Research report

Effects of temperature changes on the wing length, body weight, fat score, age distribution and abundance of the willow warbler *(Phylloscopus trochilus)* and reed warbler *(Acrocephalus scirpaceus)*

HAS green academy

4th of July 2025, Gedser, Denmark

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GEDSER FUGLESTATION

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Applied Biology

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Gedser Fuglestation

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Summary

With this research insight has been gained into the effects of temperature changes on the wing length, weight, fat score, age distribution and abundance of the willow warbler *(Phylloscopus trochilus)* and reed warbler *(Acrocephalus scirpaceus)* from the period of 2012 until 2024. It is important to gain insight into the effects of temperature changes on physiology, age distribution and abundance of passerines to be able to predict effects of changing temperatures on populations in the future. During the research birds were captured with mist nets and then ringed, measured, aged, sexed and scored on fat before release. By using ringing data from the period of 2012 until 2024 the effect of changes in temperature on the physiology, age distribution and abundance of willow warblers and reed warblers was tested. This research shows that the mean temperature per year has increased from 2012 until 2024, at the southernmost part of Denmark, where Gedser Fuglestation is located. Over the years, significant changes have been found in the fat score of the willow warbler and in the wing length of the willow warbler and reed warbler. The changes in wing length and fat score of the willow warbler were found to be connected to the mean temperature per year. Additionally, the number of birds decreased in both species over the years and this decrease was found to be connected to the mean temperature per year. For the weight, no significant changes were found in in either of the species over the years. Future research could split up the measured weights into the times (hours) of measuring and compare the weights of birds captured at the same hour of day over the years. This could make it possible to find a clearer trend in changes in weight over the years. In conclusion, this research has found that the change in temperature at Gedser Fuglestation is connected to the changes in the physical traits of the willow warbler and to the decrease in the number of birds of both the willow warbler and the reed warbler. Though, more factors can affect the physical traits and number of birds; like feeding strategy, migration speed and the number of insects. That makes this research a good starting point from where more factors could be added to assess the effects of different factors on the physical traits of birds and the density of bird populations over the years.

Contents

1. Introduction

Climate change can, for many organisms, cause a shift in the timing of seasonal activities (phenology); such as the arrival of butterflies (Roy & Sparks, 2000), flowering of plants (Fitter & Fitter, 2002) and migration of birds (Butler, 2003). Due to global warming, linked to climate change, birds can change the timing of their migration. Research showed that, over a period of 42 years, short distance migrating birds arrived 13 days earlier on wintering sites and long-distance migrating birds arrived 4 days earlier (Butler, 2003). Next to that, a response of migratory birds to climate change can be a change in migration distance. Research has found a decrease in distance to the wintering site of birds ringed in the Netherlands during breeding season (Visser et al., 2009). In studying the phenology of birds, changes in the ecology of species because of climate change can be tracked (Walther et al., 2002).

As a part of climate change, global warming can also affect the physiology of birds. Research studying changes in body weight and wing length of passerines in England found a long-term decrease in the residual body weight of bull finches *(Pyrrhula pyrrhula),* great tits *(Parus major)*, dunnocks *(Prunella modularis)* and blue tits *(Cyanistes caeruleus)* (Yom-Tov et al., 2006). This decrease in bodyweight follows the expectation of the Bergmann's rule, where warm blooded animals are smaller in warm regions (Mayr, 1970, In; Yom-Tov et al., 2006). Additionally, research on passerines found a decrease in the wing length of willow warblers *(Phylloscopus trochilus*) and an increase in the wing length of reed warblers *(Acrocephalus scirpaceus)* over the years (Yom-Tov et al., 2006). A decrease in wing length is unexpected, because according to the Allen's rule a higher temperature causes an increase in the proportion of appendage size relative to body size (Allen 1877, In; Li et al. 2024). Recent long-term research can test if the Allen's rule still does not apply to some passerine species or that the results on the wing length of passerines have changed over the years.

Additionally, as a response to climate change, the advancement in laying date of small bird species has been found to be greater than those of larger species (Stevenson & Bryant 2000, In; Leech & Crick, 2007). This suggests a higher sensitivity of small passerines for temperature changes (Leech & Crick, 2007). When the breeding date of birds does not shift as much as the food peak, a mismatch can occur (Both, 2010). This mismatch could result in parental birds reducing energy expenditure, causing fledged young to have reduced survival (Sanz et al., 2003). Which may result in bird populations with lower amounts of younger birds. Through identifying the age of birds insight can be gained on effects of climate change on age distribution in bird populations.

Lastly, long-term changes have been found in the fat score of short distance migrating passerines and resident passerines in the form of a decrease over a period of 32 years (Collins et al., 2017). Remarkably, these changes were not linked to increasing temperatures (Collins et al., 2017). The fat score of birds also changes from the time of the day. In three passerine species the highest fat score was found at the latest hour of bird catching whereas the lowest fat score was found in the first hour of catching (Goławski et al., 2015). Therefore, to be able to study if there is an effect of temperature on the fat score of long-distance migrating passerines like the reed warbler and willow warbler (Peiró, 2003; Alerstam et al., 2003), the fat score needs to be sorted in different time of day categories or a daily mean must be taken of the fat scores.

With smaller passerines possibly being more sensitive to temperature changes, the species willow warbler and reed warbler are used to research the effects of temperature on their physiology, age distribution and abundance at Gedser Fuglestation, a bird ringing center in Denmark (Leech & Crick, 2007; Lack 1965, Cramp & Simmons 1988, In; Adriaensen & Dhondt 1990). It is important to gain insight into the effects of temperature changes on physiology, age distribution and abundance of passerines to be able to predict effects of changing temperatures on populations in the future.

With this research insight was gained into the effects of temperature changes on the wing length, weight, fat score, age distribution and abundance of willow warbler and reed warbler from the period of 2012 until 2024. From the 3rd of March until the 28th of April 2025 ringing of the birds was learned and carried out. Birds were captured with mist nets and then ringed, measured, aged, sexed and scored on fat before release. By using ringing data from the period of 2012 until 2024, the effect of changes in temperature on the physiology, age distribution and abundance of willow warblers and reed warblers was tested per species. The hypothesis was that over the years, as a result of an increase in temperature, the weight, fat score, numbers of young birds and abundance of reed warbler and willow warblers would show a decrease. Finally, wing length was expected to increase through the years for both species.

2. Materials and methods

Gedser Fuglestation has been collecting data from the capture and ringing of birds via standardised methods since 2007. In this research, bird ringing was learned and carried out from the 3rd of March until the 28th of April 2025 and the research lasted until the 4th of July 2025.

2.1 Research location

Gedser Fuglestation is located on the southernmost point of the island Falster in Denmark (Figure 2.1). The garden around the station, where the mist nets were placed and birds were captured, has a size of approximately 20.000 m^2. There are shrubs and trees in de garden.

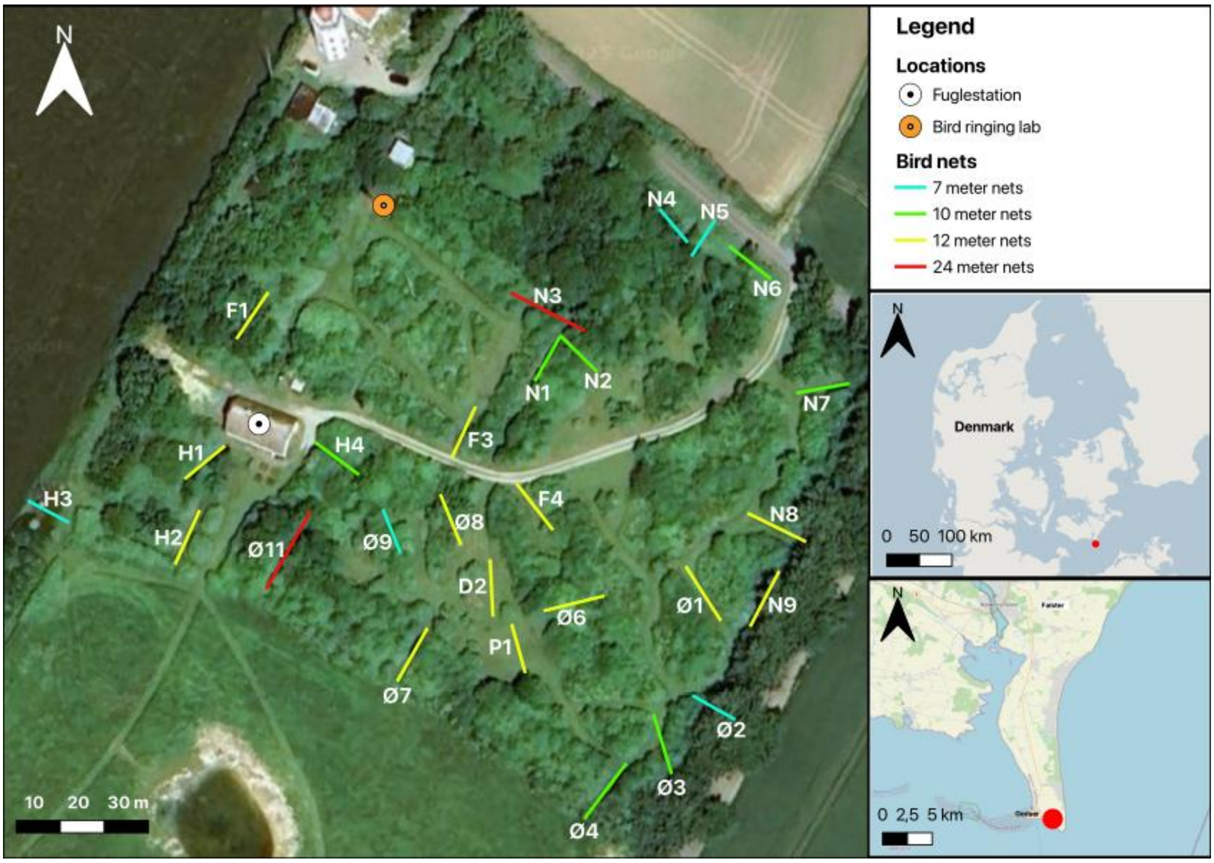

Figure 2.1: The location of Gedser Fuglestation with the lines depicting the mist nets in the garden of the Fuglestation and the colours of the lines indicate the length of the mist nets. The location points indicate the Fuglestation and bird ringing lab. (Through use of the scale bar, the length of the nets is not accurately presented, the length of the nets is indicated through colour.)

2.2 Research species

The research species chosen for this study are insectivore passerine species; willow warbler *(Phylloscopus trochilus) and* reed warbler *(Acrocephalus scirpaceus)* (Laursen, 2022 & Silveira, 2013).

2.3 Mist nets

In total there are 25 mist nets in the garden that vary in length: 7-, 10-, 12- and 24-meter nets. Additionally, a lab is located in the garden where the birds are ringed and measured (Figure 2.1).

The mist nets were placed between two poles and consist of five horizontal pockets on different heights (net shelfs) from the ground. According to the standardized monitoring protocol of Gedser Fuglestation (Appendix I) (Gedser fuglestation, 2025), the mist nets (the number of nets depends on the weather) had to be unfurled between 30 to 60 minutes before sunrise, after which the standardized ringing session began. During the ringing session the nets needed to be checked every 30 to 60 minutes and the session lasted for five hours (Appendix I).

2.4 Ringing and biometrics

When birds were captured, they were removed from the net and put in a bag to be taken to the lab for measuring. The measurements taken on birds were noted in the data collecting sheet for bird ringing (Appendix II). For this research, data on wing length, weight, fat score, age and abundance were used.

2.4.1 Wing length

By applying gentle pressure on the primary coverts or great coverts with a thumb, the primaries of the bird's wing can be flattened against a ruler. After this, the primaries are straightened sideways as much as possible and around the area of the primary coverts the side of the wing is pushed against the body of the bird. With a one or a couple of strokes the wings can be straightened along the shafts of the primaries (Appendix III) (Svensson, 2023). Then the length of the wing was measured in millimetres from the shoulder of the bird to the tip of the longest primary feather.

2.4.2 Weight

The weight of the birds was measured using an Ohaus (CL series) scale and a tube (diameter dependent on the size of the bird). First the scale, with the tube on it, was set to tare. Next, the bird was put in the tube with the headfirst and the measurement was taken in grams.

2.4.3 Fat score

To review the fat score, the bird was placed on its back and the breast feathers were blown against the growth of feathers to show the abdominal area underneath. The fat score was scored from 1 to 8 by visually looking at the presence and location of fat around the throat and abdominal area according to the BWG method (Appendix IV). Score 1 has the least fat and 8 the most (Redfern & Clark 2001).

2.4.4 Age

The age of the birds was determined by visually looking at the wing feathers, and for some species also by looking at the tail feathers. Species-specific colourations in the wings, tail, body or bill and moulting can be visible to determine age by using Identification Guide to European Passerines by Svensson (2023). When a bird hatched in the same calendar year as it was captured in it was identified as a 1k bird, if it hatched a calendar year prior to the capture it was identified as a 2k bird, and if it hatched two calendar years prior it was identified as a 3k bird. When the age determination is less certain a + can be added to it. The + means that the bird at least hatched in the year that was noted (1k,2k or 3k) but that it could also have hatched one or two calendar years prior.

2.5 Data analysis

To test the data R studio was used (version 4.4.2).

2.5.1 Temperature

The mean temperature per year from 2012 to 2024 was retrieved from the Danish Meteorologic Institute (DMI, 2025). A linear regression was used on the data (function lm, R-package Stats) where the 'year' was the explanatory variable and the 'mean temperature per year' the response variable.

2.5.2 Wing length, weight and fat score

The mean of the wing length per day was calculated per species for all full data (dataset with all data; wing length, weight and fat score per bird) from 2012 to 2024. Trough using a linear regression test (function lm, R-package Stats) the effect of the explanatory variable 'year' on the response variable 'mean wing length (day)' was tested per species.

Next to that, the mean of the weight per day was calculated per species for all full data (dataset with all data; wing length, weight and fat score per bird) from 2012 to 2024. By means of using a linear regression test (function lm, R-package Stats) the effect of the explanatory variable 'year' on the response variable 'mean weight (day)' was tested per species.

The data of the fat score was used to calculate a mean per day per species for all full data (dataset with all data; wing length, weight and fat score per bird) from 2012 to 2024. Through using a linear regression test (function lm, R-package Stats), the effect of the explanatory variable 'year' on the response variable 'mean fat score (day)' was tested per species. The p-values from the linear regressions of wing length, weight and fat score were adjusted with the Holm method (R-package Stats).

When a significant difference was found, the effect of the explanatory variable 'mean temperature per year' on the relevant response variable (wing length / weight / fat score) was calculated with a linear regression test (function lm, R-package Stats). This also applies to the wing length and weight in 1k and 2k+ birds, the age distribution and abundance of birds in both species.

2.5.3 Wing length and weight in 1k and 2k+ birds

For the wing length and weight of 1k (first calendar year) and 2k+ (second calendar year or higher) birds, the full data of 1k and 2k+ willow warblers and reed warblers in autumn (July to November; data to October) was used. The effect of the explanatory variable 'year' on the response variables 'wing length' and 'weight' was tested by means of a linear regression test (function lm, R-package Stats).

2.5.4 Age distribution

For the age the number of 1k birds and 2k+ birds were calculated per year per species for data from 2012 until 2024 from July to October. By using a linear regression test (function lm, R-package Stats), the effect of the explanatory variable 'year' on the response variable 'number of 1k birds' and 'number of 2k+ birds' was tested per species.

2.5.5 Abundance

The total abundance of birds per year per species was calculated for all data from 2012 to 2024. By means of using a linear regression test (function lm, R-package Stats) the effect of the explanatory variable 'year' on the response variable 'number of birds per year' was tested per species.

3. Results

3.1 Temperature

Over the time from 2012 to 2024 there is significant increase (LM; $p = .018$) in temperature in Gulborgsund commune, where Gedser Fuglestation is located (Figure 3.1).

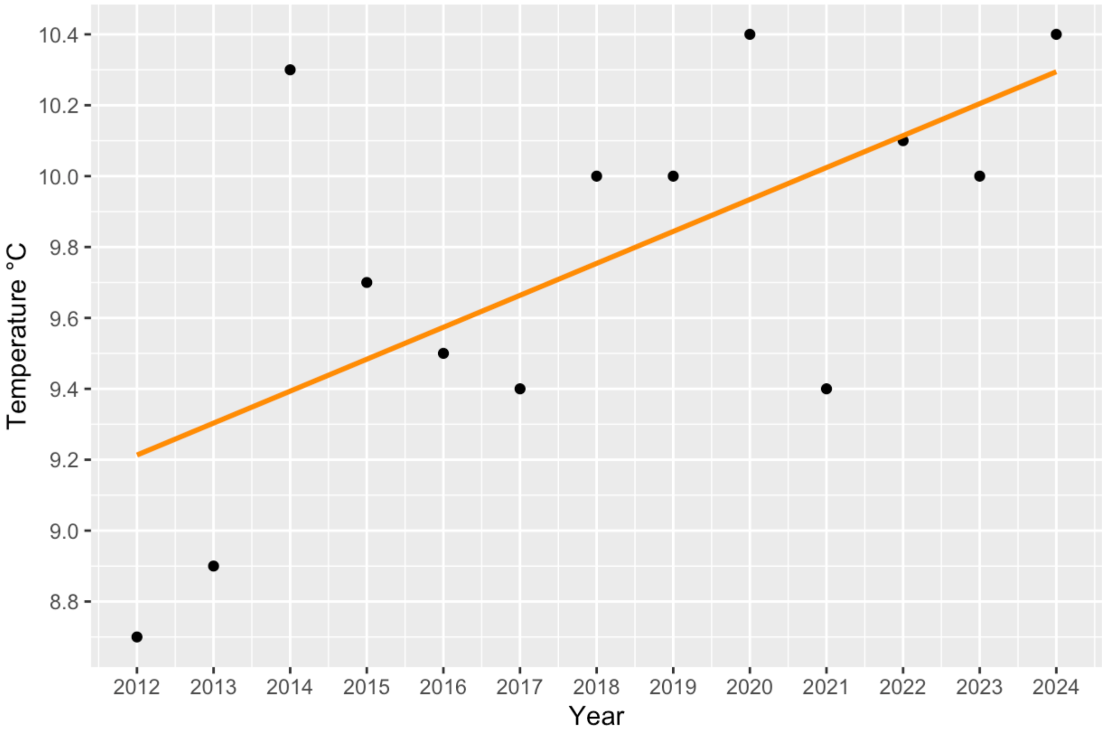

Figure 3.1: Display of mean temperature per year from 2012 to 2024 in Guldborgsund commune, Denmark.

3.2 Willow warbler

3.2.1 Wing length, weight and fat score

Between the years 2012 and 2024 there is a non-significant decrease in wing length (LM; p = .189) (Figure 3.2A) and weight (LM; p = .256) (Figure 3.2B) of willow warblers *(Phylloscopus trochilus)*. The fat score of willow warblers shows a significant increase (LM; p < .001) (Figure 3.2C) between 2012 and 2024. The mean temperature per year has a significant effect on the fat score (LM; p = .004).

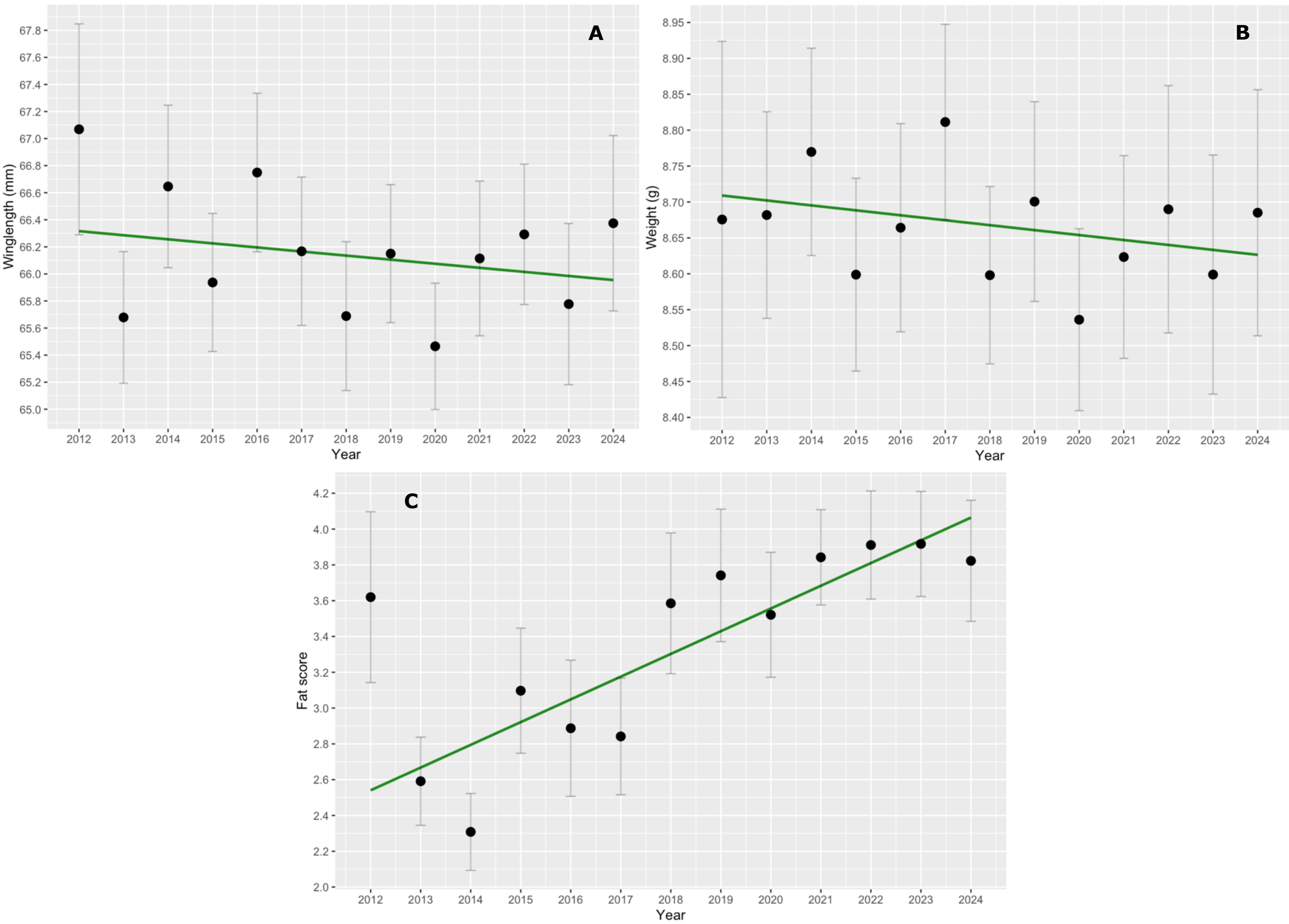

Figure 3.2: Display of (A) wing length (millimetres), (B) weight (grams) and (C) fat score of willow warblers captured at Gedser Fuglestation from 2012 to 2024.

3.2.2 Wing length and weight of 1k and 2k+ birds

In autumn, from 2012 until 2024, the wing length (LM; p=.112) and weight (LM; p= .562) of 1k willow warblers does not change significantly (Figure 3.3). For 2k+ willow warblers the wing length decreases significantly (LM; p<.001) and is significantly affected by the mean temperature per year (LM; p<.001), while the weight for 2k+ willow warblers does not change significantly (LM; p=.050) in the autumn from 2012 to 2024 (Figure 3.3).

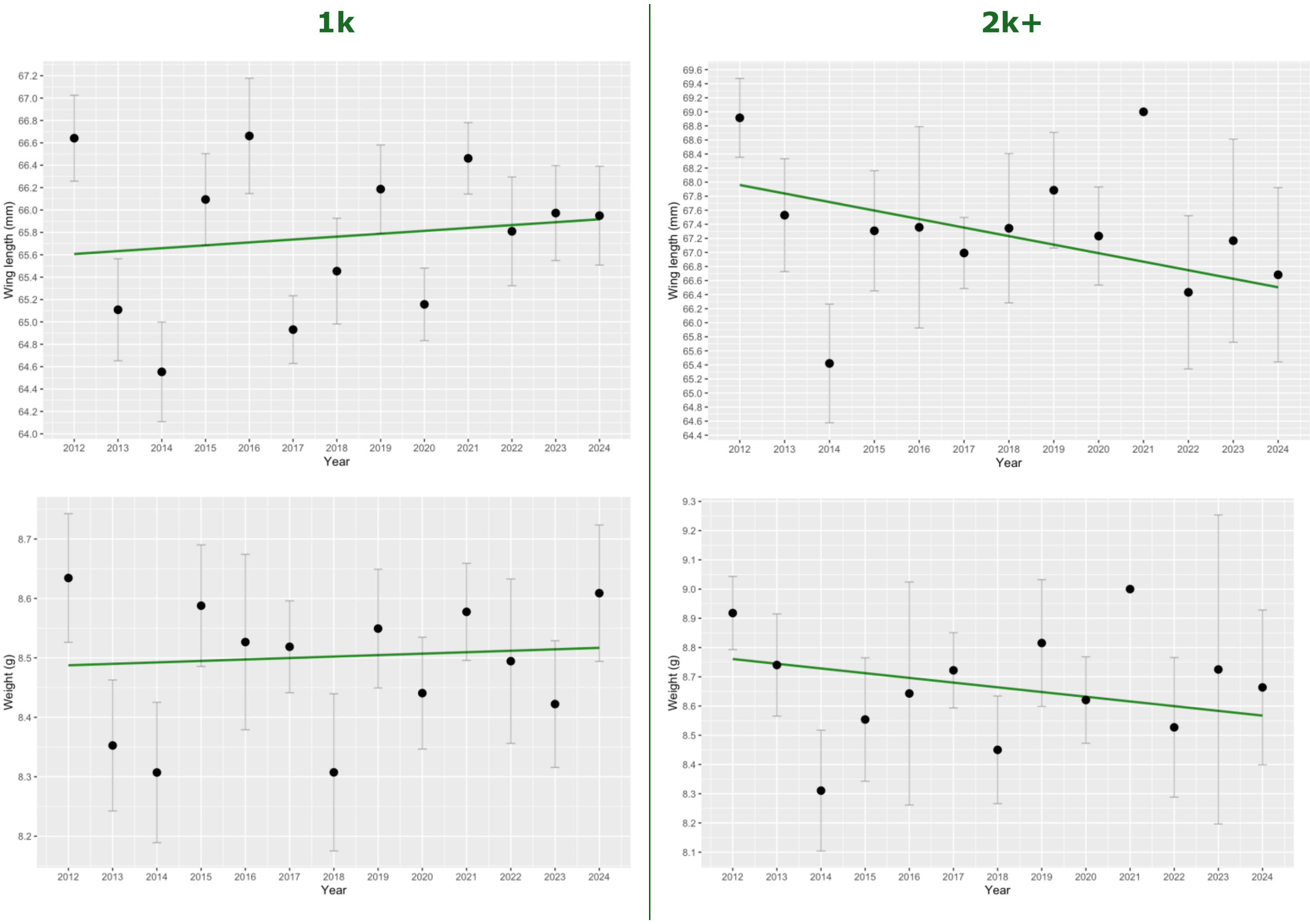

Figure 3.3: Display of the wing length in millimetres and the weight in grams of 1k willow warblers and 2k+ willow warblers captured at Gedser Fuglestation from 2012 to 2024 during autumn.

3.2.3 Age distribution

In the autumn, the number of 1k willow warblers show a non-significant decrease (LM; p= .078) (Figure 3.4A) and the number of 2k+ willow warblers show a significant decrease (LM; p= .006) (Figure 3.4B) between 2012 and 2024. The mean temperature per year has a significant effect on the number of 2k+ willow warblers (LM; p=.005).

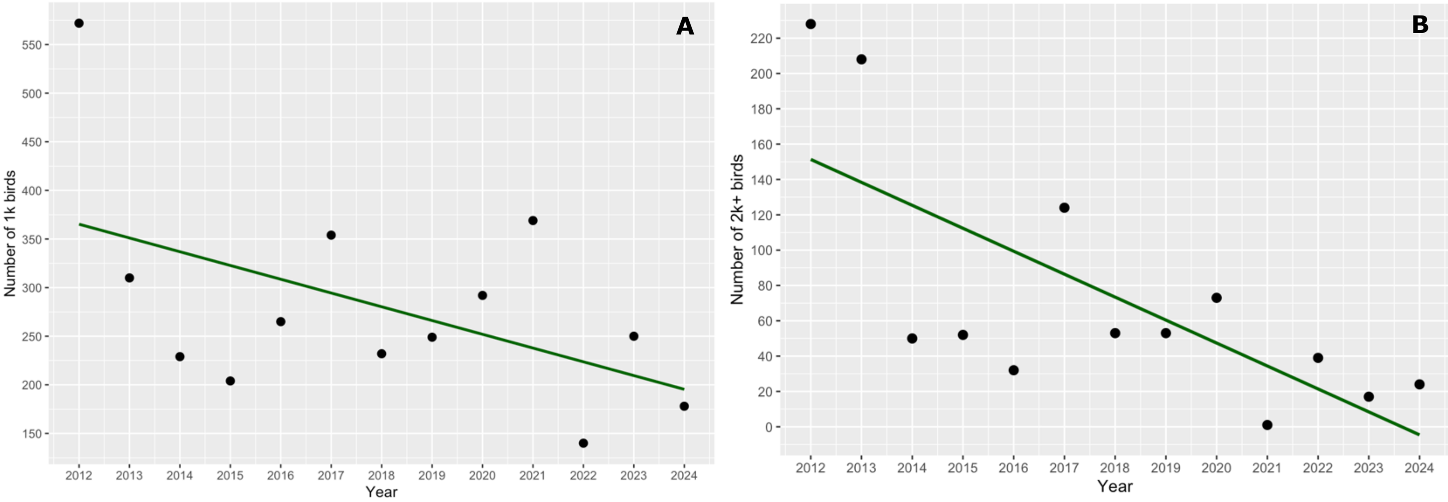

Figure 3.4: (A) Display of the number of 1k willow warblers and (B) display of the number of 2k+ willow warblers from 2012 to 2024 captured at Gedser Fuglestation during autumn.

3.2.4 Number of birds

The total number of willow warblers decreases significantly (LM; p= .018) from 2012 to 2024 (Figure 3.5) and is significantly affected by the mean temperature per year (LM; p=.018).

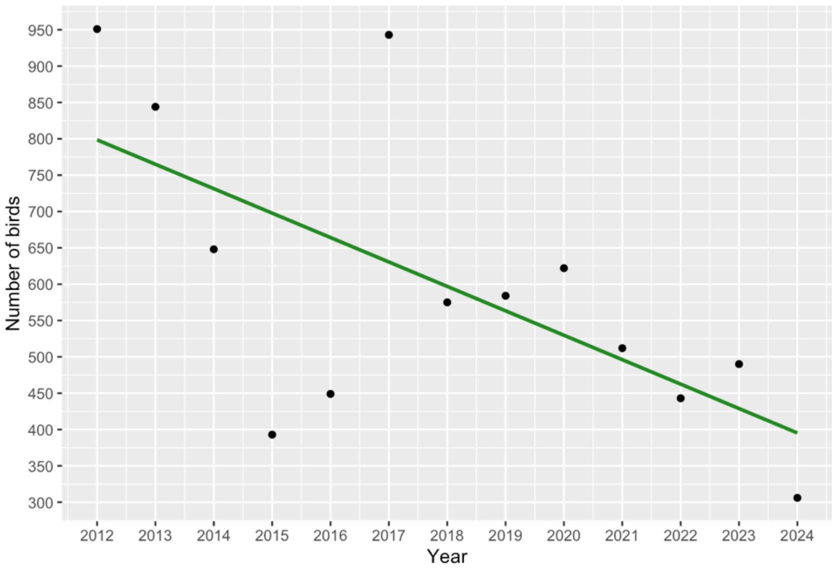

Figure 3.5: Display of total number of willow warblers captured at Gedser Fuglestation from 2012 to 2024.

3.3 Reed warbler

3.3.1 Wing length, weight and fat score

From 2012 to 2024 there is a non-significant increase in wing length (LM; p = .129) of reed warblers *(Acrocephalus scirpaceus)* (Figure 3.6A). The weight (LM; p = .288) (Figure 3.6B) and fat score (LM; p= .820) (Figure 3.6C) of reed warblers show a non-significant decrease from 2012 to 2024.

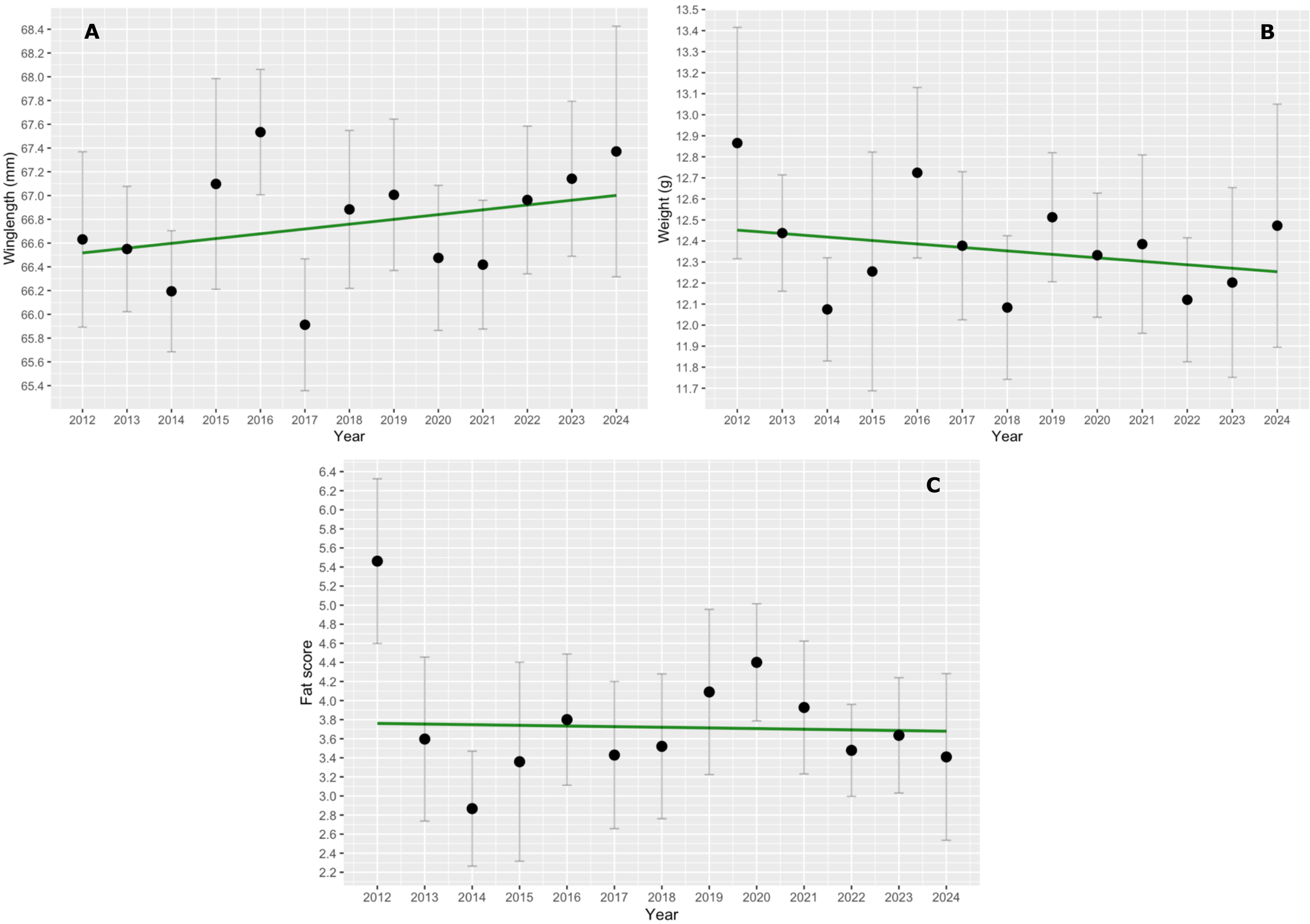

Figure 3.6: Display of (A) wing length (millimetres), (B) weight (grams) and (C) fat score of reed warblers captured at Gedser Fuglestation from 2012 to 2024.

3.3.2 Wing length and weight of 1k and 2k+ birds

During the autumn in the period of 2012 until 2024 the wing length (LM; p= .019) of 1k reed warblers increased significantly and was not significantly affected by the mean temperature per year (LM; p = .447) (Figure 3.7). The weight of the 1k reed warblers did not change significantly during that period (LM; p =.744) (Figure 3.7). The non-significant change also applied to the wing length (LM; p =.287) and weight (LM; p = .944) of 2k+ reed warblers in the autumn from 2012 to 2024 (figure 3.7).

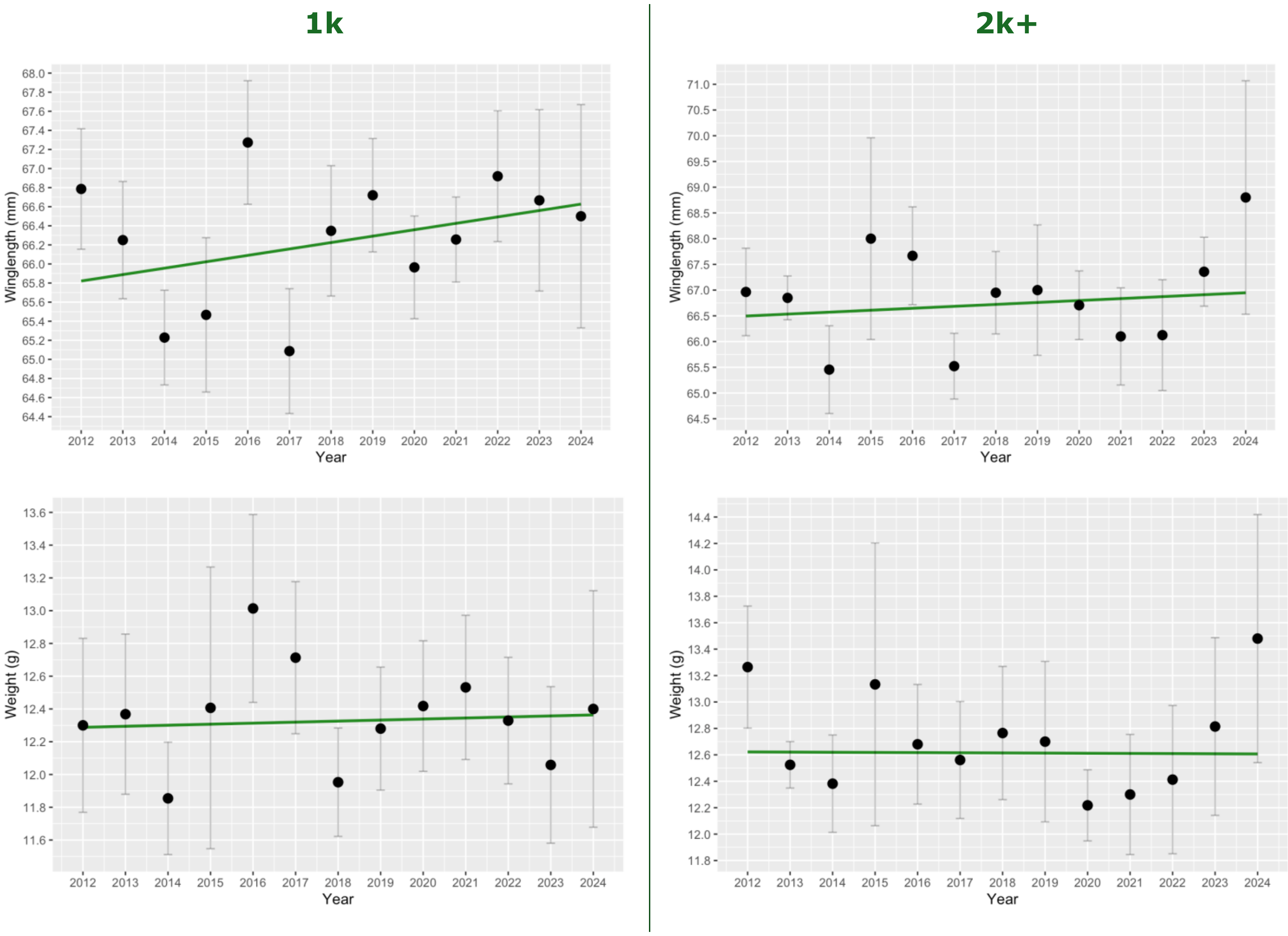

Figure 3.7: Display of the wing length in millimetres and the weight in grams of 1k reed warblers and 2k+ reed warblers captured at Gedser Fuglestation from 2012 to 2024 during autumn.

3.3.3 Age distribution

Between 2012 and 2024 in the autumn, the number of 1k reed warblers decreases non-significantly (LM; p= .061) (Figure 3.8A) and the number of 2k+ reed warblers decreases significantly (LM; p= .007) (Figure 3.8B). The mean temperature per year has a significant effect on the number of 2k+ reed warblers (LM; p= .023).

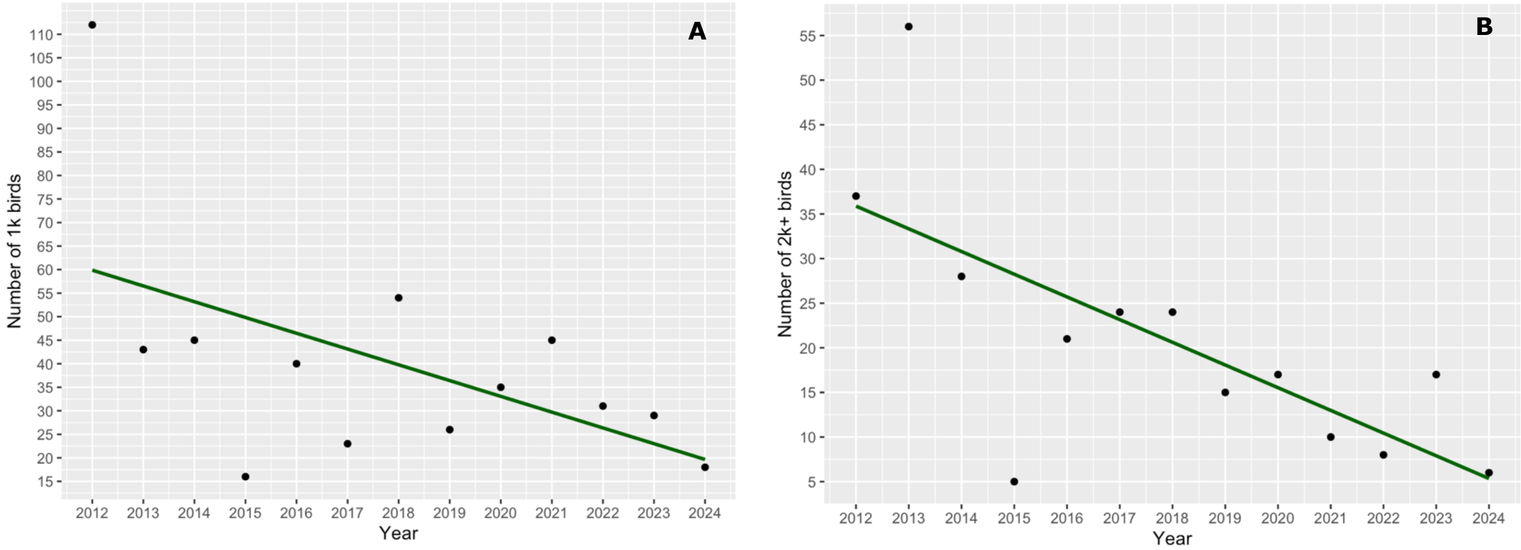

Figure 3.8: (A) Display of the number of 1k reed warblers and (B) display of the number of 2k+ reed warblers from 2012 to 2024 captured at Gedser Fuglestation during autumn.

3.3.4 Number of birds

The total number of reed warblers decreases significantly (LM; p= .007) from 2012 to 2024 (Figure 3.9) and is significantly affected by the mean temperature per year (LM; p=.010).

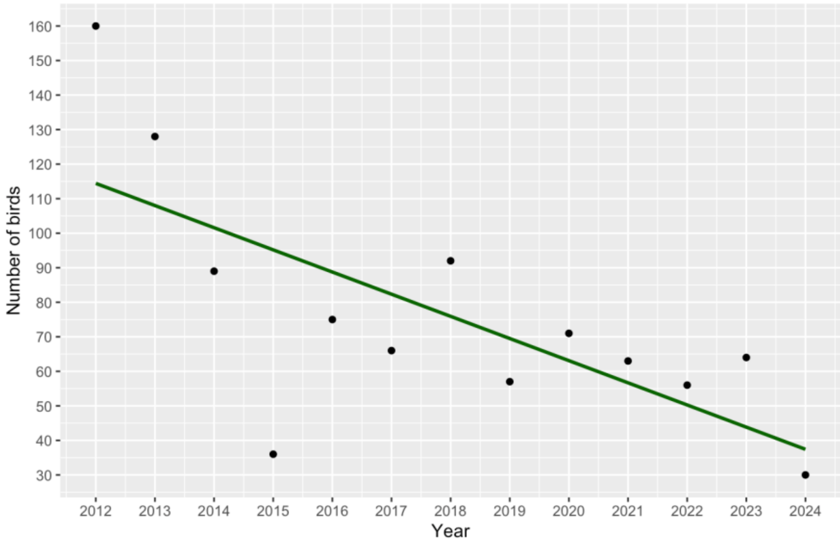

Figure 3.9: Display of total number of reed warblers captured at Gedser Fuglestation from 2012 to 2024.

4. Discussion and conclusion

4.1 Discussion

In this research, over the period from 2012 to 2024, surprisingly, no significant differences were found in the wing length and weight of the willow warbler *(Phylloscopus trochilus)* and reed warbler *(Acrocephalus scirpaceus)*. This is surprising because according to Allen's rule the wing length was expected to increase, and according to the Bergmann's rule the weight was expected to decrease as a response to the increasing temperatures that have been found (Allen 1877, In; Li et al. 2024; Mayr, 1970, In; Yom-Tov et al., 2006). However, the data where no differences have been found in wing length and weight include both young first calendar year (1k) birds and older second calendar year or higher birds (2k+). Research has shown in multiple passerine species, that first year (juvenile) passerine birds had a shorter wing length than adult ones (Alatalo et al., 1984 In: Merom et al., 1999; Ormerod et al., 1986) and that the immature birds had a lower bodyweight then the adults (Baldwin & Kendeigh, 1938). A separation of age groups, 1k and 2k+ birds, can make changes in wing length and weight for a specific age group visible when no difference is found in the two groups together.

When the first calendar year birds and second calendar year or higher birds (in autumn of 2012 to 2024) were separated, still no significant changes were found in the weight of 1k or 2k+ birds in either species. Research found that the time on which a bird reached its maximum weight of the day varied greatly among different days and different individuals (Baldwin & Kendeigh, 1938). A study that researched the activity patterns of several warbler species, found that most of the warblers had the same activity pattern with the most activity in the first hour after sunrise (Robbins, 1981). During the day birds prepare for the night by building up a fat reservoir (Haftorn, 1989). Possibly the willow warbler and reed warbler have the same activity patterns within the species and thus same hour(s) of the day wherein they reach their maximum weight for the night. This could make it possible for future research to compare the weights of birds captured at the same hour (after sunrise). By comparing the weights measured in the same hour of the day over the years, the data gets less numerous and has a higher variability (Baldwin & Kendeigh, 1938). With this, it can be possible to find a clearer trend in changes in weight over the years. Additionally, future research could measure weight of birds over the whole day, and not only for the morning hours as done in this research. Possibly the maximum gained weight of the day is not in the morning but later in the day, and the weighing of birds should be done on a different time of day.

On the other side, when the data of 1k and 2k+ birds was separated, an increase in the wing length of 1k reed warblers was found. This connects to earlier research that also found an increase in the wing length of reed warblers (Yom-Tov et al., 2006) and it follows the Allen's rule where the wing length increases with an increase in temperature (Allen 1877, In; Li et al. 2024). Though, there was no connection found between the mean temperature per year and the increase of the wing length of the reed warbler. The reason of the increase in wing length in the first calendar year birds may be to adjust the speed of their migration to arrive in an optimal period at the breeding habitat (Hahn et al., 2016). When the spring green up (increasing plant productivity in spring) at the breeding habitat of a bird is fast, the time to arrive at the breeding habitat in an optimal period is shorter (Hahn et al., 2016). Research has claimed that longer wings are favorable for adjusting the migration speed to arrive in an optimal period at the breeding habitat (Hahn et al., 2016). The reason that no increase is visible in 2k+ birds is unclear. Coming research could investigate the arrival time of reed warblers over the years and compare this to the spring green up at Gedser Fuglestation to confirm if birds are indeed arriving earlier and if this is connected to the spring green up.

In contrast to the increase in the wing length of reed warblers, a significant decrease was found in the wing length of 2k+ willow warblers. A decrease in wing length of willow warblers has also been found in earlier research (Yom-Tov et al., 2006). The decrease in wing length of the willow warblers was found to be connected to the mean temperature per year but it goes against the Allen's rule (Allen 1877, In; Li et al. 2024). A cause for this decrease could be change in feeding strategies. Willow warblers have a winter complete molt as young birds (from first calendar year bird to second calendar year bird) (Svensson, 2023). Possibly after this complete winter molt the new covert feathers of the adult are becoming shorter over the years due to a different feeding strategy for insects (Laursen, 2022) in more dense vegetation (Hamilton, 1961). Research has confirmed that the number of flying insects on Danish farmland has decreased over the years (Møller, 2019). Due to less insects in open farmland, willow warblers could have started to hunt for insects in more dense vegetation, where research suggests that shorter wings are more favorable (Hamilton, 1961).

Another physical trait that changed significantly from 2012 to 2024 is the fat score of the willow warbler. A significant increase in fat score was found. This change in fat score and not in weight is unexpected because in research from Bairlein (1985), the amount of visible fat was always linked to changes in weight of birds. Fat scoring on visibility of fat is subjective and connected to a lack of precision and repeatability, what can cause results to differ among observers (Rogers 1991). In future research a statistical correction for observer effects could be performed on the data to rule out these possible differences in fat scoring.

Next to physical traits changing over the years, the number of willow warblers and reed warblers also changed, and these changes were found to be connected to the mean temperature per year. As a response to climate change the laying date of smaller birds advances (Stevenson & Bryant 2000, In; Leech & Crick, 2007). This can, if it does not shift as much as the food peak, cause a mismatch to occur (Both, 2010). Which can in turn cause a reduced survival in fledged young (Sanz et al., 2003). This can cause there to be a decline in the total number of birds. Another cause of this decrease could be a decrease in the number of insects in Denmark, the main food source for willow warblers and reed warblers (Møller, 2019; Silveira, 2013; Laursen, 2022). The number of flying insects on Danish farmland has decreased from 1997 to 2017 with more than 80 percent (Møller, 2019). Research has found a positive correlation between the abundance of insects and the population size of other insectivore birds (barn swallows, sand martins and house martins) (Møller, 2019; Arena et al., 2011). A decline in insect abundance can therefore cause the population size of insectivore species to decline (Møller, 2019).

When looking specifically at the number of birds in the age groups in the autumn of 2012 to 2024, the 2k+ willow warblers and reed warblers show a significant decrease which is connected to the mean temperature per year. Though, no change was found in the number of 1k birds. With the number of 2k+ birds decreasing, a decrease in 1k birds would also be expected. Especially when looking at a mismatch that can occur between the food peak and laying date, which can in turn cause a reduced survival in young birds (Both, 2010). On the other hand, due to passerine birds advancing their breeding time as a response to climate change, there is more time for replacement clutches, and this can therefore increase the possibility for a successful nesting attempt (Morrison et al., 2019). That way, even though there is a reduce in 2k+ birds, the higher success in nesting can cause there to be more young per adult bird, which keeps the number of 1k birds constant over the years.

4.2 Conclusion

This research shows that the mean temperature per year has increased from 2012 until 2024, at the southernmost part of Denmark, where Gedser Fuglestation is located. This change in temperature is connected to the changes in the physical traits of the willow warbler and to the decrease in the number of birds of the willow warbler and reed warbler. Though, more factors can affect the physical traits and number of birds; like feeding strategy, migration speed and the number of insects. That makes this research a good starting point from where more factors could be added to assess the effects of different factors on the physical traits of birds and the density of bird populations over the years.

5. Literature

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Appendix I Standardized monitoring protocol Gedser Fuglestation

Ringing at Gedser Bird Observatory & Ringing Station

Standardized monitoring protocol

Welcome to Gedser Bird Observatory & Ringing Station. This protocol outlines some important information regarding our standardized bird ringing program in order to ensure high quality data collection. This protocol should be used as a guideline for foreign ringers as well as for the local staff. We request that all ringers, who intend to carry out standardized bird ringing at Gedser, are familiar with the contents of this protocol and follow the instructions outlined below when ringing.

Before setting up the nets

Always prepare the ringing equipment, eg. extra ring series, new sheets etc., the day before a ringing session.

You should always have a look at the weather forecast before setting up the nets! Keep an eye on the weather (precipitation) radar during ringing sessions and take appropriate action **before** weather conditions turn bad.

Link to radar: **http://www.dmi.dk/vejr/maalinger/radar-nedboer/**

Timing and fulfilling the standardized ringing program

The last net to be set up in the morning, should be active for catching no later than 30 minutes before sunrise, preferably between 60 minutes and 30 minutes before. The standardized ringing session begins between 30 and 60 minutes before sun rise (the time at which all nets were set) and lasts for five hours. The minimum requirements for the standardized monitoring program is 300 mistnet meter hours, which can, for instance, be obtained by running 5 mist nets of 12 meters for 5 hours (5x12x5). You can use more nets if you wish, but only if you can keep up doing rounds every 30–60 minutes.

After 5 hours of standardized ringing, please make a note in the ringing data for each ring series that the standard time has ended. This is important for data registration.

Link to almanac: **http://www.torbenhermansen.dk/almanak/almanak.php**

If for some reason (rain, storm, illness etc.) you have to furl the nets before the scheduled end of standard ringing, the ringing still can, potentially, be registered as a standard ringing session. If you have the nets open 30 minutes before sun rise and for at least 4 hours after, the data is still registered as a standard ringing session. Also, if you are forced to furl the nets in the middle of a ringing session, standard ringing can be continued if the maximum time that the nets are closed does not exceed one hour.

If the weather conditions are unsuitable for ringing early in the morning and you have to postpone opening the nets, you can still complete a standard ringing session if the nets are up no later than 2 hours after normal setup time and are open for at least 5 hours. Please write the reason for ending standard ringing prematurely in the notes field when entering the ringing data in Zuschlag's Bird Ringing Database

Net rounds

The time interval between net rounds should be between 30 and 60 minutes, with 30 minutes being the normal interval and 60 minutes being the rare exception! The order in which the nets should be set up and checked is stated below:

H1 -> H2 -> H4 -> F1 -> H5 -> F3 -> F4 -> N1 -> N2 -> N3 -> N4 -> N5 -> N6 -> N7 -> N8 -> Ø1 -> N9 -> Ø2 -> Ø3 -> Ø4 -> Ø6 -> P2 -> D1 -> Ø7 -> Ø8 -> Ø9 -> Ø11

(A diagram of the net positions and net lengths is available in the lab ringing manual.)
The following nets are not part of the standardized ringing program:
E01 (field nets in front of the station), P2 with sparrowhawk nets from 1st September – 15 November.
D1 and P2 are included with the standardized nets when passerine nets are used before the 1st September. After this date the passerine nets should be replaced with sparrowhawk nets and are no longer included in the standardized design.

Ringing the birds

The birds can be either bagged and ringed in the lab or ringed directly by the nets. We recommend that all birds are taken back to the lab for further investigation and measurements, however if this is not an option due to the number of birds caught, you can ring directly by the nets using a fully equipped ringing waistcoat!

You are advised to use our recommended list of ring sizes, which can be found in the lab ringing manual. We ask you not to deviate from the list of recommended ring sizes. However, in rare cases, there may be good reasons to deviate from the recommended list of ring sizes. If you decide to use another ring size than what is recommended, please make a note in the note field in Zuschlag's Bird Ringing Database for the specific ringing record.

Ringing in the lab: Please keep track of which birds belong to which round or hour by hanging the bird bags on different hooks and assigning an appropriate label, i.e. "hour 6" for birds collected between 6am and 7am. The hour interval to be written in the notebook is the hour interval in which the bird was extracted from the mistnet.

Ringing by the nets: The hour interval to be written in the notebook, is the hour interval in which the bird was ringed/extracted.

Data registration, methods and biometrics

Sheets designed specifically for the standardized ringing program should be used for ringing as well as for recapture data. A copy of the sheet is shown in the lab ringing manual. Please keep one sheet for each ring size, however, all recaptures go in the same sheet.

If you decide to ring by the nets, please be sure that the notebook you are using has a number on the front. If it doesn't, please label it with the correct code (labels are found in the lab ringing manual).

Standard biometrics include: 1) Wing length 2) Fat score 3) Weight.
The standard wing length measurement is the maximum cord according to "Identification Guide to European Passerines" (page 19-21) by Lars Svensson. Information about fat score is found in the lab at the ringing table.

Special projects: We measure the wing formula of Sparrowhawks according to the method listed in the lab ringing manual.

Data entry

All ringing data (new ringing records and controls) is to be entered by the ringer in Zuschlag's Bird Ringing Database daily and totals entered into Dofbasen.dk. We will introduce you to these programs, when you arrive.

Even if no birds have been ringed during a standardized session (simply because there were no birds around), you should register the basic weather data, net time, net meters etc. in the ringing database.

If standardized bird ringing is not achievable, the basic weather data, net time, net meters etc. should also be entered in the ringing database. In that case you put a "0" in the "total net meters" field.

Blogging
We kindly ask that you post daily news on our blogspot, which is an integrated part of our website. Feel free to personalize your blogs. It would also be very much appreciated if the text is supported by one or more pictures. Our blog is visited by more than 100 people each day during the ringing seasons and the blogspot is an important window to the outside world, i.e. the public, various organisations and more.

Park ranger duties

When working as a ringer you are requested to help with essential gardening, which includes lawn mowing, regular pruning of bushes and trees, etc. Make sure to mow the grass under the nets regularly, so that the birds do not get wet and cold when dangling from the lower net shelf.

Using the sound system

The night before(from 2 am) and during standard ringing it is not permitted to manipulate passerine migration by using the sound system. The only exception to this rule is the tape lure of Tengmalm's Owl during October and November. However, when using the sound system you should always be aware that you are not causing any serious disturbance to birds, neighbours or public visitors. You should always consider animal ethics before turning on the sound system.

General advice

The garden is a public area allowing people to walk through the garden, have lunch and more, but people are not allowed to walk in-between the nets. If this happens, please guide them to the main path or the front yard.

Remember that the birds come first. This means that you should never open more nets than you can handle on your own! We want the bird ringing at Gedser to be carried out by responsible people who care more about the birds and the quality of the data than numbers or rare birds!

It is important that you are ready when the day starts. Have breakfast before you do the first round or set up the nets. You might suddenly find yourself busy with constant bird ringing for the next 5 hours or even more.

Remember, that you are not allowed to sleep while the nets are open. When catching nightjars and owls you should preferably do so with another person and take turns checking the nets. If you intend to carry out ringing during the hours of darkness on your own, you are not allowed to sleep between net rounds, because of the possibility of not waking up!

It is highly recommended that you always carry your cell phone with you. – You might want to call for assistance or inform other people about the spectacular bird you just extracted from a mist net. A telephone list is available in the lab ringing manual!

Remember that only the ringer decides if a bird is going to be shown to the public (this includes local people, birders and photographers). If there are too many birds in the nets or the bird has no fat or seems weak – then the bird should be released – take photos and let it go. Animal ethics always come first.

Appendix II Data collection sheet bird ringing

Data collection sheet for bird ringing with type of record (ringed or recaptured), ring number (Ring no.), ring size, date (dd,mm,yyyy), time (hour), license number, species, age, sex, wing length in mm (Wing), weight in grams, fat (score 1 until 8) and space for comments.

Gedser Bird Observatory & Ringing Station

Coding: dd = day, mm = month, yyyy = year

Type of record: ☐ Ringing ☐ Recapture

Ring size:

Correctur stuff

Liebzi rocks

RING no.	dd	mm	yyyy	hour	Licens nr	Species	Age	Sex	Wing	Weight	Fat	Comments	Input	Datacheck
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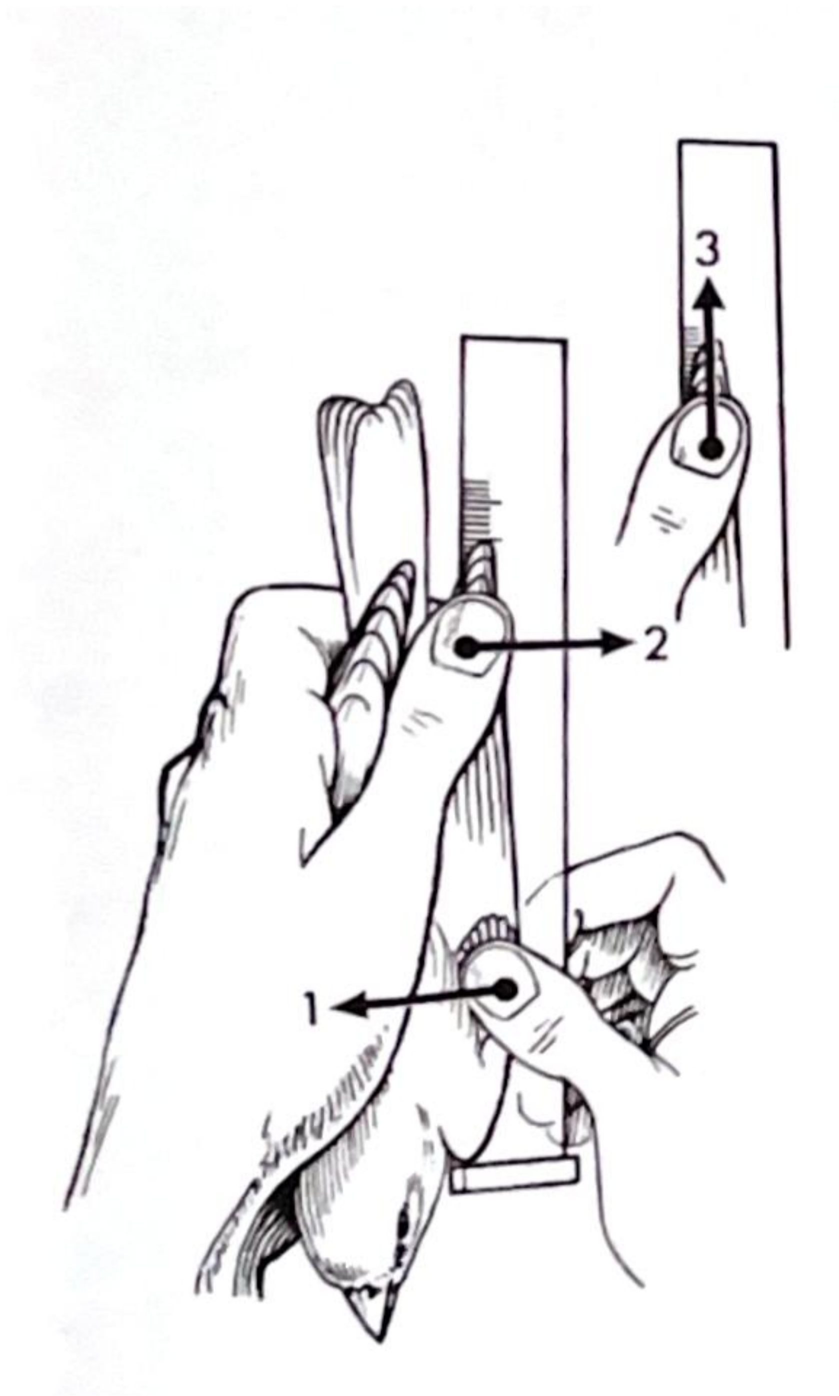
Appendix III wing length

Method of measuring the wing length of a bird (Svensson, 2023).



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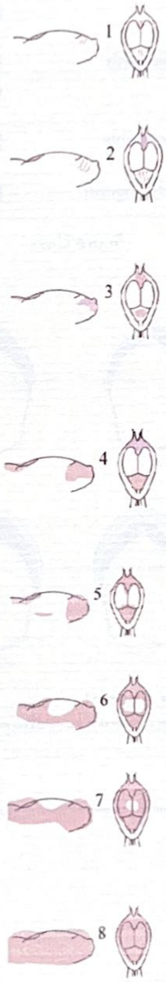
Appendix IV Fat score

System for determining the fat score of birds with fat scores ranging from 1, with the least fat present, to 8 with the most fat present. The method that will be used is the BWG system (Redfern & Clark, 2001).

Fat Scores

Score	(a) ESF system – Description	(b) BWG System – Description
0	no visible fat. Dark red	no visible fat. Dark red
1	F: wide wedge of fat. A: trace of fat. Light red	F: trace of fat. (~E0.5) Light red/pink
2	F: completely covered but deeply concave. A: slips of fat. Light yellow	F: base of tracheal pit obscured by fat to about one third full. (~E1.0) Yellow-pink
3	F: moderate fat reserves cover ends of inter-clavicles but concave. A: flat or slightly bulging pad. Light yellow	F: tracheal pit about two-thirds full. Muscle within tracheal pit visible between fat and clavicles. (E~1.5) Yellow-pink
4	F: filled up to far end of clavicles. A: covered by clearly bulging pad of fat. Yellow	F: completely filled up to far end of clavicles but still concave (not bulging). (~E3.0) Pale yellow
5	F: convex bulge, perhaps overlapping breast muscles. A: extreme convex bulge. Yellow	*As ESF*
6	F and A: fat covering breast muscles by several mm.	*As ESF*
7	F and A: 3/4 of breast muscles covered. Yellow	*As ESF*
8	F and A: breast muscles not visible. Yellow	*As ESF*



(F=Furcular region or tracheal pit; A=Abdomen)

Under the BWG scale, ESF scale equivalents are given (eg E0.5) eg a score of 3 on the BWG scale is equivalent to about 1.5 on the ESF scale.

From *Ringers' Manual* BTO, Thetford