



Til Landbrugsstyrelsen

**Levering på bestillingen "Årlig opgørelse af antal bistader, der er klar til indvintring i Danmark"**

Landbrugsstyrelsen har i bestilling sendt d. 10. september 2018 bedt DCA – Nationalt Center for Fødevarer og Jordbrug – om at estimere hvor mange bistader der er klar til indvintring i Danmark.

Besvarelsen i form af vedlagte notat er udarbejdet af seniorforsker Per Kryger og videnskabelig medarbejder Mette Balslev Greve fra Institut for Agroøkologi ved Aarhus Universitet. Seniorforsker Annie Enkegaard fra Institut for Agroøkologi ved Aarhus Universitet har været fagfællebedømmer.

Besvarelsen er udarbejdet som led i "Rammeaftale om forskningsbaseret myndighedsbetjening mellem Miljø- og Fødevareministeriet og Aarhus Universitet" under ID 1.36 i "Ydelseaftale Planteproduktion 2018-2021".

Venlig hilsen

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## Estimation of the number of honey bee colonies in Denmark

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The estimated number of honey bee colonies living in Denmark from September to December 2018 is 90,599, based on our method, but taking the number of colonies estimated in spring 2018 into account the best estimate is 120,000 honey bee colonies.

Denmark does not have a mandatory registry of apiaries, hence data are lacking as to the number of honey bee colonies. In order to estimate the number of colonies, we produced a series of maps, which were distributed to the Danish bee inspectors employed to assist the Ministry in honey bee health questions. A total of 48 bee inspectors completed the task of inspecting their designated areas and returned their maps with a list of apiaries found within their 4 by 4 km<sup>2</sup> area, with the exception of the three inspectors in Copenhagen, who were given maps of 3 x 3 km<sup>2</sup>, due to the high density of apiaries in the capital. The number of bee inspectors responding was lower than in 2017, where 63 dataset were returned, mainly due to having fewer bee inspectors employed. The number of apiaries ranged from 0 to 27, the number of colonies per map varied from 0 to 185, and the number of colonies per apiary ranged from 1 to 86 colonies. Five maps were returned without a single apiary. A total of 1,554 colonies were located on the 48 maps, in a total of 243 apiaries.

None of the maps consisted entirely of land, i.e. had 16 km<sup>2</sup> area available for bee colonies, but rather the maps covered a smaller area due to ponds and lakes. This resulted in areas ranging from 8.70 km<sup>2</sup> to 15.98 km<sup>2</sup>, leading to a total surveyed area of 726.48 km<sup>2</sup>, which is less than the theoretical maximum of  $45 \times 16 + 3 \times 9 = 747$  km<sup>2</sup>. The corresponding total area of Denmark, minus water bodies, is 42,354.08 km<sup>2</sup>. Thus, the best estimate for the number of colonies in Denmark is:  $1554 \text{ colonies} \times 42,354.08 \text{ km}^2 / 726.48 \text{ km}^2 = 90,599$  colonies.

On average, there were 6.35 colonies per apiary in 2018, compared to 7.85 in 2017. As was the case in 2017, the variation is considerable (standard deviation = 8.41) as numbers of colonies per apiary ranges from 1 to 86 colonies, plus 5 maps returned without any apiaries. With the aim of estimating a confidence interval, a bootstrap calculation with 5,000 random samples was performed in relation to the 251 original observations, including the 5 empty maps. The resulting 95% confidence interval is 5.10 to 7.98 colonies per apiary, which translates to a lower limit of 72,252 colonies and an upper limit of 112,996 colonies for Denmark. Bootstrapping is done by resampling a new dataset based on the 251 actual observations by randomly drawing and replacing 251 new values from the full data of 251 observations, and calculating a new mean for each random selection.

The occurrence of 5 empty maps, i.e., up to 16 km<sup>2</sup> without a single apiary, may be explained by bee inspectors being unable to locate apiaries, perhaps due to the larger survey area per bee inspector compared to 2017. In 2017 we used maps that were either centred around the bee inspectors' homes or just next to it. This resulted in a minor bias, with more apiaries being located on the maps centred around bee inspectors' homes. In order to avoid this bias, the maps of this year were placed some distance away from the bee inspectors' home addresses, which however, also meant that the bee inspectors had less precise local knowledge. In fact, 28 bee inspectors indicated that they may have missed between 3 % and 60 % of the bee colonies on their map. However, most bee inspectors were completely certain or very certain that they had detected all apiaries in their designated areas, while only 8 bee inspectors stated that they were somewhat uncertain about locating all apiaries. It seems probable that we failed to spot apiaries since this year we found only 246 apiaries on 726.48 km<sup>2</sup>, compared to 213 on 519 km<sup>2</sup> last year, i.e. a decrease in apiary density from 0.41 to 0.34 apiaries/km<sup>2</sup>. Clearly, the distribution of apiaries in Denmark is not even, as demonstrated by the fact that we have a range of 0 to 27 apiaries per map, with an average of 6.3 apiaries per returned map. This year a larger area was inspected in order to reduce the number of empty maps, but still 5 empty maps were returned. A likely explanation why apiaries are sometimes overlooked, is the fact

that Danish beekeepers like to place their apiaries at some distance from public roads, and often were they are not easily seen.

In conclusion, fewer maps were returned this year, but still covering a larger area. The total number of estimated colonies in 2018 (90,599) is much lower than in 2017 (140,938). It seems highly unlikely that the number of bee colonies is reduced by this amount; it is more likely that the actual number of bee colonies in Denmark lies between the two estimates. As regards to the number of apiaries the inspectors probably failed to spot apiaries in the present count, as the opposite is impossible: we cannot find apiaries that do not exist. Consequently, the method generally underestimate the number of bee colonies. Taking the two years together, we therefore estimate the number of colonies to be 120,000.