

Woodcock hunting in Denmark

Status and recent changes

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Based on data on Woodcock hunting in Denmark obtained from the Danish Game Bag Record (collected since 1955) and from the Danish Wing Survey (collected since 1985), we examined changes in Woodcock hunting in relation to numbers shot, hunting method, age-ratios and temporal distribution of the bag. The bag of Woodcock has increased markedly since the 1950s, from a level of c. 10,000-20,000 to more than 60,000 in the most recent seasons, 2008/09 and 2009/10. This increase is significantly correlated with an increasing number of hunters that bag Woodcocks. Overall most Woodcocks are shot by hunters using pointing dogs (season average: 65%) and during battue hunting (season average: 21%), but with the proportion of Woodcocks shot during battue hunting showing an increase in the later time periods. During the open season October-December, the majority of the Woodcock bag is consistently taken during the first half of November. Comparing the time periods 1985-1993, 1994-2003 and 2004-2010, there is a clear tendency for bagging declining numbers in October and increasing numbers in December for both adults and juvenile birds, indicating that autumn migration of Woodcocks at present occurs progressively later in the season. A significant decline in the overall proportion of juvenile Woodcocks in the Danish bag during 1985-2010 indicate that reproduction success is slowly declining in the Woodcock populations of northern Scandinavia and North-west Russia. The present phenological changes are in accordance with changes expected from climate change and may reflect both later migration and longer staying times.

In Denmark, hunting is regulated through statutory enactments to the Hunting Act, which on a three-year basis set the open seasons. Changes in the open season are based on evaluations of both hunting monitoring schemes and on national and international surveys/evaluations of population trends, to ensure that hunting is in accordance with the principle of sustainability. Since 1979 the Danish Wildlife Committee has been the advisory assembly for the responsible ministry, recommending changes to the hunting seasons for all game species when deemed necessary based on the available information.

As with most game species, the Woodcock (*Scolopax rusticola*) has been subject to changing hunting regulations over the years. Most markedly the spring hunting of Woodcocks was banned in 1972, but more recently, the open season has been expanded from the period 1 October – 31 December to include the first 15 days of January in 2004, and from 2011 the open season was further extended to include all January. The late start of the hunting season and the ban on spring hunting ensure that hunting in Denmark mainly affects migrating birds on their way from breeding areas in Fennoscandia and Russia to the main wintering areas in Great Britain and France (cf. Clausager 1974, Bønløkke *et al.* 2006).

Woodcock hunting in Denmark has previously been described in detail up to 2002 (Clausager 2006). Thus the aim of the present analyses was to provide an updated 2010 status, as well as to assess more long-term changes or developments in the hunting bag, hunting practices and in the temporal distribu-

tion of the bag. Given that changes in migratory patterns has been associated with global warming (Gatter 1992, Walther *et al.* 2002, Visser *et al.* 2009), with some species showing delayed migration and more northerly wintering distribution, we specifically look for patterns that potentially relate to this hypothesis.

Method

Data on Woodcock hunting in Denmark was obtained from the Danish Bag Record (cf. Noer *et al.* 2009) and the Danish Wing Survey (Clausager 2004, www.bios.au.dk/vinger). The Danish Bag Record provides annual totals of bagged Woodcocks on a county level, based on mandatory bag reports from all holders of hunting licences, whereas the Wing Survey provides dated information on the proportions of adult and juvenile Woodcocks, as well as specific geographical information of the bag, and information on the type of hunting. The number of Woodcock wings received by the Wing Survey ranged between 600 and 2 500 per year, constituting on average c. 3% of the total annual bag. The Danish Bag Record goes back to 1941, whereas detailed data on Woodcocks have been compiled in the Wing Survey since 1985. In the present analysis, data on the total bag is available for the period 1955 to 2009, while data on Woodcock wings goes up to 2010.

Age determination of Woodcock wings was based on several characteristics including wear of primary feathers, shape colour and moult pattern of under wing secondary coverts and colour of upper wing primary coverts (OMPO 2002). With

only three experienced persons involved in age determination of wings since 1985, the accuracy in determination is considered extremely high. Only very few wings were not aged in a given year, and then mainly due to the wings being in very poor physical condition.

In data analyses we applied standard t-tests, Kolmogorov-Smirnov test and regression analyses (Sokal & Rohlf 1981) when appropriate. For analyses of changes in the temporal distribution of the bag, we corrected for changes in the hunting season by only using wings from the period October-December. In assessing relations between annual Woodcock hunter numbers and annual total Woodcock bag we used the actual number of hunters reporting bagged Woodcock and actual reported total Woodcock bag, and not the corrected official Bag Record taking into account a varying number of missing bag records (*cf.* Noer *et al.* 2009). In the assessments of potential effects of global warming on the temporal occurrence of Woodcocks, we expected that the proportion shot in the first half of the season (October-mid-November) should decrease, while the proportions shot in the late season (mid-November-December) should increase. Thus in testing specific directional changes we used a one-tailed Anova ($\alpha = 0.10$) in analysing differences within separate seasonal periods between time periods. In all other analyses the significance level was $\alpha = 0.05$.

Results

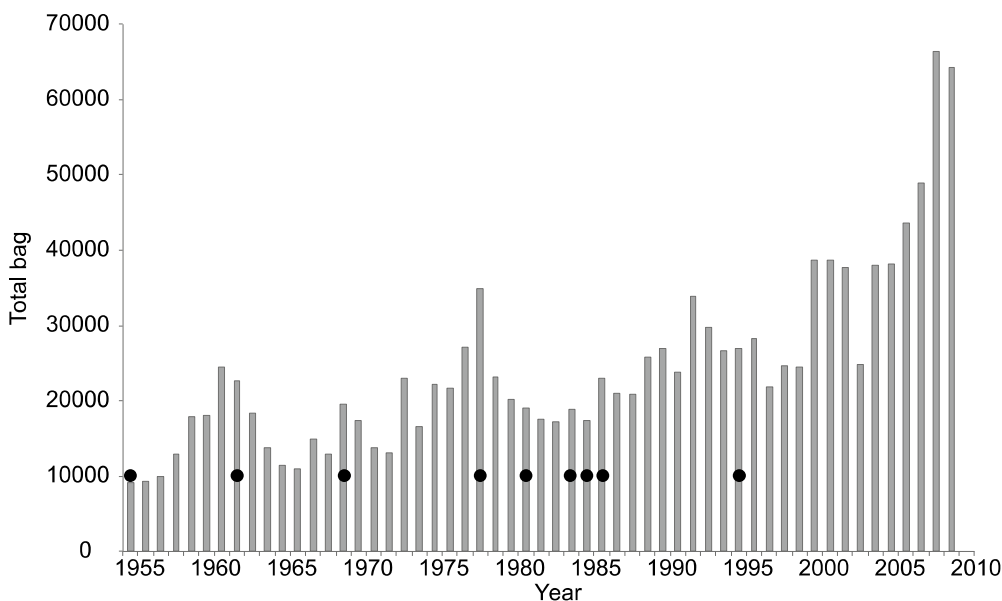
The total Danish bag of Woodcocks for the period 1955 to 2009 (*Figure 1*) shows an overall increase, with an all-time high number of more than 60 000 bagged Woodcocks in 2008 and 2009. Comparing 10-year periods, the average annual numbers shot show significant increases between the 1980s and 1990s ($t = 4.78, p < 0.001$) and between the 1990s and 2000s (2000-2009) ($t = 4.11, p = 0.002$) (*Table 1*). For unknown reasons, the Woodcock bag tends to show a cyclic pattern with peak numbers shot in the early 1960s, late 1970s and early 1990s. As the number of Woodcocks staging in Denmark is affected by ambient temperatures and decreases during cold spells, severe winters potentially affect the bag. However, there is no obvious relationship between the occurrence of recorded ice winters in Denmark and the cyclic pattern of the Woodcock (*cf.* *Figure 1*).

Woodcocks are traditionally shot by use of pointing dogs or during battue hunting (hunting parties) and more rarely by other types of hunting. For the period 2003-2010 on average 58% of all Woodcocks in the Wing Survey were shot during hunting with pointing dogs, 25% shot during battues and 5% as flushed birds. Compared to the corresponding values for the period 1985-2002: 66% pointing dogs, 17% battues, 6% flushed birds (Clausager 2006), slightly more Woodcocks are shot during battues and fewer by pointing dogs in recent years. On a seasonal basis, battue hunting increases throughout the

Table 1. Average annual number of Woodcocks shot by decade since 1955 and p-values of pair-wise comparisons (t-tests, $\alpha = 0.05$). Note that only five years are included in the 1950s; all other periods include 10 years. *compared actual decade with next decade and so on.

	1950s	1960s	1970s	1980s	1990s	2000s
Average	11,871	16,705	21,277	20,112	26,760	43,932
Standard error	1,670	1,474	2,069	872	1,081	4,034
Minimum	9,147	11,007	13,169	17,204	21,908	24,887
Maximum	17,939	24,499	34,832	25,875	33,963	66,332
p	0.055*	0.091	0.613	<0.001	0.002	
N	5	10	10	10	10	10

Figure 1. Total Danish bag of Woodcock during 1955-2009. Officially recorded ice winters (DMI) are marked by red dots. The year denotes the start of the hunting season or ice winter (e.g. 2009 = the open season 2009-2010).



season, while hunting by pointing dogs decreases, although this latter method dominates in all time periods (Figure 2).

The number of hunters that have reported Woodcocks to the Bag Record during 2000-2009 has increased significantly from an average of 16 500 (2000- 2006) to a level of c. 20 700 in 2008 and 2009 ($t = 3.03, p = 0.029$). This increase in hunters with a Woodcock bag is significantly correlated with the corresponding increase in numbers shot ($F_{1,8} = 271.8, p < 0.0001, R^2 = 0.97$; Figure 3). However, we do not know if this is caused by an increasing number of hunters or Woodcocks. But, as the increase in the proportion of successful Woodcock hunters, increasing from 22.5% in 2000-01 to 30.7% in 2008-09, has occurred during a period where the total number of bag reports have been stable ($F_{1,8} = 0.09, p = 0.77, R^2 = 0.01$), the present results suggests that Woodcock numbers have increased or that Woodcocks have prolonged their stay in Denmark during this period.

The temporal distributions of bagged adult and juvenile Woodcocks for the time periods 1985-1993, 1994-2003 and 2004-2010 is shown in Figure 4. The majority of both adult and juvenile Woodcocks are bagged during the first half of November for all time periods. Overall the proportions bagged show a tendency to decrease in the early season (late October-early November) and a tendency to increase in the late season (late November-December) for both adult and juvenile birds. This pattern indicates that Woodcocks are shot later in the season in recent years, which is partly supported by statistical analyses, showing significant directional differences in

average proportions in the predicted directions in the first half of December for adults (Anova one-tailed: $F = 3.12, p = 0.063$), and in the second half of October ($F = 3.06, p = 0.066$), second half of November ($F = 2.94, 0.073$) and first half of December ($F = 9.11, p = 0.001$) for juveniles (cf. Figure 4).

In 2004 the open season on Woodcocks was expanded to include the first half of January. On average the January bag of Woodcocks constitutes 5.6% of the annual bag, when assessed from the wing survey data, but the proportion shot in January shows a significant decline from c. 10% in 2004 to c. 1% in 2010 ($F_{1,5} = 20.7, p = 0.006$), which is consistently found for both adults and juveniles. In January, the proportion of adult Woodcocks constitutes on average 43.6%.

Corrected for the change in season length, the annual proportion of juvenile birds in the wing survey has shown a slight, but significant decline during the period 1985-2010 ($p = 0.045, R^2 = 0.16$) (Figure 5). Apparently this decline is mainly related to low juvenile proportions shot during the period 2000-2010, where juveniles averaged 59.1% of the annual bag compared to 66.2% during the preceding period. Two years, 1992 and 2002, were characterised by extremely low proportions of juveniles (Figure 5), of which the low 1992 figure may relate to a generally poor reproductive year for northerly breeding birds in Europe and European Russia due to a volcanic eruption in Indonesia (Ganter & Boyd 2000, Mitchell *et al.* 2008). The significance of the decline in the proportion of juveniles in the bag increases when omitting these outliers ($p = 0.009, R^2 = 0.27$).

Figure 2. Average seasonal distribution of Woodcock bag related to different hunting methods during 2000-2010. Data from the Wing Survey. Other methods include birds flushed, birds on migration and various incidental encounters.

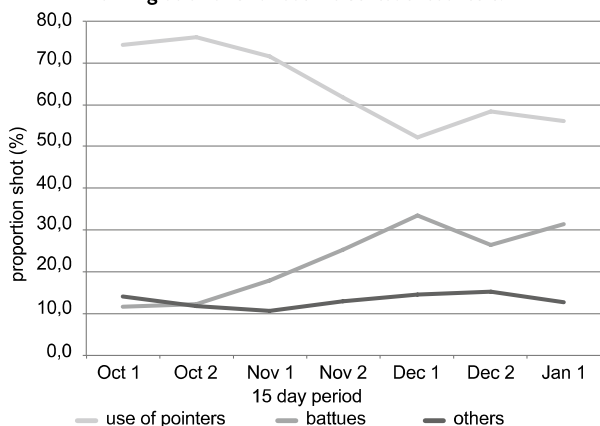


Figure 3. Relationship between the proportion of hunters shooting at least one Woodcock and the size of the total Woodcock bag.

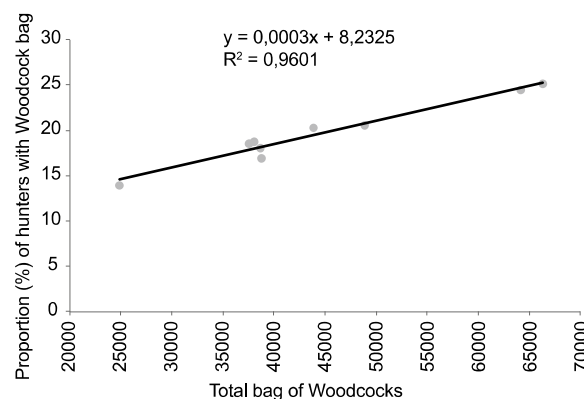
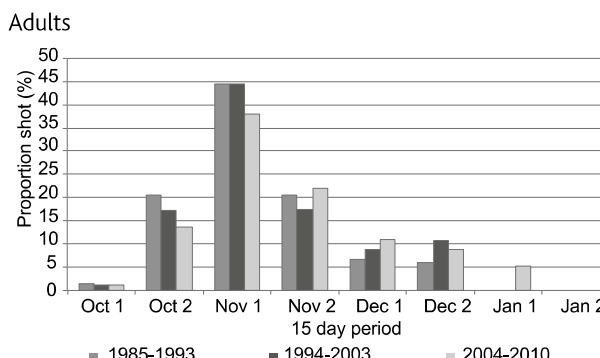
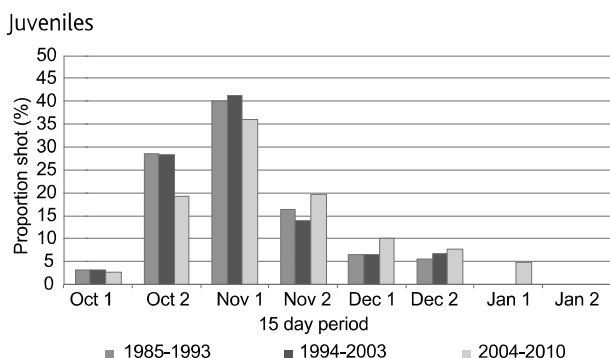


Figure 4. Temporal (half monthly) distribution of bagged juvenile (top) and adult (below) Woodcocks for the periods 1985-1993, 1994-2003 and 2004-2010.



Discussion

The number of Woodcocks shot in Denmark has shown a long-term increase since the 1950s and a more marked recent increase in the period 2000–2010. With a breeding population of 2,500–3,000 pairs in Denmark (Birdlife International 2004) and an annual Woodcock bag of 40,000–60,000, autumn hunting of Woodcocks mainly affects birds from breeding populations in Fennoscandia and European Russia passing through Denmark on migration to wintering sites in Great Britain and France (cf. Bønløkke *et al.* 2006). Although the Danish bag of Woodcocks is known to fluctuate on a year to year basis as a result of variable temperature regimes (Clausager 2006), when cold spells induce further southward migration in otherwise staging Woodcocks, the present result documents that more and more Woodcocks are shot in Denmark.

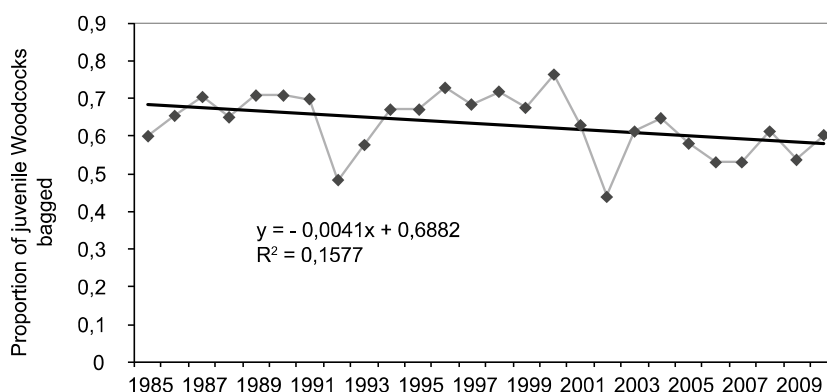
In the present analyses we did not find any relationship with the Woodcock bag size of the nine officially recorded ice-winters that have occurred since 1955 (DMI 2011). The reason for this is probably related to the time of onset of severe winter conditions, as the onset of winter (with daily minimum temperatures below zero) in most years takes place in late December or even in January. In relation to Woodcock hunting in Denmark, the onset of winter conditions in December will normally affect the period in which less than 20% of the total bag is accomplished, while onset in November will affect the period including approximately 80%, if all birds have left the country. Consequently, it will be more relevant to analyse the variation in bag size in relation to more fine-scaled temperature data that includes at least the month of November. That an early onset of winter has an effect on Woodcock hunting is exemplified by very low numbers of wings received in 2010 ($N = 876$), when severe conditions (temperatures below zero) started in mid-November, compared to high numbers of wings in 2009 ($N = 2117$), when severe conditions started in mid-December.

Overall the increase in the bag of Woodcocks may relate to either an increase in specialised Woodcock hunters or an increase in the number of encounters between hunters and Woodcocks. In the present analyses we found that the total number shot was highly correlated with the number of hunters reporting Woodcocks, and that the proportion of hunters with a Woodcock bag was increasing. In combination with an unchanged average number of Woodcocks reported per hunter, and an increase in the proportion of battue-shot Woodcocks from 17% to 25%, these results strongly indicate that the

increase in the annual bag is related to an increase in encounters between hunters and Woodcocks, rather than related to a marked increase in the number of specialised Woodcock hunters. Although there has been a slight increase in specialised Woodcock hunters in recent years, such an increase is probably small relative to the number of hunters participating in the much more commonly occurring activity of hunting parties (battues), where Woodcocks are not the primary game species. Estimated from the wing survey, the proportion of battue-shot Woodcocks is probably under-estimated and pointer-shot Woodcocks over-estimated (Clausager 2000, 2006). For the period 1985–2002, Clausager (2006) found that in the total bag, 30% and 25% of birds, respectively, were shot by battue-hunting and pointing dogs, compared with 17% and 66% in the Wing Survey. This discrepancy most probably relates to the voluntary contribution of wings to the Wing Survey by more dedicated and enthusiastic hunters, which, however, gives a biased picture of hunting activities actually undertaken in Denmark.

An increase in encounters between hunters and Woodcocks may relate to either an increased number of Woodcocks or an unchanged number of Woodcocks that have prolonged their stay, and hence are available to hunters for a longer period. Our results on the temporal change in the Woodcock bag towards an increasing number of Woodcocks shot in the late season (November–December), supports the hypothesis of Woodcocks staging longer in Denmark in recent years. However, we also found that numbers shot in October and early November tended to decline, which in combination with the increase later in the season, suggests that Woodcock migration occurs progressively later in the season, rather than reflecting a tendency for an extension of the staging period. These results favour the explanation that the number of Woodcocks passing through Denmark has increased, although it does not exclude the possibility that Woodcocks also tend to stay for longer. Whether a potentially higher number of Woodcocks in Denmark may relate to a larger proportion of an unchanged population migrating on a more northerly route as a result of climate changes, or relates to an actual increase in the Woodcock populations that pass through northern Europe is unknown. Some breeding Woodcock populations in Fennoscandia are reported as stable or slightly increasing (Birdlife International 2004), although practical difficulties in surveying breeding Woodcocks, with a reported total population of 10–25 million birds in the Western Palearctic area (Wetlands International 2006), makes population trends difficult to assess. The observed pattern of a postponed migration period fits

Figure 5. Proportion of juvenile Woodcocks in the Wing Survey 1985–2010.



the pattern predicted from behavioural responses to increasing global warming, which have been reported for other bird species in relation to changing climate conditions (Walther *et al.* 2002, Morozov 2007, Gregory *et al.* 2009, Rosenfield *et al.* 2011). To establish an effect of global warming on the migratory pattern of Woodcock will, however, need a more detailed analysis, including temperature changes in both breeding and wintering areas.

In the present study we found that the proportion of juvenile Woodcocks in the bag had declined from c. 66% before 2000 to a level of c. 58% in recent years. As reduced reproductive success is characteristic of declining populations and Woodcock populations are reported to be stable or slightly increasing, there is no obvious explanation for this change. However, a relative decline in Woodcocks bagged by hunting with pointing dogs and an increase in battue hunting, as seen in the present study, will lower the proportion of juvenile birds in the total bag towards a more fifty-fifty % ratio, as pointing dog hunting provides on average 61% juveniles and 39% adults, while battue hunting provides 52% juveniles and 48% adults.

In conclusion, the number of Woodcocks bagged in Denmark is increasing markedly, especially during the last decade. At the same time, the numbers shot are declining in the early season and increasing in the late season, indicating a gradual change in the temporal distribution of the bag, which fits with changes expected to occur as a result of global warming. The increasing bag of Woodcocks seems to be related to an increasing number of encounters between hunters and Woodcocks, while more birds are shot incidentally during battue hunting, suggesting that more Woodcocks are passing through Denmark on migration. A declining proportion of juvenile birds in the Woodcock bag indicates poor reproductive success in the flyway population, and although alternative explanations for this change may exist, it will be important to closely monitor this vital population parameter in the coming years.

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