MIGRATION ATLAS OF EUROPEAN SPECIES OF PALEARCTIC ANATIDAE WITH THE POPULATION OUTLINE (FROM THE DATA OF THE BIRD RINGING CENTRE OF RUSSIA).

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INTRODUCTION

By this moment a number of migration bird atlases have been already published. They are based on the data from several bird ringing centers in Europe and Bird Banding Laboratory in North America. At the end of the last century Bird Ringing Centre of Russia published the series of books on migration of waterfowl birds (Migrations of birds of Eastern Europe and Northern Asia: Ciconiifirmes-Anseriformes, 1979; Anseriformes, 1989; Anseriformes. Dabbling Ducks, 1997). Those books were published in Russian language with English summaries. They have presented the results of huge work performed by many ornithologists. However this work has been done in the “before computer” period, therefore data treatment and maps in those issues are not as detailed as it is possible to make now, when data are usually treated on computer. Also modern GIS systems allow drawing convenient and informative maps. EURING website now contains interactive The Eurasian African Bird Migration Atlas (2022, https://migrationatlas.org/), that is a standard type atlas and not complete, because data of the Bird Ringing Centre of Russia are not used there.

Till now, no one migration atlas on data from Bird Ringing Centre of Russia has been published. Russia holds 1/9 part of the land and 1/6 part of the World. This area is the main breeding place for a great number of European and Asian bird species; Anatidae comprises the important part of them. In many countries Anatidae birds are the resource for game shooting and consume hunting. Therefore, it is quite actual to present the imagination of bird migration within this huge territory.

Bird Ringing Centre of Russia has considerably less number of ring recoveries than many European ringing centers, but they cover extensive territory with different life zones. This is the main advantage of the data set. Since our task is to present as much information on migration as possible, we have used all ring recoveries that we have in our database. Data from a number of key European ringing centers are already published (Speek, Speek, 1984; Roggeman et al., 1995; Wernham et al., 2002; Bakken et al, 2003; Bonlokke et al., 2006; Fransson, Pettersson, 2001; Spina, Volponi, 2008; Bairlein et al., 2014). However, for consistency, we place maps with „Moskwa‟ scheme ring recoveries in species accounts for species with large number of records.

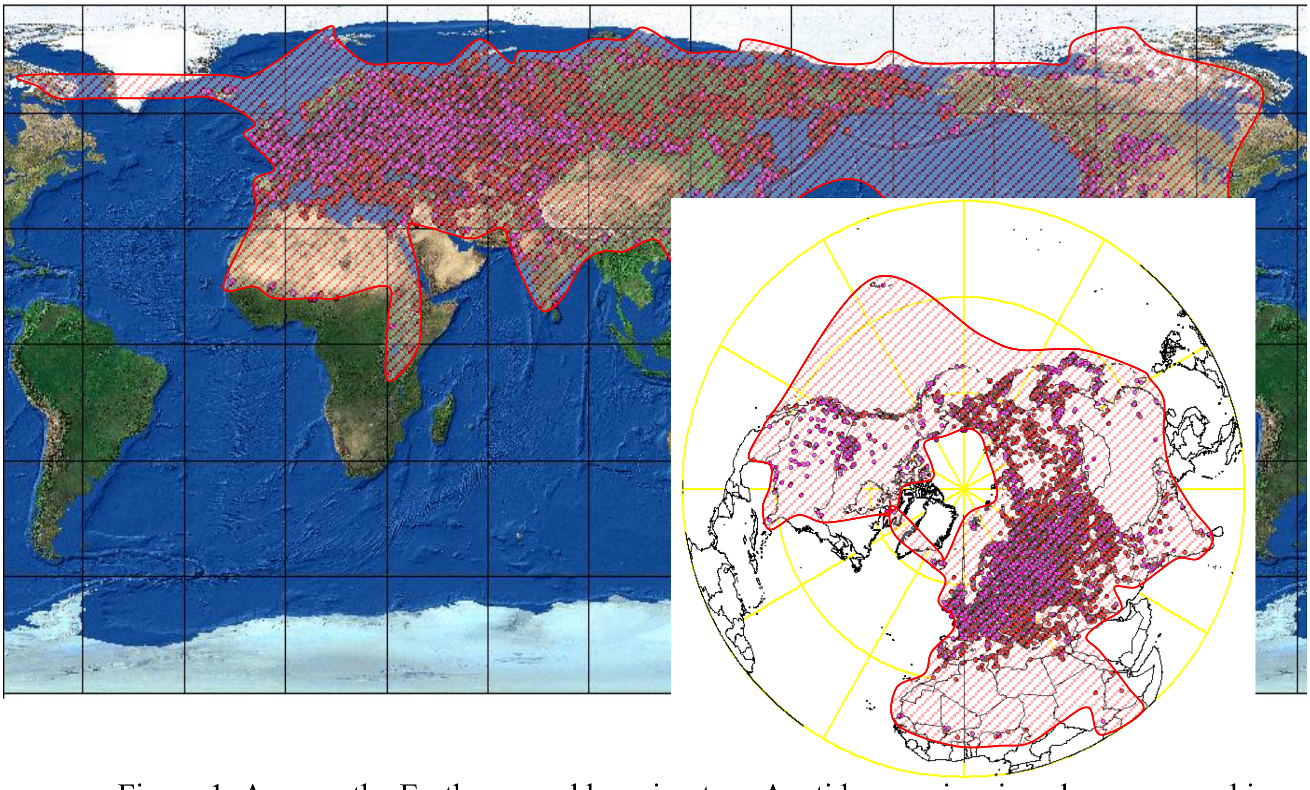


Figure 1. Area on the Earth covered by migratory Anatidae species ringed or recovered in the former USSR (dashed area). Purple dots represent ringing sites, red dots – recovery sites.

Anatidae birds that migrate from and to Russia and other former USSR countries fly as far to the west as to Northwest Territories, Nunavut, Canada (Long-tailed Duck recovered at 66.35N, 71.45W); and as far to the east as to Northwest Territories, Nunavut, Canada as well (Common Eider, 64.19N, 74.29W), almost encircle the Earth in the Arctic (Fig. 1).

In this Atlas we have tried to display as much information on waterfowl migration as possible to obtain from data we have in the Bird Ringing Centre of Russia database. Number of recoveries is different in different species. Mallard and Northern Pintail are represented in the database by more than seven thousand recoveries, but in White-headed Duck we have only six recoveries. Anyway, we try to use all we have to outline not only the migration pattern of the species, but as more population parameters (e.g., mortality rate) as we can (Cooke, 1999; Lebreton, 1999).

In this Atlas we present the migration of European Anatidae species. However, to outline the migration pattern of these species more completely, we consider it not only in the European part of Russia, but over the whole Russian territory, including Far East. If species in their eastern part of the ranges migrate to North America, Japan or India, these migratory routes are described, as well. In this manner, we can consider not only species, but groups of species that are close to each other, and not long ago have been considered as one species (e.g. Brent Goose-Black Brant species complex). Anatidae species that do not have originally breeding areas in European Russia are considered only for birds that escaped from captivity in Europe and have long distance ring recoveries. Migration of the non-European species from their natural breeding range is not considered here.

In Russia bird ringing commenced since 1907 (Dobrynina, Litvin, 1999). Bird Ringing Centre of Russia was founded in 1924 (Dobrynina, 1994), therefore our mane bulk of data started since this year. However, ringing activities have been performed in Russia since early years of the 20th Century. Unfortunately, most of those data have been lost; however there are few records from 1909 in our database. The latter were taken from the publication (Jespersen, Taning, 1950).

Main subjects that we tried to highlight in each species account of this Atlas are: 1) to draw migratory routes of Anatidae from the data of ring recoveries (if data are available, to compare results of ringing with the migration pattern obtained from other marking methods, e.g., neck-collars); 2) to plot and describe the monthly distribution of all species recoveries; 3) if the number of recoveries is large, to outline migration movements month-by-month for birds from different parts of breeding or wintering ranges; 4) in order to have better imagination of the migratory movements to involve the satellite transmitter tracking data in some cases, if data sources are available; 5) if the data collecting period is quite long, to analyse changing of migration pattern over decades since 1920s; 6) to present the life span of the species; 7) to present data which allow assuming the speed of migration; 8) to outline the Anatidae populations that can be revealed from ring-recovery data; 9) to calculate average mortality rate for a species, sometimes for some distinctive groups within it, e.g., different sexes.

Some interesting regularities might be revealed during the considering ringing and recovery places in relation to each other and to the features of the land where these sites are situated. To get more sophisticated understanding of the migratory movements we have defined some additional tasks for this Atlas. These two additional subjects are described in two separate chapters: 1) to consider distribution of recoveries in relation to each other within species; 2) to analyze distribution of recoveries in relation to ecological features of the area.

We should do one important remark concerning bird systematic. During time of the Bird Ringing Centre of Russian exists a number genera names changed, the order of systematic subdivisions changed, as well. However, we consider, as the ringing process is going many years, the bird ringing centre should be the most conservative organization concerning bird systematic. Therefore, we do not follow recent systematic changes and rely on the systematic from L.S.Stepanian, 2003.

MATERIALS AND METHODS

General Methods. Method of the ring-recovery processing is very common for many countries. Ringing in Russia is usually performed by scientific institutions and nature reserves. In addition, individual volunteers take part in this process. In the database we collect ringing details as: species (sometimes subspecies), sex, age, ringing date and ringing place. The latter includes region, district (optionally), nearest human settlement, in recent years – exact ringing site with its geographical coordinates as degrees and minutes. For older recoveries we define coordinates as precise as possible to the very ringing place (it is possible for long lasting ringing sites in nature reserves and scientific stations) or we take the coordinates of the nearest settlement.

For the finding data we place the recovery site, date, finding conditions and how the bird was called by a finder. If some important and interesting comments of a ringer or/and finder are available, we also include them in the database. For this reason the Ringing Centre tries to keep original letters since 1924 because during data treating questions and mistakes might occur. As recovery place we usually consider the nearest settlement to a recovery site if precise coordinates are not available. Since the number of settlements is much less in Siberia and Far East, the finding coordinates for those areas in general are less precise than for European Russia. The same is true also for the finding dates: in the Russian north it is not rare when hunters collect rings from birds during many years. From time to time those rings with finding details might be obtained if some ornithologist visit remote settlements and speak with hunters. Certainly, in many such cases the recovery place is known, but dates might have very low accuracy. For this case, as accepted by many other ringing centers, we input an interval of dates as recovery date accuracy. In some quite rare cases this interval may comprise several years. During data treating we took into account the preciseness of any particular data and selected data with suitable preciseness for different analyses.

Sometimes a correspondent does not inform the date of recovery and does not answer to requests. In the latter case we use the date of the envelope stamp as a finding date. The database contains so called “postal” dates, which have special marks. To plot ringing and recovery site distribution across months only such recoveries were used where ringing date accuracy was less than 31 days, recovery date accuracy did not exceed 3 months. All recoveries where postal date was used as a finding one were removed from the monthly distribution analysis.

In case of several recoveries per one ringing mark (ring, neck-collar, etc.) each encounter after marking we considered as a separate recovery with the ringing details at the initial ringing. Elapsed time we calculated as a number of days between ringing and recovery dates. In case the ringing or/and recovery dates were represented as a time interval, we took the middle date of the interval. This middle date was used as a ringing or/and recovery date in the producing of the elapsed time value.

Since the most Anatidae species are game ones, main finding condition for them is “shot”. Therefore, low populated areas might create a question – whether the distribution of recoveries for some species is real, or it is biased and reflects mostly the distribution of hunters. To answer this question it is useful to look at the recovery picture of several species in the same area. Different recovery distribution of another species confirms that the recovery distribution of the former species is real. Good example for this approach is Pintail-Wigeon recovery patterns in Siberia. Pintail recoveries have well noticeable gap in this area. The first impression is that the gap area holds low number of hunters. However, if we consider Wigeon recoveries in Siberia, there is some concentration of recoveries exactly in the gap of Pintail recoveries. On the other hand Wigeons have Siberian gap, as well, but in the area where there is no gap in Pintails. These analysis shows that hunters are everywhere in Siberia, and recovery patterns of Pintails and Wigeons are real (see below in species accounts). It turned out that every duck species has spatial gap of recoveries in Siberia, every species in its own area (see below).

For some examinations one can neglect differences between ringing and finding places because these sites can be interchanged. The point is that both ringing and recovery places are records of a bird. Therefore, if we do not consider flight direction, we can accept that ringing and recovery places are equal ones, and consider both sites as "control points" where we record a bird. Now this approach is getting more spread among European ornithologists; and even the new EURING database code (version 3) concords with this approach. It is possible to analyze migration links between birds of any two geographical areas basing on the notion of "control points". For the analysis we sample birds ringed or recovered in the given two areas. After that, we consider control points in both areas as separate sub-samples, without telling differences between ringing and finding sites.

To compare spatial distributions of control points in different areas we used Mardia-test with Robson's suggestions (Robson, 1968). For testing we applied the computer programme kindly granted by J.E.Hines and slightly changed by one of the authors (Kharitonov, 1997).

There is a disputable question, how to plot the recoveries on maps: whether it is better to use average or median coordinates. Although in the past ornithologists have used median co-ordinates quite often (Perdeck 1980 in Zemitis 1987), this approach contains a contradiction. In the common accepted Mardia-test, centers of sample areas are calculated on the basis of average coordinates, not medians. To overcome this contradiction, we think, it is necessary to use average coordinates again. In our analysis the usage of means instead of medians does not misrepresent the relations between calculated centers of areas and does not affect final conclusion. Moreover, we are not aware of any case in migration studies, where the interchange of these quantities has made a considerable difference. In this Atlas, whenever needed, we have calculated mean coordinates, medians have not been used.

It is common approach for the ring-recovery data to divide the whole data set into direct and indirect recoveries. The recoveries during one migration season, i.e. not later than one year after ringing, are considered as direct ones. Recoveries where the elapsed time (number of days between ringing and recovery dates) is greater than one year (365 days) are considered as indirect recoveries. This approach suggests that direct recoveries show the real migratory route of particular bird between control points.

Distance and bearing calculation. In the bird migration analysis two commonly accepted quantities are used: distance between ringing and recovery point and bearing from the ringing to the recovery points. There are quite a few formulae for calculation those quantities. The formulae are different in their preciseness. We found that most applicable formulae for these calculations are the formulae from Zemitis, 1987:

$$D = 6365.5612 \bullet \arccos(\sin(B_1) \bullet \sin(B_2) + \cos(B_1) \bullet \cos(B_2) \bullet \cos(L_2 - L_1));$$

$$\alpha = \frac{arctg(L_2 - L_1)}{\ln tg(\frac{\pi}{4} + \frac{B_2}{2}) - \ln tg(\frac{\pi}{4} + \frac{B_1}{2})};$$

A= α if $B_1<B_2$ and $L_1<L_2$; A= 180 – |α | if $B_1>B_2$ and $L_1<L_2$;

A= 180 + α if $B_1>B_2$ and $L_1>L_2$; A= 360 – |α | if $B_1<B_2$ and $L_1>L_2$;

where D is the distance between two geographical points, α – angle between direction of flight and the nearest meridian, A – azimuth, B_1 – ringing latitude, L_1 – ringing longitude, B_2 – finding latitude, L_2 – finding longitude.

These formulae appeared to be very precise by means of the following test: when we shift ringing and recovery points in the formula for distance calculation, distance stays practically the same. Many other formulae do not pass this test. For example, formulae published in Payevsky, 1985 works well on distances less than 3000 km only. In larger distances shift of ringing and recovery places may produce disagreement between results by more than 100 km.

Statistical remarks. In biological studied the most prominent result is considered when the differences between some sample characteristics are significant. This is because in many cases samples are not large. In very large samples differences between sample characteristics often appeared significant just for the reason of the large sample size. In large samples even very small differences often are significant, whereas in small or moderate samples even considerable differences could be non-significant. In all these cases pure statistical effect works: in large samples statistical error (commonly accepted, it is called standard error) is very small *per se*. Taking this effect into account, we rely not only on the result of statistical tests, but on the magnitude of differences for our conclusions. E.g., in Mardia test in mallards the centers of areas of direct and indirect recoveries differ along latitude by as little as 23 minutes, along longitude – 1 degree and 14 minutes, however the difference is significant. In Scaup differences are greater – 53 minutes along latitude and as large as 22 degrees by longitude, but insignificant. Sample size for mallards is near 7000 recoveries, for scaup 99 recoveries. As we see in Mallard, difference between centres of direct and indirect recoveries is very little in comparison to the whole recovery area, therefore in such cases we prefer consider then as about the same point in spite of significant difference. In case of Scaup the differences between these centers as very big in comparison to the recovery area, therefore we prefer to consider them as different in spite of insignificant difference, the latter probably originated just from the small sample size. To tell shorter: in Scaup we may consider areas of direct and indirect recoveries as more different than in case of Mallard, in spite of insignificant difference in scaup and significant difference in mallard. In this manner, for small samples significant difference is more important, whereas for large samples (where significance is almost "automatic") insignificant difference is more important. This is because the insignificant differences in very large samples really could mean greater degree of similarity than in case of significant differences. Since in migration studies many samples are very large, the most interesting cases are those ones where difference is not significant. To our mind, in distinction from small samples, in large samples namely the insignificant difference needs special explanations.

As statistical criteria we have used commonly accepted ones: t – Student, Z – Mann-Whitney and chi-squared tests. In addition we used t-test Bailey (Plokhinsky, 1978). The latter criterion is applicable for any type of variant distributions. Bailey test is the parametrical one and can be used not only for normal distributions, but for the non-normal distributions of data. For this reason the Bailey criterion is more powerful than the non-parametrical Mann-Whitney test. In practice, Bailey test gives the same conclusions as the Mann-Whitney test, but is easier calculated and creates fewer difficulties with very large samples. It is much easier programmable in the treating specially written utilities, than the Mann-Whitney one.

Population recognition. In Anatidae the whole species range (breeding and wintering ranges) might be divided into geographical populations (Isakov, 1967). Later on the notion of "geographical populations" served as the basis for the concept of migratory areas, or flyways (Boere, Stroud, 2006). We use the same approach trying to delineate populations from the data of ring recoveries. As a separate populations we consider areas of control points more or less separate from neighbouring ones. The precise procedure for population definition is not yet elaborated (probably it is not possible); therefore, in the population recognition, the considerable part of the definition is the arbitral one. In this Atlas we are able to outline only those populations that can be derived from available data on migration. In case of absence of data for some populations, e.g., population of Boreal Common Eider (*Somateria mollisima borealis*), we have not separated such populations on the population maps.

In some known publications related to Anatidae population definition, e.g., Scott and Rose, 1996, the fact that part of populations of several duck species breeding in Western Siberia and wintering in Western Europe, bend Ural Mountains over the south on their spring and autumn migration, have not been taken into account at all. This caused improper population definition in those species (Scott, Rose, 1996). However, there is well known fact of spring migration from Western Europe practically straight to the east till Urals, then bending mountains, then moving to the north of Western Siberia (vise versa in autumn) (Krivenko, 1991). Herewith, we take into consideration this regularity, together with many others not published yet.

In order to "find" populations from recoveries we elaborated a sequence (order) how to plot recoveries on the map. In our studies we use GIS MapInfo versions 5.5 – 8.0. To draw straight lines; one of the authors, Sergey P. Kharitonov has written an additional utility in MapBasic language, then included this programme into MapInfo "Tools" Menu. To highlight populations we draw ring-recovery lines on the map in the sequence from area to area from west to the east, using rectangles to plot recoveries step by step just to see the space between populations more visible (Fig.2). Sizes of the areas were defined arbitrary, depending on the amount of recoveries in each particular area: the greater amount of recoveries the lesser area is defined (Fig. 2). For every species with suitable amount of recoveries, first of all we draw lines for birds ringed or recovered in Iceland (area number 1 in Fig.2). Then we do the same for the area, which includes western and central Africa (latitude<=35˚N, longitude from 30˚W to 30˚E, number 2, Fig.2); then for all other areas enlisted in Fig.2: eastern Africa and approximate Middle East (latitude<=35˚N, longitude greater than 30˚E to 60˚E, number 3, Fig.2); India and China (latitude<=35˚N, longitude from 60˚E to 125˚E, number 4, Fig.2); Japan (number 5, Fig.2); North America (number 6, Fig.2); western Europe with western longitude (latitude>35˚N, longitude < 30˚W to 0˚E, number 7, Fig.2); western and central Europe with eastern longitude (latitude>35˚N, longitude > 0˚E to 15˚E, number 8, Fig.2); central and eastern Europe (latitude>35˚N, longitude > 15˚E to 30˚E, number 9, Fig.2); eastern Europe (latitude>35˚N, longitude > 30˚E to 60˚E, number 10, Fig.2); Siberia (latitude>35˚N, longitude > 60˚E to 125˚E, number 11, Fig.2); Far East (latitude>35˚N, longitude > 125˚E to 170˚W, number 12, Fig.2). Recoveries already used for one area in the sequence have not been used in other areas. In this way recoveries are placed in "layers" by longitude.

In case something stayed unclear we drew additional "layers" of recoveries by latitude: 1) birds ringed or recovered northward of 60˚N; 2) birds ringed or recovered at latitude <60˚N and >=50˚N; 3) birds ringed or recovered at latitude <50˚N and >=40˚N and so on.

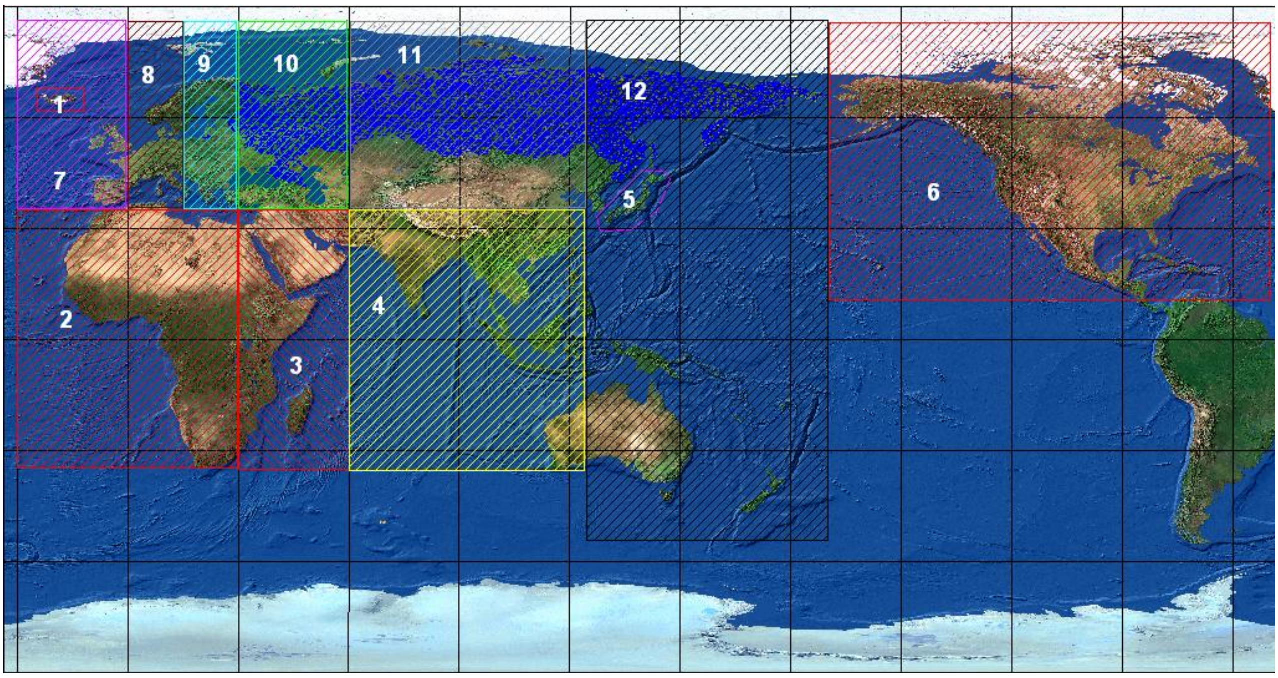
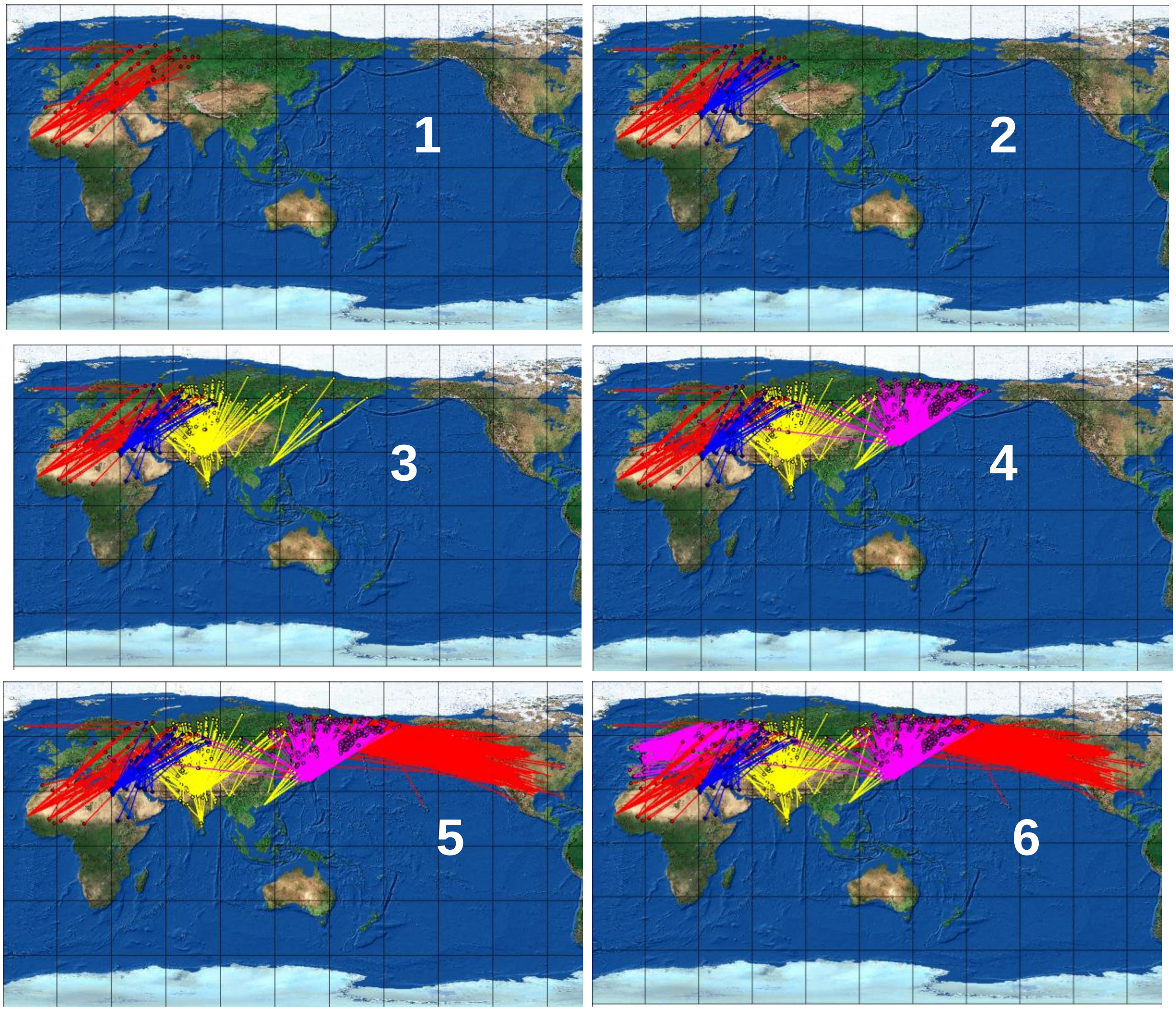


Figure 2. Elaborated areas for population recognition in Anatidae. Dashed areas are sequential zones in which we substantially drew lines connecting ring and recovery sites (see text).

The illustration how the method works could be performed by the example of Pintail, a species which has over 7000 recoveries covering an extensive area. Map with Icelandic and west African recoveries shows that they belong to different populations, although they overlap in the very north of the breeding range (Fig.3, 1). After plotting Middle East recoveries we learned that part of birds from European Russia and west Siberia fly to western Africa direction, part of birds fly to Persian Gulf and eastern Africa, detecting the third population. The latter overlaps with west-african-eastern-european population in its breeding range (Fig.3, 2). Yellow lines from recoveries in India and China show two populations: indian-west-chinese-western-central-siberian and eastern-chinese-far-eastern ones (Fig.3, 3). Purple lines indicate the japanese-far-eastern population (Fig.3, 4). American recoveries indicate north-american-north-far-eastern population (Fig.3, 5). Then we return back to Europe; recoveries connected with western Europe with western longitude form the population that differs from west-african-european popultaion, but similar with the Icelandic one (Fig.3, 6). Adding more eastern recoveries indicates that these birds belong partly to European, partly to the two Africa-connected populations (Fig.3, 7-10). Far Eastern birds (black lines in Fig.3, 10) definitely belong to eastern-chinese-far-eastern population. Full population picture is shown in the Pintail species account (see below).



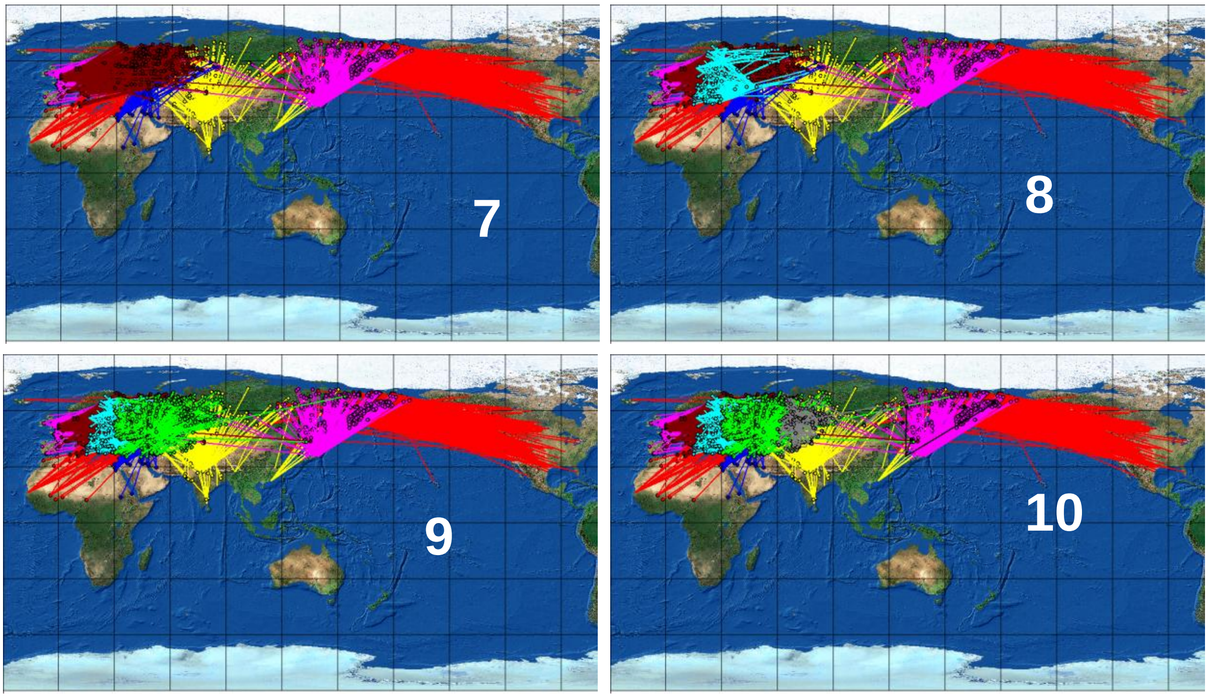


Figure 3. Illustration of the method of population separation by the example of Pintail. 1 – steps 1 and 2 (Fig.2); 2 – step 3 (Fig.2); 3 – step 4 (Fig.2); 4 – step 5 (Fig.2); 5 – step 6 (Fig.2); 6 – step 7 (Fig.2); 7 – step 8 (Fig.2); 8 – step 9 (Fig.2); 9 – step 10 (Fig.2); 10 – steps 11 and 12 (Fig.2).

Populations of species that perform longer distance migrations usually have greater ranges, e.g., Pintail, Common Shelduck. Populations of species that perform shorter distance flights have smaller ranges, e.g., Ruddy Shelduck.

Every species has movements that are exceptionally long for a species. Such movements usually connect areas of two different, not necessarily neighbouring populations, and can be called as "cross-population movements". Some of such flights are visible in Fig.3 in Pintail.

Mortality rate. Survival and the opposite value – mortality are considered as the most important population parameters. Survival-mortality allows predicting population numbers. Ring-recovery data are the good material for calculating several population parameters of bird species. For more precise and better way calculation of the survival/mortality rate we need data about how many birds were ringed in the considered cohort and how many recoveries we obtained from this particular ring set. If we have these data we can, depending of ringing and/or recovery conditions, use one the numerous models of “capture-recapture” process. Huge amount of literature related to this process (e.g., quite detailed textbook Brownie et al., 1985; Nichols, Hines, 1993; Lebreton et al., 1992). However, the problem is, most of these methods need the number of birds that initially ringed (marked). The situation in the BRCR, the same as in many other ringing centres is very different. In many cases the total number of ringed birds of a species stays unknown. That happens for many reasons. In earlier times Bird Ringing Centre of Russia received ringing reports on paper sheets, now a huge and hard work should be done to calculate the number of ringed birds. Not a rare reason is when ringer have not sent ringing report at all, but answer questions about ringing details of the particular recovered birds. The most common reason – for foreign rings the number of ringed birds is almost never known, data exchange usually concerns only ringing and finding details.

Therefore, mortality calculation should be performed basing on the recovered birds. This method exists and quite old (Lack 1954, Haldane, 1955, Payevski 1985 and others). In modern conditions special stochastic math models are used. A number of models are gathered in special programme packages, one of them is well known programme MARK (White, Burnham, 1999;

www.cnr.colostate.edu/~gwhite/software.html). Since we can rely only on number of recoveries, in programme MARK we can Select Data Type as: “BTO Ring Recoveries” (in the version 2.5) or Dead Recoveries -> BTO Dead Recoveries and Unknown Ringing (version 8).

Therefore, not all recoveries have been used for evaluation of mortality rate. Only “dead” recoveries with more or less exact ringing and finding dates are applicable. For our analysis recaptures and birds with postal dates (because of large data inaccuracy) have been removed from the data set. Then we need to choose the Model. For these choice we have 6 (or 7 in the later versions) Link Functions, each of them has 2 variants of estimation ways, therefore we should choose one of 12 (14) models. However, they are pure math models; no biological characteristics for each model can be given. Besides that, every model has 7 options. In addition to this, each math parameter of a model can be fixed or not. As a result, a lot of different survival rates are obtained; difference between them is mathematical, not biological. To choose the best model we should use the AIC criterion (Burnham, Anderson, 1998) that is calculating in the MARK programme, as well. The result of test where the meaning of this criterion is lowest, together with deltaAIC=0 and lowest number of parameters indicates that this model is the best related to the original data (Burnham, Anderson, 1998). However, practical use of these models and criteria is not only quite difficult; it does not spare us from the arbitrary decisions during the way of survival (mortality) calculation (see below). In this situation a scientist almost compulsory needs to apply to a very qualified biologist-mathematician just to calculate the survival (mortality) rate. Also not all versions of the programme MARK produce the average survival rate, if produce, there used a formulae that slightly complicated than common accepted average value calculation. However, "in most cases, standard errors of the estimates will typically dominate such transformation bias, so that the bias in the back-transformed estimate of the mean is usually ignored". (Programme MARK, 13 edition of the User's Manual). Normally MARK gives a number of values of survivals for the selected temporal interval (usually per one year). It needs to import the output file from MARK to MS Excel and only after that the average value can be calculated. We should add that preparation of the input file for MARK is not an easy process. To our mind, the described way of survival calculation is overcomplicated. One more complication is computer problems: different versions of the MARK program (which are developed once every few years) might give radically different results for the same data set and in the case of applying the same model.

The default Link Function that programme MARK proposes to use is the SIN Link Function which, according to the used formula really appeared a linear function. However, the mortality process in a population is usually exponential process and, logically, the exponential Link Functions exist in the programme MARK, e.g., Logit, LogLog, Complimentary LogLog (Cloglog). It is no clear, why one of this functions is not proposed to be default (as it is appeared, the Cloglog function looks the most appropriate one – see below and in the species accounts).

It could be that MARK program might have a high-precision mathematical apparatus. However, whatever the mathematical accuracy, it cannot be higher than the accuracy of the incoming biological material. While it is impossible to do without the MARK program for many ringing cases, where a fairly large number of parameters are initially known (the number of originally ringed birds, etc.), there is no need to resort to excessive mathematical accuracy for the case when the number of input parameters is the smallest. This refers to the greatest mass material of any European ringing center, when only the number of recoveries from dead birds is known for the sample under consideration, but the total number of ringed birds is unknown. In addition, in these cases the main requirement of the MARK program for such recoveries is usually not fulfilled, namely the constancy of the share of recoveries for the entire territory surveyed. This requirement especially cannot be fulfilled for the entire vast territory of Russia. Under these conditions, there is no guarantee that the survival/mortality values obtained with the help of the MARK program will be more accurate than the results obtained by simpler methods.

Such a guarantee may exist, if the data received correspond strictly to the conditions of the model, which may happen in very-very rare cases.

Besides the MARK programme, there is much more simple and understandable way for survival-mortality calculation (Kharitonov, 1997, 1998, 2017). It is possible to derive just one and explicit model which really is a Link Function, as well. In addition, the method proposed by me makes it possible not only to calculate the required population parameters (the survival and mortality rates), but also to assess the status of the species or population under study during ringing and ring recovery. The MARK program does not support such an additional possibility.

Our proposed model is an exponential one and based on the regularity that some initial bird cohort gradually decreases every year because some amount of birds die every year. On average, the number of live birds in each year represents a geometrical progression (exponent line). The first term of such progression comprises the total amount of birds which have been alive in the initial point of the consideration (on ringing) and died during a number of years. The number of years can be denoted with n. The last-named term of the progression represents the value in the n+1th year, when all the birds already died. Mathematically, in n+1th year "less than one bird left alive (for the calculations we took 0.99). In this case annual survival (denoted with *S*) will be the nominator of such progression (Kharitonov, 1998; 2002; 2017):

$$S = \sqrt[n]{\frac{0.99}{N}},$$

where *S* is the average survival rate for the cohort from *N* birds over *n* years.

However, in real samples quite often in the last year number of birds left is greater that 1. To do the formula for survival calculation more universal, it was modified as:

$$S = \sqrt[n]{\frac{D-0.001}{N}},$$

where *D* is number of alive birds in the last year under consideration.

Mortality rate (M) is calculated as M=1-S.

Substitution the annual mortality rate, obtained by the described way, in the tables, designed by other authors for different bird species (e.g., Lack 1954, Onno 1967), creates even better fitness to their results. To obtain the standard error for the mortality rate we use commonly accepted formula (Haldane, 1955; Payevsky, 1985):

$$E_M = M \bullet \sqrt{\frac{1-M}{N}},$$

where E_M is standard error of mortality, *M* – average mortality rate, *N* – total number of birds in the cohort. The mortality rate in this formula is taken from the described approach in which the average mortality rate is calculated by mathematically precise way (geometrical progression), however, the standard error is taken as a statistical value. The use of the standard error obtained by the statistical method is necessary so that the average mortality rate will more adequately correspond to the amount of available data (the size of the group of birds considered).

It is known that a mortality rate is calculated from birds, which were born in different breeding seasons. These birds are considered as members of the same age cohort (Payevsky 1985). Authors take different dates as initial points: 1 January (Lack 1954), 1 July (Onno, 1967), autumn migration start (Paeyvsky, 1985). In this issue ringing date has been accepted as initial point. A number of years of life for "dead" recoveries (when bird is recovered as dead) have been calculated from elapsed time periods divided by 365.

To compare the way of calculations and results we need to refer to several examples and see calculation processes in detail. As an example we will use data on Pintail and Steller"s Eider recovery sets. In Pintail, the set contains 6728 dead recoveries (see "Mortality rate" section in the "Northern Pintail" species account). First, we tried do define Mortality rate via the Programme MARK. Using 12 of proposed Link Models, the lowest AIC criterion with the deltaAIC = 0 belongs to the Log 2ndPart link model. If we simply calculate mean survival rate from this model, we obtain S=4.38613, mortality rate = -3.38613. It is clear, that "the best" model gives total nonsense. Trying to escape this nonsense, we look at the "Real Function Parameters" in the output file and see, that in two parameters real annual survival rate is 43.227799. Intuitively, we feel that it could not be, because survival rate never exceeds 1. So we should make a trick – arbitrary decide that these two "ugly parameters" should be removed from the survival rate calculation. In addition, we see in the programme MARK table, that in the Log 2nd Part model uses only 22 of 24 parameters of the output file. But which 22 parameters of 24 are used is not pointed in the output file. Therefore, we arbitrary decide that these two ugly parameters should not be used. Indeed, when we remove these two parameters, we obtain acceptable survival rate = 0.686923, mortality rate = 0.313077. Then, we calculate mortality rate via the presented above formulae of the geometric progression. The result is: mortality rate = 0.3184. We neither need a complicated input file (like in the programme MARK) nor any tricks. Difference between our method and "the best" MARK model, after arbitrary correction is as little as 0.53%. This comparison shows no need of the complicated way via programme MARK; geometrical progression gives us the result which is precise enough.

After the example with the Pintail set, one could decide that there is enough to remove obvious ugly parameters and continue usage of programme MARK for mortality calculations. Unfortunately, it is not so. The next example with the Steller"s Eider recovery set will show us that in this species, if we perform calculation in MARK, we need to use even more tricks. For the Steller"s Eider set (431 dead recoveries) the Log 2ndPart link Model appears the best one, as well. In this case output file contains 22 parameters; model uses only 20, but does not point which parameters are used. One parameter is definitely ugly (survival rate=432.67820), so, no question what parameter should be removed. However, we have removed only one, what second parameter should be removed? All others do not exceed 1, so are not "ugly". Looking at the output file, we see that one of the parameters is probably too small to be real. Here we should make another arbitrary decision: to remove this very small parameter, too. Only after that we obtain more or less acceptable meaning of the survival (mortality) rate. And again – geometric progression method gives us acceptable meaning of mortality rate (see "Mortality rate" section in the "Steller"s Eider" species account) without much difficulties and arbitrary decisions.

Unfortunately this is not all. Programme MARK has, at least, one bigger disadvantage. Not only meaning of AIC, deltaAIC, but the number of used parameters in some models depends on the order of running models. For instance, we consider the mentioned Pintail dead recovery set. If the link model LogHessian is considered as 10th model in the order, it has 25 parameters; if it is considered as 2nd model in the order, it has 26 parameters. In the programme MARK such cases are numerous. Therefore, working with programme MARK we practically always should use tricks. What can do a practicing ornithologist in this situation? The most predicted way: for every case when survival rate definition is needed he (she) should invite a specialist on models who is familiar with “proper” tricks. We believe that all presented examples are good arguments for using the geometric progression model, which is quite simple and does not need tricks.

For comparison of MARK results and results of the geometric progression way in species accounts we use not “the best” method that need to remove ugly and some other non-suitable parameters, but only models that do not contain such parameters. Anyway, results of the mortality calculation by method of geometrical progression often are very close to ones of the programme MARK models (Tab. 1). This means that among number of models that used in the programme MARK there is at least one model that gives practically the same results as the geometrical progression. The problem is so serious; therefore we have decided to present these data here, before the description in species accounts.

Special tests of samples with different volume show that results obtained with the geometric progression method are more stable and less dependent on the sample volume than models are included in the programme MARK.

Table 1. Average mortality rate from ring-recovery data compared with programme MARK values.

SPECIES	Mortality rate from geometric progression model (%)	Nearest value for mortality rate from MARK (TYPE OF MODEL)	Difference (%)
Wigeon	20.47±0.33	20.93% (CLogLog_2ndPart)	0.46%
Gadwall	26.48±0.90	26.41% (CLogLog_2ndPart)	0.07%
Pintail	31.84±0.32	30.20% (CLogLog_2ndPart)	1.64%
Mallard	27.82±0.29	28.35% (CLogLog 2ndPart)	0.54%
Garganey	30.44±0.67	29.60% (Sin_2ndPart)	0.84%
Shoveller	28.86±0.68	29.39% (CLogLog_2ndPart)	0.53%
Common Pochard	29.74±0.51	29.25% (CLogLog_2ndPart)	0.49%
Tufted Duck	26.00±0.38	26.77% (Sin_2ndPart)	0.77%

The described way of mortality calculation appeared not only easier that commonly accepted method reflected in the programme MARK. In distinction to programme MARK, it allows evaluating the population status (prosperity). To perform the latter we need to compare theoretical and real mortality patterns of a bird cohort (species, population, sex group, etc.). Theoretical mortality pattern is produced from the geometrical progression on the basis of the average survival (mortality) rate. This procedure makes possible calculating a number of birds that must theoretically be alive in every particular year after ringing. The equation for this is quite obvious:

$$Y = N \cdot S^{x}$$

where: N is the total number of birds in the cohort, S – mean annual survival rate, x – number of years after ringing, Y – number of birds that are alive at the x year after ringing.

On the other hand, database offers us the real number of such birds for every year. Significance of differences between theoretical and real mortality pattern is evaluated by the standard chi-squared criterion. These mortality patterns can be visualized in one chart (Pintail as an example, Fig. 4) and from this chart we can evaluate the population prosperity quite well.

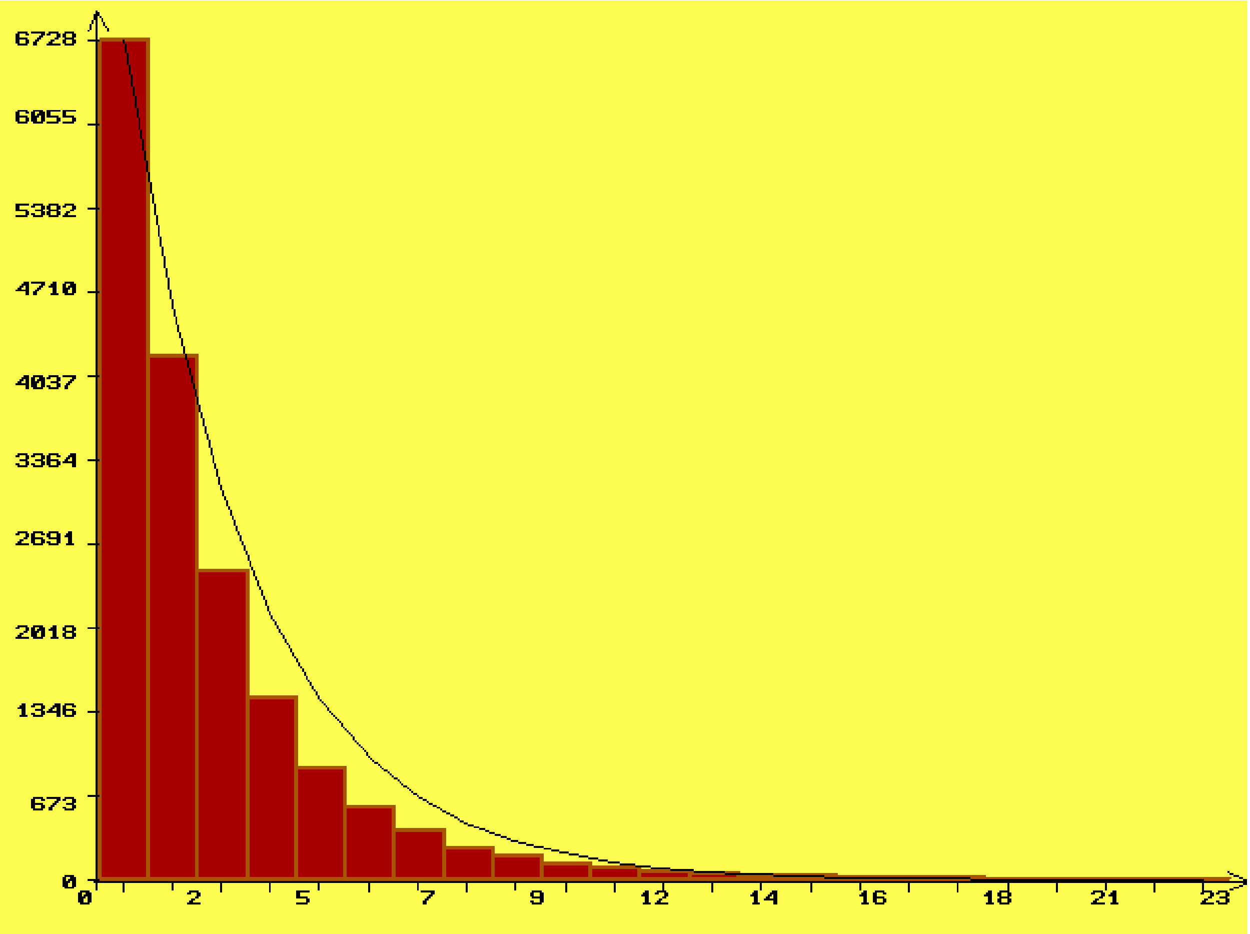


Figure 4. Mortality pattern in Pintail produced from the recovery data. Y axis reflects the number of birds that are alive at different years; X axis is the number of years after ringing. Line is the number of live birds per year calculated from geometrical progression model. Bars – real numbers of live birds.

It turned out that if we know that a species or population is in stable condition, its theoretical and real mortality patterns lay very close in the chart shown in Fig.4. Atlantic Brent Goose or American-central-Siberian population of Steller‟s Eider can serve as examples (see species accounts). If bars of the real mortality rate stay above theoretical line, it means that the species or considered population is in good condition and growing in numbers. This is true for Pacific Black Brant and Barnacle Goose (see species accounts). It is even possible to detect the source of this good population condition. If the theoretical curve is exceeded by bars of the first years after ringing, it means that population growth is due to younger birds (less numbers of years after ringing), see Pacific Black Brant species account. If real numbers exceed the curve for greater years, it means that older birds have greater impact on population prosperity (see species account on Barnacle Goose). If tops of bars of real year-by-year bird numbers lay considerably below the theoretical curve, especially if this "deflection" is more prominent in the part of chart with first several years after ringing (presumably – in younger ages), this signals that the species or population is decreasing in numbers.

To make the evaluation of the population status more exact, we need to use one additional expedient. The point is that, some species have very long lived individuals. Their age greatly exceeds the nearest age of other not so long-lived bird. For making conclusion on the population status those exceptional very long-lived birds should be temporally excluded from the sample. For example, the oldest Tufted Duck male lived more than 44 years, the nearest oldest bird lived less than 27 years (see Tufted Duck species account). The latter is much close to the main bulk of duck ages, so for some analysis we might consider exceptionally long-lived male as an outlying case.

On the base of the mortality pattern we derived numerical index of the population demographic status. It is calculated in percentages as a sum of differences between real and theoretical mortality rates in each year starting from the second year after ringing divided by the number of years minus 1, then, in turn, divided by N (the number of birds in a sample) and multiplied by 100. Standard error (in percentages, as well) is calculated by the standard way. Using additional coefficients (Kharitonov, 2020) we derived the transformed numerical index or the numerical "indicator of population prosperity". To produce this index we involve coefficients to adjust the numerical indicator for the stable population to be zero. Transformed numerical index or the numerical indicator of population prosperity makes possible to reveal the population trend: whether the population is stable, decreasing or increasing. Positive indicator of population prosperity indicates that population condition is good, negative – that it is bad and numbers of the population or species are declining. We propose to use the indicator of population prosperity as a criterion of the rational use of the game waterfowl species. It indicates whether we can continue hunting the particular species or the species needs protection (Kharitonov, in press).

Summing up the proposed approach to the mortality evaluation we should stress that if we use recoveries only, the real fluctuation of recovery rate through the different areas of Russia and other countries is quite high. In programme MARK models recovery rate is postulated as being constant, for the geometrical progression model it does not matter. Therefore, it makes no sense to use more complicated models if we can obtain about the same result using simplified model. It is also no sense to use more complicated models because in real nature conditions we cannot evaluate a number of important ringing-recovery rate parameters, and process of the model choice in many cases looks like gambling (Rinne et al., 1999).

Geometrical progression approach is much simpler than models collected in the programme MARK. Moreover the former model gives us also an imagination of the population condition. We have commonly accepted quite complicated method, however we are not assured that this method is more precise than the other one. Geometrical progression method is also a model, but it is more simple, logical and practical: as a first step we obtain average mortality rate. Then, on the basis of it we are able to build the theoretical curve of mortality. Later on we can draw the chart of real mortality rate and compare with the theoretical one. After this comparison we get the imagination of the population condition, which is not possible to understand from models of the programme MARK.

Materials. Main data treatment performed during 2013-2023. The latest data that we collect for the Atlas from the database of the Bird Ringing Centre of Russia is 27.05.2023. For that moment we had the total near 44 597 waterfowls recoveries for 36 species (including Brent Goose group here accepted as one species), that have their species ranges in Europe and 9 non-European species which have recoveries in Europe. Therefore these recoveries were used in species accounts. Non-European species ringed in their natural ranges are not included in the subject of this Atlas. However for the Part II and Part III of the Atlas main migration regularities mostly as there were for 2013-2015, therefore we decided to publish the available treated data without additional treating.

ACKNOWLEDGEMENTS

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A.N.Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences. Many thanks to all staff members of the Bird Ringing Centre of Russia for their long-term efforts for creating and managing our database. Many thanks to all ringers and to all finders! Without their efforts this Atlas could have never been written.

PART I SPECIES ACCOUNTS.

MUTE SWAN
(*CYGNUS OLOR*)

Breeding range in Eurasia. Brief description of the breeding range is shown in Fig 5. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

Photo by Sergey P. Kharitonov

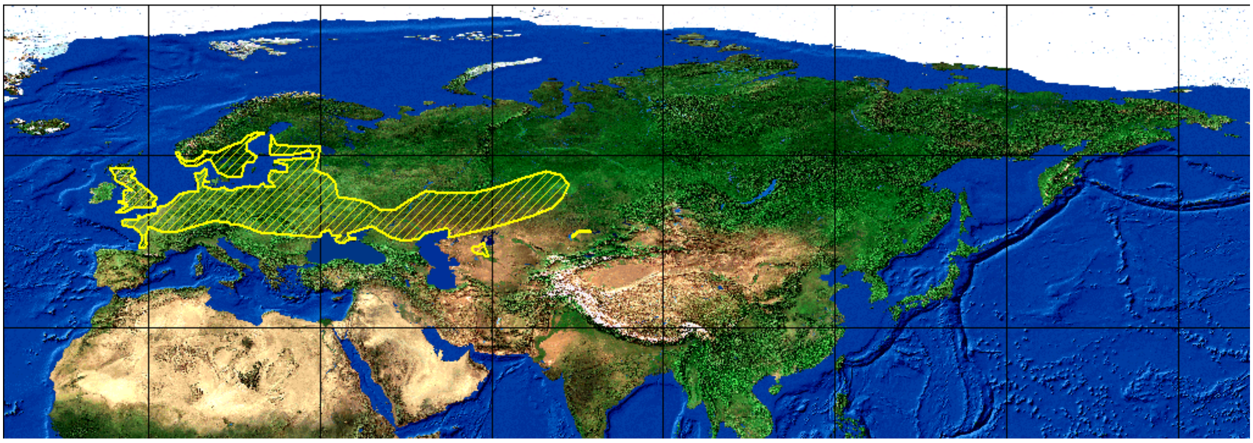


Figure 5. Breeding range of the Mute Swan in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 750 marked birds were used, which gave 856 recoveries (Fig. 6). 541 were marked with metal rings only, 136 swans held neck-collars together with rings, one swan held wing-tag. Ringing dates are since 19.08.1954 till 29.07.2011, recovery dates since 01.12.1954 till 21.07.2013. Swans only with rings had from one to 12 recoveries per bird, birds with neck-collars from 1 to 6 recoveries per bird. This is exceptional because usually the number of color mark sight records is greater than rings only. In this manner, one bird with ring „Moskwa" Z-67 721 was observed 11 times being marked with the ring only, on 11th encounter it was recaptured, neck-collar was added and after that the swan was met only once.

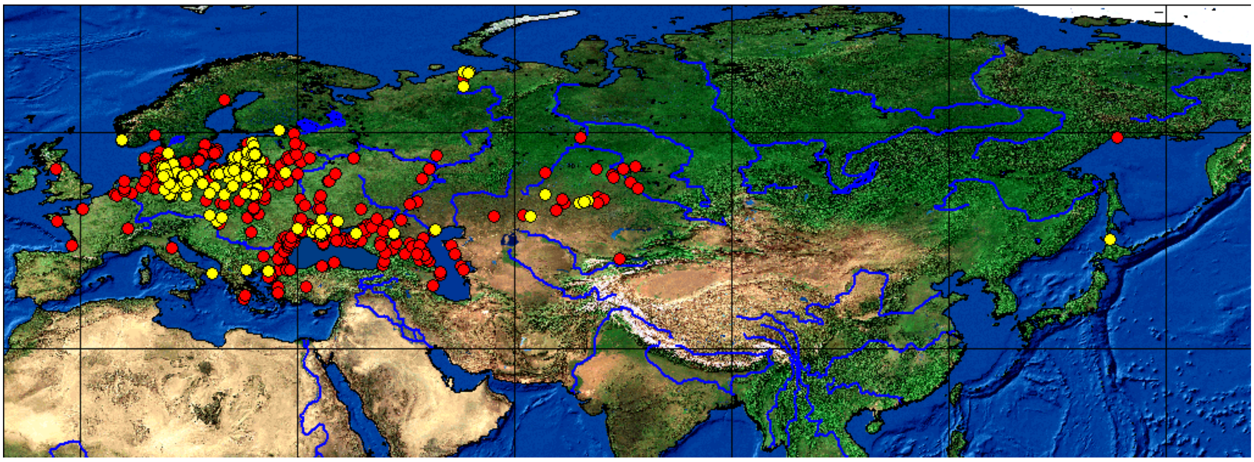


Figure 6. Position of all Mute Swan control points. Yellow dots – ringing sites, red dots – recovery sites.

Most recoveries are connected with the natural breeding range. We have one additional recovery from a bird ringed in Japan, where the Mute Swan population is introduced. The bird was ringed in April in Japan, in May it was shot at the northern coast of the Sea of Okhotsk (Fig. 9). This indicates that feral swans fly along the same migratory routes as wild geese and swans in the particular area were the feral birds live.

'Moskwa' scheme recoveries. This sample contains 524 recoveries of the scheme „Moskwa". They are from birds ringed mostly in Latvia, Lithuania, southern Ukraine, Volga River Delta and Central Kazakhstan (Fig. 7).

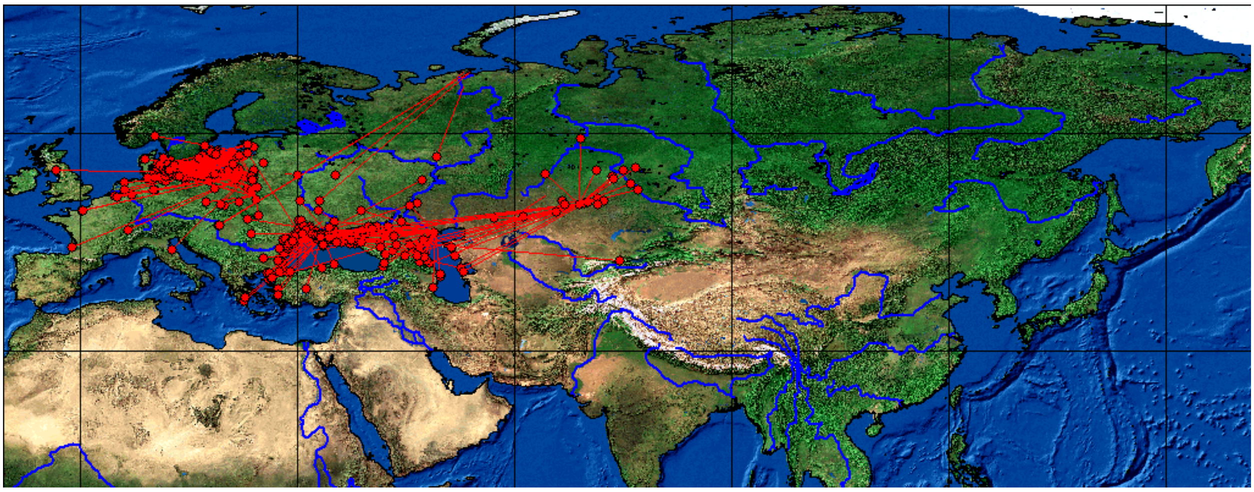


Figure 7. „Moskwa" scheme recoveries. Here and on all other similar figures lines start from the ringing sites, recovery sites are marked with red dots.

Finding details. This analysis includes all 856 recoveries. More than 1/3 of recoveries were shot (7%), found dead or died, the second largest amount are sight records of either rings or colour marks, the third is "caught and released", other kinds of finding details play lesser role (Fig 8). 29 swans hit wires or were found dead under overhead wires, one was electrocuted. Just one was killed by car.

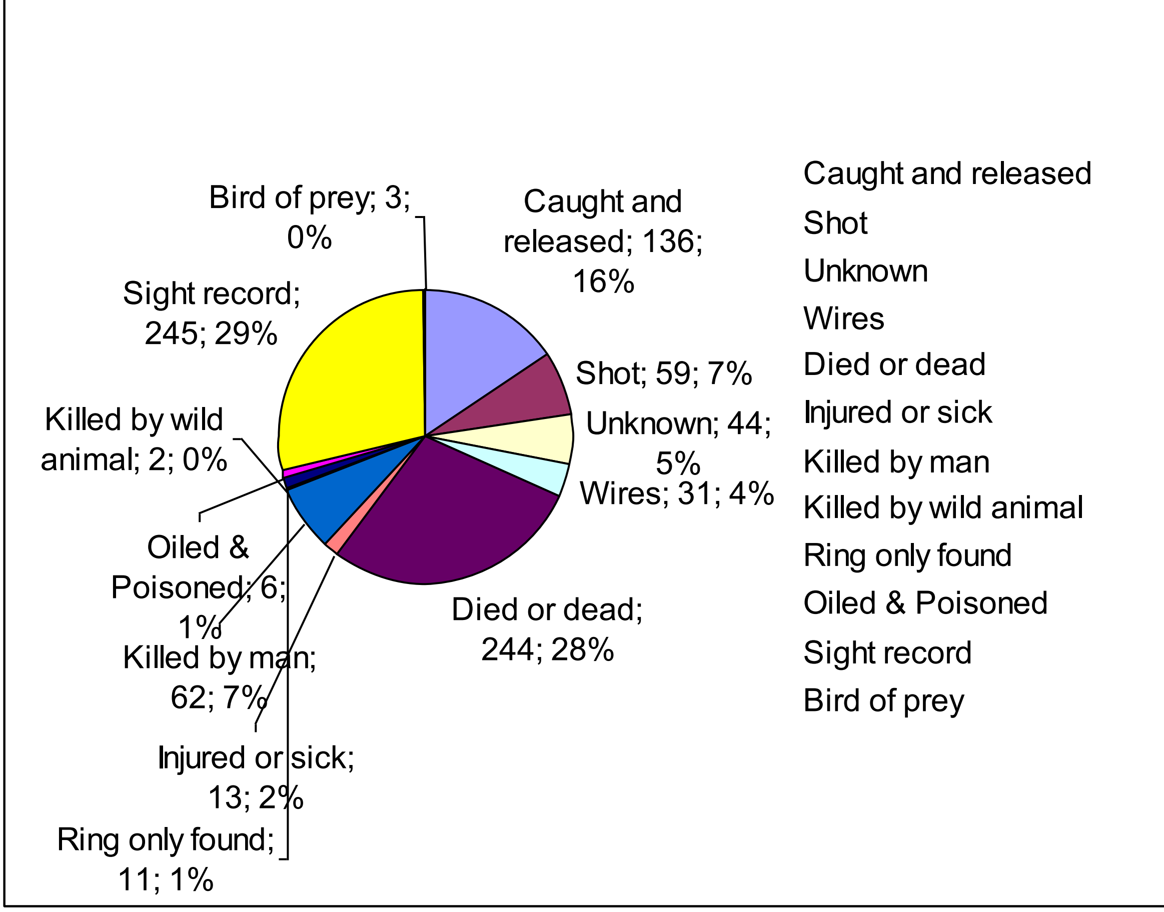


Figure 8. Finding details of Mute Swans.

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries do not differ much from each other (Fig. 9, 10).

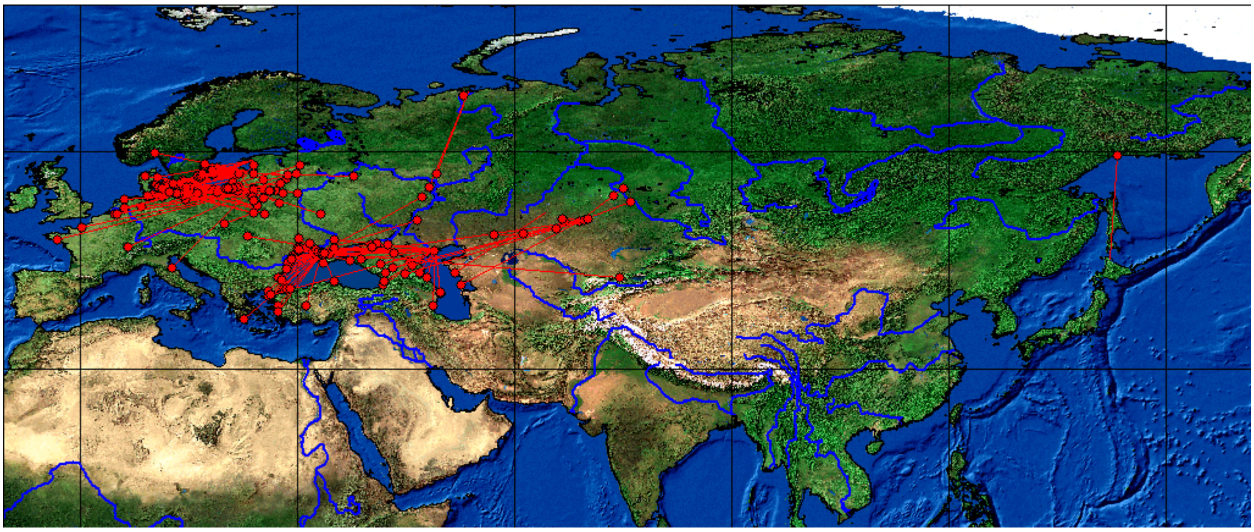


Figure 9. Map of Mute Swan direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

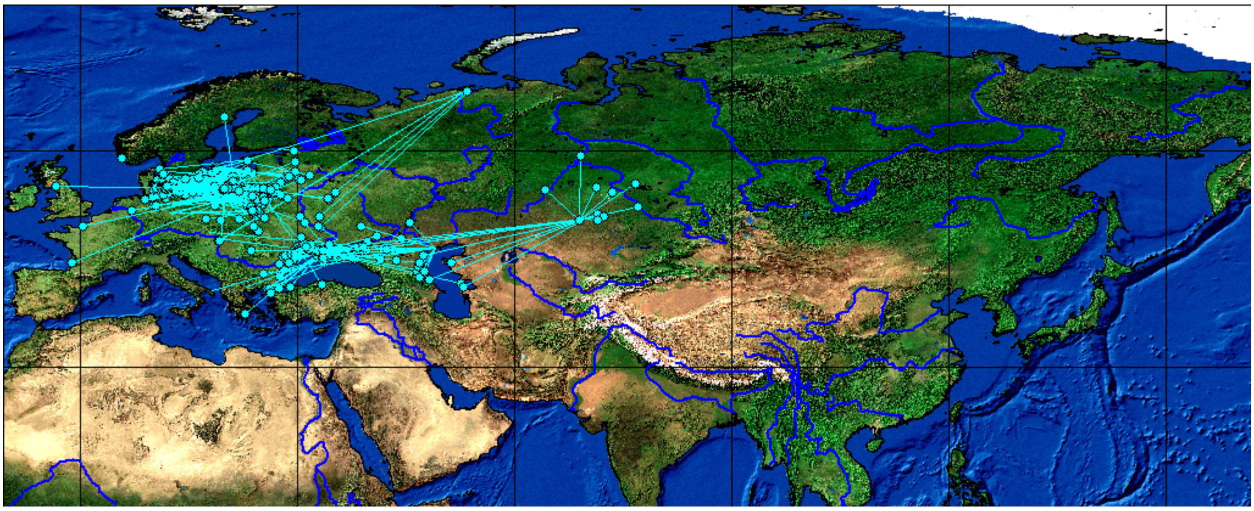


Figure 10. Map of Mute Swan indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

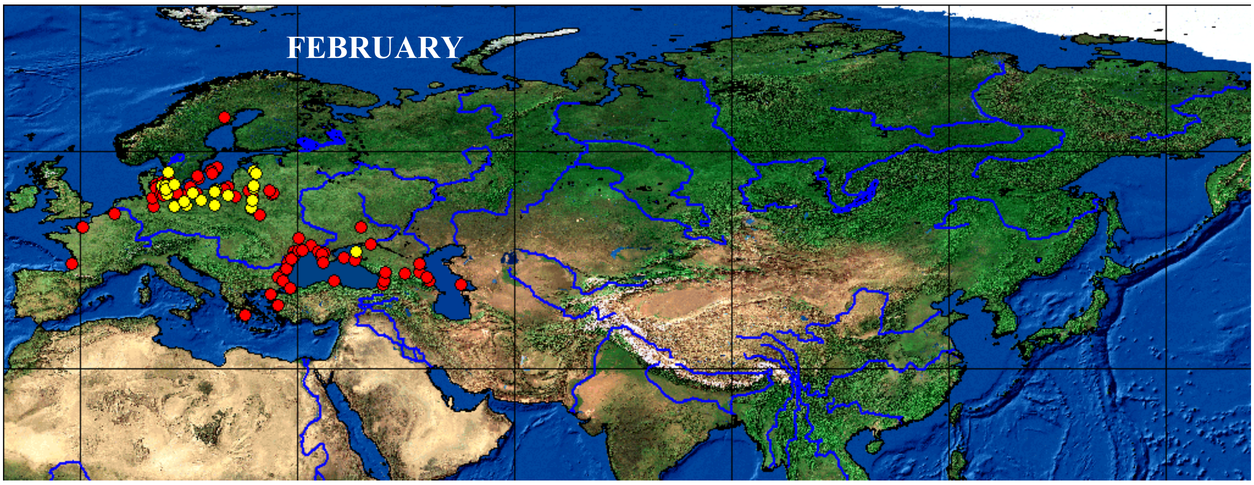
According to the Mardia test with Robson correction, areas of direct and indirect recoveries differ insignificantly ($\chi^2 = 3.24$, 300 direct recoveries and 556 indirect ones, df = 2, P = 0.37), even including one recovery from bird ringed in Japan. Centers of areas of direct and indirect recoveries posed very close to each other: 51°54'N, 24°42'E –direct, 51°51'N, 24°52'E-indirect ones.

Difference between means is not so large: 601.5±25.3 km for direct recoveries and 518.3±18.7 for indirect ones, significant (t-Bailey=2.65, P=0.008). Average distance for birds with colour marks, mostly neck collars, is slightly shorter than that for birds with rings only, however not significant (522.1±27.4 and 556.7±18.7 km respectively; N_{ring}=629, N_{marks}=227, t-Bailey = 1.05, P = 0.29).

Monthly movements. Direct and indirect recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in Mute Swan (Fig. 11). Movements to breeding grounds start as early as in February (compare January and February, Fig 11). Within the natural breeding range Mute Swans fly at relatively short distances (see April, May, June, July in Fig 11). But, the bird ringed in mid-April in Japan was shot in late May after covering 1577 km from the ringing site. This is quite long distance for migration to breeding site for this species.

However, after breeding mute swans fly to moulting sites, and they could fly along the same directions as during spring migration, but much further. These moulting migrations are the longest ones (both direct and indirect ones), when birds often fly far outside of the breeding range. Many European Mute Swans moult in August at the Barents Sea, in Nenets Autonomic Area, Russia (August, Fig. 11). In September Mute Swans turn back to the wintering grounds. However, in October, November and even December the recoveries of dead and injured birds make some reflection of the former (August) long-distance migration (Octoder, November, December, Fig 11).


JANUARY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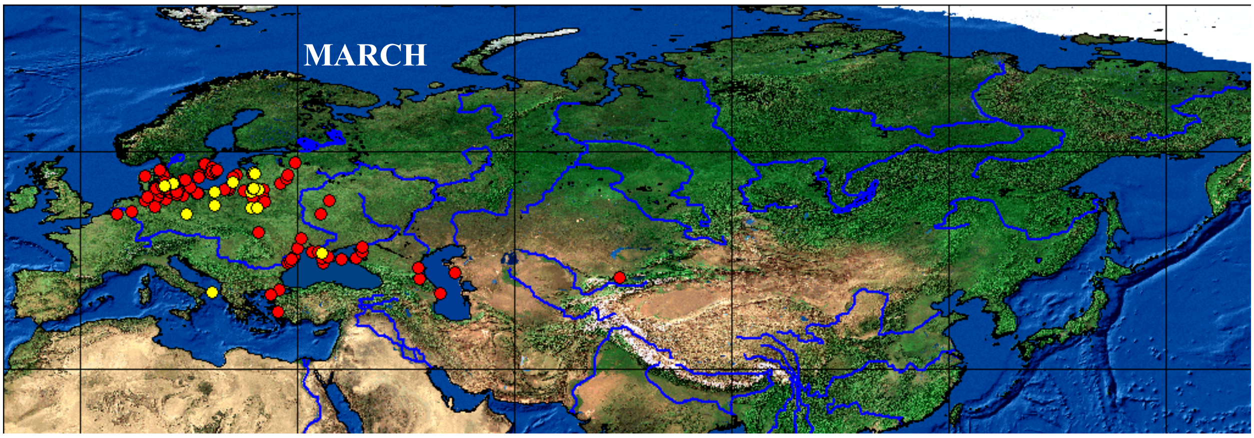
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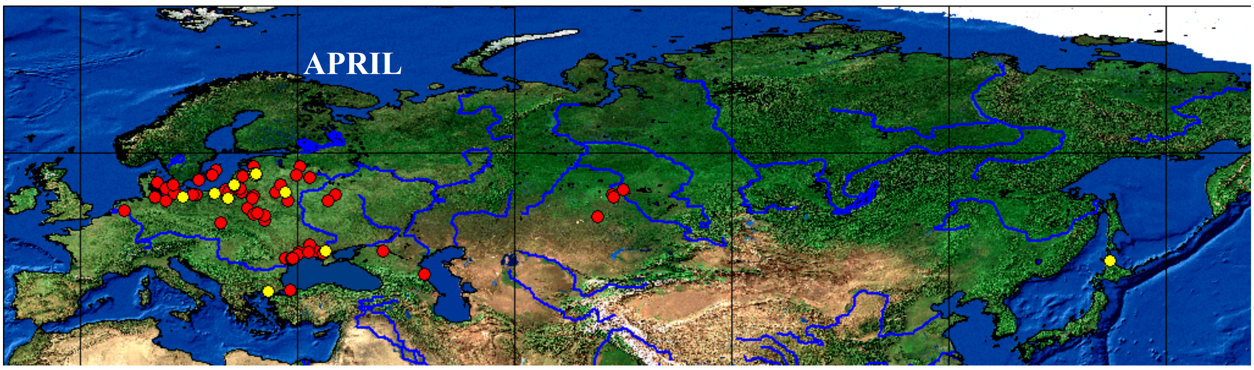
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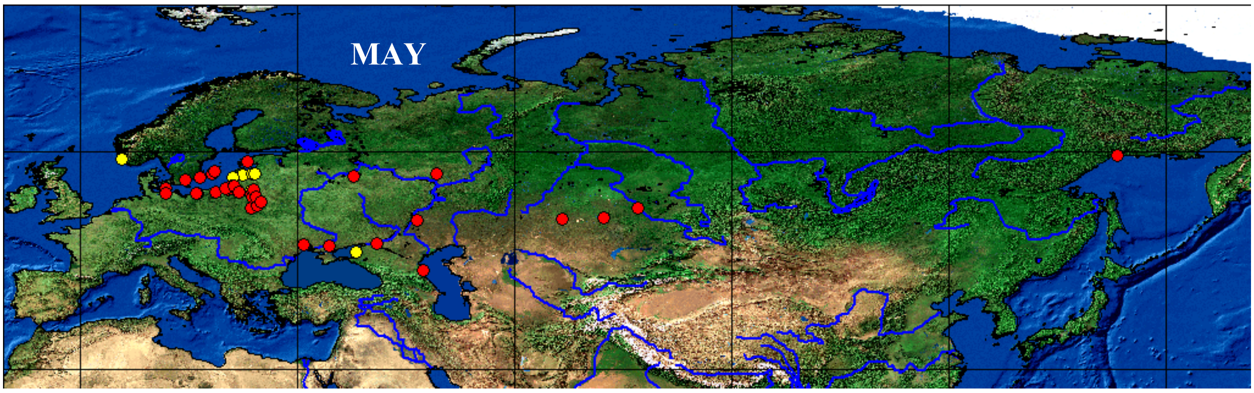
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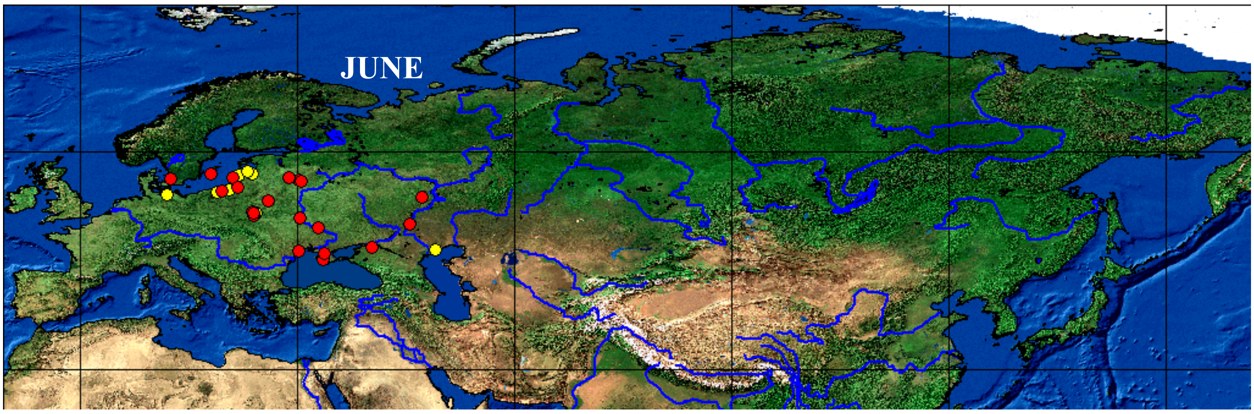
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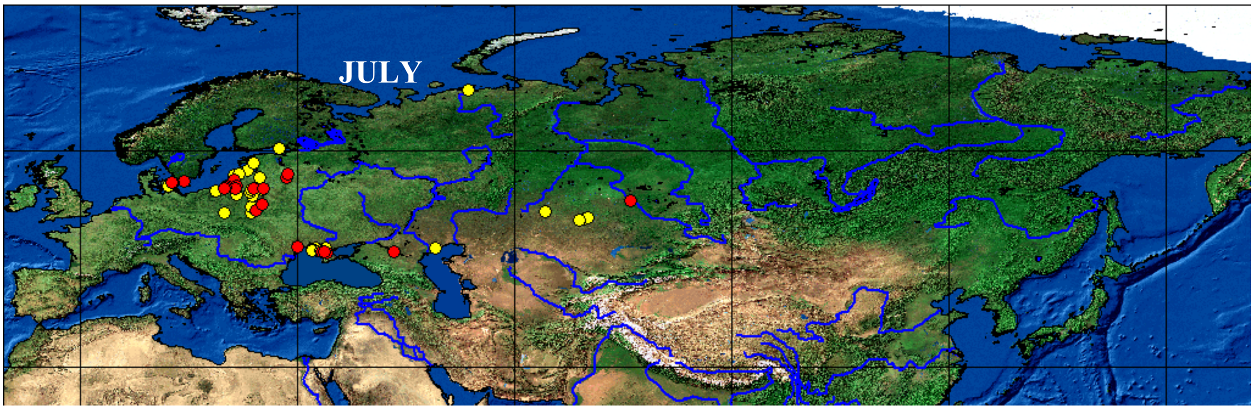
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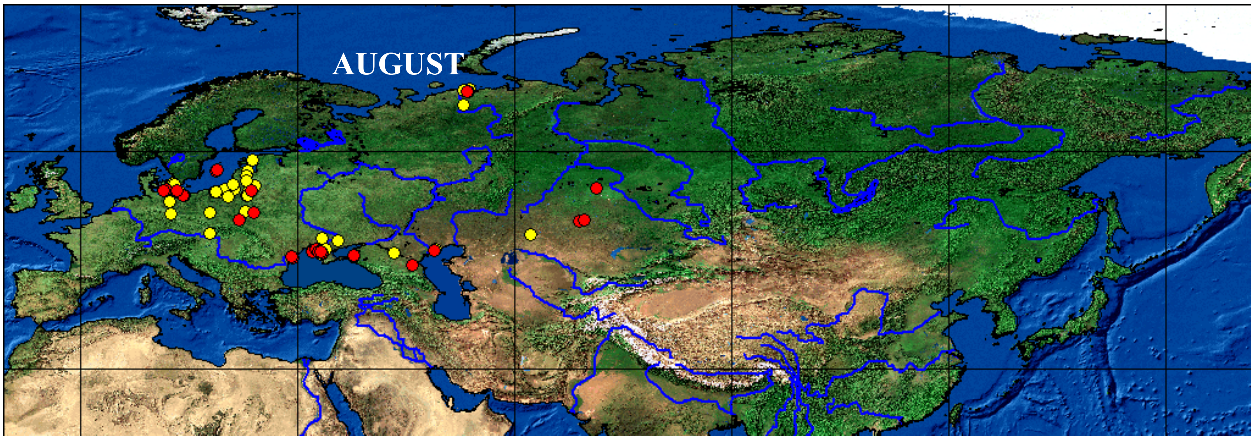
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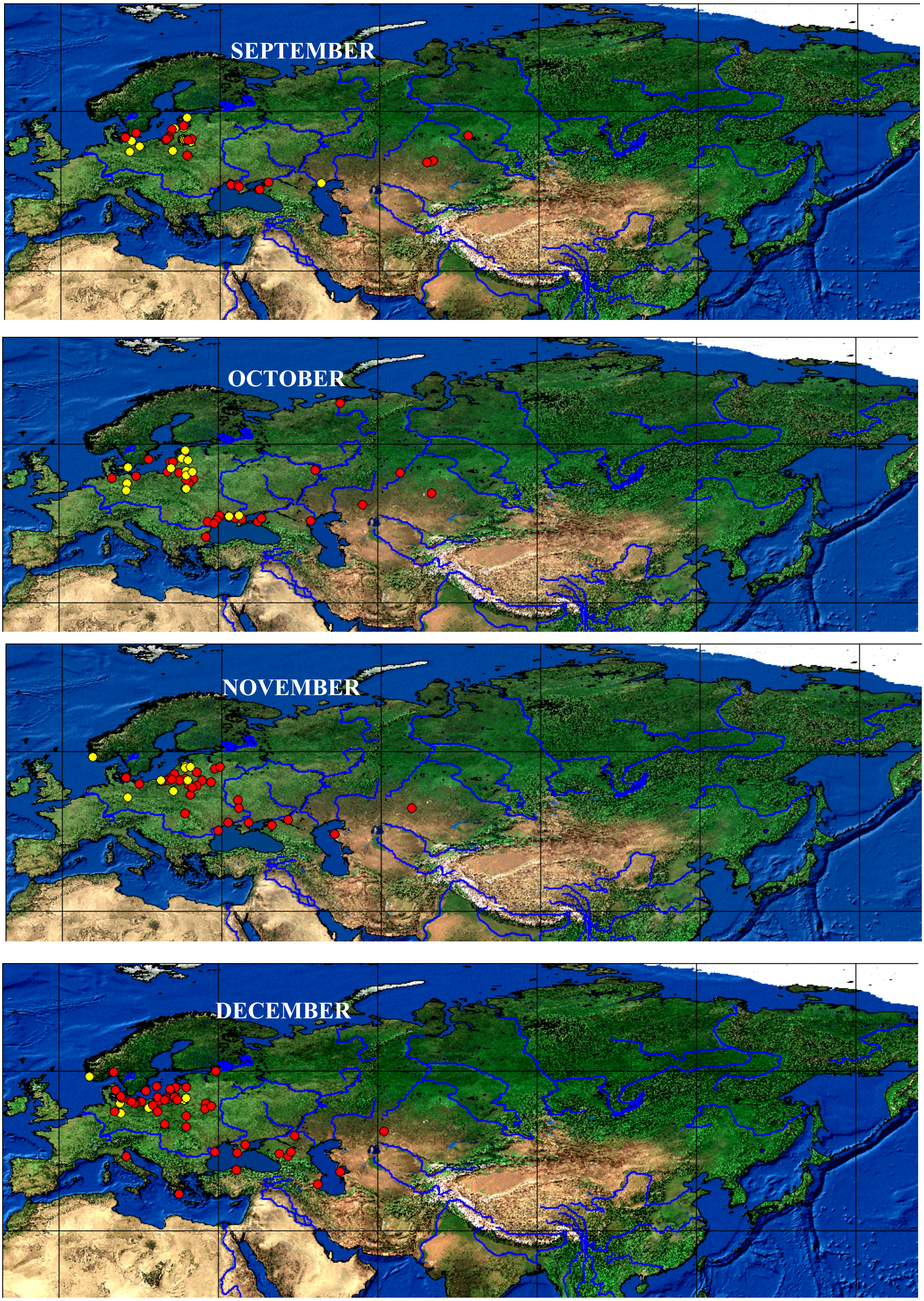


Figure 11. Mute Swan monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. Main direction is west-east, although longest distances are along south-west and north-east directions (Fig. 12). Most of direct flight distances are shorter than

1000 km (Fig. 13), but maximal direct distance is 3356 km. Generally, indirect flight distances are greater, than direct ones, but maximal distance in the indirect flights is 3031 km (Fig. 14).

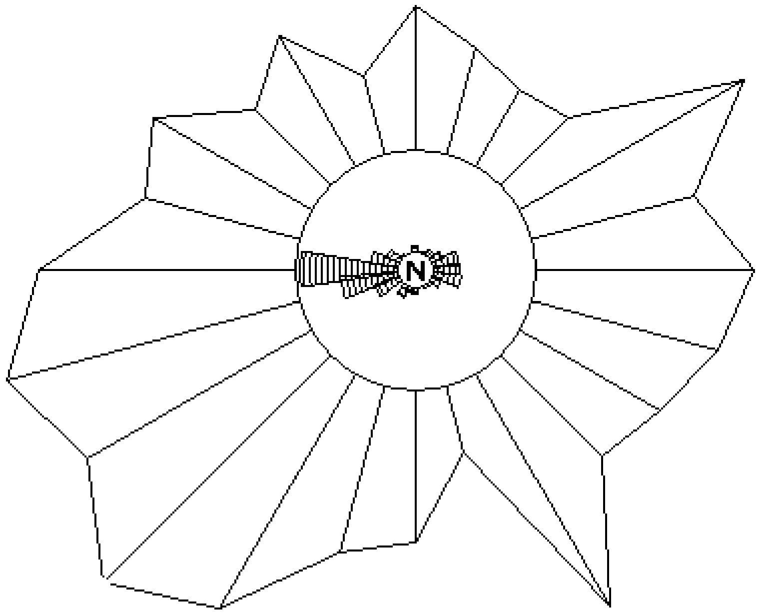


Figure 12. Recovery rose graph for Mute Swans: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar chart) and average flight distances along each direction (radar chart). Sector = 15.0°; total recoveries - 856; number of recoveries in sectors: from 1 up to 191. Inner bar graph reflects numbers of recoveries per each sector direction (denoted with “N”); radar graph reflects mean distance per sector. Mean distance in sectors: from 170.8 km up to 799.6 km

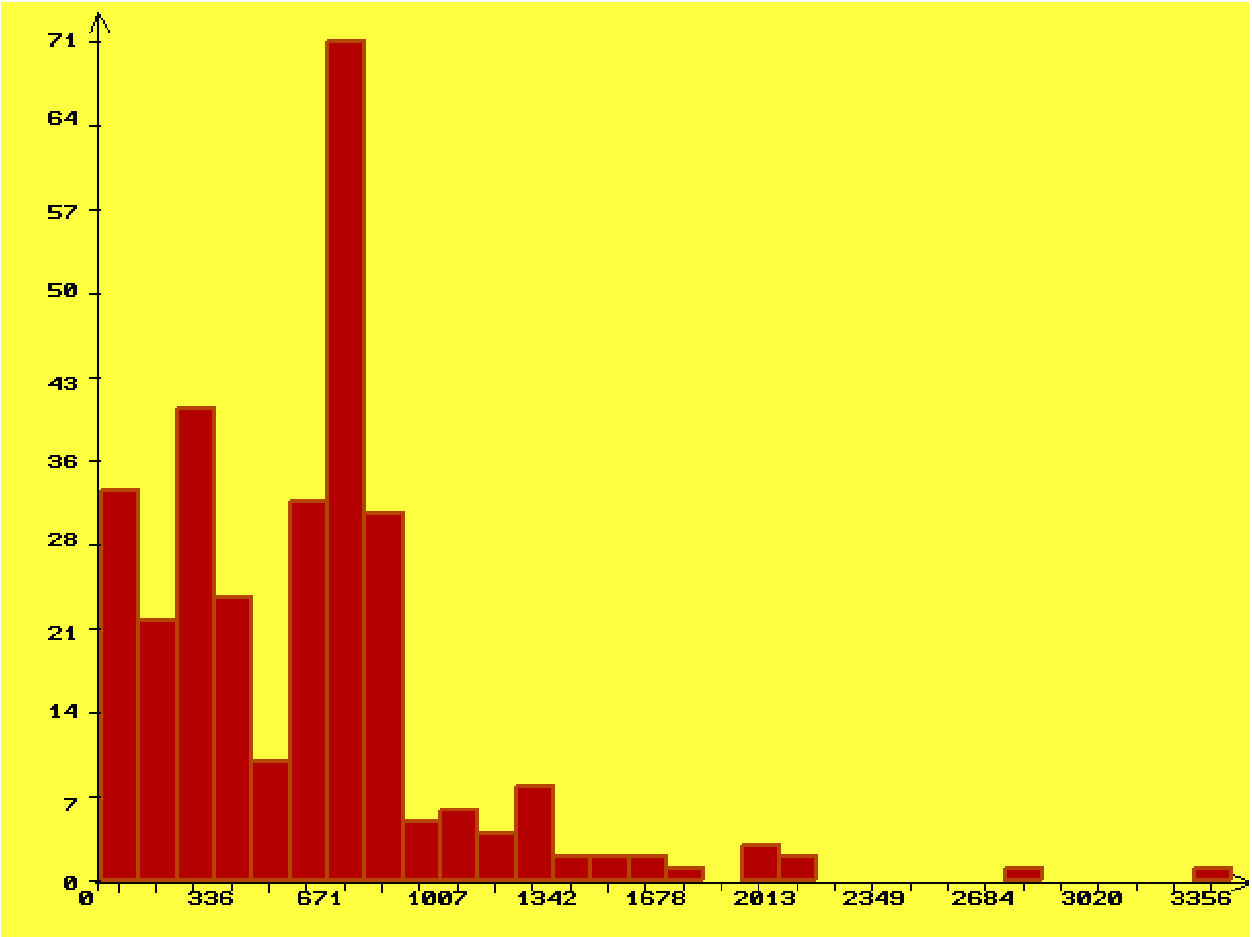


Figure 13. Distribution of direct recovery distances in Mute Swans. X axis is the flight distance; Y axis is the number of distances.

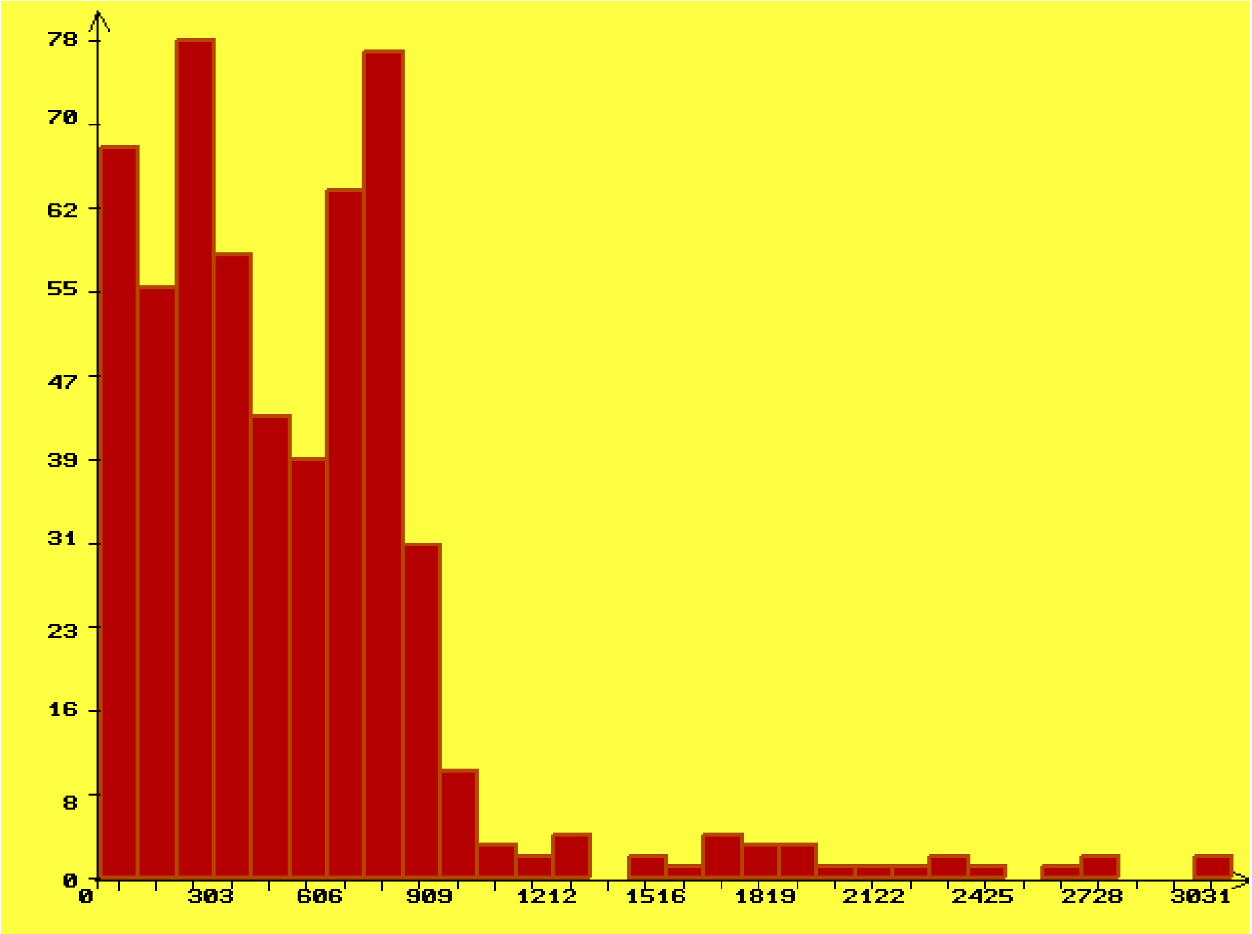


Figure 14. Distribution of indirect recovery distances in Mute Swans. X axis is the flight distance; Y axis is the number of distances.

Mean flight distance in young birds (ringed as „pull“ or „juv“ or „1 y“) is by almost 100 km longer than in adults: 606.0±19.4 and 510.8±21.2 km respectively (N_{ad} = 526, N_{young} = 330, t-Bailey = 3.2, P=0.0009). Wider dispersion is more characteristic for young birds of many species than for adults. In distinction to ducks, Mute Swan cygnets have such possibility because this species is not heavily hunted, and young Mute Swans are quite strong birds.

Female mean flight distance is greater than in males by about 100 km (535.8±56.0 and 423.2±29.4 km respectively), and almost significant (N_{males} = 175, $N_{females}$ = 112, t-Bailey=1.8, P = 0.076). The reason is unknown, these swans migrate mostly in pairs and distance should be more close to each other.

Speed. Mute Swan speed of movements is not high. The fastest movement was recorded for the bird with the ring Lithuania Kaunas 7 119. This swan covered 730.5 km in 11 days. All other birds moved much slower.

Populations. Our ringing data allow defining at least three Mute Swan populations in the natural part of the breeding range: 1) western-central-eastern-european population (white polygon, No 1, Fig. 15); 2) south-eastern-european-black-sea-nothern-european-russian population (yellow polygon, No 2, Fig. 15); 3) south-eastern-european-black-sea-caspian-sea-northern-kazakhstanian population (red polygon, No 3, Fig. 15). These populations are partly overlap. A number of birds from No 1 and No 2 populations fly to moult far north from breeding grounds, up to Barents Sea coast in the north-east of European Russia.

The forth, separate central-asian population probably exists (No 4, Fig. 15). Introduced japanese-far-eastern population can be detected, as well, but the area of this population is not as clear as in three populations connected with Europe.

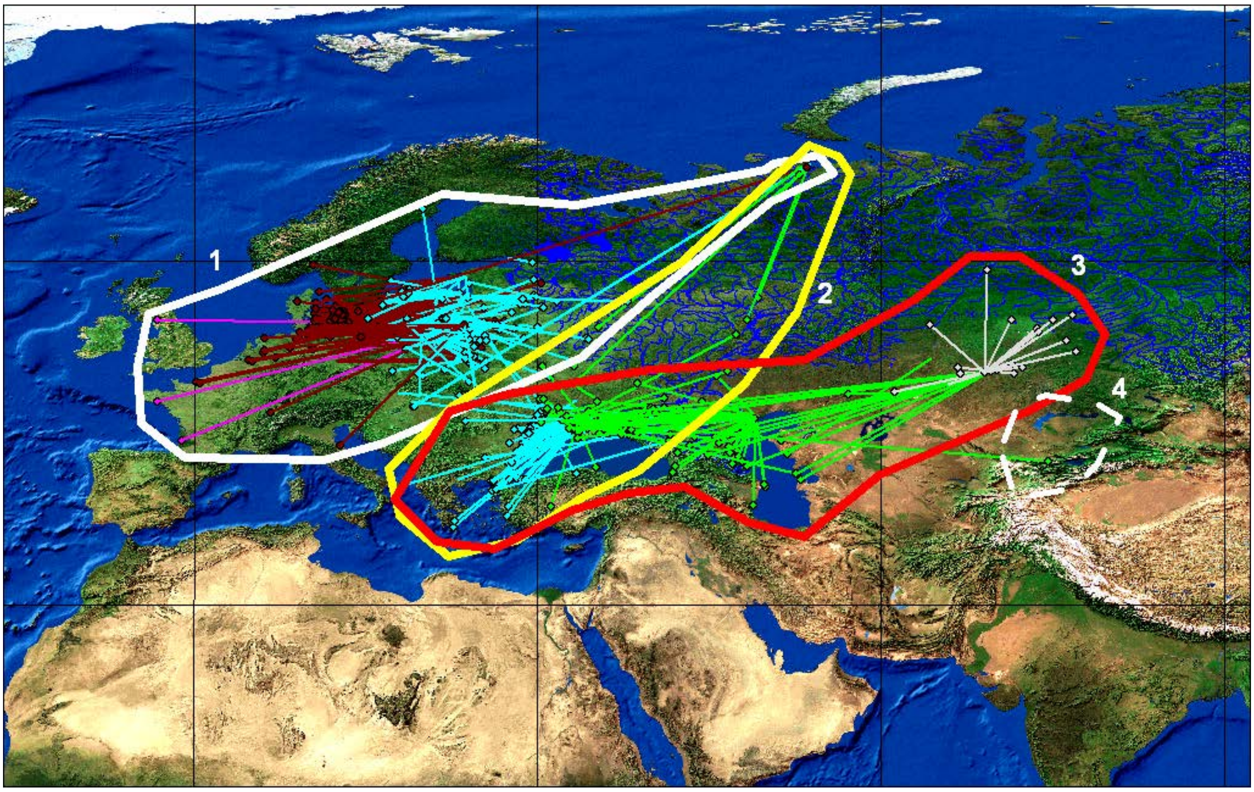


Figure 15. Mute Swan populations in the natural breeding range. White polygon (№ 1) outlines western-central-eastern-european population; yellow polygon is south-eastern-european-black-sea-nothern-european-russian population; 3) red polygon outlines south-eastern-european-black-sea-caspian-sea-northern-kazakhstanian population; 4) white dashed polygon represents the suggested central-asian population.

Ten-year distances. In Mute Swan average flight distance decreased from 1950s to 1970s. Then for three decades flight distance was more or less stable. In 1990s and 2000s distance has increased (Table 2). The later decreasing seems connected with wider use of colour marks that allow seeing birds at short distance from the ringing place.

Table 2. Mute Swan mean flight distance per decade.

Decade (years)	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2023
Distance (km)	772.1	550.1	560.3	532.1	624.6	560.0	399.0
Number of recoveries	34	195	232	234	67	11	83

Lifespan. Maximal known longevity in Mute Swan exceeds 25 years. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest known Mute Swan lived more than 28 years 10 months. Our data have the oldest swan with Moskwa ring A-60 250 ringed in Crimea 01.08.1961 as adult (it means that bird was not less than 4 years old) and recovered 20.04.1985 in Odessa Region, Ukraine in 23.7 years. Therefore, this bird lived at least 27 years 8 month. Quite a few birds from the database lived over 20 years.

Mortality rate. 418 dead recoveries were used in the mortality rate analysis. Mean annual mortality rate in Mute Swan is 21.45$\pm$0.93%. Real mortality pattern significantly differs from the theoretical one (χ^2 = 278.9, df = 22, P<0.001). Programme MARK, Model CLogLog 2ndPart (Hessian, well as) shows 22.14%, difference is 0.69%. Real survivals are below the theoretical line, younger ages have greater mortality than it is expected (Fig. 16). The mortality pattern for the ringing-recovery period looks as the species (population) was not in a good condition (explanations see in “Materials and Methods”).

Only during recent years Mute Swan breeding range has expanded to the north and east. If the northern part of the species population seems to be in good condition, the eastern natural population suffers from hunting (Field Guide…., 2011). These big swans quite often get into bad freezing conditions, either being too late at migration start from breeding grounds or in wintering areas. As we can see in the mortality pattern, young birds suffer first in these crashes.

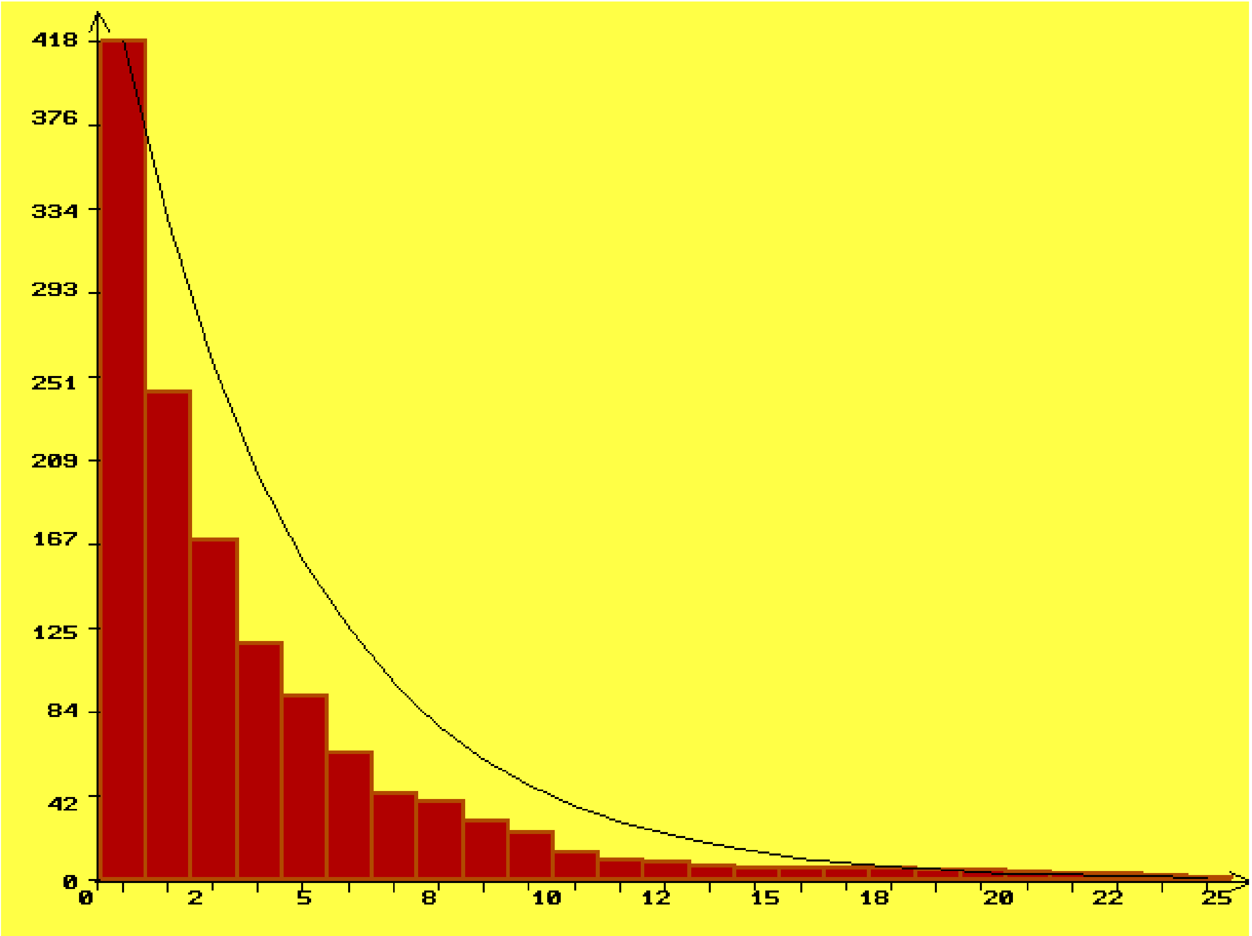


Figure 16. Mortality pattern in Mute Swan. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, for birds ringed as adults, females live longer than males: 3.21 (N=43) and 2.66 (N=45) years respectively, although insignificant. Male mortality is 17.34$\pm$2.35 %, female mortality is 16.40$\pm$2.29 %. Mortality pattern indicates that males are in worse condition in comparison with females (Fig. 17).

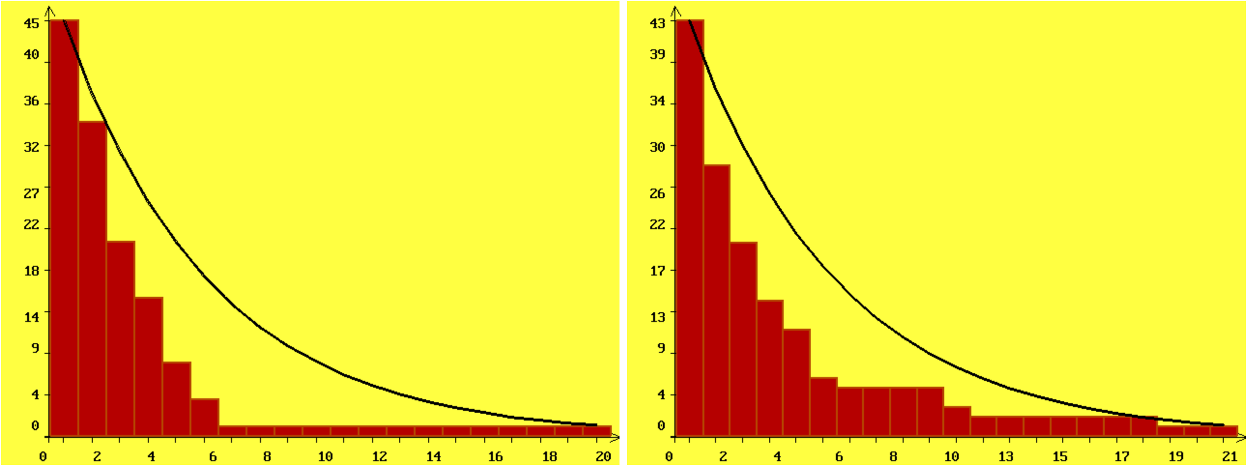


Figure 17. Mortality pattern in males (left) and females (right). X axis is number of years, Y axis is the number of birds alive till the X year.

BEWICK'S SWAN
(*CYGNUS BEWICKII*)

Photo by Nikolay B. Konyukhov

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 18. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

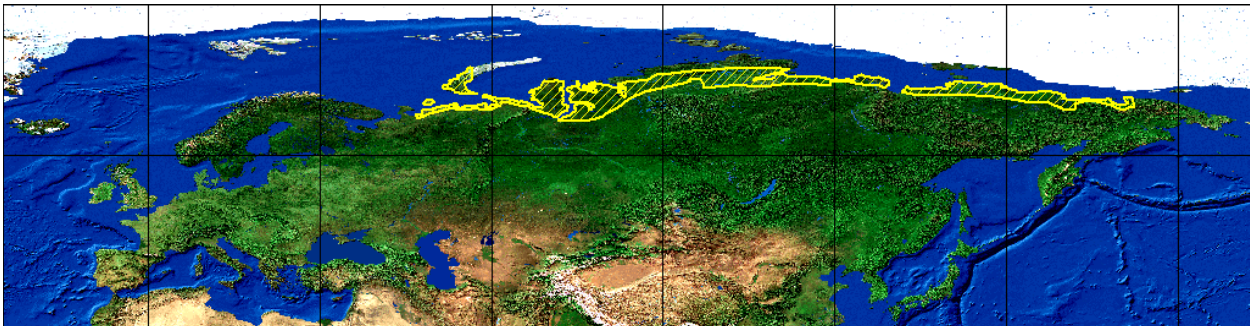


Figure 18 Breeding range of the Bewick's Swan in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 466 marked birds were used, that gave 724 records (Fig. 19). 36 birds were marked with rings only, 166 swans held neck-collars (a number of then wore colour rings, as well), 197 swans held colour rings without neckcollar, 4 were marked with satellite transmitters, 21 birds in additional to neck-collar held GSM or satellite transmitter or GPS-trecker. According to the number of recoveries from colour marks, we would like to stress, that not all sight records registered in Europe are in the BRC database. Considerable amount of these records are in the databases of other ringing centers.

Ringing dates are since 10.02.1963 till 22.08.2021, recovery dates since 19.05.1964 till 19.01.2022. Swans with rings had from one to 3 recoveries per bird, birds with neck-collars from 1 to 9 recoveries per bird, colour ringed swans had up to 5 recoveries. 36 birds only with metal rings were met 40 times after ringing, 1.11 encounters per ringed bird. 166 birds with neck-collars were recorded 240 times, 1.45 encounters per bird, 197 colour ringed swans were met 313 times, 1.59 encounters per swan. Bird Ringing Centre of Russia database contains only one swan found with neck-collar icing (see "Finding details"). In general, it means that in Bewick's Swans, opposite to Mute Swans, neck-collars are not so harmful, and this method can be used for Bewick's Swans.

The rest 4 birds were marked with satellite transmitters, but our database has only one record for each bird, the farthest locations from the ringing points. In addition, one bird with colour ring had satellite transmitter as well, and we also have one satellite tracking point for this bird.

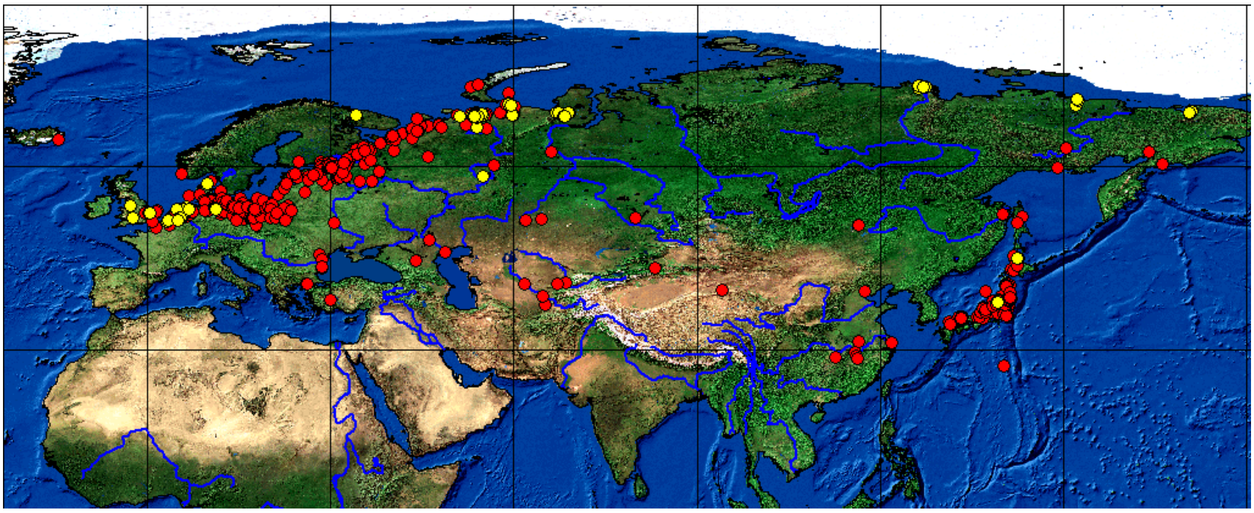


Figure 19. Positions of all Bewick's Swan control points. Yellow dots – ringing sites, red dots – recovery sites.

Most of recoveries are connected with the European part of the breeding range. Also we have data on birds wintering in Japan and Eastern China.

'Moskwa' scheme recoveries. This sample contains 516 recoveries of the scheme „Moskwa". They are from birds ringed within the Russian Federation, regions: Nenets Autonomic area, Yamal Peninsula, Yakutia and Chukotka (Fig. 20).

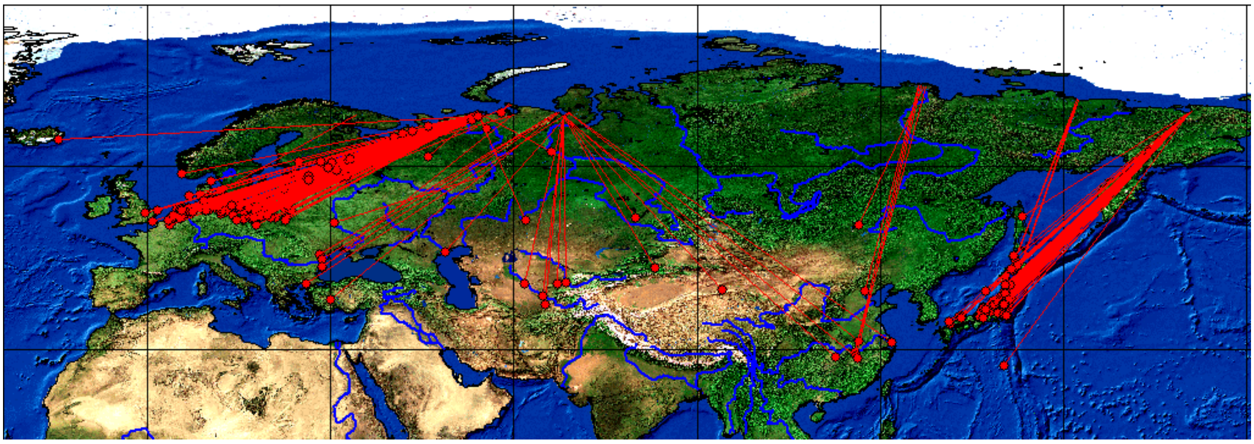


Figure 20. „Moskwa" scheme recoveries. Here and on all other similar figures lines start from the ringing site, recovery sites are marked with red dots.

Finding details. This analysis includes all 724 recoveries. Sight records comprise more than two thirds of recoveries – 562 recoveries (77 %), 62 (8%) birds were found dead or died, 40 (6%) birds were shot, one bird was found with icing on its neck collar, other recovery reasons are not so common (Fig. 21).

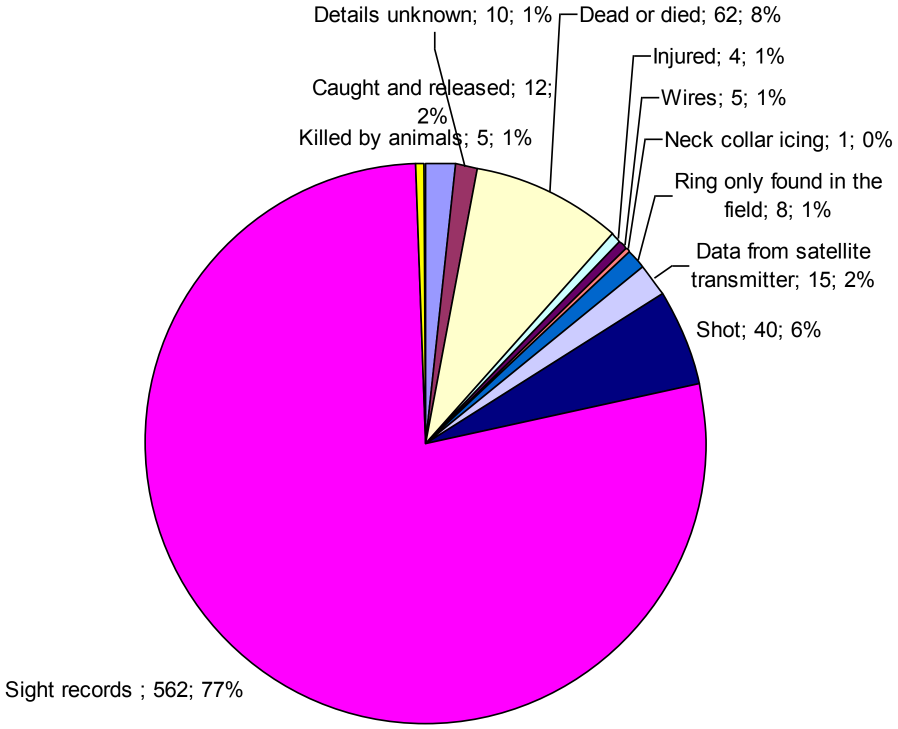


Figure 21. Finding detail of Bewick's Swans.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries do not much differ from each other (Figs. 22, 23).

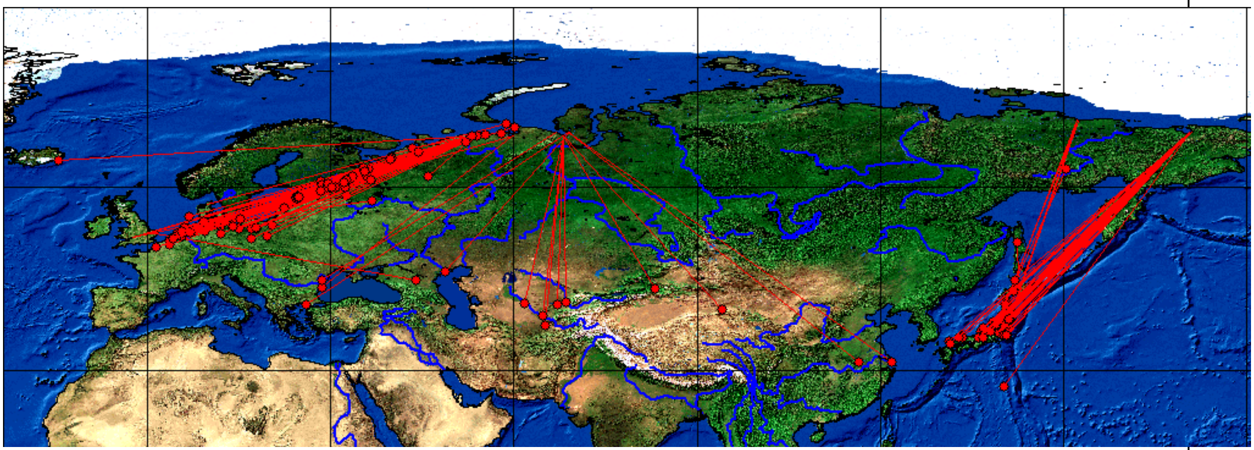


Figure 22. Map of the Bewick's Swan direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

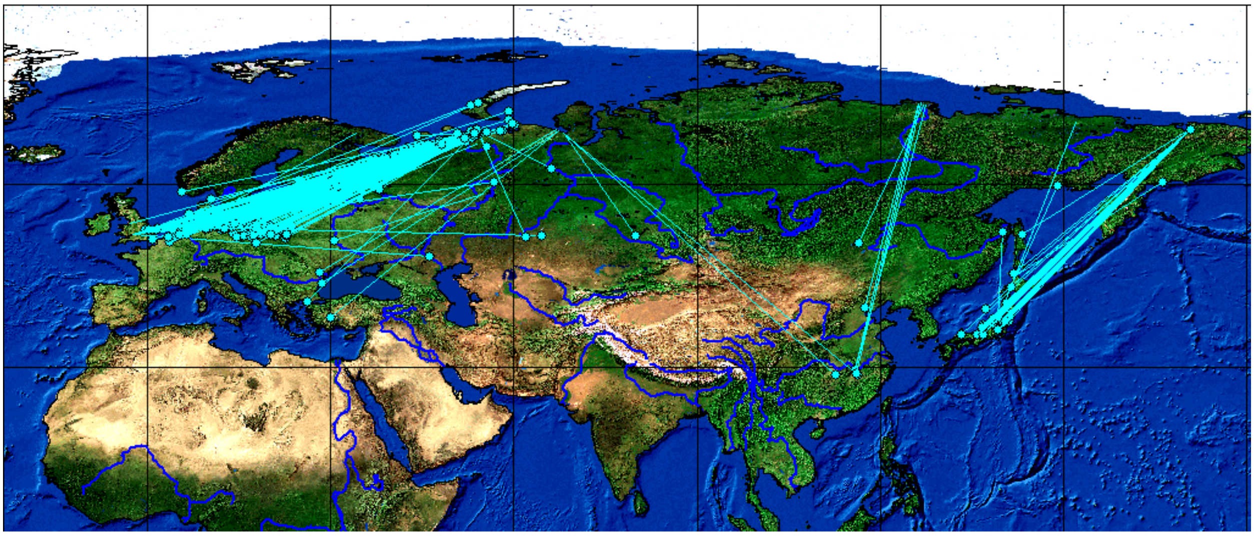


Figure 23. Map of the Bewick's Swan indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

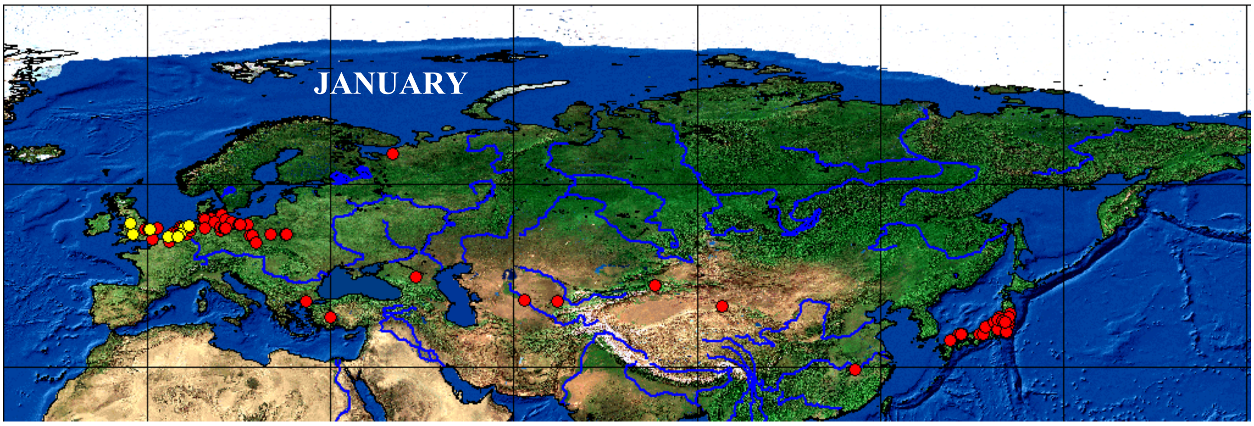
Four groups of recoveries are prominent on the maps: 1) ringed and recovered in Europe; 2) ringed on Yamal Peninsulsa and recovered in Europe and China; 3) ringed in the Lena Delta, Yakutia and recovered from China; 4) ringed and recovered in Japan-Chukotka area. The European sample is the largest one. For Yakutia-China sub-sample we have indirect recoveries only, the Japan-Chukotka migratory route also contains few recoveries (Fig. 22, 23).

In this manner, comparison between direct and indirect recovery areas makes sense for European birds only. Mardia-test with Robson correction shows significant difference between European direct and indirect recoveries ($\chi^2 = 9.37$, 109 direct recoveries and 371 indirect ones, df = 2, P = 0.009): centre of indirect recoveries locates almost 3 degrees to the east from the centre of direct recoveries. Mean distances in both European samples are similar – 2431.5$\pm$75.0 and 2319.9$\pm$44.7 km respectively for direct and indirect ones. This is the same as in Mute Swans, although insignificant, indirect distances are slightly shorter than direct ones.

Average distance for birds with neck collars is shorter than for birds with colour rings, however longer than for birds with metal rings only: 2711.9 km (N=240), 2815.4 km (N=313) and 2376.7 km (N=40) respectively. It is understandable, because birds with neck collars and colour rings are more visible.

Monthly movements. Both direct and indirect recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in Bewick's Swan (Fig. 24). Movements to breeding grounds start in March (compare February and March, Fig. 24), about one month later than in Mute Swan. In April Bewick's Swans still fly to breeding grounds. In May European Bewick's Swans arrive at the breeding grounds in northern European Russia, but some birds continue to migrate further northeastwards, how far is yet clear. Birds from Japan are still on spring migration in May. They arrive at Chukotka in June (Krechmar, Konratyev, 2006), on maps they can be detected in July (see April, May, June, July in Fig. 24).

In July and August Swans are still on their breeding grounds, but some birds move further northeastwards for moult (Fig. 27). Movements back to wintering grounds start in September. In October these movements continue and first birds reach wintering grounds in southwestern Baltic and North Sea (Waddensee) coasts, as well as big rivers in Poland, and in Great Britain. In November Swans concentrate in their wintering sites. A number of Bewick's Swans spend winter in southern Europe (Greece) and northern Caucasus areas (Fig. 24). Birds from Chukotka spend winter in Japan, Yakutian Bewick's Swans fly to quite broad area in eastern China (Fig. 24).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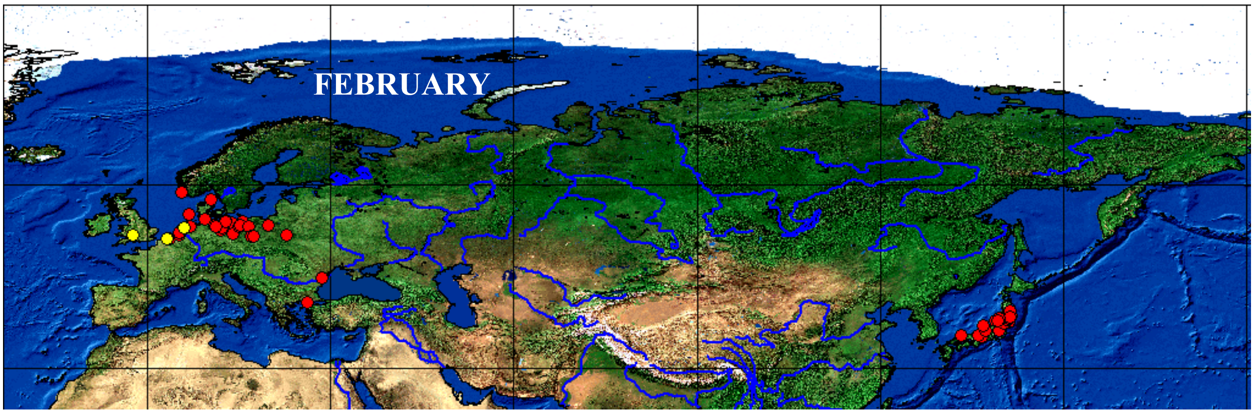
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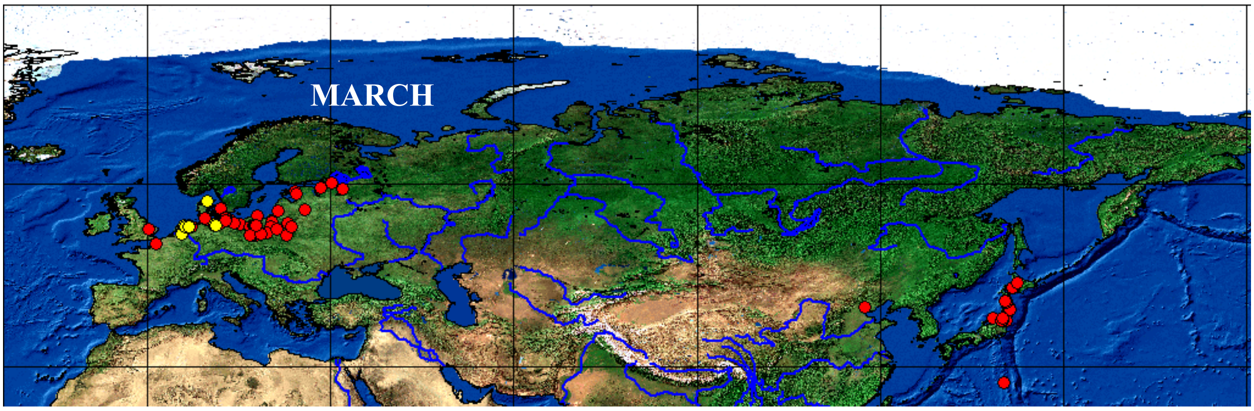
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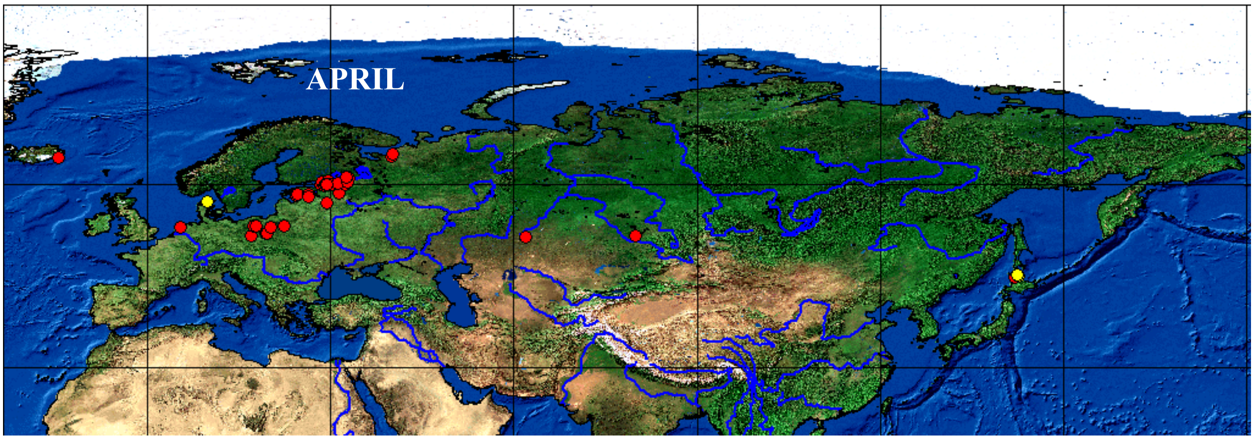
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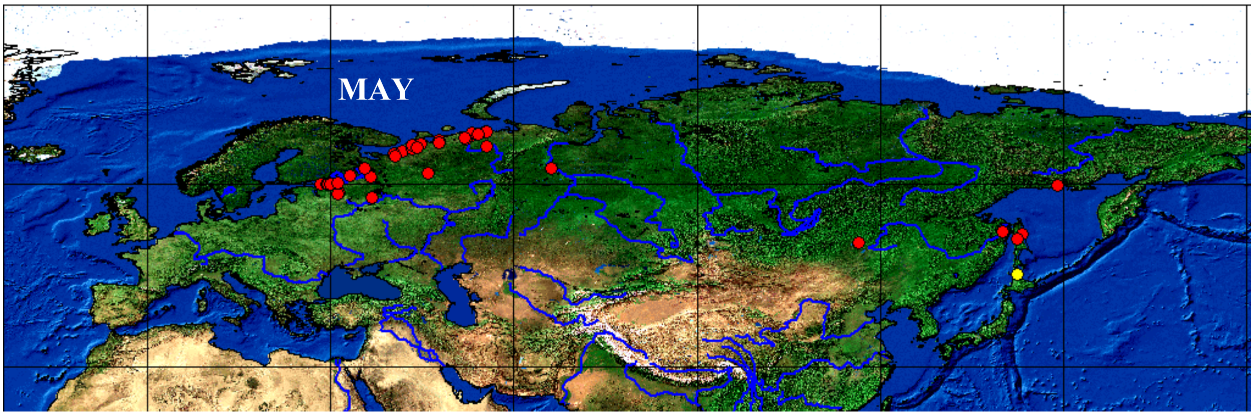
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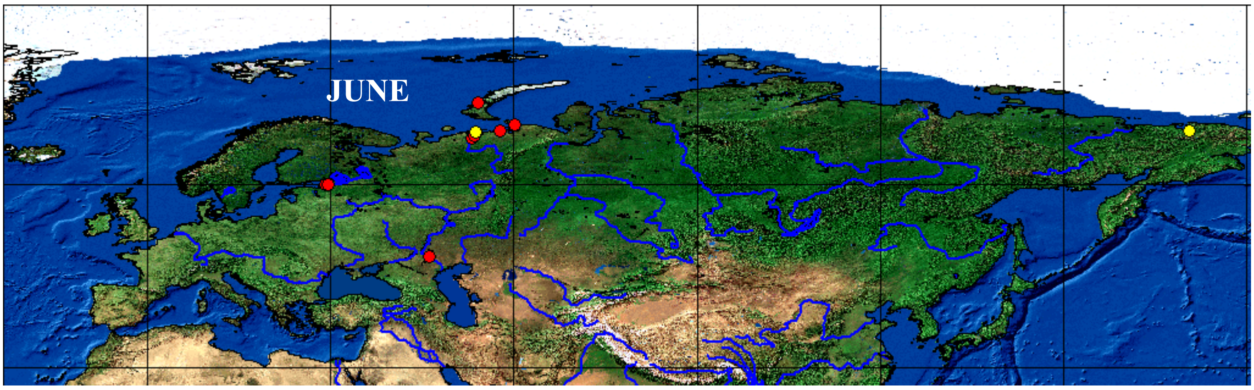
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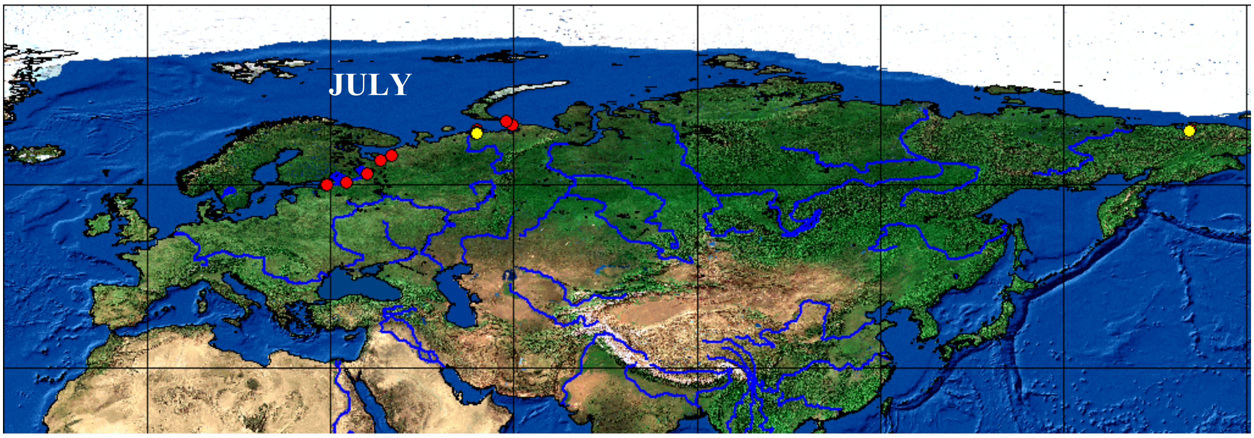
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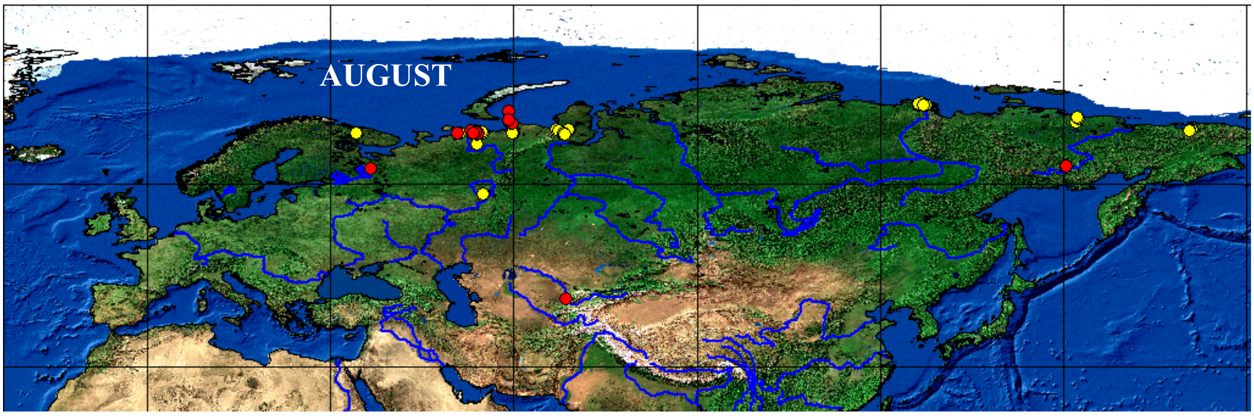
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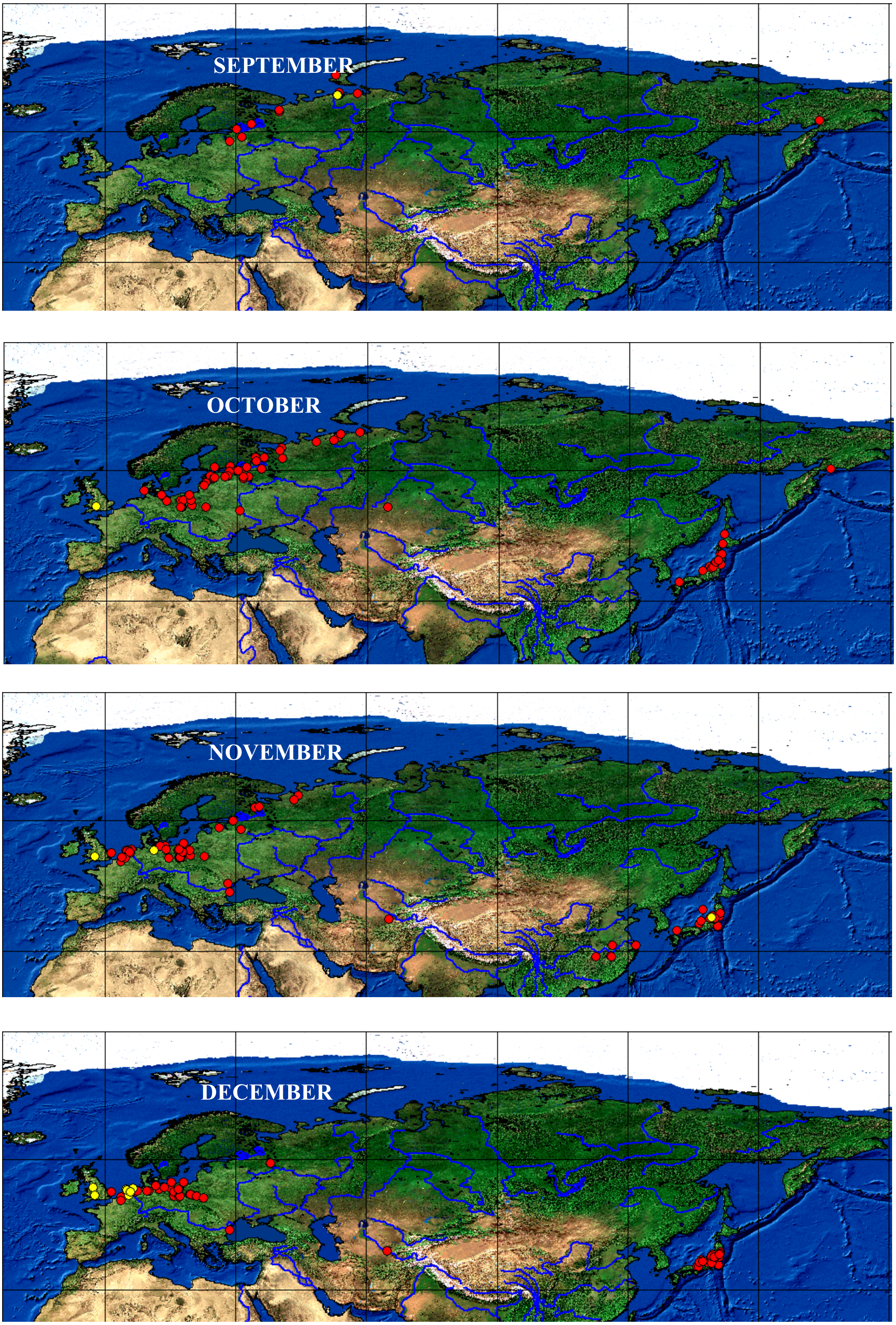


Figure 24. Bewick's Swan monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. Movement directions in Bewick's Swan are clearly visible on maps (Figs 22, 23), so for this species we do not need to build recovery rose chart as for many other species (see species accounts). European Bewick's Swans migrate along northeast-southwest direction, most frequent bearings are 60˚ and 235˚. Birds that nest in the Lena River Delta fly to winter almost southwards, birds from Chukotka migrate to south-southwest. Partly birds migrate to Japan with bend to Sakhalin, others probably via the Kuril Islands. Migration from Jamal Peninsula will be considered in the **GSM-transmitter tracking data** section of this species account.

Most of direct flight distances are 2500-3500 km (Fig. 25), maximal distance of the direct recovery flight is 5320 km. For indirect recoveries most frequent distances are less than 3000 km (Fig. 26), the longest distance is 5387 km.

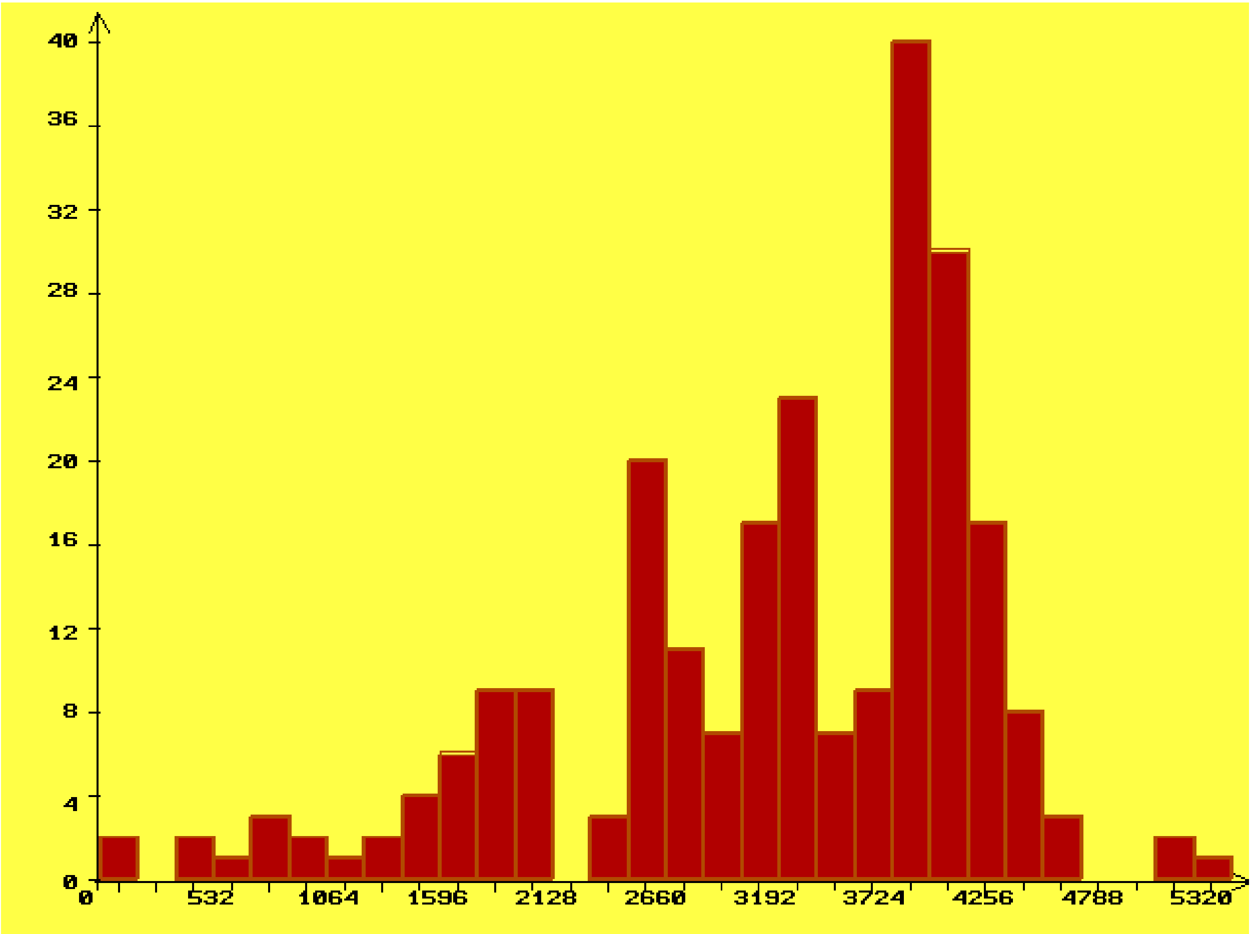


Figure 25. Distribution of direct recovery distances in Bewick's Swans. X axis is the flight distance; Y axis is the number of distances.

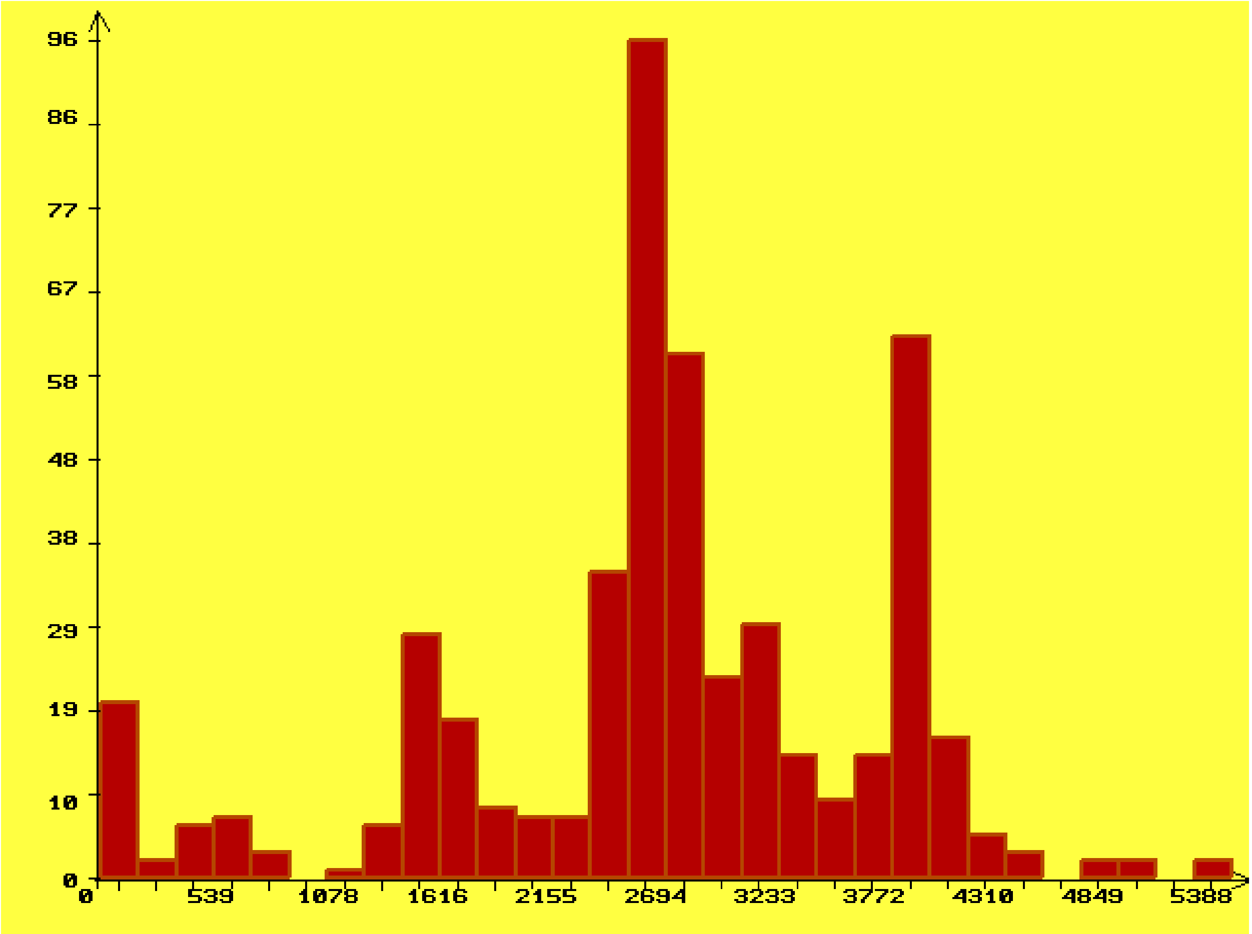


Figure 26. Distribution of indirect recovery distances in Bewick's Swans. X axis is the flight distance; Y axis is the number of distances.

In opposite to Mute Swans, mean flight distance in Bewick's Swan young birds (ringed with the age as „pull" or „juv" or „1 y") is by over 200 km shorter than in adults: 2673.7±137.0 and 2866.5±39.7 km respectively (N_{young} = 78, N_{ad} = 646), however insignificant.

Male and female mean flight distances are very close to each other: 2404.1±62.3 km and 2401.0±54.1 km respectively, N_{males} = 234, $N_{females}$ = 257, significantly not different (t-Bailey=0.038, P=0.97). This is understandable since these swans migrate mostly in pairs.

Sample of European (ringed west of 60˚E) Bewick's Swan is large enough to allow outlining of monthly mean locations for these birds. From wintering grounds in Europe they migrate along so called Baltic Sea – White Sea migratory route. In May they are partly on the route, partly move to mainland tundra where they breed. By June they are in the tundra and breed. Then in July non-breeding and failure Swans move to the coast again, birds with chicks move there later. In August they continue to move along spring migratory route, i.e., to the northeast. In this time they migrate to the moulting sites on the Barents Sea coast (e.g., Korovinskaya Guba). During September-January they move along the same White Sea - Baltic Sea migratory route, but in the backward direction to wintering grounds.

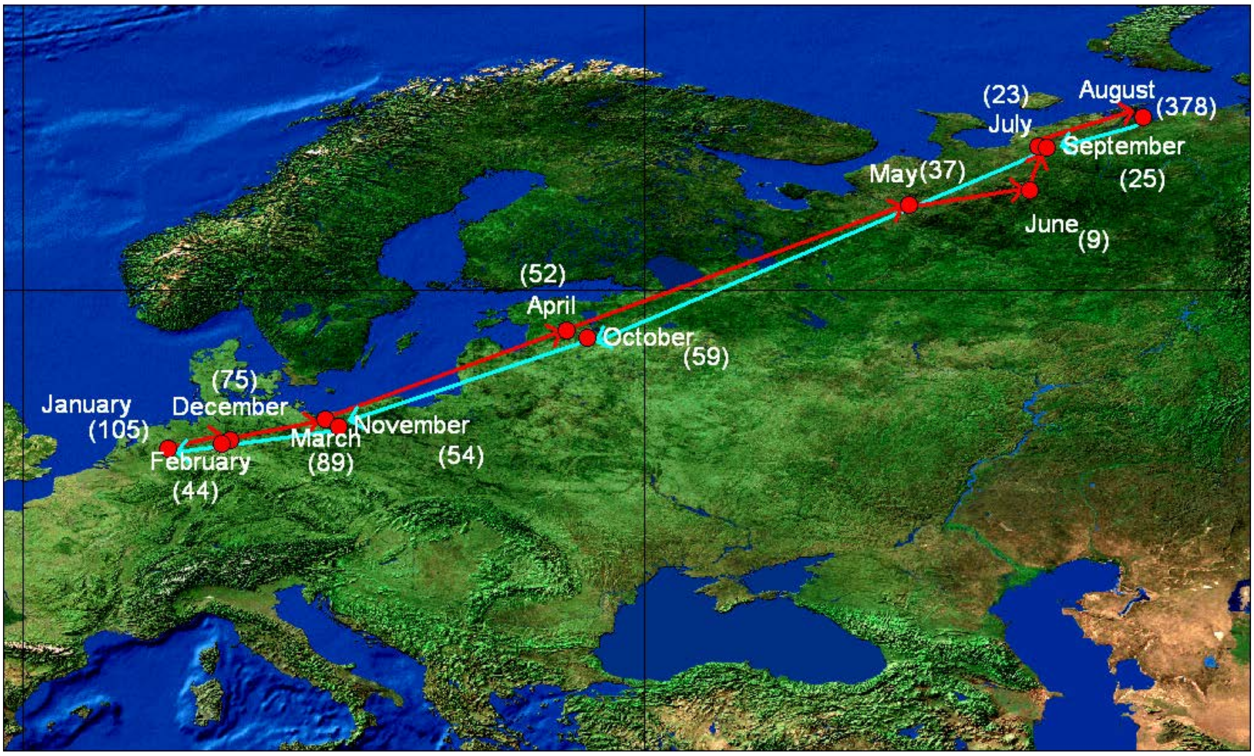


Figure 27. Mean monthly locations of European Bewick's Swan control points. Red dots are mean monthly locations of swans. Arrows show directions of movements, movements from January to August denoted with red arrows, from August to December the arrows are blue-green.

GSM-transmitter tracking data. 12-14.08.2015 four males and two females were marked with 35-g GPS-GSM transmitters in the southwestern Yamal Peninsula, at the Yuribey River, around 68.54N 69.11E (Vangeluwe, 2016). Migratory routes of the birds were obtained from 5 birds and represented in Fig. 28. Three birds migrated to China where stay on the Poyang Lake and within Shanghai vicinities. Two birds flew along Ob River to the south, via northern Kazakhstan. One of the latter birds stayed for winter in the Volga River Delta, moving within the delta. The other swan migrated further: first to the Sea of Azov, 12 December moved to Bulgaria, later on moved to Greece. On 13.12.2015 this swan reached Evros Delta.

These results show that Bewick's Swan marked in the same place and in close dates flew for wintering to places, that located in more than 8 200 from each other. This has raised an issue about the boundary between western and eastern populations of the species.

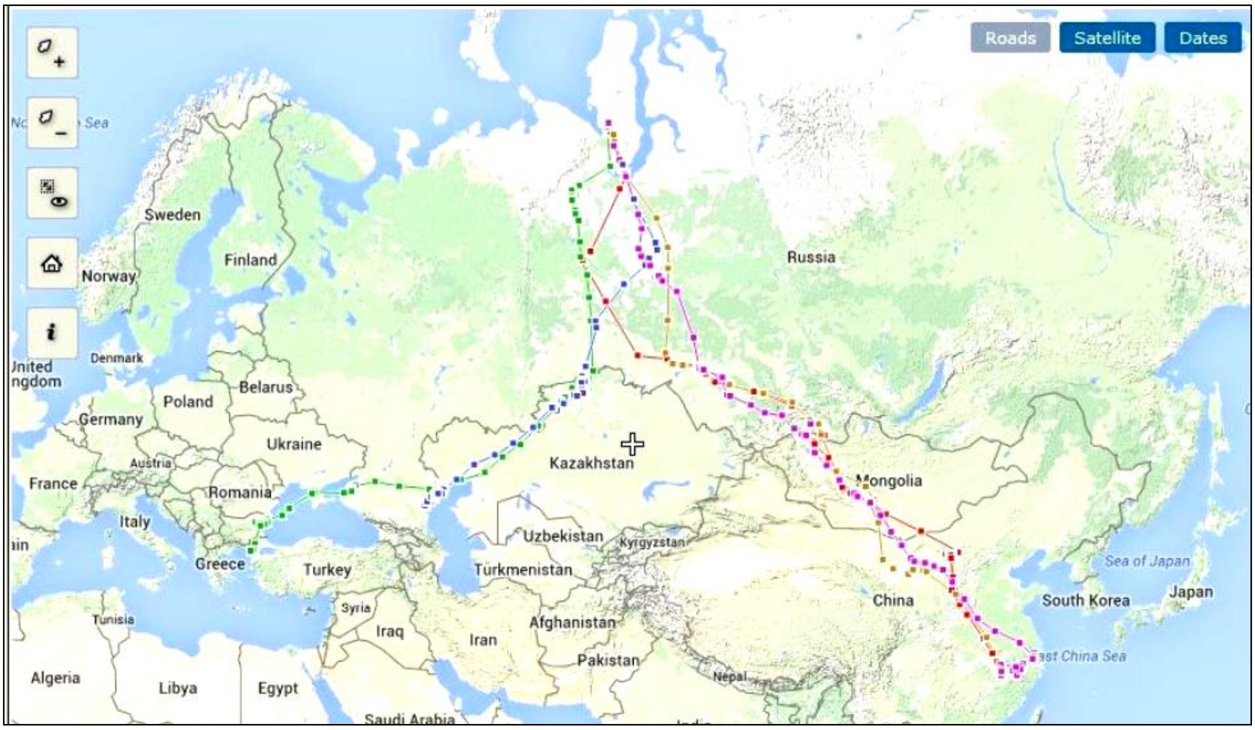


Figure 28. Autumn migratory routes of Bewick's Swans, marked with GPS-GSM transmitters in 2015 at Yamam Peninsula (Vangeluwe, 2016).

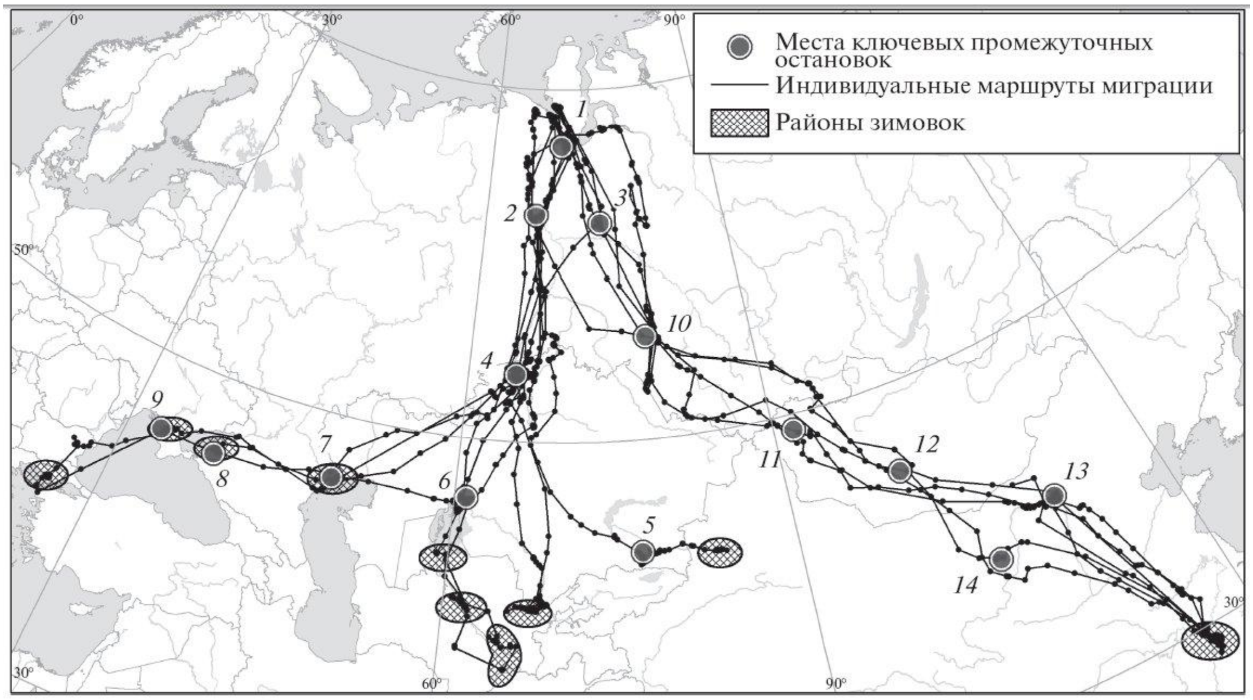


Figure 29. Individual migratory routes, key stopovers and wintering grounds of Bewick's Swans from Yamal Peninsula. Circles – stopovers, lines with dots – individual migratory routes, dashes areas – wintering grounds. Key stopovers: 1 – Obskaya Bay, 2 – Dvuobye, 3 – Ob River valley, 4 – Turgai depression, 5 – Ili River valley, 6 – Aral Sea, 7 – northern near Caspian Sea area, 8 – eastern Black Sea area, 9 – northern Black Sea area, 10 – Barabinskaya Depression, 11 – Great Lakes, Mongolia, 12 – Orog-Nuur Lake, Mongolia, 13–14 – Inner Mongolian, China (Vangeluwe et at., 2017).

However, in the autumn-winter 2016-2017 new surprising data of the Bewick's Swan migration and wintering were obtained from the GPS-GSM transmitters. Birds marked at the Baidaratskaya Bay (west of Yamal Peninsula, Siberia) migrated not only to southern Europe and eastern China, but displayed new known migratory routes and wintering grounds. Three birds after autumn stopover in the Turgay depression in Kazakhstan then continued migration not along the “traditional” south-western way to the Caspian Sea, but flew along their individual routes in different areas of Central Asia, where wintered (Vangeluwe et al, 2017). Therefore, the new wintering sites of the Bewick's Swan were found in Xinjiang (Uygur) Autonomic Region of China, in Turkmenistan and Uzbekistan (Fig. 29).

Speed. Bewick's Swan speed of movements is not high. Our base does not show their real flight speed during migration. The highest speed of movement was detected for the bird with ring Moskwa AA-3012 with white neck-collar and GSM-transmitter in it. During 106 days after ringing this 2-year old male covered 5319.8 km, which means more than 50 km per day. This swan was ringed 14.08.2015 in Baydaratskaya Bay, Yamal Peninsula, sighted on 28.11.2015 on Hengsha Island, Shanghai, China. However, real speed of this bird was higher, because in August Bewick's Swans do not migrate yet. Since the migration starts in September, we can presume that this Swan started to migrate, e.g., on 15 September. In this case it was on the way 74 days covering, on average, near 72 km per day. The same logic operations for the swan Moskwa A-099 312 with red neck collar shows the speed of near 76 km per day. GSM-transmitter informs the maximal speed as about 1160 km per day.

Populations. Our ringing data allow outlining the following populations: 1) western-central-eastern-southern-european-western-siberian population (polygon No 1, Fig. 30); 2) north-western-central-siberian-central-asian-east-chinese population (polygon No 2, Fig. 30); 3) chukotka-japanese population (polygon No 3, Fig. 30). First two populations are overlapped a little in their northern areas. Besides that, there is one recovery from Pechora River delta to Iceland, which could be the inter-population exchange between western-central-eastern-southern-european-western-siberian population and probable icelandican-european population. North-western-central-siberian-east-chinese and chukotka-japanese populations likely do not overlap.

Nowadays the Bewick's Swan numbers in the world seem to grow (see divisions “Ten-year distances” and “Mortality rate”); and swans occupy new wintering grounds creating new, straighter migratory routes to them. Number of Bewick's Swans Greece, Evros River Delta is growing sharply during last years (Didier Vangeluwe, personal communication). As an example, a flock of 6-7 Bewick's Swans was found in Greece, Evros River Delta, on 04.02.1997. The flock contained one marked male (Copenhagen ring V 4 306, blue collar 306P) ringed 15.08.1992 in Korovinskaya Guba, Nenets Autonomic Area, northern Russia. In autumn of the same year, 08.11.1997, this bird was recovered (details unknown) in the Novgorod Region. Novgorod Regions is situated almost exactly in between Korovinskaya Guba and Greece. Therefore, with high likelihood the swan flew to the same wintering place in Greece again.

In recent years Bewick's Swan surveys in Moscow Region show increasing number of this species during autumn migration period (Alexandr Mishchenko, personal communication). Since 2009 the new stopover site was found in the Volga-Akhtuba Rivers floodplain. Number of staging Bewick's Swans there is up to 2000 birds (Belik et al, 2012). The increasing number of birds in western-central-eastern-southern-european-western-siberian population and shortening the migratory route to the southern European and Black-Caspian Seas wintering sites is the additional indication that Bewick's Swans habituate southern wintering grounds and replace there from western European ones.

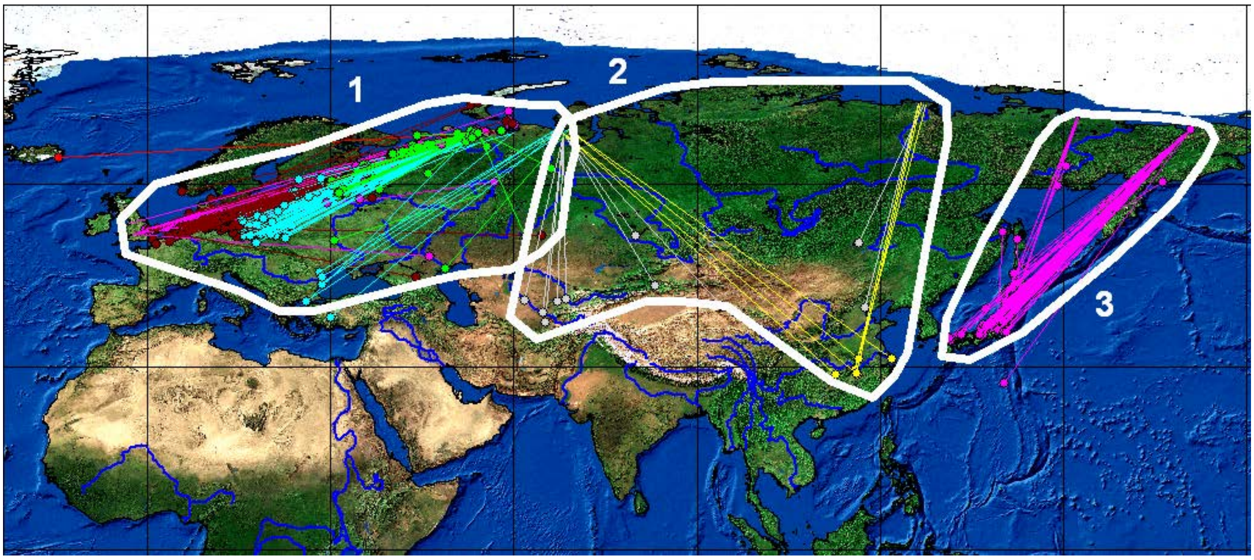


Figure 30. Bewick's Swan populations. White polygon (№ 1) outlines western-central-eastern-southern-european-western-siberian population; 2) polygon № 2 outlines north-western-central-siberian-central-asian-east-chinese population; 4) polygon № 3 outlines chukotka-japanese population.

Ten-year distances. If we take into account all Bewick's Swans, data show the decrease of decade mean distance (Table 3). However, there are data from 3 or 4 very different populations. Since 2000s we have recoveries from Lena Delta to China and Japan-Sakhalin where distances are originally greater than in European birds, therefore we have considerable and significant increase of distance from 2001-2010 to 2011-2023 (Table 3).

Table 3. Bewick's Swan mean flight distance per decade.

Decade (years)	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2023
Distance (km)	2768.4	3120.9	2469.1	2166.0	2375.2	3127.4
Number of recoveries	3	16	20	108	114	463

To understand real changes in migratory route length we should restrict our analysis to one population data (the European population), and better take a set with the longest period of marking and the farthest distances between breeding (or moulting) and wintering grounds. The northeastern most ringing place is the Barents Sea coast in Nenets Autonomic Area, the southwestern most wintering area in this population is Great Britain.

If we consider migratory route length for birds, marked on breeding and moutling grounds in Nenets AA (swans there were marked with „Moskwa", „Copenhagen" and „London" schemes rings), we see just slight and insignificant distance increase from 1990-s to 2001-2010: 2095.±111.8 km (N=86) for 1991-2000 to 2207.8±97.7 km (N=94) for 2001-2010 and significant increase to 2566.9±53.8 (N=224) for 2011-2023 (t-Bailey=3.7, P=0.001).

Above, it has been "the view" from the breeding and moulting places. Let's see what will happen with migration distances if we consider birds marked in the permanent wintering area. For swans ringed in Great Britain mean distance for 1961-1990 is: 2723.6±153.6 km (N = 29), for years after 1990 we see some decrease – 2572.3±184.8 km (N = 32), however insignificant.

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) of 26 November 2010, the oldest known Bewick's Swan lived more than 23 years 7 months. Our database does not have good data about longest lived birds. The bird ringed as adult male and recovered in more than 21 year has postal (i.e., not precise) recovery date. There is one recovery of 22 years 2 months between ringing and recovery dates, however ring not sent. We have more exact data for a swan ringed as adult male and recovered ("killed by dog") in 19.5 years after ringing. This bird lived at least 21 years.

Mortality rate. 115 dead recoveries were used in the mortality rate analysis. Mean annual mortality rate in Bewick's Swan is 18.64$\pm$1.57%. Real mortality pattern differs from the theoretical one insignificantly (χ^2 = 13.1, df = 20, P=0.87). Programme MARK, Model CLogLog_2ndPart shows 18.27%, difference is as little as 0.37%. Real survivals lay almost along the theoretical one, younger ages have greater mortality than expected, adults – slightly greater than expected (Fig. 31).

The mortality pattern for the ringing-recovering period indicates that the species (population) during the study period is in good condition (explanations see in "Materials and Methods"). This coincides with the species number increase observed in recent years (Field Guide of the Anseriforms of Russia, 2011). E.g., in the central parts of the Taimyr Peninsula on the Agapa River (left tributary of the Pyasina River), Bewick's Swan population growth has occurred at least since 2004. In 2013 the counted number was the highest, several pre-moulting concentrations exceeded 20 swans, and one such concentration contained 60 birds (Sergey Kharitonov, unpublished data). This is the biggest flock whenever observed in this area. Increasing numbers in Central Russia (Alexandr Mishchenko, personal communication) also indicate the overall population growth. In the mortality pattern (Fig. 31) number of birds with 8-12 years after ringing (these digits indirectly point to the bird ages) exceeds figures predicted by theoretical line. This means that population increase occurs mostly due to lesser mortality of middle-age birds and their greater input into population.

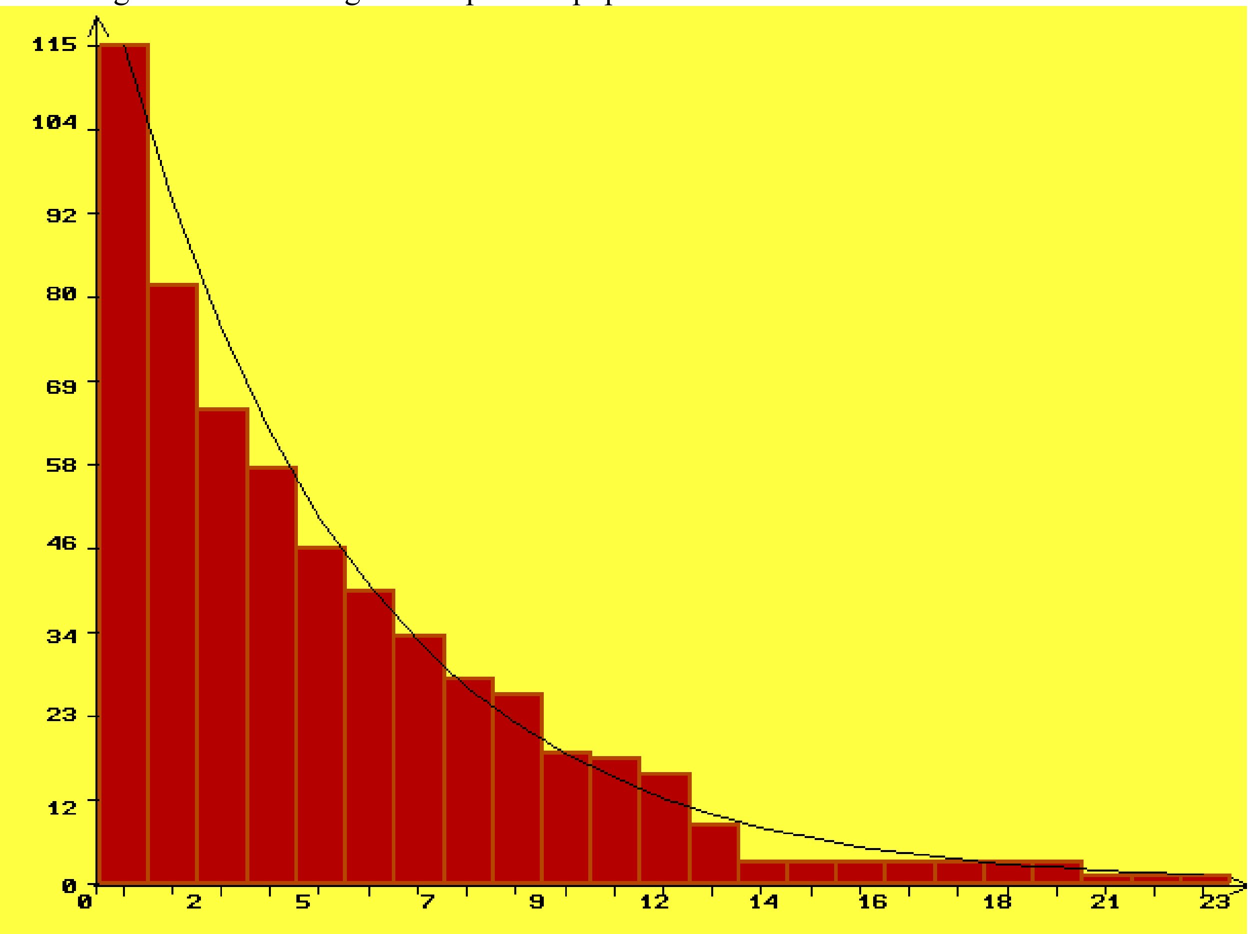


Figure 31. Mortality pattern in Bewick's Swan. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, males live longer than females: 5.2±0.69 (N=55) and 4.21±0.58 (N=51) years respectively, although insignificant. Male mortality is 15.99+2.22%, female mortality is greater - 17.85±2.27%. Mortality pattern indicates that both sexes are in good population condition (Fig. 32).

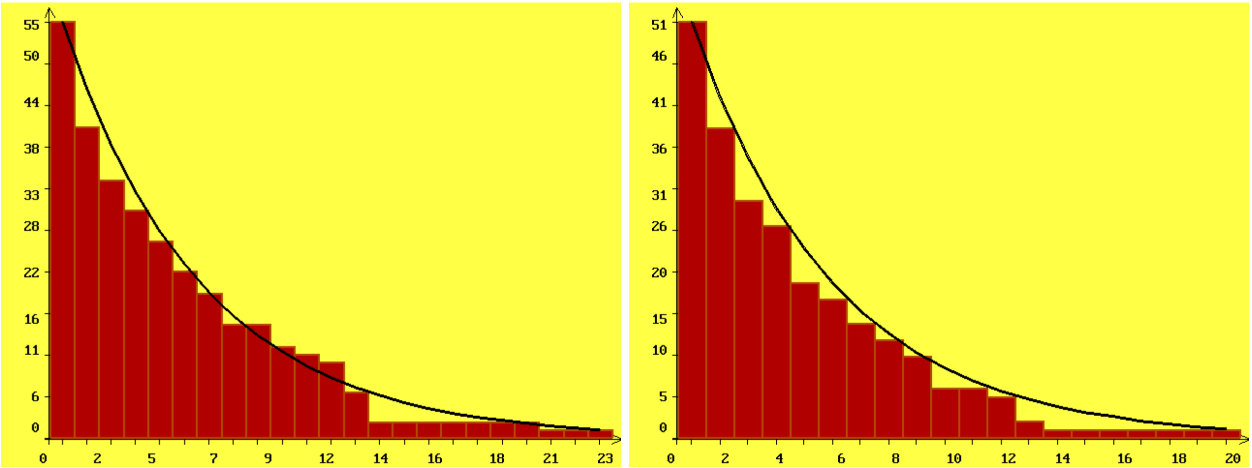


Figure 32. Mortality pattern in Bewick's Swan males (left) and females (right). X axis is the number of years after marking. Y axis is the number of live birds.

WHOOPER SWAN
(*CYGNUS CYGNUS*)

Photo by Irina A. Kharitonova

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 33. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

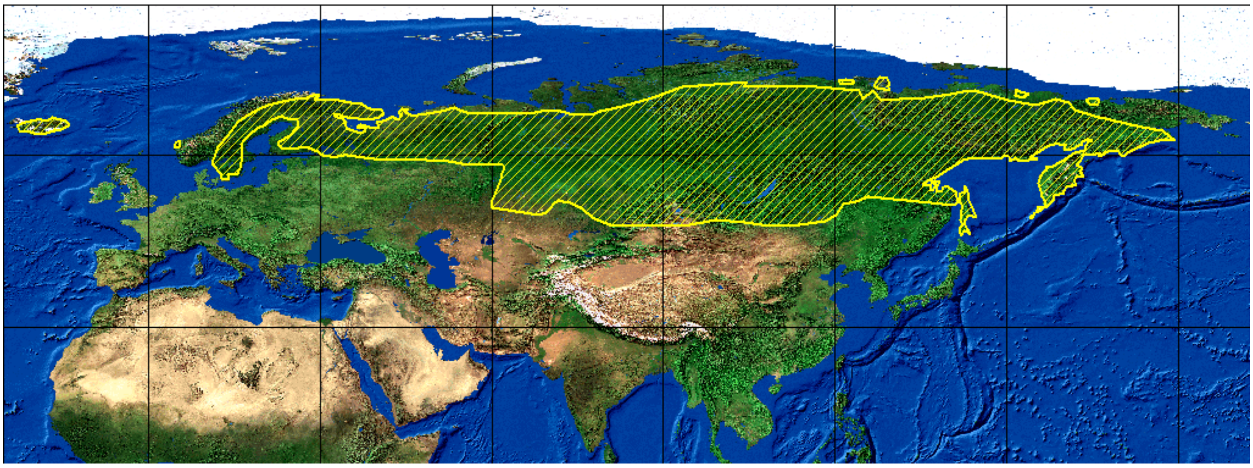


Figure 33. Breeding range of the Whooper Swan in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 112 marked birds were used, which gave 169 recoveries (Fig. 34); 51 worn rings only, 55 birds also with neck-collars, 4 had transmitters. Ringing dates are since 21.02.1941 till 16.08.2018, recovery dates since 18.05.1941 till 18.03.2023. 50 swans with rings had only one recovery per bird, one bird – two recoveries; birds with neck-collars gave from 1 to 13 recoveries per bird. 55 birds with neck-collar were recorded 108 times, 1.96 encounters per swan. As one can see, neck-collars produce the highest number of recoveries either in absolute meaning or in relation to number of marked birds. No Whooper Swan with neck-collar icing was detected (see "Finding details").

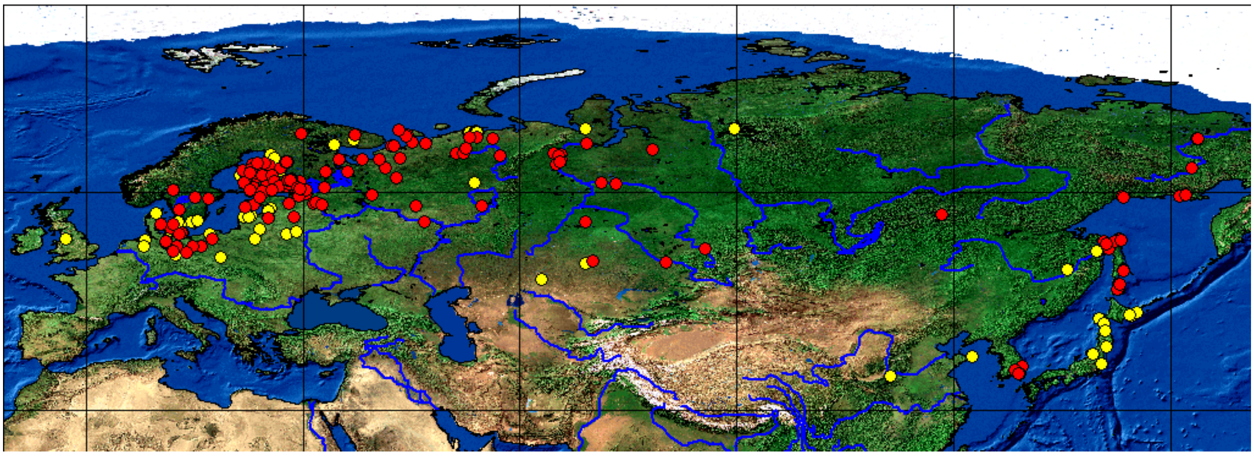


Figure 34. Position of all Whooper Swan control points. Yellow dots are ringing sites, red dots are recovery sites.

Most of recoveries are related to the European and West Siberian part of the breeding range. Also we have data on birds wintering in Japan and South Korea.

'Moskwa' scheme recoveries. This sample contains 84 recoveries of the scheme „Moskwa". They are from birds ringed within the Russian Federation, in regions: Nenets Autonomic Area, Komi Republic and Khabarovskiy Kray (Fig. 35).

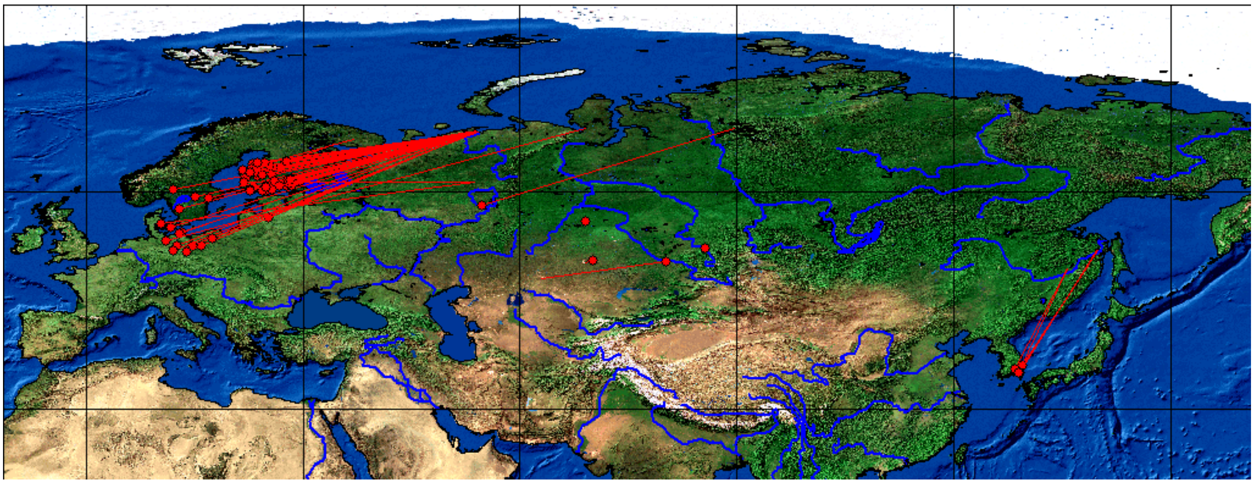


Figure 35. „Moskwa" scheme recoveries. Here and on all other similar figures lines start from ringing sites, recovery site are marked with red dots.

Finding details. This analysis includes all 169 recoveries. Sight records comprise more than one half of recoveries, 26 birds were found dead or died, 27 (24%) birds were shot, other recovery reasons are not so common (Fig. 36).

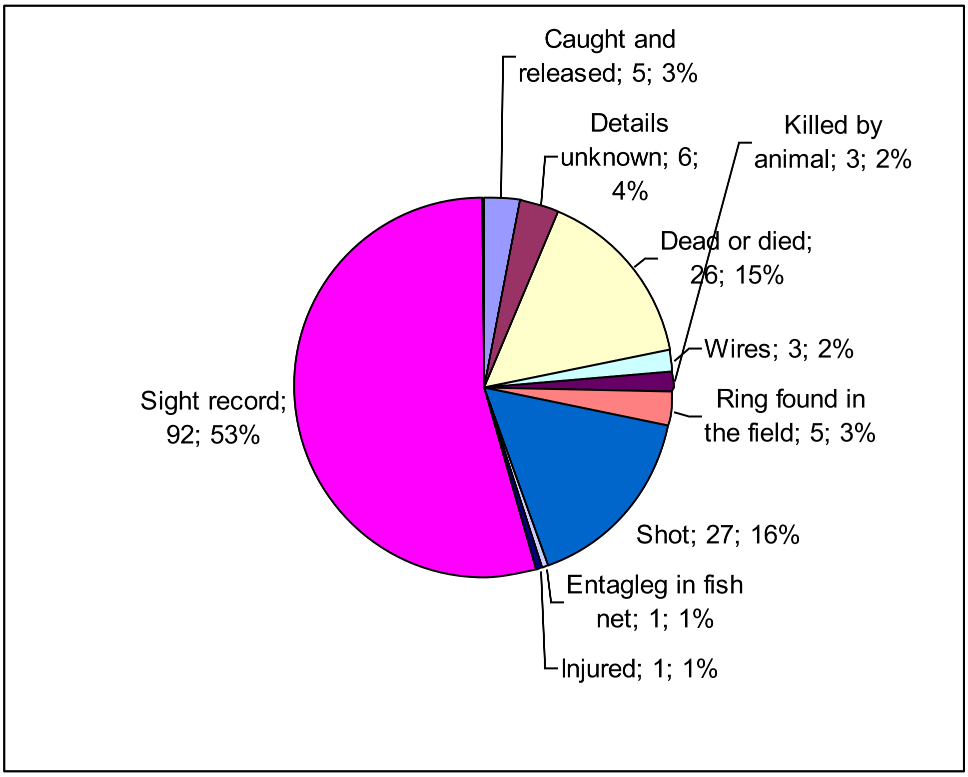


Figure 36. Finding details of Whooper Swans.

Direct and indirect recoveries. In the Whooper Swan pictures of direct and indirect recoveries look considerably different (Figs 37, 38).

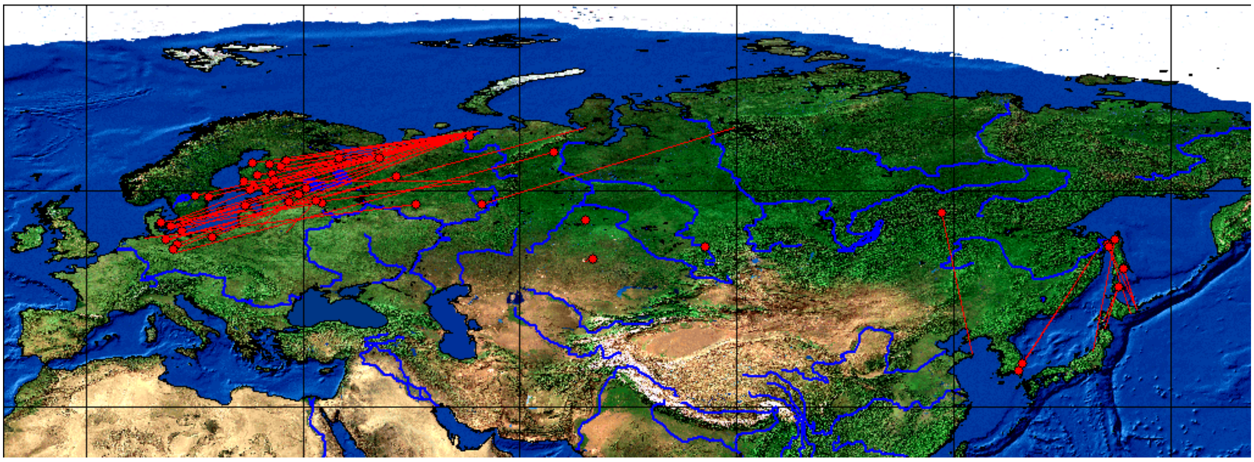


Figure 37. Map of the Whooper Swan direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

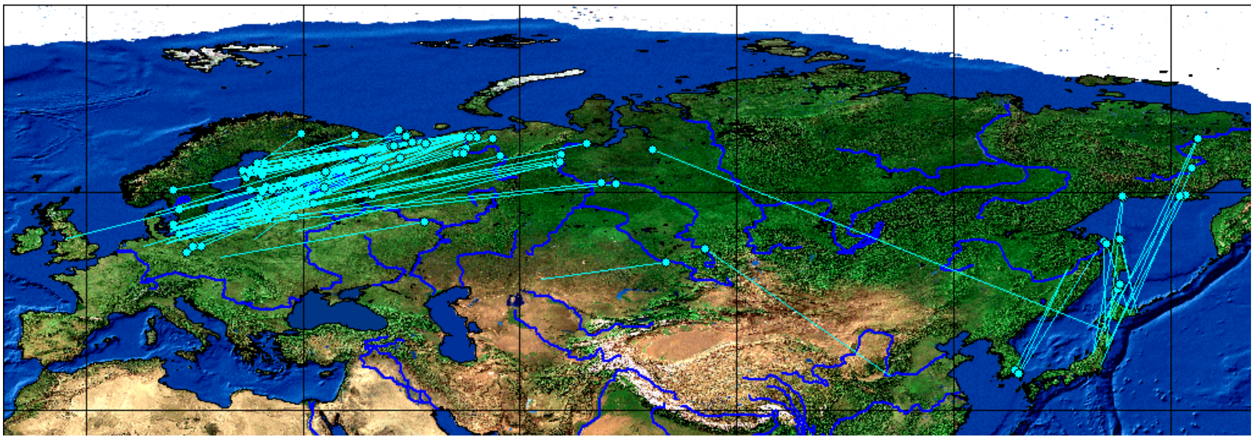


Figure 38. Map of the Whooper Swan indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

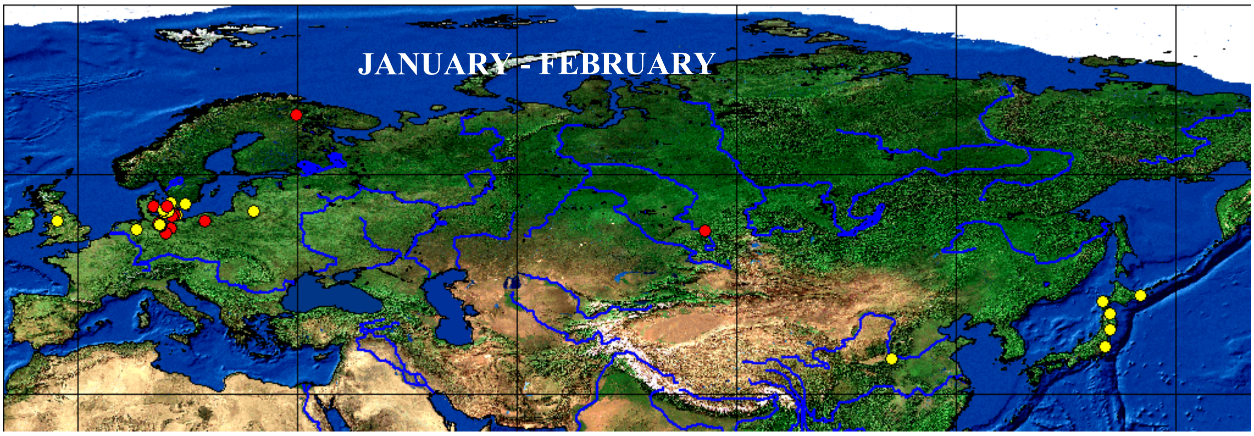
Maps show two groups of recoveries: 1) ringed and recovered in Europe, Western and Central Siberia and Kazakhstan; 2) ringed and recovered in Japan-South Korea-Sakhalin-Khabarovsliy Kray-North Russian Far East area. The largest sample is the European one (Figs 37, 38). In spite of not large samples in Whooper Swan, Mardia-test (with Robson correction) for all recoveries shows significant differences between areas of direct and indirect recoveries (χ^2 = 12.14, df=2, 58 direct recoveries and 111 indirect ones, P = 0.002). Centre of indirect recoveries locates more than 1 degree to the north and almost 3 degrees to the east in comparison to the centre of direct recoveries.

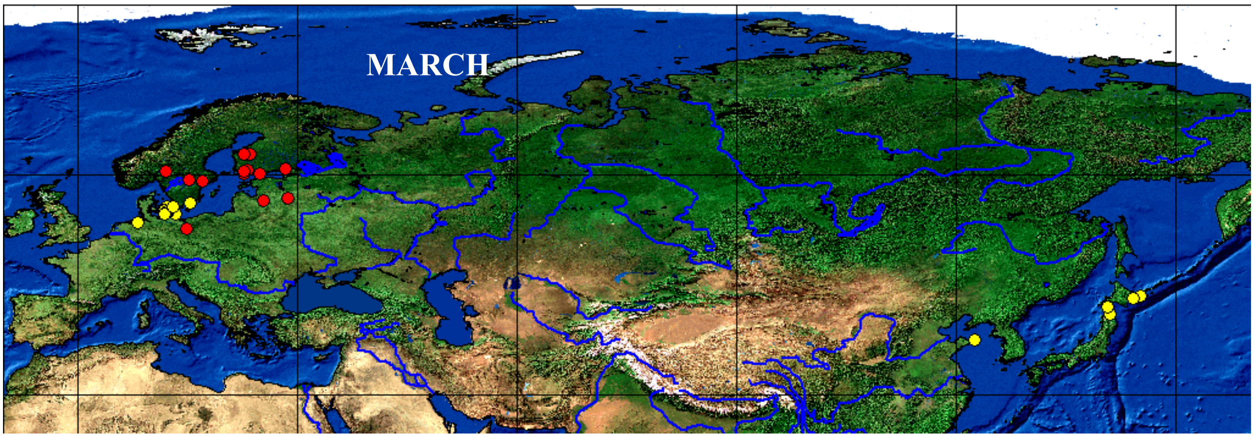
Mean distances in direct and indirect recoveries are: 1618.5$\pm$111.7 and 1819.3$\pm$77.9 km respectively. In opposite to Mute and Bewick's Swans indirect distances are noticeably and significantly longer than direct ones. The same is for both European and Far Eastern cohorts of recoveries. Proportion of birds, ringed as young, is approximately equal in both samples. We suggest that this regularity indicates that Whooper Swans have less breeding site fidelity than Mute and Bewick's Swans. Additional argument for this suggestion is the long-distance recovery from Japan to Yamal-Nenets AA (Fig. 38).

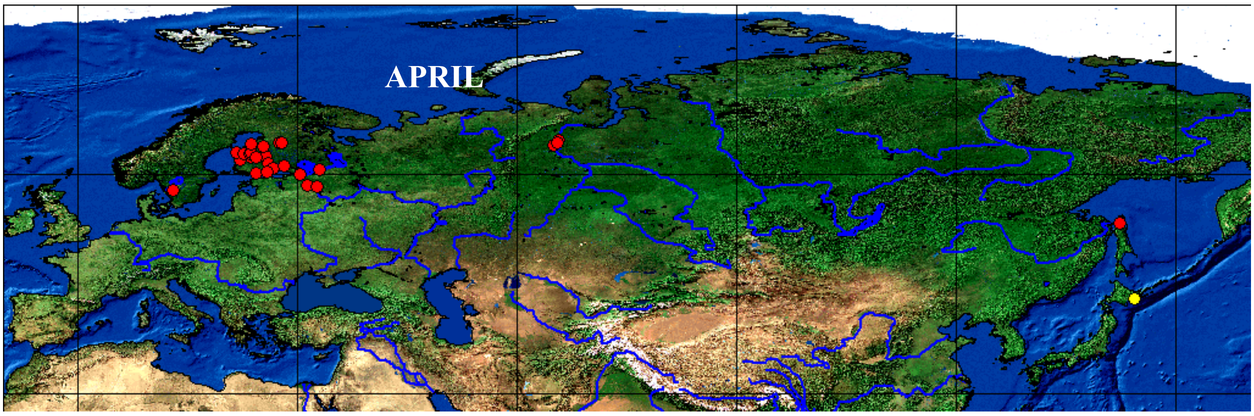
Average recovery distance for birds with neck collars and other marks is shorter than for birds with metal rings only: 1719.7$\pm$68.1 km (N = 117) and 1819.4$\pm$140.1 (N = 52) respectively, however insignificant. The explanation could be the same as for other swans: birds with neck collars are more visible, therefore they start to give records closer to ringing sites than birds without collars.

Monthly movements. Both direct and indirect recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in Whooper Swans (Fig. 39). For European Whopper Swans movements to breeding grounds start in March (compare January-February and March, Fig. 39), the same as in the Bewick's Swan. In April part these Whooper Swans arrive at the breeding grounds, other birds are still on migration. May-June-July birds are on the breeding grounds (see April, May, June, July in Fig. 39). In August part of European Swans start to move to wintering places, however, there are birds that are still within the breeding range in September-October. In November-December some Whooper Swans were found in breeding areas, but these were sick or injured birds. One such bird was recorded there even in January (see January-February, Fig. 39).

Whopper Swans wintering in Japan and South Korea start to move to the north in April, and some birds already in April can reach the breeding grounds at the northern Sakhalin. In May these Whooper Swans reach the northern boundary of the breeding range in the Far East. Low number of recoveries does not allow detecting, when Far-Eastern swans turn back to wintering areas, however some birds could stay on the northern coast of the Sea of Okhotsk even in October (see September-October, Fig. 39).



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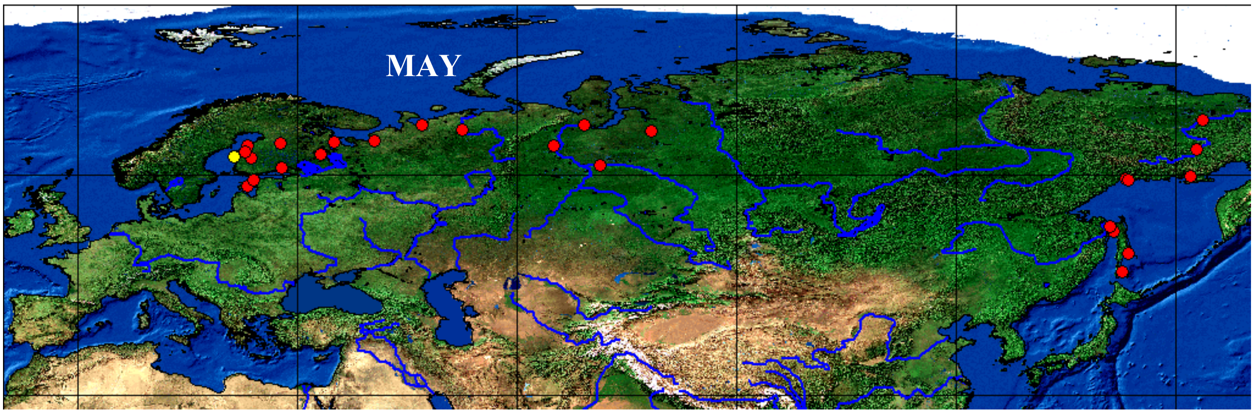
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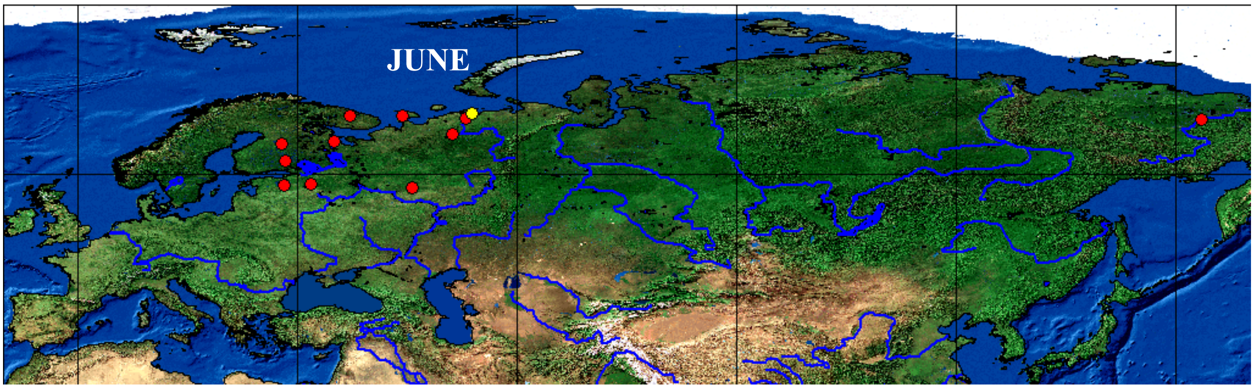
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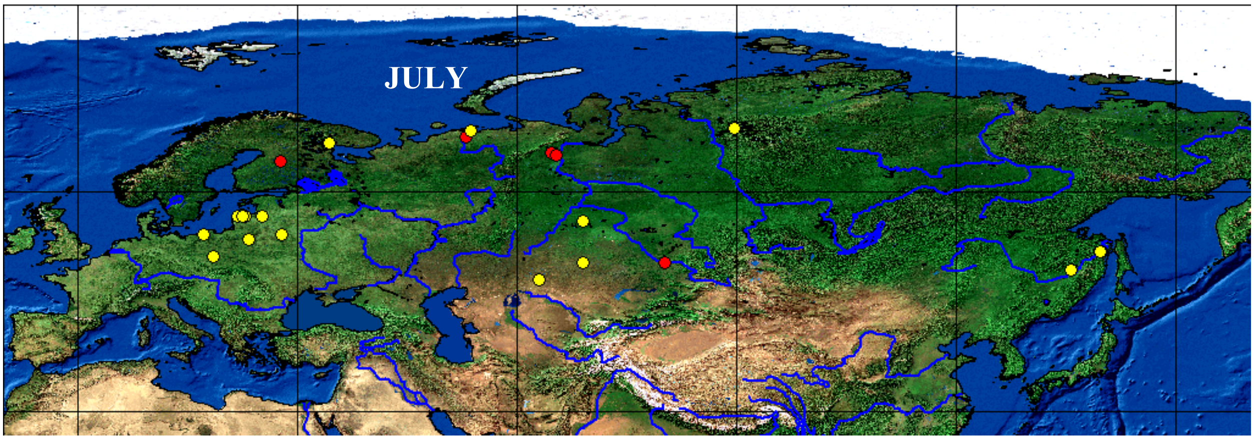
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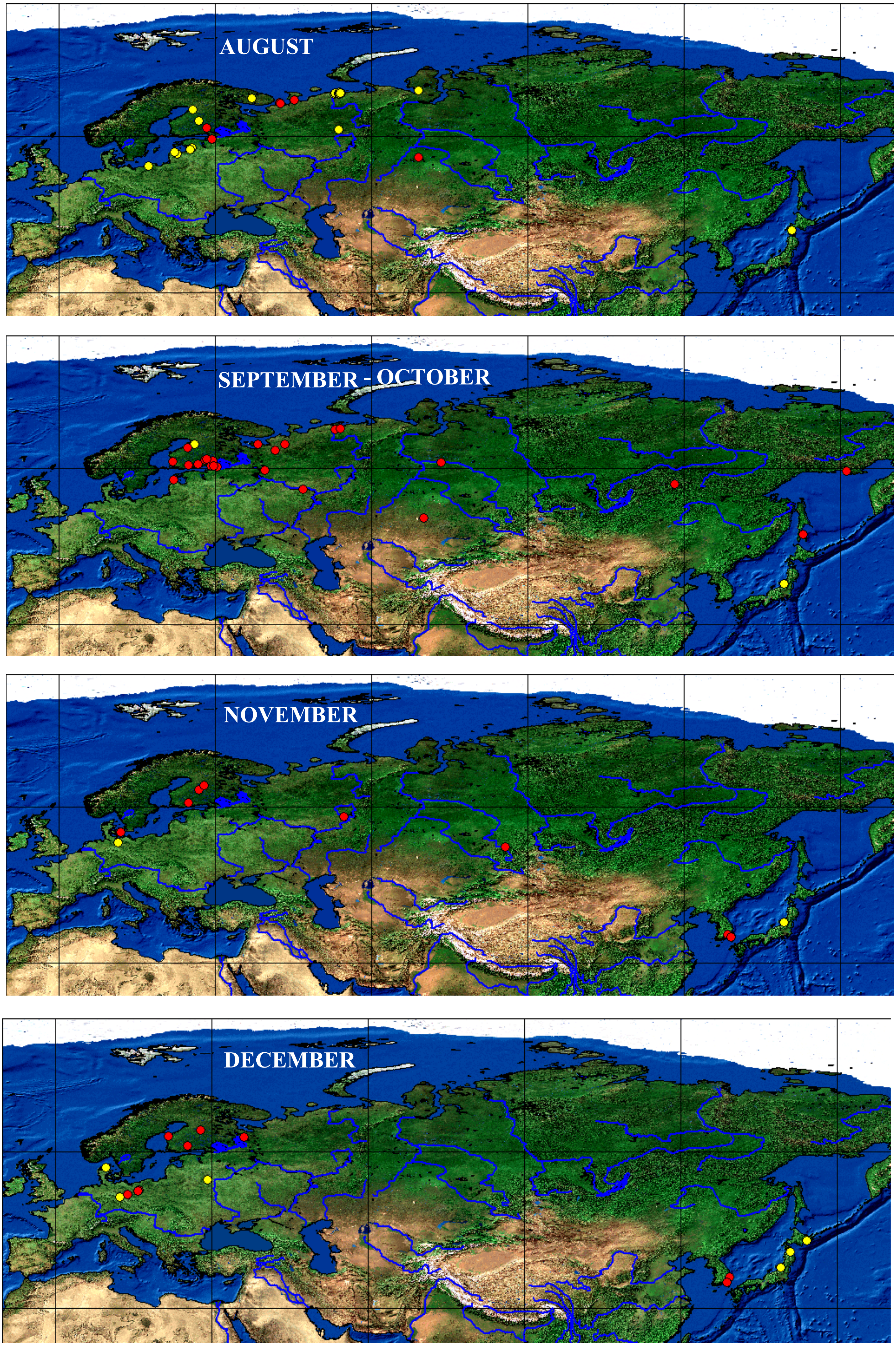


Figure 39. Whooper Swan monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. European Whooper Swans migrate along northeast-southwest directions, most frequent opposite bearings are 60˚ and 240˚. Far-Eastern birds in spring go mostly by bearings 15˚ or 345˚ (Fig. 40). Birds wintering in Japan seem to fly over the land as much as possible: firstly they arrive at Sakhalin, cross the island from south to north, then at least part of swans move to the coast west of Sakhalin (Khabarovskiy Kray), other part likely fly over the northern portion of the Sea of Okhotsk, moving to Magadan Region and Chukotka. In autumn Far-Eastern birds move in direction about 210˚ (Fig. 40). These are birds ringed in Khabarovskiy Kray which fly to South Korea to winter. Presumably, birds breeding in Chukotka, Magadan Region and northern Sakhlin spend winter in Japan, more westerly breeding birds winter west of Japan, i.e., in the South Korea.

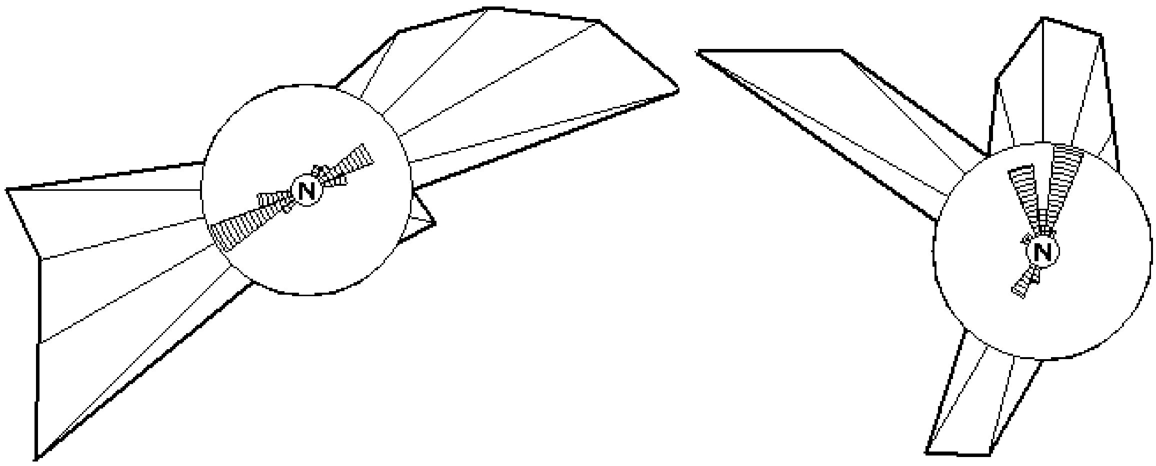


Figure 40. Recovery rose graphs for Whooper Swans: number of recoveries of birds flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Left chart is for European and western Siberia birds, excluding one outstanding recovery in this area from Japan and two recoveries for swans ringed and recovered in Kazakhstan. Sector = 15.0°; total recoveries - 136; number of recoveries in sectors: from 0 up to 46. Mean distance in sectors: from 0 km up to 2441.8 km. The longest flight distance in these birds is 3489.7 km.

Right chart represents Far-Eastern birds, excluding the same outstanding recovery from Japan to central Siberia. Sector = 15.0°; total recoveries - 31; number of recoveries in sectors: from 0 to 10. Mean distance in sectors: from 0.0 km up to 4695.5 km. The longest flight distance in the Far-Eastern birds is 4695.5 km.

Most of direct flight distances are 1000-2800 km (Fig. 41); maximal distance of a direct recovery is 3991 km. For indirect recoveries most frequent distances are less than 3600 km (Fig. 42), the longest distance is 4695.5 km.

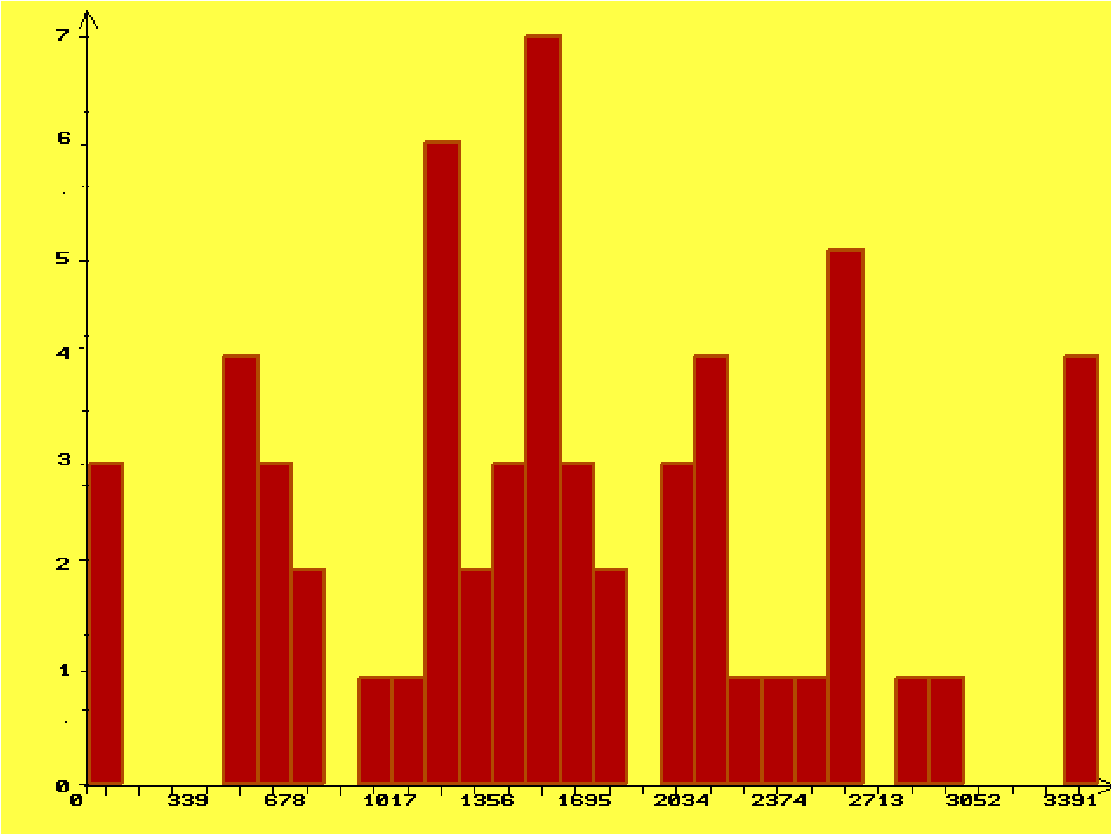


Figure 41. Distribution of direct recovery distances in Whooper Swans. X axis is the flight distance; Y axis is the number of distances.

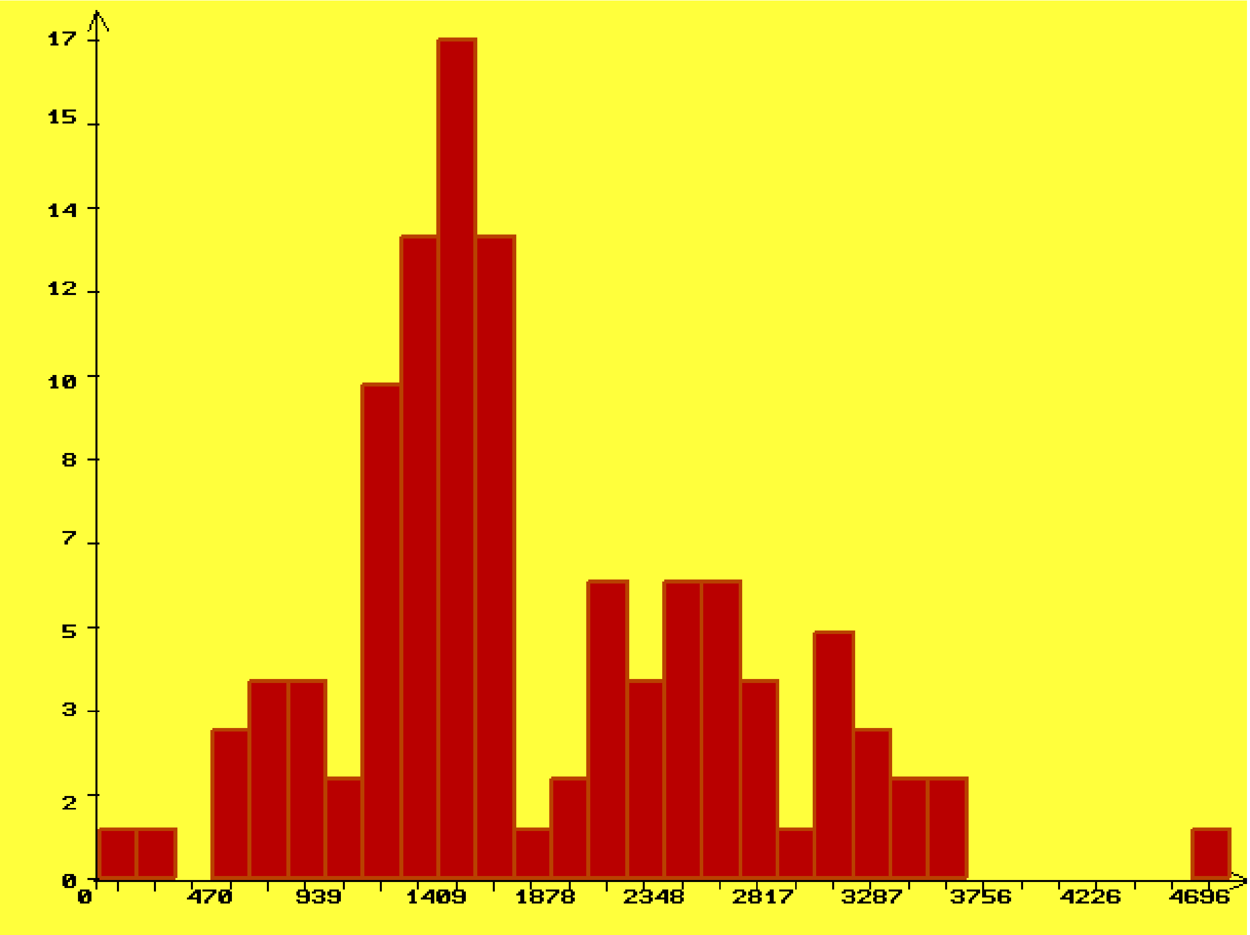


Figure 42. Distribution of indirect recovery distances in Whooper Swans. X axis is the flight distance; Y axis is the number of distances.

Similar to the close species Bewick's Swan, mean flight distance in Whooper Swan young birds (ringed as „pull" or „juv" or „1 y") is by about 400 km shorter than in adults: 1347.9±190.1 and 1827.0±65.6 km respectively (N_{ad} = 142, N_{young} = 27, t-Bailey = 2.43, P=0.015). Shorter distance in young witnesses, that young bird mortality on their first migration in Whooper Swans is greater than in adults. There are very few sight records of young birds in comparison to adults. Whopper Swan is hunted more often than Mute and Bewick's Swans – 16% of recoveries are "shot" that greater than in the two latter species (Fig. 36).

Female mean flight distance is longer than in males: 1814.3±141.7 km and 1751.1±150.4 km respectively, N_{males} = 38, $N_{females}$ = 35 recoveries, although insignificantly.

Speed. Whooper Swans in general, migrate quite slowly, even though our database does not contain information on real flight speed during migration. The bird with the ring Copenhagen 190 281 was ringed on 18.04.1952 in Denmark. After 36 days after ringing, this adult male covered just 1285.4 km, being shot on 23.04.1952 in the Novgorod Region. Since the bird could start its migration in mid-March, it covered on average 35 km per day.

In the eastern part of the range, the swan was ringed in Japan with the ring 150-0 041 on 09.04.1986, just before spring migration period. In 37 days the swan was found dead (16.05.1986) in Khabarovskiy Kray. It had covered 1100 km, i.e., moved, on average, near 30 km per day.

Populations. Whooper Swan population structure is not clear. Our ring-recovery data allow outlining the following populations: 1) european-west-central-siberian population (polygon № 1, Fig. 43); 2) relatively small kazakhstanian-caspian-sea population (polygon № 2); 3) extensive, not certain in western boundaries central-eastern-siberian-fareastern-korean-japanese population (polygon № 3, Fig. 43). The first and the third populations partly overlap in their eastern and western parts respectively. One indirect recovery, being inside of one geographical population (№ 3), shows cross-population movement, because it falls in the overlapping area (Fig. 43). Therefore, northern western and central Siberia is probably the "inter-population exchange zone" (Kharitonov, 2002) for Whooper Swans.

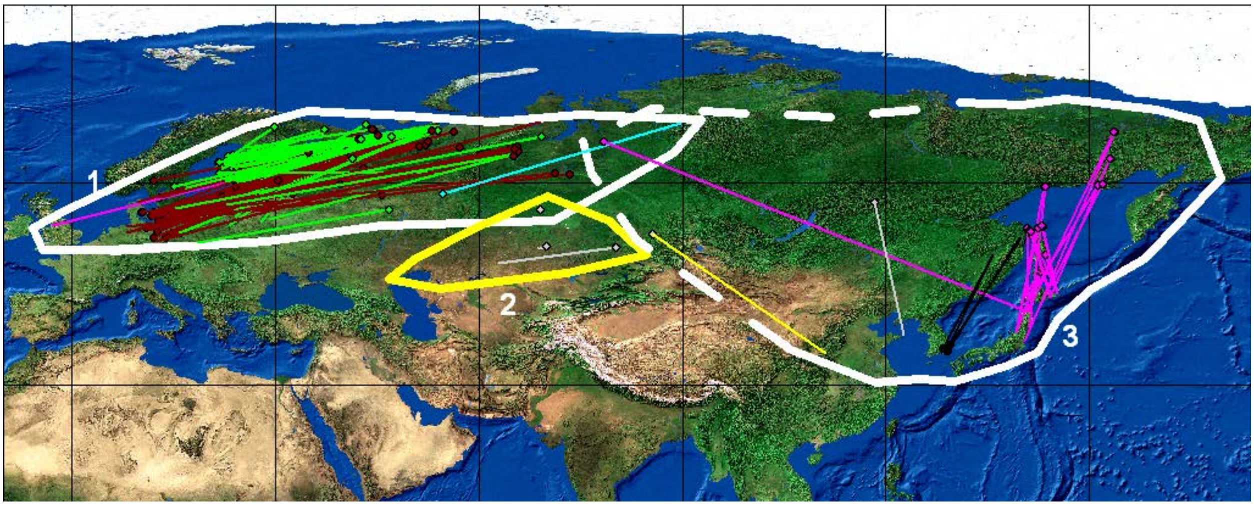


Figure 43. Whooper Swan populations. White polygon (№ 1) outlines european-west-central-siberian population. Yellow polygon № 2 is kazakhstanian-caspian-sea population; polygon № 3 (dashed in its western side, which means that this boundary is much less certain than other ones) outlines central-eastern-siberian-fareastern-korean-japanese population.

Ten-year distances. No trend is seen in mean flight distance along decades (Table 4). However, the data set in Whooper Swan is not large, probably not enough data for such analysis.

Table 4. Whooper Swan mean flight distance per decade.

Decade (years)	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2023
Distance (km)	1821	1342.1	2186.2	1882.9	1978.7	1175.9	1845.5	1731.6
Number of recoveries	3	7	7	10	13	9	24	96

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest known Whooper Swan lived 26 years 6 months. Our database probably contains similar long-lived bird. The bird Stockholm H 8 946 was ringed on 20.02.1982 as >2 years. On 13.08.2005 after 23 years 6 months is was „killed by dog". Therefore, this bird lived at least 26 years 6 month.

Mortality rate. Just 59 dead recoveries are possible to be used in the mortality rate analysis. Mean annual mortality rate in Whooper Swan is 13.15±1.60%. Real mortality pattern (Fig. 44) is significantly different from the theoretical one (χ^2 = 69.85, df = 21, P=0.0000). Programme MARK, Model CLogLog 2ndPart shows 15.08%, difference is 1.93%, however the sample is not large. The mortality pattern indicates that the species (population) during the study period was not in a good condition (explanations see in "Materials and Methods"). Therefore, although Whooper Swan now is expanding and growing in numbers (Field Guide…., 2013), in not distant past the species was not in good condition.

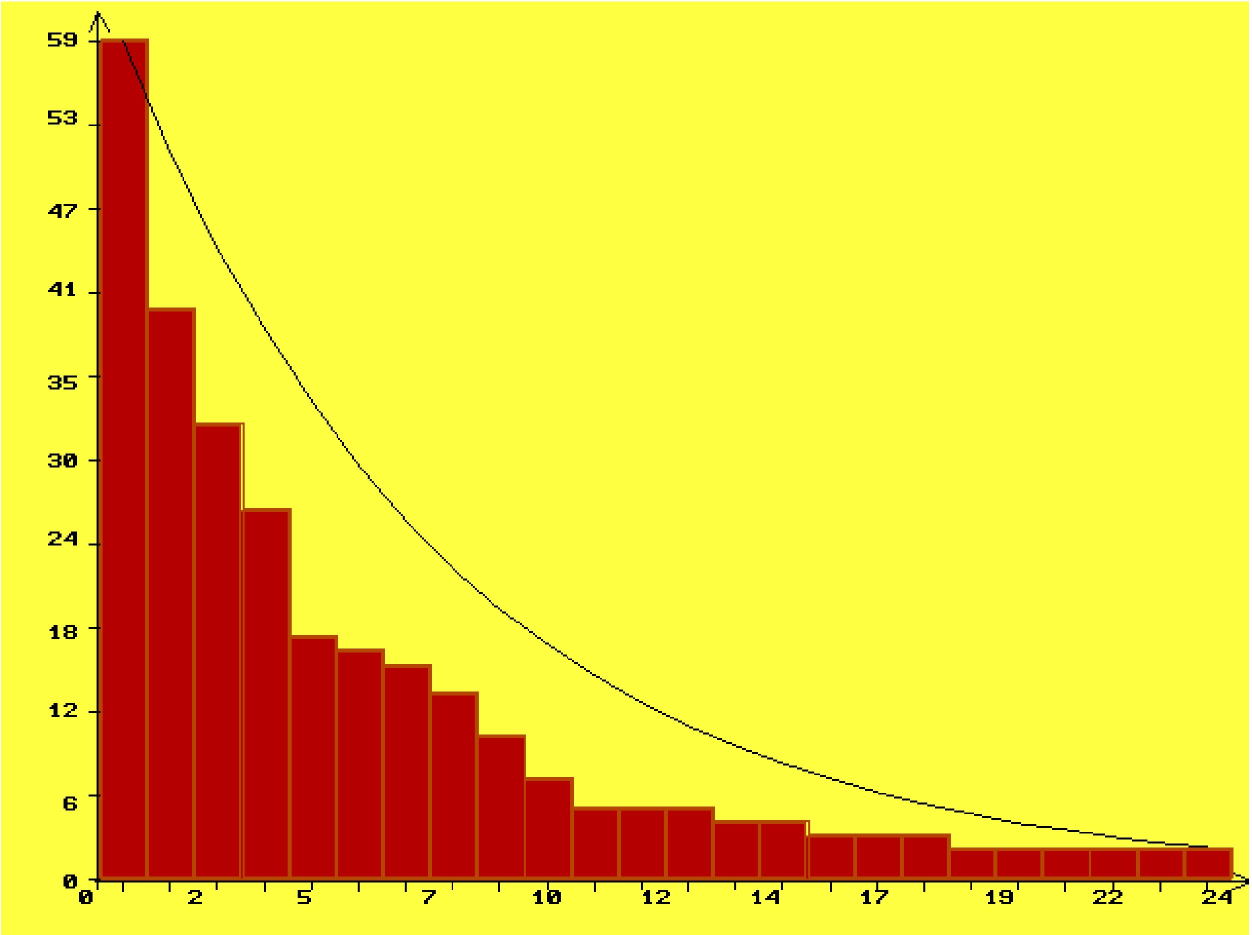


Figure 44. Mortality pattern in Whooper Swan. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Data show that, on average, males live longer than females: 3.26±0.84 (N=17) and 2.96+1.22 (N=9) years respectively, although insignificant. However, the number of dead recoveries of birds with known sex is not much, so these results are not accurate. Probably, they indicate just a general tendency.

SWAN GOOSE
(*ANSER CYGNOIDES*).

https://img-fotki.yandex.ru/get/9313/101743230.46/0_898ea_82036490_XL.jpg

Breeding range of the Swan Goose locates in Mongolia, China and south of the Russian Far East. The goose spends winter in China and South Korea. In the European Russia we have just one recovery of a bird that escaped from captivity from the Moscow Region Division of Moscow Zoo. The goose was marked on 31.10.1975 and recovered in 1989 as "ring only found in the field". Ring was found near Taganrog, Rostov Region. The bird covered 955 km (Fig. 45). Flight direction is in general from north to south, which, although not exactly, but resembles direction and distance of migration in natural area of this species.

Figure 45. Flight direction of Swan Goose escaped from Moscow Zoo. Beginning if line indicates ringing site, red dot at the end indicates the recovery point.

BEAN GOOSE
(*ANSER FABALIS*)


Photo by Sergey P. Kharitonov

Taxonomic remarks. Bean goose species contains at least four subspecies: Forest Bean Goose (*Abser fabalis fabalis*), Tundra Bean Goose (*Abser fabalis rossicus*), Taiga Bean Goose (*Abser fabalis middendirffii*) and Eastern Bean Goose (*Abser fabalis serrirostris*). On ringing in Russia in a number of cases the subspecies was recorded, in many other cases – no. As a rule, in recoveries we obtain from abroad only species name without subspecies is pointed. Therefore, in our analysis we take all ring-recovery data on Bean Goose in one pool, without special subspecies separation. We mentioned the subspecies taxa only in some examples where separate individuals were described.

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 46. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

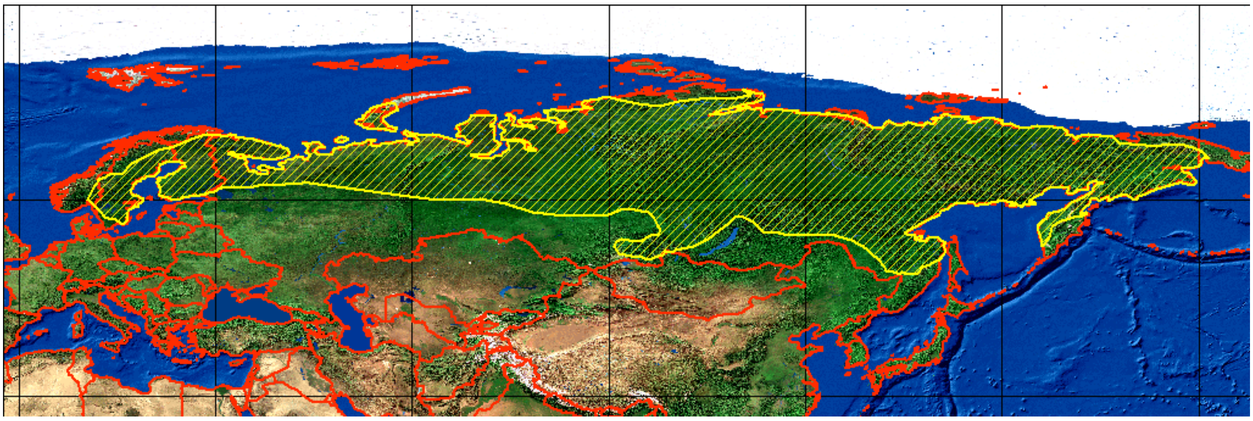


Figure 46. Breeding range of the Bean Goose in Eurasia (yellow dashed area).

Distribution of control points. For this species account 1236 marked birds were used, that gave 1302 recoveries (Fig. 47), 1036 birds were marked with rings only, 200 geese held neck-collars and, sometimes, colour rings in addition to neck-collar and transmitters. Transmitters were placed on 5 birds. According to the number of recoveries from colour marks, we would like to stress, that not all sight records registered in Europe are in the BRC database. Considerable amount of these records are in the databases of other ringing centers.

Ringing dates are since 30.07.1940 until 03.11.2021, recovery dates since 27.04.1941 until 11.10.2022. Bean Goose with rings had only one recovery per each ring, birds with neck-collars had from 1 to 8 recoveries per bird. 157 birds with neck-collars were recovered 243 times, 1.55 encounters per bird. The most of these birds were marked by „Moskwa‟ scheme rings. Birds with neck-collars of foreign schemes in our database have only one recovery per bird and usually they are shot (see section “Finding details”).

To understand how birds with neck-collars feel, we compare samples ring-recovery distances of only ringed and neck-collared birds sequentially in three schemes where neck-collars were used, taking into account birds died for any reason and excluding young birds. For „Hiddensee" scheme mean distance for birds with neck-collars was greater, than for rings only: 2095.4+81.5 and 1931.5+102.4 km respectively (32 and 41 geese respectively were involved in this comparison), although insignificant. The same regularity was found in „Arnhem" or „Leiden" marked geese – 2856.0+93.2 and 2781.1+28.1 km respectively, N1 = 31, N2 = 767 birds; and „Moskwa" marked – 1292.9+166.8 and 1216.9+221.9 km, N1 = 36, N2 = 31 birds. These data clearly shows that in the Bean Goose neck-collars are not harmful, and this method can be used with success in this species.

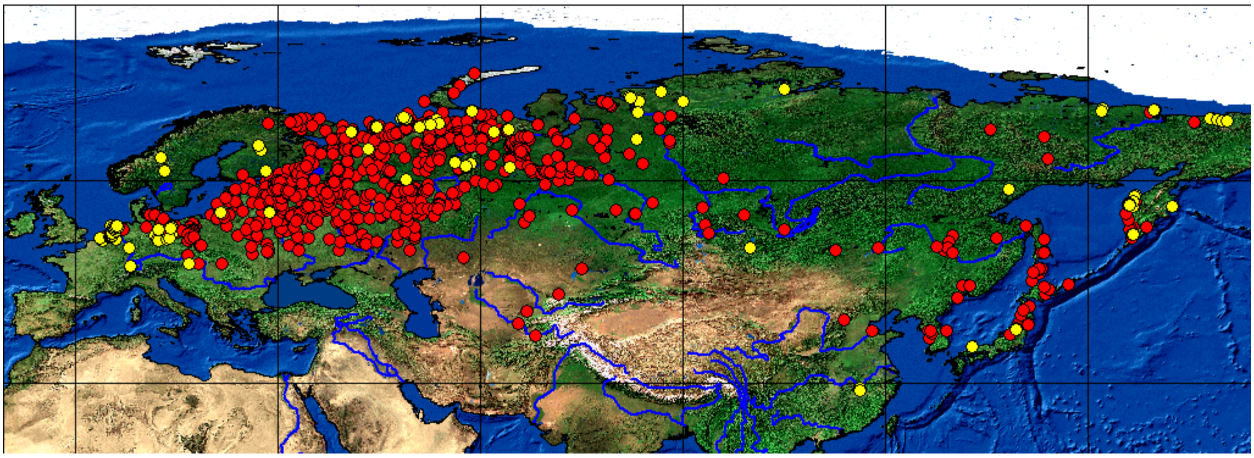


Figure 47. Position of all Bean Goose control points. Yellow dots – ringing sites, red dots – recovery sites.

Most of recoveries are connected with the European part of the breeding range. Also we have data on birds wintering in Japan, Eastern China and Mongolia.

'Moskwa' scheme recoveries. This sample contains 130 ring recoveries of the scheme „Moskwa". They are from birds ringed within the Russian Federation, in many regions: Arkhangelsk Region, Nenets Autonomic area, Komi Republic, Taimyr Autonomic Area, Yakutia, Khabarovskiy Krai and Kamchatka (Fig. 48). The latter area belongs to the *A.f.serrirostris* subspecies breeding range.

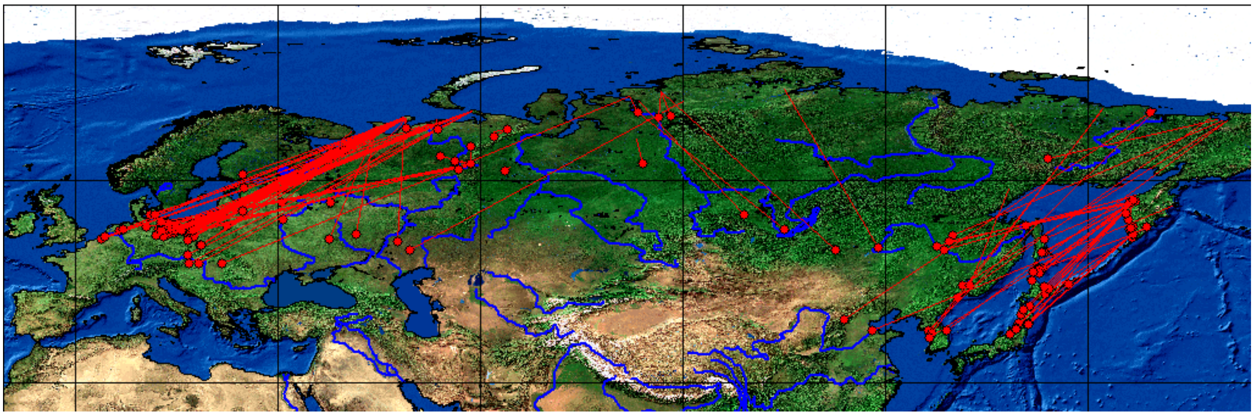


Figure 48. „Moskwa" scheme recoveries of the Bean Goose. Here and on all other similar figures lines start from the ringing sites, recovery sites are marked with red dots.

Finding details. This analysis includes all 1302 recoveries. More than 3/4 of recoveries (79%) are „shot", details unknown usually mean „shot", as well. Sight records are very few, other reasons are not so common (Fig 49).

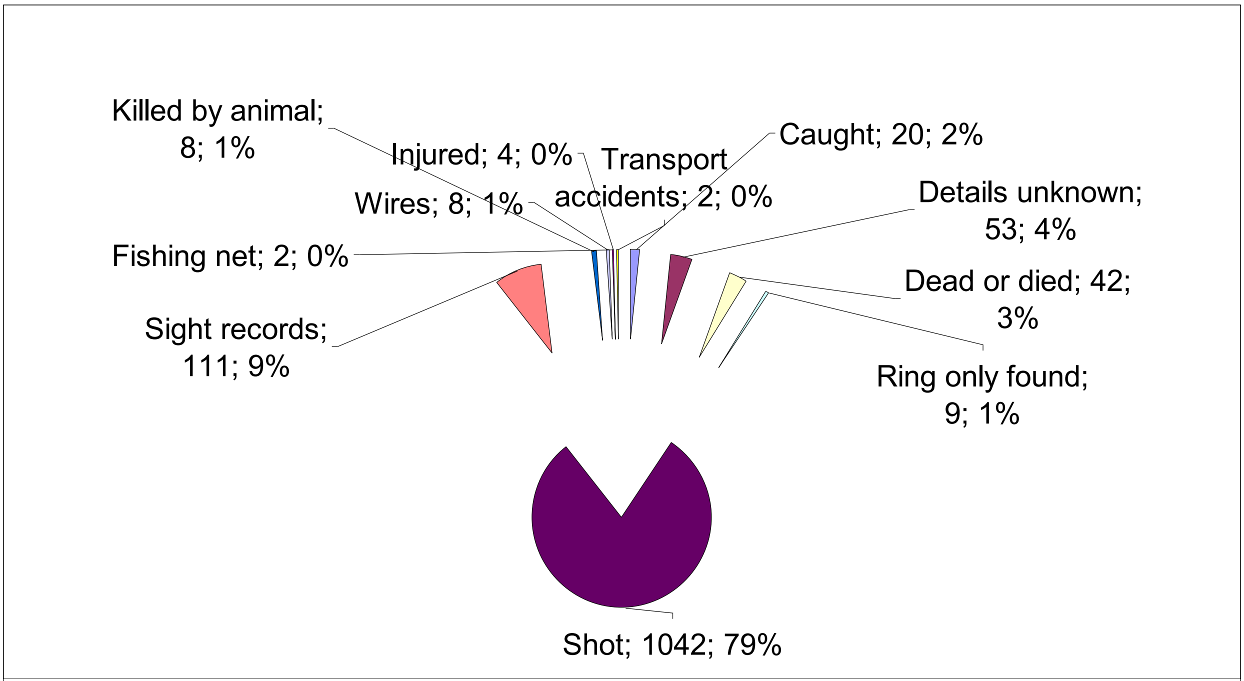


Figure 49. Finding details in Bean Geese.

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries show little difference from each other (Figs 50, 51).

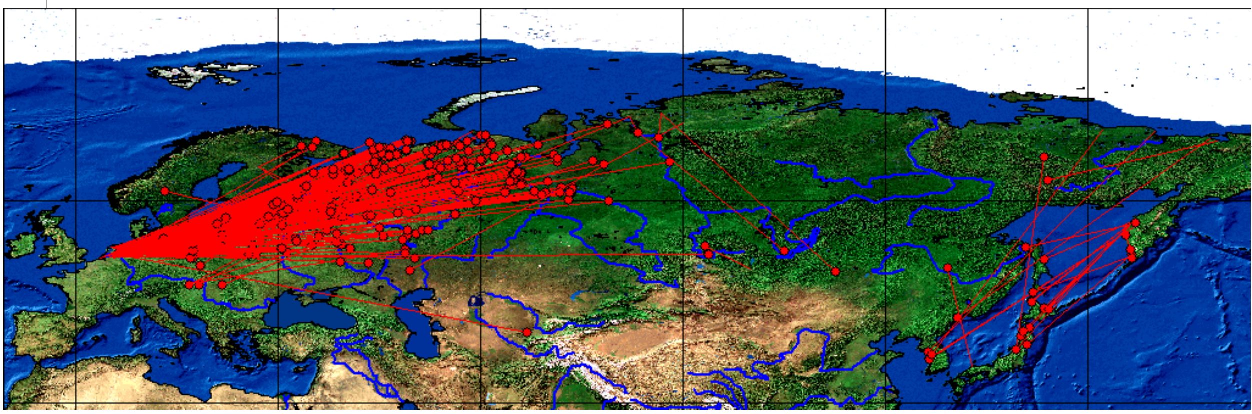


Figure 50. Map of the Bean Goose direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

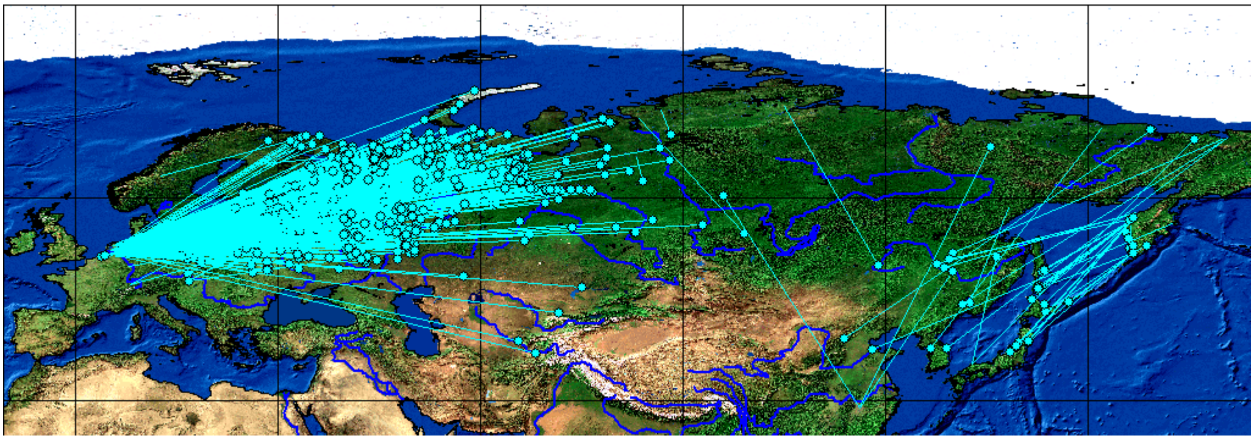
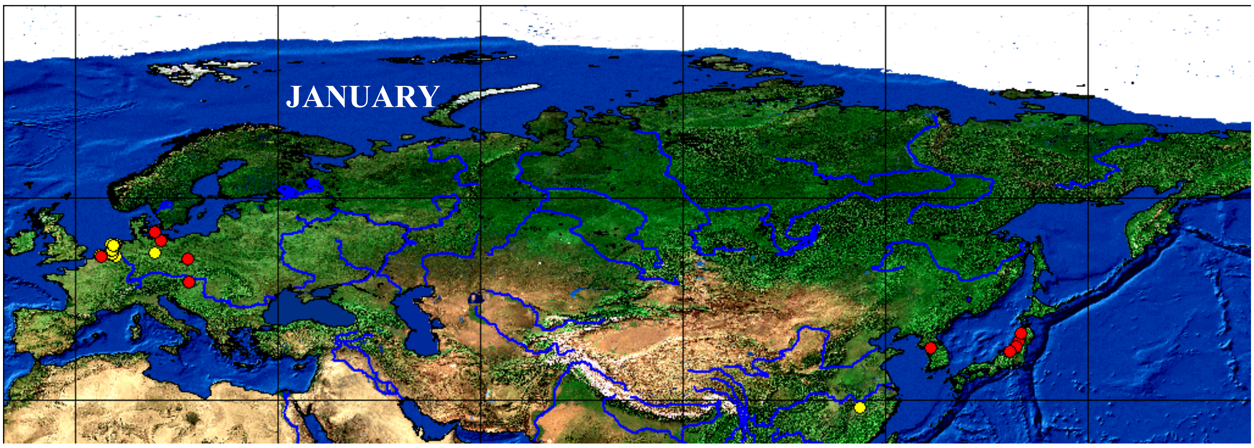


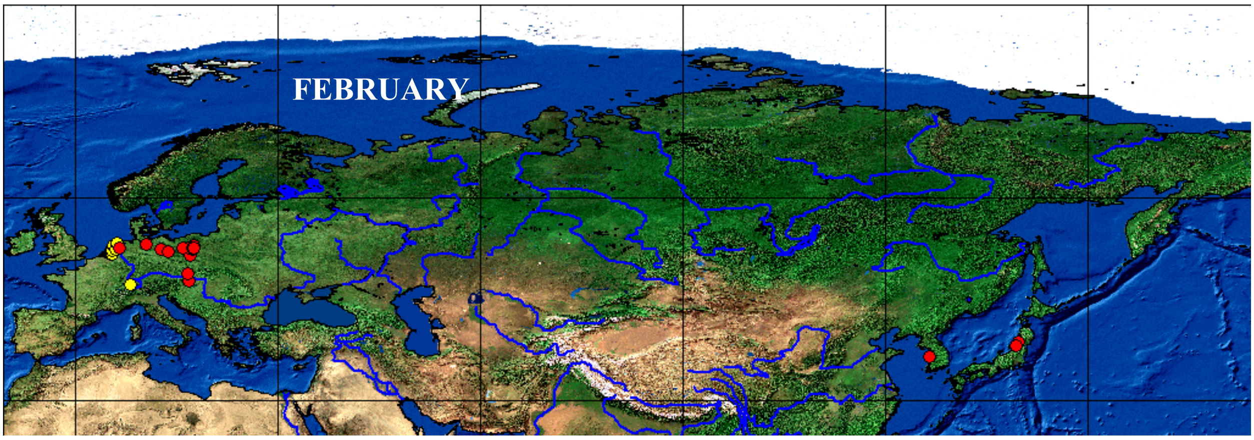
Figure 51. Map of the Bean Goose indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

Maps clearly indicate that north of the central Siberia (western part of Taimyr Peninsula) is the area where from part of Bean Geese migrate to wintering grounds in Western Europe, the others – to southeast, i.e., to Central Asia, Mongolia and China. Meridian of 85°E is the approximate boundary between these cohorts of Bean Geese (Figs 50, 51).

Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them (χ^2 = 13.58, df = 2, 313 direct recoveries and 989 indirect ones, P = 0.0011). Centre of direct recoveries is located about at the same latitude, however in more than 8 degrees to the eats from the centre of indirect recoveries, which is unusual for waterfowl (usually vise versa). Mean distances in both samples are practically the same – 2592.7±57.7 and 2595.6±27.0 km respectively for direct and indirect ones.

Monthly movements. All direct and indirect recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in Bean Goose (Fig. 52). Movements to breeding grounds in European wintering Bean Geese start in March, probably late February (compare January, February and March, Fig. 52). In March migration is already very active, these geese move very fast: a vanguard bird was recovered in Komi Republic, Russia on 12 March in more than 3000 km from the wintering areas. Far Eastern geese in March are still on the wintering grounds. In April Bean Geese are already on the breeding grounds in European Russia, but have not yet reached breeding areas in Western and Central Siberia. Far Eastern birds in April start their migration and penetrate only for more than 1500 km from wintering places in Japan. Kamchatka breeding birds reach their breeding grounds in April, as well. In May birds of all populations are on their breeding places, although in western and central Siberia breeding season for this species starts not earlier than in early June. In these areas migration in June still continue (personal observations). June-July-August Bean Geese are in their breeding and moulting areas. As to European birds, their moulting areas are situated farther from wintering grounds than breeding sites, sometimes long distance away from the nearest boundary of the breeding range (see section "Satellite tracking data"). Movements back to wintering grounds start in September. In October these movements continue however many European wintering Bean Geese are still in their breeding areas (Fig. 52. October). At the Far East these geese (*A.f.middendorffii*) are near the finish of their autumn migration. In November geese practically leave breeding areas. Far Eastern birds are on their wintering grounds, but rest of European birds still can be met („shot" recoveries) on migration. In December all birds are in their wintering locations (compare November and December, Fig. 52)

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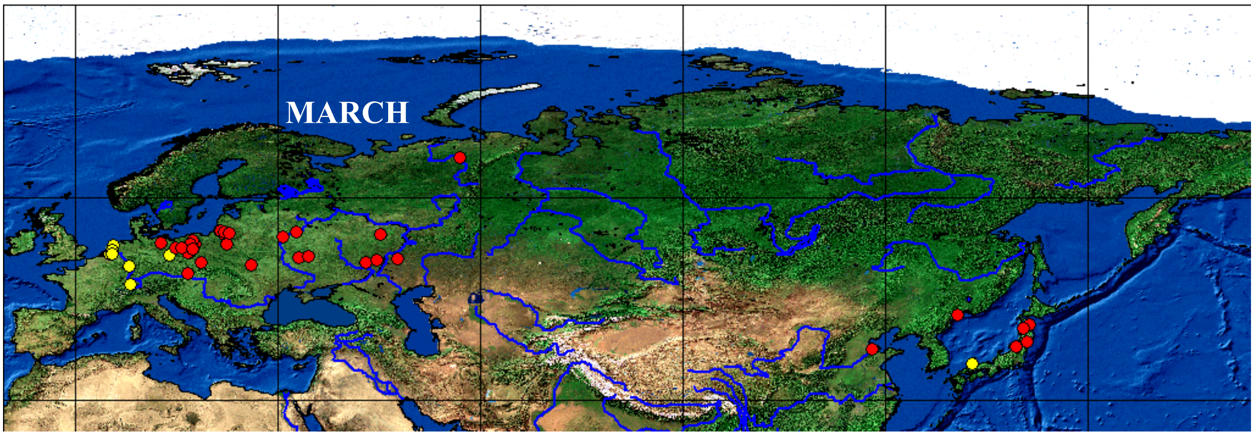
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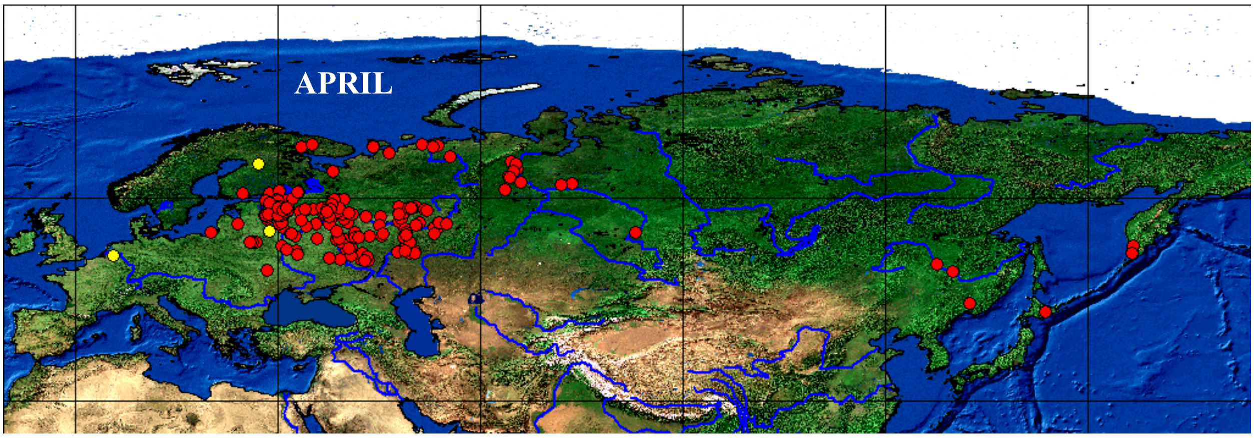
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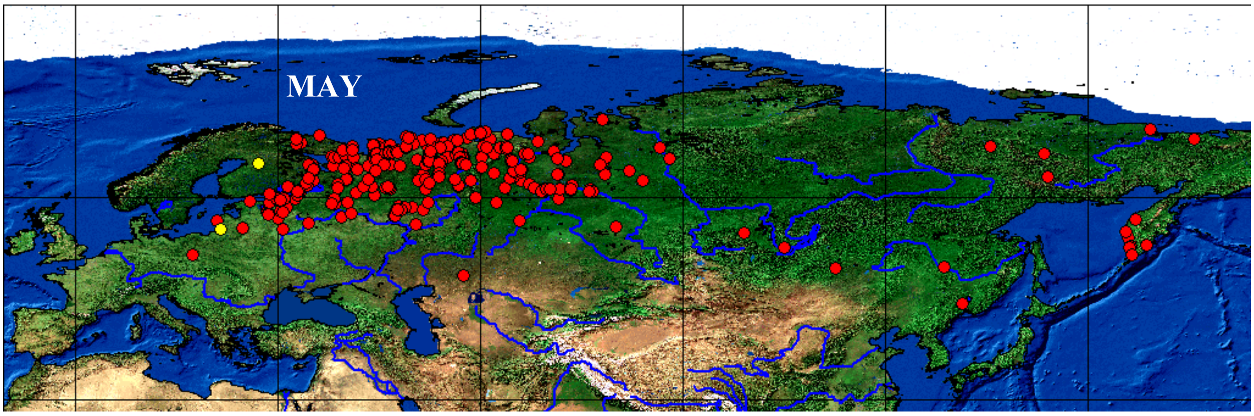
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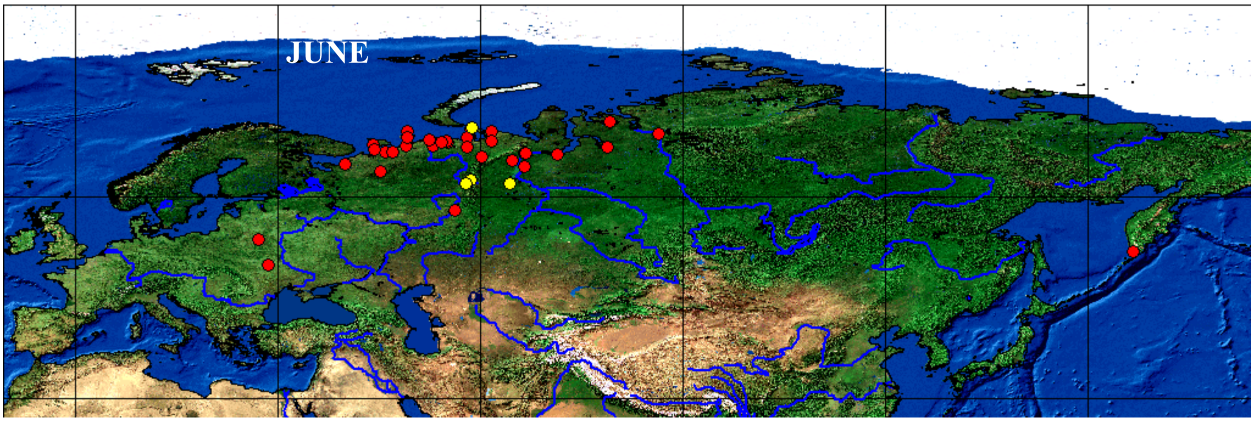
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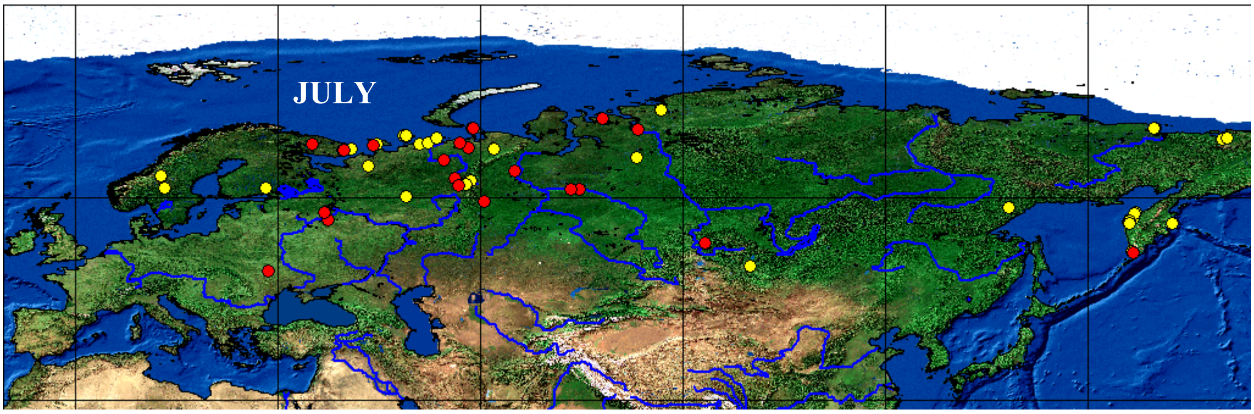
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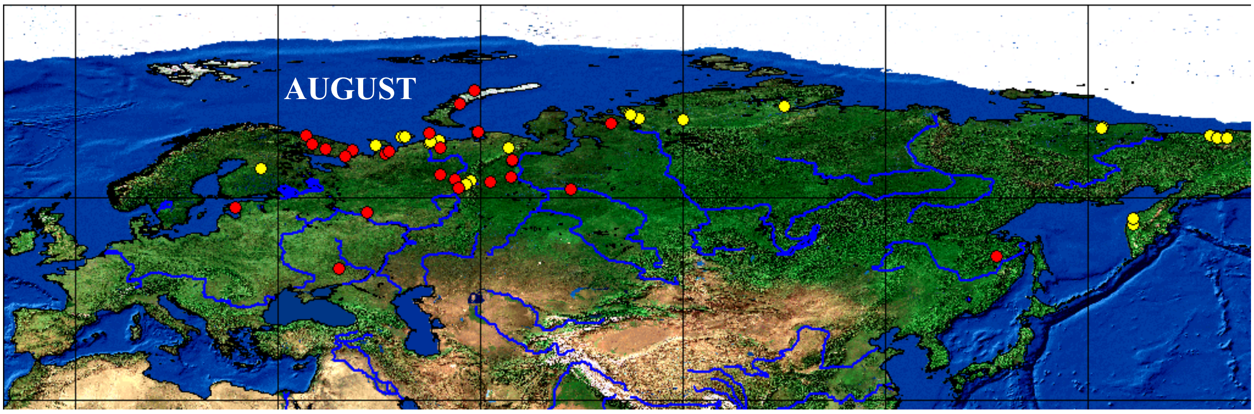
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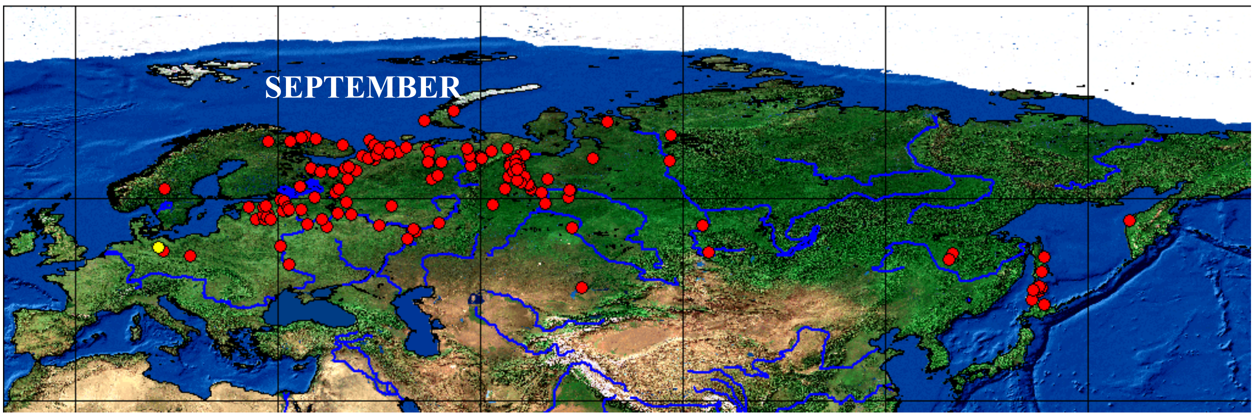
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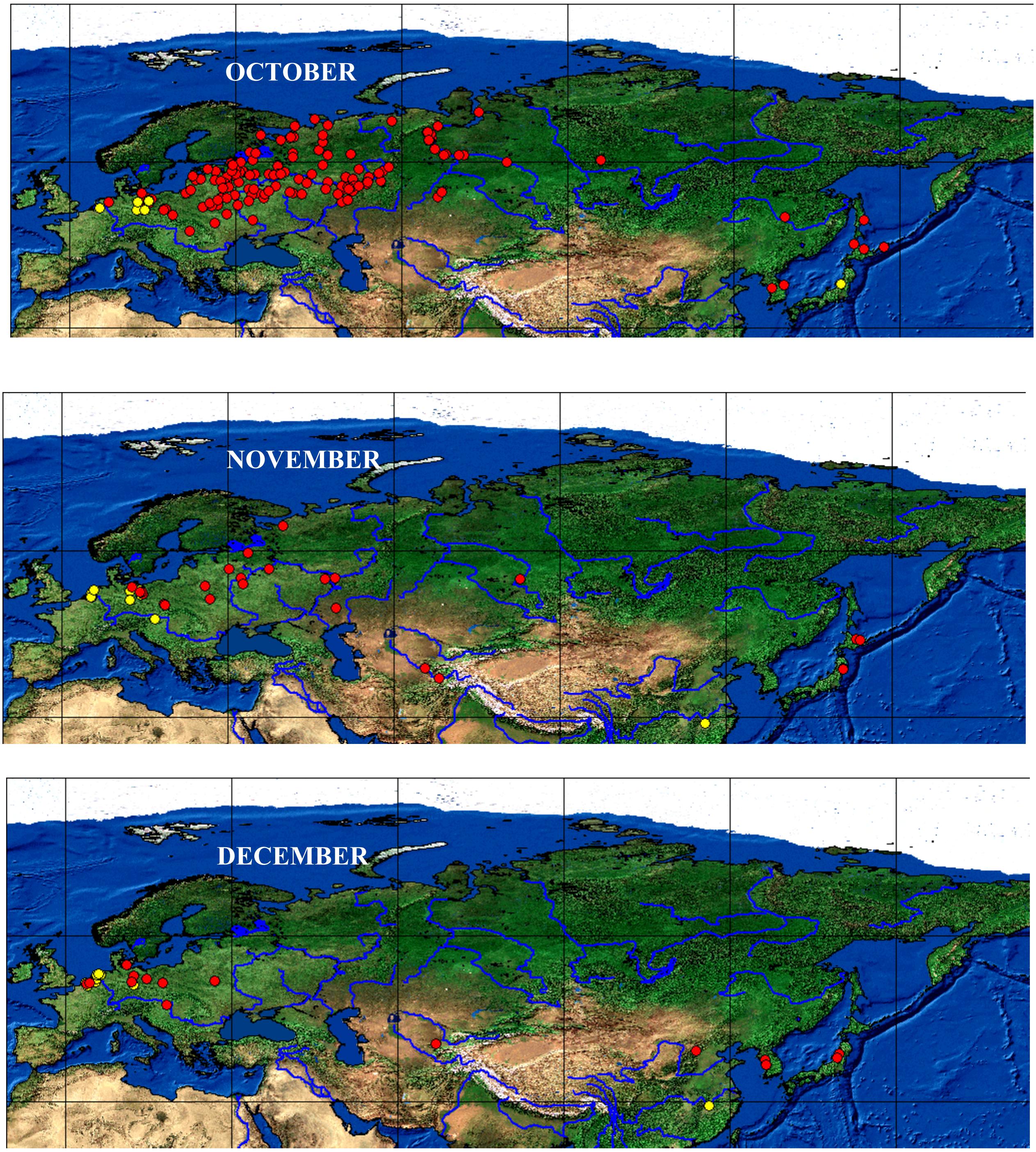


Figure 52. Bean Goose monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. Most of Bean Geese that are in the database migrate between European Russia and western Siberia – and Central and Western Europe. European Bean Geese Migrate along directions northeast-southwest, most frequent bearings are approximately 47-82˚E. Most birds, that breeds on Taimyr Peninsula, overlapping with European birds, winter in Central Asia, Mongolia and China. From breeding grounds they fly to south-south-east, along bearings 150˚ and 315˚. Far-Eastern geese migrate between Kamchatka, north-eastern Yakutia and Sakhalin to wintering areas in Japan and eastern China. Most frequent bearings are near 210˚ and 350˚ (Fig. 53).

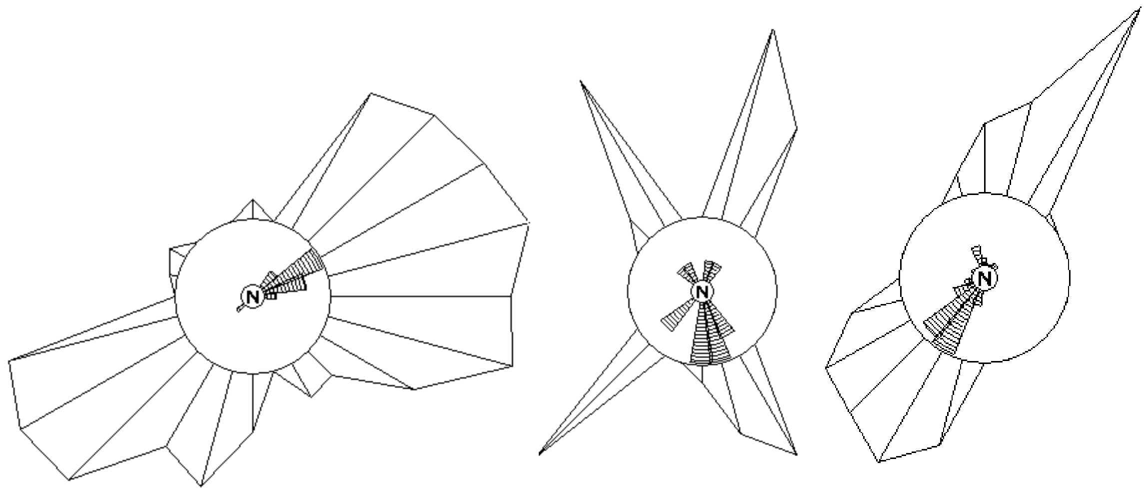


Figure 53. Recovery rose graphs for Bean Goose: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Left chart is for European wintering birds, area of recoveries from birds ringed from western up to central Siberia, up to 80˚E. Sector = 15,0°; total recoveries - 1206; number of recoveries in sectors: from 0 up to 489. Mean distance in sectors: from 0 km up to 2919.3 km. The longest flight distance of these birds is 5688.3 km.

Central chart represents Central Siberian birds (80˚E-120˚E). Sector = 15,0°; total recoveries - 14; number of recoveries in sectors: from 0 to 3. Mean distance in sectors: from 0.0 km up to 4444.9 km. The longest flight distance in the central Siberian birds is 4444.9 km.

Right chart represents Far-eastern birds, mostly *A.f.middendorffii*, geese ringed easter of 120˚E. Sector = 15,0°; total recoveries - 79; number of recoveries in sectors: from 0 to 24. Mean distance in sectors: from 0.0 km up to 4209.0 km. The longest flight distance in the Far-eastern birds is 4331.8 km.

Most of direct flight distances are 1500-4000 km (Fig. 54), maximal distance of the direct recoveries flight is 5669 km. For indirect recoveries most frequent distances are from 1300 to 4300 km (Fig. 55), the longest distance is 5380 km, which is about the same as in direct recoveries.

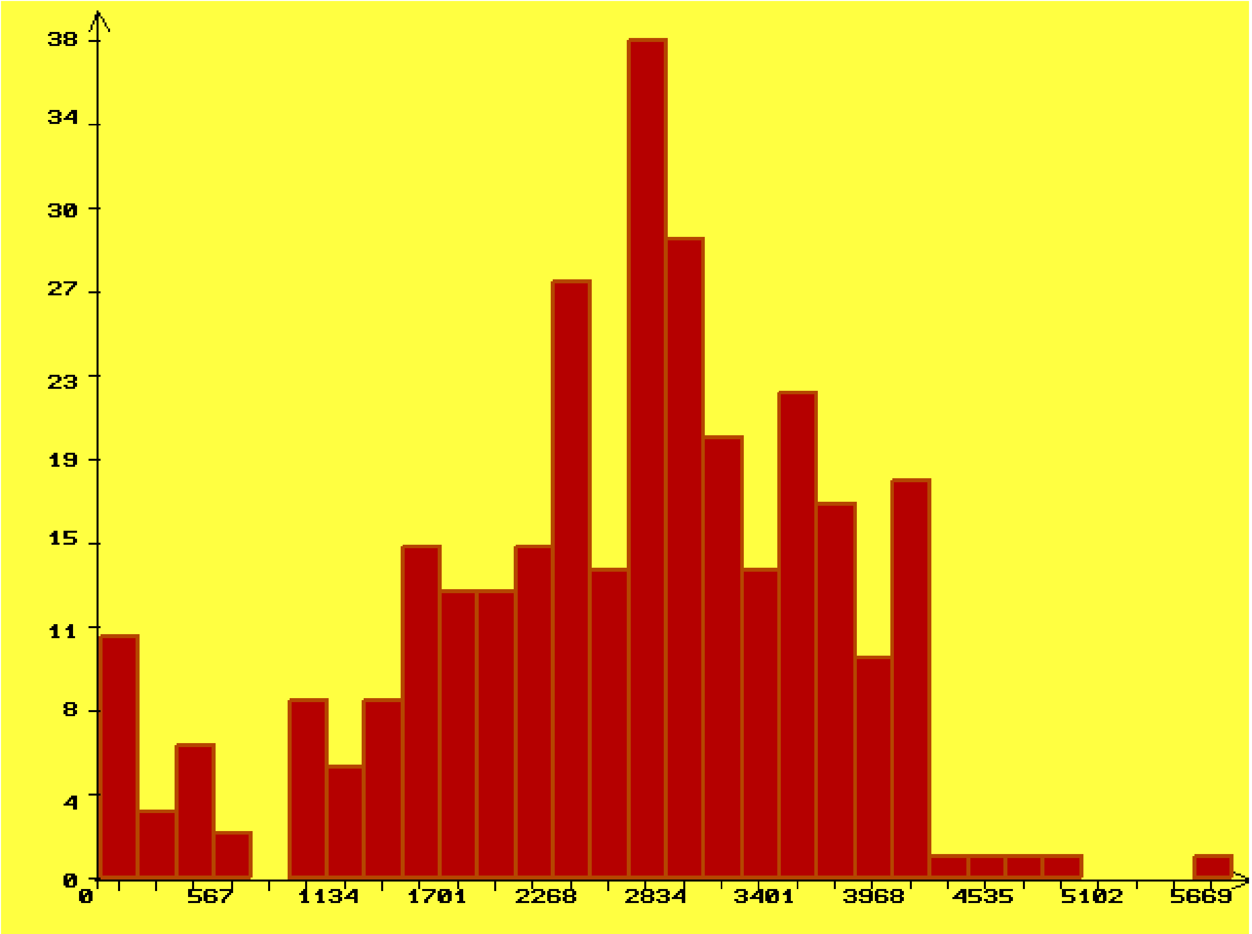


Figure 54. Distribution of direct recovery distances in Bean Geese. X axis is the flight distance; Y axis is the number of distances.

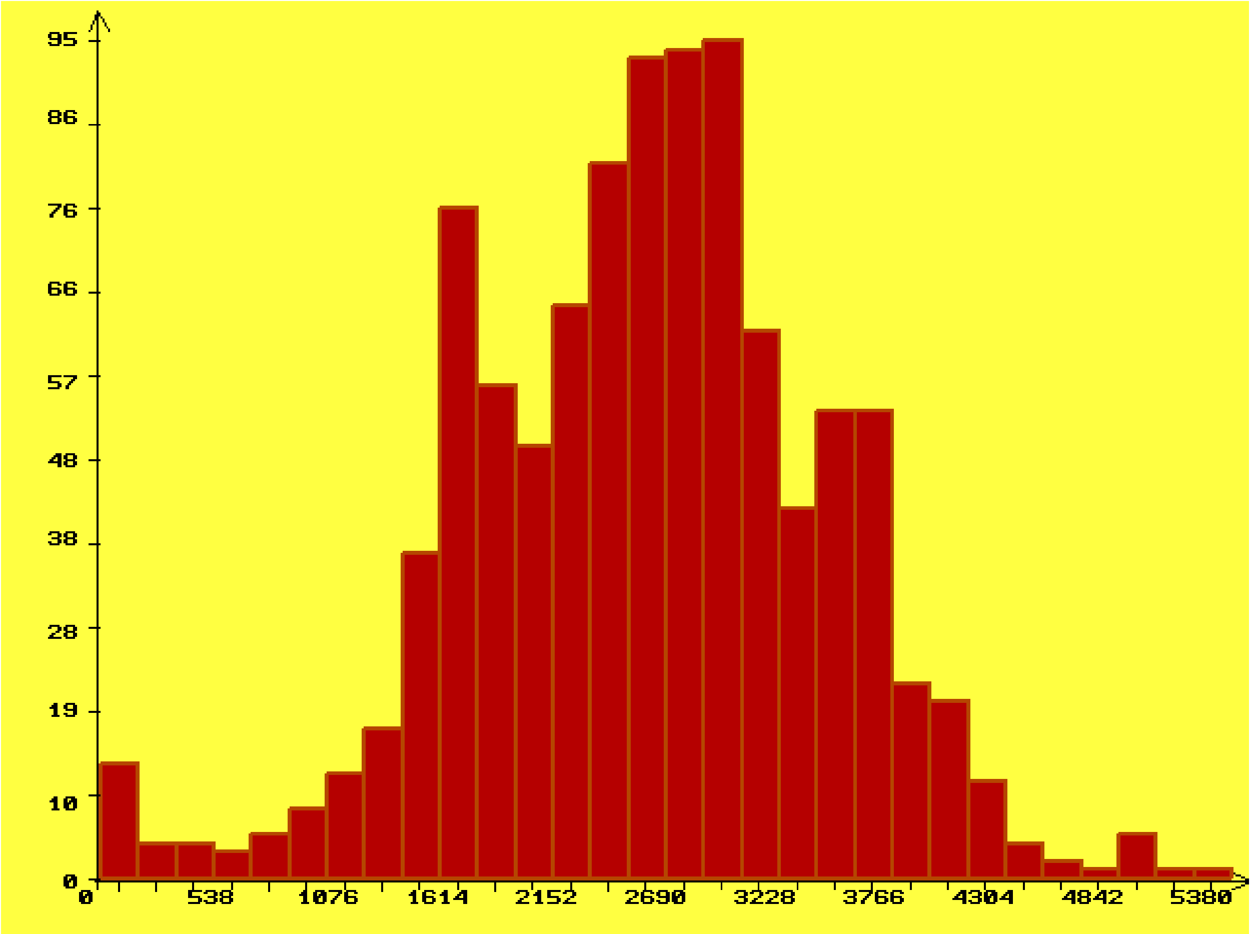


Figure 55. Distribution of indirect recovery distances in Bean Geese. X axis is the flight distance; Y axis is the number of distances.

Mean flight distance in Bean Goose young birds (ringed with the age as „pull“ or „juv“or „1 y“) is close to the same as in adults: 2557.3±60.4 and 2602.7±27.1 km respectively (N_{young} = 223, N_{ad} = 1079). Female mean flight distances appeared greater than in males: 2707.4±31.2 km and 2659.7±34.4 km respectively, $N_{females}$ = 616, N_{males} = 551, however insignificant.

Sample of European Beans is quite large; therefore it allows outlining of monthly mean locations for these birds. Here are two sets of recoveries (control points): „Arnhem“ and „Leiden“ schemes rings (947 recoveries, or 1894 control points) and „Hiddensee“ scheme rings (127 recoveries, or 254 control points). Monthly movements of geese ringed in The Netherlands and Germany appeared different (Fig. 56 and Fig. 57).

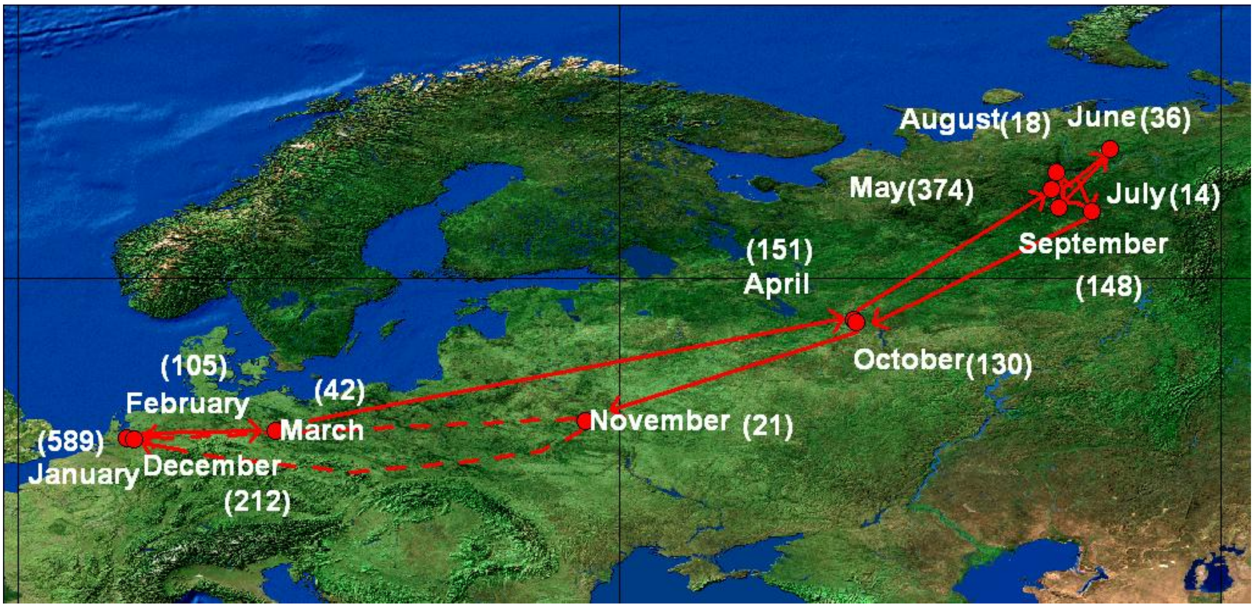


Figure 56. Mean monthly locations of control points of Bean Goose for birds, ringed on wintering places in The Netherlands. Red dots are mean monthly locations of geese. Arrows show directions of movements. Dashed arrows reflect broader autumn migratory route for these geese. Digits in brackets mean the number of control points for each month.

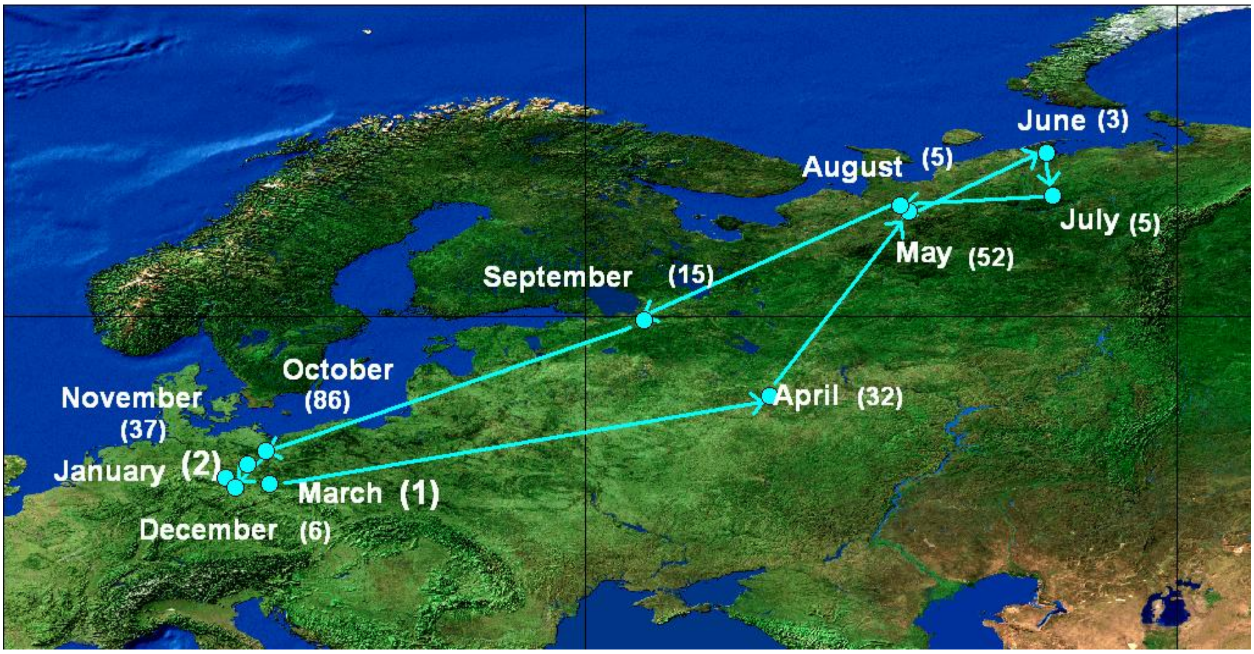


Figure 57. Mean monthly locations of control points of Bean Goose for birds, ringed on migration in Germany. Blue-green dots are mean monthly locations of geese. Arrows show directions of movements. Digits in brackets mean the number of control points for each month.

It is clear, that birds ringed in Germany, on average, appeared more to the north in breeding months and on autumn migration than birds ringed in The Netherlands. In autumn Germany ringed birds fly, on average, as well, along the White Sea-Baltic Sea migratory route, whereas Netherlands ringed birds generally fly more to the south and a month behind. These features need explanations.

The explanation could be the following. Bean Geese in Germany were ringed mostly in October and November, very few in December. Control points for January, February and March for Germany ringed birds are absent. In the Netherlands geese were ringed mostly in December through February. It means that on the way to wintering places geese fly through Germany to The Netherlands where they spend winter. Why routes look different?

The answer will be obtained if we plot „Arnhem", „Leiden" and „Hiddensee" recoveries on one map (Fig. 58).

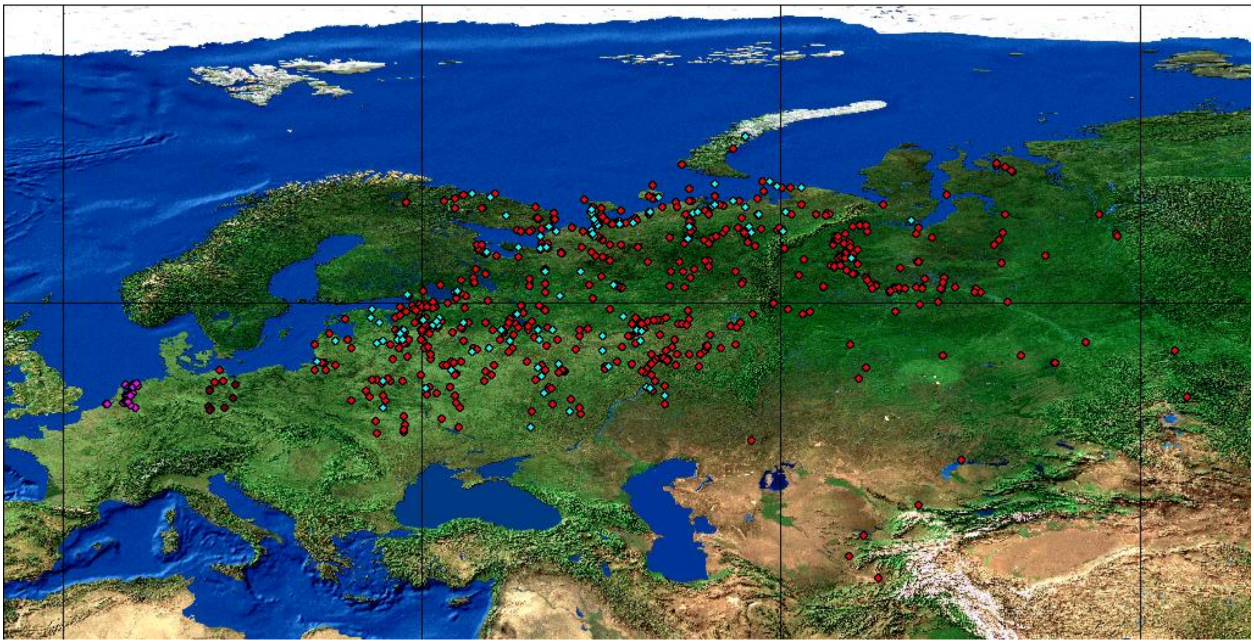


Figure 58. Control points of Bean Geese ringed in The Netherlands and in Germany. Purple dots – ringing sites of the „Arnhem" and „Leiden" schemes, brown dots – ringing sites in Germany, red dots – recovery sites of the Netherland birds, blue-green dots – „Hiddensee" recoveries.

In the Fig. 58 we can see, that geese ringed in The Netherlands then recovered in much broader area. Considerable part of those birds flies to breed over the Urals to Western Siberia and even to western parts of Central Siberia. Germany ringed birds recovered mostly in northern Europe, in Western Siberia one can see very few of those geese (Fig. 58). Thus, Germany and Netherlands ring birds partly from different cohorts. They certainly partly mix in Germany on autumn migration. Three autumn recoveries (2 of them in October) in our database from the former DDR of birds ringed in the Netherlands, could serve as some proof of it. Geese that move from Russia to wintering grounds in The Netherlands fly along broad stream. Many birds fly more to the south from the ringing sites in Germany. In this more southern part of streams there are both birds from European Russia (see „Moskwa" recoveries in Fig. 48) and from the Western Siberia. The latter generally migrate in autumn mostly in the southern part of migration stream (Lower dashed arrow in the Fig. 56).

In spring Bean Geese migration stream for Germany and Netherlands ringed birds at its start and in mid-way seems the same one: April locations for both bird cohorts are practically the same – geese fly via central parts of the European Russia (Fig. 56 and Fig. 57). As a result, Germany ringed birds form noticeable "loop migration": in spring birds fly to the breeding grounds making bend to central European Russia where they can stay and feed for some time. In autumn they migrate straight along the White Sea-Baltic Sea migratory route. Thus, these Bean Geese in their migration pattern are similar to European White-fronted Geese (see the species account on the White-fronted Goose). That part of The Netherlands ringed birds that migrate farther east to Western and Central Siberia does not form any loop, and migrate via European Russia along about the same migratory routes in spring and in autumn (Fig. 56).

Satellite tracking data. Interesting and unexpected data from tracking of satellite transmitter mounted birds were obtained from Taiga Bean Geese (*Anser fabalis fabalis)* marked in 2009 at the western coast of the Gulf of Bothnia (http://www.zoo.ekol.lu.se/waterfowl/BEANGOOSE/SATTELIT-GEESE.htm). It turned out that two of those geese spent their moulting time at Novaya Zemlya. One bird migrated directly from the northern Sweden to the northern coast of Norway and then moved to the North Island of the Novaya Zemlya, as far to the north as to the Borzova Bay (76° N), later on moved slightly south to the Nordenscheldt Bay, which is ca. 200 km more north than the known boundary of the Bean Goose breeding range. This PTT locations show that Bean Geese are able to cover >1100 km over the open sea and moult quite far away from their breeding range. It is important both that Bean Geese are capable to fly long distance over the sea and existence of the Bean Geese concentration relatively far to the north of the known breeding species range. The latter was suggested before that satellite tracking (Kalyakin, 1995). This article also contains information from literature about large Bean Geese concentration in 1910 in the Nordenscheldt Bay. Now we can assume that this concentration held moulting Taiga Bean Geese from Scandinavia.

Speed. Our database does not contain direct recoveries with the highest flight speed of Bean Goose. There are several recoveries with the maximal day-by-day movements near 56 km per day in our database.

Populations. Population structure of Bean Geese consists of at least three populations with their own migratory routes. In addition, one more population might be detected (Fig. 59). Our ringing data allow outlining the following populations: 1) european-west-central-siberian population (polygon No 1, Fig. 59) with generally west-east migration movements; 2) central-east-siberia-mongolia-east-chinese population (polygon No 2, Fig. 59) with general south-north migrations; 3) far-eastern-japanese-east-chinese population (polygon No 3, Fig. 59) with north-east – south-west movements. First two populations are partly overlapped in their northern areas. The second and the third populations overlapped at their southern edges. Possibly, there is one more not certain central-siberian-central-asian population (polygon No 4, Fig. 59). Migratory movements in it presumably should be north-south with some „slope" to the east. Unfortunately, we have no recoveries that detect such migratory routes in this area. However, many recoveries in this area of Bean Geese from Europe are visible on the map. Some of them (the northernmost ones) appeared early in the spring and indicated that part of Bean Geese fly straight crossing the Ural mountains directly to Gydan and western part of Taimyr peninsula. More southern recoveries (southern part of western Siberia) can indicate that part of migrating Bean Geese bend the Ural mountains around the south end (as White-fronted Geese and many duck species do). However, the way to southernmost recoveries in southern Kazakhstan through Tajikistan is far south of Ural Mountains; therefore this way hardly represents just a bend. Probably, these most southern recoveries, as well as some of more northern recoveries reflect cross-population movements between European and this uncertain central-siberian-central-asian population.

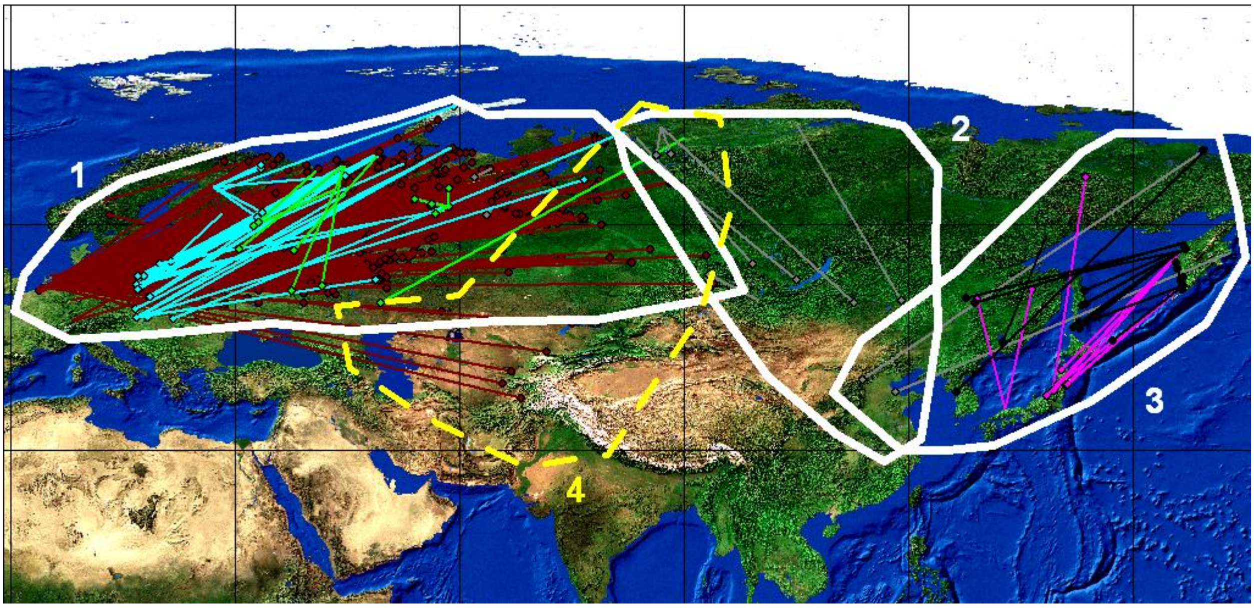


Figure 59. Bean Goose populations. White polygon № 1 outlines european-west-central-siberian population. White polygon № 2 is central-east-siberian-mongolia-east-chinese population. Polygon № 3 outlines far-eastern-japanese-east-chinese population. Yellow polygon № 4 outlines possible central-siberian-central-asian Bean Goose population.

Ten-year distances. For all Bean Goose recoveries mean decadal distance first increased by 1970s then decreased (Table 5). For geese ringed in the wintering areas in The Netherlands this regularity was even more prominent with one more remarkable feature – in 2011-2023 mean distance started to increase again. Since the Netherlands ringed birds comprise a great bulk of the Bean Geese sample, it is clear that the very Netherlands geese create such pattern in the mean distance fluctuations.

Table 5. Bean Geese mean flight distance per decade.

Decade (years)	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2023
Distance (km)	1598.9	2300.5	2646	2935.8	2568.2	2413.9	2457.4	2437.3
Number of recoveries	6	31	206	252	357	155	122	172

For this reason it is worth to dwell upon Netherlands ringed birds. Our database does not contain Netherlands bird recoveries for 1940s, therefore the consideration starts from 1950s. In the picture in Fig. 60 one can see that after 1950s distances became longer and some more southern recoveries appeared. In 1970s the distances became longer and the tendency to fly to the southern areas was the most prominent. In 1980s this tendency still existed, but likely in lesser extend than in the previous decade. Through 1991-2023 area covered by recoveries shrank and shifted more to the north (like in 1950s), fly distances shortened (Fig. 60).

Thus, the recovery area was the greatest in 1970s, when Bean Geese were more spread over their breeding range that in other decades. It is not clear whether this pattern is connected with global warming, probably yes: bean geese started to increase distances in 1970s. However, the other clear pattern affected this process: changes in the geese species conditions. 1970s were a kind of “golden era” for geese. In that decade their numbers in Europe and Japan increased by approximately 15% annually (Fox et al., 2010). This high population growth produced more birds which start to fly over greater area. Then, the conditions for Bean Geese likely deteriorated (see "Mortality"), less birds were recovered at long distances. Increasing distances after 2010 might detect either additional global warming effect or the new improvement of the population status. In 2011-2023 (56 recoveries), this increasing might be real, because ten-year mean distance dynamic pattern in Bean Geese is about the same as in White-fronted Geese, where data are more abundant.

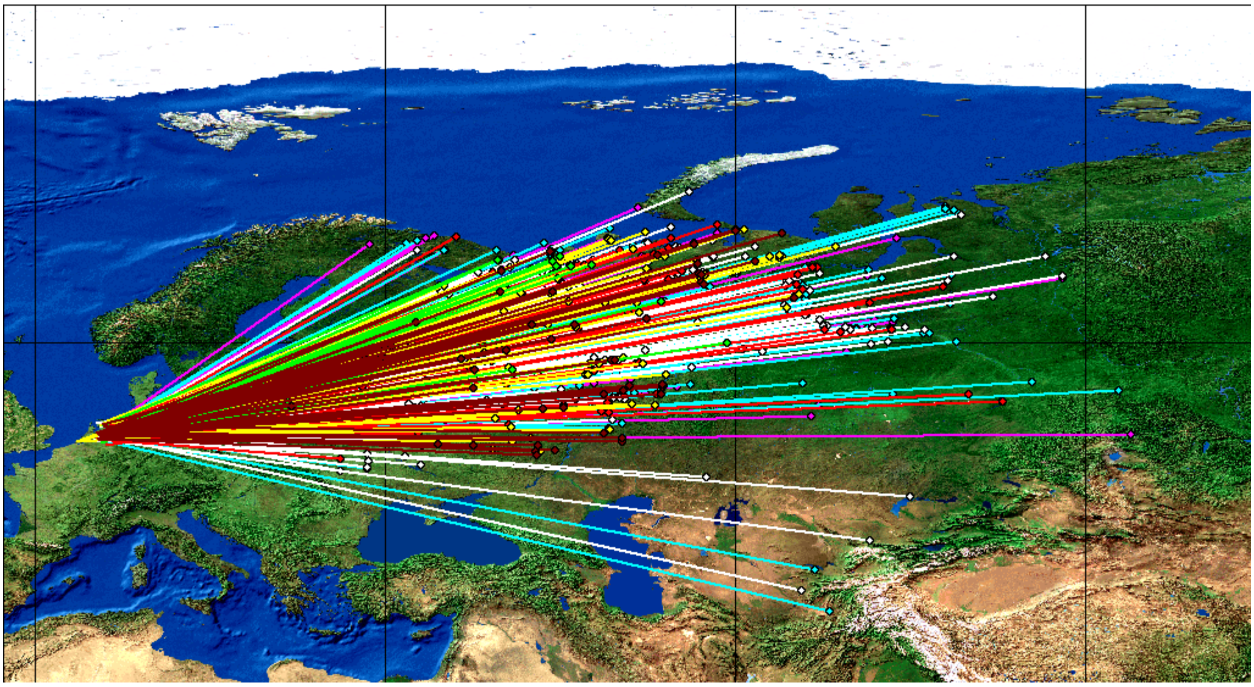


Figure 60. Map of the recoveries of Bean Geese ringed in the Netherlands. Lines start at ringing sites and end at recovery points. A dot at the end of each line represents the recovery point. Colour of lines and dots: green – recoveries in 1951-1960, purple – 1961-1970, blue-green – 1971-1980, white – 1981-1990, red – 1991-2000, yellow – 2001-2010, brown – 2011-2023.

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) of 26 November 2010, the oldest Bean Goose lived more than 25 years 7 months. Our database, however, contains recovery for the bird ringed with Arnhem ring 8.500.820 as 2 year old male on 04.02.1964 in The Netherlands and shot on 04.05.2002 in the Nenets AA, after 38 years 3 months after ringing. Ring has not been sent, but the recovery has been obtained from known hunter and looks reliable. Thus, the bird lived about 40 years; this is the maximal known age for Bean Geese. The bird with the longest lifespan where ring was send, male, recovered as „shot", lived more than 28 years 3 months.

Mortality rate. 1107 dead recoveries can be used in the mortality rate analysis. However, for consistency we exclude two outstanding recoveries with the lifespan more than 28 years, so 1105 recoveries left. Mean annual mortality rate in Bean Goose is 27.28±0.70 %. Real mortality pattern differs from the theoretical one significantly (χ^2 = 610, df = 19, P=0.0000). Programme MARK, Model CLogLog 2ndPart shows 28.54%, difference is 1.26%. Real survivals lay above the theoretical line (Fig. 61) and bar graph going down quite steadily with more or less equal mortality per ages. That means that the Bean Goose, especially from European population (because most of birds in the analysis are the European ones) is in more or less good condition. Likely, this is not so for two Asian populations, but data on those populations are very scarce.

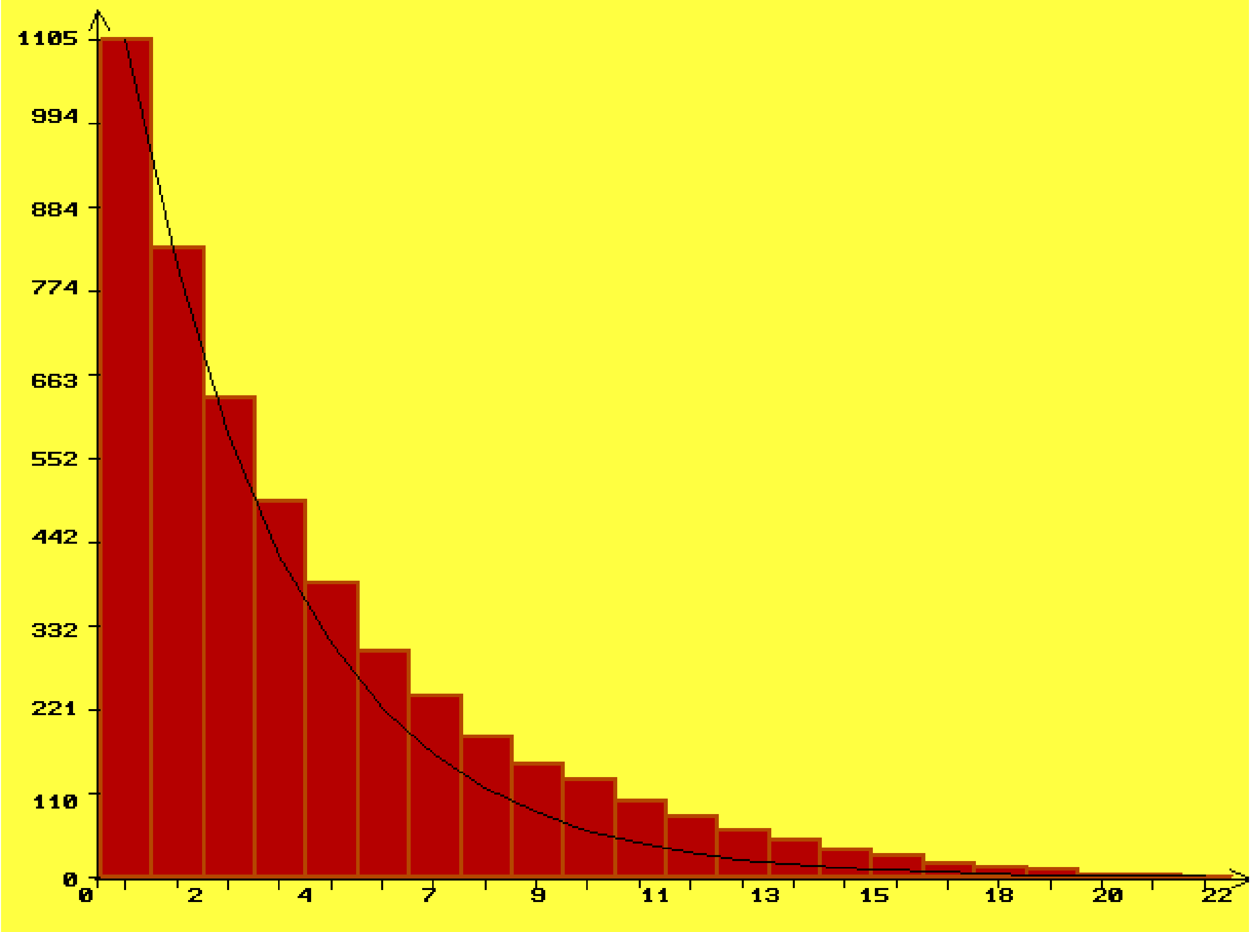
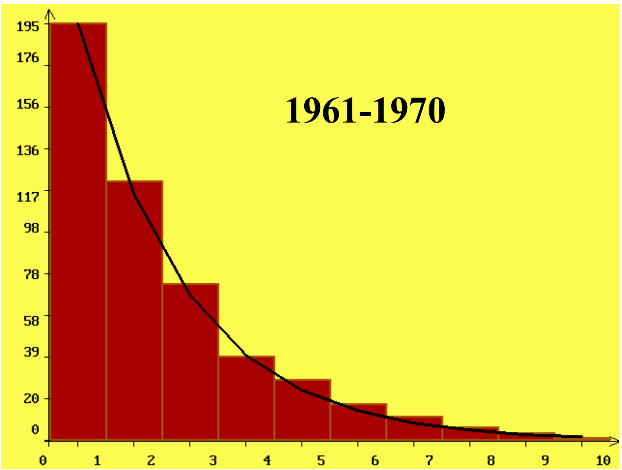
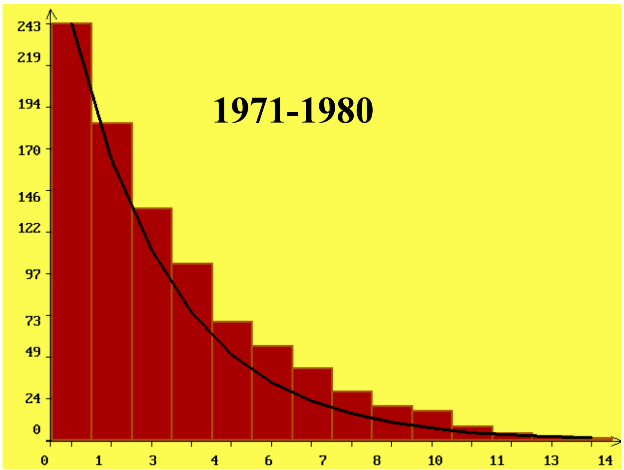


Figure 61. Mortality pattern in Bean Goose. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Nevertheless, our analysis performed in the section „Ten-year distance" provided some indication that prosperity of European Bean Geese deteriorated during the last two decades. In this manner, using our method of evaluation of the population prosperity we can draw the mortality pattern chart for birds recovered in each decade. For the purpose of increasing sample sizes we include all birds in the analysis, not only the Netherlands ones. Decades 1941-1960 are not considered since they contain very few recoveries.





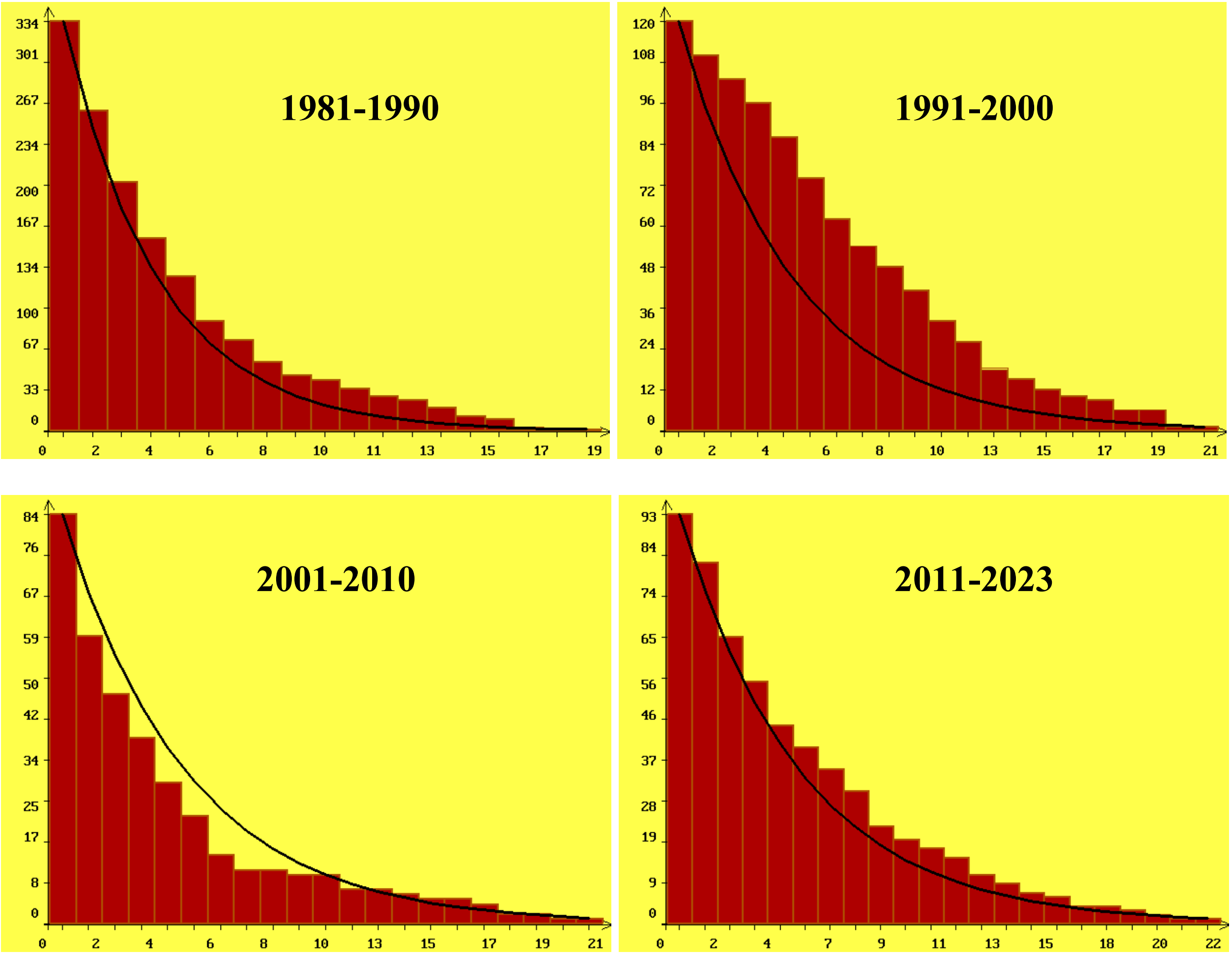


Figure 62. Mortality pattern in Bean Geese recovered in different decades. X axis is the number of years after marking. Y axis is the number of live birds.

Result of mortality pattern comparison not totally coincides with ten-year period distance comparison, although shows similar tendencies. For 1960s sample is not large, but mortality pattern indicates “normal” population (species) condition: real data are practically conform with the theoretical line. In 1970s the species prosperity grew: real mortality chart lays above the theoretical line. In 1980s the situation is close to that in 1970s. However, 1990s showed very good situation for Bean Geese; in 2000s situation deteriorated, and real mortality pattern became worse than theoretical one. After 2010 the overall Bean Goose population status improves again (Fig. 62).

On average, males and females ringed as adults, live about the same number of years: 3.98±0.18 (N=497) and 3.81±0.17 (N=495) years respectively. Male mortality for birds with the elapsed years not more than 21 is 25.60±0.99%, female mortality for the same elapsed time is greater – 26.68±1.03%. Mortality pattern indicates that both sexes are in good condition (Fig. 63).

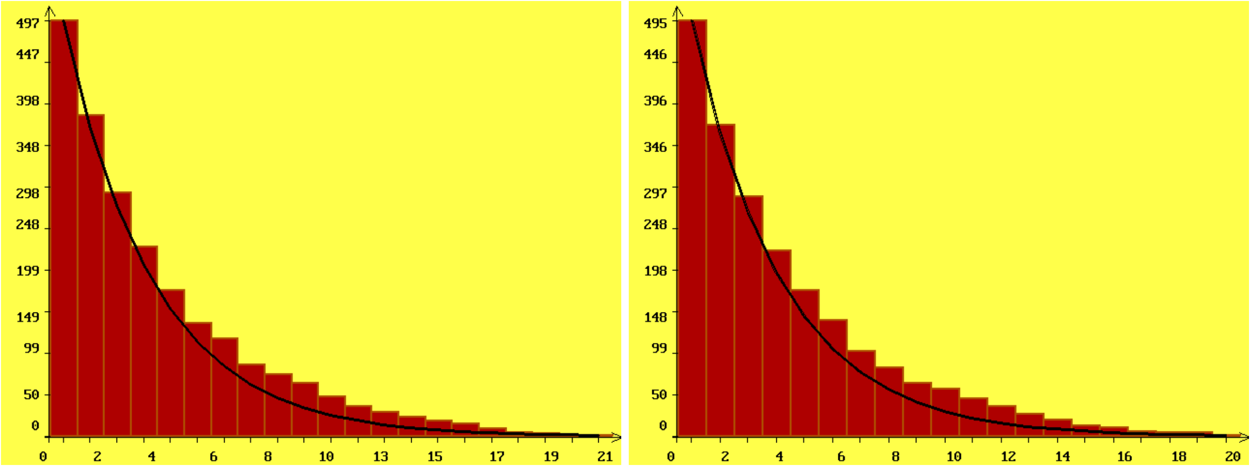


Figure 63. Mortality pattern in Bean Goose: males (left) and females (right). X axis is the number of years after marking. Y axis is the number of live birds.

PINK-FOOTED GOOSE
(*ANSER BRACHYRHYNCHUS*).

Photo by Sergey P. Kharitonov

Pink-footed Goose habituates Svalbard, Iceland, eastern Greenland and Franz-Josef Land. Bird Ringing Centre of Russia has two recoveries from vagrant birds (Fig. 64). One bird, adult male, was ringed on wintering grounds in the Netherlands on 25.01.1982 and ten years later was shot in Kirov Region, European Russia. The second adult male was ringed on Svalbard on 15 July 1954 and two years later, on 07.10.1956 was shot in the Tverskaya Region.

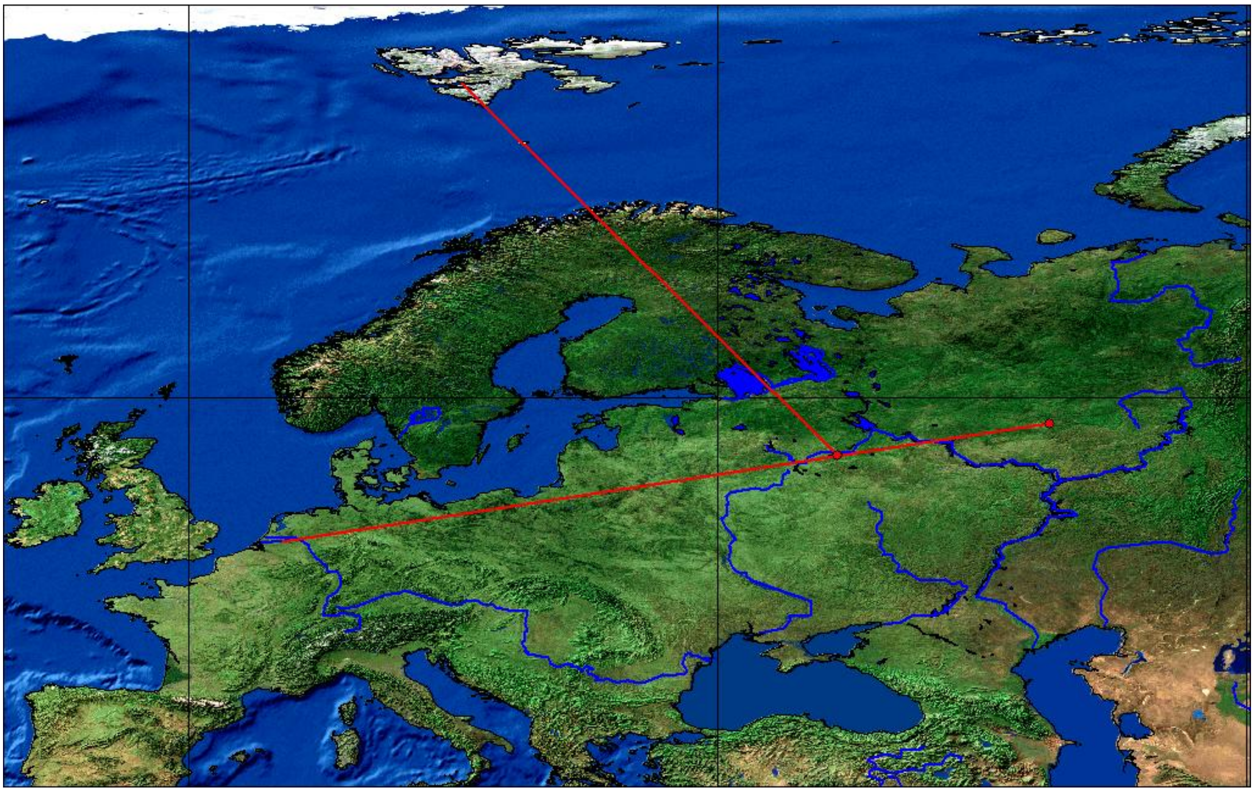


Figure 64. Flight directions of two Pink-footed Geese in Russia. Beginning of lines indicate ringing site, red dots at the end indicate recovery points.

The first recovery might indicate on the very interesting regularity. The point is that, satellite transmitter study on pink-footed geese ran to conclusion that during about the last 10 years these geese started to fly for the summer on Novaya Zembla (Madsen et al., 2023). However, the recovery of the bird ringed in the Netherlands in winter of 1982 happened on 03.05.1992, i.e., on the spring migration. It is quite possible that the goose (probably in a flock) moved to Novaya Zembla (see map on the Fig. 64). It possibly means, that the Pink-footed Geese migration to Novaya Zembla formed much earlier that the last 10 ten years.

SNOW GOOSE
(*ANSER CAERULESCENS*).

Photo by Sergey P. Kharitonov

Almost the whole modern breeding range of the Snow Goose in Eurasia locates on the Wrangel Island, Russia. Separate pairs breed irregularly on the main coast of northern Chukotka. This goose spends winter in North America. In the European Russia this goose lives in captivity in a number of Zoos: Moscow Zoo, Askania-Nova Zoo, Ukraine, etc. Bird Ringing Centre of Russia has 14 recoveries of birds escaped from Askania-Nova (ringed by Moskwa scheme) and one recovery from Germany, Nordrhein-Westfalen, Neuss (Hiddensee scheme). From Askania-Nova Snow Geese flew in all directions (Fig. 65), but most flights are directed to north-west. According to migration pattern, Snow Geese "consider" this Zoo in the southern Ukraine as a place which is equivalent to their natural wintering place. In North America they fly to breeding grounds in the north and north-west direction. Askanian geese did the same after escapes (Fig. 65). The goose from Germany flew approximately in one of Bean Goose flight directions, probably together with the latter. This Snow Goose appeared on the Murmansk coast, Russia.

From time to time Snow Geese are observed wandering in the central parts of the European Russia (Kostin, Egorova, 1998).

The maximal lifespan of the considered Askanian birds exceeds 20 years.

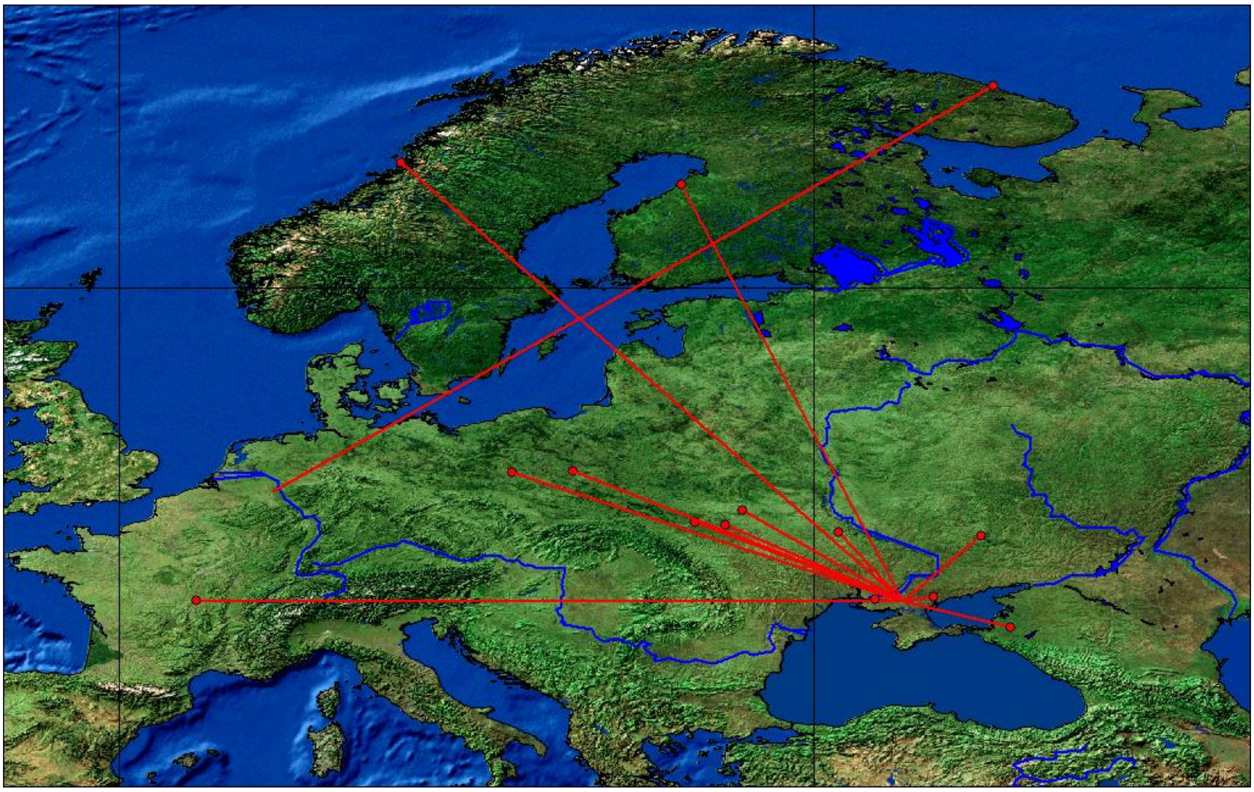


Figure 65. Flight directions of Snow Geese escaped from Askania-Nova Zoo and from captivity in Germany. Beginning of lines indicate ringing sites, red dots at the end indicate recovery points.

WHITE-FRONTED GOOSE
(*ANSER ALBIFRONS*)

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 66. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

Photo by Sergey P. Kharitonov

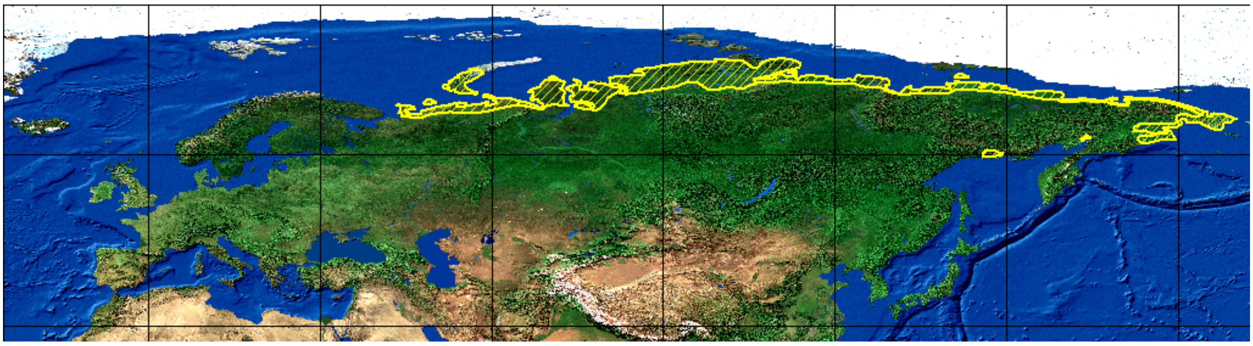


Figure 66. Breeding range of the White-fronted Goose in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 3811 marked birds were used, which gave 3906 recoveries (Fig. 67). 2196 birds were marked with rings only, two of them then also marked with neck-collars, 1055 geese held neck-collars from the very beginning (great bulk of birds) or different kind of colour rings, sometimes additionally to neckcollars. Eleven birds wore satellite transmitters, however in the main description we used only ringing and the last recovery information on these geese. According to the number of recoveries from colour marks, we would like to stress, that not all sight records registered in Europe are in our BRC database. Considerable amount of these records are in the databases of other ringing centers.

Ringing dates are since 21.07.1941 till 24.11.2021, recovery dates are since 08.06.1942 till 28.04.2023. Only 2 White-fronted Geese with metal rings had 2 recoveries per ring, the rest had only one recovery per ring, birds with neck-collars or/and colour rings had from 1 to 11 recoveries per bird. 1055 birds with neck-collar were recorded 1132 times, 1.073 encounters per bird.

To understand how birds with neck-collars feel, we compare samples of ring-recovery distances of only ringed and neck-collared (some with colour rings) birds sequentially in four countries where neck-collars were used. For geese ringed in German („Hiddensee“, „Helgoland“ and „Radolfzell“ schemes) mean distance for birds with neck-collar was greater, than with rings only: 2255.9±88.9 and 2479.7±172.1 km respectively (35 and 22 geese respectively were involved in this comparison), although insignificant. For „Moskwa“ marked birds the relation is vise versa: birds with rings only flew slightly longer distance from the ringing site: 2758.5±66.9 and 2570.6±125.4 km, however insignificant ($N_{collars}$ = 376, N_{rings} = 99 birds). For „London“ marked geese the regulation is the same: 3092.6±72.3 for geese with rings only (N_{rings} = 51), 2978.6±103.0 km for colour marked geese ($N_{collars}$ = 20), insignificant. However, the sample from wintering places in Great Britain is not large. Much greater sample from Netherlands confirms the regularity obtained from birds of the „London“ scheme. For more consistent analysis young birds and sight records were excluded from the sample of White-fronted Geese ringed in the Netherlands, since it was large enough. Geese marked with collars in the

Netherlands covered, on average, by about 50 km shorter distance than birds with ring only: 2426.7±25.4 ($N_{collars}$ = 425) and 2478.8±12.5 (N_{rings} = 1987). In spite of relatively little difference, nearly significant (t-Bailey=1.84, P=0.066).

Thus, White-fronted Geese marked on breeding and moulting grounds with collars flew on average longer distances than birds with rings only. This is understandable, because most marked geese from Russia go to winter to Europe where many bird-watchers live, and they read color codes more successfully than ring numbers. For birds ringed on wintering places, then going to Russia the situation is opposite. In Russia spring hunting in many areas is opened, therefore the most finding details for birds with rings only and for collars are shot, the proportion of „shot"recoveries is the same as in Bean Goose. There is an opinion that hunters, even without special purpose, automatically shoot collared birds slightly more often because they are more distinctive in flocks – that is what we see. The question is – why for Bean Geese marked in the Netherlands the situation is different, although the latter have the same proportion of shots (see Bean Goose species account). The reason is probably the following. Spring hunting terms in Russia are more adjusted to the migration terms of White-fronted Geese; Bean Geese, in general, fly earlier, when hunting season is not yet opened. In addition, Bean Geese move faster and stay shorter time at stopovers, hence the hunters have less time to hunt Bean Geese and pay less attention to them than to White-fronted Geese. The other reason could be that Bean Goose is more strong bird and thus more capable to wear a neck collar. Anyway, these data mean, that in the White-fronted Goose neck-collars do not impact much harm, and this method can be successfully used for this species.

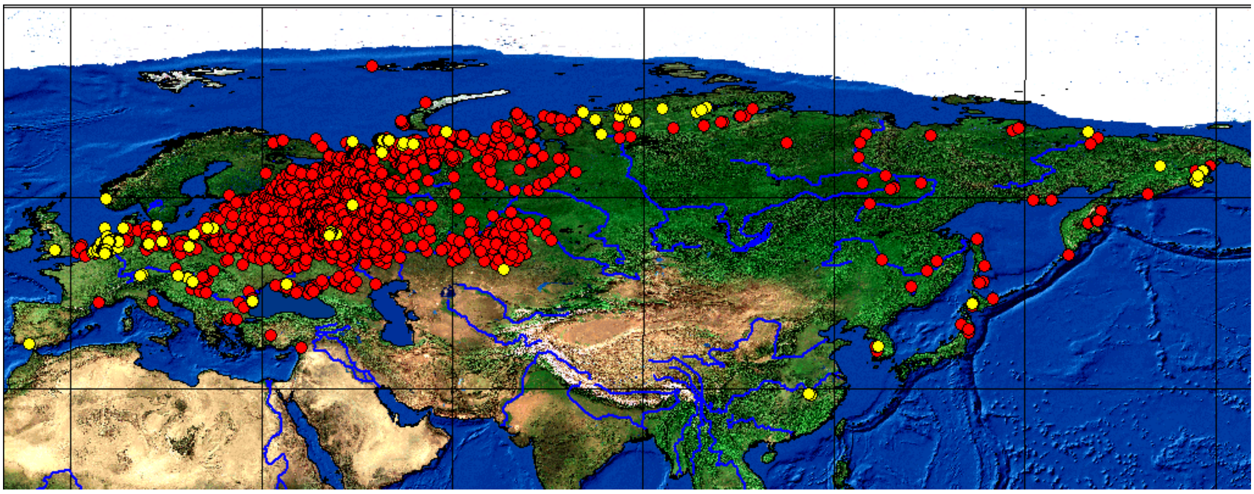


Figure 67. Position of all White-fronted Goose control points. Yellow dots are ringing sites, red dots are recovery sites.

Most of recoveries are related to the European part of the species range. Also we have data on birds wintering in Japan, South Korea and Eastern China.

'Moskwa' scheme recoveries. This sample contains 527 recoveries of the scheme „Moskwa". They are from birds ringed within the Russian Federation, in many regions: Arkhangelsk Region, Nenets Autonomic area, Ryazan and Kostroma Regions (Central European Russia), Taimyr Autonomic Area, Magadan Region and Chukotka (Fig. 68).

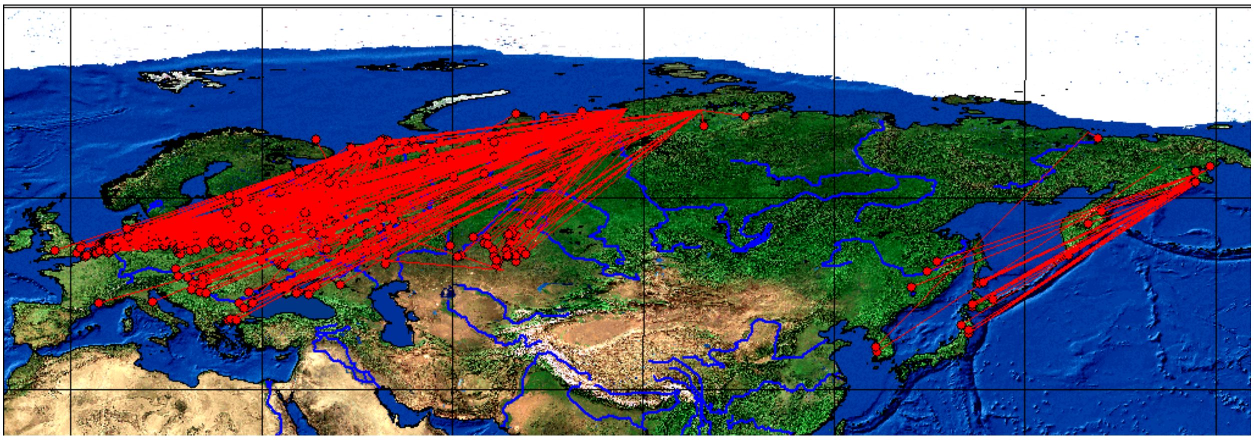


Figure 68. „Moskwa" scheme recoveries of the White-fronted Goose. Here and on all other similar figures lines start from ringing sites, recovery sites are marked with red dots.

Finding details. This analysis includes all 3906 recoveries. Almost 5/6 of recoveries (82%) are „shot". Sight records, although comprise twice greater portion than in Bean Goose, nevertheless, are not numerous – just 10%. Other reasons are not so common (Fig. 69).

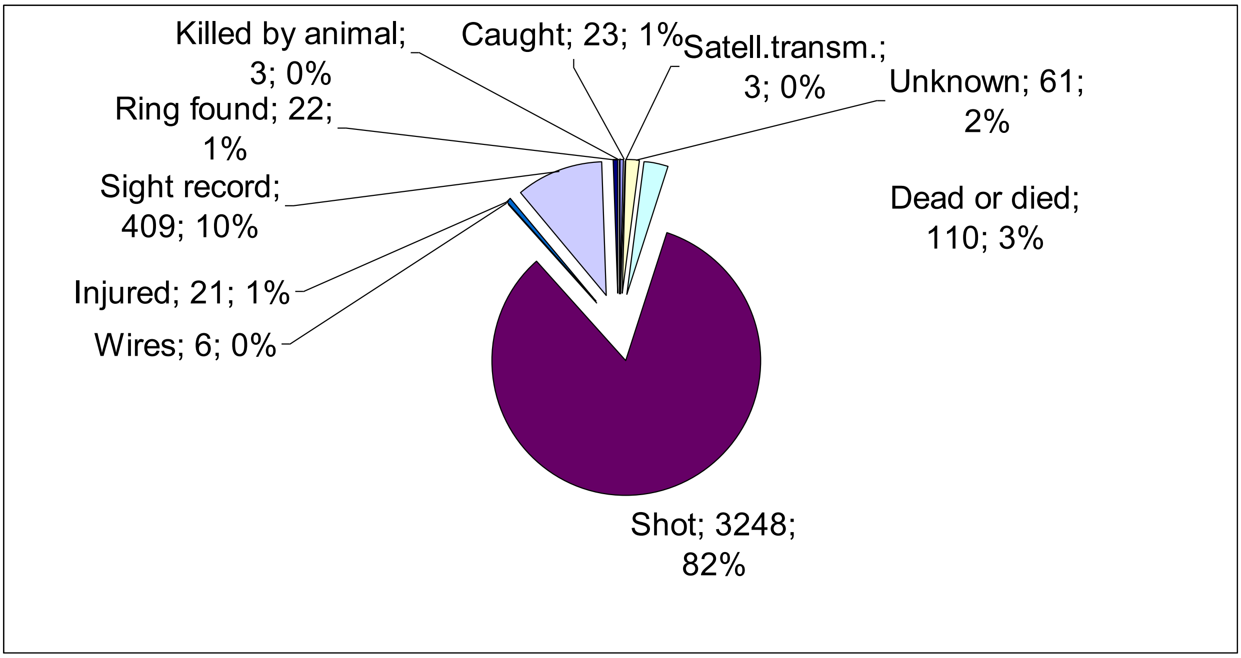


Figure 69. Finding details in the White-fronted Goose.

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries does not differ much from each other (Figs 70, 71).

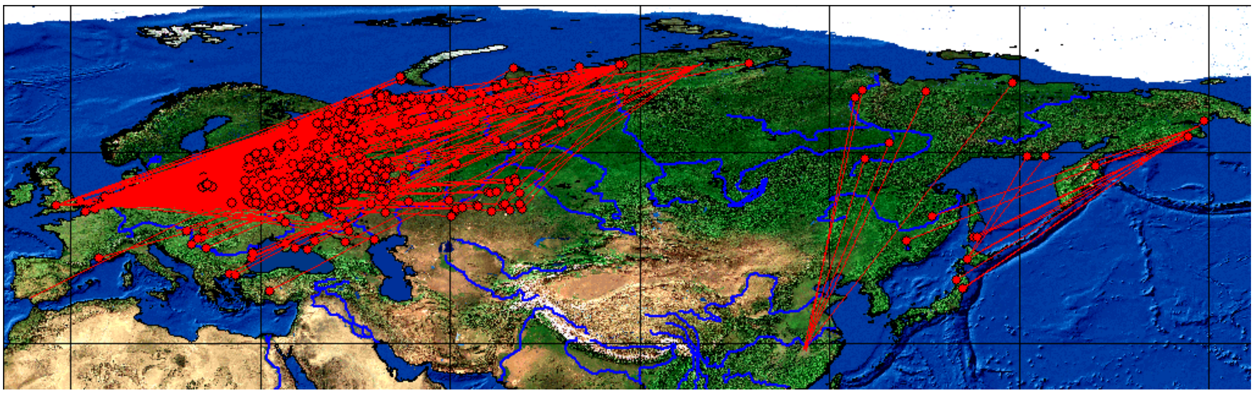


Figure 70. Map of the White-fronted Goose direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

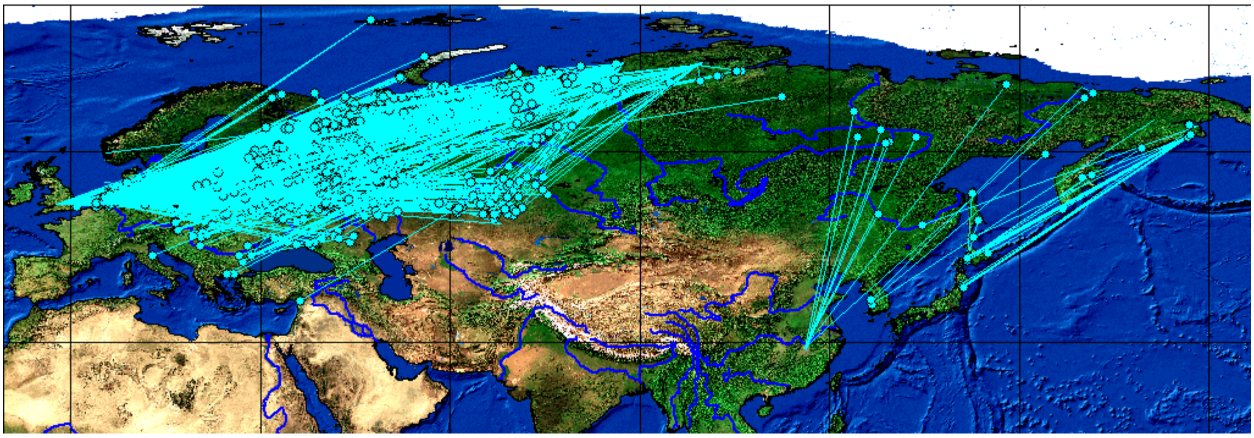
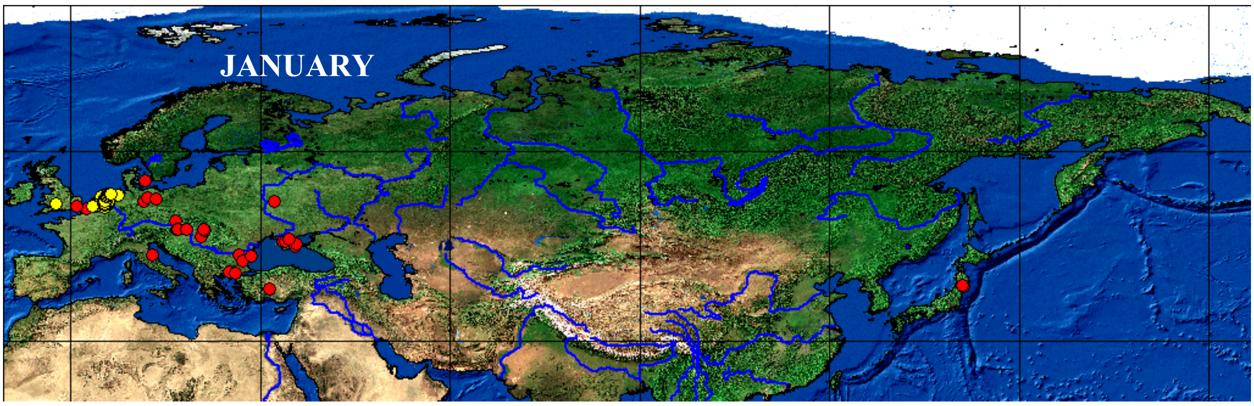


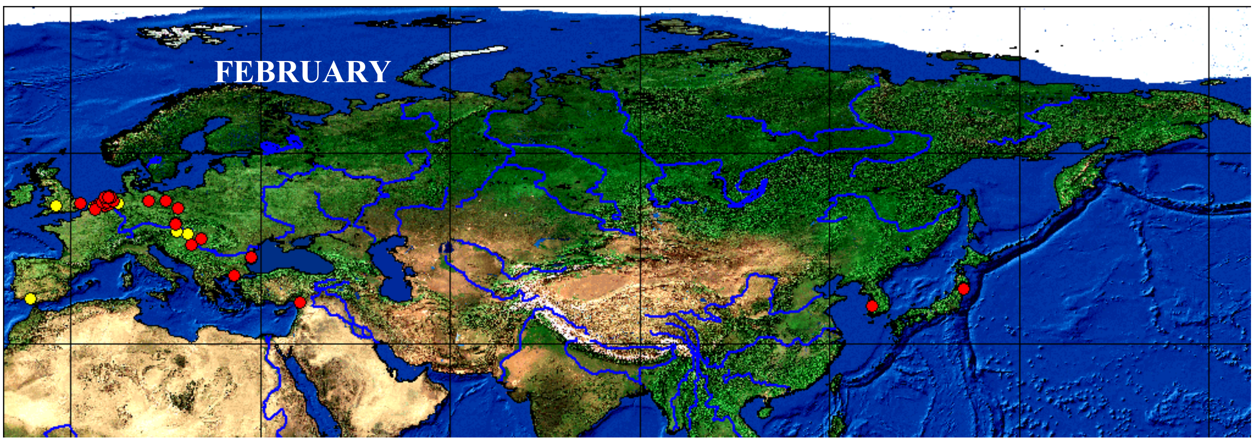
Figure 71. Map of the White-fronted Goose indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

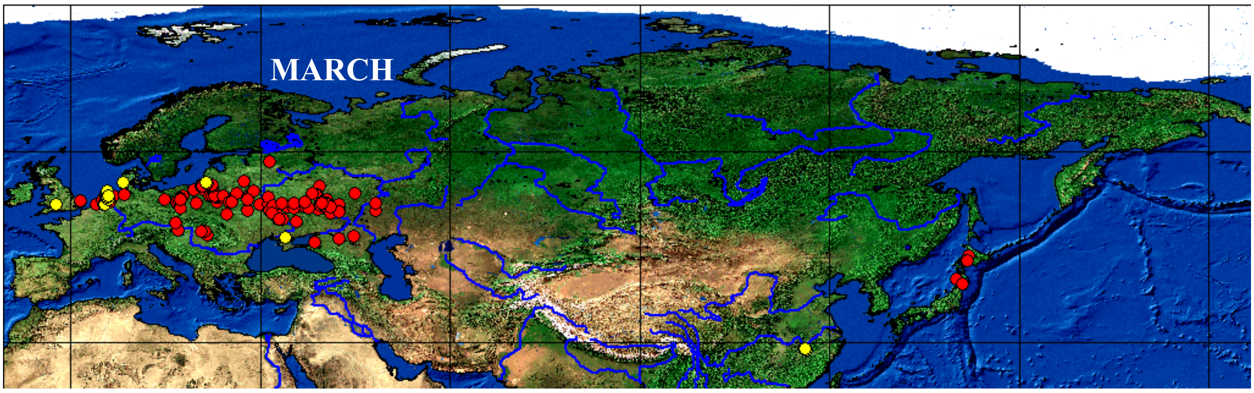
Maps clearly indicate that White-fronted Geese wintering in Europe fly to breed to the north of European Russia, north of western and central Siberia, approximately up to meridian 110˚E (Figs 70, 71). Data for eastern parts of Russia are scarce, however they allow stating, that White-fronted Geese from areas east of 110˚E longitude migrate to winter to eastern China, South Korea and Japan.

Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them (χ^2 = 7.2, df = 2, 929 direct recoveries and 2977 indirect ones, df = 2, P = 0.03). However, really, the centers of areas, occupied by indirect recoveries differ from the area of direct ones only by 7'' in latitude and 52'' in longitude, so the significance is mostly just because of very largr samples. Very small difference between direct and indirect recoveries points, that White-fronted Geese have the strong tendency to fly in the same areas year-by-year. Average flight distances in direct and indirect recoveries are very similar: 2501.0±24.9 and 2508.2±13.2 km respectively. Such closeness of flight distances within a year and during a number of years is the additional confirmation of the quite strong area fidelity in White-fronted Geese.

Monthly movements. All direct and indirect recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in the White-fronted Goose (Fig. 72). Movements to breeding grounds in European wintering White-fronted Geese start in March (compare February and March, Fig. 72). In March, however, migration does not show much progress: first flying geese are not farther than in western half of the European Russia. Far Eastern geese in March are still on wintering grounds. In April some European White-fronted Geese are already on the breeding grounds in European Russia and western Siberia (Yamal Peninsula), but the great bulk of geese are in the Central European Russia, where they stay usually for a month or more at the spring stopovers. Far Eastern birds in April start their migration and still are not far from their wintering places. In May part of birds of all populations are on breeding grounds, although in western and central Siberia breeding season for this species starts not earlier than in early June. The other part of White-fronted Geese are still at spring stopovers far away from their breeding grounds. Comparing of monthly control point distributions in April and May (Fig. 72) we can image the migratory routes of the European White-fronted Geese. The April concentration on stopovers in the Central European Russia divides into two streams: one stream is going to the north to the bottleneck around the northern end of Ural Mountains, then move further east to Siberia (concentration of recoveries along the northern coast, Fig. 72, May); the second stream goes through the bottleneck around the southern end of Urals and penetrates in the northern Kazakhstan and south of Western Siberia (see recovery concentration on Fig. 72, May). Practically no or very few White-fronted Geese pass through Ural Mountains directly. The southern stream after bending Urals turns directly to the north, to the breeding grounds in Western and Central Siberia. Migration in June is still continues, however most of White-fronted Geese already start to breed. Some geese, probably wounded and weak ones, can be met at stopovers in the Central European Russia as late as in June (Fig. 72, June). In June-July-August White-fronted Geese are in breeding and moulting areas. As to European birds, their moulting areas are located farther from wintering grounds than breeding sites. E.g., along the coast near Dikson, Taimyr, the migration to the moulting sites starts since early July. Thousands of White-fronted Geese fly along the coast farther east – several hundreds (may be thousands) km from western Siberia to Pyasina River Delta (personal observation), where they concentrate into huge (many thousands of birds) moulting aggregations. Movements back to wintering grounds start in September. In October these movements continue, all birds bred in Siberia are already absent on their breeding grounds, geese bred in northern European Russia partly are still in breeding areas (Fig. 72, October). Two concentrations of the October recoveries in the northern European Russia and northern Kazakhstan indicate that geese split again into two streams: one goes to Europe directly along northern migratory routes, second stream consists of birds that move first to the south, then bend southern end of the Urals (like in spring, but in opposite direction), then fly west to the western European wintering grounds (see section “Migratory routes”). At the Far East geese are near the finish of their autumn migration. In November geese have practically left breeding areas and completed their migration. Far Eastern birds are on wintering grounds, but rest of European birds still can be met („shot“ recoveries) on migration. In December all birds are in their wintering locations (compare November and December, Fig. 72)



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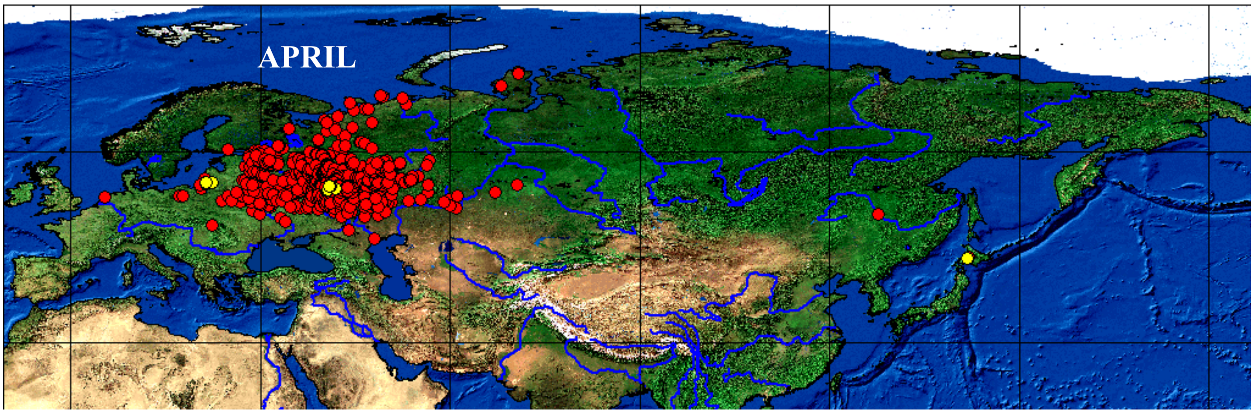
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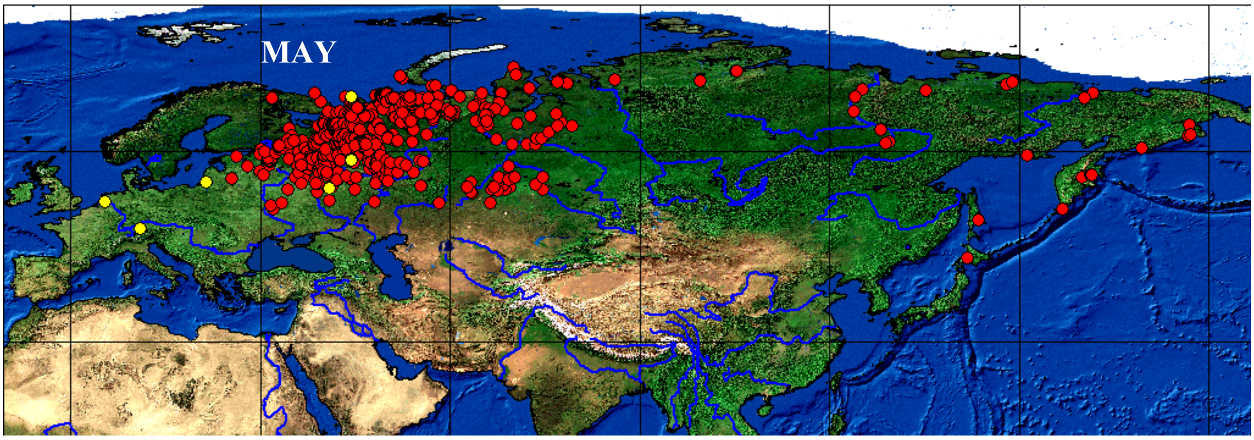
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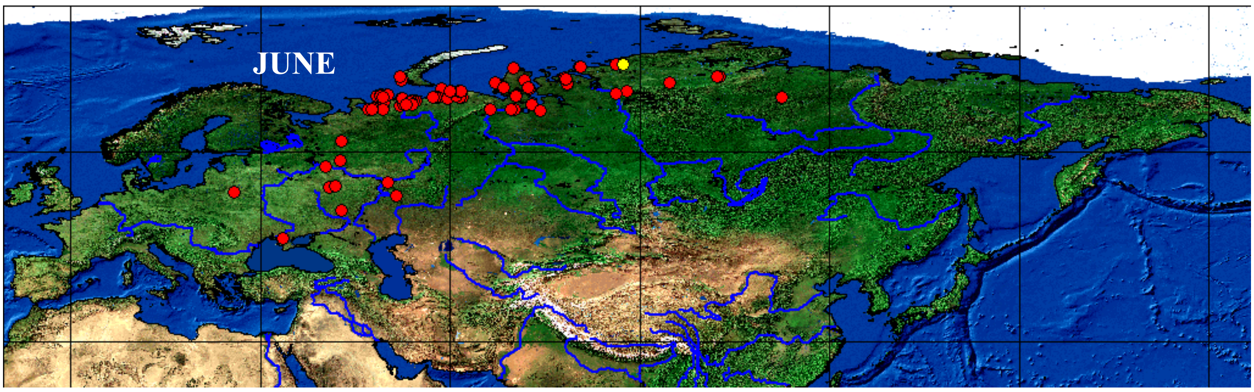
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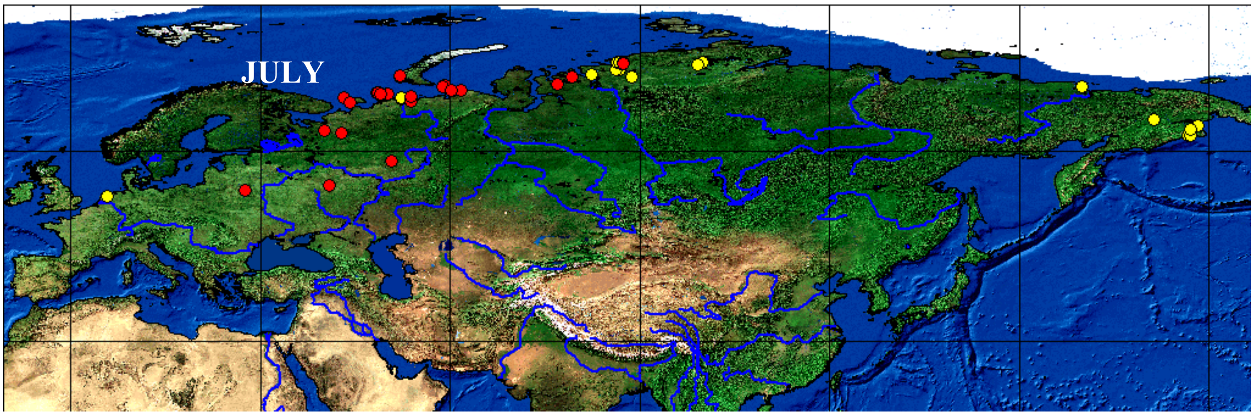
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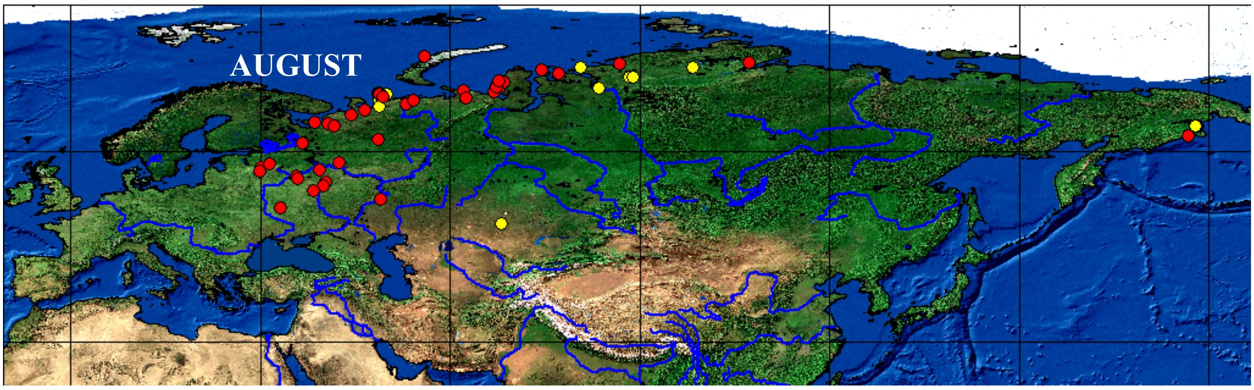
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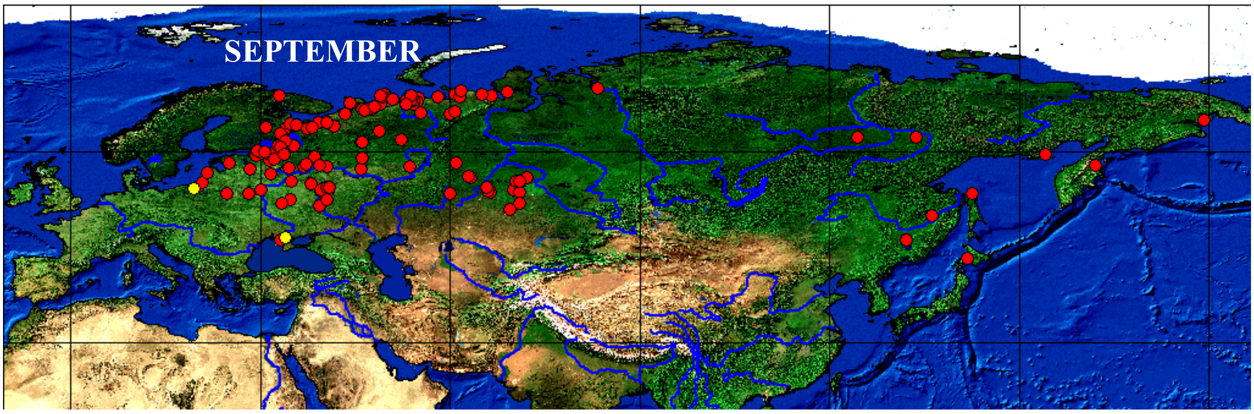
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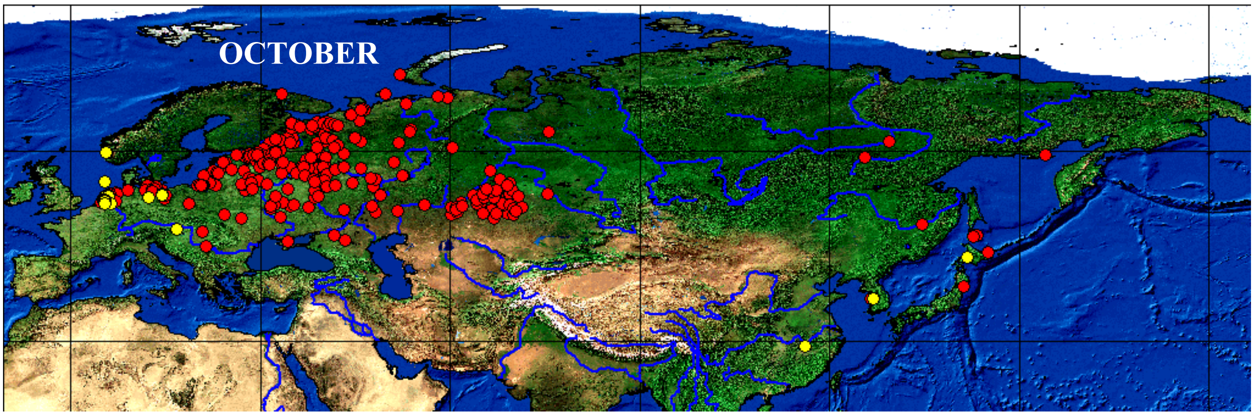
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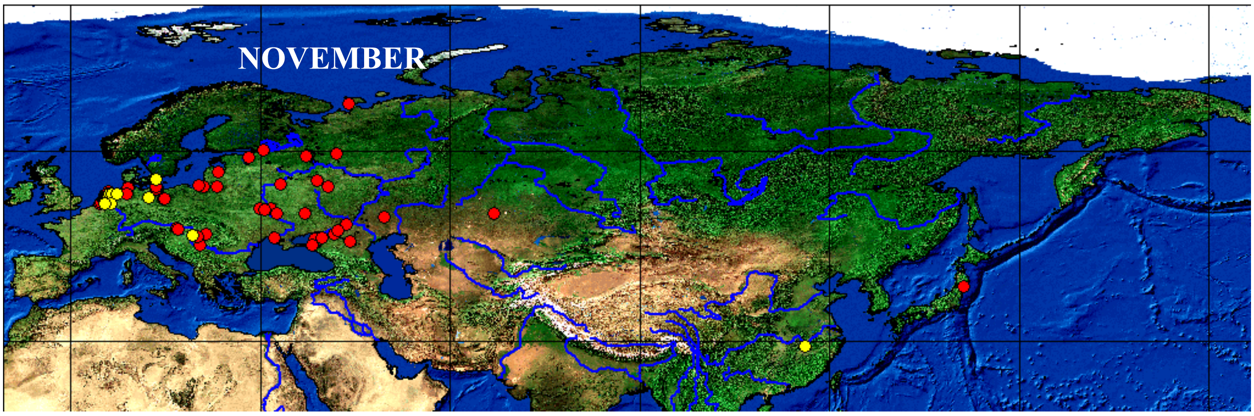


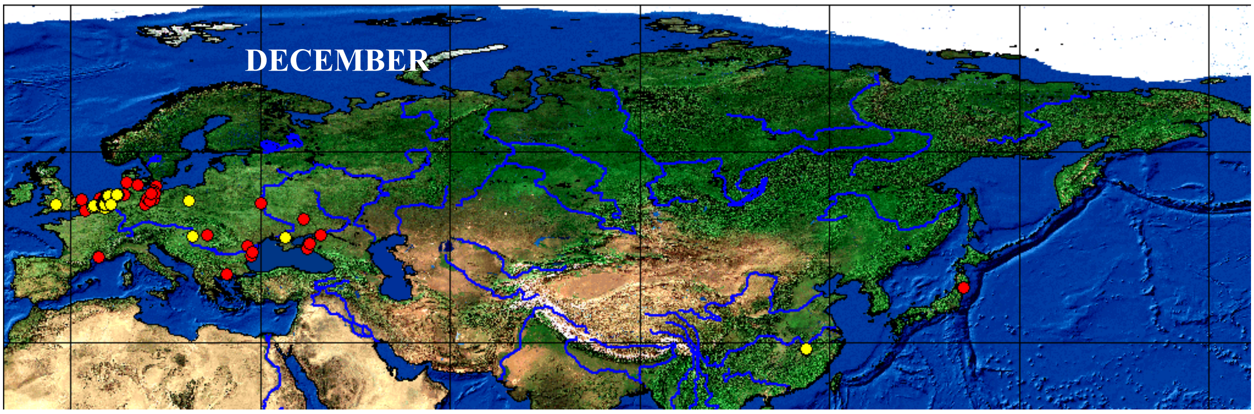
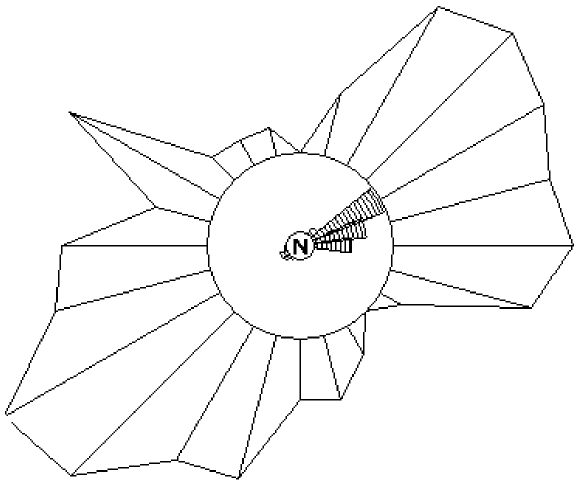


Figure 72. White-fronted Goose monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. Most of White-fronted Geese that are in our database migrate between European Russia and western-central Siberia – and Central and Western Europe. European wintering White-fronted Geese migrate along directions northeast-southwest, most frequent bearings are 60˚ and 230˚. Most birds breeding east of 110˚E migrate along bearings of 215˚ and 15-25˚ (Fig. 73). There are no any visible overlapping areas between European and Far-Eastern White-fronted Geese.



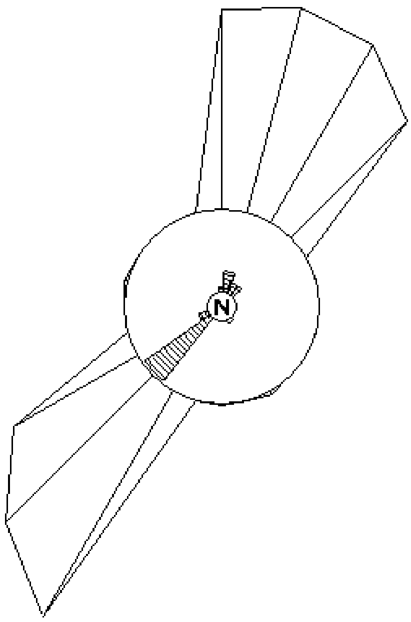


Figure 73. Recovery rose graphs for White-fronted Geese: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Left chart is for European wintering birds, area of recoveries from Netherlands to central Siberia, up to 113˚E. Sector = 15.0°; total recoveries - 3832; number of recoveries in sectors: from 0 up to 1422. Mean distance in sectors: from 0 km up to 3384.9 km. The longest flight distance of these birds is 5364.0 km.

Right chart represents migration of White-fronted Geese in areas east of 113˚E.. Sector = 15.0°; total recoveries - 74; number of recoveries in sectors: from 0 to 38. Mean distance in sectors: from 0.0 km up to 4227.2 km. The longest flight distance in the Far-Eastern birds is 5230.3 km.

Most of direct flight distances are 1500-3700 km (Fig. 74), maximal distance of the direct recoveries is 5277 km. For indirect recoveries most frequent distances are than from 1600 to 3300 km (Fig. 75), the longest distance is 5364 km, close to that in direct recoveries.

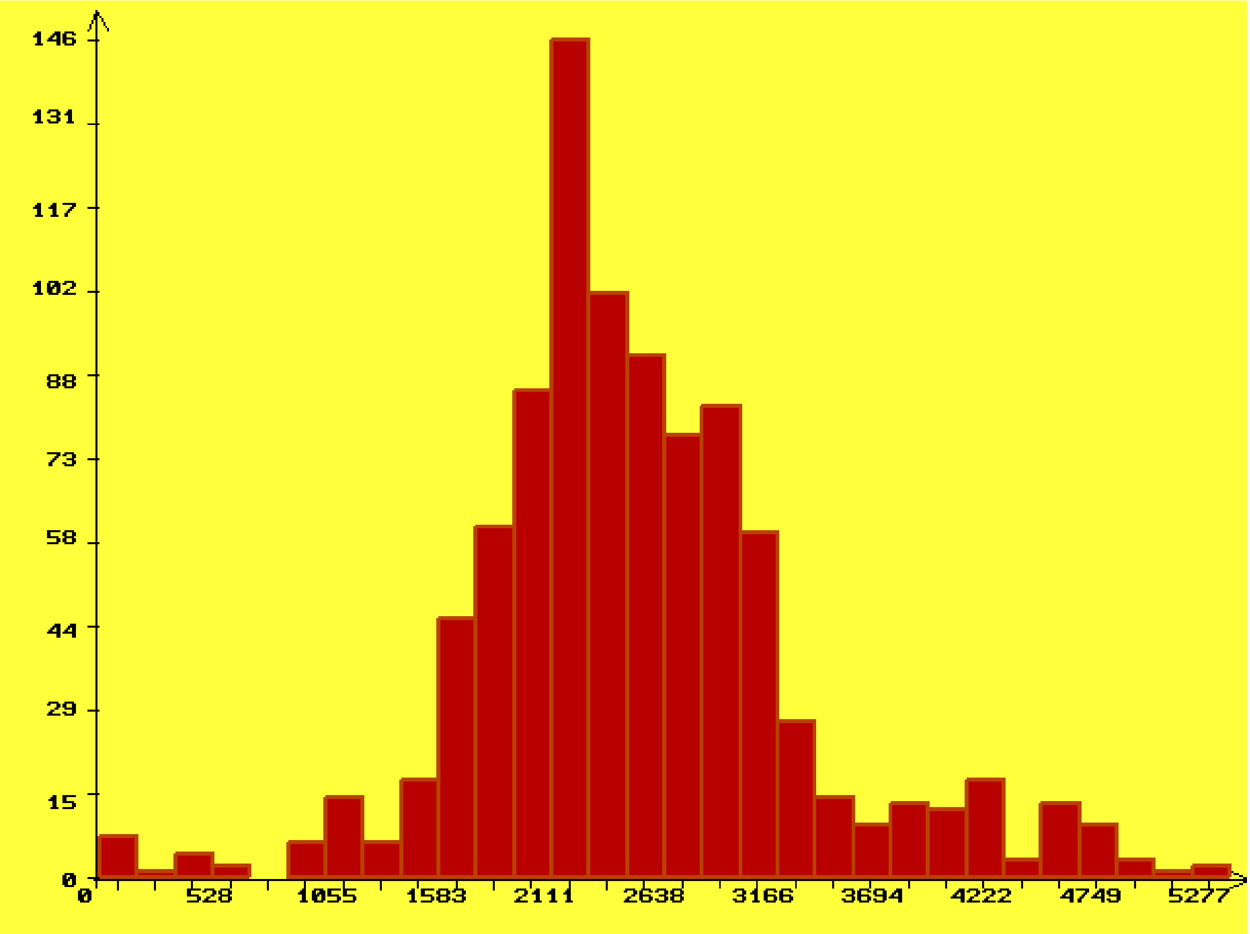


Figure 74. Distribution of direct recovery distances in White-fronted Geese. X axis is the flight distance; Y axis is the number of distances.

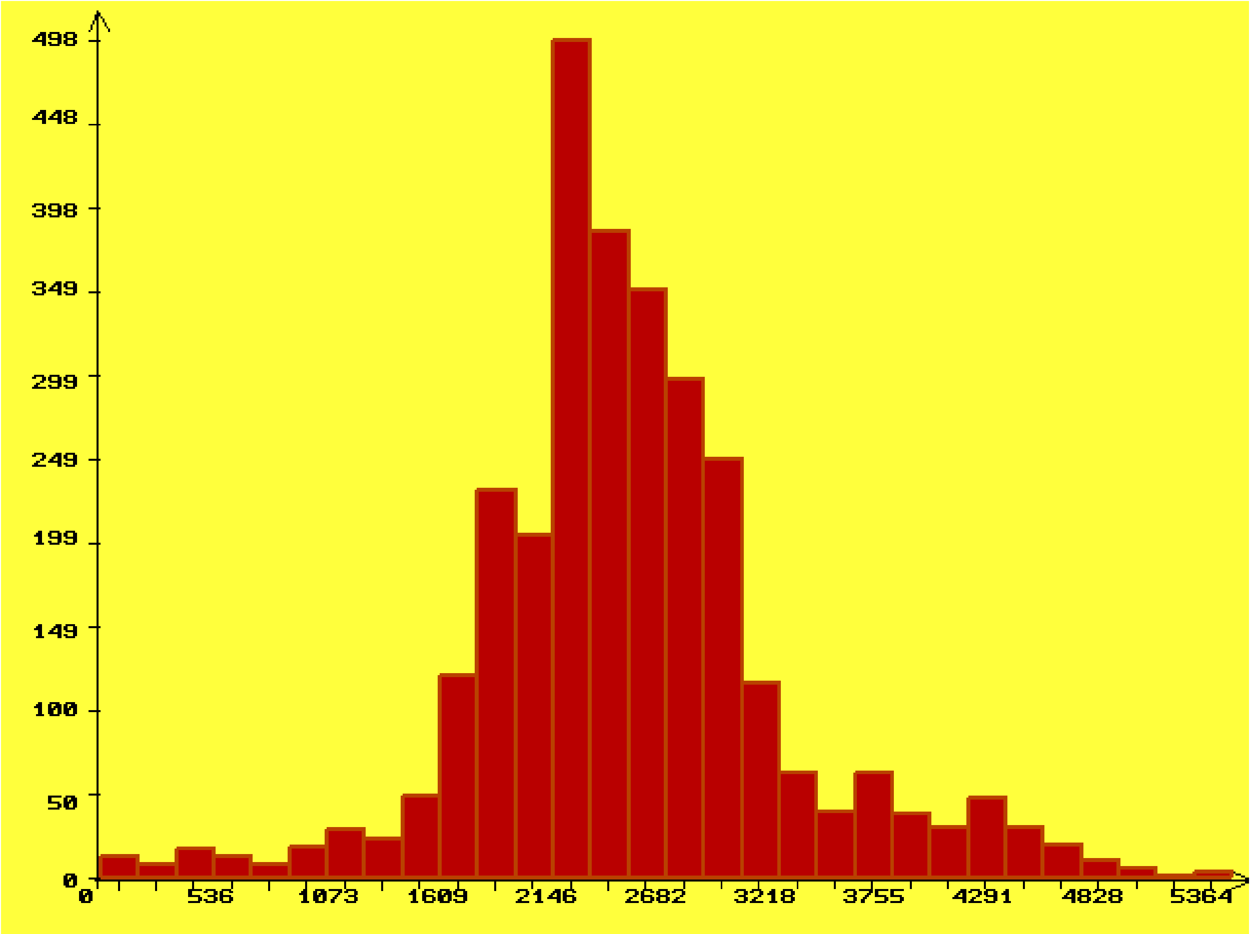
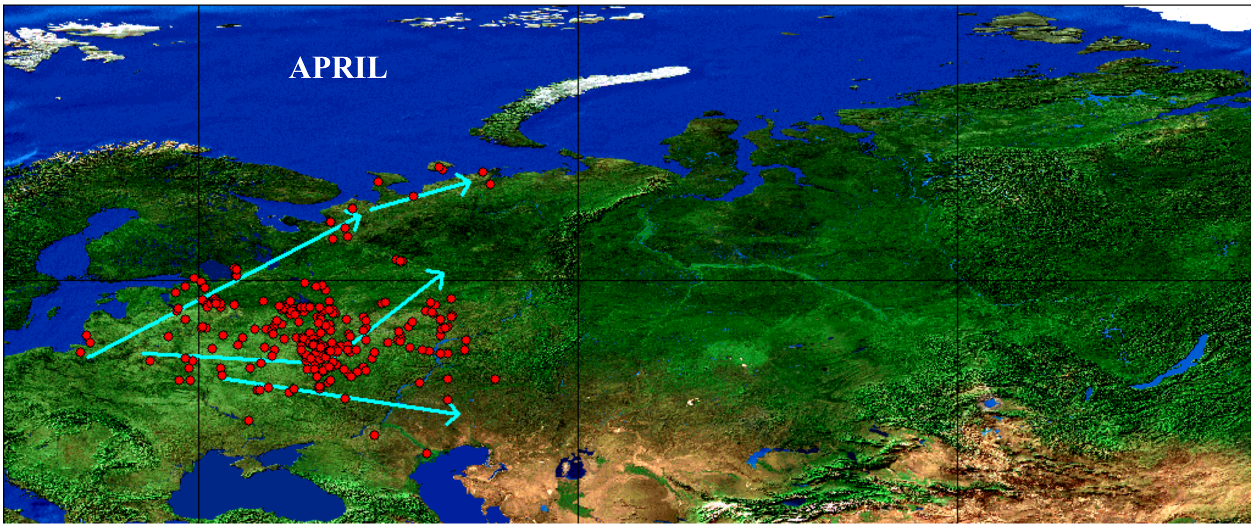


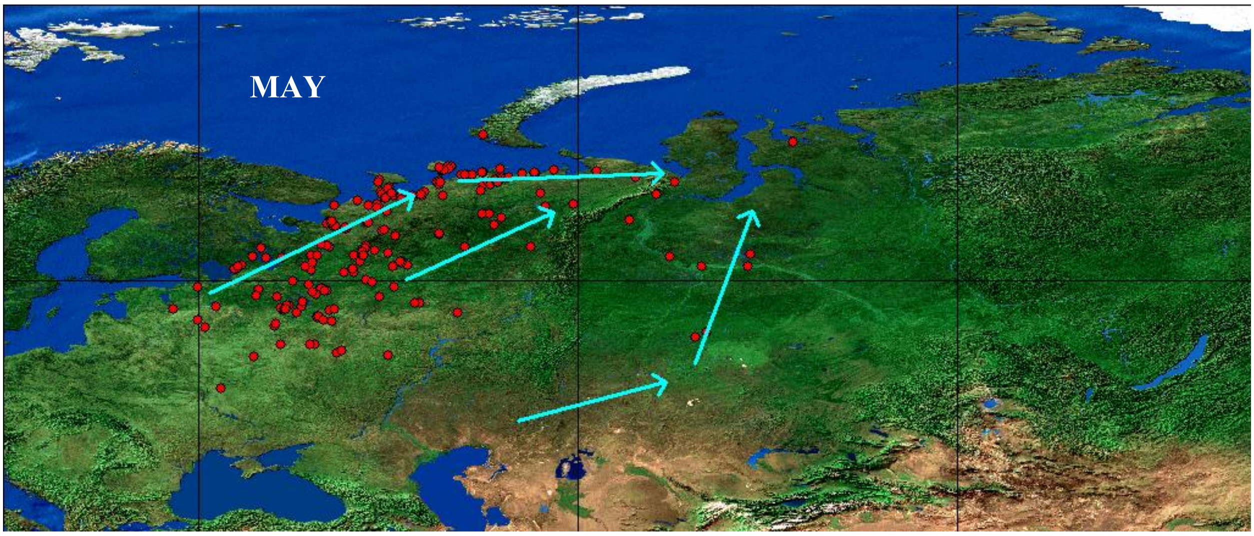
Figure 75. Distribution of indirect recovery distances in White-fronted Geese. X axis is the flight distance; Y axis is the number of distances.

Mean flight distance in White-fronted Goose young birds (ringed as „pull" or „juv"or „1 y") is practically the same as in adults: 2493.4±26.0 and 2509.1±13.0 km respectively (N_{young} = 647, N_{ad} = 3249). For geese, marked in the Netherlands, flight distances of adults - 2446.6±10.8 km (N_{ad} = 2584), of young, slightly longer – 2502.2±23.7 km (N_{young} = 599), significant – t-Bailey = 2.1 P=0.03. Male mean flight distance is slightly longer than in females: 2502.3±16.3 and 2471.5±15.7 km (N_{males} = 1888, $N_{females}$ = 1863), however insignificant. For geese ringed in The Netherlands distances are almost equal: 2467.7±13.8 km and 2448.9±14.0 km respectively, $N_{females}$ = 1569, N_{males} = 1576.

Migratory routes of White-fronted Geese are quite complicated. As we see in monthly means (Fig. 76), White-fronted Geese from large wintering grounds on the Wadensee (Netherlands) fly first in a "big heap" from the wintering grounds approximately till the border of the former USRR, then split at least in two streams: 1) the northern one move directly to the north-east along the Baltic-Sea – White Sea migratory route; 2) the central Russian one, that goes to the Central European Russia where geese stay for a month or more at the spring stopovers. The second stream, in its turn, splits into two streams, as shown in the section "Monthly movements": 1) part of geese turn to the north to the breeding grounds in the European Russia North and, around the northern end of the Urals, penetrate into western Siberia up to the east of Taimyr Peninsula. 2) the other part pass through the Central European Russia, bend Urals over the southern end and fly to the north of Western an Central Siberia (Fig. 76, see April concentration very close north of Kazakhstan, Tyumen Region; certainly, many geese fly through the northern Kazakhstan, but spring hunting in Kazakhstan have been closed for several decades, therefore no spring recoveries from this area). Both these big migration steams join again in the north-western and Central Siberia up to the east end of the Taimyr Peninsula. Since such mixing of migratory routes takes place, it is no sense to draw the monthly mean picture for birds, ringed in the Netherlands, because these means will not show real migratory routes. Samples for German and Great Britain ringed geese are small to give us the proper picture. Therefore, we should rely on other characteristics of migration (e.g., concentration of recoveries, see section "Monthly movements"), rather than on such monthly means.

Some geese fly along their spring migratory route through central European Russia (see positions of recoveries on September and October maps, Fig. 76). However, during autumn a great part of the White-fronted Geese fly along the other routes than on spring migration. In autumn White-fronted Geese do not form long-term stopovers; therefore they mostly fly over quickly and more straight. A number of data confirms so called "loop migratory movements": geese that fly to the north and north-east in spring through central European Russia, in autumn fly directly along the White Sea-Baltic Sea migratory route (see September recovery concentration in the Fig. 76 September, and August-September direct recovery concentration in Fig. 76). First this White-fronted Geese migratory loop has been discovered by M. I. Lebedeva (1979) and Kishchinsky (1979). Such loop is confirmed by considering monthly position of direct recoveries (Fig. 76). Geese perform this northern loop in counter clockwise way (Fig. 76).

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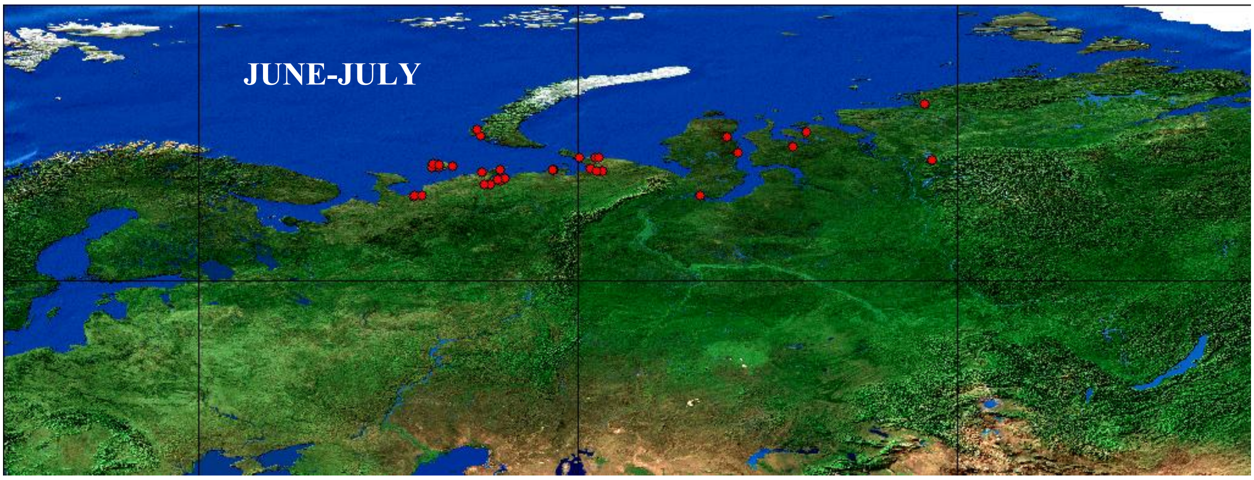
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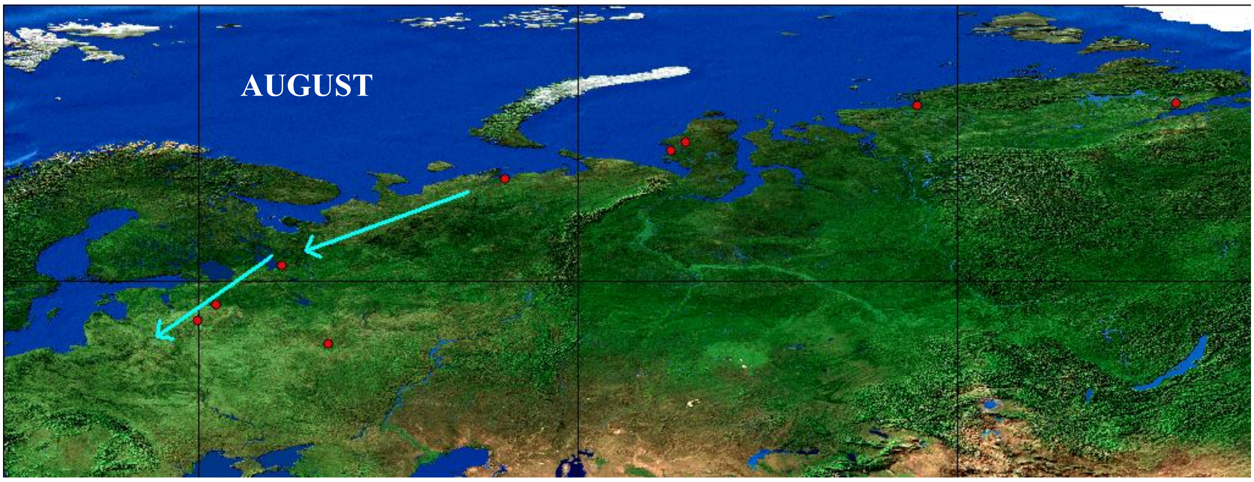
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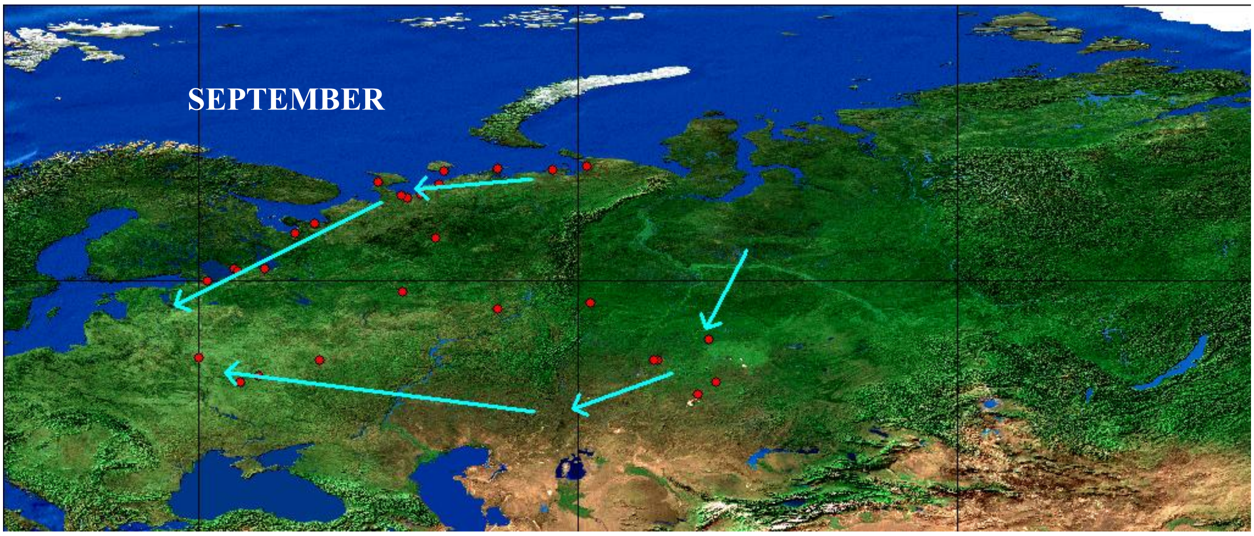


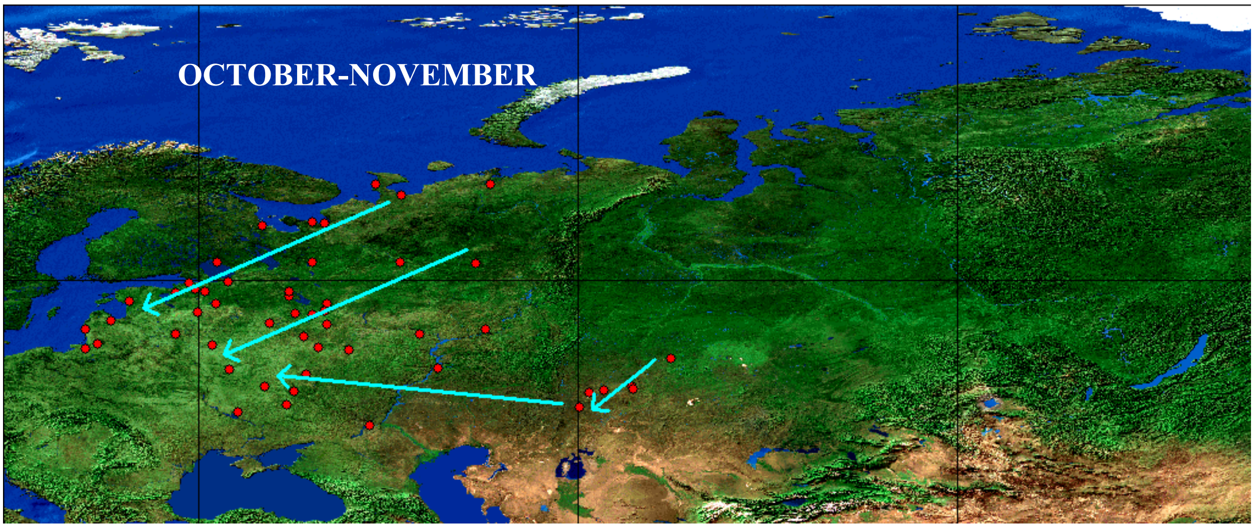


Figure 76. Position of direct recoveries of White-fronted Geese ringed in the Nertherlands and their migratory routes. Red dots – recovery sites, blue-green arrows show directions of migratory movements.

However one more loop, the southern one, also exists. This loop is formed in opposite, i.e., clockwise direction. Monthly means of „Moskwa" ring recoveries for birds ringed in summer time on Taimyr Peninsula helps us to reveal this southern loop (Fig. 77). In spring a great part of White-fronted geese fly to Taimyr via central European Russia and the "northern gate" of Urals. Then, as characteristic to geese, in July they fly to moult further east along the spring migratory route. In autumn they return back through western Siberia and northern Kazakhstan, through the "southern gate" of Urals. They fly along autumn migratory route to the west as late as till February: February mean point is located more westward than January one (Fig. 77).

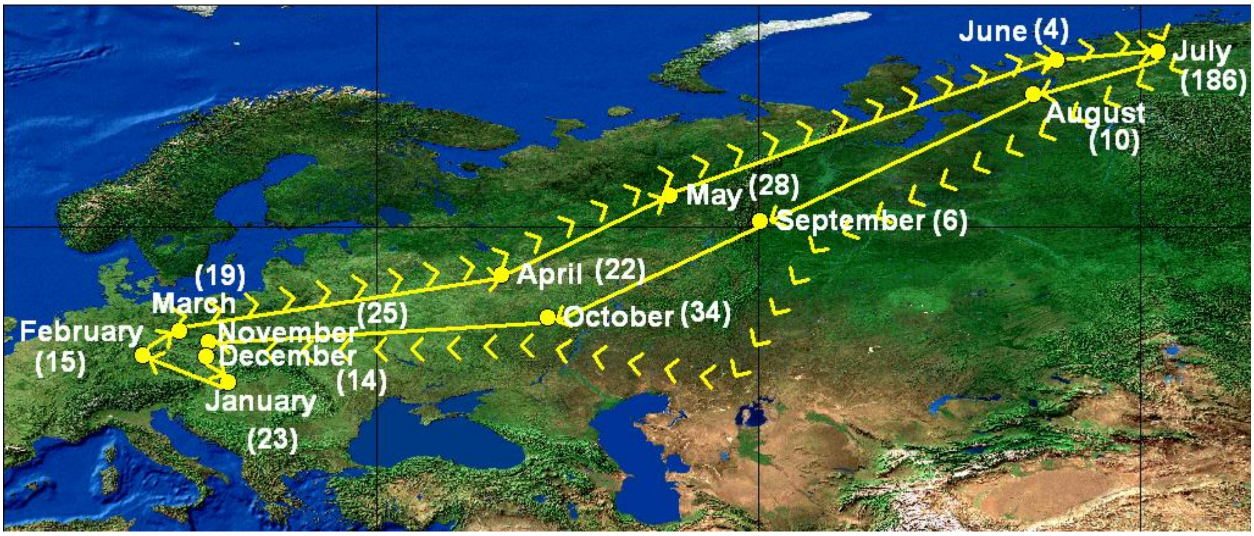


Figure 77. Mean monthly locations of White-fronted Geese control points for birds, ringed in the summer time at the Taimyr Peninsula. Yellow dots are mean monthly locations of geese. Arrows show directions of movements. Dashed arrows outline migratory routes of these geese.

Summarising all about migratory routes, we can outline spring and autumn White-fronted Goose migratory movements of the European birds (Figs 78, 79). Migratory routes of the Far Eastern birds look simpler (in spring – to the north-east, in autumn – to the south-west), however our data set from that area is small.

Figure 78. Outline of spring migratory routes for White-fronted geese that winter in Western Europe. Red arrows are directions of migratory movements.

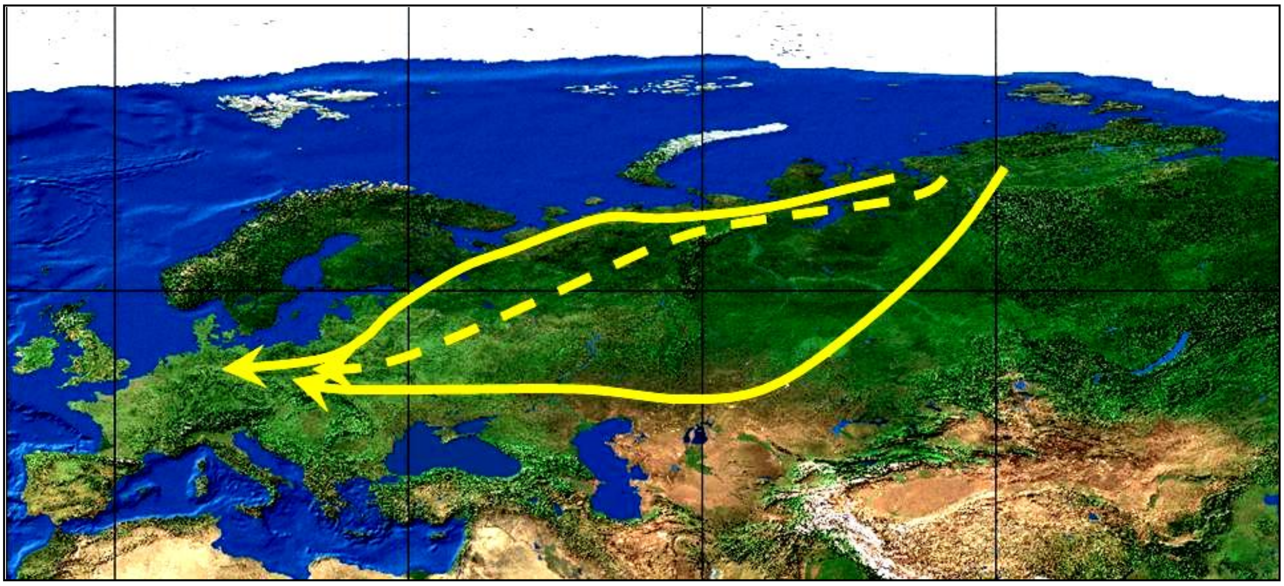


Figure 79. Outline of autumn migratory routes for White-fronted Geese wintering in Western Europe. Solid yellow arrows – main directions of migratory movements, dashed arrow - secondary way of migration.

Some additional remarks. We would like to say some words about satellite transmitter usage. It turned out that this is very good way to study migratory routes. However, the area, covered with birds mounted with transmitters appeared smaller, than the area occupied by birds marked with rings or/and neckcollars. This has found in White-fronted Geese marked in Europe (Wijk et al., 2011), and in the northern Pintails marked in Japan (Hupp et all, 2011). It looks like birds encumbered with transmitters fly more straight than birds with rings or collars only. At least, the satellite transmitter marking in the Netherlands has confirmed the northern migratory routes, but none of birds with a transmitter have taken the longer way, and none of such birds from Western Europe bent the Urals over the south end (Wijk et al., 2011) although ring-recovery data indicates this route.

There may be a question why White-fronted Geese usually do not cross Ural Mountains, although these mountains are not high. This regularity is also valid to many duck species. It seems only Bean Geese in considerable amount cross Urals in spring. The reason for this could be the historical one: when Glacier Age was finishing, Ural Mountains were covered by glacier for much longer time than the Central Russian Plain and West Siberian Lowlands.

Satellite tracking data. In Western Europe White-fronted Geese satellite transmitter marking efforts started in 2006, 23 birds were tracked during this project (www.blessgans.de). Fig. 80. Tracking data well confirm one of the migratory loops previously found from ring-recovery data. Satellite transmitter tracking allowed outlining the loop of White-fronted Geese migrating to the north of European Russia in detail (Fig. 80).

Satellite birds that in spring flew by the relatively narrow corridor from Western Europe to about the latitude of Warsaw, further migrated by the broader front, spreading from the Baltic Sea to the Kyev Region, Ukraine. In 13 cases it was possible to follow the autumn migration of the birds with known spring migration. Two birds, which in spring migrated along the Baltic Sea-White Sea route, in autumn returned by the same way, repeating the spring migration, but in the opposite direction. In one case the autumn migration tracks were located to the south of the spring route, the route itself was much straighter than in spring. The majority of geese in autumn flew more to the north of their spring route, forming already mentioned loop, turned in the counter clockwise direction. Satellite data have shown that geese keep the same migration strategy for a number of years.

In 2013 a new international project on the GPS-GSM transmitter marking started. Bird Ringing Centre of Russia takes part in this project. Five males were marked in Kologriv area, Kostroma Region, Russia, at the well known large spring stopover of the White-fronted Goose central Europen Russia migratory route. One of the birds then moved to the Barents Sea coast in the Nenets AA, two males reached Novaya Zemlya, one goose migrated to the Kolguyev Island. It was possible to follow the autumn migratory routes of three those geese. All three routes were stretched along the White Sea-Baltic Sea migratory route. Therefore, all these birds took a long way in spring and short way in autumn. Longer and more southern spring route offers to geese more warm and comfortable conditions, possibilities for foraging and rest, whereas the straight route (that geese use in autumn) in spring is still under snow (Kishchinsky, 1979). Satellite transmitter data confirmed that White-fronted Geese movements between stopovers in great extent depend on the sharpness of the ambient temperature increasing (Wijk et al., 2011).

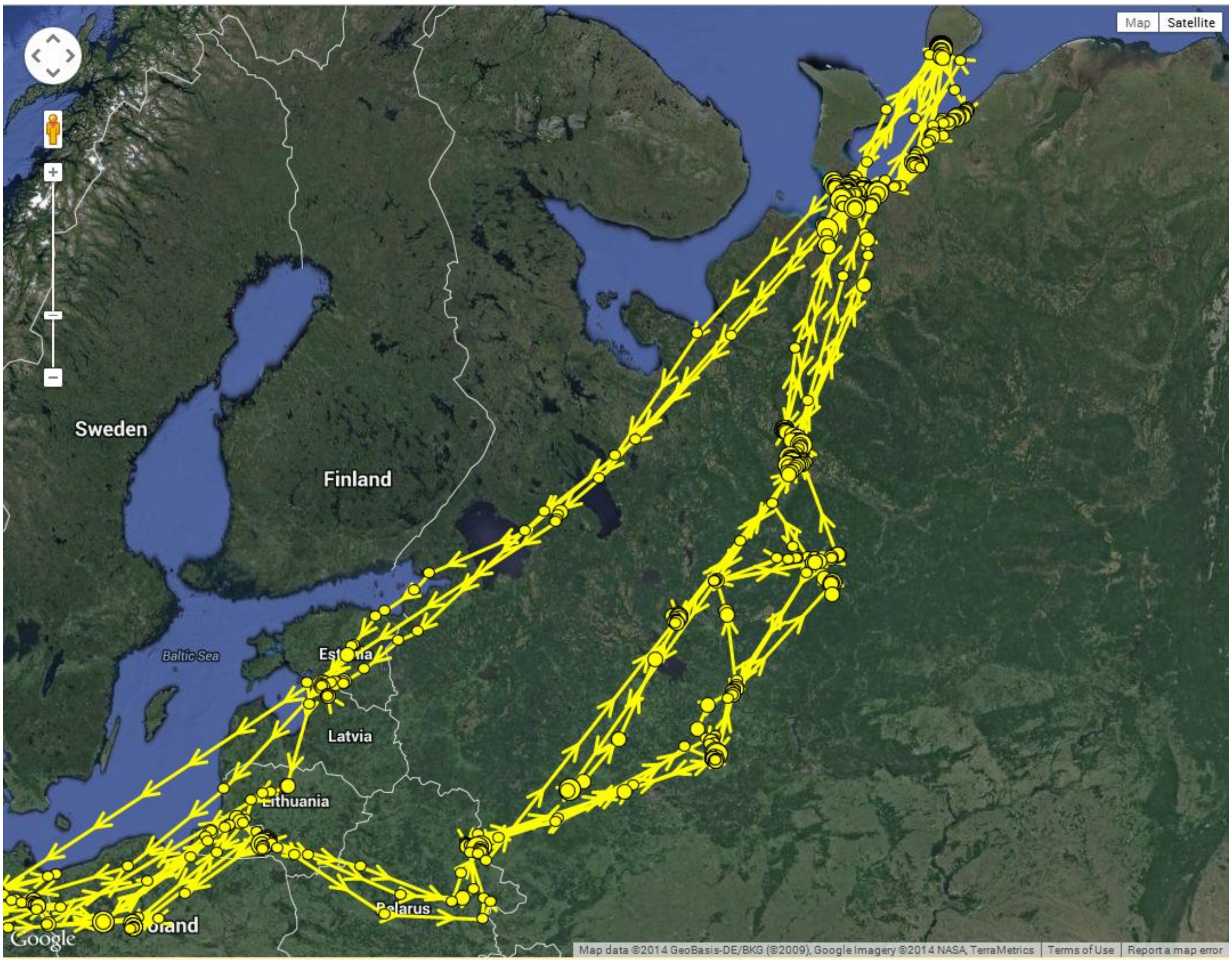


Figure 80. Tracks of three spring and autumn migrations of one adult White-fronted Goose marked with PTT (www.blessgans.de).

Migratory routes of White-fronted Geese wintering in the southern parts of the Eastern Europe (www.blessgans.de) are especially important because of lack of ring-recovery data from this area. In 2013 three adults and one young were marked at the wintering site in Hungary. In early April the birds moved to the south-eastern Ukraine. As we can see, the boundary between this relatively southern migratory route and more northern migratory route of geese migrating from the Western Europe is stretched along Donetsk and Lugansk Region, Ukraine, then through the south of Voronezh Region, centre of the Saratov Region, southern parts of Samara, Orenburg and Chelyabinsk Regions, Russia. By 20 April adult geese arrived at the known stopover places in the northern Kazakhstan, and left them on 16-17 May 2013. Then geese moved to the north up to Ob river mouth. One bird was likely shot, other two flew to the east to Gydan and then Taimyr Peninsulars. Both marked geese did not breed, moulted in July at the central Taimyr in 30 km from each other. Autumn migratory route generally was similar to the spring one, but with small broadening in the northern Kazakhstan (Fig. 81). Then, on the way to the west, one more goose was shot, the other one crossed the Volga River and since 12.11.2013 till 16.12.2013 stayed at the Manych-Gudilo Lake. In warm winters geese could stay at this lake for the whole wintering period. Then the goose moved to the Sivash Lake, southern Ukraine, where stayed in January 2014. Data on these two marked geese have not confirmed the loop flight previously detected from ring-recovery data. This might be for two reasons: 1) only two marked geese on the autumn migration; 2) the migratory route in the Western Siberia is much longer than in geese in the European Russia, therefore Siberian geese encumbered with transmitters fly more straight than usual and do not perform a migratory route loop.

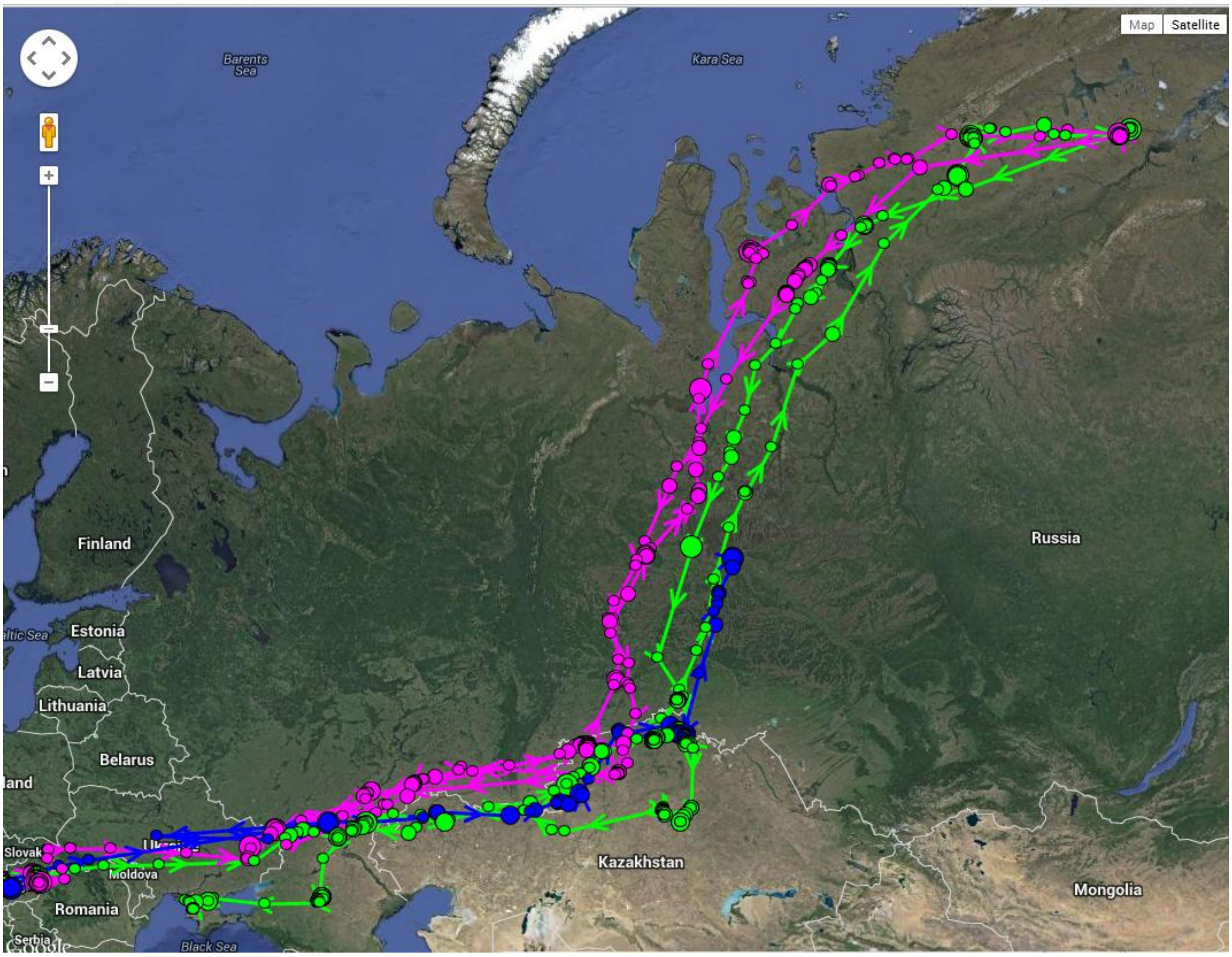


Figure 81. Tracks of three adult White-fronted Geese marked with PTT on the wintering grounds in Hungary (www.blessgans.de). Purple and blue arrows show spring migration, green ones – autumn migration. Different colour arrows are different birds.

Speed. Bird Ringing Centre of Russia database does not contain direct recoveries with maximal flight speed of White-fronted Geese. There are several recoveries in our database with the maximal speed over 70 km per day. Maximal speed recorded at the level of ringing is 103 km per day. Real speed is certainly greater, because the bird was ringed and collared in May in Kologriv lowland, Kostroma Region, Russia, at the spring stopover where it stayed a number of days after ringing.

Populations. Population structure of White-fronted Geese consists of at least three populations with their own migratory routes. Bird Ringing Centre of Russia ring-recovery data allow outlining the following populations: 1) european-west-central-siberia population (polygon No 1, Fig. 82) with generally west-east migration movements; 2) central-siberia-asia-minor population (polygon No 2, Fig. 82) with general north-east – south-west migrations; 3) east-siberia-far-eastern-east-china-japanese population (polygon No 3, Fig. 82) with north-east – south-west migratory movements. First two populations overlap greatly; European-west-central-siberia population includes almost all area of the central-siberia-asia-minor. Likely, the latter one is the remains of the relict population, that in the past was more separate from the European one and stretched in its wintering range as far to the south as to Messopotamia, the same as in the Lesser White-fronted Goose (see the species account). At present White-fronted Geese, besides Western Europe, winter in the extensive areas at the Caspian Sea and in the surrounding of the Black Sea and Sea of Azov. It is very likely, that in the last Glacier Age the main wintering sites were located in these areas. Later on, with the Glacier retreat, winter areas expanded more to the west and north-west to there modern position. However, the relict migratory route around southern end of the Urals (see section "Migratory routes") still exists, the same as in several duck species (see species accounts). Northern migratory route around the northern end of the Urals has appeared later.

The third, east-siberia-far-eastern-east-china-japanese population does not show any overlapping zones with the two first populations, however we probably do not have enough data to recognize this zone.

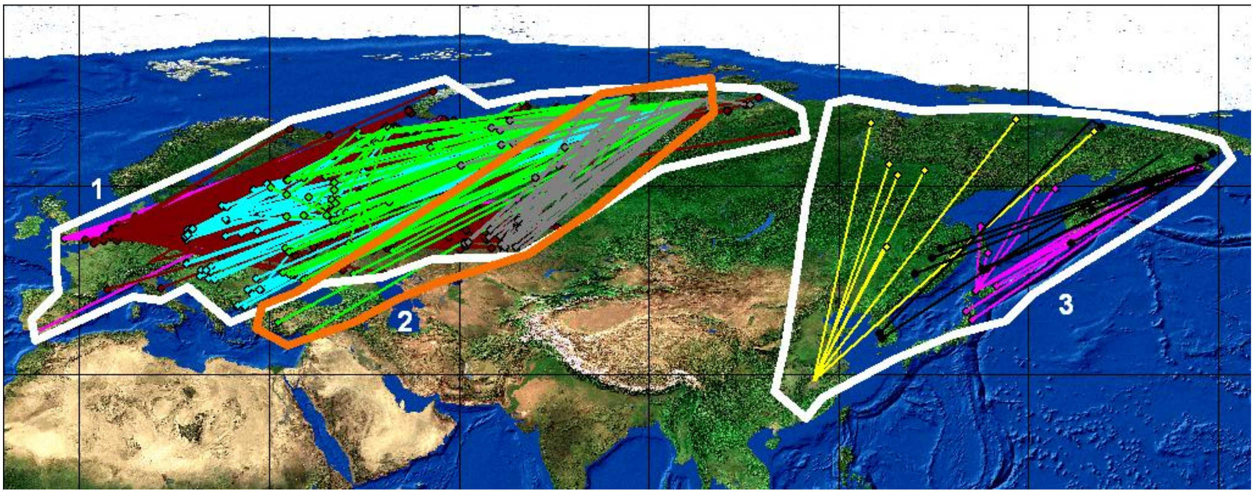


Figure 82. White-fronted Goose populations. White polygon № 1 outlines european-west-central-siberia population. Light brown polygon № 2 is central-siberia-asia-minor population. White polygon № 3 outlines east-siberia-far-eastern-east-china-japanese population.

Ten-year distances. For all White-fronted Goose recoveries mean decadal distance first increased to 1970s, stayed the same up to 1990s, and then decreased in 2001-2010, in 2011-2023 increased again (Table 6). For geese ringed in the wintering areas in the Netherlands these feature is even more prominent with one difference – after increasing in 1970s the distance started to decline in 1980s, second increase occurred in 2011-2023, the latter is the same as in the general sample. Since the Netherlands ringed birds comprise a great bulk of the White-fronted Geese sample, it is interesting to consider the Netherlands geese ringed in the one wintering area.

Table 6. Mean White-fronted Geese flight distance per decade.

Decade (years)	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2023
Distance (km)	2548.5	2739.5	2454.3	2637.0	2522.3	2618.8	2421.9	2525.8
Number	6	111	574	181	263	472	1187	1104

of recoveries								

Bird Ringing Centre of Russia database does not contain Netherlands bird recoveries for 1940s, therefore we start consideration from 1950s. In the Fig. 83 one can see the general pattern of the distance and recovery distribution dynamics of the Netherlands ringed White-fronted Geese through decades. The general mean distance increasing after 1950s is visible. And, in distinction to Bean Geese, recovery distributions in White-fronted Geese over the decades are similar to each other. In comparison to Bean Geese, White-fronted Geese recovery occupied area is less extended along south-north direction and more extended along west-east direction (Fig. 83).

The mean ring-recovery distance in White-fronted Geese is the greatest in 1970s. It is not clear whether this pattern is related to the global warming, but probably yes. White-fronted Geese started to increase flight distance in 1970s partly probably due to the global warming. However, the other stronger pattern took part in this process: changes in the geese species condition. 1970s was a kind of "golden era" for geese – their numbers in Europe and Japan in that decade increased by 15% annually (Fox et al., 2010). This good population growth produced more birds which started to inhabit greater area and fly along greater distances to their breeding sites. Then the condition of White-fronted Geese likely has become worse (although not bad, see section "Mortality"), and less birds are recovered at long distances. Increasing distances after 2010 might reflect either additional global warming effect or the new improvement in the population condition.

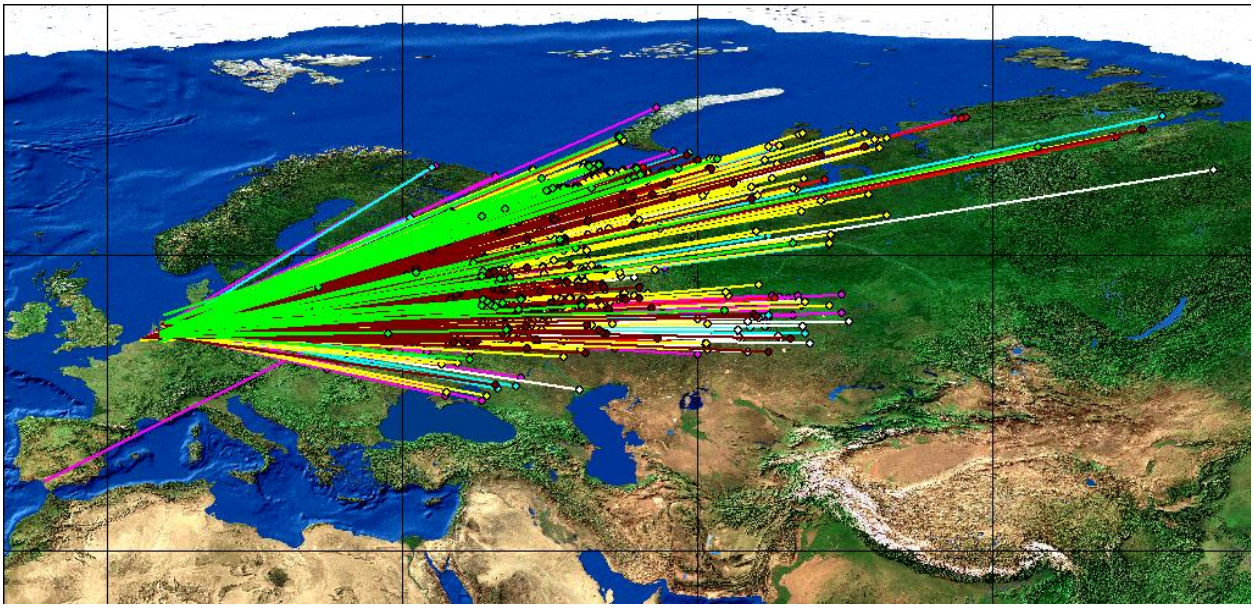


Figure 83. Map of the recoveries of White-fronted Geese ringed in the Netherlands. Lines start at the ringing sites and end at the recovery points with dots. Colour of lines and dots: green – recoveries in 1951-1960, purple – 1961-1970, blue-green – 1971-1980, white – 1981-1990, red – 1991-2000, yellow – 2001-2010, brown – 2011-2013.

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest White-fronted Goose lived more than 25 years 3 months. Our database, however, contains several recoveries of birds of more than 30 years old. The most reliable one, where ring was sent, is the ring Arnhem 8 016 627: adult female was ringed on 09.01.1967 in the Netherlands and shot in May of 1997 after more than 30 years. Since the bird was initially adult, it lived more than 32 years. We have two less reliable recoveries where ring were not sent for females lived more than 34 and 37 years. Besides that, there is a recovery of the ring Arnhem 8 000 286 with the male which was shot >49 years after ringing, really lived more than 52 years. Although the ring was not sent, the letter contains information that the body of the bird was present. It seems White-fronted Geese are capable to survive up to more than 50 years. Anyway, for the consistency, we do not use the latter recovery in the mortality rate analysis.

Mortality rate. According to the common criteria (see "Materials and Methods") 3272 dead recoveries are applicable for the mortality rate analysis. In addition, for consistency, we excluded 1 bird where elapsed time exceeded 50 years (see the "Lifespan" section). Therefore, for analysis we used 3271 dead recoveries. Mean annual mortality rate in White-fronted Goose is 19.18±0.30 % (Fig. 84). Real mortality pattern differs from the theoretical one significantly (χ^2 = 624.5, df = 35, P=0.0000). Programme MARK, Model CLogLog 2ndPart shows 20.00%, difference is 0.82%. White-fronted Goose mortality pattern chart shows drawdown of the real survival dynamics in the comparison to the theoretical one. However, bar graph going down quite steadily with more or less equal mortality per ages. Really, this drawdown of bar chart in relation to the theoretical line is caused by three outstanding long-lived birds, not from the high mortality rate in young. If we take these two birds out of consideration (explanations see in "Materials and Methods") the bar chart will be much closer to the theoretical line. This means that the White-fronted Goose, especially in European population (because most of birds in the analysis are the European ones) is in more or less good prosperity. It seems this is not so for two Asian populations, but data on those populations are very scarce.

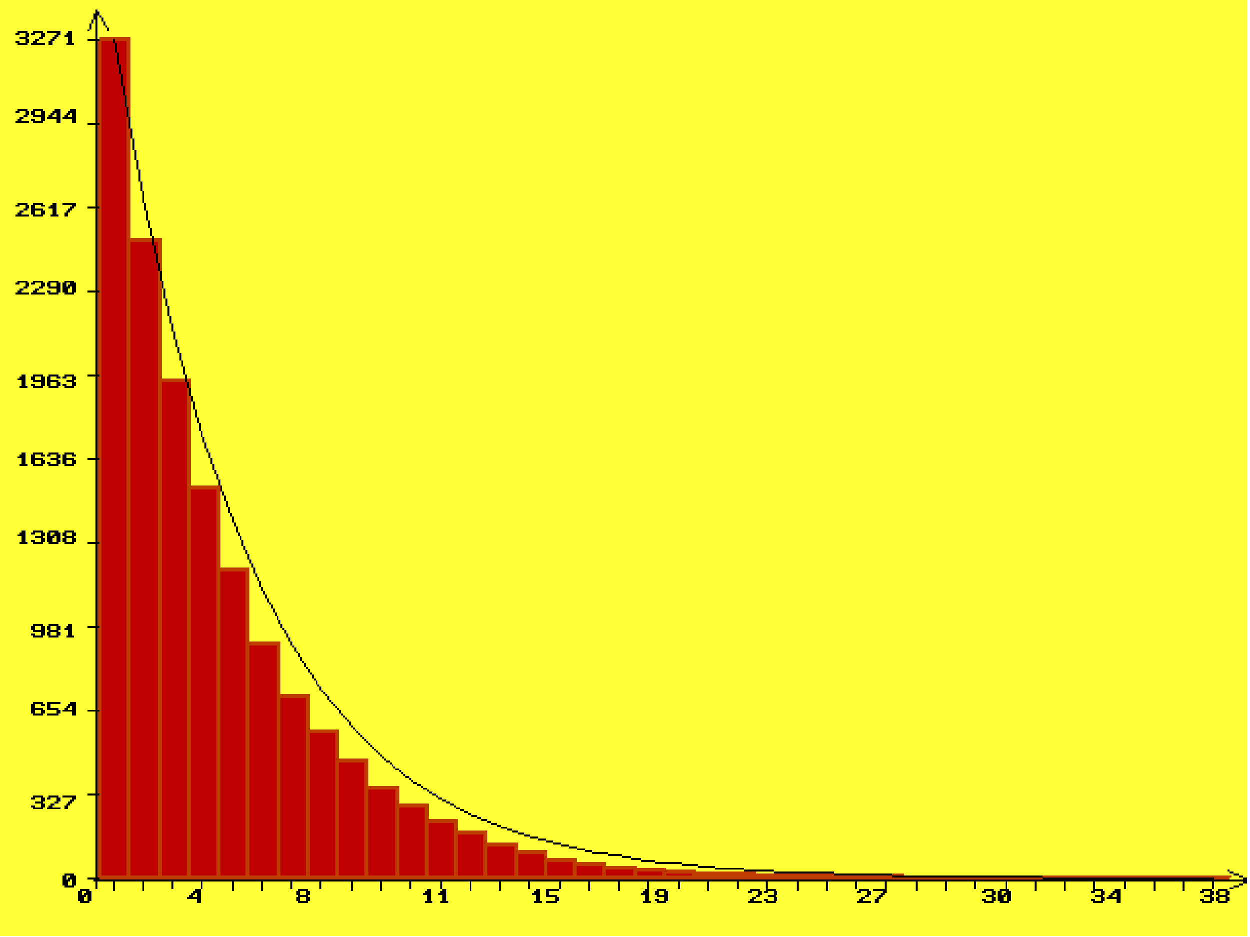
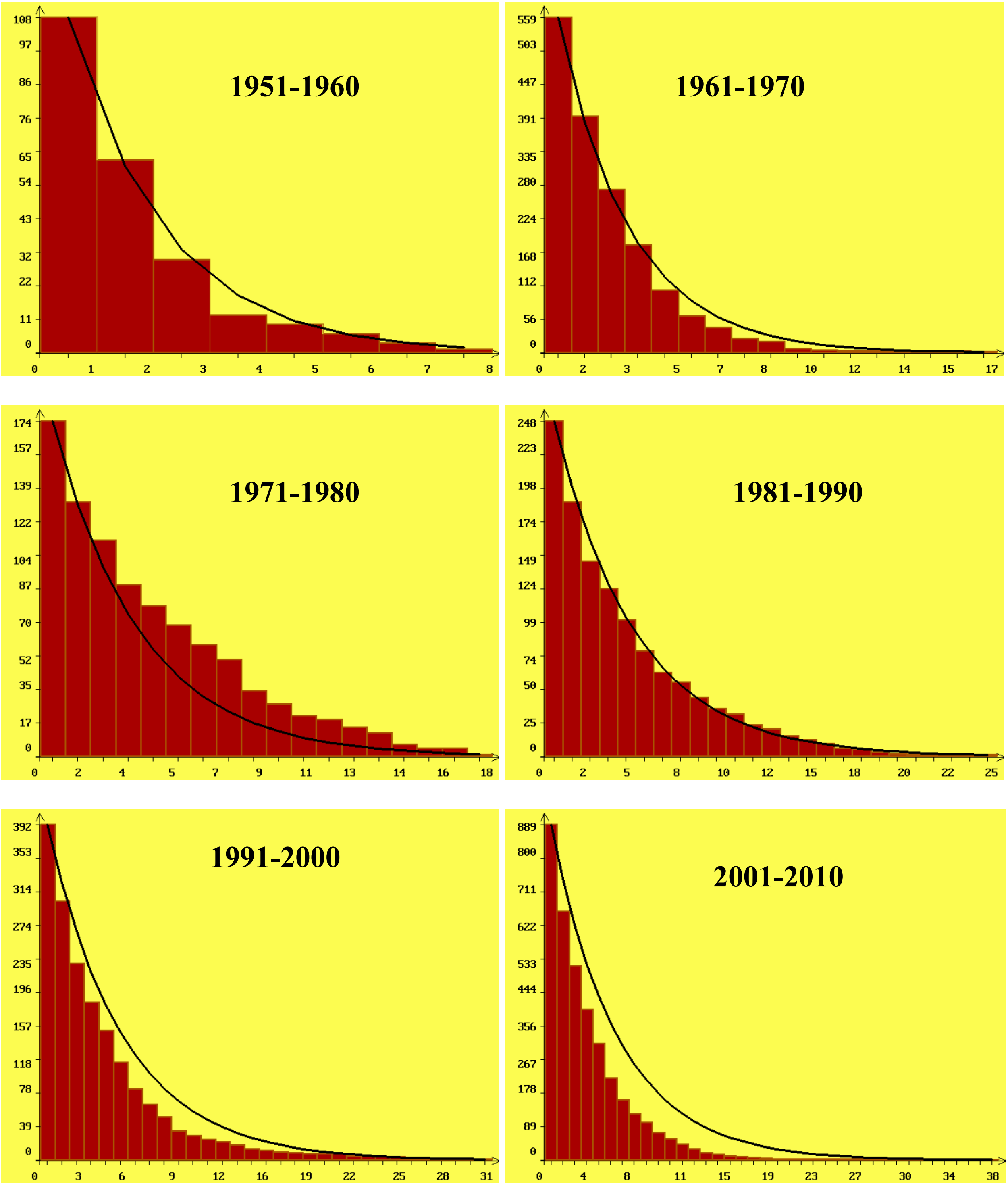


Figure 84. Mortality pattern in the White-fronted Goose. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Nevertheless, our analysis performed in the section „Ten-year distance" provided some indication that prosperity of European White-fronted Geese have been deteriorating during the recent two decades. In this manner, using our method of the evaluation of the population prosperity we can draw the mortality pattern chart for birds recovered in each decade. The same as in Bean Geese, we include all birds in this analysis. Decade 1941-1950 is not considered because of too few recoveries.



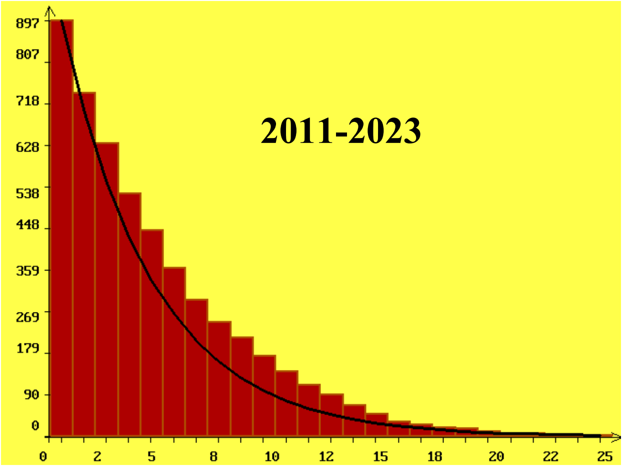


Figure 85 Mortality pattern in White-fronted Geese recovered in different decades. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

For 1960s we have not much data, but mortality pattern indicates "normal" population (species) condition – real data practically follow the theoretical line. In 1970s the species condition of White-fronted Geese was the best: real mortality chart went above the theoretical line (Fig. 85, 1971-1980). 1970s was a kind of "golden era" for geese – their numbers in Europe and Japan in that decade increased by 15% annually (Fox et al., 2010). In 1980s the situation is not the best, but good anyway. For 1990s and 2000s the situation dropped down, and real mortality pattern became not as good as in the 1971-1990. However, in recent year the overall population status became good (see mortality pattern in 2011-2023).

On average, males and females live about the same number of years: 3.93 (N=1576) and 3.84 (N=1561) years respectively, difference is not significant. To compare male and female mortalities we need to exclude temporally several outstanding long lives, because all of them are females. Male sample does not have such birds. After this operation the obtained mortality rates will be greater than the real ones, but they will be valid for comparison between male and female sub-samples. Male mortality for birds with the elapsed years not more than 25 is 23.42$\pm$0.52%, female mortality for the same elapsed times is practically the same – 23.38$\pm$0.52 %. Mortality pattern indicates that both sexes are in good condition, although for females the situation is slightly worse (Fig. 86).

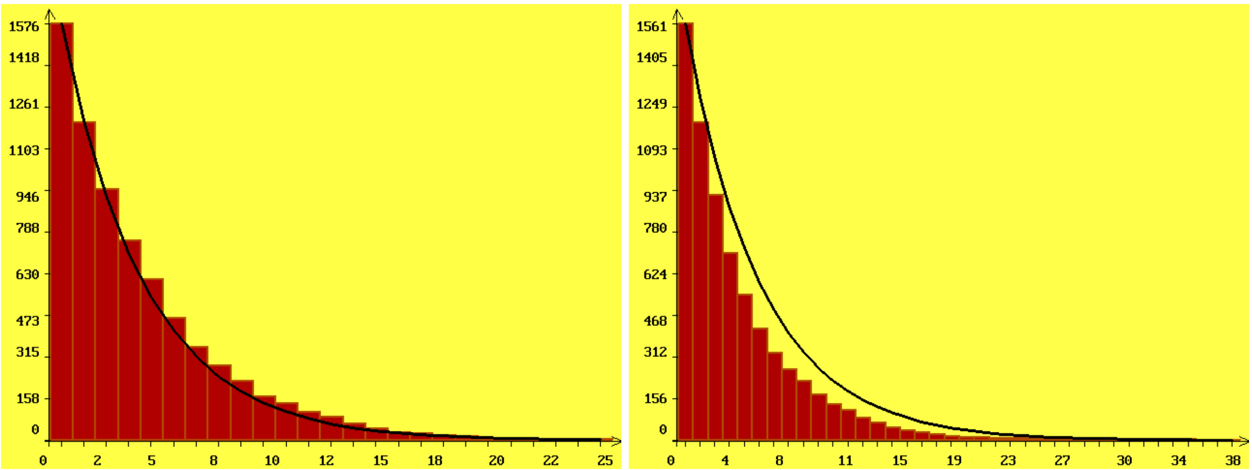


Figure 86. Mortality pattern in White-fronted Goose: males (left) and females (right).

LESSER WHITE-FRONTED GOOSE
(*ANSER ERYTHROPUS*)

Photo by Nadezhda A. Dorofeeva

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 87. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

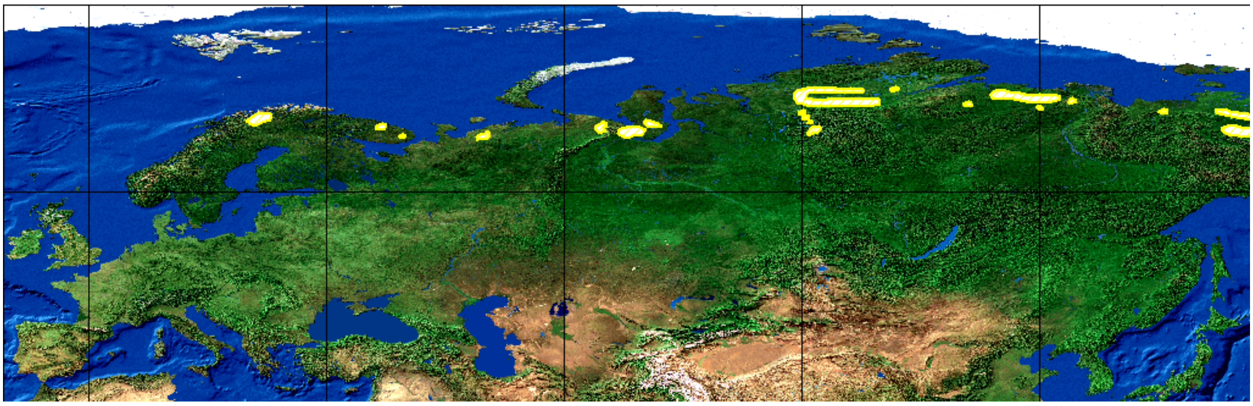


Figure 87. Breeding range of the Lesser White-fronted Goose in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 40 marked birds were used, which gave 64 recoveries (Fig. 88). 24 were marked with rings only, 14 birds also with colour rings (great bulk of birds) and sometimes additionally neck-collars. Two birds of all wore satellite transmitters, here however we used only ringing and the last recovery information on these geese. Ringing dates are since 19.07.1953 until 07.06.2016, recovery dates are since 01.09.1957 until 28.05.2017. Lesser White-fronted Geese with rings have one recovery per bird, birds with neck-collars have up to two recoveries per bird, colour ringed birds have up to 9 recoveries. Data are scarce, however it witnesses that for Lesser White-fronted Geese colour rings are definitely more preferable than neck-collars.

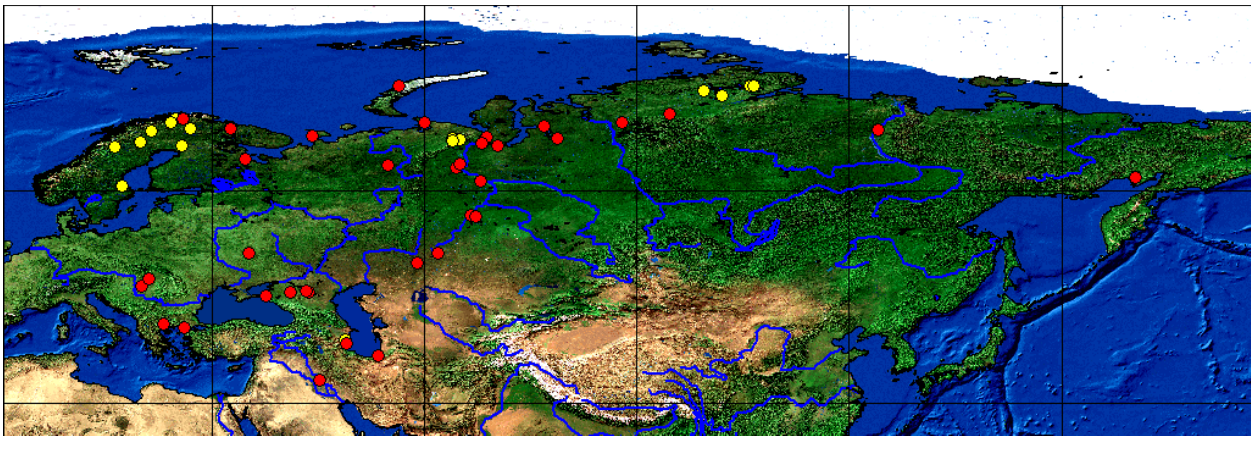


Figure 88. Position of all White-fronted Goose control points. Yellow dots – ringing sites, red dots – recovery sites.

Most of recoveries are connected with the European - west and central Siberia part of the breeding range. Only one recovery obtained from Magadan Region.

'Moskwa' scheme recoveries. „Moskwa" scheme recoveries are represented in 52 recoveries of total 64. They are from birds ringed within the former USSR, in regions: Nenets Autonomic Area, Taimyr Autonomic Area, Komi Republic and Azerbaidzhan (Fig. 89). Four birds which gave 22 recoveries were marked with „Moskwa" rings in Norway.

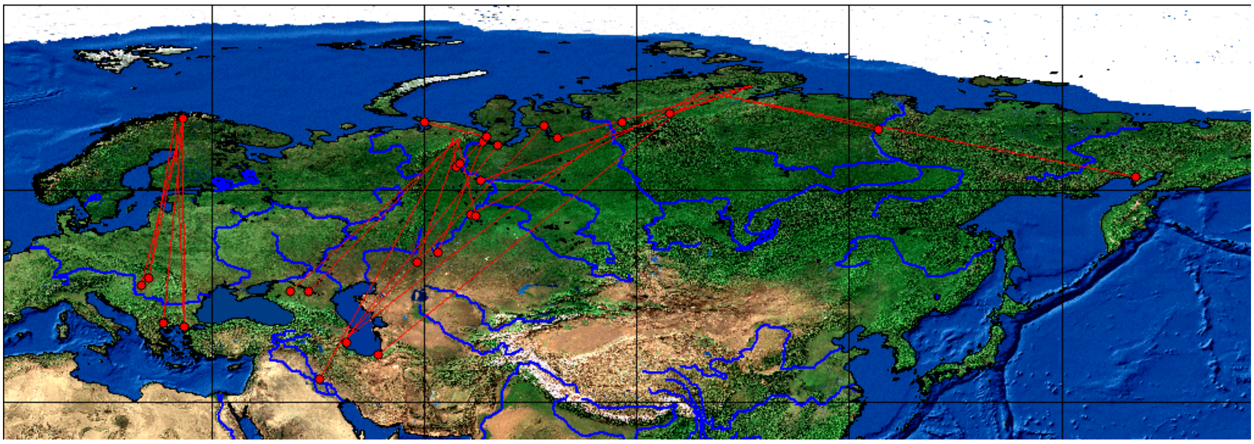


Figure 89. „Moskwa" scheme recoveries of the Lesser White-fronted Goose. Here and in all other similar figures lines start from ringing sites, recovery sites are marked with red dots.

Finding details. This analysis includes all 64 recoveries. Near a half of recoveries (44%) are „sight records". Although Lesser White-fronted Goose is highly protected species, the proportion of „shot" recoveries is large. „Details unknown" for geese usually also means that they were shot, therefore practically one half of Lesser White-fronted Geese recoveries in the database were shot. Other reasons are not so common (Fig. 90).

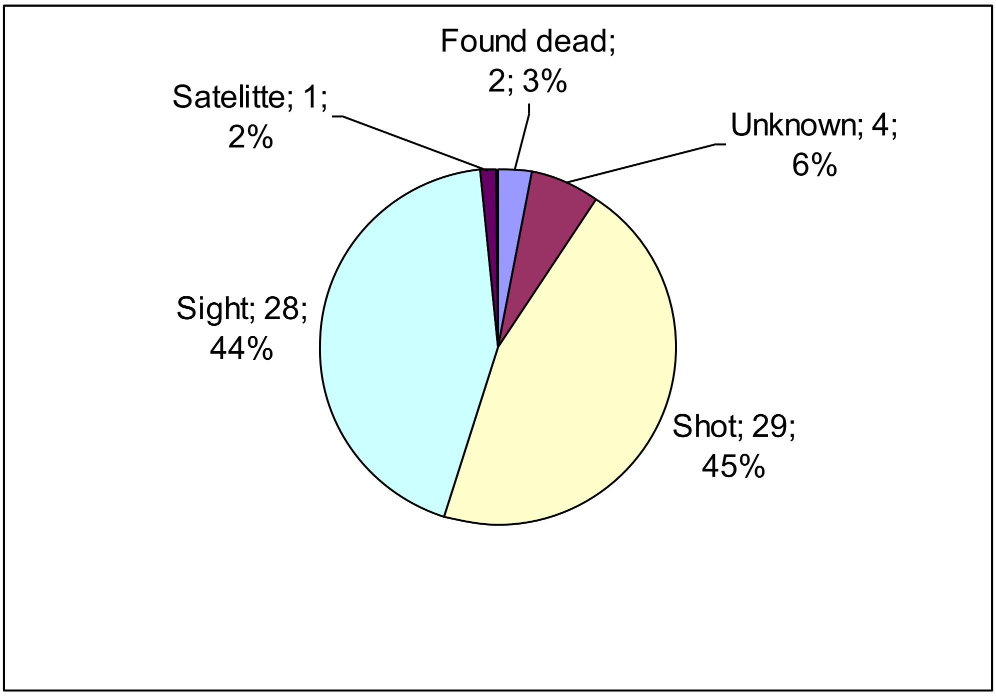


Figure 90. Finding details in the Lesser White-fronted Goose.

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries are similar, except for one recovery from Taimyr Peninsula to the northern coast of the Sea of Okhotsk (Fig. 91, 92).

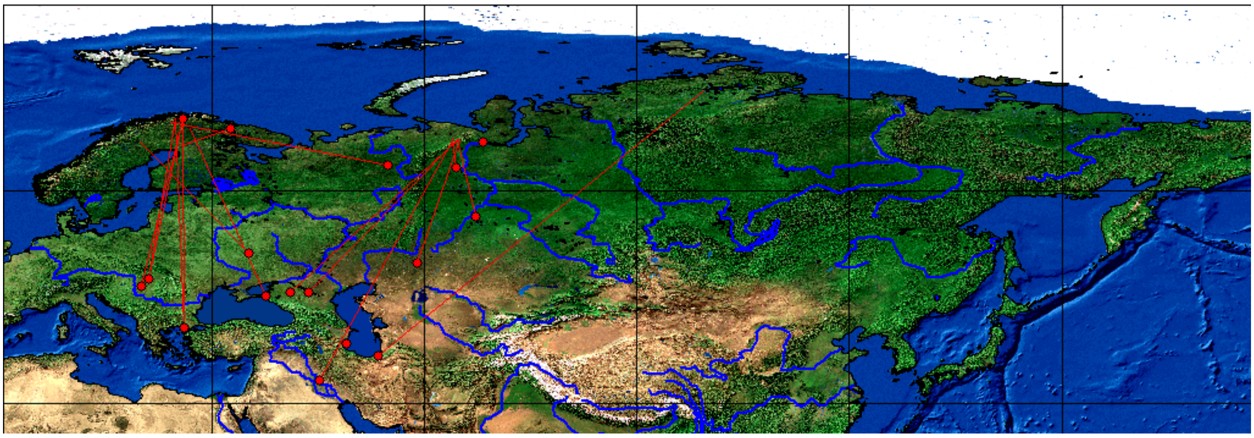


Figure 91. Map of the Lesser White-fronted Goose direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

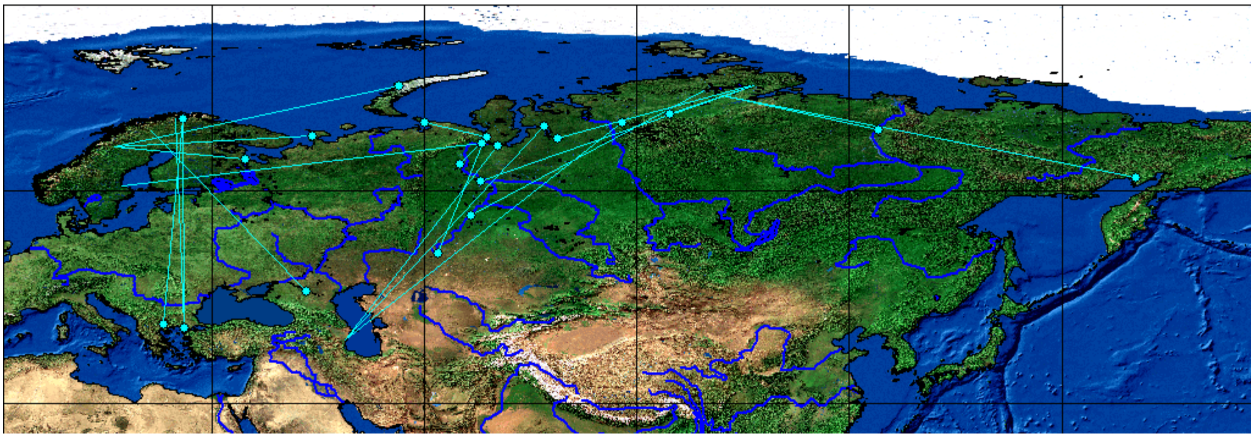


Figure 92. Map of the Lesser White-fronted Goose indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

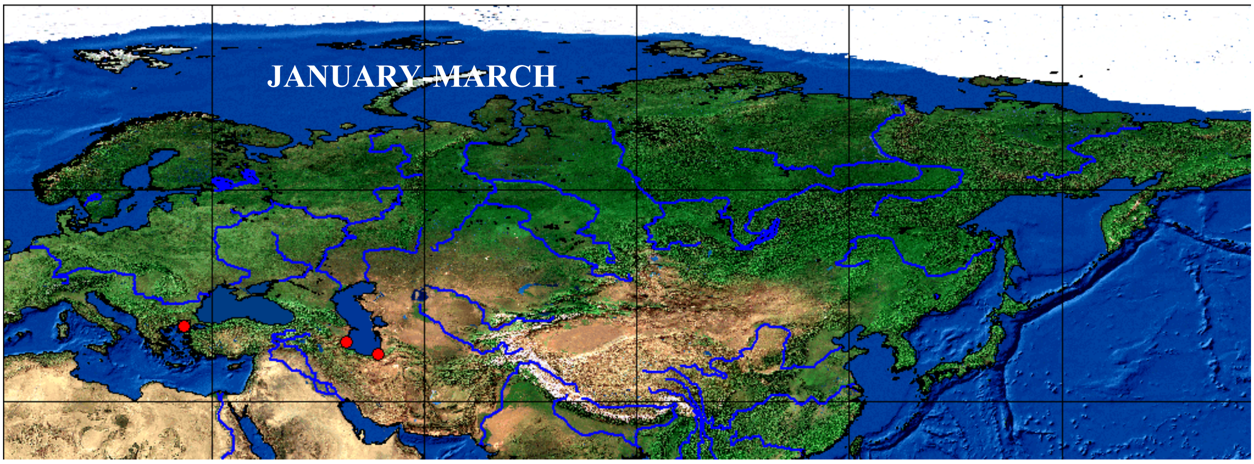
Maps indicate that White-fronted Geese breeding in the northern Europe winter mostly in the south-eastern Europe: Balkan and Black Sea area, up to the Caspian Sea. Geese breeding in the north of western and central Siberia, winter from the Caspian and Black Sea areas and more to the south up to the Mesopotamia. Wintering grounds for far-eastern Lesser White-fronted Geese are not represented in the Bird Ringing Centre of Russia database, however presumably they are expected to be in Japan, South Korea and eastern China.

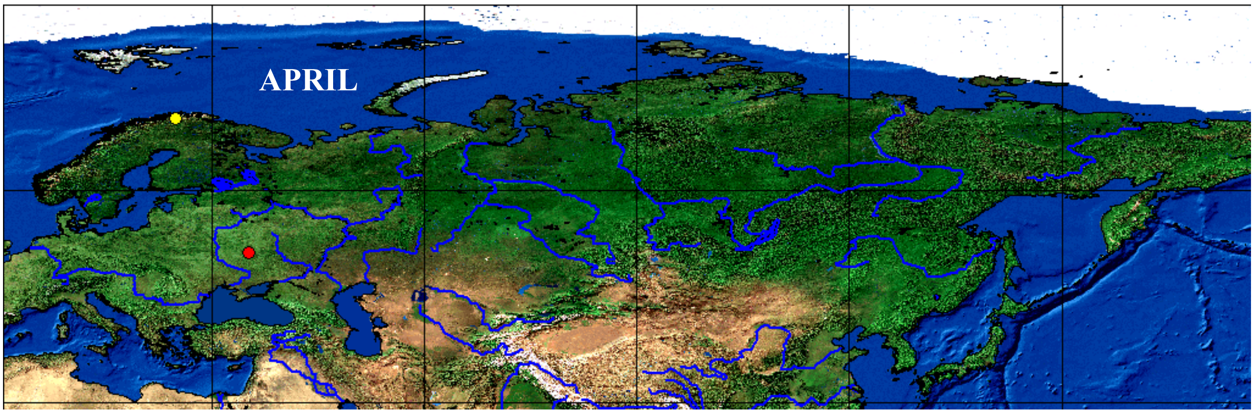
Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them (one cross-population recovery from eastern Taimyr to Magadan Region has been removed): χ^2 = 8.56, 37 direct recoveries and 26 indirect ones, df = 2, P = 0.014). Centre of area of indirect recoveries located in 1293 km north-east of the area of direct recoveries. Average flight distances for direct and indirect recoveries are very similar: 2034.9±223.7 and 1982.4±254.8 km respectively, difference for so small samples is insignificant.

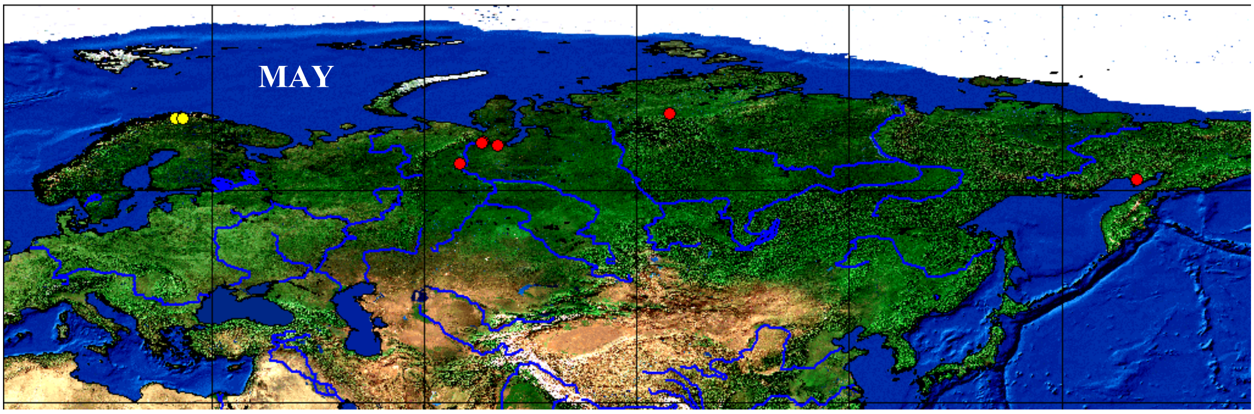
Monthly movements. All direct and indirect recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery locations) reflect a general way of seasonal movements in the Lesser White-fronted Goose (Fig.

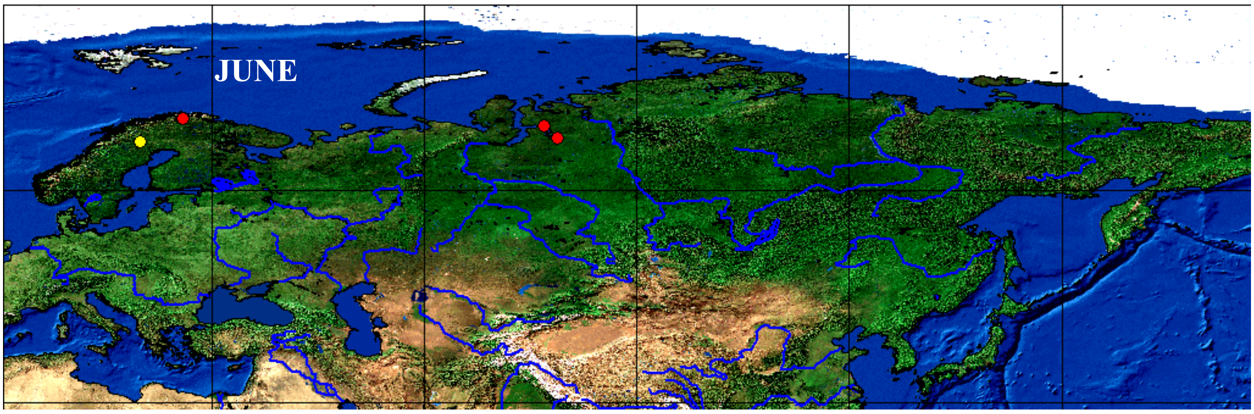
93). Movements to breeding grounds in wintering Lesser White-fronted Geese are not detected till April (compare January-March and April, Fig. 93). In April geese are already on their breeding grounds in the northern Norway, in May they appear on breeding grounds in western and central Siberia, and stay there in June. In July some birds move further east for moulting, main bulk of geese stay in the same areas as in June (Fig. 93). In August migration starts, continues in September, although in September some birds are still not far away from breeding or moulting grounds. In October-November Lesser White-fronted Geese are still on migration, the completing the migration in December (Fig. 93).

Data sample is not large; however, it is clear that Lesser White-fronted Geese do not cross Ural Mountains directly. Like Greater White-fronted Geese, they fly through „northern gate" (the corridor between northern end of Urals and sea coast) or „southern gate" (around the southern end) of Urals.





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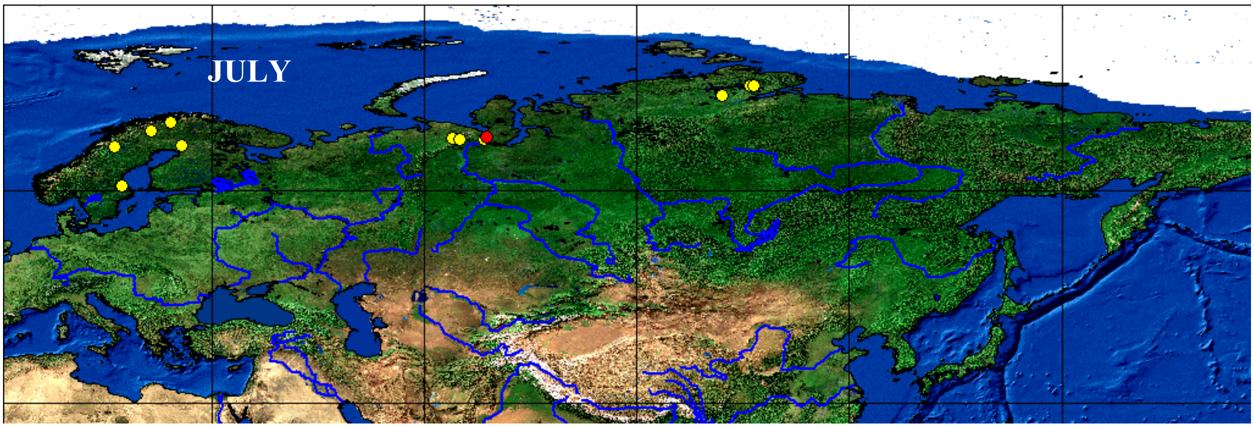
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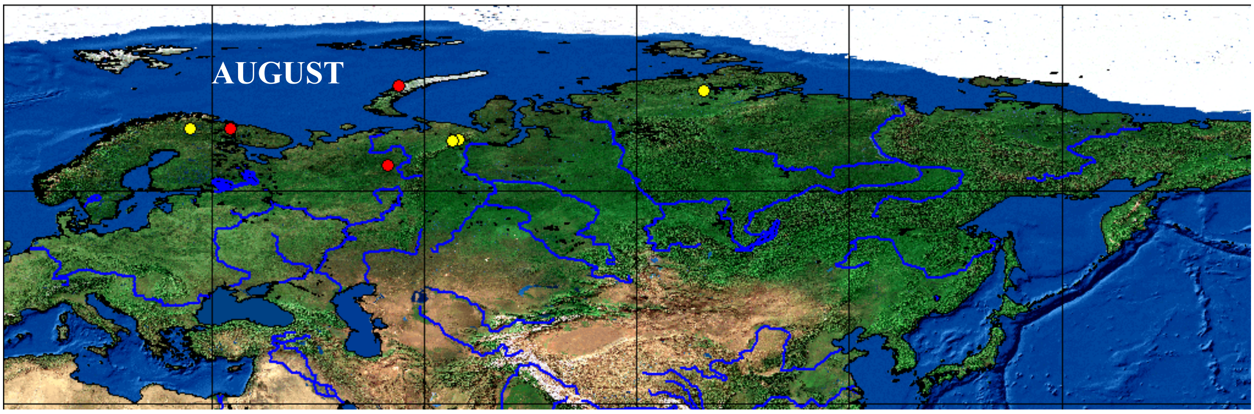
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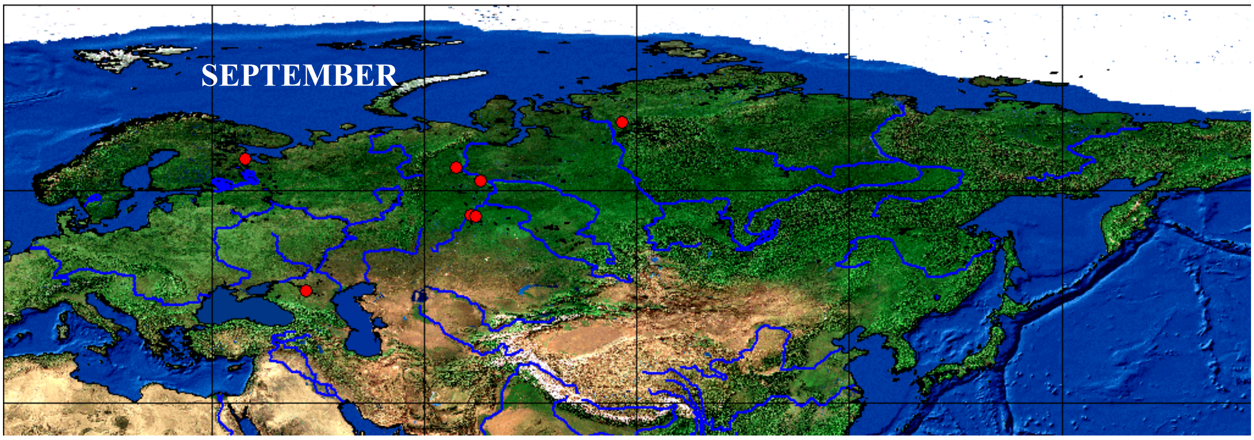
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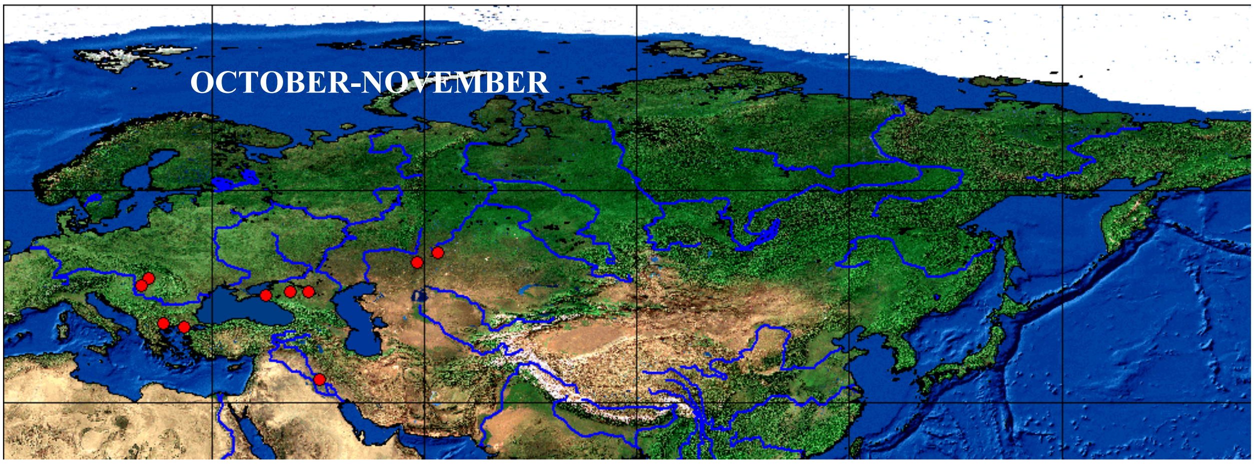


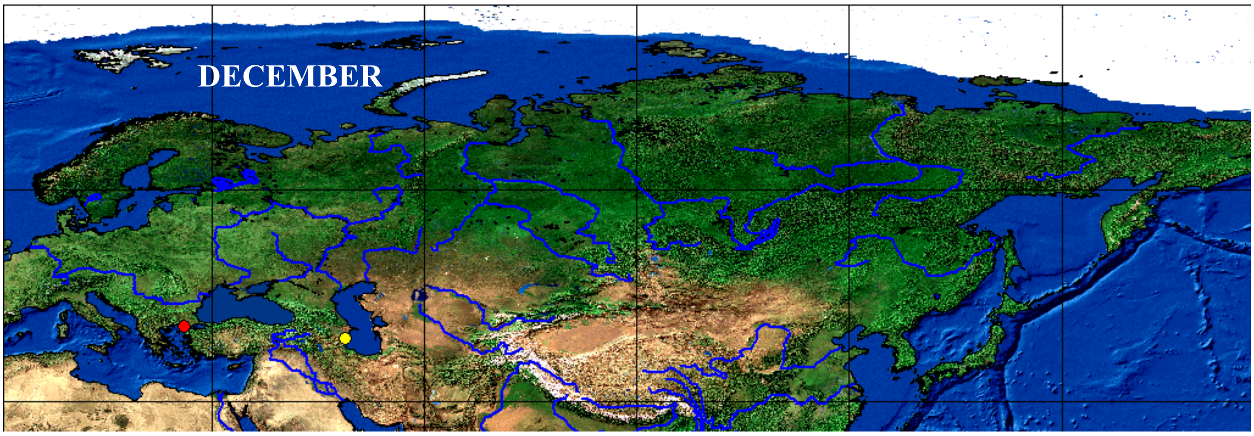


Figure 93. Lesser White-fronted Goose monthly movements. Yellow dots are ringing sites, green dots are recovery sites.

Migratory routes. Most of Lesser White-fronted Geese represented in our database migrate between European Russia and western-central Siberia to the south-eastern Europe and in the Black Sea-Caspian Sea areas (legend to Fig. 94). Geese that marked in the very north of Norway (Valdak, Finnmark) spend winter in Greece, mostly in the Euros Delta. They fly there with a small bend via Hungary (Figs 94 and 95). However, geese that habituate area south of Valdak in the northern Norway, Sweden and Finland migrate along very complicated way. Several recoveries from there are posed to the east ringing sites – birds move first to the northern European Russia, where meet birds that breed here. Then we see the concentration of Lesser White-fronted recoveries over the northern end of Ural Mountains and beyond them. Recoveries between the Black and Caspian Seas are recorded very late in the season – in October and November. No concentration of recoveries is near Urals in the European part of Russia, the concentration is seen near Urals in the Siberian part. Many of these recoveries encountered in September, earlier than mentioned recoveries between Black and Caspian Seas. All that suggests that migratory route for the great part of northern European Lesser White-fronted Geese is directed first to the east till Urals, then bending the northern end of Urals geese penetrate in western Siberia, then move south to the northern Kazakhstan, where turn back to the west and bend Urals over the southern end of the mountain ridge (Fig. 95). After that most of those birds fly along the direction to the south-eastern Europe, probably winter not far from birds that arrived there directly and along much shorter way (Fig. 95). Part of these birds do not bent Urals, but continue to move to the south-west to the southern coast of the Caspian Sea and up to Mesopotamia.

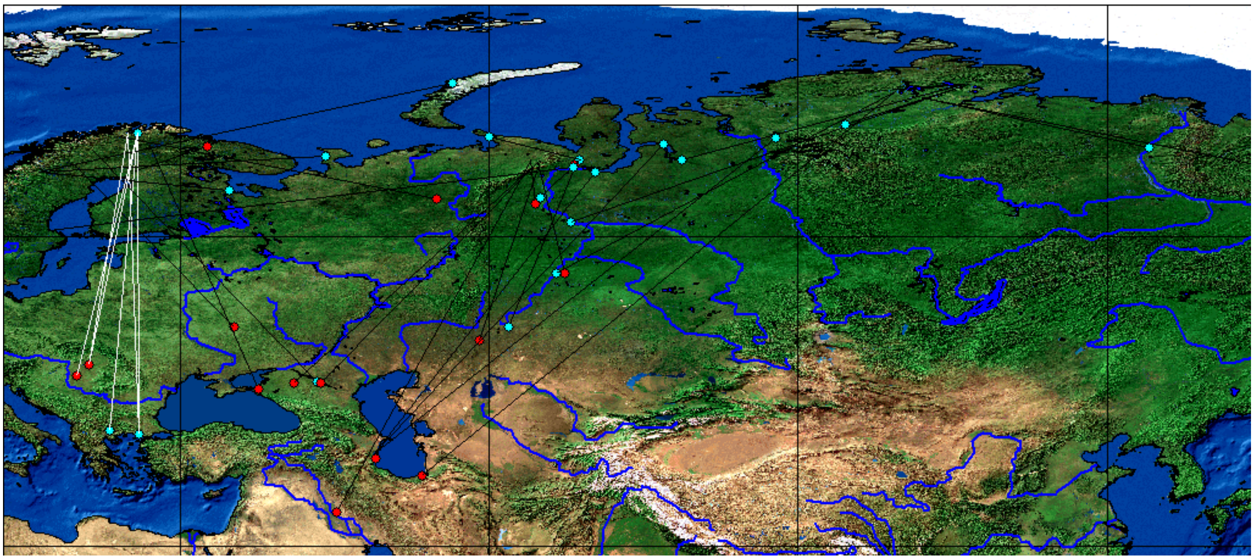


Figure 94. Direct (red dots) and indirect (blue-green dots) recoveries of Lesser White-fronted Geese marked in different areas. White lines represent recoveries of geese, ringed in Valdak, Finnmark, Norway. Black lines – all other recoveries. Dots are posed at the recovery sites.

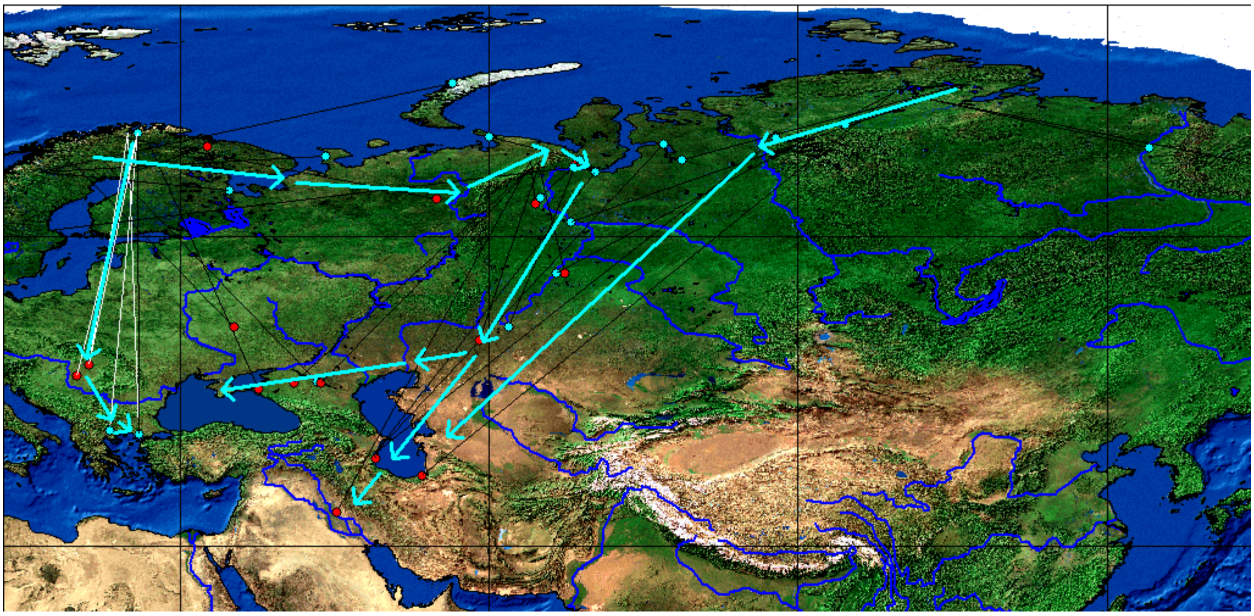


Figure. 95. Outline of the autumn migratory routes of the Lesser White-fronted Geese marked in different areas (arrows). Red dots and blue-green dots represent direct and indirect recoveries of Lesser White-fronted Geese. White lines represent recoveries of geese, ringed in Valdak, Finnmark, Norway. Black lines – all other recoveries. Dots are posed at the recovery sites.

Lesser White-fronted Geese breeding in the north of western and central Siberia, in autumn move more or less to the south-west to Caspian Sea and Mesopotamia, as well. Probably, some of these birds join the northern European birds and fly in the Black Sea direction. Some birds from Taimyr Peninsula fly far to the east then, logically, should turn to the south directing to China, but there are no data for discussing this way of autumn migration. Spring migratory routes cannot not be outlined from the amount of data which Bird Ringing Centre of Russia.

Satellite tracking data. Some populations of the Lesser White-fronted Goose have complicated (even sophisticated) migratory routes. In the same time, low numbers of this species in the World do not allow using mass ringing and collaring for revealing the migration features in detail. Therefore satellite tracking data for the Lesser White-fronted Goose is especially important. During 1994-1998 25 those geese were mounted with satellite transmitters in Norway and Russia (www.piskulka.net, Lorentsen et al., 1998). However, these efforts gave information on the autumn routes and stopovers, wintering grounds were not revealed by those birds. Only the bird marked in 2004 at the northern Urals reached its wintering area (Morozov, Aarvak, 2004), located in Messapotamia. (Marking and final locations of this already mentioned bird are included in the database and used for the analysis together with ring-recovery data). Lesser White-fronted Geese from Plateau Putorana (Central Siberia) spend winter in the same wintering area (http://gis-lab.info/projects/piskulka, partly published in Romanov, Pospelov, 2010).

Lesser White-fronted Geese marked in Norway first migrated to the east, bend Ural Mountains around its northern end and reached Ob River mouth (generally this route can be seen from the ring-recovery data (Fig. 95) then flew south to the northern Kazakhstan where stopped for quite long time. It turned out that the area around Ob River mouth is the “place of gathering” of the Lesser White-fronted Geese from two populations (populations number 2 and 3, Fig. 98). Geese from Norway, presumably also from European Russia north, northern Urals Yamal, Gydan, Taimyr Peninsulars and Plateau Putorana in autumn fly to this area as into the “funnel”, then migrate along the lower stream of the Ob River (Fig. 96). Some birds, however, join this migratory route more south (Fig. 96, red track). In autumn all geese that migrate along Ob River stay at stopovers in the northern Kazakhstan and neighbouring areas in Russia. Satellite tracking data show that this extensive stopover is the last place used by Lesser white-fronted Geese from different breeding areas. Later on, birds marked in 2006 in Norway, left Kazakhstan and moved to Ukraine via Tsymlyanskoye Reservoir. Then these birds moved to the Sivash Lake, south-eatern Ukrain, then arrived at the Lake Kerkini and Evros Delta, Greece. Non-breeding geese from Norway could perform even more complicated migratory route. On the flight from Norway to Western Siberia they could pass by Ob River mouth and move considerably further east up to Taimyr Peninsula where moult together with Lesser White fronted Geese of the west-central-siberia-caspian-sea-mesapotamia population. After moulting they migrate back to the west to the mentioned “funnel”, moving along the described migratory route via Kazakhstan and Ukraine to Greece, covering more than 9000 km (Fig. 97).

The most interesting that ring recoveries and site records showed that birds in case of non-breeding passed such long and complicated way, in years when they bred flew to the wintering grounds to Greece along the straight route, together with their young. They migrated directly to the south via Hungary to Greece, total distance was near 3500 km. In the past this had been the main migratory route of the Lesser White-fronted Geese from breeding grounds in Norway.

Geese breeding at the northern Urals and Plateau Putorana generally fly to the south-east to the discovered not long ago wintering area in Azerbaidzhan and Iran. Part of birds, likely cross the Caspian Sea and go to the southernmost wintering places in Mesopotamia. Other part of birds bend the Caspian Sea over the northern end, stop on the Manych-Gudilo Lake and lakes in the Rostov Region, Kalmykia, Stavropolsky Krai and Kizlyar Bay in Dagestan. Then birds were detected in Turkey (Lake Van), Iran and Iraq.

In general, spring Lesser White-fronted Geese migratory routes go along the same areas as in autumn. Birds use the same stopovers west of the Caspian Sea and in Kazakhstan. One of birds started spring migration on 20 March, in mid-April it arrived to the Petropavlovsk Region, Kazakhstan. In spring birds flew from Kazakhstan to the north along Ob River without long-lasted stops.

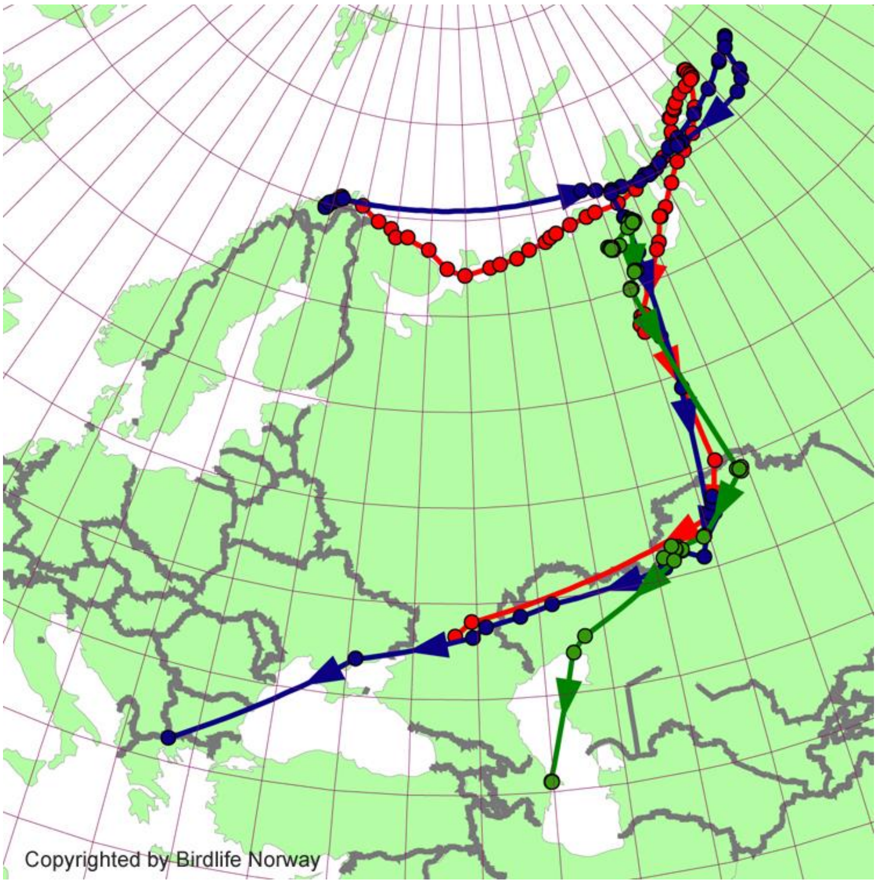


Figure 96. Migration of the Lesser White-fronted Geese mounted with satellite transmitters in autumn 2006. Green line is for birds marked at the northern Urals, blue and red lines – birds from Norway (www.piskulka.net).

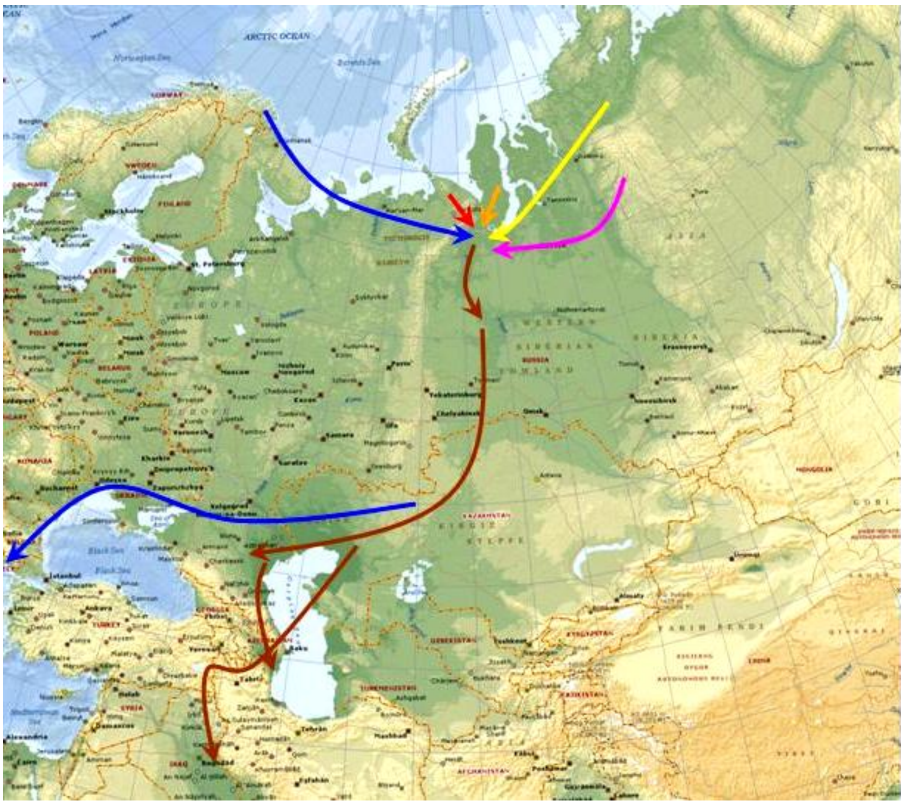


Figure 97. General schematic map of the autumn migration of Lesser White-fronted Geese from different populations and breeding sites (the latter is showed by the different colour of arrows).

Speed. Bird ringing Centre of Russia database does not contain direct recoveries with maximal flight speed of the Lesser White-fonted Goose. The database contains a recovery with the maximal day-by-day movements more than 57 km per day: a goose covered 1486.1 km during 26 days. Real speed is certainly greater.

Populations. Population structure of Lesser White-fronted Geese consists of several populations. Three of them are more or less clear. Bird Ringing Centre of Russia ringing data allow outlining the following populations: 1) northernmost-european-east-european-balkan-area population (polygon No 1, Fig. 98) with generally north-east migration movements; 2) northern-european-west-central-siberian-black-sea-caspian-sea-mesapotamian population (polygon No 2, Fig. 98) with the complicated migratory movements (see section “Migratory routes”); 3) west-central-siberia-caspian-sea-mesapotamian population (polygon No 3, Fig. 98) with north-east – south-west migratory movements. These populations are partly overlapped on their west or east edges.

There is one or more Lesser White-fronted Geese populations to the east of the west-central-siberia-caspian-sea-mesapotamian population. Suggested population is outlined as a polygon № 4 in the Fig. 98

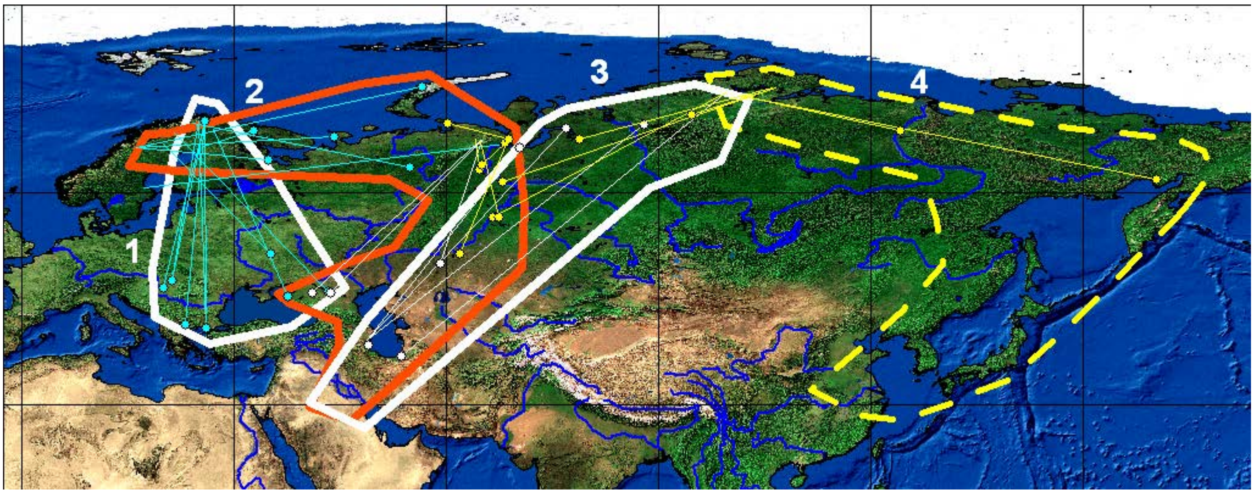


Figure 98. Lesser White-fronted Goose populations. White polygon № 1 outlines northernmost-european-east-european-balkan-area population. Light brown polygon № 2 is the northern-european-west-central-siberian-black-sea-caspian-sea-mesapotamian population. Polygon № 3 outlines west-central-siberia-caspian-sea-mesapotamian population. Dashed yellow polygon № 4 indicates suggested east-siberian-far-eastern-japanese-korean-eastern-china population.

Time period distances. Scarce data do not allow performing analysis on decadal changes of the migration distances in the Lesser White-fronted Geese. Nevertheless, it is possible to compare recovery distances for birds recovered before 2001 and after 2000. In the recent years the mean recovery distance is greater: 1639.9±267.8 km (N=27) for 1957-2000 and 2302.5+197.7 km (N=37) for 2001-2017, the difference is significant (t-Bailey = 1.99, P = 0.05).

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest Lesser White-fronted Goose lived more than 14 years 9 months. The oldest bird in our database lived more than 11 years 2 months.

Mortality rate. According to the common criteria (see "Materials and Methods") only 34 recoveries could be used for the mortality rate analysis. Since the amount of data is very low, our mortality rate access here should be considered as the preliminary one. Mean annual mortality rate in Lesser White-fronted Geese Goose is 25.47+3.77% (Fig. 99). Real mortality pattern differs from the theoretical one insignificantly (χ^2 = 12.5, df = 9, P=0.18). Programme MARK Model CLogLog_2ndPart gives 25.04%. Difference is just 0.43%, within the standard error. Lesser White-fronted Goose mortality pattern chart shows drawdown of the real survival dynamics in the comparison with the theoretical one. The main difference from the theoretical line is owed to exceptionally high number of birds died during the first year after ringing. That clearly points to the bad state of the Lesser White-fronted Goose as a species.

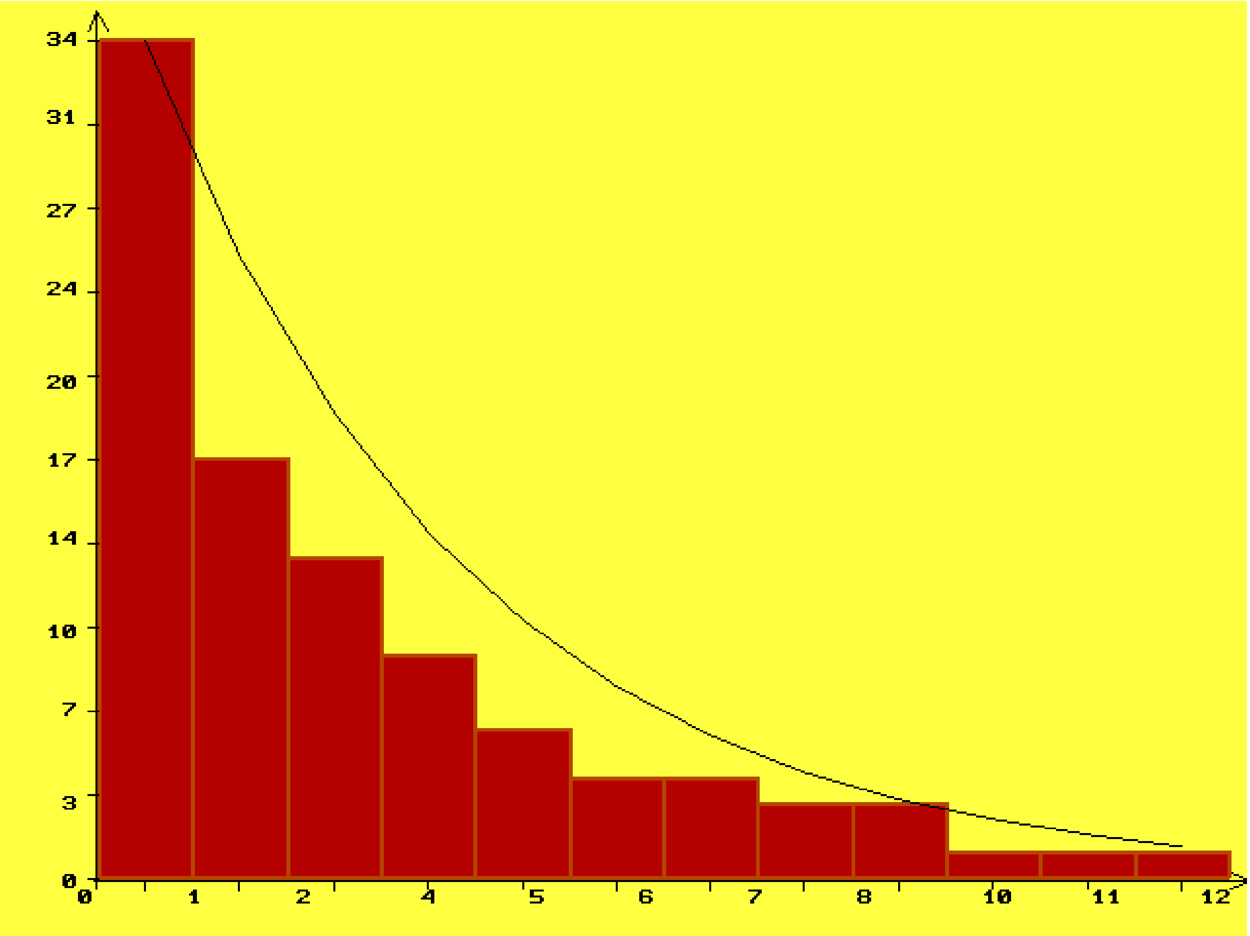


Figure 99. Mortality pattern in the Lesser White-fronted Goose. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Although data are extremely scarce, we would like to represent male and female mortality rate. Difference is obviously insignificant, but the extent of difference is very alarming: mean male age is 2.963±1.740 years (N=6), female age is much less - 0.097±0.013 years (N=3). All these males and females were shot; such great difference could indicate that females are much more sensitive to hunting, which could be the reason for the number decline in the Lesser White-fronted Goose.

GREYLAG GOOSE
(*ANSER ANSER*)

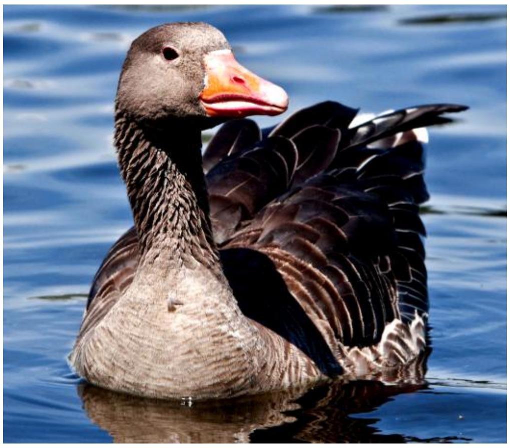


Photo by Nikolay B. Konyukhov

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 100. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

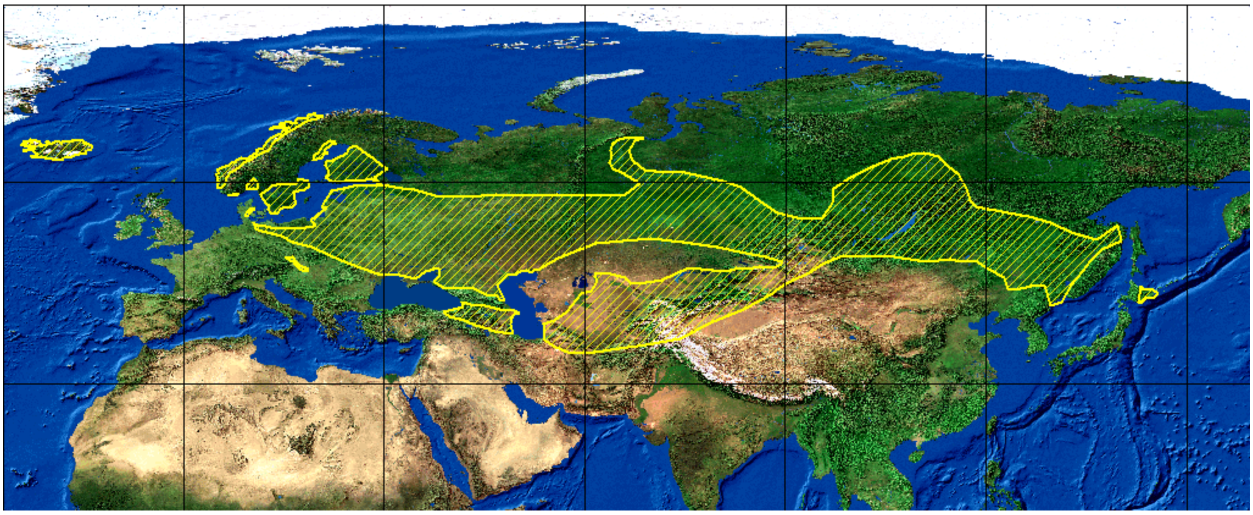


Figure 100. Breeding range of the Greylag Goose in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 297 marked birds were used, that gave 297 recoveries (Fig. 101), 283 were marked with rings only, 10 birds held neck-collar, one – colour rings, three-satellite or GSM transmitters. Part of the marked geese escaped from captivity. We do not know all of these birds, but most of them are known. There are 64 geese ringed in the open range zoo "Askania-Nova", plus one bird ringed as „experimental bird" in the Seewiesen, Kr. Starnberg, Institute of Behavioural Physiology, and one more bird ringed in the Wildlife Park of Moritzburg, north of Dresden. Two young birds that escaped form captivity in the Amur Region were shot after few days near the ringing place. Therefore, 229 birds of total 297 can be considered as really wild ones. In many analyses wild and formerly captive birds are considered together. Ringing dates are since 27.07.1927 until 22.08.2022, recovery dates are since 26.03.1929 until 15.02.2023.

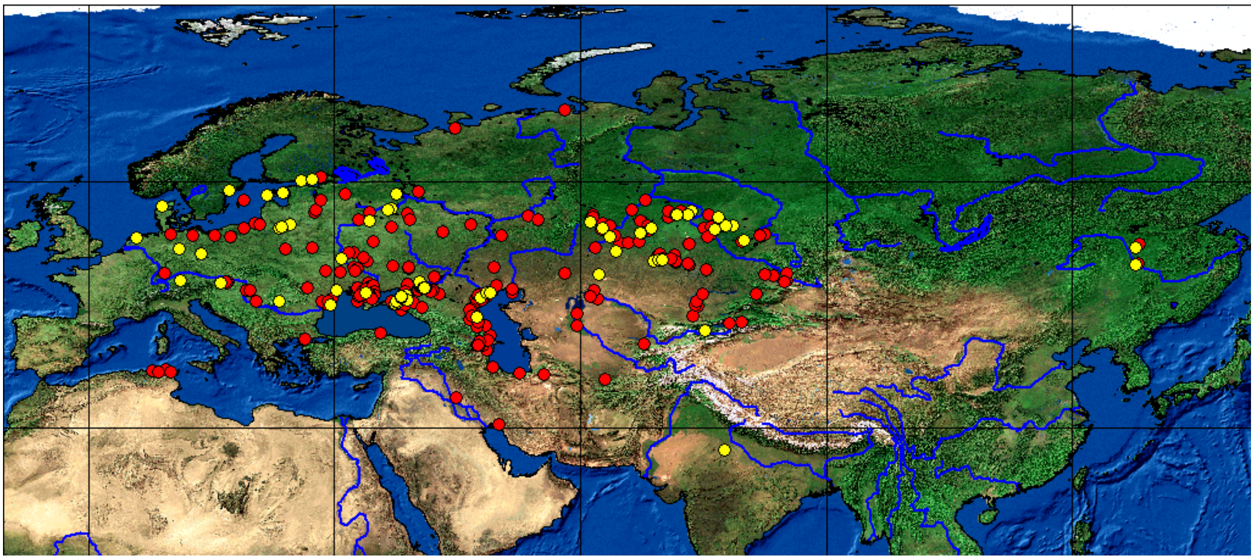


Figure 101. Position of all Greylag Goose control points. Yellow dots – ringing sites, red dots – recovery sites.

Most recoveries are connected with Central and Eastern Europe, Western and Central Siberia, Sea of Azov, Black and Caspian Sea (western coast) area. There are high concentrations of recoveries near the latter seas.

'Moskwa' scheme recoveries. The sample contains 276 recoveries of the „Moskwa" scheme, which is the great bulk of all recoveries we have. They are from birds ringed within the former USSR area, in several countries (Ukraine, Kazakhstan, Kyrgyzstan) and many Russian Federation regions (Fig. 102). Main ringing sites are: Arstrakhan Nature Reserve, Astrakhan Region (45 recoveries); Kurgaldzhinskiy Nature Reserve, Akmola Region, Kazakhstan (39 recoveries); Askania-Nova Nature Reserve and Zoo (64 recoveries).

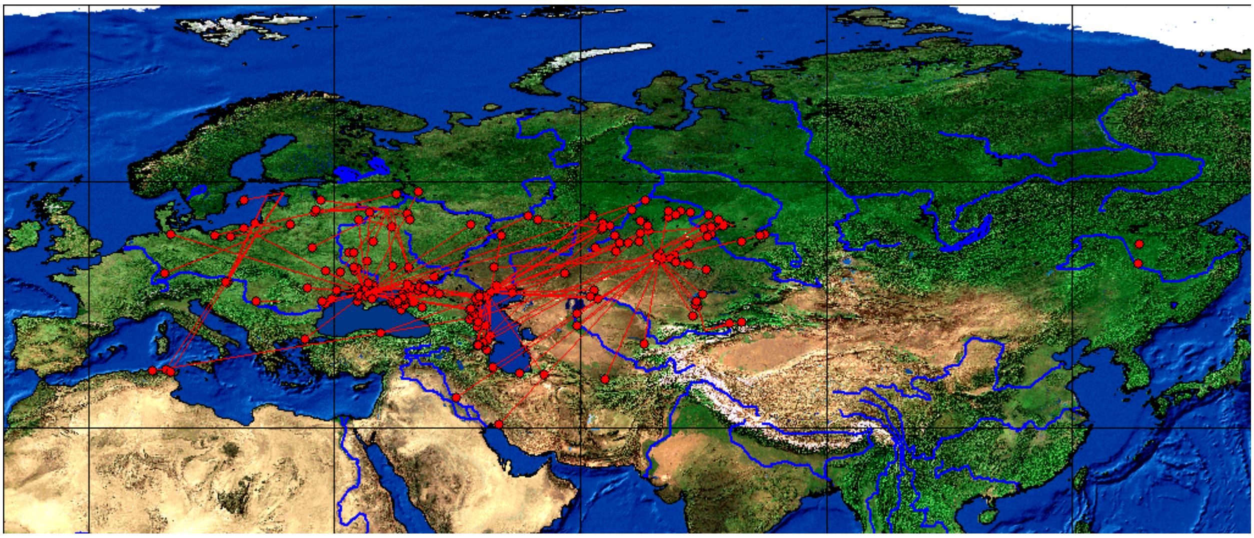


Figure 102. „Moskwa" scheme recoveries of the Greylag Goose. Here and on all other similar figures lines start from ringing sites, recovery sites are marked with red dots.

Finding details. This analysis includes all 297 recoveries. Two thirds of recoveries (70%) are „shot". In 53 (18%) recoveries „details are unknown", which practically mean shot, as well. Therefore, we can assume that 88% of birds were shot. Other reasons are not so common (Fig. 103).

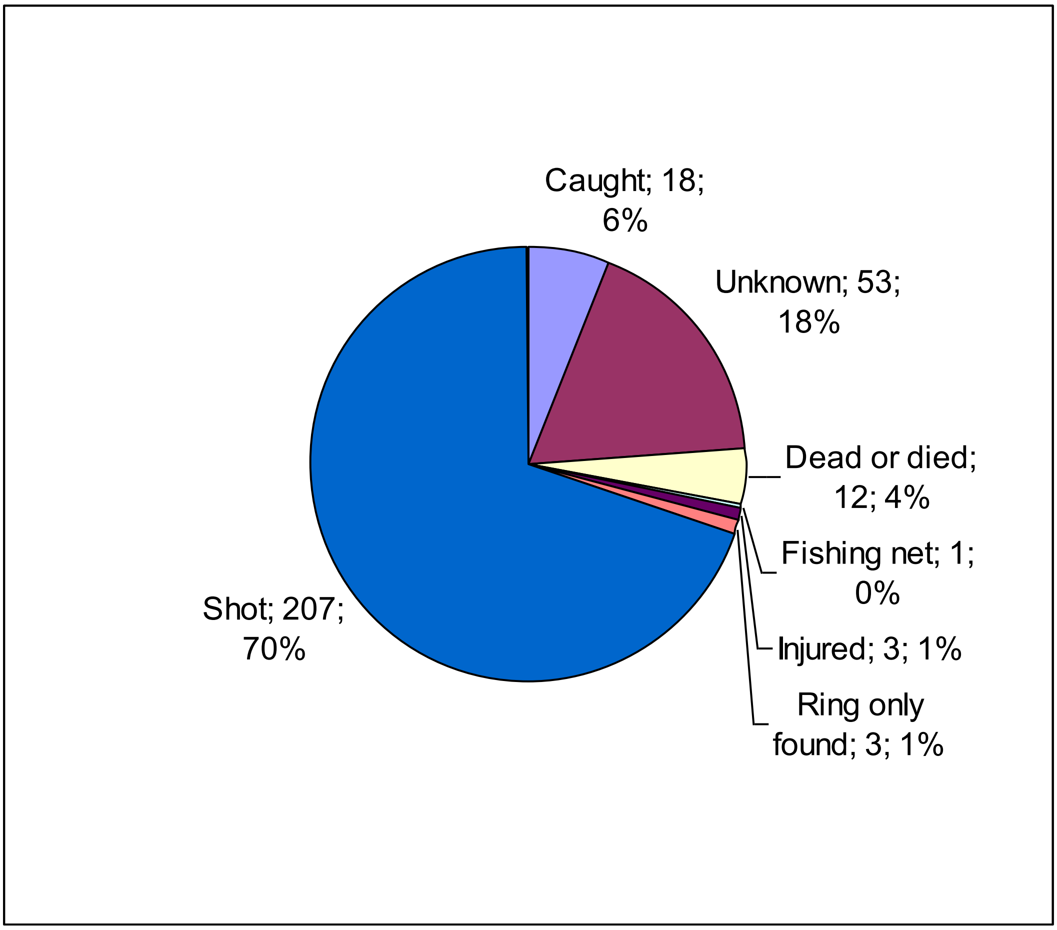


Figure 103. Finding details in the Greylag Goose.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries differ from each other considerably (Figs 104, 105).

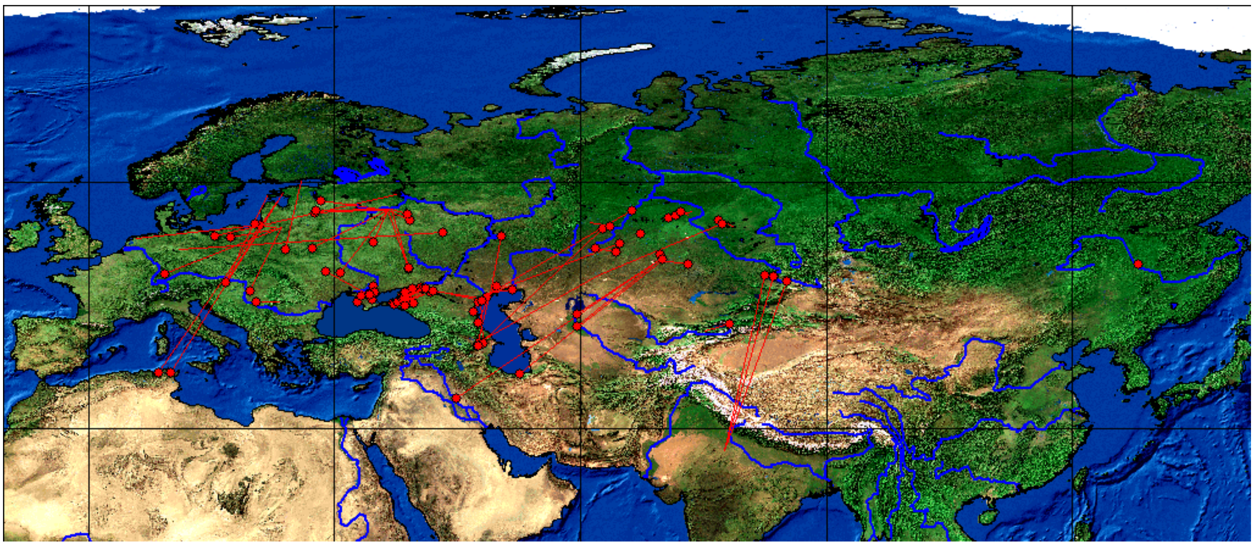


Figure 104. Map of the Greylag Goose direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

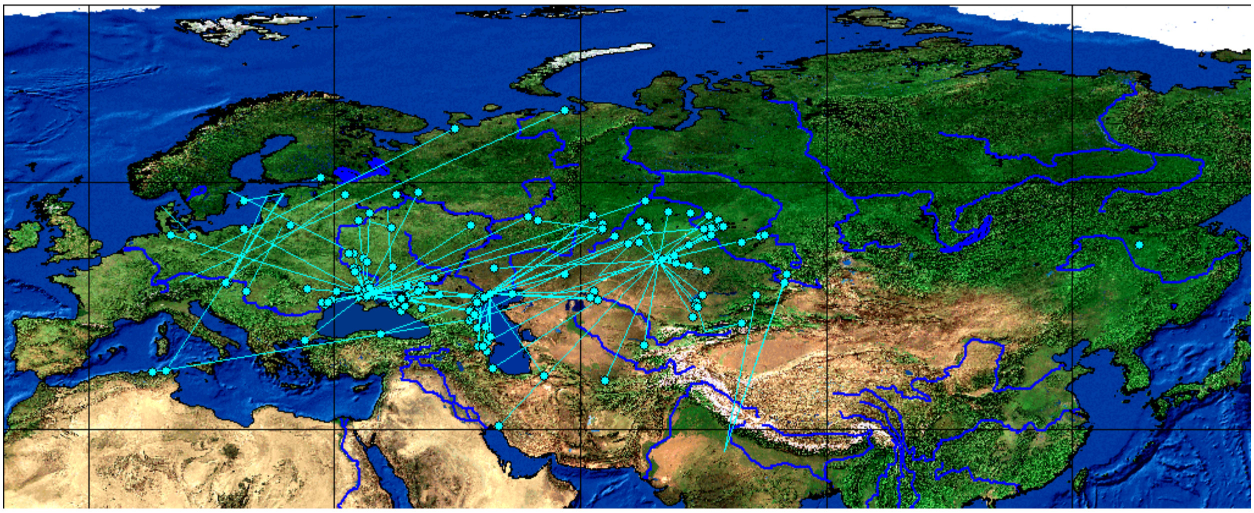
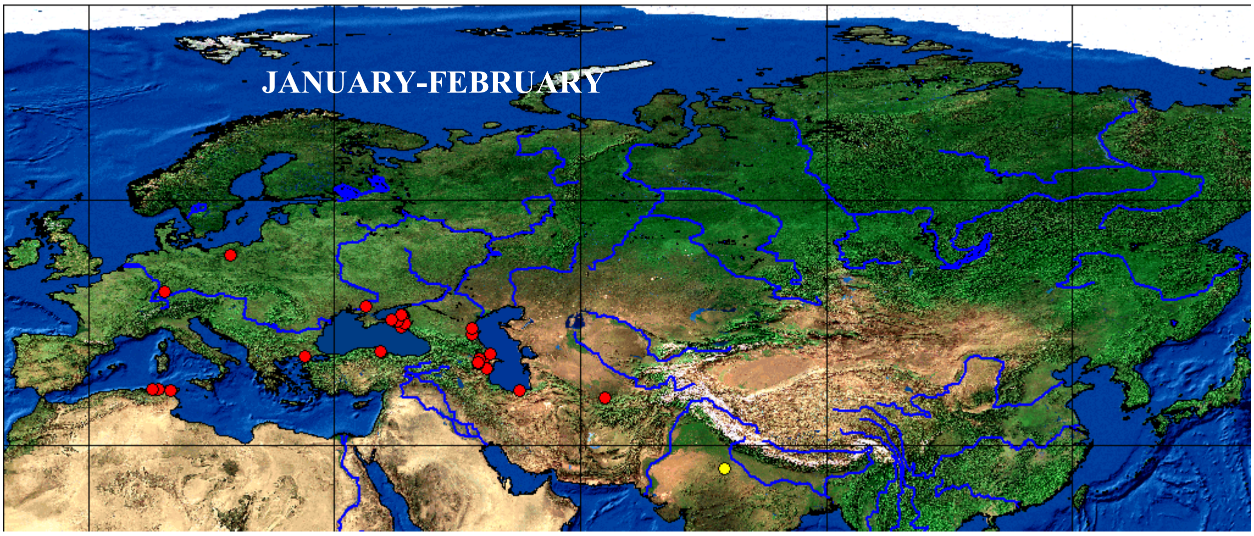


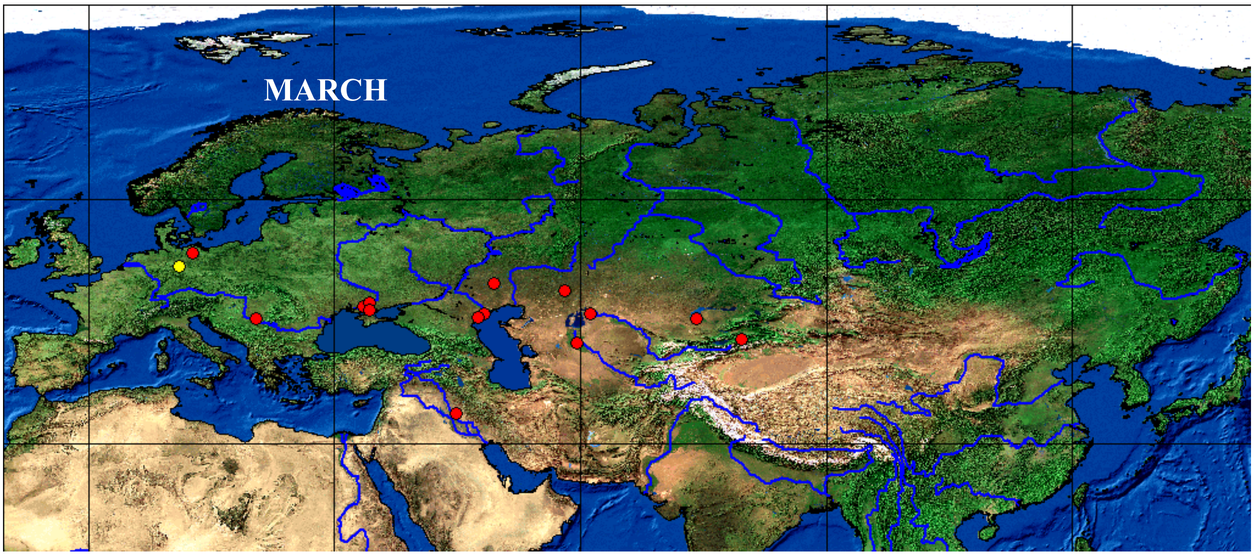
Figure 105. Map of the Greylag Goose indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

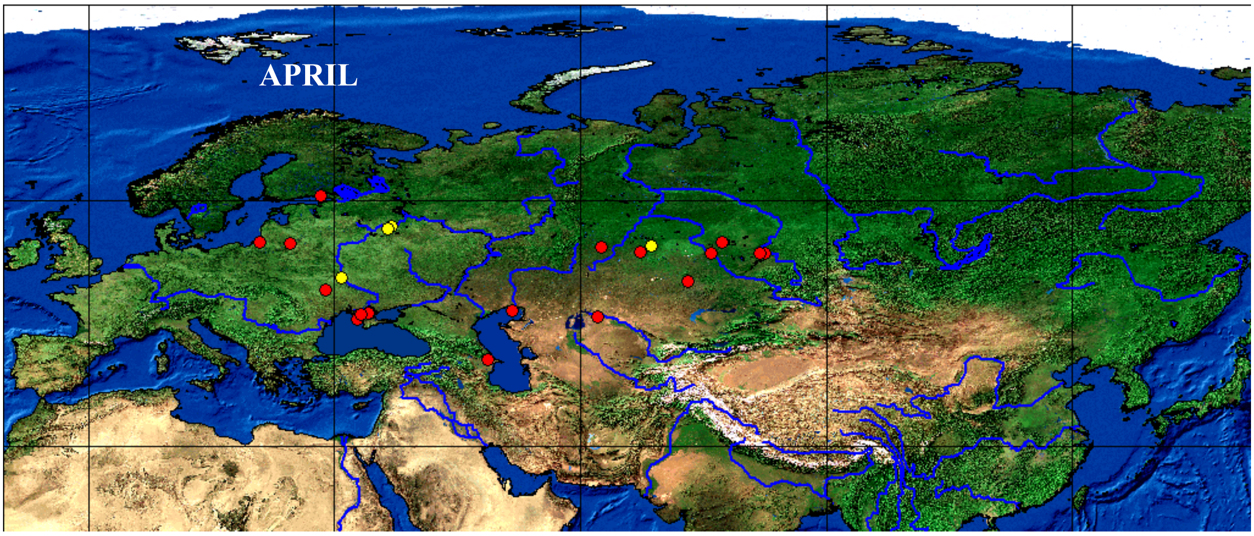
Maps indicate that Greylag Geese are not northern birds; they migrate on shorter distances than Bean and White-fronted Geese and, as a rule, winter not so far from the breeding places. However, from time to time vagrant Greylag Geese can be encountered along the Barents Sea coast (two indirect recoveries, Fig. 105); and even on the Kara Sea coast – in July 2004 a pair of Greylag Geese was met on sea islands near Dikson, western Taimyr Peninsula by Damian and Agnieszka Nowak (personal communication).

Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows no significant difference between them (χ^2 = 6.45, df = 2, 114 direct recoveries and 163 indirect ones, df = 2, P = 0.039). Centre of indirect recoveries is located in 30‟ to the north and 3˚17‟ to the east from the centre of direct recoveries. An average flight distance in indirect recoveries is greater than in direct ones: 655.7±53.1 and 519.4±65.7 km respectively, although insignificant. If we consider only wild birds they show the same regularity, the difference between direct and indirect recoveries appeared: 585.0±73.3 km (N=99) and 653.7+61.3 km (N=130). Peculiarities of Greylag Geese ringed in zoos will be considered in the section "Zoo birds".

Monthly movements. Both direct and indirect recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in Greylag Goose (Fig. 106). In January and February Greylag Geese are on wintering grounds, which located in east and central Europe (Poland and Germany), north African coast, Balkan area, Southern Ukraine, Turkey, Cis- and Trans- Caucasus, Iran, Turkmenistan and India. Movements to breeding grounds in Greylag Geese start in March (compare January-February and March, Fig. 106). Since breeding grounds located not far from the wintering places, a number of Greylags already in March appear on their breeding grounds. Spring migration lasts during April and May as well: the northernmost breeding sites are reached in May. June, July, August, September Greylag Geese are on the breeding and moulting grounds, which in this species likely are about the same areas. Autumn migration starts in October, but not yet in the considerable extent. Migration continues in November. In December geese are on their wintering grounds (Fig. 106).


JANUARY-FEBRUARY


MARCH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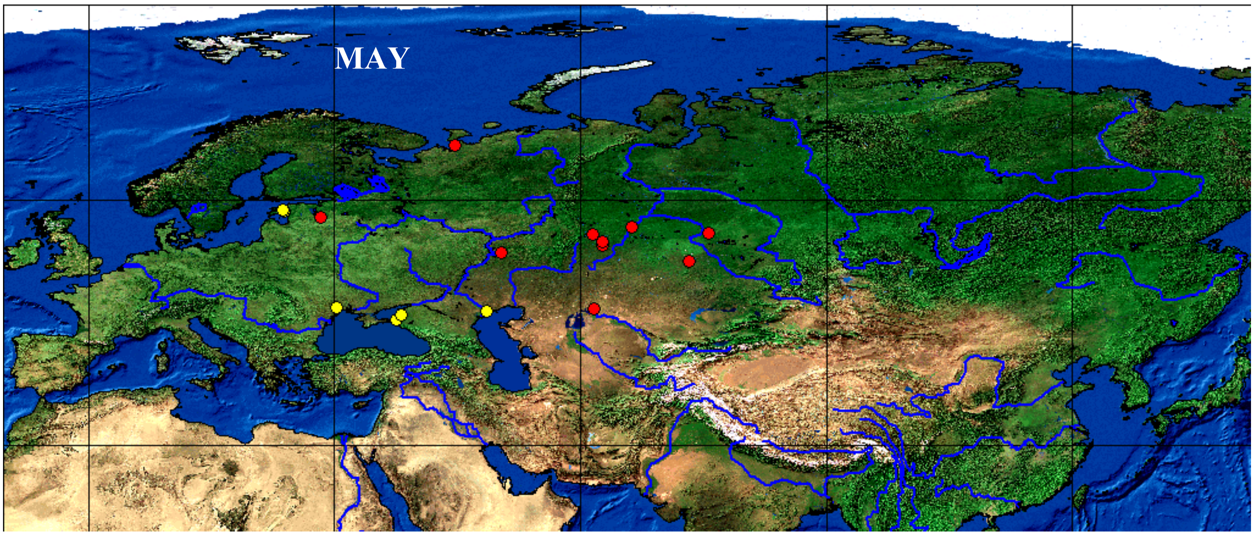
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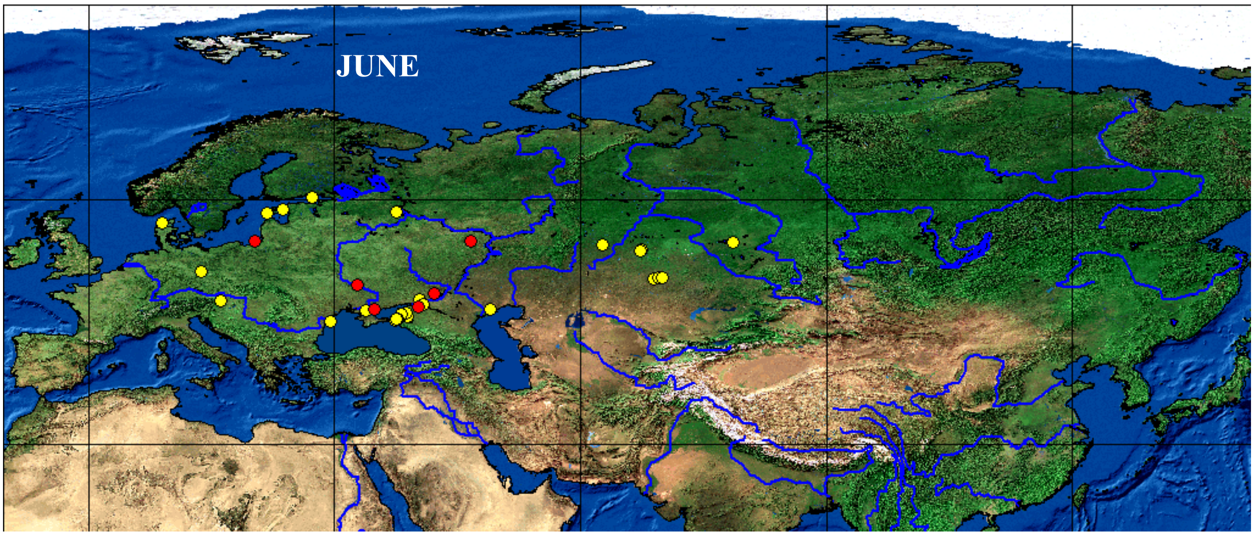
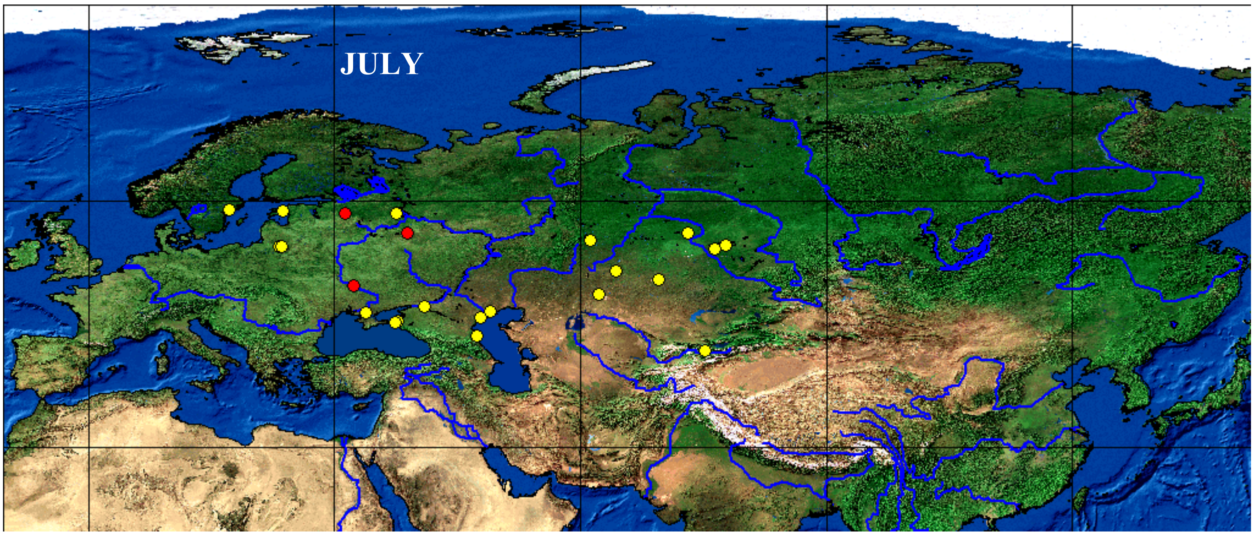

JUNE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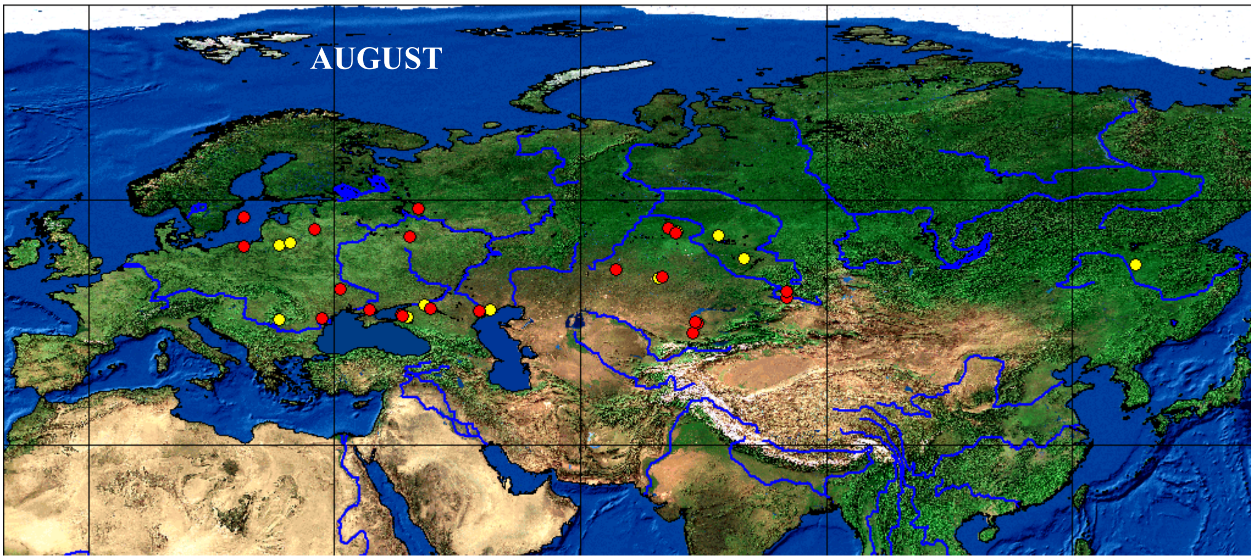
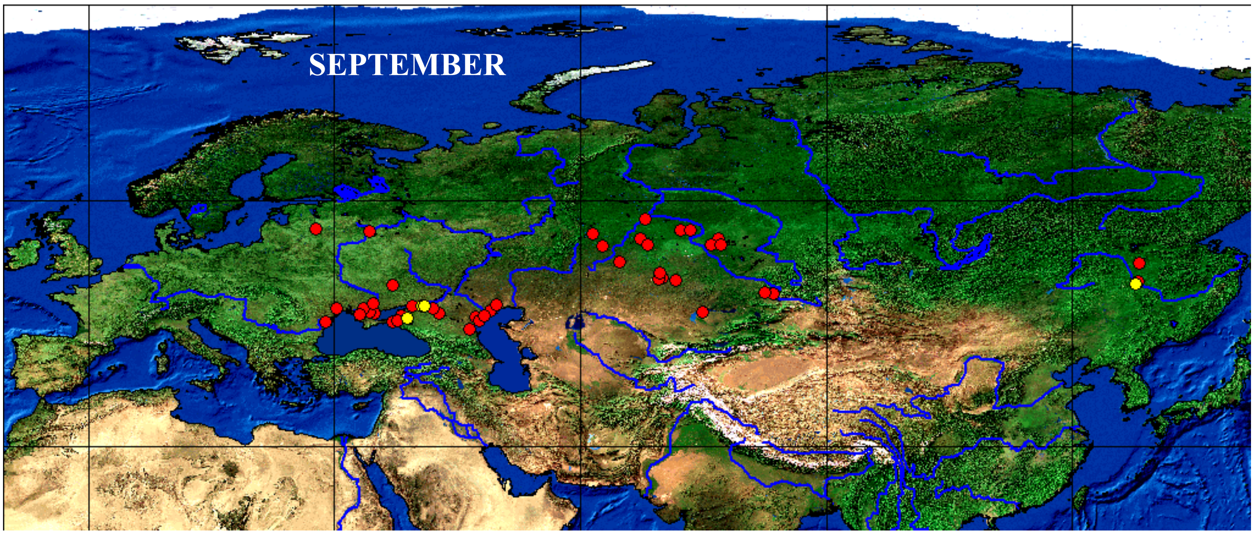

AUGUST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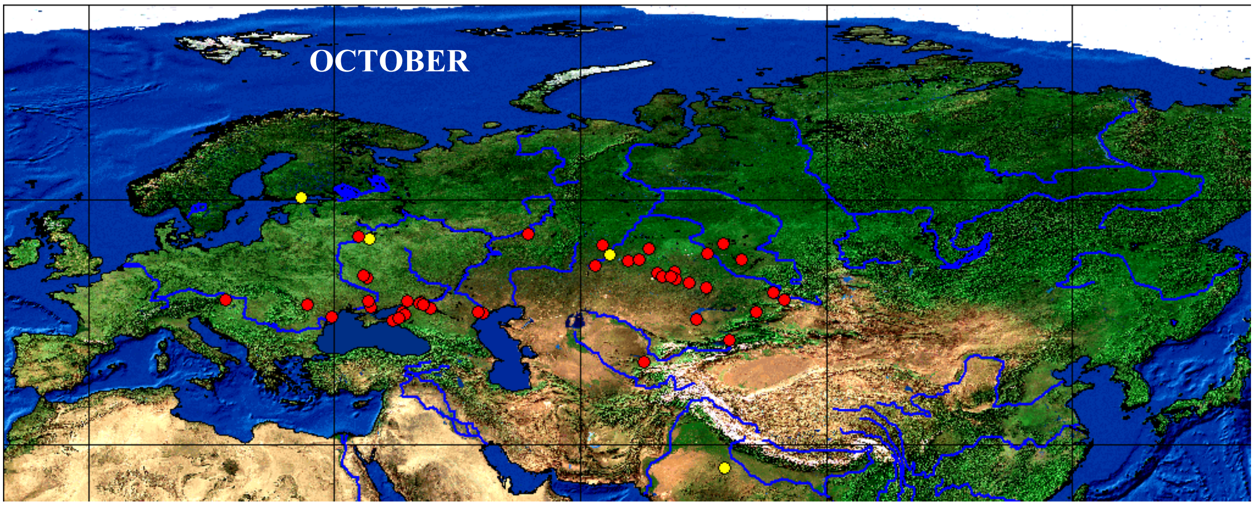
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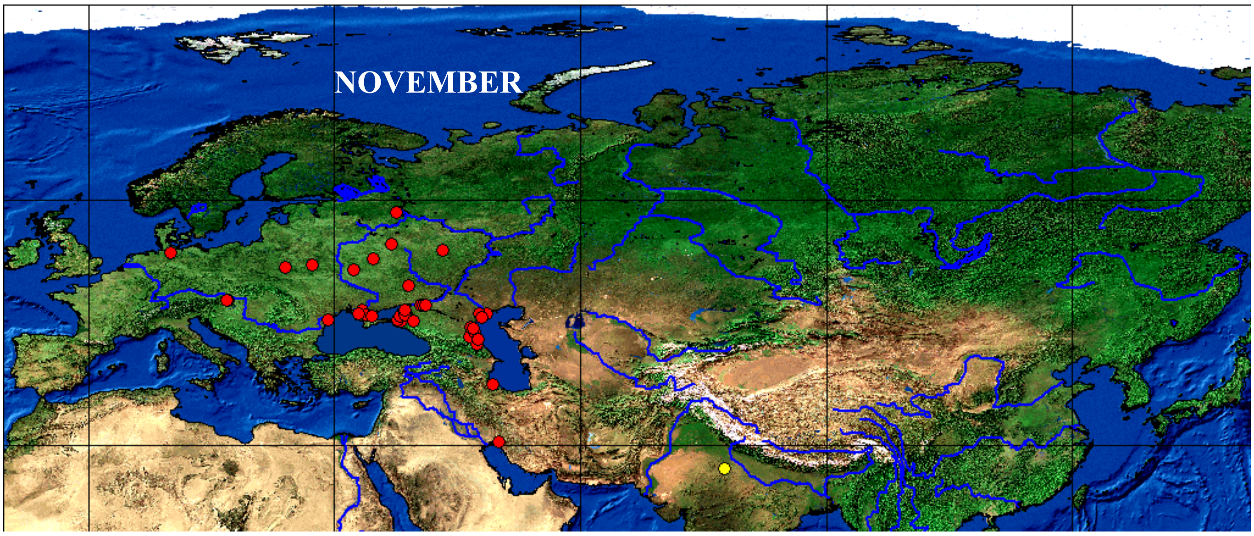


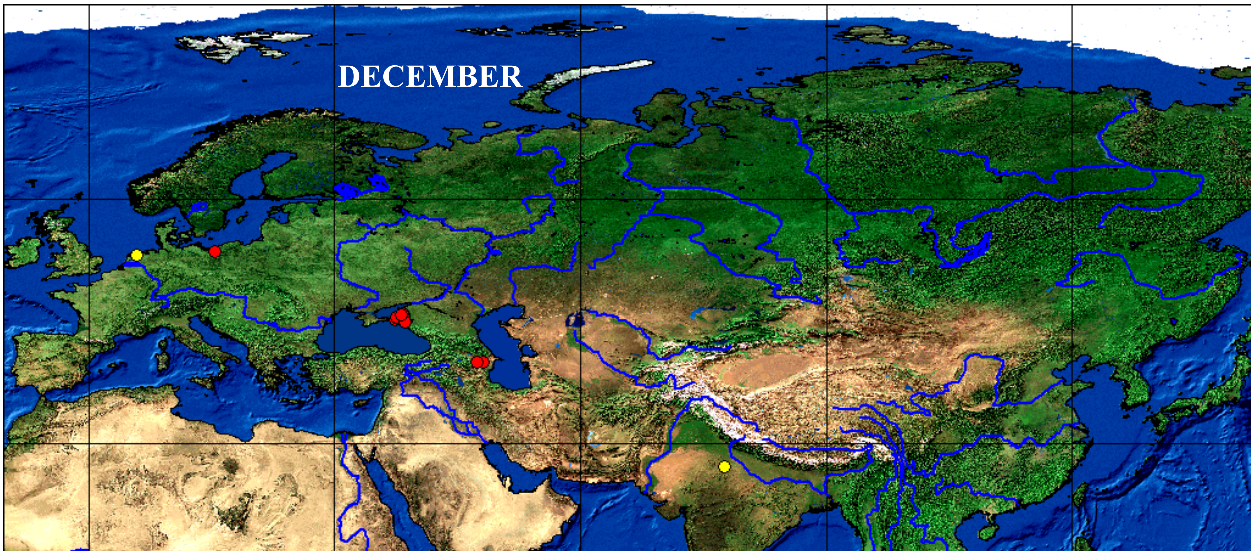


Figure 106. Greylag Goose monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Zoo birds. Method of bird ringing, besides studies of migration, population parameters, etc., sometimes allows understanding additional biological features of bird species. Ringing of Greylag Geese in open range zoos where from they are capable to fly away reveals the mechanism of the habituation of the surrounding area by escaped birds. For the Askania-Nova escaped Greylag Geese distance of the direct recoveries is greatly and significantly less, than distance of indirect recoveries: 94.6$\pm$32.5 (N=13) and 571.7$\pm$87.4 km (N=51) respectively, t-Bailey = 5.09, P = 0.0000. This is clearly visible in Fig. 107.

To find the explanation of this fact, we plot distributions of distances on one chat (Fig. 107). We can see that escaped from captivity Greylag Geese (in distinction to escaped Red-breasted Geese – see the species account) first stay no far from the captivity site for quite long time. Most birds stay nearby forever (probably for this reason Greylag Goose turn out to be a species that is good for domestication). When time is passing, more and more birds fly away at longer distances. In the Askania-Nova sample the first such bird appeared in 299 days after ringing. It flew at 466 km, whereas all other 12 birds stayed within 137 km from the ringing place (see upper chart in Fig. 107). After a year more birds (but not all) venture to move away along hundreds and thousands km. Additional reason for it could be that almost all geese marked in Askania-Nova are young birds. The first winter they spend together with parents. The latter, as described, do not fly away far from the place of escaping.

Two recoveries from two German captivity places confirm this way of habituation. In many years after ringing both these birds flew in more than 2000 and 3000 km to the Barents Sea coast (Fig. 107). One of these geese showed the longest ring-recovery distance in the Graylag Goose sample – 3430 km.

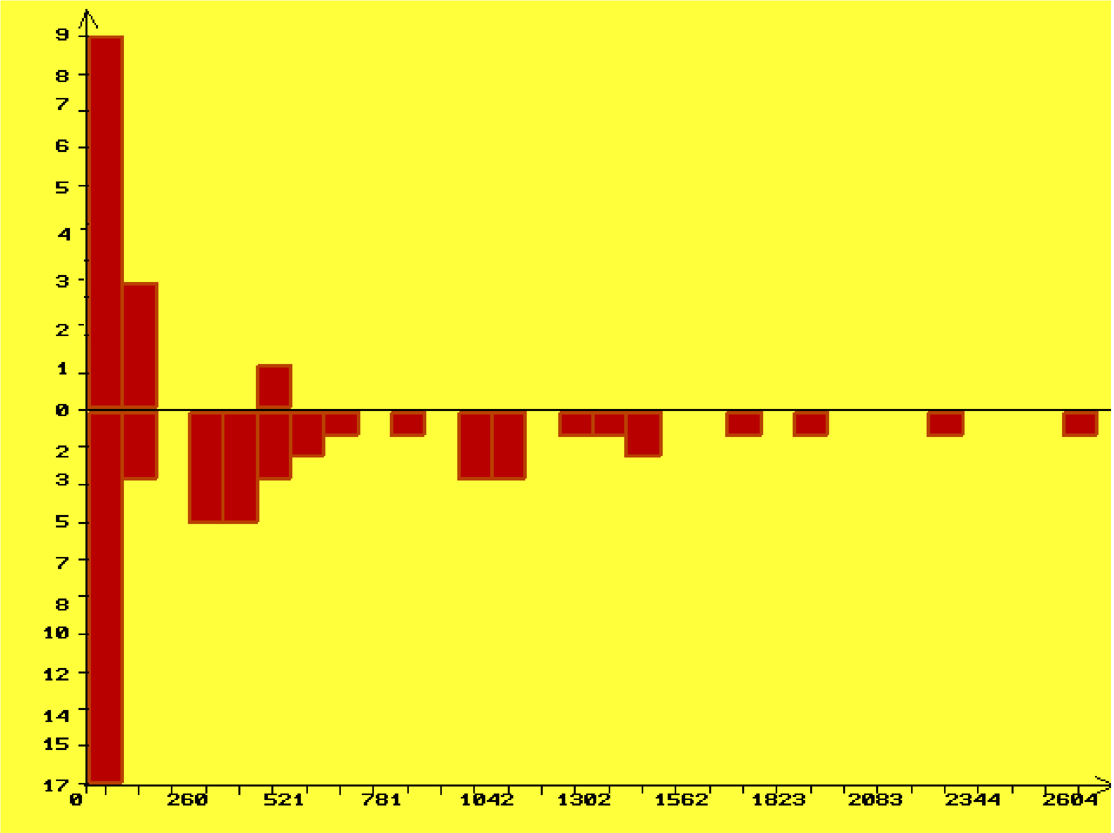


Figure 107. Distribution of distances in direct (upper chat) and indirect (below chart) recoveries of Greylag Geese escaped from captivity of the Askania-Nova open range zoo. X axis represent ring-recovery distance, Y axis – number of birds rounded to the nearest integer.

Geese that escaped from the Askania-Nova open range zoo, flew to different directions, but one direction was preferable (Fig. 108). Birds definitely concentrated along southeast direction, bearing about 105˚. It means they moved to the large wintering place on the southwestern coast of the Caspian Sea, however not directly, because high Caucasus Mountains are on the direct way. The way is presumed to bend the Caucasus Mountains over their north-east edge. Two geese of 12 reached the Caspian Sea in Dagestan, all others‟ movements were shorter.

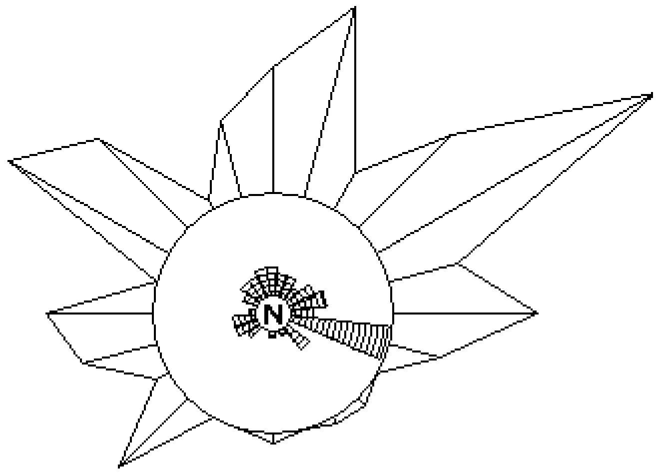


Figure 108. Recovery rose for Greylag Geese ringed in Askania-Nova. Sector = 15.0°; Total recoveries - 64; N in sectors: from 0 up to 13, average distance in sectors: from 0.0 km up to 1641.7 km; the longest flight distance for the sample is 2603.2 km.

Migratory routes. Migratory routes in Greylag Geese in general are not long; directions are different for the different parts of the breeding range. These geese could fly not compulsory to the nearest wintering place, sometimes they chose very remote places, e.g., Algeria and Tunisia coast or Mesopotamia and Persian Gulf coasts instead of places located much more close (Fig. 104 and 105). Birds ringed in the Astrakhan Region (northern coast of the Caspian Sea) where Greylag Geese breed and concentrate for moult, fly mostly along two directions: to the south – wintering grounds on the southwestern coast of the Caspian Sea, or to the north-east – to the breeding grounds in the northern Kazakhstan and south of Western Siberia (Fig. 109, left chart).

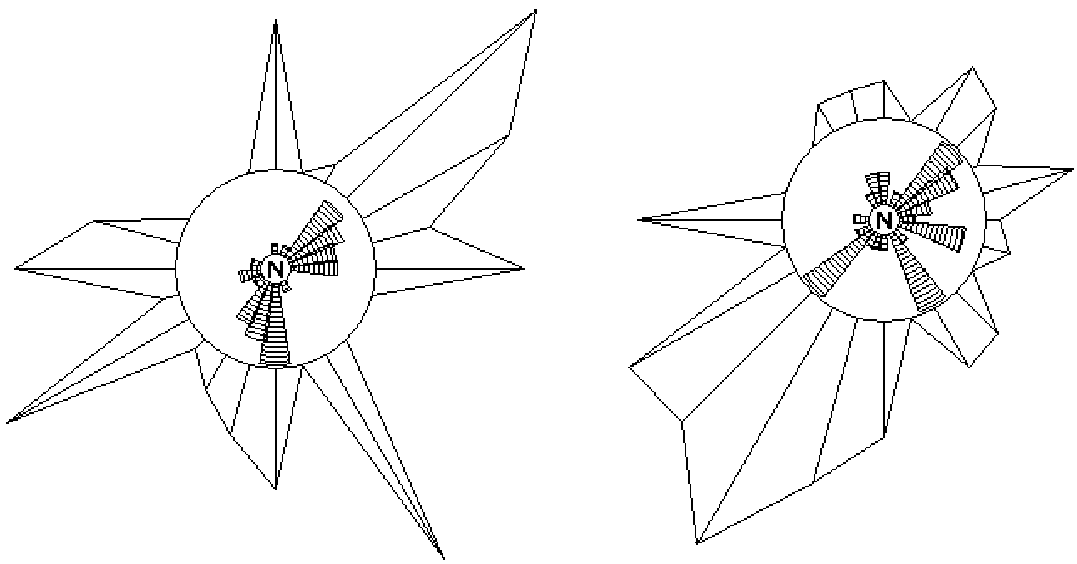


Figure 109. Recovery rose graphs for Greylag Goose: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Left rose graph represents geese ringed in the Astrakhan Region. Sector = 15.0°; Total recoveries - 45; N in sectors: from 0 up to 7; Average distance in sectors: from 0.0 km up to 1395.2 km; The longest flight distance is 1632.2 km;

Right chart of the Fig. 109 represents migration of Greylag Geese ringed in the Kurgaldzhinkiy Nature Reserve, Kazakhstan. Sector = 15.0°; Total recoveries - 39; N in sectors:

from 0 up to 5; Average distance in sectors: from 0.0 km up to 2708.4 km; The longest flight distance is 2740 km.

Geese ringed in the Kurgaldzhinsky Nature Reserve fly mostly in three directions: 1) to the wintering grounds on the southern Caspian Sea coast and further to the Persian Gulf and Mesopotamia; 2) to the breeding areas in the south of Western Siberia; 3) to mouling, wintering and probably breeding area in the south-eastern Kazakhstan, not overlapping with geese, wintering in India. Birds that winter in the northern India breed in the eastern Kazakhstan (Fig. 109 and 112, see section “Populations”).

Most of direct and indirect flight distances in Greylag Geese are less than 1500 km (Fig. 110 and 111), maximal distance of the direct recovery flight is 2740 km. For indirect recoveries the longest distance is 3430 km, considerably greater than in direct recoveries.

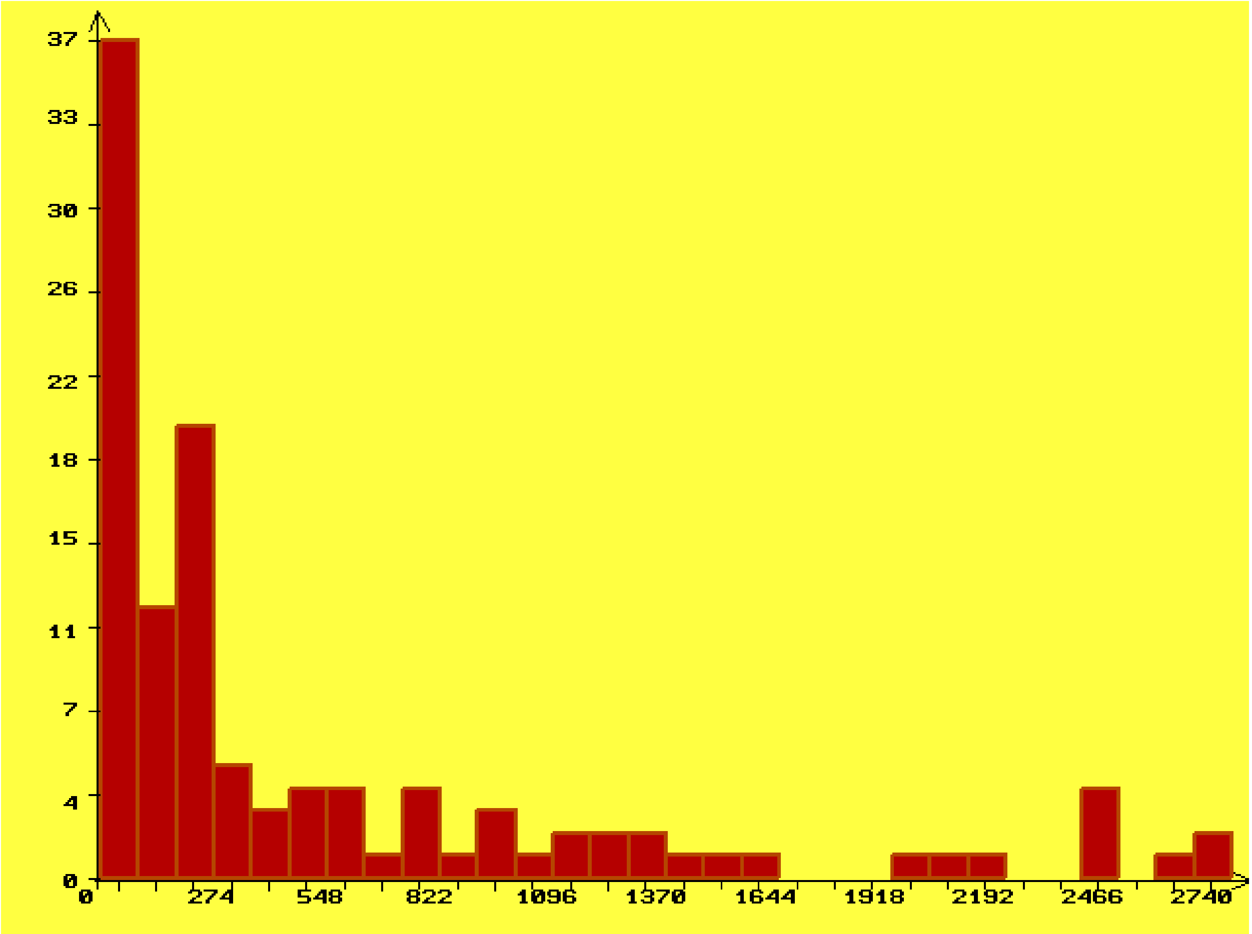


Figure 110. Distribution of direct recovery distances in Greylag Geese. X axis is the flight distance; Y axis is the number of distances.

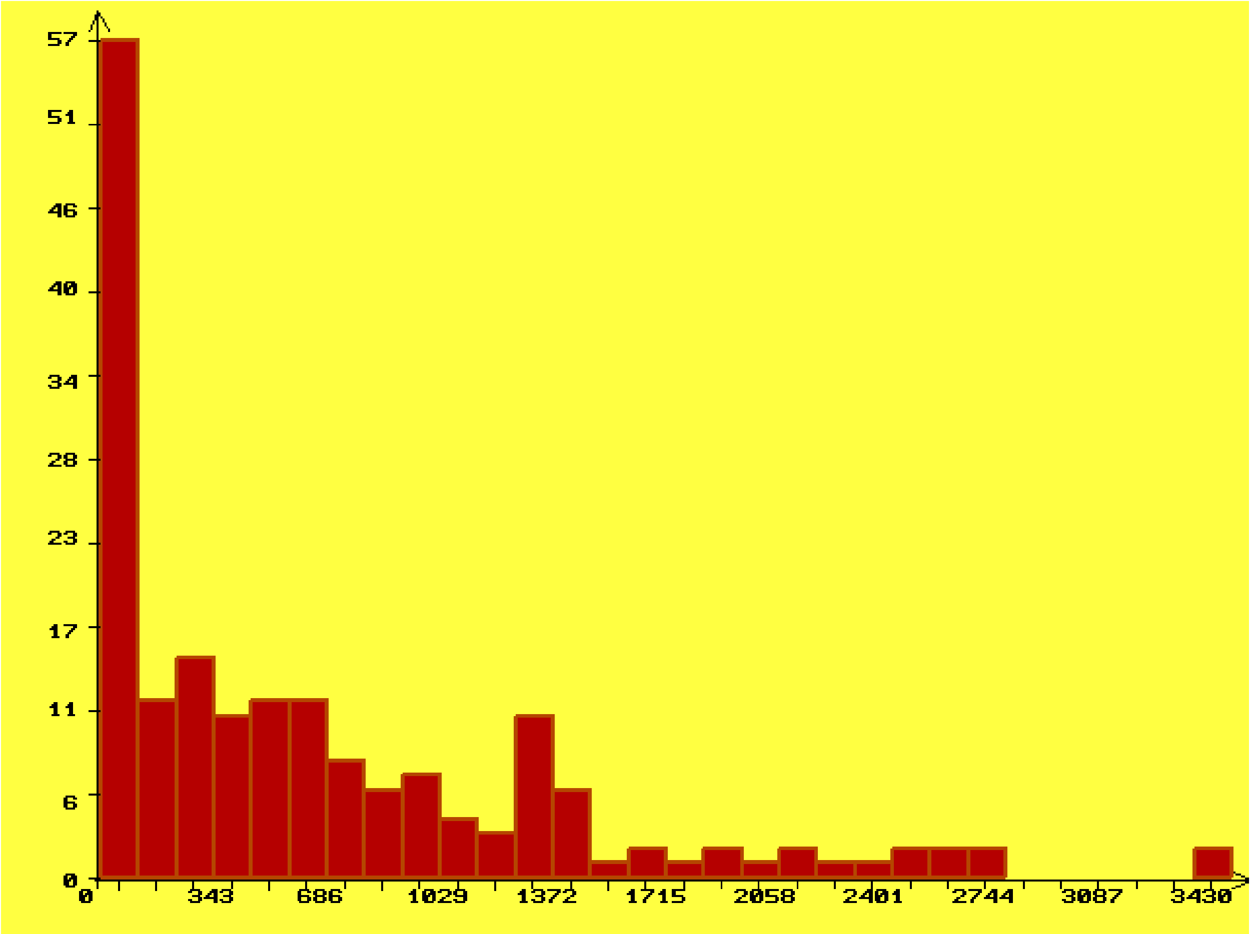


Fig. 111. Distribution of indirect recovery distances in Geylag Geese. X axis is the flight distance; Y axis is the number of distances.

Mean flight distance in Greylag Goose young birds (ringed as „pull" or „juv" or „1 y") is shorter than in adults: 493.5±54.3 and 754.7±61.7 km respectively (N_{young} = 172, N_{ad} = 125), significant (t-Bailey = 3.18, P = 0.002). If we exclude escaped birds from the sample, the regularity stays the same, but the differences in the fly distance become smaller and insignificant. Female mean flight distance is twice greater than in males: 1195.2±224.1 and 646.4±160.7 km ($N_{females}$ = 13, N_{males} = 15), nearly significant in spite of small samples (P = 0.08). If the shorter distance for young is understandable (these birds are weaker than adults), the longer flight distance in females in this not sex polymorphic goose is not clear. Sets of the ringing places in both sexes look similar; the mean longevity in both sexes is about the same (see section "Mortality rate"). The Greylag Goose is the bird with strong mate fidelity. The very preliminary and speculative explanation could be that Greylag Goose males are more faithful to the area and sites. Since the pair bond process in Greylag Geese takes place on the wintering grounds, in case of a partner change (when male perished) females follow males, which could origin from different populations.

Speed. Bird Ringing Centre of Russia database does not contain direct recoveries with maximal flight speed of Bean Goose. In the database the maximal day-by-day movement is just near 40 km per day, which is definitely not the maximal Greylag Goose movement speed.

Populations. Population structure of Greylag Geese consists of five or more populations with their own migratory routes. Bird Ringing Centre of Russia ringing data allow outlining the following populations: 1) central-east-european-north-african population (polygon No 1, Fig. 112) with different migration movements; 2) southern-east-european population (polygon No 2,

Fig. 112) with general north-west – south-east migrations; 3) southern-west-siberia-kazakhastanian-caspian-sea-mesopotamian population (polygon No 3, Fig. 112) with north-east – south-west migratory movements; 4) east-kazakhstan-hindostanian population with north, north-west – south, south-east migration movements (polygon No 4, Fig. 112). Populations slightly overlap in their eastern and western margins, sometimes probably do not overlap at all, like southern-west-siberia-kazakhastanian-caspian-sea-mesopotamian and east-kazakhstan-hindostanian populations. For the latter case the reason why population do not overlap is not clear, because no mountains present between recovery areas in the eastern Kazakhstan (Fig. 112 № and 4 populations).

However, seemingly, they may overlap considerably in bird contents. Population inter-gradation areas are detected in: 1) the Volga River Delta where in the former time large moulting area located; 2) the northern African coast there is a strict area in Tunisia and Algeria. These two inter-gradation zones are responsible for the population exchange of the first three populations. The forth population likely is more isolated.

In East Siberia and Far East Greaylag Geese not numerous, the population structure in this area is not clear.

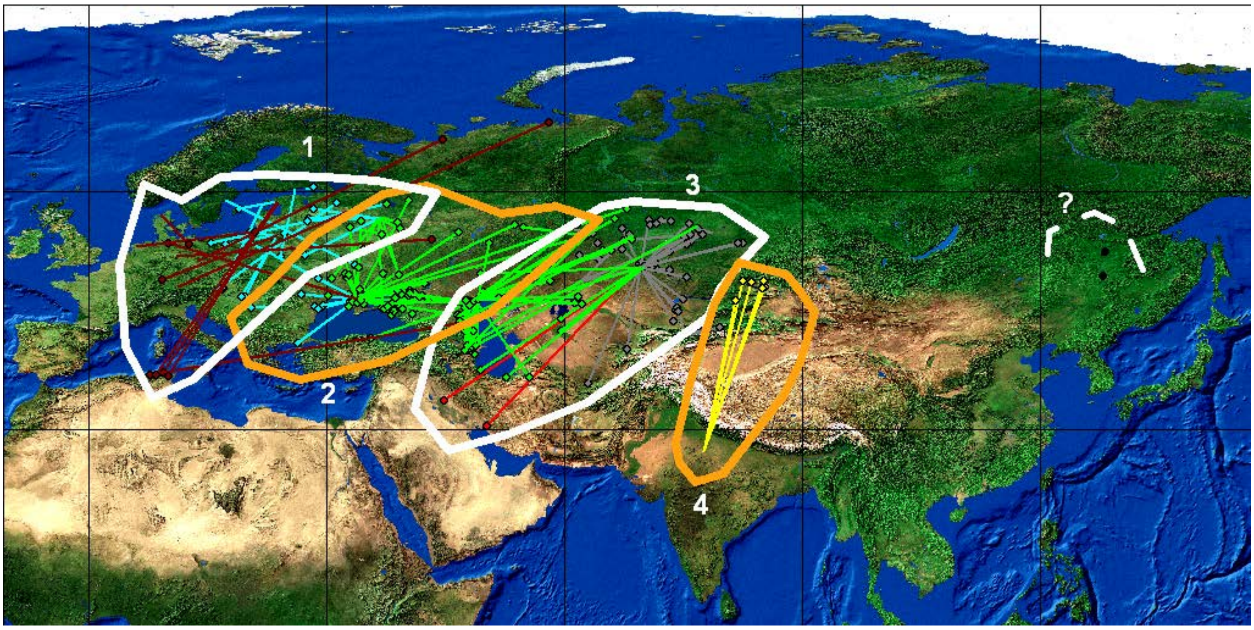


Figure 112. Graylag Goose populations. White polygon № 1 outlines central-east-european-north-african population. Light brown polygon № 2 is southern-east-european population. Polygon № 3 outlines southern-west-siberia-kazakhastanian-caspian-sea-mesopotamian population. Light brown polygon № 4 is the east-kazakhstan-hindostanian population.

Ten-year distances. In this analysis only wild Greylag Geese recoveries were used. In the period of 1929-1960 the mean decadal movement distance was quite stable (Table 7). In the decade 1961-1970 it declined almost significantly (Bailey-test, P = 0.057), then significantly increased sharply in 1970s (Bailey-test, P = 0.00007). Then probably declined again (small sample) insignificantly.

Distance decline in 1960s could be explained by severe hunting in these years, because the number of recoveries for 1961-1970 is considerably higher than in all other decades. The mean ring-recovery distance in Greylag Geese is the greatest in 1970s. It is not clear if this pattern is connected with global warming, possibly yes. However, the other stronger pattern took place in this process: changes in the geese species condition. The same as in Bean and White-fronted Geese, 1970s was a kind of “golden era” for geese (Fox et al., 2010). This good population growth produced more birds which start to fly over greater area and along greater distances to their breeding sites.

Table 7. Greylag Geese mean flight distance per decade.

Decade (years)	1929-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2023
Distance (km)	682.6	666.9	602.4	658.3	420.4	1613.9	1100.4	436.2	239.2
Number of recoveries	3	33	19	34	61	22	11	1	50

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest Greylag Goose lived more than 24 years. Our database contain recovery where bird lived more than 29 years (27 years 2 months elapsed time+ringed as adult), but ring not sent. And, our database, however, contains confirmed recovery (ring sent) of a goose with age more than 26 years. The bird was ringed on 16.07.1958 as adult at the Kurgaldzhin Lake, Kazakhstan, recovered on 10.10.1983 after more than 25 years after ringing. These two birds are exceptional in the set; all other Greylag Geese lived less than 17 years.

Mortality rate. According to the common criteria (see “Materials and Methods”) 265 dead recoveries are applicable for the mortality rate analysis. (Two far outstanding aged birds wer excluded from this sample, as well). Mean annual mortality rate in Greylag Geese Goose is 27.81$\pm$1.45 % (Fig. 113). Real mortality pattern differs from the theoretical one significantly (χ^2 = 106.0, df = 12, P=0.0000). Programme MARK, Model CLogLog 2ndPart shows 27.50%, difference is 0.31%. Greylag Goose mortality pattern chart does not shows big drawdown of the real survival dynamics in the comparison with the theoretical one. This pattern means stable species status. However, this is not for the current moment. The point is that, most of recoveries were obtained before 1990; only 9 recoveries appeared in the period 1991-2013. Really, the period before 1970s was bad for Greylag Geese, later on the species was taken under protection. Now the situation is improving.

On average, males and females live about the same number of years: 2.12$\pm$0.95 (N=15) and 2.60$\pm$1.01 (N=13) years respectively. For the mortality rate calculation of different sexes the data are too scarce.

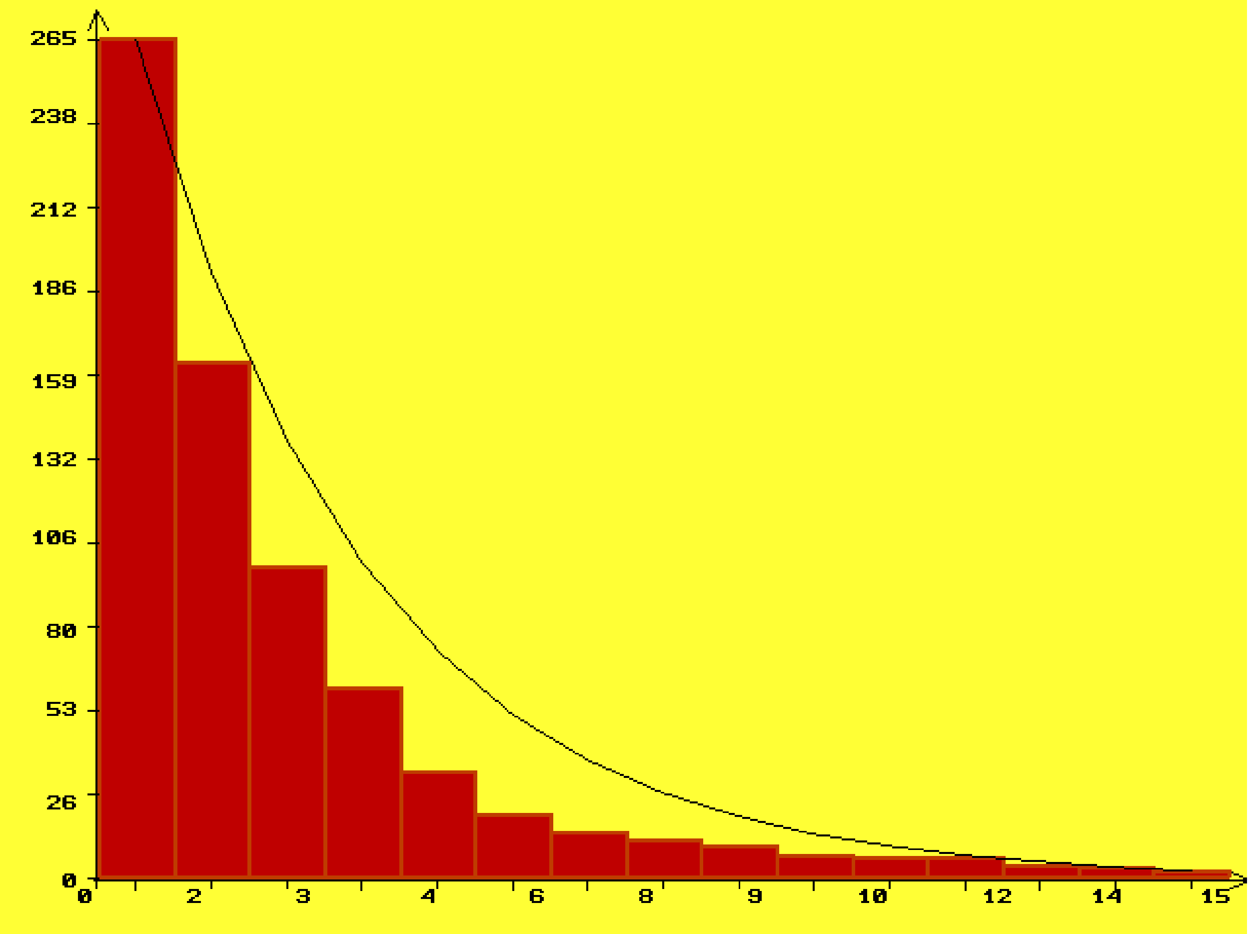


Figure 113. Mortality pattern in the Greylag Goose. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

BAR-HEADED GOOSE
(*ANSER INDICUS*)

Photo by Nikolay B. Konyukhov

Bird Ringing Centre of Russia has 9 Bar-headed goose recoveries from Europe (Fig. 114). All birds escaped from Zoos: tree birds flew away from the Moscow Zoo, five birds from the Askania-Nova Zoo, one bird from the Seewiesen Zoo, Bavaria, Germany.

Figure 114. Flight directions of six Bar-headed Geese. Beginning of lines indicate ringing sites, red dots at the end indicate the recovery points.

Bird from the Moscow Zoo flew not far away from the escaping site. Birds from other zoos, possibly, joined wild geese flocks. According to the movement directions, they likely join Bean Geese. These four birds migrated to the northern European Russia to the wild geese breeding areas. It is interesting, that the three birds from Askania-Nova were ringed in the same day 19.07.1969 and all were recovered during almost two years after ringing, 17.05.1971 in the Komi Republic. For two of those geese finding details are 'shot', for the third one – 'details unknown', presumably shot, as well.

Vagrant Bar-headed Geese from time to time are recorded by ornithologists who work in the European Russia tundra.

BARNACLE GOOSE
(*BRANTA LEUCOPSIS*)

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 115. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

Photo by Nikolay B. Konyukhov

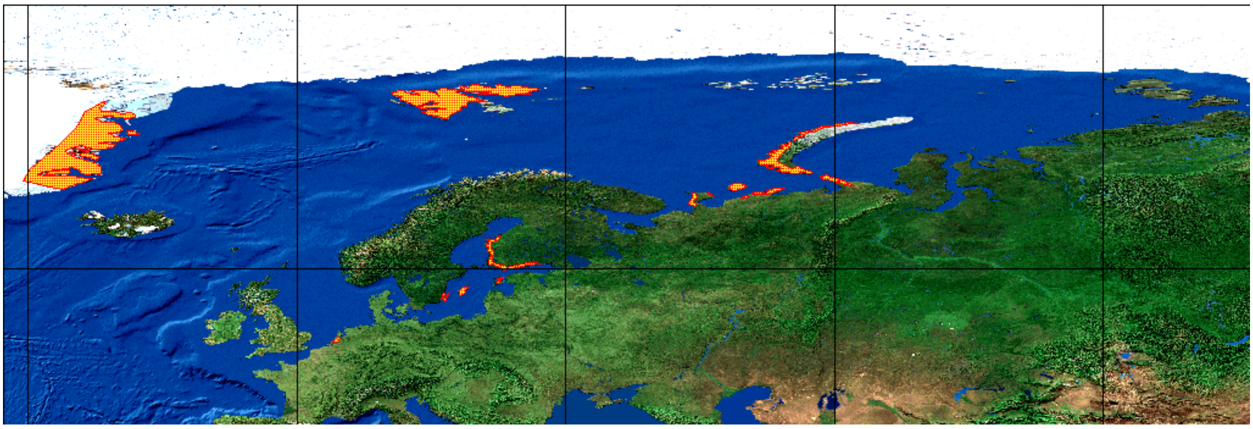


Figure 115. Breeding range of the Barnacle Goose in Eurasia (orange dashed areas).

Distribution of control points. Bird Ringing Centre database contains data on 550 marked birds that gave 561 recoveries. However, two of those birds was a captive ones, one ringed in the Velikiy Ustyug Zoo (Vologda Region), shot very close to this place after escaping. The second one was ringed in Moscow Zoo, two years later was seen in some places in Moscow four times. Since these birds had no any connections with the natural breeding range and migratory routes, they are excluded from the total Barnacle Goose sample. Therefore, for this species account 548 marked birds were used. They gave 556 recoveries (Fig. 116), 371 birds (375 recoveries) were marked with metal rings only, 3 birds worn web-tags only, 185 bird had colour rings of different kinds, 1 bird in addition to metal ring was mounted with satellite transmitter, two – with logger. Most of birds have one recovery per mark, 3 birds have 3 recoveries per each bird, one bird – 3 recoveries. Ringing dates are since 15.01.1958 until 02.03.2022, recovery dates are since 25.05.1958 until 12.05.2023.

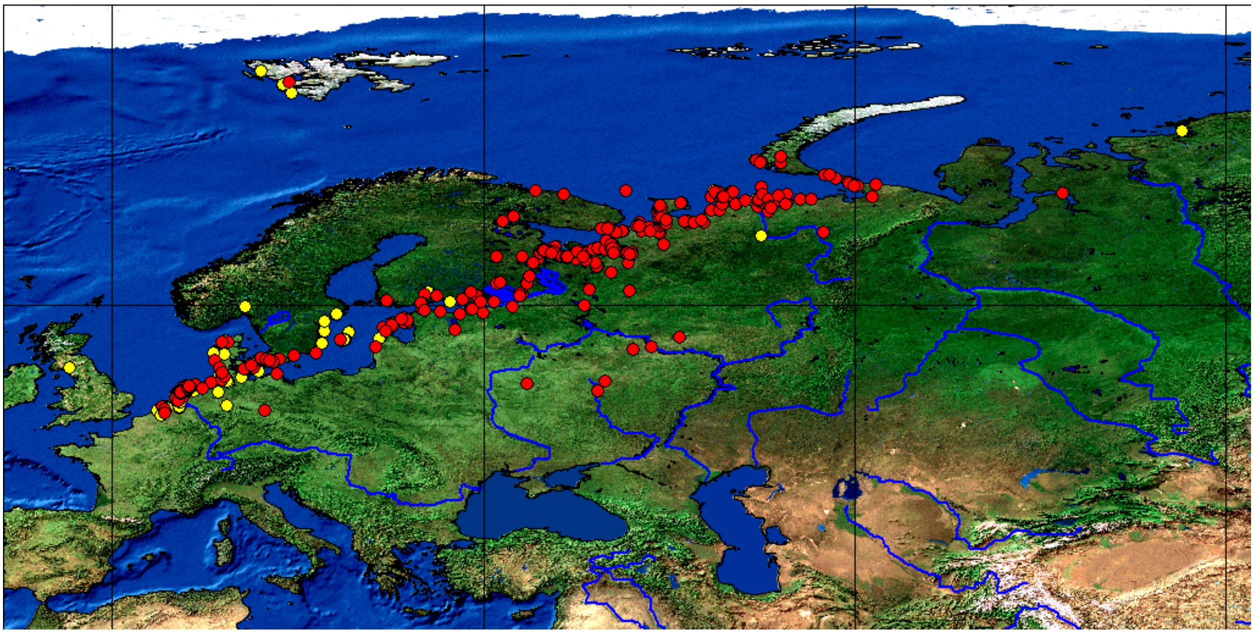


Figure 116. Position of all Barnacle Goose control points. Yellow dots – ringing sites, red dots – recovery sites.

Most recoveries concentrate along well visible White Sea – Baltic Sea migratory route between northern European Russia and Western Europe (Fig. 122).

'Moskwa' scheme recoveries. The sample contains 66 recoveries of the „Moskwa" scheme. 199 those birds ringed in Barnacle Goose colonies at the Barents Sea coast: Korovinskaya Guba and Kolguyev Island, Nenets Autonomic Area. One bird was ringed in the Pyasina River Delta, Taimyr Peninsula (Fig. 117). The latter bird was a vagrant goose, stayed in a moulting flock of other geese species. However later, since 2015 Barnacle geese start to breed on Taimyr Peninsula in the Lemberova River mouth 8 km south of Dikson (Golovnyuk et al., 2015)

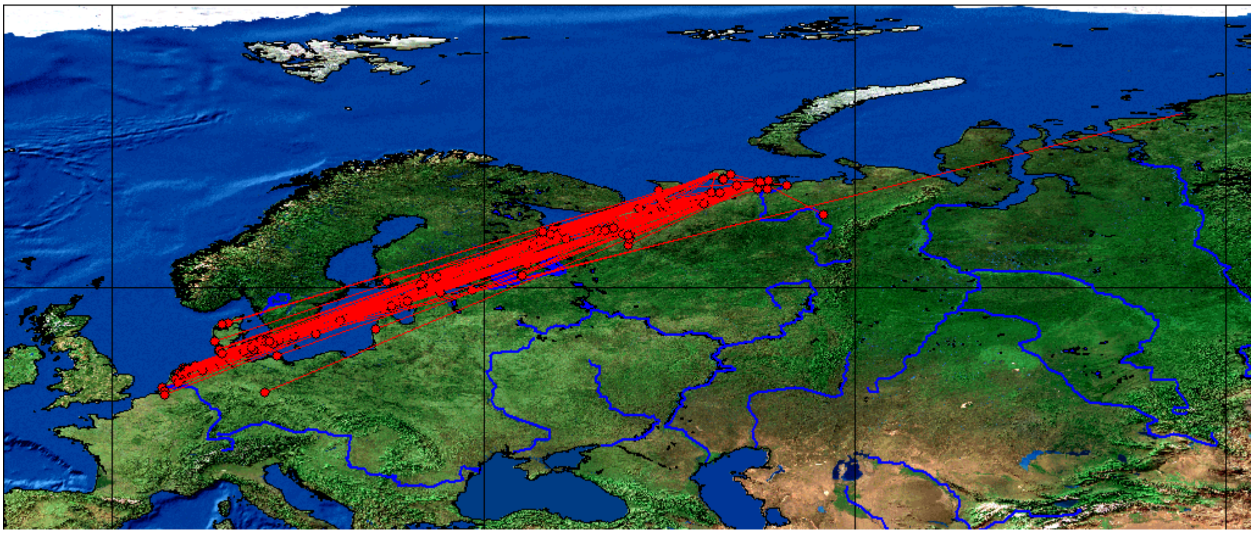


Figure 117. „Moskwa" scheme recoveries of the Barnacle Goose. Here and on all other similar figures lines start from the ringing sites, recovery sites are marked with red dots.

Finding details. This analysis includes all 556 recoveries. Three quarters of recoveries (75%) are „shot". In 7 (1%) recoveries „details unknown", which practically mean, that birds were shot, as well. Therefore, we can assume that 76% of birds were shot. Other recovery reasons are not so common (Fig. 118).

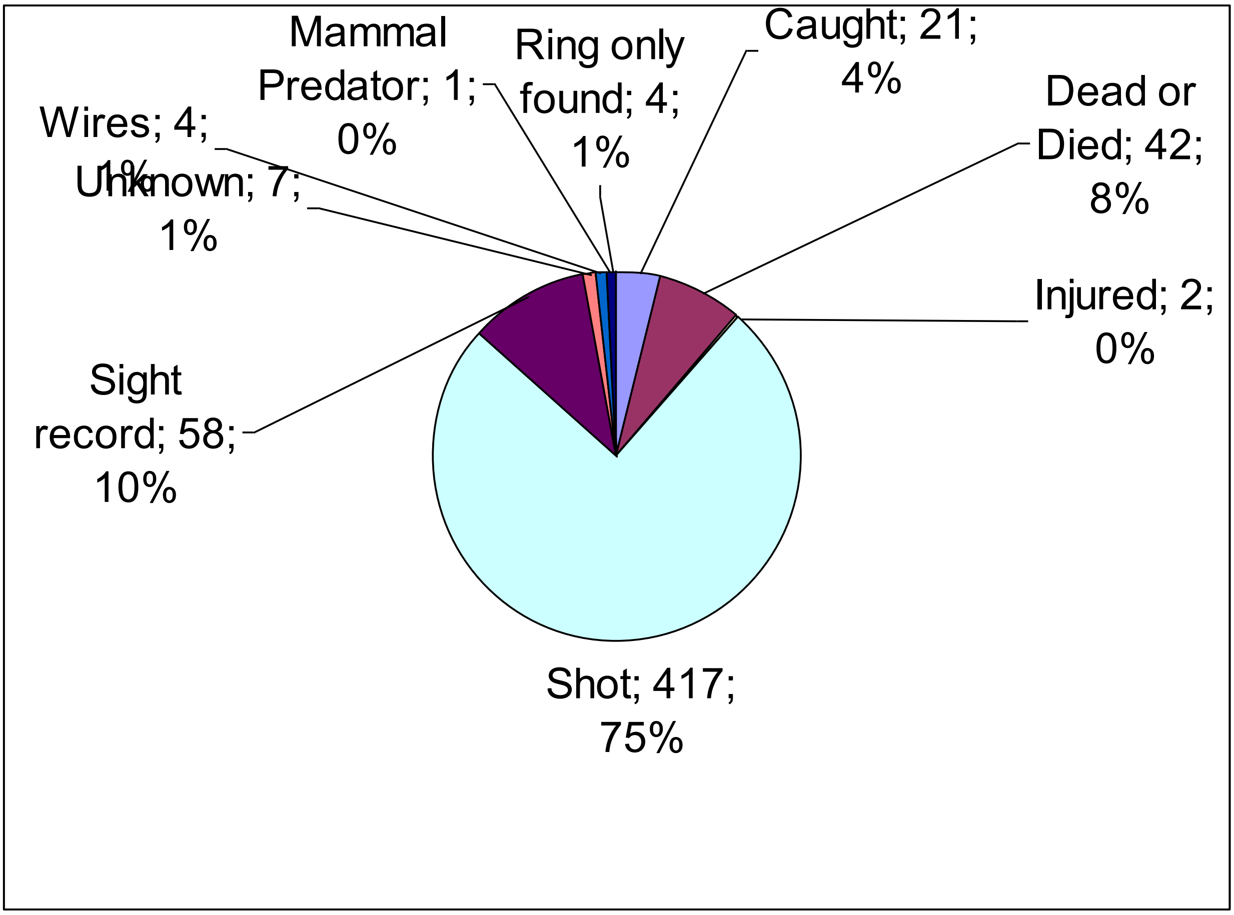


Figure 118. Finding details in the Barnacle Goose.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries are similar, although indirect recoveries cover broader area (Figs 119, 120).

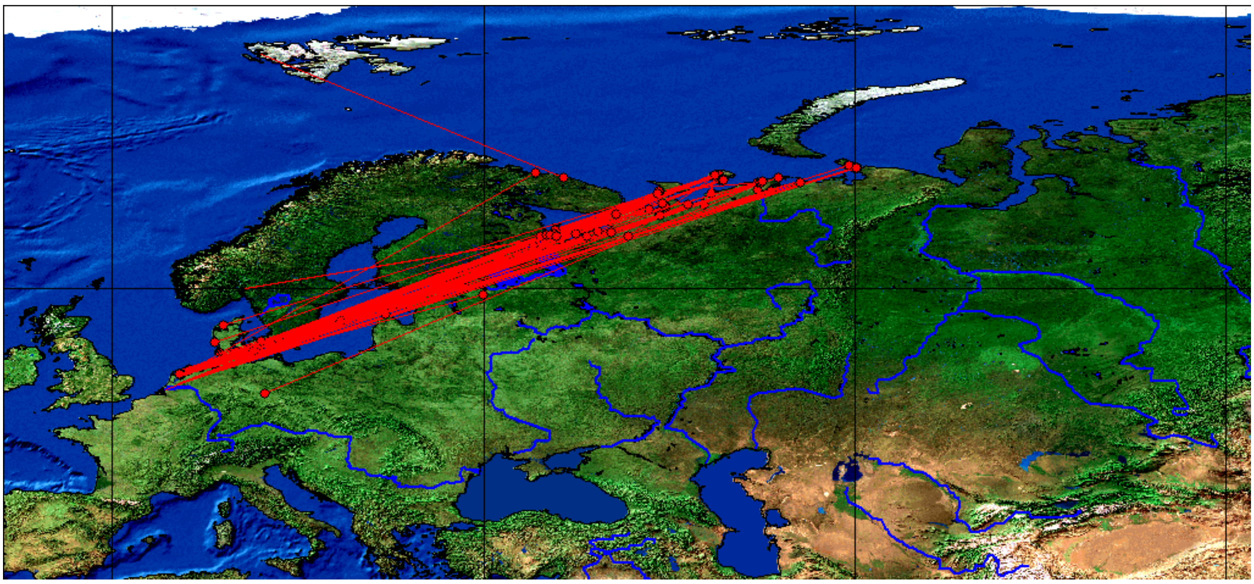


Figure 119. Map of the Barnacle Goose direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

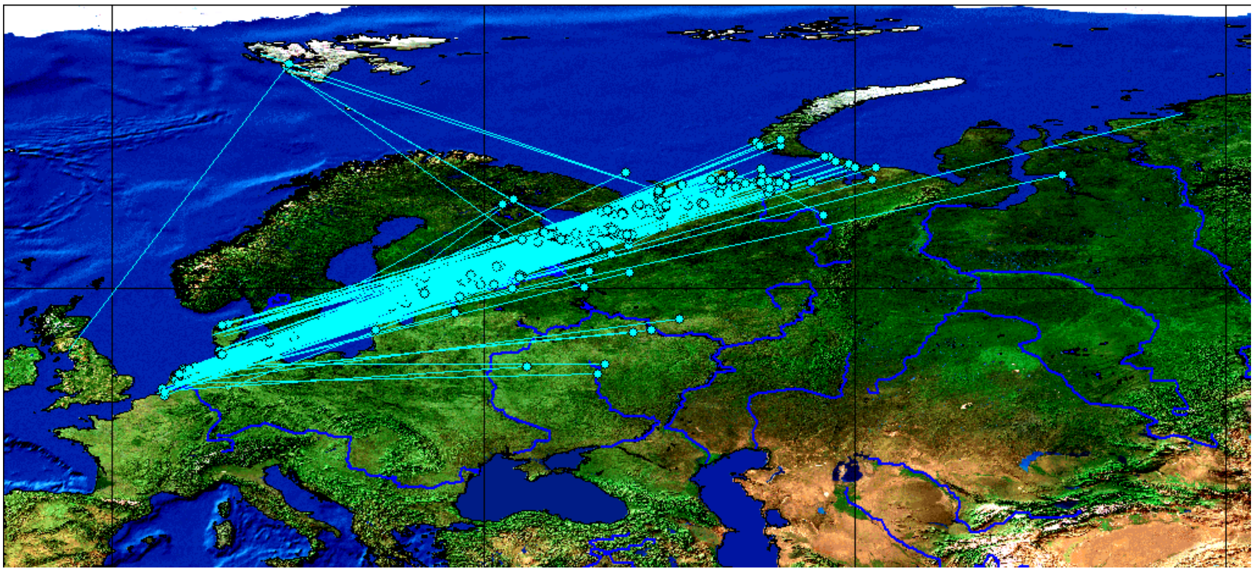


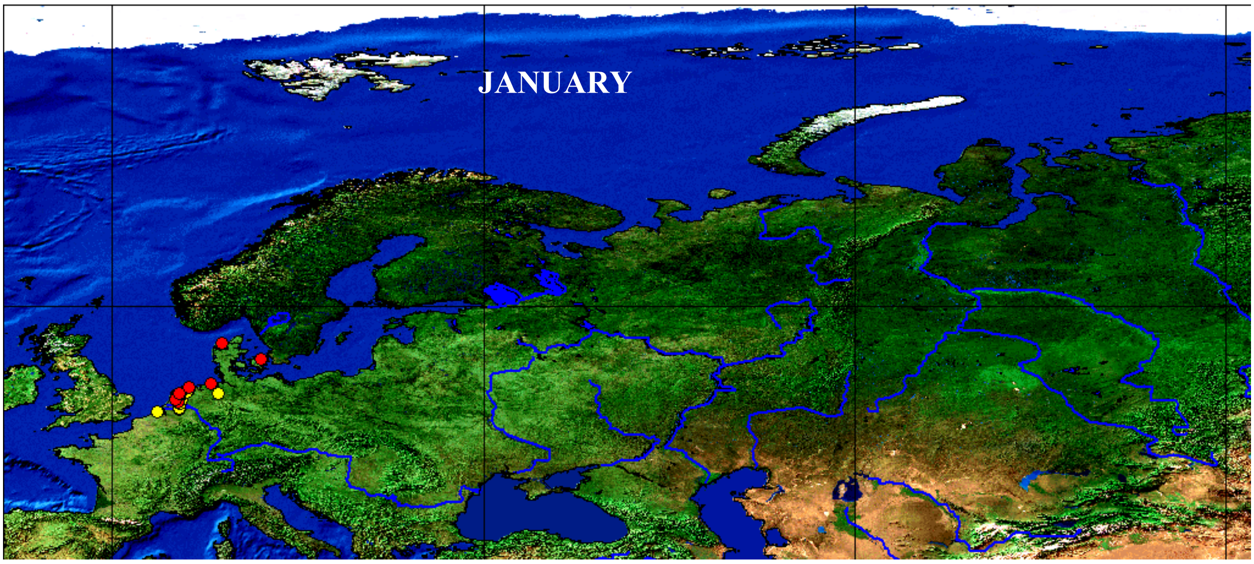
Figure 120. Map of the Barnacle Goose indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

From maps in Fig. 119 and 120 it is clear that the main bulk of the recoveries belong to the mainland Barnacle Goose population (see also “Population structure”). 549 recoveries belong to this population, 7 recoveries belong to the other population which is poorly represented in the Bird Ringing Centre database. For this reason those 6 recoveries are excluded from several analysis, mentioned below.

In the centroid comparison by means of Mardia-test with Robson correction we used only birds from the mainland population. Comparison of all direct and indirect recovery areas shows no significant difference between them (χ^2 = 1.78, 101 direct recoveries and 448 indirect ones, df = 2, P = 0.41). Average flight distances in direct and indirect recoveries are similar; the difference is insignificant: 22098.1$\pm$94.8 and 2224.5$\pm$38.1 km respectively.

Monthly movements. All recoveries (but not from Zoos) from both populations are included in demonstration of migrations month-by-month. Monthly distributions of control points (both ringing and recovery) reflect a general way of seasonal movements in the Barnacle Goose (Fig. 121). This species is originally the Arctic one; however nowadays it is capable to breed not only in the north, but within wintering areas, as well. These birds staying wild sometimes breed in parks of Netherlands, Denmark, Sweden and Finland (Fig. 115). Barnacle Geese can alter breeding in the mentioned countries and in the Arctic.

Migration start later than in Bean and White-fronted Geese, i.e., since April (Fig. 121). They migrate fast, and first birds reach breeding grounds in the Arctic in the same month. In May migration completes, geese start breeding. In June, July and August most birds are on the breeding grounds, however some birds, probably non-breeding individuals, still stay or move along the general migratory route. In September migration back to Western Europe becomes active; in October it continues, and the first birds arrive to their wintering places, whereas the last are still at breeding areas. In November and December Barnacle geese are on their wintering grounds (Fig. 121).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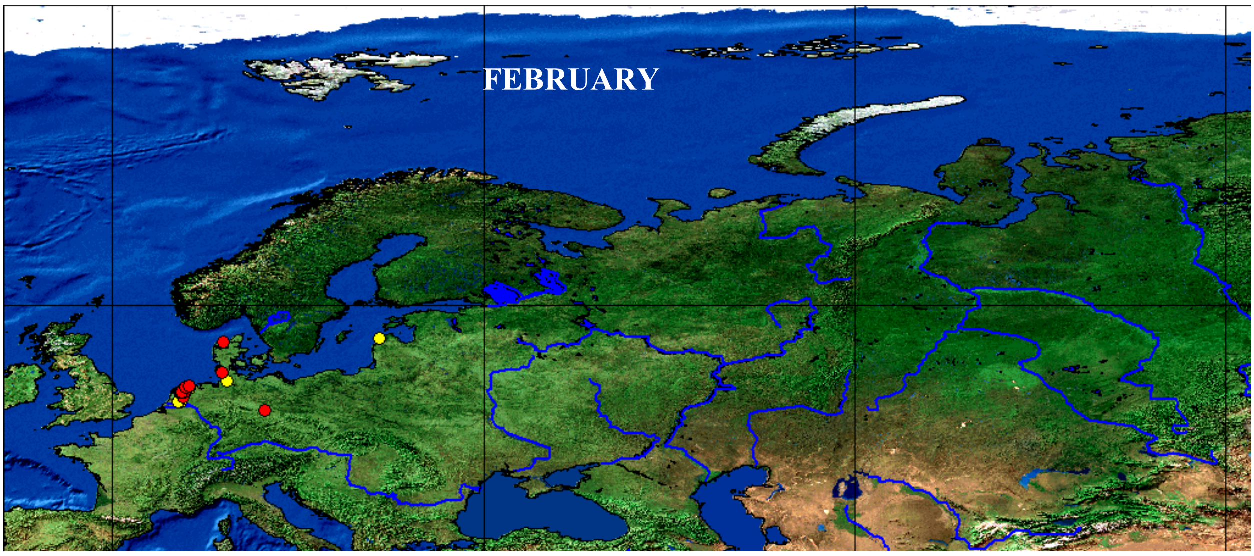
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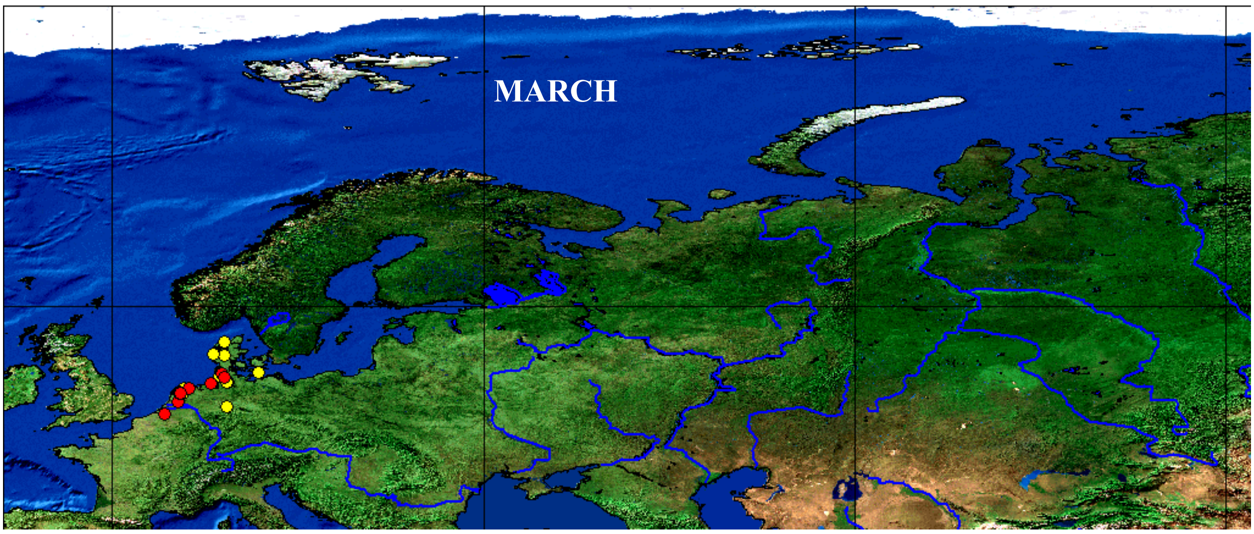
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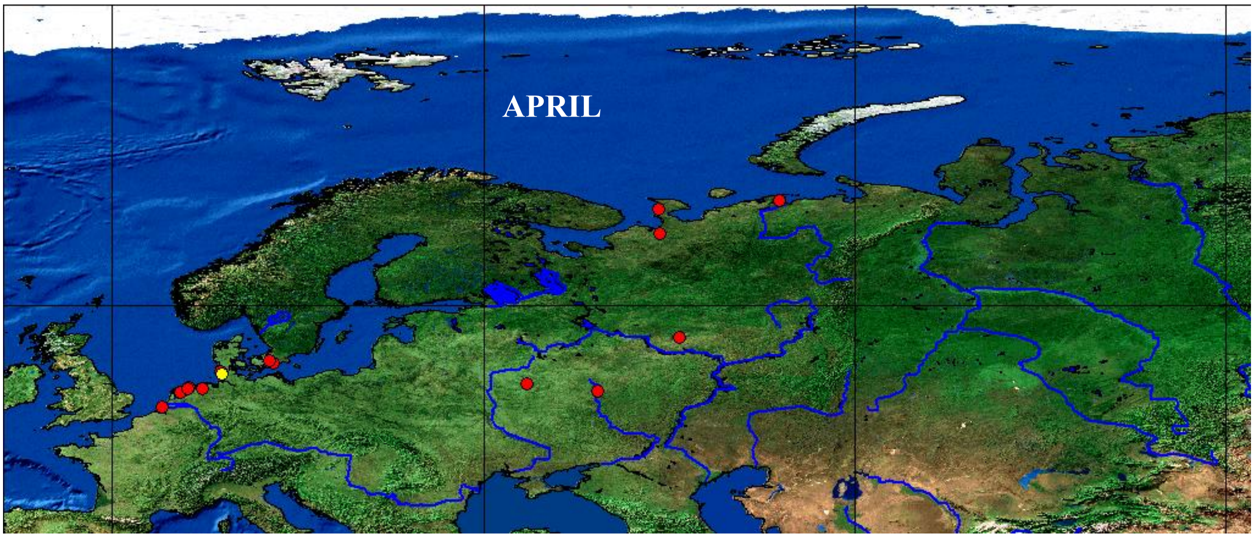
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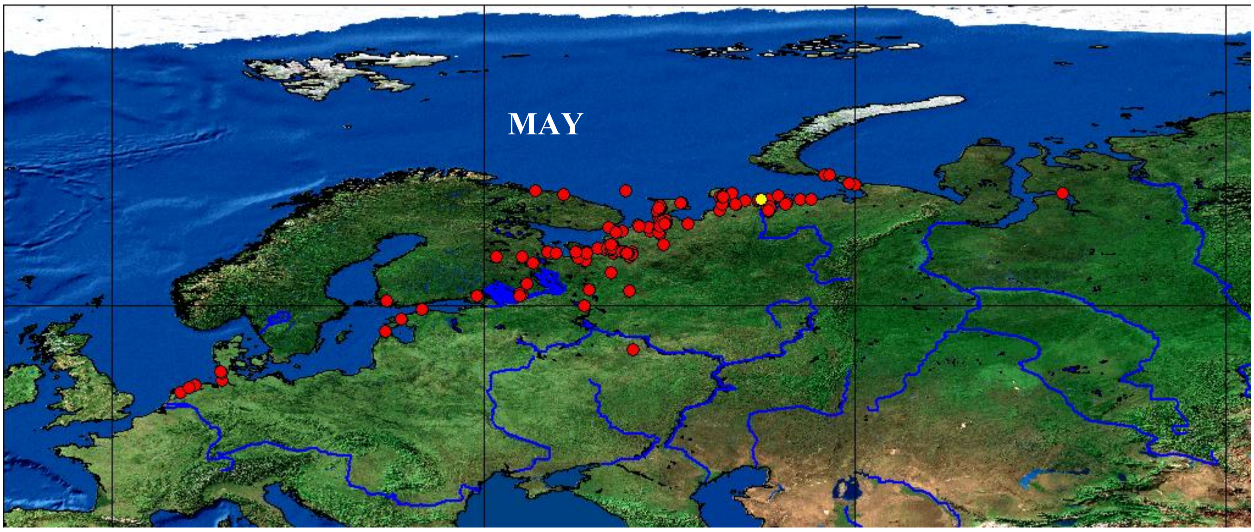
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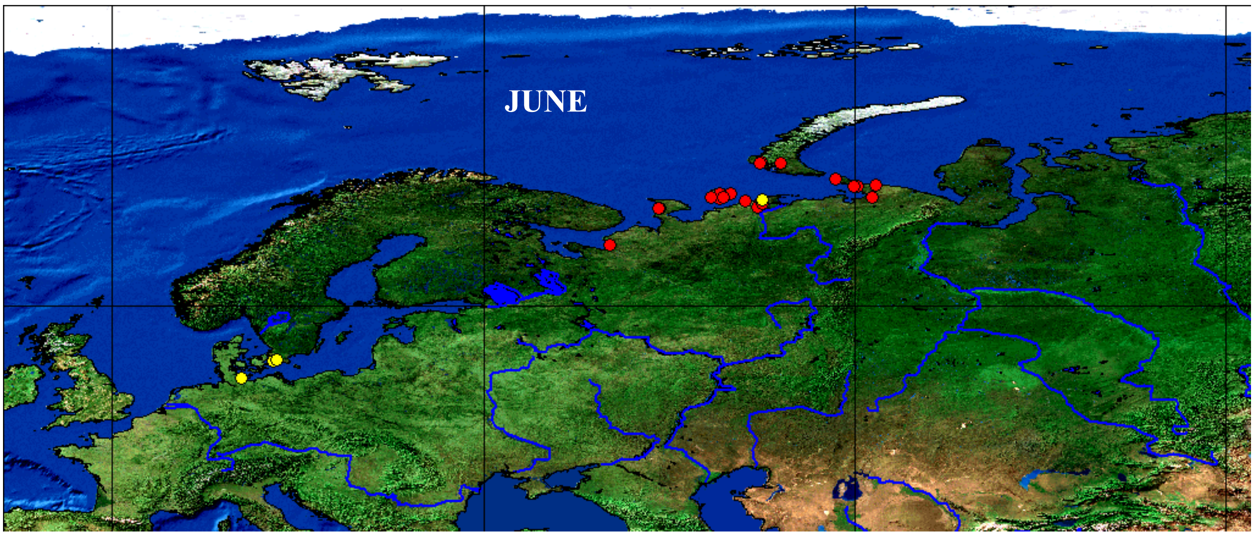
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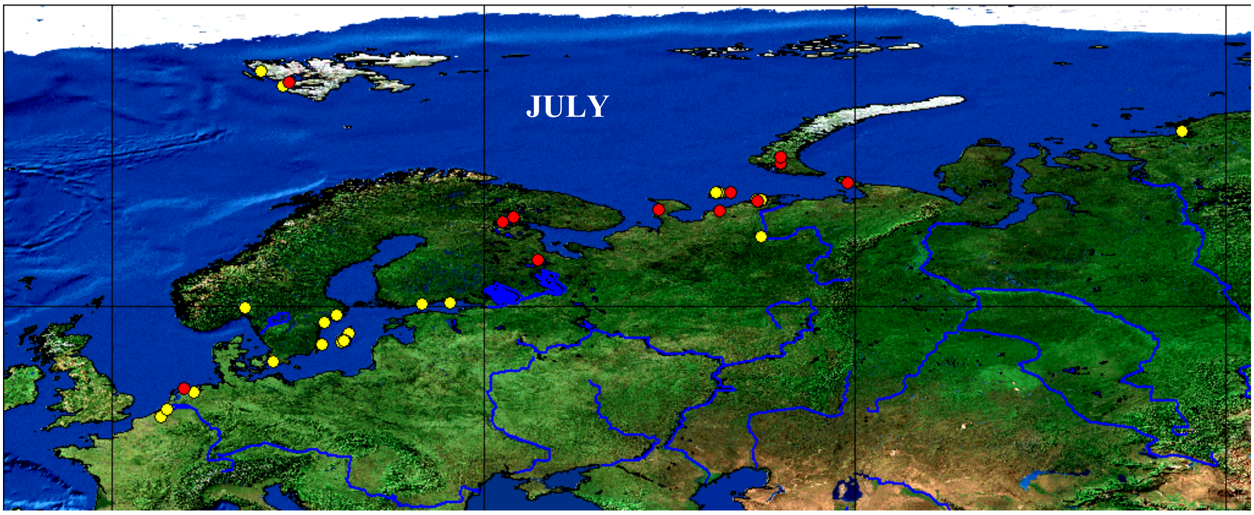
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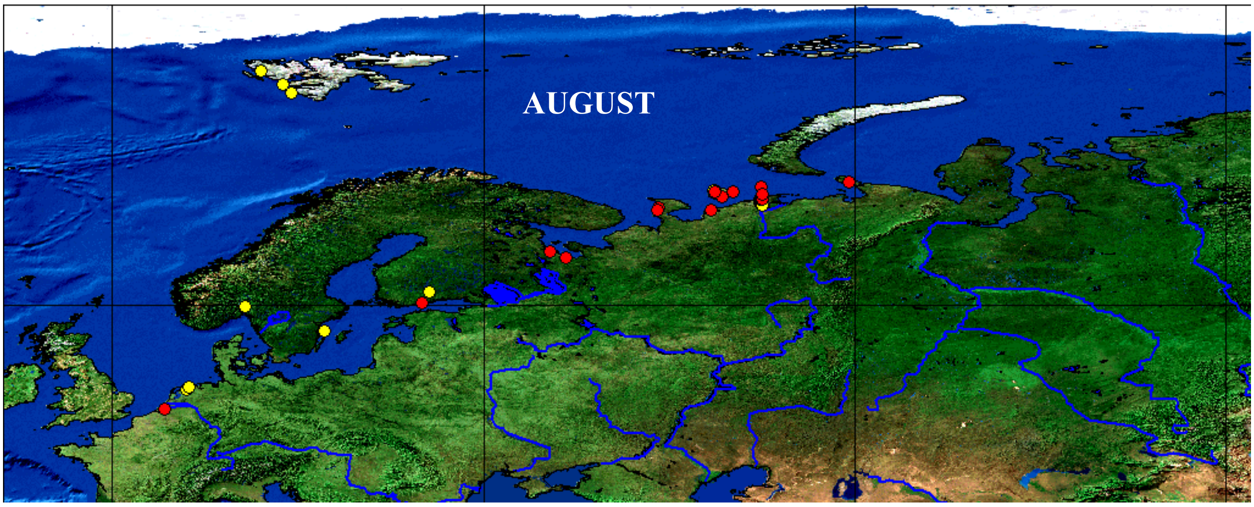
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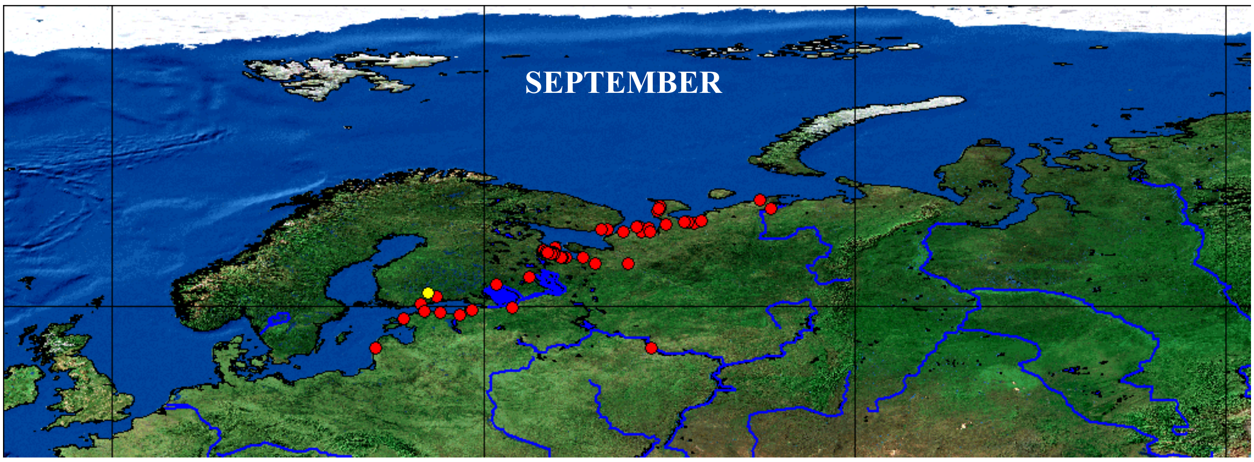
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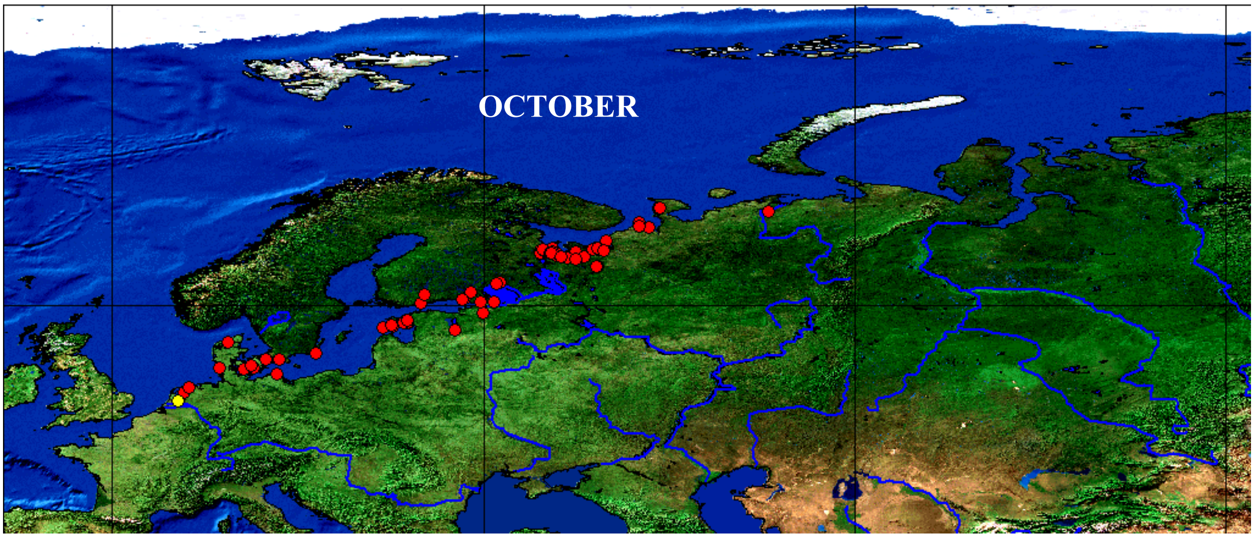
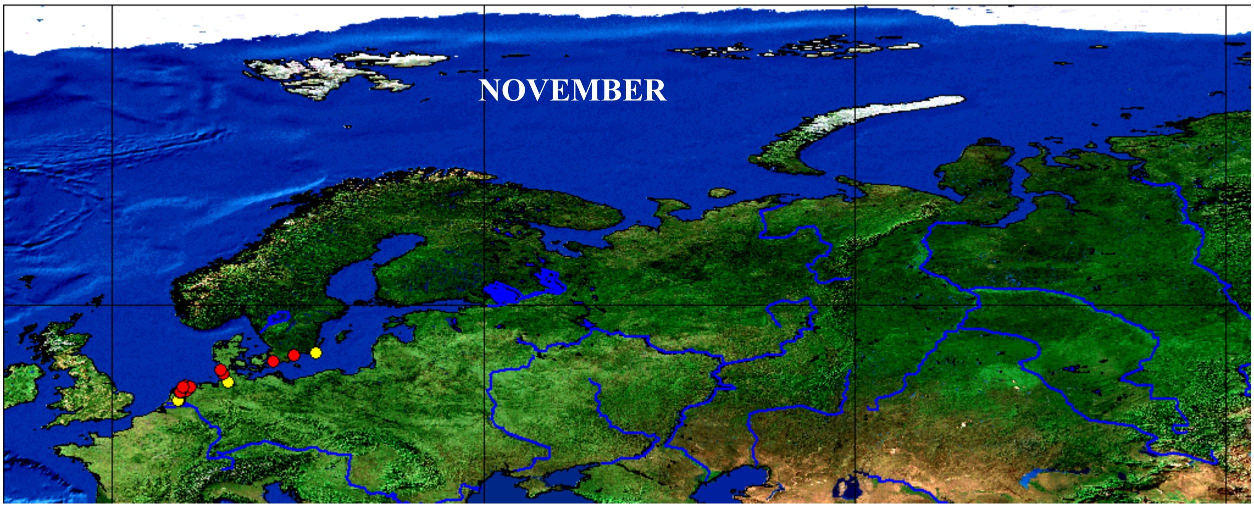




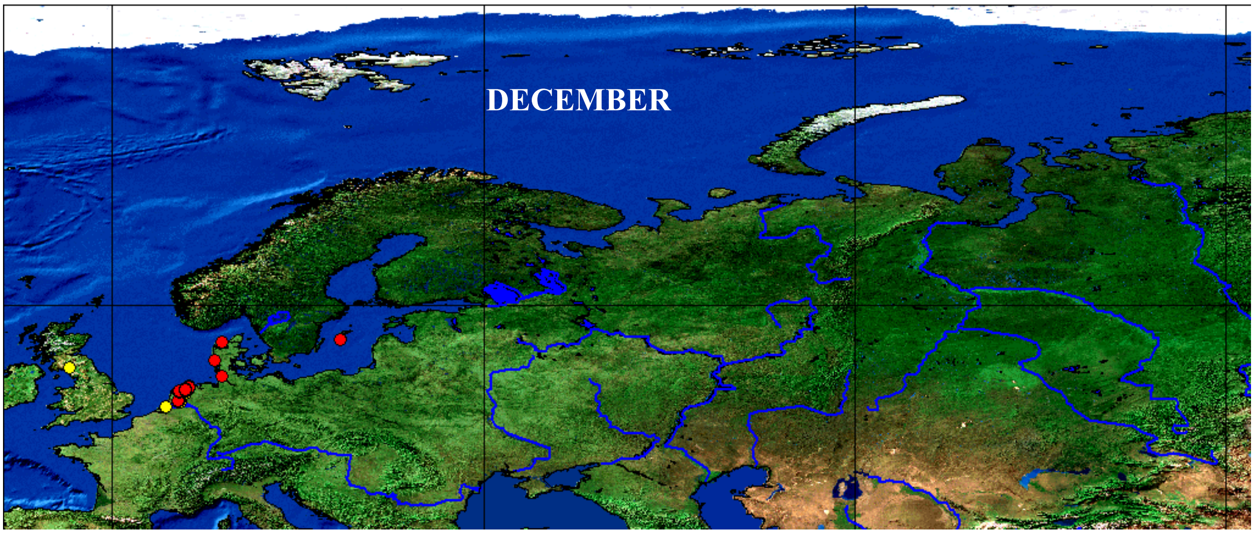


Figure 121. Barnacle Geese monthly movements. Yellow dots point on ringing sites, red dots point on recovery sites.

Migratory routes. Migratory route in Barnacle Geese of the mainland population is quite simple. It is stretched along well known European White Sea – Baltic Sea migratory route, which is in use by several geese species. Main bearings are 37-67˚ (to breeding places), and the opposite – 217-247˚ (to wintering places) (Fig. 122).

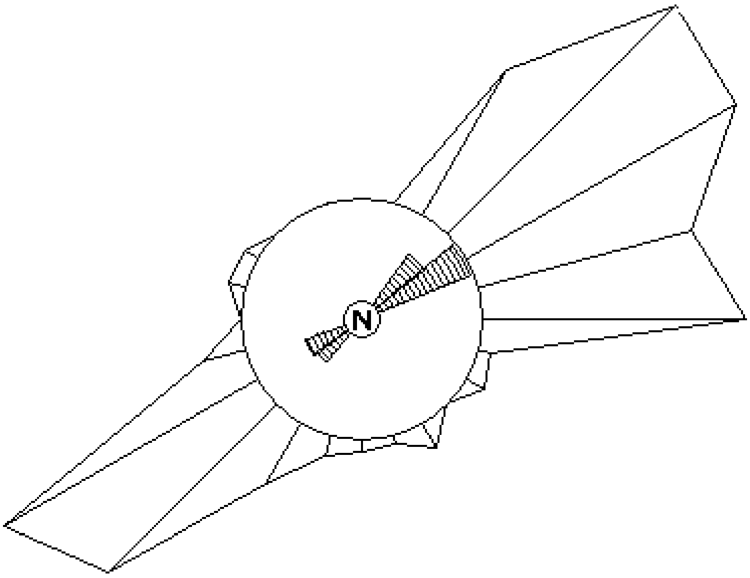


Figure 122. Recovery roses graph for Barnacle Goose: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar chart). Sector = 15.0°; Total recoveries - 549; N in sectors: from 0 up to 205; Average distance in sectors: from 0,0 km up to 2498,5 km; The longest flight distance is 3900.9 km.

Besides the main migratory route along northern European Russia –White Sea-Baltic Sea – Netherlands coast, there are a number of recoveries within Central European Russia. It is remarkable that these recoveries form a chain of points in the parallel way to the main migratory route, but located more to the south (Fig. 116, 120). It is known that singles and small groups of Barnacles migrate in spring and autumn in flocks of other geese species. E.g., separate Barnacle Geese were recorded several times in spring in the Moscow and Kostroma Regions (K.E. Litvin, personal observations). Certainly, those records belong to such birds.

Most of direct and indirect flight distances in Barnacle Geese are about the same and concentrate around 2700 km (Fig. 123).

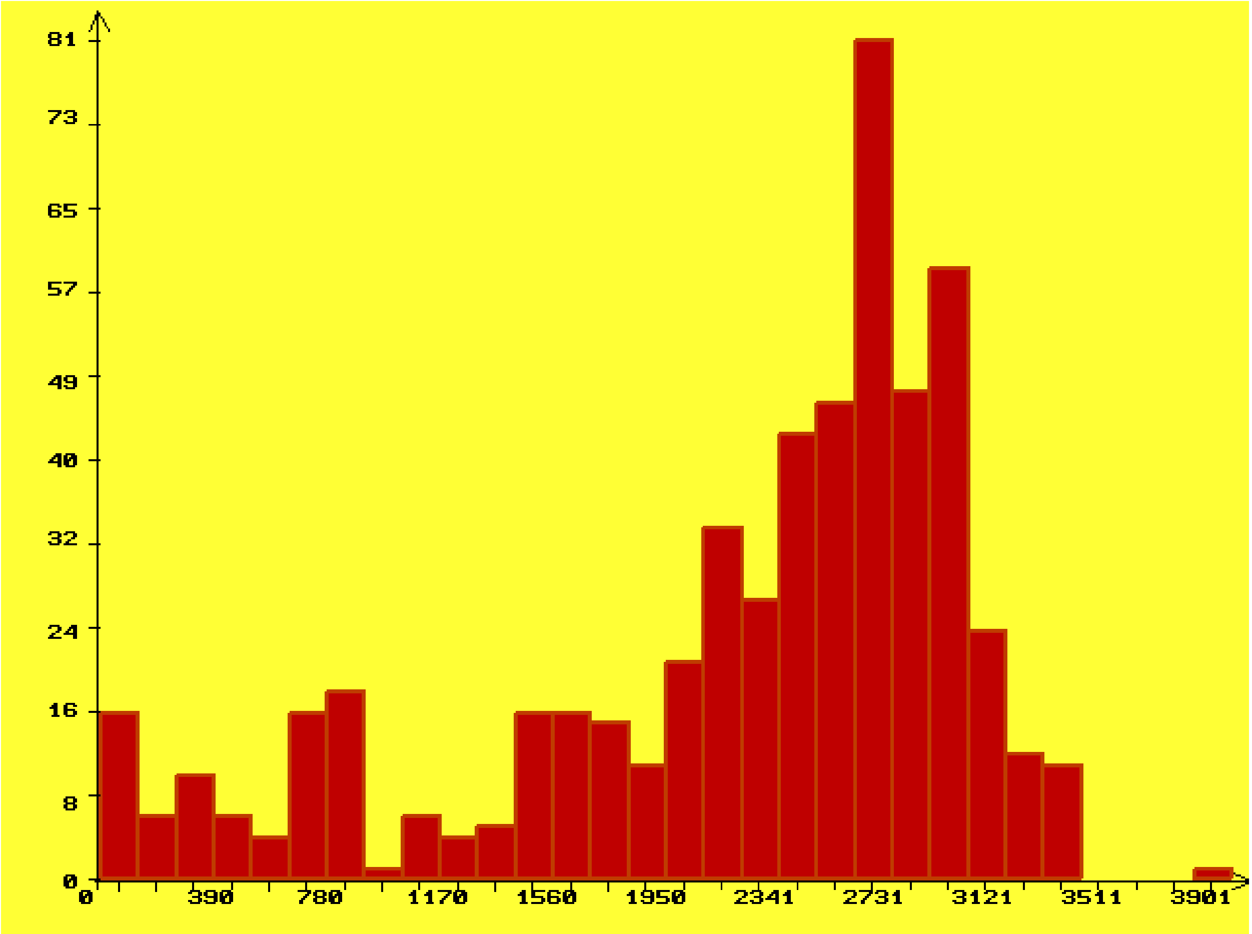


Figure 123. Distribution of all ring-recovery distances in Barnacle Geese. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in Barnacle Goose young birds (ringed with the age as „pull" or„juv" or „1 y") is shorter than in adults: 1899.4±82.0 and 2293.5±37.3 km respectively (N_{young} = 137, N_{ad} = 419), highly significant (tBailey = 4.37; P = 0.0000). Female mean flight distance is about the same as in males: 2245.2±51.8 and 2232.0±49.5 km ($N_{females}$ = 263, N_{males} = 259), insignificant.

To reveal the migration process in more detail, we should plot monthly means of cohorts of Barnacle Geese ringed in about the same area. There are two cohorts: 1) „Moskwa" ringed birds (geese ringed at the breeding or moulting places on the Barents Sea coast); 2) Netherlands ringed birds – these geese were marked at their wintering grounds.

Figure 124. Barnacle Geese monthly mean locations. Red circles and white labels represent Netherlands ringed birds, yellow circles and yellow labels – „Moskwa“ scheme ringed geese.

Terms of migratory movements of these two cohorts in some parts of migration route are different (Fig. 124). Birds ringed at breeding and moulting places stayed longer in the breeding area than birds ringed earlier on wintering grounds. Birds of the first cohort moved faster at the onset of autumn migration and slightly slower at the second half of migration way. In spring „Moskwa“ scheme ringed geese migrate slower than birds ringed on wintering grounds (see position of monthly mean locations in Fig. 124).

Satellite tracking data. First data on the satellite tracking of Barnacle Geese were obtained in 2004 by usage of implanted transmitters (weight 35 g) and by marking of geo-loggers within the scope of international expedition of the Groningen University and Bird Ringing Centre of Russia at Tobseda Village (68.34E, 52.20E , Kolokolkova Bay, Nenets AA). Partly the data have been published (Eichhorn, 2005) and are available at www.wildlifetracking.org. Later on extensive marking were performed in 2008 in The Netherlands (SOVON data, https://www.sovon.nl/) during investigations of the Barnacle Goose foraging strategy on wintering grounds (Si et al., 2011).

Before these projects, in 2003 19 gees were marked in the Tobseda area with geo-loggers only (Eichhorn et. al., 2006). This marking reveals that Barnacle Geese during autumn migration perform several strategies. One bird stopped on practically all known fall stopover places, including Kanin Peninsula, Onega Bay of the White Sea and Baltic Sea islands in Estonia. This bird moved gradually by the short distance flights between stopovers (Fig. 125). The other most prominent route Barnacle Geese performed starting from breeding places at the Kolokolkova Bay and by single flight reached their wintering grounds in Western Europe. As a whole, 80% of 19 marked birds stopped at the Kanin Peninsula for the term of 3-28 days. Stopover sites on the Baltic Sea were less important: only 8 birds stayed there for longer that one day. Baltic Sea stopovers appeared important during spring migration: all birds used these sites for the term up to 50 days.

In mid-May of 2004 Barnacle Geese commenced intensive migration from stopover sites at the Baltic Sea. Most of those birds by 18 May arrived at the Kanin Peninsula and Dvina River Delta. 6-11 June 2004 these geese arrived at their breeding places near Tobseda, four days before start of egg-laying period.

The width of Barnacle Geese migration corridor is considerably narrower than in Bean Geese and White-fronted Geese. The former is comparable and as narrow as in Brent Geese, the species that also is closely related with the sea. In spring Barnacles starting from stopovers at eastern Baltic Sea, fly to the east both along northern and southern coasts of the Gulf of Finland. Then, southern boundary of the migratory corridor passes via centre of the western Ladoga Lake coast, northern part of the Onega Lake, Kholmogorskiy District of the Arkhangelsk Region and taiga area in about 50 km south of Mezen‟. Northern boundary of the corridor is stretched from islands in Estonia to Finland via the line Helsinki-Kuopio, then Muyezercsky District and Kem‟ in Karelia, later on crosses the White Sea north of Solovetskiye Islands, south coast of the Kola Peninsula, ended at the Kanin Peninsula north of Shoina. Breeding area of the western-european-northern-european-russian population (see section "Population") spreads to the east of western coast of Kanin Peninsula. Within breeding range geese fly to the east to Kolguyev Island where the mouth of the Peschanka River holds the biggest Barnacle Goose colony in the World (Anisimov, 2007, Kondratyev et al., 2013). Geese breed in the colonies of Novaya Zemlya and Vaigach Island where long-term colonies of this species exist (Syroechkovky, 1995a). General view of the migration corridor is in the Fig. 126.

In several Barnacle Geese satellite transmitters have been working for a number of years; therefore they offer data of the several full migration cycles. One of those birds marked on 20.02.2009 holds the transmitter that is still working in March 2014. These long-term data confirmed not only high breeding site fidelity in Barnacle Goose females, but the fidelity to the same migratory routes and stopovers, as well.

In distinction to White-fronted Geese, Barnacles do not perform long-distanced movements to moulting sites. Birds with goslings moult nearby their breeding areas, failures can fly for moult to the east up to Novay Zemlya and Vaigach Island.

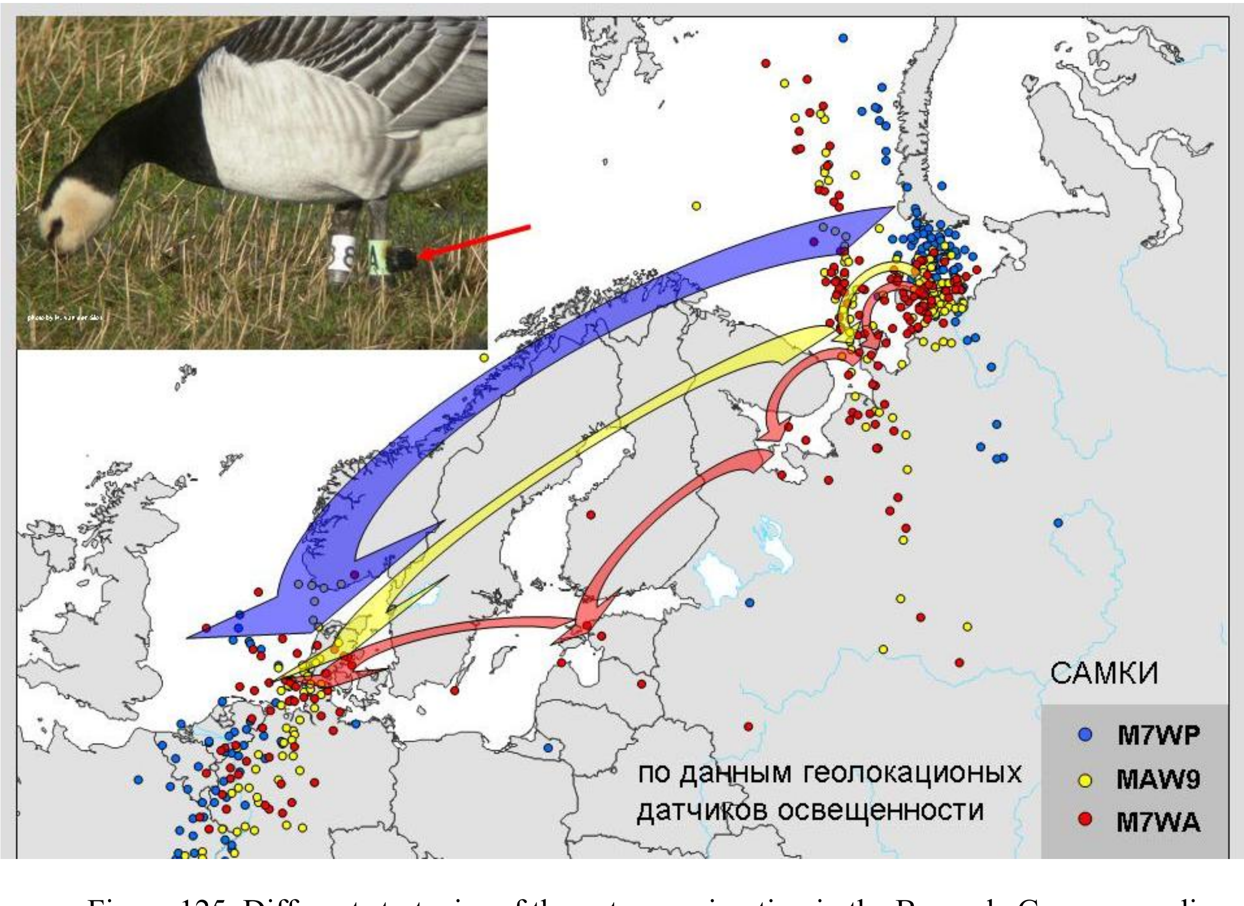


Figure 125. Different strategies of the autumn migration in the Barnacle Geese according to the data from geo-loggers (Eichhorn, 2005).

Figure 126. Migration corridor and routes of Barnacle Geese in spring according to the data of satellite transmitters.

Speed. Bird Ringing Centre of Russia database does not contain direct recoveries with maximal flight speed of Barnacle Goose. Maximal day-by-day movement in the database is just near 34 km per day, which is definitely not the maximal Barnacle Goose movement speed.

Populations. Population structure of Barnacle Geese contains three population (Scott, Rose, 1996, Fig. 127), which we denote as: 1) britain-island-greenland population; 2) britain-svalbard population; 3) western-european-northern-european-russia population. Bird Ringing Centre of Russia has data mostly on the third, mainland population and on four recoveries that represent cross-population movements. Populations do not overlap, but there is some exchange between them via cross-population movements. Those movements were detected between breeding grounds of the britain-svalbard and western-european-northern-european-russia populations (Fig. 127).

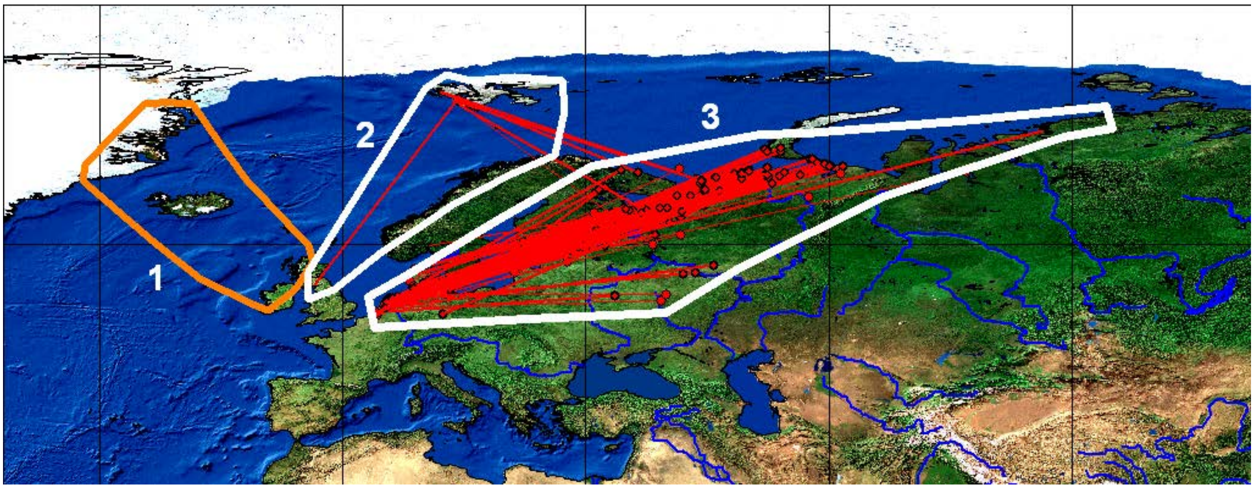


Figure 127. Barnacle Goose populations. Light brown polygon № 1 outlines britain-iceland-greenland population. White polygon № 2 is britain-svalbard population. Polygon № 3 outlines the western-european-northern-european-russia population. Populations №№ 1 and 2 were drawn from Scott, Rose, 1996, population № 3 outlined from the data of the Bird Ringing Centre of Russia.

Ten-year distances. Only Netherlands marked cohort is valid to perform decadal comparison of the ring-recovery distances (Table 8). Data show no noticeable changes in the migration distances.

Table 8. Barnacle Geese mean flight distance per decade (for geese, ringed on the wintering grounds in The Netherlands).

Decade (years)	1958-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2023
Distance (km)	2553.5	2562.5	2567.9	2541.5	2576.0	2523.9
Number of recoveries	34	25	30	25	75	97

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) of 26 November 2010, the oldest Barnacle Goose lived more than 28 years. Our database contains a recovery of male ringed as adult and recovered after 25 years 6 months, therefore its lifespan is greater than 27 years. In addition, we have a record of bird with more than forty years between ringing and recovery dates. However, the real recovery date could be up to five years before the date reported by the hunter. Anyway, this bird lived about 35 years. However, due to the absence of definite conformation we do not use this bird, together with the several of the same kind, for the longevity and mortality rate analysis.

Mortality rate. According to the common criteria (see "Materials and Methods") 418 dead recoveries are applicable for the mortality rate analysis. Mean annual mortality rate in Barnacle Goose is 21.45±0.93% (Fig. 128). Real mortality pattern differs from the theoretical one significantly (χ^2 = 272.2, df = 22, P=0.0000). Programme MARK, Model CLogLog 2ndPart shows 22.02%, difference is 0.57%. Barnacle Goose mortality pattern is principally different from mortality patterns of all before considered swan and geese species. In the Barnacle Goose bars of the real mortality lays above theoretical line. This means that the species is in good condition and growing in numbers. It is known that the population of Barnacle Geese now is really growing (Field Guide…, 2011). Data on ringing of Barnacle Geese are “fresh”; therefore the mortality pattern confirms the good modern condition of the species. Real numbers exceed the theoretical curve for greater years after ringing. It means that older birds (i.e., birds with longer ring-recovery period) have greater impact on population prosperity. The impact of the primary aged birds in the population growth means that the mainland population of Barnacle Geese now is close to its saturation in numbers, and this population growth soon will stop, numbers will go on a plateau.

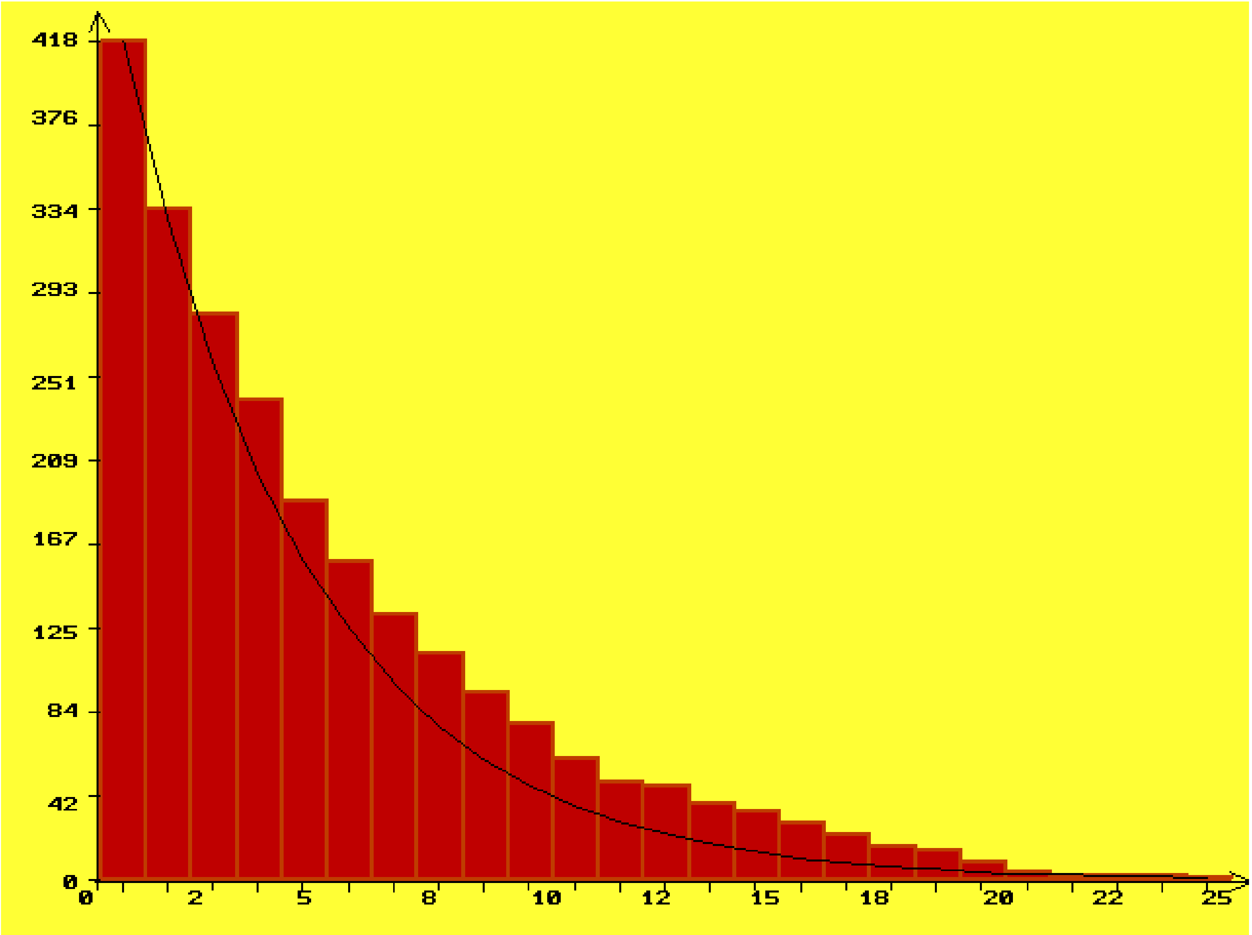


Figure 128. Mortality pattern in the Barnacle Goose. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, males live longer than females: 5.76 (N=193) and 4.84 (N=197) years respectively, near significant (t_{Bailey} = 1.79, P = 0.074). Male mortality rate is slightly less: 18.99+1.23% vs. 19.76+1.26%. Males are in better conditions while younger, females – while older (Fig. 129).

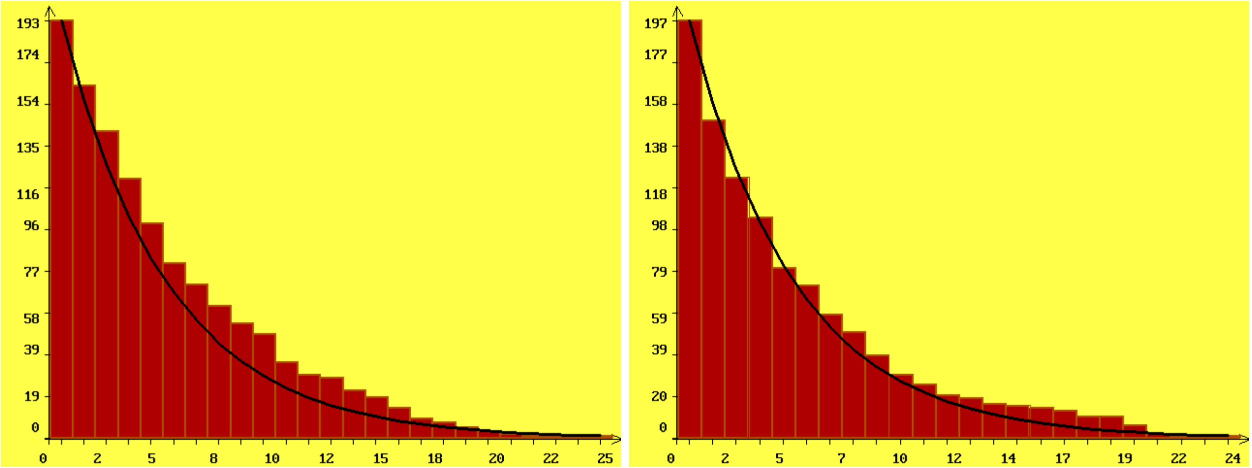


Figure 129. Mortality pattern in Barnacle Geese: males (left) and females (right).

CANADA GOOSE
(*BRANTA CANADENSIS*)

Photo by Nikolay B. Konyukhov

This originally American species has occupied several areas in the north-western Europe as breeding grounds. Small area in the Kuban River Basin (Krasnodarskiy Krai) holds few breeding pairs of Canada Geese (Field Guide, 2011). No breeding birds in the northern Europe are recorded, however vagrant Canada Geese can be seen there in flocks of other geese species. Bird Ringing Centre of Russia has 14 recoveries in Europe (Fig. 130).

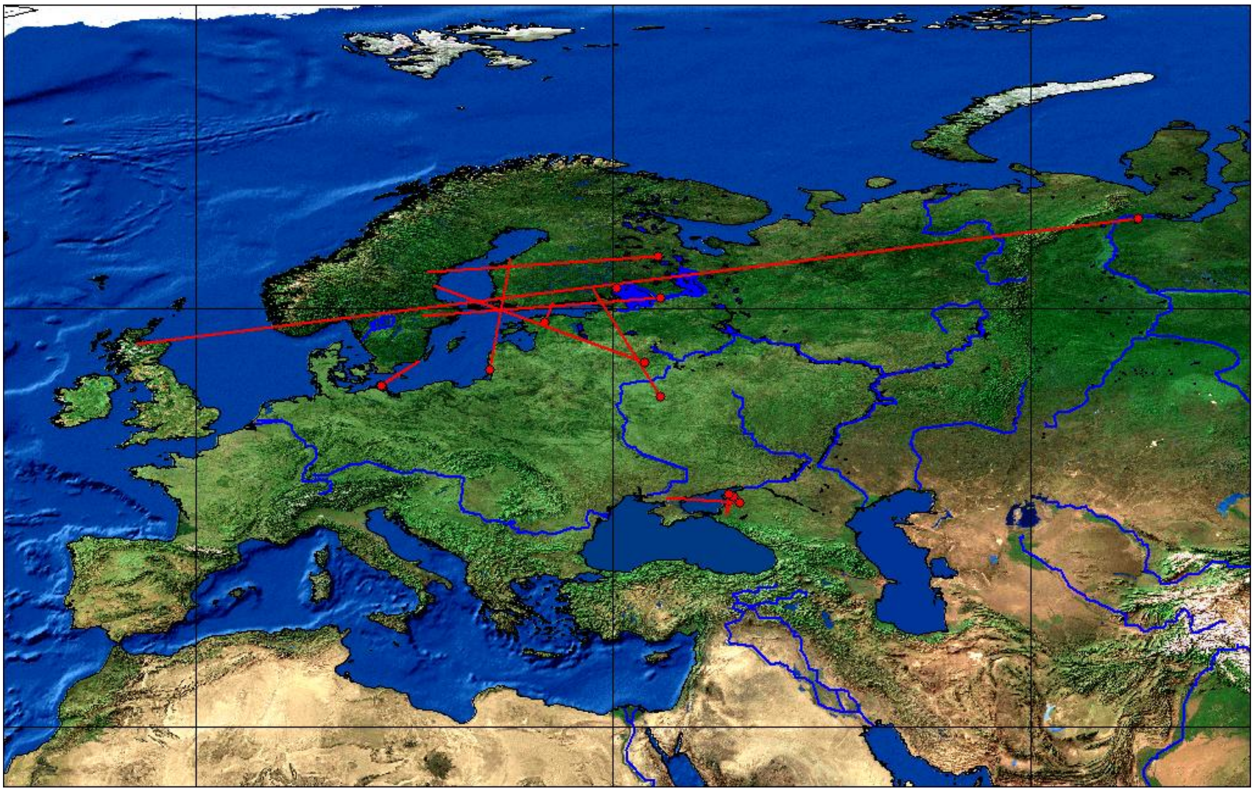


Figure 130. Flight directions in Canada Geese. Beginning of lines indicate ringing sites, red dots at the ends indicate the recovery points.

Almost no migration was detected in birds near the Kuban River (Fig. 130). One bird of this category was ringed in Askania-Nova, two in the Kuban River area. All three were taken into captivity in less than a year. Birds from northern Europe and British Islands were recovered when they moved far to the east of ringing sites, up to Western Siberia. Four birds ringed in Finland and Sweden over the long time were recovered to the south of their ringing sites. Most Canada Geese were recovered as ‘shot’, ‘found dead’, ‘details unknown’, ‘ring only found in the field’. Besides above mentioned three birds taken in captivity, one sight record is present.

BRENT GOOSE
(*BRANTA BERNICLA*)

Photo by Sergey P. Kharitonov

Taxonomic remarks. Russia holds breeding ranges of two taxonomic forms of the Brent Goose: 1) Atlantic Black-bellied Brent Goose (*B.b.bernicla*); 2) Pacific Black Brant (*B.b.nigricans* or *B.nigricans*). The latter Pacific form in different years and by different authors is considered either subspecies or a separate species. Other Brent Goose forms are rare in Russia, on the mainland coast such birds are mostly vagrant. Since the systematic questions do not have high importance for this Atlas, here we consider migration of both these taxonomic forms, notwithstanding their taxonomic statuses, species or subspecies. However, for presenting more detailed information about migration and population parameters, in several analysis Atlantic and Pacific Brent Geese are considered separately.

Breeding range in Eurasia. Brief description of the breeding range is shown in the Fig. 131. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data. Main species breeding range for the Atlantic Brent Goose is stretched along the Arctic coast of Russia from the northern top of Yamal Peninsula to the east up to Lena Delta. Small groups of these geese breed in the European Russia: on Kanin Peninsula. Black Brant breeds along the coast from eastern Chukotka to the west up to Lena Delta. Lena Delta is the area where two these forms meet and hybridize (Syroechkovsky et al, 1998).

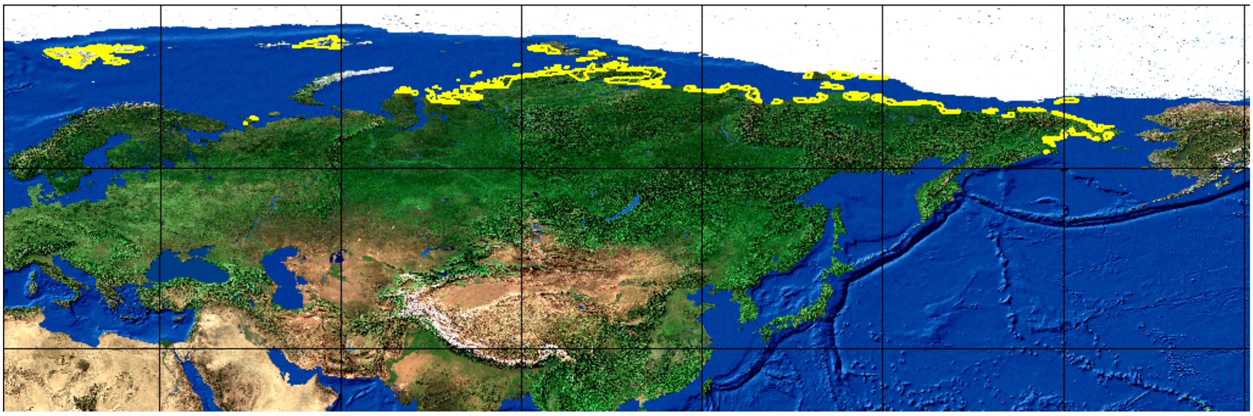


Figure 131. Breeding range of the Brent Goose in Eurasia (yellow dashed areas).

Distribution of control points. Bird Ringing Centre database contains data on 368 marked birds of the Atlantic form, that gave 487 recoveries. Great part of geese were marked with colour rings in addition to metal rings or, sometimes, without metal rings. Birds with metal ring only gave from 1 to 6 recoveries per bird, birds with colour rings produced up to 16 recoveries per bird. For the Pacific form we received 303 recoveries from 297 marked geese, mostly one recovery per bird, geese with colour rings gave up to 3 recoveries per bird. Ringing dates are since 29.07.1949 till 07.01.2019, recovery dates are since 31.05.1950 till 02.10.2022.

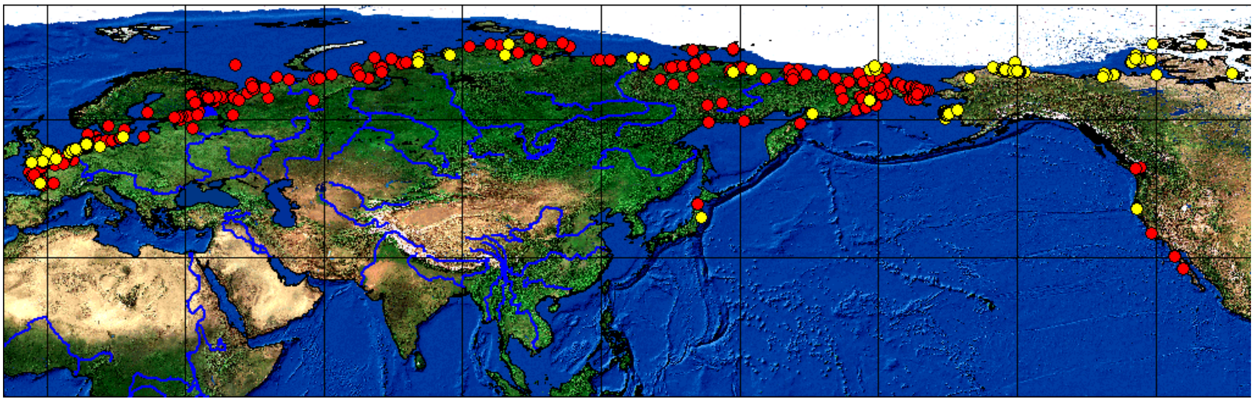


Figure 132. Position of all Brent Goose control points. Yellow dots – ringing sites, red dots – recovery sites.

Most recoveries concentrate along the mainland breeding range and well visible White Sea – Baltic Sea migratory route between northern European Russia and Western Europe, and Chukotka – western North America migratory route. Several recoveries were obtained from the small Black Brant group wintering in Japan (Fig. 132).

'Moskwa' scheme recoveries. The sample contains 280 recoveries of the „Moskwa" scheme, ringed, mostly, at the western Taimyr Peninsula, Lena Delta and Wrangel Island (Fig. 133).

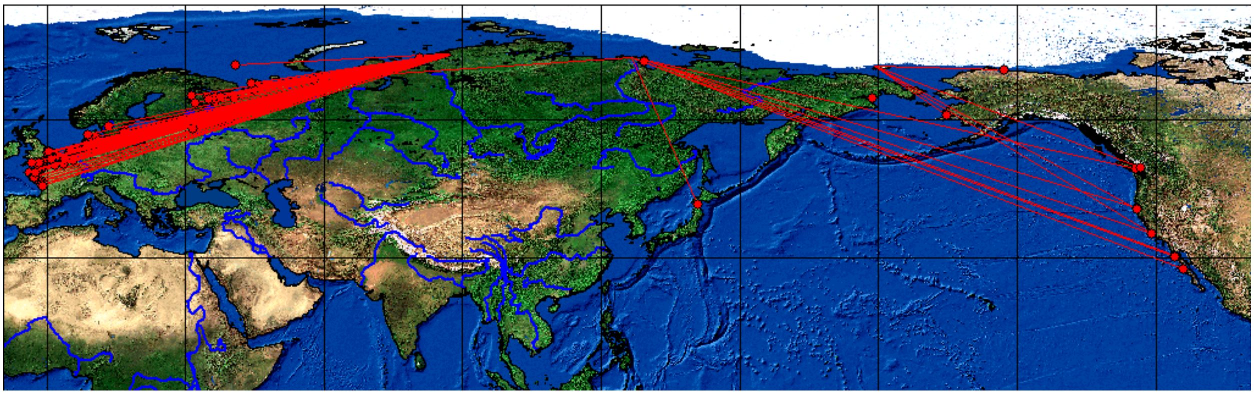


Figure 133. „Moskwa" scheme recoveries of the Brent Goose. Here and in all other similar figures lines start from the ringing sites, recovery sites are marked with red dots.

Finding details. This analysis includes all 790 recoveries. More than a half of recoveries (54%) are „shot". In 15 (2%) recoveries „details unknown", which practically mean, that they were shot, as well. Therefore, we can assume that 56% of birds were shot. Other reasons are not so common, although human-induced causes in Brent Geese are more numerous than in other geese species (Fig. 134).

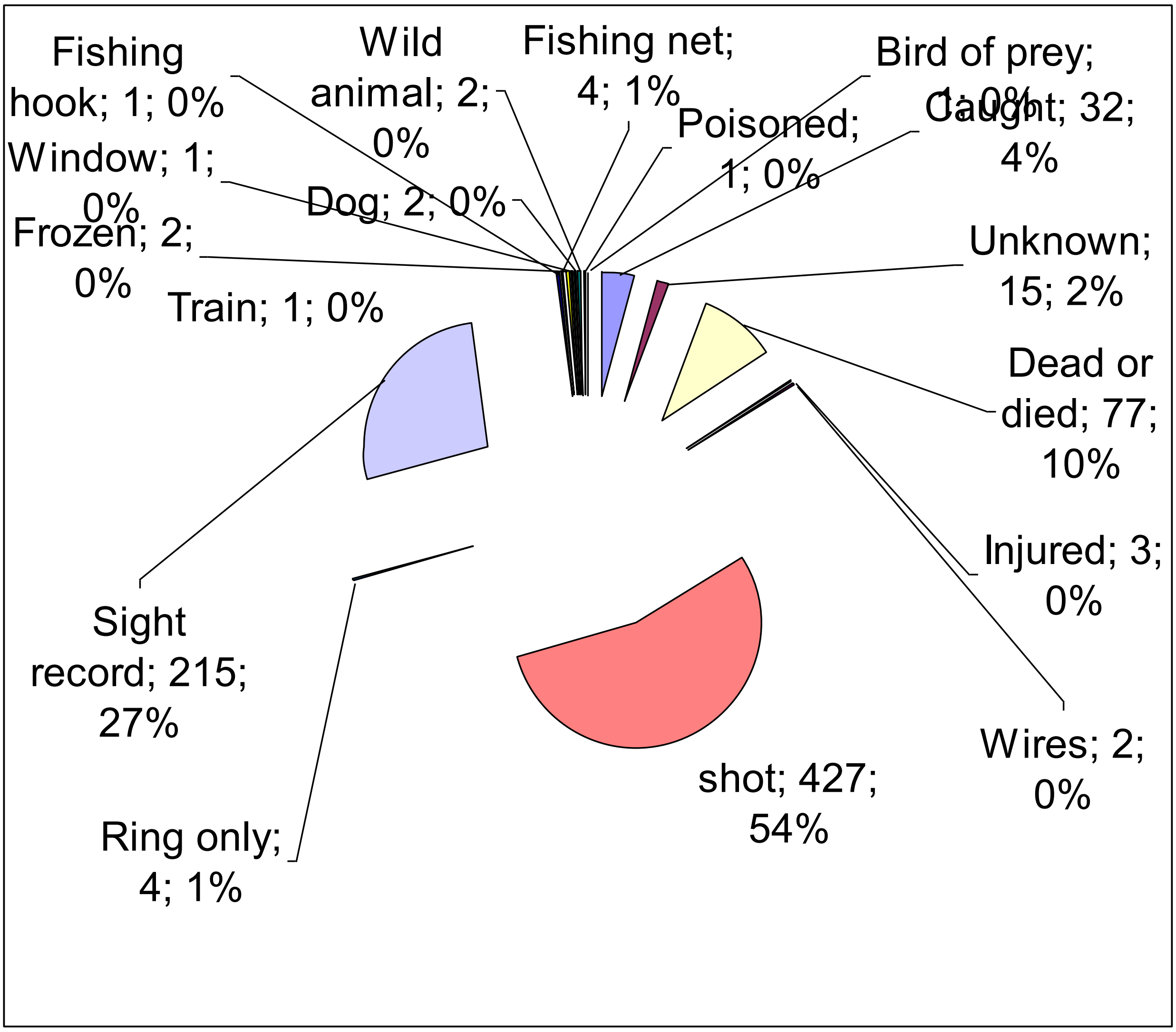


Figure 134. Finding details in the Brent Goose recoveries.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries of both Brent Goose forms are similar, the amount of indirect recoveries is greater (Figs 135, 136).

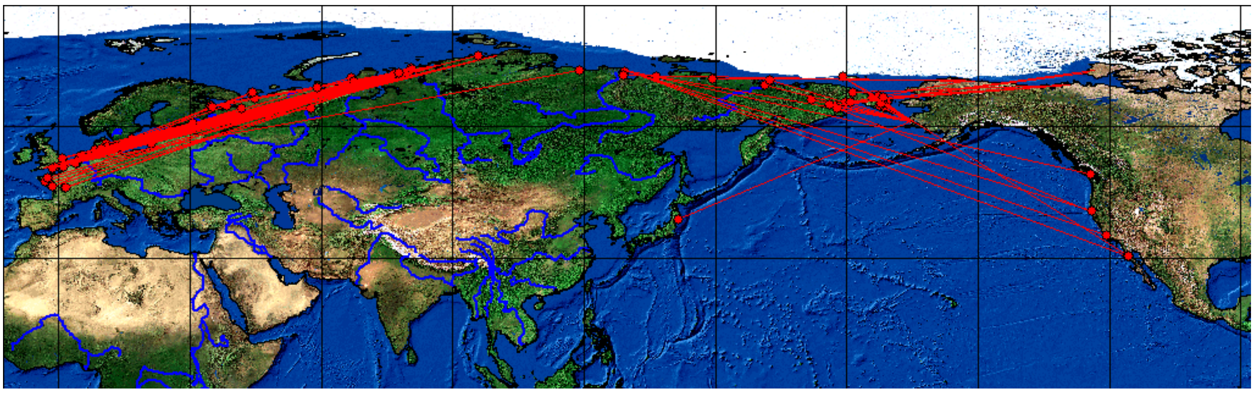


Figure 135. Map of the Brent Goose direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

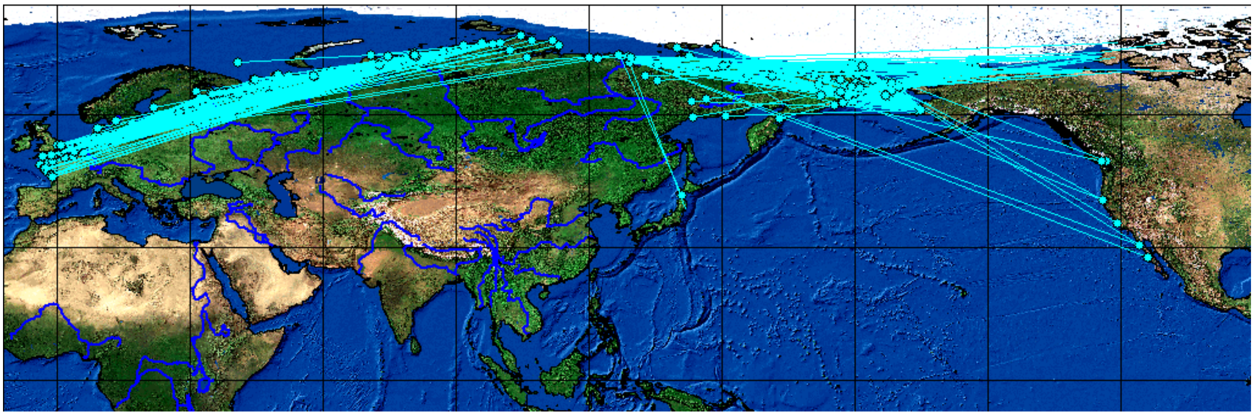


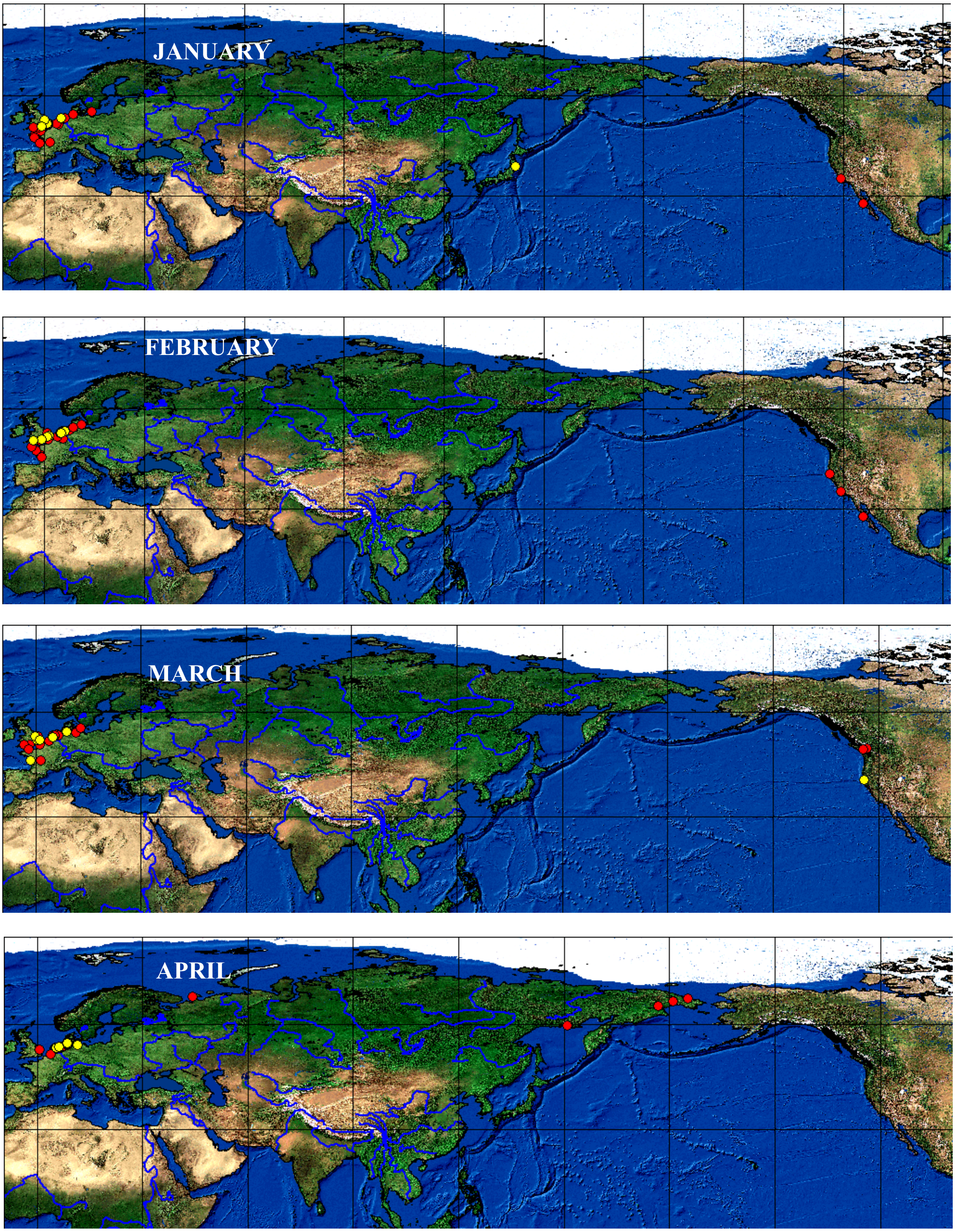
Figure 136. Map of the Brent Goose indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

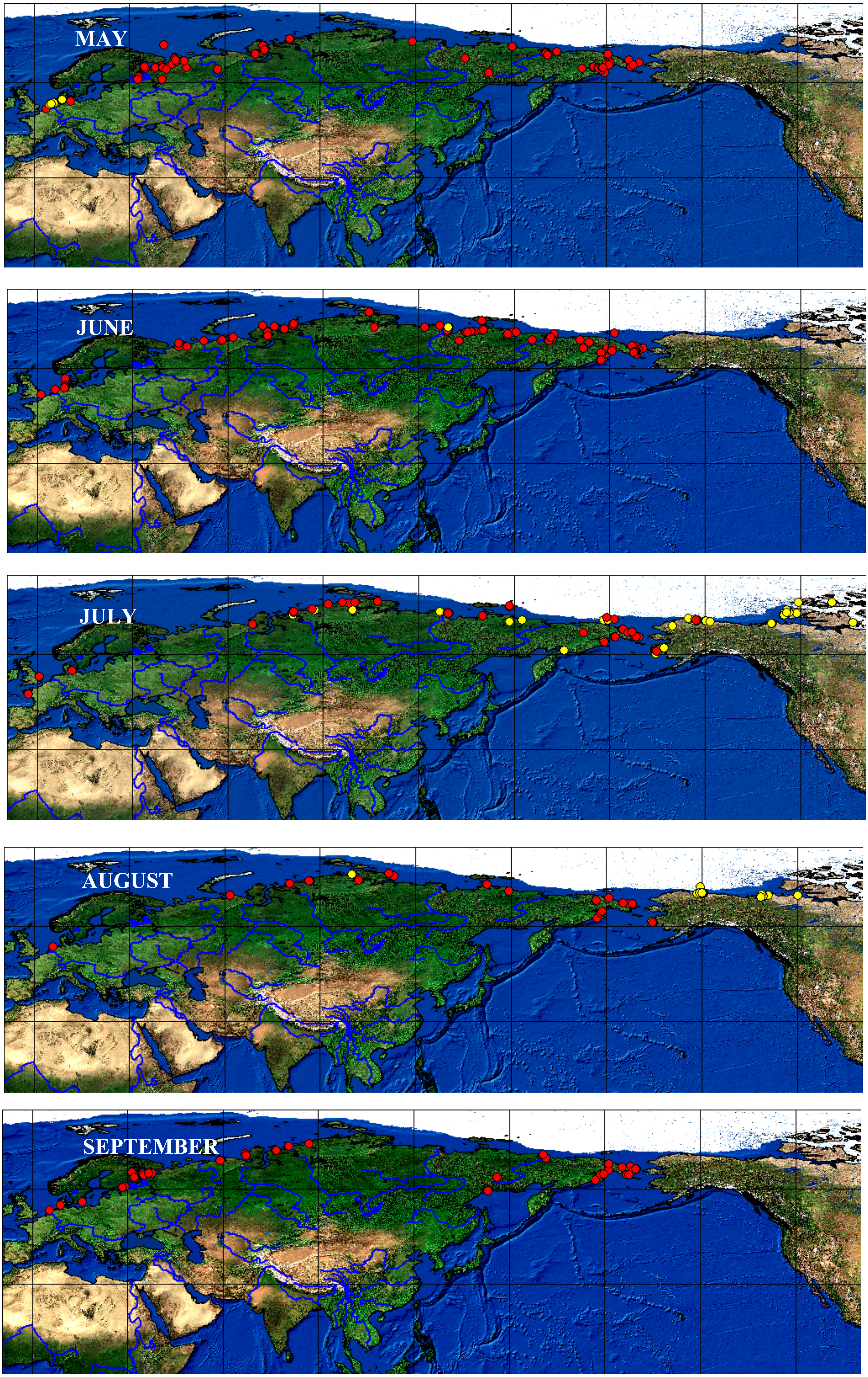
Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows near significant and significant difference between them for both Atlantic and Pacific populations (for Atlantic birds χ^2 = 4.8, 97 direct recoveries and 389 indirect ones, df = 2, P = 0.09; for Pacific birds χ^2 = 7.8, 33 direct recoveries and 271 indirect ones, df = 2, P = 0.02). Average flight distances in direct and indirect recoveries are: 1) for Atlantic birds 3925.6±83.8 and 3582.8±53.1 km respectively, difference is significant (t-Bailey = 3.45, P = 0.0007); 2) for Pacific birds 2307.2±353.0 and 1679.1±77.2 km respectively, near significant (t-Bailey = 1.74, P = 0.09). The situation when indirect distances are considerably shorter is unusual among birds. Usually (and logically) it should be vise versa. Trying to explain the situation, we compared a proportion of „shot" birds in Atlantic geese. In direct recoveries this proportion is 74.2%, in indirect 88.6%, significant (T=2.26, P=0.02). If we remove all „shot" recoveries the distance difference becomes expectable: distances in indirect recoveries are greater than in direct ones. This is also understandable: if a bird is shot, it cannot perform full migration flight, so the mean distance becomes shorter. For some unknown reason Brent Geese during the first season after ringing fall under only one hunting season on their autumn migration. Why almost no birds were shot in spring during the first season after ringing (no matter where a bird was ringed – at breeding or wintering area) is not clear. Already in the second year after ringing (between 365 and 730 days) birds are exposed to two hunting seasons, and the mean distance becomes shorter by about 300 km, and then does no change in the subsequent years. Since after one year after ringing birds start to suffer two hunting seasons per year, the proportion of „shot" birds becomes twice as great in comparison to direct recoveries.

Monthly movements. All recoveries from both populations are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in the Brent Goose (Fig. 137). In January and February Brent Geese are on their wintering grounds. In March first movements to the north are detectable in the pacific population. In atlantic population no signs of movements are seen (Fig. 137 March). April is the onset of the migration, in atlantic population only few birds start to move, in the pacific population movement is more pronounced. Migration in both populations lasts during May and at least part of June. Only in July migrating Brent Geese can be detected only on the breeding and moulting grounds (not considering birds that did not migrate and stayed at their wintering grounds)- see Fig. 137, July. Atlantic Brent Geese, the same as White-fronted Geese, fly to moult further east along their spring migratory route. On moult they appear farther from their wintering grounds than during breeding attempts. E.g., on the west of Taimyr Peninsula in late June spring migration to breeding sites changes for the migration to moulting places further east, to Pyasina River Delta. In the pacific population most Black Brant move for moult to the east, as well (compare June and July, Fig. 137). But, in distinction to

Atlantic birds, they follow along autumn migratory route, therefore on moult become closer to their wintering grounds.

In August migration starts in the Atlantic birds, but likely does not start yet in the pacific ones. September-October migration in Atlantic geese is well pronounced, but records from the database do not allow revealing the autumn migration in the Pacific‟s. However it is known that already in September Black Brant are concentrated on the Alaskan lagoons for the autumn stopovers (References on Ward et al., 1990; Ward et al., 2009). In November and December Brent Geese are on their wintering grounds, last Atlantic geese in November are still finishing autumn migration (Fig. 137).




MAY
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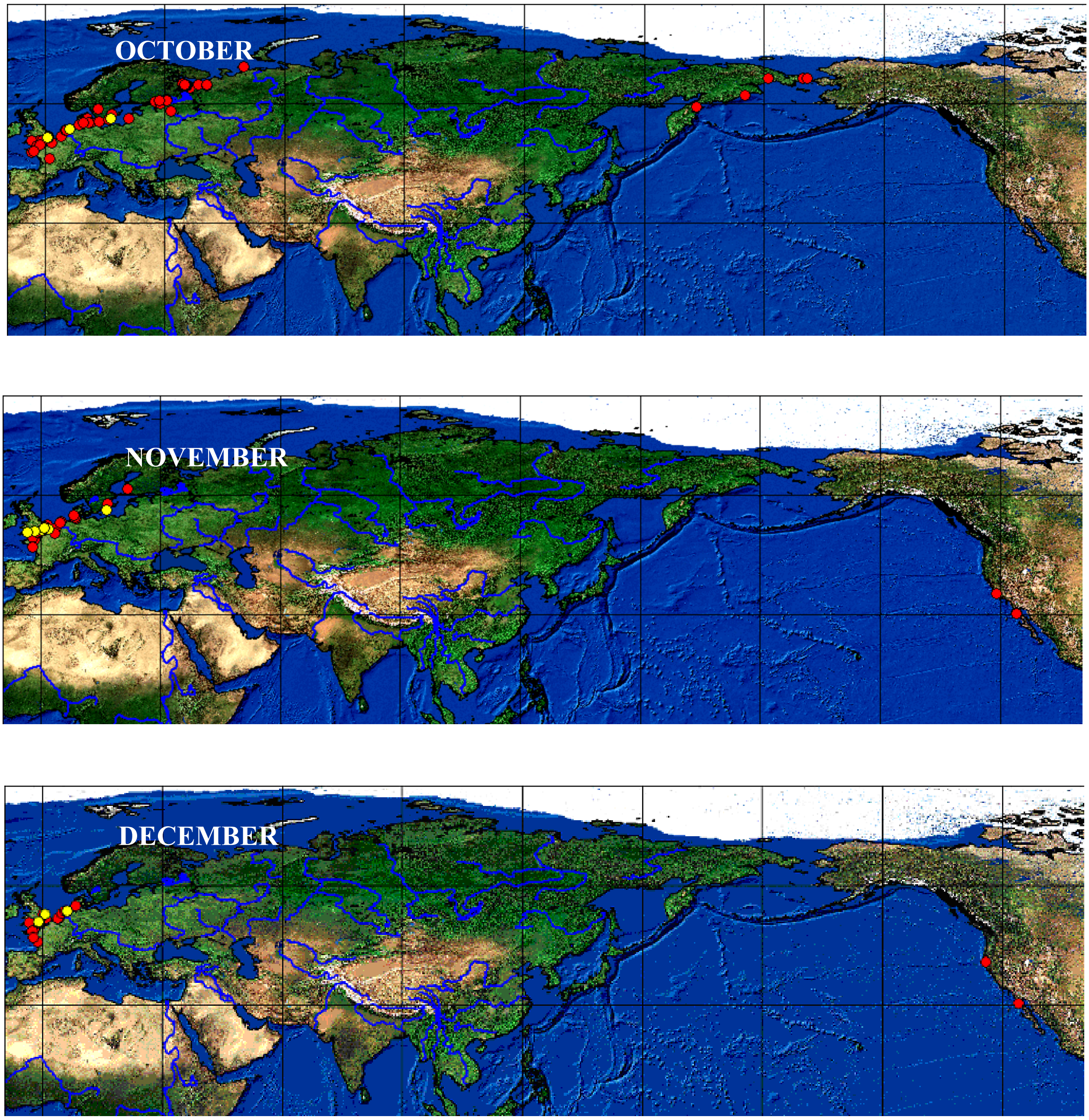


Figure 137. Brent Goose monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. Migratory routes in Brent Geese are quite simple. They are stretched along the northern Arctic coast of Russia and well known European White Sea – Baltic Sea migratory route, which is in use by several geese species. For Atlantic geese main bearings are 37-67˚ (to breeding places), and the opposite 217-247˚ (to wintering places) (Fig. 138). In Black Brant bearings are more diverse: 112-157˚ (to wintering places) and 232-338˚ (to breeding places).

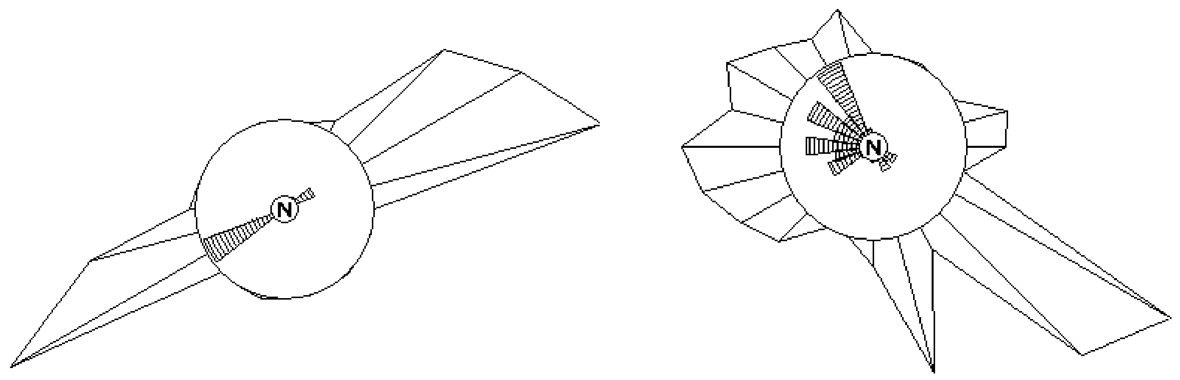


Figure 138. Recovery rose graphs for Brent Goose: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distance along each direction (radar charts).

Left chart characterizes Atlantic Brent Geese. Sector = 15.0°; Total recoveries - 486; N in sectors: from 0 up to 356; Average distance in sectors: from 0,0 km up to 4101.1 km; The longest flight distance is 5591.2 km.

Right chart characterizes pacific Brant Geese. Sector = 15.0°; Total recoveries - 304; N in sectors: from 0 up to 66; Average distance in sectors: from 0,0 km up to 6357.6 km; The longest flight distance is 7897.6 km.

Most of direct and indirect flight distances in Atlantic Brent Geese are concentrated around 3600-4800 km (Fig. 139). In Pacific Brent Geese, although maximal distances are greater then in Atlantic ones, most birds fly shorter distances, mostly 700-3200 km (Fig. 140).

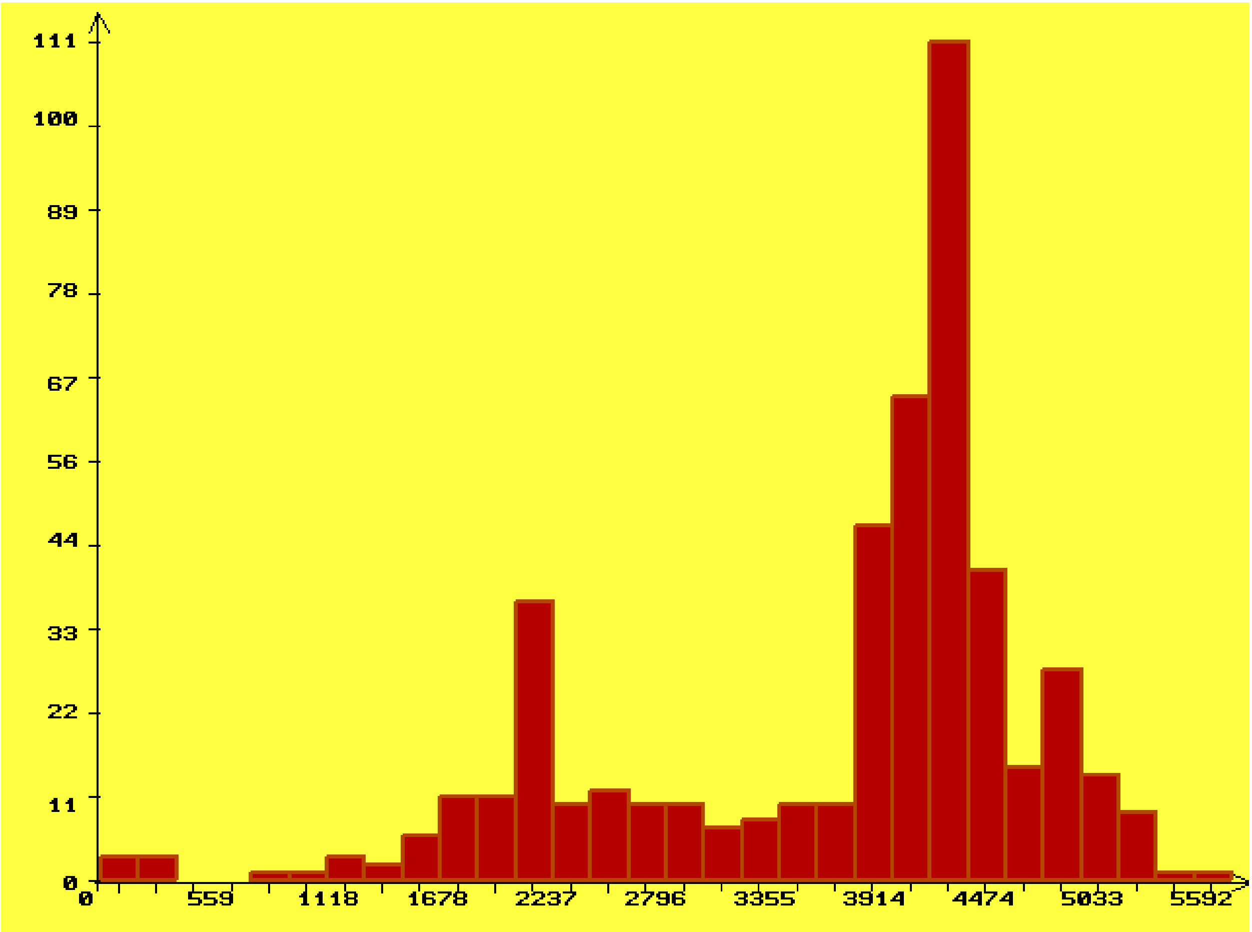


Figure 139 Distribution of all ring-recovery distances in Atlantic Brent Geese. X axis is the flight distance in km; Y axis is the number of distances.

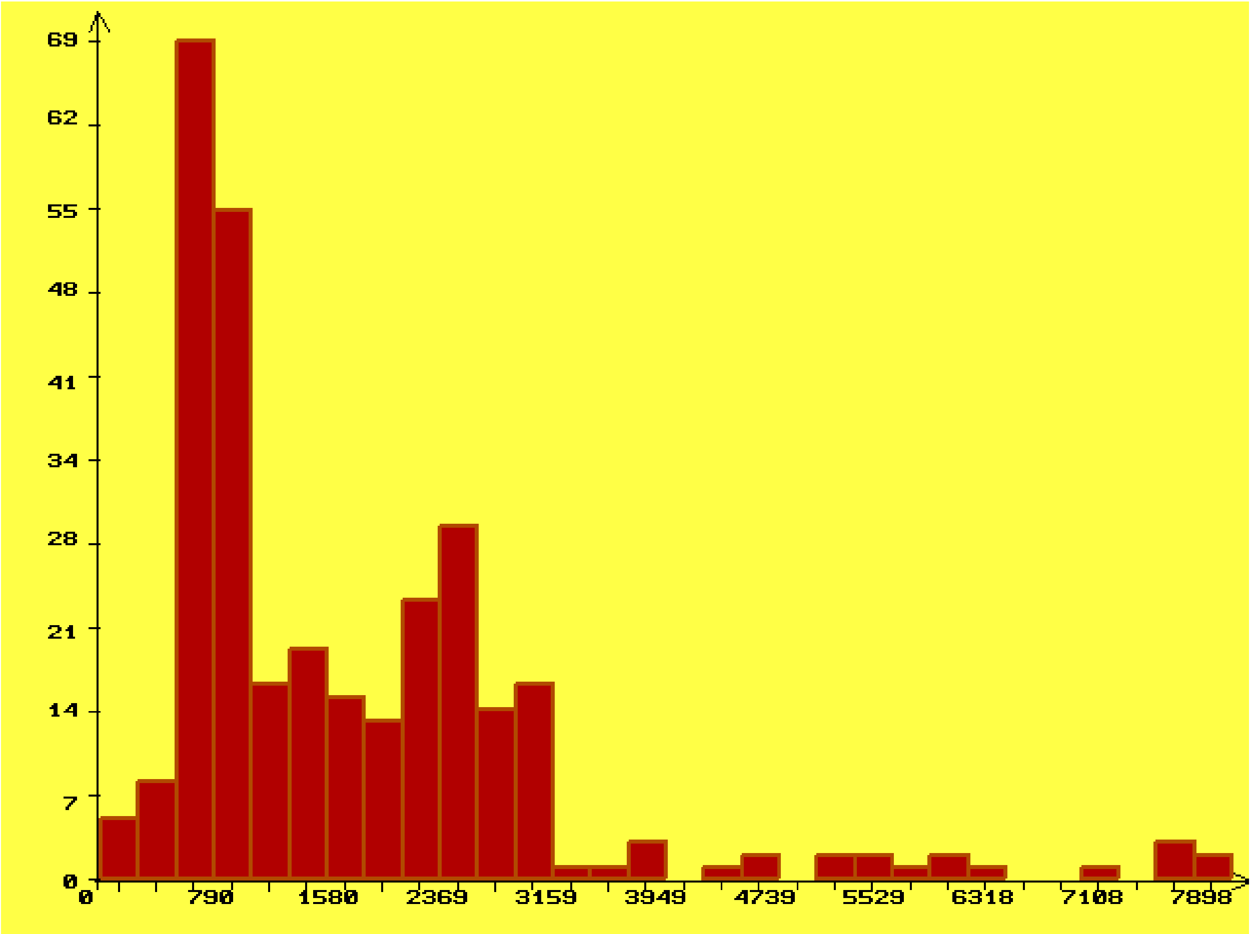


Figure 140. Distribution of all ring-recovery distances in Pacific Brent Geese. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in young Atlantic Brent Geese (ringed as „pull" or „juv" or „1 y") is greater than in adults: 3579.2+257.0 and 3650.+46.9 km respectively, although insignificant. Mean flight distance in young Pacific Brent Geese (ringed as „pull" or „juv" or „1 y") is significantly shorter than in adults: 1414.6+103.1 and 1872.5+100.8 km respectively (N_{young} = 83, N_{ad} = 221, t-Bailey = 3.17, P=0.002). Male mean flight distance is about the same as in females: 1) Atlantic birds - 3683.3+69.2 and 3675.4+66.1 km (N_{males} = 216, $N_{females}$ = 217) respectively; 2) Pacific birds - 1633.7+68.3 and 1771.2+213.5 km respectively (N_{males} = 186, $N_{females}$ = 87) – everywhere is insignificant.

To reveal the migration process in more detail, we should plot monthly means of control points for each of Brent Goose populations (Figs 141 and 142). In support of the results in the "Monthly movements" section, Fig 141 shows that Atlantic birds have easternmost position in August, Pacific birds have westernmost position in June (although there are not much data for summer months for pacific birds). This confirms that in both populations moulting sites are situated in the eastern parts of the breeding ranges, father from wintering areas in Atlantic birds and closer in Pacific ones.

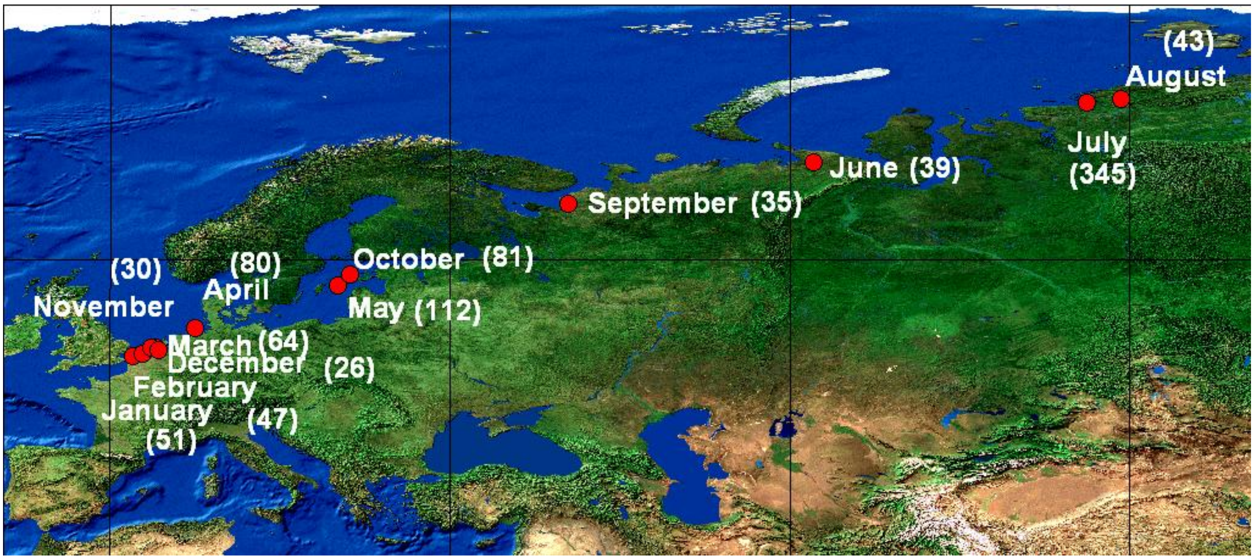


Figure 141. Atlantic Brent Geese monthly mean locations. Red circles and white labels represent all Atlantic ringed birds; digits in parenthesizes are numbers of recoveries per each month.

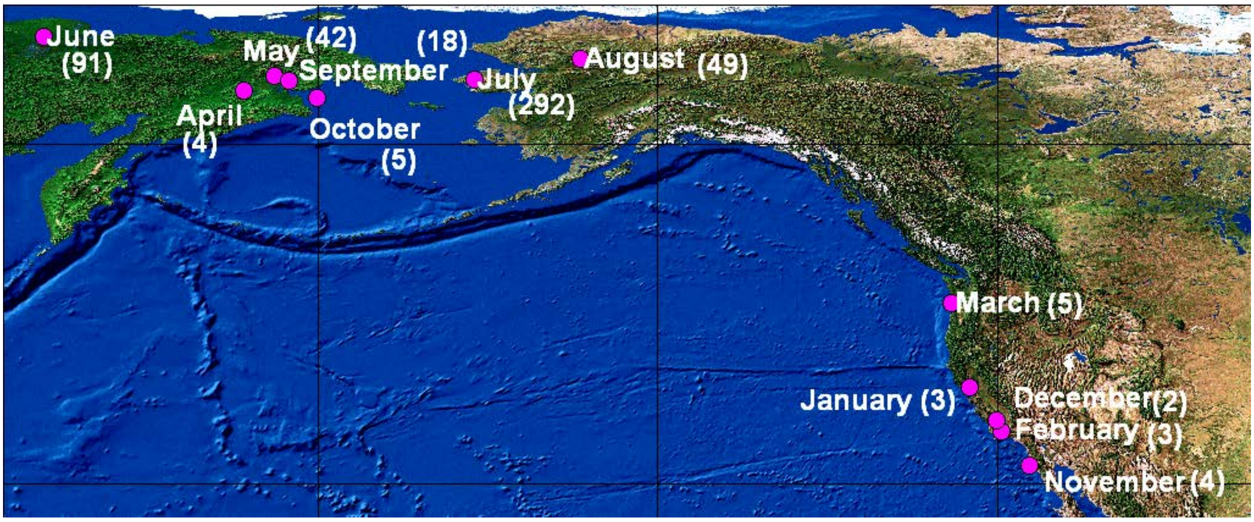


Figure 142. Pacific Brent Geese monthly mean locations. Purple circles and white labels represent all Pacific ringed birds, digits in parenthesizes are numbers of recoveries per each month. January recovery from Japan is not included.

Satellite tracking data. In 1999 six Brent Geese were marked by satellite transmitters at the Terschelling Islands, Netherlands. Five transmitters gave data both on spring and autumn migration of birds breeding in Russia. Satellite data confirmed that Brent Geese fly along the narrowest migration corridor in comparison to other geese. Routes of spring and autumn migration practically coincide. In distinction to the previously known data (Syroechkovsky, Litvin, 1998), satellite data revealed that in spring the migration corridor is broader than in autumn. The number of stops is less in autumn. Main stopovers in the Russian north are: Onega Bay , Dvina Bay of the White Sea, Mezen" Bay and south-west of Kanin Peninsula, west of the Kanin Peninsula, Sengeysky Island and Kolokolkova Bay, Pesyakov Island and Khaypudyrskaya Bay, Torasovay Island and Amderma, western Yamal Peninsula, north-east of Yamal Peninsula, Bely Island, Yavay Peninsula and Vilkitskogo Island (Green et al., 2002). Brent Geese fly mostly along the sea coast; however in some places they perform shortcuts over the land.

Speed. The fastest speed of migration movements was shown by a male ringed 11.05.1961 with the ring Kalo 305 647 in Denmark and shot on 18.05.1961 in Komi Republic, ring sent. During 7 days the bird covered 2854.1 km, or 408 km of the straight distance per day. Data on pacific geese do not contain information about quick movements; the maximal speed for this population is near 62 km per day.

Populations. Population structure of Brent Geese group consists of two populations (Fig. 143), which are denoted as the Atlantic and Pacific ones. Positions of the population are already described. These two populations overlap in the Lena River Delta.

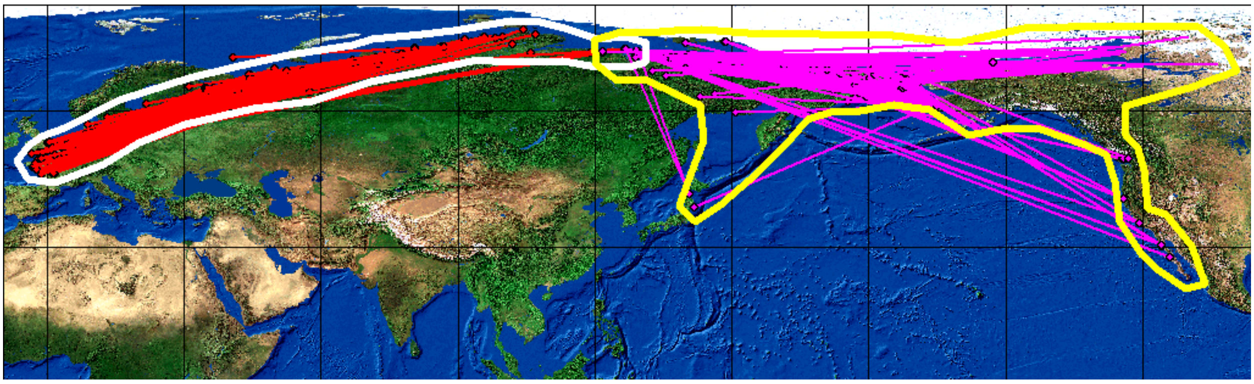


Figure 143. Brent Goose populations. White polygon outlines Atlantic population, yellow polygon outlines Pacific population.

Ten-year distances. In both populations mean decadal distance fluctuates, steadily increasing (Table 9 and 10).

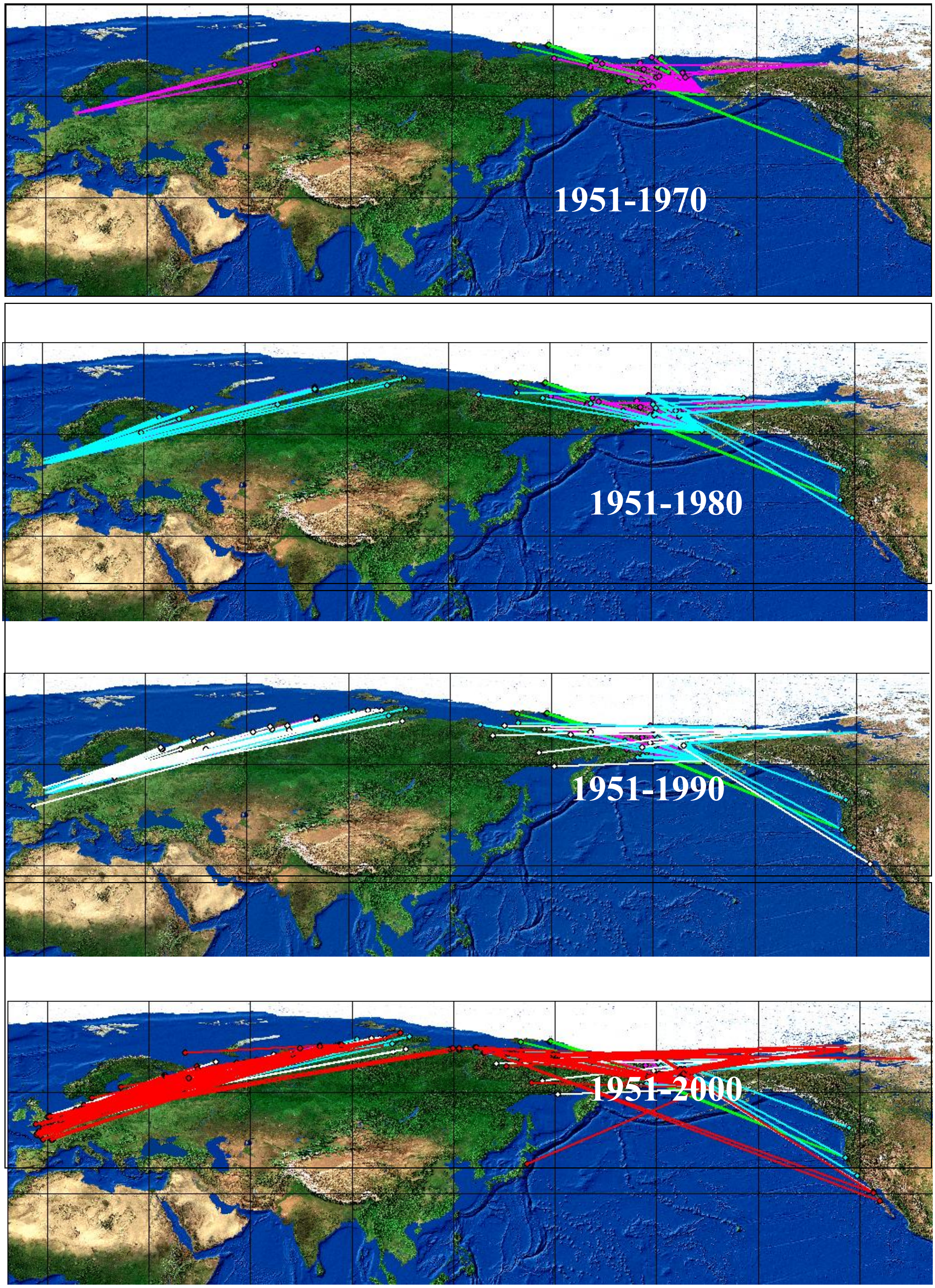
Table 9. Atlantic Brent Geese mean flight distance per decade (all birds).

Decade (years)	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2023
Distance (km)	3273.6	3658.2	3018.4	3587.9	3521.5	3892.9
Number of recoveries	3	20	29	178	165	93

Table 10. Pacific Brent Geese mean flight distance per decade (all birds).

Decade (years)	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001 - 2010	2011-2023
Distance (km)	1897.4	1205.8	1566.0	2700.7	2034.3	1486.6	2108.1
Number of recoveries	14	27	36	11	90	97	23

On the other hand, since early 1970s both the Atlantic and Pacific populations have demonstrated the tendency for increasing of maximal (not mean) flight distances. In the pacific population this is more expressed than in the Atlantic one. These two populations have been "moving" to each other during decades. Before 1970s none of the populations reached Lena Delta. In 1970s pacific population reached Lena Delta (just 1 recovery yet). In 1990s and 2000s both population reliably reached Lena Delta and "met" there (Fig. 144). Thus, Atlantic and Pacific populations connected not long ago.


1951-1970
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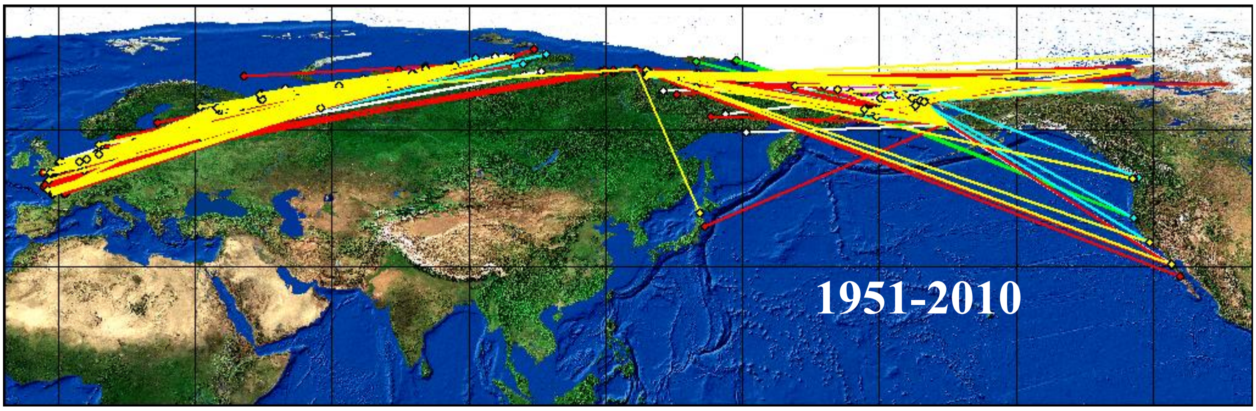


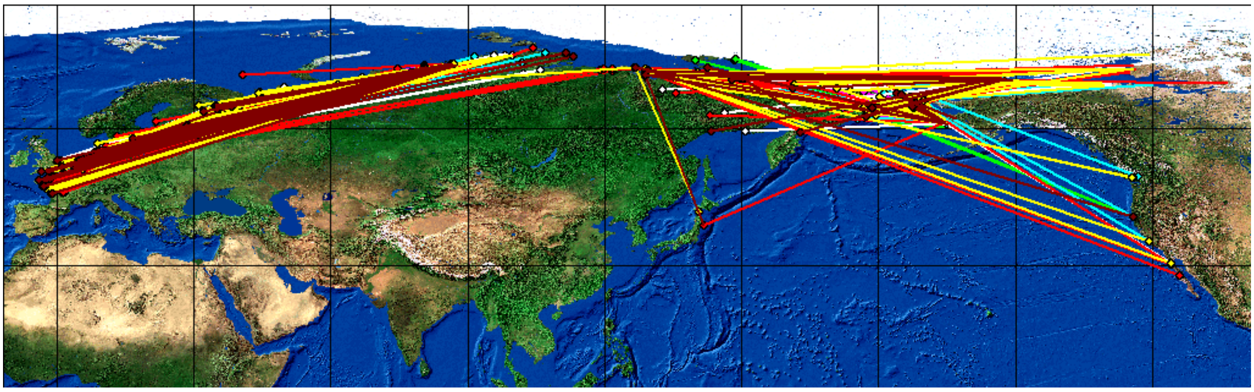


Figure 144. Developing of Atlantic and Pacific Brent Goose population intergradations. Green lines – ring-recovery connections in 1951-1960, purple – in 1961-1970, blue-green – in 1971-1980, white – in 1981-1990, red – in 1991-2000, yellow – in 2001-2010, brown 2011-2023.

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) of 28 November 2019, the oldest Brent Goose lived 28 years 10 months. Bird Ringing Centre database contains a recovery of female Brent Goose ringed as 2-year old bird and recovered in 28 years 2 months (ring not sent), therefore its lifespan was greater than 29 years. In the Black Brant the oldest bird was ringed as nestling and then lived near 26 years.

Mortality rate. According to the common criteria (see "Materials and Methods") 238 dead recoveries of Atlantic Brent Goose and 213 dead recoveries of Pacific Black Brant are applicable for the mortality rate analysis. Mean annual mortality rate in Atlantic Brent Geese is 17.20+1.01%. Real mortality pattern well conforms the theoretical one (χ^2 = 16.9, df = 26, P=0.91). Programme MARK, Model CLogLog 2ndPart shows 18.63%, difference is 1.43%. Pacific population shows 22.54$\pm$1.36% annual mortality (Fig. 145). Real mortality differs from the theoretical one (χ^2 = 96.4, df = 18, P=0.0000). MARK ClogLog_2ndPart 24.28%, difference is 1.74%.

The same as in Barnacle Geese, Brent Geese mortality pattern differs from mortality patterns of all other considered before swan and geese species. The situation when real mortality pattern does not differ from the theoretical one, that we have in Atlantic Brent Geese means that population is stable. This is true for Atlantic Brent (Fox et al, 2010). In the Black Brant bars of the real mortality are situated above the theoretical line. That means that the species is in good condition and growing in numbers. It is known that now the number of pacific Black Brant is fluctuating, with the positive population trend (Ward et al., 2009; Christian Dau, personal communication). In distinction to Barnacle Geese, real numbers exceed the theoretical curve for first years after ringing. It means that younger birds (i.e., birds with short ring-recovery period) have greater impact on population prosperity. The impact of the primary young birds in the population growth means that Black Brant population is far from its upper possible limit; therefore the population has good possibilities for growth.

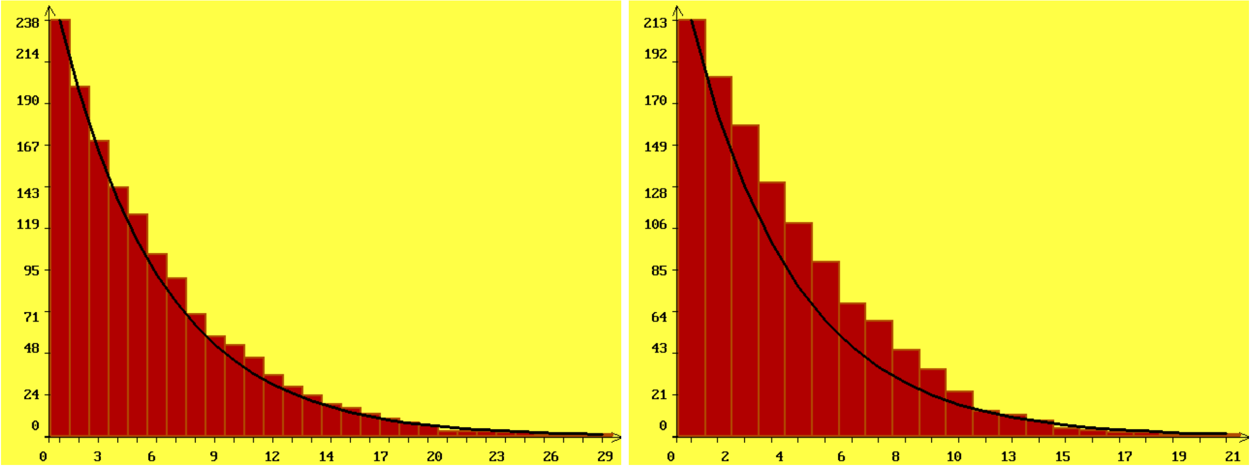


Figure 145. Mortality pattern in the Brent Goose. Left chart reflects the mortality rate of Atlantic Brent Geese, right of pacific Black Brant. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Males of the Atlantic population live longer than females: 6.15±0.53 (N=99) and 5.24±0.50 (N=96) years respectively, insignificant. Mortality rates are close: males - 16.8±1.5%, females - 14.6±1.4%. In the Pacific population the situation is different: females live significantly less than males: 5.78±0.32 (N = 132) and 4.29±0.53 (N = 55) respectively, t-Bailey=2.39. df (Bailey) = 96, P = 0.02. Mortality rate in females is very different to that in males: 17.4±1.1% and 23.8±1.8 % respectively.

RED-BREASTED GOOSE
(*BRANTA RUFICOLLIS*)

Photo by Sergey P. Kharitonov

Breeding range in Eurasia. The brief description of the breeding range is in the Fig. 146. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996; Litvin, Gurtovaya, 2006 and own data. Red-breasted Goose is the endemic species of Russia. Main species breeding range includes Yamal, Gydan and Taimyr Peninsulas, and north-western Yakutia. In recent years separate breeding pairs appeared in the European Russia North: on Kolguyev Island and Barents Sea mainland coast in the Nenets Autonomic Area (Fig. 146). Central part of the breeding range is Taimyr Peninsula where 85% of the Red-breasted Goose population is breeding (Syroechkovsky, 1995).

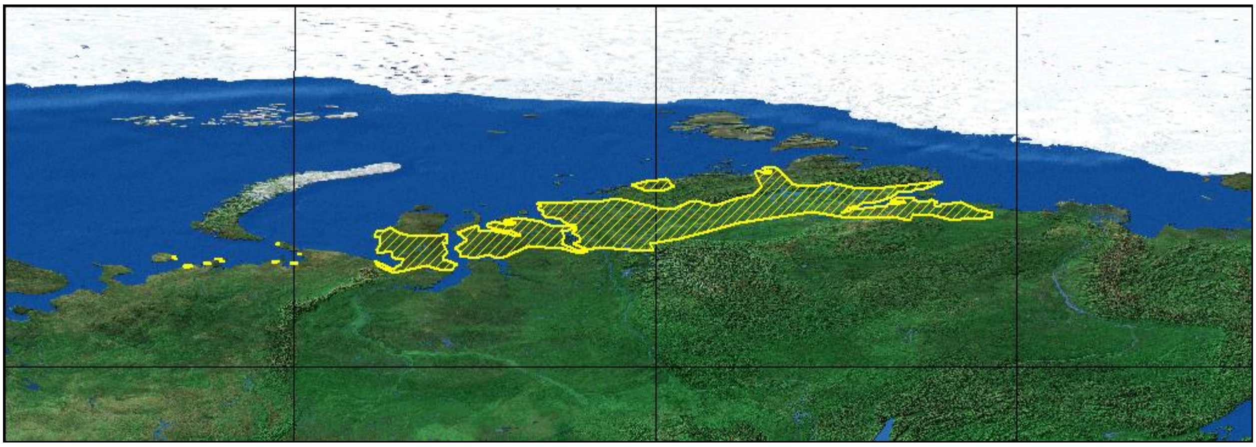


Figure 146. Breeding range of the Red-breasted Goose (yellow dashed areas).

Distribution of control points. Bird Ringing Centre database contains data on 32 marked birds, which gave 32 recoveries. 1 bird in addition to metal ring had neck-collar, 1 bird – wingtag, 9 birds - colour rings, 1 bird had colour ring without metal ring, 6 birds together with metal ring worn a colour ring and satellite transmitter. Ringing dates are since 21.07.1941 till 16.07.2014, recovery dates are since 05.01.1942 till 07.03.2017. 27 recoveries are rings of the „Moskwa" scheme, 1 – „Arnhem", 1 – „Radolfzell", 3 – „Sofia". 28 birds were marked in nature, 4 birds escaped from zoos.

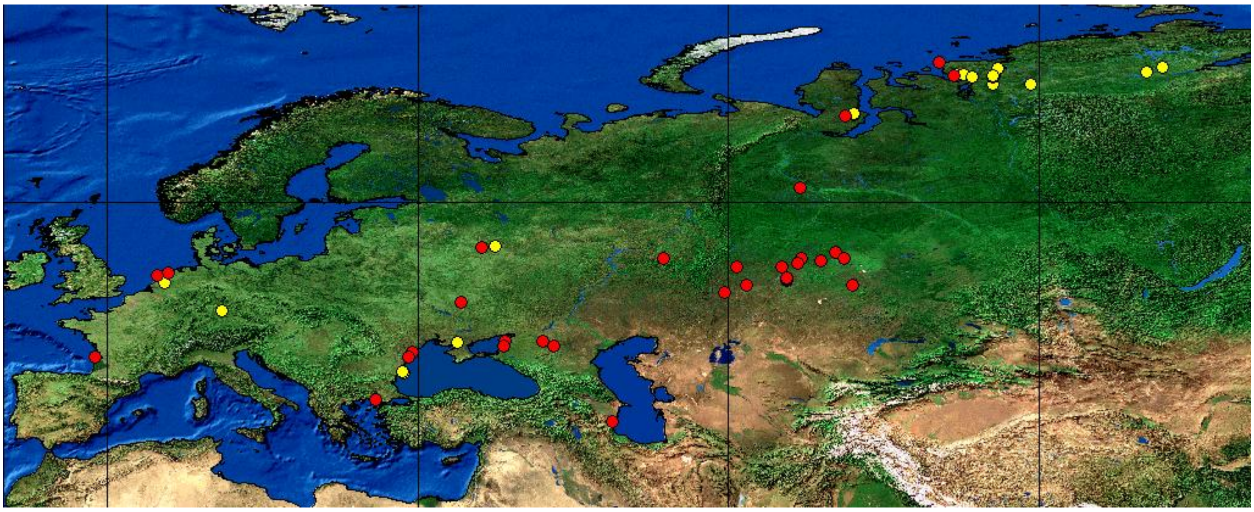


Figure 147. Position of all Red-breasted Goose control points. Yellow dots are ringing sites, red dots – recovery sites.

Ringing and recovery points are widely distributed overall Europe (excluding Scandinavian countries), Western Siberia and Taimyr Peninsula (Fig. 147).

Finding details. This analysis includes all 32 recoveries. In 19 cases (59.4%) are „shot". In 4 birds „details unknown", which practically mean shot, as well. Therefore, we can assume that 72% of birds were shot. 3 birds were found dead, 1 entangled in fishing net, 1 hit by car, 1 was taken by a bird of prey, 2 was killed by wild animal, 1 ring was just found in the field.

Populations. All Red-breasted Geese are considered as belonging to one population (Fig. 148). Population range includes not only main breeding and wintering grounds, but also a broad area where wild vagrant birds mix with geese escaped from captivity and form new breeding sites and migratory routes (see below).

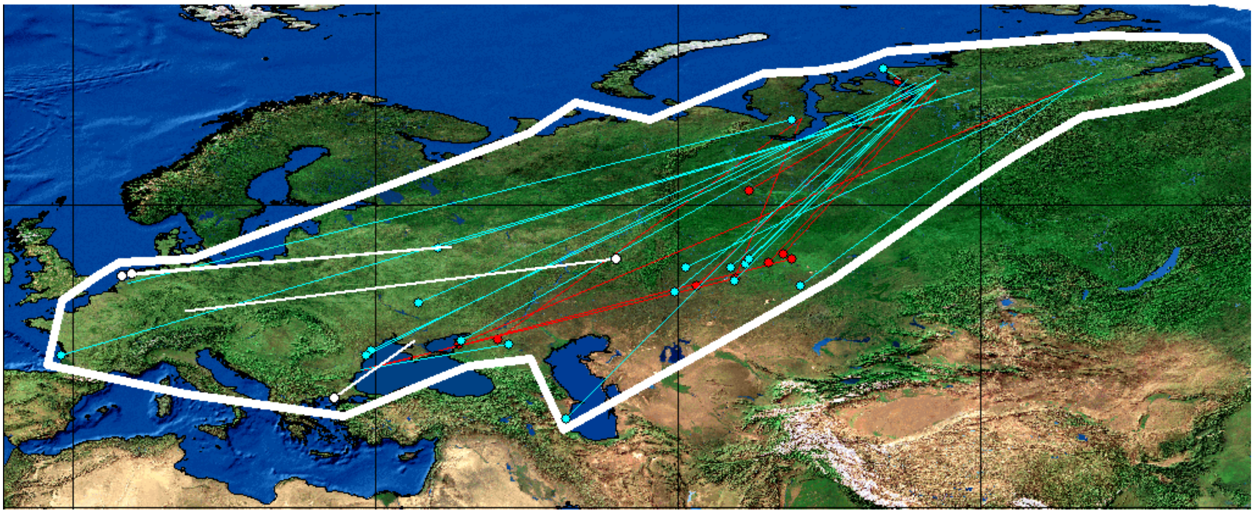
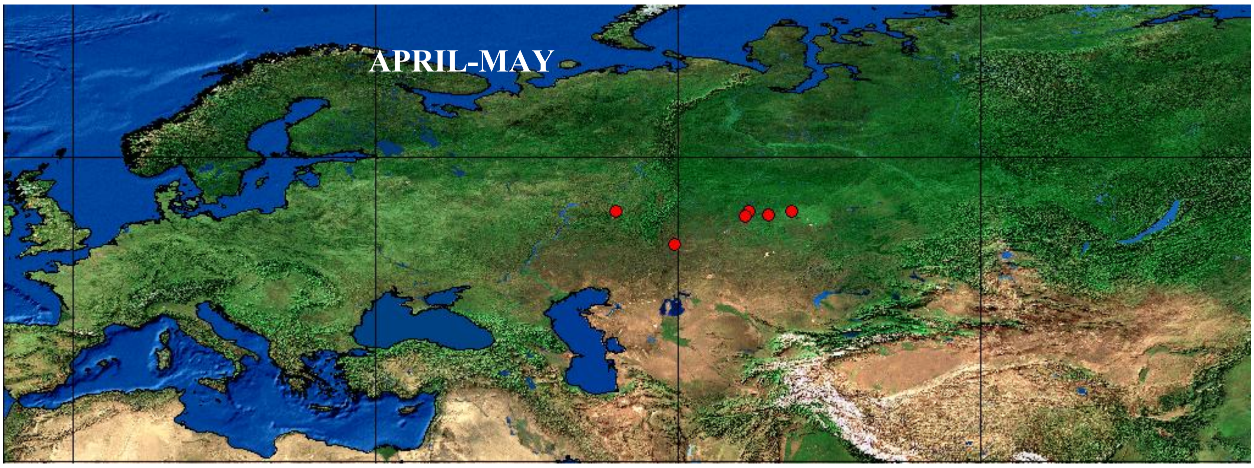


Fig. 148. Red-breasted Goose population. White polygon is the population boundary. Red lines and dots represent direct recoveries, blue-green lines and dots are indirect recoveries, white lines and dots represent ways of birds escaped from captivity.

Direct and indirect recoveries. Those recoveries are drawn in Fig. 148. Average flight distance in direct recoveries is shorter than in indirect ones: 2497.4±372.7 (N = 11) and

2954.4±301.5 (N = 17) km respectively. Difference is not significant; however, data sample is small.

Monthly movements. All recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery locations) reflect a general way of seasonal movements in the Red-breasted Goose (Fig. 149). In January and February Red-breasted Geese are on their wintering grounds. In March first movements to the east are detectable (Fig. 149 March). April and May – Red-breasted Geese migrate step-by-step, spending long time on spring stopovers along Manych River and in the northern Kazakhstan. In early or mid June (depends on weather conditions) these birds arrive on breeding grounds. This species is the latest goose species appearing in spring on Taimyr Peninsula. In June, July and August birds are on there breeding grounds where they nest and moult. Two vagrant birds were recovered in August in Netherlands and France (Fig. 149, August). The bird recovered in France is the wild one, ringed on Taimyr Peninsula. September-October is the autumn migration, step-by-step also with long time spent on stopovers in northern Kazakhstan and Manych River. We have no control points for November. In December all birds are on their wintering grounds (Fig. 149, December).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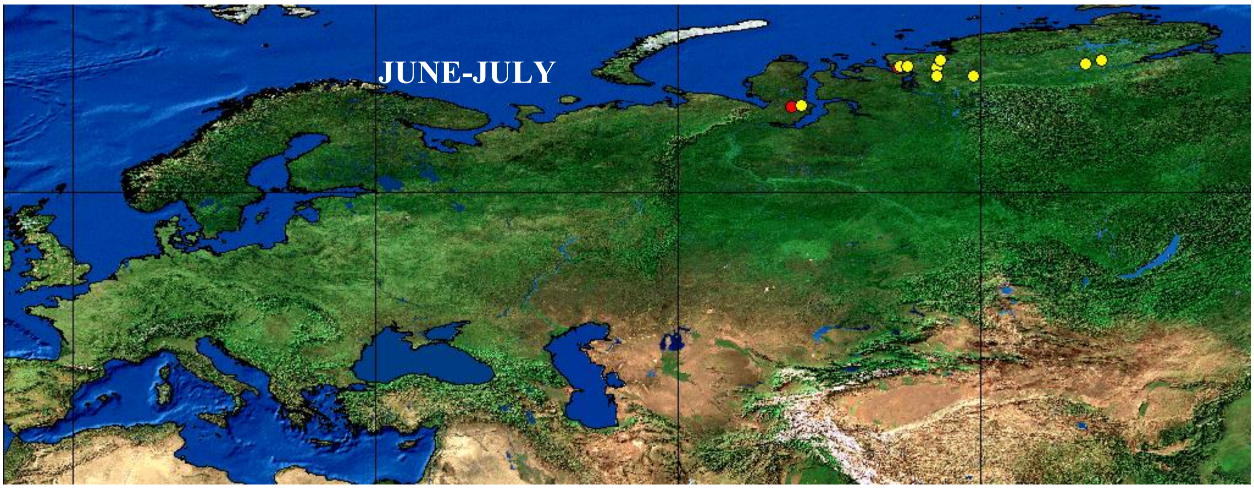
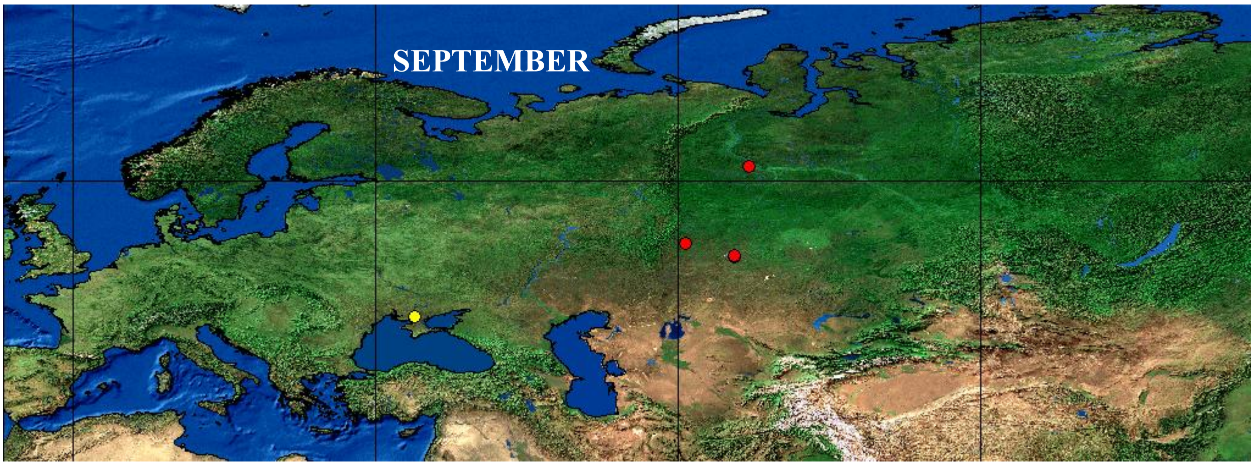

JUNE-JULY


AUGUST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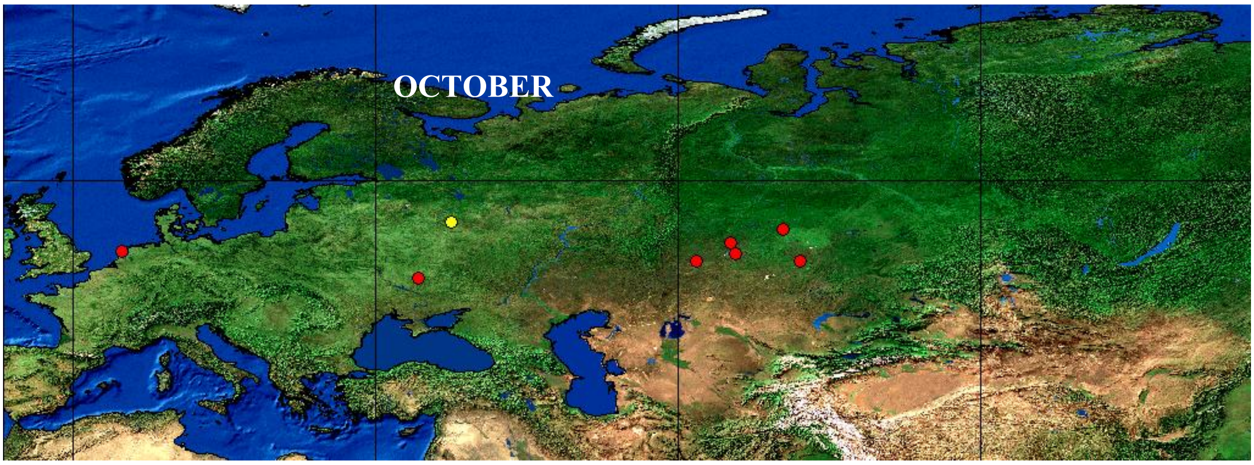


Figure 149. Red-breasted Goose monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Zoo birds. Red-breasted Geese that escaped from captivity (in distinction to escaped Greylag Geese – see the species account) are capable to fly at long distances in a short time after escaping. The other remarkable feature – the escaped birds fly along or close to their natural migratory routes and arrive to their natural wintering grounds wherever they are located (Fig. 148).

Migratory routes. Modern migratory routes and main wintering areas have formed not long ago. Before 1967 Red-breasted Geese wintered mostly in a compact group on the south-western end of the Caspian Sea, Azerbaidzhan. This place was not good for geese due to high level of illegal hunting. Small group wintered in Dobrudzha, Romania since 1940 (Rogacheva, 2000). In the summer of 1968 Breeding conditions on Taimyr Peninsula were so severe, that those geese even did not breed that year. After the summer of 1968 the whole Red-breasted Goose population sharply changed the wintering grounds: they shifted from the Caspian Sea to the north-western coastal area of the Black Sea (Vinokurov, 2001). However, the latter place is not totally new for Red-breasted Geese. They spent winters there in ancient times. There are several Red-breast Goose fossils of Pleistocene from Hungary, Greece, Crete Island, western Italy and Bulgaria (Rogacheva, 2000). In recent times up to 2000 wintering geese of this species are recorded in Greece (Syroechkovsky, 1995). Still they are recorded at the Caspian Sea in small amounts (Babayev et al., 2005). In mild winters they stay at Manych Lake in high numbers, in recent times they do it practically every year (Badmayev, Badmayev, 2005). In winter theyare recorded in Turkey and even in the south-eastern China (Zhu Lei et al, 2012, Ding Chang-Qing, personal communication; John Takekawa, personal communication). In the latter case Red-breasted Goose singles or pairs were observed in flocks of the Tundra Bean Goose (*A.f.*

serrirostris), the species that breeds on Taimyr Peninsula, as well. In any season, but especially in winter, at present thousands of Red-breasted Geese spread over Europe. Many of these birds are escaped ones, but some of them are wild.

Current migratory routes in Red-breasted Geese are well visible from the direct recoveries. Main migratory route in autumn starts from breeding grounds on Taimyr and Yamal Peninsulas, then goes along Ob River to the south, i.e., to the lakes of northern Kazakhstan. Then, after a rest on those lakes, geese turn to the west, bending Ural Mountains over the southern end together with other geese and ducks. After that they fly to the west to the western Black Sea coast, to Bulgaria and Romania. Part of birds penetrates up to the central Europe (Fig. 150). In spring they fly back exactly along the same way.

However, it looks like the other, minor northern migratory route exists and is probably developing. Several records of migrating flocks within central and northern European Russia, suggest that there is the Red-breasted Goose way between Siberia and Europe over the northern top of Urals, like in other geese, mostly White-fronted Geese (Kharitonov, 2005). We still have no direct evidences of this route existence, but indirect evidences are increasing in amount.

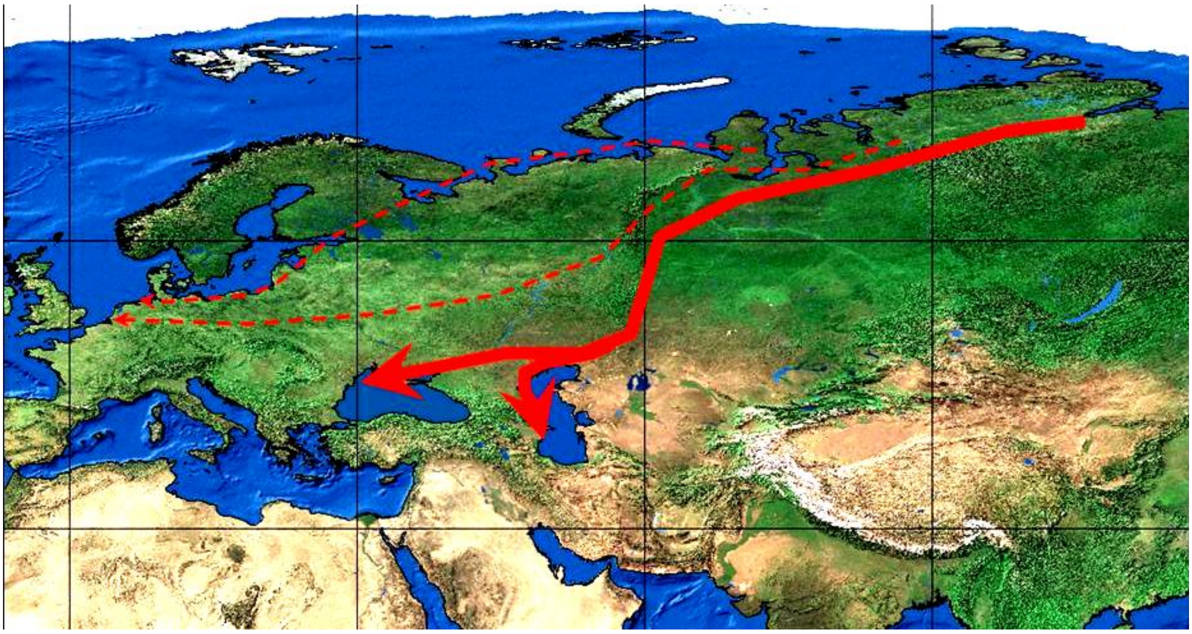


Figure 150. Migratory routes of Red-breasted Geese from breeding to wintering grounds (red arrows). Solid line represents the main migratory route, dashed lines – minor or suggested migratory routes.

E.g., since 2007 in Poland the number of recorded Red-breasted Geese have been growing sharply, with the peak of numbers in November and March (Jawicki, Stawarczyk, 2012), exactly in the migration time. Separate Red-breasted Geese were met on Kolguyev Island and Barents Sea coast, in recent years separate pairs started to breed there (Litvin, Gurtovaya, 2006). Really, it does not matter what birds have appeared there first – escaped geese from Europe that commenced breeding, or some geese from western Siberia. Anyway, these birds, very likely, form and develop Red-breasted Geese northern migratory route.

Satellite tracking data. Red-breasted Geese migratory routes that are revealed on the basis of ring-recovery data are generally clear. Anyway, usage of satellite and GPS transmitters involved more detailed information on the migration features, i.e., information on the new stopovers and smaller migratory streams (Fig. 151). First data on satellite tracking was obtained in 2012 within the scope of project Le Balkan Bulgaria Foundation/USFWS (http://www.redbreastedgoose.org/). A male marked at the wintering site on the northern

Bulgarian coast started its migration on 16.03.2012 and on the next day landed in the Zaporizhzhya Region, Ukraine. Then the bird crossed the Sea of Azov and spent a week in the reed covered areas on the eastern coast of the Sea of Azov. This stopover site has not been known before. Next stop for two weeks (27.03-10.04) was performed at the Manych-Gudilo Lake (area between Black and Caspian Seas), then the bird moved to the north-east to the northern Kalmykia. Later on, by the series of short flights via Astrakhan and Orenburg Regions on 24.04.2012 the bird appeared at the well-known stopover area with many lakes in the northern Kazakhstan, where the goose was shot by poachers.

Another three birds in 2013 moved from Bulgaria to the east along traditional Red-breasted Goose migratory route. In mid-May these birds stopped at the northern Kazakhstan where spent nearly a month, than moved directly to the north, and on 12.06.2013 reached their breeding areas on the western Taimyr. Autumn migration of marked birds commenced as early as on 26.08.2013. By 13.09.2013 these birds reached the Ob River month (south-west of their breeding area) then migrate south along the Ob River valley. All these birds arrived to the northern Kazakhstan during 22.09-04.10.2013 where spent more than a month. They started to move to the west as late as 13.12-16.12.2013. After several flights to the west, at the end of December birds still stayed in the western Crimea, Ukraine (www.seaturtle.org/tracking/?project_id=709).

In 2012 Red-breasted Geese that marked with GPS transmitters on the breeding grounds at Gydan Peninsula (north-east of the Western Siberia) first moved to the Ob River and used the Ob River valley as an autumn migratory route to the south. In 2013 11 geese were marked with GPS-GSM transmitters at the south-eastern part of Taimyr, near Khatanga City (http://www.naturalsciences.be/RBG-RBINS/). Birds migrated first to the west along southern part of the Yenisey Bay directly to the Ob River mouth, on 13-12 September they reached this mouth. Then all birds flew to the south and south-east along Ob River valley till Khanty-Mansiysk, where turned directly to the south. On 27.10-04.11 the birds arrived at the northern Kazakhstan and Orenburg Region where they stayed till 08.11.2013. The front of migration became broader while birds moved to the west from the northern Kazakhstan to the area north of the Caspian Sea. Red-breasted Geese crossed Volga River in its lower streams from Volgograd up to the mouth. One bird made a stop at the earlier unknown place at the very west of the Volga River Delta. Most birds stayed at the known stopover area at the Manuch-Gudilo up to the second half of December when they moved to Crimea, Ukraine. In January several birds winter in Crimea, others flew to the Romania and Bulgaria (Lake Durankulak).

In spring of 2013 another three Red-breasted Geese were marked in Durankulak Lake, Bulgaria. Then two birds flew to Siberia (Gydan and Taimyr Peninsulars) along usual migratory route via northern Kazakhstan. However, one bird performed migration along very unusual route. Before reaching the Volga River, this goose turned sharply to the north-east and move in 200-300 km west of the Volga River stream. The bird had crossed Urals at ca 64˚N and on 24.06.2013 reached the eastern coast of the Yamal Peninsula (Simeonov et al, 2014).

Satellite and GPS-GSM transmitter tracking together with not numerous ring-recovery data allowed making important conclusions on the Red-breasted Geese migration along the main migratory route of these species. In general, spring migratory route coincides with the autumn one. The migratory route stretched from the western Black Sea area to the northern Kazakhstan. The main stopover on this way is the Manych-Gudilo Lake together with the neighbouring water bodies. Islands on these lake are important for Red-breasted Geese as places for spending nights. There are several important stopover sites in the northern Kalmykia (Sarpa Lakes) and on the east of the Orenburg Region. Key sites for Red-breasted Geese are numerous lakes in the northern Kazakhstan. These stopovers are the most pronounced on the geese route. Without data from transmitters it has not been known how these birds cross the Western Siberia. New data indicates the loop migration there (Fig. 151). In spring geese fly straight to the north over the taiga and taiga bogs to the breeding areas on Gydan and Taimyr Peninsulars. In autumn from these breeding areas geese first fly not to the south (not along the spring migratory route), but to the west up to Ob River, and only then turn to the south, flying to the west of their spring migratory route. Transmitters allowed revealing unknown stopover sites on the eastern coast of the Sea of Azov (north of Primorsko-Akhtarsk) and at the shallow waters of the Sivash Lake (southern Ukraine). In the latter area Red-breasted Geese could spend winter since this area is low populated and hardly accessible by humans. GPS-GSM transmitter data outlined the width of the autumn migratory route. It turned out that after moving along Ob River from the north, at the latitude of 60˚N bird leave the Ob River and fly directly to the south to the northern Kazakhstan by the front of near 750 km width. From stopovers of the northern Kazakhstan they fly to the west first by the narrow route along the southern boundaries of the Orenburg Region, Russia and northern boundaries of the Actyubinsk Region, Kazakhstan. More to the west geese fly already by the broad front, crossing Volga River in its lower streams. Then the migration stream becomes narrow again at the Manych River valley. This area really is the eastern boundary of the Red-breasted Goose wintering area, where they could stay over winter when a winter is mild enough.

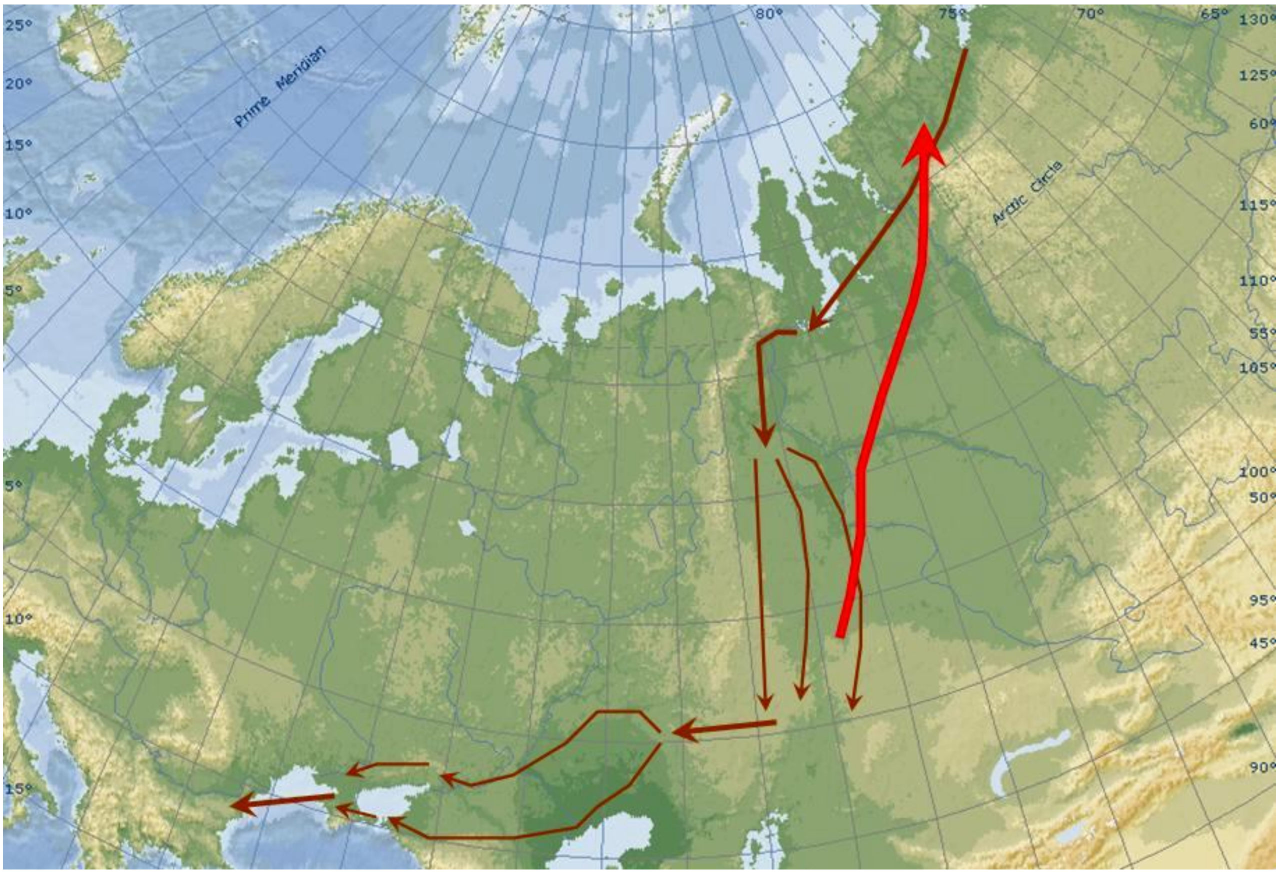


Figure 151. Loop Red-breasted Goose migration in the Western Siberia. Red arrow is the spring migratory route; brown arrows are autumn migratory routes.

Lifespan. EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010 does not contain information about Red-breasted Goose lifespan. Bird Ringing Centre database contains a recovery of female ringed as adult bird and recovered in 8 years 5 months (ring not sent), really this bird lived more that 11 years. We think that this is not a limit for the Red-breasted Geese.

Mortality rate. According to the common criteria (see “Materials and Methods”) 30 dead recoveries are applicable for the mortality rate analysis. Sample is small, but we would, anyway, calculate the mortality rate as a preliminary result. Mean annual mortality rate in Red-breasted Goose is 31.48$\pm$4.76% (Fig. 152). Real mortality pattern significantly not different from the theoretical one (χ^2 = 1.167, df = 6, P=0.98). Programme MARK, Model CLogLog 2ndPart shows 31.82%, in spite of very small sample the difference is 0.34% only, much less than standard error. Mortality rate pattern indicates that now Red-breasted Goose population is in good condition. This confirms many recent field studies (Rosenfeld et al., 2012; Rosenfeld et al., 2012).

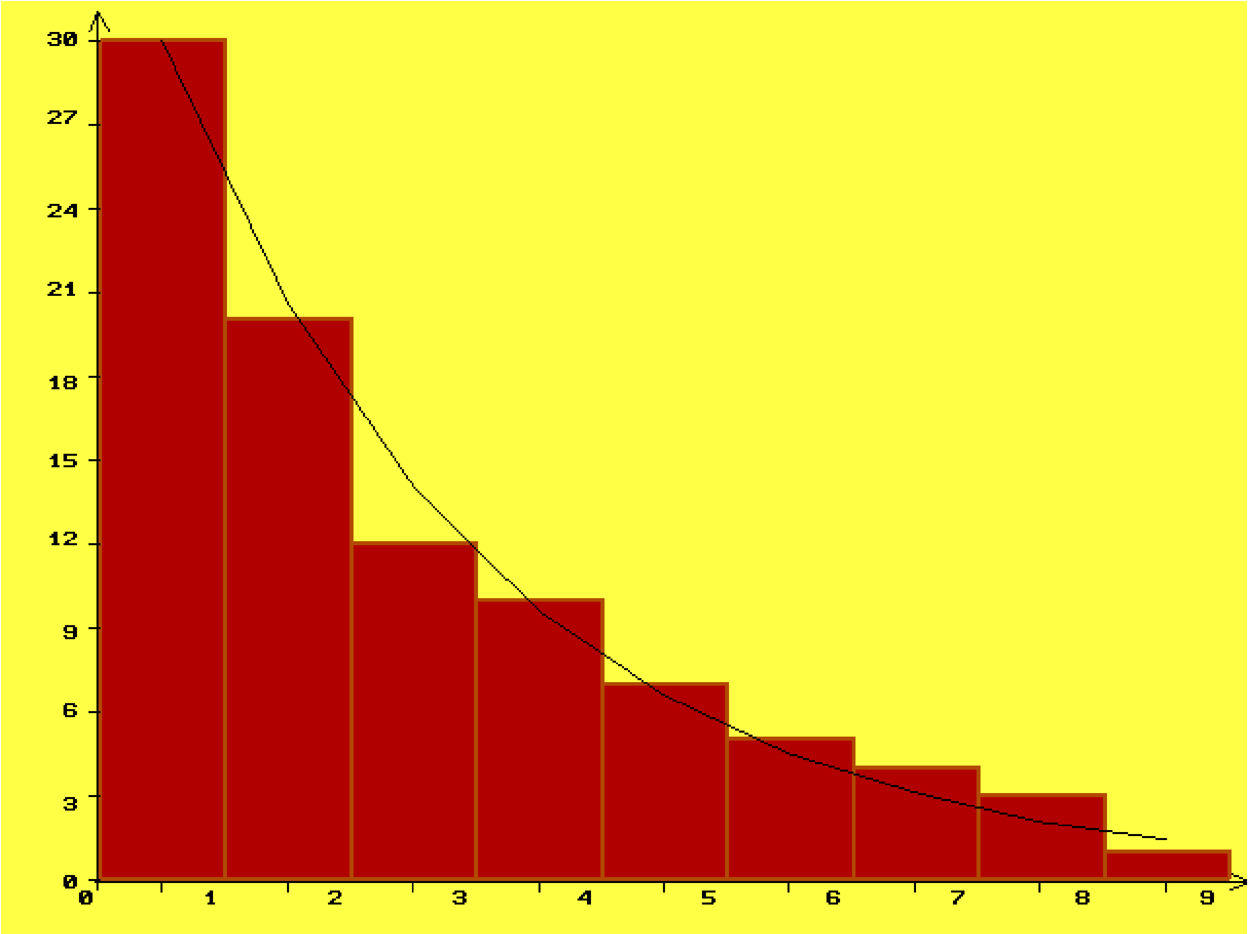


Figure 152. Mortality pattern in the Red-breasted Goose. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

RUDDY SHELDUCK
(*TADORNA FERRUGINEA*)

Photo by Irina A. Kharitonova

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 153. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

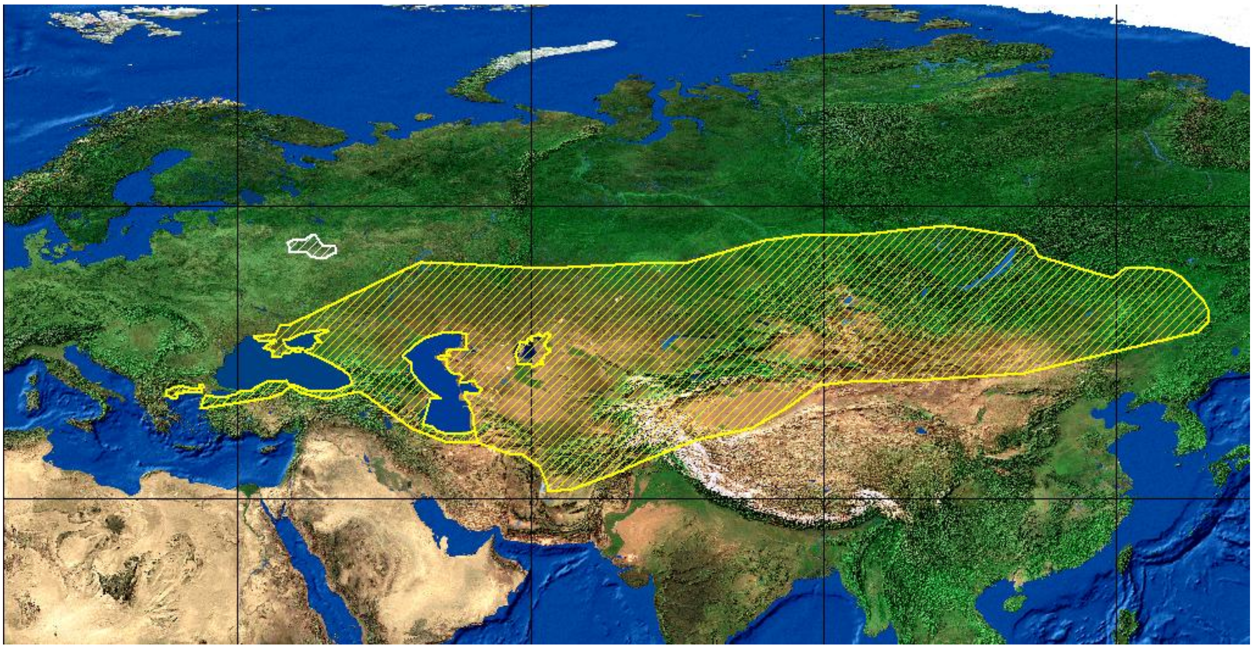


Figure 153. Breeding range of the Ruddy Shelduck in Eurasia (yellow dashed areas). Area rounded with white line represents the introduced population in the Moscow City and Moscow Region.

Besides natural, this species has been introduced in several areas in Russia and Europe where creates separate populations, sometimes mixed with the natural ones, like in the southern Ukraine.

Distribution of control points. Bird Ringing Centre database contains data on 102 marked birds which gave 104 recoveries, i.e., one recovery per bird. 100 ducks were marked with metal rings only, one duck with metal ring and neck-collar, one with metal and colour ring, two birds had colour rings only without metal rings. Ringing dates are since 01.07.1938 till 01.03.2012, recovery dates are since 09.03.1941 till 22.12.2013.

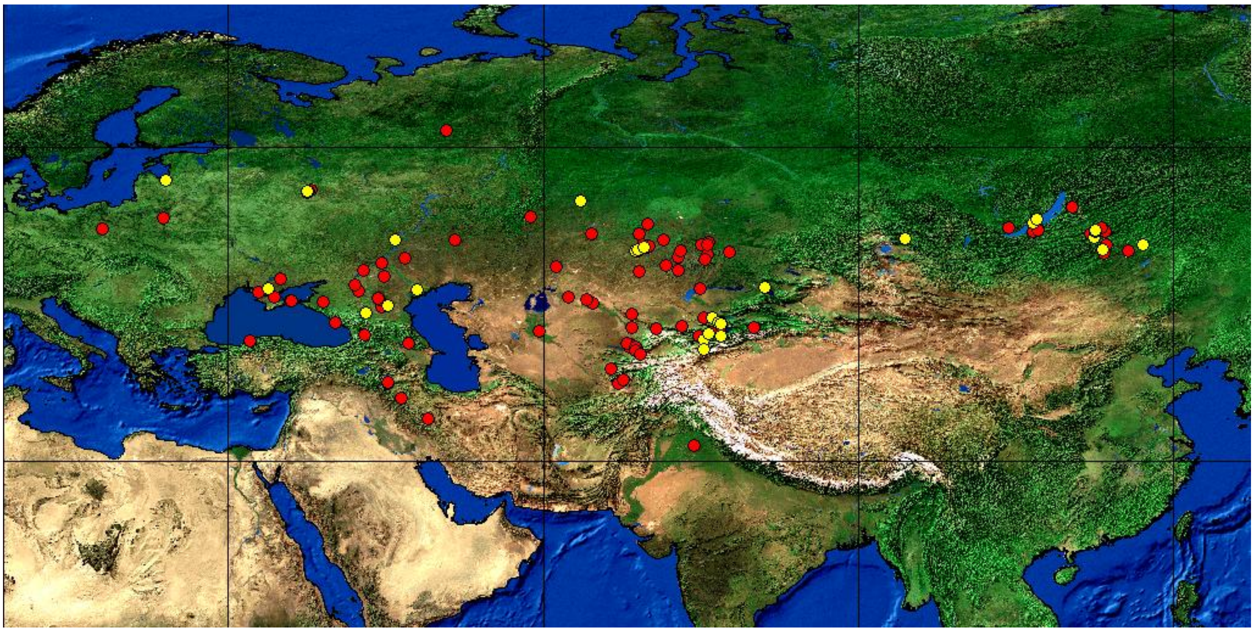


Figure 154. Position of all Ruddy Shelduck control points. Yellow dots – ringing sites, red dots – recovery sites.

103 birds were marked with rings of the „Moskwa" scheme. Ducks were ringed in many places of the southern Russia, Kazakhstan and Kyrgyzstan. 45 birds of 102 were ringed in the Kurgaldzhinsky Nature Reserve, Kazakhstan. Recoveries are spread over many areas, sometimes outside of the natural breeding range (Fig. 154). One bird was ringed with the „Kiev" scheme, the bird was ringed 20.06.2011 in the Askania-Nova Zoo, recovered 22.12.2013 in Russia, Kalmykia.

Finding details. This analysis includes all 104 recoveries. Three quarters of recoveries (76%) are „shot". In 4 (4%) recoveries „details unknown", which practically mean shot, as well. Therefore, we can assume that 82% of birds were shot. Other reasons are not so common (Fig. 155).

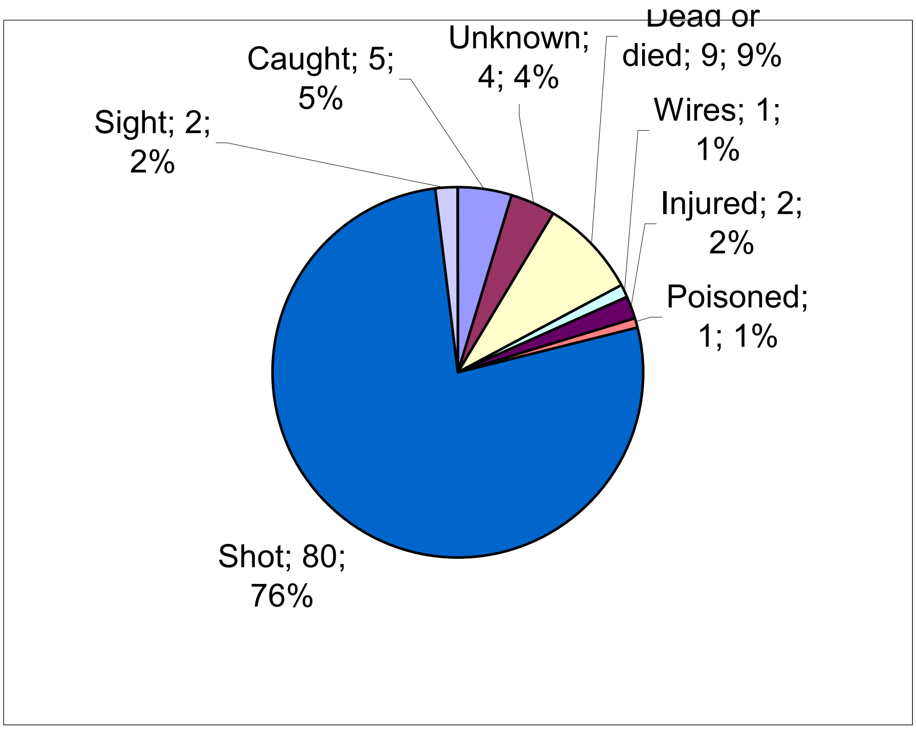


Figure 155. Finding details in the Ruddy Shelduck

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries of Ruddy Shelduck are similar, number of indirect recoveries is slightly lower than direct ones (Figs 156 and 157).

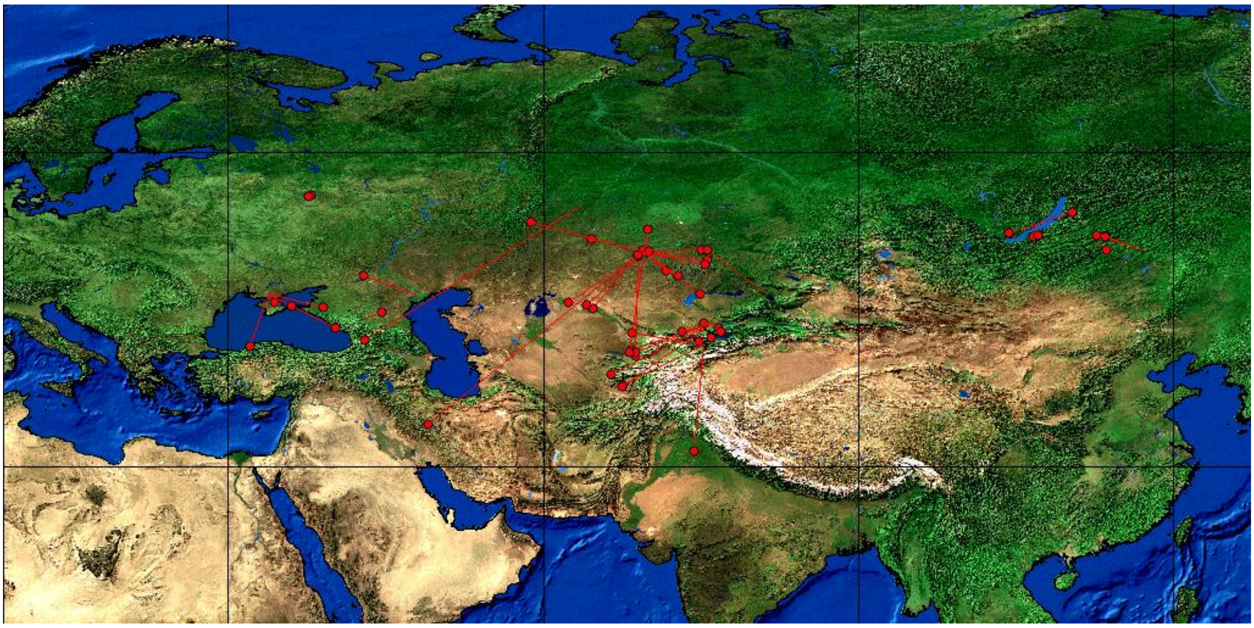


Figure 156. Map of the Ruddy Shelduck direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

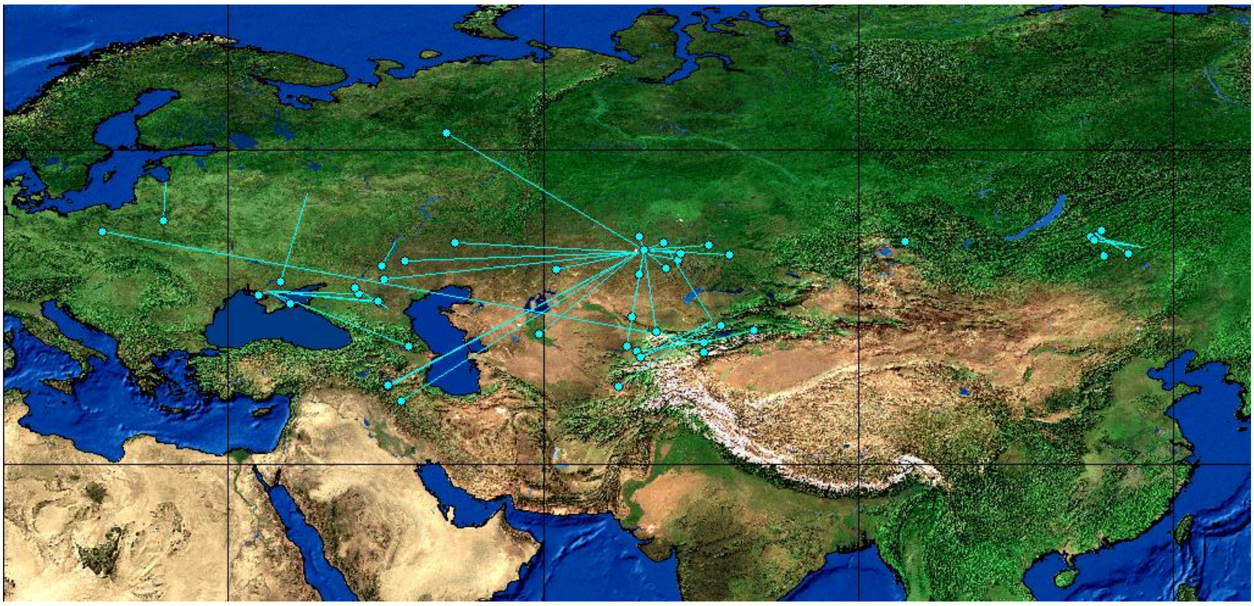
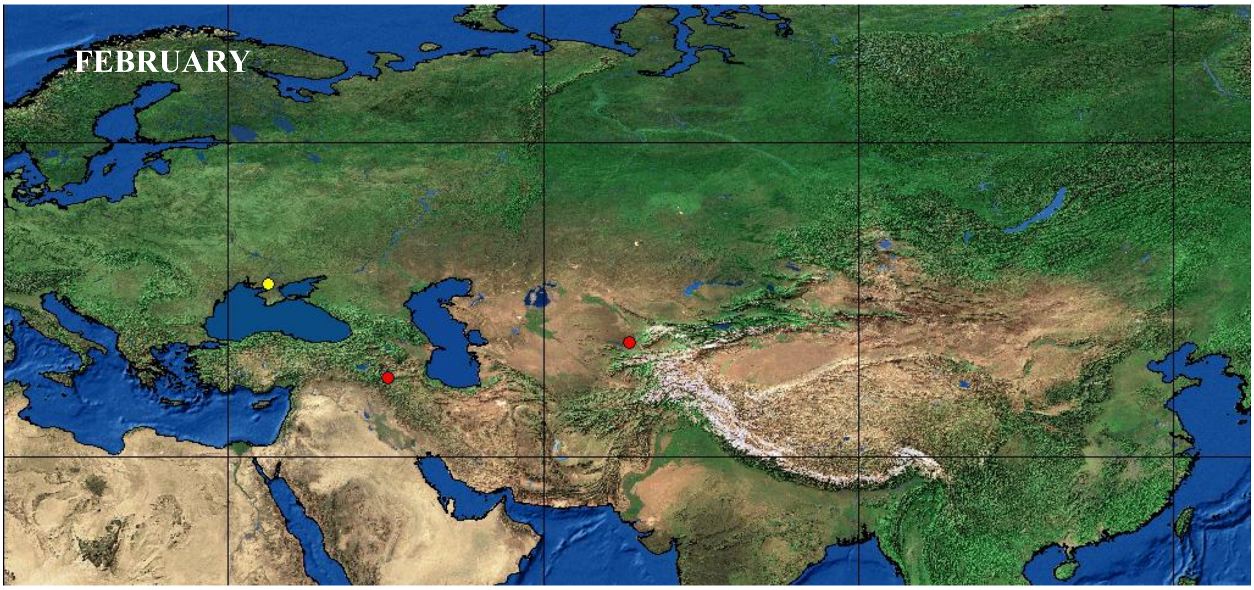
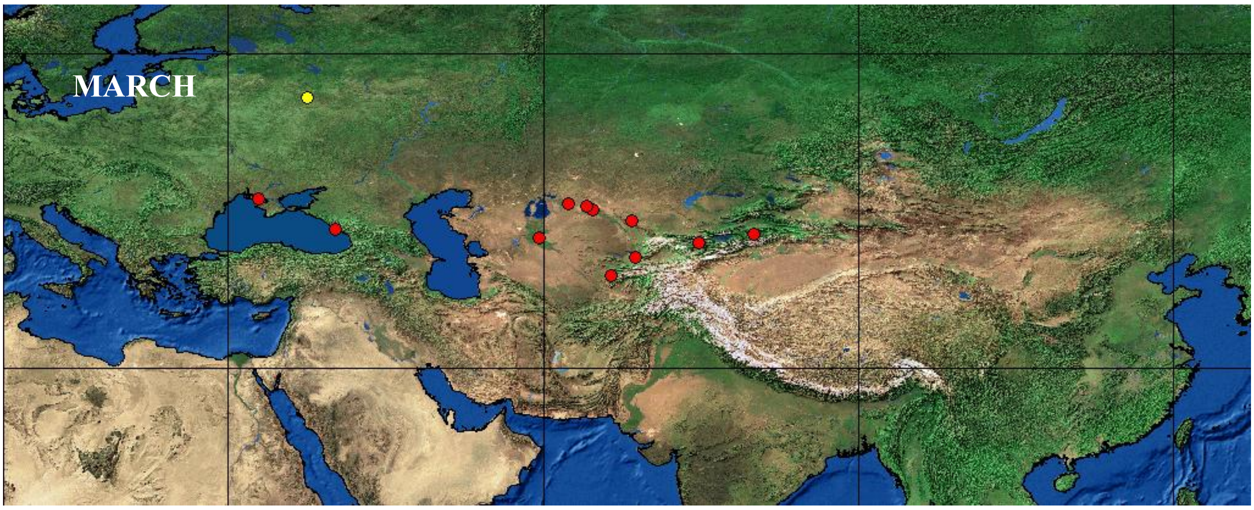


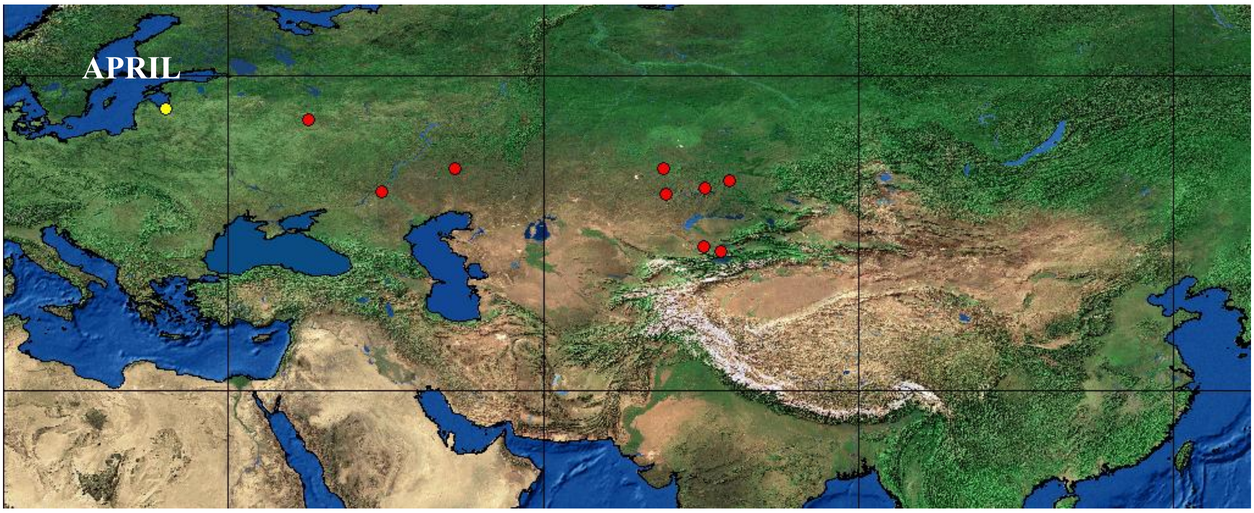
Figure 157. Map of the Ruddy Shelduck indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows no significant difference between them ($\chi^2 = 0.38$, 54 direct recoveries and 50 indirect ones, df = 2, P = 0.83). Average flight distances in direct and indirect recoveries are 439.8±65.6 and 726.1±116.9. Mean distance in indirect recoveries is significantly longer (t=Bailey = 2.14, P = 0.035). Such difference between distances means, that Ruddy Shelduck is not very site-faithful and changes its breeding sites quite often.

Monthly movements. All recoveries from both populations are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in the Ruddy Shelduck (Fig. 158). No recoveries are available for January. In February Ruddy Shelducks are on the wintering grounds, likely no migration movements occur in this month (February, Fig. 158). In March and April movements are directed to the north. In May, June, July, August, September most birds are on breeding grounds, however, the same as in Common Shelduck, some birds are within wintering range (there is one such recovery in June). Autumn migratory movements take place in October and November. In December Ruddy Shelducks are in the wintering areas (Fig. 158).



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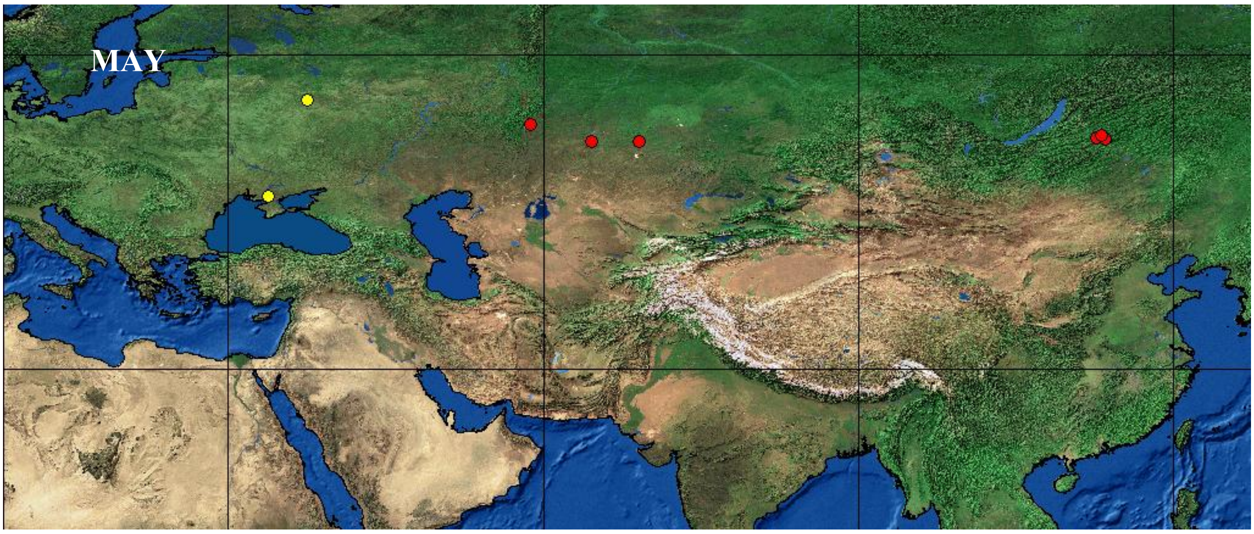
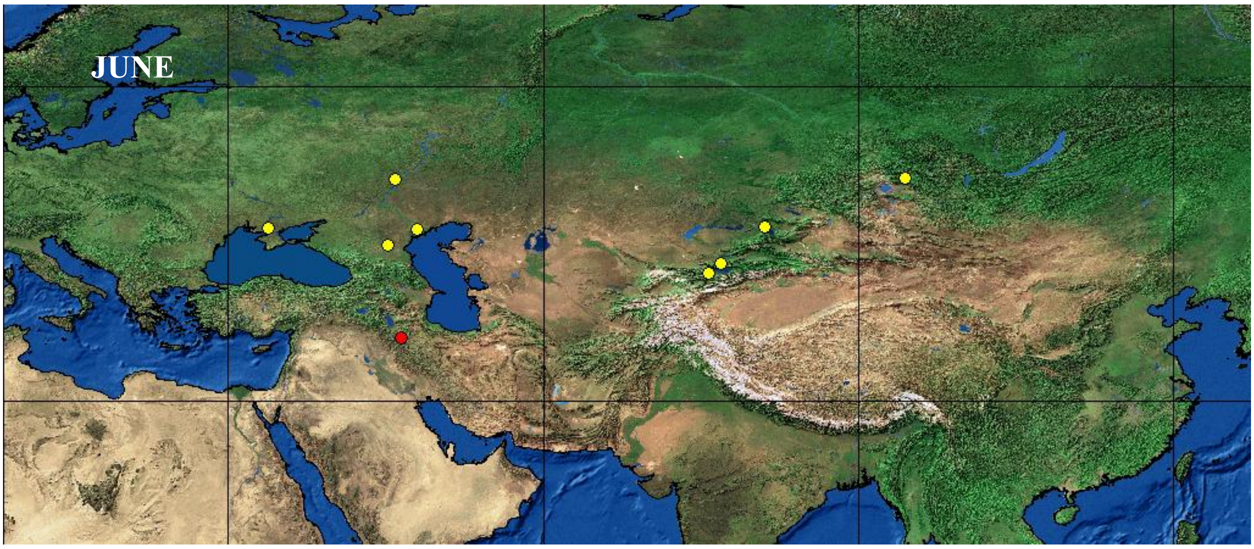

MAY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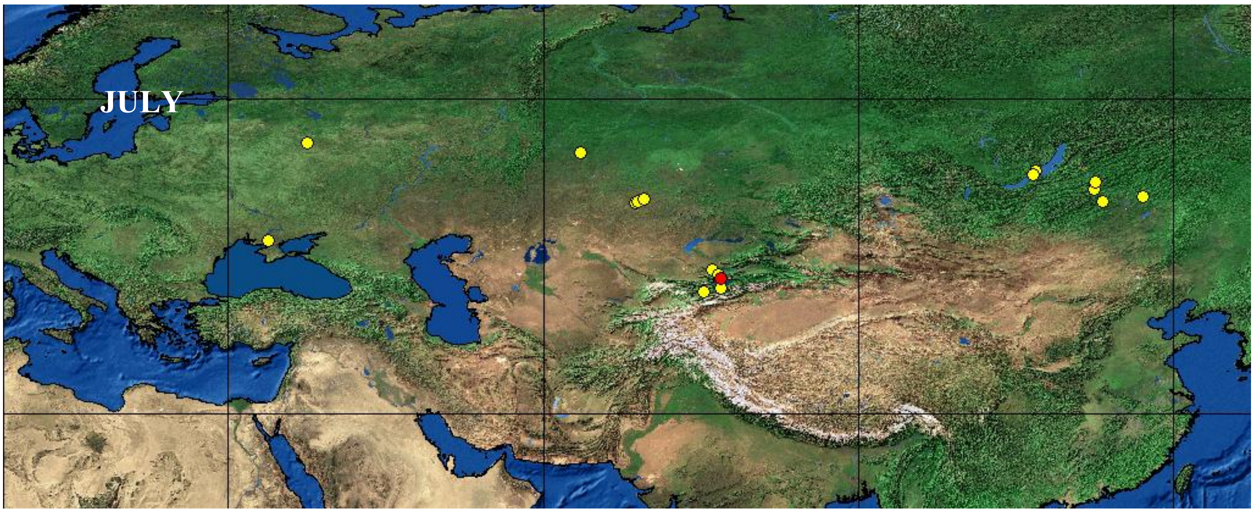
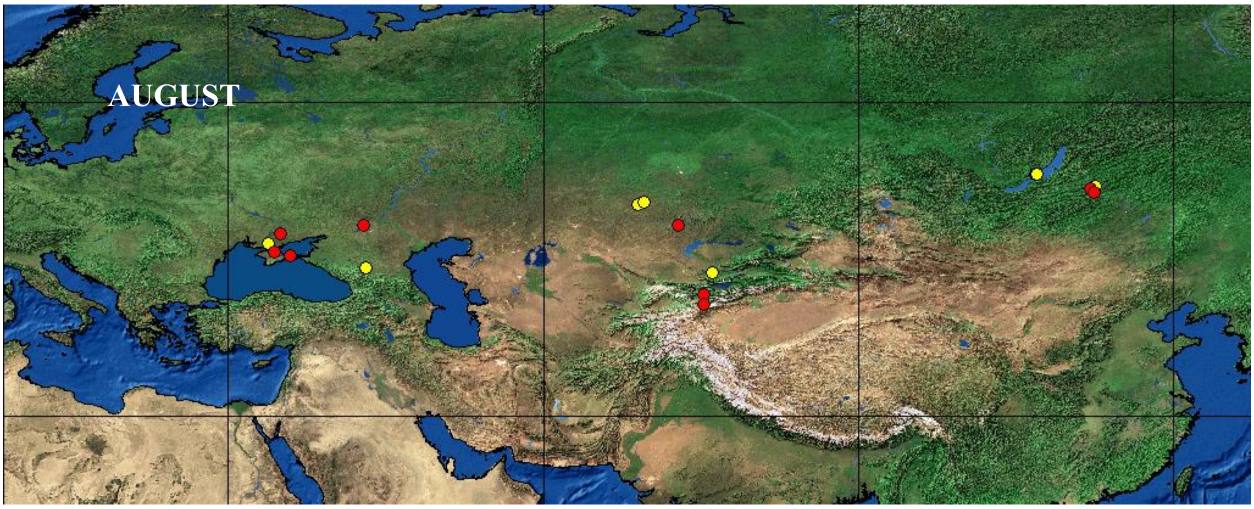
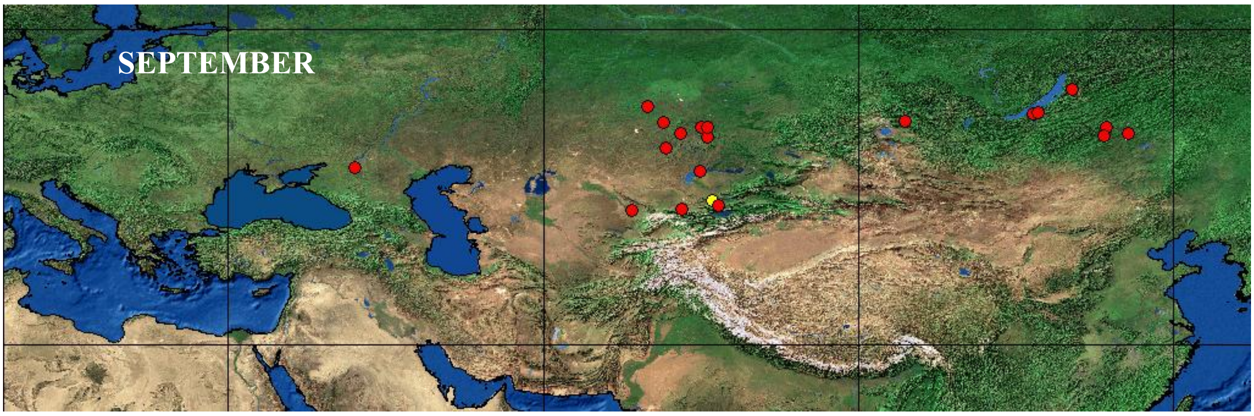

JULY


AUGUST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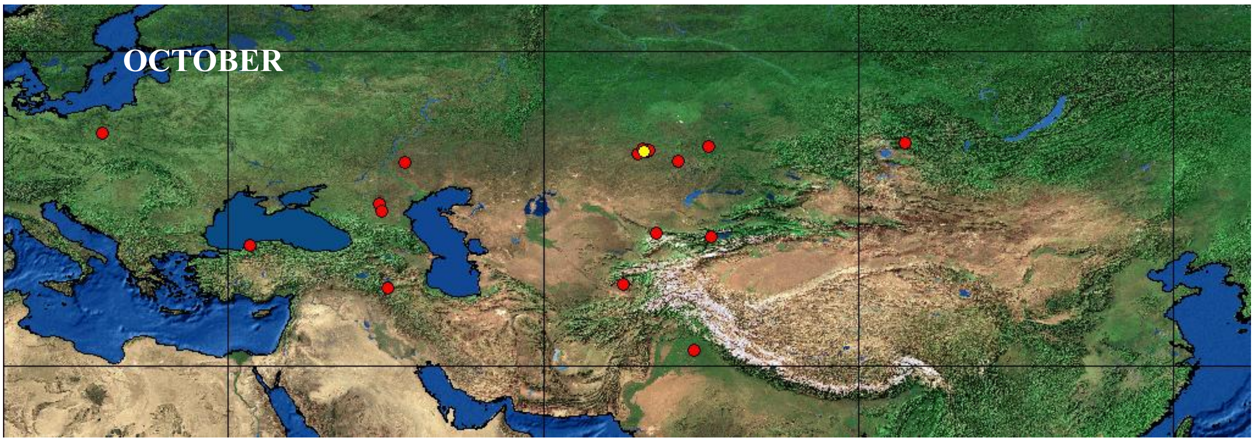
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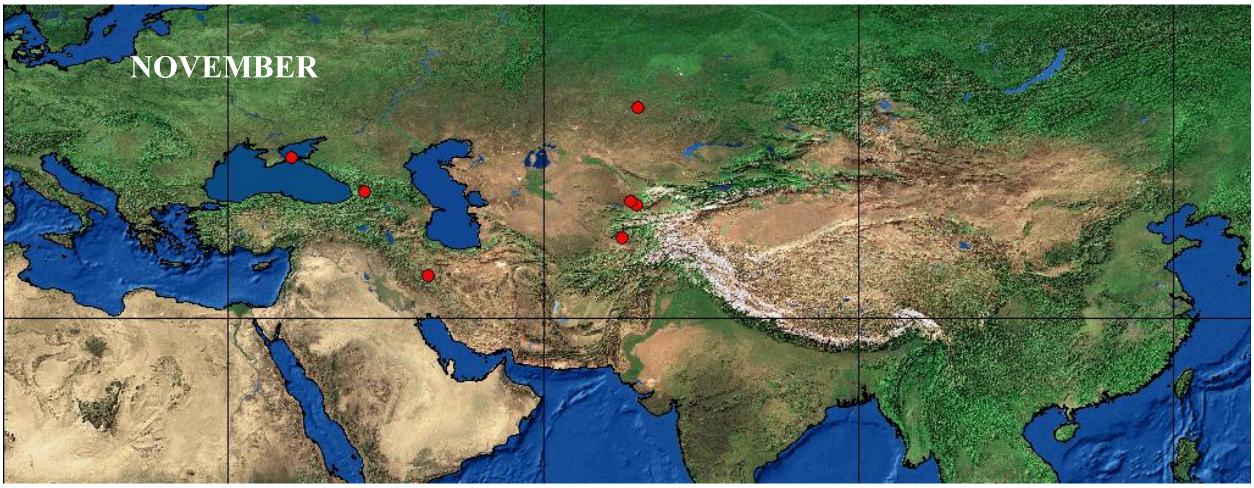


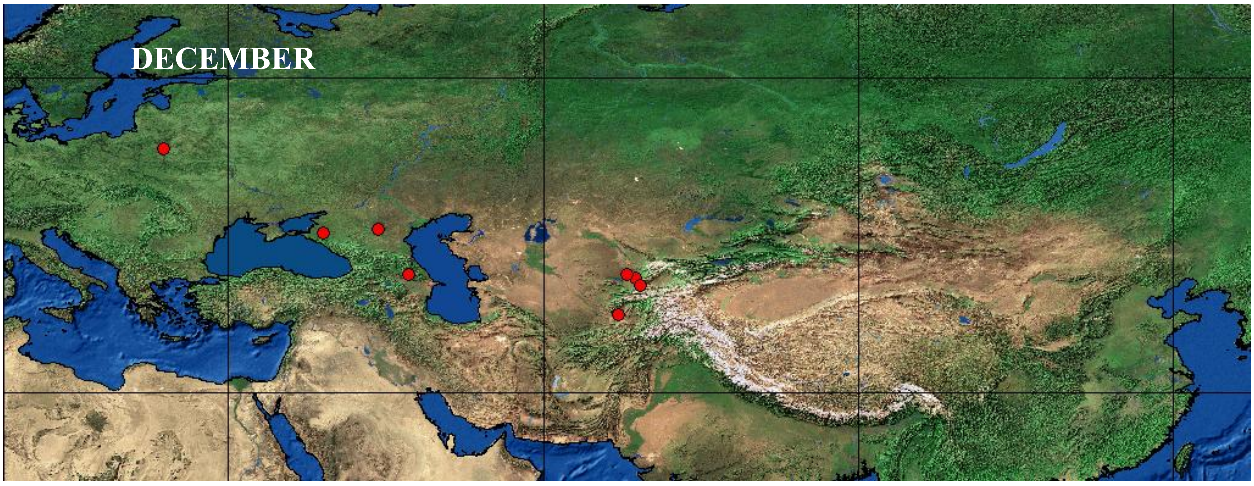


Figure 158. Ruddy Duck monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. Really, Ruddy Shelducks do not created definite migratory routes; they fly from the ringing sites practically in any direction (Fig. 159).

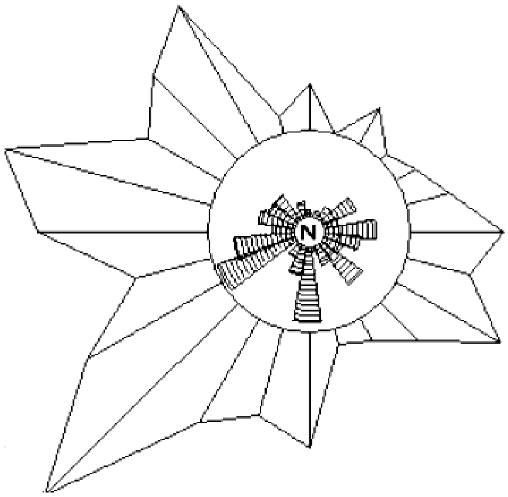


Figure 159. Recovery roses graph for Ruddy Shelduck: number of recoveries of birds that had flown from ringing sites in different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts). Sector = 15.0°; Total recoveries - 104; N in sectors: from 0 up to 11; Average distance in sectors: from 0.0 km up to 1534.8 km; the longest flight distance is 4381.4 km.

In general, movement distances are relatively short – not more than several hundred km. However, there is one exceptional recovery, which comprises 4381 km, much longer than any other recovery (Figs 159, 160). The latter means that, in spite of that short flight distance is normal for this species, it is capable to perform a very long "jump".

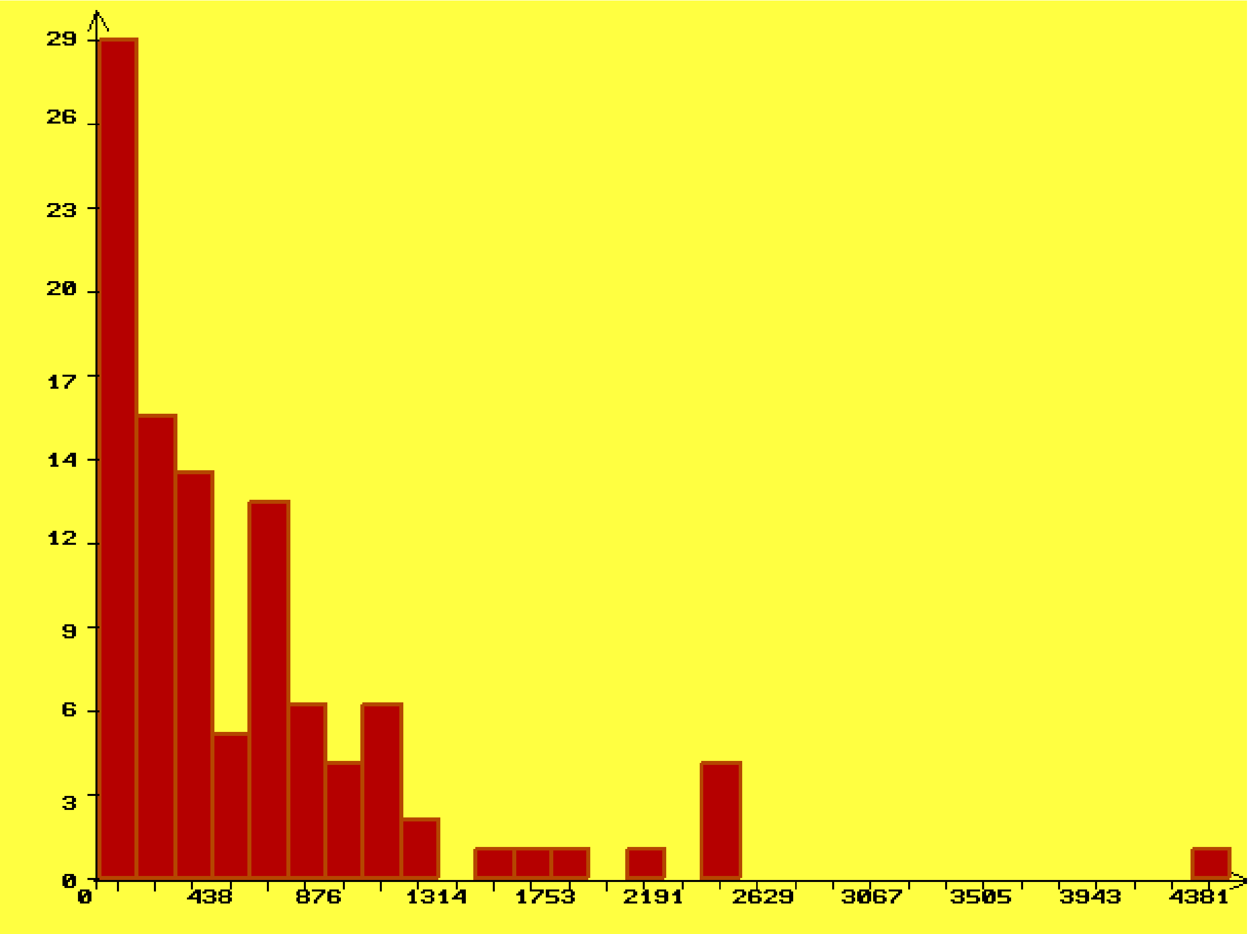


Figure 160. Distribution of all ring-recovery distances in Ruddy Shelducks. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in young birds (ringed as „pull" or „juv" or „1 y") is shorter than in adults: 493.5±109.0 (N_{young}=44) and 639.0±83.6 (N_{ad}=59) km respectively, although insignificant. Male mean flight distance is considerably shorter than in females: 686.5±147.6 and 1027.6±322.6 km (N_{males} = 21, $N_{females}$ = 6) respectively, although insignificant.

The same as in Common Shelduck, some adults in Ruddy Shelducks in some years do not fly to the breeding area, but stay within the wintering area – there is one such recovery of the bird, ringed as adult male in Kazakhstan, Tengiz lake and recovered in Iran in June. About probable movements of such birds within wintering area no data are available. However, keeping in mind, that Ruddy Shelduck is less mobile duck than Common Shelduck, we think that there are either no such movements or they are not as extensive as in Common Shelduck.

Zoo birds. 14 birds of 104 were ringed in Zoos and then moved to outside areas. 3 ducks were ringed in the Moscow Zoo, 11 – in the Askania-Nova Zoo, southern Ukraine. It turned out that escaped birds are capable to migrate practically along the same routes as wild ones (Fig. 161). Recoveries are at both short and long distances from the ringing sites, within one year after ringing as well as more than a year after ringing.

Figure 161. Ring-recovery lines of Ruddy Shelducks ringed in Zoos. White lines start in ringing sites, recovery sites are marked with white dots.

Speed. It looks like the Ruddy Shelduck is slow moving duck, even slower than Common Shelduck. The database contains many recoveries with little elapsed time, and flight distances in all cases are not long. It seems this duck mostly covers not more than several tens km per day.

Populations. Ruddy Shelduck normally is not long-distance moving duck, therefore this species form many small populations (Fig. 162), some of those are not certain for the reason of small amount of data. Nevertheless, long-distance cross-population movements are possible in this species (Fig. 162). The same as in Common Shelduck, Tengiz Lake, Kazakhstan is the zone where two populations overlap.

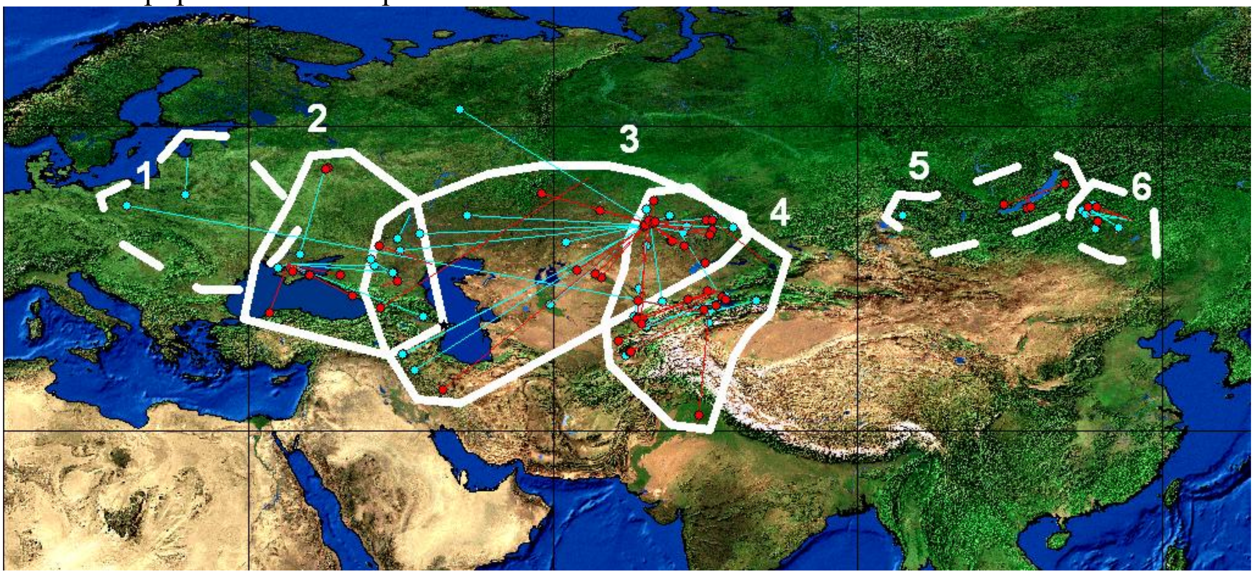


Figure 162. Ruddy Shelduck populations. White polygons with solid lines outline more or less certain populations, dashes polygons display less certain populations. Red lines are direct recoveries, blue-green lines are indirect recoveries.

Ten-year distances. **M**ost recoveries of Ruddy Shelduck were received in 1961-1991. Ring-recovery distance for all birds recovered before 1971 is 462.7±74.0 km (N=53), after 1970 - 696.7+110.7 km (N=51), the tendency to increase distance of movements with years has progressed, and the difference is close to be significant (t-Bailey = 1.76, P=0.082).

Lifespan. EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010 displays no data on the Ruddy Shelduck lifespan. Bird Ringing Centre database contains appropriate recovery of the bird ringed as adult and recovered after slightly more than 12 years (ring sent); therefore its lifespan is greater than 14 years.

Mortality rate. According to the common criteria (see "Materials and Methods") 92 dead recoveries of Ruddy Shelduck are applicable for the mortality rate analysis. Mean annual mortality rate in the Ruddy Shelduck is 29.38±2.57% (Fig. 163). Real mortality pattern significantly differs from the theoretical one (χ^2 = 56.1, df = 10, P=0.0000). Programme MARK, Model CLogLog 2ndPart shows 31.31%, difference is 1.93%. Mortality rate pattern shows considerable drawdown of the real mortality pattern in the comparison to the theoretical one. It means, that the condition for the most natural Ruddy Shelduck population is not good. Several studies show number decline and even extirpation of this duck in some southern regions (Zavyalov et al., 2004; Field Guide…, 2011).

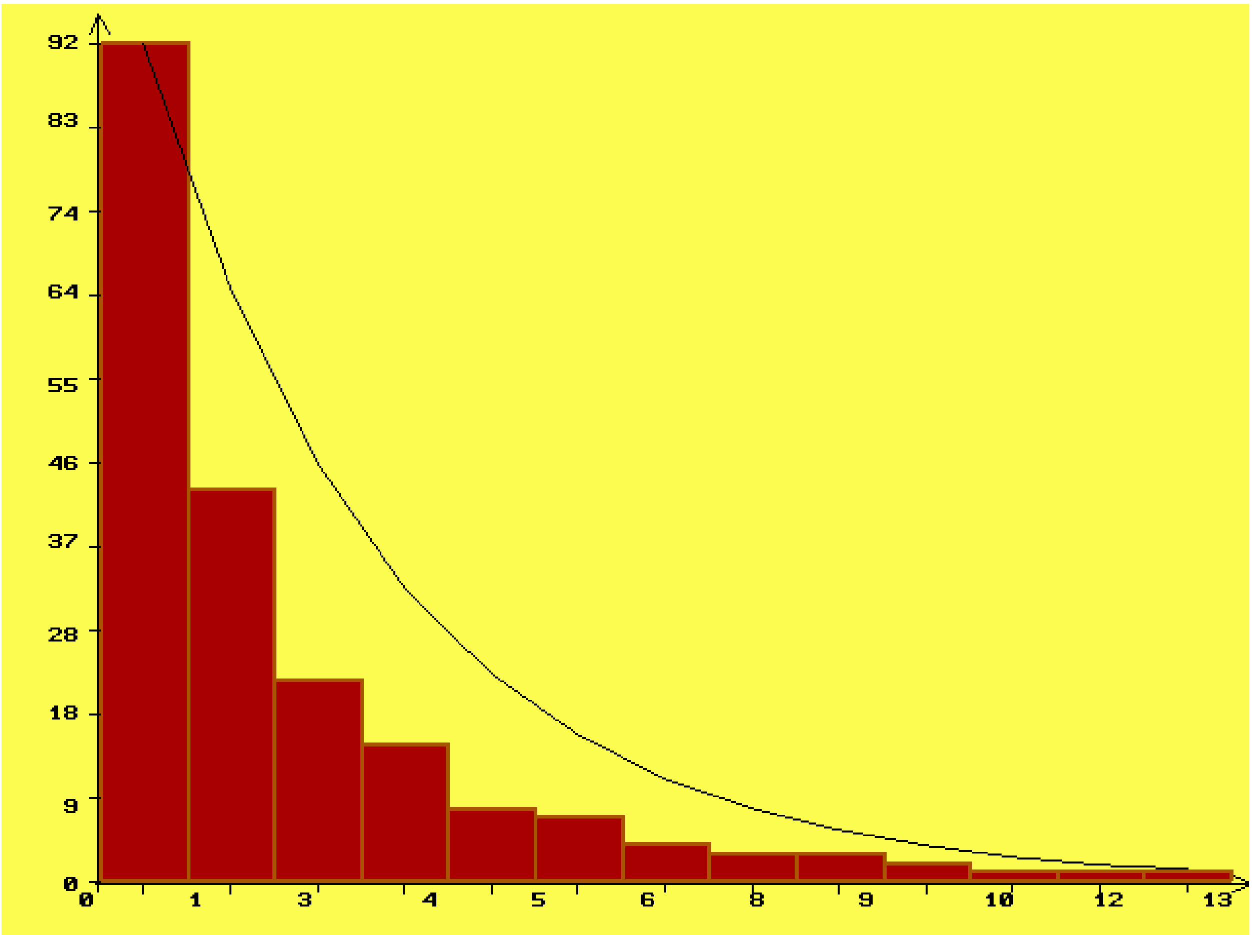


Figure 163. Mortality pattern in the Ruddy Shelduck. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Males of Ruddy Shelduck lived, on average, longer than females: 1.81 (N=21) and 1.31 (N=6) years respectively, insignificant, but the samples are small, especially for females.

COMMON SHELDUCK
(*TADORNA TADORNA*)

Photo by Vladimir I. Deryabin

Breeding range in Eurasia. Brief description of the breeding range is in Fig. 164. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

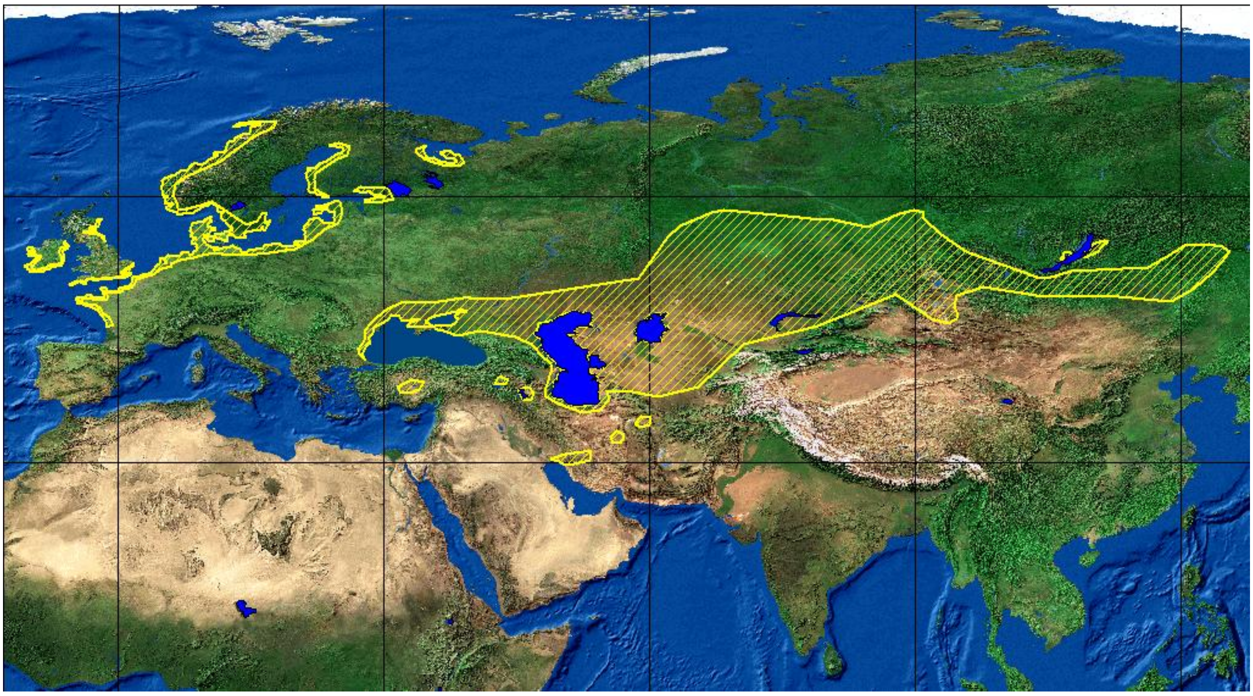


Figure 164. Breeding range of the Common Shelduck in Eurasia (yellow dashed areas).

Distribution of control points. Bird Ringing Centre database contains data on 299 marked birds, that gave 299 recoveries, i.e., one recovery per bird. All ducks were marked with metal rings only. Ringing dates are since 01.07.1930 till 08.12.1990, recovery dates are since 12.02.1931 till 20.03.2001.

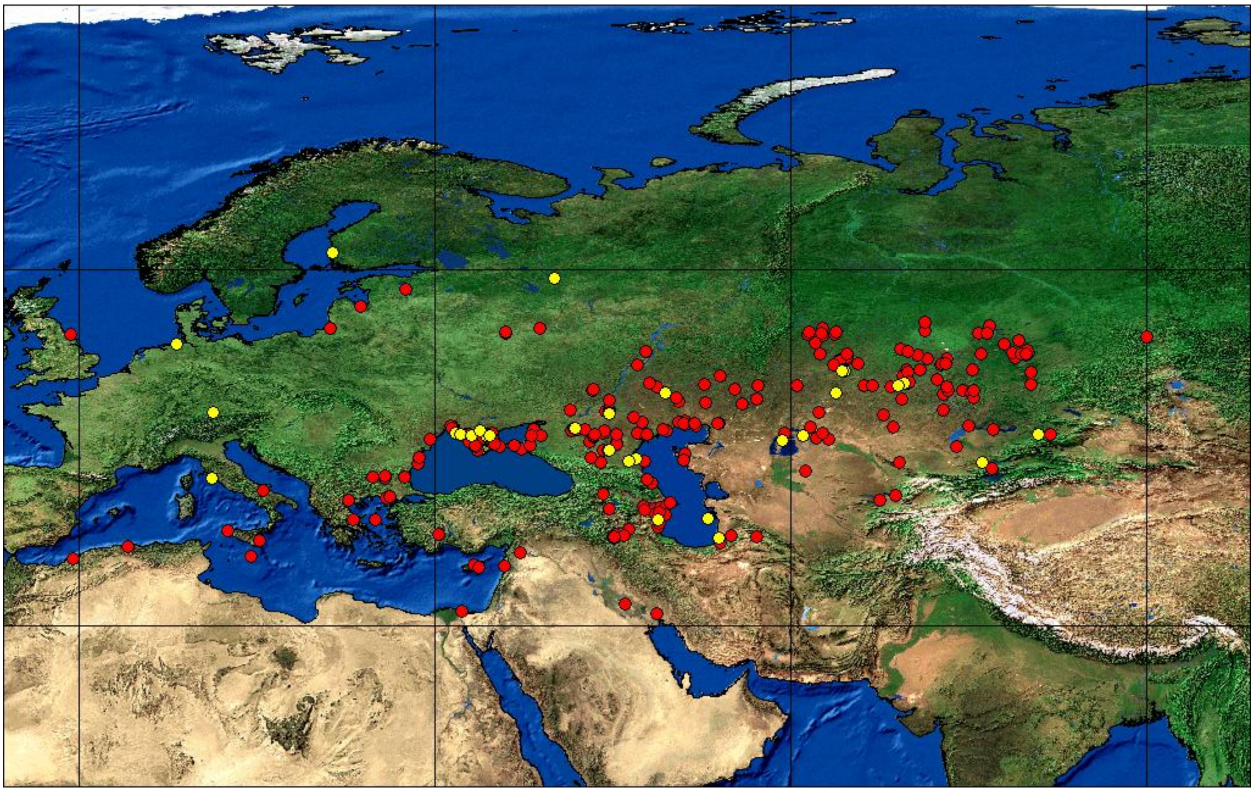


Figure 165. Position of all Common Shelduck control points. Yellow dots – ringing sites, red dots – recovery sites.

292 of 299 birds were marked with rings of the „Moskwa" scheme, 4 with „Helgoland" scheme, 2 with „Helsinki" and one with „Bologna, Ozzano". 206 ducks were ringed in the Kurgaldzhinsky Nature Reserve, Kazakhstan, 205 of them at the Tengiz Lake, 1 – at the Kurgaldzhin Lake, not far from the Tengiz Lake. Therefore, most recoveries are spread over Kazakhstan, south Euripean Russia, south of Western Siberia and area between Black and Caspian Seas (Fig. 165).

Finding details. This analysis includes all 299 recoveries. Two thirds of recoveries (68%) are „shot". In 25 (8%) recoveries „details unknown", which most likely mean they were shot, as well. Therefore, we can assume that 76% of birds were shot. Other reasons are not so common (Fig. 166). Remarkably, that the considerable amount of birds died because of wires or were oiled.

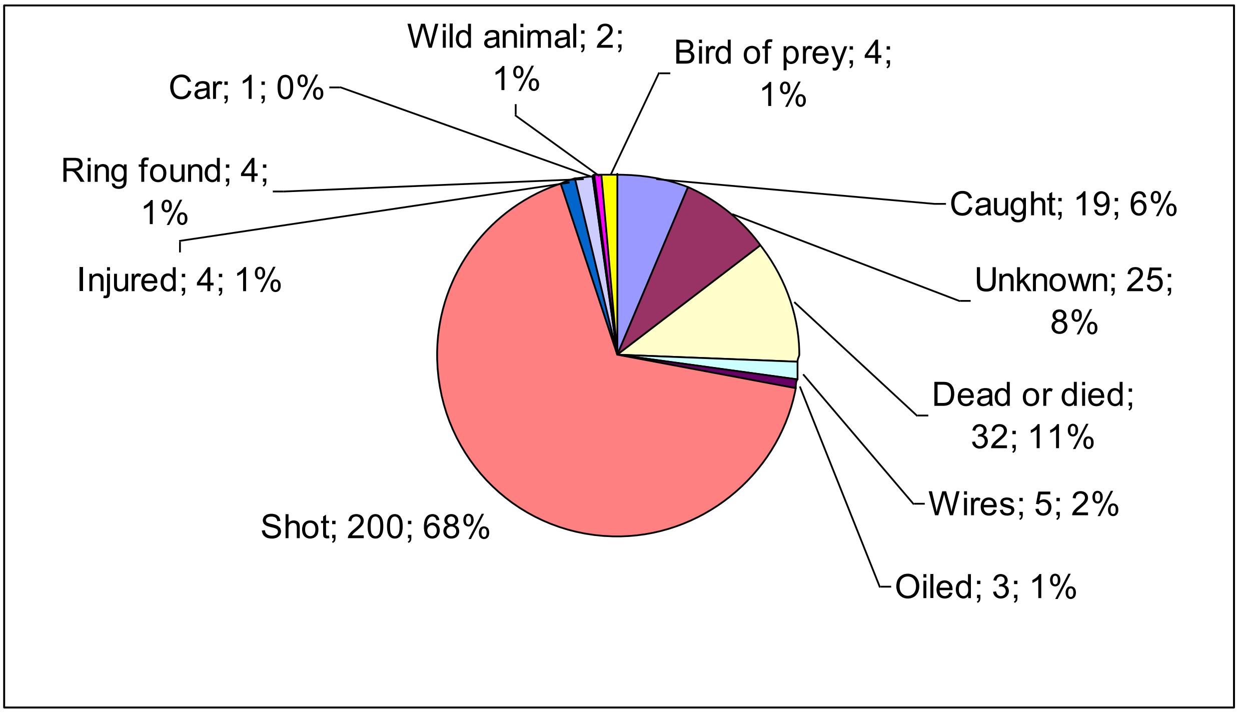


Figure 166. Finding details in the Common Shelduck.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries of Common Shelducks are similar, the amount of indirect recoveries is greater (Figs 167 and 168).

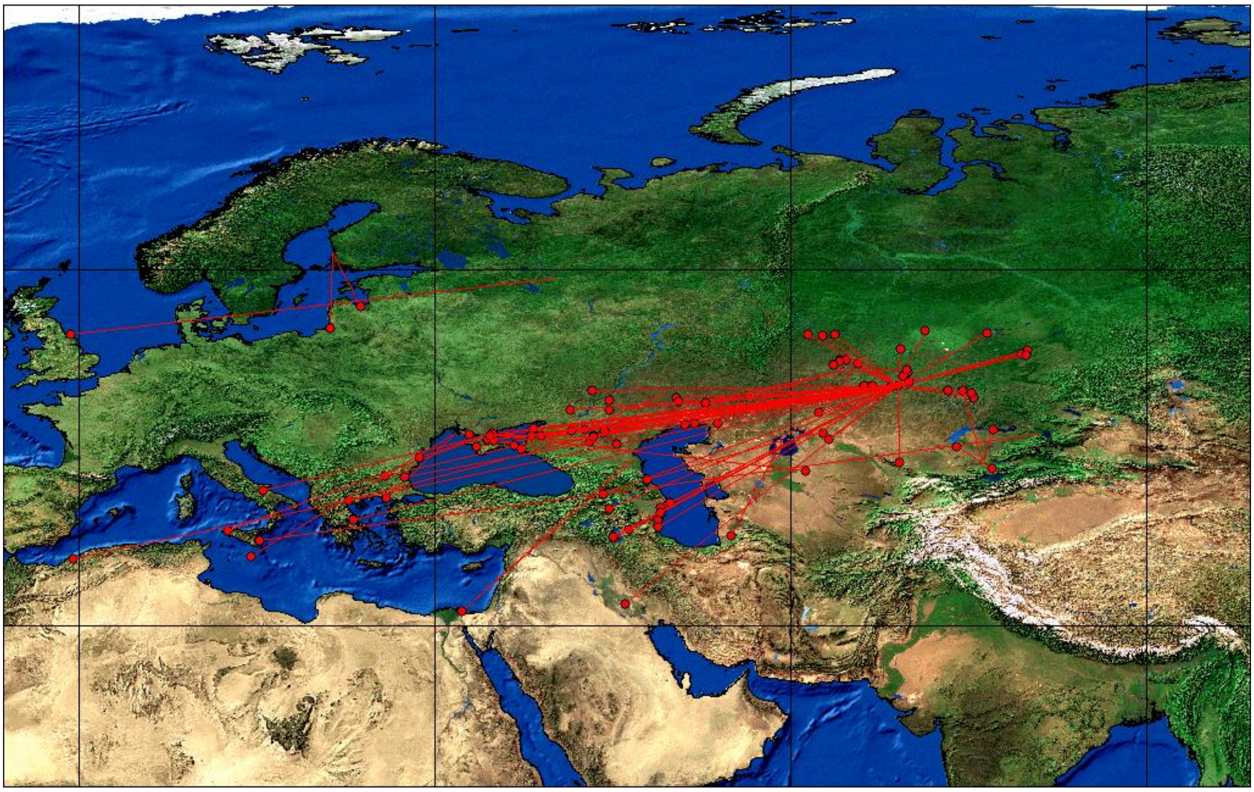


Figure 167. Map of the Common Shelduck direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

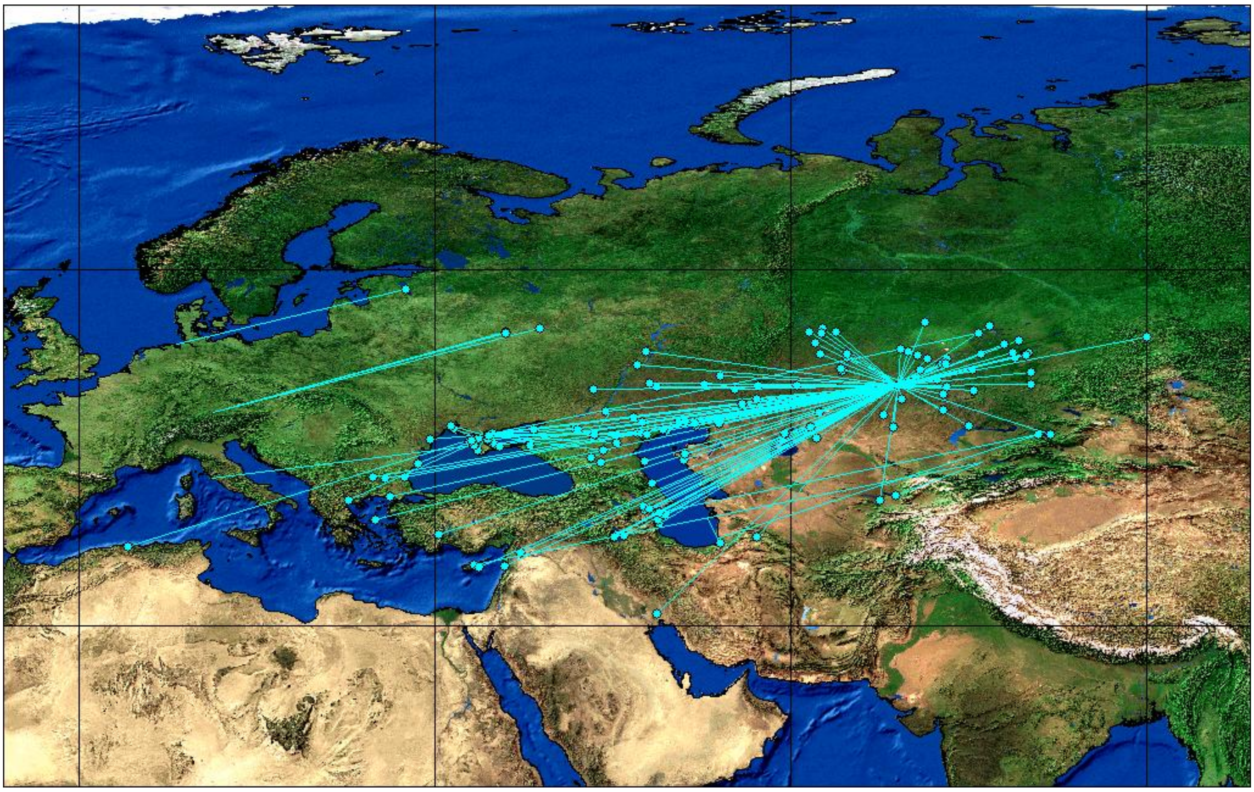
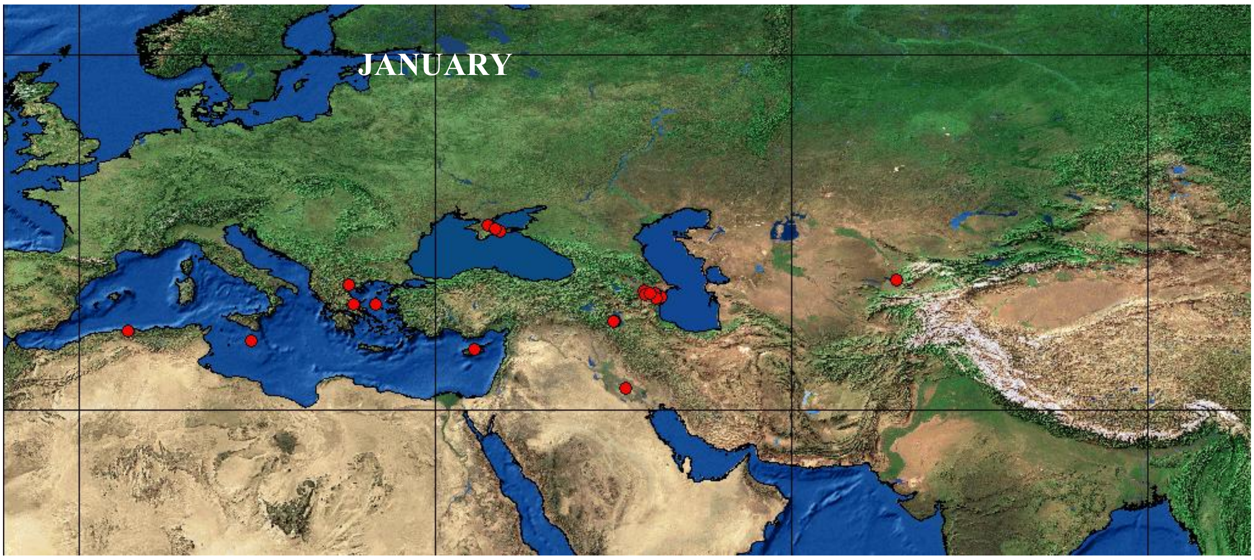


Figure 168. Map of the Common Shelduck indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows no significant difference between them ($\chi^2 = 0.97$, 109 direct recoveries and 190 indirect ones, df = 2, P = 0.62). Average flight distances in direct and indirect recoveries are 1244.8±111.0 and 1160.3±69.7, no significant difference (P = 0.97).

Monthly movements. All recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in the Common Shelduck (Fig. 169). In January Common Shelduck are on the wintering grounds. It looks like, the first movements to the east (to the breeding grounds) starts as early as in February; although most birds are still within the wintering range, some ducks are already on the breeding grounds (compare January and February, Fig. 169). In March and April movements to the east, north-east are well pronounced, although some birds are still in the wintering areas. In May, June, July, August, September, October most birds are on the breeding ground, however a number of them stay within wintering range. The latter is the most prominent in June – probable explanation see in “Migratory routes”. Mass autumn migratory movements commence in November, in December Common Shelducks are in their wintering areas (Fig. 169).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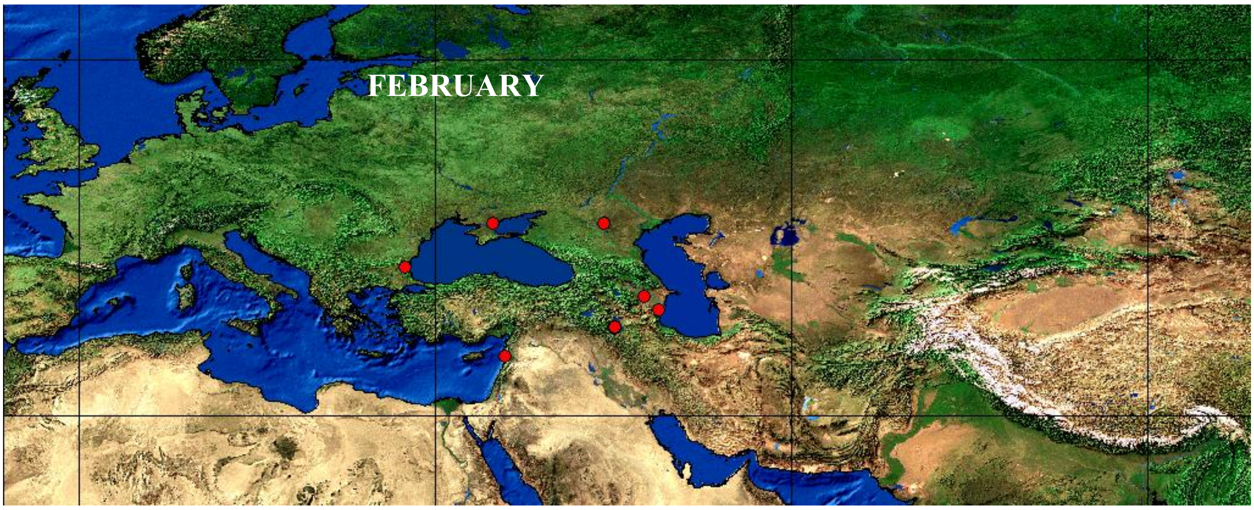
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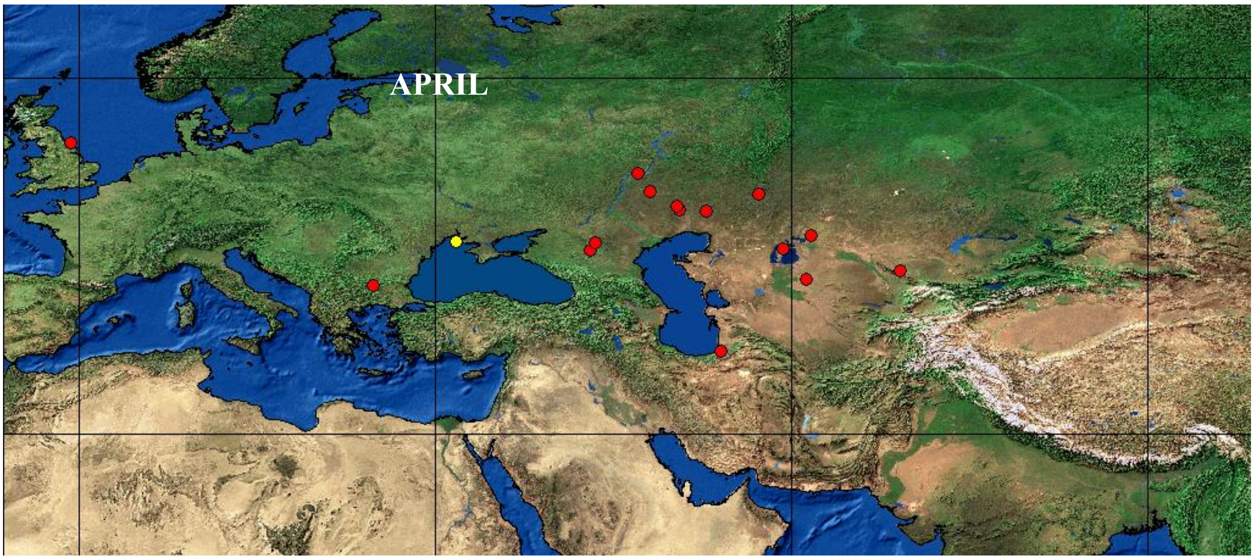
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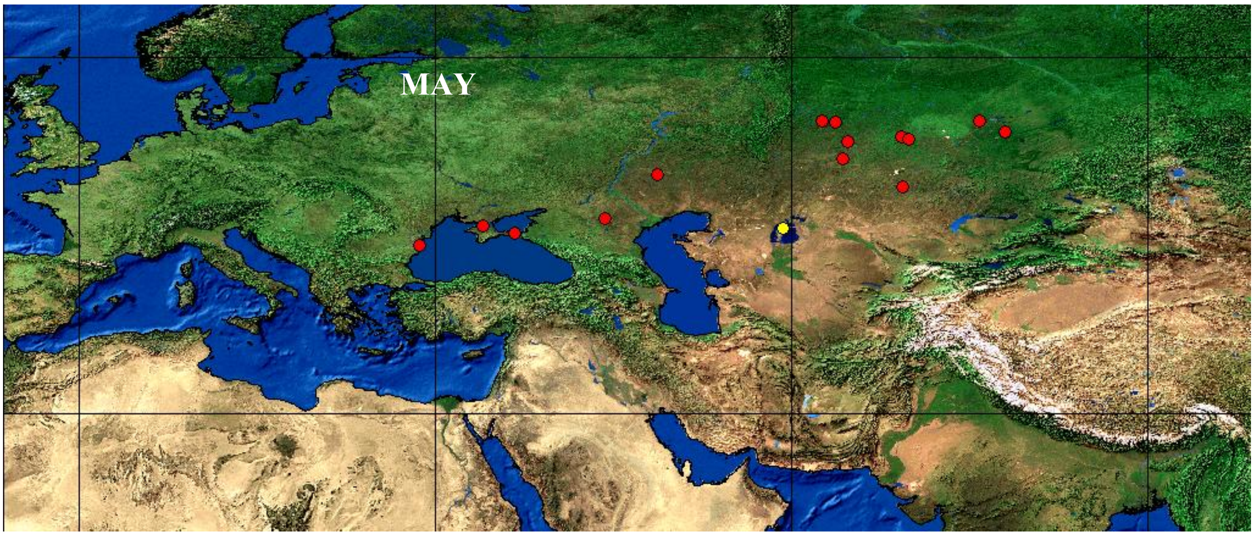
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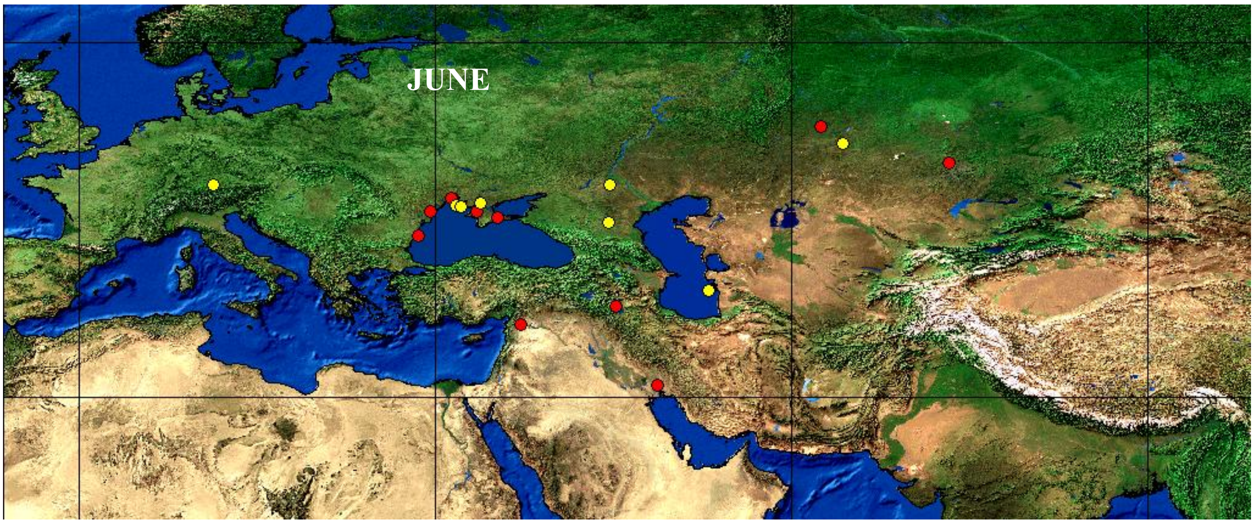
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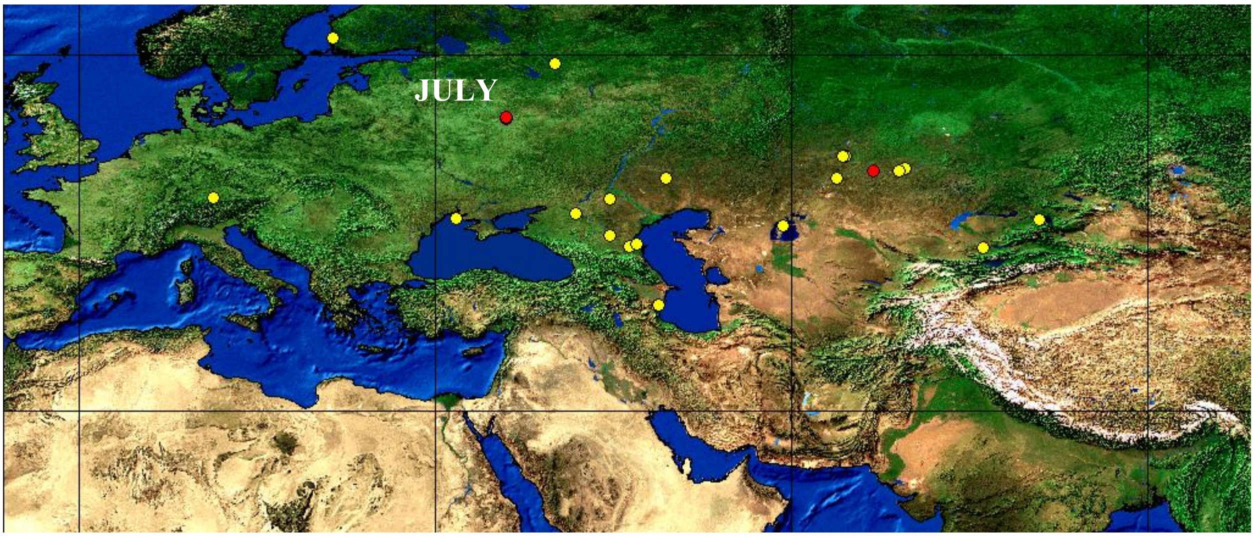
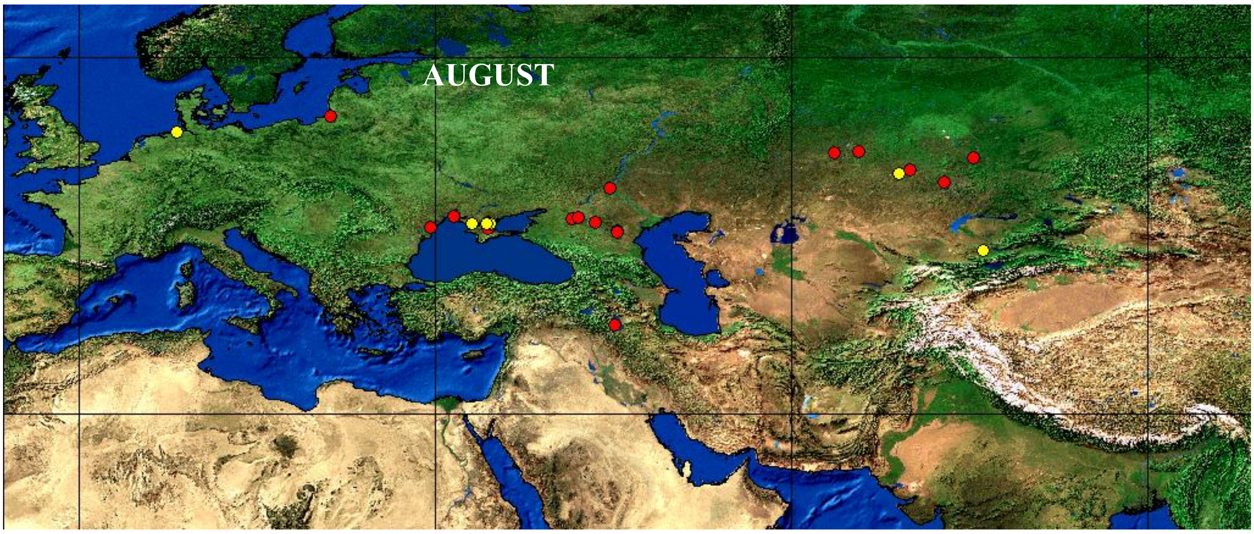

JULY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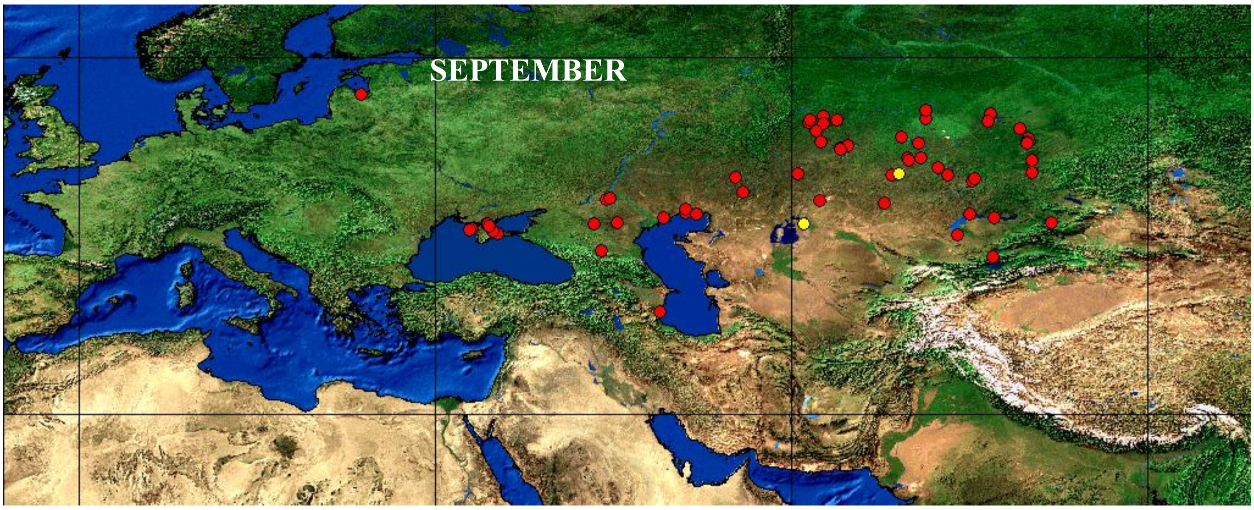
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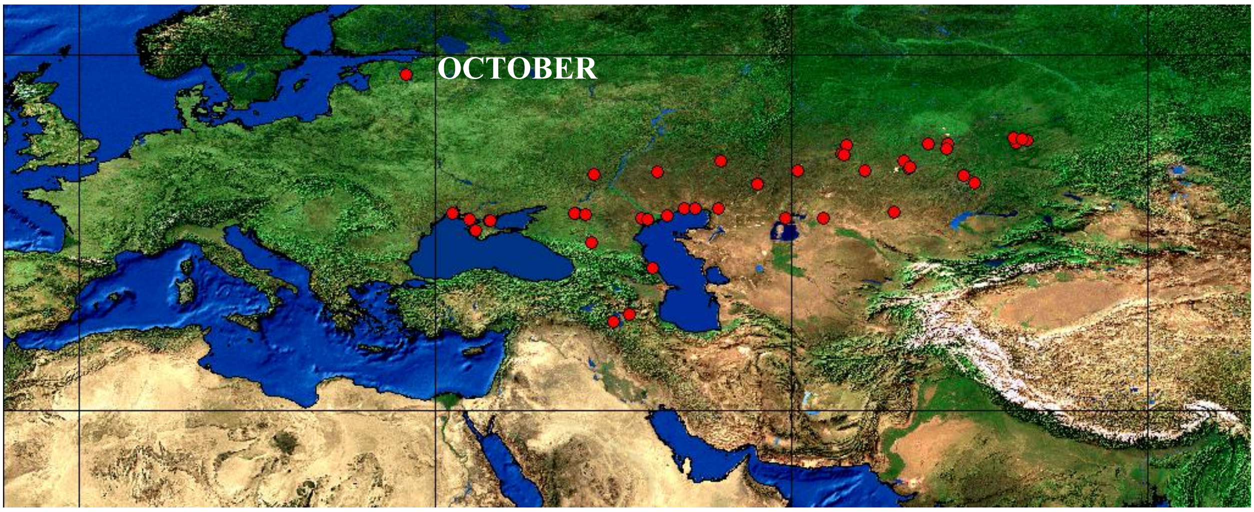


Figure 169. Common ShelDuck monthly migrations. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. Migratory routes in almost all Common Shelducks directed either west, south-west with preferable bearings 217-277˚ (to wintering places), ors the opposite – 52-97˚ (to breeding places) (Fig. 170).

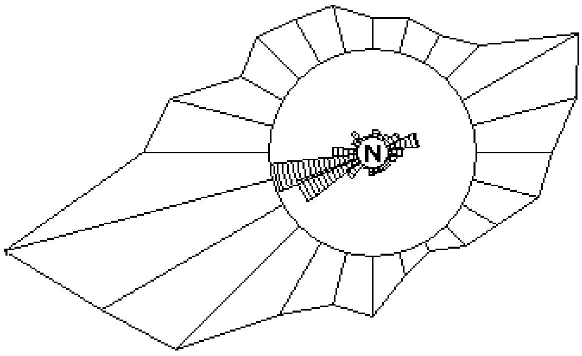


Fig. 170. Recovery roses graph for Common Shelduck: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts). Sector = 15,0°; Total recoveries - 299; N in sectors: from 2 up to 66, Average distances in sectors: from 87,7 km up to 2267,3 km; the longest flight distance is 5655.3 km.

Flight distances distribution in Common Shelduck (Fig. 171) has some unusual peculiarities. All recoveries might be divided into two categories: 1) quite numerous short-distance recoveries (less than 200 km), with movements directed almost everywhere (Figs 167 and 168); 2) long-distance recoveries (all others), just these flights are directed east, north-east – west, south-west, as it has been described . Both categories include direct and indirect recoveries. The second category has several preferable distances (see local peaks in Fig.171). All this means that migratory movements in Common Shelduck are quite complicated (see below).

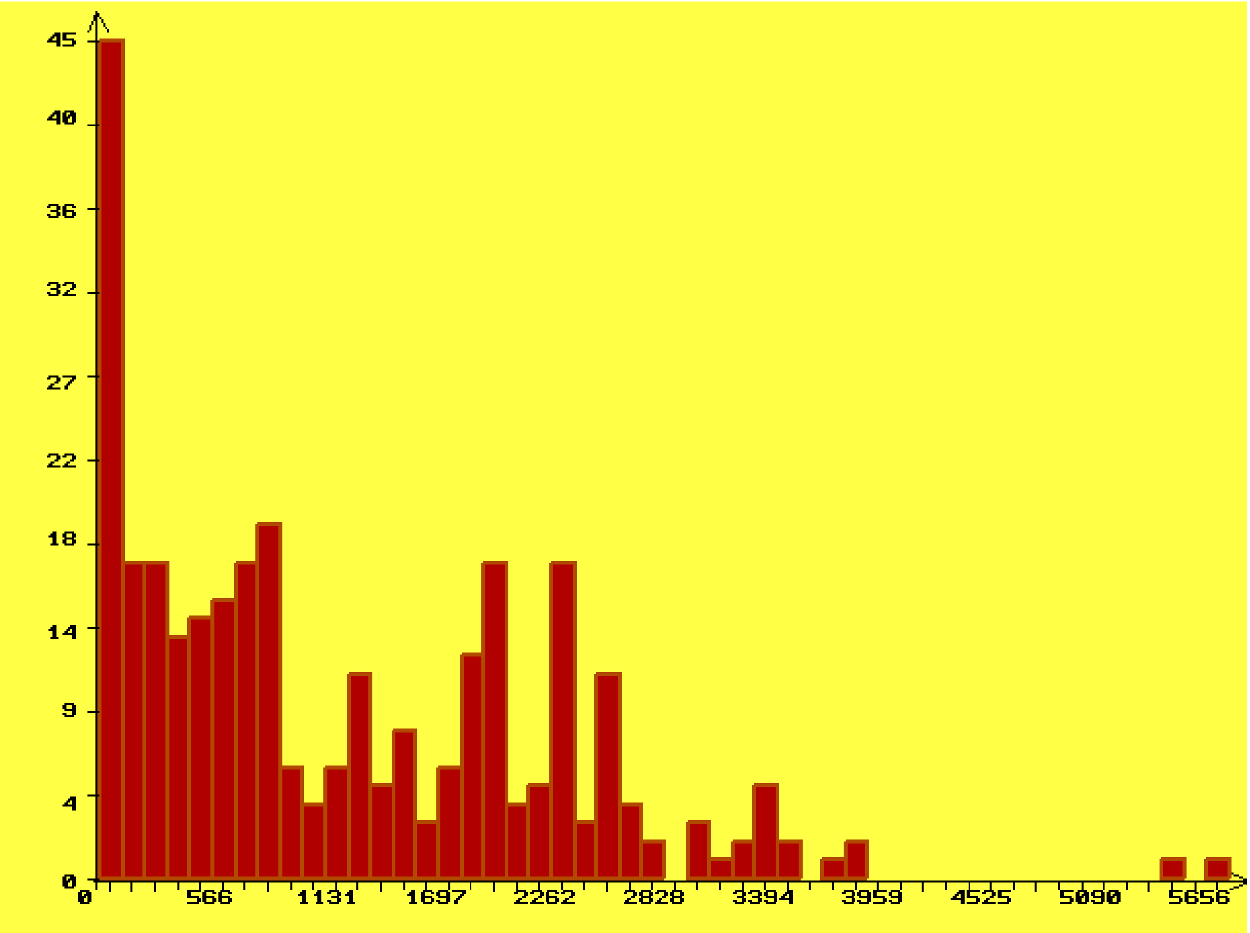


Figure 171. Distribution of all ring-recovery distances in Common Shelducks. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in young birds (ringed as „pull" or „juv" or „1 y") is shorter than in adults: 1054.5±169.4 (N_{young} =62) and 1226.8±61.3 (N_{ad} =237) km respectively, difference is significant (Mann-Whitney Z=2.65, P=0.0000). Male mean flight distance is shorter than in females: 1184.6±69.2 and 1391.9±137.0 km (N_{males} = 163, $N_{females}$ = 62) respectively, although insignificant.

Great bulk of these ducks was ringed in one breeding and moulting place – Kurgaldzhinsky Nature reserve. We are capable to consider their migration movements in detail (Fig. 172). In most characteristics the order of movements conforms with that described above in the section "Monthly movements", but one peculiarity is more pronounced in this map (Fig. 172). June monthly mean is definitely outside of the expectable order of the seasonal movements. Although samples for some months are small, we suggest an explanation. As we have already seen in the section "Monthly movements", in summer time these ducks are recovered not only on the breeding grounds, but continue to give recoveries from the wintering area located more to the south-west. It is very likely, that these birds omit the breeding season, both males and females are among those ducks. In June we have 6 recoveries with definite recovery dates, some of then are situated in Iran, Iraq, Turkey. It is interesting, that concentrations of recoveries in this area occur especially in June, no recoveries from there in March, April, May, July, and only one recovery in August. This might mean that Common Shelducks arrive in this area just in June and leave it soon.

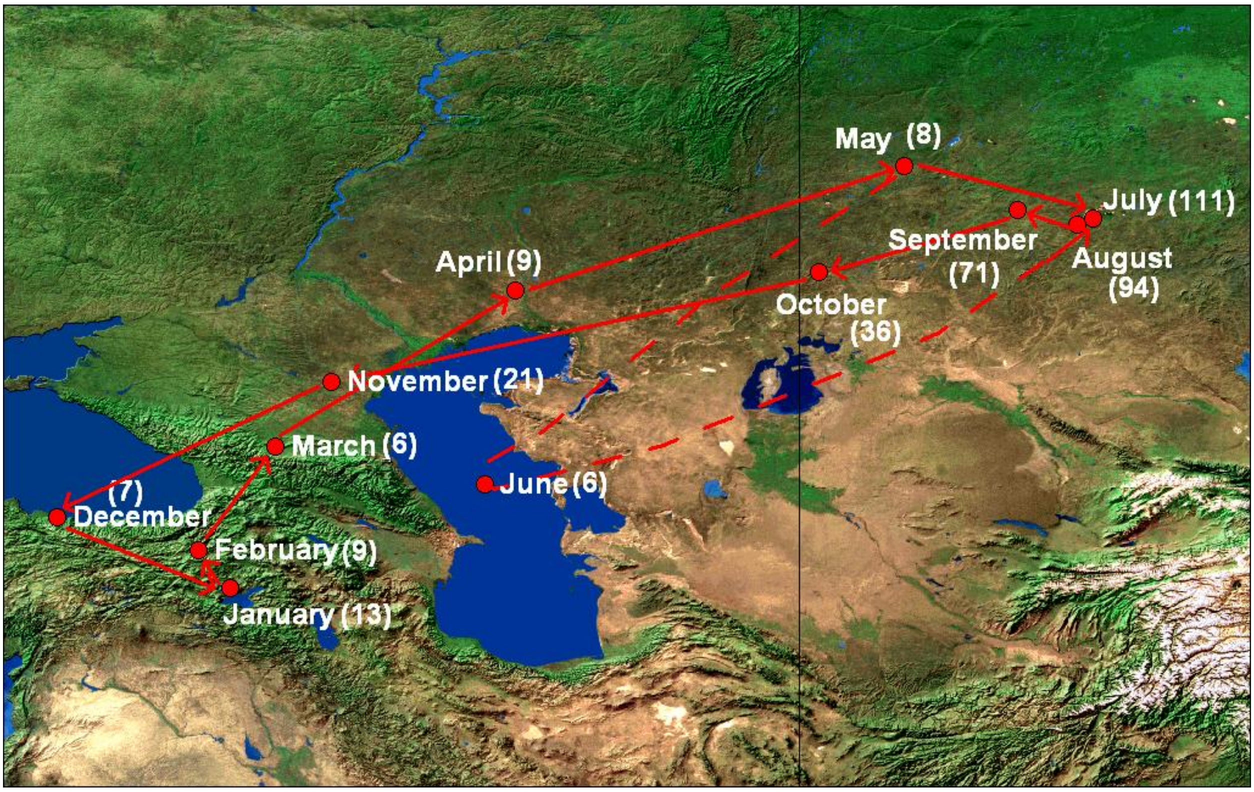


Figure 172. Monthly mean locations of the Common Shelducks ringed in the Kurgaldzhinsky Nature Reserve, Kazakhstan. Red circles represent the average monthly locations of the control points, digits in parenthesizes present the number of recoveries per each month, arrows show averaged month-by-month movements. Dashed arrow is an assumed way of movements, however from non-breeders.

Our analysis allows preliminary conclusion about two peculiarities of Common Shelduck: 1) part of adult birds (both males and females) in some years do not fly in the breeding area, but stay within the wintering area; 2) birds, that remain within the wintering area do not stay in the same sites during a long time, they move broadly over this wintering area.

Speed. It looks like the Common Shelduck is slow-moving duck. The database contains many recoveries with little elapsed time, and flight distances in all cases are not long. These ducks likely move, mostly, not more than several ten of km per day.

Populations. Ring-recovery data of the Bird Ringing Centre of Russia allow revealing three or four populations in the Common Shelduck (Fig. 173). They are: one or two European populations which probably not overlap, although data on them are scarce. Two others: western-siberian-kazakhstanian-south-european-north-african-asia-minor and kazakhastanian-central-asian-middle-eastern population greatly overlap with intergradations zones at the Tengiz Lake, Kazakhstan (Fig. 173). There are two main wintering concentrations of the recoveries. A number of birds tend to winter in areas in the middle of the Mediterranean Sea wherever they breed; others spend winter from eastern parts of the Mediterranean Sea up to Persian Gulf and mainland Iran areas. These wintering places are the intergradations zones between populations, as well.

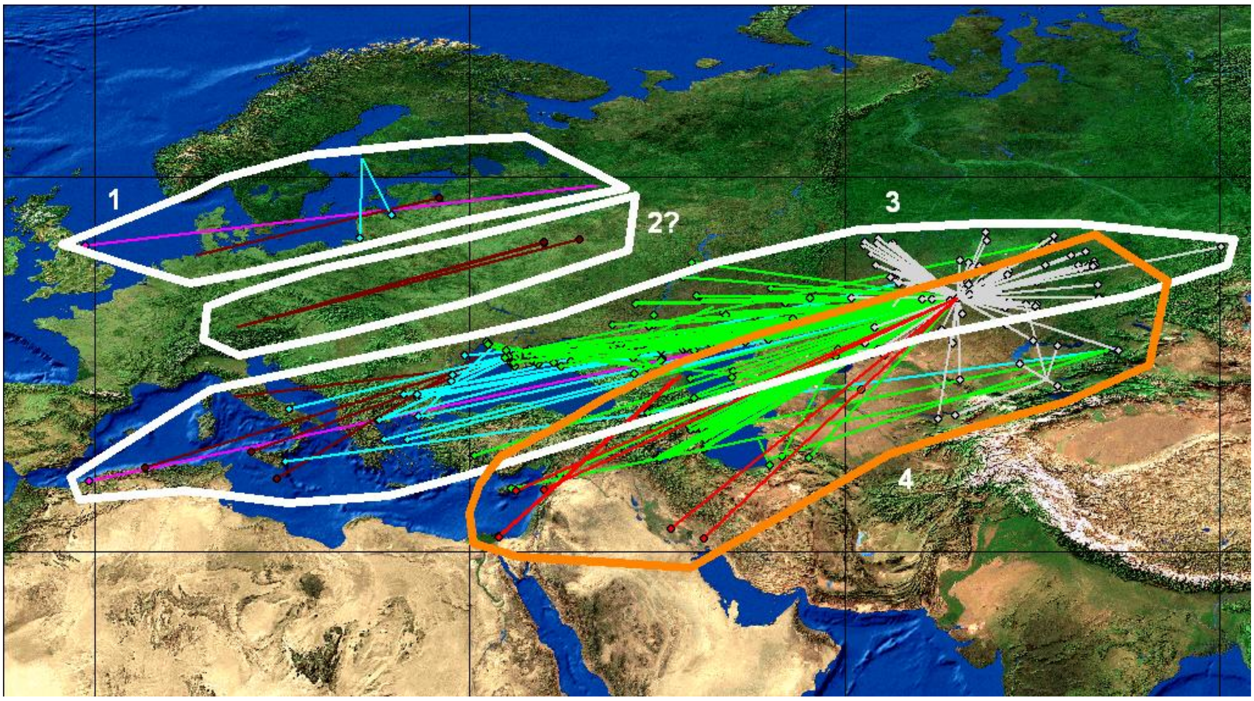


Figure 173. Common Shelduck populations. White polygons №№ 1 and 2 outline one or two European populations. Polygon № 3 rounds western-siberian-kazakhstanian-south-european-north-african-asia-minor population. Light brown polygon № 4) rounds kazakhastanian-central-asian-middle-eastern population.

Ten-year distances. Since most recoveries are from ducks ringed in one place, Kurgaldzhinsky Nature Reserve, the decadal distance analysis only from there makes sense (Table 11). There is a tendency for mean flight distance increase during the period of 1967-2001 (for the later years we have no relevant recoveries), but insignificant in any test combinations.

Table 11. Common Shelduck mean distance per 10-17 year periods (for birds ringed in the Kurgaldzhinsky Nature Reserve, Kazakhstan).

Decade (years)	1967-1980	1981-1990	1991-2001
Distance (km)	1236.3	1423.8	1554.5
Number of recoveries	84	112	10

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) of 26 November 2010, the oldest Common Shelduck lived 24 years 9 months. Bird Ringing Centre database contains a recovery of male ringed as adult bird and recovered in 13 years 2 months (ring sent), therefore its lifespan is greater than 15 years.

Mortality rate. According to the common criteria (see "Materials and Methods") 254 dead recoveries of Common Shelduck are applicable for the mortality rate analysis. Mean annual mortality rate in Common Shelduck is 32.67±1.18% (Fig. 174). Real mortality pattern close to the theoretical one (χ^2 = 17.6, df = 11, P=0.09). Programme MARK, Model CLogLog 2ndPart shows 33.68%, difference is 0.99%. Mortality rate pattern points to good population condition. However, we should keep in mind that the data on Common Shelducks are mostly from 1970-1980s; we have no recoveries after 2001. Therefore, the conclusion about the species condition is relevant for those years, not for the modern situation.

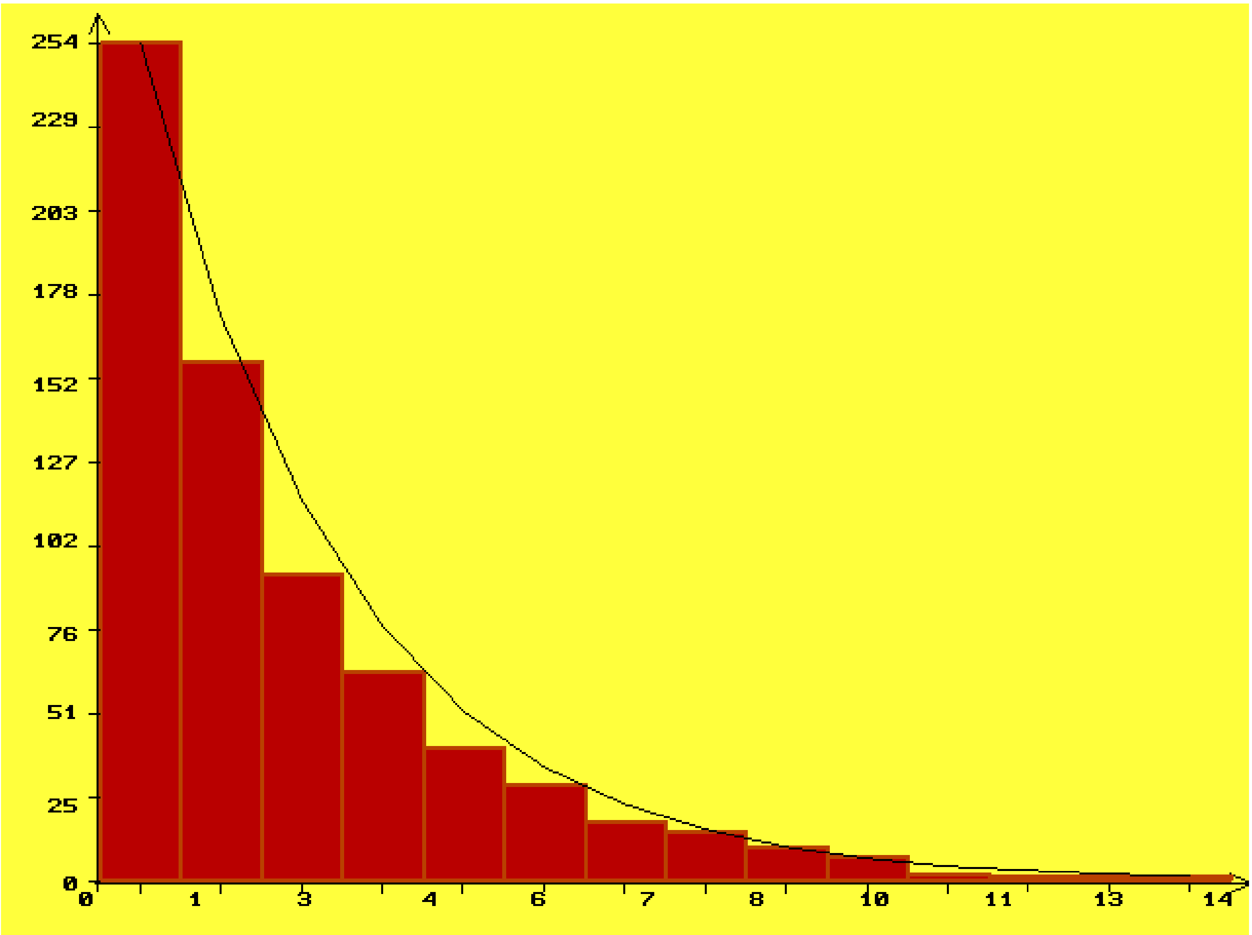


Figure 174. Mortality pattern in the Common Shelduck. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Males and females of Common Shelduck in the period before 2001 (see explanation above) lived, on average, the same number of years: 2.27 (N=140) and 2.25 (N=50) years respectively. Mortality rate was about the same in both sexes: males - 29.76$\pm$2.11%, females - 29.93$\pm$3.54%.

EURASIAN WIGEON
(*ANAS PENELOPE*)

Photo by Irina A. Kharitonova

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 175. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

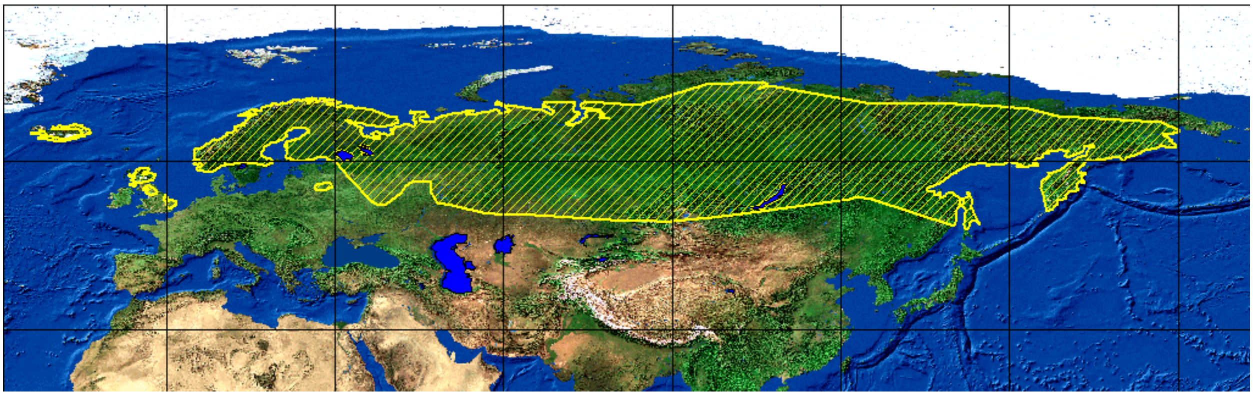


Figure 175. Breeding range of the Wigeon in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 3397 marked birds were used, which gave 3398 recoveries (Fig. 176), 70 of them wore different kind of colour marks: colour rings, wing-tags or nasal marks. Three ducks wore geo-logger, three – different tranmitters. 3396 birds gave one recovery per duck, one – two recoveries per duck. Ringing dates are since 15.04.1923 until 06.03.2022, recovery dates are since 20.07.1925 until 14.03.2023. All birds but one were wild, one duck escaped from the Moscow Zoo.

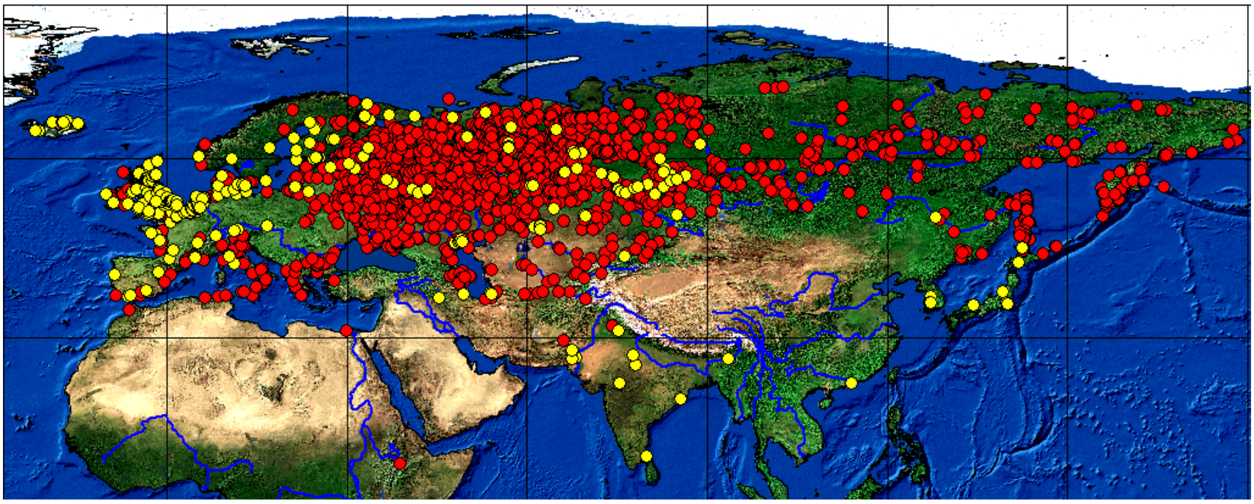


Figure 176. Position of all Wigeon control points. Yellow dots – ringing sites, red dots – recovery sites.

Most of Wigeons were ringed in Europe, western Siberia, Iran, India, Pakistan, south-eastern China, South Korea and Japan. Most of recoveries are from Europe, western Siberia and Russian Far East. There is a noticeable gap within recovery area in the eastern Siberia with very few recoveries in it (Fig. 176). This gap is real and is not caused by the low human population density, because different duck species has this Siberian gap in different areas. Areas of such gaps in Mallard and Pintail are filled with recoveries of Wigeon in spite of low human population densities there (see the example with Pintail and Wigeon in the section “Material and Methods”).

‘Moskwa’ scheme recoveries. This sample contains 601 recoveries of the scheme „Moskwa‟. They are from birds ringed within the Russian Federation and countries of the former USSR (Fig. 177). Considerable amount of birds (187 recoveries) were ringed in the former huge moutlting place in the Volga River Delta, where many duck species concentrated for moult. Now this moulting area no more exists because of Caspian Sea level growing (Viksne et al, 2010).

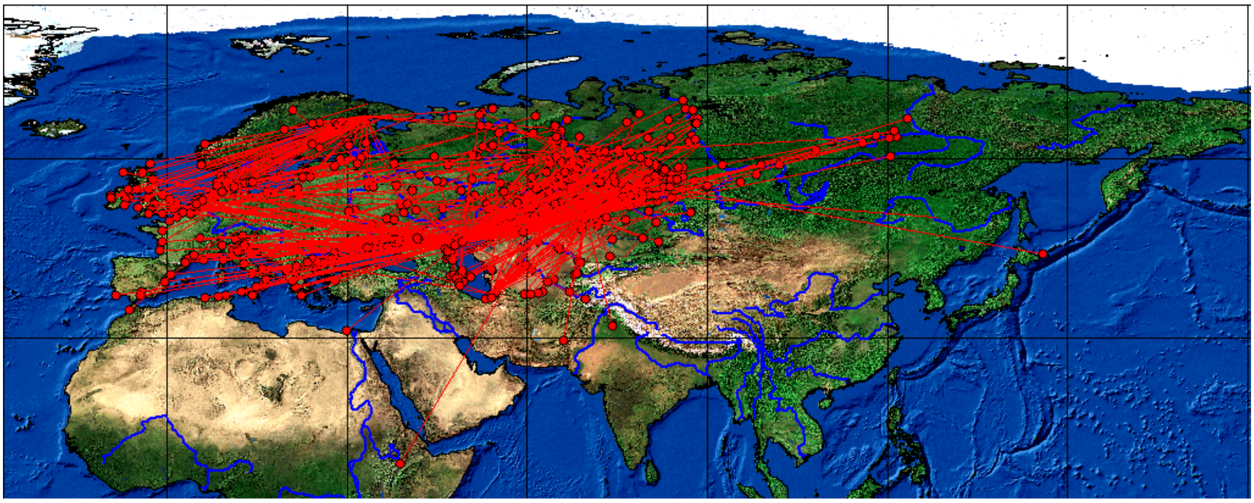


Figure 177. „Moskwa‟ scheme recoveries of the Wigeon. Here and on all other similar figures lines start from ringing sites, recovery sites are marked with red dots.

Finding details. This analysis includes all 3398 recoveries. Almost 9/10 of recoveries (88%) are „shot‟. In 258 (8%) recoveries „details unknown‟, which practically mean shot, as well. Therefore, we can assume that 96% of birds were shot. Other reasons are not so common (Fig. 178).

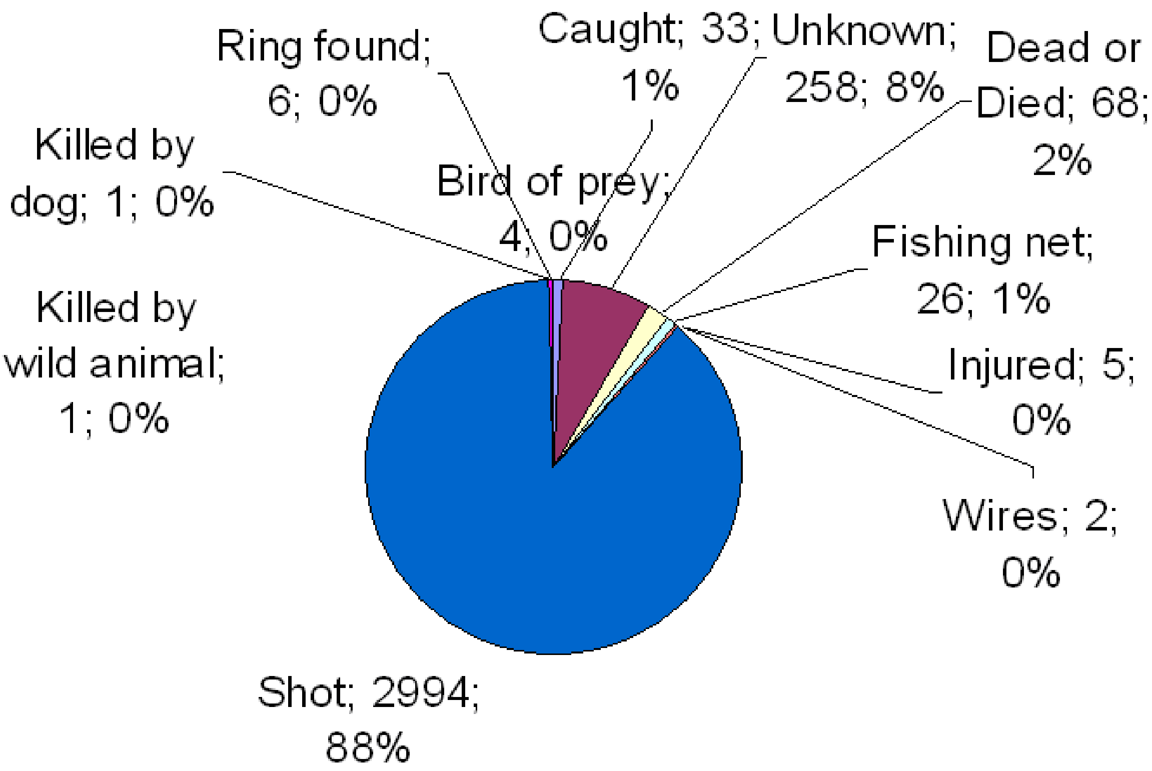


Figure 178. Finding details in the Wigeon.

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries do not much differ from each other (Figs 179 and 180), although they are considerably different in areas (see below).

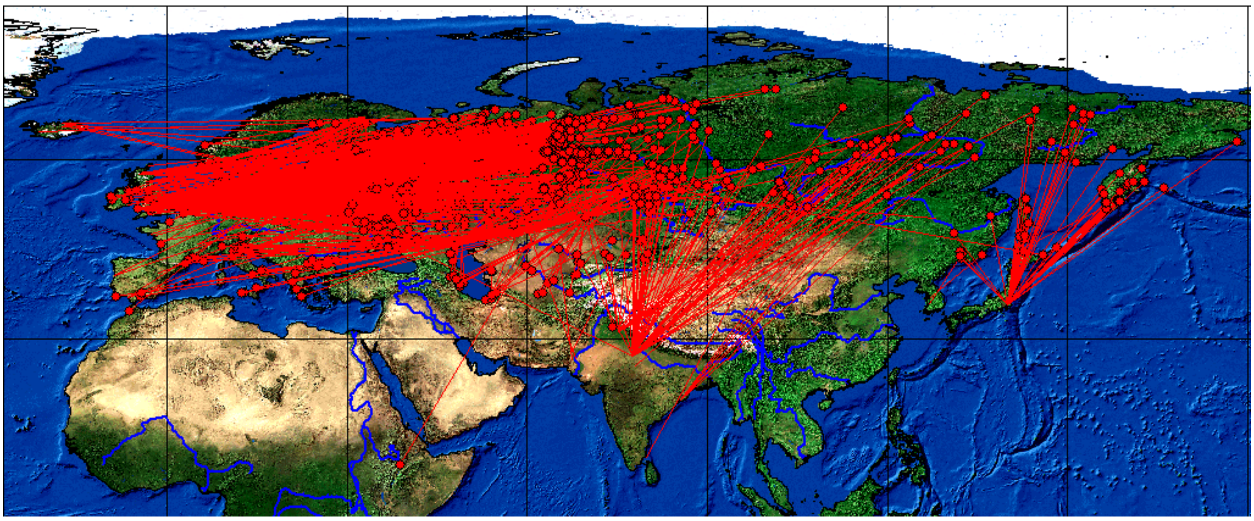


Figure 179. Map of the Wigeon direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

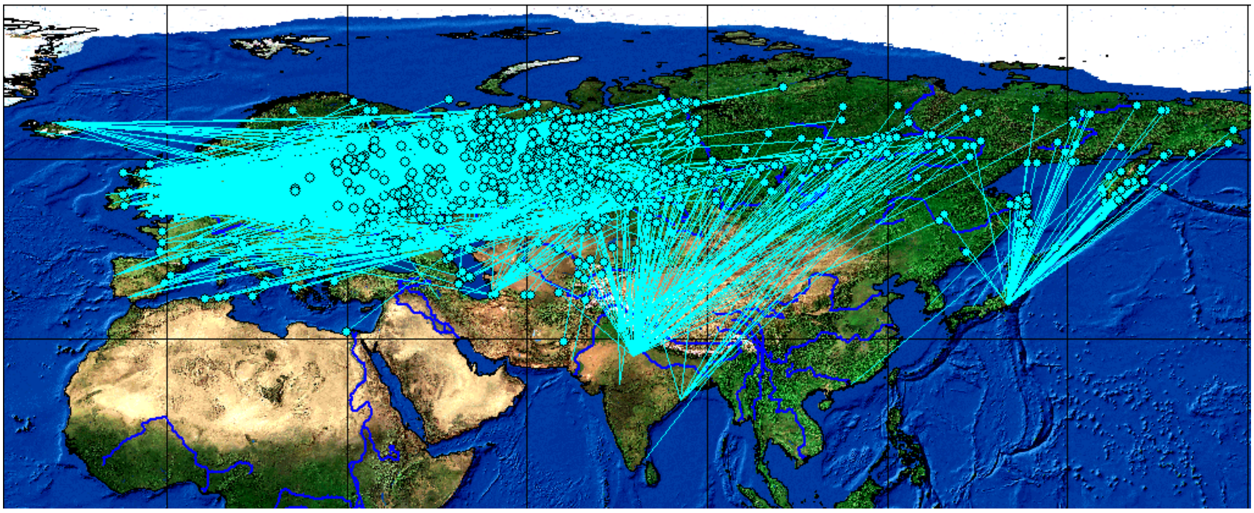


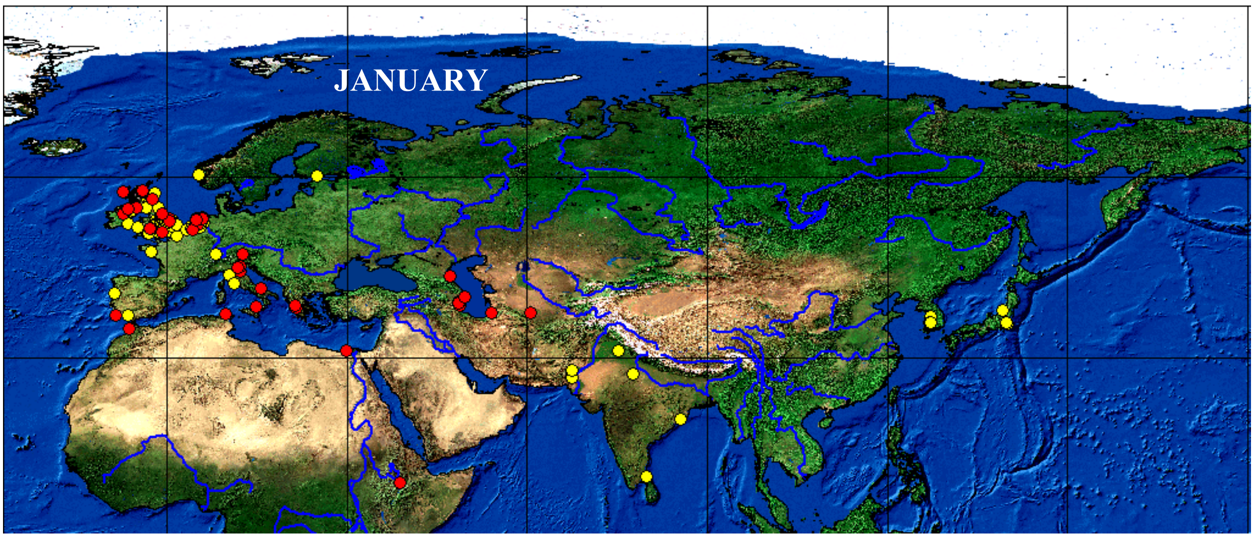
Figure 180. Map of the Wigeon indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

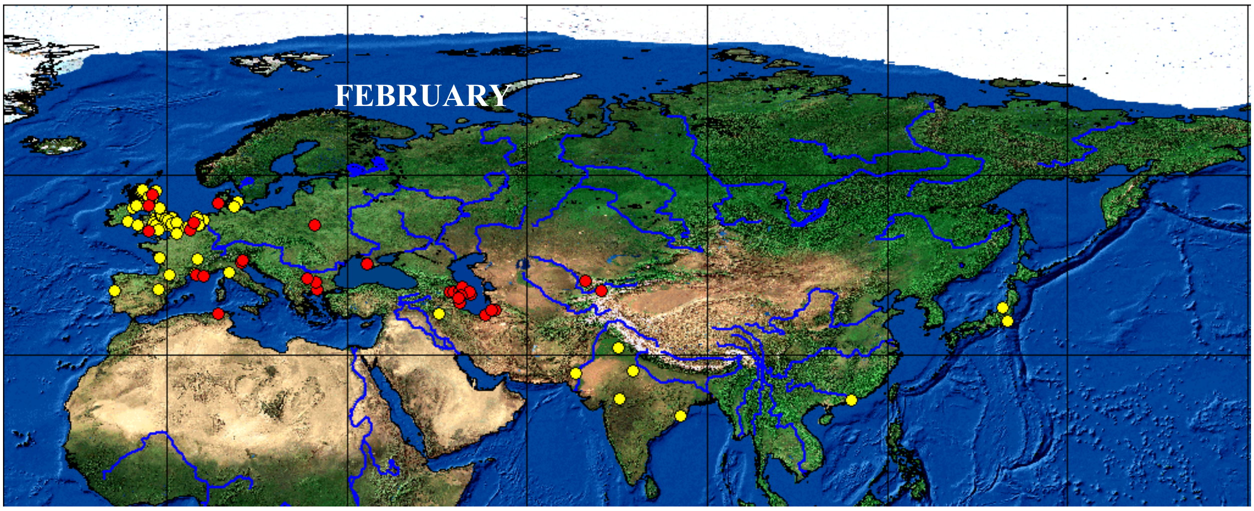
Maps clearly indicate that Wigeons wintering in Europe and India fly to breed to the European Russia, southern half of western and central Siberia approximately up to meridian 135˚E from the west (Figs 179 and 180), which is more easterly than both Mallards and Pintails. Most birds wintering in Japan and South Korea breed in the Far East and eastern Siberia approximately up to meridian 140˚E from the east. Between 135˚-140˚E there is the inter-population gap area with very few recoveries. This gap is much narrower than in Mallards and Pintails. We expect, that here might be the area where China-wintering birds should breed. However, we have only one recovery of „China" scheme. This means, that either very small amount of Wigeons winter in China or the ringing amount of this species in China is very small. In distinction to Pintail, this Siberian gap of Wigeon recoveries starts by 45 degrees more to the east than in Pintail. This is related to the feature of Wigeon: its migratory routes directed to the east in much greater extent than in Mallard and Pintail (see section "Migratory routes"). Thus, Indian wintering Wigeons "fill" the central and eastern Siberia in addition to European recoveries; and the area of Indian recoveries lays more easterly than area of European recoveries. Eastern end of the gap locates more to the east than in Pintails, as well. This is also related with more eastern directed flights of any Wigeon population, because Japan wintering Wigeons migrate to breed easterly than Japan wintering Pintails (see section "Migratory routes").

Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them (χ^2 = 14.02, 2196 indirect recoveries and 1202 direct ones, df = 2, P = 0.0009). It seems, the main reason for this significance is quite large samples, because the position of centers of direct and indirect recoveries are very close to each other. Center of indirect recoveries locates just by 1˚ 12" more to the north and 1˚ 50" to the east from the centre of direct recoveries. Average flight distances in direct and indirect recoveries are different: 2849.1$\pm$33.4 and 2973.0$\pm$22.4 km respectively. Difference is significant – t-Bailey = 3.00, P=0.002. Long-distance cross-population movements occur both in direct and indirect recoveries.

In Wigeon the longest recovery (indirect) distance is 6906 km, from Italy to Yakutia. There is direct recovery from India to Latvia – 4980 km. We have also one direct recovery from Kazakhstan to Ethiopia – 4855 km.

Monthly movements. All direct and indirect recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in Wigeons (Fig. 181). In January most ducks are on wintering grounds in the western and southern Europe, Cis- and Trans- Caucasus, Central Asia, India, Iran, Pakistan, eastern China, South Korea, Japan. First very small movements in the direction to breeding grounds are noticeable as early, as in February (February, Fig. 181). These movements are related to the western and southern wintering areas: Eastern Europe, south-eastern Europe, Caucasus area and India. No movements in February are visible in the Far East. In March migratory movements are well noticeable in European and Indian Wigeon populations; no movements are detected for birds wintering in Japan. Birds from Western Europe move to the east, north-east, from southern Europe and Caucasus area – to the north-east, from India and Pakistan – first to the north. It is noticeable from the position of the new appeared green dots, which mark the recovery sites (Fig. 181, March). In April migration continues through May and finishes in June when these ducks reach the northern boundary of the breeding range, i.e., Eurasian tundra zone. According to ring-recovery data, Far Eastern Wigeons start to migrate only in April, finish migration mostly in May, possibly in very early June. In Wigeons, unlike Mallards and Pintails, no spring concentration of recoveries around southern end of Urals is visible. Really, April recoveries in the Urals area are distributed more or less evenly (Fig. 181 April). This indicates that Wigeons in spring cross Ural Mountains directly, without pronounced streams around northern or southern Urals. In April and early May many Wigeons spend some days at the spring stopovers. E.g., a prominent stopover locates in the Moscow Region, Russia, on the flood land of the Moskwa River (Mishchenko et al., 2008), where Wigeons can stay for 2-3 weeks. Ring-recovery data show that migrating Wigeons can be divided into two categories of birds. One of them fly very fast and cover thousands km in a few days, others move much slower, with stops, and covering the same distances in many days (see section “Speed”). In June birds are on the breeding grounds; in July part of Wigeons start to move slightly back to the wintering ground directions for moult. In August breeding birds start to move southwards and westwards. In August moulting birds and failures either stay at moulting sites or move further to wintering grounds. In Wigeons, in contract to Mallards and Pintails, no backward flights to the breeding grounds after moult are noticeable. October indicates intensive migration, but some birds still stay in breeding areas. In September and October there is a concentration of recoveries in the south of Western Siberia and northern Kazakhstan, close to Urals, whereas over the Urals, in distinction to spring, no recoveries are seen (Fig. 181, September, October). This indicates the same phenomenon as in Mallards and Pintails: on their autumn migration to wintering grounds in Europe, Wigeons bend the Urals around the southern end, as well. I.e., Wigeons also perform bending of Ural Mountains, but only in autumn. In November migration is very weak; most birds are already on wintering grounds. In December no migratory movements are seen (Fig. 181).

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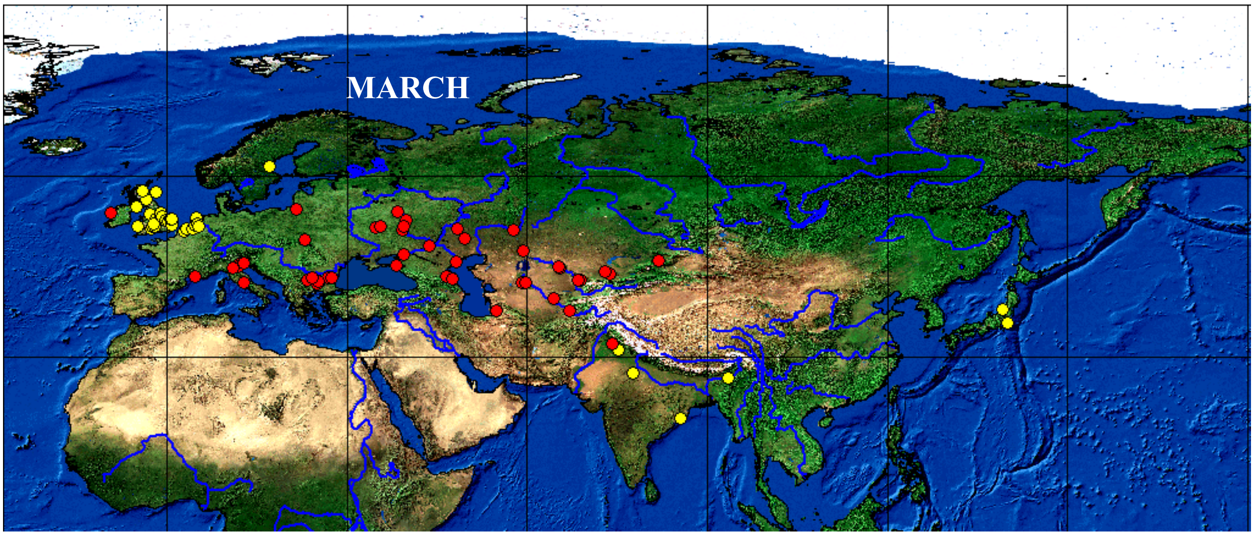
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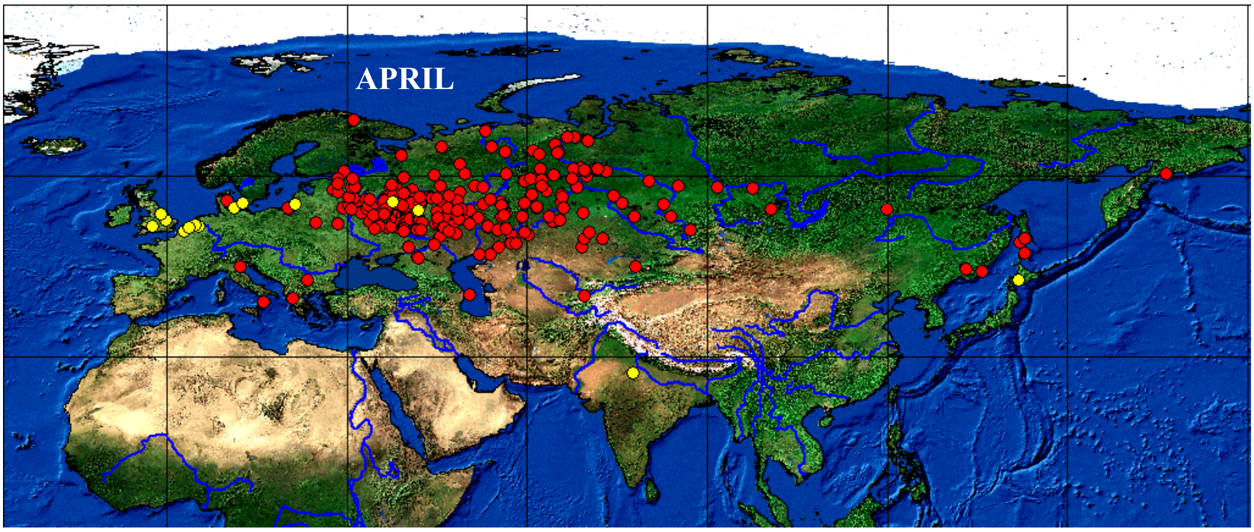
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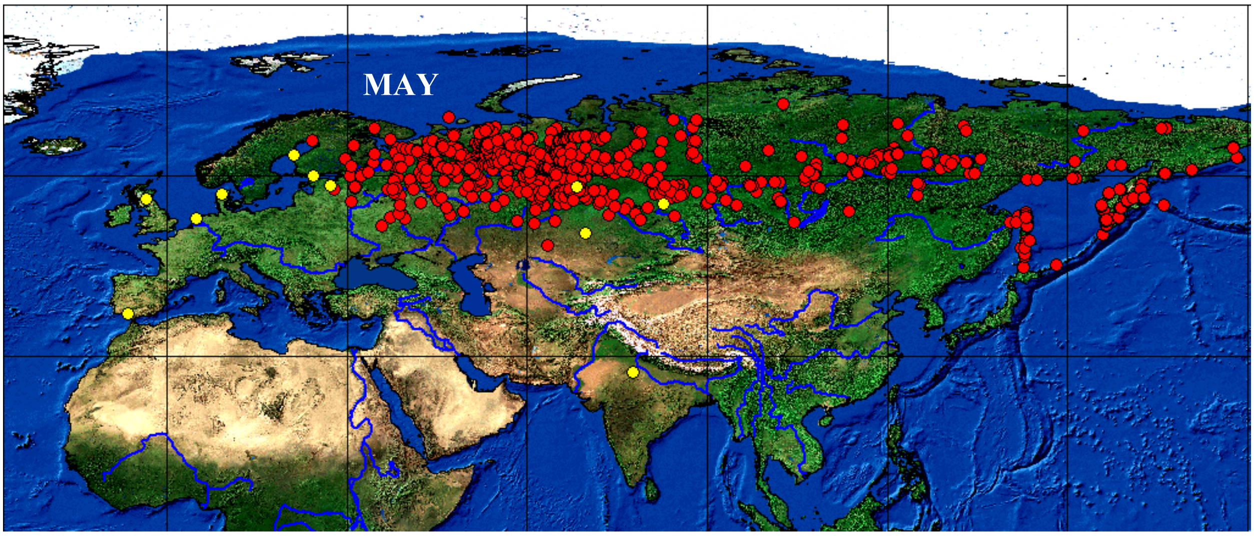
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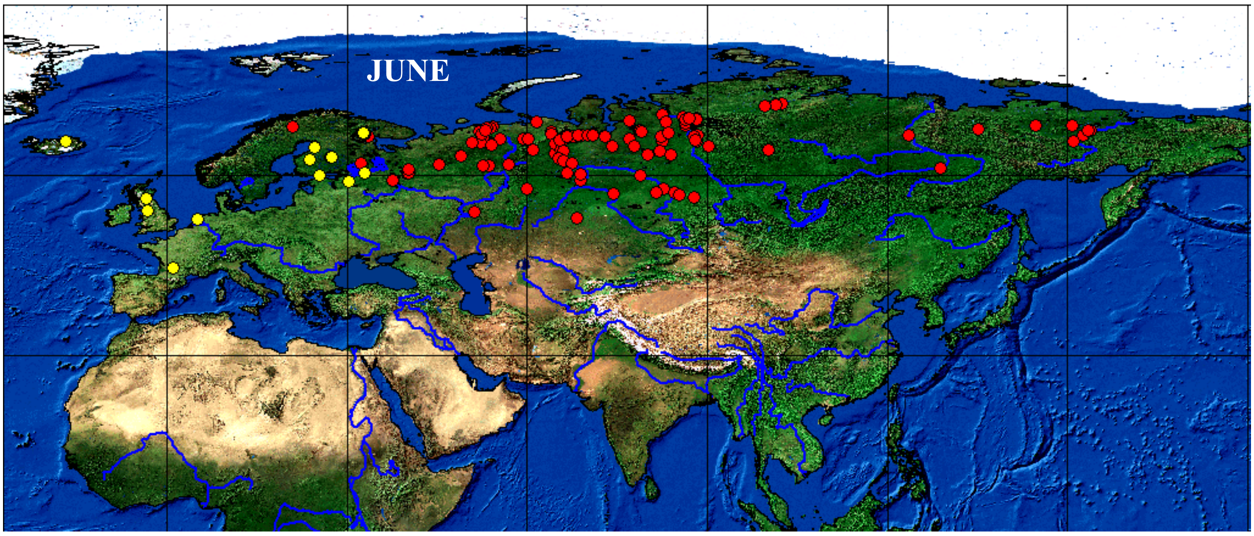
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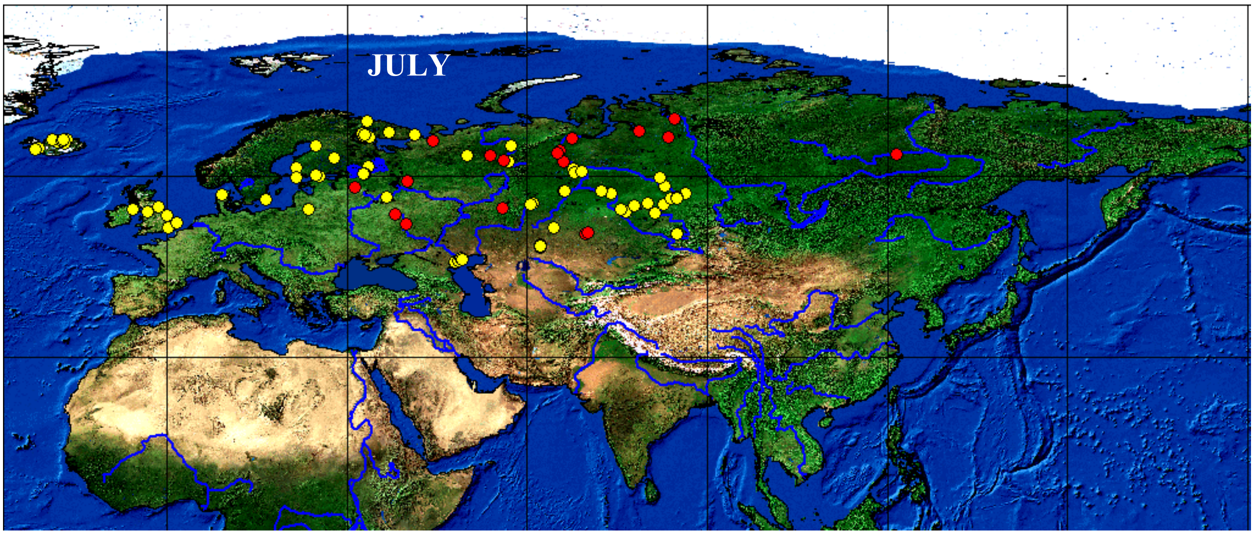
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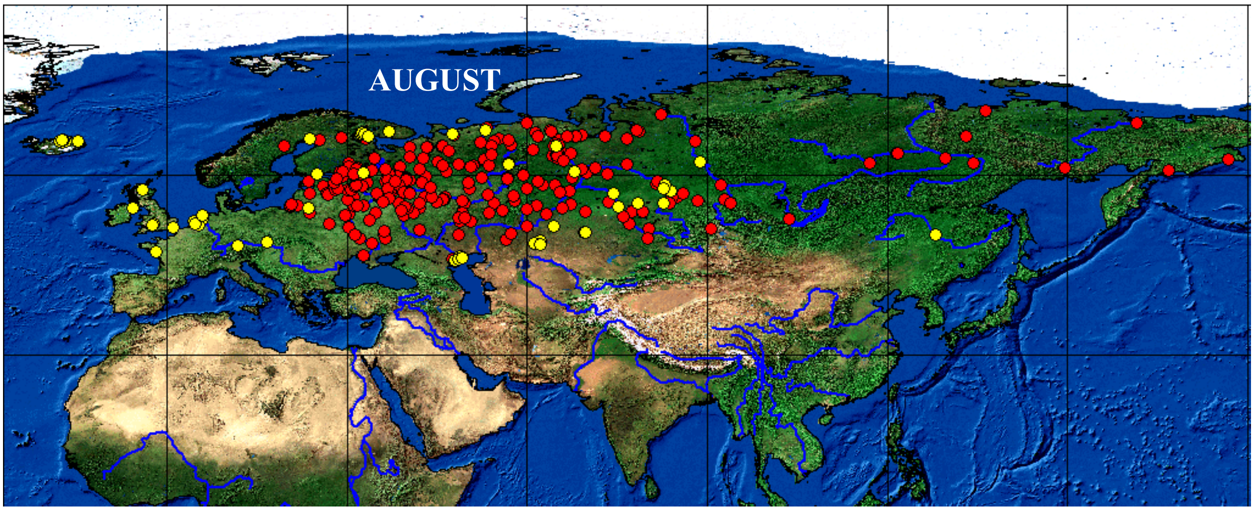
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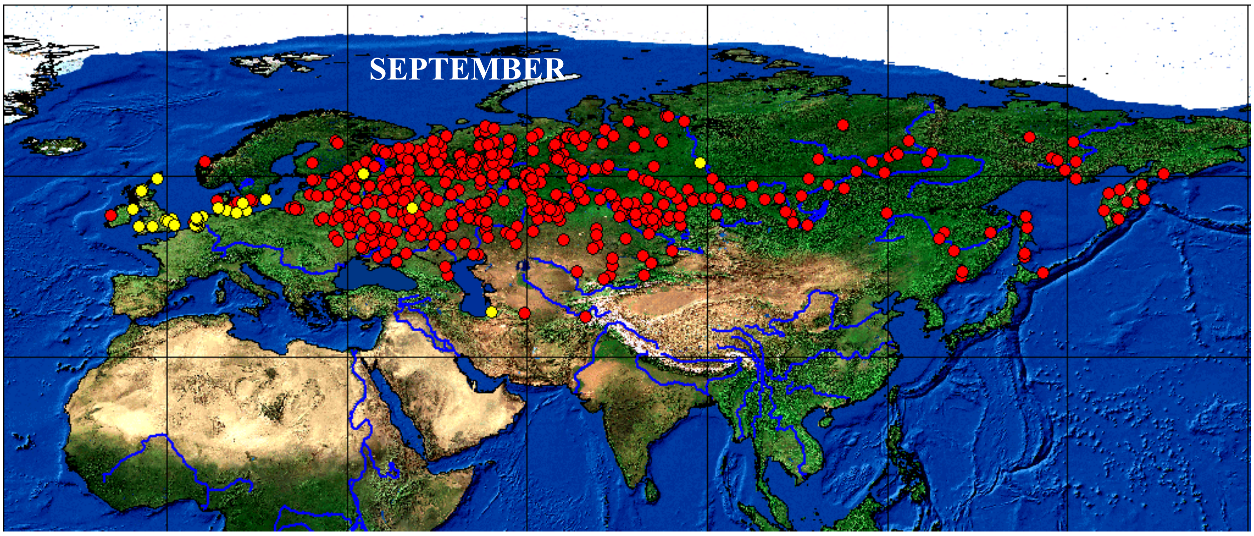
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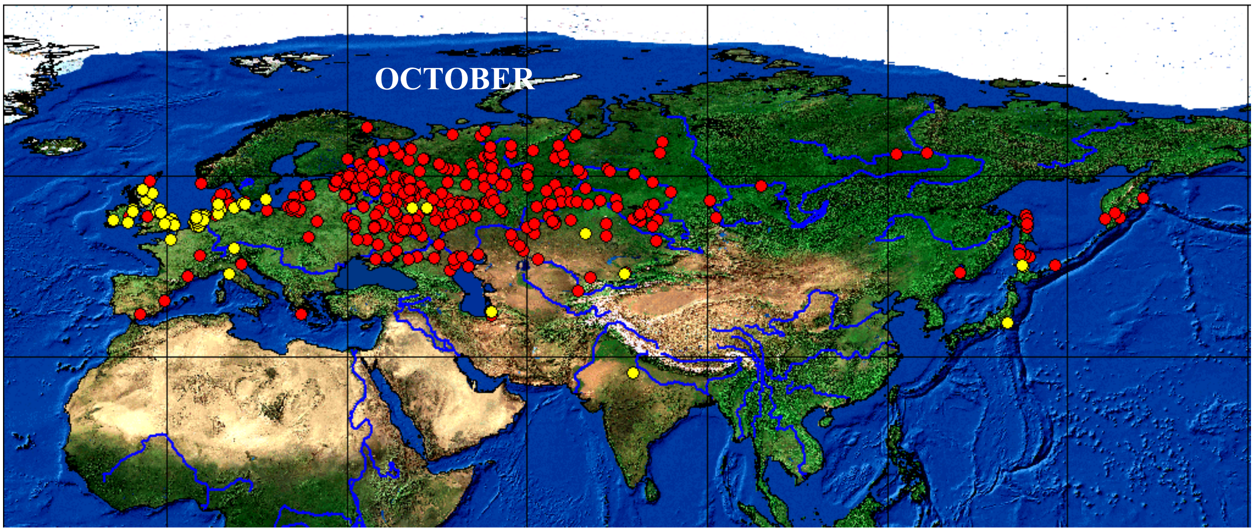
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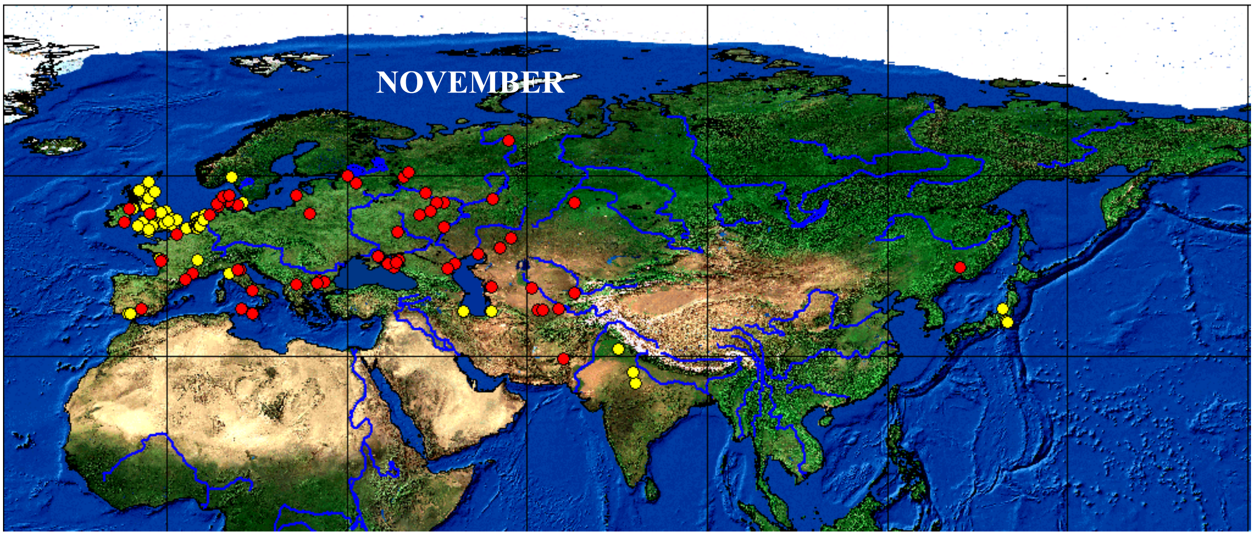


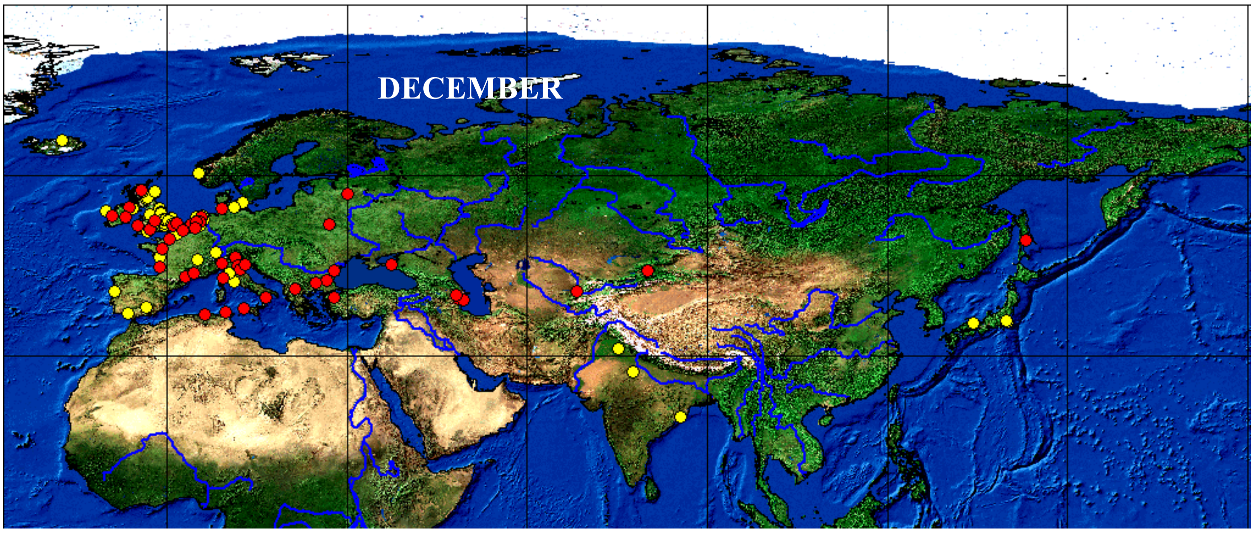


Figure 181. Wigeon monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. As it is preliminary shown in the section “Monthly movements”, Wigeons from different wintering areas migrate in different directions. Birds ringed in areas with longitude <=30˚E move to north-east in spring (bearings 52-112˚, mostly 52-97˚ Fig. 182), and in opposite direction in autumn. For birds ringed in area with longitude 30˚-60˚E preferable flight bearings are 22-82˚ in spring and 202-292˚ in autumn. In this section there are a number of birds ringed in the Volga River Delta, which is close to the southern end of Ural Mountains. Although the turn from western to north-eastern direction occurring near the southern end of Urals exists, it is less pronounced than in Mallard and Pintail. It is the additional argument that Wigeon had lesser tendency to fly around the southern end of the Ural Mountains. Section “Monthly movements” shows that this bend is more characteristic for autumn migration. For ducks ringed in 60˚-90˚E preferable bearings are 350-68˚, mostly 22-53˚ - this is spring flight direction of Wigeons ringed in India. For Far Eastern birds ringed in Japan and South Korea and eastern China spring flight bearings are 350-50˚, mostly 22-37˚ (Fig. 182); certainly, the opposite should be in autumn.

In comparison to Pintails, Wigeons have generally more easterly directed movements in spring in all parts of the species range within Eurasia, in autumn they migrate relatively westerly than Pintails (see Pintail species account). Wigeon migratory movements are more stretched from west to east than in Pintails, recovery roses are more sloped to the east (Fig. 182).

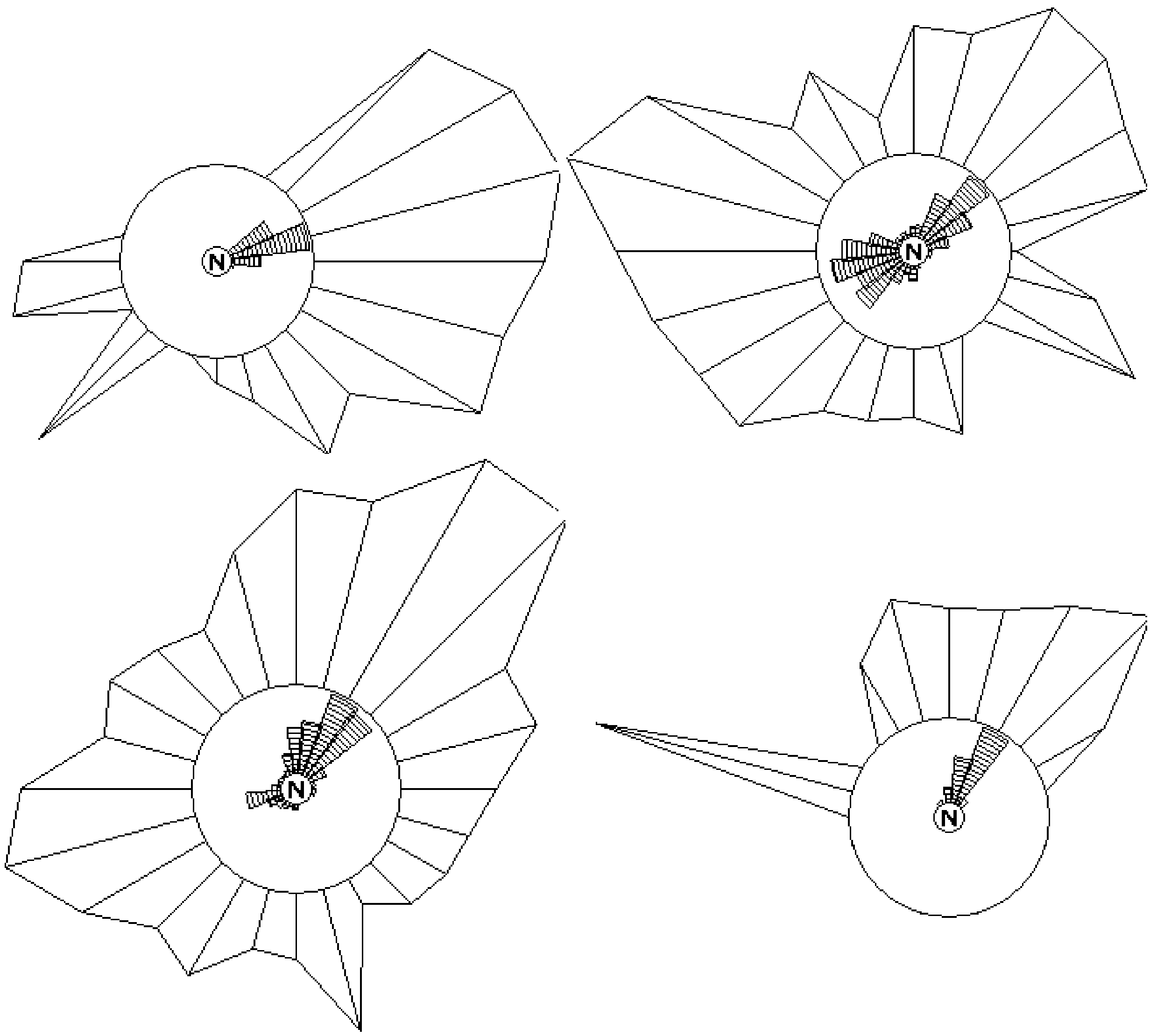


Figure 182 Recovery rose graphs for Wigeons, ringed in different longitudes: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Upper left chart is for European wintering Wigeons, area of recoveries from British Isles to central Siberia, to 90˚E. Sector = 15.0°; Total recoveries - 2335; N in sectors: from 0 up to 1226; Average distance in sectors: from 0.0 km up to 3286.4 km; The longest flight distance is 6906.1 km.

Upper right chart is for Wigeons ringed in the southern European Russia, area of recoveries from British Isles, to central Siberia, to 135˚E. Sector = 15.0°; Total recoveries - 323; N in sectors: from 0 up to 44; Average distance in sectors: from 0.0 km up to 3340.7 km; The longest flight distance is 4779.9 km.

Lower left chart is for Wigeons ringed mostly in India and Pakistan, area of recoveries is western and central Siberia, to 135˚E; Sector = 15.0°; Total recoveries - 536; N in sectors: from 1 up to 102; Average distance in sectors: from 407.1 km up to 3963.6 km; The longest flight distance is 6771.9 km.

Lower right chart is for Pintails ringed in Japan, South Korea and eastern China, recoveries are mostly on the Russian Far east, east of 140˚E; Sector = 15.0°; Total recoveries - 204; N in sectors: from 0 up to 102; Average distance in sectors: from 0.0 km up to 4907.5 km; the longest flight distance is 5153.9 km.

Preferable flight distances both for direct and indirect recoveries are less than 4500 km, which is about the same as in Pintails, although the ring-recovery distance distribution is more skewed to the longer distances than in Pintails. Peak distances in Pintails are about 3200 km, in Wigeons about 4000 km. Maximal distance in the indirect recoveries, as already mentioned, is 6906.1 km (Fig. 183).

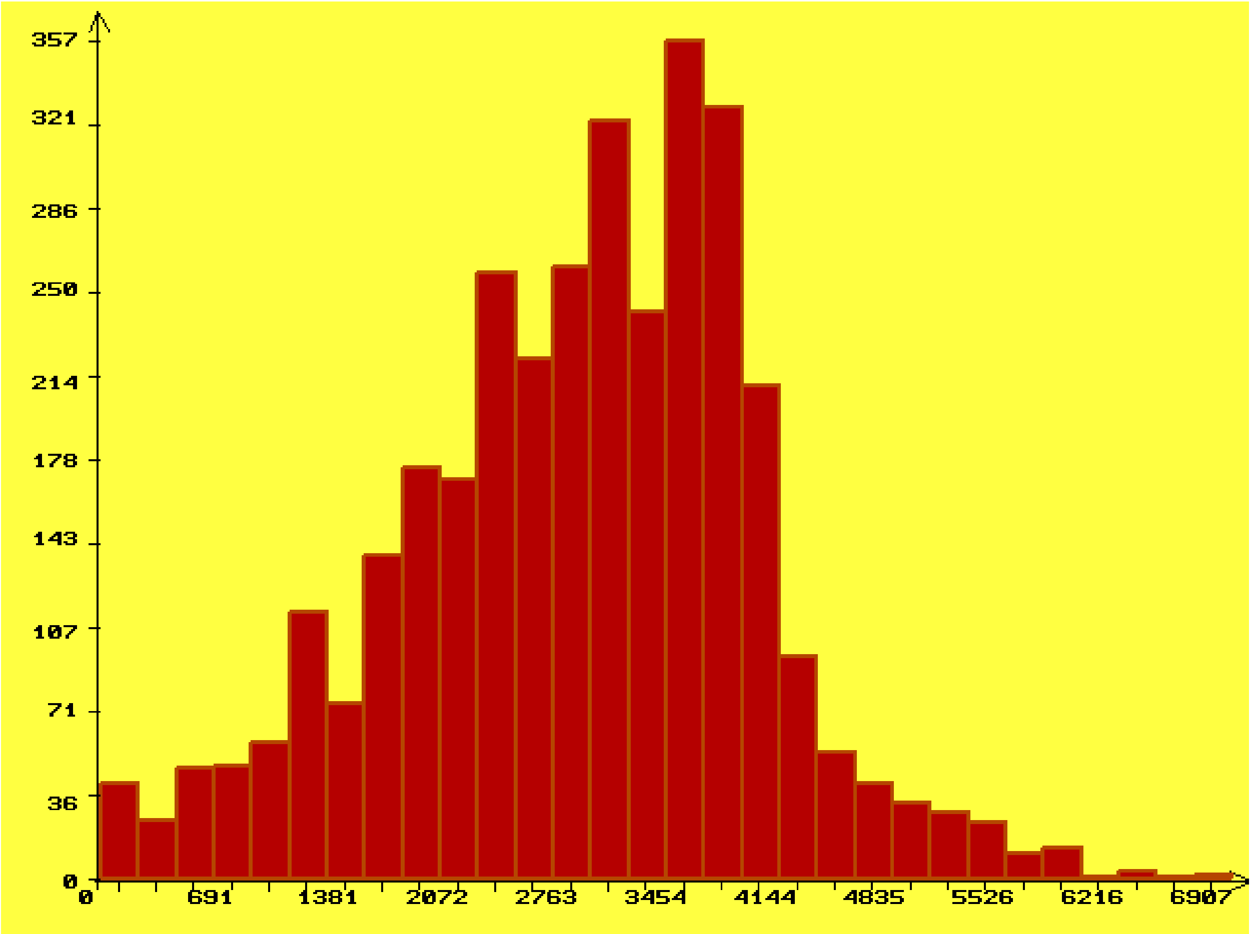


Figure 183. Distribution of all ring-recovery distances in Wigeon. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in Wigeon young birds (ringed as „pull"or „juv"or „1 y") is slightly shorter than in adults: 2843.6$\pm$38.1 and 2953.7$\pm$21.4 km respectively (N_{young} = 744, N_{ad} = 2654), significant (t-Bailey=2.52, P=0.012). Male mean flight distance is about the same as in females: 2979.3$\pm$24.0 and 3015.4$\pm$31.2 km respectively (N_{males} = 1951, $N_{females}$ = 1066), insignificant.

Before outlining the Wigeon migratory routes and revealing the migration process in more detail, we should plot monthly means of these ducks, ringed in different places. Wigeons breed in about the same time as Pintails. It is confirmed by the fact that the most northern and eastern monthly mean is in June, the same as in Pintails. This is illustrated by the examples of ducks ringed on the British Isles, Netherlands, and former huge moulting place for ducks of different species in the Volga River Delta and in Japan (Figs 184–188). Ducks, ringed with „Bombay" scheme, in spring migrate not directly to the north, as Pintails do. First they start migration with the north direction, then, during flights they turn to the east (Fig. 187). Japan ringed Wigeons, the same as Indian ringed ducks, start their flight generally to the north, then turn to the east. This is in distinctions to Pintails that turn to the west after leaving Japan (Fig. 188).

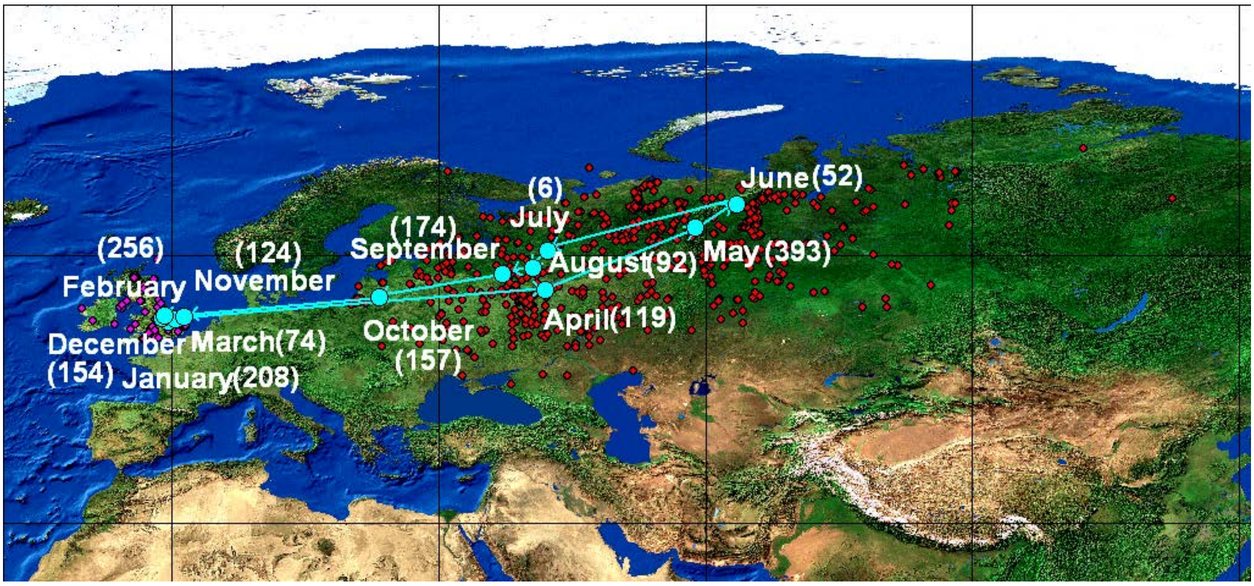


Figure 184. Mean monthly locations of Wigeon control points for birds, ringed on the wintering grounds in the Great Britain and Ireland. Blue-green large circles are mean monthly locations of Wigeons. Arrows show directions of movements. Number of control points in each month is represented in parentheses. Purple dots are ringing sites, red dots – recovery points.

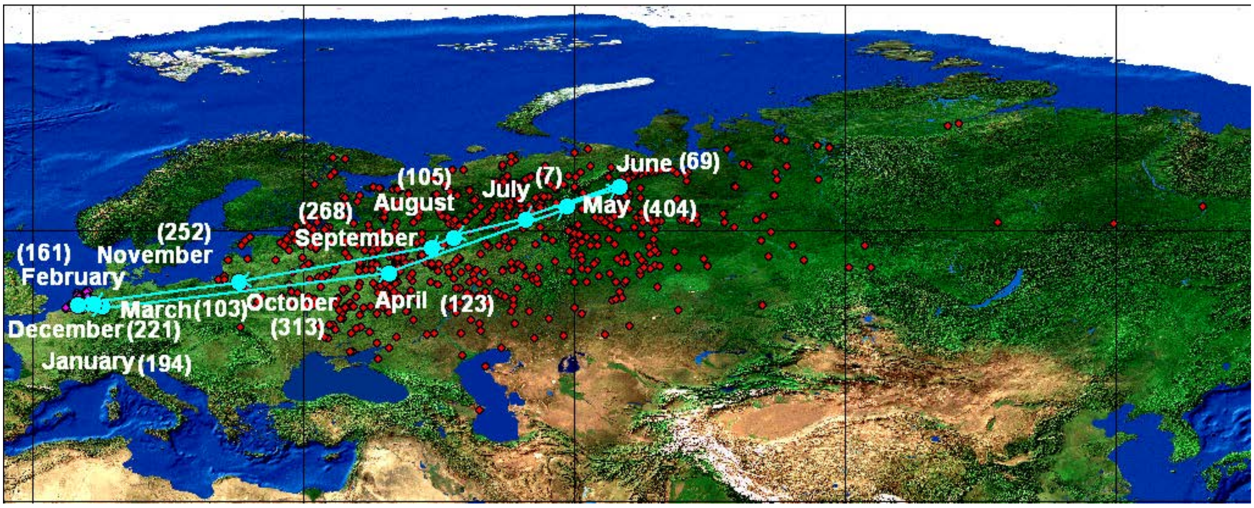


Figure 185. Mean monthly locations of Wigeon control points for birds, ringed on the wintering grounds in the Netherlands. Blue-green large circles are mean monthly locations of Wigeons. Arrows show directions of movements. Number of control points in each month is represented in parentheses. Purple dots are ringing sites, red dots – recovery points.

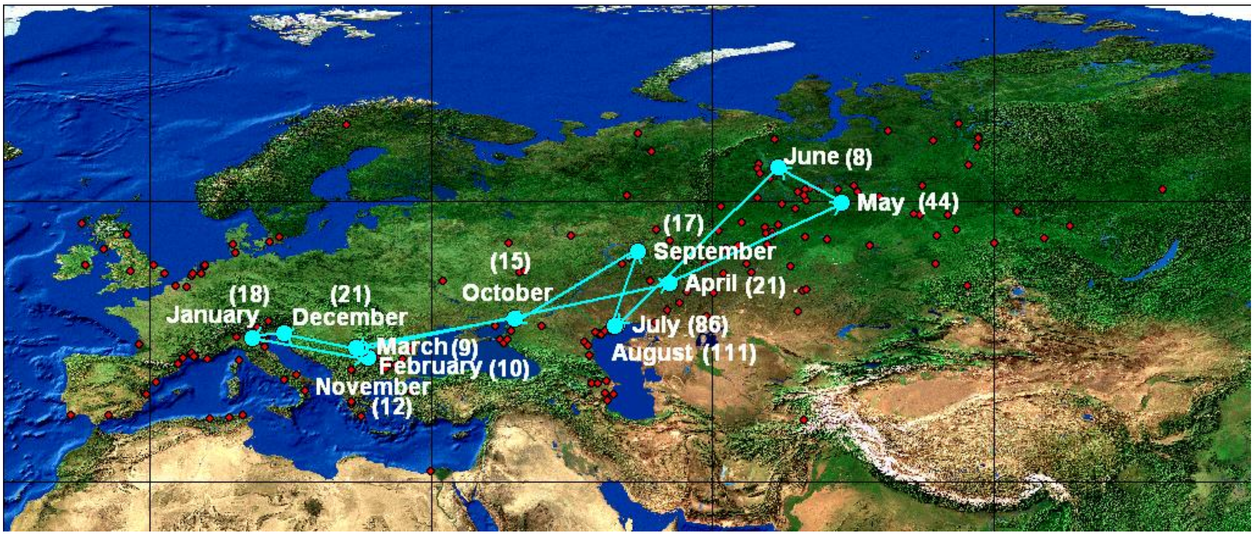


Figure 186. Mean monthly locations of Wigeon control points for birds, ringed on the moulting grounds in the Volga River Delta. Blue-green large circles are mean monthly locations of Wigeons. Arrows show directions of movements. Purple dots are ringing sites, red dots – recovery points. Number of control points in each month is in parentheses.

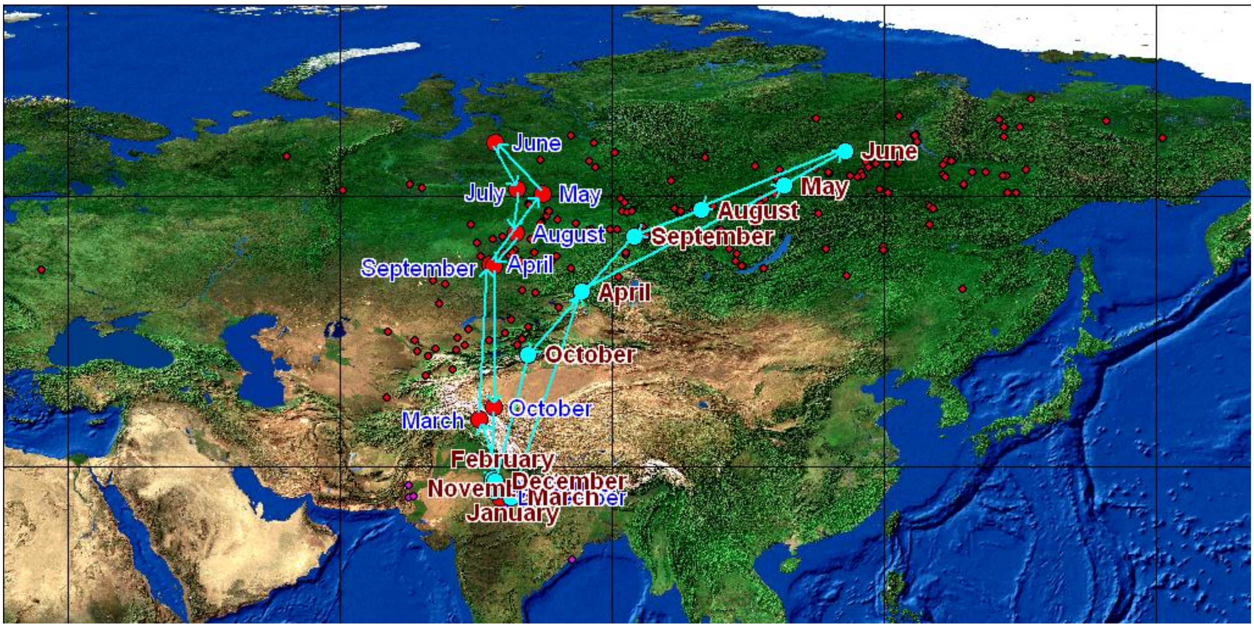


Figure 187. Mean monthly locations of Pintails and Wigeon control points for birds, ringed on the wintering grounds in India and Pakistan. Blue-green large circles are mean monthly locations of Wigeons. Arrows show directions of movements. Number of control points in each month represented in parentheses. Purple dots are the ringing sites, red dots – recovery points. Red large circles represent mean monthly locations in Pintails, ringed in India, Pakistan and Bangladesh.

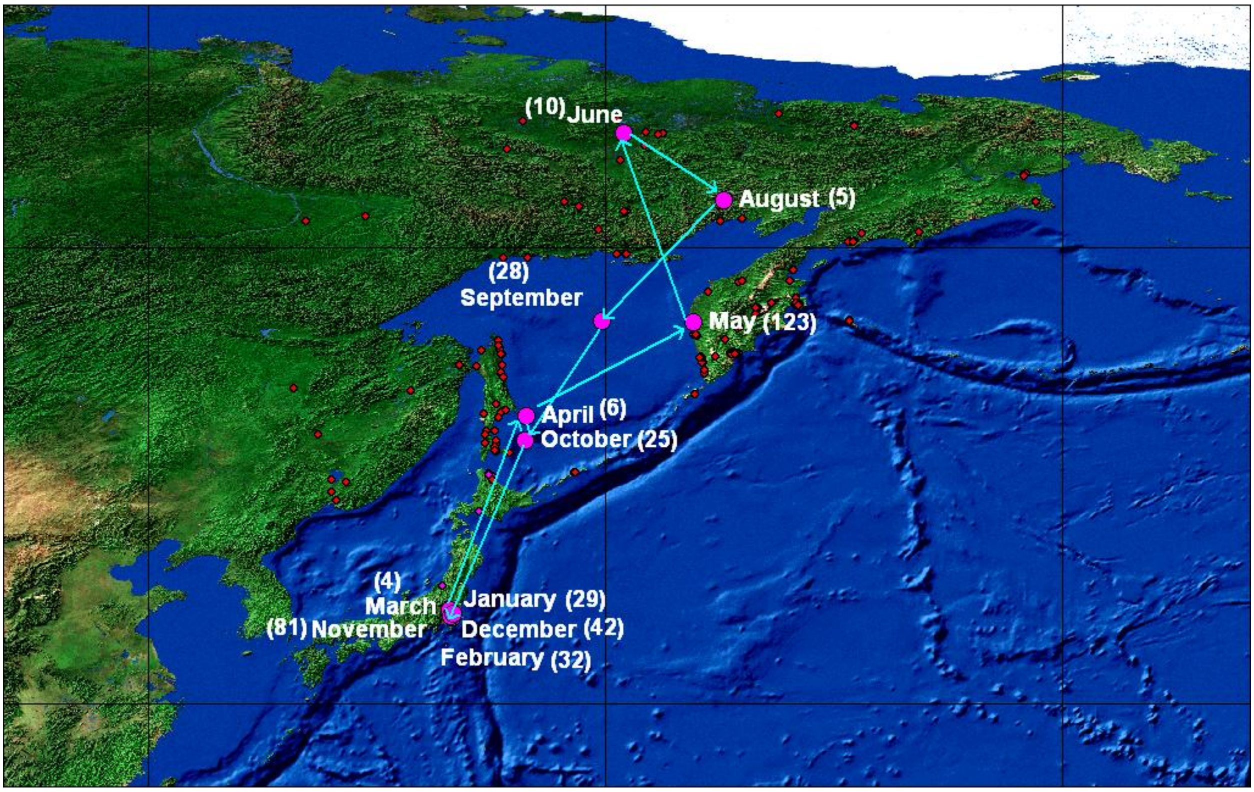


Figure 188. Mean monthly locations of Wigeon control points for birds, ringed on the wintering grounds in Japan. Purple large circles are mean monthly locations of Wigeons. Arrows show directions of movements. Number of control points in each month is represented in parentheses.

Summarising all about migratory routes, we can outline spring and autumn Wigeon migratory movements (Figs 189 and 190). Wigeon is the same northern breeding bird as Pintal. In distinction to Mallards and Pintails, during spring migration Wigeons do not use the „southern gate" from Europe to Western Siberia; they fly directly over the Ural Mountains. However, on autumn migration Wigeons bend the southernmost end of Urals. In distinction to Pintails, migratory routes in Wigeons are more stretched along west-east direction.

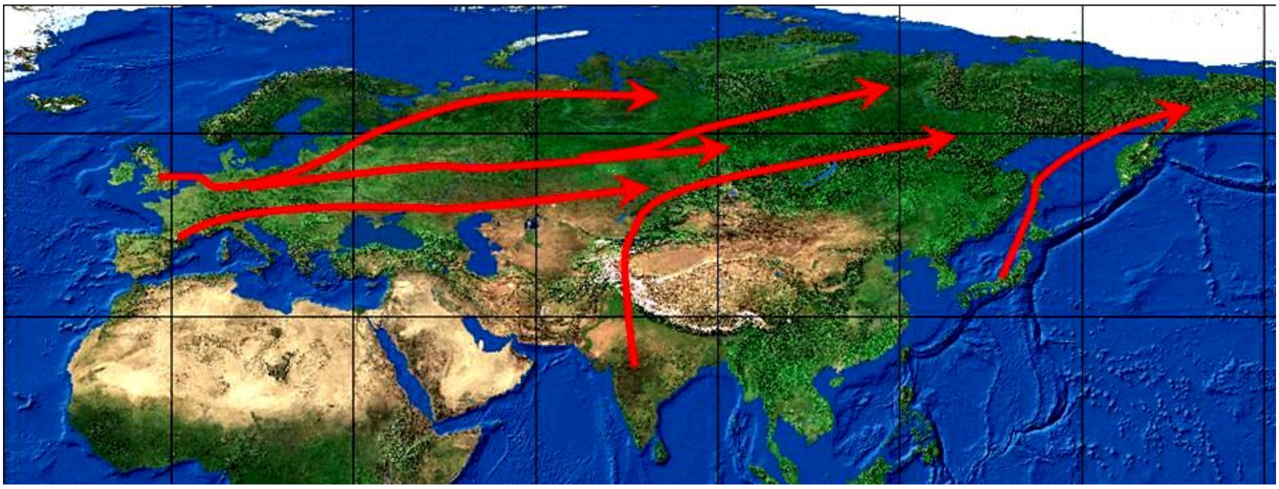


Figure 189. Outline of spring migratory routes for Wigeons. Red arrows – directions of migratory movements.

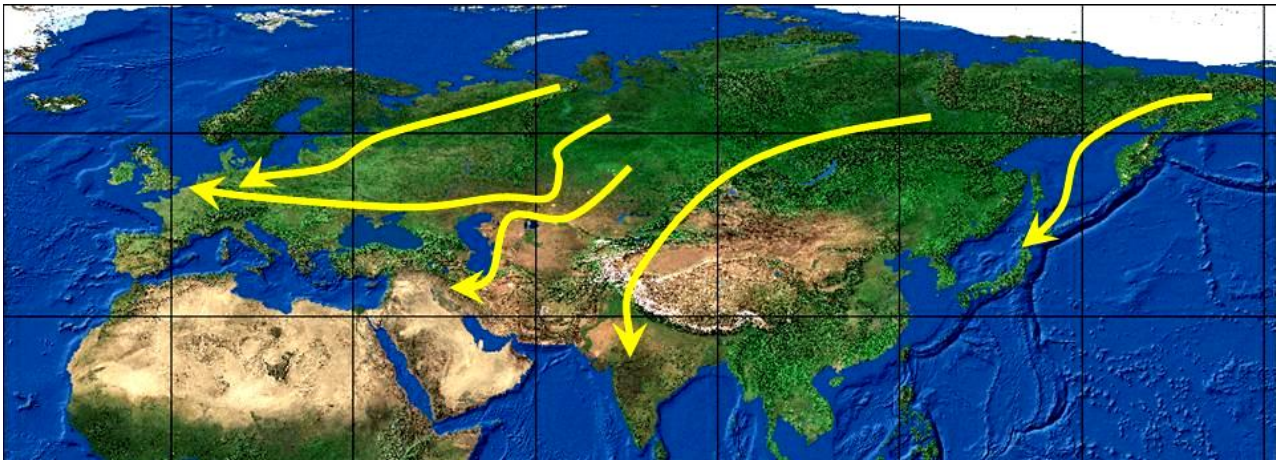


Figure 190. Outline of autumn migratory routes for Wigeons. Yellow arrows – main directions of migratory movements.

The same as in the White-fronted Goose, Mallards, etc., there can be a question why Wigeonss usually do not cross Ural Mountains on autumn migration, although these mountains are not high. This regularity is also valid to many other duck species. The reason for this could be the historical one: when Glacier Age was finishing, Ural Mountains were covered by glacier much longer time than the Central Russian Plain and West Siberian Lowlands. However, Wigeons seem to be better fliers than Mallards and Pintails (see also section "Speed"), and in spring, when many birds try to arrive to the breeding grounds as fast as possible, Wigeons cross Ural Moutains.

Speed. Bird Ringing Centre of Russia database contains several Wigeon direct recoveries with high speed of flight. Highest speed of movements is detected in thebird with the ring of the „Sevilla Biol. Donana" Scheme N 1 232. 2-year male ringed 03.05.1967 in Spain, on 08.05.1967 was shot in Yamalo-Nenetskiy Autonomic Area (ring sent). The duck covered 5457 km in 5 days or 1091 km per day. The original letter is available, no reason to doubt this recovery, especially knowing that Wigeons quite often fly several hundreds km per day. However, Wigeons could cover the maximal migratory distance quite slowly, during 45, 60 or more days. In the latter case they spend long time at stopovers (see above).

Populations. As it is shown above, Wigeon is even more mobile duck than Pintail, therefore, Wigeon populations are larger than in Pintails, and the number of populations is lesser – only four ones. Bird Ringing Centre of Russia data allow outlining the following Wigeon populations: 1) iceland-all-european-west-central-siberian population (polygon No 1, Fig. 191) with generally west-east migratory movements; 2) south-european-middle-east-west-siberian population (polygon No 2, Fig. 191) with general north-east – south-west migrations; 3) indian-central-asia-west-central-eastern-siberian population (polygon No 3, Fig. 191) with north-eastern – south-western directions of migrations; 4) japanese-south-korea-eastern-china-far-eastern population (polygon No 4, Fig. 191) with north-south migratory movements.

All populations overlap, but not in great extent. Intergradations zone is located mostly in Western Siberia and, in the past, Volga River Delta. As in other dabbling ducks, long-distance cross-population movements exist. The longest of them are: from India to Latvia and from Italy to Yakutia.

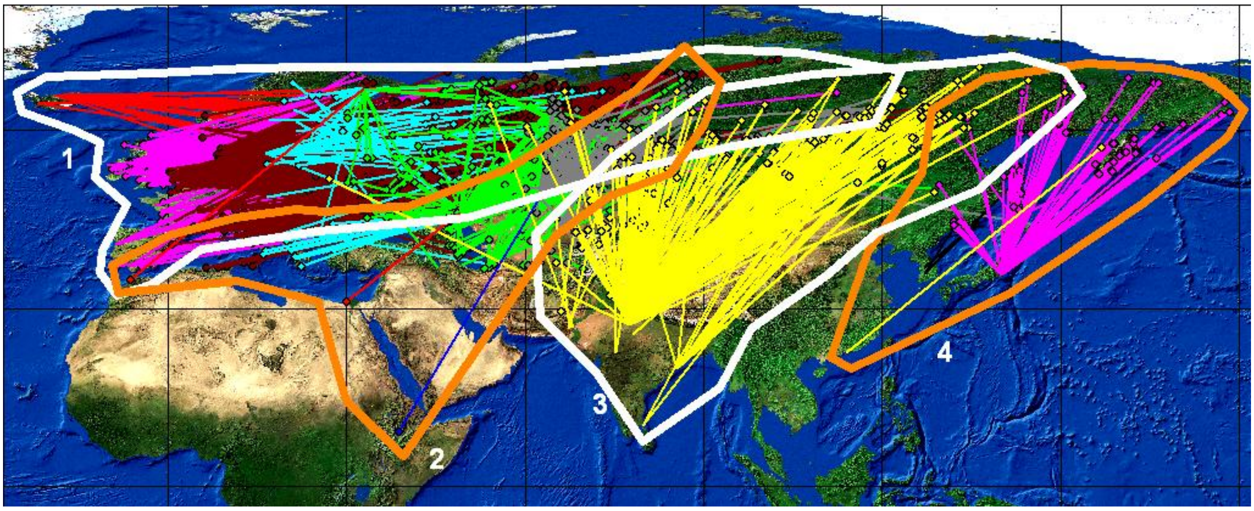


Figure 191. Wigeon populations. White polygon № 1 outlines iceland-all-european-west-central-siberian population. Light brown polygon № 2 is south-european-middle-east-west-siberian population. White polygon № 3 outlines indian-central-asia-west-central-eastern-siberian population. Light brown polygon № 4 shows the japanese-south-korea-eastern-china-far-eastern population.

Ten-year distances. Mean flight distance in all Wigeon recoveries fluctuates by decades, however demonstrates the tendency for increasing (Table 12). This tendency becomes more clear it we take only Wigeons ringed in the Netherlands, or in India and Pakistan. To reveal it more reliablly, we should combine some decades and compare. Mean distance for the period of 1927-1960 is 2598.9$\pm$41.6 km (N = 675), for the period of 1961-2023 is 3011.4$\pm$20.6 (N = 2723). Overall increase is more than 400 km, significant – t-Bailey = 8.9, P=0.0000.

Table 12. Wigeon mean flight distance per decade.

Decade (years)	1923-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2023
Distance (km)	3304.2	2556.1	2838.2	2550.4	2650.8	2947.7	3229.1	3124.0	3244.2	3270.2
Number of recoveries	14	61	76	524	662	697	475	331	298	243

Most birds were ringed at wintering and moulting places. As it is shown in species account of the Bewick's Swan, during global warming birds with permanent wintering place habituate more and more large area for breeding, flying more to the north or/and east. Thus, we observe the same process in the Wigeon.

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest Wigeon lived 35 years 2 months. This is the record from our database of the ring of „London" scheme AT 71 365 (ring sent).

Mortality rate. According to the common criteria (see "Materials and Methods") 3228 dead recoveries are applicable for the mortality rate analysis. Since the sample contains one very outstanding variant – 35 year old bird, whereas all others have elapsed years not more than 24, we should remove this variant from the sample. Mean annual mortality rate in Wigeon is 27.61$\pm$0.41%. Real mortality pattern differs from the theoretical one insignificantly (χ^2 = 1124, df = 22, P=0.0000). Programme MARK, Model CLogLog Hessian shows 28.46, difference is

0.85%. Wigeon mortality pattern chart shows some drawdown, but not deep (Fig. 192). It means that Wigeon species condition might be not bad.

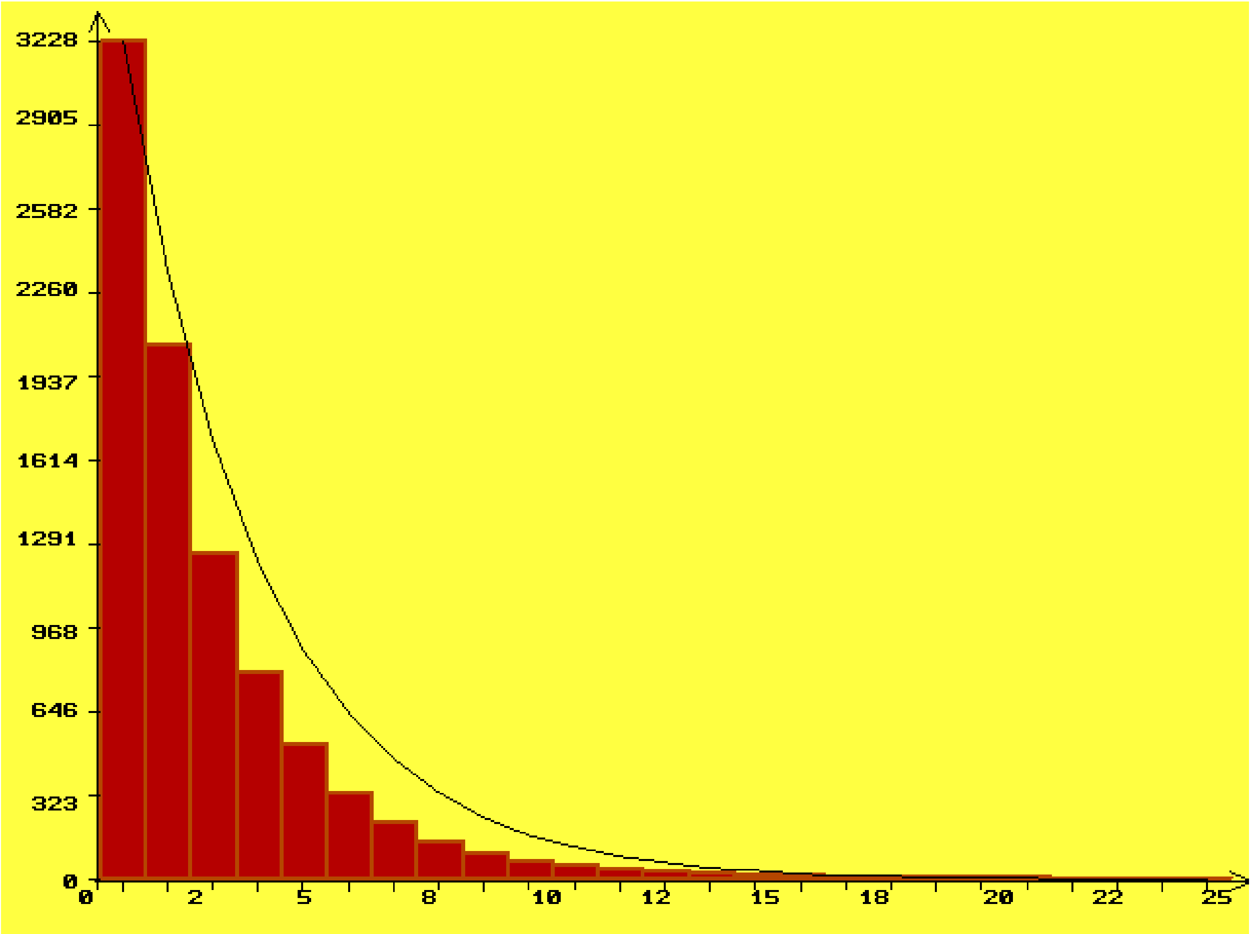
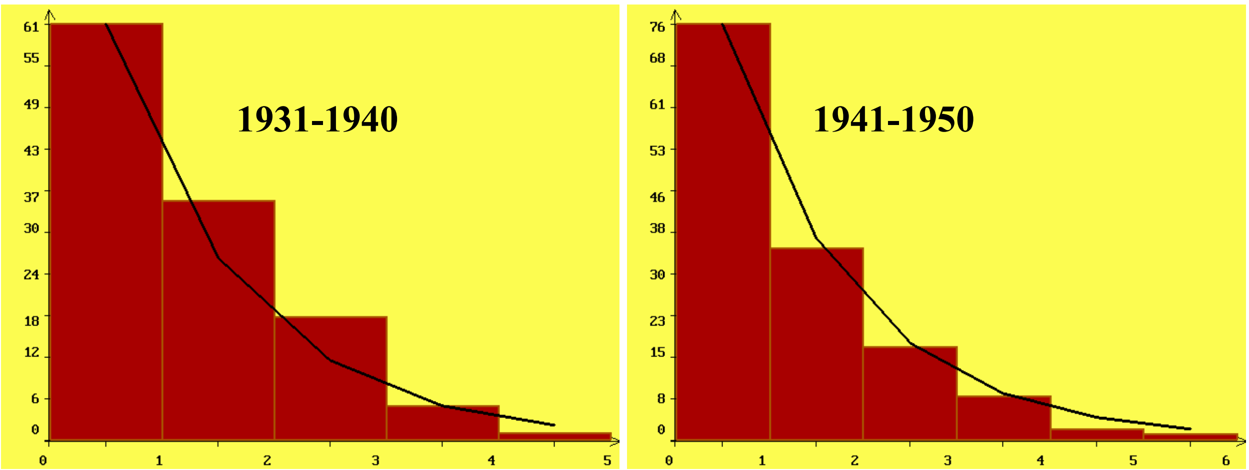
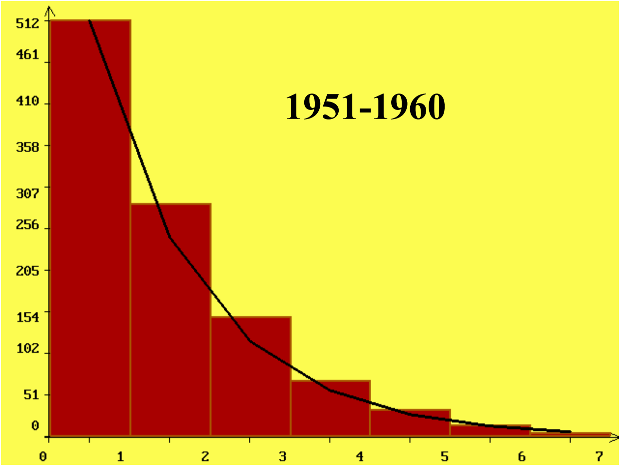
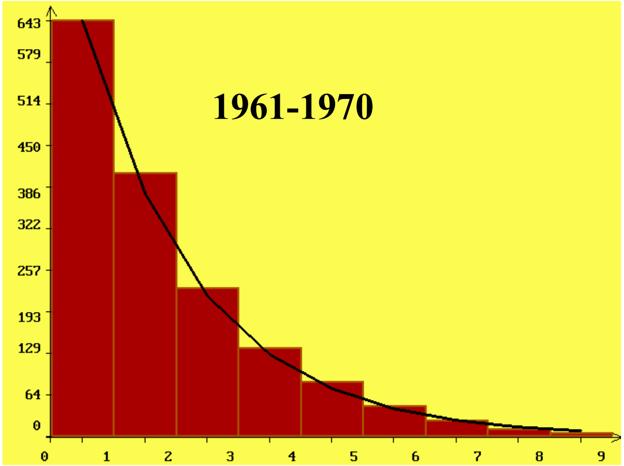


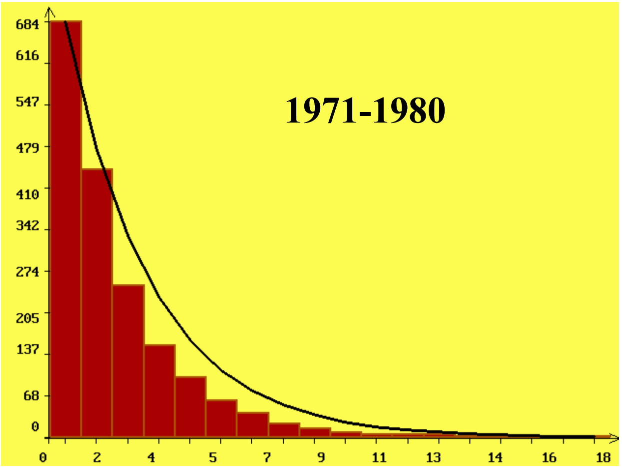
Figure 192. Mortality pattern in the Wigeon. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

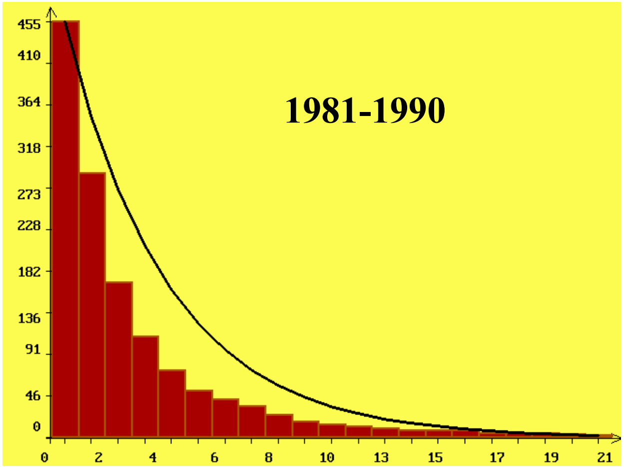
For 1930s and 1940s mortality pattern indicates good population (species) condition – real data are not very different from the theoretical line (Fig. 193: 1931–1940, 1941–1950). Situation continues to be good in 1950s and 1960s. Then, in 1970s species condition deteriorated, getting worse in 1980s, and then improved in 1990s and 2000s till the current moment (Fig. 193). Overall, Wigeon had never been in such bad situation as Pintail.




1951-1960
512
461
410
358
307
256
205
154
102
51
0
0 1 2 3 4 5 6 7


1961-1970
643
579
514
450
386
322
257
193
129
64
0
0 1 2 3 4 5 6 7 8 9


1971-1980
684
616
547
479
410
342
274
205
137
68
0
0 2 4 5 7 9 11 13 14 16 18


1981-1990
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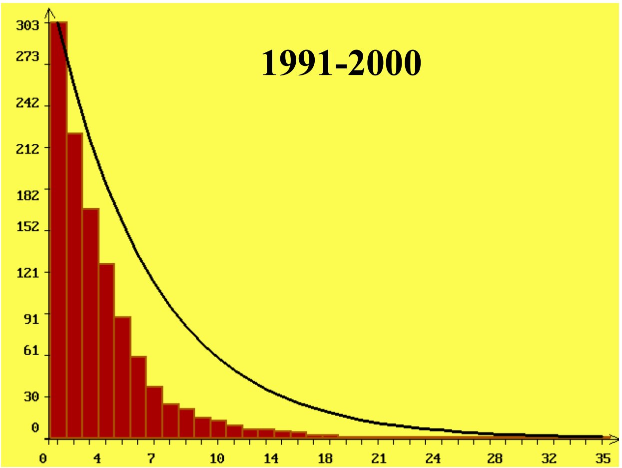
410
364
318
273
228
182
136
91
46
0
0 2 4 6 8 10 13 15 17 19 21


1991-2000
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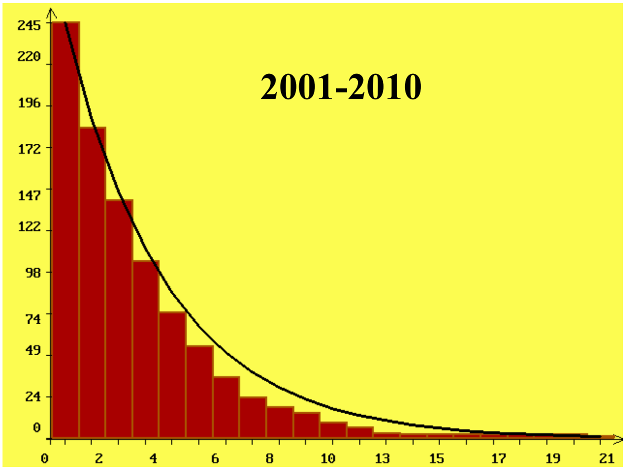
273
242
212
182
152
121
91
61
30
0
0 4 7 10 14 18 21 24 28 32 35


2001-2010
245
220
196
172
147
122
98
74
49
24
0
0 2 4 6 8 10 13 15 17 19 21

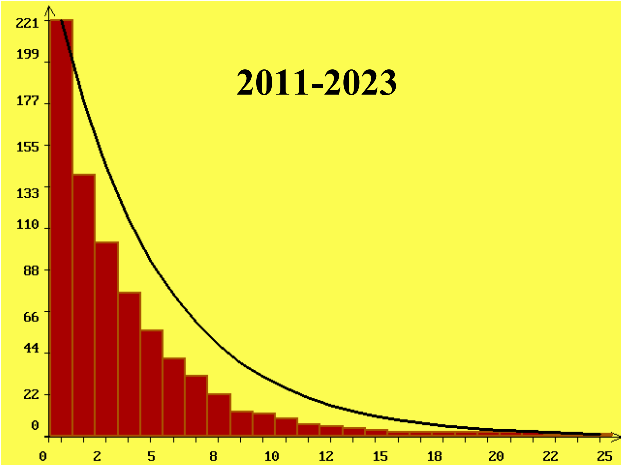


Figure 193. Mortality pattern in Wigeons recovered in different decades. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, males live slightly significantly longer than females: 2.45±0.06 (N = 1844) and 2.12±0.07 (N = 1016) years respectively (t-Bailey=3.38, P=0.0007). Female overall annual mortality is lesser than in males: 24.19±0.66% and 28.95±0.57% respectively. Shorter life makes mortality pattern in females worse (deeper drawdown on the mortality pattern) than in males, because the chat drawdown in females is greater (Fig. 194).

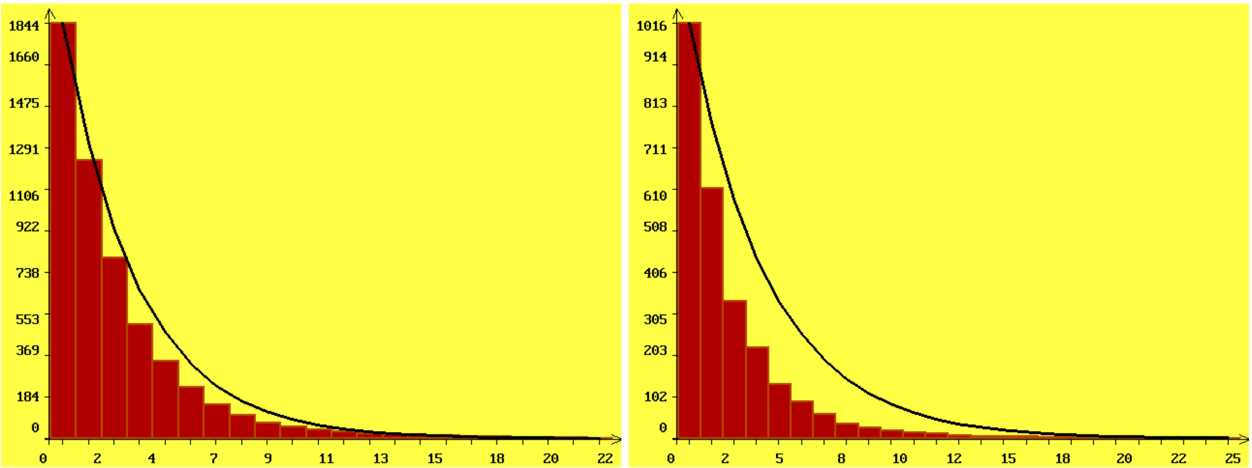


Figure 194. Mortality pattern in Wigeons: males (left) and females (right). X axis is the number of years after marking. Y axis is the number of live birds.

GADWALL
(*ANAS STREPERA*)

Breeding range in Eurasia. Brief description of the breeding range is in Fig. 195. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

Photo by Nadezhda A. Dorofeeva

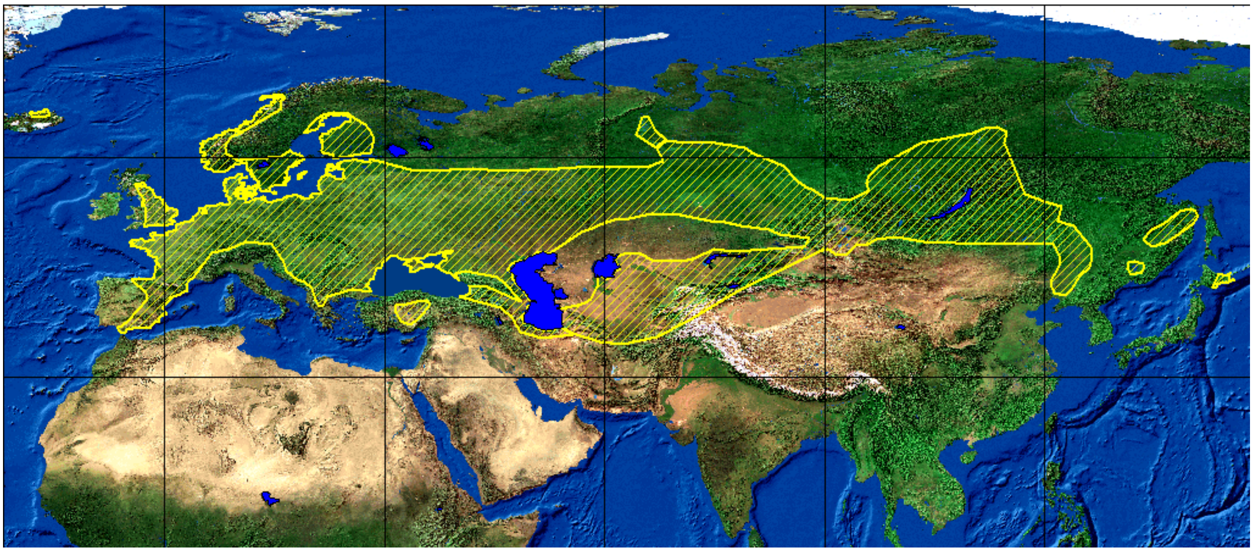


Figure 195. Breeding range of the Gadwall in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 667 recoveries from 667 marked birds have been used (Fig. 196). None of Gadwalls were marked with additional marks besides rings. Ringing dates are since 27.07.1927 until 10.09.2013, recovery dates are since 01.10.1928 until 09.08.2014.

This duck is not as common as many other dabbling ducks. During recent years their breeding range expanded northwards (Kouzov, Kravchuk, 2012). Probably this caused a number of recoveries far to the north outside of the species breeding range (Fig. 195).

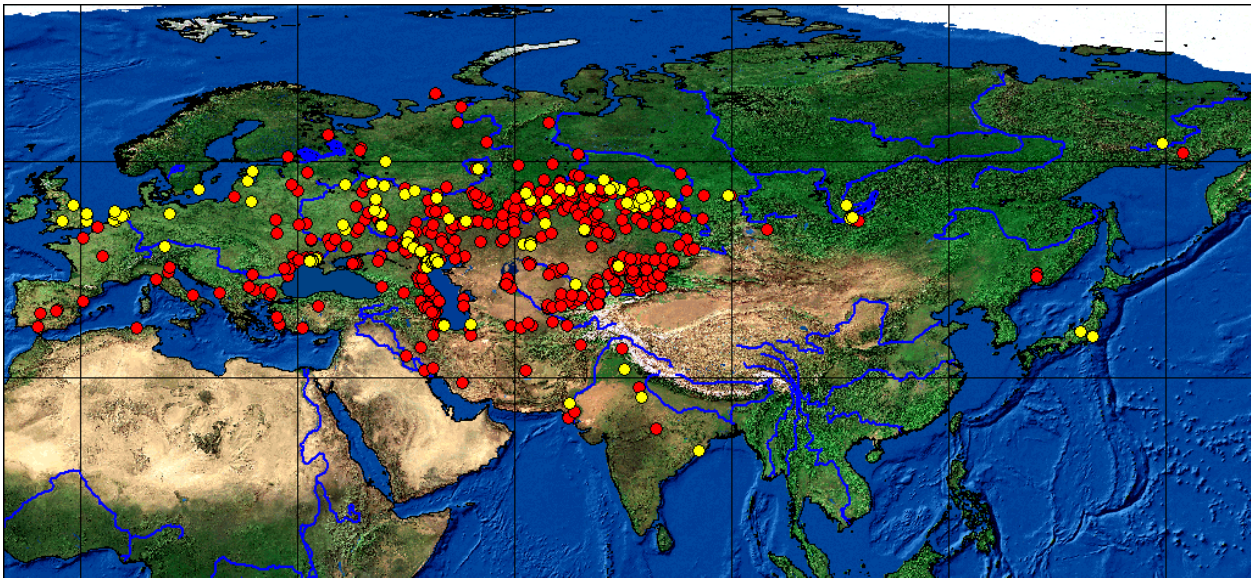


Figure 196. Position of all Gadwall control points. Yellow dots are ringing sites, red dots are recovery sites.

Most of Gadwalls were ringed in Europe and Western Siberia, most of recoveries were from those areas, eastern Trans-Caucasus, Kazakhstan, Central Asia. Small amount of Gadwalls ringed near Baikal Lake and on wintering grounds in Japan, recovered not far from those ringing sites. Ringing data from the eastern part of the breeding range are very fragmentary.

'Moskwa' scheme recoveries. This sample contains 465 recoveries of the scheme „Moskwa". They are from birds ringed within the Russian Federation and countries of the former USSR (Fig. 197). About a half of these birds (233 recoveries) were ringed in the former huge moutlting place in the Volga River Delta, where many duck species concentrated for moult. Now this moulting area does not exist any more for the reason of Caspian Sea level growth (Viksne et al, 2010).

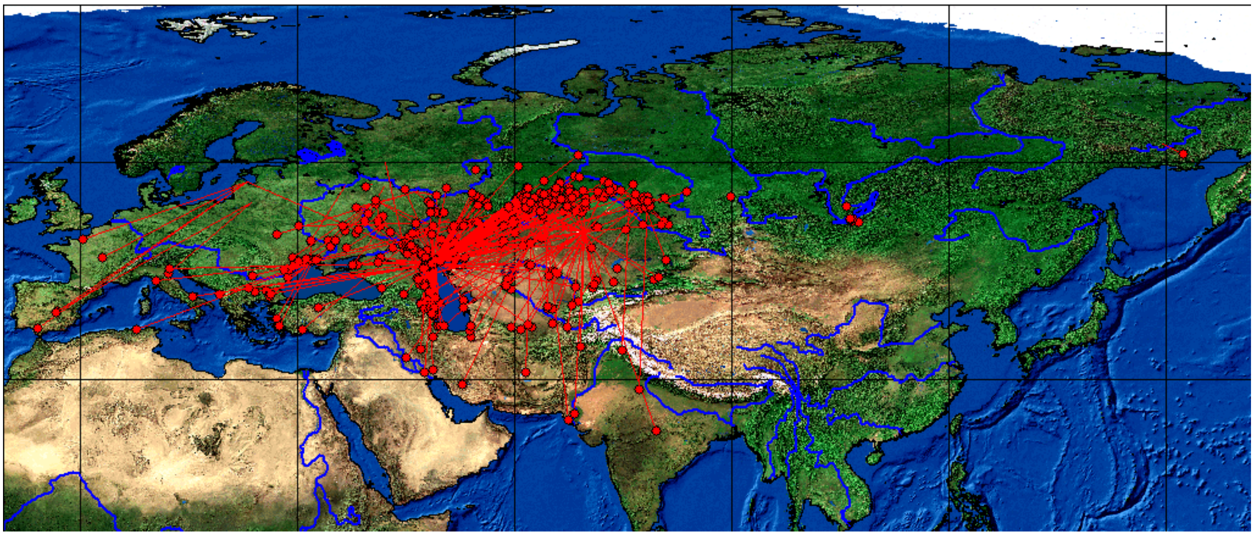


Figure 197. „Moskwa" scheme recoveries of the Gadwall. Here and in all other similar figures lines start from the ringing site, recovery sites are marked with red dots.

Finding details. This analysis includes all 660 recoveries. More than 2/3 of recoveries (70%) are „shot“. In 184 (28%) recoveries „details unknown“, which most likely mean they were shot, as well. Therefore, we can assume that near 98% of Gadwalls were shot. Other reasons are n[illegible] (Fig. 198).

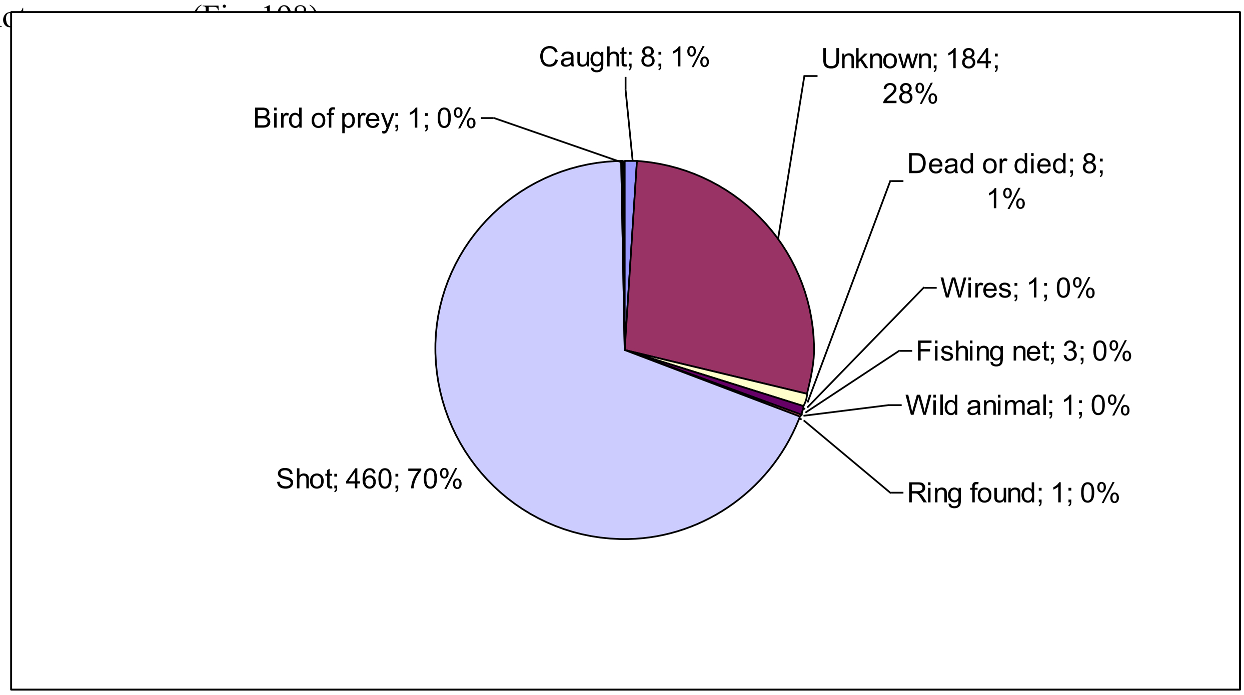


Figure 198. Finding details in the Gadwall.

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries look different (Figs 199 and 200).

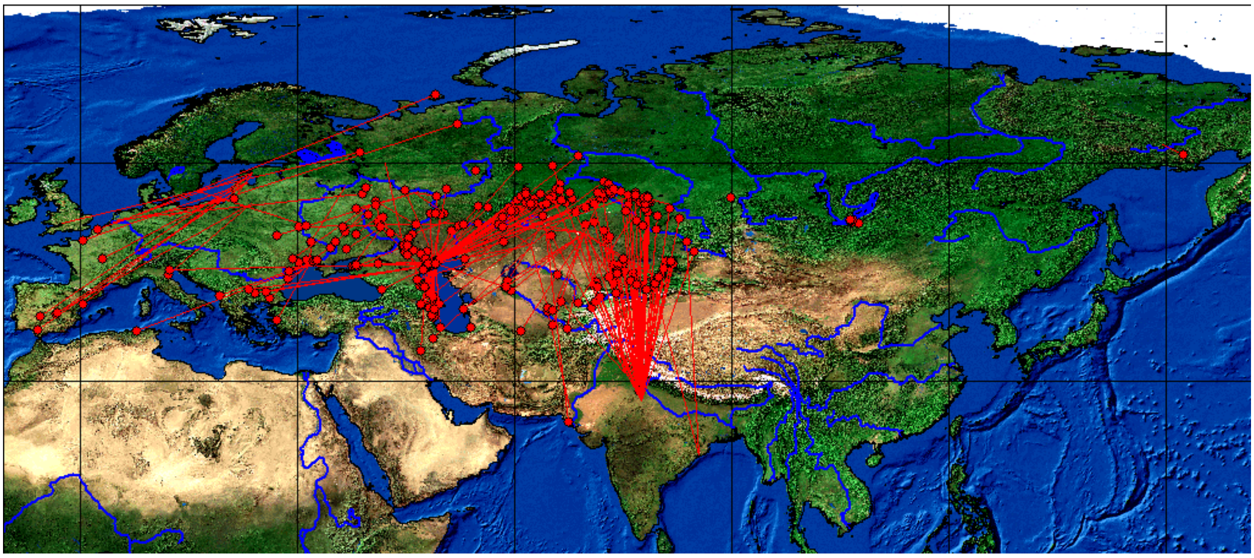


Figure 199. Map of the Gadwall direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

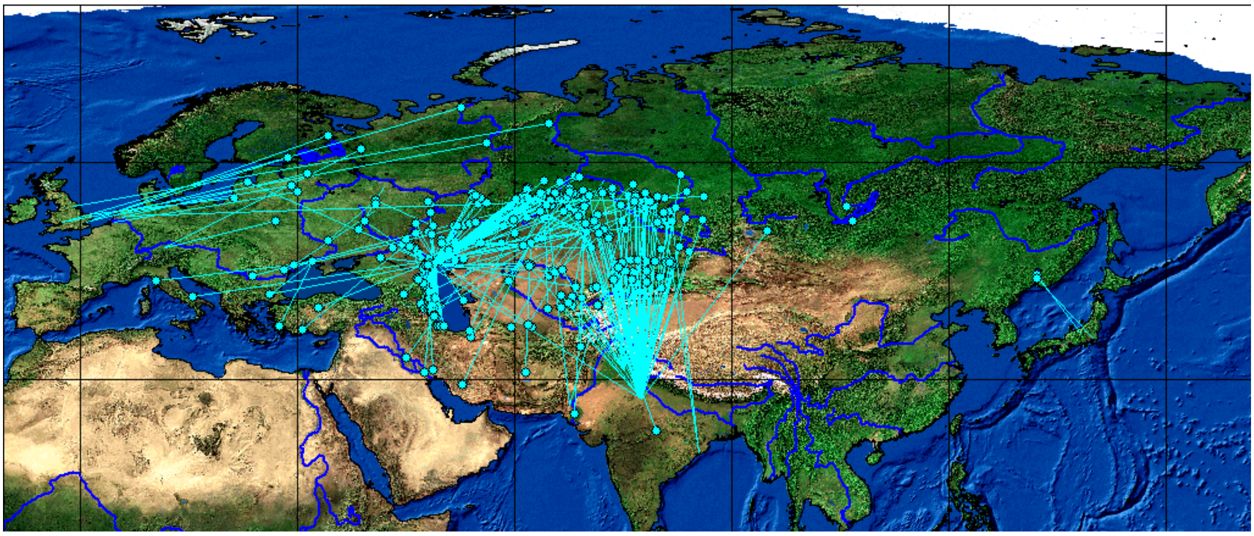


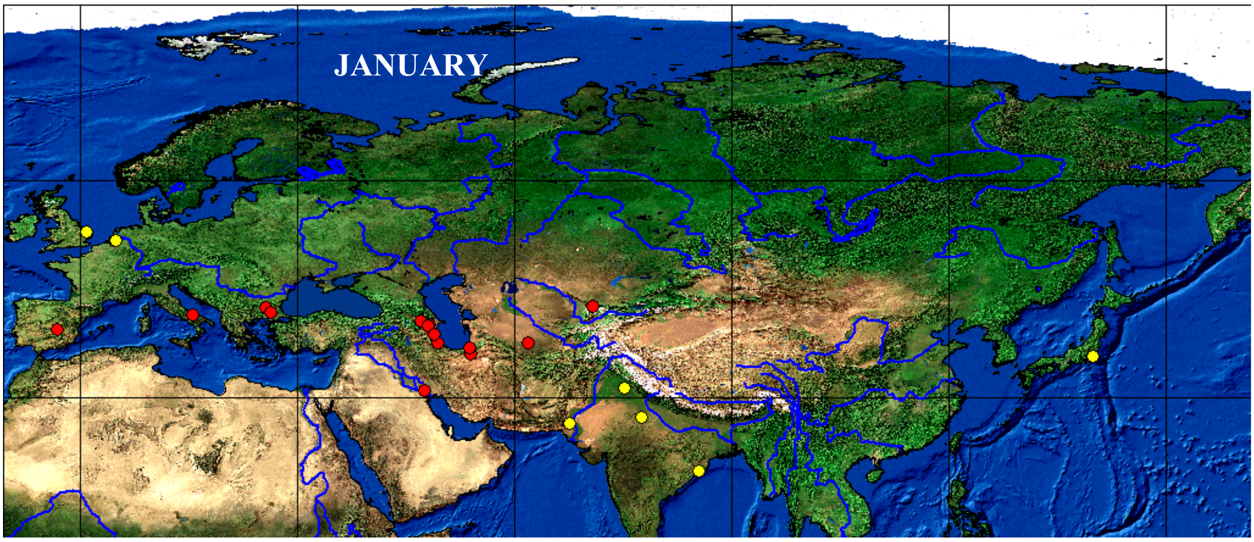
Figure 200. Map of the Gadwall indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

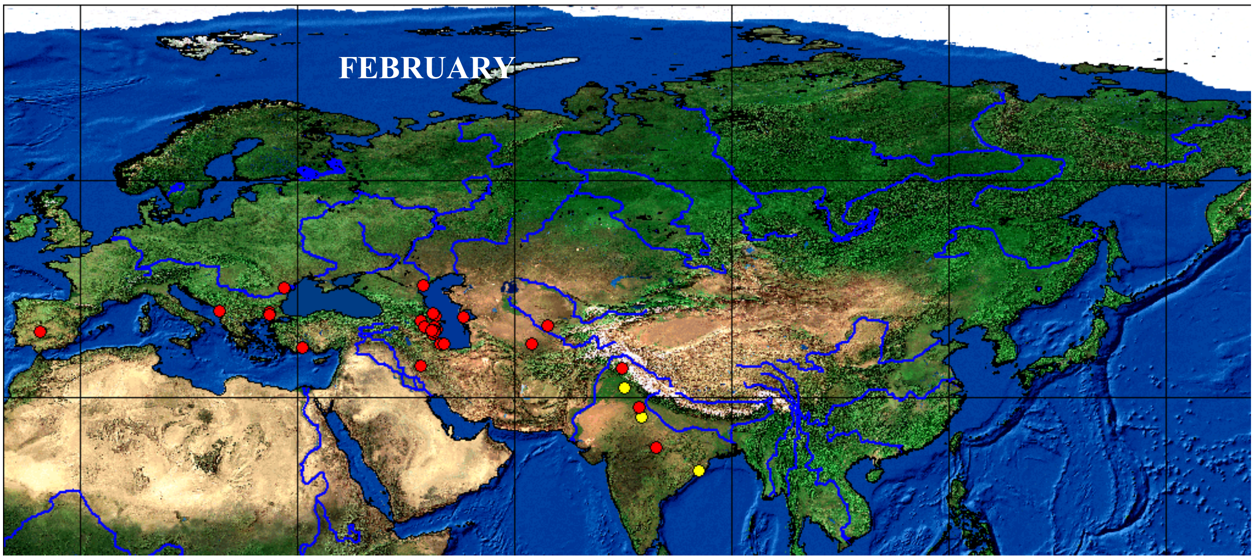
Maps show that Gadwalls, wintering in the northern part of Western Europe, fly to breed to the northern European Russia. Birds wintering in central and southern Europe breed in the southern half of the European Russia, and up to southern half of Western Siberia approximately up to meridian 75˚E (Fig. 199), slightly overlapping with birds having arrived from wintering grounds in India. The latter expands to the east, mostly till 85˚E. Birds from Japan fly to the nearest mainland area, Primorskiy Krai.

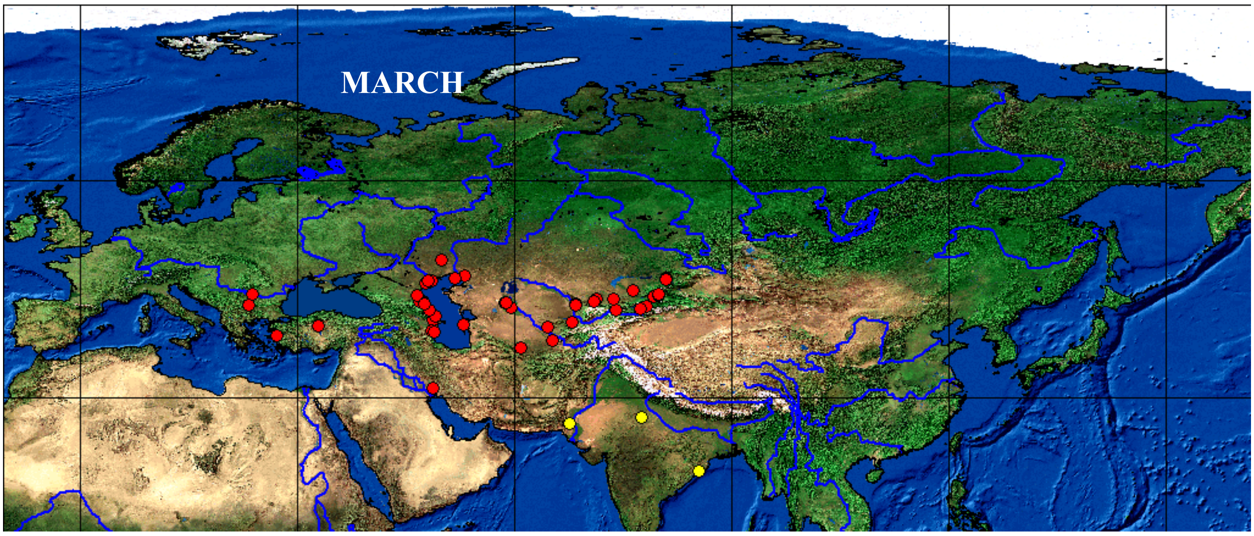
Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them (χ^2 = 6.32, 324 direct recoveries and 343 indirect ones, df = 2, P = 0.04). Really, the difference between centers of areas is 9‟ over the latitude and 2˚ 30‟ over the longitude (centre of indirect recoveries is more to the east). Average flight distances in direct and indirect recoveries are quite different: 1117.0$\pm$56.0 and 1404.9$\pm$52.9 km respectively. Mean distance of direct recoveries is significantly less by about 300 km – t-Bailey = 3.7, P=0.0002.

Monthly movements. All direct and indirect recoveries are included in demonstration of month-by-month movements. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in Gadwall (Fig. 201). We should note, that concerning Gadwall, as for all other waterfowl species accounts, we use only the data from the Bird Ringing Centre of Russia. However, in 2002 the article on the Gadwall migratory routes and some population parameters was written, where data from several European Ringing Centers, obtained via EURING DATA BANK, were used (Kharitonov, 2002a). Unfortunately, not all regularities of Gadwall migration (certainly, the same in other waterfowl, as well) can be revealed if we consider recoveries of only one ringing centre. It does not concern all regularities, e.g., the population structure analysis, after years, is possible to be performed in detail basing only on the Bird Ringing Centre of Russia data (see section "Populations"). However the possibility of revealing some regularities is poor due to lack of data. Therefore, in this species account we have added formation on migration features from that former study.

In January and February most ducks are on wintering grounds in the southern Europe, Transcaucasia, Iran, Central Asia, India, Pakistan and Japan. As it has been shown, autumn migration in Gadwalls, at least to the European wintering grounds, lasts as late as till March (Kharitonov, 2002a). First spring migratory movements, at least for western Caspian Sea wintering places, are detectable in February (compare maps of January and February, Fig. 201). In March migration starts from the Indian wintering grounds: there are two direct recoveries of ducks ringed in winter and recovered in March in Kyrgyzstan. March movements to the north are well noticeable for the western Caspian Sea area, as well. Southern European wintering Gadwalls likely have not started yet. In April migration is very active for all population, finishing in May. June – July birds are in the breeding and moulting areas. In July a great number of birds, males and non-breeding or failed females move to the moulting areas. This time is very convenient to catch and ring adult birds, and positions of the ringing sites (Fig. 201, July) show that Gadwalls, the same as other dabbling ducks (see species accounts), move close to the wintering areas for moult. In August and September many birds are still on breeding grounds, but the northern boundary of recovery area shrinks to the south. This occurs because in May and June there are a number of recoveries to the north of the of the breeding range boundary, in July and later no such recoveries exist. Although most ducks fly in the direction to wintering grounds after moult, some birds perform the backward flights. They move off the wintering areas, again to the north and east in the direction to breeding areas; however they will not breed at that time. This feature has been found first in Gadwall (Kharitonov, 2002a). Anyway, later the north and north-eastward migration of Gadwall after breeding season has been confirmed by the direct observations on the Kurgalsky Peninsula, Baltic Sea (Kouzov, Kravchuk, 2012). In September Gadwalls occupy about the same area as in August. In September - October European wintering Gadwalls actively migrate to the southwest. In Siberia and Kazakhstan migration is much less pronounced in October: many ducks are still on the breeding grounds. In November European birds, as well as the Asian ones, are still on migration, but the former are much closer to the wintering grounds that the latter. In December most birds are on wintering grounds, however, some Caspian Sea wintering birds still migrate (Fig. 201, December, January).



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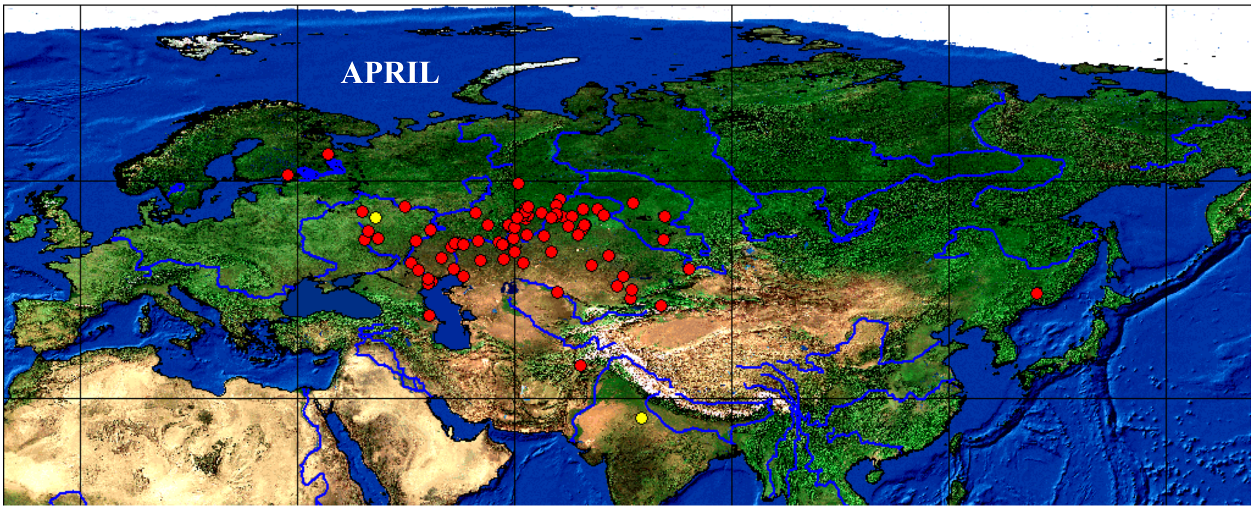
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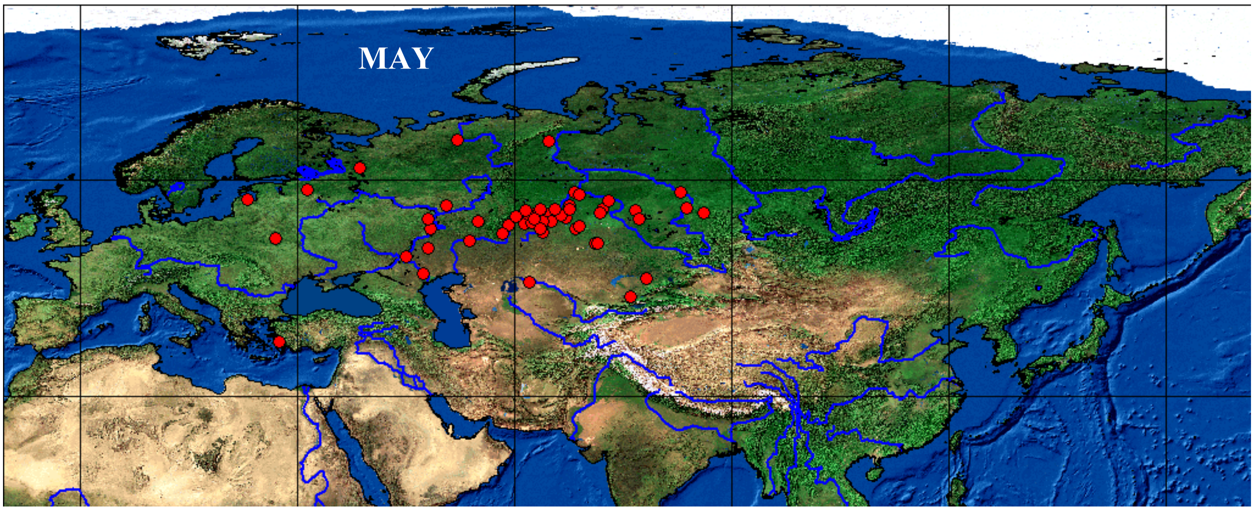
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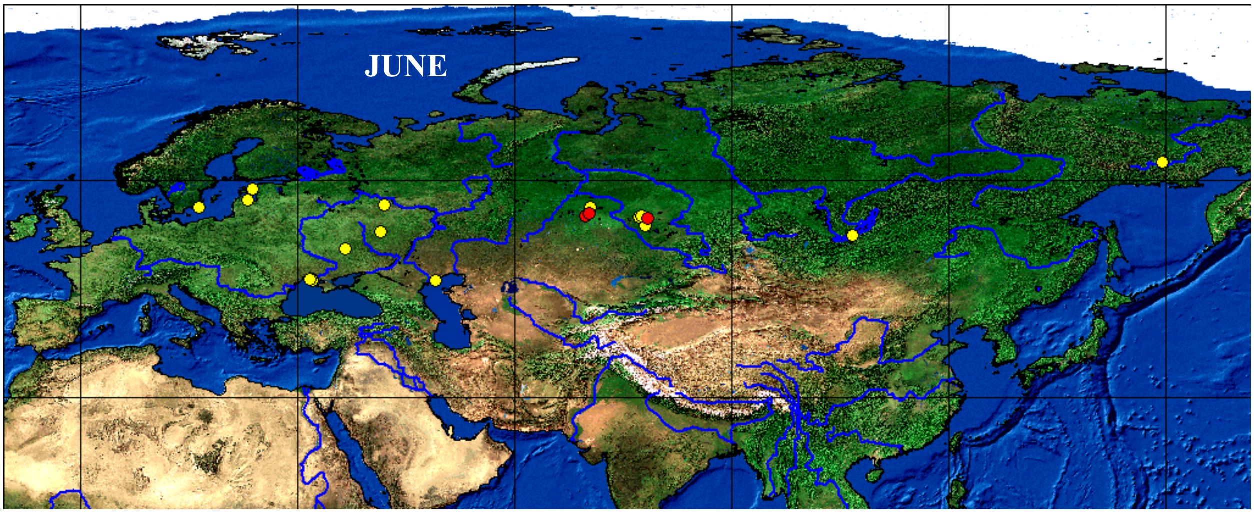
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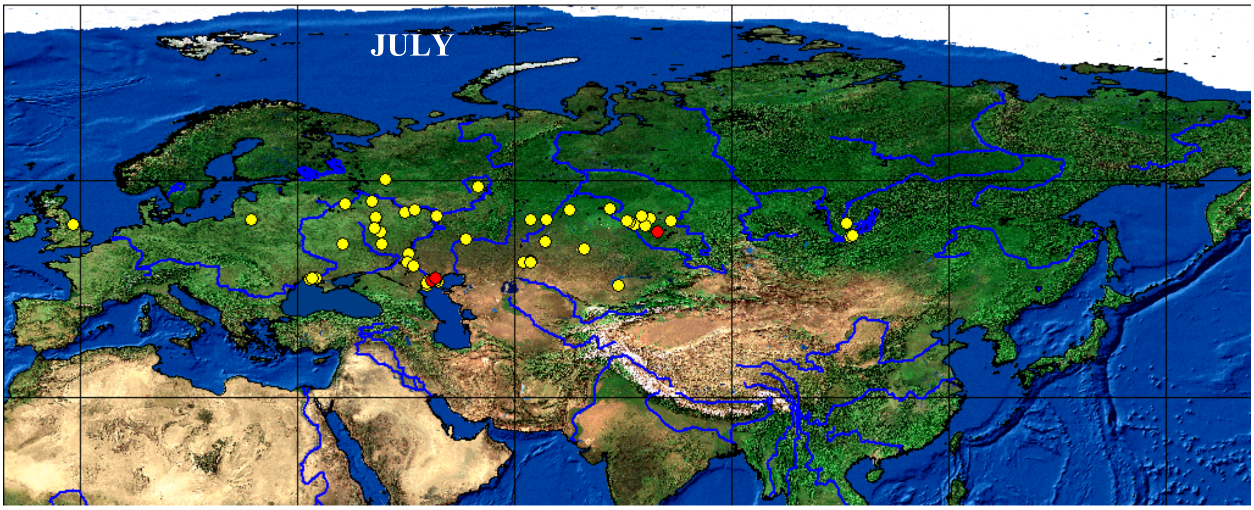
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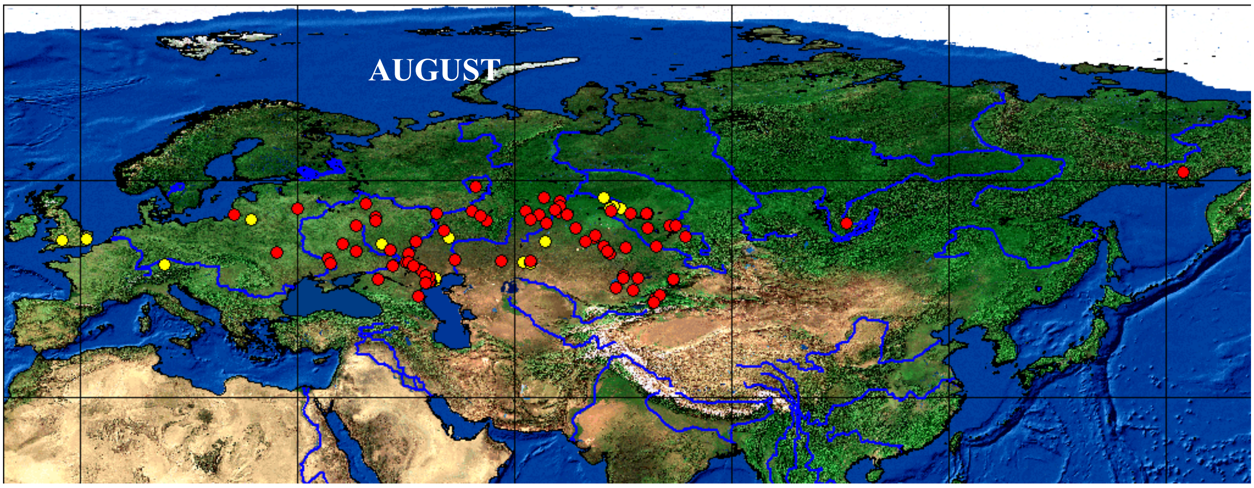
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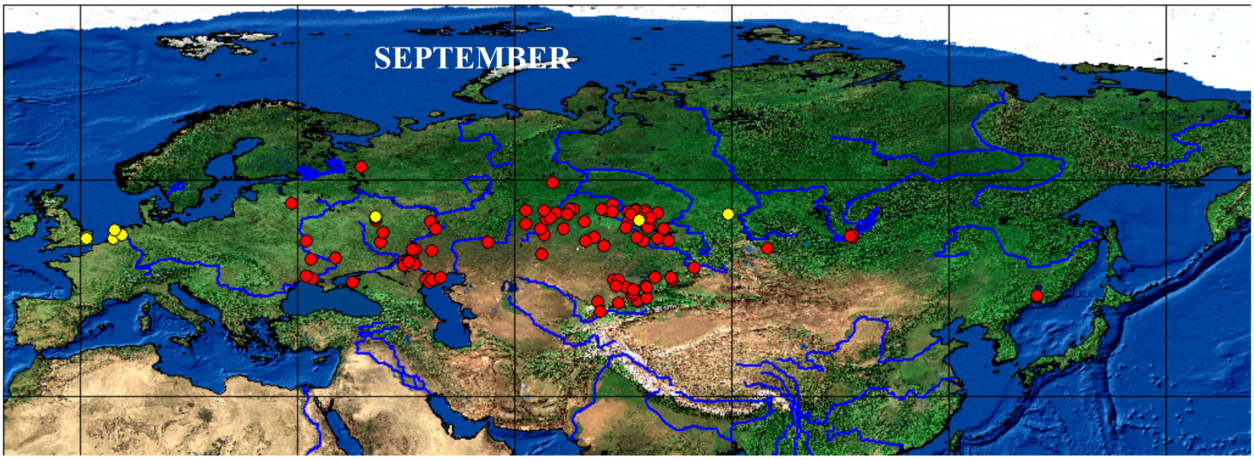
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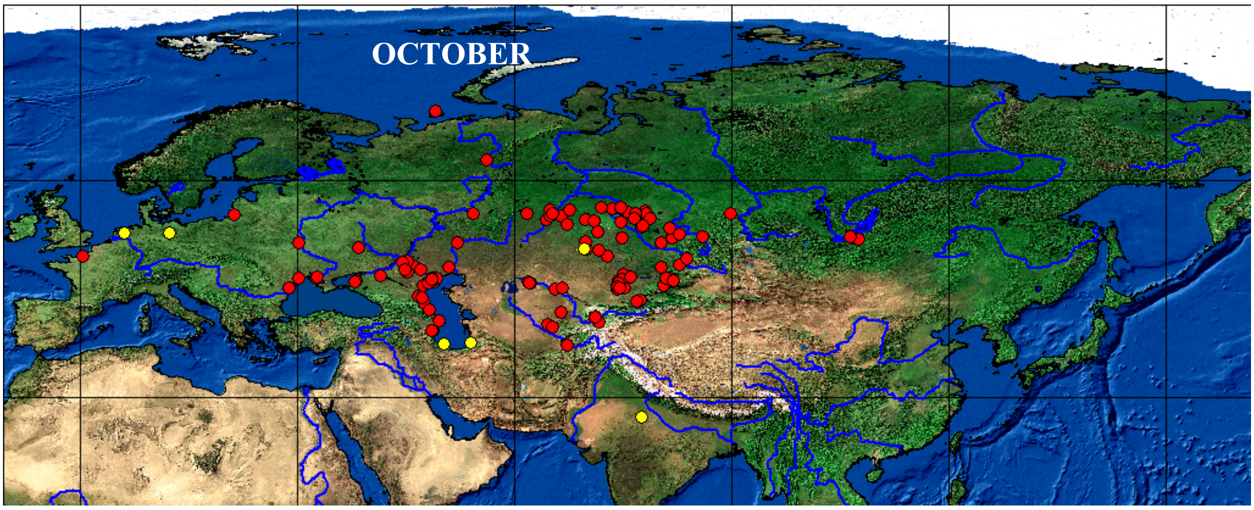
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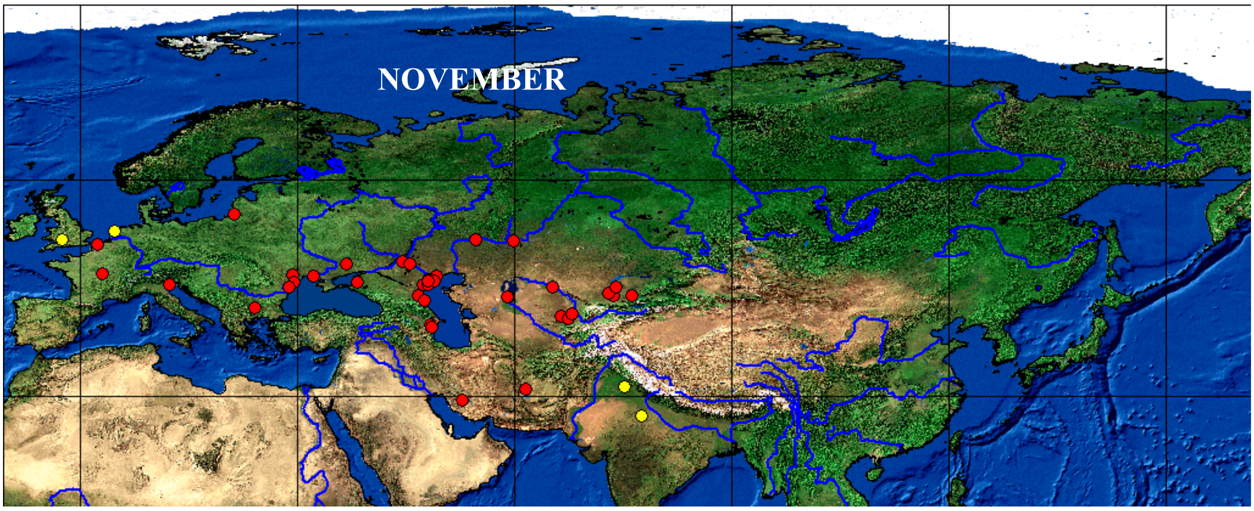


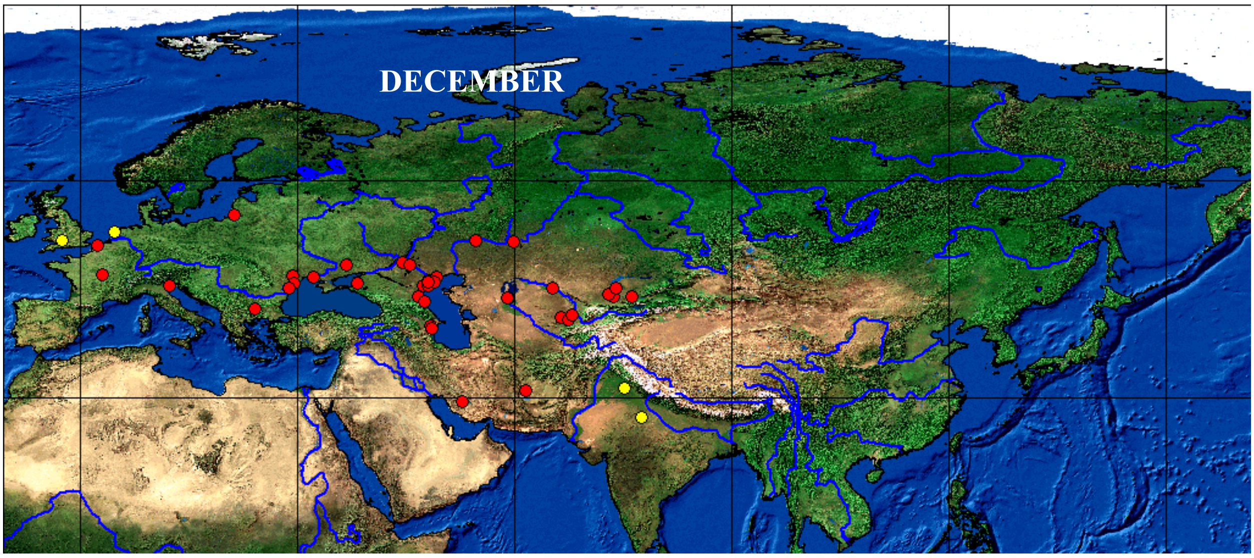


Figure 201. Gadwall monthly movements. Yellow dots are ringing sites, green dots are recovery sites.

Migratory routes. As it has been preliminary shown in the section "Monthly movements", Gadwalls from different wintering areas migrate to different directions. As we see in Fig. 202, migration directions of Gadwalls, ringed at longitudes less than 60˚ differs from those of all other dabbling ducks. Birds ringed in areas with longitude <=30˚E move to the north-east in spring (bearings 37-82˚, Fig 202), and in 218-248˚ direction in autumn. For birds ringed in area with longitude 30˚-60˚E preferable flight bearings are 37-68˚ in spring and 172-188˚ in autumn. The point is that, within 30˚-60˚E the Volga Delta ringing site is located where most of the ringing was performed. Those bearings indicate the following migratory routes. Birds from the wintering area near the south-western corner of the Caspian Sea (see winter concentration of recoveries on monthly maps) in spring fly to the north along western Caspian Sea coast till the Volga Delta and then, generally, turn to the north-east to Western Siberia. On the autumn migration Gadwalls gather in the Volga Delta, and then turn to the south. This shows that Gadwalls do not fly across the Caspian Sea; they prefer to migrate along the coasts, bending the sea over its north-western corner. For those ringed within 60˚-90˚E preferable bearings are directly to the north, i.e., 352-22˚, and opposite in autumn (Fig 202).

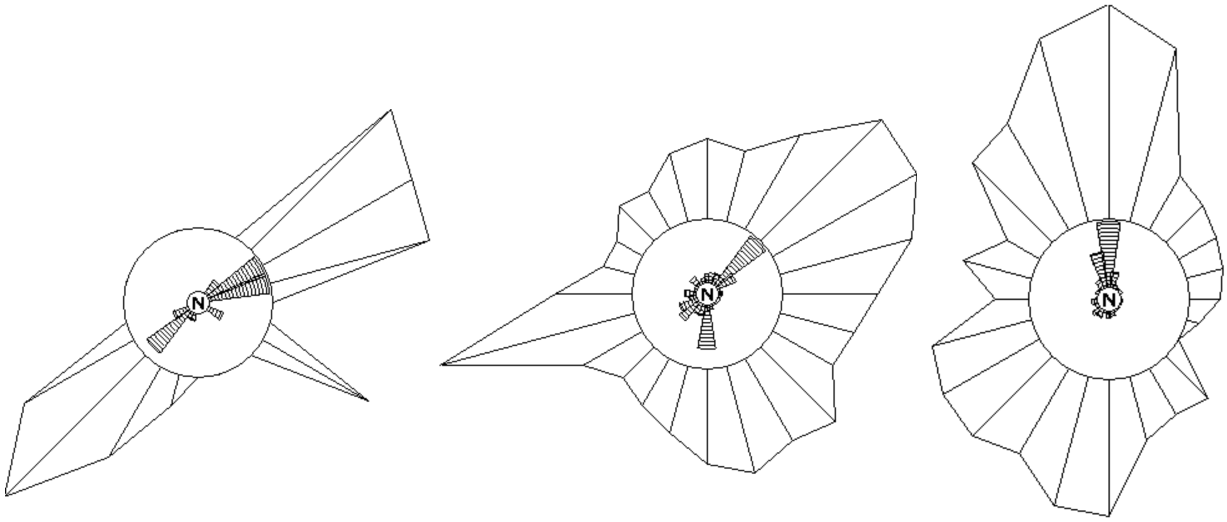


Figure 202. Recovery rose graphs for Gadwalls, ringed at different longitudes: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Left chart is for European wintering birds, area of recoveries from European Russia to western Siberia, to 85˚E. Sector = 15.0°; Total recoveries - 28; N in sectors: from 0 up to 7; Average distances in sectors: from 0.0 km up to 2637.3 km; the longest flight distance is 3700.5 km.

Central chart is for Gadwalls ringed in the southern European Russia, area of recoveries from European Russia to western Siberia, to 85˚E. Sector = 15.0°; Total recoveries - 308; N in sectors: from 2 up to 59; Average distance in sectors: from 223.2 km up to 1540.1 km; The longest flight distance is 2822.1 km.

Right chart is for Gadwalls ringed in the western Siberia, Central Asia, India and Pakistans area of recoveries from European Russia to western Siberia, to 85˚E; Sector = 15,0°; Total recoveries - 310; N in sectors: from 0 up to 93; Average distances in sectors: from 0,0 km up to 2483.7 km; The longest flight distance is 3726.5 km.

Preferable flight distances both for direct and indirect recoveries are 1ess than 3400 km, maximal distance in direct flights is 3652.8 km, in indirect recovery flights 3726.5 km (Fig. 203). The same as Mallards, large amount of Gadwall fly at very short distances, less than 100 km (see distance distributions in Mallard, Fig 239).

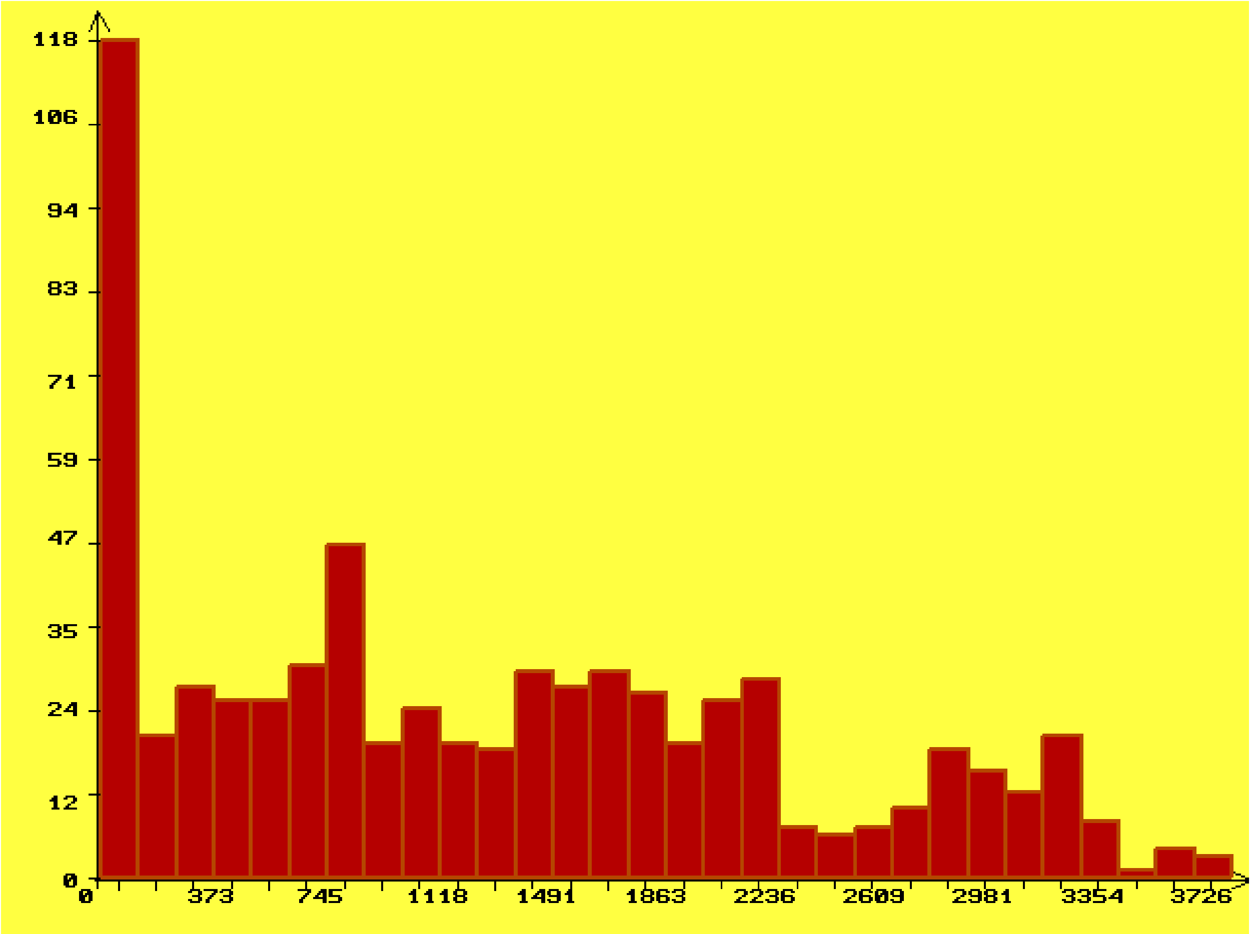


Figure 203. Distribution of all ring-recovery distances in Gadwall. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in Gadwall young birds (ringed as „pull" or „juv" or „1 y") is much less than in adults: 735.0±100.5 and 1350.0±40.6 km respectively (N_{young} = 98, N_{ad} = 568, t-Bailey=5.68, P=0.0000), which is characteristic for heavily hunted species. Male mean flight distance is by 180 km shorter than in females: 1423.2±50.6 and 1595.4±83.6 km respectively (N_{males} = 308, $N_{females}$ = 151), near significant (t-Bailei = 1.76, P=0.08).

Since the amount of data on Gadwall is not large, it does not worth plotting monthly means of Gadwalls, ringed in different places, because pictures are biased for the migratory route search. However, this method can help us in the population definition; because in that case accuracy of maps is enough, and bias in some monthly mean positions does not affect the result (see section "Populations"). Anyway, the information presented in sections "Direct and Indirect recoveries", "Monthly movements" and in the three recovery roses (Figs 199–202) seems enough to outline main Gadwall migratory routes (Figs 204 and 205).

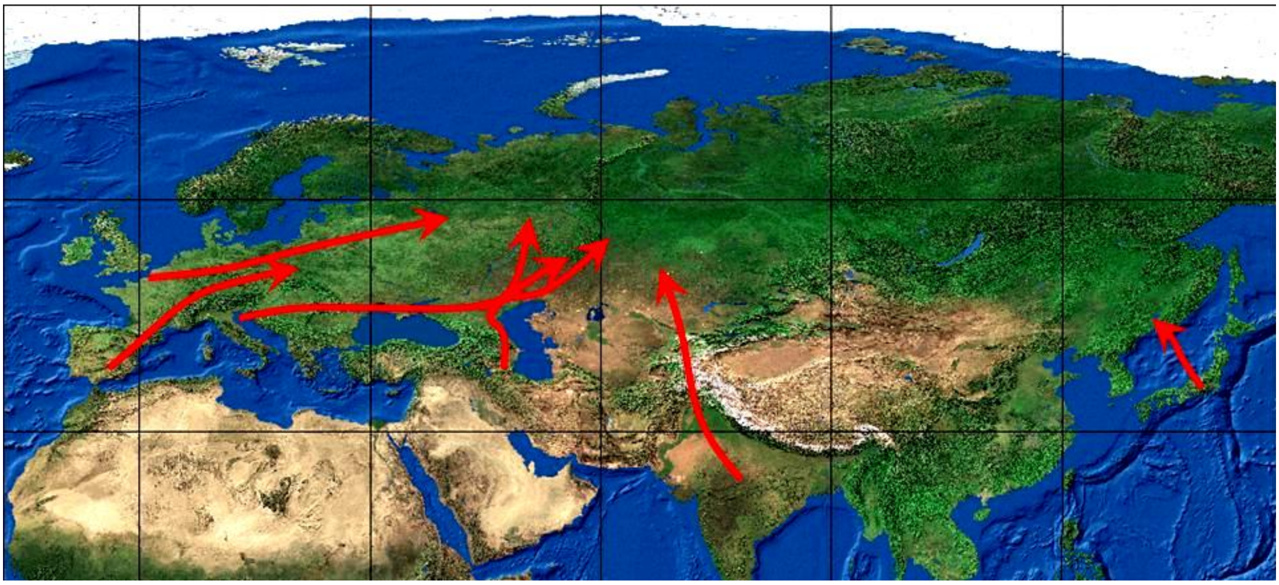


Figure 204. Outline of spring migratory routes for Gadwall. Red arrows are directions of migratory movements.

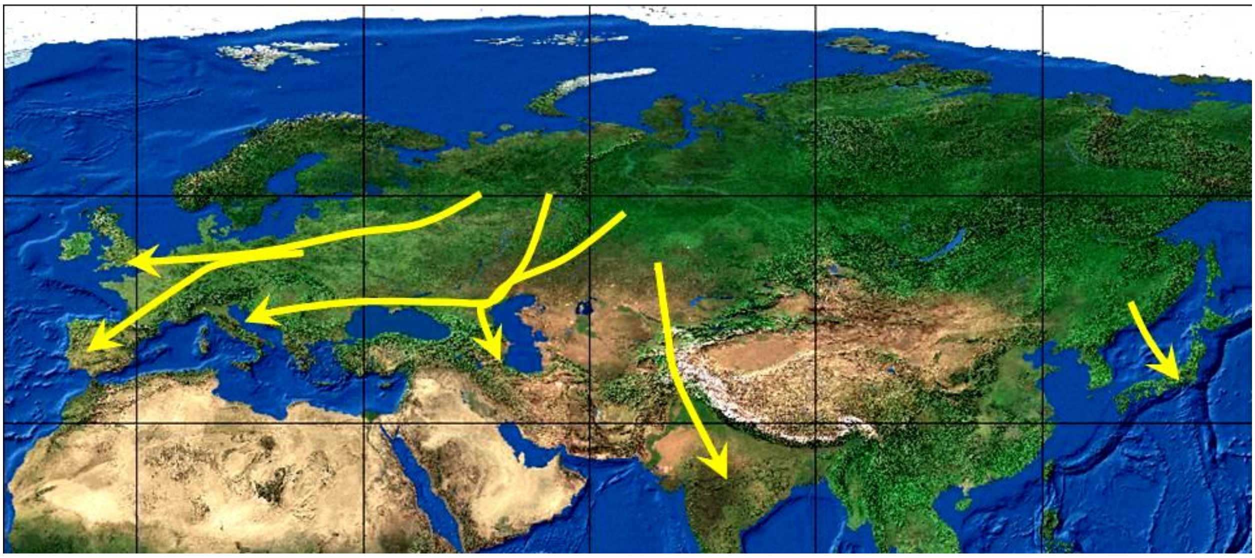


Figure 205. Outline of autumn migratory routes for Gadwall. Yellow arrows are main directions of migratory movements.

Speed. Bird ringing Centre of Russia database does not contain data on maximal possible speed of Gadwall migratory movements; the highest speed do not exceed 70 km per day. However, having data from several other ringing centers, we have defined maximal Gadwall speed as 342.6 km per day (Kharitonov, 2002a).

Populations. In this species one can expect stronger population isolation because Gadwalls migrate at relatively short distances in comparison with other dabbling ducks. In spite of the fact, that this time we have lesser amount of data than for writing article on Gadwall (Kharitonov, 2002a), now we have managed to reveal Gadwall population structure even in more detail than earlier.

Monthly means of Gadwalls, ringed in several regions: Kherson Region; Aktyubinsk Region, Kazakhstan; Akmola Region, Kazakhstan (Kurgaldzhinskiy Nature Reserve); Omsk Region together with Novosibirsk Region, Russia, have provided good information for the population separation. These monthly means allow imaging approximate distinctive lines between 3 of the 6 defined populations (Fig. 206).

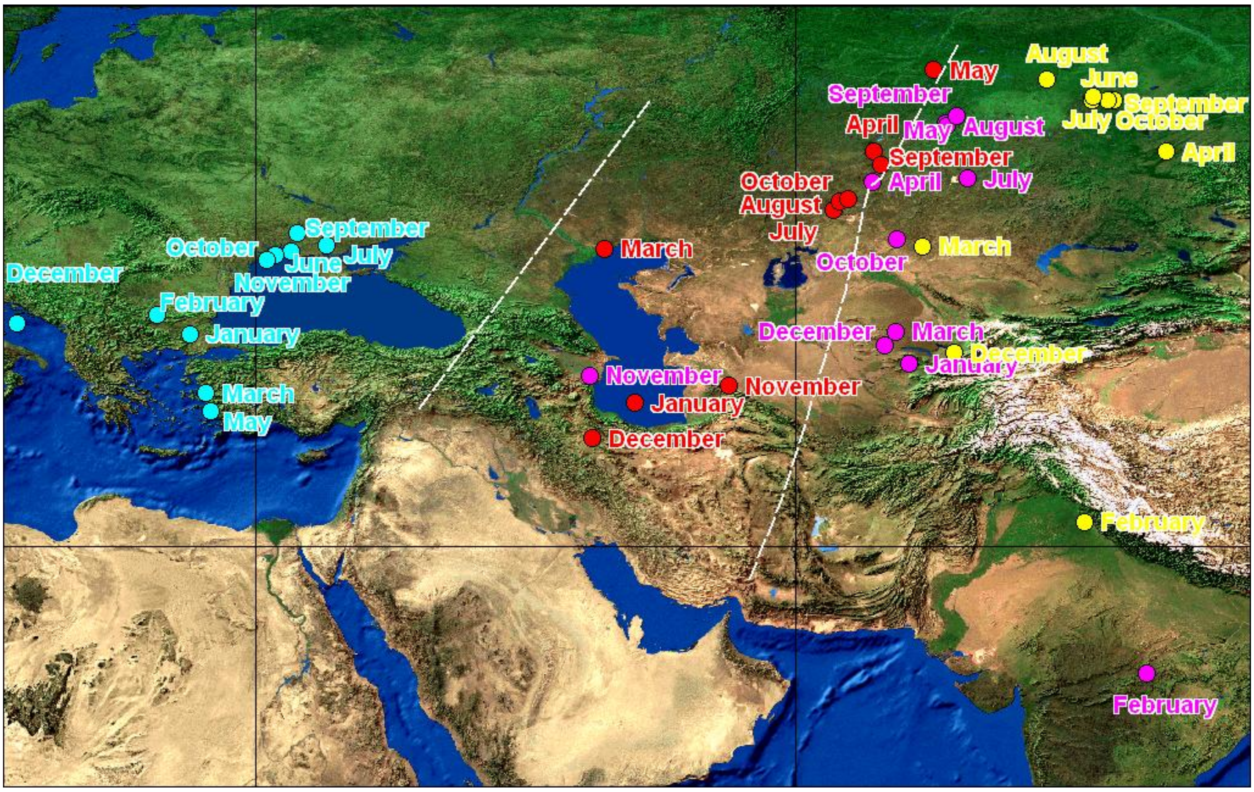


Figure 206. Monthly means of Gadwall control points. Blue-green circles and labels are monthly mean positions for birds ringed in Kherson Region, Ukraine; Red circles and labels are monthly mean positions for birds ringed in Aktyubinsk Region, Kazakhstan; Purple circles and labels are monthly mean positions for birds ringed in Akmola Region, Kazakhstan; Yellow circles and labels are monthly mean positions for birds ringed in Omsk and Novosibirsk Regions, Russia.

Bird ringing Centre of Russia ringing data allow outlining the following populations: 1) western-central-european-northern-european-russian population (polygon No 1, Fig. 207) with generally north-east – south-west migratory movements; 2) south- eastern-european-middle-eastern population (polygon No 2, Fig. 207) with general north-east – south-west migrations; 3) caspian-persian-uralean-western-siberian population (polygon No 3, Fig. 207) with complicated north-east – south-west, bending Caspian Sea migratory movements; 4) west-siberian-kazakhstanian-central-asian-hindostanian population (polygon No 4, Fig. 207) with preferably north-south migrations; 5) a part of probable Baikal population; 6) a part of probable japanese-far-eastern population.

First three populations overlap in quite little extent, the caspian-persian-uralean-western-siberian and west-siberian-kazakhstanian-central-asian-hindostanian populations overlap in their northern part.

Intergradations zones are located in Western Siberia (two populations), also, in the past, in the Volga River Delta. The third such zone in the southern Europe near Balkan Mountains, that has been revealed in the former study (Kharitonov, 2002a), is not visible from the amount of data of one ringing centre.

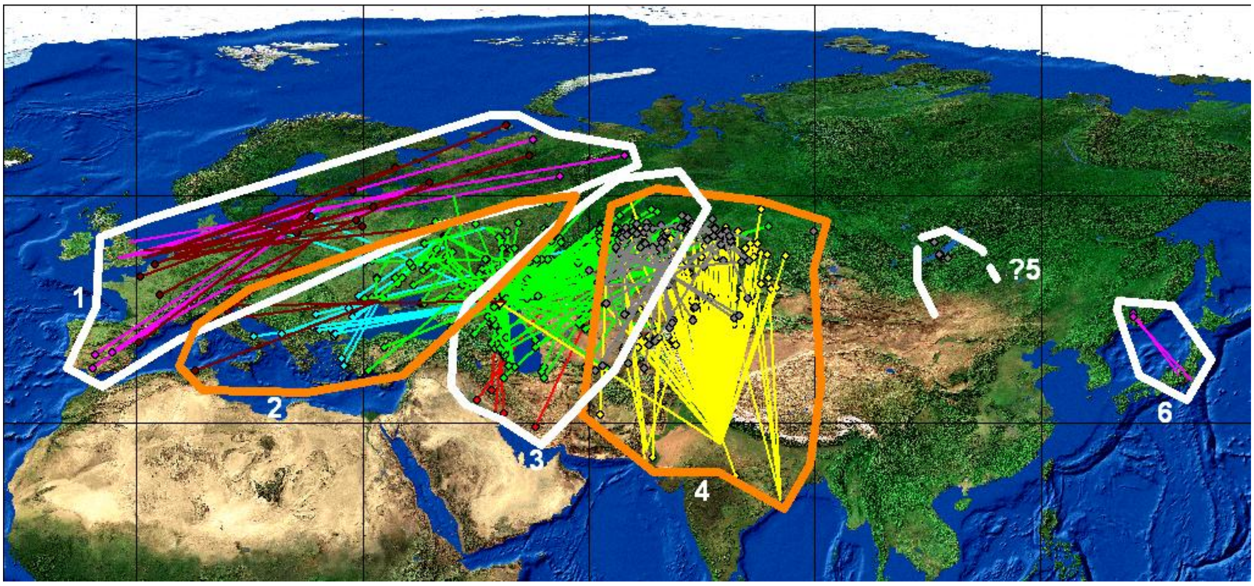


Figure 207. Gadwall populations. White polygon № 1 outlines western-central-european-northern-european-russian population. Light brown polygon shows south-eastern-european-middle-eastern population (polygon No 2). White polygon № 3 is the caspian-persian-uralean-western-siberian population. Light brown polygon № 4 is the west-siberian-kazakhstanian-central-asian-hindostanian population. Dashed polygon № 5 shows a part of probable Baikal population. White polygon № 6 is a part of probable japanese-far-eastern population.

It turned out that within western-central-european-northern-european-russian population, according to migratory route position, it is possible to outline two subpopulations: 1) north-western-european subpopulation; 2) south-western-central-european subpopulation (Fig. 208).

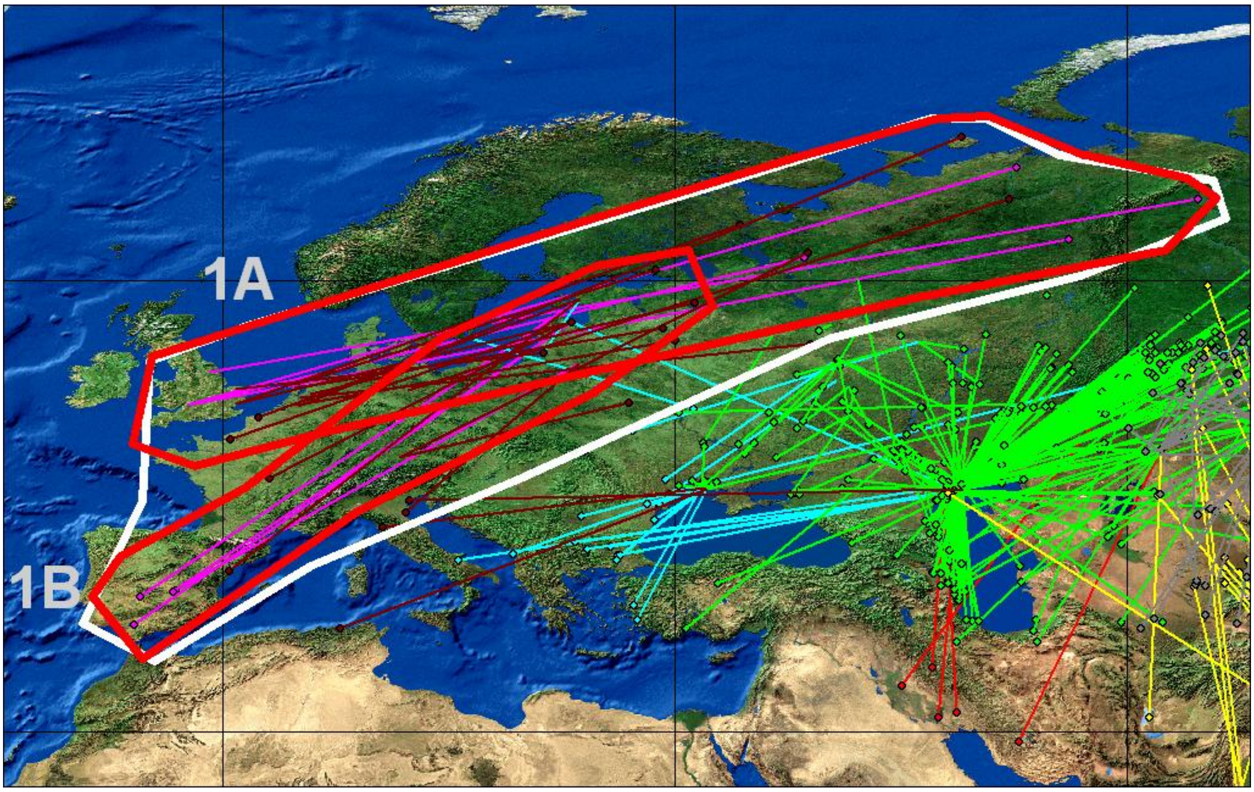


Figure 208. Gadwall north-west European subpopulations: polygon 1A - north-western-european subpopulation; polygon 1B - south-western-central-european subpopulation. White polygon outlines western-central-european-northern-european-russian population.

Ten-year distances. Data on Gadwall allow analyzing overall Gadwall recovery mean decadal distances only, because numbers of ringed ducks in any separate site is either small or does not cover long-term period. Mean flight distance first increases to 1990, then decreased in 1991-2011 (Table 13). Decreasing might be owed by sharp declining of ringing activity for Gadwall in 1990-2000s (Table 13).

Table 13. Gadwall mean flight distance per decade.

Decade (years)	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2020
Distance (km)	654.9	855.1	824.5	851.5	1101.0	1818.6	2416.9	1008.7	891.2
Number of recoveries	21	115	39	131	132	149	59	5	10

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest Gadwall lived more than 22 years 4 months. Our database contains a duck with ring-recovery span 20 years 6 months. It was an adult female; really the bird lived more than 21 years 6 months.

Mortality rate. According to the common criteria (see “Materials and Methods”) 646 dead recoveries are applicable for the mortality rate analysis. Mean annual mortality rate in Gadwall is 26.52$\pm$0.89%. Real mortality pattern differs from the theoretical one insignificantly (χ^2 = 737, df = 18, P=0.0000). Programme MARK, Model CLogLog 2ndPart shows 26.32%, difference is 0.2%. Gadwall mortality pattern chart shows considerable drawdown of the real survival dynamics in the comparison to the theoretical one (Fig. 209). This is signal of not good situation with the species. However, the ring-recovery data on Gadwall are mostly from the period 1927-1990, for the later period we have only 14 dead recoveries that valid for mortality calculations.

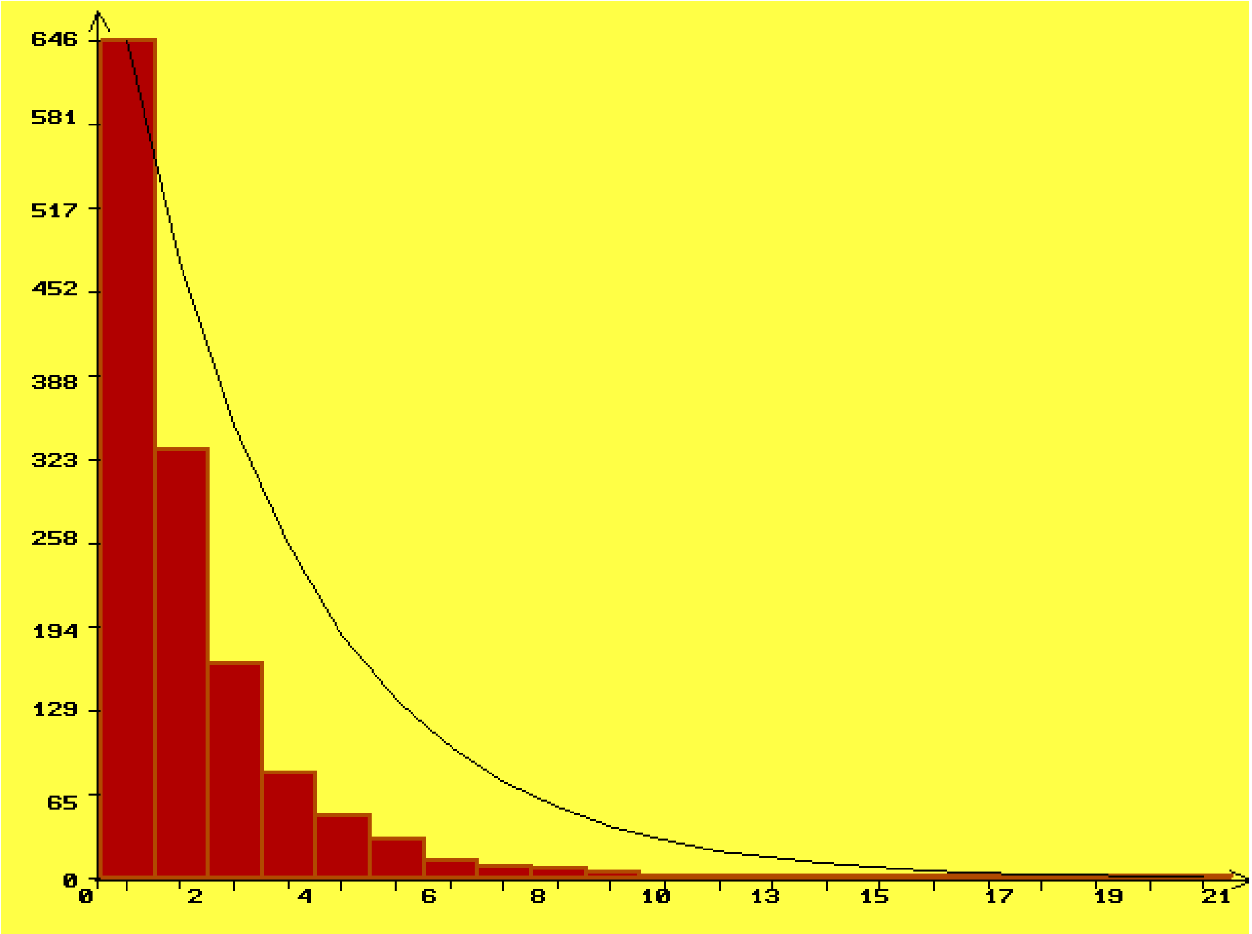


Figure 209. Mortality pattern in the Gadwall. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Data allows performing more detailed analysis of mortality rate in the past decades. For 1930s mortality pattern indicates more or less “normal” population (species) condition: real data do not much different from the theoretical line. The same good situation we oserve in 1940s (hunting pressure likely was low during the World War II). Hunting in Russia during the war was not possible, because shotguns had been confiscated (Bianki, 2005). In 1950s the species goodness dropped down sharply; it seems, in the tough period after the war hunting increased considerably. Situation improved in 1960s, getting worse in 1970s, and dropped down more in 1980s (Fig. 210). Now the situation with Gadwall in Russia is quite complicated: very bad in the south of European Russia (Belik, 2013), but good in the northern part (Sukhanova et al., 2009; Kouzov, Kravchuk, 2012). The species is expanding its breeding range to the north (Kouzov, Kravchuk, 2012).

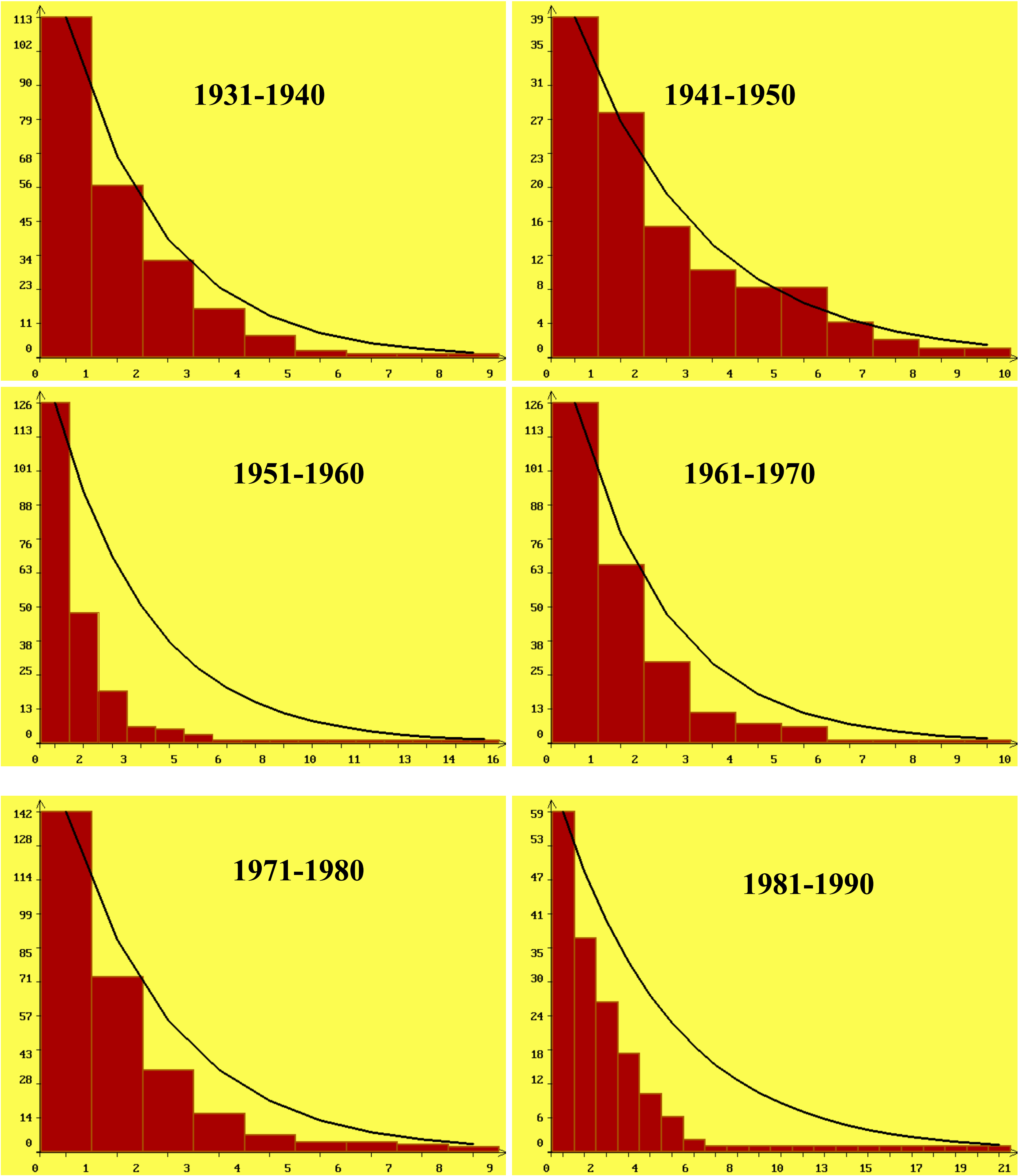


Figure 210. Mortality pattern in Gadwall recovered in different decades. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, males live slightly longer than females: 1.79+0.10 (N=308) and 1.76+0.17 (N=151) years respectively, insignificant. It is no sense to present mortality rates of different sexes because samples are very unequal.

COMMON TEAL
(*ANAS CRECCA*)

Photo by Alexandr L. Mishchenko

Breeding range in Eurasia. Brief description of the breeding range is in Fig. 211. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

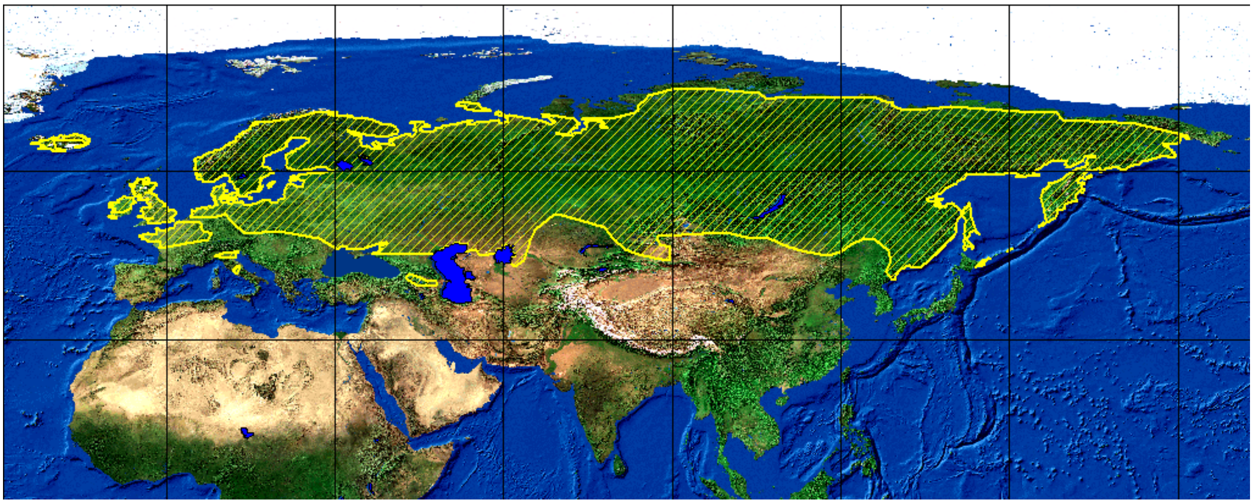


Figure 211. Breeding range of the Common Teal in Eurasia (Yellow dashed areas).

Distribution of control points. For this species account 5372 marked birds were used, that gave 5374 recoveries (Fig. 212); 52 teal held nasal marks in addition to metal rings. 5368 birds gave one recovery per duck, two birds gave 2 recoveries per duck. Ringing dates are since 25.07.1926 till 18.12.2022, recovery dates are since 09.11.1926 till 05.05.2023.

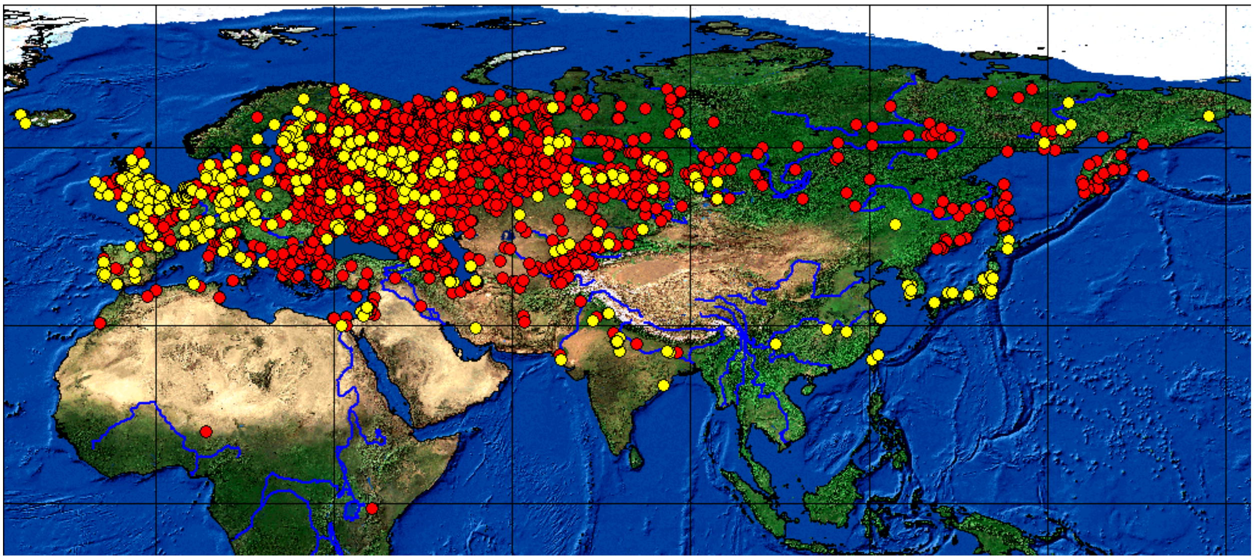


Figure 212. Position of all Common Teal control points. Yellow dots – ringing sites, red dots – recovery sites.

Most of Common Teal were ringed in Europe, western Siberia, Middle East, Iran, Central Asia, India, Pakistan, southern China, South Korea and Japan, north of the Russian Far East. Most recoveries are from Europe, Caucasus area, western Siberia and Russian Far East. Gap in recovery area in Siberia, which is characteristic for Mallard, Pintail and Wigeon, is not pronounced in the Common Teal (Fig. 212). There are two African recoveries south of Sahara on the map. We consider them since they are in the database; however these recoveries need some comments. Both of them are doubtful. The first one – „Moskwa" scheme E-727 688 ringed as „juv" in the Leningrad Region, shot in Nigeria as a „duck". It is probably mistake in the ringed species: probably, it is Garganey. The second one, ringed as adult male in the Volga Delta during moult, recovered in Kenya as „Shoveler", the recovery letter received from Great Britain. Therefore, it is likely that this is really Shoveler, because there is one more recovery of a bird, ringed as Shoveler, from Kenya, as well (see Shoveler species account).

'Moskwa' scheme recoveries. This sample contains 1287 recoveries of the scheme „Moskwa". They are from birds ringed within the Russian Federation and countries of the former USSR (Fig. 213). Considerable amount of birds (601 recoveries) were ringed in the former huge moutlting place in the Volga River Delta, where many duck species concentrated for moult. Now this moulting area does not exist any more for the reason of Caspian Sea level growth (Viksne et al, 2010).

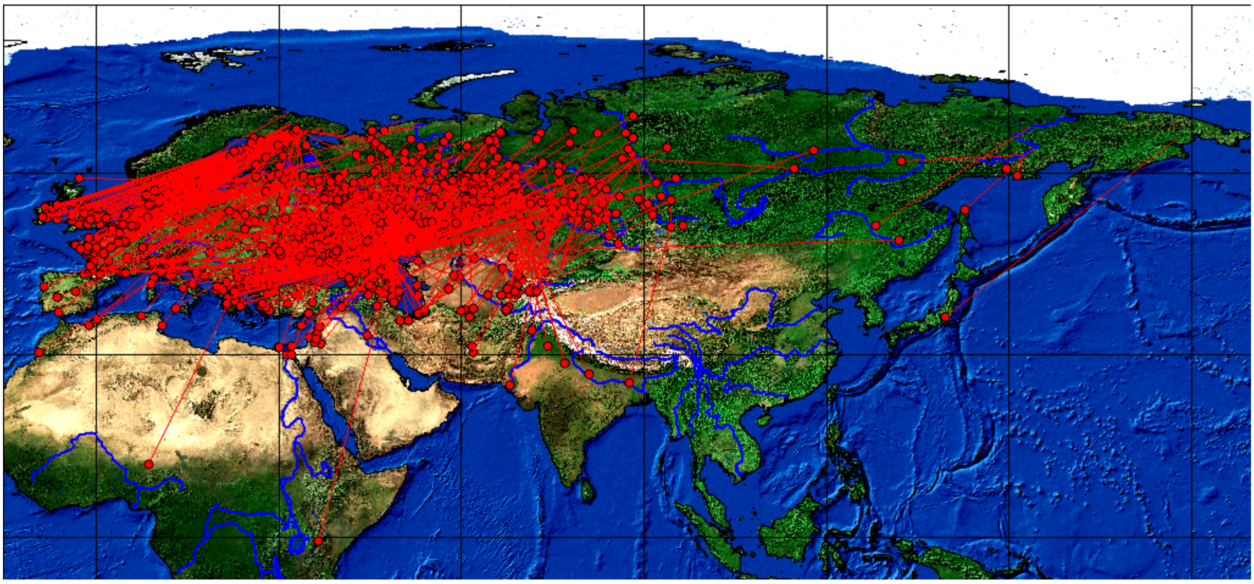


Figure 213. „Moskwa" scheme recoveries of the Common Teal. Here and on all other similar figures lines start from the ringing site, recovery sites are marked with red dots.

Finding details. This analysis includes all 5372 recoveries. Almost 9/10 of recoveries (88%) are „shot". In 527 (8%) recoveries „details unknown", which most likely mean they were shot, as well. Therefore, we can assume that 96% of birds were shot. Other reasons are not so common (Fig. 214).

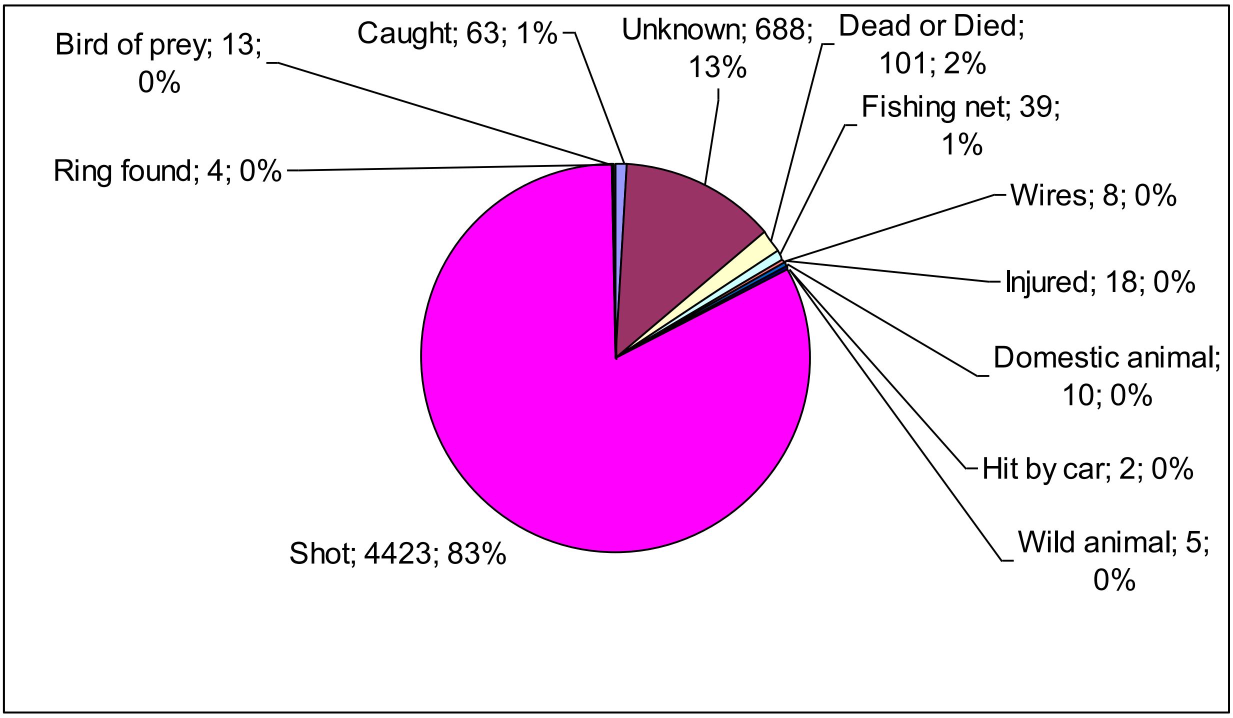


Figure 214. Finding details in the Common Teal.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries represented in Figs 215 and 216.

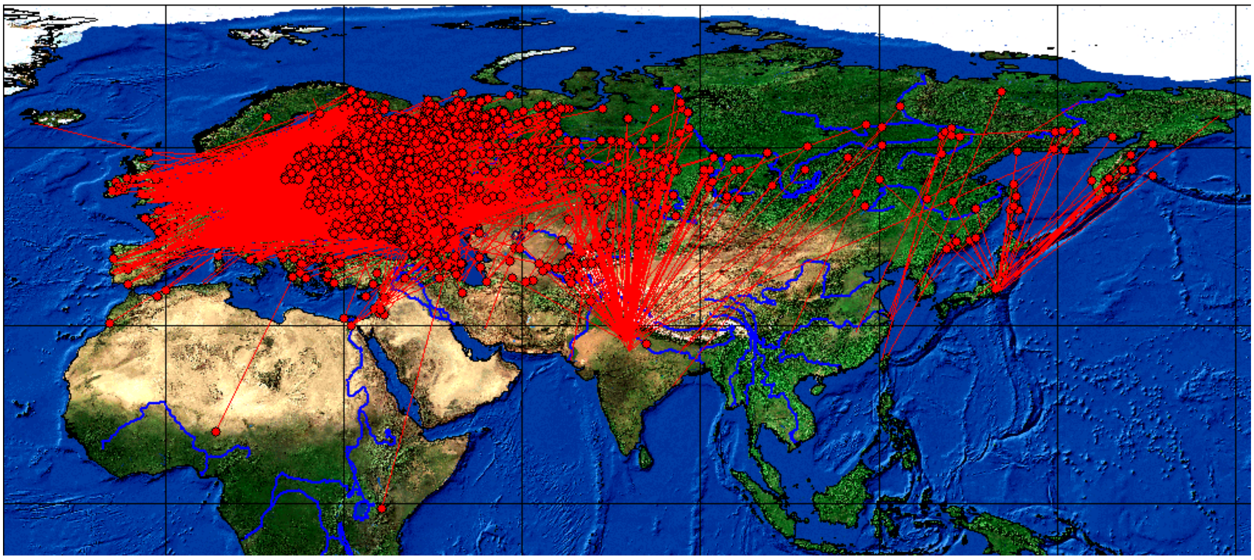


Figure 215. Map of the Common Teal direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

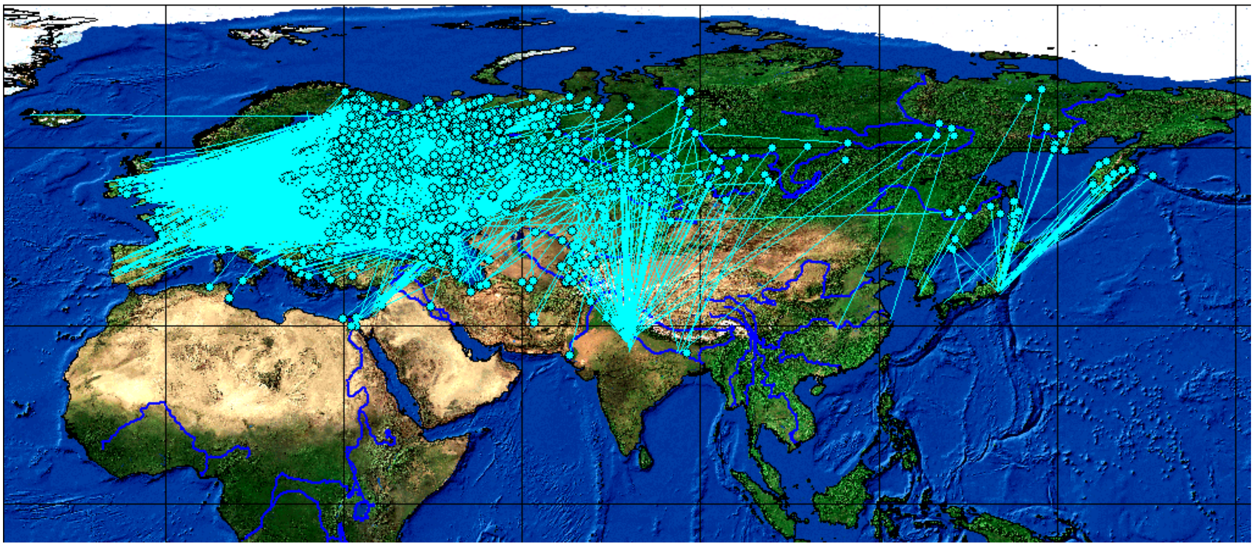


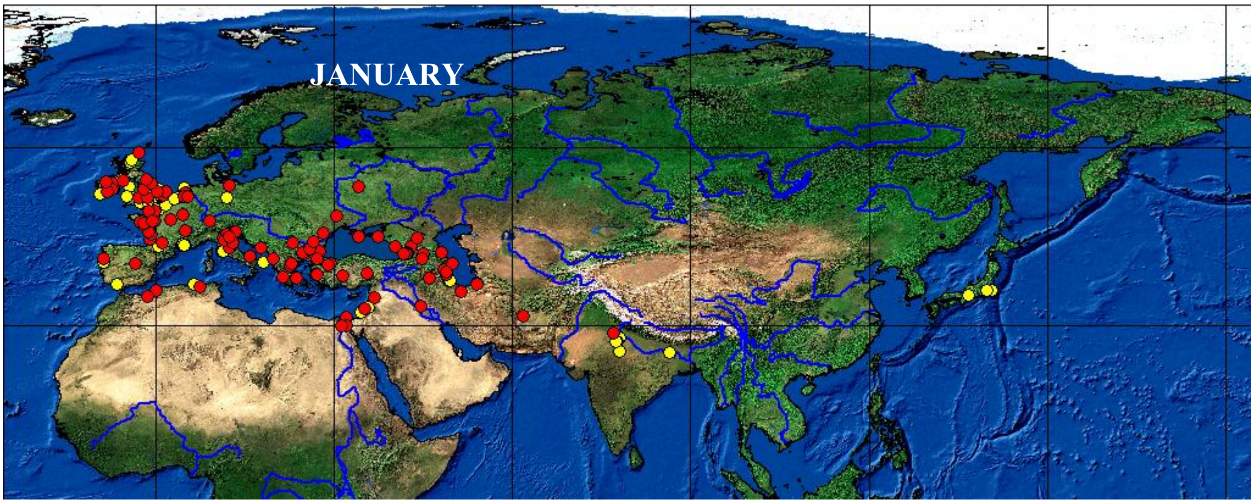
Figure 215. Map of the Common Teal indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

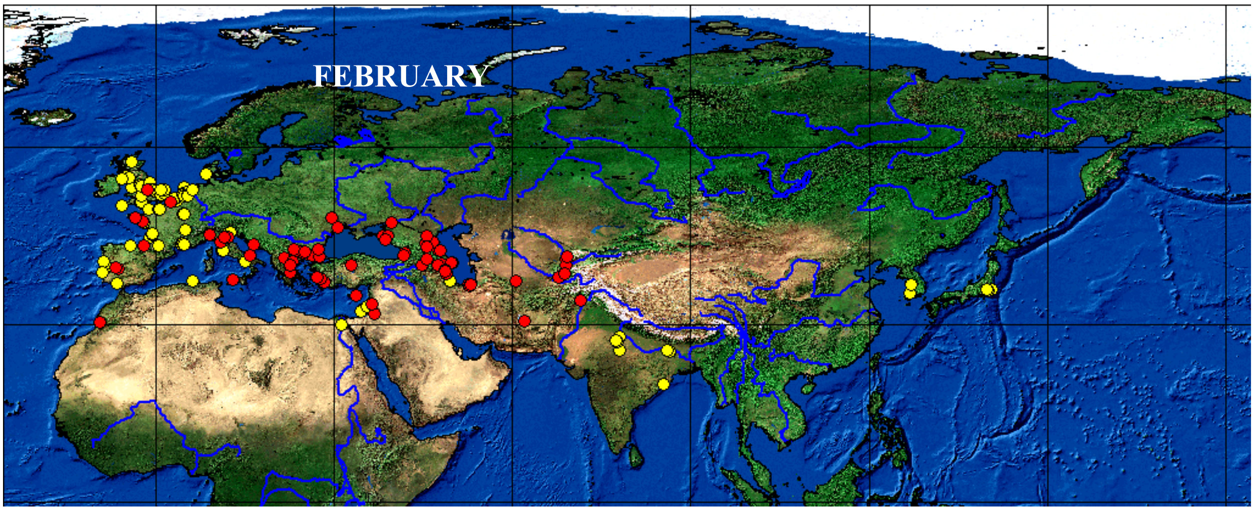
Maps clearly indicate that Common Teal wintering in Europe fly to breed to the European Russia, Western Siberia and western part of Central Siberia. Common Teal ringed in India fly to breed, mostly, to the western, central and eastern Siberia, approximately up to meridian 135˚E from the west, about the same as India-ringed Wigeons (Fig 187). Most birds that winter in Japan and South Korea breed in the Russian Far East and Eastern Siberia, approximately up to meridian 135˚E from the east; therefore no gap between Indian and Japanese ringed bird recoveries is noticeable. Probably, this is due to the same effect like in Wigeon: birds ringed in India migrate to the north, and then turn to the east (see section "Migratory routes").

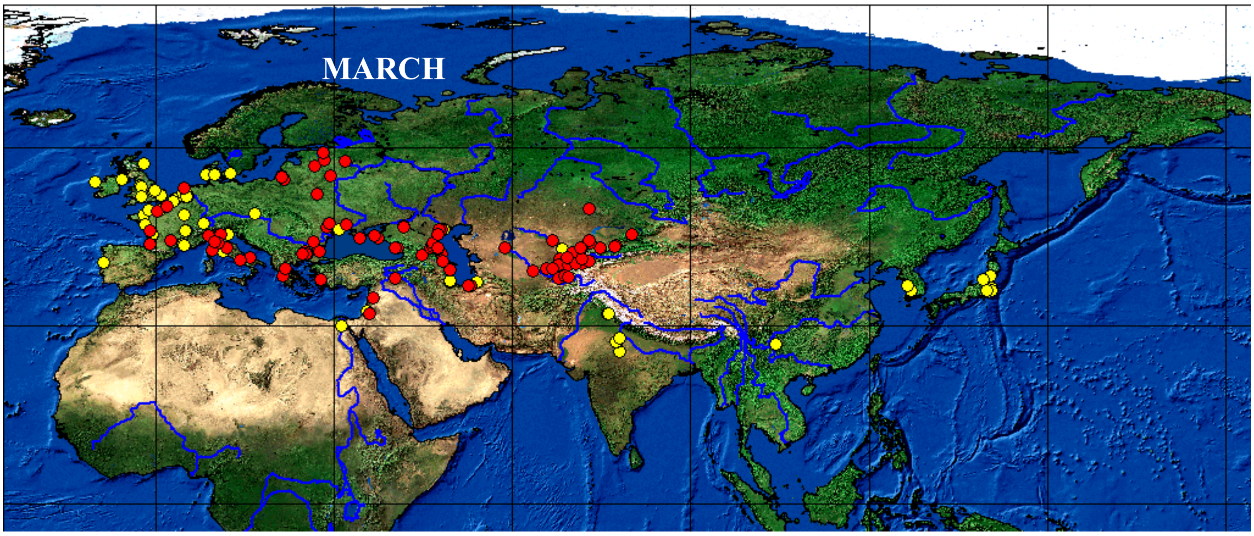
Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them (χ^2 = 64.08, 2740 indirect recoveries and 2634 direct ones, df = 2, P = 0.0000). It seems, the main reason for the significant difference is quite large samples, since the positions of centers of direct and indirect recovery areas are very close to each other. Center of indirect recoveries locates just by 1˚ 13‘‘ more to the north and 0˚ 33‘‘ to the east from the centre of direct recoveries. Average flight distances in direct and indirect recoveries differ by just 111 km: 2166.6$\pm$19.1 and 2277.1$\pm$17.2 km respectively, however highly significant (t-Bailey = 4.33, P=0.0000), also probably due to very large samples. Long-distance cross-population movements are very rare in this species, mostly, these movements occur only between the neiboughring populations (see section "Population structure").

Monthly movements. Two doubtful African recoveries are excluded from demonstration of migrations month-by-month, all other direct and indirect recoveries are included. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in Common Teal (Fig. 216). In January most ducks are on wintering grounds in the western and southern Europe, Transcaucasia, Middle East, India, Iran, eastern China, South Korea and Japan. First slight movements in direction to breeding grounds are noticeable as early, as in February (February, Fig. 216). These movements occur in southern wintering areas: south-eastern Europe, Caucasus area and India. No movements in February are visible in the Far East. In March migratory movements are still very little. This concerns mostly ducks from wintering grounds in Europe, Caucasus and India. In China, South Korea and Japan birds definitely stay on the wintering grounds. Birds from Western Europe move to the east and north-east, from southern Europe and Caucasus area to the north-east, from India and Pakistan first to the north. It is visible from the position of the new appeared green dots, which point to the recovery sites

(Fig. 216, March). In April migration continues through May, probably in May it finishes even in the very northern areas, i.e., Eurasian tundra zone. According to ring-recovery data, Far Eastern Common Teal start to migrate only in April, and finish migration mostly in May, probably in early June. April recovery picture shows that Common Teal, migrating during this month from southern Europe to Western Siberia, bend over the southern end of Urals, the same as in Mallard and Pintails (this is confirmed by the concentrations of recoveries close before and after Ural Mountains, with the zone over the mountains clear of recoveries, see Fig. 216, April. However, in May Teal already fly straight over Ural Mountains (Fig. 216, May). In June birds are on the breeding grounds everywhere; in July part of Teal start to move back in the direction to the wintering grounds for moult. In August breeding birds start to move southward and westward. In August moulting birds and failures either stay in moulting sites or move further to wintering grounds. In Common Teal, the same as in Wigeon, no backward flights to the breeding grounds occur. September - October indicate intensive migration, but some birds still are in the breeding areas. In September there is a concentration of recoveries east of Urals and very close to them, whereas over the Urals, the same as in April, no recoveries can be seen (Fig. 216, September). This indicates the same phenomenon as in Mallards, Pintails and Wigeons: on their autumn migration to the wintering grounds in Europe Common Teal bend the Urals over the southern end, as well. I.e., Common Teal also perform bending of Ural mountains: in spring only first migrating birds, in autumn, likely, most birds from Siberia. In distinction to Mallard, Pintail and Wigeon, in Common Teal this bend is not so steep, because many Teal from Siberia fly to winter not to western Europe, but to southern Europe and Middle East (see also section "Migratory routes"). In November and even in December migration is still in process, although most birds are already on the wintering grounds. (Fig. 216). Only in January all Common Teal are on their wintering grounds.



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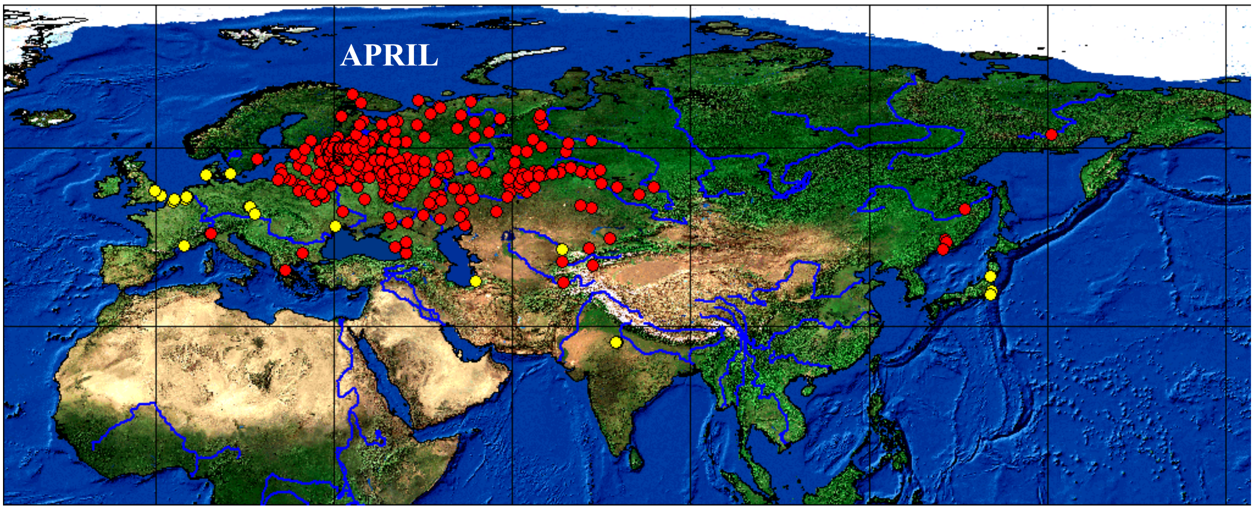
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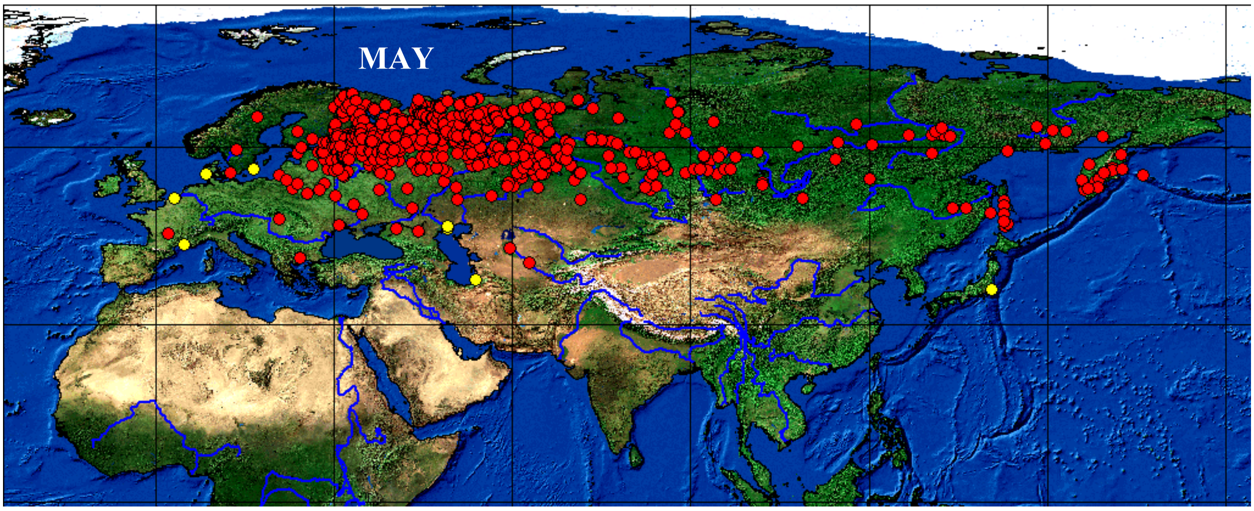
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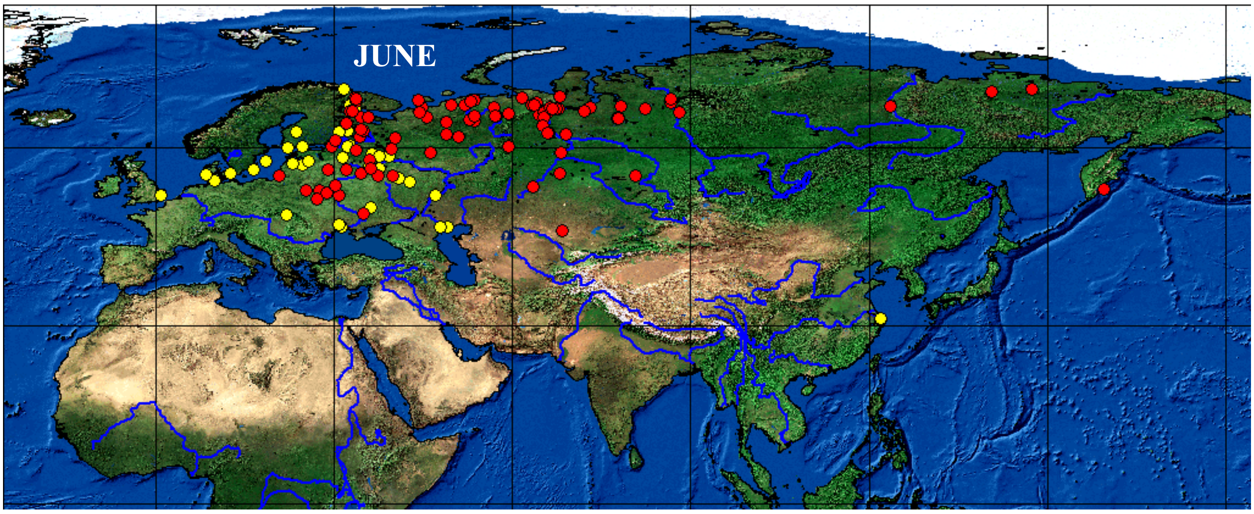
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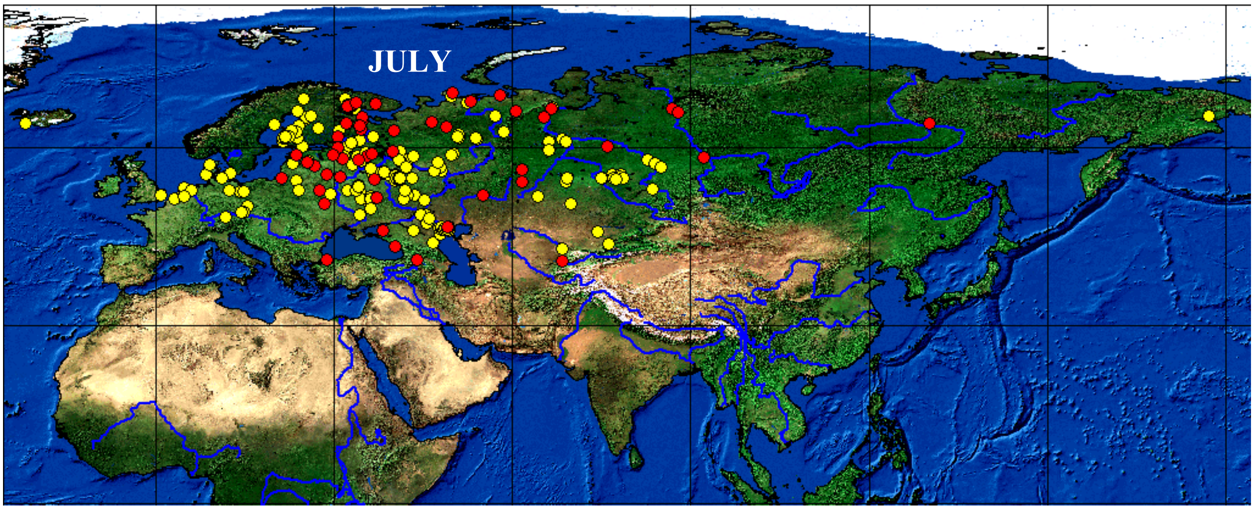
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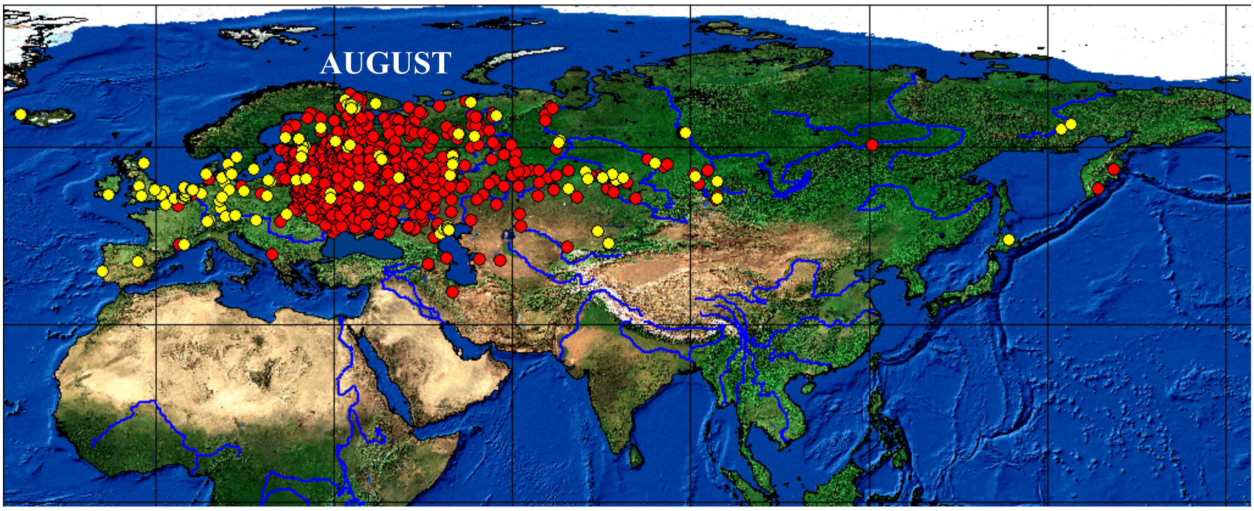
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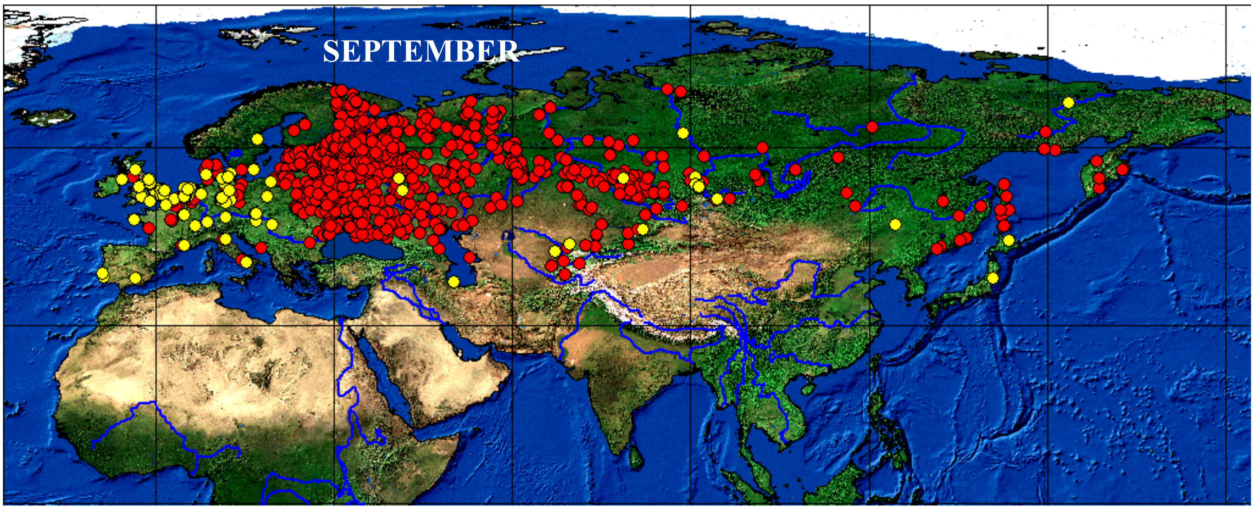
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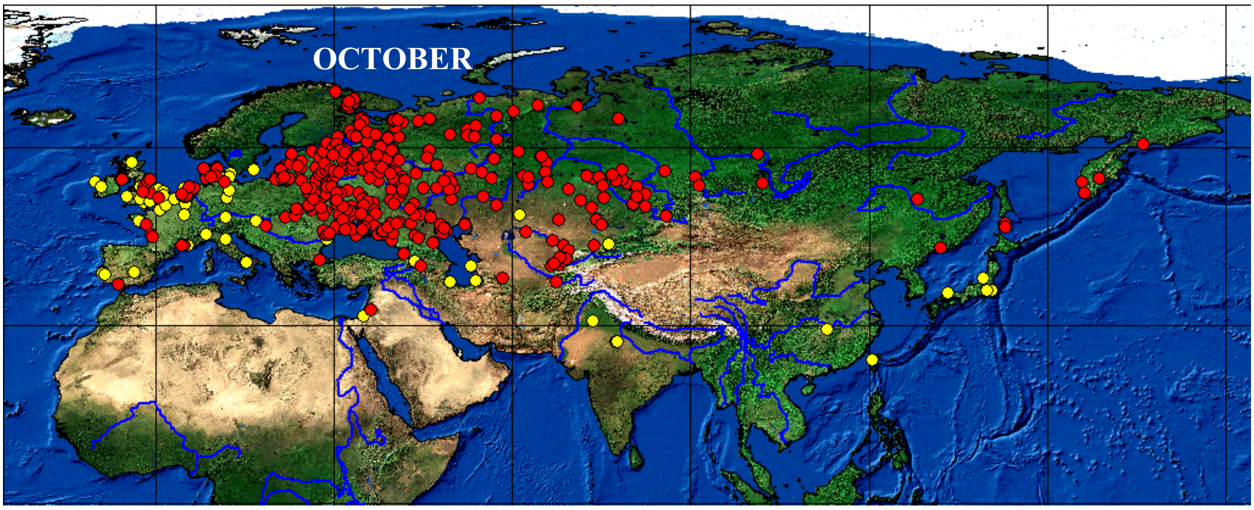
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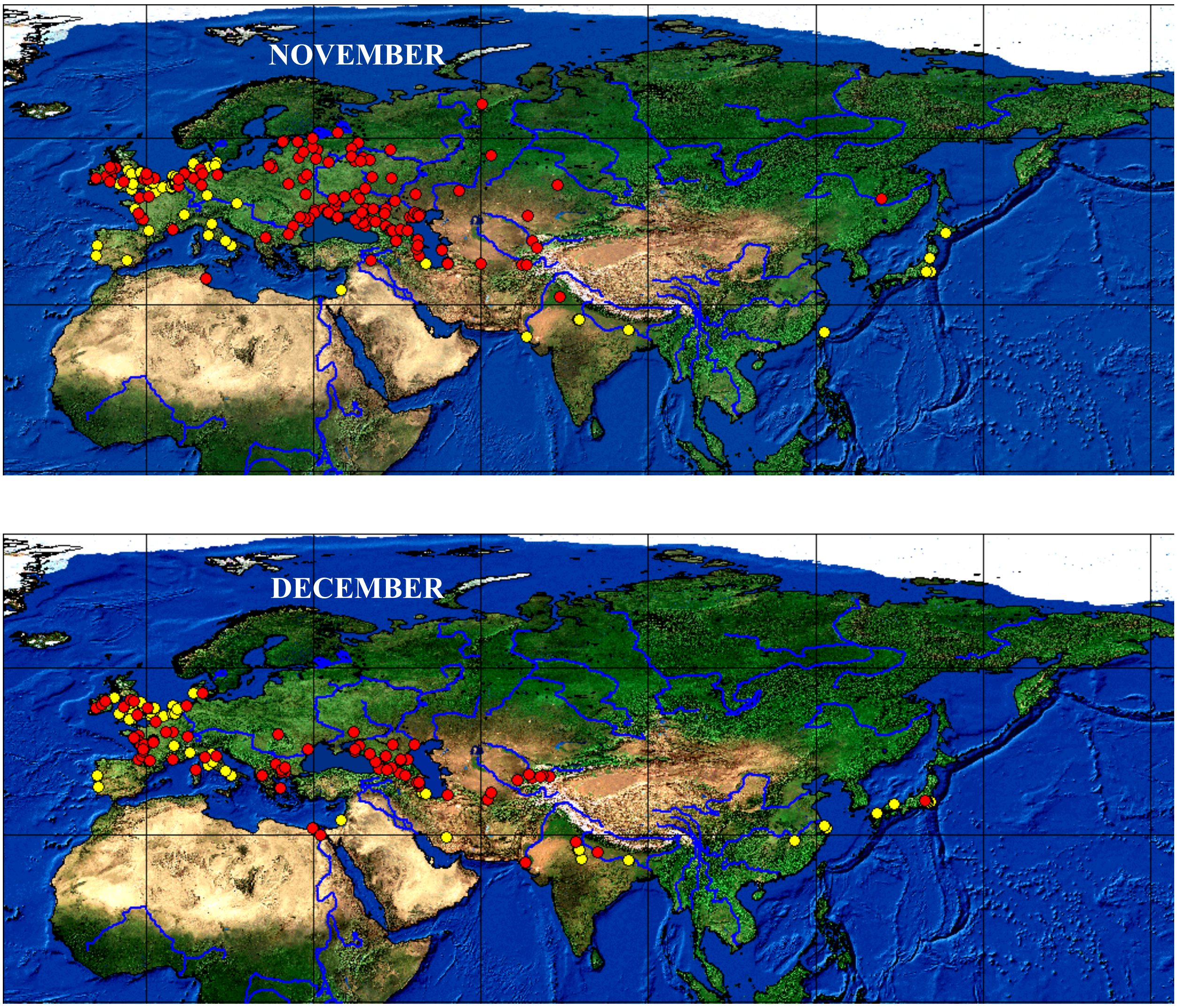


Figure 216. Common Teal monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. As it has been preliminary shown in the section “Monthly movements”, Common Teal from different wintering areas migrate to different directions. Birds ringed in areas with longitude <=30˚E move to north-east in spring (bearings 22-112˚, mostly 37-82˚ Fig. 217), and in opposite direction in autumn. For birds ringed in area with longitude 30˚-60˚E preferable flight bearings are 22-52˚ in spring and 202-247˚ in autumn. In this section there are a number of birds that ringed in the Volga River Delta, which is close to the southern end of Ural Mountains. Although the turn from western to north-eastern directions that occurs near the southern end of Urals exists, it is less pronounced even than in Wigeon, because, in distinction to Wigeon, Common Teal‟s route to the wintering grounds lays further south than that in Wigeon. For ducks ringed at 60˚-90˚E preferable bearings are 322-52˚; these are spring flight directions for Common Teal ringed in India. For Far-Eastern birds ringed in Japan, South Korea and eastern China spring flight bearings are 350-50˚, mostly 22-37˚ (Fig. 217); certainly, the opposite should be in autumn.

In comparison to Wigeon, Common Teal have generally more northerly directed movements in spring in the western part of the breeding range within Eurasia, in autumn they migrate relatively southerly than Wigeons (see Wigeon species account).

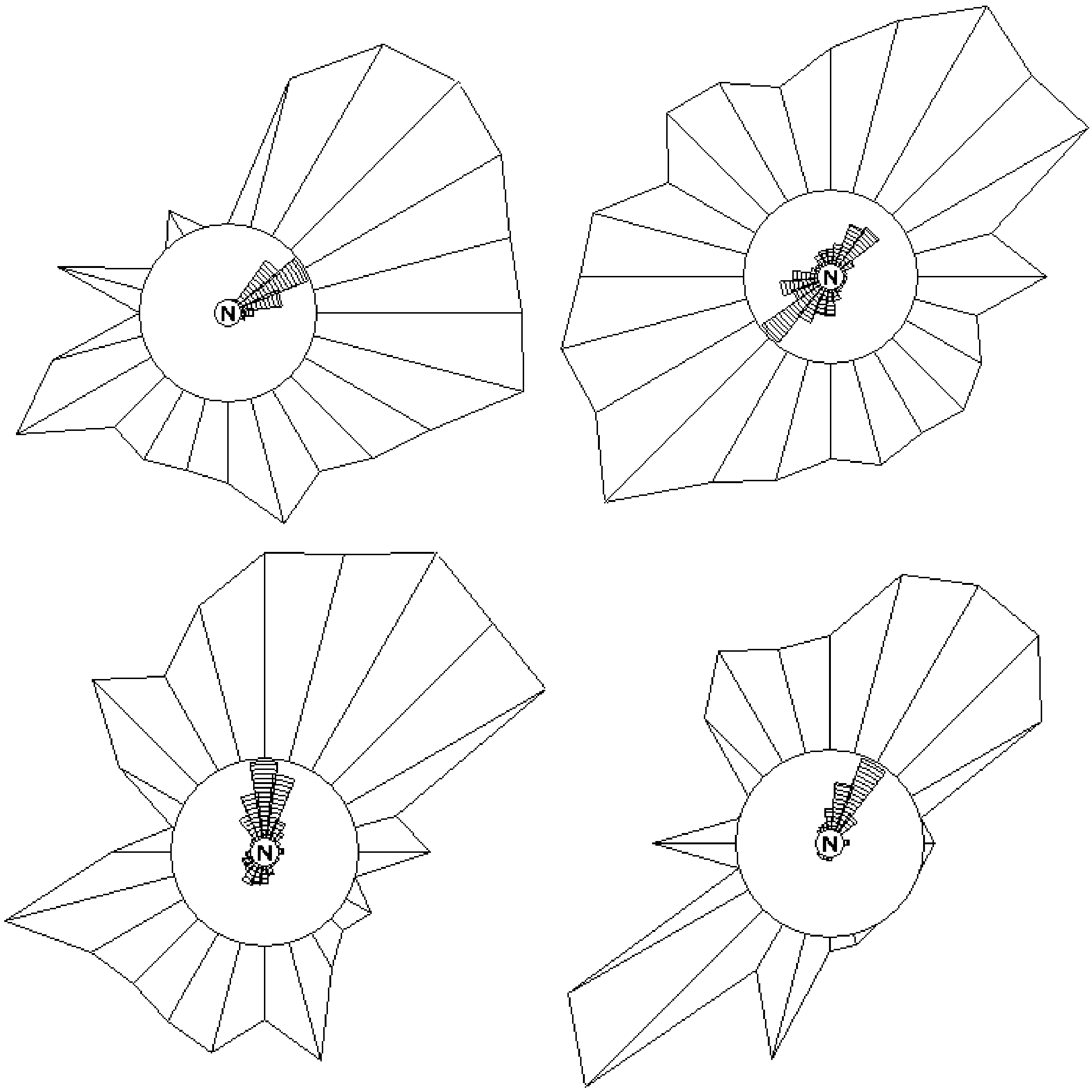


Figure 217. Recovery rose graphs for Common Teal, ringed at different longitudes: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Upper left chart is for European wintering Common Teal, area of recoveries from British Isles to central Siberia, to 90˚E. Sector = 15.0°; Total recoveries - 3579; N in sectors: from 0 up to 1344; Average distance in sectors: from 0.0 km up to 2615.5 km; The longest flight distance is 5994.3 km.

Upper right chart is for Common Teal ringed in the southern European Russia, area of recoveries from Eastern Europe to central Siberia, to 90˚E. Sector = 15.0°; Total recoveries - 1149; N in sectors: from 5 up to 159; Average distances in sectors: from 579.8 km up to 2072.5 km; The longest flight distance is 5875.5 km.

Lower left chart is for Common Teal ringed mostly in India, area of recoveries is western, central and eastern Siberia, to 135˚E; Sector = 15,0°; Total recoveries - 333; N in sectors: from 0 up to 64; Average distances in sectors: from 0,0 km up to 3566,6 km; The longest flight distance is 6512 km.

Lower right chart is for Common Teal ringed in Japan, South Korea and eastern China, recoveries are mostly from the Russian Far East, east of 135˚E; Sector = 15,0°; Total recoveries - 107; N in sectors: from 0 up to 37; Average distances in sectors: from 0,0 km up to 3161,3 km; The longest flight distance is 4269.9 km.

Preferable flight distances both for direct and indirect recoveries are less than 4000 km, with the peak near 2600 km. Maximal distance of the indirect recoveries flight is 6512 km (Fig. 218). Common Teal are less mobile than Pintails and Wigeons.

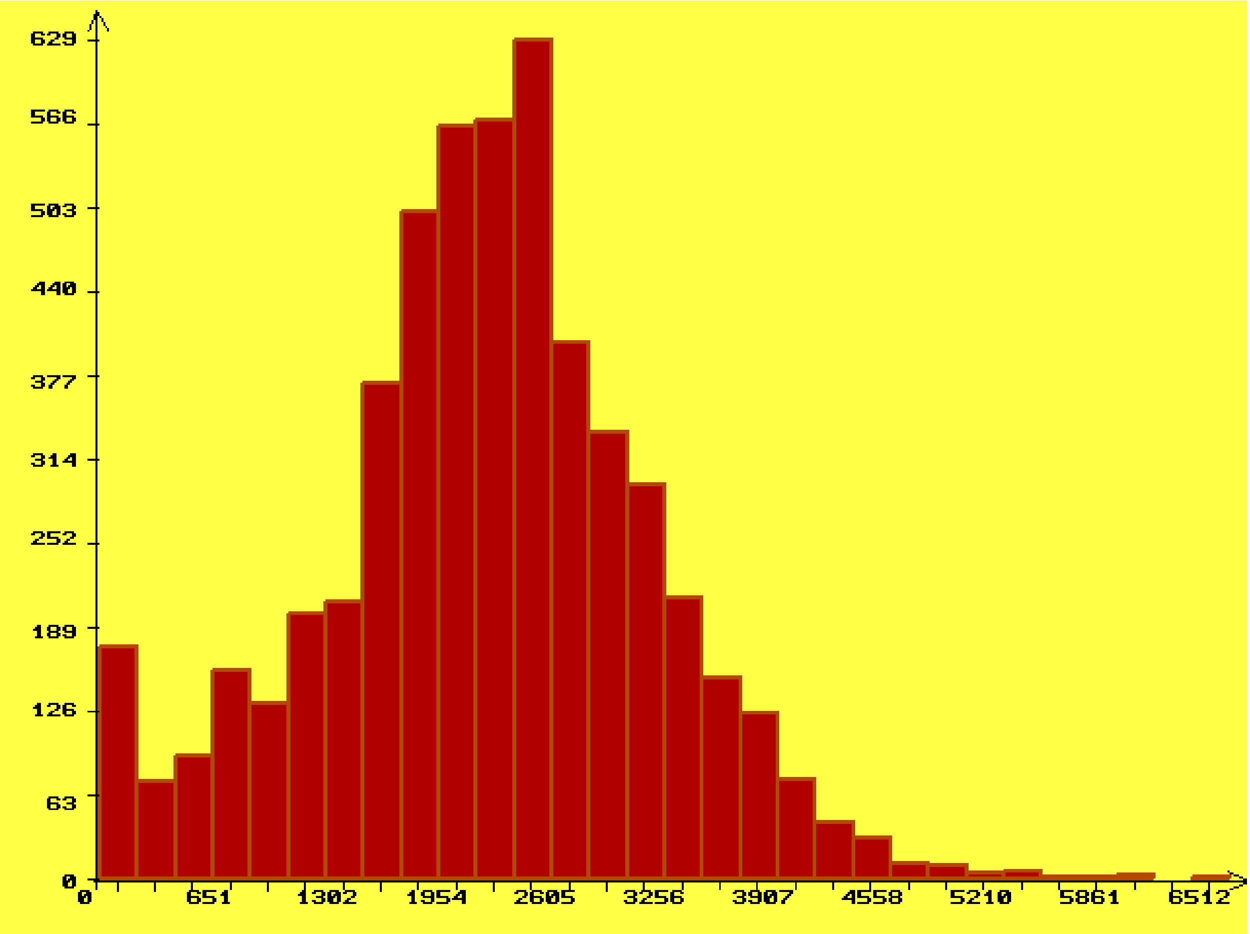


Figure 218. Distribution of all ring-recovery distances in Common Teal. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in Common Teal young birds (ringed as „pull"or „juv"or „1 y") is by more than two hundred km shorter than in adults: 2009.7±36.5 versus 2265.1±13.5 km respectively (N_{young} = 878, N_{ad} = 4496), significant (t-Bailey=6.55, P=0.0000). Male mean flight distance is similar to that in females: 2324.5±17.2 and 2301.1±21.3 km respectively (N_{males} = 2835, $N_{females}$ = 1578, t-Bailey=0.85, P=0.39).

Before outlining the Common Teal migratory routes and reveal the migration process in more detail, we should plot monthly means for these ducks, ringed at different sites. In Common Teal the most northern and eastern monthly mean is in June, the same as in Pintails and Wigeons. This is illustrated by the examples of ducks ringed on the British Isles, in Netherlands, at former huge moulting site of different duck species in the Volga River Delta (Figs 219-223). Common Teal ringed on British Isles migrate more northerly and not as far to the east, as birds ringed in the Netherlands (Fig. 219). The latter migrate in the parallel way to the British Teal and move further east for breeding. Migratory route of birds ringed in France generally is more sloped to the north than in British and Netherlands birds, they penetrated to the east in greater extent than British birds, but less than Netherlands ones (Fig. 219).

Ducks ringed by „Bombay" scheme, in spring generally migrate more straightly to the north than Wigeons, and then turn to the east (Fig. 222). Japan ringed Common Teal, the same as

India ringed ducks, start their flight generally to the north, then turn to the east, the same as Wigeons, but southerly in the Far East area (Fig. 223).

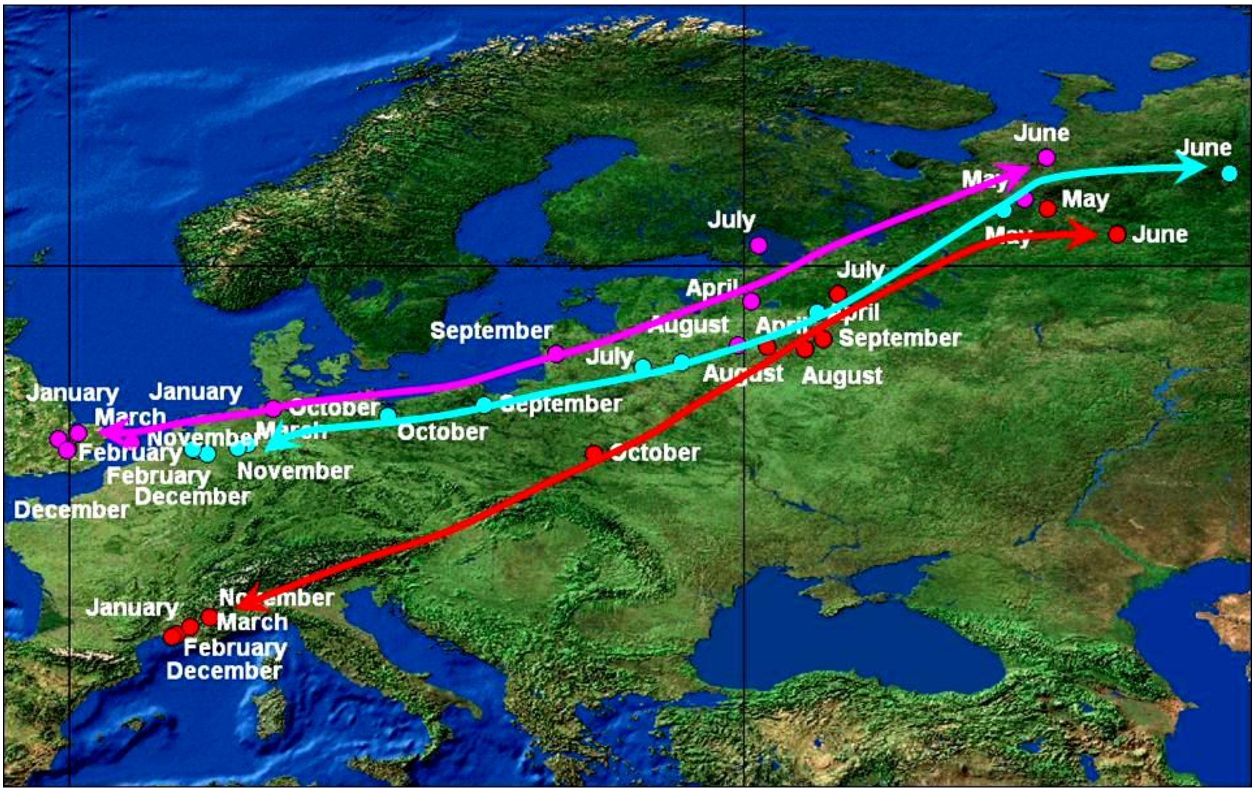


Figure 219. Mean monthly locations of control points and generalized migratory ways in Common Teal for birds, ringed on the wintering grounds on the British Isles, in Netherlands and France. Blue-green circles are mean monthly locations of Teal ringed in the Netherlands. Purple circles represent monthly means of Teal, ringed on British Isles, red dots - in France. Arrows show directions of movements of those cohorts of birds, arrow colours are relevant to the colours of circles.

During migration Common Teal can form migratory loops, in European breeding birds this loop curled in counter clockwise direction, the same as in the White-fronted Geese (see species account), but in lesser extent. Teal, ringed in the Murmansk Region, Russia displays an example of such loop (Fig. 220). More southerly migrating birds, flying to breed to Siberia, perform the clockwise loop (Fig. 221), also similar to White-fronted Geese, migrating in this area.

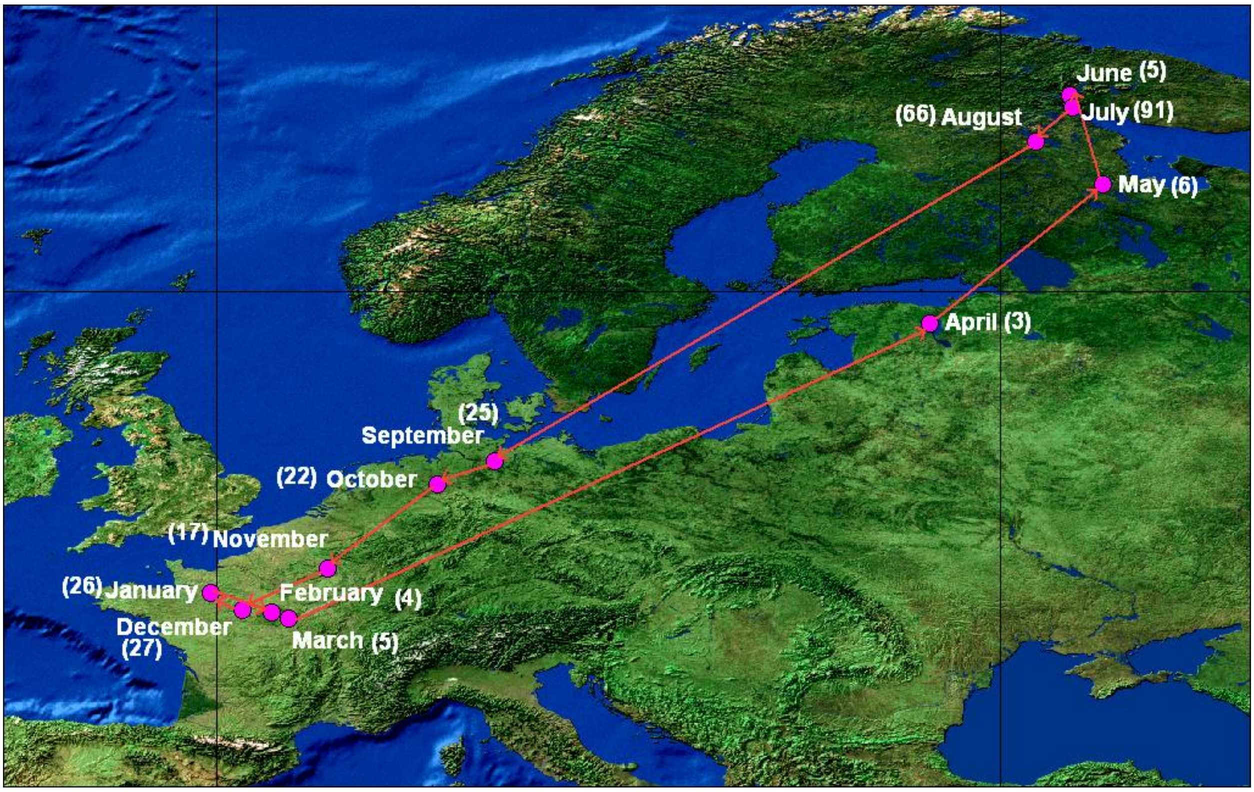


Figure 220. Monthly means for Common Teal ringed in the Murmansk Region, Russia (purle circles). Arrows show direction of migratory movements. Number of control points in each month is in parentheses.

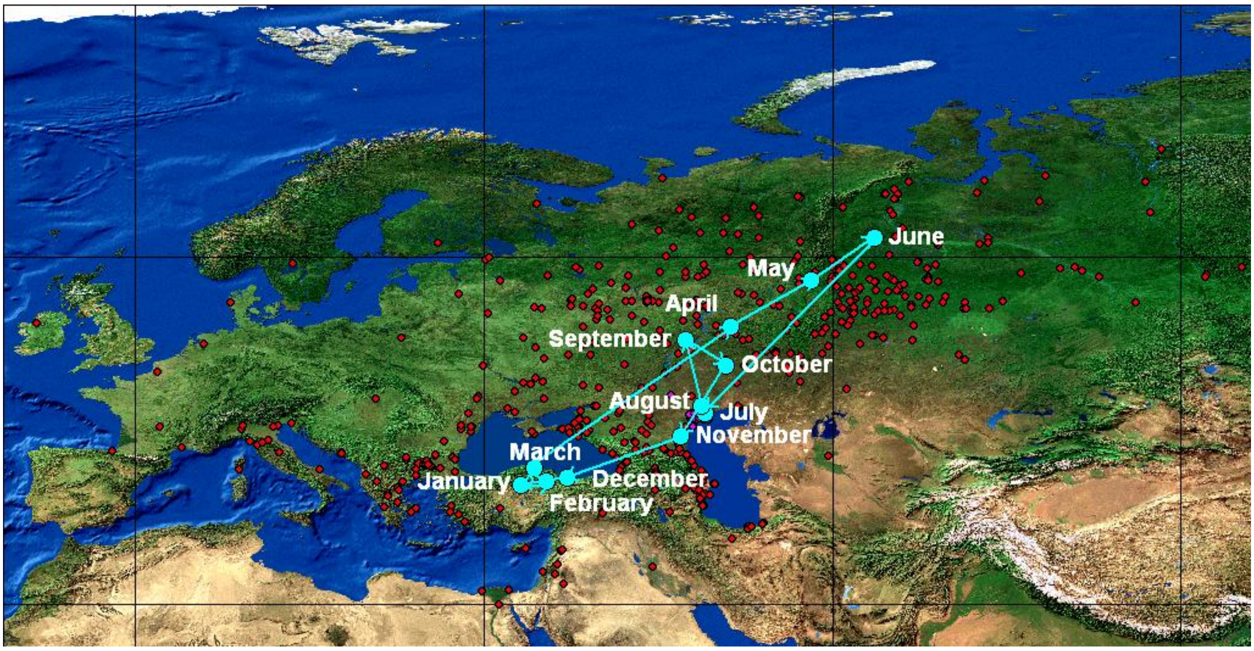


Figure 221. Mean monthly locations of Common Teal control points for birds, ringed on the wintering grounds in the Volga River Delta. Blue-green large circles are mean monthly locations of Common Teal. Arrows show directions of movements. Purple dots are the ringing sites, red dots – recovery points.

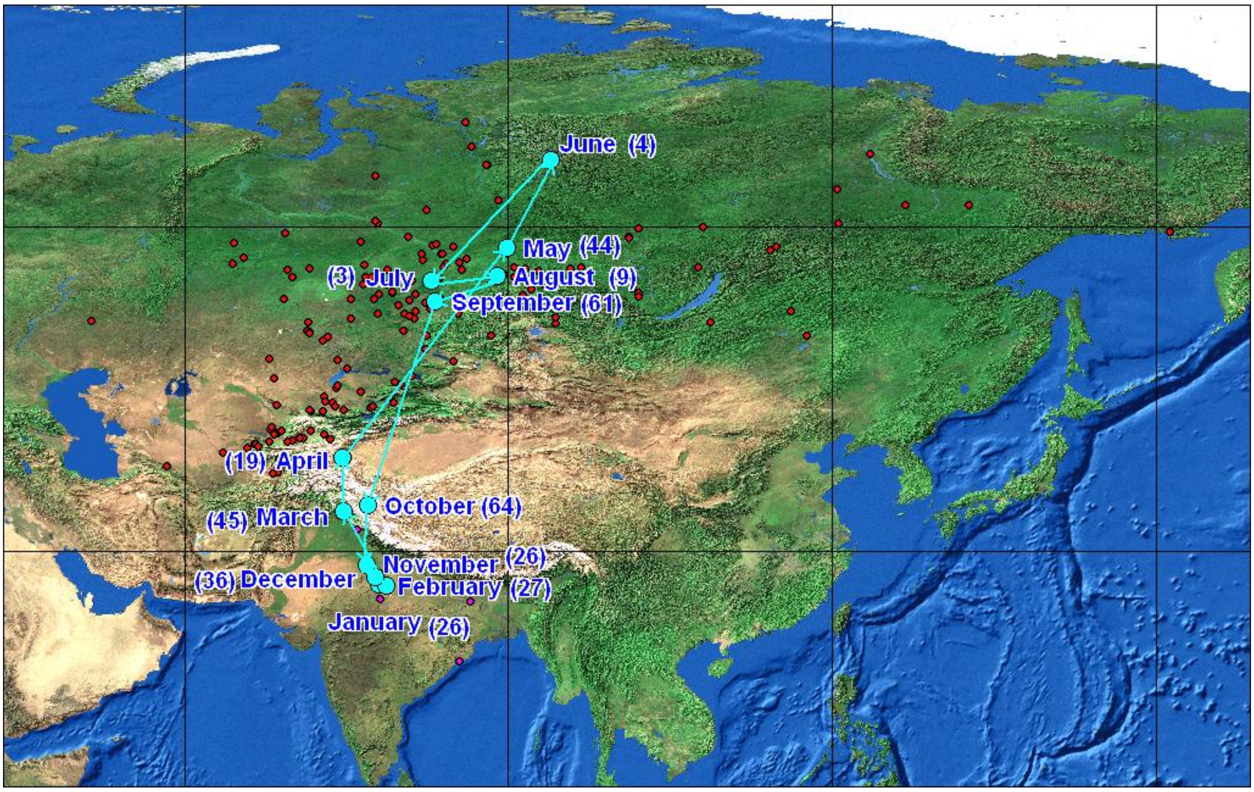


Figure 222. Mean monthly locations of Common Teal control points for birds, ringed on the wintering grounds in India and Pakistan. Blue-green large circles are mean monthly locations of Common Teal. Arrows show directions of movements. Number of control points in each month represented in parentheses. Purple dots are the ringing sites, red dots – recovery points.

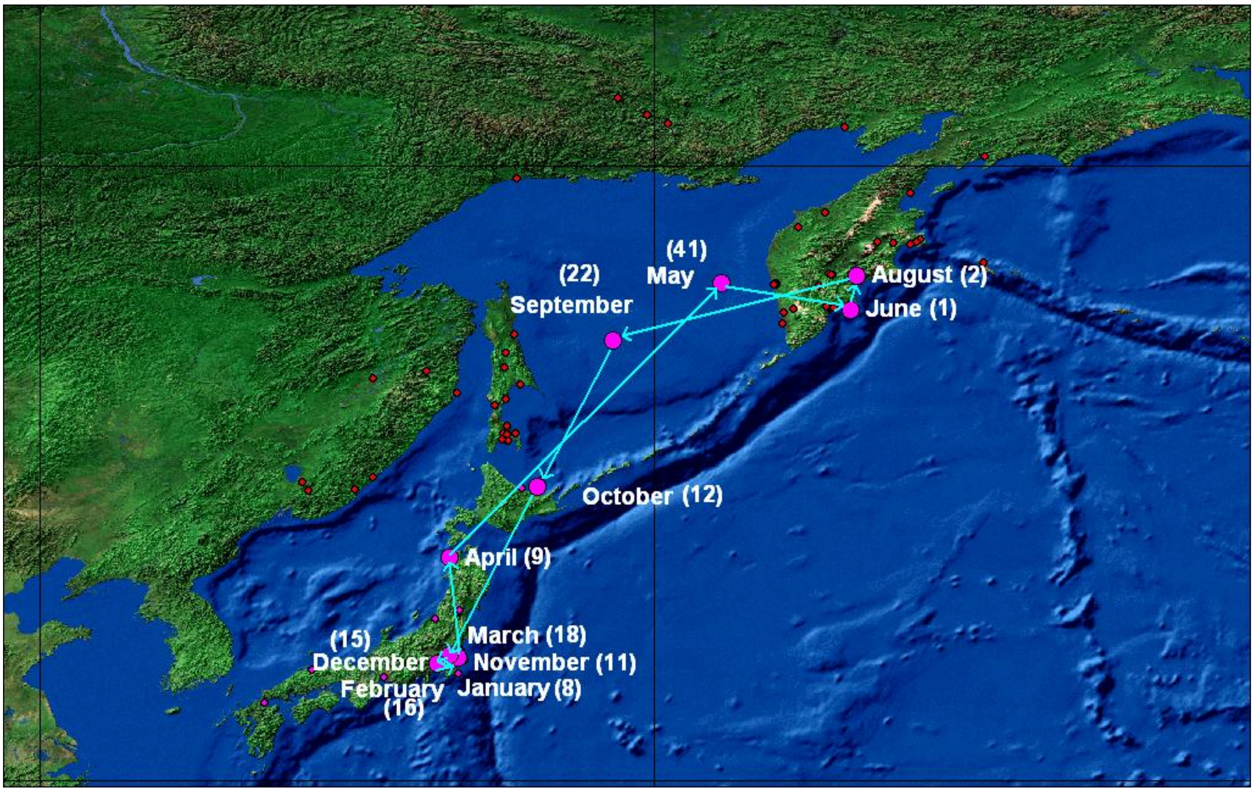


Figure 223. Mean monthly locations of Common Teal control points for birds, ringed on the wintering grounds in Japan. Purple large circles are mean monthly locations of Commoneal. Arrows show directions of movements. Number of control points in each month represented in parentheses.

Summarising all about migratory routes, we can outline spring and autumn Common Teal migratory movements (Figs 224 and 225).

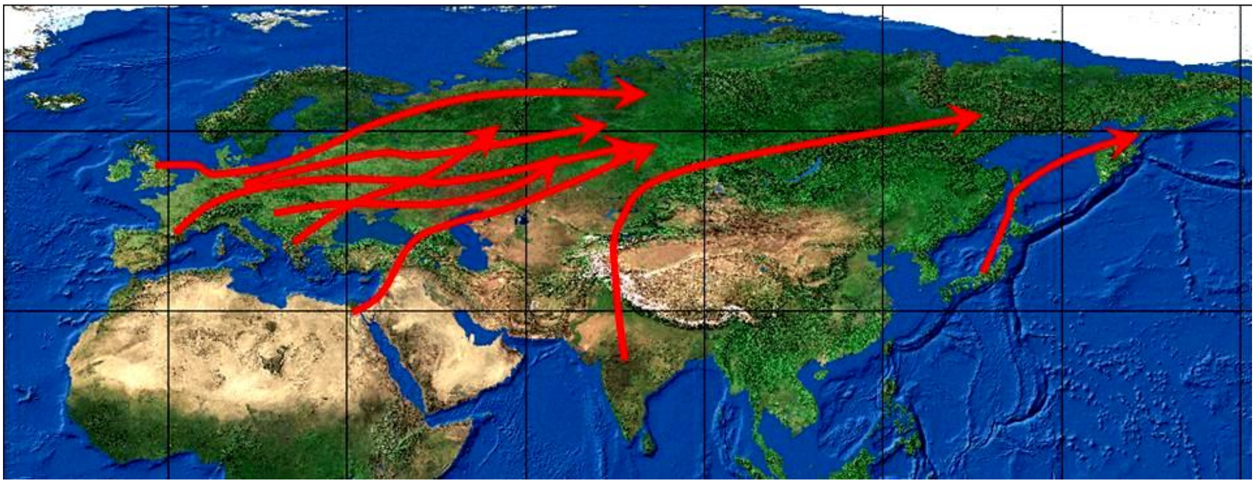


Figure 224. Outline of spring migratory routes for Common Teal. Red arrows – directions of migratory movements.

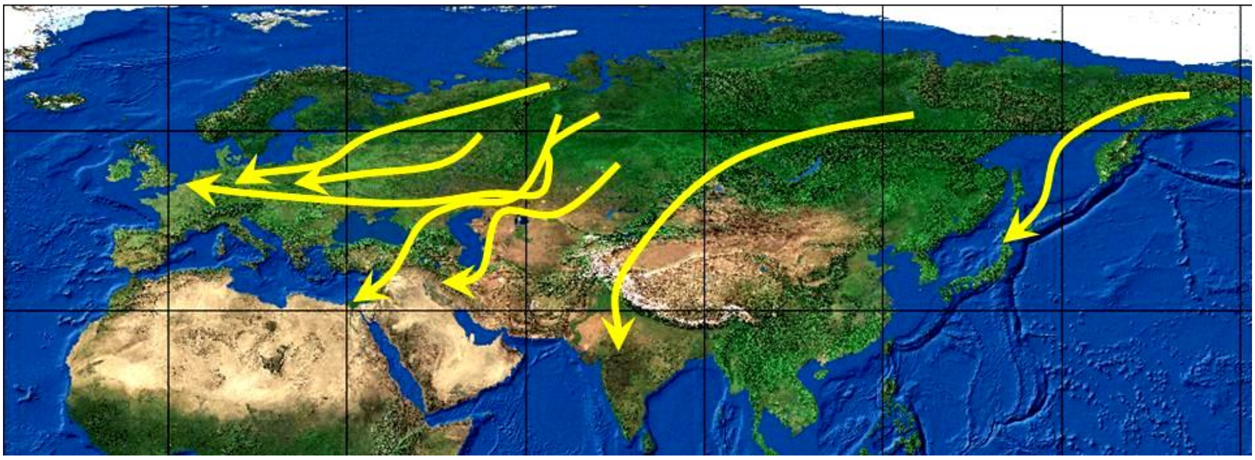


Figure 225. Outline of autumn migratory routes for Common Teal. Yellow arrows – main directions of migratory movements.

The phenomenon of bending the southern end of Ural Mountains in Common Teal is expressed in the specific way. In spring these ducks, flying to western Siberia, in the beginning bend the mountains. Later on, when migration progresses, they fly directly over these not high mountains. In autumn they bend southern end of Urals again. Probably, this connected with the time of the breeding onset. First birds in spring fly relatively early, and they have time to prolong their migration way. Ducks that fly later are more in a hurry: they try to make a bee-line to their breeding sites. In autumn there is no need for birds to move quickly, and they again choose longer, but likely more convenient way.

Speed. Bird Ringing Centre of Russia database contains several Common Teal direct recoveries with speed of movement about 400 km per day. This is probably the preferable speed of Common Teal on migrations.

Populations. As it has been shown above, Common Teal is less mobile than Wigeon. Besides that, Common Teal, although are capable to cover long distances, do not perform long-distance cross-population movements. Long distance migrations cause large size of the Common Teal populations. Absence of long cross population movements is responsible for the relatively lesser extent in the population overlap. Bird Ringing Centre of Russia ringing data allow outlining the following Common Teal populations: 1) iceland-all-european-north-african-west-central-siberian population (polygon No 1, Fig. 226) with generally west-east migratory movements; 2) south-east-european-middle-east-west-siberian population (polygon No 2, Fig. 226) with general north-east – south-west migrations; 3) indian-central-asia-west-central-eastern-siberian population (polygon No 3, Fig. 226) with north-eastern – south-western directions of migrations ; 4) japanese-south-korea-eastern-china-far-eastern population (polygon No 4, Fig. 226) with north-south migratory movements.

All populations overlap, but not in large extent. Intergradations zone is situated mostly in Western Siberia and in the past in the Volga River Delta.

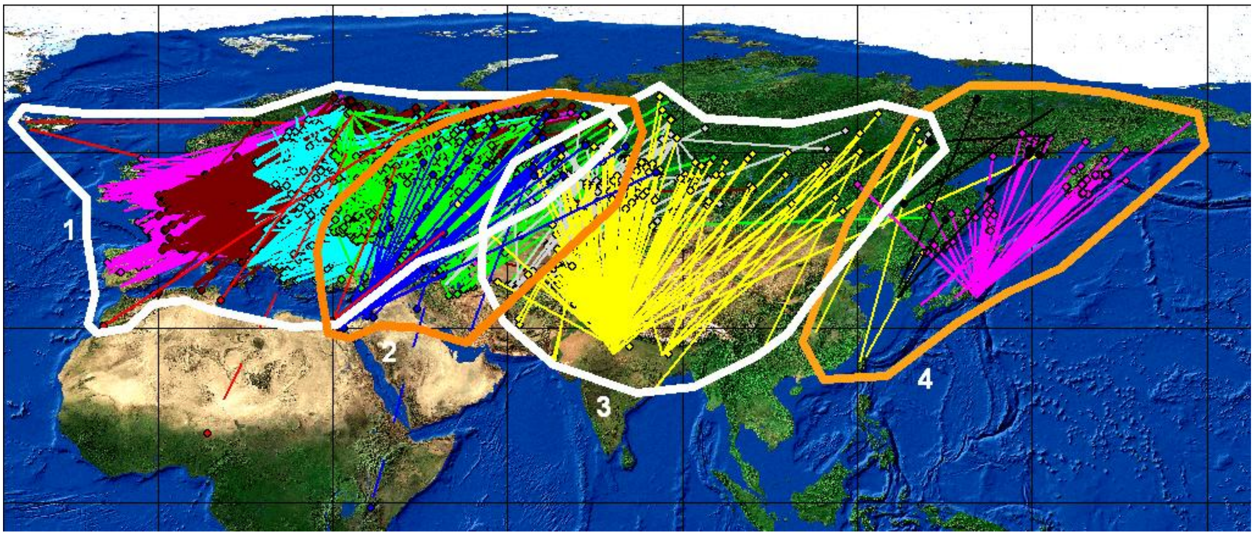


Figure 226. Common Teal populations. White polygon № 1 outlines iceland-all-european-north-african-west-central-siberian population. Light brown polygon № 2 is the south-east-european-middle-east-west-siberian population. White polygon № 3 outlines indian-central-asia-west-central-eastern-siberian population. Light brown polygon № 4 shows the japanese-south-korea-eastern-china-far-eastern population.

Ten-year distances. Mean flight distance in all Common Teal recoveries demonstrates definite increase through decades (Table 14).

Table 14. Common Teal mean flight distance per decade.

Decade (years)	1926-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2023
Distance (km)	1276.3	1529.7	1826.0	2197.8	2255.7	2075.3	2335.7	2430.3	2729.0	2924.0
Number of recoveries	9	215	168	1637	1757	707	366	106	173	209

There is a key place for revealing of the probable changes in migratory routes over long-term periods. This is the Volga Delta, a place which is located in the southern part of the breeding range. Ducks from there moved mainly in two directions (see recovery roses in different duck species): 1) to the breeding areas to western Siberia (usually in years next after ringing); 2) to the wintering grounds in Europe (both in the same and next years). In Common Teal, the same as in Wigeon, but in opposite to Mallard, Shoveler and probably Pintail, no significant changes found in the mean bearings of ducks, moving from the Volga Delta to Western Europe before 1971 and after 1970. It looks like Common Teal have used generally the same wintering sites in Europe during all decades of this species ringing.

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) of 26 November 2010, the oldest Common Teal lived 21 years 6 months. Bird Ringing Centre of Russia database contains confirmed recovery (ring sent) of the ring of „Moskwa" scheme E-59 944, adult bird ringed in the Volga River Delta on 04.08.1939, shot as „teal" on 03.05.1962 in Arkhangelsk Region, after 22 year, 8 months. Really this bird lived more than 23 years.

Mortality rate. According to the common criteria (see "Materials and Methods") 5202 dead recoveries are applicable for the mortality rate analysis. Mean annual mortality rate in Common Teal is 29.76±0.35%. Real mortality pattern differs from the theoretical one significantly (χ^2 = 3486, df = 21, P=0.0000). Programme MARK, Model CLogLog 2nd Part shows 30.26%, difference is 0.5% (Fig. 227). Teal is heavily exploited game species.

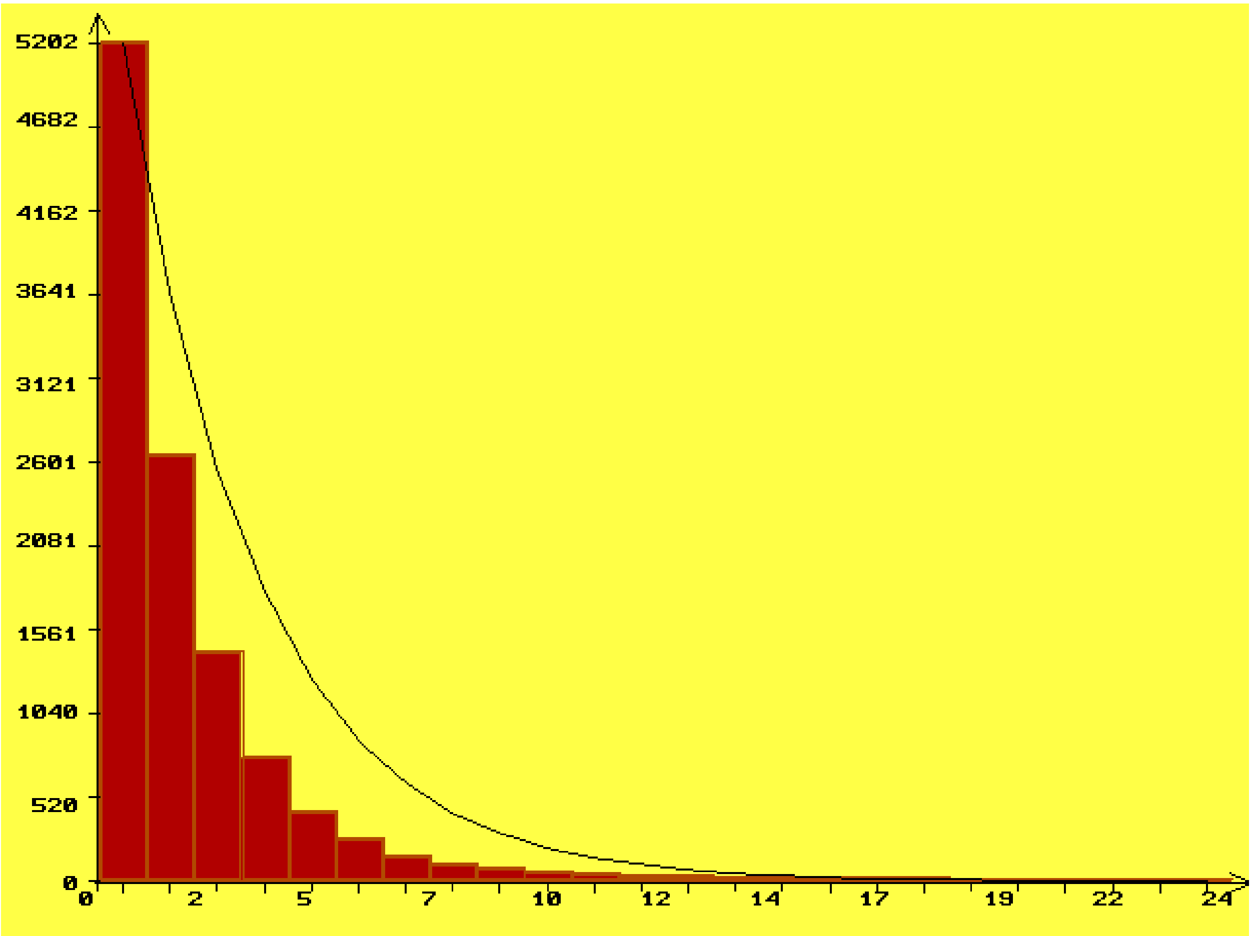
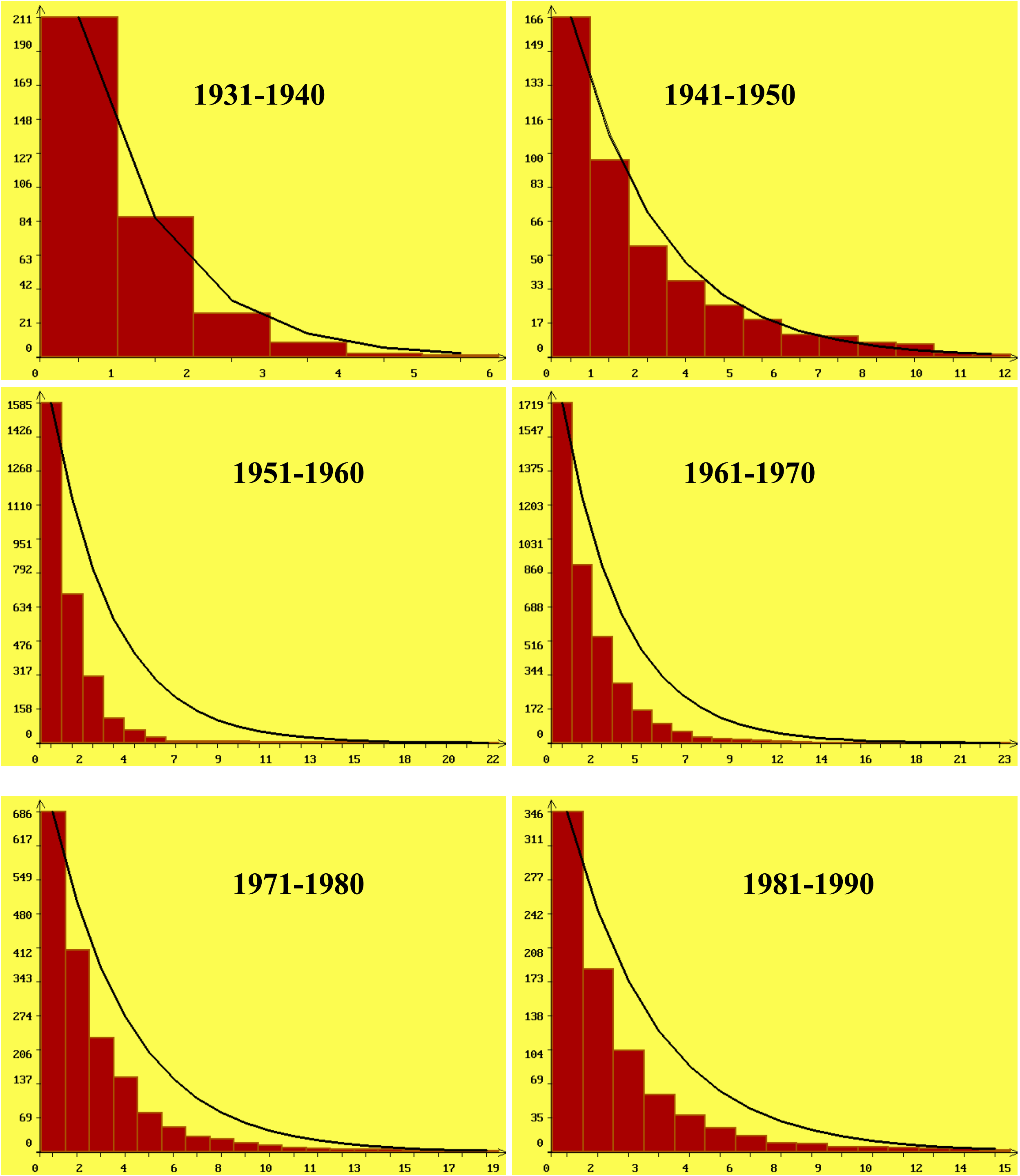


Figure 227. Mortality pattern in the Common Teal. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Since large amount of data is available, it is possible to analyse species condition dynamics over decades (Fig. 228). For 1930s and 1940s mortality pattern indicates good population (species) condition: real data are not very different from the theoretical line (Fig. 228: 1931-1940, 1941-1950). Then, for all subsequent decades the condition for the Common Teal has become not good. The Common Teal is not a meadow breeding bird (like, e.g., Pintail); therefore it did not suffer greatly during the World War II period in 1940s. Hunting during the war was not possible in Russia, because shotguns had been confiscated (Bianki, 2005). It fell under heavy hunting pressure in the next decade, 1951-1960. Situation with the species population slightly improved in 1990s, and then dropped down again (Fig. 228).



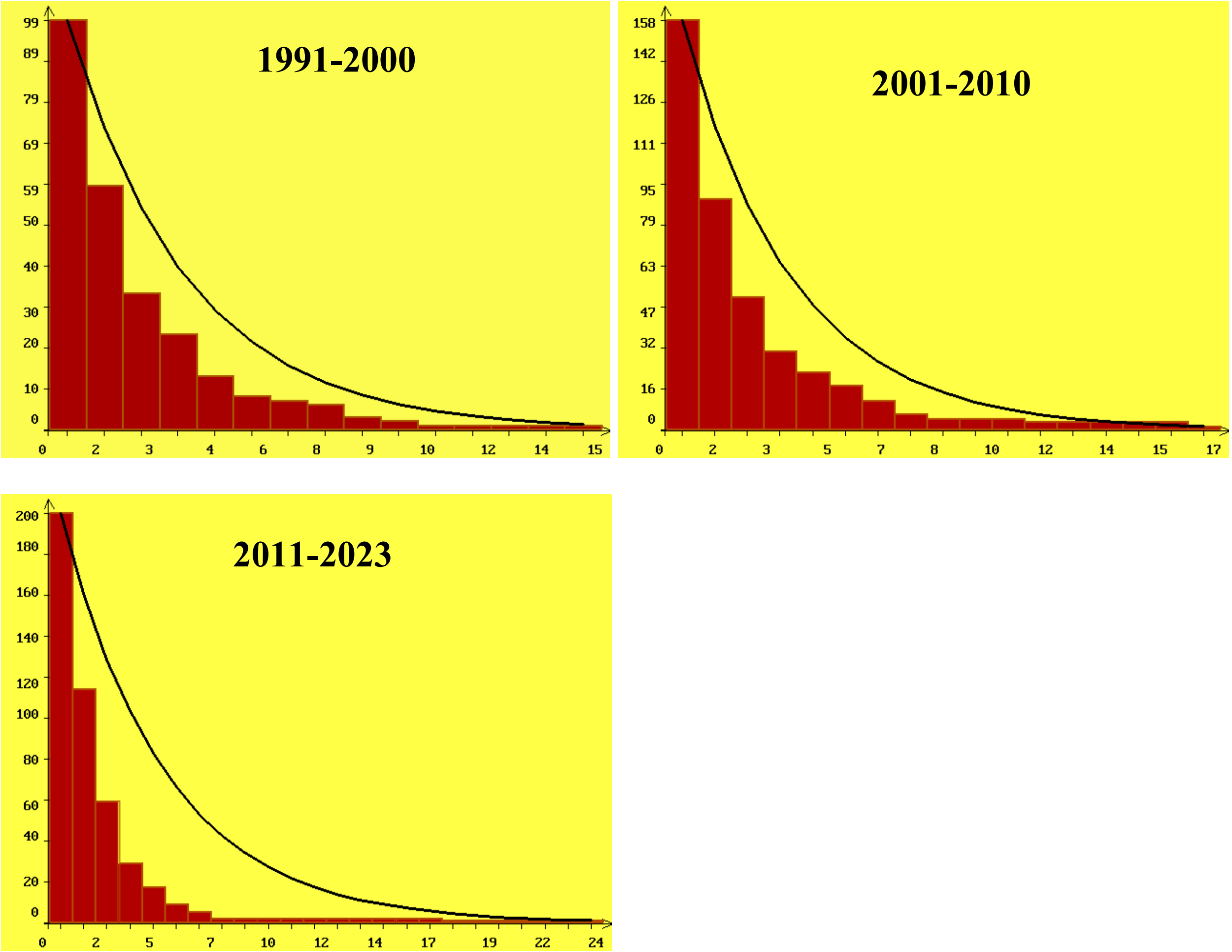


Figure 228. Mortality pattern in Common Teal recovered in different decades. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, males live almost significantly longer than females: 1.74±0.03 (N = 2739) and 1.63±0.05 (N = 1530) years respectively (t-Bailey=1.91, P=0.057). Female overall annual mortality rate is lesser than in males: 26.33±0.58% and 30.22±0.48% respectively (Fig. 229).

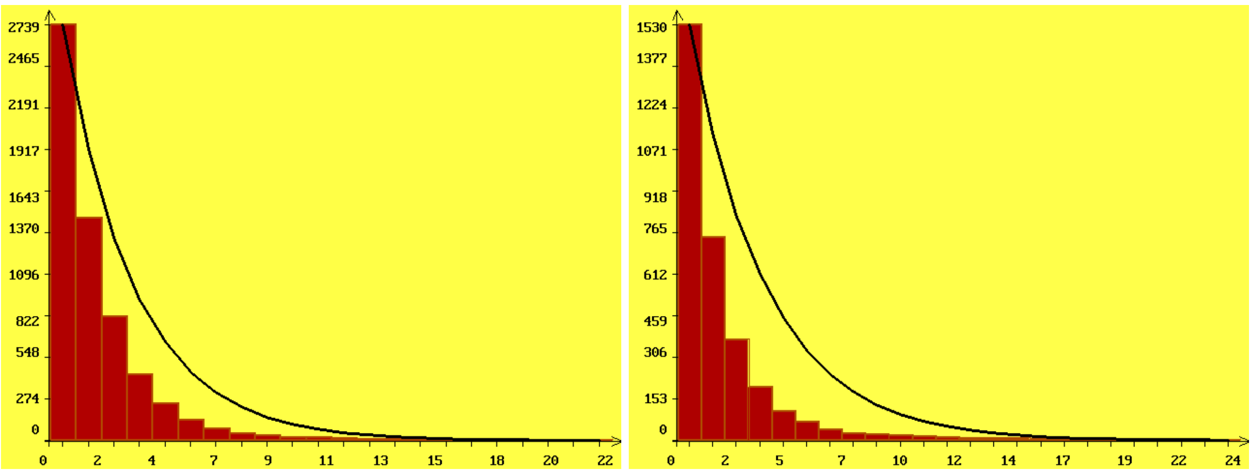


Figure 229. Mortality pattern in Common Teal: males (left) and females (right). X axis is the number of years after marking. Y axis is the number of live birds.

MALLARD
(*ANAS PLATYRHYNCHOS*)

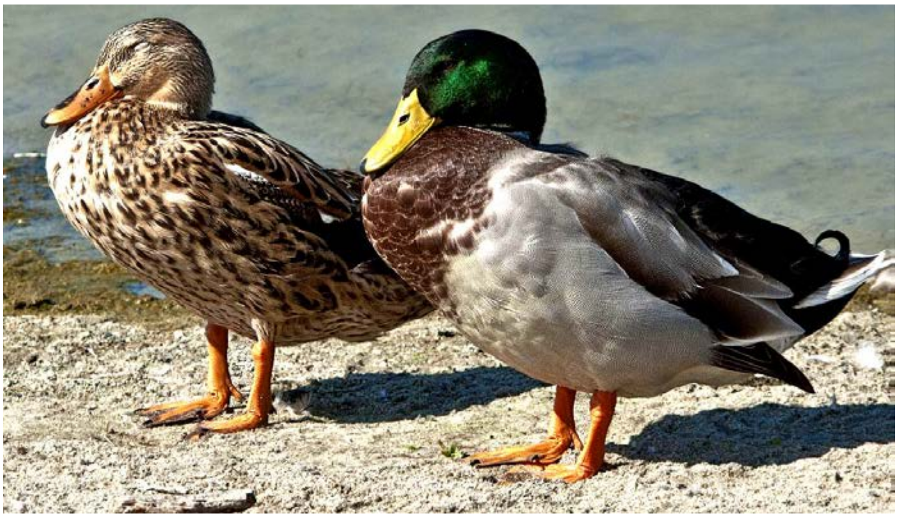


Photo by Nikolay B. Konyukhov

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 230. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

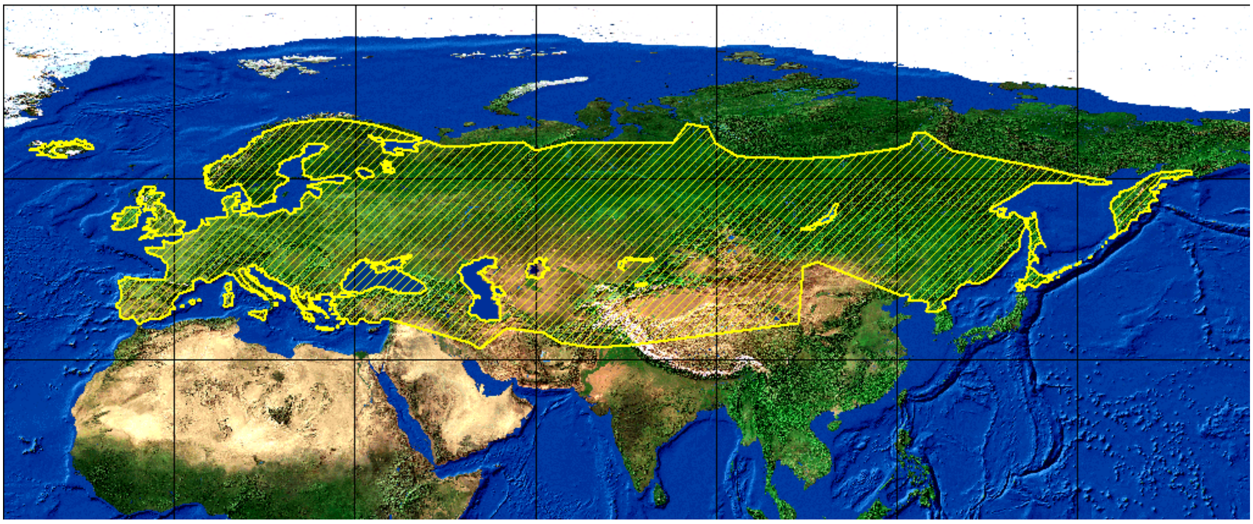


Figure 230. Breeding range of the Mallard Duck in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 7356 marked birds were used, which gave 7378 recoveries (Fig. 231), 68 of them held different kind of colour marks: colour rings, wing-tags, nasal marks or neckcollars. 3 birds carried radio transmitters. 7336 birds gave one recovery per duck, 19 – two recoveries, 1 – 4 recoveries. The latter was a bird with metal ring, no colour marks were added. Ringing dates are since 19.05.1926 until 29.12.2022, recovery dates are since 14.01.1927 until 03.05.2023. Several recoveries were recorded far to the north outside of the species breeding range.

This duck is very wide-spread in Eurasia. In addition to wild populations it contains many captive, escaped and feral groups, introduced and urban populations, also large groups reared in captivity and released for hunting. E.g., 14 mallard females were ringed as game attractive ducks and escaped, etc. All these cohorts of birds were ringed and recovered. Sometimes even it is not known what kind of bird is ringed. Therefore, we consider all recoveries in one pool. But the greatest bulk of ringed and recovered birds, nevertheless, are the wild ones.

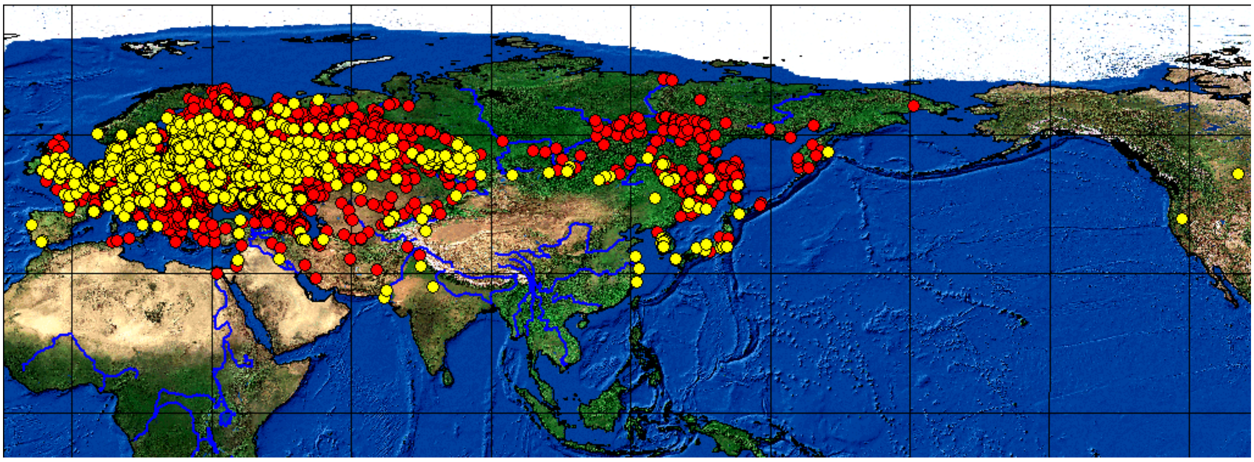


Figure 231 Position of all Mallard control points. Yellow dots – ringing sites, red dots – recovery sites.

Most of Mallards were ringed in Europe and Western Siberia; most of recoveries are from those areas, as well. Two birds recovered in Russia were ringed in North America. There is one more concentration of recoveries in the eastern Siberia and Far East. There is a noticeable gap within recovery area in the Central Siberia with very few recoveries in it (Fig. 231). This gap is real and cannot be referred to the low human population, because different duck species has this Siberian gap in different areas. Areas from both sides of such gaps are filled with recoveries in spite of low human population densities there (see the example with Pintail and Wigeon in the section "Material and Methods").

'Moskwa' scheme recoveries. This sample contains 4253 recoveries of the scheme „Moskwa". They are from birds ringed within the Russian Federation and countries of the former USSR (Fig. 232).

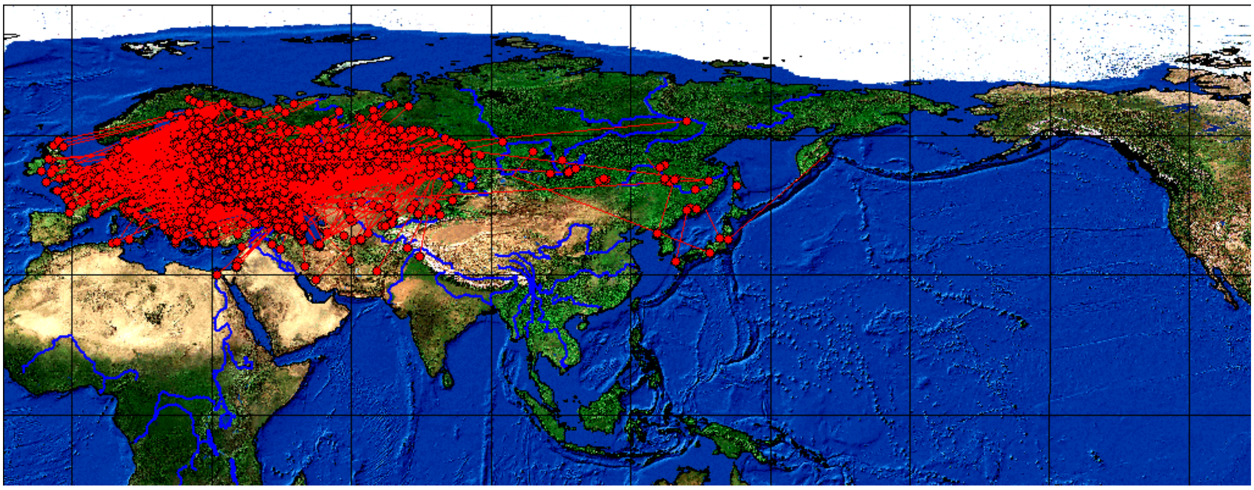


Figure 232. „Moskwa" scheme recoveries of the Mallard Duck. Here and on all other similar figures lines start from the ringing sites, recovery sites are marked with red dots.

Finding details. This analysis includes all 7356 recoveries. Almost 3/4 of recoveries (75%) are „shot". In 1318 (19%) recoveries „details unknown", which practically mean shot, as well. Therefore, we can assume that 94% of birds were shot. Other reasons are not so common (Fig. 233).

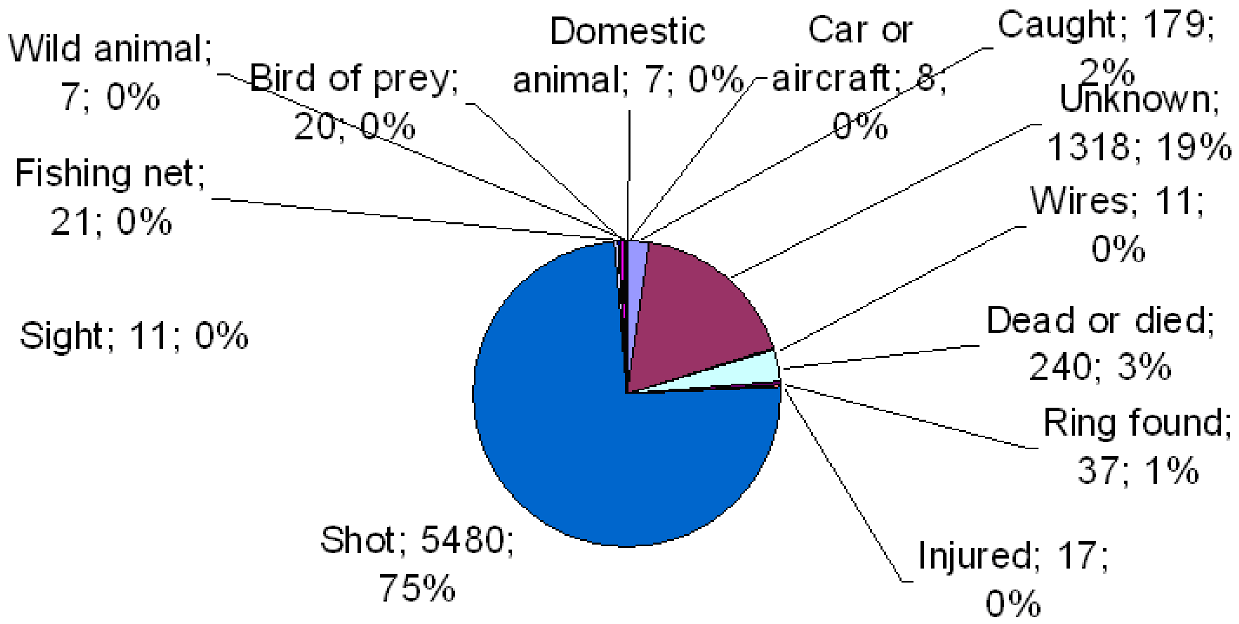


Figure 233. Finding details in the Mallard Duck.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries differ from each other. Cross-population movements, especially between farthest populations, more often occur in indirect recoveries. (Figs 234 and 235).

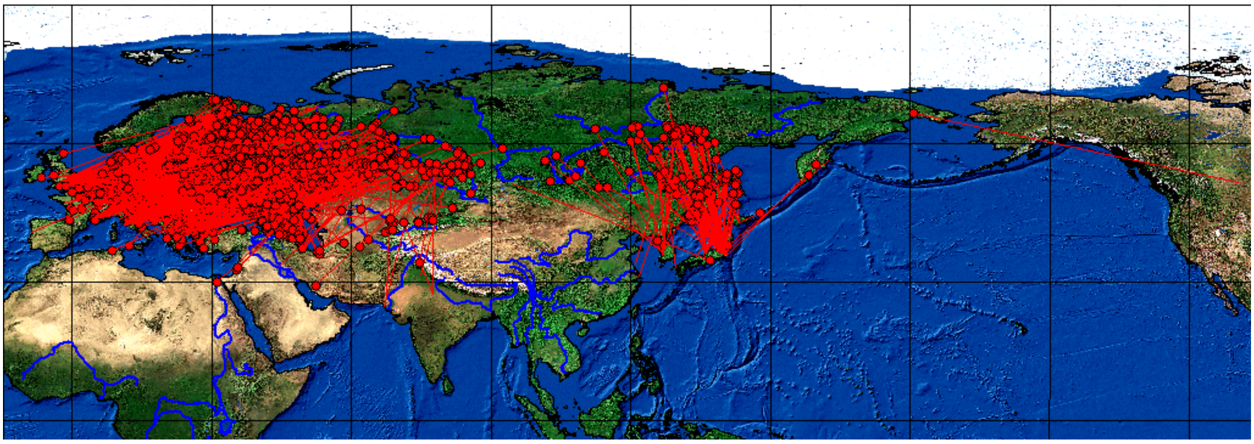


Figure 234. Map of the Mallard duck direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

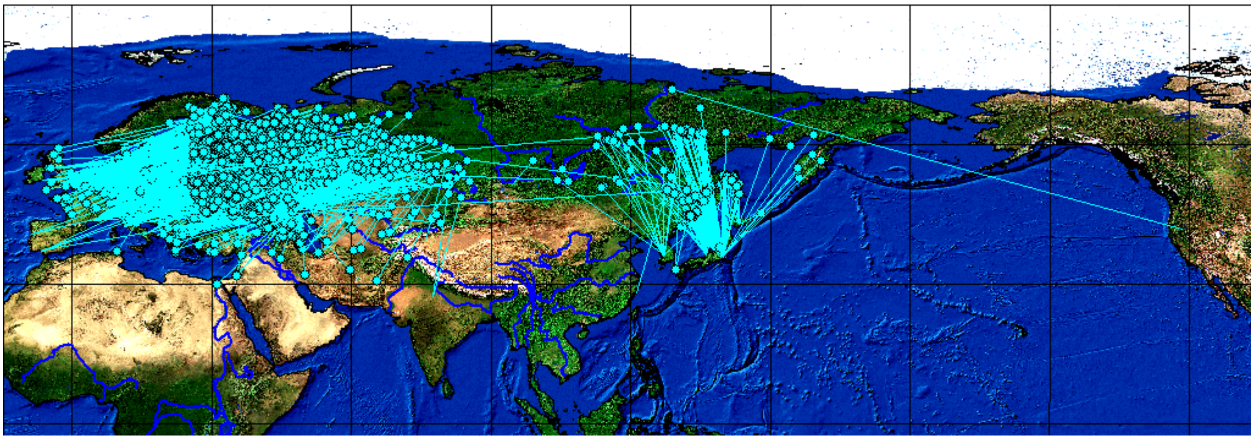


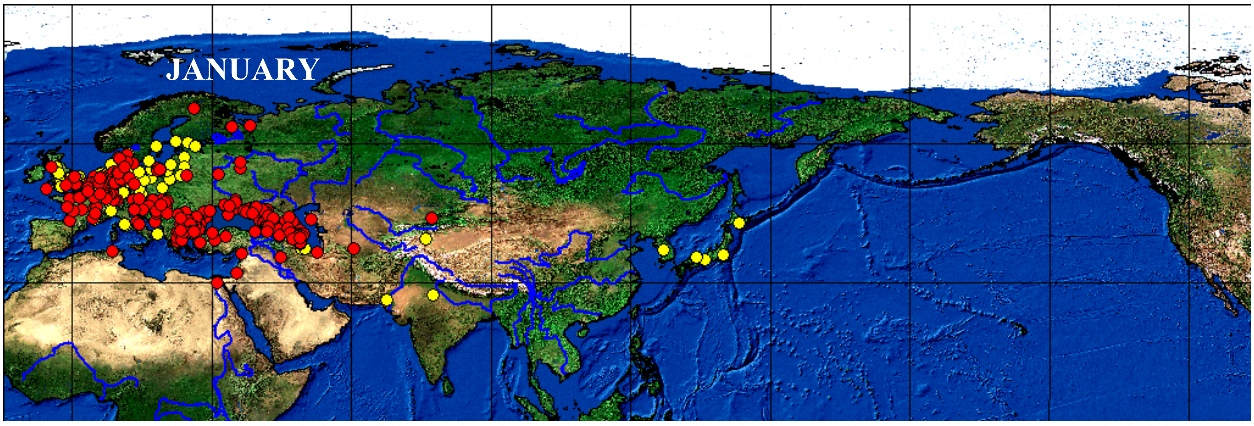
Figure 235. Map of the Mallard indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

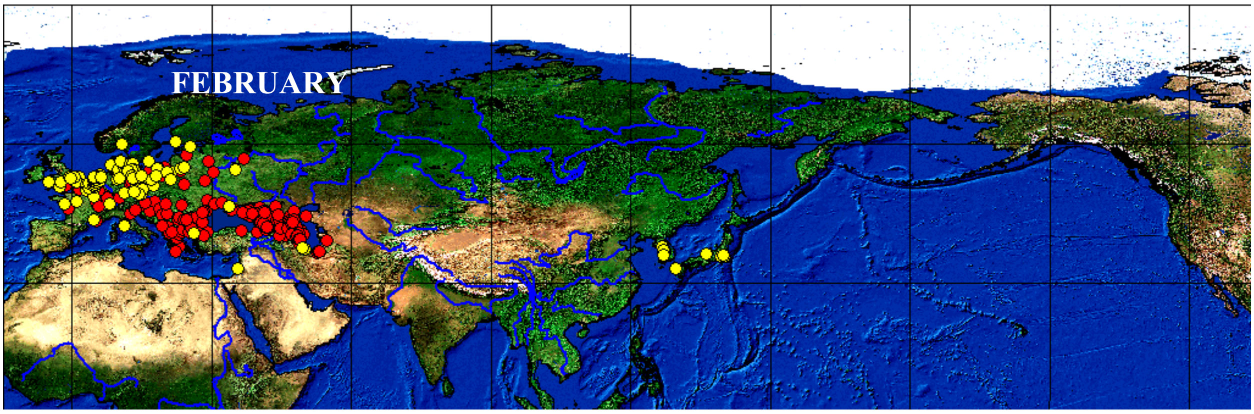
Maps clearly indicate that Mallards wintering in Europe fly to breed to the European Russia and southern half of western and central Siberia approximately up to meridian 85˚E (Fig 234). Most birds that winter in Japan and South Korea breed in the Far East and Eastern Siberia approximately up to meridian 115˚E from the east. Between 85˚-115˚E there is the inter-population gap area with very few recoveries. This area is expected to host breeding Mallards wintering in India and Pakistan. Then China-wintering birds should breed more to the east. However, we have only 6 recoveries of the „Bombay" scheme, 1 recovery of „China" scheme and 2 recoveries of the „Hong Kong" scheme. This means, that either very small amount of Mallards winter in India and China or the number of ringed birds of this species is very small.

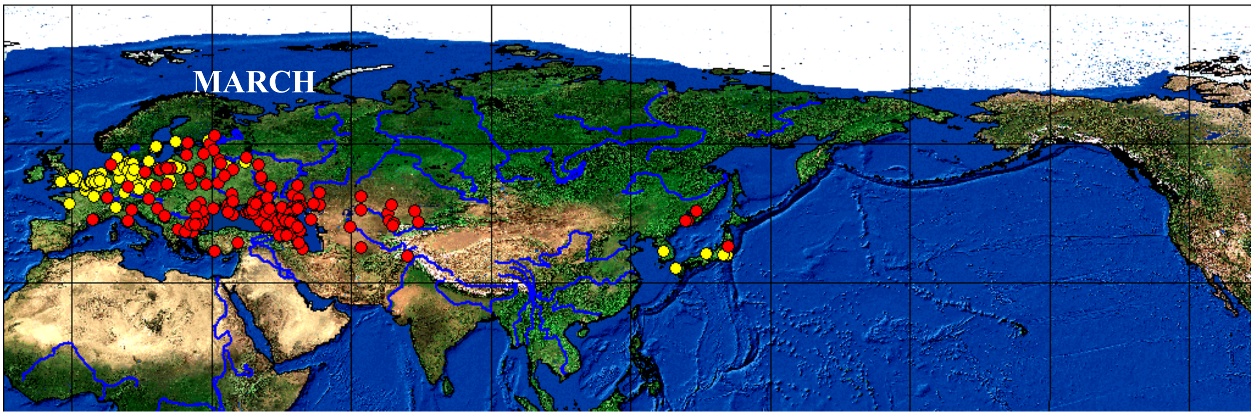
Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them (χ^2 = 17.7, 3810 direct recoveries and 3568 indirect ones, df = 2, P = 0.0001). Really, the difference between centers of areas is very small: just 37" over the latitude and 59" over the longitude. However, samples are very large; therefore even a small difference can be significant. Unusually, the number of direct recoveries is greater than indirect ones; this might be additional indicator of the heavy huntable species. Average flight distances in direct and indirect recoveries are very different: 944.2$\pm$14.4 and 1276.1$\pm$14.2 km respectively. Difference is highly significant – t-Bailey = 16.4, P=0.0000. This confirms mentioned above, that long cross-population exchange show up mostly in indirect recoveries.

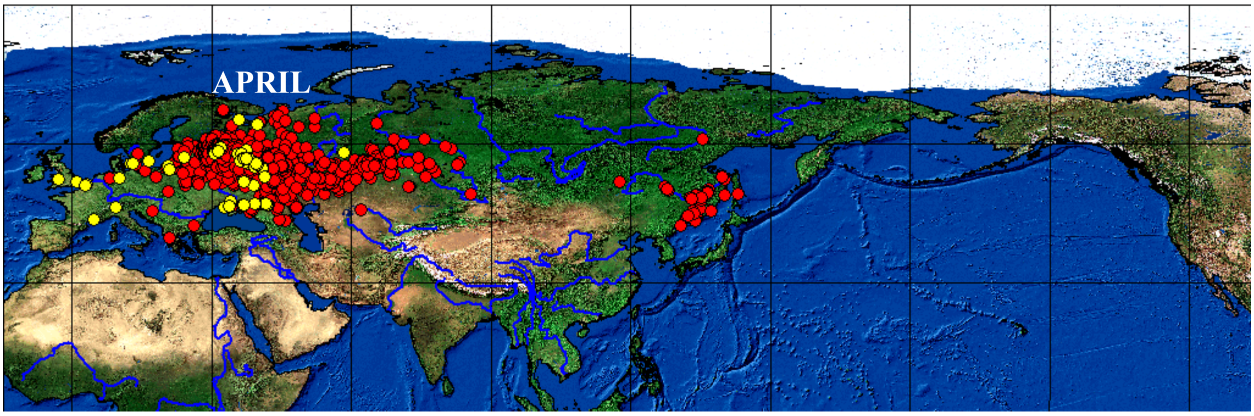
Monthly movements. All direct and indirect recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in Mallards (Fig. 236). In January and February most ducks are on wintering grounds in the western and southern Europe Cis- and Transcaucasia, Central Asia, India, South Korea and Japan. In addition, in these months there are some recoveries outside of the wintering areas but within normal breeding range. These recoveries belong to the newly formed sedentary urban or near-urban categories of Mallards (January and February, Fig. 236). In March migratory movements are well noticeable in all Mallard populations. Birds from Western Europe move to the east, north-east, from southern Europe and Caucasus area – to the north-east, from India and Pakistan – to the north, from South Korea and Japan – to the north as well. It is noticeable from the position of the new appeared green dots, which point to the recovery sites (Fig. 236, March). April is the peak of migration of the European and western Siberian birds, already in April most of then arrive on their breeding grounds and start breeding. Concentration of the April recoveries within the „strip" posed from south-eastern European Russia – northern Kazakhstan – southernmost Western Siberia (Fig. 236, April) indicates that during spring migration from Europe to western Siberia Mallards normally do not cross Ural Mountains, but bend them around the southernmost edge. In May birds that appear in Western Siberia turn and move to the north. In the Far-Eastern ducks migration shows lesser progress in April. May is the finishing of migration of all Mallards, breeding season is in the full swing. In June, July, August birds are on their breeding grounds. However, in July a great number of birds, males and non-breeding or failed females move to the moulting areas. This time is very convenient to catch and ring adult birds, and positions of the ringing sites (Fig. 236, July) show that for moult Mallards, the same as other dabbling ducks (see species accounts), move closer to wintering areas. The latter is in distinction to several geese species that fly to moult farther from wintering grounds. In August breeding birds start to move southerly and westerly. Although most ducks after moult fly in the direction to wintering grounds, some birds after moult perform the backward flights. Instead of moving to the wintering areas, they fly again to the north and east in the direction to breeding areas (Fig. 237), however they will not breed at this time. This feature, which at first has been found in Gadwall (Kharitonov, 2002), really is characteristic for several dabbling duck species.

In September Mallards occupy about the same area as in August. In October the area with control points shrinks. In September and October the concentration of recoveries in the south of Western Siberia and northern Kazakhstan indicates the same phenomenon as in spring: on their autumn migration to wintering grounds in Europe Mallards bend the Urals over the southern end, as well. In November autumn migration is continuing. In December recovery pattern looks like the one in January and February (Fig. 236, December, January). However, for the reason of broad Mallard wintering area in Europe, we possibly do not notice migration movements within this area if they exist. For checking it, it is convenient to use Mallard ringed as chicks (as „pull" or „juv") in Latvia, where many Mallards have been ringed. Mean distance from ringing to recovery sites for these ducks in November is 917 km (N=15), in December – 1021 km (N=17), in January - 1335 km (N=14), in February – 1298 km (N=4). These calculations show that in December Mallards could still migrate, and only in January and February they stay on their wintering grounds.





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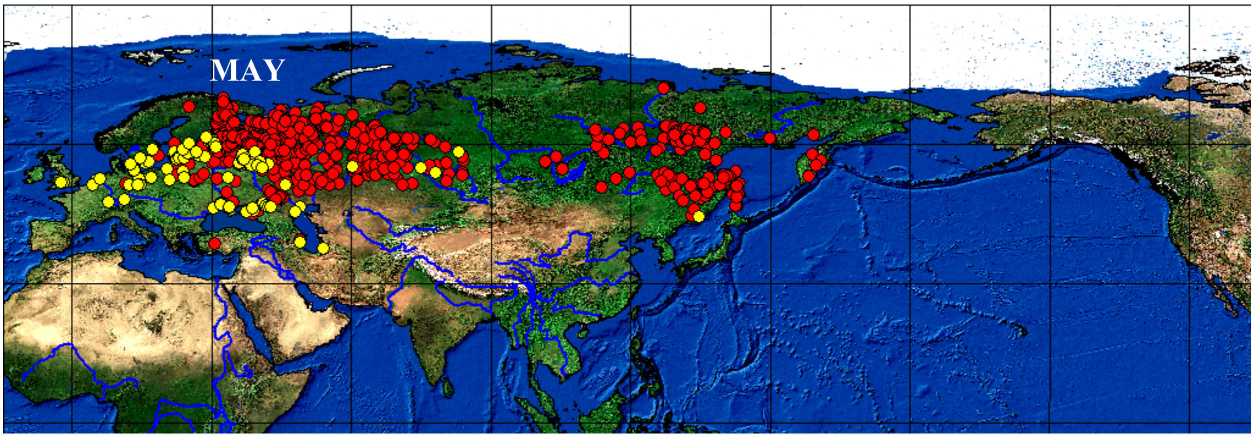
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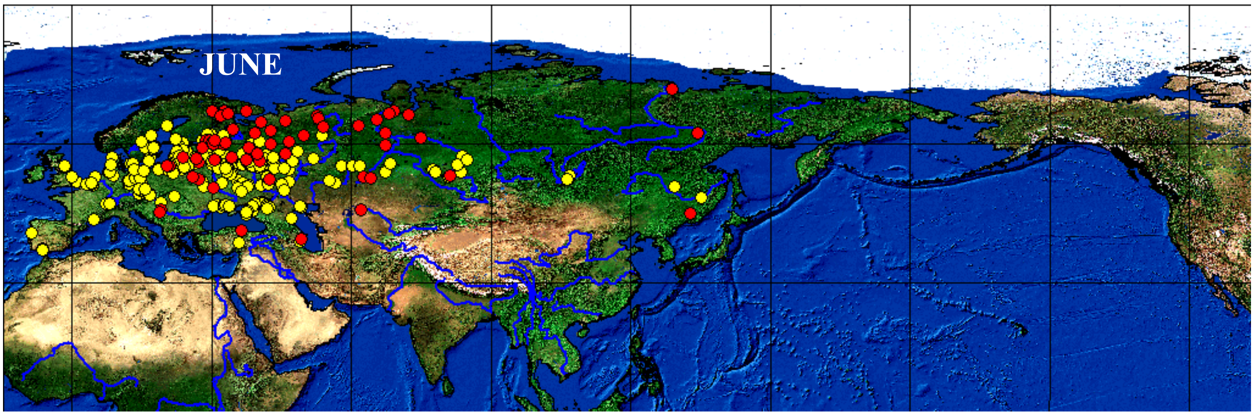
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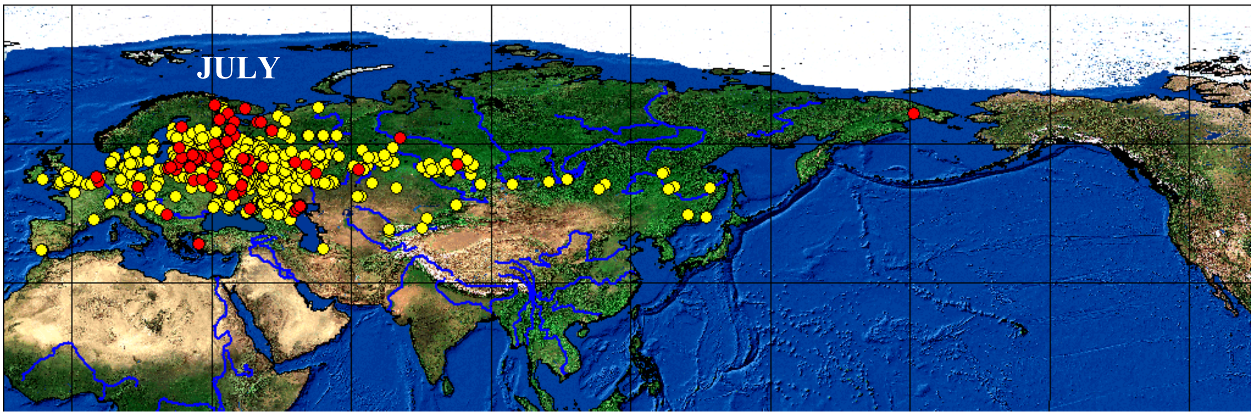
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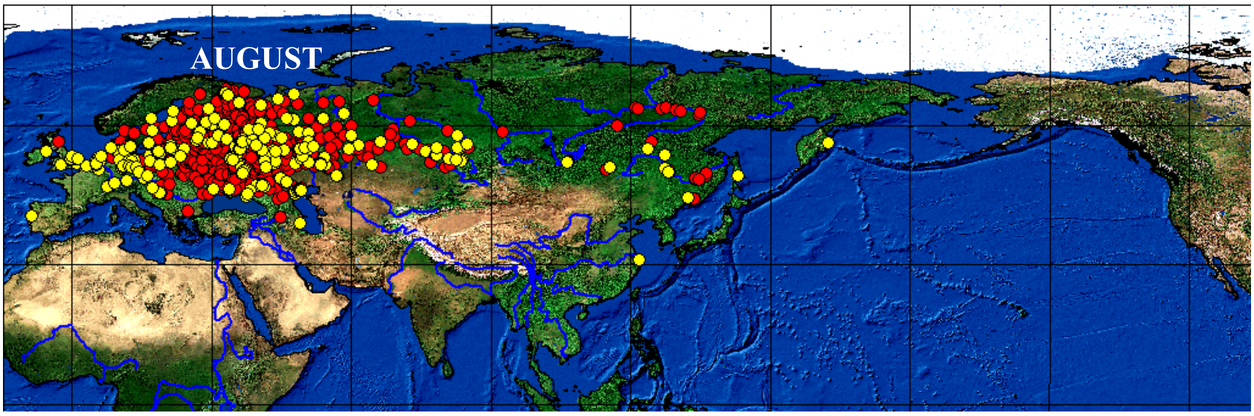
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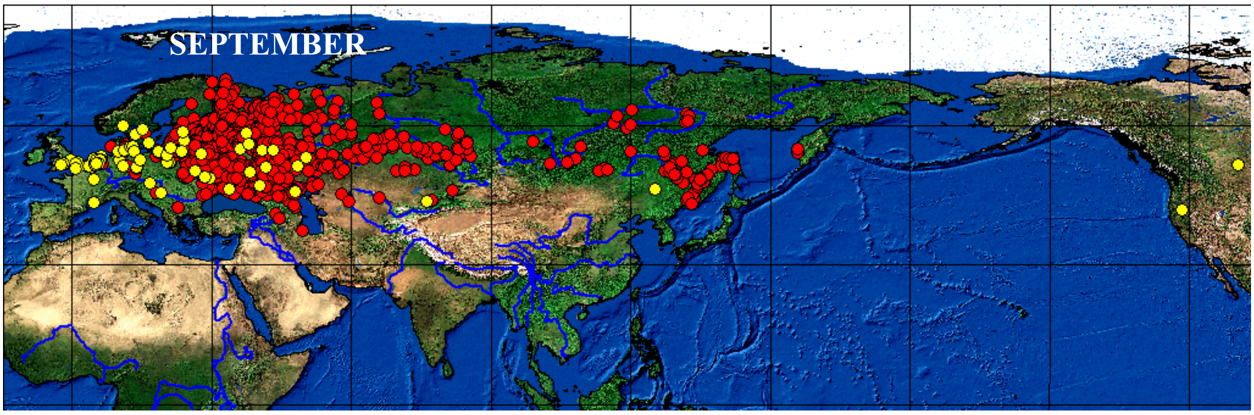
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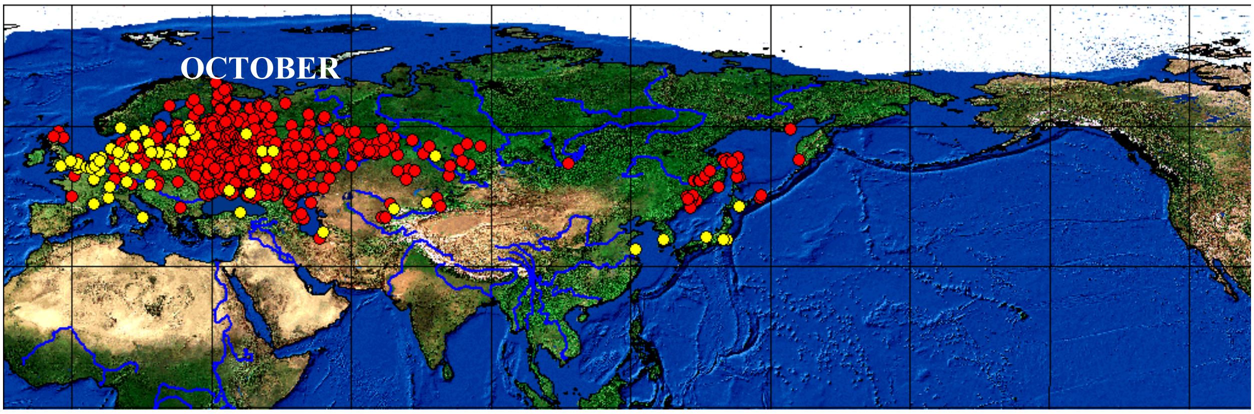
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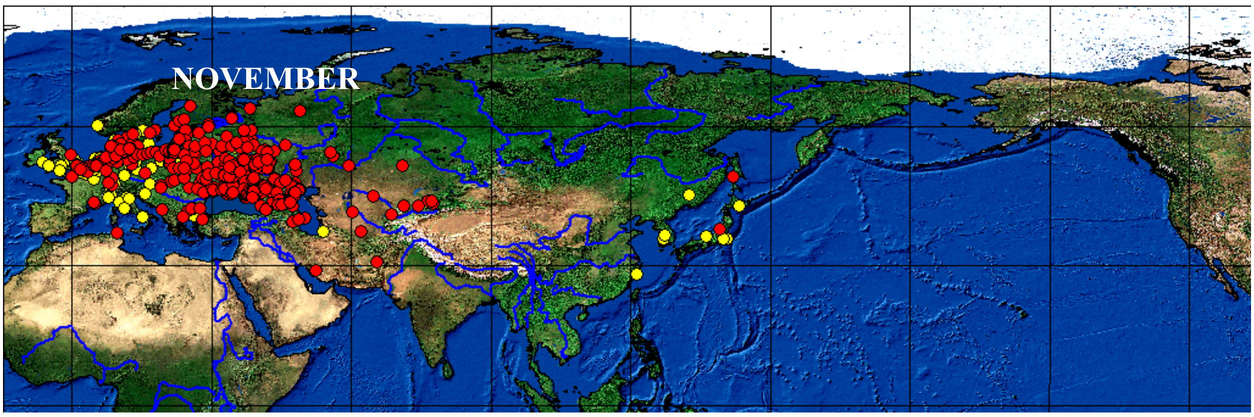
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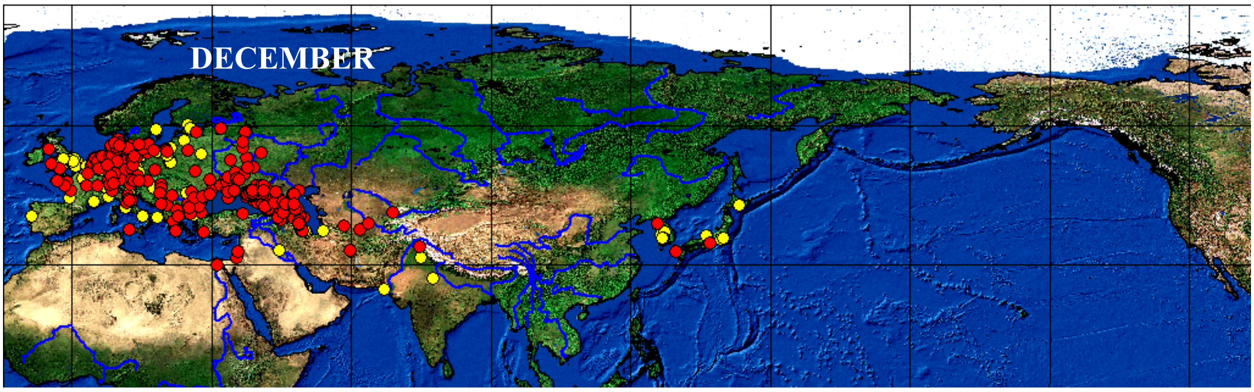


Figure 236. Mallard monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

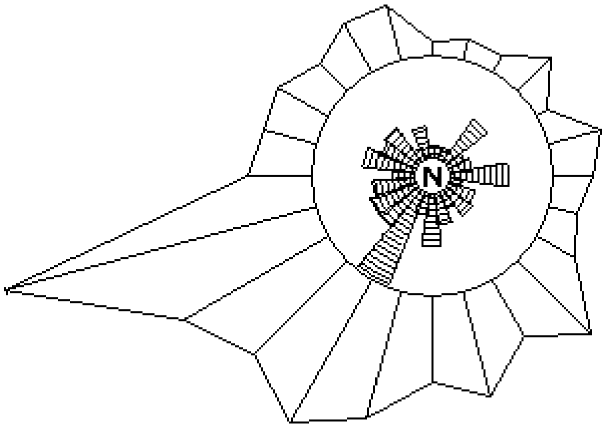


Figure 237. Recovery rose graphs for Mallards ringed in July and recovered during 60 days after ringing: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts). Sector = 15.0°; Total recoveries - 303; N in sectors: from 3 up to 20; Average distance in sectors: from 30.7 km up to 794.0 km; The longest flight distance is 2486.5 km.

Migratory routes. As it was preliminary shown in the section “Monthly movements”, Mallards from different wintering areas migrate to different directions. Birds that ringed in areas with longitude <=30˚E move to the east, north-east in spring (bearings 37-82˚, Fig. 238), and in opposite direction in autumn. For birds ringed in the area with longitude 30˚-60˚E preferable flight bearings are 22-67˚ in spring and 217-247˚ in autumn. For those ringed in 60˚-85˚E preferable bearings are 152-172˚ and 202-217˚ in autumn, and opposite in spring. For Far-Eastern birds, ringed in Japan and South Korea, spring flight bearings are 322-8˚ (Fig. 238), and the opposite in autumn.

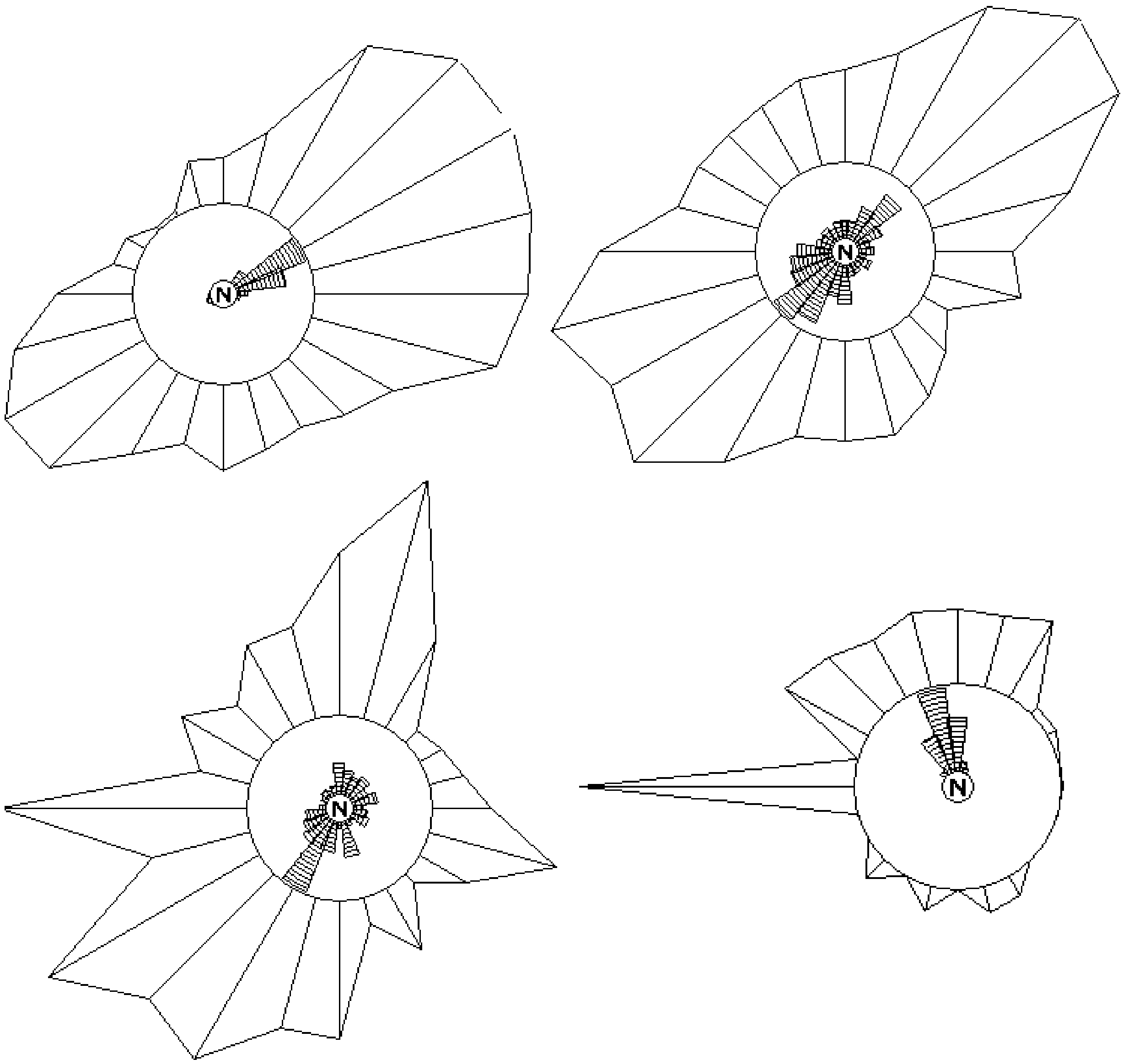


Figure 238. Recovery rose graphs for Mallards, ringed in different longitudes: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Upper left chart is for European wintering birds, area of recoveries from Netherlands to western Siberia, to 85˚E. Sector = 15.0°; Total recoveries - 3055; N in sectors: from 1 up to 1246; Average distance in sectors: from 29.8 km up to 1731.7 km; the longest flight distance is 6113 km.

Upper right chart is for Mallards ringed in the southern European Russia, area of recoveries from Netherlands to western Siberia, to 85˚E. Sector = 15.0°; Total recoveries - 3749; N in sectors: from 42 up to 350; Average distance in sectors: from 151.0 km up to 1278.4 km; The longest flight distance is 4849 km.

Lower left chart is for Mallards ringed in Western Siberia, Central Asia, India and Pakistan, area of recoveries from European Russia to western Siberia, to 85˚E; Sector = 15.0°; Total recoveries - 178; N in sectors: from 1 up to 21; Average distance in sectors: from 88.6 km up to 1770.3 km; The longest flight distance is 3797.3 km.

Lower right chart is for Mallards ringed in Japan and South Korea, recoveries are mostly from the Russian Far East, east of 115˚E; Sector = 15.0°; Total recoveries - 364; N in sectors: from 0 up to 138; Average distance in sectors: from 0.0 km up to 7593.7 km; The longest flight distance is 7593.7 km.

Preferable flight distances both for direct and indirect recoveries are less than 3200 km, maximal flight distance of the indirect recoveries is 7594 km (Fig. 239).

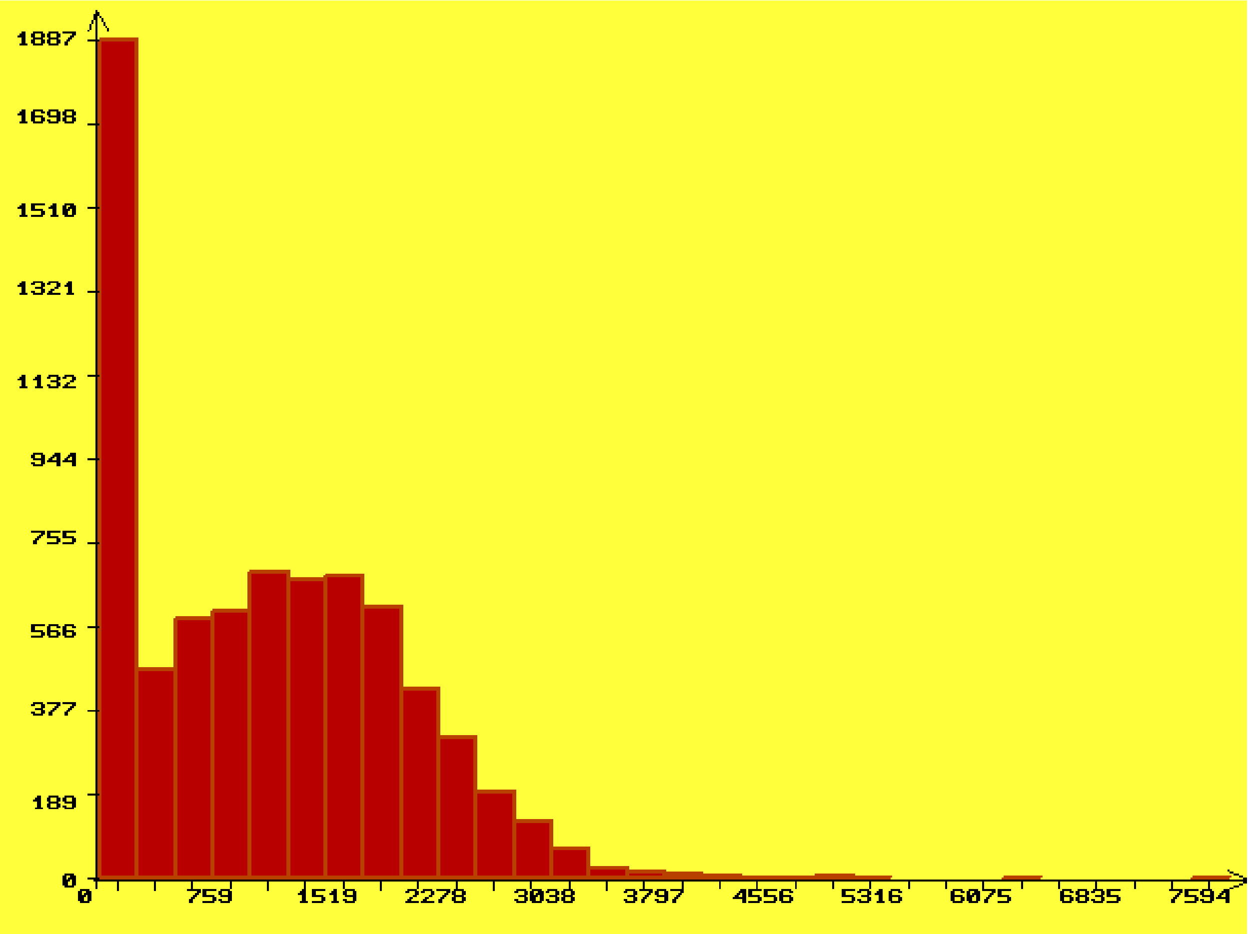


Figure 239. Distribution of all ring-recovery distances in Mallard. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in Mallard young birds (ringed as „pull" or „juv" or „1 y") is much less than in adults: 791.4±17.7 and 1251.8±12.1 km respectively (N_{young} = 2387, N_{ad} = 4991, t-Bailey=21.20, P=0.0000), which is characteristic for heavily hunted species. Male mean flight distance is about the same as in females: 1242.9±13.8 and 1255.8±21.1 km respectively (N_{males} = 3634, $N_{females}$ = 1812), insignificant difference.

Before outlining the Mallard migratory routes and for revealing the migration process in more detail, we should plot monthly means for Mallards, ringed in different places. Mallard is the early breeding duck. It is confirmed by the fact that the most northern and eastern monthly mean falls on May. This is illustrated by the examples of ducks ringed in Great Britain, Netherlands and in the former huge moulting place for different duck species in the Volga River Delta (Figs 240–243). (Now this moulting area no more exists because of Caspian Sea level growing (Viksne et al, 2010)). Already in June and especially in July part of birds (males, non-breeding females and failed females) move from the breeding grounds to moulting places, which located in the direction from breeding grounds to the wintering areas. In August mostly birds from other category are recovered. These are successful breeders, moulting closer to the breeding sites than ducks, encountered in June and July. This is the main reason for the „loops" of monthly means through May-June-July-August. However, these loops are partly real, because some birds after moult move backward to the north and east breeding grounds (the latter is shown in the section "Monthly movements").

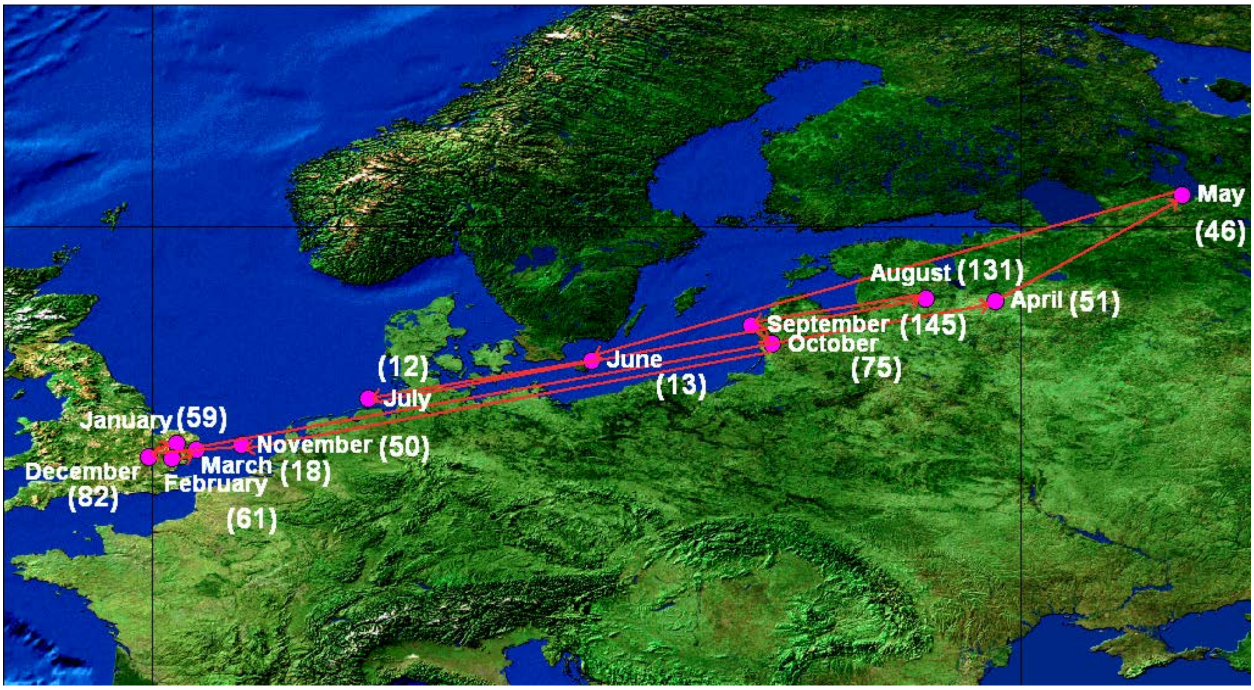


Figure 240. Mean monthly locations of Mallard control points for birds, ringed on the wintering ground in Great Britain. Purple dots are mean monthly locations of ducks. Arrows show directions of movements. Number of control points in each month is represented in parentheses.

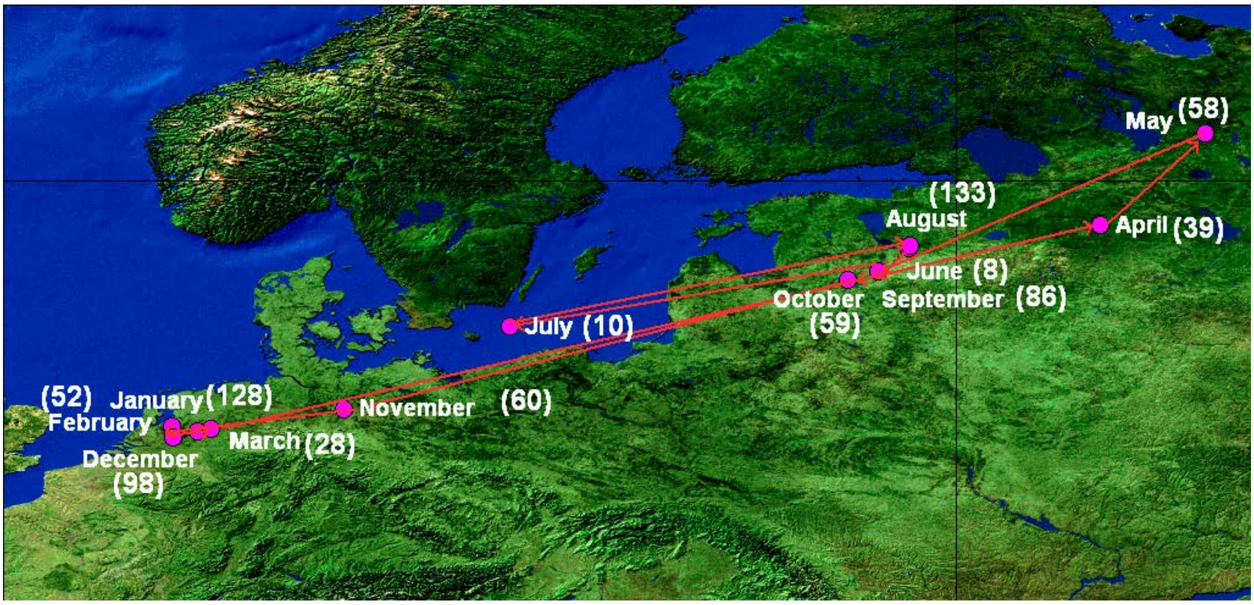


Figure 241. Mean monthly locations of Mallard control points for birds, ringed on the wintering ground in the Netherlands. Purple dots are mean monthly locations of ducks. Arrows show directions of movements. Number of control points in each month is represented in parentheses.

During migration Mallards could form migratory loops, in the same way as described for Common Teal and Shoveler. In European breeding birds these loops curled in counter clockwise direction, the same as in the White-fronted Goose and Common Teal (see species accounts), but in lesser extent. This loop is well visible for ducks, ringed in Latvia (Fig. 242).

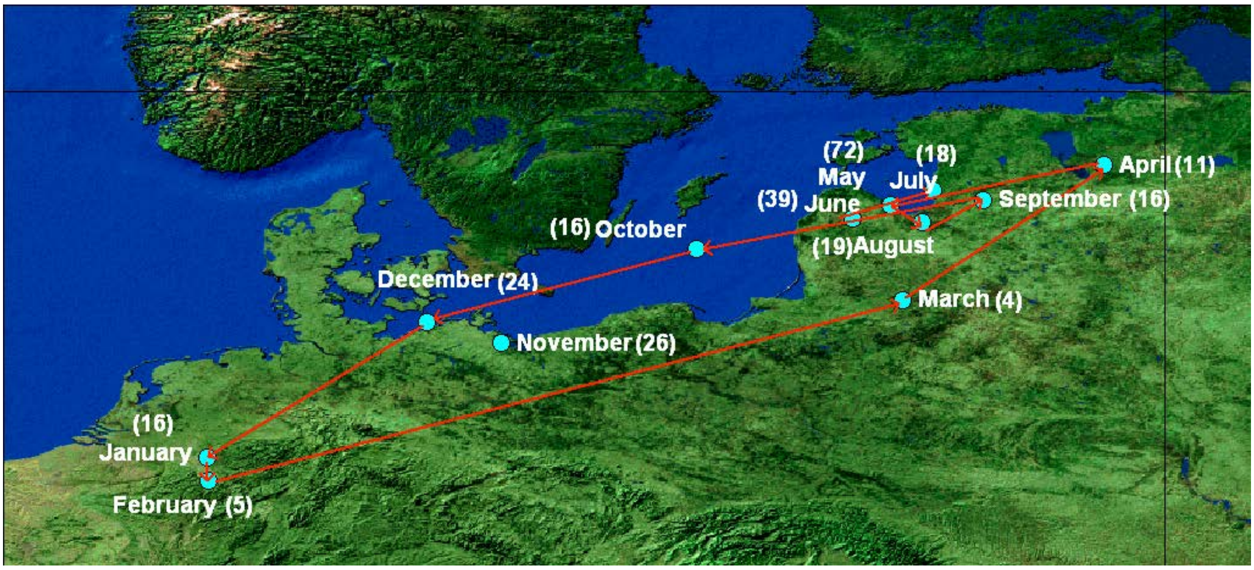


Figure 242. Mean monthly locations of Mallard control points for birds (mostly young), ringed on the breeding grounds in Latvia. Blue-green dots are mean monthly locations of ducks. Arrows show directions of movements. Number of control points in each month is represented in parentheses.

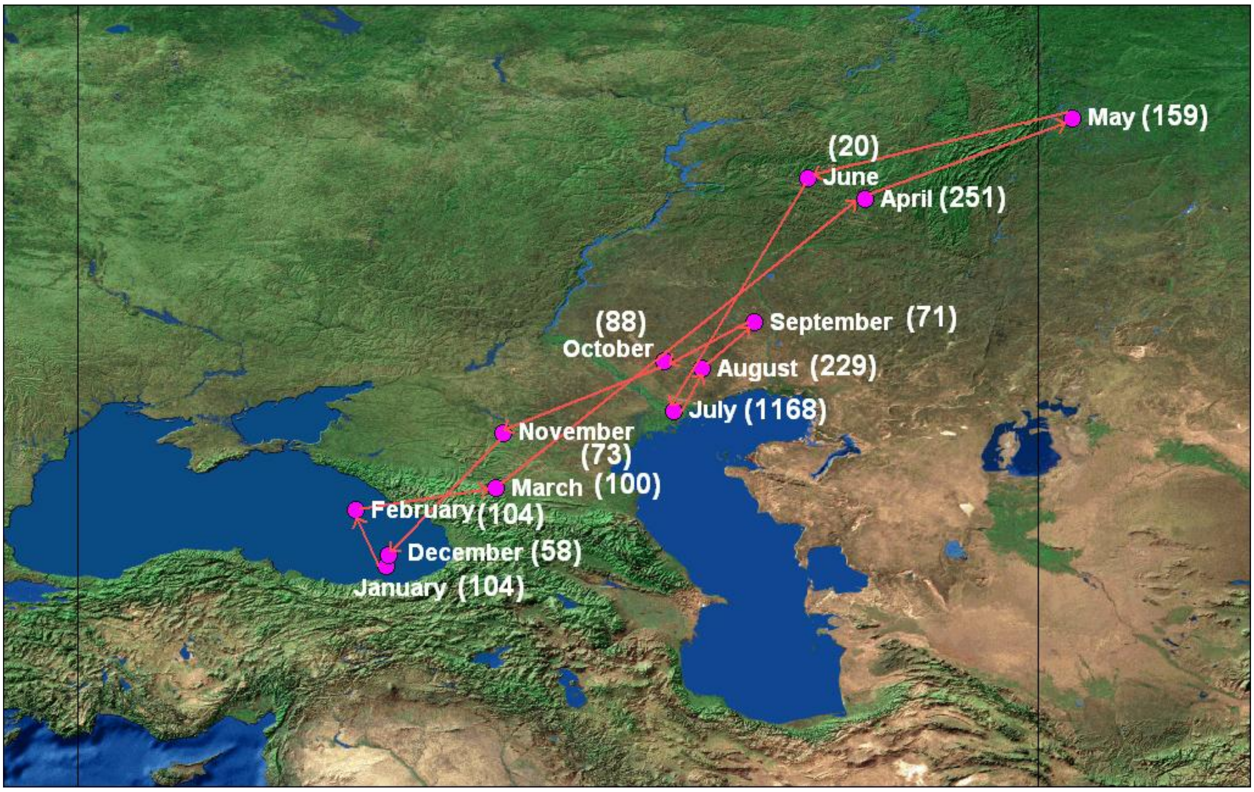


Figure 243. Mean monthly locations of Mallard control points for birds, ringed in the Volga River Delta. Purple dots are mean monthly locations of ducks. Arrows show directions of movements. Number of control points in each month is represented in parentheses.

Monthly means do reflect the whole areas, occupied by recoveries from Mallards ringed in different places. For the purpose of outlining recovery areas we plot them in Fig. 244. From this map it is clear, that birds from Great Britain, Netherlands and France fly to breed both to the European Russia and western Siberia. As it is shown in the section "Monthly movements", Mallards penetrate from European Russia to Western Siberia throughout the „southern gate": area between the Caspian Sea and southernmost edge of the Ural Mountains.

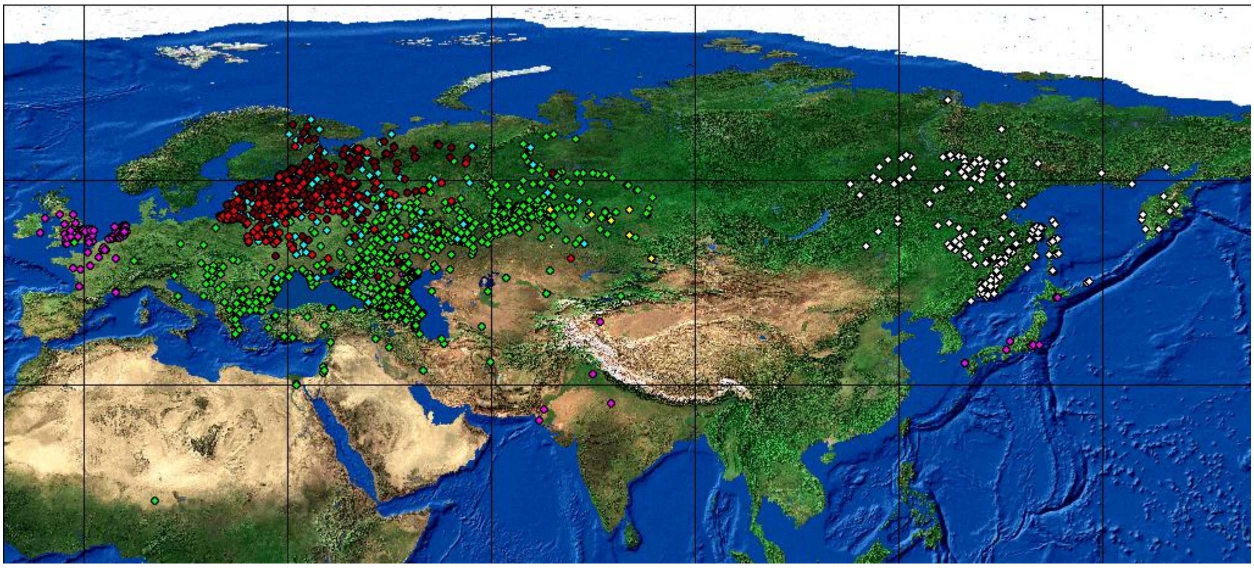


Figure 244. Positions of the recoveries of Mallards ringed in different places. Purple dots represent ringing sites, blue-green dots are recoveries from birds ringed in Great Britain, red dots – for birds ringed in France, brown dots – ringed in the Netherlands, green dots – ringed in the Volga River Delta, yellow dots – ringed in India and Pakistan, white dots – recoveries from birds ringed in Japan.

Summarising all about migratory routes, we can outline spring and autumn Mallard migratory movements (Fig. 245 and 246).

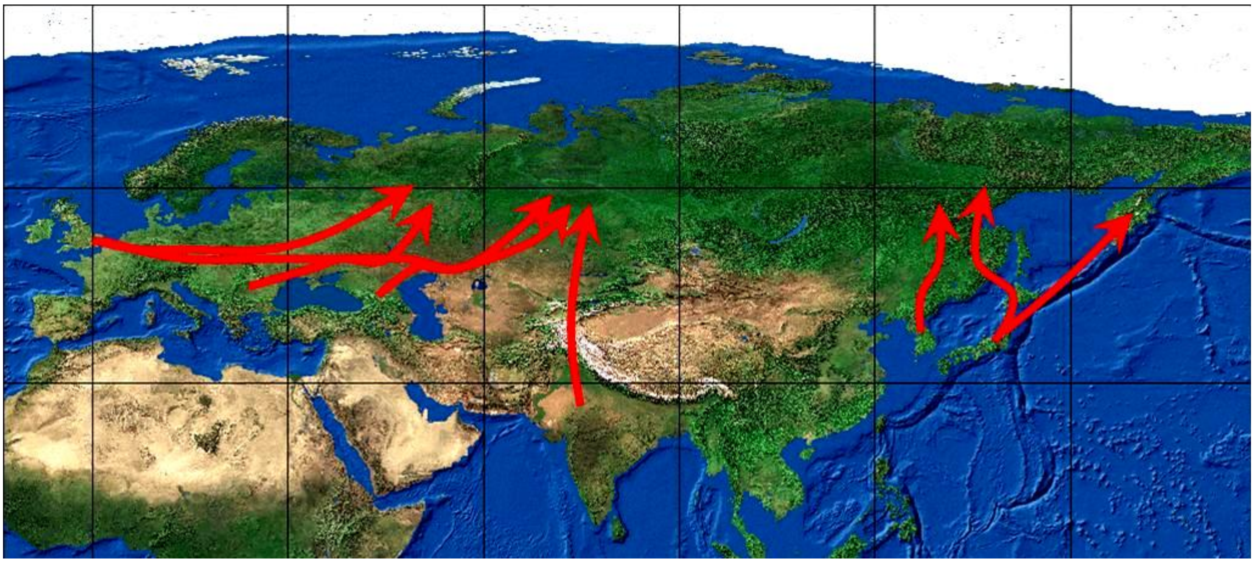


Figure 245. Outline of spring migratory routes for Mallards. Red arrows – directions of migratory movements.

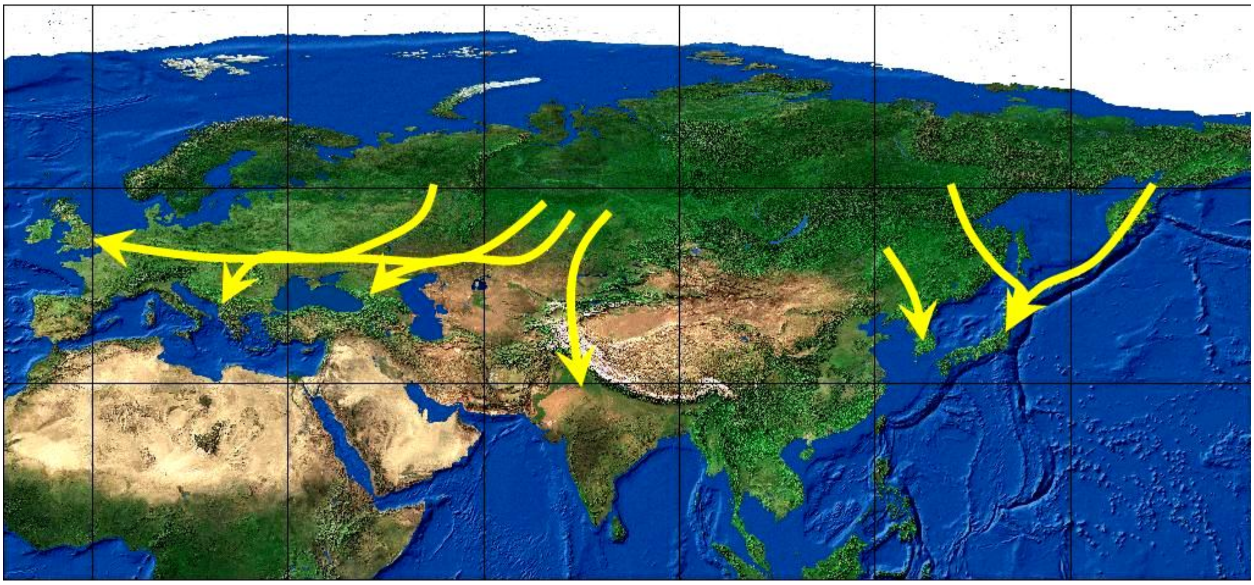


Figure 246. Outline of autumn migratory routes for Mallard. Yellow arrows – main directions of migratory movements.

The same as in the White-fronted Goose, there may be a question why Mallards usually did not cross Ural Mountains, although these mountains are not high. This regularity is also valid for many other duck species. The reason for this could be the historical one: when Glacier Age was finishing, Ural Mountains were covered by glacier for much longer time than the Central Russian Plain and West Siberian Lowlands.

Speed. Bird Ringing Centre of Russia database contains one Mallard direct recovery with high flight speed. Duck with the ring „Moskwa" D-760 299 was ringed in the Okskiy Nature Reserve, Ryazan Region on 24.09.1977 and recovered 25.09.1977 in the Kharkov Region, Ukraine. Direct flight distance 594 km was covered during one day. Ring is not sent in, but the original letter is available.

Populations. Mallard normally move at not so long distances like Pintail and Wigeon (see species accounts), therefore Mallard populations are smaller in size. Population structure of Mallard could be considered as consisting of four populations with their own migratory routes. We do not consider here the Icelandic population which is isolated from others and even is genetically different (Svazas et al, 2013), for the reason of absence of such recoveries in our database. Bird Ringing Centre of Russia ringing data allow outlining the following populations: 1) west-cenral-east-european-west-siberian population (polygon No 1, Fig. 247) with generally west-east migratory movements; 2) south-east-european-west-central-siberian population (polygon No 2, Fig. 247) with general north-east – south-west migrations; 3) east Indian-central-asia-west-siberian population (polygon No 3, Fig. 247) with north-south migratory movements; 4) japanese-south-korea-far-eastern population (polygon No 4, Fig. 247). First three populations greatly overlap and connected with the japanese-south-korea-far-eastern population via exceptionally long-distance cross-population movements.

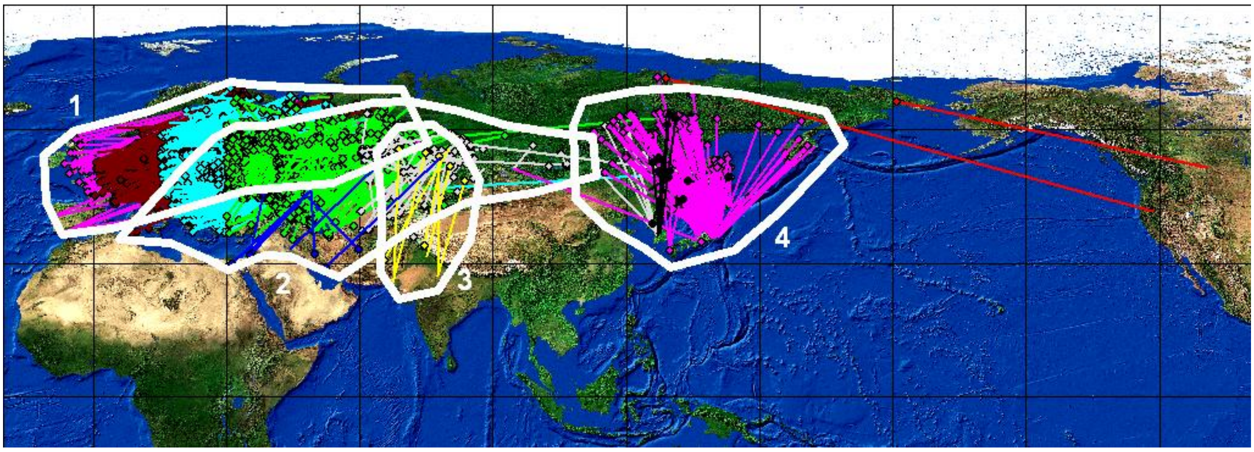


Figure 247. Mallard populations. White polygon № 1 outlines west-cenral-east-european-west-siberian population. White polygon № 2 is south-east-european-west-central-siberian population. Polygon № 3 outlines indian-central-asia-west-siberian population. Polygon № 4 outlines japanese-south-korea-far-eastern population. Two red lines from North America represent vagrant movements from North America to the areas outside of the breeding range in the north-eastern Asia.

Ten-year distances. Data on Mallard allow analyzing overall Mallard recovery mean decadal distance only, because numbers of ringed ducks in any separate place either small or does not cover long-term period. Mean flight distance first increased up to 1990s, then decreased in 2001-2023, but in the lesser extent (Table 15).

Table 15. Mallard mean flight distance per decade.

Decade (years)	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2023
Distance (km)	1086.9	938.9	1028.9	1081.8	1124.5	950.0	1205.8	1584.8	1224.4	1339.1
Number of recoveries	21	898	178	1450	1739	1202	975	212	250	444

Since the distances have been generally changing though decades, it is interesting to see whether the directions of migrations have been also changing or not. Comparison of the mean bearings in direction of flights for birds ringed in several places in Western Europe has not revealed the significant changes in bearing before and after 1970. However, there is a guidable place for this analysis. This is Volga Delta, a place which is located in the southern part of the breeding range, and ducks from there move mainly in two directions (see recovery roses in different duck species): 1) to the breeding areas to western Siberia (usually in years next after ringing); 2) to the wintering grounds in Europe (both in the same and next years). Mean Mallard movement bearing in the sector 0-180˚ for years before 1971 comprised 42.4˚ (N=502), after – 53.9˚ (N=83), difference is nearly significant (P=0.063). However, in the sector 180-360˚ (way to the wintering grounds) bearing has became considerably more northerly: before 1971 – 255.4˚ (N=507), after – 269.7˚ (N=146), t-Bailey=3.36, P=0.0009. It means that after 1970 Mallards change their wintering grounds in Europe for more northern ones. In this manner, we should mention, that shift of wintering sites in ducks should be easier process than in geese or swans. It needs to add that this shift of the wintering grounds to the north is not compulsory related to the climate change (although it is quite possible). It might be also caused by continuous human developing of southern parts of Europe and extirpation of habitats which are suitable for ducks.

Having mean distance dynamics over decades, it is interesting to follow mean decadal position of Mallard control points and recoveries only over decades (Fig. 248). It is shown that in 1950-1960s the control points and recovery locations moved, on average, to the west. The reason for that is not clear. Thereafter 1960s decadal means returned to the east again, but in the more northern position. The latter could be related to the global warming that leads to extending the breeding range to the north.

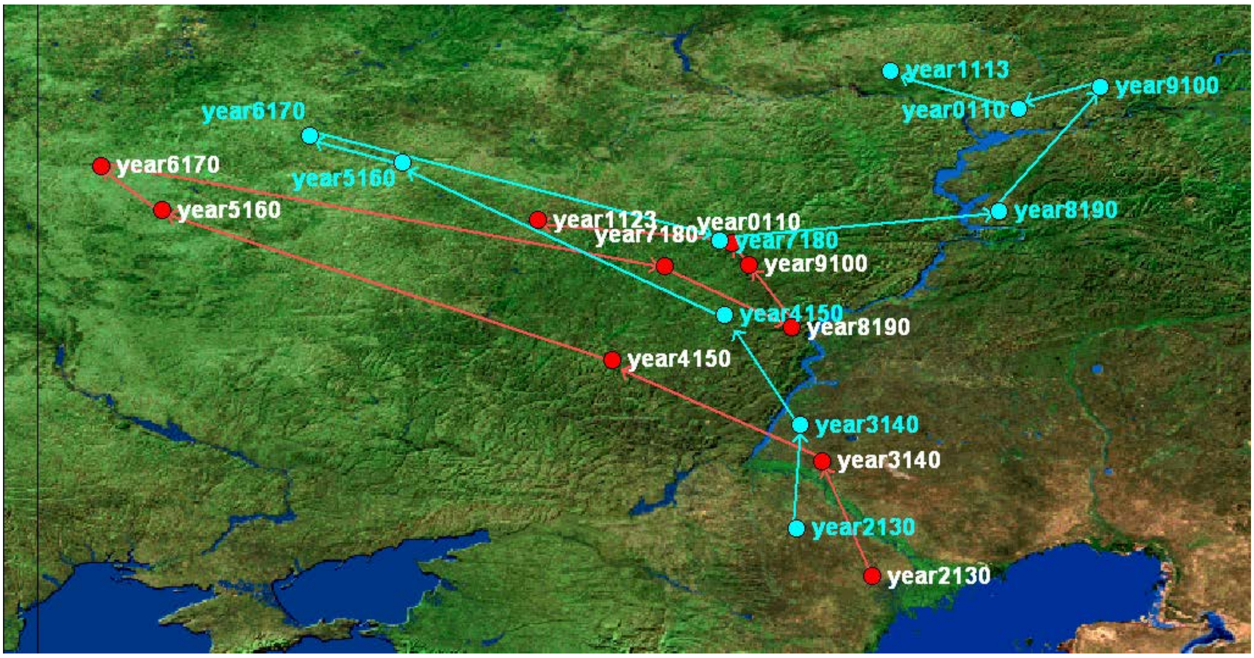


Figure 248. Map of the recoveries of Mallards: mean decadal position of Mallard control points (red dots and arrows) and recoveries only (blue-green dots and arrows).

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest Mallard lived more than 23 years 3 months. Our database, however, contains a recovery of duck with „Hiddensee" ring 360 807, ringed as female of unknown age and shot after 26 years 4 months. Ring was not sent, but the species was confirmed and original letter is available. Really the bird lived more than 27 years.

Mortality rate. According to the common criteria (see "Materials and Methods") 6961 dead recoveries are applicable for the mortality rate analysis. Mean annual mortality rate in Mallard is 27.95±0.28%. Real mortality pattern differs from the theoretical one significantly (χ^2 = 5341, df = 24, P=0.0000). Programme MARK, Model CLogLog 2ndPart shows 28.57%, difference is 0.62%. Mallard mortality pattern chart shows considerable drawdown of the real survival dynamics in the comparison to the theoretical one (Fig. 249). That is a signal for not good situation with the species. It is known, that the Mallard is heavily exploited species. Since large amount of data is available, it is possible to analyse species condition dynamics over decades (Fig. 250).

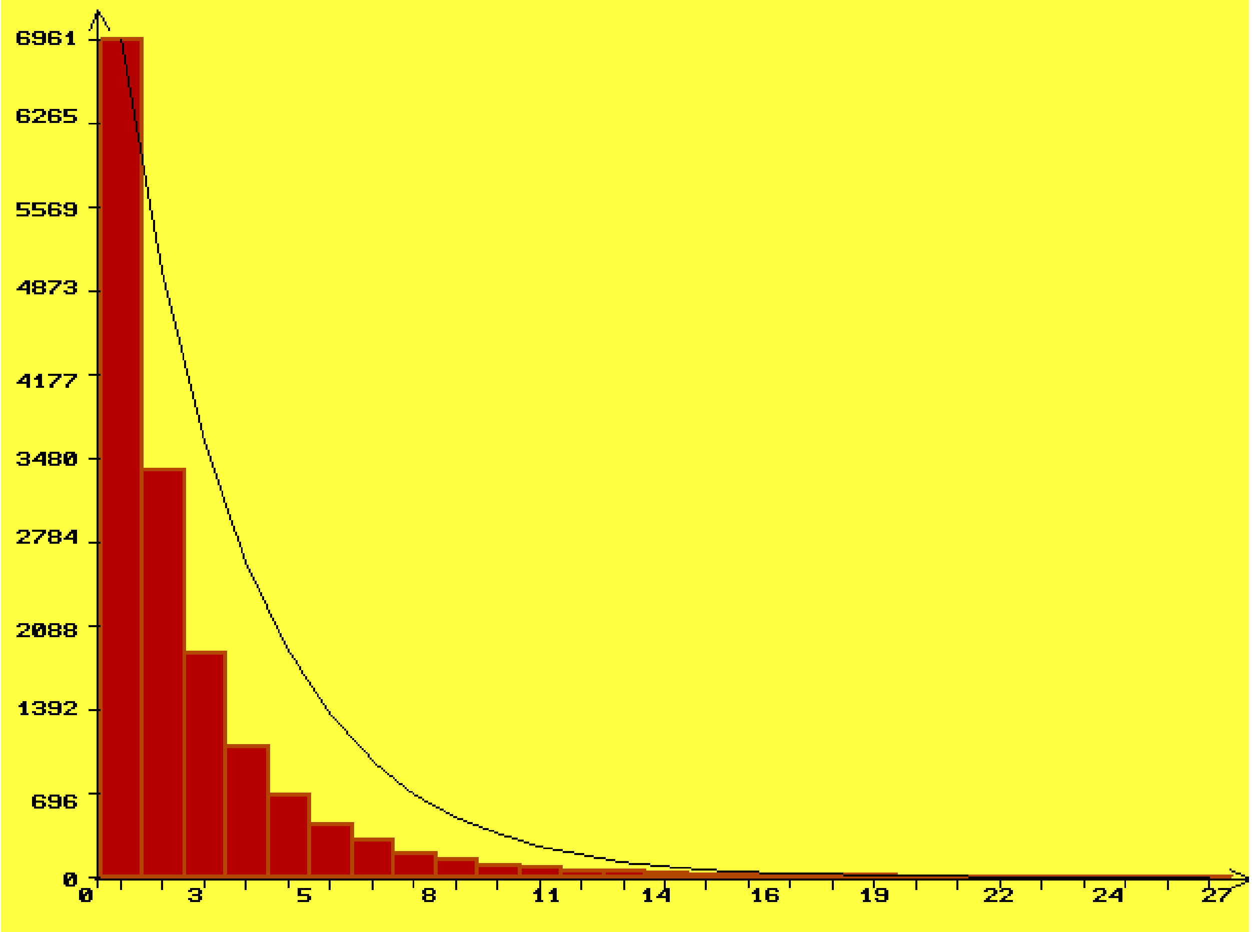
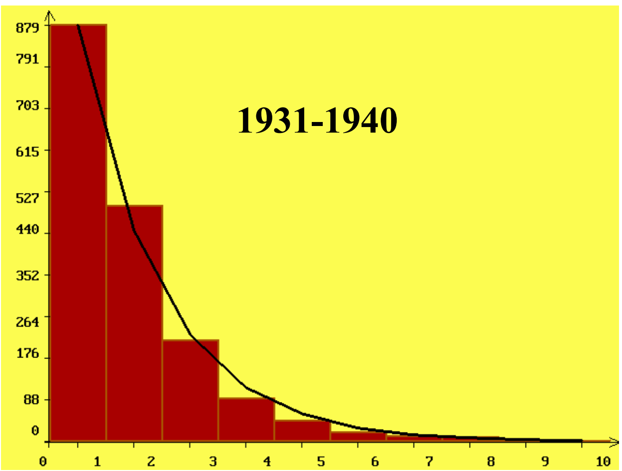
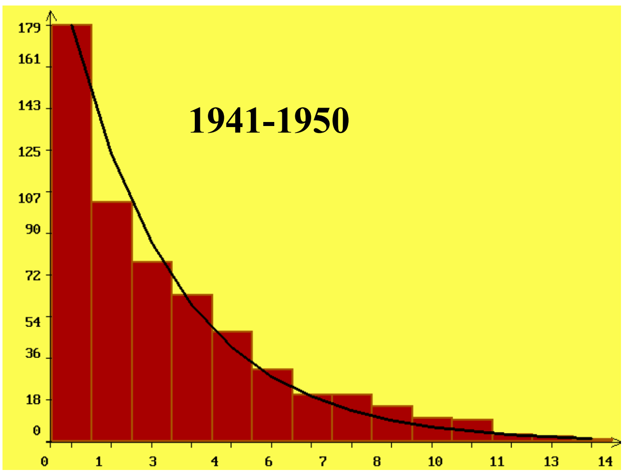
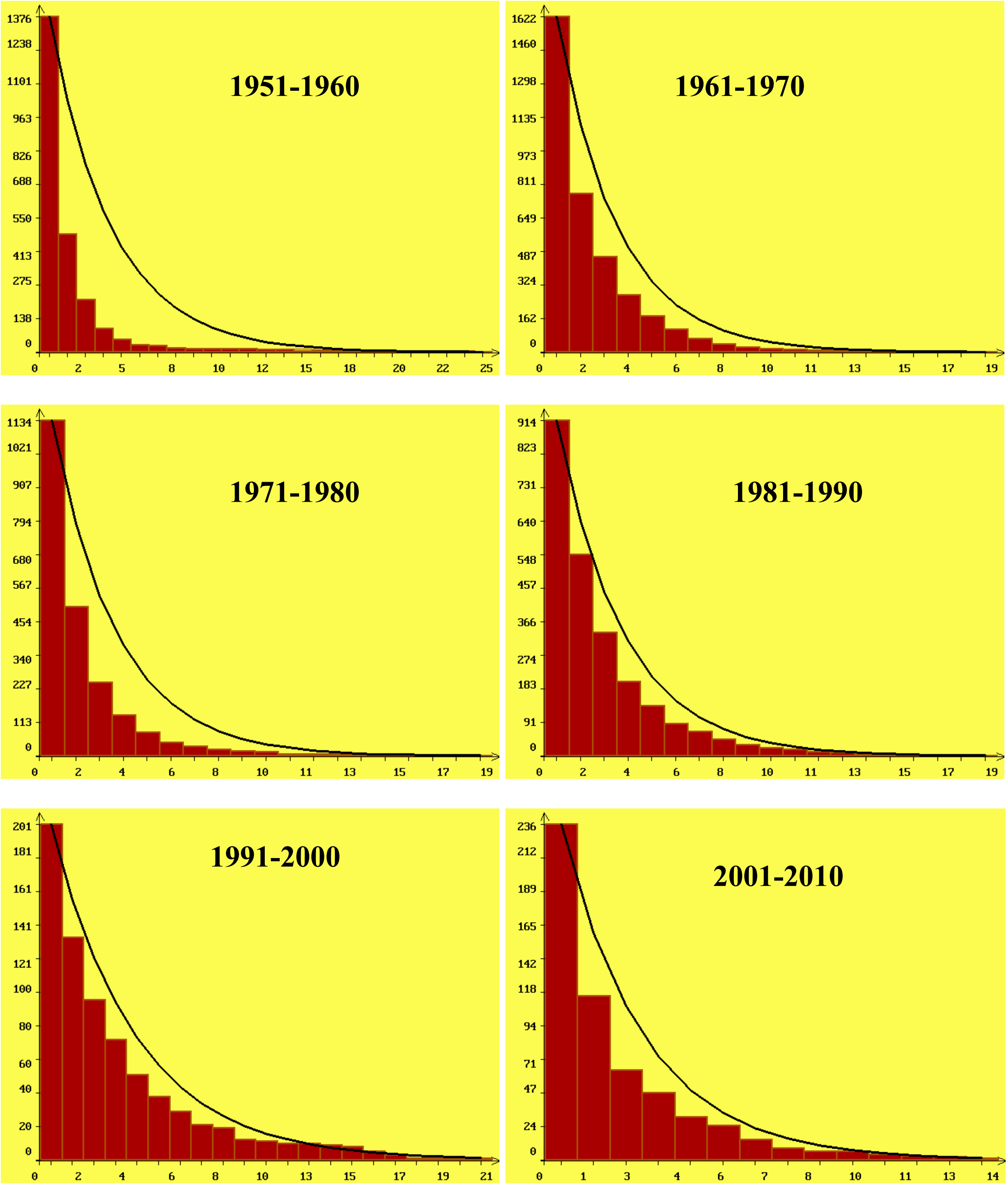


Figure 249. Mortality pattern in the Mallard Duck. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

For 1930s mortality pattern indicates "normal" population (species) condition – real data are practically confirm the theoretical line. The same good situation was in 1940s (in spite of the World War II; probably, due to low hunting pressure). Hunting during the war was not possible, because shotguns had been confiscated (Bianki, 2005). In 1950s the species goodness dropped down sharply – it seems, in the tough period after the war hunting increased considerably. Situation improved in 1960s, became worse in 1970s, improved considerably during 1980-1990s and dropped down again in the modern time (Fig. 250_1).






1951-1960
1376 1238 1101 963 826 688 550 413 275 138 0
0 2 5 8 10 12 15 18 20 22 25
1961-1970
1622 1460 1298 1135 973 811 649 487 324 162 0
0 2 4 6 8 10 11 13 15 17 19
1971-1980
1134 1021 907 794 680 567 454 340 227 113 0
0 2 4 6 8 10 11 13 15 17 19
1981-1990
914 823 731 640 548 457 366 274 183 91 0
0 2 4 6 8 10 11 13 15 17 19
1991-2000
201 181 161 141 121 100 80 60 40 20 0
0 2 4 6 8 10 13 15 17 19 21
2001-2010
236 212 189 165 142 118 94 71 47 24 0
0 1 3 4 6 7 8 10 11 13 14

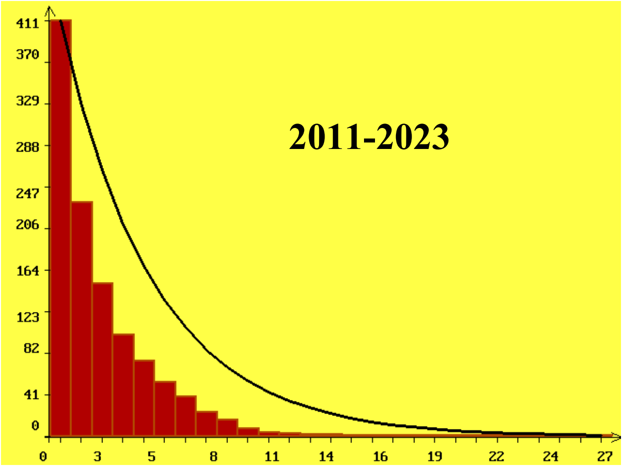


Figure 250_1. Mortality pattern in Mallard recovered in different decades. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, males live slightly longer than females: 1.80±0.04 (N=3471) and 1.50±0.05 (N=1700) years respectively, significant (t-Bailey=1.70, P=0.012, Fig 250_2). Female annual mortality is less than in males: 24.08±0.51% and 27.83±0.40%, respectively. This is understandable, because in Mallard spring hunting is directed more to males.

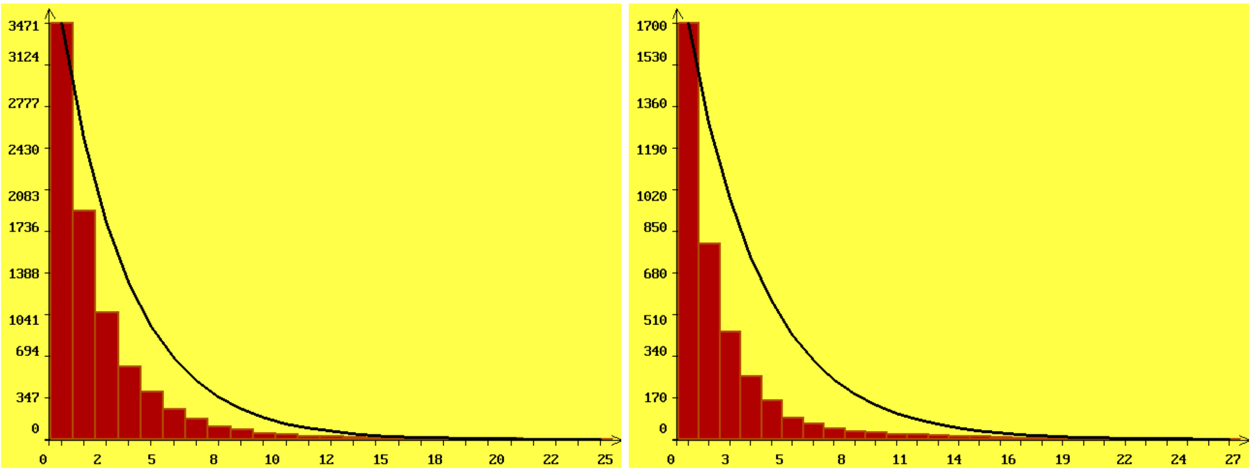
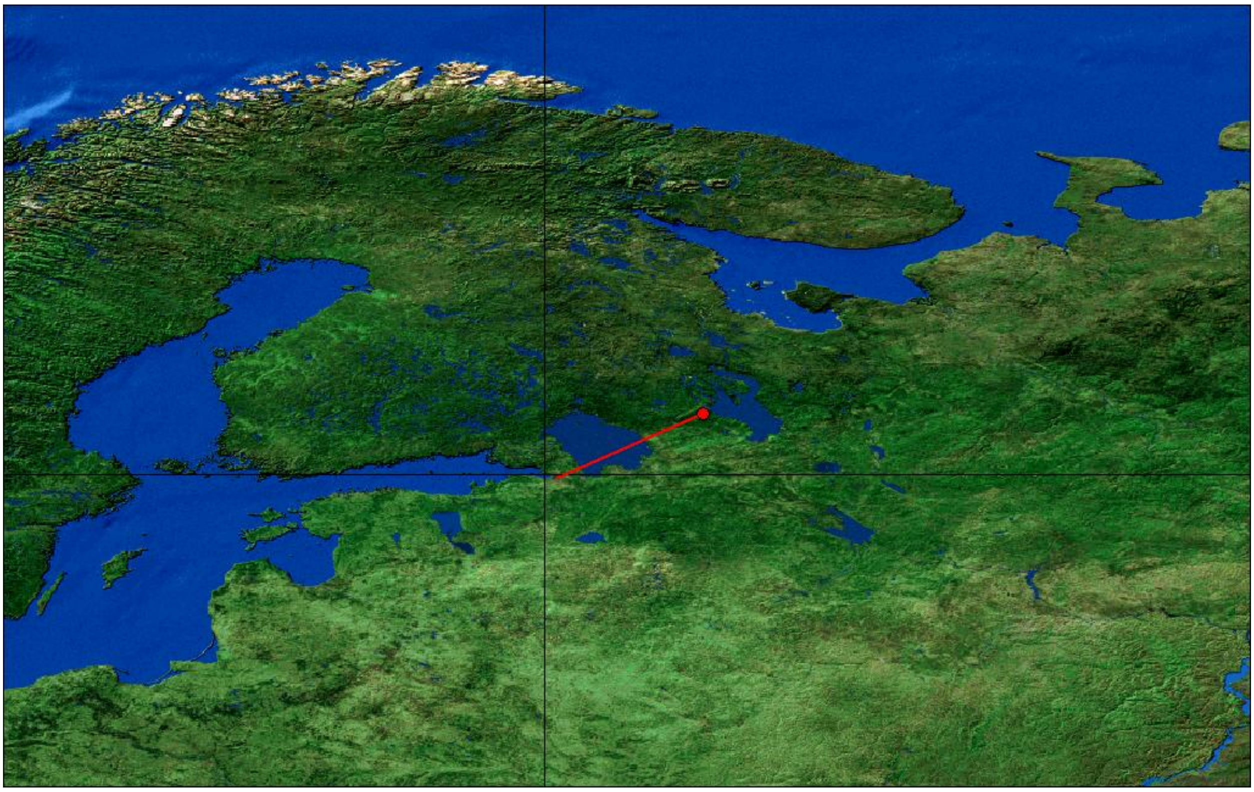


Figure 250_2. Mortality pattern in Mallards: males (left) and females (right). X axis is the number of years after marking. Y axis is the number of live birds.

SPOT-BILLED DUCK
(*ANAS POECILORHYNCHA*).

Photo by Alexandra A. Panyutina

Breeding range of the Spot-billed Duck locates in Baikal area, center of eastern Siberia, south of the Russian Far East, eastern China, Korean Peninsula, northern half of Japan. The duck spends winter in China, South Korea and Japan. In the European Russia we have just one recovery of a bird that escaped from captivity from the Leningrad Zoo, Sankt-Petersburg. The duck was ringed on 14.07.1996 as duckling and recovered on 06.03.1997 as “sight record” in Petrozavodsk, Karelia. The duck spent time in the flock of Mallards. The bird covered 289 km (Fig…). Flight direction was to the north-east, exactly along the Baltic-Sea – White Sea migratory route. Masses of ducks and geese fly along this route. However, the interesting feature of this recovery was that the bird moved along the migratory route in the opposite direction. This duck could escape only during first autumn or first winter of its life. In autumn, the most likely time of escaping, main migration stream directs from the north-east to the south-west. However, the duck moved from south-west to the north-east. In winter the weather is cold in this area, and no bird migration takes place. The spring migration, which should occur in the north-east direction had not yet commenced till the moment the duck was recovered.



Fig… Flight direction of the Spot-billed Duck escaped from the Leningrad Zoo. Beginning of the line indicates ringing site, red dot at the end indicates the recovery point.

NORTHERN PINTAIL
(*ANAS ACUTA*)

Photo by Irina A. Kharitonova

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 251. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

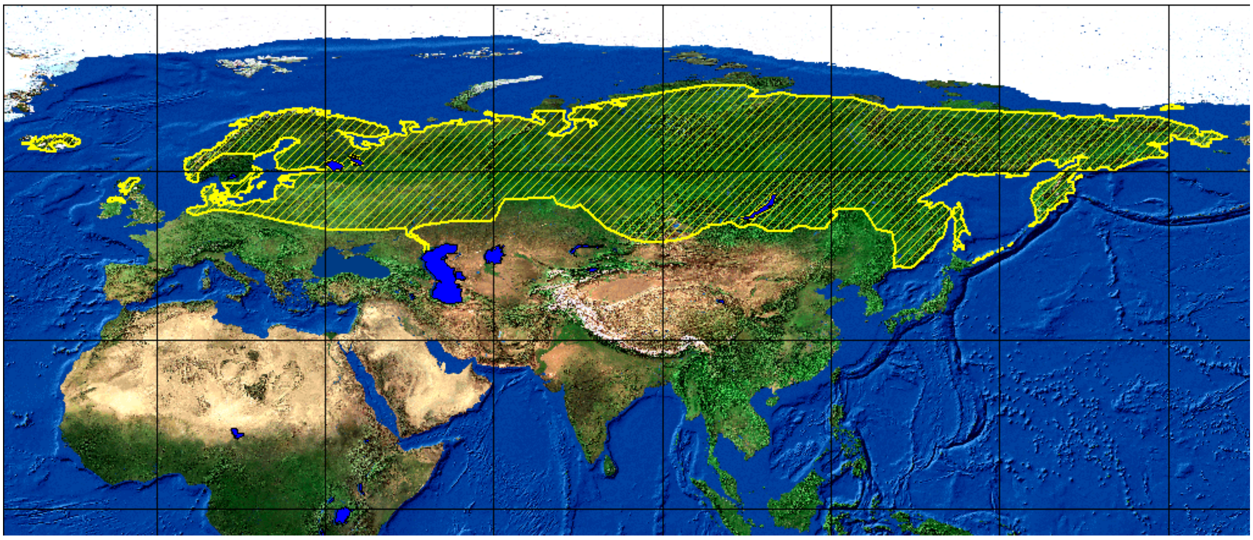


Figure 251. Breeding range of the Pintail in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 7361 marked birds were used, which gave 7370 recoveries (Fig. 252). In addition to metal rings, 15 of them held different kinds of colour marks: colour rings, wing-tags or nasal marks. Two birds were mounted with radio transmitters. 7352 birds gave one recovery per duck, 9 - two recoveries. Ringing dates are since 06.10.1908 until 04.01.2022, recovery dates are since 27.07.1909 until 20.07.2022. This duck is very wide-spread in Eurasia and North America (Fig. 252).

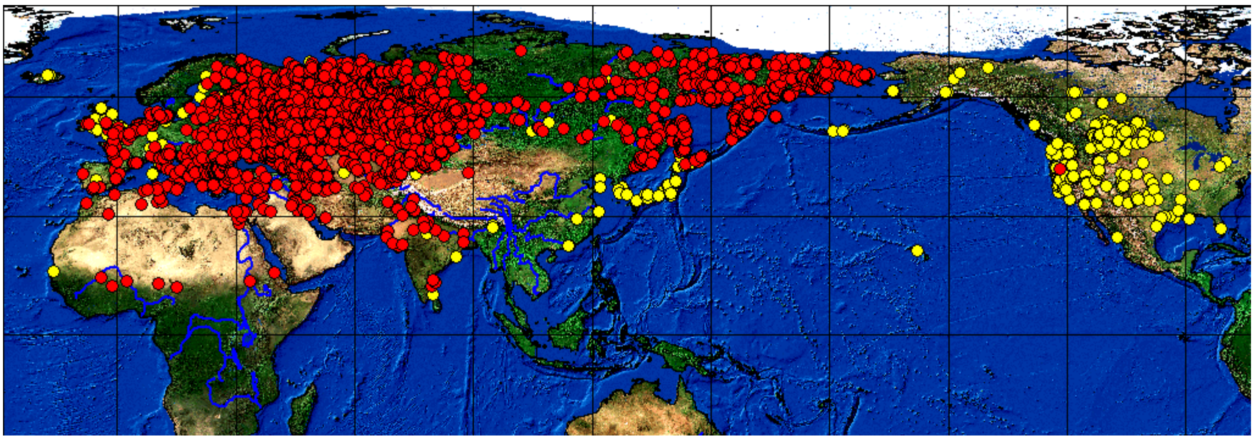


Figure 252. Position of all Pintail control points. Yellow dots – ringing sites, red dots – recovery sites.

Most of Pintails were ringed in Europe, western Siberia, India, Japan, North America. Most of recoveries are from Europe, western Siberia, India, Far East. There is a noticeable gap within recovery area in the Central Siberia with very few recoveries in it (Fig. 252). This gap is real and is not caused by the low human population, because different species has this Siberian gap in different areas. Areas from both sides of such gaps are filled with recoveries in spite of low human population densities there, as well (see the example with Pintail and Wigeon in the section "Material and Methods").

'Moskwa' scheme recoveries. This sample contains 3520 recoveries of the scheme „Moskwa". They are from birds ringed within the Russian Federation and countries of the former USSR (Fig. 253). Most of these birds (3016 recoveries) were ringed in the former huge place in the Volga River Delta, where many duck species concentrated for moult. Now this moulting area no more exists because the Caspian Sea level is growing (Viksne et al, 2010).

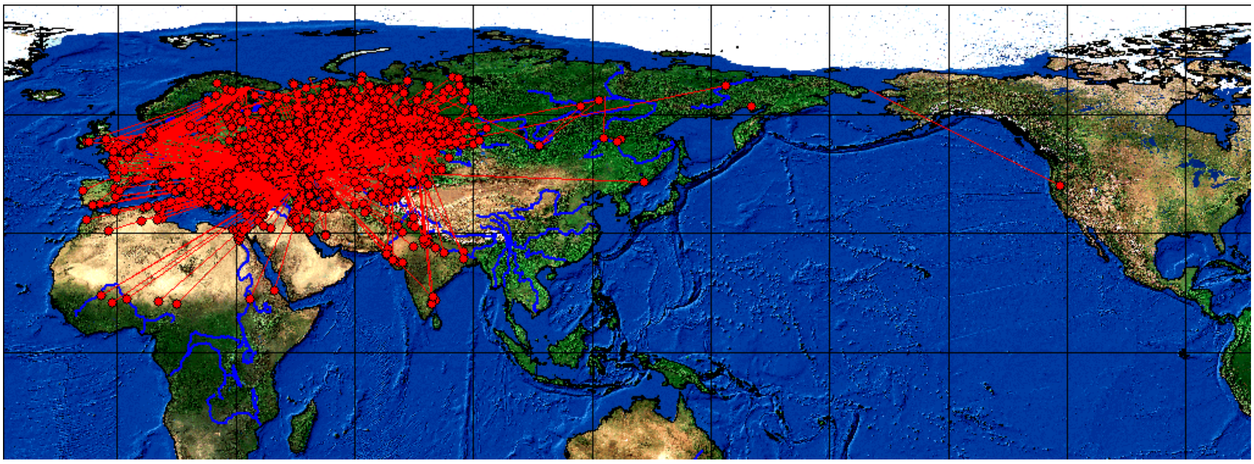


Figure 253. „Moskwa" scheme recoveries of the Pintail. Here and on all other similar figures lines start from ringing sites, recovery sites are marked with red dots.

Finding details. This analysis includes all 7370 recoveries. Almost 3/4 of recoveries (74%) are „shot". 1549 (21%) recoveries are „details unknown", which practically mean shot, as well. Therefore, we can assume that 95% of birds were shot. Other reasons are not so common (Fig. 254).

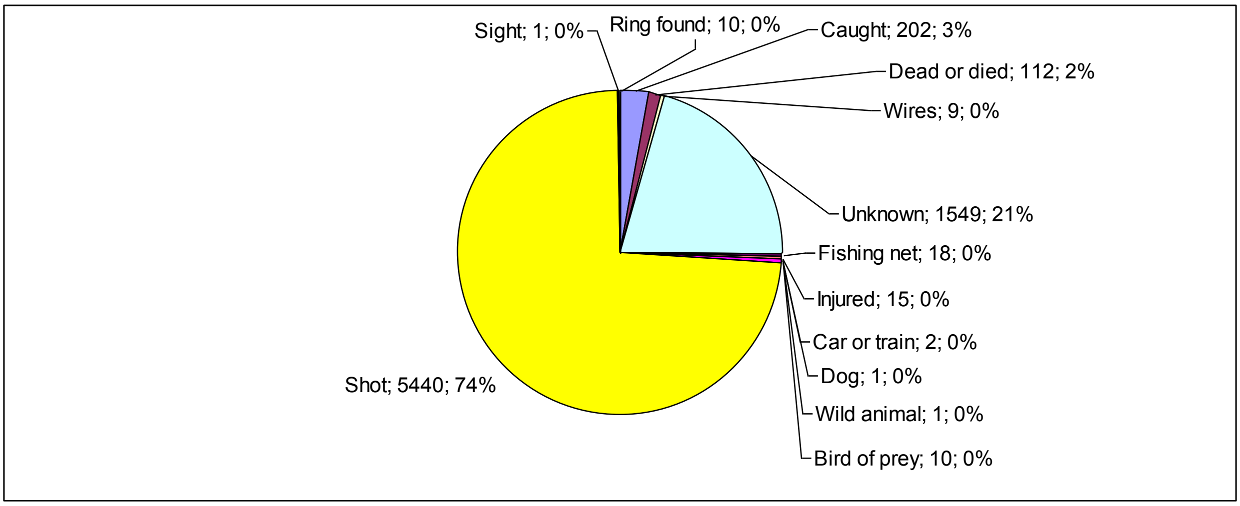


Figure 254. Finding details in the Pintail.

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries do not differ much from each other (Figs 255 and 256), although they are considerably different in areas (see below).

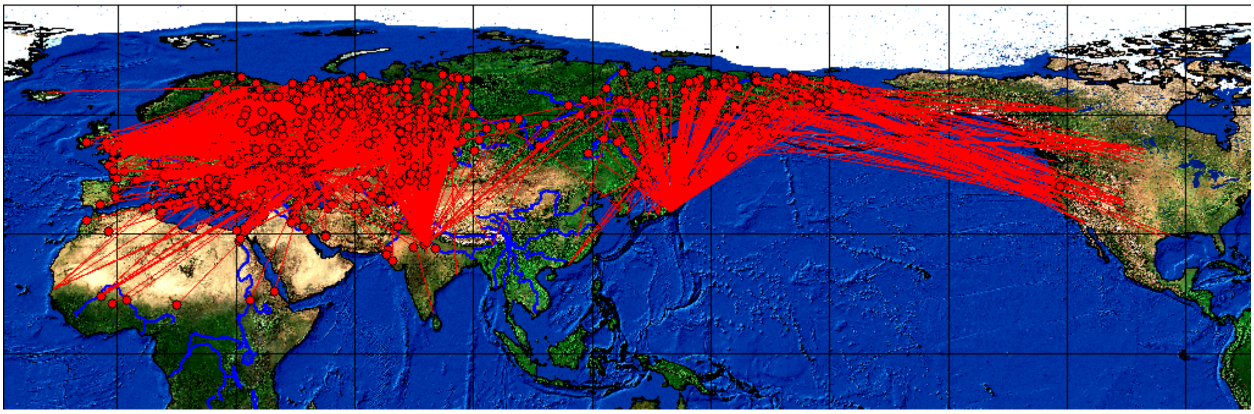


Figure 255. Map of the Pintail direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

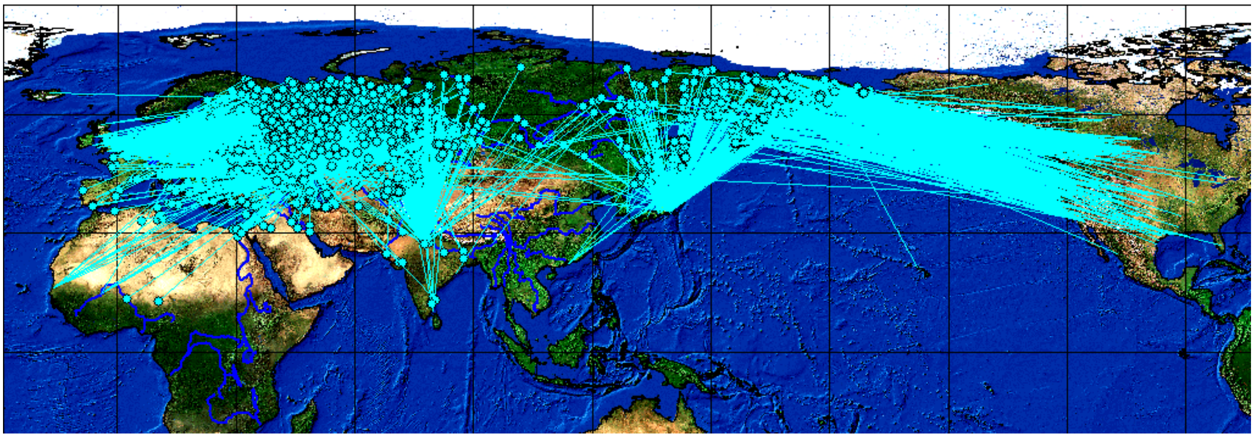


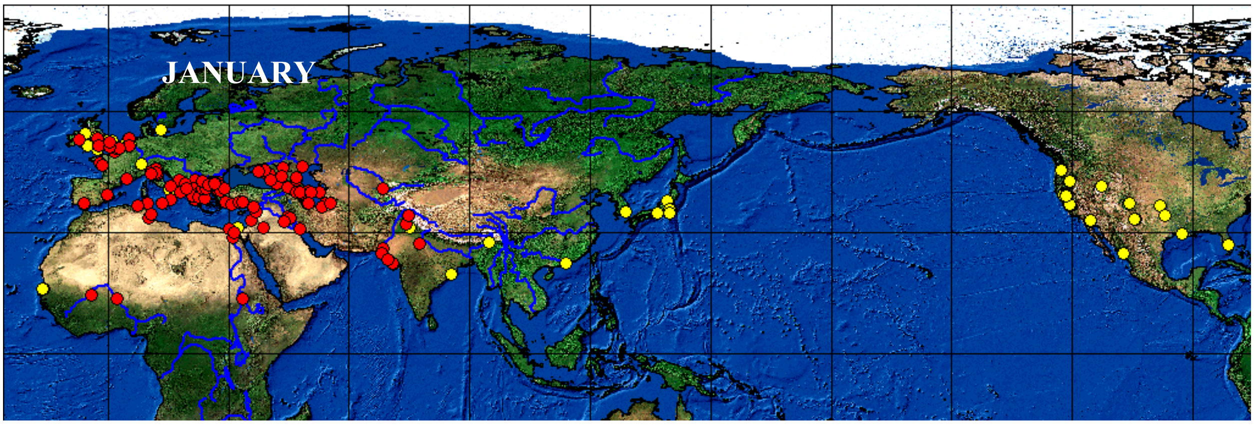
Figure 256. Map of the Pintail indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

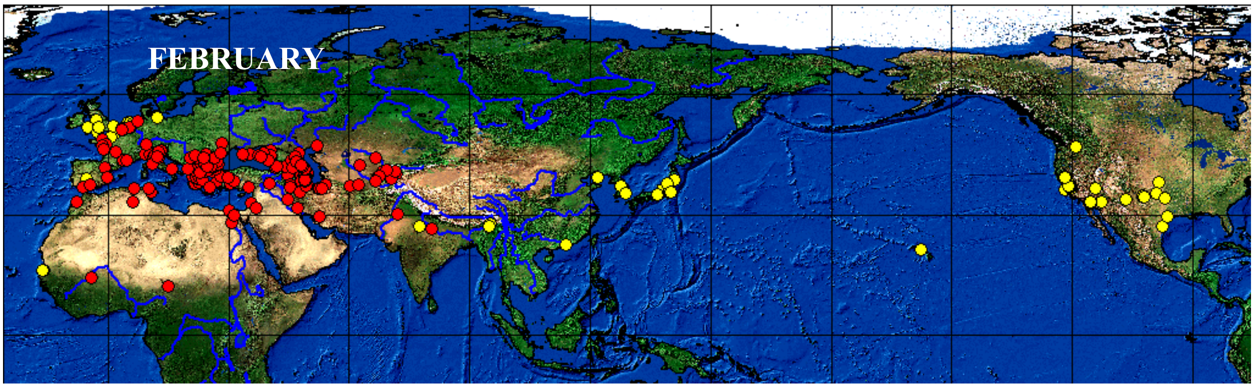
Maps clearly indicate that Pintails wintering in Europe and India fly to breed to the European Russia, western and central Siberia approximately up to meridian 90˚E (Fig. 255). Most birds that winter in Japan and South Korea breed in the Far East and Eastern Siberia approximately up to meridian 125˚E from the east. Between 90˚-125˚E there is the inter-population gap area with very few recoveries. Expected, that here might be the area where China-wintering birds should breed. However, we have only 1 recovery of „China‟ scheme and 13 recoveries of the „Hong Kong‟ scheme. This means, that either very small amount of Pintails winter in China or the ringing amount of this species in China is very small. In distinction to Mallard, this Siberian gap of recoveries starts 5 degrees more to the east than in Mallard. This looks understandable, because the number of recoveries from India in Pintail is much greater than in Mallard, and Pintails from India fly to Western Siberia. Thus, India-wintering Pintails "fill" Western Siberia in addition to European recoveries, and the area of Indian recoveries lays more to the east than the area of European recoveries. However, the eastern end of the gap is situated more to the east than in Mallard, as well. It is less clear, probably it is related to the position of the eastern boundary of the breeding range in each species: Pintail inhabits the area more to the east and north-east than Mallard.

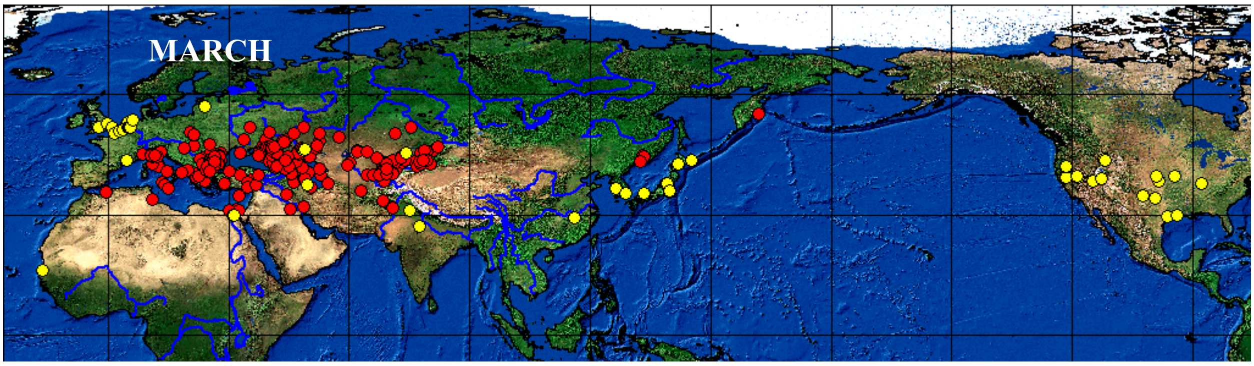
Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them (χ^2 = 80.06, 2727 direct recoveries and 4643 indirect ones, df = 2, P = 0.0000). However, in case of Pintail large sample is not the main reason for this significance. In distinction to Mallard, the difference between the centers of direct and indirect recovery areas is considerable. Centre of the area with indirect recoveries locates by almost 2 degrees to the north and more than 11 degrees to the east in comparison with the centre of area of direct recoveries. Average flight distances in direct and indirect recoveries are different: 2100.4$\pm$25.5 and 2381.6$\pm$21.1 km respectively. Difference is highly significant – t-Bailey = 8.5, P=0.0000. In distinction to Mallard, long-distance cross-population exchange occur both in direct and indirect recoveries. Pintail has the longest distance in recoveries (indirect) whenever observed in ducks: adult female ringed with „Washinton DC" scheme on 14.01.1962 in Gridley, California, in 6 years 6 months was shot in Lugansk Region, Ukraine (ring sent), in 10025.4 km from the ringing site. For direct recoveries the longest distance is shorter – 7767 km: Pintail ringed in Senegal and in 214 days was shot in the Khanty-Mansi Autonomic Area, Tyumen Region, Western Siberia. The second longest distance in direct recoveries is for the bird, ringed in Colorado, USA and in 259 days shot in Khabarovskiy Krai, covered 7543 km.

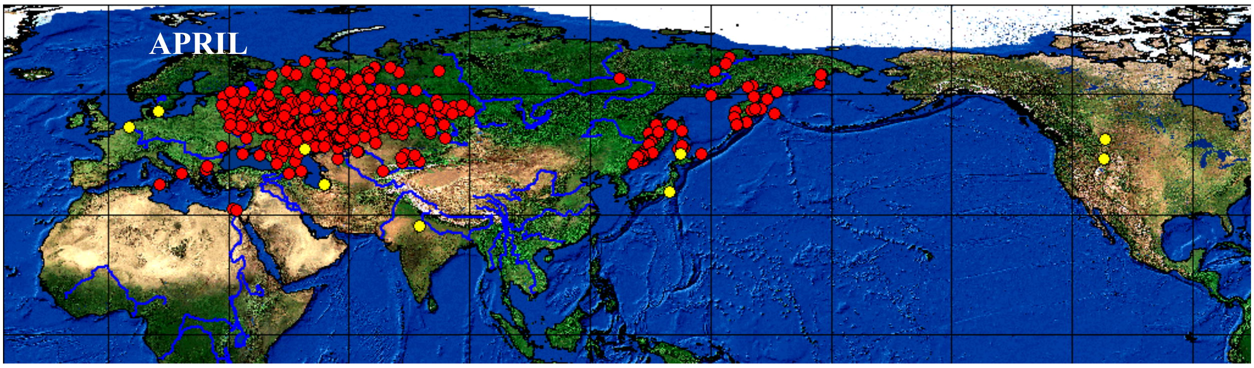
Pintail is one of two dabbling ducks (the second one is Garganey) which crosses Sahara Desert during migrations and winter in countries to the south of Sahara (Senegal, Mali, Nigeria, others). And the only dabbling duck where birds from Asia perform considerable mixing with the North American birds (Figs 255 and 256).

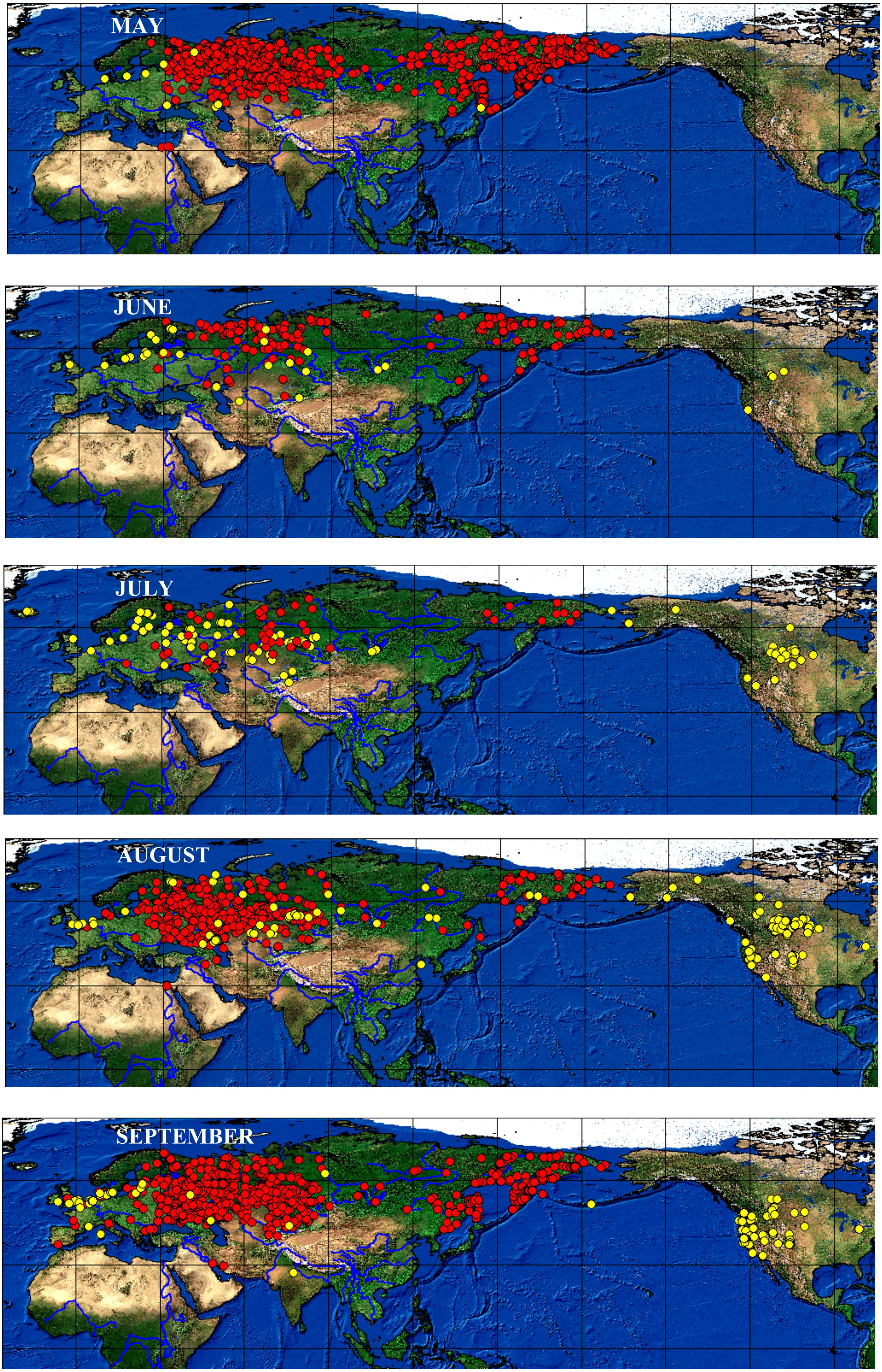
Monthly movements. All direct and indirect recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery locations) reflect a general way of seasonal movements in Pintails (Fig. 257). In January most ducks are on wintering grounds in the western and southern Europe, Cis- and Transcaucasia, Central Asia, Pakistan, India, Bangladesh, eastern China, South Korea, Japan and central inland areas of North America. First small movements to breeding grounds are noticeable as early as in February, (February, Fig. 257). These movements owed by the southern wintering areas: south-eastern Europe, Caucasus area and Transcaucasia, India. No movements in February are visible for Far East and America wintering Pintails. In March migratory movements are well noticeable in all Eurasian Pintail populations, no data are available for North America. Birds from Western Europe move to the east, north-east, from southern Europe and Caucasus area – to the north-east, from India and Pakistan – to the north, from China, South Korea and Japan – to the north as well. It is visible from the position of the new appeared green dots, which point the recovery sites (Fig. 257, March). In April migration continues and finishes in May when these ducks reach the northern boundary of the breeding range, i.e., Eurasian tundra zone. Concentration of the April recoveries within the „strip" located from south-eastern European Russia via northern-Kazakhstan to southernmost Western Siberia (Fig. 257, April), however, less pronounced than in Mallard, indicates that during spring migration from Europe to Western Siberia considerable part of Pintails normally do not cross Ural Mountains, but bend them over the southernmost edge. In May Pintails, very likely, use also the „northern gates": land strip between northern top of Urals and Barents Sea-Kara Sea coast. In June birds are on the breeding grounds, in July the recovery area moves a little bit to the south: in July a great number of birds, males and non-breeding or failed females move to the moulting areas. This time it is very convenient to catch and ring adult birds; and positions of the ringing sites (Fig. 257, July) show that for moult Pintails, the same as other dabbling ducks (see species accounts), move closer to the wintering areas. The latter is in distinction to several geese species that fly to moult farther from wintering grounds. In August breeding birds start to move southerly and westerly. Although most ducks after moult fly in the direction to wintering grounds, some birds perform the backward flights after moult. They move not to the wintering areas, but fly backward to the north-east in the direction to breeding areas (Fig. 258), however they will not breed at this time. This feature which firstly has been found in Gadwall (Kharitonov, 2002), really is characteristic for several dabbling duck species. In Pintails it is noticeable, as well, from the distribution of recoveries in August and in September more attached to the northern areas, than in July. October indicates intensive migration, but some birds still are in breeding areas. In October and November the concentration of recoveries in the south of Western Siberia and northern Kazakhstan indicates the same phenomenon as in spring: on their autumn migration to wintering grounds in Europe Pintails bend the Urals over the southern end, as well. In autumn migration finishes as late as only in December.










MAY
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SEPTEMBER

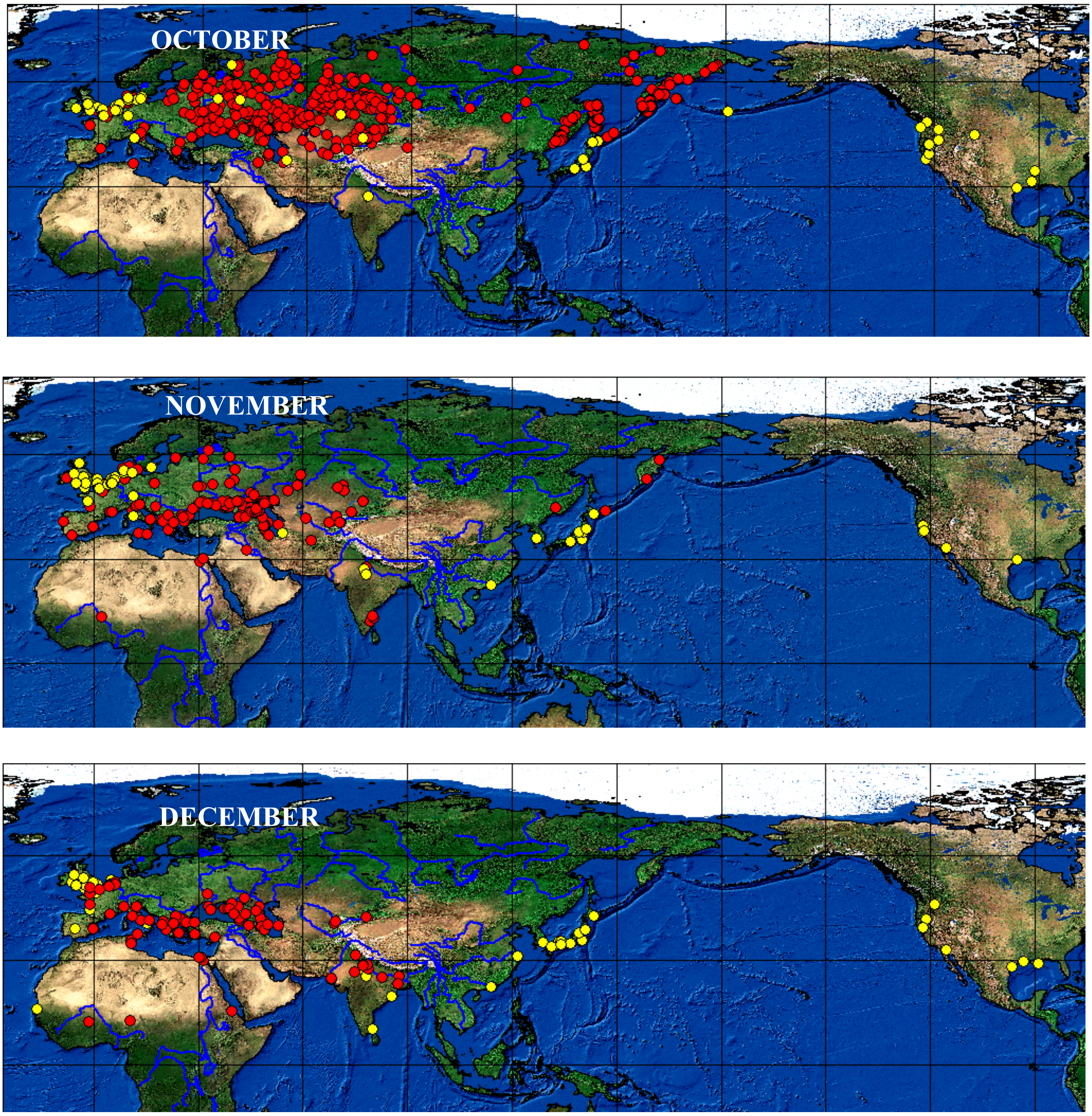


Figure 257. Pintail monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

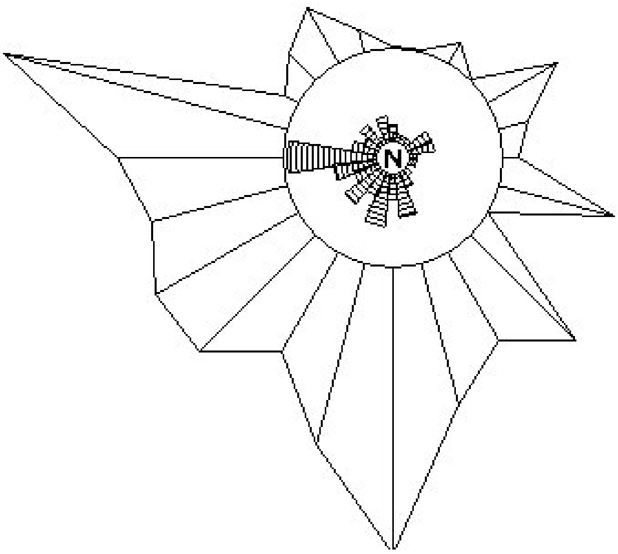
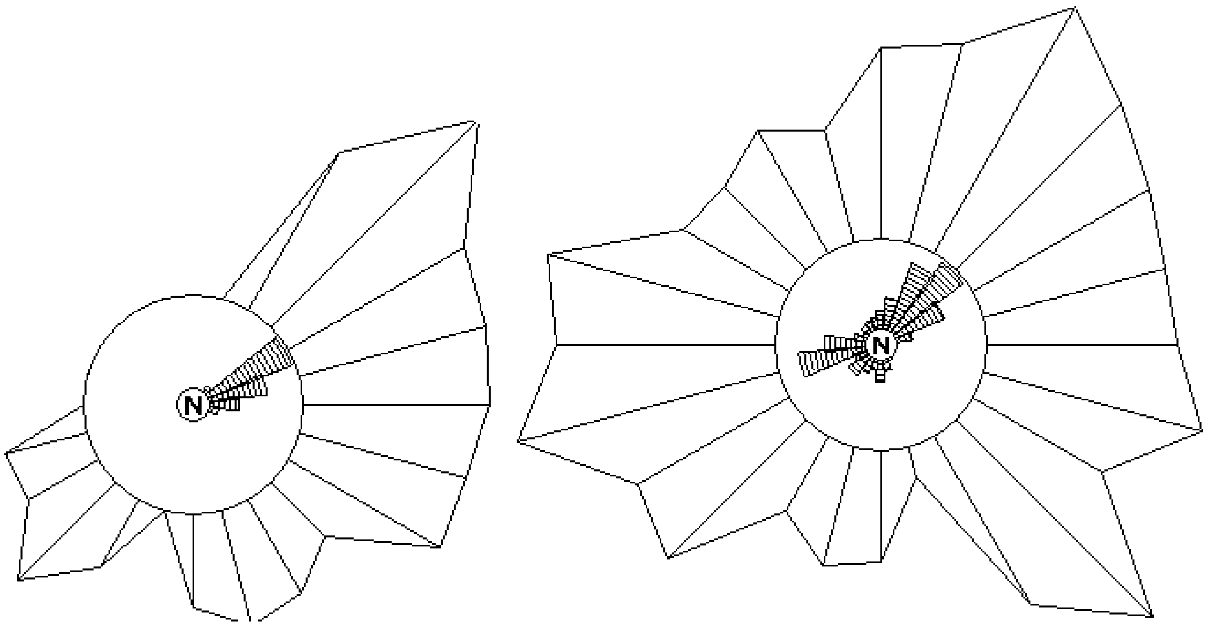


Figure 258. Recovery rose graphs for Pintails ringed in July and recovered during 60 days after ringing: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts). Sector = 15.0°; Total recoveries - 83; N in sectors: from 0 up to 10; Average distance in sectors: from 0.0 km up to 1605.5 km; The longest flight distance is 3800.6 km.

Migratory routes. As it was preliminary shown in the section "Monthly movements", Pintails from different wintering areas migrate to different directions. Birds ringed in areas with longitude <=30˚E move to north-east in spring (bearings 40-100˚, mostly 50-70˚ Fig. 259), and in opposite direction in autumn. For birds ringed in area with longitude 30˚-60˚E preferable flight bearings are 352-70˚ in spring and 247-280˚ in autumn. In this section there are numerous birds ringed in the Volga River delta, which is close to the southern end of Ural Mountains, and recovery rose here clearly shows the corner between western and north-eastern directions located near the southern end of Urals. For ducks ringed in 60˚-90˚E preferable bearings are 350-10˚ - this is spring flight direction for Pintails ringed in India. For Far-Eastern birds ringed in Japan, South Korea and eastern China spring flight bearings are 0-50˚ (Fig. 259), Certainly the opposite should be in autumn. Birds wintering in North America, in spring fly, generally, at 280-310˚. Pintails are capably to fly long distances over the open sea; and Pintails wintering in Japan often fly to Kamchatka by the straight way over the Sea of Okhotsk (Hupp et al, 2011), America-wintering birds cross about 2500 km over the ocean (Miller et al., 2005).

In comparison to Mallard, Pintails have generally more northerly directed movements in spring in all parts of the breeding range within Eurasia. In autumn birds from European Russia and Western Siberia have greater tendency to migrate to Western Europe, whereas Mallards tend more to go to the southern Europe (see Mallard species account).



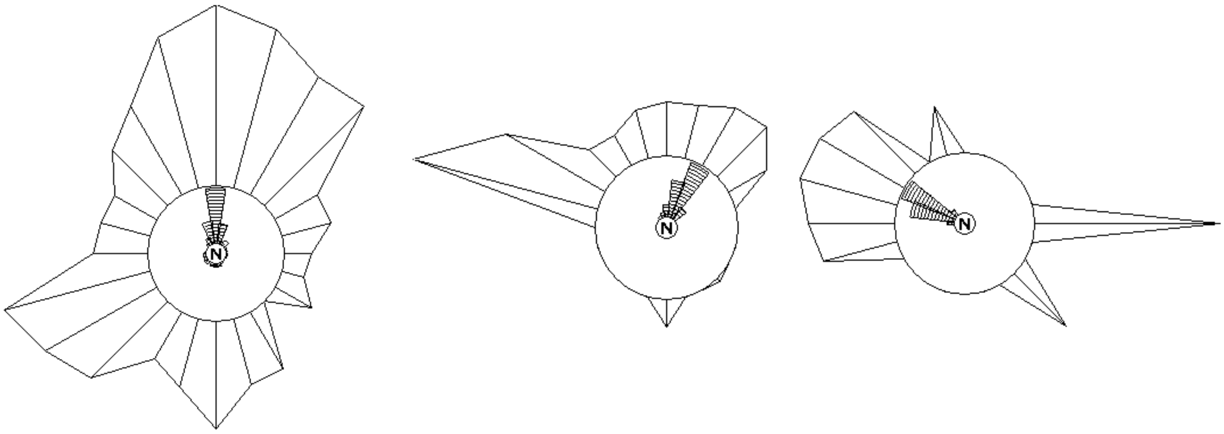


Figure 259. Recovery rose graphs for Pintails, ringed in different longitudes: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distance along each direction (radar charts).

Upper left chart is for European wintering Pintails, area of recoveries from Great Britain to western Siberia, to 90˚E. Sector = 15.0°; Total recoveries - 1133; N in sectors: from 0 up to 490; Average distances in sectors: from 0.0 km up to 4177.5 km; The longest flight distance is 8405.5 km.

Upper right chart is for Pintails ringed in the southern European Russia, area of recoveries from Great Britain, Africa, including countries south-west of Sahara, to western Siberia, to 90˚E. Sector = 15.0°; Total recoveries - 3169; N in sectors: from 9 up to 473; Average distances in sectors: from 220.7 km up to 2026.4 km; the longest flight distance is 6326.6 km.

Lower left chart is for Pintail ringed mostly in India and Pakistan, area of recoveries is in western Siberia, to 90˚E; Sector = 15.0°; Total recoveries - 873; N in sectors: from 0 up to 295; Average distance in sectors: from 0.0 km up to 3148.2 km; The longest flight distance is 5905.2 km.

Lower centre chart is for Pintails ringed in Japan, South Korea and eastern China, recoveries are mostly on the Russian Far East, east of 125˚E; Sector = 15.0°; Total recoveries - 1679; N in sectors: from 0 up to 721; Average distance in sectors: from 0.0 km up to 8212.5 km; The longest flight distance is 8397.6 km.

Lower right chart is for Pintails ringed in extensive wintering area in North America. They breed mostly on Chukotka. Sector = 15.0°; Total recoveries - 476; N in sectors: from 0 up to 226; Average distance in sectors: from 0.0 km up to 10025.4 km; The longest flight distance is 10025.4 km.

Preferable flight distances in both direct and indirect recoveries are less than 4500 km, which is in about 1300 km greater than the most frequent flight distances in Mallards. Maximal distance of the indirect recovery flight, as already mentioned, is 10025.4 km (Fig. 260, 267).

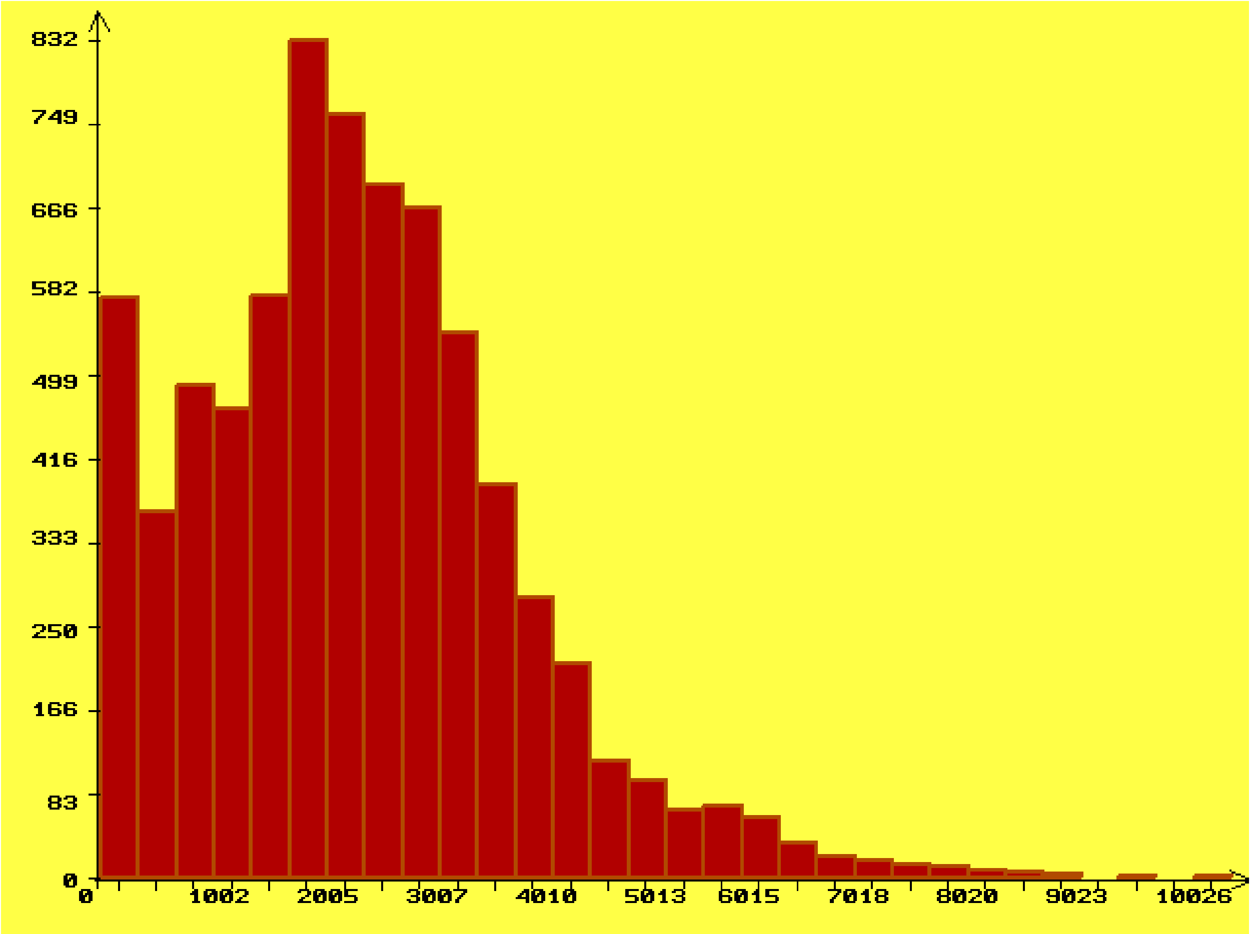


Figure 260. Distribution of all ring-recovery distances in Pintail. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in Pintail young birds (ringed as „pull" or „juv" or „1 y") is considerably longer than in adults: 2826.3±64.3 and 2225.2±16.7 km respectively (N_{young} = 642, N_{ad} = 6728, t-Bailey=9.17, P=0.0000). Longer distance in young signals that in spite of the main source of recoveries in Pintails is „shot" recoveries (which is common for many duck species), Pintails probably suffer from hunting lesser than Mallards. For this reason, the not good condition of many Pintail populations (see section "Mortality rate") is likely more related to human induced habitat changes, than to the direct shooting. Longer distance in young ducks also means that Pintails have less fidelity to the place of birth than Mallards. Male mean flight distance is about the same as in females: 2324.5±20.5 and 2268.6±30.0 km respectively (N_{males} = 4559, $N_{females}$ = 2288), insignificant.

Before outlining the Pintail migratory routes and reveal the migration process in more detail, we should plot monthly means of Pintails, ringed in different places. Pintail is the early breeding duck, the second earliest after Mallard. It is confirmed by the fact that the most northern and eastern monthly mean is not in May, like in Mallard, but in June. This is illustrated by the examples of ducks ringed in Great Britain, Netherlands, south-west of Sahara, former huge moulting place for ducks of different species in the Volga River Delta and in Japan (Figs 261–266). Ducks, ringed by „Bombay" scheme in spring migrate directly to the north (Fig. 265).

In July part of birds (males, non-breeding females and failed females) move from the breeding grounds to the moulting places, located in the direction from breeding grounds to the wintering areas. In August most recoveries belong to the other category of birds – successful breeders, which are more close to the breeding sites than ducks, encountered in May, June and July. This is the main reason for the „loops" of monthly means through May-June-July-August.

However, these loops are partly real, because after moult some birds move backward more to the north and east breeding grounds (the latter is shown in the section “Monthly movements”).

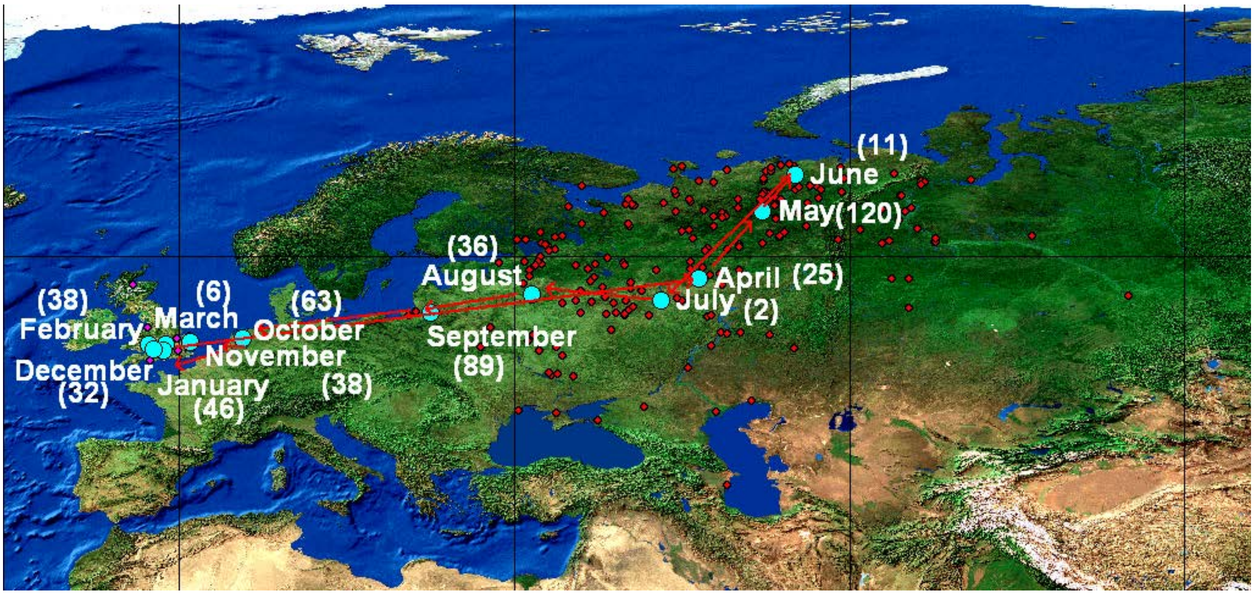


Figure 261. Mean monthly locations of Pintails control points for birds, ringed on the wintering grounds in Great Britain. Blue-green large circles are mean monthly locations of Pintails. Arrows show directions of movements. Number of control points in each month is represented in parentheses. Purple dots are the ringing sites, red dots – recovery points.

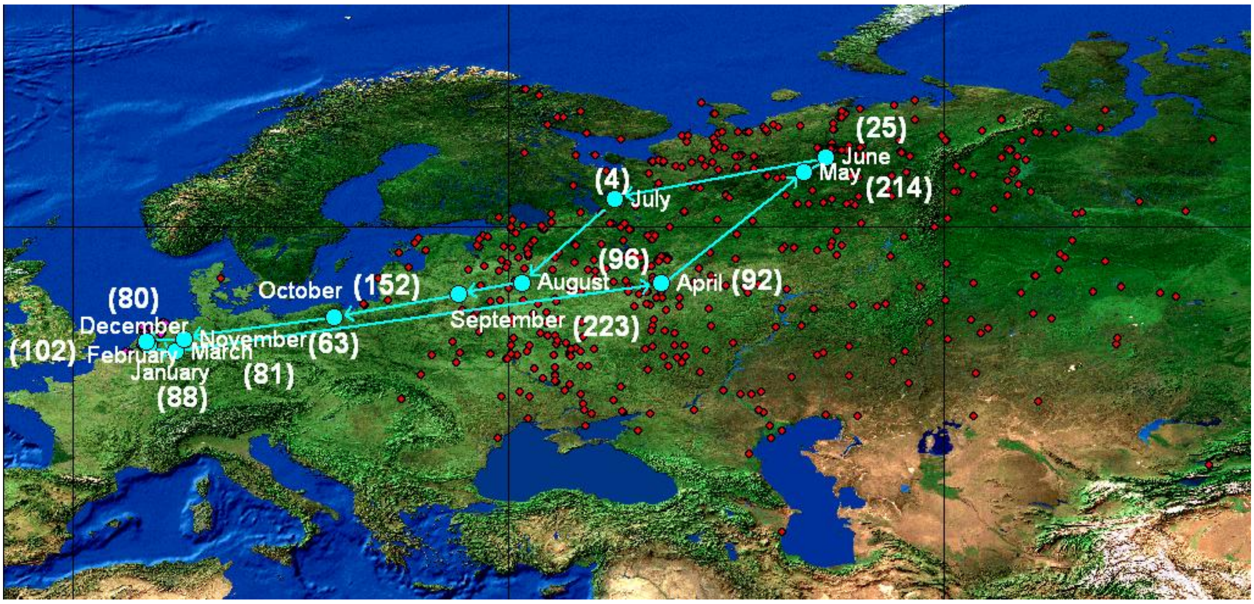


Figure 262. Mean monthly locations of Pintails control points for birds, ringed at the wintering grounds in the Netherlands. Blue-green large circles are mean monthly locations of Pintails. Arrows show directions of movements. Number of control points in each month is represented in parentheses. Purple dots are the ringing sites, red dots – recovery points.

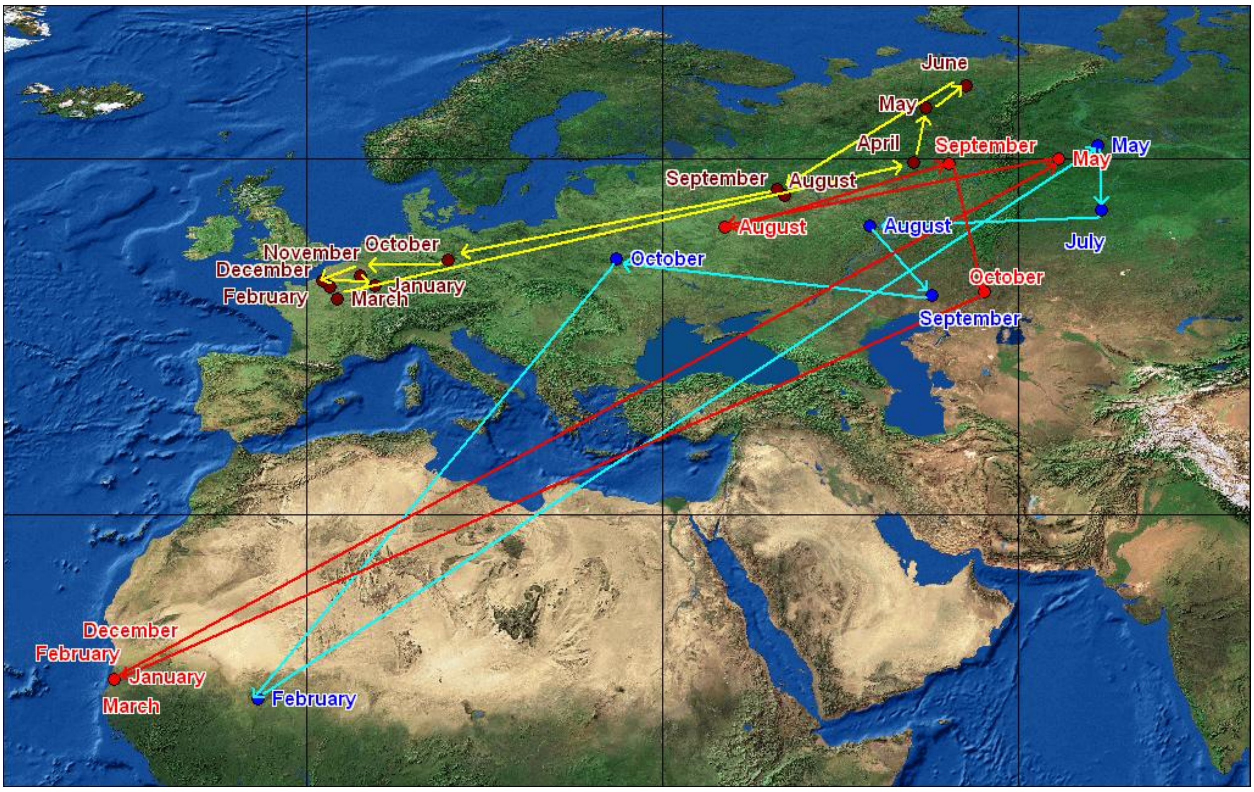


Figure 263. Mean monthly locations of Pintails control points for birds, marked with „Paris" scheme rings at the wintering grounds in France (brown circles), Senegal (red circles) and Mali (blue circles). Arrows show directions of movements.

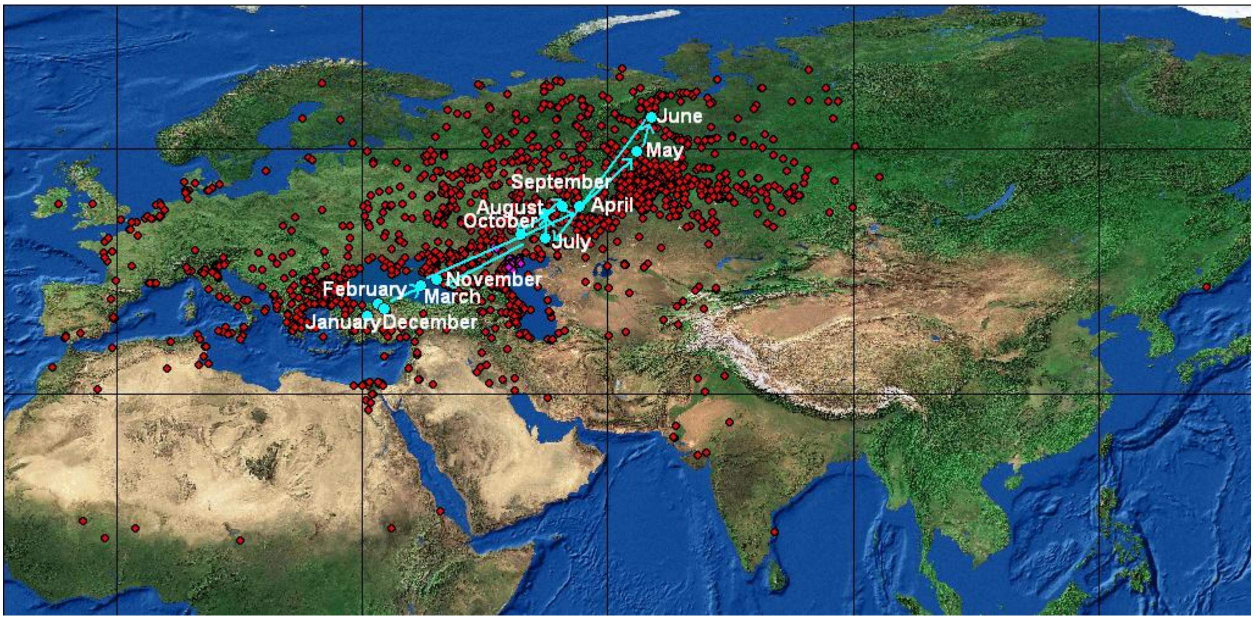


Figure 264. Mean monthly locations of Pintail control points for birds, ringed on the moulting grounds in the Volga River Delta. Blue-green large circles are mean monthly locations of Pintails. Arrows show directions of movements. Purple dots are the ringing sites, red dots – recovery points.

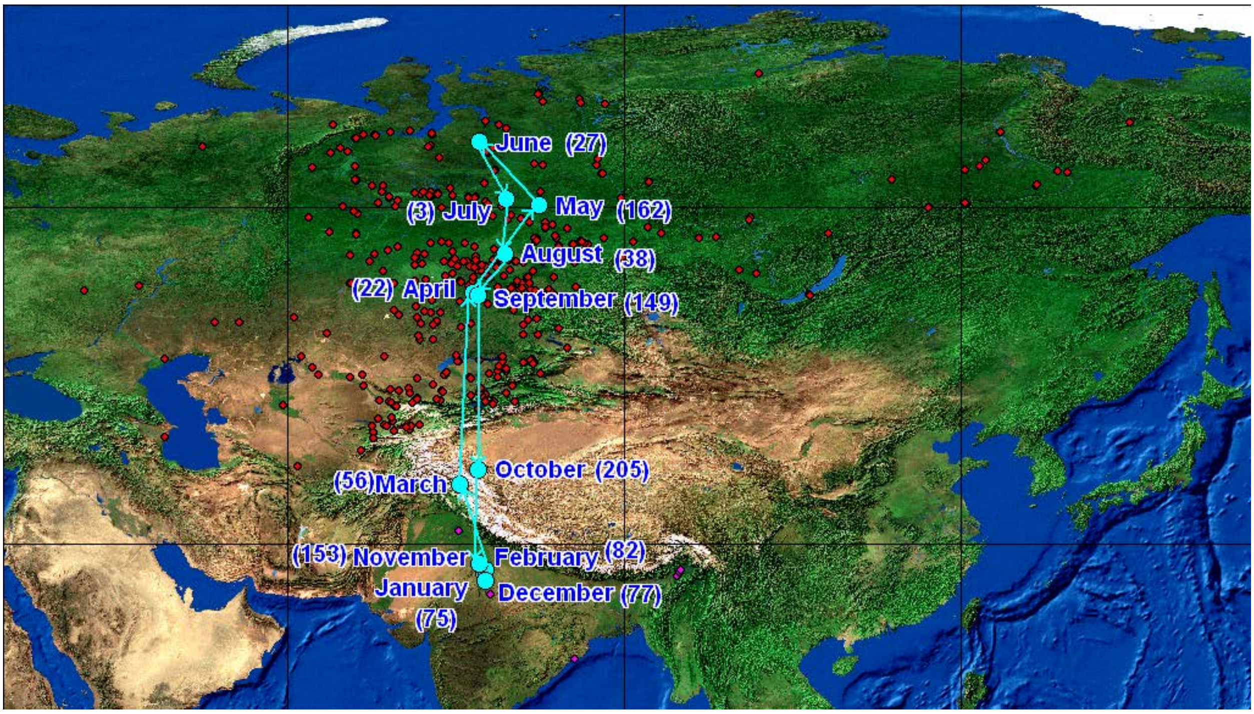


Figure 265. Mean monthly locations of Pintail control points for birds, ringed on the wintering grounds in India, Pakistan and Bangladesh. Blue-green large circles are mean monthly locations of Pintails. Arrows show directions of movements. Number of control points in each month is represented in parentheses. Purple dots are the ringing sites, red dots – recovery points.

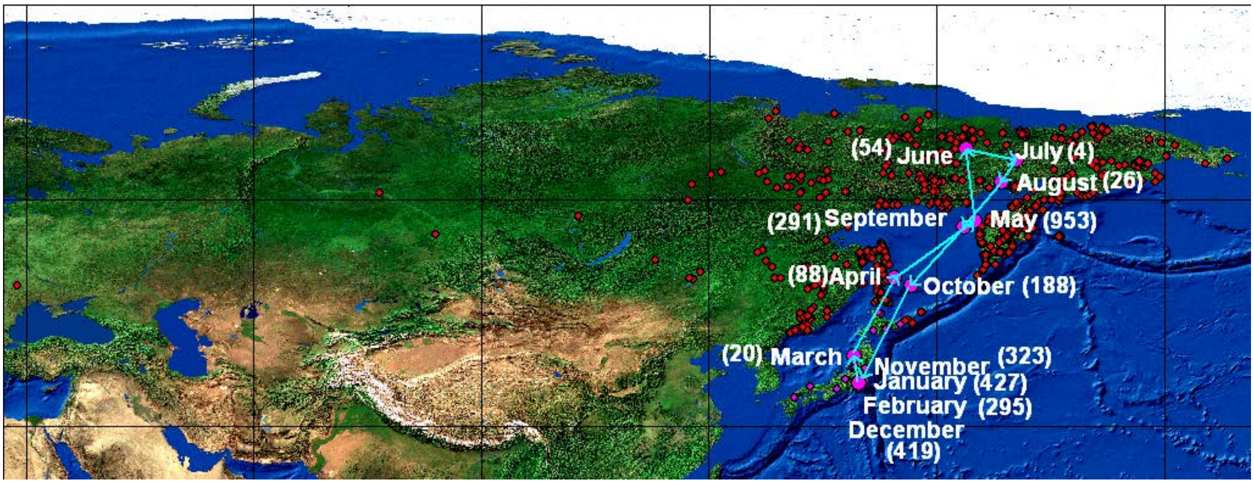


Figure 266. Mean monthly locations of Pintails control points for birds, ringed on the wintering grounds in Japan. Blue-green large circles are mean monthly locations of Pintails. Arrows show directions of movements. Number of control points in each month is represented in parentheses. Purple dots are the ringing sites, red dots – recovery points.

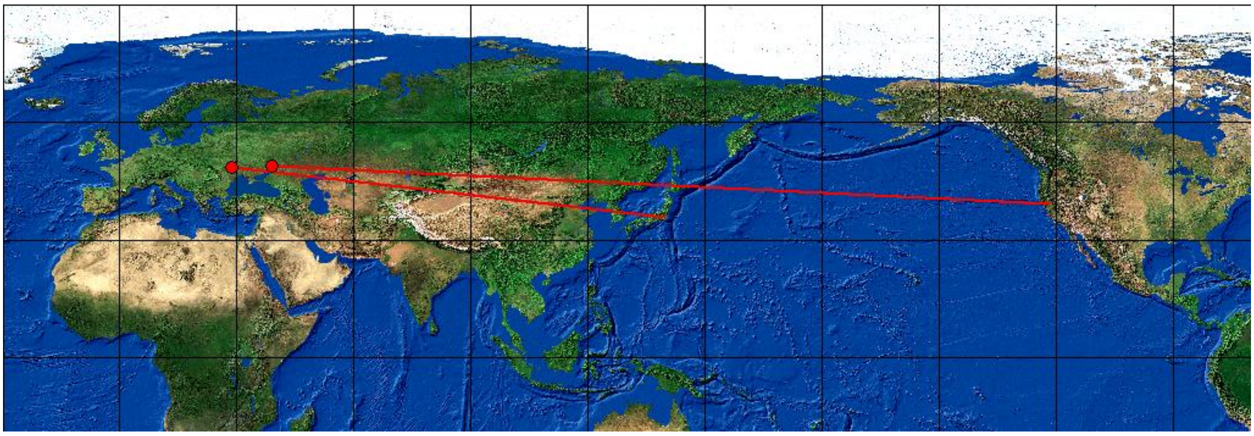


Fig. 267. Longest distance Pintail recoveries (indirect ones) from North America and from Japan. Red dots are recovery points; red lines connect ringing and recovery sites.

Summarising all about migratory routes, we can outline spring and autumn Pintail migratory movements (Figs 268 and 269). In distinction to Mallards, during migration Pintails use both the „southern gate" from Europe to Western Siberia (bending Ural Mountains over the southern end), and the „northern gate" (bending Ural Mountains over the northern end). Pintail migratory streams from Europe to Western Siberia are wider and even partly include areas of Urals, which are in the neighbouring position to the mentioned „gates". In the same time it is more spread along latitudes: in Pintail the southern limit of the wintering grounds is located much southerly, than in Mallards. In distinction to Mallards, Pintails are capable to cross thousands of km of open sea or desert areas.

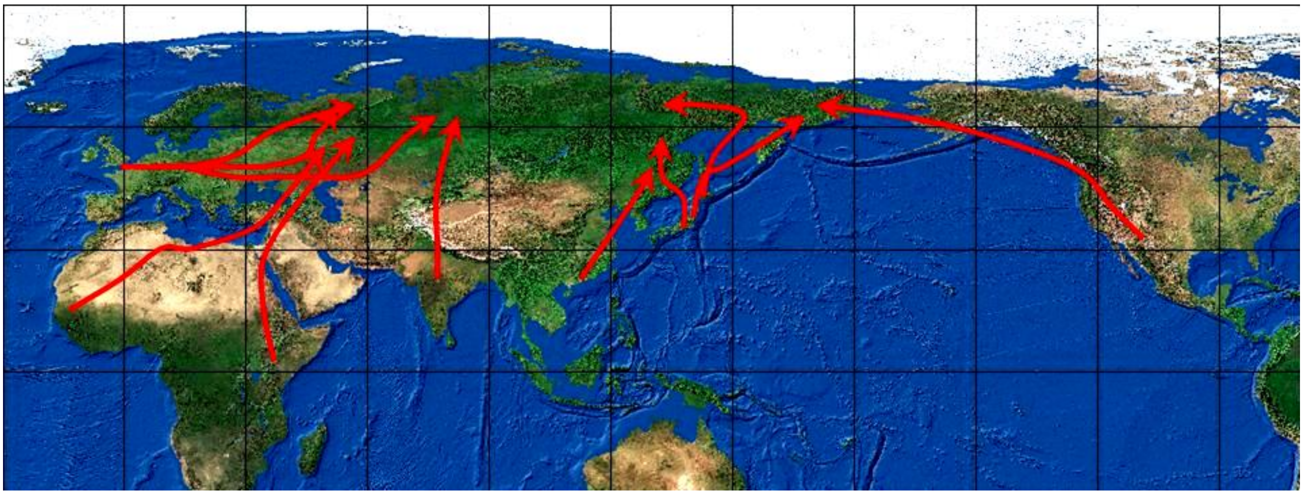


Figure 268 Outline of spring migratory routes for Pintails. Red arrows – directions of migratory movements.

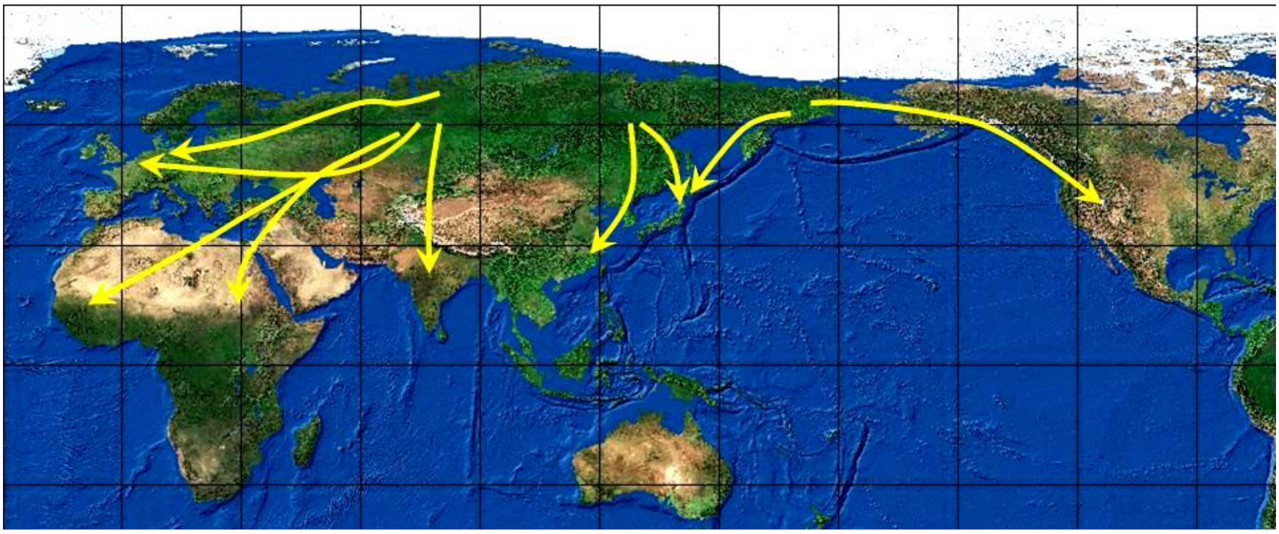


Figure 269. Outline of autumn migratory routes for Pintails. Yellow arrows – main directions of migratory movements.

Some additional remarks. We would like to say some words about satellite transmitter usage. It turned out that this is very good way to study migratory routes. However, the area, covered with birds mounted with transmitters appeared less, that the area, occupied with birds marked with ring or/and neckcollars. This was found in Pintails, marked in Japan (Hupp et all, 2011). It looks like birds encumbered with transmitters fly more straight than birds with rings or collars only. A good confirmation of this statement is the absence of satellite transmitter track points over the Kuril Islands. Ring recoveries show good spring and autumn migratory route over Kurils (Ostapenko et al., 1997; this species account); directs observations of Far Eastern ornithologists clearly indicate existence of this migratory route (M. Ushakova, personal communication). At the same time, none of 198 birds with transmitters had flown over Kurils, they flew straightly over the Sea of Okhotsk (Hupp et al., 2011).

The same as in the White-fronted Goose, Mallards, etc., there could be a question why Pintails usually do not cross Ural Mountains, although these mountains are not high. This regularity is also valid for many other duck species. The reason for that could be the historical one: when Glacier Age was finishing, Ural Mountains were covered by glacier for much longer time than the Central Russian Plain and West Siberian Lowlands.

Speed. Bird Ringing Centre of Russia database contains several Pintail direct recoveries with high flight speed. 370 km per day is the highest speed of movements detected both for European ringed birds and for Japan ringed birds

Populations. Pintail is more mobile duck than Mallard, it flies generally at about 1.5 times longer distances, species area (breeding plus wintering range) of Pintails is much greater than in Mallard, therefore, Pintail populations are considerably more sizable than Mallard ones. Bird Ringing Centre of Russia data allow outlining the following Pintail populations: 1) iceland-european-west-siberian population (polygon No 1, Fig. 270) with generally west-east migration movements; 2) west-central-african-central-eatern-european-west-siberian population (polygon No 2, Fig. 270) with general north-east – south-west migrations; 3) east-african-arabian-middle-eastern-east-european population (polygon No 3, Fig. 270); 4) indian-central-asia-east-european-siberian population (polygon No 4, Fig. 270) with north-south migratory movements; 5) japanese-south-korea-eastern-china-far-eastern population (polygon No 5, Fig. 270); 6) north-american-north-far-east-eastern-siberian population (polygon No 6, Fig. 270) with preferably north-west – south-east migratory movements. First four populations overlap greatly, the forth and fifth populations overlap, as well, but in lesser extent. Japanese-south-korea-eastern-china-far-eastern and north-american-north-far-east-eastern-siberian populations overlap practically in all breeding parts of these flyways.

Intergradation zones are located in Western Siberia, north of the Far East and – in the past – Volga River Delta. As in other dabbling ducks, long-distance cross-population movements exist, the longest of them is the mentioned one from the easternmost north-american-north-far-east-eastern-siberian population and westernmost iceland-european-west-siberian population.

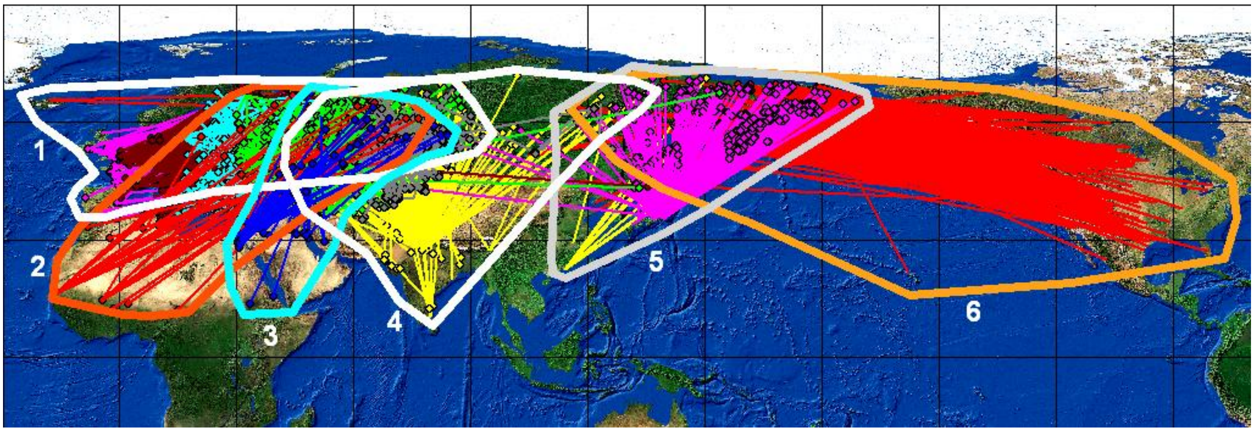


Figure 270. Pintail populations. White polygon № 1 outlines iceland-european-west-siberian population. Light brown polygon № 2 is west-central-african-central-eatern-european-west-siberian population. Blue-green polygon outlines east-african-arabian-middle-eastern-east-european population (polygon No 3). White polygon № 4 shows the indian-central-asia-east-european-siberian population. Grey polygon № 5 shows japanese-south-korea-eastern-china-far-eastern population. Light brown polygon № 6 outlines north-american-north-far-east-eastern-siberian population.

Ten-year distances. Data on Pintail allow analyzing overall recovery mean decadal distance only, because numbers of ringed ducks in any separate place either small or does not cover long-term periods. Mean flight distance fluctuates among decades, however demonstrates the tendency for increasing (Table 16). To reveal it more clearly, we should try to combine some decades and compare. Mean distance for the period of 1908-1960 is 1601.3+/23.0 km (N = 2831), for the period of 1961-2023 is 2699.4±19.9 (N = 4539). Overall growing is more than 1000 km, significant – t-Bailey = 36.1, P=0.0000.

Since ringing places sometimes changed and different amount of ducks were ringed in different places, the 1000 km growing might be exaggerative result. To be certain, we compare distances for Pintails ringed in the Volga River Delta in years when recoveries from birds ringed there were available. For 1927-1960 the mean flight distance was 1383.6±18.4 (N = 2414), for 1961-1998 (no later ringing in this area) was 1557.5±40.0 (N = 599), growth is significant, as well: t-Bailey = 3.95, P=0.0001.

Table 16. Pintail mean flight distance per decade.

Decade (years)	1908-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2023
Distance (km)	1975.8	1637.4	1812.1	1446.7	1633.0	2436.6	2817.5	2868.2	2700.4	2481.5	2679.7
Number of recoveries	9	19	203	704	1895	1095	1665	954	249	343	206

There is a guidable place for test of the probable changes in migratory routes over long term periods. This is the Volga Delta, a place which is located in the southern part of the breeding range, and ducks from there move mainly in two directions (see recovery roses in different duck species): 1) to the breeding areas to western Siberia (usually in years next after ringing); 2) to the wintering grounds in Europe (both in the same and next years). In Pintail directions of flight both to Siberia and to Western Europe became more northerly after 1970, than before, however insignificantly.

Most birds were ringed at wintering or moulting sites. As it is shown in species account of the Bewick's Swan, during global warming birds with permanent wintering place habituate larger area for breeding, flying more to the north or/and east. Thus, we observe the same process in Pintails.

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest Pintail lived more than 27 years 5 months. Our database contains several recoveries of males with ring-recovery span more that 22 years, real life more than 23 years. One recovery Japan 090-80 592 happened after 35 years 4 months after ringing. However, conditions are “found sceleton” and “ring not sent” make this recovery unreliable. Therefore we exclude it from the mortality calculation sample.

Mortality rate. According to the common criteria (see “Materials and Methods”) 6896 dead recoveries are applicable for the mortality rate analysis. Mean annual mortality rate in Pintail is 28.82$\pm$0.29%. Real mortality pattern differs from the theoretical one significantly (χ^2 = 2210, df = 23, P=0.0000). Programme MARK, Model CLogLog 2ndPart shows 29.33%, difference is 0.51%. Pintail mortality pattern chart shows some drawdown of the real survival dynamics in the comparison to the theoretical one (Fig. 271). However, the Pintail range is large; conditions in different part of this range are very different. Since the large amount of data is available, it is possible to analyse species condition dynamics over different time periods, places and even latitude belts.

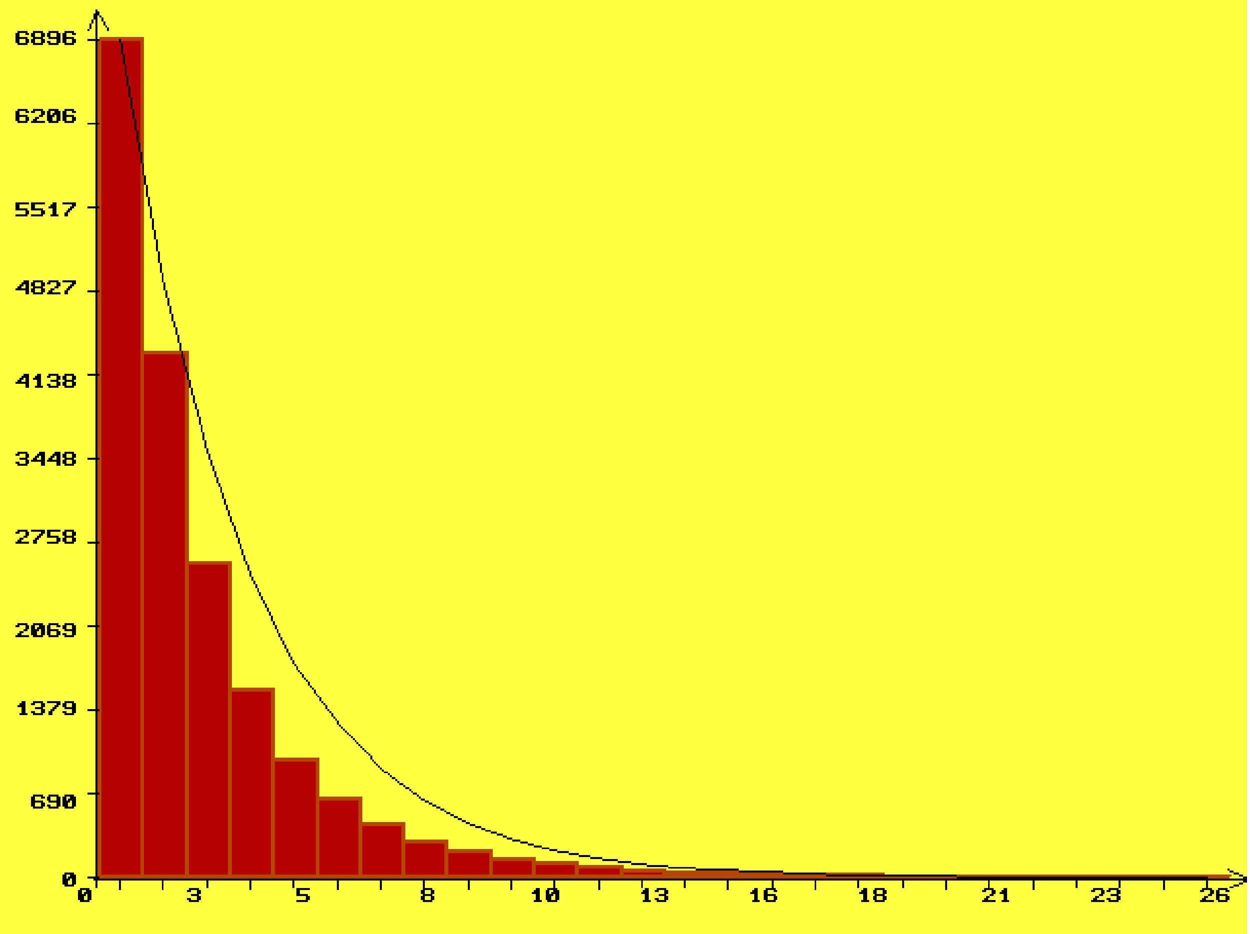
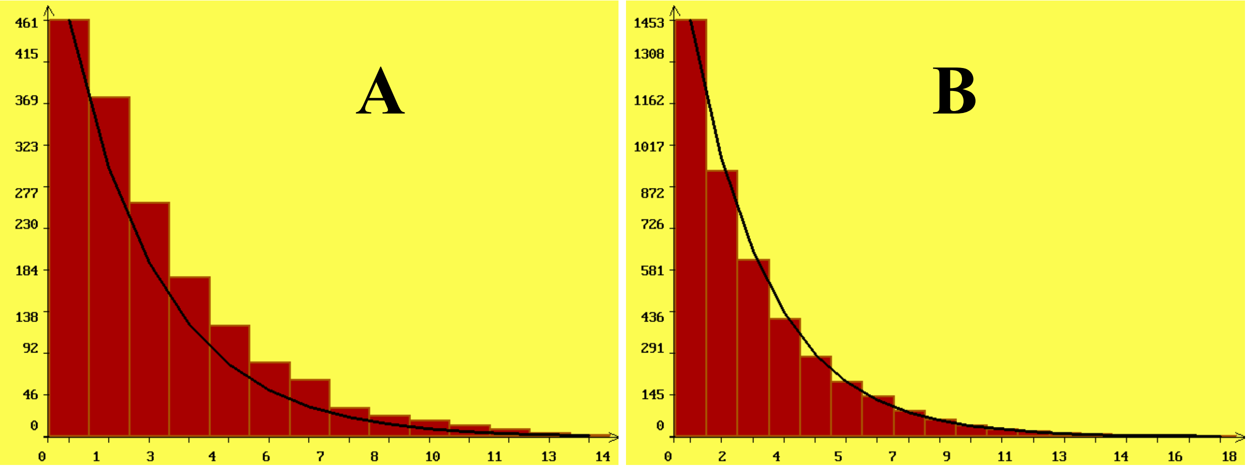


Figure 271. Mortality pattern in the Pintail. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Mortality pattern shows that, in spite of large decrease for the whole North America during recent 40 years (Butcher, Niven, 2007) the north-american-north-far-east-eastern-siberian Pintail population is in good condition and growing (Fig. 272, A). Pintails that winter in Japan are in good condition, population seems stable (Fig. 272, B). For birds wintering in India, Pakistan and Bangladesh drawdown of the real mortality pattern is considerable, therefore this population does not feel good (Fig. 272, C). Situation is probably better, but not good enough for Pintails, ringed all over Europe with small additional amount in Africa (Fig. 272, D).



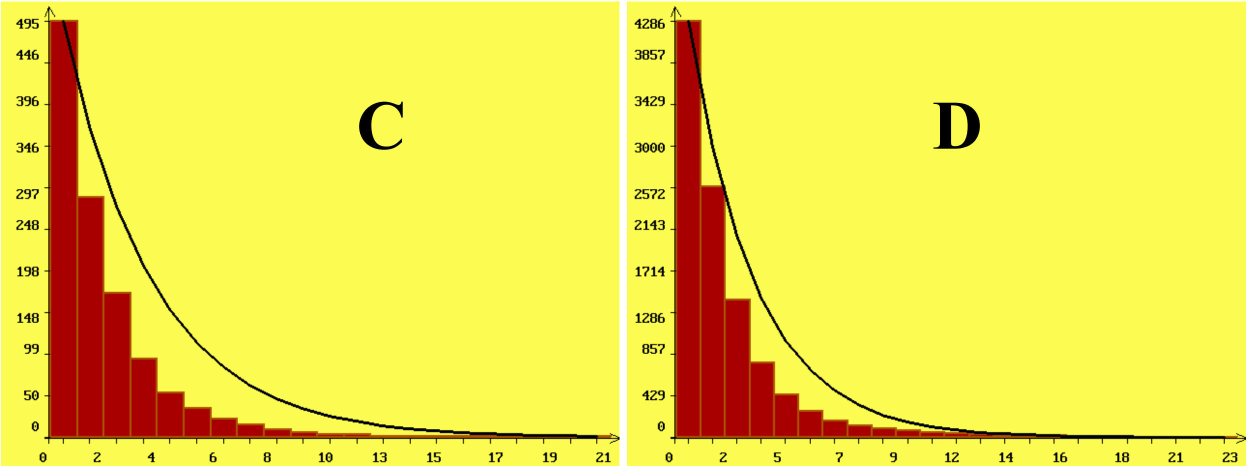
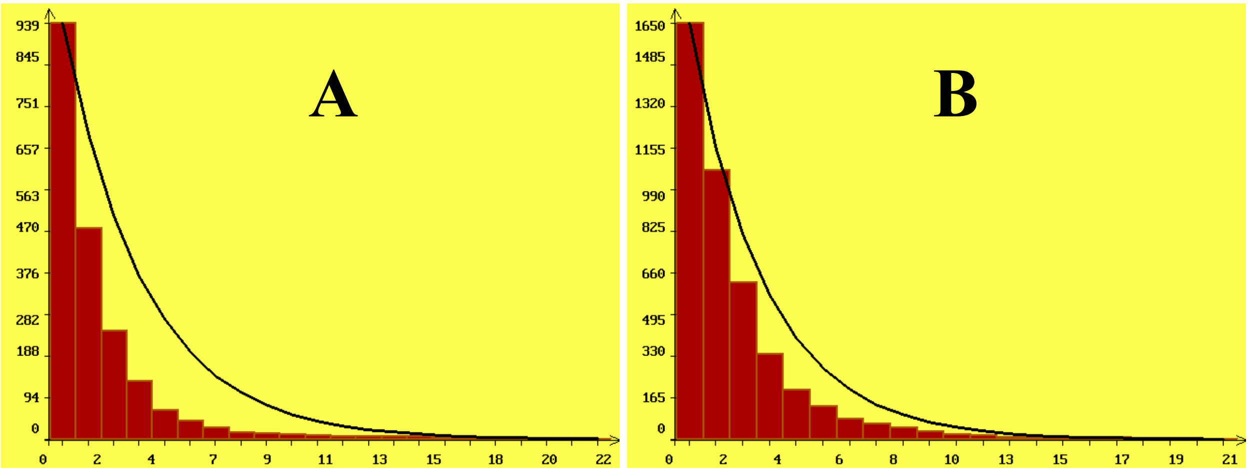


Figure 272. Mortality pattern in the Pintail, ringed in different wintering areas. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

A- Pintails ringed in North America, B – ringed in Japan; C- Ringed in India, Pakistan and Bangladesh; D- ringed in Europe and Africa.

Within European, West and Central Siberian Pintails (ringing in Europe, Africa and India), Pintails that breed (recovered) in different latitude belts display considerably different population status (Fig. 273). For Pintails recovered in the south (less or equal 45˚N) situation looks not good (Fig. 273,A), for Pintails in the belt 55-65˚N population condition is better (Fig. 273, B) and drops down again to the north or equals 65˚N (Fig. 273, C).

As an example we consider Murmansk Region, northern European Russia. In this area Pintail population condition during past decades deteriorated (I.A. Kharitonova, personal observations). Mortality pattern for Pintails ringed or recovered in the Murmansk Region confirms this, in spite of a small data set and the longest ring-recovery time only 8 years (Fig. 273, D).



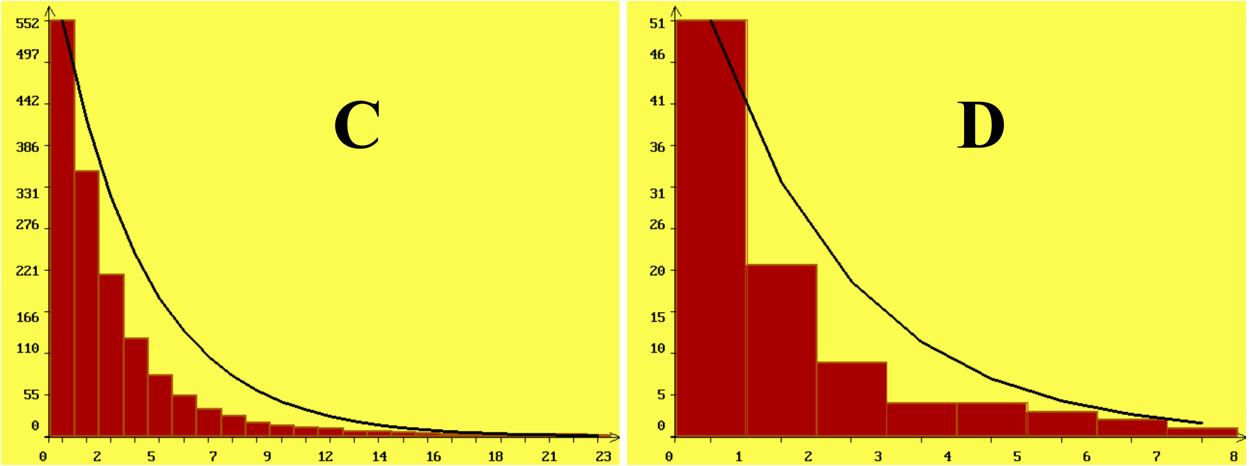
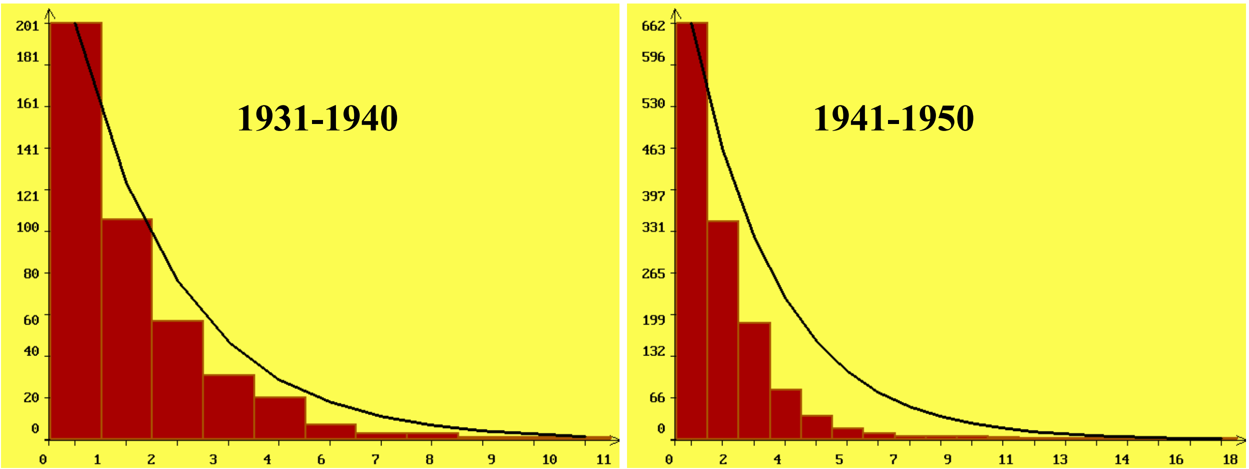
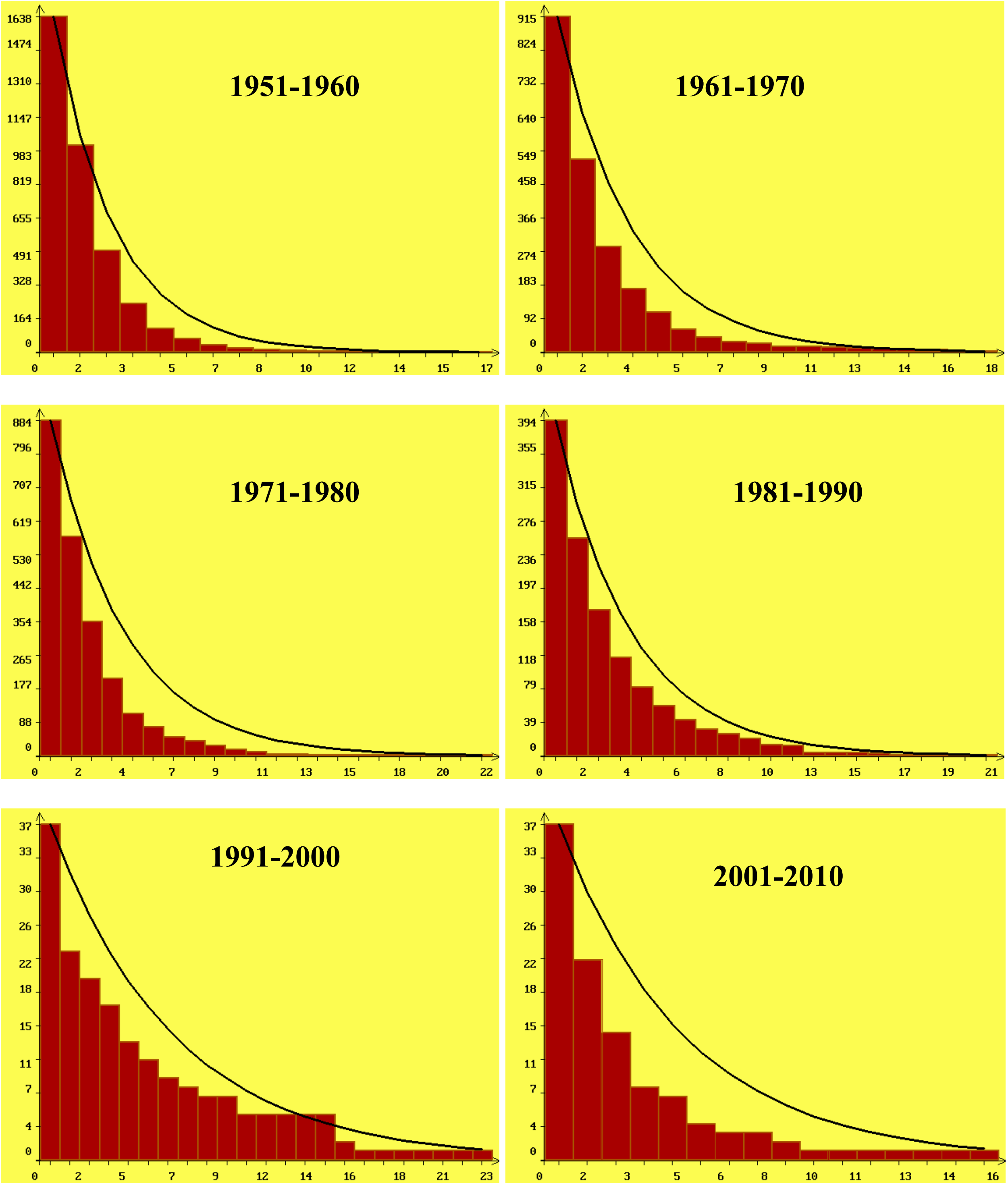


Figure 273. Mortality pattern in the Pintail, recovered in different latitude belts, for birds ringed in Europe, Africa and India. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

A- Pintails recovered to the south of 45˚N, B – recovered in the belt 55-65˚N; C-recovered to the north of 65˚N; D-ringed and recovered in the Murmansk Region, north European Russia.

If we consider European ringing pintails (ringing longitude<=60˚N), for 1930s mortality pattern indicates more or less "normal" population (species) condition – real data are not very different from the theoretical line (Fig. 274, 1931-1940). In distinction to Mallard, the situation in 1940s with Pintails is bad. It seems the War has affected Pintail in the opposite way than Mallard. Probably, it is related to the habitat preference of Pintail: this duck is more dry meadow nesting than Mallard, which breeds usually very close to water. Meadow nesting species should suffer more during battle preparations and battles themselves. Hunting during the war was not possible, because shotguns had been confiscated (Bianki, 2005). In 1950s the species goodness improved, probably Pintails suffered from hunting less than Mallards. Then, species condition fluctuated (Fig. 274_1).




1951-1960
1638 1474 1310 1147 983 819 655 491 328 164 0
0 2 3 5 7 8 10 12 14 15 17
1961-1970
915 824 732 640 549 458 366 274 183 92 0
0 2 4 5 7 9 11 13 14 16 18
1971-1980
884 796 707 619 530 442 354 265 177 88 0
0 2 4 7 9 11 13 15 18 20 22
1981-1990
394 355 315 276 236 197 158 118 79 39 0
0 2 4 6 8 10 13 15 17 19 21
1991-2000
37 33 30 26 22 18 15 11 7 4 0
0 2 5 7 9 12 14 16 18 21 23
2001-2010
37 33 30 26 22 18 15 11 7 4 0
0 2 3 5 6 8 10 11 13 14 16

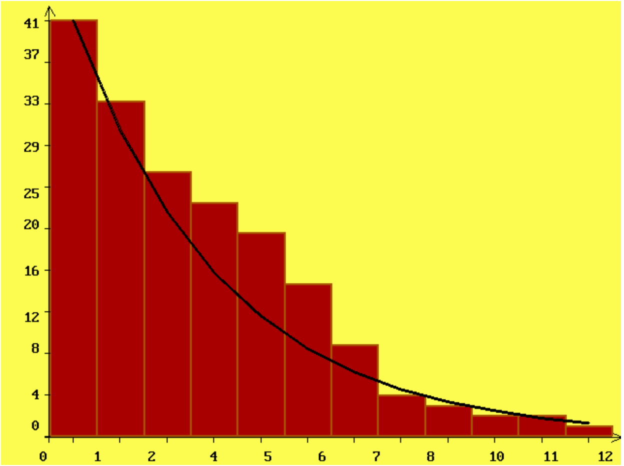
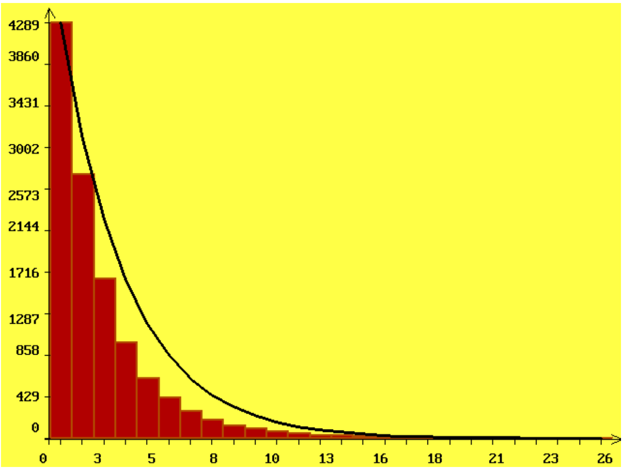


Fig. 274_1. Mortality pattern in Pintails recovered in different decades. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, males live slightly longer than females: 2.25±0.04 (N = 4289) and 2.14±0.05 (N2 = 2113) years respectively, significant (t-Bailey=1.94, P=0.05). Female overall annual mortality is noticeably greater than in males: 33.61±0.60 % and 27.51±0.36 % respectively (Fig. 274_2). The reason for it is not clear. Probably this rather high female mortality is responsible for the Pintail declining in the Europe-connected populations.



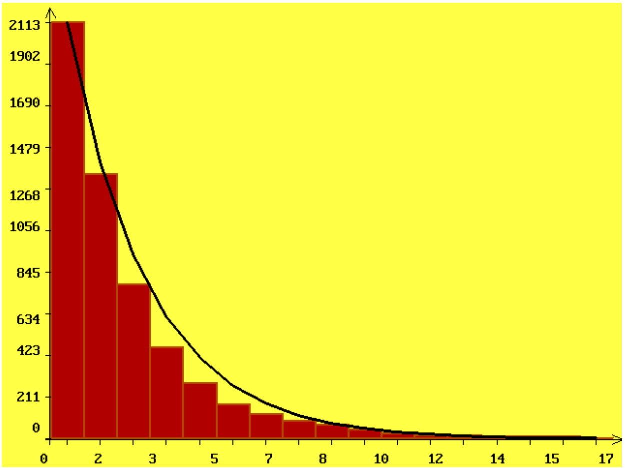


Fig. 274_2. Mortality pattern in Pintails: males (left) and females (right). X axis is the number of years after marking. Y axis is the number of live birds.

GARGANEY
(*ANAS QUERQUEDULA*)

Breeding range in Eurasia. Brief description of the breeding range is in Fig. 275. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

Photo by Vladimir I. Deryabin

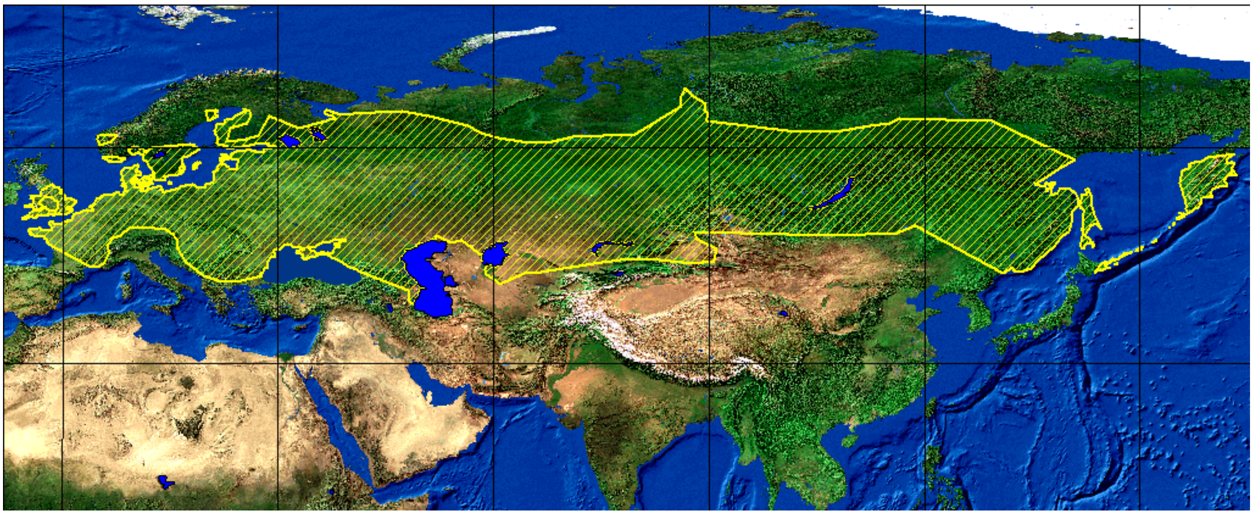


Figure 275. Breeding range of the Garganey in Eurasia (yellow dashed areas).

Distribution of control points. 1515 ring recoveries from 1515 marked birds were used for this species account (Fig. 276), none of birds held any kind of colour marks. Ringing dates are since 02.07.1929 until 12.06.2018, recovery dates are since 24.08.1929 till 14.05.2019. This duck is very wide-spread in Eurasia (Fig. 275).

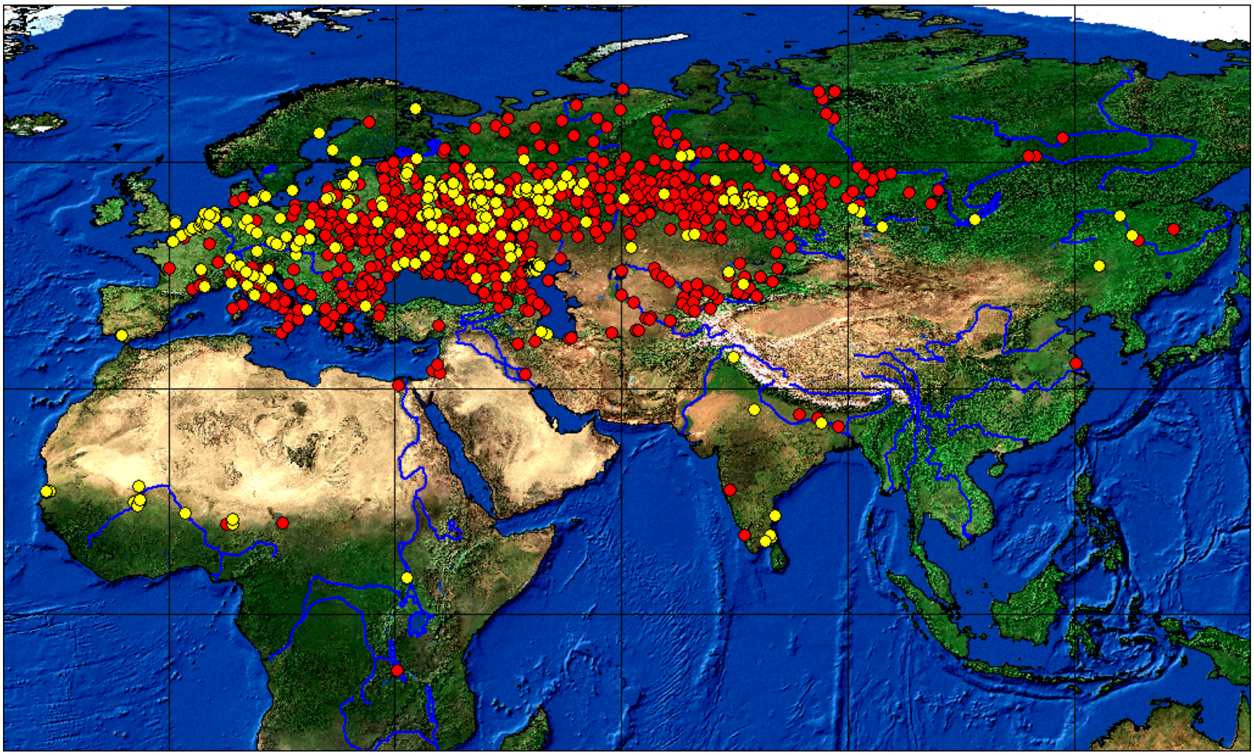


Figure 276. Position of all Garganey control points. Yellow dots are ringing sites, red dots are recovery sites.

Most of Garganeys were ringed in Europe, Azerbaidjan, western Siberia, Africa, India, Far East. Most of recoveries are from Europe, western Siberia, India, Russian Far East. Graganey is the second dabbling duck species (together with Pintail), that is capable to cross Sahara Desert.

'Moskwa' scheme recoveries. This sample contains 964 recoveries of the scheme „Moskwa". They are from birds ringed within the Russian Federation and countries of the former USSR (Fig. 277). More than a half of these birds (465 recoveries) were ringed in the former huge moutlting place in the Volga River Delta, where many duck species concentrated for moult. Now this moulting area does not exist any more for the reason of Caspian Sea level growth (Viksne et al, 2010).

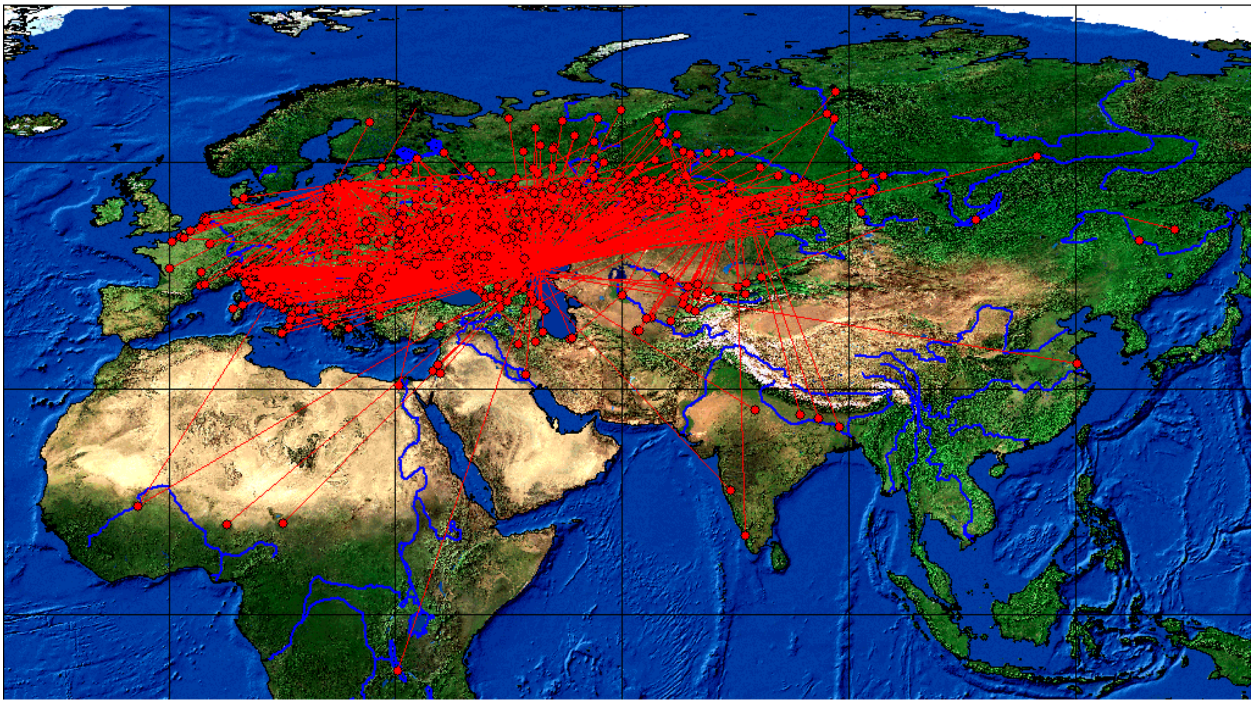


Figure 277. „Moskwa" scheme recoveries of the Garganey. Here and in all other similar figures lines start from ringing site, recovery sites are marked with red dots.

Finding details. This analysis includes all 1515 recoveries. More than 2/3 of recoveries (70%) are „shot". In 304 (22%) recoveries „details unknown", which probably mean they were shot, as well. Therefore, we can assume that 92% of birds were shot. Other reasons are not so common (Fig. 278).

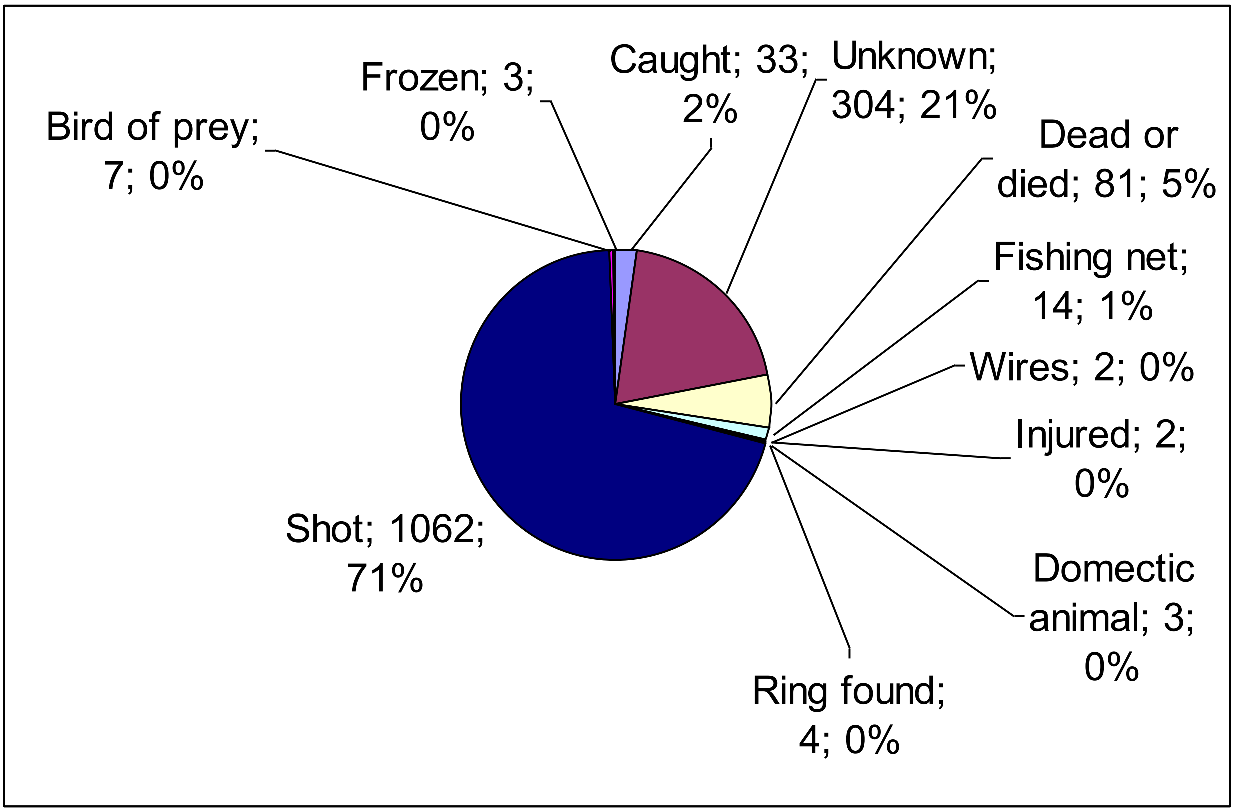


Figure 278. Finding details in the Garganey.

Direct and indirect recoveries. Areas covered by direct and indirect recoveries do not much differ from each other (Figs 279 and 280).

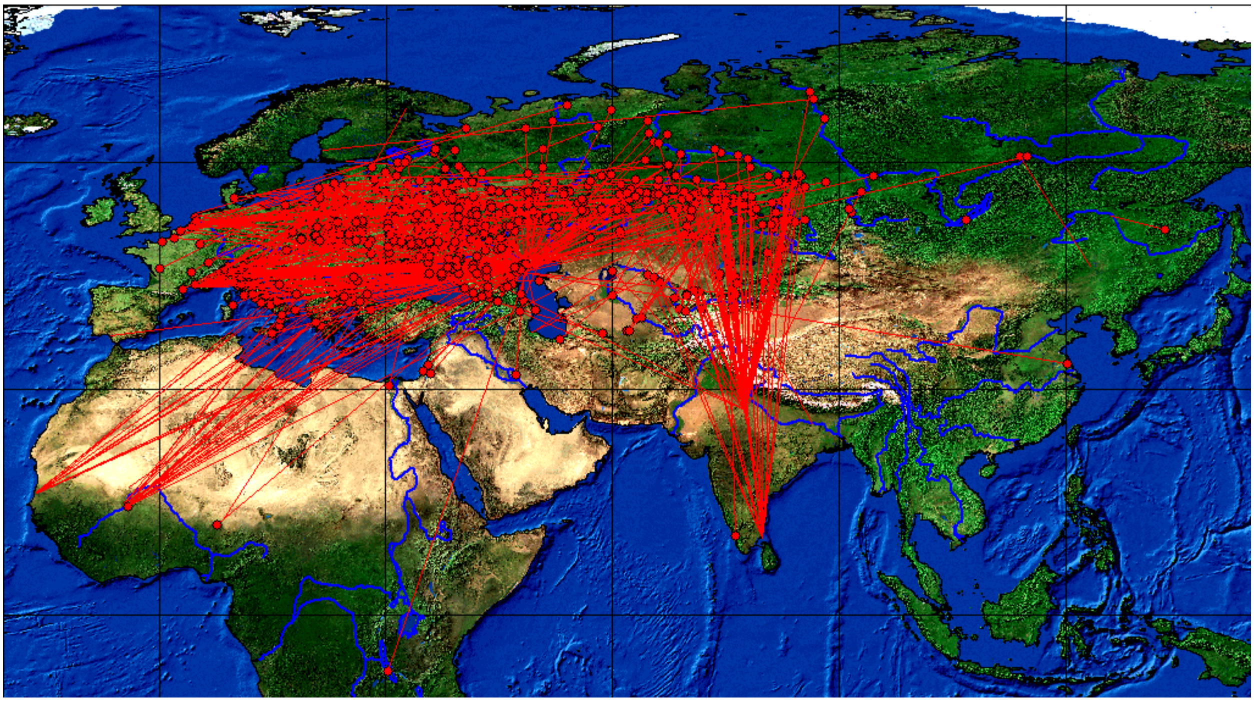


Figure 279. Map of the Garganey direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

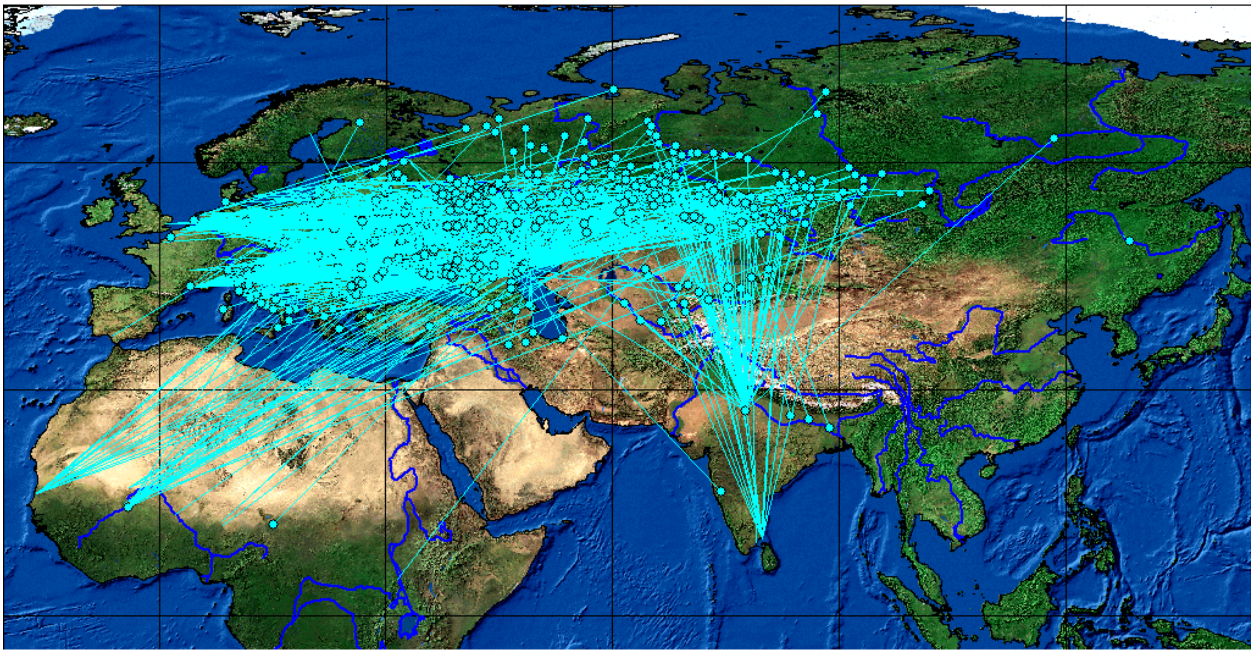


Figure 280. Map of the Garganey indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

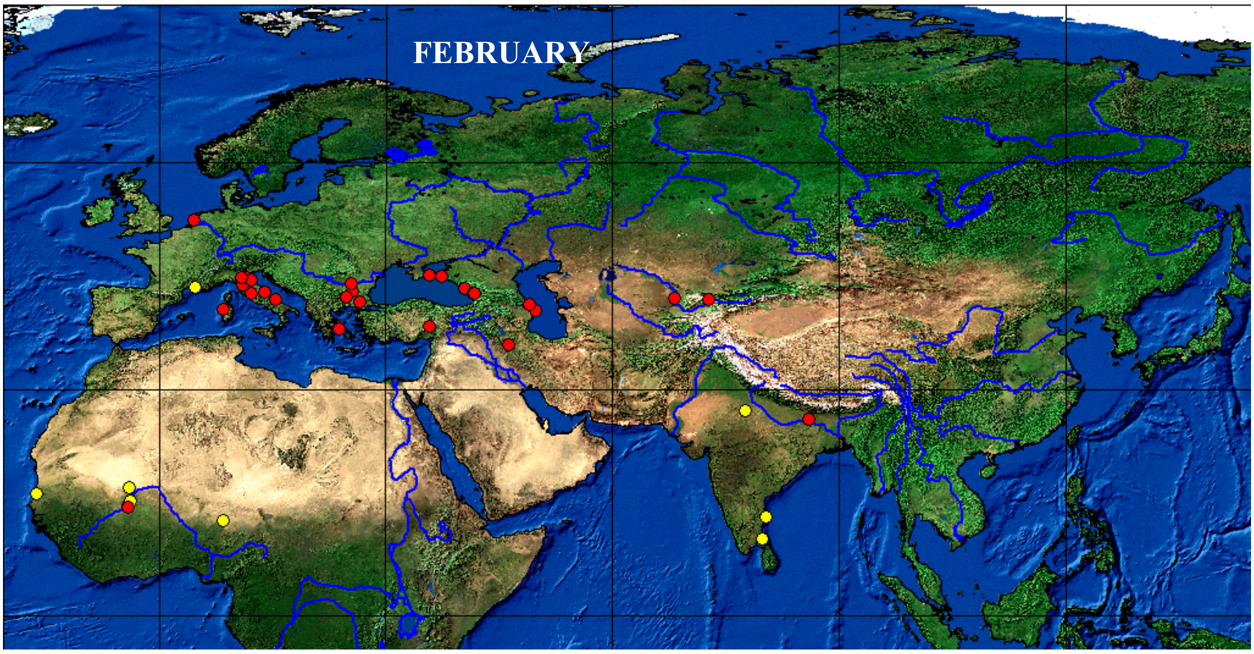
Maps clearly indicate that Gardaneys wintering in Europe and India fly to breed to the European Russia, Western and Central Siberia approximately up to meridian 135˚E (Fig. 279). Garganeys from India fly to the western Siberia. Thus, recoveries from Indian wintering Garganeys “fill” Western Siberia in addition to European recoveries, and area of Indian recoveries coincides with the area of European recoveries in western Siberia. Garganeys from European wintering grounds cover longer distances in their flights to Western Siberia than all other dabbling ducks. Data on Far-Eastern Gardaneys in our database are scarce.

Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them ($\chi^2 = 31.11$, 735 direct recoveries and 780 indirect ones, df = 2, P = 0.0000). Centre of the area with indirect recoveries is situated in just 37 minutes to the north and 5 degrees 08 minutes to the eats in comparison with the centre of the area of direct recoveries. Average flight distances in direct and indirect recoveries are very different: 1773.7 ± 59.3 and 2400.3 ± 61.3 km respectively. Difference is highly significant – t-Bailey = 7.3, P=0.0000. Like in Pintails, in Garganeys long-distance cross-population movements are among both direct and indirect recoveries. In Garganey the longest distance in indirect recoveries is 9537 km: adult male with the „Paris" ring FT 0227 was marked in Mali on 05.02.1979 and in about 3.5 years was shot in the Irkutsk Region. For direct recoveries the longest distance is shorter – 8464 km, also for a bird, ringed in Mali and recovered in Tomsk Region, Western Siberia. Garganeys ringed in Senegal and Mali display very long migration distances both in direct and indirect recoveries.

Garganey is one of the two dabbling ducks (the second one is Pintail) which crosses Sahara Desert during migration; and winter in countries to the south of Sahara - Senegal, Mali, Nigeria, others (Figs 279 and 280).

Monthly movements. All direct and indirect recoveries are included in demonstration of migration month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in Garganeys (Fig. 281). In January and February most ducks are on the wintering grounds in the western and southern Europe, Black Sea area, Africa south of Sahara, Middle East, Central Asia, Iran, India. First small movements in direction to breeding grounds are noticeable in Mach (Fig 281, March). These movements to the north or north-east start frim the southern wintering areas: south-eastern Europe, Black Sea and Caspian Sea areas and India. It is noticeable from the position of the newly appeared green dots, which point to the recovery sites (Fig. 281, March). In April migration continues and finishes in May when these ducks reach not only the northern boundary of the breeding range; many birds, mostly vagrant ones fly considerably further north, up to Eurasian tundra zone. For Garganeys in European Russia it occurs in May, in Siberia in June (Fig. 281, May, June). It looks like the numerous penetrations out of the breeding range is the peculiarity of Garganeys. Recovery pictures show that Ural Mountains are not the obstacle for this species. Garganeys can cross these mountains both on spring and autumn migration. In June, the area of recoveries in European Russia shrinks in its northern part: birds start to move to the south and west, appearing within the boundaries of the species breeding range. However, in Siberia the recovery area continues to expand in northward direction. In European Russia already in June a great number of birds, males and non-breeding or failed females fly to the moulting areas. This time is very convenient for catching and ringing adult birds, and positions of the ringing sites (Fig. 281, July) show that Garganeys, the same as other dabbling ducks (see species accounts), move close to the wintering areas for moult. In Garganey, these movements in June and July are more long distance and more complicated then in other dabbling duck species. At this time European Russian Garganeys, in a strange way, move to the west at considerable distances (see section "Migratory routes"). In August breeding birds start to move southward and westward. Although most ducks fly in the direction to wintering grounds after moult, some birds perform the backward flights after moult. They move not to the wintering areas, but fly again to the east in the direction to breeding areas (Fig. 282), however they will not breed at this time. In August birds are mostly on the breeding grounds within the species breeding range. September and October indicate intensive migration, but some birds still are in the breeding areas. In November migration is finishing, in December Garganeys are on the wintering grounds (Fig. 281).


JANUARY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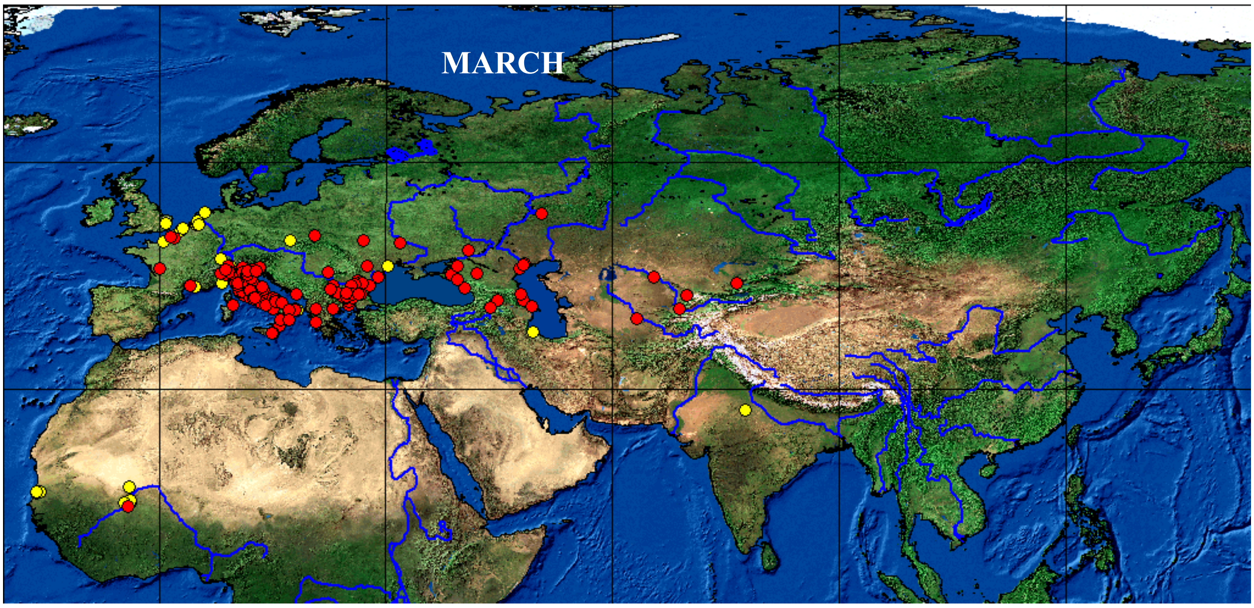
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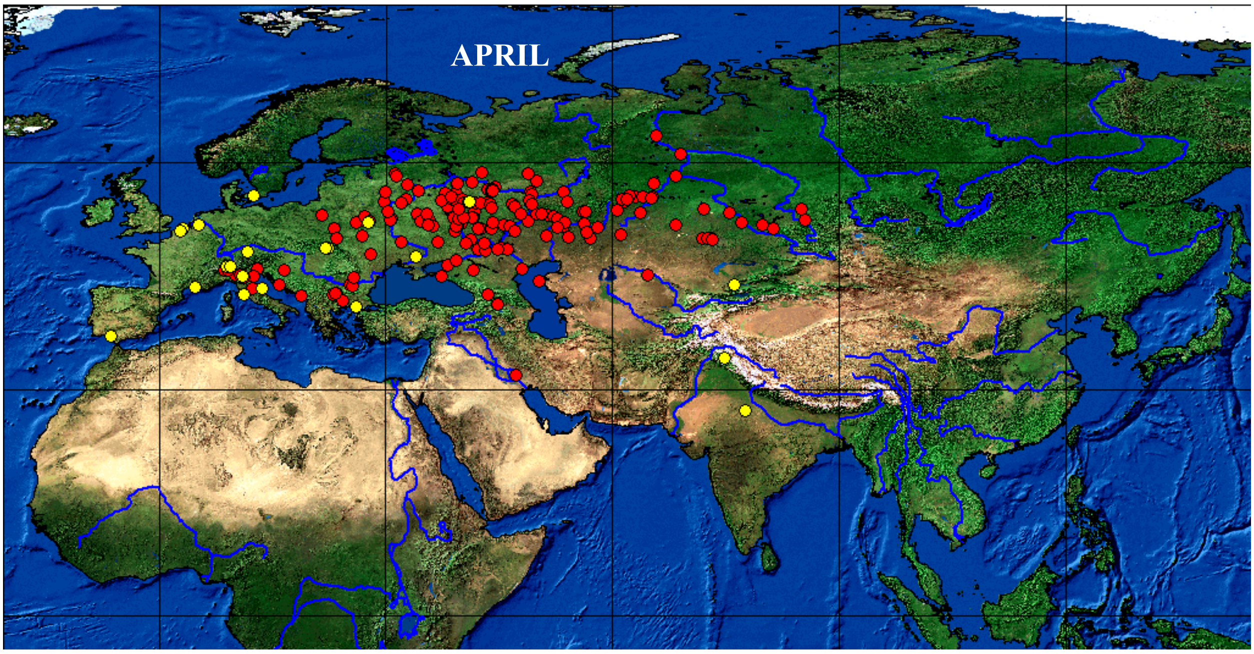
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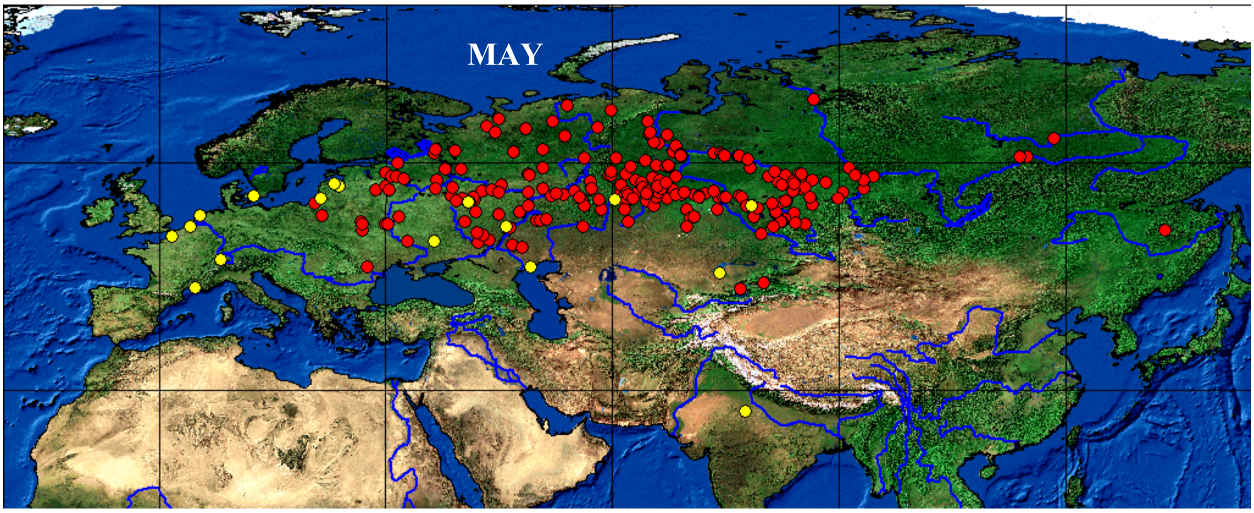
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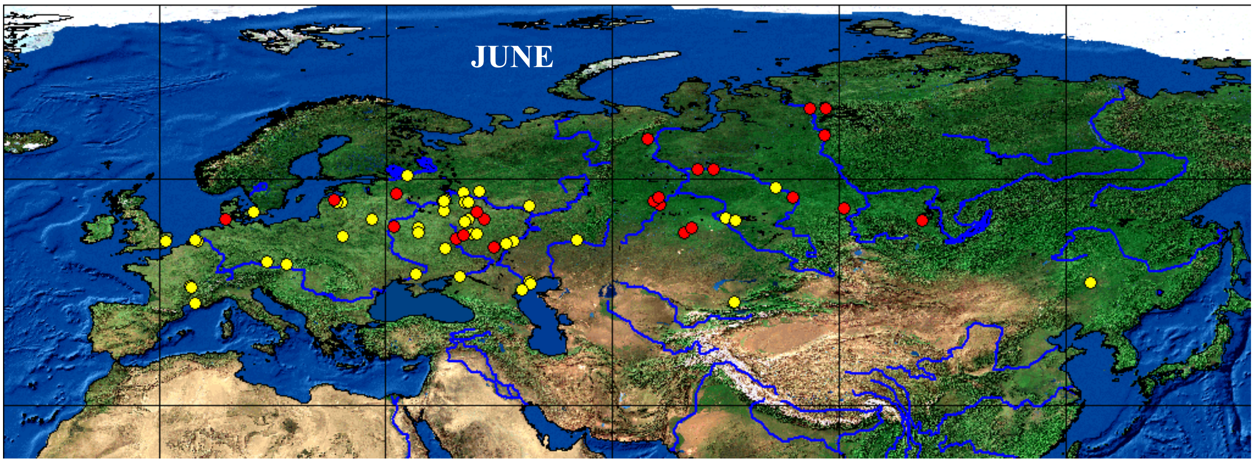
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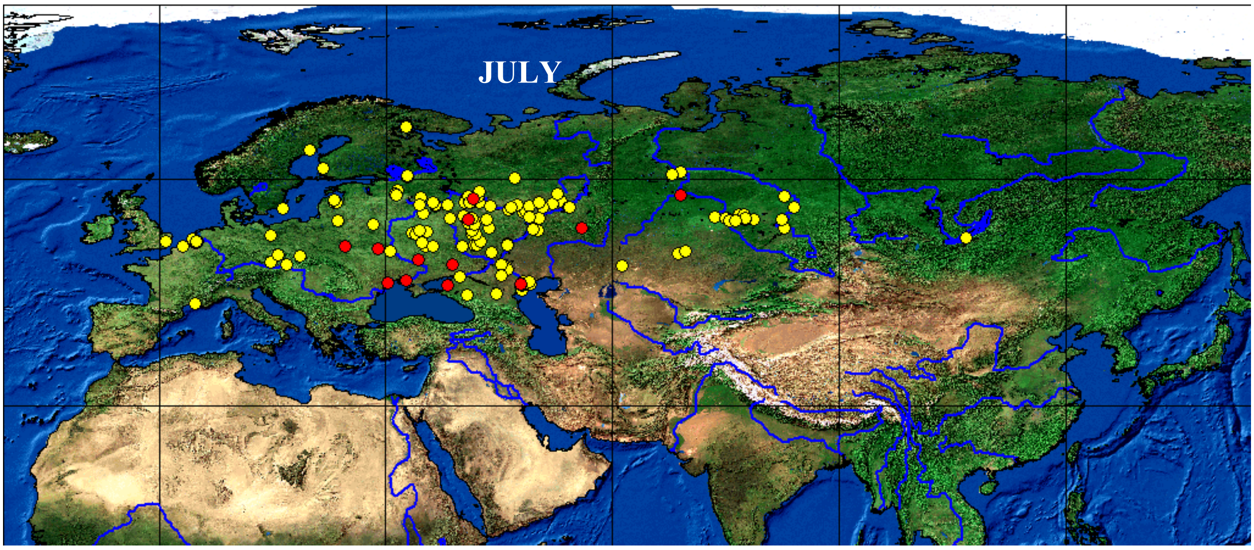
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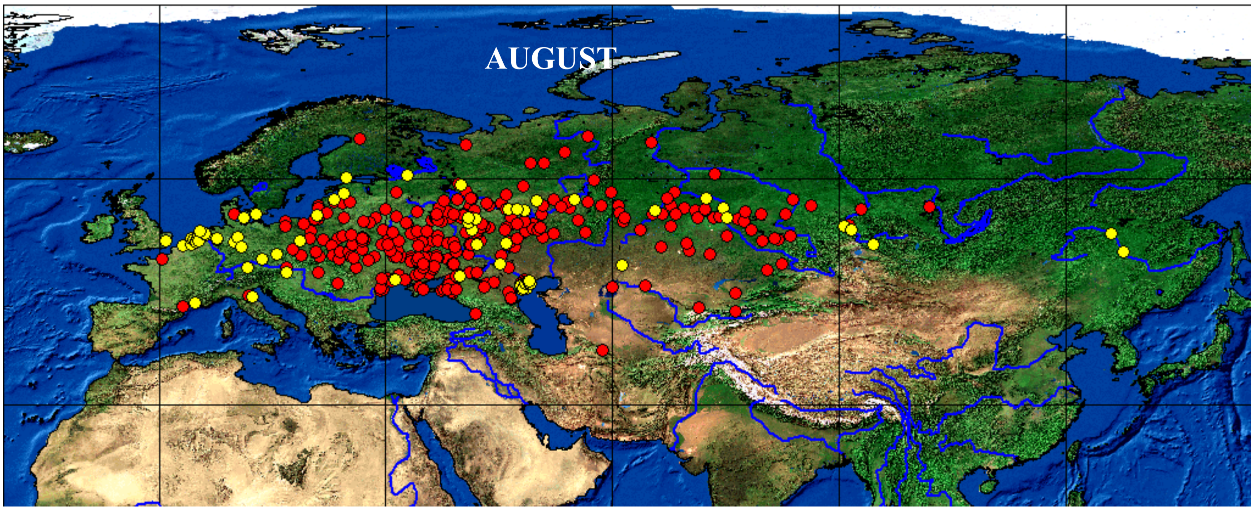
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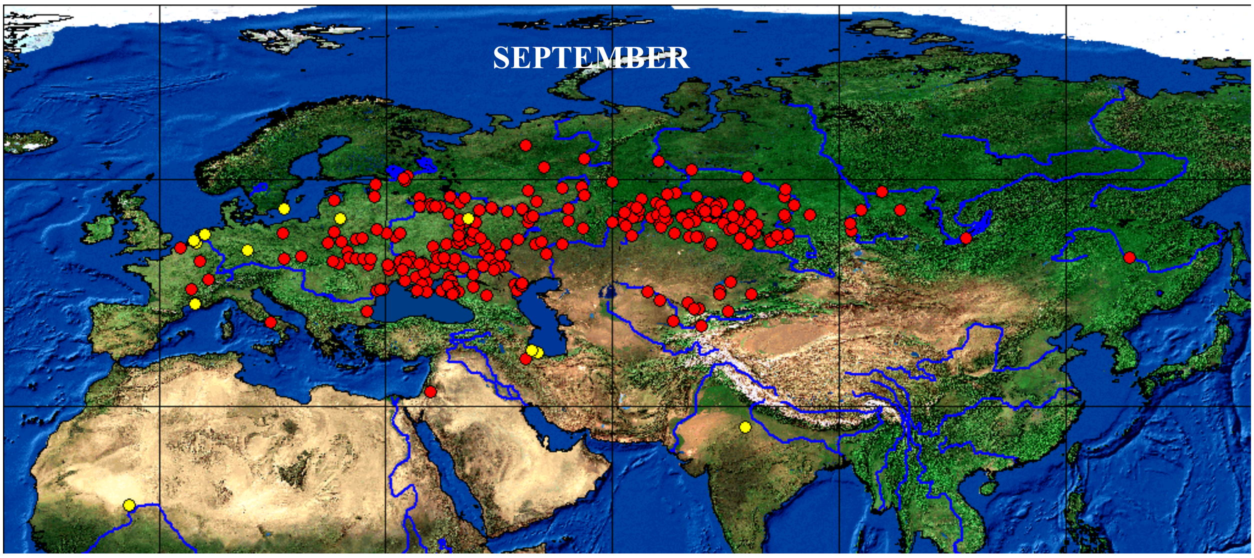
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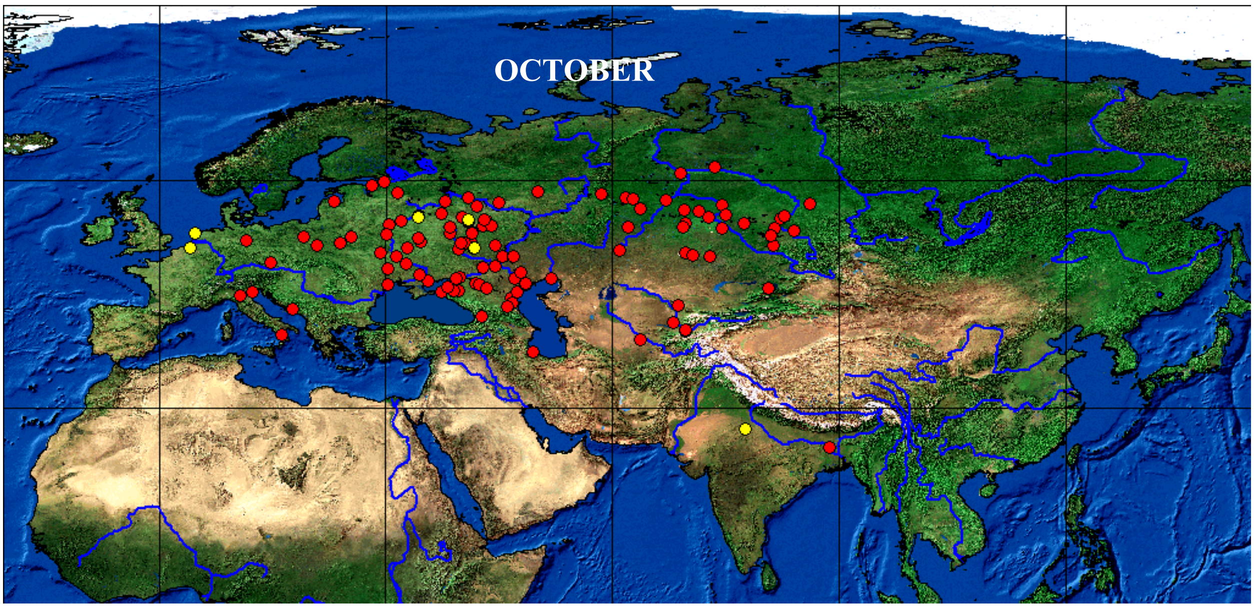
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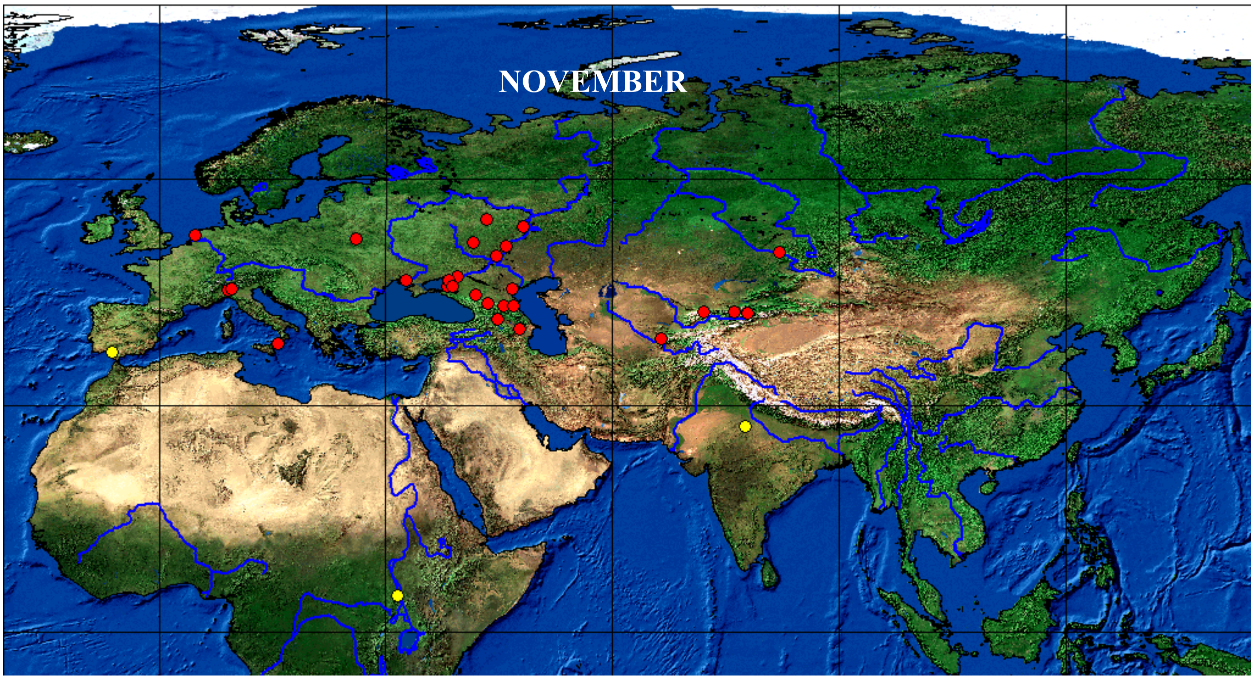


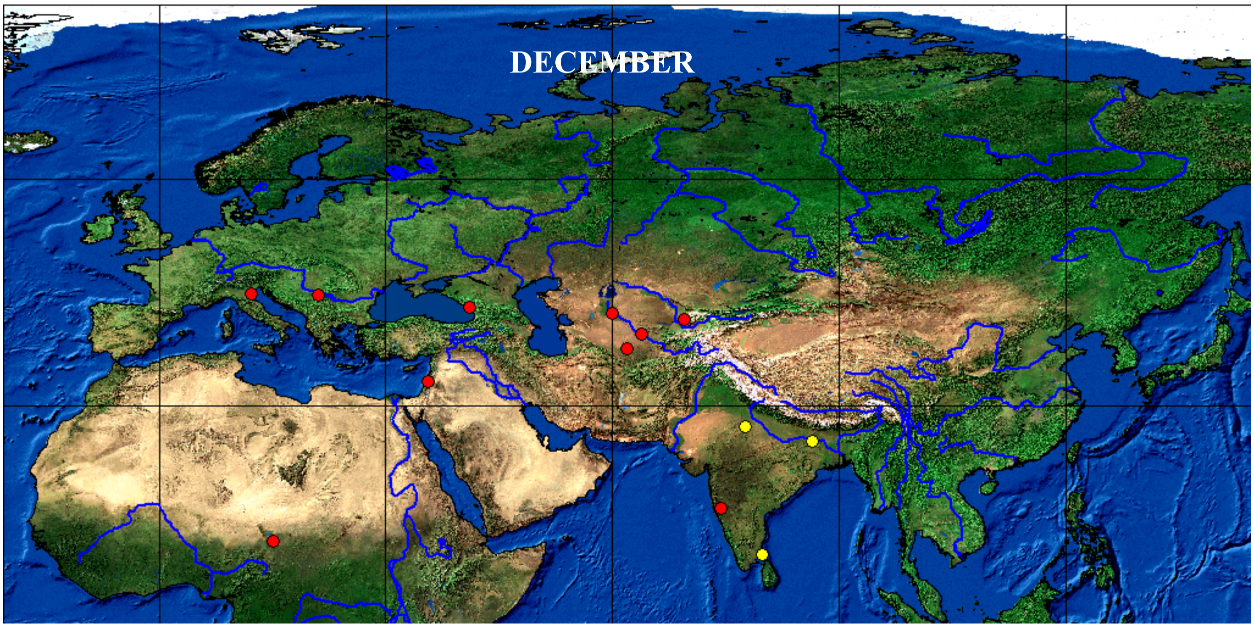


Figure 281. Garganey monthly movements. Yellow dots point on ringing sites, red dots point on recovery sites.

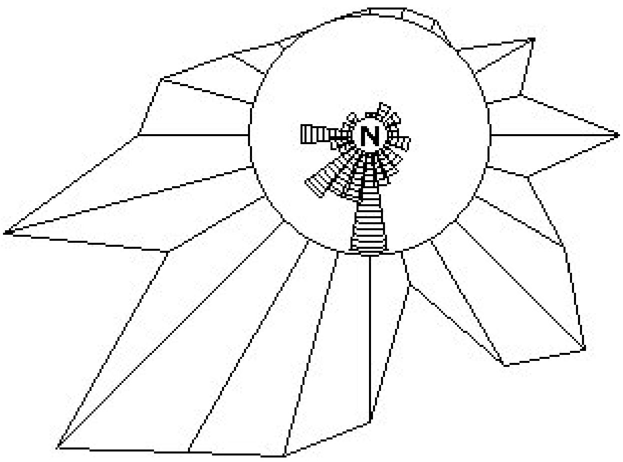


Figure 282. Recovery rose graphs for Garganeys ringed in July and recovered during 60 days after ringing: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts). Sector = 15.0°; Total recoveries - 124; N in sectors: from 0 up to 17; Average distance in sectors: from 0.0 km up to 1100.2 km; the longest flight distance is 2593.2 km.

Migratory routes. To analyse movement directions, we draw several recovery roses for birds ringed in different longitude zones. Since almost all Garganeys were ringed not easterly than 90˚E, we consider three longitudal zones. Birds ringed in areas with longitude <=30˚E move to the east, north-east in spring (bearings 37-112˚, mostly 67-90˚ Fig. 283), and in the opposite direction in autumn. For birds ringed in the area with longitude 30˚-60˚E preferable flight bearings are 32-82˚ in spring and 247-290˚ in autumn. There are numerous birds in this section ringed in the Volga River data, which is close to the southern end of Ural Mountains, and recovery rose here shows some turn between western and north-eastern directions that occurs near the southern end of the Urals. However, this turn is not sharp, therefore it is not compulsory indicates rounded flight over the Ural Mountains. For ducks ringed in 60˚-90˚E preferable bearings area 350-10˚; this is spring flight direction for Garganeys ringed in India (Fig. 283); certainly, the opposite should occur in autumn.

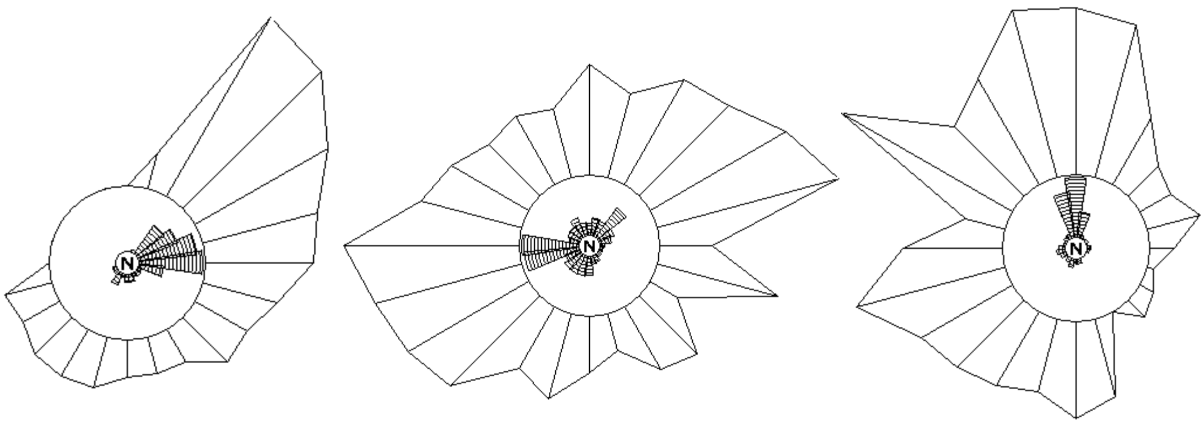


Fig 283. Recovery rose graphs for Garganeys, ringed at different longitudes: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Left chart is for European-wintering Garganeys, area of recoveries from western mainland Europe and western half of Africa to Central Siberia, to 135˚E. Sector = 15.0°; Total recoveries - 3579; N in sectors: from 0 up to 1344; Average distances in sectors: from 0.0 km up to 2615.5 km; The longest flight distance is 5994.3 km.

Central chart is for Garganeys ringed in the southern European Russia, area of recoveries are from western mainland Europe and western half of Africa to central Siberia, to 135˚E. Sector = 15.0°; Total recoveries - 747; N in sectors: from 6 up to 92; Average distances in sectors: from 383.6 km up to 2268.9 km;The longest flight distance is 6687.3 km.

Right chart is for Garganeys ringed mostly in India, area of recoveries is in western and central Siberia, to 135˚E; Sector = 15.0°; Total recoveries - 250; N in sectors: from 0 up to 65; Average distances in sectors: from 0,0 km up to 3920.4 km; The longest flight distance is 5702 km.

Garganey maximal flight distances are very long, close to those in Pintails. In spite of that, Garganeys tend to move, preferably, over less than 3500 km, which is by about 1000 km less than in Pintails (Fig. 284). In the same time, Garganey is one of the two most mobile ducks, especially with its peculiarity for relatively long-distance summer movements (see below).

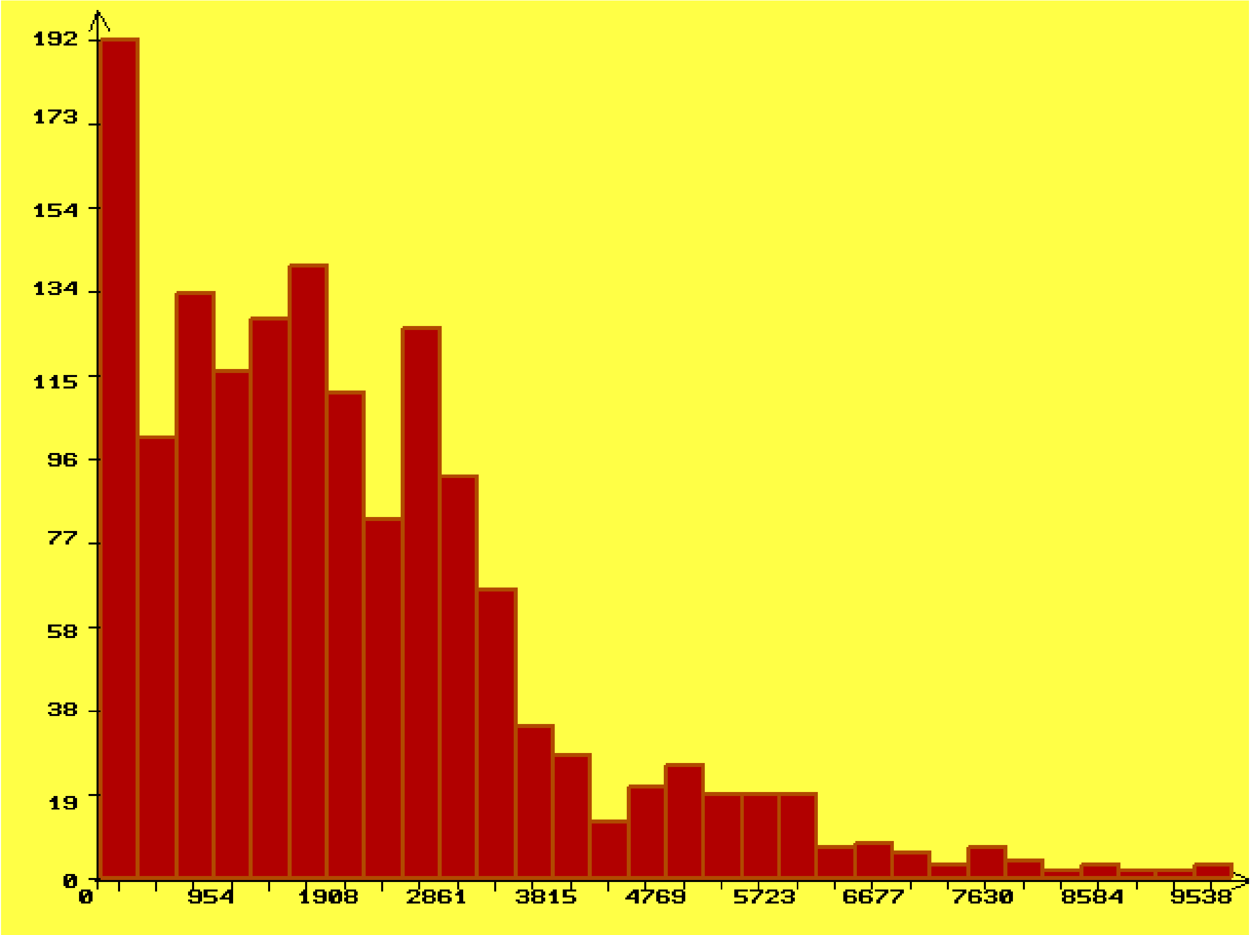


Figure 284. Distribution of all ring-recovery distances in Garganey. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in young Garganeys (ringed as „pull" or „juv" or „1 y") is twice shorter than in adults: 1166.1±62.9 and 2426.4±51.0 km respectively (N_{young} = 397, N_{ad} = 1118, t-Bailey=15.6, P=0.0000). Such shorter distance in young birds, keeping in mind that the most recoveries are „shot", suggests that this species is heavily exploited as a game species. This coincides with bad demographic situation, which mortality pattern shows (see section "Mortality rate"). Male mean flight distance is about the same as in females: 2502.4±67.6 and 2506.9±100.8 km respectively (N_{males} = 681, $N_{females}$ = 318), significantly not different (t-Bailey=0.037, P=0.97).

Before outlining the Garganey migratory routes and reveal the migration process in more detail, we should plot monthly means of these ducks, ringed in different places. European and African wintering birds in the European Russia breed, mostly, in May. Siberian birds, wintering in India and nearby areas, as well as in Europe, breed mostly in June. This is illustrated by the examples of ducks ringed in different parts of Europe, Africa south-west of Sahara and former huge moulting place for ducks of different species in the Volga River Delta (Figs 285–294). Garganeys perform strange, mostly west-east movements during summer; they are more characteristic for birds wintering in Europe and Africa (Figs. 385–289). Reasons for these movements are not clear.

In June and July part of birds (males, non-breeding females and failed females) move from the breeding grounds to the moulting sites, that located on the way to the wintering areas. In August most recoveries are from the other category of birds – successful breeders, which are closer to the breeding sites than ducks, encountered in May, June and July. This is the main reason for the „loops" of monthly means through May-June-July-August. However, these loops are partly real, because some birds after moult move backwards to the north and east breeding grounds (the latter is shown in the section "Monthly movements").

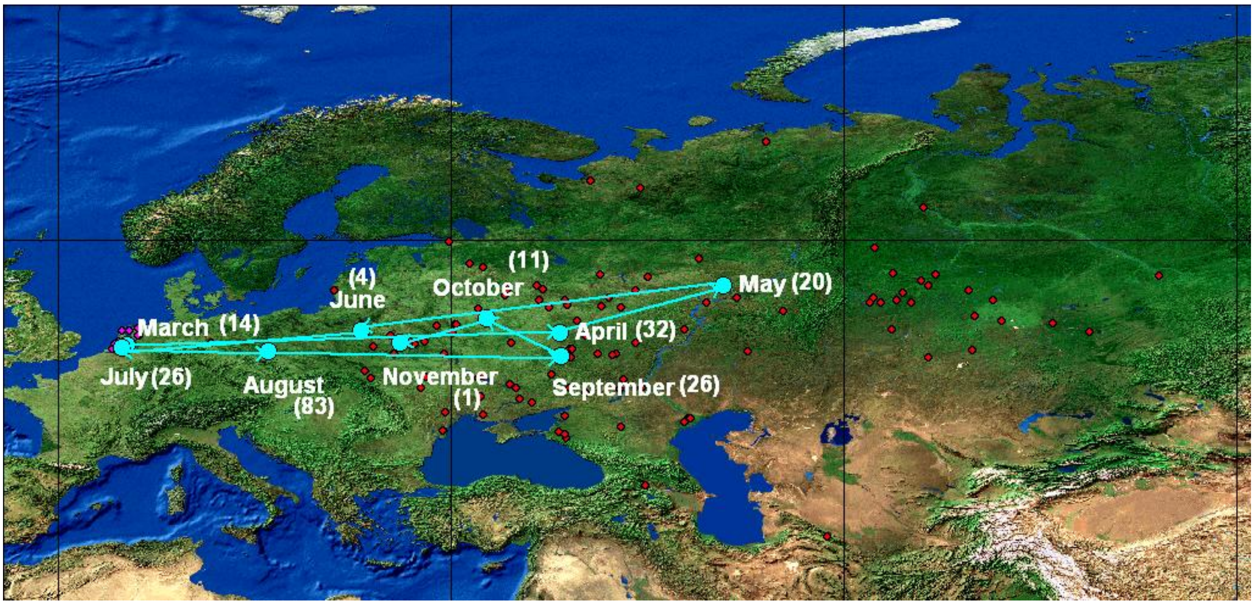


Figure 285. Mean monthly locations of Garganey control points for birds, ringed on the wintering grounds in the Netherlands. Blue-green large circles are mean monthly locations of Garganeys. Arrows show directions of movements. Number of control points in each month represented in parentheses. Purple dots are ringing sites, red dots – recovery points.

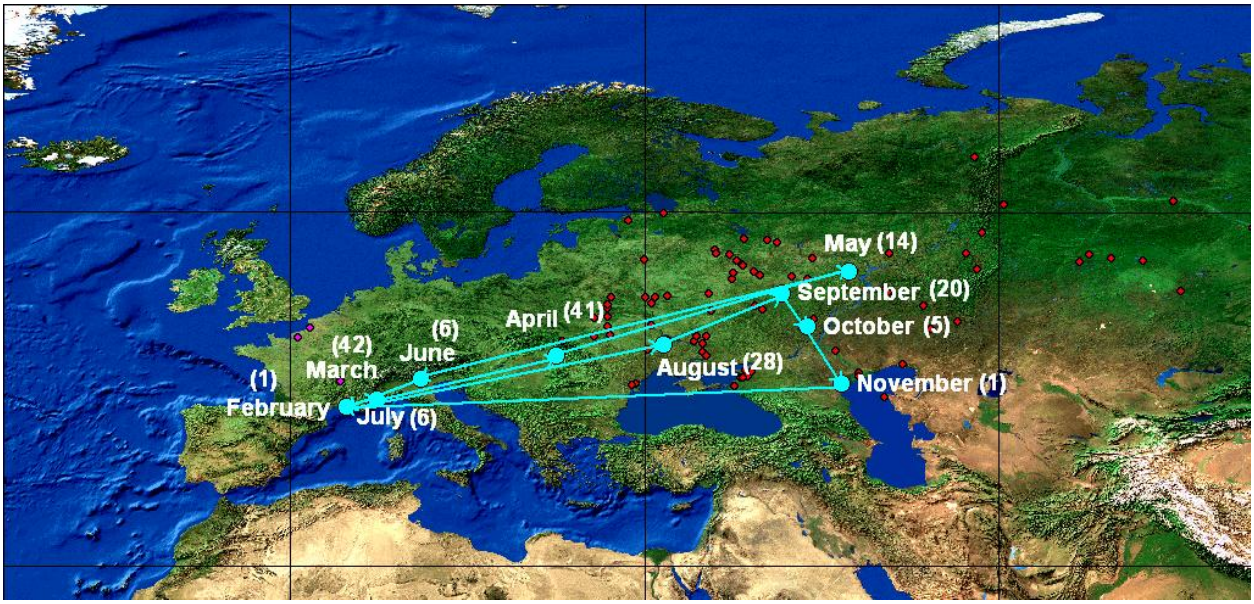


Figure 286. Mean monthly locations of Garganey control points for birds, ringed on the wintering grounds in France. Blue-green large circles are mean monthly locations of Garganeys. Arrows show directions of movements. Number of control points in each month represented in parentheses. Purple dots are ringing sites, red dots – recovery points.

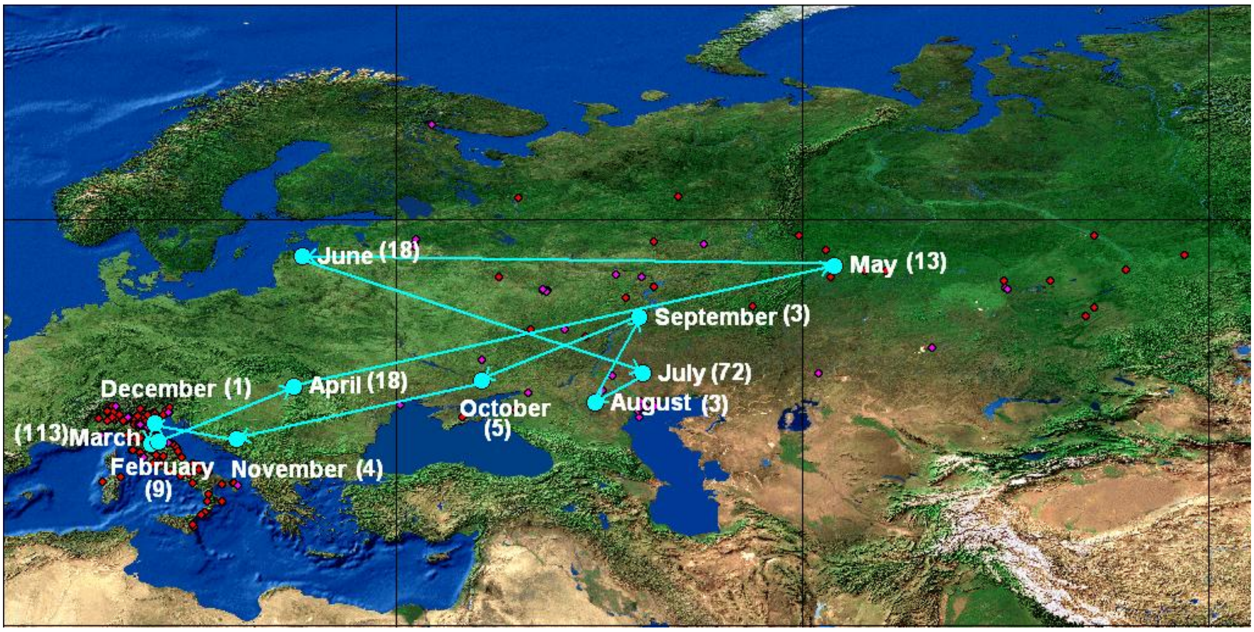


Figure 287. Mean monthly locations of Garganey control points for all birds, ringed and recovered in Italy. Blue-green large circles are mean monthly locations of Garganeys. Arrows show directions of movements. Number of control points in each month represented in parentheses. Purple dots are ringing sites, red dots – recovery points.

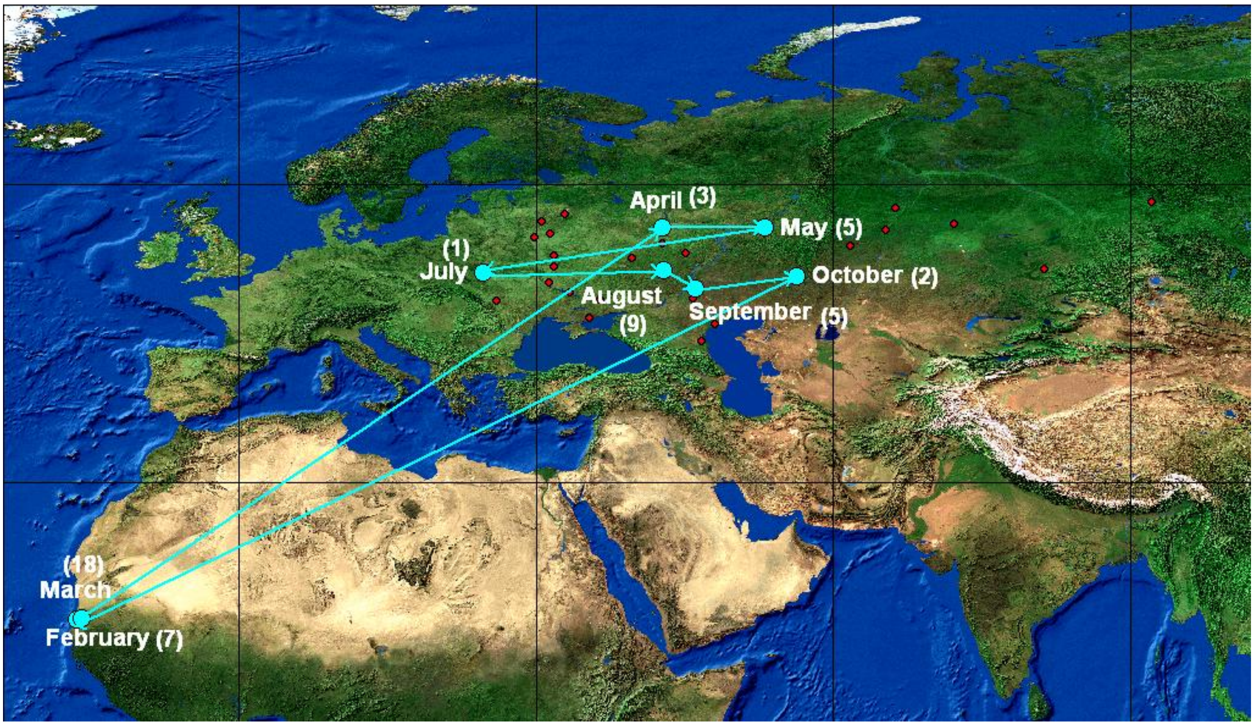


Figure 288. Mean monthly locations of Garganey control points for birds, ringed on wintering grounds in Senegal. Blue-green large circles are mean monthly locations of Garganeys. Arrows show directions of movements. Number of control points in each month represented in parentheses. Purple dots are ringing sites, red dots – recovery points.

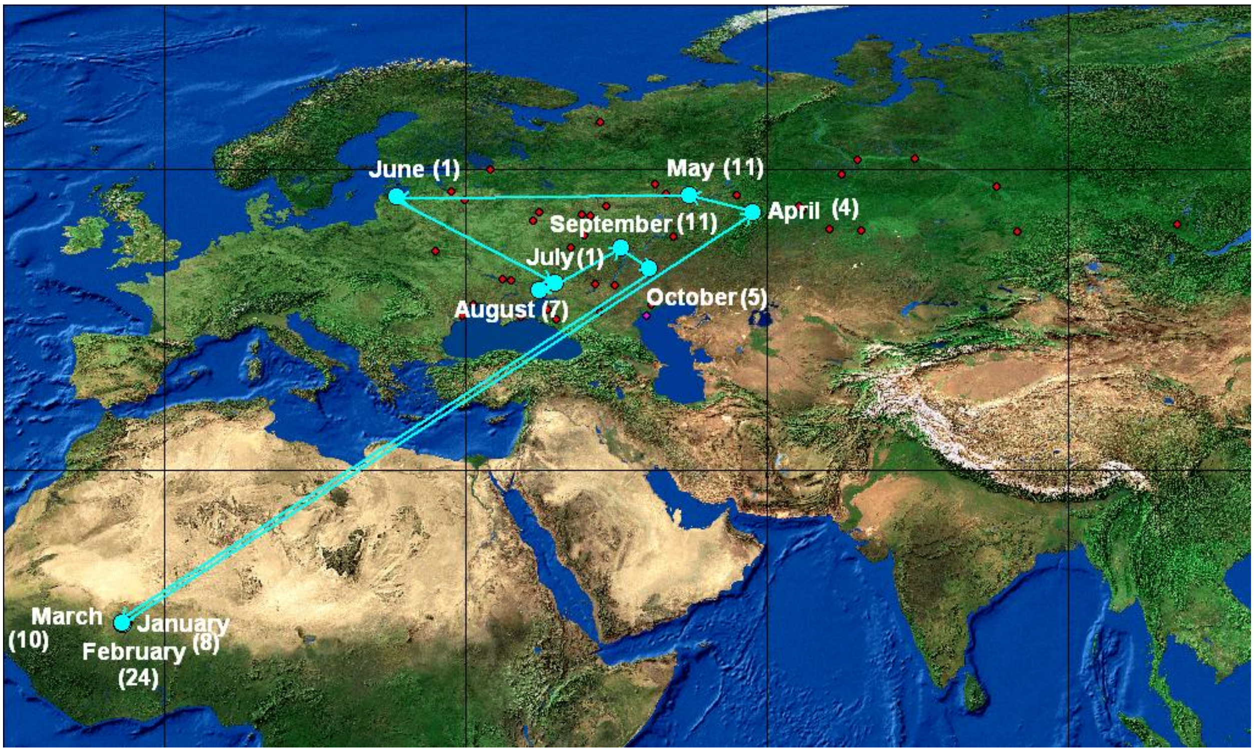


Figure 289. Mean monthly locations of Garganey control points for birds, ringed and recovered on wintering grounds in Mali. Blue-green large circles are mean monthly locations of Garganeys. Arrows show directions of movements. Number of control points in each month represented in parentheses. Purple dots are ringing sites, red dots – recovery points.

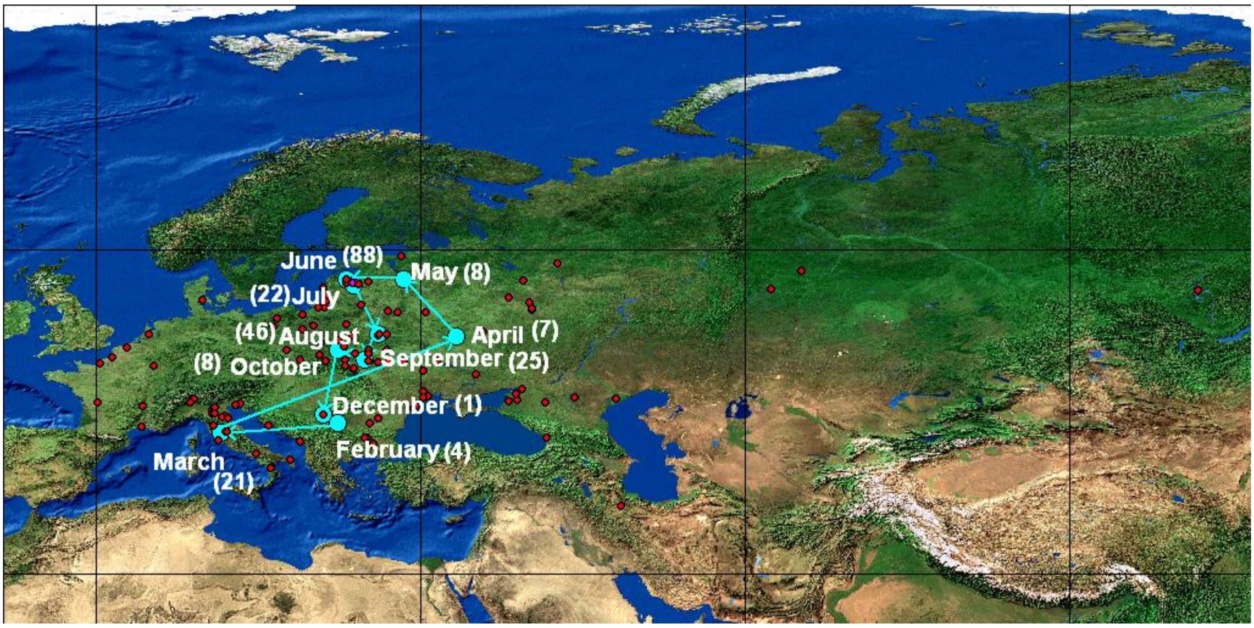


Figure 290. Mean monthly locations of Garganey control points for birds, ringed on breeding and moulting grounds in Latvia. Blue-green large circles are mean monthly locations of Garganeys. Arrows show directions of movements. Number of control points in each month represented in parentheses. Purple dots are ringing sites, red dots – recovery points.

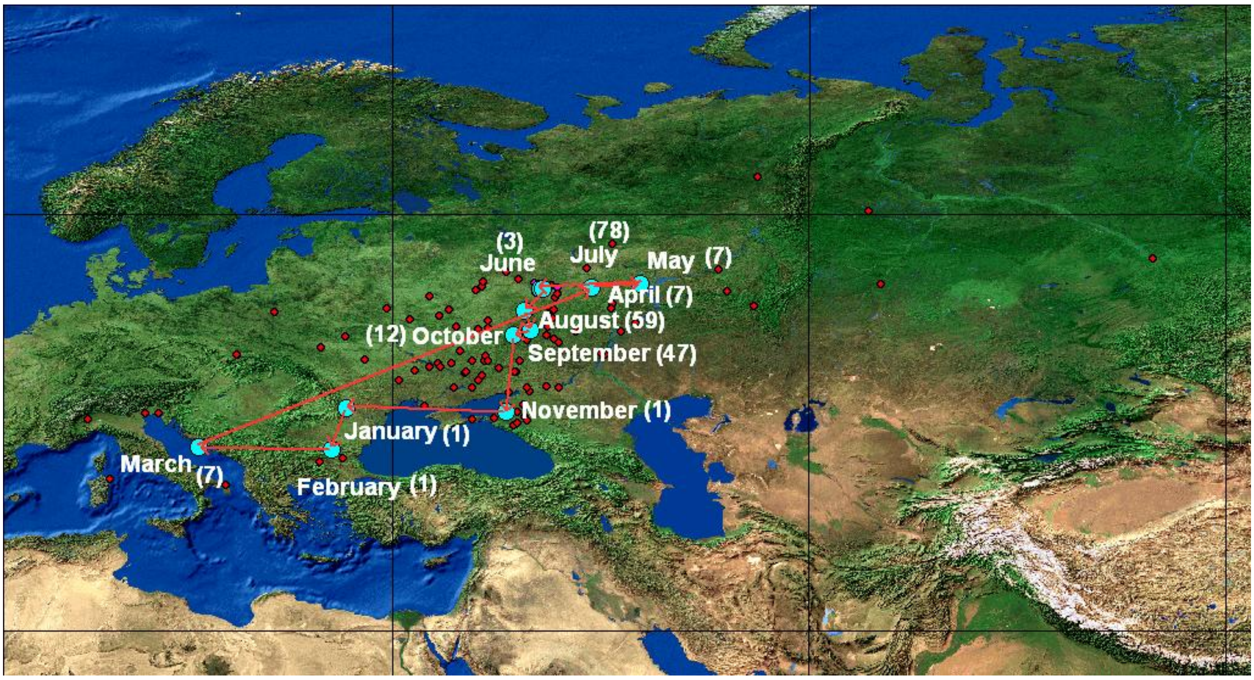


Figure 291. Mean monthly locations of Garganey control points for birds, ringed on breeding and moulting grounds in Ryasan Region, European Russia. Blue-green large circles are mean monthly locations of Garganeys. Arrows show directions of movements. Number of control points in each month represented in parentheses. Purple dots are ringing sites, red dots – recovery points.

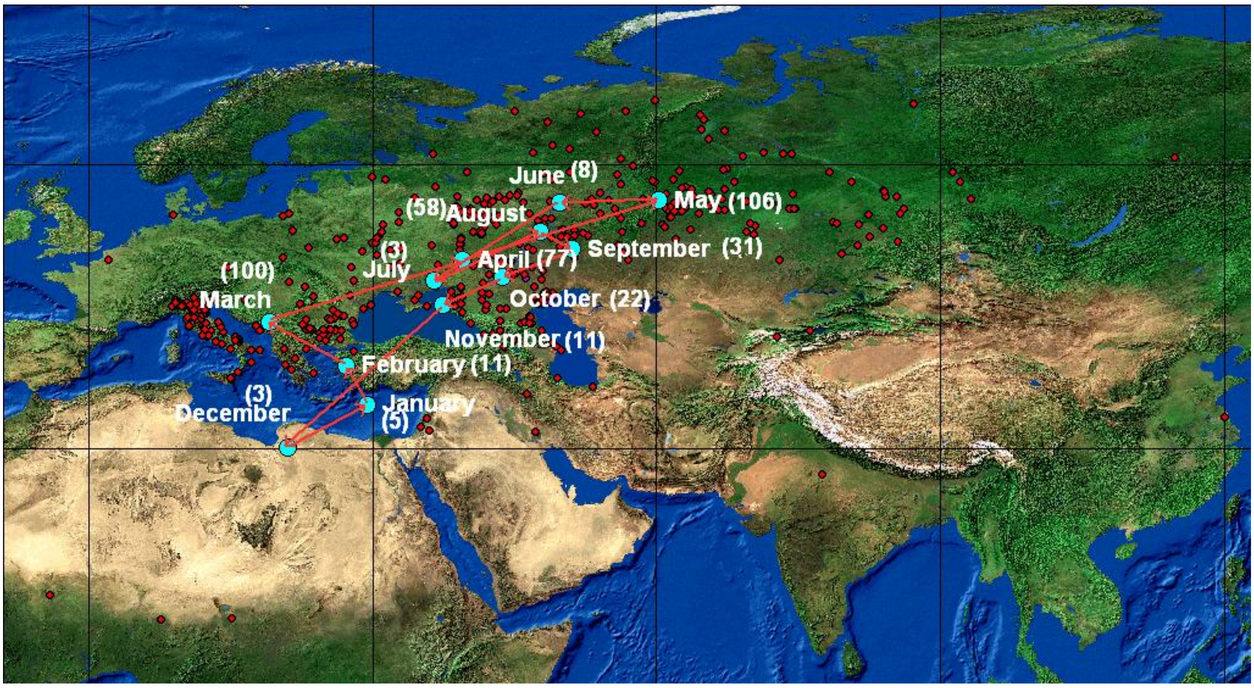


Figure 292. Mean monthly locations of Garganey control points for birds, ringed on the moulting grounds in the Volga River Delta. Blue-green large circles are mean monthly locations of Garganeys. Arrows show directions of movements. Purple dots are ringing sites, red dots – recovery points.

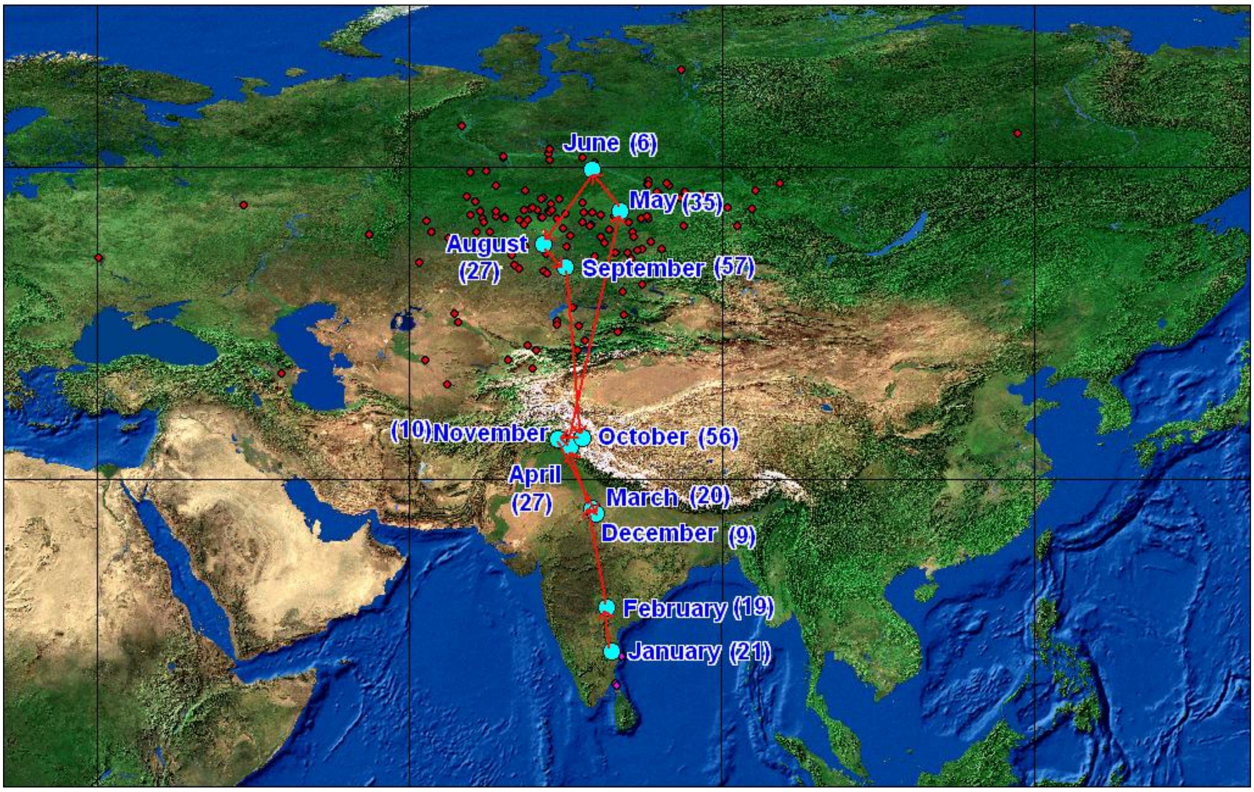


Figure 293. Mean monthly locations of Garganey control points for birds, ringed ont the wintering grounds in India. Blue-green large circles are mean monthly locations of Garganeys. Arrows show directions of movements. Number of control points in each month represented in parentheses. Purple dots are ringing sites, red dots – recovery points.

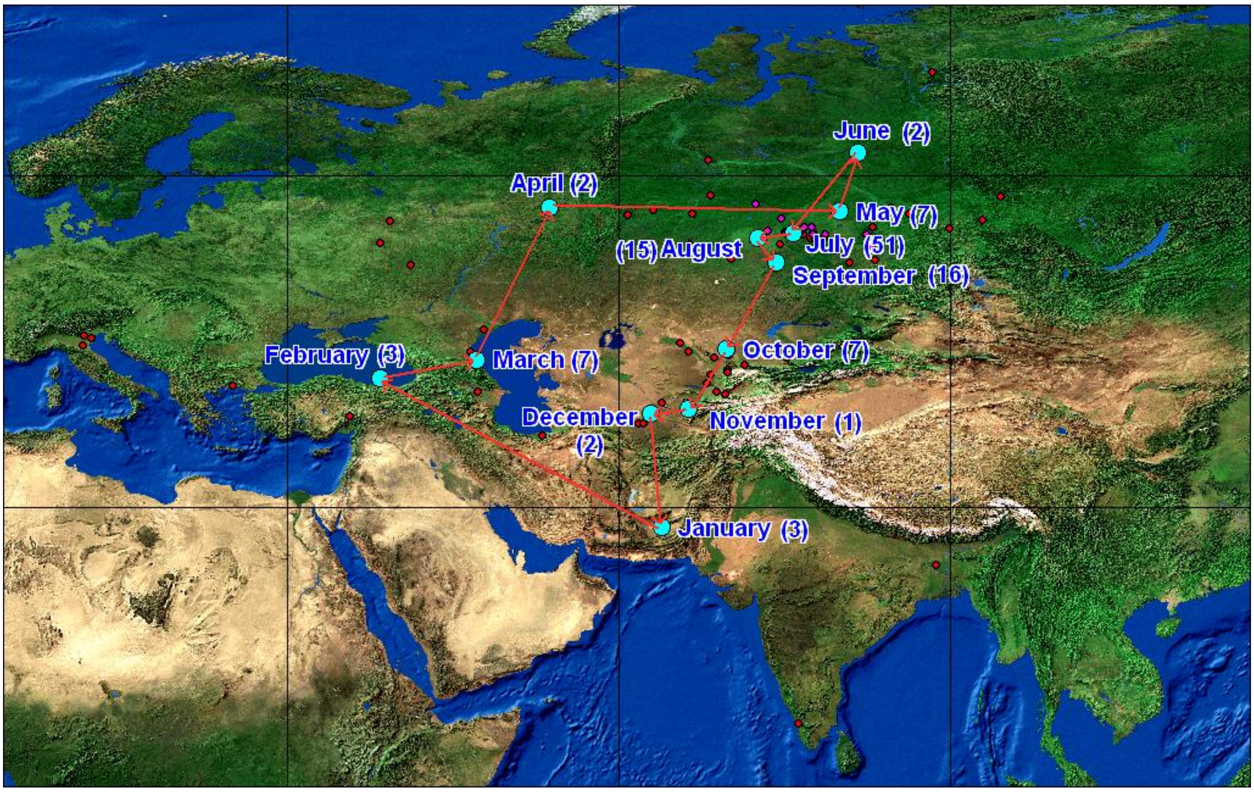


Figure 294. Mean monthly locations of Garganey control points for birds, ringed on the breeding and moulting grounds in Novosibirsk and Omsk Regions, Western Siberia. Blue-green large circles are mean monthly locations of Garganeys. Arrows show directions of movements.

Number of control points in each month represented in parentheses. Purple dots are ringing sites, red dots – recovery points.

Data in the Bird Ringing Centre Database show that Garganey probably has the most complicated migratory routes among ducks. Our data are not numerous, but even such amount of data allows making such conclusion. Summarizing everything about migratory routes, we can outline spring and autumn Garganey migratory movements (Figs 295 and 296).

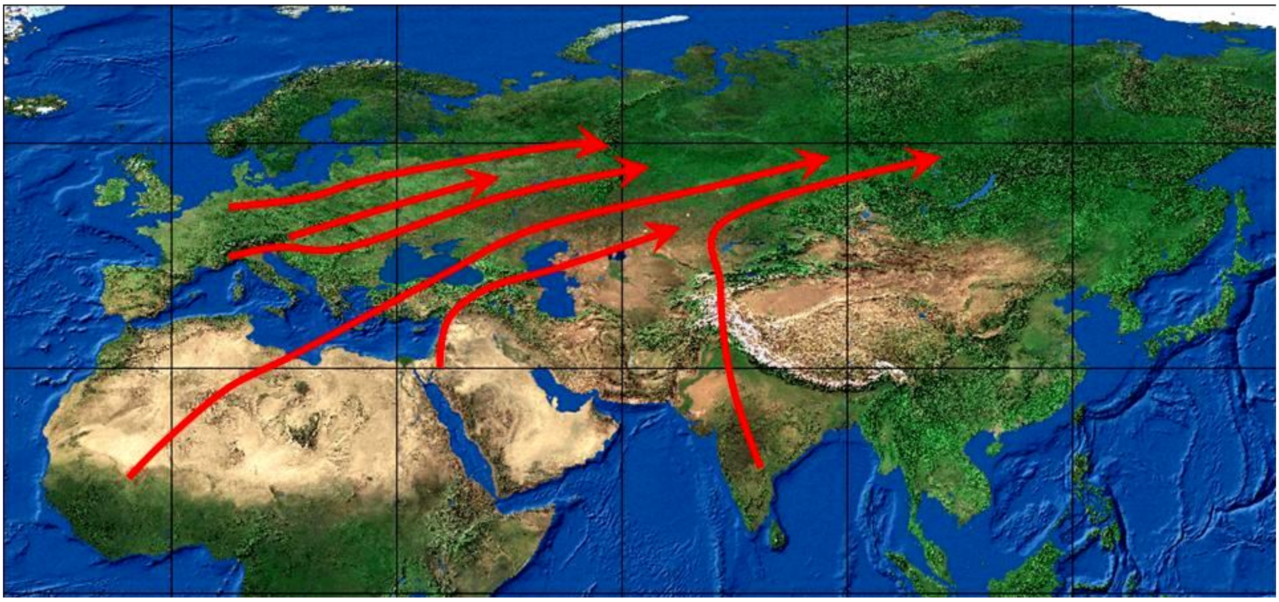


Figure 295. Outline of spring migratory routes for Garganeys. Red arrows – directions of migratory movements.

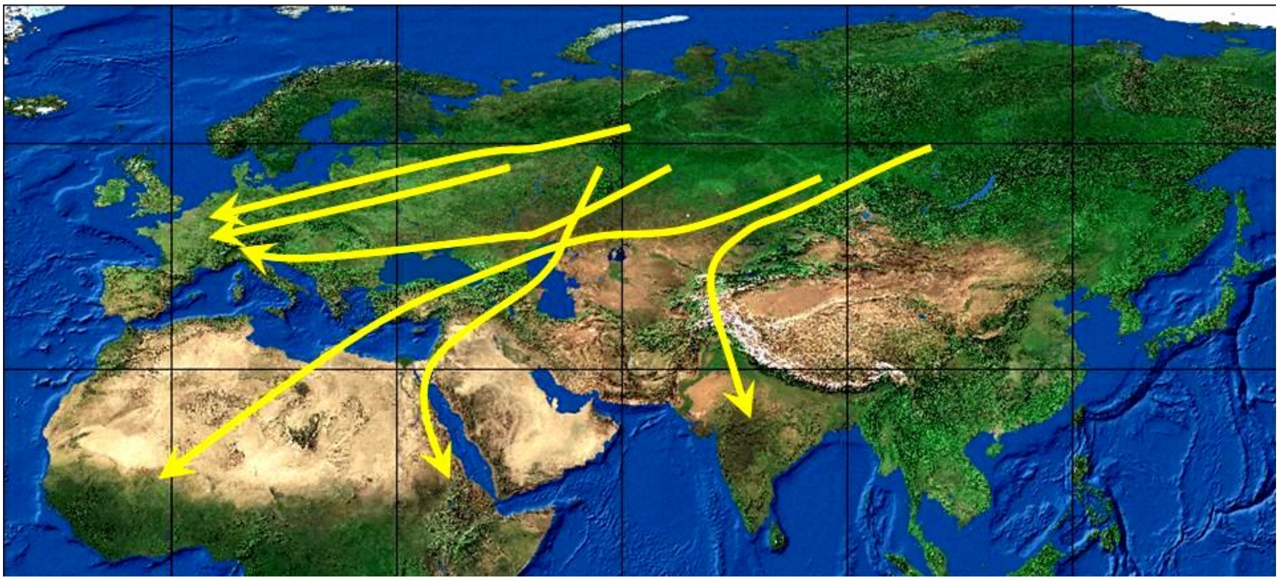


Figure 296. Outline of autumn migratory routes for Garganeys. Yellow arrows are main directions of migratory movements.

Speed. Bird Ringing Centre of Russia database does not contain data on maximal Garganey speed; daily movements do not exceed 200 km.

Populations. Maps of the monthly means (Figs 285–294). show that Garganey populations highly mix, therefore its populations are the most difficult to separate. Complicated migratory movements bring additional difficulties in this process. Birds ringed in the Netherlands, France, Africa and Volga River Delta fly practically to the same breeding grounds. Overlapping is great; in addition – central and southern European birds differ in their migration terms (Figs… from the section "Migratory Routes"). This leads, we think, to the temporal separation between populations. Therefore, we propose to define here two populations instead of one (Fig. 283). Really, the movement patterns are even more interesting. African wintering birds move slower in March, but very fast in April, even faster than central European birds. In April African and European ducks penetrate to about the same area; and African wintering birds appeared even more to the east (up to central Siberia), than European ones. In May ducks from Italy have flown the longest way, while African birds have already started backward movement to the west. All these create very sophisticated population structure in the Garganey.

Garganey populations are the most sizeable among dabbling ducks. Bird Ringing Centre of Russia ringing data allow outlining the following Garganey populations: 1) european-west-central-siberian population (polygon No 1, Fig. 297) with generally west-east migration movements; 2) west-central-african-central-eastern-european-west-central-siberian population (polygon No 2, Fig. 297) with general east, north-east – west, south-west migrations; 3) east-african-arabian-middle-east-west-central-siberian population (polygon No 3, Fig. 297); 4) indian-central-asia-west-central-siberian population (polygon No 4, Fig. 297) with north-south migratory movements. There are one or two more populations to the east of the defined ones; however ring-recovery data do not allow outlining them. All four defined populations overlap greatly, although only the first population belongs to the AEWA Flyway, populations number 2, 3 and 4 belongs to the other two or three flyways.

Intergradations zones are located in northern Europe (of two or three populations) and Western Siberia (four populations), also, in the past, Volga River Delta. As in most other dabbling ducks (but Common Teal), long-distance cross-population movements exist; the longest of them is the mentioned one from Mali to central Siberia.

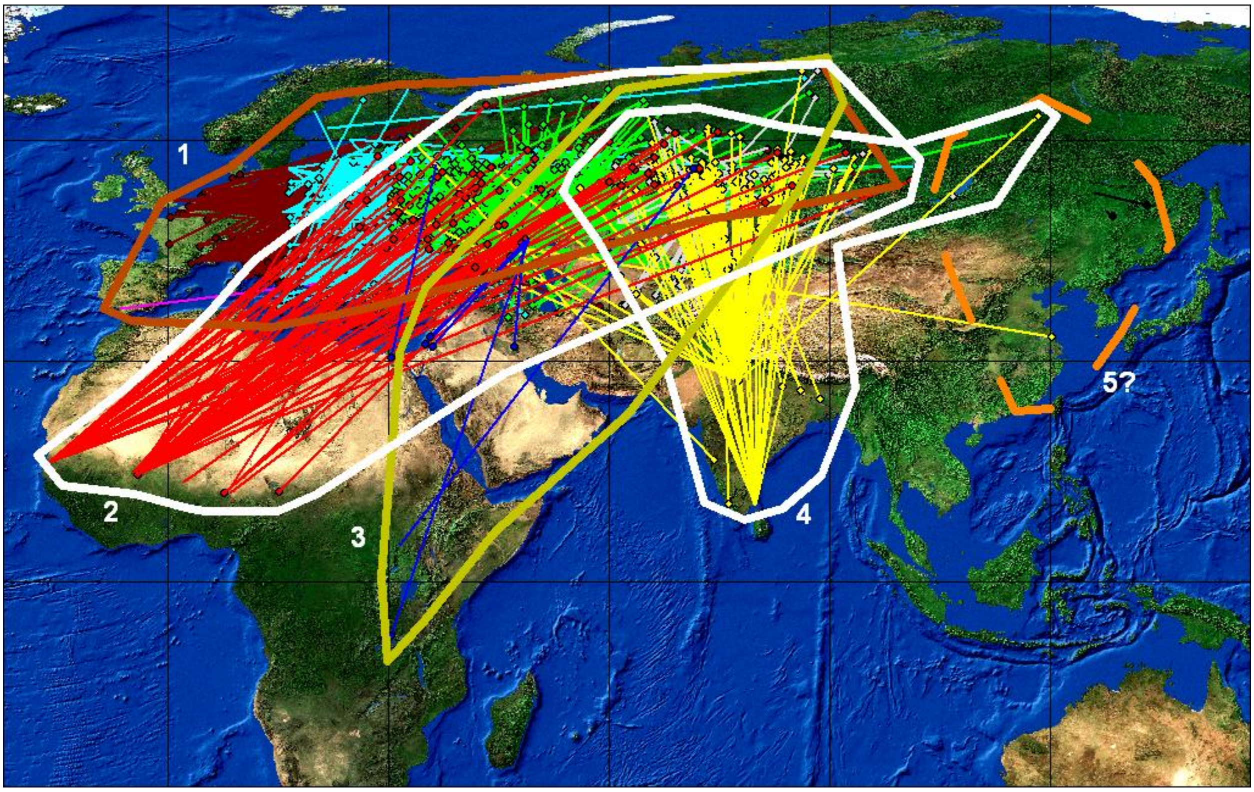


Figure 297. Garganey populations. Brown polygon № 1 outlines european-west-central-siberian population. White polygon № 2 is west-central-african-central-eastern-european-west-central-siberian population. Dark-green polygon outlines east-african-arabian-middle-east-west-

central-siberian population (polygon No 3). White polygon № 4 shows the indian-central-asia-west-central-siberian population. Dashed polygon № 5 with question mark shows the uncertain population.

Ten-year distances. Garganey is one of the species in which the phenomenon of the decadal distance increasing has been revealed (Dobrynina, Kharitonov, 2006). Data on Garagneys allow analyzing overall recovery mean decadal distance only, because numbers of ringed ducks in any separate place either small or does not cover long-term periods. Mean flight distance fluctuates among decades, however demonstrates the definite tendency for increasing (Table 17).

Really the picture is more complicated. To confirm the regularity we should consider the process of decadal distance change in details. As it can be seen in Fig. 298, in 1960-1980s three very remote ringing places – Senegal, Mali and India appeared. Since these areas are quite far from breeding grounds, it should lead to mean distance increasing; and we observe it in the Table 17. In 1900s and 2000s we have no recoveries from those three areas. Therefore, mean decadal distance decreases, but only in little extent. Means for 1990-2000s are considerably greater than ones before 1961 (Table 17). Difference is highly significant: mean for 1929-1960 is 1540.8±43.1 km, for 1991-2012 is 3036.2±237.8 km (t-Bailey=6.19, P=0.0000), growth comprises about 1500 km during more than 75 years.

Table 17. Garganey mean flight distance per decade.

Decade (years)	1929-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2011	2011-2020
Distance (km)	1665.3	1589.7	1486.2	1851.1	2852.3	3105.0	2839.2	2914.9	3323.9
Number of recoveries	128	107	388	419	332	80	13	19	8

Most birds were ringed at wintering and moulting sites. As it is shown in species account for the Bewick's Swan, during global warming birds with permanent wintering place habituate more and more large area for breeding, flying more to the north or/and east. Thus, we observe the same process in Garganey.

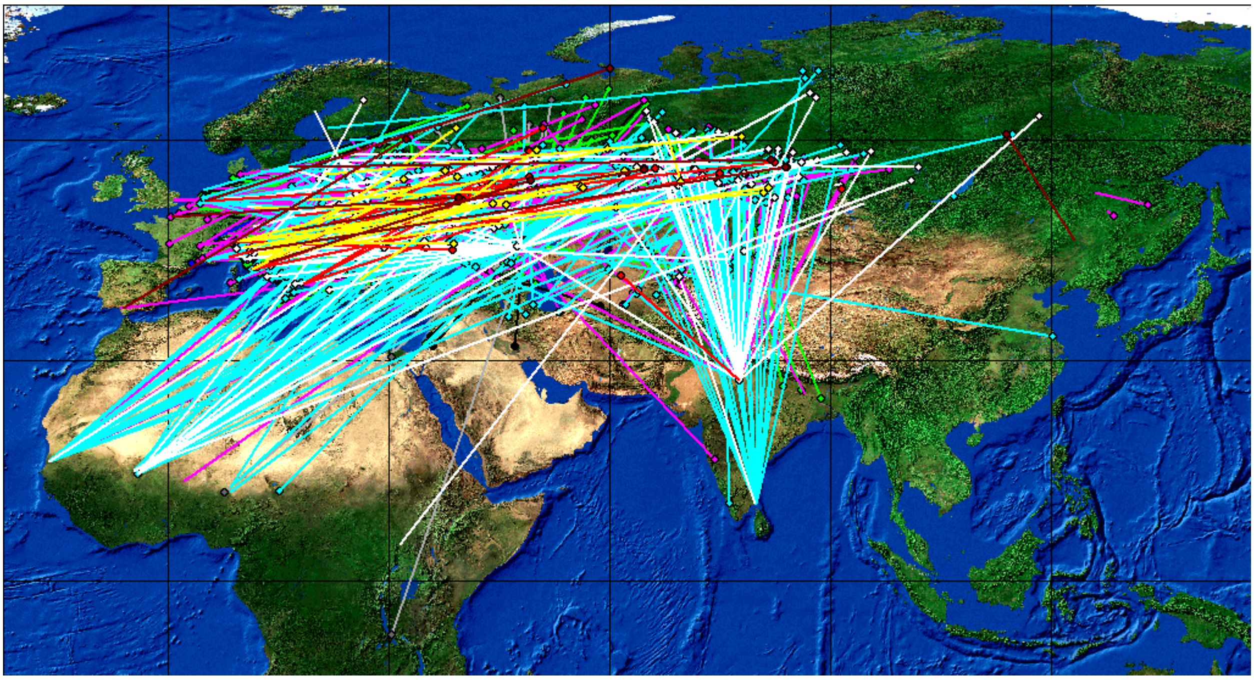


Figure 298. Migration in Garganey by decades. Grey lines reflect movements in 1931-1940, black – in 1941-1950, green – in 1951-1960, purple – in 1961-1970, blue-green – in 1971-1980, white – in 1981-1990, red – in 1991-2000, yellow – in 2001-2010, brown – in 2011-2020.

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) of 26 November 2010, the oldest Garganey lived 14 years 8 months. Our database, however, contains several recoveries of males and females with ring-recovery span more that 15 years. The oldest bird was ringed as adult and shot in 19 years 8 months, ring not sent. The second oldest is adult male ringed 29.03.1952 in the Netherlands, shot in September 1970, as „Garganey-sized duck", ring sent. This bird lived, at least, more than 19 years.

Mortality rate. According to the common criteria (see "Materials and Methods") 1445 dead recoveries are applicable for the mortality rate analysis. Mean annual mortality rate in Garganey is 30.50±0.67%. Real mortality pattern differs from the theoretical one insignificantly (χ^2 = 865, df = 17, P=0.0000). Programme MARK, Model CLogLog 2ndPart shows 29.62%, difference is 0.93%. Garganey mortality pattern chart shows some drawdown of the real survival dynamics in the comparison to the theoretical one (Fig. 299). This is a signal for not good situation with the species. As we suggested in the section "Direct and indirect recoveries", Garganey is heavily exploited species. Mortality pattern confirms it. Since enough data are available, it is possible to analyze species condition dynamics over decades (Fig. 300_1).

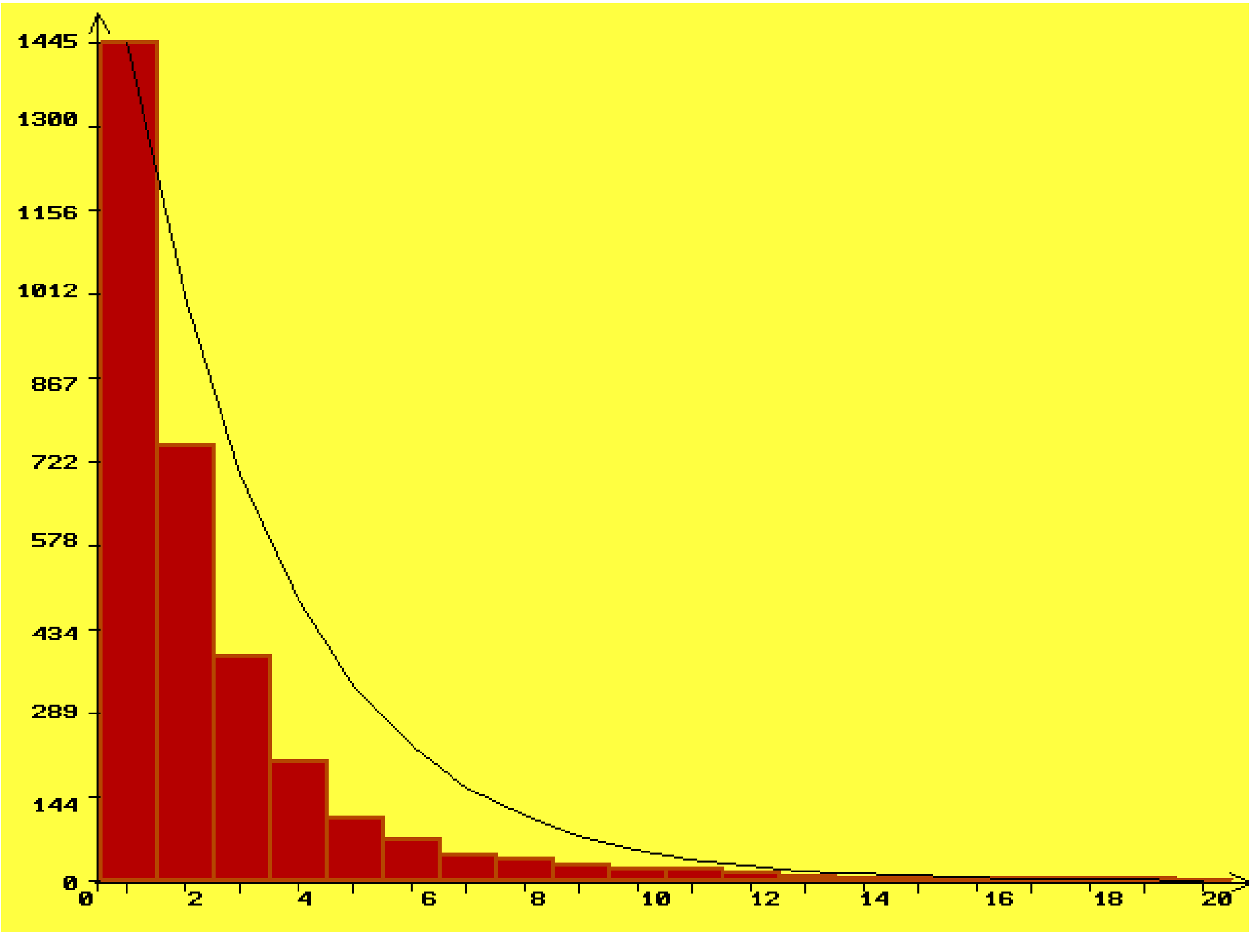
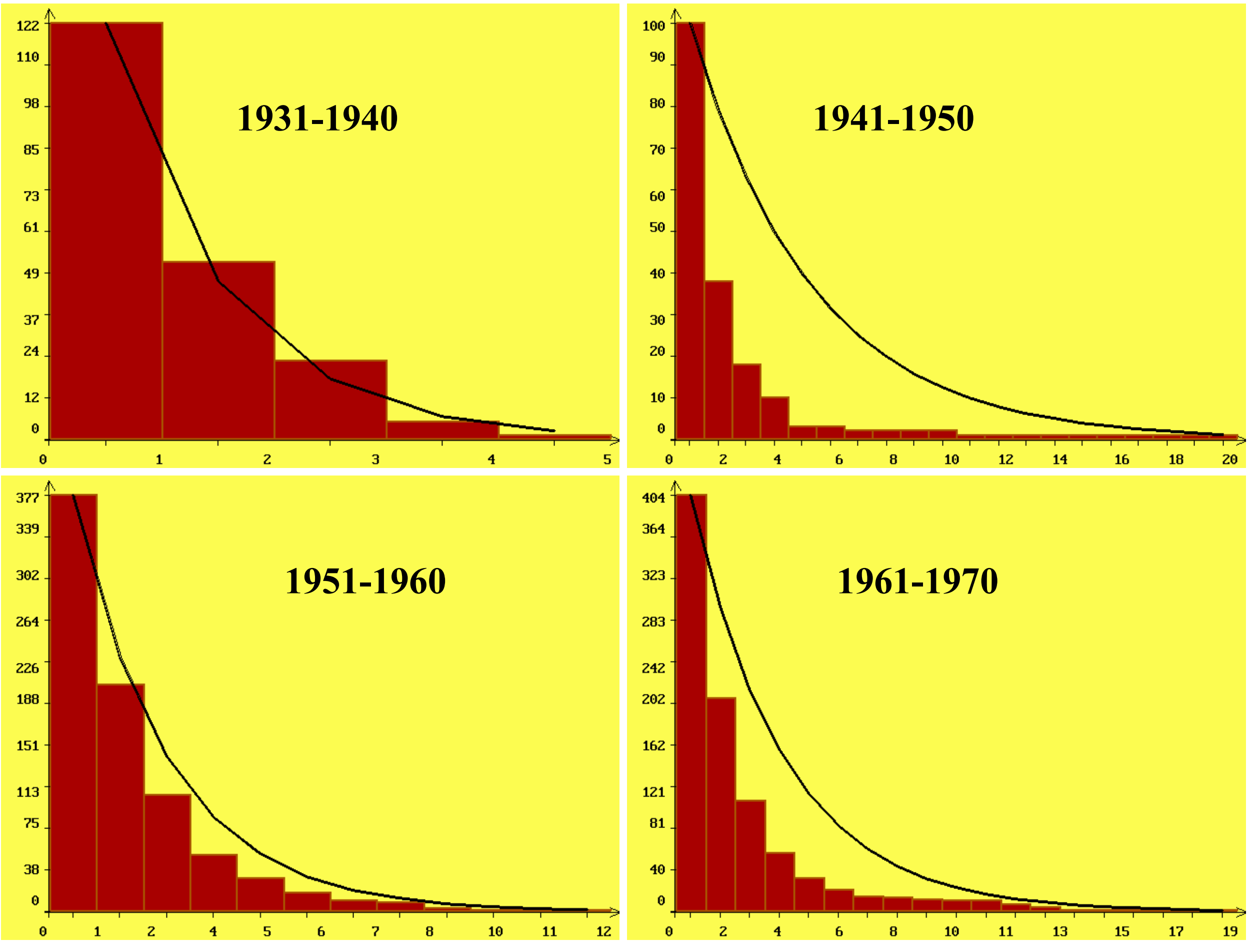


Figure 299. Mortality pattern in the Garganey. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

For 1930s mortality pattern indicates "normal" population (species) condition – real data are not very different from the theoretical line, although amount of data is not large (Fig. 300, 1931-1940). The same as in Pintails, the situation in 1940s with Graganeys was bad. Seems, the World War II has affected dry meadow breeding species, and Pintail and Garganey belong to them. Meadow nesting species, in distinction to species breeding closer to water (Mallard, Common Teal), should suffer more during battle preparations and battles themselves. Hunting during the war was not possible in Russia, because shotguns had been confiscated (Bianki, 2005). In 1950s the species goodness improved, probably in that period Garganeys less suffered from hunting than Mallards. In 1960-1970s situation was bad again, then partly improved in 1980s and also improved later, although not to the completely good level (Fig. 300).



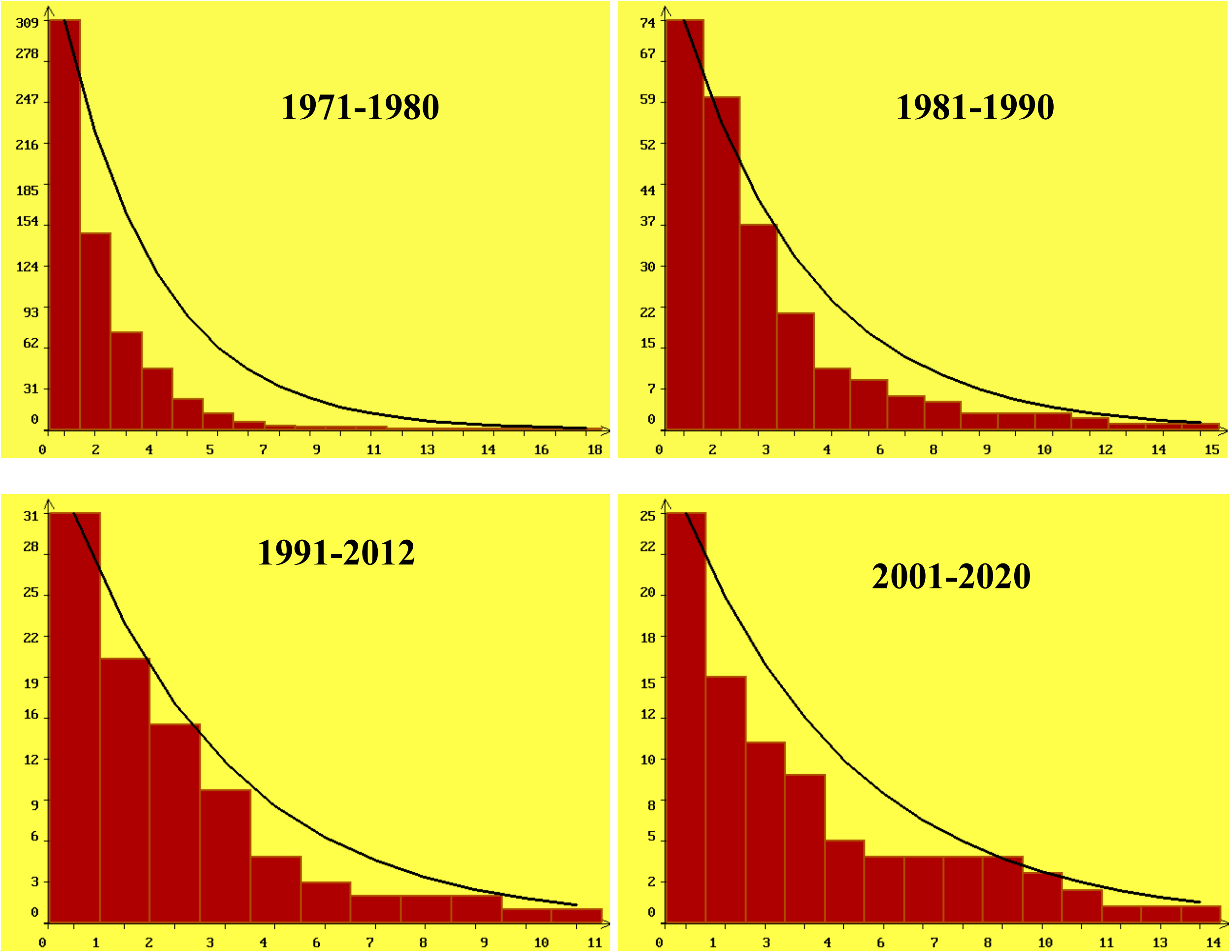


Figure 300. Mortality pattern in Garganeys recovered in different decades. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, males live slightly longer than females: 1.74±0.07 (N = 650) and 1.52±0.11 (N = 302) years respectively, with the tendency to be significant (t-Bailey=1.67, P=0.095). Male overall annual mortality rate is slightly greater than in females: 28.89±0.96% and 27.19±1.34% respectively, although the demographic situation in females looks worse (Fig. 300_2).

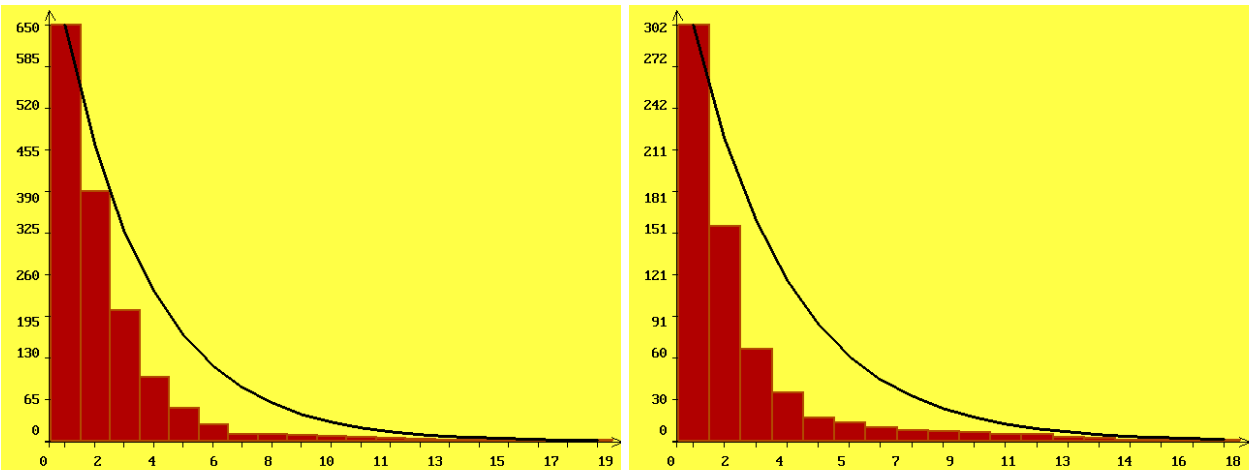


Figure 300_2. Mortality pattern in Garganey: males (left) and females (right). X axis is the number of years after marking. Y axis is the number of live birds.

SHOVELER
(*ANAS CLYPEATA*)

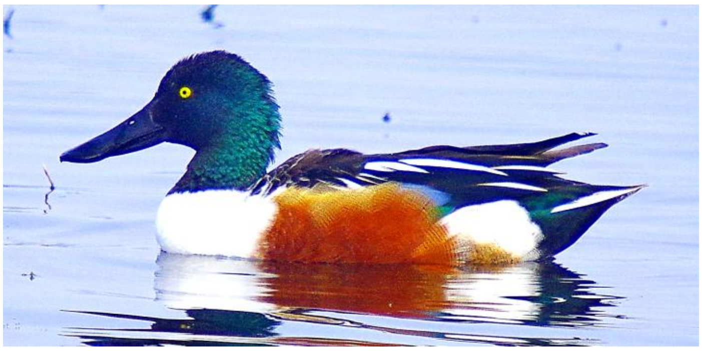


Photo by Alexandr L. Mishchenko

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 301. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

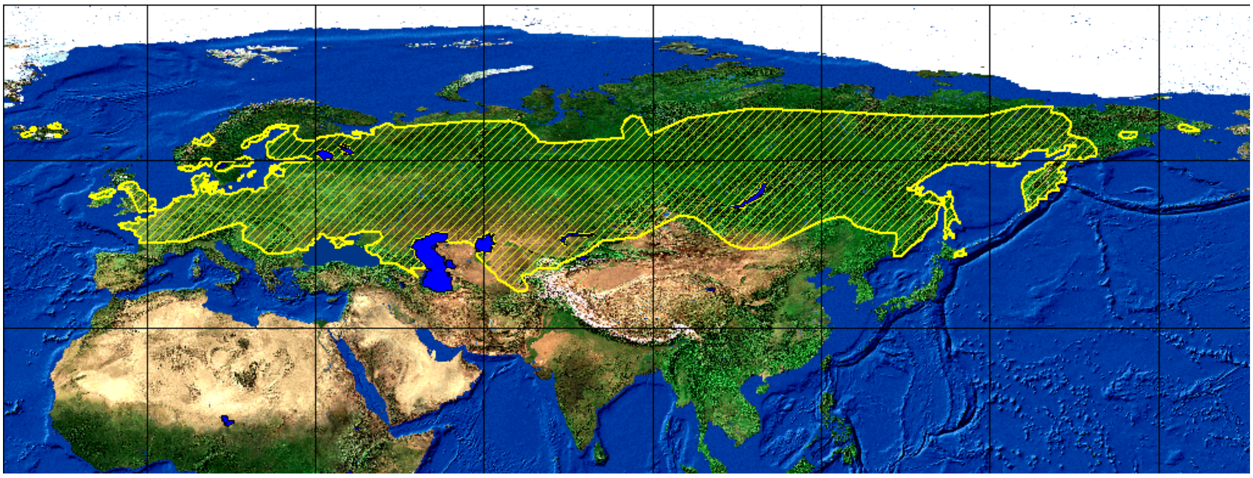


Figure 301. Breeding range of the Shoveler in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 1374 marked birds were used, which gave 1375 recoveries (Fig.302), only one Shoveler held nasal mark. 1373 birds gave one recovery per duck, one bird gave 2 recoveries. Ringing dates are since 30.03.1929 until 15.03.2022, recovery dates are since 15.04.1929 till 13.08.2022.

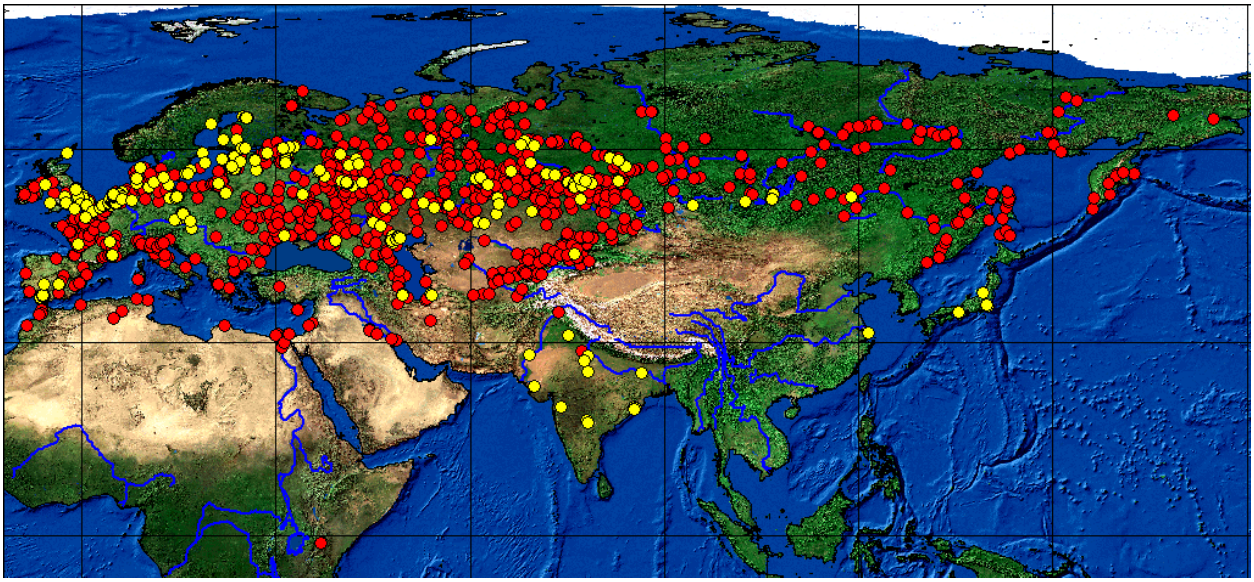


Figure 302. Position of all Shoveler control points. Yellow dots – ringing sites, red dots – recovery sites.

Most of Shovelers were ringed in Europe, western, central and eastern Siberia, Kazakhstan, India, Pakistan, Japan. Most of recoveries are from Europe, north and eastern Africa, Caspian Sea area, whole Siberia and Russian Far East. Gap in recovery area in Siberia, which is characteristic for Mallard, Pintail and Wigeon, in Shoveler is less pronounced (Fig. 302). Really it is visible only in direct recoveries (Fig. 305). This gap is located approximately between 125-130˚E, and, as in the mentioned duck species represents a zone between Indian and Japanese recoveries.

There is one African recovery south of equator in the set. Probably, there are really two such Shoveler recoveries, one of them is likely ringing error (a Shoveler ringed as „Common Teal", see "Common Teal" species account).

'Moskwa' scheme recoveries. This sample contains 685 recoveries of the scheme „Moskwa". They are from birds ringed within the Russian Federation and countries of the former USSR (Fig. 303). Considerable amount of birds (203 recoveries) were ringed in the former huge moutlting place in the Volga River Delta, where many duck species concentrated for moult. Now this moulting area no more exists because of Caspian Sea level growing (Viksne et al, 2010).

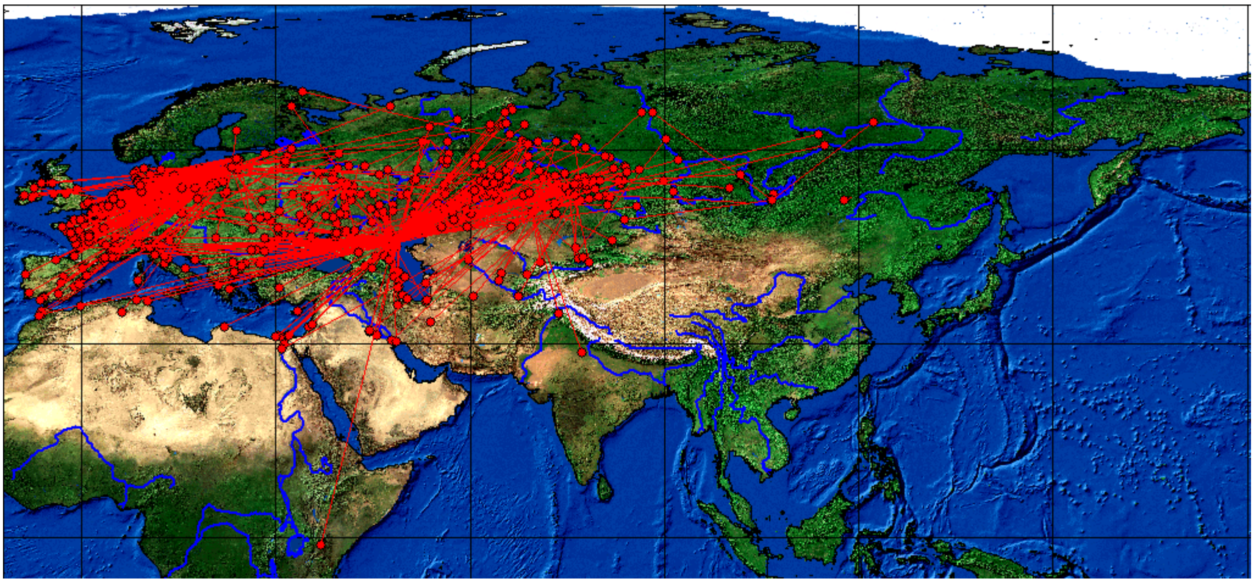


Figure 303. „Moskwa" scheme recoveries of the Shoveler. Here and on all other similar figures lines start from ringing sites, recovery sites are marked with red dots.

Finding details. This analysis includes all 1375 recoveries. 4/5 of recoveries (81%) are „shot". In 206 (15%) recoveries „details unknown", which practically mean shot, as well. Therefore, we can assume that 96% of birds were shot. Other reasons are not so common (Fig. 304).

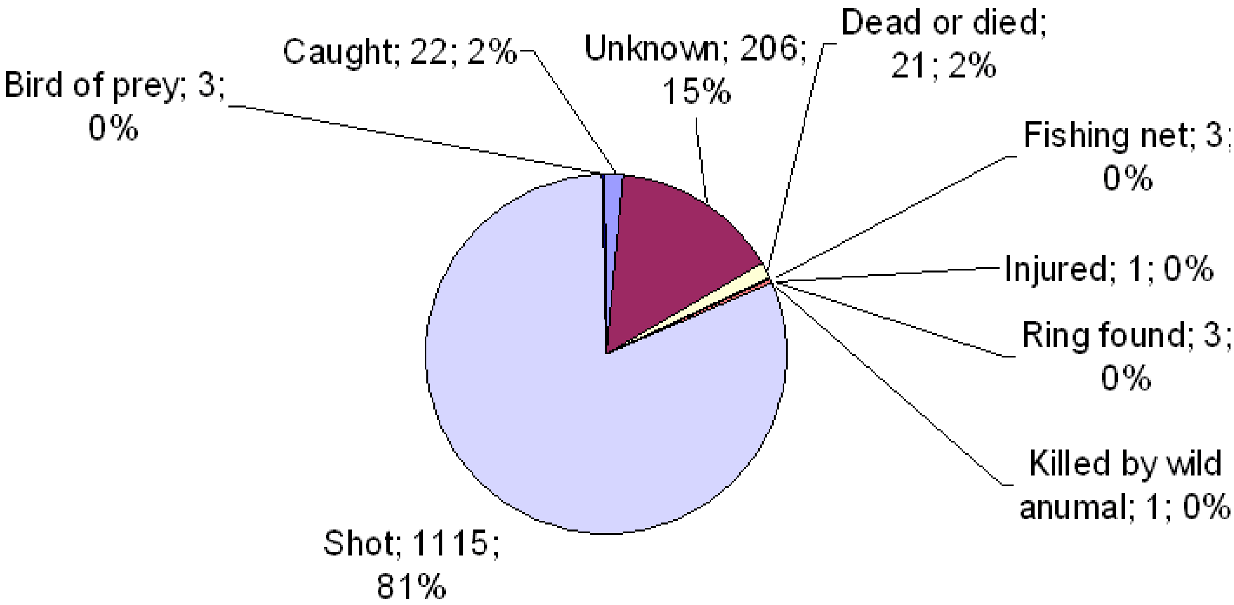


Figure 304. Finding detail in the Shoveler.

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries are represented in Figs 305 and 306.

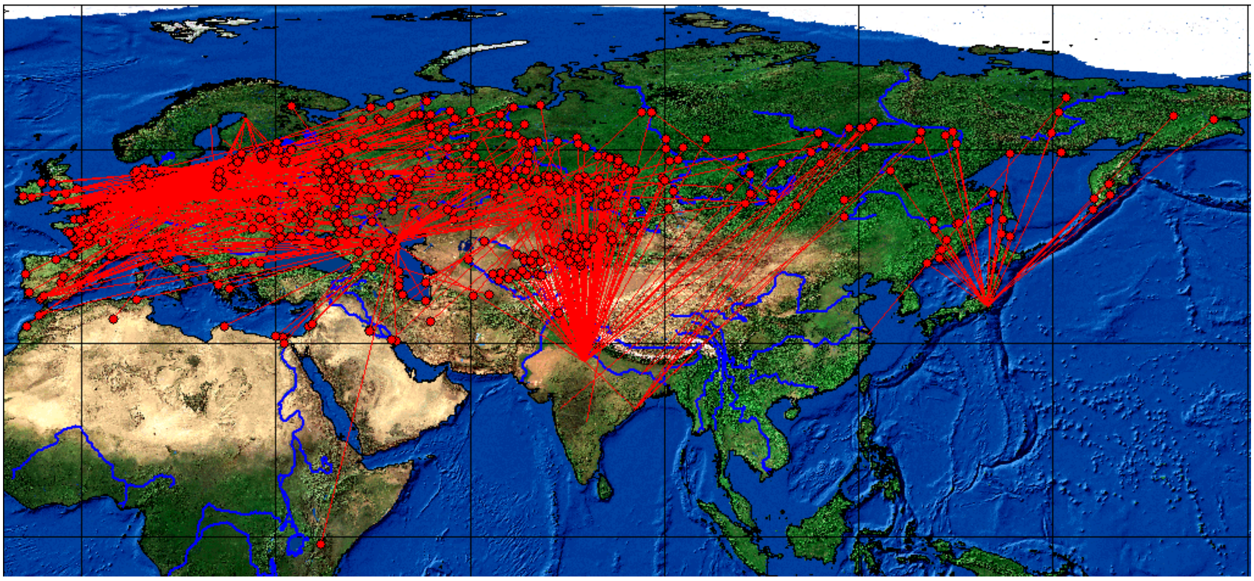


Figure 305. Map of the Shoveler direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

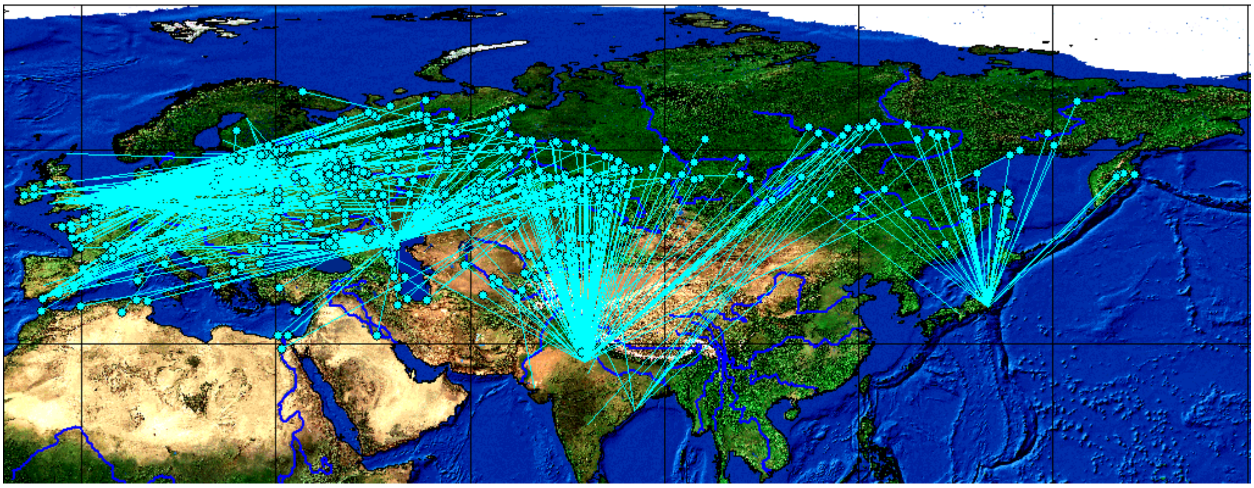


Figure 306. Map of the Shoveler indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

Maps indicate that Shoveler wintering in Western Europe fly to breed to the European Russia and northern half of Western Siberia to about the meridian of 70˚E. Birds wintering in the southern Europe migrate to southern European Russia, southern half of Western Siberia and northern Kazakhstan up to the meridian 85˚E. Shovelers ringed in India fly to breed, mostly, to the Central Asia, western, central and eastern Siberia approximately up to meridian 125˚E from the east (Fig. 305). Most birds that winter in Japan breed in the Far East and Eastern Siberia approximately up to meridian 130˚E, therefore the gap between Indian and Japanese ringed bird recoveries is very small (Fig 305).

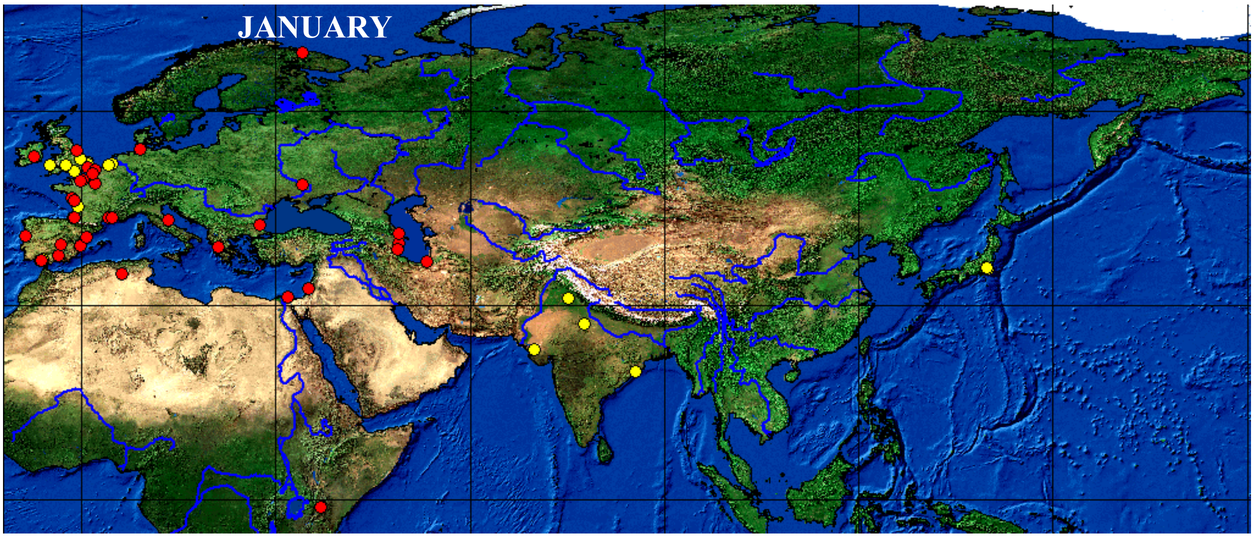
Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them (χ^2 = 26.02, 614 indirect recoveries and 761 direct ones, df = 2, P = 0.0000). Shoveler differs from other dabbling duck in the proportion of direct recoveries: direct recoveries considerably prevail over indirect ones. Center of indirect recoveries locates by 1˚ 20'' more north and 7˚ 50'' east from the centre of direct recoveries. Such big difference is also characteristic of Shoveler, the same as Pintail. Average flight distances in direct and indirect recoveries are different in about 250 km: 1964.2±44.0 and 2212.2±47.8 km respectively, however highly significant (t-Bailey = 3.85, P=0.0001). Long-distance cross-population movements are not characteristic for this species (the same is found in Common Teal), these movements concern only the neighbouring populations (see section "Populations").

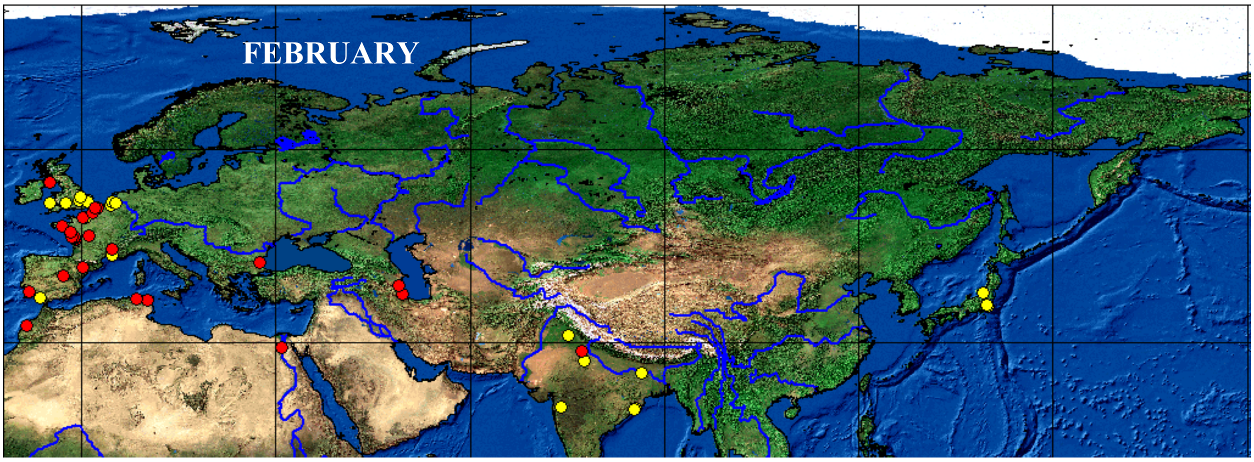
Monthly movements. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in Shoveler (Fig. 307). Pattern of recoveries indicates that in January, although most ducks are on wintering grounds in the western and southern Europe, Transcaucasia, Middle East, India and Japan, some northern and central European birds are still on migration. One duck ringed in the Volga River Delta, in next winter flew as far south as to Kenya, over the Equator. One bird was recovered very far north, in the Murmansk Region in the area outside of the regular breeding range. However, Shovelers sometimes breed there, about one time per 10 years (Bianki et al., 1993). February shows quiet situation – Shovelers are on the wintering grounds.

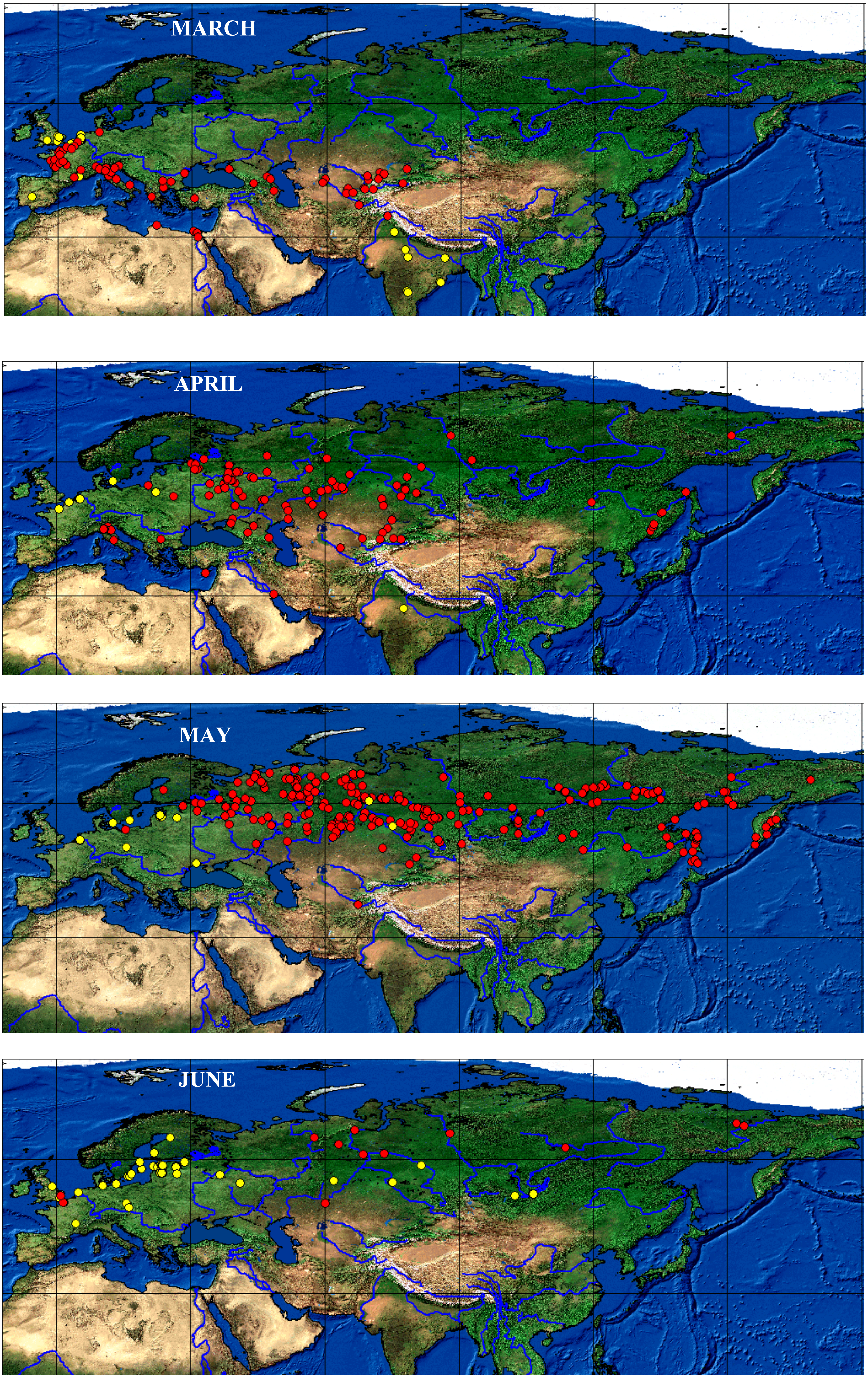
In March spring migration commenced actively everywhere (but no information about Japan wintering birds), more pronounced in southern Europe, Caucasus, Central Asia. Birds from Western Europe move to the east, north-east; from southern Europe – to the north-east, from Caucasus and India - to the north. It is noticeable from the position of the new appeared green dots displaying the recovery sites (Fig. 307, March). In April migration continues, noticeable in all populations, however some birds are still on wintering grounds (south Europe, Middle East, Persian Gulf, India). In May Shovelers practically loose the connection with wintering areas and fill the species breeding range up to its northern boundary.

May concentrations of Shovelers just east of Ural Mountains with the absence of recoveries at Urals themselves indicate, that ducks migrating during this month from southern Europe to western Siberia, bend over the southern end of Urals, the same as Mallards and Pintails (see Fig. 307, May). In June the number of control points is scarce, but they are on the breeding grounds. In July part of Shovelers starts to move back to the wintering grounds for moult. In August breeding birds start to move southerly and westerly. In August, moulting birds and failures either stay in moulting area or move further to wintering grounds. This time is very convenient for capturing and ringing adult birds. Positions of the ringing sites (Fig. 307, July) show that for moult Shoveler, the same as other dabbling ducks (see species accounts), move close to the wintering areas. In August and even September no considerable movements to the wintering grounds are performed. Although most ducks after moult fly in the direction to wintering grounds, some birds after moult perform the backward flights. They move not to the wintering areas, but fly again to the north and east (in case of Shoveler – to the east, see Fig. 308) in the direction to breeding areas. However they will not breed at this time. In Shoveler these backward flights seem less pronounced than, e.g., in Mallard (Fig. 237).

Only in October migration becomes well noticeable. Since during August, September and October no recoveries observed over the Ural Mountains, in means that, the same as in May, on their autumn migration to wintering grounds in Europe Shovelers bend the Urals over the southern end, as well. This bend is additionally proved by well exposed, quite steep change of migration way for birds ringed in the Volga River Delta (Fig. 308). In November and even in December (and January – see above) migration still continues, although most birds are already on their wintering grounds (Fig. 307).



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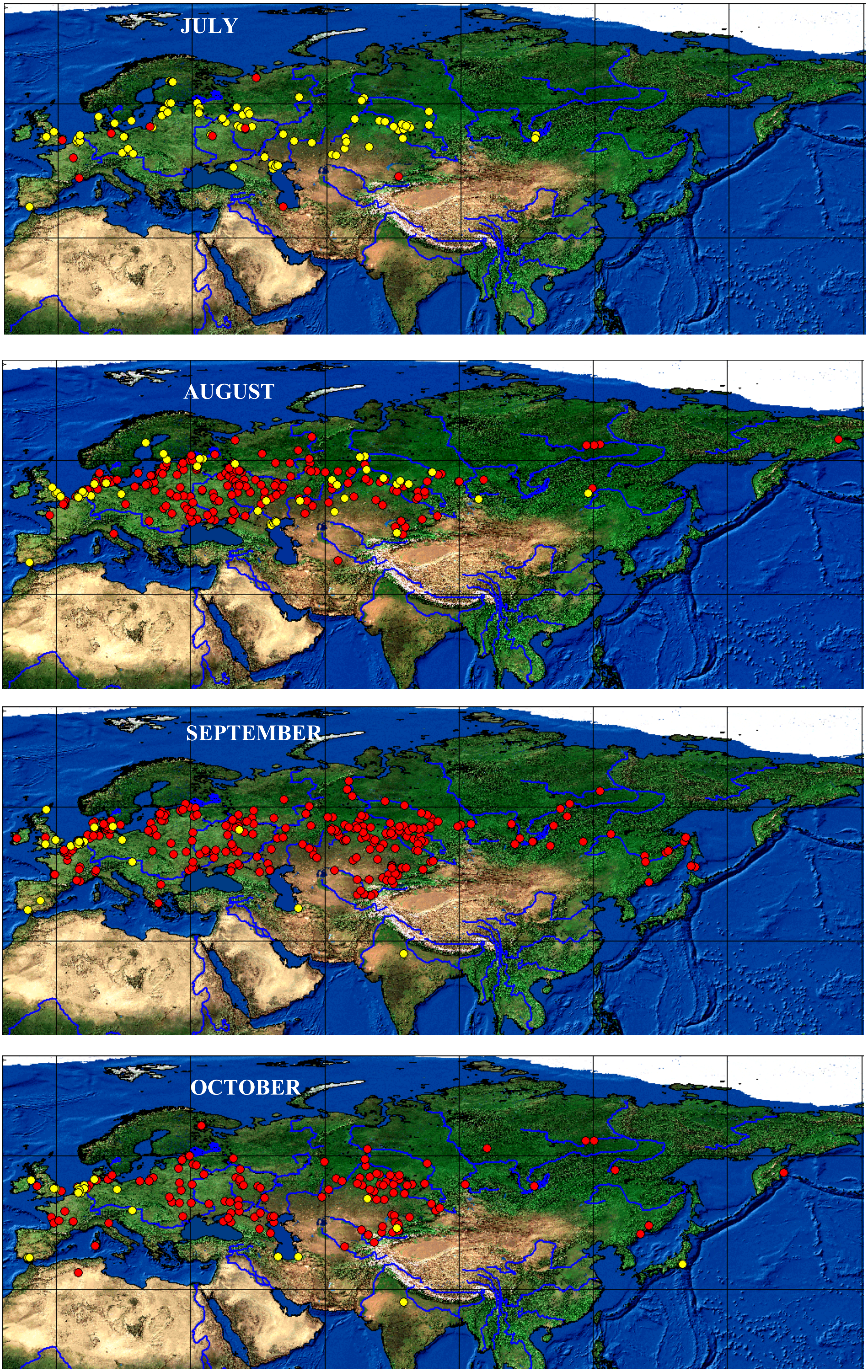
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AUGUST
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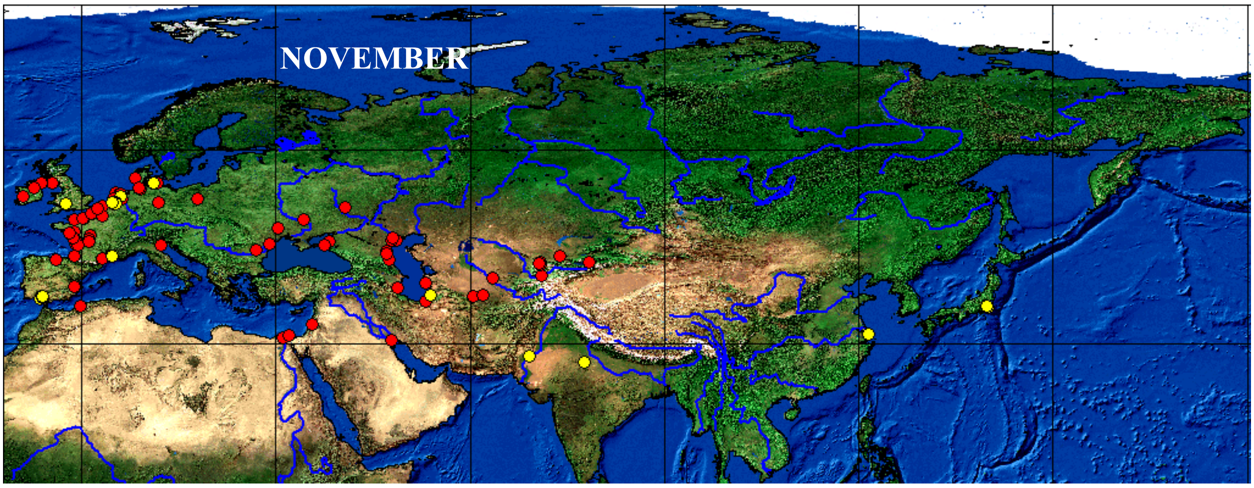


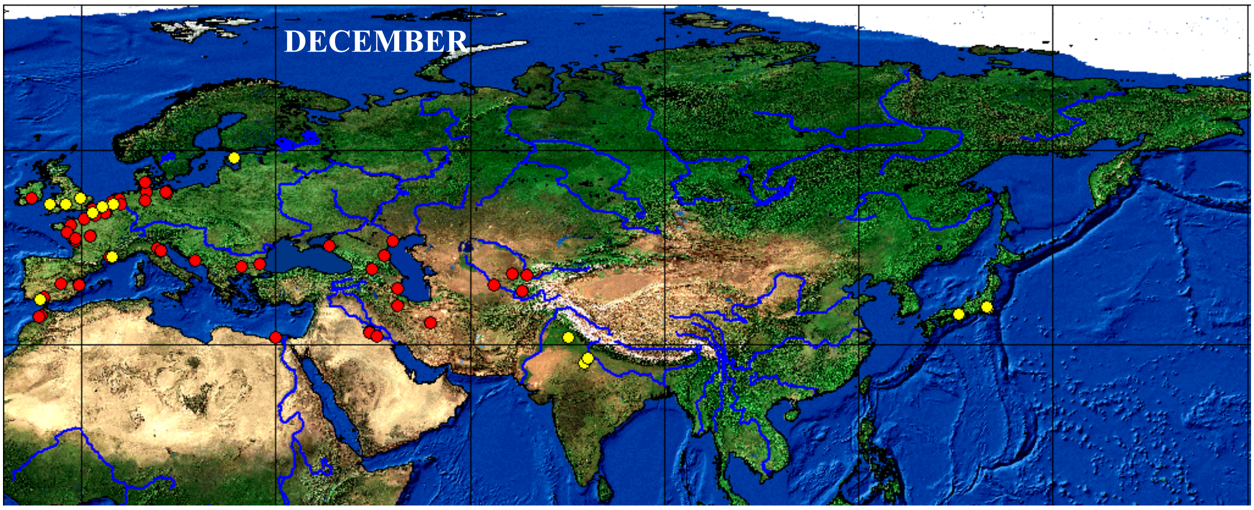


Figure 307. Shoveler monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

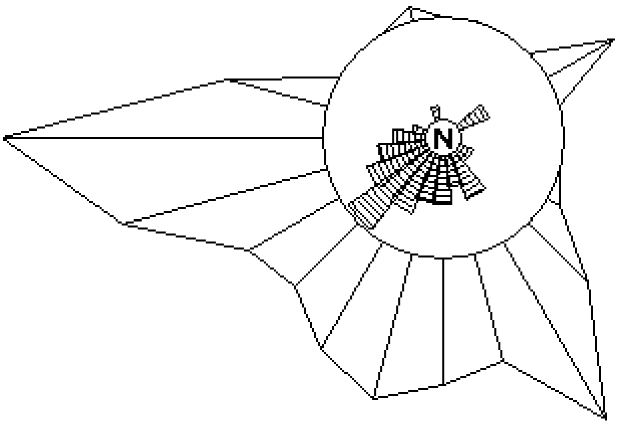


Figure 308. Recovery rose graphs for Shovelers ringed in July and recovered during 60 days after ringing: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts). Sector = 15.0°; Total recoveries - 44; N in sectors: from 0 up to 6; Average distance in sectors: from 0.0 km up to 1848.8 km; the longest flight distance is 2775.3 km.

Migratory routes. As it is preliminary shown in the section "Monthly movements", Shovelers from different wintering areas migrate in different directions. Birds ringed in areas with longitude <=30˚E move to the east, north-east in spring (bearings 37-112˚, mostly 52-82˚ Fig. 309), and in opposite direction in autumn. For birds ringed in area with longitude 30˚-60˚E preferable flight bearings are 22-67˚ in spring and 172-277˚, mostly 247-277˚ in autumn. In this section there are a number of birds ringed in the Volga River Delta, which is close to the southern end of Ural Mountains. In Shoveler the turn near the southern end of Urals is well pronounced. For ducks ringed in 60˚-90˚E preferable bearings are 322-52˚ - these are spring flight directions for all duck species, ringed in India. For Far Eastern birds ringed in Japan spring route "fan" is broader than in other dabbling ducks, bearings are 322-52˚, (Fig. 309) certainly the opposite should be in autumn.

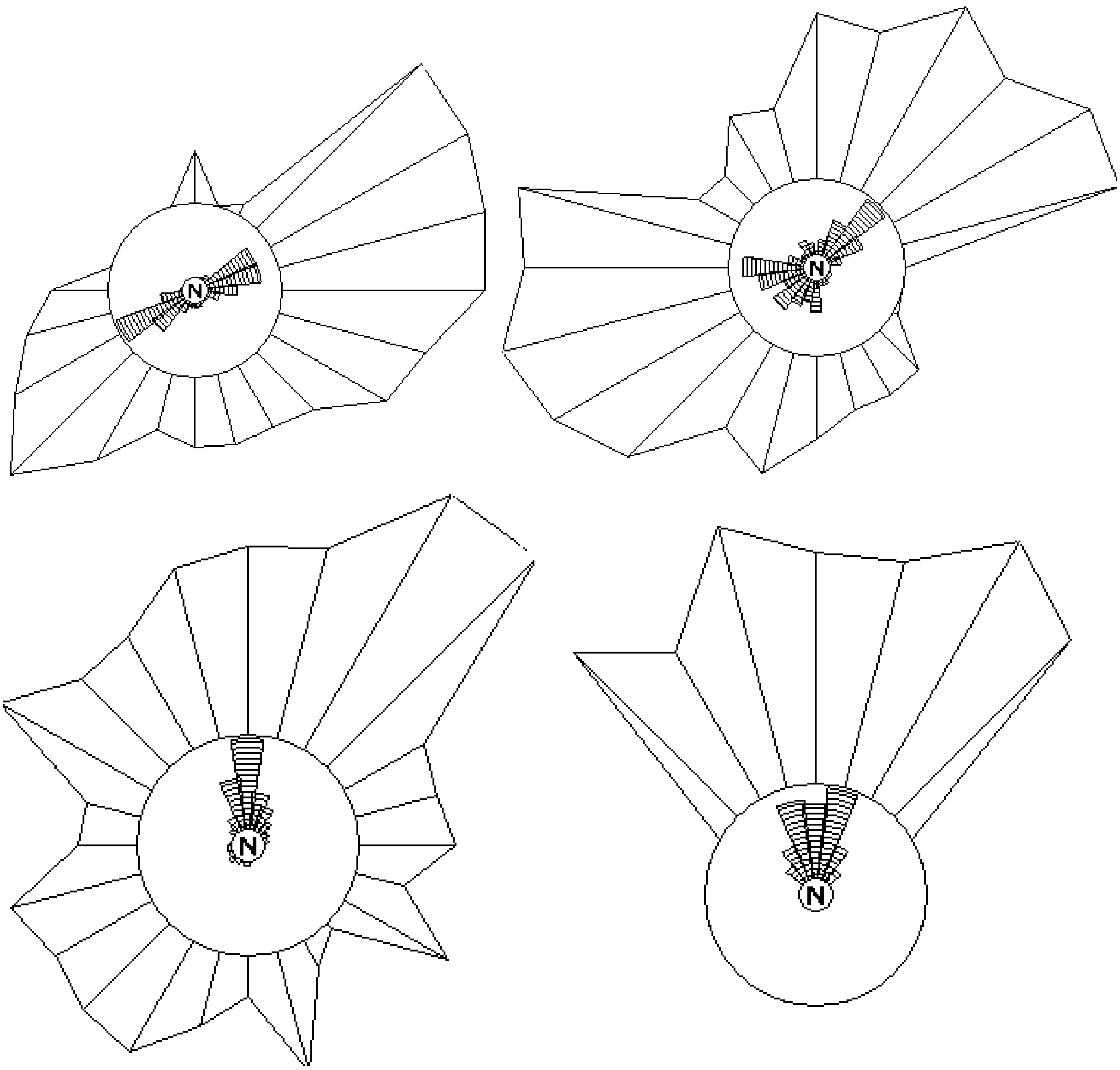


Figure 309. Recovery rose graphs for Shovelers, ringed in different longitudes: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distance along each direction (radar charts).

Upper left chart is for European wintering Shovelers, area of recoveries from British Isles to Western Siberia, to 70˚E. Sector = 15.0°; Total recoveries - 615; N in sectors: from 0 up to 129; Average distance in sectors: from 0.0 km up to 2882.0 km; The longest flight distance is 5594.5 km.

Upper right chart is for Shovelers ringed in the southern European Russia, area of recoveries from southern Europe to central Siberia, to 85˚E. Sector = 15.0°; Total recoveries - 275; N in sectors: from 0 up to 37; Average distance in sectors: from 0.0 km up to 2104.7 km; The longest flight distance is 5413.1 km.

Lower left chart is for Shovelers ringed mostly in India, area of recoveries is western and central Siberia, to 125˚E; Sector = 15.0°; Total recoveries - 399; N in sectors: from 1 up to 115; Average distance in sectors: from 104.0 km up to 4396.7 km; The longest flight distance is 6402 km.

Lower right chart is for Shovelers ringed in Japan, recoveries are mostly in the Russian Far East, east of 130˚E; Sector = 15.0°; Total recoveries - 67; N in sectors: from 0 up to 17; Average distance in sectors: from 0.0 km up to 2732.7 km; The longest flight distance is 3771.2 km.

Preferable flight distances both for direct and indirect recoveries are less than 4000 km, with the peak near 2000 km (Fig. 310). Maximal distance of direct recoveries is 6402 km, indirect recoveries – 6149 km.

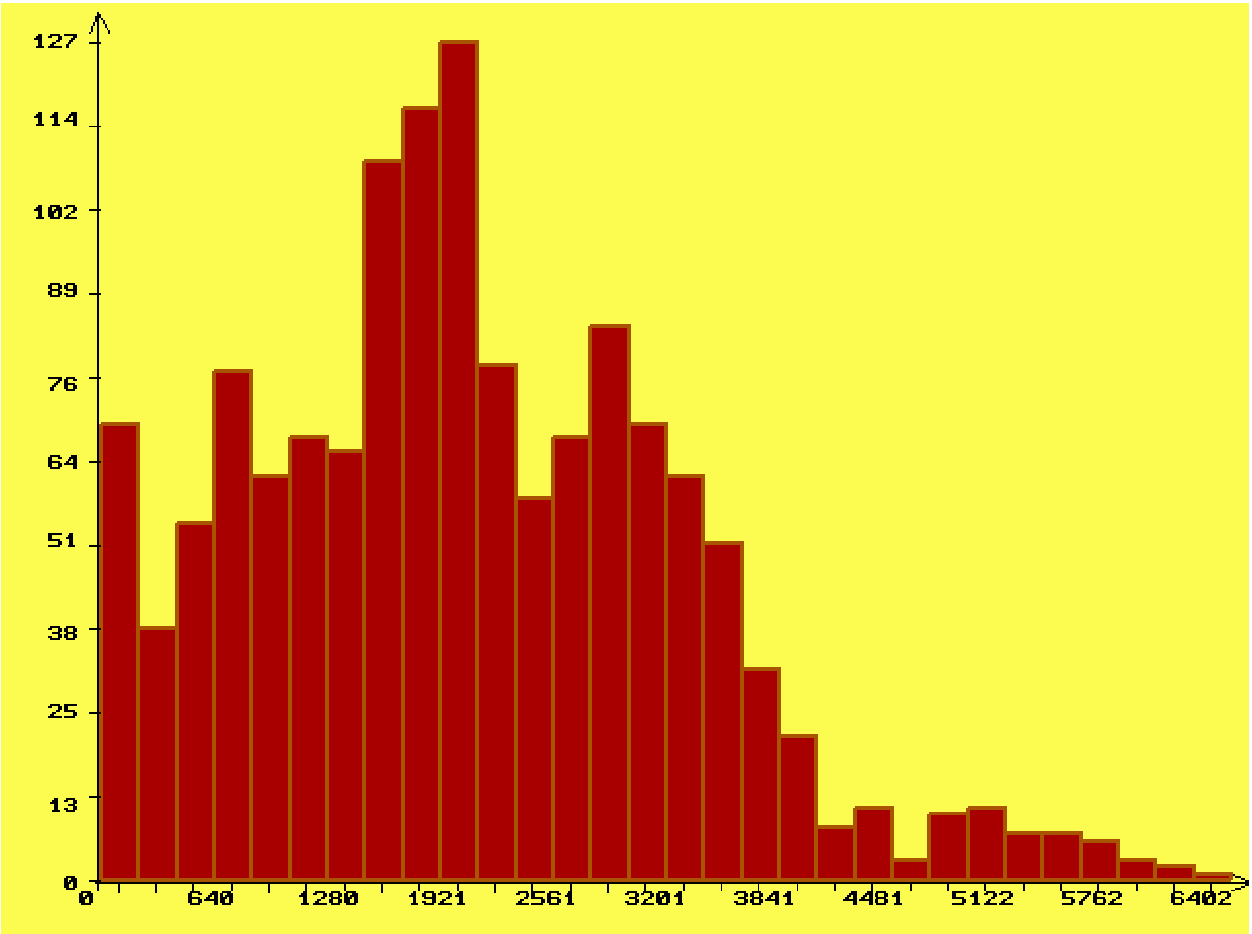


Figure 310. Distribution of all ring-recovery distances in Shoveler. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in Shoveler young birds (ringed as „pull" or „juv" or „1 y") is by more than six hundred km shorter than in adults: 1488.0±44.7 versus 2355.8±39.5 km respectively (N_{young} = 445, N_{ad} = 930), significant (t-Bailey=14.5, P=0.0000), which is characteristic for heavily hunted species. Male mean flight distance is shorter than in females: 2330.1±52.2 and 2430.9±63.8 km respectively (N_{males} = 531, $N_{females}$ = 327), insignificant.

Data on Shovelers ringed in different areas consist of different categories of birds with relatively small numbers in each category; therefore most monthly means do not give the proper information on the detailed migratory routes. Only moulting birds ringed in the Volga Delta and sample of only youngsters („pull" or „juv") ringed in Latvia, produces good definitions of migratory routes in concordance with monthly movement maps and recovery roses (Figs 311, 312).

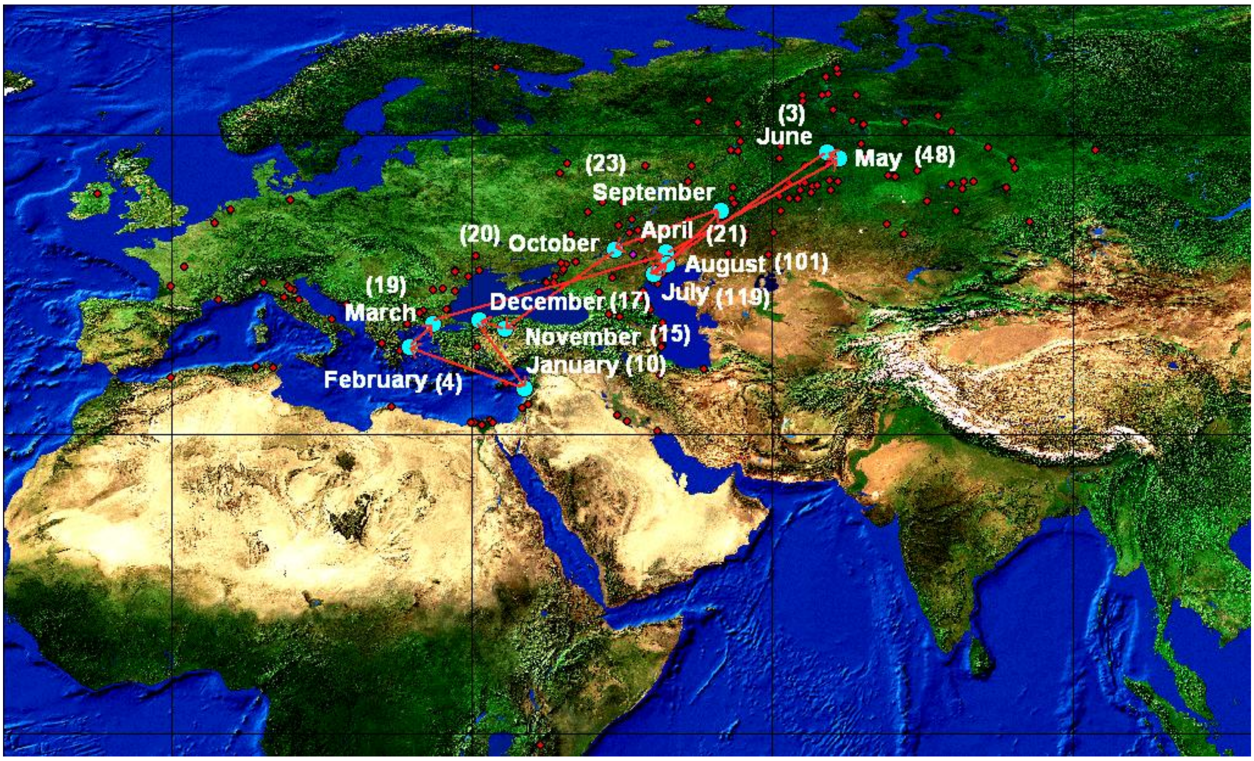


Figure 311. Mean monthly locations of Shoveler control points for birds, ringed on the moulting grounds in the Volga River Delta. Blue-green large circles are mean monthly locations of Shovelers. Arrows show directions of movements. Purple dots are the ringing sites, red dots – recovery points. Number of control points in each month is in parentheses.

Shovelers can form migratory loops during migration, in the same way as described for Common Teal. In European breeding birds these loop is curled in counter clockwise direction, the same as in White-fronted Geese and Common Teal (see species accounts), but in lesser extent and located more to the south than the loop of the two mentioned species. This loop is well visible for ducks, ringed as young in Latvia. (Fig. 312). Recovery areas of birds ringed in different places also give much information on migratory routes (Fig. 314).

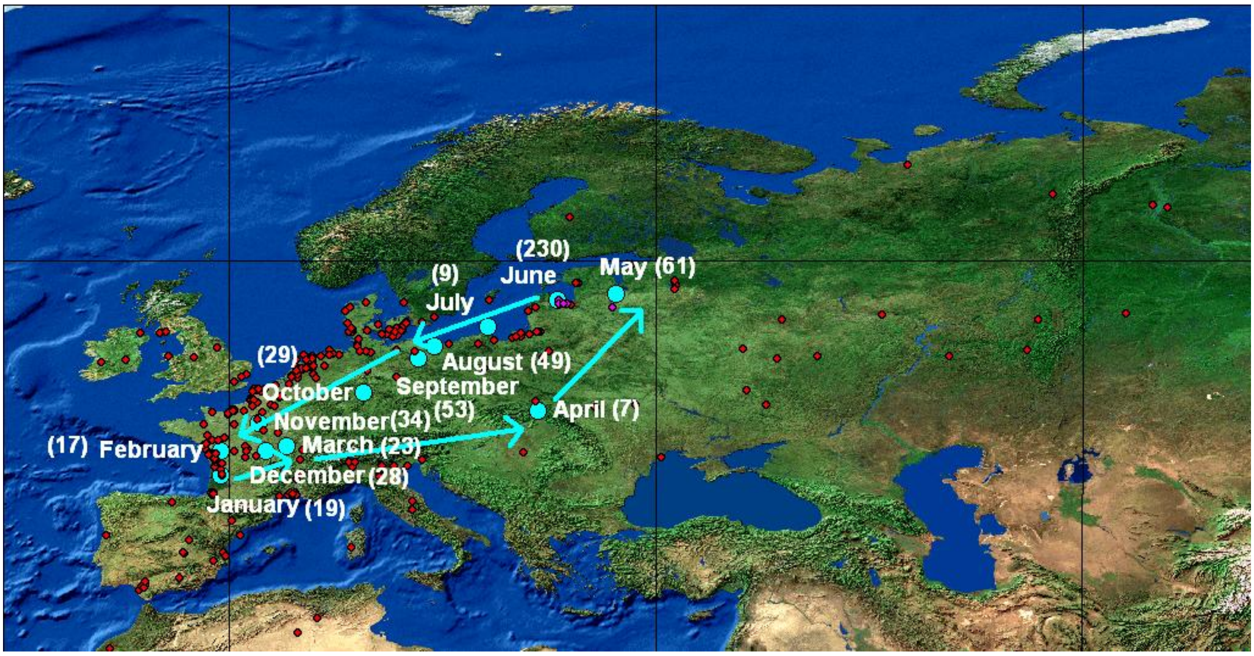


Figure 312. Monthly means for Shovelers, ringed in Latvia (blue-green circles). Arrows show direction of migratory movements. Number of control points in each month is in parentheses.

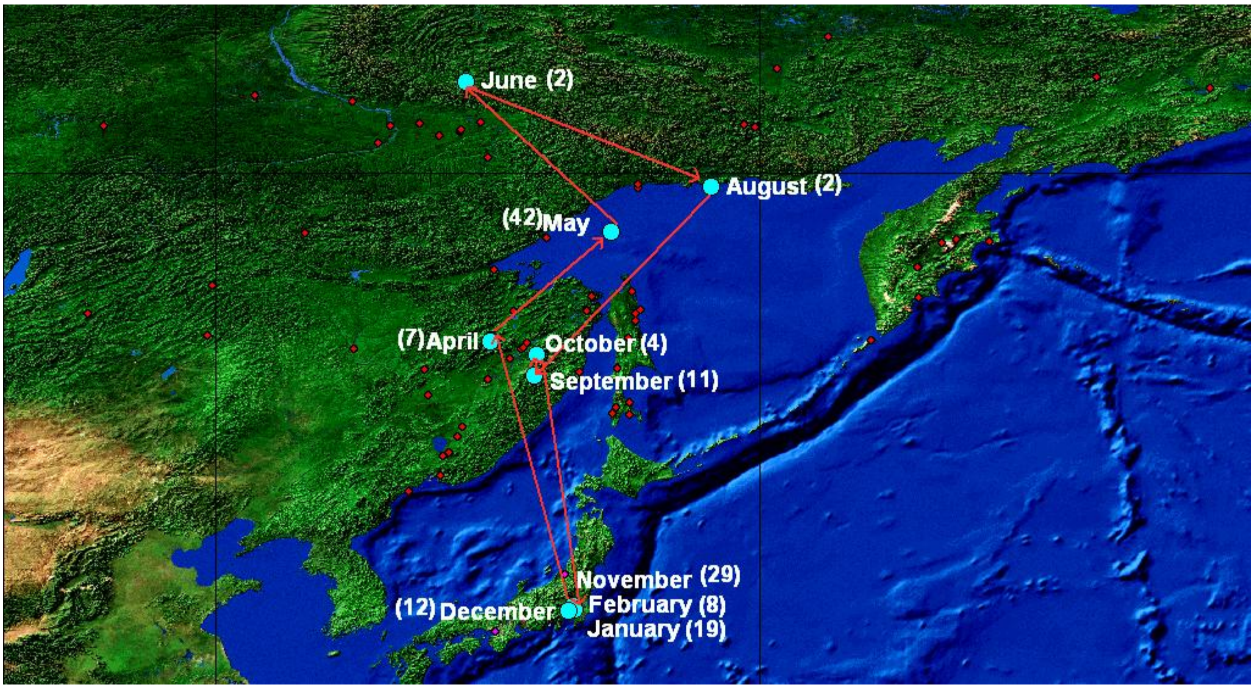


Figure 313. Mean monthly locations of Shoveler control points for birds, ringed on the wintering ground in Japan. Blue-green large circles are mean monthly locations of Shovelers. Arrows show directions of movements. Number of control points in each month is represented in parentheses.

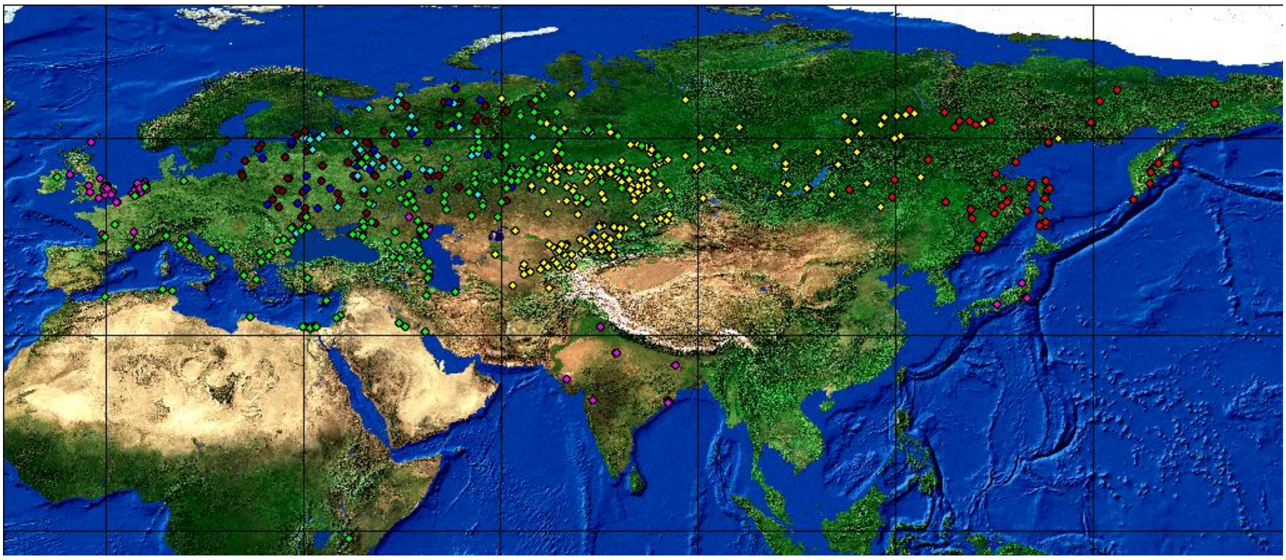


Figure 314. Recovery areas of Shovelers ringed in different places. Purple dots represent ringing places, blue-green dot are recoveries for birds ringed in British Isles, brown dots – ringed in the Netherlands, blue dots – ringed in France, green dots – ringed in the Volga River Delta, yellow dots – ringed in India, red dots – ringed in Japan (see also Fig. 313).

Summarising all about migratory routes, we can outline spring and autumn Shoveler migration movements (Figs 315 and 316).

Figure 315. Outline of spring migratory routes for Shoveler. Red arrows are directions of migratory movements.

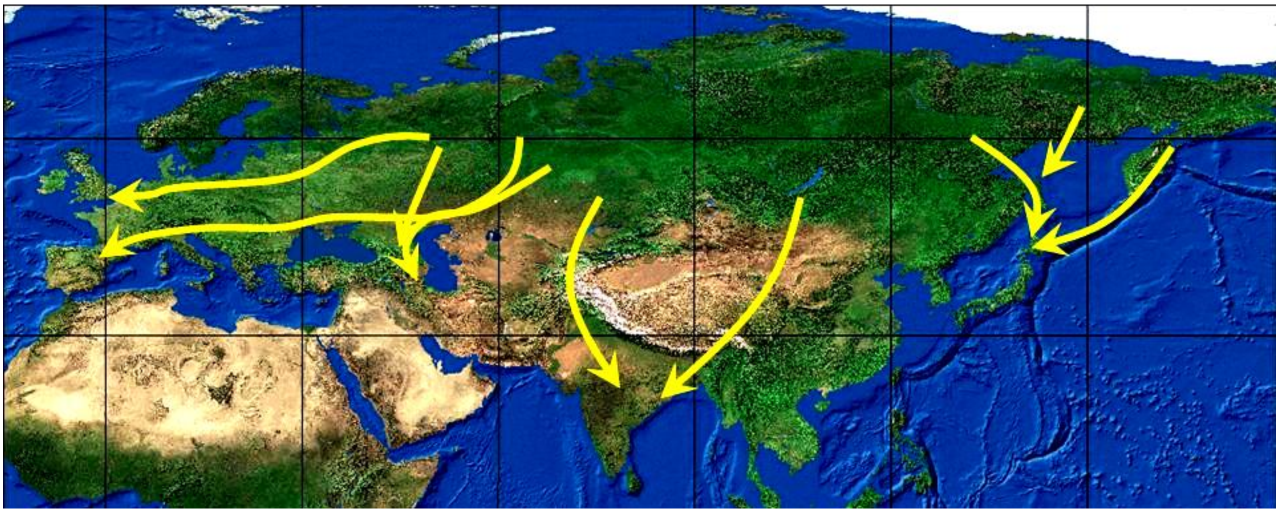


Figure 316. Outline of autumn migratory routes for Shovelers. Yellow arrows are main directions of migratory movements.

Speed. Bird Ringing Centre of Russia database contains several Shoveler direct recoveries with speed of movement near 200 km per day. Seems, this is the preferable speed of Shoveler on migration.

Populations. Shoveler is a duck with less mobility, than Pintail or Wigeon. Although Shovelers are capable to cover long distances, they usually do not perform long-distance cross-population movements. Shoveler populations are quite large, small number of long cross-population movements is responsible for relatively lesser extent of the population overlapping than in Pintails and Wigeons, but greater extent than in Common Teal. Bird Ringing Centre of Russia ring-recovery data allow outlining the following Shoveler populations: 1) european-north-african-west-siberian population (polygon No 1, Fig. 317) with generally east, north-east – west, south-west migratory movements; 2) south-east-european-middle-east-persian-west-siberian population (polygon No 2, Fig. 317) with generally north-east – south-west migrations; 3) hindostanian-central-asian-west-central-eastern-siberian population (polygon No 3, Fig. 317) with north – south directions of migrations ; 4) japanese-far-eastern population (polygon No 4, Fig. 317) with north-south migratory movements. It is possible to separate distinctive nile-middle-eastern-western-siberian subpopulation within south-east-european-middle-east-persian-west-siberian population (Fig. 317 2A).

All populations overlap moderately. Intergradations zones are located mostly in Western Siberia, in the past – in theVolga River Delta (between 1, 2 and 3 populations) and eastern Siberia – between 3 and 4 populations.

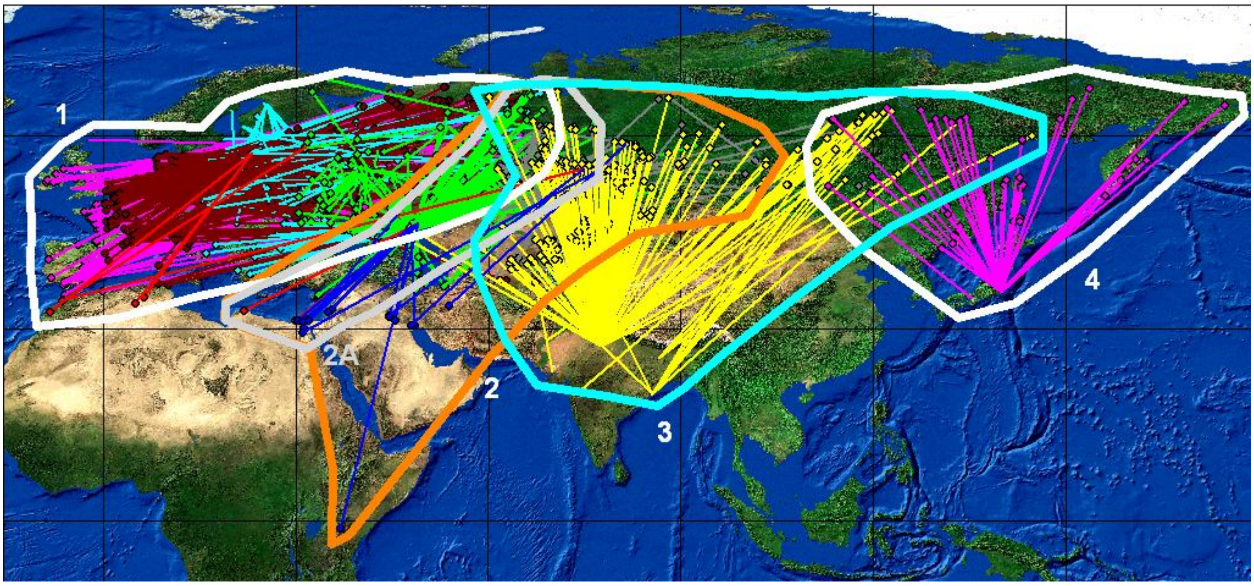


Figure 317. Shoveler populations. White polygon № 1 outlines european-north-african-west-siberian population. Light brown polygon shows the south-east-european-middle-east-persian-west-siberian population (polygon № 2). Blue-green polygon is the hindostanian-central-asian-west-central-eastern-siberian population (polygon № 3). White polygon № 4 shows japanese-far-eastern population. Grey polygon № 2A is the nile-middle-eastern-western-siberian subpopulation.

Ten-year distances. Mean flight distance in all Shoveler recoveries demonstrates definite increasing through decades (Table 18). Sharp increase happened in 1970s.

Table 18. Shoveler mean flight distance per decade.

Decade (years)	1929-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2023
Distance (km)	1601.6	1826.3	1584.6	1820.4	2269.3	2773.0	2702.1	3248.9	2996.8
Number of recoveries	97	30	169	472	364	152	22	26	32

Since 1970s when have been Shovelers enlarging their migratory distances. It is interesting to see whether the directions of migrations changed or not. It turned out that after 1970 bearings generally have become more northwards (Fig. 318). At the same time, set of ringing places have not changed from nearest years before 1970 to after 1970. Comparison of the mean bearings in direction of flights for birds ringed in several places in western Europe does not reveal the significant changes in bearing before and after 1970. However, there is a guide place for analysis of bearing shift. This is Volga Delta, a place which is located in the southern part of the breeding range. Ducks from there move mainly in two directions (see recovery roses in different duck species): 1) to the breeding areas to western Siberia (usually in years next after ringing); 2) to the wintering grounds in Europe (both in the same and next years). Mean movement bearing in the sector 0-180˚ for years before 1971 comprised 51.6˚ (N=76), after – 66.5 (N=22), difference is insignificant. However, in the sector 180-360˚ (way to the wintering grounds) bearing became significantly more northward: before 1971 it was 256.7˚ (N=80), after – 278.9˚ (N=25), t-Bailey=2.24, P=0.03. It means that after 1970 Shovelers change their wintering grounds in Europe for more northern ones. In this manner, we should mention, that changing wintering sites for ducks should be easier process than for geese or swans. It needs to add that this shift of the wintering grounds to the north is not compulsory related to the climate change (although it is quite possible). It might be connected with continuation of human developing of southern Europe and extirpation suitable habitats for ducks from there.

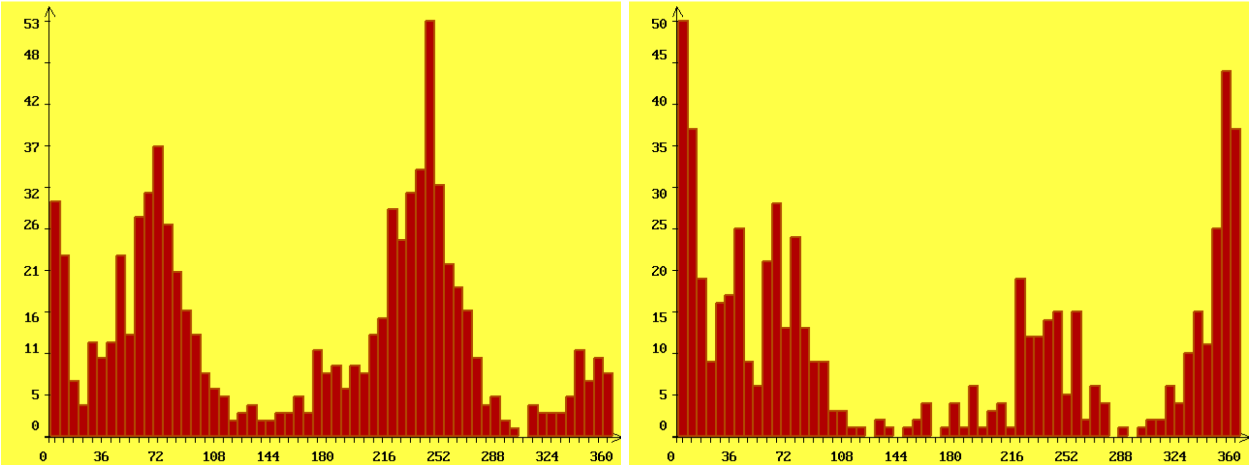


Figure 318. Distribution of bearings from ringing to recovery places in Shovelers in years before 1971 (left histogram) and after 1970 (right histogram).

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest Shoveler lived 20 years 4 months. This bird is from the Bird Ringing Centre of Russia database.

Mortality rate. According to the common criteria (see “Materials and Methods”) 1316 dead recoveries are applicable for the mortality rate analysis. Mean annual mortality rate in Shoveler is 28.97±0.67%. Real mortality pattern differs from the theoretical one insignificantly (χ^2 = 1317, df = 18, P=0.0000). Programme MARK, Model CLogLog 2^{nd}Part shows 29.23%,, difference is 0.26%. Shoveler mortality pattern chart shows considerable drawdown of the real survival dynamics in the comparison to the theoretical one (Fig. 319). This is a signal for not good situation with the species. It is known, that Shoveler is a heavily exploited species. However, this is the result for a long period. To understand the present status of the Shoveler we should analyse mortality rate pattern over decades.

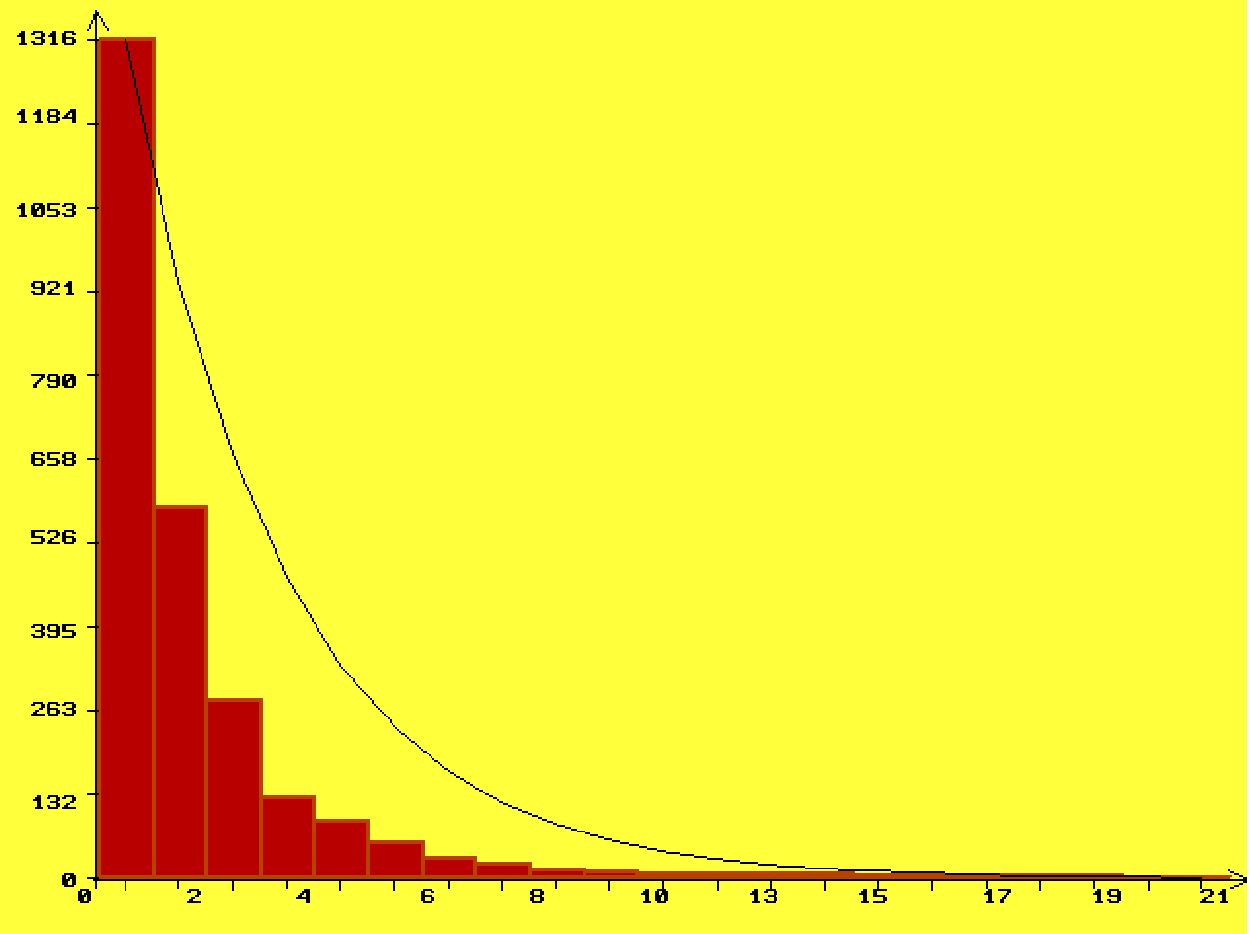
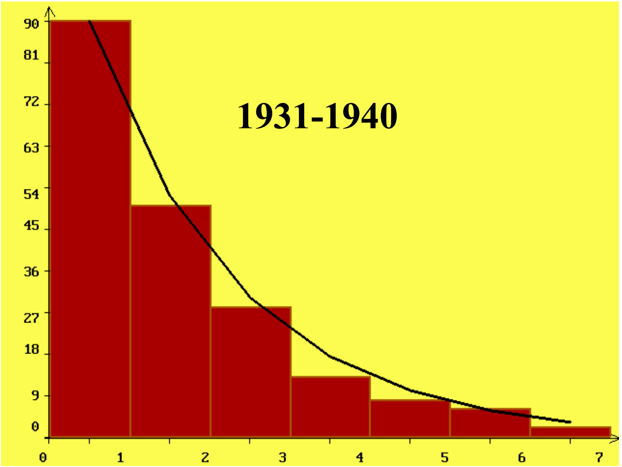
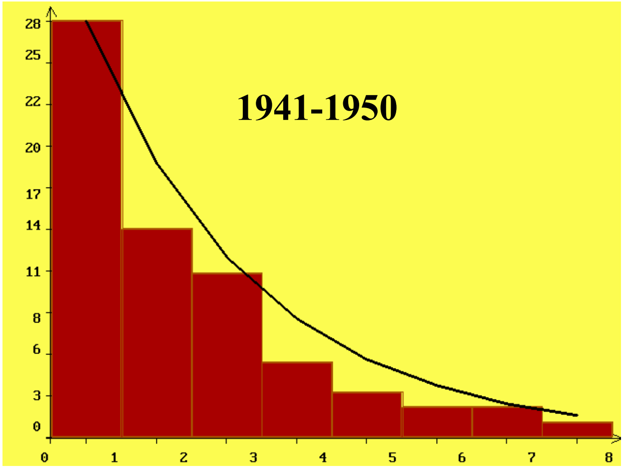
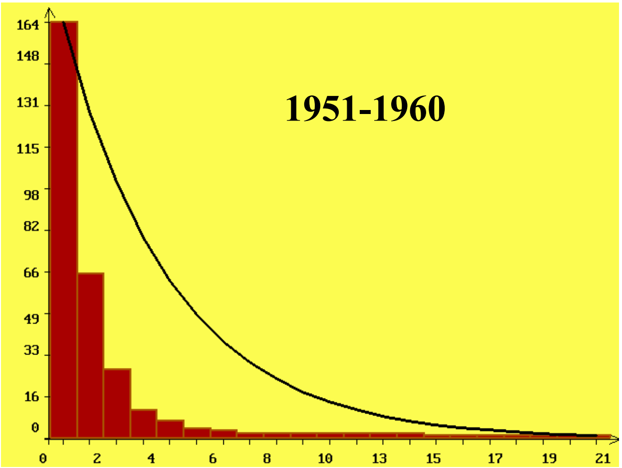


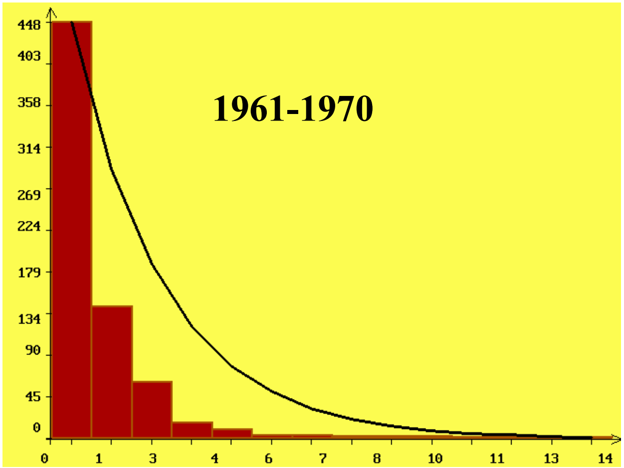
Figure 319. Mortality pattern in the Shoveler. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

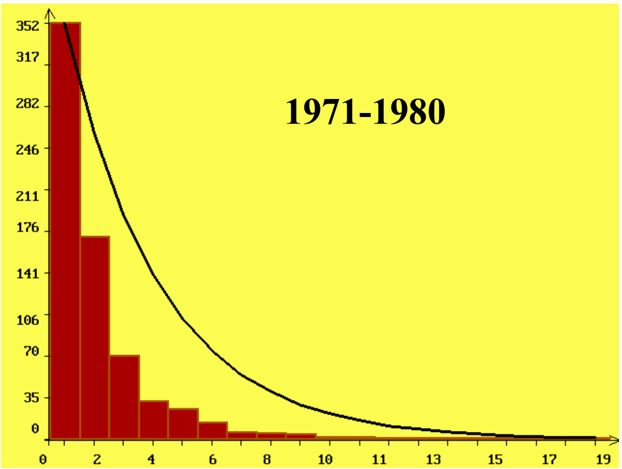
Since great amount of data is available, it is possible to analyse species condition dynamics over decades (Fig. 320_1). For 1930s and 1940s mortality pattern indicates good population (species) condition – real data are not very much different from the theoretical line (Fig. 320, 1931-1940, 1941-1950). Hunting during the World War II was not possible, because shotguns had been confiscated (Bianki, 2005). Then, in the decade 1951-1960 the Shoveler condition became worse. The Shoveler is a meadow breeding bird, however, not like Pintail or Garganey, who breed on more or less dry meadows. Shoveler breeds on the extensive wet meadows. Since wet areas are much less convenient for battles or battle preparation movements, we think the species did not suffer during the war decade. However, it suffered greatly soon after (decade 1951-1960), from intensive hunting. The situation started to improve in 1980s; then it has been getting better through the recent years (Fig. 320). Now in Central European Russia the situation with Shoveler populations is quite good (Alexandr Mishchenko, personal communication) and see mortality patterns for 2001-2010 and 2011-2023.

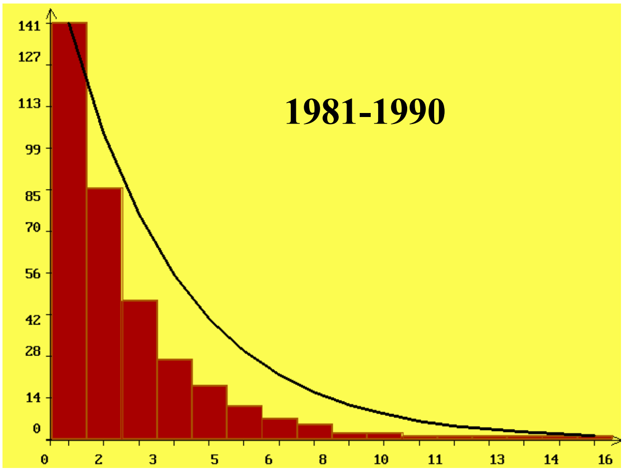

1931-1940
90
81
72
63
54
45
36
27
18
9
0
0 1 2 3 4 5 6 7

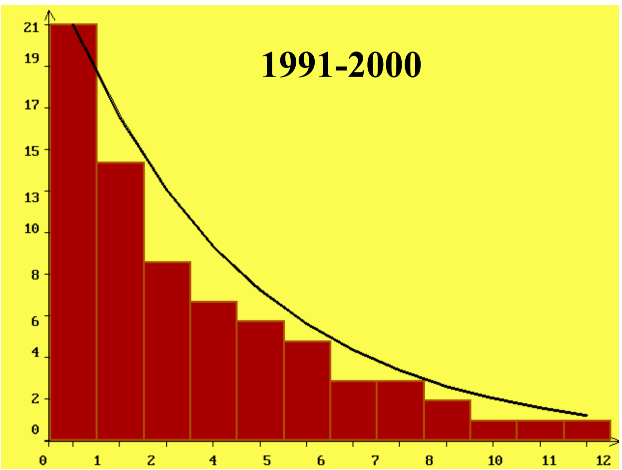

1941-1950
28
25
22
20
17
14
11
8
6
3
0
0 1 2 3 4 5 6 7 8

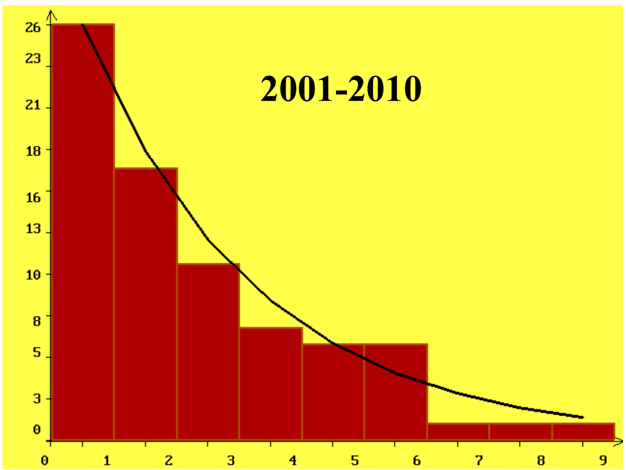

1951-1960
164
148
131
115
98
82
66
49
33
16
0
0 2 4 6 8 10 13 15 17 19 21


1961-1970
448
403
358
314
269
224
179
134
90
45
0
0 1 3 4 6 7 8 10 11 13 14


1971-1980
352
317
282
246
211
176
141
106
70
35
0
0 2 4 6 8 10 11 13 15 17 19


1981-1990
141
127
113
99
85
70
56
42
28
14
0
0 2 3 5 6 8 10 11 13 14 16


1991-2000
21
19
17
15
13
10
8
6
4
2
0
0 1 2 4 5 6 7 8 10 11 12


2001-2010
26
23
21
18
16
13
10
8
5
3
0
0 1 2 3 4 5 6 7 8 9

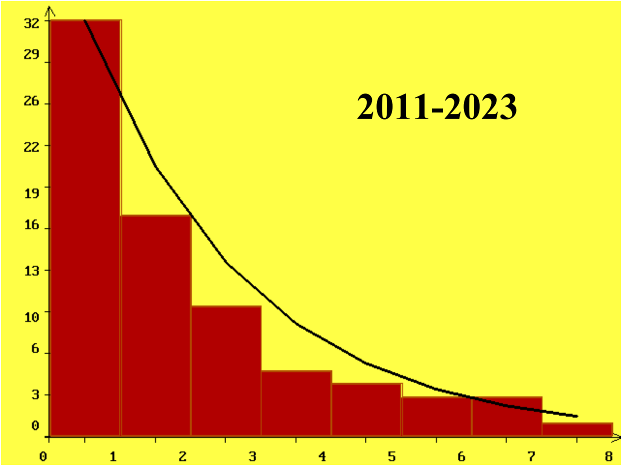


Figure 320_1. Mortality pattern in Shovelers recovered in different decades. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, males live slightly longer than females: 1.71±0.09(N = 504) and 1.50±0.10 (N = 309) years respectively, insignificant. Female and male overall annual mortality rate is about the same: 26.05±1.27% and 25.64±0.99% respectively (Fig.320_2).

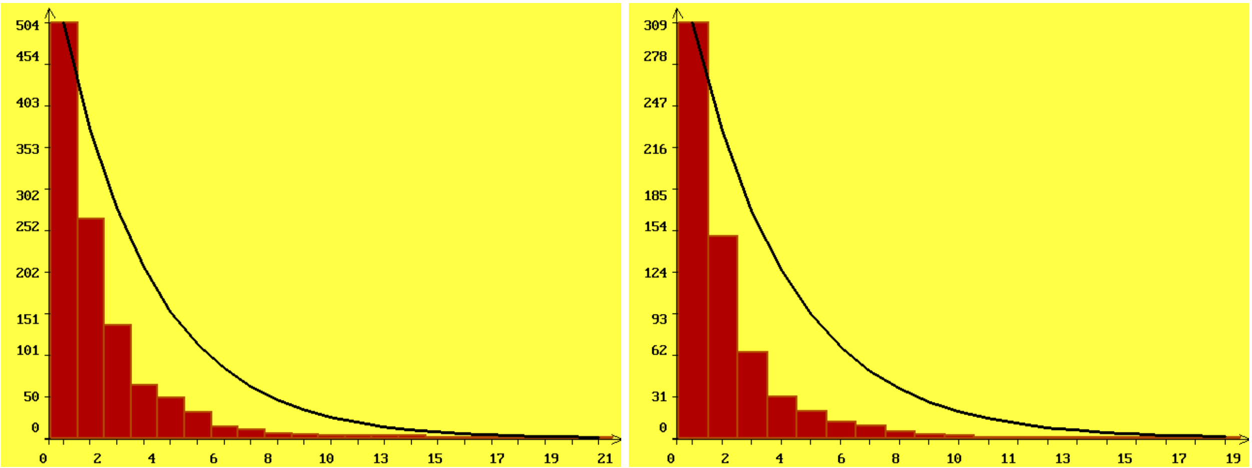


Figure 320_2. Mortality rate pattern Tufted Duck sexes: left – males, right – females. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

CAPE TEAL
(*ANAS CAPENSIS*).

Photo by Eugeniy L. Yakhontov

Species range of the Cape Teal is situated in Africa (Scott, Rose, 1996). In the European Russia we have one recovery of a bird that escaped from captivity, from the Slimbridge Zoological Garden, Great Britain. The duck with ring of 'London' scheme, number 349 was marked in 1957 and shot on 23.09.1960 in the Volgograd Region, Russia (ring sent). The bird covered 3100 km (Fig. 321). The bird flew directly to the east (bearing 93˚). Certainly, this duck was involved in the migration stream by other teal species that normally migrate along about this way from Western Europe to western Siberia.

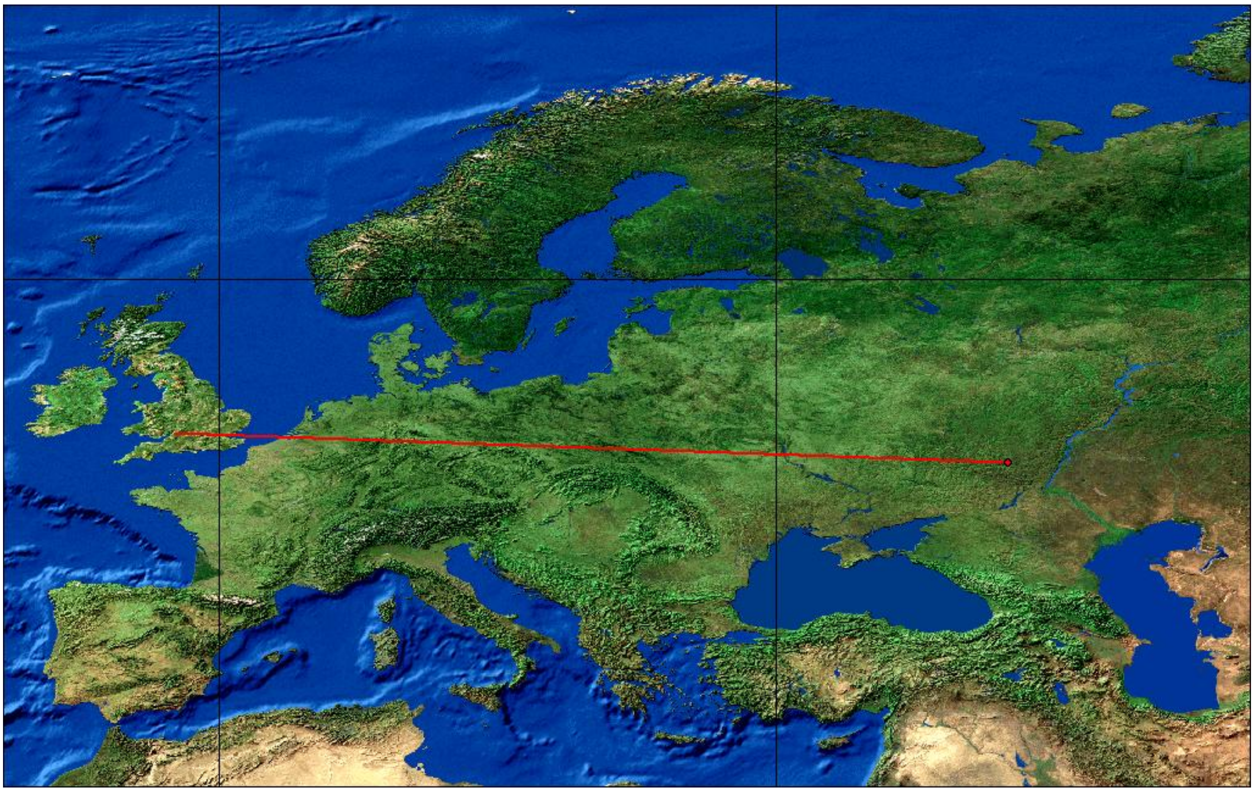


Figure 321. Flight direction of Cape Teal escaped from Slimbridge, Great Britain. Beginning of the line indicates ringing site, red dot at the end indicates the recovery point.

MANDARIN DUCK
(*AIX GALERICULATA*).

Photo by Nikolay B. Konyukhov

Breeding range of the Mandarin Duck is situated in China, Japan, Korea and south of the Russian Far East. These ducks spend winter in China and South Korea. In the European Russia we have four recoveries of birds escaped from captivity from three European Zoos: 1) Two recoveries from birds ringed in Tarlow Court, Buckingham, Great Britain; 2) Zoo of Nurnberg, Bayern, Germany; 3) the Moscow Zoo (Fig. 322). Flight distances are from 807 up to 2608 km. In three of the four flights distance considerably exceeds the length of natural migratory movements of the species. Flight directions coincide with those in wild ducks in Europe. It is almost certain, that Mandarin Ducks were involved into the migration streams by other duck species that normally migrate along about these ways. Bird that escaped from the Moscow Zoo was recovered after more than three years after ringing, from British Zoo – in two years and more than 5 years. However, the Mandarin Duck from Germany was recovered in less than a year after ringing, but covered 1873 km. This witnesses, that Mandarin Ducks are capable to fly at very long distances soon after escaping.

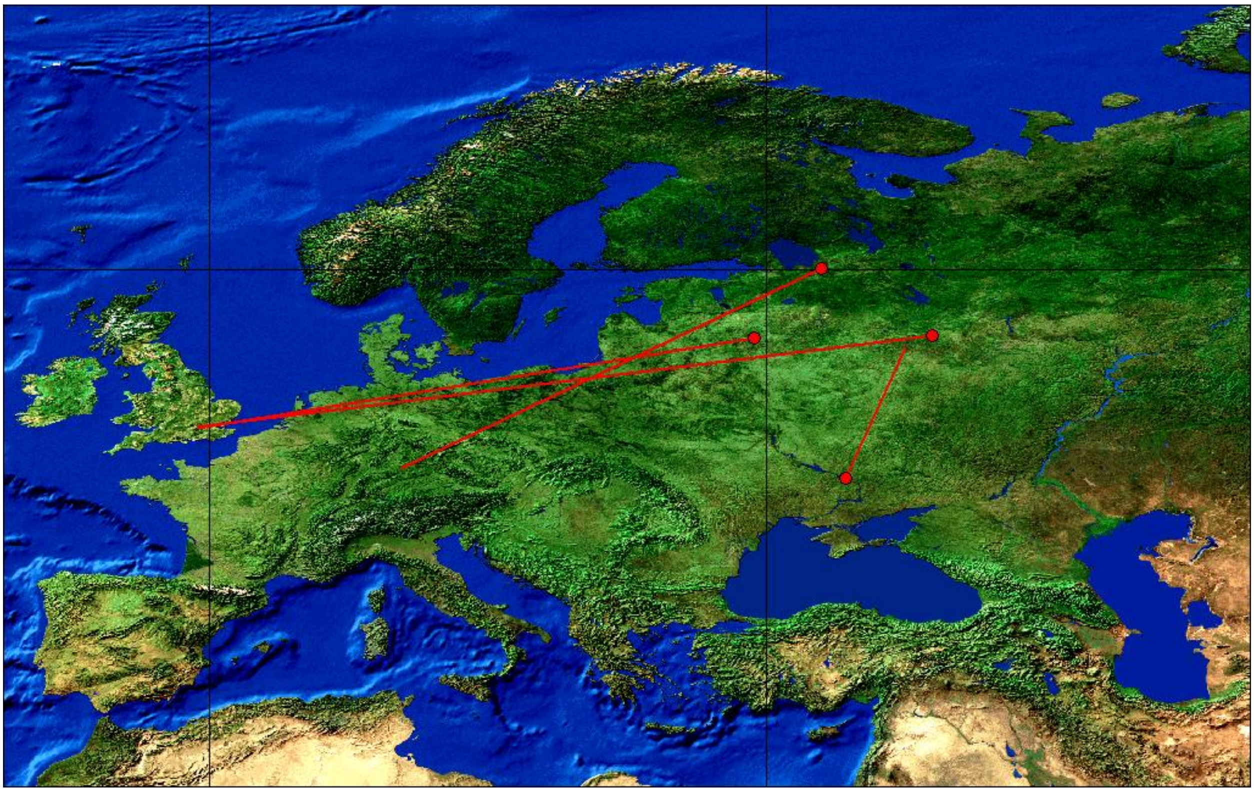


Figure 322. Flight direction of Mandarin Ducks escaped from Zoos. Beginning of each line indicates ringing site, red dot at the end indicates the recovery point.

CAROLINA DUCK
(*AIX SPONSA*).

Photo by Nikolay B. Konyukhov

Breeding range of the Carolina Duck is situated in North America. In the European Russia we have one recovery of a bird that escaped from captivity from the Moscow Zoo. The duck was marked on 25.08.1961 and shot on 28.11.1961 after 95 days in Caucasus (ring sent). The bird covered 1487 km (Fig. 323). Such long flight distance witnesses that Carolina Ducks are capable to cover very long distances very soon after escaping. Flight direction is in general from north to south, which resembles direction and distance of migration in the natural range (North America) of this species, although not exactly.

Figure 323. Flight direction of the Carolina Duck escaped from the Moscow Zoo. Beginning of the line indicates ringing site, red dot at the end indicates the recovery point.

YELLOW-BILLED PINTAIL
(*ANAS GEORGICA SPINICAUDA*).

http://carolinabirds.org/People/AthanasLG/Pintail,_Yellow-billed_Nick_Athanas.jpg

Breeding range of the Yellow-billed Pintail locates in South America (Howard and Moore, 1991). In the European Russia we have one recovery of a bird that escaped from the captivity from Seewiesen, Oberbayern, Germany. The duck with the ring of 'Radolfzell' scheme, number C 22 549 was seen last time in the zoo on 13.04.1966 and shot on 29.04.1967 in the Pskov Region, Russia (ring sent). The bird covered 1584 km (Fig. 324). Flight direction was to the north-east (bearing 47˚). It is almost certain, that this duck was involved into the migration stream by other duck species that normally migrate along about this way from central to north-eastern Europe.

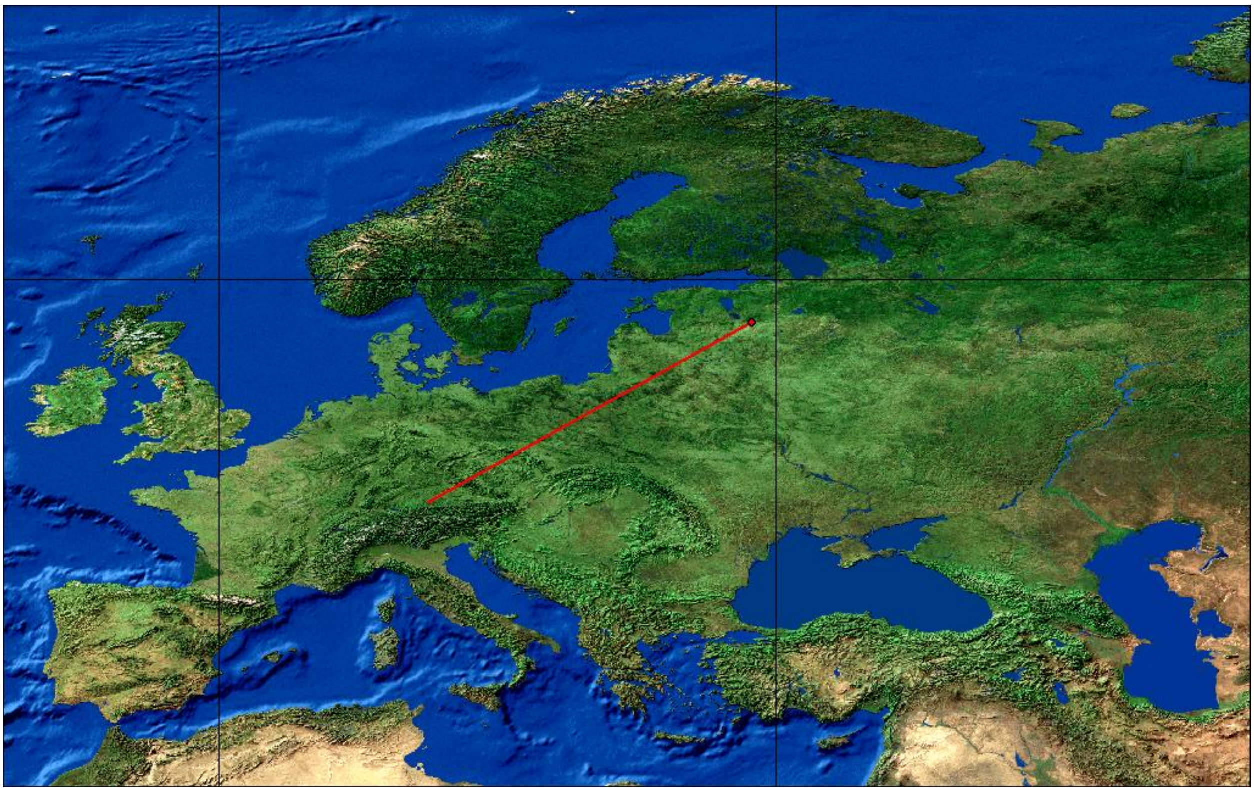


Figure 324. Flight direction of Yellow-billed Pintail which escaped from Seewiesen, Oberbayern, Germany. Beginning of the line indicates ringing site, red dot at the end indicates the recovery point.

RED-CRESTED POCHARD
(*NETTA RUFINA*)

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 325. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

Photo by Vladimir I. Deryabin

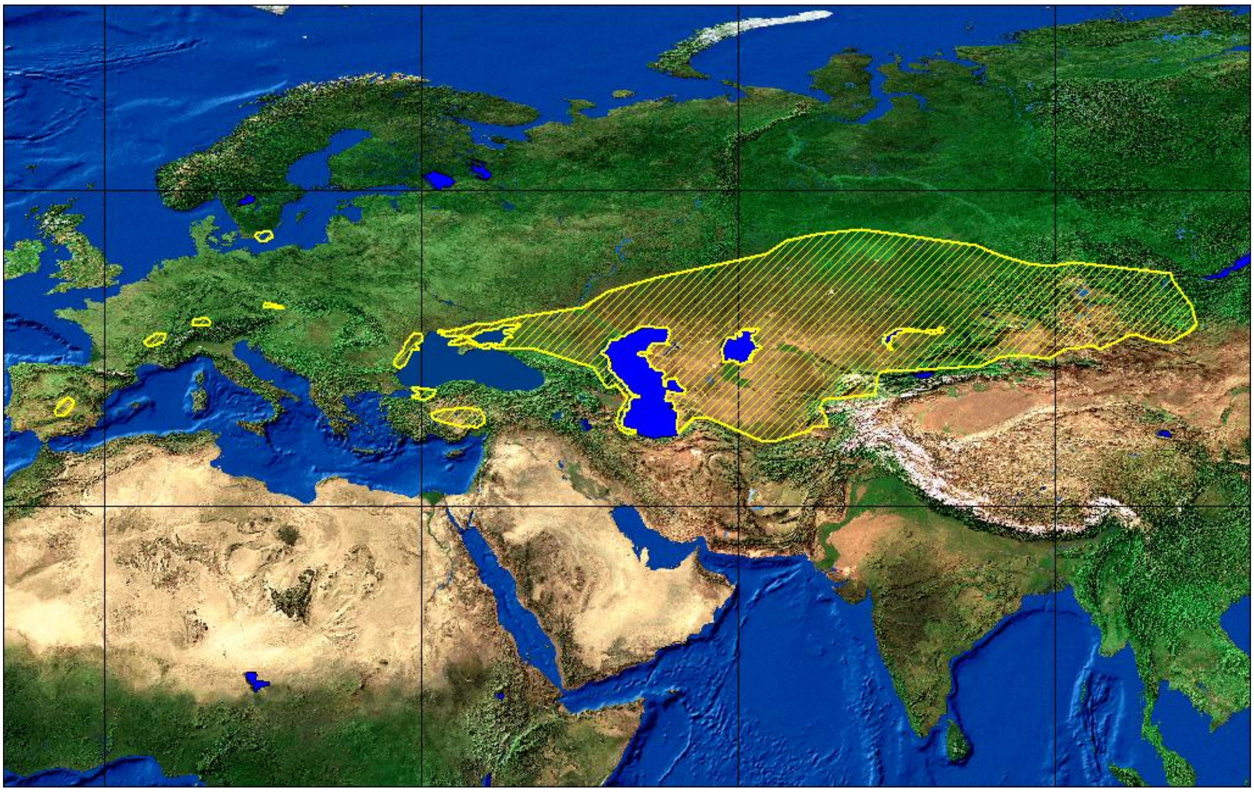


Figure 325. Breeding range of the Red-crested Pochard in Eurasia (yellow dashed areas).

The species data set likely contains several birds escaped from parks.

Distribution of control points. Bird Ringing Centre database contains data on 91 marked birds which gave 91 recoveries, i.e., one recovery per bird. All ducks were marked with metal rings only. Ringing dates are since 07.03.1935 till 25.07.1989, recovery dates are since 21.08.1938 till 21.12.1989.

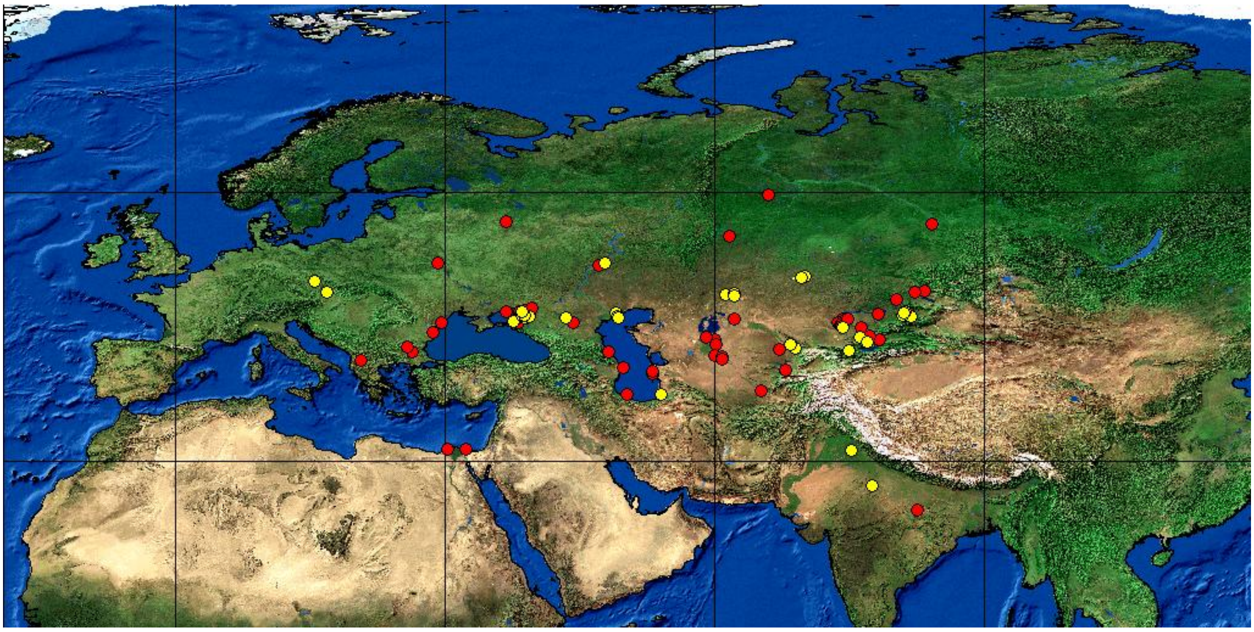


Figure 326 Position of all Red-crested Pochard control points. Yellow dots – ringing sites, red dots – recovery sites.

71 ducks were marked with the „Moskwa", 18 - „Bombay" and 2 - „Praha" schemes. Ducks were ringed in many places of the southern Russia, Kazakhstan, Kyrgyzstan, Turkmenistan, Czech Republic and India. Recoveries sometimes appeared outside of the natural breeding range (Fig. 326).

Finding details. This analysis includes all 91 recoveries. 68 (75%) are „shot". In 16 (18%) recoveries „details unknown", which practically mean shot, as well. Therefore, we can assume that 92% of birds were shot. Other reasons: caught – 5 birds, found dead – 1, leg with ring found – 1.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries of Red-crested Pochard are similar (Figs 327 and 328). Direct recoveries prevail over the indirect ones two-fold.

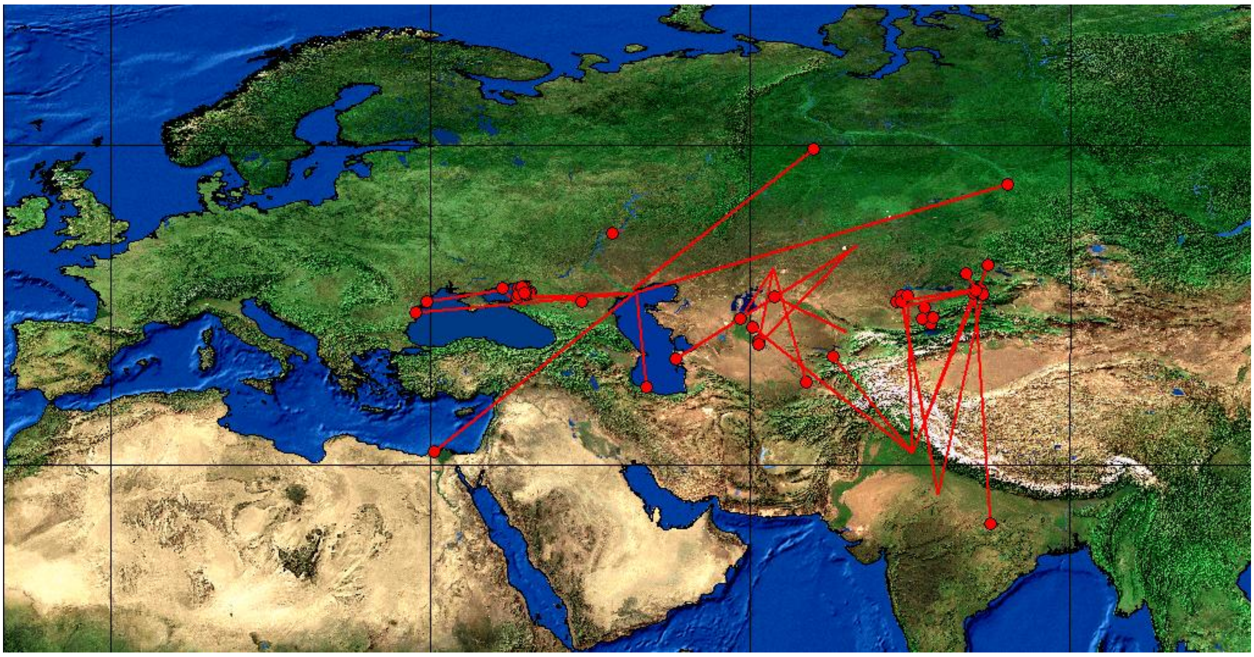


Figure 327. Map of the Red-crested Pochard direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

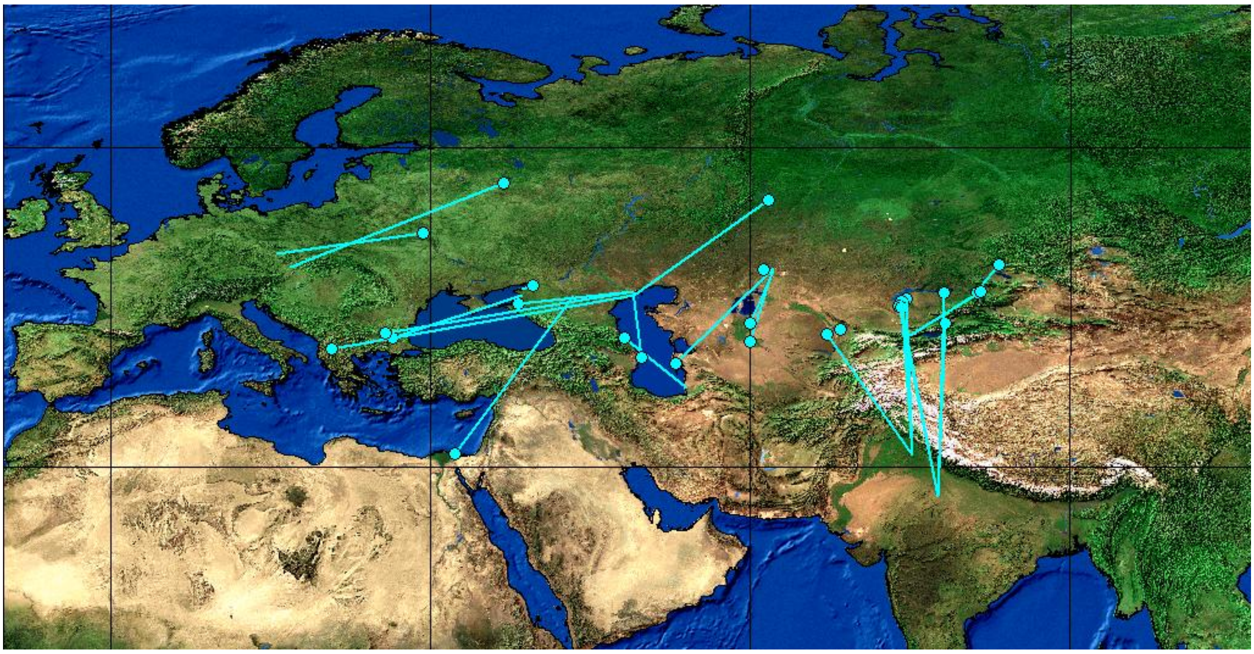
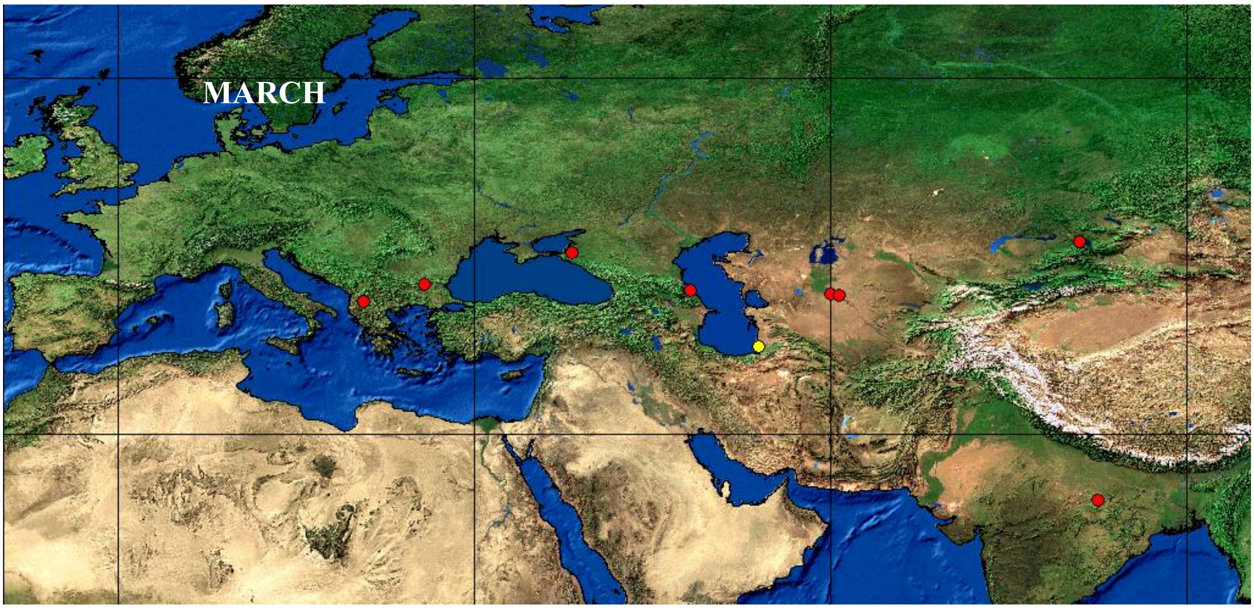


Figure 328. Map of the Red-crested Pochard indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

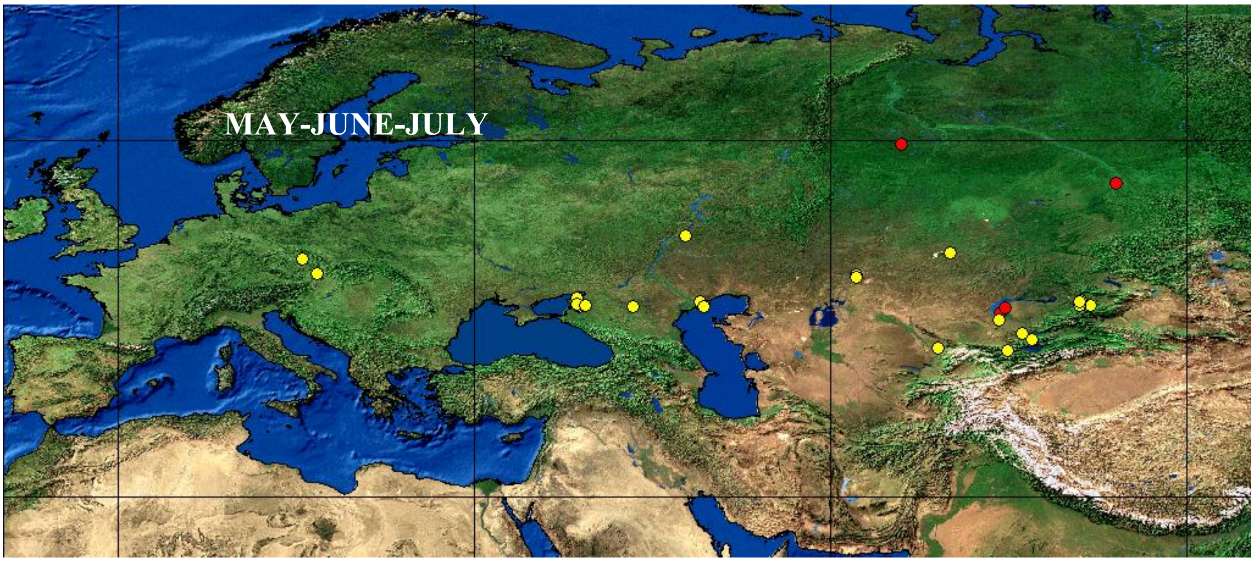
Average flight distances in direct and indirect recoveries are 608.6±102.5 (N=62) and 1218.1±133.4 (N=29). Distance in indirect recoveries is twice significantly longer (t-Bailey = 3.6, P = 0.0006). Such difference between distances means, that Red-crested Pochard is not very site faithful; it is capably quite often change its breeding sites.

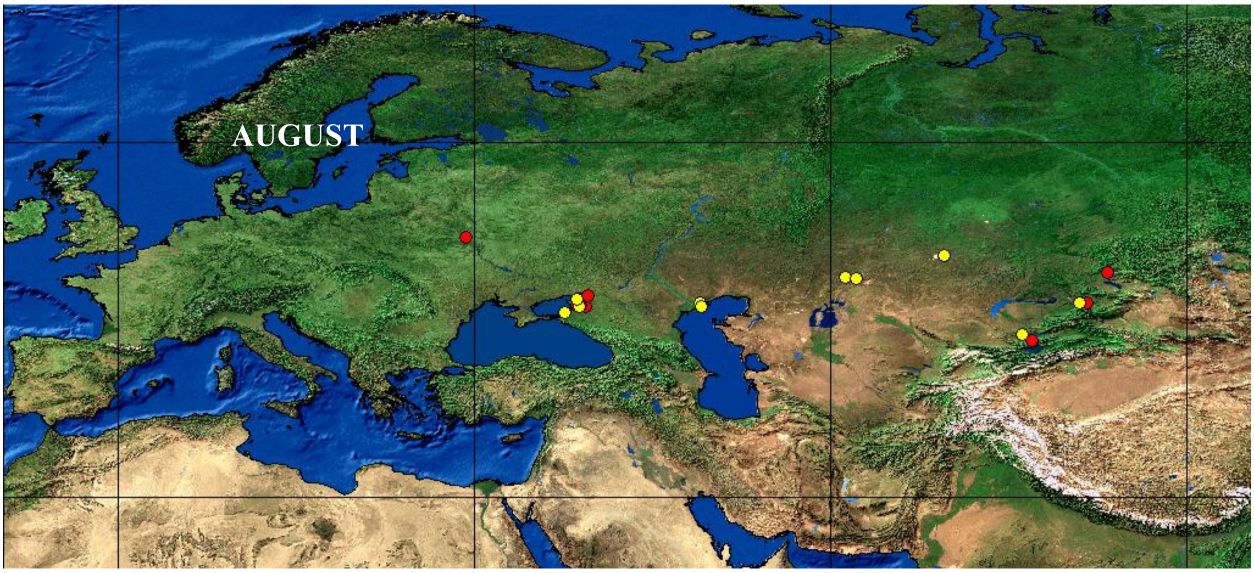
Monthly movements. All recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery sites) reflect a general way of seasonal movements in the Red-crested Pochard (Fig. 329). In January and February birds are on the wintering ground in the south-eastern Europe, Nile Delta, western coast of the Caspian Sea, India. In March migratory movements are already noticeable – to the east, north-east for European and African wintering ducks, to the north – for Indian wintering ducks (March, Fig. 329). In April–May, probably early June, Red-crested Pochards slowly move to the north within the breeding range. In July through October ducks are within the breeding area. Autumn migration takes place in November, in December Red-crested Pochards are in wintering areas (Fig. 329).

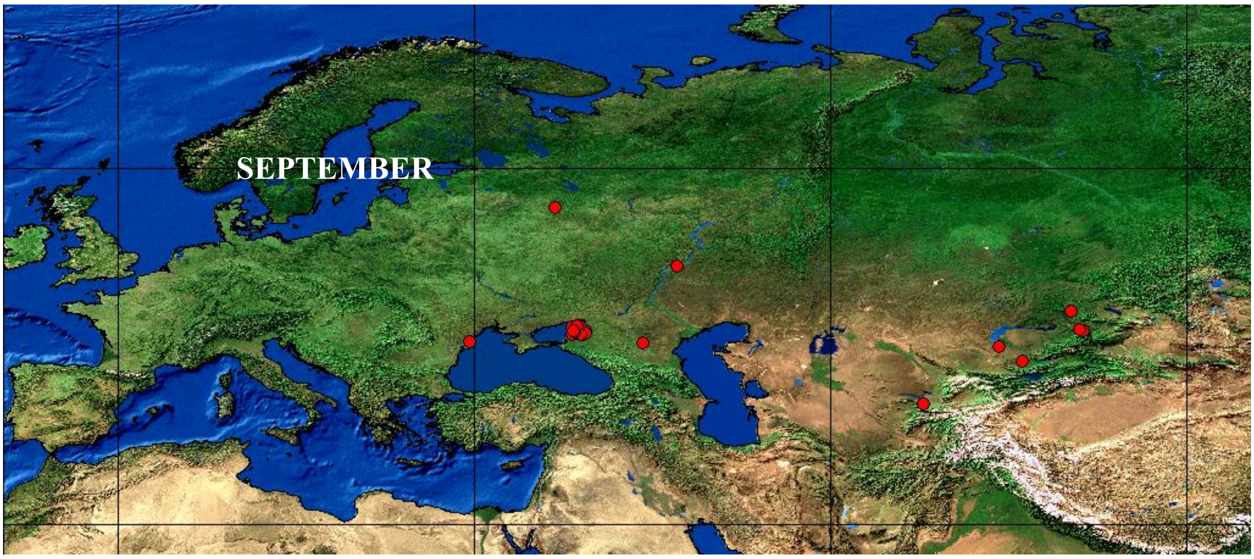

JANUARY-FEBRUARY


MARCH


APRIL


MAY-JUNE-JULY


AUGUST


SEPTEMBER

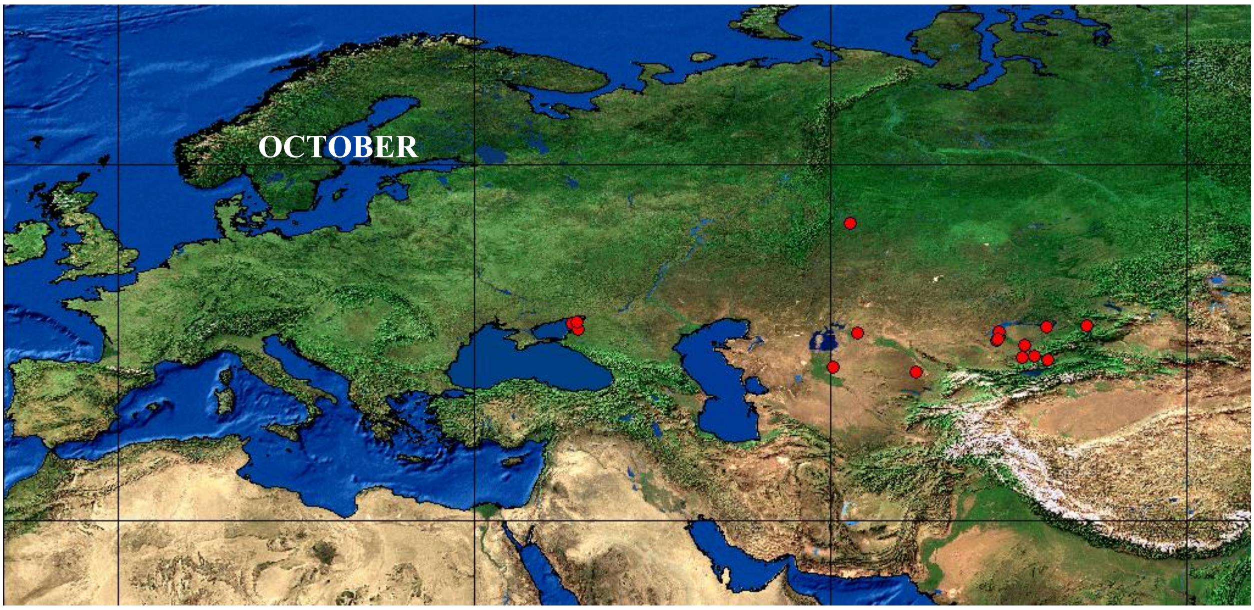


Figure 329. Red-crested Pochard monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. South-eastern European and African wintering Red-crested Pochards migrate to the east, north-east up to 85˚E. Indian wintering duck migrate along north-south directions (Fig. 330).

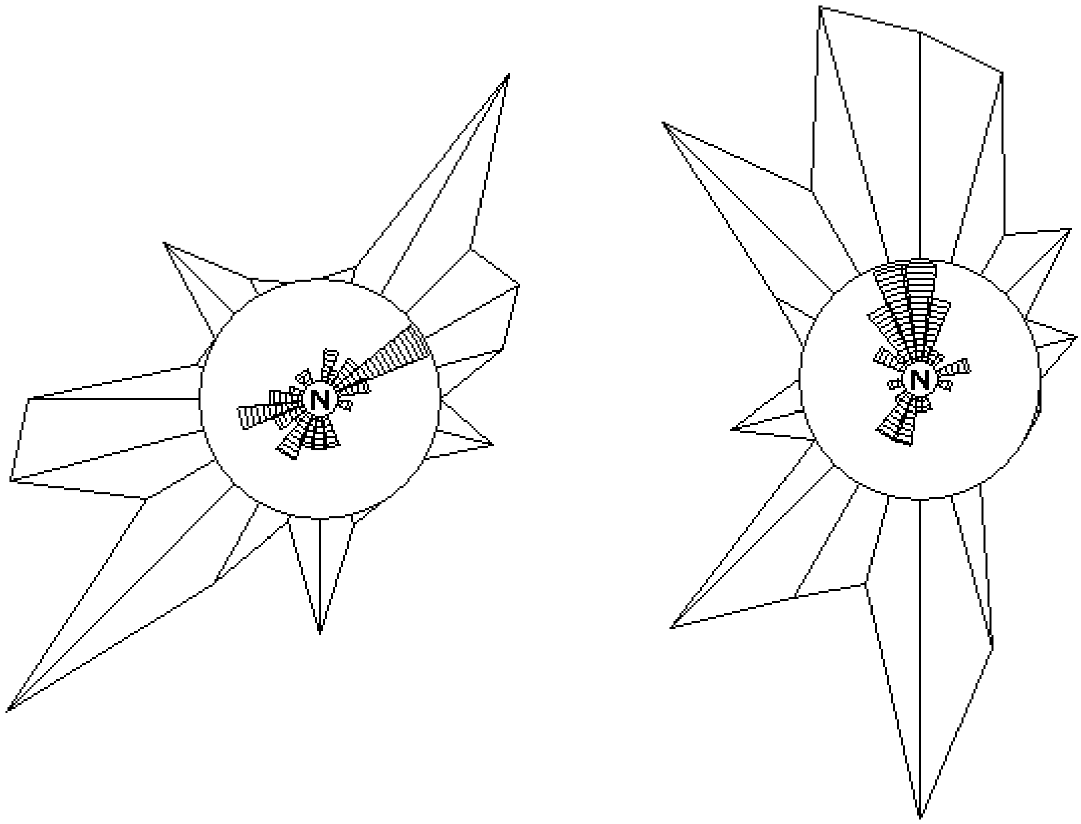


Figure 330. Recovery roses graph for Red-crested Pochard: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Left chart is for ducks, ringed in longitudes less or equal 60°E, area of recoveries from Balkan Mountains up to north-eastern Kazakhstan, to 85˚E. Sector = 15.0°; Total recoveries - 47; N in sectors: from 0 up to 6; Average distance in sectors: from 0.0 km up to 2307.6 km; the longest flight distance is 2646.3 km.

Upper chart is for Red-crested Pochards ringed in India, Central Asia and southern Kazakhstan, area of recoveries is up to approximately 85˚E. Sector = 15.0°; Total recoveries - 44; N in sectors: from 0 up to 6; Average distance in sectors: from 0.0 km up to 2449.9 km; the longest flight distance is 2449.9 km.

As a whole, movement distances are relatively quite moderate for ducks (Fig. 331). Fly distances greater 200 km distributed relatively uniformly. The longest distance in direct flights is 2646.3 km, in indirect recoveries – 2334.7 km.

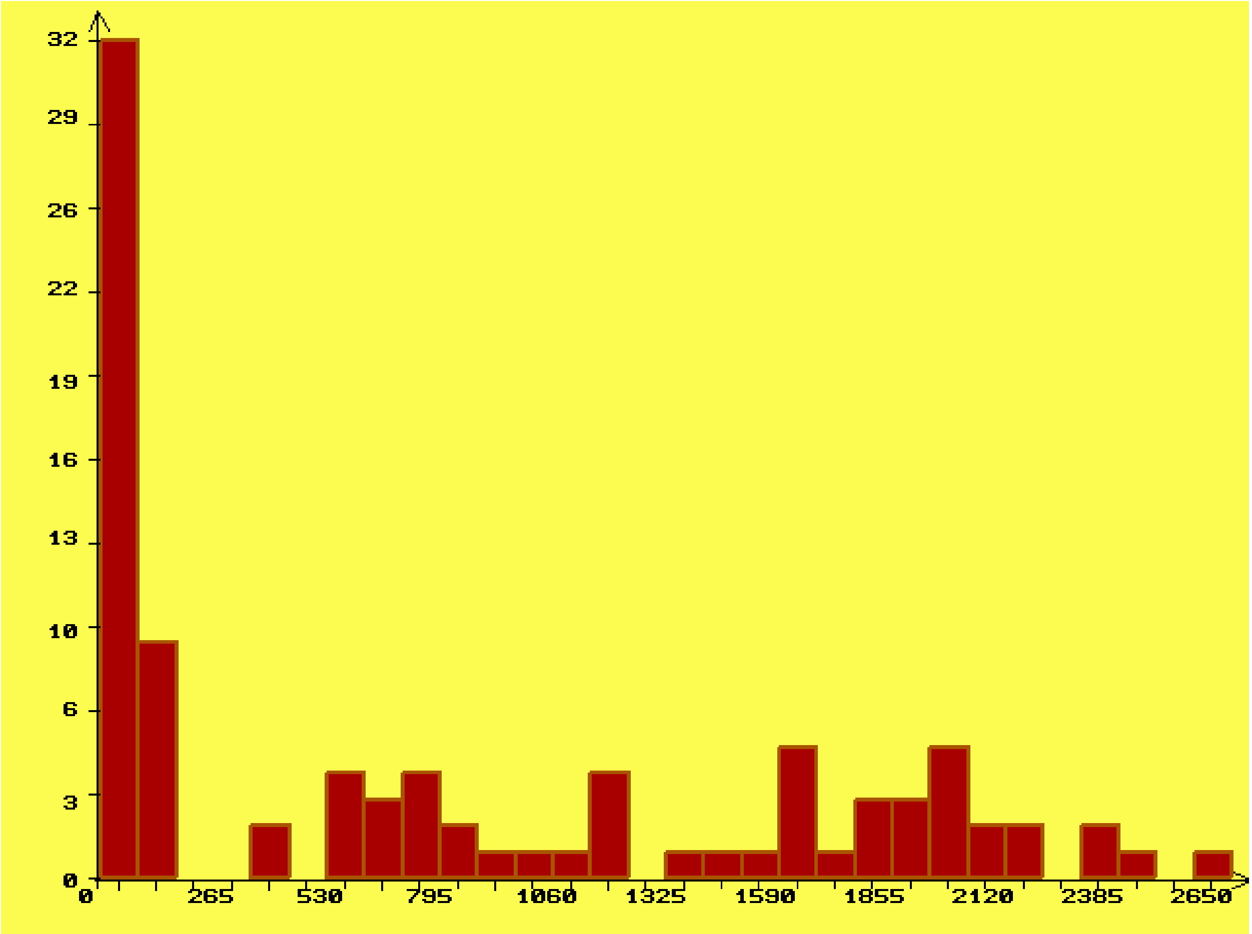


Figure 331. Distribution of all ring-recovery distances in Red-crested Pochard. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in young birds (ringed as „pull" or „juv" or „1 y") is almost twice shorter than in adults: 487.6±145.5 (N_{young} =25) and 922.2±102.8 (N_{ad} =66) km respectively, significant t-Bailey= 2.43, P=0.018. This means that hunting has considerable impact on the Red-crested Poshard populations. Male mean flight distance is slightly greater than in females: 1395.4±159.4 and 1324.1±179.1 km (N_{males} = 19, $N_{females}$ = 19) respectively, insignificant.

Zoo birds. At least 2 birds of 91 were ringed in Zoos or parks outside the breeding range. Birds were ringed in Czech Republic, and recovered after more than 4 years. These two birds migrated in the same direction (in the parallel way) as European Pochards do, however in more northern deposition (Fig. 332).

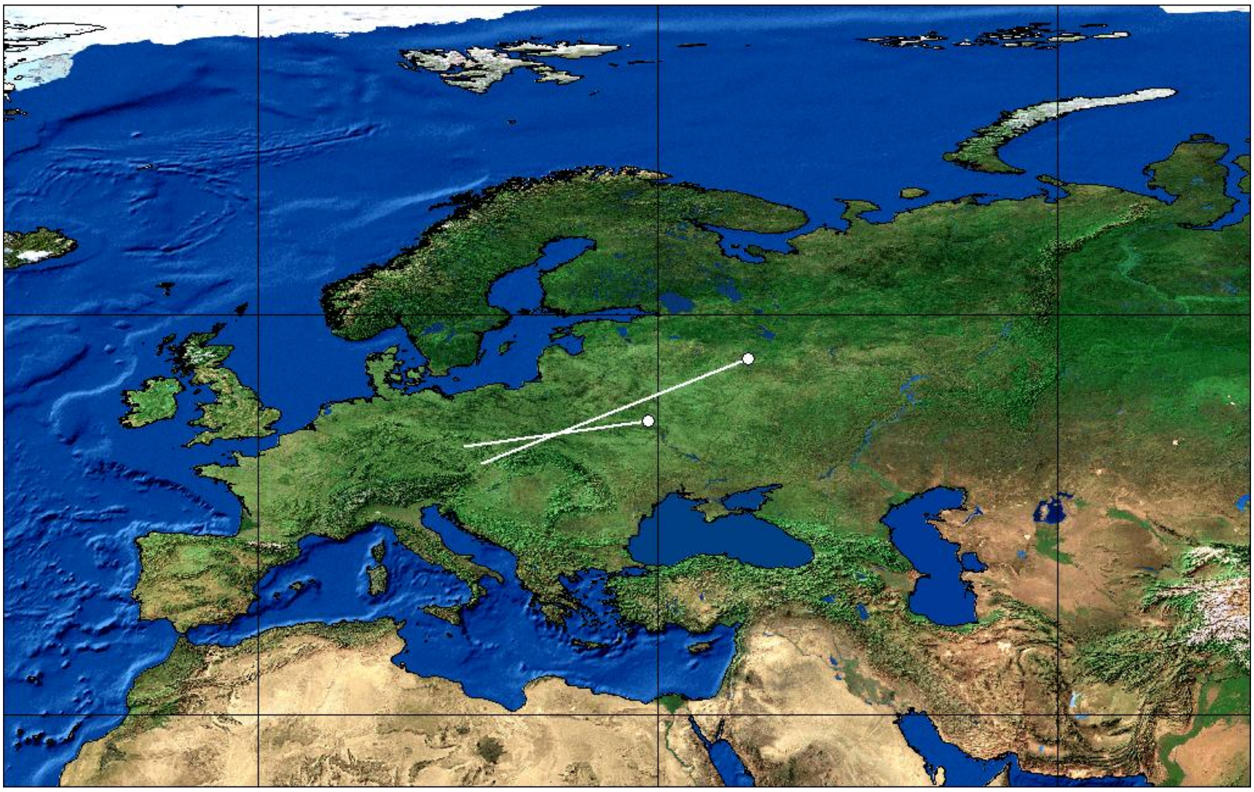


Figure 332. Ring-recovery lines of Red-crested Pochard ringed in Zoos. White lines start in ringing sites, recovery sites are marked with white dots.

Speed. Red-crested Pochard is a quite mobile duck. The database contains recoveries with daily speed up to 80 km.

Populations. Red-crested Poshards perform relatively long flights quite often (Fig. 333), therefore populations in this species are lager, than, for example, in Ruddy Shelduck or Ferruginous Duck. Bird Ringing Centre of Russia data allow separating three Red-crested Porchard populations: 1) south-eastern-european-south-western-siberia-nothern-kazakhstanian population (polygin № 1, Fig. 333) with east, north-east – west, south-west migratory movements; 2) Nile-middle-eastern-caspian-sea-south-western-siberian population (Polygon № 2) with preferably north-east – south-west movements, with the exception of the western Caspian Sea coast, where movements are directly north or south along the coast; 3) kazakhstanian-central-asian-hindostanian population (polygon № 3) with generally north-south migratory movements.

Zones of population intergradations are located in the south of Western Siberia (all three populations) and – in the past – Volga River Delta (two populations).

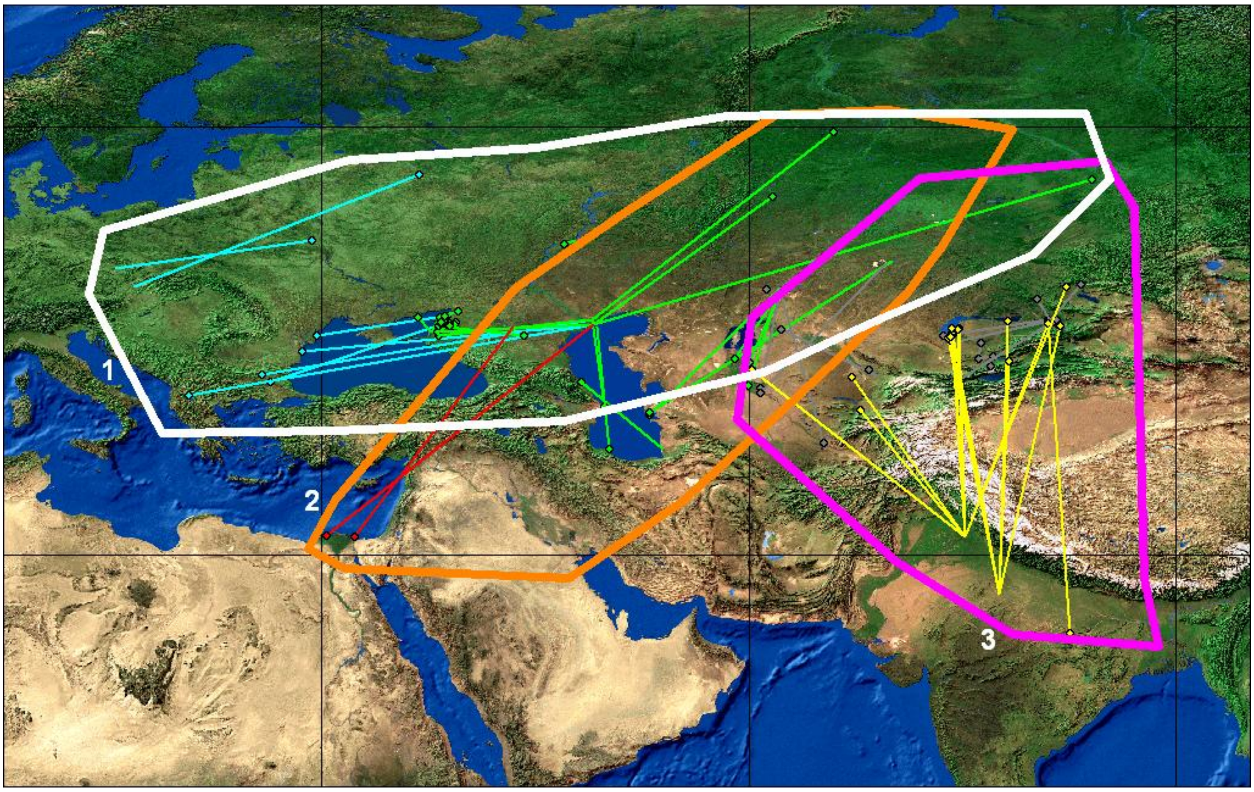


Figure 333. Red-crested Pochard populations. White polygon № 1 outlines south-eastern-european-south-western-siberia-nothern-kazakhstanian population. Orange polygon № 2 is Nile-middle-eastern-caspian-sea-south-western-siberian population. Purple polygon № 3 represents kazakhstanian-central-asian-hindostanian population.

Lifespan. EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010 displays data on the Red-crested Pochard lifespan as more than 8 years 5 months or 8 years 9 months. Bird Ringing Centre database contains confirmed recovery of male ringed as adult and recovered after slightly more than 6 years (ring sent), therefore its lifespan is greater than 7 years.

Mortality rate. According to the common criteria (see “Materials and Methods”) 82 dead recoveries of Red-crested Pochard are applicable for the mortality rate analysis. Mean annual mortality rate in the Ruddy Red-crested Pochard is 46.72$\pm$3.77% (Fig. 334). Real mortality pattern significantly differs from the theoretical one (χ^2 = 23.0, df = 4, P=0.0001). Programme MARK, Model CLogLog 2ndPart shows 47.10%, difference is 0.38%. In spite of small amount of data in the set, mortality rate pattern shows considerable drawdown of the real mortality pattern in comparison to the theoretical one. However, we should keep in mind that the data on Red-crested Pochard are from 1935-1989. Therefore, the conclusion about bad species condition from the data set is relevant for those years, not for the modern situation.

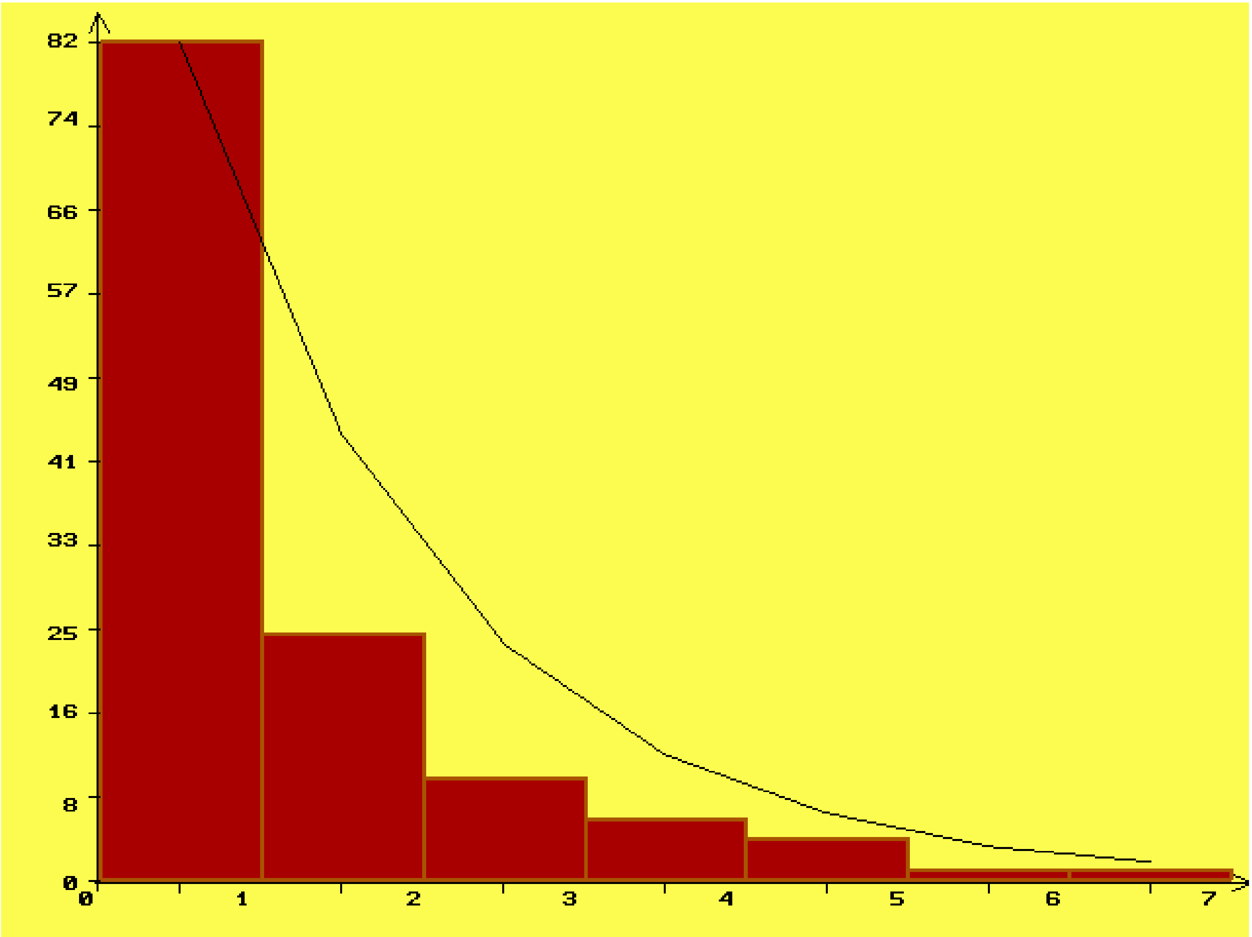


Figure 334. Mortality pattern in the Red-crested Pochard. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Males of Red-crested Pochards lived, on average, longer than females: 1.78±0.39 (N=17) and 1.05±0.25 (N=18) years respectively, insignificantly, probably because of the samples are small.

COMMON POCHARD
(*AYTHYA FERINA*)

Breeding range in Eurasia. Brief description of the breeding range is in Fig. 335. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

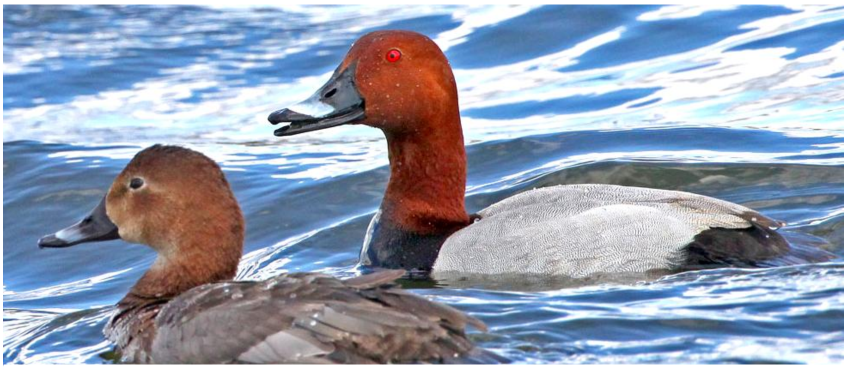


Photo by Vladimir I. Deryabin

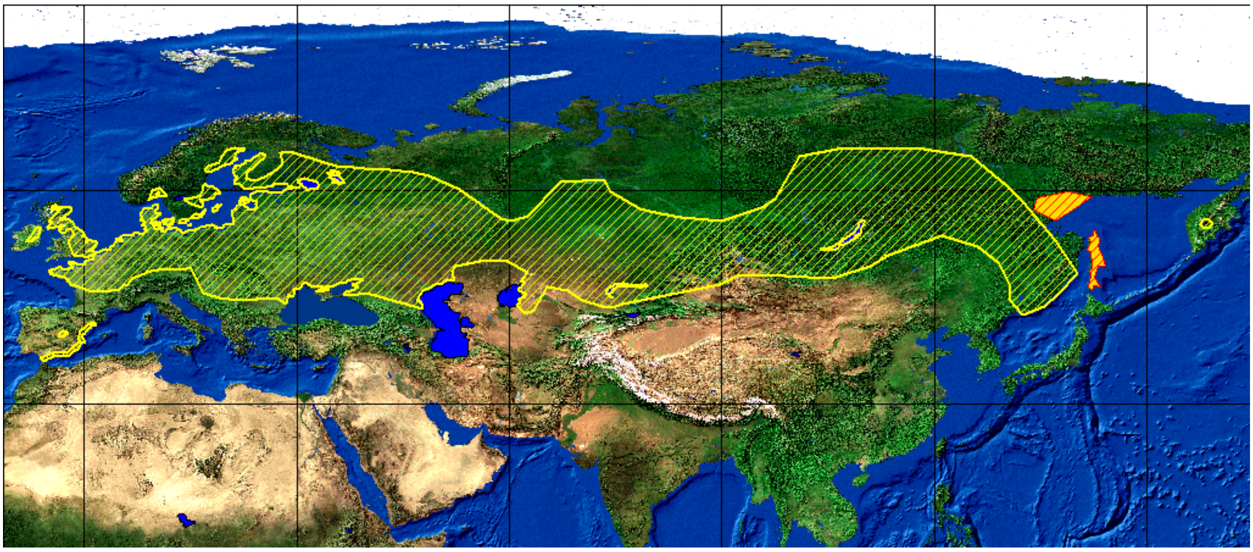


Figure 335. Breeding range of the Common Pochard in Eurasia (yellow dashed areas). Yellow striped areas on the Far East are probable breeding grounds.

During the last two decades Common Pochard habituates Russian Far East as breeding grounds. It started to nest at the Khanka Lake and surroundings (Vladimir Medvedev, personal communication), was recorded in moulting flocks of Tufted Ducks on Sakhalin Island (Vladimir Zykov, personal communication).

Distribution of control points. 2583 marked birds were used for this issue, which gave 2592 recoveries (Fig. 336), 18 Pochards held nasal marks. 2575 birds gave one recovery per duck, 7 birds gave 2 recoveries each, one bird 3 recoveries. Ringing dates are since 19.01.1930 till 02.03.2022, recovery dates are since 04.12.1931 till 22.04.2023. Unfortunately there is a serious lack of data from birds ringed in Russia after 1980 because since that time the duck ringing in this country practically ceased. Lack of these materials is the serious drawback of this analysis; however we try to do best relying on the available data.

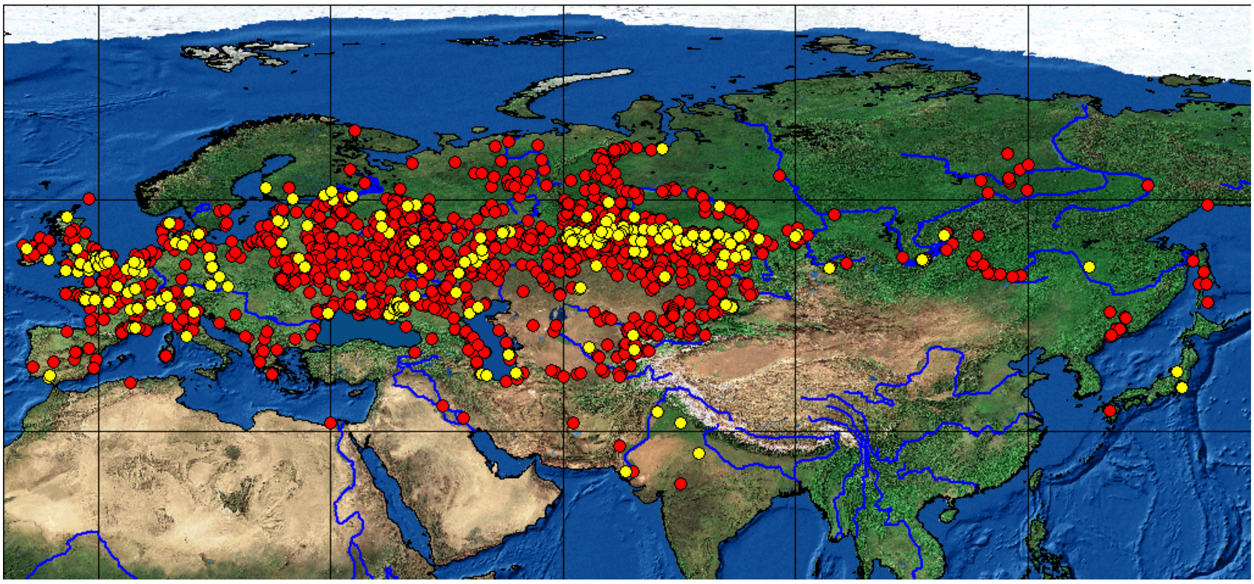


Figure 336. Position of all Common Pochard control points. Yellow dots – ringing sites, red dots – recovery sites.

Common Pochards were ringed in Europe from its very west to east, in Western and Central Siberia (Baikal Lake area), Far East, Kazakhstan, India, Pakistan and Japan. Most of recoveries are from Europe, northern Africa, Caspian Sea area, all Siberia and Russian Far East.

'Moskwa' scheme recoveries. This sample contains 1044 recoveries of the scheme „Moskwa" rings. They are from birds ringed within the Russian Federation and countries of the former USSR (Fig. 337).

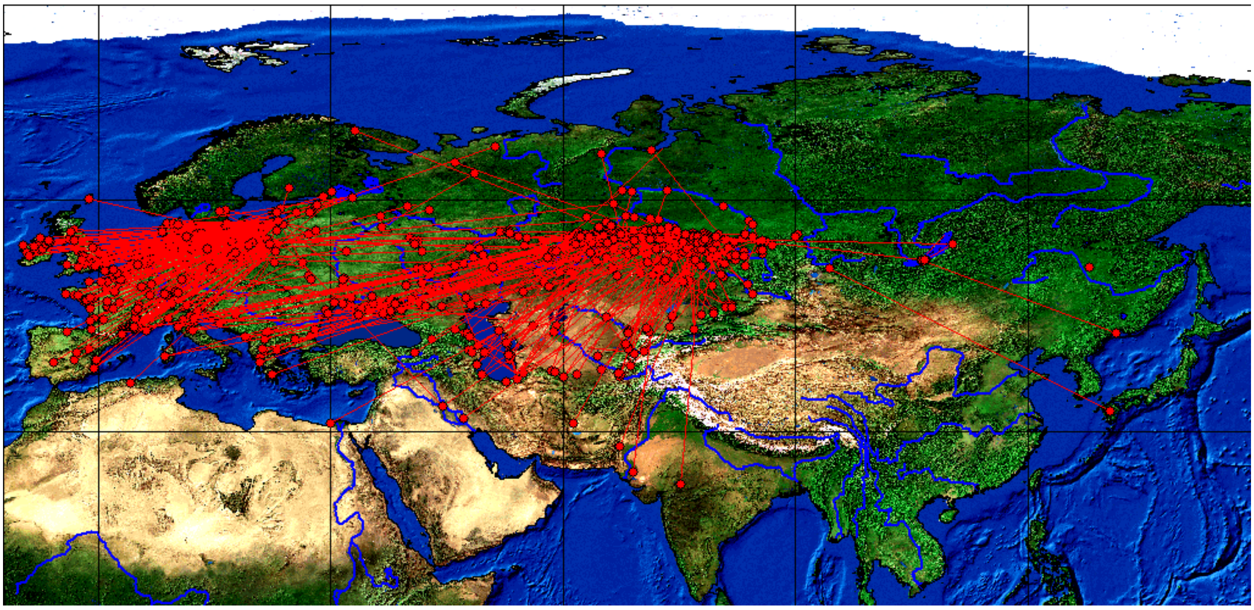


Figure 337. „Moskwa" scheme recoveries of the Common Pochard. Here and on all other similar figures lines start from the ringing site, recovery sites are marked with red dots.

Finding details. This analysis includes all 2592 recoveries. 2225 recoveries (87%) are „shot". In 136 (6%) recoveries „details unknown", which practically mean, that they were shot, as well. Therefore, we can assume that 92% of birds were shot. Other reasons are not so common (Fig. 5).

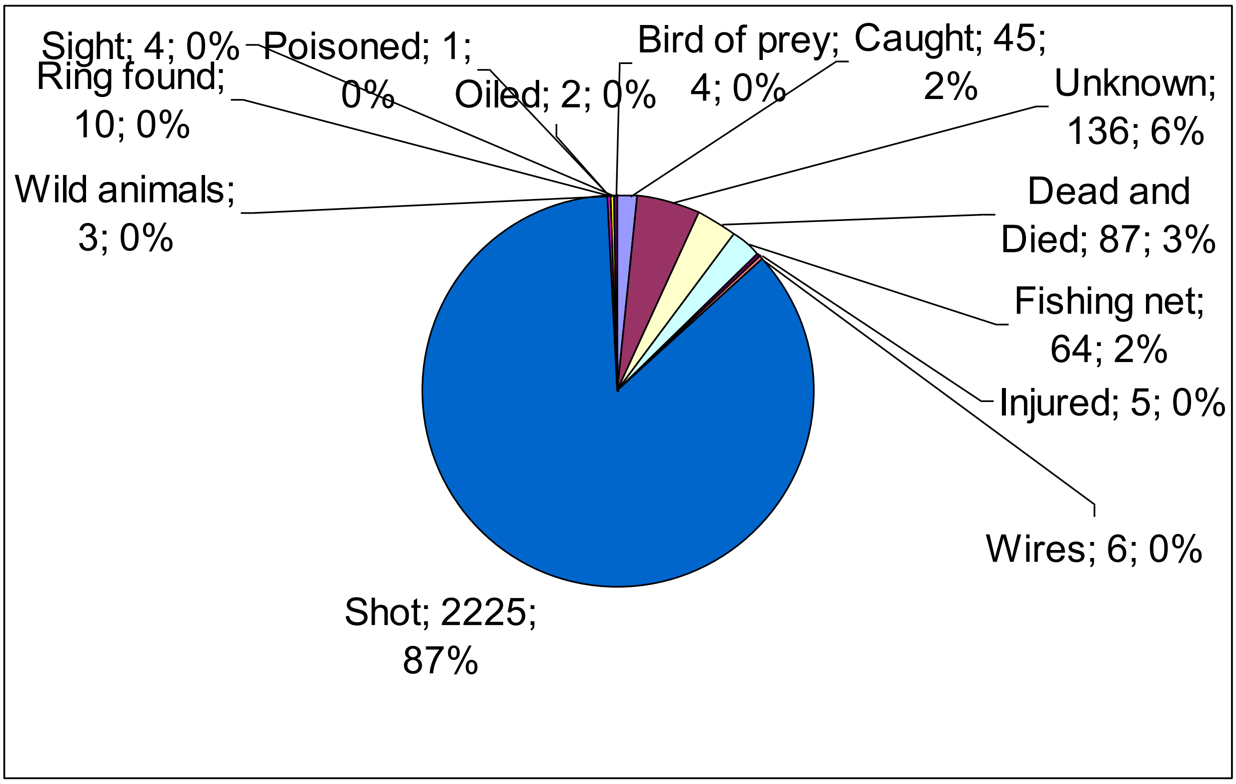


Figure 338. Finding details in the Common Pochard.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries represented in Figs 339 and 340.

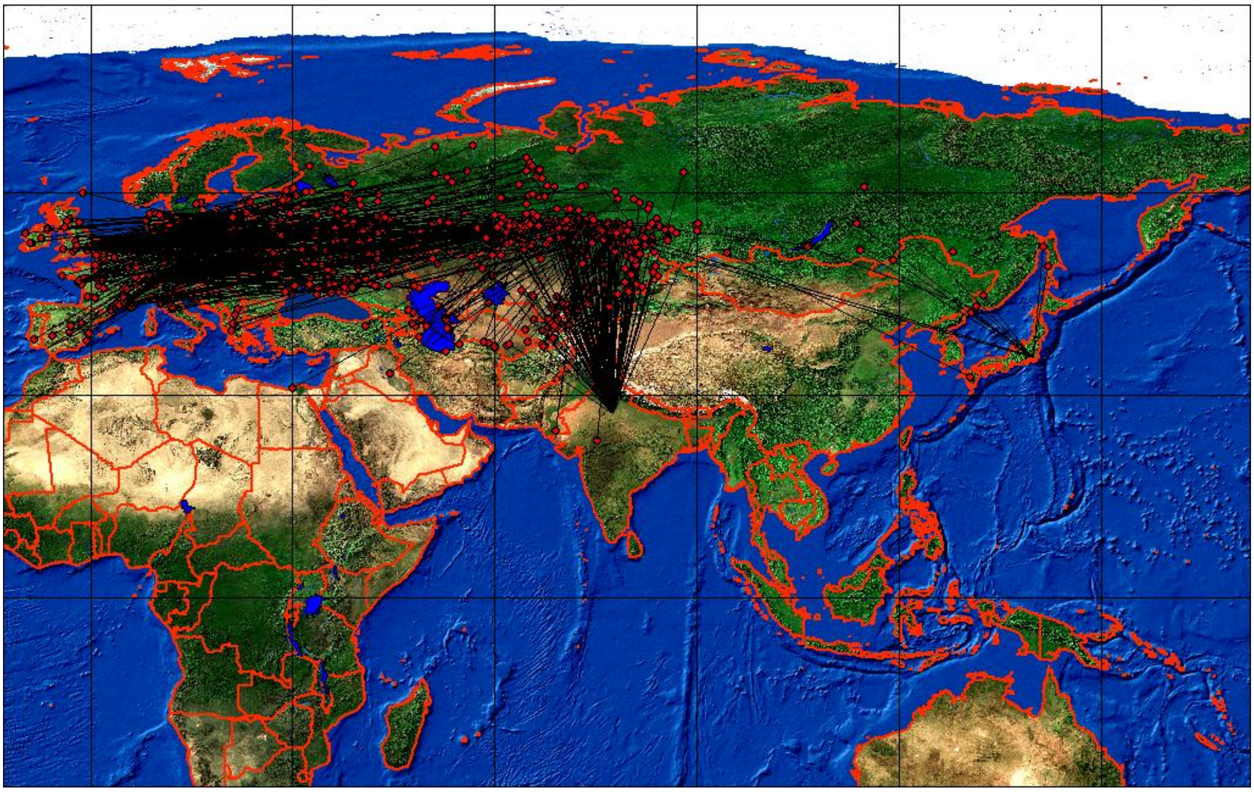


Figure 339. Map of the Common Pochard direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

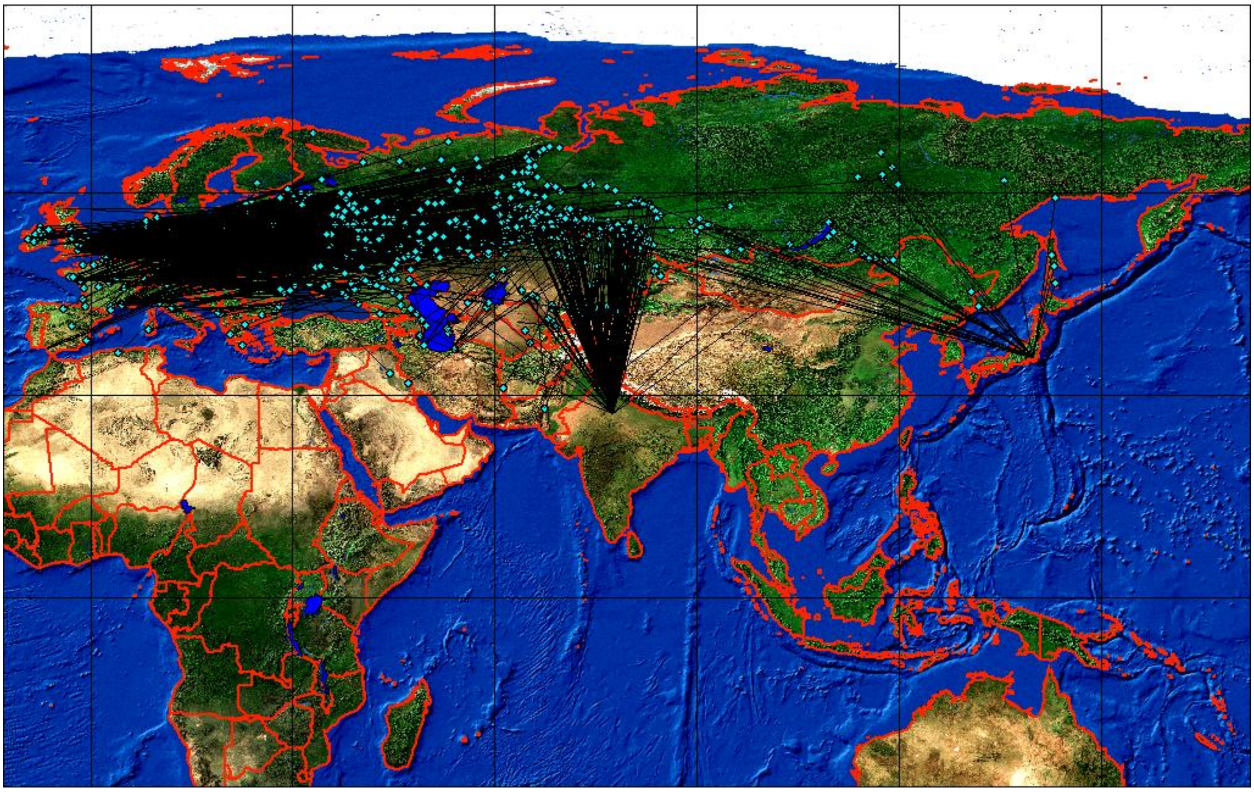


Figure 340. Map of the Common Pochard indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

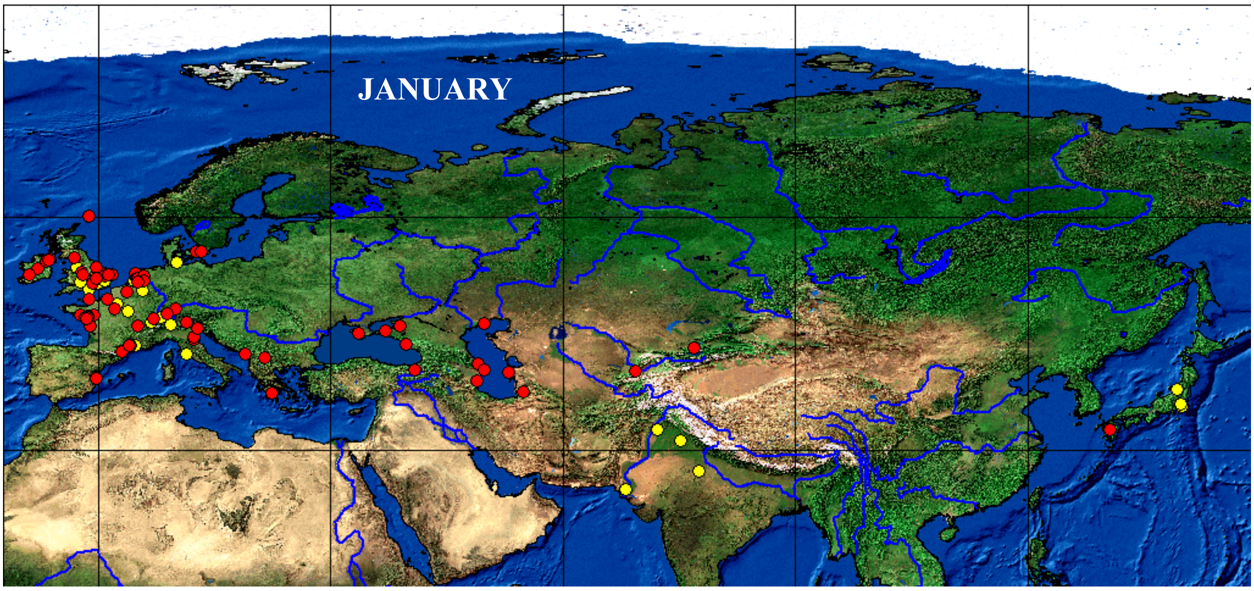
Maps indicate that Common Pochards wintering in western Europe fly to breed to the European Russia and Western Siberia to about the meridian of 75˚E. Birds wintering in the southern Europe migrate to southern European Russia, southern half of Western Siberia and northern Kazakhstan up to meridian 75˚E. Common Pochards ringed in India fly to breed mostly to the Central Asia, Kazakhstan, Western Siberia approximately up to meridian 90˚E (Fig 339), indirect recoveries recorded up to 120˚E. Most birds that winter in Japan breed from western Siberia, approximately east of 70˚E up to the Sea of Japan and Sea of Okhotsk, probably including Sakhalin Island (Fig 339).

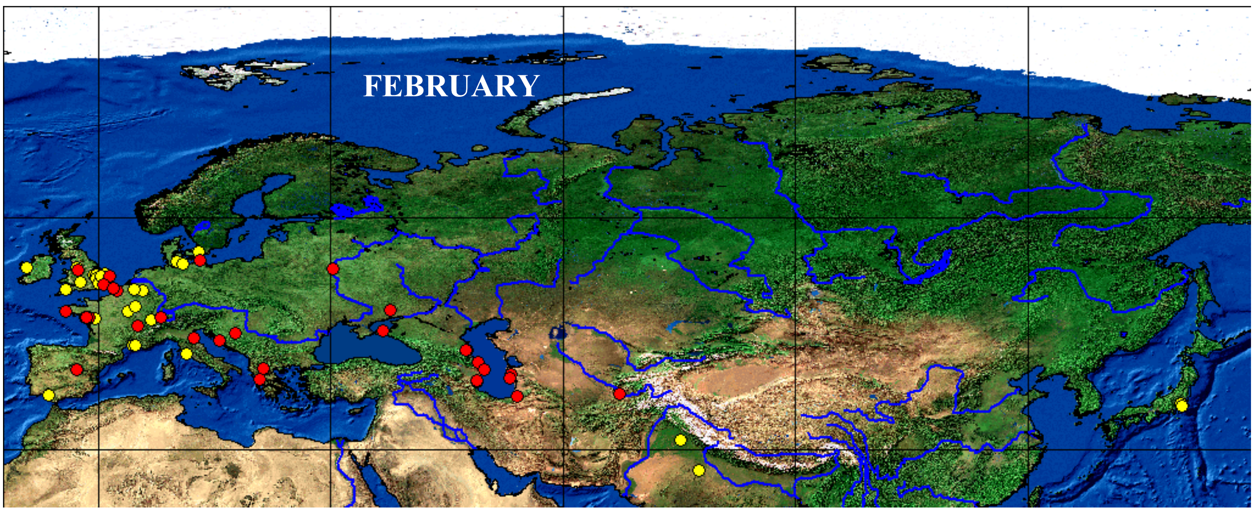
Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them (χ^2 = 138.6, 1393 indirect recoveries and 1189 direct ones, df = 2, P = 0.0000). Center of indirect recoveries is located by 2˚ more to the north and by 52" to the west (not east, as in dabbling ducks) of the centre of direct recoveries. This difference is very small in comparison to all recovery area, so there are no sense to discuss these small difference even if they are significant. The only one can notice that population exchange areas in the Common Pochard, in distinction to most other duck species (but the same as in Goldeneye), is situated more westerly.

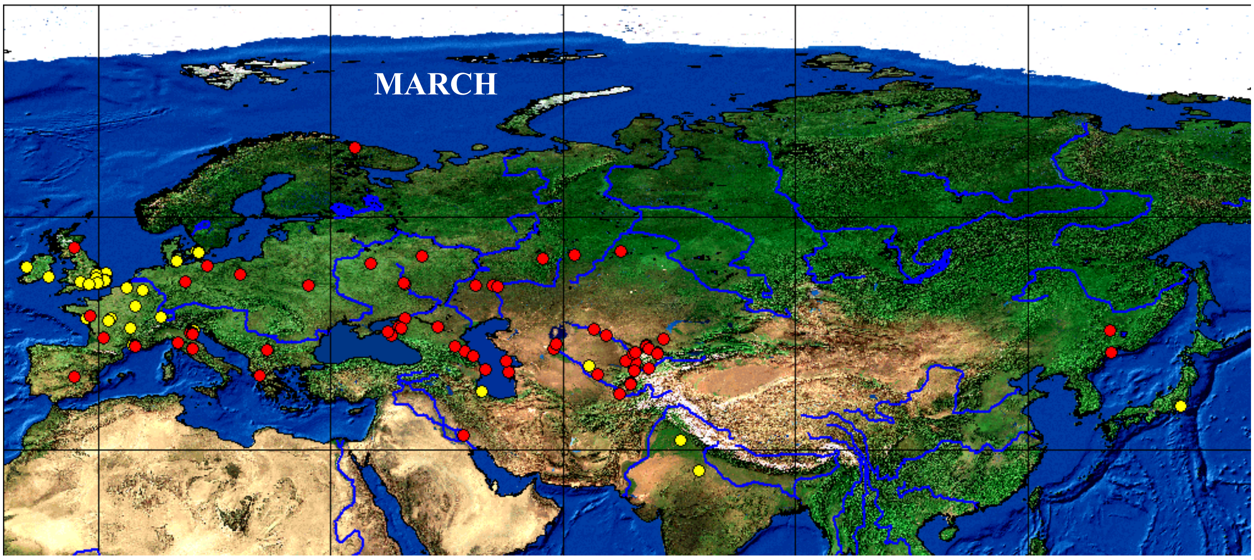
Average flight distance in direct recoveries are about two times less than in indirect recoveries: 1400.7±39.7 and 2656.6±34.0 km respectively, highly significant (t-Bailey = 24.0, P=0.0000). Long-distance cross-population movements are performed mostly in more than one year (see section "Populations").

Monthly movements. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in Common Pochard (Fig. 341). Pattern of recoveries indicates that in January and February most ducks are on the wintering grounds in western and southern Europe, Caucasus area, Central Asia, Kazakhstan, India and Japan. In March spring migration actively commence everywhere, more pronounced for European and India wintering birds. Birds from western Europe move to the east, north-east; from southern

Europe to the north-east; from southern European Russia to the north, north-east and (in distinction to dabbling ducks) - to the north-west; from India birds fly to the north. All this is clear from the position of the newly appeared green dots, which point to the recovery sites (Fig.341, March). In April migration continues, noticeable in all populations, however some birds are still on wintering grounds in southern Europe; part of birds breed there. In May Common Pochards practically fill the species breeding range up to its northern boundary, many ducks penetrate far to the north outside of the breeding range. Absence of recoveries over Ural Mountains together with the concentration of recoveries immediately east of Urals in April, May and June during spring migration and in August, September and October on autumn migration indicates, that ducks migrating in spring from southern Europe to western Siberia, bend over the southern end of Urals, the same as dabbling ducks (see Fig. 341). The same bend Pochards perform on autumn migration along the way from Western Siberia to Europe. In June the number of control points is scarce, but they are on the breeding grounds. In July most of Pochards concentrate within breeding grounds, just one recovery is to the north of the breeding range. It seems moult takes place on the breeding grounds. It is interesting, young birds ringed in July then might fly first in any direction, even predominantly to the north (Fig. 342). The same peculiarity is characteristic to young birds ringed in August (Fig. 342), but in August only few birds move to the north, north-west, west; eastern and southern directions prevail. In August and even September almost no movements to the wintering ground occur. Only at the end of September and in October autumn migration becomes well noticeable. In November migration seem to be finishing, in December birds are on their wintering grounds (Fig. 341).



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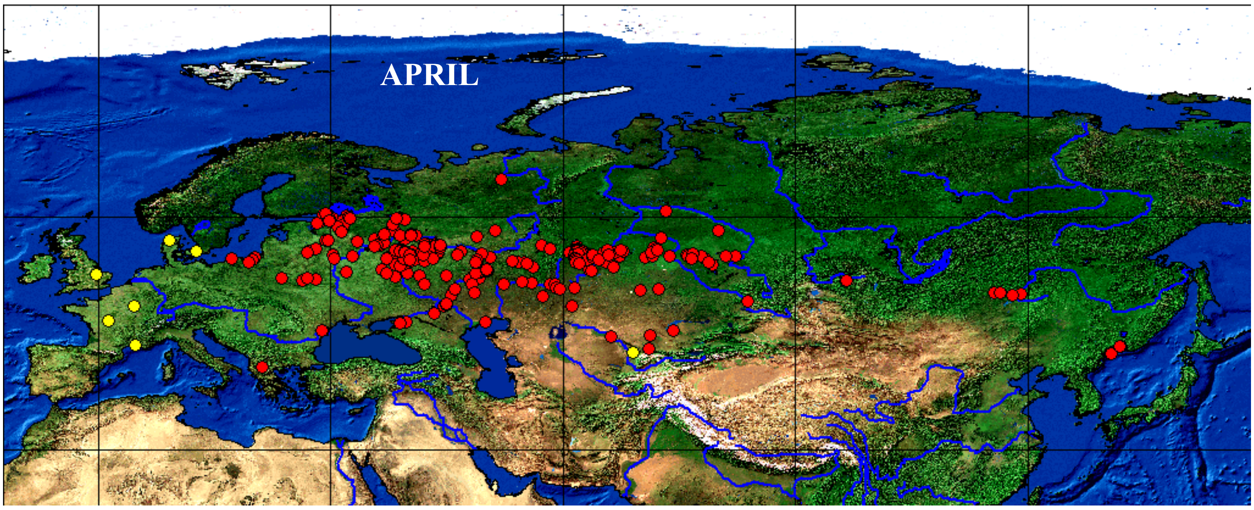
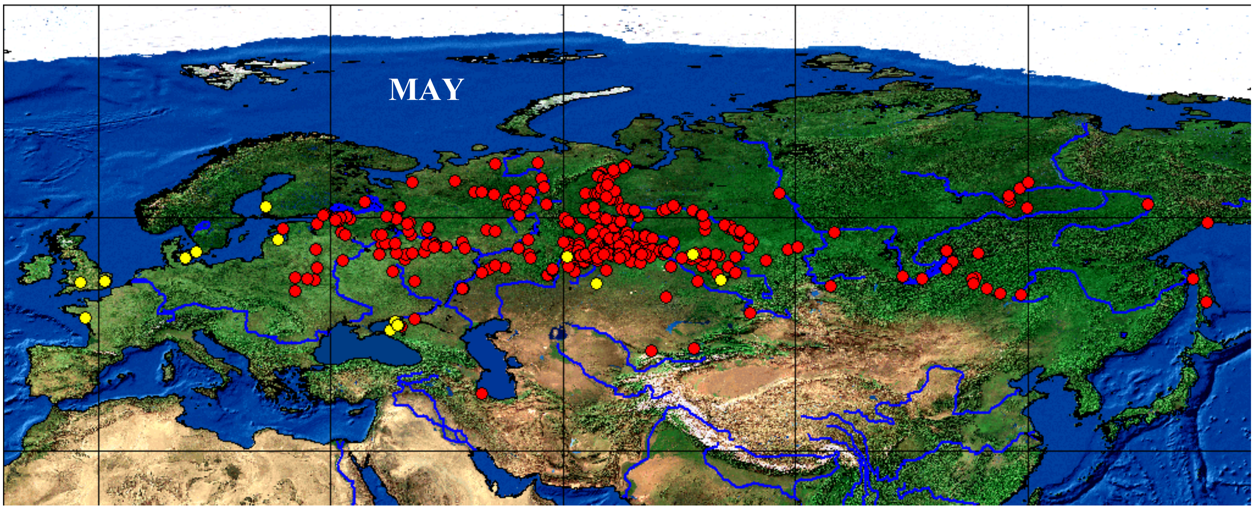

APRIL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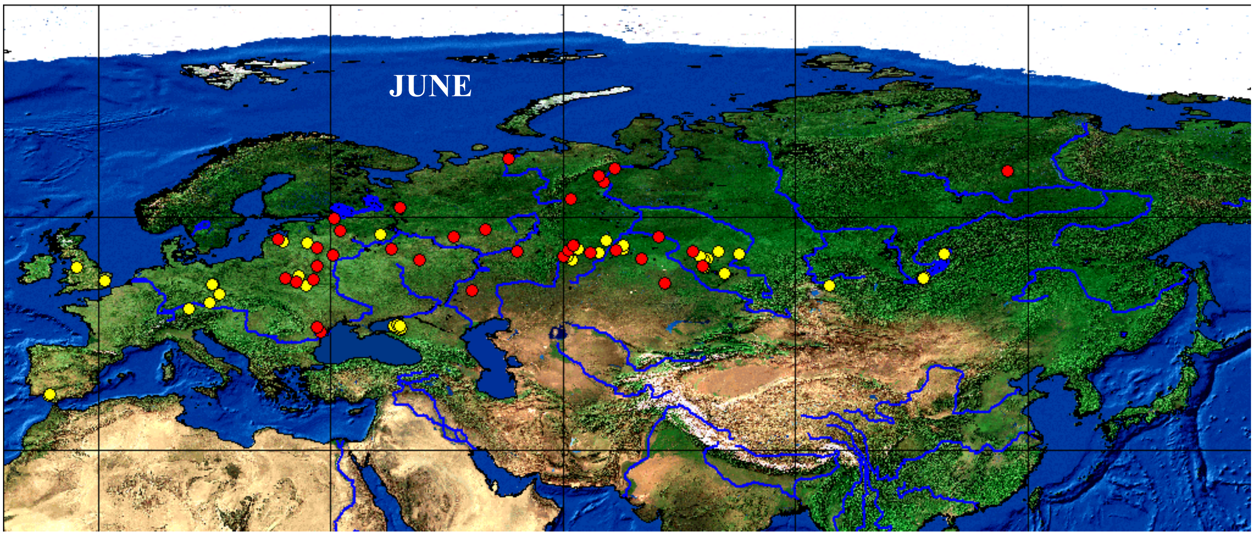
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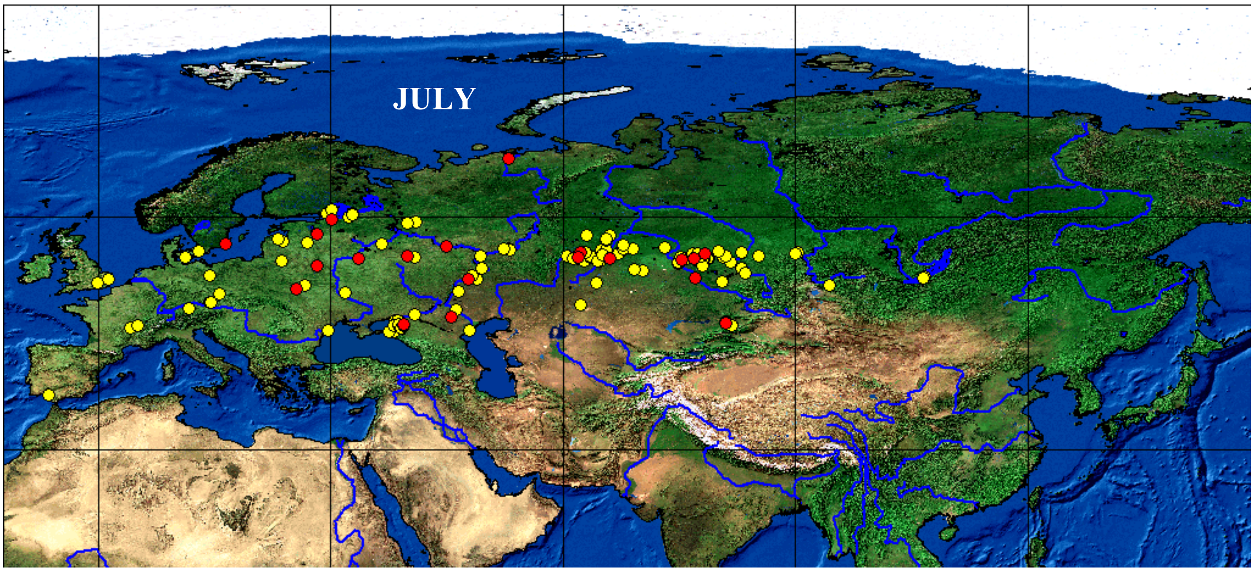
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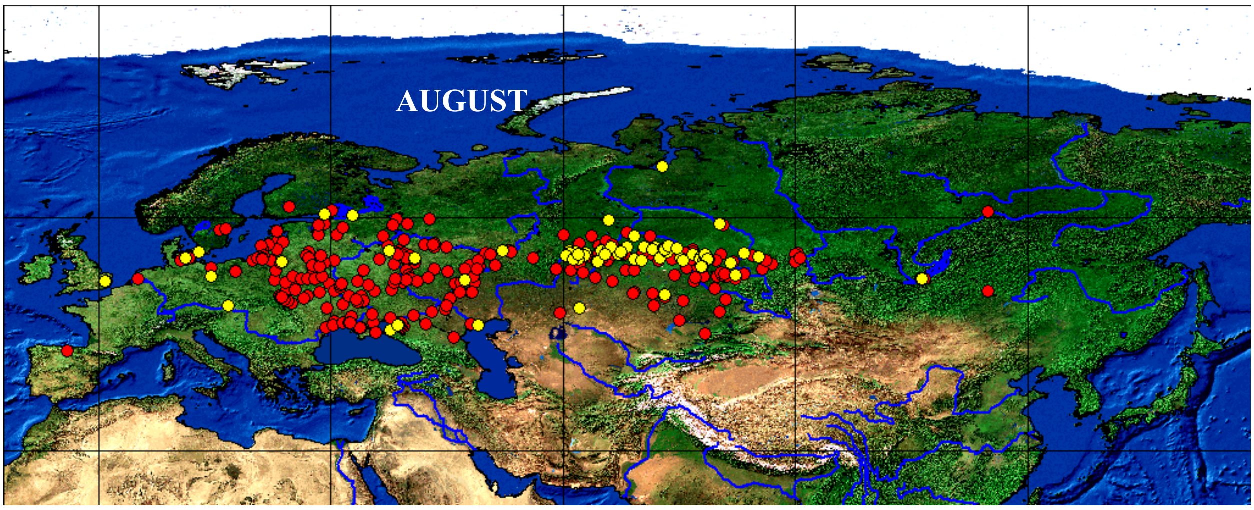
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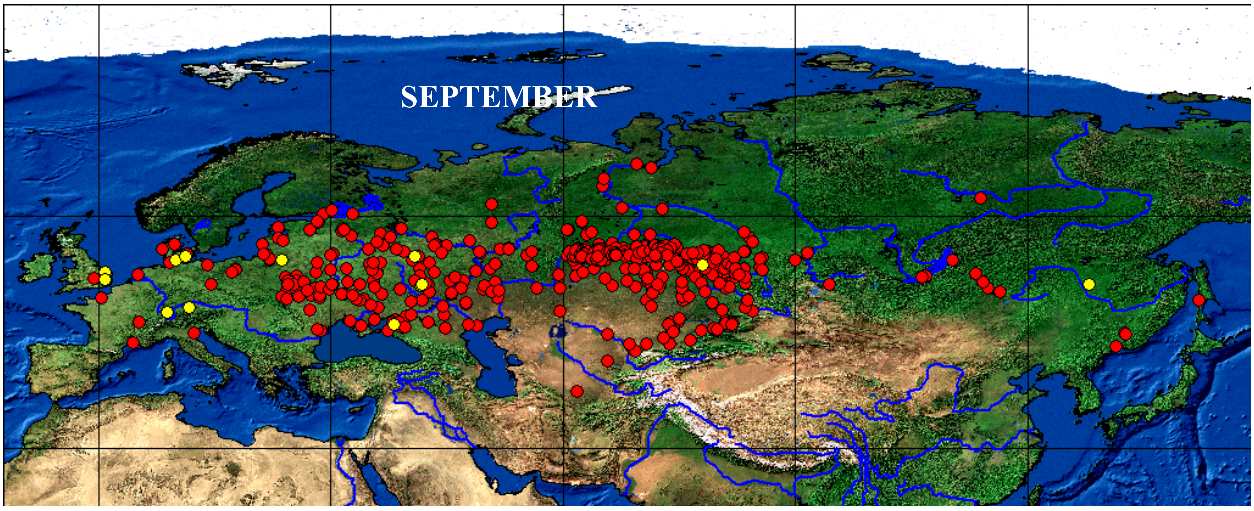
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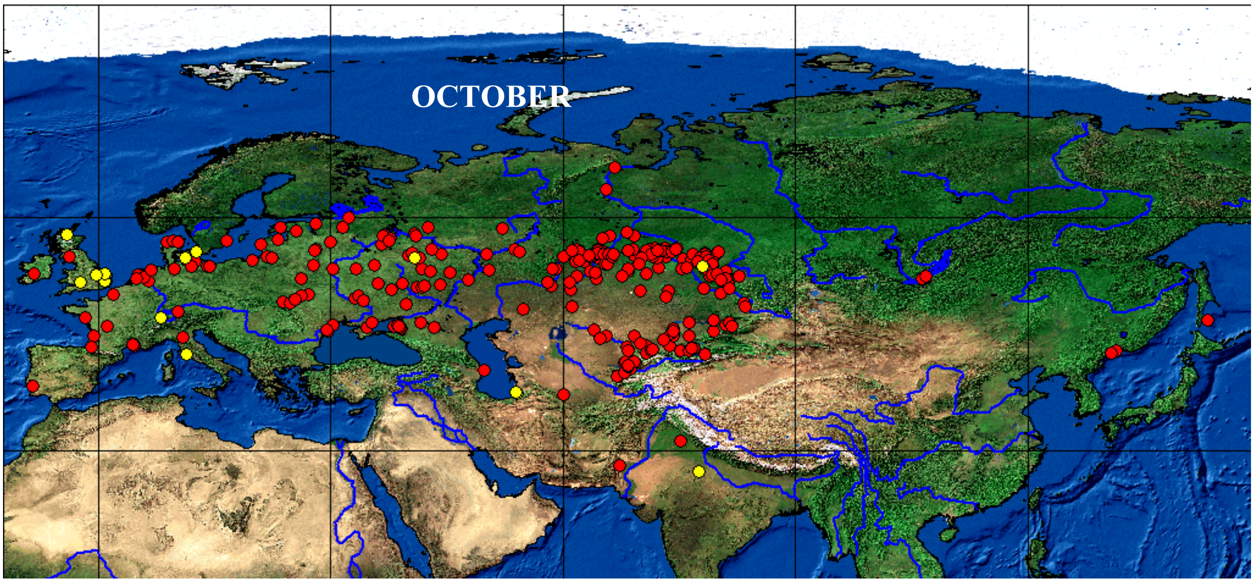
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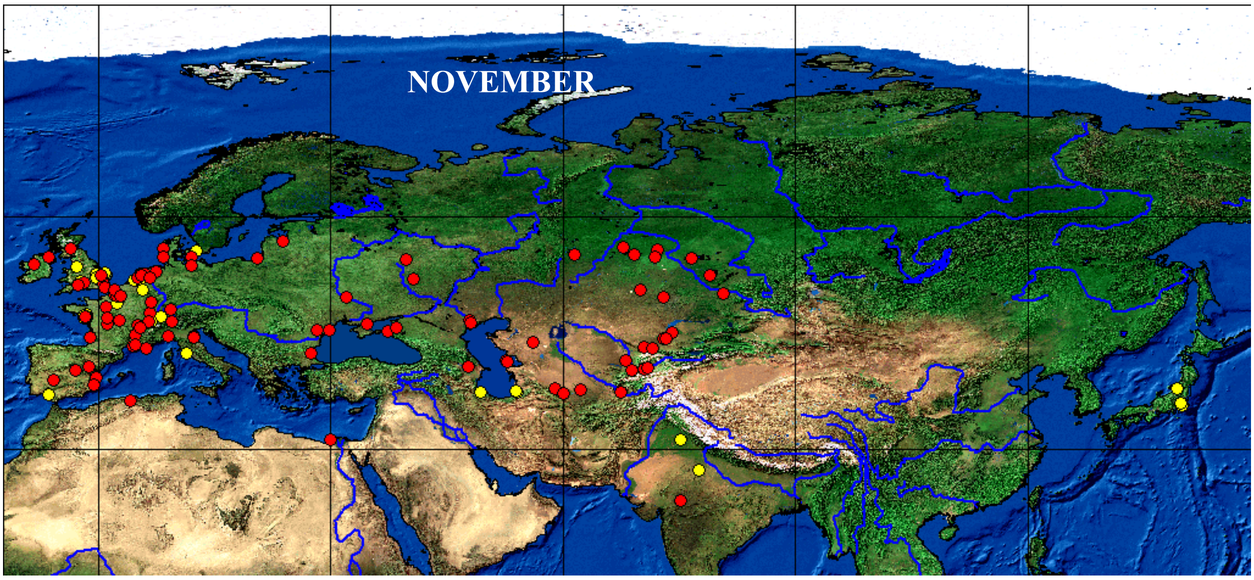
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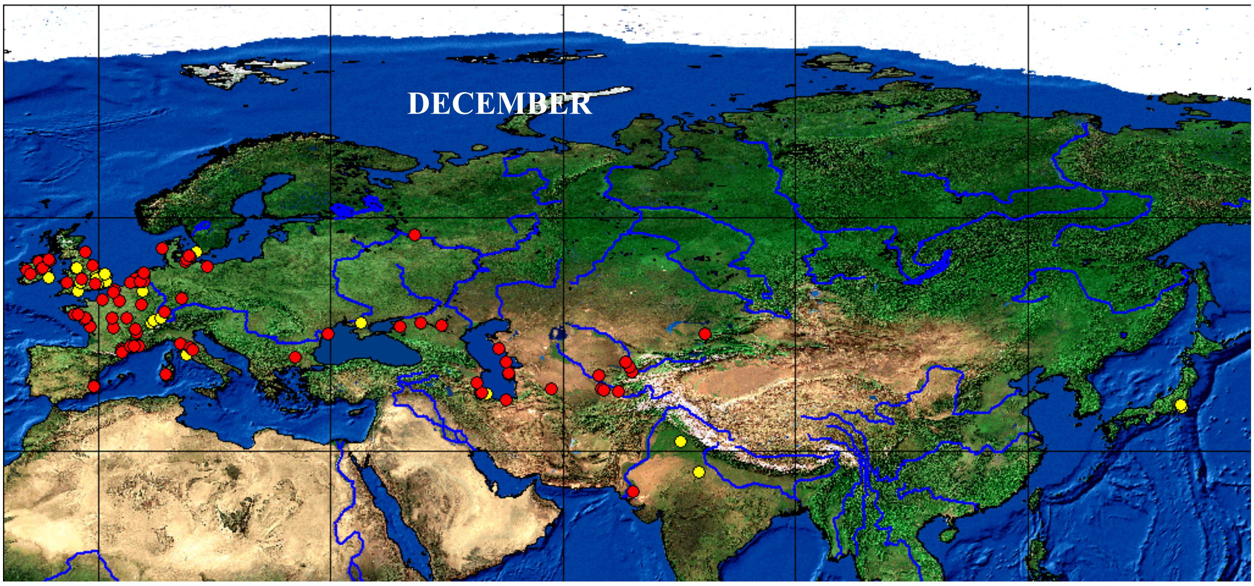


Figure 341. Common Pochard monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

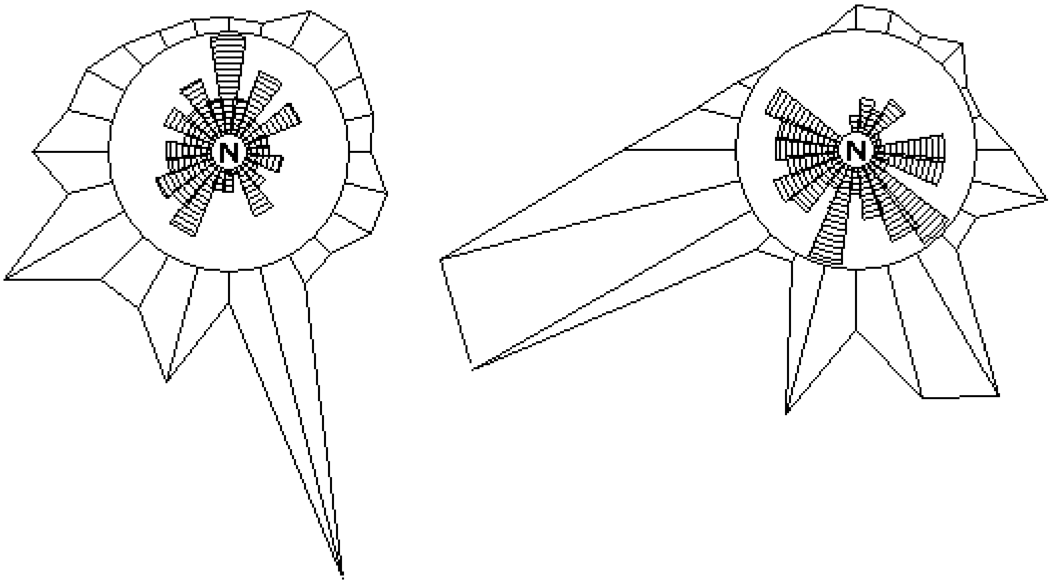


Figure 342. Recovery rose graphs for Common Pochard ringed in July, mostly young birds (left recovery rose) or August, mostly young birds, as well (right rose) and recovered during 60 days after ringing: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Left chart. Sector = 15,0°; Total recoveries - 161; N in sectors: from 1 up to 13; Average distance in sectors: from 45,2 km up to 1241,8 km; The longest flight distance is 1856 km.

Right chart. Sector = 15,0°; Total recoveries - 143; N in sectors: from 0 up to 11; Average distance in sectors: from 0,0 km up to 721,3 km; The longest flight distance is 2803 km.

Migratory routes. As it is preliminary shown in the section “Monthly movements”, Common Pochards from different wintering areas migrate in different directions. Birds ringed in areas with longitude <=30˚E move to the east, north-east in spring (bearings, mostly, 52-97˚ Fig. 343), and in opposite directions in autumn. For birds ringed in area with longitude 30˚-60˚E preferable flight bearings are to the east and north in spring and to the west and south-west in autumn. For ducks ringed in 60˚-90˚E area preferable bearings are 337-8˚ , these are spring flight directions for all duck species, ringed in India. For birds ringed in Japan spring flight “fan” is directed much more to the west than in dabbling ducks, bearings are 277-8˚, mostly 307-323˚ (Fig. 343), certainly, the opposite should occur in autumn.

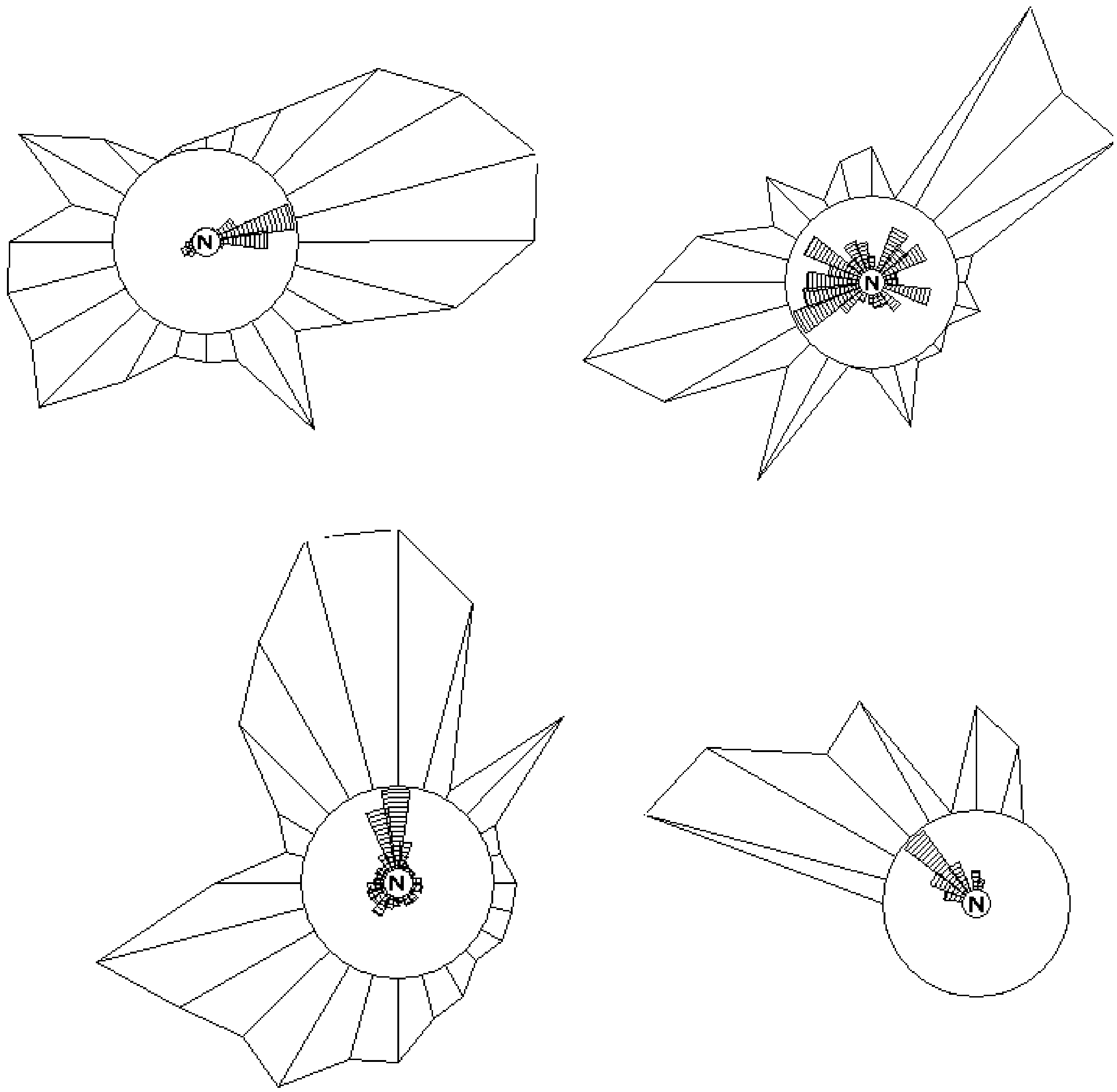


Figure 343. Recovery rose graphs for Common Pochards, ringed at different longitudes: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distance along each direction (radar charts).

Upper left chart is for European wintering Common Pochards, area of recoveries from British Isles to western Siberia, to 75˚E. Sector = 15,0°; Total recoveries - 1405; N in sectors: from 0 up to 556; Average distances in sectors: from 0,0 km up to 3307,6 km; the longest flight distance is 6233.9 km.

Upper right chart is for Common Pochard ringed in the southern European Russia, area of recoveries from southern Europe to western Siberia, to 75˚E. Sector = 15,0°; Total recoveries - 167; N in sectors: from 0 up to 15; Average distances in sectors: from 0,0 km up to 1689,2 km; the longest flight distance is 3285.5 km.

Lower left chart is for Common Pochards ringed mostly in India, area of recoveries is Western and Central Siberia to 120˚E; Sector = 15,0°; Total recoveries - 915; N in sectors: from 7 up to 161; Average distances in sectors: from 79,7 km up to 2418,1 km; the longest flight distance is 5180.9 km.

Lower right chart is for Common Pochards ringed in Japan, recoveries are from Western Siberia to the Russian Far east, east of 70˚E; Sector = 15,0°; Total recoveries - 59; N in sectors: from 0 up to 23; Average distances in sectors: from 0,0 km up to 5073,2 km; the longest flight distance is 5749.4 km.

In direct recoveries short distances prevail, however longer distances up to 5000 km are also common. Preferable distances of indirect movements are much greater, with the peak 1800-4800 km (Fig. 344). Maximal distance in direct recoveries is 5181 km, in indirect recoveries – 6234 km.

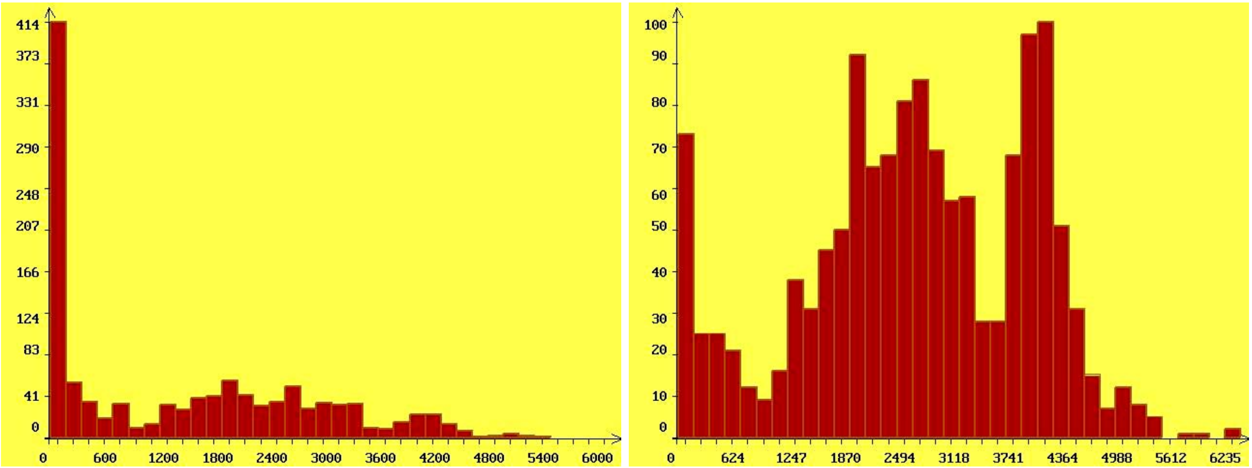


Figure 344. Distribution of all Common Pochard ring-recovery distances. Left chart – direct recoveries, right chart – indirect recoveries. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in Common Pochard young birds (ringed as „pull“ or „juv“ or „1 y“) is two times less than in adults: 1225.8±43.0 versus 2567.7±32.0 km respectively (N_{young} = 935, N_{ad} = 1657), significant difference (t-Bailey=25.1, P=0.0000), which is characteristic for game species. This is understandable, because recoveries of young birds are more often direct ones, and direct distances are generally lesser than for indirect ones. However, if we consider only direct recoveries, the difference become even greater – in three times: 748.12 ±41.34 versus 2089.2±55.9 km respectively (N_{young} = 607, N_{ad} = 585), significant (t-Bailey=19.3, P=0.0000). Male mean flight distance is considerably longer than in females: 3022.4±33.7 and 2300.5±48.4 km respectively (N_{males} = 1088, $N_{females}$ = 537), significant: t-Bailey= 12.2, P=0.0000. This means that males prospect for the new areas and contribute to population exchange much more than females. If so, it is not clear, why males live longer than females, and are in better condition than females (see section “Mortality”).

Data sets on Common Pochards ringed in some sites include different categories of birds with relatively small numbers of each category, therefore most monthly means do not give the proper information on the detailed migratory routes. However, it is possible to rely on monthly mean movements for Pochards ringed in several areas (Figs 345–350).

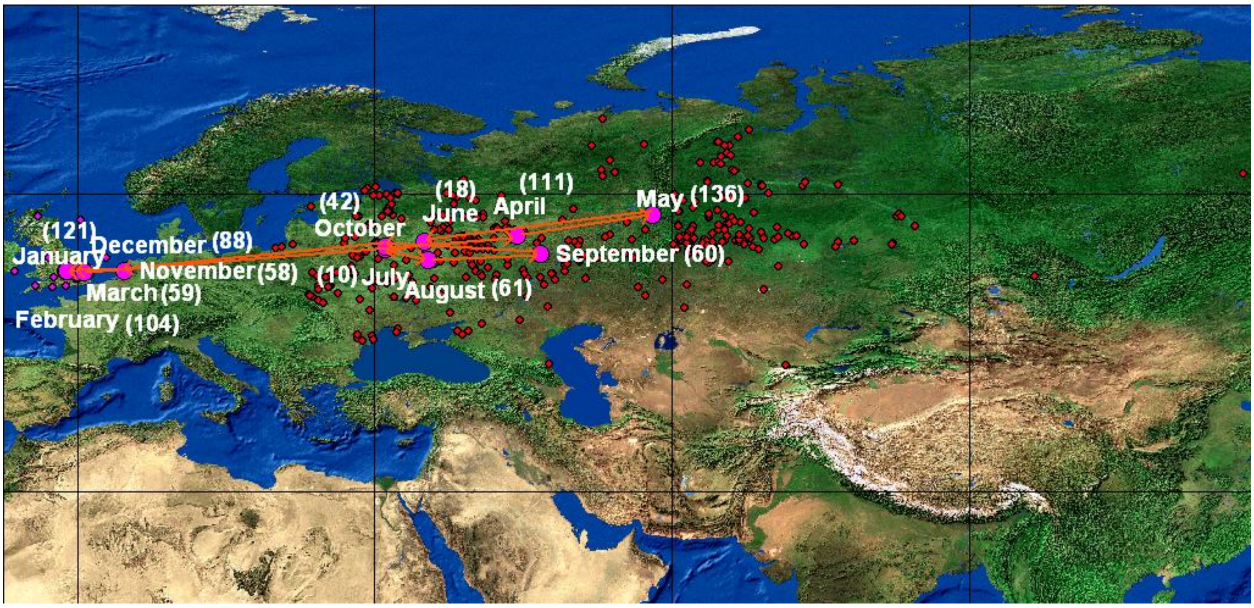


Figure 345. Mean monthly locations of Common Pochard control points for birds, ringed on the wintering ground at British Isles. Large circles are mean monthly locations of Common Pochards. Arrows show directions of movements. Small purple dots are the ringing sites, red dots – recovery points. Number of control points in each month is in parentheses.

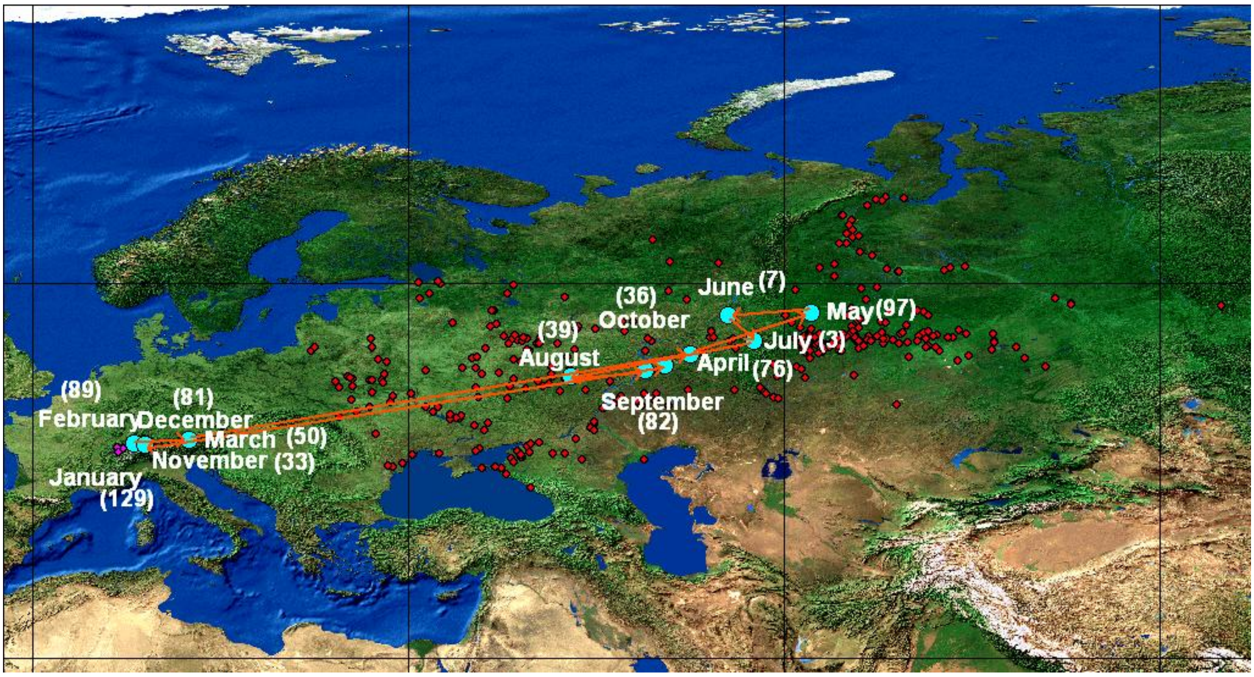


Figure 346. Mean monthly locations of Common Pochard control points for birds, ringed on the wintering ground in Switzerland. Large blue-green circles are mean monthly locations of Common Pochards. Arrows show directions of movements. Small purple dots are the ringing sites, red dots – recovery points. Number of control points in each month is in parentheses.

Common Pochards, in distinction to Tufted Ducks (see species account), can form migratory loops during migration, in the same way as described for Mallards, Common Teal and Shoveler. European breeding birds form the loop curled in counter clockwise direction, the same as in the White-fronted Geese and Common Teal (see species accounts), but in lesser extent and located more to the south than loops of the two mentioned species. This loop is well visible for ducks, ringed as young in Latvia. (Fig. 347).

Figure 347. Monthly means for Common Pochards, ringed in Latvia (purple circles). Arrows show direction of migratory movements. Numbers of control points in each month are in parentheses.

The recoveries of Common Pochards ringed as pulls are scattered over more eastern area than of birds ringed as adults, many of the former do not return to places of birth. A loop, performed by young birds in central Europe is narrower than in adults (Fig. 348).

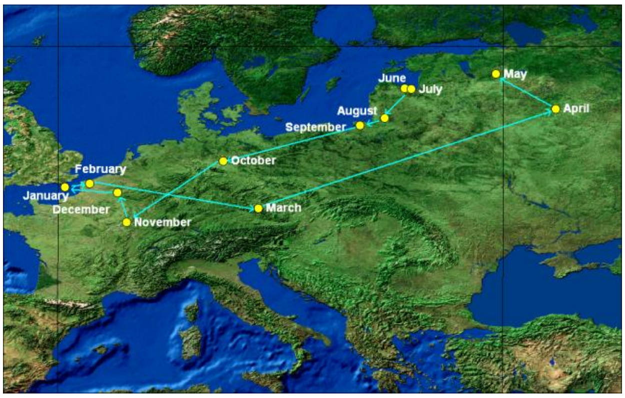


Figure 348 Monthly means for Common Pochards, ringed in Latvia as adults (left map) and as pulls (right map). Arrows show direction of migratory movements.

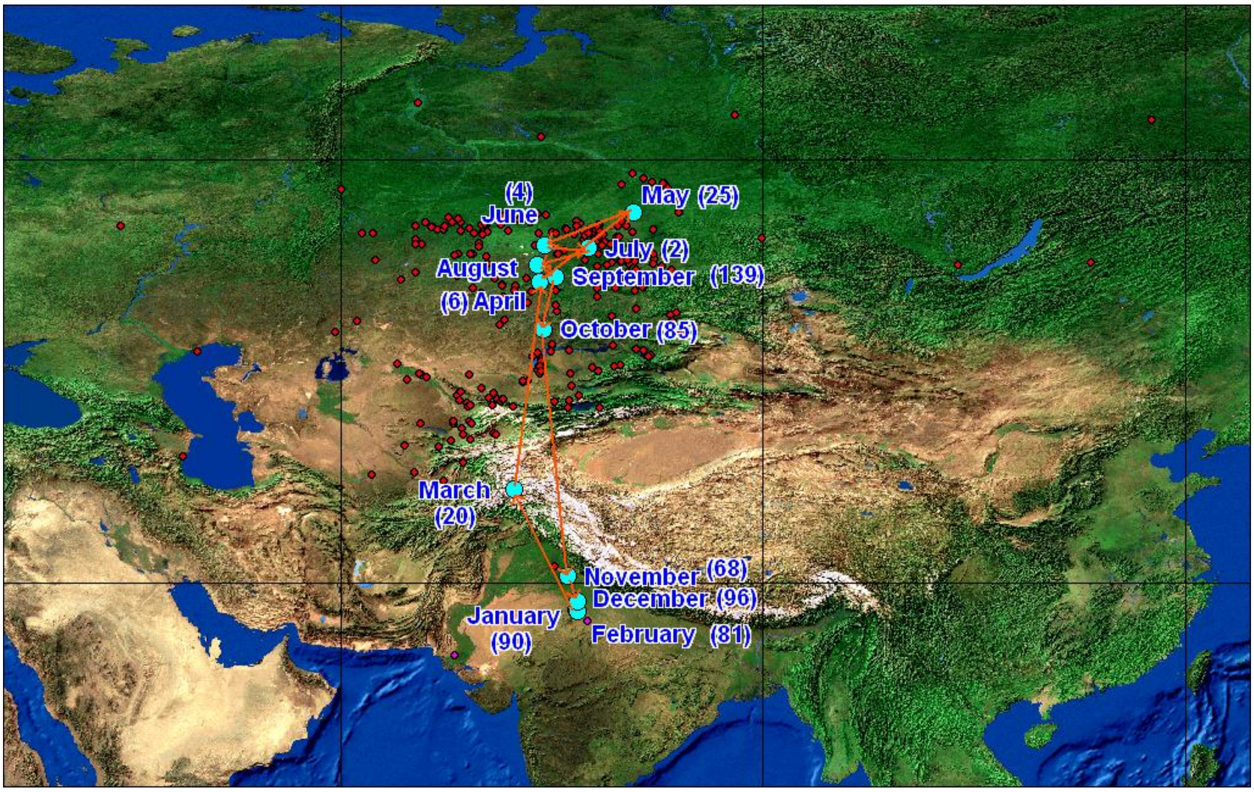


Figure 349. Monthly means for Common Pochards, ringed in India and Pakistan (blue-green circles). Arrows show direction of migratory movements. Number of control points in each month is in parentheses.

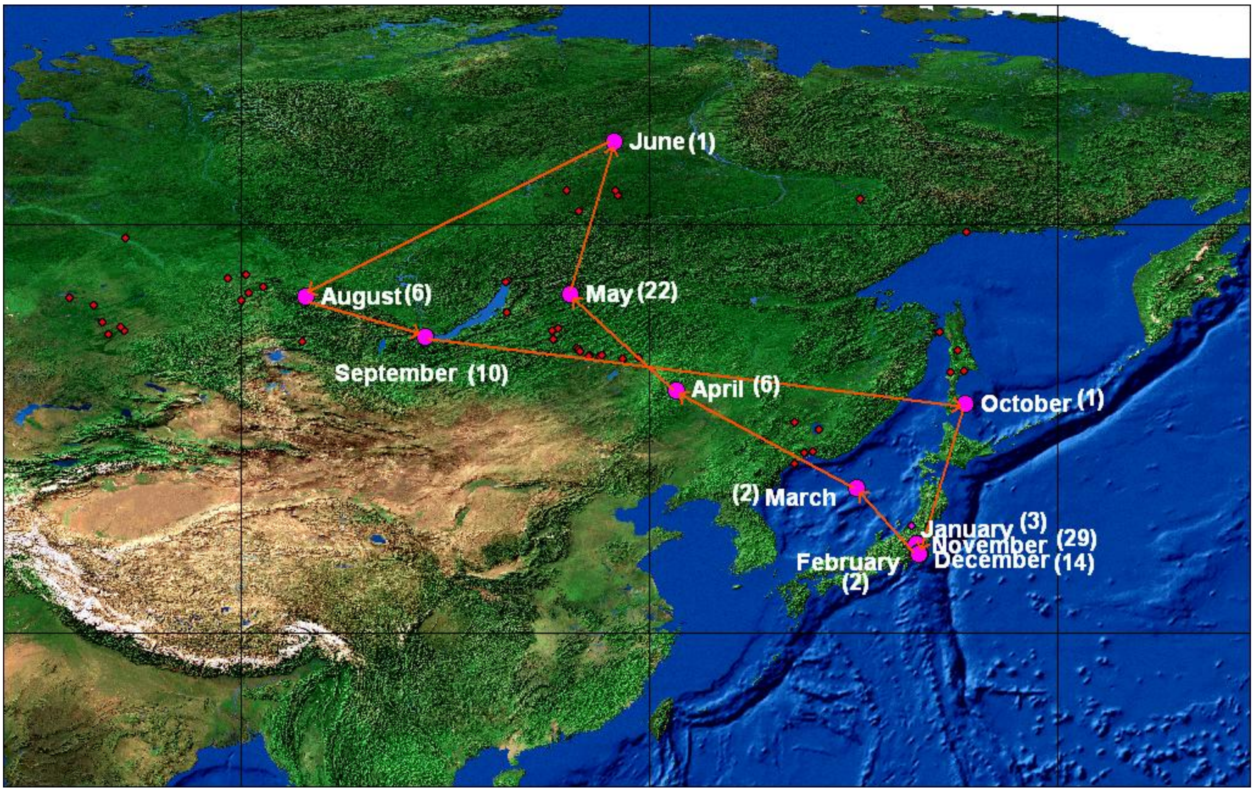


Figure 350. Mean monthly locations of Common Pochard control points for birds, ringed on the wintering grounds in Japan. Purple large circles are mean monthly locations of Common Pochards. Arrows show directions of movements. Number of control points in each month is presented in parentheses.

Summarising all about migratory routes, we can outline spring and autumn Common Pochard migration movements (Figs 351 and 352).

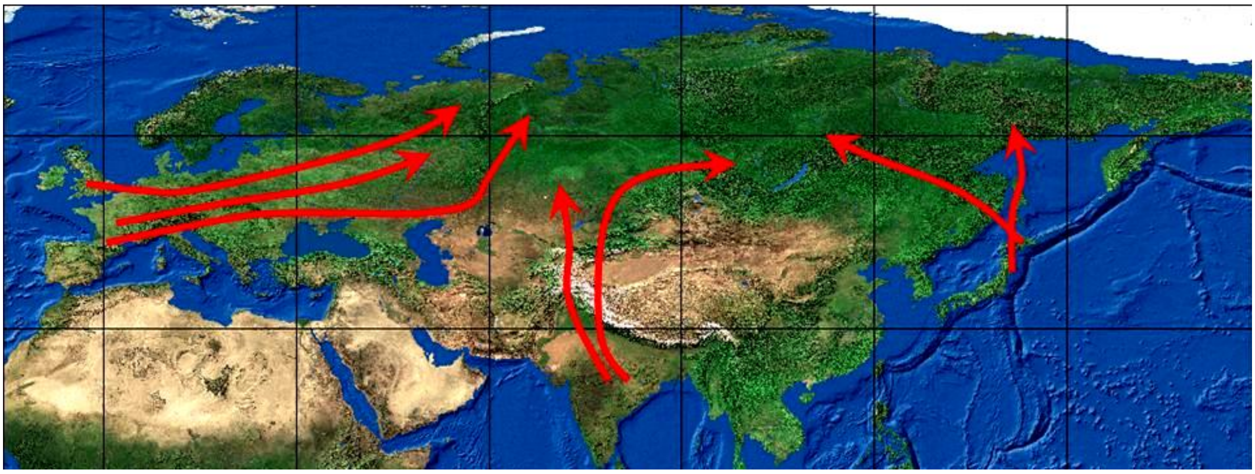


Figure 351. Outline of spring migratory routes for Common Pochard. Red arrows – directions of migratory movements.

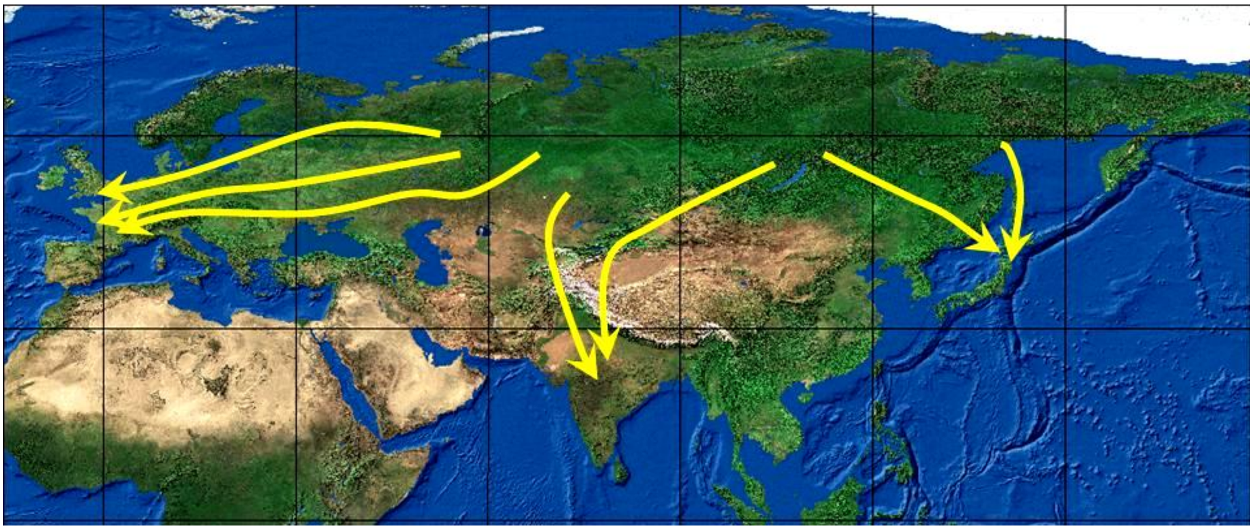


Figure 352. Outline of autumn migratory routes for Common Pochard. Yellow arrows – main directions of migratory movements.

Speed. Bird Ringing Centre of Russia database contains Common Pochard direct recovery with speed of movement about 210 km per day.

Populations. Common Pochard is a duck with great mobility, is capable to cover long distances. It performs long-distance cross-population movements. Therefore, Common Pochard populations are large and overlap greatly. Bird Ringing Centre of Russia ringing data allow outlining the following Common Pochard populations: 1) european-north-african-west-siberian population (polygon No 1, Fig. 353) with generally east, north-east – west, south-west migration movements; 2) south-east-european-persian-west-siberian population (polygon No 2, Fig. 353) with general north-east – south-west migrations; 3) hindostanian-central-asian-west-central-eastern-siberian population (polygon No 3, Fig. 353) with north – south directions of migrations ; 4) japanese-far-eastern population (polygon No 4, Fig. 353) with north-south migratory movements.

All populations overlap considerably. The main zone of intergradations is located in Western Siberia where all four populations overlap.

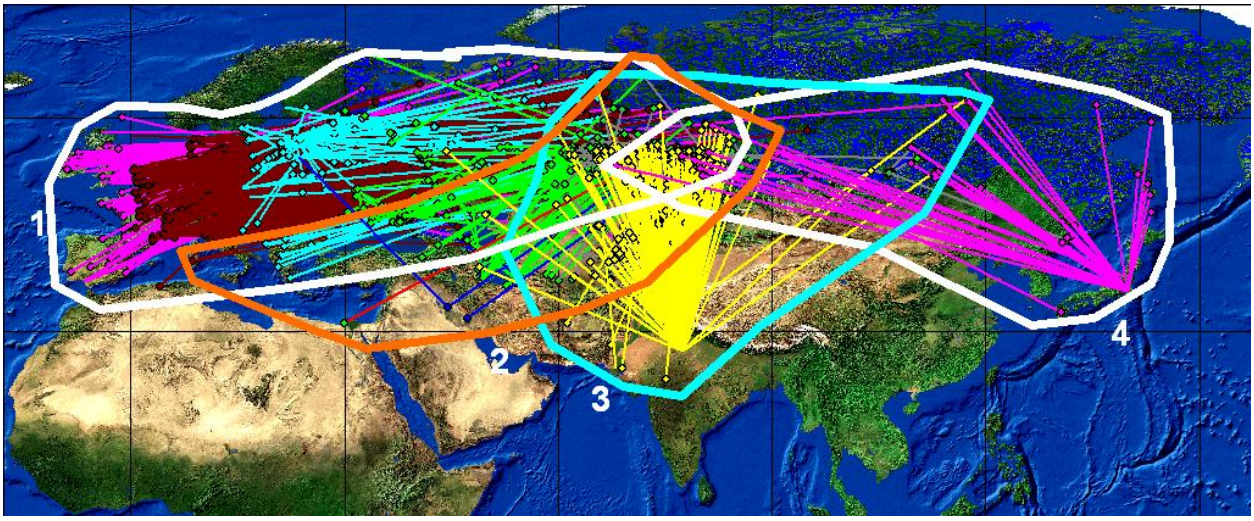


Figure 353. Common Pochard populations. White polygon (№ 1) outlines european-north-african-west-siberian population. Light brown polygon (№ 2) shows the south-east-european-persian-west-siberian population. Blue-green polygon (№ 3) is the hindostanian-central-asian-west-central-eastern-siberian population. White polygon (№ 4) shows japanese-far-eastern population.

Ten-year distances. Mean flight distance in all Common Pochard recoveries demonstrates definite increasing through decades (Table 19). First increase occurred in 1960s, but likely was not the result of natural causes: in this decade ringing in India and Japan started. Sharp increase has been happening since 1980s when ringing in all countries continues.

Table 19. Common Pochard mean flight distance per decade.

Decade (years)	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011 – 2023
Distance (km)	1300.4	597.8	883.6	1116.5	1920.7	2465.8	3317.8	3449.0	3122.8
Number of recoveries	62	12	176	685	556	410	335	255	100

Now Common Pochard increases its breeding range, probably for the reason of climate change, and one of the features of this process is enlarging of flight distances between wintering and breeding areas.

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/ EURING_longevity_list_20170405.pdf, the oldest Common Pochard lived more than 23 years 2 months. The oldest bird in the Bird Ringing Centre of Russia database was ringed as 1-year-old male and shot after 21 years 5 months (ring sent).

Mortality rate. According to the common criteria (see “Materials and Methods”) 2416 dead recoveries are applicable for the mortality rate analysis. Common Pochard mortality rate is 29.82±0.51%. Real mortality pattern differs from the theoretical one significantly (χ^2 = 304, df = 19, P=0.0000). Common Pochard real mortality pattern, although differs from the theoretical one, shows some drawdown of the real survival dynamics in the comparison with the theoretical one (Fig. 354). According to the Population Demographic Status Index (2.46±1.04%) for this ring recovery set the overall Common Pochard population condition looks more or less stable. However, we should keep in mind that the most of recoveries are from the second half of 20th , so this general evaluation relates mostly to second half of the last century. Besides that, this general evaluation may not coincides with the demographic status of local populations (see below). Having enough data, we are able to analyze mortality rate pattern over decades.

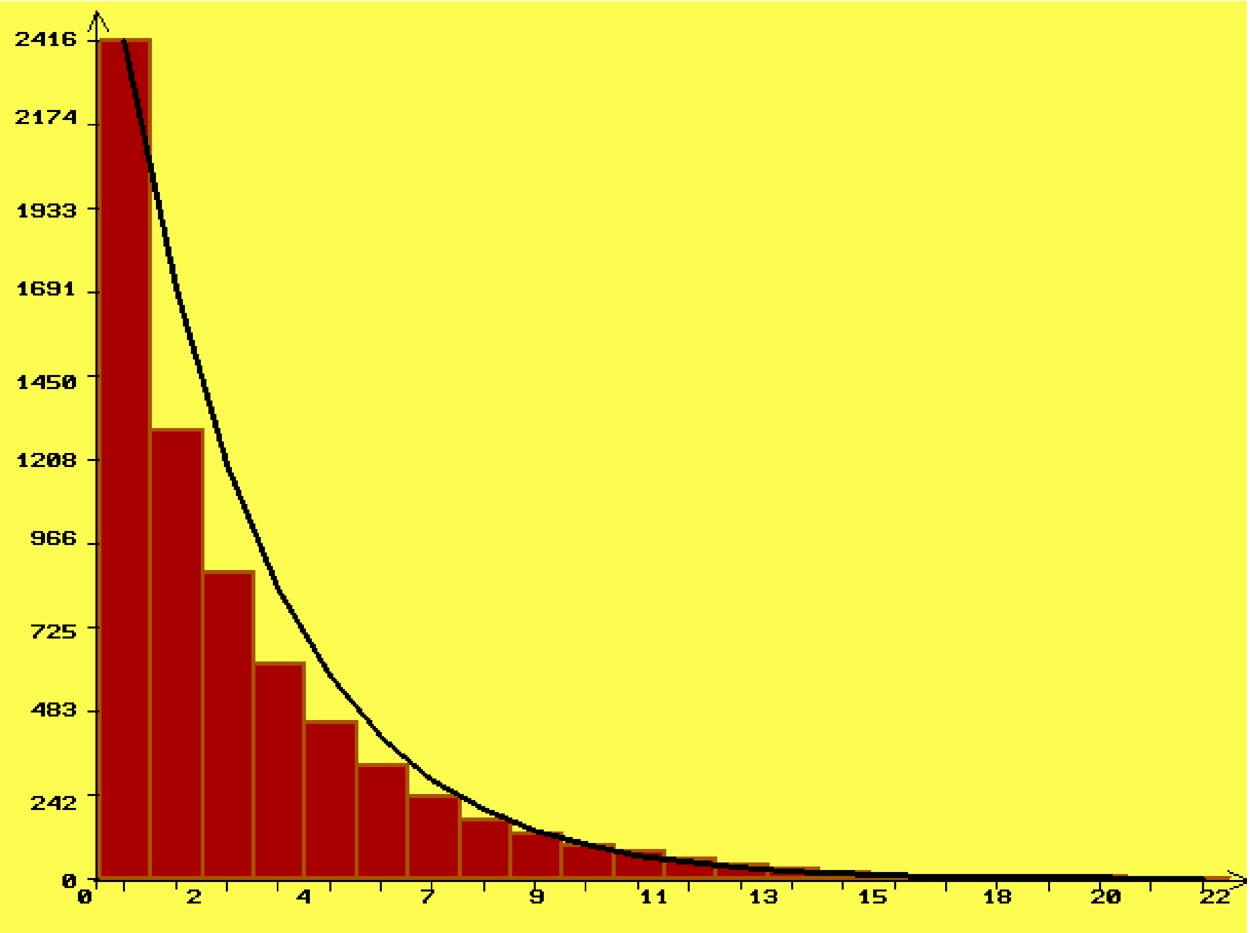
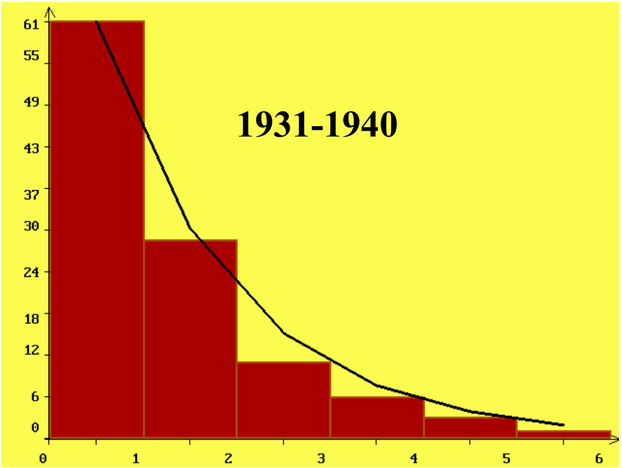
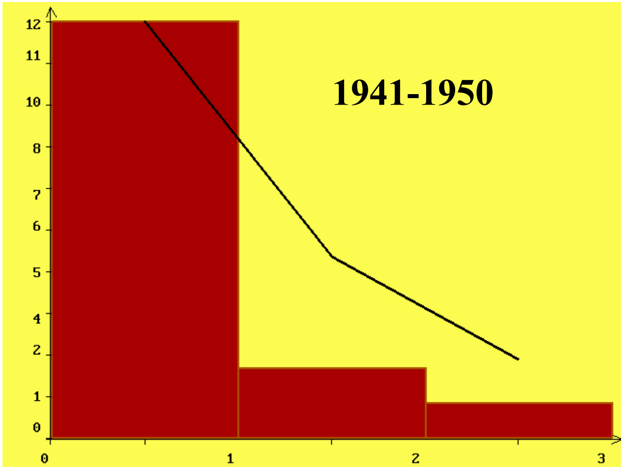
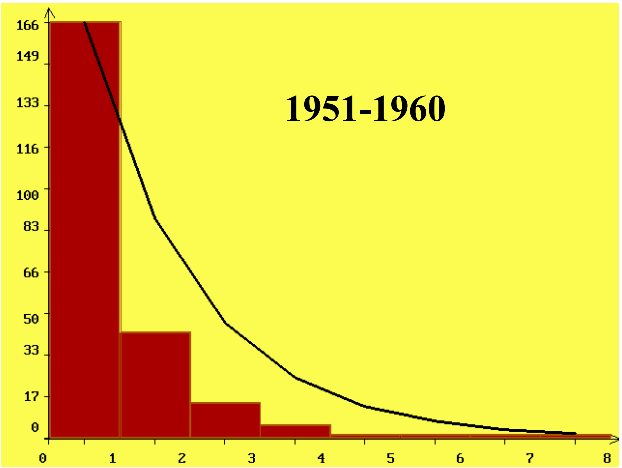


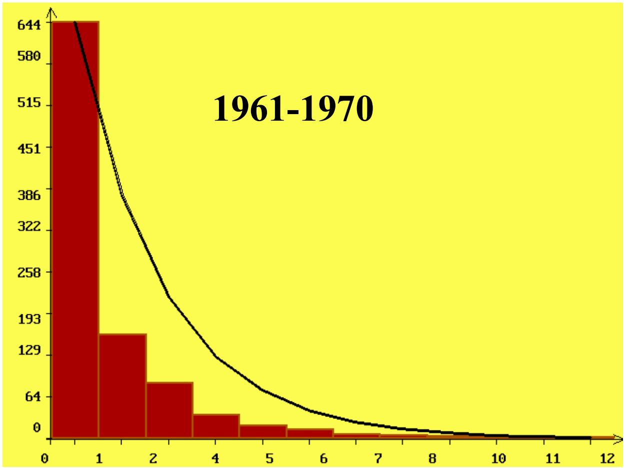
Figure 354. Mortality pattern in the Common Pochard. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

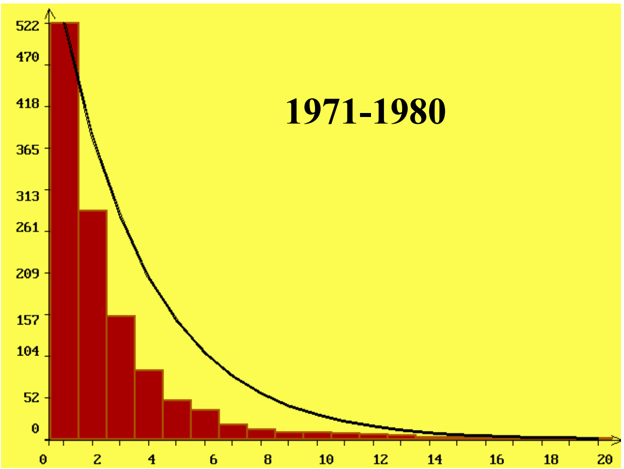
For 1930s mortality pattern indicates good population (species) condition: real data are not much different from the theoretical line (Fig. 355, 1931-1940). For 1941-1950 the sample is very small, that does not allow judging about the species status in the decade. Then, for the decade 1951-1960 conditions for Pochards were not good. Probably, Common Pochard as a bird breeding on wetlands, did not suffer much from battles and troop movements during the World War II, since wet areas were much less convenient for these actions. On the other hand, during the war hunting in Russia was not possible, because shotguns had been confiscated (Bianki, 2005). However, this species suffered soon after (decade 1951-1960), from intensive hunting, and later from intensive melioration. The situation started to improve only in 1980s. Since then the species condition has been getting better (Fig. 355). In 2000s the real survival exceeds the theoretical line, which means that Common Pochard numbers have been displaying some growth during the last decades (Fig. 355). That is also confirmed by the following facts: about ten years ago Common Pochard started to breed in Primorskiy Krai, Far East (Vladimir Medvedev, personal communication), and very likely had become a breeding bird in Sakhalin and Khabarovskiy Krai (see breeding range).

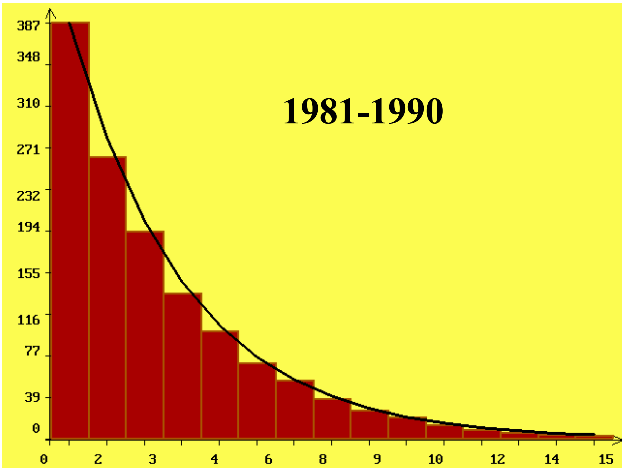

1931-1940
61 55 49 43 37 30 24 18 12 6 0
0 1 2 3 4 5 6


1941-1950
12 11 10 8 7 6 5 4 2 1 0
0 1 2 3


1951-1960
166 149 133 116 100 83 66 50 33 17 0
0 1 2 3 4 5 6 7 8


1961-1970
644 580 515 451 386 322 258 193 129 64 0
0 1 2 4 5 6 7 8 10 11 12


1971-1980
522 470 418 365 313 261 209 157 104 52 0
0 2 4 6 8 10 12 14 16 18 20


1981-1990
387 348 310 271 232 194 155 116 77 39 0
0 2 3 4 6 8 9 10 12 14 15

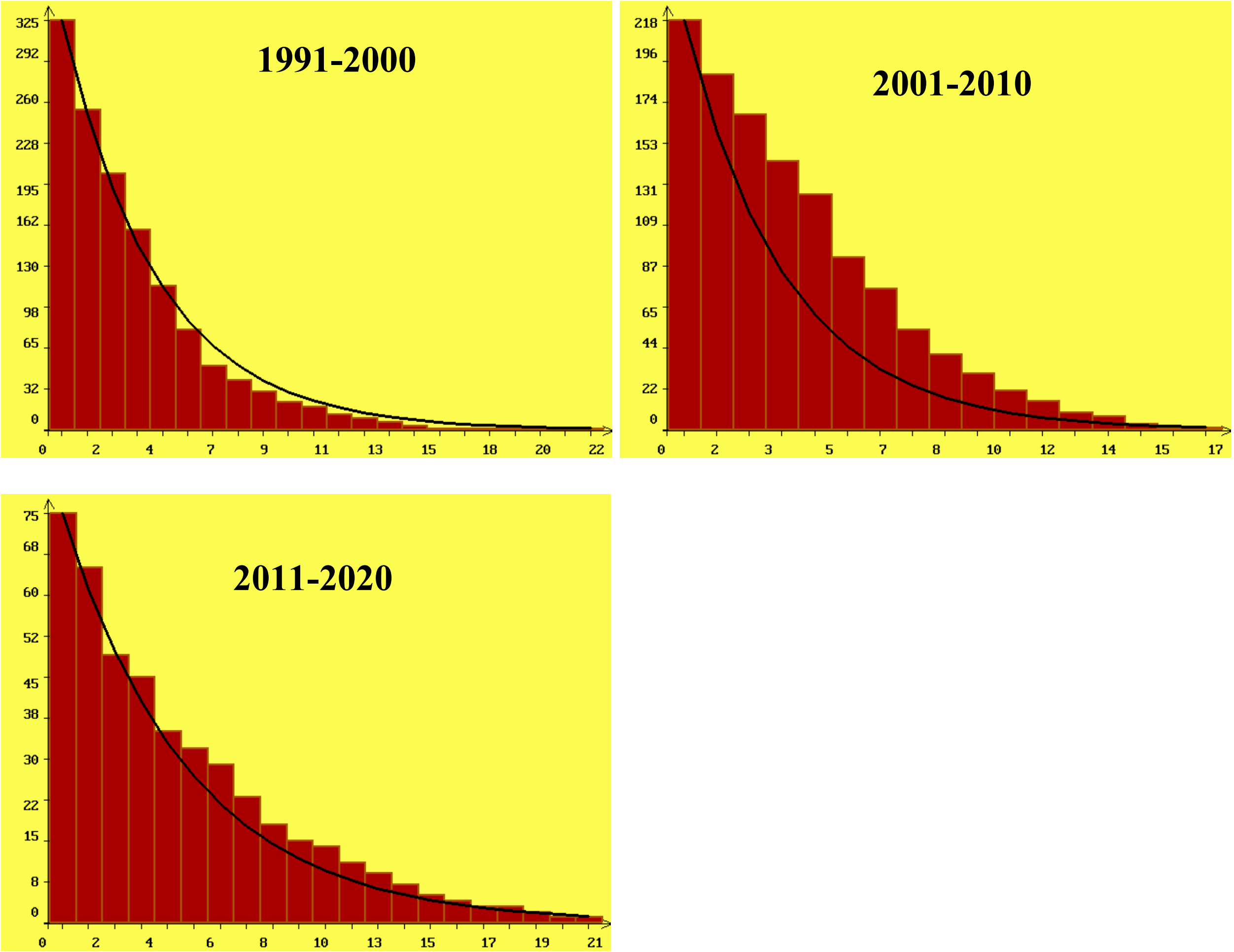


Figure 355. Mortality pattern in Common Pochards recovered in different decades. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, males live considerably longer than females: 3.51±0.10 (N = 1016) and 1.90±0.10 (N = 498) years respectively, significant – t-Bailey=11.2, P=0.0000. Although female overall mortality rate is lesser than in males: 25.61±1.00% and 27.00±0.72% respectively, the demographic conditions for females looks worse (Fig. 356). Probably, this is one of the reasons for the recent number declining in Common Pochard in Europe.

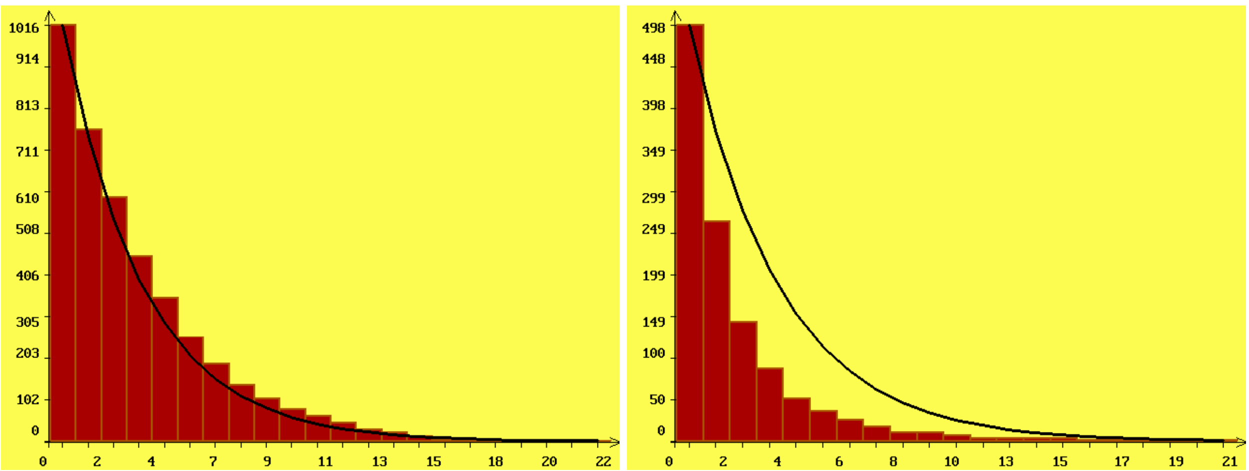


Figure 356. Mortality rate pattern of Common Pochard sexes: left – females, right – males. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

FERRUGINOUS DUCK
(*AYTHYA NYROCA*)

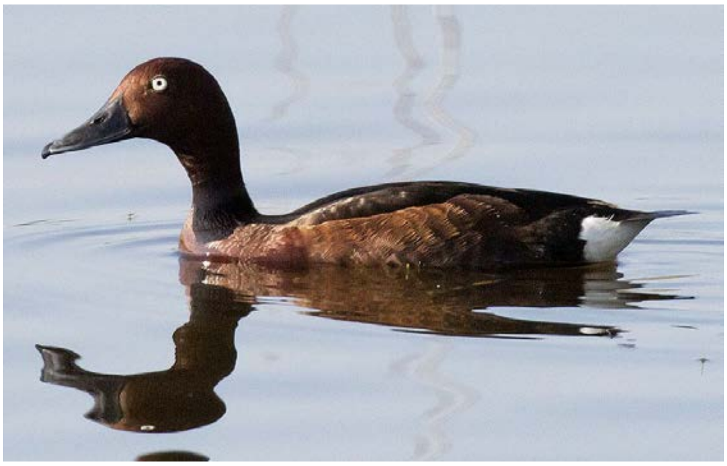


Photo by Vladimir I. Deryabin

Breeding range in Eurasia. Brief description of the breeding range is in Fig. 357. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

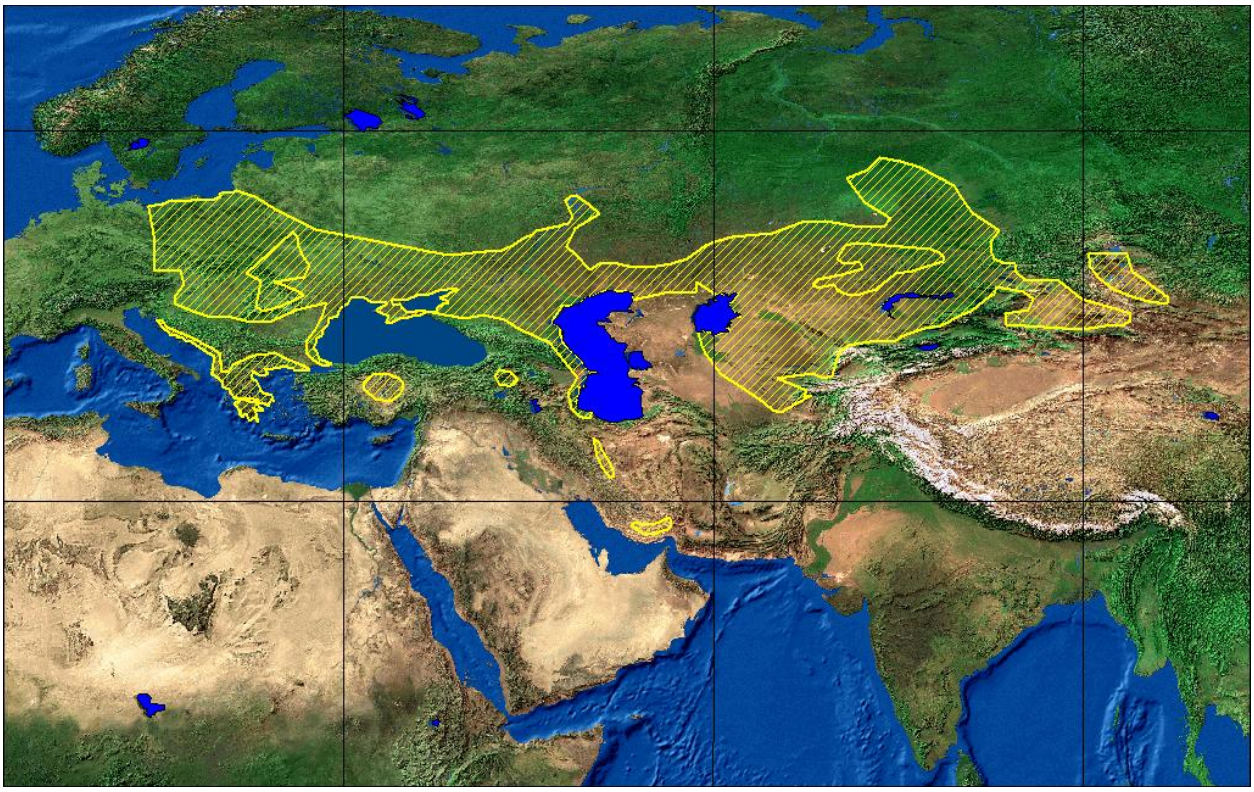


Figure 357. Breeding range of the Ferruginous Duck in Eurasia (yellow dashed areas).

Distribution of control points. Bird Ringing Centre of Russia database contains data on 27 marked birds with 27 recoveries, i.e., one recovery per bird. All ducks were marked only with metal rings. Ringing dates are since 25.07.1947 till 20.11.1982, recovery dates are since 09.08.1947 till 01.10.1986. After these dates till 25.05.2023 no more recoveries appeared in the Birds Ringing Centre of Russia database. So, this species becomes more and more rare.

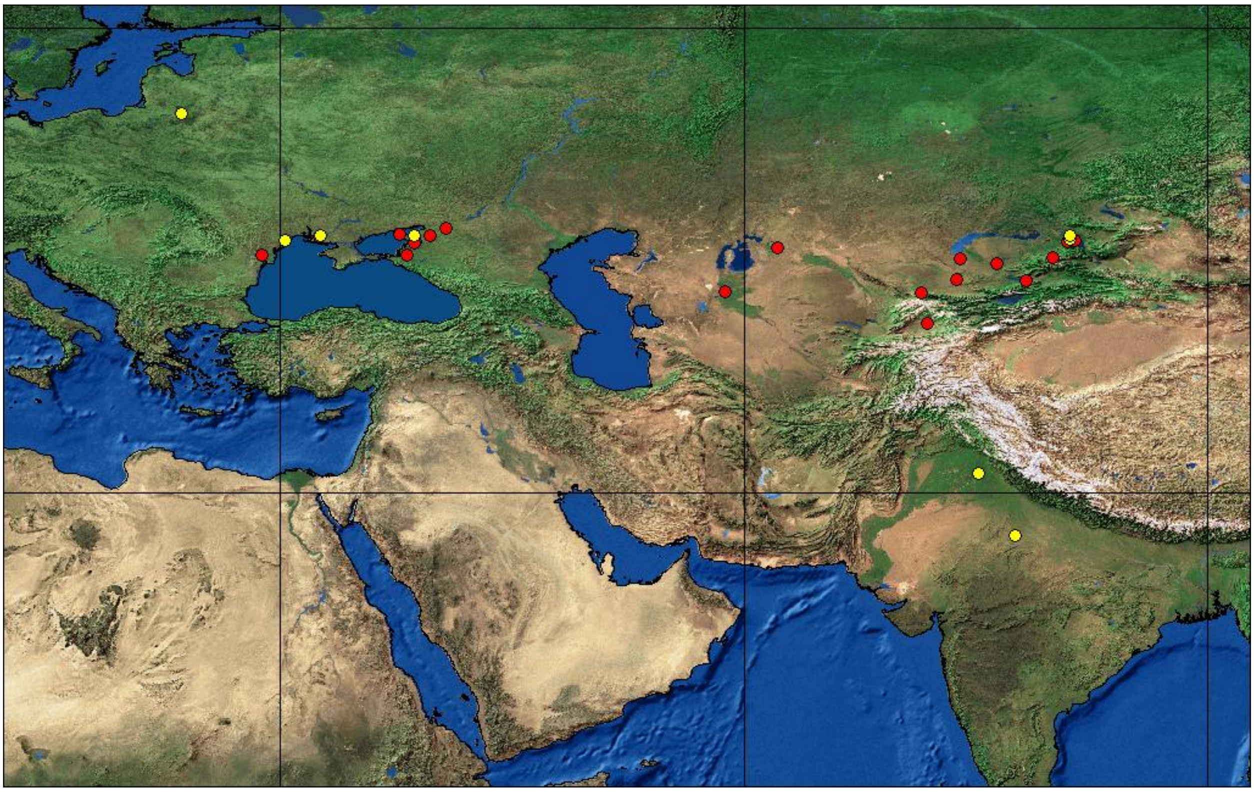


Figure 358. Position of all Ferruginous Duck control points. Yellow dots – ringing places, red dots – recovery places.

The data set on Ferruginous Duck is very little: 14 ducks were marked with the „Moskwa", 12 - „Bombay" and 1 - „Lithuania Kaunas" schemes. Ducks were ringed in Ukraine, Kazakhstan, Lithuania and India. All recoveries are within the natural breeding range (Fig. 358).

Finding details. This analysis includes all 27 recoveries. 18 (67%) are „shot". In 6 (22%) recoveries „details unknown", which most likely mean they were shot, as well. Therefore, we can assume that 89% of birds were shot. Other reasons: caught, fate unknown – 1 bird, found dead - 1, found frozen -1.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries of Ferruginous Duck is represented on the population map (Fig. 360). Average flight distances in direct and indirect recoveries are 511.0$\pm$182.1 (N=19) and 2039.4$\pm$74.6 (N=8) respectively. Distance in indirect recoveries is four times significantly longer (t=Bailey = 7.8, P = 0.0000). Such difference, to our mind, means that young birds are vulnerable to hunting very much; and also that Ferruginous Duck is not very site-faithful; it is capable of changing its breeding site quite often.

Monthly movements. All recoveries are included in demonstration of month-by-month migrations. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in the Ferruginous Duck (Fig. 359). Since the number of recoveries is very small, it is possible to outline monthly movements only preliminary (Fig. 359). Till February birds are on wintering grounds, recoveries appear in March: ducks from India arrive into Central Asia and southern Kazakhstan. No recoveries for April and May are available. In June-July- August birds are on the breeding grounds in Kazakhstan, Ukraine and Lithuania, some ducks are still on the wintering grounds in India. In September birds are on the breeding grounds as well. From October through December migration and wintering occur (Fig. 359).

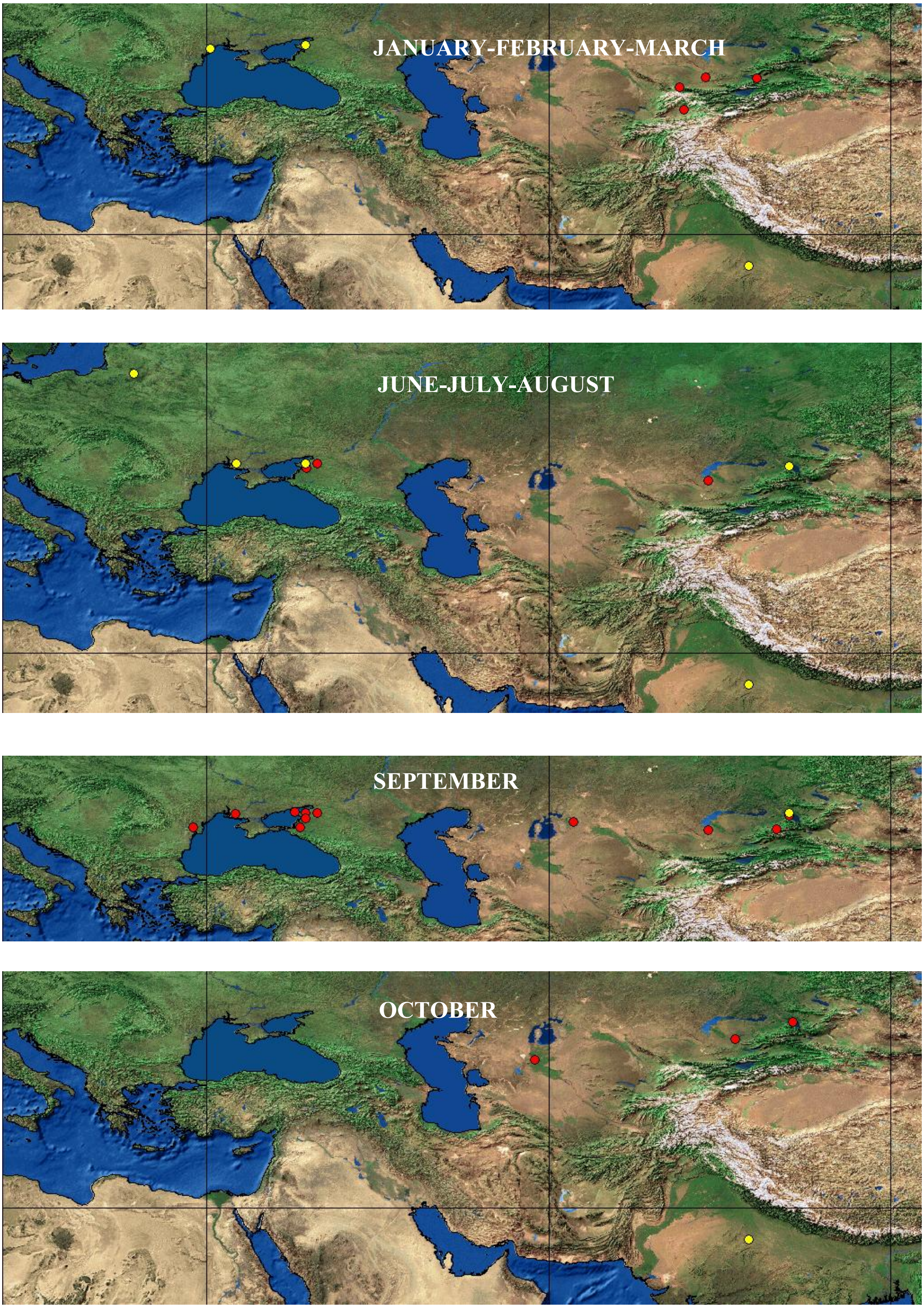

JANUARY-FEBRUARY-MARCH
JUNE-JULY-AUGUST
SEPTEMBER
OCTOBER

Figure 359. Ferruginous Duck monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. Information is very scarce. It seems, east European Ferruginous Ducks fly along the way, different from other ducks, i.e., to the south-west. E.g., a bird ringed on the Zhuvintas Lake, Lithuania flew to Rostov Region. Most likely this bird was shot on its way to the Caspian Sea, because it had already passed the Sea of Azov. This is one of the reasons why we prolong the eastern population area to and over the Caspian Sea (Fig. 360). Ducks that breed in the Central Asia and Kazakhstan, winter in India; flying mostly in north-south directions, passing mountains up to 2500 km along their route. The longest flight in direct recoveries is 2008 km, indirect flight – 2470.5 km.

The same as in Common and Ruddy Shelducks, some adult Ferruginous Ducks in some years do not fly to the breeding area, but stay in the wintering grounds: there is one such recovery of the bird, ringed as adult female in India in July and recovered in Kazakhstan on autumn migration in two years.

Speed. It looks like the Ferruginous Duck is slow-moving duck. The database contains recoveries with little elapsed time, and flight distances in all cases are not long. It seems this duck mostly covers not more than several first tens of km per day.

Populations. Since the Ferruginous Duck is not highly mobile duck, therefore this species form many small populations (Fig. 360); some of those are not certain for the reason of very small amount of data. We have separated three populations, one of them is totally hypothetic (dashed light brown polygon in the Fig. 360), drawn on the base of the breeding range and relief peculiarities (Ural Mountains and Caspian see) of the area. Only one population, Number 2 in the Fig. 360, hindostanian-central-asian-south-kazakhstanian population is relatively certain.

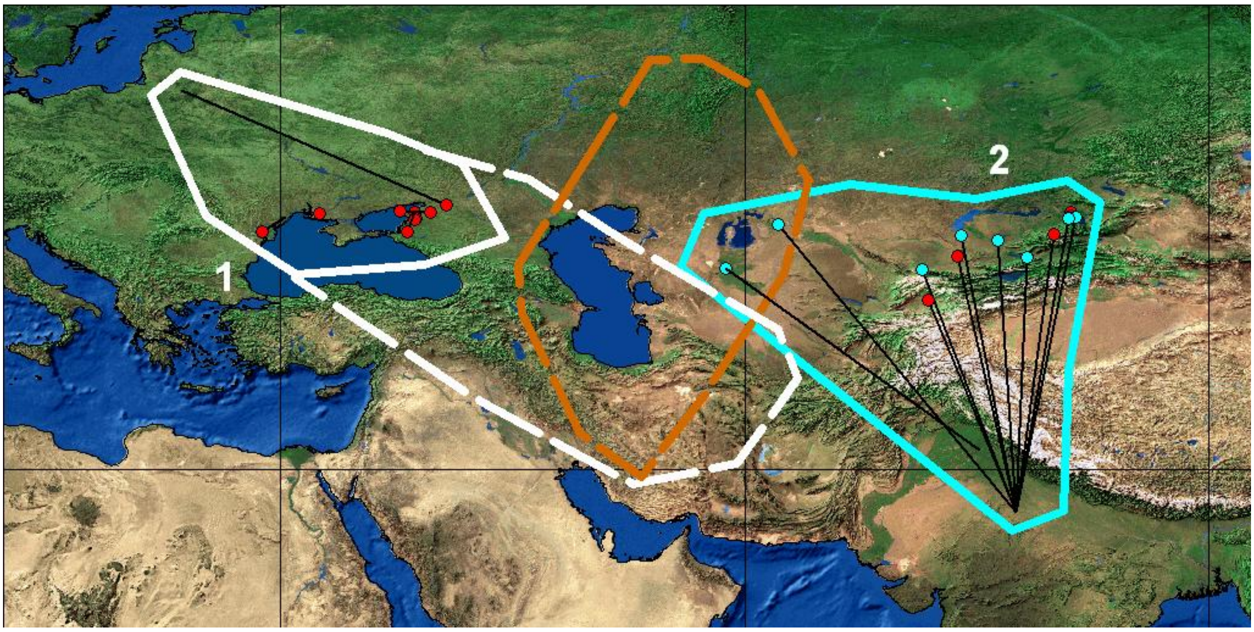


Figure 360. Ferruginous Duck populations. Polygons with solid lines outlines more or less certain populations, dashed line polygons display less certain populations. Black lines and red dots – direct recoveries, black lines and blue-green dots – indirect recoveries.

Lifespan.EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) of 26 November 2010 displays data on the Ferruginous Duck lifespan as more than 9 years. Bird Ringing Centre of Russia database contains a recovery from adult female that lived more than 6 years.

Mortality rate. According to the common criteria (see "Materials and Methods") 25 dead recoveries of Ferruginous Duck are applicable for the mortality rate analysis. Mean annual mortality rate in the Ferruginous Duck is 47.48±6.88%. Real mortality pattern significantly differs from the theoretical one (χ^2 = 6.4, df = 2, P=0.04). Programme MARK, Model CLogLog 2ndPart shows 45.85%, difference is 1.37%. In spite of little amount of data in the set, mortality rate pattern shows considerable drawdown of the real survival in the comparison to the theoretical one. However, these data on Ferruginous Duck are from 1947-1986. Therefore, the conclusion about bad species condition from the data set is relevant only for those years.

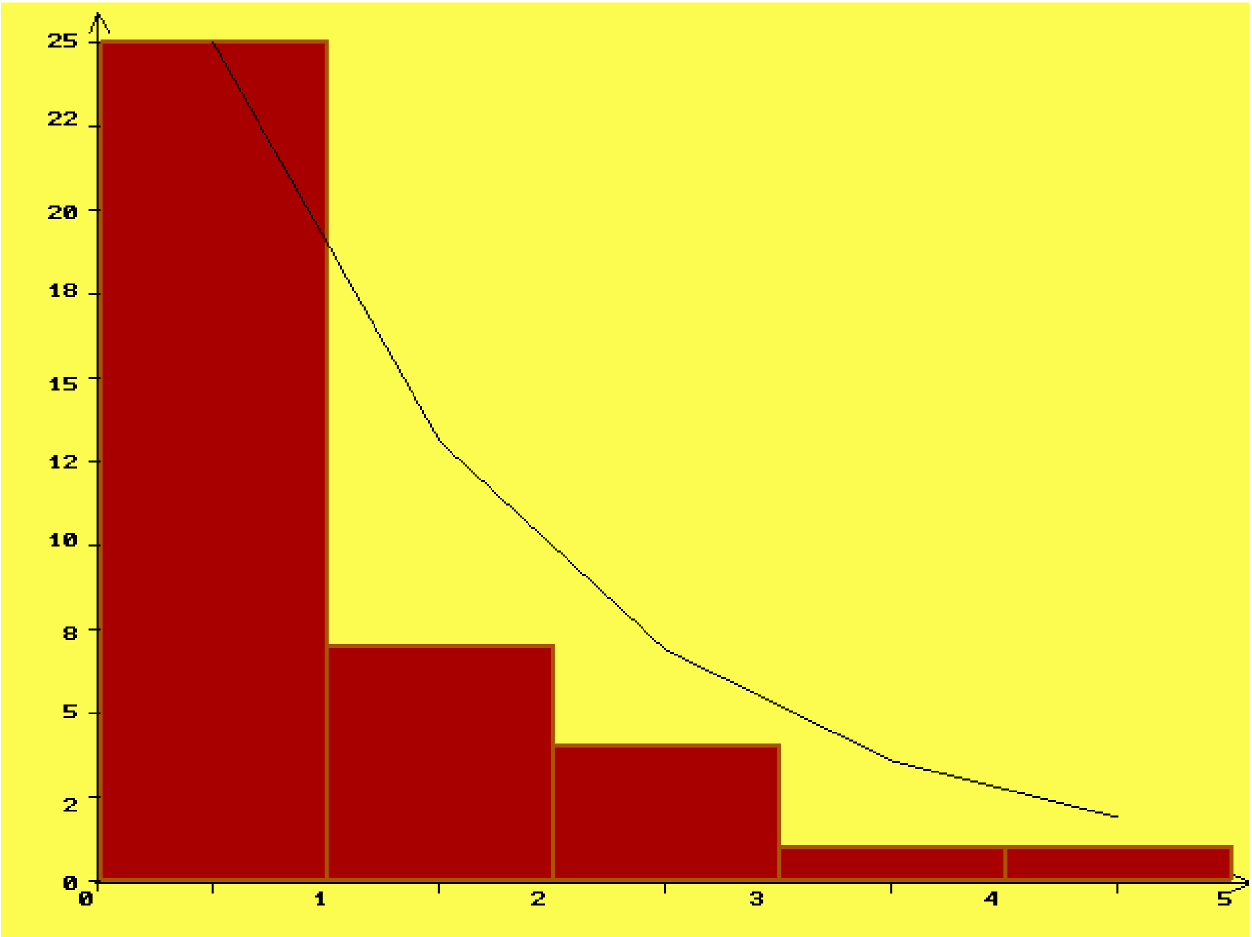


Figure 361. Mortality pattern in the Ferruginous Duck Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

TUFTED DUCK
(*AYTHYA FULIGULA*)

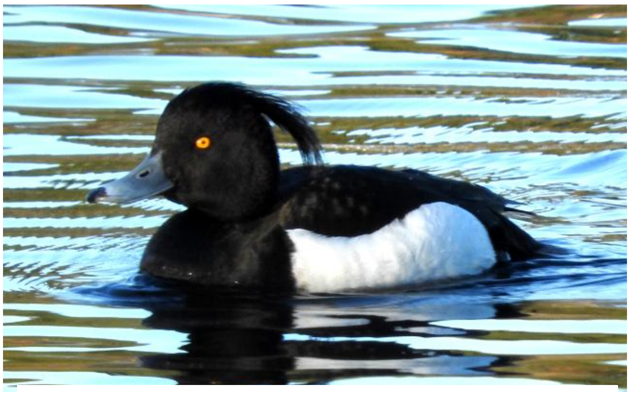


Photo by Irina A. Kharitonova

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 362. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

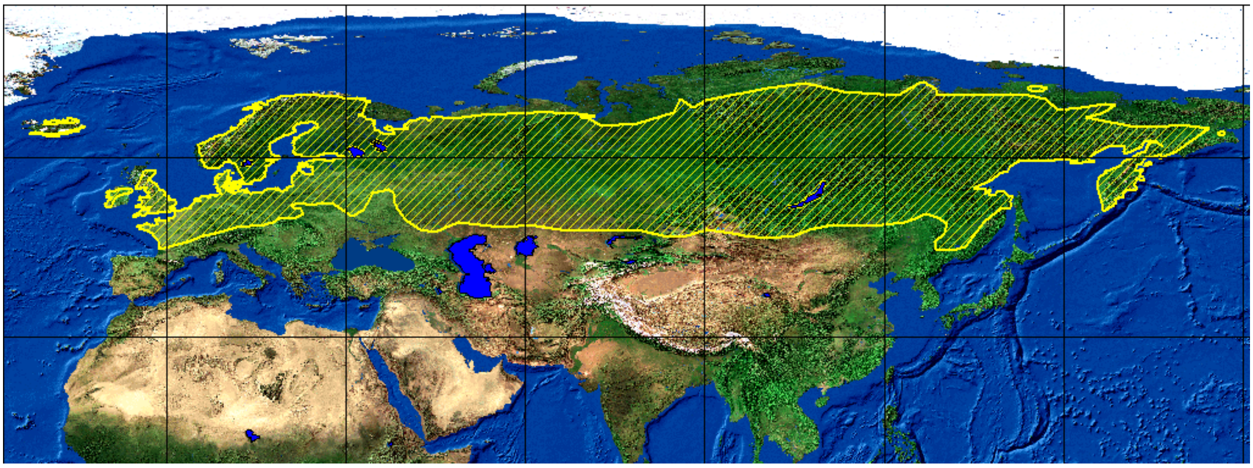


Figure 362. Breeding range of the Tufted Duck in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 3937 marked birds were used, which gave 3998 recoveries (Fig. 363), 24 Tufted Ducks held nasal mark, one duck – web-tag, one duck – radio transmitter, one – satellite transmitter. 3891 birds gave one recovery per duck, one bird had 6 recoveries, 3 birds gave 4 recoveries each, 5 birds – 3 recoveries, 37 birds – two recoveries. Ringing dates are since 18.08.1931 until 28.02.2022, recovery dates are since 01.05.1932 until 17.04.2023.

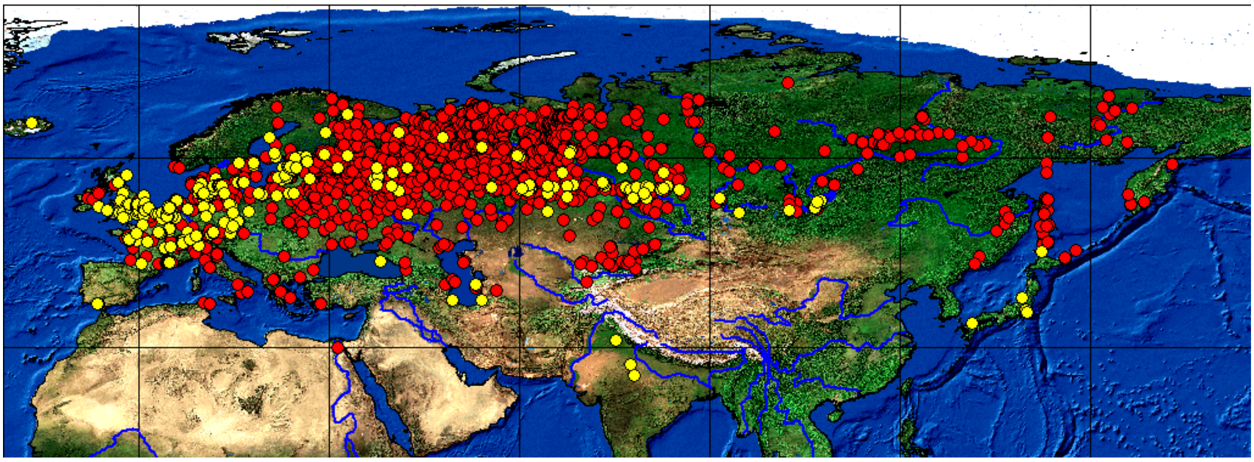


Figure 363. Position of all Tufted Duck control points. Yellow dots are ringing sites, red dots are recovery sites.

Tufted Ducks were ringed in Europe from the very west to east, western and central Siberia (Baikal Lake area), India and Japan. Most of recoveries are from Europe, North Africa, Caspian Sea area, the whole Siberia and Russian Far East.

'Moskwa' scheme recoveries. This sample contains 675 recoveries of the scheme „Moskwa". They are from birds ringed within the Russian Federation and countries of the former USSR (Fig. 364). Considerable amount of birds (498 recoveries) were ringed at lakes in Latvia where deep population studies on Tufted Ducks were performed (Viksne et al, 2010).

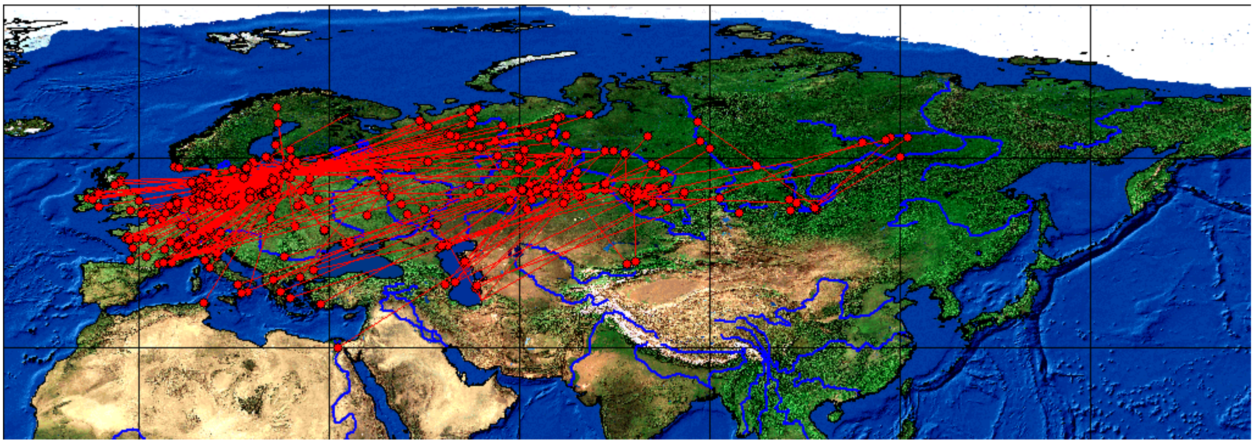


Figure 364. „Moskwa" scheme recoveries of the Tufted Duck. Here and on all other similar figures lines start from ringing sites, recovery sites are marked with red dots.

Finding details. This analysis includes all 3998 recoveries. 3419 (87%) recoveries are „shot". In 120 (3%) recoveries „details unknown", which practically mean shot, as well. Therefore, we can assume that 90% of birds were shot. Other reasons are not so common (Fig. 365).

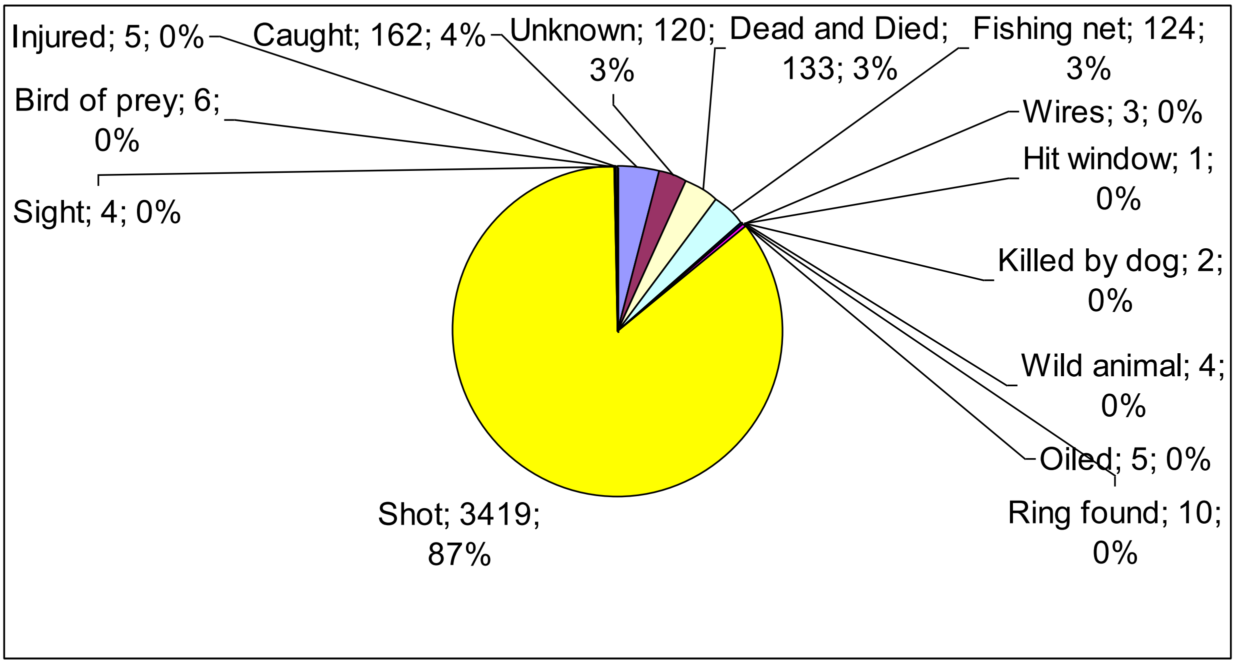


Figure 365. Finding detail in the Tufted Duck.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries represented in Figs 366 and 367.

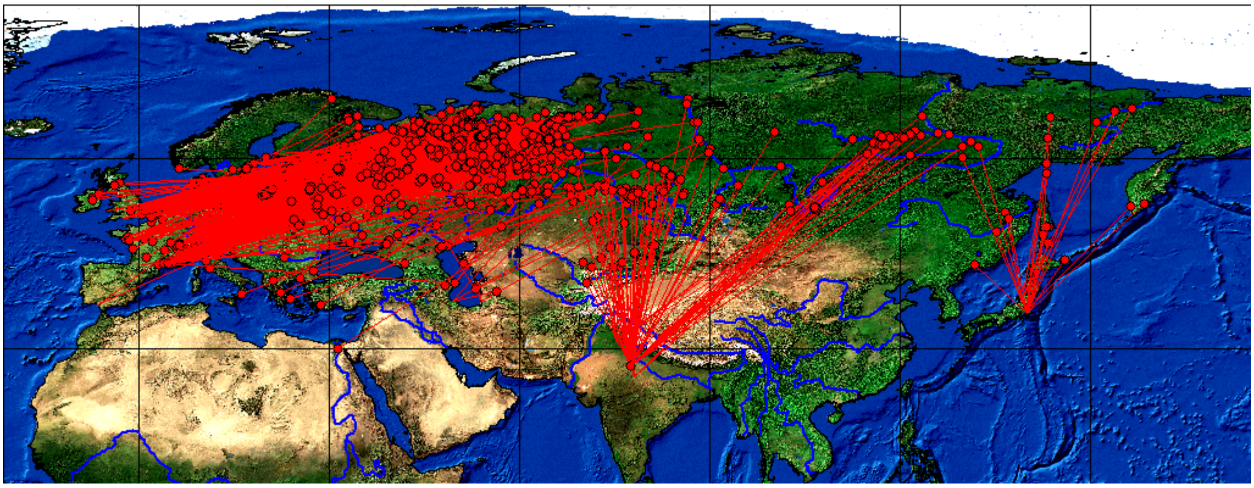


Figure 366. Map of the Tufted Duck direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

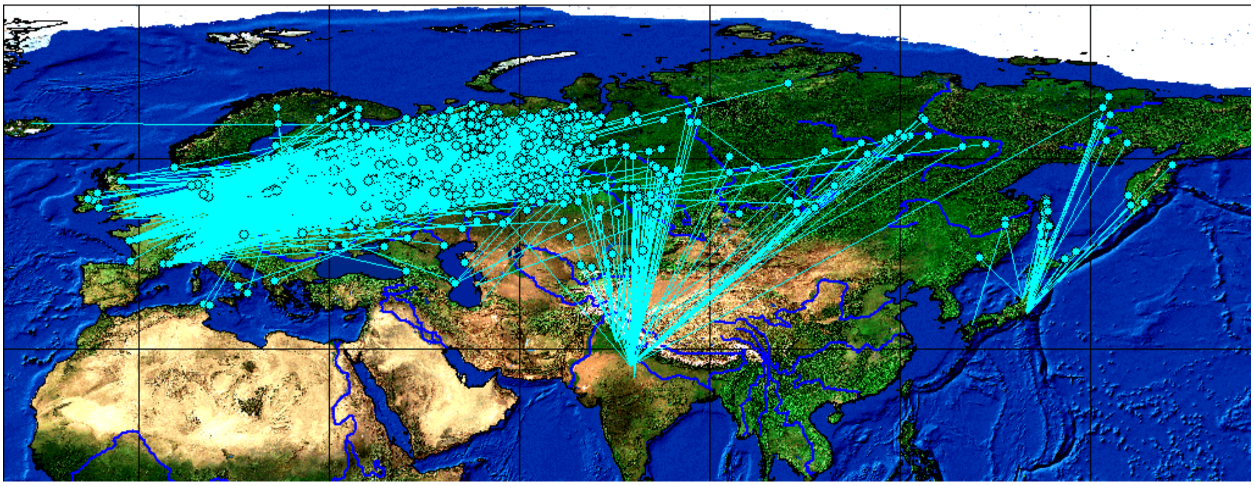


Figure 367. Map of the Tufted Duck indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

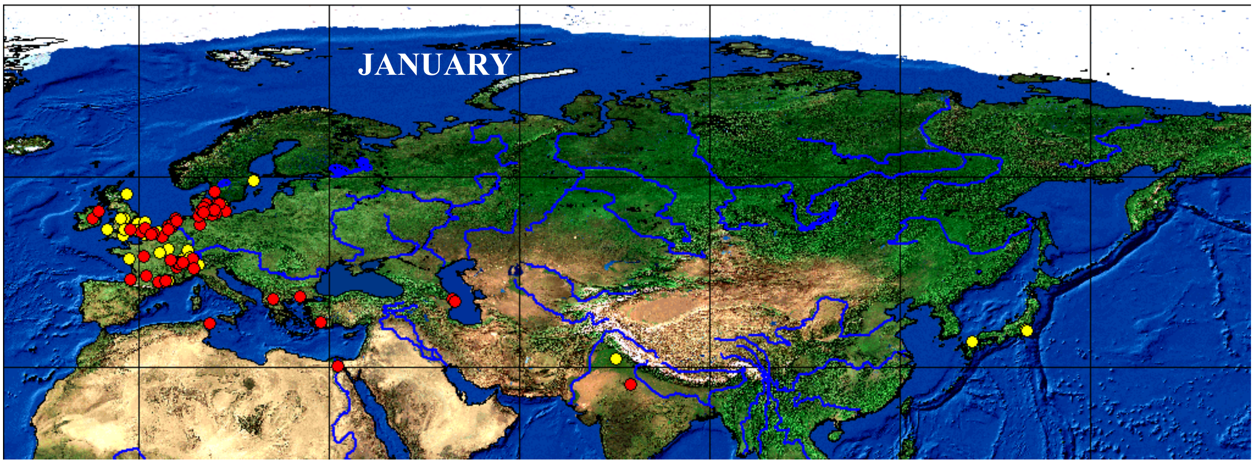
Maps indicate that Tufted Ducks wintering in Western and southern Europe fly to breed to the European Russia and western Siberia to about the meridian of 75˚E, although one indirect recovery penetrated up to 135˚E. Tufted Ducks ringed in India fly to breed, mostly, to the Central Asia, Kazakhstan, western Siberia mostly to 130˚E, one indirect recovery is located at 150˚30'E (Fig. 366). Most birds wintering in Japan breed from western Siberia, approximately east of 130˚E (i.e., much more to the east than Common Pochards) up to the Sea of Okhotsk and Kamchatka (Fig. 367).

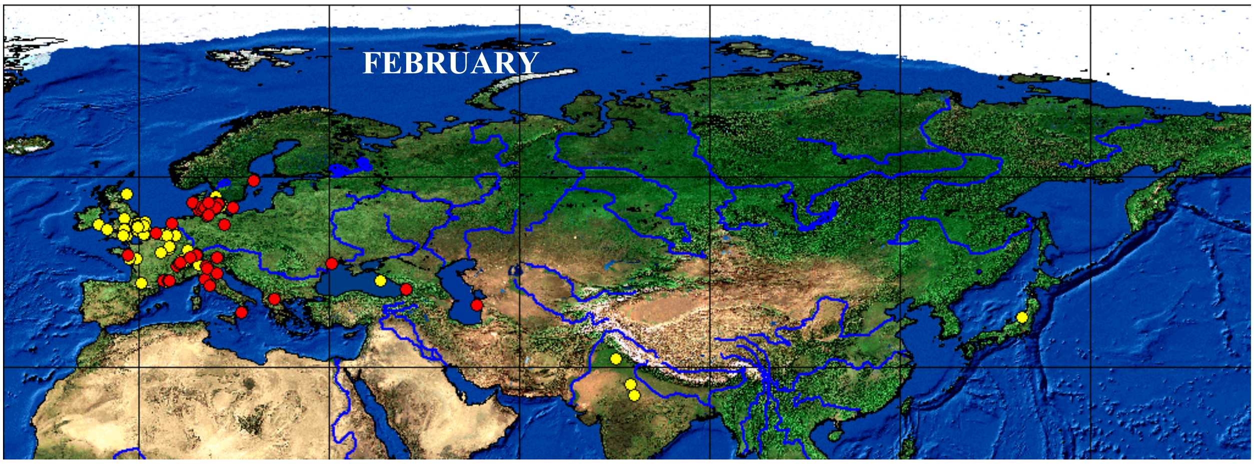
Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them (χ^2 =103.5, 2749 indirect recoveries and 1129 direct ones, df = 2, P = 0.0000). Center of indirect recoveries is located 2˚ 8'' more to the north and 2˚ 30'' to the east from the centre of direct recoveries. Average flight distance in direct recoveries is shorter than in indirect recoveries, but in lesser extent than in Common Pochards: 2332.6±38.4 and 2675.8±21.0 km respectively, significant (t-Bailey = 7.8, P=0.0000). Long-distance cross-population movements are not common in Tufted Ducks.

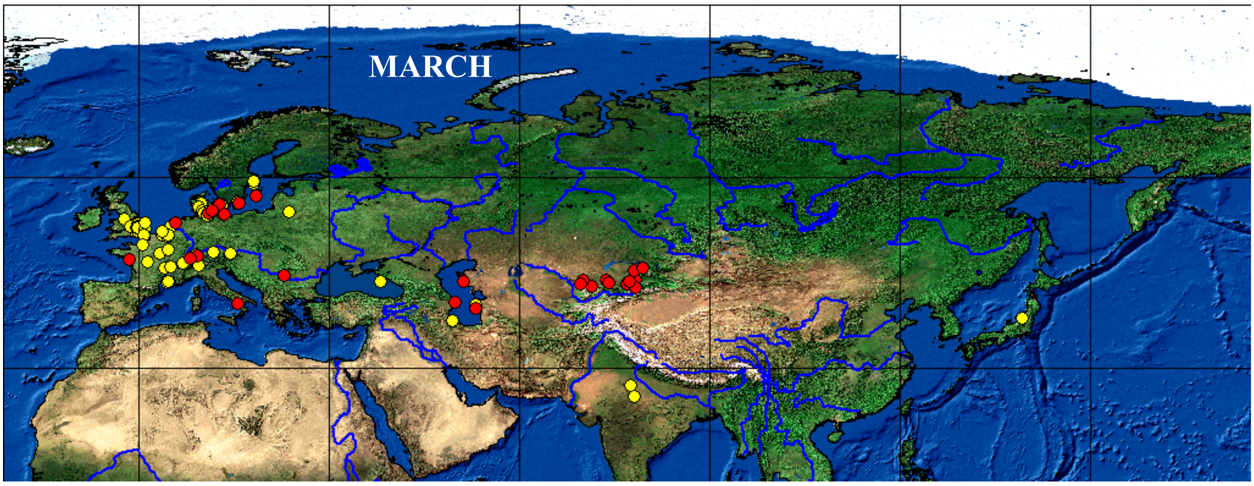
Monthly movements. Monthly distributions of control points (ringing and recovery sites) reflect a general way of seasonal movements in Tufted Duck (Fig. 368). The same as in Common Pochard, pattern of control points indicates that in January and February most ducks are on wintering grounds in the western and southern Europe, Caucasus area, India and Japan. In western Europe wintering and breeding ranges considerably coincide. In March spring migration commenced actively everywhere, except Japan. Birds from western Europe move to the east, north-east; from southern Europe – to the north-east, from southern European Russia – to the north, north-east; from India birds fly to the north. It is noticeable from the position of the new appeared green dots, representing the recovery sites (Fig. 368, March). In April migration continues, noticeable in all populations, birds from Japanese wintering grounds likely just only start their migration in April. In May Tufted Ducks continue to migrate, however, not yet filling the species breeding range up to its northern boundaries. Only in June the spring migration is completed in all parts of the breeding range. Configuration of recovery positions shows that these ducks do not have considerable migration through the „southern gate" – area to the south of the southern end of Ural Mountains. Most birds fly over the northern half of the European Russia. It looks like, on this way they cross the Ural Mountains along straight-line. The point is that although there is a gap over northern half of Urals between European and western Siberian recovery concentrations (see Fig. 368, May), this gap is very narrow. This gap could mean, that no spring hunting occurs right in the Mountains, because northern Urals are higher than the southern ones, therefore the ridge is covered by the snow and not convenient for hunting during Tufted Duck migration. In June, July and August these ducks are detected within breeding range. In August probably first migratory movements to the wintering grounds take place, see a recovery in the southern Kazakhstan (Fig. 368, July).

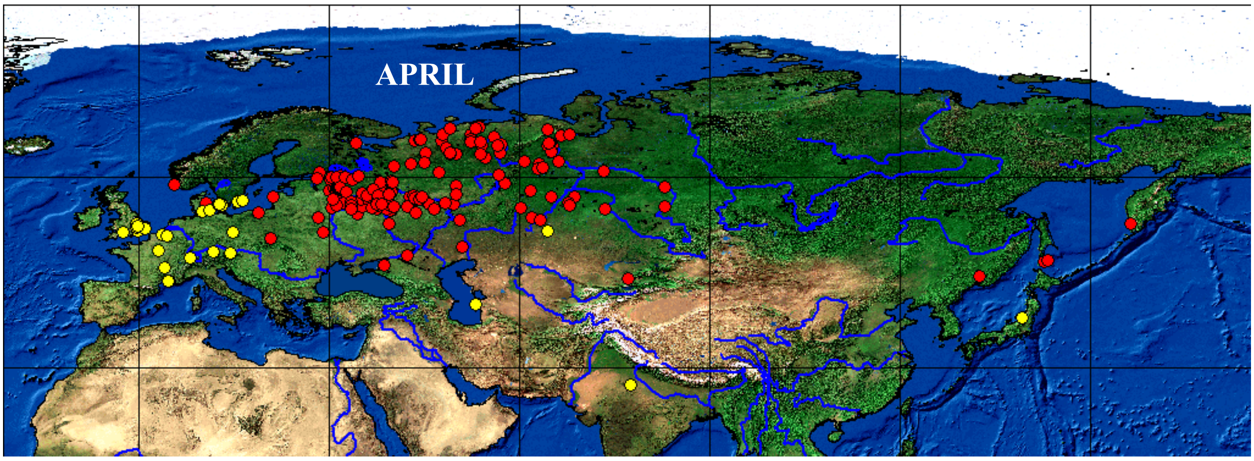
The same as in Common Pochard, young birds ringed in July then could fly first in any direction (Fig. 369), but predominantly to the south. For young Tufted Ducks ringed in August (Fig. 369), none of birds fly to the north (not like Common Pochards). This difference might be explained by the fact, that the Tufted Duck is more northern species than the Common Pochard, therefore its movements for birds ringed in July or August are more southerly directed than in Common Pochard.

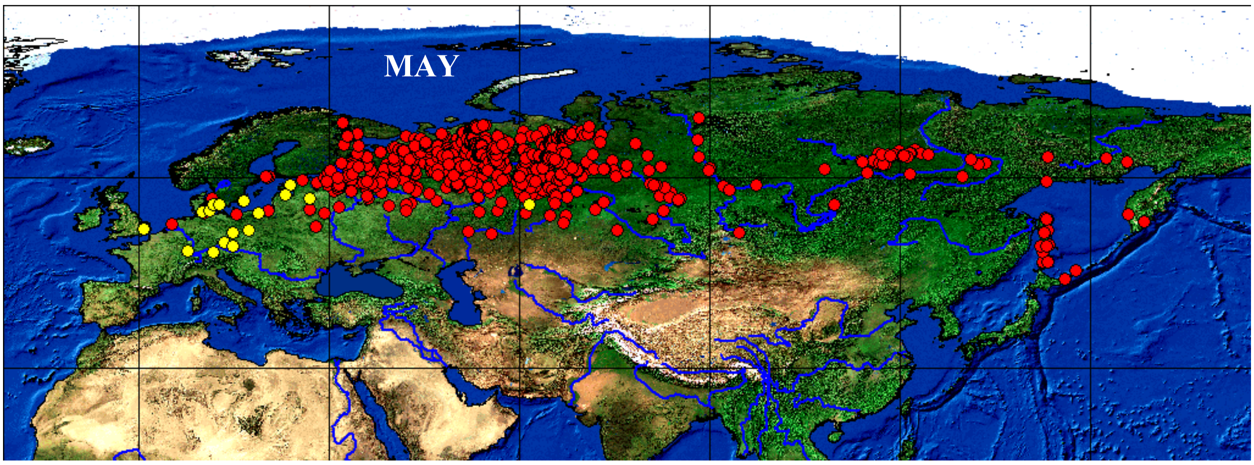
In September migration definitely starts, some birds are already in the northern India. In September migration is more pronounced in areas from central Siberia to Far East – ducks „clean out" the northern parts of the breeding range in this area. In October the latter area is almost free of Tufted Ducks, in European Russia these Ducks are mostly still on breeding grounds, shrinking of breeding range from the north starts in the Western Siberia. In November migration in European Russia still continues and completes only in December (Fig. 368). In autumn no gaps over the northern Ural Mountains is noticed, seems these birds cross Urals on autumn migration straight over, the same as in spring, but in the opposite direction.

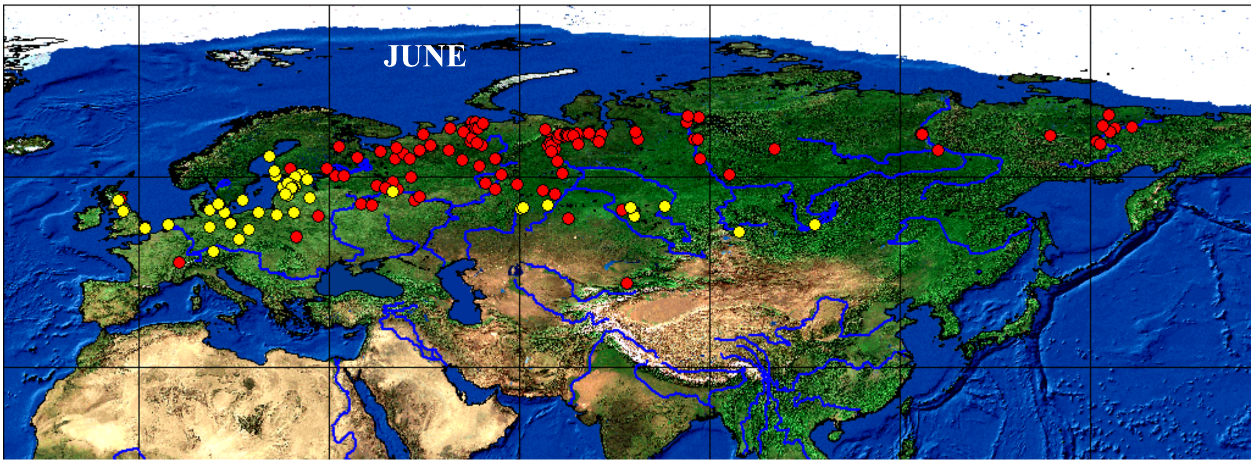



FEBRUARY


MARCH


APRIL


MAY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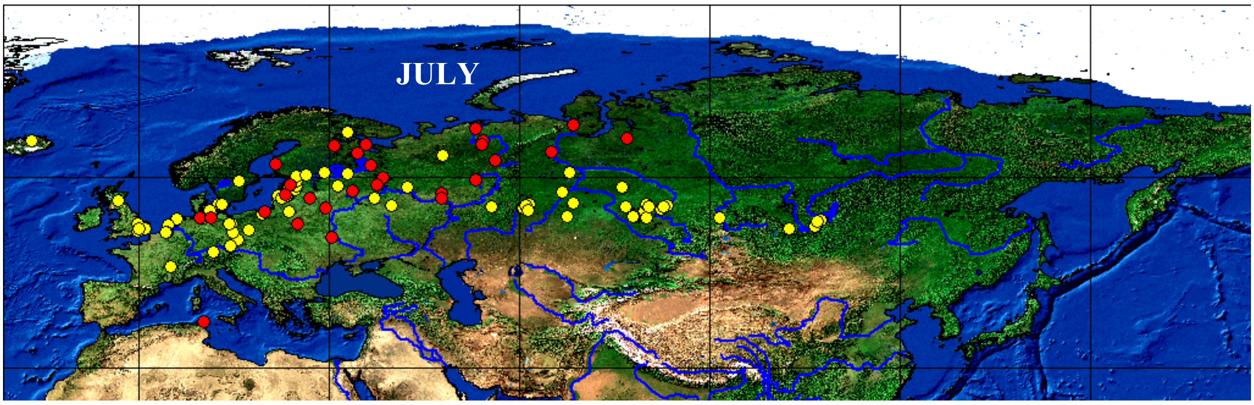
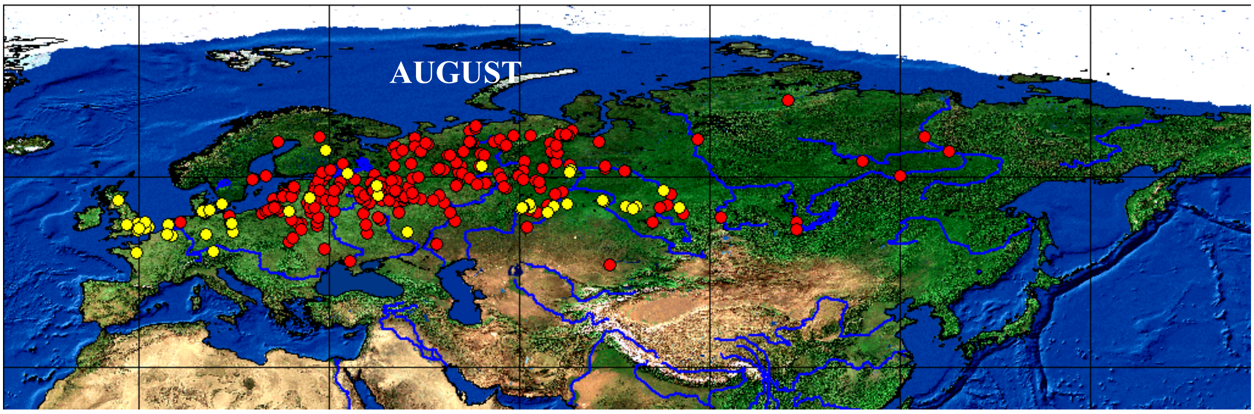
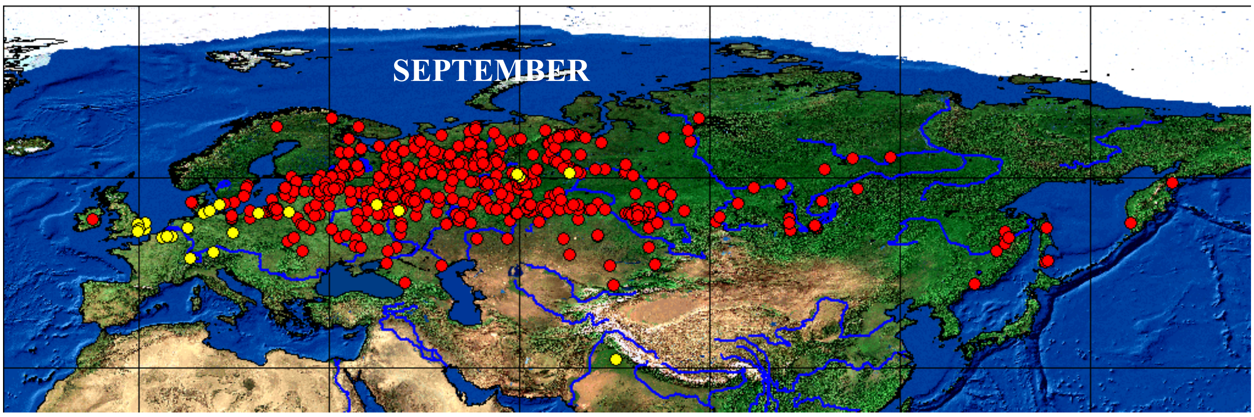

JULY


AUGUST


SEPTEMBER

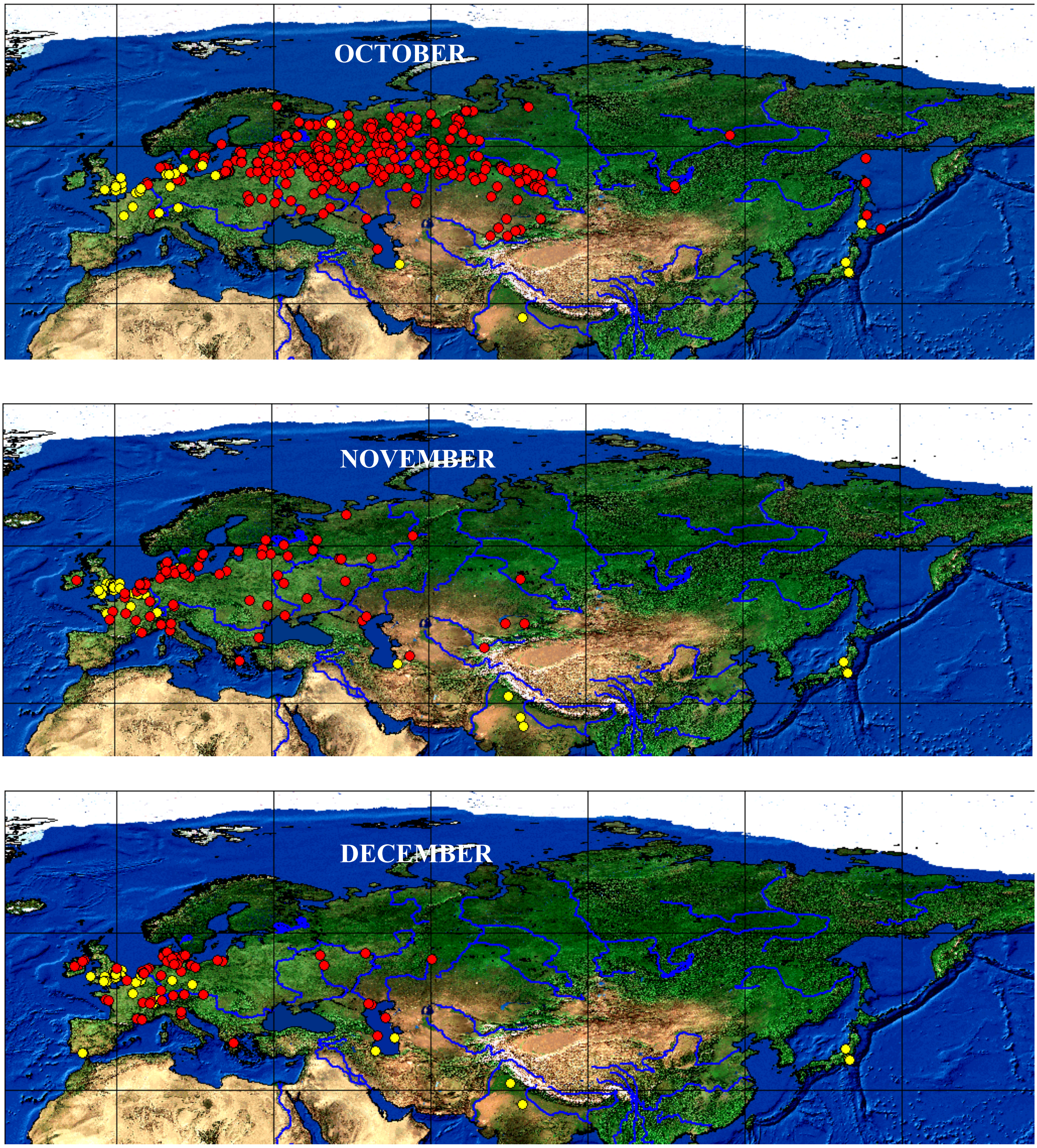


Figure 368. Tufted Duck monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

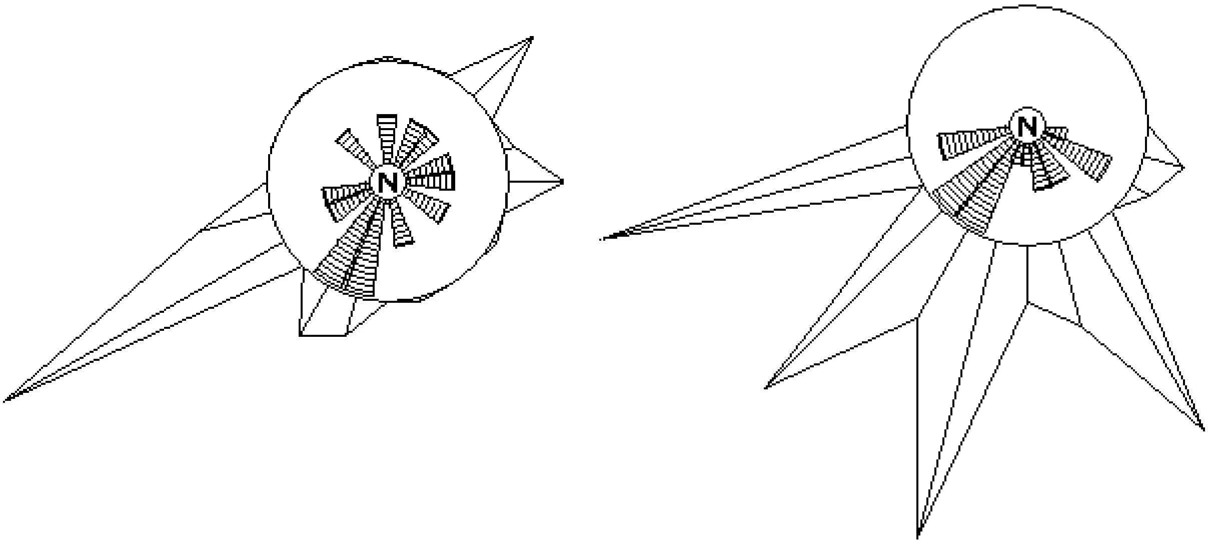


Figure 369. Recovery rose graphs for Tufted Ducks ringed in July, mostly young birds (left recovery rose) or August, mostly young birds, as well (right rose) and recovered during 60 days after ringing: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Left chart. Sector = 15.0°; Total recoveries - 27; N in sectors: from 0 up to 2; Average distance in sectors: from 0.0 km up to 1158.2 km; The longest flight distance is 1158.2 km.

Right chart. Sector = 15.0°; Total recoveries - 27; N in sectors: from 0 up to 4; Average distance in sectors: from 0.0 km up to 703.1 km: The longest flight distance is 2055 km.

Migratory routes. As it is preliminary shown in the section “Monthly movements”, Tufted Ducks from different wintering areas migrate to different directions. Birds ringed in areas with longitude <=30˚E move to north-east in spring (bearings 37-97˚, mostly 52-68˚, Fig. 370), more to the north than Common Pochards, and in the opposite direction in autumn. For birds ringed in area with longitude 30˚-60˚E, in distinction to dabbling and other diving ducks, most movements directed to the north or south. It is definitely related to the absence of the dominating ringing site (like the Volga River Delta) in other duck species. For ducks ringed in 60˚-90˚E preferable bearing area 337-52˚ - these are spring flight directions for all duck species, ringed in India. For birds ringed in Japan spring flight “fan” of directions is about the same as in dabbling ducks, bearings are 352-38˚ (Fig. 370), certainly the opposite is in autumn.

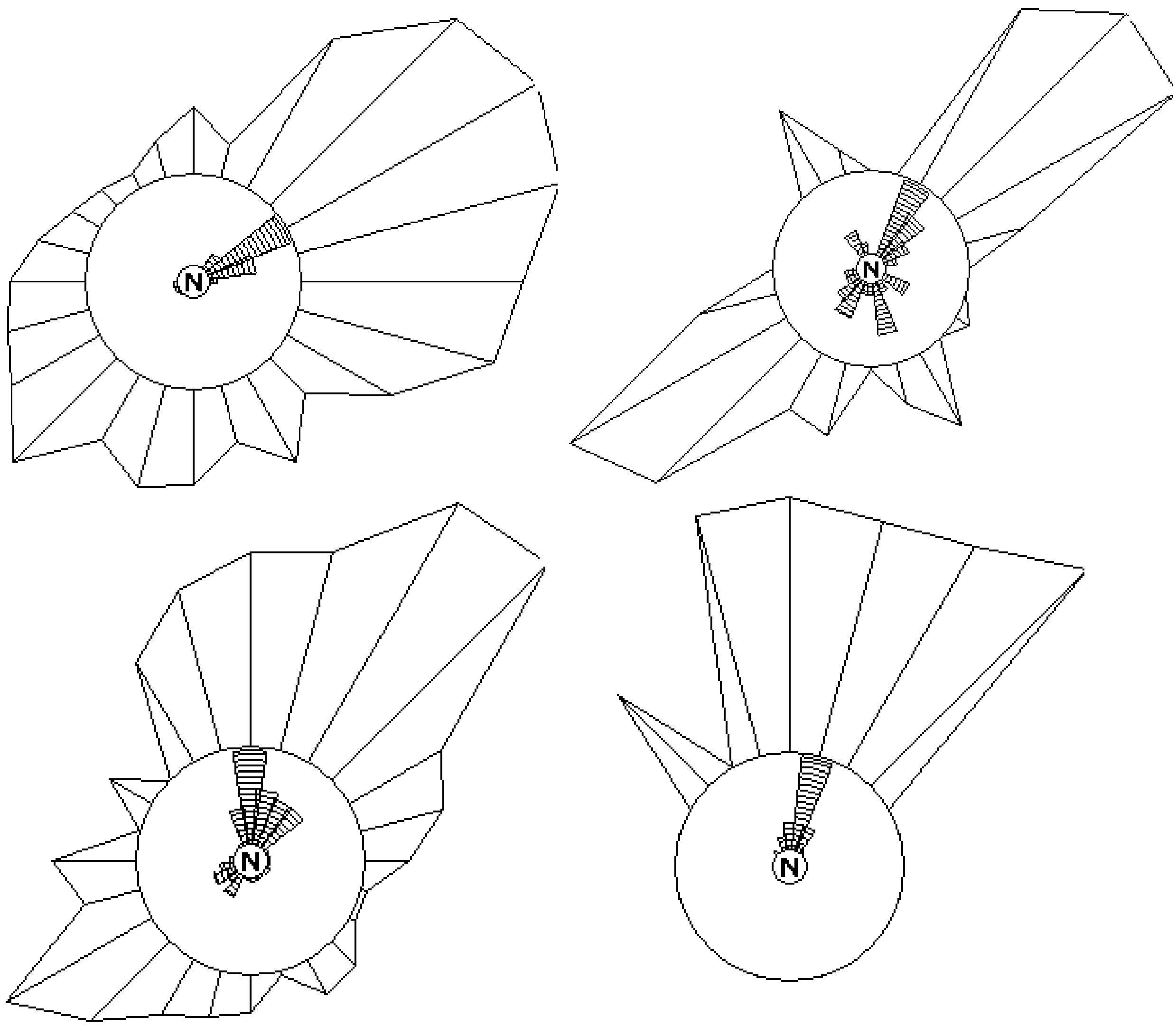


Figure 370. Recovery rose graphs for Tufted Ducks, ringed in different longitudes: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Upper left chart is for European wintering Tufted Ducks (with longitude <=30˚E), area of recoveries from British Isles to western Siberia, to 75˚E. Sector = 15.0°; Total recoveries - 3546; N in sectors: from 1 up to 1645; Average distance in sectors: from 168.7 km up to 3050.7 km; the longest flight distance is 6914.4 km.

Upper right chart is for Tufted Ducks ringed in the southern European Russia (longitude 30˚-60˚E), area of recoveries from western Europe to western Siberia, to 75˚E. Sector = 15.0°; Total recoveries - 43; N in sectors: from 0 up to 6; Average distance in sectors: from 0.0 km up to 2750.1 km; the longest flight distance is 4679.2 km.

Lower left chart is for Tufted Ducks ringed mostly in India, area of recoveries is western and central Siberia to 130˚E; Sector = 15.0°; Total recoveries - 324; N in sectors: from 0 up to 66; Average distance in sectors: from 0.0 km up to 4427.4 km; the longest flight distance is 6558.1 km.

Lower right chart is for Tufted Ducks ringed in Japan, recoveries are from Western Siberia to the Russian Far East, east of 130˚E; Sector = 15.0°; Total recoveries - 69; N in sectors: from 0 up to 37; Average distance in sectors: from 0.0 km up to 2397.7 km; the longest flight distance is 3872.8 km.

In direct recoveries short distances prevail, however longer distances up to 4000 km (lesser than in Common Pochards) are also common. Preferable distances of indirect movements are not much greater, with the peak 1800-4100 km (Fig. 371). Maximal distance of direct recoveries is 5506km, indirect recoveries – 6914 km, in both cases greater than in Common Pochard, although preferable distances are shorter.

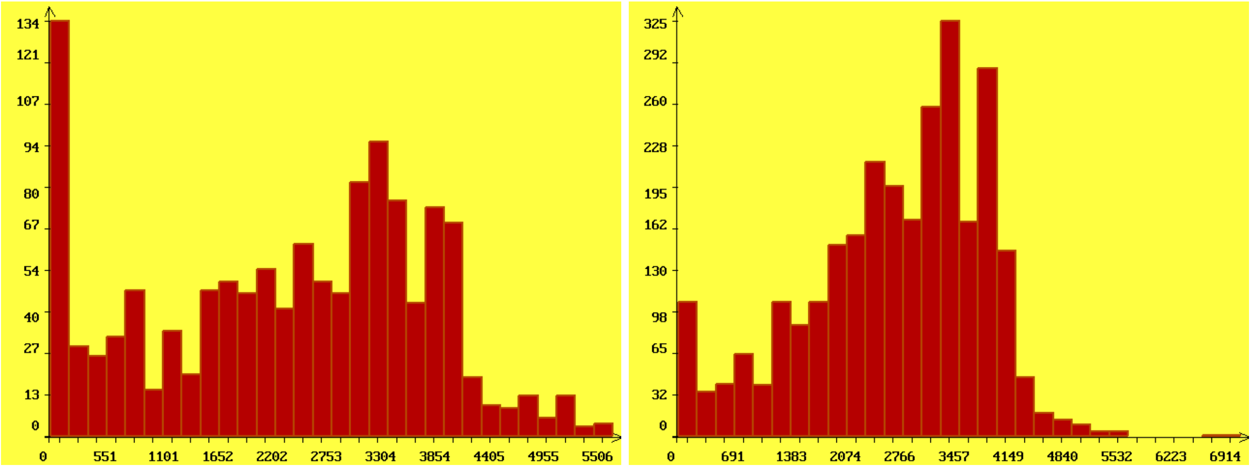


Figure 371. Distribution of all ring-recovery distances in Tufted Duck. Left chart – direct recoveries, right chart – indirect recoveries. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in Tufted Duck young birds (ringed as „pull"or „juv"or „1 y") is by more than 800 km shorter than in adults: 1918.9±41.5 versus 2784.7±19.6 km respectively (N_{young} = 998, N_{ad} = 3000), significant (t-Bailey=18.7, P=0.0000), which is characteristic for hunted species. The same as in Common Pochards, male mean flight distance is considerably longer than in females: 2973.6±18.1 and 2491.5±41.5 km respectively (N_{males} = 2170, $N_{females}$ = 1003), significant: t-Bailey= 10.7, P=0.0000. This means that males prospect for the new areas and population exchange much more than females. Then it is not clear, why males live longer than females and are in better condition than females (see section "Mortality").

Data on Tufted Ducks ringed in some places appeared to consist of different categories of birds with relatively small numbers in each category; therefore most monthly means do not give the proper information on the detailed migratory routes. However, it is possible to rely on monthly mean movements for duck ringed in several sites (Figs. 372-375).

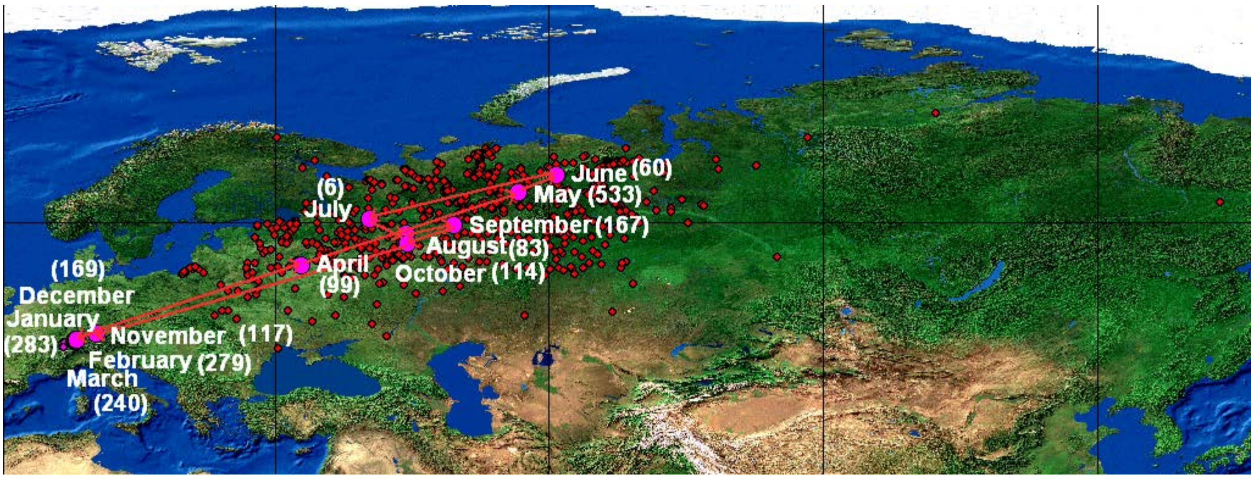


Figure 372. Mean monthly locations of Tufted Duck control points for birds, ringed on the wintering grounds in Switzerland. Large purple circles are mean monthly locations. Arrows

show directions of movements. Small purple dots are the ringing sites, red dots – recovery points. Number of control points in each month is in parentheses.

In distinction to Common Pochards (see species account), Tufted Ducks do not form any migratory loops during migration. In autumn Tufted Ducks fly back to the wintering grounds along exactly the same way as in spring, but in the backward direction. It is well visible from birds ringed in Latvia (both adults and young), in India and Japan (Figs 373-375). The same as in Common Pochard, ringed Tufted Duck ducklings disperse much more (mostly in the eastern directions) than birds ringed as adults, many of the former do not return to places of birth.

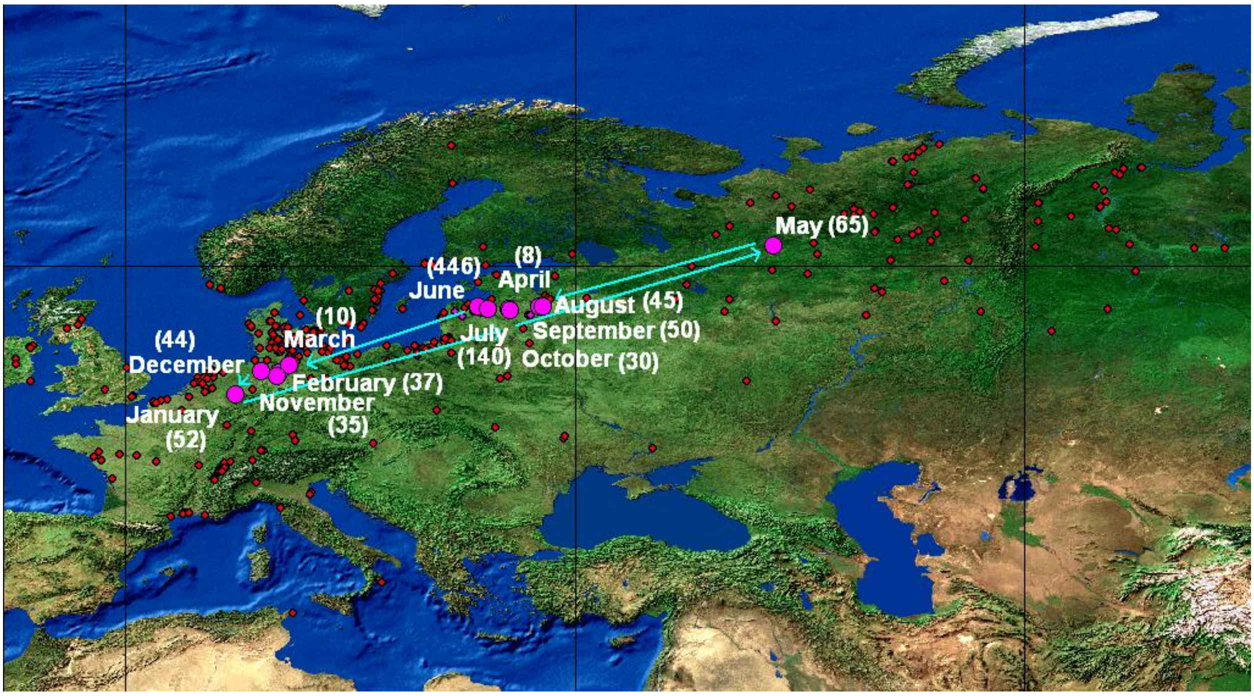


Figure 373. Monthly means for Tufted Ducks ringed in Latvia (large purple circles). Arrows show directions of migratory movements. Number of control points in each month is in parentheses.

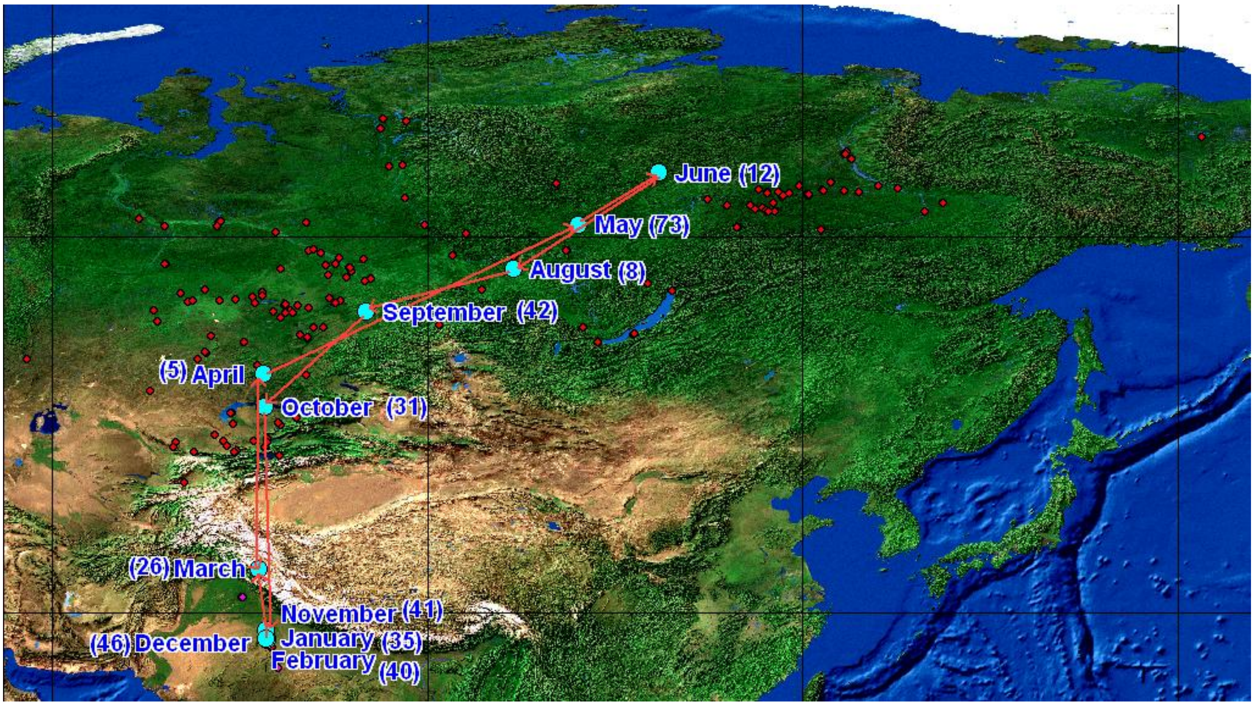


Figure 374. Monthly means for Tufted Ducks ringed in India (blue-green circles). Arrows show directions of migratory movements. Number of control points in each month is in parentheses.

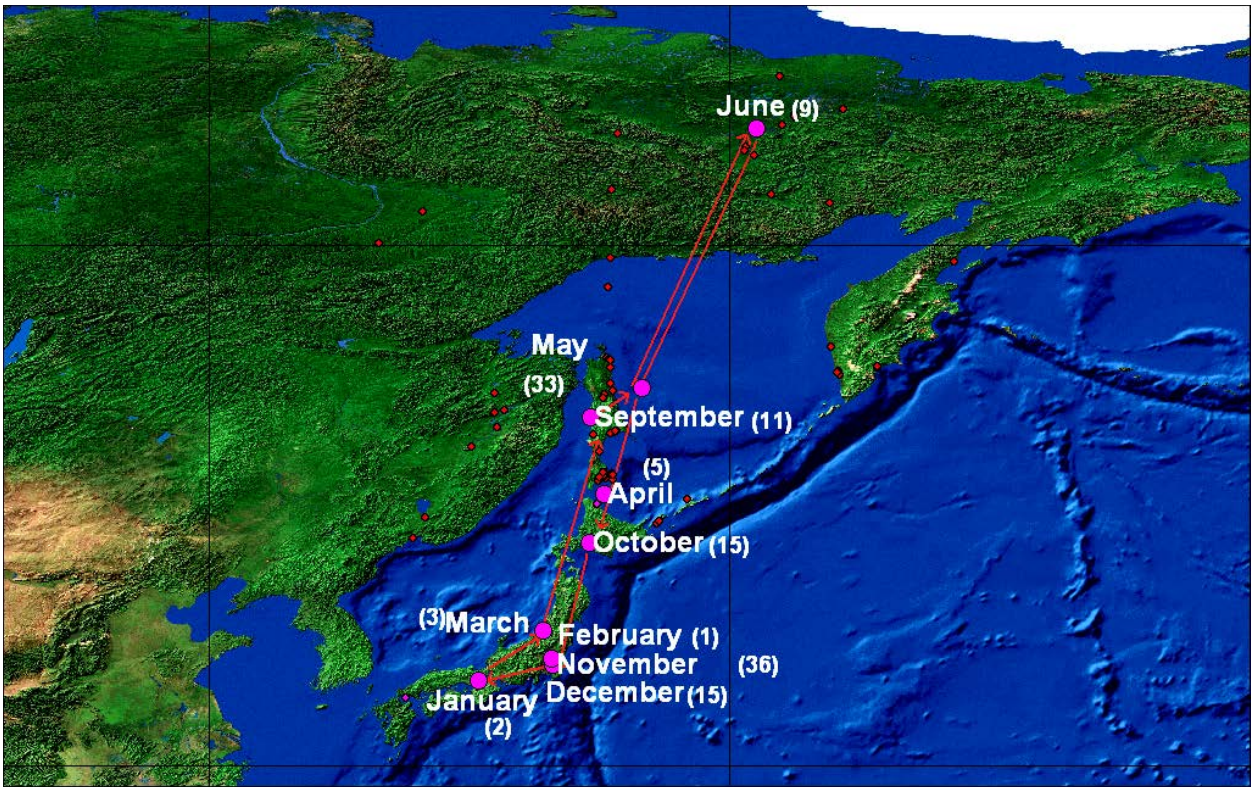


Figure 375. Mean monthly locations of Tufted Ducks control points for birds, ringed at the wintering grounds in Japan. Purple large circles are mean monthly locations. Arrows show directions of movements. Number of control points in each month represented in parentheses.

Summarising all about migratory routes, we can outline spring and autumn Tufted Ducks migratory movements (Figs 376 and 377).

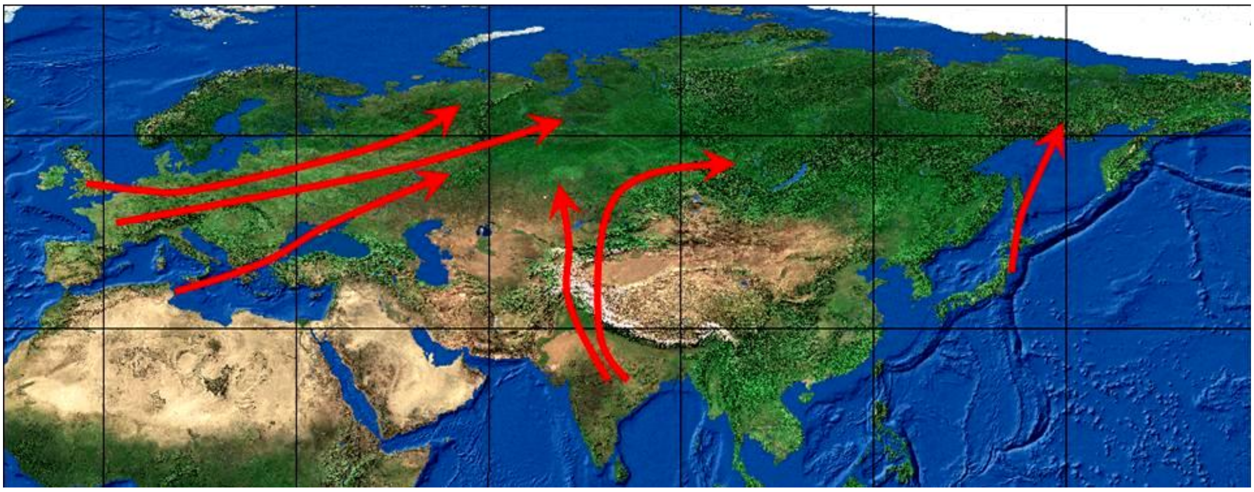


Figure 376. Outline of spring migratory routes for Tufted Duck. Red arrows are directions of migratory movements.

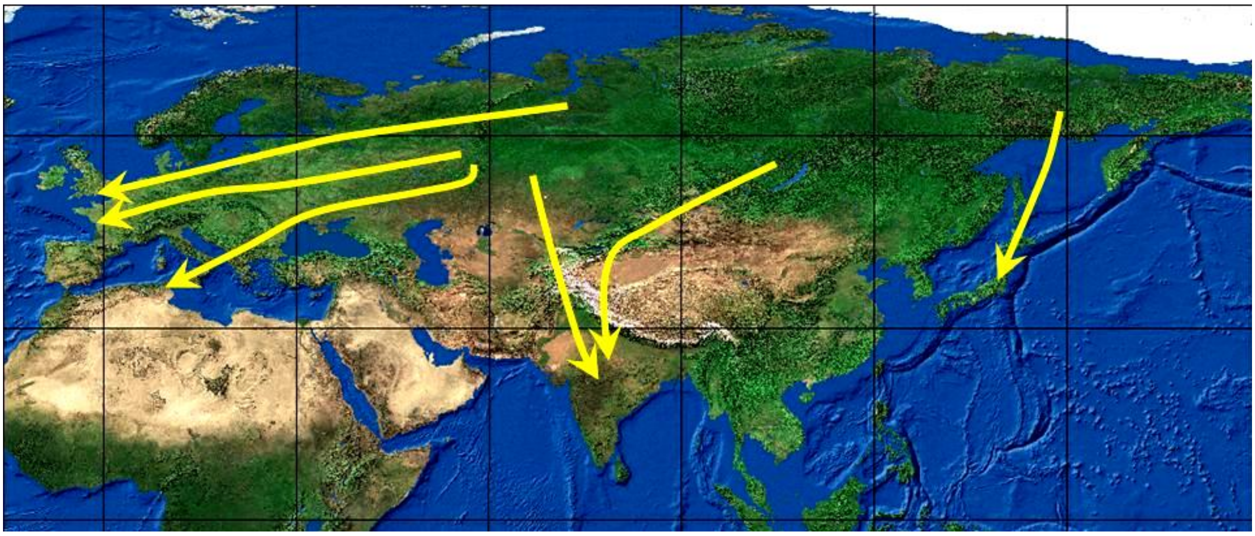


Figure 377. Outline of autumn migratory routes for Tufted Ducks. Yellow arrows are main directions of migratory movements.

Speed. Bird Ringing Centre of Russia database contains Tufted Duck direct recovery with speed of movement of about 160 km per day.

Populations. Tufted Duck is a duck with great mobility, it is capable to cover long distances, and however does not perform long-distance cross-population movements. Most of Tufted Duck populations are large and overlap greatly. But the easternmost population stays more or less isolated from others. In Tufted Duck icelandean-britannic population definitely exists, with birds migrating between British Isles and Iceland (polygon № 1, Fig. 378). Bird Ringing Centre of Russia ring-recovery data allow outlining the following Tufted Duck populations: 1) european-north-african-west-central-siberian population (polygon № 2, Fig. 378) with generally north-east – south-west migratory movements; 2) south-east-european-middle-east-persian-west-siberian population (polygon No 3, Fig. 378) with general north-east – south-west migrations; 3) hindostanian-central-asian-west-central-eastern-siberian population (polygon № 5, Fig. 378) with north – south directions of migrations; 4) japanese-far-eastern population (polygon № 5, Fig. 378) with north-south migratory movements.

Three of the four latter populations overlap considerably. Main intergradations zone is located in Western Siberia where these populations overlap. Some overlapping exists between hindostanian-central-asian-west-central-eastern-siberian and japanese-far-eastern populations, but not as large as between the former three (Fig. 378).

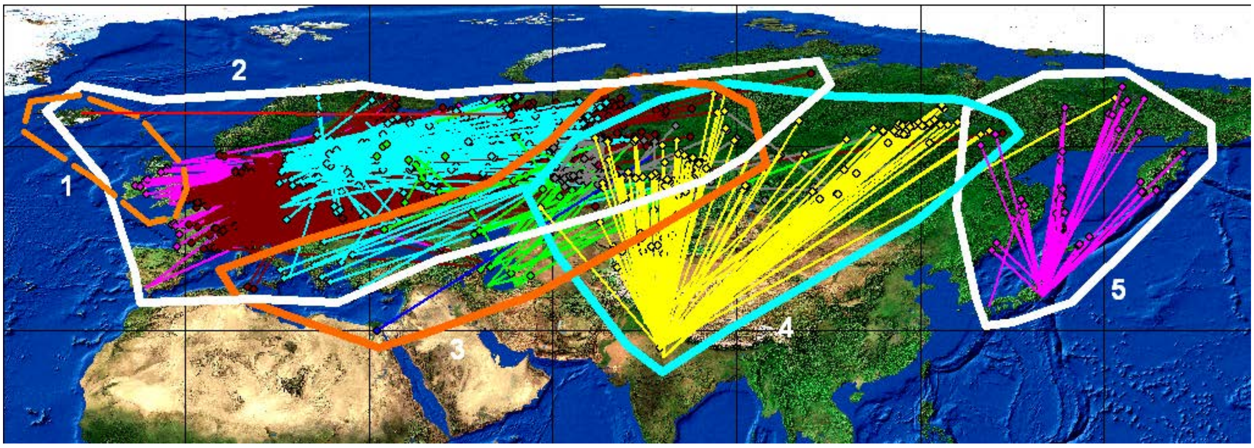


Figure 378. Tufted Duck populations. Brown dashed polygon outlines icelandean-britannic population (polygon № 1). White polygon № 2 outlines european-north-african-west-central-siberian population. Light brown polygon shows the south-east-european-middle-east-persian-west-siberian population (polygon № 3). Blue-green polygon is the hindostanian-central-asian-west-central-eastern-siberian population (polygon № 4). White polygon № 5 shows japanese-far-eastern population.

Ten-year distances. Mean flight distance in all Tufted Ducks recoveries demonstrates definite increase through decades (Table 20) in spite of changing of some ringing sites during the study period. This increase is not as great as in Common Pochard.

Table 20. Tufted Duck mean flight distance per decade.

Decade (years)	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2023
Distance (km)	1611.2	2364.1	2501.0	1792.4	2436.1	2769.7	2894.8	3030.5	3235.1
Number of recoveries	16	11	122	816	759	1158	484	311	286

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest Tufted duck lived more than 45 years 3 months. This bird is from the Bird Ringing Centre of Russia database. This Tufted Duck with the ring of „Copenhagen" scheme was ringed as adult male on 25.04.1964 and shot on 11.10.2008 in the Chelyabinsk Region, Russia, the elapsed time is 44 years 6 months (ring sent). The second oldest duck is the adult female ringed in Switzerland with ring-recovery span of 26 years 6 months. And there is one extremely long lived male: the ring is Sempach Z 15 224. The bird was ringed as 2-year old male 26.02.1972, recovered in 16.05.2020 after more than 48 years, ring sent. Really this bird lived near 50 years.

Mortality rate. According to the common criteria (see "Materials and Methods") 3636 dead recoveries are applicable for the mortality rate analysis. Two long-lived bird is greatly outstanding. For the consistency, we removed these records from the further calculations. From the sample the annual mortality rate is 26.19±0.37 %, significantly differs from the theoretical mortality rate (χ^2 = 238.4, df = 24, P=0.0000). In this case programme MARK, Model CLogLog_2[nd]Part shows 27.08%, difference is 0.71%. Tufted Duck real mortality pattern, although differs from the theoretical one, shows very little drawdown of the real survival dynamics in the comparison to the theoretical one (Fig. 379). This indicates stable condition of the species. Owing enough data, we are able to analyze mortality rate pattern over decades.

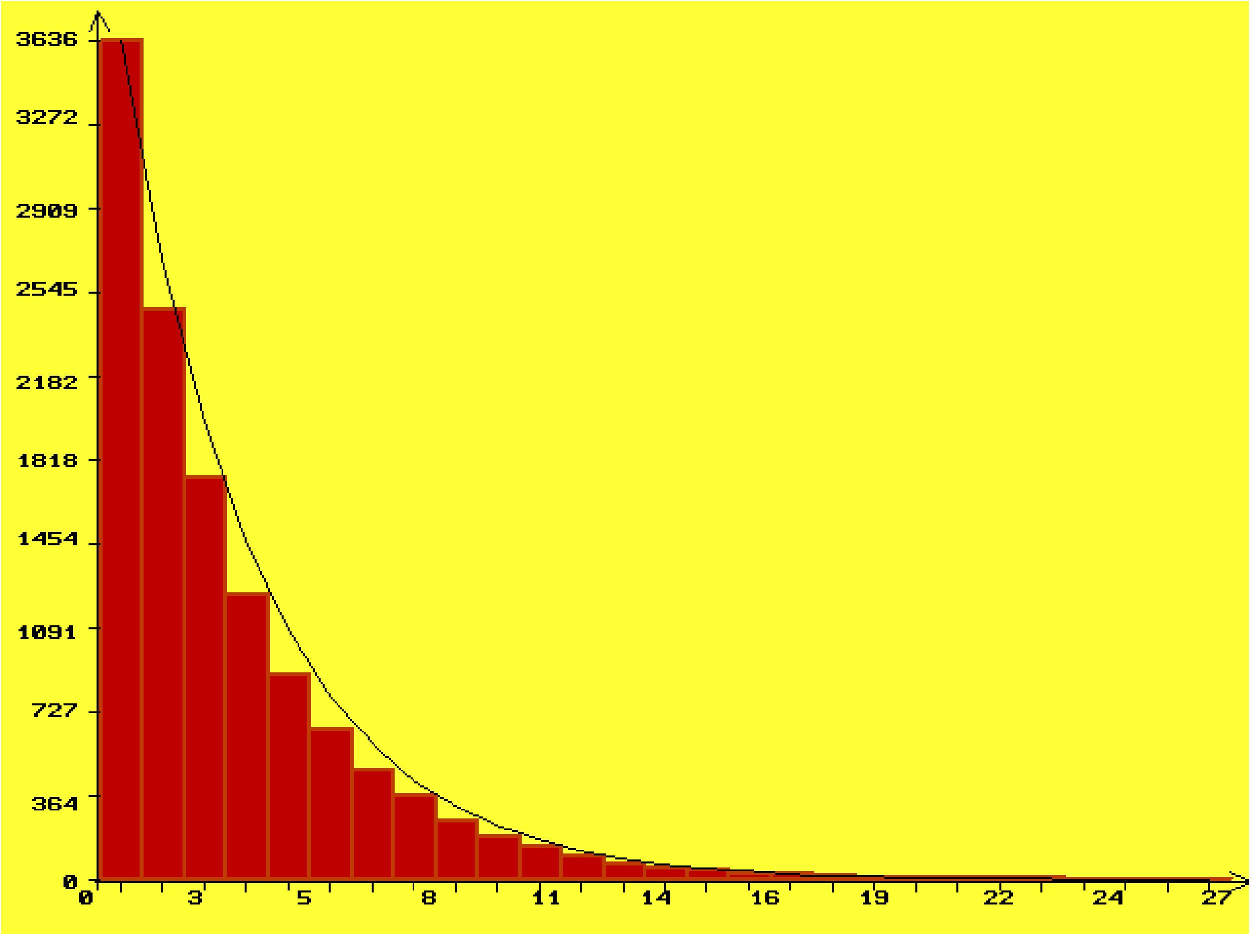
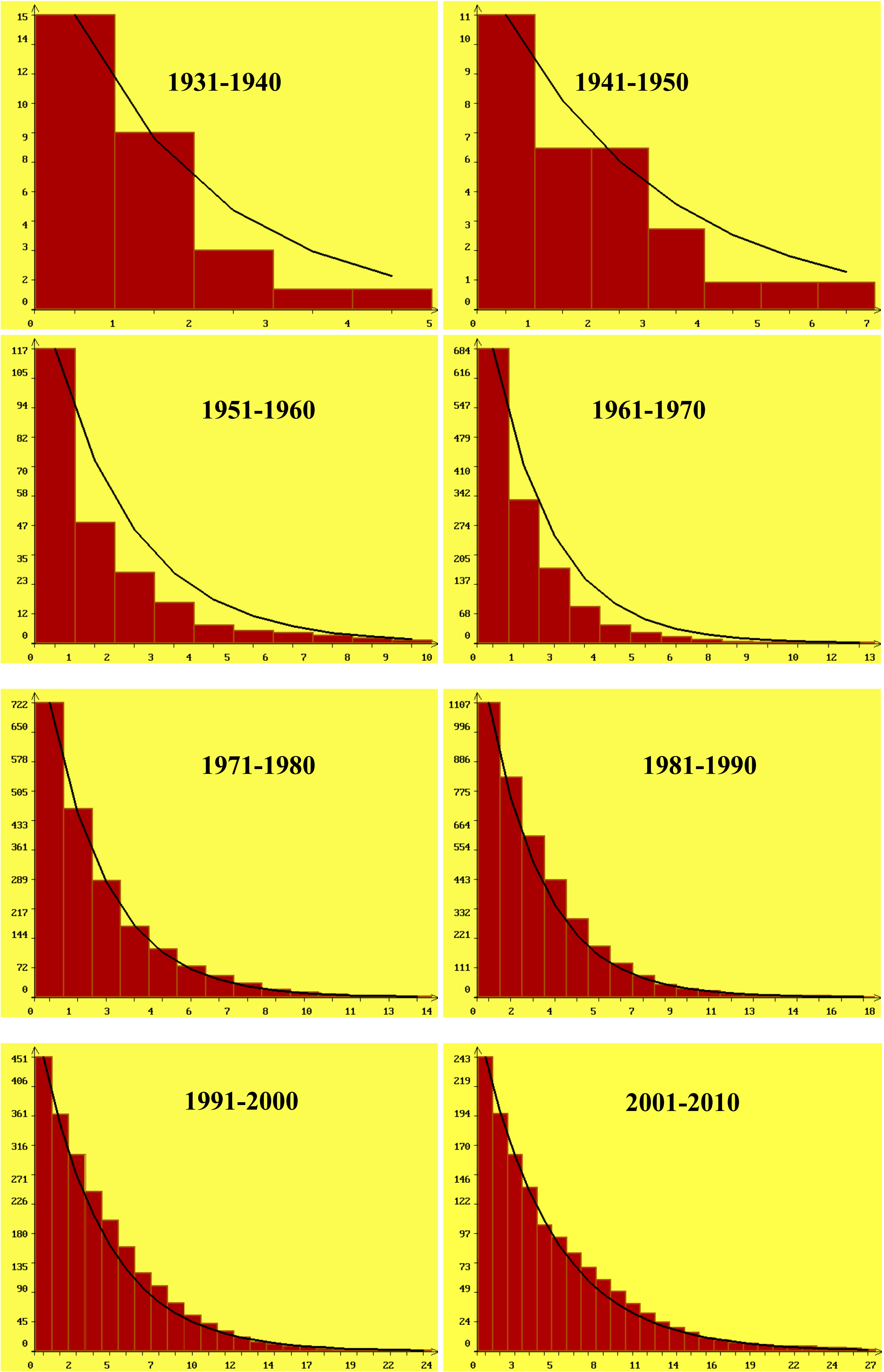


Figure 379. Mortality pattern in the Tufted Duck. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

For 1930s and 1940s mortality pattern indicates good population (species) condition – real data do not differ much from the theoretical line (Fig. 380, 1931-1940, 1941-1950). Then, for the decade 1951-1960 the condition of the Tufted Duck is getting worse. It looks like Tufted duck as a bird nesting in wet areas, had not suffered from battles and troop movements during World War II, since wet areas had been much less convenient for battles or battle preparation movements, On the other hand, hunting during the war was not possible in Russia, because shotguns had been confiscated (Bianki, 2005). However, Tufted Ducks suffered soon after (decade 1951-1960), from intensive hunting. Situation started to improve in the next decade. Then it has been getting better up till the recent years (Fig. 380). From 1981 till now the real picture of survival exceeds the theoretical line, which means the Tufted Duck population displays some growth during the recent three decades (Fig. 380).


1931-1940
15 14 12 10 9 8 6 4 3 2 0
0 1 2 3 4 5
1941-1950
11 10 9 8 7 6 4 3 2 1 0
0 1 2 3 4 5 6 7
1951-1960
117 105 94 82 70 58 47 35 23 12 0
0 1 2 3 4 5 6 7 8 9 10
1961-1970
684 616 547 479 410 342 274 205 137 68 0
0 1 3 4 5 6 8 9 10 12 13
1971-1980
722 650 578 505 433 361 289 217 144 72 0
0 1 3 4 6 7 8 10 11 13 14
1981-1990
1107 996 886 775 664 554 443 332 221 111 0
0 2 4 5 7 9 11 13 14 16 18
1991-2000
451 406 361 316 271 226 180 135 90 45 0
0 2 5 7 10 12 14 17 19 22 24
2001-2010
243 219 194 170 146 122 97 73 49 24 0
0 3 5 8 11 14 16 19 22 24 27

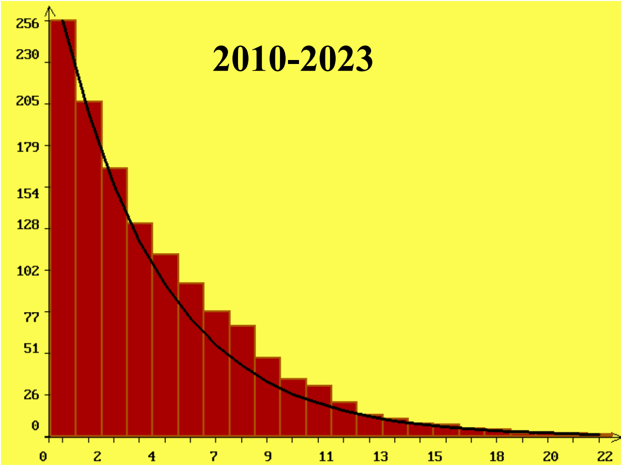


Figure 380. Mortality pattern in Tufted Ducks recovered in different decades. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Even after removing very long-lived male, the same as in Common Pochard, on average, males live considerably longer than females: 3.41±0.07 (N = 2016) and 2.17±0.08 (N = 866) years respectively, significant – t-Bailey=11.25, P=0.0000. Although female overall mortality rate is lower than in males: 22.16±0.66 and 26.24±0.50% respectively, the demographic condition of females looks worse because the chat drawdown in females is greater (Fig. 381)

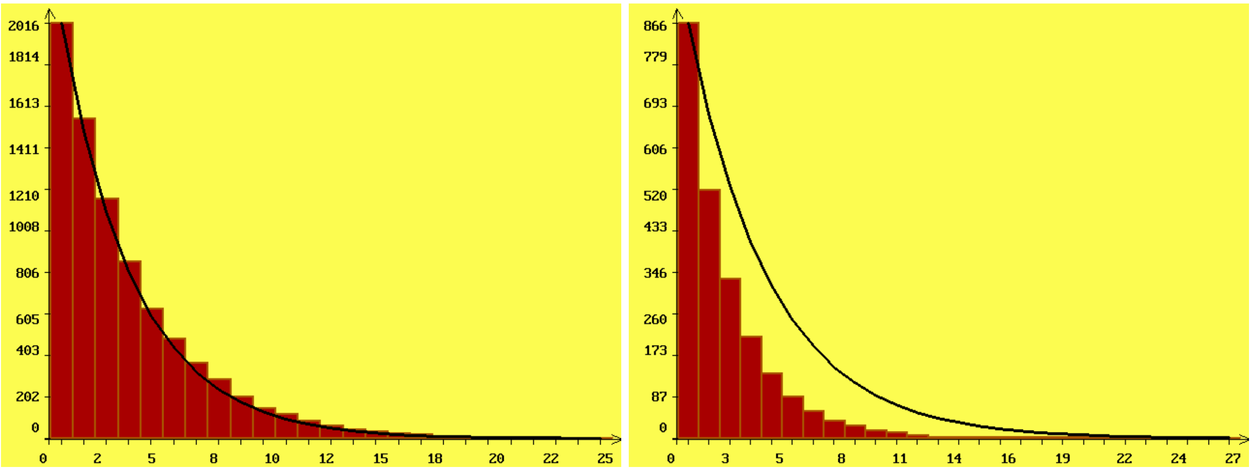


Figure 381. Mortality rate pattern Tufted Duck sexes: left – males, right – females. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

GREATER SCAUP
(*AYTHYA MARILA*)

Photo by Nikolay B. Konyukhov

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 382. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

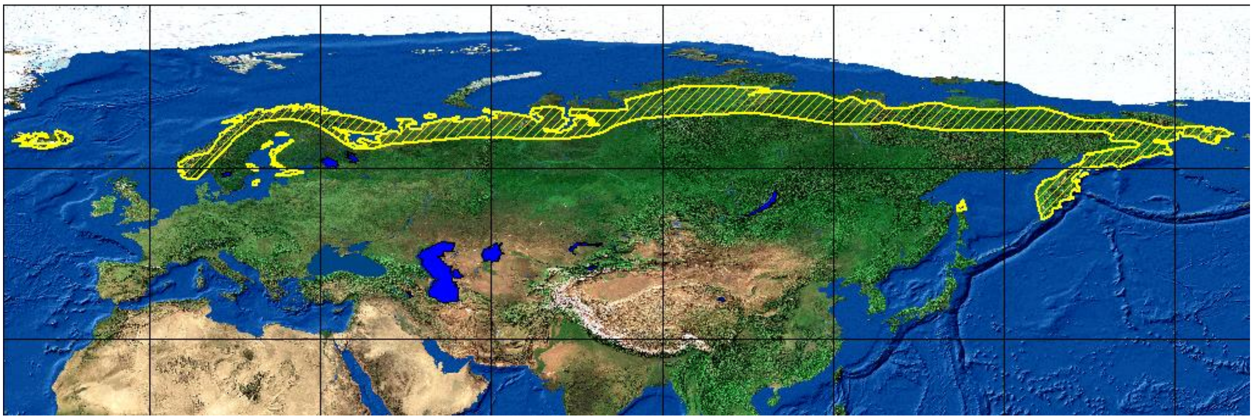


Figure 382. Breeding range of the Greater Scaup in Eurasia (yellow dashed areas).

Distribution of control points. Bird Ringing Centre database contains data on 104 marked birds, which gave 105 recoveries, i.e., 103 ducks gave one recovery, one duck – two recoveries. All ducks were marked with metal rings only. Ringing dates are since 03.03.1931 until 09.12.2007, recovery dates are since 27.05.1931 until 01.10.2014.

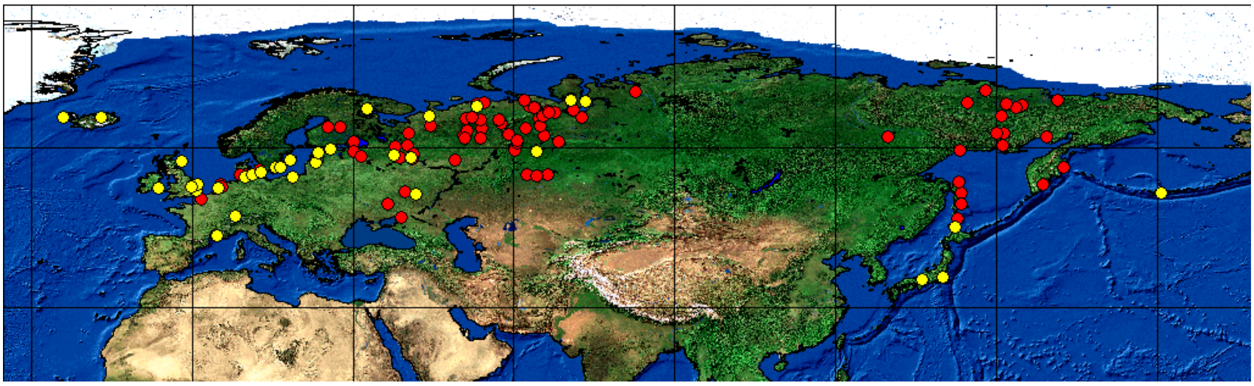


Figure 383. Position of all Greater Scaup control points. Yellow dots – ringing sites, red dots – recovery sites.

Greater Scaups in the Bird Ringing Centre Database were marked by rings of 13 schemes. Ducks were ringed in many places of the Western Europe, Russia, Ukraine, Japan, USA (the latter – at the Aleutians) (Fig. 383).

'Moskwa' scheme recoveries. This sample contains 28 recoveries of the scheme „Moskwa". They are from birds ringed within the Russian Federation, Latvia and Estonia (Fig. 384). 13 birds were ringed in the Kandalaksha Nature Reserve, Murmansk Region.

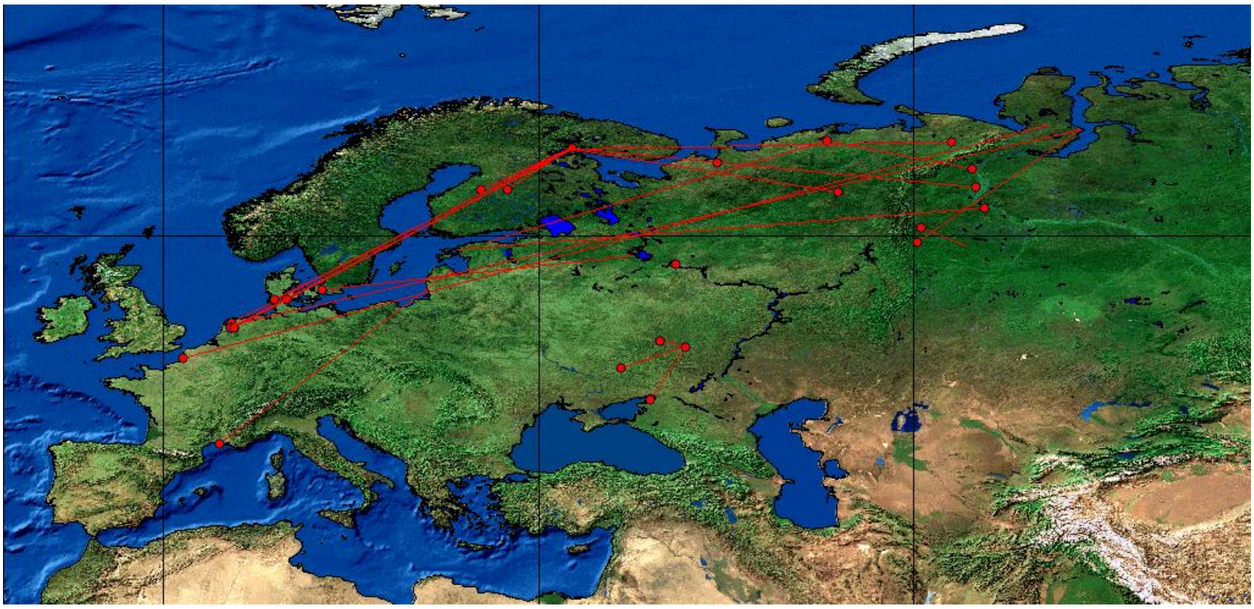


Figure 384. „Moskwa" scheme recoveries of the Greater Scaup. Here and on all other similar figures lines start from the ringing site, recovery sites are marked with red dots.

Finding details. This analysis includes all 99 recoveries. 90 (86%) are „shot". In 5 (5%) recoveries „details unknown", which practically mean shot, as well. Therefore, we can assume that 91% of birds were shot. Other reasons: caught – 2 birds, found dead – 2, found dead in fishing net – 6.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries of Scaup are similar (Figs 385 and 386).

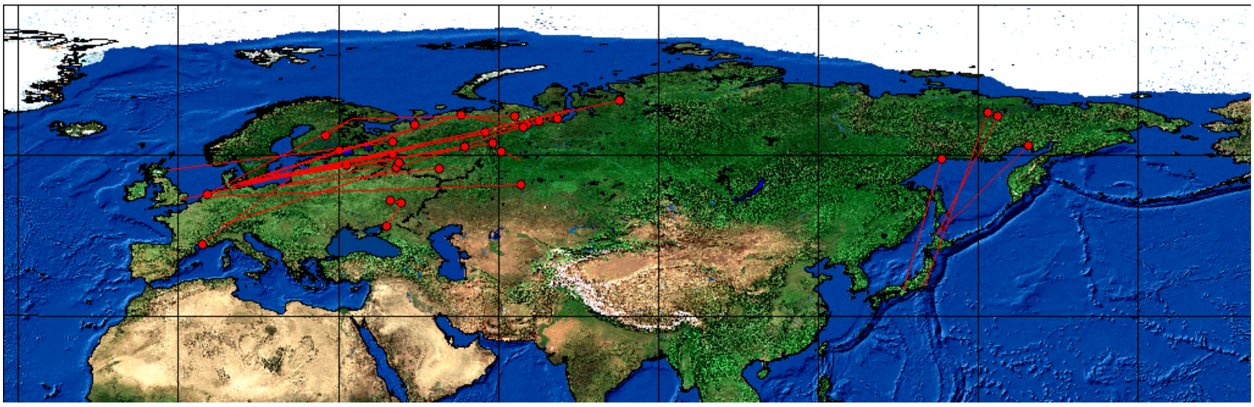


Figure 385. Map of the Scaup direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

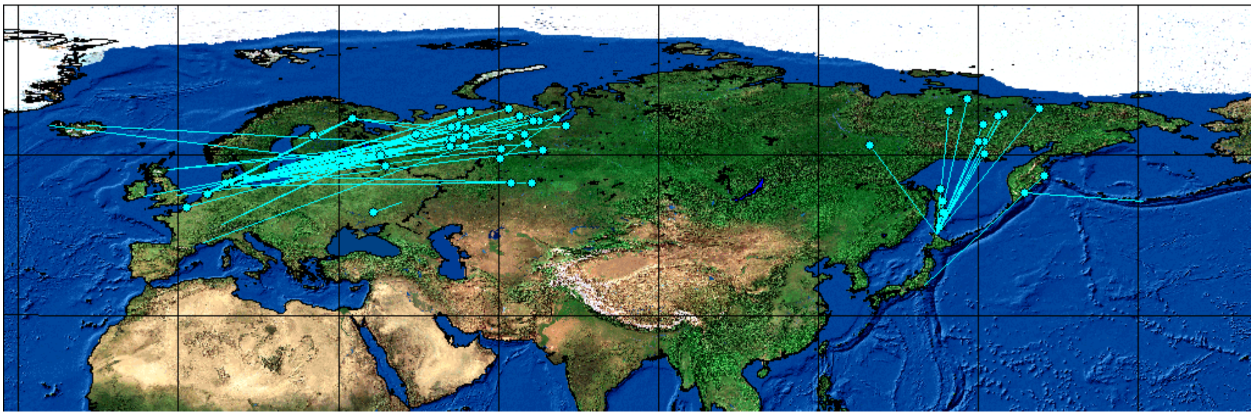
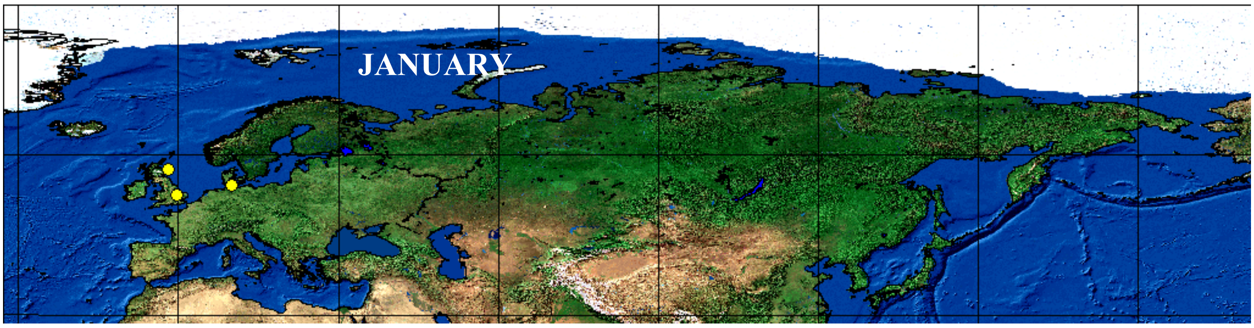
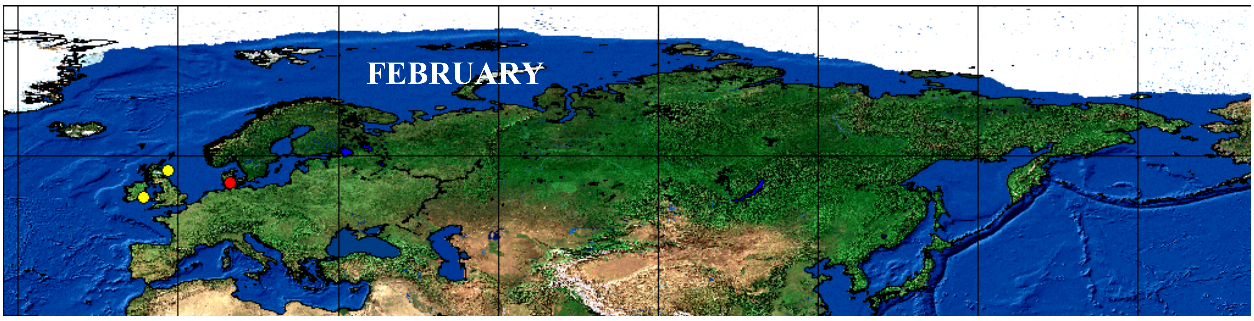


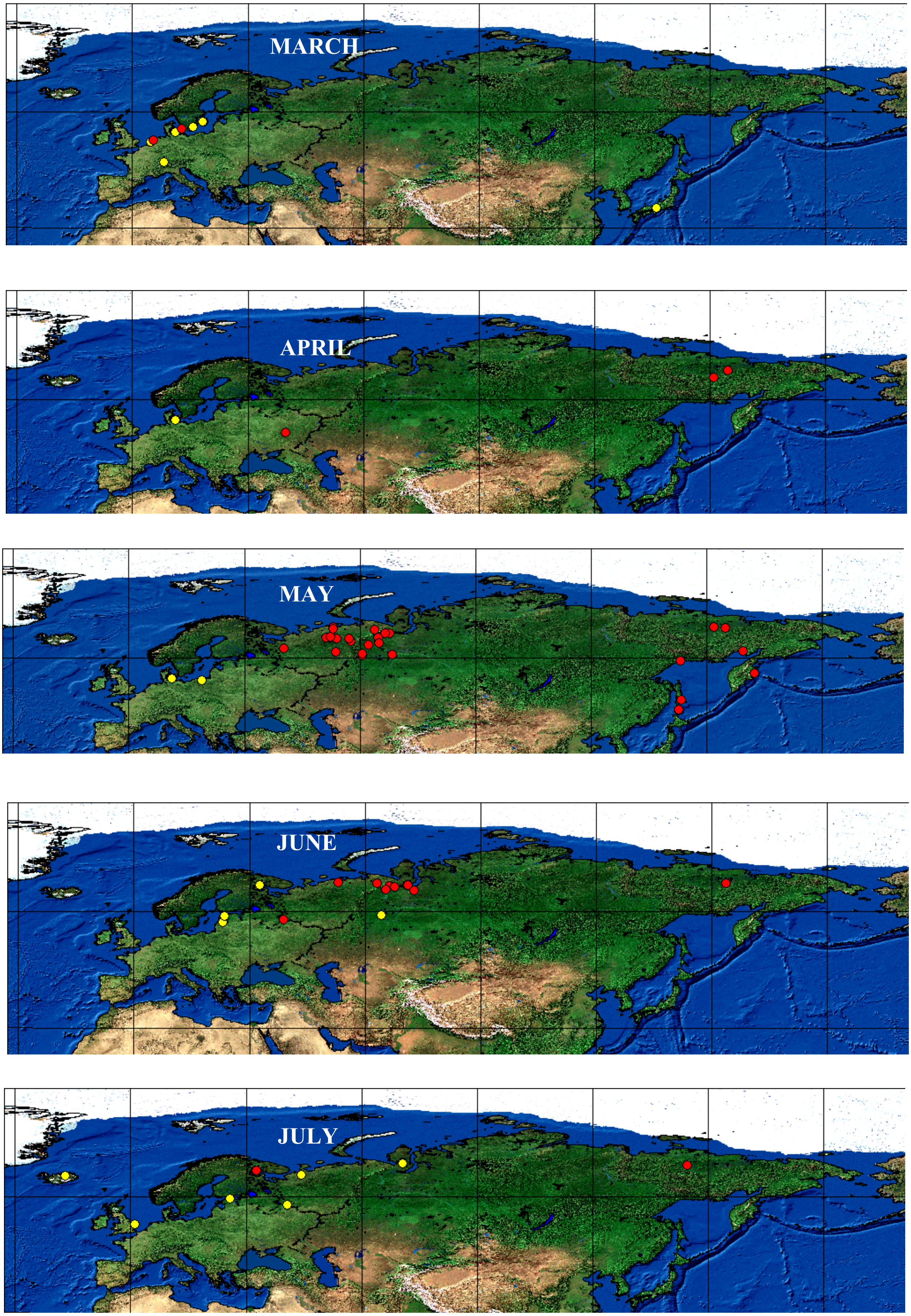
Figure 386. Map of the Scaup indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

Average flight distances in direct and indirect recoveries are close to each other: 2037.2±210.7 (*N*=35) and 2266.5±119.1 (*N*=70) respectively, difference is insignificant.

Monthly movements. All recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery sites) reflect a general way of seasonal movements in the Greater Scaup (Fig. 387). In January and February birds are on the wintering grounds in western Europe, on the Black Sea (although no recoveries from there, but several recoveries of migration to and from the Black Sea area exist), no data on winter months for Japan are available, but certainly birds winter there, as well. In March some weak migratory movements are noticeable – to the east for European wintering ducks (March, Fig. 387). In March in Japan there is a recovery from the wintering grounds only. In April–May Scaups fill their breeding range. In June through August ducks are within their breeding area, although in July and August there are some control points of these ducks in the wintering area in Western Europe. Autumn migration commences in September in all populations, finishing in November. In December Scaups are in wintering areas (Fig. 387).






MARCH
APRIL
MAY
JUNE
JULY

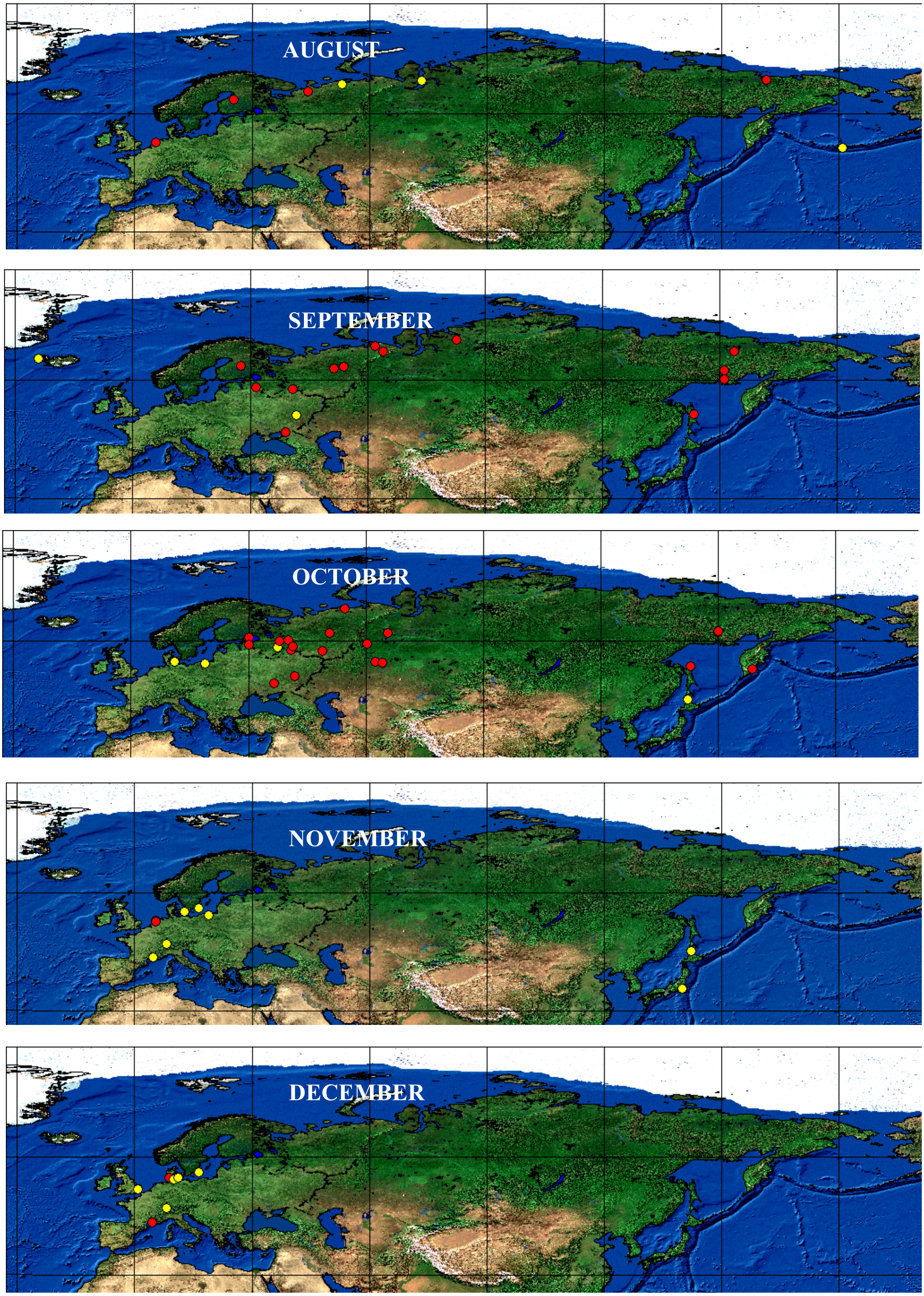


Figure 387. Scaup monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. Western European wintering Scaups migrate to the east, north-east up to 82˚E. There is a population with uncertain boundaries (see section “Populations”) that spend winter in the Black Sea area, probably at the Caspian Sea, as well. Our data on this population are scarce; it is not possible to draw any complete migratory route. Logically, birds of this population should migrate along north (possibly even north, north-east) and south directions. Japan wintering ducks migrate along north-south directions (Figs 385 and 386). Little is known about Scaups migrating from or to North America.

Distribution of distances indicates that Scaup is very mobile duck, because there are relatively small numbers of very short distances and peak of distances falls on 1800-3500 km (Fig. 388). The longest flight for direct recoveries is 3993.2 km, for indirect ones – 4427.7 km.

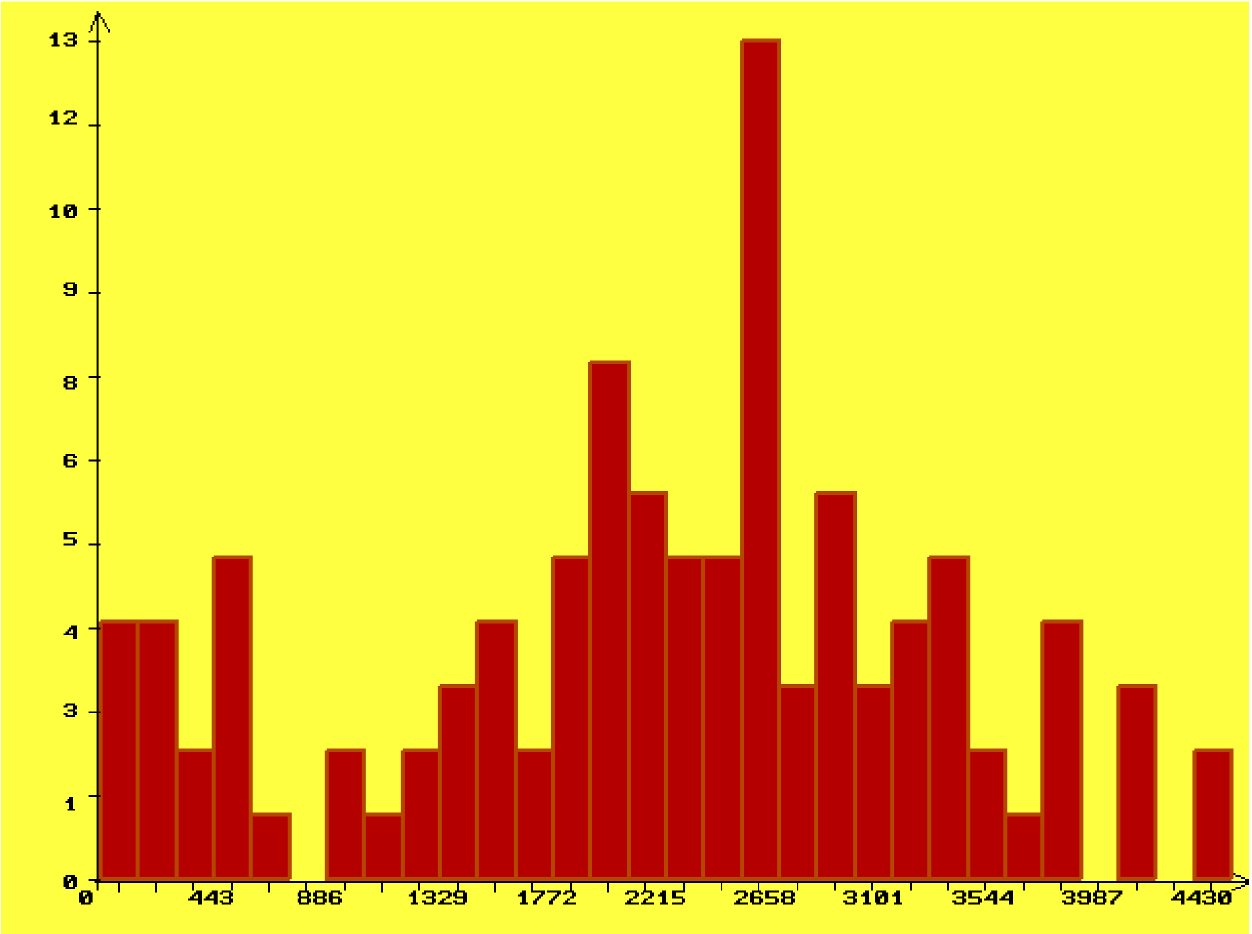


Figure 388. Distribution of all ring-recovery distances in the Scaupe. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in young birds (ringed as „pull" or „juv" or „1 y") is close to that in adults: 2128.0±156.6 (N_{young} = 41) and 2299.9±141.7 (N_{ad} = 64) km respectively, insignificant. This means that the species does not noticeably suffer from hunting. This conclusion is also confirmed by the stable demographic status in Scaups (see section „Mortality"). Male mean flight distance is slightly longer than in females: 2442.7±154.6 and 2262.9±160.6 km (N_{males} = 45, $N_{females}$ = 37) respectively, insignificant.

Speed. Scaup is a mobile duck. The database contains recoveries with the speed up to more than 90 km per day.

Populations. Data set on Greater Scaup is quite small, therefore allows separating only two more or less certain populations and 2-3 uncertain ones (Fig. 389). They are: 1) icelandean-britanic population (The Migration Atlas, 2002); 2) european-siberian population (polygon № 2) with east, north-east – west, south-west directions of movements; 3) uncertain black-caspian-sea-northen-european-russia-wetern-siberian population (№ 3) with logically north-south migrations; japanese-far-eastern population (№ 4); 5) a part of north-american-far-eastern population (№ 5).

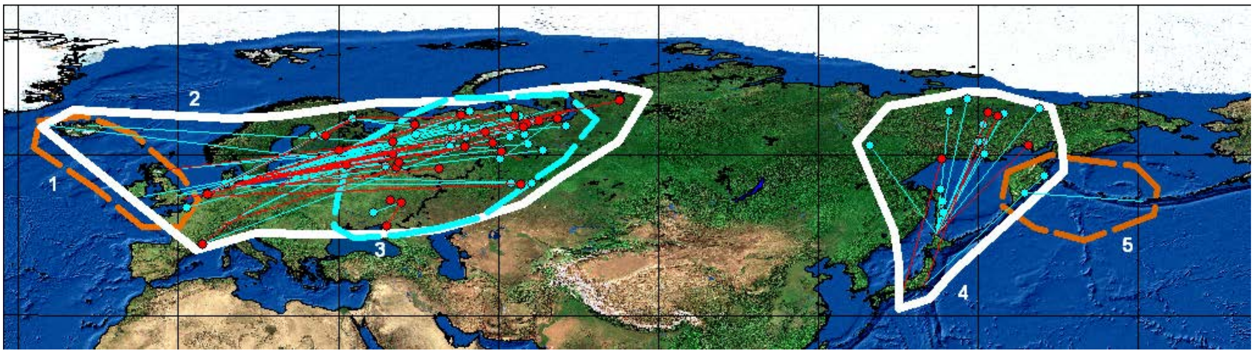


Figure 389. Scaup populations. Brown dashed polygon outlines icelandean-britanic population. White polygon № 2 outlines european-siberian population. Blue-green polygon (№ 3) outlines uncertain black-caspian-sea-northen-european-russia-wetern-siberian population. White polygon № 4 shows japanese-far-eastern population. Brown dashed polygon (№ 5) is a part of north-american-far-eastern population. Red lines with red dots at the recovery places represent direct recoveries, blue-green lines with purple dots at the recovery places represent indirect recoveries.

Ten-year distances. Mean flight distance in all Scaup recoveries demonstrates slight increase through decades, however insignificant.

Lifespan. EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010 displays data on the Scaup lifespan as 15 years 3 months. Bird Ringing Centre database contains confirmed recovery of male ringed as 1-year-old and recovered after 10 years 6 months (ring sent).

Mortality rate. According to the common criteria (see “Materials and Methods”) 94 dead recoveries of Greater Scaups are applicable for the mortality rate analysis. Mean annual mortality rate in the Greater Scaup is 33.84±2.84%. Real mortality pattern is similar to the theoretical one (χ^2 = 3.58, df = 8, P=0.89). Programme MARK, Model CLogLog 2ndPart shows 31.36%, difference is 2.48% within the limit of the standard error. In spite of little amount of data in the set, mortality rate pattern suggests the conclusion on the stable condition of the species (Fig. 390), however data are from the period not later than 2014.

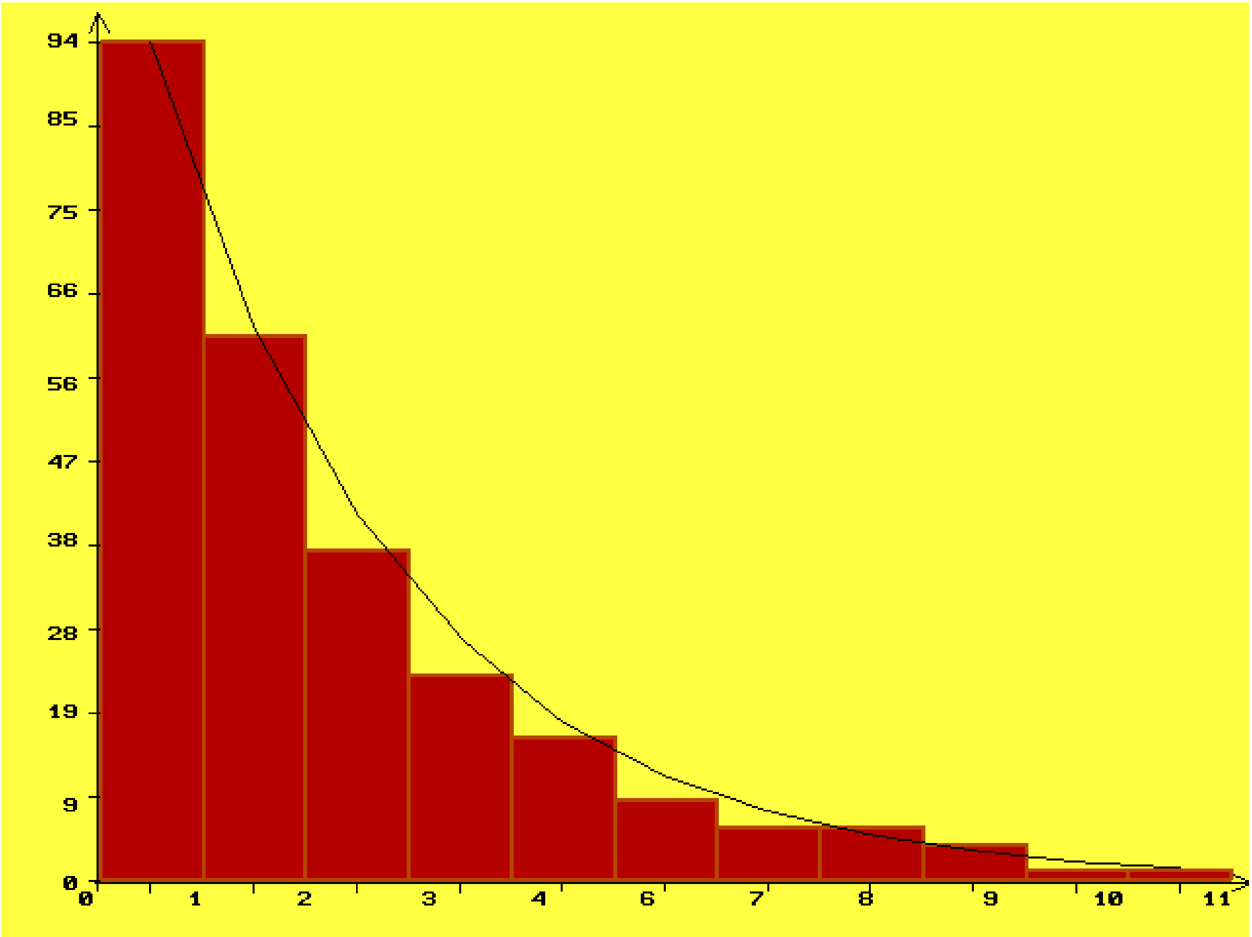


Figure 390. Mortality pattern in the Scaupe. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Males of Scaup live, on average, longer than females: 2.91±0.39 (N=41) and 1.97±0.30 (N=31) years respectively, with the tendency to be significant (t-Bailey = 1.91, P = 0.061).

COMMON EIDER
(*SOMATERIA MOLLISSIMA*)

Breeding range in Eurasia. Brief description of the breeding range is in Fig. 391. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

Photo by Nikolay B. Konyukhov

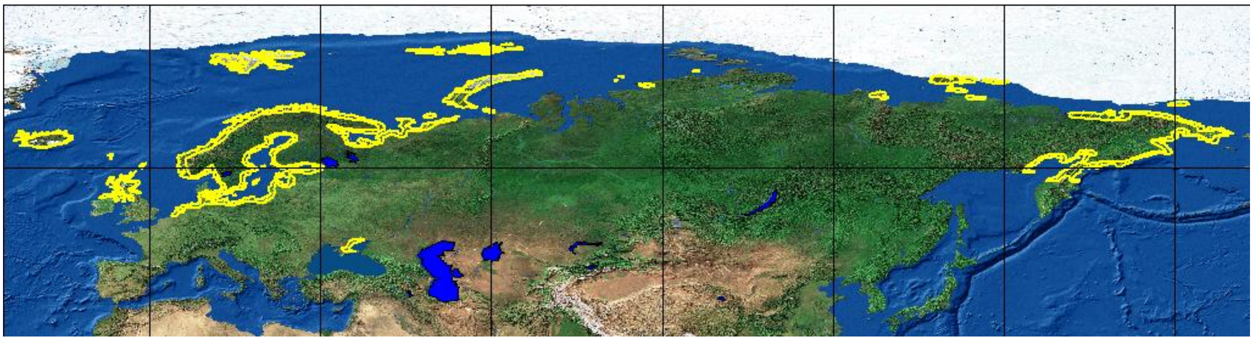


Figure 391. Breeding range of the Common Eider in Eurasia (yellow dashed areas).

Distribution of control points. Bird Ringing Centre database contains data on 72 marked birds, they gave 72 recoveries, one recovery per bird. 61 ducks were marked with metal rings only, 4 ducks in addition to metal ring worn colour-rings, one bird – colour neck-collor. Ringing dates are since 25.06.1940 until 14.06.2019, recovery dates are since 24.05.1943 until 20.05.2020.

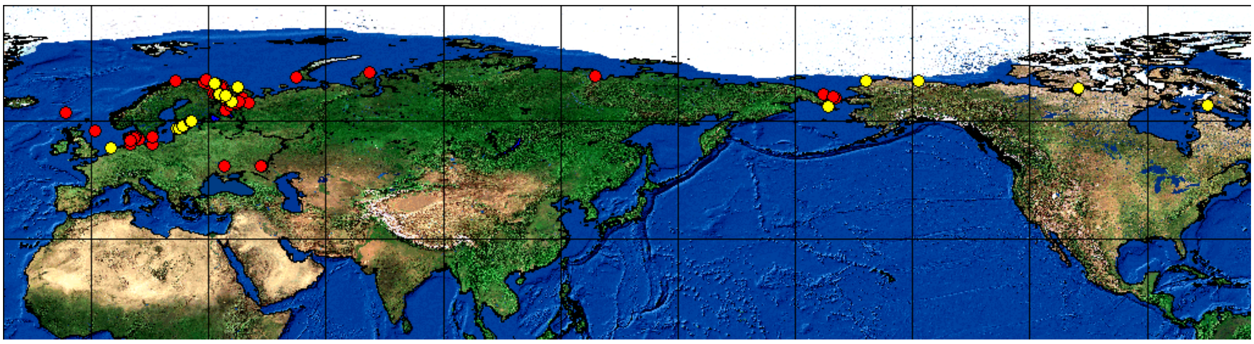


Figure 392 Position of all Common Eider control points. Yellow dots are ringing sites, red dots are recovery sites.

Bird Ringing Centre database contains recoveries of Common Eiders marked by rings of 4 schemes: „Moskwa" scheme – 60 recoveries, „Washington" scheme – 7, „Arnhem" – 2, „Helsinki" - 3. Ducks were ringed in many places of the Western and northern Europe, Russia, USA and Canada (Fig. 392). Common Eider breeding range has a considerable break in Central Siberia, where this species does not breed; and two great areas to the west and east of the Central Siberia where this duck breeds. Therefore, we can consider two super-populations of the Common Eider: 1) european-western-siberian super-population (65 recoveries); 2) north-american-far-eastern-eastern-siberian super-population (7 recoveries). The first one spreads from Iceland to the middle of Taimyr Peninsula, the second one from Lena River Delta at least to the eastern Canada. These super-populations differ in some visible characteristics. E.g., distances of movements of birds from the second super-population look much greater, than from the european-western-siberian one (see below). However, we should keep in mind, that data from ducks ringed in North America are highly biased, because we do not have the information about short movements of those birds. This is because records of short movements fall out of the Russian territory. For this reason, some analyses are performed only for the european-western-siberian super-population. Anyway, maximal distances of movements in both super-populations might be compared.

Finding details. This analysis includes all 72 recoveries. 28 (40%) were „shot". In 8 (11%) recoveries „details unknown", which really means they are shot, as well. Therefore, we can assume that 51% of birds were shot, which is much less than in other ducks. Other reasons: caught – 3 birds, found dead – 17, found dead in fishing net – 8, oiled – 1, ring found in the field – 5, killed by wild animal -1, taken by the bird of prey – 1.

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries of Common Eider are considerably different. Indirect recoveries cover breeding range more completely, thus they give more information about Common Eider movements than direct ones (Fig. 393 and 394).

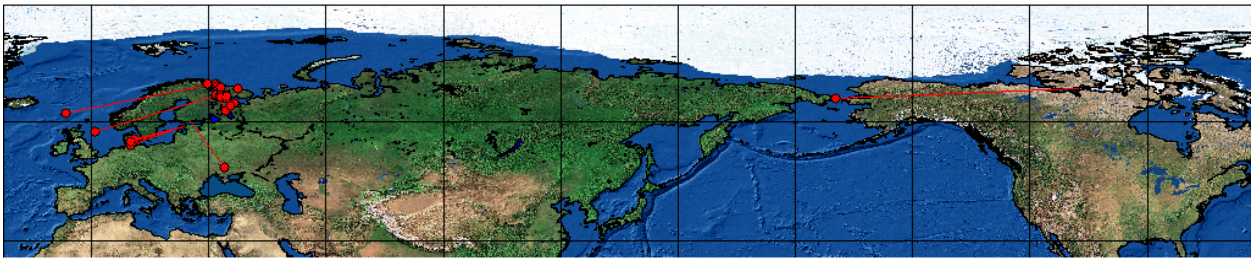


Figure 393. Map of the Common Eider direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

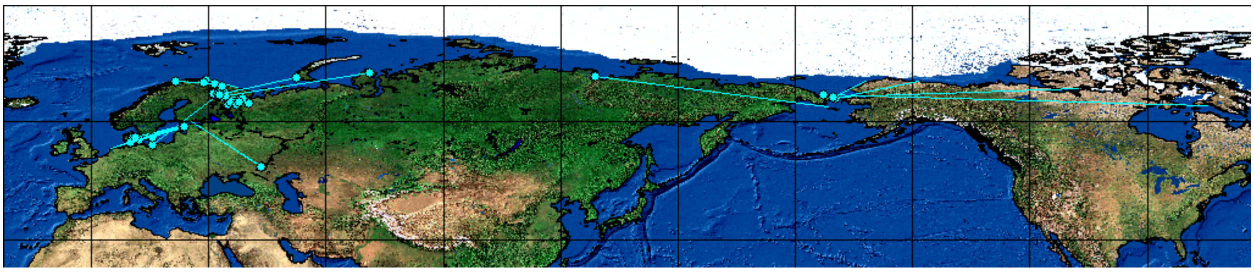
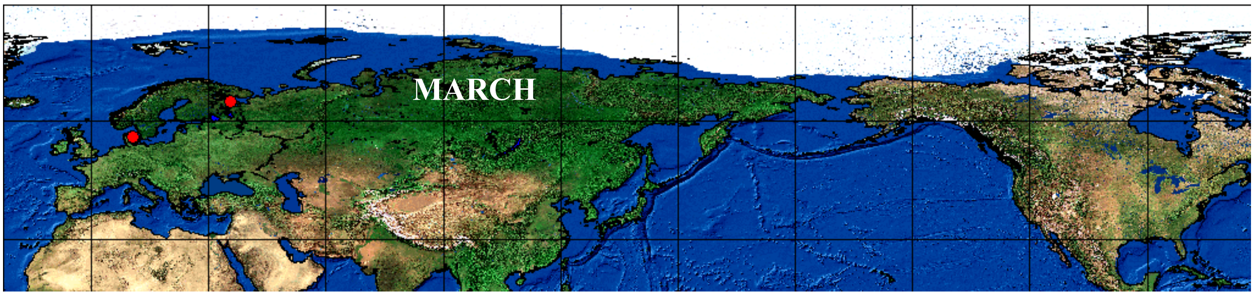


Figure 394. Map of the Common Eider indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

Average flight distances in direct recoveries are considerably shorter than in indirect ones for the european-western-siberian Eiders: 401.6$\pm$110.1 (N=27) and 510.4$\pm$87.6 (N=38) respectively, difference insignificant, probably because of small samples.

Monthly movements. All recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in the Common Eider (Fig. 395). Common Eider is a sea duck, it can cover long distances by swimming, quite often spends winter just in several tens or hundreds km from the breeding areas. At the same time it is capable to fly long distances, covering more than thousand km over the mainland. In January and February birds are on their wintering grounds in western Europe, on the Sea of Azov and Black Sea (although no recoveries from there, but one recovery of migration to or from the Black Sea area exists). No data on North America in these months are available, but certainly birds winter there, as well. In March some migratory movements generally are not noticeable yet (March, Fig. 395). For April data are absent. In May-June-July-August-September Eiders are in their breeding range. In October migration is not noticeable, as well, but one recovery in the southern Ukraine indicates movement between Azov, Black and Baltic Seas. The point is that, since middle of the 20th Century there is a small azov-black-sea Common Eider breeding population, which definitely originates from the baltic-sea population (Koryakin et al, 1982; Bianki, 1989). It is quite possible, that Baltic birds migrate to the Black Sea for wintering. In November birds are on their wintering grounds both in the western Europe and in the White Sea. There ducks winter not far from their breeding grounds. At the same time, in November one bird was recovered in the Volgograd Region, exactly on the line connecting the Baltic and Caspian Sea (Fig. 395). This allows suspecting the formation or even existence of the new, caspian-sea Common Eider population. According to the opinion of the Common Eider specialist Alexandre Koryakin, formation of the Caspian Eider population in current time is quite possible (see section "Populations"). In December all birds are definitely on their wintering grounds (Fig. 395).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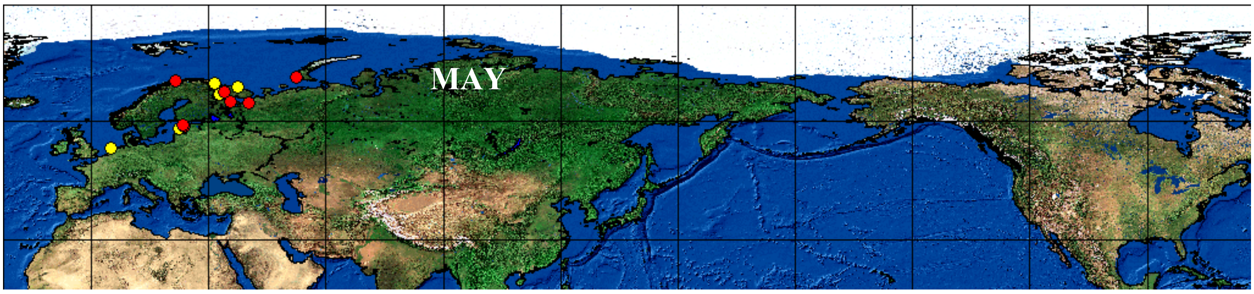
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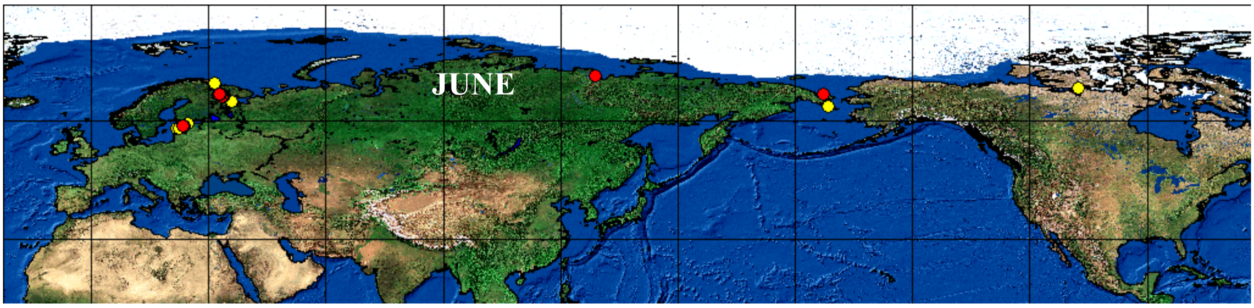
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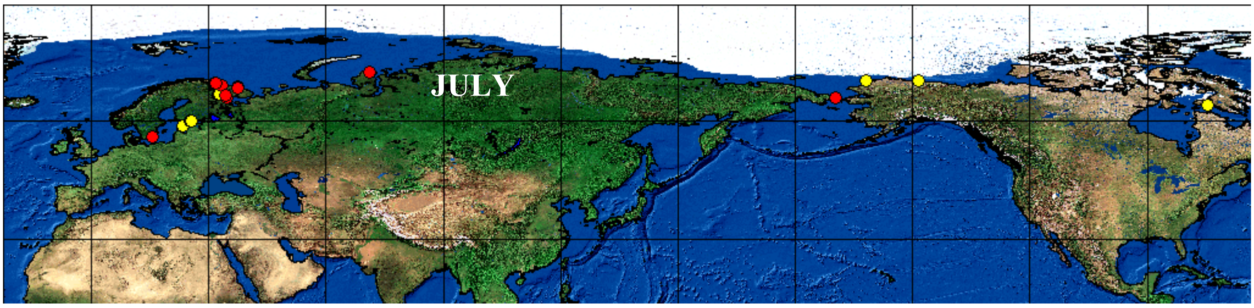
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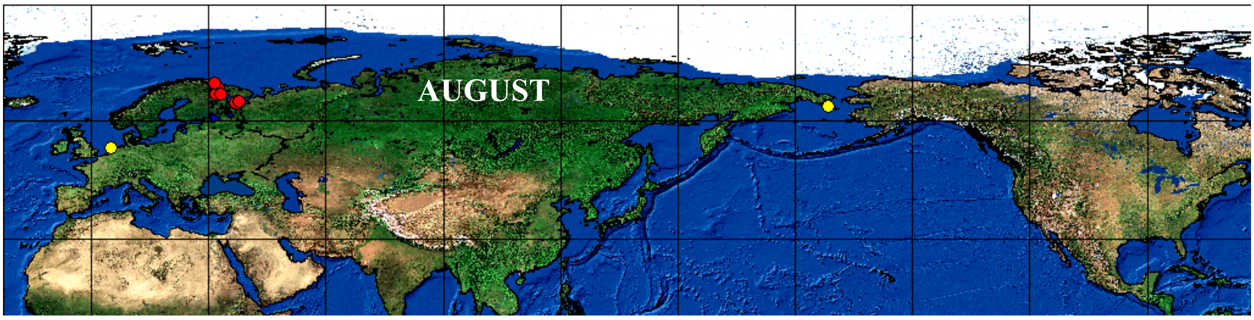
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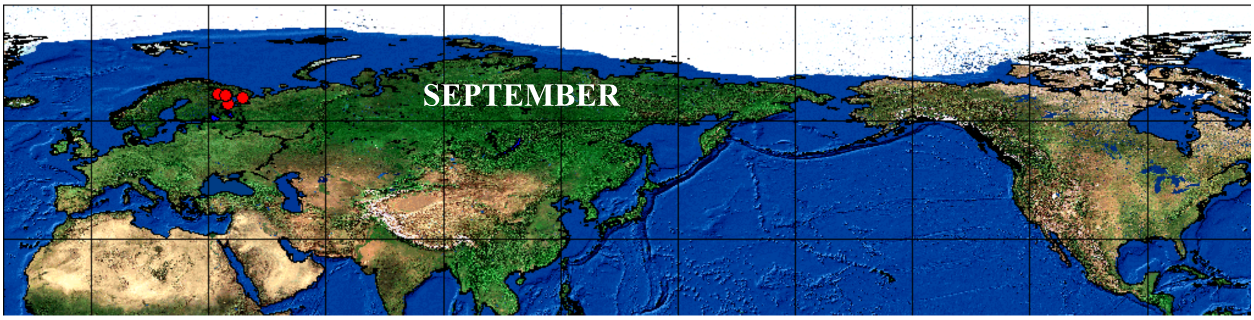
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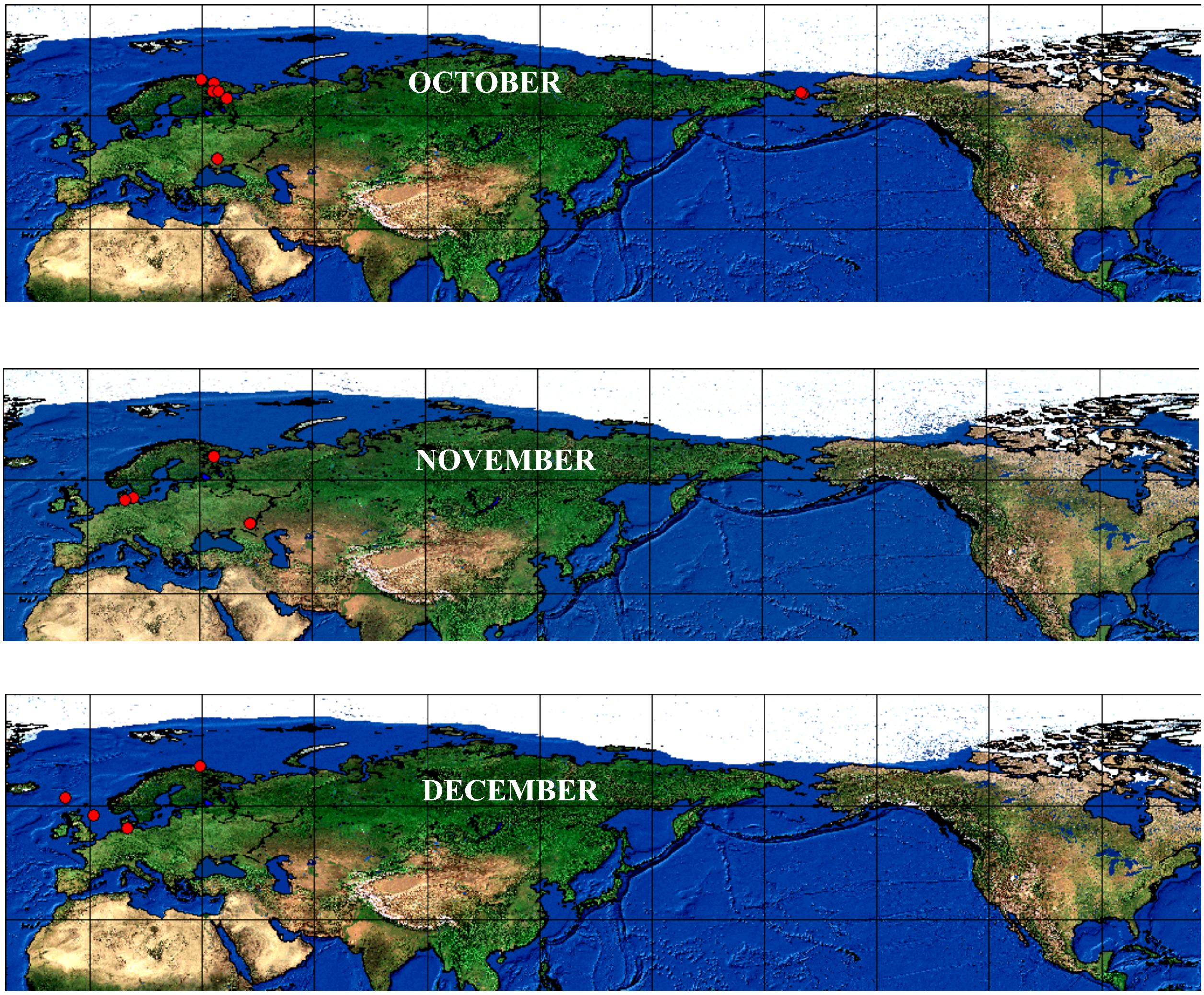


Figure 395. Common Eider monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. Most Common Eider movements are directed along the coasts of northern seas, east-west. There are also flights between the White and Baltic Seas, with south-west – north-east directions. Flights over land to Black and Caspian Seas mean southward flight directions.

Distances distribution indicates that, as it was already mentioned above, Common Eider can cover both very short and quite long distances (Fig. 396). Distances of european-western-siberian Eiders do not exceed 2000 km, all greater distances belong to the north-american-far-eastern-eastern-siberian birds (Fig. 397). The longest distance of movements of the former eiders is 1898.6 km. For the birds from the eastern super-population mean distance is 2255.0$\pm$436.9 km (N=7) with the maximal one 4045.4 km.

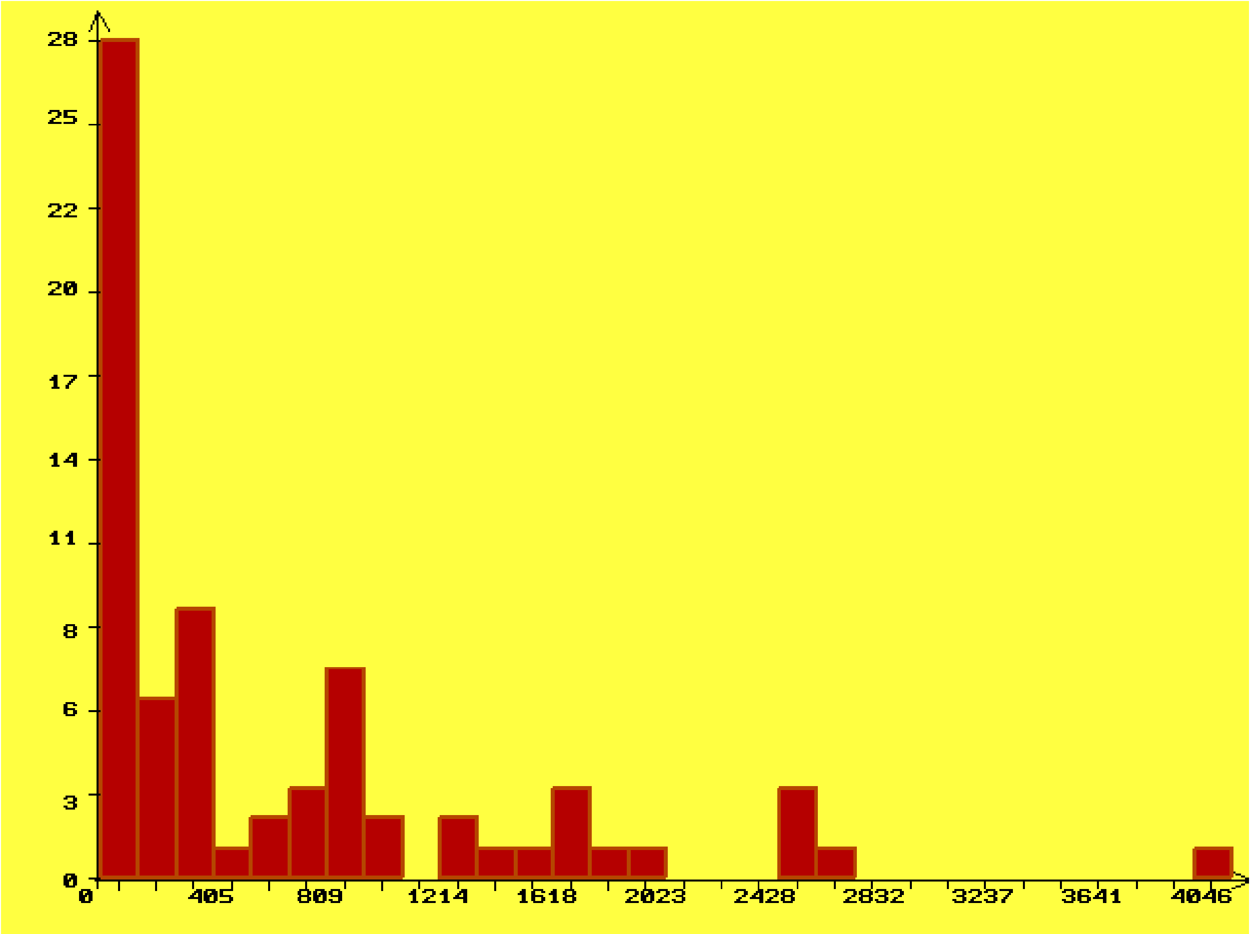


Figure 396. Distribution of all ring-recovery distances in the Common Eider. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in young birds (ringed as „pull" or „juv" or „1 y") from western super-population is greater than that in adults: 520.2±125.1 (N_{young} =20) and 440.7±82.4 (N_{ad} =45) km respectively, insignificant. This means that the species does not noticeably suffer from hunting. Male mean distance of movements is much lesser than in females: 357.2±136.1 and 496.0±105.7 km (N_{males} = 13, $N_{females}$ = 30) respectively, insignificant probably due to small samples. Anyway, this might mean that males are more faithful to their breeding areas than females.

Speed. Common Eider is slow moving duck. For birds connected with Europe daily speed does not normally exceed first tens of km. American-far-eastern birds, according to the database, can move up to more than 70 km per day. Daily speed of these ducks when they cross mainland is unknown.

Populations. Data set on Common Eider is quite small; however it is possible to separate at least three populations in the western and northern Europe and Western Siberia. Azov-black-sea population is also included in the set of populations, and we suggest the formation or existence of the caspian-sea Common Eider population (Fig. 397). So we outline the following populations: 1) northern-european population (polygon № 1); 2) northern-european-western-siberian population (polygon № 2); 3) western-european-baltic-sea population (polygon № 3); 4) small azov-black-sea population (polygon № 4); 5) probable caspian-sea population (Fig 397). Overlaps exist between the first three mentioned populations, but in little extent.

Within north-american-far-eastern-east-siberian super-population we can separate two populations: 1) east-siberian-chukchian population; 2) north-american population (Fig. 398).

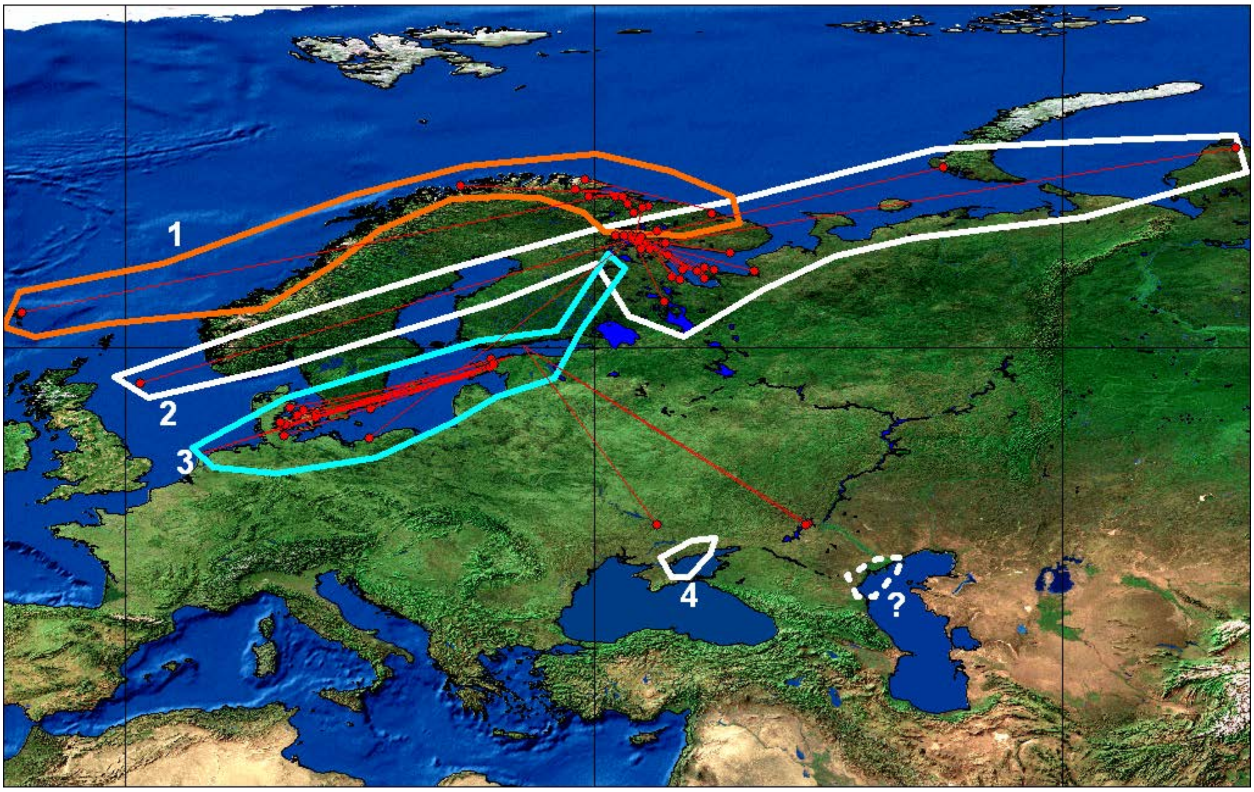


Figure 397. Common Eider western populations. Brown polygon № 1 outlines northern-european population. White polygon № 2 outlines north-european-western-siberian population. Blue-green polygon (№ 3) outlines western-european-baltic-sea population. White polygon № 4 shows azov-black-sea population. White dashed polygon with question mark is a suggested caspian-sea population.

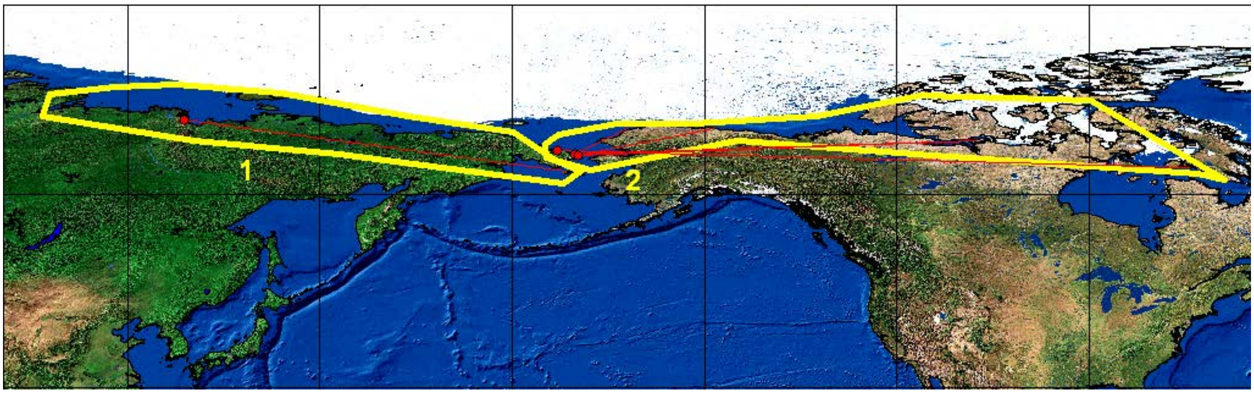


Figure 398. Common Eider eastern populations. Yellow polygon № 1 outlines east-siberian-chukchian population. Yellow polygon № 2 outlines north-american population.

Ten-year distances. Common Eiders of the European-western-siberian super-population does not show an increase of mean distance of movements. Mean distance for birds recovered before 1981 is 477.0±79.4 km (*N*=49), after 1980 – 428.9±138.8 km (*N*=16).

Lifespan.EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) of 26 November 2010 displays data on the Common Eider lifespan as more than 36 years 10 months. Bird Ringing Centre database contains confirmed recovery of female ringed as adult bird and recovered (died in a fishing net) after 16 years (ring sent).

Mortality rate. According to the common criteria (see “Materials and Methods”) 51 dead recoveries of Common Eider of the european-western-siberian population are applicable for the mortality rate analysis. Mean annual mortality rate in the Common Eider is 21.79±2.70%. Real mortality pattern does not show differences with the theoretical one (χ^2 = 8.19, df = 13, P=0.83). Programme MARK, Model CLogLog 2ndPart shows 22.98%, difference is 1.19% within the limit of the standard error. In spite of small sample, it is possible to conclude the stable condition of this population on the base of mortality rate pattern (Fig. 399), with probable tendency for deterioration (because of small drawdown in the younger ages). However current ring-recovery data on Common Eider are almost absent.

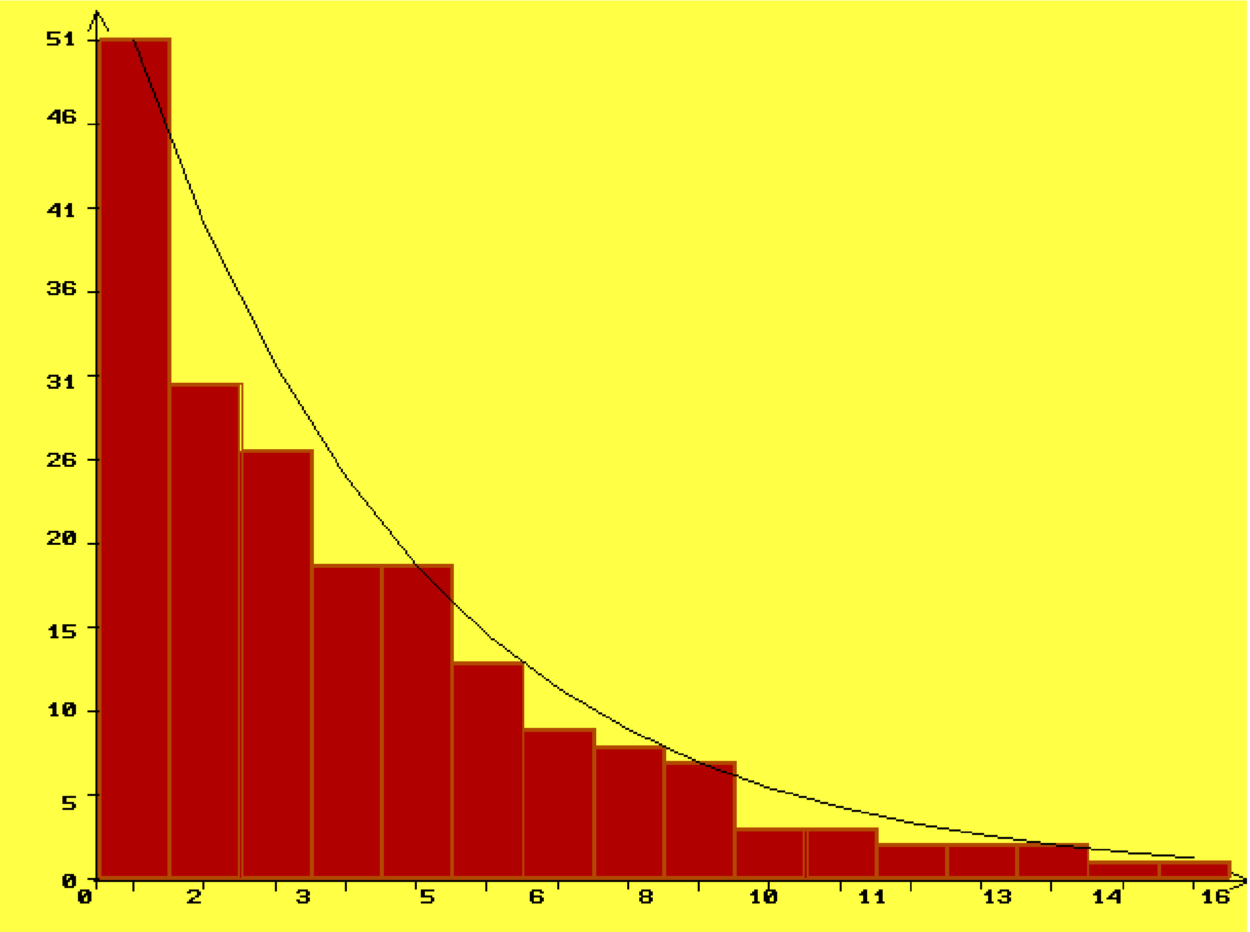


Figure 399. Mortality pattern in the Common Eider. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

European-western-siberian males live, on average, about the same as females: 4.26±1.2 (*N*=13) and 4.13±1.20 (*N*=30) years respectively, difference is insignificant.

KING EIDER
(*SOMATERIA SPECTABILIS*)

Photo by Nikolay B. Konyukhov

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 400. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

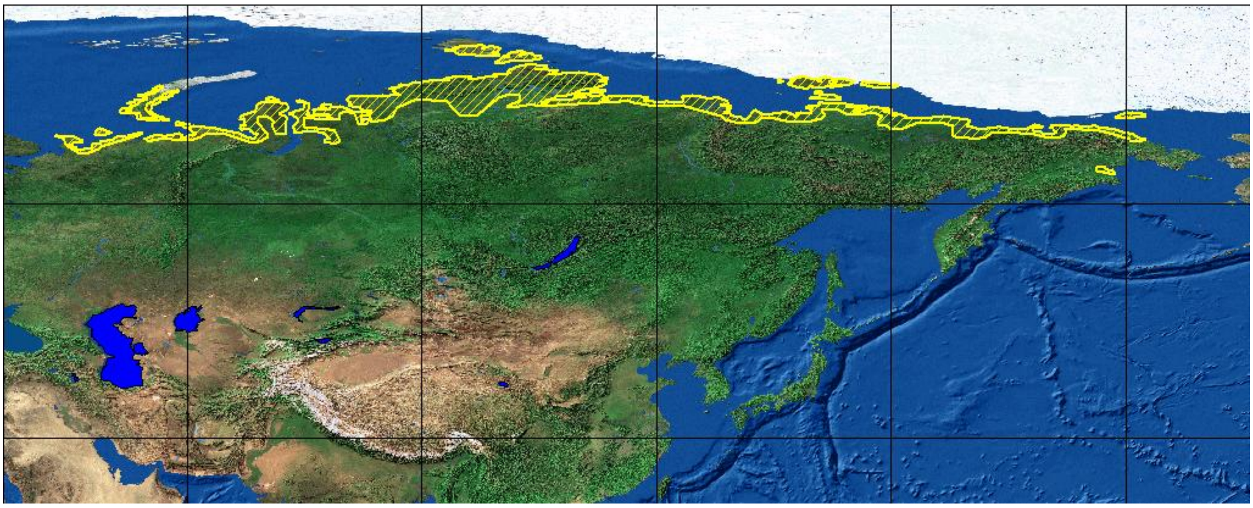


Figure 400. Breeding range of the King Eider in Eurasia (yellow dashed areas).

Distribution of control points. Bird Ringing Centre database contains data on 23 marked birds with 21 recoveries, one recovery per bird. 18 ducks, all ringed with „Moskwa" scheme, were marked with metal rings only, 5 ducks are all „Washington" scheme in addition to metal ring worn colour rings (two birds) and satellite transmitter on the back (three birds). Ringing dates are since 11.06.1934 until 15.06.2005, recovery dates are since 12.05.1934 untill 16.07.2017.

King Eiders were ringed in the Russian north, on Alaska and Canada, recovered in the Russian north (Figs 401 and 402).

Finding details. This analysis includes all 23 recoveries. 7 birds were shot, in 15 birds details unknown, one bird – ring found in the field.

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries of King Eider are different, indirect recoveries cover breeding range more completely, thus they give more information about King Eider movements than direct ones (Figs 401 and 402).

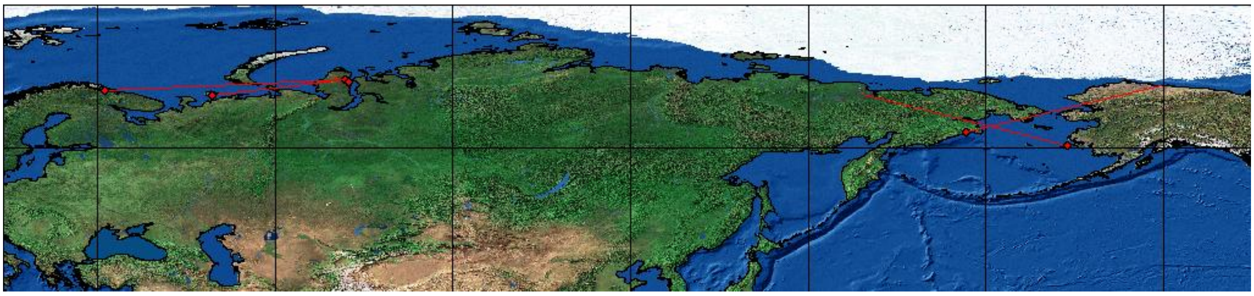


Figure 401. Map of the King Eider direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

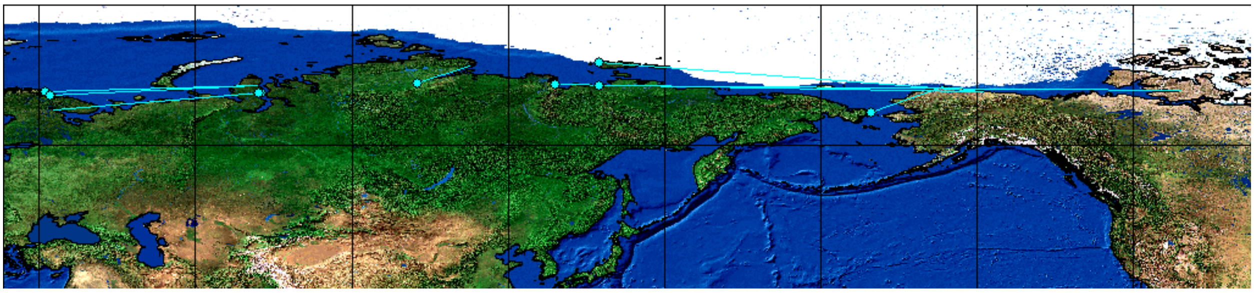
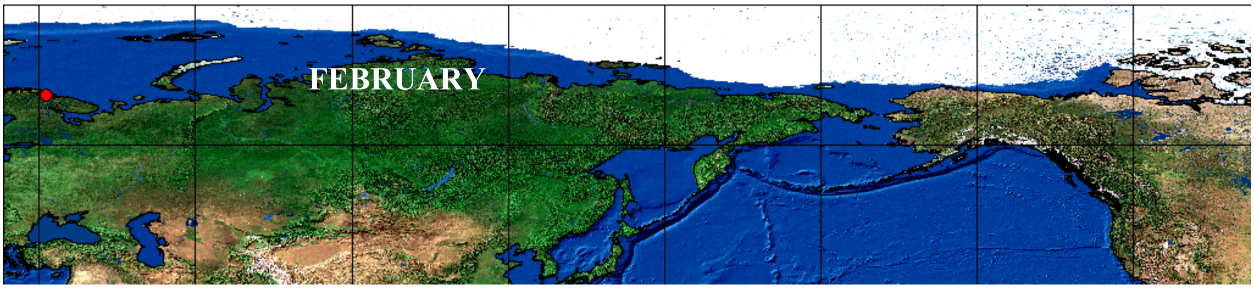
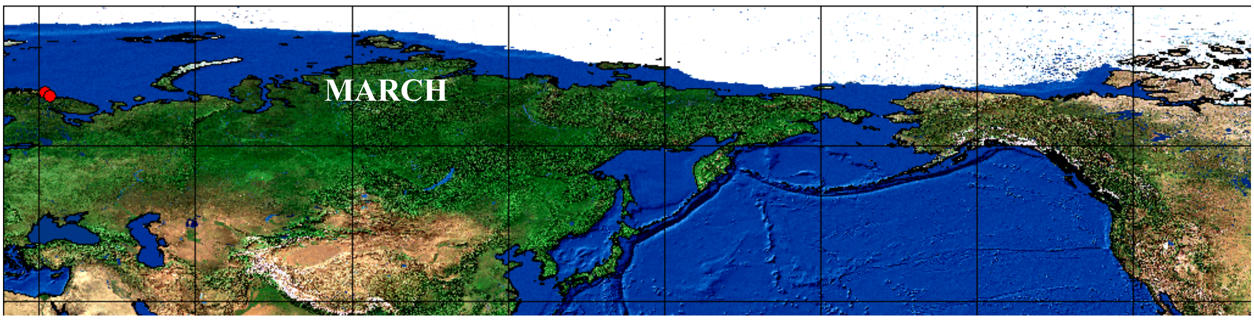


Figure 402. Map of the King Eider indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

Average distance of movements in direct recoveries is twice shorter than in indirect ones: 747.6±174.3 (N=14) and 1587.4±364.8 (N=9) respectively, difference is close to be significant ($t=2.08$, $P=0.06$).

Monthly movements. All recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in the King Eider (Fig. 403); however, not for all months data are available. King Eider is a sea duck, it can move long distances swimming, spend winter in unfrozen waters of the Barents and Bering Seas not far from the breeding areas (Fig. 403). It is capable to fly long distances, covering more that thousand km, however, in distinction to Common Eider, mostly along sea coasts. In February and March birds are on the wintering grounds in northern Europe and in the Bering Sea. For April and May data are absent. In June-July-August Eiders are in their breeding range. For October we have one recovery from the bird which is already in the wintering area near Alaska (Fig. 403).





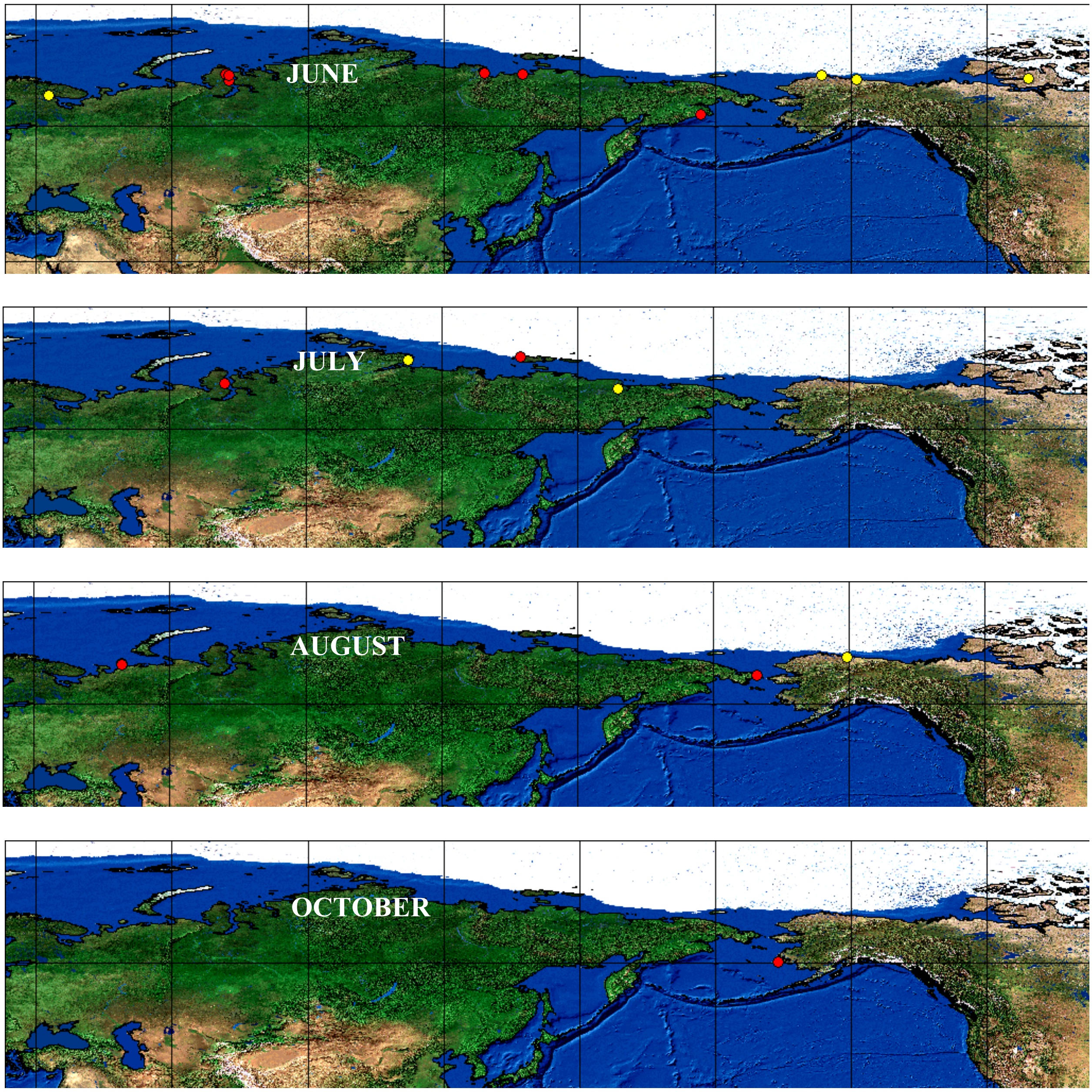


Figure 403. King Eider monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. King Eider displays movements along northern sea coasts – east-westward movements. The longest distance in direct movements is 1877.9 km, indirect ones - 3463.6 km.

Mean flight distance in young birds (ringed as „pull" or „juv" or „1 y") is 2.5 times longer than that in adults: 2081.3+312.8 (N_{young} =3) and 925.5±205.6 (N_{ad} =20) km respectively. In spite of very small sample for young, difference is significant – t-Bailey=3.12, P=0.037. Such big difference is unique among ducks, no explanation is visible. In distinction to Common Eider, male mean distance of movements is much longer than in females: 1146.3 ±250.9 and 615.8+311.1 km (N_{males} = 16, $N_{females}$ = 5) respectively, insignificant. Data set is too small for making conclusions.

Speed. Common Eider is slow moving duck. Bird Ringing Centre of Russia database contains several recoveries with daily movements of 15 km per day.

Populations. Data set on King Eider is quite small; however it is possible to separate at least two populations in the western and northern Europe and Central Siberia – Alaska. They are:1) northern-european-russia-western-siberian population (polygon № 1); 2) central-east-siberian-far-eastern-northern-alaskan population (polygon № 2) (Fig. 404). Overlap between populations probably exists.

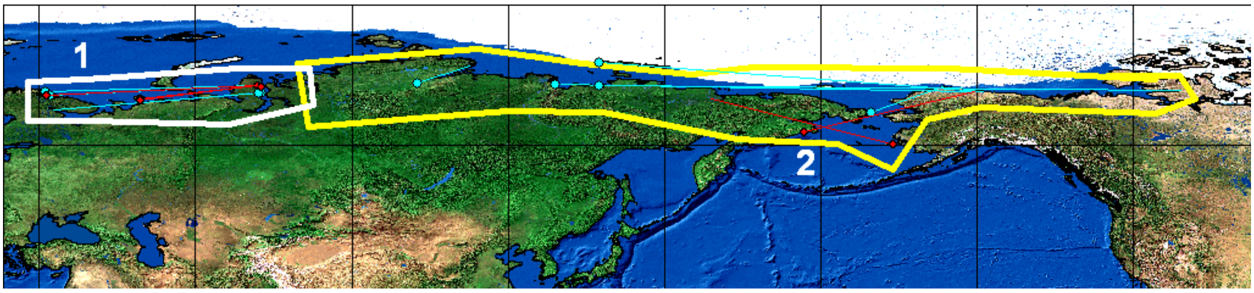


Figure 404. King Eider populations. White polygon № 1 outlines northern-european-russia-western-siberian population. Yellow polygon № 2 outlines central-east-siberian-far-eastern-northern-alaskan population.

Lifespan. EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010 does not contain data on the King Eider lifespan. Bird Ringing Centre database contains a recovery of male ringed as „>2 y" and shot after 11 years 2 months (ring not sent). This is the ring Washington 1587-53426, i.e. bird lived more than 13 years.

Mortality rate. According to the common criteria (see "Materials and Methods") 20 dead recoveries of King Eider are applicable for the mortality rate analysis. Mean annual mortality rate in the King Eider is 22.41±4.31% (Fig. 405). Real mortality significantly differs from the theoretical one (χ^2 = 18.81, df = 6, P=0.027). Programme MARK, Model CLogLog 2ndPart shows 20.97%, difference is 1.44% within the limit of the standard error. In spite of small data set, it is possible to see not good condition of the species from mortality rate pattern, due to considerable drawdown in the younger ages.

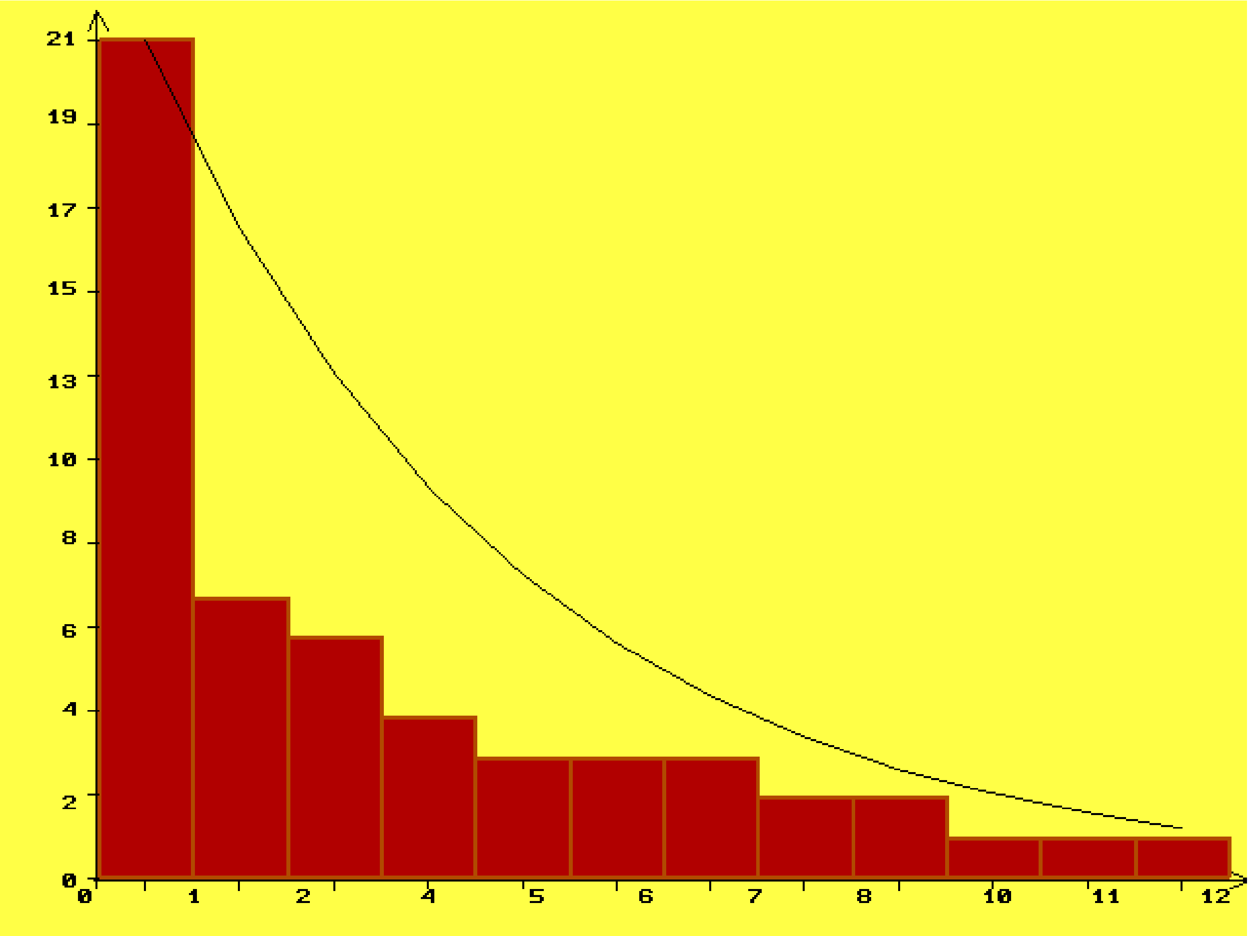


Figure 405. Mortality pattern in the King Eider. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Males and females live practically the same: 3.09±0.72 (N=16) and 3.21±2.26 (N=5) years respectively, significantly not different (tBailey=0.046, P=0.94).

STELLER'S EIDER
(*POLYSTICTA STELLERI*)

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 406. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

Photo by Sergey P. Kharitonov

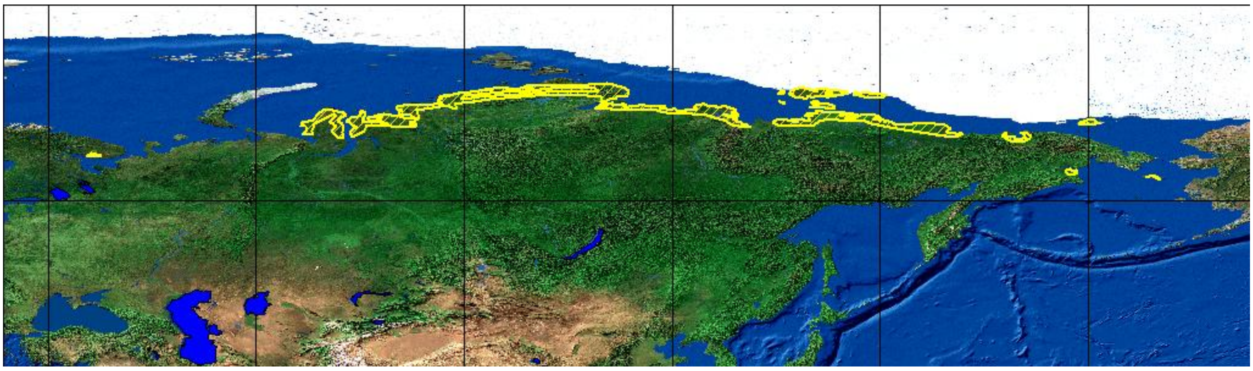


Figure 406. Breeding range of the Steller‟s Eider in Eurasia (yellow dashed areas).

Distribution of control points. Bird Ringing Centre database contains data on 547 marked birds, which gave 549 recoveries, 545 birds gave one recovery per bird, two birds gave 2 recoveries each. 545 ducks were marked with metal rings only, one duck in addition to metal ring worn colour ring, one duck worn nasal mark. Ringing dates are since 29.06.1940 until 15.07.2012, recovery dates are since 22.08.1952 until 15.06.2020.

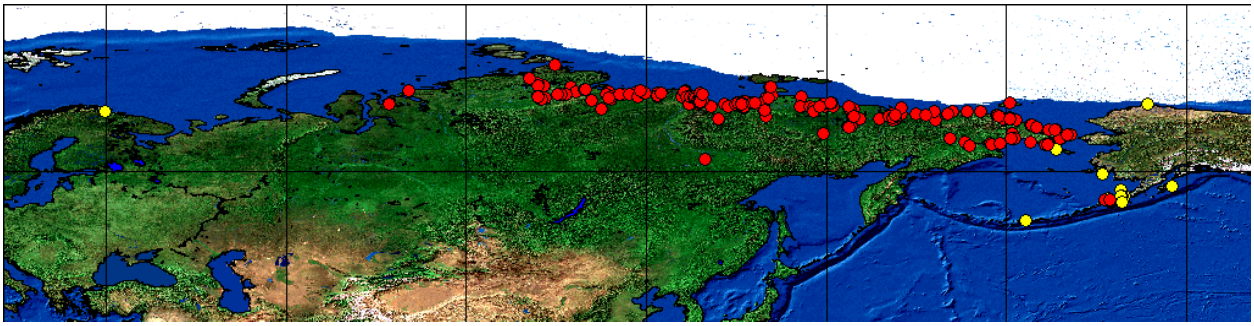


Figure 407. Position of all Steller‟s Eider control points. Yellow dots are ringing sites, red dots are recovery sites.

Steller‟s Eiders in the Bird Ringing Centre database were marked by rings of 2 schemes only. One bird, which belongs to the north-european-western-siberian population was ringed in Finnmark, Norway, recovered in the middle of Gydan Peninsula (see Fig. 406, the westernmost recovery). All others 548 recoveries belong to birds from all-siberian-alaskan population (see section "Populations"). These birds were ringed by „Washington‟ scheme rings; mostly, at the autumn stopover on the Alaska Peninsula, recovered on breeding grounds from Chukotka up to as far to the west, as to western part of Taimyr Peninsula (Fig. 407).

Finding details. This analysis includes all 549 recoveries. 530 (96.5%) are „shot". In 7 (1%) recoveries „details unknown", which practically mean shot, as well. Therefore, we can assume that 98% of birds were shot. Other reasons: caught – 4 birds, found dead – 4, found dead in fishing net – 2, found dead under overhead wires – 1, ring only found in the field – 1.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries of Steller"s Eiders of the all-siberian-alaskan popultaion are similar. The only European recovery is the indirect one (Figs 408 and 409).

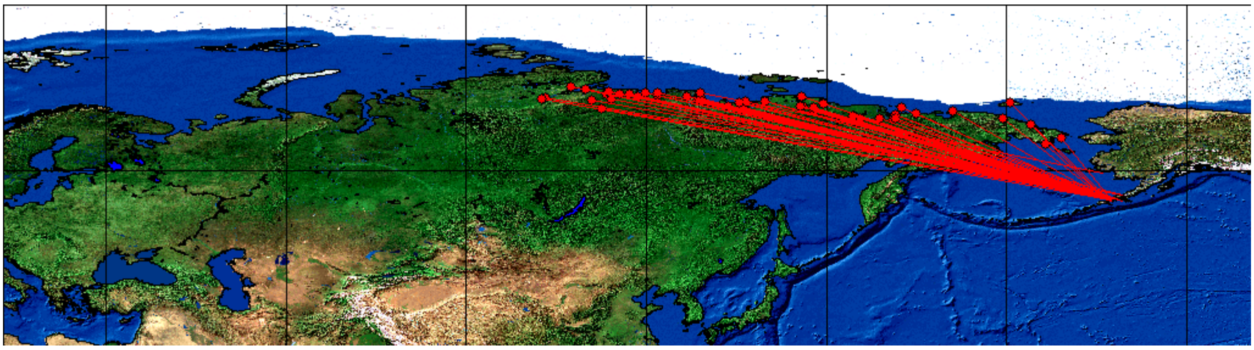


Figure 408. Map of the Steller"s Eider direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

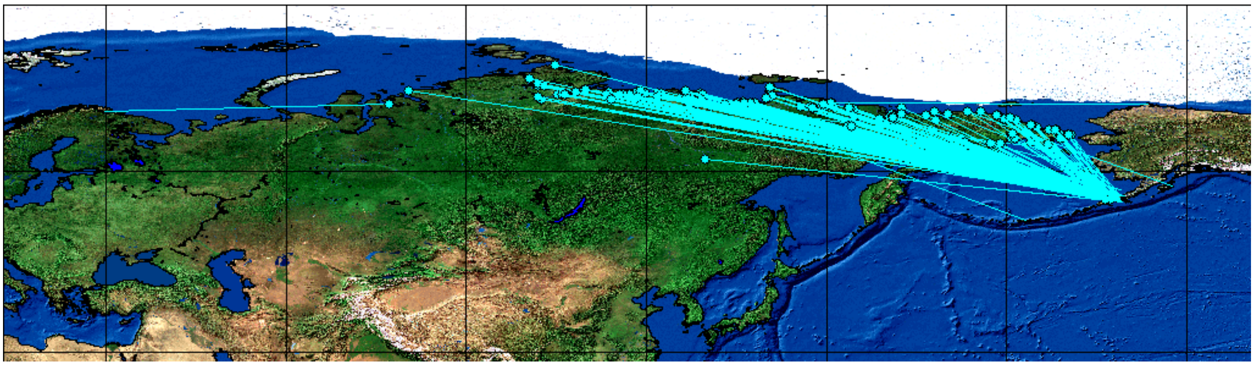
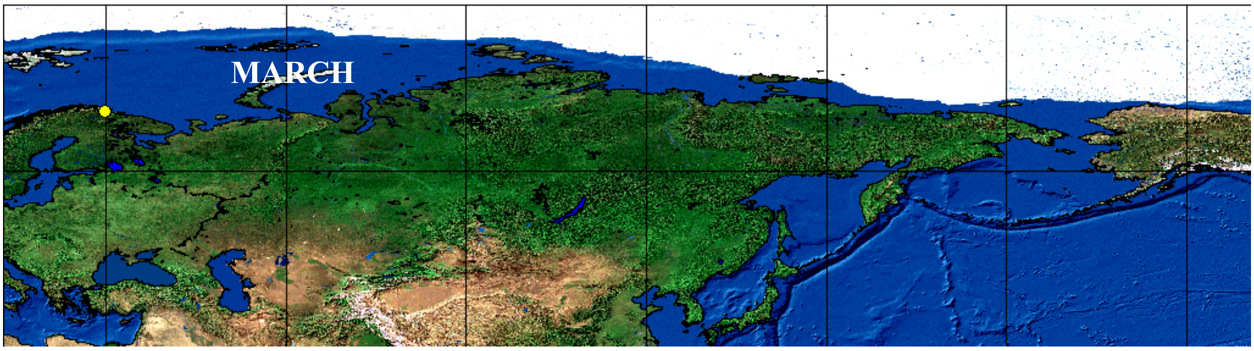
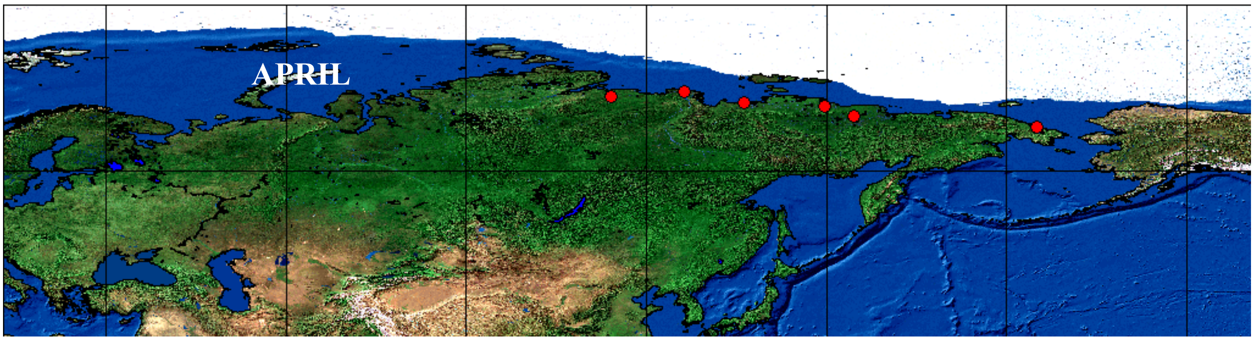


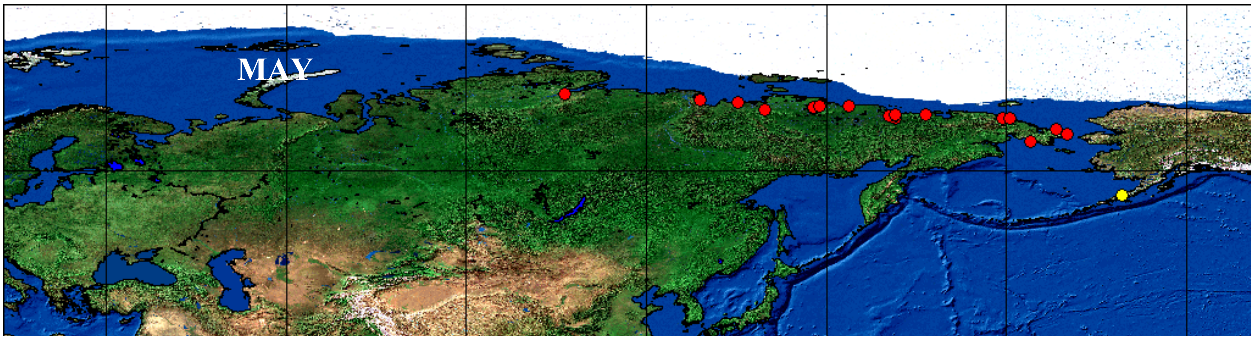
Figure 409. Map of the Steller"s Eider indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

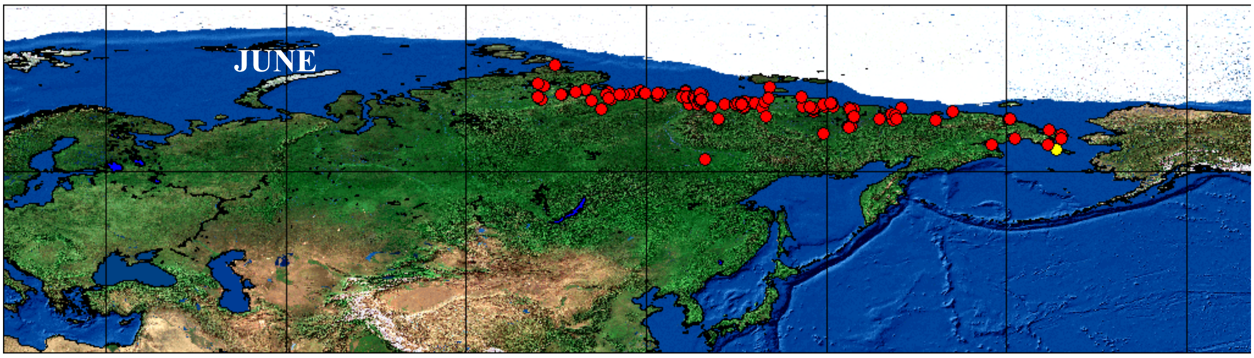
The only European bird covered 1704.8 km, elapsed time is 5 years 4 months. For the all-siberian-alaskan population average distances in direct and indirect recoveries are similar: 3215.3±80.3 (N=83) and 3124.7±41.5 (N=466) respectively, difference is insignificant. However, we should keep in mind, that data on ducks ringed in North America are biased, because we have no information about short movements of those birds. This is because records of short movements fall outside of the Russian territory.

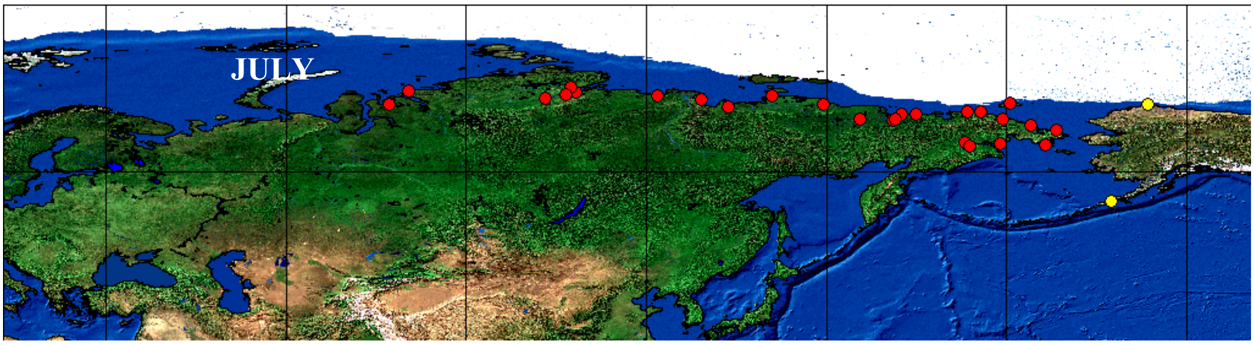
Monthly movements. All recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery sites) reflect a general way of seasonal movements in the Steller"s Eider (Fig. 410). Steller"s Eider is a sea duck, it can cover long distances by swimming, quite often spends winter just in several tens or hundreds km from the breeding areas. Data on January and February locations are absent. In March there is only one control point – a bird was ringed definitely in the wintering area on the unfrozen sea in the northern Norway. In April through August birds are in the breeding area; in September the area covered by recoveries shrinks to the east, and in September many birds are already at the autumn stopover near Cold Bay, Alaska Peninsula. In October some ducks are still within breeding area. In November-December birds are on wintering grounds (Fig. 410).











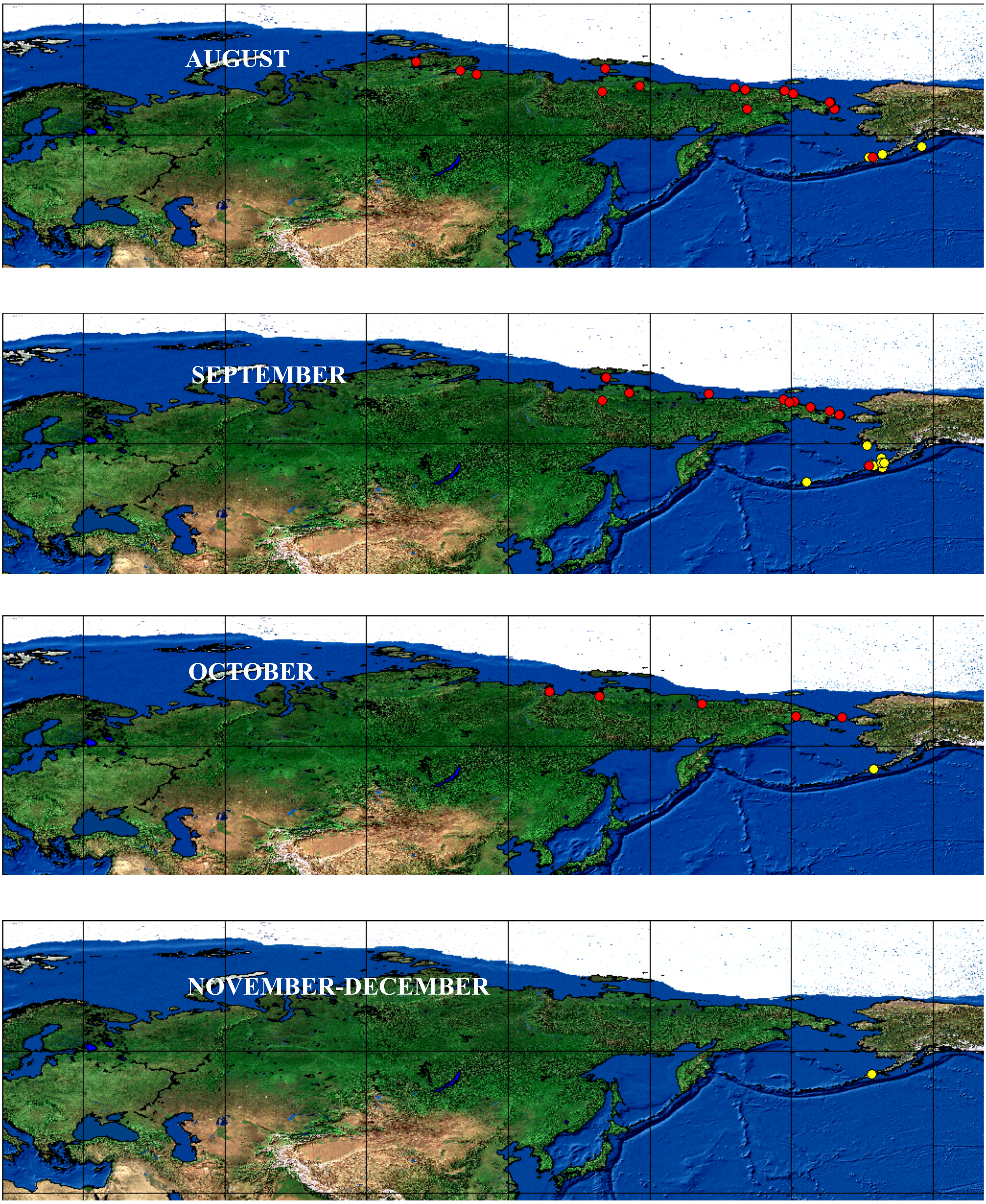


Figure 410. Steller‟s Eider monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. All Steller‟s Eider movements are directed along northern seas – eats-west movements. If we exclude short distances (since the sample is biased in the absence of the short distances), distance distribution indicates that Stelles‟s Eider mostly move at distances near 4000 km (Fig. 411). Maximal distance is 4908 km.

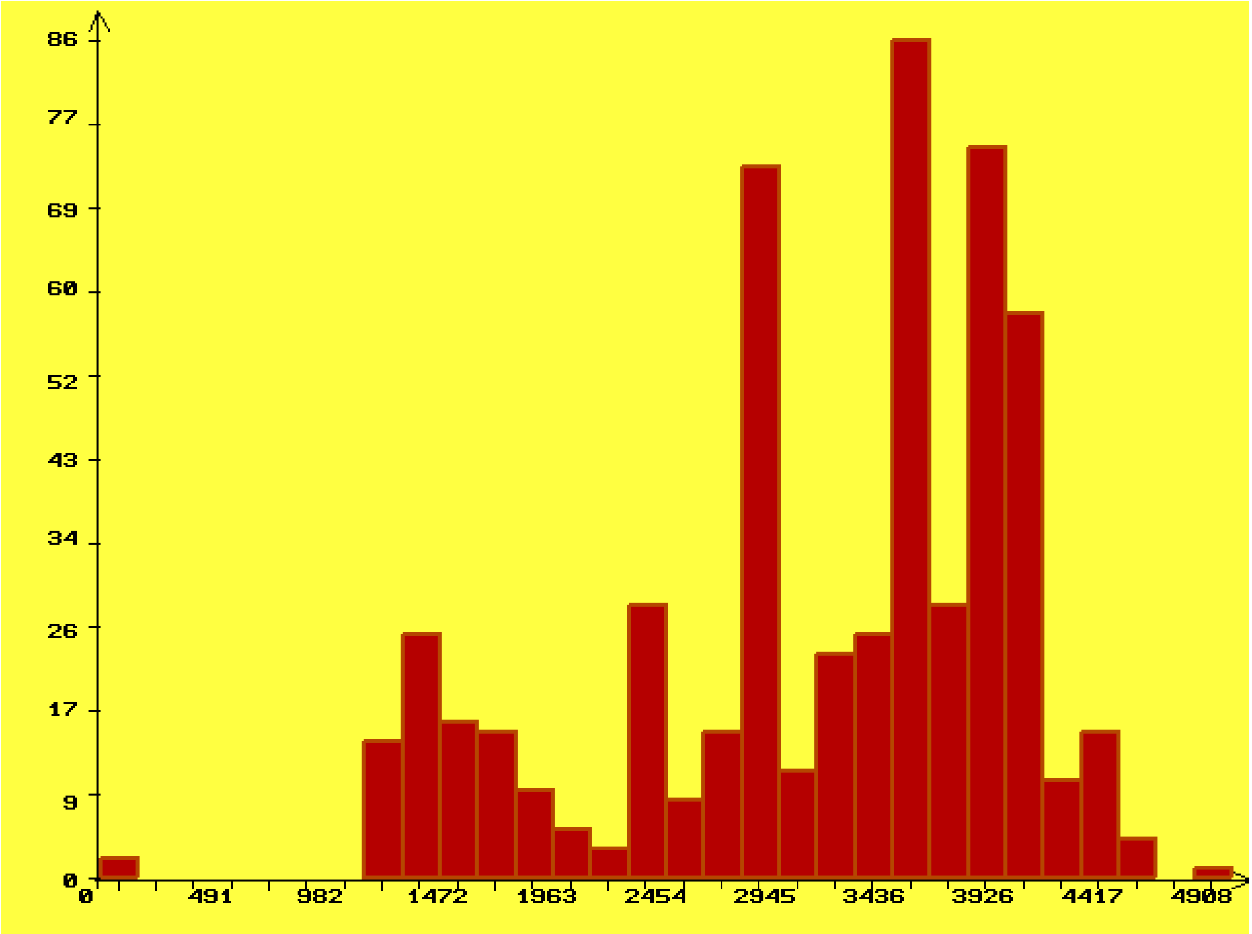


Figure 411. Distribution of all ring-recovery distances in the Steller‟s Eider. X axis is the flight distance in km; Y axis is the number of distances.

Within the scope of bias (i.e., in the set of distances greater than 1000 km), mean distance of movement in young birds (ringed as „pull" or „juv" or „1 y") is about the same as in adults: 3074.2±128.8 (N_{young} =24) and 3153.3±37.8 (N_{ad} = 523) km respectively, insignificant. Male and female mean distances of movements are about the same, as well: 3147.3±51.5 and 3159.0±52.0 km (N_{males} = 284, $N_{females}$ = 261) respectively, insignificant.

The sample of Steller‟s Eider of siberian-alaskan population is large enough to outline monthly movements of this species (Fig. 412). Steller‟s Eider movement pattern looks unusual. Scheme indicates back and forth movements of these birds during breeding season. Such picture can originate from two different reasons: 1) every month different categories of birds are recovered; 2) Steller‟s Eiders really change the movement directions several times per season. What possibility is true not clear yet. The suggestion is that migration in Steller‟s Eider goes by very distinctive „waves": each cohort of birds migrate and breed in the time considerably different from birds of other cohorts.

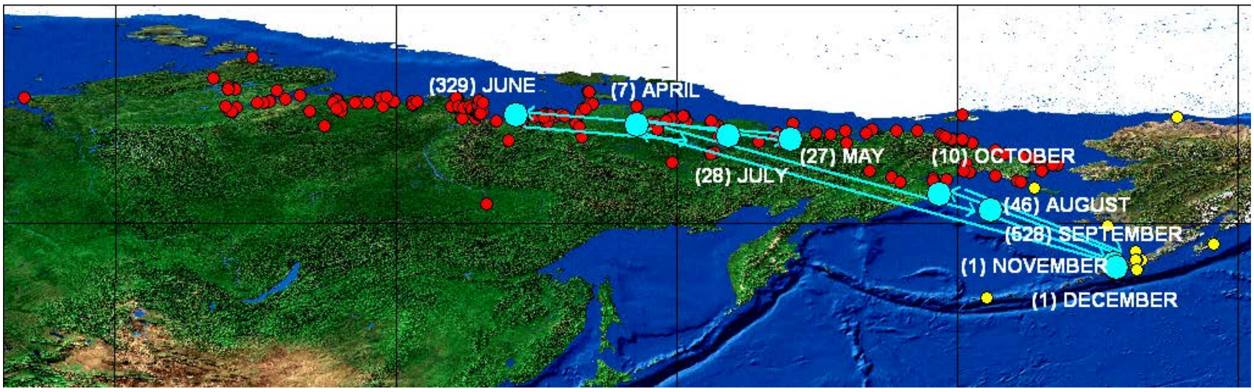


Figure 412. Mean monthly locations of Steller‟s Eider control points for birds, ringed at the autumn stopovers on Alaska. Blue-green large circles are mean monthly locations. Arrows show directions of movements. Yellow dots are the ringing sites, red dots – recovery places. Number of control points in each month represented in parentheses.

Speed. According to the Bird Ring Centre database Steller‟s Eiders move up to 300 km per day. They can cover about 3000 km during 11 or less number of days.

Populations. Steller‟s Eider breeding range in Eurasia is clearly divided in two big populations: 1) north-european-western-siberian population (polygon № 1, Fig. 413); 2) all-siberian-alaskan population (polygon № 2). Although available ring-recovery data do not show overlapping, these populations really overlap in Western Siberia (Field Guide of the Anseriforms in Russia, 2011).

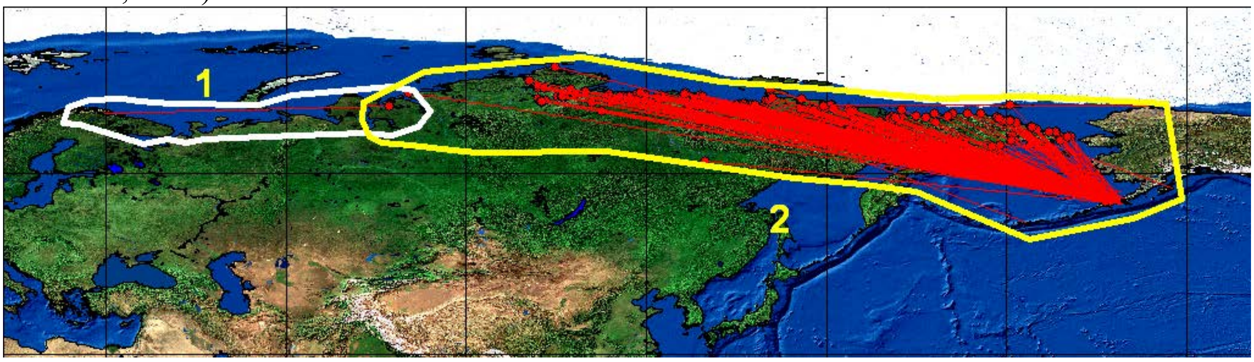


Figure 413. Steller‟s Eider populations. White polygon № 1 outlines northern-european-western-siberian population. Yellow polygon № 2 outlines all-siberian-alaskan population.

Ten-year distances. Steller‟s Eiders decadal distance fluctuates in a different way in comparison to other duck species: mean distance first increases up to 1990-s, then decreases in about the same extent that was the former increase (Table 21). All these changes are significant: from 1951-1990 to 1991-2000 t-Bailey = 6.3, P=0.0000; from 1991-2000 to 2011-2020 t-Bailey = 4.6, P=0.0000.

Table 21. Steller‟s Eider mean movement distance per decade (all-siberian-alaskan population).

Decade (years)	1951-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2020
Distance (km)	2459.3	2956.0	3037.8	3389.8	2948.6	2437.6
Number of recoveries	32	55	48	287	106	20

Lifespan. EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010 displays data on the Steller"s Eider lifespan as more than 12 years 9 months. Bird Ringing Centre database contains confirmed recovery of male ringed as adult and shot after more than 20 years, however ring not sent. The ring was sent for the female, ringed as adult (ring Washington 1287-11263) and shot after 16 years 8 months.

Mortality rate. According to the common criteria (see "Materials and Methods") 448 dead recoveries of Steller"s Eider of the all-siberian-alaskan population are applicable for the mortality rate analysis. Mean annual mortality rate in the Steller"s Eider is 25.23±1.03%. Real mortality pattern significantly different from the theoretical one (χ^2 = 70.0, df = 18, P=0.000). Programme MARK, Model CLogLog 2ndPart shows 25.27%, difference is 0.04% practically nothing. Mortality rate pattern suggests the stable current condition of the species (Fig. 414).

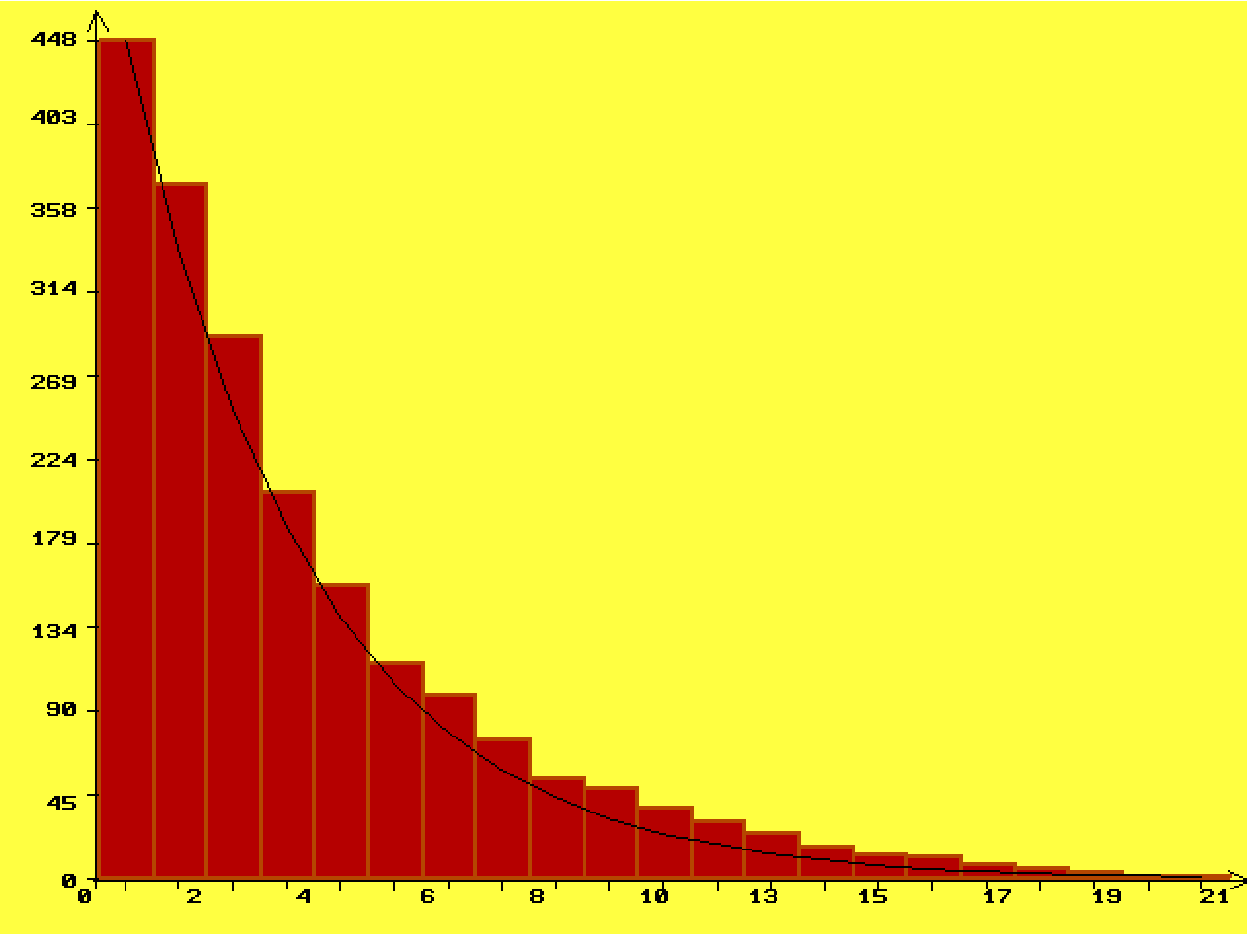


Figure 414. Mortality pattern in the Steller"s Eider. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

All-siberian-alaskan males and females live, on average, practically the same number of years: 4.27±0.25 (N=225) and 4.17±0.24 (N=221) years respectively, different insignificantly. Annual mortality rate for males is 22.74±1.33%, females - 23.0±1.36%, both sexes are in stable condition (Fig. 415).

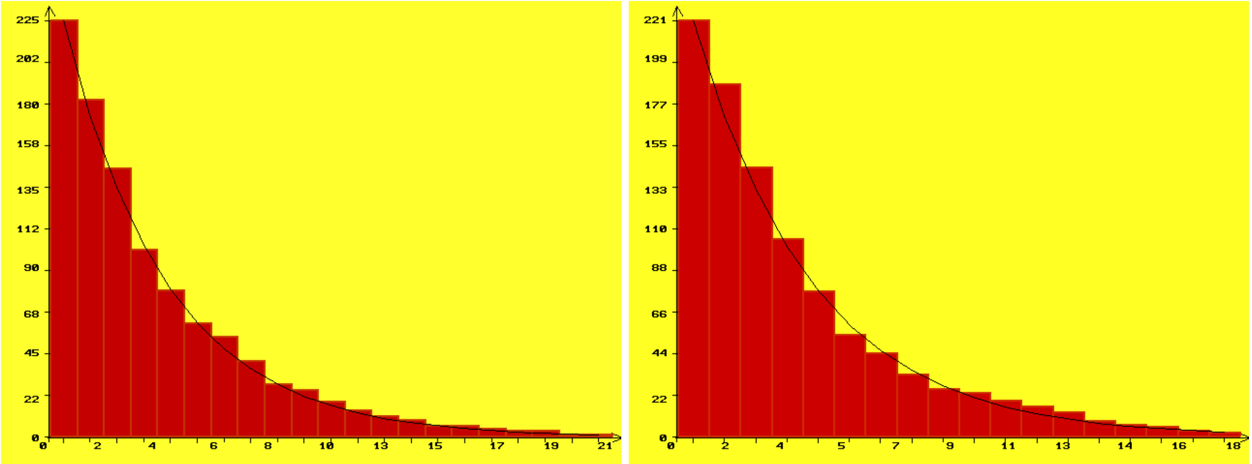


Figure 415. Mortality pattern in Steller"s Eider males (left) and females (right). X axis is the number of years after marking. Y axis is the number of live birds.

LONG-TAILED DUCK (*CLANGULA HYEMALIS*)

Photo by Sergey P. Kharitonov

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 416. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

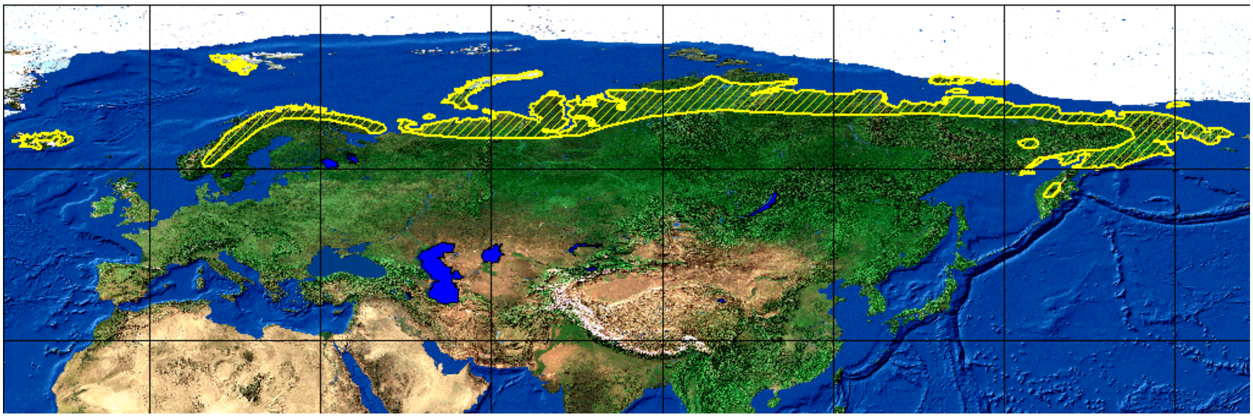


Figure 416. Breeding range of the Long-tailed Duck in Eurasia (yellow dashed areas).

Distribution of control points. Bird Ringing Centre database contains data on 95 marked birds, which gave 95 recoveries, one recovery per bird. 94 ducks were marked with metal rings only, one duck in addition to ring worn nasal mark. Ringing dates are since 30.07.1932 till 12.06.2018, recovery dates are since 25.09.1932 till 13.05.2020.

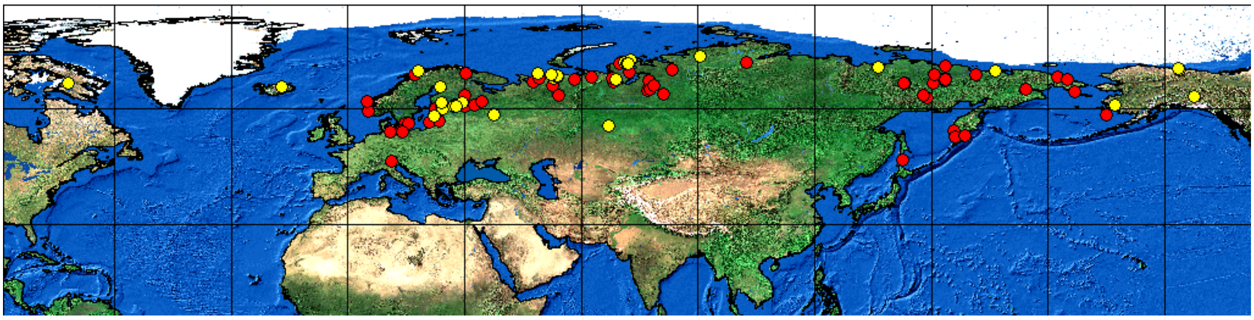


Figure 417. Position of all Long-tailed Duck control points. Yellow dots – ringing sites, red dots – recovery sites.

Long-tailed Duck in the Bird Ringing Centre database were marked by rings of 7 schemes: „Moskwa" scheme – 58 recoveries, „Washington" scheme – 22 recoveries, „Stavanger" – 1, „Helsinki" – 10, „Stockholm Museum" -1, „Reykjavik Iceland" – 2, „Matsalu Estonia". Ducks were ringed in many places of the western and northern Europe, Russia, USA and Canada (Fig. 417). In the Long-tailed Duck breeding range is a circumpolar one. Wintering areas are locates both just to the south of the breeding range or quite far away to the south: on the Mediterranean, Black and Caspian Seas and the Sea of Japan. Within Eurasia breeding range can be divided into two well-visible large populations (see section "Populations"). Both are connected with North America – birds from the western (north-american-europen-west-siberian) population fly to the east, from eastern (central-eastern-siberian-far-eastern-alaskan) – to the west of the American continent. Birds from both populations move at long distances.

Finding details. This analysis includes all 95 recoveries. 39 (41%) are „shot". In 39 (41%) recoveries „details unknown", which practically mean, shot, as well. Therefore, we can assume that 82% of birds were shot, which is less than in other ducks. Other reasons: caught – 7 birds, found dead – 6, found dead in fishing net – 2, ring found – 1, hit wires – 1.

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries of Long-tailed Duck are similar (Figs 418 and 419).

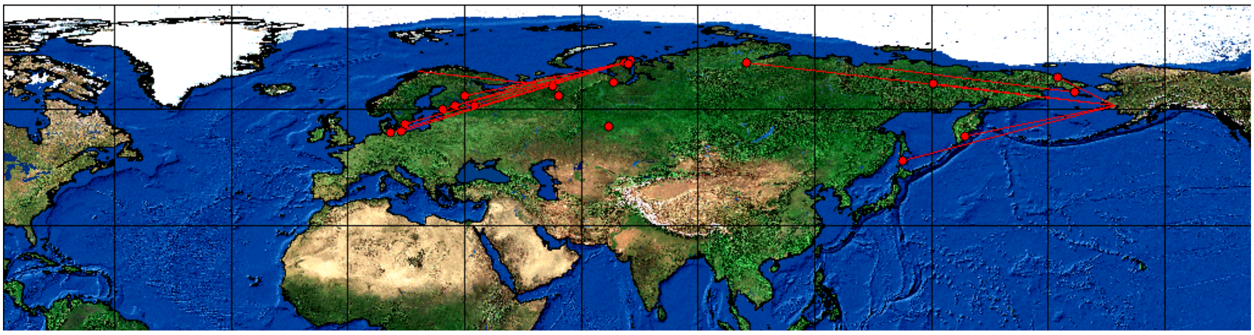


Figure 418. Map of the Long-tailed Duck direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

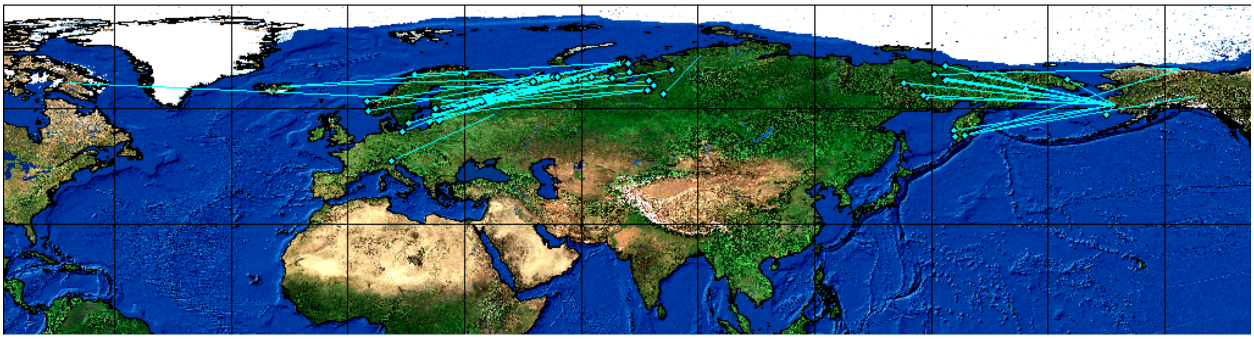
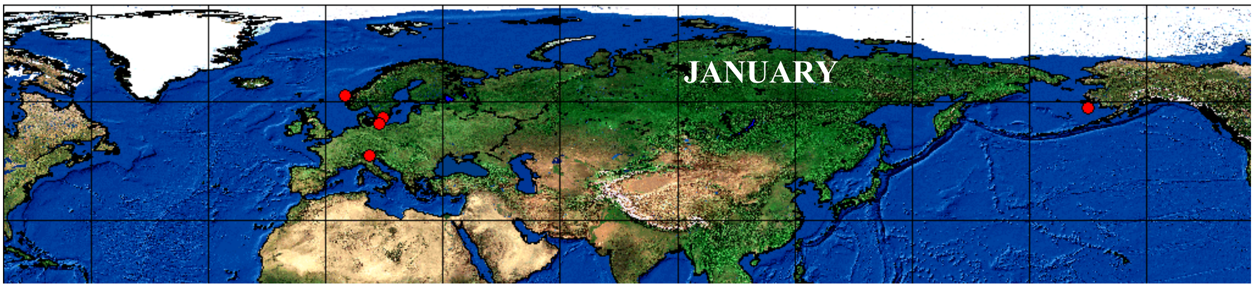


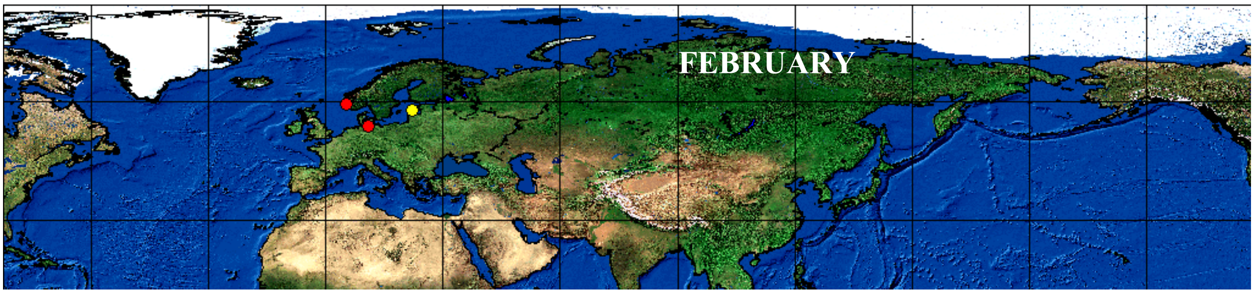
Figure 419. Map of the Long-tailed Duck indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

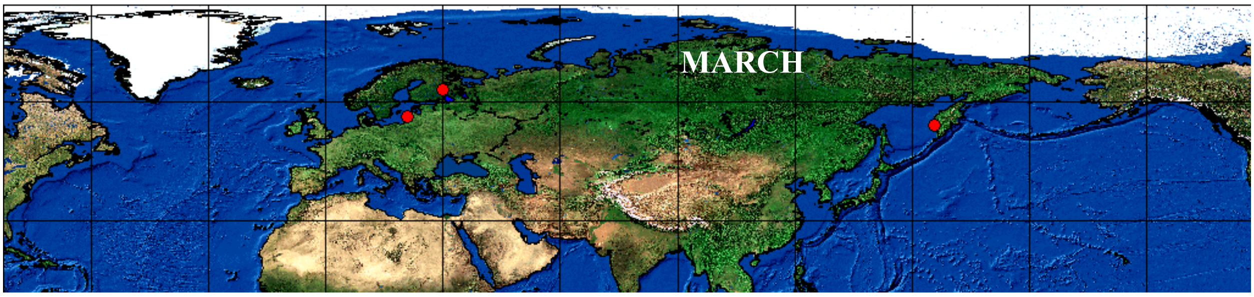
Maps indicate that Long-tailed Ducks wintering in northern, central and southern Europe fly to breed to the European Russia and western Siberia to about the meridian of 80˚E from the west, likely further. Long-tailed Ducks ringed on Alaska fly to breed westward to the Far East and Siberia up to 130˚E from the east (Fig. 418). Birds that breed in northern European Russia have migration connections with Iceland and even Northwest Territories, Canada.

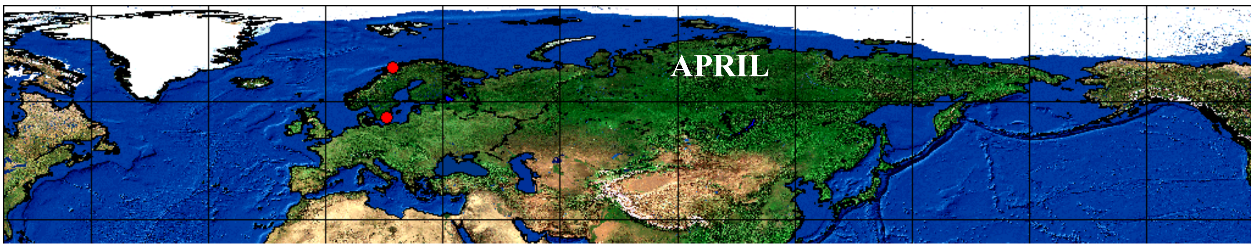
Average distances in direct and indirect movements for birds from the north-american-europen-west-siberian population are: 898.1±281.0 km (*N*=20) and 1190.4±176.7 km (*N*=52) respectively, insignificant. For birds of central-eastern-siberian-far-eastern-alaskan population these distances are generally longer (the same regularity as in Common Eider): 2615.5±434.7 (*N*=6) and 2176.8±209.3 (*N*=17) km respectively, insignificant. However, we should keep in mind, that data about ducks ringed in North America are highly biased, since we do not have information about short movements of those birds. This is because records of short movements fall outside of the Russian territory.

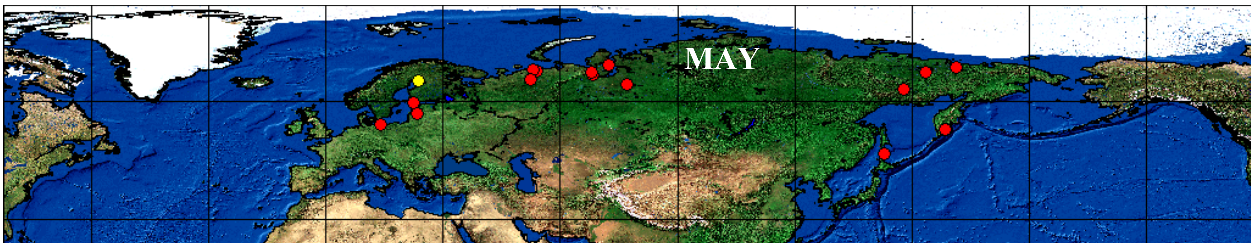
Monthly movements. All recoveries are included in demonstration of migrations month-by-month. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in the Long-tailed Duck (Fig. 420). Long-tailed is a sea duck, it can move long distances resting on the sea surface, quite often spend winter just nearby of breeding grounds in the unfrozen waters. At the same time it is capable to fly long distances, covering more that thousand km over the sea or mainland. In January and February birds are on the wintering grounds, according to the position of control points - in the northern Europe, on the Bering Sea, south of Alaska. In March some migratory movements might be noticed in European wintering birds. On Pacific, there is one recovery on Kamchatka, still on wintering grounds (March, Fig. 420). For April data are scarce, indicate birds on wintering grounds. In May ducks are mainly in the breeding area, although a number of recoveries are in wintering areas in the Baltic Sea, Kamchatka, south of Sakhlin. In June-July the situation is about the same: birds are on breeding grounds; however some were ringed well to the south of the breeding grounds, probably birds that stayed at the spring stopovers – in Vologda and Kurgan Regions (see June, July in Fig. 420). August-September-October most birds are on the breeding grounds, as well; those which stayed in the inter-median stopovers are still there. November-December – birds are on wintering grounds, November is a month of the migration completion (Fig. 420).







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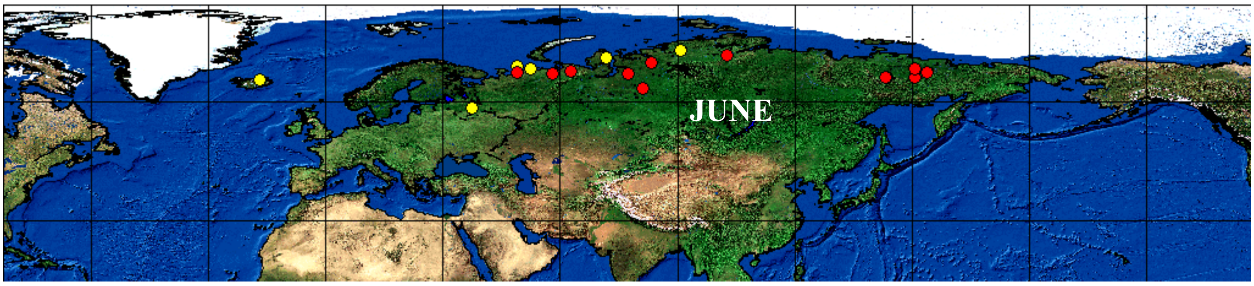
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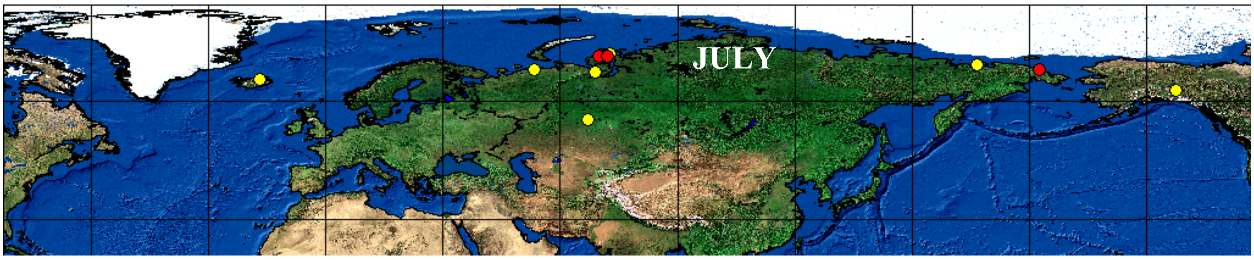
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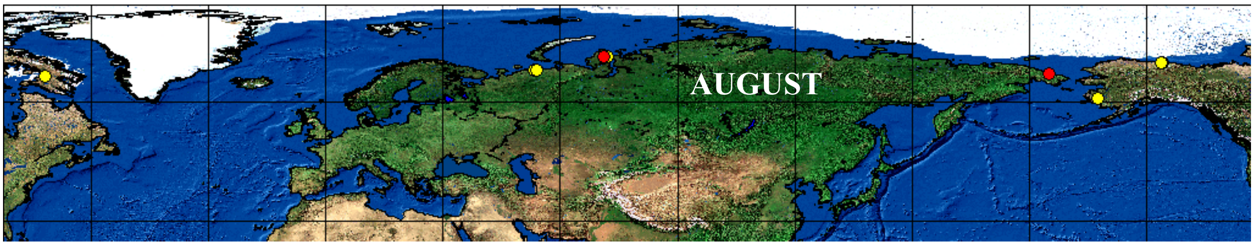
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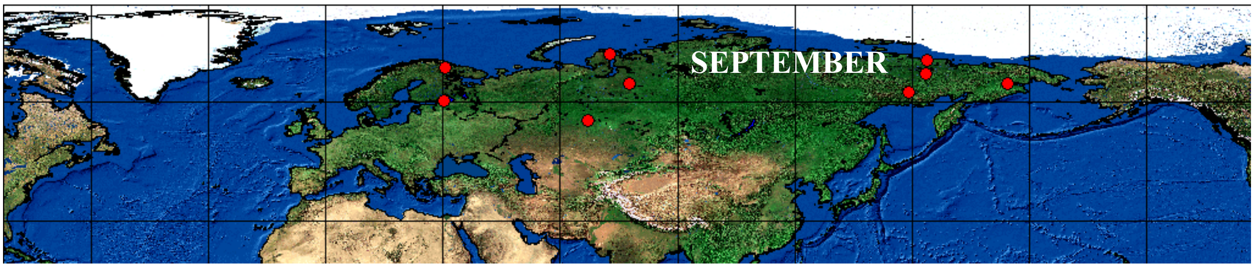
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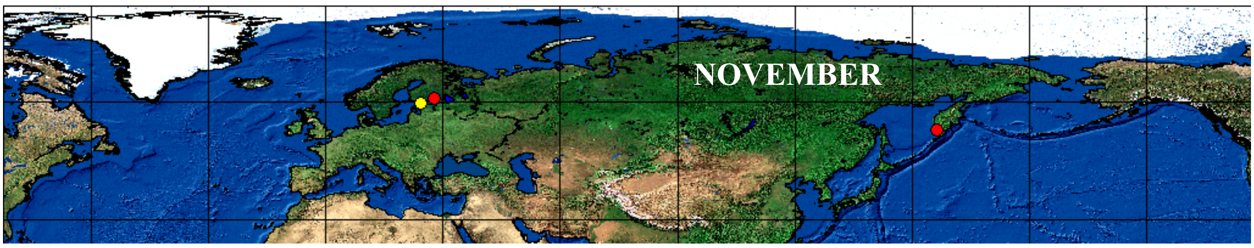
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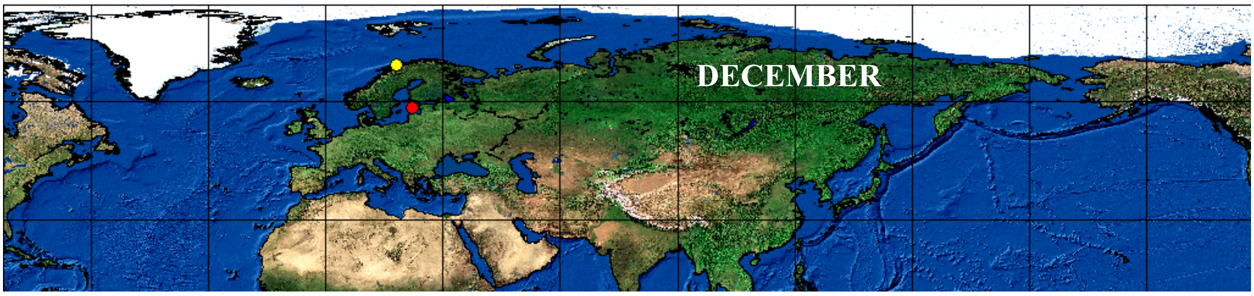

Figure 420. Long-tailed Duck monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. Most Long-tailed Duck movements are directed along northern coasts of Eurasia and North America and connecting seas – east-west movements. The same as in Common Eiders, there are movements between the White and Baltic Seas, along south-west – north-east directions. For birds that spend winter in the western parts of northern Europe, spring migration is directed generally eastwards, back in autumn. Birds wintering in the Pacific have the opposite „pendulum" migrations. Since Long-tailed Ducks can spend winter in the seas located deeply inside the mainland, i.e., the Sea of Azov, Black and Caspian Seas, this duck can be recorded in many places inland on their migration from the Arctic Ocean to those seas.

Distribution of distances indicates that, as it is already mentioned above, Long-tailed Duck can move both at very short and quite long distances (Fig. 421). The longest distance of movements, 4533 km, belongs to the more westerly located north-american-europen-west-siberian population of this duck.

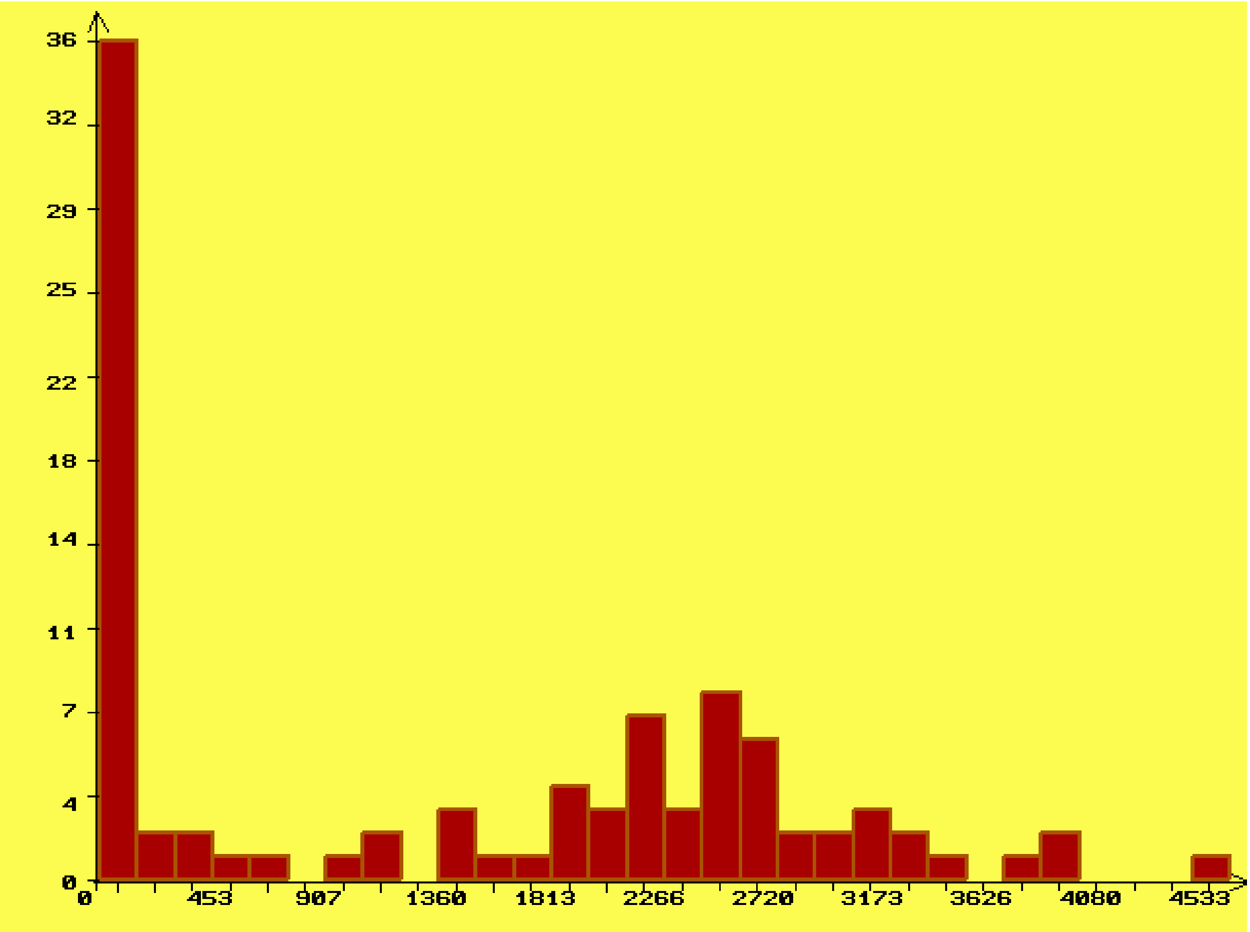

Figure 421. Distribution of all ring-recovery distances in the Long-tailed Duck. X axis is the flight distance in km; Y axis is the number of distances.

Mean flight distance in young birds (ringed as „pull" or „juv" or „1 y") for the western population of the Long-tailed Ducks is greater than the one in adults: 1721.8±326.4 (N_{young} =14) and 961.4+163.3 (N_{ad} =58) km respectively, significant – t-Bailey=2.08, P=0.05. That means that this population does not noticeably suffer from hunting because young birds have are capable to keep long-distance flights without stop by shooting. Male mean distance of movements in the western birds is lesser than in females: 933.8±196.2 and 1486.4±452.6 km (N_{males} = 46, $N_{females}$ = 9) respectively, insignificant. This means that males are more faithful to their areas than females. For the population connected with Alaska no much difference in both pairs of distance analysis are found, however, these results are biased (see above).

Speed. For Long-tailed Duck daily speed do not normally exceeds first tens of km. Daily speed of these ducks when they cross mainland is unknown.

Populations. Data set on Long-tailed Duck allows separating two populations in this species: 1) north-american-europen-west-siberian (polygon № 1, Fig. 422); 2) central-eastern-siberian-far-eastern-alaskan population (polygon № 2). In spite of data do not show any overlaps, control points in both populations lay close, therefore the overlapping is quite possible.

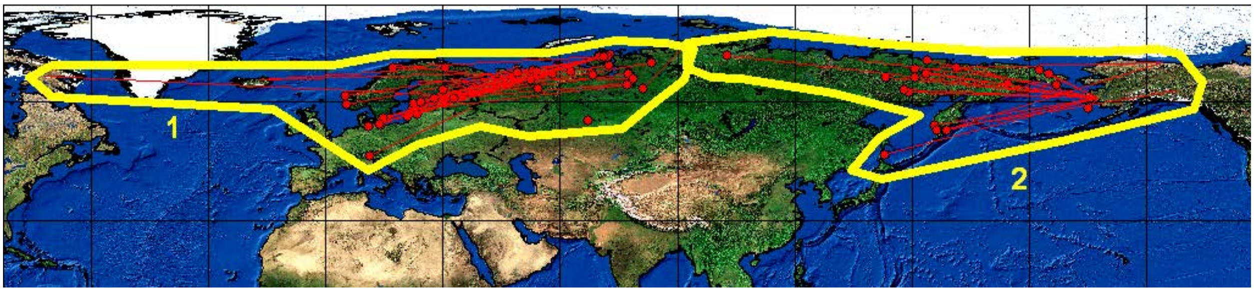

Fig. 422. Long-tailed Duck populations. Yellow polygon № 1 outlines north-american-europen-west-siberian. Yellow polygon № 2 outlines central-eastern-siberian-far-eastern-alaskan population.

Ten-year distances. For Long-tailed Ducks of the north-american-europen-west-siberian population there is a considerable increase of mean distance of movements, even when the longest outstanding distance is removed from the sample. Mean distance for birds recovered before 1971 is 796.2±175.6 km (N=50), after 1970 - 1691.5±187.3 km (N=21), highly significant P=0.0009. There is an increase for the central-eastern-siberian-far-eastern-alaskan population, as well, however insignificant, probably because of small sample.

Lifespan.EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010 displays data on the Long-tailed Duck lifespan as 22 years 8 months. This bird is from the Bird Ringing Centre of Russia database.

Mortality rate. According to the common criteria (see "Materials and Methods") 83 dead recoveries of Long-tailed Ducks are applicable for the mortality rate analysis. Mean annual mortality rate in the Long-tailed Duck is 17.61±1.72%. Real mortality pattern shows significant difference from the theoretical one (χ^2 = 35.54, df = 13, P=0.017). Programme MARK, Model CLogLog 2ndPart shows 18.60%, difference is 0.99% within the limit of the standard error. In spite of small amount of data in the set, on the basis of mortality rate pattern it is possible to make conclusion about condition of the species, even for the two considered populations separately. It is quite obvious that western (connected with Europe) population „feels" worse than the siberian-alaskan birds (Fig. 423). Really, if we compare the mortality rate for birds that live no more than 12 years (the top age of the siberian-alaskan birds) in both populations, we see that mortality rate for these important ages in the north-american-europen-west-siberian (connected with Europe) population is considerably greater than for siberian-alaskan birds: 29.1±3.11% vs. 22.4±4.31%.

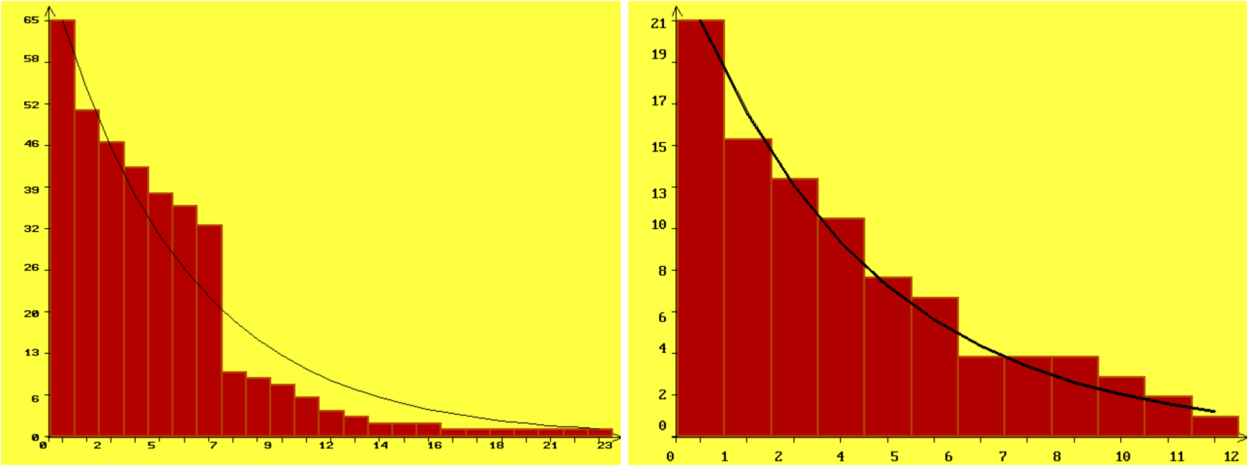

Figure 423. Mortality pattern of western (left) and eastern (right) Long-tailed Ducks. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

Males from the western population live, on average, longer than females: 5.06±0.46 (N=40) and 4.94±0.99 (N=8) years respectively, insignificant. For the eastern birds recovered in Russia, females‟ life is slightly longer: 4.65±1.98 (N=3) and 4.11±1.09 (N=12), respectively, insignificant.

COMMON SCOTER
(*MELANITTA NIGRA*)

Breeding range in Eurasia. Brief description of the breeding range is in Fig. 424. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

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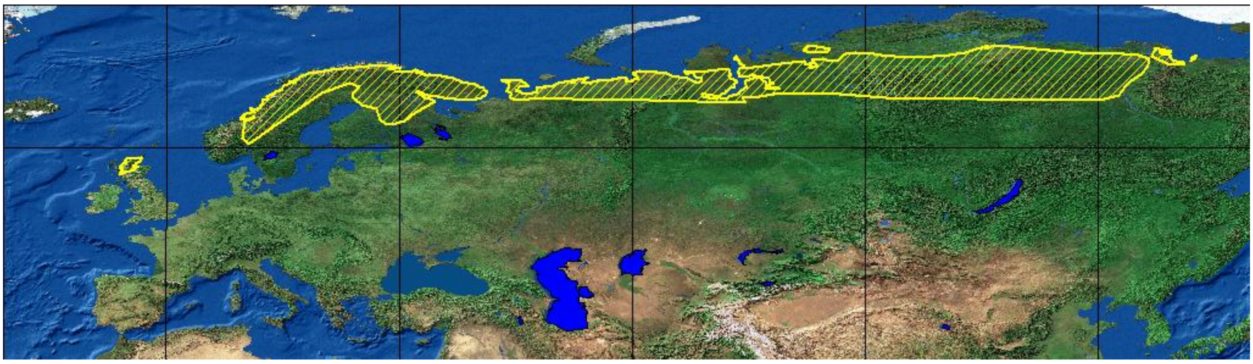


Figure 424. Breeding range of the Common Scoter in Eurasia (yellow dashed areas).

Distribution of control points. Bird Ringing Centre database contains only 9 recoveries from 9 Common Scoters All ducks were marked with metal rings only. Two birds had rings of the 'Moskwa' scheme, 4 – 'London', 2 – 'Arnhem', one – 'Copenhagen'. Ringing dates are since 23.07.1968 till 23.02.2003, recovery dates are since 06.09.1970 till 29.09.2019.

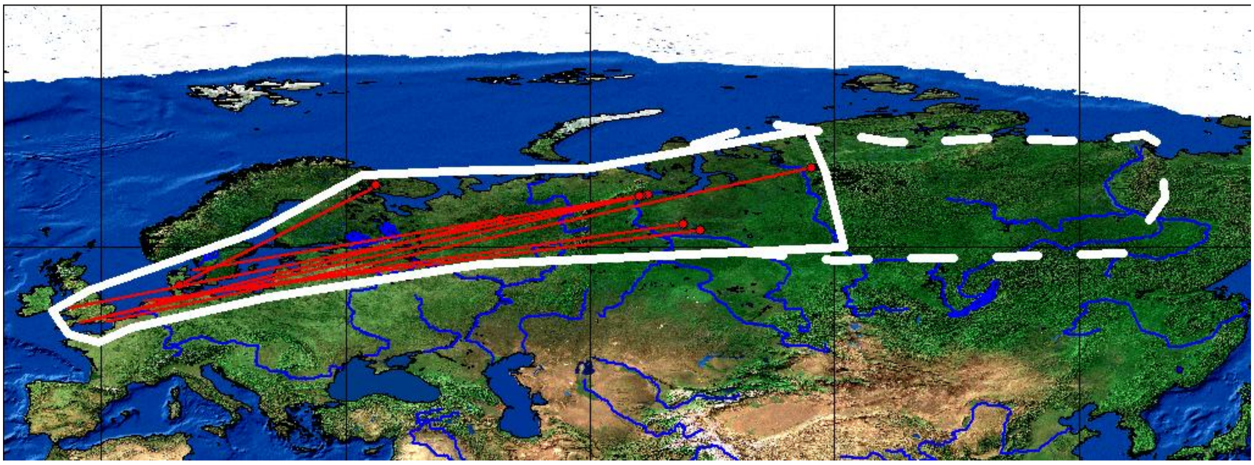


Figure 425. Common Scoter recoveries and population. Red lines connect ringing and recovery sites, recovery sites are marked with red dots. White polygon outlines european-siberian population, dashes white line show approximate uncertain part of the population.

All recoveries are indirect ones. All birds were shot. Main wintering grounds locate in the Baltic Sea-North Sea area; main migratory way stretches along White Sea-Baltic Sea migratory route, which is used by many waterfowl species (Fig. 425). Mean distance of movements is 3183.4±478.7 km (N=9), maximal recorded distance is 4682 km.

The species seems to contain only one population, the european-siberian population (Fig. 425). One recovery in February is in Denmak, certainly on the wintering grounds, May-July – on the breeding grounds in the north-western Siberia up to Yenisey River, in September on recovery is in Murmansk Region, western part of the European Russia. Although the latter recovery is situated within the breeding range, it might indicate autumn migration, as well.

Lifespan.EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) of 27 May 2023 displays data on the Common Scoter lifespan as more than 16 years 9 months. Bird Ringing Centre database contains confirmed recovery of male ringed on 15.02.2002 as adult bird (ring is ‘London’ GN 38 578) in Great Britain, Wales and shot on 29.09.2019 in the Taimyr Autonomic Area, Yenisey River, ring sent, species confirmed by the finder. Elapsed time for this male was more than 17 years 7 month. The bird was ringed as 2 year old one, so the life span of this bird really was around 19 years.

VELVET SCOTER
(*MELANITTA FUSCA*)

Photo by Nadezhda A. Dorofeeva

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 426. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

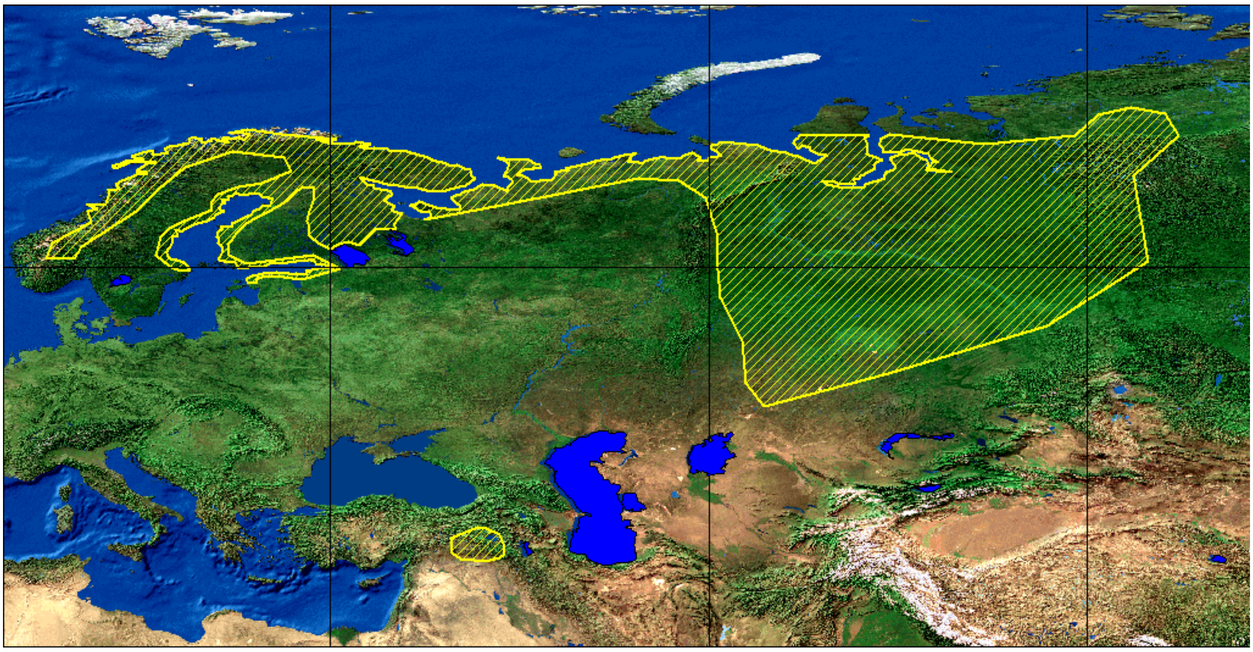


Figure 426. Breeding range of the Velvet Scoter in Eurasia (yellow dashed areas).

Distribution of control points. Bird Ringing Centre database contains data on 29 marked birds, which gave 29 recoveries, one recovery per bird. All ducks were marked with metal rings only. Ringing dates are since 22.10.1948 till 20.16.1989, recovery dates are since 29.08.1949 till 15.07.1996.

26 Velvet Scoters were marked by ring of the „Moskwa" scheme, 2 rings – „Matsalu Estonia" scheme, 1 – „Helsinki" scheme. Ducks were ringed in Estonia, Murmansk, Arkhangelsk and Chelyabinsk Regions and in Finland. Recovered on the wintering grounds at the Baltic Sea, Western and northern Europe, in breeding area in the western part of the north European Russia and on migration or vagrancy deeply mainland (Figs 427 and 428).

Finding details. This analysis includes all 29 recoveries. 10 (34%) are „shot". In 3 (10%) recoveries „details unknown", which practically mean shot, as well. Therefore, we can assume that 44% of birds were shot. Other reasons: caught – 4 birds, found dead - 10, found dead in fishing net - 1, ring only found -1.

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries of Velvet Scoter are similar (Figs 427 and 428).

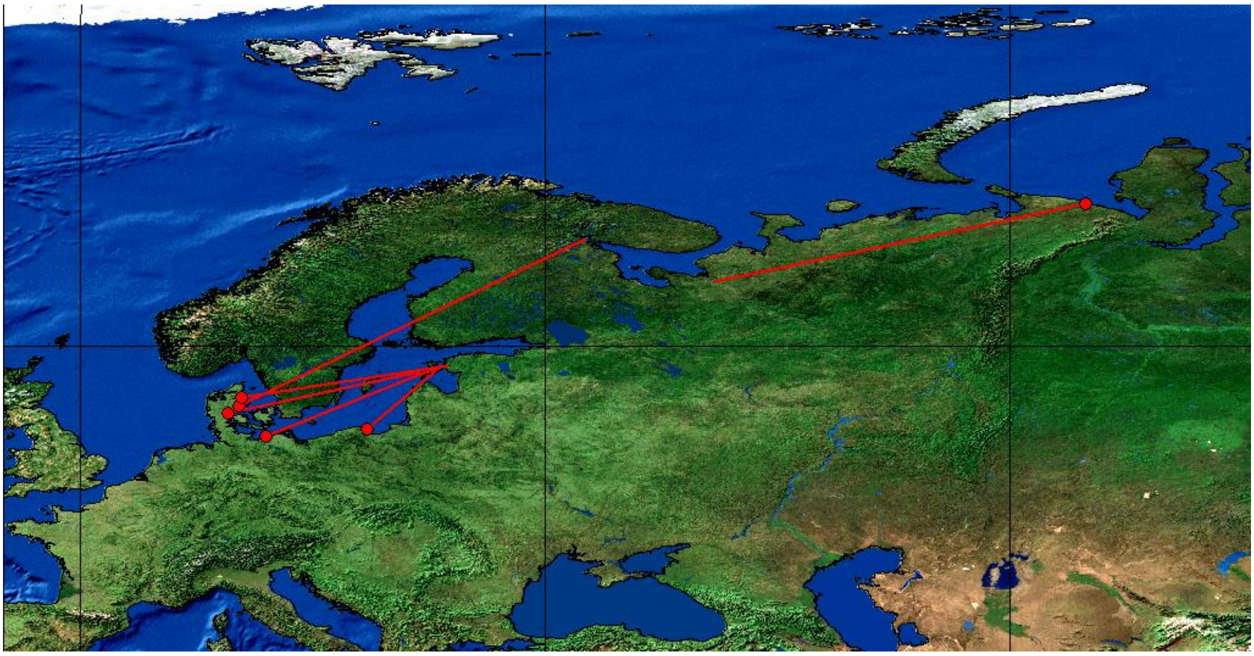


Figure 427. Map of the Velvet Scoter direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

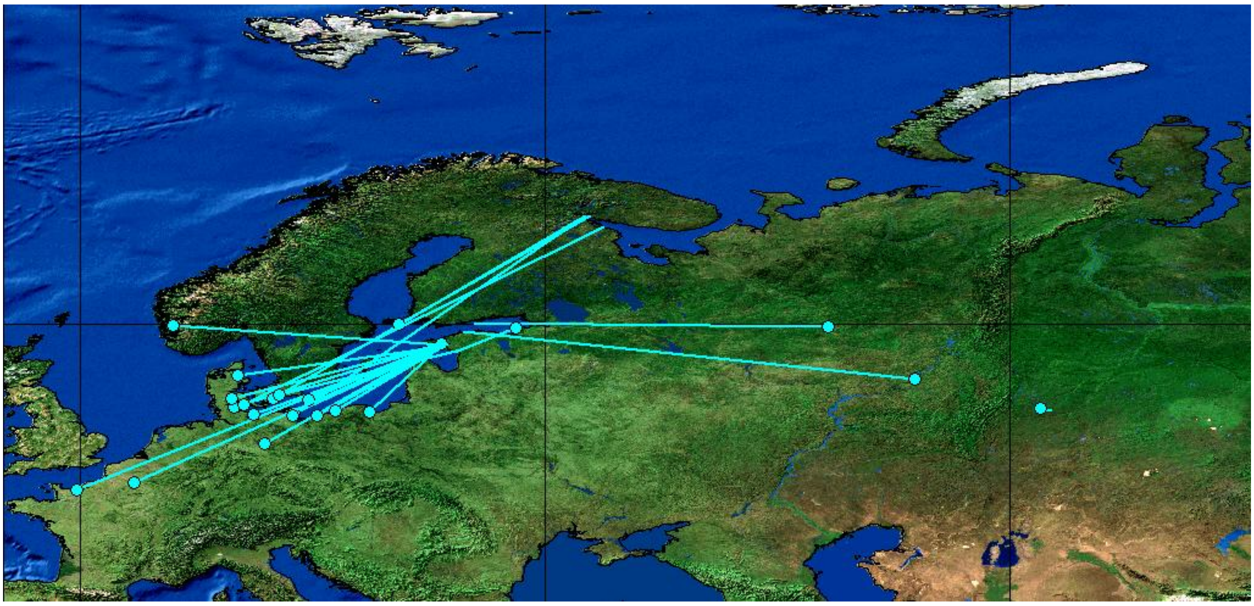


Figure 428. Map of the Velvet Scoter indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

Average flight distances in direct and indirect recoveries are close to each other: 981.0±161.3 (N=6) and 987.3±112.7 (N=23) respectively, difference insignificant.

Velvet Scoter data set is small; therefore monthly recoveries do not completely reflect the seasonal movements. It is certain, that birds in November through Mach are on the wintering grounds. Spring migration likely lasts during April and May, breeding season – all summer months. September and October are months of autumn migration.

The same as in the Common Scoter, main wintering grounds locate in the Baltic Sea-North Sea area, main migration streams go along White Sea-Baltic Sea migratory route, used by many waterfowl species. There are some wintering populations at the Black and Caspian Seas; however they are not in the scope of our ring-recovery set. Maximal distance of movements is

1849.6 km. Young birds move at similar distances as adults. The data set contains only one adult male and 22 adult females, no comparison between sexes is possible.

Populations. Data set on Velvet Scoter is quite small, anyway allows separating two more or less certain populations (Fig. 429). They are: 1) western-european-baltic-white-seas population; 2) Baltic-sea-north-european-russia-western-siberian population (Fig. 429).

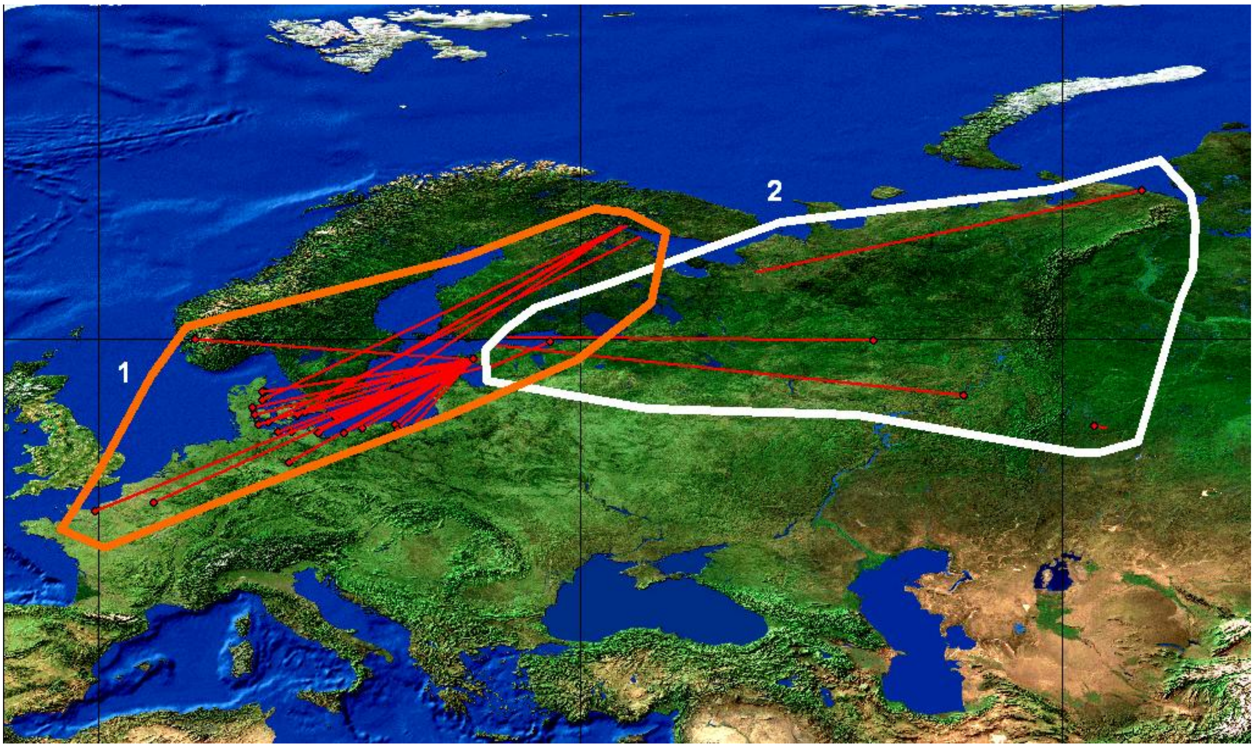


Figure 429. Velvet Scoter populations. Brown polygon outlines western-european-baltic-white-seas population (polygon № 1). White polygon № 2 outlines Baltic-sea-north-european-russia-western-siberian population.

Ten-year distances. Mean flight distance in all Velvet Scoter recoveries demonstrates small increasing through decades, however insignificant.

Lifespan. EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010 displays data on the Velvet Scoter lifespan as more than 21 years 5 months. Bird Ringing Centre database contains confirmed recovery of female ringed as adult and recovered after 8 years 7 months (ring sent).

Mortality rate. According to the common criteria (see "Materials and Methods") 25 dead recoveries of Velvet Scoter are applicable for the mortality rate analysis. Mean annual mortality rate in the Velvet Scoter is 24.47±4.25%. Real mortality pattern is significantly not different from the theoretical one (χ^2 = 1.07, df = 6, P=0.98). Programme MARK, Model CLogLog 2ndPart shows 26.09%, difference is 1.62% within the limit of the standard error. In spite of small amount of data in the set, mortality rate pattern suggests the stable condition of the species (Fig. 430), however data are from the period not later than 1996.

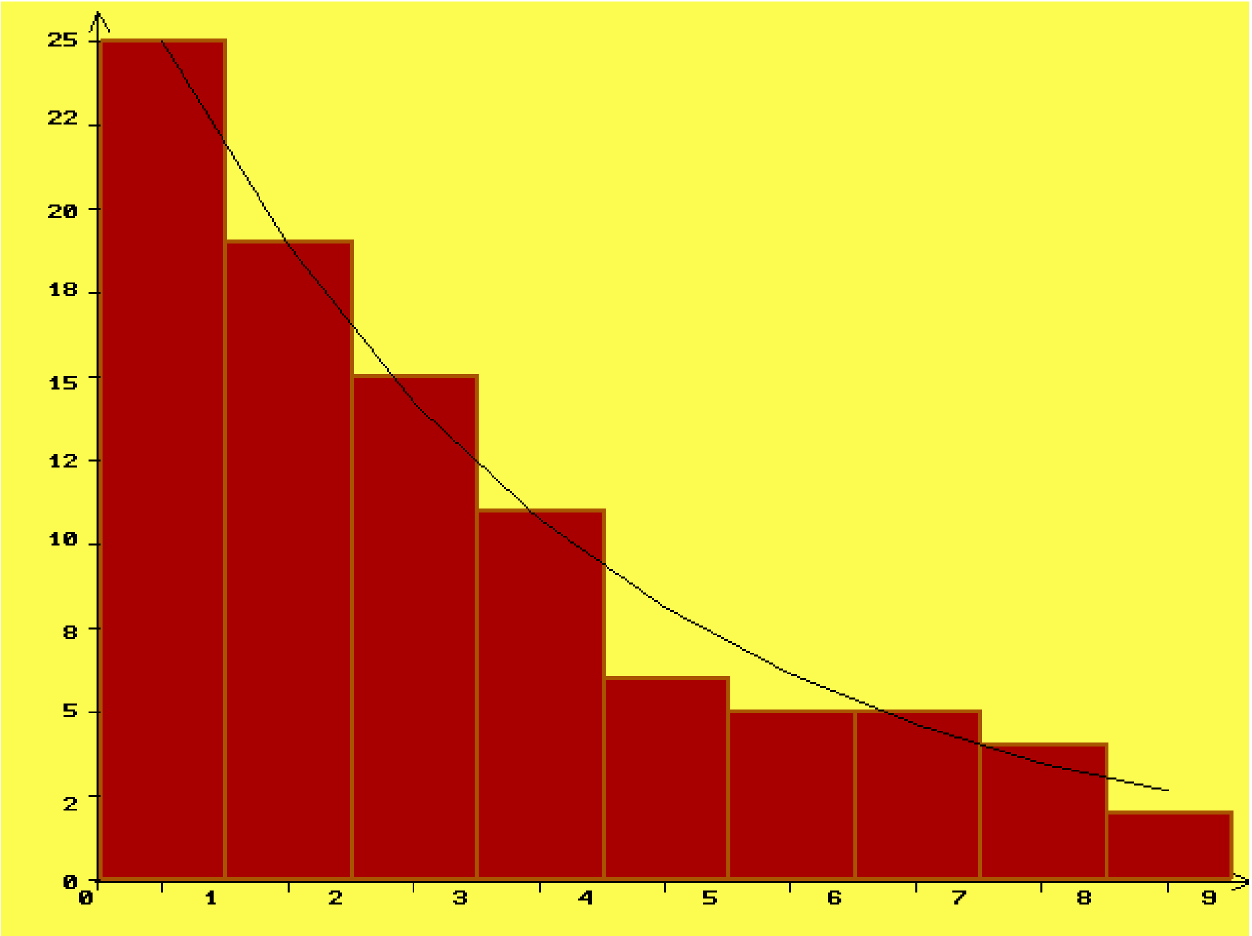


Figure 430. Mortality pattern in the Velvet Scoter. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

GOLDENEYE (*BUCEPHALA CLANGULA*)

Photo by Irina A. Kharitonova

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 431. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

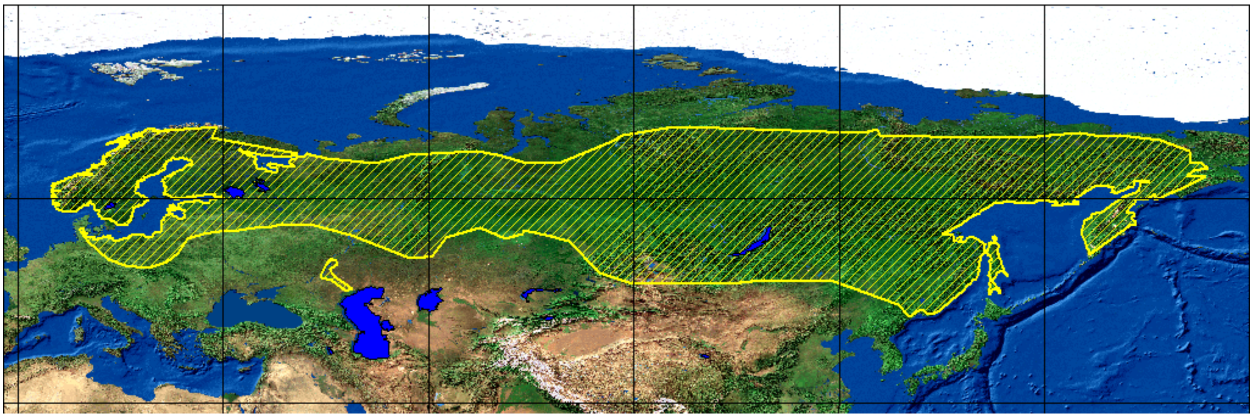


Figure 431. Breeding range of the Goldeneye in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 598 recoveries from 565 marked birds were used (Fig. 432). All birds were marked with metal rings, no other marks were used. 537 birds gave one recovery per duck, 2 birds gave 4 recoveries, 5 birds – 3 recoveries, 17 birds – two recoveries. Ringing dates are since 05.07.1931 until 29.05.2016, recovery dates are since 14.08.1931 until 03.10.2017.

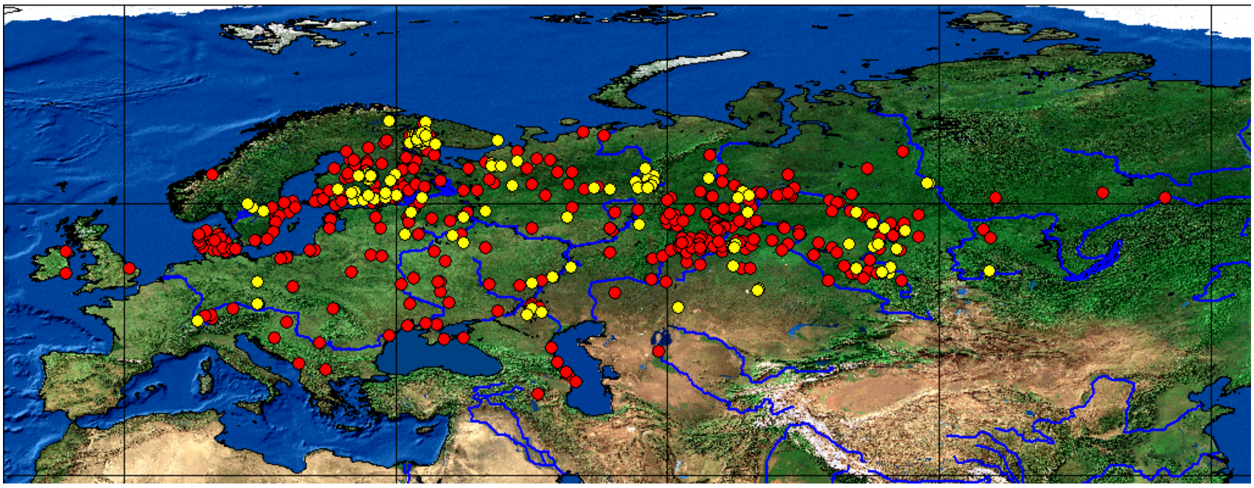


Figure 432. Position of all Goldeneye control points. Yellow dots – ringing sites, red dots – recovery sites.

Goldeneyes were ringed from central Europe to the east through north of eastern Europe, European Russia, Western Siberia and western part of Central Siberia. Most recoveries were from Europe, European Russia, Black and Caspian Sea areas, Western Siberia, Central Siberia up to 115°E, northern Kazakhstan.

‘Moskwa’ scheme recoveries. This sample contains 553 recoveries of the scheme „Moskwa“. They are from birds ringed within the Russian Federation and countries of the former USSR (Fig. 433). Considerable amount of birds were ringed in three main areas: Murmansk Region – Laplandsky and Kandalakshsky Nature Reserves (158 recoveries), Komi Republic (44 recoveries), Kurgan Region (229 recoveries). Other schemes area: „Helsinki“ – 37, „Praha“ – 3, „Stockholm museum“ – 3, „Radolfzel“ – 1, „Sempach“ – 1.

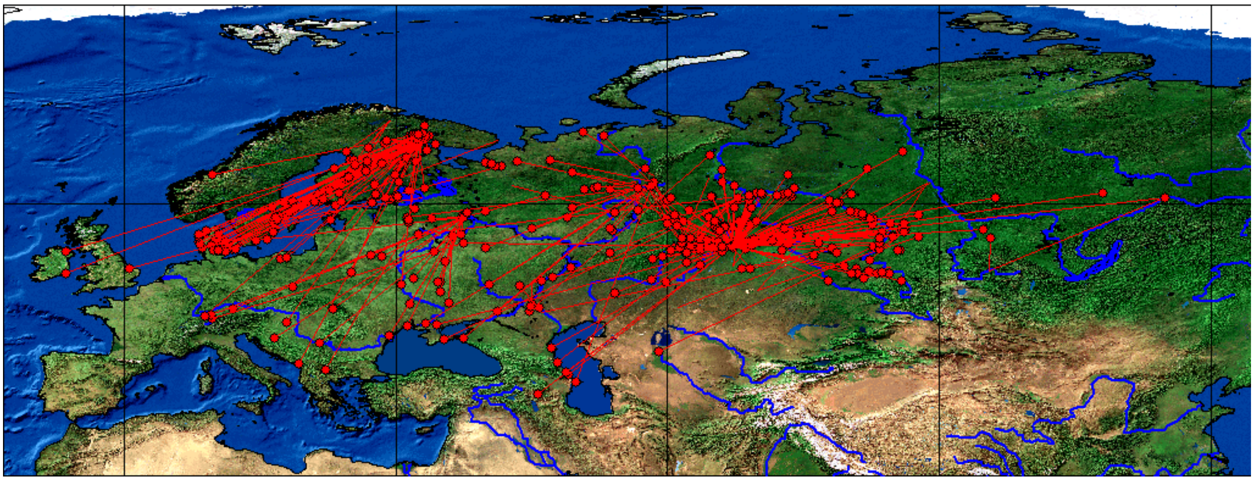


Figure 433. „Moskwa“ scheme recoveries of the Goldeneye. Here and in all other similar figures lines start from the ringing sites, recovery sites are marked with red dots.

Finding details. This analysis includes all 598 recoveries. 220 (37%) recoveries are „shot“. In 254 (3%) recoveries details are unknown. The latter usually means shot, as well. Probably, we can assume that 80% of birds were shot. Considerable amount (15% of recoveries) is „caught“, which includes all types of control with capture. Other reasons are not so common (Fig. 434).

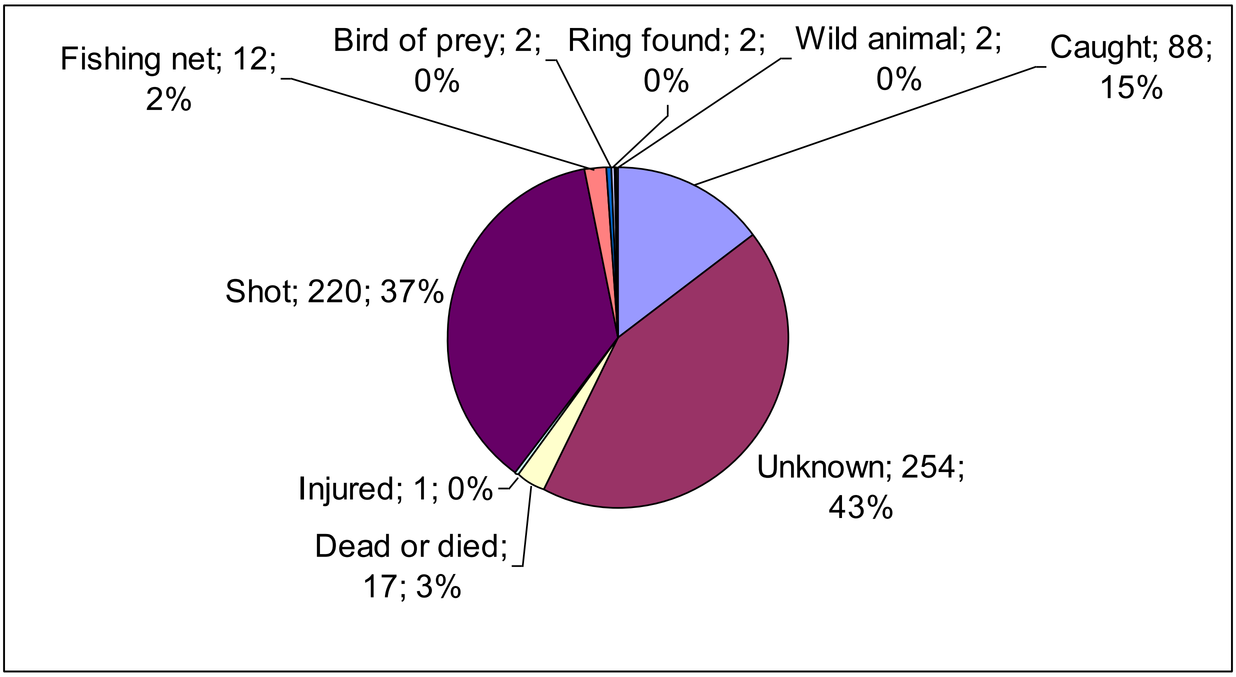


Figure 434. Finding details in the Goldeneye.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries is represented in Figs 435 and 436.

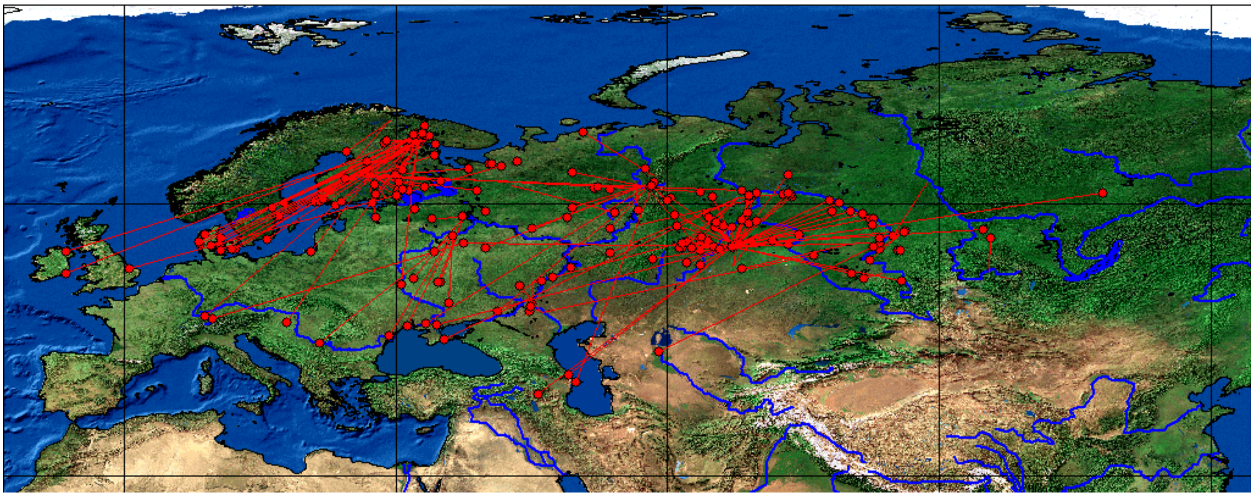


Figure 435. Map of the Goldeneye direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

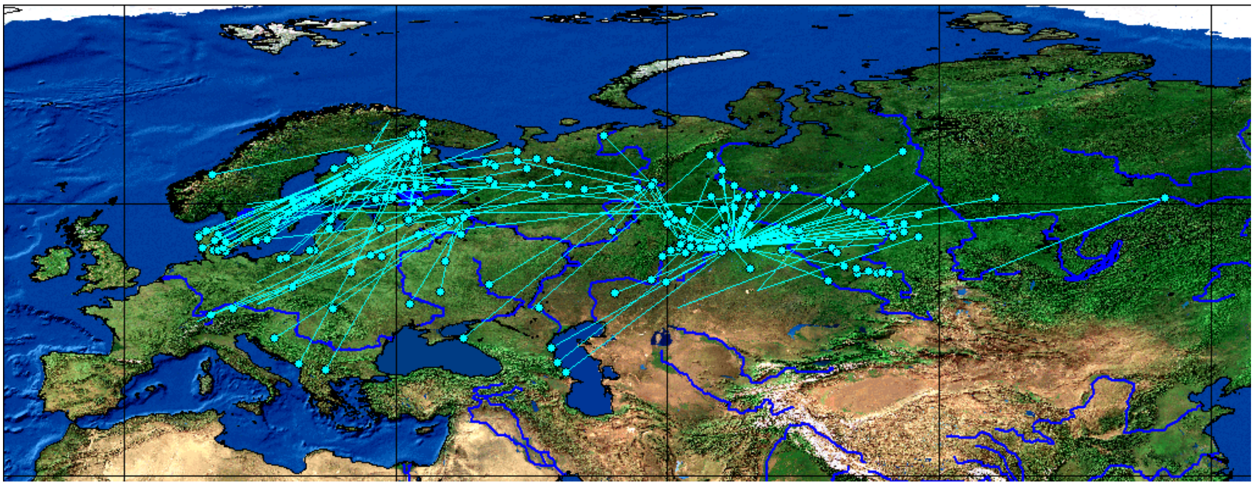
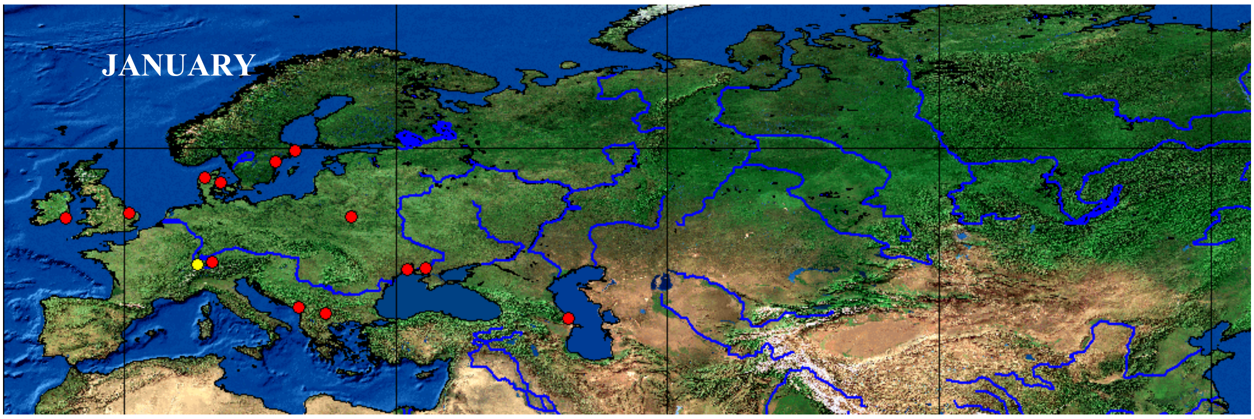


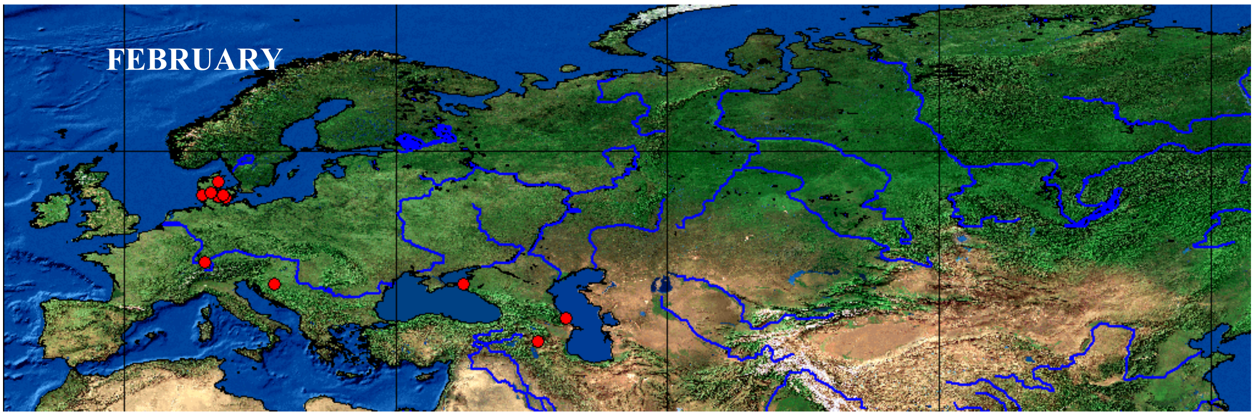
Figure 436. Map of the Goldeneye indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

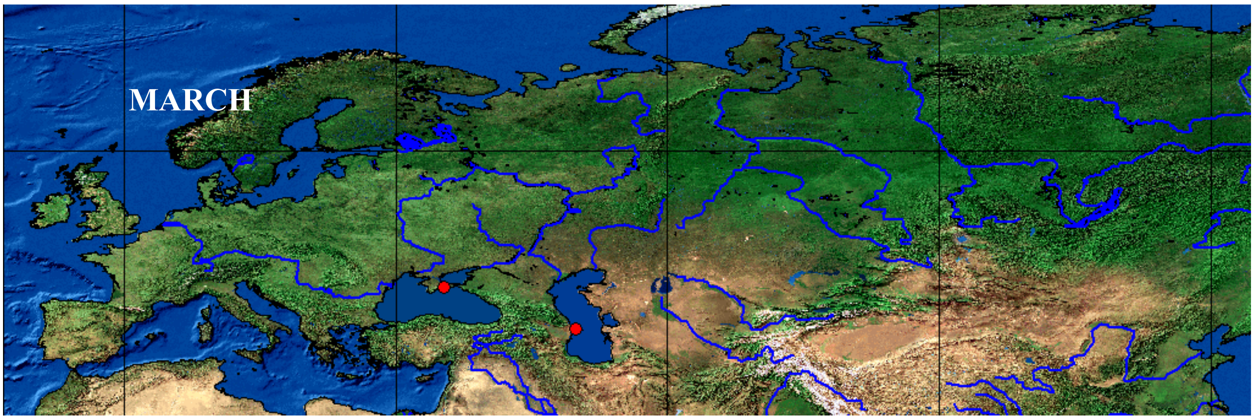
Maps indicate that Goldeneyes breeding in the western part of the northern European Russia winter mostly on the Baltic Sea in the compact area between Denmark, Germany and Sweden. Goldeneyes from the central European Russia, winter from central and southern Europe to the east up to the Black Sea and Sea of Azov area. Ducks from eastern parts of the northern European Russia migrate to the Black and Caspian Sea coasts. Birds ringed in the Western Siberia fly mostly to the Caspian Sea, some to the Black Sea and Trans-Caucasus.

Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them (χ^2 =11.4, 328 indirect recoveries and 270 direct ones, df = 2, P = 0.003). Center of indirect recoveries locates 1˚ 36‘‘ north and 3˚ 10‘‘ west (not east as in most duck species) of the centre of direct recoveries. The latter means that population exchange in the Goldeneye, in distinction to most of other duck species (but the same as in Common Pochard, Smew, Red-breasted Merganser and Goosander), occurs more to the west. Average flight distances in direct recoveries are slightly shorter than in indirect ones: 530.4±40.7 and 568.1±36.6 km respectively, insignificant.

Monthly movements. Monthly distributions of control points (ringing and recovery points) reflect a general way of seasonal movements in Goldeneye (Fig. 437). Pattern of control points indicates that in January and February most ducks are on wintering grounds at the Baltic Sea, Central and southern Europe, Black and Caspian Seas. Some birds penetrate up to British Isles. For March our data set is little and does not show the start of the spring migration. However, really Goldeneyes start to move in March and even can be noticed on the potential breeding grounds in the central Russia (Zubakin et at, 1988). In April migration is well pronounced everywhere. In May Goldeneyes complete their migration, appearing in the northernmost parts of the breeding range. In June-July-August ducks are within breeding range. The same as in several other duck species, Goldeneyes after breeding and moulting can migrate in the directions which are more characteristic for the spring and not for autumn. Birds ringed in July and recovered during 60 days after, move in any direction, to the north-east, as well (Fig. 438). This peculiarity of movements is confirmed by the fact, that north-eastern boundary of the control point area in August is located more to the north-east than in July (Fig. 437, July, August). In September the control point area starts to shrink from its north-eastern side. This is confirmed by the absence of the north-directed movements of birds ringed in August and recovered during next 60 days (Fig. 438). Thus, autumn migration starts in September. In October migration continues, although most of birds are still within breeding and moulting areas. In November autumn migration finishes sharply – in November and in December most Goldeneyes are on the wintering grounds. In addition to that, Goldeneyes are capable to spend winter in the snow covered areas if there are enough unfrozen waters. This explains a recovery of the Goldeneye shot in December in the Moscow Region, Central European Russia (Fig 437, December).



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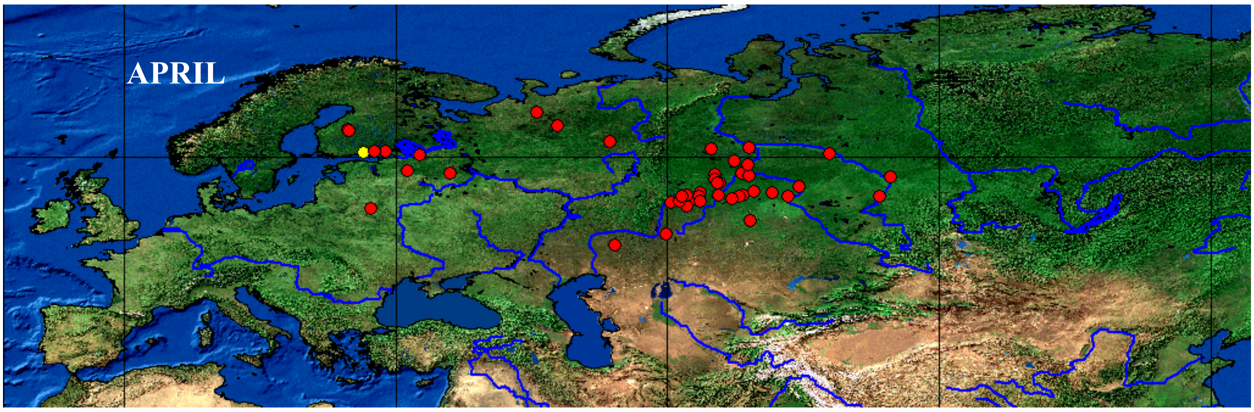
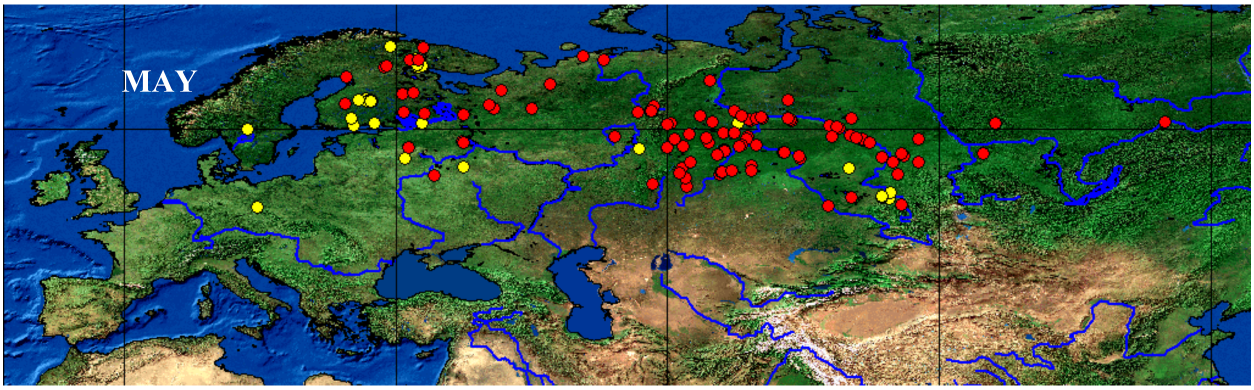

APRIL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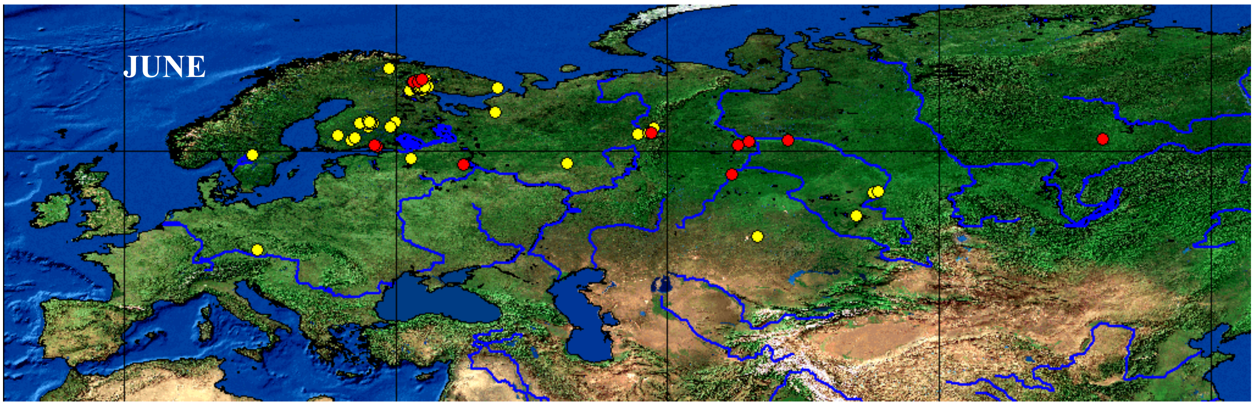
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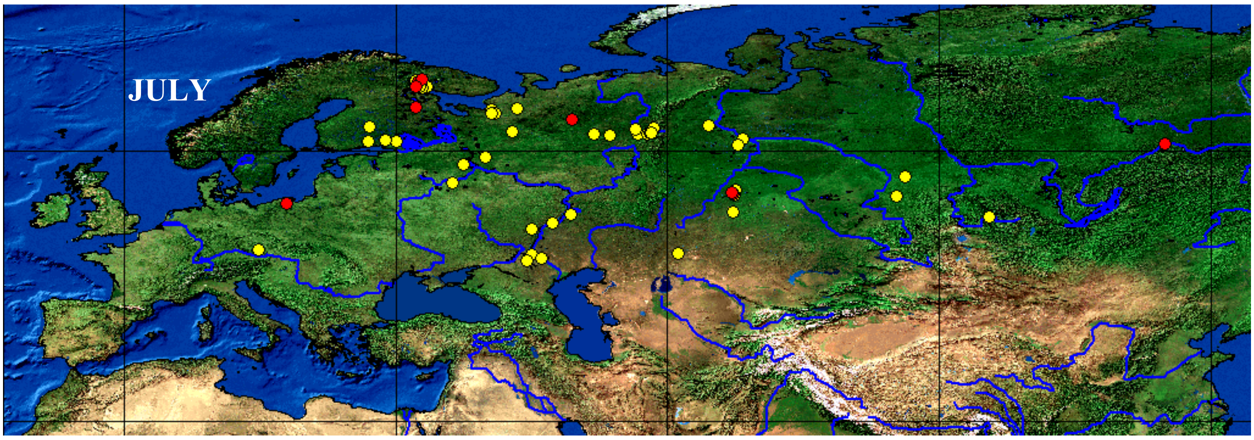
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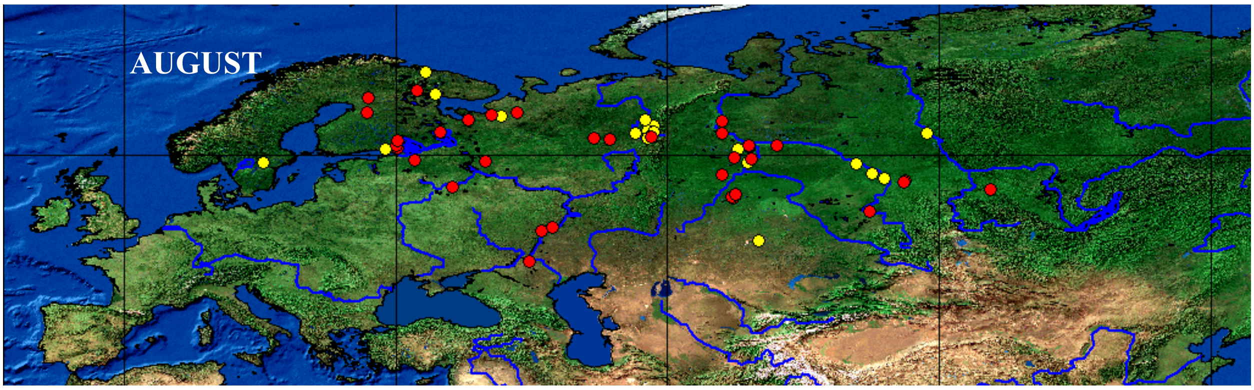
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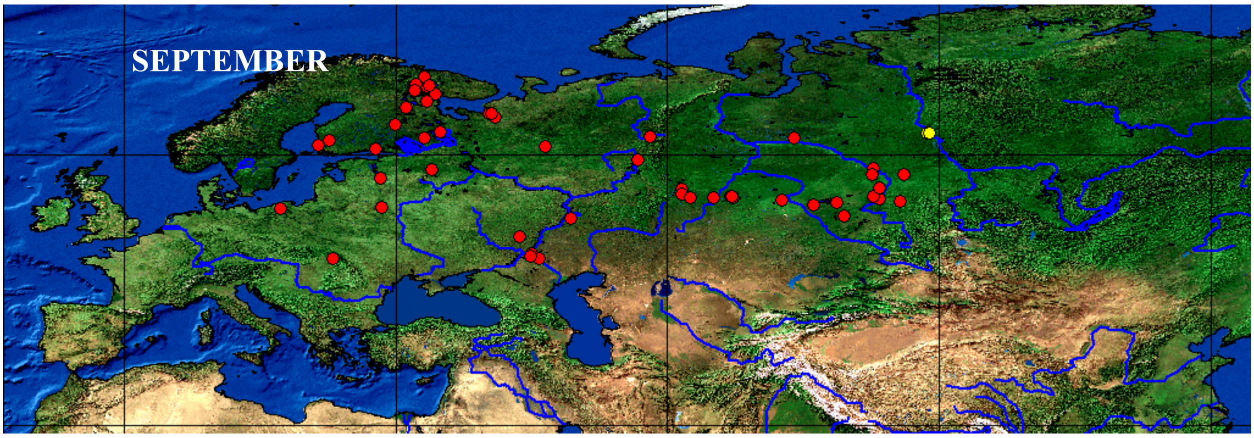
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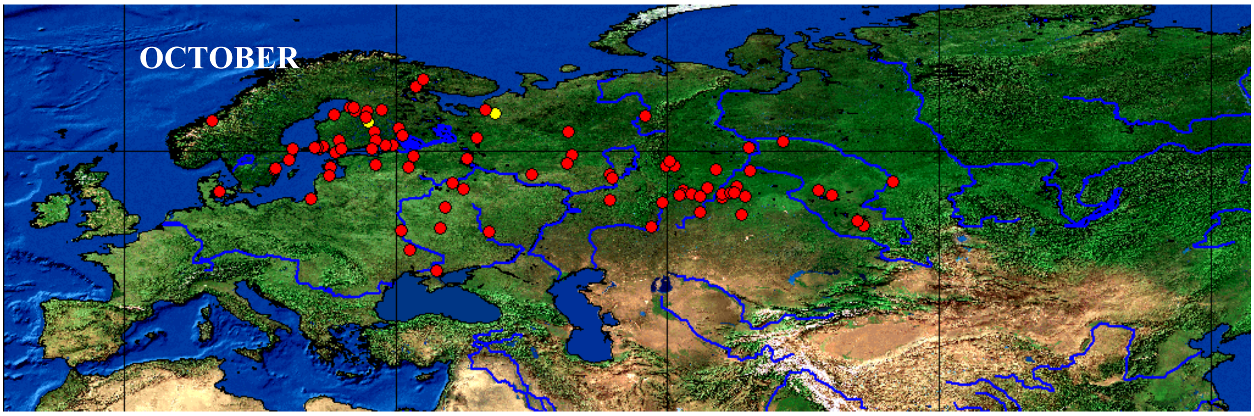
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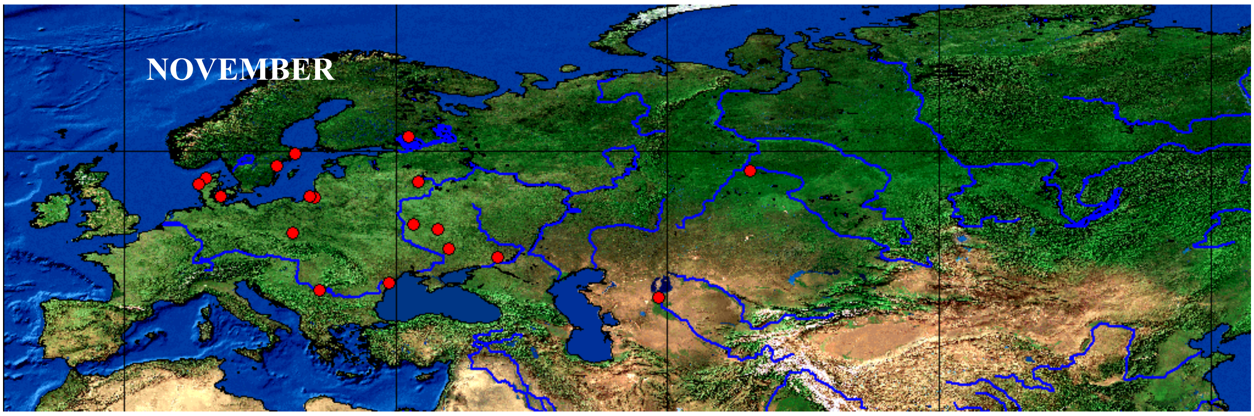


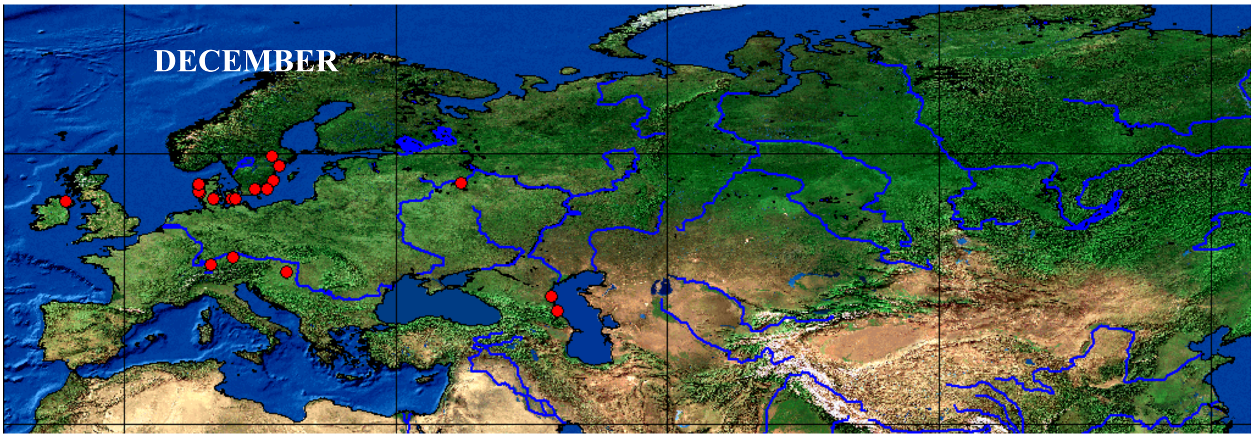


Figure 437. Goldeneye monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

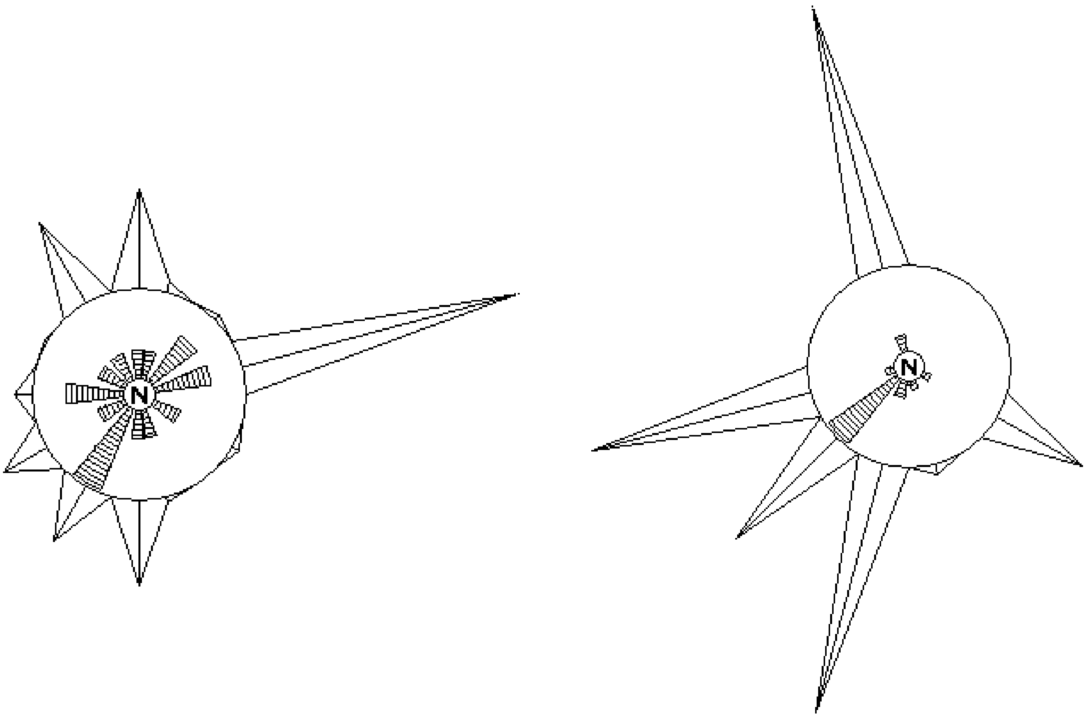


Figure 438. Recovery rose graphs for Goldeneyes ringed in July, mostly young birds (left recovery rose) or August, mostly young birds, as well (right rose) and recovered during 60 days after ringing: number of recoveries of birds that had flown from ringing sites to different

directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Left chart. Sector = 15.0°; Total recoveries - 33; N in sectors: from 0 up to 3; Average distance in sectors: from 0.0 km up to 1130.8 km; the longest flight distance is 2182.2 km.

Right chart. Sector = 15.0°; Total recoveries - 20; N in sectors: from 0 up to 9; Average distance in sectors: from 0.0 km up to 367.1 km; the longest flight distance is 1077.2 km.

Migratory routes. As it was preliminary shown in the section "Direct and indirect recoveries", Goldeneyes from different breeding areas migrate to different directions. Birds ringed in wintering and breeding areas within longitude <=30˚E move in the broad sector of directions 22-217˚ (Fig. 439) and in opposite directions in autumn. For birds ringed on breeding grounds in the area with longitude 30˚-60˚E, most movements directed to the south-east (bearing are 172-247˚, mostly 187-232˚ - Fig. 439), which comprises the autumn migration direction. Definitely, in spring birds fly in the opposite directions. Ducks ringed in 60˚-90˚E move in almost all directions (spring and autumn migration), only the south-eastern sector of movements is practically clear (Fig. 439).

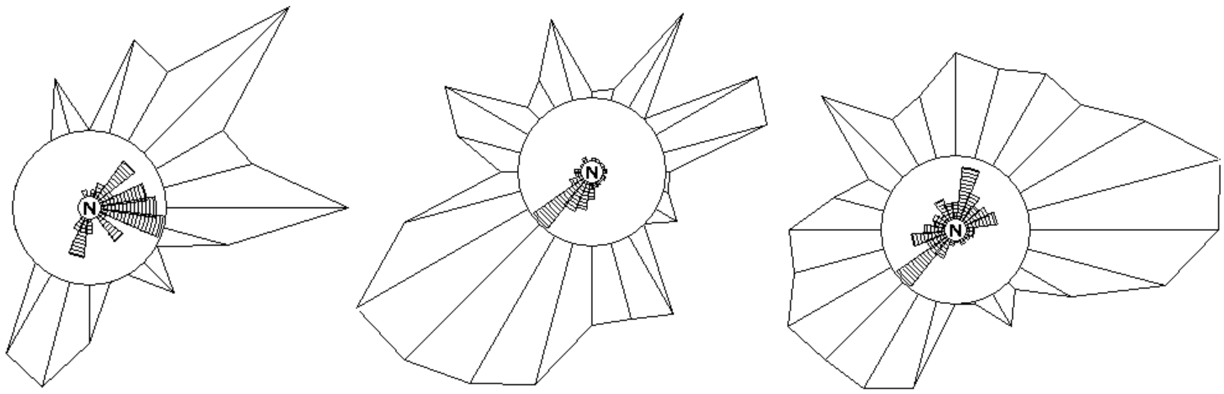


Figure 439. Recovery rose graphs for Goldeneyes, ringed in different longitudes: number of recoveries of birds that had flown from ringing sites to different directions (denoted as sectors, bar charts) and average flight distances along each direction (radar charts).

Left chart is for Baltic Sea and Europe wintering Goldeneyes, area of recoveries from western Europe to western Siberia, to about 70˚E. Sector = 15.0°; Total recoveries - 49; N in sectors: from 0 up to 8; Average distance in sectors: from 0.0 km up to 1692.9 km; the longest flight distance is 2638.2 km.

Central chart is for Goldeneyes ringed in many different places of the European Russia, area of recoveries from western British Isles to western Siberia. Sector = 15.0°; Total recoveries - 264; N in sectors: from 0 up to 47; Average distance in sectors: from 0.0 km up to 1402.5 km; the longest flight distance is 2851.5 km.

Right chart is for Goldeneyes ringed in Western Siberia, area of recoveries is Ukraine, European Russia (Black and Caspian Seas area), Transcaucasia, northern Kazakhstan, western and central Siberia to 115˚E; Sector = 15.0°; Total recoveries - 279; N in sectors: from 0 up to 29; Average distance in sectors: from 0.0 km up to 1107.4 km; the longest flight distance is 2808 km.

Goldeneyes prefer to move on relatively short distances, however longer distances up to 2851.5 km are also common (Fig. 440). The latter distance is the maximal distance in indirect recoveries. For direct recoveries the maximal distance is 2740.6 km.

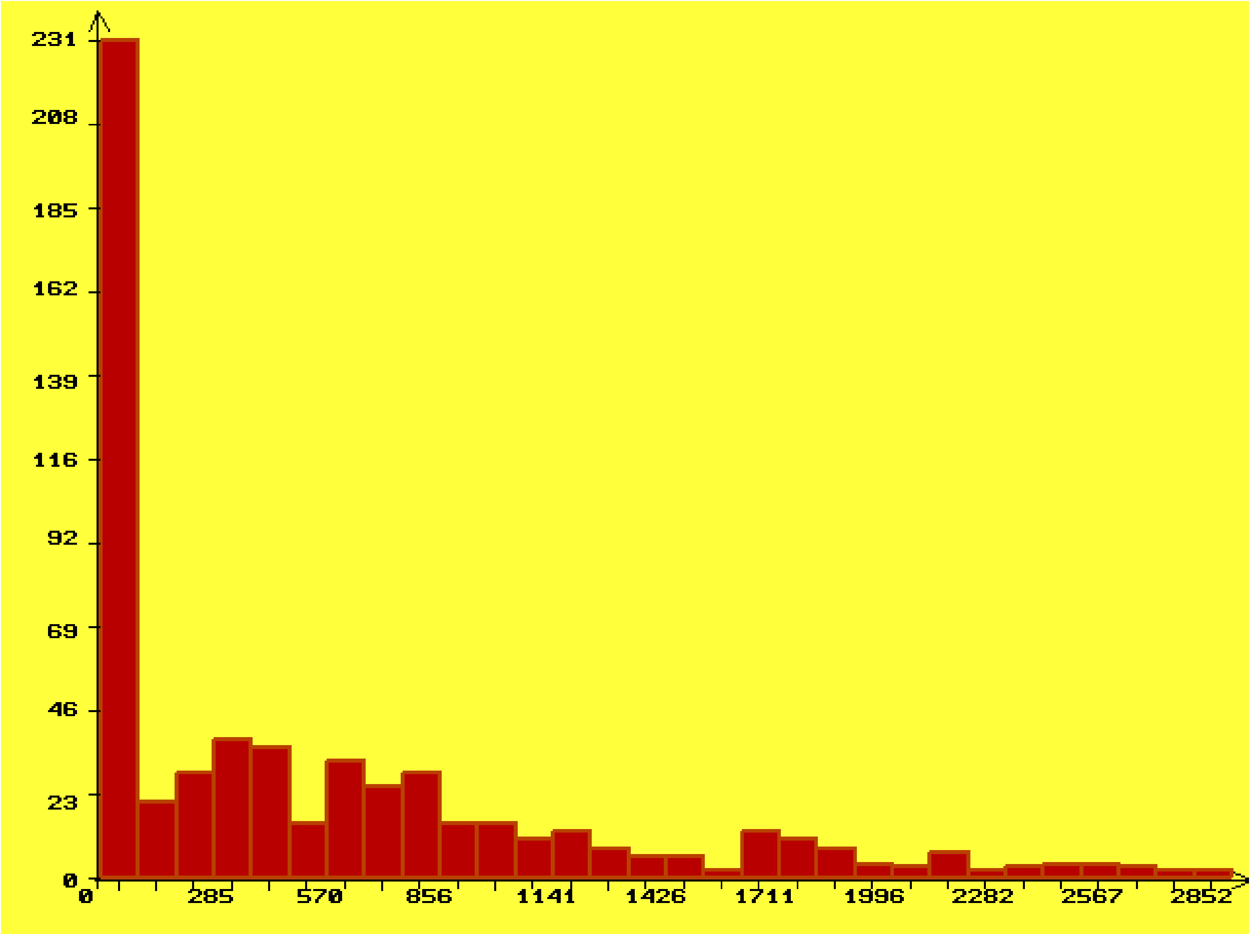


Figure 440. Distribution of all ring-recovery distances in Goldeneye. X axis is the flight distance in km; Y axis is the number of distances.

Mean distance of movements in Goldeneye young birds (ringed as „pull"or „juv"or „1 y") is by more than 300 km greater than in adults: 784.6±56. versus 450.5±29.2 km respectively (N_{young} = 180, N_{ad} = 418), significantly (t-Bailey=5.28, P=0.0000). That could mean two things: 1) Goldeneye do not suffer greatly from hunting (however it does not concord with not good species condition in the past, see section "Mortality rate"); 2) young birds are not very faithful to their places of birth. Male mean flight distance is by more than 100 km longer than in females: 577.7±49.8 and 466.1±46.7 km respectively (N_{males} = 96, $N_{females}$ = 206), however insignificant. Anyway, longer distances in males mean that males in this species are prospecting for the new areas and population exchange more than females.

Before outlining the general Goldeneye migratory routes, we present some illustrations to monthly mean positions for birds, ringed in different areas (Figs. 441–442). Goldeneyes during migration do not form any migratory loops. In autumn, Goldeneyes move to the wintering grounds along about the same way as in spring, but in backward direction. It is well visible from birds ringed in Murmansk Region, both adults and young (Fig. 441) and in Kurgan Region (Fig. 442).

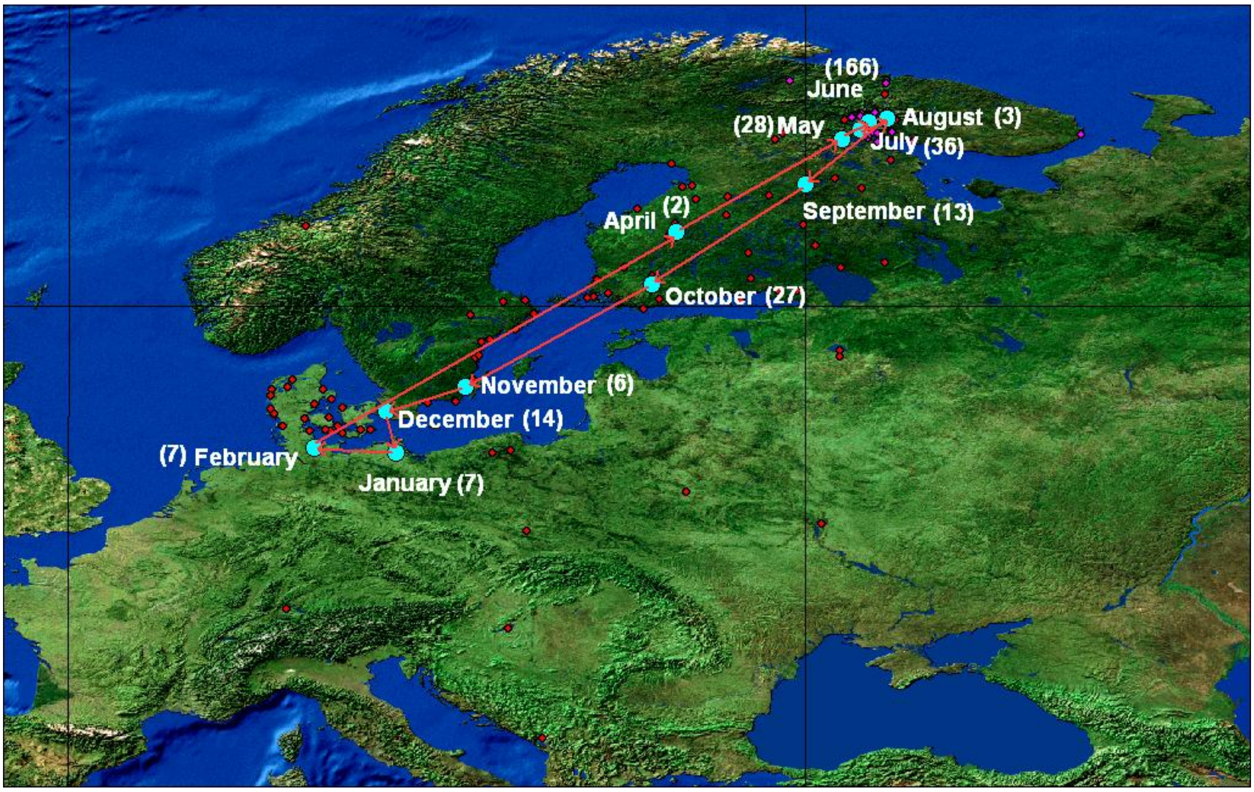


Figure 441. Mean monthly locations of Goldeneye control points for birds, ringed on the breeding grounds in Murmansk Region. Large blue-green circles are mean monthly locations. Arrows show directions of movements. Small purple dots are the ringing sites, red dots – recovery points. Number of control points in each month is in parentheses.

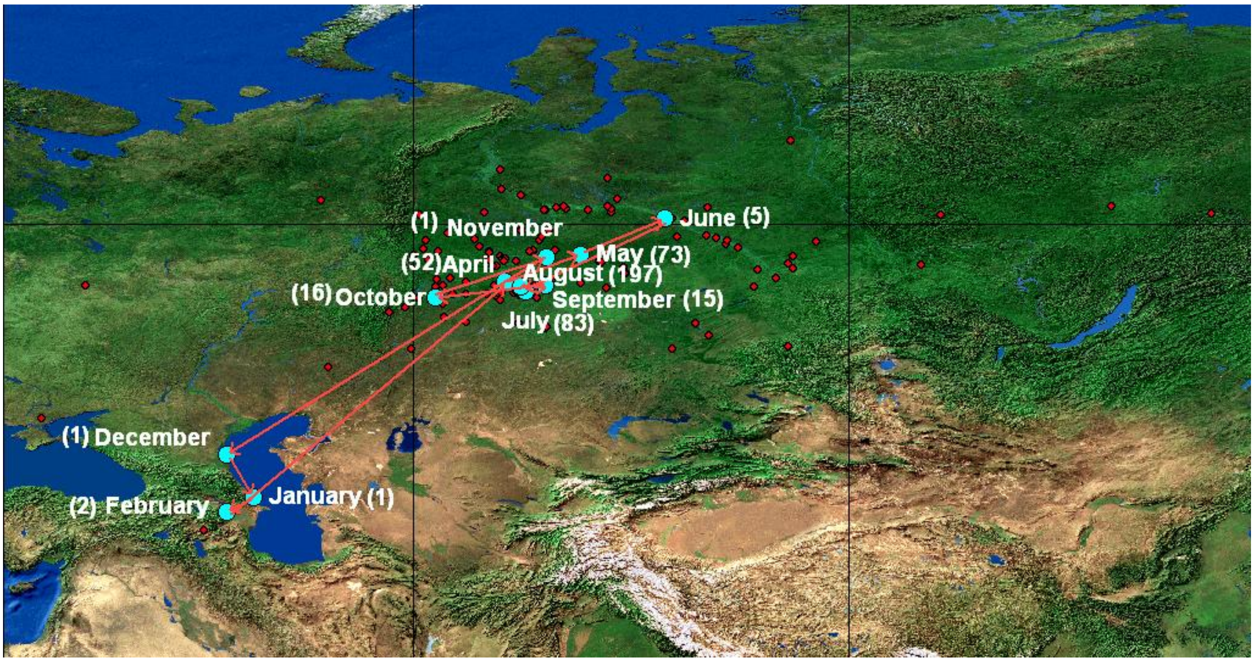


Figure 442. Mean monthly locations of Goldeneye control points for birds, ringed on the breeding grounds in the Kurgan Region. Blue-green large circles are mean monthly locations. Arrows show directions of movements. Small purple dots are the ringing sites, red dots – recovery points. Number of control points in each month represented in parentheses.

Summarizing all about migratory routes, we can outline spring and autumn Goldeneye migratory movements (Figs 443 and 444).

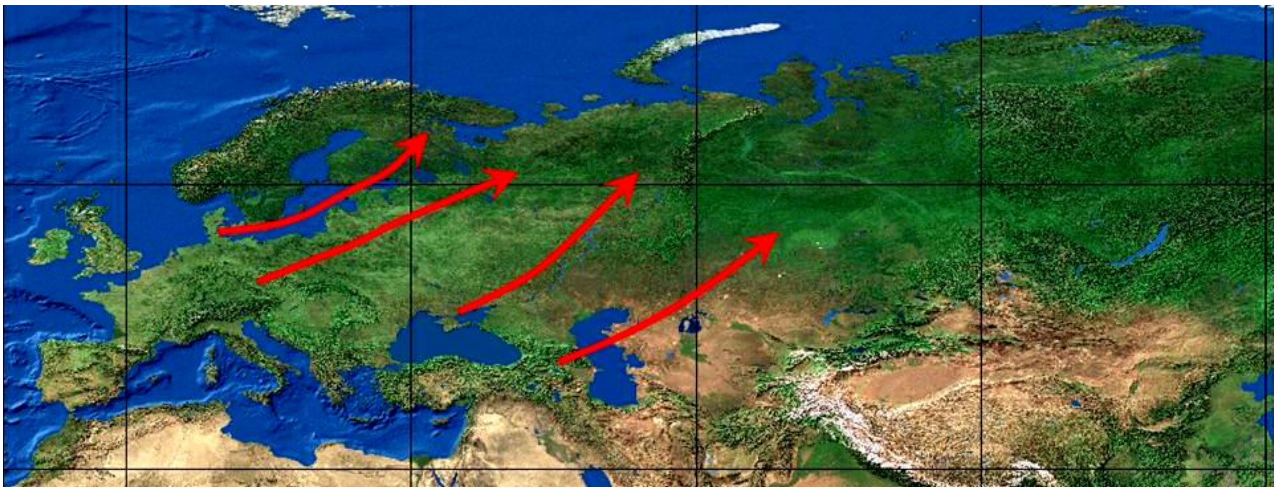


Figure 443 Outline of spring migratory routes for Goldeneyes. Red arrows are directions of migratory movements.

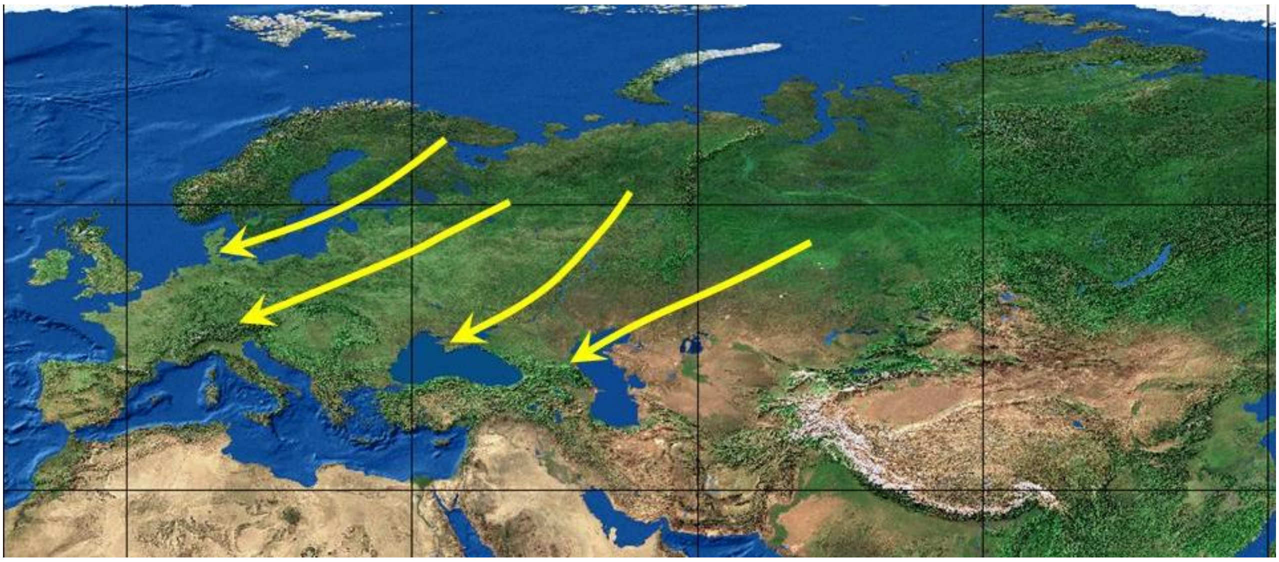


Figure 444. Outline of autumn migratory routes for Goldeneyes. Yellow arrows are main directions of migratory movements.

Speed. Bird Ringing Centre of Russia database does not contain enough data to define Goldeneye daily speed.

Populations. In general, Goldeneyes move at lesser distances than many other ducks. Therefore, size of the Goldeneye populations is quite moderate. Bird Ringing Centre of Russia data allow outlining the following Goldeneye populations: 1) west-european-baltic-north-west-european-russian population (polygon № 1, Fig. 445); 2) south-eastern-european-central-european-rissian population (polygon No 2, Fig. 445); 3) black-sea-urals-north-western-siberian population (polygon № 3, Fig. 445); 4) caspian-sea-kazakhstanian-southern-western-siberian population (polygon № 4, Fig. 445). All populations generally expose north-east – south-west migration movements (Fig. 445).

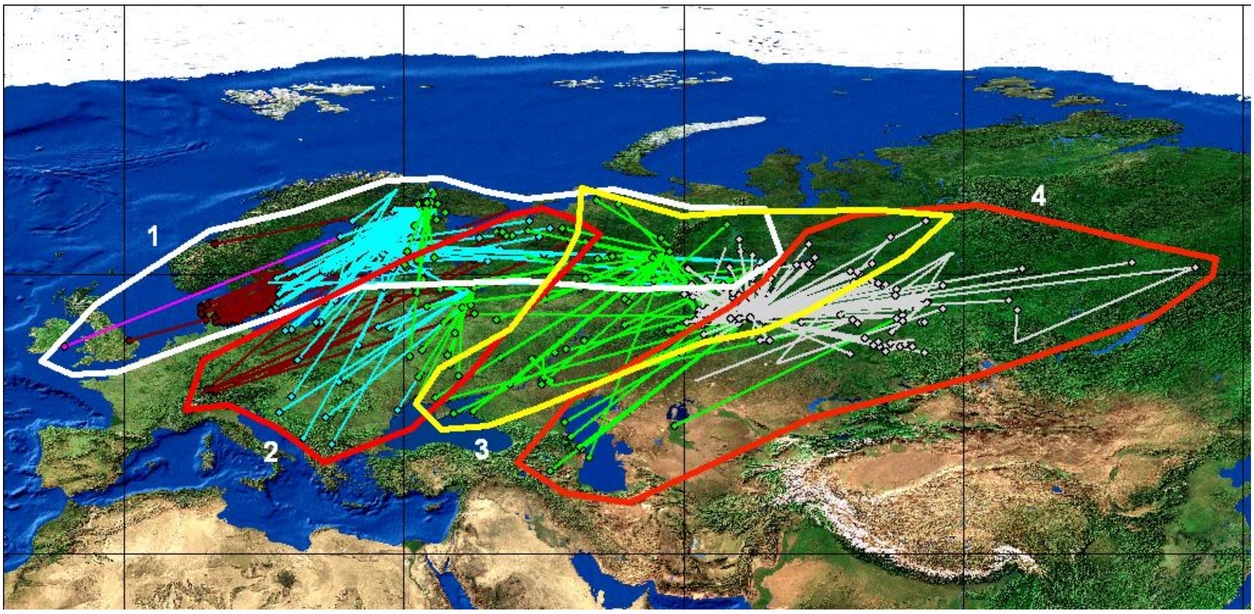


Figure 445. Goldeneye populations. White polygon outlines west-european-baltic-north-west-european-russian population (polygon № 1). Red polygon shows south-eastern-european-central-european-rissian population (№ 2). Yellow polygon № 3 is black-sea-urals-north-western-siberian population. Orange polygon № 4 is the caspian-sea-kazakhstanian-southern-western-siberian population.

Ten-year distances. Mean distance of movements in all Goldeneye recoveries demonstrates definite increasing through decades (Table 22) in spite of changing of some ringing places during the study period.

Table 22. Goldeneye mean flight distance per decade.

Decade (years)	1931-1940	1941-1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2017
Distance (km)	418.4	495.7	516.0	523.3	556.0	952.0	853.7	820.3
Number of recoveries	230	17	38	97	118	58	27	13

To understand the process in more detail we should choose one ringing place with relatively large number of recoveries during long time period. In Murmansk Region birds were ringed mostly in two places, posed close to each other – Laplandsky and Kandalakshsky Nature Reserves during the period 1951-2016. Ring-recovery distance in Goldeneyes increased through decades, as well. This increase is significant in all three tests that we have performed. For birds recovered before 1971 mean distance was 395.3±133.1 (N=32), after 1970 - 692.4±67.3 (N = 126), difference is significant t-Bailey =1.99, P =0.05. If we divide the set into other intervals, the result will be the same: for birds recovered before 1981 mean distance was 509.5±69.9 (N=118), after 1980 - 994.5±103.4 (N = 40), difference is significant t-Bailey =3.9, P =0.0002. For birds recovered before 1991 mean distance was 601.4±66.7 (N=138), after 1990 – 845.1±126.1 (N = 20), difference is almost significant t-Bailey = 1.71, P = 0.098. This result is not explainable from the point of view of global warming. The point is that, these Goldeneyes were ringed at the breeding place. In this case the mean distance should decrease because wintering places during warming expectably should shift closer to the breeding grounds. This regularity is noticed in the Baltic Sea wintering Bewick's Swans (see species account). However in the Goldeneyes the regularity is generally vise versa: wintering places shift more and more away from the breeding grounds. This suggests steadily habitat deterioration in those wintering areas, which are located closer to the breeding sites.

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) of 26 November 2010, the oldest Goldeneye lived 16 years 11 months. Bird Ringing Centre of Russia database contains a recovery of the ring „Stockholm Museum" scheme 90A 00 321. This Goldeneye was ringed as „pull" in Sweden on 25.05.1991 and shot near 05.05.2012 in Karelia, Russia after almost 21 years (ring sent).

Mortality rate. According to the common criteria (see "Materials and Methods") 498 dead recoveries are applicable for the mortality rate analysis. If we use all recoveries for calculations, mean annual mortality rate in Goldeneye is 25.61±0.99%. Real mortality pattern differs from the theoretical one insignificantly (χ^2 = 441.7, df = 18, P=0.0000). Programme MARK, Model LogLog 2ndPart shows 26.66%, difference is 1.05%, just slightly exceeds standard error. Goldeneye real mortality pattern shows considerable drawdown in comparison with the theoretical line (Fig. 446). This might indicate not good situation with the species. Having enough data, we are able to analyze mortality rate pattern over decades.

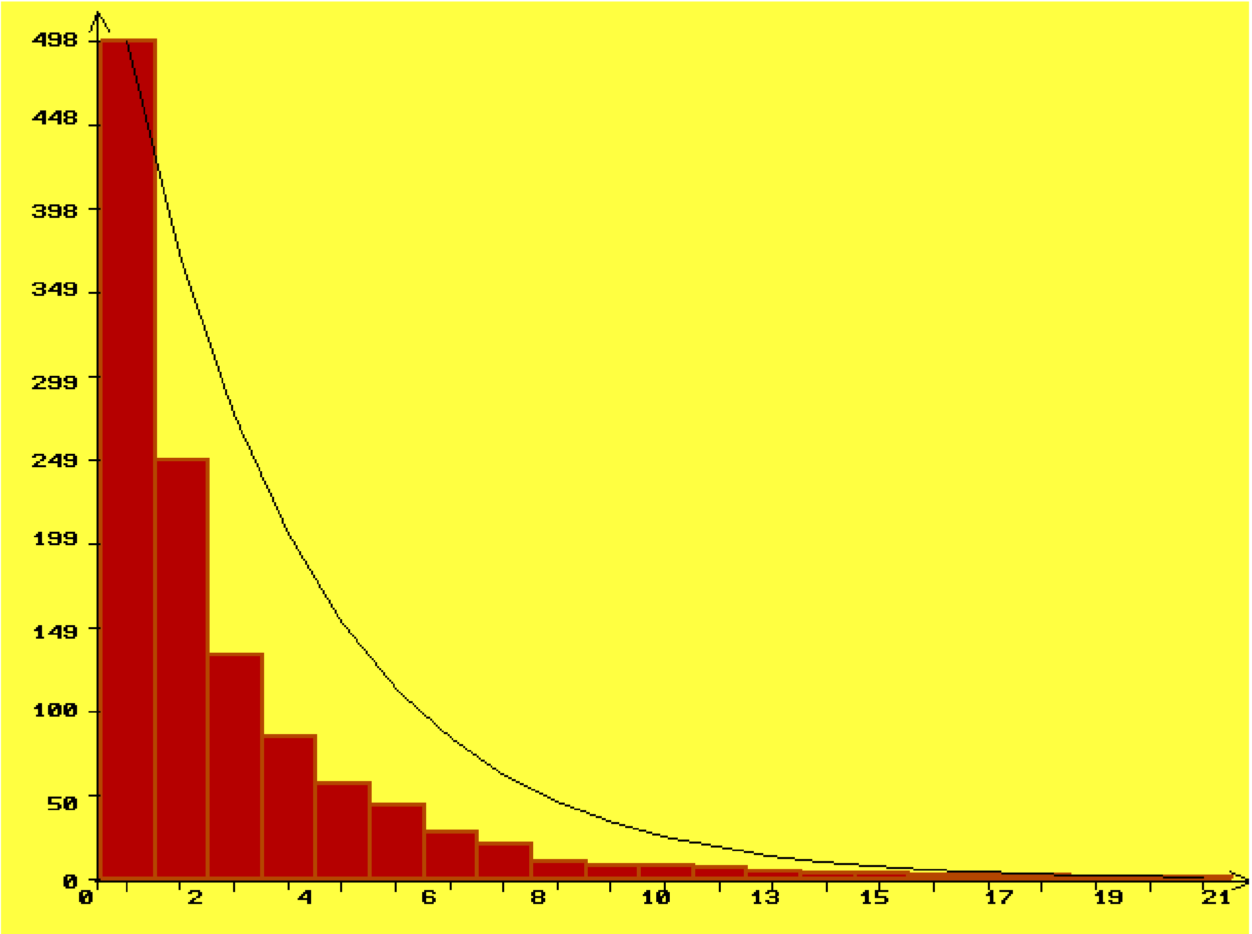
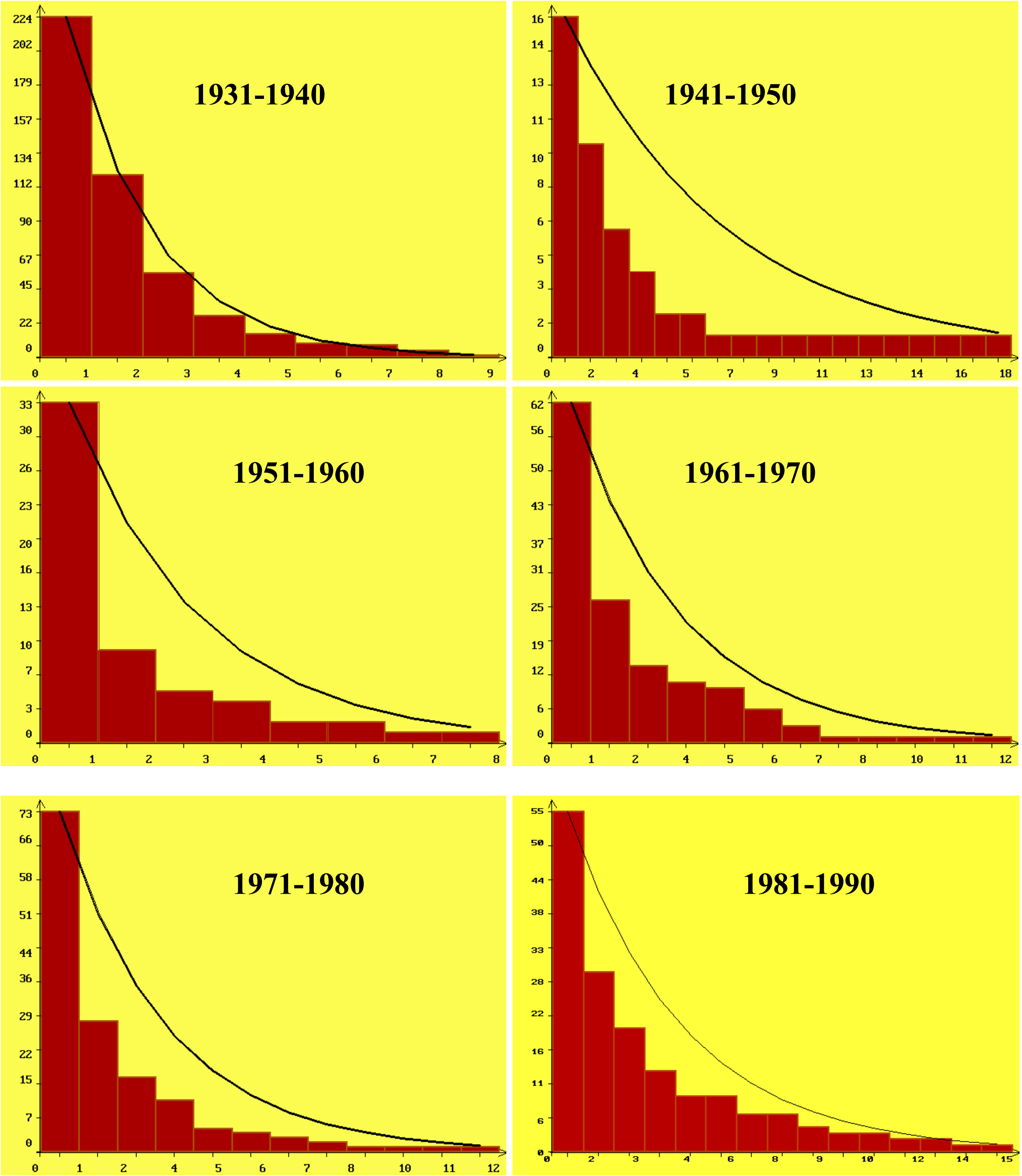


Figure 446. Mortality pattern in the Goldeneye. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

For 1930s mortality pattern indicates good population (species) condition – real data are not very much different from the theoretical line (Fig. 447, 1931-1940). Nearly a half of recoveries were obtained in that decade. Then, in the decade 1941-1950, Goldeneye condition became much worse. We think that it is related to habitat deterioration both on wintering (battles on the Baltic Sea) and breeding (decreasing number of available trees with hollows) grounds during the World War II. Situation stayed not good for the 1960s through 1980s. Some improvements are observed in 1990s; the data set for 2001-2017 is very little (Fig. 447).



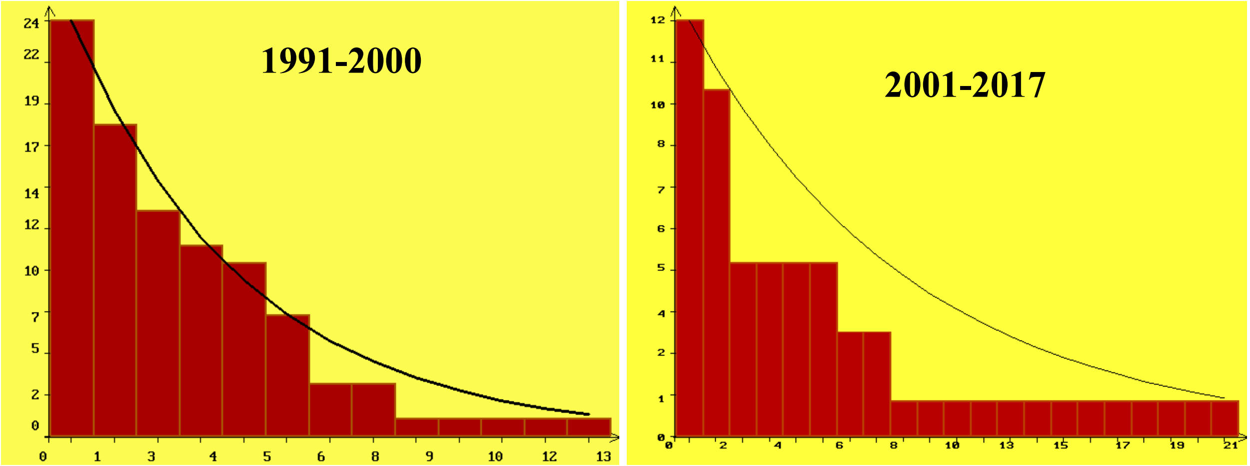


Figure 447. Mortality pattern in Goldeneyes recovered in different decades. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, females live significantly longer than males: 2.53±0.21 (N = 130) and 1.91±0.18 (N = 90) years respectively, significantly – t-Bailey=2.2, P=0.029. Female overall mortality rate is lesser than in males: 27.79±2.06% and 33.58±2.88% respectively, the demographic conditions for males looks worse (Fig. 448).

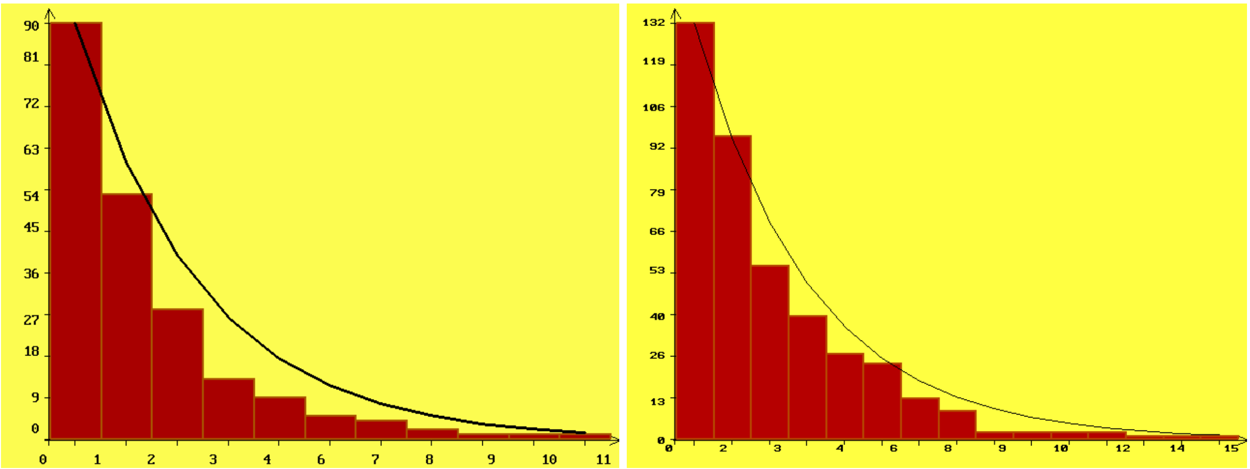


Figure 448. Mortality rate pattern in Goldeneye sexes: left – females, right – males. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

SMEW
(*MERGUS ALBELLUS*)

Photo by Irina A. Kharitonova

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 449. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

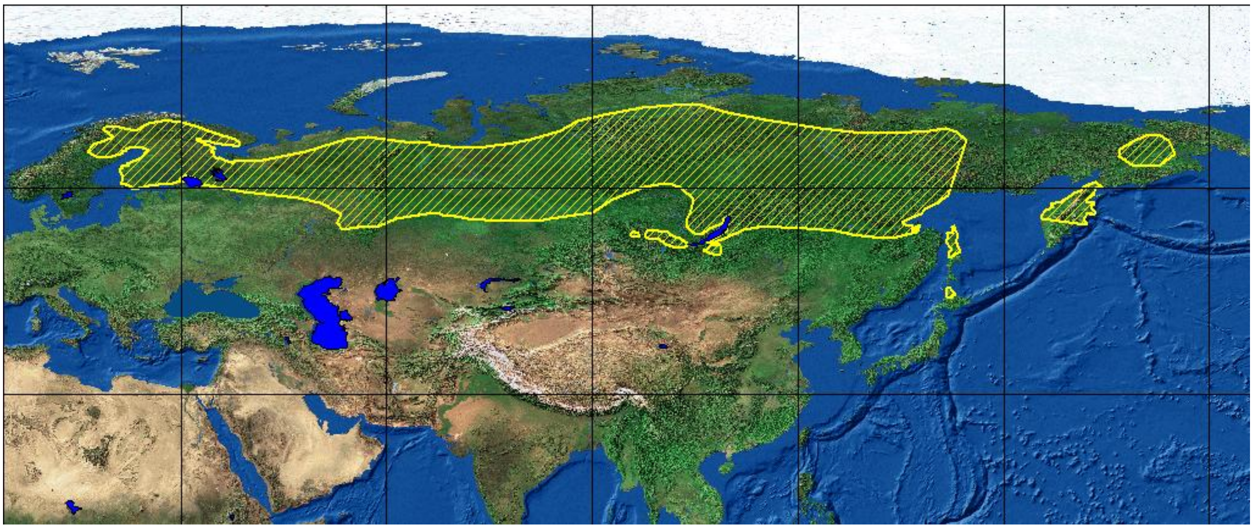


Figure 449. Breeding range of the Smew in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 30 marked birds were used, which gave 30 recoveries (Fig. 450). All birds were marked with metal rings, no other marks were used. Ringing dates are since 16.08.1945 until 04.07.2018, recovery dates are since 27.05.1946 until 30.10.2022.

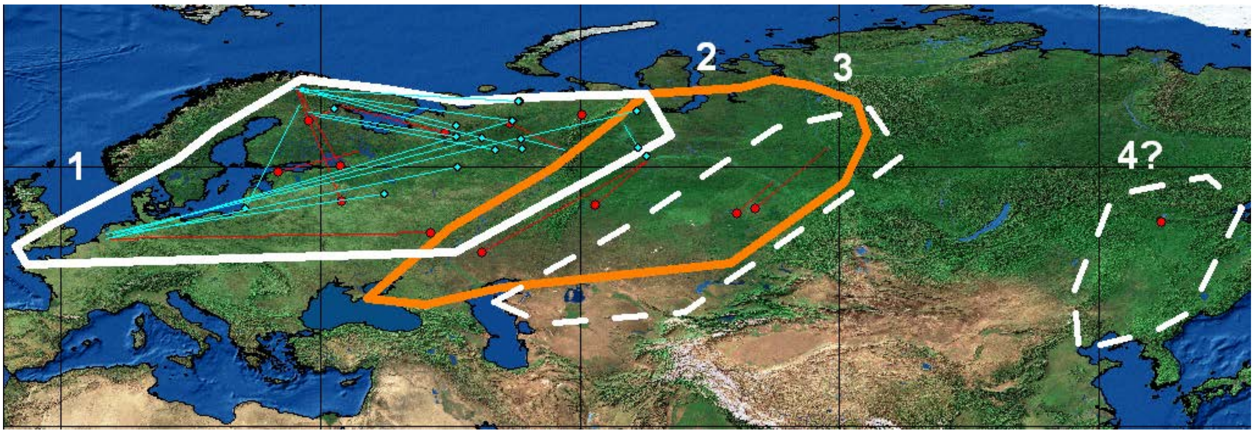


Figure 450. Smew populations. White polygon № 1 outlines western-eastern-european-western-siberian population. Brown polygon № 2 outlines south-east-european-west-siberian population. White dashed polygon (№ 3) outlines uncertain caspian-sea-western-central-siberian population. White dashed polygon № 4 shows uncertain east-sibirian-far-eastern population. Red lines with red dots at recovery sites represent direct recoveries, blue-green lines with blue-green dots at recovery sites represent indirect recoveries.

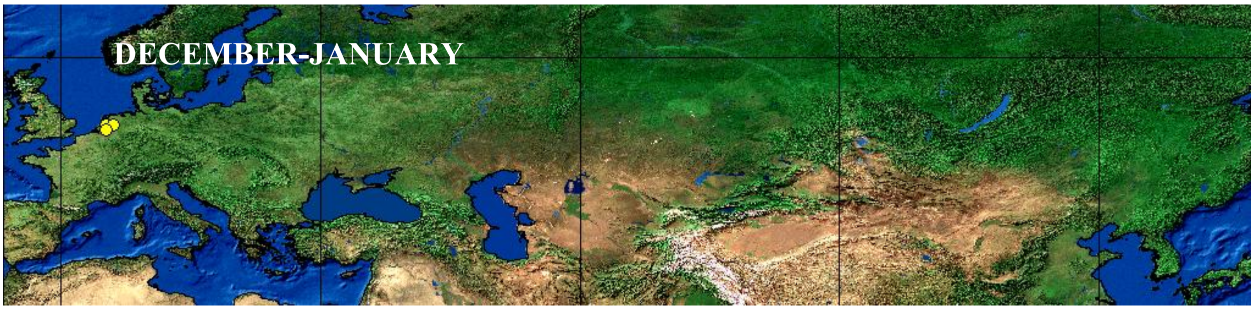
14 Smews were marked with rings of the „Moskwa" scheme, 5 – „Leiden" scheme, 10 – „Helsinki", 1- „Helgoland". Birds were ringed from western Europe to the east through eastern Europe, European Russia, Siberia. Recoveries are from eastern Europe, European Russia, Western and Eastern Siberia.

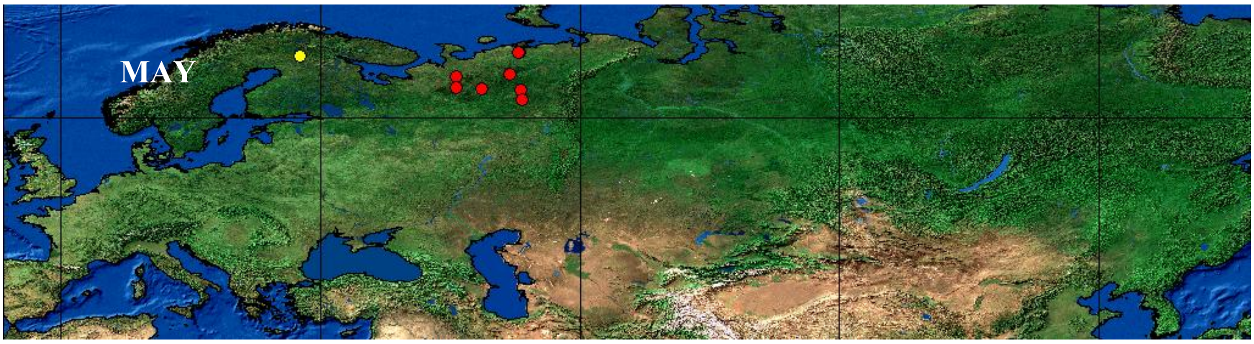
Finding details. This analysis includes all 30 recoveries. 22 (73%) recoveries are „shot". In 4 (13%) recoveries – „details unknown". The latter usually means shot, as well. Probably, we can assume that 86% of birds were shot. Found dead – 2 recoveries, injured – 1, found dead in the fishing net – 1.

Direct and indirect recoveries. Migration patterns of direct and indirect recoveries are represented in Fig. 450. The map indicates that Smews breeding in the northern European Russia winter mostly in Western Europe. Smews from Western Siberia, judging from the direction of their flights (Fig. 450), spend winter on the Black and Caspian Sea coasts. For birds ringed in the Eastern Siberia data are absent; logically, they should winter in the eastern China (Field Guide of Anseriforms in Russia, 2011).

Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows significant difference between them (χ^2 =6.4, 17 indirect recoveries and 13 direct ones, df = 2, P = 0.04). Direct recoveries appeared more spread, centre of indirect recoveries appeared more to the north-west from the centre of direct recoveries (Fig. 450). Why it is so not yet clear. Average flight distance of direct recoveries is noticeably shorter than of indirect ones: 825.7$\pm$198.4 and 1378.5$\pm$260.5 km respectively. Difference is insignificant, probably because of small samples.

Monthly movements. Data on monthly distributions of the Smew control points is not complete (Fig. 451). In December and January birds are on the wintering grounds. April through August spring migration and breeding occur: from May through August birds are on the breeding grounds. Autumn migration commences in September and finishes in November (Fig. 451).

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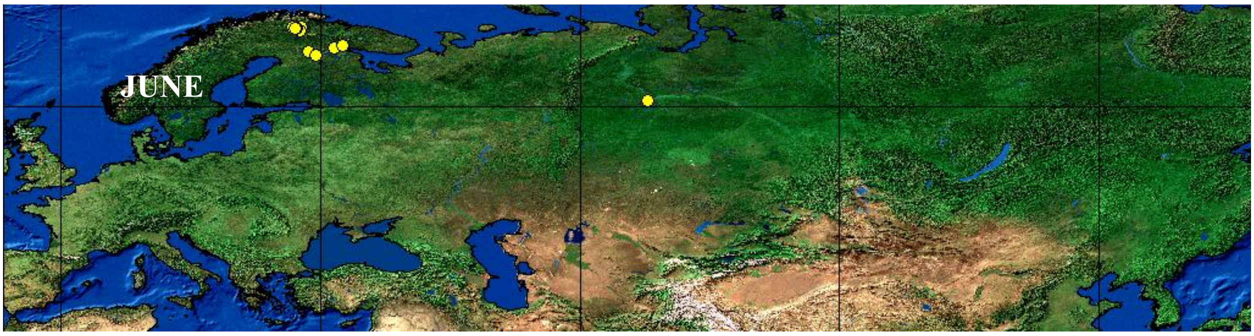
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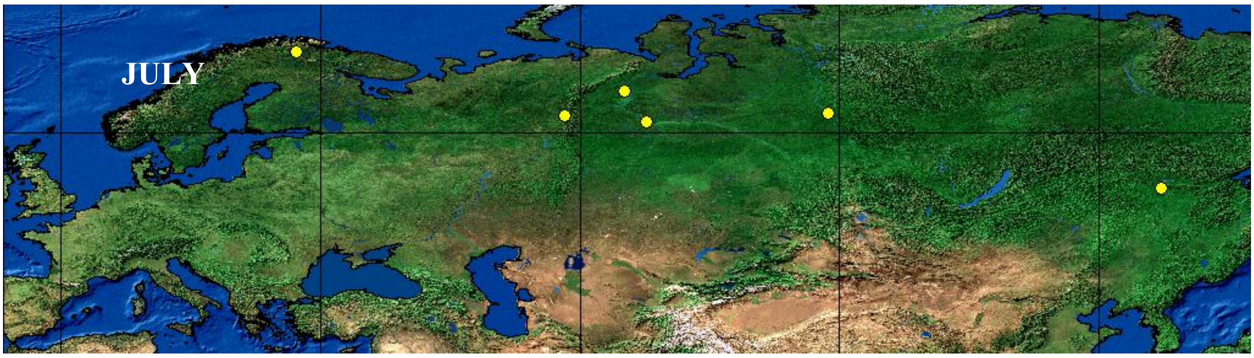
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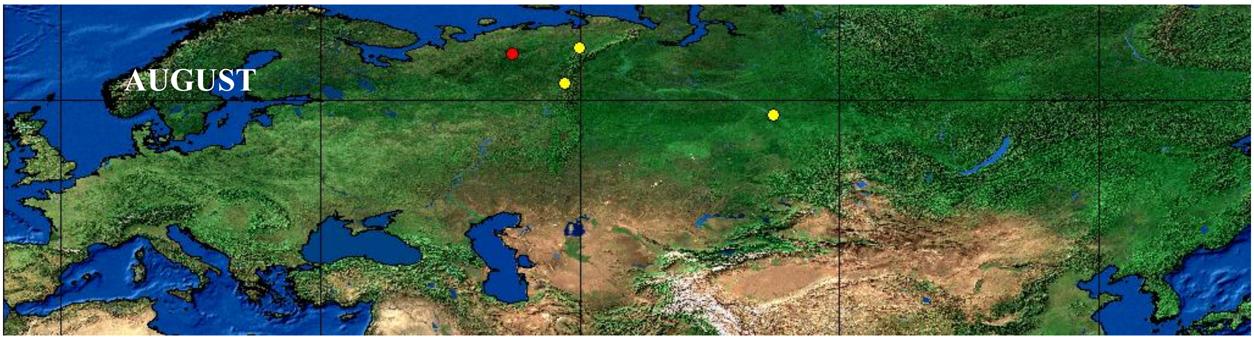
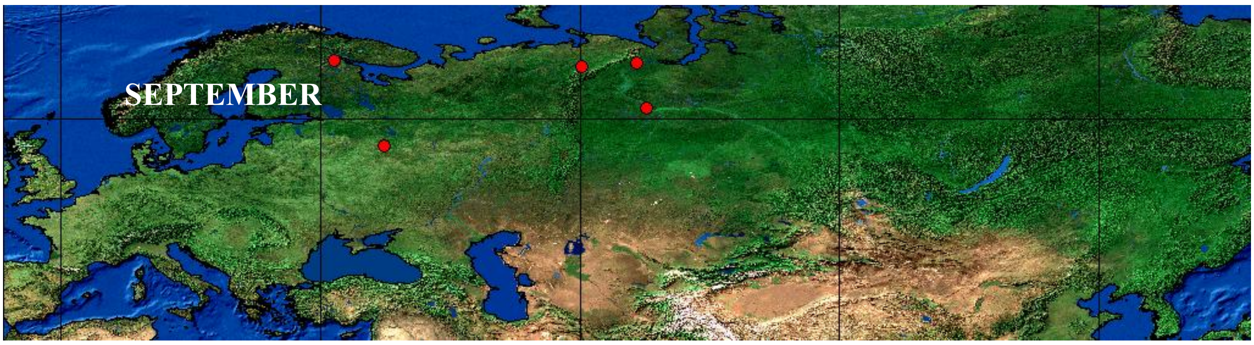

AUGUST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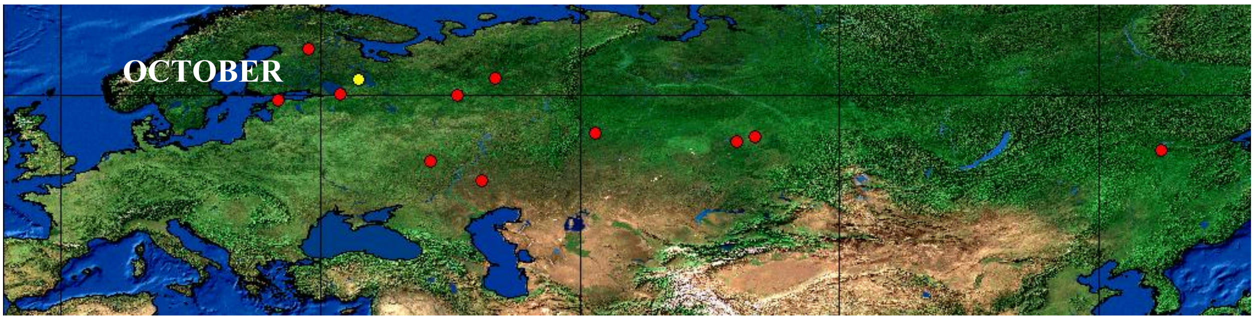


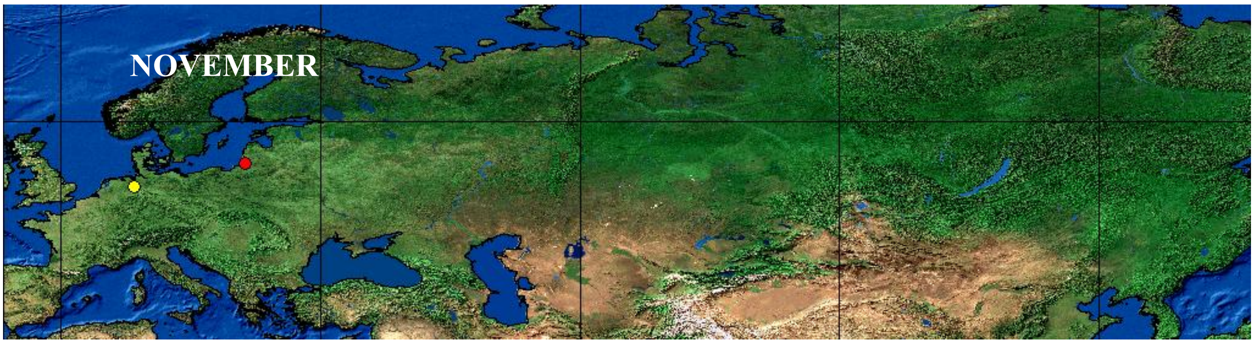


Figure 451. Smew monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. Smews move both at relatively short distances and at longer ones up to 3625.2 km. The latter distance is the maximal distance in indirect recoveries. For direct recoveries the maximal distance is 2527.6 km. Mean distance of movements in young Smews (ringed as „pull" or „juv" or „1 y") is in almost 1.6 times shorter than in adults: 852.0$\pm$133.3 versus 1390.0$\pm$305.2 km respectively (N_{young} = 14, N_{ad} = 16), however insignificant (t-Bailey=1.65, P=0.11). Comparison of male and female mean distances is not reasonable because the data set contains only two male recoveries. Smews spring and autumn migratory routes are well visible from map of direct and indirect recoveries (Figs 450).

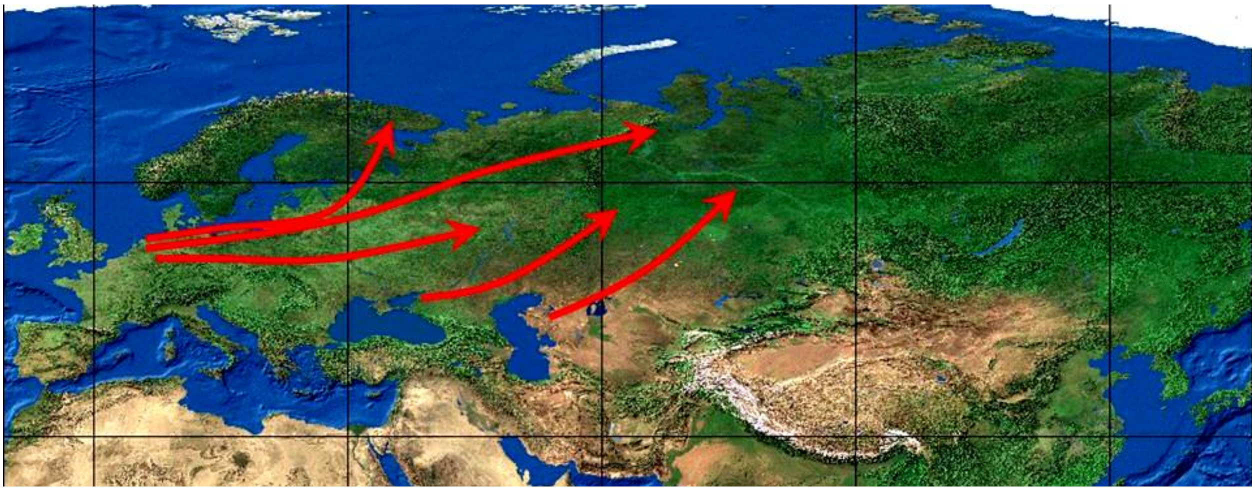


Figure 452. Outline of spring (red arrows) migratory routes of the Smew.

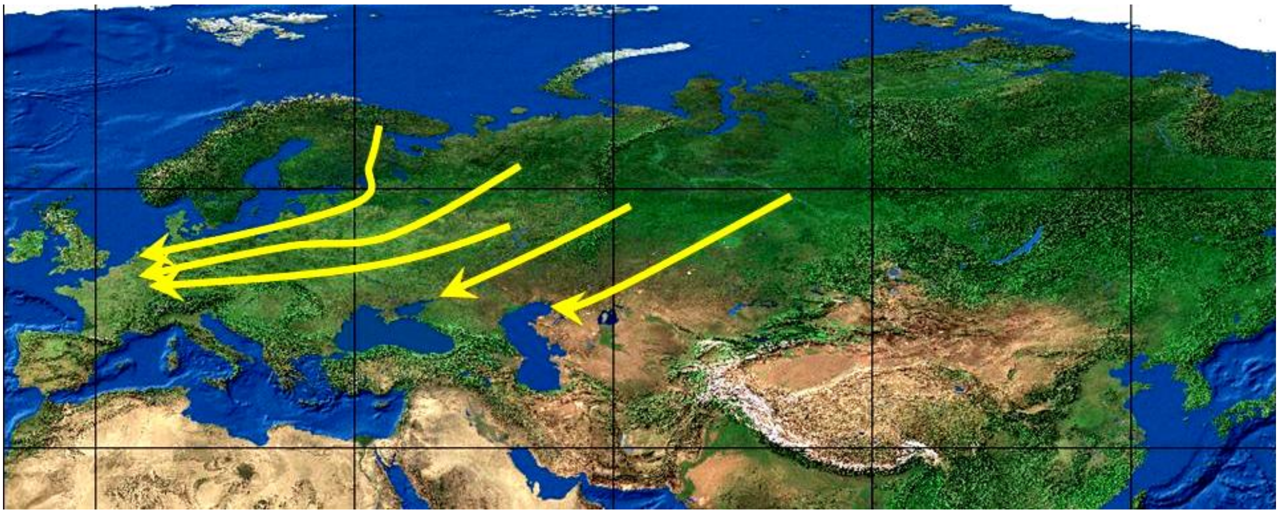


Figure 453. Outline of autumn (yellow arrows) migratory routes of the Smew.

Speed. Bird Ringing Centre of Russia database contains data that shows about 50 km Smew daily speed.

Populations. Smew data set is very small. It allows separating two more or less certain populations and at least two uncertain ones (Fig. 450). They are: 1) western-eastern-european-western-siberian population (polygon № 1, Fig. 450) with north-east – south-west or east-west migratory movements; 2) south-east-european-west-siberian population (polygon № 2) with north-east – south-west migratory movements; 3) uncertain caspian-sea-western-central-siberian population (polygon № 3, Fig..450) with north-east – south-west migratory movements; 4) uncertain east-sibirian-far-eastern population with presumably south-east migratory movements (polygon № 4, Fig. 450).

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest Smew lived more than 10 years. Bird Ringing Centre of Russia database contains a recovery of the ring „Leiden" scheme 250 486. The Smew was ringed as adult female in the Netherlands on 29.01.1960 and shot about 15.10.2074 in the Vologda Region, Russia after more than 14 years (ring sent). Really this bird lived more than 15 years.

Mortality rate. According to the common criteria (see "Materials and Methods") 29 recoveries of 30 total are applicable for the mortality rate analysis. If we use all recoveries for calculations, mean annual mortality rate in the Smew is 20.11$\pm$3.34%. Real mortality pattern differs from the theoretical one is significantly (χ^2 = 25.98, df = 12, P=0.01). Programme MARK, Model CLogLog 2ndPart shows 21.39%, difference is 1.28%. Smew real mortality pattern shows considerable drawdown in comparison with the theoretical line (Fig. 454). This indicates not good situation with the species. Removing of the one very much outstanding record does not change the mortality pattern and conclusion. However, most data in our database are not current. Really, in recent years the situation with the Smew is getting better. Number of breeding Smews in the Murmansk Region and Karelia shows the tendency to grow (Bianki et al., 2004; Gilyazov, 2012; Yakovleva, 2003); recently Smews have been more frequently recorded on spring stopovers and wandering outside of the breeding range (S.P. Kharitonov, personal observations).

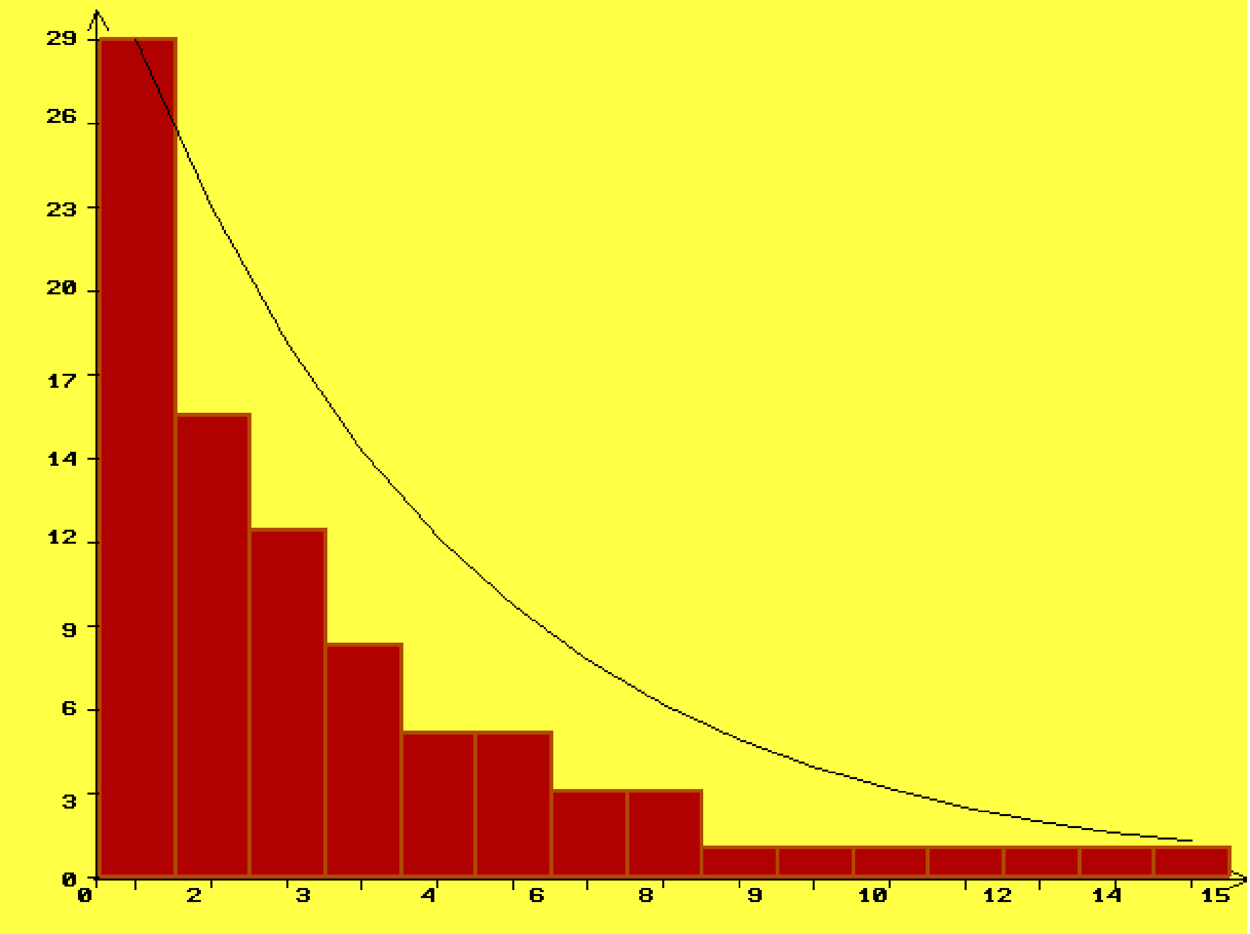


Figure 454. Mortality pattern in the Smew. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

RED-BREASTED MERGANSER
(*MERGUS SERRATOR*)

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 455. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

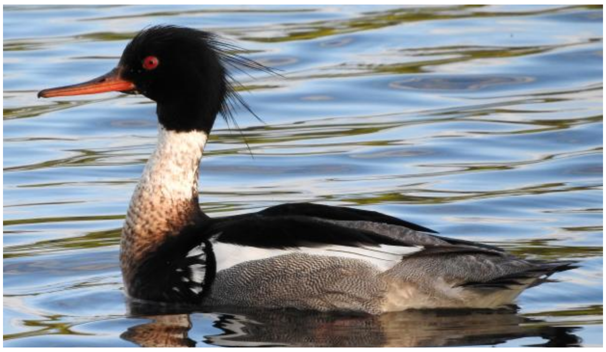


Photo by Irina A. Kharitonova

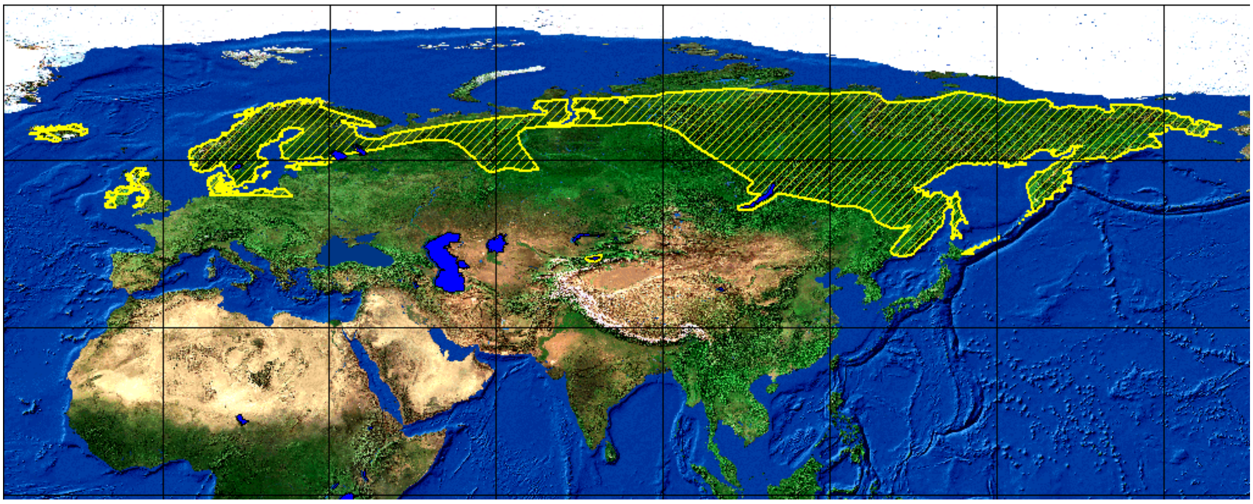


Figure 455. Breeding range of the Red-breasted Merganser in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 112 marked birds were used, which gave 112 recoveries (Fig. 456). All birds were marked with metal rings, two birds in addition were marked with wing-tags. All birds gave one recovery per ring. Ringing dates are since 13.08.1941 until 28.07.2016, recovery dates are since 17.04.1943 until 27.11.2017.

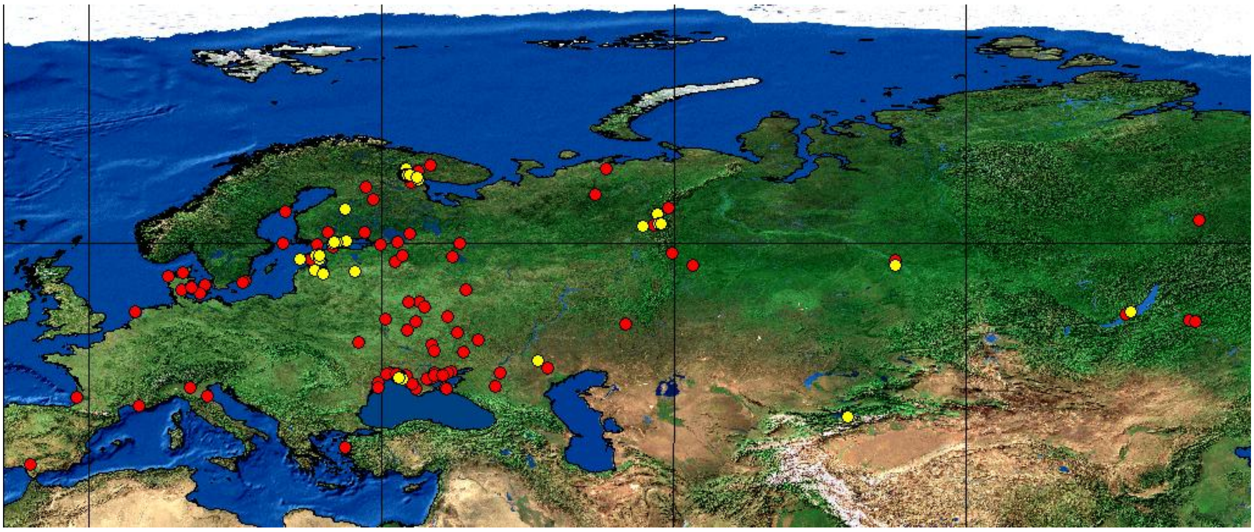


Figure 456. Position of all Red-breasted Merganser control points. Yellow dots are ringing sites, red dots – recovery sites.

Red-breasted Mergansers were ringed from the north of eastern Europe to the east through Ukraine, European Russia, western Siberia to the Baikal Lake area, Kyrgyzstan. Recoveries are from Europe, European Russia, Black Sea and Sea of Azov areas, Western and Central Siberia (Fig. 456). This sample contains 103 recoveries of the scheme „Moskwa", 7 recoveries of the „Helsinki" scheme, 2 – „Matsalu Estonia" scheme.

Finding details. This analysis includes all 112 recoveries. 77 (69%) recoveries are „shot". In 6 (5%) recoveries - „details unknown". The latter usually means shot, as well. Probably, we can assume that 74% of birds were shot. Considerable amount - 10 (9% of recoveries) is „Caught", which includes all types of control with capture. Other reasons: found dead – 12 recoveries, found dead in fishing net – 4, injured – 1, sick – 1, ring only found – 1.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries represented in Figs 457 and 458.

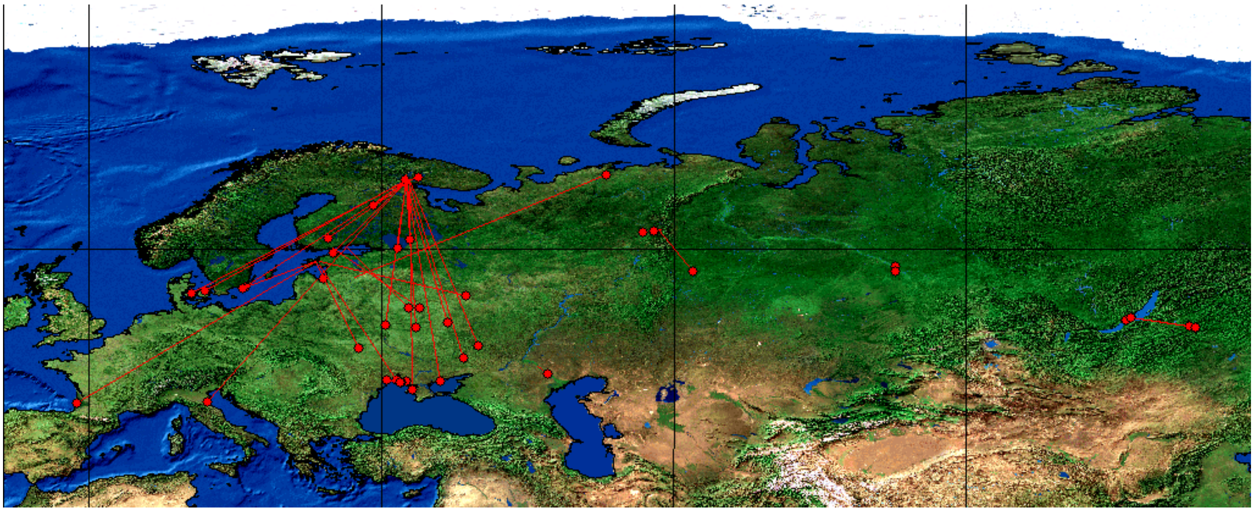


Figure 457. Map of the Red-breasted Merganser direct recoveries. Lines start in ringing sites, recovery sites are marked with red filled dots.

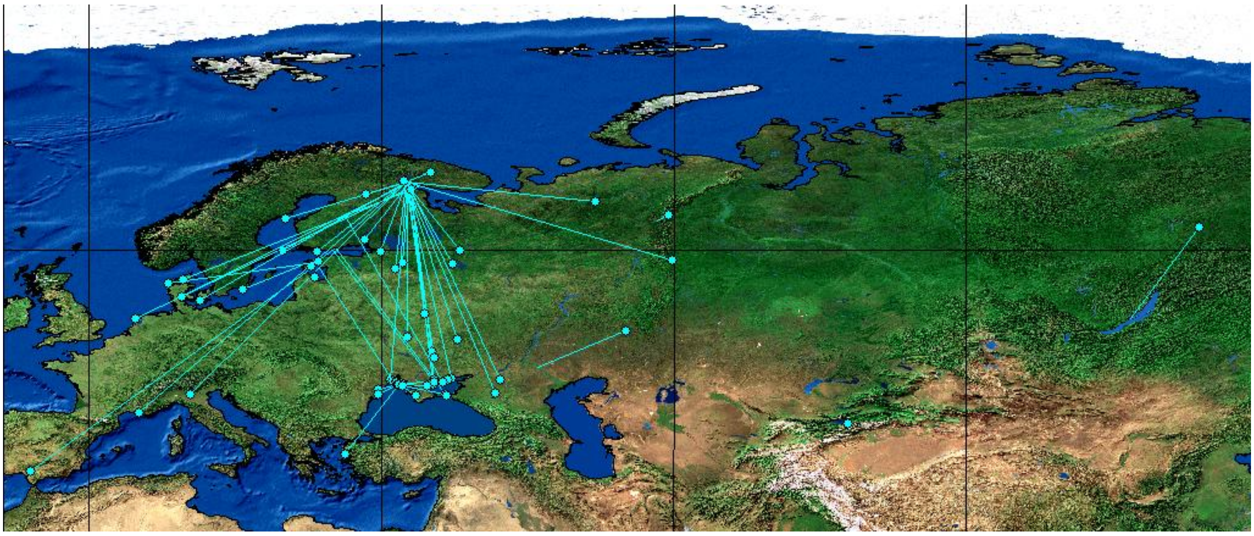
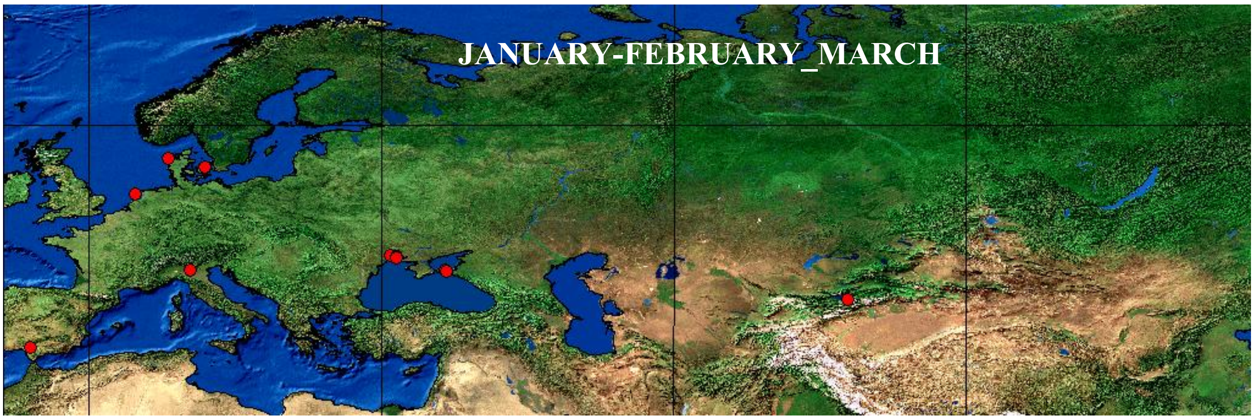


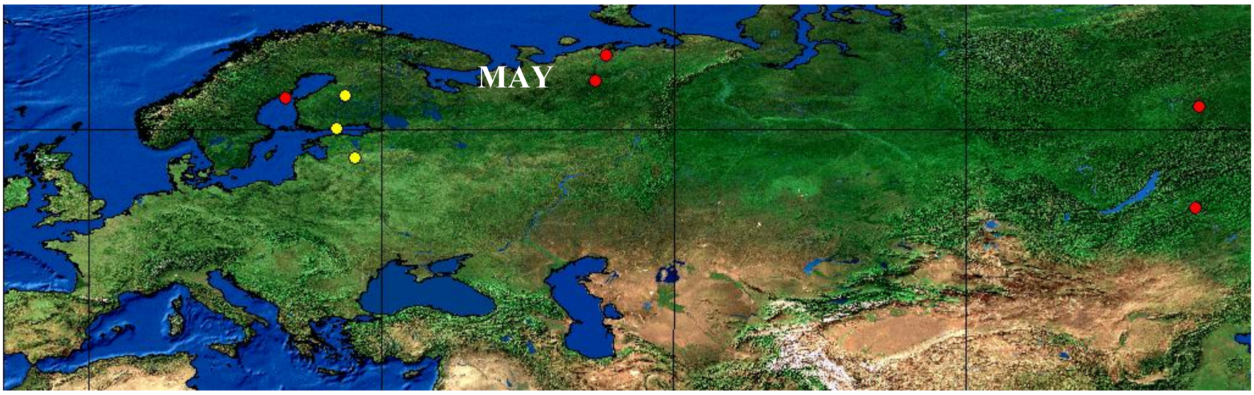
Figure 458. Map of the Red-breasted Merganser indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

Maps indicate that Red-breasted Mergansers breeding in European Russia winter mostly in two areas: 1) the Baltic Sea in the compact areas between Denmark, Germany and Sweden, some birds fly deeply to the western and south-western Europe; 2) Azov-Black Seas, some birds fly to the Mediterranean Sea. We have not enough recovery data for siberian Mergansers.

Comparison of all direct and indirect recovery areas by means of Mardia-test with Robson correction shows insignificant difference between them (χ^2 =3.58, 67 indirect recoveries and 45 direct ones, df = 2, P = 0.15). Average flight distances in direct recoveries are slightly shorter than in indirect ones: 808.2$\pm$124.2 and 943.9$\pm$112.6 km respectively, insignificant.

Monthly movements. Monthly distributions of control points (ringing and recovery locations) reflect general routes of seasonal movements in the Red-breasted Merganser (Fig. 459), although the data set is not large. Pattern of control points indicates that in January, February and March most ducks are on wintering grounds at the Baltic Sea, Waddensee, southern Europe, Black Sea, Sea of Azov, Central Asia. Migration should already start in March, since there is a recovery in April located deeply inside the breeding area (Fig. 459, April). Some birds in April are still on the wintering grounds (a recovery from Denmark). May-June-July-August birds are on breeding grounds; at the same time quite a few Mergansers spend time in the north-western corner of the Black Sea, i.e., in the wintering area. The same as in several other duck species, Red-breasted Mergansers in July and even August can migrate in the directions which are more characteristic for the spring way rather then for the autumn one. There is one bird, ringed on 17 July in the Kandalaksha Nature Reserve, Murmansk Region, and found dead on 12 September in 64 km to the north-east from the ringing site. Another bird ringed on 08.08.1961 in Tomsk Region, western Siberia, was shot 21.09.1961 in 59 km exactly to the north of the ringing site. In September and October autumn migration takes place. November is a month of migration finish; most birds already are on their wintering grounds, the same as in December. (Fig. 459).

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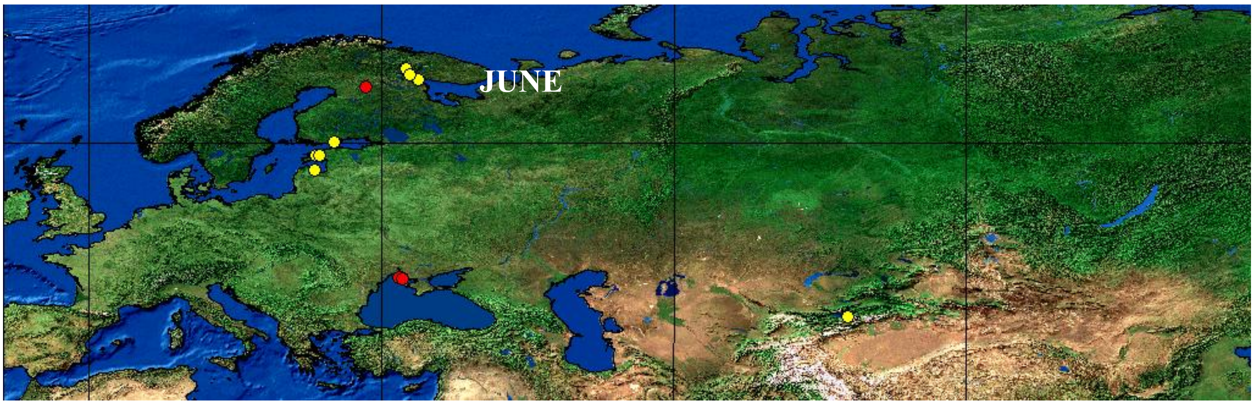
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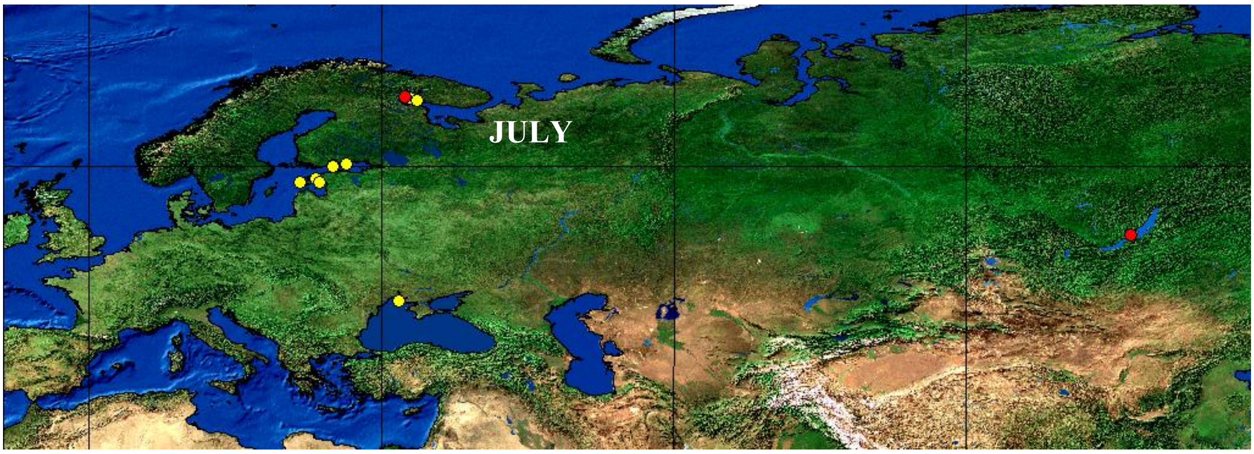
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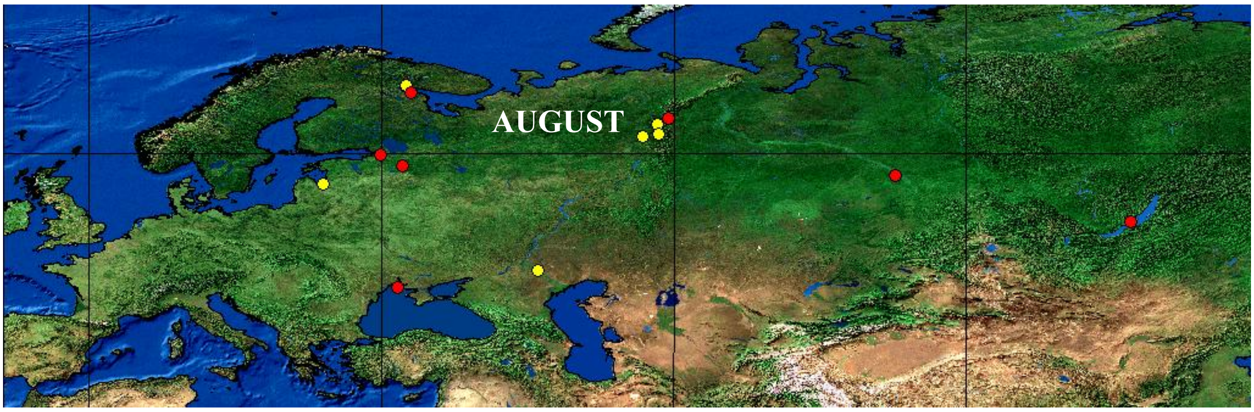
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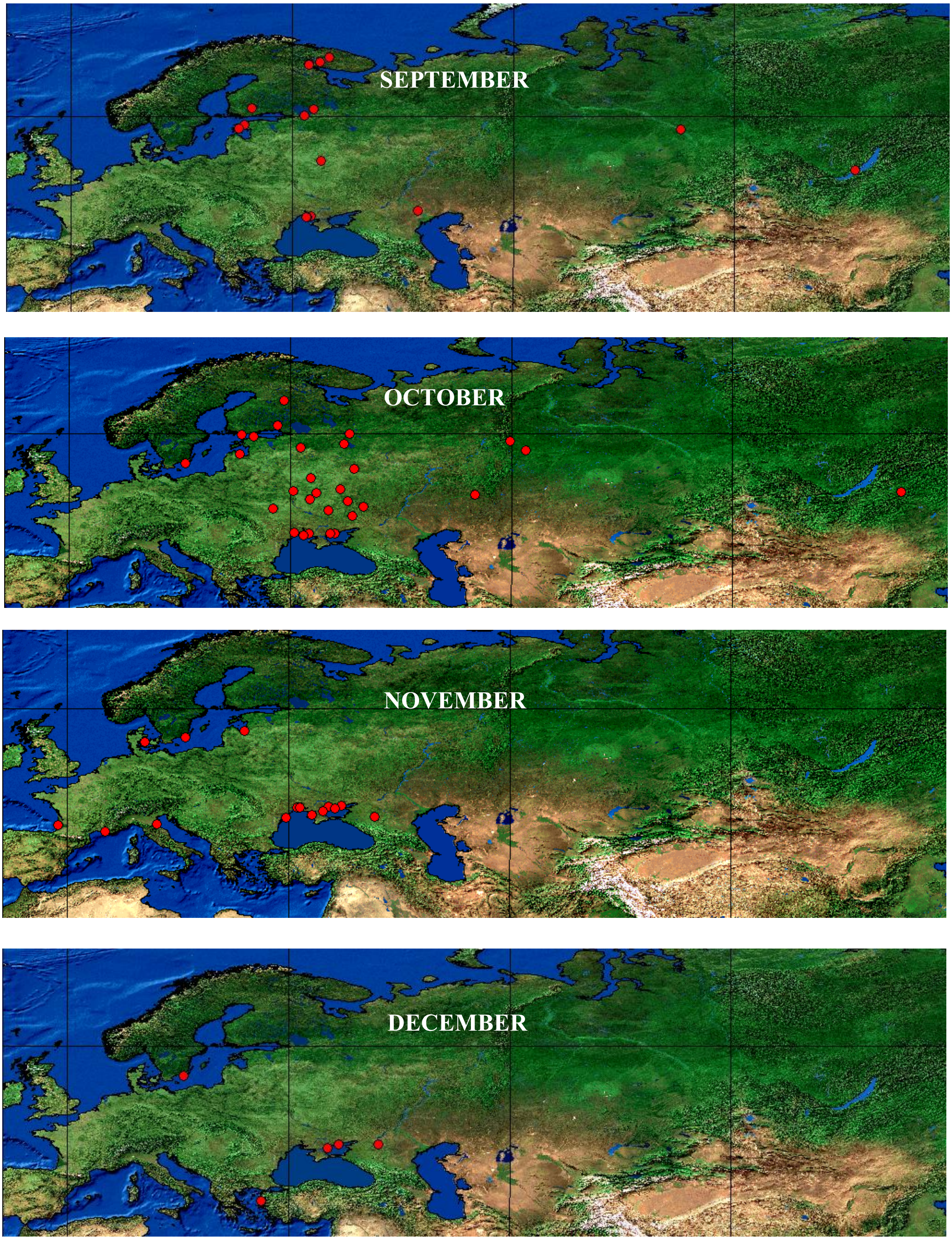


Figure 459. Red-breasted Merganser monthly movements. Yellow dots are ringing sites, red dots are recovery sites.

Migratory routes. Population structure of the Red-breasted Merganser is quite complicated (see section “Populations”), e.g., one compact breeding place, the head of the Kandalaksha Bay, White Sea, can host mergansers, wintering in two very different areas: 1) the Baltic Sea and Waddensee and southern Europe; 2) Azov-Black Sea area. The former in autumn migrate to the south-west, the latter – directly to the south. Our data do not allow to indicate migratory routes of birds from Siberia.

Red-breasted Mergansers move at relatively short distances; longer distances up to 3187.3 km are also common (Fig. 460). The latter distance is the maximal one in indirect recoveries. The longest distance of direct recoveries is 2789.8 km.

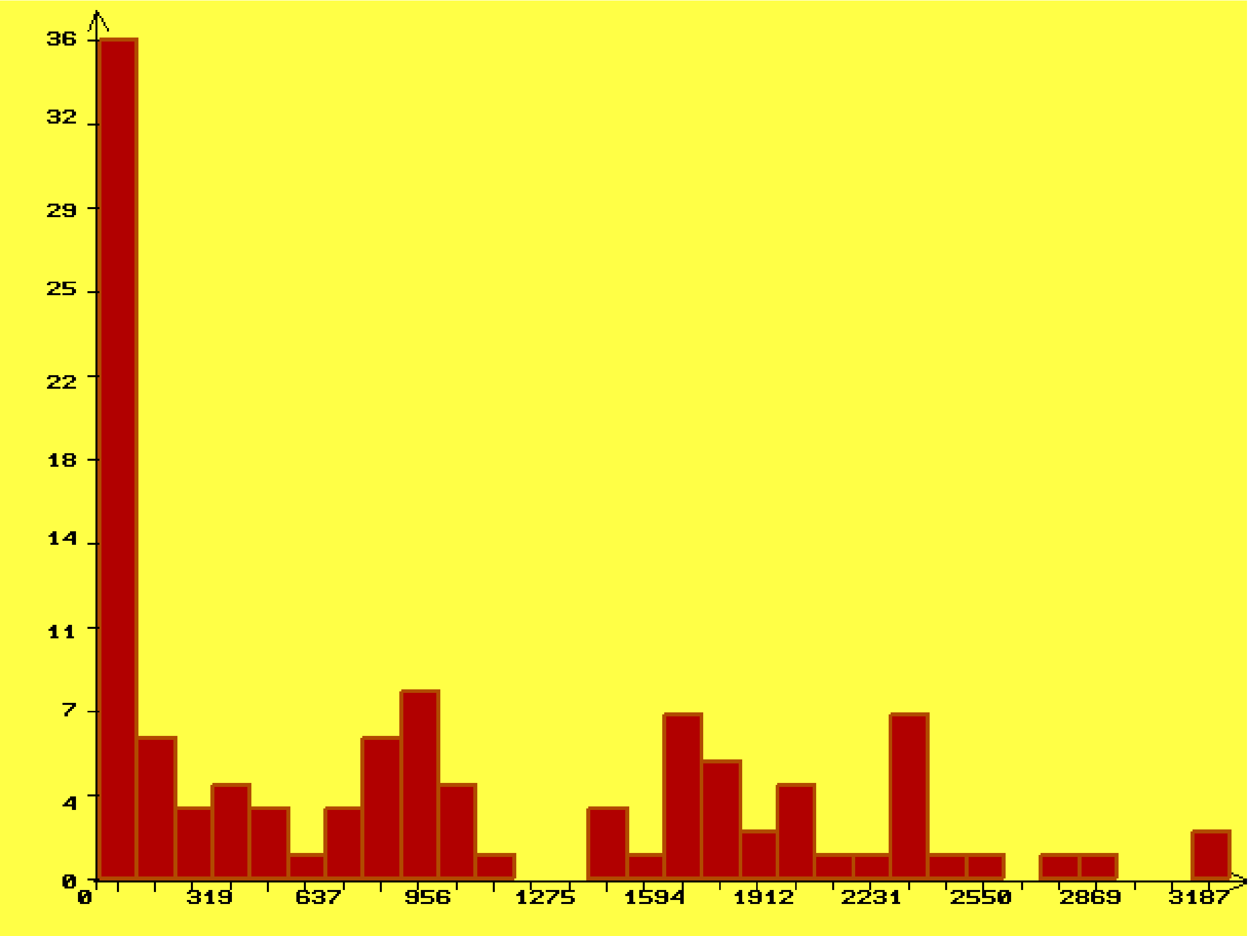


Figure 460. Distribution of all ring-recovery distances in Red-breasted Merganser. X axis is the flight distance in km; Y axis is the number of distances.

Mean distance of movements in Red-breasted Merganser young birds (ringed as „pull"or „juv"or „1 y") is by almost 200 km greater than in adults: 1003.8±139.3 versus 809.6±103.4 km respectively (N_{young} = 46, N_{ad} = 66), however insignificant. Male mean flight distance is considerably shorter than in females: 628.4±267.0 and 1031.5±118.3 km respectively (N_{males} = 6, $N_{females}$ = 51), though insignificant.

Summarising all about migratory routes, we can outline spring and autumn migratory movements of the Red-breasted Merganser (Fig. 461).

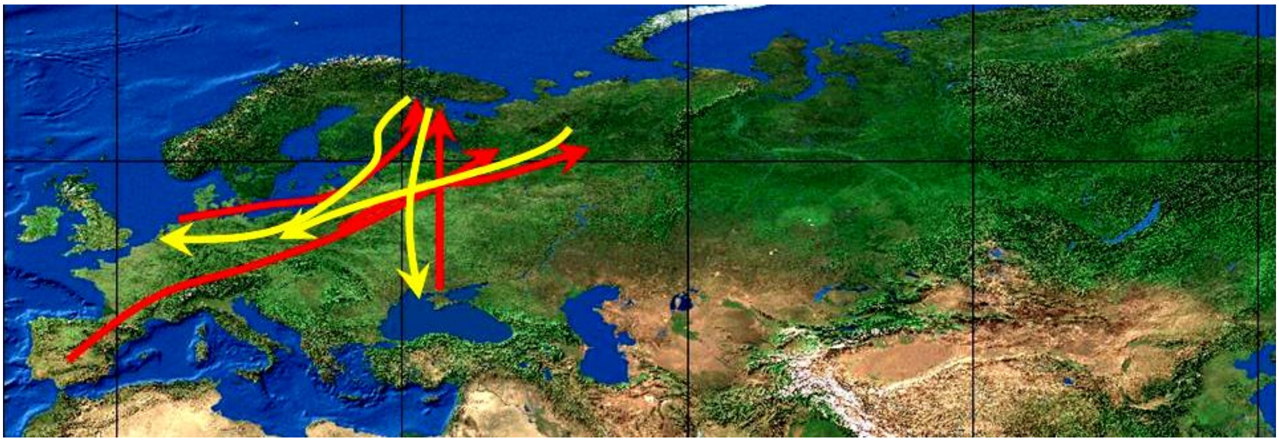


Figure 461. Outline of spring (red arrows) and autumn (yellow arrows) migratory routes of Red-breasted Merganser.

Speed. Bird Ringing Centre of Russia database contains data that shows Red-breasted Merganser daily movement speed of about 150 km.

Populations. Data set for Red-breasted Merganser is very small. It allows more or less recognizing two populations. They could be: 1) western-eastern-european-north-european-russia-western-siberian population (polygon № 1) with preferably north-east – south-west migratory movements; 2) north-eastern-russia-black-mediterranean-seas population (polygon № 2) with north-east migratory movements (Fig. 462). Both populations overlap greatly in their northern part: birds breeding in one compact area could belong to two different populations.

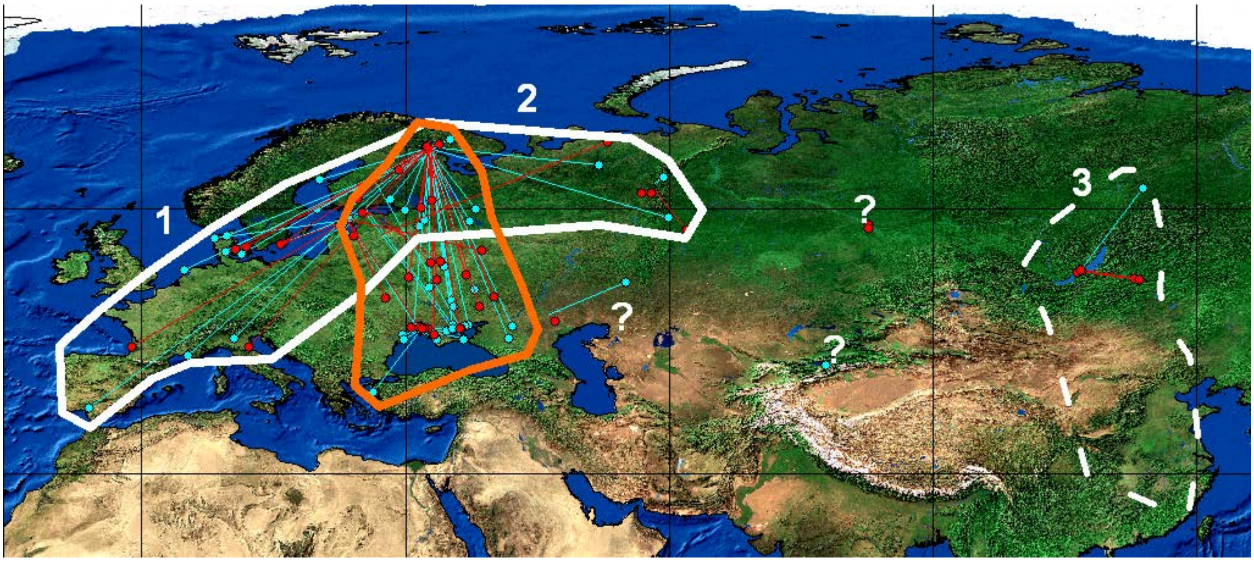


Figure 462. Red-breasted Merganser populations. White polygon № 1 outlines western-eastern-european-north-european-russia-western-siberian population. Light brown polygon is north-eastern-russia-black-mediterranean-seas population (polygon № 2). Dashed line shows very uncertain eastern-siberian-eastern-chinese population (№ 3). Red lines and dots –direct recoveries, blue-green lines and dots are indirect recoveries.

Ten-year distances. The data set is very heterogeneous and do not allow performing decadal analysis.

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest Red-breasted Merganser lived 21 years 4 months. Bird Ringing Centre of Russia database contains a recovery of a bird that lived at least 8 years 4 months.

Mortality rate. According to the common criteria (see "Materials and Methods") 94 recoveries are applicable for the mortality rate analysis. If we use all recoveries for calculations, mean annual mortality rate in Red-breasted Merganser is 39.64±3.18% The difference of the real mortality pattern from the theoretical one is very little, insignificant (χ^2 = 2.3, df = 6, P=0.89). Programme MARK, Model CLogLog 2ndPart shows 38.26%, difference is 1.38%. Mortality pattern indicates stable situation in the Red-breasted Merganser as a species (Fig. 463).

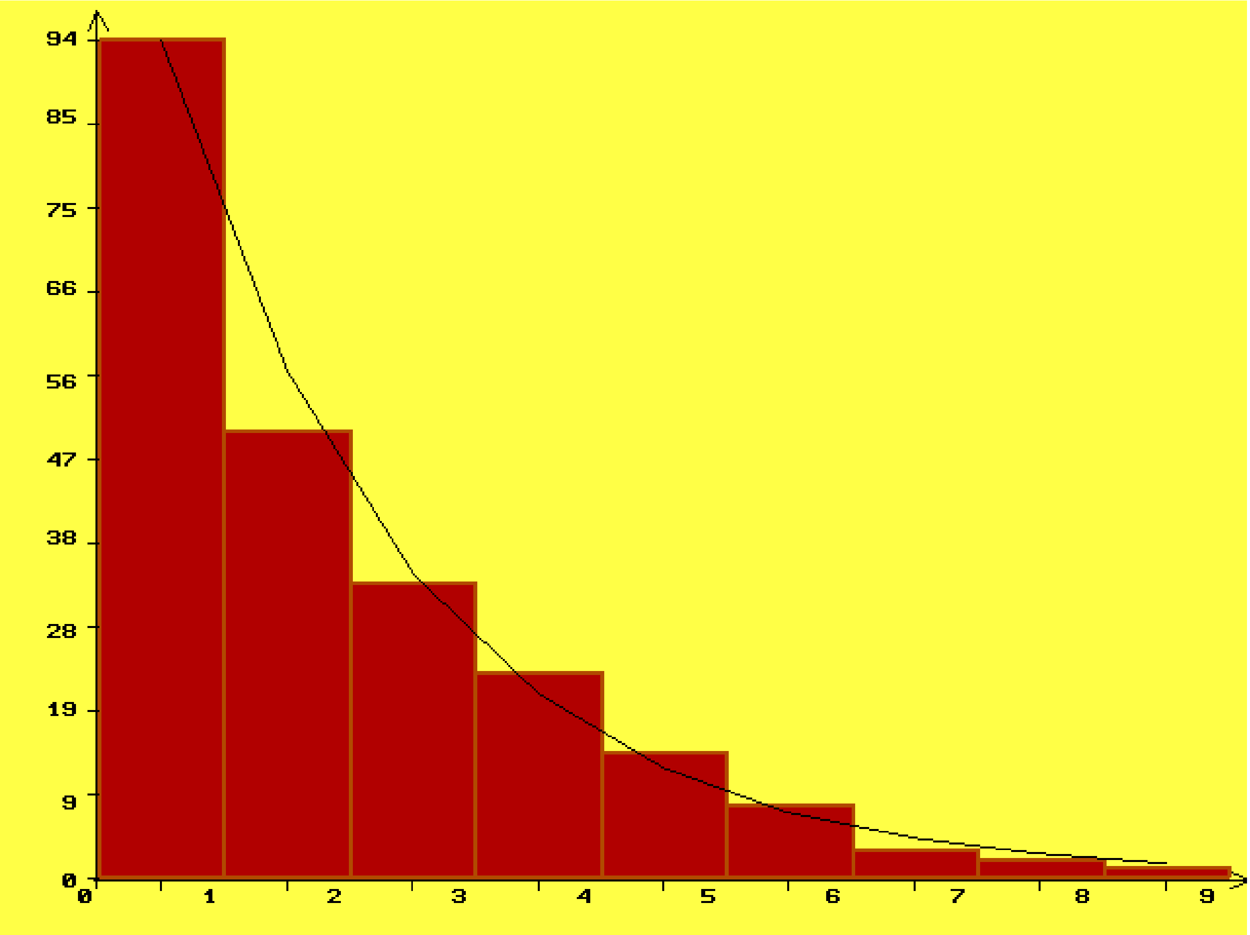


Figure 463. Mortality pattern in the Red-breasted Merganser. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, females live longer than males: 2.19±0.28 (N = 51) and 1.77±0.72 (N = 6) years respectively, insignificant.

GOOSANDER
(*MERGUS MERGANSER*)

Breeding range in Eurasia. Brief description of the breeding range is in Fig. 464. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002; Scott, Rose, 1996 and own data.

Photo by Irina F. Kharitonova

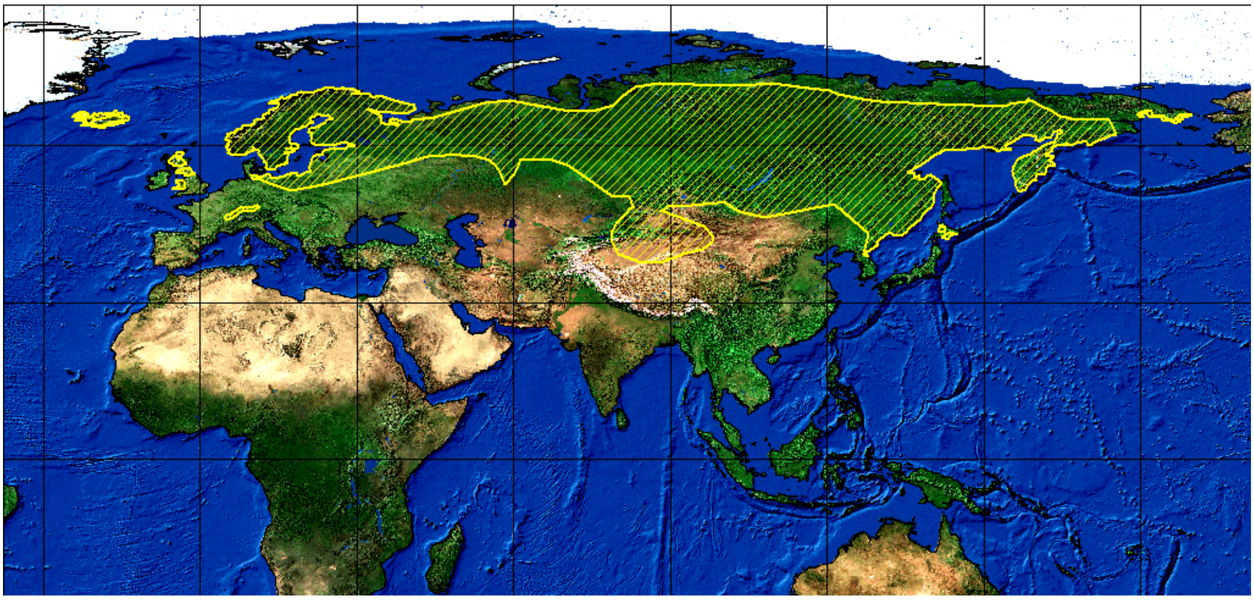


Figure 464. Breeding range of the Goosander in Eurasia (yellow dashed areas).

Distribution of control points. For this species account 75 marked birds were used, that gave 79 recoveries (Fig. 465). All birds were marked with metal rings; one bird in addition was marked with wing-tags. 73 birds gave one recovery per ring, one bird – two recoveries, one bird – four recoveries. Ringing dates are since 01.08.1938 till 12.06.2010, recovery dates are since 25.04.1939 till 03.05.2016.

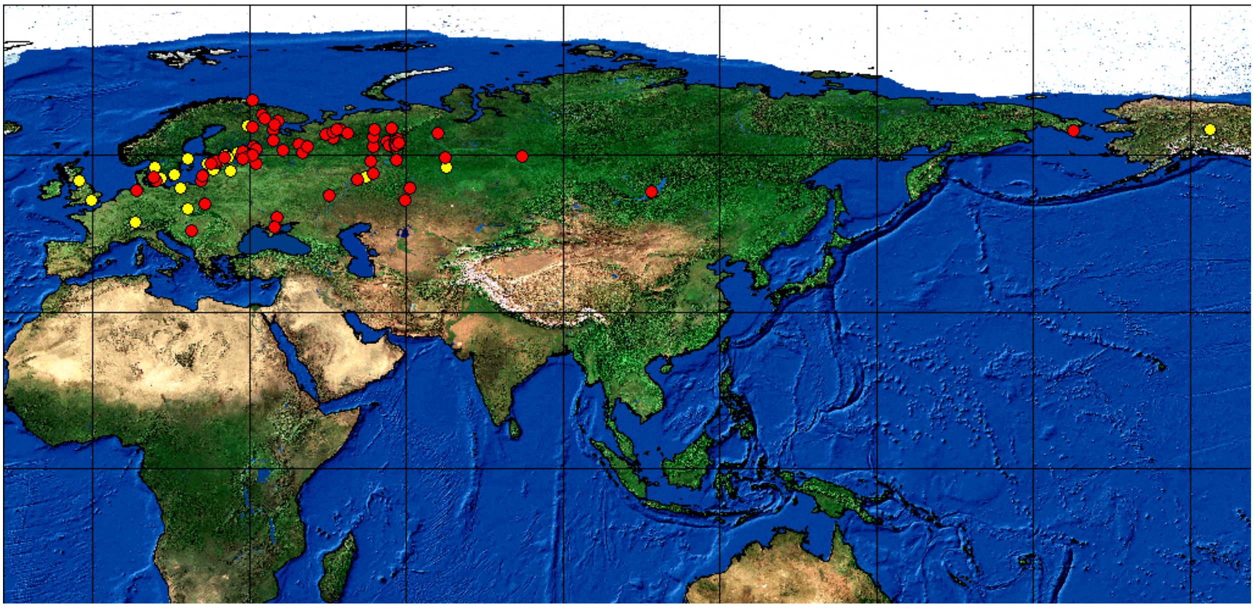


Figure 465. Position of all Goosander control points. Yellow dots – ringing sites, red dots – recovery sites.

Goosanders were ringed from British Isles trough all Europe, western Siberia, Bailkal Lake area. One bird, that was recovered on Russian territory, was ringed in North America, Alaska. Recoveries are from Europe, European Russia, Ukraine, Western and Central Siberia (Fig. 465). This sample contains 39 recoveries of the scheme „Moskwa", the rest of recoveries are Goosanders, marked with rings by 11 other ringing schemes.

Finding details. This analysis includes all 79 recoveries. 53 (67%) recoveries are „shot" or „killed". In 11 (14%) recoveries are „details unknown". The latter usually means shot, as well. Probably, we can assume that 81% of birds were shot. 7 (9% of recoveries) is „caught", which includes all types of control with capture. Other reasons: found dead – 5 recoveries, found dead in fishing net – 3 recoveries.

Direct and indirect recoveries. Migration pattern of direct and indirect recoveries is represented in Figs 466 and 467.

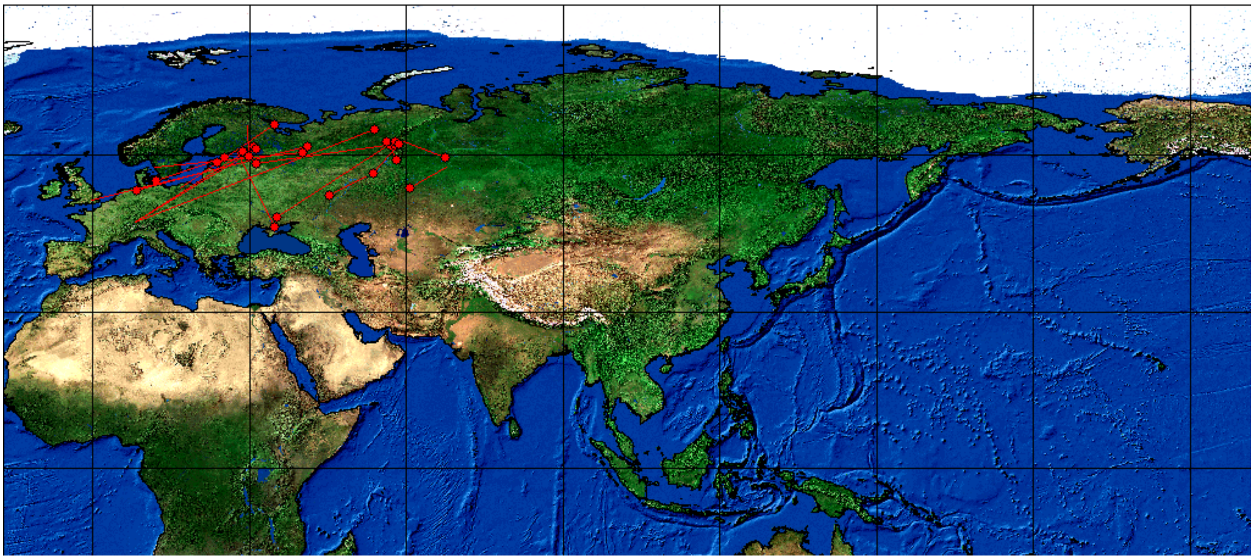


Figure 466. Map of the Goosander direct recoveries. Lines start in ringing sites, recovery sites are marked with red dots.

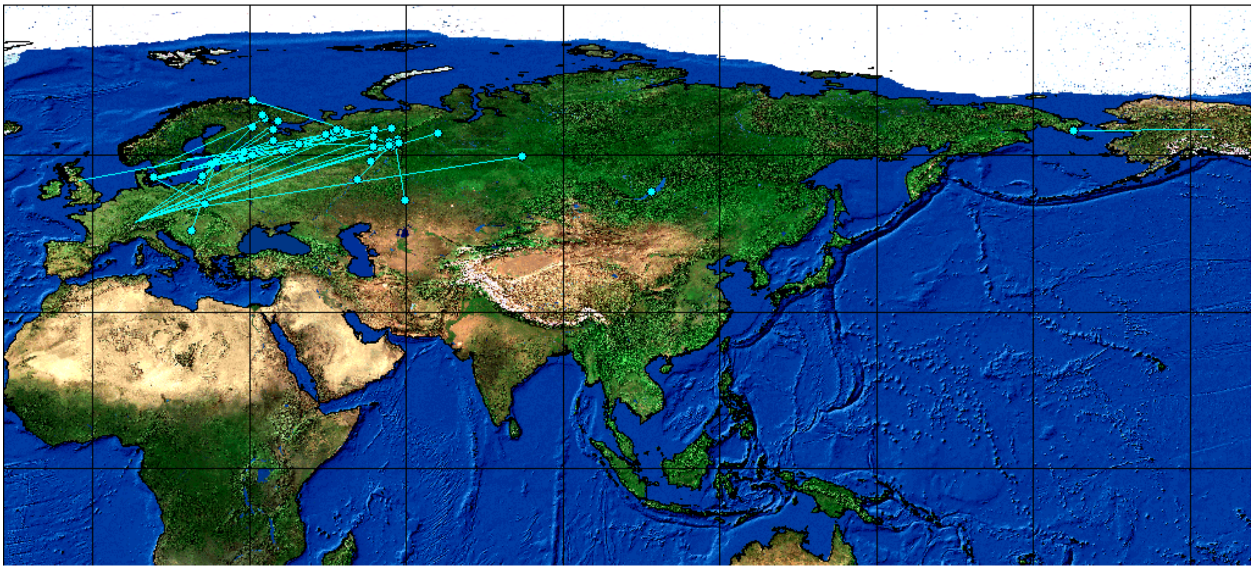
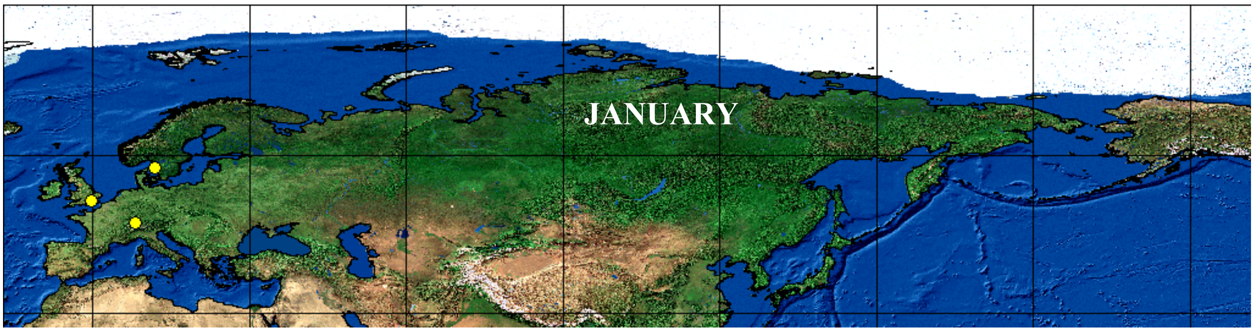


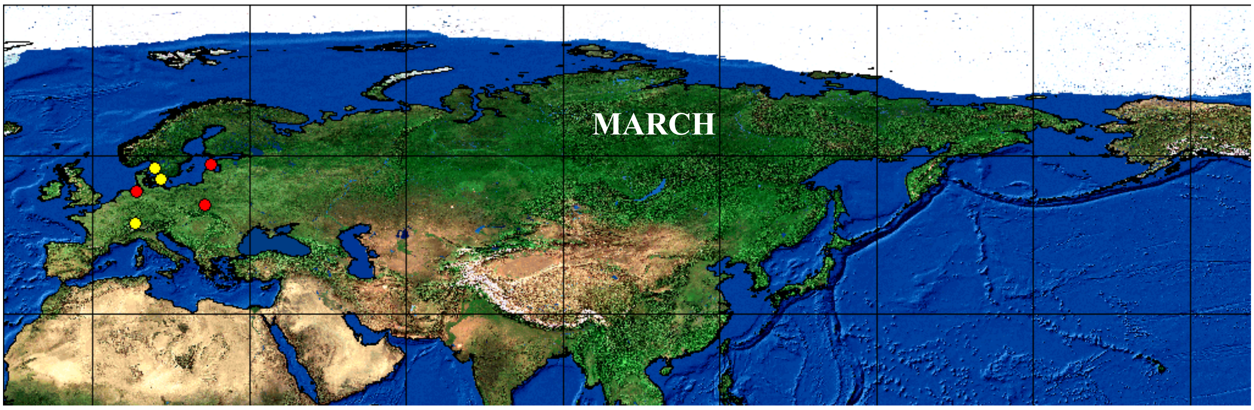
Figure 467. Map of the Goosander indirect recoveries. Lines start in ringing sites, recovery sites are marked with blue-green dots.

Maps indicate that Goosanders breeding in European Russia winter mostly in two areas: 1) western and central Europe; 2) Azov-Black Seas. We have not enough recovery data for Siberian ducks. Goosanders from Chukotka could fly to winter to North America. Average flight distances in direct recoveries are shorter than in indirect ones: 823.1$\pm$173.8 (N=30) and 1269.6$\pm$178.1 (N=49) km respectively, difference is in low level of significance (t_{Bailey}=1.79, P=0.077).

Monthly movements. Monthly distributions of control points (ringing and recovery locations) reflect a general way of seasonal movements in the Goosander (Fig. 468), although the data set is not large. Pattern of control points indicates that in January and February Goosanders are in wintering areas in central Europe and Baltic Sea where breeding and wintering grounds intermix. In March some first migratory movements at the Baltic Sea are noticeable (Fig. 468, March). In April migration is well pronounced (Fig. 468, April). May-June-July-August birds are on breeding grounds. The same as in several other duck species, in late summer Goosanders can migrate in the directions which are more characteristic for the spring way rather than for autumn way. Two such birds, ringed in August in Komi Republic on 22 and 23 September were recovered in 60 and 74 km to the north-west of the ringing sites. In the mentioned two cases in Goosander, it is not clear whether these movements really coincide with the spring direction; but certainly these movements are not directed to the wintering areas. First signs of autumn migration can be noticed in September (a recovery in the west of the Baltic Sea (Fig. 468, September). In October migration is in full swing. Data for November are absent, in December Goosanders are on the wintering grounds. However, there is one recovery in Komi Republic (the ring „Moskwa" H-7266): sick bird was shot in the unfrozen polynya on a river (Fig. 468, December).


JANUARY


FEBRUARY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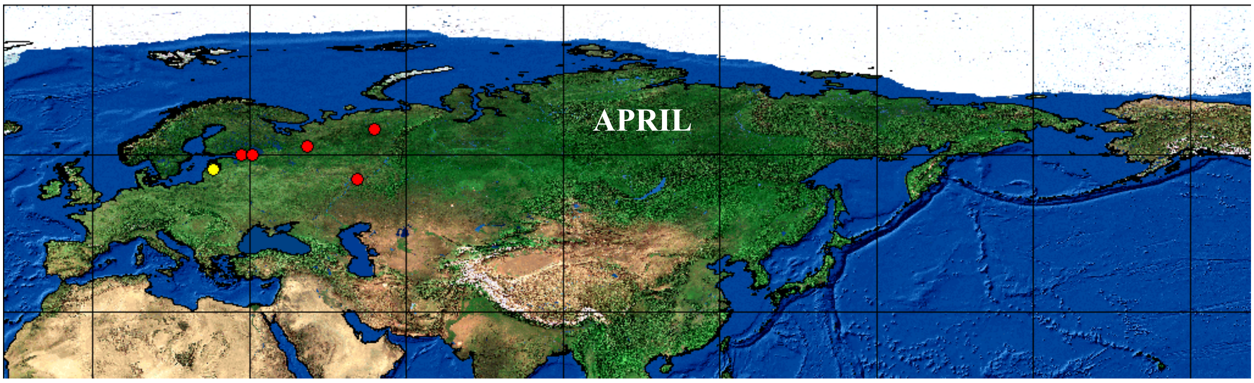
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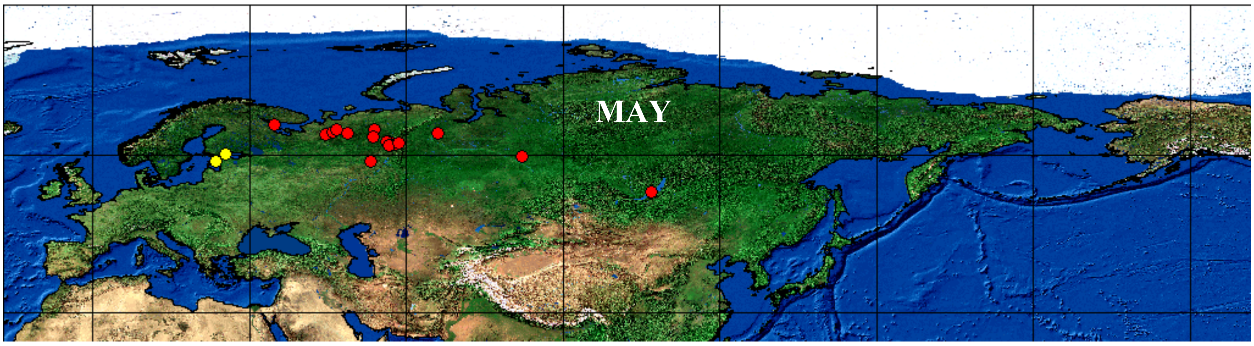
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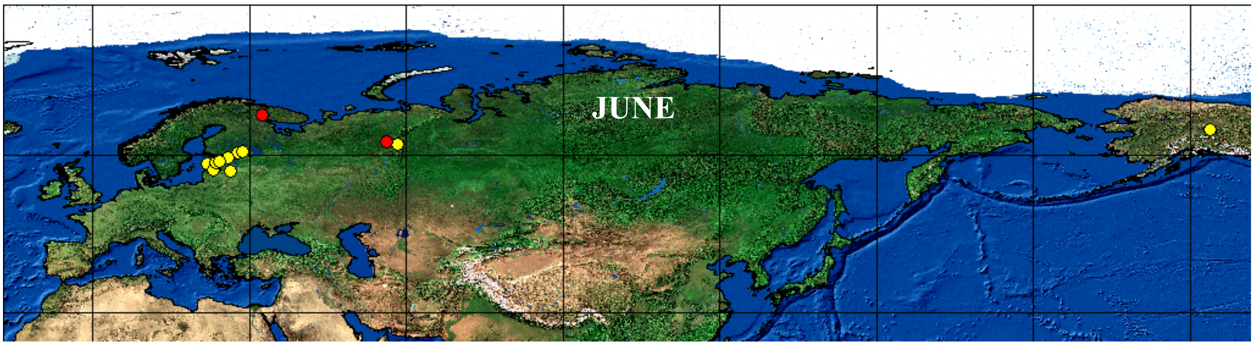
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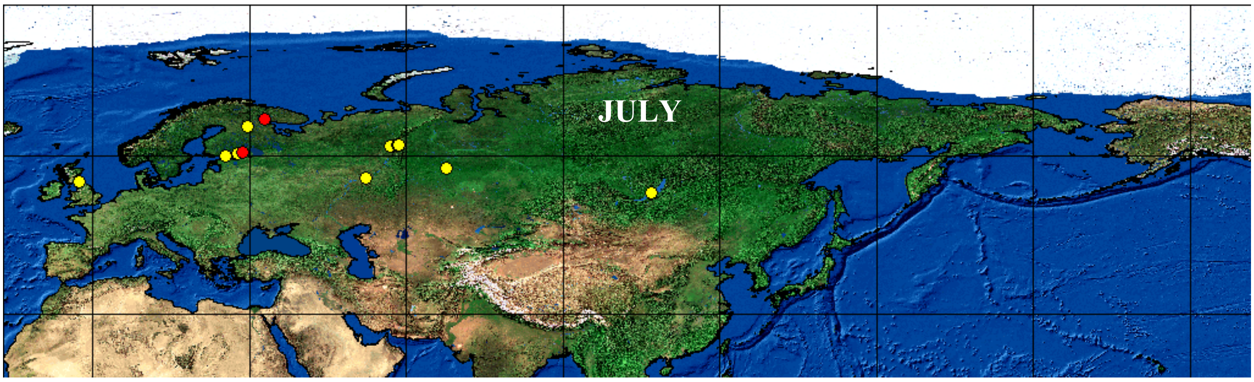
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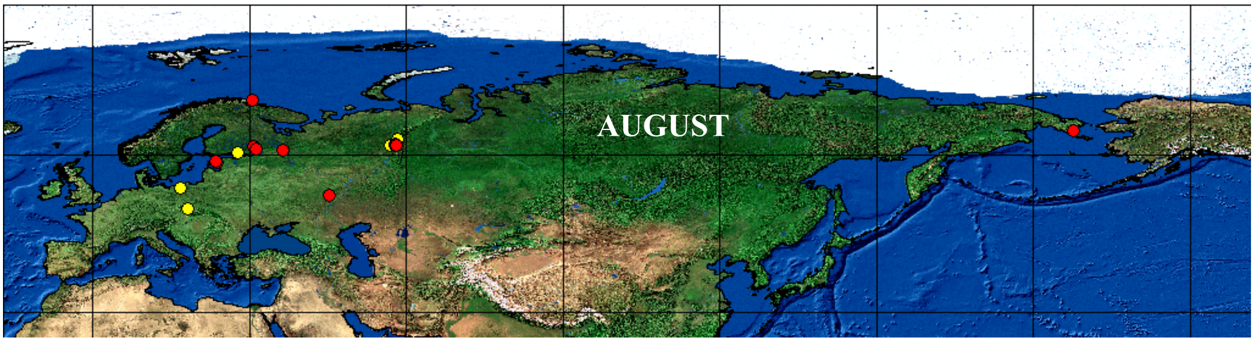
AUGUST


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Figure 468. Goosander monthly movements. Purple dots are ringing sites, green dots are recovery sites.

Migratory routes. Bird Ringing Centre of Russia data reveal two main general migratory movement streams: 1) well visible one between northern half of European Russia with part of the western Siberia and Western Europe; 2) not so clear, but detectable from the flight directions of some recoveries, migratory stream between east of the European Russia (likely with part of western Siberia) and the Black Sea area. Our data do not show migratory routes of birds from Siberia, but migratory route between Chukotka and North America is quite predictable.

Goosanders move on relatively short distances as well as on longer distances up to 4051.5 km (Fig. 469). The latter distance is the maximal distance in indirect recoveries. For direct recoveries the maximal distance is 3348.7 km. Both these distances are longer than the same ones in the Red-breasted Merganser.

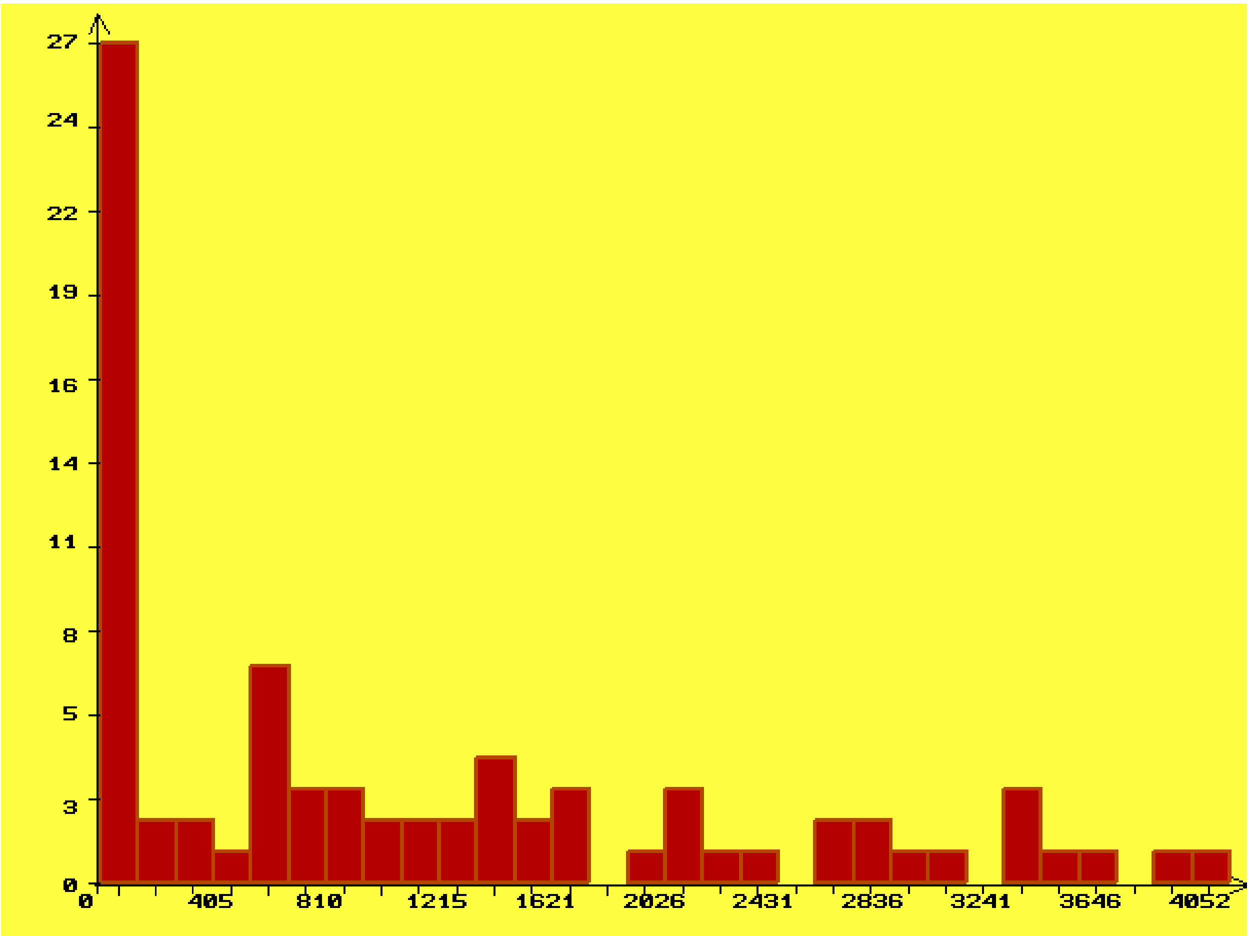

Figure 469. Distribution of all ring-recovery distances in Goosander. X axis is the flight distance in km; Y axis is the number of distances.

Mean distance of movements in Goosander young birds (ringed as „pull"or „juv"or „1 y") is shorter than in adults: 1004.6±186.0 versus 1188.5±183.6 km respectively (N_{young} = 38, N_{ad} = 41), however insignificant. Mean flight distance in males is more than twice longer than in females: 2265.7±277.3 and 917.2±255.0 km respectively (N_{males} = 14, $N_{females}$ = 22), significant – t-Bailey=3.58, P=0.001. Longer distances in males mean that males in this species are much more prospecting for the new areas and population exchange than females.

Summarising all about migratory routes, we can outline spring and autumn Goosander migratory movements (Fig. 470).

Figure 470. Outline of spring (red arrows) and autumn (yellow arrows) migratory routes for Goosander.

Speed. Bird Ringing Centre of Russia database does not contain appropriate data for defining Goosander daily speed on migration.

Populations. Data set for Goosander is very small. It does not allow outlining whole population structure of the species. In Goosander it is possible to recognize only one population, others are very uncertain. More or less recognizable is western-central-european-european-russia-west-siberian population (polygon № 1, Fig. 471) with mostly east, north-east – west, south-west migratory movements. It is very likely, that there is black-sea-southern-european-russia-western-siberian population (Polygon № 2, Fig 471) with generally north-east – south-west migratory movements and wintering grounds on the Black Sea. The latter population overlaps greatly with the former one. Some population exists in the western Siberia (polygon № 3). Only one recovery from Alaska indicates the chukchian-north-american Goosander population.

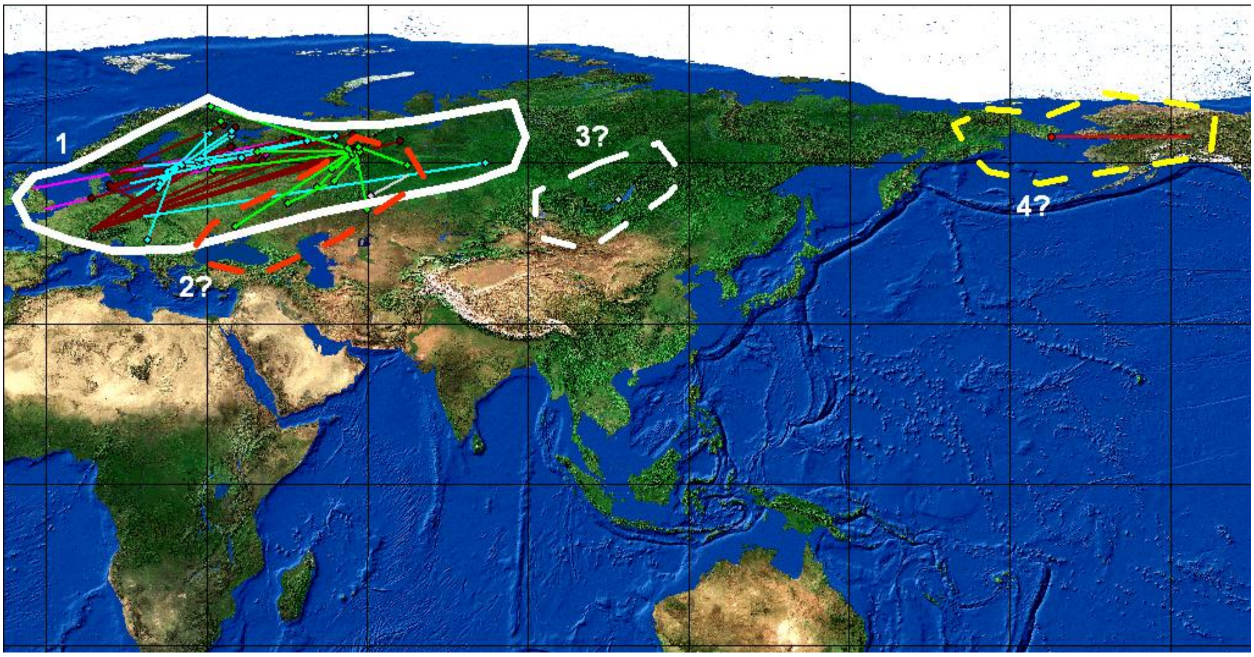

Figure 471. Goosander populations. White polygon № 1 outlines western-central-european-european-russia-west-siberian population. Dashed brown polygon is the black-sea-southern-european-russia-western-siberian population (polygon № 2). White dashed line shows very uncertain population in central Siberia (№ 3). Yellow dashed polygon № 4 shows very uncertain chukchian-north-american population.

Ten-year distances. Data in the Goosander set are very heterogeneous. However it turned out that it is possible to find a way to compare earlier and later distances. „Moskwa" scheme recoveries are distributed unevenly: 38 of 39 total recoveries of the „Moskwa" scheme are in years before 1981. On the other hand, recoveries of other European ringing centres distributed between decades more evenly. For the European ringing centers, but „Moskwa" mean distance of movement for the years before 1981 is 1255.5±266.2 (N=17), for later than 1980 - 2125.2±249.4 (N=23). In spite of small samples, mean distance increased significantly with years: t-Bailey=2.38, P=0.02.

Lifespan. According to EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010, the oldest Goosander lived 14 years 10 months. Bird Ringing Centre of Russia database contains a recovery of a bird („Sempach" Z 55 000) with ring-recovery span 14 year almost 2 months. This bird was ringed as 2-year old male; therefore it lived more than 16 years.

Mortality rate. According to the common criteria (see "Materials and Methods") 69 recoveries are applicable for the mortality rate analysis. If we use all recoveries for calculations, mean annual mortality rate in Goosander is 24.60±2.57% Real mortality pattern differs from the theoretical one significantly (χ^2 = 36.95, df = 12, P=0.0002). Programme MARK, Model CLogLog 2ndPart shows 25.66%, difference is 1.06%. Mortality pattern indicates small drawdown of the real mortality pattern in comparison to the theoretical one. However, judging to the "given demographic status index" of the considered populations (Kharitonov, 2020), this could signal about more or less stable population condition in the Goosander (Fig. 472).

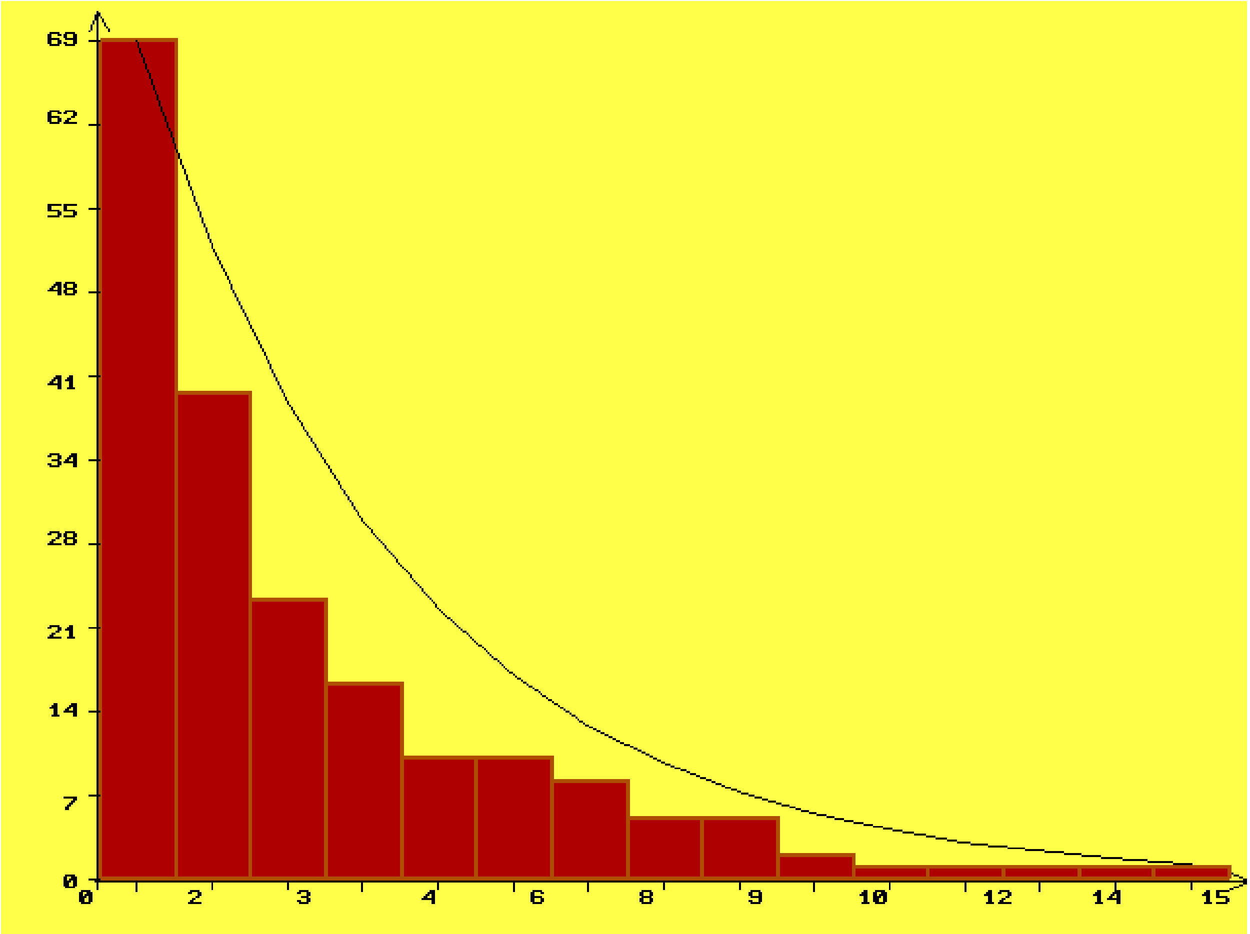

Figure 472. Mortality pattern in the Goosander. Line – theoretical number of live birds in each year, bars – real numbers. X axis is the number of years after marking. Y axis is the number of live birds.

On average, males live much longer than females: 5.60±1.02 (N = 14) and 2.21±0.66 (N = 22) years respectively. Difference is significant – t-Bailey=3.01, P=0.007. The reason for such misbalance is not clear.

WHITE-HEADED DUCK
(*OXYURA LEUCICEPHALA*)

Photo by Viktor V. Popov

Breeding range in Eurasia. Brief description of the breeding range is in the Fig. 473. Data are compiled from Field Guide for Anseriforms of Russia, 2011; Linkov, 2002: Scott, Rose, 1996 and own data.

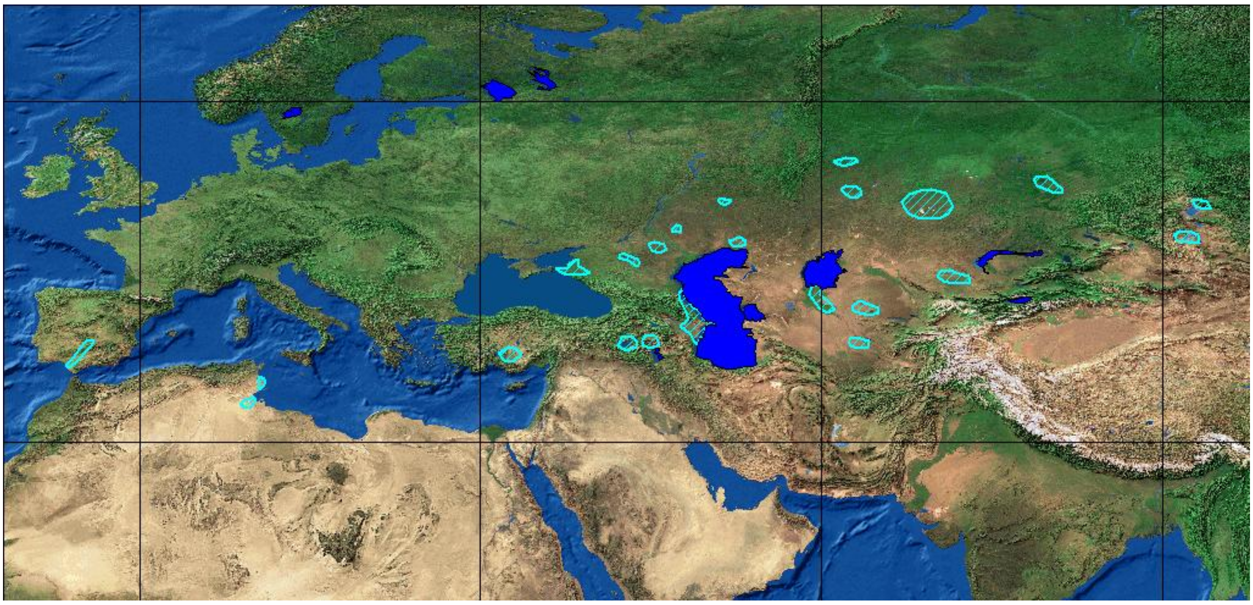

Figure 473. Breeding range of the White-headed Duck in Eurasia (blue-green dashed areas).

Distribution of control points. Bird Ringing Centre database contains only 6 recoveries from 6 White-headed Ducks. All ducks were marked with metal rings only. All birds had rings of the ‘Moskwa’ scheme. Ringing dates are since 21.08.1932 till 16.04.1960, recovery dates are since 15.05.1933 till 24.05.1960.

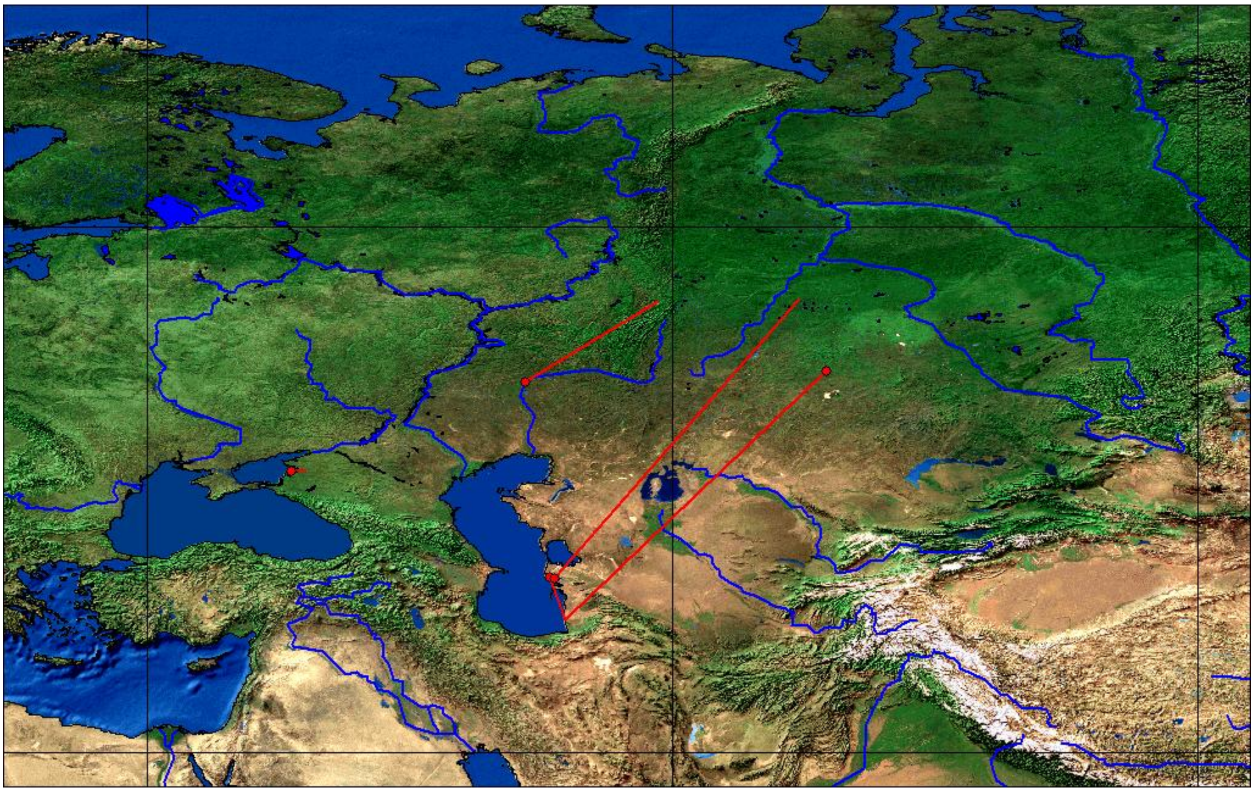

Figure 474. White-headed Duck movments. Lines connect ringing and recovery sites, recovery sites are marked with green dots.

White-headed duck in the area, covered by recoveries, winter at the Caspian and Black Seas and migrate for breeding to the north-east from the wintering grounds (Fig. 474). Black and Caspian Seas breeding and wintering areas are intermixed. Three ducks were shot, in two recoveries details unknown, one bird was found dead. Four recoveries are direct ones with the longest distance 2051.3 km; two recoveries are indirect ones with about the same longest distance - 1958.8 km.

Lifespan. EURING Longevity list (http://www.euring.org/data_and_codes/longevity.htm) from 26 November 2010 does not contain data on the White-headed Duck lifespan. Bird Ringing Centre database contains a recovery of duck (sex and age are unknown) with ring-recovery span 3 years and 3 months.

PART II. DISTRIBUTION OF RECOVERIES IN RELATION TO EACH OTHER

As we have already stated in the section "Materials and Method", the distribution of recoveries generally is biased for two reasons. The first one – density of recoveries in any particular area depends on the density of the human population (Hupp et al, 2012). The second one – recovery coordinates are defined mostly as the coordinates of the nearest human settlement. The latter in conditions, for example of Siberia, might mean several tens kilometers. Nevertheless, waterfowl, especially ducks is a good group to study the recovery distribution because they are game species and give many recoveries from hunters. Since the hunters try to spread along the areas with duck habitats (often, but not always, excluding protected areas), we are able to obtain recoveries practically from the most part of territory of different countries. Although the recovery positions of the duck recoveries are biased, in different species they are biased more or less in the same way. This offers us good possibilities to perform comparison between different species in the same areas. For this comparison it is convenient to use two main systematical and ecological groups of ducks: dabbling ducks and diving ducks. Logically, the comparison should be performed within each of these categories of ducks separately. We considered 7 species as dabbling ducks: Mallard, Pintail, Wigeon, Common Teal, Garganey, Gadwall, Shoveler. As diving ducks we considered 6 species Tufted Duck, Common Pochard, Scaupe, Red-crested Pochard, Ferruginous Duck, Goldeneye.

In addition to the distribution of all recoveries in each species, it is interesting to outline this distribution in different parts of the species recovery area, because those different parts are characterized by different natural conditions, human population density and possibilities for hunting.

Two characteristics of distribution have been chosen: 1) degree of recovery aggregation (aggregativeness) – mean nearest neigbour distance between recoveries; 2) degree of recovery concentration in groups (concentrativeness) with different number of recoveries that located at not more than some distance (might be called as "key distance") from each other. The latter might be assessed via number of recoveries (or relative number of recoveries, e.g., percentages) in groups with different size and relative number of such groups within a species.

Since in different species the number of recoveries is different; we should exclude the factor of sample size from the consideration. As it is commonly accepted in such cases, we should compare not absolute but relative values. In dabbling ducks for this purpose, as a frame of reference, we chose the Pintail, as a species with the highest number of recoveries. In diving ducks for this purpose, as a frame of reference, we chose the Tufted Duck, as a species with the highest number of recoveries among this duck category. To obtain the relative nearest neighbour distance (NND) of a species, we need first to divide number of Pintail (or Tufted Duck) recoveries by the number of recoveries in the particular species. In such way we obtain the quantity that might be referred to as "Relation" (e.g., Table 23). After that, we need to divide the real NND of a species by the Relation. By this operation we obtain the "Relative NND". Relative NND represents the NND that would be in case the number of recoveries of a particular species is the same as the number of recoveries in Pintail (or Tufted Duck). These operations allow us to evaluate, in what species recoveries have a stronger tendency to be in the same areas as other recoveries, i.e., we can evaluate the degree of aggregation in each species in relation to other. Obviously, in which species the Relative NND is lesser, this species has the stronger tendency to produce aggregations in some restricted areas.

Together with the distribution of recoveries within the whole recovery area, it is interesting to figure out such distribution in different geographical areas. For this purpose we separate the following geographical areas with relatively great number of duck recoveries: western and central Europe (up to 20˚E), eastern Europe (20˚-60˚E), north of Western Siberia (north of 60˚N, 60˚-90˚E), south of Western Siberia and northern Kazakhstan (35˚-60˚N, 60˚-90˚E), central Siberia through Chukotka (east of 90˚E, excluding south Far East, and Sakhalin and Kamchatka), south Far East (south of 55˚N, 120˚-141.3˚E), Sakhalin and Kamchatka.

As it was already mentioned, degree of recovery concentration in groups (concentrativeness) with different number of recoveries was measured via number and size of groups where recoveries are located in a distance from each other, but in not more than some arbitrary chosen key distance. After several tests with different key distances (considered: NND, 25 km, 50 km, 100 km, 200 km), we chose 100 km as a key distance for the group search in all duck species. To our mind, this key distance produces quite moderate number of groups and for this reason looks illustrative enough. The method of group search is the following: from some arbitrary chosen recovery nearest neighbour distance to some other recovery is calculated, then this distance is compared with the key distance. If the calculated NND does not exceed the key distance, both recoveries are considered as belonging to one group. Then the NND from the second recovery point is calculated and compared with the key distance, etc. As a result of this procedure we receive a number of clusters of recovery sites; some clusters might contain many recoveries, other – not so many, considerable number of clusters would contain just one recovery. The latter occurs when the nearest distance from a recovery to any other exceeds 100 km. The coordinates of the centre of each cluster is calculated, centers are posed on a map.

Then, for each species separately the size of groups is ranged from clusters with the highest number of recoveries in the particular species to the lowest number. Then all groups were ranged in size within MapInfo programme with the method of "Natural Breaks". Natural Breaks method creates ranges by averaging ranges to distribute data more evenly across the ranges. Then thematic map is created, where size of a circle posed in each centre of a group reflects the size of this group. It is important to stress that the biggest group size in each species is different, but the sizes of circles for biggest groups in each species are the same. Smaller groups are represented with the circles of smaller size. The regularity in smaller circles is the same one – the same circle size in each species represents different number of recoveries. Such approach allows comparing number and distribution of groups with relatively about the same ranks (large, medium, small) in each species without addressing to the real group size, that is very different in each species because of very different numbers of recoveries in species (see legends of maps below).

For this section we used data from the Bird Ringing center of Russia database collected by the end of 2013. Nevertheless, these results are true since the most waterfowl recoveries we received by the end of this calendar year.

1. Dabbling Ducks

It turned out that Gadwall has the smallest Relative nearest neighbour distance between recoveries among all seven considered dabbling duck species (Table 23).

Table 23. Real and relative nearest neighbour distance between recoveries in the dabbling duck species.

SPECIES	MEAN NEAREST NEIGHBOUR DISTANCE $\pm$Standard Error (km)	NUMBER OF RECOVERIES	Relation (number of pintail recoveries /number of recoveries in the species)	Relative NND (km)
Pintail	13.87$\pm$0.68 (km)	7196	1	13.87
Mallard	13.21$\pm$0.41 (km)	7002	1.027706	12.85387
Common Teal	17.59$\pm$1.02 (km)	5168	1.392415	12.63273
Wigeon	23.05$\pm$1.16 (km)	3172	2.2686	10.16045
Shoveler	47.20$\pm$3.12 (km)	1330	5.410526	8.723735
Garganey	39.81$\pm$2.81 (km)	1487	4.839274	8.226441
Gadwall	50.48$\pm$3.42 (km)	660	10.90303	4.629906

The smallest Relative NND in Gadwall means that within the whole species recovery areas Gadwall is the most aggregative (try to be closer to con-specifics) in comparison to all other considered dabbling duck species. The real number of recoveries in Gadwall is 660, however in case of 7196 recoveries the mean NND in Gadwall would be 4.63 km, whereas Pintail having 7196 recoveries, has mean NND 13.87 km. Pintail appeared the dabbling duck that has the least tendency for aggregations. These regularities are quite visible if we plot recoveries of more than one species in the same map. Tendency in Gadwall to have the greater extent of aggregation is well visible (Fig. 475). Gadwall has the least number of recoveries among other dabbling duck species. It could mean the lesser numbers of this species among others. It looks like, the lesser numbered species has the greatest social attraction of individuals to each other, so it appeared the most aggregative species. Example with other species show which species is more aggregative in comparison to others (Figs 475–477).

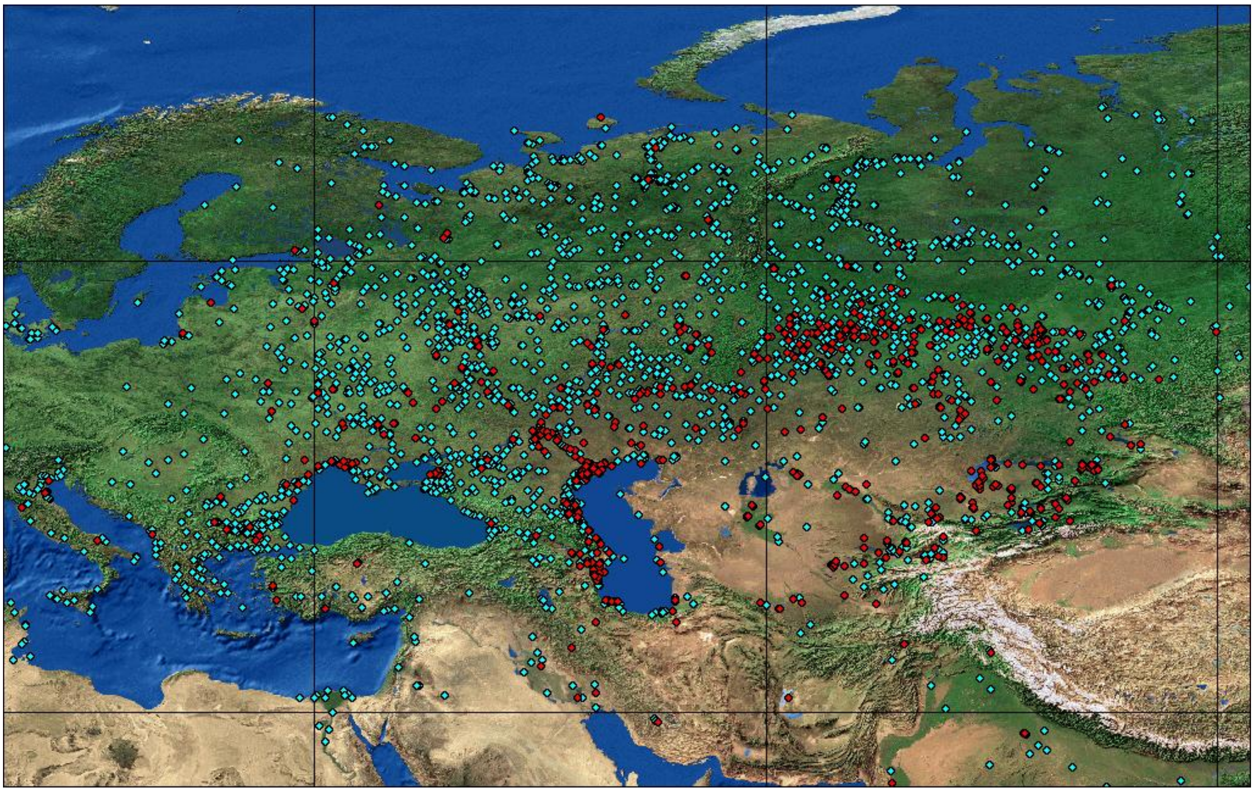

Figure 475. Gadwall recoveries (red dots) on the background of the Pintail recoveries (blue-green dots).

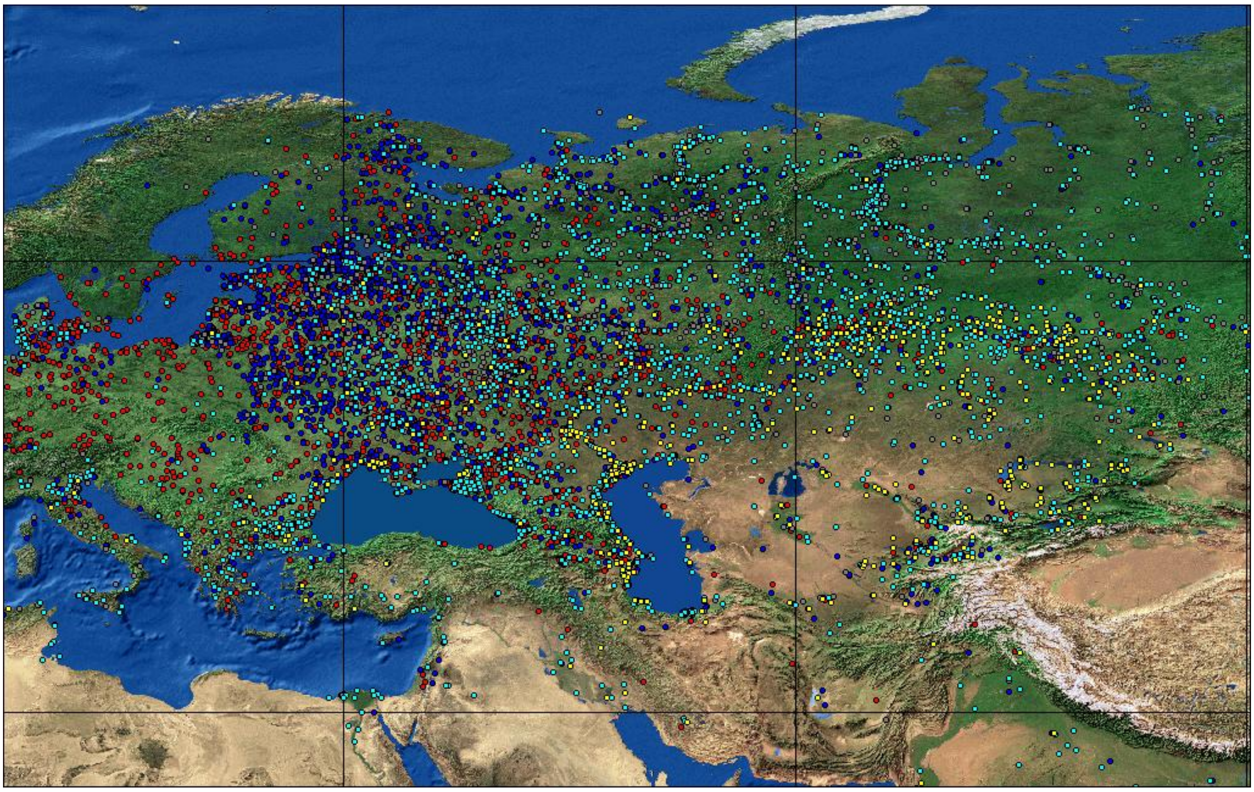

Figure 476. Gadwall recoveries (yellow dots) on the background of the Mallard (red dots), Pintail (blue-green dots) and Common Teal (blue dots) recoveries.

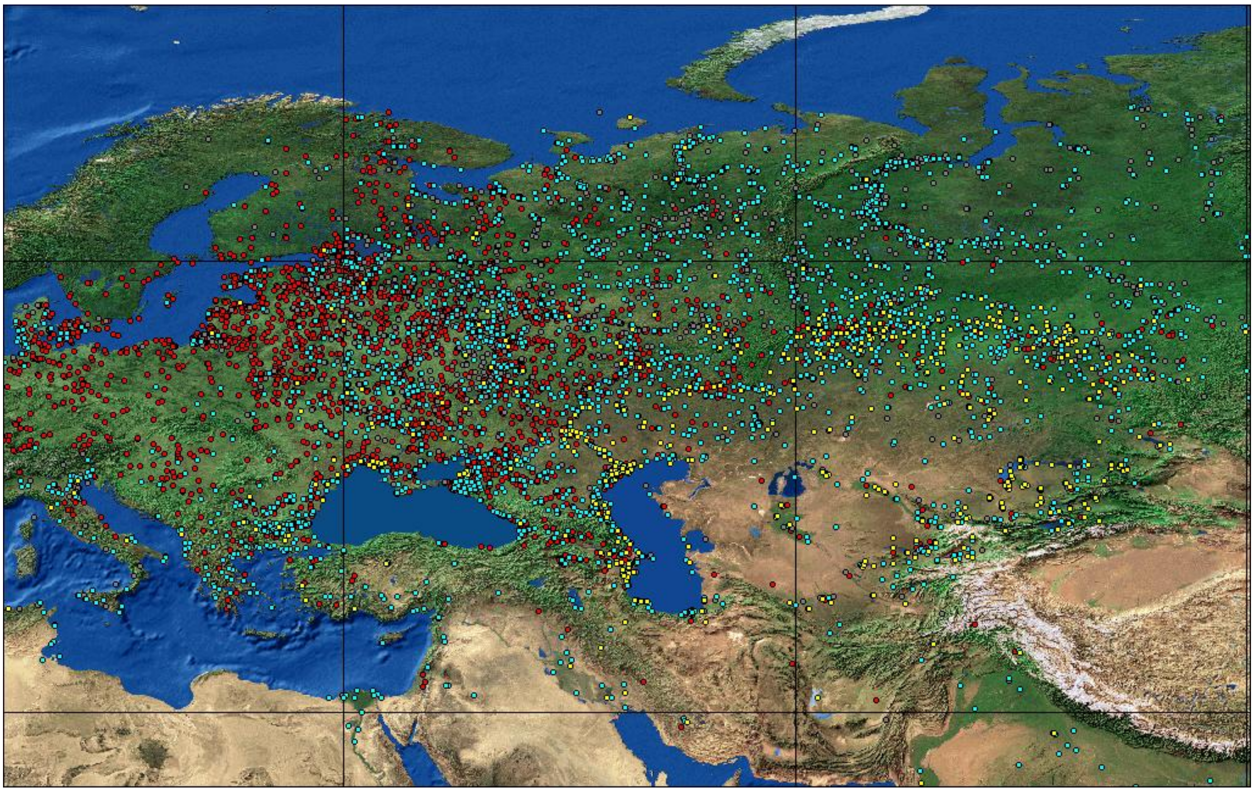

Figure 477. Gadwall recoveries (yellow dots) on the background of the Mallard (red dots), Pintail (blue-green dots) and Wigeon (grey dots) recoveries.

Tendencies look more prominent if we remove the landscape from the map background (Fig. 478).

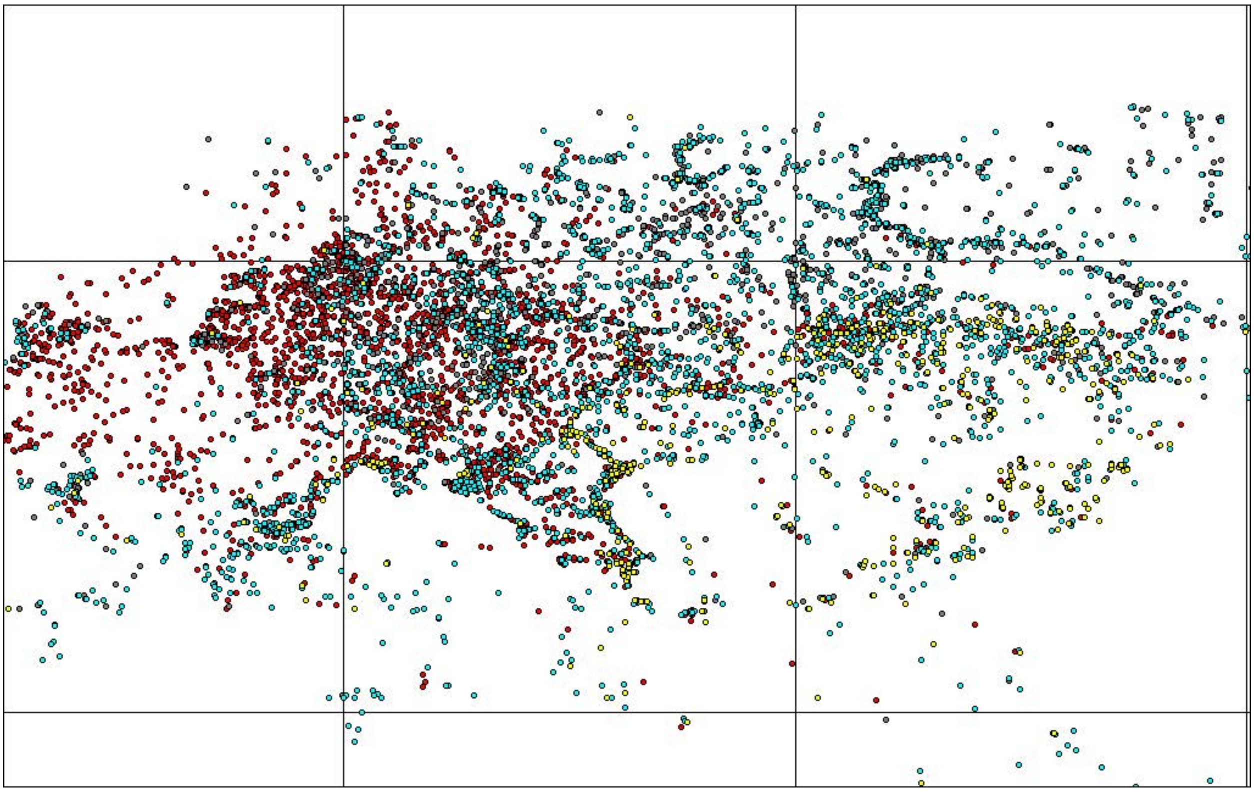

Figure 478. Gadwall recoveries (yellow dots) on the background of the Mallard (red dots), Pintail (blue-green dots) and Wigeon (grey dots) recoveries.

Since the Gadwall has the Relative NND which is very different from others, the degree of aggregation in this species can be easily concluded from the map view. However, in many cases it is not easy to recognize the degree of aggregation in a species from the map view, e.g., in case of Mallard in comparison to Pintail (Fig. 479). In these cases the quantity of Relative NND helps to make a proper conclusion. Mallard and Pintail have about the same overall degree of aggregation (Table 23).

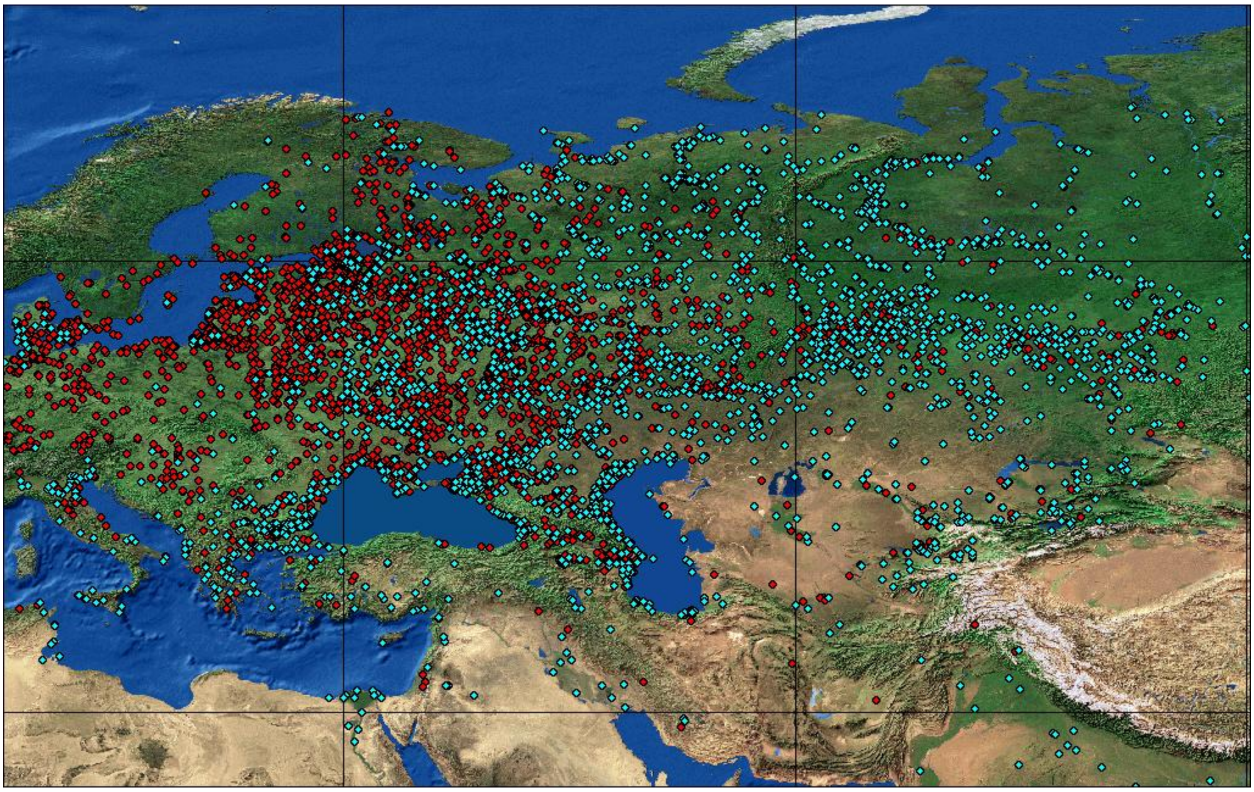

Figure 479. Pintail recoveries (blue-green dots) on the background of the Mallard (red dots) recoveries.

In different geographic areas different dabbling duck species have different degree of aggregation. It could become greater or lesser then in other species (Table 24).

Table 24. Real and relative nearest neighbour distance between recoveries in the dabbling duck species in different geographic areas.

SPECIES	GEOGRAPHIC AREA	MEAN NEAREST NEIGHBOUR DISTANCE±Standard Error (km)	NUMBER OF RECOVERIES	Relation (number of recoveries in the species/number of pintail recoveries)	Relative NND (km)
Pintail	west and central Europe	32.63±3.90	231	12.21212	2.671902
Mallard	west and central Europe	30.07±1.48	472	0.489407	61.44668
Common Teal	west and central Europe	44.29±4.18	232	0.99569	44.47987
Wigeon	west and central Europe	62.97±6.02	142	1.626761	38.70806
Shoveler	west and central Europe	35.41±3.14	291	0.793814	44.60763
Garganey	west and central Europe	41.13±4.50	155	1.490323	27.59848
Gadwall	west and central Europe	232.98±50.39	14	16.5	14.12023
Pintail	eastern Europe	14.04±0.48	2821	1	14.03811
Mallard	eastern Europe	8.70±0.23	5660	0.49841	17.46244
Common	eastern Europe	10.20±0.29	4202	0.671347	15.1994

Teal					
Wigeon	eastern Europe	19.30+0.76	1511	1.866976	10.34099
Shoveler	eastern Europe	45.19+2.58	479	5.889353	7.673079
Garganey	eastern Europe	30.81+1.51	902	3.127494	9.851321
Gadwall	eastern Europe	47.08+4.09	283	9.968198	4.723074
Pintail	north of Western Siberia	6.45+0.70	674	1	6.446531
Mallard	north of Western Siberia	37.31+5.77	47	14.34043	2.601396
Common Teal	north of Western Siberia	20.27+2.93	157	4.292994	4.722487
Wigeon	north of Western Siberia	7.67+0.62	718	0.938719	8.173513
Shoveler	north of Western Siberia	30.06+5.23	58	11.62069	2.587061
Garganey	north of Western Siberia	34.45+6.78	38	17.73684	1.942006
Gadwall	north of Western Siberia	378.85+131.89	2	337	1.124196
Pintail	northern Kazakhstan – south of Western Siberia	12.40+0.66	1260	1	12.39666
Mallard	northern Kazakhstan – south of Western Siberia	22.05+1.82	455	2.769231	7.961259
Common Teal	northern Kazakhstan – south of Western Siberia	28.77+1.89	390	3.230769	8.903471
Wigeon	northern Kazakhstan – south of Western Siberia	30.44+2.28	405	3.111111	9.783143
Shoveler	northern Kazakhstan – south of Western Siberia	31.74+2.04	343	3.673469	8.641282
Garganey	northern Kazakhstan – south of Western Siberia	29.92+1.93	351	3.589744	8.33441
Gadwall	northern Kazakhstan – south of Western Siberia	33.82+2.64	335	3.761194	8.990902
Pintail	Central Siberia – Chukotka	14.23+1.23	979	1	14.22612
Mallard	Central Siberia – Chukotka	62.35+11.37	134	7.30597	8.533999
Common Teal	Central Siberia – Chukotka	89.73+15.23	80	12.2375	7.332327
Wigeon	Central Siberia – Chukotka	36.48+4.03	237	4.130802	8.830873
Shoveler	Central Siberia – Chukotka	80.67+10.10	92	10.6413	7.58114
Garganey	Central Siberia – Chukotka	102.23+28.26	21	46.61905	2.192953
Gadwall	Central Siberia – Chukotka	23.63+15.97	12	81.58333	0.28963
Pintail	south Far East	40.07+25.88	153	1	40.07142
Mallard	south Far East	16.10+2.37	190	0.805263	19.9892
Common Teal	south Far East	123.72+21.93	14	10.92857	11.32047
Wigeon	south Far East	124.23+26.69	12	12.75	9.743386

Shoveler	south Far East	108.31+20.21	22	6.954545	15.57429
Garganey	south Far East	366.19	2	76.5	4.78681
Gadwall	south Far East	59.27	2	76.5	0.774745
Pintail	Kamchatka and Sakhalin	2.86+0.29	977	1	2.862227
Mallard	Kamchatka and Sakhalin	52.34+9.72	28	34.89286	1.499944
Common Teal	Kamchatka and Sakhalin	34.12+7.27	61	16.01639	2.130453
Wigeon	Kamchatka and Sakhalin	9.05+1.82	140	6.978571	1.296349
Shoveler	Kamchatka and Sakhalin	63.37+17.50	19	51.42105	1.232306

Pintail is the most aggregative duck in western and central Europe. In this geographic area Pintail prefer to habituate sea coasts and streams of big European rivers (see also the chapter III). Mallards in Europe have a tendency to aggregate more inland than Pintails (Fig. 480), although Mallards also prefer big river basins (see also chapter III) and coast of the Baltic Sea (Fig. 480). Shovelers in this part of Europe are more coastal ducks whereas in eastern Europe this duck is deeply inland one. In Western Siberia, Shovelers concentrate along big rivers. Gadwalls in eastern Europe aggregate mostly in the lower streams of Volga River, as well as Black Sea and Caspian Sea coasts. In Western Siberia Gadwalls more frequently can be met in the area with many lakes on the boundary of the Western Siberia and northern Kazakhstan (Fig. 480). In the Central Siberia Gadwalls are scarce (12 recoveries only), however this species seems to be the most aggregative in this area (Table 24, Fig. 481). Other useful information might be taken from the quantities represented in Tables 23 and 24 and maps with the relative distribution of dabbling duck species (Figs 475–481).

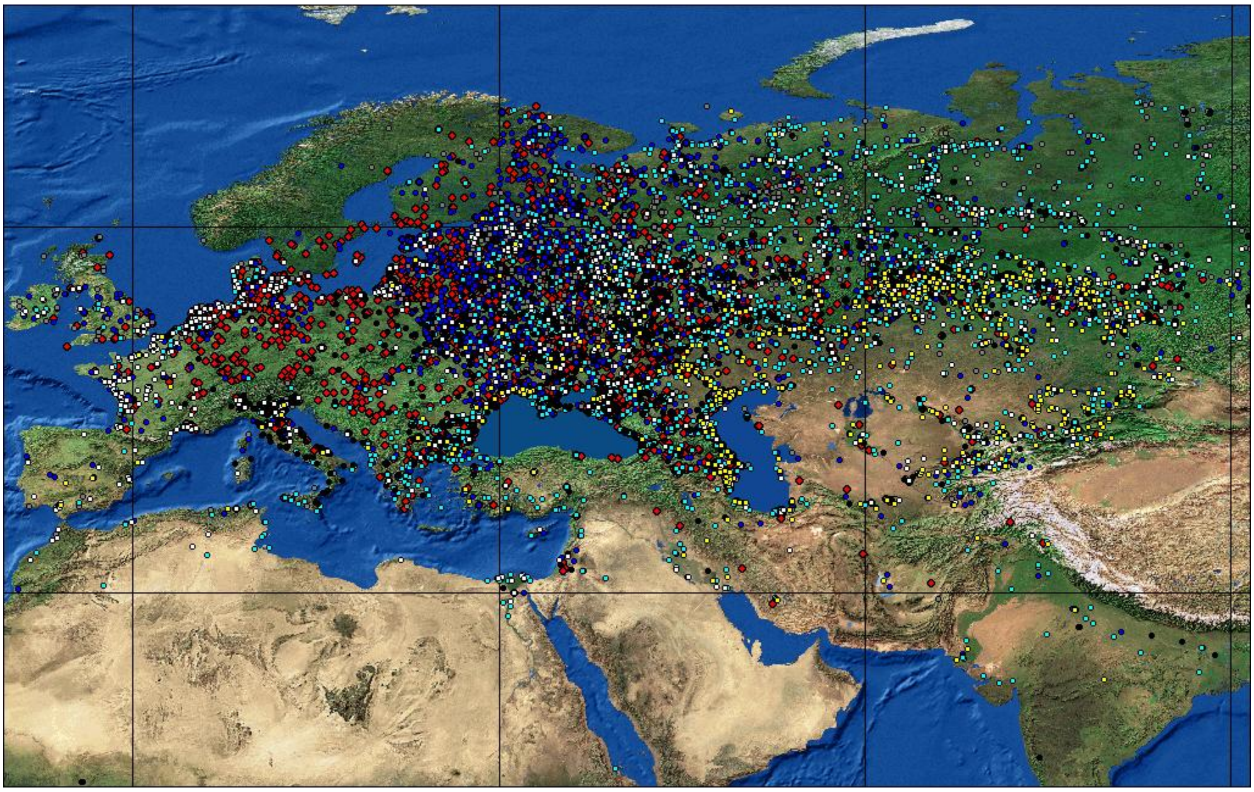

Figure 480. All dabbling duck species recoveries in areas: western and central Europe, eastern Europe, north of Western Siberia, south of Western Siberia – northern Kazakhstan. From background to foreground: Mallard (red dots), Pintail (blue-green dots), Wigeon (grey dots),

Common Teal (blue dots), Shoveler (white dots), Garganey (black dots) and Gadwall (yellow dots).

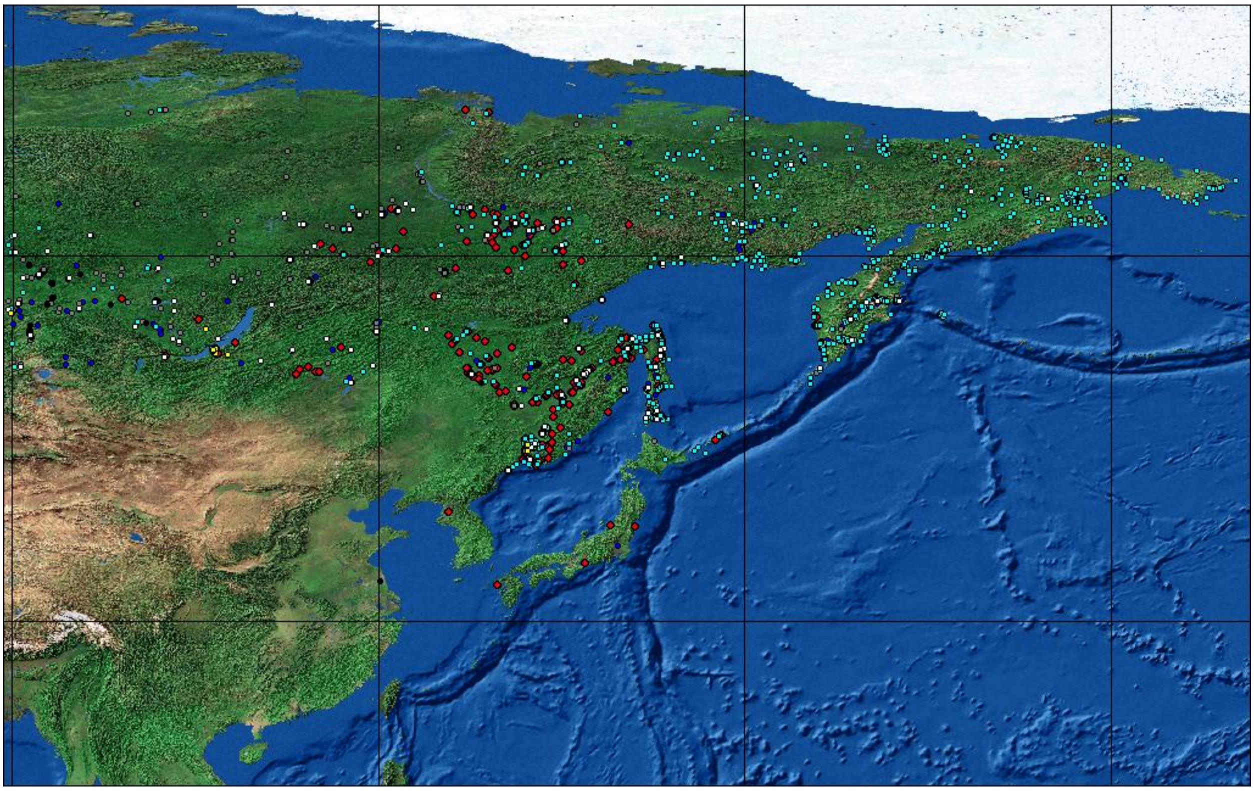

Figure 481. All dabbling duck species in recoveries areas: Central Siberia through Chukotka, south Far East, Kamchatka and Sakhalin. From background to foreground: Mallard (red dots), Pintail (blue-green dots), Wigeon (grey dots), Common Teal (blue dots), Shoveler (white dots), Garganey (black dots) and Gadwall (yellow dots).

Positions of groups (clusters) of recoveries with different number show that Mallard and Common Teal form the largest concentrations among ducks (Figs 482 and 485), i.e., they are the most concentrated species. In the Common Teal most of recoveries are gathered in one big cluster that contains 3167 recoveries of 5168 total (Fig. 485), in the Mallard – in two big clusters – 2981 and 2002 recoveries of 7002 total. In both species concentrations have centers in the eastern Europe, clusters themselves stretch: in Common Teal from eastern Europe through the whole eastern Europe, Mallard - from central Europe through the European Russia, as well (Fig. 482). Pintails are distributed more easterly, two largest clusters contain relatively lesser number of recoveries (1614 and 1024 of 7196 total) than in Common Teal and Mallard (Fig. 483). Wigeon is less concentrated than Pintail; number of smaller groups is relatively greater than in the former three species (Fig. 484).Garganey is more or less equally spread across eastern Europe and Western Siberia, this duck is less concentrated than the former four species (Fig. 486). Then Gadwall comes (Fig. 487); the least concentrated species appeared to be in Shoveler. The latter species has relatively highest number of smallest sized clusters (Fig. 488).

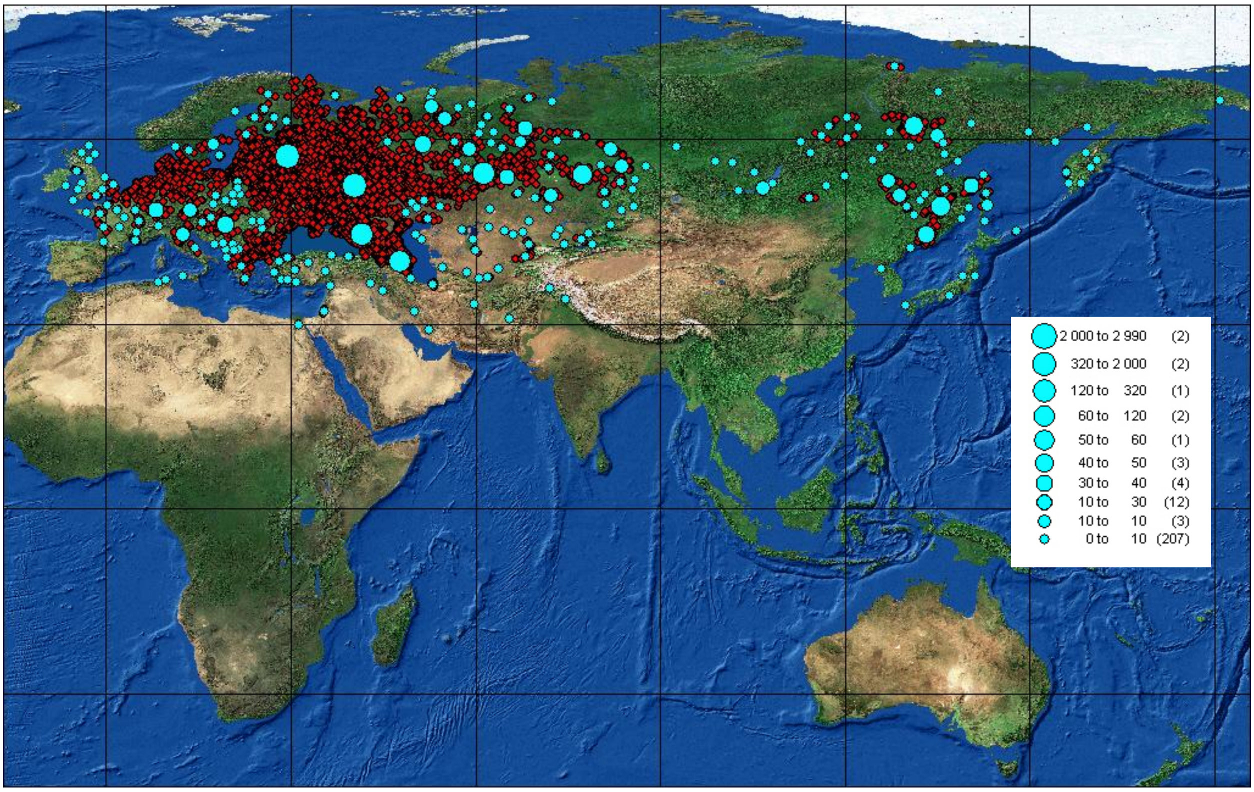

Figure 482. Mallard groups of recoveries. Red dot – recoveries, blue-green circles of different size (see legend) are centers of the groups (clusters) with the distance not more than 100 km between recoveries.

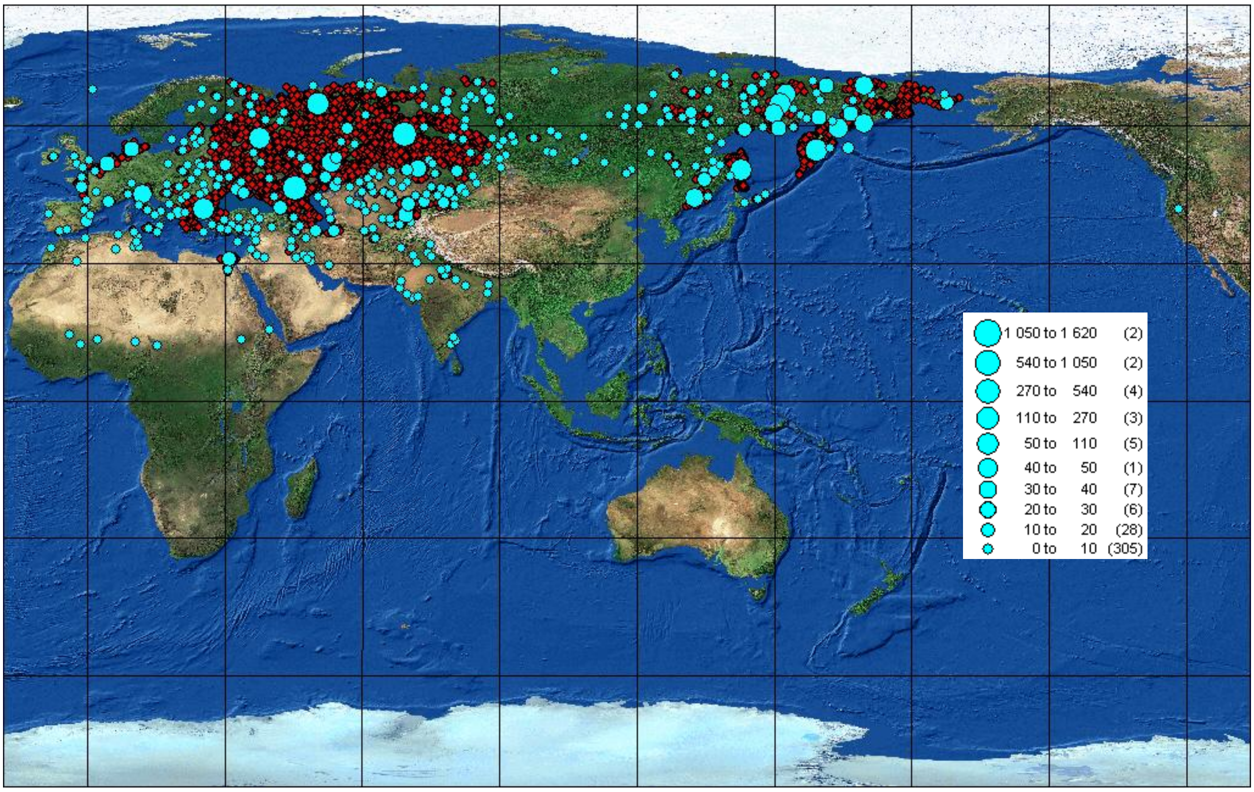

Figure 483. Pintail groups of recoveries. Red dot – recoveries, blue-green circles of different size (see legend) are centers of the groups (clusters) with the distance not more than 100 km between recoveries.

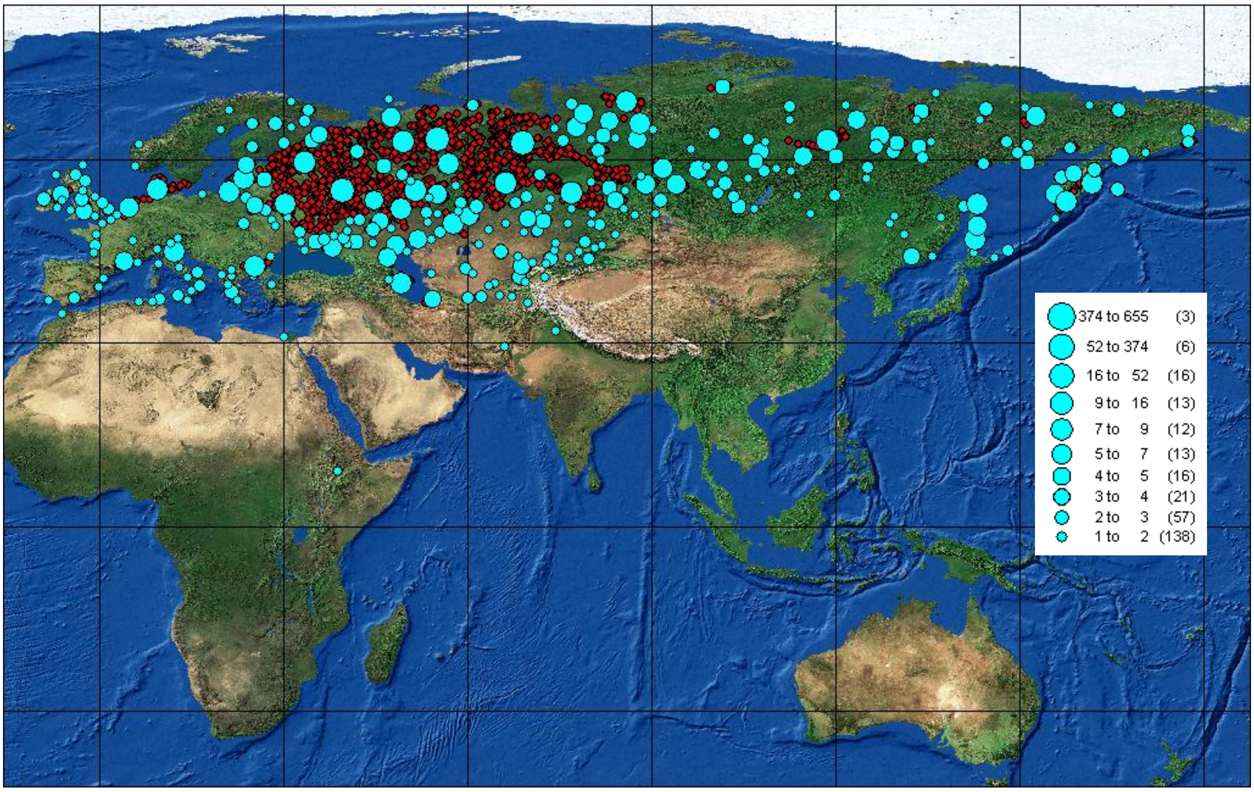

Figure 484. Wigeon groups of recoveries. Red dots – recoveries, blue-green circles of different size (see legend) are centers of the groups (clusters) with the distance not more than 100 km between recoveries.

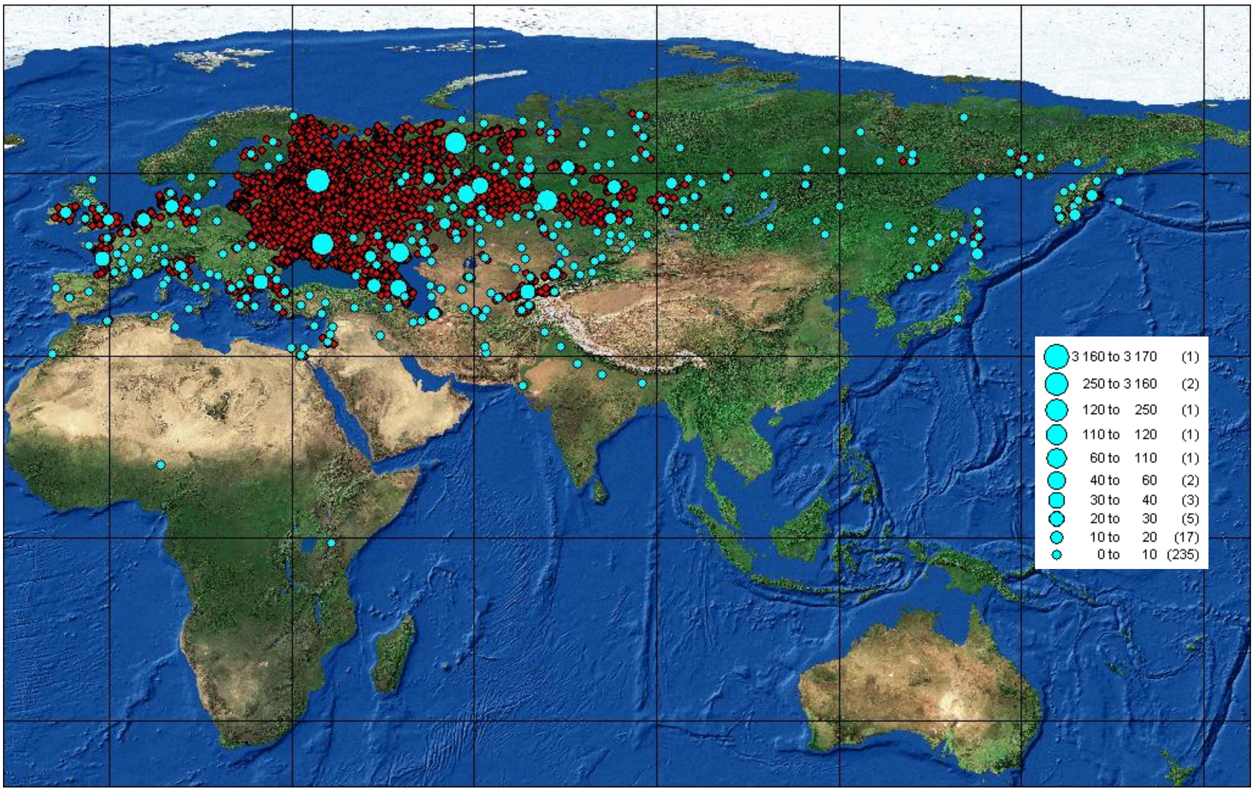

Figure 485. Common Teal groups of recoveries. Red dot – recoveries, blue-green circles of different size (see legend) are centers of the groups (clusters) with the distance not more than 100 km between recoveries.

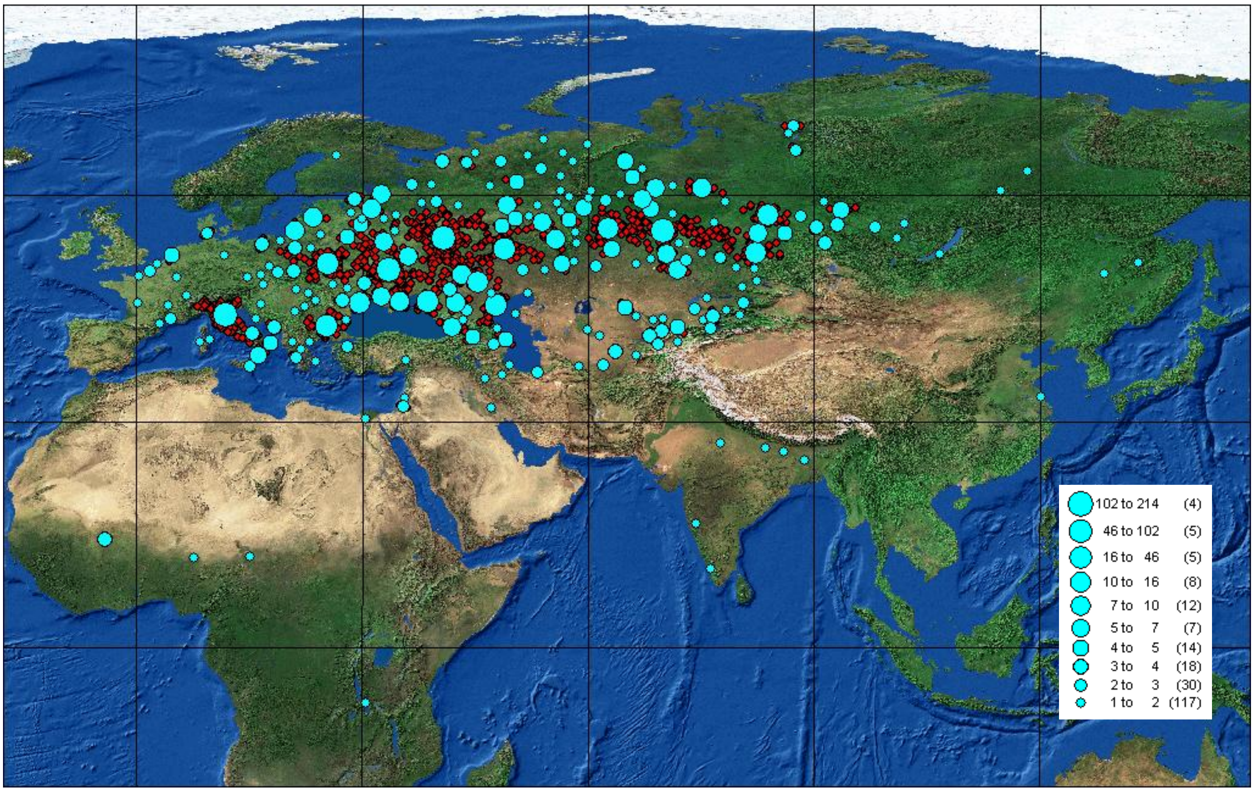

Figure 486. Garganey groups of recoveries. Red dot – recoveries, blue-green circles of different size (see legend) are centers of the groups (clusters) with the distance not more than 100 km between recoveries.

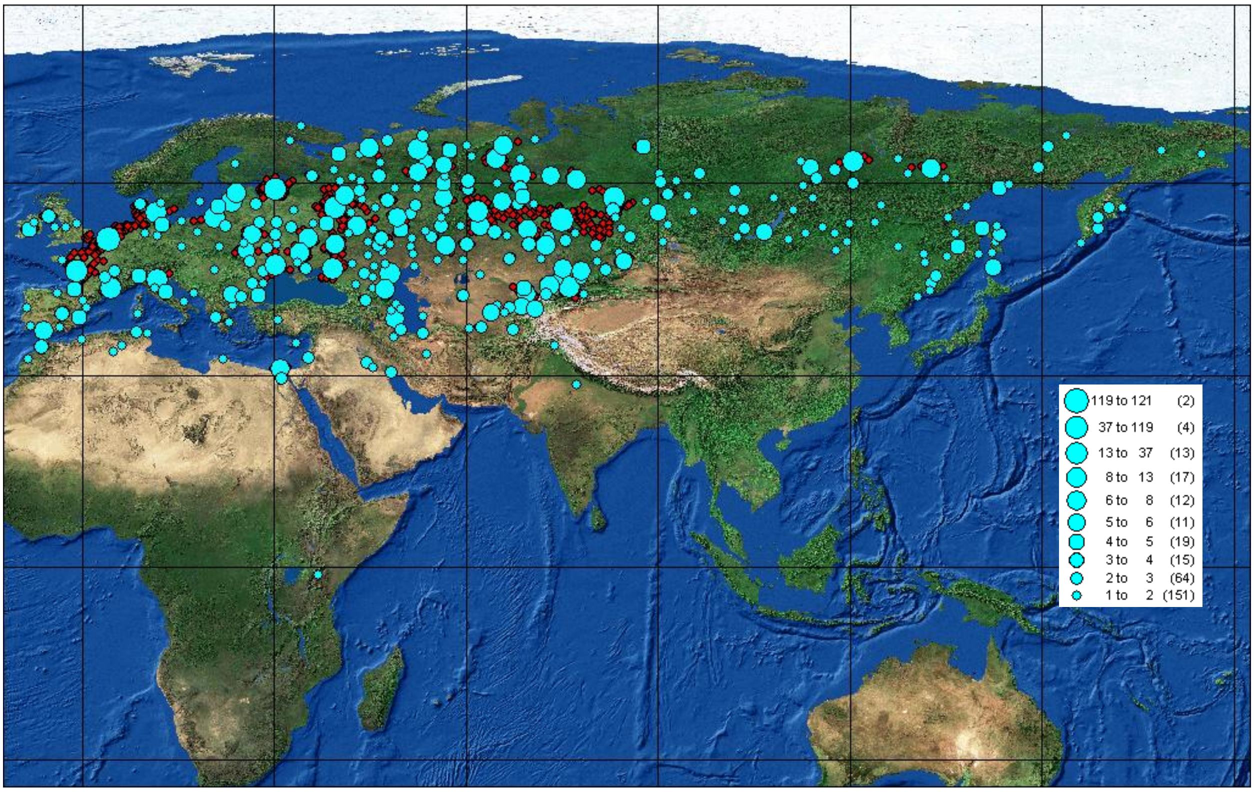

Figure 487. Shoveler groups of recoveries. Red dot – recoveries, blue-green circles of different size (see legend) are centers of the groups (clusters) with the distance not more than 100 km between recoveries.

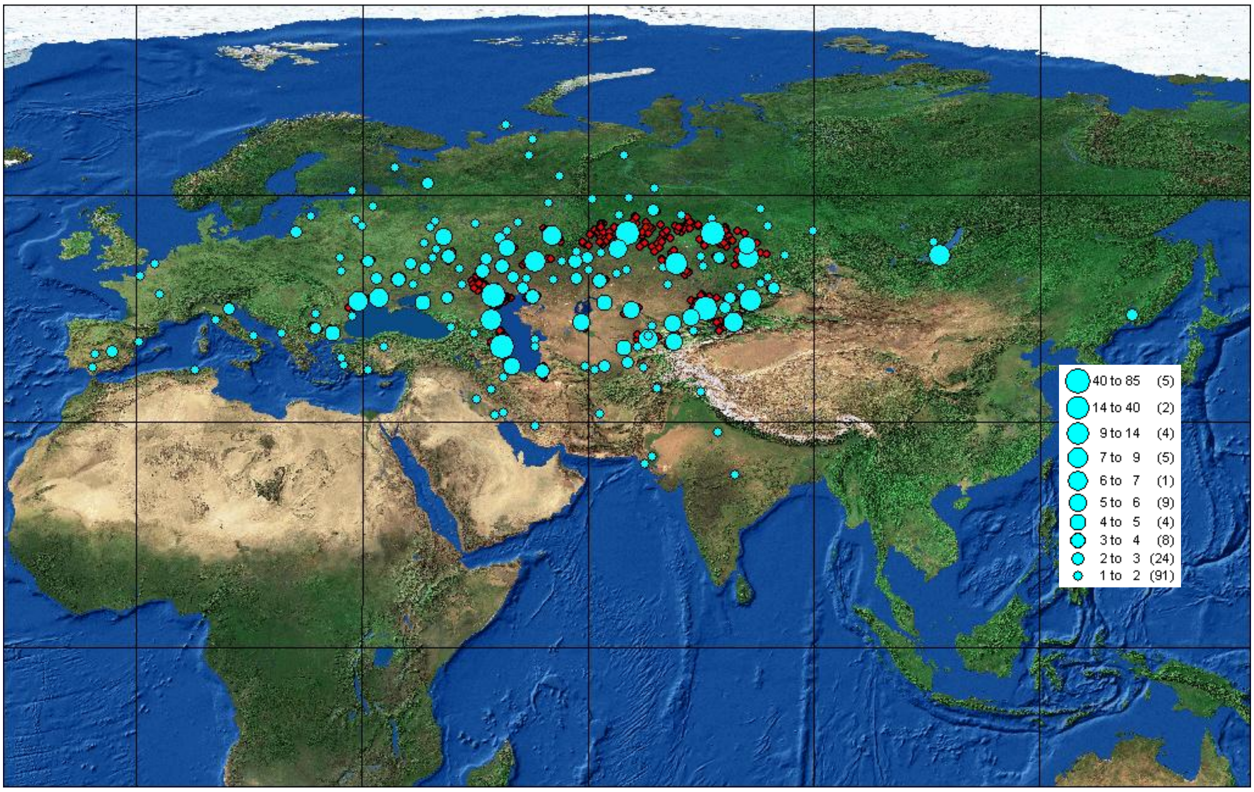

Figure 488. Gadwall groups of recoveries. Red dot – recoveries, blue-green circles of different size (see legend) are centers of the groups (clusters) with the distance not more than 100 km between recoveries.

Although in legends in Figures 482 through 488 the number of groups of different numbers of recoveries is enumerated, for more clear visualization it is useful to summarize all such data on one chart (Fig. 489). It is clear that such species as Common Teal, Mallard, Pintail and, in lesser extent, Wigeon, have small amount of groups with small number of recoveries. Garganey, Shoveler and Gadwall has relatively much smaller concentrations and single recovery groups (Fig 489).

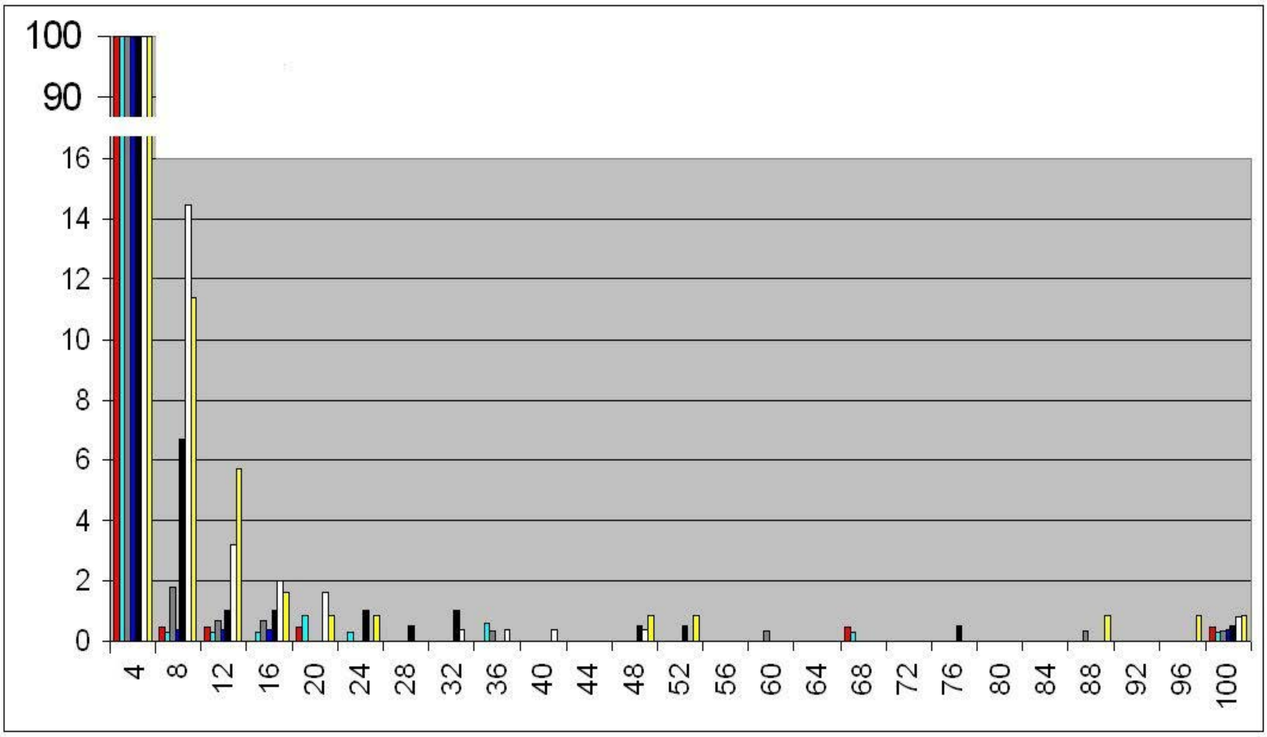

Figure 489. Relative number of groups of different size in dabbling duck species. X axis represents the percentage of a group size in relation to the biggest size group in each species. Y axis is the percent of groups of different relative size in comparison to the number of the smallest groups in a species, the number of smallest groups in each particular species is accepted as 100%. Red bars – Mallard, blue-green bars – Pintail, grey – Wigeon, blue – Common Teal, black – Garganey, white – Shoveller, yellow – Gadwall.

It is clear that aggregativeness and concentrativeness of recoveries are different characteristics of a species. For example, Pintail is the least aggregative duck among dabbling ducks, but it is the third score duck in the capacity to form recovery spatial concentrations. Gadwall is the most aggregative duck, but the second least one in the capacity of group formation. Aggregativeness shows how close recoveries are located in relation to each other. Consentrativeness shows what size of spatial groups of recoveries a species forms within the recovery area.

2. Diving Ducks

In these ducks the data sets for different species are very unequal. In three species – Tufted Duck, Common Pochard and Goldeneye – numbers of recoveries are not small. In other three species – Scaup, Red-crested Pochard and Ferruginous Duck numbers of recoveries are small – 99, 91 and 27 respectively. Nevertheless, even these amounts could produce results for illustration; therefore we decide not to remove them from the analysis, considering the results on the latter three species as the preliminary ones.

Ferruginous Duck seems to have the smallest relative nearest neighbour distance between recoveries among all six considered diving duck species (Table 25).

Table 25. Real and relative nearest neighbour distance between recoveries in the diving duck species.

SPECIES	MEAN NEAREST NEIGHBOUR DISTANCE±Standard Error (km)	NUMBER OF RECOVERIES	Relation (number of recoveries in the species/number of pintail recoveries)	Relative NND (km)

Common Pochard	23.89±1.18 (km)	2505	1.480639	16.13493
Tufted Duck	15.85±0.80 (km)	3709	1	15.85
Greater Scaup	128.46±15.99 (km)	99	37.46465	3.428833
Ferruginous Duck	105.49±25.77 (km)	27	137.3704	0.767924
Red-crested Pochard	131.61±29.62 (km)	91	40.75824	3.22904
Goldeney	43.98±3.23 (km)	594	6.244108	7.04344

In spite of little number of recoveries, recovery aggregations in Ferruginous Duck are visible on maps (Fig. 490). This species appeared to be the most aggregative among diving ducks; that is likely connected with its relatively small breeding range where the distribution of ducks progressively becomes patchier. Red-crested Pochard and Scaup are considerably less aggregative than Ferruginous Duck (Table 25), but their degrees of aggregation are quite high. It is less visible in the Scaup than in the Red-crested Pochard, probably because of greater species range with about the same number of recoveries as in the latter species. Common Pochard and Tufted Duck have the least tendency for aggregations. Goldeneye is moderate in it aggregation capacity, definitely form aggregations along big rivers and coasts (see also Part III). These regularities are quite visible if we plot recoveries of more than one species on the same maps (Figs 491–493).

Tendencies look more prominent if we remove the landscape from the map background (Fig. 495).

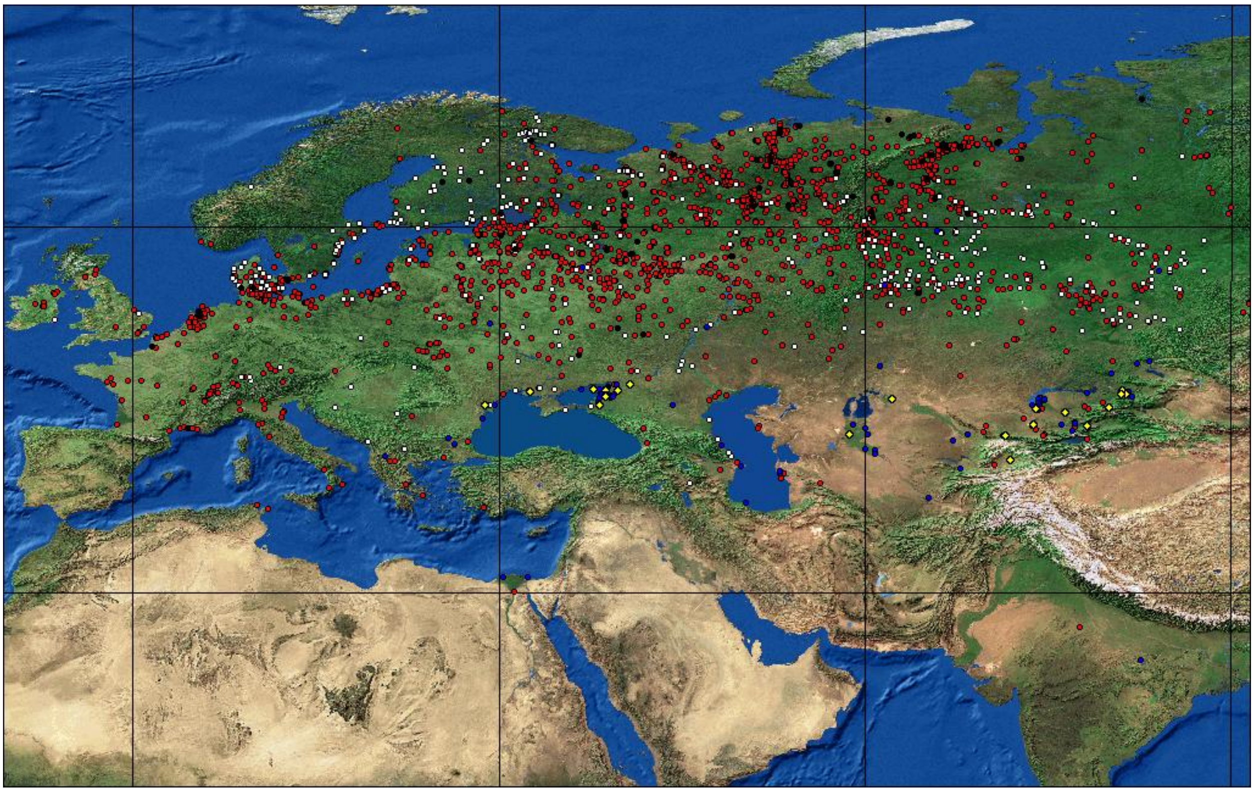

Figure 491. Ferruginous Duck (yellow dots), Red-crested Pochard (blue dots), Scaup (black dots) and Goldeneye (white dots) recoveries on the background of the Tufted Duck (red dots) recoveries.

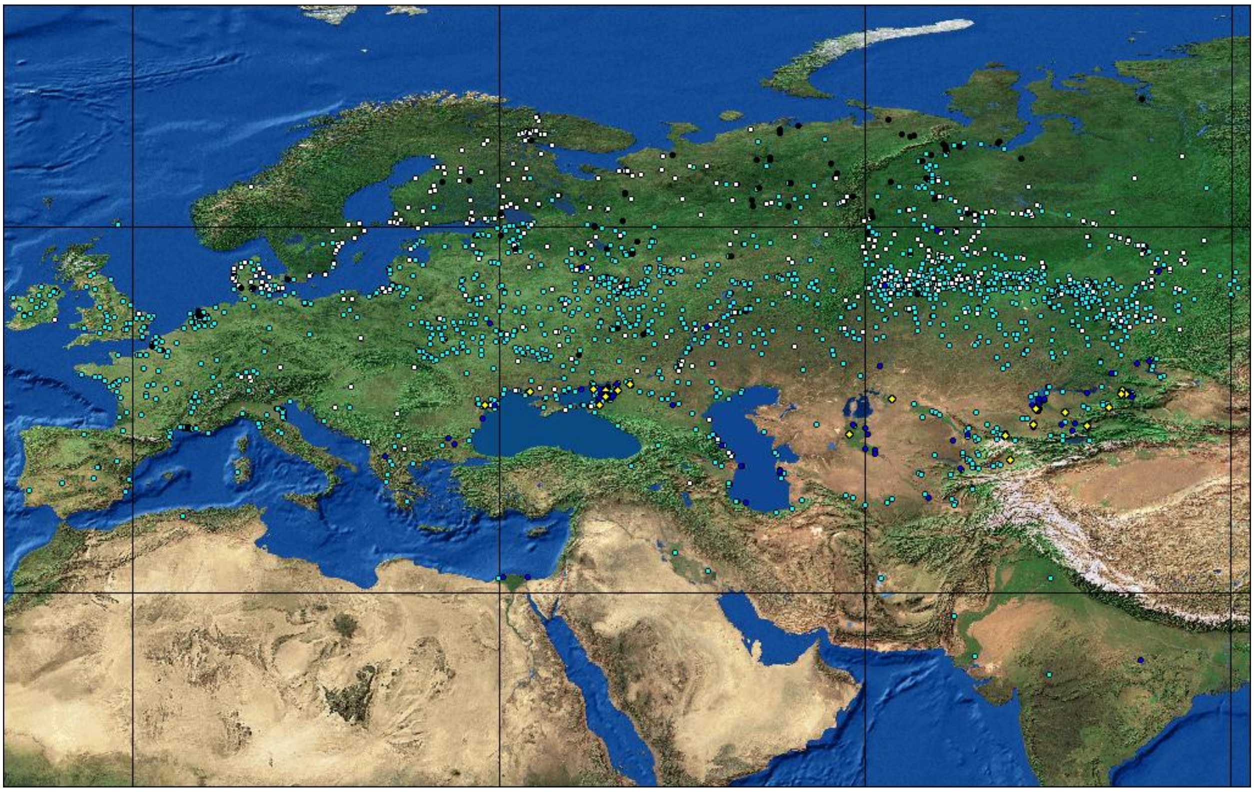

Figure 492. Ferruginous Duck (yellow dots), Red-crested Pochard (blue dots), Scaup (black dots) and Goldeneye (white dots) recoveries on the background of the Common Pochard (blue-green dots) recoveries.

Figure 493. Ferruginous Duck (yellow dots), Red-crested Pochard (purple dots), Scaup (black dots) recoveries.

In different geographic areas different diving duck species have different degree of aggregation. It could become greater or lesser than in other species (Table 26).

Table 26. Real and relative nearest neighbour distance between recoveries in the diving duck species in different geographic areas.

SPECIES	GEOGRAPHIC AREA	MEAN NEAREST NEIGHBOUR DISTANCE±Standard Error (km)	NUMBER OF RECOVERIES	Relation (number of recoveries in the species/number of pintail recoveries)	Relative NND (km)
Common Pochard	western and central Europe	38.03±3.52	273	1.172161	32.4452
Tufted Duck	western and central Europe	24.26±2.12	320	1	24.25677
Scaup	western and central Europe	155.24±79.20	10	32	4.85115
Goldeneye	western and central Europe	83.14±17.98	50	6.4	12.99115
Common Pochard	eastern Europe	27.33±1.47	866	2.542725	10.7482
Tufted Duck	eastern Europe	12.08±0.64	2202	1	12.08214
Scaup	eastern Europe	107.99±19.65	40	55.05	1.961726
Ferruginous Duck	eastern Europe	88.11±38.81	14	157.2857	0.560193
Red-crested Pochard	eastern Europe	104.58±28.26	47	46.85106	2.232088
Goldeneye	eastern Europe	52.80±5.24	266	8.278195	6.37793
Common Pochard	north of Western Siberia	19.90±6.14	100	7.19	2.767191
Tufted Duck	north of Western Siberia	6.88±0.77	719	1	6.878113
Scaup	north of Western Siberia	95.07±29.40	21	34.2381	2.776816
Goldeneye	north of Western Siberia	48.04±11.04	41	17.53659	2.739231
Common Pochard	northern Kazakhstan – south of Western Siberia	11.34±0.58	1180	0.278814	40.65564
Tufted Duck	northern Kazakhstan – south of Western Siberia	25.01±2.42	329	1	25.01124
Scaup	northern Kazakhstan – south of Western Siberia	370.00±231.74	2	164.5	2.249246
Ferruginous Duck	northern Kazakhstan – south of Western Siberia	124.21±34.29	13	25.30769	4.90797
Red-crested Pochard	northern Kazakhstan – south of Western Siberia	110.57+/-28.53	41	8.02439	13.77973
Goldeneye	northern Kazakhstan – south of Western Siberia	21.37+/-2.28	231	1.424242	15.00749
Common Pochard	Central Siberia – Chukotka	51.79+/-13.77	63	1.571429	32.95863
Tufted Duck	Central Siberia – Chukotka	67.80+/-11.68	99	1	67.79936

Scaup	Central Siberia – Chukotka	132.00+/-35.94	19	5.210526	25.33343
Goldeneye	Central Siberia – Chukotka	169.48+/-71.39	6	16.5	10.27163
Common Pochard	south of Far East	164.46+/-69.51	8	0.5	328.919
Tufted Duck	south of Far East	245.19+/-86.59	4	1	245.1935
Common Pochard	Kamchatka and Sakhalin	103.35+/-52.47	5	6.2	16.66974
Tufted Duck	Kamchatka and Sakhalin	36.98+/-17.95	31	1	36.97871
Scaup	Kamchatka and Sakhalin	228.69+/-64.15	7	4.428571	51.64016

In western and central Europe recoveries of two species (Ferruginous Duck and Red-crested Pochard) are absent. Scaup is the most aggregative species there; Common Pochard is the least aggregative. In this geographic area Goldeneye prefers to habituate sea coast mostly (see also chapter III). In eastern Europe Tufted Ducks have lesser tendency to form aggregations than Common Pochards (not like in the western and central Europe); Scaup is even more aggregative than Red-crested Pochard. Goldeneye in the eastern Europe and Western Siberia have a tendency to aggregate more inland than in western and central Europe (Fig. 494), which is understandable, since western and central Europe are mostly wintering areas for Russia breeding Goldeneyes. In northern half of Western Siberia Common Pochard is considerably greater aggregative than Tufted Ducks. Three species – Common Pochard, Scaup and Goldeneye display practically the same degree of aggregation (Table 26). Although Goldeneye recoveries are mostly stretched along big rivers (e.g., Ob River), Common Pochard recoveries are mostly in the lake area at the boundary between Russia and northern Kazakhstan (see also chapter III). In the southern part of the Western Siberia and northern Kazakhstan Common Pochard appear to be the least aggregative species, Tufted Duck is the second least one (Table 26). In areas east of Western Siberia recoveries from four species (Common Pochard, Tufted Duck, Scaup and Goldeneye) are located. Goldeneye appear to be the most aggregative among them, even exceeding the degree of aggregation of the Scaup. Much other useful information might be taken from the quantities represented in Tables 25 and 26 and maps with the relative distribution of diving duck species recoveries (Figs 494–496).

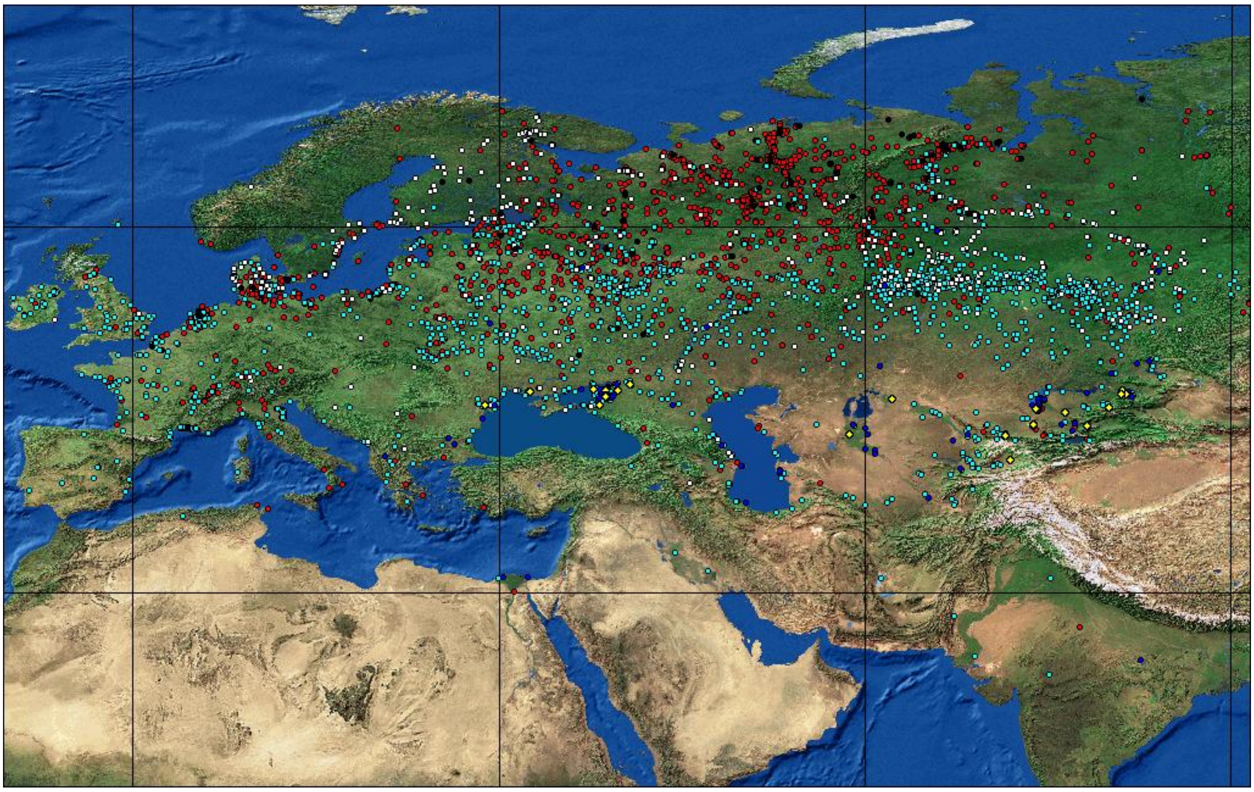

Figure 494. All diving duck species recoveries in areas: western and central Europe, eastern Europe, north of western Siberia and south of Western Siberia – northern Kazakhstan. From background to foreground: Tufted Duck (red dots), Common Pochard (blue-green dots), Red-crested Pochard (blue dots), Goldeneye (white dots), Scaup (black dots), Ferruginous Duck (yellow dots).

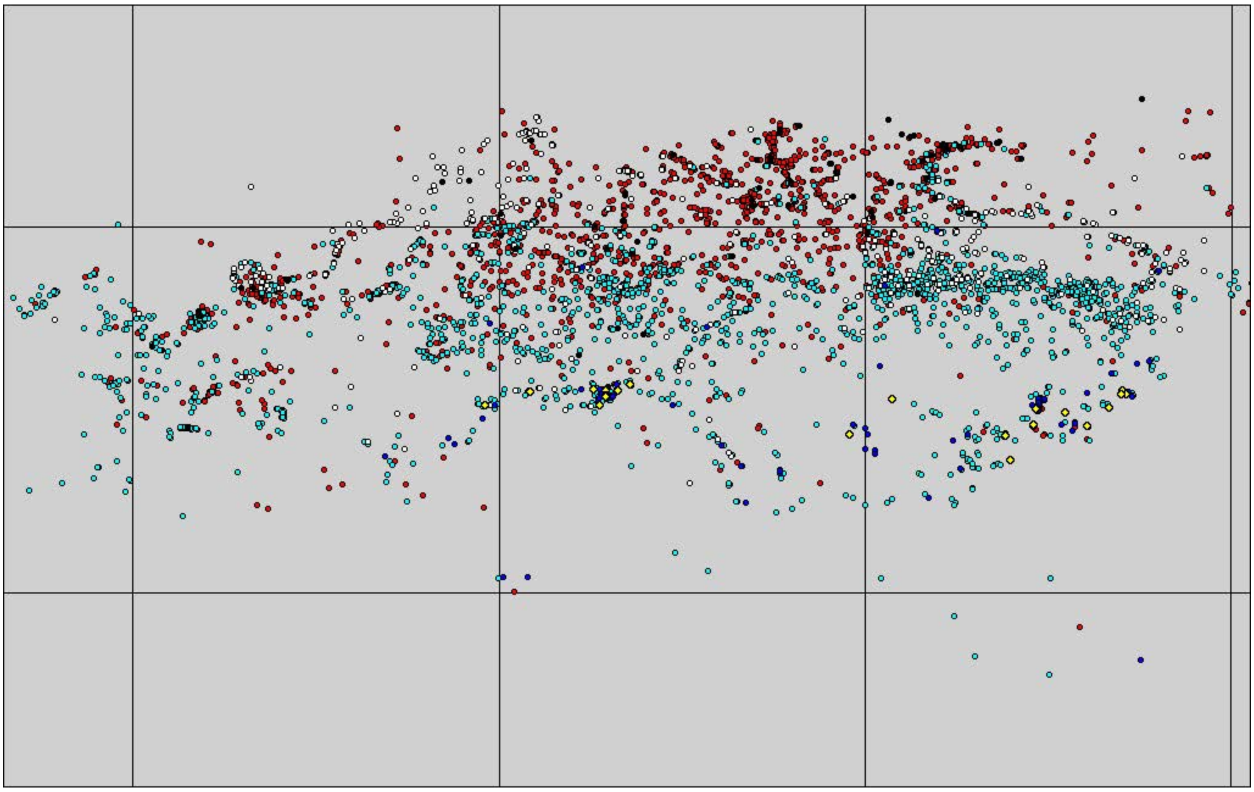

Figure 495. All diving duck species recoveries in areas: western and central Europe, eastern Europe, north of Western Siberia and south of Western Siberia – northern Kazakhstan

without landscape background. Species from background to foreground: Tufted Duck (red dots), Common Pochard (blue-green dots), Red-crested Pochard (blue dots), Goldeneye (white dots), Scaup (black dots), Ferruginous Duck (yellow dots).

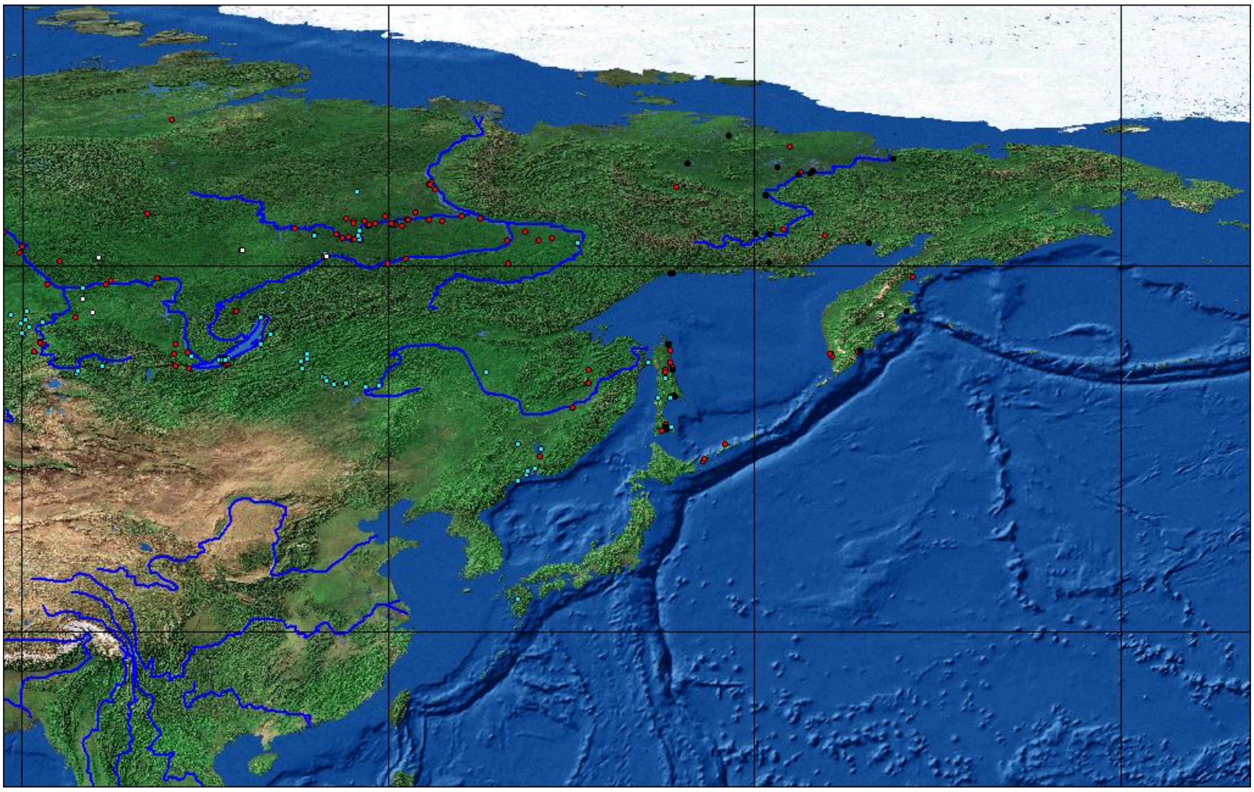

Figure 496.All diving duck species recoveries in areas: central Siberia through Chukotka, south Far East, Kamchatka and Sakhalin. From background to foreground: Tufted Duck (red dots), Common Pochard (blue-green dots) and Scaup (black dots).

It looks like in the overview of degree of recovery concentration in diving ducks only three species – Common Pochard, Tufted Duck and Godeneye – can be used. This is because other three ones have very little number of recoveries and therefore cannot form large groups of recoveries even if the species themselves are capable to perform that. Positions of groups (clusters) of recoveries with different number shows that the Tufted duck is the most concentrative across the three mentioned above species. In this species two biggest clusters contain 1789 and 794 recoveries. In total it exceeds more that 60% of the whole number of the species recoveries. Then goes Common Pochard, in which two biggest clusters comprise less than 50% of recoveries. Differences in the concentrativeness of these two species are well visible from Fig 497 and Fig 498 Tufted Duck contains considerably less clusters with low relative numbers of recoveries. The Goldeneye is the least concentrative species: 33% of recoveries are in two biggest clusters. This is also visible in the Fig. 499.

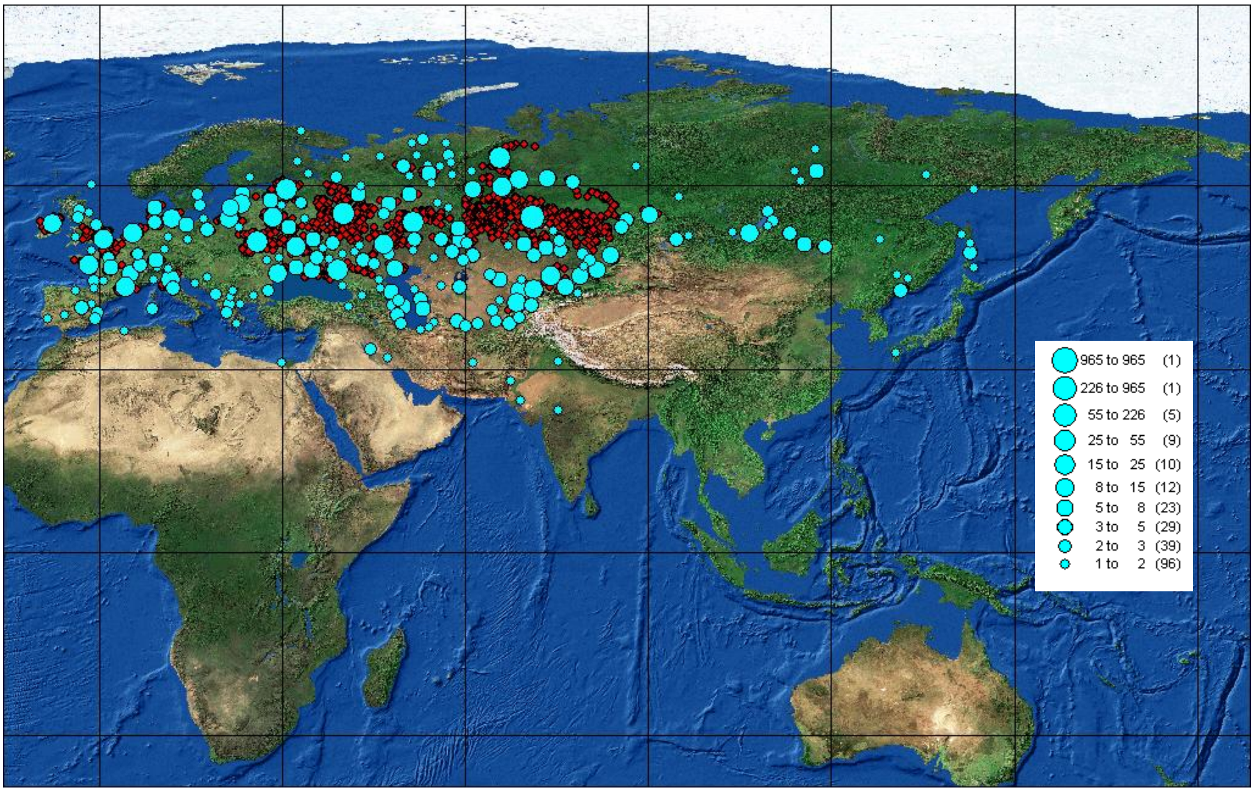

Figure 497. Common Pochard groups of recoveries. Red dot – recoveries, blue-green circles of different size (see legend) are centers of the groups (clusters) with the distance not more than 100 km between recoveries.

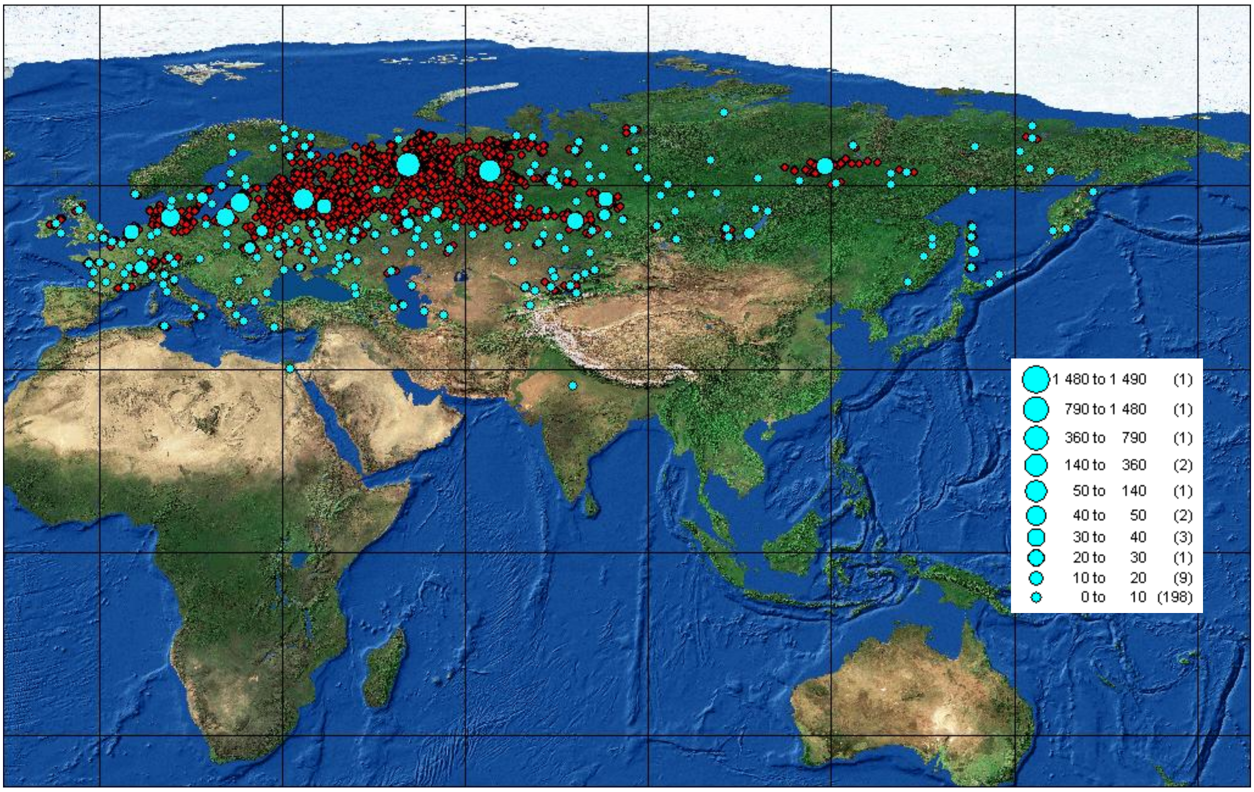

Figure 498. Tufted Duck groups of recoveries. Red dot – recoveries, blue-green circles of different size (see legend) are centers of the groups (clusters) with the distance not more than 100 km between recoveries.

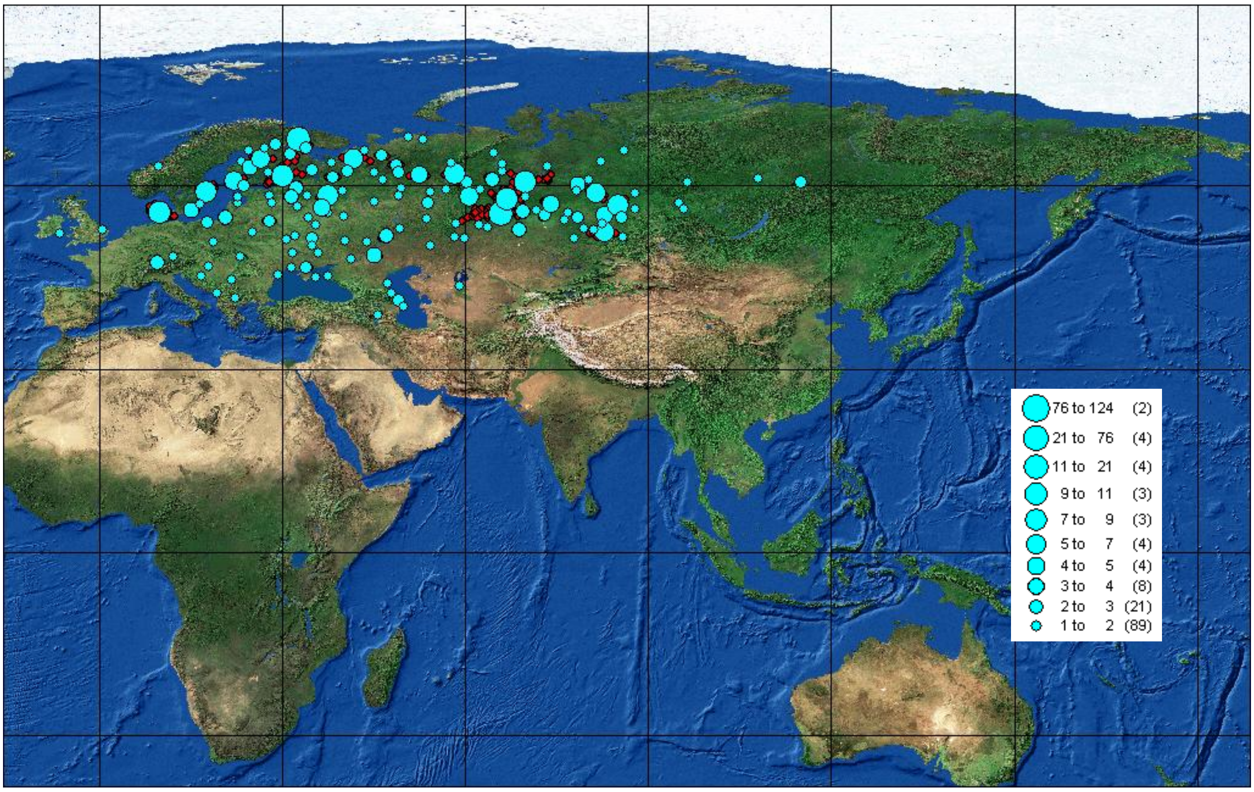

Figure 499. Goldeneye groups of recoveries. Red dot – recoveries, blue-green circles of different size (see legend) are centers of the groups (clusters) with the distance not more than 100 km between recoveries.

Although in legends in Figures 497 through 499 the number of groups of different numbers is enumerated, for the more clear visualization it is useful to summarize all such data on one chart (Fig. 500). From this picture it is clear that Tufted Duck has small amount of groups with small number of recoveries, Common Pochard has relatively greater amount of such groups, Goldeneye has the highest relative number of smaller concentrations and single recovery groups (Fig 500).

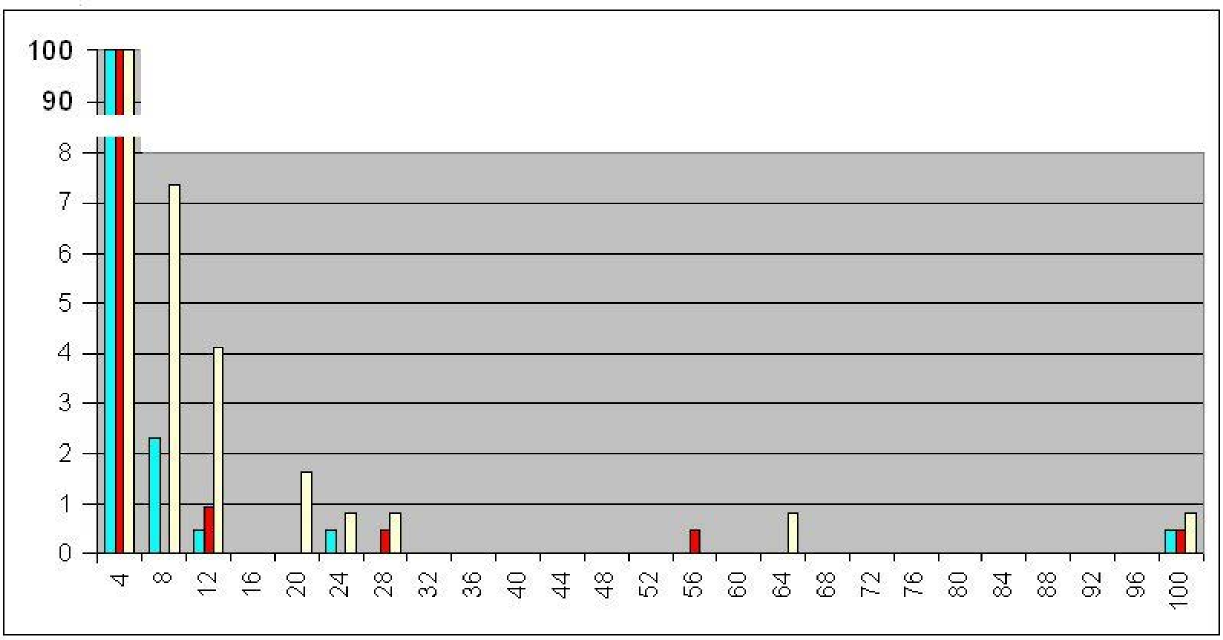

Figure 500. Relative number of recovery groups with different size in three diving duck species. X axis represents the percentage of a group size in relation to the biggest size group in each species. Y axis is the percent of groups of different relative size in comparison to the number of the smallest group in a species, the number of the smallest group in each particular species is accepted as 100%. Blur-green bars – Common Pochard, red bars – Tufted Duck, white – Goldeneye.

In diving ducks, the same as in dabbling ducks, it is clear that aggregativeness and concentrativeness of recoveries are different characteristics of a species. Common Pochard and Tufted Duck are the least aggregative species; however they are the most concentrative species. We would like to stress one more time, that aggregativeness shows how close recoveries are to each other. Consentrativeness shows what size of spatial groups of recoveries the species forms within the recovery area.

PART III. DISTRIBUTION OF RECOVERIES IN RELATION TO ECOLOGICAL FEATURES OF THE AREAS

Since ducks are waterfowl, they closely related to water. Data allow figuring out in some extent how do they relate to water during migration, winter and summer stay. To figure this out, we need to compare some ecological characteristics of duck recoveries in different geographical areas. Two ecological characteristics were selected as obviously can be obtained from the recovery distribution: 1) distance from a recovery to the nearest river or lake, the latter should be not so big; 2) distance from a recovery to the nearest sea coast or shore of a big lake. As "big lakes" we consider several very big lakes, which commonly accepted as seas or sea-sized water bodies: Caspian and Aral Seas, Ladoga, Onega, Baikal and Balkhash Lakes. If the distance from a recovery to the nearest river or lake is relatively large, this means that a duck has been recovered at some small water body like pond, very small lake, swamp, forest bog, etc., i.e., in some not deep water wetland. If such distance is small, that might mean that recovery obtained on or near relatively deep water areas. These areas might be considered as "waterland", which are relatively more water-filled than "wetland". The same is when we consider the closeness to the sea shore or to the shore of the commonly accepted as seas or sea-sized enumerated water bodies. Since the finding coordinates of each particular recovery in many cases are not accurate (see "Materials and Methods"), we cannot characterize ecology of each particular recovery because recovery coordinate definition is biased. For the reason of this bias it is no sense to discuss the absolute meaning of the mentioned ecological distances. On the other hand, as it was stressed before, this bias is applicable for all species we deal with. For this reason we can compare averaged distances across different species, revealing in what species positions of recoveries are closer or farther to the different kind of water bodies without paying special attention to the obtained value of these distances. If we consider the average distances for the large geographic areas, we might be able to evaluate some ecological features of duck species in the particular areas.

The procedure of obtaining such distances was the following. On the geographic map with recoveries the nearest points on the rivers and shores to each recovery were manually posed. Then coordinates of all those artificially produced points were scanned. After that computer programme found the nearest point on river or shore to each recovery. Two distances were obtained for each recovery: one to the nearest river, the other one to the nearest shore (Fig. 501). For further calculations only shorter distance of the two ones was chosen. This is because many recoveries are located very close to the river, but several hundred km from the nearest shore, e.g., recoveries located deeply inland. For such recovery the distance to the nearest shore ecologically does not have sense. Therefore, for such recovery only distance to the nearest river was chosen for further calculations, distance to the shore was omitted. The same is for the shore-close recoveries. If the distance from a recovery to the nearest shore was shorter than one to the nearest river, the distance to the shore was chosen, distance to the river was omitted. Later on data separated by species and different geographical areas, averaged through the standard process for this operation and compared between each other and to the data from duck aggregation characteristics (PART II). The same as in Part II, the analysis was performed for two duck categories: dabbling and diving ducks.

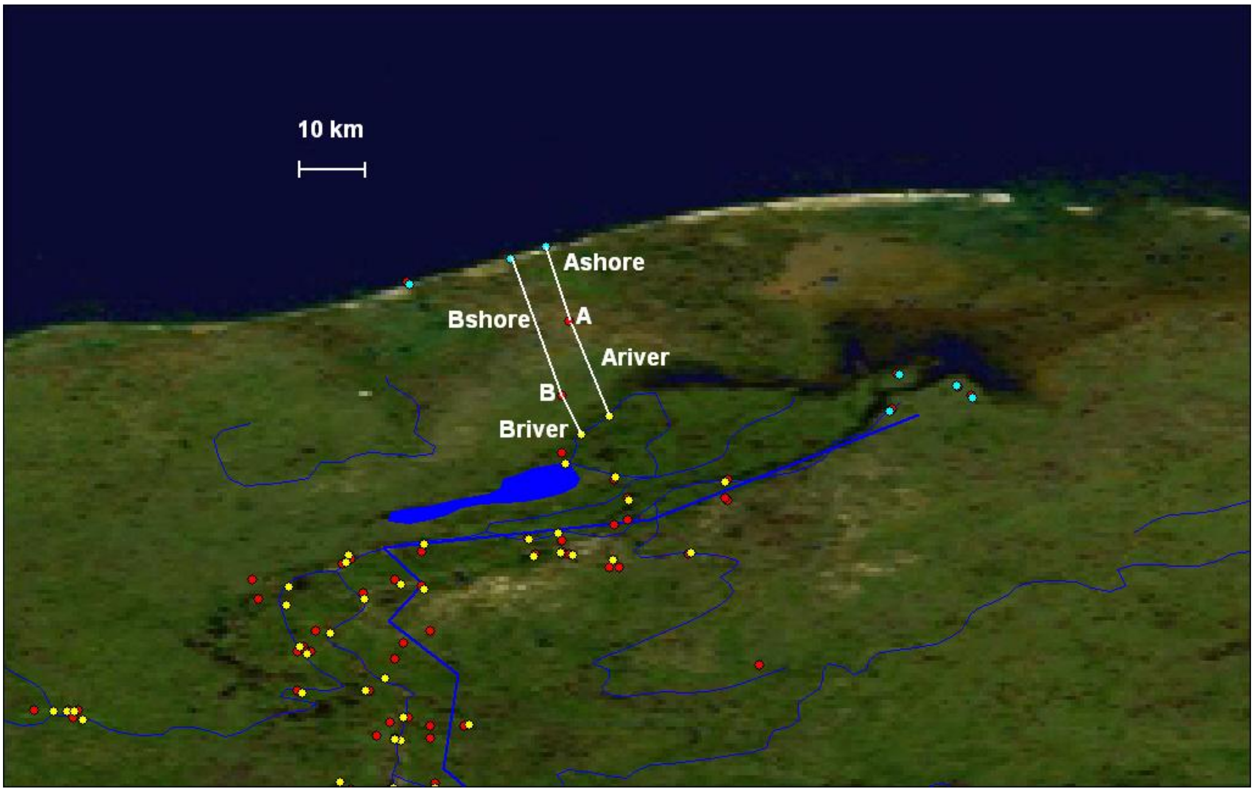

Figure 501. Method of obtaining distances from a recovery to the nearest shore or nearest river. Red dots represent recovery positions, blue-green dots are manually pointed positions to the nearest shore from recoveries, and yellow dots are manually pointed positions to the nearest river from recoveries. From “A” recovery two distances were produced: Ashore – distance to the nearest shore, and Ariver – to the nearest river. Ashore is lesser than Ariver, therefore for the “A” recovery Ashore will be chosen for further (average distance) calculations. For the “B” recovery Briver is shorter than Bshore – therefore for the “B” recovery only Briver will be chosen.

For this section we used data from the Bird Ringing center of Russia database collected by the end of 2013. Nevertheless, these results are true since the most waterfowl recoveries we received by the end of this calendar year.

1. Dabbling ducks.

Dabbling duck species recoveries in different geographical areas display different distribution according to the ecological conditions of the areas (Table 27).

Table 27. Distances to the nearest river or lake and distances to the nearest sea shore or shore of a big lake in dabbling ducks.

Species	Geographic Area	Distance to the nearest river or lake±standard error (km)	Number of recoveries	Distance to the nearest sea or big lake shore±standard error (km)	Number of recoveries
Mallard	western and central Europe	3.995±0.382	316	4.466±0.445	156
Pintail	western and central Europe	4.581±0.652	118	11.326±2.575	113
Wigen	western and central Europe	6.321±1.014	60	21.886±7.502	82
Common Teal	western and	9.320±1.226	147	10.274±3.816	85

	central Europe				
Garganey	western and central Europe	3.610±0.498	99	7.120±2.479	56
Gadwall	western and central Europe	7.275±2.761	10	5.393±2.318	4
Shoveler	western and central Europe	8.268±1.170	184	4.832±0.588	107
Mallard	eastern Europe	6.323±0.124	5004	6.124±0.425	656
Pintail	eastern Europe	6.705±0.215	2435	6.414±0.714	386
Wigeon	eastern Europe	6.658±0.242	1413	5.133±1.239	98
Common Teal	eastern Europe	6.029±0.132	3738	4.914±0.344	464
Garganey	eastern Europe	7.304±0.389	840	6.673±1.043	62
Gadwall	eastern Europe	6.881±0.803	233	5.572±1.802	50
Shoveler	eastern Europe	6.401±0.490	417	6.676±1.544	62
Mallard	north of Western Siberia	4.470±1.071	47		0
Pintail	north of Western Siberia	4.136±0.166	673	0.000	1
Wigen	north of Western Siberia	4.735±0.233	718		0
Common Teal	north of Western Siberia	5.168±0.448	156	0.679	1
Garganey	north of Western Siberia	4.263±0.617	38		0
Gadwall	north of Western Siberia	6.853±2.578	2		0
Shoveler	north of Western Siberia	3.754±0.517	58		0
Mallard	northern Kazakhstan – south of Western Siberia	12.970±1.268	454	2.262	1
Pintail	northern Kazakhstan – south of Western Siberia	15.884±0.646	1245	10.446±4.684	15
Wigen	northern Kazakhstan – south of Western Siberia	13.672±1.462	401	2.025±1.214	4
Common Teal	northern Kazakhstan – south of Western Siberia	16.973±1.813	383	22.935±16.167	7
Garganey	northern Kazakhstan – south of Western Siberia	13.454±0.953	349	2.058±0.206	2
Gadwall	northern Kazakhstan – south of Western Siberia	14.300±1.265	314	2.218±0.457	21
Shoveler	northern Kazakhstan – south of Western Siberia	16.106±1.510	331	3.884±0.810	12
Mallard	central Siberia – Chukotka	5.626±0.651	128	1.961±1.053	6
Pintail	central Siberia – Chukotka	6.388±0.289	722	4.391±0.389	257
Wigen	central Siberia – Chukotka	7.881±0.590	222	3.049±0.923	15

Common Teal	central Siberia – Chukotka	9.262+1.377	73	2.339+0.704	7
Garganey	central Siberia – Chukotka	7.691+1.325	20	0.000	1
Gadwall	central Siberia – Chukotka	5.355+0.841	11	0.000	1
Shoveler	central Siberia – Chukotka	7.500+0.949	83	13.753+8.407	9
Mallard	south of Far East	9.416+1.077	175	25.920+5.991	15
Pintail	south of Far East	8.482+1.112	107	107.510+85.557	46
Wigen	south of Far East	9.330+3.538	9	3.527+2.655	3
Common Teal	south of Far East	7.416+2.309	8	8.714+3.570	6
Garganey	south of Far East	7.023+4.817	2		0
Gadwall	south of Far East	12.399+4.537	2		0
Shoveler	south of Far East	5.403+1.577	15	20.433+6.103	7
Mallard	Kamchatka and Sakhalin	12.916+4.287	6	31.778+17.798	22
Pintail	Kamchatka and Sakhalin	40.141+4.762	154	21.086+1.600	823
Wigen	Kamchatka and Sakhalin	34.324+12.935	20	21.721+5.012	120
Common Teal	Kamchatka and Sakhalin	23.665+16.899	7	30.492+5.897	54
Shoveler	Kamchatka and Sakhalin	3.965	1	30.082+11.196	18

Mallards ringed or recovered in Russia, in western and central Europe are more attached to the deep water than in eastern Europe. This is clear from the greater distance of Mallard recoveries to the nearest river or small lake in the eastern Europe (Table 27). This means that in the eastern Europe Mallards spend more time in less moist areas than in western and central Europe. The same tendency concerns not only rivers but sea or big lake shores, as well (Table 27). In the northern part of Western Siberia Mallards have greater tendency to concentrate in deep water than in eastern Europe, this tendency is well visible on the map (Fig. 502). In south part of the Western Siberia and northern Kazakhstan Mallard recoveries are at much greater distance from the deep waters than in the north of the Western Siberia (Table 27, Fig. 502). This might be explained by the greater amount of open areas with huge number of very small shallow water bodies to the south of north of Western Siberia. In Central Siberia through Chukotka Mallard recoveries again display the greater attachment to deep water, the same as in eastern Europe and northern part of Western Siberia (Table 27, Fig. 503). At the south Far East, Sakhalin and Kamchatka Mallard recoveries are getting away from the deep water again, in Sakhalin and Kamchatka even in greater extent than in the south parts of Western Siberia and northern Kazakhstan (Table 27, Figs. 502 and 503).

Figure 502. Mallard recoveries in eastern Europe, north of Western Siberia area and south Western Siberia–northern Kazakhstan area. Red dots are recoveries.

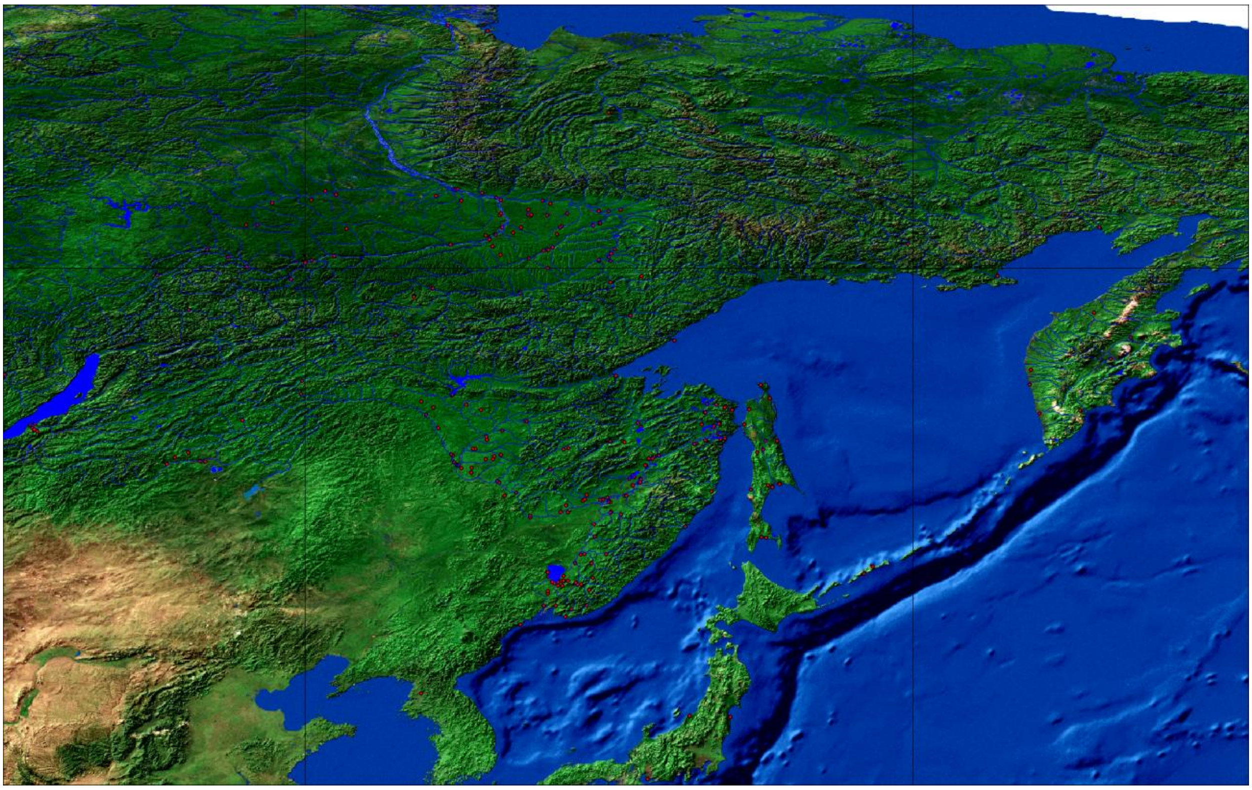

Figure 503. Mallard recoveries in Central Siberia through Chukotka, south Far East, Sakhalin and Kamchatka areas. Red dots are recoveries.

Pintails that ringed or recovered in Russia, in western and central Europe, in distinction to Mallards in this area, are more attached to rivers than to the sea shore. Pintail recoveries in western and central Europe are more attached to the deep water than in the eastern Europe, but less attached to the sea shores (Table 27). In the eastern Europe Pintails are recovered in the areas with the similar water ecological characteristics as in Mallards. This is true both for riverside and coastal areas (Fig. 504). In the rest of areas Pintail recoveries follow generally the same tendencies as Mallard recoveries, but in the south of Far East the Pintail appears much more inland duck than Mallard, at Kamchatka and Sakhalin – more coastal (Table 27, Fig. 505).

Figure 504. Pintail recoveries in eastern Europe, north of Western Siberia area and south of the Western Siberia–northern Kazakhstan area. Red dots are recoveries.

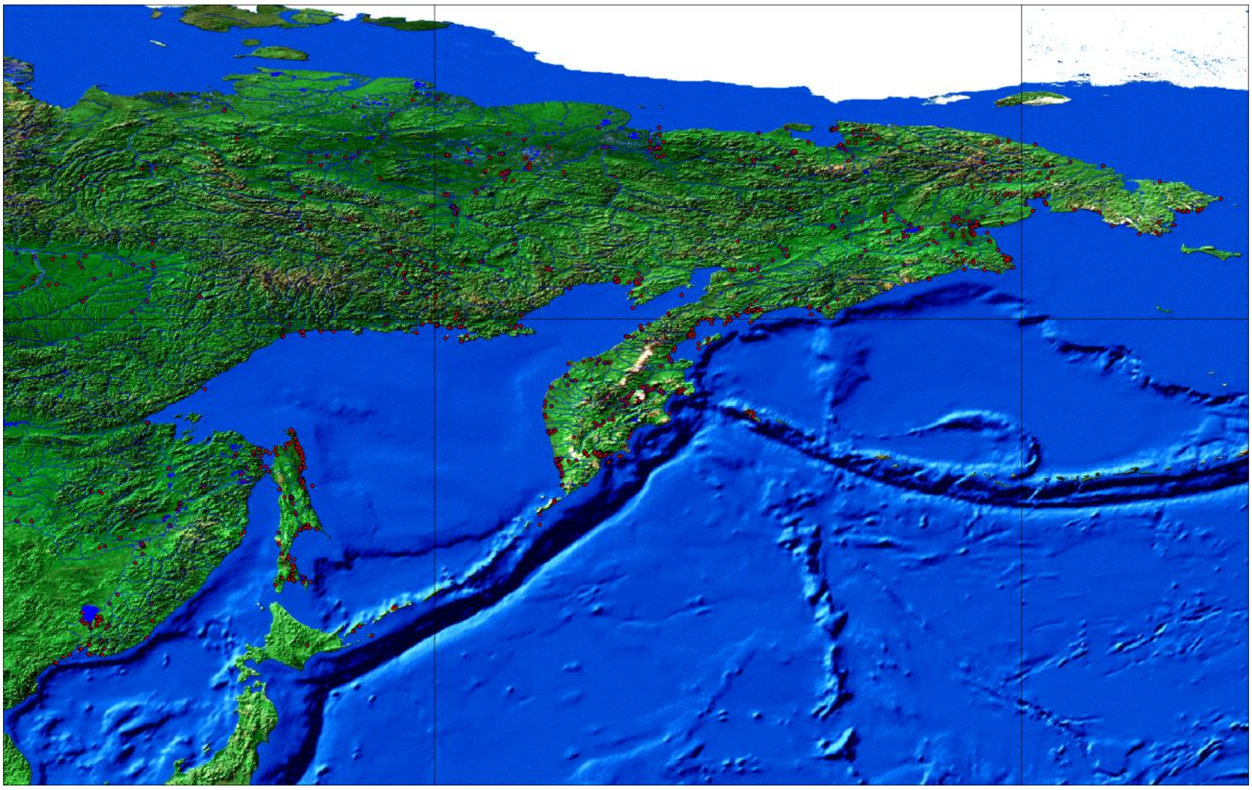

Figure 505. Pintail recoveries in Central Siberia through Chukotka, south Far East, Sakhalin and Kamchatka areas. Red dots are recoveries.

Wigeons in western and central Europe are less attached to rivers and coastal areas than Mallards and Pintails, but in eastern Europe Wigeon ecological features that related to wetlands, are about the same as in the two former species (Table 27, Fig. 506), however Wigeon creates lesser concentrations (see Part II). The same is for Western Siberia and northern Kazakhstan, Central Siberia through Chukotka (Table 27, Figs 506 and 507). In the south Far East Wigeon recoveries appear much more attached to the coast than Mallard and Pintail. This is clear in spite of Wigeon small data set for the south Far East (Table 27).

Figure 506. Wigeon recoveries in eastern Europe, north western Siberia area and south of Western Siberia–northern Kazakhstan area. Red dots are recoveries.

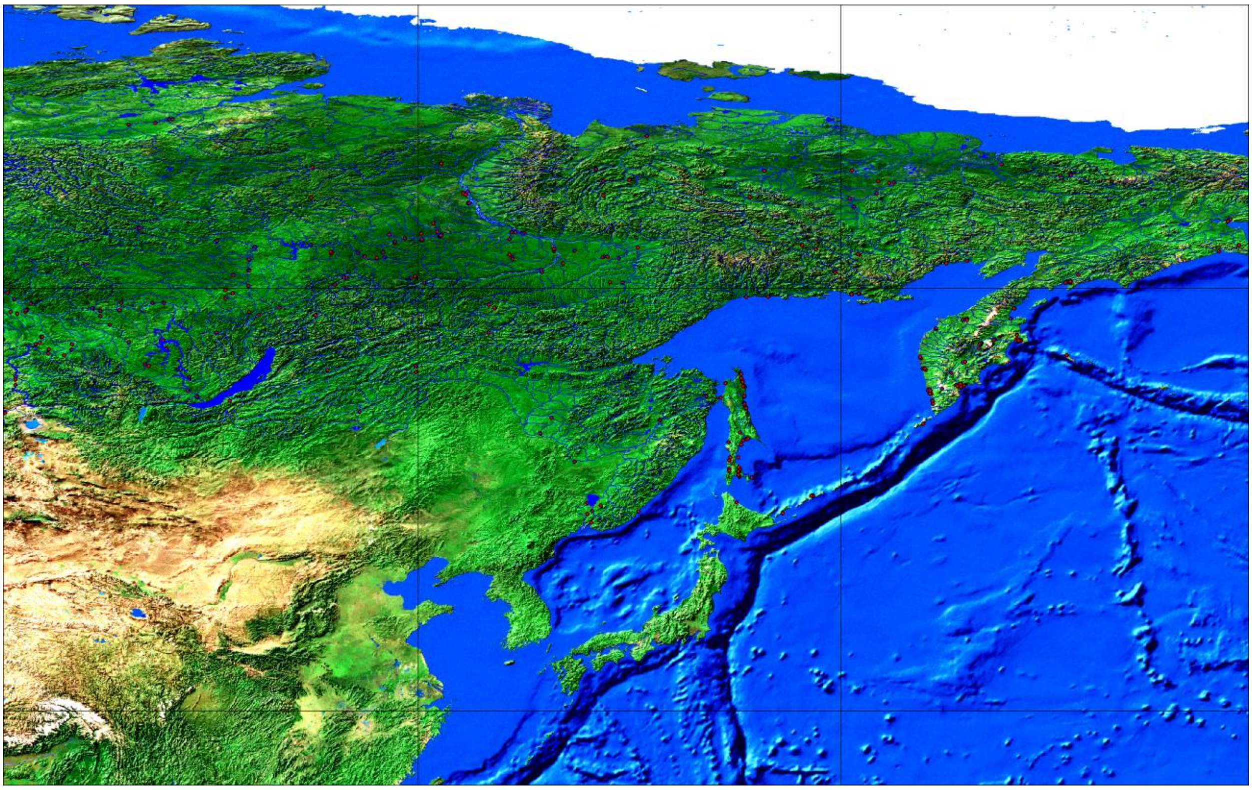

Figure 507. Wigeon recoveries in Central Siberia through Chukotka, south Far East, Sakhalin and Kamchatka areas. Red dots are recoveries.

Common Teal inland recoveries in the western and central Europe located in greater distance from rivers than Mallard, Pintail and Wigeon. There recoveries in the coastal areas are attached to sea shores in about the same extent than in Pintails (Table 27). In eastern Europe recoveries that related to shores of seas or big lakes locate in lesser distance from deep water than in Mallards, Pintails and Wigeons (Table 27, Fig. 508). In the north of Western Siberia Teal stay more away from rivers than the three mentioned duck species, the same in the Central Siberia through Chukotka (Table 27, Fig 508 and 509). In the southern part of Western Siberia and north Kazakhstan Common Teal ecologically behave in the same way as the former three dabbling duck species. South Far East Common Teal recoveries, vise versa, are more attached to rivers than Mallards, Pintails and Wigeons. At Kamchatka and Sakhalin Common Teal recoveries locate quite far away both from rivers and shore; therefore in these areas Teal prefer small shallow water bodies.

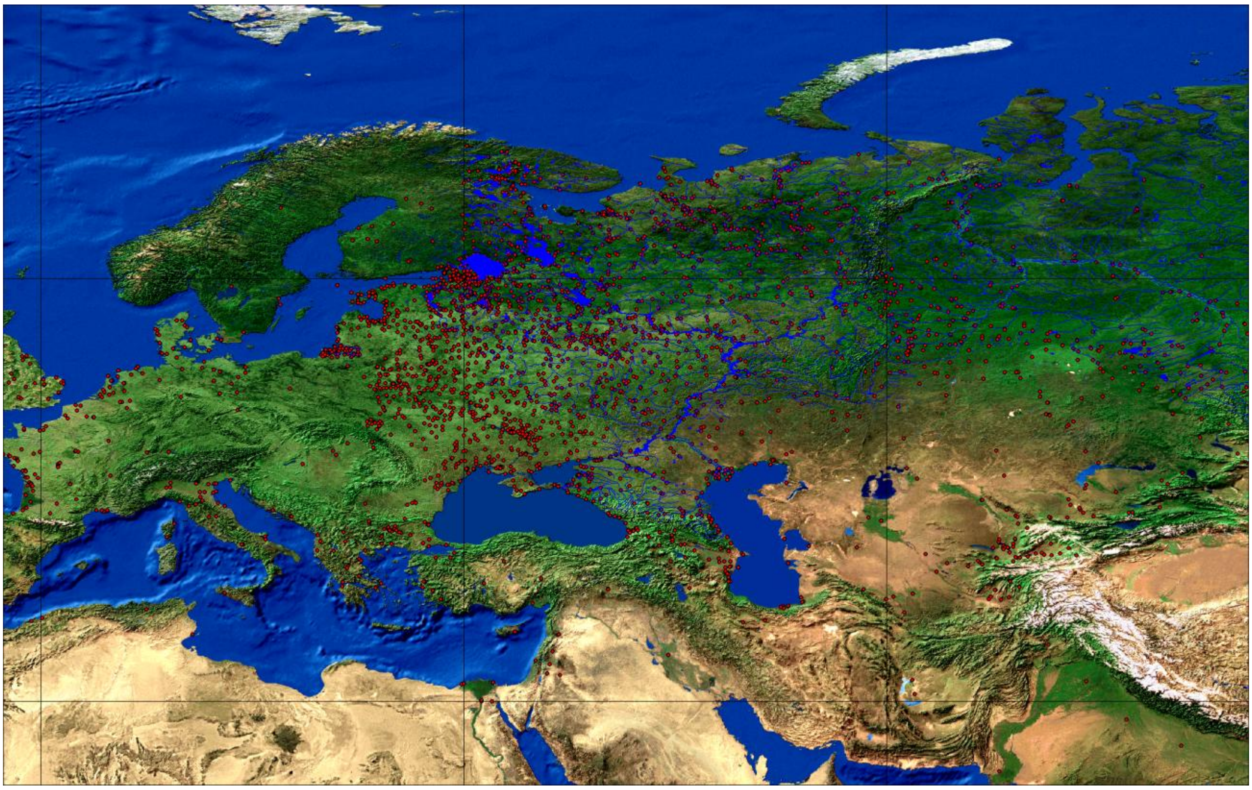

Figure 508. Common Teal recoveries in western and central Europe, eastern Europe, north of Western Siberia area and south of Western Siberia–northern Kazakhstan area. Red dots are recoveries.

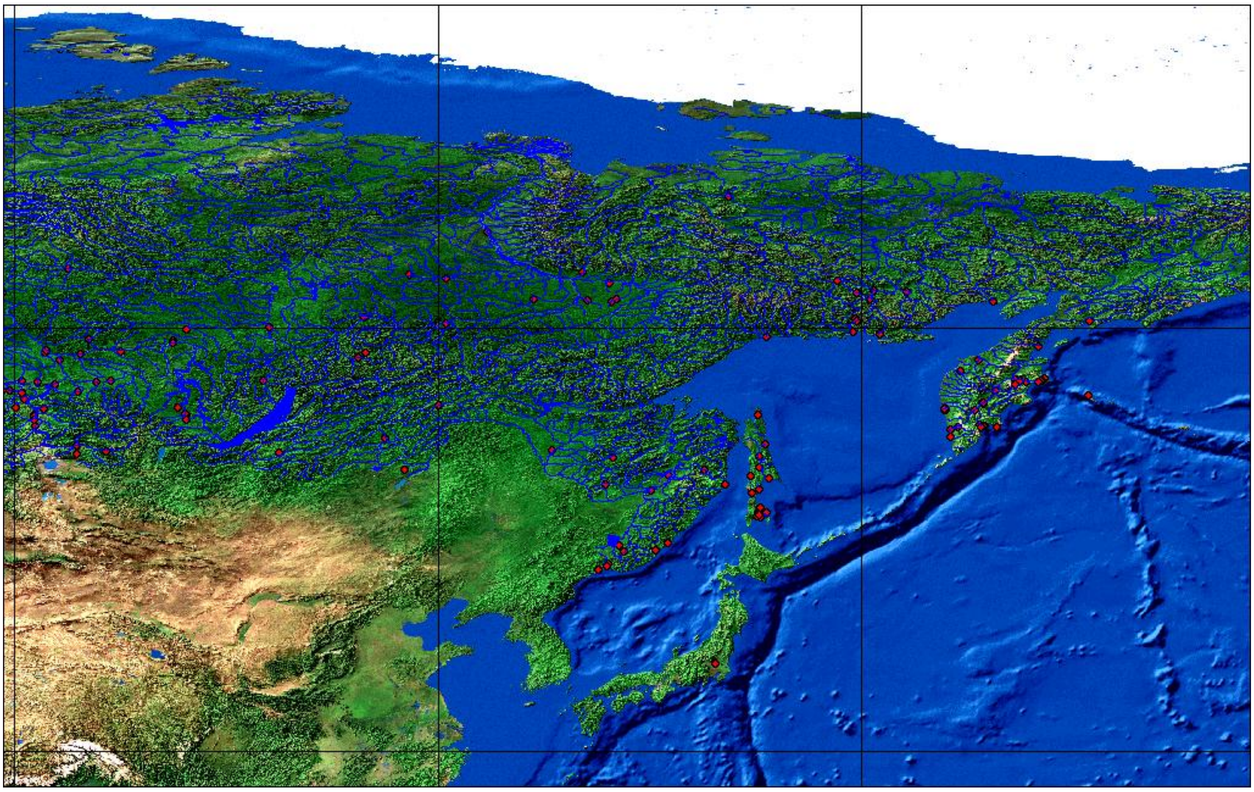

Figure 509. Common Teal recoveries in Central Siberia through Chukotka, south Far East, Sakhalin and Kamchatka areas. Red dots are recoveries.

In western and central Europe where Garganeys from Russia spend winter, this species is the most attached to rivers than all other dabbling duck species (Table 27), whereas in eastern Europe this species is the least attached to the water lands, in the most extent it prefers small shallow water bodies (Table 27, Fig 510). In Western Siberia and northern Kazakhstan Garganey ecologically behave similarly to other dabbling duck species. In areas east of Western Siberia Garganey recoveries are not so numerous than in western and central Europe, eastern Europe and Western Siberia. Data sets for these areas are small or absent.

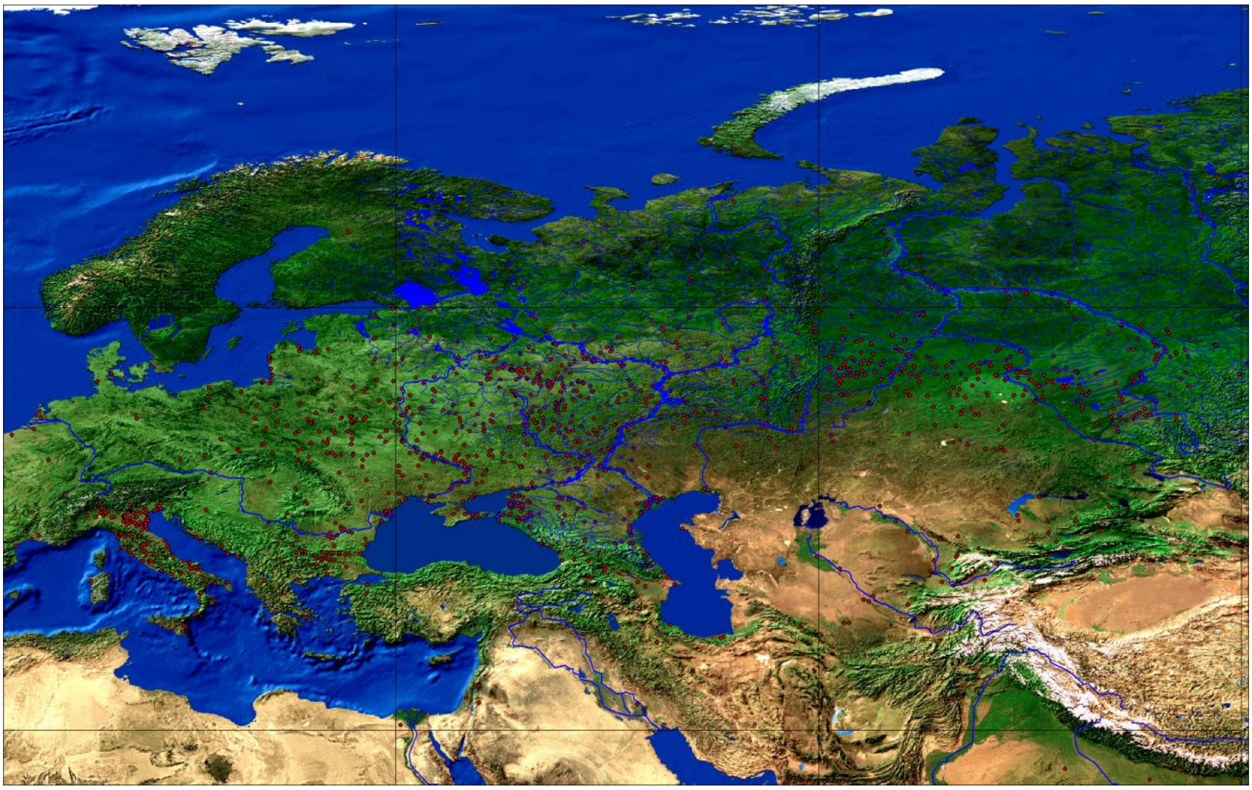

Figure 510. Garganey recoveries in western and central Europe, eastern Europe, north of Western Siberia area and south of Western Siberia–northern Kazakhstan area. Red dots are recoveries.

Gadwall recoveries in western and central Europe are scarce. In eastern Europe, Ukraine, Byelorussia and south of Western Siberia and northern Kazakhstan Gadwall does not much differ from other dabbling ducks (Table 27, Fig. 511). For other geographical areas Gadwall data sets are small.

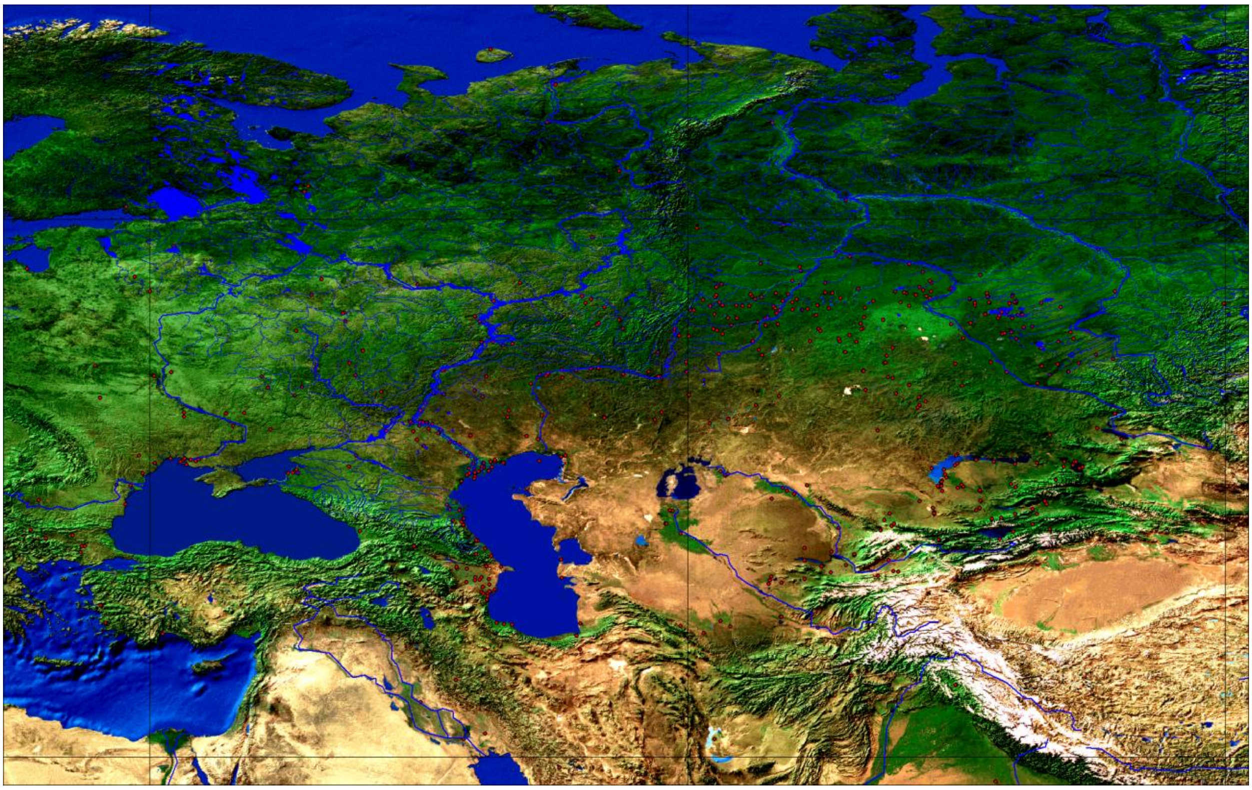

Figure 511. Gadwall recoveries in eastern Europe, north of Western Siberia area and south of Western Siberia–northern Kazakhstan area. Red dots are recoveries.

In western and central Europe Shoveler coastal recoveries are located in about the same closeness to the sea shore is in Mallard. “Moskwa” recoveries in these two ducks in western and central Europe are the most shore attached among all seven considered dabbling duck species (Table 27). In eastern Europe and neighbouring European countries Shoveler is ecologically similar to all other dabbling duck species. However, in northern part of Western Siberia Shoveler (as well as in the south Far East) is the most “riverside” bird than others (Table 27, Fig. 512). In southern parts of Western Siberia and northern Kazakhstan Shovelers, the same as all other ducks are recovered on numerous steppe water bodies and their surroundings. In Central Siberia through Chukotka in its closeness to rivers Shoveler resembles Wigeons and Garganeys (Table 27, Fig. 513). In this geographical area shore-attached Shoveler recoveries are the farthest from shore than in all other dabbling duck species.

Figure 512. Shoveler recoveries in western and central Europe, eastern Europe, north of Western Siberia area and south of Western Siberia–northern Kazakhstan area. Red dots are recoveries.

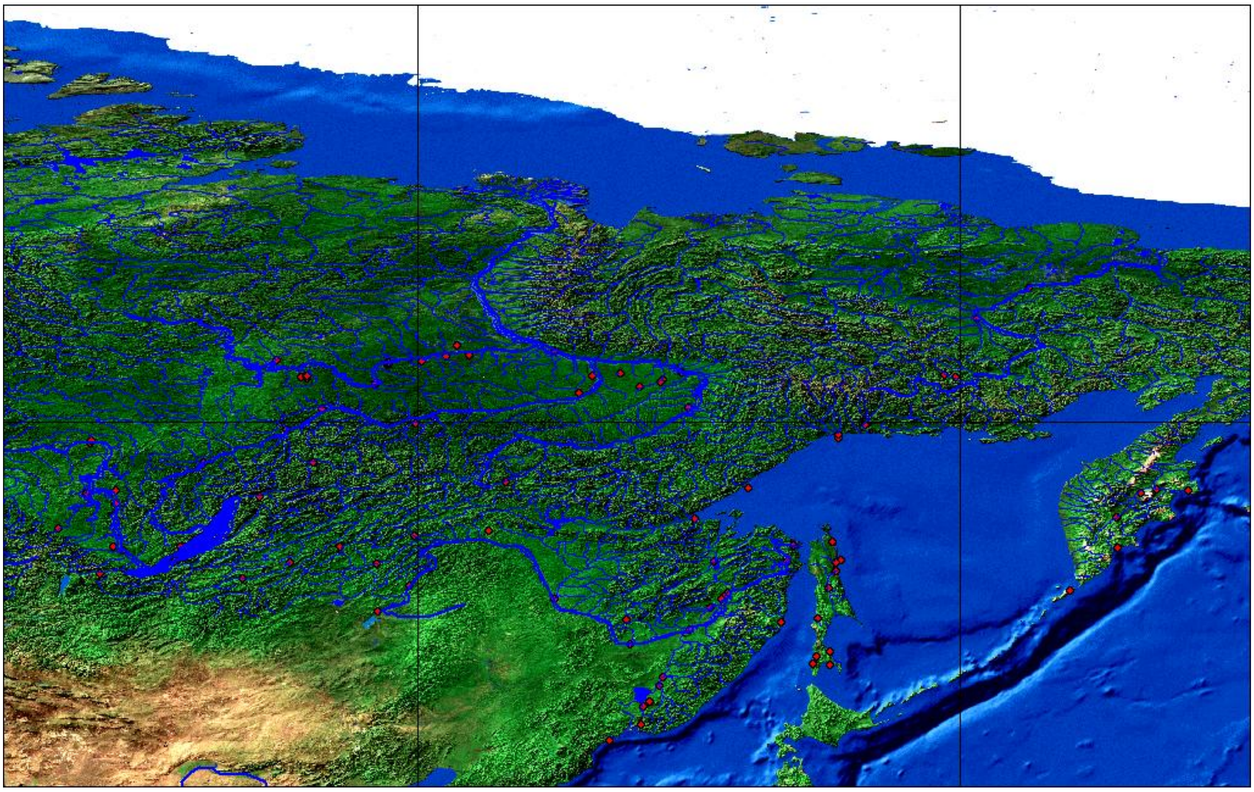

Figure 513. Shoveler recoveries in Central Siberia through Chukotka, south Far East, Sakhalin and Kamchatka areas. Red dots are recoveries.

2. Diving ducks

Generally, recoveries of diving duck are located closer to any deep water than recoveries of dabbling ducks (Table 27, 28) which is not unusual and fully coincides with the biology of these two duck ecological groups. Diving duck species recoveries in different geographical areas display different distribution according to the ecological conditions of the areas (Table 28). Ferruginous Duck amount of recoveries is too small for some analyses.

Table 28. Distances to the nearest river or lake and distances to the nearest sea shore or shore of a big lake in diving ducks.

Species	Geographic Area	Distance to the nearest river or lake±standard error (km)	Number of recoveries	Distance to the nearest sea or big lake shore±standard error (km)	Number of recoveries
Tufted Duck	western and central Europe	5.622±1.715	100	3.225±0.339	220
Common Pochard	western and central Europe	5.930±0.700	154	10.571±3.934	119
Scaup	western and central Europe		0	2.216±1.379	10
Goldeneye	western and central Europe	5.947±1.610	14	2.429±0.555	36
Ferruginous Duck	eastern Europe	3.943±0.899	12	4.675±4.675	2
Tufted Duck	eastern Europe	5.598±0.250	1939	5.762±1.178	263
Common Pochard	eastern Europe	6.398±0.869	735	4.439±0.436	131
Scaup	eastern Europe	5.699±2.184	37	3.122±2.260	3
Red-crested	eastern Europe	2.892±0.623	28	3.098±0.514	19

Pochard					
Goldeneye	eastern Europe	4.442±0.312	234	4.994±1.342	32
Tufted Duck	north of Western Siberia	3.214±0.108	703	2.470±0.681	16
Common Pochard	north of Western Siberia	3.217±0.203	99	5.604	1
Scaup	north of Western Siberia	4.076±0.843	21		0
Goldeneye	north of Western Siberia	3.073±0.482	41		0
Ferruginous Duck	northern Kazakhstan – south Western Siberia	1.929±0.574	11	2.255±0.948	2
Tufted Duck	northern Kazakhstan – south Western Siberia	9.765±1.134	326	1.235±0.617	3
Common Pochard	northern Kazakhstan – south Western Siberia	8.106±0.371	1164	3.683±0.586	16
Scaup	northern Kazakhstan – south Western Siberia	24.325±22.184	2		0
Red-crested Pochard	northern Kazakhstan – south Western Siberia	4.827±0.702	35	1.681±0.346	6
Goldeneye	northern Kazakhstan – south Western Siberia	4.668±0.274	231		0
Tufted Duck	Central Siberia – Chukotka	15.279±5.691	89	9.160±2.293	10
Common Pochard	Central Siberia – Chukotka	23.195±12.178	38	7.170±0.683	25
Scaup	Central Siberia – Chukotka	36.352±25.713	18	2.047	1
Goldeneye	Central Siberia – Chukotka	2.023±1.048	6		
Tufted Duck	south Far East	9.795±4.320	4		
Common Pochard	south Far East	15.052±4.667	4	9.593±5.470	4
Tufted Duck	Kamchatka and Sakhalin	12.168±6.482	3	14.294±2.070	28
Common Pochard	Kamchatka and Sakhalin	3.513	1	5.240±1.053	4
Scaup	Kamchatka and Sakhalin			6.797±1.555	7

Tufted Ducks breeding in Russia, in western and central Europe in coastal areas are more marine species than dabbling ducks, however in slightly less extent than Common Pochard and Goldeneye (Table 28). In the area that denoted as eastern Europe Tufted Duck is about equally marine and river bird (Table 28, Fig. 514). In the north of Western Siberia coastal Tufted Duck recoveries are more attached to the deep water than in eastern Europe. Even in steppe areas (south of Western Siberia and northern Kazakhstan) Tufted Ducks are recovered in lands that are more water-filled than all dabbling duck species in the same area, but not as close to the deep water as Ferruginous Duck (Table 28). In Central Siberia through Chukotka Tufted Ducks behave ecologically similarly to dabbling ducks, preferring wetlands with shallow water (Table 28, Fig. 515). Data on south Far East and Sakhalin and Kamchatka areas are scarce (Table 28).

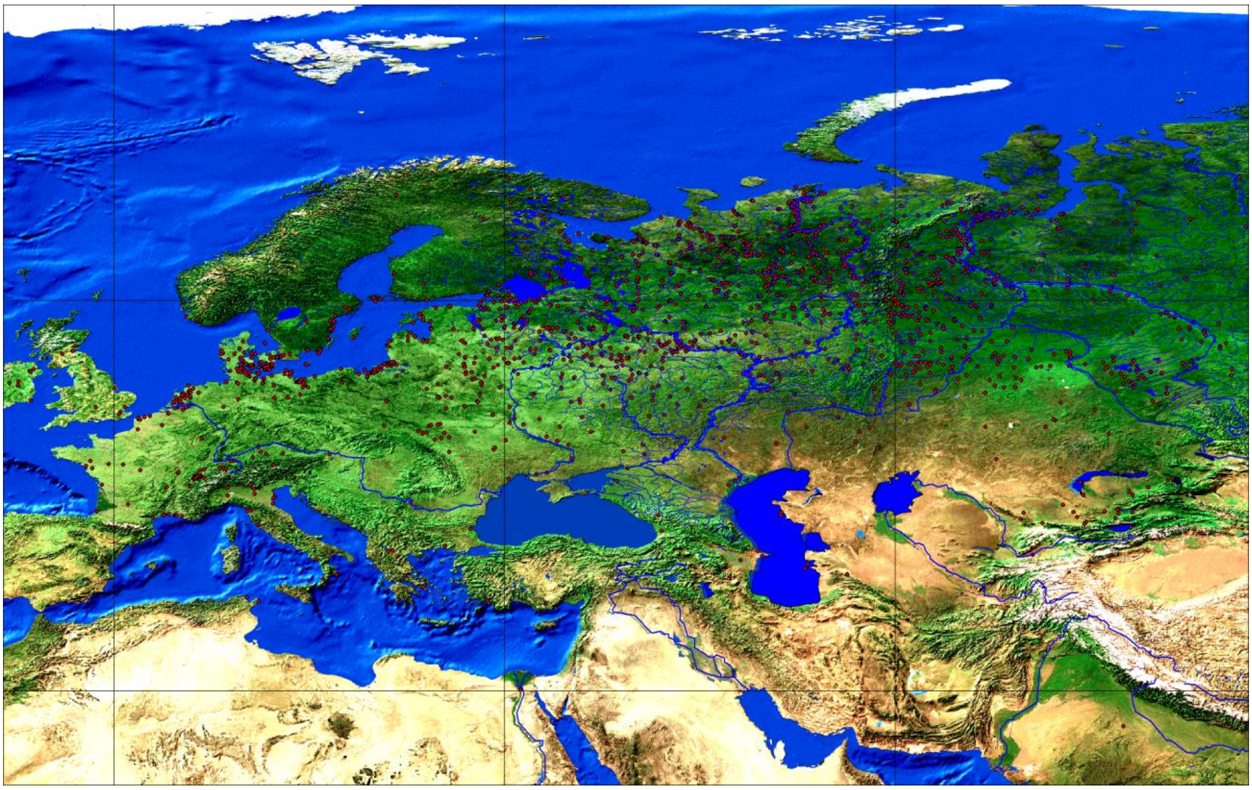

Figure 514. Tufted Duck recoveries in western and central Europe, eastern Europe, north of Western Siberia area and south of Western Siberia–northern Kazakhstan area. Red dots are recoveries.

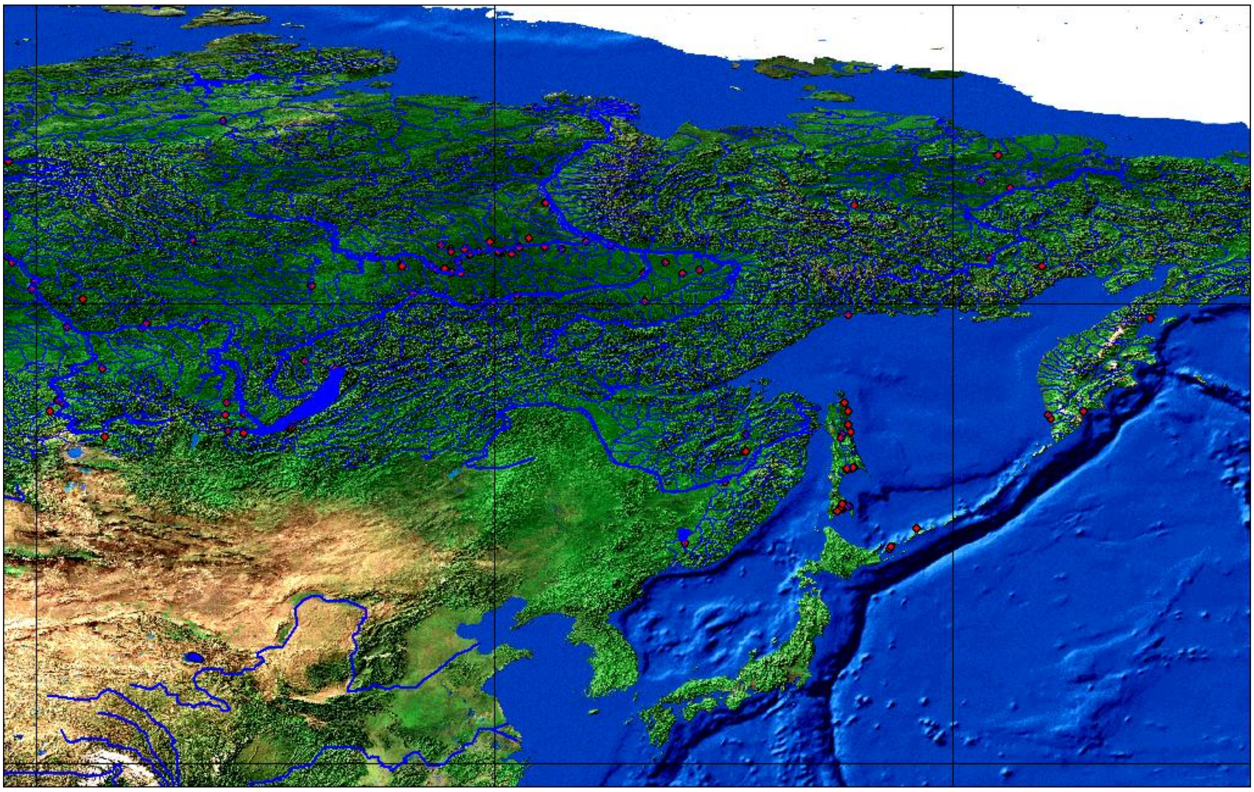

Figure 515. Tufted Duck recoveries in Central Siberia through Chukotka, south Far East, Sakhalin and Kamchatka areas. Red dots are recoveries.

According to the position of wintering Common Pochard recoveries in western and central Europe one can conclude that in this geographic area the Pochard is the most inland duck among other diving ducks, and in about in the same extent inland as Pintails and Common Teal (Table 28, 27, Fig. 516). In eastern Europe Common Pochards are more attached to deep water (both rivers and sea shores) than in western and central Europe, but in comparison to other diving ducks this species is the least attached to the deep water in this geographic area. In the northern part of Western Siberia Common Pochard recoveries are located more close to rivers than in European part of the breeding range and in about the same extent as in other diving duck species (Table 28, Fig. 516). In the south of Western Siberia and northern Kazakhstan the Common Pochard, the same as many other diving and dabbling duck species, becomes more inland and attached to not so deep waters. In central and eastern parts of Siberia these Pochards definitely becomes more shallow-water birds than in all areas to the west (Table 28, Fig. 517).

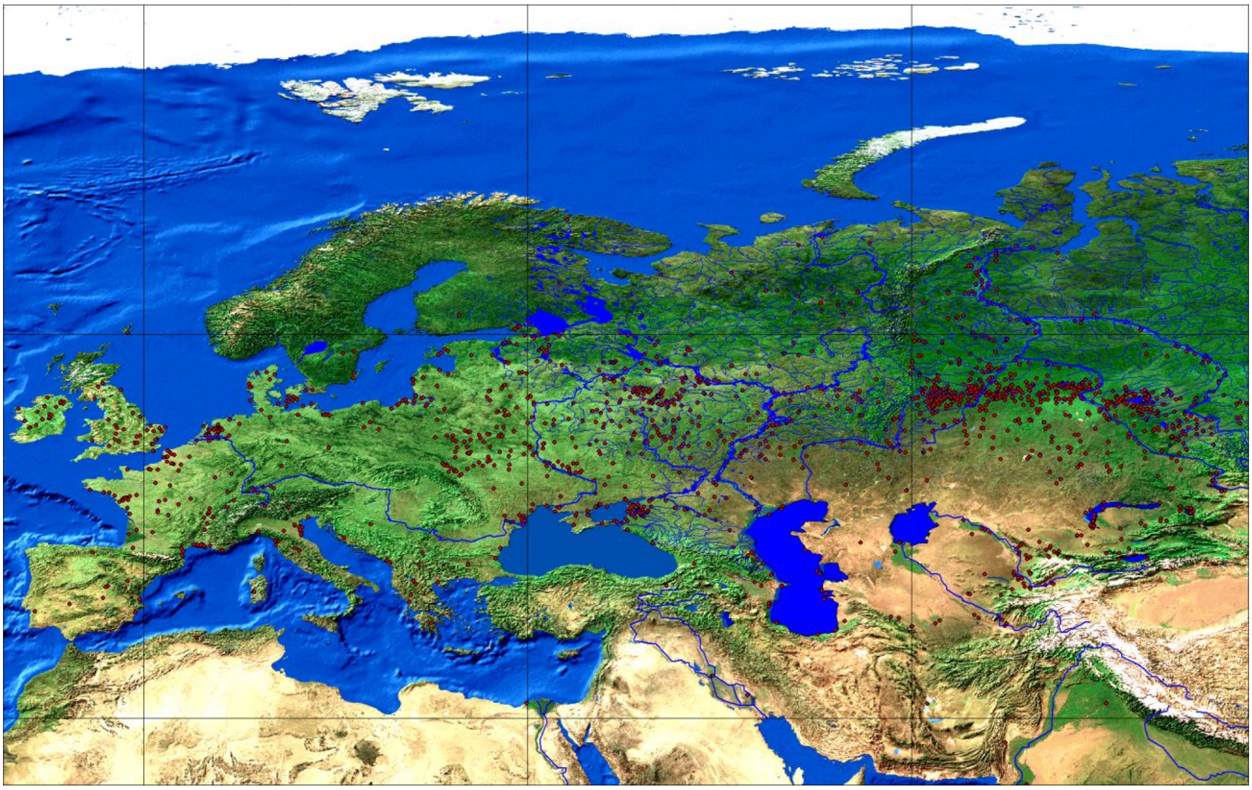

Figure 516. Common Pochard recoveries in western and central Europe, eastern Europe, north of Western Siberia area and south of Western Siberia–morthern Kazakhstan area. Red dots are recoveries.

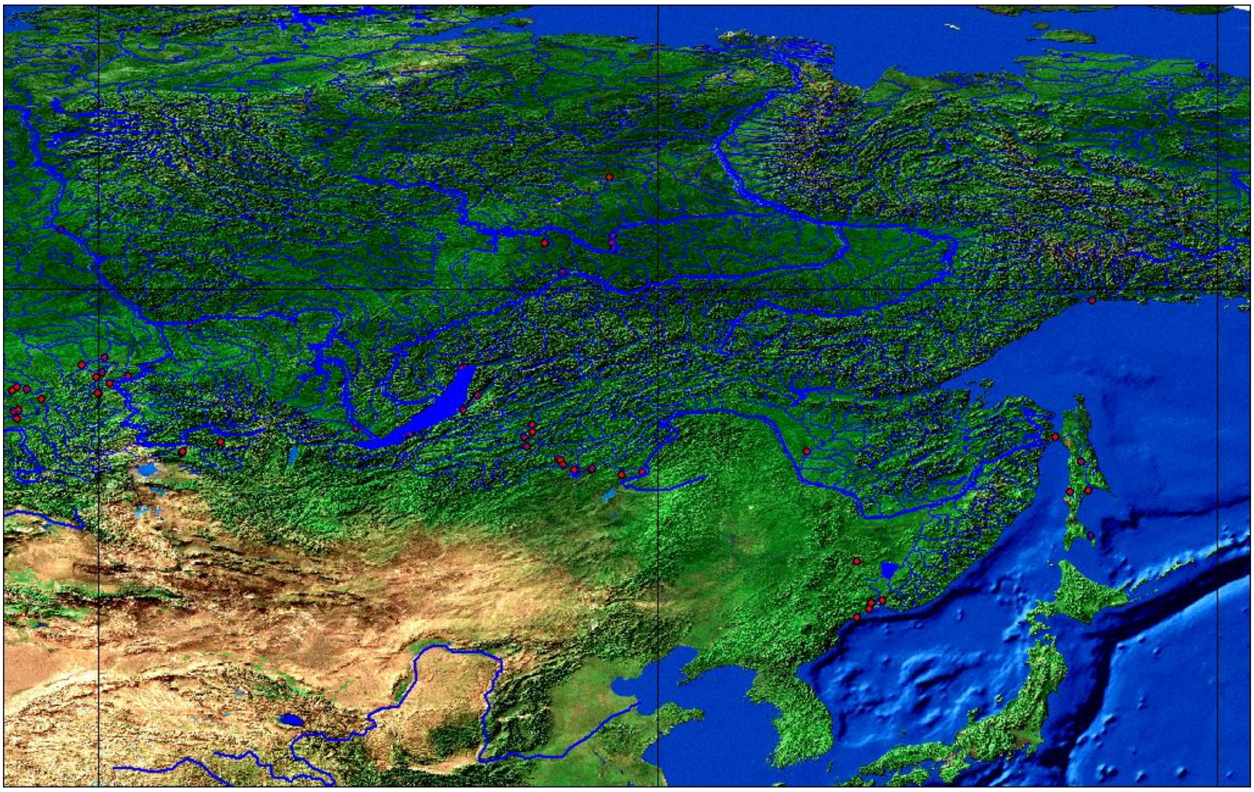

Figure 517. Common Pochard recoveries in Central Siberia through Chukotka, south Far East, Sakhalin and Kamchatka areas. Red dots are recoveries.

Red-crested Pochards were recovered only in the two geographic areas: eastern Europe and south of Western Siberia and northern Kazakhstan (Table 28, Fig. 518). In eastern Europe these Pochards are the most “water-attached” diving ducks: mean distances to the nearest river and to the nearest shore from recoveries of this species are the least across all diving duck species. In south part of the Western Siberia and northern Kazakhstan Red-crested Pochards are also closely attached to the water, in greater extent that Tufted Duck and Common Pochard, in about the same way as Goldeneye, but in much lesser extent than Ferruginous Duck (Table 28). In spite of small number of recoveries, we can conclude that Ferruginous Duck is the most “water” bird (among diving ducks) in this geographic area.

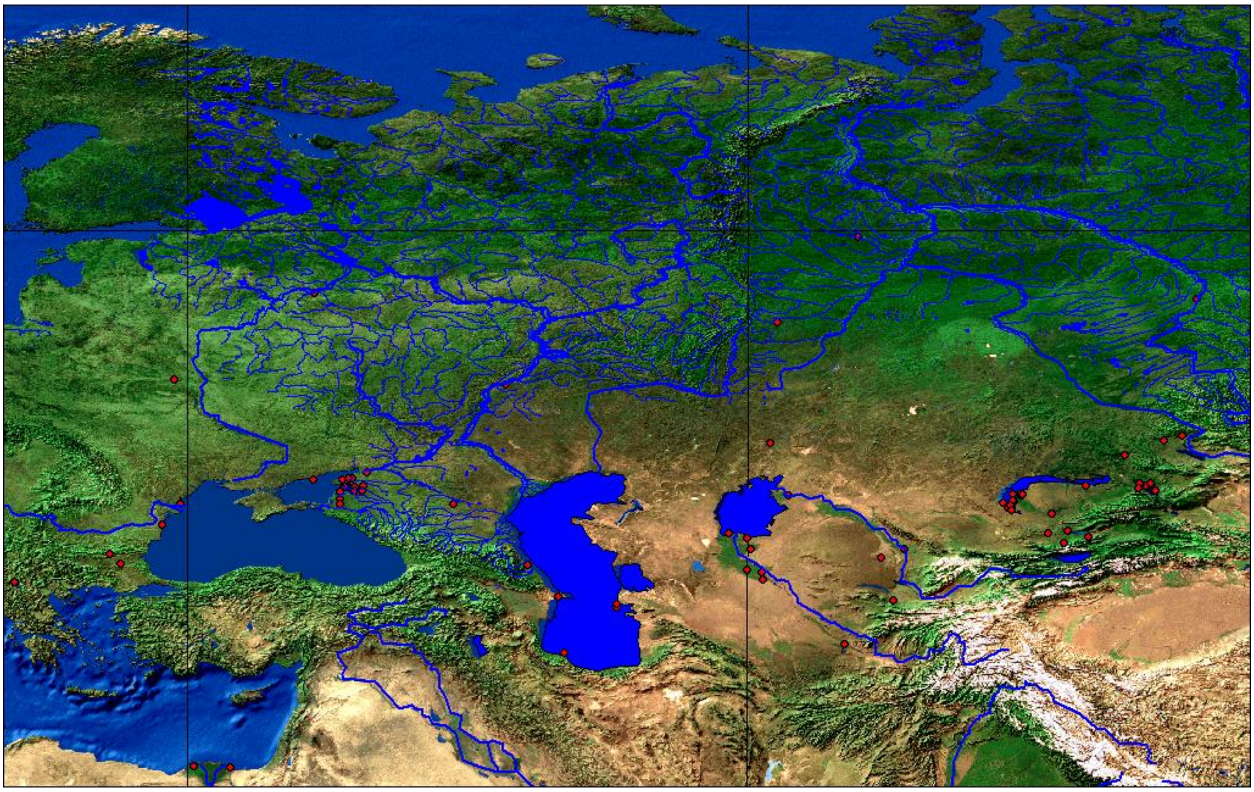

Figure 518. Red-crested Pochard recoveries (red dots).

Scaup recoveries form quite small sample (a total of 99 recoveries), however some suggestions can be made for this species, as well. In western and central Europe this duck was recovered in the coastal areas only and very close to shores, which could really mean at sea (Table 28, Fig. 519). In eastern Europe the Scaup ecological preferences are very similar to Tufted Duck; and in the northern part of Western Siberia it is slightly less attached to deep water than the latter. In Central Siberia through Chukotka Scaup was recovered the most far away from rivers in comparison to other diving ducks (Table 28, Fig. 520). At Kamchatka and Sakhalin Island Scaup recoveries were obtained from costal areas, much closer to the sea than in Tufted Ducks and slightly farther than in Common Pochards (Table 28, Figs 517 and 520).

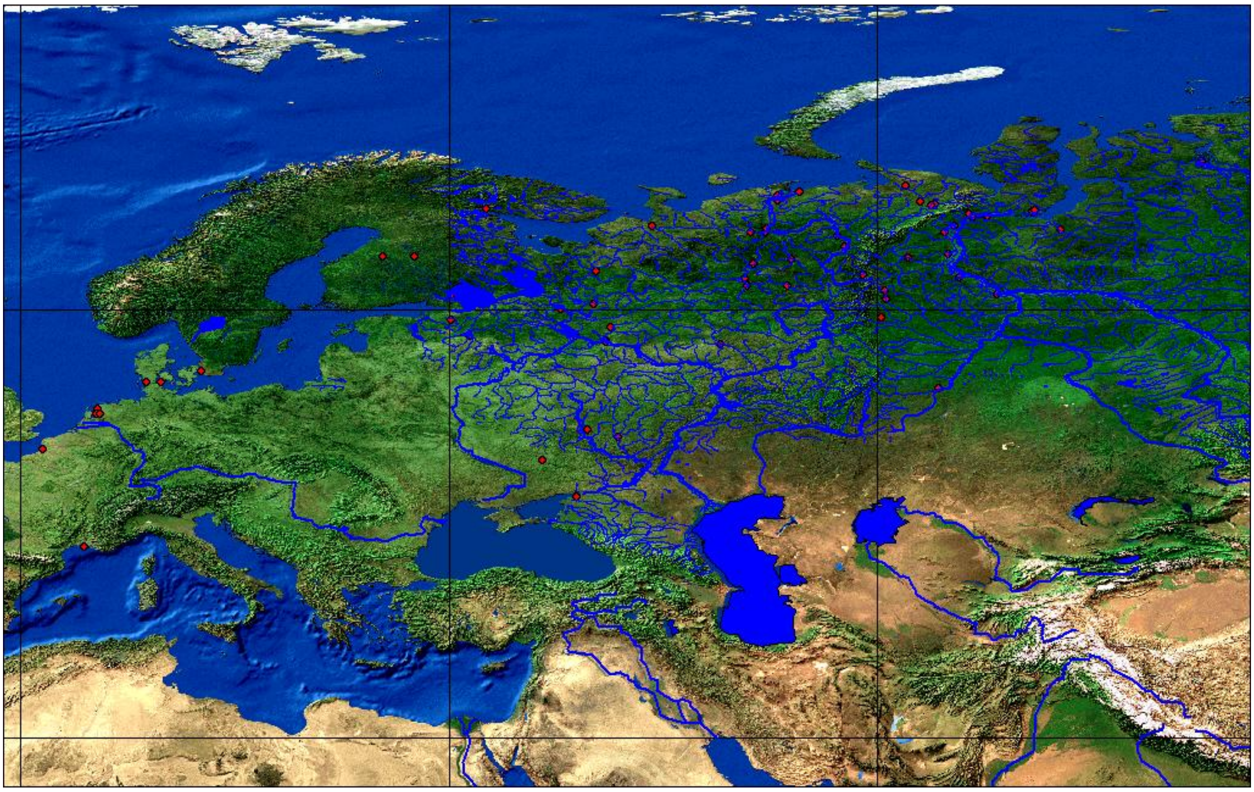

Figure 519. Scaupe recoveries in western and central Europe, eastern Europe, north of Western Siberia area and south of Western Siberia–northern Kazakhstan area. Red dots are recoveries.

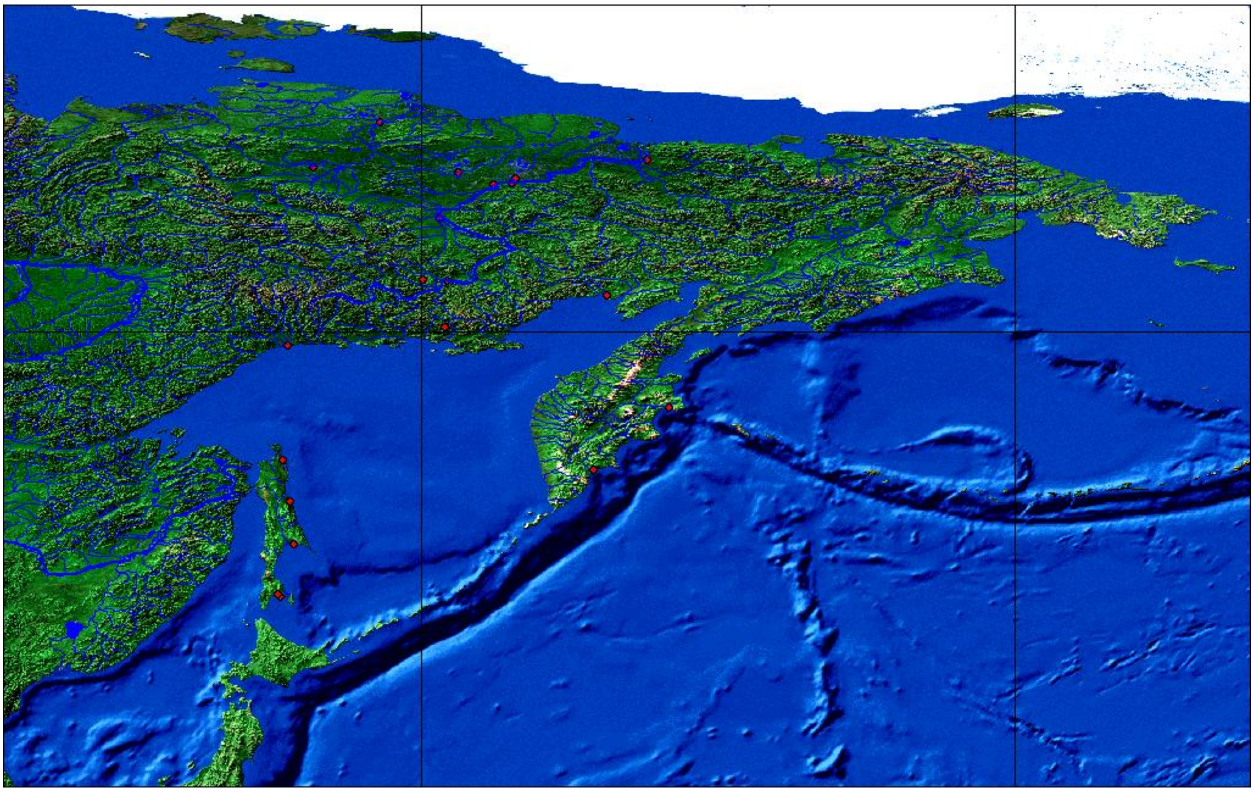

Figure 520. Scaup recoveries in Central Siberia through Chukotka, south Far East, Sakhalin and Kamchatka areas. Red dots are recoveries.

Goldeneye recoveries in western and central Europe in riverside areas are in about in the same distances as Tufted Ducks and Common Pochards. In coastal areas they are the same marine as Scaup (Table 28). In eastern Europe Goldeneyes are more attached to deep waters that Tufted Ducks, Common Pochards and Scaups, but in lesser extent than Red-crested Pochards and Ferruginous Ducks (Table 28). In north of Western Siberia Goldeneyes were recovered quite close to big rivers (Table 28, Fig. 521). That is not much different from other diving ducks. In south of Western Siberia Goldeneyes managed to be very closely attached to deep waters which are not so common in this area. This duck is the second closest to rivers across diving ducks, ranking below Ferruginous Duck only (Table 28). We have only 6 Goldeneye recoveries from Central Siberia through Chukotka; in this geographic area Goldeneyes appear the most attached to big rivers than all other diving duck species in this area (Table 28).

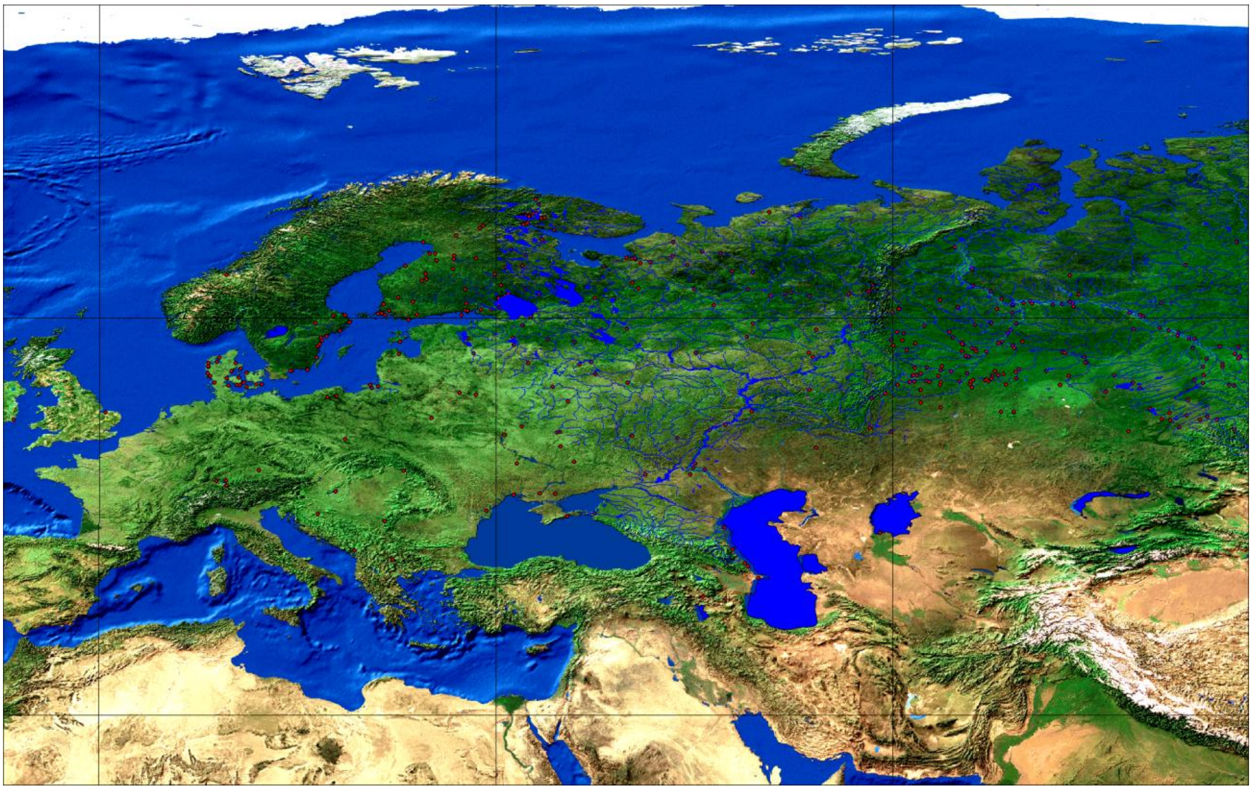

Figure 521. Goldeneye recoveries in western and central Europe, eastern Europe, north of Western Siberia area and south of Western Siberia–northern Kazakhstan area. Red dots are recoveries.

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