How does the fact that many ornithologists have age-related hearing loss affect the recorded long-term population changes in birds? Results from recordings with and without hearing aids and from a BirdWeather PUC bird sound recording tool are compared.

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Abstract

Capsule: The average age of bird counters has increased. Age-related hearing loss has become widespread. How has this affected bird population indices?

Aims: To measure how many fewer birds older bird counters register. Differences for bird calls with high, medium and low pitch.

Methods: Simultaneous recordings were made by a person with hearing aids, without hearing aids and by an electronic listening device, a BirdWeather PUC.

Results: With hearing aids, the person heard 60% of the actual number of bird sounds (47% without hearing aids). For high pitch it was 28% (9%), for medium pitch 69% (57%) and for low pitch 100% (96%).

Conclusion: For birds that live in dense habitats, a large proportion is recorded because of their voices. Over the past 30-40 years, the proportion of bird counters with age-related hearing loss has increased sharply. This has meant that the registration rate for bird species with high pitched sounds in particular has decreased significantly. This is believed to have led to false declines in population indices for these species. This is supported by comparisons between index numbers for ringing and point counts. Ringing is not dependent on hearing. Ringing indices have increased more / decreased less than point count indices for species with high pitches sounds.

Introduction

Some of the bird counts used to calculate long-term population changes in birds are carried out by older ornithologists with age-related hearing loss. Does this lead to differences between the recorded population changes and the actual population changes for species with high-pitched sounds (Kayser 2017)?

To gain a better understanding of this issue, we need to know not only how much worse an ornithologist with hearing loss is at hearing bird sounds without the use of hearing aids than an ornithologist with hearing aids. We also need to know how much worse an older ornithologist

wearing hearing aids is at recording bird sounds than a young ornithologist who hears well within the entire frequency range of bird sounds.

Young people can hear sounds from about 20 Hz to 20000 Hz (National Library of Medicine 2001). As people get older their ability to hear sounds is reduced (National Institute on Deafness and Other Communication Disorders 2025). For age-related hearing loss, the loss hits first and foremost high frequencies and later low frequencies. Hearing loss typically starts around the age of 50 years.

Bird sounds cover a wide frequency span from as low as 50 Hz to about 16000 Hz (Cohen 2021). Most bird sounds fall between 1000 and 8000 Hz.

This means that young people can hear all bird sounds. As people get older their ability to hear the sounds is reduced, especially for high-pitched sounds. Using hearing aids significantly reduces the loss of ability to record bird sounds (Kayser 2013), but still there is a reduction when compared to the ability of young people to record bird sounds.

How much is the ability to record bird sounds improved by wearing hearing aids? And how much do older birdwatchers still miss although they are wearing hearing aids?

This study attempts to answer both questions. The recording of the bird sounds has been carried out by a 68-year-old birdwatcher with age-related hearing loss with and without hearing aids. The results have been compared to bird sounds recorded by an electronic recording tool, a BirdWeather PUC (BirdWeather 2025).

Materials and methods

The recordings of bird sounds were made in Denmark in the village Stensby (54.980°N, 12.049°Ø) in a big garden surrounded by fields and forests and about 2 km from the coast.

Recordings have been made each half-month from November 2024 to October 2025. Recordings were made by a human listener as well as with the BirdNET tool, a so called BirdWeather PUC (BirdWeather 2025). Tool settings: Recording time: 9 sec. Probability: 5%. Confidence: 75%. It is assumed that the BirdWeather PUC is equally efficient at different sound frequencies from about 50 to about 8000 Hz. The human listener used Signia Pure 312 X hearing aids.

The human recordings were made from the hour before sunrise to the hour after sunset. Records were made for 10 minutes each hour. For each minute records were made of the bird species heard.

The records made by the BirdNET tool in the same periods as the records made by the human were compared manually minute by minute. That way, for each ten minutes period, a number from zero to ten minutes with sounds from each of the bird species was obtained for the human as well as for the BirdNET tool.

This survey was based on one person and one bird sound recording tool. The listening person is 68 years old, has a typical age-related hearing loss; i.e. the loss is significant for high-frequency sounds and very small for low-frequency sounds.

In the hours starting at 9 a.m., 11 a.m., 1 p.m. and 3 p.m. recordings were made in two ten-minutes periods. In the first period the human listener was wearing hearing aids; in the second he did not. This paper analyses the data from these four hours in each half-month.

The general pitch level of bird sounds of relevant bird species was obtained from sonograms given in Cramp *et al.* (1977-1994). If the main sound pressure was above 4 kHz, the voice was classified as high-pitched, if it was below 2 kHz, it was classified as low-pitched, and if it was between 2 and 4 kHz, it was classified as medium.

Results

Reduction in the efficiency of recording bird sounds without hearing aids compared to recordings where hearing aids are used

With 24 half-months with 4 recording hours, 96 10-minute recordings were made using hearing aids and 96 without hearing aids. The person wearing hearing aids recorded 2465 bird sounds, the person without hearing aids 1935 bird sounds and the BirdWeather PUC recorded 397.

For each species with at least 50 records by the person wearing hearing aids, the percentage reduction in the recorded number, when not using hearing aids, is shown (table 1).

For each sound pitch level, the percentage reduction in the recorded number when not using hearing aids is shown (table 2). Number of sounds recorded by a BirdWeather PUC in the same time periods is shown too.

All in all, there was a 21 percent reduction in the number of recorded bird sounds when the listening person was not wearing hearing aids compared to when he was wearing hearing aids. For low pitched sounds the reduction was only 4 percent, for medium pitched sounds the reduction was 17 percent and for high pitched sounds it was 69 percent.

Reduction in the efficiency of recording bird sounds with and without hearing aids compared with the "actual" number of bird sounds.

A person wearing hearing aids does not record bird sounds as efficiently as a young listener with optimal hearing. An optimal listener was not available in this study. Instead, the BirdWeather PUC was used. It is assumed that PUC is equally efficient for low-, medium- and high-pitched sounds, and that the listening person is nearly 100 percent efficient for low-pitched sounds when wearing hearing aids.

Given these assumptions it is possible to calculate a low-frequency-to-PUC correction factor by dividing the number of low-frequency sounds recorded by the person wearing hearing aids by the number recorded by the BirdWeather PUC. Correction factor $F_{Correction} = n_{With\text{-}Low} / n_{PUC\text{-}Low.}$

With 858 records made by the human with hearing aids and 83 by the PUC the low frequency – PUC correction factor is 10.3.

For each combination of pitch and listener the estimated listener efficiency can be calculated. E.g. for high pitched sound and without hearing aids the percentage loss compared to the actual number

of bird sounds can be calculated as $F_{Reduction} = n_{Without\text{-}High} / (n_{PUC\text{-}High} * F_{Correction}) * 100$ (table 3, figure 1).

All in all, when comparing the "actual" numbers of bird sounds with numbers recorded by the person, there was a 40 percent reduction in the number of recorded bird sounds when the listening person was wearing hearing aids and a 53 percent reduction when he not wearing hearing aids. For low pitched sounds the reduction was 0 (one of the assumptions used in the calculations) with aids and only 4 percent without aids. For medium pitched sounds the reduction was 31 with hearing aids and 43 percent without aids. For high pitched sounds the reduction was 72 with hearing aids and 91 percent without aids.

Discussion

The results from this study have confirmed that people with age-related hearing loss detect significantly fewer bird sounds when they are not using hearing aids than when they are wearing hearing aids (Kayser 2013). The reduction is very small for low-pitched sounds; it is about one-sixth for medium-pitched sounds and about two-thirds for high-pitched sounds.

It is now documented how much of a reduction there is in the number of registrations even for an older birdwatcher wearing hearing aids. Compared to the actual number of bird sounds calculated from registrations made by a BirdWeather PUC listening unit, the person only registers a little more than half of the actual number of bird sounds when wearing hearing aids, and about half without hearing aids. For low-frequency sounds, there is almost no reduction; for medium-high sounds, the reduction is a third with hearing aids and a little over a third without hearing aids. Finally, it was found that for high-frequency sounds, the reduction compared to the actual number of bird sounds was about three-quarters for a person with hearing aids and as much as nine-tenths for a person without.

In Denmark, changes in breeding populations of birds have been monitored since 1976 using a nationwide Point Count Program. Around 1980, the average age of bird counters was probably around 30-40 years and many of these counters have remained active. In 2012, the average age of members of Birdlife Denmark was 60-70 years. Hence many bird counters must have had age-related hearing loss (Kayser 2017). At that time, we only knew the reduction in the number of recorded bird sounds for a person without hearing aids compared to a person with hearing aids (Kayser 2013), not the reduction from the actual number of bird sounds to the number recorded by a person wearing hearing aids. The reduction in the number of recorded sounds from a person with to a person without hearing aids was around one third.

More than half of the birds recorded in dense habitats such as forests were recorded due to their sounds (Kayser 2013). The population changes recorded by the Point Count Program for several species were thus influenced by the ability of the bird counters to hear the bird sounds. A comparison was made of the changes recorded by the Point Counts and the number of ringed birds in the same period. For species with high-pitched sounds such as Goldcrests, Chiffchaffs and the Dunnocks, it was found that the long-term (1980-2013) changes in numbers showed significantly greater increase / less decline in ringing data than in point counting data (Kayser 2017). The results,

e.g. the ringing, that were not dependent on the ornithologists' hearing ability, thus showed a greater increase than records dependent on the ornithologists' hearing. False population declines have probably been recorded, especially for bird species with high-pitched sounds, due to hearing loss among the bird counters as they have aged over the decades.

With the new results from this study, which indicate that older bird counters, even with hearing aids, only register slightly over half of the actual number of bird sounds, it has become even more relevant to look at the possibilities of introducing a hearing loss correction factor for long-term bird counts, especially for species where many of the birds are registered because of their sounds

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Tables

Table 1. Number of sound recordings of each species made by a human listener with and without hearing aids and the percentage reduction when not using hearing aids. Only species with more than 50 records with aids are shown.

Common name	Scientific name	Sound pitch	Number With aids	Number Without aids	Percent reduction without aids
Barnacle Goose	*Branta leucopsis*	Medium	50	49	2
Greylag Goose	*Anser anser*	Low	106	97	8
Ring-necked Pheasant	*Phasianus conchicus*	Medium	58	39	33
Woodpigeon	*Columba palumbus*	Low	323	358	-11
Magpie	*Pica pica*	Medium	73	87	-19
Jackdaw	*Coloeus monedula*	Medium	162	155	4
Rook	*Corvus frugilegus*	Low	175	169	3
Hooded Crow	*Corvus cornix*	Low	244	186	24
Blue Tit	*Cyanistes caeruleus*	High	84	16	81
Great Tit	*Parus major*	High	63	28	56
Chiffchaff	*Phylloscopus collybita*	High	110	53	52
Blackcap	*Sylvia atricapilla*	Medium	57	36	37
Wren	*Troglodytes troglodytes*	High	90	20	78
Blackbird	*Turdus merula*	Medium	298	295	1
Tree Sparrow	*Passer montanus*	Medium	174	121	30
Chaffinch	*Fringilla coelebs*	Medium	51	43	16
All species			**2464**	**1937**	**21**

Table 2. Number of sounds for each sound pitch level recorded by a human listener with and without hearing aids and the percentage reduction when not using hearing aids. Number of sounds recorded by a BirdWeather PUC in the same time periods.

Sound pitch	Number With aids	Number Without aids	Percent reduction without aids	Number PUC
High	430	133	69	148
Medium	1176	979	17	166
Low	858	825	4	83
All pitches	**2464**	**1937**	**21**	397

Table 3. Percentage of the sounds of each sound pitch recorded by a human listener with and without hearing aids compared to the "actual" number of sounds.

Sound pitch	Number With aids	Number Without aids
High	28	9
Medium	69	57
Low	100	96
All pitches	60	47

Figures

Figure 1. Percentage of the sounds of each sound pitch recorded by a human listener with and without hearing aids compared to the "actual" number of sounds.