Seventh European Woodcock and Snipe Workshop

Proceedings of an International Symposium
of the IUCN/Wetlands International Woodcock & Snipe Specialist Group
16-18 May 2011

Edited by Y. Ferrand

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Office national de la chasse et de la faune sauvage

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Scientific Committee:
A. Hoodless (Game & Wildlife Conservation Trust, Great-Britain)
D. Gonçalvès (CIBIO-*Centro de Investigação em Biodiversidade e Recursos Genéticos/Universidade do Porto*, Portugal)
Y. Ferrand (*Office national de la chasse et de la faune sauvage*, France)

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Denmark

Thomas Christensen

Estonia

Jaanus Elts
Marja Riho

France

Claudine Bastat
Jean-Paul Boidot
Yves Ferrand
Patrice Février
Francois Gossmann
Gilles Leray
Guy-Noël Olivier
Jeannette Olivier
Bertrand Piel
Sophia Zaramella

Germany

Joerg Tillmann
Joachim Wadsack

Great-Britain

Peter Bickford-Smith
Matthew Ellis
Andrew Hoodless
Adele Powell
Owen Williams

Hungary

Sándor Faragó
Denes Fluck
Kristóf Hecker
Richard László
Gergely Schally
László Szemethy

Lithuania

Saulius Svazas

Portugal

David Gonçalves
Tiago Rodrigues

Romania

Cosmin Maris

Russia

Roman Anoshin
Sergey Buslaev
Darja Cigankova
Sergei Fokin
Kyrill B. Gerasimov
Vladimir I. Golovan
Ivan V. Iljinsky
Ilia Kaplin
Marina Kudryashova
Vladimir Melnikov
Anton Mezhnev
Vasily G. Pchelintsev
Sergej Soloviev
Dmitri Vachugov
Mikhail V. Verevkin
Vadim Vysotsky
Petr Zverev

Ukraine

Volodymyr Vovchenko

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Foreword

For the first time, the Woodcock and Snipe Workshop was held in Russia, at Saint-Petersburg. The choice of this location for the seventh workshop was made for several reasons. First, during the last 20 years, a strong partnership has been established with our Russian colleagues and knowledge on Woodcock and Snipe in Russia has been greatly advanced. Russia has also been clearly shown to be an important reservoir of Woodcock and Snipe breeding populations that migrate to the wintering sites of the western and southern part of Europe. Thus, from a Woodcock and Snipe point of view, the links between these two parts of Europe are strong. The forests, marshes and meadows of Russia are clearly essential in the conservation of these species.

In total, about 50 people from 10 different countries attended the workshop.

To provide information on Woodcock and Snipe research was the main objective: 22 communications and 9 posters were presented and I believe that the results and the discussions were very interesting and useful for each of us.

The proportions of Woodcock and Snipe communications were similar, compared to previous workshops where the number of Woodcock presentations has been highest. This shows that research on Snipe has been progressing and this is very important because of the conservation problems these species face with losses and changes in their habitats.

In addition to scientific exchanges, this workshop also offered the opportunity for WSSG members to meet and improve the efficiency of our network. Indeed, our specialist group has to be able to provide up-to-date data and recommendations on the conservation of Woodcock and Snipe species. We are a part of Wetlands International and of the International Union for Conservation of Nature and this confers upon us a great responsibility as consultants on different international publications.

As Herby Kalchreuter, the previous WSSG Coordinator, promoted, we have to make hunters and conservationists work together. The presence of representatives of CIC, the Russian Federation of Hunters and Fishermen, OMPO, the International Club of Snipe Hunters, the Regional Hunters' Federation of Brittany, the French National Club of Woodcock's Hunters, the Hungarian Woodcock Club, the British Association for Shooting and Conservation showed the great interest that these organisations take in our work.

The final objective of our research has to be an applied one. Of course, we greatly need fundamental knowledge, for example to provide demographic models, to improve information on migration, on behaviour, on the ecology of our species, but we must also help hunting managers in providing information and advice.

We must work together in order to find the right way to manage Woodcock and Snipe populations and to ensure that the hunting rules we may propose are understood and well accepted by the hunters. It's one of the keys to a secure future for Woodcock and Snipe species.

I want to express my sincere thanks to the Embassy of France in Russia, the Russian Federation of Hunters and Fishermen, the CIC International and ONCFS, the French Hunting and Wildlife Agency, for their financial support in organising this workshop. Mme Elisabeth Barsacq, Consul General in Saint-Petersburg, Mr Eduard Benderskiy, President of the Russian Federation of Hunters and Fishermen and Mr Bernard Lozé, President of the CIC International, honoured our workshop by their presence.

Nothing is possible without good organisation and I would like to thank the Oasis Company, and more specifically Daria Minina and Karina Matveeva for their competence and availability. The field trip was very interesting and well organised by Ivan Iljinsky and Mikhail Verevkin whom I warmly thank.

Surely this workshop has contributed to strengthening the links between us. It was a great opportunity for many of us to meet our Russian colleagues. Thanks to the enthusiasm of each, the three days we spent together was successful and certainly profitable for developing new partnerships in the Woodcock and Snipe World.

D^{r} Yves Ferrand
Chair of the IUCN/Wetlands International
Woodcock & Snipe Specialist Group

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Woodcock

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Application of new technologies to the study of Eurasian Woodcock migration

Andrew Hoodless Game & Wildlife Conservation Trust, Burgate Manor, Fordingbridge, Hampshire, SP6 1EF, UK.
E-mail: ahoodless@gwct.org.uk
Adele Powell Edward Grey Institute of Field Ornithology, Department of Zoology,
South Parks Road, Oxford, OX1 3PS and Game & Wildlife Conservation Trust,
Burgate Manor, Fordingbridge, Hampshire, SP6 1EF, UK.
Yves Ferrand Office National de la Chasse et de la Faune Sauvage, 39 Bd Albert Einstein CS 42355,
44323 Nantes Cedex, France.
Andrew Gosler Edward Grey Institute of Field Ornithology, Department of Zoology,
South Parks Road, Oxford, OX1 3PS, UK.
James Fox Migrate Technology Ltd., PO Box 749, Coton, Cambridge, CB1 0QY, UK.
Jason Newton NERC Life Sciences Mass Spectrometry Facility, Scottish Universities Environmental Research
Centre, Rankine Avenue, Scottish Enterprise Technology Park, East Kilbride, G75 0QF, UK.
Owen Williams Woodcock Network, c/o Pantamlwg, Trefenter, Aberystwyth, SY23 4HJ, UK.

The last five years have seen a huge expansion in studies of bird movements and migration owing to rapid technological developments in techniques which provide alternatives to ringing. We give an overview of stable isotope analysis and various options for tracking migration routes of individual birds. We demonstrate that stable hydrogen isotope analysis of feathers sampled on the wintering grounds is a valid technique for assessing Eurasian Woodcock breeding origins and population composition at different sites. We present preliminary data from geolocators indicating that Woodcock undertake their migrations by making flights of 590-1,040 km interspersed with stops of 8-16 days. Flight speeds average c.30 km/h, but may reach 93 km/h. We discuss the relative merits and application of geolocators, archival GPS tags and satellite tags to the study of Woodcock migration.

Bird movements have been a subject of scientific study for at least 100 years, but human observers, in particular hunters, have been fascinated by bird migration for far longer. Put simply, the questions to which we seek answers can be summarized as where, when, why and how? The first two questions concern movements between breeding and wintering grounds and are generally addressed by observational studies of marked individuals. Good knowledge of the timing and distance of migrations is required before we can start to investigate the necessity to migrate and the mechanics of doing so, both of which require detailed knowledge of the species' ecological niche, metabolism and physiology. As well as being of academic interest, an understanding of annual migrations is important for the conservation of many birds, especially for species which are hunted.

There is increasing evidence that habitat quality and environmental conditions at wintering and breeding sites used by migratory species may profoundly influence the fitness and survival of individuals (Marra *et al*. 1998, Webster *et al*. 2002, Møller & Hobson 2003, Norris *et al*. 2003). For migratory birds, such as waders in north-west Europe, that overwinter thousands of kilometres from their summer breeding grounds, any deterioration in quality or loss of suitable stop-over sites and wintering areas is of conservation concern. For hunted species, such as the Eurasian Woodcock *Scolopax rusticola*, the cumulative level of harvest along the migratory route is another factor. However, in order to evaluate the importance of threats at stop-over sites or wintering areas at the population scale, detailed knowledge of migratory routes and linkages between breeding and wintering sites is required.

The European population of the Woodcock is estimated at 14-16 million birds, c.96% of which breeds in Scandinavia, Finland, the Baltic States and Russia (Thorup 2006). In winter (December-mid-March), the population is concentrated principally in Britain, Ireland, France, Spain, Italy and Greece, with migrant birds starting to arrive from late September to mid-October. The Woodcock is a prized quarry species in all of these countries in winter and is also hunted in most central European countries during autumn migration, as well as in Russia, Belarus and Romania when roding (Ferrand & Gossmann 2009a). Because of this widespread hunting, an understanding of migration routes, stop-over sites and timings is of conservation relevance for the species. Such knowledge is also important in evaluating the effects of changes in habitat and climate at stop-over sites and wintering areas. To better inform management and hunting policies across Europe, reliable information is currently needed on the status of Woodcock in different countries and details of their migrations. Based on available information, which is of variable quality between countries, the European population of the Woodcock appears to be stable (Ferrand & Gossmann 2009a), but the numbers of breeding Woodcock in Britain and Switzerland are believed to be declining (Estoppey, 2001, Mulhauser 2001, Gregory *et al*. 2002) and there is evidence for a low adult survival rate among Woodcock wintering in France (Tucker & Heath 1994, Tavecchia *et al*. 2002).

Current knowledge of the movements of migrant Woodcock is based on direct observations and recoveries of ringed birds. Records from bird observatories can provide an indication of first arrival dates. For instance, the first migrant Woodcock are usually seen in Scotland during the second week of October, whereas the first birds are seen in southern England and Ireland about ten days later (Hoodless & Coulson 1994). Recoveries of ringed Woodcock have been used to estimate the main breeding areas of Woodcock wintering in the UK, France and Spain (Hoodless & Coulson 1994, Wernham *et al*. 2002, Bauthian *et al*. 2007, Guzmán *et al*. 2010). However, because the majority of recoveries are through hunting (e.g. 94% of all recoveries of known cause of Woodcock ringed or recovered in Britain, Wernham *et al*. 2002), analyses are subject to regional biases in recovery probability. With the exception of France, analyses have also been based on small numbers of recoveries (<400) accumulated over approximately 100 years and hence are subject to temporal biases in ringing effort and in recovery probability, resulting from changes in hunting seasons.

It has proved extremely difficult to establish connections between particular breeding, stopover and wintering sites on the basis of recovering metal rings or re-sighting colour rings for most migratory birds. However, recent technological advances have led to a range of alternative techniques which have great potential for rapidly increasing our understanding of various aspects of bird migration. The techniques fall into three categories: (1) analysis of intrinsic markers to indicate a bird's breeding or wintering ground, (2) data loggers which store a bird's location at pre-defined intervals but require tag retrieval and downloading and (3) transmitting tags which relay positional information in near real time.

Birds carry several intrinsic markers, such as fatty acid profiles, DNA, trace elements and stable isotopes, in their tissues, which provide the potential for tracing their breeding or wintering grounds. The use of stable-isotope analysis shows most promise in the study of animal migration (Hobson 1999). Most chemical elements naturally occur in two or more stable forms, which vary in mass, known as isotopes. Among biologically important elements, the lightest stable isotope is usually about 20 times more abundant than its heavier counterpart. Differences in the relative abundances of these isotopes can be measured in a mass spectrometer and expressed as the ratio of the heavy to light form in delta (δ) notation, e.g. for carbon the ratio of ^{13}C to ^{12}C, expressed as $\delta^{13}C$, or for hydrogen the ratio of ^{2}H (deuterium) to ^{1}H, expressed as $\delta^{2}H$ or δD. For animal migration studies, variation in stable isotopes of hydrogen ($\delta^{2}H$), oxygen ($\delta^{18}O$), carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), sulphur ($\delta^{34}S$) and strontium ($\delta^{87}Sr$) have proved the most useful. The ratios of these stable isotopes vary geographically with a range of biogeochemical factors and isotope profiles in organisms reflect those in their food and environment. For inert tissues like feathers, profiles of assimilated isotopes reflect the environment in which they were grown.

Pioneering studies in North America in the late 1990s demonstrated the potential of stable-isotope analysis to increase our understanding of bird migration and its value as a conservation tool for certain species. Examination of the isotopic composition of hydrogen ($\delta^{2}H$) and carbon ($\delta^{13}C$) in feathers of neotropical migrant songbirds enabled the linking of breeding and wintering grounds, because in North America $\delta^{2}H$ in precipitation varies across the continent, being deuterium-enriched in the south-east and deuterium-depleted in the north-west and among terrestrial plants, C_3, C_4 and CAM plants have different $\delta^{13}C$ signatures, which are reflected in the tissues of insect consumers and hence in the tissues of birds eating them (Chamberlain *et al*. 1997, Hobson & Wassenaar 1997). Three studies illustrate the new insights gained by the application of stable-isotope analysis. The study by Chamberlain *et al*. (1997) on Black-throated Blue Warblers *Dendroica caerulescens* found the first evidence for mixing of individuals of this species from different breeding populations on the same wintering grounds. A study of Wilson's Warblers *Wilsonia pusilla*, sampled on wintering areas from Mexico down through central America, demonstrated a classic leap-frog migration, whereby birds breeding furthest north in North America wintered furthest south (Kelly *et al*. 2002). This was unsuspected in this species and not apparent from the limited available ring recovery data. Using hydrogen stable-isotope ratios, Hobson *et al*. (2001) were able to link populations of the declining Bicknell's Thrush *Catharus bicknelli* breeding in north-east North America with known wintering grounds in the Dominican Republic. However, the study identified a sub-population of wintering birds with more depleted stable-isotope ratios than those measured in known breeding areas and eventually two previously unknown breeding areas were located in the south-eastern part of the boreal forests of Quebec.

To date, there have been fewer studies employing stable-isotope analysis in Europe than in North America, but $\delta^{13}C$ signatures have been used to examine connectivity between European breeding populations and wintering areas in Africa. For instance, $\delta^{13}C$ values suggest that breeding populations of Barn Swallows *Hirundo rustica* in England and Switzerland probably winter in geographically distinct parts of sub-Saharan Africa (Evans *et al*. 2003). In the globally threatened Aquatic Warbler *Acrocephalus paludicola*, for which, until very recently, the wintering grounds were unknown, significant differences in $\delta^{13}C$ values in feathers between breeding sites suggested that the most north-western breeding birds moult, and possibly winter, further north in sub-Saharan Africa (Pain *et al*. 2004). This information has subsequently guided efforts to find the wintering areas of Aquatic Warblers (Walther *et al*. 2007). A correlation between $\delta^{2}H$ in the feathers of resident birds of a range of species and $\delta^{2}H$ patterns in rainfall in Europe has now been demonstrated by Hobson *et al*. (2004), opening up the possibility of studies on species migrating south-west from breeding grounds in Russia and Scandinavia.

Stable isotope data can be highly variable (e.g. Wunder *et al*. 2005, Lott & Smith 2006, Powell & Hobson 2006) and this variation has led some to question the reliability of isotopes as a tool for geographic assignment (Rocque *et al*. 2006, Farmer *et al*. 2008, Smith *et al*. 2009). Whilst the technique has the considerable advantage over ringing that birds do not need to be marked and subsequently recovered, it is apparent that the resolution of stable-isotope analysis, at least based on a single element, is limited to several degrees of latitude and longitude and hence is not suitable for geographical assignment of individual birds. Good knowledge of the timing and duration of moult is required for interpretation of isotope-ratio values and the technique is best suited to studies of population composition.

To track the migration routes of individual birds, data loggers or tags that transmit positional information via satellites are required. Two types of data loggers, geolocators and archival GPS trackers, have been refined for use in studying bird movements and increasingly used during the last five years. Geolocators work by logging time-stamped daylight levels at regular intervals of two to ten minutes, from which the time of sunset and sunrise can be determined and hence latitude and longitude at midday and midnight can be deduced (Hill 1994). In good conditions, the accuracy of positional fixes can be to within 150 km of the true location, although latitudinal information can be very inaccurate for three to four weeks around the equinoxes (Fudickar *et al*. 2012). Geolocators are small and lightweight (currently as low as 0.6 g), but have the disadvantage that they need to be retrieved to download the data. Nevertheless, they have been used successfully to document complete migratory tracks for several bird species over long distances, e.g. Wood Thrush *Hylocichla mustelina* from North America to southern Mexico and Central America and Arctic Tern *Sterna paradisaea* from Greenland to Antarctica (Stutchbury *et al*. 2009, Egevang *et al*. 2010). They are increasingly providing novel insights into the migrations of waders (e.g. Niles *et al*. 2010, Klaassen *et al*. 2011, Minton *et al*. 2011, Johnson *et al*. 2012). GPS trackers employ a GPS receiver and antenna to estimate the position of the unit from orbiting satellites and store it to flash memory at preset intervals, in exactly the same way as in handheld GPS units used for recreational pursuits and in vehicle satellite navigation systems. Until 2010, GPS loggers were too large and heavy for use on birds below 500 g, but recent miniaturization and the incorporation of solar charging have resulted in units more suited to smaller birds. GPS loggers are capable of recording very accurate locations (<15 m) but, as with geolocators, they need to be retrieved in order to download the data.

Satellite telemetry has the advantage over data loggers that, as well as providing reasonably accurate locations, it permits the tracking of animals in near real-time. Satellite telemetry utilizes a platform transmitter terminal (PTT) which sends an ultra high frequency (401.650 MHz ± 30 KHz) signal to satellites belonging to the Argos system, a global satellite-based location and data collection system (http://www.argos-system.org). These polar-orbiting satellites orbit at 850 km above the earth's surface picking up signals, storing them and relaying them back to earth. Receiving dishes on earth relay the transmitted data to processing centres and the tag location is estimated from the difference between transmitted and received frequencies, based on the Doppler effect. The accuracy of each location estimate is dependent on the number of satellites detecting the tag during each transmission period. Until recently, the use of satellite telemetry on birds has been limited by tag size, but in 2006 a solar-powered 9.5 g PTT was produced and a 5.0 g PTT is now available.

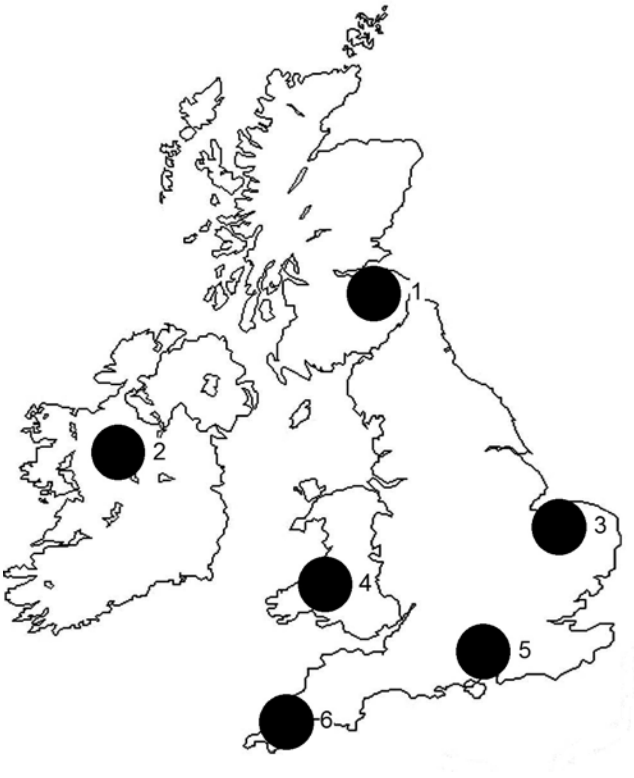
The aim of this paper is to describe some initial results from a collaborative study employing stable isotope analysis and geolocators to gain a better insight into the origins and migration routes of Woodcock wintering in Britain, Ireland and France. We discuss problems particular to Woodcock in using current technology to study aspects of migration, assess the relative merits and cost-effectiveness of alternative techniques and highlight areas for future development.

Methods

Feather collection

A total of 135 innermost primary feathers were collected during mid-April to September (2002-2010) from 29 breeding locations across Norway, Sweden, Finland, Estonia, Latvia, Belarus, Russia, Germany, Spain and the UK. Birds were aged as adults or first-years according to Ferrand & Gossmann (2009b). In winter, wings from 1,129 Woodcock shot by hunters in six wintering areas across Britain and Ireland during December and January in four winters (2004/5, 2008/9, 2009/10, 2010/11) were selected for analysis. Samples were collected in Scotland (Borders, Fife), Wales (Ceredigion, Pembrokeshire), Ireland (Roscommon) and the English counties of Norfolk, Hampshire and Cornwall (***Figure 1***).

Figure 1. Locations of the six sampling areas of Woodcock feathers in winter (1 Scottish Borders, 2 Roscommon, 3 Norfolk, 4 mid-Wales, 5 Hampshire, 6 Cornwall).



Stable-isotope analysis

Samples were taken from the distal tip of the first primary as this is the first feather to be moulted by adults and the one most likely to have a stable-isotope ratio representative of the breeding area. Only fully grown feathers were used to ensure that all samples were metabolically inert. The barbs along the vane of each feather were sampled and the rachis avoided, owing to the ^{2}H depletion of the latter (Wassenaar & Hobson 2006).

Analysis of stable-hydrogen isotopes was undertaken at two laboratories, Iso-Analytical, Cheshire, UK and NERC LSMSF, East Kilbride, UK, following standard but slightly different analytical protocols. Feather samples were washed (Iso-Analytical: 0.25M sodium hydroxide solution, NERC LSMSF: 2:1 chloroform: methanol solution) and dried. Sub-samples of 0.1 mg (±20%) were then weighed into silver capsules and left open for a period of not less than 4 days alongside several keratin standards to allow exchangeable hydrogen in sample chitin to fully equilibrate with moisture in the laboratory air.

At Iso-Analytical, the technique used for analysis was EA-IRMS (Elemental Analyser – Isotope Ratio Mass Spectrometry). Samples and references were dropped into a furnace at 1080 °C and thermally decomposed to H_2 and CO over glassy carbon. Any traces of water produced were removed by magnesium perchlorate and any traces of CO_2 formed were removed via a Carbosorb trap. H_2 was resolved by a packed column gas chromatograph held at 35°C. The resultant chromatographic peak entered the ion source of the IRMS where it was ionised and accelerated. Gas species of different mass were separated in a magnetic field, then simultaneously measured on a Faraday cup universal collector array. At the NERC LSMSF, samples were reduced at high temperatures using flash pyrolysis and stable hydrogen isotope ratios were obtained using EA-IRMS, employing high temperature conversion (Thermal Conversion/Elemental Analyser (TC/EA); ThermoFisherScientific, Bremen, Germany) coupled to a Delta V isotope ratio mass spectrometer (ThermoFisherScientific, Bremen, Germany).

Both laboratories used as one of the keratin standards BWB-II (bowhead whale baleen) with a known non-exchangeable $\delta^2H_{V\text{-}SMOW}$ value of -108 ± 4 ‰. At Iso-Analytical, IA-R002 (mineral oil) calibrated against NBS-22 (mineral oil, International Atomic Energy Agency reference standard), IAEA-CH-7 (polyethylene foil) and egg shell membrane were also included as standards. At NERC LSMSF, additional standards were CFS (chicken feather standard), ISB (Icelandic seabird – Black-legged Kittiwake, *Rissa tridactyla*) and WG (Willow Grouse *Lagopus lagopus* feathers). Stable-isotope ratios were corrected using the frequently adopted comparative steam equilibration procedure (Wassenaar & Hobson 2003). There was a significant 1:1 correlation between feather δ^2H values estimated for the same samples at the two laboratories ($r_{18} = 0.87, P<0.001$).

Interpretation of isotope data

The samples from known breeding sites were used to examine the relationship between δ^2H in Woodcock feathers and in precipitation. Preliminary analysis involved checking for a difference in feather δ^2H values (δ^2H_f) between first-year and adult Woodcock, using analysis of variance (ANOVA) with bird age and sampling location as factors. Relationships between δ^2H_f values and latitude and longitude were examined with analysis of covariance (ANCOVA) incorporating bird age as a factor. Precipitation δ^2H values (δ^2H_p) at each of the sampling locations were determined using the online isotopes in precipitation calculator (Bowen *et al.* 2005, http://wateriso.eas.purdue.edu/waterisotopes/pages/data_access/oipc.html). Relationships between δ^2H_f and mean annual (MAD) and detrended growing season (GSD) δ^2H_p values were examined separately using ANCOVA with bird age as a factor. Growing season δ^2H_p values used for first-year birds were the mean of May and June values for the UK and Spain, June values for Norway and Germany and the mean of June and July values for Sweden, Finland, Russia and the Baltic States. Growing season δ^2H_p values for adult Woodcock were taken as the mean of August and September values for all regions. Relationships for predicting δ^2H_p from δ^2H_f were estimated using reduced major axis regression because both variables were measured on the same scale and both subject to measurement error (Sokal & Rohlf 1981).

Differences in likely origin of samples collected in winter were examined using ANOVA with δ^2H_f values as the dependent variable and winter and sampling region as factors. For estimation of the breeding areas of Woodcock sampled in each winter location, we used a likelihood-based assignment that incorporated estimates of uncertainty combined with prior probabilities generated from ring recoveries (Van Wilgenburg & Hobson 2011).

Geolocators

During February and March 2010, 23 Woodcock were fitted with 1.5 g geolocators with the light sensor on a 25 mm stalk (Mk14-S model, British Antarctic Survey, Cambridge, UK) on the Lizard Peninsula, Cornwall (50°03′ N, 5°07′ W). In March 2011, a further 28 birds were tagged at the same site. Geolocators were mounted at the base of the spine using a Rappole-Tipton (1991) style leg-loop harness made from 1.5 mm diameter elastic threaded through 'Silastic' medical-grade silicone tubing. This study site was chosen on the basis that we knew from previous ringing that Woodcock wintering there exhibited high site fidelity and there is also relatively high shooting pressure (Hoodless 1994). In Brittany (average location: 48°00′ N, 2°50′ W) in March 2010, 25 Woodcock were fitted with the same model of geolocator using a wing-loop harness of 1.5 mm diameter elastic crimped over the sternum and a further 13 geolocators were deployed at the same site in March 2011. Our calculations indicated a 15-20% chance of tag retrieval at these sites.

Data from geolocators retrieved in subsequent winters were downloaded and analyzed using BASTrak v16 software (British Antarctic Survey, Cambridge, UK). Sunrise and sunset threshold values of 20 corresponding to a sun angle of -4°, produced least uncertainty for the calibration location. A minimum dark period filter set at four hours was applied and then the estimated time of each sunrise and sunset was manually verified. Movement compensation was applied in BASTrak and both midnight and noon locations were used to estimate the trajectories of birds. Latitude and longitude estimates from BASTrak were imported into MapInfo v11.0 (Pitney Bowes Software, Connecticut, USA) with a WGS84 projection for the calculation of distances flown.

Stopovers and breeding locations were typically represented by clusters of points and these were consolidated into a single point by calculating the centroid location. We plotted flights as a series of 12-hour sections and produced maps of spring and autumn migration tracks for individual birds. For each flight between stops along the track (hereafter termed a 'stage'), we estimated the bird's ground speed from the total distance flown. The duration of stages varied from 12 hours to 72 hours. The only precise geographic locations in this paper are the GPS coordinates where the geolocators were deployed. Given the positional error associated with geolocation estimates (±50 km to ±300 km in other studies, Minton *et al.* 2010, 2011, Fudickar *et al.* 2012), other locations (stopovers and breeding sites) must be regarded as approximate. We considered only movements of more than 150 km in 12 hours as migratory flights and attributed any shorter distance positional shifts to geolocation error.

Results

Feather stable isotopes as breeding origin markers

It was apparent from the raw known-origin data that feather δ^2H values (δ^2H_f) were more deuterium depleted in first-year birds than adults. Controlling for sampling site, the difference averaged 28 ‰ (permil) (adults -57.35 ± 1.71 ‰, first-years -85.41 ± 1.81 ‰, ANOVA bird age $F_{1,106} = 176.16$, $P < 0.001$, sampling site $F_{27,106} = 6.15$, $P < 0.001$). Feather δ^2H values were significantly related to both latitude and longitude and the slopes of the relationships were similar for adult and first-year Woodcock (ANCOVA latitude $F_{1,131} = 7.79$, $P = 0.006$, longitude $F_{1,131} = 32.80$, $P < 0.001$, bird age $F_{1,131} = 192.54$, $P < 0.001$, latitude x bird age $F_{1,129} = 0.64$, $P = 0.426$, longitude x bird age $F_{1,129} = 3.46$, $P = 0.065$).

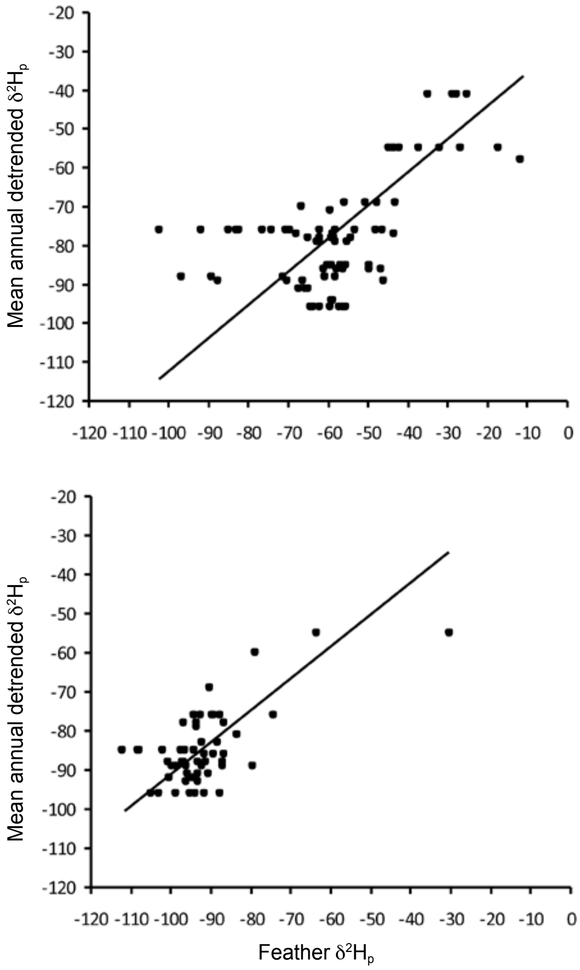
There was a significant relationship between the δ^2H_f values of known origin samples and growing season δ^2H_p values, with slopes similar for first-year and adult Woodcock (ANCOVA GSD δ^2H_p $F_{1,132} = 62.28$, $P < 0.001$, bird age $F_{1,132} = 241.39$, $P < 0.001$, GSD δ^2H_p x bird age $F_{1,131} = 0.75$, $P = 0.387$). There was a similar relationship between δ^2H_f and mean annual δ^2H_p (ANCOVA MAD δ^2H_p $F_{1,132} = 76.99$, $P < 0.001$, bird age $F_{1,132} = 179.32$, $P < 0.001$, MAD δ^2H_p x bird age $F_{1,131} = 0.35$, $P = 0.553$). Mean annual δ^2H_p and bird age explained slightly more of the variation in δ^2H_f than the relationship including growing season δ^2H_p and bird age ($r^2 = 0.73$ compared with $r^2 = 0.71$). Reduced major axis regression relationships for predicting mean annual δ^2H_p from δ^2H_f (***Figure 2***) were:

Adult	MAD $\delta^2H_p = 0.828\ \delta^2H_f - 27.962$
First-year	MAD $\delta^2H_p = 0.828\ \delta^2H_f - 10.479$

Breeding origins of Woodcock wintering in Britain and Ireland

Estimated MAD δ^2H_p values from Woodcock sampled in winter differed significantly between sampling regions but not between winters (ANOVA region $F_{5,1120} = 10.64$, $P < 0.001$, winter $F_{3,1120} = 1.95$, $P = 0.120$, ***Figure 3***). The data suggest a high degree of mixing amongst Woodcock originating from Scandinavia, Finland, Russia and the Baltic States across all six wintering areas, but there is an indication of broadly parallel links between the core breeding regions associated with each wintering area. A high proportion of the Woodcock wintering in Scotland and Ireland come from central and northern Scandinavia, whereas in southern England a higher proportion of birds originate from southern Sweden and the Baltic States (***Figure 4***).

Figure 2. Relationships between stable hydrogen isotope ratios in precipitation (δ^2H_p) and in feathers (δ^2H_f) at 29 breeding locations across Europe for adult (top) and first-winter (bottom) Woodcock.



Overall, we estimated that approximately 51% of the Woodcock wintering in Britain and Ireland come from north-western Russia and the Baltic States, 39% from Scandinavia and Finland, with only 10% from central Europe, Britain and Ireland. Woodcock attributed to central European breeding grounds constituted only 2% of the wintering birds in Scotland ranging to 19% in Hampshire.

Migration timings and routes estimated from geolocators

Of the geolocators fitted in February/March 2010, four were recovered on the Lizard Peninsula during the winter of 2010/11 and one in winter 2011/12. Two were recovered in Brittany during winter 2010/11. Two of the geolocators fitted in March 2011 were recovered on the Lizard Peninsula during winter 2011/12 and one was recovered in Brittany. This equates to an 11% recovery rate, although there is a chance that further loggers will be recovered in future years. All of the tags recovered in Cornwall were from birds killed on shoots, whereas the three in Brittany were retrieved by recapturing live birds. Complete data were downloaded from nine of the tags, but the data from one were partially corrupted. Position fixes were not obtained for every day because shading by vegetation caused noise on the light curve at dawn or dusk, but this was mainly an issue during June-August. During the migration periods the light data were relatively clean. Shading, probably by the birds' plumage, rendered the data from the two tags retrieved in Brittany in winter 2010/11 unusable. Latitudinal data were very obviously inaccurate for about three weeks before and after the equinoxes, but longitudinal data were unaffected at these times. The data were sufficient to identify stopover locations, breeding areas and overall journey times.

We present results from the first four geolocators recovered in Cornwall during winter 2010/11. All departed between 22 and 30 March and these birds travelled total distances of 4,100-8,660 km in a year, with three breeding in western Russia and one in Norway (***Table 1***). They reached their breeding sites between 9 April and 13 May and were all back in Cornwall by 28 November. Birds travelled 158-2,472 km between stops, with flights lasting 12-72 hours. Average minimum flight speeds were 24-33 km/h, but maximum speeds for 12-hour sections during flights were 60-93 km/h. There was no difference in stage distance or flight speed between spring and autumn migrations (stage distances: spring 855 ± 183 km, autumn 645 ± 111 km, ANOVA season $F_{1,30} = 1.31$, $P = 0.261$, bird $F_{3,30} = 0.74$, $P = 0.539$; stage speed: spring 32 ± 5 km/h, autumn 28 ± 3 km/h, ANOVA season $F_{1,30} = 1.01$, $P = 0.323$, bird $F_{3,30} = 0.89$, $P = 0.458$). The Woodcock made 1-5 stops on their spring migrations and 2-6 stops during their autumn migrations. Stopovers varied in duration between 1 and 37 days, but mean duration did not differ between spring and autumn (9 ± 3 days and 12 ± 3 days respectively, GLM season $F_{1,20} = 1.28$, $P = 0.271$, bird $F_{3,20} = 0.61$, $P = 0.618$).

Figure 3. **Distributions of stable hydrogen isotope ratios in precipitation (δ^2H_p) estimated from feathers for the six winter sampling locations. Data for adults and first-year birds were first pooled after subtraction of the mean difference in δ^2H_f values between age classes from first-year values.**

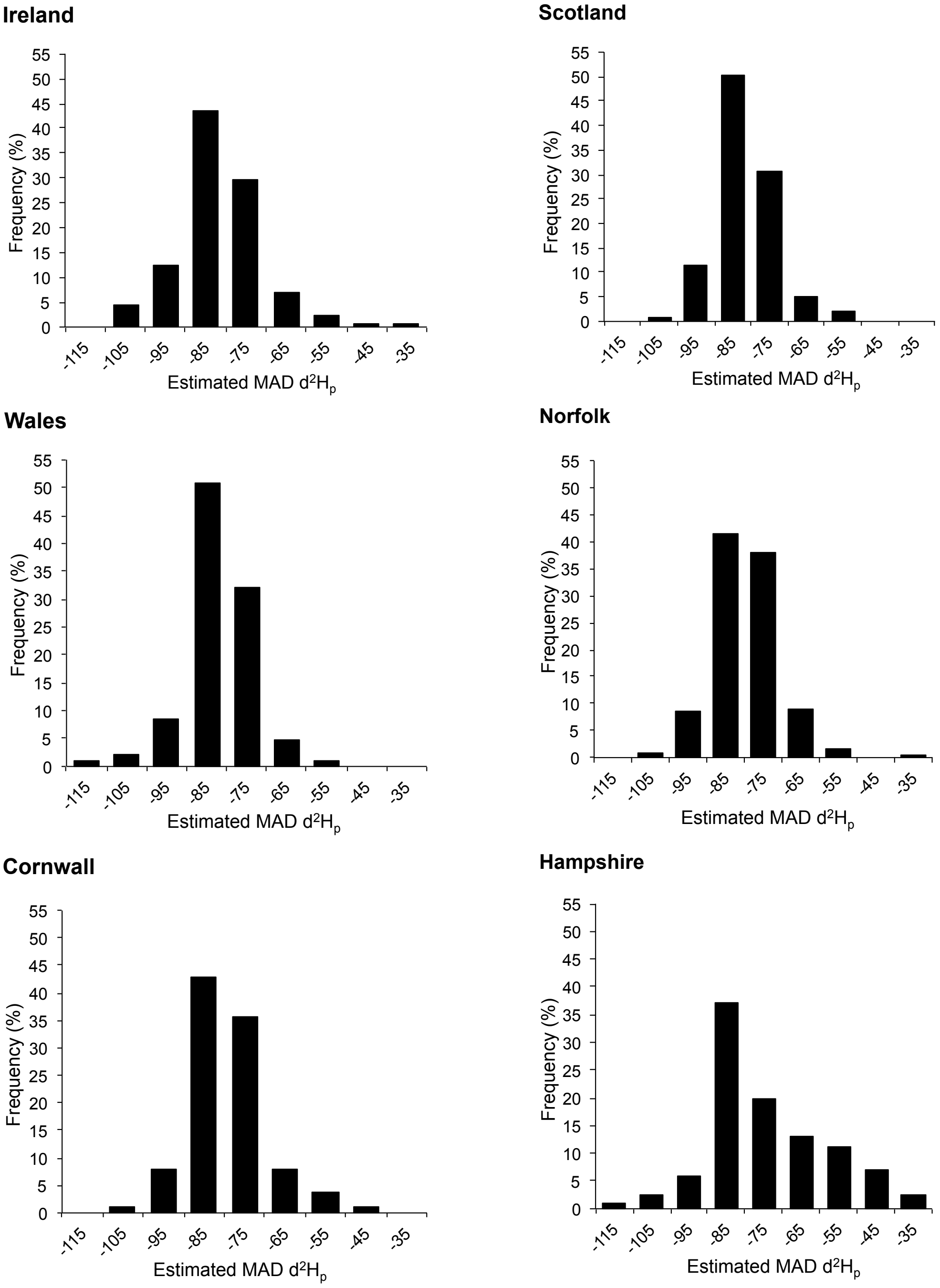
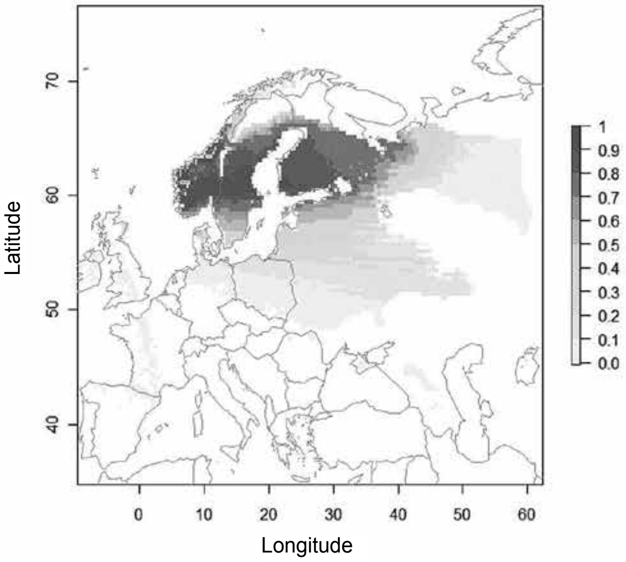


Table 1. Summary of migration timings, destinations, distances and stopovers for four woodcocks fitted with geolocators in Cornwall during February/March 2010 that returned to the same site in November 2010. A stage is defined as a continuous flight between stops.

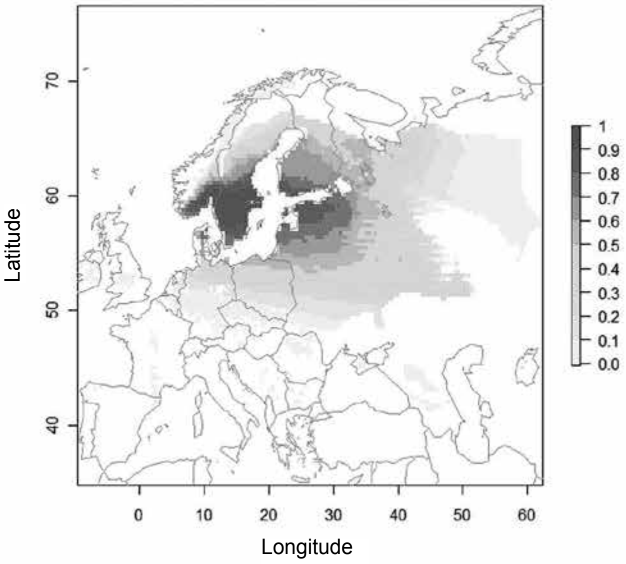
Bird ID	Spring migration dates and stopovers	Autumn migration dates and stopovers	Breeding location	Total distance travelled (km)	Mean distance per stage (km) ± SE	Mean stage speed (km/h) ± SE	Mean stopover duration (days) ± SE
9824	30 March – 22 April, 3 stops	1 October – 28 November, 6 stops	Saransk, Mordovia province, Russia	8658	787 ± 118	31.4 ± 5.9	8 ± 3
9815	26 March – 9 April, 1 stop	27 October – 28 November, 3 stops	Roslavl, Smolenskaya province, Russia	6244	1041 ± 380	33.3 ± 2.4	10 ± 3
9817	24 March – 13 May, 5 stops	7 October – 26 November, 3 stops	Demyakhi, Tverskaya province, Russia	6718	611 ± 153	23.9 ± 4.8	11 ± 4
9811	22 March – 11 April, 2 stops	20 August – 5 November, 2 stops	Gjovik, Oppland, Norway	4096	585 ± 101	32.6 ± 6.9	16 ± 7

Figure 4. Examples of breeding origin maps determined from stable hydrogen isotope analysis of Woodcock primary feathers, showing the breeding areas of adult Woodcock wintering in Scotland and in Norfolk. The scale is a percentage probability, with darker grey areas indicating the highest likelihood of origin.

(a) South-east Scotland



(b) Norfolk



Discussion

Stable isotopes

Since the first pioneering studies in 1997, stable isotope analysis has been increasingly used to improve our understanding of bird migration (e.g. Marra *et al.* 1998, Wassenaar & Hobson 2000, Hobson *et al.* 2004, Mehl *et al.* 2005). It has provided new and important insights into the movements of species that are difficult to detect or were previously poorly studied (e.g. Hobson *et al.* 2010, Reichlin *et al.* 2010). We expected δ^2H_f values from breeding season Woodcock feather samples to show good correspondence with known geographical patterns of δ^2H_p values because a high proportion of the Woodcock diet consists of earthworms (50-85% by weight, Granval 1987, Hoodless & Hirons 2007) and water constitutes c.90% of an earthworm. The form of the relationship derived here could be further validated by the inclusion of feather samples from central Europe and France. Few stable isotope studies have tested for age differences in δ^2H_f values, although two recent studies have recorded differences in values between age classes for Ovenbirds *Seiurus aurocapilla* and Pectoral Sandpipers *Calidris melanotus* (Haché *et al.* 2012, Yohannes *et al.* 2012). Our work shows that accurate ageing of Woodcock is important for the correct interpretation of breeding origins from δ^2H_f values, owing to a consistent difference in values between adult and first-year birds across the breeding range. We do not know the reason for this difference, but the most plausible explanation is the difference in timing of growth of the primary feathers. It is possible that a lower proportion of earthworms in the diet of chicks during their first ten days of life might also contribute to the difference in δ^2H_f values.

The similarity of relationships for MAD δ^2H_p and GSD δ^2H_p with δ^2H_f is probably explained by the fact that Woodcock eat invertebrates, particularly earthworms, whose tissues are formed over a longer time than those of seasonal plants, which comprise the main food of some bird groups. Hobson *et al.* (2004) found similar relationships with MAD δ^2H_p and GSD δ^2H_p in Europe, based on δ^2H_f of a mixed sample of feathers from 25 species. The slopes of the relationships between δ^2H_f and MAD δ^2H_p derived by Hobson *et al.* (2004) and here for Woodcock are both close to one (1.13 and 0.83 respectively), but use of the general relationship would have resulted in estimates of Woodcock origins being shifted north.

Owing to the magnitude of error associated with the relationships between δ^2H_f and δ^2H_p, stable isotope analysis is not appropriate for determining the breeding site of an individual bird, but, with a large sample size, it is suitable for estimating breeding range at the population level. Currently in Europe, δ^2H_f data are best used in combination with additional information to refine the estimation of breeding origins. We used ring recoveries and hence our analysis is still partly prone to the biases inherent in using ring recovery data alone. An alternative may be to obtain data on isotopes of additional elements, although those which are biologically relevant tend to vary over much shorter distances and continental gradients have not been documented in same way as for hydrogen. The identification and use of genetic markers which vary across the breeding range might hold more promise (Trucchi *et al*. 2011). Methods for dealing with spatial and analytical errors in stable isotope data are also continually being developed (e.g. Wunder & Norris 2008).

Hydrogen isotope data have provided far greater detail on the origins of migrant Woodcock wintering in particular areas of Britain and Ireland than was previously available. They suggest considerable mixing of birds from different breeding areas across the six wintering areas sampled. This is not surprising given that the distances between winter areas were only in the low hundreds of kilometres. Nevertheless, the indication of broadly parallel north-east to south-west links between the centroid breeding locations associated with each wintering area fits findings from ring recoveries in France, which strongly suggest that the bulk of Woodcock wintering there originate from western Russia, centred near Moscow. It would be interesting to extend the feather sampling across the winter range of Woodcock to gain a better insight into the breeding areas of birds wintering in Spain, Italy and Greece, for example.

An understanding of the degree of mixing of breeding populations across the winter range is important in understanding long-term population persistence. The relatively low connectivity found in Britain and Ireland suggests that habitat destruction, severe weather events or excessive harvesting at a particular breeding or wintering site are unlikely to have regional repercussions at the other end of the migration route. One of the major advantages of stable isotope analysis over ringing is that it could be repeated on large samples of birds at intervals in the future to provide measures of change in migratory origins in response to climate change, for instance. Ringing will continue to be important to provide complementary information, not only on accurate breeding and wintering locations, but on the timing of movements and even likely migration routes (e.g. Bauthian *et al*. 2007, Guzmán *et al*. 2011).

Geolocators

Geolocators employ a traditional method but they are lightweight and hence easily carried by birds the size of Woodcock. Our data to date suggest that a recovery rate of at least 11% is achievable if the site of deployment is chosen carefully. Validation tests with static geolocators have shown that they are capable of yielding location estimates of reasonable accuracy, even in woodland (mean error ± 95%CI, latitude 201 ± 43 km, longitude 12 ± 3 km, Fudickar *et al*. 2012). Despite shading of the sensor resulting in loss of data for some days, sufficient data were obtained for each of the retrieved geolocators to estimate plausible migration tracks. The biggest issue was inaccurate latitudinal data around the equinoxes: our data suggest that latitudinal errors occur for about six weeks around each equinox and, based on latitudes before and after the equinoxes, we believe that the errors for our tagged birds were of similar magnitude to those in the tests of Fudickar *et al*. (2012). Some latitude estimates in autumn reached 90°N and latitude data were typically unusable for about 30 days around the equinox. Unfortunately this coincides with the peak of Woodcock migration departure in spring but, in most cases, autumn migration commences at least two weeks after the equinox.

The geolocators revealed that departure of migrant Woodcock from Cornwall was fairly synchronous in late March. The destinations of the birds tagged at the same time on the same site confirmed the finding from the stable hydrogen isotope data that there can be a high degree of mixing of Woodcock from different breeding grounds on the same wintering site. However, unpublished data from Cornwall and evidence from Ireland suggest that migrants are faithful to wintering sites between years (Wilson 1983, Hoodless 1994). This implies that once juvenile Woodcock have found a suitable site during their first winter, probably as a result of innate behaviour and the influence of prevailing weather conditions, they are likely to return to it in subsequent winters.

Our data indicate that Woodcock only spend a small proportion of their migrations in flight, typically making flights of 650-850 km over 24 hours, followed by stops averaging 9-12 days. The distances covered during some 12-hour flight sections strongly suggest that Woodcock are flying during the day as well as at night during parts of their migration. In some cases the flight speeds presented are likely to be minimum estimates, because birds will not have been flying for the full 12 hours over which the distance covered was measured. It is apparent from some of the speeds calculated for 12-hour sections of flights that Woodcock are able to fly at up to 93 km/h, which equals the fastest speeds documented for other waders (e.g. Klaassen *et al*. 2011).

Interpretation of light level data from geolocators could be improved with further evaluation of geolocators in different habitats and different weather conditions across a range of latitudes. Different models and analytical techniques are now emerging, the performance of which should be compared. Template fit methods of analysis, which employ a model using algorithms based on the theoretical and empirical shapes of sunrise and sunset transitions, produce an estimate of location error and have been shown to be 26% more accurate than threshold estimation methods for location estimation on California Sea Lions *Zalophus californianus* equipped with both GPS tags and geolocators (Ekstrom 2004, http://lotek.com/template-fit.pdf). However, the same may not be true for fast-moving birds and currently data for evaluation do not exist on double-tagged birds. Ideally validation data should be obtained from Woodcock fitted with both a geolocator and a radiotag in mid-winter and during the breeding season, so that the effects of behaviour and habitat use near dawn and dusk can be assessed.

GPS tags and satellite tags

Geolocators are not the only type of tags capable of delivering information on migration routes and timings. Both archival GPS loggers and satellite tags are small enough to be carried by Woodcock. To date, GPS loggers have been used mainly in studies of small-scale bird movements over short durations where individuals are returning to a predictable location, e.g. pigeon homing behaviour and seabird foraging (Flack *et al*. 2012, Harris *et al*. 2012). Locations are very accurate (typically <15 m), but to store position fixes at daily intervals for a year requires solar charging of the internal battery. Like geolocators, these tags need to be retrieved to download the data but, compared to geolocators, they are more expensive and heavier explaining their very limited use in migration studies.

The major advantage of satellite telemetry over other techniques is that the tags transmit a signal enabling their position to be calculated and relayed within hours, hence permitting tracking of birds over long distances in near real time, without the need to ever recapture them. Studies involving satellite tags on Woodcock in recent years have provided some amazing insights into their migrations. Satellite tags were first trialled on Woodcock in Spain, where a team from the Club de Cazadores de Becada have followed Woodcock from the Basque region to the Baltic and have tracked one bird there and back in two consecutive years (Pérez *et al*. 2012, http://rtvs.ccbp.org/index.php). One bird tagged in March 2010 made an unexpected and astonishing flight of over 6200 km to breed in Siberia, central Russia. In Scotland, two Woodcock tagged by Roy Dennis on Islay, Scotland in March 2009 undertook quite different migrations, again demonstrating mixing of migrants at wintering or passage sites. One of these birds crossed mainland Scotland and the North Sea to a breeding site in Norway, taking two weeks to get there. The other made its way to north-west Russia, first flying south through northern England, across to Germany and then through Latvia and Estonia, finally reaching its breeding site two months later (http://www.roydennis.org/birds/index.asp?id=135). In 2012, the Game & Wildlife Conservation Trust (GWCT) tagged 12 woodcocks across Britain and obtained good information on breeding sites for 11 of these birds (http://www.woodcockwatch.com). With Dennis' data it suggests that birds wintering further north in Britain tend to originate from breeding sites further north in Europe and that migration routes to wintering areas are broadly parallel, even though the distance to breeding sites along the routes varies. As with the Spanish study, one of these Woodcock travelled far further east than expected, settling in Krasnoyarsk Krai province, Russia (58°N, 91°E) on 15 May, having crossed the Urals and travelled a distance of 6,300 km from Cornwall.

Despite the exciting insights provided by satellite tags, the smaller models, as deployed on Woodcock, rely on solar charging of a lithium battery and only transmit on a duty cycle of 10 hours on, 48 hours off to conserve power. This inevitably means that some information on the position of the bird's trajectory and maximum flight speed is lost. Given that Woodcock are able to fly up to c.1,000 km in 12 hours, as evidenced by geolocators, a lot of detail on the migration routes of some birds may be missed. Added to this the fact that the tags do not always charge sufficiently to transmit during every duty cycle, owing to Woodcock using dense, shaded habitats, it is apparent that these tags do not provide complete information on bird movements. Furthermore, the accuracy of position fixes delivered by satellite tags varies according to the number of satellite passes on which a tag is detected. Three or four passes result in accuracy of 150 m–1.5 km (location classes 0-3), but fewer passes provide position estimates of unknown accuracy (location classes A and B). In the GWCT data, c.60% of locations fall into classes A and B, although scrutiny of datasets containing fixes of variable accuracy has indicated that class A locations are often of comparable accuracy to class 1 locations (Hays *et al*. 2001). For Woodcock, class A locations have been estimated to be accurate to within 6 km and class B locations to within 10 km, making them usable (http://www.euskonews.com/0484zbk/gaia48404en.html).

Approaches to tracking Woodcock migration

None of the technologies currently available are perfectly suited to tracking Woodcock migration. All rely on the tag being exposed to sunlight which is not heavily obscured by vegetation, either for the estimation of location (geolocators) or for recharging internal batteries (GPS loggers and satellite tags). The behaviour and habitats used by Woodcock inevitably make this an issue affecting the quality of data returned. The merits, cost and data likely to be obtained for each type of tag need to be carefully assessed before embarking on a study (***Table 2***). Using assumptions based on data collection to date, it is possible to calculate the relative costs of obtaining a one-way track between a winter site and breeding ground or vice-versa.

Table 2. **Relative specifications and costs of geolocators, archival GPS tags and satellite tags suitable for use on Eurasian Woodcock.**

	Geolocator	Archival GPS	Satellite tag
Dimensions (mm), excluding light stalk or antenna	20 x 9 x 5	35 x 18 x 16	24 x 14 x 8 or 38 x 17 x 12
Weight (g)	0.6–1.6	4.0-13.0	5.0 or 9.5
Power source	Dry cell	Solar charging	Solar charging
Tag life (years)	1-2	3-4	3-4
Best location frequency	2/day	1/day	1/3 days
Location accuracy	Latitude 150 km, Longitude 100 km	<15 m	150 m – 10 km
Data availability	Download required	Download required	Every 3 days
Cost per tag (€)	150-280	870-3,720	Tag 2,510-2,840 Data c.750/annum

Based on the lowest cost within the range for each tag type, the assumption of similar recovery rates between geolocators and GPS loggers and estimates of, on average, data returned on a one-way track for every four geolocators or GPS tags deployed and for 1.30 tracks per satellite tag deployed, our assessment is that geolocators are currently most cost effective (€600 per track), although the data are of low accuracy, with GPS loggers (€3,480) and satellite tags (€3,485) closely matched.

Although GPS loggers are far more accurate than geolocators or satellite tags and now work well under a woodland canopy, those from specialist manufacturers are currently not a cost effective option because the cost is similar to that of satellite tags and there is greater risk in obtaining the data. However, if a GPS tag could be developed that could be powered for a year from a battery that did not require solar charging, this type of tag might be the best solution to delivering high quality data throughout the year. GPS devices as light as 15 g (equivalent to 5.5% of lowest male Woodcock breeding season weight) are cheaply available as consumer devices and within a few years it seems likely that these will be small enough to be customized for bird tracking without resorting to a specialist manufacturer.

It should be borne in mind that with a low probability of tag recovery it is possible that data obtained from geolocators or GPS tags is biased because only successfully returning birds can provide tracks. To obtain the best return on investment in geolocators or GPS tags the deployment site and strategy need to be chosen with care. To maximize the recovery rate of tags, sites should be regular wintering destinations rather than passage sites or those frequented only in certain weather conditions. This is not to say that data from birds on passage are not interesting, but that more careful timing of tagging and recapture effort will be required. In any situation, ringing should ideally be undertaken for at least two winters prior to tag deployment to estimate site fidelity and likelihood of recapture. The proportion of birds tagged at a site is important, especially if tag retrieval is dependent on live recaptures. If funding only permits use of small numbers of tags (<25), deploying them all at one site with a moderate density of birds, rather than across several sites or at a single high density site, is the best option to maximize retrieval rate. Retrieval rate should then be related to recapture effort. If retrieval is dependent solely on shooting recoveries, the number of tags returned is simply a function of the number deployed and the harvest rates at deployment sites. Current innovations include the development of a VHF data download facility (at distances of up to 500 m) for geolocators and GPS loggers, avoiding the need to recapture the bird, but this will add to the size and weight of the tag. It is unlikely that such tags will be small enough for Woodcock within the next three years.

The rapid and sustained development of tracking technologies over the last five years has led to a huge expansion in migration studies on smaller birds and opened up exciting possibilities for learning about Woodcock movements. Future developments are likely to lead to improvements in the quantity and quality of data obtained. However, there is still a need for researchers to focus clearly on the questions being asked and consider the limitations of current techniques in providing the answers. In some instances, the best approach may be to apply more than one technique in combination to address different aspects of a topic. Some questions may still be best answered by increasing ringing effort. With more data it should be possible to start to understand the "how" and "why" of migration, e.g. the effects of weather on routes taken, rather than simply the "when" and "where". Increased dialogue and collaboration between researchers in different parts of the wintering and breeding ranges will be important because the best understanding of migration patterns and strategies will be obtained from a co-ordinated approach. All tracking studies on Woodcock to date have involved tagging birds on the wintering grounds, but obtaining a complete understanding of migration routes will require the tagging of birds on different breeding grounds too.

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Woodcock breeding population survey in the Kaliningrad Region of Russia

Darja Cigankova & Yulia N. Grishanova

Immanuel Kant Baltic Federal University, Universitetskaya Street, 2,
236040 Kaliningrad, Russia.
Email: d.cigankova@mail.ru

The study of the ecology of Woodcock in the Kaliningrad region started in 2009. Within the framework of the research, more than 230 censuses of Woodcock courtship displays were organised from the end of March to July in 2009 and in 2010. The results enabled the authors to characterise the main roding parameters and reveal the influence of environmental factors and the effect of human activity.

The Woodcock is the main game bird shot in spring in the Kaliningrad region; therefore, special attention was paid to the evaluation of the species as a hunting quarry. In the last decade, the popularity of hunting roding Woodcock has increased considerably. However, rather low effectiveness of Woodcock hunting and significant annual fluctuations in bag size have been recorded.

The significant difference observed in the total number of harvested birds per year in 2007–2010 may be explained by a combination of such factors as the duration of hunting season and the number of licences issued each year, as well as the variability in weather conditions and roding parameter instability. Nevertheless, the average hunting bag per 1000 ha of forest remains at a rather high level for this territory, which has a low percentage of forest.

The shooting of Woodcock for scientific purposes was conducted during two breeding seasons. As a result, morphometric data have been collected and the age and sex ratio have been calculated for the research sample.

The Woodcock is a common species in the Kaliningrad region, nesting mainly in mixed and deciduous forests. In addition, it is a popular quarry species in spring. However, the population of breeding Woodcock has not yet been studied in this region. The decision to start a specialized study of this species was made in 2009. The main goals of the present work were: 1) to trace the changes in the number of contacts and roding duration through the course of the breeding season; 2) to reveal the influence of environmental factors; 3) to estimate the population density and size; 4) to study Woodcock as a hunting quarry.

Methods

Counts of roding Woodcock

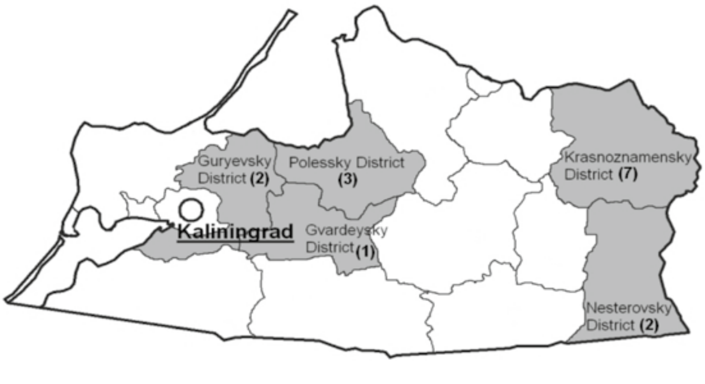
The counts of roding Woodcock were organized on 15 fixed and 16 randomly chosen listening points in five districts of the Kaliningrad region (***Figure 1***). The counts were conducted in any weather conditions; however, the data obtained on rainy and windy evenings (with heavy rain and wind speed exceeding 10 m/s) were not included in calculations of average intensity and duration of roding.

All Woodcocks seen and heard were registered and each contact was recorded to the nearest minute. From the end of March until mid-April, each period of observation lasted only one hour, because roding in this period of the year is brief and does not need a longer period of observation. From mid-April until mid-July the duration of each period of observation was two hours. The number of contacts during the time of observation reflected the intensity of roding. Counts of roding woodcocks were performed in open areas, mainly on glades and felled areas, within mixed and deciduous forests.

Age and sex determination

The sex of 32 harvested woodcocks shot from April to June, in 2009 and 2010, was determined by gonad examination after dissection. The age of 46 woodcocks shot during the period from 2004 to 2010 was determined using the method described by Ferrand & Gossmann (2009).

Figure 1. **Boundaries of the five districts in which the fixed points were located. The number of fixed points is given in brackets.**



Population density and size

In total, 55 contacts were registered from 25th May to 15th June 2009 and 64 from 25th May to 15th June 2010. These data have been used to estimate the mean population density and the total number of woodcocks in the Kaliningrad region. In order to take into account possible longitudinal changes, information on Woodcock population in East Prussia, as well as bird fauna census data, were extracted from the literature (Tischler 1941; Grishanov 1998) and applied to analyse long-term changes.

As it was not practically possible to take stock of the Woodcock population precisely, adjusted point counts were applied, in which the mean Woodcock population density was calculated in approximation. According to Fokin & Zverev (2003), the number of roding woodcocks at the listening point may be given in crude approximation by dividing the total number of contacts by three, and the territory covered by one roding male during one evening is roughly approximated to 4 km². Accordingly, the population density in our study was roughly approximated applying the following formula:

$$D = \frac{n}{3} \div 4$$

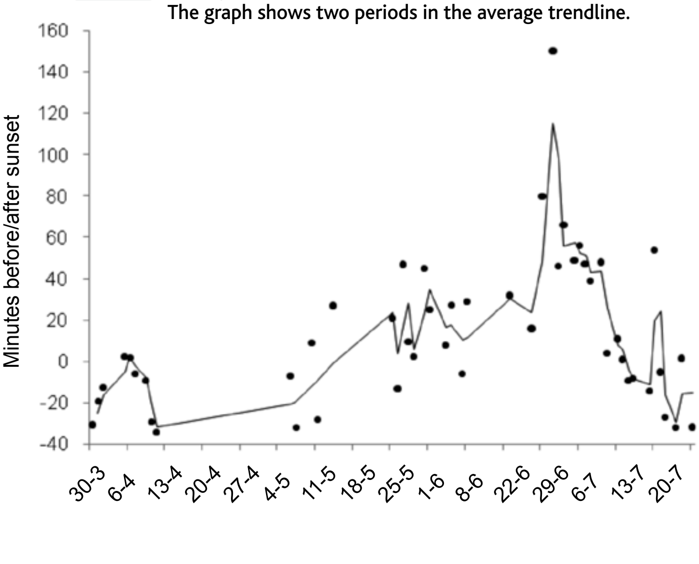
(D = density of roding males per km², n = number of contacts during two hours). As Woodcock sex ratio was assumed to be close to 1:1 (Kuzyakin 1999), the density and size of Woodcock population was expressed in pairs per km².

Hunting bags and effectiveness of hunting

We used the archives available at the Kaliningrad Regional Society of Hunters and Fishers (KRSHF), and the data collected by the organizations in charge of the control hunting in the region for the period 2007-2010.

The bag size was estimated on the basis of information found in returned hunting licences (each hunter had to purchase the licence before the hunting season and return it filled out with the number of shot birds). The effectiveness of hunting was determined as the ratio of the number of harvested woodcocks to the number of returned licences.

Figure 2. **Roding start time in relation to sunset. The graph shows two periods in the average trendline.**



Morphometry

The bill, tarsus, tail and wing of harvested woodcocks were measured with callipers. The whole birds were weighed before dissection and different organs, including gonads, were weighed after dissection.

Results and discussion

Roding activity

The roding period in the Kaliningrad region usually lasts for about four months. The first Woodcock courtship display flights begin around the 20th March, and the latest flights are registered in the last ten days of July. The available data suggest that roding starts approximately two weeks after the arrival of the first birds.

On average, evening roding starts an hour and a half later at the end of the mating season than at the beginning. In our study, roding started at 20:35 ± 13 min. from the end of March to the first decade of April, but at 22:02 ± 21 min in July. From April to June, roding started progressively earlier in relation to sunset (***Figure 2***).

Our results showed that the time of start of roding was more influenced by the change in sunset time than by weather conditions. In June, when daylight hours are the longest, the average time of start of roding in good weather conditions did not significantly differ from that in cloudy evenings with precipitations.

Roding intensity and duration depended on month and increased towards the end of the breeding season (***Table 1***).

The cause of a more than two-fold increase in roding intensity requires further special research. The possibility of a second clutch in case of the loss of the first clutch was shown by Hirons (1981) in Great-Britain. The only available evidence in the boundaries of the Kaliningrad region comes from the study of German ornithologists, who reported on a clutch found on 26 June 1933. They considered that Woodcock regularly nested twice during the same breeding season (Tischler 1941). The reports on finding late clutches on 7 July 2002 and on 30 June 2009 in the Kiliningrad region also provide some evidence in support of the existence of the second peak of Woodcock sexual activity. However, late involvement in roding of young and late mature males could also be one of the reasons for the increase in the number of contacts in June in comparison with April–May (***Figure 3***). Finally, this may also be due to the resumption of roding after a stop for a few days after mating shown by Hirons (1980).

Three periods have been identified during the 2009 breeding season: 1) an increase of roding intensity from the beginning of April until 10th-20th May; 2) a temporary decline in roding intensity from 20th May to 20th June; 3) a second peak of roding intensity observed during the first twenty days of July. In contrast, the 2010 roding intensity was not clearly structured, and the peak of intensity was registered in the last ten days of June, i.e. half a month earlier than in 2009. These results

Table 1. Variation in mean values of roding intensity and duration during mating seasons in 2009 – 2010.

Month	2009			2010		
	Mean intensity ± SD	Mean duration ± SD	Number of observation periods	Mean intensity ± SD	Mean duration ± SD	Number of observation periods
April	7.2 ± 6.2	34.85 ± 17.27	27	6.8 ± 5.4	30.80 ± 13.60	10
May	12.2 ± 8.5	56.82 ± 33.15	17	9.7 ± 8.8	53.13 ± 36.07	16
June	7.0 ± 7.3	61.08 ± 32.69	12	21.5 ± 11.5	83.04 ± 34.72	27
July	17.4 ± 11.3	61.41 ± 29.04	43	10.5 ± 7.0	47.86 ± 36.94	24

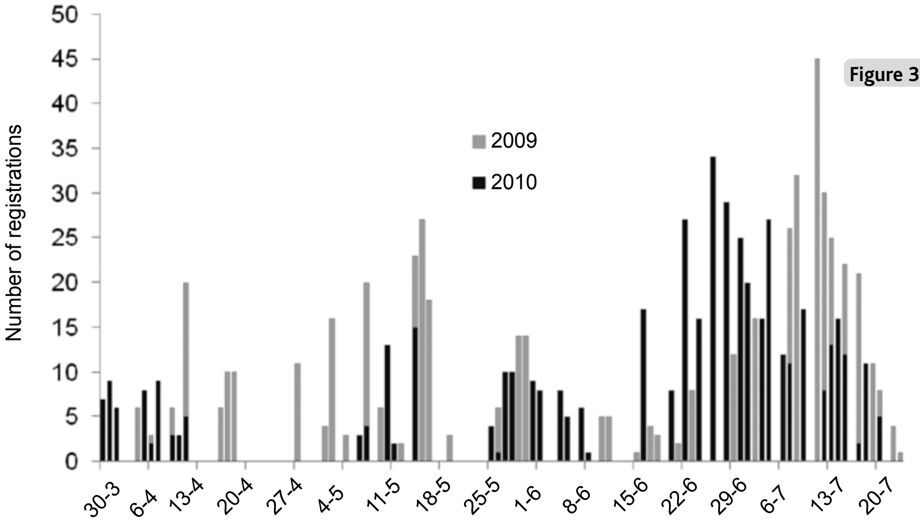


Figure 3. Numbers of contacts (intensity) of roding woodcocks at the same listening point in the Kaliningrad region during breeding seasons 2009 and 2010.

could be explained by the long-term period of drought in July when conditions for reproduction were unfavourable.

The number of contacts per evening might be influenced by weather conditions. When temperature was lower than 5°C in the evening, we registered low numbers of roding Woodcock: 4.5 ± 1.6 contacts per 2 hours (n = 4). When temperature increased to 10°-14°C the average number of contacts doubled: 9.5 ± 2.1 contacts per 2 hours (n = 20). On warm evenings when temperature was above 15°C, the highest average number of roding males was recorded: 19.7 ± 2.3 contacts per 2 hours (n = 23). However, when the evening temperature was above 20°C, a drop in roding intensity to 13.4 ±1.8 contacts per 2 hours (n = 27) was registered.

No significant difference was observed in the average number of contacts on clear compared with cloudy evening weather conditions. In June–July, at the period of the most intensive roding, intensity was 7% higher and roding duration was 5-6 min. longer when the cloud cover was about 60-100% than when there was less cloud cover. Roding also might be influenced by the wind speed. At a 0–3 wind speed Beaufort, the mean number of contacts was 17.9 ± 1.8 per 2 hours (n = 41). In contrast, with intensification of wind to 5–6 Beaufort the average was 10.1 ± 1.6 (n = 10) males per 2 hours.

Population density and size

The analysis of data compiled from available old and current studies reveal insignificant positive changes in the density of Woodcock breeding population. This discrepancy could be explained either by the difference in census methods applied for data collection or by the complex influence of multiple factors on reproductive conditions.

However, the Woodcock population size increased to a high level due to expanding woodland areas, as a result of afforestation of derelict fields caused by the decline in agricultural activity in recent decades (***Table 2***).

Evidently, the lower density in 2010, in comparison to 2009, was caused by a strong negative influence of unfavourable weather conditions on roding intensity during the breeding season.

Hunting bags and effectiveness of hunting

As KRSHF representatives confirm, the popularity of hunting roding Woodcock has increased considerably recently. Unfortunately, in 2007–2010, the licences were issued simultaneously for three species of game birds (geese, wild

Table 2. Estimated Woodcock population density and size in the Kaliningrad region.

Years	Population density, pairs/km²	Area under forests, km²	Population size, pairs
1940's (Tischler 1941)	0.5	1,600	800
1990's (Grishanov 1998)	0. 5 – 0. 8	2,649	1,200 – 2,000
2009	0. 93 ± 0.08	2,728.65	2,534 ± 207
2010	0. 82 ± 0.09	2,728.65	2,235 ± 255

duck drakes and Woodcock) which considerably complicated the estimation of the true number of hunters who exclusively hunted Woodcock. Nevertheless, we reckon that, though the number of issued licences increased each year, the number of Woodcock hunters does not exceed 65-67% of the total number of licenced hunters.

To a significant degree the hunting bag size depends on the dates of opening and closing of spring hunting (***Table 3***). For example, extremely early hunting season opening in 2008 entailed considerable reduction in the number of harvested woodcocks. A relatively large hunting bag size in 2009 and in 2010 must have been caused by favorable dates of the hunting seasons openings; in addition, these seasons were the longest in the latest nine years.

The average effectiveness of Woodcock hunting in 2007–2010 was 0.16 birds per licence. The explanation for such a low hunting effectiveness may lie in the fact that most of issued licences were used for shooting game birds other than the Woodcock. The percentage of annually harvested woodcocks in the Kaliningrad region is about 10-14% of the total hunting bag size for the species allowed for spring hunting (Grishanova 2009). In order to estimate the true effectiveness of Woodcock hunting, the licences should be separately issued for each species of game birds. KRSHF started to issue separate licences for Woodcock hunting on the rented hunting lands only in 2011. However, it is hardly possible to apply this practice to the whole territory of the region due to the inevitable increase in funding required. A collegiate decision on the solution of this problem is necessary at the governmental level.

In our region the average Woodcock hunting bag was 4.00 (min = 0.58; max = 10.95) per 1,000 ha of woodland in 2009. On average, 3.29 (min = 0.25; max = 16.06) woodcocks per 1,000 ha of woodland were harvested in 2010.

Having compared our data (normalized to a ten-day period) with the mean numbers for harvested Woodcock per 1,000 ha of forestland in the North-West region of Russia (Fokin & Blokhin 2000), we concluded that in the Kaliningrad region an average hunting bag per 1,000 ha is rather high for a region where woodland covers only 18.5% of the territory.

Morphometry

One of our goals was to define the main morphometric characteristics of the Woodcock breeding population in the Kaliningrad region. The results of measurements are presented in ***Table 4***.

All harvested roding Woodcocks were males. Developed gonads were only found for a bird shot outside roding (silent flight). The age ratio of the harvested birds was 1:1.24 (young: adult).

Conclusion

Our results enabled us to characterize roding parameters such as intensity and duration, to document their dynamics during the breeding season and to detect their dependence on the light level and weather conditions.

According to roughly estimated results of this study, the Woodcock population density and size in 2009 and 2010 was relatively stable. In order to prove the hypothesis that the population is stable to a convincing degree of confidence, it is necessary to organize further regular observations in the coming years. However, no decisive factors that could strongly influence the population density and size in the Kaliningrad region have yet been discovered. Further and more detailed studies might be necessary to detect them.

Nevertheless, as the increase in hunting roding Woodcock is evident, it is important to revise the rules of licence issuing in order to estimate the true size of hunting bag and to reveal the effect of hunting pressure on the breeding population.

Table 3. **Hunting season dates and duration in 2007-2010, number of licences issued and Woodcock spring hunting bags per season and per day in the Kaliningrad region.**

Year	Hunting season dates	Duration of spring hunting season	Number of returned licences	Hunting bag per season	Hunting bag per day
2007	24.03. – 2.04.	10	1205	238	23.8
2008	15.03. – 24.03.	7	1590	117	16.7
2009	28.03. – 12.04.	16	2483	533	33.3
2010	27.03. – 11.04.	16	2784	413	25.8

Table 4. **Measurements of Woodcock specimens shot for scientific purposes in April–June 2009 and 2010.**

Measurements	n	Mean	SD	SE	Min	Max
Bill length, mm	32	72.59	2.99	0.53	67.00	79.00
Tarsus length, mm	32	36.56	3.44	0.61	29.00	46.00
Tail length, mm	32	100.34	10.18	1.80	75.00	120.00
Wing length, mm	12	196.75	4.47	1.29	187.00	205.00
Weight, g	31	277.06	20.62	3.70	234.00	331.80

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National roding censuses of migrating Eurasian Woodcock (*Scolopax rusticola*) populations in Hungary in spring 2009 and 2010

Gergely Schally & László Szemethy Szent István University, Institute for Wildlife Conservation, Páter K. u. 1., 2100 Godollo, Hungary.
Emails: sgergo@ns.vvt.gau.hu & Szemethy.Laszlo@vvt.gau.hu

In order to be able to fulfill the requirements of the EU Birds Directive (79/409 EGK) and to estimate the size of the migrating population in Hungary, a monitoring programme was initiated by the former Ministry of Agriculture and Rural Development and the Hungarian National Chamber of Hunters in 2009.

Data collection and processing have been designed and carried out by Szent István University, Institute for Wildlife Conservation, which also undertook evaluation of the results. The aims of this study were:

a) to develop and test the workability of a long term monitoring programme of Woodcock migration in Hungary;

b) to describe the characteristics of the migration;

c) to detect and evaluate differences between years.

The essence of the programme is to collect data from as many observation points as possible at the same period of time. These are snapshots about different states of the migration. With the comparison of consecutive snapshots we can estimate dynamics, speed and extent of migration.

In spring, the basis of the monitoring programme is a roding survey performed weekly by observers on every Saturday. They recorded data on standardized forms.

To describe the characteristics of the migration we used different approaches: temporal dynamics of the number of contacts, of the national occupation rate, and of the rate of high abundance sites.

The distributions of the number of contacts fitted unimodal curves in both years. The timing of peaks in roding activity was similar in both years, but the minimum and maximum values indicate great differences between results registered at the same period of time.

The proportion of positive sites increased from mid-February to the end of March, and decreased to the beginning of May in 2009. The highest value was on 28-03-2009. At the same time, the rate of high abundance sites also reached its peak. The proportion of positive sites and the high abundance sites in 2010 was the highest on 20-03-2010.

Testing the workability, gathering methodology experiences and further development were the most important goals in the first period of the programme. From this point of view it started successfully.

Although it takes hard field work and complex organization, the series of spring surveys continued in 2011, the third year of the monitoring programme.

The temporal dynamics of spring migration in 2009 and 2010 are similar to each other, however significant difference was found between them in the case of the summarized number of contacts.

All observation values were lower in 2010 than in 2009 in the case of number of contacts, the national occupation rate, or the proportion of high abundance sites. There is no significant difference in case of the distributions of the medians, which can also be caused by the low number of cases.

The high number of observation data allows us to evaluate them with different methods. Although the main objective of the programme is to estimate the size of the migrating population in order to facilitate a sustainable harvesting, it is also very important to evaluate our data with methods used by other woodcock research programmes to be able to compare them to each other and to assist in the development of an international survey network.

Spring woodcock hunt is a centuries-old tradition in Hungary. The annual bag was always less than 10,000 individuals in the last decade (Csányi *et al*., 2009; http://vmi.info.hu/adattar/index.html). However, it is problematic from the EU Birds Directive's (79/409 EGK) point of view, because the hunting season coincides with the migration to breeding areas. The Directive allows for derogations under controlled conditions and only for a small number of birds [1% of total mortality (natural + hunting) at maximum]. In order to be able to fulfill the requirements of the EU Birds Directive it is essential to start and maintain a country-wide monitoring system.

Although there are many former observations about the migration, there is still a lack of information. To broaden our knowledge about the species and to estimate the size of the migrating population in Hungary, a monitoring programme was initiated by the former Ministry of Agriculture and Rural Development and the Hungarian National Chamber of Hunters (HCH) in 2009. Data collection and processing have been designed and carried out by Szent István University, Institute for Wildlife Conservation (IWC), which also evaluated the results.

Woodcock is known to be breeding in Hungary, however the size of the breeding population is relatively small – 10-60 pairs (BirdLife International, 2004). At migration times far more woodcock are seen. The birds' distinctive roding display makes it possible to assess woodcock numbers on migration. As former studies demonstrated that counts of roding activity (contacts) are closely correlated with numbers of males (Ferrand, 1993; Hoodless *et al*., 2008; Mulhauser & Zimmermann, 2010), the programme is based on roding survey data.

The aims of this study were: a) to develop and test the workability of a long term monitoring of Woodcock migration in Hungary; b) to describe the characteristics of the migration; c) to detect and evaluate the differences between years.

Methods

The essence of the programme is to collect data from as many observation points as possible at the same period of time. These are snapshots about different states of the migration. With the comparison of consecutive snapshots, we can estimate dynamics, speed and extent of migration.

In spring, the basis of the monitoring programme is roding survey (Bibby *et al*., 1997; Ferrand *et al*., 2008; Machado *et al.*, 2008) performed weekly by observers on every Saturday (from 28th February to 2nd May in spring 2009, from 13th February to 1st May in Spring 2010). The observers recorded data on standardized forms. Data were: number of contacts (birds seen and/or heard), estimated size of the visible area, duration of the survey, weather conditions and habitat types surrounding the observation point.

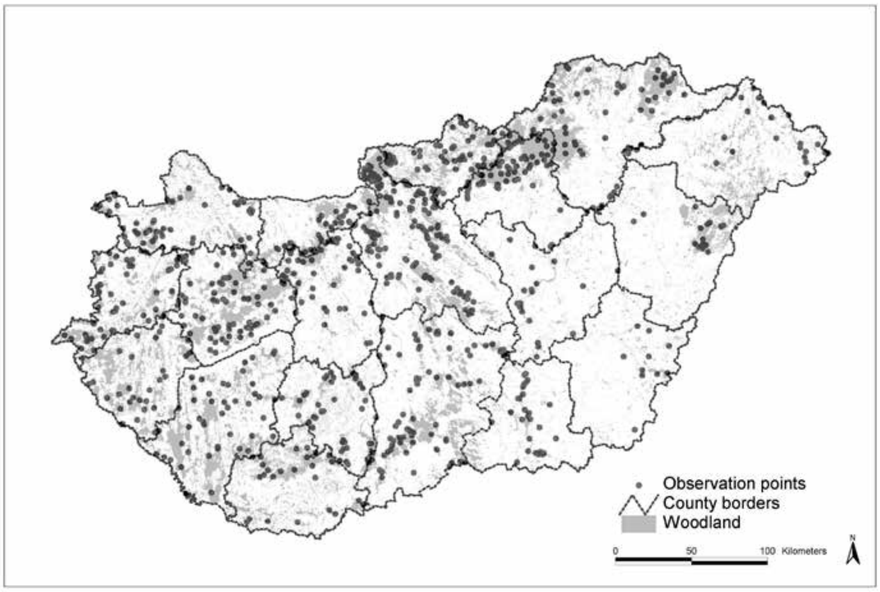
The monitoring-network can be divided into different levels: county coordinators, representatives of game management units (GMU) and observers (participating hunters), everyone for different tasks. Observation data recorded by the observers were sent to the GMU representatives each week, then the paper forms have been collected by the county coordinators (HCH active members). They uploaded the observation data electronically to a web server weekly created and maintained by IWC.

The total number of observation points was 899 in spring 2009 and 927 in spring 2010 (Preliminary results shown in Schally *et al.,* 2010 may differ). ***Figure 1*** shows their distribution. The number of valid forms was 7,776 in spring 2009 and 9,133 in spring 2010.

To describe the characteristics of the migration we used different approaches:

– Temporal dynamics of the number of contacts; we calculated the descriptive statistics (sums, medians, minimums, maximums, and quartiles) from the number of contacts for each observation week: their distribution represents the temporal dynamics and intensity of migration;

Figure 1. Distribution of the observation points in spring 2010.



– Temporal dynamics of the national occupation rate; these rates correspond to the % of listening points at which at least one roding male was observed (positive site) (Ferrand et al., 2008) at each week;

– Temporal dynamics of the rate of high abundance sites; these rates correspond to the % of positive sites at which at least five roding males were observed at each week; to detect the differences between the results of distinct years we used Chi-square test for homogeneity.

Results

Figures 2 and ***3*** show the distributions of descriptives calculated from observation data in spring 2009 and 2010. The distributions of the number of contacts fitted unimodal curves in both years, however a temporal difference between their peaks was detected. A significant difference was found between total numbers of contacts ($\chi^2 = 393.5$ df = 11 p<0,005), but no difference was found between the distributions of their medians ($\chi^2 = 0,071$ df = 3 p>0,1). The minimum and maximum values show us that there are great differences even between results registered at the same period of time. The minimum value is 0 in each case, so there were always some listening points where no Woodcock was detected.

The proportion of positive sites increased from mid-February to the end of March, and decreased to the beginning of May in 2009 (***Figure 4***). The highest value (90.5%) occurred on 28-03-2009. The peak in high abundance sites (31.0%) coincided with the peak in occurrence (***Figure 5***).

The proportion of positive sites in 2010 was the highest (88.5%) on 20-03-2010. The peak in high abundance sites was at the same time (21.6%).

Figure 2. Descriptives of the number of contacts per week in spring 2009 (medians, minimums, maximums, and quartiles). Date #1 refers to 14th February.

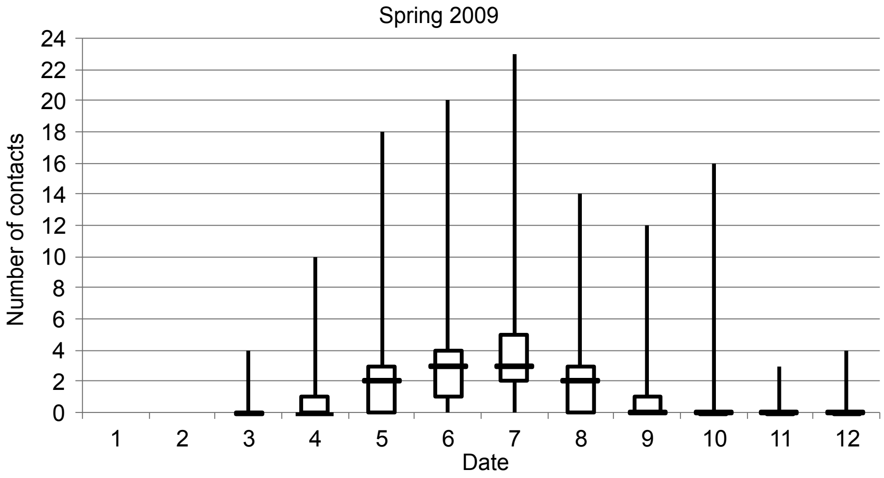
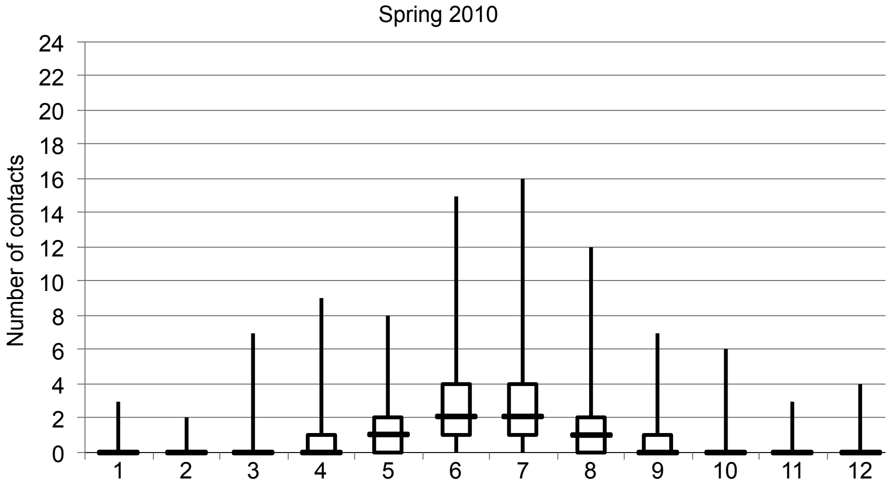


Figure 3. Mean densities of contacts per week in spring 2010 (medians, minimums, maximums and quartiles). Date #1 refers to 13th February.



Discussion

Even when there have been large-scale monitoring programmes in several countries for years (Ferrand *et al.*, 2008; Hoodless *et al.*, 2009; Blokhin & Fokin, 2006; Mongin *et al.*, 2010), it was not an easy task to put it into practice in Hungary. Testing the workability, gathering methodology experiences and further development were the most important goals in its first period. From this point of view the programme started successfully. The system of data collection and processing is functional, just a few modifications are needed. The participants work well together in cooperation, Hungarian hunters are able to cooperate with each other and to solve a task of such a magnitude. Although the programme takes hard field work and complex organization, the series of spring surveys started for the third time in 2011.

The temporal dynamics of spring migration in 2009 and 2010 are similar to each other, however significant difference was found between them in the case of the total number of contacts. All observation values were lower in 2010 than in 2009 in the case of number of contacts, the national occupation rate and the proportion of high abundance sites. There is no significant difference in case of the distributions of the medians, which can also be caused by the low number of cases. According to these, the decline of the population should also be considered, however a longer period of time should be evaluated to get reliable results.

The highest values of positive sites (***Figure 4.***) are relatively high compared to results of breeding surveys in France (Gossmann *et al.*, 2010) or in the United Kingdom (Hoodless *et al.*, 2009). Although the listening points in Hungary were not selected randomly, their number and distribution allows us to conclude that woodcock presence can be expected from most parts of the country at those times (or at least from habitats suitable for the species).

The high number of observation data allows us to evaluate them with different methods. Although the main objective of the programme is to estimate the size of the migrating population in order to facilitate a sustainable harvesting, it is also very important to evaluate our data with methods used by other woodcock research programmes to be able to compare them to each other and to assist in the development of an international survey network.

Figure 4. Distribution of the occupation rates per week in spring 2009/2010. Date #1 refers to 14th February in 2009 and 13th February in 2010.

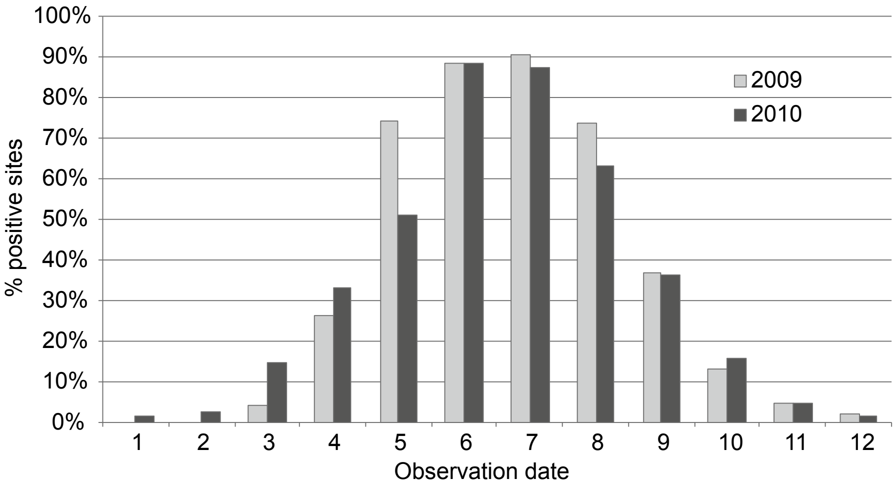
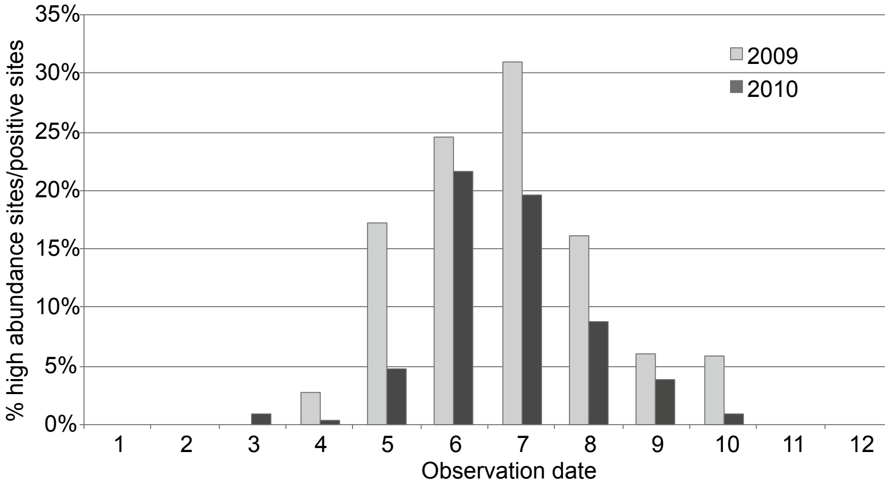


Figure 5. Proportion of the high abundance sites during the migration per week in spring 2009/2010. Date #1 refers to 14th February in 2009 and 13th February in 2010.



The first term of the programme is planned to continue for five years. Our aim is to continue and improve monitoring the species in the future based on the knowledge gathered along that period.

Acknowledgements

We are grateful to everyone who participated in the Woodcock monitoring, especially those who persist in collecting data from the beginning of the programme. The work was funded by the Hungarian National Chamber of Hunters and the former Ministry of Agriculture and Rural Development.

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Monitoring of the Woodcock population in European Russia (1996-2010)

Sergei Yu. Fokin
& Yuri Yu Blokhin

Scientific research group “Woodcock”, State Informational-analytical center
of game animals and environment (FGU “Centrokhotkontrol”), Moscow, Russia.
Emails: fokinwoodcock@mail.ru & yuri-blokhin@yandex.ru

Two main surveys were carried out in European Russia to monitor the Woodcock population: a national roding census and the estimation of hunting bags.
Since 1999, a roding census was organised every last Saturday of May in the evening. About 3,000 questionnaires were distributed every year among hunting organizations in 43 Russian regions. The Novgorod, Tver’, Arkhangelsk, Pskov and Cheliabinsk regions had the highest roding activity, with more than 10 roding contacts on average per listening point. In the whole Central-Black Soil area and in the Orenburg, Saratov and Tula regions, the number of contacts did not exceed 5. In the whole European Russia the mean number of contacts ranged from 6.9 (2010) to 9.8 (1999) and the proportion of listening points without roding varied from 1.3% (2006) to 3.3% (2010). These results showed that the Woodcock has a wide forest breeding area in European Russia, but that the observers undertaking the censuses chose habitats typical for Woodcock. During the last 12 years, the breeding Woodcock population in European Russia appeared stable.
The estimation of the Woodcock hunting bags in European Russia in the period 1996-2007 was based on official information from the Hunting Department. Every year, 200,000 woodcocks were bagged in European Russia, among them 75% in spring. This represented only 5.4% of the total hunting bag in Europe. Every spring the Russian hunters bagged from 103,000 to 171,000 male Woodcock, mainly in the European part of Russia (only 4% in the Asian part). In autumn, the hunting bags ranged from 43,000 to 64,000 birds in European Russia and from 2,000 to 5,000 in the Asian part, depending on the breeding success and weather conditions. In addition to this national inquiry, we distributed about 12,000 questionnaires in 2008-2010 among hunters. The hunting success, the individual hunting bags and the proportion of shot birds not retrieved were determined. This special inquiry showed a slightly higher mean individual hunting bag, which could be linked to participation by a higher proportion of successful hunters.

Monitoring of the Woodcock population in Russia was carried out annually since 1996 in the framework of the agreement between the Moscow “Woodcock” group and the *Office national de la chasse et de la faune sauvage* (France). This monitoring includes different topics: roding censuses, features of spring and autumn migration, estimation of breeding success, description and evolution of breeding habitats, ringing, hunting bag estimation, collection of weather data. In this paper we focus on two of them: the national roding census and the estimation of hunting bags.

National roding census

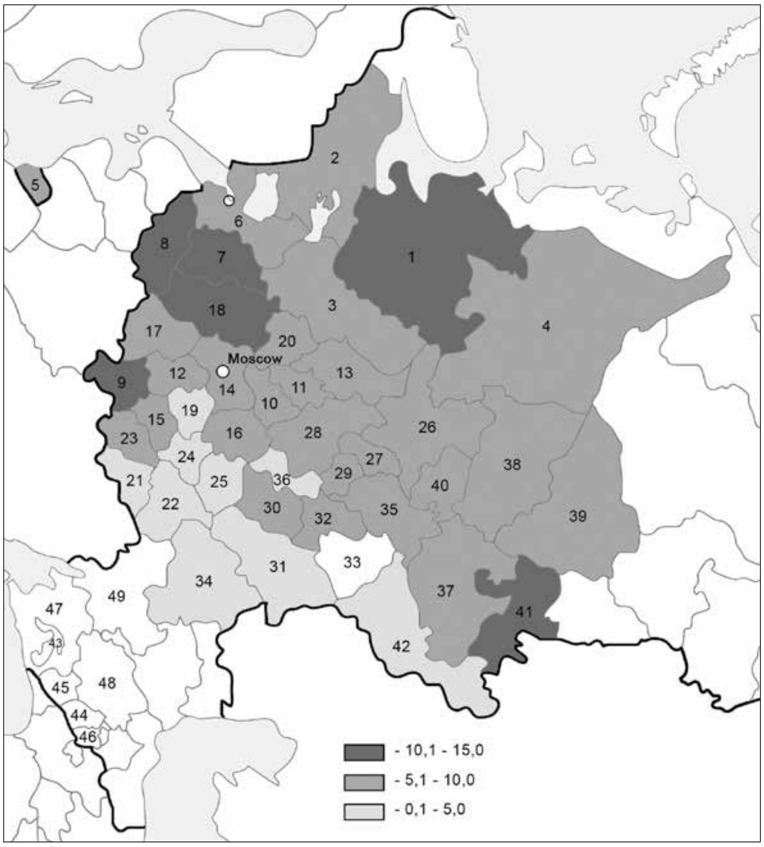
Material and methods

Since 1999, the Moscow Woodcock group, in combination with the Russian Hunting Association and others hunting organizations, carried out a national roding census in a standardized way to monitor long-term dynamics of Woodcock numbers. Every year, the observations occurred in the evening of the last Saturday of May. About 3,000 questionnaires were distributed each year from regional hunting societies. Information on the census was also provided through the hunting magazines. Simultaneously, the results of the previous census were published. The basic variable of the national census is intensity of evening roding, expressed as the number of contacts for 2 hours of observation at listening points. Absolute and relative values are considered.

Censuses covered up to 39 regions (Oblasts) and republics of the forest zone of the European part of Russia (EPR) including Ural within the limits of the woodcock breeding area, except Northern Caucasus (***Figure 1; Table 1***). The return rate of questionnaires as a whole is very high (for example in Sverlovsk and Vladimir regions), but varied from one region to another. In total, 27,133 questionnaires have been collected for all years and regions. For statistical analysis, we rejected any questionnaire for which the census protocol was not respected or the validity of data was dubious (according to our experience).

Finally, 21,243 questionnaires (78.3 % from number collected) from 43 regions of the Federation of Russia were used for analysis. From year to year, the proportion of rejected questionnaires was comprised between 1.3% in 2000 and 44.3% in 2008. Recently, we have paid more attention to the quality

Figure 1. **Distribution of roding intensity (based on the number of contacts of roding birds) in European Russia (average for 1999-2010).**



Area	N°	Region
North	1	Arkhangel'sk
	2	Karelia
	3	Vologda
	4	Komi
North-West	5	Kaliningrad
	6	Leningrad
	7	Novgorod
	8	Pskov
Central	9	Briansk
	10	Vladimir
	11	Ivanovo
	12	Kaluga
	13	Kostroma
	14	Moscow
	15	Orel
	16	Ryazan'
	17	Smolensk
	18	Tver'
	19	Tula
	20	Yaroslavl'
Black-Soil Centre (Central Black Earth)	21	Belgorod
	22	Voronezh
	23	Kursk
	24	Lipetsk
	25	Tambov
Volga-Vyatka	26	Kirov
	27	Marii El
	28	Nizhny Novgorod
	29	Chuvashia
	36	Mordovia
Volga	30	Penza
	31	Saratov
	32	Ulianovsk
	33	Samara
	34	Volgograd
	35	Tatarstan
Ural	37	Bashkortostan
	38	Perm'
	39	Sverdlovsk
	40	Udmurtia
	41	Tcheliabinsk
	42	Orenburg
North Caucasus	43	Adygea
	44	Kabardino-Balkaria
	45	Karachaevo-Cherkesya
	46	North Osetia
	47	Krasnodar
	48	Stavropol'
	49	Rostov

Table 1. **Characteristics of data used in the national roding census analysis from 1999 to 2010.**

	Years											
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Number of questionnaires received	2934	2344	740	1986	1949	2141	1873	1876	2646	3274	2915	2455
% of questionnaires analysed	77.6	98.7	86.2	87.7	95.7	92.7	97.2	87.7	69.2	55.7	59.9	63.5
Number of regions	34	35	19	32	34	35	34	29	32	37	39	32

of data and have created a protocol to improve the sorting of questionnaires. The form of the questionnaire was improved and a primary **rejection** was conducted much more strictly than in the first years of the census.

Results and discussion

For 12 years, 166,451 contacts have been registered on 21,243 points. The majority of data came from the central part of Russia where observers and listening points are more numerous. The main variable is the roding intensity expressed by the number of contacts for 2 hours at a listening point. The maximal values of the roding intensity for the whole **EPR** have been registered in 8 provinces of the Federation of Russia (based on the regional divisions in place until 2000) representing 6 areas: Northwest, Central, Central Black Earth, Volga-Vyatka, Volga regions and Ural. High values are regularly registered in Tatarstan (***Table 2***). Four times during the 12 study years, the maximum number of contacts was observed in the Volga region. From 2000 to 2007, the highest values of this variable were above 40, while in the last 3 years of the decade they never exceeded this level.

The mean annual number of contacts in the Chelyabinsk, Tver', Pskov, Arkhangelsk, Bryansk and Novgorod regions was above10, which can be considered as "good". The first ten regions with the greatest roding intensity were located in Northwest area and Western parts of the Central area (Tver', Smolensk, Bryansk), i.e. the whole West of the **EPR**. For all the study period the "good" regions (mean > 10 contacts) represented only 14.6 %, and the "average" ones (mean 6-10 contacts) 63.4%. About half of regions (51.2%) of the whole **EPR** were characterized by an annual mean roding intensity above 8.0 contacts. "Bad" regions (≤ 5 contacts) represented 22%. Except

Table 2. **Maximum number of contacts with roding birds registered in 8 regions of European Russia from 1999 to 2010.**

Regions of European Russia	Years											
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Kaliningrad	64											
Kostroma			45					44				
Lipetsk												30
Tatarstan		42		43			50					
Tver’									45			
Ulyanovsk						44						
Chelyabinsk										37	34	
Chuvashia					44							

the Kursk Orenburg, Saratov and Tula regions, all these “bad” regions are situated in the Central Black Earth soil area (for the Volgograd region and Mordovia data are insufficient). Every year, the majority of regions (53% to 72%) could be classified as “average”, except in 1999 for which “good” regions prevailed (***Figure 2***). 2005 was the year with the lowest proportion of “good” regions. The proportion of “bad” regions increased for the last 3 years.

The annual mean number of contacts varied from 6.9 (2010) to 9.8 (1999; ***Figure 3***). The minimal values varied from 1 (2009) to 3.3 (2007; ***Figure 4***). They were registered on the Southern borders of the breeding woodcock area in the Volga region, Uralsk and Central Black Earth areas. The minimal values were more often observed in the Saratov (5 years), Orenburg (4 years), Belgorod and Voronezh regions (1 year). The maximal values varied from 10.6 (2005) to 15.1 (2009; ***Figure 4***). They were registered in the Chelyabinsk and Pskov regions (1 year) and in the Arkhangelsk, Kaluga, Kirov, Nizhniy-Novgorod, Smolensk, Tver’ and Perm’ regions (1 year), and in Udmurtiya (1 year). The maximal values were more often observed in Ural (4 years) and in the Central (3 years) areas, less often in Northwest and Volga-Vyatka (2 years), and in Northern area (1 year). The largest amplitude in the annual mean number of contacts among the regions was observed in 2009 (1.0 – 15.1).

1999 was a year with an unusually high number of “good” regions (54.5%). In this year alone, the Orel, Ryazan’ and even Belgorod and Tambov regions were registered as “good” while they were always classified as “average” or “bad” regions in

Figure 2. **Inter-annual variation in the proportion of regions placed in 3 classes of roding activity according to the mean number of roding contacts during 1999-2010.**

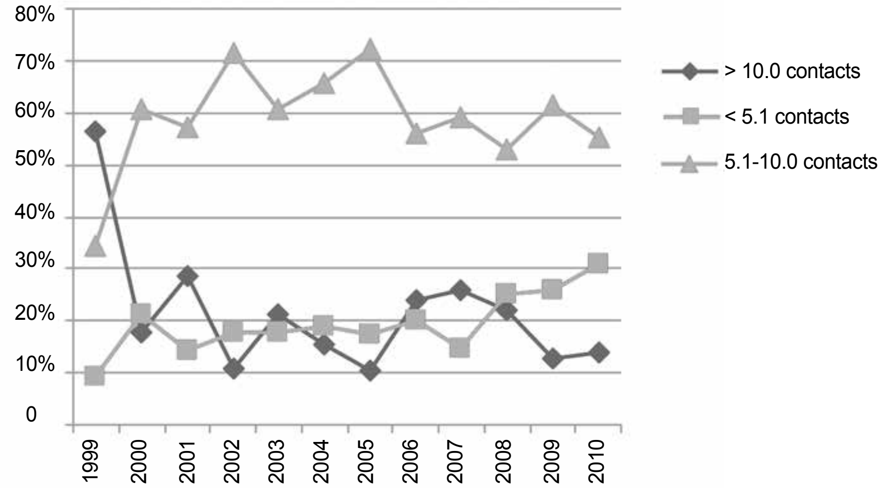
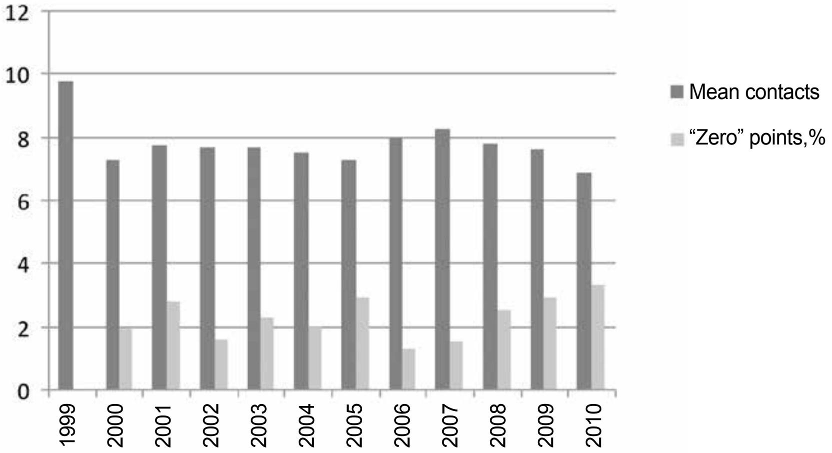


Figure 3. **Inter-annual variation in the mean number of roding contacts and in the proportion of listening sites with no contacts in European Russia during the period 1999-2010.**



the following years. After the "peak" of 2007, the mean roding intensity gradually diminished (***Figure 3***), particularly in the "good" and "average" regions of Novgorod, Pskov, Bryansk, Ivanovo, Moscow, Kursk, Chelyabinsk and in Tatarstan. However, a downward trend was not revealed in the whole EPR. For example, in the Kaliningrad, Vladimir, Ryazan' and Smolensk regions the mean number of contacts increased a little in the last years and in the Central area we observed opposite trends (***Figure 5***).

Absence of roding at listening points is also an important variable for monitoring. The proportion of points with no observation remained low and varied from 1.3% (2006) to 3.3% (2010). These low values indicate that, on the one hand, point counts are not randomly selected, but on the other hand, a large expanse of forest habitats suitable for woodcock nesting is available. The number of points without roding increased in the last 4 years, which could indicate a rather bad situation for the Woodcock population during this period.

Hunting bags

Material and methods

Until 2007 hunting bag data have been collected from regions according to the protocol of the Hunting Department of the Federation of Russia. In 2008–2010, in connection with the transfer of powers to regions, the Hunting Department did not obtain official data on hunting bags of game birds, including Woodcock. Questionnaires were sent to a selected sample of hunters to collect Woodcock data during this period. In 2011, the regions were again obliged to send their hunting bags data to the Hunting Department.

In 2008-2010, about 12,000 questionnaires were distributed among hunters of the Russian Hunting Association in order to estimate the number of woodcocks shot whilst roding (Blokhin & Fokin 2009). Data were received from 60% of 43 regions in EPR to which questionnaires were dispatched. The average return rate was about 30%. Individual hunting bags were over-estimated during this period owing to a low rate of participation by unsuccessful hunters (those who did not bag any woodcocks) in the sample. For this reason, estimation of individual hunting bags was omitted during this period.

It is important to note that the quality of the official information in all regions is rather low. This is especially the case for data about autumn hunting, as already reported (Blokhin *et al*. 2006). Quality of data has declined particularly since 2005 when licenses for Woodcock shooting were cancelled.

Results and discussion

Spring hunting

The traditional Woodcock hunting in Russia is spring hunting during evening roding, which is easily accessible and popular in the central Russia near to large cities. For example, in Moscow suburbs, 80% of the hunting licenses concern the Woodcock spring hunting.

Until 2008, spring hunting was regulated and limited to a 10-day period. Since 2009, the duration of the hunting period has been increased to 16 days. However, new rules in 2011 have restored again the10-day period. Now the opening of Woodcock hunting is not linked to that of other game birds, as was the case previously.

The data on the spring hunting bag mainly came from the EPR. The Asian part of Russia (principally Sakhalin) represented about 4% of the Woodcock bag. During 1996-2007, 103,000 to 171,000 (on average 149,000) woodcocks were bagged every spring in 40 regions of the EPR (***Figure 6***). In 2006, spring hunting was closed in the major part of regions (53.7%) of the EPR because of the avian flu threat and hunting bag hardly raised to 103,000 birds. The rather low value of spring Woodcock hunting bag (128,000) in 2003 could be explained by a drought in the previous breeding season and by harsh conditions in winter in Europe in 2002/2003. The greatest number of bagged woodcocks was observed in 2005. For 12 years, the total spring Woodcock hunting bag in the EPR could be estimated to 1,793,000 birds.

The major part of the bag was carried out in 12 regions of the Central area with an average of 77,000 (range: 46,000 – 88,000) birds every spring (51.7% of total; range: 44.4 – 59.3%). On average, 17,000 woodcocks were annually shot in the Moscow region in the 2000s and from 10,000 to 13,000 birds in the Yaroslavl, Vologda, Leningrad, Nizhniy Novgorod and Tver' regions. About 6,000 – 7,000 birds were shot in the Kaluga, Kostroma and Vladimir regions every spring. In Volga-Vyatka and Northwest regions, the Woodcock spring hunting bags always remained below the average. Finally, less than 2,000 woodcocks were shot annually in the Central Black Earth area (***Figure 7***).

No trend in Woodcock hunting bags appeared in the different regions except in the Northern area where they increased (***Figure 8***). As a whole, the Woodcock hunting bags during roding in Russia for the period was rather stable, but varied strongly from year to year in some regions, because it is linked with the spring hunting dates (***Figure 6***).

Autumn hunting

In Russia, Woodcock hunting in autumn is less popular than spring hunting. It is more common among hunters with pointing dogs and spaniels in southern regions, and also close to the large cities (Moscow, Saint Petersburg, Ekaterinburg, Nizhni Novgorod, Krasnodar) where important centres of hunting dogs are located. Without a dog, autumn Woodcock hunting is largely unproductive. For example, in Moscow suburbs, 95% of hunters who bought hunting licenses have not bagged a woodcock in autumn (Blokhin 2006).

For 9 years, the average woodcock hunting bag in autumn was estimated at about 55,000 birds (range: 43,000 – 64,000; ***Figure 6***). The trend is rather stable. In 2005, we observed a sharp increase to 73,000, due to high success by hunters in the southern regions (in Stavropol' territory, for example, 35,000 birds have been bagged). During 9 years, 498,000 woodcocks were bagged in the EPR. In the Asian part of the country, no more than 2,000 – 5,000 woodcocks were bagged annually in autumn.

Figure 4. Inter-annual variation in the minimum and maximum number of contacts with roding birds in European Russia during 1999-2010.

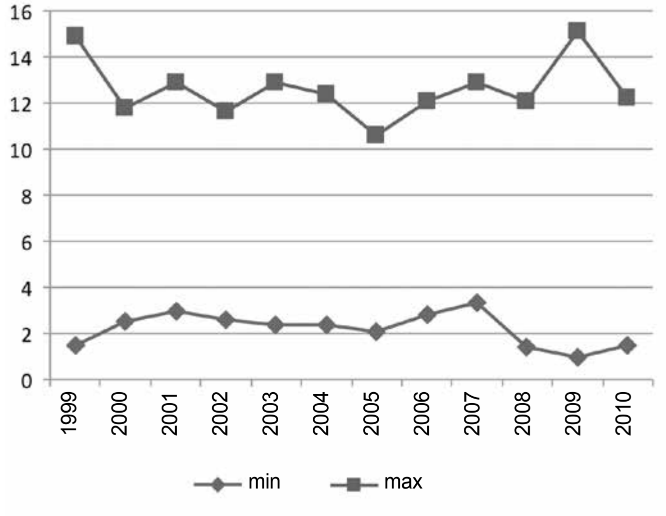


Figure 5. Inter-annual variation in the mean number of roding contacts in 5 regions of Central Russia during the period 1999-2010.

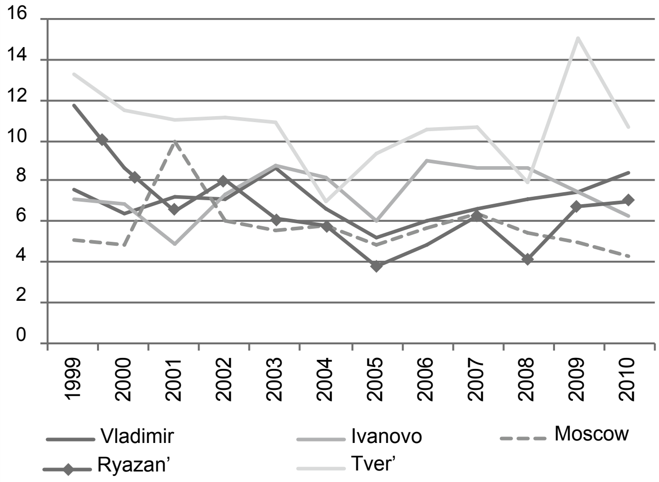


Figure 6. Woodcock bag sizes in spring and autumn in European Russia from 1996 to 2007 (in thousands).

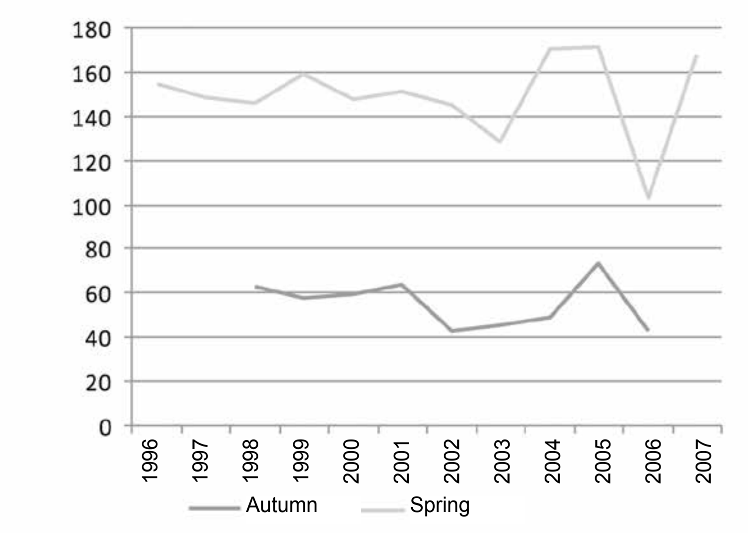
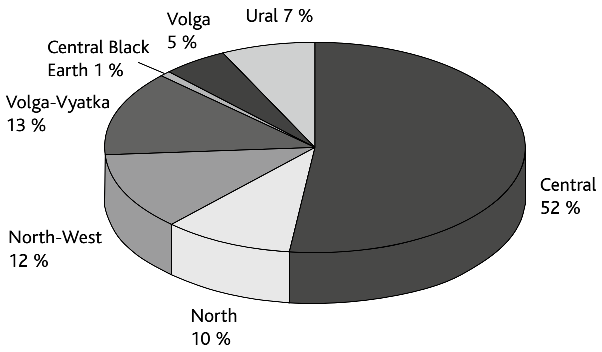


Figure 7. Proportion of spring Woodcock bag size by area in European Russia during the period 1996-2007 (left) and bag size per region (right).



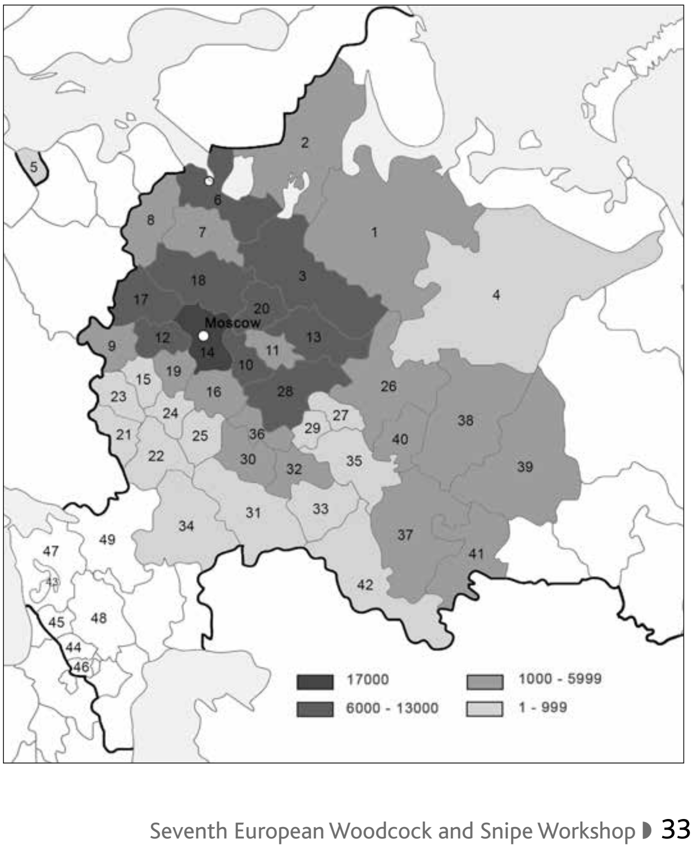


Figure 8. Inter-annual variation in spring Woodcock bag size in 7 areas of European Russia during 1996-2007.

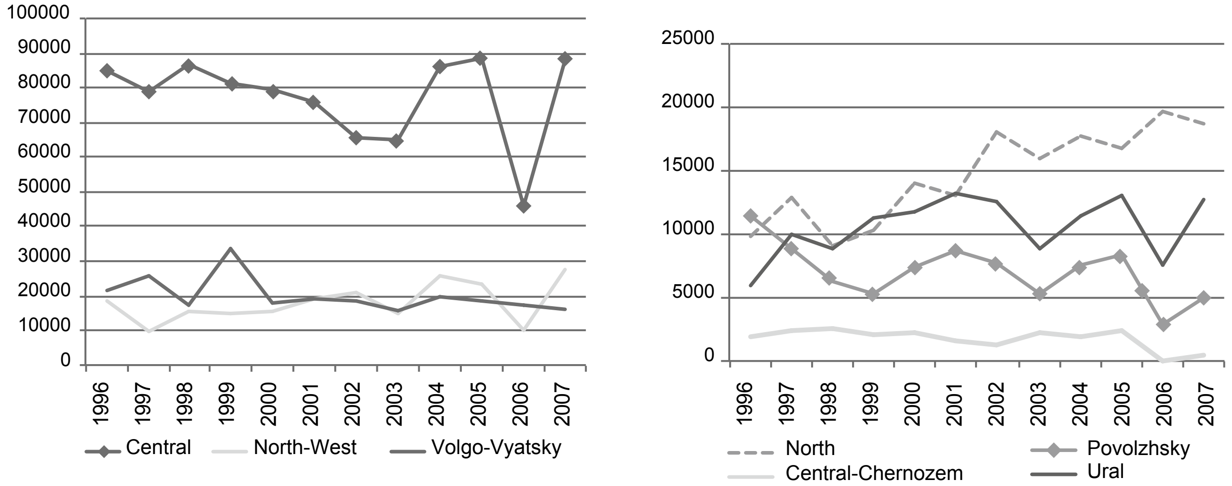
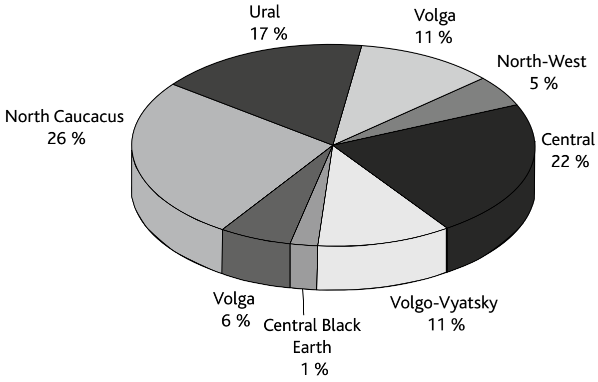


Figure 9. Proportion of autumn Woodcock bag size by area in European Russia during the period 1998-2006 (left) and bag size per region (right).



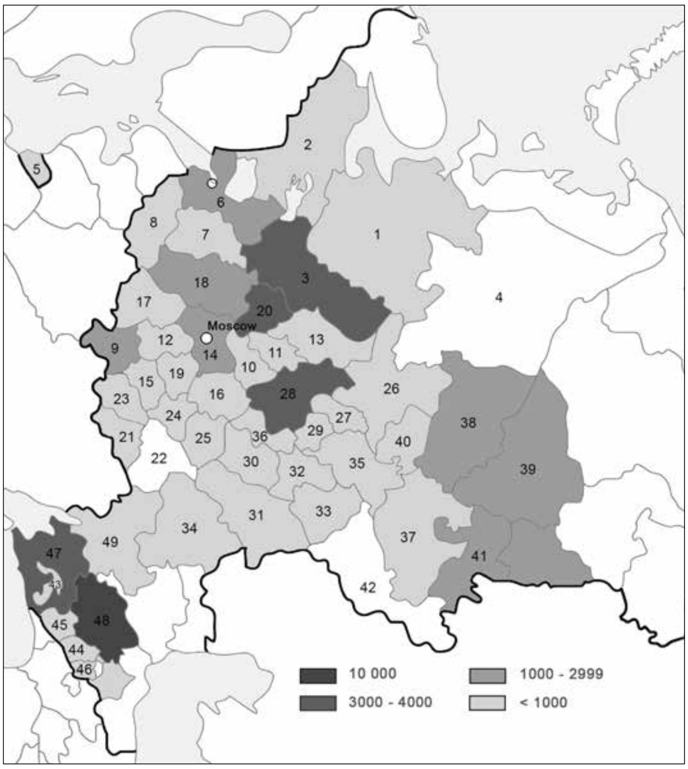
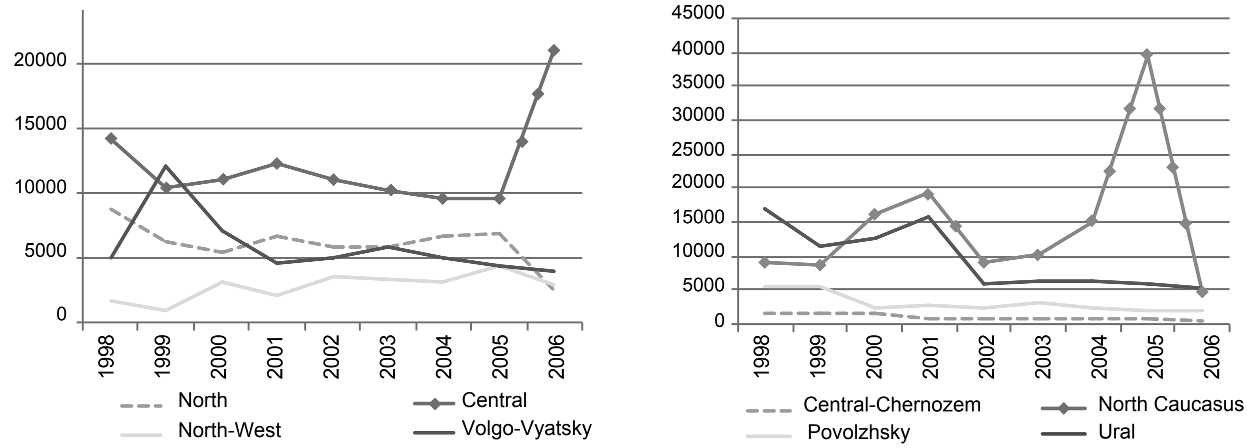


Figure 10. Inter-annual variation in autumn Woodcock bag size in 8 areas of European Russia during 1998-2006.



The Woodcock hunters in North Caucasia bagged 26.4 % of the total and those of the Central area shot 22.0%. The lowest hunting bags were observed in the Central Black Earth area (***Figures 9 & 10***).

On average 10,500 woodcocks were bagged during 1998–2006 in the Stavropol region. From 3,000 up to 4,000 birds were bagged in 8.2% of regions, from 1,000 up to 3,000 in 16.3%, and less than 1,000 in 71.4%.

Conclusion

The monitoring of the breeding Woodcock population in Russia is based on roding censuses and estimation of hunting bags. After 12 years, the breeding Woodcock numbers in the EPR can be considered as stable, even if there has been a slight decrease in roding intensity, a slight increase of the proportion of listening points with no roding and of "bad" regions have been observed in the last 3-4 years. This could be simply constitute part of a longer term natural fluctuation in numbers.

In Russia, hunters shoot about 200,000 woodcocks, of which 75% are taken in spring. This constitutes 5.4% of the total European Woodcock hunting bag. In spring, the area where most birds are bagged is Central Russia and in autumn it is North Caucasia. No trends in hunting bags have been observed for the whole EPR even though sharp fluctuations occurred in some regions, probably linked to the poor quality of the official data.

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Woodcock hunting in Denmark Status and recent changes

Thomas Kjær Christensen & Tommy Asferg
Department of Bioscience,
Aarhus University, Kalø, Grenåvej 14, DK-8410 Rønde, Denmark.
Emails: tk@dmu.dk & ta@dmu.dk

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 distribution 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

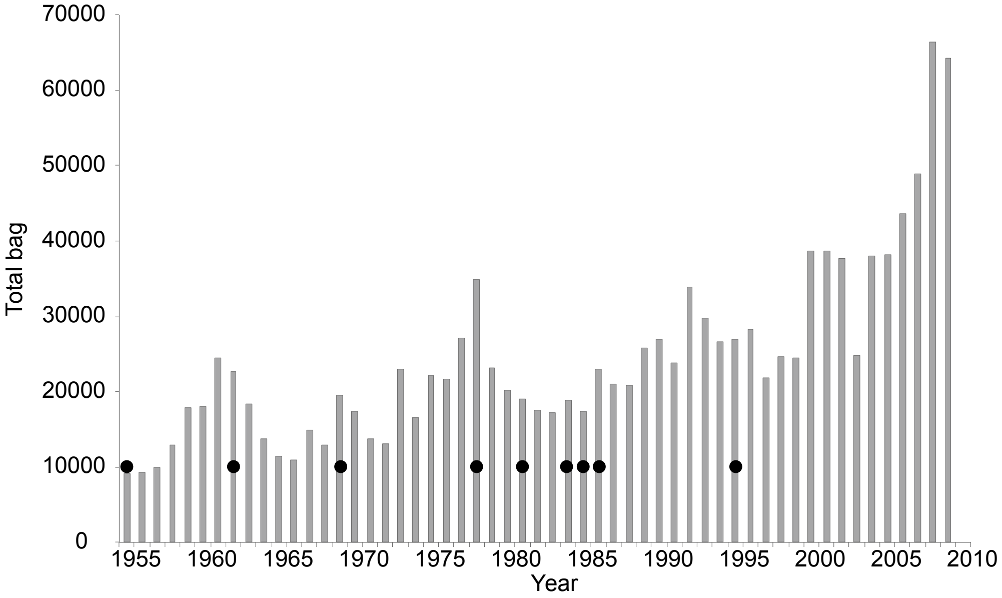
The total Danish bag of Woodcocks for the period 1955 to 2009 (***Figure 1***) shows an overall increase, with an all-time high number of more than 60 000 bagged Woodcocks in 2008 and 2009. Comparing 10-year periods, the average annual numbers shot show significant increases between the 1980s and 1990s ($t = 4.78$, $p<0.001$) 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.**

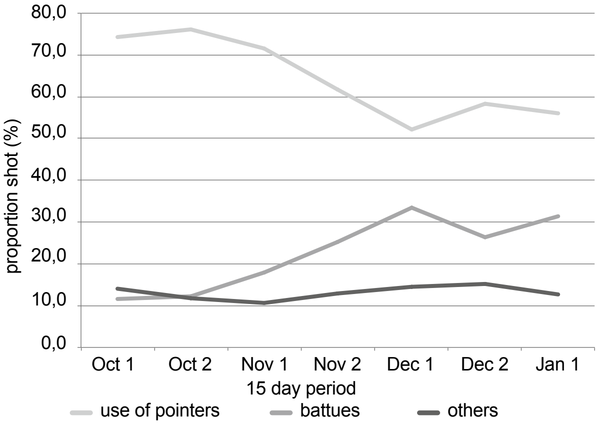


Figure 3. **Relationship between the proportion of hunters shooting at least one Woodcock and the size of the total Woodcock bag.**

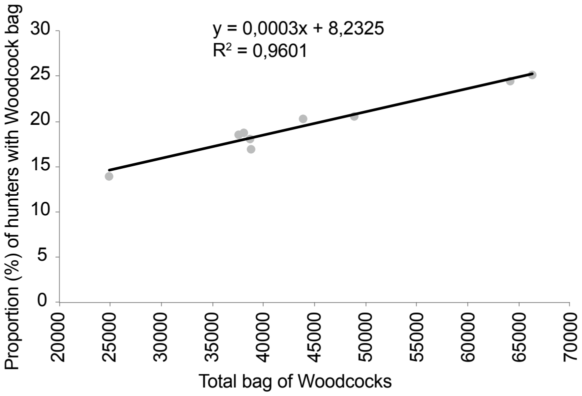
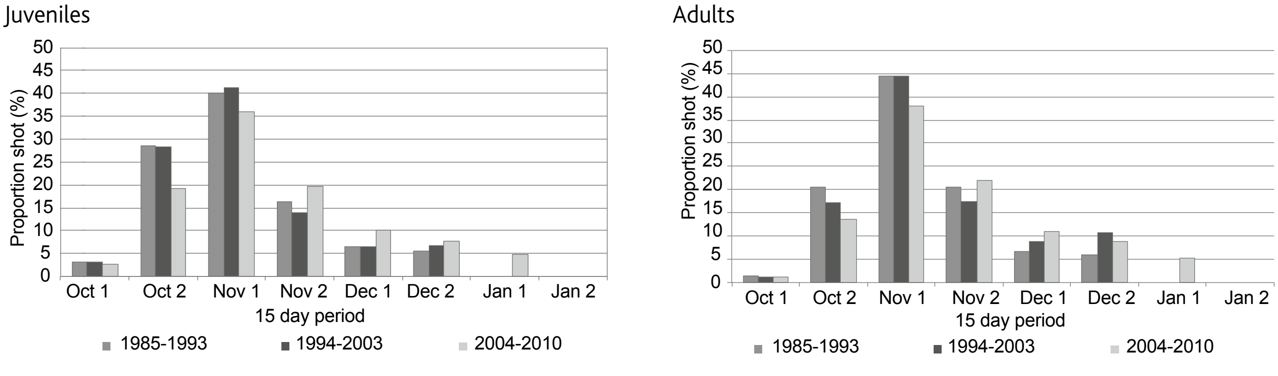


Figure 4. **Temporal (half monthly) distribution of bagged juvenile (top) and adult (below) Woodcocks for the periods 1985-1993, 1994-2003 and 2004-2010.**



Discussion

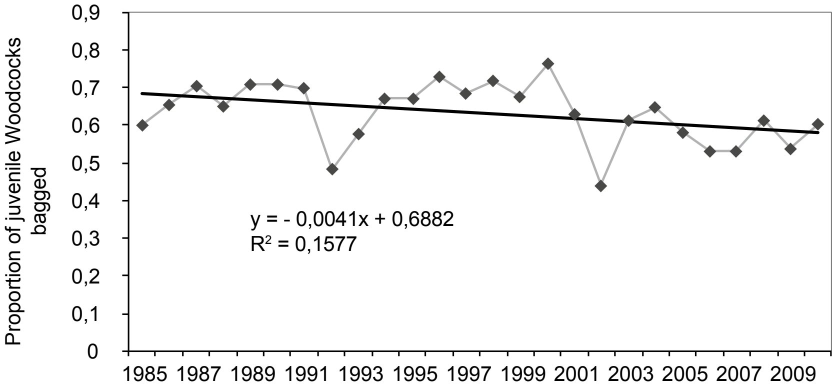
The number of Woodcocks shot in Denmark has shown a long-term increase since the 1950s and a more marked recent increase in the period 2000-2010. With a breeding population of 2,500-3,000 pairs in Denmark (Birdlife International 2004) and an annual Woodcock bag of 40,000-60,000, autumn hunting of Woodcocks 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), were 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 just 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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Long-term monitoring of the Hungarian Woodcock bag during 1995-2008

Sándor Faragó
& Richard László

Institute of Wildlife Management and Vertebrate Zoology,
University of West-Hungary, Sopron , 9400 Sopron Ady E. u. 5. Hungary
Emails: farago@emk.nyme.hu & laszlo@emk.nyme.hu

The Woodcock bag in Hungary was very low (max. 6-9,000 birds/year) in recent decades. Compared to the autumn-winter hunting seasons, in the spring bag there is a relatively low proportion (11-27%) of hens. Hunting practice was regulated by daily and personal bag limits as well as the duration of the hunting season. Hungary is located in the southern margin of the breeding distribution of the woodcock. Estimates put the Hungarian nesting population at 10-60 pairs. Since the shooting season ended on 10 April, there was very little chance that nesting birds will be part of the bag. Therefore, it is safe to conclude that spring shooting did not endanger the Hungarian breeding population.

Introduction

Hungary lies at the southern boundary of the nesting area of the Woodcock *Scolopax rusticola* (Hagemeijer & Blair, 1997), where it has a breeding population estimated at 10-60 pairs (BirdLife International, 2004). At the time of the spring and autumn migration it occurs in every forested area of the country. On meadows, fields and vineyards adjacent to forests, woodcocks only appear to feed. Information from ringing birds migrating through Hungary show that they arrive from Russian nesting places and spend the winter mostly in France and Italy (Faragó, 2009). Migration takes place on the centre-oriental route (Ferrand & Gossmann, 2009). Probably several million woodcocks migrate through Hungary and this happens both in spring and autumn. Research is going on to define the exact number (See current volume – Schally & Szemethy, 2012).

Shooting of roding Woodcock in spring is traditional in Hungary and was allowed until 2009. Hungary has been a member of the European Union since 2004, so on the basis of the Birds Directive, since 2009 there has been no open spring shooting season for the Woodcock. This paper aims to estimate the effect of spring shooting on Hungarian migrating and breeding Woodcock populations, and to explore the following questions:

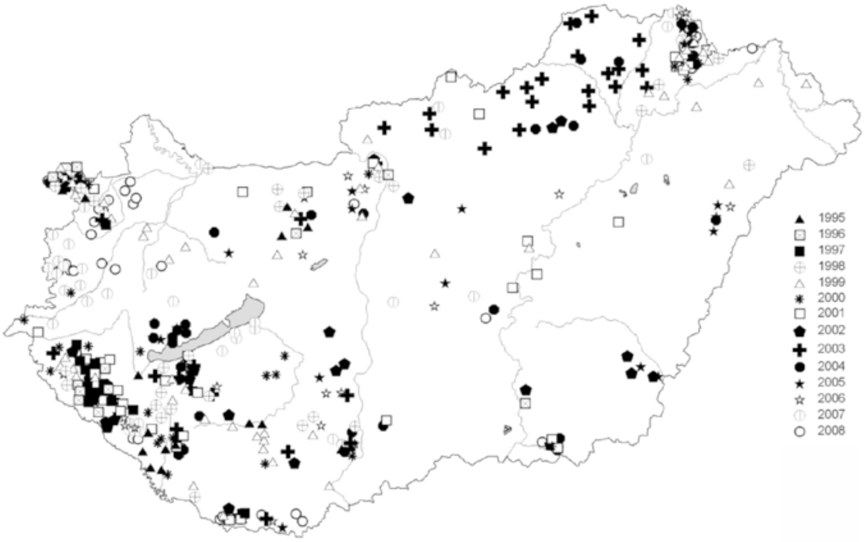
❶ What size was the Woodcock bag in Hungary?
❷ How large was the Hungarian Woodcock bag compared with the European one?
❸ Did the Hungarian hunting legislation promote the conservation of the Woodcock breeding population in Hungary?
❹ Did spring Woodcock hunting jeopardize the Hungarian woodcock breeding population?
❺ What was the effect of spring hunting on age and sex composition of Woodcock populations moving through Hungary?

Material and methods

We estimated the Woodcock bag size using historical statistics (Faragó, 2009b), namely the Hungarian Game Management Database between 1960 and 2008 (Szabolcs, 1971; Faragó, 1982,1985, 1986, 2003a; Csányi, 1996, 1999, 2000, 2001, 2002, 2003, 2004; Csányi et al., 2005, 2006, 2008, 2009) and the Hungarian Woodcock Bag Monitoring between 1990 and 2008 (Faragó *et al.*, 2000; Faragó & László, 2002, 2003, 2005, 2006a, 2006b, 2007, 2008, 2010a, 2010b).

In addition, we processed the data from 2,605 individuals from the Hungarian Woodcock Bag Monitoring (HWBM), collected in the period between 1995 and 2008. The HWBM was organized by the Institute of Wildlife Management and Vertebrate Zoology of the University of West-Hungary in Sopron. The data came from the whole country (***Figure 1***) with the help of volunteers and can be considered representative in terms of sex and age. As the Woodcock hunting season in Hungary corresponded to the beginning of the period of sexual activity, the sex was easily determined by autopsy. The sex and age were determined according to Clausager (1973), Kalchreuter (1979) and Stronach (1983).

Figure 1. **Sample sites for the monitoring of Woodcock hunting bags in Hungary.**



Results

What size was the Woodcock bag in Hungary?

In the 1930's, the annual Woodcock bag in Hungary for spring and autumn hunting ranged from 14,000 to 17,000 individuals (Faragó, 2009b). Between 1970 and 1990, only spring hunting of roding birds was allowed and the bag decreased to 1,500 – 2,000 individuals. The difference between the two periods can be explained by the assumed decrease in the stock, the change of hunting season (***Table 1***), the ban on autumn hunting and driving, and the introduction of a daily bag limit.

Despite no change in regulations and hunting pressure since 1994 (Woodcock could be shot on 41 days in every season and exclusively when migrating; the daily bag limit per person was 4 birds and the number of Woodcock hunters did not change significantly), we observed an increase in the Woodcock bag over the last twenty years. In 2001, it reached a peak of 9,538 individuals (***Figure 2***).

How large was the Hungarian Woodcock bag compared with the European one?

BirdLife International (2004) estimated the European breeding population of Woodcock at 3.6-13.2 million individuals adding that the stock was moderately decreasing. Wetlands International (2006) estimated the population size at 10-25 million individuals and considered that the demographic trend was stable.

No recent data about the European Woodcock bag are available; according to last estimations (Ferrand & Gossmann, 2001; ***Table 2***), 3.5-4 million individuals are shot annually in Europe (including the European part of Russia).

The annual Woodcock bag in Hungary (maximum 6-9,000 birds every year) was insignificant (0.1-0.2%) in comparison with the European bag, and cannot be considered as a threat to the species in Europe.

Did the Hungarian hunting legislation promote the conservation of the breeding Woodcock population in Hungary?

At the end of the 19th century and in the first half of the 20th century, woodcocks were shot both in spring, during roding and driving, and in autumn, during driving (between 1 September and 15/30 April; ***Table 1***), without a daily bag limit. Since 1994, the Woodcock could be shot exclusively during roding only between 1 March and 10 April (41 days) and the bag was limited to 4 birds/hunter/day. As a result of this kind of regulation, the annual bag is a maximum of 6-9,000 individuals, which is less than 1% of the supposed several million migrating Woodcocks.

Did spring Woodcock hunting jeopardize the Hungarian Woodcock breeding population?

Hungary is located in the southern margin of the Woodcock breeding area in Europe. The breeding population in Hungary was estimated at 10-60 pairs (MME Nomenclator Bizottság, 2008). Woodcocks very rarely start nesting at the end of March in Hungary (there have been only two observations from this period). They might mostly nest from 10-20 April until the end of July (Szabolcs, 1971, Faragó, 2002). Because the hunting season ended on 10 April, i.e. before the end of spring migration, and the Hungarian Woodcock breeding numbers are low, there was very little chance that local birds were part of the bag. Analysis of several thousand birds showed that developed eggs in oviducts of females were found only in very few cases.

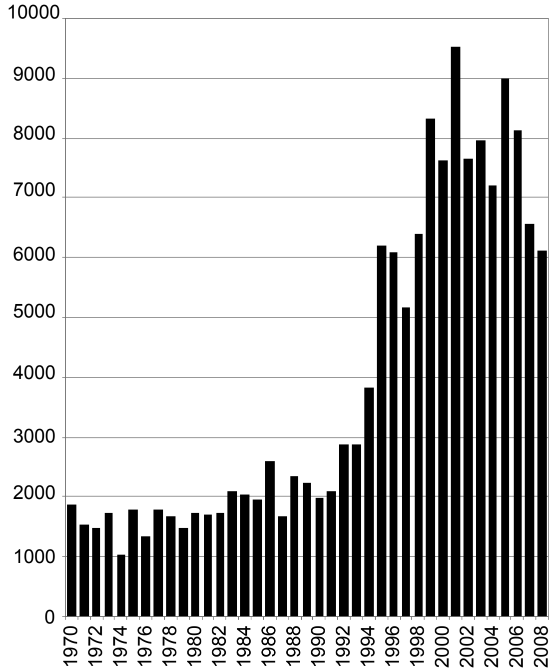
Table 1. **Woodcock hunting periods in the last 75 years in Hungary.**

1934-1964	1 September – 30 April
1965-1969	1 September – 15 April
1970-1972	1 March – 15 April
1973-1974	15 March – 15 April
1975-1976	1 March – 31 March
1977-1993	1 March – 20 April
1994-2008	1 March – 10 April
2009-	no open season

Table 2. **Size of annual Woodcock bag in different countries (after Ferrand & Gossmann, 2001).**

Country	Bag size
Austria	2,700-6,000
Denmark	25,000
Finland	5,000
France	1,200 000-1,300 000
Germany	6,000
Greece	450,000-550,000
Italy	500,000-1,500 000
Spain	7,000
Sweden	25,000
United Kingdom	150,000
Russia (European part)	200,000

Figure 2. **Annual variation in the national Woodcock bag in Hungary, 1970-2008.**



What was the effect of spring hunting on age and sex composition of Woodcock populations moving through Hungary?

During the period 1995-2008, we found that out of the 2,605 woodcocks shot, 78.8% were males (***Figure 3***). The proportion of females among adult birds comprised between 14.3% and 32.4% (20.7% on average). The proportion of females among first-year birds varied between 7.9% and 31.3% (21.8% on average). Data collected in different European countries show that the proportion of females in autumn hunting bags is about twice as large as in spring hunting bags.

Of the 2,605 woodcocks analysed, the proportion of first-year birds was 43.8% on average (***Figure 4***).

Discussion

The sex-ratio in hunting bags appears different between spring and autumn-winter. In Sweden, only 4% of the woodcocks shot in the roding period were females (Marcström, 1994). In France and the United Kingdom, the proportion of females was estimated at 56-59% (Fadat *et al.*, 1991) or 61% (Boidot *et al.*, 2008) and 70% (Hoodless, 1994) respectively. In Germany, proportions of 10%, 16% and 0% females were found in three different areas among woodcocks shot in the roding period (Berlich & Kalchreuter, 1983). In Austria, the proportion of females was estimated at 22% in the spring bag and at 41% in the autumn bag (Merán, 1984-1999). In Slovakia, females represented 4.7% of birds shot in the roding period (Hell & Lehocký, 2001). In Hungary, Merán (1987-1999) recorded females at 21% in the spring bag he shot, which corresponds well with the ratio of 22% estimated in Austria.

The age-ratio in hunting bags also differs from one country to another. Based on autumn data, the proportion of first-year birds was estimated at 69% in Norway (Ferrand & Gossmann, 1989), 77%, 44% and 54% in Sweden (resp. Gossmann & Ibanez, 1991; Marcström unpubl. cit. Berlich & Kalchreuter, 1983; Marcström, 1994). In Denmark, the proportion of first-year birds was estimated at 76 % and 63 % (Clausager, 2001, 2002). It varied between 45% and 64% in Great Britain and Ireland (Harradine, 1994). The proportion of first-year birds was estimated at 65-79% in England (Hirons, 1986; Hoodless, 1994), and 35% in Ireland which is extremely low (Crofton, 2001). The proportion of first-year birds was between 61% and 76% in France (Fadat, 1986; Fadat et al., 1991; Boidot, 2005; Boidot *et al.*, 2006; Boidot *et al.*, 2008). The estimations available for Italy were 70% (Spano, 1986), 61% (Sorace *et al.*, 1999), 49-81% (Liguria; Spano & Galli, 2002a) and 55-69% (Spano & Galli, 2002b). In Spain, the proportion of first-year birds was estimated at 53-69% (Lucio *et al.*, 1994; Lucio & Saenz, 1997). In Austria, according to Merán's data (1984-1999), the proportion of first-year birds was estimated at 47% both in the spring and autumn bags. In Hungary, out of the woodcocks shot during the roding period, 51% were first-year birds. (Faragó *et al.*, 2000; Faragó, 2003b) The proportion of first-year birds among woodcocks ringed in Belarus were 54% and 56% (Mongin *et al.*, 2005, 2006) and 73% in the European part of Russia (Leningrad region; Iljinsky *et al*, 2002).

Even though Merán's data (1984-1999) suggests that mortality in the wintering areas could have a similar effect on first-year and adult woodcocks, it can be stated that in the Carpathian Basin the proportion of first-year birds in spring hunting bags is much lower than those estimated either after the hatching period or in the wintering areas. This leads to the conclusion that first-year woodcocks suffer higher winter losses than adults. This is strengthened by the results of Aradis *et al.* (2008) in Italy. However, as the adult males migrate before the first-year males and the hunting season stopped before the end of adult migration, the adult birds could be over-represented in the spring hunting bags. Moreover, as shown by Machado *et al.* (2006) in the Azores, the majority of birds shot during roding seem to be adult males which present higher levels of sexual development compared to the first-year birds.

Based on the average proportion of females in the bag (55-60% in the wintering areas, 40% in the autumn bags and 10-24% in the spring bags), we can conclude that the mortality of female woodcocks caused by the spring hunting in Hungary is much lower than the losses in the western and southern parts of Europe. For example, the former annual Hungarian Woodcock bag of around 8,000 birds led to an average of 1,500-2,000 females shot.For a similar bag size in autumn the losses would be of 3,200-4,000 females.

In terms of conservation, we consider that the limitation of individual hunting bags and the limited shooting period ensures that the hunting of Woodcock in Hungary is in line with the principles of sustainable or wise use. Therefore, it seems safe to conclude that spring shooting did not jeopardize the Hungarian breeding stock.

Figure 3. **Annual variation in sex-ratio among a sample of woodcocks shot between 1995 and 2008.**

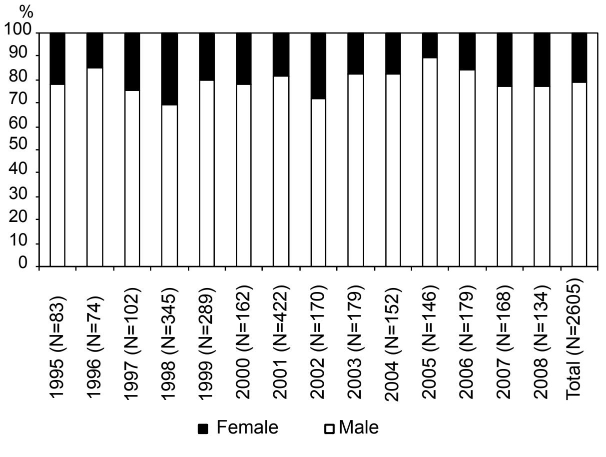
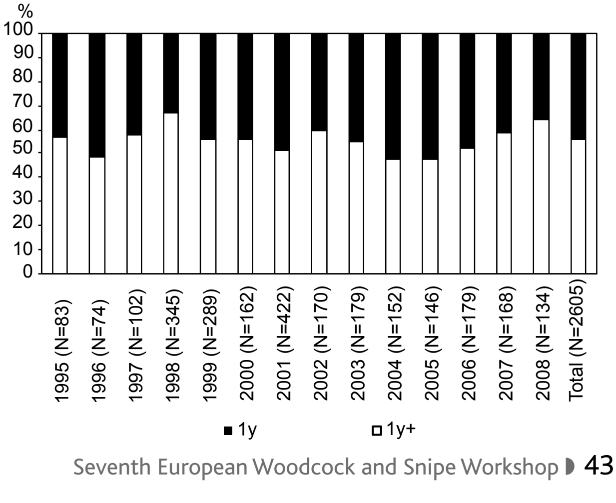


Figure 4. **Annual variation in age-ratio among a sample of woodcocks shot between 1995 and 2008.**



Conclusions

On the basis of the above results, there has been further research since 2009 in Hungary. One objective is to define the dynamics of migrating woodcocks and to clarify their exact yearly spatial-time pattern and to estimate the number of woodcocks involved (see Schally & Szemethy, 2012 in this volume). With special permission, we also want to collect 2,000-3,000 specimens with scientific aims and investigate all of them e.g. determination of body dimensions, sex and age (Faragó & László, 2010). Using data from these two projects, some models can be created to assess the impact of spring hunting in relation to numbers of migrating woodcocks in a more precise way. The first phase of the project is the five seasons between 2009/2010 and 2013/2014. In parallel with this, a ringing program has started, which will provide information on the nesting places and overwintering areas of woodcocks migrating through Hungary. The marking program with GPS transmitters that is going to start in 2013, and the tracking via satellites can clarify the time pattern and dynamics of phenology (breeding, migrating, overwintering) as well.

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Aspects of the biology of Woodcock *Scolopax rusticola* in the Crimea

Valentin. V. Serebryakov Shevchenko National University in Kiev.
Sergei .I. Reshet'ko Republican Forestry Committee
Vladimir .E.Vovchenko Zaporizhzhya National University
Email: bcssu2@gmail.com

The Woodcock is a breeding, migratory and wintering species in the forests of the mountainous regions of Crimea. Based on data collected by O.I.Levchuk (2003), the Committee of forestry and hunting of Crimea has gathered information on habitat, migration, wintering, breeding and hunting bags of Woodcock in this Ukrainian Autonomous Republic.

Habitats

The forest edges and isolated woods on foothills in the Crimean Mountains (the Yaila) can be considered the best habitats for Woodcock. Besides these highland biotopes, the birds are also encountered in small woods, orchards and scrub in the steppe part of the peninsula. During migration, however, they can be observed everywhere.

In the highlands, a proportion of the birds move from the foothills to river valleys after winter snowfall, whilst the remaining Woodcock stay close to unfrozen rivers

Autumn migration

In Crimea, the autumn migration of Woodcock generally starts in mid or late October, coinciding with stronger frost, and lasts until mid or late November. Depending on the weather conditions, the peak of migration can be observed in mid or late October or early November. Migration occurs on a broad scale in the whole territory of the peninsula. By the end of November the numbers of woodcocks decrease but they are still common throughout the mountains.

The birds can remain for several weeks on the Crimea South Coast waiting for suitable weather conditions before crossing the Black Sea. If southerly and south-westerly winds prevail the concentration of woodcocks can be high but will disappear after the first night with a north wind (Kistyakovski, 1967).

Some years a very heavy migration can be observed. For example, in mid November 1888 a hunter was able to kill about 80 birds per day (Baklanovski, 1890).

Based on observations of State gamekeepers, the chronology of autumn migration and the migratory and wintering numbers are as follow.

Wintering

Woodcock winter in small numbers in Crimea (2-3 birds per km²; Beskaravaini, 1989). They are present along the Crimea South Coast and along the banks of submountain rivers in Belogorsk region as well (Andreyev, 1957). One bird was observed on 16 January 1987 at 20 km south-east to Sevastopol, in a mountain oak forest (A. Alekseyev verbal com.).

Spring migration

The question of the Woodcock spring migration in Crimea remains open. Little information on the Woodcock spring migration is available in the literature. Spring migration only appears to involve low numbers of birds and lasts for a short period. Near Ostrovnoye (5 km north from Dzhankoi) small numbers of woodcocks were observed during spring migration. The earliest date of arrival was recorded on 20 April (Senitski, 1898).

The numbers of wintering birds decrease in late February/ early March due to their departure.

Hunting territory	Autumn migration (date/month)			Bird numbers	
	beginning	end	peak of migration	during migration	during wintering
Alushta	15/10	10/12	2/11	15,000	7,000
Bakhchisarai	13/10	23/11	3/11	70,000	1,250
Kholodnaya Gora	9/10	5/12	7/11	30,000	800
Simferopol	30/09	1/12	26/10	15,000	1,000
Starokrymskoye	5/10	14/12	15/11	14,000	2,000
Sudakskoye	20/10	30/11	15/11	15,000	1,250

Breeding

In Crimea, the Woodcock is known to breed only in the territory of the Crimea reserve.

Hunting bags

Hunting is permitted throughout the winter. The proportion of woodcocks seen that are killed varies from 23 to 40%. During the period 1995-2010, 4,300 to 14,500 were shot every hunting season in typical Woodcock habitats.

Based on these data and the need to ensure a favorable conservation status for Woodcock within the territory of the Crimean Peninsula, it is important to work out an action plan to control and monitor its population.

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Woodcock bag limits
A 6-year experience in Brittany

Yves Ferrand Office National de la Chasse et de la Faune Sauvage, Research Department – Migratory Birds Unit,
39 Bd Albert Einstein, CS 42355, F – 44323 Nantes Cedex 3
Email: yves.ferrand@oncfs.gouv.fr

Bertrand Piel Fédération Régionale des Chasseurs de Bretagne,
La Prunelle, BP 214, F – 22192 Plérin Cedex
Email: crcb@wanadoo.fr

Woodcock is a popular migratory game bird in France, especially in the Channel-Atlantic regions. To control hunting bags an individual Woodcock bag limit was implemented from the 2005/06 to the 2010/11 hunting season in Brittany. The bag limit was 30 birds/year/hunter and 3 woodcocks/week/hunter. Moreover, use of marking strips and completion of a notebook were compulsory. This 6-year experience showed that the scheme was well accepted by Breton hunters, who returned on average 80% of notebooks. From data collected, annual Woodcock hunting bags were estimated at between 112,000 and 154,800 birds during the study period. Just under 50% of hunters shoot at least one woodcock and around 2.5% shot 20 woodcocks or more. About 70% of the annual bag was achieved before the end of December, but there was large variation in the chronology of autumn migration from one season to another. This trial served as the basis for implementation of a national bag limit scheme in 2011.

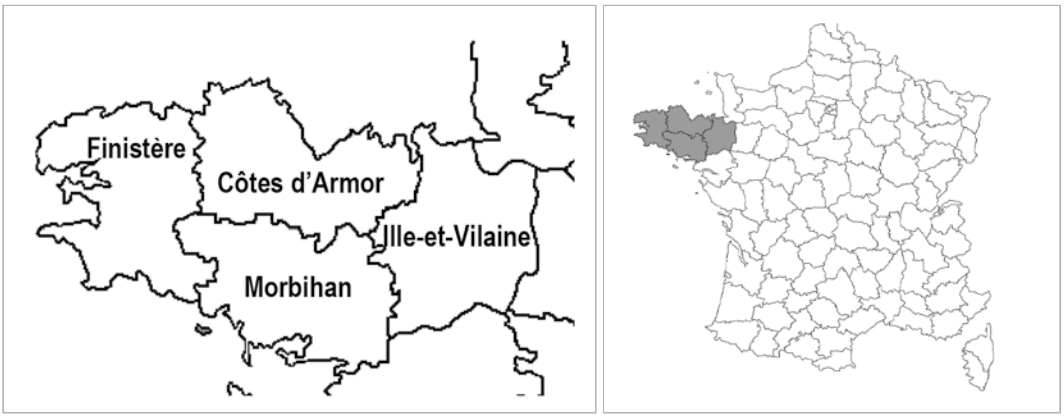
Harvest management is one of the major challenges facing hunters and biologists to ensure sustainable use of game species (Giles 1969; Strickland *et al.* 1996). It is usually based on a quota per hunting territory or per hunter, e.g. bag limit. The first case is mainly applied for sedentary species for which the population to be managed can be considered as closed. The number of individuals and their population dynamics are often reasonably well known and a daily bag control is achievable to stop the harvest when the quota is reached. This is not the case for migratory birds for which the number of individuals in a hunting territory (regularly used in autumn/winter) depends on several external factors, i.e. breeding success in distant breeding sites, weather conditions during migration and/or at wintering sites, suitability of stop-over and/or wintering sites, origin of the individuals wintering at the same site. This could only be feasible in the case of a bag control at the level of the entire wintering range, which is clearly utopian at present. Moreover, for species like European Woodcock *Scolopax rusticola*, hunting is a personal activity which makes a continuous harvest control during the hunting season difficult.

For these reasons, only a bag limit per hunter is relevant for managing the Woodcock harvest. This type of regulation has been implemented in North America for American Woodcock ***Scolopax minor,*** where a bag limit of three birds per day is applied (Cooper & Parker 2011). In Europe, several countries have already set up bag limits: Russia, Hungary, Greece, Turkey and Portugal apply national Woodcock bag limits (Ferrand & Gossmann 2009). In Belgium, Switzerland, Italy, Spain and France regional bag limits are found. In almost all cases these bag limits are not compulsory and there is reliance on hunters to respect them. To our knowledge, the only exception is in Brittany (France). In this paper we describe the Breton scheme, as well as the statistical and biological results which it yielded.

The Breton bag limit scheme

A Woodcock bag limit based on a *départemental* regulation in the four Breton *départements* (*Finistère, Côtes d'Armor, Morbihan, Ille-et-Vilaine;* ***Figure 1***) has been set in Brittany

Figure 1. **Locations of Brittany and Breton "départements".**



since the 1990's. In spite of a weak legal basis, the majority of Breton hunters freely applied it and completed and returned their Woodcock bag notebook to their ***départemental*** hunters' association. An important change occurred in 2005 when a ministerial order fixed a mutual regulation for the whole of Brittany. From the 2005/06 hunting season, Woodcock hunting was regulated as follows:

- bag limit of 30 woodcocks/year/hunter;
- bag limit of 3 woodcocks/week/hunter;
- compulsory marking strip;
- compulsory recording in a bag notebook;
- bag notebook of season ***n*** compulsorily provided before receiving a bag notebook for season ***n+1***.

In this way, any hunter who hunted in Brittany (Breton or not) was obliged to comply with this regulation and to limit his bag to 30 birds/year and 3 birds/week whatever the number and the location of his hunting territories in Brittany.

Different control arrangements are set. On the notebook, the hunter's name, his address and the number of his permanent hunting license are stated. In addition, two individual bar-code labels (corresponding to the notebook number) are available on the notebook: one remains on the notebook, the other is pasted on the annual hunting license. The hunter has also to perforate a box corresponding to the harvest week. The marking strips are removed from the notebook and put on each Woodcock's leg at the shooting site. On every marking strip, the individual notebook number, the week number and the *département* of notebook issue are listed.

Table 1. **Number of notebooks distributed per hunting season and return rate.**

Hunting season	n. notebooks distributed	% returned
2005/06	54,889	72.1
2006/07	51,224	87.7
2007/08	48,790	88.3
2008/09	49,678	87.1
2009/10	49,868	86.9
2010/11	48,121	85.7

Acceptance of the scheme

The Breton Hunters' association and the *Office national de la chasse et de la faune sauvage* (ONCFS) were heavily involved in setting up and enforcing the regulation. Information was publicised at different levels: by the associations in their local hunting magazines and by ONCFS on the occasion of hunting license checks. Knowledge of the regulation was widespread, accepted and applied by the majority of hunters. The number of infringements among Woodcock hunters remained low (1% to 4.9% per year). Finally, enforcement arrangements appeared to be reliable.

Another measure of acceptance is given by the return rate of notebooks. About 50,000 notebooks were distributed every hunting season, of which 72.1% to 88.3% were returned (***Table 1***). These high values show the hunters willingness to respect the regulation.

Information collected

Annual Woodcock bags

As the notebook return rate was high, an extrapolation of the annual hunting bag from the returned notebooks seemed justified. The annual Breton Woodcock bag ranged from 112,000 to 154,800 birds (***Table 2***) over 6 hunting seasons (2005/06 - 2010/11).

The contribution of each Breton *département* to the regional Woodcock bag followed an increasing gradient from East to West: 11.5% (*Ille-et-Vilaine*) to 40.7% (*Finistère*; ***Table 3***).

Table 2. **Estimations of Woodcock hunting bags (birds harvested) per season in Brittany after extrapolation from returned bag notebooks.**

	Breton "départements"				
Hunting season	Finistère	Morbihan	Côtes d'Armor	Ille-et-Vilaine	Total
2005/06	52,386	42,085	40,291	13,590	**148,352**
2006/07	43,985	33,245	23,710	11,138	**112,078**
2007/08	51,080	37,107	33,423	16,905	**138,515**
2008/09	59,952	38,194	33,710	14,899	**146,755**
2009/10	64,108	40,928	34,532	15,254	**154,823**
2010/11	51,821	32,981	26,533	16,262	**127,596**

Table 3. **Proportion (%) of each Breton *département* in the regional Woodcock hunting bag (birds harvested) per hunting season.**

	Breton "départements"			
Hunting season	Finistère	Morbihan	Côtes d'Armor	Ille-et-Vilaine
2005/06	35.3	28.4	27.2	9.2
2006/07	39.2	29.7	21.2	9.9
2007/08	36.9	26.8	24.1	12.2
2008/09	40.9	26.0	23.0	10.2
2009/10	41.4	26.5	22.3	9.8
2010/11	40.6	25.8	20.8	12.8
Average	**40.7**	**25.9**	**21.9**	**11.5**

Individual Woodcock bags

As expected, the individual Woodcock hunting bags followed a Poisson distribution. Every season just under 50% of hunters shot at least one woodcock (***Figure 2***) and around 2.5% shot 20 woodcocks or more (***Figure 2***).

On average, a Breton hunter shot 0.8 to 5 woodcocks each season depending on *département* and season (***Table 4***). However, when restricted to hunters who shot at least one woodcock, the individual hunting bags ranged from 3.4 to 7.8 woodcocks.

Monthly distribution of Woodcock hunting bags

Between 60.1% and 71.3% of the annual Woodcock bag was taken in November-December (***Figure 3***). For two hunting seasons (2006/07 and 2007/08) the bag was the same in these two months. For the others, a smaller value in November was compensated for by a larger number in December and vice-versa. In 2010/11, the December bag was twice that obtained in November. February usually represented less than 10% of the seasonal bag except in 2008/09 and 2009/10 for which it was around 15%. At the end of December, about 70% of the total annual Woodcock bag had usually been taken (***Figure 4***).

Chronology of migration

Assuming that the hunting bags are positively correlated with Woodcock abundance, a depiction of the chronology of autumn migration can be estimated. We limited data from week 39 to week 52 to cover the whole migration period (Ferrand & Gossmann 2009; ***Figure 5***) and pooled the data for all *départements* to get a regional result.

The different seasons clearly differ in terms of their migration chronology. Arrivals of migratory woodcocks usually occurred around week 43 (end-October) and their numbers regularly increased until week 45 (mid-November). However, in 2007/08 arrivals were about two weeks earlier than in 2009/10. While the 2008/09 season presented a unique migration peak at the end of November, two peaks appeared in 2007/08, in mid-November and mid-December. In contrast, a plateau was quickly reached in 2006/07, which lasted about 6 weeks with no marked peak. Finally, 2010/11 is characterized by a marked peak in week 49 (mid-December).

Discussion – Conclusion

In spite of the constraint imposed on hunters, the Woodcock bag limit was well accepted in Brittany probably because of a long dialogue made by the hunters' associations themselves. Indeed, before the 2005 ministerial order was signed, Woodcock bag limits were organised at the *département* level for about 10 years. Therefore, Breton hunters were already trained and aware of such a scheme.

The application of the Breton Woodcock bag limit has proved valuable in terms of hunting management and biological knowledge. However, this can be successful only if control arrangements are efficient and regulation respected by hunters,

Figure 2. Distribution of individual Woodcock hunting bags (birds harvested) per hunting season in Brittany.

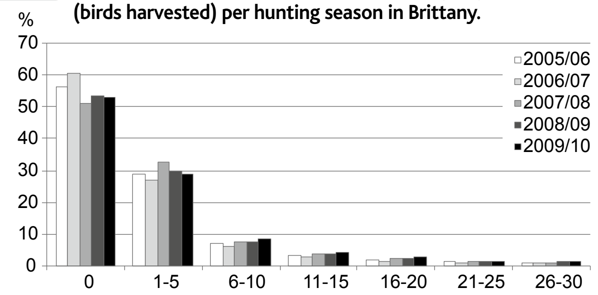


Figure 3. Monthly distribution of Woodcock hunting bags (birds harvested) per hunting season in Brittany.

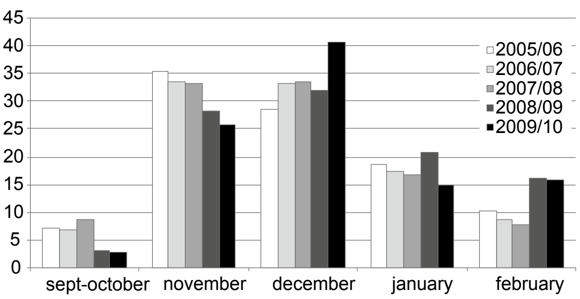


Figure 4. Cumulative frequencies of the monthly Woodcock hunting bag (birds harvested) per hunting season in Brittany.

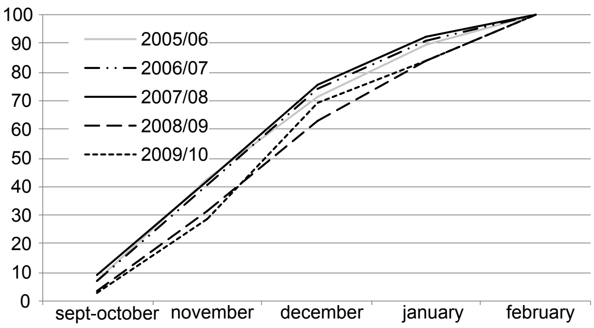


Figure 5. Chronology of the Woodcock autumn migration in Brittany per hunting season based on weekly Woodcock hunting bags (birds harvested).

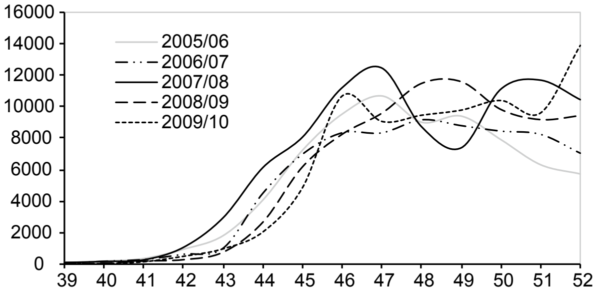


Table 4. Average Woodcock hunting bag (birds harvested) per hunter and per hunting season in Brittany for all hunters (column A) and for hunters who shot at least one woodcock (column B).

	Breton "départements"							
	Finistère		Morbihan		Côtes d'Armor		Ille-et-Vilaine	
Hunting season	A	B	A	B	A	B	A	B
2005/06	4.1	7.2	3.0	5.9	3.1	6.3	0.9	3.5
2006/07	3.5	6.4	2.7	5.7	1.9	5.4	0.8	3.5
2007/08	4.3	7.0	3.1	5.7	3.0	6.1	1.2	3.7
2008/09	4.7	7.8	3.2	6.0	2.8	6.3	1.1	4.0
2009/10	5	8.1	3.5	6.6	3.1	6.6	1.2	4.1
2010/11	4.2	6.9	3.0	5.5	2.4	5.3	1.2	3.4

as was the case in Brittany. Compulsory marking strips and a bag notebook sent back to the hunters associations at the end of the season were absolutely necessary.

The annual Woodcock bag is now well documented at a regional scale and individual level as well. The estimates available for six seasons were always lower than that given by a national inquiry for the 1998/99 hunting season (231,500; Ferrand & Gossmann 2000). The relative differences were between 33.1% and 51.6% according to the hunting season. This could be explained by an over-estimate due to the sampling method employed in the 1998/99 inquiry and/or the effect of the bag limit. Nevertheless, our results also showed that annual variations occurred in Woodcock hunting bags, probably in relation to abundance. The highest relative difference, registered between the 2006/07 and 2009/10 seasons, was 28% (≈ 43,000 woodcocks). This means that hunting bag inquiries must be performed every season to take account of annual variation.

The individual Woodcock hunting bags showed that the Woodcock is a very popular game bird in Brittany, where around 50% of hunters shoot at least one Woodcock each year. If we treat hunters that shoot at least 10 birds per year as "Woodcock specialists", they represent on average 9.4% (7.2 – 11.3) of Breton hunters every season and 2.5% of the total number of French hunters (Ferrand & Gossmann 2000).

The distribution of individual Woodcock bags and the relatively high number of specialized hunters make a Woodcock bag limit efficient in terms of bag control, *i.e.* in the case of poor breeding success in a given summer.

This 6-year experience in Brittany showed that setting a Woodcock bag limit was realistic and widely accepted by hunters. This was helpful for signing the ministerial order on May 31, 2011, which establishes a Woodcock bag limit for the whole of France with a control schedule very close to the Breton one.

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Analysis of sex and age ratios of the Woodcock population shot in spring 2010 in Hungary

Sándor Faragó, Richárd László
Dénes Fluck & Attila Bende

Institute of Wildlife Management and Vertebrate Zoology,
University of West-Hungary, Sopron , H-9400 Sopron, Ady E. u. 5. Hungary
Emails: farago@emk.nyme.hu, laszlo@emk.nyme.hu & denisfluck@yahoo.hu

The results of the renewed Woodcock hunting bag monitoring in Hungary are presented. Data were collected in spring 2010, and almost 2,500 birds were analysed. Biometric features, sex and age ratios were reported. Measurements and sex determination by autopsy were made at about 400 hunting grounds. Age determination was realised in the framework of a wing survey on the basis of 912 wings. The proportion of females and 1st year birds were respectively 16.6%, and 50%. These values were 21% and 43% in an earlier Hungarian study (1990-2008). The average body weight (312.3 g) in 2010 was not significantly different to those of woodcocks bagged in the last two decades in Hungary (313.2 g).

Shooting of roding Woodcock in spring has always been a traditional hunting practice in Hungary. The yearly bag varied from 2 000 to 10 000 birds (Faragó *et al.* in this issue). Since 2009, spring Woodcock shooting is forbidden according to the EU Birds Directive (79/409 EGK) which prohibits shooting when birds are passing through their nesting territories. The Directive allows for derogations under controlled conditions and only for a small number [1% of total mortality (natural + hunting) at maximum] of birds.

In the same time, 2 surveys were carried out in Hungary for a five-year period. The National Roding Censuses started in 2009 (Szemethy *et al.* 2010) and aimed to define the numbers of migrating birds. The National Roding Bag Monitoring started in 2010 to define the age and sex of woodcocks collected for research purposes during the spring migration. The participants in this research also performed observations concerning migrating birds in 2009 and sent the results to the National Game Management Database.

This paper aims to explore the following topics:

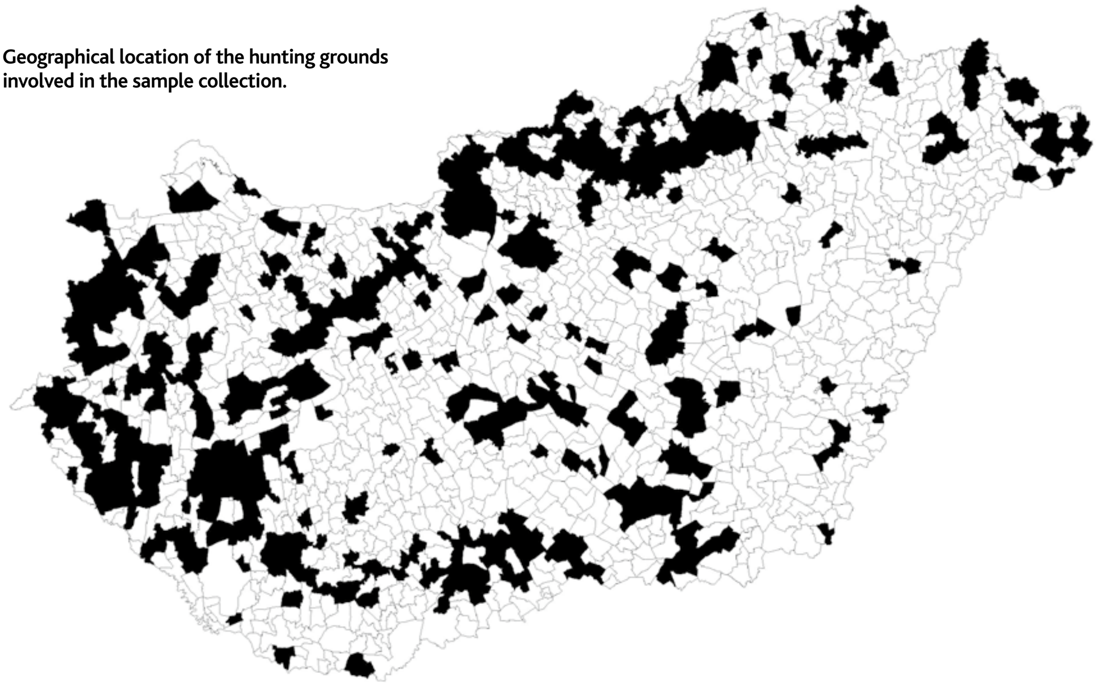
❶ annual characteristics of the body dimensions of the Woodcock;
❷ condition of the Woodcock in Hungary after the wintering period;
❸ effects of hunting pressure on the sex and age groups of the Woodcock populations moving through Hungary.

This paper shows the results of the first year of the renewed National Roding Bag Monitoring.

Material and methods

On the basis of the number of permits to shoot Woodcock, theoretically there was a chance to provide some 5 300 specimens. However, the analysis only includes 2 449 woodcocks shot on roding during spring 2010. The birds were collected on nearly four hundred hunting grounds in Hungary (***Figure 1***).

Figure 1. **Geographical location of the hunting grounds involved in the sample collection.**



The woodcocks were measured using the usual methods in ornithology (Faragó *et al.* 2000). We measured weight (in gram), body length (in mm), wing length (in mm), tail length (in mm), bill length (in 0.1 mm) and length of tarso-metatarsus (in 0.1 mm). As the Woodcock hunting season in Hungary corresponded to the beginning of the sexual active period, the sex was easily determined by autopsy. (n = 2 446; ***Figure 2***). The age was determined according to Clausager (1973), Kalchreuter (1979), Stronach (1983) and Boidot (pers. comm.) on 912 wings collected in the framework of a wing survey.

Figure 2. **Sexual organs of male (above) and female woodcocks in spring time (Photos: Faragó, S.).**

Normality of data was checked with a Fisher test and then we used a Student t-test for comparisons. When the Student t-test was not applicable (owing to non-Normal data) we applied a Welch test.

The spatial data were analysed with the help of the *Arcview* GIS software. We used the Kernel-method (60%) to study the weekly pattern of the spring migration under the assumption of a similar hunting effort thoughout the study period.

Results

The measurements of males, females and total birds are shown in ***Table 1***. No significant differences were found among sexes. The average weight was 312.3 g (n = 2 429).

The weight of males and females remained relatively stable during the study period (8 weeks) but clearly decreased at the end of the spring migration (***Table 2***). In the case of males, the values of the 6th week differed significantly from the 3rd, 4th and 5th weeks ($t_{3-6} = -1.86$, p = 0.062; $t_{4-6} = -1.71$, p = 0.088; $t_{5-6} = -1.66$, p = 0.097). A difference between the weights of males and females was shown by the t-test for the 4th and 7th weeks ($t_4 = 3.19$, p = 0.001; $t_7 = 1.92$, p = 0.062), the Welch test found it significant in the 5th and 6th weeks (p = 0.05).

The changes in wing lengths do not appear significant during migration (***Table 3***).

Table 1. **Measurements of a sample of woodcocks shot in spring 2010, in Hungary.**

Males	N	average	conf. int. ±	min. – max.
Weight (g)	2,021	311.0	*1.1*	207-420
Body length (mm)	2,001	340.1	*0.6*	286-395
Wing length (mm)	2,021	203.2	*0.9*	140-283
Tail length (mm)	2,012	85.8	*0.4*	53-119
Bill length (mm)	2,022	72.5	*0.2*	58.2-86.2
Tarsus length (mm)	*2,018*	*38.1*	*0.1*	25-51.4

Females	N	average	conf. int. ±	min. – max.
Weight (g)	405	318.8	3.0	227-419
Body length (mm)	402	339.7	1.5	284-382
Wing length (mm)	403	201.9	2.0	130-273
Tail length (mm)	400	85.0	0.8	53-106
Bill length (mm)	405	73.2	0.4	59-85.1
Tarsus length (mm)	403	38.4	0.3	30-50

Total	N	average	conf. int. ±	min. – max.
Weight (g)	2,429	312.3	1.1	207-420
Body length (mm)	2,406	340.0	0.6	284-395
Wing length (mm)	2,427	203.0	0.8	130-283
Tail length (mm)	2,415	85.6	0.3	53-119
Bill length (mm)	2,430	72.6	0.1	58.2-86.2
Tarsus length (mm)	2,424	38.1	0.1	25-51.4

Table 2. **Weekly variation in mean weight for a sample of woodcocks shot in spring 2010 in Hungary.**

Week	Period	Males		Females	
		n	gram	n	gram
1	March 1-7.	4	321.5	1	297.0
2	March 8-14.	59	310.0	6	308.8
3	March 15-21.	467	310.4	79	314.9
4	March 22-28.	836	310.9	155	318.2
5	March 29. - April 4.	*450*	310.6	112	317.7
6	April 5-11.	178	314.6	45	330.8
7	April 12-18.	41	309.8	7	308.0
8	April 19-25.	3	283.3	1	300.0
	Total	**2038**	**311.0**	**406**	**318.8**

Table 3. **Weekly variation in mean wing length for a sample of woodcocks shot in spring 2010 in Hungary.**

Week	Period	Males		Females	
		n	gram	n	gram
1	March 1-7.	4	193.3	1	188.0
2	March 8-14.	59	211.9	6	202.5
3	March 15-21.	467	202.6	79	202.1
4	March 22-28.	836	203.4	155	199.9
5	March 29. - April 4.	450	202.8	112	203.0
6	April 5-11.	178	202.7	45	204.7
7	April 12-18.	41	202.2	7	225.0
8	April 19-25.	3	220.0	1	195.0
	Total	**2038**	**203.2**	**406**	**201.9**

Under the assumption of a constant hunting effort, a low intensity of migration was registered in the beginning of March (5 to 65 birds of the sample). Then an increase of intensity occurred after 15 March (546 birds) which culminated on 22-28 March (991 birds). Finally a strong and steady decline was observed until mid-April (***Figure 3***).

The very low number of data in the periods 1-7 March (5 birds) and 19-25 April (4 birds) is not statistically representative therefore it can be ignored. On average, the females represented 16.6 % of the sample. The pattern of weekly variation in the number of females collected is similar to those of males with a peak on 22-28 March. On the other hand, a higher proportion of females was registered towards the end of March – beginning of April, comprising 20% of the sample (***Figure 4***). Since the woodcocks were exclusively shot when roding, the high proportion of females might be due to the fact that with the coming of the incubation period, the activity of females is higher in comparison with the earlier period, and this helps to ensure mating.

The proportion of 1st year birds was 50%. (n = 912) and remained relatively stable during the course of the migration (***Figure 5***).

Discussion and conclusions

The Woodcock Bag Monitoring in 2010 gave a great opportunity to describe the pattern of woodcock populations' dynamics in the whole springtime in Hungary.

The average weight (312.3g) of Woodcocks collected in 2010 did not differ from those of the Woodcocks bagged in the last two decades in Hungary (313.2g; ***Figure 6***). If we consider weight as representative of the physical condition of birds and therefore as a factor influencing the breeding success, the results did not show any difference in 2010.

This study highlighted a lower proportion of females (17%) in the Woodcock bag compared to the previous results (21%) (Faragó *et al.*, 2000; Faragó & László, 2010 and Faragó & László in this volume).

On average, a similar proportion of 1st year birds and adults were found in the sample. The proportion of 1st year birds was 43% in an earlier study (Faragó & László, 2010). The temporal pattern of the samples shows that spring hunting between 1 March and 10 April in Hungary happened during the peak of migration.

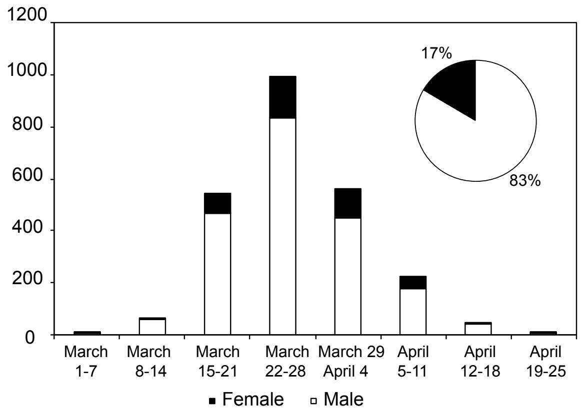


Figure 3. **Weekly dynamics of sex in the Woodcock sample collected in 2010.**

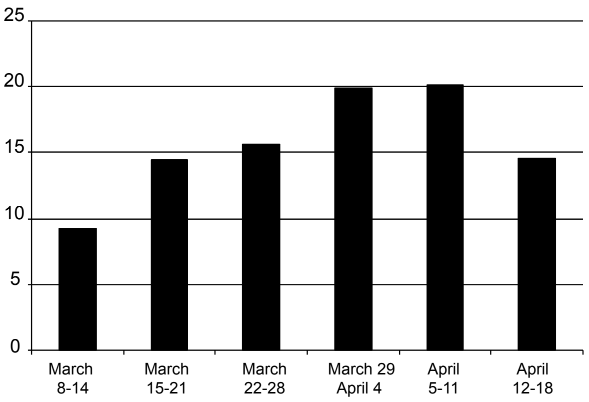


Figure 4. **Weekly dynamics of proportion of females in the Woodcock bag in spring 2010.**

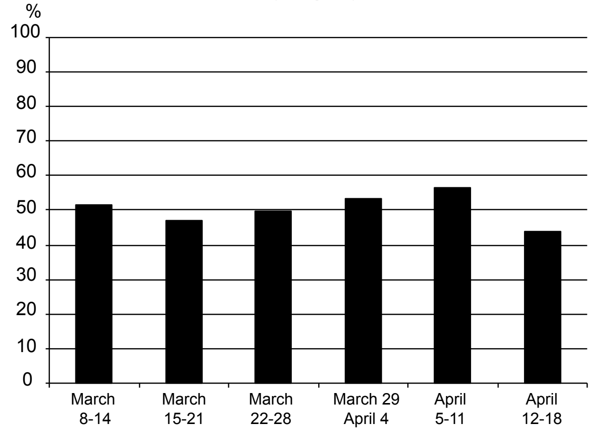


Figure 5. **Weekly dynamics of proportion of young (1y) birds in the Woodcock bag in spring 2010.**

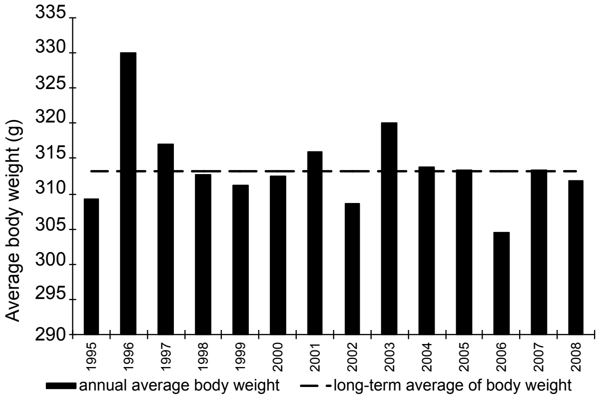


Figure 6. **Annual variation in the average weight of woodcocks in Hungary (1990-2008).**

This survey will provide a chance to obtain more information on the migration pattern of Woodcock at a regional level (***Figure 7***), and will allow the comparison of our results with those of the National Roding Censuses in Hungary (Szemethy *et al.*, 2010).

The migrating woodcocks seem to reach Hungary via three routes. On the first route (mid-March to early April) they could arrive from a South-West direction and leave the country in the North East. A second route (mid-March to early April) could concern South Hungary and continue to the North. Finally, a third route could drive the woodcocks from the eastern border along the western edge of the Carpathians.

In our future investigations, comparing the two surveys, we should have a clearer picture of time-space patterns of migration, and migration dynamics according to sex and age. A program using GPS transmitters which is expected to start in 2013 may increase the accuracy of the results of the two surveys.

Acknowledgements

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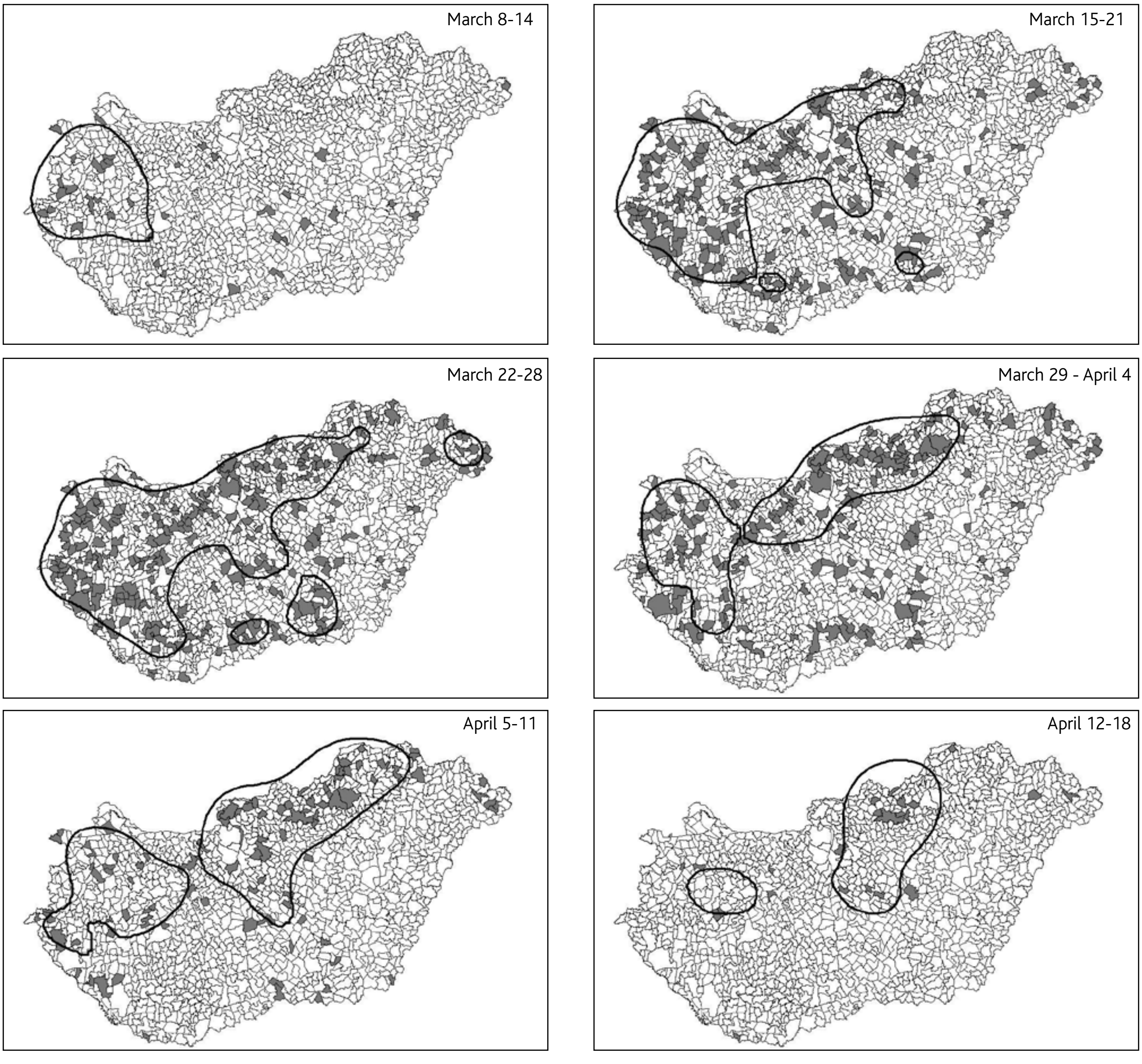
Figure 7. **Weekly pattern of Woodcock spring migration in Hungary in 2010 on the basis of hunting bags (after 60% KERNEL values).**



Effects of summer 2010 drought in European Russia on the migrating and wintering Woodcock population in France

François Gossmann Office National de la Chasse et de la Faune Sauvage, Research Department –
Migratory Birds Unit, 39 Bd Albert Einstein, CS 42355, F-44323 Nantes Cedex 3
Email: francois.gossmann@oncfs.gouv.fr

Jean-Paul Boidot Club national des bécassiers, Le Moulin du Buis, Beg Aël, 29940 La Forêt-Fouesnant, France
Email: jpboidotcnb@wanadoo.fr

Claudine Bastat & Yves Ferrand Office National de la Chasse et de la Faune Sauvage, Research Department – Migratory Birds Unit,
39 Bd Albert Einstein, CS 42355, F-44323 Nantes Cedex 3
Emails: claudine.bastat@oncfs.gouv.fr & yves.ferrand@oncfs.gouv.fr

Drought can be a source of stress for birds, especially for those like the Woodcock whose diet is based on earthworms. After a severe drought in Russia in summer 2010, this study investigated the effects on breeding success, physiology and moult of the migrating woodcocks in France. Analysis was based on data collected by ringers and by hunters. The breeding success was estimated through the proportion of juveniles. The effect on physiology and moult was defined respectively by the proportion of birds < 300 g and by the proportion of birds with incomplete moult of wing feathers. An effect of drought on breeding success was recorded in so far as the proportion of juveniles was the lowest of the last 10 years. The adult moult also seemed to be impacted. However, no drought effect was found on weight and juvenile moult. In terms of management, this study underlines the importance of weather conditions on breeding success not only at the peak of hatching but during the whole breeding period.

Hot temperatures and lack of precipitation are often a source of stress for animals not especially adapted to live in such conditions. The consequences of drought on bird populations can be varied depending on whether we look at long or short-term effects. In long term, drought can have an impact on abundance, richness and composition on avian communities in the framework of global climatic change (Albright *et al.* 2010). In the short term, it can lead to negative effects on physiology and/or survival.

During summer 2010, a harsh drought was observed in European Russia from June 20 to end August (Fokin *et al.* 2010). Temperatures above 30°C, *i.e.* 7-8°C above mean (1968-1996 period; Source: http//www.cdc.noaa.gov/Composites/Day/index.html) were registered on several days during mid July – mid August across a large area of the mixed and deciduous forest zones (Moscow, Vladimir, Ryazan, Kirov, Nizhniy-Novgorod regions). In total, 2.2 million hectares could have been burned because of forest fires in the European part of Russia (Bondur 2010). This situation has never been encountered since the meteorological data have been collected in Russia (beginning of 1900's).

For birds like Woodcock (*Scolopax rusticola*), the diet of which is mainly based on earthworms, drought greatly modifies prey availability. In a similar situation in 1978 in Maine (USA), Sepik *et al.* (1983) showed that American Woodcock (*Scolopax minor*) suffered from starvation and delayed their moult. In relation to this study, we hypothesized that the 2010 Russian drought had an effect on physiology, moult and breeding success of Woodcock and we considered that the consequences could be observed in the migrating/wintering woodcocks in France.

Material and methods

Two sources of data were used for analysis: the birds ringed by the French ONCFS/FNC/FDC Woodcock network and the birds shot by hunters of the *Club national des bécassiers* (CNB) (***Table 1***). Three main age classes were defined for all birds: adult, juveniles with complete greater coverts moult (JCM) and juveniles with interrupted greater coverts moult (JIM). A fourth class was determined among adults only in the shot birds' sample: adult with complete moult after Boidot (1999). Determination of age was carried out both by ringers and hunters according to the Woodcock sample. We hypothesized that experience could have been different in every group of observers and we analysed the data separately.

Table 1. **Total number of birds (n) available for analysis per season and per variable analysed.**

Season	Weight (n)	Age and moult - ONCFS) (n)	Age and moult - CNB (n)
2000/01	1,061	-	-
2001/02	1,117	3,745	8,196
2002/03	746	3,512	6,033
2003/04	1,256	4,300	8,238
2004/05	1,419	5,009	9,940
2005/06	1,203	4,545	9,423
2006/07	1,471	5,102	8,810
2007/08	1,627	5,894	9,815
2008/09	1,573	6,204	9,895
2009/10	1,989	6,662	10,324
2010/11	1,334	4,746	8,538

As the weight measurement is more accurate on live than on dead birds, we used in our analysis only the weight (± 1 g) of ringed birds.

Two main migration flyways are known for Woodcock migrating/wintering in France: a Fenno-Scandinavian one and a Central-Eastern one (Bauthian *et al*. 2007). South-East France is only influenced by the Central Eastern flyway, whereas about 30% of woodcocks found in North-West France come from the Fenno-Scandinavian flyway. As the Central-Eastern flyway has the highest probability to have been affected by drought and the Northern the lowest, migrating/wintering data were divided into 3 regions: “North”, “South-East” and “rest of France”. Because ringed woodcocks were more evenly distributed over the whole of France than hunted woodcocks, we selected the sample of ringed birds for the regional analysis with the exception of the analysis of the proportion of adults with complete moult which was recorded only for shot birds.

The physiological effect of the summer 2010 drought was tested from the proportion of woodcock weights < 300 g among birds captured until 30 November, *i.e.* during autumn migration. On the one hand, such a weight can be considered as abnormal at this period of the year. On the other hand, the birds can more easily recover their energetic reserves after migration and find again their normal weight.

The effect on breeding success was tested from the proportion of juveniles among captured woodcocks in France.

The effect on moult was tested from the proportion of JIM among juveniles and from adults with a complete moult of wing feathers. Indeed, post-juvenile moult is stopped by post-nuptial migration and birds hatched after the end of June do not have enough time to completely moult their greater upper-wing coverts (Ferrand & Gossmann 2009a). Drought mainly took place in July-August and could have had a greater effect on these types of juveniles. In the same way, adult post-nuptial moult is observed from late June to early October (Ferrand & Gossmann 2009a) and could have been disturbed by drought.

To test these effects we used descriptive statistics (Score confidence Interval method; Agresti & Coull 1998) and compared 2010/11 data with data collected since 2001/02 (2000/01 for weight).

Results

Effects on weight

The proportion of Woodcock weights < 300 g in 2010/11 remained close to the average (2000/01 – 2009/10 period) for all weighed birds (9.4% compared to 8.8%), adults (8.3% compared to 6.9%) and JIM (10.6 compared to 10.4) but a large difference was observed for JCM (12.4 compared to 8.4). However, the 2010/11 JCM values do not differ statistically from the majority of the other seasonal values (***Table 2***). Similarly, no statistical difference is observed when data are divided by the three French regions.

Figure 1. Proportion of juveniles per season ranked by increasing order (95% CI) for ringing data (ONCFS) and hunting data (CNB) collected in total France. *Black dot*: season 2010/11.On the *x*-axis the year corresponds to the beginning of the season, e.g. 2001 stands for the season 2001/02.

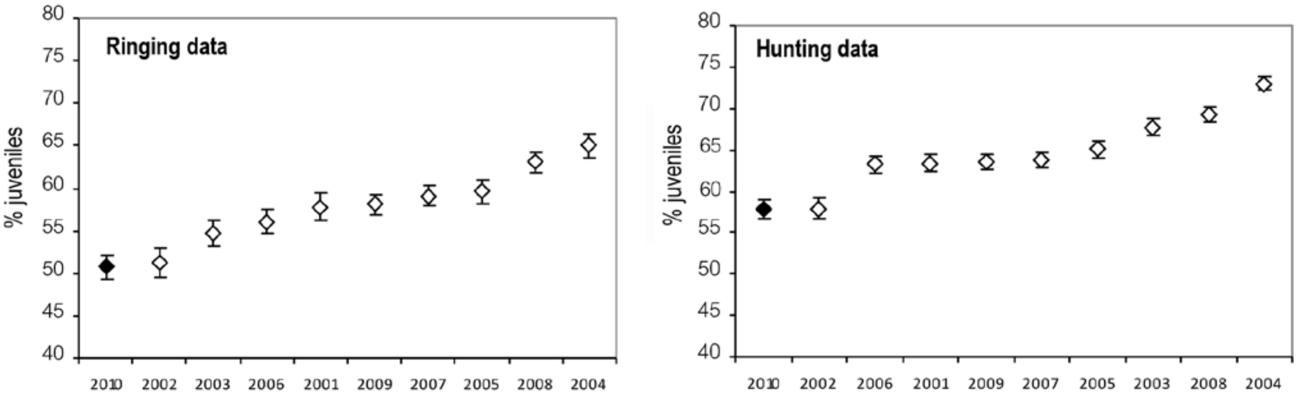


Table 2. Proportion of juveniles with complete greater coverts moult (JCM) weighing < 300 g ringed up to 30 November each season (95% CI) for total France and for each of the three regions (*cf. text*).

Season	Total France		North		South East		Rest of France	
	%	CI	%	CI	%	CI	%	CI
2000/01	6.7	4.6 - 9.6	3.9	1.3 - 10.8	7.8	3.1 - 18.5	7.3	4.7 - 11.1
2001/02	9.2	6.6 - 12.5	4.8	1.6 - 13.1	14.1	7.6 - 24.6	9.0	6.0 - 13.3
2002/03	9.4	6.0 - 14.6	8.9	3.5 - 20.7	8.8	3.0 - 23.0	9.9	5.5 - 17.3
2003/04	6.5	4.5 - 9.2	0.0	0.0 - 6.0	10.5	4.9 - 21.1	7.0	4.7 - 10.4
2004/05	9.0	6.9 - 11.6	1.9	0.6 - 5.4	17.2	9.6 - 28.9	10.9	8.0 - 14.6
2005/06	9.3	7.0 - 12.2	9.8	6.1 - 15.3	19.2	10.8 - 31.9	7.1	4.6 - 10.8
2006/07	10.0	7.7 - 12.8	5.5	2.8 - 10.5	12.2	6.5 - 21.5	11.6	8.4 - 15.6
2007/08	7.0	5.2 - 9.4	5.9	3.2 - 10.5	5.7	2.5 - 12.8	7.9	5.5 - 11.3
2008/09	8.8	6.9 - 11.3	2.1	0.7 - 6.0	13.0	8.2 - 20.1	10.0	7.4 - 13.5
2009/10	8.4	6.6 - 10.6	4.8	2.5 - 8.8	17.9	11.9 - 26.0	7.4	5.3 - 10.3
2010/11	12.4	9.7 - 15.8	9.9	5.5 - 17.3	13.4	8.0 - 21.6	13.0	9.5 - 17.7

Effects on breeding success

The proportion of juveniles among ringed and shot woodcocks observed in 2010/11 (50.7% and 57.8%, respectively) appeared clearly lower than in the previous year but close to the 2002/03 value (51.3% and 57.8% respectively; ***Figure 1***). This result is undoubtedly confirmed in the "rest of France" region and to a small extent in the "South East" region. However, no clear statistical difference was observed in the "North" region (***Figure 2***).

Effects on moult

The proportion of JIM among juveniles analysed in 2010/11 did not differ from the values registered in the last 10 years for the ringed birds and was visibly in the highest values for shot birds (***Table 3***). No significant result was recorded in the regional analysis, although the 2010/11 "South East" value corresponds to the lowest of the decade (***Table 3***).

However, an effect on adult moult was apparent through the proportion of adults with complete moult (***Figure 3***). The 2010/11 value is the second lowest of the last 10 years and differed statistically from seven annual values. A similar result was observed for "South East" and "rest of France" regions but not for "North" region.

Figure 2. **Proportion of juveniles (ONCFS ringing data) per season ranked by increasing order (95% CI) for the three regions (cf. text).**
Black dot: **season 2010/11.On the x-axis the year corresponds to the beginning of the season. e.g. 2001 stands for the season 2001/02.**

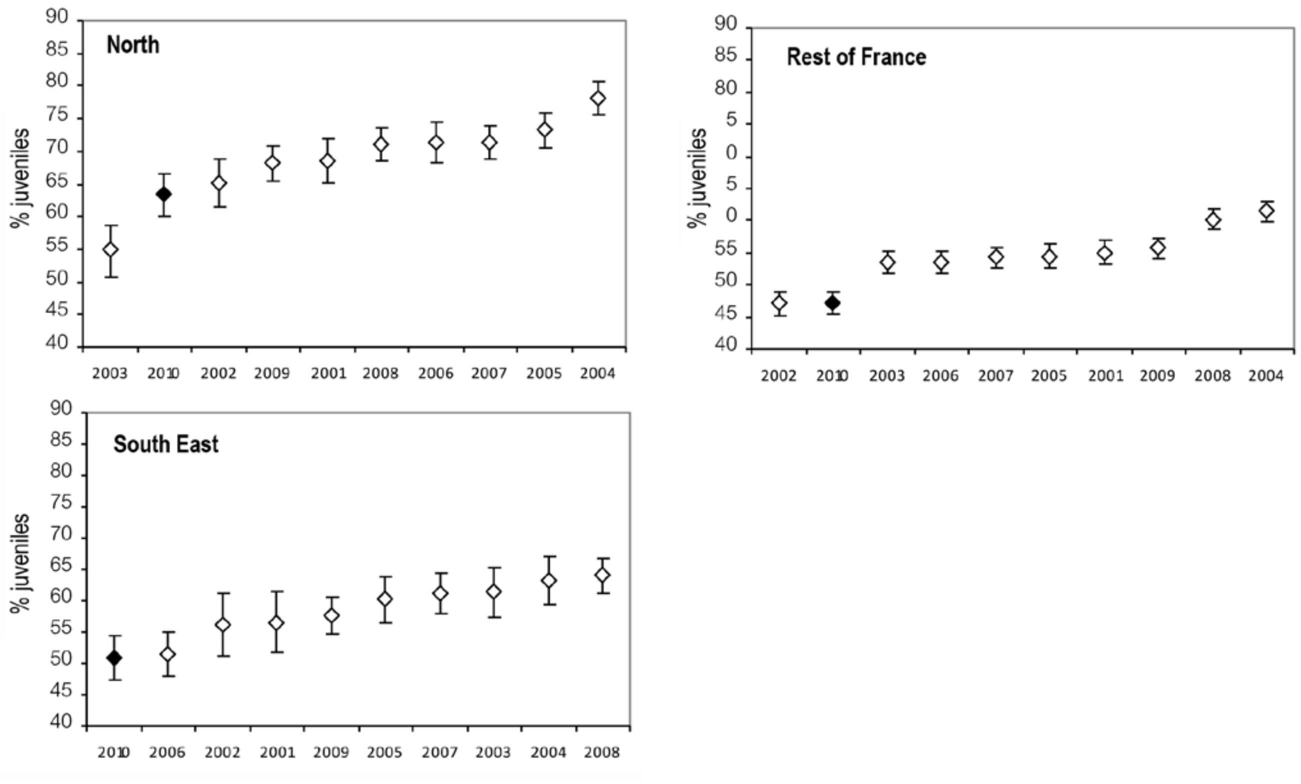
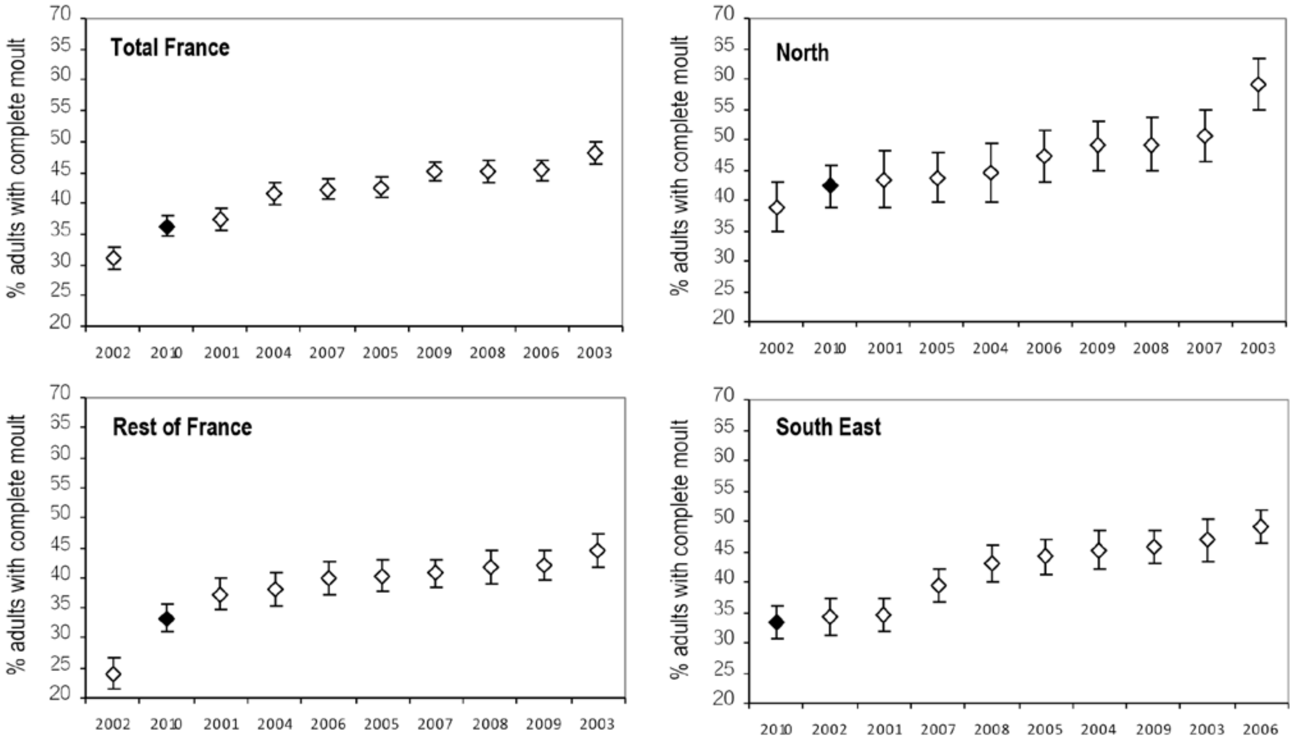


Table 3. **Proportion of juveniles with interrupted post-juvenile moult (JIM) per season (95% CI) for ringing data (ONCFS), hunting data (CNB) and for each of the three regions (*cf. text*).**

Season	Total France (ringing data		Total France (hunting data)		North		South East		Rest of France	
	%	CI	%	CI	%	CI	%	CI	%	CI
2001/02	41.5	39.3 - 43.6	37.6	36.3 - 38.9	55.1	50.5 - 59.6	35.1	28.9 - 42.0	37.7	35.2 - 40.4
2002/03	43.9	41.5 - 46.3	43.6	41.9 - 45.2	45.9	40.9 - 51.0	41.6	35.0 - 48.5	43.6	40.6 - 46.6
2003/04	39.5	37.5 - 41.6	39.7	38.4 - 41.0	45.9	40.4 - 51.5	38.3	32.9 - 44.0	38.5	36.1 - 41.0
2004/05	38.2	36.5 - 40.0	36.1	35.0 -37.2	46.2	42.6 - 49.8	37.6	32.6 - 42.8	35.4	33.3 - 37.5
2005/06	37.2	35.3 - 39.1	35.9	34.7 - 37.1	43.6	40.0 - 47.3	32.5	27.9 - 37.5	35.2	32.9 - 37.7
2006/07	37.1	35.3 - 38.9	33.3	32.1 - 34.5	38.8	34.8 - 42.8	30.6	25.9 - 35.7	37.8	35.6 - 40.1
2007/08	39.6	37.9 - 41.2	33.5	32.3 - 34.7	49.1	45.8 - 52.3	36.8	32.7 - 41.0	35.8	33.7 - 38.0
2008/09	37.6	36.0 - 39.1	34.5	33.4 - 35.6	46.3	43.0 - 49.7	33.1	29.8 - 36.5	35.7	33.8 - 37.8
2009/10	34.8	33.3 - 36.4	34.9	33.8 - 36.1	40.0	36.6 - 43.6	33.3	29.6 - 37.3	33.5	31.7 - 35.5
2010/11	36.5	34.5 - 38.4	39.1	37.7 - 40.4	47.3	43.1 - 51.4	27.5	23.2 - 32.2	34.7	32.2 - 37.2

Figure 3. **Proportion of adults with complete moult per season ranked by increasing order (95% CI). Data are from hunted birds (see text) and are presented for total France and for each of the three regions (cf. text). *Black dot*: season 2010/11. On the *x*-axis the year corresponds to the beginning of the season, e.g. 2001 stands for the season 2001/02.**



Discussion-Conclusion

A low proportion of juveniles in ringed and shot woodcocks seems the only effect that we can link to the summer 2010 drought in European Russia. An effect more apparent in "South-East" and "rest of France" regions strengthens this hypothesis according to the migration flyways. A very low proportion of juveniles (45%) observed among birds ringed in North-West Russia in autumn 2010 agrees with our results (Vysotsky & Iljinsky 2010) This corresponds to a general low breeding success which can be due to depletion of food and/or mortality at hatching because of hot temperatures. Moreover, in drought conditions birds tend to concentrate in humid forest sites where higher levels of predation can occur and mainly concern inexperienced juveniles.

In this respect, no effect found on the proportion of JIM in France is surprising, despite the very low value (8.4%) observed in Central Russia at the beginning of autumn migration (Fokin ***et al.*** 2010). Indeed, woodcocks hatched in June-July were expected to suffer more from drought and consequently to be less numerous than usual among juveniles. This could be explained with moult problems for all bird categories as the results for adults seem to illustrate. Moult demands high energy and requires high food abundance. The proportion of adults with a complete moult appears low compared with the ten-year values and could point to problems in food availability. This also concerns juveniles in their post-juvenile moult. Consequently, a fraction of juveniles hatched in the first part of the breeding period could have delayed the achievement of their moult and be misclassified as in JIM. Hence, a lack of JIM due to drought could have been compensated by misclassified JCM.

The absence of a physiological effect can be explained by the choice of variables recorded. Indeed, stress due to drought can be expressed not only as weight. Fat level records and hormonal dosages would have been more relevant to investigate this question. Moreover, woodcocks can refuel at stop-over sites and get fat quickly (2.4 g/day, Ferrand & Gossmann 2009b).

The 2010/11 season was similar to the 2002/03 season in relation to age-ratio and adult moult. Spring and summer 2002 were equally very dry in European Russia: 2-3 mm/day below mean (1968-1996) in precipitation from the whole May-August period (Source: http//www.cdc.noaa.gov/Composites/Day/index.html). Moreover, a cool period (3-6°C below mean) at the peak of hatching in the last 20 days of May and a hot period in July-August (2-4°C above mean) were registered. Therefore, a severe drought in spring-autumn 2002 led to the same effects.

This study emphasizes the effect of a summer drought on Woodcock breeding success. This means that not only the weather conditions during the peak of hatching in May, but also those of the whole breeding period will have to be considered in order to predict the abundance during the following autumn-winter hunting season.

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Nothing would have been possible without the important field work of the ringers of the ONCFS/FNC/FDC Woodcock Network and of the members of the *Club national des bécassiers* (France).

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Survival rates of Eurasian Woodcock (*Scolopax rusticola*) in North-West Russia based on ring recovery analyses

Vadim Vysotsky
Zoological Institute, Russian Academy of Sciences,Universitetskaya nab.,
1, St.Petersburg, 199034, Russia.
Email: avesvgv@zin.ru

Ivan Iljinsky
St.Petersburg State University,
Biology and Soil Faculty,Universitetskaya nab.,
7/9, St.Petersburg, 199034, Russia
Email: ivi-2008@yandex.ru

Woodcocks have been trapped and ringed annually since 1994 in Leningrad region, not far from St.-Petersburg. Woodcocks were captured at night in open field habitats using a spot-light technique; All trapped birds were aged (young = first-year hatched during the calendar year of ringing, and adult hatched before the calendar year of ringing) using plumage characteristics, moult and feather wear. Most woodcocks were ringed during autumn migration (September and October). According to recoveries during breeding period, these migratory birds belong to populations from north-western Russia (Vysotsky & Iljinsky, 2004; 2007). We used only hunting recoveries (shot or trapped by other means). We analysed a total of 339 recoveries of woodcocks from 2,525 birds ringed. Ring-recovery matrices were tabulated for 1994-2011 by each age class, using number ringed and ring recoveries. We used a Seber (1970) parameterization of ring-recovery models in Program MARK ver 6.1 (White & Burnham 1999) to estimate annual survival and reporting rates. Two age-class models are relevant in our study.

This approach permitted separate estimation of first-year and adult survival and reporting rates (i.e. to test for age effects). The global model for the ring-recovery analyses assumed that survival and recovery rates for woodcocks were time-dependent and age-dependent. We constructed an a priori set of 23 candidate models from a global model with age (first-years, adults) and time-dependent annual survival and reporting rates through to no age or time-dependent survival and reporting rates (*i.e.* various reduced-parameter models with constant rates). We looked for a global model fitting the data. A simulation approach was used to calculate the goodness-of-fit between our data and the global model. A distribution of expected deviance for the global model was generated from 1,000 simulations. Observed deviance was then compared to the distribution of simulated values to determine whether the global model was an adequate fit to the data. Subsequently, we tested for effects of yearly variation and age on survival and reporting rates. We used variance an inflation factor (Cooch & White 2001, Burnham & Anderson 2004) as a measure of overdispersion. We calculated variance the inflation factor as the observed deviance from the global model divided by the mean deviance from 1000 parametric bootstrap simulations of the global model. We estimated the variance inflation factor from the global model as □=1.107, which was used to correct the models for overdispersion.

Goodness-of-fit tests based on 1,000 simulations indicated that the global model was a satisfactory starting point (P-value = 0.202). Model selection was based on the information-theoretic approach (Burnham & Anderson 2004). Model selection favored models in which survival was a function of age and time. Reporting rate model selection favored models that contained the effect of age. Using Akaike's Information Criterion we chose a final additive model in which variation in survival with time was parallel for two age classes, and age-specific (first-years vs. adults) reporting rate was constant between years. Annual survival rates varied from 0.28 (SE = 0.075) during the season 1998/99 to 0.81 (SE = 0.079) during the season 2006/07 in adults and varied from 0.26 (SE = 0.086) during the season 1998/99 to 0.78 (SE = 0.097) during the season 2006/07 in first-years. Adult woodcocks had slightly higher survival rates than first-years. The first-year birds were full-grown when ringed and were probably physiologically equivalent to adults. First-year woodcocks had higher constant recovery rates (r = 0.175, SE = 0.026) than adults (r = 0.123, SE = 0.013). Hence, we found evidence that recovery rates were age-specific and were constant.

Aspects of the migration of Russian Woodcock (*Scolopax rusticola*), based on ringing data

Ivan V. Iljinsky St. Petersburg State University, St.Petersburg, Russia.
E-mail: ivi-2008@yandex.ru

Vadim G. Vysotsky Zoological Institute of the Russian Academy of Sciences, St.Petersburg, Russia.
E-mail: avesvgv@zin.ru;

Sergei Y. Fokin
& Peter A. Zverev State informational-analytical center of game animals and environment («Centrokhot kontrol»), Moscow, Russia.
E-mails: fokinwoodcock@mail.ru & peterzverev@mail.ru

Woodcock ringing in Russia commenced in June 1911, when Vladimir Dits first ringed woodcocks in the province of St.Petersburg in the vicinities of Gatchina. In 1985, H.A. Mihelson published the first analysis of woodcock ringing in Russia, based on just 64 recoveries of birds ringed in the former USSR, including 33 recoveries of woodcocks ringed in Russia, and 10 recoveries of birds ringed in other countries and shot in Russia.

In 1991, a new ringing program in Russia was organized by the *Office National de la Chasse et de la Faune Sauvage (ONCFS*, France). This paper presents some results of Woodcock ringing in Russia during 1991–2010, and over the last 100 years. In 1991-2010, the ringing has been carried out by ornithologists of St.Petersburg and Moscow together with the experts of ONCFS. The woodcocks were caught in September and October, just before and during post-nuptial migration. The Russian ornithologists used the French dazzling method for capturing birds. The ringing was carried out in 11 regions of the European part of Russia. During 20 years, more than 5,000 woodcocks were ringed (including more than 2,500 in the Leningrad region) and more than 600 recoveries were obtained, mainly from birds shot by hunters. To date, 720 recoveries of woodcocks ringed in Russia and 636 recoveries of woodcocks ringed in other countries and found in Russia are available in the 100-year database. This extensive collection of recoveries has enabled us to update our knowledge on the annual spatial distribution of woodcocks (breeding and wintering areas and migration directions) from various regions of Russia. To date, the birds ringed in the European part of Russia have been found in 27 countries. Besides France, where the majority of recoveries were reported (more than 350), important wintering areas include also Italy (57), Great Britain (53), Spain (40) and Greece (19 recoveries). Hypotheses about age-specific distribution within winter range and age-specific migratory direction were tested. The adults and the first-winter woodcocks of northwest Russia were found to have a similar average direction of migration, but the average distance was different. The first-year woodcocks, on average, spend their winter further away from the breeding grounds than adults. Because of this feature of migration, a higher concentration of young birds is observed on the Atlantic coast France and in the south of Italy. The capture of birds, which is carried out annually during autumn migration in the same places, enables annual fluctuations in their numbers to be monitored. The index of abundance (number of birds trapped or observed per hour) varied from year to year (from 1.3 up to 6.8 observed birds per hour for the woodcocks from the Leningrad region) and has a slight negative trend. It is possible to estimate, from trapping results, the brood survival of Woodcock using the young/adult ratio. This parameter varied from year to year (average 2.34 juveniles per adult in the Leningrad region) and was the lowest (0.8) in autumn 2010. The recoveries also enable the calculation of an annual survival rate: this shows obvious annual variations, but has no long-term trend.

Spring abundance of roding Woodcock in Moscow Region

Roman Anoshin Email: romian07@gmail.com

The Woodcock is the main quarry species during the spring hunting season in the central regions of the European territory of Russia. The Moscow Society of Hunters and Fishermen (MSHF) has collected data from a survey of hunters in order to monitor Woodcock populations in the Moscow area during the spring hunting season for the last four years. The most accessible method of gathering data on Woodcock is to question hunters who have obtained a hunting permit. In 2009 we developed a modified questionnaire comprising "the Individual card of shooting in a spring season". Hunters are asked to complete a table with a column corresponding to each day of the spring hunting season (16 days in total). The questionnaires rely on voluntary participation and anonymity of the hunters, but they are obligatory for the regional hunting organizations. In 2009 we received 1886 completed questionnaires, in 2010 we received 1250 and in 2011a total of 1856. Processing of the questionnaires consists transferring the numbers of woodcocks seen and shot per day during the hunting season to an Excel spreadsheet. These Excel tables are made for each local hunting area. Then the results are reduced to level of administrative area and to region as a whole. As hunting in the Moscow Region first opens in southern areas, followed a week later in northern areas, the survey records changes in total Woodcock numbers over 23 days. The greatest interest for us is represented by average indices of the woodcocks noted on every evening during the season. They allow the temporal pattern of roding Woodcock activity to be monitored throughout the hunting season and comparison of relative numbers for the area as a whole between years. Comparison between 2009 and 2010 has shown a difference of more than 20 %. The average number of woodcocks seen by one hunter on one evening in 2009 was 3.42, whereas in 2010 it was 2.71. The difference is explained by adverse conditions during winter 2009/10 and, despite the poor weather, hunting. The distribution of woodcocks across areas, in general, did not change. However, in 2009 there was a steady increase in the number of roding woodcocks throughout the spring hunting season, whereas in 2010 a decrease was observed.

Woodcock (*Scolopax rusticola*) nesting in Russia

Sergei Fokin Scientific research group «Woodcock», State Informational-analytical center
of game animals and environment (FGU «Centrokhotkontrol»), Moscow, Russia.
Email: fokinwoodcock@mail.ru

Peter Zverev
& Sergey Buslaev Russian Society for Conservation and Studies of Birds, Moscow, Russia
Email: peterzverev@mail.ru

Dmitry Vachugov Hunting Department of Moscow region

Forests occupy 45.5 % of the Russian territory. The Woodcock breeding area spreads from Karelia to Sakhalin in almost all wooded areas of the European part of Russia. One of the main tasks of scientific researches on Woodcock is the study of breeding biology and habitats. Since 1993, the "Woodcock" scientific group has collected data on Woodcock nests and broods. Searches for nests and broods were carried out with the help of pointing dogs. A detailed geobotanical description around all nests and broods located was systematically made. Owing to difficulties in finding nests and broods even with special searches, we also used information collected by foresters and hunters.

For the period 1993-2010, we collected information on 85 nests and 34 broods. The results showed that more than 70 % of nests were located at less than 100 m from open places (glades, clearfells, forest tracks, edges adjoining fields), 20 % were in open places (clearfells, glades) and only 10 % in the depth of a wood. The distribution of the nests in different types of forests is presented. The fate of 56 nests was registered. Among them, almost half (48 %) were unsuccessful, with causes of failure being abandonment by females, destruction by predators, snowfall or washing out in heavy rain.

The earliest date of first egg laying was on April 8, 2001 (Vladimir region), the latest on July 21, 2006 (Moscow region). Among all 85 nests, 18 were found in April (21 %), 39 in May (46 %), 19 in June (22 %) and 9 in July (11 %). During the study period, we registered about 50 broods. Data on ringing of chicks and recovery results are presented.

Census of roding Woodcock (*Scolopax rusticola*) in the "Sebezhsky" National Park (Pskov region, Russia)

Sergei A. Fetisov "Sebezhsky" National Park, Pskov region, Russia
E-mail: seb_park@mail.ru

The Woodcock *Scolopax rusticola* is a common bird in the Pskov region. This species is very important for the Russian hunters, including those of the Sebezh district in the Pskov region which borders with Latvia and Belarus. In the "Sebezhsky" National Park, a census of roding woodcocks has been carried out since 2000 using the standard census method developed in France.

Monitoring was carried out every year in May-June for 9 years (2000-2008). Field observations were recorded at 16 sites in two forest areas (24 x 24 km). Three census sites were situated in a mixed broad-leaved-spruce forest, 4 in a small-leaved forest, 4 between the mixed broad-leaved-spruce forest and the small-leaved forest, 5 between the mixed broad-leaved-spruce forest and the pine forest. The basic results of field observations for the estimation of a number of roding male woodcocks are presented.

The mean roding Woodcock index recorded in the "Sebezhsky" national park appeared high. In some years this index was twice as high as the mean index for Russia as a whole. During the last 5 years, the mean roding Woodcock index was not stable, probably due to unfavorable weather conditions in spring. Every year, the mean roding Woodcock index was higher in the small-leaved and mixed broad-leaved-spruce forests than between the same forests and the pine forest.

Results from ten years of the Woodcock roding census (*Scolopax rusticola*) in the Leningrad region

Ivan V. Iljinsky, Valery A. Buzun, Mickael A. Verevkin, Vladimir I. Golovan, Alexander V. Kondratyev, Vasily G. Pchelintsev, Evgeny A. Krechmar, Svetlana V. Menshikova, Dmitry V. Chistyakov
St.-Petersburg State University, St.-Petersburg, Russia
Email: ivi-2008@yandex.ru

Vadim. G. Vysotsky
Zoological Institute of the Russian Academy of Sciences,
St.-Petersburg, Russia
Email: avesvgv@zin.ru

Monitoring of the Woodcock population in the Leningrad region during 1999-2008 was part of a large international program, supported by the *Office National de la Chasse et de la Faune Sauvage* (France). Within the framework of this program the roding census was carried out in 23 permanent test areas, the location of which, whenever possible, did not change from year to year. Each study area was a quadrat (144 km²), sectioned into 36 small (2 x 2 km) sites, which served every year as "listening points". From 7 to 9 listening points were randomly chosen every year in each of the study areas. The census of roding male activity was carried out from 21 May until 20 June, and performed within 2 hours during the evening (0.5 hours before sunset and 1.5 hours after sunset). The number of 'contacts', display flights of one or several birds, were recorded.

During 1999-2008, roding birds were censused at 1,742 points and for 3,484 hours of evening observations. In total, 16,496 contacts of woodcocks were recorded. In the forests of the Leningrad region the Woodcock roding can be observed almost everywhere. "Zero" results (no woodcock roding registered during 2-hour observations) were only obtained 67 times (3.8% of the total number of listening points). The maximal number of contacts could exceed 30, reaching 43 in one instance. The mean number of roding contacts for randomly chosen listening points in all study areas during 1999 to 2008 was 9.5 ± 0.15 (n = 1,742). Significant differences (up to 2-3 times) in the mean number of contacts were found between different study areas. These differences were mainly related to both landscape and forest types within the study areas. The lowest numbers of contacts were recorded at study areas situated in the south-western part of the Karelian Isthmus, where pine forests dominate (*Cladinosum* forest types). Annual variations in the mean number of contacts were apparent. The minimum number of contacts was registered in 2002-2006, whereas the peak numbers were observed in 1999-2001 and 2007. The number of contacts for a 2–hour period counted at one spot during 37 consecutive days (from May 21 till June 30, area "Zaostrovye", Lodeinoye Pole district) varied from 0 to 25 with a mean of 10.9. As observations were not performed in unfavorable weather conditions, the observed variability in male activity could be explained by the presence and behaviour of females. Thus, we may conclude that the number of contacts during Woodcock roding is a complex parameter, dependent on many different factors, which needs further study.

Woodcock monitoring in Azores

David Gonçalvès
CIBIO - Centro de Investigação em Biodiversidade e Recursos Genéticos,
Universidade do Porto, Campus Agrário de Vairão, Rua Padre Armando Quintas,
7, 4485-661 Vairão, Portugal / Departamento de Biologia, Faculdade de Ciências,
Universidade do Porto, Rua Campo Alegre, s/n, 4169-007 Porto, Portugal
Email: drgoncal@fc.up.pt

Manuel Leitão
Serviço Florestal de Ponta Delgada, Rua do Contador, nº 23, 9500-050,
Ponta Delgada, Portugal

André Jesus
Serviço Florestal do Nordeste; Rua do Poceirão s/n, 9630-171 Nordeste, Portugal

Jaime Ponte
& José Costa
Serviço Florestal do Pico, Estrada Regional nº 62 -
Cais do Pico, 9940-334 S. Roque do Pico, Portugal

José Sequeira
& João Luís Pacheco
Serviço Florestal de Ponta Delgada, Rua do Contador, nº 23, 9500-050,
Ponta Delgada, Portugal / Serviço Florestal das Flores e do Corvo,
Rua Senador André de Freitas, 8, 9970-337 St.ª Cruz das Flores, Portugal

Aníbal Lopes
/ Serviço Florestal das Flores e do Corvo, Rua Senador André de Freitas,
8, 9970-337 St.ª Cruz das Flores, Portugal

Sara Cabeceiras
& Carla Moutinho
Serviço Florestal de São Jorge, Av.ª do Livramento, 9800-522 Velas, Portugal

The Woodcock (*Scolopax rusticola*) is a resident bird in the Azorean archipelago (Portugal), where it is an important game species. An annual survey was started in Pico island in 2001 and later the survey was enlarged to other three islands: São Miguel, since 2003; Flores, since 2007; São Jorge, since 2010 (at São Miguel and São Jorge, Woodcock hunting is not allowed). The annual survey is based primarily on counts of roding birds at dusk during March-April (breeding abundance). From Pico island, since 2002, we also have records provided by local hunters (hunting season: October-November) which complement the information provided by the breeding survey. Presently, Flores seems to have the highest Woodcock breeding abundance, followed by Pico and São Jorge. São Miguel still has the lowest abundance. Concerning the hunting records from Pico, where a bag limit of three birds/hunter/day exists, we present and discuss the annual variation in the number of woodcocks encountered per hunter per hour, and that in the age and sex ratios among bagged birds.

Woodcock nest and brood searching using pointing dogs

Fabrice Etienne
Fédération départementale des chasseurs de l'Ardèche, « Le col de l'Escrinet »,
07200 Saint-Etienne-de-Boulogne, France

Benoit Dutertre
Fédération départementale des chasseurs de l'Isère, BP 18 Gières,
38408 Saint-Martin-d'Hères Cedex, France

François Gosmann
Office National de la Chasse et de la Faune Sauvage, Research Department –
Migratory Birds Unit, 39 Bd Albert Einstein, CS 42355, F – 44323 Nantes Cedex 3
Email: francois.gossmann@oncfs.gouv.fr

During 2003-2008, a joint venture was established between the Moscow Woodcock Research Group, and four French organizations (*Fédération départementale des chasseurs de l'Isère*, *Fédération départementale des chasseurs de Ardèche*, *Office national de la chasse et de la faune sauvage*, *Conseil général de l'Isère*). Every year, 8 to 10 days of fieldwork were performed in late May – beginning of June to search for Woodcock nests and broods. Suitable forests were prospected with pointing dogs such as Setters, Braques, Pointers, and Brittany Spaniels. In total, 11 broods and 7 nests were found and 29 chicks were ringed. The most suitable sites were deciduous forests with young trees, glades, regeneration after cutting, and old mixed forests with clearings.

Monitoring of Woodcock hunting season in mainland Portugal

David Gonçalvès
& Tiago Rodrigues
CIBIO - Centro de Investigação em Biodiversidade e Recursos Genéticos,
Universidade do Porto, Campus Agrário de Vairão,
Rua Padre Armando Quintas, 7, 4485-661 Vairão, Portugal /
Departamento de Biologia,
Faculdade de Ciências, Universidade do Porto,
Rua Campo Alegre, s/n, 4169-07 Porto, Portugal
Emails: drgoncal@fc.up.pt & tmgrodrigues@gmail.com

Manuel Russo
Associação Nacional de Caçadores de Galinholas,
Apartado 107, 7050-097 Montemor-o-Novo, Portugal

In mainland Portugal, the Woodcock (*Scolopax rusticola*) is only present during autumn and winter. The Woodcock hunting season normally lasts from the beginning of November to the middle of February. Hunting is allowed on Sundays, Thursdays and national holidays, with a bag limit of three birds/hunter/day. We present the results for the 2009/2010 hunting season in mainland Portugal, based on i) information collected during hunting trips (number of woodcocks seen and shot; duration of hunting trips), which allowed the estimation of the hunting index of abundance (ICA) and ii) on harvested birds, which allowed the estimation of age and sex ratios.

For the 2009/2010 season, a total of 71 hunting trip reports was analysed. The hunting index of abundance, calculated as the number of different woodcocks seen per hunter during a hunting trip (mean duration ± s.e. = 3.6h ± 0.13h) was 1.28 ± 0.14. A total of 182 wings were analysed, 86 birds were weighed, and 58 sexed. For 57 woodcocks, no geographic information was provided. The percentage of juveniles was 53.6% and the percentage of males was 48.3%. The mean weight of females and males was 305.0g and 305.5g, respectively.

Snipe

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Distribution and trend in numbers of Common Snipe (*Gallinago gallinago*) in the North of the Moscow Region

Tatiana V. Sviridova A. N. Severtsov Institute of Ecology and Evolution of the Russian Academy of Sciences, Moscow, Russia.
Email: t-sviridova@yandex.ru

Olga S. Grinchenko Water Problems Institute of the Russian Academy of Sciences, Moscow, Russia.

Vitali V. Kontorschikov Darwin Museum, Moscow, Russia.

Sergei V. Volkov A. N. Severtsov Institute of Ecology and Evolution of the Russian Academy of Sciences, Moscow, Russia.

Dmitri B. Kol'tsov Russian Bird Conservation Union, Moscow, Russia.

*Counts of displaying common snipes (*Gallinago gallinago*) were conducted in the north of the Moscow Region, Russia, in 2006-2009 in the framework of a joint Russian-French project on Common Snipe in Russia. In addition, data collected from 1992 to 2005 were also analyzed. In farmland, the snipes were found nesting in wet lowlands with or without shrubs and adjacent meadows. Within forest-bogs they preferred the wet patches of transitional mires, the forest margins and openings amidst the mires with black alders and birches, the boggy mires with floating mats and willow stands. The densities of common snipes were highest in transitional mires (3-6 to 8.2 displaying males, equivalent to nesting pairs/km^2) and lowest in agricultural lands (0.12 to 0.28 displaying males, equivalent to nesting pairs/km^2). Different trends in numbers were observed during the last 10-15 years: stable/fluctuating in the agricultural lands and decreasing in transitional mires. We were not able to estimate the general trend of the species in the Moscow region.*

The Common Snipe (*Gallinago gallinago*) is one of the most abundant breeding waders of the Moscow region (Sviridova *et al.*, 1998), however, available information about this species in the region is very scarce because of the bird's cryptic behaviour during incubation and difficulties in conducting research in forest-mire complexes. In the framework of the joint Russian-French project "Surveys of breeding populations of the Common Snipe in Russia" (Blokhin, 2007) research into the current distribution and abundance of this species was carried out in the north of the Moscow Region (in the Dubna marshes and adjacent areas, commonly referred to as the "Homeland of the Crane" area, an Important Bird Area and on the candidate list of Ramsar Sites) in 2006–2009.

Materials and methods

Studies were carried out in the southern part of the Verkhnevolzhskaya lowland, in the vicinity of the Dubna river lowlands (Taldom and Sergiev–Posad districts of the Moscow region).

Data were collected in 2006-2009 within the framework of the above-mentioned international project. In addition, we analyzed all available observations of common snipes in the study area collected in 1992-2005 during the course of other ornithological studies in the "Homeland of the Crane" area.

In 2006-2009, counts of displaying common snipes were conducted on transects and on several tens of permanent plots (from 0.5 to 300 ha). The plots were located within agricultural lands and forest - bogs of Dubna river lowlands and adjacent to them Taldomskaya upland. The open grasslands and boggy areas as well as wet forest margins were the principal study sites. The central parts of large forests were not surveyed because of high labour costs associated with reaching such areas.

The abundance of displaying males was determined based primarily on absolute counts of birds within bounded plots and transect count data. The parameters of transect surveys were the same as those we used before the 2006-2009 period for censuses of common snipes: the birds were counted on transects within a survey belt of 200m at open areas and 150m in the forest (Sviridova *et al.*, 1998), and on transects of unlimited width at forest margins and along rivers. In some cases, point counts were made with a radius equal to the belt width of transects.

During the nesting period, one displaying male was considered equivalent to one nesting pair. The absolute number of displaying males or nesting pairs (or absolute nesting density) was assessed as the number of birds recorded in a restricted area of known size (small local plots, relatively wide natural boundary, outlined boggy area, etc.). The relative nesting density was assessed as the number of displaying males per square kilometre estimated on transects with fixed survey belts or in areas within a radius equal to belt width of transects. The mean density of displaying males was estimated by dividing the total number of recorded males within a large study site by the total area of this site. The mean density of displaying males was used to compare overall abundance of breeding snipes between three principal landscapes where data on absolute numbers were available for 2006-2009, although different census methods were used in each of them to study the long-term trend in bird numbers. We did not take into account differences in the density of snipes between habitats within these principal landscapes (Apsarevo area, Kostolygino bog & Zabolotskoye lake, see their descriptions below) because it was not possible to obtain accurate estimates of area of preferred habitats. Bird density per 1 km was estimated for line transects of unlimited belt width.

The highest level of display activity in local (breeding at survey area) males in the study area almost completely overlapped with the period of migration and thus with displaying of migrating snipes. Hence, searches for local breeding common snipes on plots and transect counts were conducted primarily in May–June, after the end of migration. However, the activity of most local males declined notably in the 10-20 May period, and some completely stopped displaying. The display patterns were highly variable between males, and decline of the activity was not synchronized. Accordingly, we tried to visit all plots at least two or more times during the season.

All counts in the early morning (04.00–09.00) and evening (19.00–22.00) were carried out in favourable weather conditions for displaying, avoiding windy conditions, fog, rain and rapid cold snaps. The daytime studies on the plots were carried out during warm clear weather.

Each year, we recorded a simple spring phenology (early, average, late) and habitat humidity. Humidity was determined by a number of factors difficult to assess quantitatively and independent of the spring phenology in the study area (Sviridova *et al.*, 2008). Accordingly, each year was assigned a humidity rank (dry, average or wet) based on visual evaluation of the mean habitat humidity, conducted by the same observer in 1994-2009.

Description of the main survey areas

Apsarevo area (48 km^2, ***Figure 1***) is a large agricultural complex located in the Taldomskaya upland. This is a watershed with arable fields and grasslands interspersed with forest patches of 2-5 up to 200 ha, small sedge meadows with or without shrubs in the wet depressions, artificial ponds and channels. Most of the grasslands were abandoned land of 3-19 years old on the sites of former arable fields, hay crops and pastures. Over two thirds of the grassland area was not mowed during the second half of the 2000s (Sviridova *et al.*, 2006). Forest patches were represented by stands of birch, aspen, grey alder, black alder, mixed spruce forest and pine stands on forest bogs.

Kostolygino bog (2.3 km^2) was located on the northern slope of the Dubna river valley, and represented a cotton-grass–dwarf shrub–sphagnum transitional mire with sparse pines, white birches *Betula alba* and dwarf birches *Betula humilis*. In spring and summer the water table is close to the surface in this area.

Zabolotskoye lake (2 km^2) is an ancient lake mire in the Dubna river lowland. Now the lake depression is comprised of boggy mires with friable floating mats with patches of willow stands and narrow channels, which appeared after the filling of the lake basin with algae. The lake is surrounded by a belt of reed adjoined by black alder-birch mires. Open water surface was present only during spring floods. The lake became impassable for humans by June, but remained an attractive feeding site for waders due to the presence of numerous patches of bare soil and mud among the floating vegetation mats.

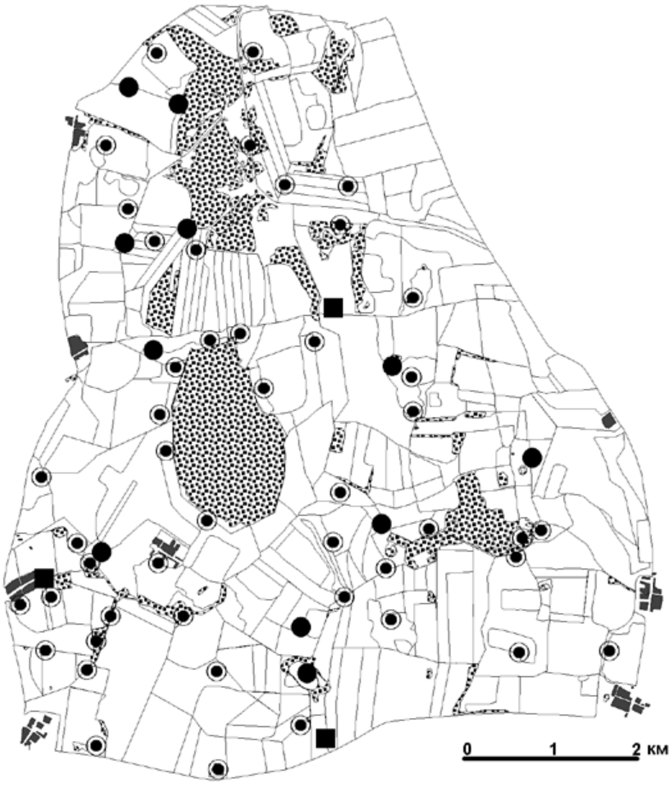
Observations were also carried out in the floodplain areas of the Dubna river (meadows, forests, forest margins, riverside) and in the wet forest of the Khotcha river basin (southern right tributary of the Volga River) on the Taldomskaya upland.

Results and discussion

Activity of displaying males

The earliest observations of displaying males of Common Snipe were made on 29 March 2008 and 30 March 2007. Both migrant and local males displayed actively during April, and it was not possible to assess their numbers separately. However, the majority of local snipes stopped displaying from 10-20 May, both in early morning and in the evening. Timing of displays of local males was restricted in May-June to a period from 7:00 to 9:00 in the morning and from 19:40 to 20:00 in the evening, while twilight periods and day-time were avoided by snipes. Moreover, many local males did not display and the duration of their activity was reduced to 5-10 s: sounds «te-ke-ke-ke»

Figure 1. **Display sites of Common Snipe males recorded at Apsarevo study area in 1996–2009 (all circles and boxes on the map). Filled circles: nesting males (= pairs) in 2009. Filled boxes: displaying males which certainly did not stay for nesting in 2009. Dotted polygons: forests. Grey polygons: villages.**



in flight or on the ground (once or infrequently), or short fragments of the display flight at a low height for 4-7 s. This behaviour was observed primarily in watershed areas, on floodplain meadows, forest edges and in the middle of large forest clearings. Many males in these habitats probably did not display in their territories from late April to late June. Twice we found nests in plots where not a single display had been recorded previously during 3-5 weeks of repeated visits in April-May.

The situation was different in the Kostolygino bog where very active displaying males were recorded on 22 May 2007 and 3 May 2008 throughout daylight hours, and not just during the morning counts. Similar patterns of display activity were observed on 8 June 2007, 10 and 13 June 2008, 13–14 June 2009 in Zabolotskoye lake. The differences in the display activity can be explained by a higher density and intensity of territorial competition of snipes on bogs, compared with agricultural lands and forest where birds were distributed as isolated pairs separated by large distances.

Some males continued to display until late June, more rarely until early July. In 2009, the snipes stopped displaying in the Apsarevo area by 15 June, while the activity of displays was still high at Zabolotskoye lake on 13-14 June. The latest displaying males were recorded on 21 June in 2005, 4 July in 2004 and 2007, and at Zabolotskoye lake on 23 July 1995.

Nests

In total only 5 nests were found during the study period. However, high variations in laying dates appeared from this small sample (***Table 1***). The earliest date of start of incubation was 30 April 2007, and the latest was 27 June 1994.

Distribution and abundance of Common Snipe in the three main survey areas

At the Apsarevo area (***Figure 1***), nesting of isolated pairs was recorded mainly on abandoned or used grasslands adjacent to waterlogged flushes, or within wet flushes partially overgrown with shrubs or comprising sedge meadows. Some of these were located at the edges of forest patches. There were ponds or channels in most of the flushes. The high humidity of most flushes was due to subsoil water flooding the soil surface. Some of these areas were beds of streams running from the adjacent hills. Rarely high humidity resulted from anthropogenic effects (for example, permanent over flow from water towers).

In total, 61 display sites were recorded in 1996-2009 in the Apsarevo area. In some years, birds displayed at certain sites but did not stay to nest (***Figure 1***). The maximum number of displaying snipes in the Apsarevo area, including migrants, ranged from 3 to 28 and the total area flown over by the displaying males in one breeding season did not exceed 300 ha (***Table 2***).

Table 1. Nesting habitats of the common snipe in the study areas.

Date of nest finding; nest contents	Habitat
27 June1994; 4 eggs at an early stage of incubation	At the base of a birch in a sedge-covered transitional mire.
30 April 2007; 4 eggs at an early stage of incubation	Clearing with sedges and moisture-loving forbs in a birch-black alder forest near a floodplain lake; the nest was on a sedge tussock surrounded by water.
21 May 2006; 4 eggs at an early stage of incubation	Border of a dry hay field and wet sedge-reed depression with standing water; the nest was in a narrow belt of unmown grass left from the previous year.
26 May 2006; 4 eggs at an early stage of incubation	Small transitional mire amidst a large area of agricultural lands; the nest was in a sphagnum tussock in a moss-sedge clearing adjacent to wet willow-birch stands and a pool of water.
10 May 2008; 4 eggs at an early stage of incubation	Stream bed of off-flow from the adjacent hills with willows on the watershed with unmown meadows; the nest was on a tussock 0.5 m from open water.

Table 2. Spring conditions and total number of common snipes in the Apsarevo area.

Year	Spring phenology and humidity	Absolute number of snipes		Total area over flown by displaying males (ha)**
		Maximum number of displaying males	Number of males (= pairs), remaining for nesting *	
1996	Average in timing, very dry	3	3?	?
1997	Delayed in timing, cold and wet	3	3?	?
1999	Average in timing and humidity	17	1?	?
2004	Average in timing and humidity	14	14?	?
2005	Average in timing, extremely wet	23	23?	300
2006	Delayed and dry	18	6–8	200
2007	Unusually early with average humidity	28	≥ 20	150 (115)
2008	Early and dry (humidity increased in late May)	14	12–14	170 (155)
2009	Unusually late (20 year record) and dry	14	11	145 (135)

* Active in the second half of May and June.
** Including all sites with observations of displaying males in April-June; in the brackets: excluding migrant or wandering males.

The small area of wet submerged flushes and wet meadows, suitable for the nesting and feeding of waders, which remains in the Apsarevo area following drainage reclamation during 1970-1980s, can explain the low abundance of common snipes in these agricultural lands. Common snipes annually utilised only 13 to 33% of 61 sites in the study plot that were potentially suitable for nesting (an example for 2009 is shown in ***Figure 1***). Observations on humidity in several small plots within the Apsarevo area in 2006-2009 showed fluctuations in this variable due to combined effects of weather and water regime on particular plots. This could explain the use of only a portion of all suitable nesting sites each year. For example, high humidity in 2007 resulted in an increase of areas suitable for feeding and nesting on plots with flat surfaces, and the density of snipes increased there compared with 2006. In contrast, high humidity on other plots in 2007 resulted in the disappearance of common snipes. Thus, the abundance of birds declined at ponds and quarries with shallow water areas and muddy margins when they were flooded in 2007, while they were used by snipes in the dry season of 2006. Humidity was low in the dry seasons 2008-2009 on most of the plots surveyed in the Apsarevo area, which resulted in low total numbers of common snipes there (***Table 2***). At the same time, there were convenient damp margins along the banks of a pond and channels on one plot inhabited by a pair of snipes in the dry spring 2006, while the water table was high in the pond on this plot in May 2009 due to late snowmelt and the impact of a dam recently built by beavers. This resulted in unfavourable conditions for snipes on this plot due to the abundance of water and the absence of suitable margins rather than insufficient humidity, as on all other plots in the dry spring 2009. Similar conditions were observed in 2008 on three plots in the area. In spite of variations in absolute numbers of displaying snipes in small local plots within the Apsarevo area, the total area of display territories was of similar magnitude between seasons. However, a peak was registered in the extremely wet spring of 2005 (***Table 2***).

With the aim of comparing abundance with other areas, we estimated mean nesting density of snipes in the Apsarevo area as the total number of recorded males divided by the total study area, including both agricultural habitats and forest patches. This variable ranged from 0.12 to 0.28 displaying males (= nesting pairs/km^2) in dry breeding seasons, and reached 0.4 displaying males (= nesting pairs/km^2) in 2007 which was a season with average humidity.

Zabolotskoye lake is a unique habitat for common snipes in the north of the Moscow region. The open water area on the lake was much smaller in 2007 than in 2008-2009 due to the absence of a spring flood on the Dubna river. However, this factor had no strong impact on numbers of displaying snipes. The local relative density (density of snipes displaying within radius 200 m of the count point) was 23-45 displaying males/km^2 on 8 June 2007 and 20-27 displaying males/km^2 on 13-14 June 2009. The mean nesting density of snipes across the entire lake area was 2.7-4.5 displaying males (= nesting pairs/km^2) on 10 and 13 June 2008 and from 2.7-3.6 to 5.4 (based on evaluation by different observers within the lake) displaying males (= nesting pairs/km^2) in 2009, which was considerably higher than in the Apsarevo area.

The highest density of common snipes was recorded on Kostolygino transitional mires (***Table 3***). However, the relative nesting density of common snipes, obtained on 200 meters wide transects, decreased considerably there in 2007-2008, compared with the 1990s (***Table 3***). The decline occurred probably in early 2000s because this species was still abundant in the mires in 1997. A major part of snipes inhabited patches with sparse dwarf birch *Betula humilis* and tussocks of sedges and open water in transitional mires, while the areas dominated by sphagnum and areas with pines were avoided. The decline could have probably been caused by a gradual over-growing of dense stands of dwarf birch and willow during the last 20 years. In spite of this decline, the mean nesting density of snipes (***Table 3***) evaluated across the entire bog area was still much higher than in the Apsarevo area and on Zabolotskoye lake.

Table 3. **Density of displaying males in Kostolygino bog in different years.**

Year	Spring phenology and humidity	Relative nesting density (RD) of snipes (displaying males/km^2)	Trend of RD in comparison with the 1990s.	Mean nesting density of snipes (displaying males/km^w)
1991	Early and dry	16–23	0	?
1992	no data	15–23	0	?
1997	Delayed in timing, cold and wet	≥ 15–20	0?	?
2001	Early and dry	1–3	↓↓?	?
2006	Delayed and dry	3–5	↓↓?	?
2007	Unusually early with average humidity on watersheds, but low humidity in the Dubna river floodplain	3.7–7.4	↓↓	3–6
2008	Early and dry (humidity increased in late May)	≥ 9.3	↓↓	≥ 8.2

Distribution and abundance of Common Snipe in other study areas

Data on Snipe abundance are available also for the Nushpoli floodplain of the Dubna river (5 km^2). These wet meadows were poorly managed in the 1990s and at least 20-30% of the area became encroached by heath. The situation changed significantly after a peat fire in 2000. New drainage channels were dug out in the floodplain to restore meadows after the fire, meadows were ploughed up, and the area of heath reduced to 2-3% of the floodplain area. The absolute number of nesting snipes was rather low before the fire: 3-5 pairs in 1994 and 1999 (Sviridova *et al.*, 2006). The numbers of snipes counted in this floodplain on a permanent line transect were not high even in early May during the period of the highest display activity of local and migrating males, with the exception of the season 2009 (***Table 4***), when a peak in male display activity could have been caused by an unusually late spring. Low abundance of displaying males was observed in years when the duration of flood was below 20 days (***Table 4***). A maximum of only 1-3 pairs were censused during the breeding period across all meadows remaining in the Nushpoli floodplain after flood recession, and in some years snipes were not found there at all. Apparently both local and migrant snipes were recorded in the Apsarevo area and the Nushpoli floodplain in the period of the highest display activity. The absolute nesting density of common snipes fluctuated with no trend in the Nushpoli floodplain during the 2000s or declined slightly compared with 1990s.

Along a stretch of approximately 20 km the Dubna river separates the boggy and wet black alder-birch forest from the open agricultural lands in the floodplain, while the remaining part of the river runs entirely in the boggy black alder forest and willow stands (approximately 12-15 km) or across open meadow floodplain (approximately 11-13 km). The abundance of common snipes ranged from 0.33 displaying males per 1 km on the border of the wet forest and open floodplain habitat to 1.3-2 displaying males per 1 km in the floodplain entirely covered by forest. The abundance of snipes did not exceed 0.5 displaying males per 1 km along the river stretch running across the open meadow floodplain with sparse shrubs, which was lower than in the forested parts of the floodplain. ***Table 5*** shows that the abundance of snipes also varied appreciably on transects surveyed at different times along approximately the same stretch of the Dubna river.

Available quantitative data from most other areas in the north of the Moscow region are even less consistent. However, our data obtained on several small plots and on line transects confirmed that the abundance of displaying males was stable or fluctuated without trend in the study area during the last 10–15 years.

We found that a single observation of male displays was not sufficient for confirmation of an established territory and nesting of a female in the area. Likewise, absence of displaying males (especially during a single visit) should not be taken as absence of breeding snipes. This has important methodological implications and caution is required in the interpretation of data on the abundance of snipes which are subject to annual variations in habitat humidity and other factors.

Table 4. **Absolute number of displaying snipes on a permanent transect (6 km) in the Nushpoli floodplain in early May.**

Date	Number of counted displaying males	Duration of flood and humidity on count days
9 May 2004	4	28 days There were still some pools within the area.
8 May 2005	6	32 days There were some pools, soil was damp, some damp patches were still without grass.
7 May 2007	0	14 days Soil was concrete dry on meadows; after flooding water remaining in solitary pools was at maximum 5–7 centimetres deep.
12 May 2008	1	17 days There were some pools, some of which were 35-40 centimetres deep, but the total area of water was small.
10 May 2009	10	24 days There were some pools, soil was damp, large area of open water was up to 20 centimetre deep.

Table 5. **Number of displaying snipes on similar stretches of the Dubna river.**

Count	Date of census	Length of transect			Absolute number of displaying males	Displaying males per 1 km
		Total (km)	Part in forest			
			km	%		
1	29 April 2007	3	1.7	56.7%	2	0.7
2	11–12 April 2008	3.5	2.2	62.9%	2	0.6
3	26–28 April 2008	9	1.9	21.1%	6	0.7
4	1–21 June 2008	4	2.7	67.5%	4–5	1-1.25
5	10 May 2009	2	0.7	35%	2	1
6	19 June 2009	3	1.7	56.7%	1	0.33

Conclusions

Our analysis of available data indicated that the Common Snipe has uneven distribution in the study area. In farmland, nesting of isolated pairs was recorded in wet lowlands and adjacent meadows. Within forest-bog areas waders preferred wet patches of transitional mires, forest margins and openings amidst black alder-birch mires, boggy mires with floating mats and willow stands. The highest density of common snipes was observed in transitional mires and the lowest density in agricultural lands.

The Common Snipe is not a rare breeding wader in the north of Moscow region (Sviridova *et al.*, 1998). However, the transitional mires and boggy mires with floating mats, where the nesting densities are the highest, occupy smaller areas than agricultural lands and forests. According to our preliminary estimation a maximum of 40-50 pairs of Common Snipe nested in transitional mires of the survey area and about 15-20 pairs nested at Zabolotskoye lake. The small area of wet depressions and wet meadows remaining in the farmland after drainage reclamation could be the reason for the low abundance of common snipes on agricultural lands. In the Apsarevo area the absolute number of common snipes in 1990-2000 was similar to the numbers of rare species like the Black-tailed Godwit *Limosa limosa* and Eurasian Curlew *Numenius arquata*, listed in the Red Data Book of the Moscow region and the Red data Book of Russia. Our estimate of the maximum habitat carrying capacity for nesting snipes in the Apsarevo area is 61 potential nesting sites, of which 14-28 sites were actually used annually. Vast meadows (12 km^2), established in the late 1970s after the agricultural improvement of transitional and lowland mires, were used for nesting in 2004 by 10-15 pairs of snipes at maximum (Sviridova *et al.*, 2006), while most observations of displaying birds were made there in a belt of meadows adjacent to remaining large forest-bog patches, which indicated the preference for forest edges by snipes. Taking into account all these data and the fact that common snipes were not found in 2006-2009 on peat moss raised bogs, including their open parts, in dry forests and on most of the watershed meadows, we can conclude that a major part of the nesting population of the Common Snipe in the north of the Moscow Region is restricted to different types of wet and boggy forest with clearings and to clearings and edges inside lowland bogs with forest. Unfortunately, these habitats remain the most challenging for carrying out reliable Snipe censuses due to difficult access.

Trends in numbers of common snipes during the recent 10-15 years differed between agricultural lands and transitional mires. Numbers of common snipes were stable or fluctuated slightly during the last 10-15 years in the large Apsarevo survey area and some smaller study sites, but decreased in transitional mires. This fact, along with almost complete absence of previous and current data on snipe numbers in forests, occupying at least 35-40% of the study area, does not enable us to assess the general trend in the species' populations in the north of the Moscow Region with confidence.

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The breeding population of Common Snipe in wetland habitats of the Russian plain

Yuri Yu. Blokhin
& Sergei Yu. Fokin

Russian Bird Conservation Union, Shosse Enthuziastov,
60, bld.1, 111123 Moscow, Russia,
Emails: yuri-blokhin@yandex.ru & fokin@mk.ru

Censuses of drumming male Common Snipe were carried out in the period 2003-2009 in different geographical zones, from southern tundra to the deciduous forest, mainly in the basins of the rivers Volga, Pechora, Northern and Western Dvina. In total, 292 census squares (336 km²) were visited. The numbers of breeding Common Snipe, the densities of breeding snipes in different habitats and their inter-annual fluctuations were defined.

The breeding population of Common Snipe in European Russia was estimated at about 1 527 000 ± 384 000 pairs. The flooded and meadow habitats suitable for the Common Snipe are widely available but they occupy a small area compared to the bog habitats. Less than 4% of the Common Snipe population lives in the flood-lands of the rivers and lakes in the Russian plain breeding area. The average density was higher in the tundra and forest-tundra (11.8 ± 1.3), than in the taiga (3.5 ± 0.3) and coniferous-deciduous forest (7.9 ± 0.6). During the study period, the average density in the flood-lands varied from 2.7 ± 0.6 (2003) to 8.0 ± 1.8 (2004). Abnormal weather conditions were registered in the census period which differently affected the population of Common Snipe. However, no particular trend was observed.

The Common Snipe is one of the most abundant species among the Palearctic waders and an important gamebird in the West-European countries. The breeding area of Common Snipe is vast and mainly located in Russia. However, no large-scale research on its population has been carried out in this country. Data on numbers and breeding success of Common Snipe are extremely poor and even absent for many natural regions. Therefore, research work aiming to fill the gaps in our knowledge of Common Snipe is a high priority.

Studies engaged by the Russian Birds Conservation Union with the help of the French *Office national de la chasse et de la faune sauvage* showed a great diversity of nesting habitats of Common Snipe in Russia. The objective of the present paper is to improve our knowledge on numbers and distribution of the Common Snipe in the flood land habitats of the Russian Plain.

Methods

The census method is mainly based on research carried out in Great Britain (Smith, 1981; Green, 1985). Following a pilot study in the European part of Russia in 2003-2004 (Blokhin *et al.*, 2004) some changes were made to adapt the method to a Russian context. The censuses were based on counts of displaying ("drumming") males in the period of their highest activity. As is usually accepted, we considered that the number of displaying males approximately correlates with the number of females nesting in the same area.

The census occurred after the end of spring migration when only the local birds are present. The total period of display is rather long for the whole country: from late March to late July. The census period in the central provinces took place from 20 April to 30 June and in Northern provinces from 1 May-15 June (or from the beginning of display) to 15 July.

Two variables were collected: the number of displaying males and the number of breeding pairs/km2.

Material

In 2003-2009, censuses of Common Snipe were conducted in April-July in 52 districts of 18 oblasts (provinces) of the Russian Federation, in various geographical subzones from southern tundra to deciduous forests (***Figure 1***, ***Table 1 & 2***). Observations were made by 44 participants.

The censuses were principally carried out in the breeding habitats of the basins of the rivers Volga, Pechora, Severnaya and Zapadnaya Dvina, Neva, Luga and their tributaries. The counts were made in 292 plots on a total area of 336 km^2 in various habitats.

We used the types of habitats defined by Katz (1971) and Vompersky *et al.* (2005): tundra and forest-tundra, forests and clear forest stands, flood lands and meadows.

During the period 2003-2009, the weather conditions differed from one season to another. They were favorable for Common Snipe breeding in 2004 and 2008 in the whole Russian plain and in 2005 only in central Russia. The weather conditions were unfavourable in the other years and had an effect on the Common Snipe numbers and their breeding success.

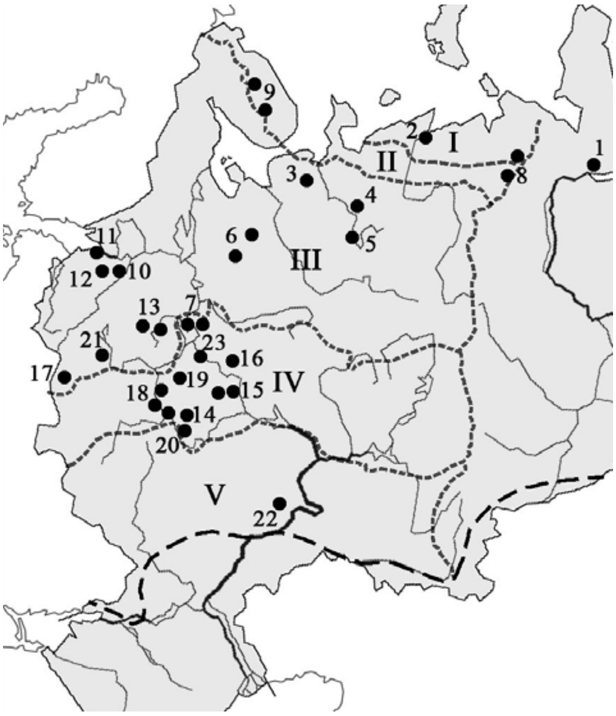


Figure 1. **Location of the census sites for Common Snipe in 2003-2009 (# in the Table 2).**
Wide dotted line: southern border of the Common Snipe breeding area, small dotted line: boundaries of groups of mire provinces.
I: provinces with flat-hilly bogs (tundra),
II: big-hilly bogs (forest-tundra),
III: forests and 'distinct' bogs in the mainland and sea coasts of inland seas (north, middle and south taiga),
IV: eutrophic and oligotrophic pine-sphagnum bogs of Eastern Europe (south taiga and coniferous-deciduous forests),
V: eutrophic bogs of the Russian forest-steppe, steppe and desert.

Table 1. **Census effort on Common Snipe in different regions of Russia.**

Seasons	Oblasts (Provinces)	Districts	Number census grounds	Total area, ha
2003	6	9	24	8,643
2004	10	18	29	4,559
2005	11	18	30	3,446
2006	8	16	41	4,246
2007	10	19	76	5,736
2008	8	18	59	5,046
2009	7	15	33	1,952
Total	18	52	292	33,628

Table 2. **Description and location of the census sites visited in the 2003-2009 period.**

Zone	Sub-area	Rivers and their tributaries lakes, reservoirs, bays	Oblasts (provinces), republics and autonomous regions (census site number; *see figure 1*)
Tundra	South, or shrubby tundra	Pechora: Usa; Ob': Schuchya	Komi (8), Nenetsky a. r.(2), Yamalo-Nenetsky a. r.(1)
Forest-tundra		Pechora: Usa; Ponoy, L. Lovozero	Komi(8), Murmansk (9)
Forest	North taiga	Severnaya Dvina: Kuloy; Pechora: Usa;	Arkhangelsk (3), Komi (8)
	Middle taiga	Onega; Severnaya Dvina: Pinega, Pokshenga, Vaga	Arkhangelsk (4,5,6)
	South taiga	Volga: Mologa, Sheksna, Nerl, Kostroma, Cheremukha, Tebza, Ukhtoma, Siyukha, Nolya; Rybinskoye, Uglichskoye & Uglichskoye reservoir; Zapadnaya Dvina; Neva: Mga; Luga, Oredej, Volkhov; Gulf of Finland; L. Ilmen' &. Velikoye	Vologda (7), Leningrad (10,11), Ivanovo (15), Kostroma(16), Novgorod (12,13), Tver (7,19,21,23), Yaroslavl (7,23)
	Coniferous-deciduous forests	Volga: Sura, Oka, Klyazma, Moskva, Dubna, Hotcha, Lopasnya, Pakhra, Istra, Ikshinskoye & Rybinskoye reservoir; Zapadnaya Dvina	Vladimir(14), Moscow Region (14,19), Ryazan'(20), Smolensk(17), Penza (22)
	Deciduous forests	Volga: Moskva	Moscow Region (18)

Results and discussion

Breeding habitats

The Common Snipe was found in various breeding habitats but preferably in flood lands and reservoirs with stagnant water. In flood lands, the species inhabited the peat quarries, hayfields and pastures but also on river banks and shores of flood land lakes. In the Russian plain, the Common Snipe was found in damp flood land meadows, shores of lakes, reservoirs and ponds. It prefers hummocky and boggy patches along shores of large stagnant reservoirs (ponds, lakes) and river flood lands, where it breeds over flood land grassy and hummocky meadows.

Population dynamics and Common Snipe distribution

Differences were observed in the density of breeding snipe in various sites and even within the same habitats.

As opposed to bog habitats, the flood land habitats depend on hydrological conditions of the basins. The floods can have a negative or a positive effect on the breeding of Common Snipe. Cases of nest losses were registered on census sites and in other areas as a result of floods. Within the frame of the present project, the observers described prolonged floods over large areas which resulted in substantial shifts in the breeding conditions or, locally, in a total absence of breeding. On the other hand, the flood land meadows and bogs were considered as the best breeding habitats for the Common Snipe in dry years.

The results show high inter-annual variations in male numbers in the same plot, depending on the local conditions. The data collected on 7 permanent plots in the Central region are presented in ***figures 2 and 3***. All these plots were located in flood land habitats (rivers Moskva, Klyazma and Dubna) where the waterless valleys and the damp meadows alternate with fens and small reservoirs.

Similar results were obtained on permanent census plots in other sites of the species' habitats. In order to correctly estimate the scale of these fluctuations, data were collected over many sites and in various habitats within the Common Snipe breeding range. During the 7 years of censuses in the flood plains, the average indices of density fluctuated from 2.7 ± 0.6 (2003) to 8.0 ± 1.8 (2004) (***Figures 4 & 5***).

Abnormal weather conditions were registered during the study period which affected differently the breeding conditions. However no decrease in the Common Snipe numbers was observed.

Numbers of Common Snipe

The flood plain wetlands are an important component of the breeding area of the species. The Common Snipe breeds at high densities in this type of habitat, especially where there is a combination of flooded meadows and transitive bogs. Based on our studies, the maximum densities reached 83.3 pairs/km2 in the taiga zone, 20 in the forest-tundra and 6.7 in the southern tundra. On all plots located in the flood plain wetlands, the average density appeared higher in the tundra and forest-tundra (11.8 ± 1.3) than in the taiga (3.5 ± 0.3) and in the coniferous-deciduous area (7.9 ± 0.6).

According to our calculation based on extrapolation from the densities encountered in the different habitats, we estimate the Common Snipe breeding population in European Russia to be about 1 527 000 ± 384 000 pairs. However, the distribution in the large Russian Plain territory is uneven. About 55% of common snipe nest in the tundra and forest-tundra zones and about 45% in the taiga zone (Blokhin, 2010). However this proportion differs from the average in the flood lands where only 32 % of common snipe breed in tundra and forest-tundra and 68 % in the forest zone.

The flood plains and meadows suitable for the Common Snipe represent a small area of the Russian Plain, compared with the marsh habitats (Blokhin, 2010). From our estimations, 4-6% of the population breeds in the flooded sites of the rivers

Figure 2. **Maximum number of displaying male Common Snipe on 3 areas in the flood lands of the river Klyazma (Vladimir Region).**

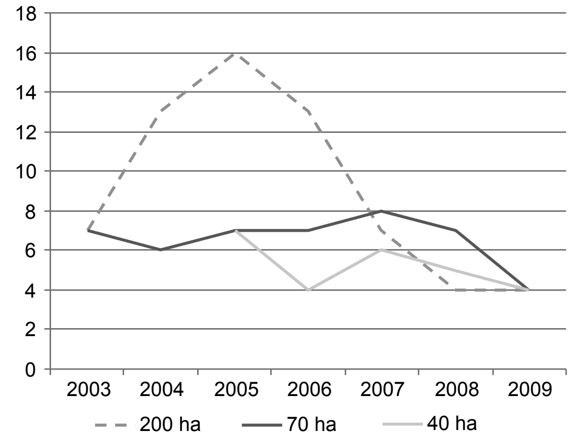


Figure 3. **Maximum number of displaying male Common Snipe on 4 plots in the flood-lands of the Moscow Region.**

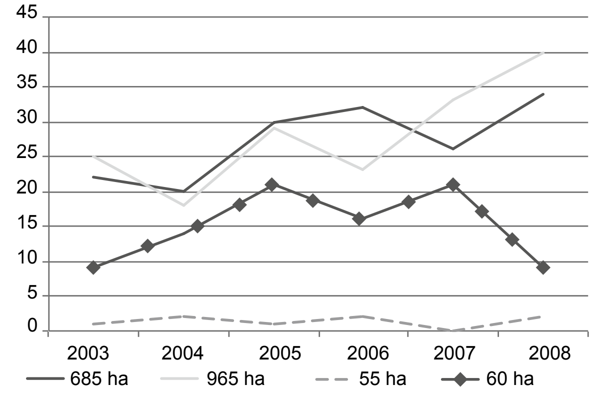


Figure 4. **Density (pairs/km²) of Common Snipe in the flood-lands and meadows of the Russian Plain during 2003-2009.**

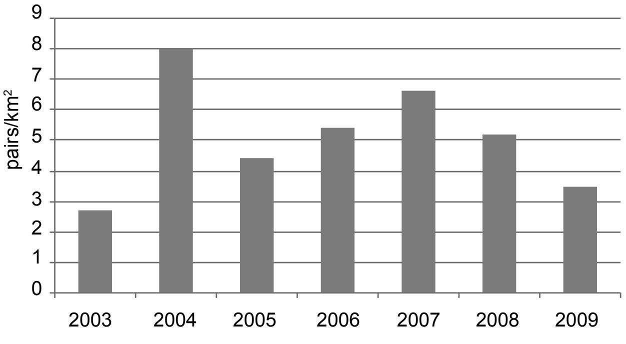
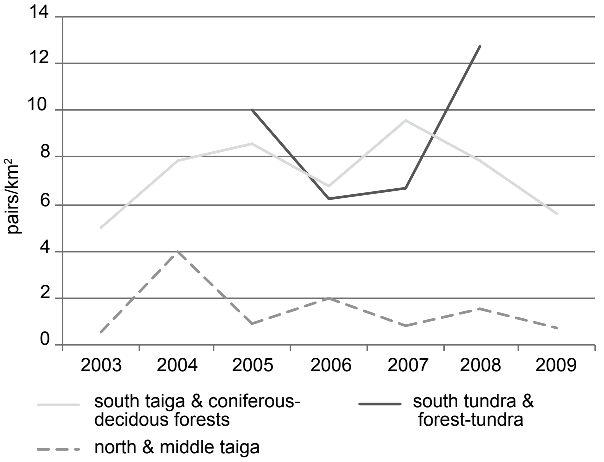


Figure 5. **Annual variation in Common Snipe density (pairs/km²) in the flooded lands of different sub-zones of European Russia in the 2000s.**



and lakes of the Russian Plain, i.e. 62 000-3 000 pairs (***Table 3***). The majority live in the north, middle and south taiga (group III, ***Figure 6***). This can be explained by the high proportion of flooded land (63.6% of 7 500 km2) in the group of provinces concerned by comparison with other areas.

The importance of bog habitats in interfluves' land increases from north to south for the breeding of Common Snipe in the flooded lands and meadow habitats, (***Table 3***). Only 1.1% of common snipes in the forest-tundra (group II) breed in the flood lands and meadow habitats. In contrast, the breeding numbers of Common Snipe in the flooded lands and meadows of the south taiga and coniferous-deciduous forests (group IV) can represent 11-23.7% of the Common Snipe population of this area. Further south, in forest-steppe and steppe (group V) the proportion of snipe breeding in the flooded lands and meadows reaches 50% of the total number for this area. This should certainly be linked with the fact that the north of the Russian plain is naturally highly waterlogged, in comparison with the south. Recently, the southern and central regions have become the subject of more extensive drainage than the northern region, and consequently large areas of former bogs have turned to agricultural lands. Therefore, the flooded lands in the northern regions should be more attractive to the Common Snipe. In the south, the majority of the Common Snipe population is attracted to the flooded land habitats.

Conclusion

The use of up-to-date information on the bog and marsh areas in Russia was essential to present a preliminary estimation of Common Snipe numbers and their distribution. Within the frame of a specific project, the censuses shown that the breeding numbers of Common Snipe in the flooded lands and meadow habitats of the Russian plain is rather small in comparison with the total resource available to the species in this area. At the same time, it was underlined that the importance of the flooded lands as breeding habitats for the Common Snipe substantially rises from north to south in the Russian plain. The variations in density in the flooded lands and meadows appeared non-synchronous among different habitats. No trend was observed in the Common Snipe numbers for the seven study years.

Acknowledgments

This work was possible thanks to a successful co-operation between ONCFS (coordinator Dr. Y. Ferrand) and RBCU and the participation of a large team of ornithologists. The author thanks all participants of the project, especially: A. Yu. Blokhin, Dr. V.G. Borschevsky, O. S. Grinchenko, M. V. Kozlova, Dr. V. N. Mel'nikov, A. P. Mezhnev, Dr. A. L. Mischenko, V. V. Morozov, Yu. M. Romanov, Dr. M.V. Sidenko, Dr. O. V. Sukhanova, Dr. T.V. Sviridova.

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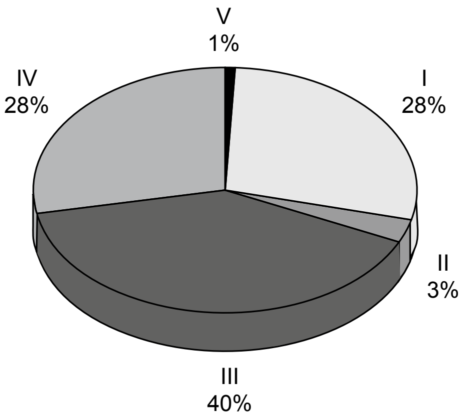
Table 3. **Breeding numbers of Common Snipe in the flooded lands and meadows by groups of provinces in the European part of Russia.**

	Groups of provinces (*cf. Figure 1*)					
	I	II	III	IV	V	Total
surface area (in thousands km^2)	1.6	0.2	7.5	2.4	0.1	11.8
breeding pairs (in thousands)	17-21	2-3	24-29	18-20	1	62-73
% of the Common Snipe numbers in bog habitats*	2.9-3.5	1.1	4.1-5.9	11.0-23.7	50	4.0-5.7

* Bloklin, 2010.

Figure 6. **Distribution of the Common Snipe resources in the flooded lands of the Russian Plain (see Figure 1 for description of the I to V labels).**



Current state of the breeding population of Common Snipe in mainland Portugal

Tiago Rodrigues	CIBIO - Centro de Investigação em Biodiversidade e Recursos Genéticos, Universidade do Porto, Campus Agrário de Vairão, Rua Padre Armando Quintas, 7, 4485-661 Vairão, Portugal; Departamento de Biologia, Faculdade de Ciências, Universidade do Porto, Rua Campo Alegre, s/n, 4169-007 Porto, Portugal. Email: trodrigues@cibio.up.pt
Tiago Silva	Departamento de Biologia, Faculdade de Ciências, Universidade do Porto, Rua Campo Alegre, s/n, 4169-007 Porto, Portugal.
Marisa Rodrigues	CIBIO - Centro de Investigação em Biodiversidade e Recursos Genéticos, Universidade do Porto, Campus Agrário de Vairão, Rua Padre Armando Quintas, 7, 4485-661 Vairão, Portugal.
Carlos Pereira	Rua Ana de Castro Osório, 9, 4º Dto, 2845-360 Paivas, Portugal.
Maria de Lurdes Santarém	ICNF- Instituto da Conservação da Natureza e das Florestas, Parque Nacional da Peneda-Gerês, Av.ª António Macedo, 4704-538 Braga, Portugal.
Miguel Pimenta	ICNF- Instituto da Conservação da Natureza e das Florestas, Parque Nacional da Peneda-Gerês, Av.ª António Macedo, 4704-538 Braga, Portugal.
David Gonçalves	CIBIO - Centro de Investigação em Biodiversidade e Recursos Genéticos, Universidade do Porto, Campus Agrário de Vairão, Rua Padre Armando Quintas, 7, 4485-661 Vairão, Portugal; Departamento de Biologia, Faculdade de Ciências, Universidade do Porto, Rua Campo Alegre, s/n, 4169-007 Porto, Portugal.

*Until the 1960s, the Common Snipe (*Gallinago gallinago*) breeding range in mainland Portugal apparently extended over the north of the country. A strong decline was denoted in the last decades, but no detailed study or monitoring program was ever implemented. Currently this breeding population is considered Critically Endangered and, along with a few other nuclei in Spain, may be isolated from the main European breeding core. The present work aims to: a) update the knowledge on current breeding range of the Common Snipe in mainland Portugal, b) assess the size of the breeding population, and c) assess the local breeding phenology.*

From 2006 to 2010, the presence of the Common Snipe was evaluated by playback surveys and flush counts. Between June and July 2006 a large area (6,624 km^2) covering the Northwest of Portugal was systematically surveyed using a 2x2 km UTM grid. In 2007 and 2008, between March and July, the presence of the species was evaluated in the places where it was present in 2006, and in a close locality in Spain where it was assumed to breed. In 2009 and 2010, the presence of snipe was assessed at least once between May and July, in all the previously identified places. Nest/broods observations and published data on Common Snipe breeding in the Northwest Iberia were used to assess the fortnight distribution of first egg dates.

In 2006, the Common Snipe was observed in 6 of the surveyed cells (n = 178), all in the region of Montalegre. In 2007 and 2008, the number of places where snipe were present diminished from March to May, but the places where snipe were present between May and July were already occupied in March. In March some birds were already displaying but the peak in the displaying activity was observed in May. Although in the region some nests may start during May, the peak of clutch initiation occurs on the second fortnight of June, suggesting a delay on the nesting season when compared with other populations. The estimated number of breeding pairs varied between 8-10 (2006) and 3-4 (2010).

Our results indicate a local decline, both on the breeding area and the number of Snipe breeding pairs. Additionally, we noticed a local delay in the nesting season, highlighting a particularity of this population.

The Common Snipe (*Gallinago gallinago*) is a regular passage migrant and a winter visitor to the Iberian Peninsula wetlands (Asensio & Carrascal 1987, Catry *et al*. 2010), where it also occurs in small breeding populations (Reis Jr. 1924, Silva Jr. 1924, Santos Jr. 1979, Domínguez *et al*. 1987, Ramos *et al*. 2003, Equipa Atlas 2008, Catry *et al*. 2010, Lorenzo & Planelles 2010).

During spring and summer the Common Snipe distribution in the Iberian Peninsula seems restricted to two regions, the Spanish Central System and the Iberian Northwest (Ramos *et al*. 2003, Equipa Atlas 2008) (***Figure 1***), where it occupies a few places and is assumed to breed. Despite some nests and chicks reported in the past, due to the species habits and its occurrence in low densities, the knowledge of the Common Snipe breeding distribution in Iberia is mainly based on displaying birds (Ramos *et al*. 2003, Equipa Atlas 2008). Some observations have been reported outside those regions between May and August, including a failed nesting attempt in the Basque country (Calleja & Gureñu 2003). Nevertheless, these observations are more likely to be late or early migrants, or even young birds dispersing (Santos Jr. 1979, Equipa Atlas 2008).

The breeding of the Common Snipe in mainland Portugal was reported for the first time after a nest was observed in 24th June 1918 in Montalegre (41°49'N 7°47'W; Reis Jr. 1924). According to some observations of nests and displaying birds, at least until the 1960s, the species had a broad breeding range in North Portugal (Silva Jr. 1924, Coverley 1932, Santos Jr. 1979). Also folktales, spreading from Bragança (41°48'N 6°45'W)(Ninguém 1972) to Monção (42°04'N 8°28'W)(pers. obs.), referring to the 'goat bird' seem to support a past wide breeding distribution.

The Iberian breeding populations are within the Southern limits of the species breeding range in the European mainland (Hagemeijer & Blair 1997). Their closest breeding neighbours are the 110-160 breeding pairs estimated for France (De Seyne 2009), where the species is considered Endangered (UICN France *et al*. 2011). In Spain, where the species is also considered Endangered (Salvadores *et al*. 2004), a recent study estimated the breeding population as 69-118 pairs (Lorenzo & Planelles 2010). A large part of these individuals, between 60 and 105 pairs, occur in the Central System, while the maximum number estimated for Galicia is 13 pairs (Lorenzo & Planelles 2010). In mainland Portugal, the Common Snipe breeding population is considered Critically Endangered (Cabral *et al*. 2005). In 1978, Santos Jr. (1979) estimated between 200 and 300 nests just for Montalegre and Boticas regions. The estimates dropped to 50-100 pairs for the period 1978-1984 (Snow and Perrins 1998). Some years later Rufino (1989) assessed the breeding population in 100-1000 pairs, but soon after, based on the same data (collected in 1984 and 1986) these values were corrected to 100-150 pairs (Rufino & Neves 1991). For 2002, the BirdLife International (2004) estimates between 2-20 pairs breeding in Portugal. In 2006 the ICN (2006) admitted less than 50 mature individuals. For the same year, based on our work, the Portuguese Breeding Birds Atlas (Equipa Atlas 2008), states between 8 and 10 pairs.

Apparently, the Common Snipe breeding in Iberia are isolated from the European core population (Rufino & Neves 1991) but their migratory or resident habits are still unknown (Rufino 1989, Ramos *et al*. 2003, ICN 2006, Catry *et al*. 2010). Based on opportunistic nest observations, Santos Jr. (1979) suggested that the Portuguese breeding population breed later (i.e. June and July), when compared to the populations from North-west

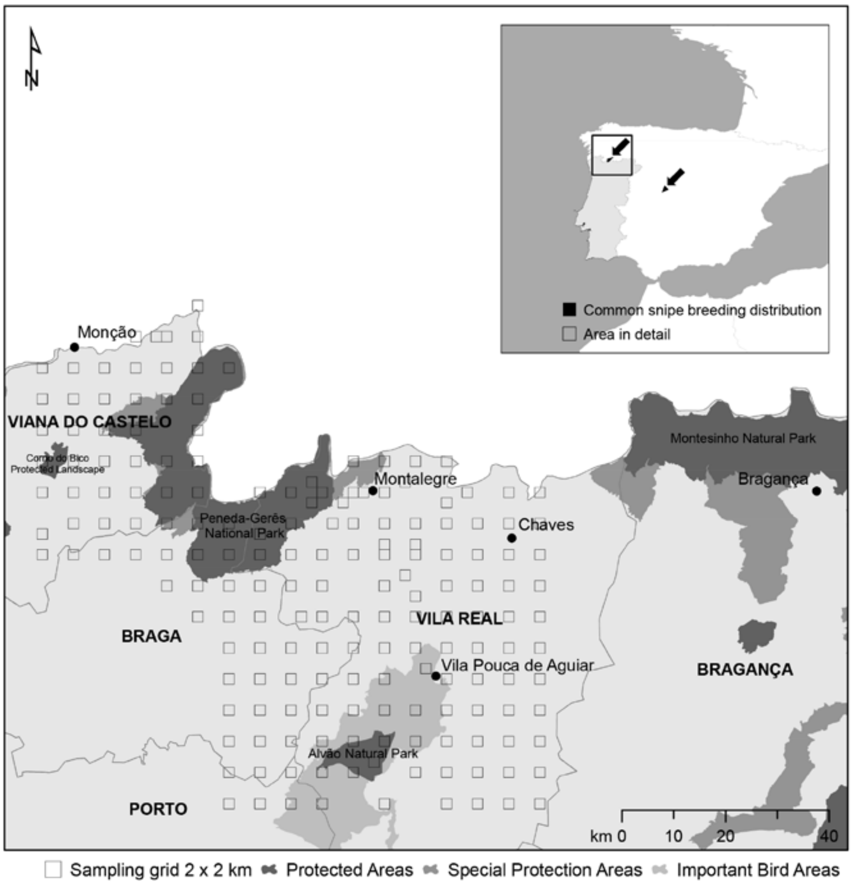


Figure 1. **Breeding distribution of the Common Snipe in the Iberian Peninsula [upper right corner, adapted from Equipa Atlas (2008) and Lorenzo & Planelles (2010)]. Study area and sampling grid used for the 2006 Common Snipe distribution survey.**

Europe (egg-laying from early April; Snow & Perrins 1998); in the British Isles most clutches start in the second fortnight of April (Mason & Macdonald 1976). However, no efforts to monitor the Portuguese population during spring, and test this hypothesis, were ever done.

The present work aims to: a) update the knowledge on current breeding range of the Common Snipe in mainland Portugal, b) assess the size of the breeding population, and c) assess the local breeding phenology.

Methods

Distribution

In 2006, to assess the current range of the Portuguese breeding population, based on a search of all the reports of Common Snipe breeding evidences available in the literature (Reis Jr. 1924, Silva Jr. 1924, Coverley 1932, Ninguém 1972, Santos Jr. 1979, Rufino 1989, Rufino & Neves 1991) (***Table 1***), we defined a survey area, in the Northwest Portugal (***Figure 1***), covering 6,624 km^2 (latitude 41°14’ to 42°11’N; longitude 7°21’ to 8°35’W) in the districts of Viana do Castelo, Braga, Porto and Vila Real, including some protected areas, like Corno do Bico (PTCON0040, 5,139 ha), Alvão/Marão (PTCON0003, 58,788 ha) and Peneda-Gerês (PTCON0001, 88,845 ha). The latter includes also the majority of the surface of the Special Protection Area of Serra do Gerês (PTZPE0002; 63,438 ha)

The survey was based on a 2x2 km grid (***Figure 1***), used to implement a systematic sampling method: a first square was chosen randomly (generation of random numbers) and the others were selected to the survey with an interval of two squares around. Whenever a selected square had inappropriate characteristics to the species and/or prospection (e.g., rocky or urban areas), one of the adjacent squares was selected to prospect using the military map (1:25,000). A search for patches with suitable habitat was made in each square. Also when a place with suitable habitat to the species was known to occur on a non-selected 2x2 km square (from literature or pers. comm.), it was visited. Given that previous nesting evidences were mainly from June and July (Reis Jr. 1924, Silva Jr. 1924, Santos Jr. 1979) (***Table 1***) the survey was carried during these months. In all the suitable habitat patches, the presence of Common Snipe was evaluated using playback and flush counts, mainly at dusk/early morning and late afternoon, periods of the day when snipe detectability is high (Hoodless *et al*. 2006). Playback surveys consisted of 10 minutes of passive listening followed by two sequences of 1 minute of playback and 2 minutes of listening. Flush counts were performed by one or two observers (usually one), walking to within 20 m of every point within suitable habitat surfaces. Each flush count was preceded by a playback survey. Besides seen or heard individuals, the species was also considered present when other evidences were observed: foot and bill prints, feathers, or droppings.

Breeding phenology

Between March and July 2007 and 2008 we monitored all the localities where the Common Snipe was observed during the 2006 survey, as well as some unoccupied places with suitable habitat identified at that time, and new places with suitable habitat meanwhile identified. Given the geographical proximity of one locality in Spain, Río Calvos (Orense province, Galicia;

Table 1. Common Snipe breeding evidences in the literature and registered by the authors of the present study.

Observation	observation or report date	number of eggs or chicks	estimated fortnight of first egg date	Place/Municipality	Reference
nest	23-06-1918	4*	----	Montalegre/Montalegre	Reis Jr. (1924)
nest	24-06-1918	3+	june 2	Montalegre/Montalegre	Reis Jr. (1924)
nest	10-06-1924	3*	may 2	Veiga de Chaves/Chaves	Silva Jr. (1924)
chicks	26-06-1932	“some”#	may 1	Montalegre/Montalegre	Coverley (1932)
nests (n=?)	29-05-1933	----	----	Montalegre/Montalegre	Coverley (1933)
nest	12-07-1959	3+	july 1	Beça/Boticas	Santos Jr. (1979)
nest	??-07-1959	3?	----	Lavradas/Boticas	Santos Jr. (1979)
nests (n=4)	20-06-1961	----	----	Beça/Boticas	Santos Jr. (1979)
nest	15-06-1962	4*	june 1	Beça/Boticas	Santos Jr. (1979)
nest	19-07-1962	4*	june 2	Beça/Boticas	Santos Jr. (1979)
nest	03-08-1969	3?	july 2	Beça/Boticas	Santos Jr. (1979)
nest	09-07-2003	2+	july 1	Chã dos Forninhos-Pitões das Júnias/Montalegre	M.Pimenta& M.L. Santarém (pers. obs.)
nest	23-07-2003	1+	july 2	Chã dos Forninhos-Pitões das Júnias/Montalegre	M.Pimenta& M.L. Santarém (pers. obs.)
nest	23-07-2003	3+	july 2	Chã dos Forninhos-Pitões das Júnias/Montalegre	M.Pimenta& M.L. Santarém (pers. obs.)
nest	26-06-2006	1+	june 2	Chã dos Forninhos-Pitões das Júnias/Montalegre	present study
nest	26-06-2006	2+	june 2	Chã dos Forninhos-Pitões das Júnias/Montalegre	present study
nest	26-06-2006	4*	june 1	Lama do Pastor-Pitões das Júnias/Montalegre	present study
chicks	18-07-2010	3&	june 2	Chã dos Forninhos-Pitões das Júnias/Montalegre	present study
nest	30-06-2002	3*	june 1	Río Calvos/Orense (Spain)	Lorenzo and Planelles (2010)

* clutch complete; + clutch incomplete; ?clutch stage not clear; # size of *Lymnocryptes minimus*; &five days old

41°55'57.92"N, 7°53'51.80"W), with suitable habitat and regular presence of Common Snipe during the breeding season, it was also monitored. The presence of Common Snipe was evaluated by playback and flush count surveys, as described previously (see "Distribution"). Playback surveys were performed weekly (2007) or fortnightly (2008). Flush counts were performed fortnightly (2007) or monthly (2008). Each flush count was preceded by a playback survey. Additional evidences of snipe presence were again registered.

In 2007, during each survey, the behaviour of each bird was systematically recorded. The first contact with a bird was classified as: "spontaneous" (any observation, apparently not caused by the observer, obtained during the initial 10 minutes of passive listening of a playback survey); "playback" (any observation obtained during or just after playback, apparently stimulated by it); "flushed" (bird flushed during a flush count). The subsequent behaviour of each bird was classified as 'escaping' (escape from the observer) or "displaying" [chipper-call, chip-call, distraction display, drumming-flight (Cramp and Simmons 1983), or approach to playback].

From the literature search previously mentioned (see "Distribution") we collected all observations of Common Snipe nests and/or broods for mainland Portugal. For these and our observations, whenever possible, the fortnight of first egg date was estimated, considering an egg laying-rate of one egg/day, 19 days for incubation and a mean clutch size of four eggs (Tuck 1972); chicks were aged according to Tuck (1972).

Breeding population size

To evaluate the breeding population size and trend, from 2007 to 2010, the localities where the Common Snipe was observed in 2006 were visited at least once between May and July and the number of snipes present was evaluated by flush counts, preceded by playbacks surveys, as described previously (see "Breeding phenology").

Results

Distribution

A total of 178 sampling squares (2x2 km) were surveyed in 2006. The species was observed only on six squares, all located in the region of Montalegre, inside or in the edge of the Special Protection Area of Serra do Gerês. Three of these squares are also within the limits of the Peneda-Gerês National Park (***Figure 2***).

Breeding phenology and population size

A total of 26 and 17 places were monitored in 2007 and 2008 respectively (***Figure 3***), including Río Calvos (in Spain). In the region studied in both years, the number of places where the Common Snipe was present decreased from March to May (***Figure 3***), despite the fact that some of the abandoned places preserved suitable habitat during summer. The surface of the

Figure 2. **Presence/absence of Common Snipe by square (2x2 km) surveyed in 2006.**

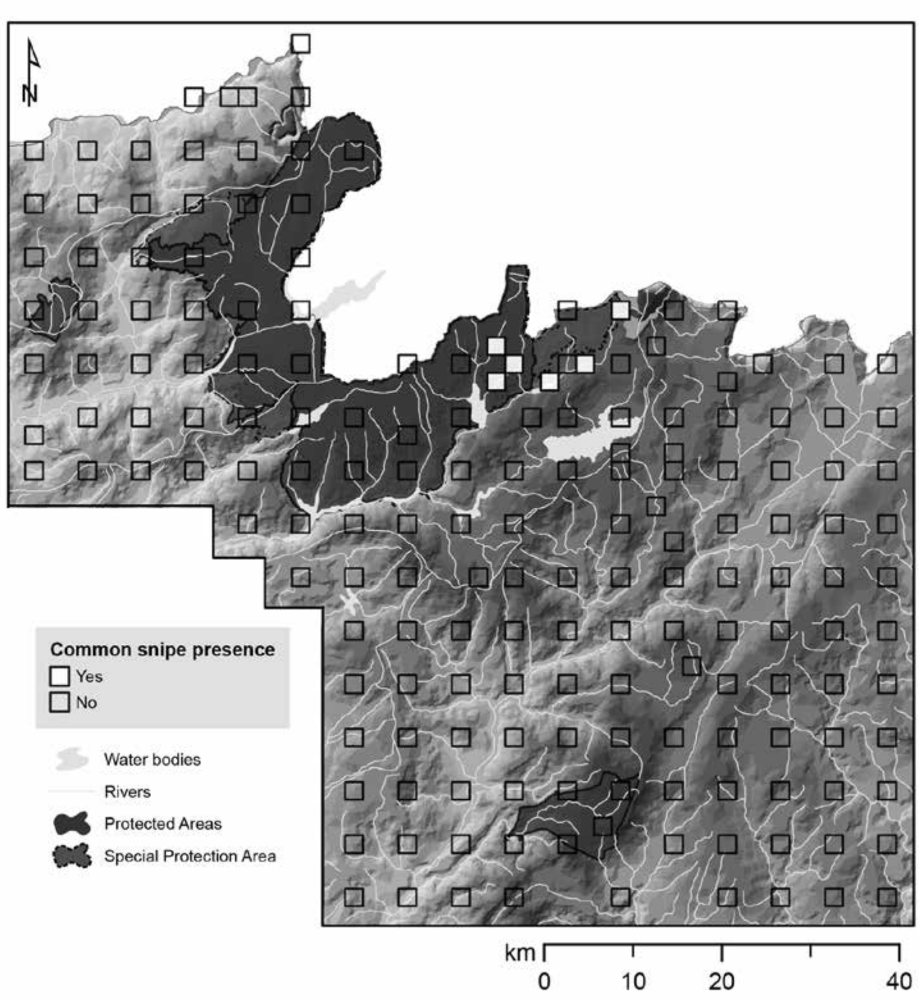


Table 2. **Surface of the surveyed places (habitat patches) in 2007 and 2008 where Common Snipe was detected between March and July. After 2008 these places were surveyed annually until 2010.**

Places	Surface (ha)
Lama do Pastor	0.51
Sezelhe	1.02
Ribeira do Rabagão	1.51
Chã dos Forninhos	1.70
Lama de Porto Chão	2.48
Veiga de Montalegre	3.72
Lamas de Sendim	5.37
Lama Longa	8.97
Río Calvos (Spain)	7.29

surveyed places varied between 0.5 ha and 9.0 ha (median = 2.5 ha; n = 9; Table 2). The places where the species was present between May and July were already occupied in March (***Figure 3***).

In March 2007 snipes were already displaying (drumming-flight) (***Figure 4***). From March to May 2007, among first contacts, the proportion of events of birds flushed decreased from 90.0% to 20.8% ($\chi^2_2 = 27.1$, $P < 0.0001$), and the proportion of events of birds in spontaneous activity or contacts due to playback increased from 3.3% to 12.5% and from 6.7% to 66.7%, respectively; after, until July, these proportions decreased to 11.1% and 38.9%, respectively. Therefore, in 2007 the peak in displaying activity was observed in May (***Figure 4***). Birds were listened in chipper-call from March to July; drumming-flights were observed until June, and chip-calls were restricted to the period between April and June. A single distraction display (Williamson 1950) was observed in June.

Additionally to nests and/or broods gathered from the literature (***Table 1***), in July 2003 three nests were observed by M. Pimenta and M. L. Santarém at Chã dos Forninhos (41°50'N 7°55'W), the same place where, during field work for the present study, two nests (in 2006) and three chicks (in 2010, probably from the same brood) were observed (***Table 2***). Another nest was observed at Lama do Pastor during the present study (in 2006). For the Galician breeding population apparently only one nest was ever recorded (Lorenzo and Planelles 2010; ***Table 1***). For 15 of the occurrences described in ***Table 2*** (including the nest in Orense) it was possible to estimate the corresponding fortnight of first egg date. In mainland Portugal two clutches began in May, but the majority began later, during June and July, in contrast with what was observed in the Azores ($\chi^2_8 = 31.45$, $P = 0.001$) and in the British Isles ($\chi^2_{10} = 81.84$, $P < 0.0001$, where the majority of the clutches began in April (***Figure 5***).

The estimated number of breeding pairs varied between 8-10 (2006) and 3-5 (2010) (***Figure 6***).

Figure 3. **Presence/absence of Common Snipe in places surveyed in 2007 and 2008 for the breeding phenology study.**

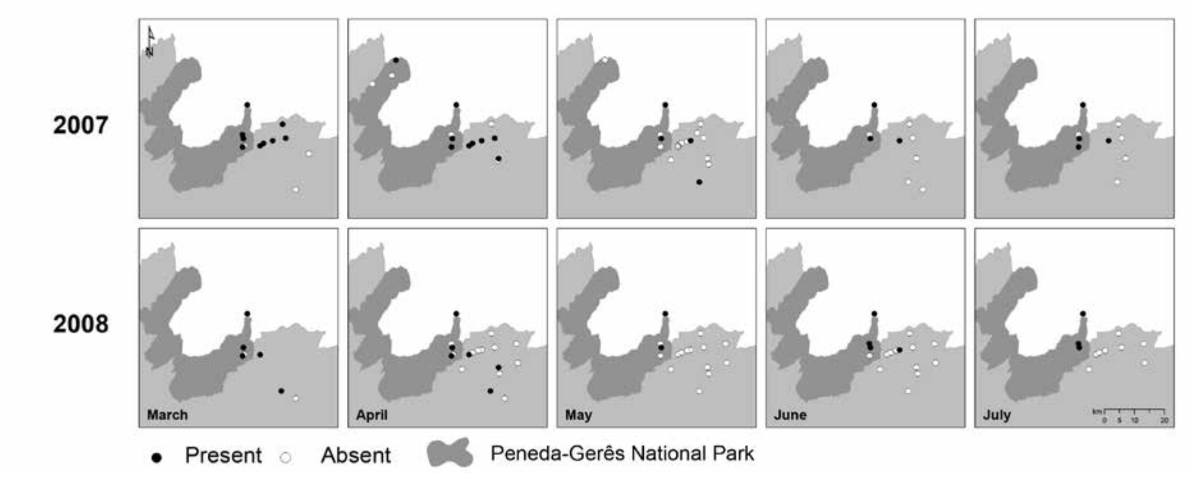


Figure 4. **Monthly variation during 2007 in the frequency of behaviours registered at first contact with a bird (playback, spontaneous and flushed) and subsequently (displaying versus escaping). For definition of behaviour classes see "Methods".**

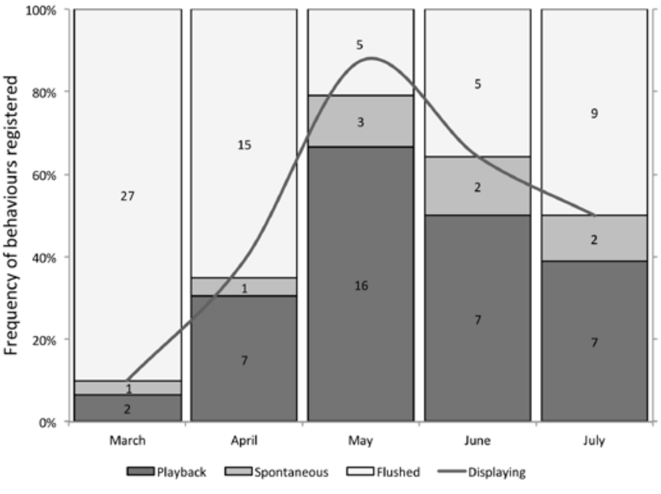


Figure 5. **Fortnightly variation in first egg dates: Northwest Iberia (n = 15)- from the literature (Reis Jr. 1924, Silva Jr. 1924, Coverley 1932, Santos Jr. 1979, Lorenzo & Planelles 2010) and registered by present study authors; British Isles (n = 582) - Mason & Macdonald (1976); São Jorge Island (Azores, Portugal) (n = 26) - Rodrigues & Gonçalves 2011.**

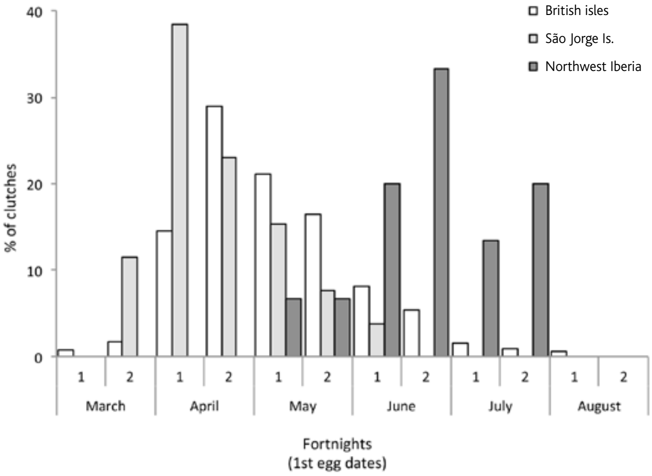
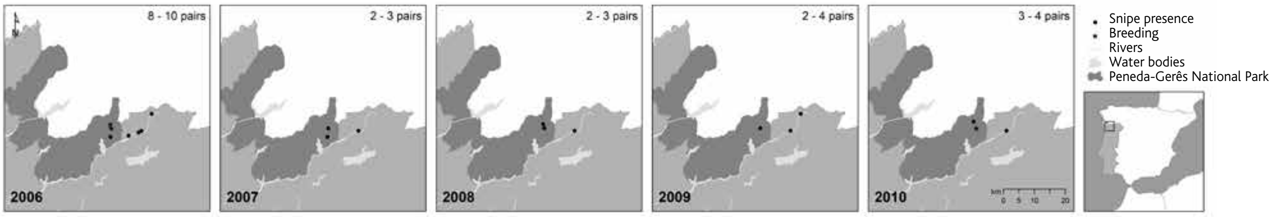


Figure 6. **Presence of Common Snipe during May to July, from 2006 to 2010 and estimated annual number of breeding pairs.**



Discussion

Distribution

A broad area was surveyed in 2006, including places where the Common Snipe was reported to have bred, like Veiga de Chaves (41°46'N 7°25'W) (Silva Jr. 1924), Campeã (41°17'N 7°54'W) and Vila Pouca de Aguiar (41°30'N 7°39'W) (Santos Jr. 1979). Currently, most of these places have little or none breeding habitat for the Common Snipe. During the 1960s several nests were reported in the marshy areas and semi-natural meadows (*lameiros*) of Beça (41°41'N 7°42'W) and Lavradas (41°42'N 7°46'W) (Santos Jr. 1979). At that time, a local hunter estimated that near 100 nests should have occurred every year in the area (Santos Jr. 1979). Nowadays, although these places might be used as wintering areas (especially the meadows in Lavradas), during spring and summer months they dry and no snipe was observed there. Despite this, in Lavradas, locals still refer to the Common Snipe as *Berra* ("bleater") (pers. obs), which suggests that some birds might be observed displaying there.

Some nests were also reported in the meadows bordering the Alto Rabagão reservoir (41°46'N 7°49'W), namely in Negrões (41°44'N 7°47'W) and S. Vicente da Chã (41°47'N 7°47'W) (Santos Jr. 1979). The species was not detected there during the 2006 survey, but in late April 2007 a bird was observed displaying in the meadows where the river Rabagão meets the reservoir, near S. Vicente da Chã. Because these meadows are under the influence of the reservoirs water level, they dry during the driest months, consequently the species was never observed there after April.

Except for one, all the surveyed squares with suitable breeding habitat are within the previous known breeding area of the Common Snipe in mainland Portugal (Rufino and Neves 1991). The exception is a square located in the Peneda Mountain, where several peat bogs remain wet all year, namely at Planalto de Castro Laboreiro (42°4'N 8°10'W) and Gavieira (41°59'N 8°16'W). Despite the habitat suitability for the Common Snipe during all year, there are no references of its breeding on these localities. Nevertheless, the species is present there during winter (pers. obs.).

Between May and July, the Common Snipe in mainland Portugal occupies the semi-natural meadows around the village of Montalegre (41°49'N 7°48'W), in the border of the Cávado river, a few small peat bogs at Planalto da Mourela (41°50'N 7°55'W), and occasionally some marshy areas in the Montalegre region, all to the north of the Alto Rabagão reservoir (***Figure 2***).

Breeding phenology and population size

From March to May, the Common Snipe distribution became more restricted. During this period the species was always observed in the places where it was present between May and July (***Figure 3***). Despite the seasonal drought observed in some of the abandoned areas, in various localities the habitat remained apparently suitable enough for the Common Snipe during summer. However, during that period the species was never present there. These observations seem to indicate the occurrence of two groups of snipes in the region, the local breeders and the passage migrants.

Despite some observations of snipes chipping or drumming during winter (Tuck 1972), these behaviours are mostly restricted to the breeding season. However, since a number of cases of drumming-flights during spring migration have been described, this behaviour is not by itself an indicator of breeding snipe (Tuck 1972). According to the literature, in mainland Portugal, drumming-flights may be observed after the first days of April (Silva Jr. 1924). We registered this behaviour since late March, similar to that observed in the Spanish Central System, in the Gredos mountain (Castellanos 1977). In 2007 some birds were observed displaying between March and late April, in some of the abandoned localities, where the habitat persisted suitable afterwards. Since these dates overlap with the departure of migratory Common Snipe from Iberia (Asensio and Carrascal 1987, Equipa Atlas 2008), it is possible that those birds were spring migrants. The higher proportions of displaying birds observed between May and July 2007 suggest this as the breeding period in mainland Portugal (***Figure 4***). Furthermore, the repertoire of behaviours observed in June included a distraction display, which normally is performed by the incubating female, or by both sexes when caring for chicks, to distract intruders from the brood (Tuck 1972).

The estimated fortnight variation on first egg dates suggests that the peak of clutch initiation on Northwest Iberia occurs on the second fortnight of June. The brood observation (in 2010) is the first to be reported in the region since 1932 (Coverley 1932). The majority of the previous references on Common Snipe breeding in mainland Portugal were reported in June, July or August (Reis Jr. 1924, Silva Jr. 1924, Coverley 1932, Santos Jr. 1979). Only three suggest May as the first egg date (Silva Jr. 1924, Coverley 1932, Coverley 1933).

It is possible that some birds continue incubating during August. In the British Isles, the earlier Common Snipe clutches start in March and might extend till August, but the highest frequency occurs in the second half of April (Mason & Macdonald 1976). In the Azores (São Jorge Island) the highest frequency of first egg dates occur during the first fortnight of April (Rodrigues

& Gonçalves 2011). Given the southern location of the Iberian Peninsula, one would expect snipe start nesting in April, or even in March, similarly to that observed in the Azores. This delay was previously noticed by Santos Jr. (1979). In Galicia, Lorenzo & Planellas (2010) observed one nest in late June 2002, and interpreted it as a possible replacement clutch. According to our results, and all the available references on Common Snipe breeding in Iberia, there is not much reason for such an interpretation.

Because the only two nesting evidences for the Spanish Central System population are from May, a difference in the timings of the breeding season of the Northwest Iberia and the Spanish Central System populations was suggested (Salvadores *et al*. 2004). However, like for the Northwest Iberia population, in the Spanish Central System the Common Snipe can be observed displaying between late March (Castellanos 1977) and July (Sánchez 1987). The apparently relatively late breeding season, when all migratory birds have left the area, might minimize the recruitment of new individuals to the local population, and reduce the gene flow between the Iberian snipes and their northern counterparts. A future effort should be done to characterize these populations, and evaluate their connectivity with the common snipe populations outside Iberia.

Despite the variability of the estimated number of breeding pairs, after a higher decrease between 2006 and 2007, from 8-10 to 2-3 pairs respectively, our subsequent estimates are rather stable, but in a worryingly low number, around 2-4 pairs each year. In some localities, the drought of the habitat, certainly contributed to the decrease in the number of places where the Common Snipe could be observed displaying. This was clearly the reason of the disappearance, between 2006 and 2007, of some displaying birds from the meadows bordering the Cávado River.

Since the first references for mainland Portugal, the Common Snipe is mentioned to breed on semi-natural meadows (Reis Jr. 1924, Silva Jr. 1924, Santos Jr. 1979), one of the most characteristic elements of the mountain landscapes of Northern Portugal (Vieira J. *et al*. 2004, Pôças et al. 2011a, Pôças *et al*. 2011b). The abandonment of these traditional irrigated permanent areas has been highlighted as a cause for the reduction observed in the Common Snipe breeding area (ICN 2006). However, in the region, during the last decades, the area occupied by meadows increased (Vieira J. et al. 2004, Pôças *et al*. 2011a,b). Just for Montalegre, an increase of 60% is estimated to have occurred between 1979 and 2002 (Pôças *et al*. 2011a,b). These results suggest a trend toward changing from traditional mixed crop-livestock farming systems into specialized livestock farming systems, which is a consequence of the Common Agricultural Policy and of the implementation of agro-environmental measures appropriately focusing the mountain areas (Pôças *et al*. 2011a,b). Our results stress the decrease, both on the breeding area and the number of Snipe breeding pairs. Therefore, maybe the specialized livestock farming systems do not benefit the Snipe breeding population. But other reasons, including intrinsic problems due to a reduced number of individuals, may be compromising this Snipe breeding population.

During the last decades, an hypothetical partnership between the Portuguese and Galician authorities to restore the Common Snipe habitat in these regions has been discussed several times. Meanwhile, not only the breeding range is shrinking in Portugal, but also some breeding nuclei in Galicia have almost disappeared (Domínguez *et al*. 1987, Lorenzo & Planelles 2010).

In the Iberian Peninsula, the Common Snipe has a peripheral population. Because they occupy the limits of their species range, these populations probably occur in suboptimal environmental conditions. They are frequently small and isolated, and might show low levels of genetic variability, that can make them susceptible to environmental and demographic changes, and stochastic and catastrophic events. Also, the geographic isolation might contribute to the occurrence of diversification processes, including speciation, revealing their importance in the context of biodiversity conservation.

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Trophic adaptations of the different species of snipes on the basis of morphology of the feeding apparatus

Kyrill B. Gerasimov Moscow Lomonosov State University, Biological Faculty, Vertebrate Zoology Department,
119991, Vorobievy Gory, Moscow, Russia
Email: gerasimov.kyrill@gmail.com

The shape of the bill, the papillae on the palatal surface of the upper bill, the salivary glands, and the bill tip organ were studied in 10 species of Scolopacinae. These and some other morphological characteristics suggest the following adaptations. *Gallinago gallinago* and, particularly, *Limnodromus scolopaceus* are specialized in extracting relatively small prey from the benthic layer of mud to the depth of their bills. *Lymnocryptes minimus* is also well adapted to extracting small worm-like food objects from mud, but is unspecialized in probing for surface invertebrates, including low-flying insects. *Limnodromus scolopaceus* is also partly specialized in feeding on the surface invertebrates. *G. media* and *G. megala*, as well as *Scolopax rusticola*, are specialized in feeding on large prey taken from dense substrates; *S. rusticola* feeds in drier habitats. The imago of insects, extracted exclusively by touch during probing of the leaf litter, must comprise an important part of the diet of *Scolopax*. *S. minor* is particularly specialized in feeding on insects extracted by touch from the leaf litter. In *G. hardwickii* and *G. solitaria*, the adaptations for the extraction of large prey from fairly dense substrates could have evolved over a short period of time, as suggested by their morphological similarity to *G. gallinago*. These waders could have previously inhabited much wetter landscapes. Five specimens of *G. stenura* showed considerable differences in the relative length of the bill ridge and in the orientation of the anterior palatal papillae. With regard to its feeding specialization, this species is close to *G. media* and *G. megala*, whereas *G. stenura* of the Yamal populations are developing specialization for feeding almost exclusively on large underground prey, often extracted from the grass and sedge tussocks.

Adaptations of the feeding apparatus of snipes

Kyrill B. Gerasimov Moscow Lomonosov State University, Biological Faculty, Vertebrate Zoology Department,
119991, Vorobievy Gory, Moscow, Russia
Email: gerasimov.kyrill@gmail.com

The feeding apparatus of *Limnodromus scolopaceus*, *Lymnocryptes minimus*, *Gallinago gallinago*, *G. stenura*, *G. hardwickii*, *G. megala, G. solitaria*, *G. media*, *Scolopax rusticola* and *S. minor* were investigated. We considered the natural position of the Scolopacinae skull, i.e. with a horizontal orientation of the jugal bars, indicating the same position of the braincase, and the downward pointing bill. In this case, the eye is displaced back- and upwards along the bill axis by the base of the upper bill. The ability of these waders to open their bills in dense substrates has been widely discussed, but the jaw apparatus of snipes enables them to pull out objects from the substrate. This is achieved by reduction of the external jugomandibular ligament, with squeezing characterized by the independent muscular control of the jaws; downward orientation of the bill (clinorhynchy); the increased length of the upper jaw along with the fixed length of the lower jaw; the distal rhynchokinesis; and notable hypertrophy of the nasal premaxillar processes fastening the basal two-thirds of the bill ridge. The ability of snipes and other probing waders to actively lower the tip of the lower jaw is denied.

Common Snipe, Great Snipe and Jack Snipe in the eastern upper Volga area

Vladimir N. Mel'nikov Ivanovo State University, Russia
Email: ivanovobirds@mail.ru

The eastern upper Volga includes the basin of the Gor'kovsky Reservoir and the lower part of the Klyaz'ma River (territory of the Ivanovo Region and adjacent parts of the Kostroma, Nizhegorodsky, and Vladimir regions). The Common Snipe (*Gallinago gallinago*) is common, widely distributed and inhabits all suitable habitats. In the Klyaz'ma State Refuge, breeding density is low (0.4-2.8 pairs/km^2) and strongly depends on water depth and duration of the spring flood. An estimate of numbers and distribution in different habitats was made in May-June in the Ivanovo Region. The plot census method, adapted for Common Snipe, was used. GPS navigators were used for measurements and mapping of plots, and for recording snipe locations. Ten observers took part in the counts and 4-5 surveys were made at 36 plots, covering a total survey area of 1664.4 ha. In the shallow bank of the Gor'kovsky Reservoir, covered with dense vegetation, we recorded the maximal density (29.2 pairs/km^2) and the maximal activity of snipes. The density was also high in humid meadows, i.e. at the Gor'kovsky Reservoir banks (19.0 pairs/km^2) and in the floodplain of Lukh River (13.5 pairs/km^2). A high density was found in large burned parts of pine forests in the Balakhna lowland (on average, 11.9 pairs/km^2). The average density is somewhat lower on old (recently abandoned) turf (peat) fields (7.4 pair/km^2). However, Common Snipe were patchy distributed here, showing preference for moderately humid fields, and avoiding dry parts as well as completely flooded ones, and fields with small birches and dense dead standing birches. In old turf quarries, the breeding density is stable (8.3 pair/km^2). In abandoned arable lands, an increasing humidity is observed, with the start of formation of bogs. Such areas attract snipes as well, and density in humid parts of such fields is 5.2 pairs/km^2. In the forests with small wetlands and lakes, the density was 5.6 pairs/km^2. On lowland moors and high moors, snipes are found only in some parts, and density is low (2-3 pairs/km^2). In transitional moors in lower parts between arable lands on a moraine hummock ridge, the Snipe density is significantly higher (10.6 pairs/km^2). The following key factors affect the spatial distribution of snipes in every habitat: a presence of open areas without forest, shallow pools or wetlands with places of open water, suitable perching points (usually dead standing trees with crushed tips), interrelations with other bird species, timing of grass burning.

The Great Snipe (*Gallinago media*) is not abundant and locally distributed. A set of permanent habitats is available and leks exist. In the Klyaz'ma River floodplain, it inhabits the Klyaz'ma Refuge with an average density of 0.4 to 1.4 pair/km^2. Areas with concentrations and leks can move depending on water depth and duration of the spring flood. Leks are observed in the floodplain of Lukh River and on the banks of the Gor'kovsky Reservoir. In recent years, Great Snipe began to settle in the humid parts of abandoned arable lands. A nesting population is known in the surroundings of Ivanovo, in fields of the instructional farm of Ivanovo Agricutural Academy.

The Jack Snipe (*Lymnocryptes minimus*) is very rare and probably nesting. An aerial display has been observed for many years in the middle stream of Lukh River, in the Uvod' River mouth, and in wetlands of the Balakhna lowland. On 20 June 2000, in the Kosovka bog in the Klyaz'ma Refuge, a brood of three flying chicks was observed.

Woodcock and Snipe

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Eurasian Woodcock and Common Snipe of the Omsk oblast

Sergei. A. Soloviev Omsk State University
Email: solov_sa@mail.ru

The status and numbers of Eurasian Woodcock *Scolopax rusticola* and Common Snipe *Gallinago gallinago* in the Omsk and Tara regions and adjacent territories of forest and forest-steppe areas are presented, based on our research carried out in 1986-2010 in the Omsk Oblast. Additional information collected in the north of Omsk region (taiga) in May and June, 2000-2005 is given and literary sources dating from 1881 are summarized. We also analyzed the work of Herman Grote.

The Eurasian Woodcock is a nesting and migratory species. It is regularly seen in the right-bank territory of the Tarskiy region (northern part of the Omsk oblast). It has been observed on migration in Omsk and adjacent territories (forest-steppe) in spring and autumn, but wader numbers have been declining year on year. From 22 September until 6 October 2001, we marked 2 Eurasian woodcocks in the forest artificial line in the northern part of Omsk.

The Common Snipe is a nesting and migratory species. Its numbers have decreased since the middle of the 20th century. In June 1994, a displaying male was seen in the flooded land not far from Atak village in Tarskiy region and a bird was seen sitting on a haystack at the same place on 16 June 1997. In the first part of the 20th century, the Common Snipe was a common nesting species. On average, the Common Snipe is very common in the southern part of the forest-steppe in summer (23 birds/km^2), whereas it is very rare in the urban lowland (0.01/km^2), as well as on the lake banks (0.08/km^2). It is on average very rare in the forest-steppe in the southern part of the Omsk Oblast (0.001/km^2). During migration it becomes common (3/km^2), but by the end of summer its numbers increase two-fold.

Advancement of arrival of the Woodcock (*Scolopax rusticola*) and Common Snipe (*Gallinago gallinago*) to Estonia, 1923-2009: does weather play a role?

Jaanus Elts
& Riho Marja
Institute of Ecology and Earth Sciences, Tartu University,
46 Vanemuise St., Tartu 51014, Estonia
Email: Janus-elts@eoy.ee

The aim of the present study was to find out whether the timing of spring arrival of the Woodcock and Common Snipe in Estonia has changed during the last ninety years and to determine the typical weather conditions upon arrival of these two species. Phenological data of Woodcock is available since 1923 and for Common Snipe since 1936. Advancement of arrival of the Woodcock was most pronounced in the middle of the last century, whereas in the beginning of the 20th century and in the end of the 20th century, arrival time of the Woodcock did not show any clear trend, although at the end of the century it was still some 10 days earlier. The Common Snipe also advanced its arrival by 10 days. Influence of weather conditions on arrival date of both species was analysed, based on data from years 1966-2009. The predominant wind direction during the three days before the first record of both species was southward. In years with low March temperatures, Woodcock tended to arrive later than Common Snipe, whereas in warmer years, the arrival sequence was the reverse.

Notes

This volume is the Proceedings of the Seventh European Woodcock and Snipe Workshop organised by the Woodcock & Snipe Specialist Group of IUCN (International Union for Conservation of Nature) and Wetlands International. This international meeting was held in May 2011 in Saint-Petersburg, Russia and attended by 50 participants from 11 countries.
It contains 27 papers and abstracts covering a wide range of topics on biology, monitoring and management, chiefly focusing on Woodcock (*Scolopax rusticola*) and Common Snipe (*Gallinago gallinago*).
A general paper describes the new technologies used in the study of Woodcock migration. The workshop was characterised by a large representation of Russian researchers who provided updated information on a key region for many migratory species in Europe.

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our website: www.oncfs.gouv.fr

or contact:
Yves Ferrand
Office national de la chasse et de la faune sauvage
Direction des études et de la recherche
39, bd Albert Einstein – CS 42355
44323 Nantes Cedex – France
Tph : 33 (0)2 51 25 07 88
Fax : 33 (0)2 40 48 14 01
E-mail : yves.ferrand@oncfs.gouv.fr