines in our bird populations is through deterioration of our soundscapes. Integration of citizen science monitoring data from Europe and North America with sound recordings of birdsong has made it possible for us to reconstruct historical soundscapes from monitoring sites across both continents. Comparing the waveform of the same BBS site in 1998 and 2018, the difference is stark, with changes in bird communities and local extinctions leading to soundscapes becoming quieter and less varied across both continents.

This study helps to highlight one of the main ways in which declines in our bird populations can influence our connection to nature. As we collectively become less aware of our natural surroundings, we also start to notice less or care less about their deterioration. A soundscape that is normal to me now would likely seem depauperate to my grandparents' generation. This is, however, something we can use to our advantage; such studies heighten awareness of these losses in a tangible, relatable way and are a powerful demonstration of the impact of biodiversity loss on human well-being. Involving people in our actions will be critical to recovering populations and citizen science data can play a key role in this.



▲ **CHANGING SOUNDS**
An example waveform of the recreated historical soundscape at a single BBS monitoring site in 1998 and 2018. The reduction in the number of peaks and amplitude in the waveform is driven by a reduction in the number and abundance of species. This leads to a quieter and less varied soundscape. You can listen to these soundscapes here: **soundcloud.com/user-920953289**

Data handling, with care

One of the greatest considerations when analysing any dataset is whether it accurately represents the wider population we are monitoring, and how it is changing from year to year. This is an issue that can be addressed at the data collection or data analysis stage, and is discussed in more detail in this issue's Opinion article (pages 10–11). The BBS and its counterparts across Europe are designed in a way that generates non-biased information about how our bird populations are faring. However, not even these surveys are bulletproof. Recent work led by BTO's Principal Data Scientist, Simon Gillings, highlighted the impact of the COVID-19 pandemic on the BBS. This revealed that, during 2020, there was a 49% reduction in survey coverage and a bias in the habitats monitored. These biases become a problem when population changes are not equal across all squares and habitats, as any changes in the number of birds counted may simply reflect differences in the monitoring sites surveyed, rather than changes in population size. It is for this reason that trends for only 40 species in England could be produced from the 2020 BBS data.

A similar issue occurred in 2001, when access to the UK countryside was limited due to an outbreak of foot and mouth disease. While these rare missing years are something to bear in mind when working with these data, luckily, the BBS is now in its 27th year, and they are therefore likely to have a minimal impact on our ability to detect longer-term changes.

◀ Short-term disruptions to data collection are not insurmountable with long-term datasets.

WILLOW WARBLER & NIGHTINGALE: EDMUND FELLOWES/BTO, WARNING SIGN: BEN GAMBLE/FLICKR

Using citizen science data to target conservation actions

▲ Lapwing populations are unable to grow because of low productivity.

LAPWING: CHRIS KNIGHTS/BTO

1 TARGETING DEMOGRAPHIC RATES

Reversing population declines requires increases in the number of birds entering the population (productivity) or reductions in the rate at which individuals leave (mortality). Critically (and maybe slightly counterintuitively), the drivers of declines may not always be the processes we need to address to recover populations. For example, UK-wide Lapwing population declines were initially driven by several cold winters causing increases in adult mortality. However, despite subsequent lower levels of mortality in warmer years, Lapwing numbers have been unable to recover due to low productivity (Masterclass, *BTO News* 341). In this case, targeting conservation efforts at survival rates, the driver of decline, would be fruitless and efforts would be better targeted at increasing productivity (e.g. predator control).

2 TARGETING IN SPACE

Implementing conservation action in areas where survival and productivity are already high could be a waste of valuable resources, therefore in addition to targeting the correct demographic rates, we also need to target the correct sites. To do this, we need to know if areas with consistently low demographic rates exist, or whether productivity and survival vary so much between years that effective targeting will be hard to achieve. To conduct this sort of analysis requires a huge amount of statistical power, so we need to cover a lot of sites in a lot of years. In our most recent paper, we therefore turned to the European CES dataset and found that for 26 songbird species, productivity on CES sites tended to be consistently high or low across years, while the survival rates of these species tended to vary more between years than between sites. This suggests that local conditions on CES sites are a major cause of the high (or low) productivity and, if we can work out the key differences between these sites, we might be able to target actions to increase the number of sites achieving high productivity.

The drivers of declines may not always be the processes we need to address to recover populations

3 TARGETING ENVIRONMENTAL DRIVERS

Periods of low songbird survival often occur when they encounter severe weather, and sustained periods of severe weather can cause severe population declines. For example, several migratory species that cross the Sahel region of Africa declined dramatically during the Sahel droughts of the 1970s and 1980s. However, unless periods of low survival could be predicted in advance, targeting actions to boost survival rates is likely to be both challenging and limited in effectiveness.

The patterns revealed in the European CES data strongly suggest that targeting actions to boost productivity would be the more effective use of conservation funds and efforts. The next step is therefore to work out why productivity is better on some sites than others, and hence what type of actions might be needed. For example, it may be that sites with high productivity are part of larger areas of suitable habitat, where resources are more abundant and the risk of encountering nest predators is lower, compared to smaller or more isolated sites. Alternatively, there may be key features that differ between productive and less productive sites, such as water availability or vegetation complexity.

None of this work would be possible without the volunteers who contribute to these schemes. Bringing together the vast amount of data is a real privilege and allows us to explore patterns and processes over scales that otherwise wouldn't be possible. ■

Find out more For further reading, please see:
Gillings *et al*. 2021. *Bird Study* **68**: 220–232.

Morrison *et al*. 2013. *Diversity & Distributions* **19**: 1051–1058.

Morrison *et al*. 2021. *Nature Communications* **12**: 6217.

Morrison *et al*. 2021. *Proceedings of the Royal Society* **288**: 1946.

Morrison *et al*. 2022. *Royal Society Open Science* **9**: 211671.

Robinson *et al*. 2014. *Methods in Ecology & Evolution* **12**: 1361–1372.

Credits

This work was made possible by strong Pan-European collaborations and friendships and is the result of thousands of hours of fieldwork by dedicated volunteers. We thank all the volunteers of the national monitoring and ringing schemes.

The author

Catriona Morrison is a post-doctoral researcher at the University of East Anglia. Her primary research interests lie in understanding the demographic and environmental processes influencing the population dynamics of birds. You can easily find her on Twitter: **@CatMorrison18**