Institute of Avian Research
„Vogelwarte Helgoland“
Wilhelmshaven
Director: Prof. Dr. Franz Bairlein

EURING Eurasian-African Bird Migration Project

Report

to the Convention of Migratory Species (CMS)

on

Analysis of the current migration seasons of hunted species

as of

KEY CONCEPTS OF ARTICLE 7(4) OF DIRECTIVE 79/409/EEC

provided by

Prof. Dr. Franz Bairlein, Institute of Avian Research, Wilhelmshaven, Germany

in collaboration with

Dr. Frank Mattig, Institute of Avian Research, Wilhelmshaven, Germany

and

Dr. Roberto Ambrosini, University of Milan, Milan, Italy

Wilhelmshaven

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Background

The Key Concept of Article 7(4) of the Birds Directive 79/409/EEC is to "*present information on the timing of the reproduction period and of prenuptial migration (return to the breeding areas) for bird species listed on Annex II of the Directive on the conservation of wild birds (79/409/EEC) occurring in EU28.*" (Key Concept 2014).

According to Article 7 (1), species listed in Annex II "*may be hunted under national legislation. Member States shall ensure that the hunting of these species does not jeopardize conservation efforts in their distribution area."* As of Article 7 (4) Member States shall further "*see in particular that the species to which hunting laws apply are not hunted during the rearing season nor during the various stages of reproduction. In the case of migratory species, they shall see in particular that the species to which hunting regulations apply are not hunted during their period of reproduction or during their return to their rearing grounds.*" (Birds Directive)
To achieve this, Member States were required to submit information on the timing of reproduction and prenuptial return migration, which finally led to listing periods of reproduction and periods of prenuptial migration in the Key Concept document. The information gathered by each Member States was basically founded on published sources and data derived from consulting relevant stakeholders.

The data from the Member States were finally compiled in the report KEY CONCEPTS OF ARTICLE 7(4) OF DIRECTIVE 79/409/EEC (latest version of 2014; European Commission 2014). After the release of this Document, a specific ruling of the Court of Justice of the EU on the spirit of this article has further clarified that all birds which are in return migration towards the breeding grounds are to be excluded from hunting and that any method of identification of the decades of onset of return migration which would lead to any percentage of these birds being excluded by the regime of protection would not comply with the spirit of implementation of Art. 7.4 of the Birds Directive.An example for the period of prenuptial migration is given in Figure 1. It lists the period of return migration by country in monthly 10-days periods (decades).

At the same time, it implies pronounced differences in e.g. the onset of prenuptial (return) migration between even neighbouring Member States (countries). These results very likely from giving the information from each Member States priority and thus the likelihood of different interpretations of the timing of migration.

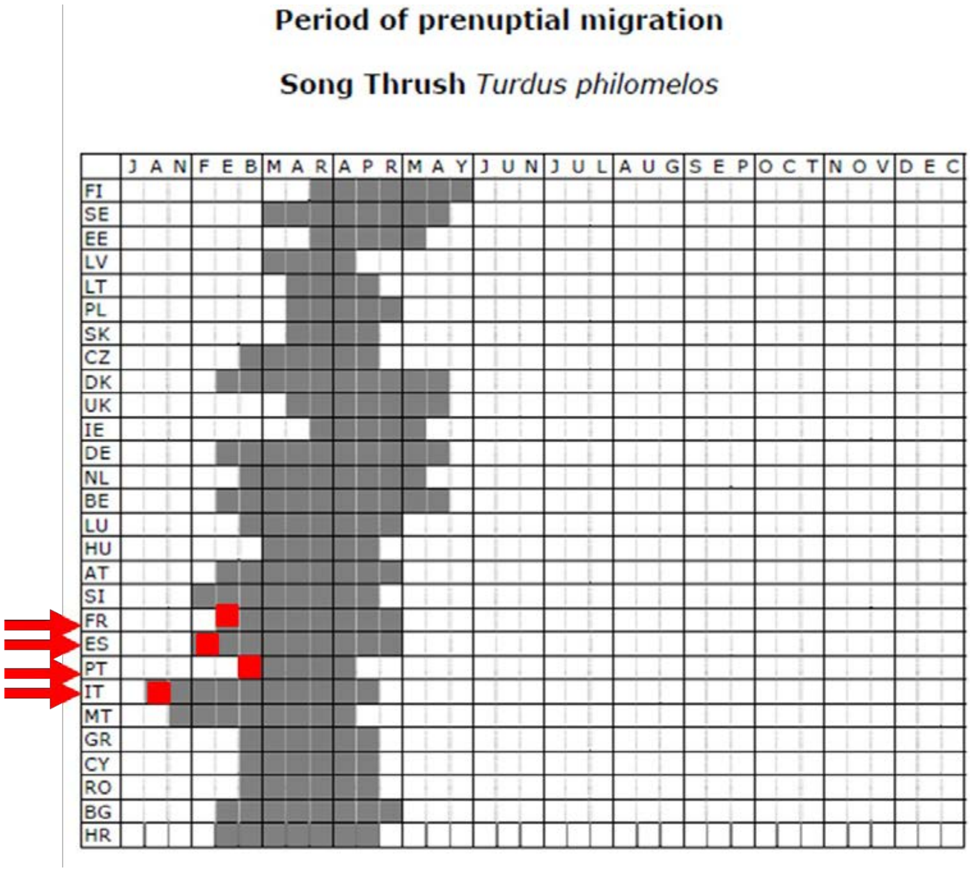

Fig. 1: Example of Song Thrush taken from the Key Concept version 2014 to show structure of information as well as the discrepancy of start of prenuptial migration in even neighbouring countries.

Objective of current study

As a consequence of the inconsistencies in national estimates of migration timing noted immediate above the question arose whether data of individually marked birds can provide information for the revision of the Key Concepts document.

This kind of data is available in the European Union for Bird Ringing (EURING) databank (EDB). The EDB harbors more than 24 million of ringing and recovery that have been gathered by bird ringing schemes throughout Europe (du Feu et al 2016). The databank is hosted by the British Trust for Ornithology. The data are computerized according to standard protocols that are used by all EURING schemes. These data are used here for the analysis of the current migration seasons of hunted species.

The analysis takes two different methodological approaches into account. The one is the use of each individual recovery and the information on timing, distance and direction of movement. The other one is using each encounter of a ringed and/or recovered bird in a given geographical area to model the spatial and temporal course of return migration.

Data and Methods

The analysis is solely based on the data available by the EDB (https://euring.org/data-and-codes/euring-databank-index; see also du Feu et al. 2016). For each bird reported ringed and recovered data is available for the location (coordinates) of ringing and recovery place, date of ringing and recovery, time elapsed between ringing and recovery, or between subsequent recoveries, and distance and direction of movement, i.e. between recovery and ringing. Records of birds that were ringed but not recovered were not included, as most of these records are not in the EDB.

Assessing timing of pre-nuptial migration by use of recoveries

This approach is based on the assumption that in Europe, return migration movements are mostly directed north, northeast or northwest. Therefore, we assigned each bird moving in a direction between 315-135° northbound (Figure 2).

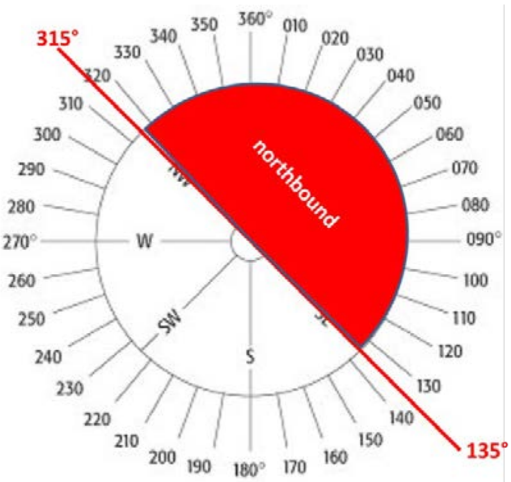

Fig. 2: Illustration of the definition of “northbound”

For birds ringed at (southern) sites during “winter”, the mean distance between ringing place and place of recovery should increase as birds start moving northbound. We further assigned each bird as migrating if its calculated distance between place of recovery and place of ringing exceeded 100 km. This is a conservative approach (i.e., birds which are actively involved in return migration can move distances also lower than 100 km) but takes into account that EURING schemes may not have reported their local recoveries to EDB, or only for recent years. In particular in the past, recoveries of ringed birds were often only reported if they exceeded 100 km distance between place of ringing and recovery. Including shorter distance recoveries would have biased the results towards schemes which reported these data.

In cases where a ringed bird was recovered (reencountered, re-sighted) more than once (multiple recoveries) we calculated the direction and distance of movement to each of the immediate preceding location of recovery. For further analysis, only those of these multiple recoveries were included if they moved northbound with at least 100 km distance (for illustration see Figure 3).

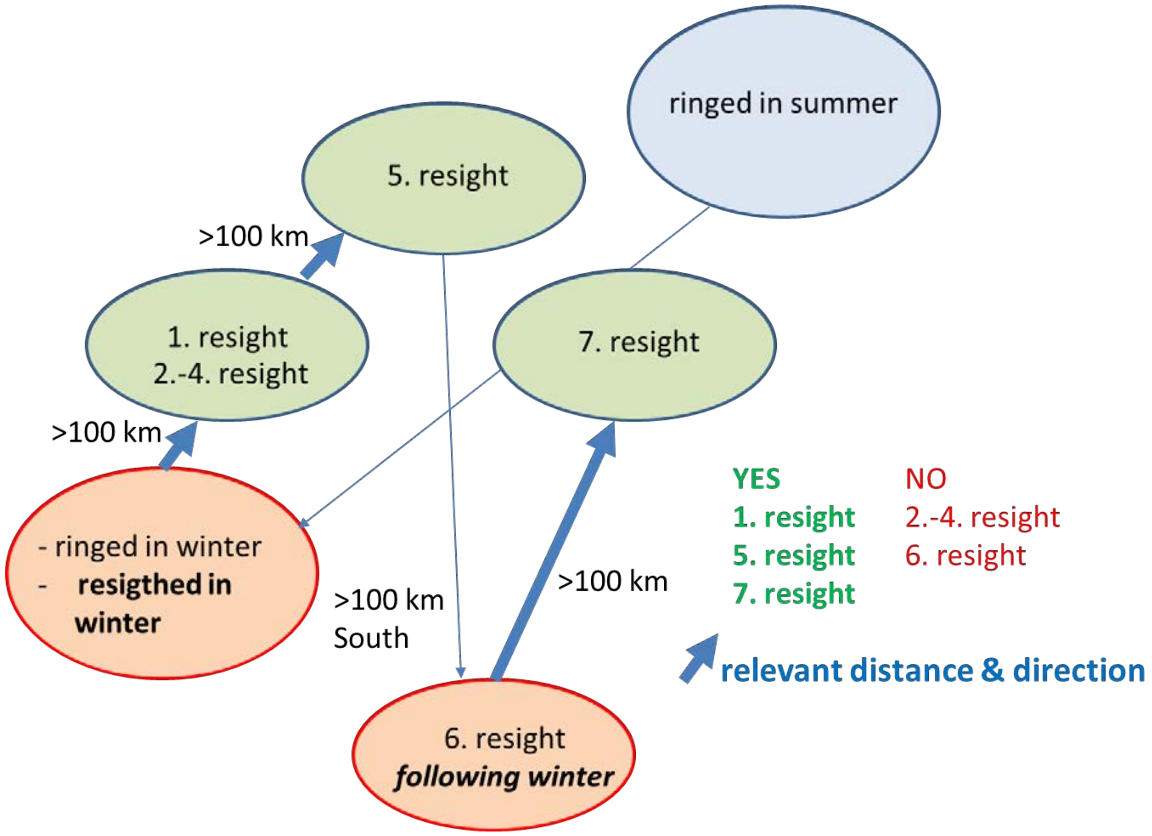

Fig. 3: Illustration of the use of multiple recoveries. Only movements were considered in the analysis if they went northbound for at least 100 km. Consequently, in the current example, only recoveries #1, #5 and #7 are considered.

To evaluate the <u>seasonal course</u> of northbound pre-nuptial (return) migration we considered only those recoveries which were recovered within the first 16 10-days periods (decades) of a year, which cover the period between 1 January and 31 May (Table 1).

Tab. 1: 10-day periods (decades) included in the analysis

number of decade	period	month
1	1-10 Jan	January
2	11-20 Jan	
3	21-31 Jan	
4	1-10 Feb	February
5	11-20 Feb	
6	21-28/29 Feb	
7	1-10 Mar	March
8	11-20 Mar	
9	21-31 Mar	
10	1-10 Apr	April
11	11-20 Apr	
12	21-30 Apr	
13	1-10 May	May
14	11-20 May	
15	21-31 May	

In a first step we included only birds which were ringed in December – February and recovered northbound >100 km in the immediate following 15 decades (intra-year recoveries). However, this filtering led to rather few remaining recoveries for the subsequent analyses. Consequently, we extended our data set by including inter-year recoveries in the respective decades as well. But even then, samples sizes per decade remained low in most species. Therefore, we extended further and included all recoveries (intra- as well as inter-year) in decades 1-15 of birds ringed in a designated area (see below) between 1 August and 31 March.

With these definitions we derived the following data (Figure 4):

1) Number of birds that moved at least 100 km northbound in each 10-days period between 1 January - 31 May (decades 1-15)
2) Median 10-days period of onset of prenuptial (return) migration
3) Proportion of birds in each of the 15 decades as to the total number of recoveries for the entire 15 decades period.
4) Median distance of birds that moved at least 100 km northbound in each 10-days period. The median was, however, calculated only for decades with at least 3 recoveries.

When considering the process of data selection wich has led to the samples analysed with this method, a most conservative approach has been applied, which has limited the cases considered only to birds which were undoubtedly involved in return movements. Hence, any number or percentage of birds reported having moved at least 100 km in the selected directions has to be referred to birds to be considered *sensu* Art. 7.4 of the Directive.

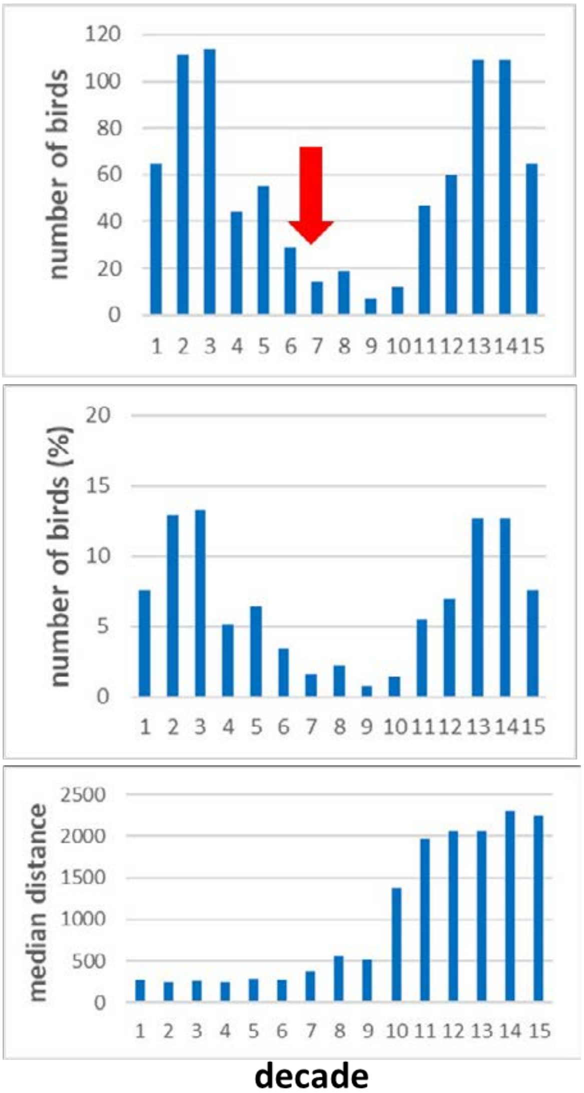

Fig. 4: Derived data: Top panel: Number of recoveries per decade that moved at least 100 km northbound and median decade of migration (red arrow); central panel: Proportion of recoveries per decade as of the sum of all recoveries in decade 1-15; lower panel: median distance of birds that moved at least 100 km northbound if sample size per decade was at least 3. Consequently, the reading of this example figure is as follows: In decade 1 (1-10 January) 65 birds (7.6% out of 860) moved a median distance of 270 km.

Geographical regions

Regarding the available number of recoveries but mainly because of following a flyway rather than a national country (Member State) approach we grouped countries to regional units (Figure 5) adopting the regional grouping according to The World Factbook (https://www.cia.gov/library/publications/the-world-factbook/) but considering that the Mediterranean districts of France (except Corsica) are biologically better suited to SW-Mediterranean (South-west) and Corsica to the central Mediterranean (South-central).

Each of the above mentioned analyses was conducted for each of these geographical regions separately. By doing so, one can see by region how many birds in each decade moved at least 100km northbound and the distance they moved on (median) average.

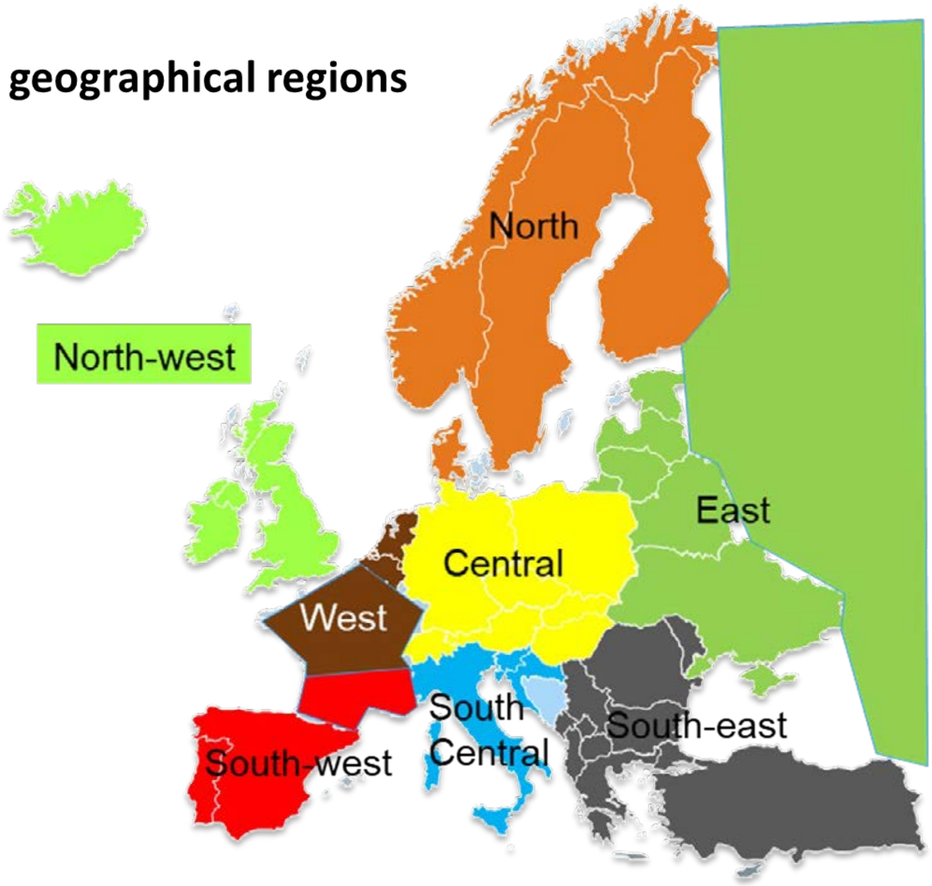

Fig. 5: Geographical regions as used in this analysis (after: The World Factbook; https://www.cia.gov/library/publications/the-world-factbook/; extended).

Modelling of movement probabilities

by Roberto Ambrosini, University of Milan, Italy

The analysis of timing of migration progression is based on the ring recoveries available in the EURING Databank. The methodological approach is based on the work on the Barn Swallow *Hirundo rustica* published in 2014 (Ambrosini et al. 2014. Modelling the progression of bird migration with conditional autoregressive models applied to ringing data. PloS one, 9-7, e102440), modified to fit data on partial migratory species.

In the original method, study area is divided into cells of arbitrary dimension and the number of encounters (either ringing data or recoveries) per calendar date per cell is calculated. This means that encounters from all years are considered together, independently on the year of encounter. The number of encounters per day is then transformed first into the proportion of encounters per calendar date and then into the cumulative proportions; which allow easier model interpolation. The cumulative proportions of encounters at each date and cell are then modelled using a binomial Generalized Linear Mixed Model (GLMM) with a cloglog link function (Fig. 1a). An inversion of this model allows calculating the calendar date when a given cumulated proportion of encounters is expected.

The procedure proposed by Ambrosini et al. (2014) has been improved in several aspects. First, according to the suggestions by Fränzi Korner, we use a GLMM with an exponential spatial covariance structure to account for spatial autocorrelation in the data. Day-of-the-year (centered to its mean value) is the only fixed predictor, while the random part of the model includes cell ID as a random factor. In addition, the random part includes a intercept and a random slope for of day-of-the-year within cell (i.e random intercept and slope model). The model is fitted with the glmmTMB procedure in R. With respect to the model used by Ambrosini et al. (2014), the present one allows an easier inversion of the model (F. Korner, personal communication).

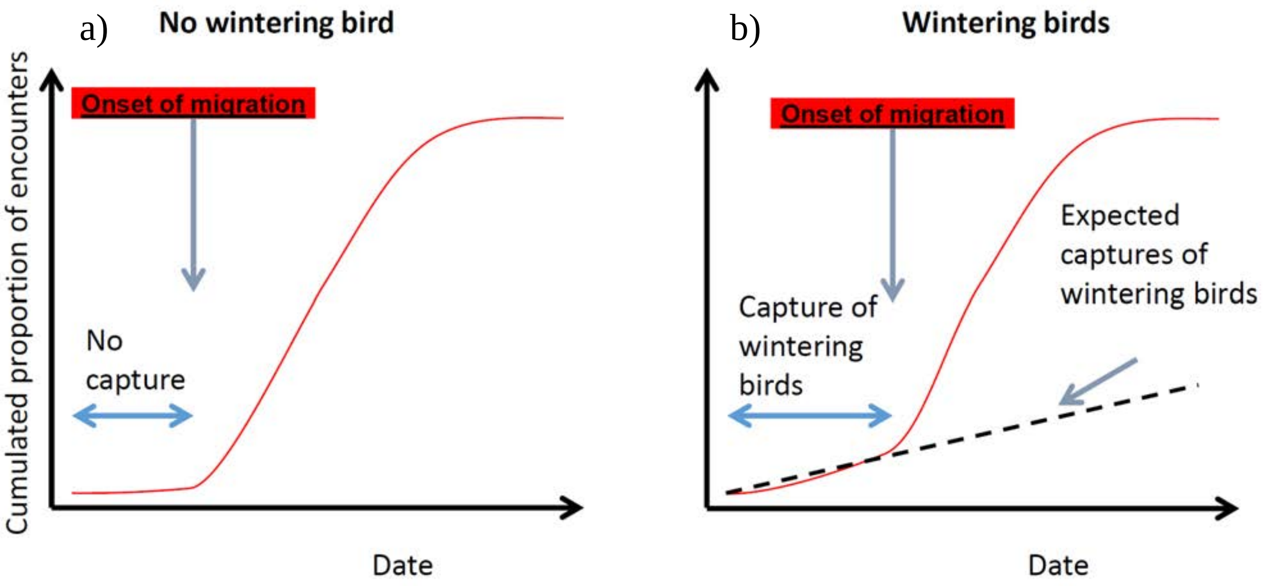

Fig. 6: a) Complementary log-log curve interpolating the cumulative proportion of encounters in a cell for a bird species that does not winter in the study area. b) Cumulative proportion of encounters for a partial migrant. The onset of non-stationary period is estimated as the date when the curve deviates from an approximately linear growth in the left tail.

A second change with respect of the procedure of Ambrosini et al. (2014) was necessary for extending the analyses to species than are present in winter at least in some parts of the study area. Indeed, for a long-distance migratory species, the onset of migration can be estimated from model inversion as the date when a given proportion of encounters is expected in a given cell because, for such species, no encounter is expected during winter. This criterion, however, does not hold if some individuals are already present in some cells at the beginning of the period investigated. The extension of the method is based on the assumption that the probability of encountering an individual is larger during non-stationary than during stationary periods in all cells, including those where the birds are wintering. This assumption is reasonable, as birds have higher probability of being captured when they start moving for migration than during the stationary winter period. The number of encounters is therefore expected to increase during non-stationary periods. In addition, it is necessary to assume that the probability of encountering wintering individual is constant during stationary periods.

Under these assumptions, the function interpolating the cumulative proportion of encounters should have a left tail that interpolates encounters during the stationary period (Fig. 6b). This part of the curve should grow approximately linearly, until the cumulative proportion of encounters starts growing more quickly because the birds enter a non-stationary period. It is important to note that this growth may be due either to new birds entering the cell or to “local” birds leaving the cell.

A third possibility is that the encounter probability are already high at the beginning of the study period. This occurs, for instance, in cells where birds winter, and that when migration starts, we simply observe a decline in the encounter probability. This scenario, however, still implies a curve with an approximately linear phase in its left part.

Under all scenarios, the day of the onset of the non-stationary period at a cell can therefore be estimated as follows. Cumulative proportion of encounters should be calculated starting from a date where birds are reasonably stationary in all their range. From the cloglog curve fitted by the GLMM, the expected proportion of encounters at each day-of-the-year and cell is estimated. These expected proportions at each cell are then regressed on date. This latter analysis is initially limited to a period of 10 days starting from the earliest date considered (i.e. in a period when birds are stationary), and the sum of the absolute residuals of the regression is noted. This analysis is then repeated by considering a time-span of 11 days and so on, until the sum on the absolute values of the residuals reaches a threshold set to 0.05. This criterion proved to be more robust than an alternative one based on R-squared values of the regressions particularly when the fitted curve is already steep at the beginning of the considered period (third scenario above). This approach identifies the longest possible time-span over which the left tail of the cloglog curve grows approximately linearly. The end of this time span therefore indicates the end of the stationary period of birds and the onset of migration at a cell.

This method also allows calculating the day when the curve that estimates the cumulated proportion of birds is a give value (e.g. 5%) above the cumulated proportion of encounters at the end of the stationary period. Technically, if at the end of the initial linear phase, the cloglog curve has value A, and we want to calculate the day when a proportion p of migrant has arrived, the procedure calculates the date when the cloglog curve reaches the value

$$A + p(1 - A).$$

A third update with respect to the procedure of Ambrosini et al. (2014) is that a procedure has been introduced to generate cells of different size, inversely proportional to encounter density Preliminary, a geographical clustering algorithm identifies clusters of encounters that are spatially isolated from other encounters and are less than the minimum sample size required at a cell. This preliminary step prevents the procedure to produce unreasonably large cells.

The study area is then divided into cells of 2° x 2° (latitude - longitude) and the remaining encounters are assigned to a cell. If a cell does not include at least 20 encounters in at least 10 different days of the year (minimum sample size), it is then merged with the cell immediately to the east of it. If all the cells in a 2° latitude belt do not reach minimum sample size even if merged all together, that latitude belt in merged with that immediately to the north of it. The so formed belt is then divided longitudinally as above. If the easternmost cell does not reach minimum sample size, it is merged with the cell to the west of it. Similarly, if all the cells in the northernmost band together do not reach minimum sample size, the band is merged with that immediately to the south of it.

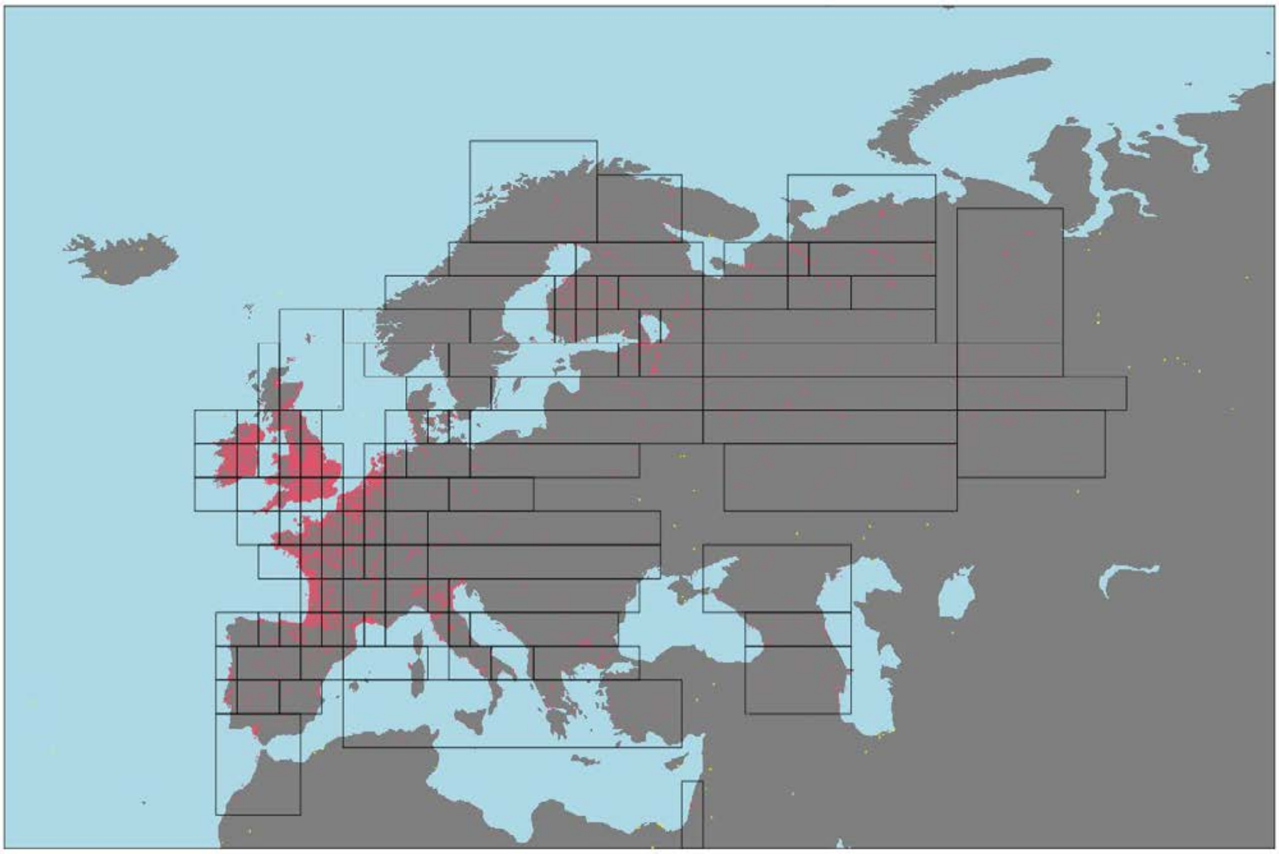

Fig. 7: Final result of the cell merging algorithm on the Teal dataset. Red dots are the encounters included in the analysis (30,455). Yellow dots are discarded encounters.

This procedure therefore favours merging of cells at the same latitude and joins cells at different latitude only if the data in a latitudinal band are not sufficient. To avoid merging too many cells in a latitude band, this procedure has been applied separately to cells included in 4 longitudinal bands (band 1: 30° W – 2° E, band 2: 2° E - 36° E, band 3: 36° E, 60° E, band 4: 60° E – 90° E). Limits of band 1 were set to include the whole UK, those of band 2 to include the whole UE within bands 1 and 2 (Cyprus reaches 35° E and bands must include an integer number of cells). A latitudinal range from 30° N to 80° N was also set, and data outside this range were discarded. An example of the application of this procedure to the Song Thrush is reported in Fig. 2. The weight centre (mean of latitude and longitude) of encounters at each cell was then calculated, and its coordinates used as coordinates of the cell in the cloglog mixed model. This method has the advantage that we can set large values for the minimum sample size at each cell, which allow robust estimates while discarding few data.

Predicted values form the model are then spatially interpolated using a grid with 2 x 2 degree cells. Interpolation is based on the inverse distance weighting algorithm using the Shepard method to calculate weights. A leave-one-out validation routine is applied to measure the error in the interpolated values and to choose the best power function for interpolation.

Finally, the resulting interpolated map is downscaled to obtain the expected values at cells of one degree of size (latitude x longitude) using the bilinear method.

The procedure includes a set of parameters, whose values were chosen arbitrarily. To asses the robustness of the method,-we re-run the analyses with different values of all the parameters. Table1 lists such parameters, their meanings and the different values used. By combining the different values of the parameters, we obtained 27 final maps, for each value of the predicted proportion of arrived migrants (i.e. for each value of PRED in Table 2). Finally, we averaged the results (Fig 8) and calculated a map of the standard error of the predictions at each cell. (Fig. 9).

Table 2: Parameters entered in the procedure and values used for predictions.

Name in the procedure	Description	Values used
StartD	First day-of-the year considered and first day for the linear phase. Last day-of-the-year considered is 151 = 31 May	-30 (1 December) - 25 (6 December) - 20 (11 December)
NP	Minimum number of encounters in a cell	15, 20, 25
DN	Minimum number of different day-of-the-year for the encounters in a cell	Values are univocally defined according to NP values: NP = 15 -> ND = 7 NP = 20 -> ND = 10 NP = 25 -> ND = 15
NumDayLin	Minimum length of the linear phase	10
THR	Threshold value of the sum of absolute residuals of the linear regression of the left-hand part of the interpolated curve on time used to assess the end of the linear phase	0.05, 0.07, 0.1
PRED	Predicted proportion of individuals that has arrived used for model inversion	0, 0.01, 0.05, 0.1, 0.5

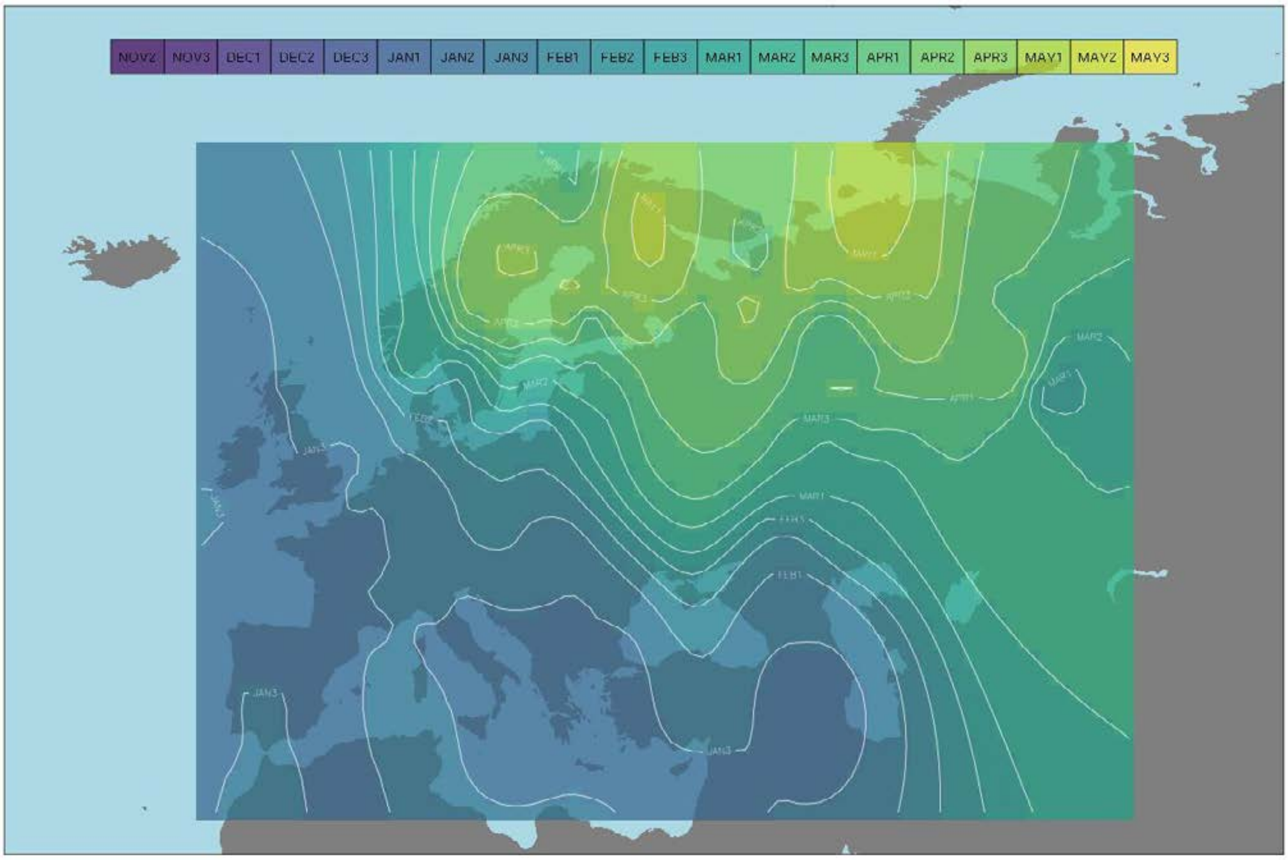

Fig. 8: Map of Teal pre-nuptial migration progression obtained with the method exposed above. The maps represents the expected day-of-the-year when 5% of migratory birds has arrived at a cell. Colours represent ten-day periods defined according to the Key Cocepts of Article 7(4) of Directive 79/409/EEC (period 1 corresponds to 1-10 January).

Fig. 9: Map of standard errors at each cell from the ensemble of models used to generate the map in Fig. 8.

<u>Validation of the model</u>

In order to validate the model we compared the model results for Song Thrush with published data on spring passage of Song Thrush at two different locations in Germany, (1) the long-term standardized trapping data of the Institute of Avian Research on the island of Helgoland (Hüppop & Hüppop 2011; Dierschke et al. 2014), (2) long-term observational data of spring passage in SW-Germany (Hölzinger 1999).

The comparisons reveal that the spatial model matches the “real” passage of Song Thrush at both sites very well, in particular the onset of migration (Fig. 10) and the median date of passage on Helgoland, but less the median data of observations in SW-Germany (Fig. 11).

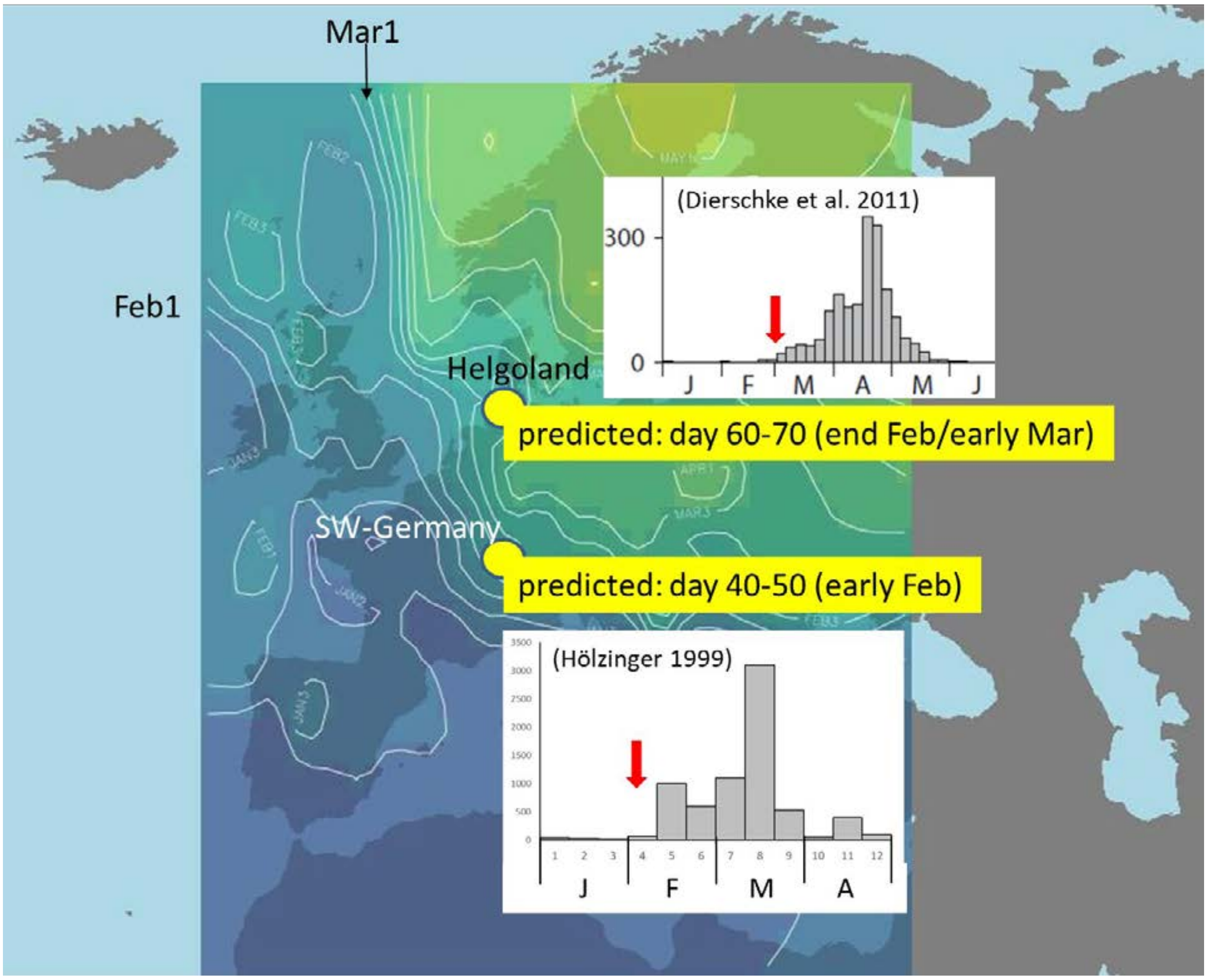

Fig. 10: Comparison of the results of modelling the onset of migration in Song Thrush with published data of spring passage of Song Thrush at two locations in Germany (Helgoland: trapping data; SW-Germany: observations). Predicted onsets by the model match the trapping/observational data (red arrows).

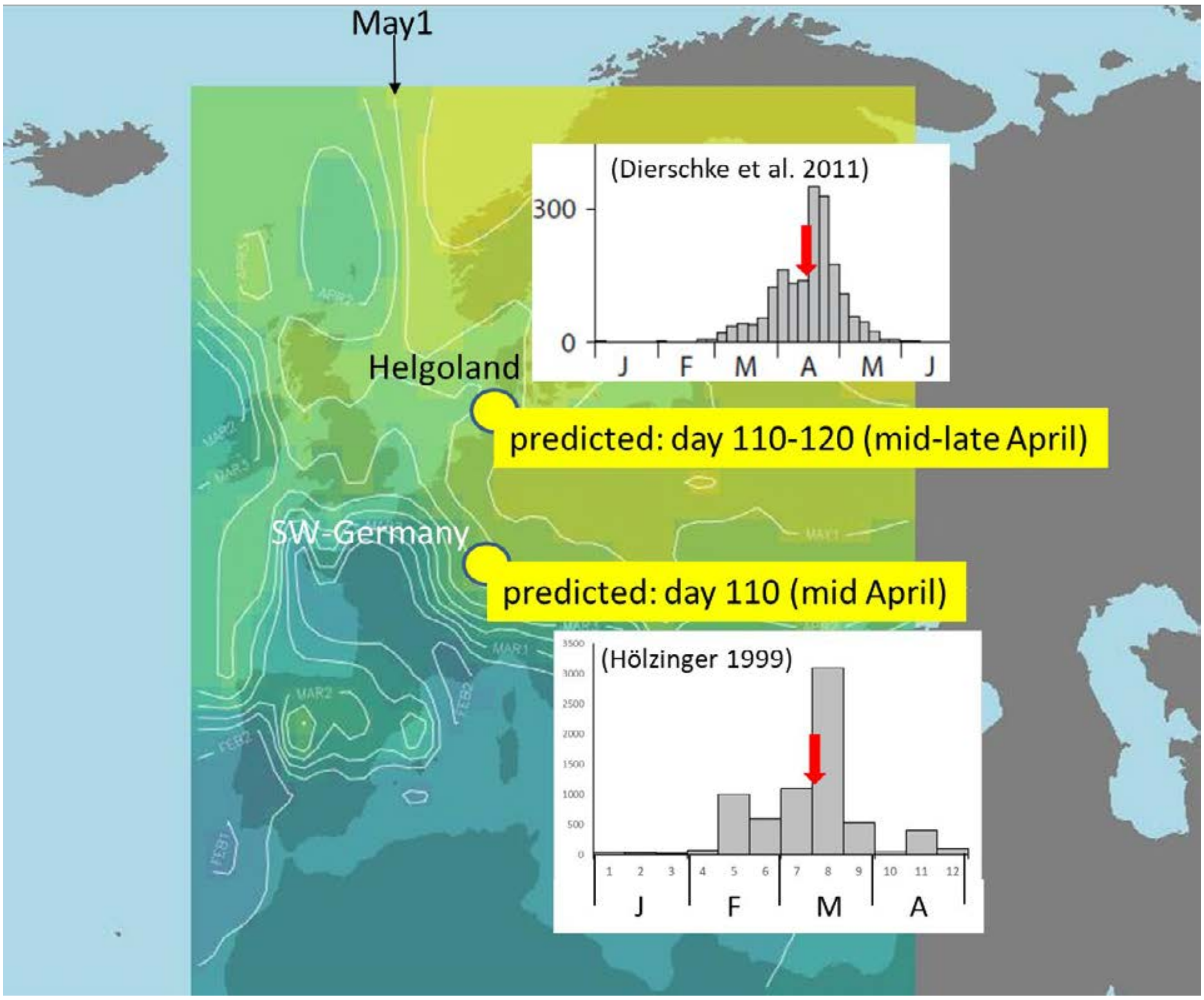

Fig. 11: Comparison of the results of modelling the median date of migration in Song Thrush with published data of spring passage of Song Thrush at two locations in Germany. Predicted median dates by the model match the trapping data (Helgoland) well (red arrows), but the observational data in SW-Germany less, likely because of local climatic conditions there.

Comparison of recovery and model data

As shown by Fig. 12, data derived from the analysis of recovery data match well the spatial temporal modelling. Modelling as well as recovery analysis reveal onset of return migration of Song Thrush in the SW in early January, and both methods show the median date of return migration in decade 5-6.

Thus, both independent approaches reveal very similar results underpinning the validity of both. While the results of the recovery-approach are affected by sample size, the modelling enables a more robust assessment of migration movements with higher spatial resolution.

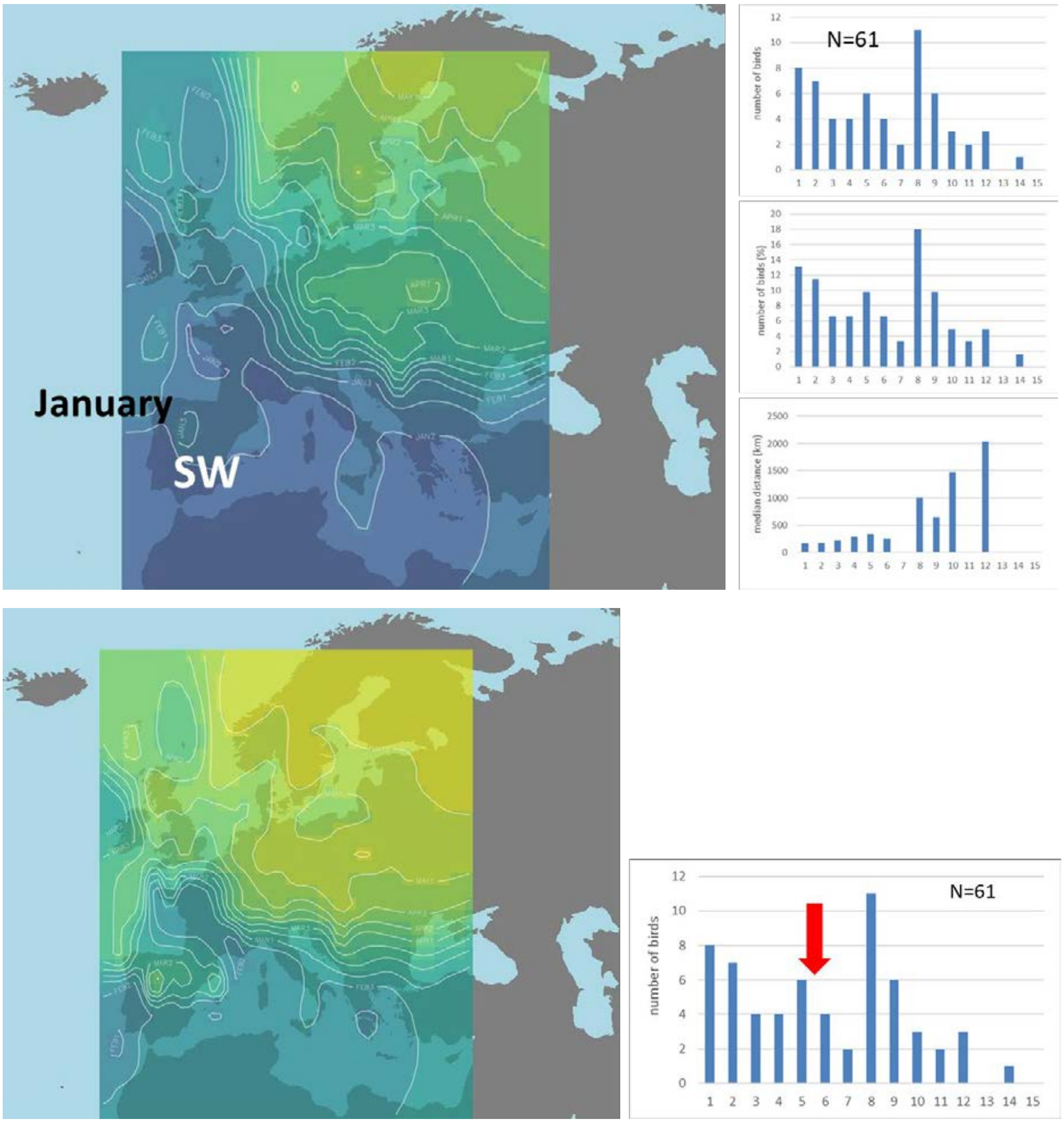

Fig. 12: Comparison of both methods for onset (top panel) as well as median date (low panel) of return migration of Song Thrush for the South-west region.

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Species accounts

Of the total 80 species listed in Annex II of the Bird Directive as huntable in Member States 79 have entries in the EURING databank but only 57 species (Tab. 3) provide sufficient data for either recovery analysis and/or mapping of onset of pre-nuptial migration. In 22 species (Tab. 4), neither recovery analyses nor mapping could be conducted because of lack of data.

Table 3: Annex II species with sufficient data for either the recovery analysis and/or the mapping of onset and progression of pre-nuptial migration.

	Species			
EURING code	common name	scientific name	number of records, northbound >100 km, decade 1-15	number of encounters for mapping
01520	Mute Swan	*Cygnus olor*	7145	311,201
01570	Bean Goose	*Anser fabalis*	2217	11,324
01580	Pink-footed Goose	*Anser brachyrhynchus*	1284	10,297
01590	Greater White-fronted Goose	*Anser albifrons*	5281	27,974
01610	Greylag Goose	*Anser anser*	878	70,038
01660	Canada Goose	*Branta canadensis*	74	29,541
01680	Brant Goose	*Branta bernicla*	43	2042
01790	Eurasian Wigeon	*Anas penelope*	1381	9981
01820	Gadwall	*Anas strepera*	128	2754
01840	Eurasian Teal	*Anas crecca*	2223	30,455
01860	Mallard	*Anas platyrhynchos*	2262	125,821
01890	Northern Pintail	*Anas acuta*	1098	5923
01910	Garganey	*Anas querquedula*	154	1893
01940	Northern Shoveler	*Anas clypeata*	134	1930
01980	Common Pochard	*Aythya ferina*	1036	9214
02030	Tufted Duck	*Aythya fuligula*	2047	23,989
02060	Common Eider	*Somateria mollissima*	133	77,878
02180	Common Goldeneye	*Bucephala clangula*	17	6341
02230	Common Merganser	*Mergus merganser*	70	2338
03700	Common Quail	*Coturnix coturnix*	4	3538
04700	Water Rail	*Rallus aquaticus*	31	1941
04240	Common Moorhen	*Gallinula chloropus*	175	15,835
04290	Eurasian Coot	*Fulica atra*	765	72,584
04500	Eurasian Oystercatcher	*Haematopus ostralegus*	2179	45,477
04850	European Golden Plover	*Pluvialis apricaria*	97	3377
04860	Grey Plover	*Pluvialis squatarola*	21	647
04930	Northern Lapwing	*Vanellus vanellus*	200	25,894
04960	Red Knot	*Calidris canutus*	658	14,552

05170	Ruff	*Philomachus pugnax*	165	5802
05180	Jack Snipe	*Lymnocryptes minimus*	5	1668
05190	Common Snipe	*Gallinago gallinago*	83	5896
05290	Eurasian Woodcock	*Scolopax rusticola*	1535	16,062
05320	Black-tailed Godwit	*Limosa limosa*	1017	6539
05340	Bar-tailed Godwit	*Limosa lapponica*	103	3361
05410	Eurasian Curlew	*Numenius arquata*	242	6300
05460	Common Redshank	*Tringa totanus*	309	23,085
05820	Common Black-headed Gull	*Larus ridibundus*	16,014	437,660
05900	Mew Gull	*Larus canus*	2817	65,842
05910	Lesser Black-backed Gull	*Larus fuscus*	4513	116,842
05920	Herring Gull	*Larus argentatus*	9811	285,135
06000	Great Black-backed Gull	*Larus marinus*	558	23,382
06680	Stock Dove	*Columba oenas*	9	4072
06700	Common Wood Pigeon	*Columba palumbus*	167	9363
06840	Eurasian Collared Dove	*Streptopelia decaocto*	58	8981
06870	European Turtle Dove	*Streptopelia turtur*	10	1125
09760	Eurasian Skylark	*Alauda arvensis*	138	3526
11870	Common Blackbird	*Turdus merula*	3583	306,674
11980	Fieldfare	*Turdus pilaris*	516	12,517
12000	Song Thrush	*Turdus philomelos*	630	54,448
12010	Red-Winged Thrush	*Turdus iliacus*	361	11,615
12020	Mistle Thrush	*Turdus viscivorus*	17	4058
15390	European Roller	*Garrulus glandarius*	136	9641
15490	Eurasian Magpie	*Pica pica*	9	2688
15600	Western Jackdaw	*Corvus monedula*	154	39,212
15630	Rook	*Corvus frugilegus*	1193	14,098
15670	Carrion Crow	*Corvus corone*	1001	27,567
15820	Common Starling	*Sturnus vulgaris*	6496	157,062

Table 4: Annex II species with no data for either recovery analysis or mapping

	Species	
EURING code	**Common name**	**scientific name**
01960	Red-crested Pochard	*Netta rufina*
02040	Greater Scaup	*Aythya marila*
02120	Long-tailed Duck	*Clangula hyemalis*
02130	Black Scoter	*Melanitta nigra*
02150	Velvet Scoter	*Melanitta fusca*
02210	Red-breasted Merganser	*Mergus serrator*
03260	Hazel Grouse	*Bonasa bonasia*
03290	Red Grouse	*Lagopus lagopus*
03300	Rock Ptarmigan	*Lagopus mutus*
03320	Black Grouse	*Tetrao tetrix*
03350	Western Capercaillie	*Tetrao urogallus*
03550	Chukar Partridge	*Alectoris chukar*
03570	Rock Partridge	*Alectoris graeca*
03580	Red-legged Partridge	*Alectoris rufa*
03590	Barbary Partridge	*Alectoris barbara*
03640	Black Francolin	*Francolinus francolinus*
03670	Grey Partridge	*Perdix perdix*
03940	Common Pheasant	*Phasianus colchicus*
05380	Whimbrel	*Numenius phaeopus*
05450	Spotted Redshank	*Tringa erythropus*
05480	Common Greenshank	*Tringa nebularia*
06650	Common Pigeon	*Columba livia*
06840	Eurasian Collared Dove	*Streptopelia decaocto*

In the following **species accounts**, we present standardized results for each species with at least one geographical region providing sufficient data for the recovery analysis or with sufficient data for the mapping.

Recovery analysis

Figure 1 of the recovery analysis shows the onset of pre-nuptial (return) migration of the species by geographical region and decade. The upper panel shows per decade the number of recoveries of birds that moved at least 100 km in northbound directions. The asterix denotes the median date of onset of return migration. The middle panel shows the proportion of recoveries of birds that moved at least 100 km in northbound directions for each decade, and the lower panel gives the median distance moved for each decade in which at least three recoveries were available.

Important notice:
For the analysis of onset of pre-nuptial migration based on recovery data of ringed birds we applied a most conservative approach by selecting only those birds which have been already on return migration.

Mapping

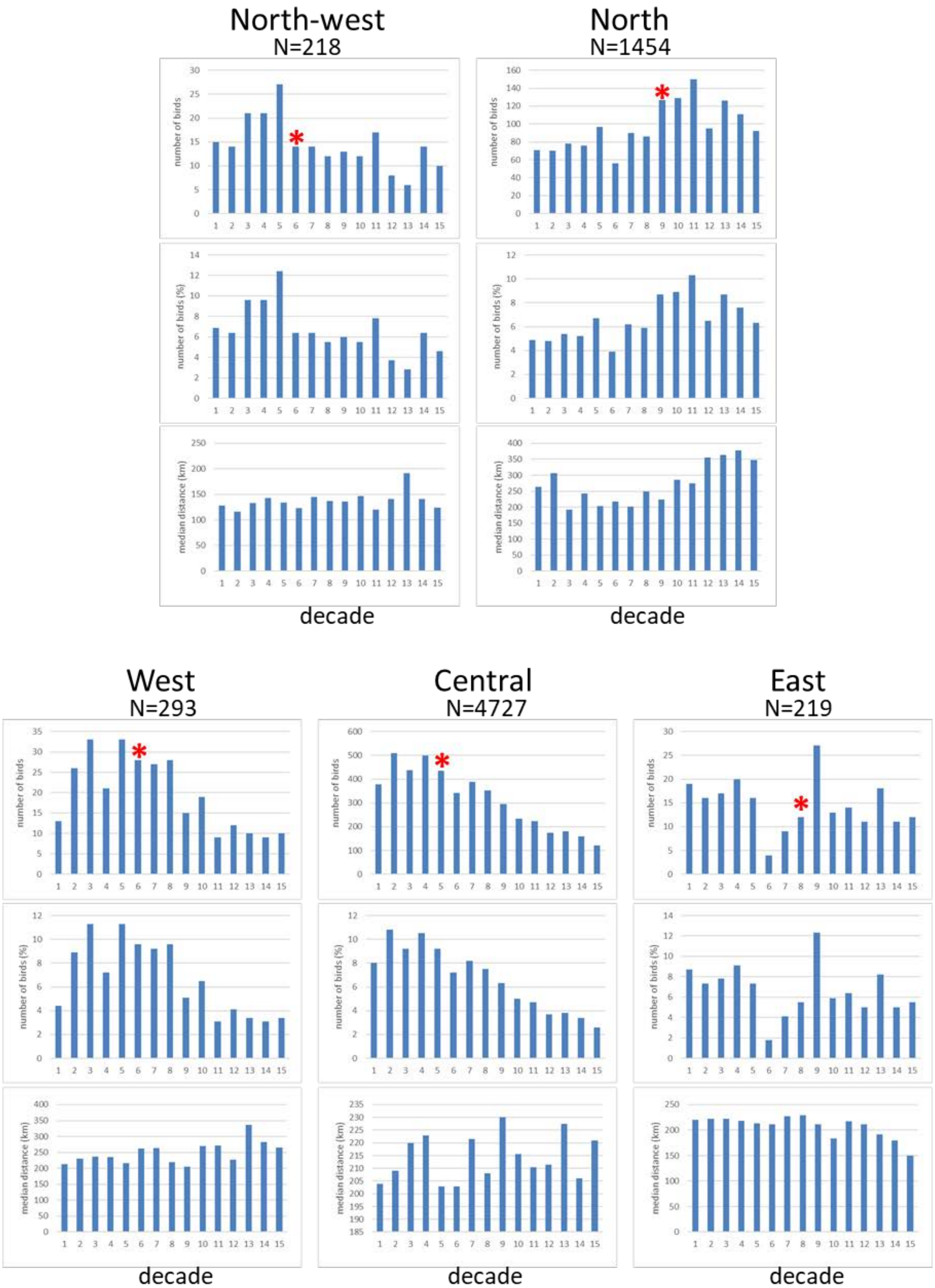
Three maps derived from the modelling of movement probabilities are presented: map 1 shows the grids used for the analyses of pre-nuptial migration progression with the number of encounters used, the minimum number of encounters in a cell, and the minimum number of different encounter dates in a cell. Map 2 shows the onset of pre-nuptial migration, i.e. the monthly decade when 5% of individuals are on migration, and map 3 shows the median migration date (decade of migration of the first 50% of individuals). Colours in map 2 and 3 represent the monthly ten-day periods, lines show the isochrones.

The modelling of movement probabilities for each species with sufficient data resulted in a set of 27 maps with all possible parameter combinations. These maps were used to produce a map of the uncertainty in the timing of onset of pre-nuptial migration due to the uncertainty in the parameters entered in the model. The standard error was used as a measure of such uncertainty. These species-specific maps of the standard error of the date of onset of pre-nuptial migration progression are shown in Appendix 1.

All maps for each species can be viewed at https://unimibox.unimi.it/index.php/s/2JDoWL6fxyA7jeP

01520 Mute Swan *Cygnus olor*

Recovery analysis



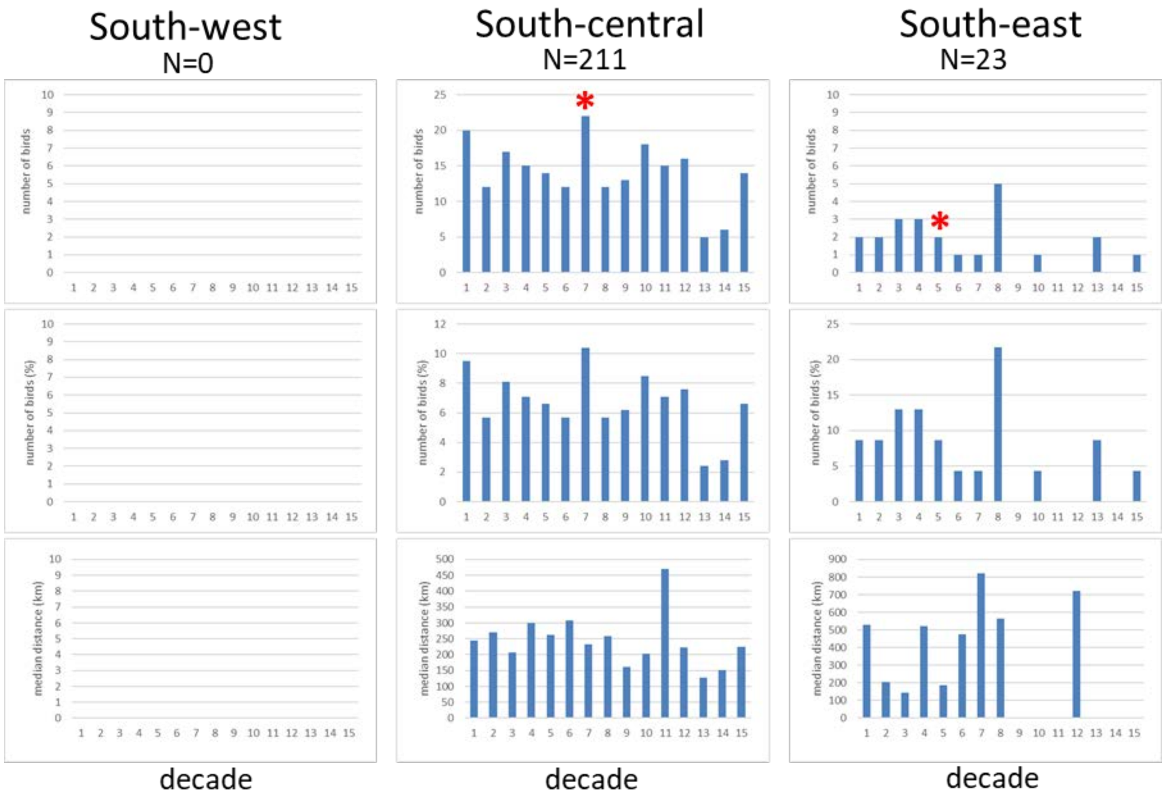


Fig. 1: Onset of prenuptial (return) migration of Mute Swan by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

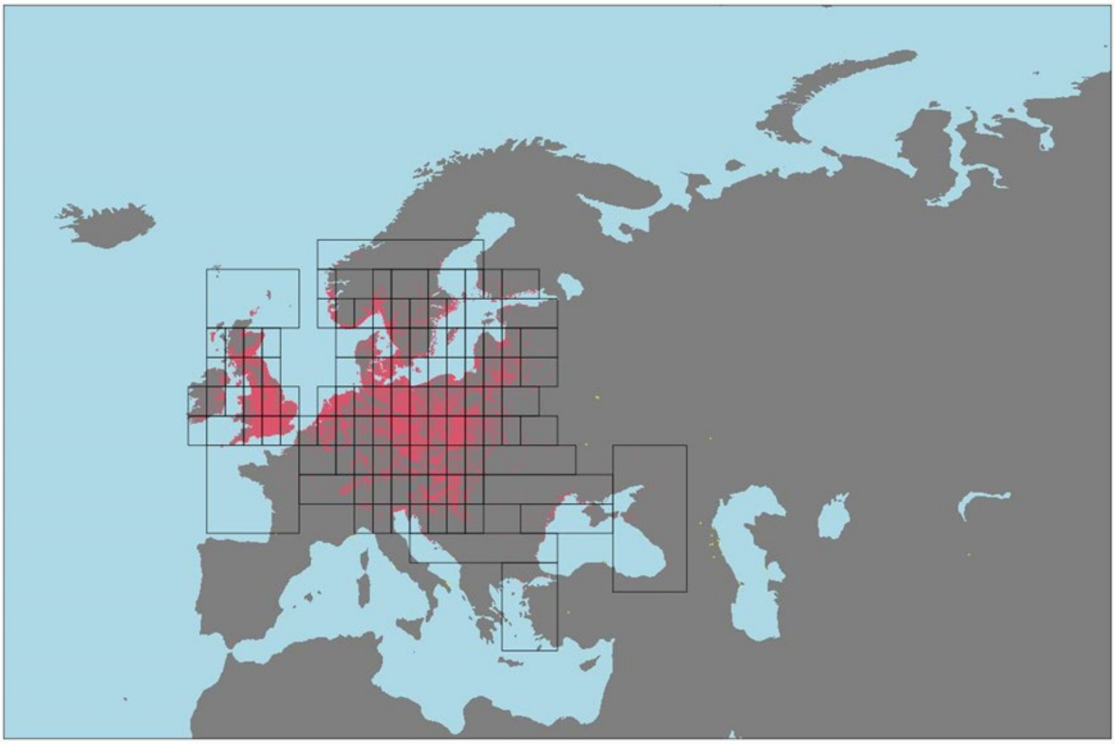


Fig. 2: Data availability for the analyses of Mute Swan pre-nuptial migration. Red dots: encounters used (311,201), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell =10.

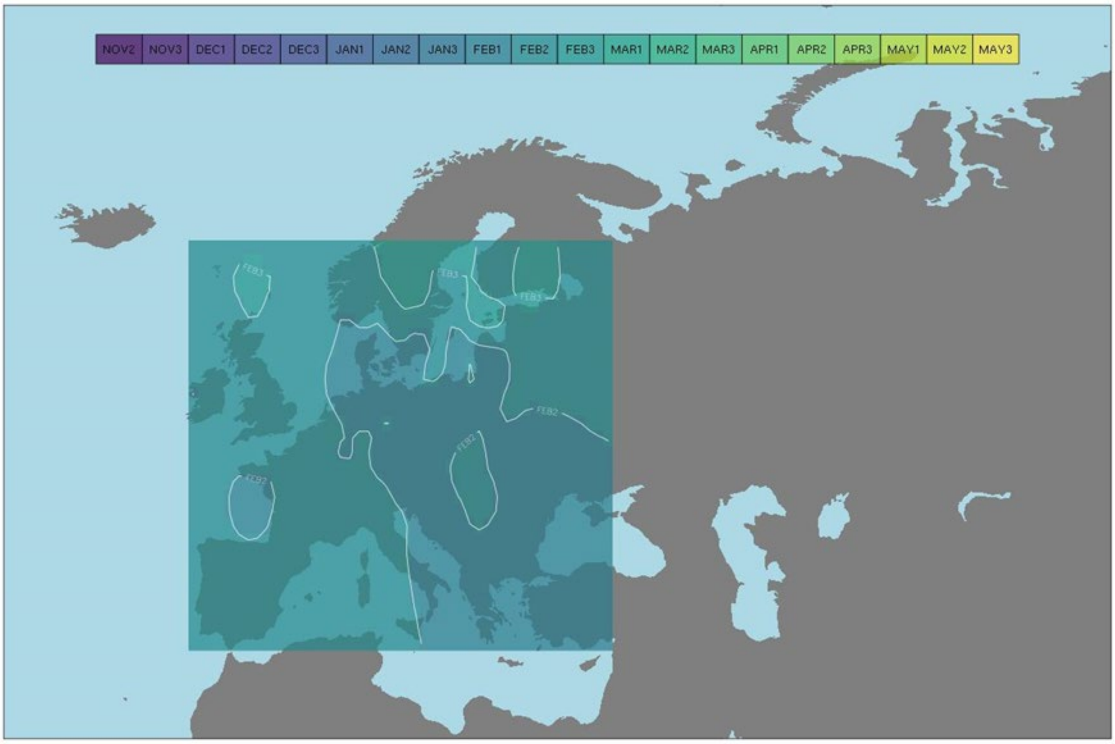


Fig. 3: Onset of pre-nuptial migration of Mute Swan. The map shows the date when 5% of individuals are on migration.

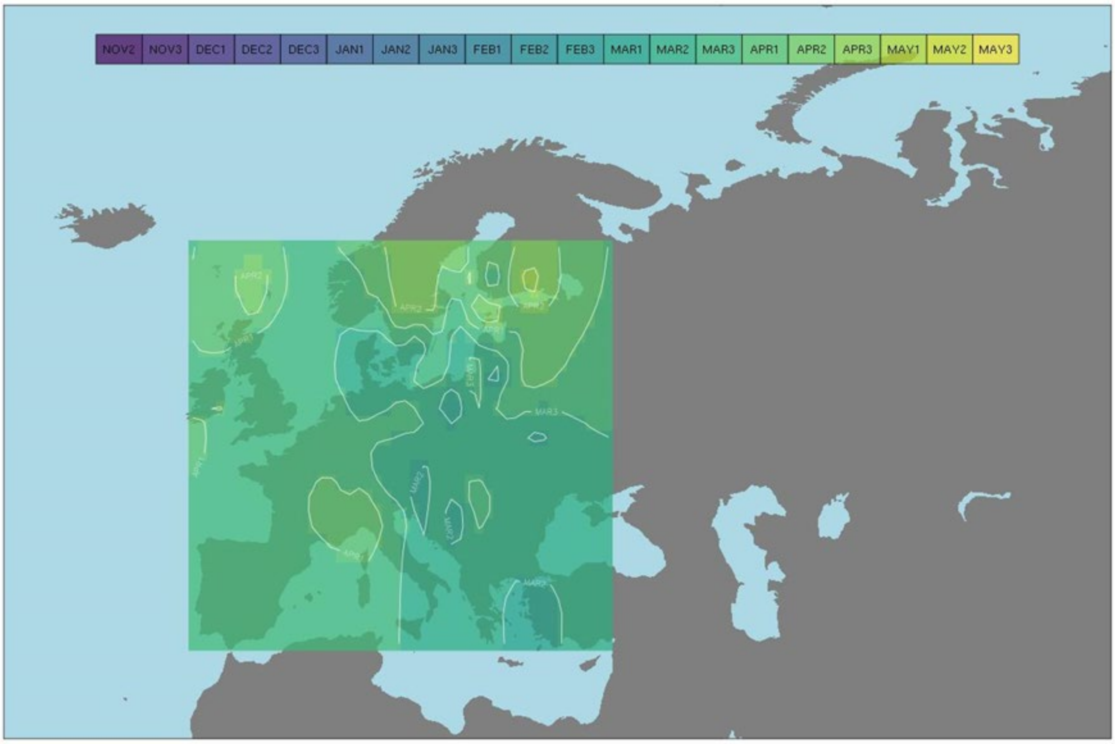


Fig. 4: Median migration date of pre-nuptial migration of Mute Swan. The map shows the date when 50% of individuals are on migration.

01570 Bean Goose *Anser fabalis*

Recovery analysis

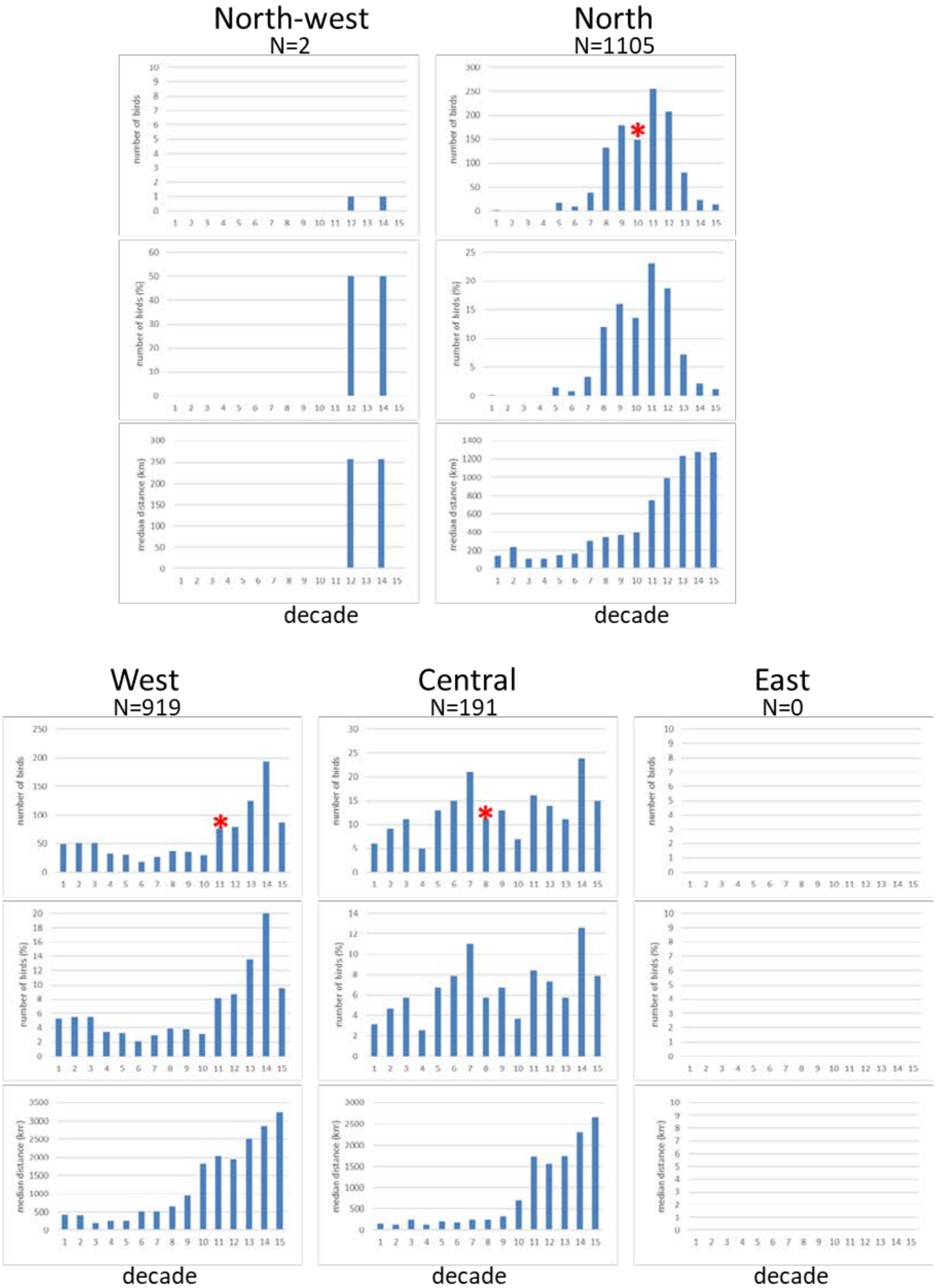


Fig. 1: Onset of prenuptial (return) migration of Bean Goose by geographical region and decade. The asterix denotes the median date of onset of return migration. No data for South-west, South-central, South-east.

Mapping analysis

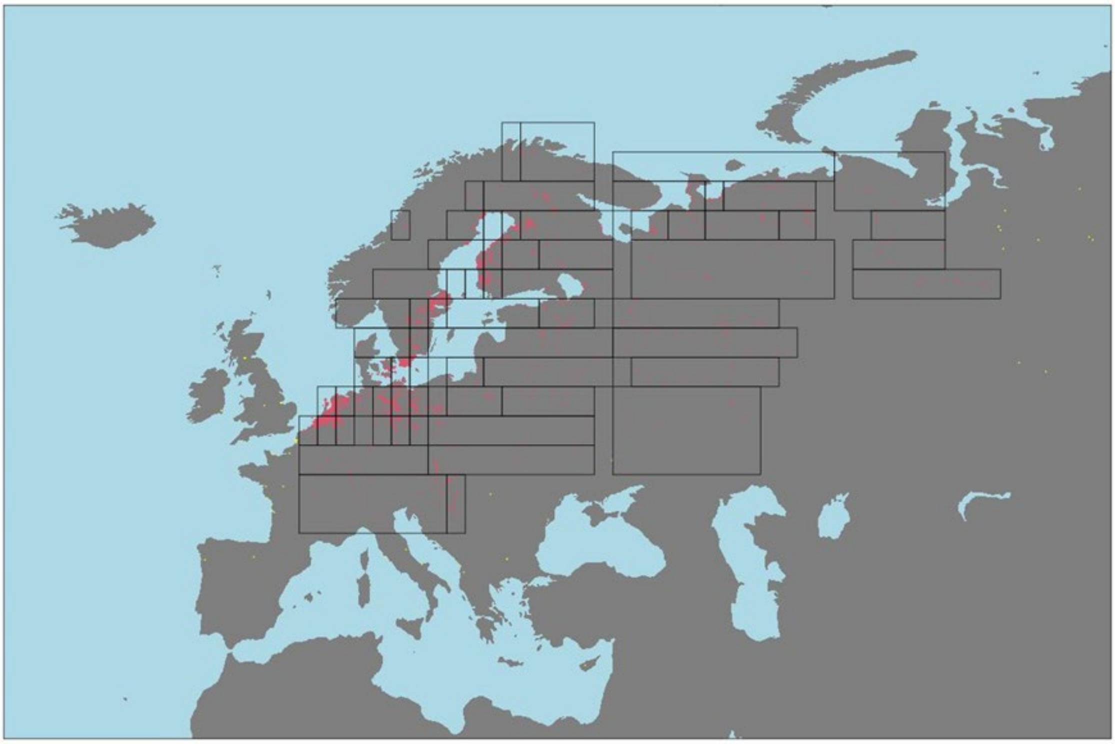


Fig. 2: Data availability for the analyses of Bean Goose pre-nuptial migration. Red dots: encounters used (11,324), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell =7.

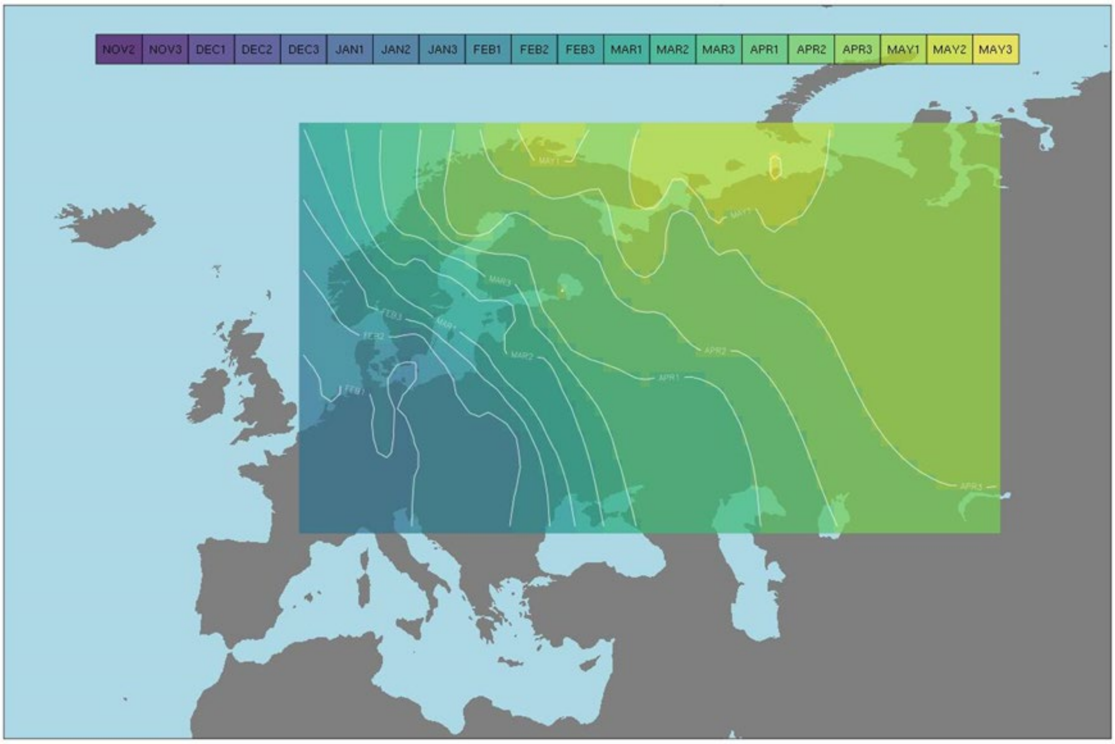


Fig. 3: Onset of pre-nuptial migration of Bean Goose. The map shows the date when 5% of individuals are on migration.

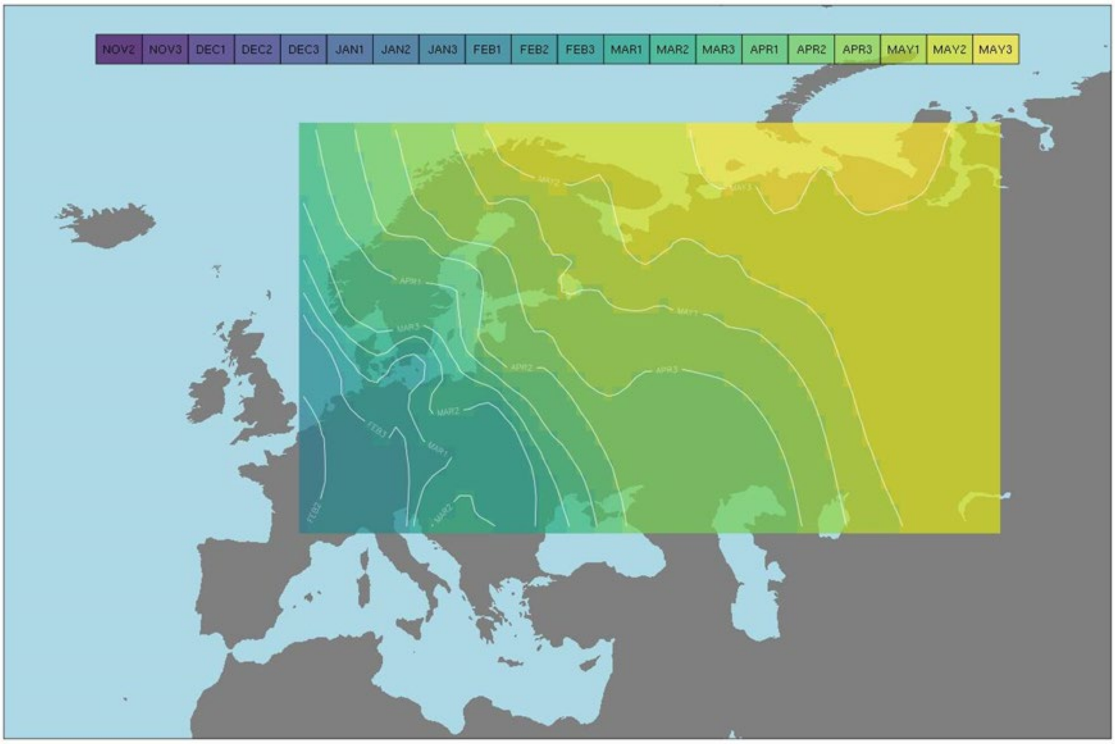


Fig. 4: Median migration date of pre-nuptial migration of Bean Goose. The map shows the date when 50% of individuals are on migration.

01580 Pink-footed Goose *Anser brachyrhynchus*

Recovery analysis

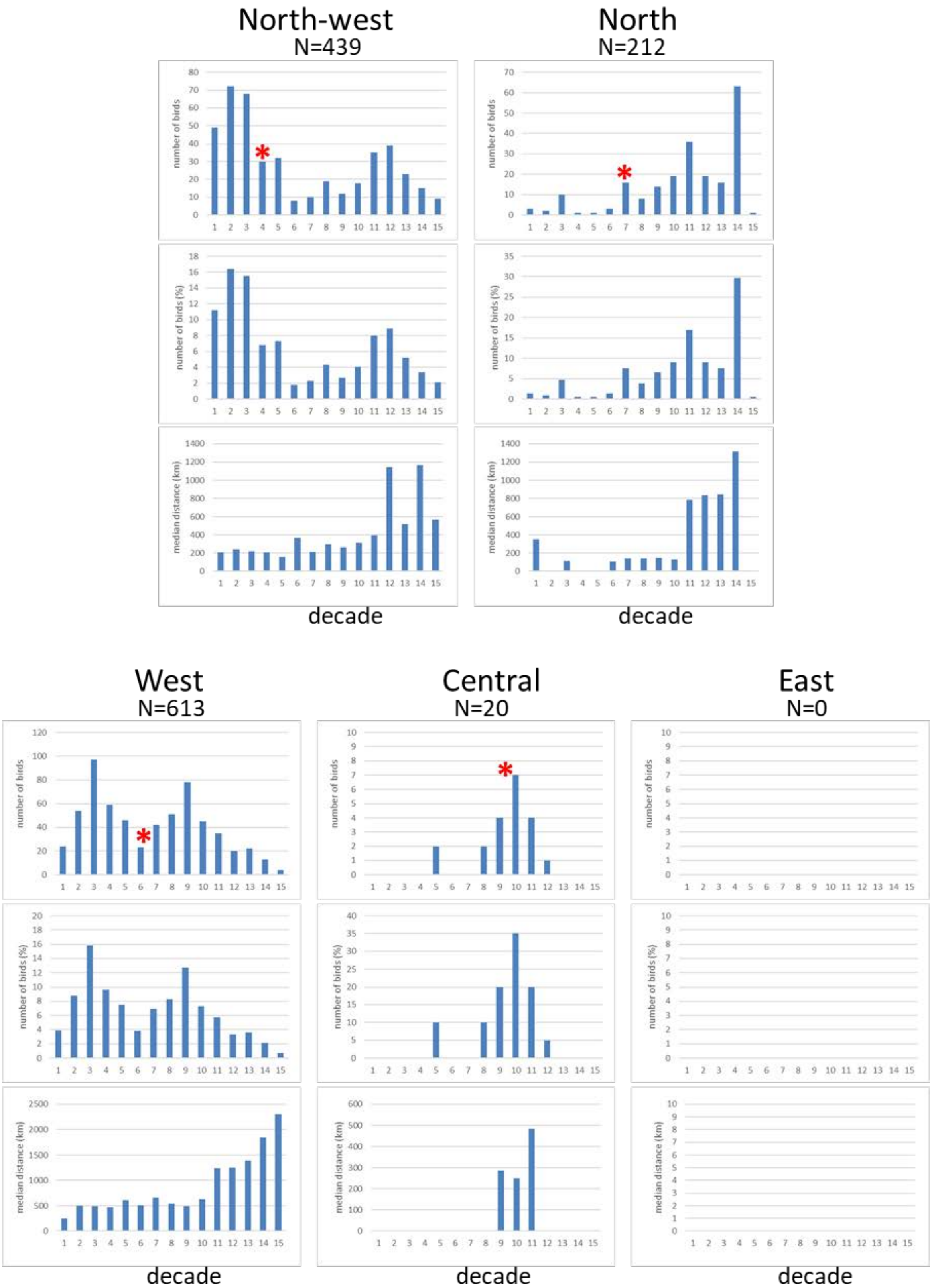


Fig. 1: Onset of prenuptial (return) migration of Pink-footed Goose by geographical region and decade. The asterix denotes the median date of onset of return migration. No data for South-west, South-central, South-east.

Mapping analysis

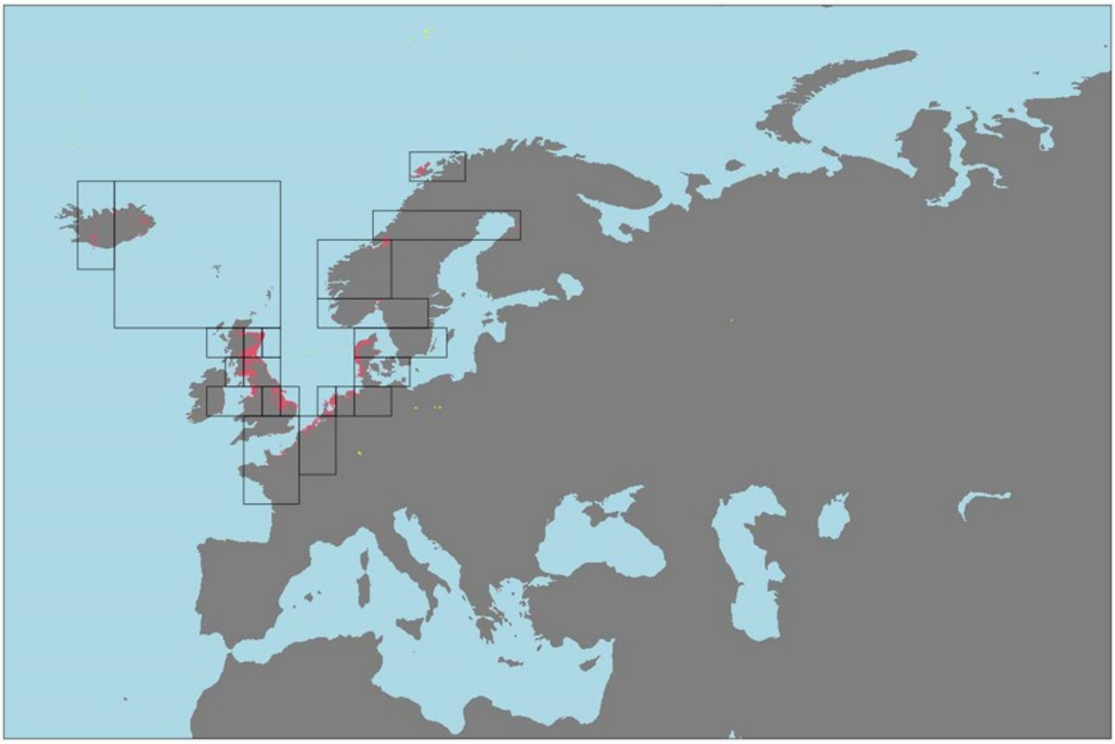


Fig. 2: Data availability for the analyses of Pink-footed Goose pre-nuptial migration. Red dots: encounters used (10,297), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

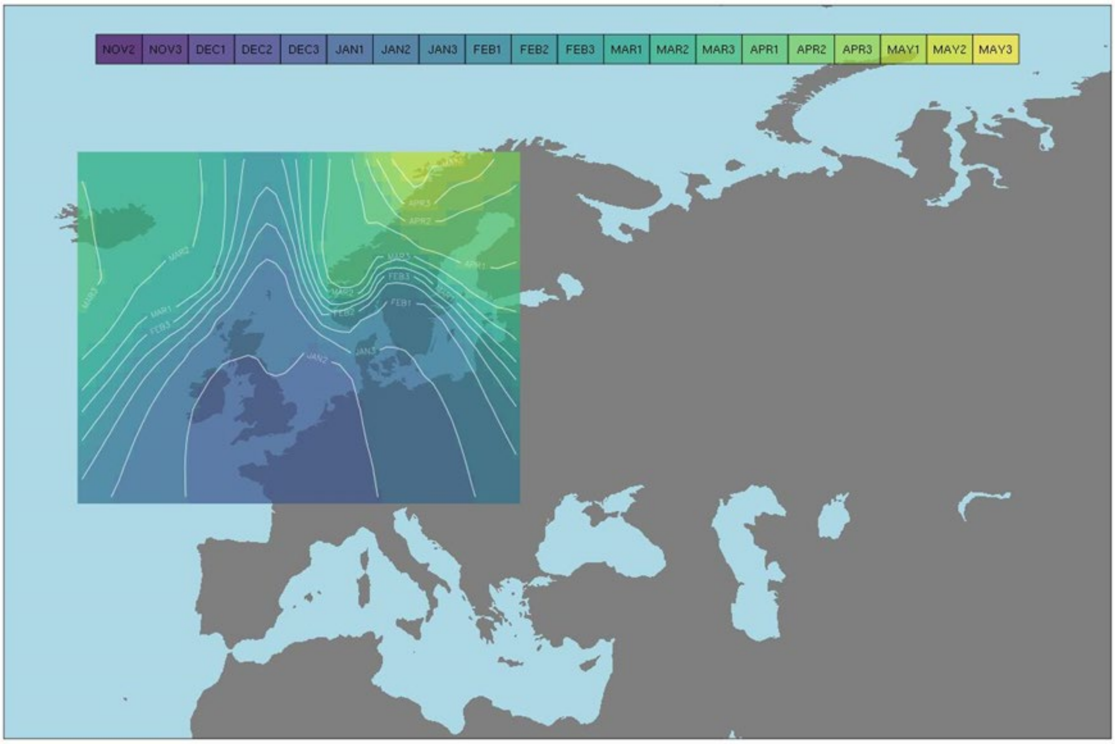


Fig. 3: Onset of pre-nuptial migration of Pink-footed Goose. The map shows the date when 5% of individuals are on migration.

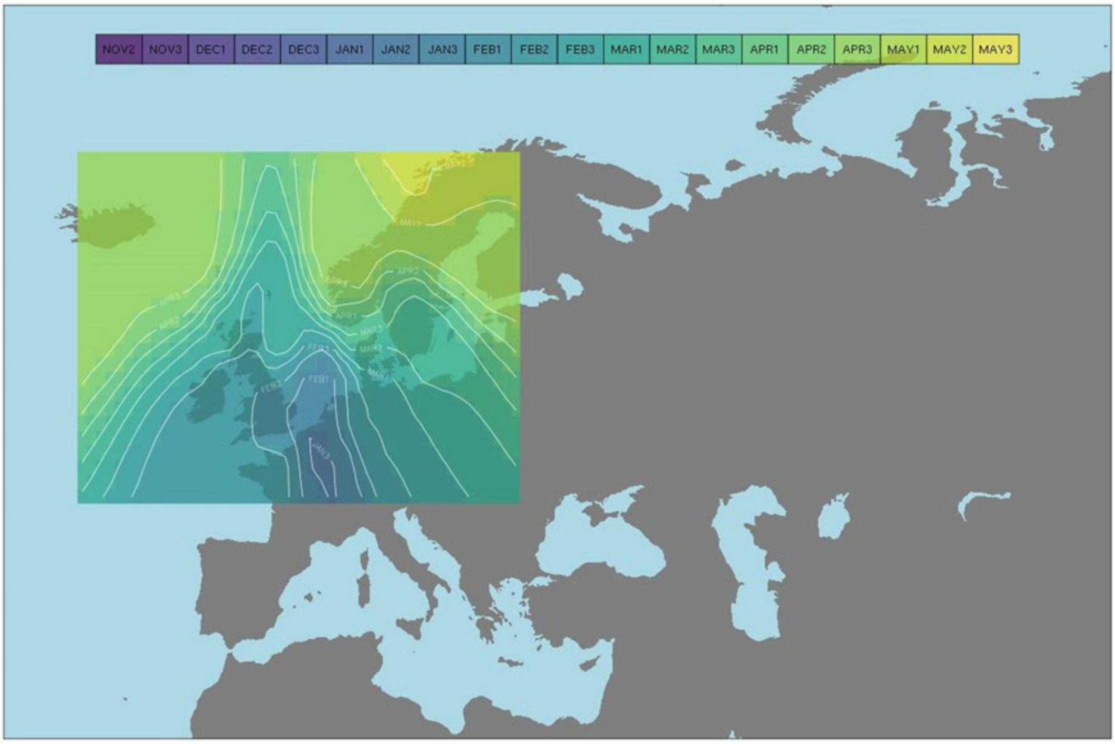
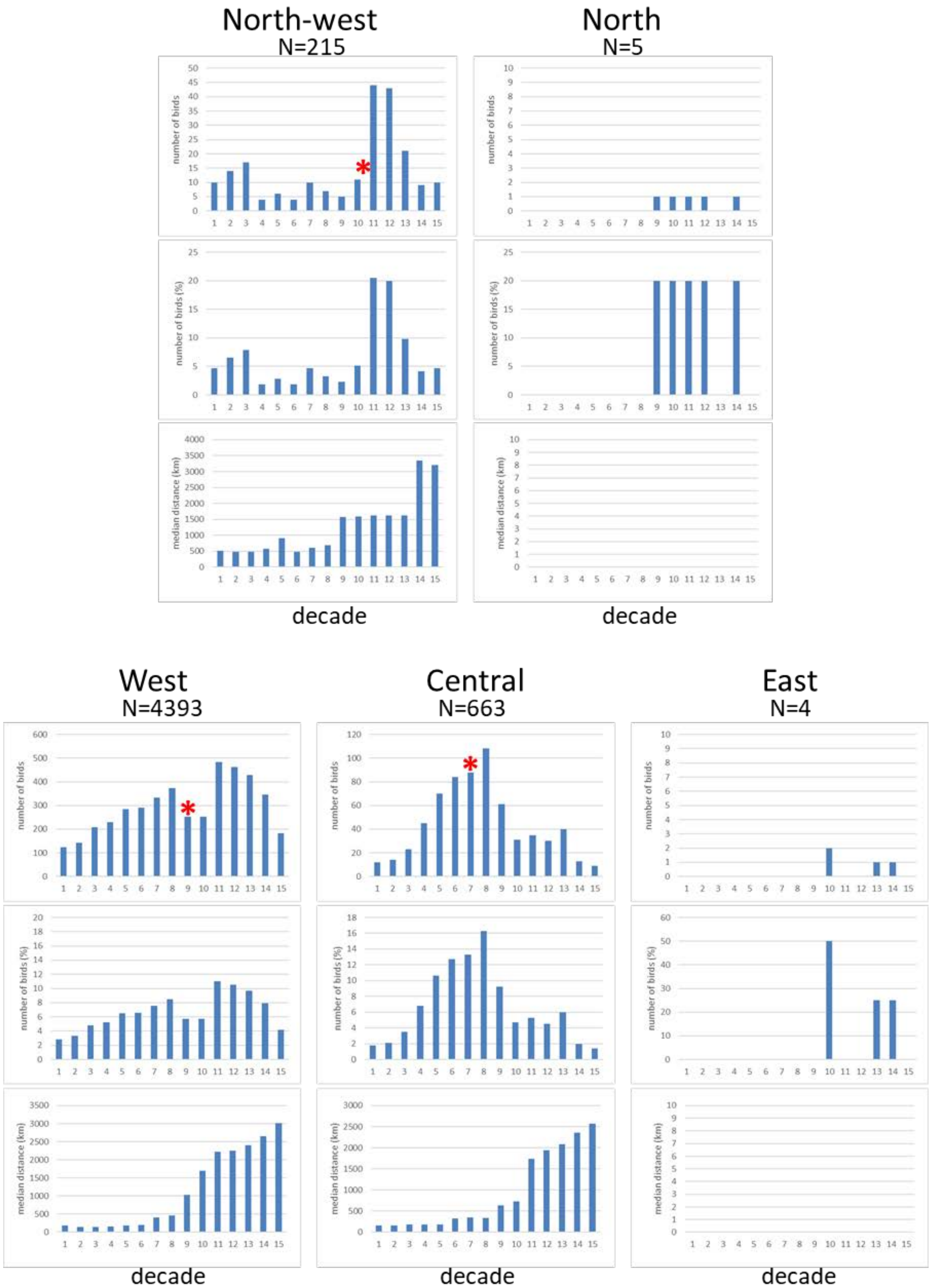


Fig. 4: Median migration date of pre-nuptial migration of Pink-footed Goose. The map shows the date when 50% of individuals are on migration.

01590 Greater White-fronted Goose *Anser albifrons*

Recovery analysis



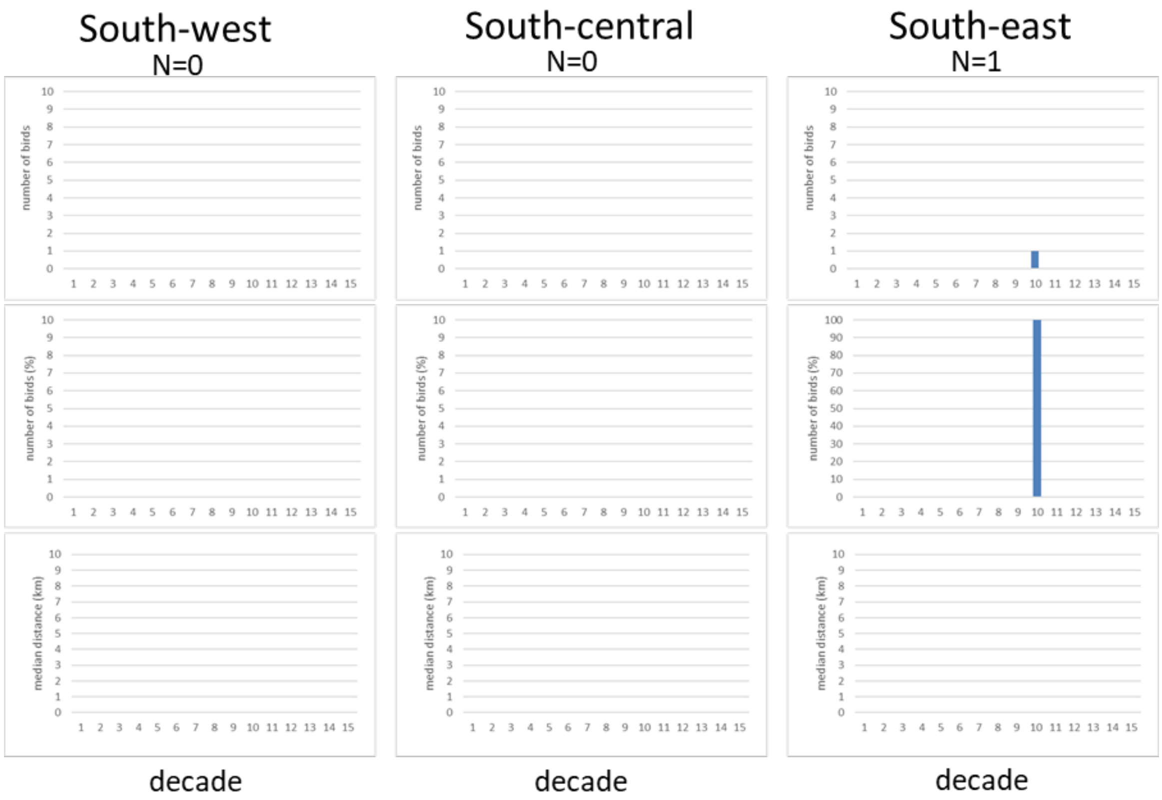


Fig. 1: Onset of prenuptial (return) migration of Greater White-fronted Goose by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

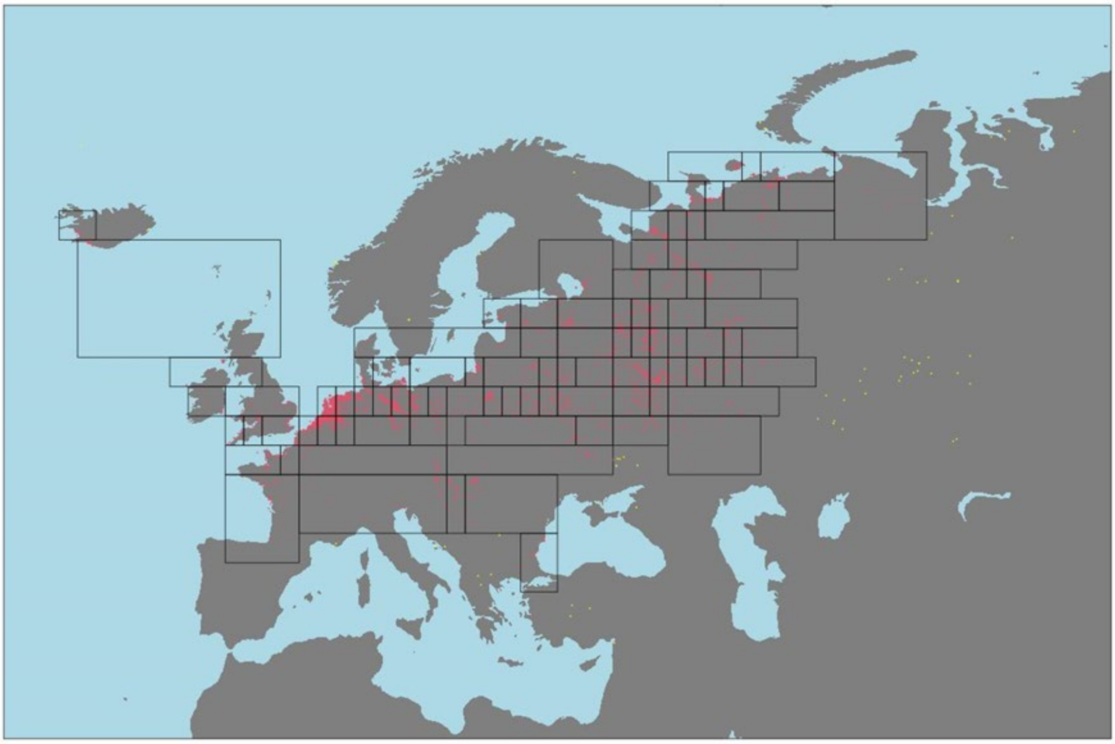


Fig. 2: Data availability for the analyses of Greater White-fronted Goose pre-nuptial migration. Red dots: encounters used (27,944), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

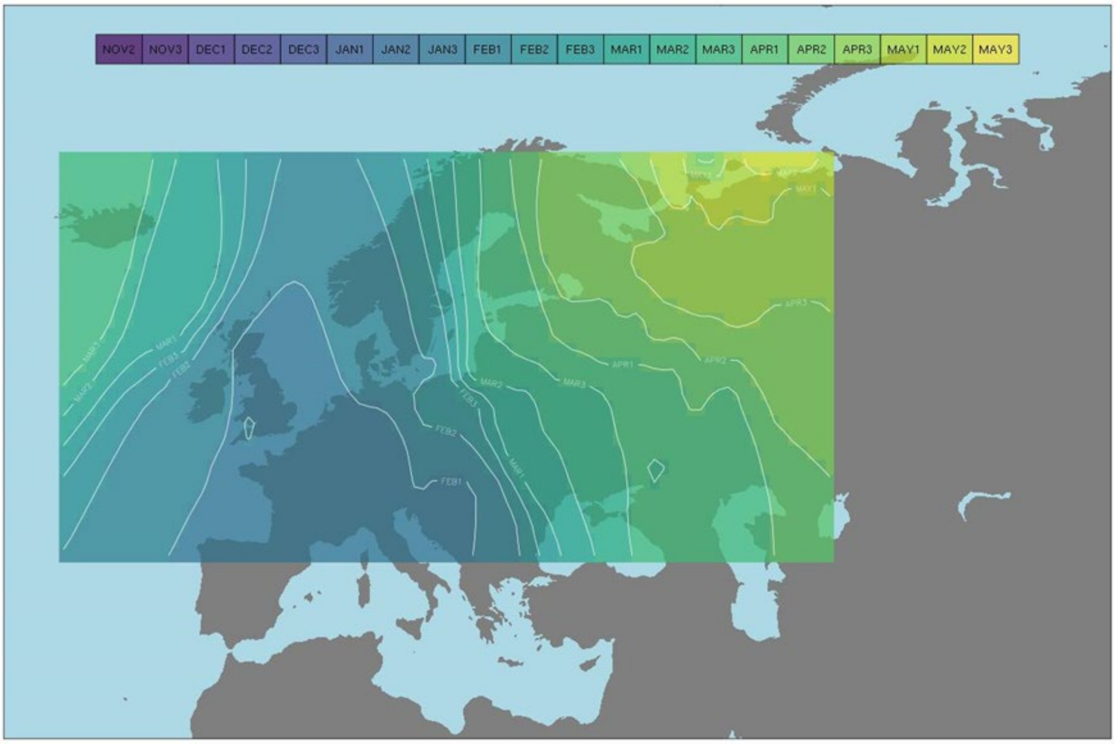


Fig. 3: Onset of pre-nuptial migration of Greater White-fronted Goose. The map shows the date when 5% of individuals are on migration.

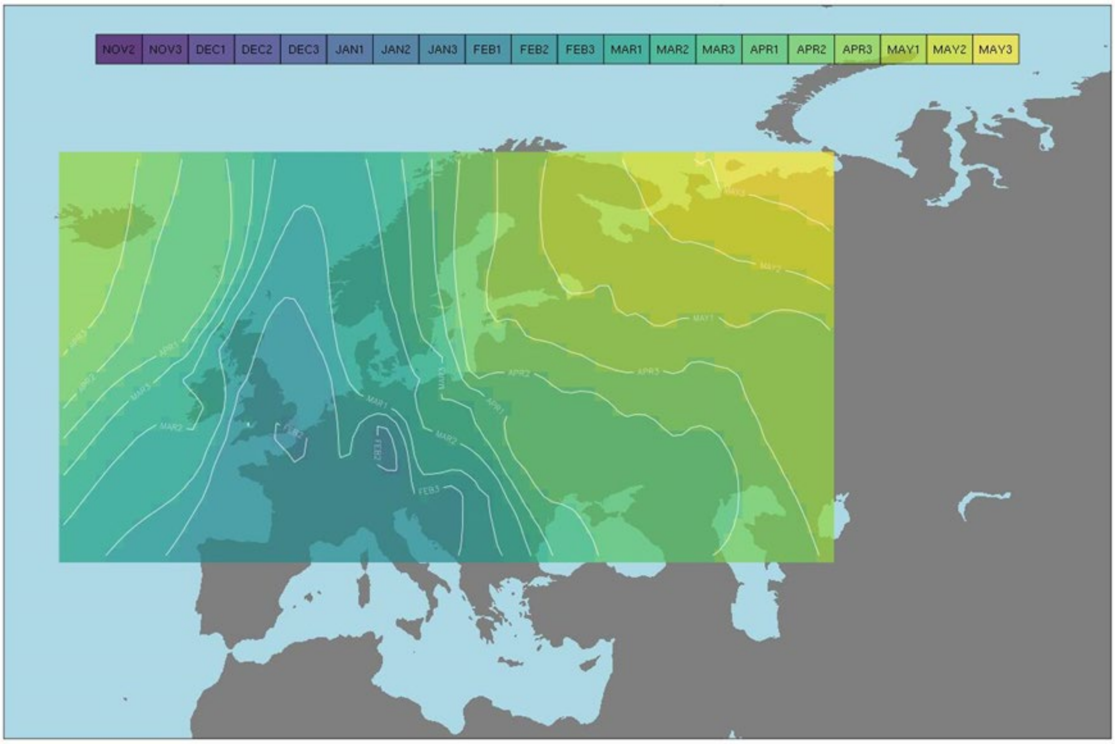
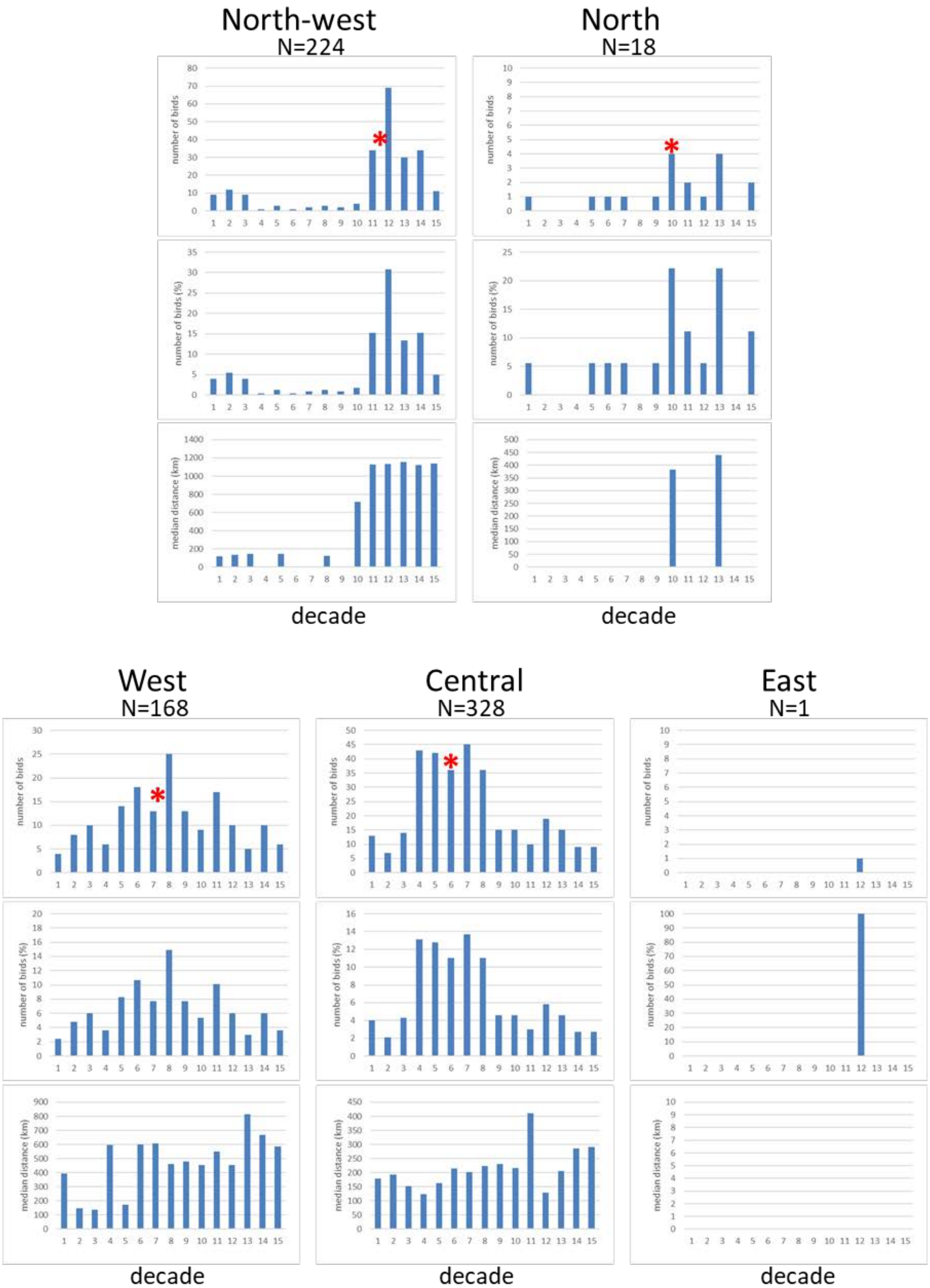


Fig. 4: Median migration date of pre-nuptial migration of Greater White-fronted Goose. The map shows the date when 50% of individuals are on migration.

01610 Greylag Goose *Anser anser*

Recovery analysis



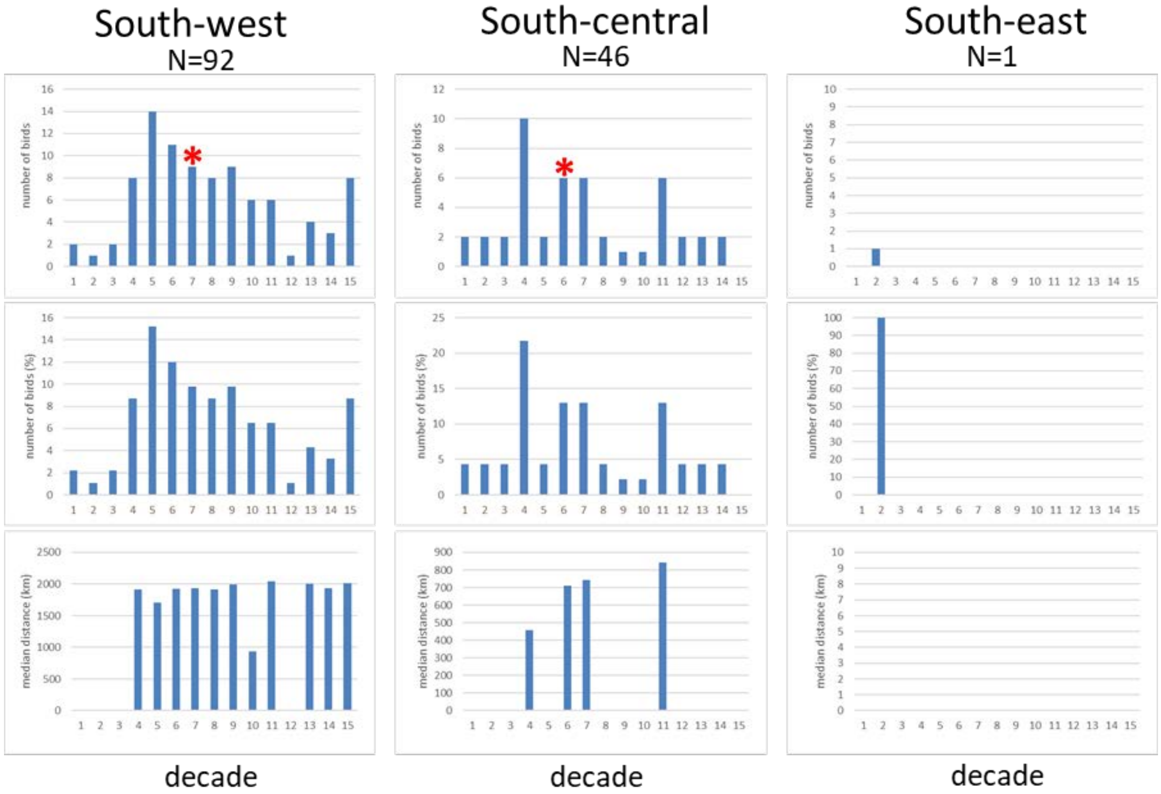


Fig. 1: Onset of prenuptial (return) migration of Greylag Goose by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

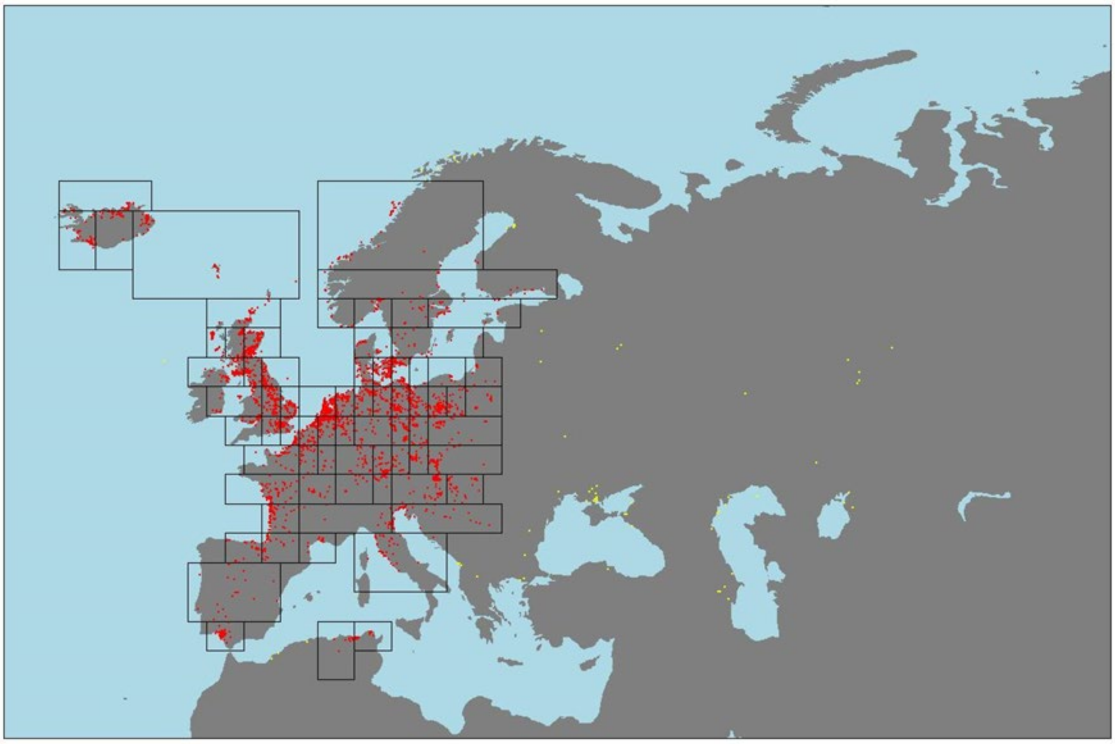


Fig. 2: Data availability for the analyses of Greylag Goose pre-nuptial migration. Red dots: encounters used (70,038), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

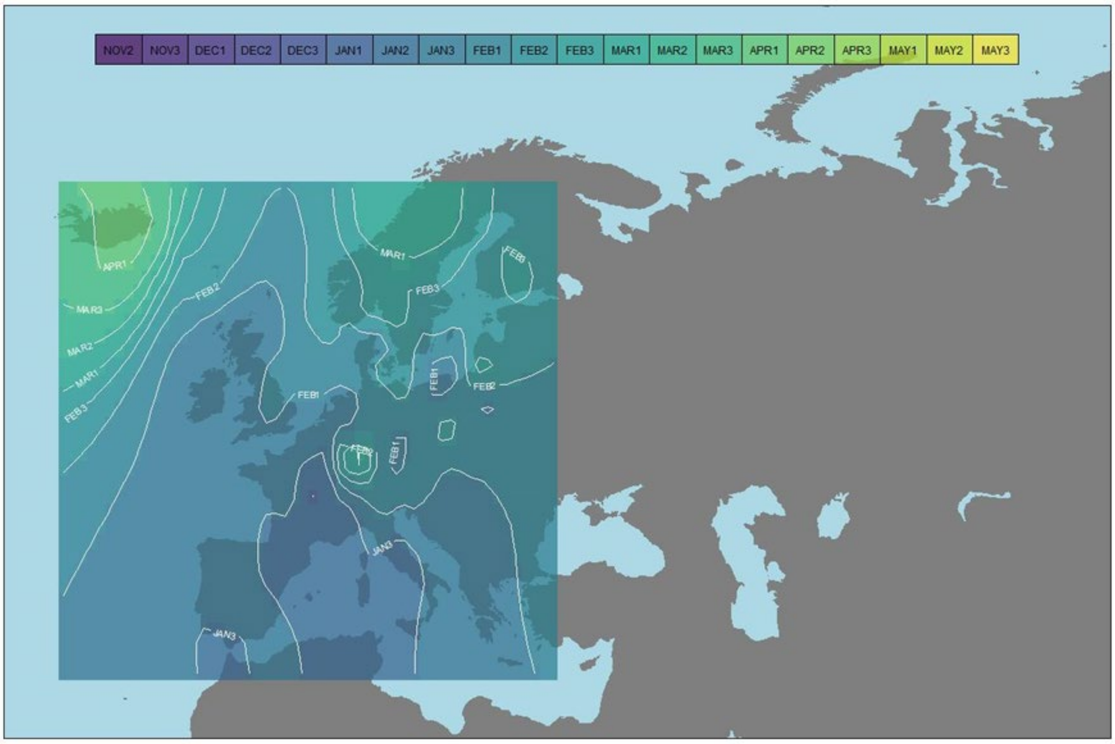


Fig. 3: Onset of pre-nuptial migration of Greylag Goose. The map shows the date when 5% of individuals are on migration.

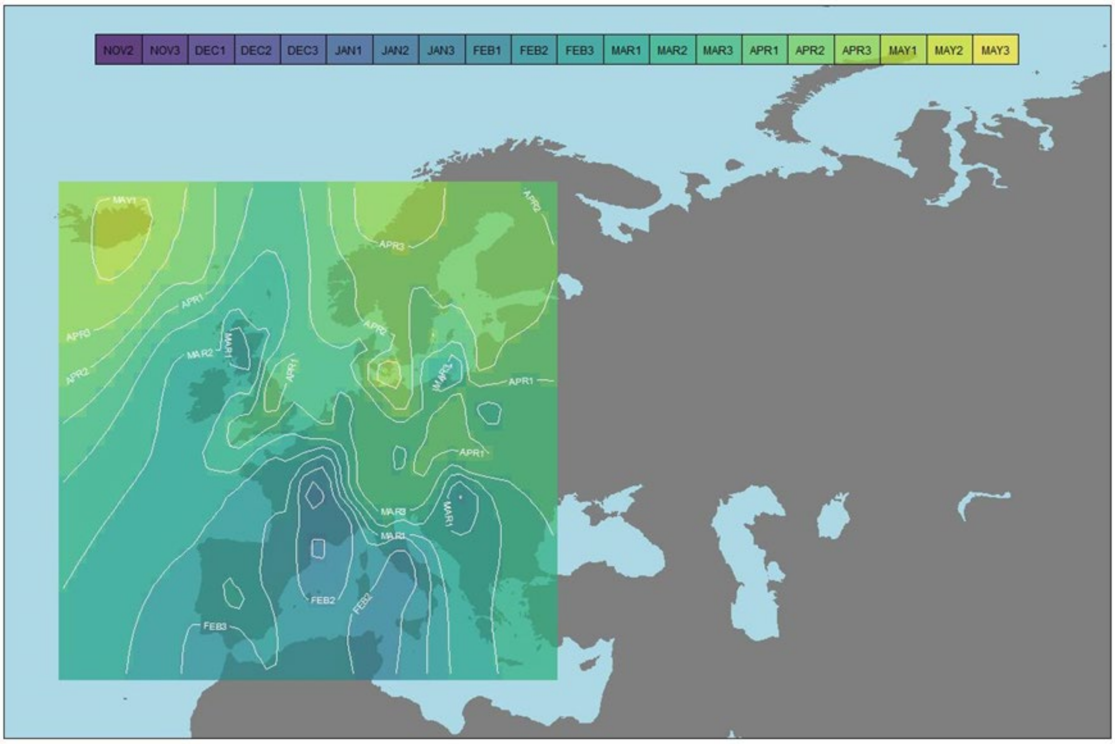


Fig. 4: Median migration date of pre-nuptial migration of Greylag Goose. The map shows the date when 50% of individuals are on migration.

01660 Canada Goose *Branta canadensis*

Recovery analysis

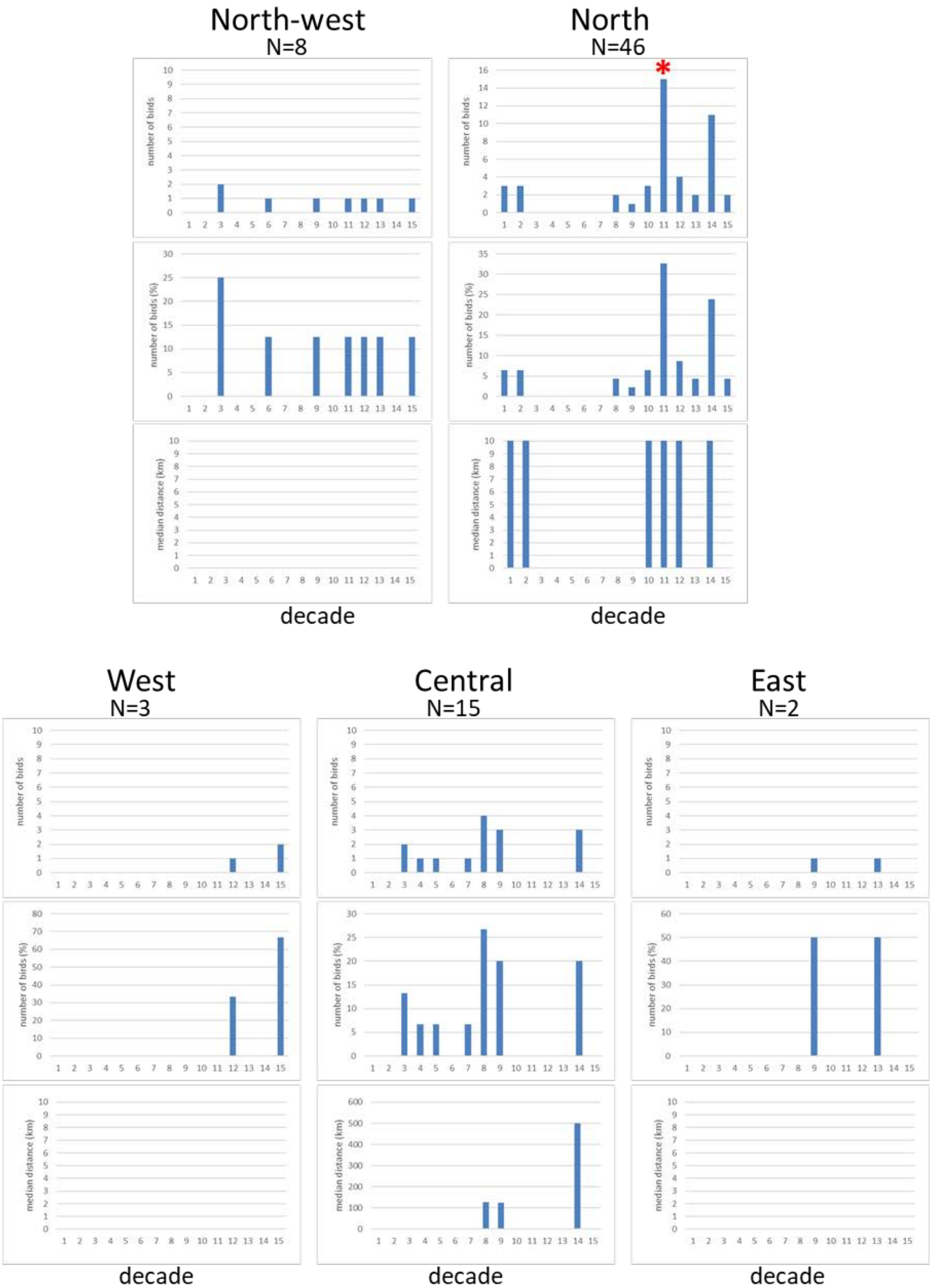


Fig. 1: Onset of prenuptial (return) migration of Canada Goose by geographical region and decade. The asterix denotes the median date of onset of return migration. No data from South-west, South-central, South-east.

Mapping analysis

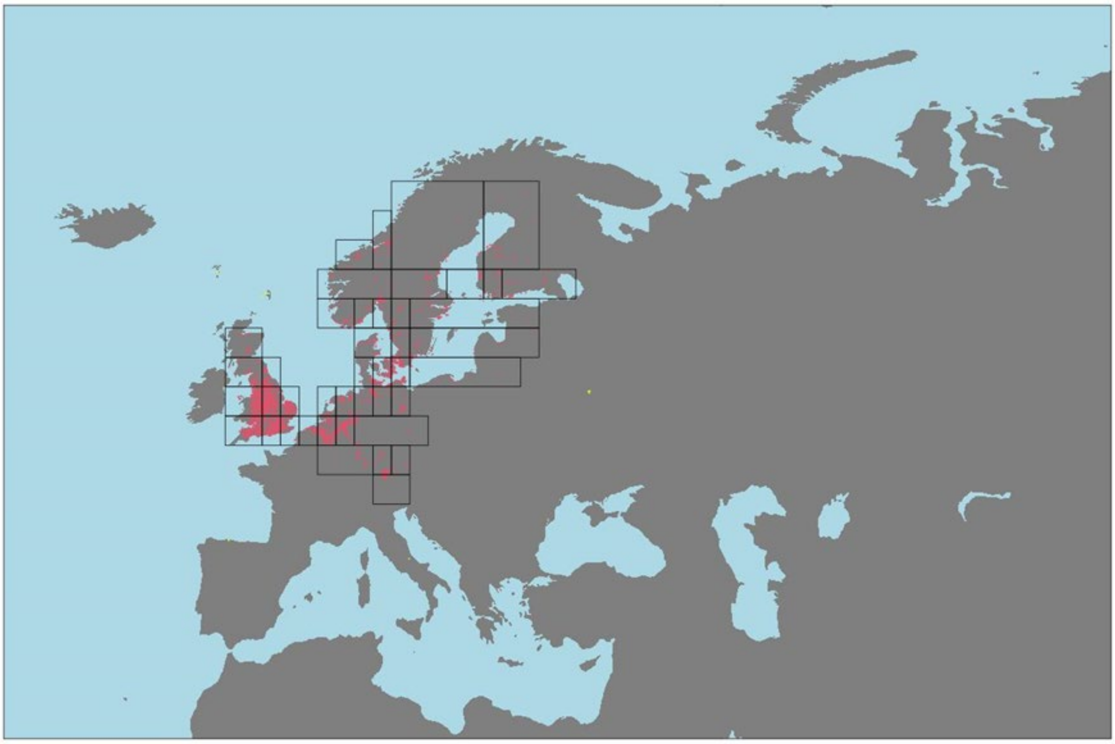


Fig. 2: Data availability for the analyses of Canada Goose pre-nuptial migration. Red dots: encounters used (29,541), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

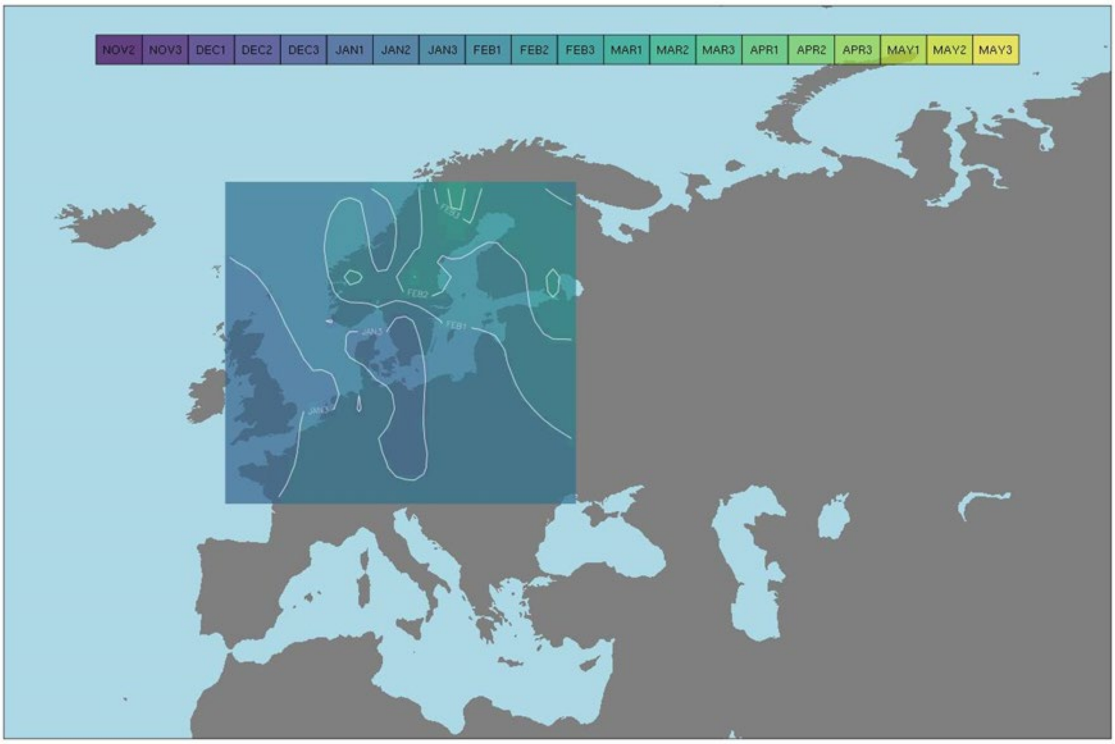


Fig. 3: Onset of pre-nuptial migration of Canada Goose. The map shows the date when 5% of individuals are on migration.

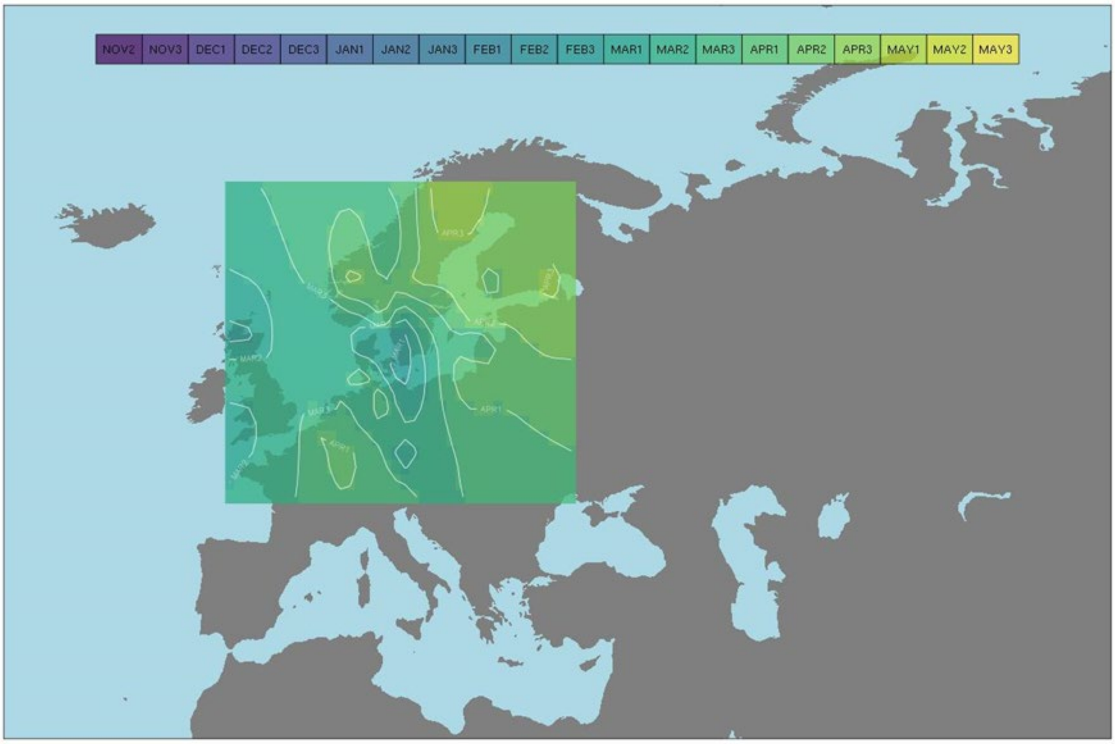


Fig. 4: Median migration date of pre-nuptial migration of Canada Goose. The map shows the date when 50% of individuals are on migration.

01680 Brant Goose *Branta bernicla*

Recovery analysis

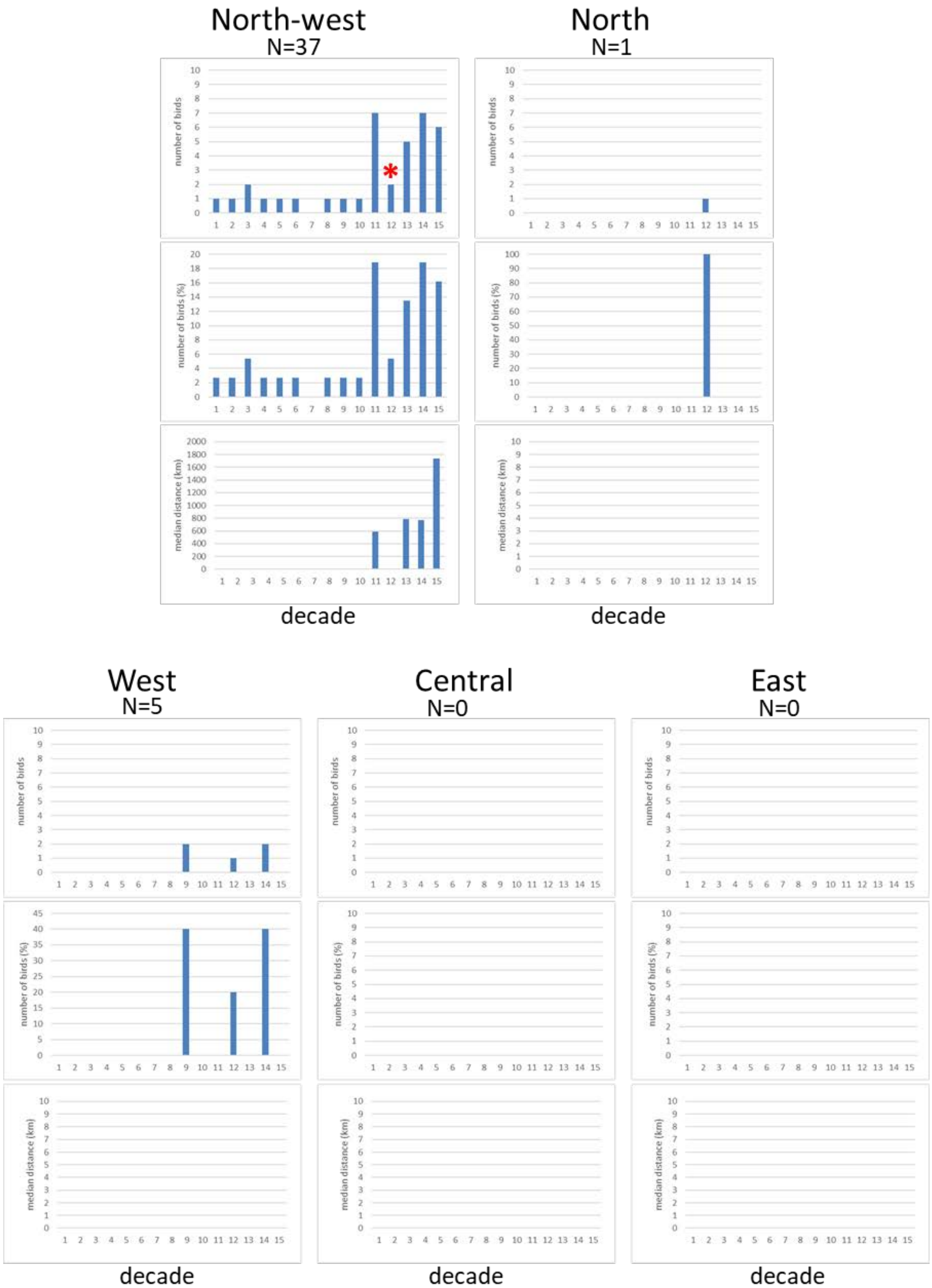


Fig. 1: Onset of prenuptial (return) migration of Brant Goose by geographical region and decade. The asterix denotes the median date of onset of return migration. No data from South-west, South-central, South-east.

Mapping analysis

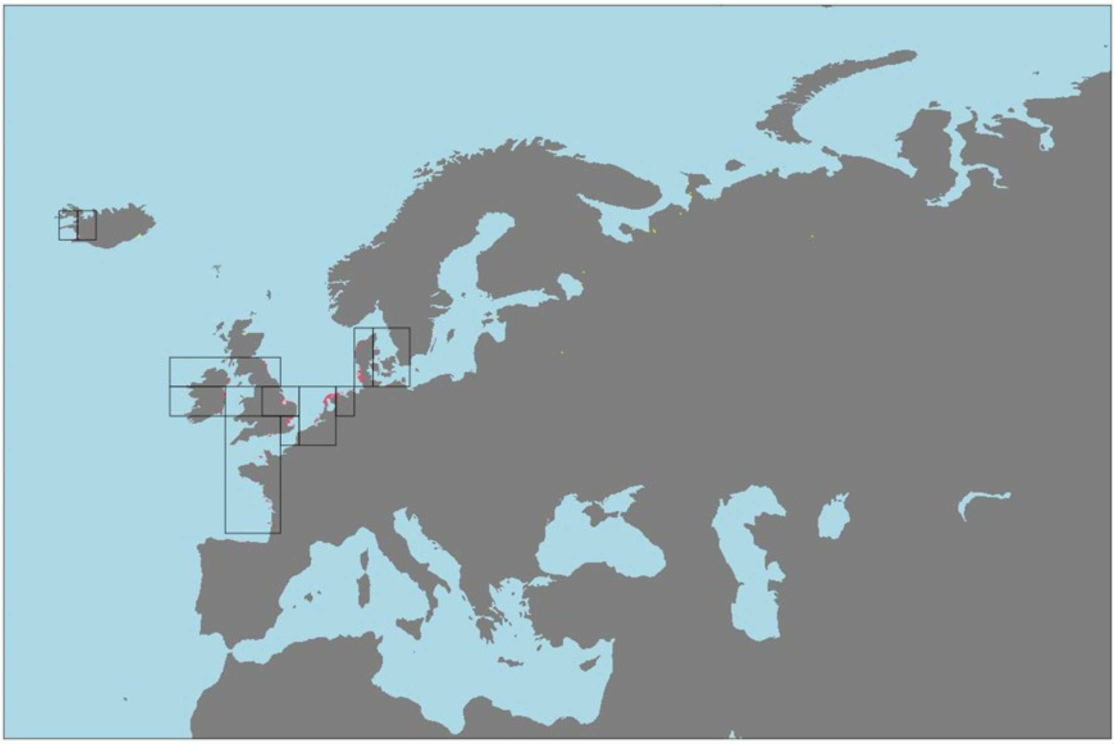


Fig. 2: Data availability for the analyses of Brant Goose pre-nuptial migration. Red dots: encounters used (2042), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

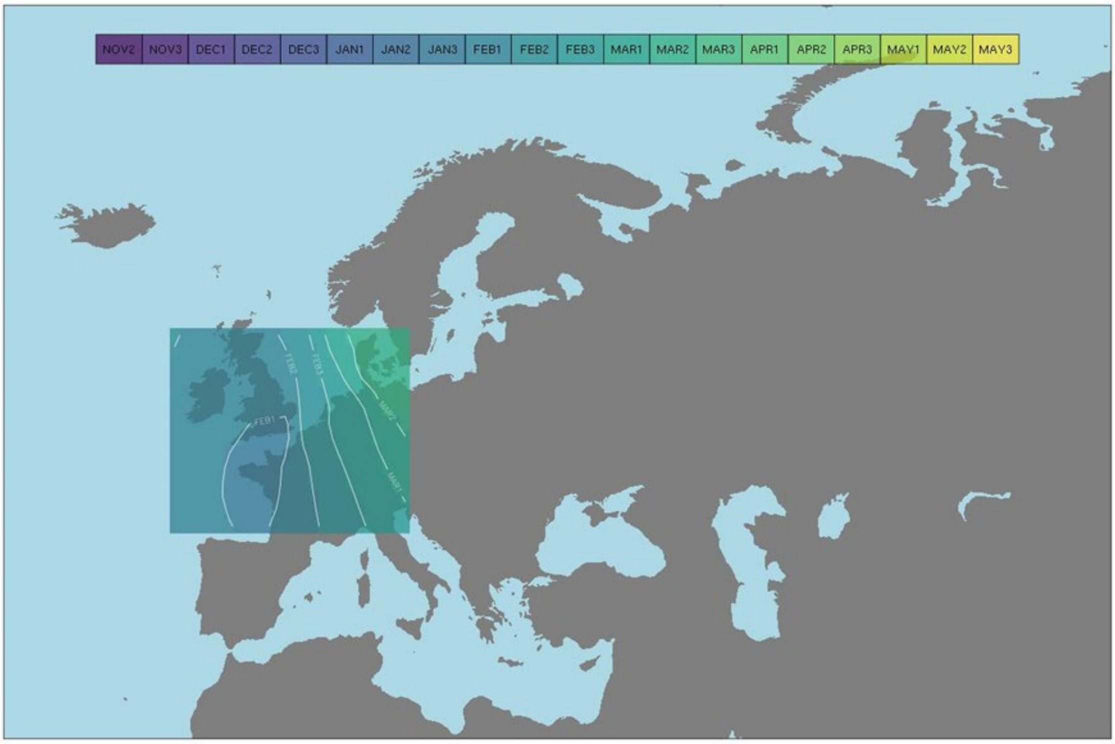


Fig. 3: Onset of pre-nuptial migration of Brant Goose. The map shows the date when 5% of individuals are on migration.

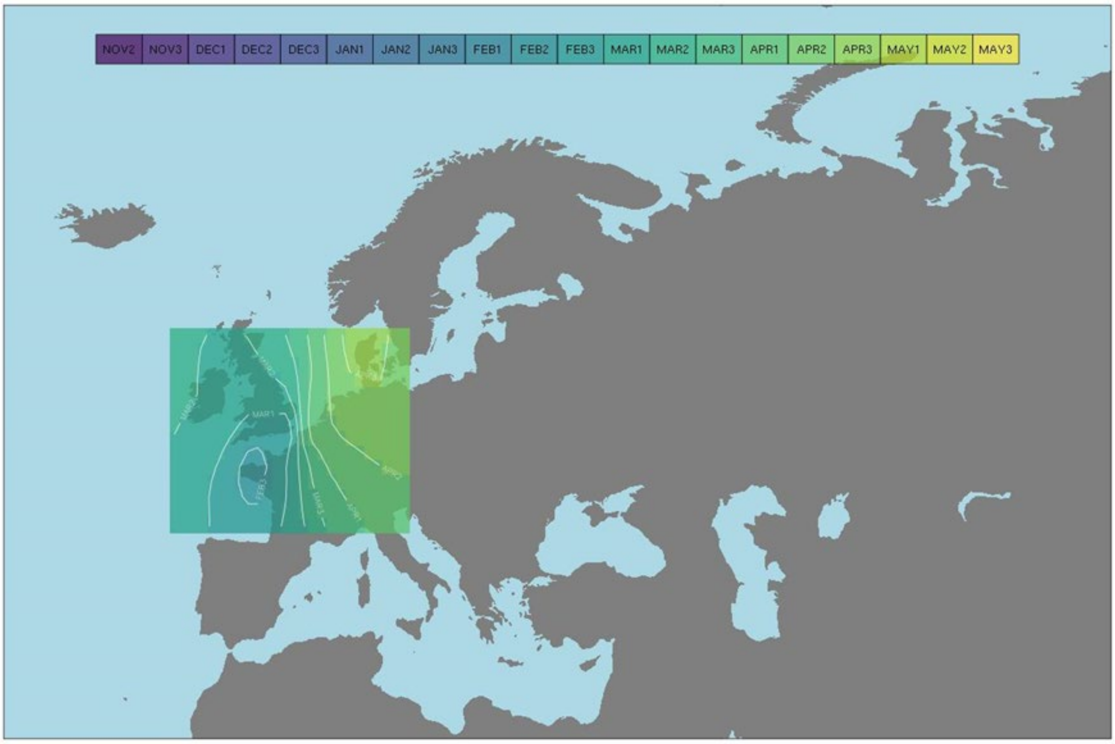
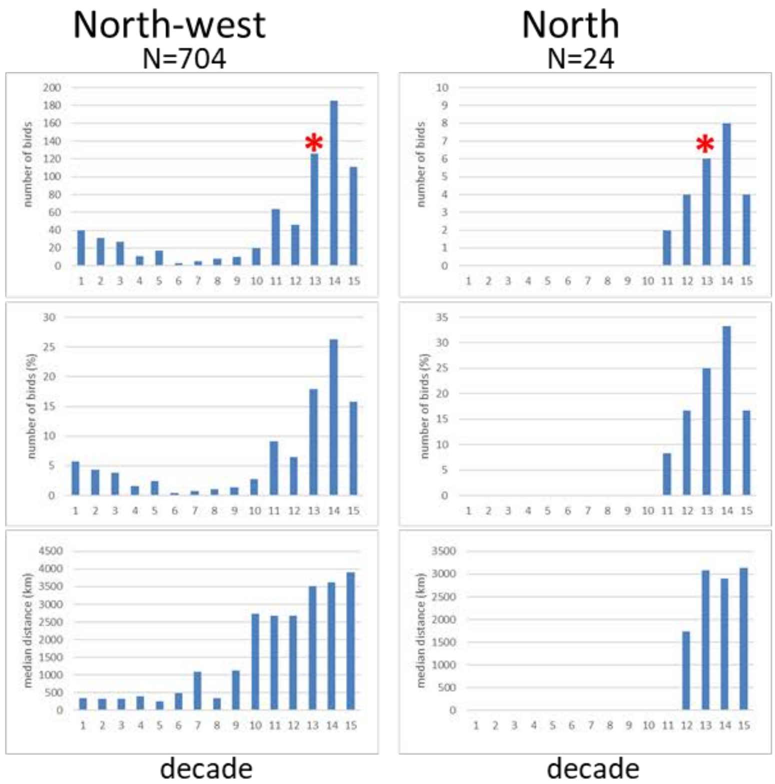
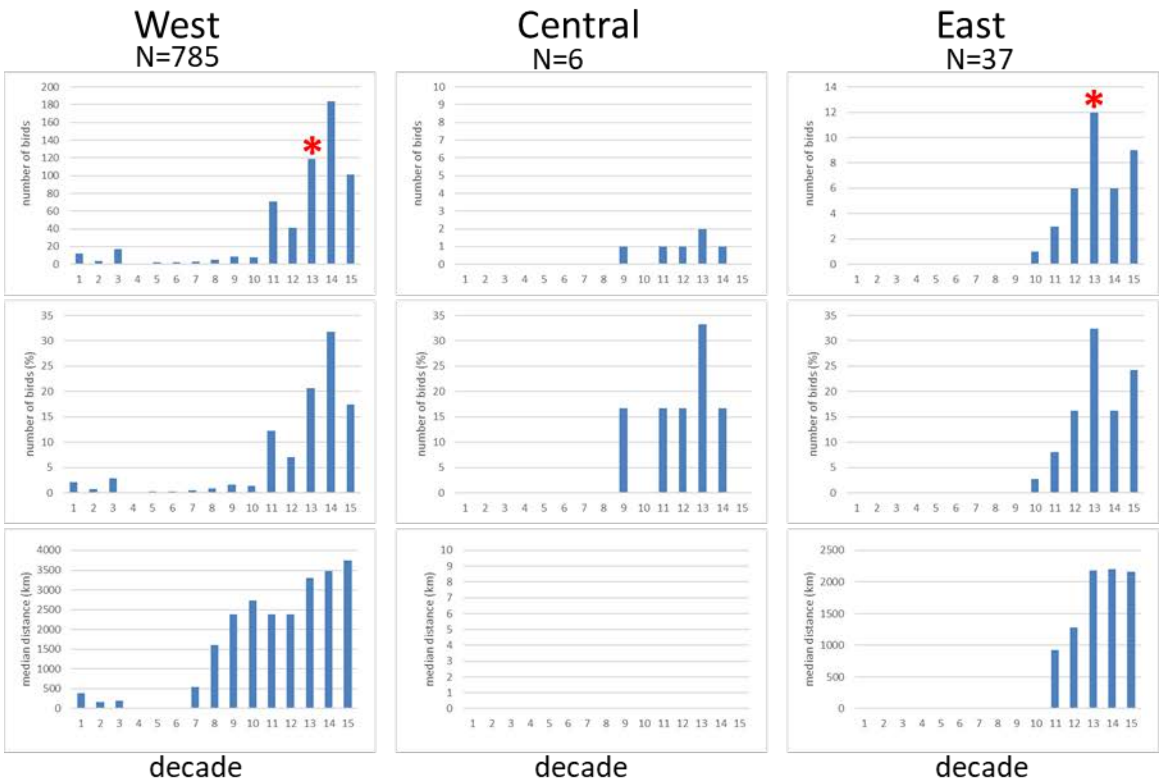


Fig. 4: Median migration date of pre-nuptial migration of *Brant Goose*. The map shows the date when 50% of individuals are on migration.

01790 Eurasian Wigeon *Anas penelope*

Recovery analysis





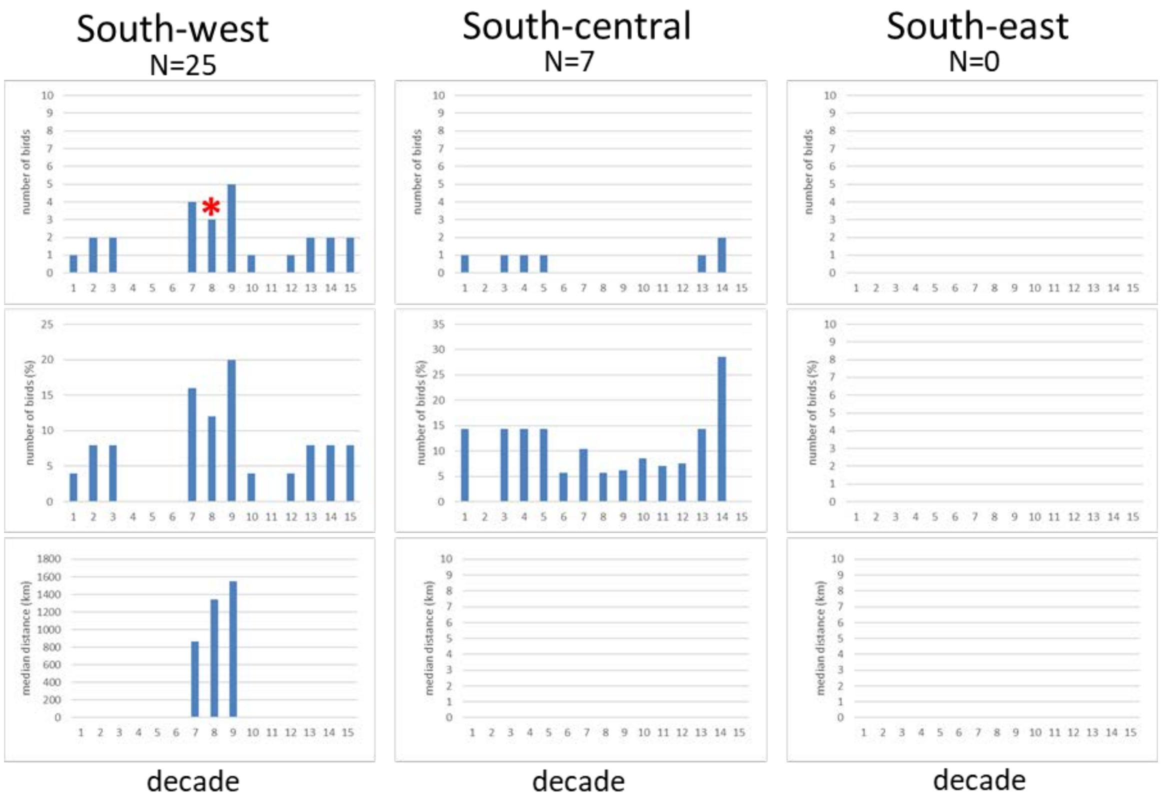


Fig. 1: Onset of prenuptial (return) migration of Eurasian Wigeon by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

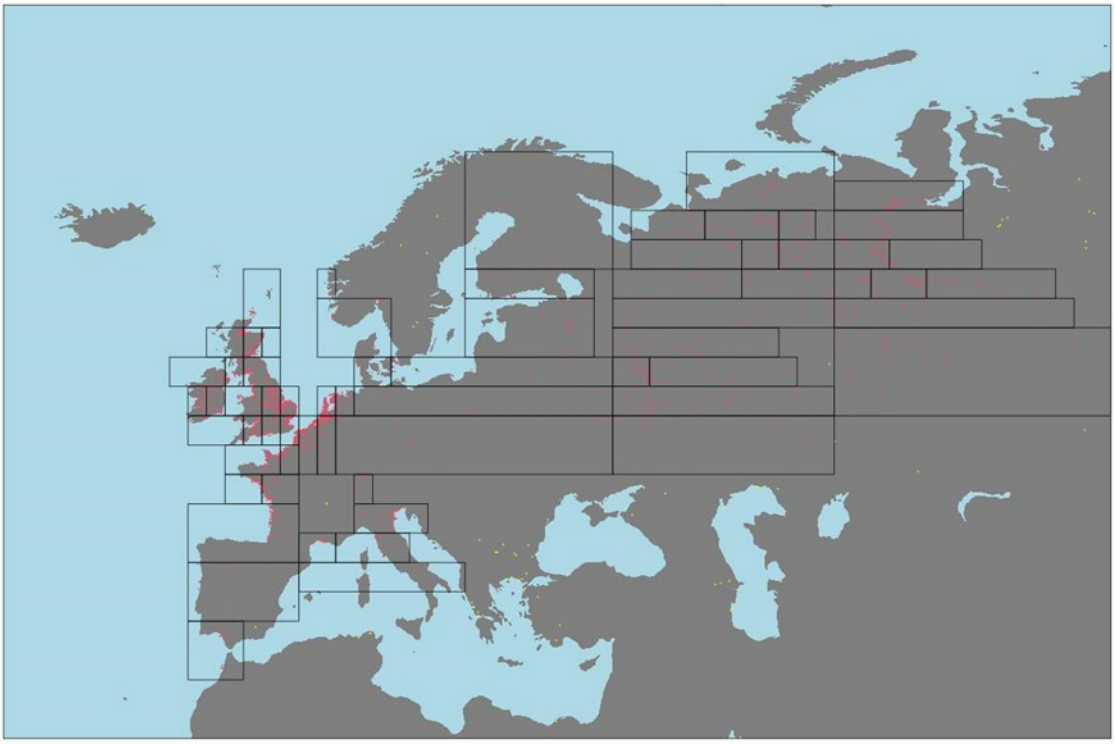


Fig. 2: Data availability for the analyses of Eurasian Wigeon pre-nuptial migration. Red dots: encounters used (9982), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

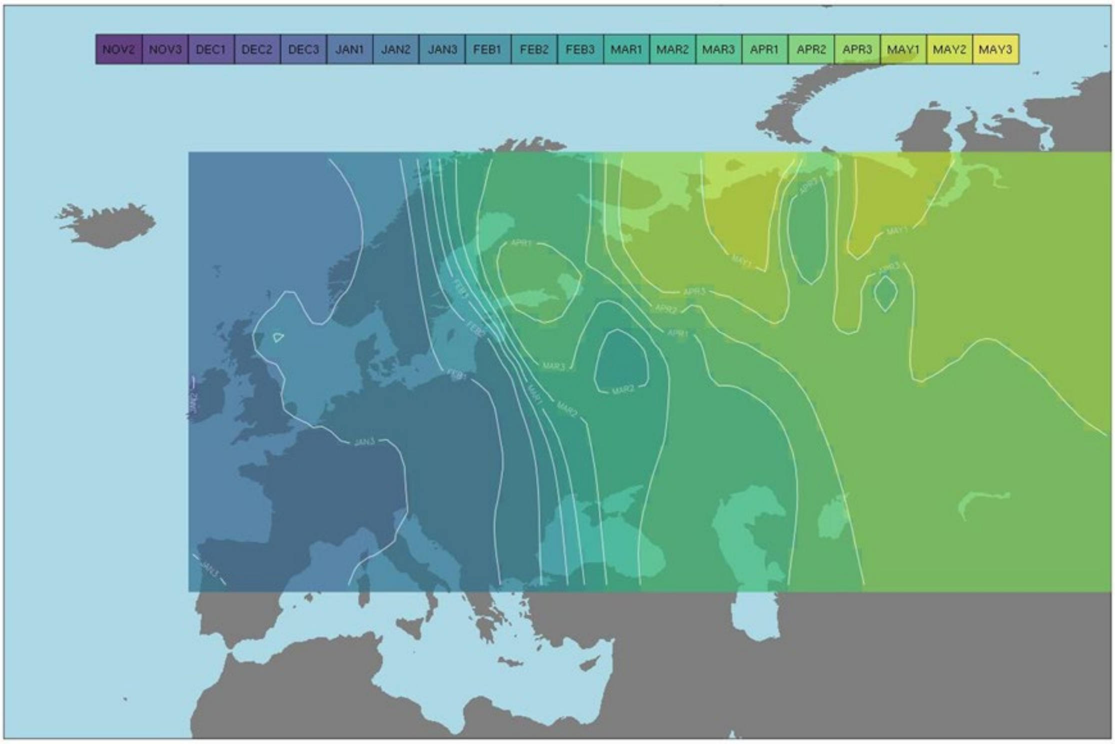


Fig. 3: Onset of pre-nuptial migration of Eurasian Wigeon. The map shows the date when 5% of individuals are on migration.

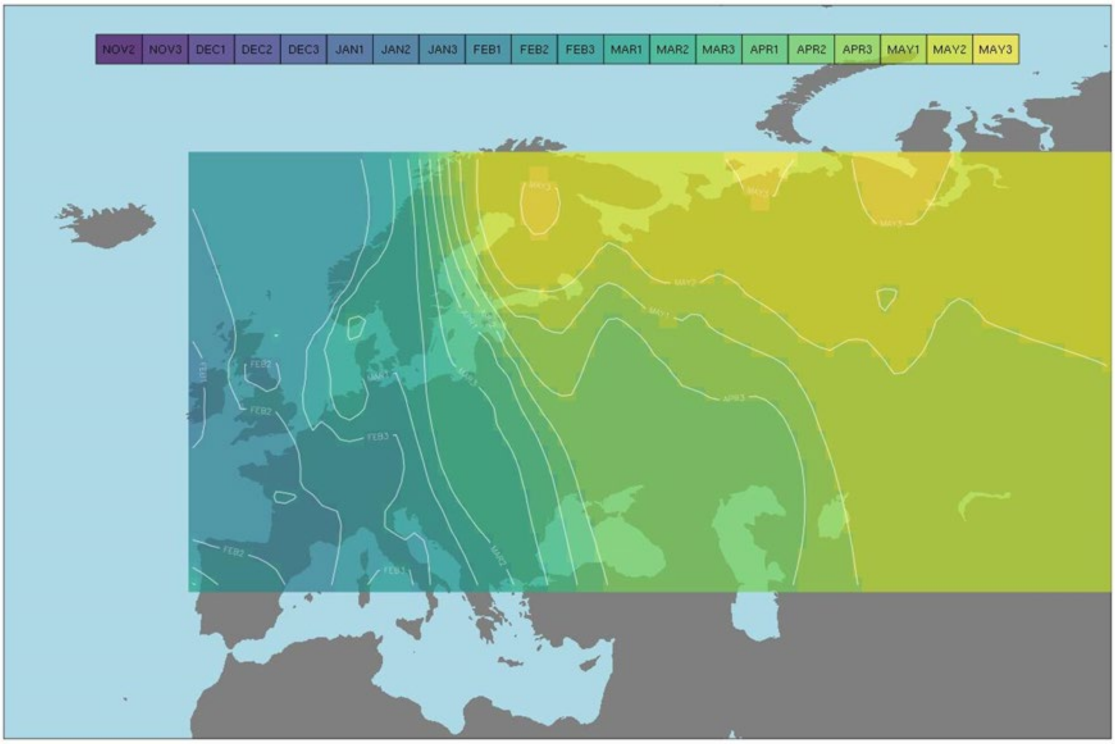
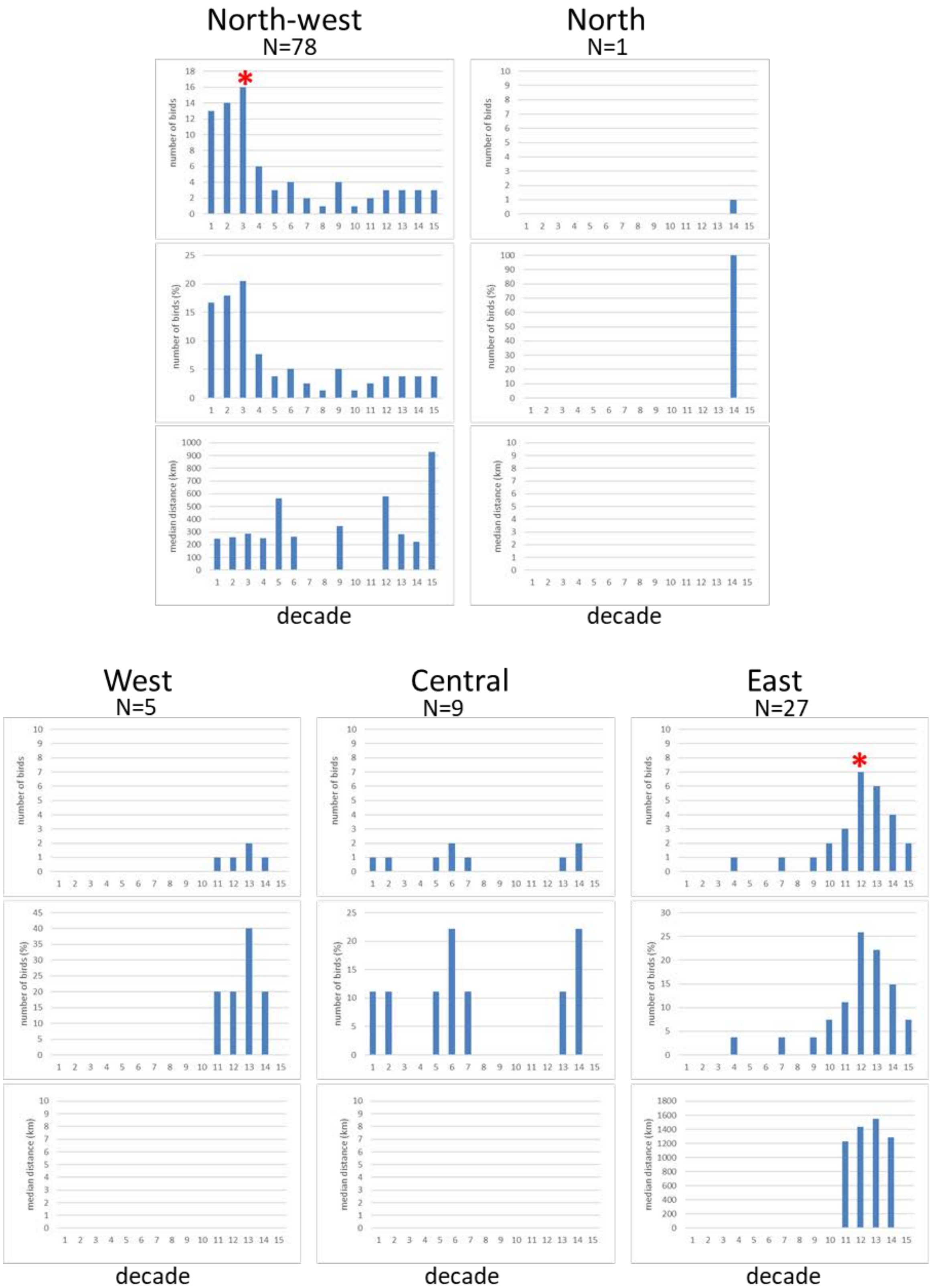


Fig. 4: Median migration date of pre-nuptial migration of Eurasian Wigeon. The map shows the date when 50% of individuals are on migration.

01820 Gadwall *Anas strepera*

Recovery analysis



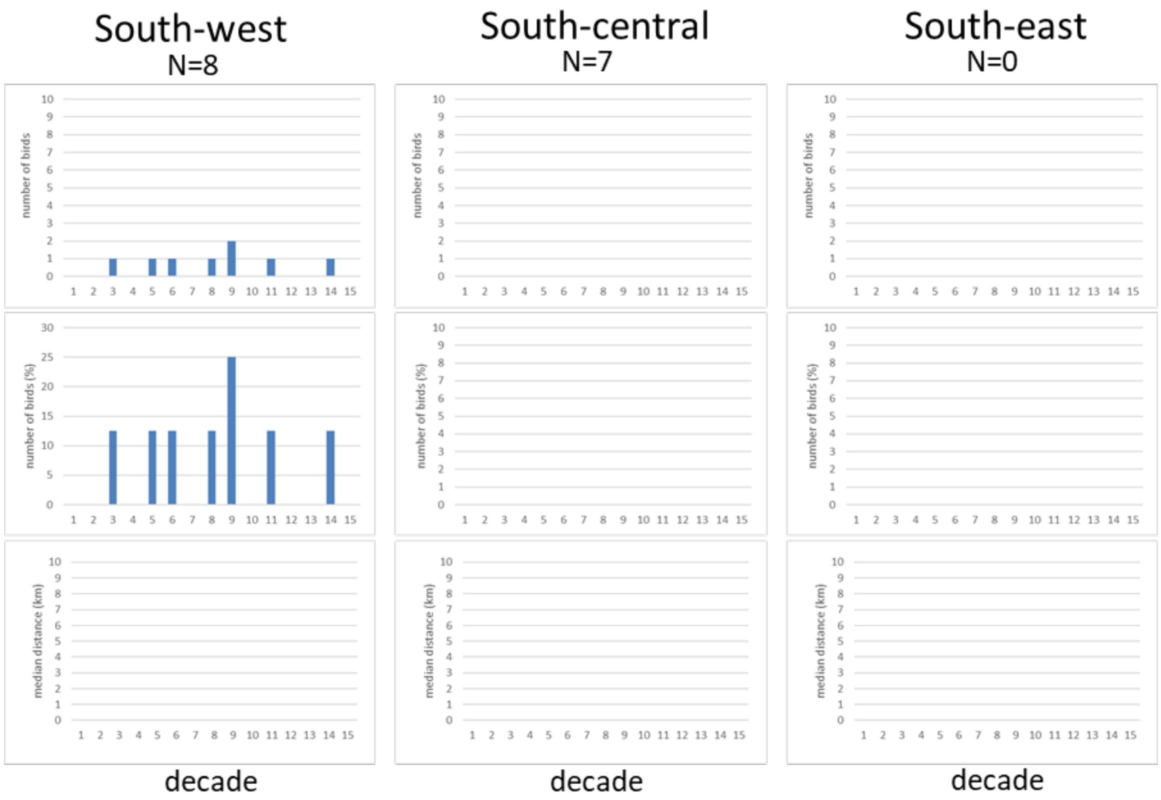


Fig. 1: Onset of prenuptial (return) migration of Gadwall by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

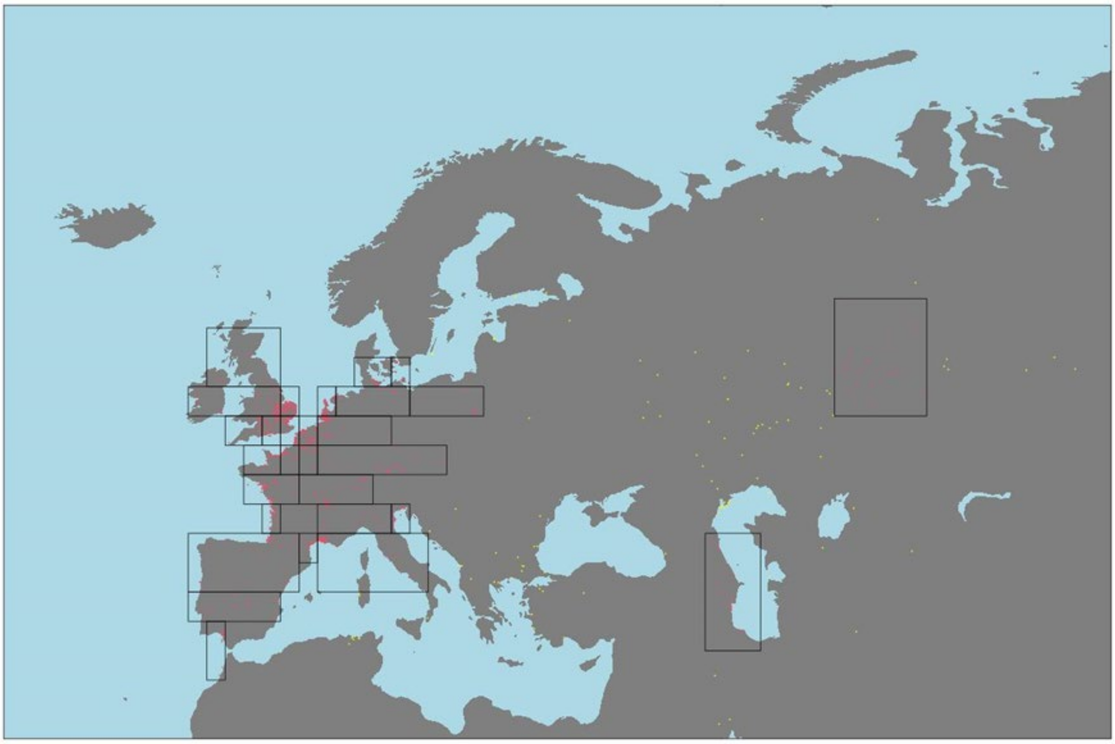


Fig. 2: Data availability for the analyses of Gadwall pre-nuptial migration. Red dots: encounters used (2754), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

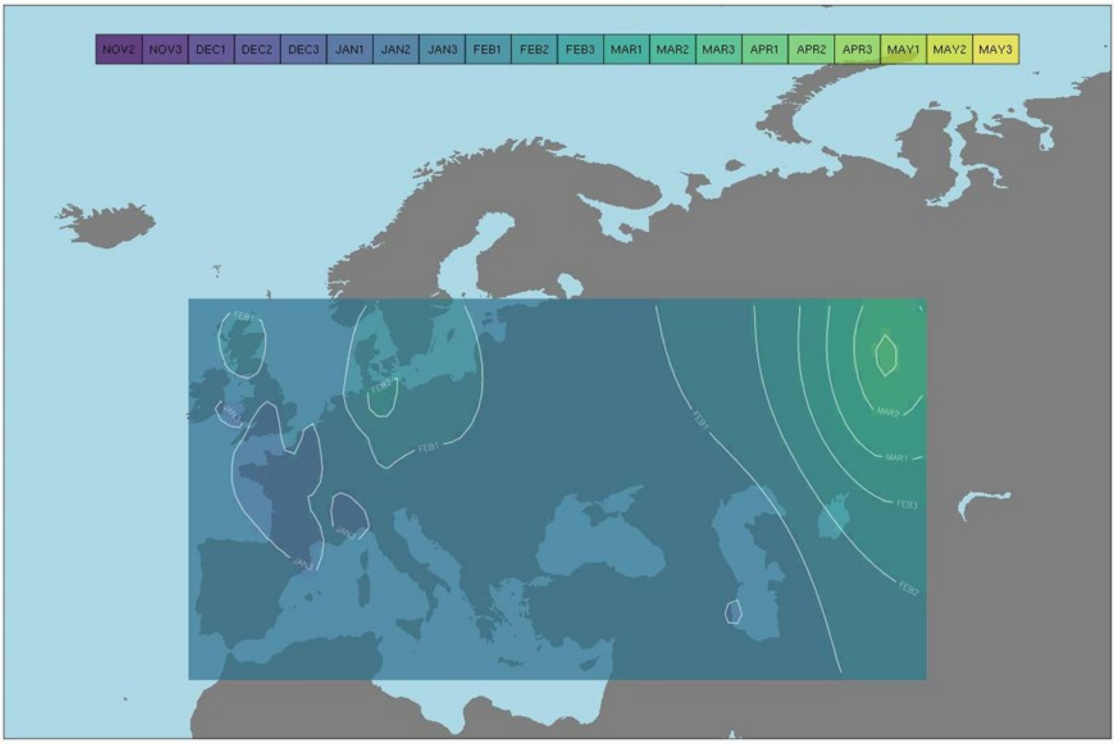


Fig. 3: Onset of pre-nuptial migration of Gadwall. The map shows the date when 5% of individuals are on migration.

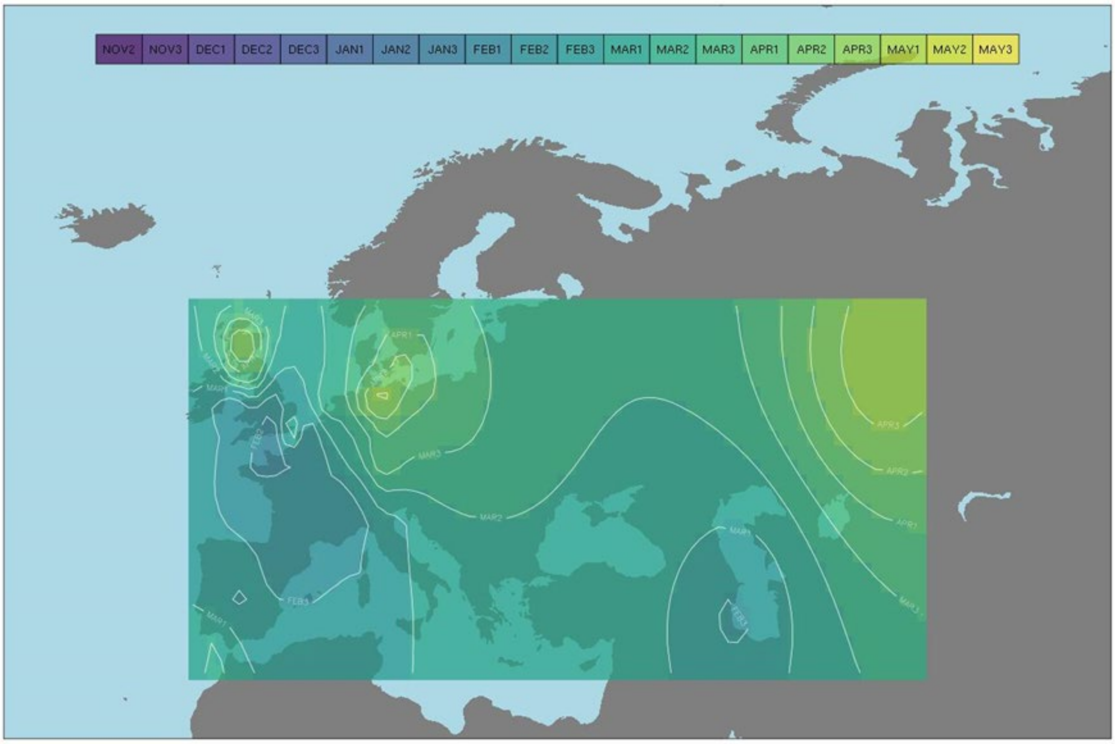
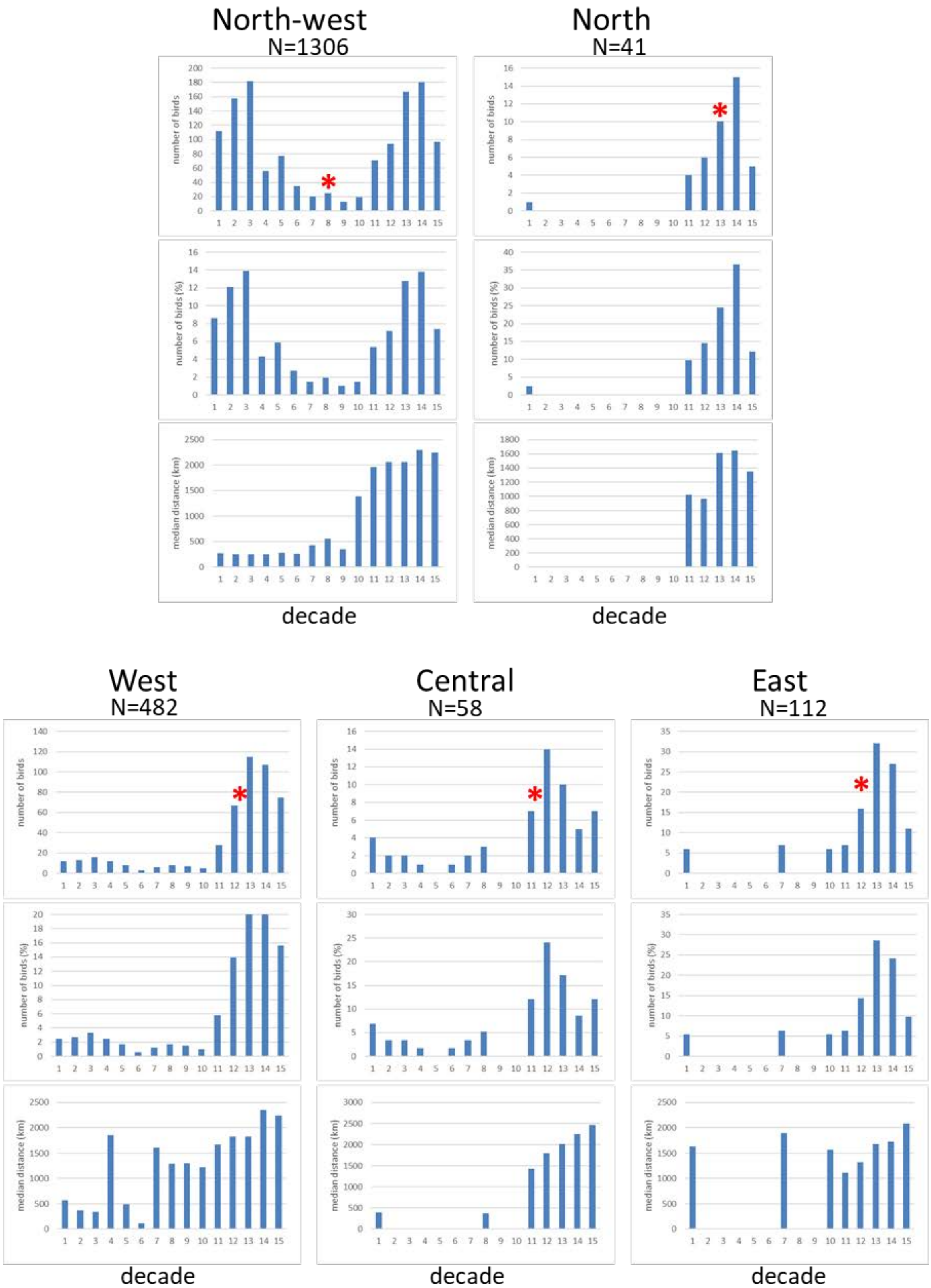


Fig. 4: Median migration date of pre-nuptial migration of Gadwall. The map shows the date when 50% of individuals are on migration.

01840 Eurasian Teal *Anas crecca*

Recovery analysis



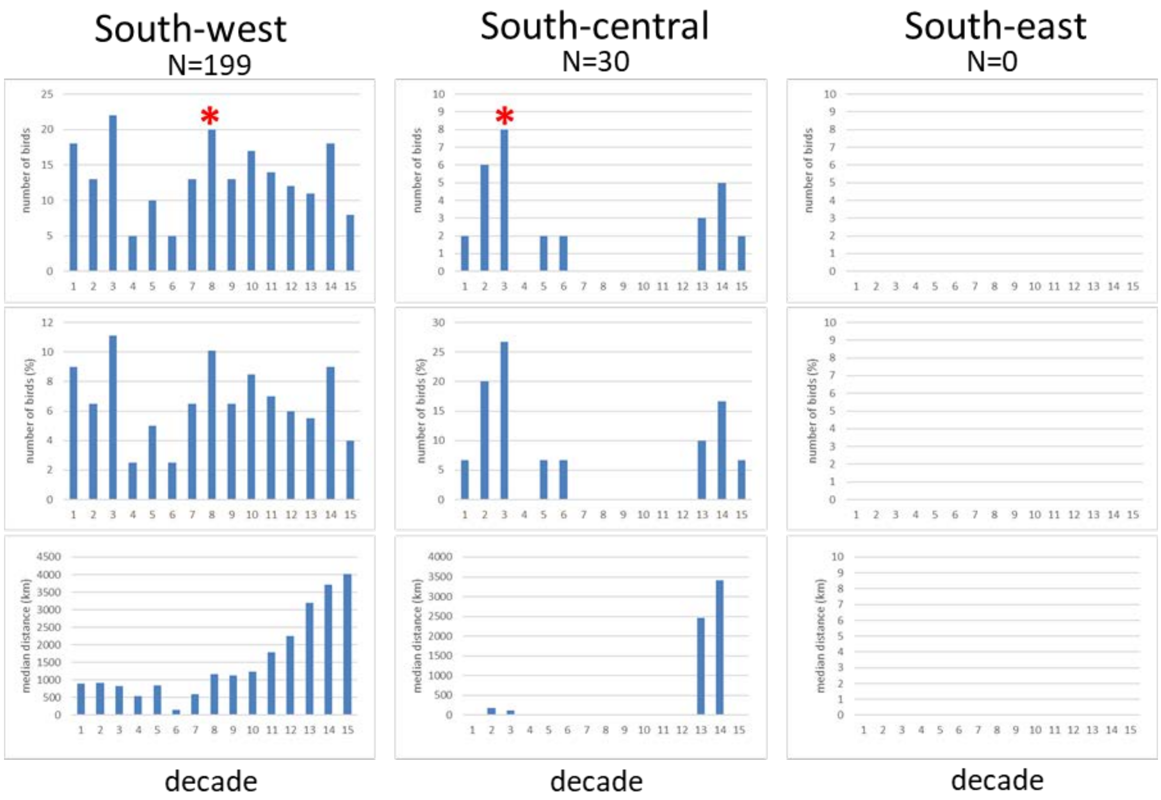


Fig. 1: Onset of prenuptial (return) migration of Eurasian Teal by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

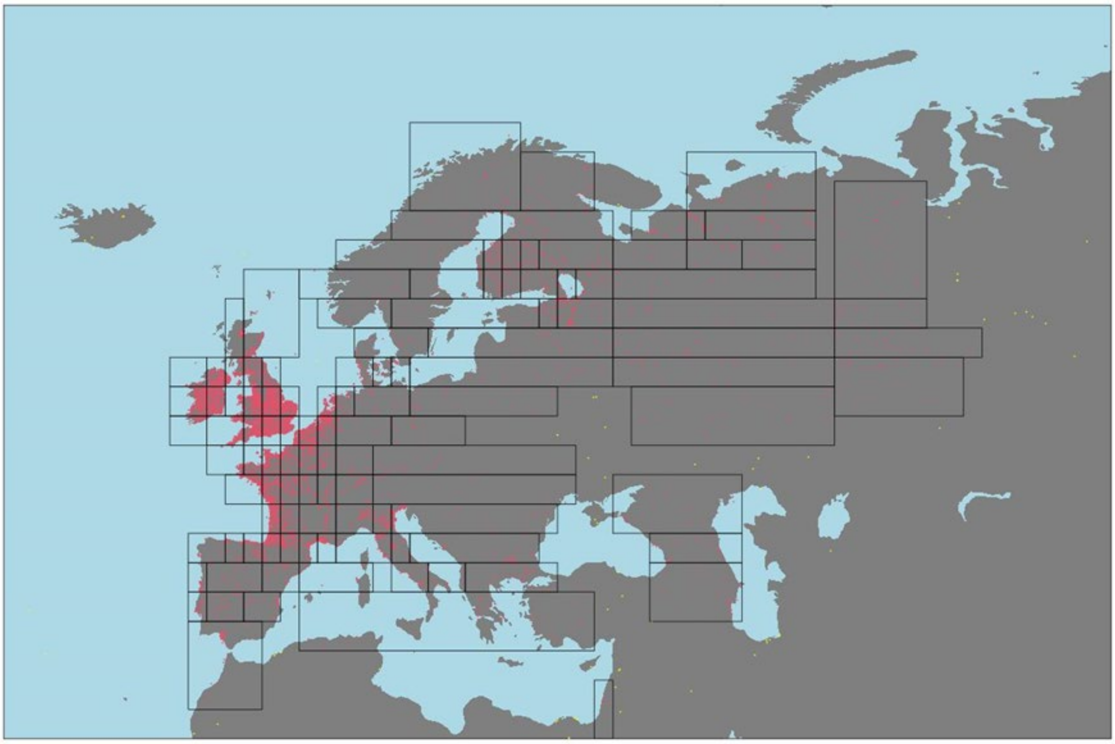


Fig. 2: Data availability for the analyses of Eurasian Teal pre-nuptial migration. Red dots: encounters used (30,454), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

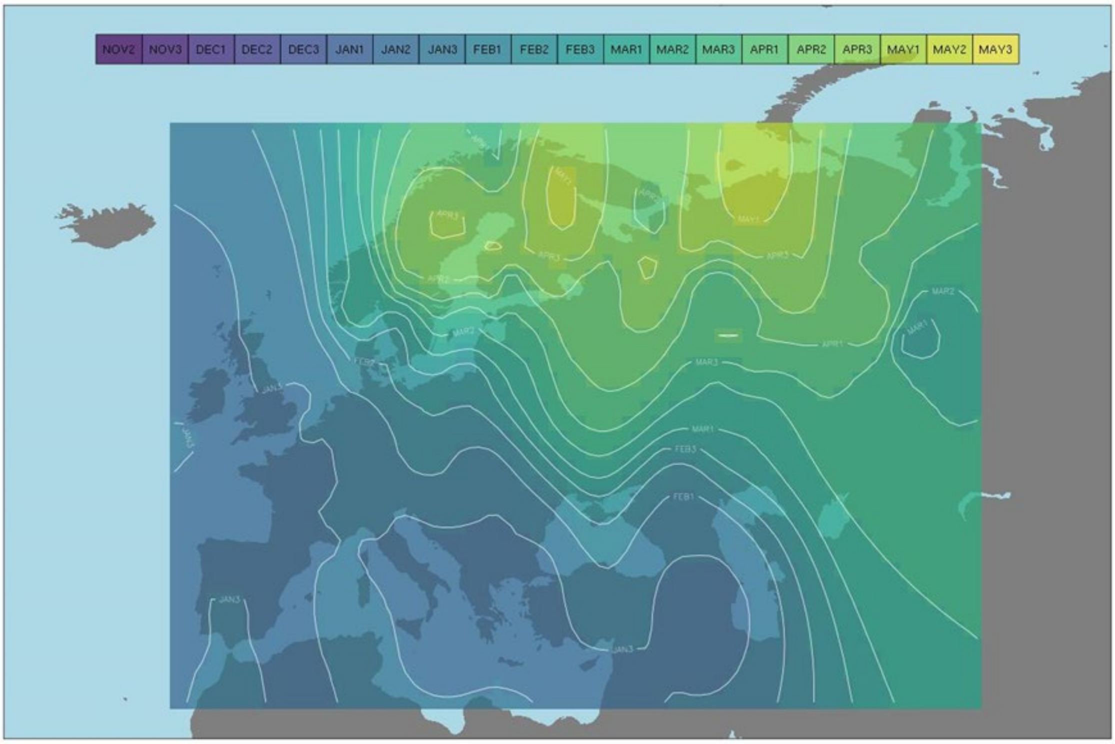


Fig. 3: Onset of pre-nuptial migration of Eurasian Teal. The map shows the date when 5% of individuals are on migration.

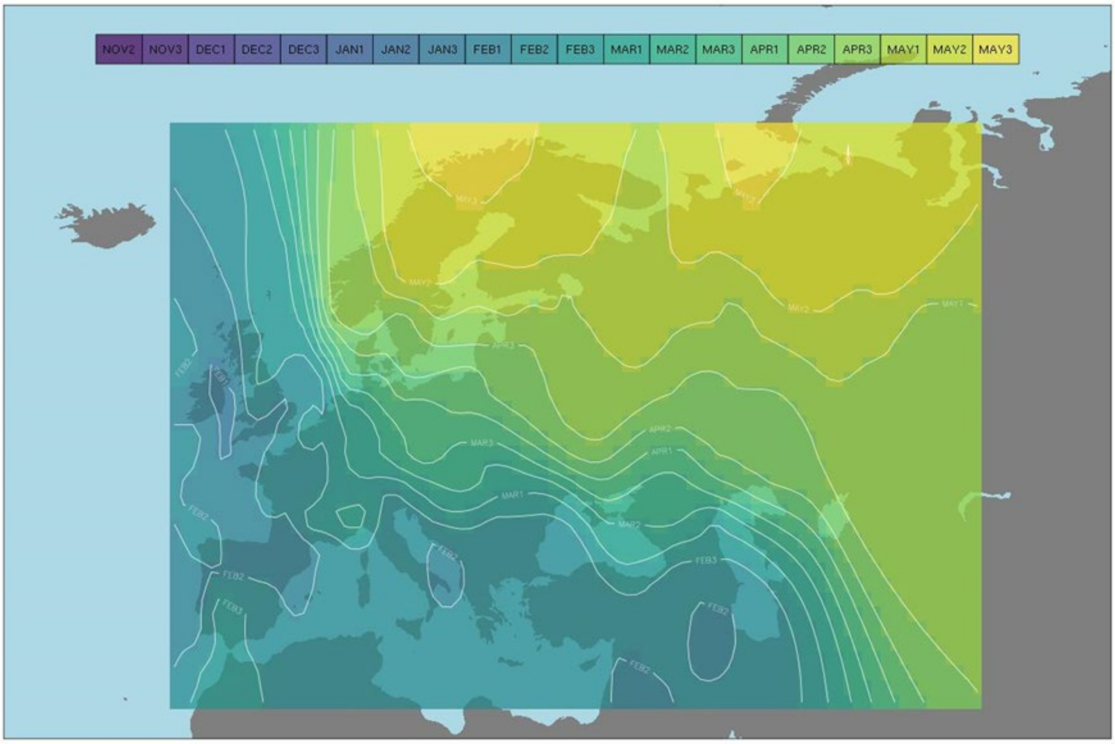
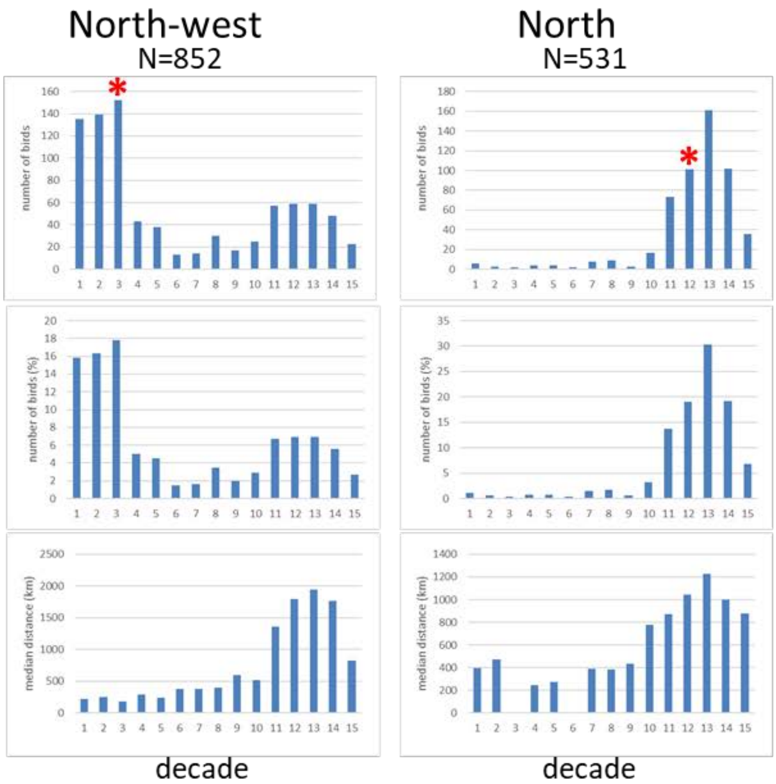
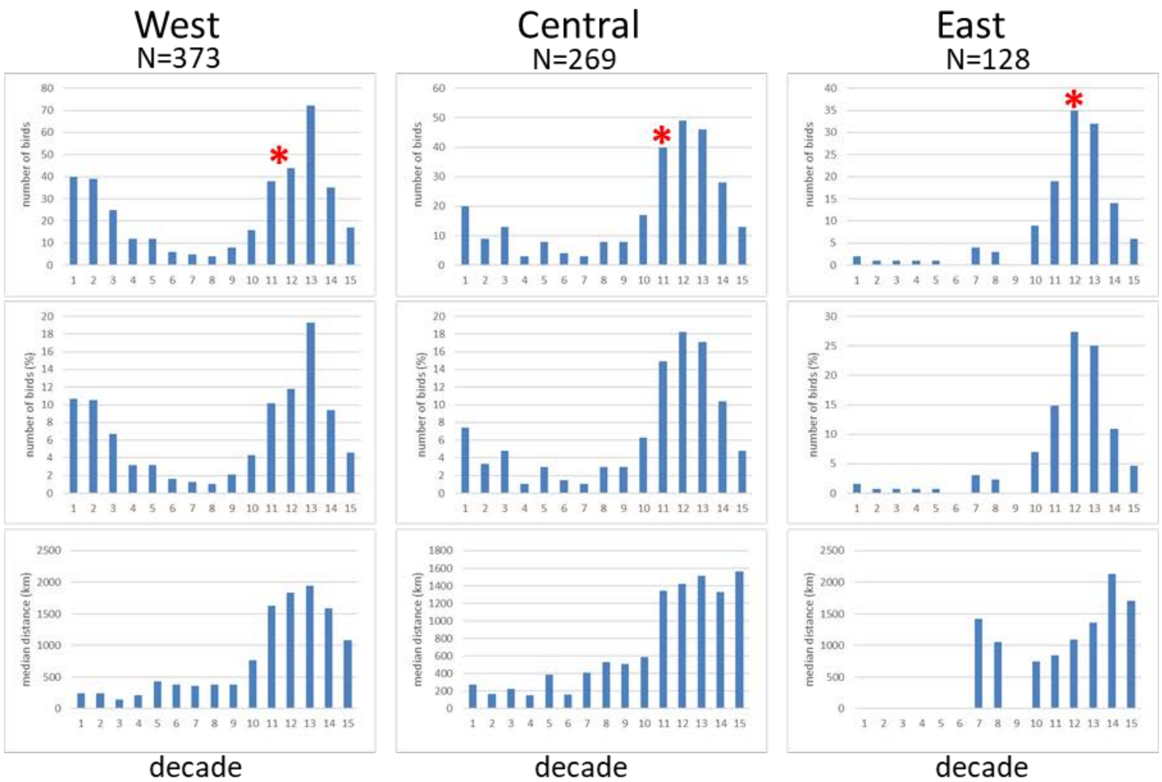


Fig. 4: Median migration date of pre-nuptial migration of Eurasian Teal. The map shows the date when 50% of individuals are on migration.

01860 Mallard *Anas platyrhynchos*

Recovery analysis





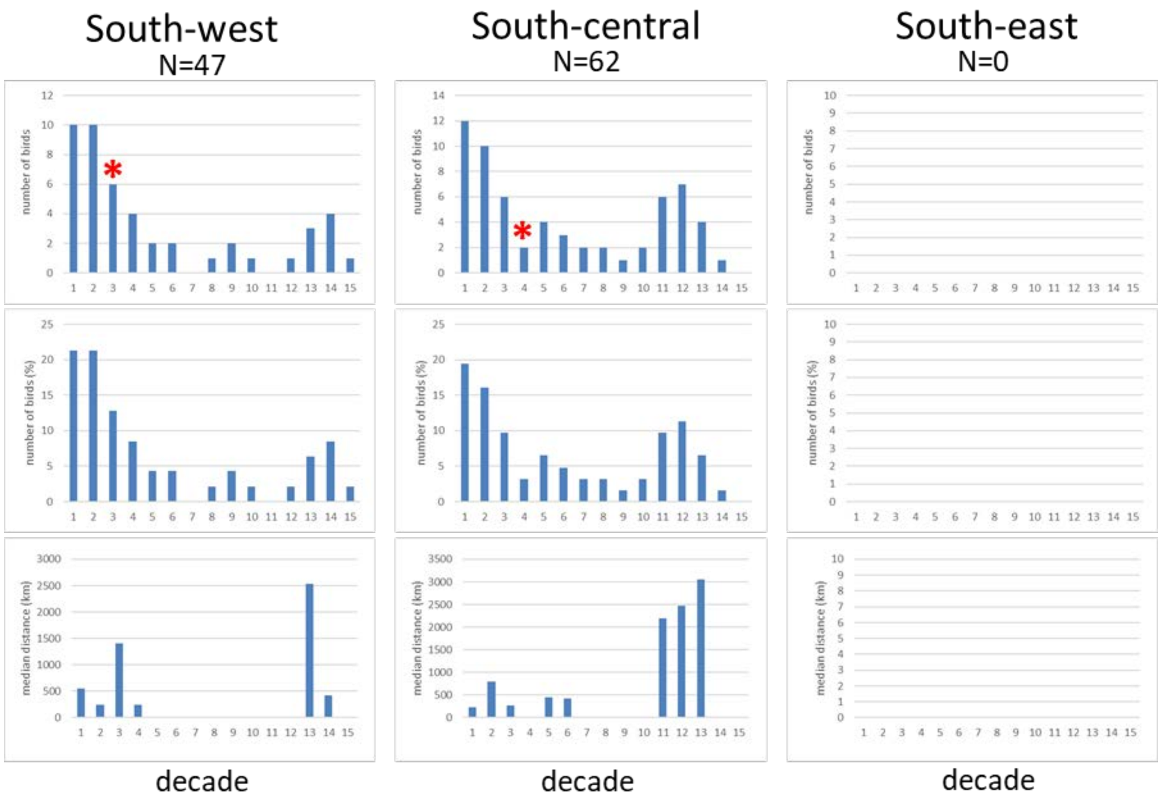


Fig. 1: Onset of prenuptial (return) migration of Mallard by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

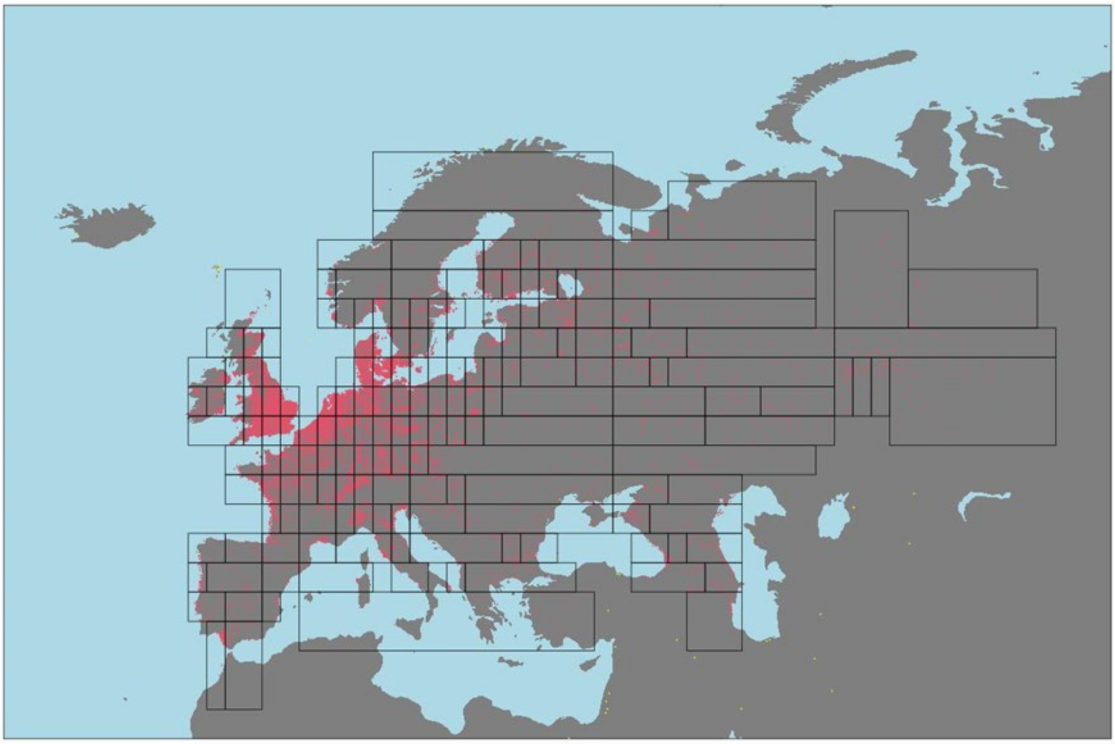


Fig. 2: Data availability for the analyses of Mallard pre-nuptial migration. Red dots: encounters used (125,821), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

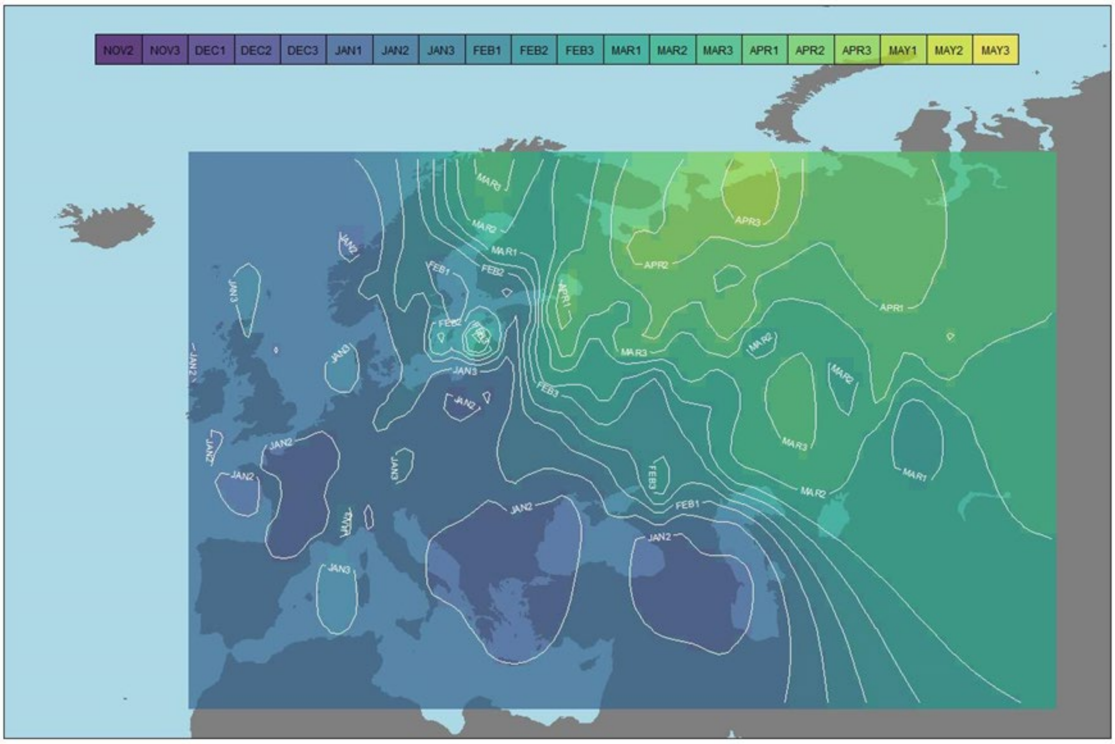


Fig. 3: Onset of pre-nuptial migration of Mallard. The map shows the date when 5% of individuals are on migration.

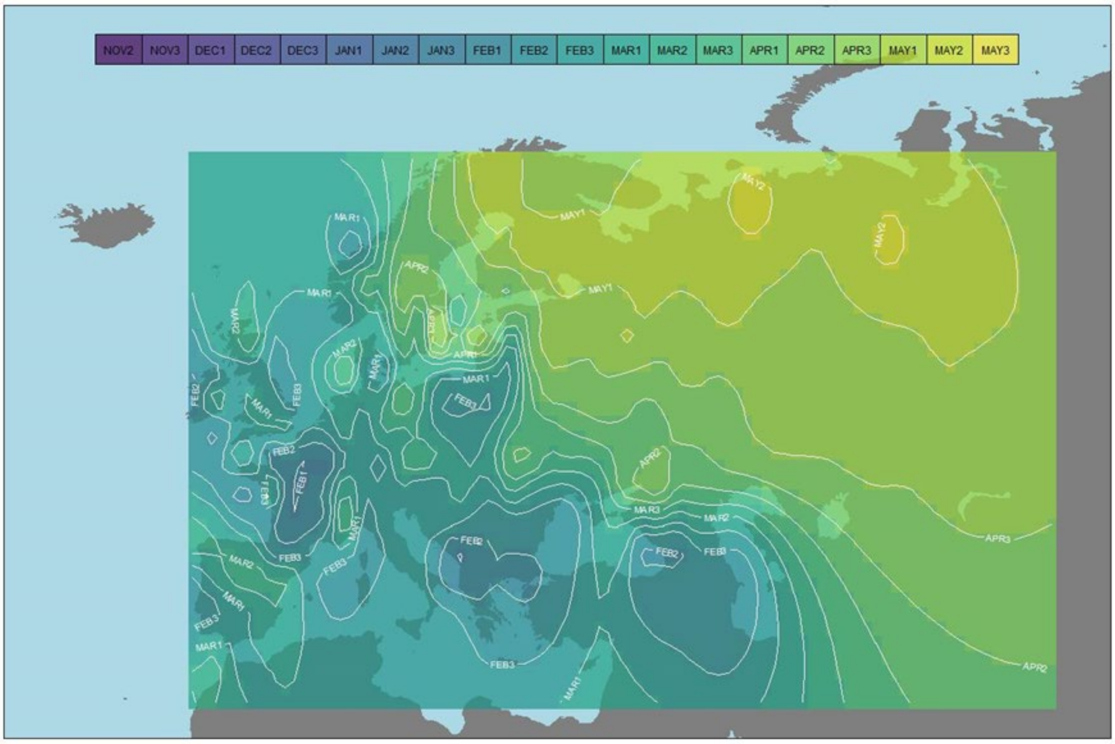
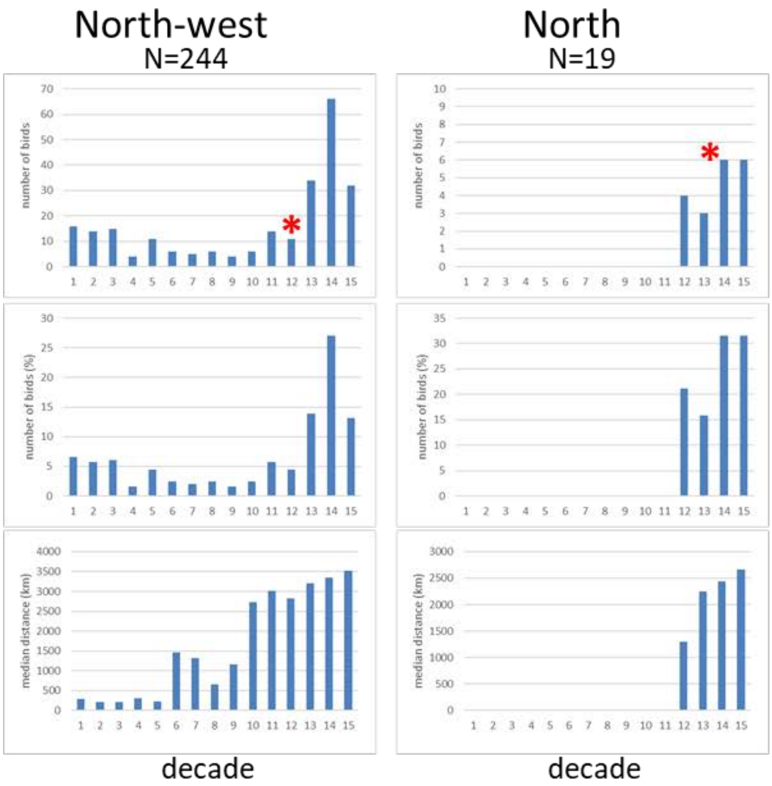
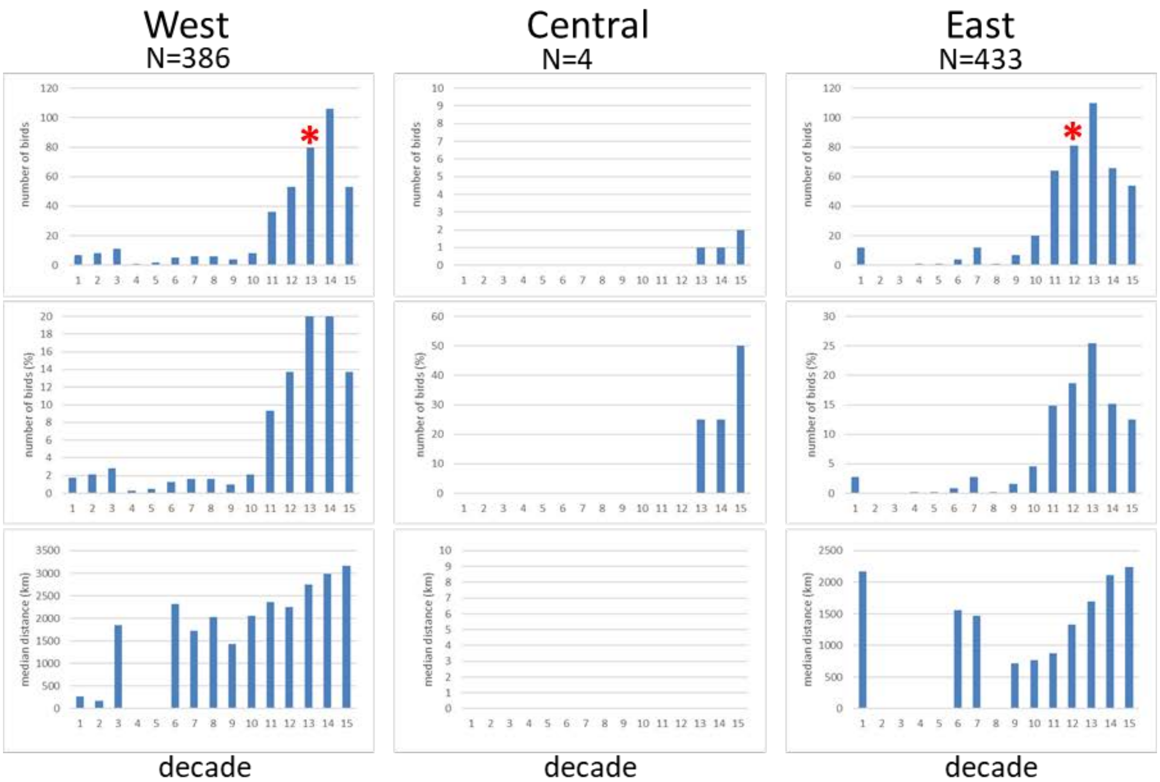


Fig. 4: Median migration date of pre-nuptial migration of Mallard. The map shows the date when 50% of individuals are on migration.

01890 Northern Pintail *Anas acuta*

Recovery analysis





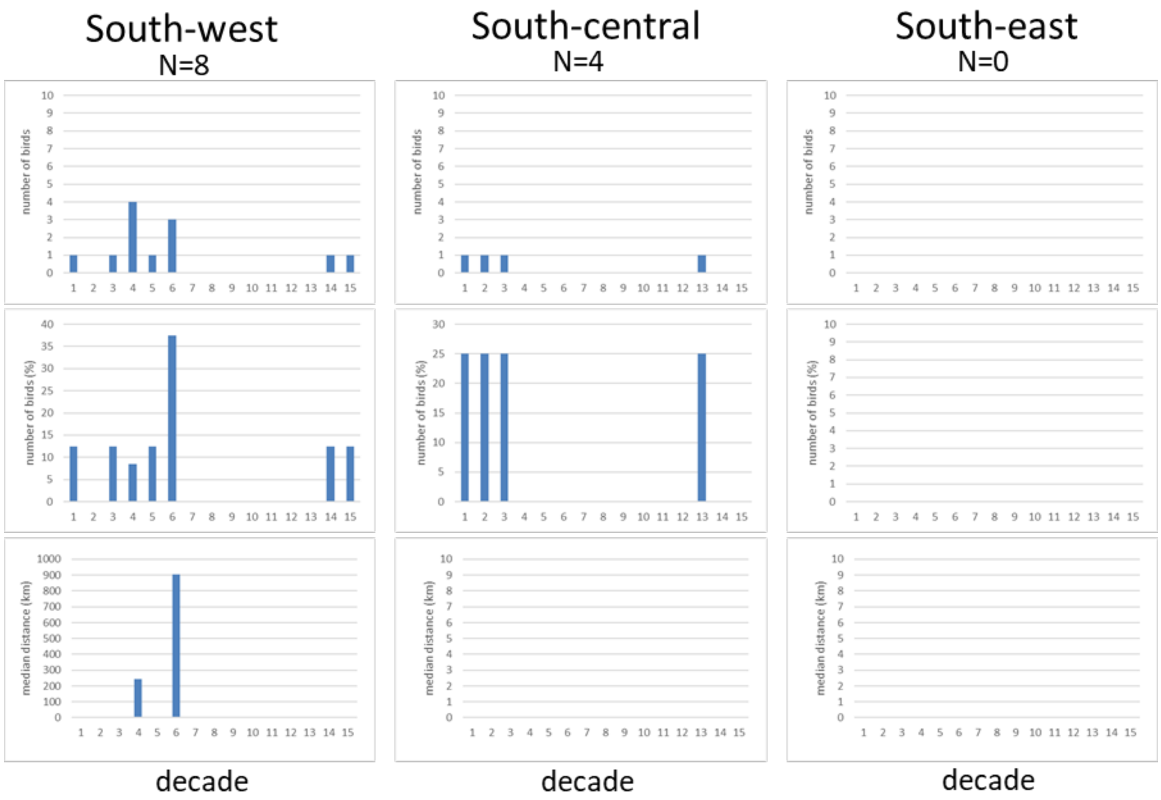


Fig. 1: Onset of prenuptial (return) migration of Northern Pintail by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

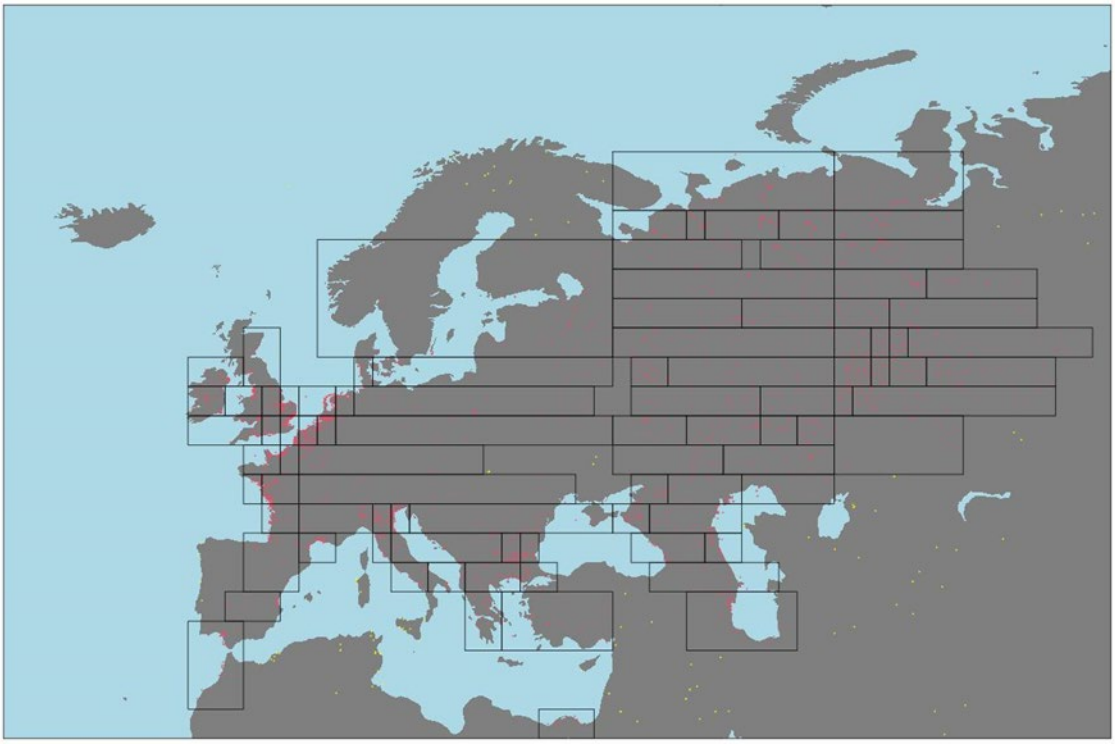


Fig. 2: Data availability for the analyses of Northern Pintail pre-nuptial migration. Red dots: encounters used (5923), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

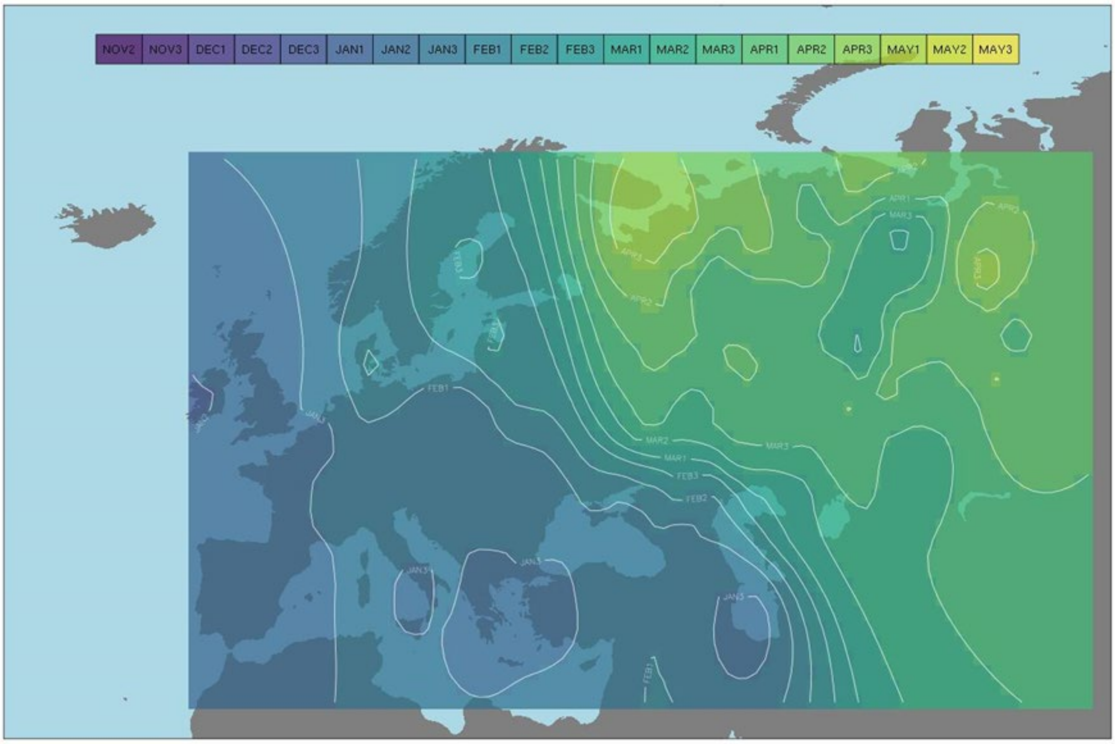


Fig. 3: Onset of pre-nuptial migration of Northern Pintail. The map shows the date when 5% of individuals are on migration.

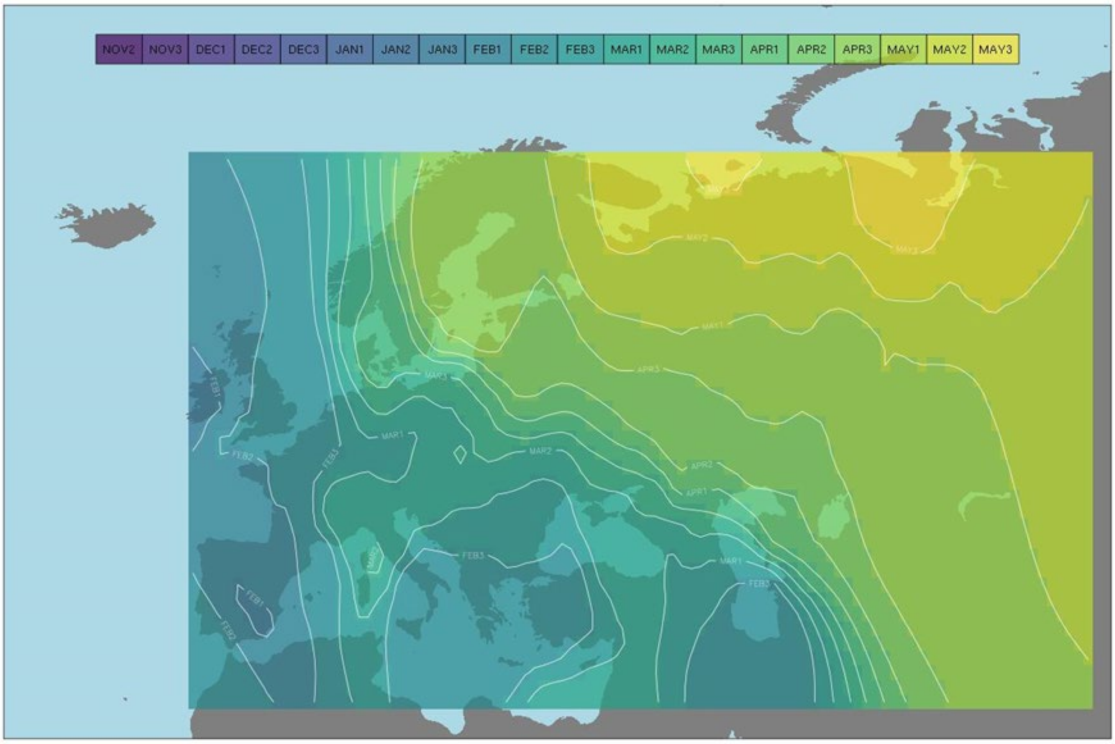
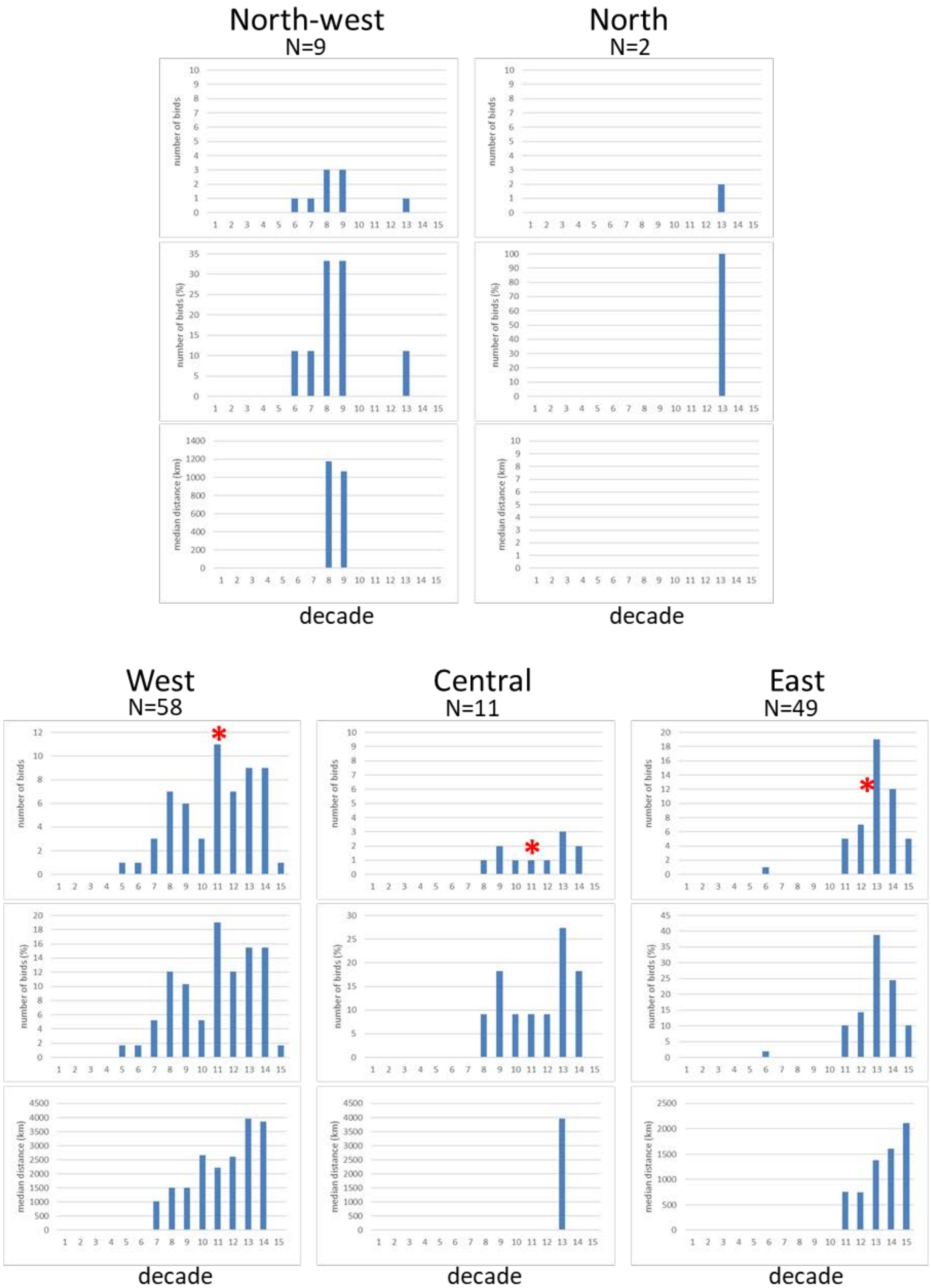


Fig. 4: Median migration date of pre-nuptial migration of Northern Pintail. The map shows the date when 50% of individuals are on migration.

01910 Garganey *Anas querquedula*

Recovery analysis



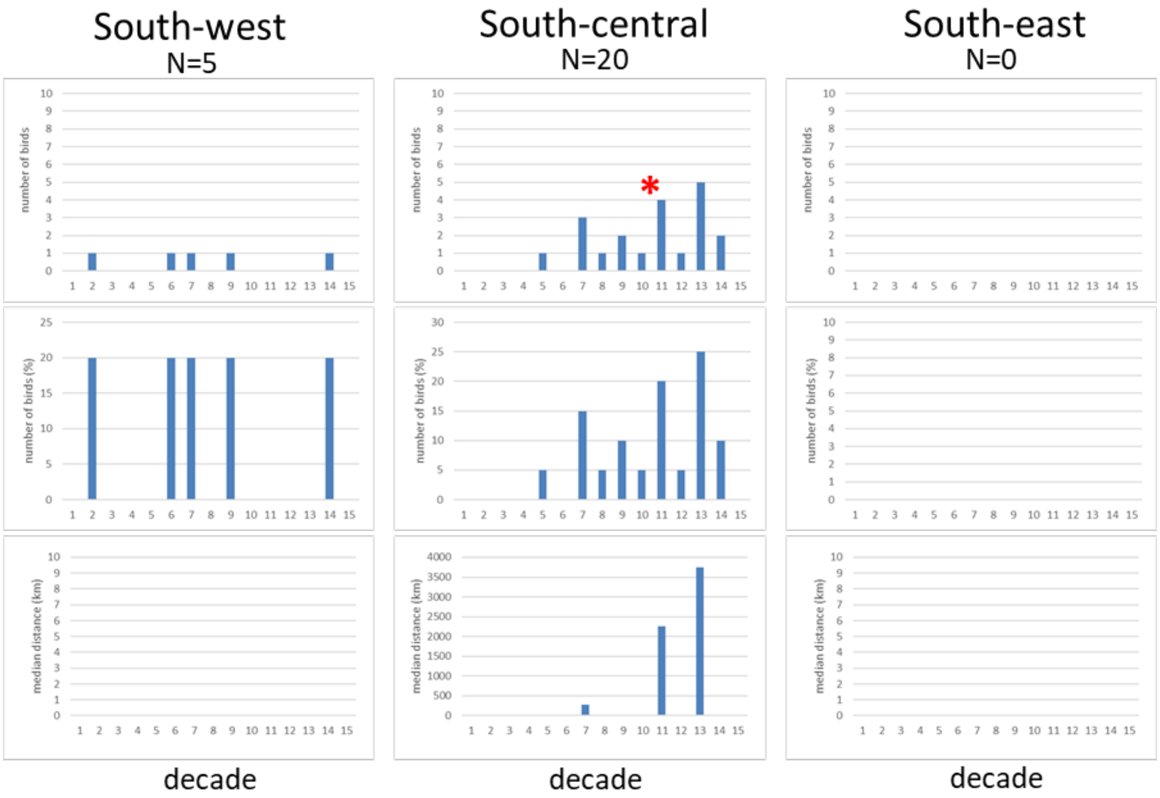


Fig. 1: Onset of prenuptial (return) migration of Garganey by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

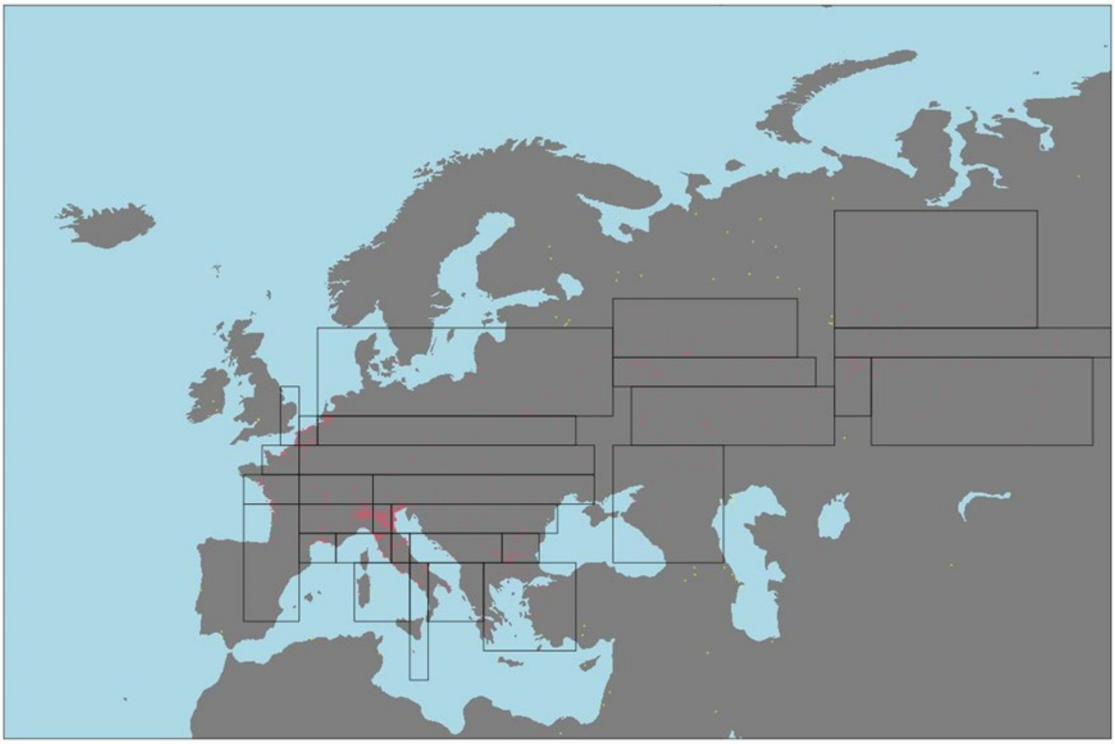


Fig. 2: Data availability for the analyses of Garganey pre-nuptial migration. Red dots: encounters used (1893), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

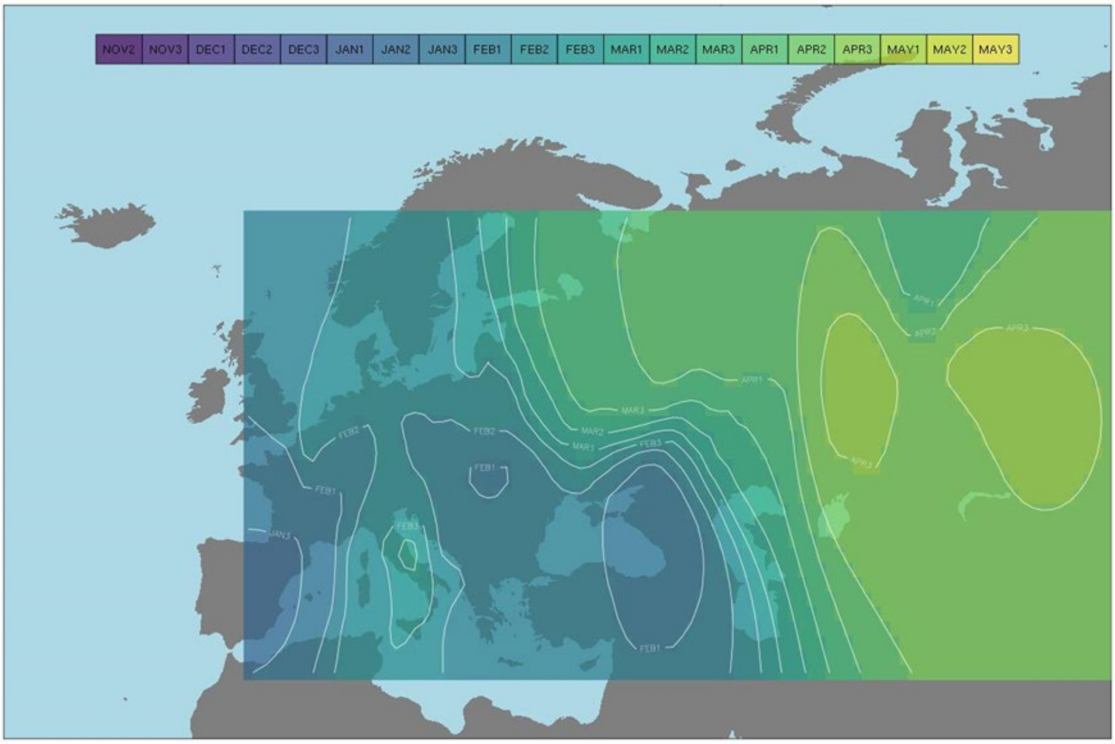


Fig. 3: Onset of pre-nuptial migration of Garganey. The map shows the date when 5% of individuals are on migration.

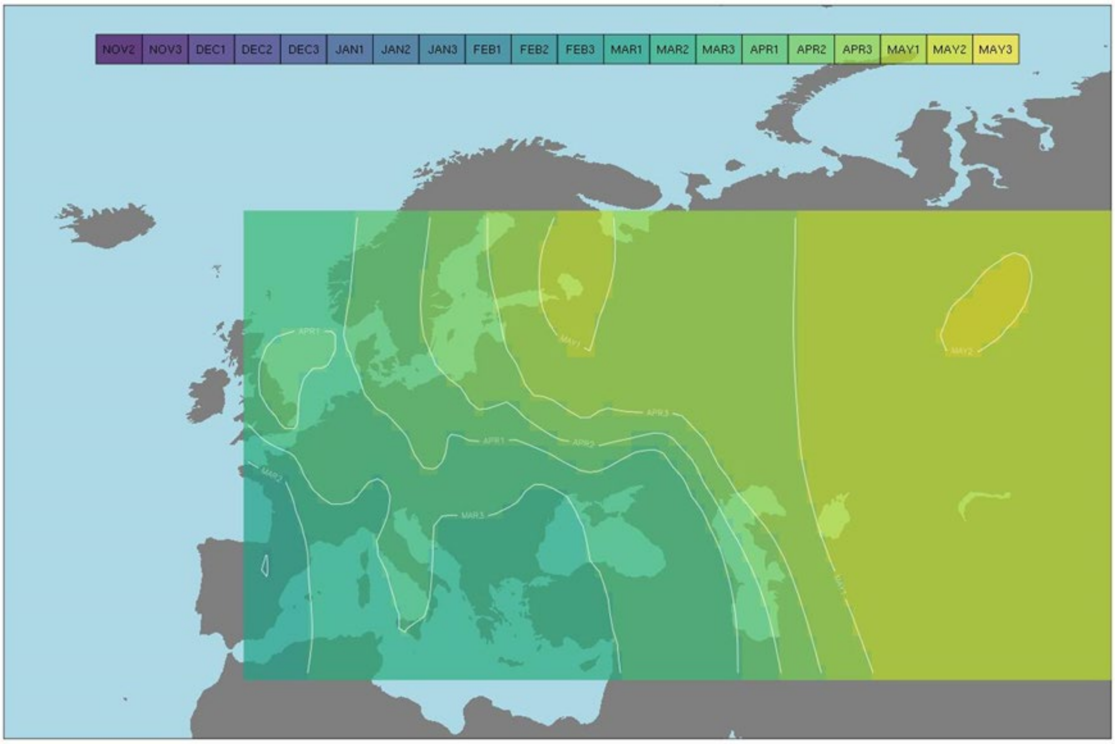
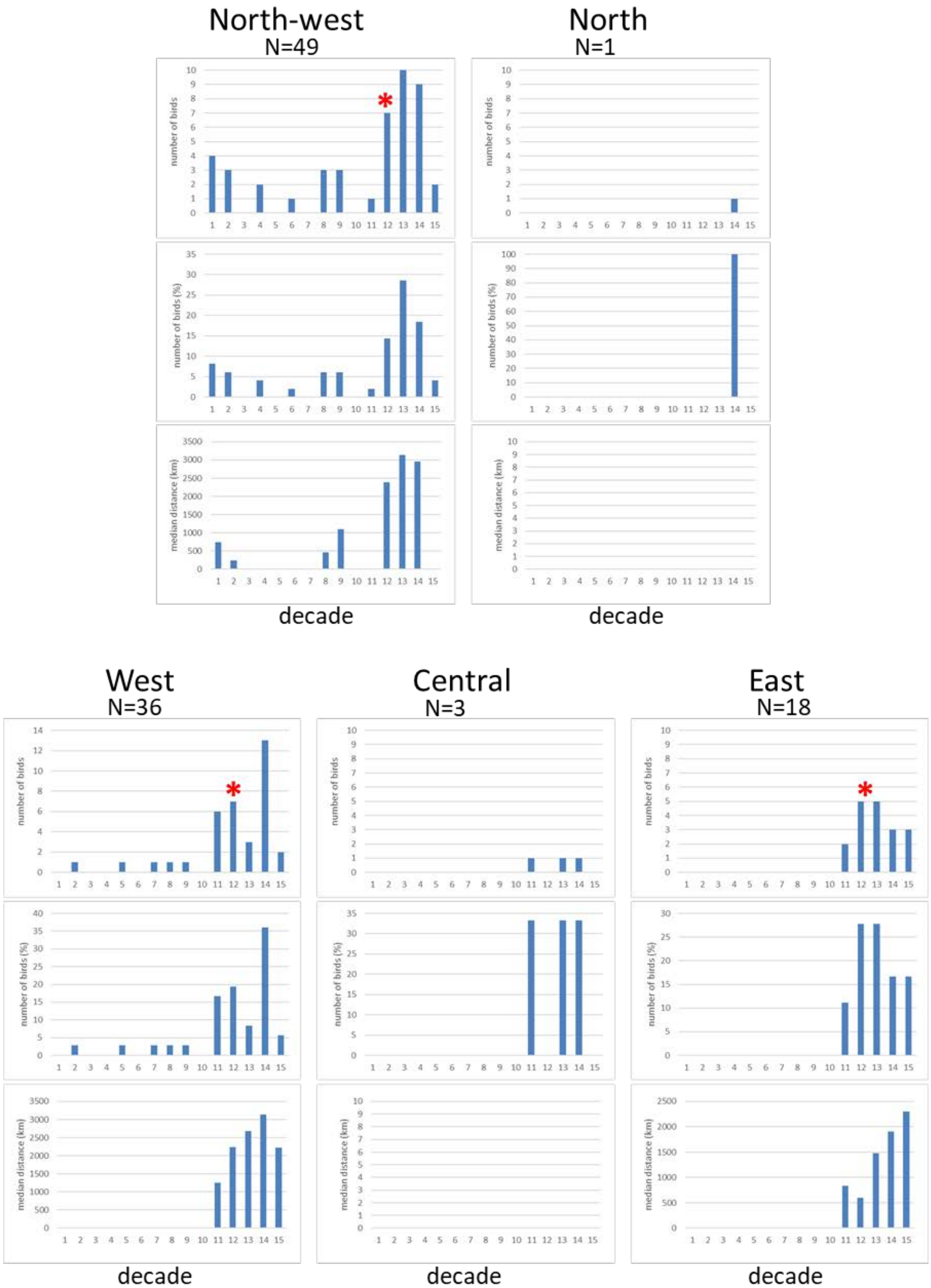


Fig. 4: Median migration date of pre-nuptial migration of Garganey. The map shows the date when 50% of individuals are on migration.

01940 Northern Shoveler *Anas clypeata*

Recovery analysis



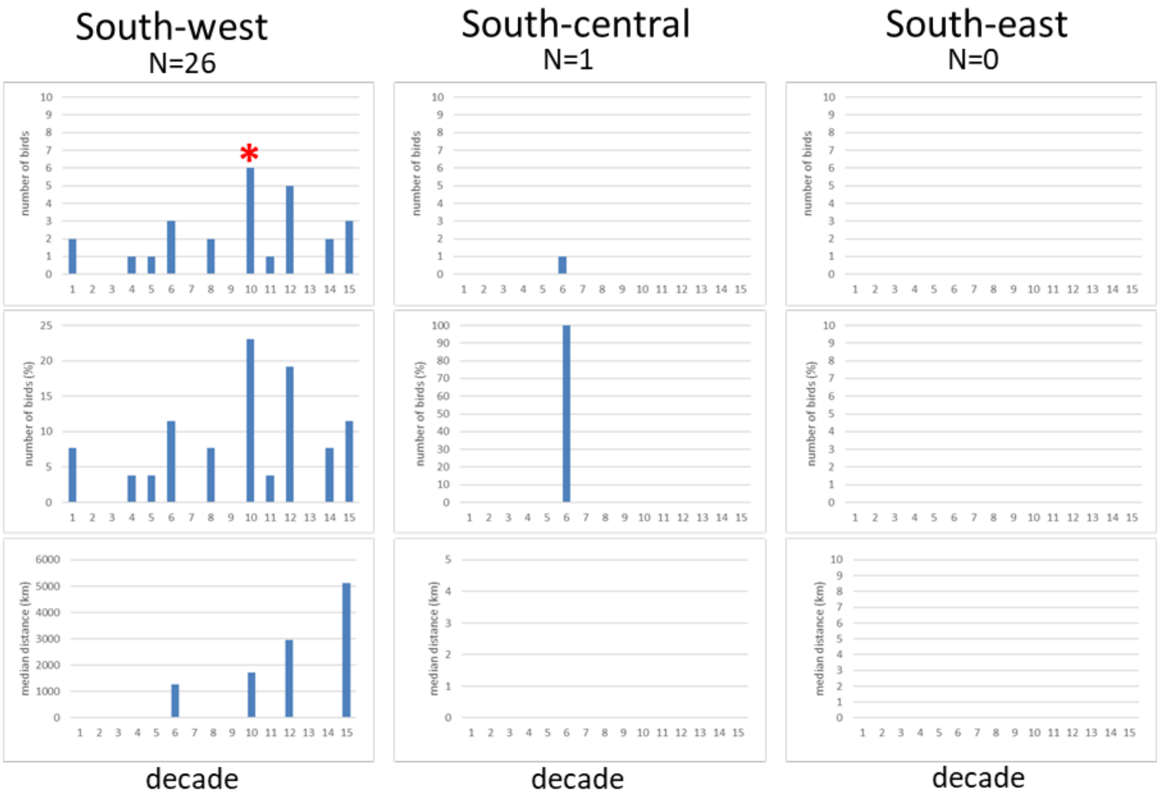


Fig. 1: Onset of prenuptial (return) migration of Northern Shoveler by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

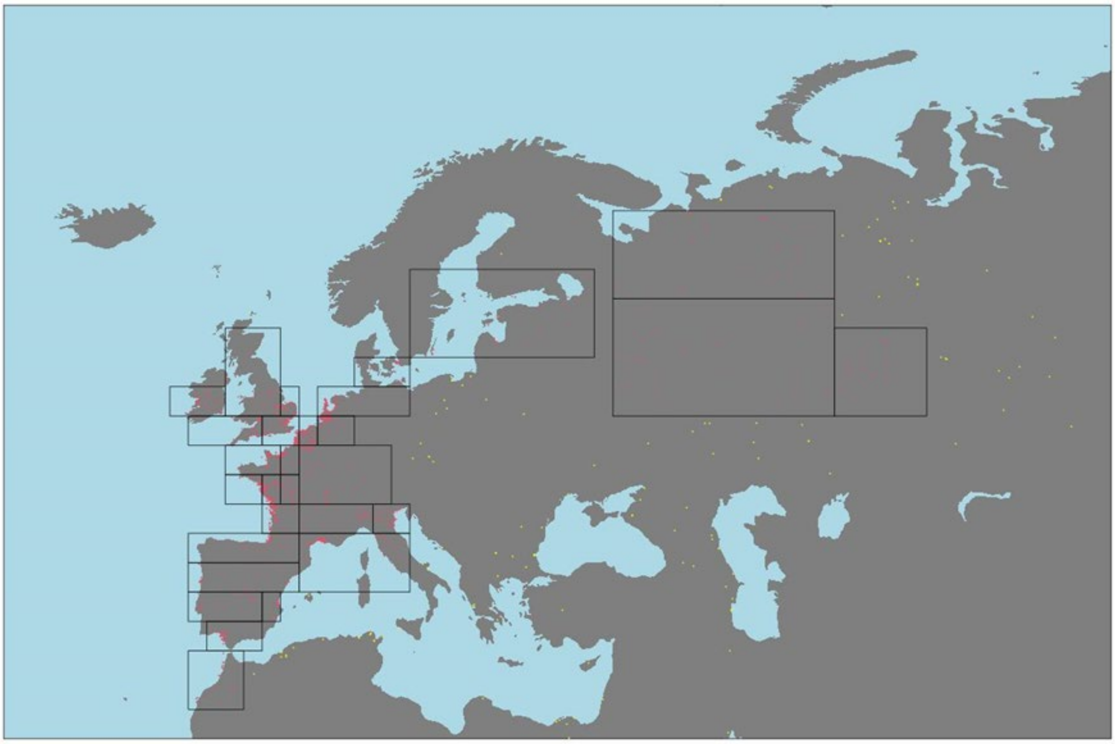


Fig. 2: Data availability for the analyses of Northern Shoveler pre-nuptial migration. Red dots: encounters used (1930), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

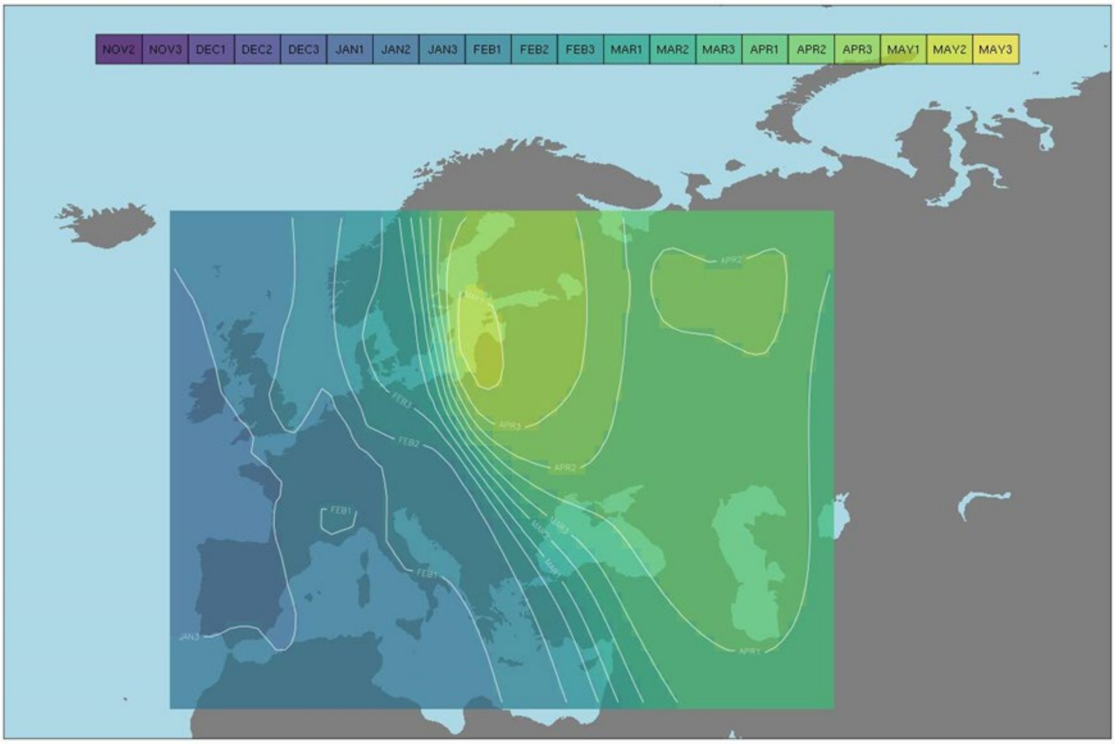


Fig. 3: Onset of pre-nuptial migration of Northern Shoveler. The map shows the date when 5% of individuals are on migration.

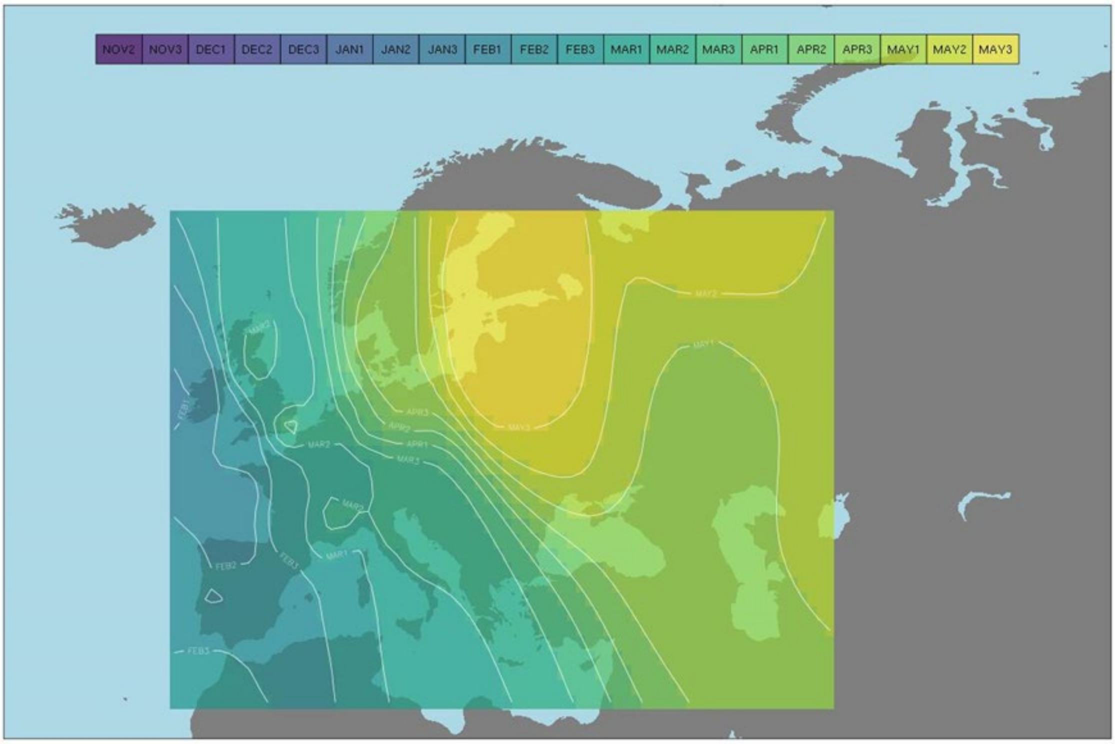
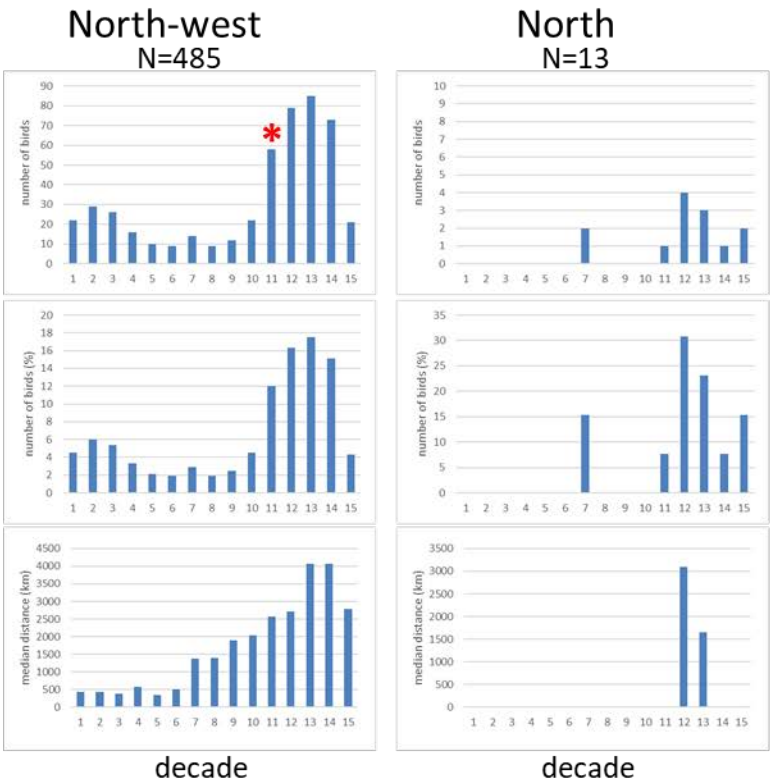
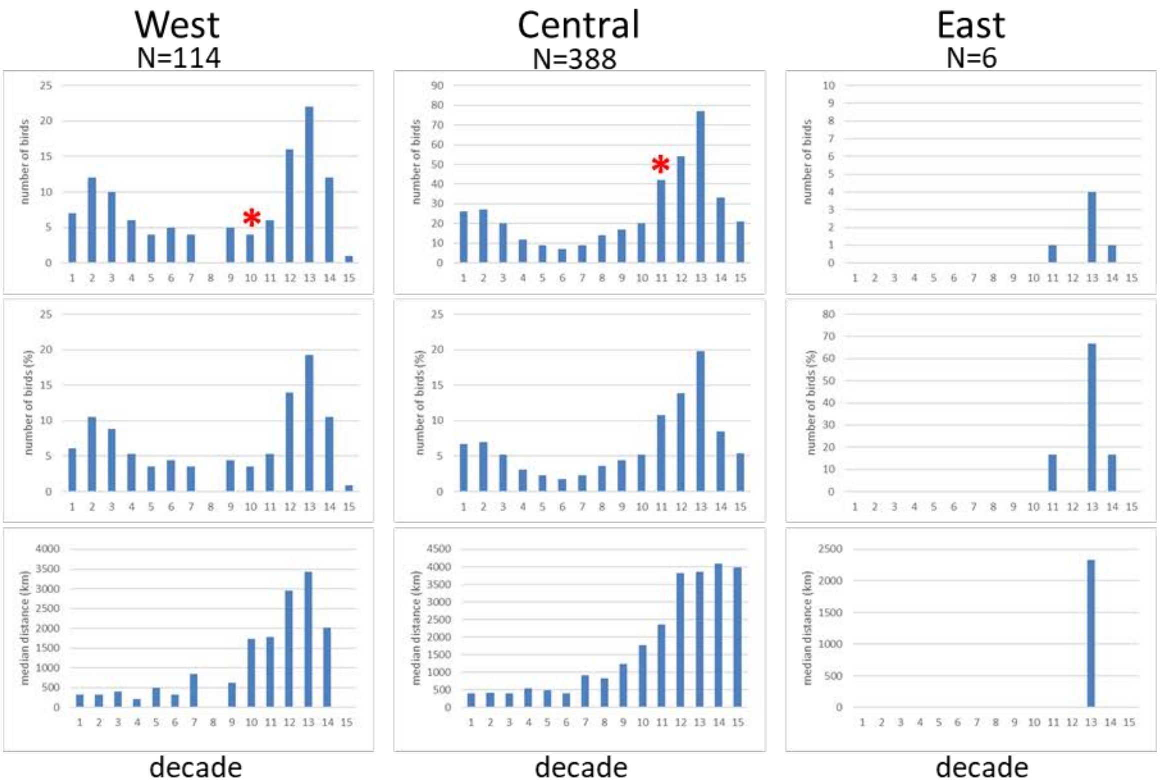


Fig. 4: Median migration date of pre-nuptial migration of Northern Shoveler. The map shows the date when 50% of individuals are on migration.

01980 Common Pochard *Aythya ferina*

Recovery analysis





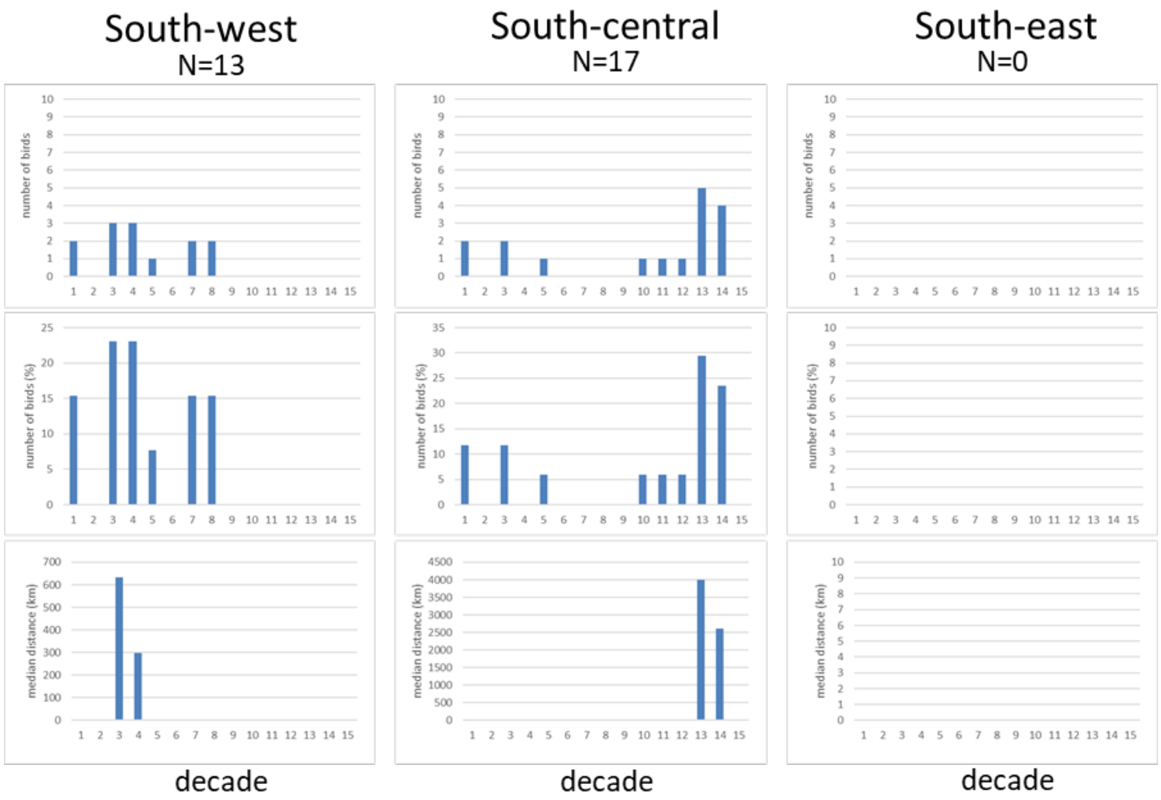


Fig. 1: Onset of prenuptial (return) migration of Common Pochard by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

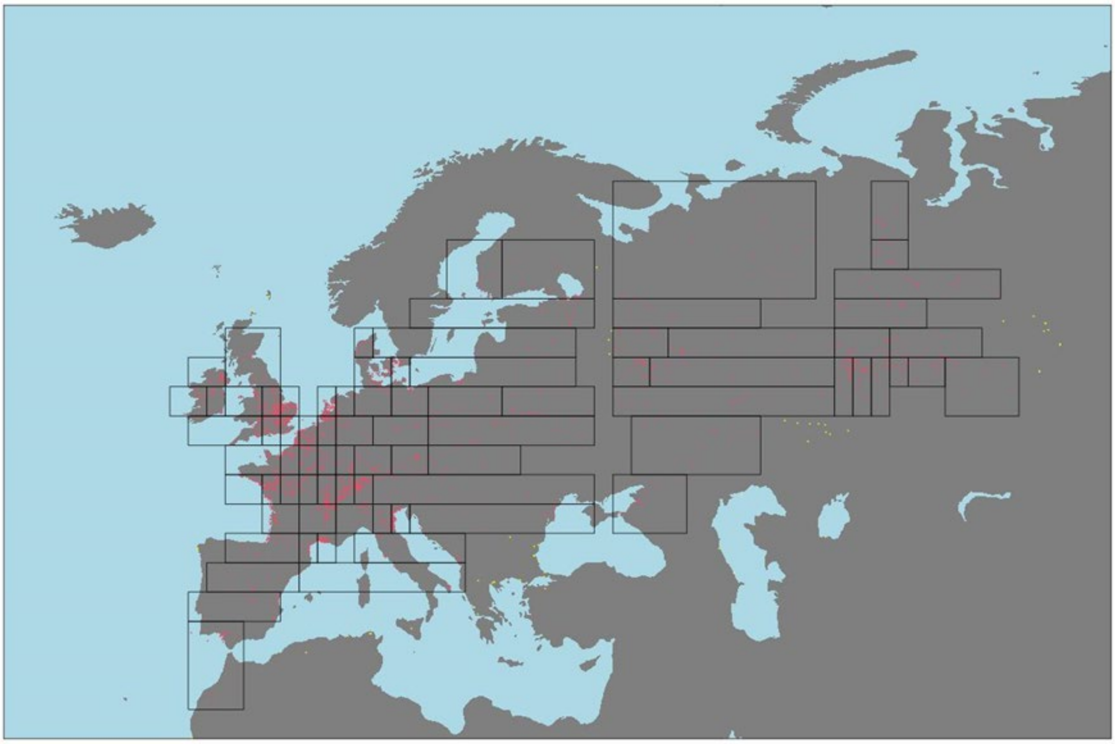


Fig. 2: Data availability for the analyses of Common Pochard pre-nuptial migration. Red dots: encounters used (9214), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

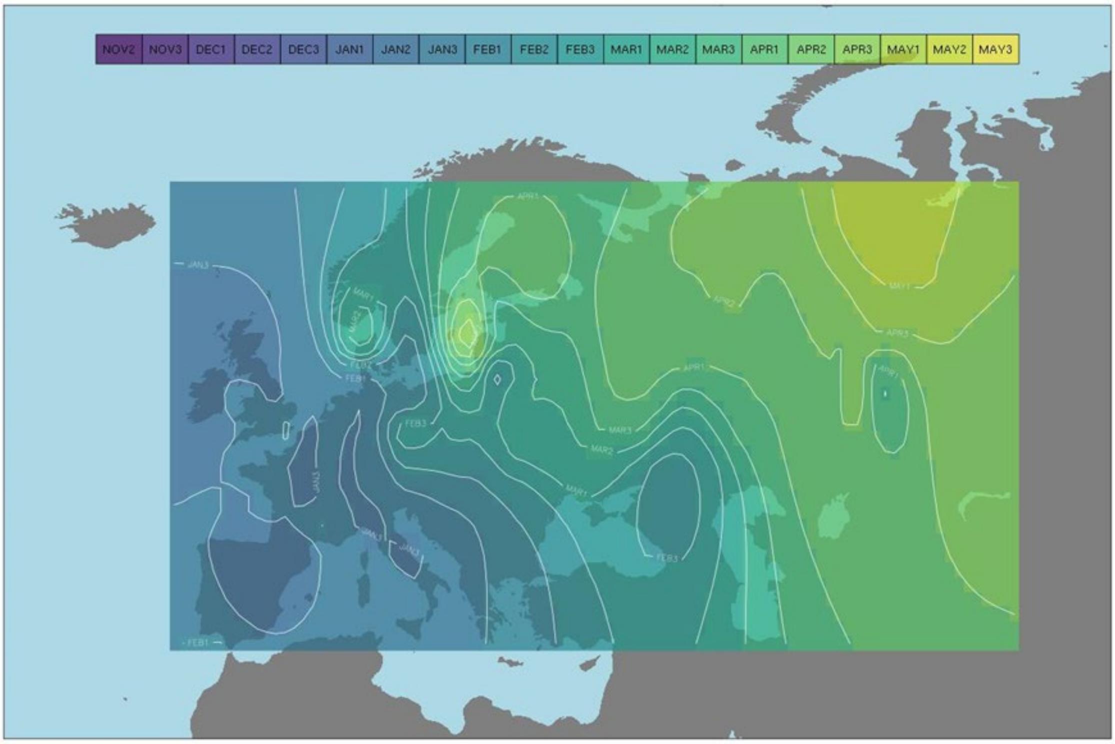


Fig. 3: Onset of pre-nuptial migration of Common Pochard. The map shows the date when 5% of individuals are on migration.

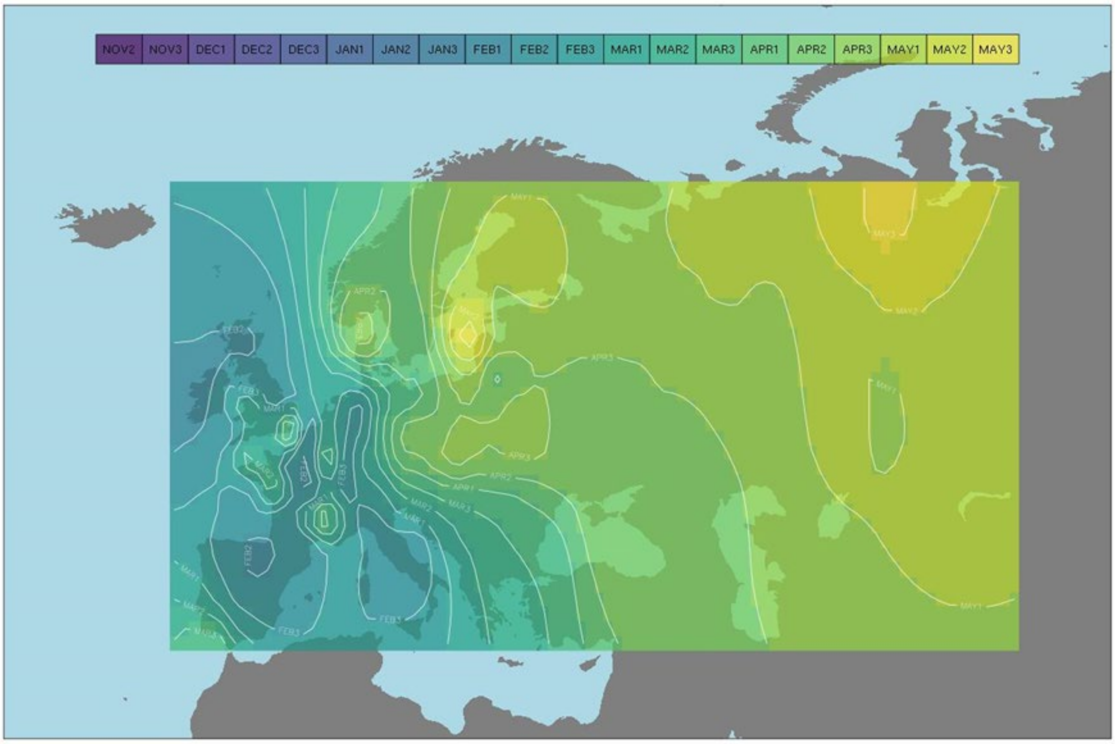
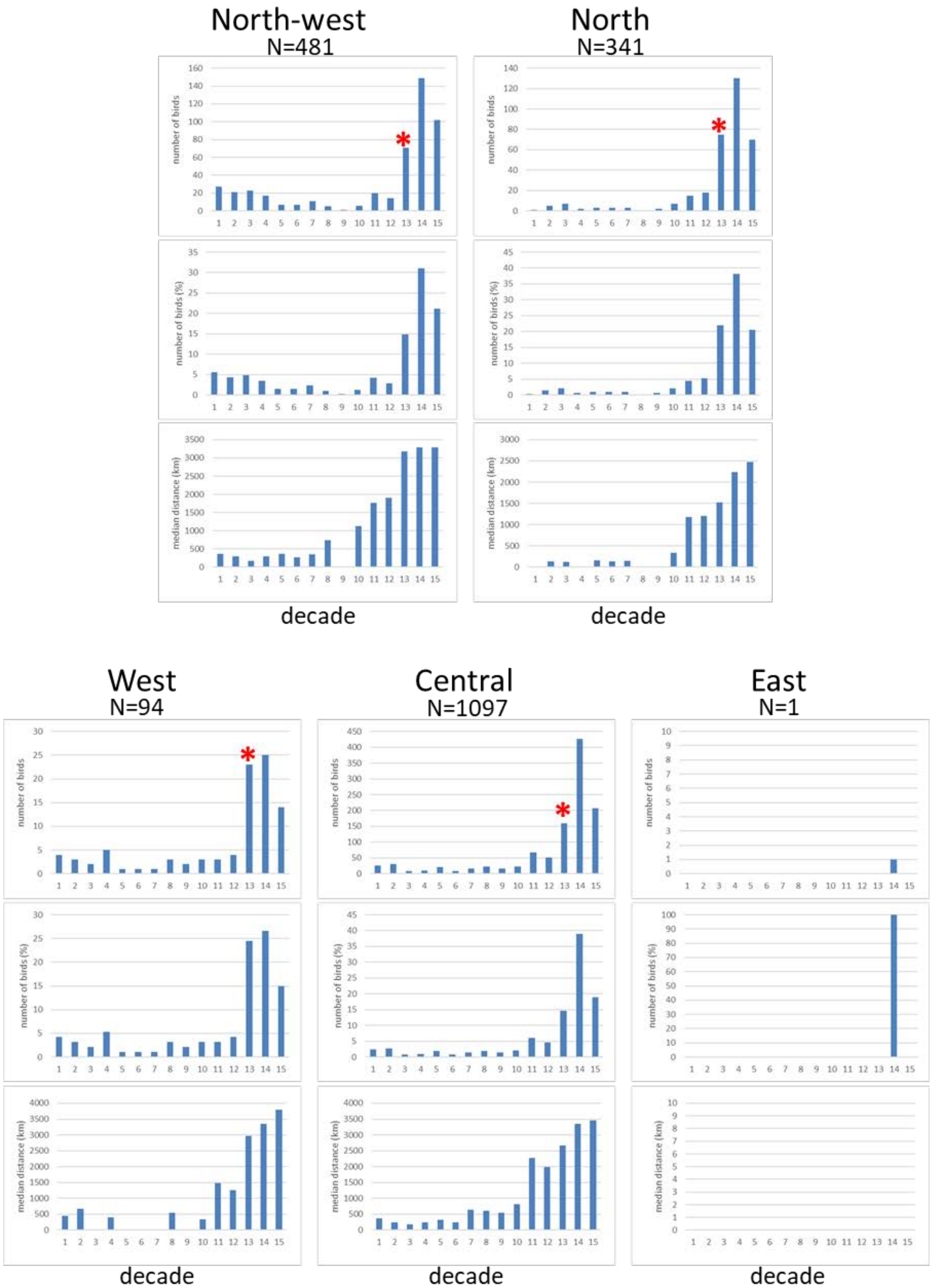


Fig. 4: Median migration date of pre-nuptial migration of Common Pochard. The map shows the date when 50% of individuals are on migration.

02030 Tufted Duck *Aythya fuligula*

Recovery analysis



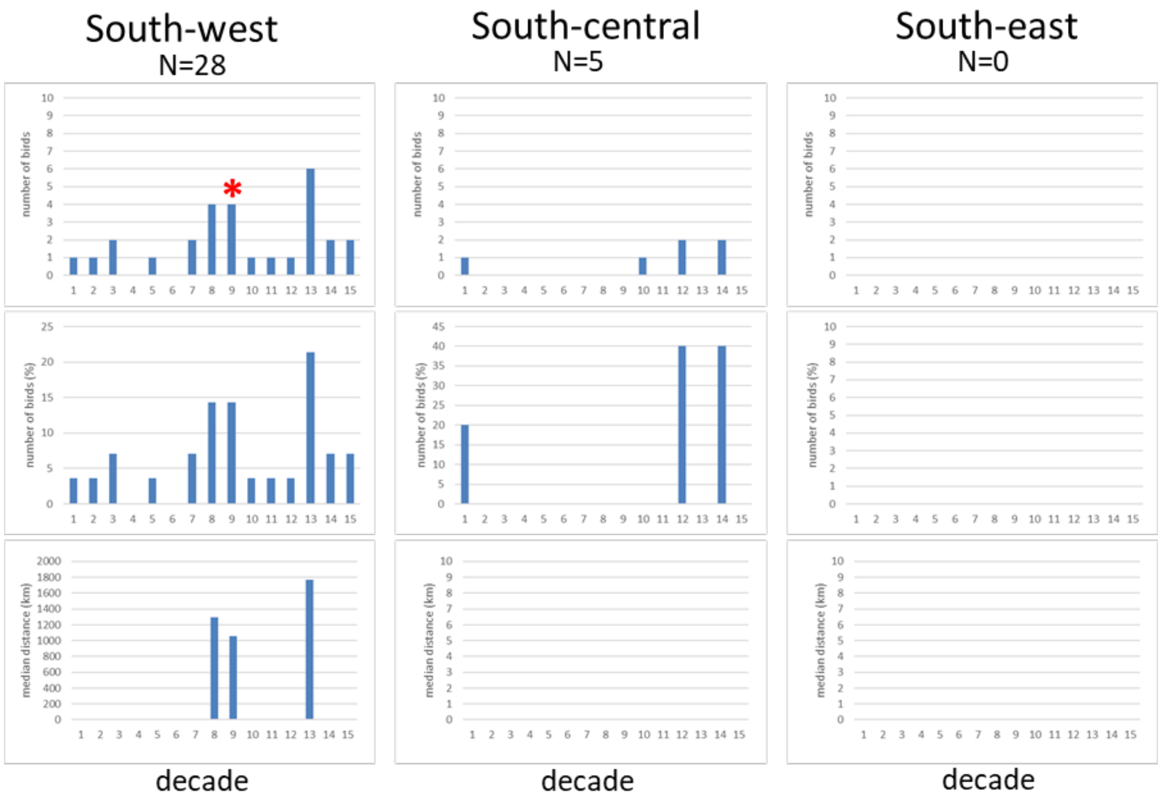


Fig. 1: Onset of prenuptial (return) migration of Tufted Duck by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

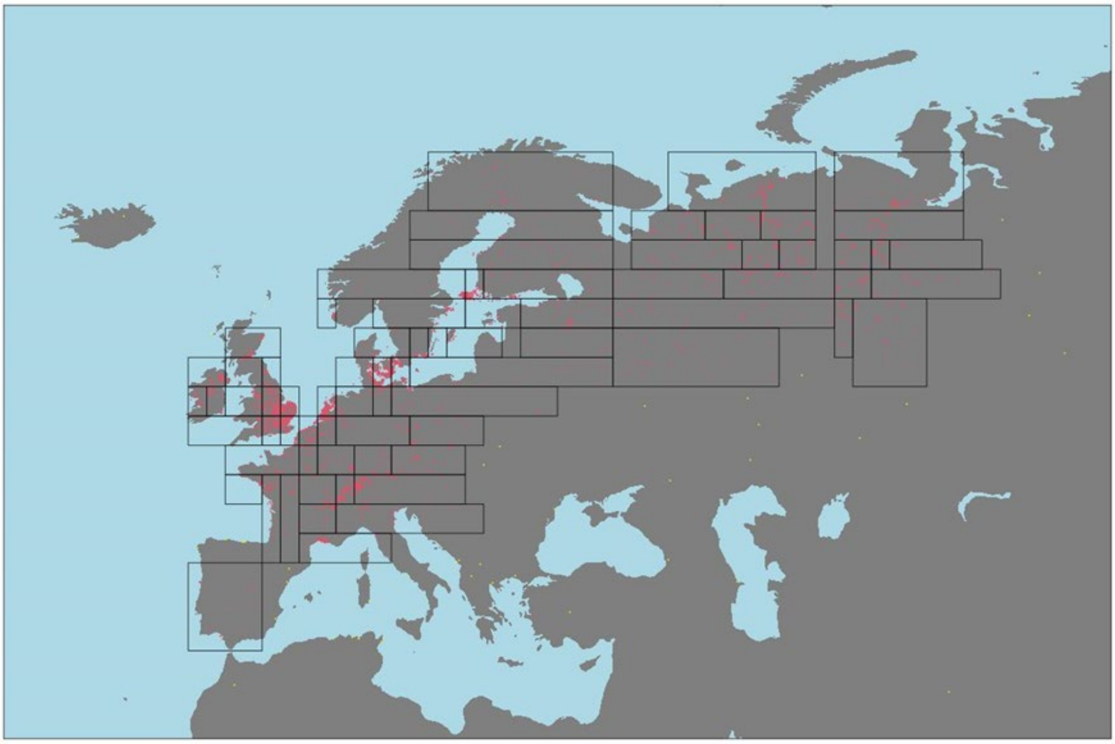


Fig. 2: Data availability for the analyses of Tufted Duck pre-nuptial migration. Red dots: encounters used (23,989), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

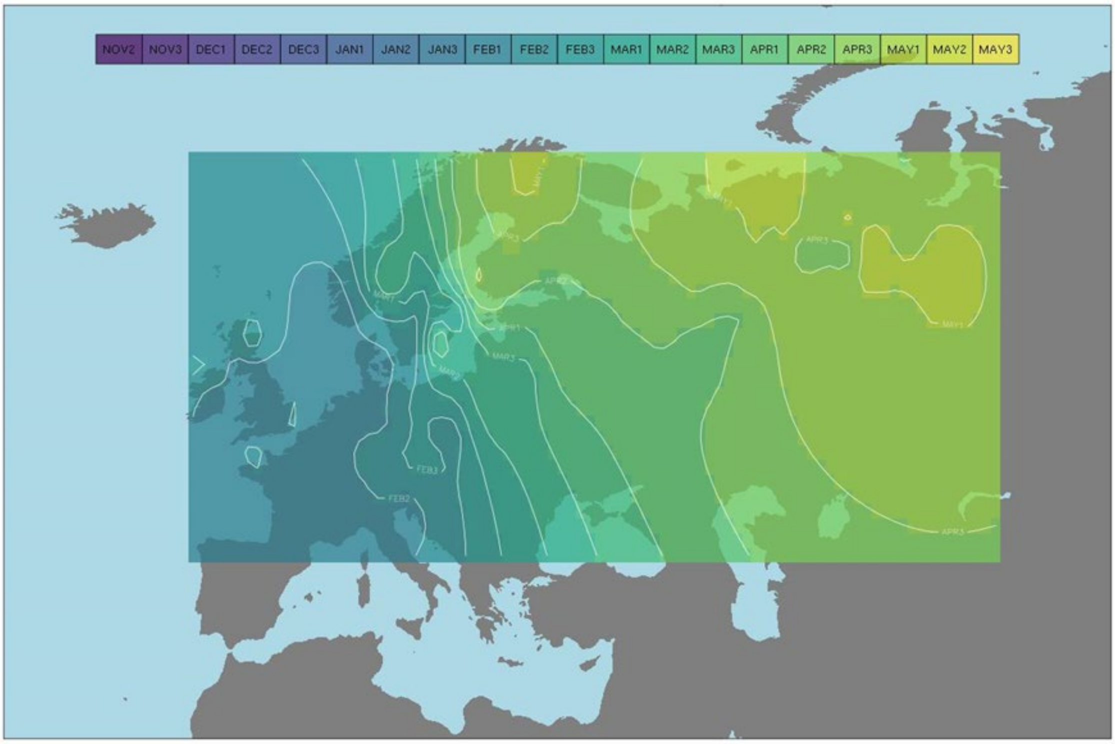


Fig. 3: Onset of pre-nuptial migration of Tufted Duck. The map shows the date when 5% of individuals are on migration.

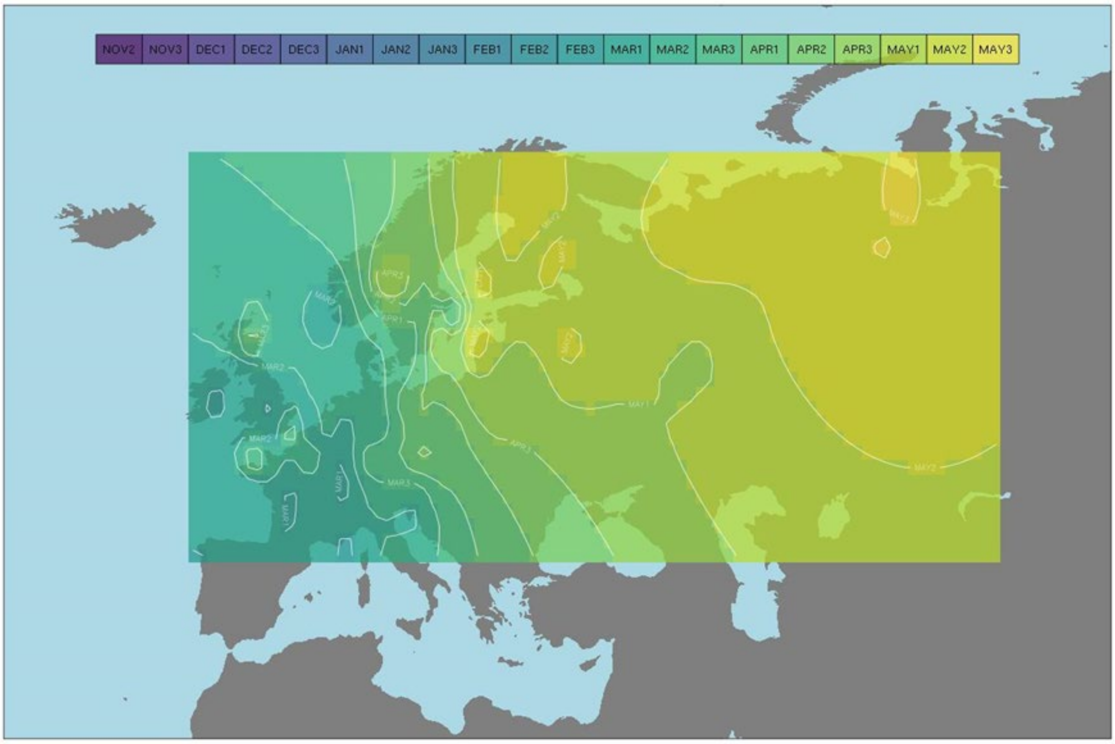


Fig. 4: Median migration date of pre-nuptial migration of Tufted Duck. The map shows the date when 50% of individuals are on migration.

02060 Common Eider *Somateria mollissima*

Recovery analysis

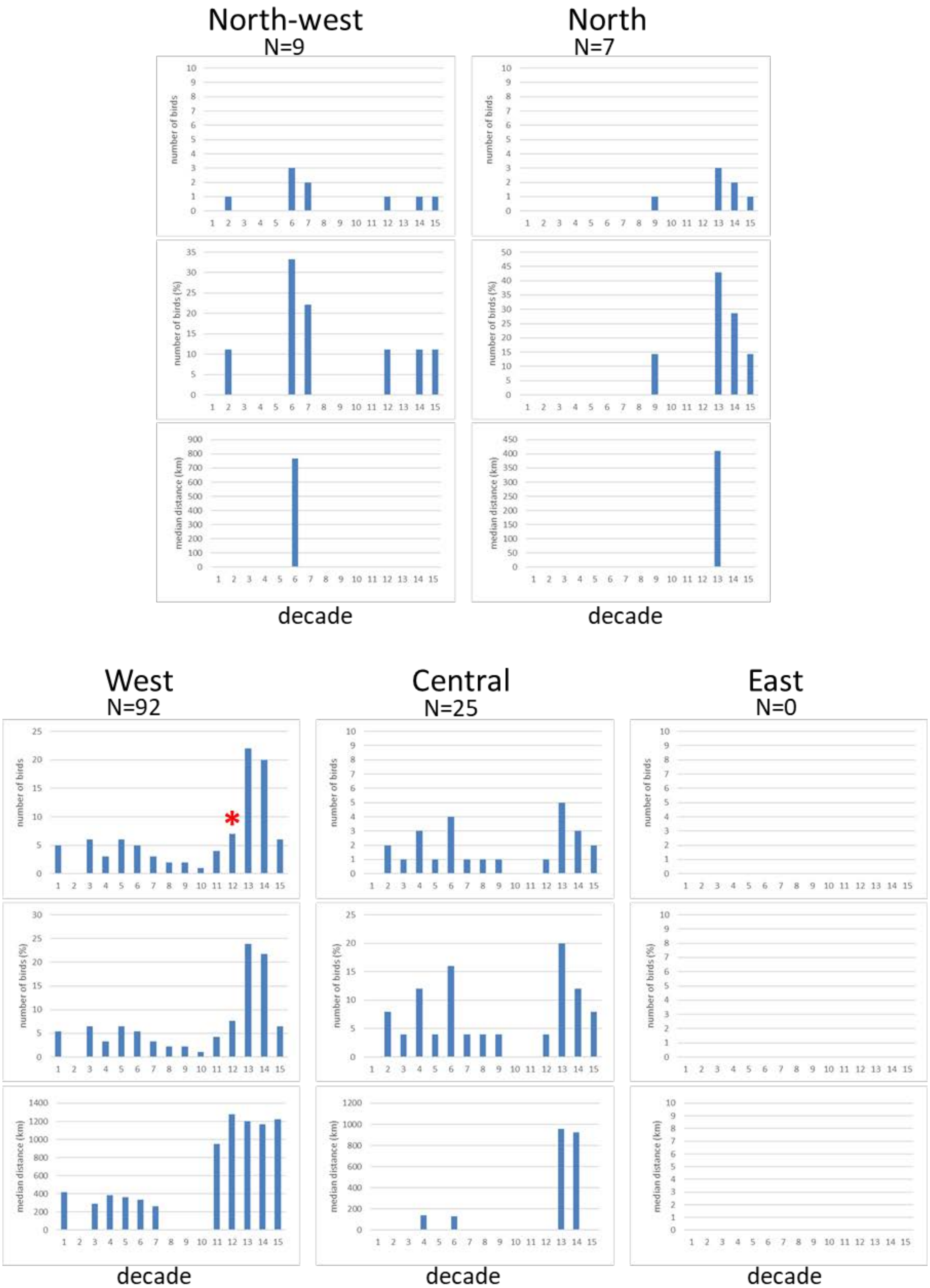


Fig. 1: Onset of prenuptial (return) migration of Common Eider by geographical region and decade. The asterix denotes the median date of onset of return migration. No data from South-west, South-central, South-east.

Mapping analysis

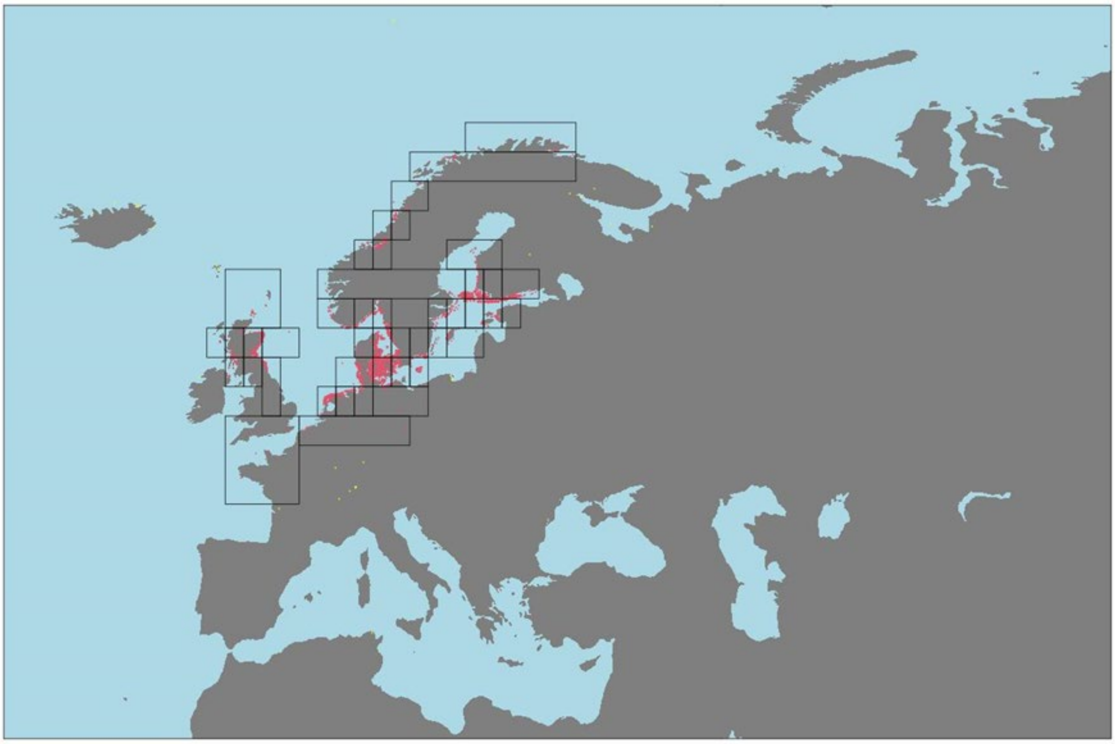


Fig. 2: Data availability for the analyses of Common Eider pre-nuptial migration. Red dots: encounters used (77,878), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

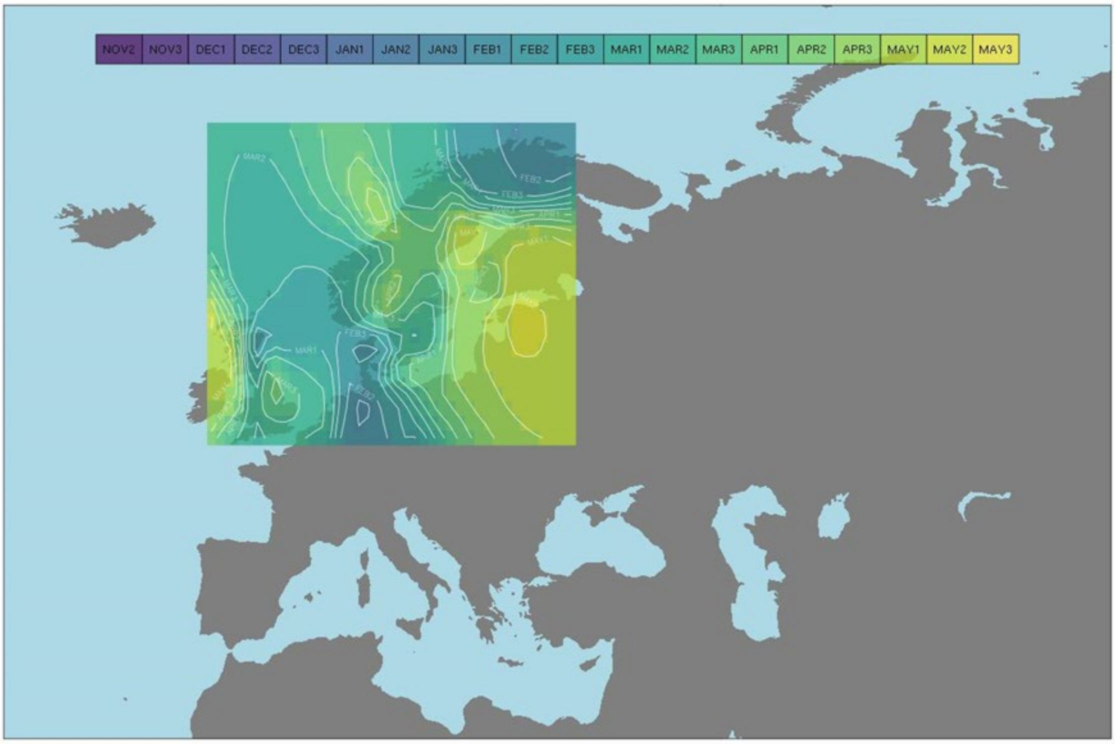


Fig. 3: Onset of pre-nuptial migration of Common Eider. The map shows the date when 5% of individuals are on migration.

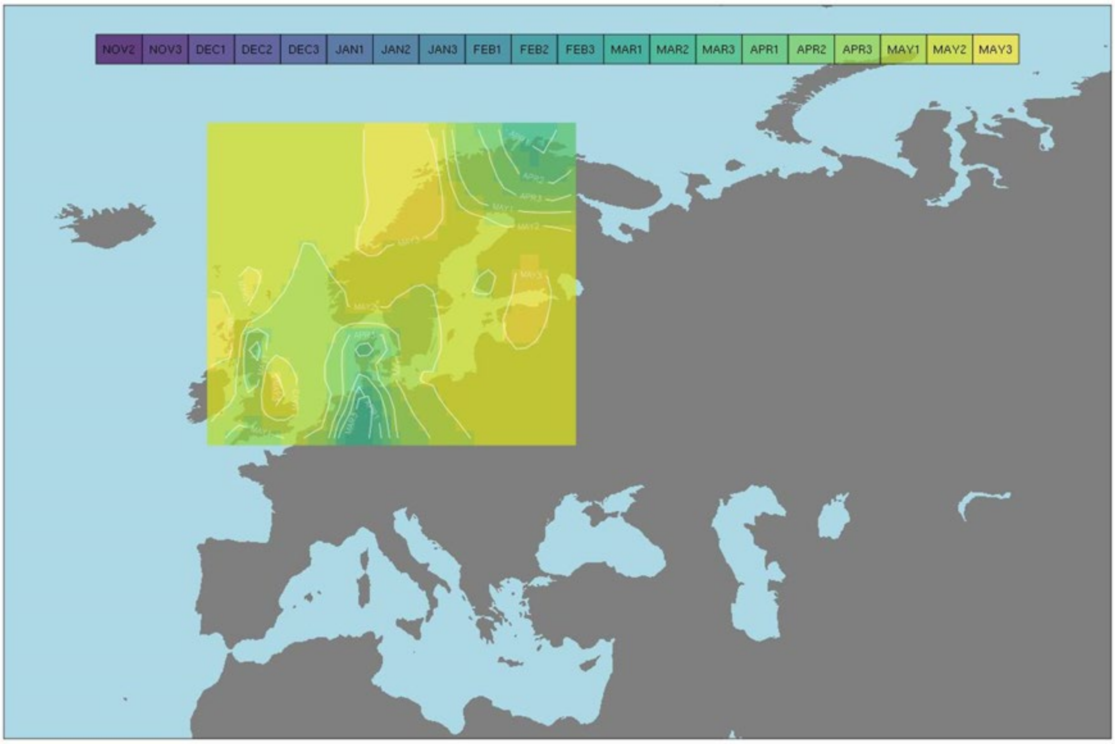


Fig. 4: Median migration date of pre-nuptial migration of Common Eider. The map shows the date when 50% of individuals are on migration.

02180 Common Goldeneye *Bucephala clangula*

Recovery analysis

No data for the recovery analysis.

Mapping analysis

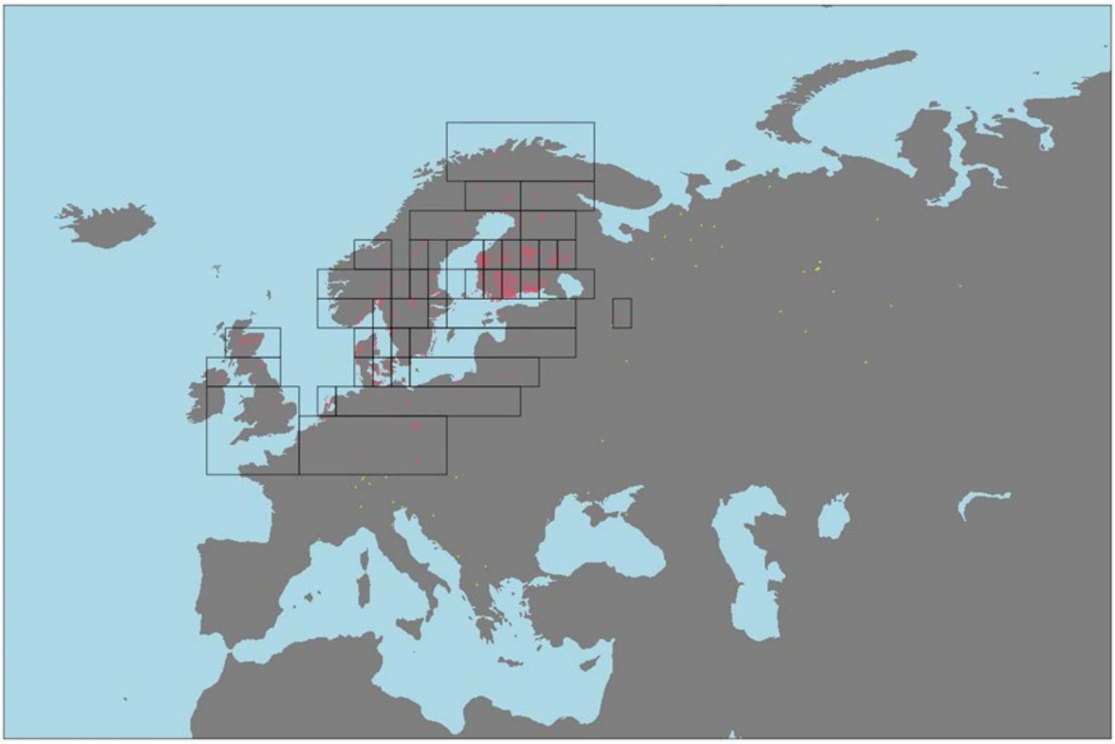


Fig. 2: Data availability for the analyses of Common Goldeneye pre-nuptial migration. Red dots: encounters used (6341), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

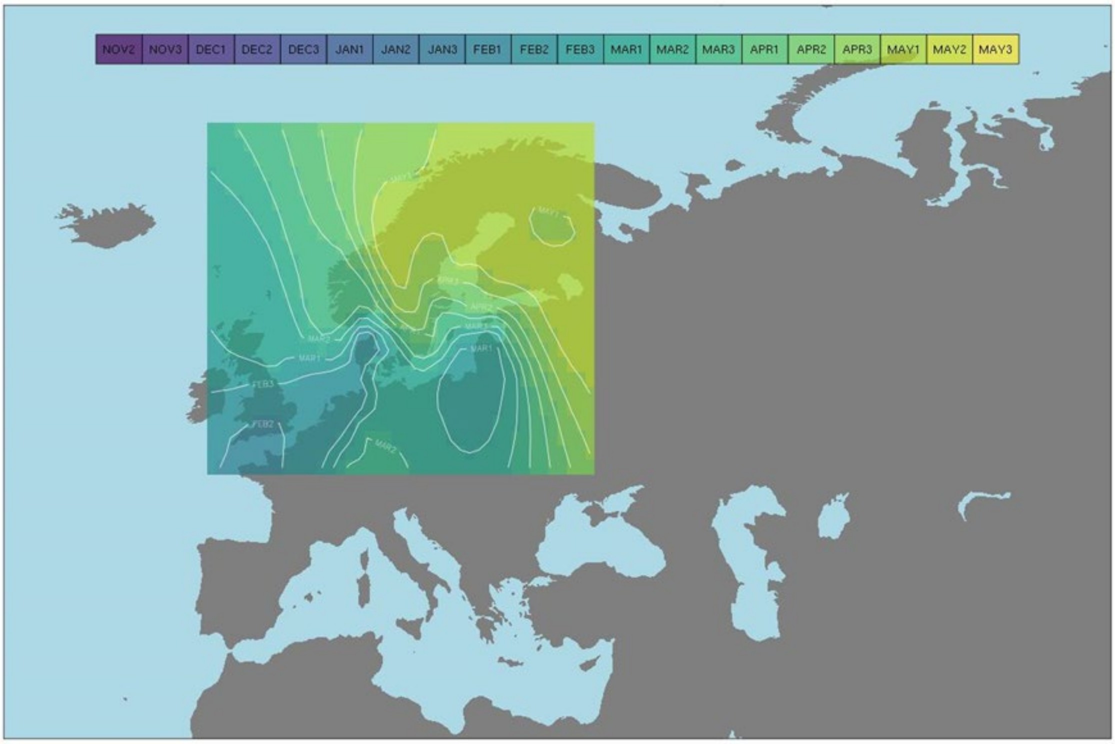


Fig. 3: Onset of pre-nuptial migration of Common Goldeneye. The map shows the date when 5% of individuals are on migration.

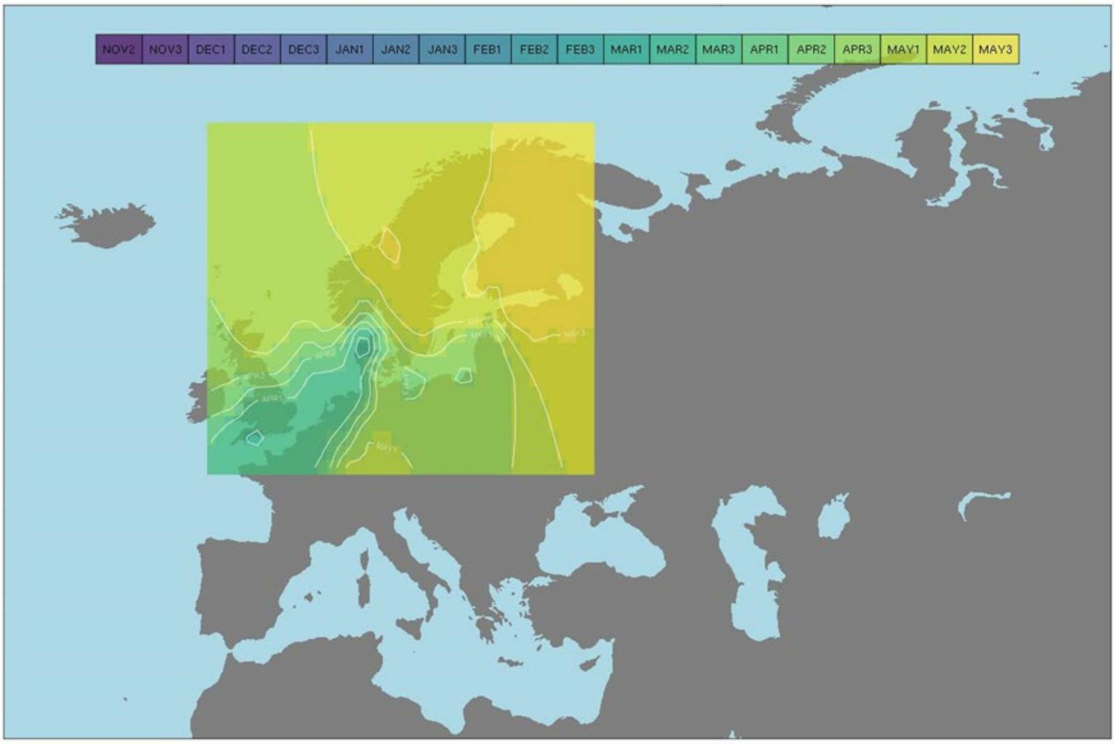


Fig. 4: Median migration date of pre-nuptial migration of Common Goldeneye. The map shows the date when 50% of individuals are on migration.

02230 Common Merganser *Mergus merganser*

Recovery analysis

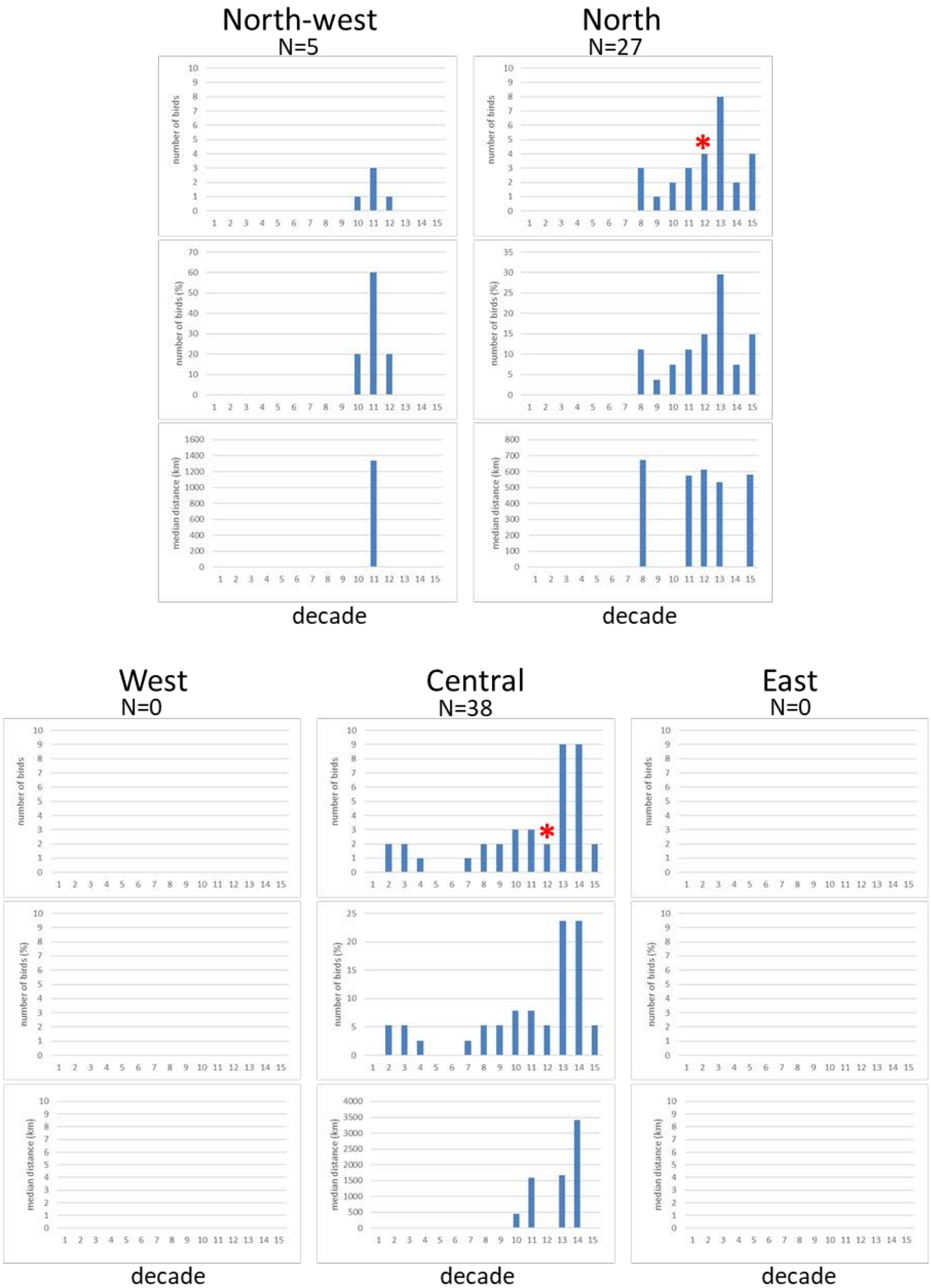


Fig. 1: Onset of prenuptial (return) migration of Common Merganser by geographical region and decade. The asterix denotes the median date of onset of return migration. No data from South-west, South-central, South-east.

Mapping analysis

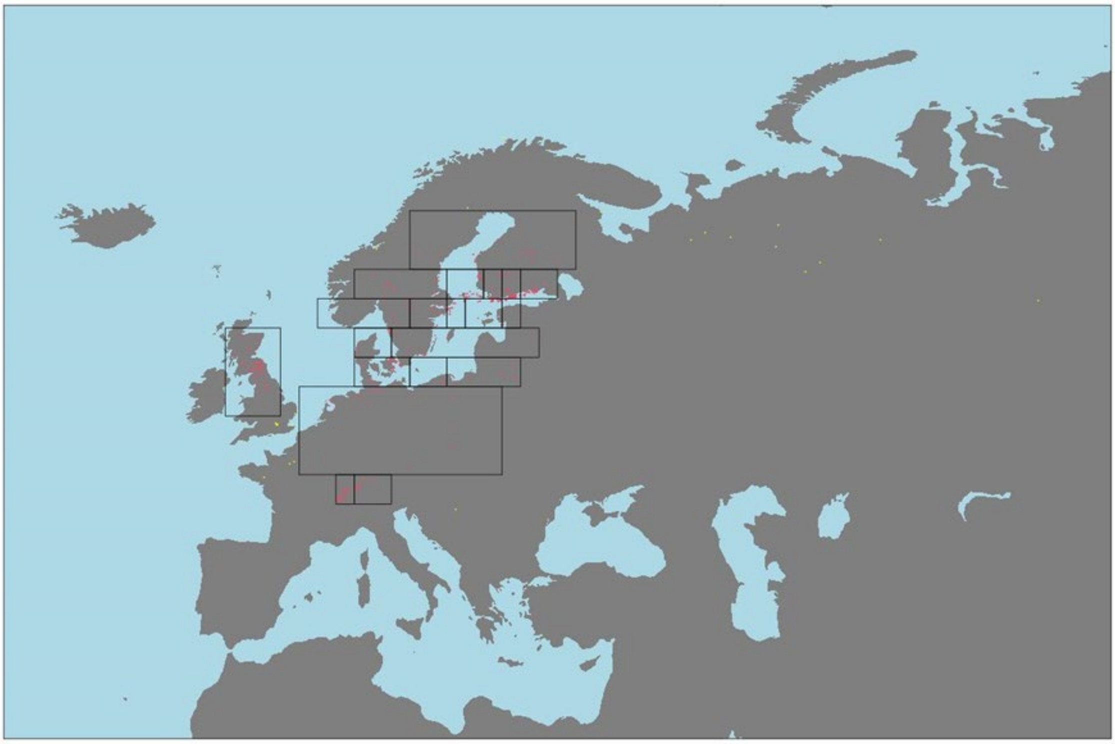


Fig. 2: Data availability for the analyses of Common Merganser pre-nuptial migration. Red dots: encounters used (2338), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

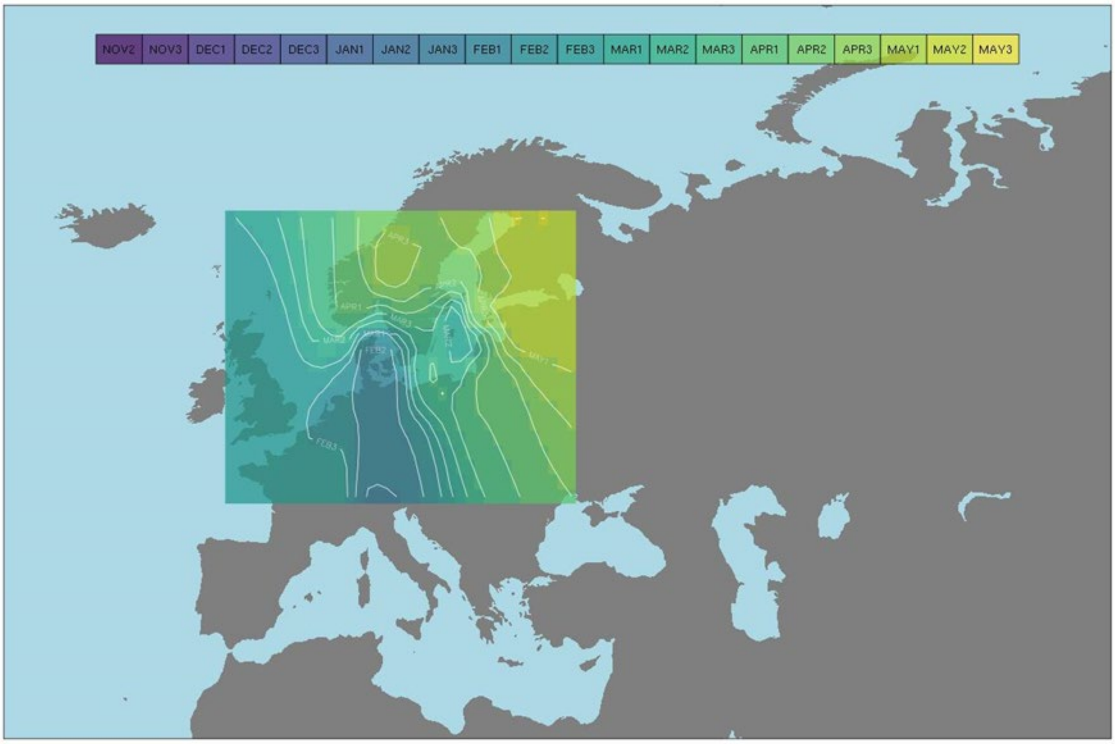


Fig. 3: Onset of pre-nuptial migration of Common Merganser. The map shows the date when 5% of individuals are on migration.

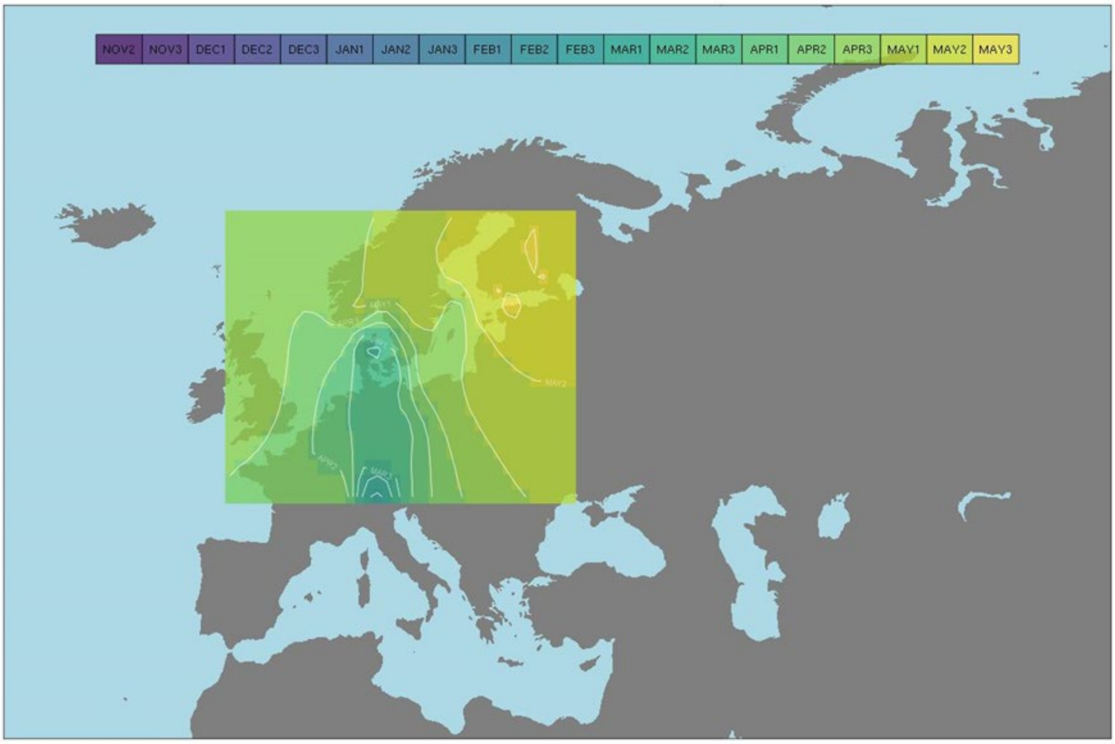


Fig. 4: Median migration date of pre-nuptial migration of Common Merganser. The map shows the date when 50% of individuals are on migration.

03700 Common Quail *Coturnix coturnix*

Recovery analysis

No data for recovery analysis.

Mapping analysis

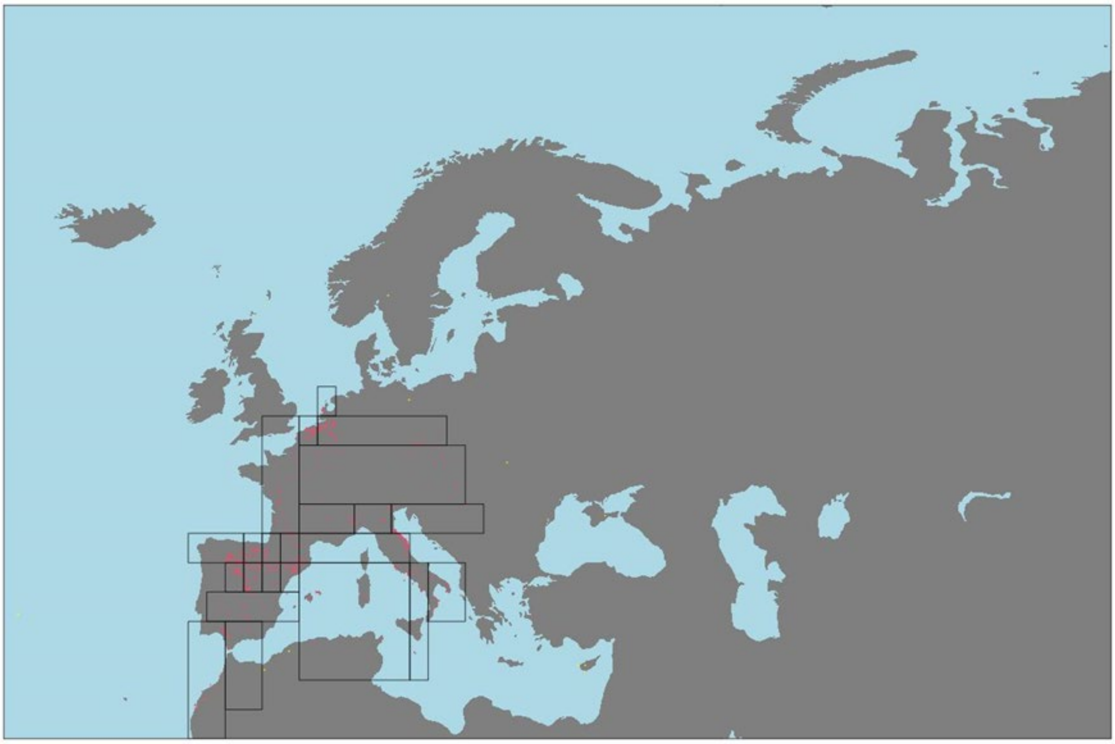


Fig. 2: Data availability for the analyses of Common Quail pre-nuptial migration. Red dots: encounters used (3538), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

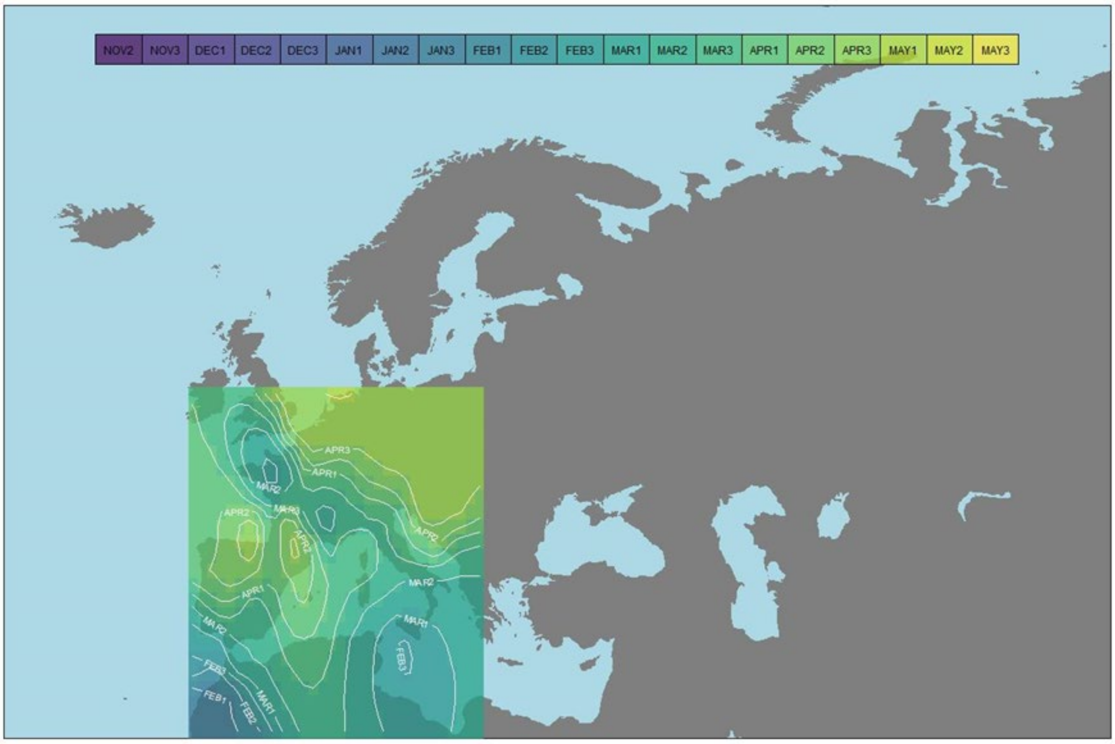


Fig. 3: Onset of pre-nuptial migration of Common Quail. The map shows the date when 5% of individuals are on migration.

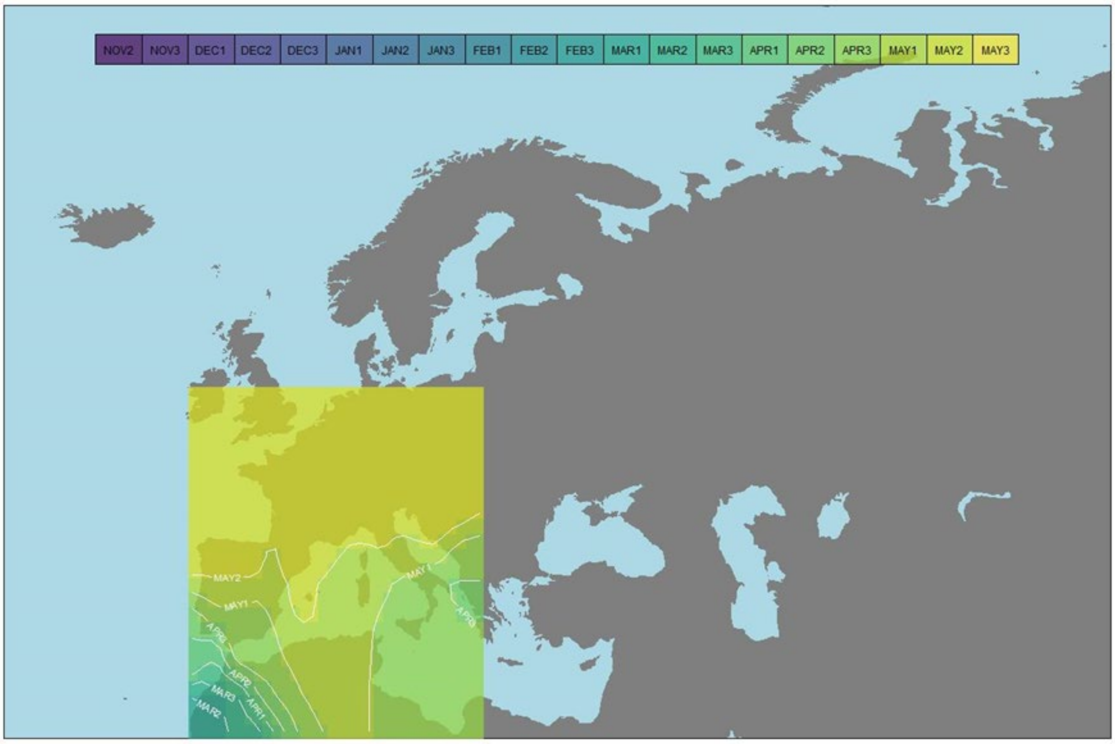


Fig. 4: Median migration date of pre-nuptial migration of Common Quail. The map shows the date when 50% of individuals are on migration.

04070 Water Rail *Rallus aquaticus*

Recovery analysis

No data for recovery analysis.

Mapping analysis

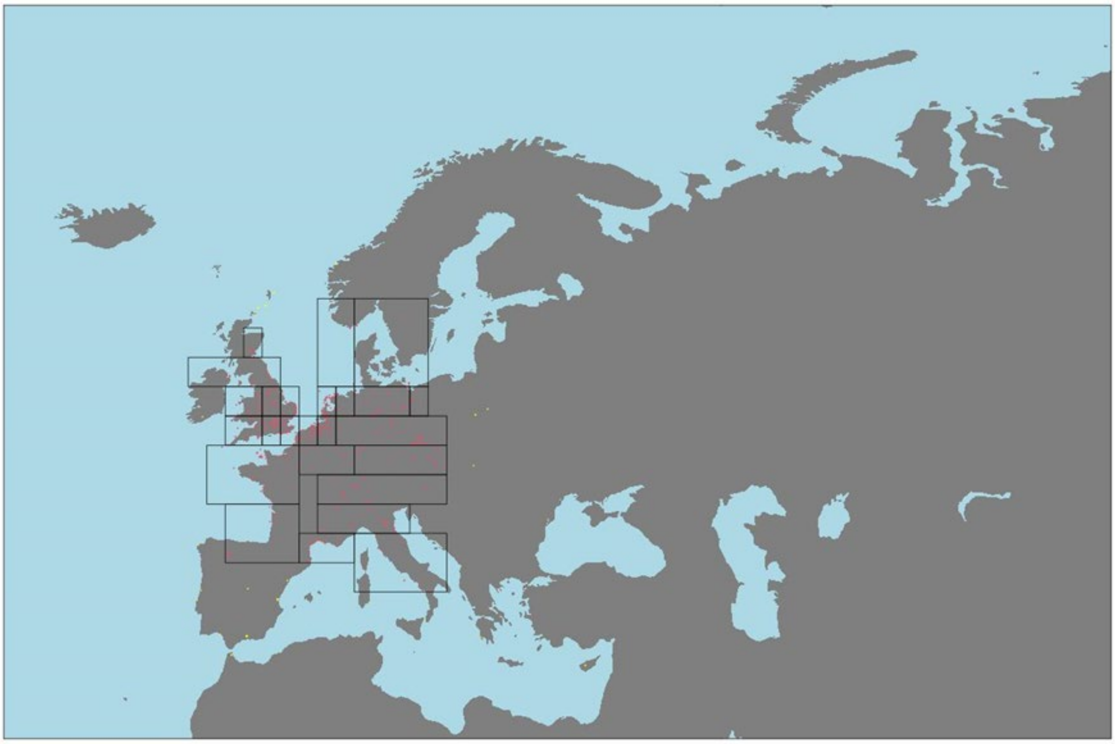


Fig. 2: Data availability for the analyses of Water Rail pre-nuptial migration. Red dots: encounters used (1941), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

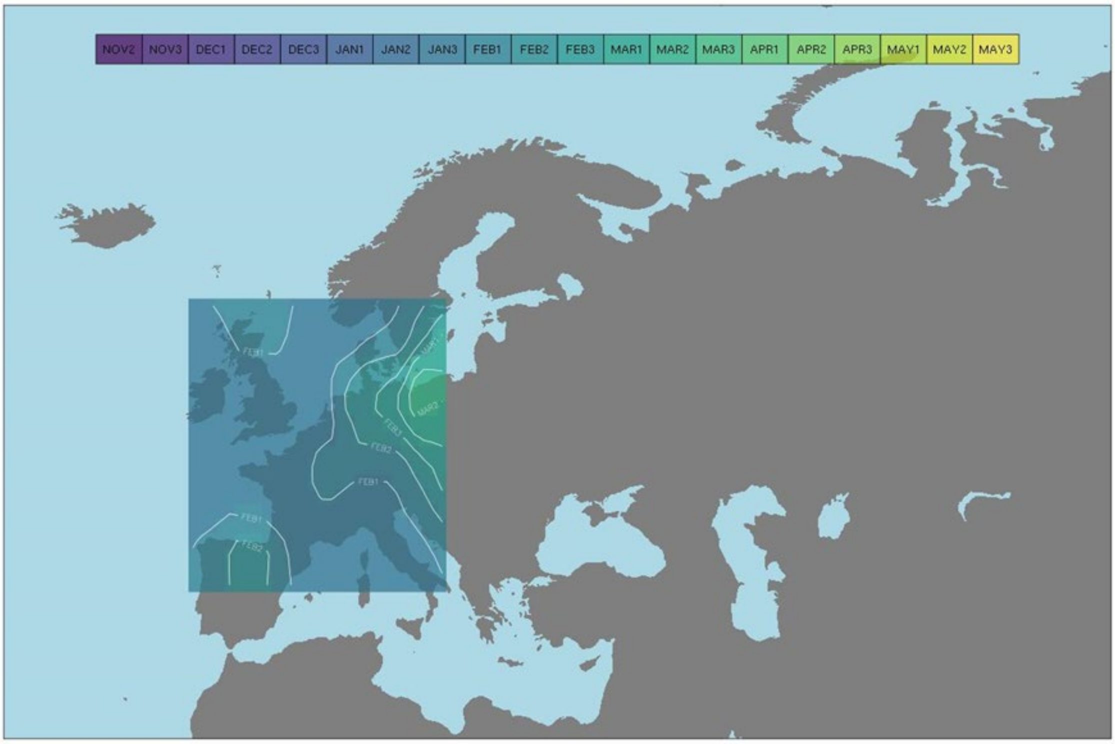


Fig. 3: Onset of pre-nuptial migration of Water Rail. The map shows the date when 5% of individuals are on migration.

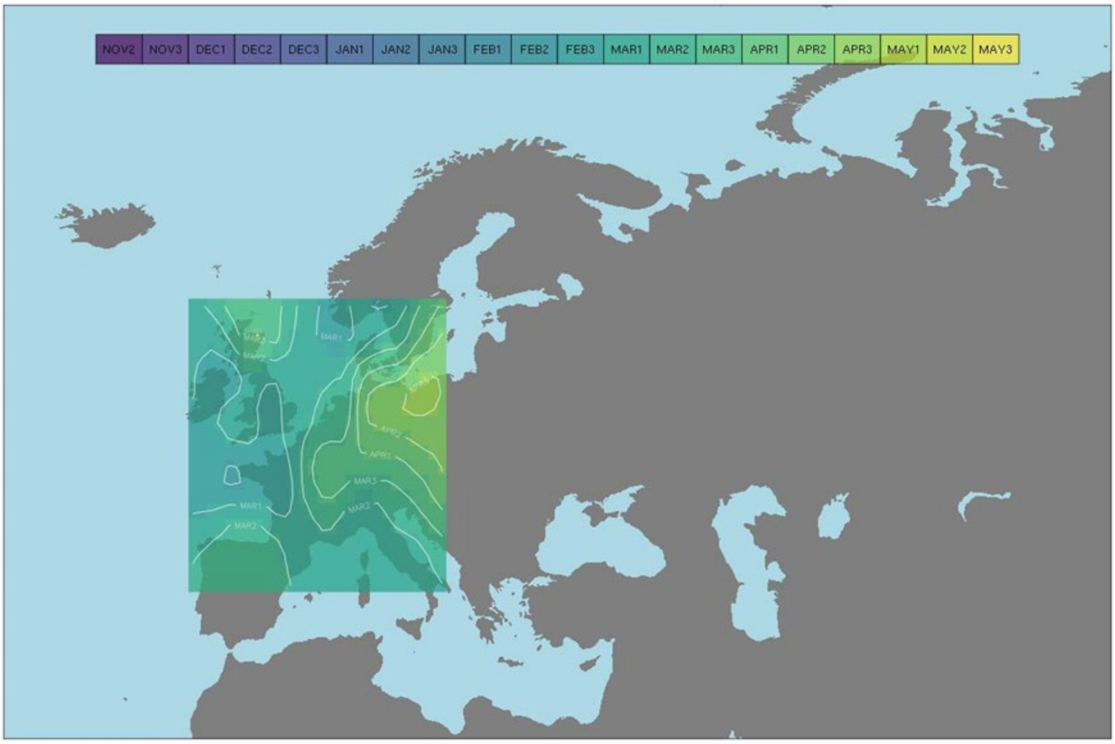


Fig. 4: Median migration date of pre-nuptial migration of Water Rail. The map shows the date when 50% of individuals are on migration.

04240 Common Moorhen *Gallinula chloropus*

Recovery analysis

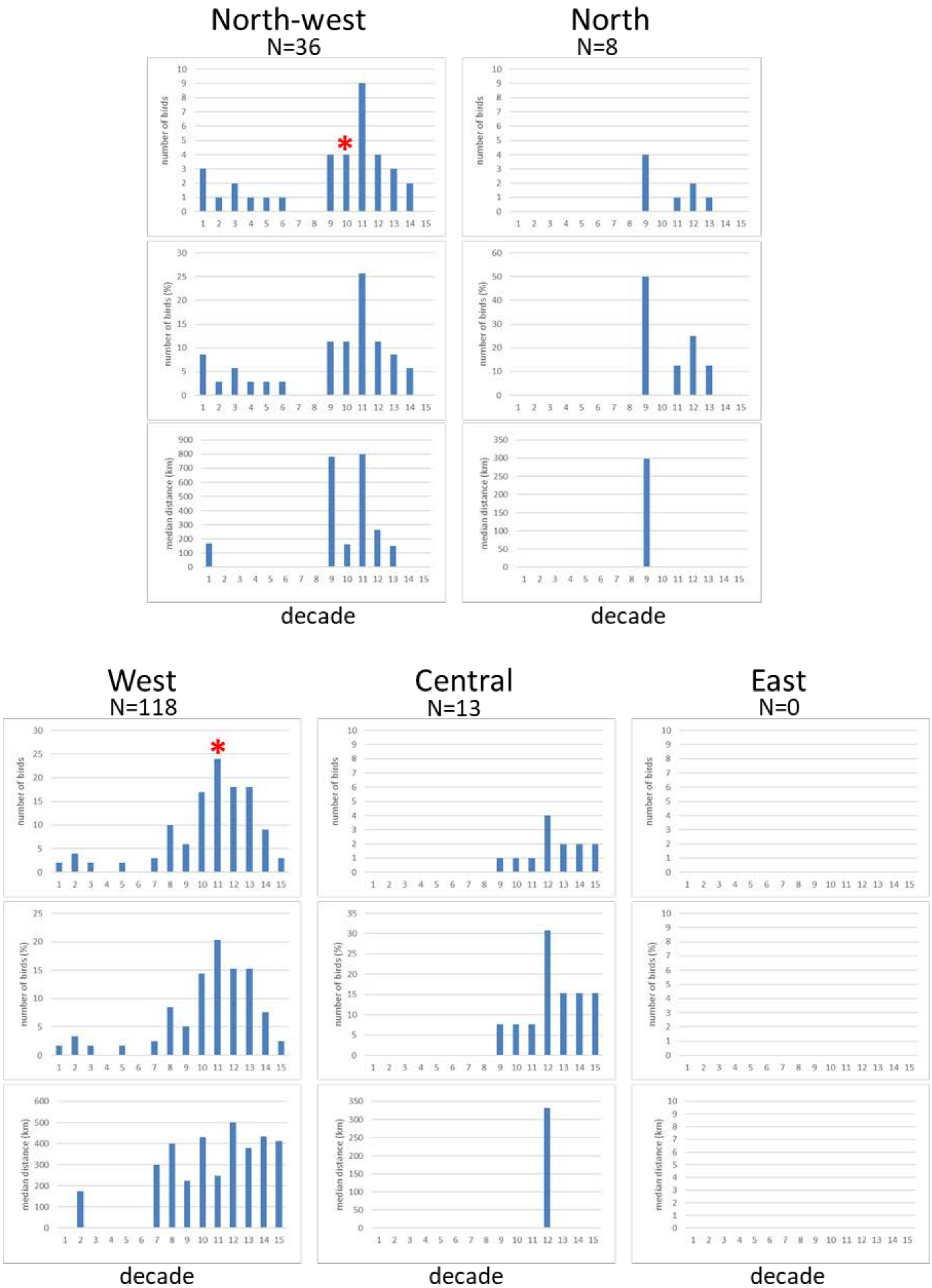


Fig. 1: Onset of prenuptial (return) migration of Common Moorhen by geographical region and decade. The asterix denotes the median date of onset of return migration. No data from South-west, South-central, South-east.

Mapping analysis

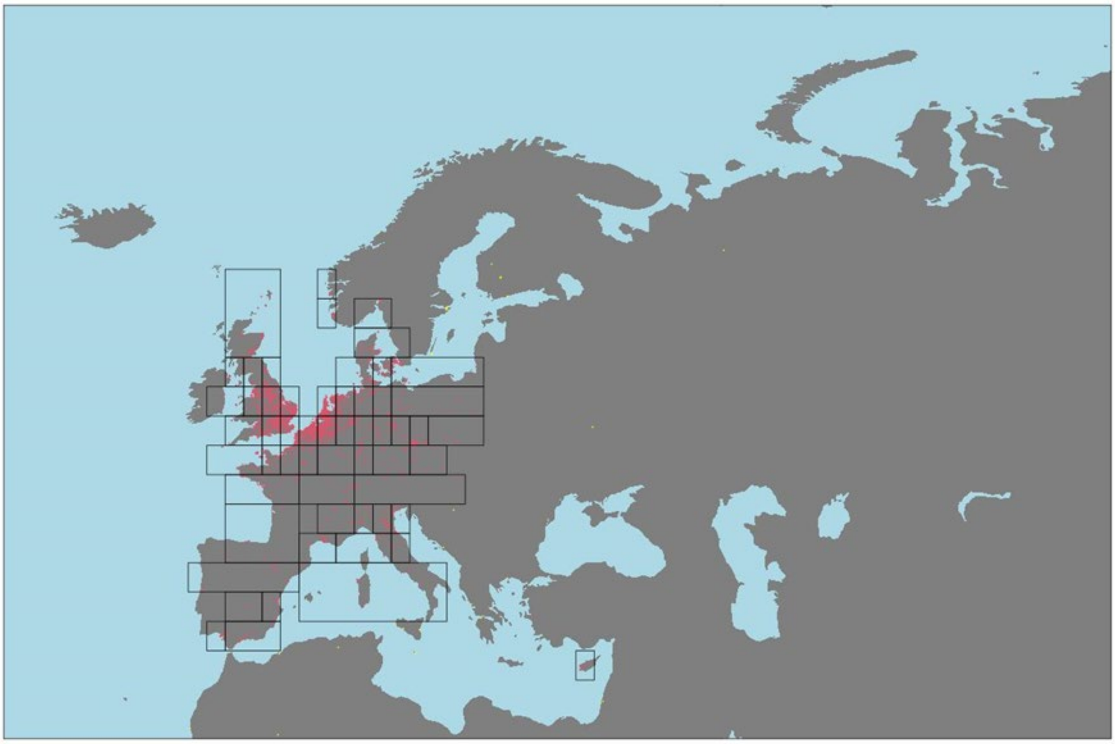


Fig. 2: Data availability for the analyses of Common Moorhen pre-nuptial migration. Red dots: encounters used (15,835), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

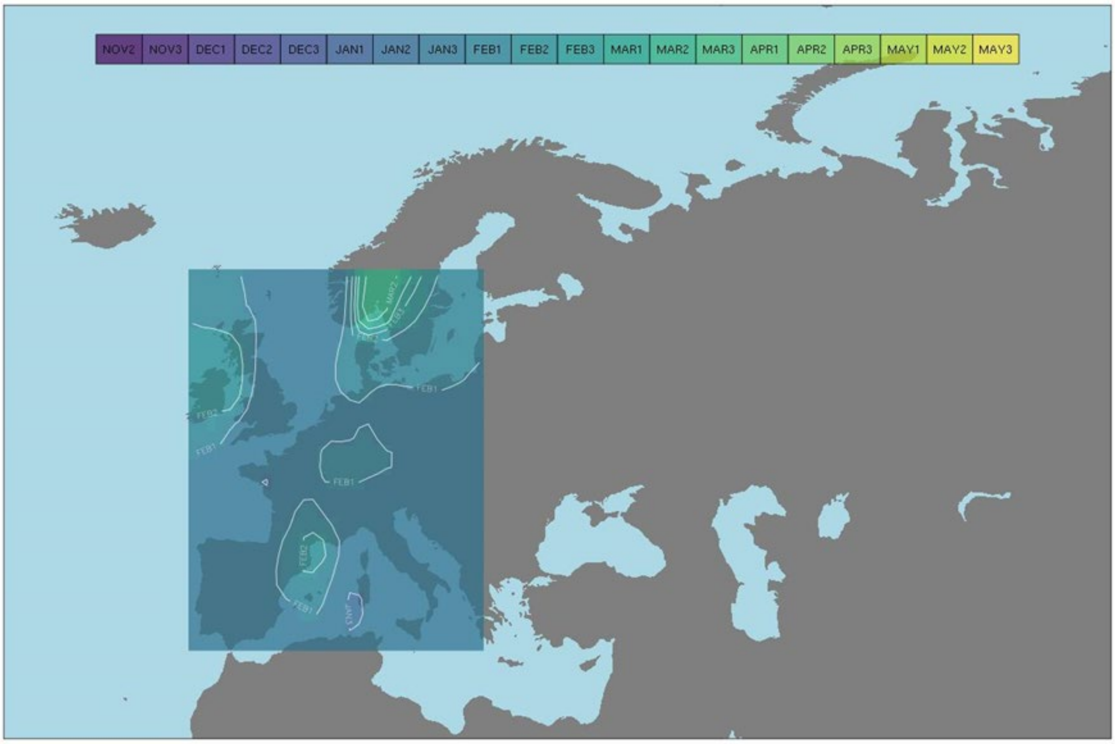


Fig. 3: Onset of pre-nuptial migration of Common Moorhen. The map shows the date when 5% of individuals are on migration.

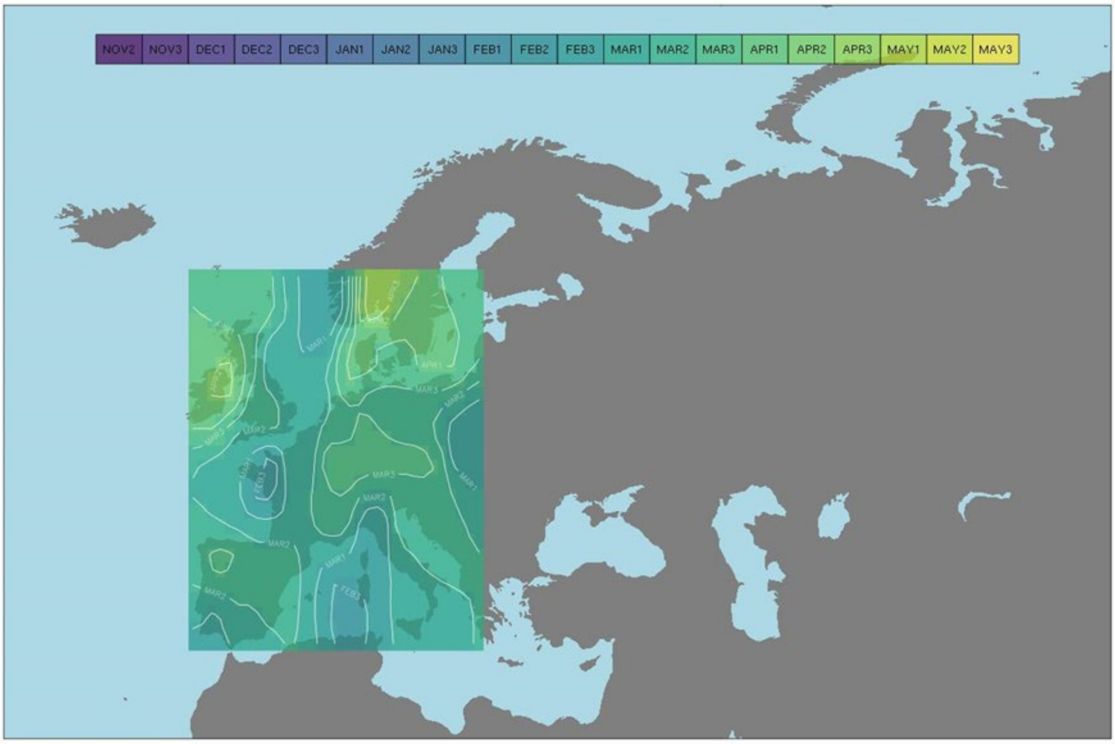
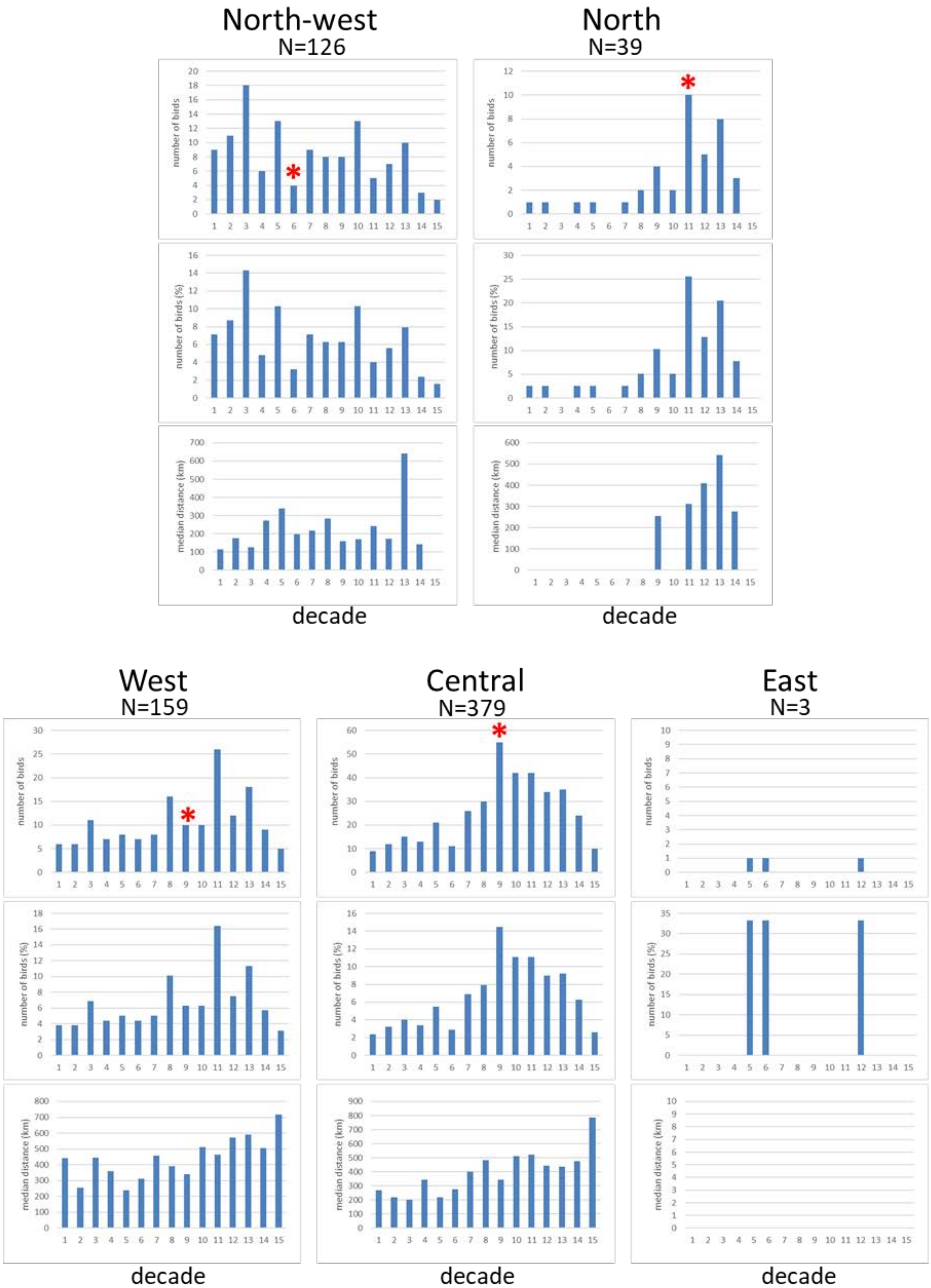


Fig. 4: Median migration date of pre-nuptial migration of Common Moorhen. The map shows the date when 50% of individuals are on migration.

04290 Eurasian Coot *Fulica atra*

Recovery analysis



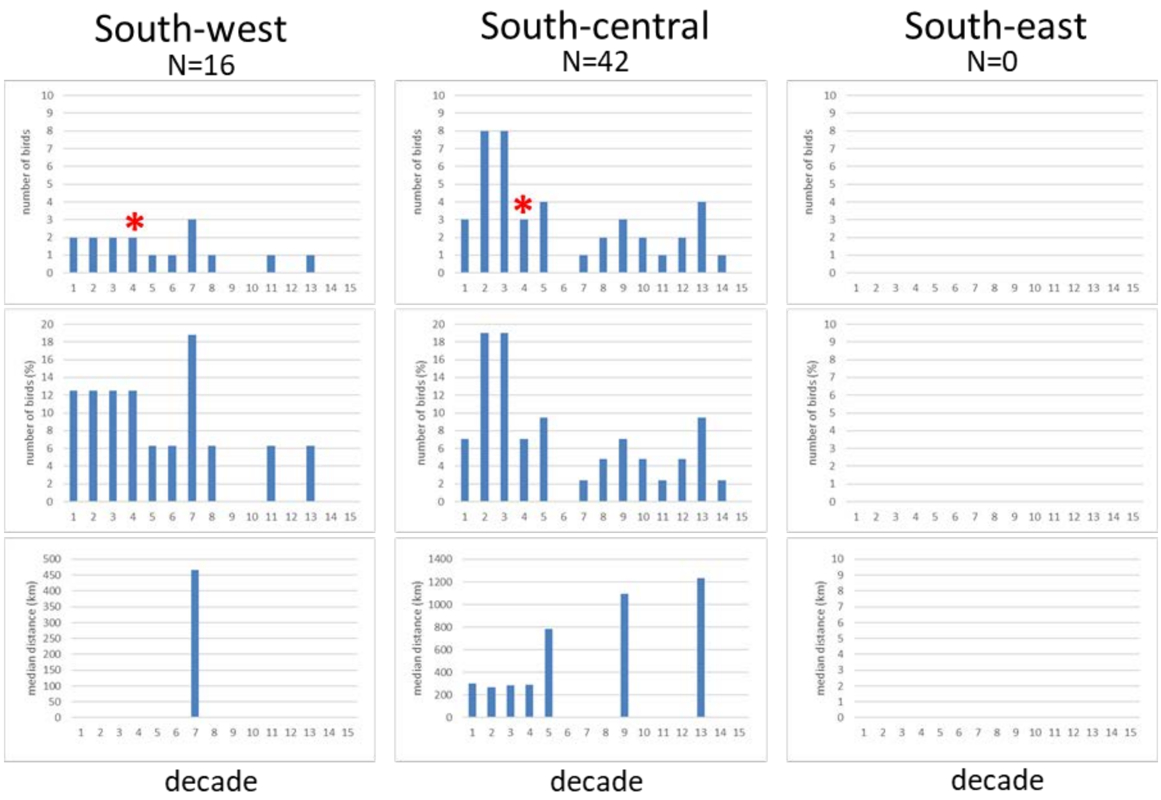


Fig. 1: Onset of prenuptial (return) migration of Eurasian Coot by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

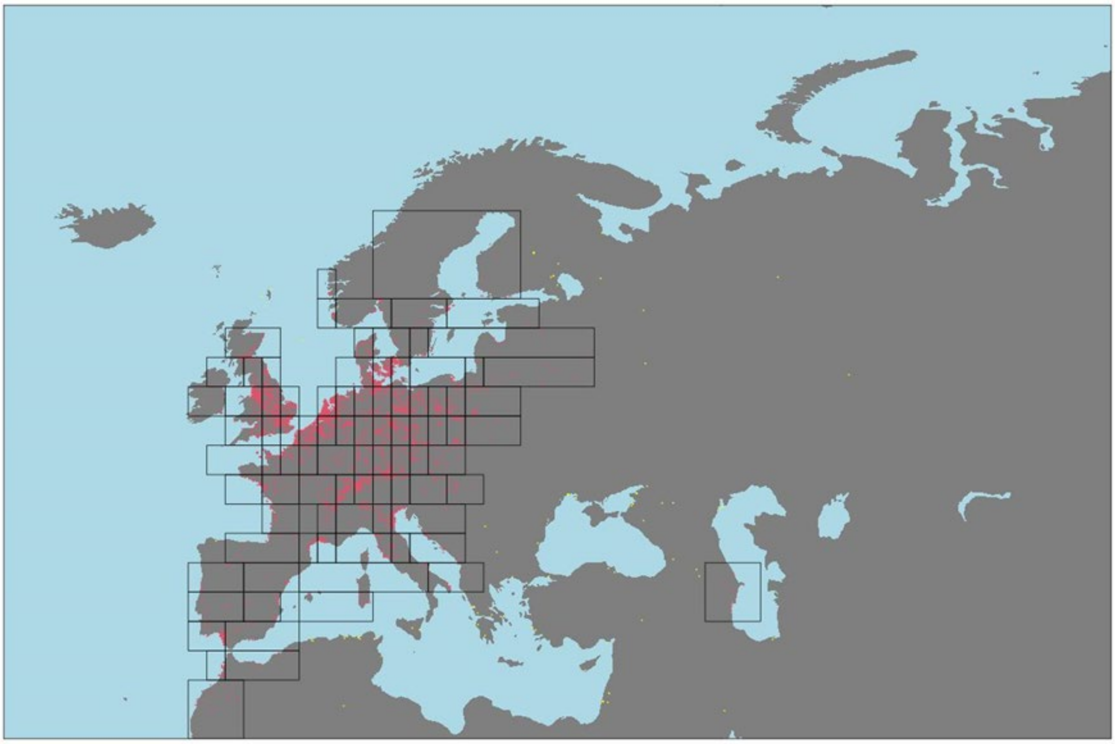


Fig. 2: Data availability for the analyses of Eurasian Coot pre-nuptial migration. Red dots: encounters used (72,584), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

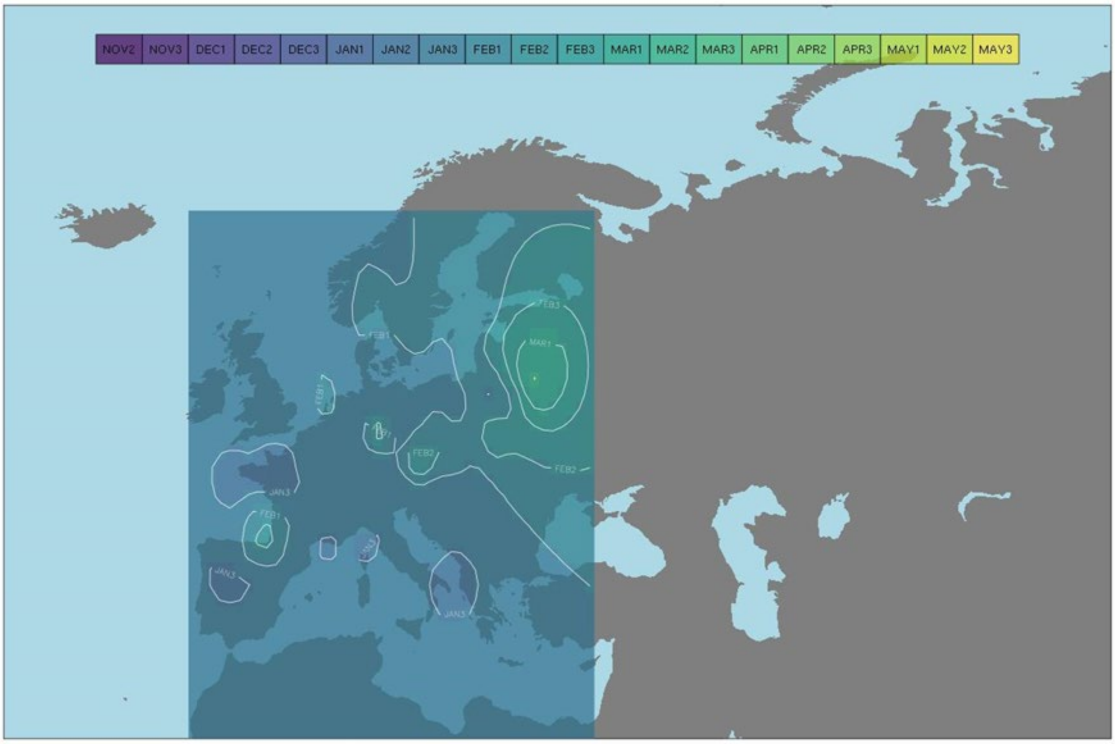


Fig. 3: Onset of pre-nuptial migration of Eurasian Coot. The map shows the date when 5% of individuals are on migration.

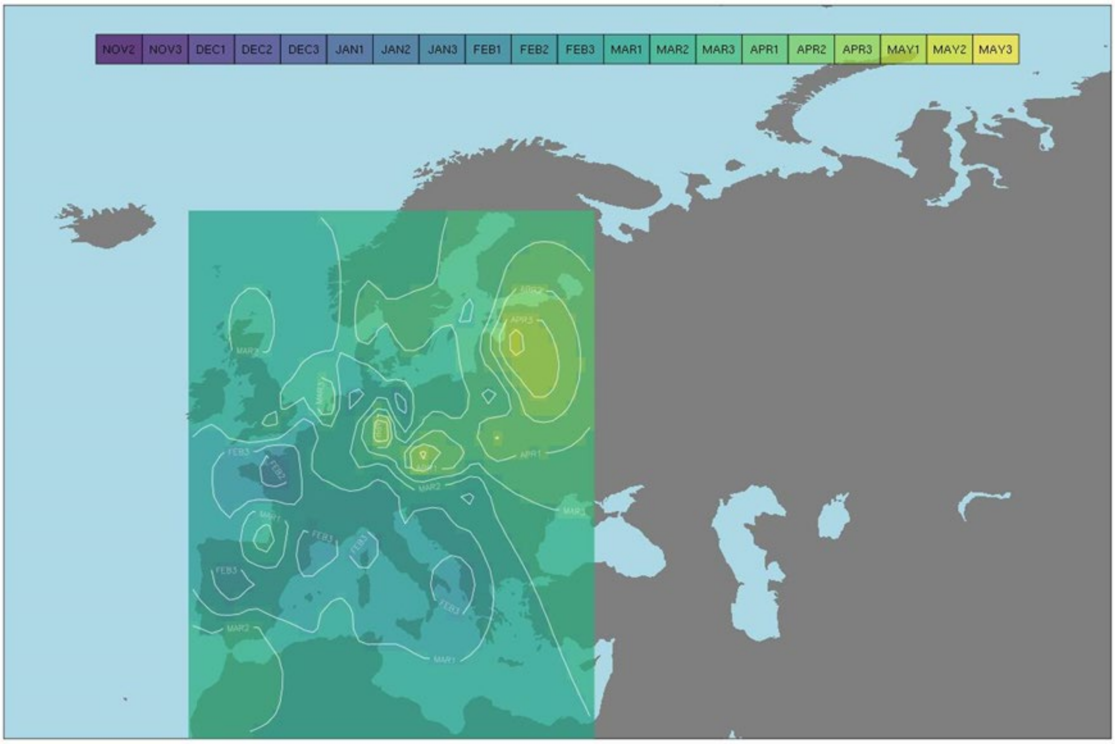
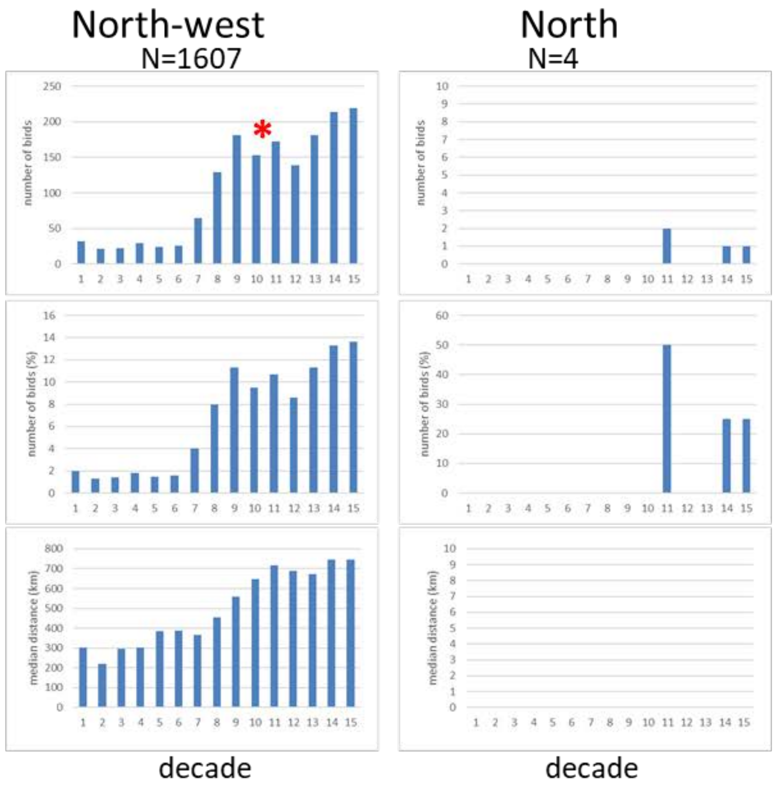
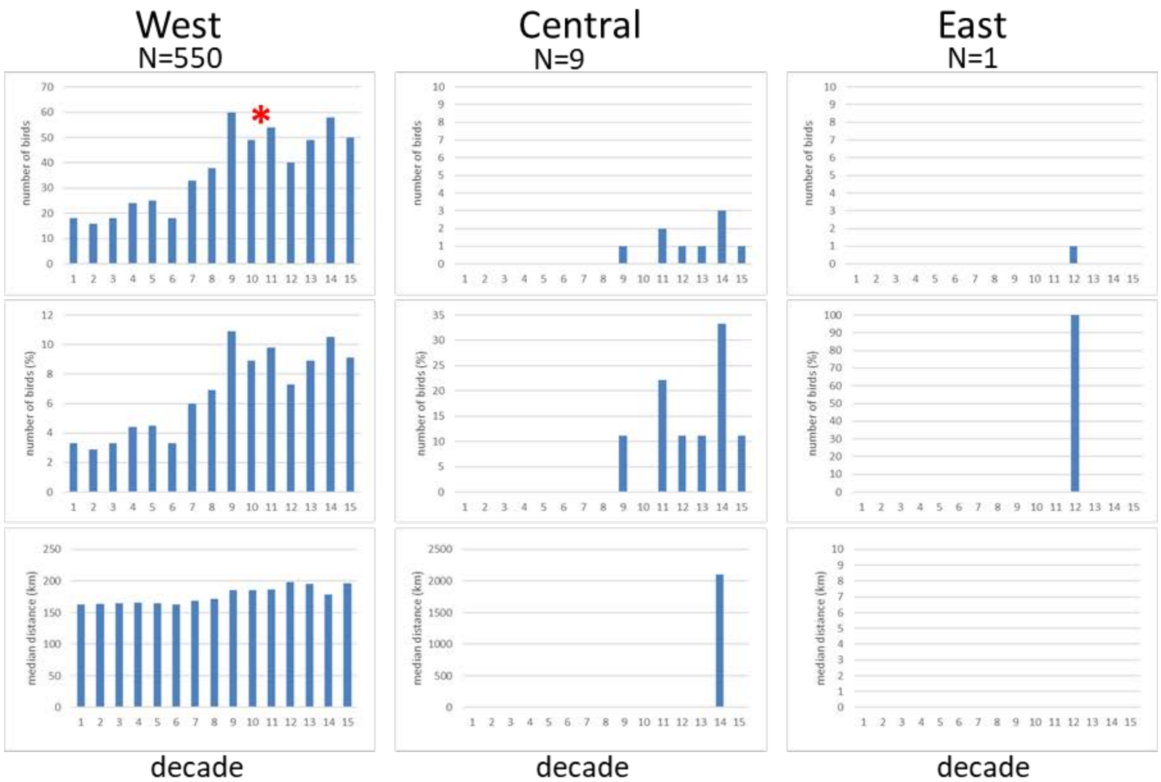


Fig. 4: Median migration date of pre-nuptial migration of Eurasian Coot. The map shows the date when 50% of individuals are on migration.

04500 Eurasian Oystercatcher *Haematopus ostralegus*

Recovery analysis





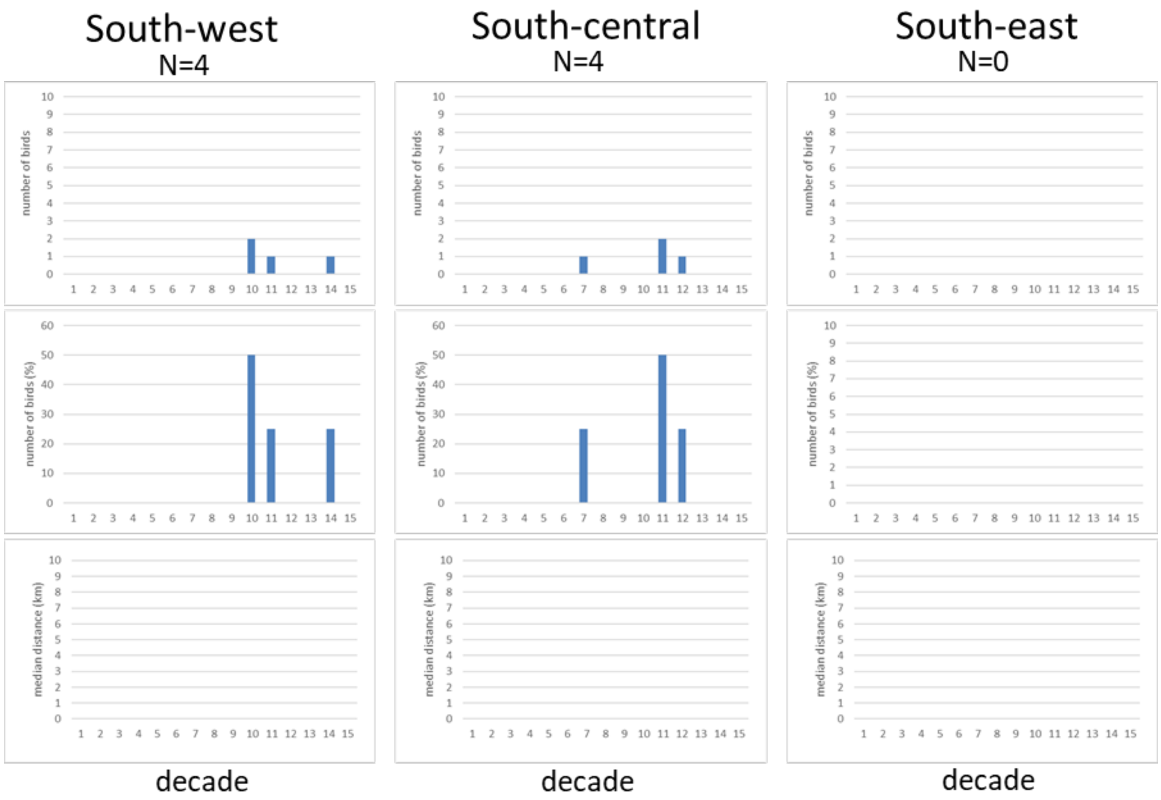


Fig. 1: Onset of prenuptial (return) migration of Eurasian Oystercatcher by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

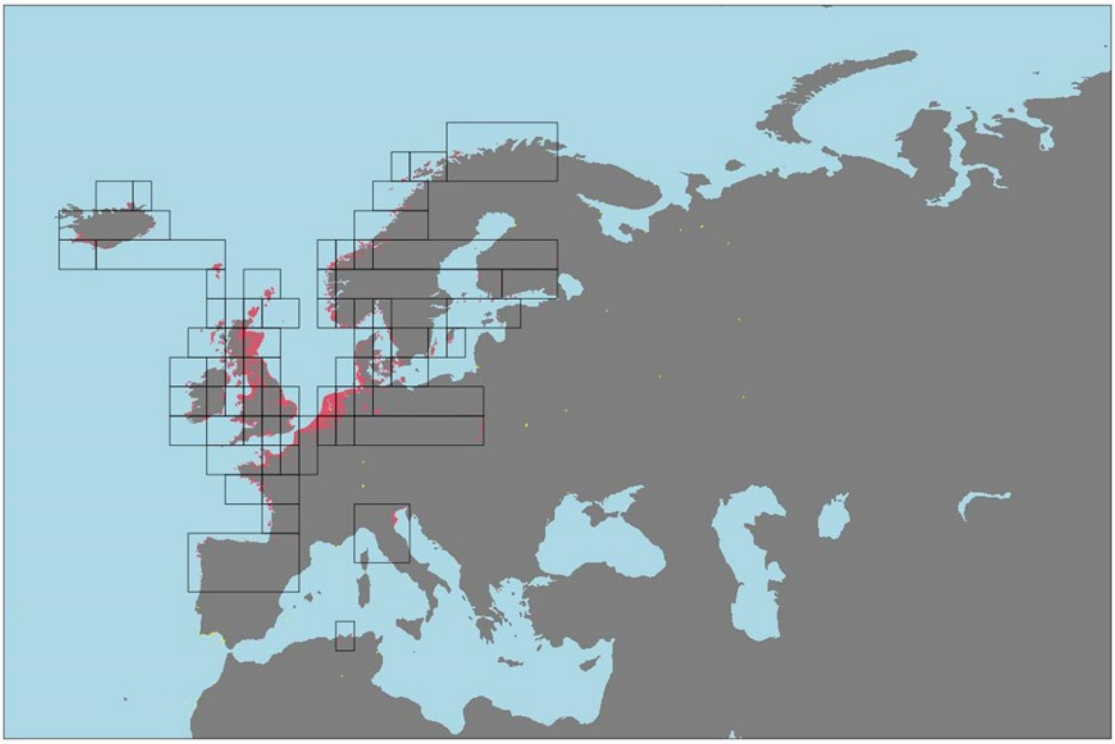


Fig. 2: Data availability for the analyses of Eurasian Oystercatcher pre-nuptial migration. Red dots: encounters used (45,477), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

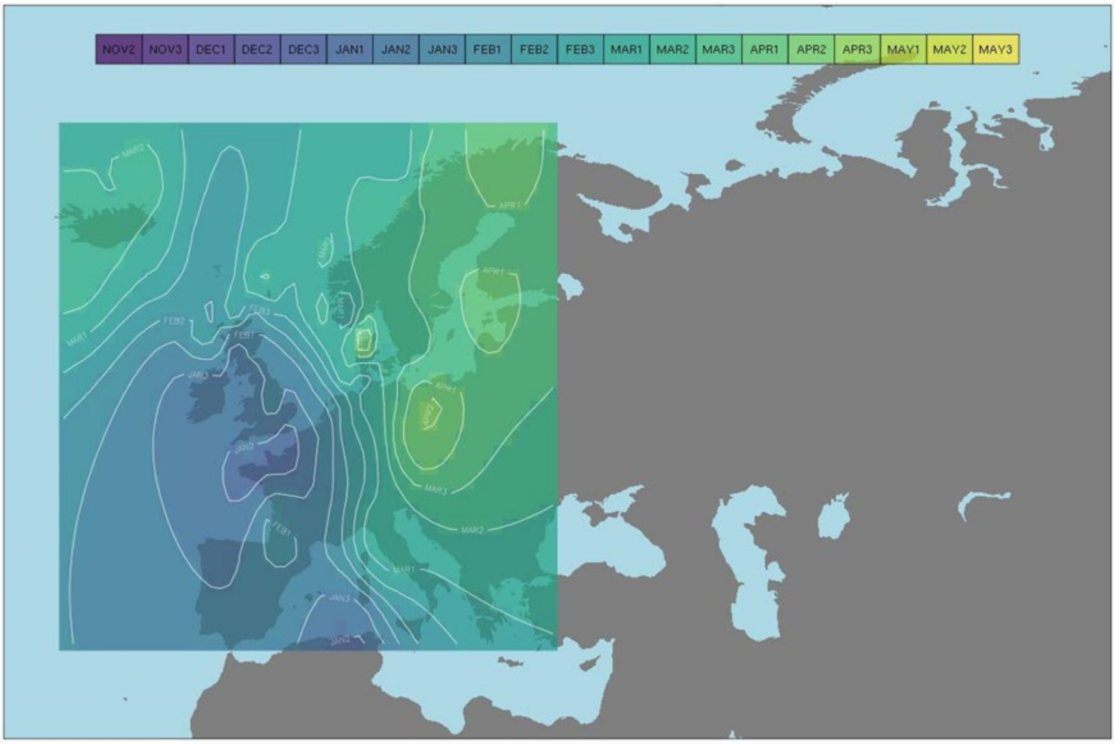


Fig. 3: Onset of pre-nuptial migration of Eurasian Oystercatcher. The map shows the date when 5% of individuals are on migration.

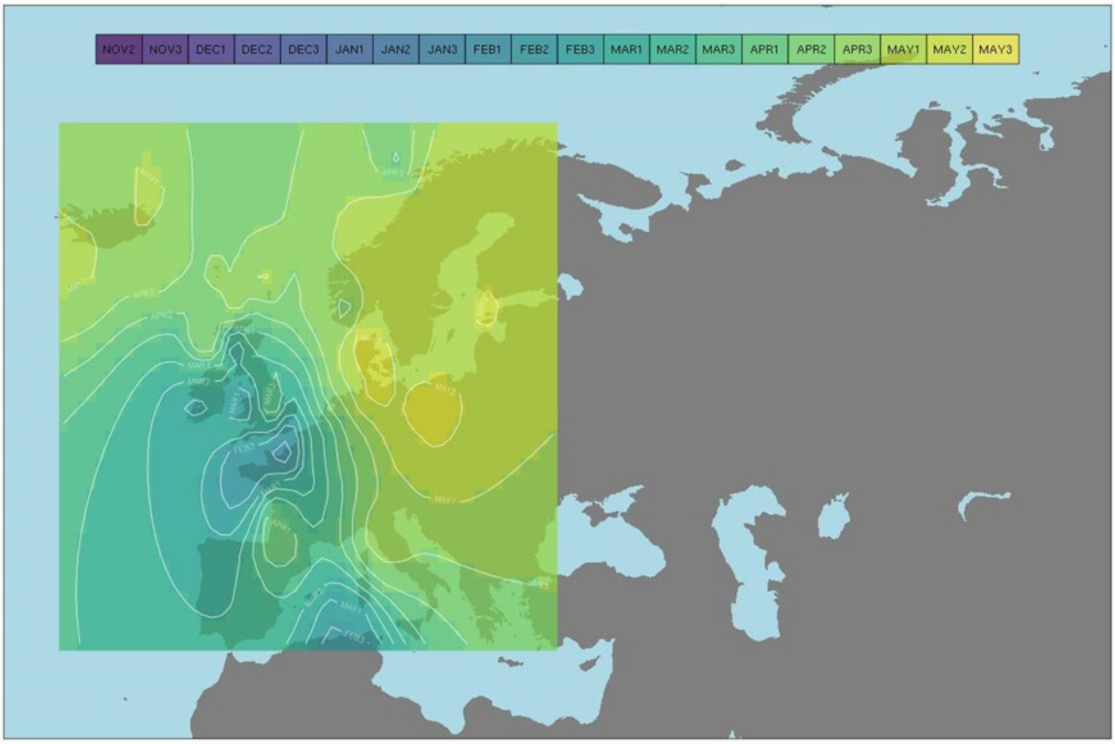
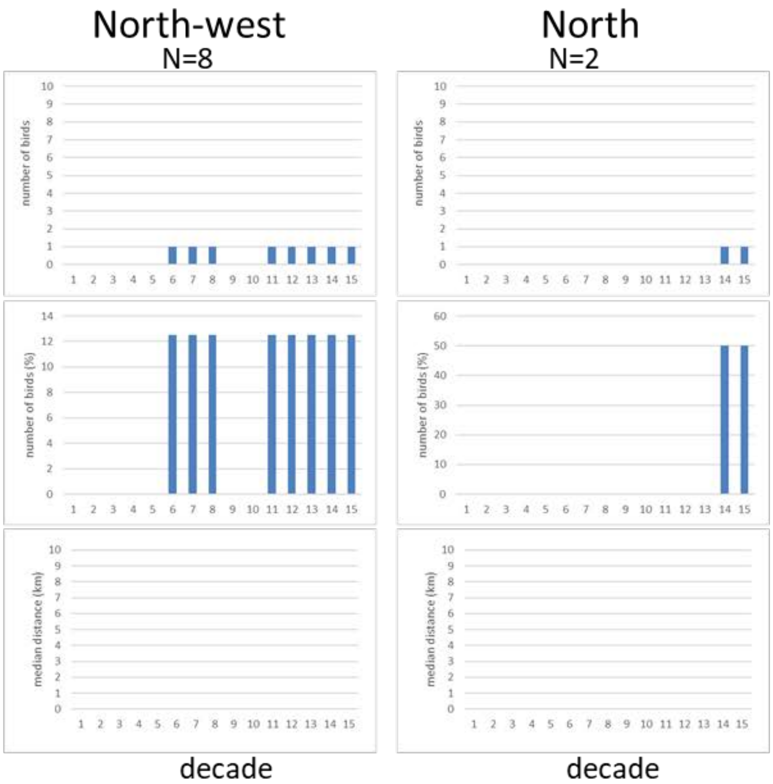
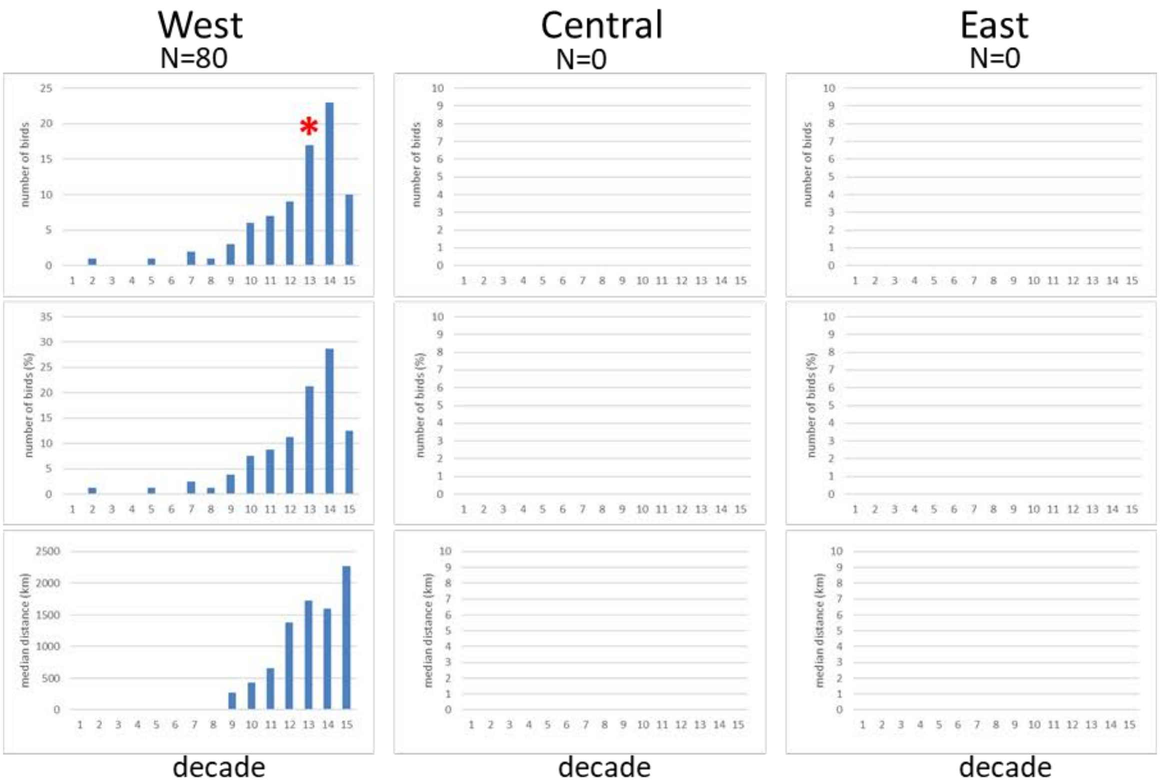


Fig. 4: Median migration date of pre-nuptial migration of Eurasian Oystercatcher. The map shows the date when 50% of individuals are on migration.

04850 European Golden Plover *Pluvialis apricaria*

Recovery analysis





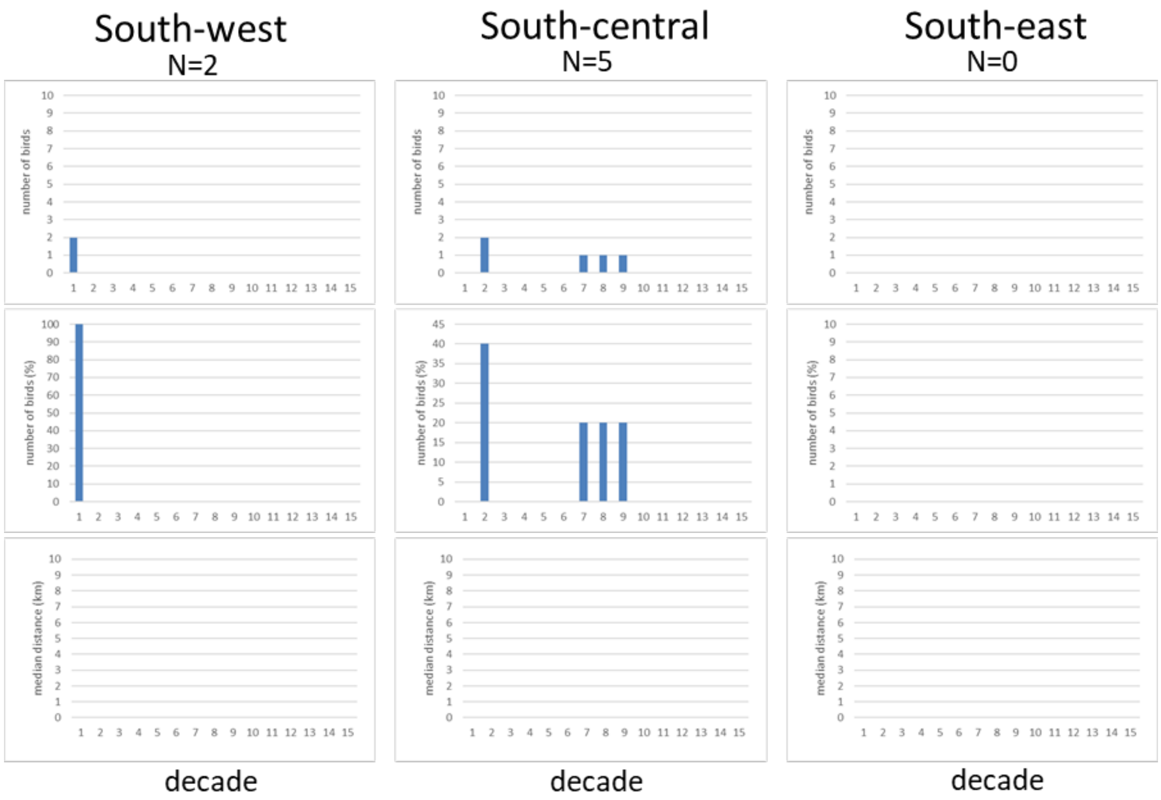


Fig. 1: Onset of prenuptial (return) migration of European Golden Plover by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

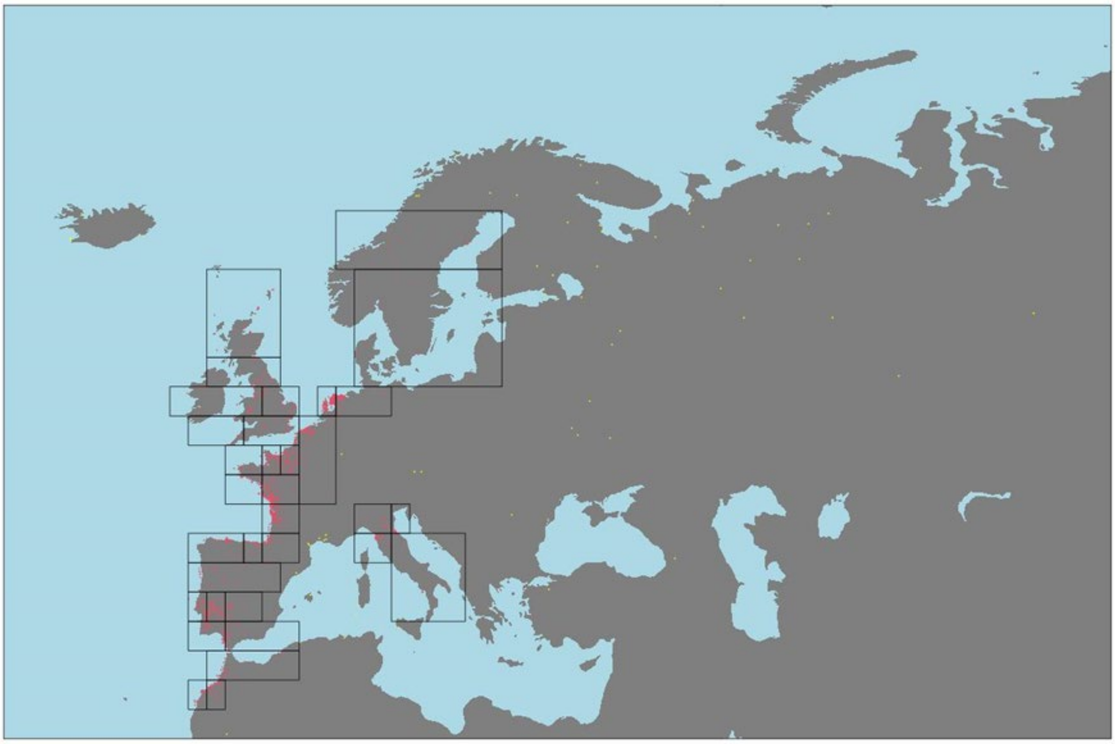


Fig. 2: Data availability for the analyses of European Golden Plover pre-nuptial migration. Red dots: encounters used (3377), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

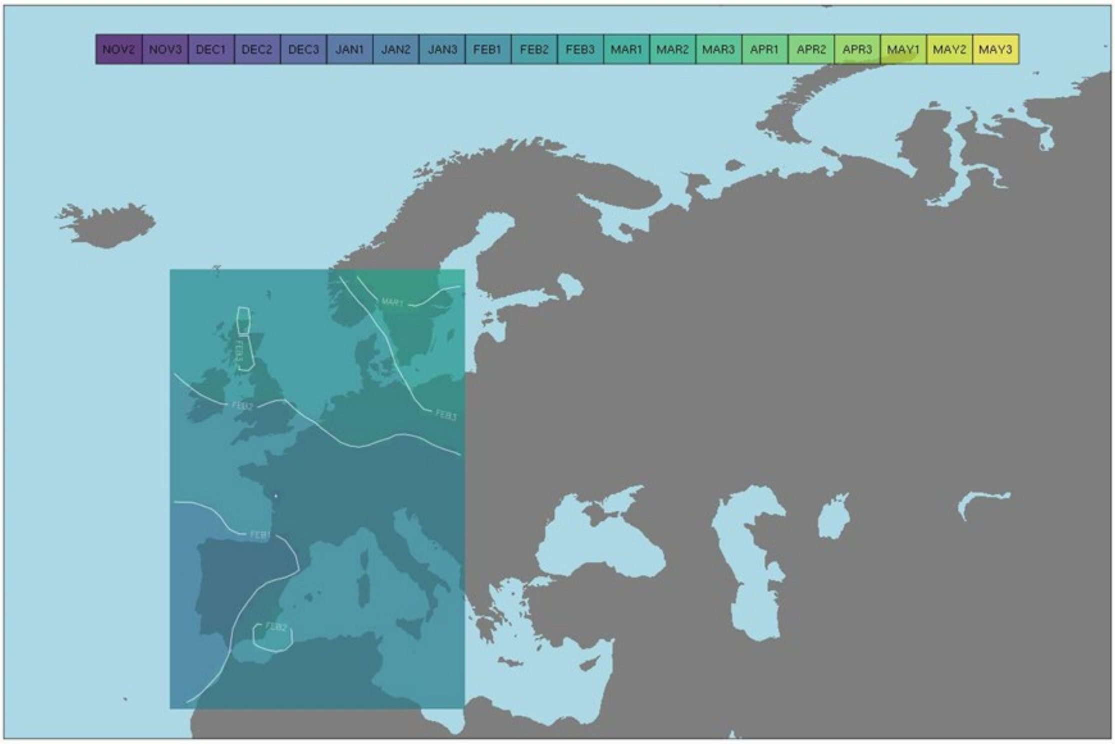


Fig. 3: Onset of pre-nuptial migration of European Golden Plover. The map shows the date when 5% of individuals are on migration.

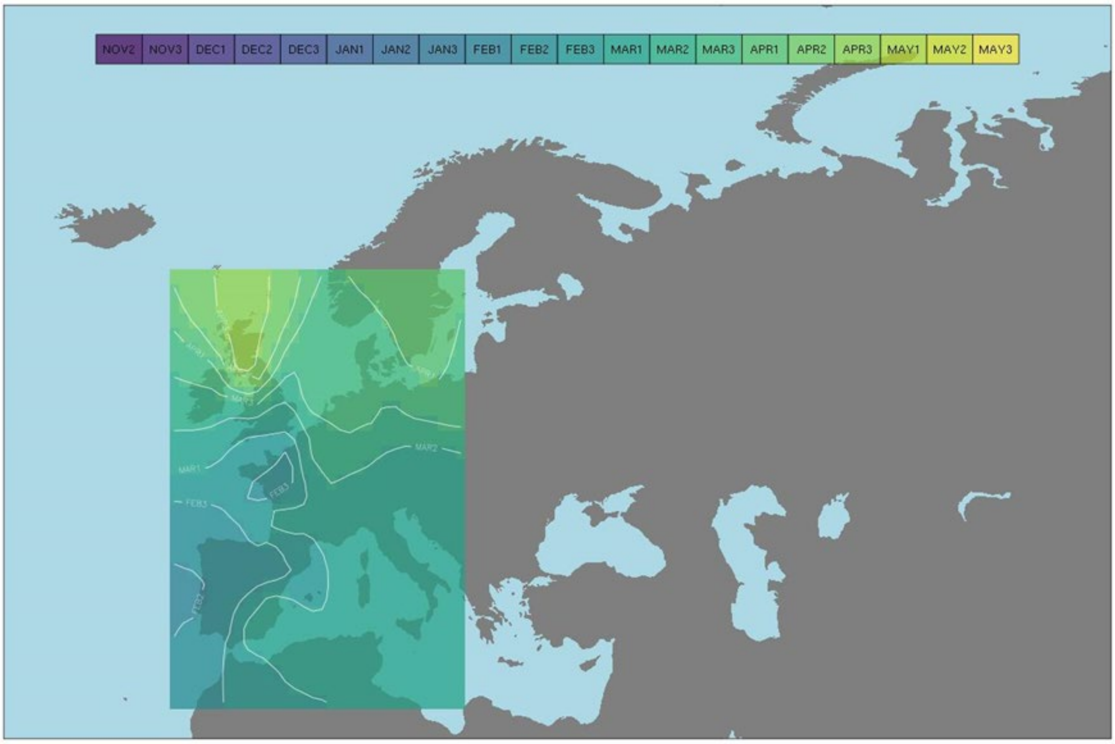


Fig. 4: Median migration date of pre-nuptial migration of European Golden Plover. The map shows the date when 50% of individuals are on migration.

04860 Grey Plover *Pluvialis squatarola*

Recovery analysis

No data for recovery analysis.

Mapping analysis

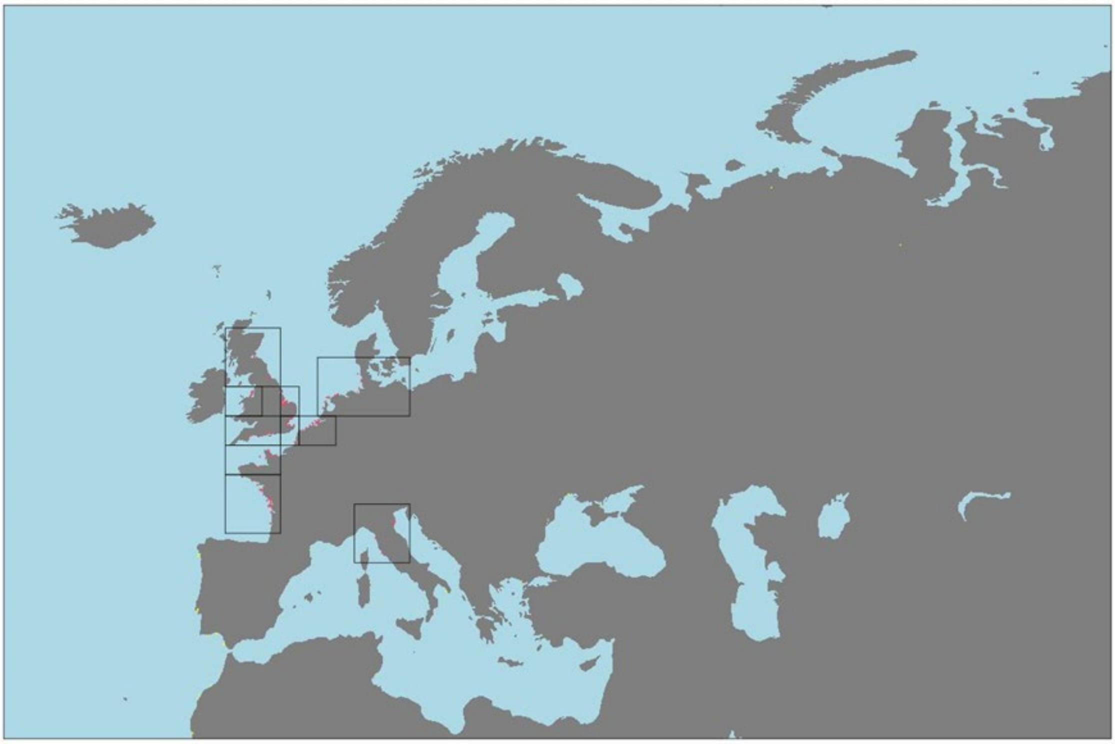


Fig. 2: Data availability for the analyses of Grey Plover pre-nuptial migration. Red dots: encounters used (647), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

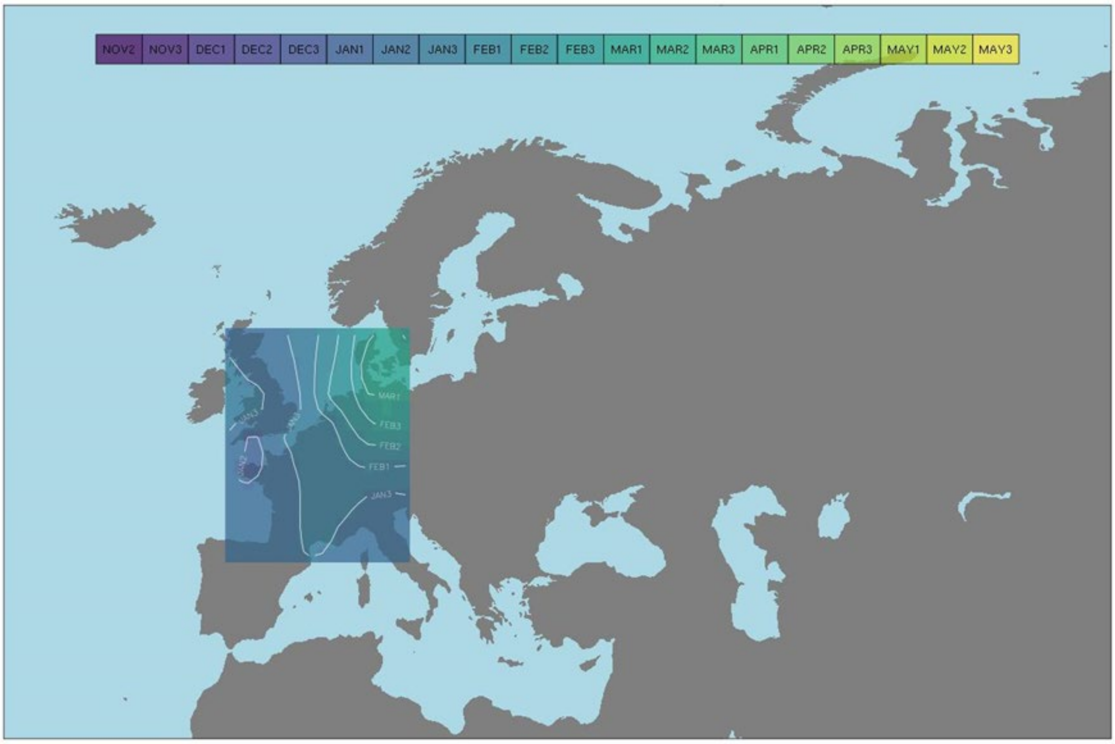


Fig. 3: Onset of pre-nuptial migration of Grey Plover. The map shows the date when 5% of individuals are on migration.

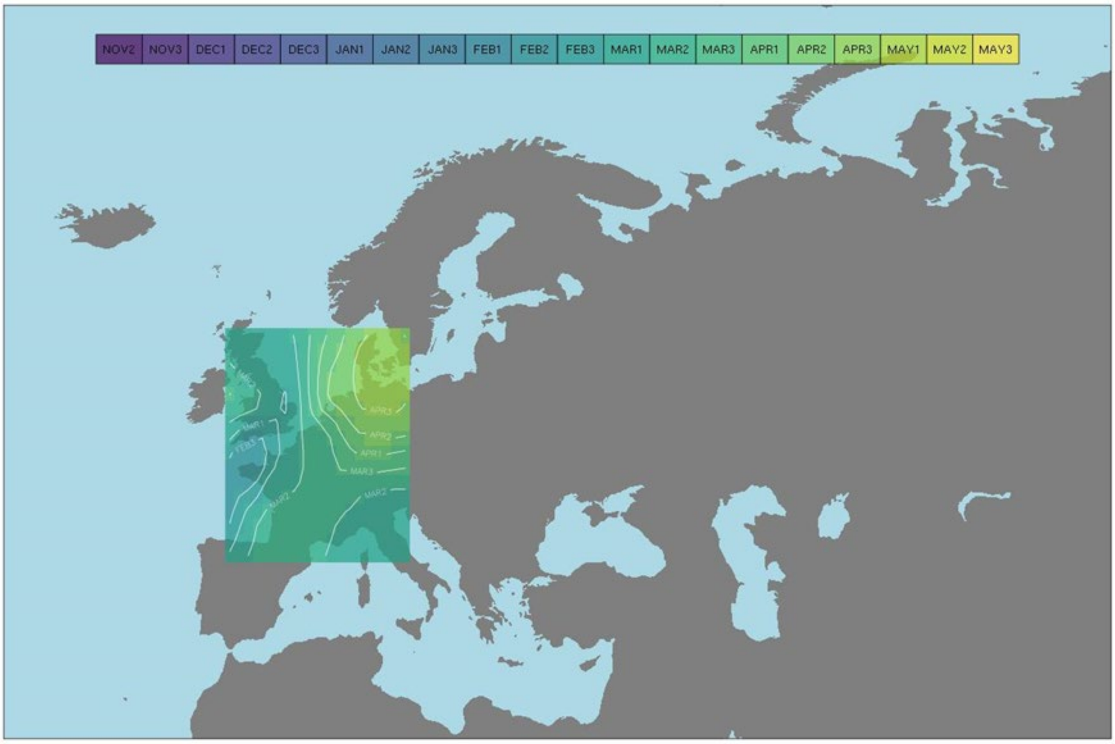
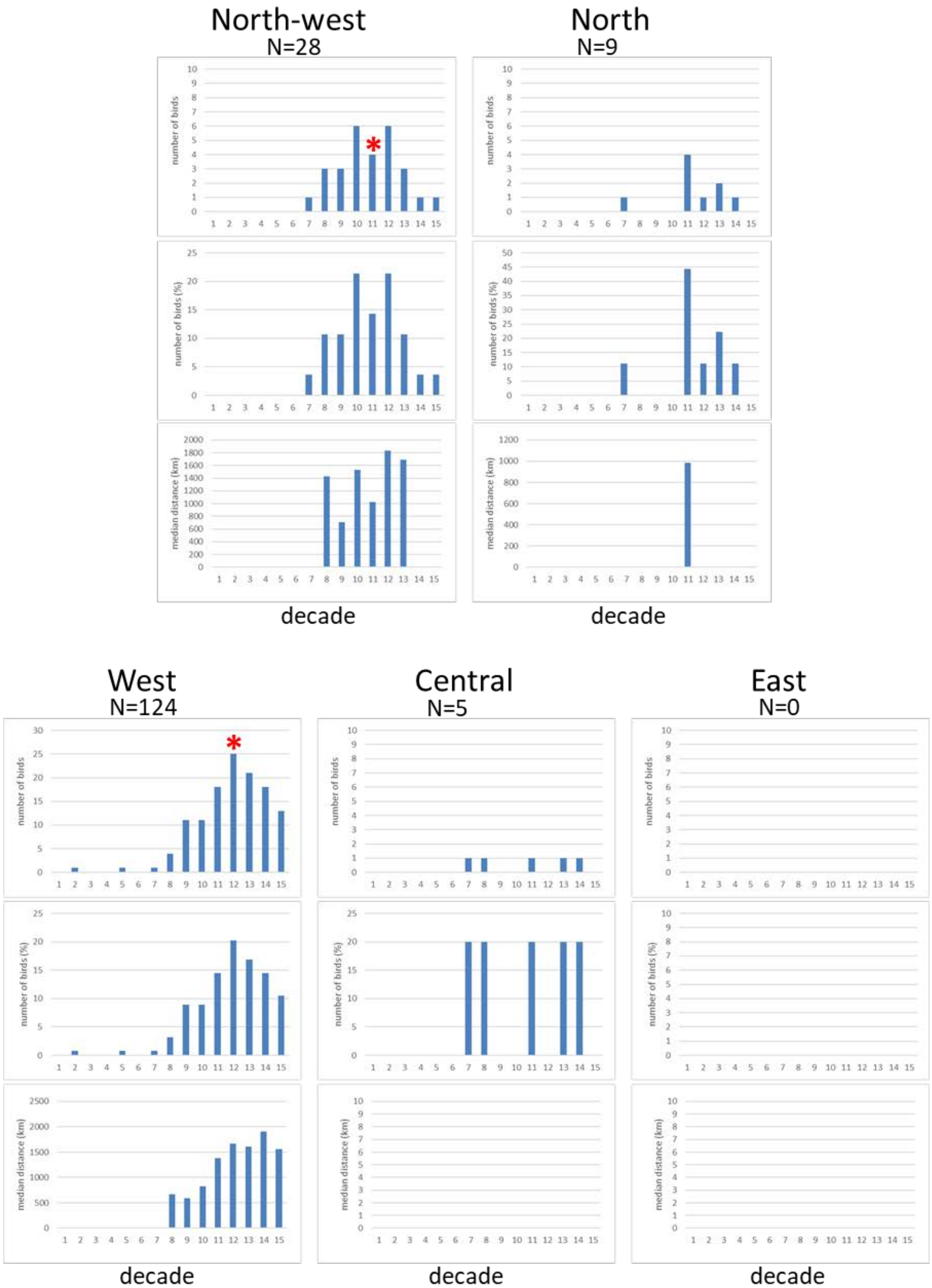


Fig. 4: Median migration date of pre-nuptial migration of Grey Plover. The map shows the date when 50% of individuals are on migration.

04930 Northern Lapwing *Vanellus vanellus*

Recovery analysis



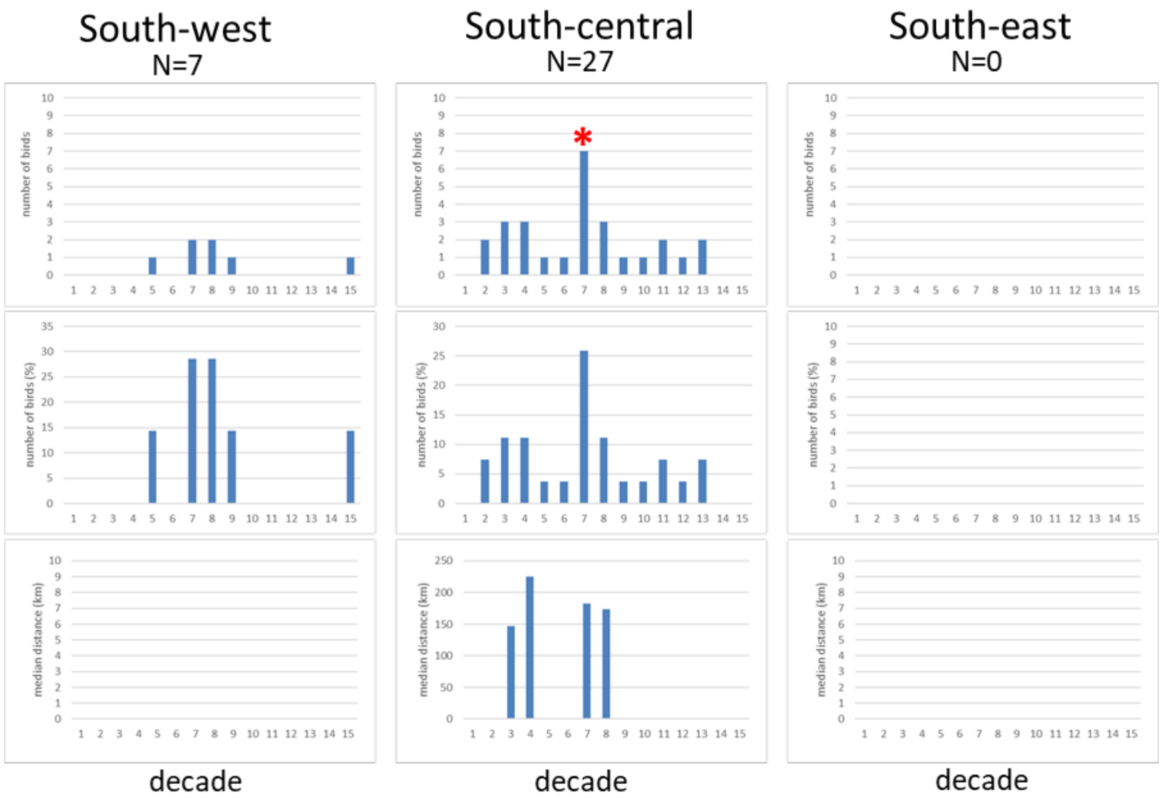


Fig. 1: Onset of prenuptial (return) migration of Northern Lapwing by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

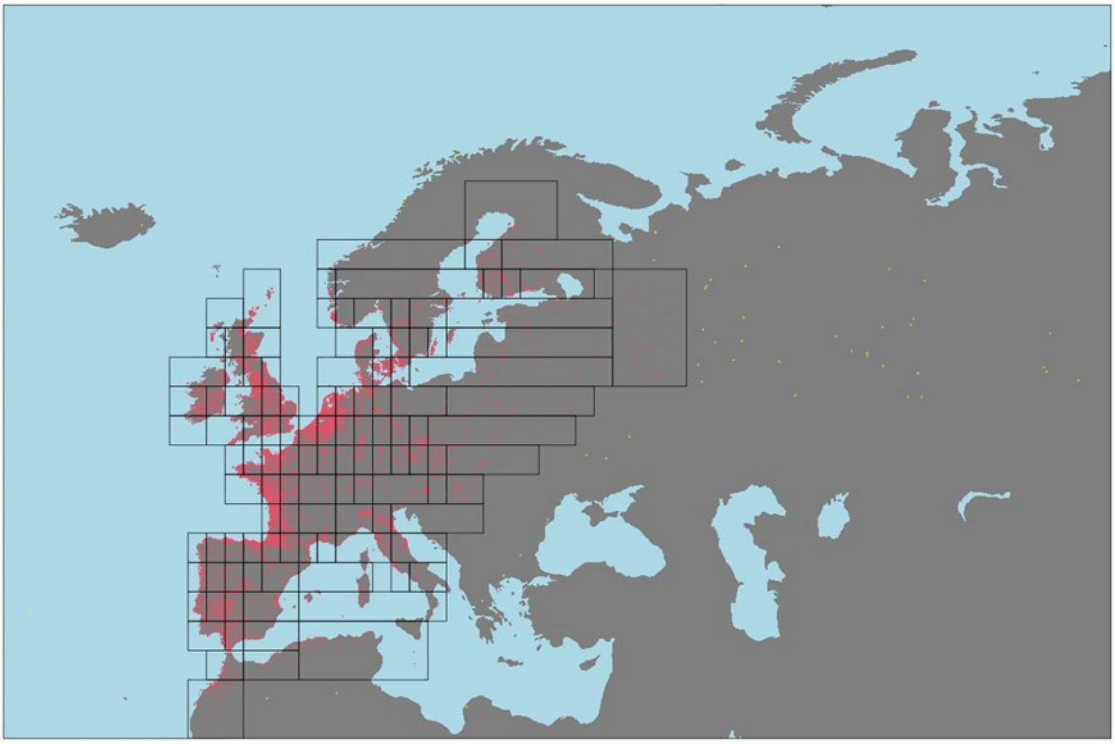


Fig. 2: Data availability for the analyses of Northern Lapwing pre-nuptial migration. Red dots: encounters used (25,894), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

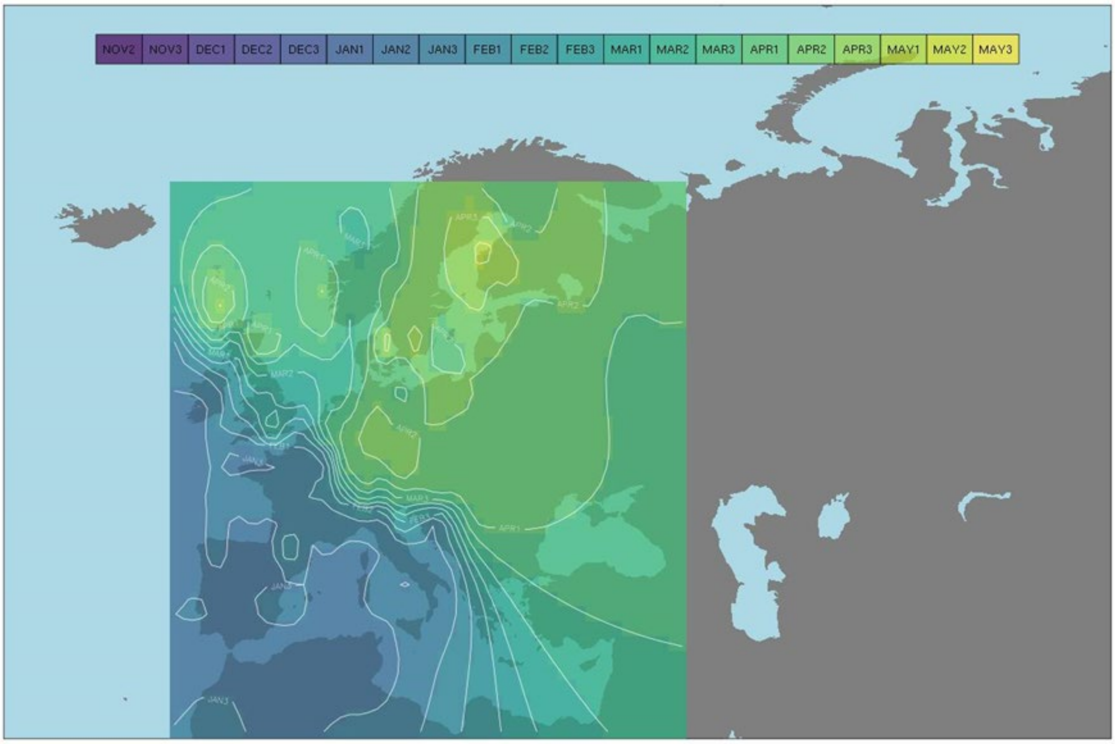


Fig. 3: Onset of pre-nuptial migration of Northern Lapwing. The map shows the date when 5% of individuals are on migration.

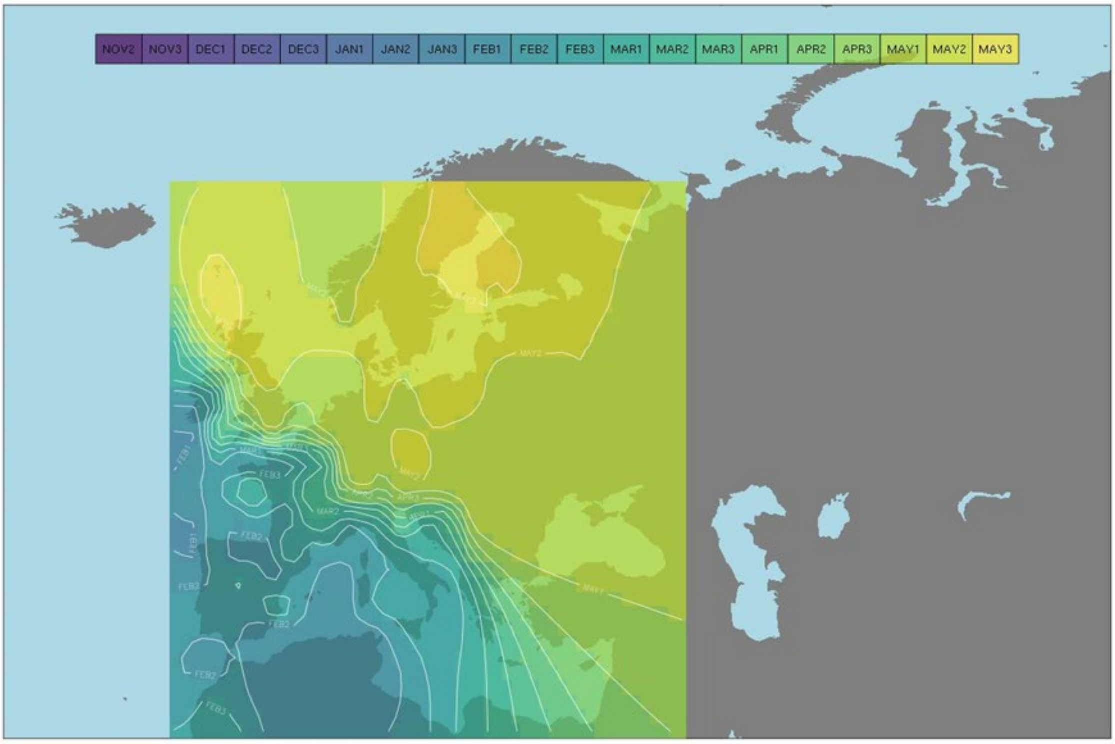


Fig. 4: Median migration date of pre-nuptial migration of Northern Lapwing. The map shows the date when 50% of individuals are on migration.

04960 Red Knot *Calidris canutus*

Recovery analysis

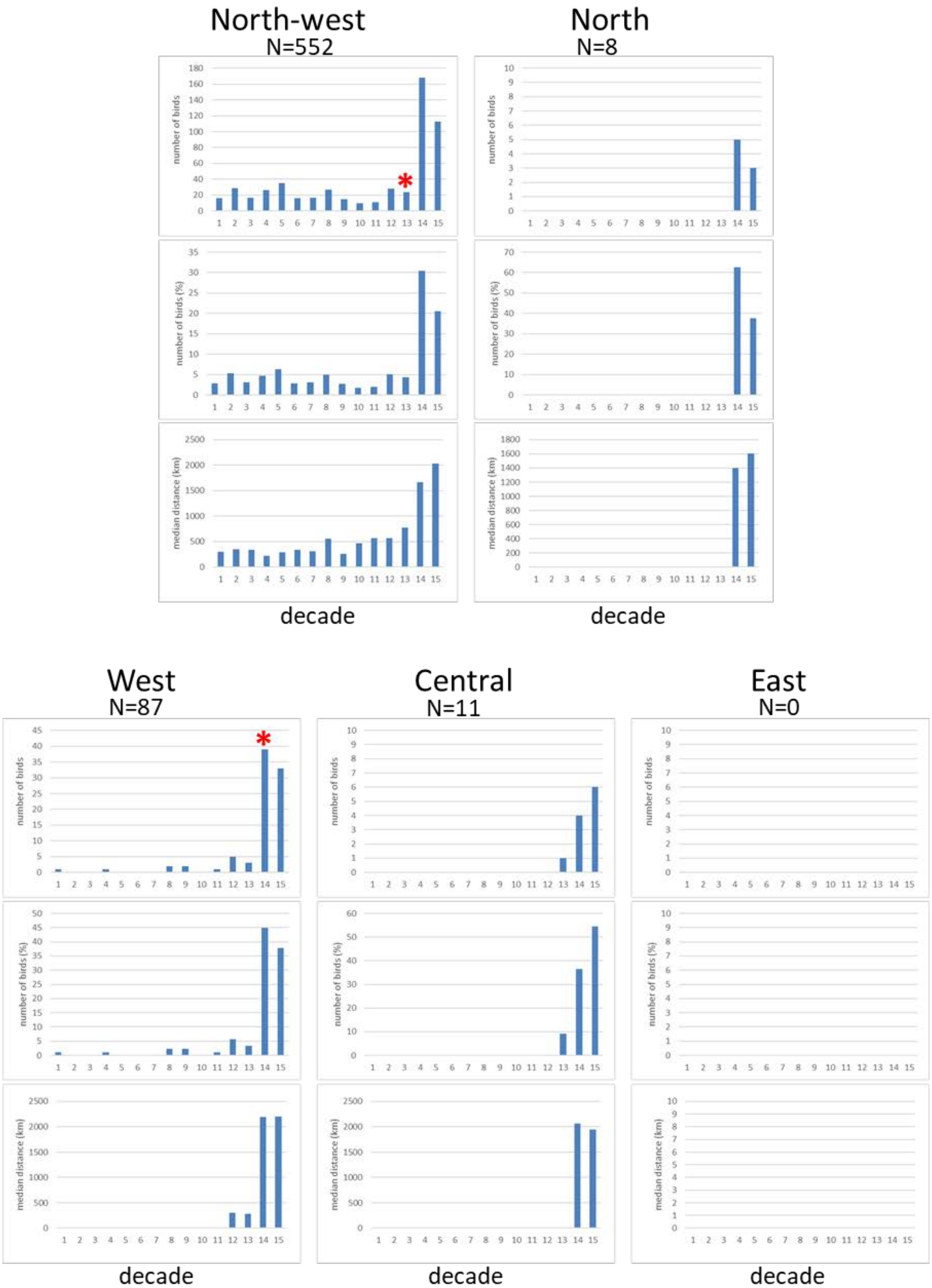


Fig. 1: Onset of prenuptial (return) migration of Red Knot by geographical region and decade. The asterix denotes the median date of onset of return migration. No data from South-west, South-central, South-east.

Mapping analysis

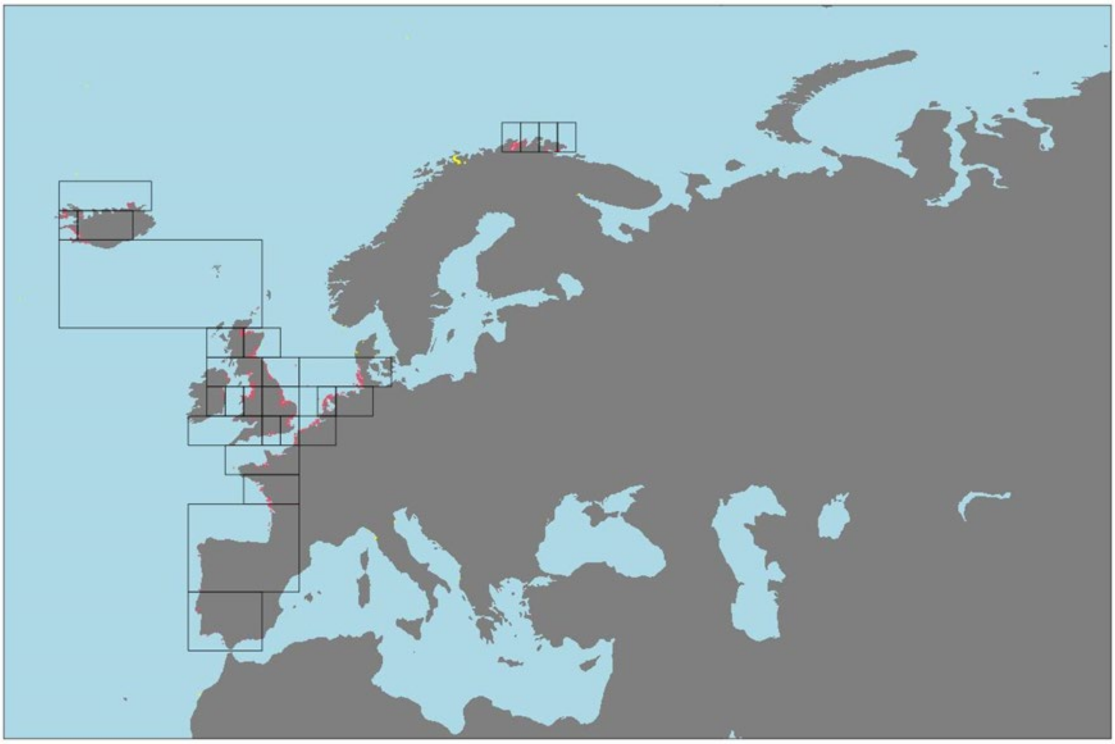


Fig. 2: Data availability for the analyses of Red Knot pre-nuptial migration. Red dots: encounters used (14,552), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

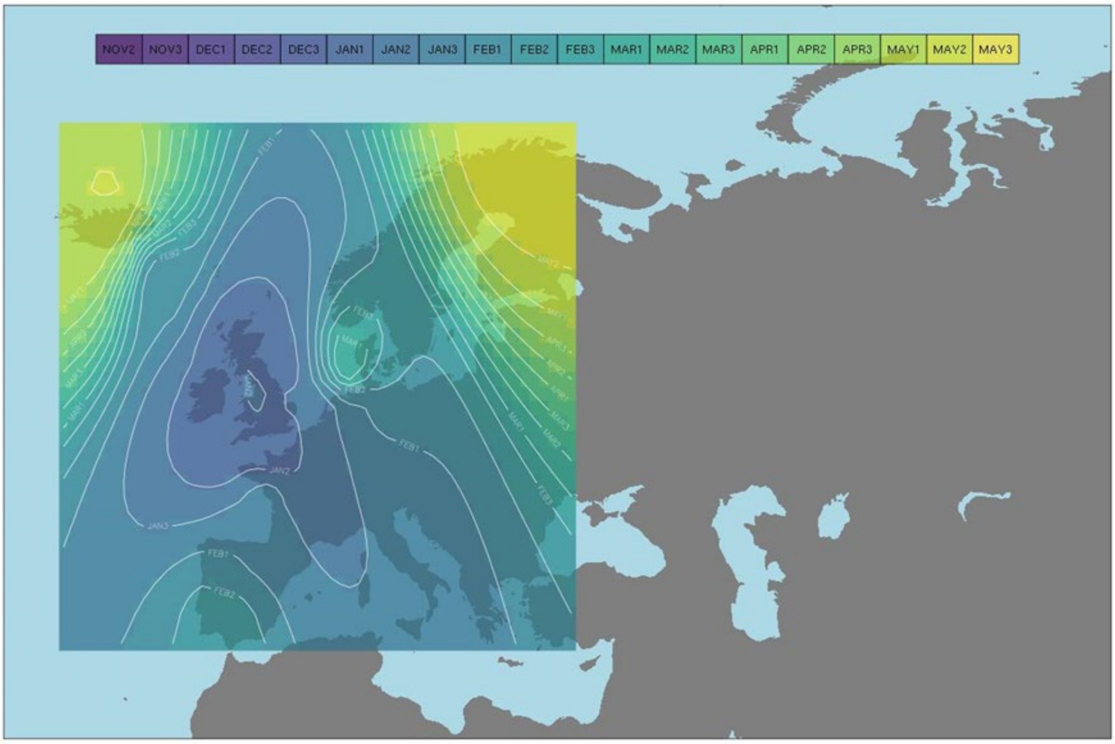


Fig. 3: Onset of pre-nuptial migration of Red Knot. The map shows the date when 5% of individuals are on migration.

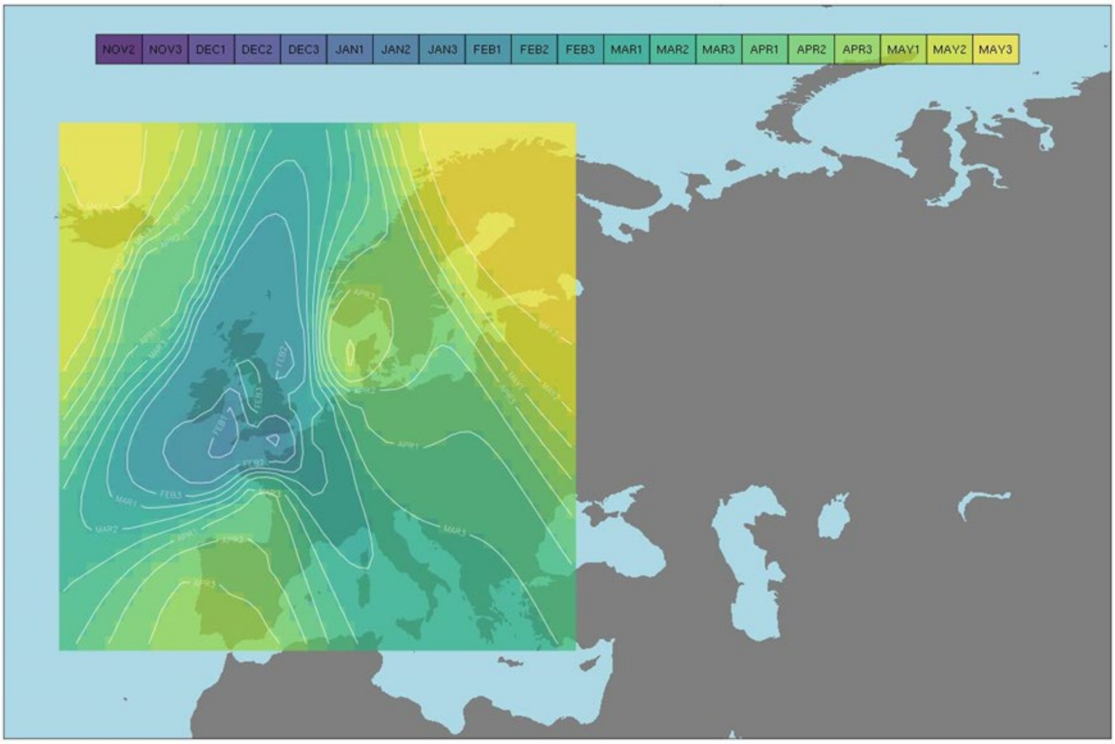
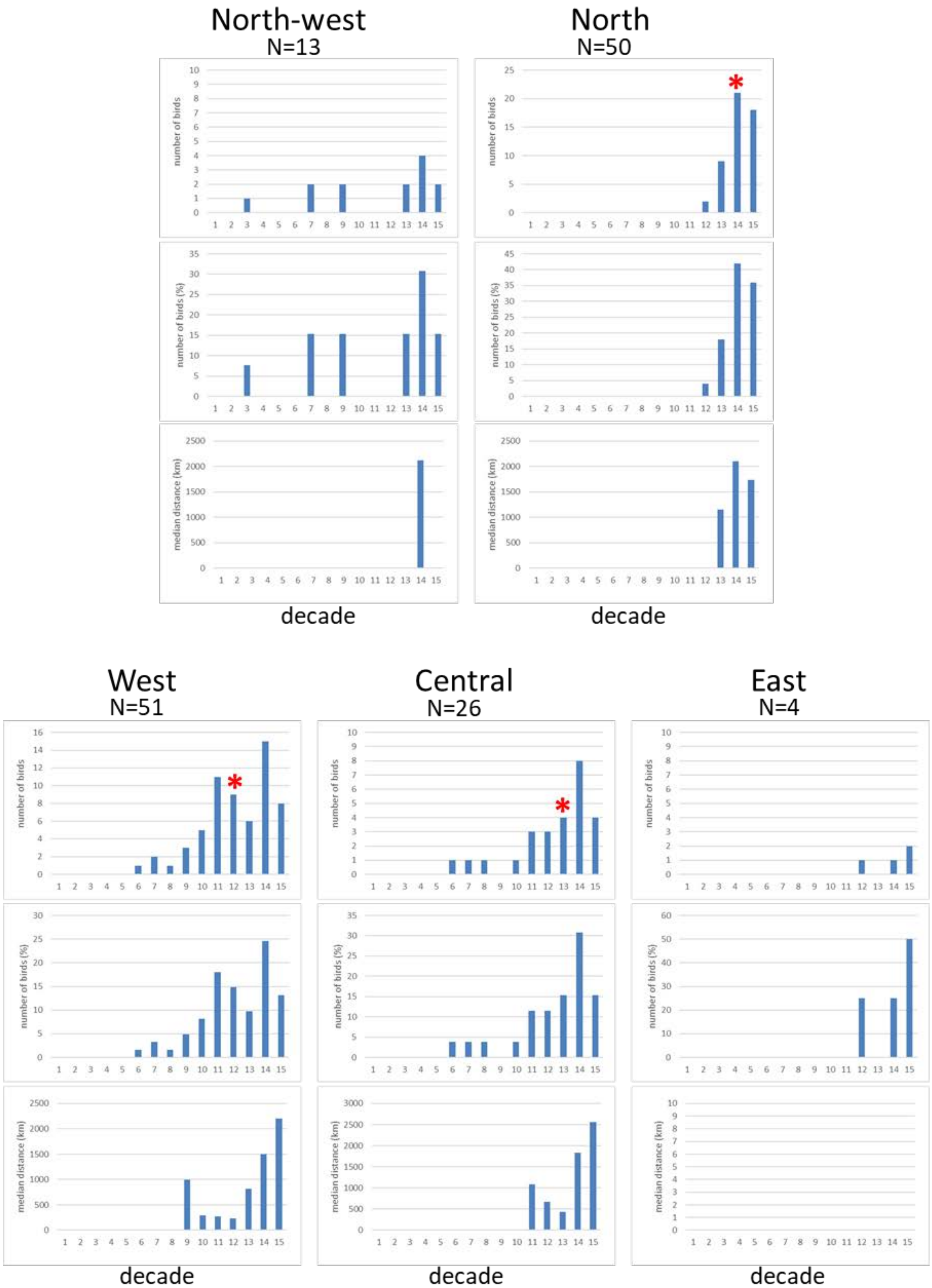


Fig. 4: Median migration date of pre-nuptial migration of Red Knot. The map shows the date when 50% of individuals are on migration.

05170 Ruff *Philomachus pugnax*

Recovery analysis



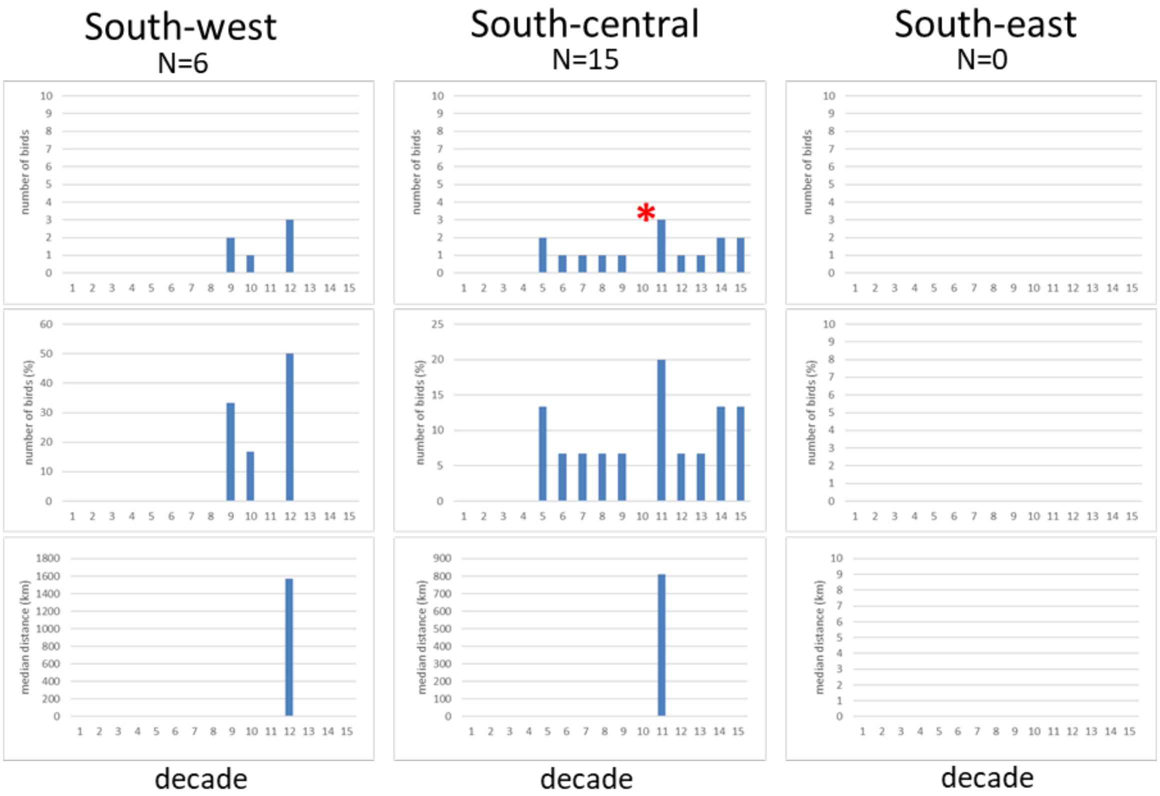


Fig. 1: Onset of prenuptial (return) migration of Ruff by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

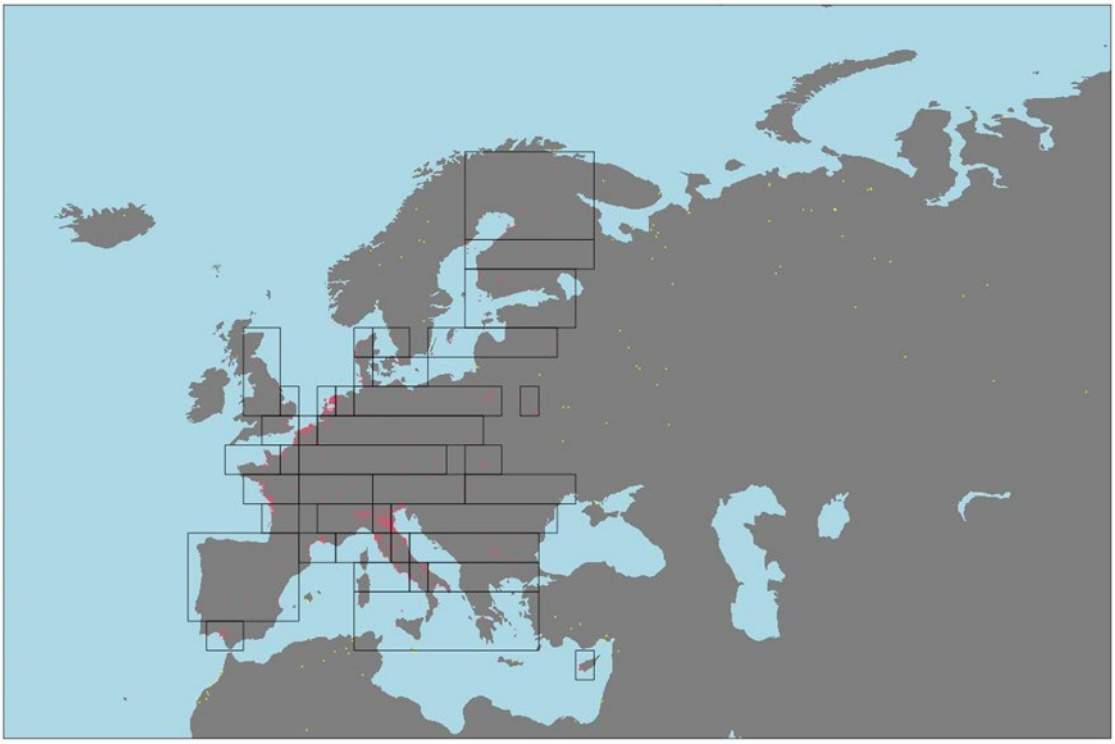


Fig. 2: Data availability for the analyses of Ruff pre-nuptial migration. Red dots: encounters used (5802), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

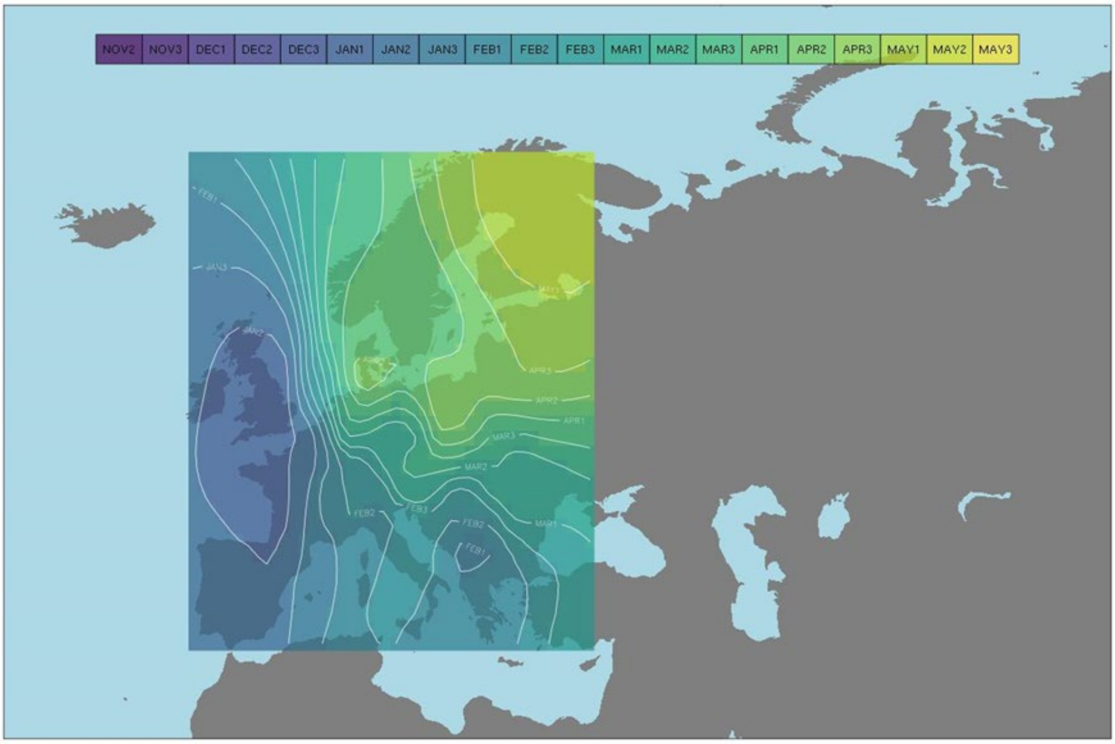


Fig. 3: Onset of pre-nuptial migration of Ruff. The map shows the date when 5% of individuals are on migration.

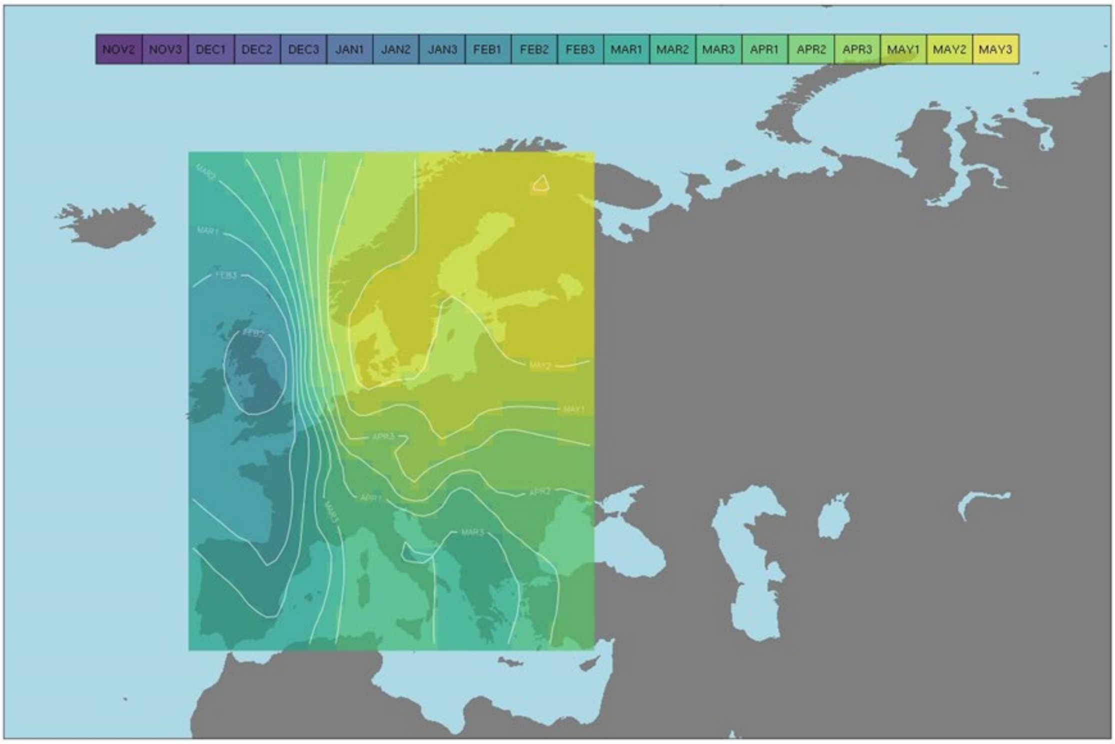


Fig. 4: Median migration date of pre-nuptial migration of Ruff. The map shows the date when 50% of individuals are on migration.

05180 Jack Snipe *Lymnocryptes minimus*

Recovery analysis

No data for recovery analysis.

Mapping analysis

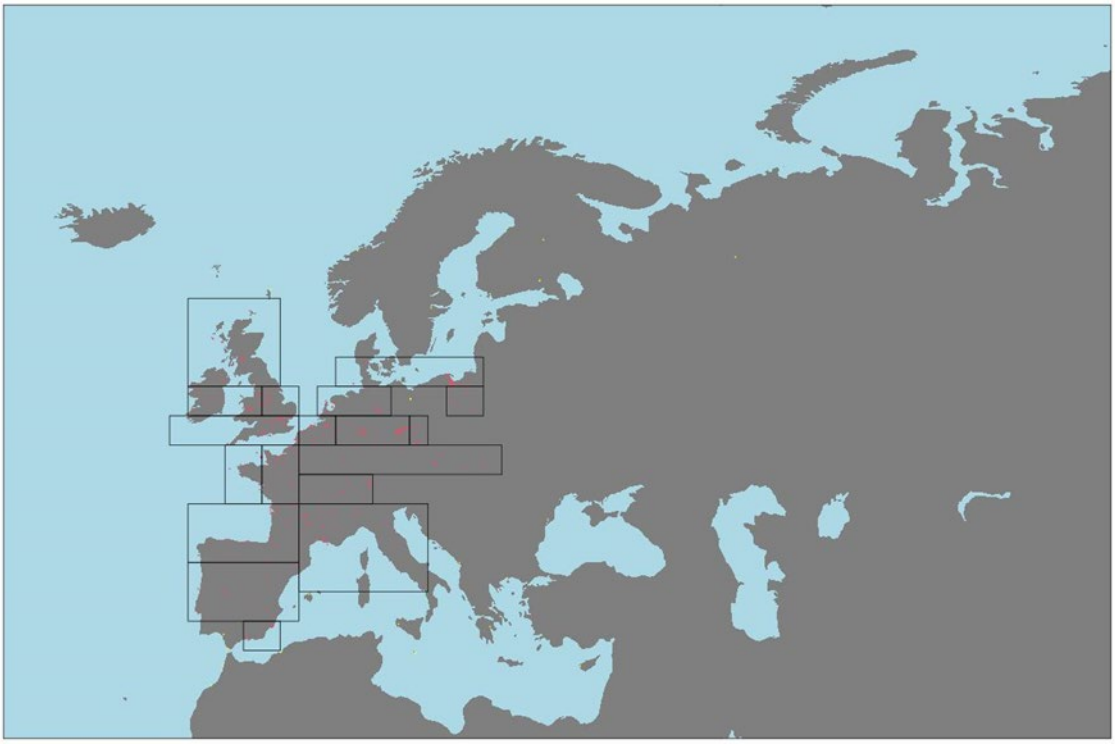


Fig. 2: Data availability for the analyses of Jack Snipe pre-nuptial migration. Red dots: encounters used (1668), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

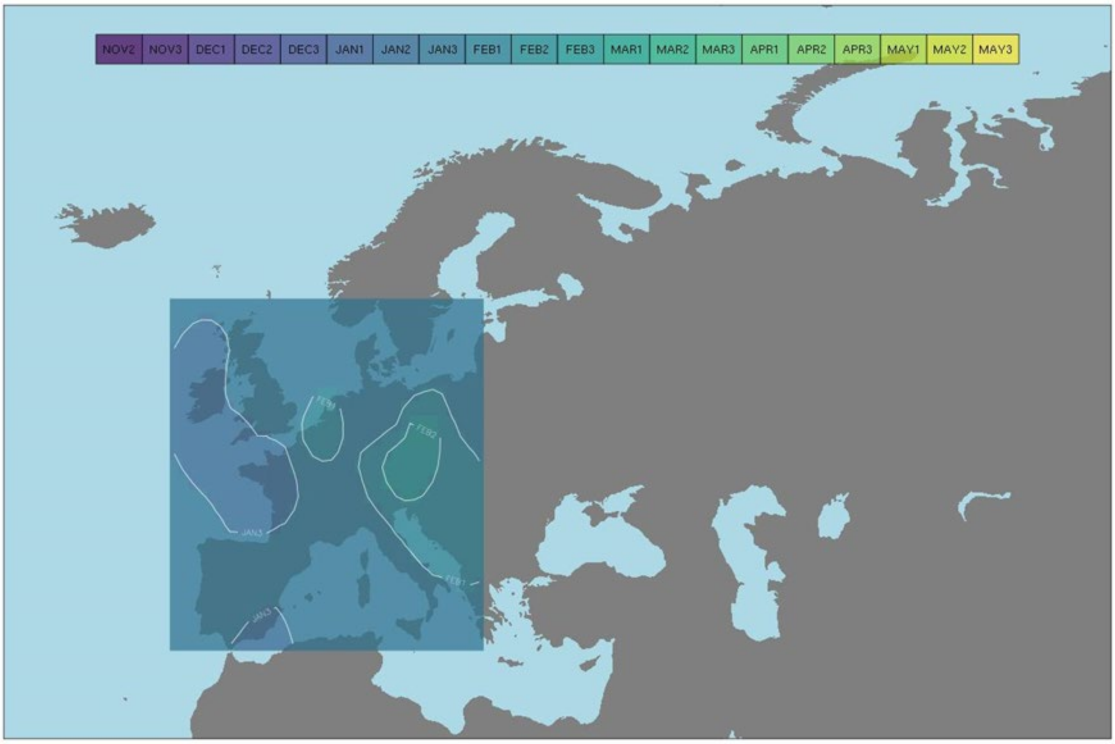


Fig. 3: Onset of pre-nuptial migration of Jack Snipe. The map shows the date when 5% of individuals are on migration.

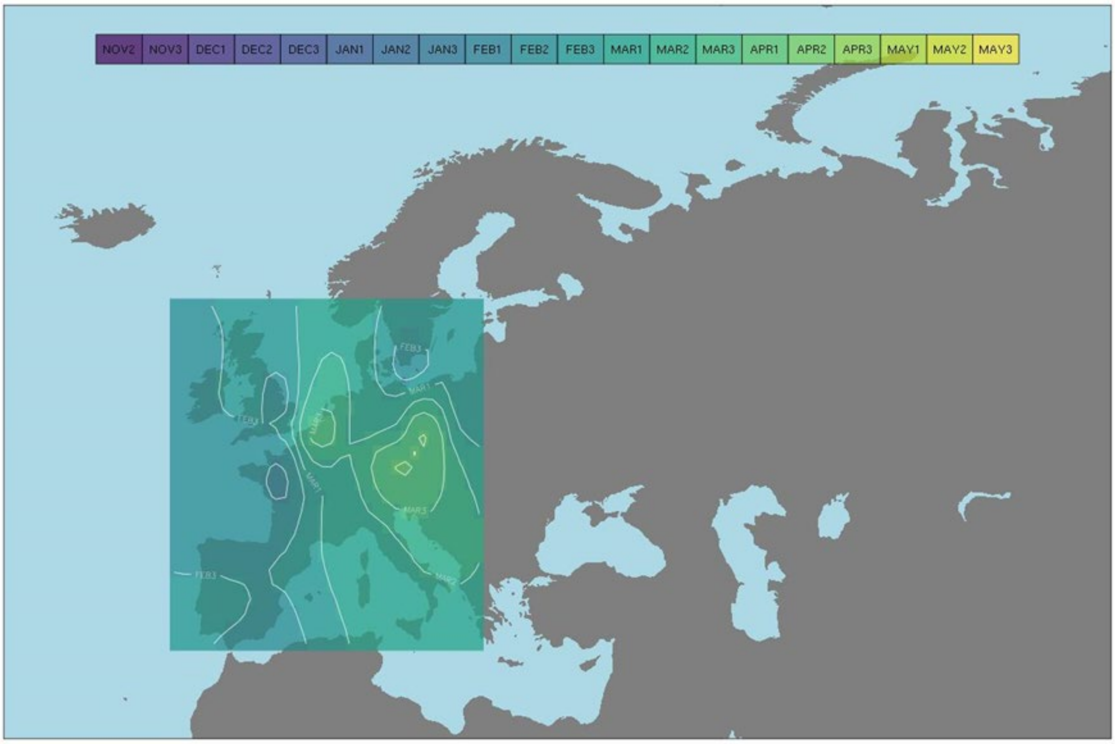
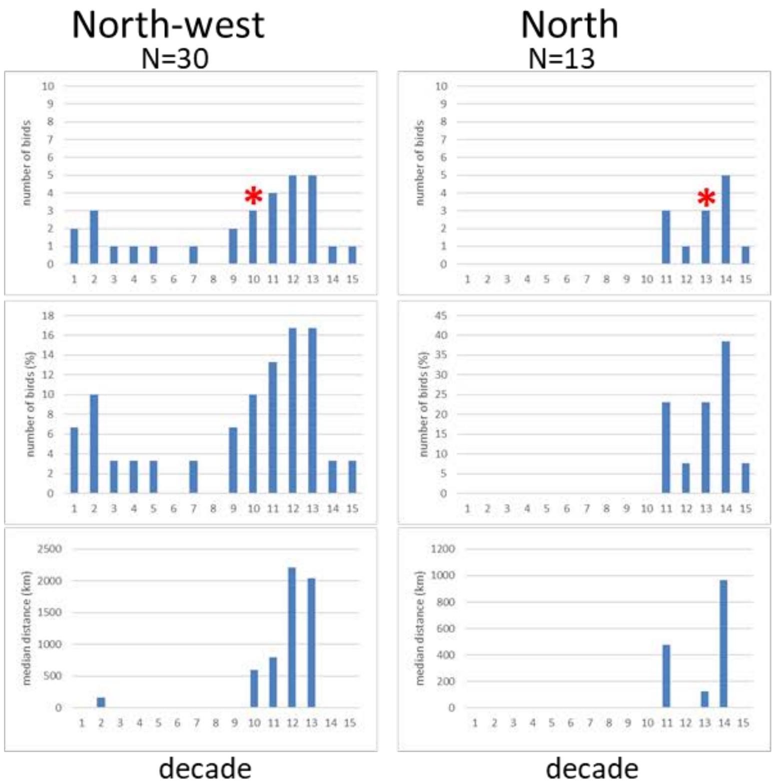
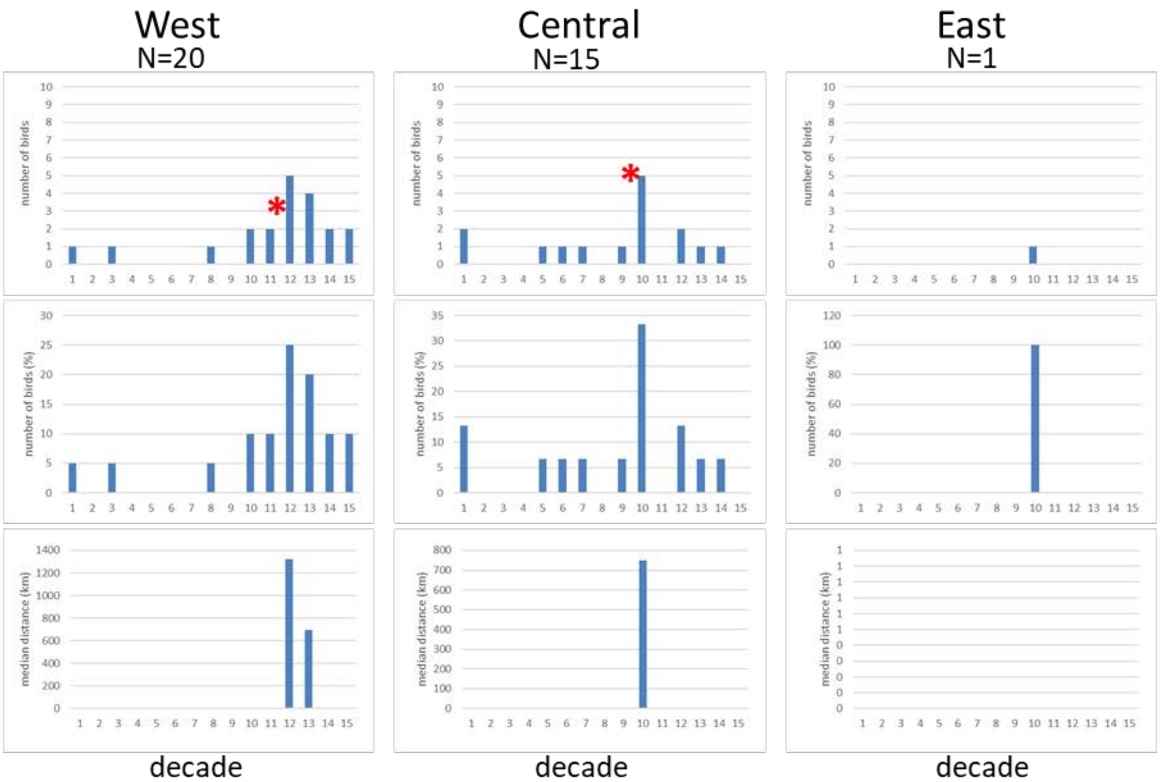


Fig. 4: Median migration date of pre-nuptial migration of Jack Snipe. The map shows the date when 50% of individuals are on migration.

05190 Common Snipe *Gallinago gallinago*

Recovery analysis





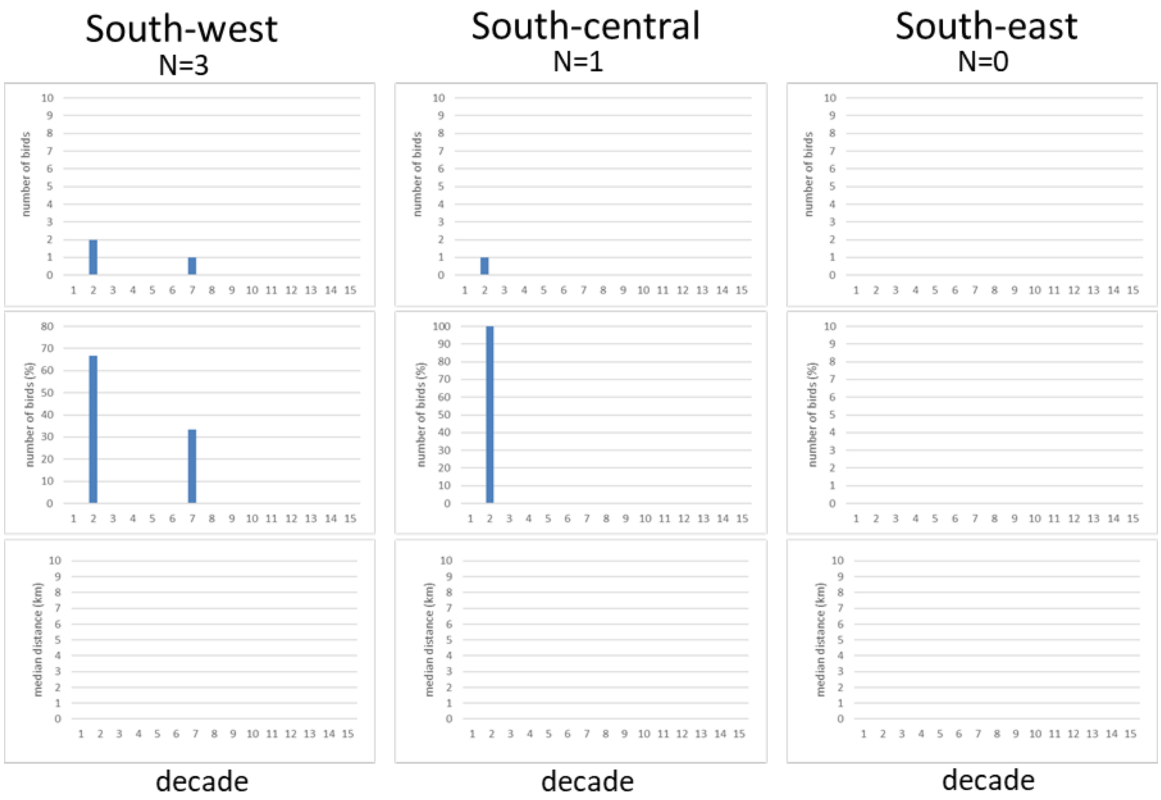


Fig. 1: Onset of prenuptial (return) migration of Common Snipe by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

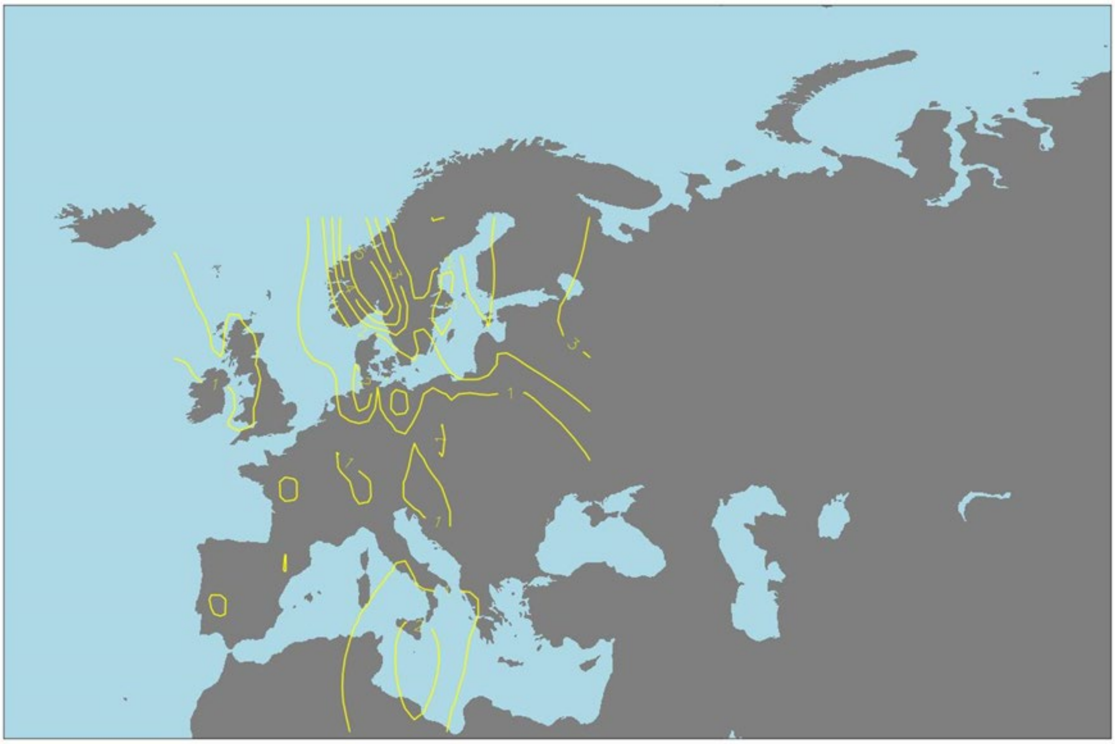


Fig. 2: Data availability for the analyses of Common Snipe pre-nuptial migration. Red dots: encounters used (5896), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

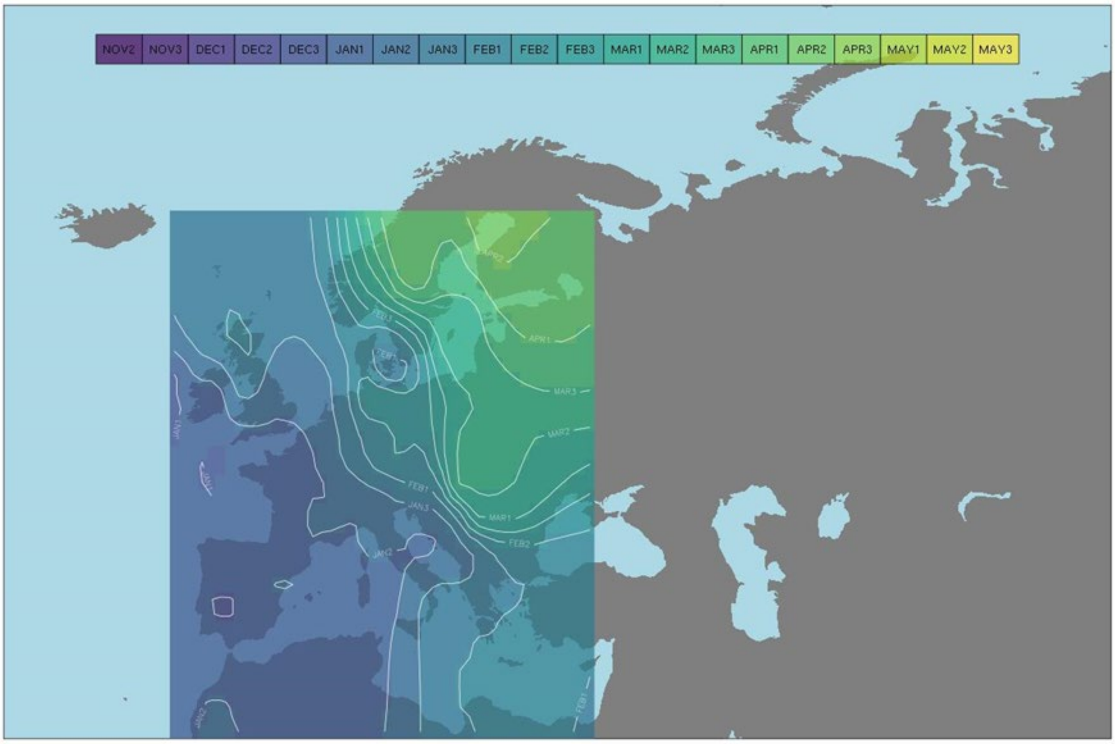


Fig. 3: Onset of pre-nuptial migration of Common Snipe. The map shows the date when 5% of individuals are on migration.

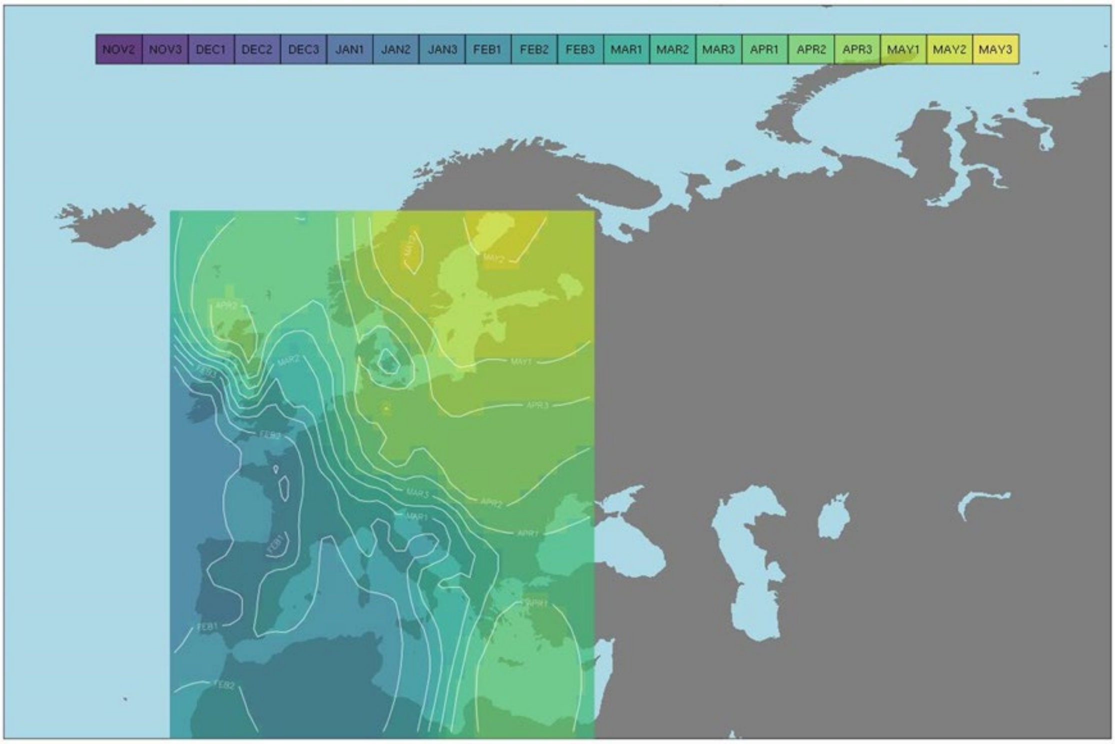
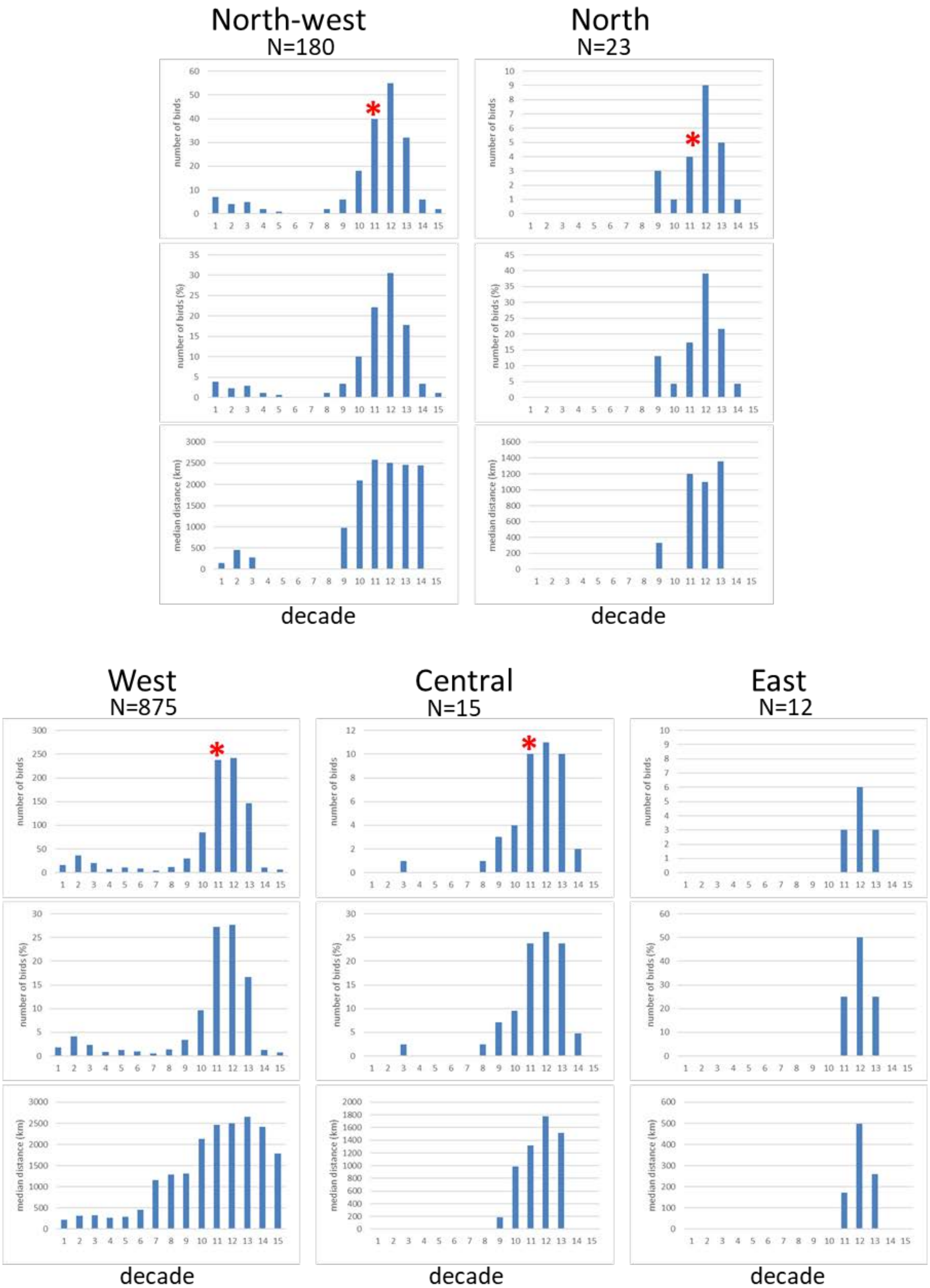


Fig. 4: Median migration date of pre-nuptial migration of Common Snipe. The map shows the date when 50% of individuals are on migration.

05290 Eurasian Woodcock *Scolopax rusticola*

Recovery analysis



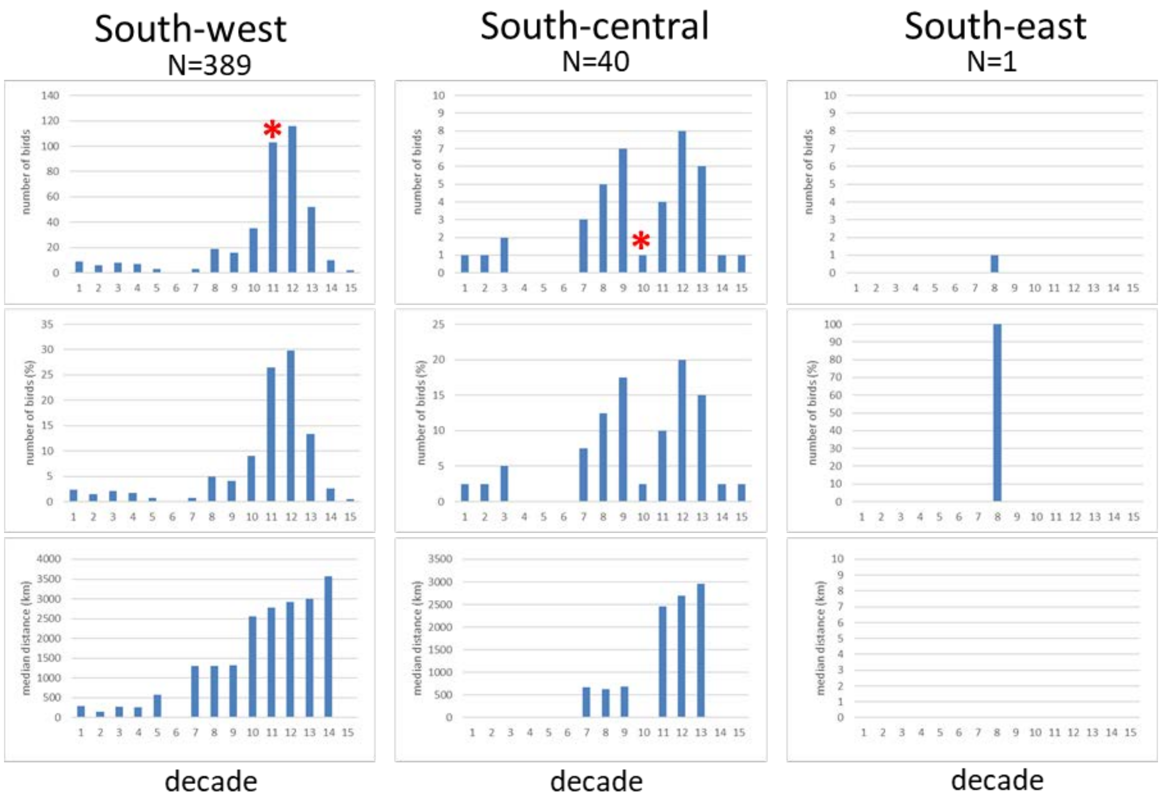


Fig. 1: Onset of prenuptial (return) migration of Eurasian Woodcock by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

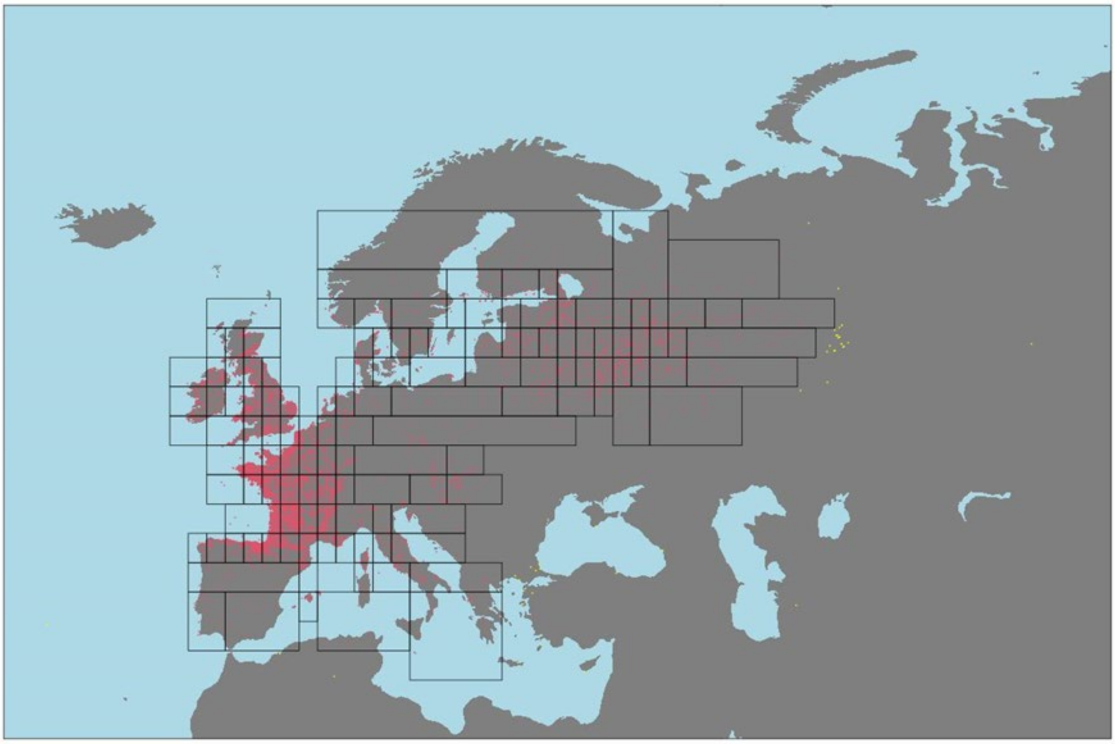


Fig. 2: Data availability for the analyses of Eurasian Woodcock pre-nuptial migration. Red dots: encounters used (16,062), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

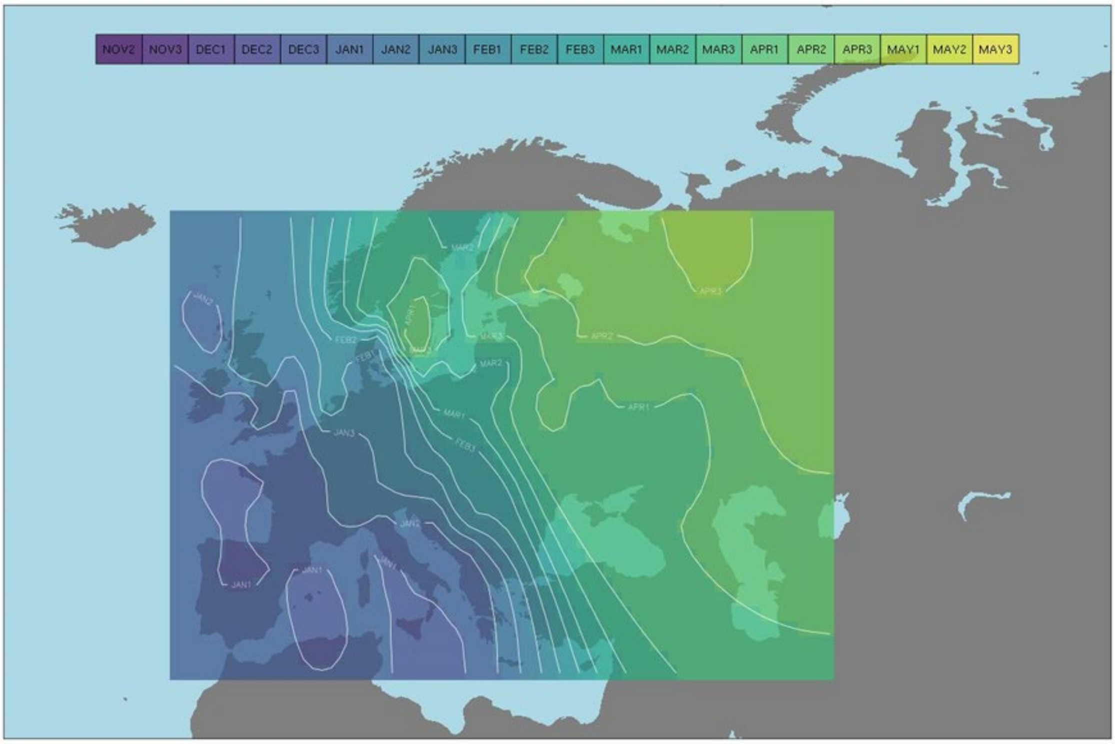


Fig. 3: Onset of pre-nuptial migration of Eurasian Woodcock. The map shows the date when 5% of individuals are on migration.

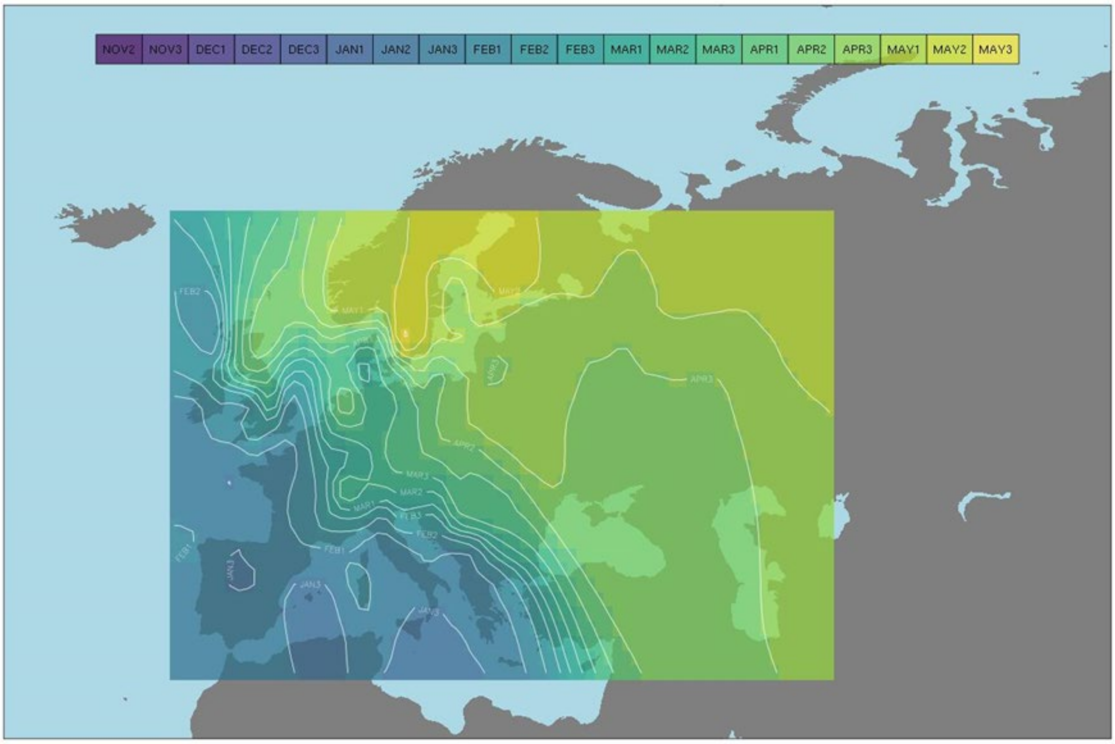
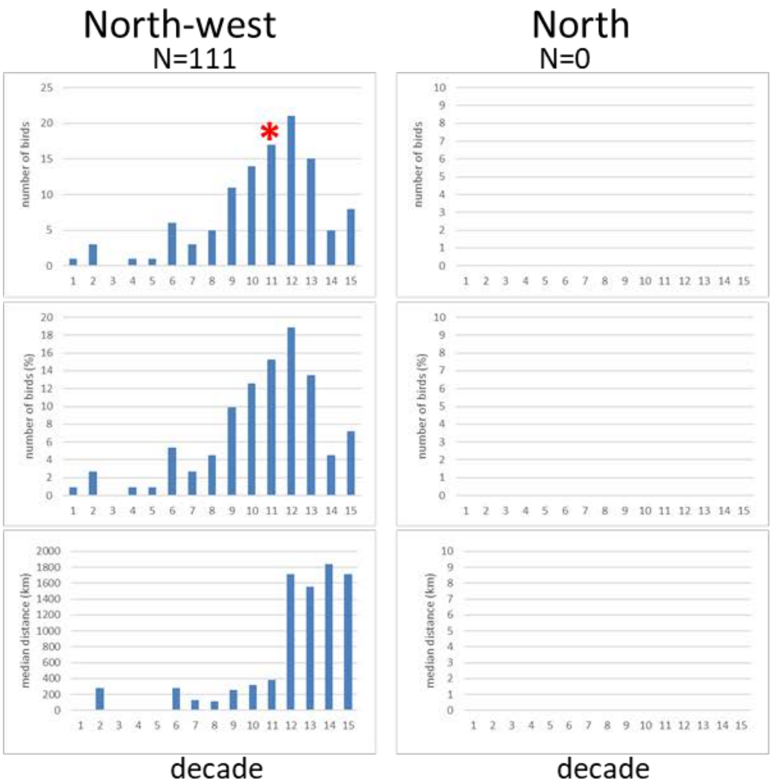
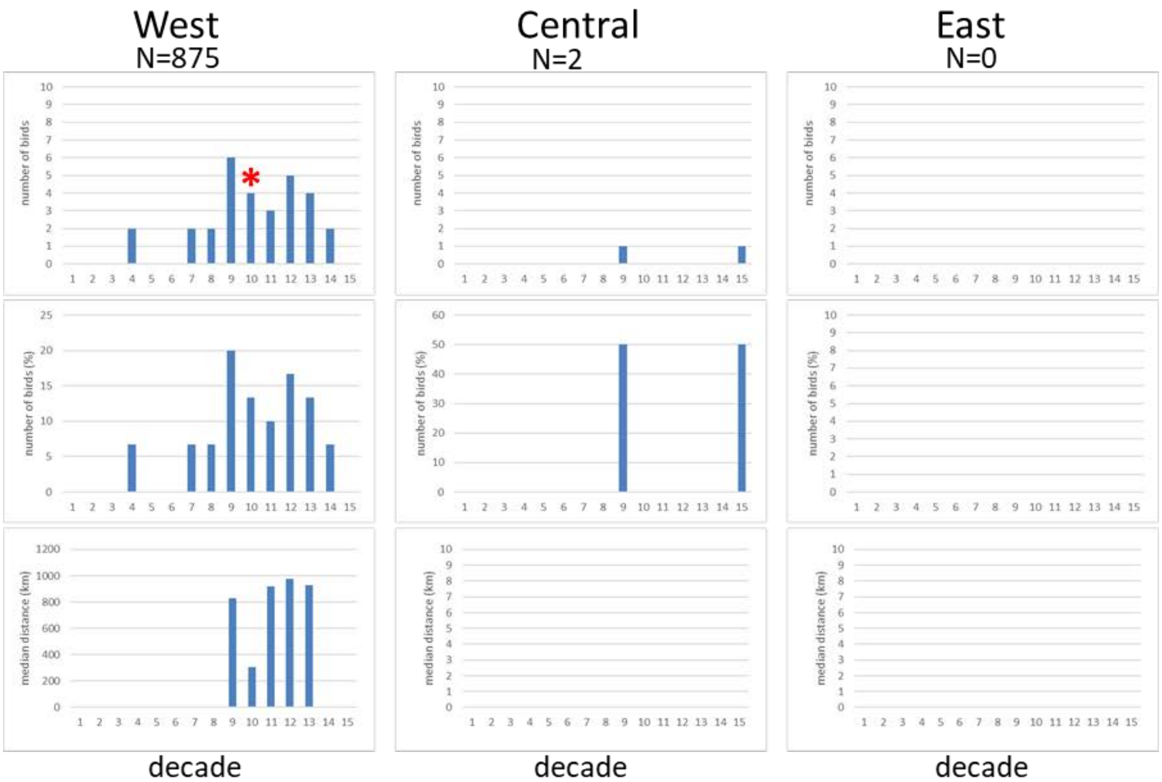


Fig. 4: Median migration date of pre-nuptial migration of Eurasian Woodcock. The map shows the date when 50% of individuals are on migration.

05320 Black-tailed Godwit *Limosa limosa*

Recovery analysis





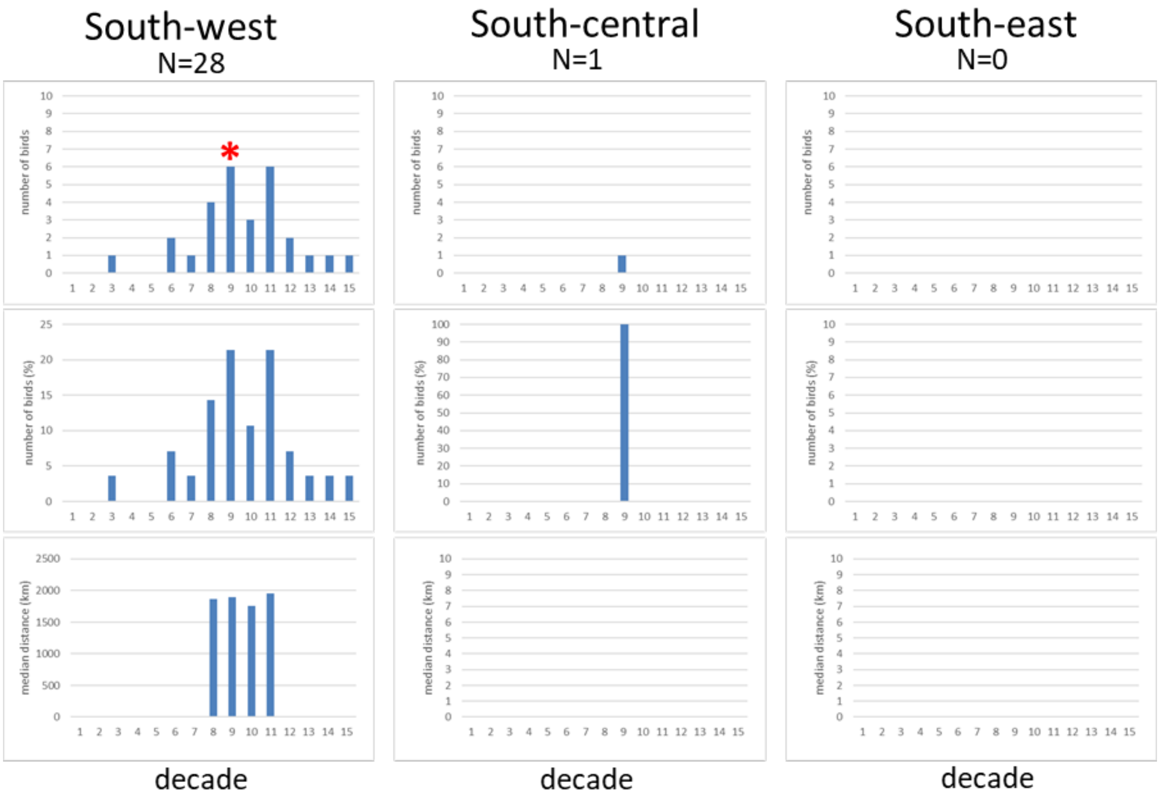


Fig. 1: Onset of prenuptial (return) migration of Black-tailed Godwit by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

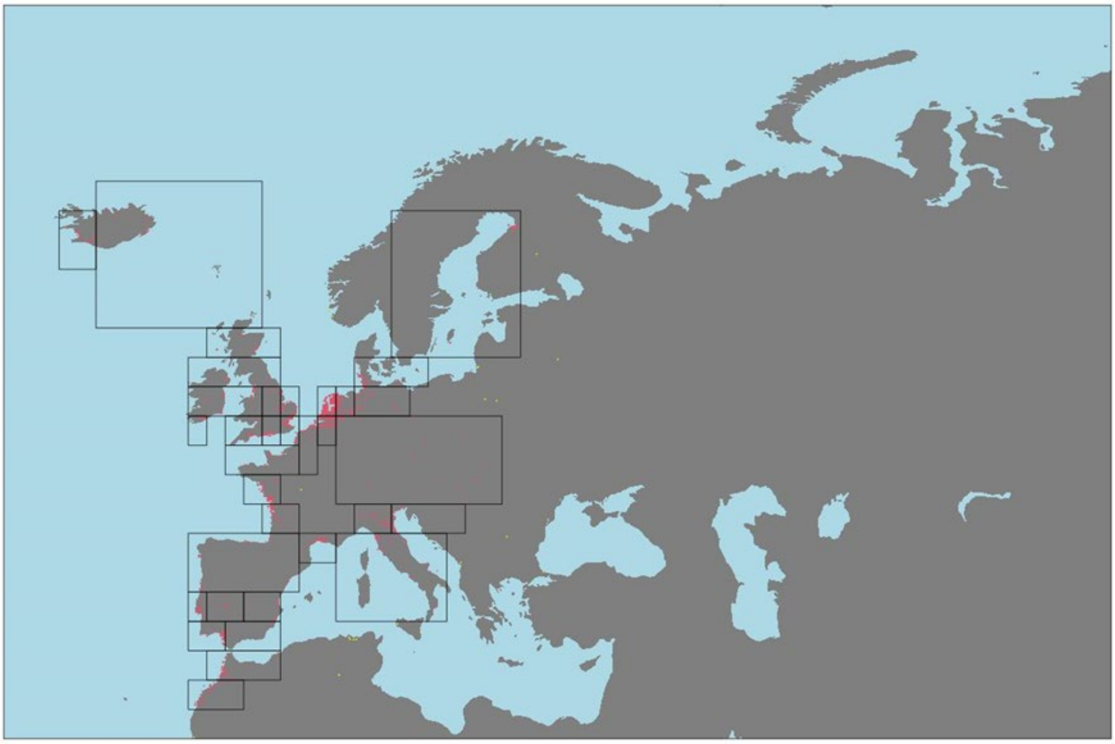


Fig. 2: Data availability for the analyses of Black-tailed Godwit pre-nuptial migration. Red dots: encounters used (6539), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

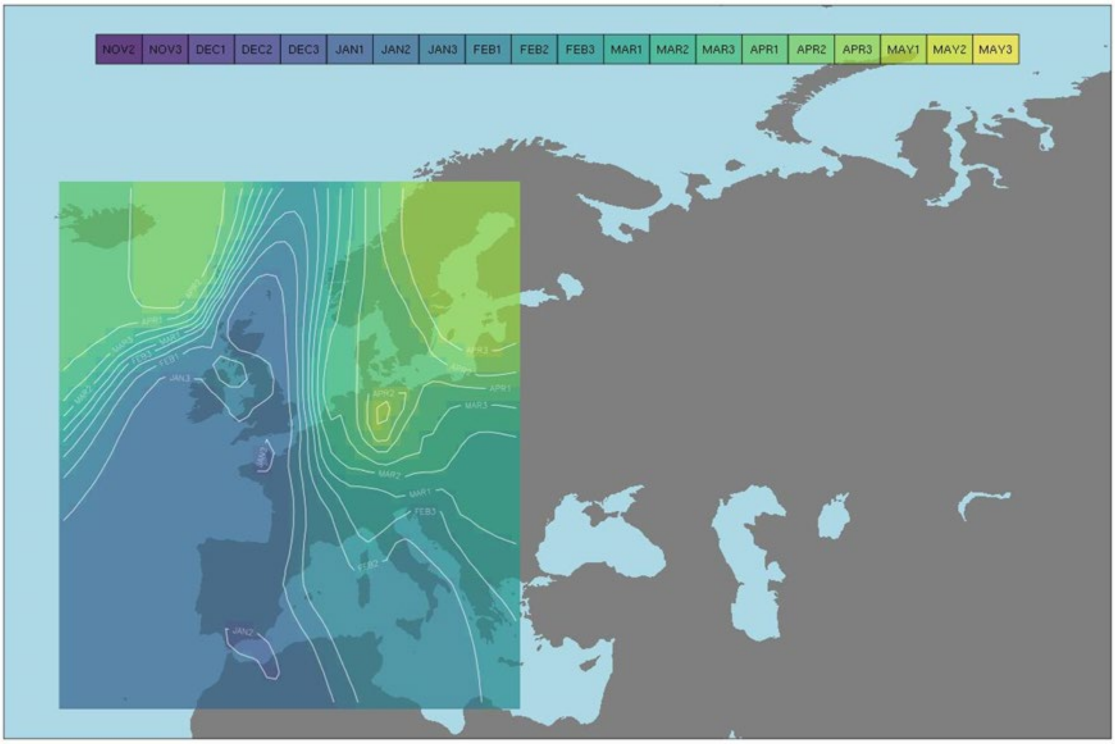


Fig. 3: Onset of pre-nuptial migration of Black-tailed Godwit. The map shows the date when 5% of individuals are on migration.

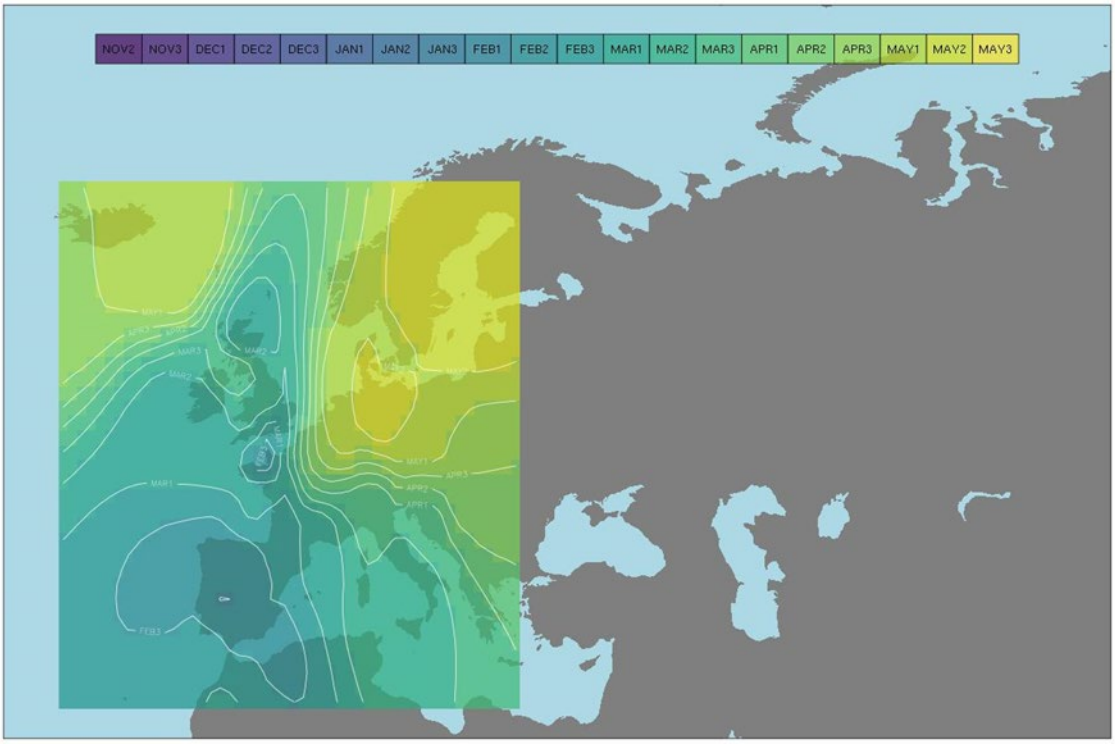
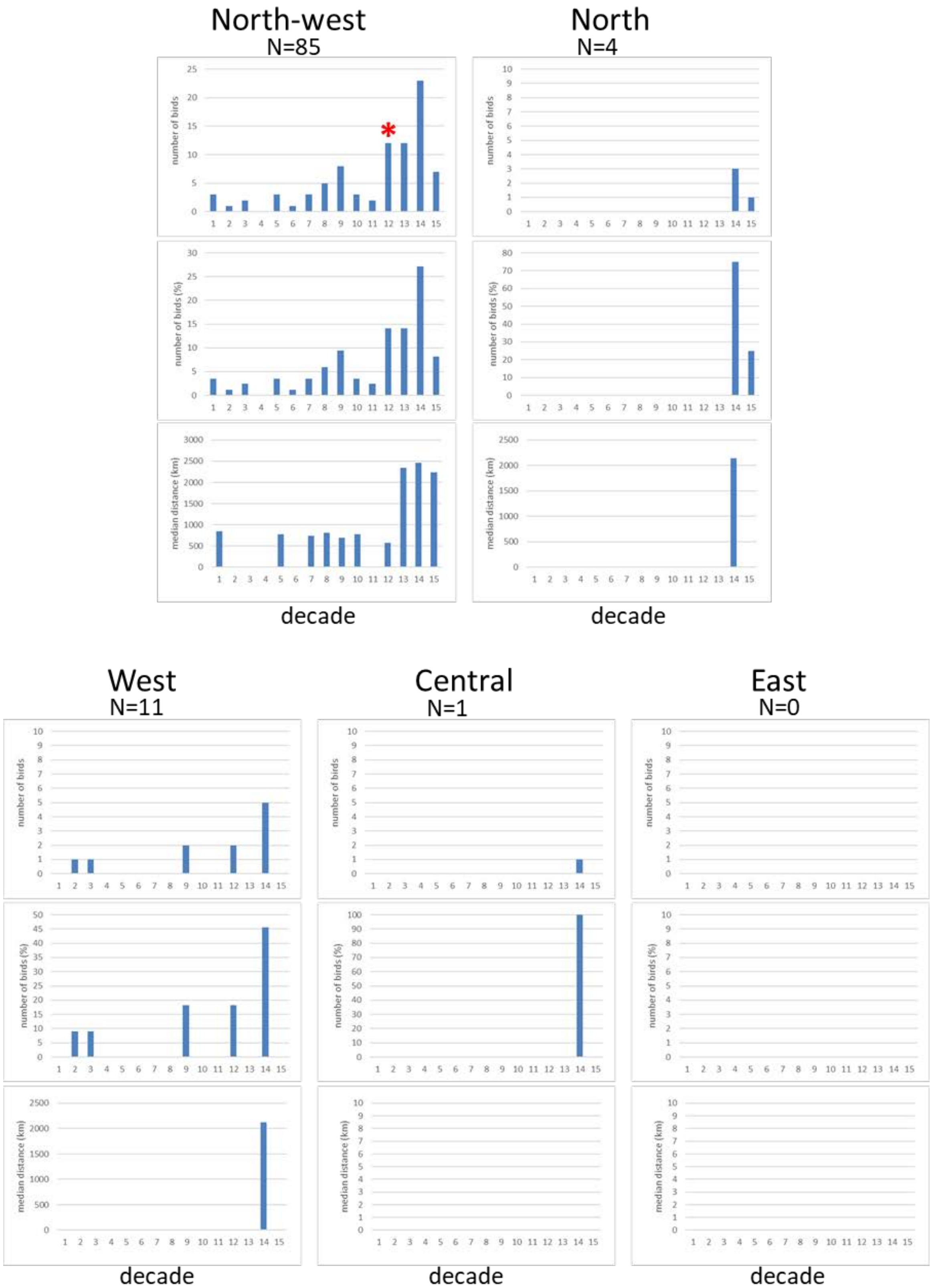


Fig. 4: Median migration date of pre-nuptial migration of Black-tailed Godwit. The map shows the date when 50% of individuals are on migration.

05340 Bar-tailed Godwit *Limosa lapponica*

Recovery analysis



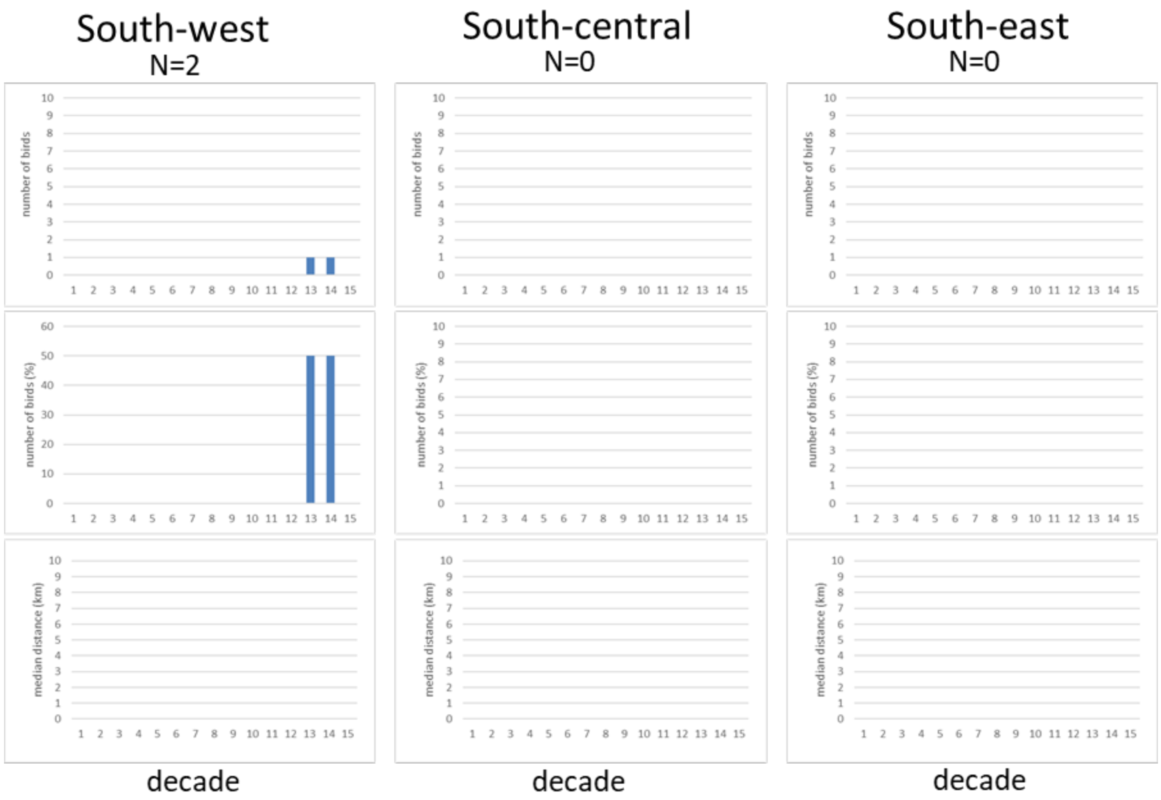


Fig. 1: Onset of prenuptial (return) migration of Bar-tailed Godwit by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

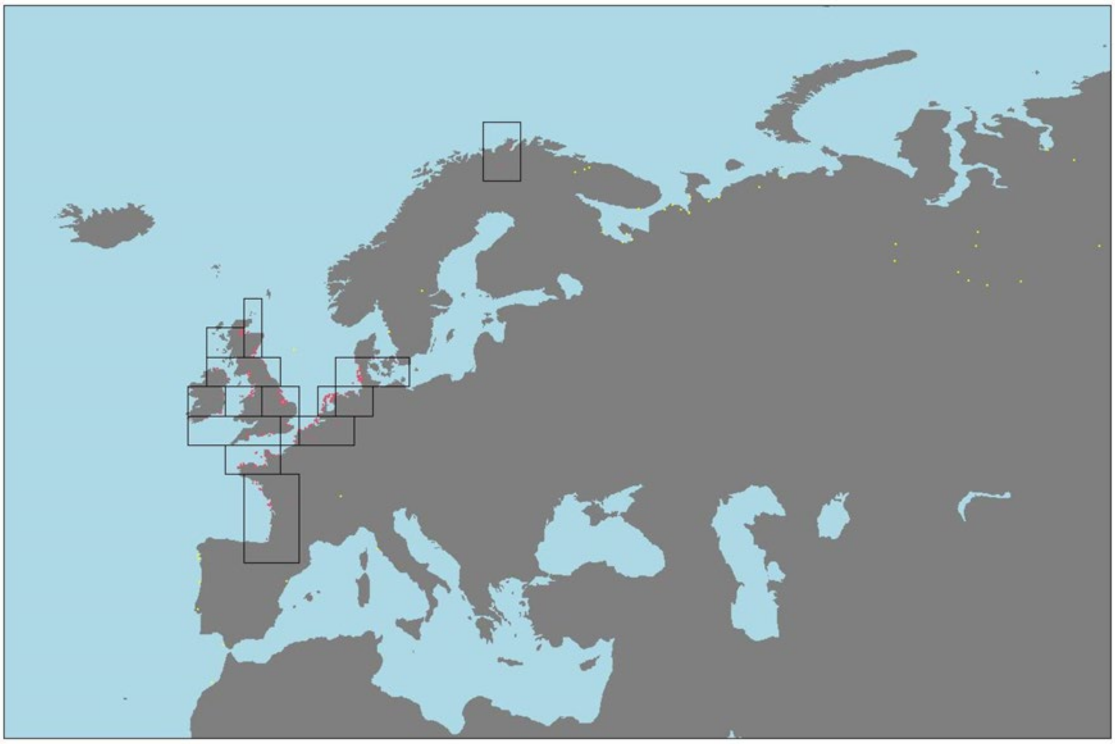


Fig. 2: Data availability for the analyses of Bar-tailed Godwit pre-nuptial migration. Red dots: encounters used (3361), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

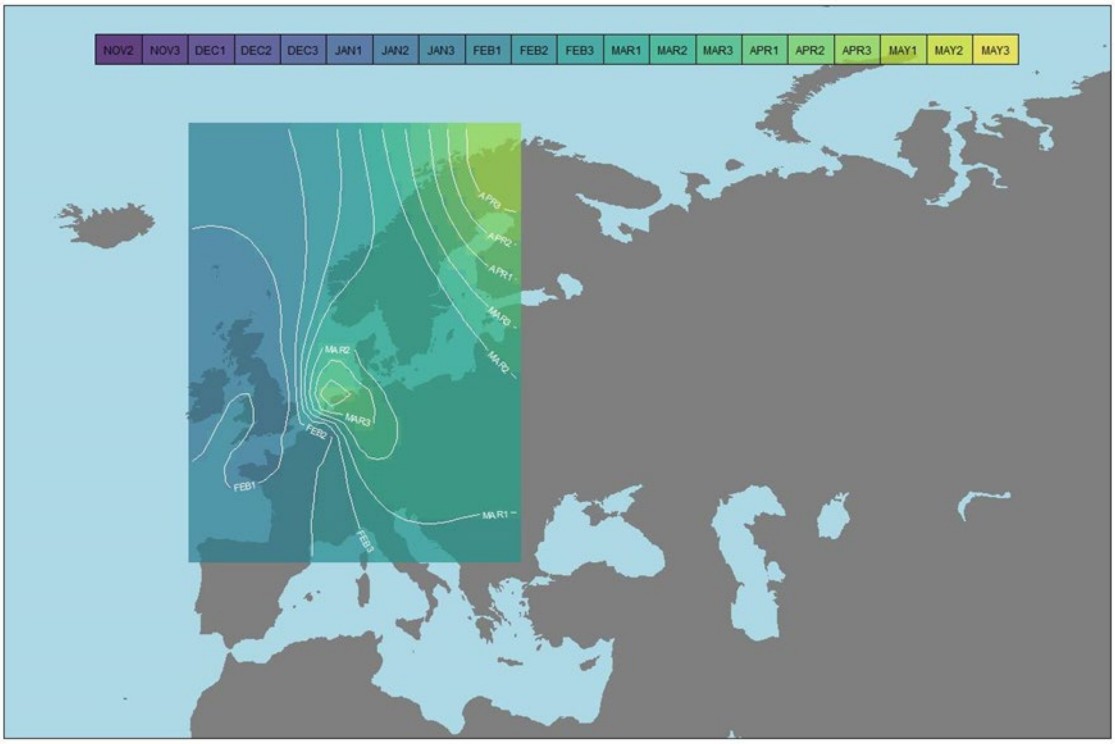


Fig. 3: Onset of pre-nuptial migration of Bar-tailed Godwit. The map shows the date when 5% of individuals are on migration.

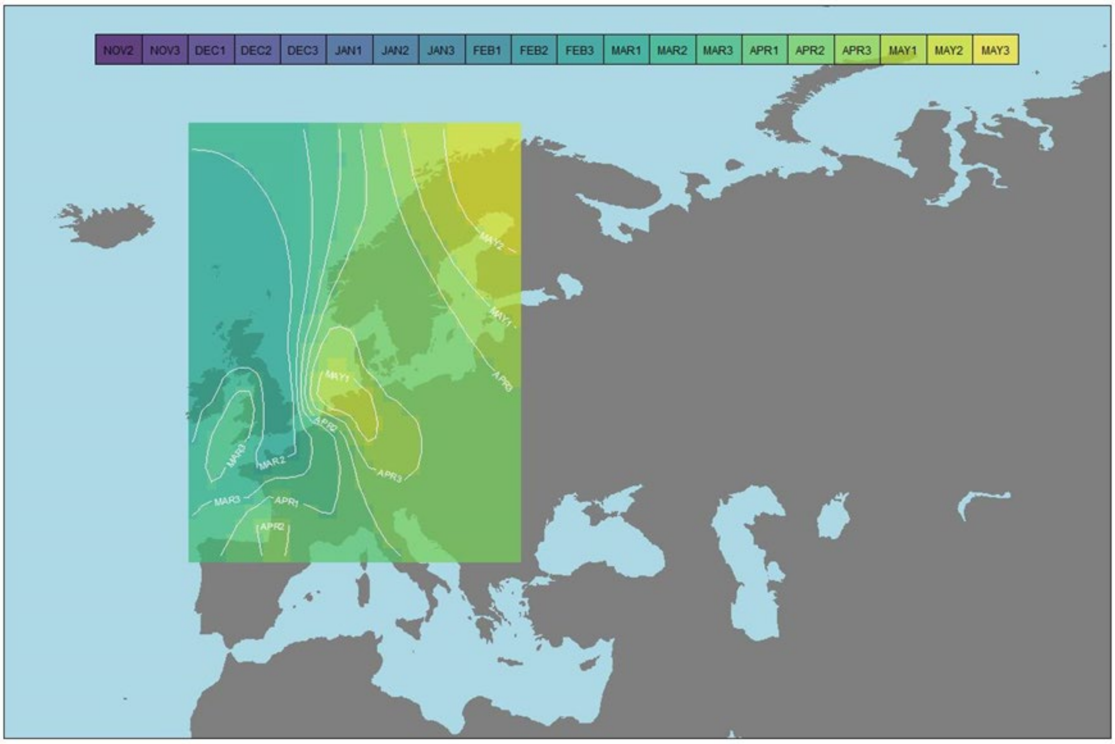
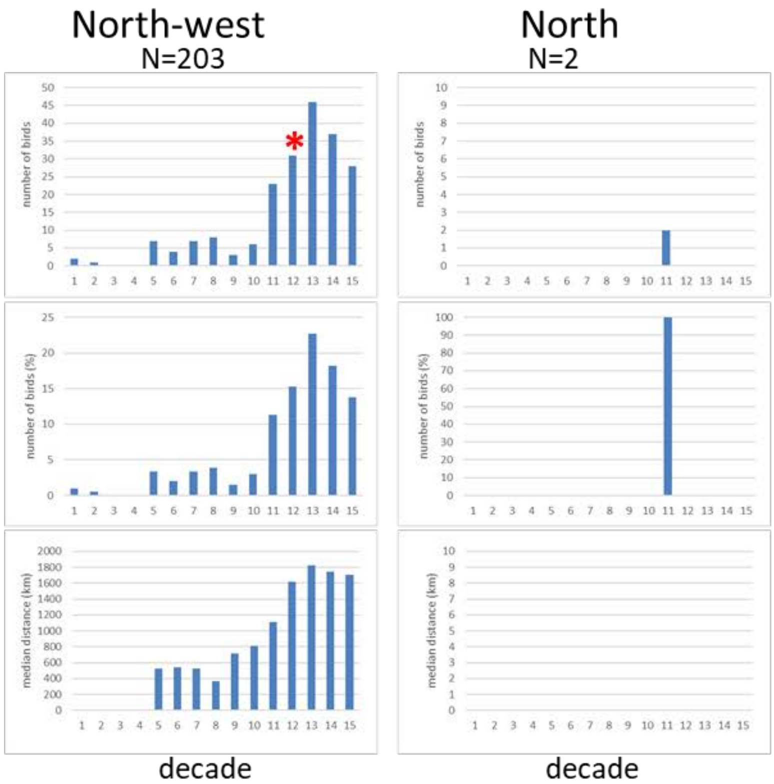
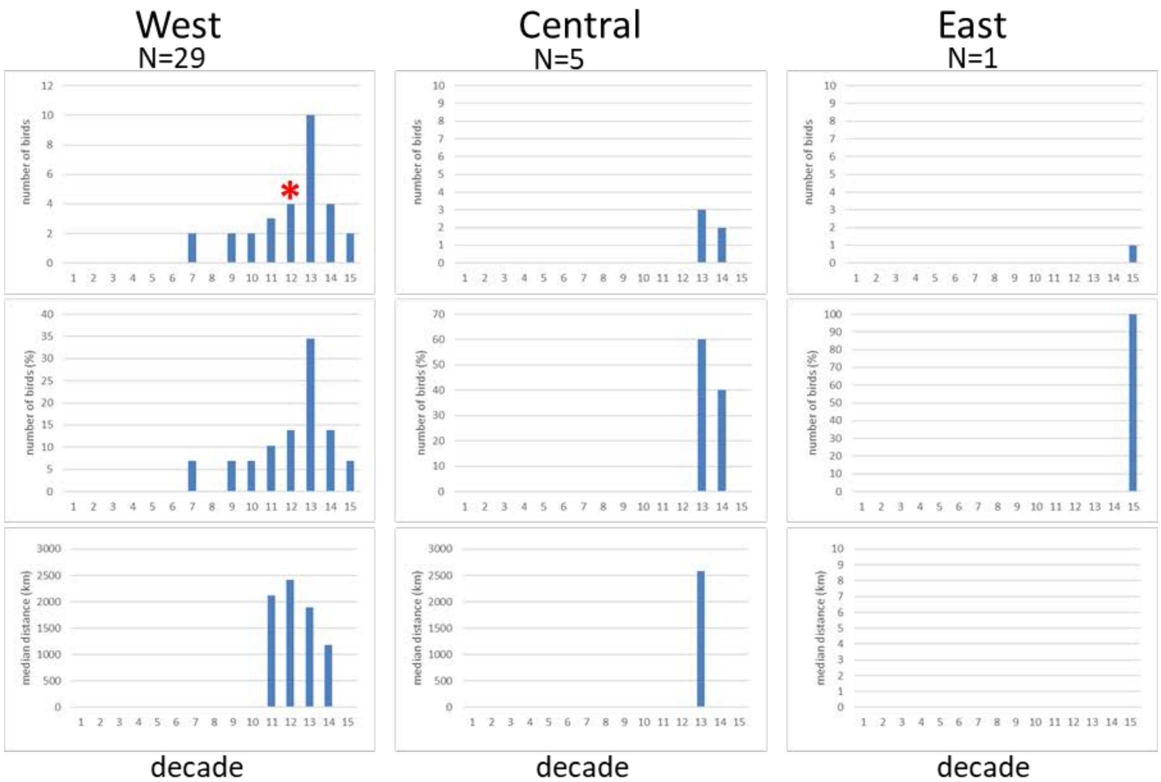


Fig. 4: Median migration date of pre-nuptial migration of Bar-tailed Godwit. The map shows the date when 50% of individuals are on migration.

05410 Eurasian Curlew *Numenius arquata*

Recovery analysis





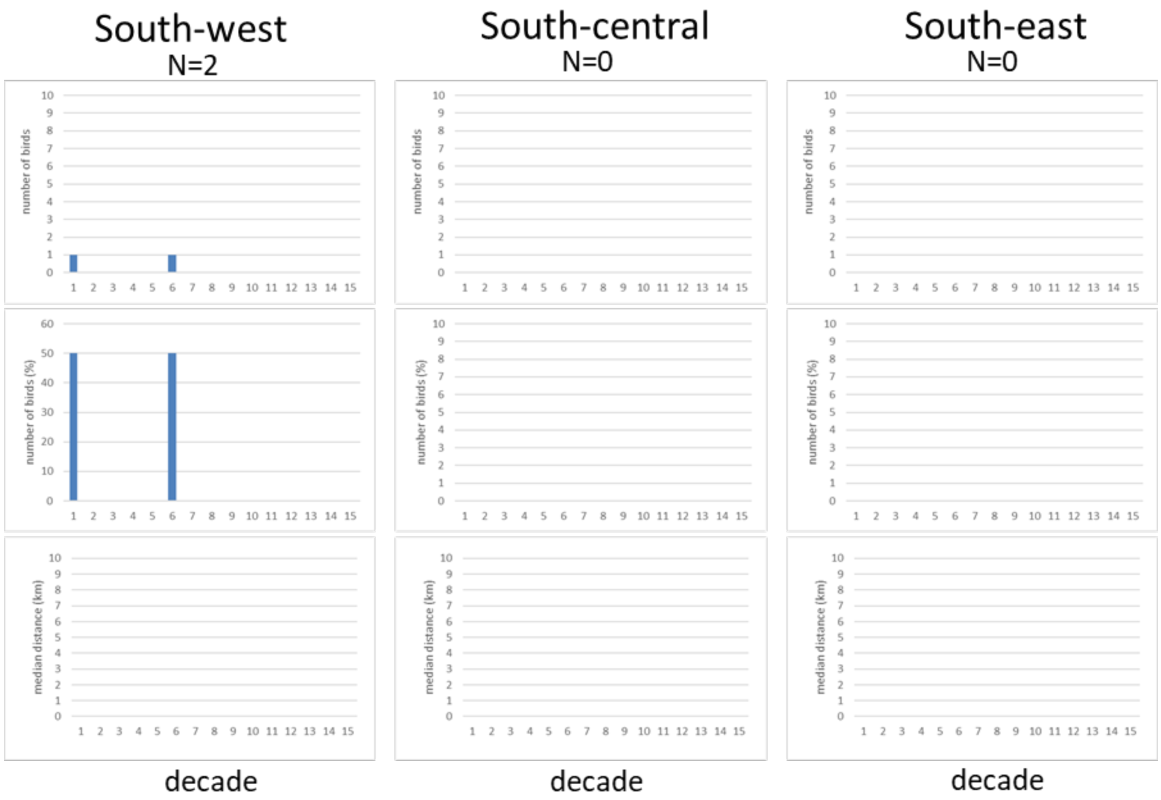


Fig. 1: Onset of prenuptial (return) migration of Eurasian Curlew by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

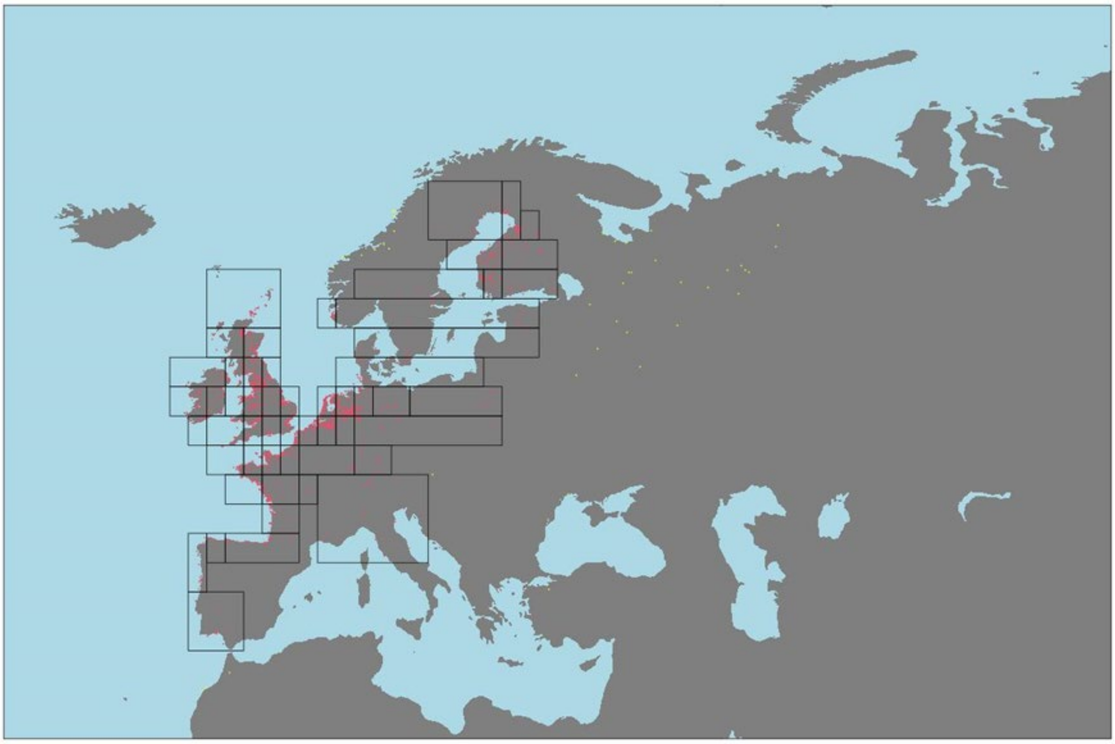


Fig. 2: Data availability for the analyses of Eurasian Curlew pre-nuptial migration. Red dots: encounters used (6300), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

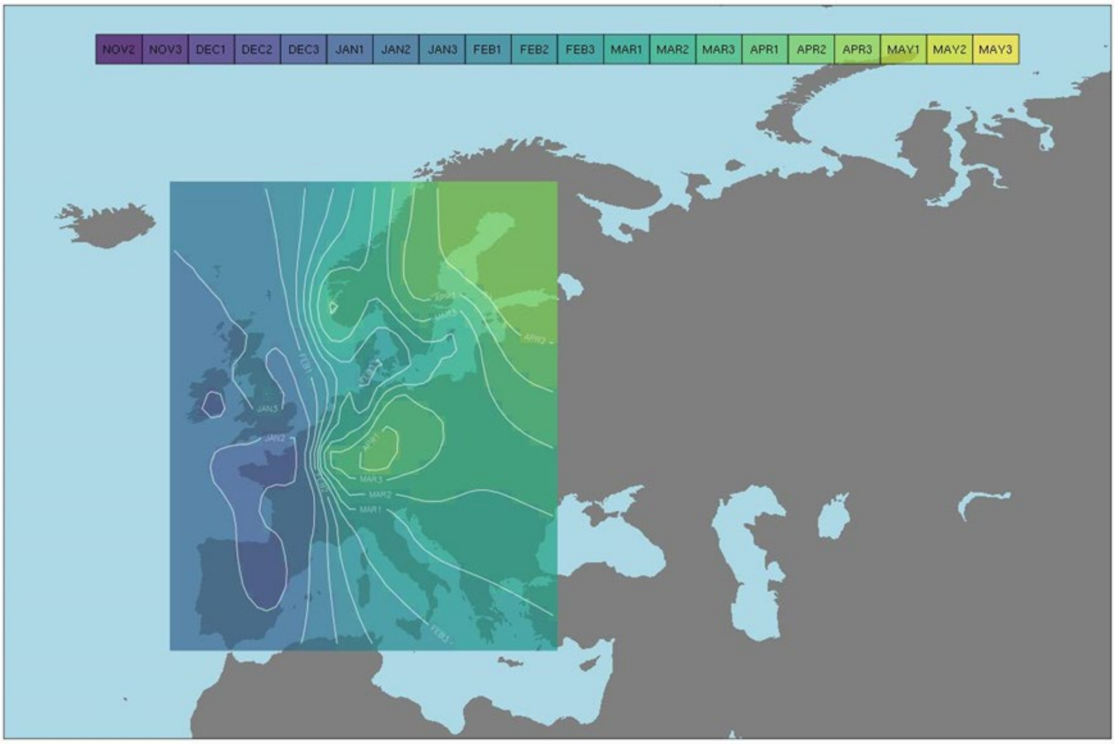


Fig. 3: Onset of pre-nuptial migration of Eurasian Curlew. The map shows the date when 5% of individuals are on migration.

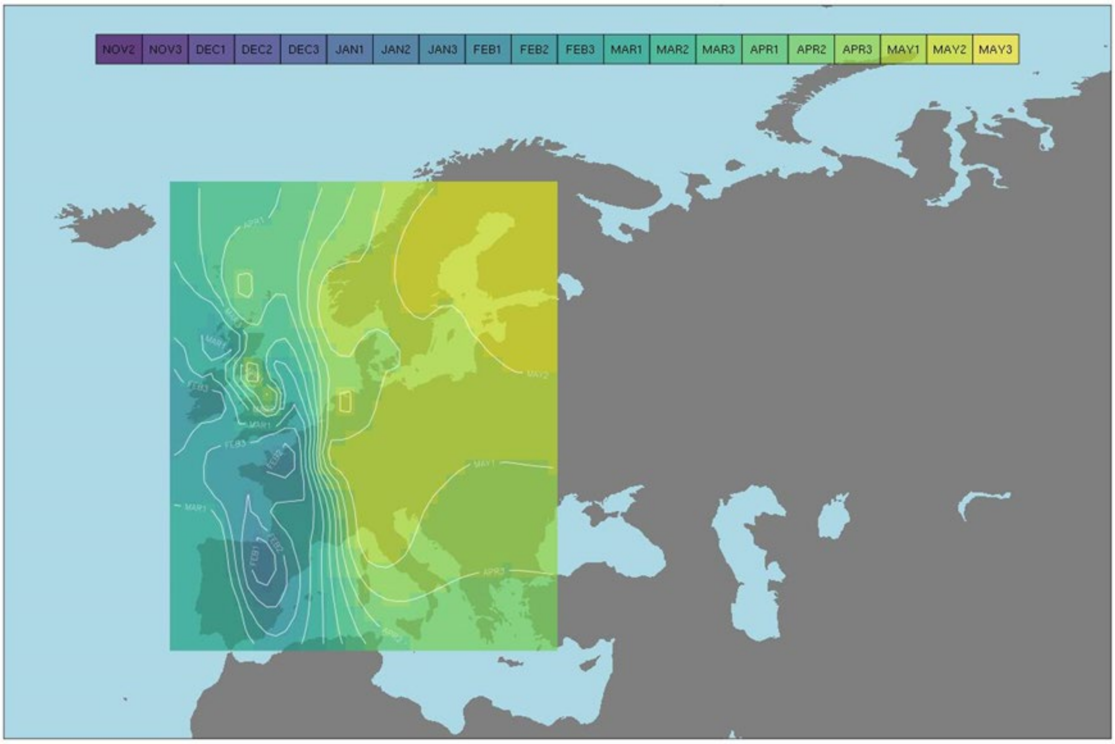
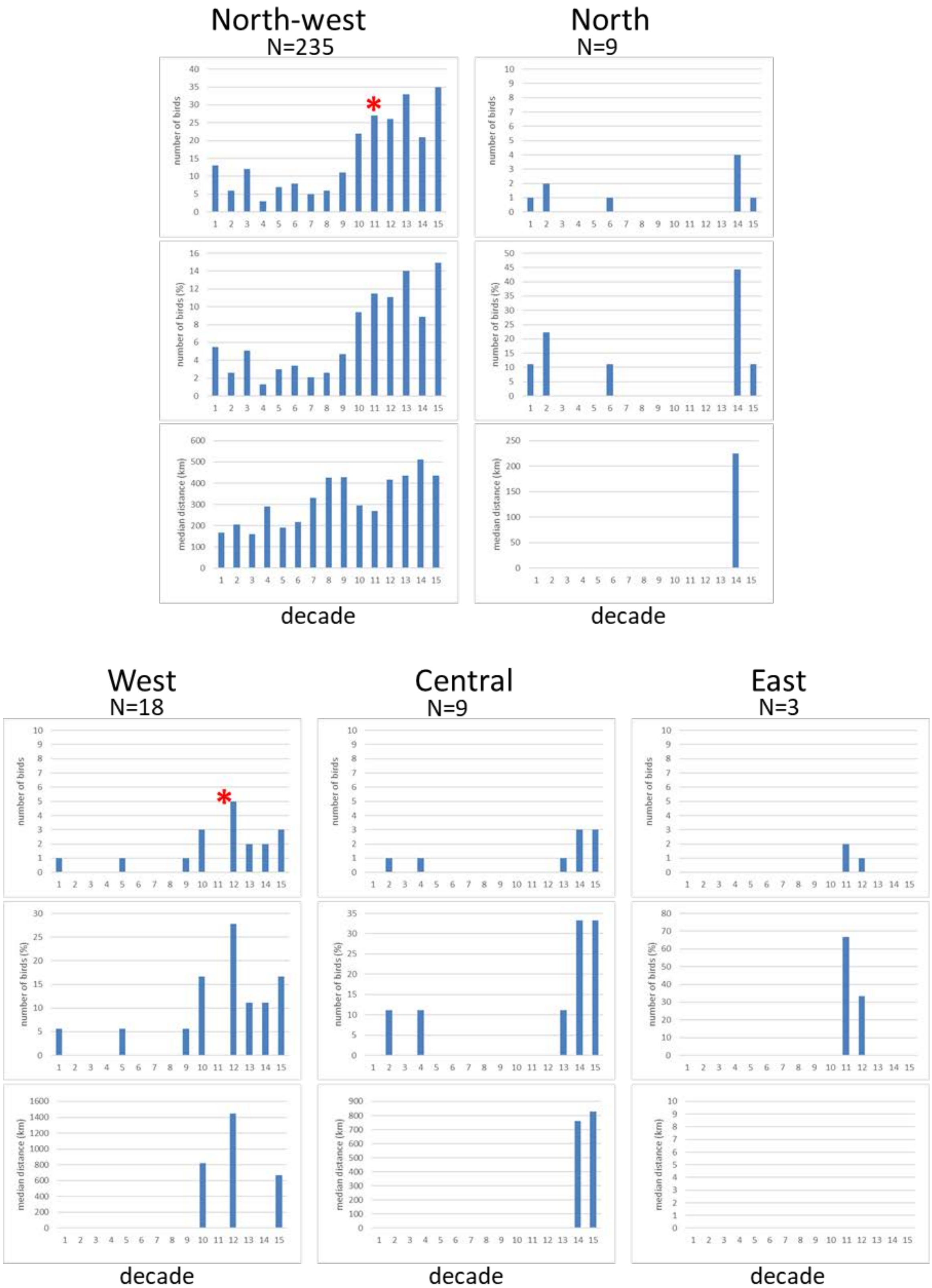


Fig. 4: Median migration date of pre-nuptial migration of Eurasian Curlew. The map shows the date when 50% of individuals are on migration.

05460 Common Redshank *Tringa totanus*

Recovery analysis



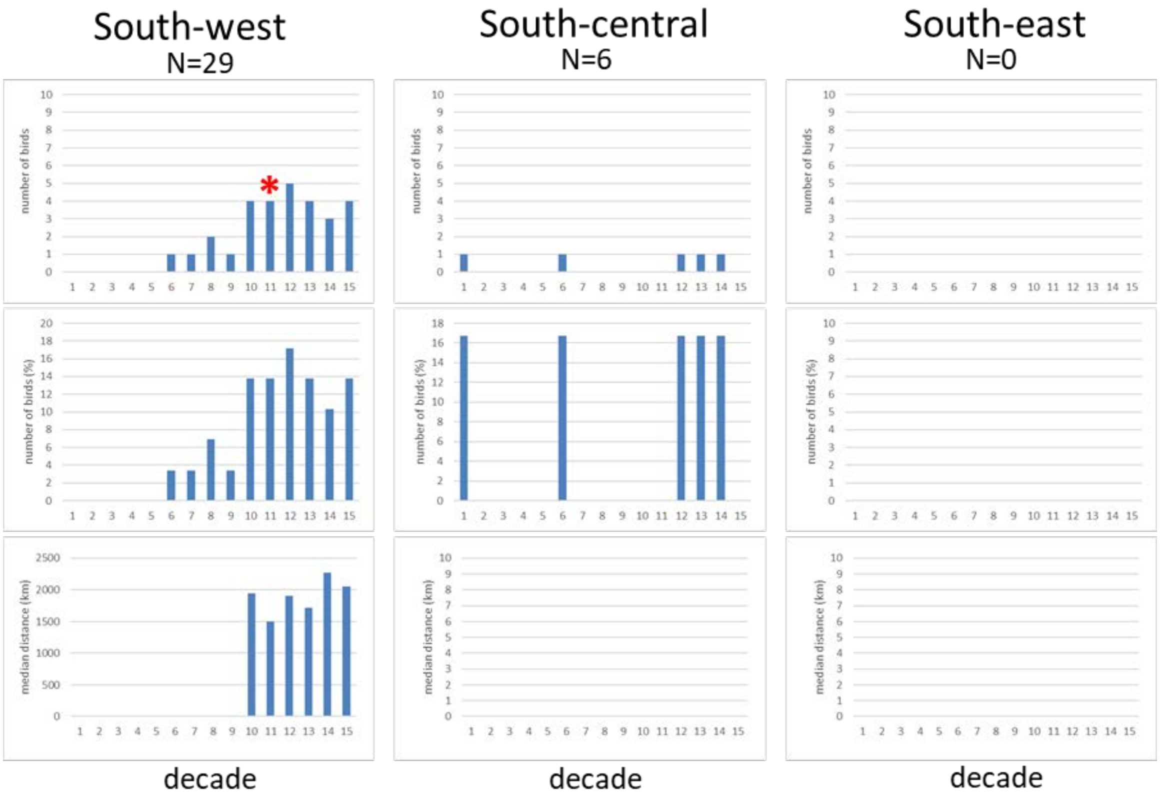


Fig. 1: Onset of prenuptial (return) migration of Common Redshank by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

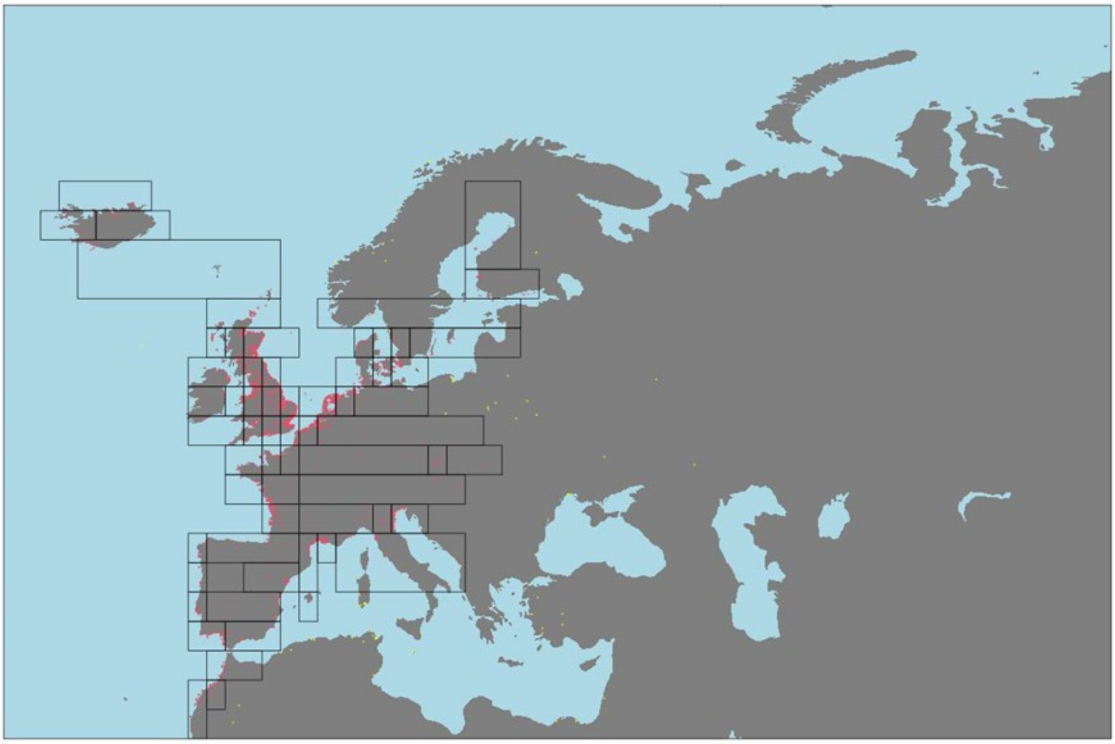


Fig. 2: Data availability for the analyses of Common Redshank pre-nuptial migration. Red dots: encounters used (23,085), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

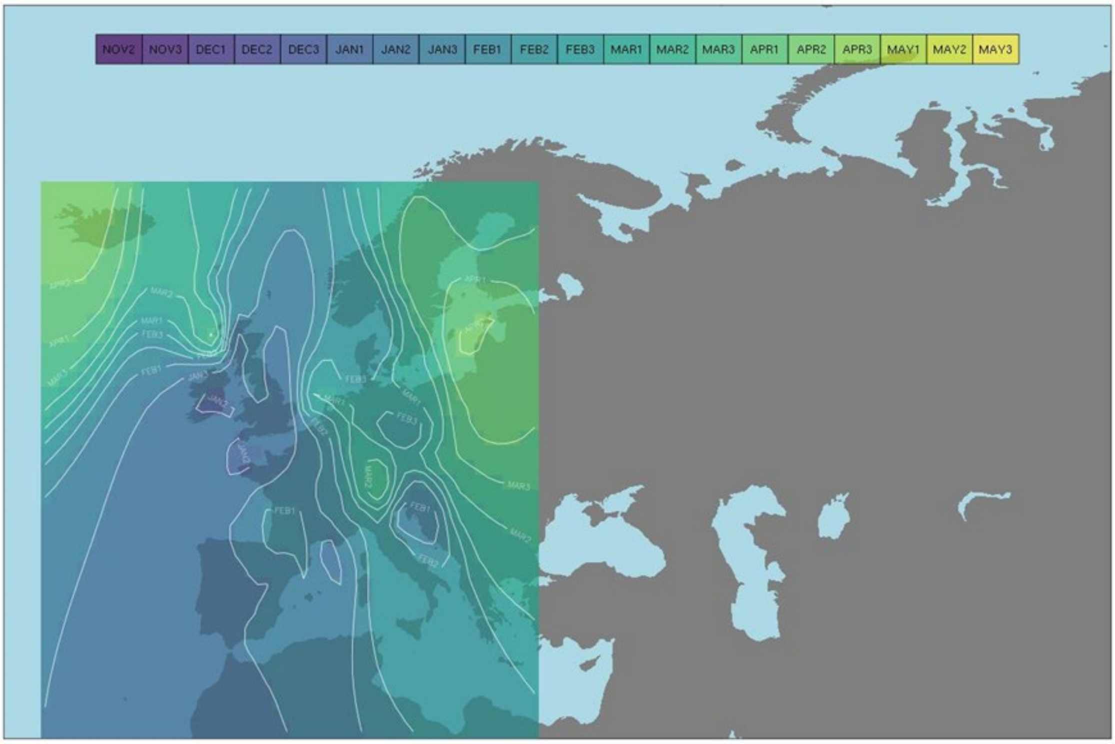


Fig. 3: Onset of pre-nuptial migration of Common Redshank. The map shows the date when 5% of individuals are on migration.

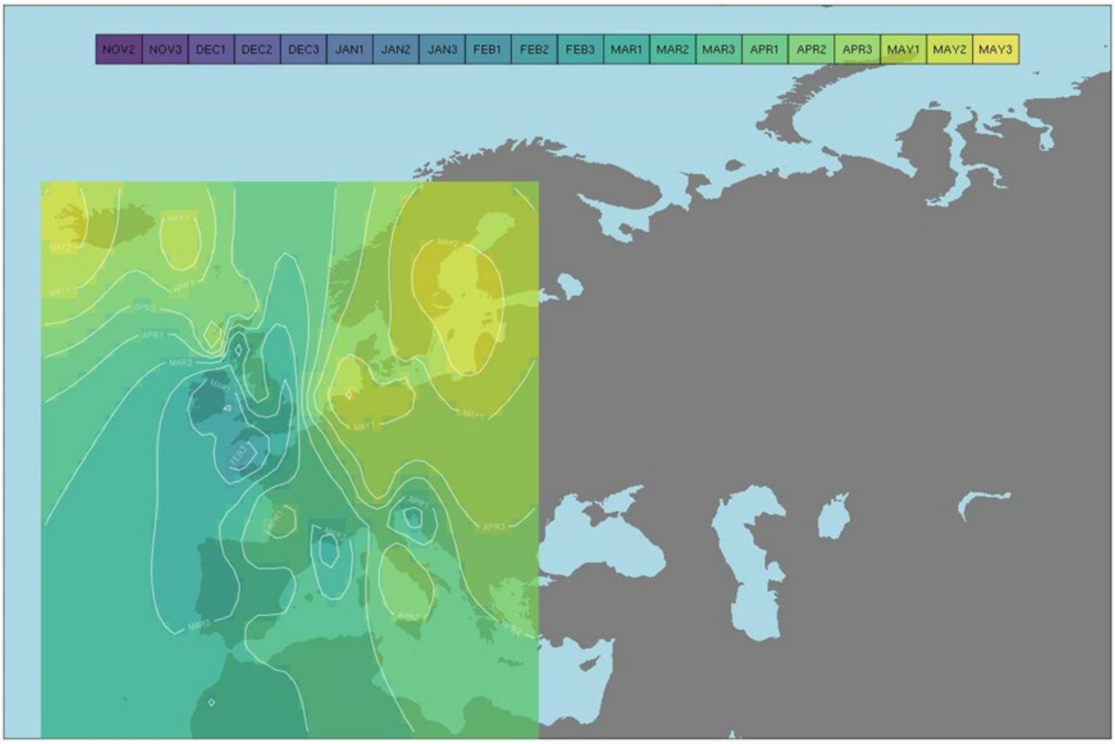
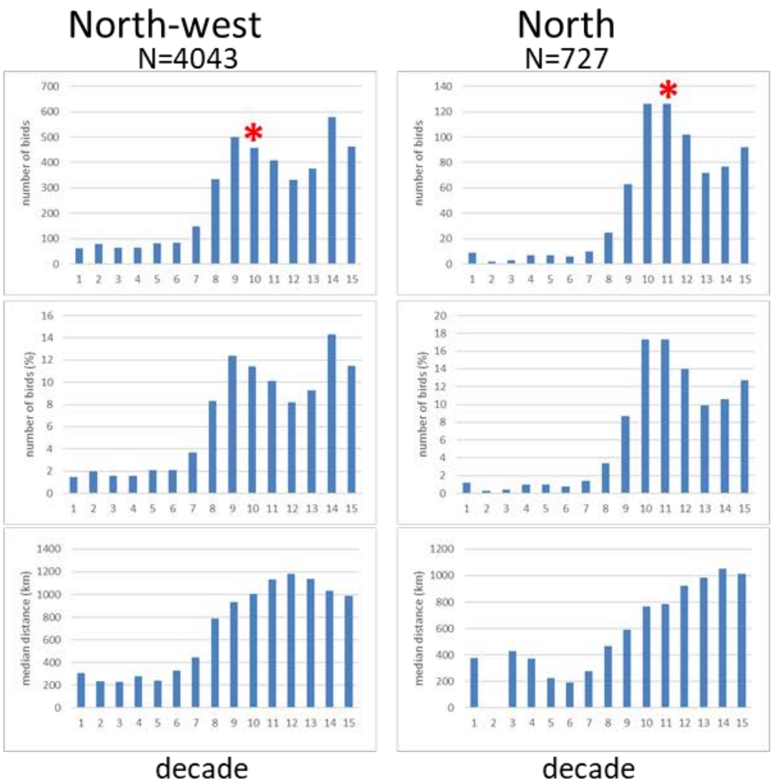
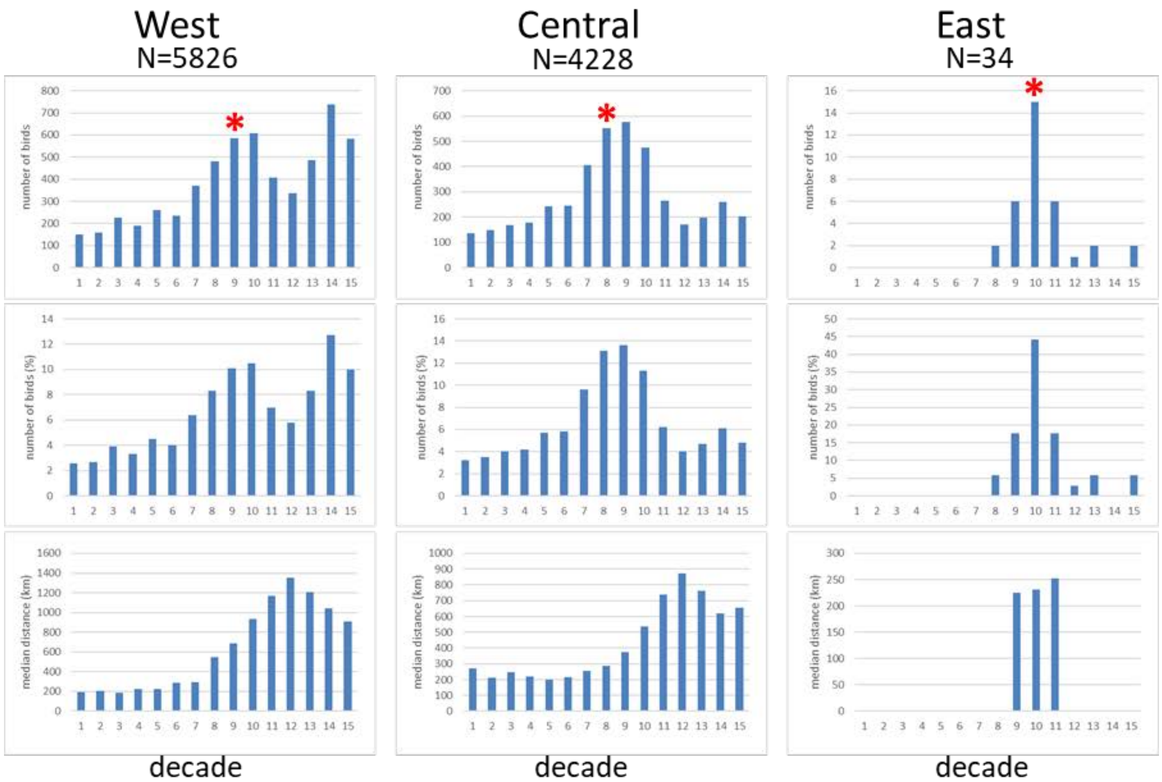


Fig. 4: Median migration date of pre-nuptial migration of Common Redshank. The map shows the date when 50% of individuals are on migration.

05820 Common Black-headed Gull *Larus ridibundus*

Recovery analysis





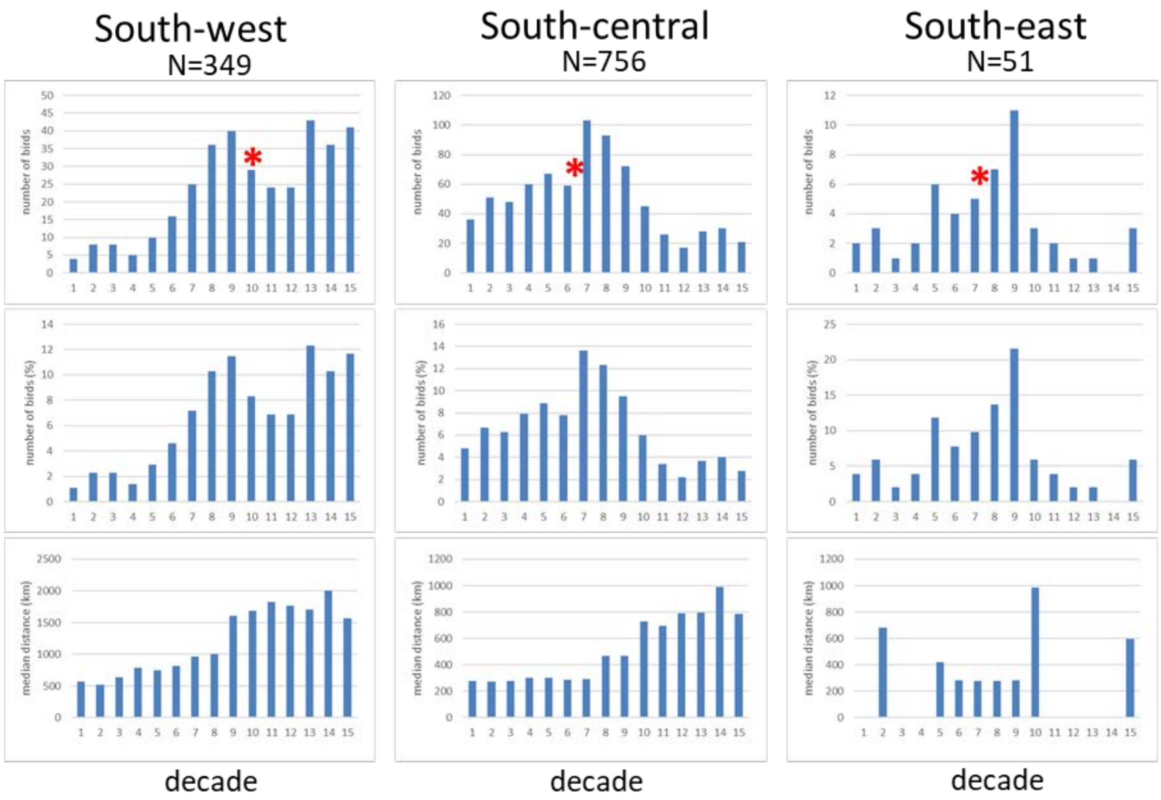


Fig. 1: Onset of prenuptial (return) migration of Common Black-headed Gull by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

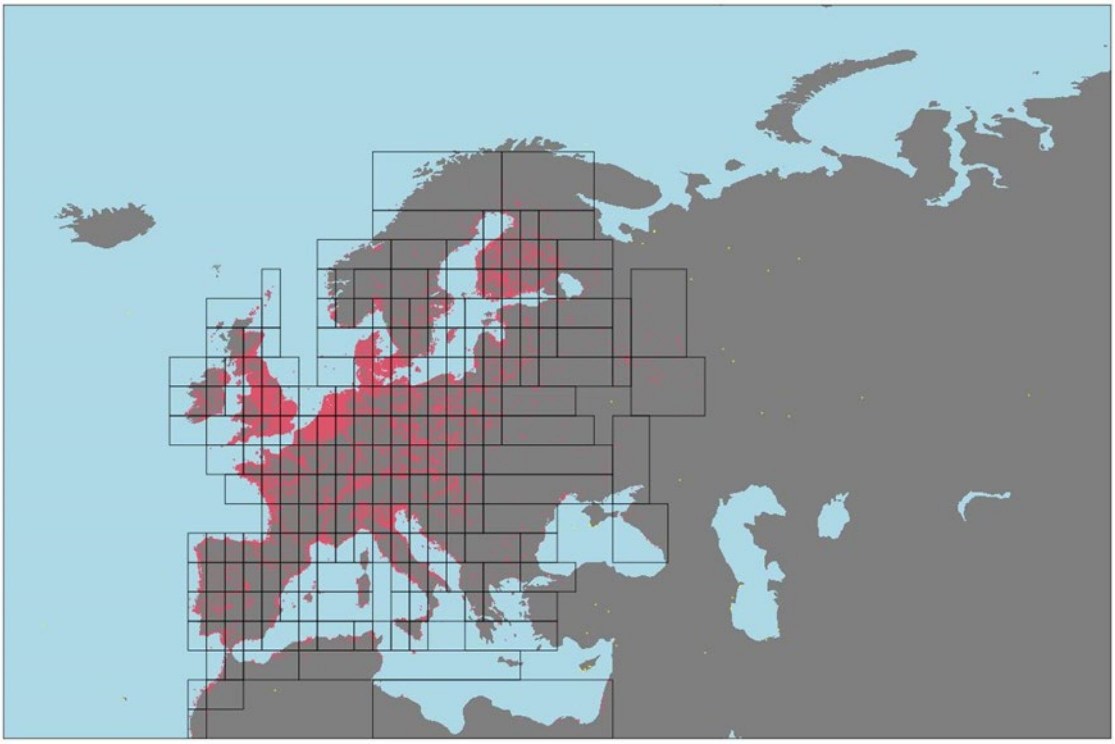


Fig. 2: Data availability for the analyses of Common Black-headed Gull pre-nuptial migration. Red dots: encounters used (437,660), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

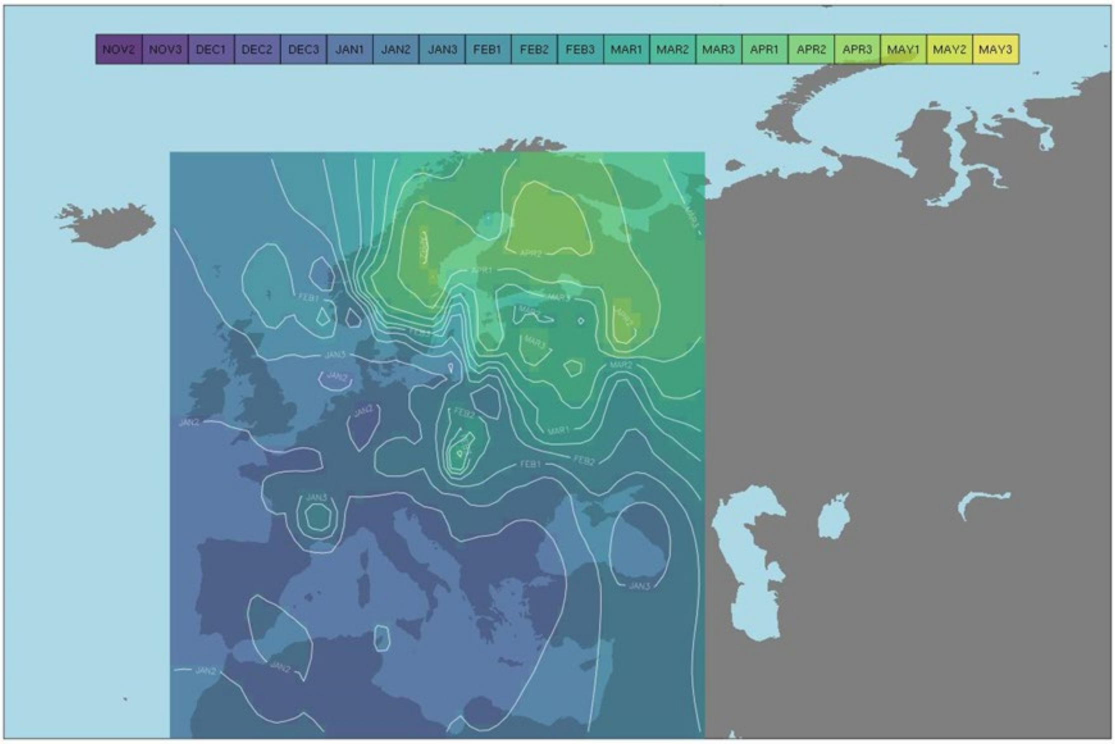


Fig. 3: Onset of pre-nuptial migration of Common Black-headed Gull. The map shows the date when 5% of individuals are on migration.

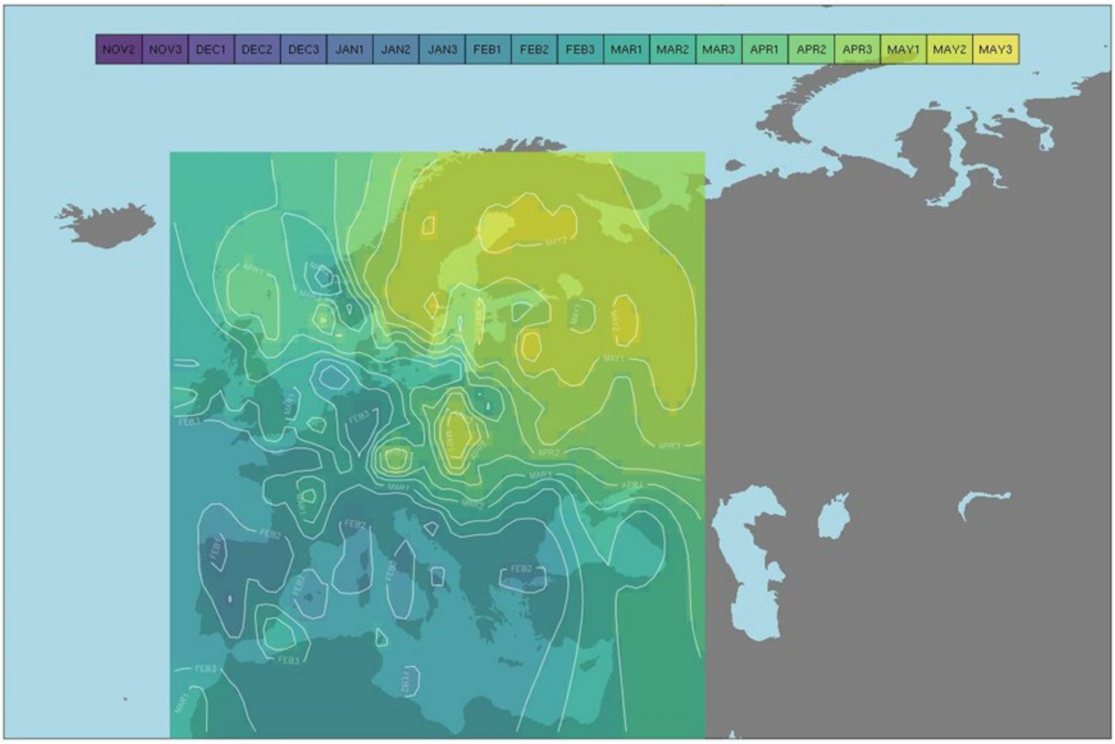
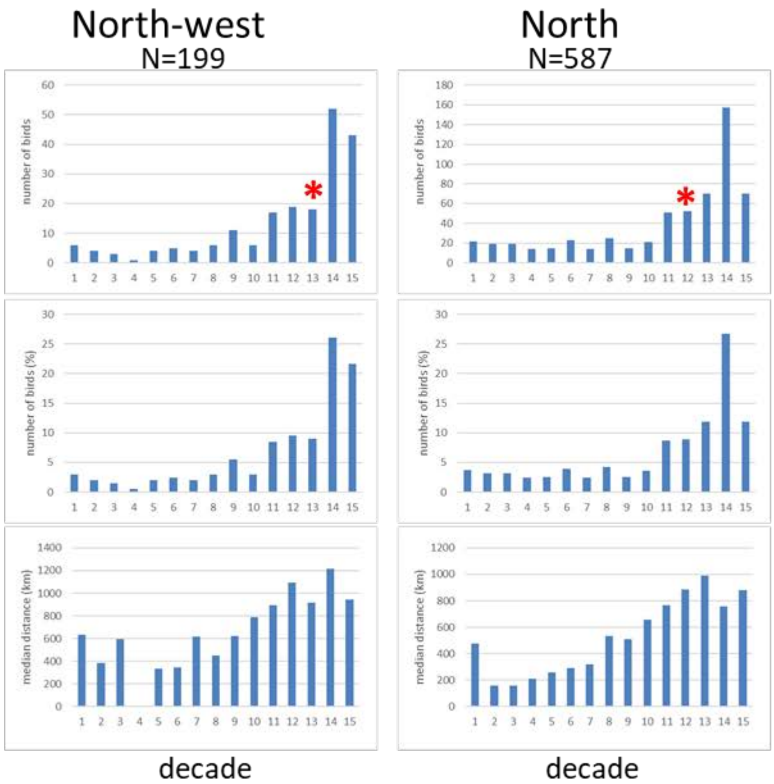
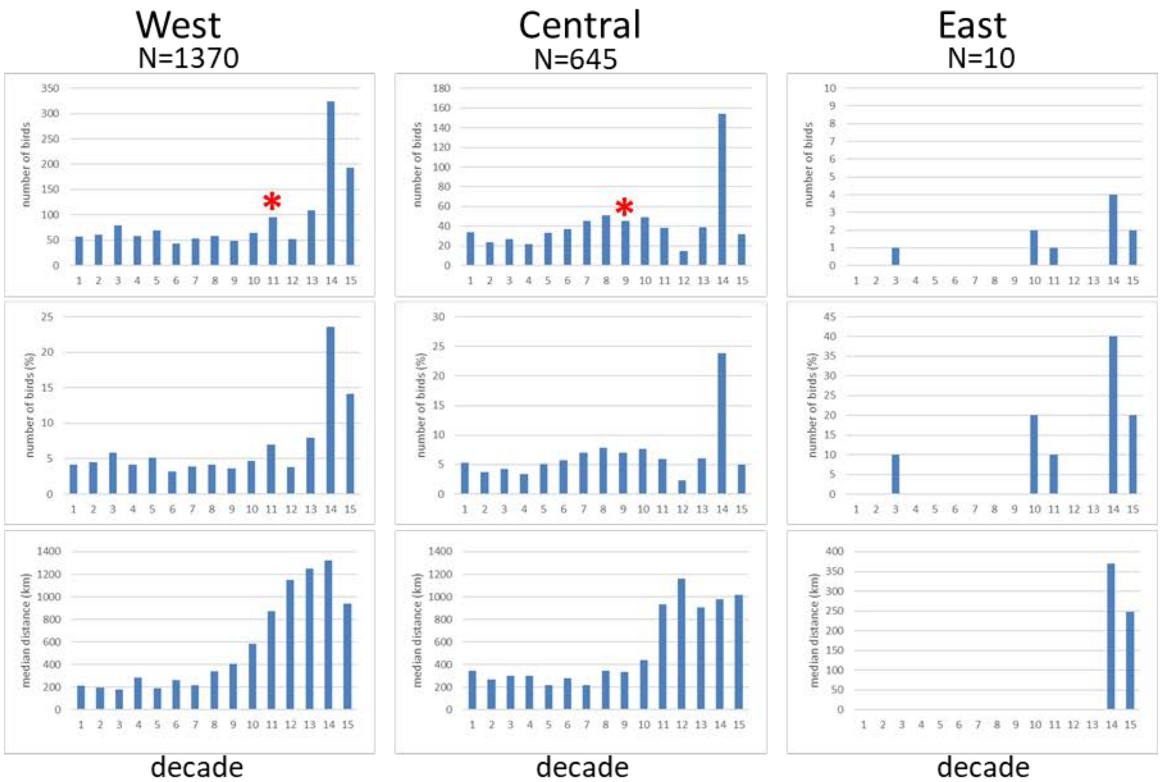


Fig. 4: Median migration date of pre-nuptial migration of Common Black-headed Gull. The map shows the date when 50% of individuals are on migration.

05900 Mew Gull *Larus canus*

Recovery analysis





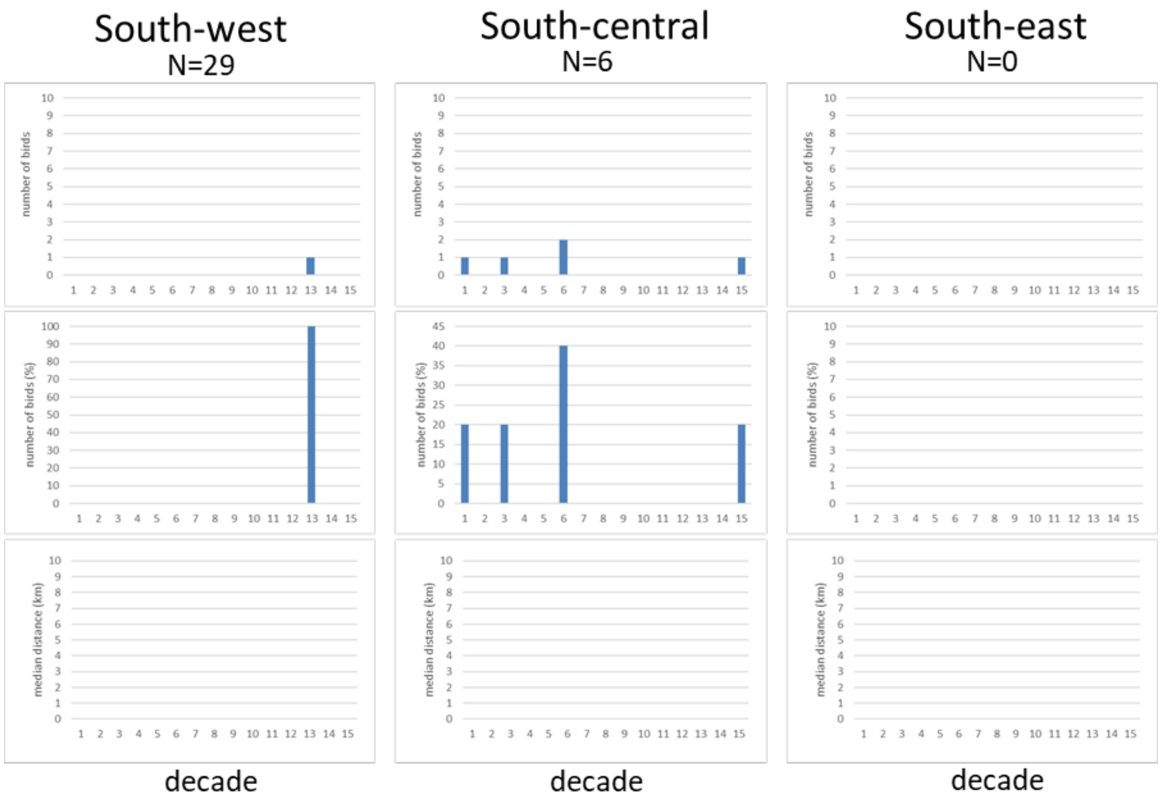


Fig. 1: Onset of prenuptial (return) migration of Mew Gull by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

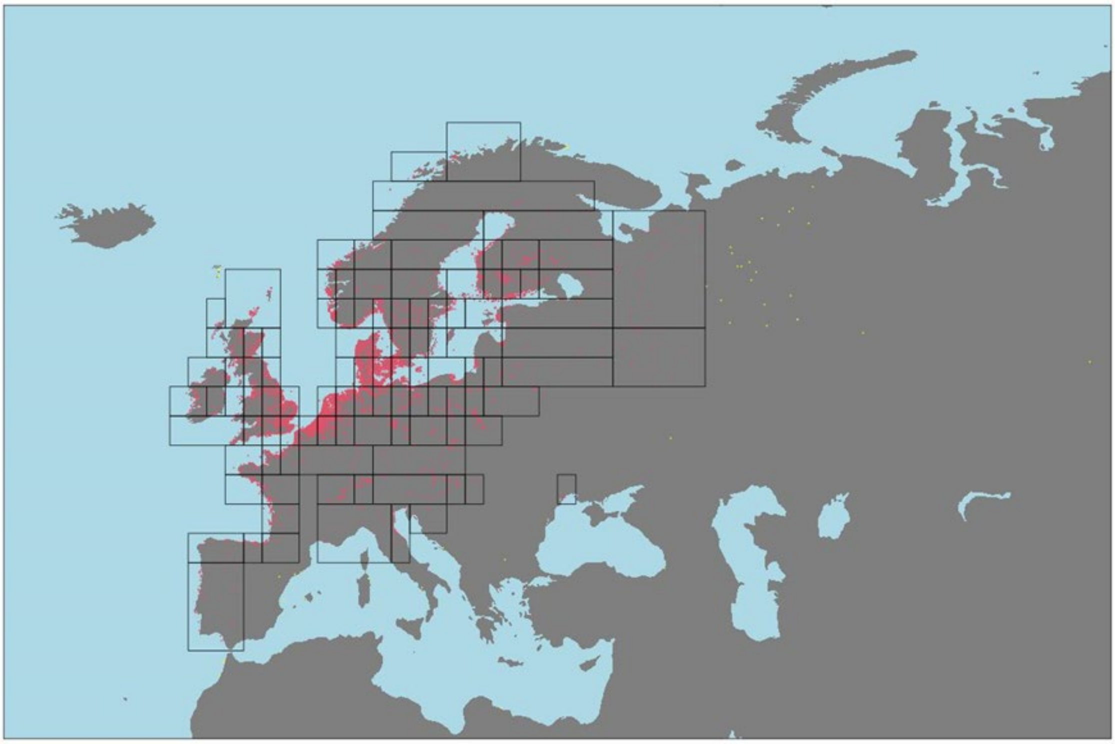


Fig. 2: Data availability for the analyses of Mew Gull pre-nuptial migration. Red dots: encounters used (65,842), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

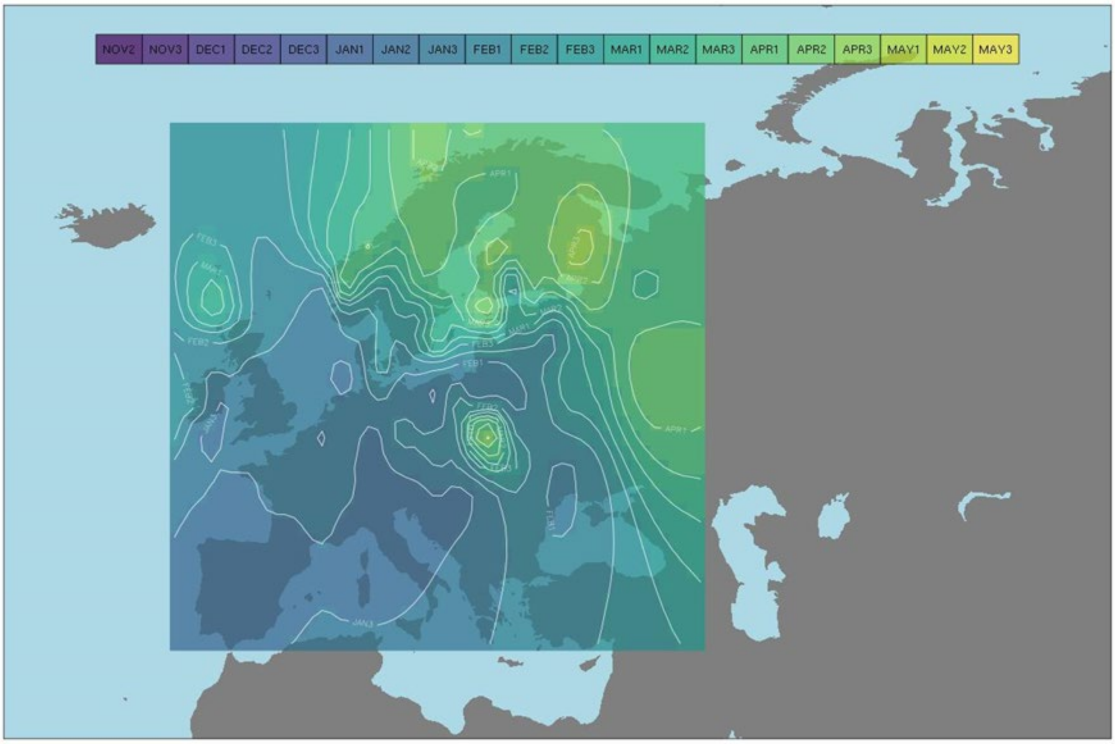


Fig. 3: Onset of pre-nuptial migration of Mew Gull. The map shows the date when 5% of individuals are on migration.

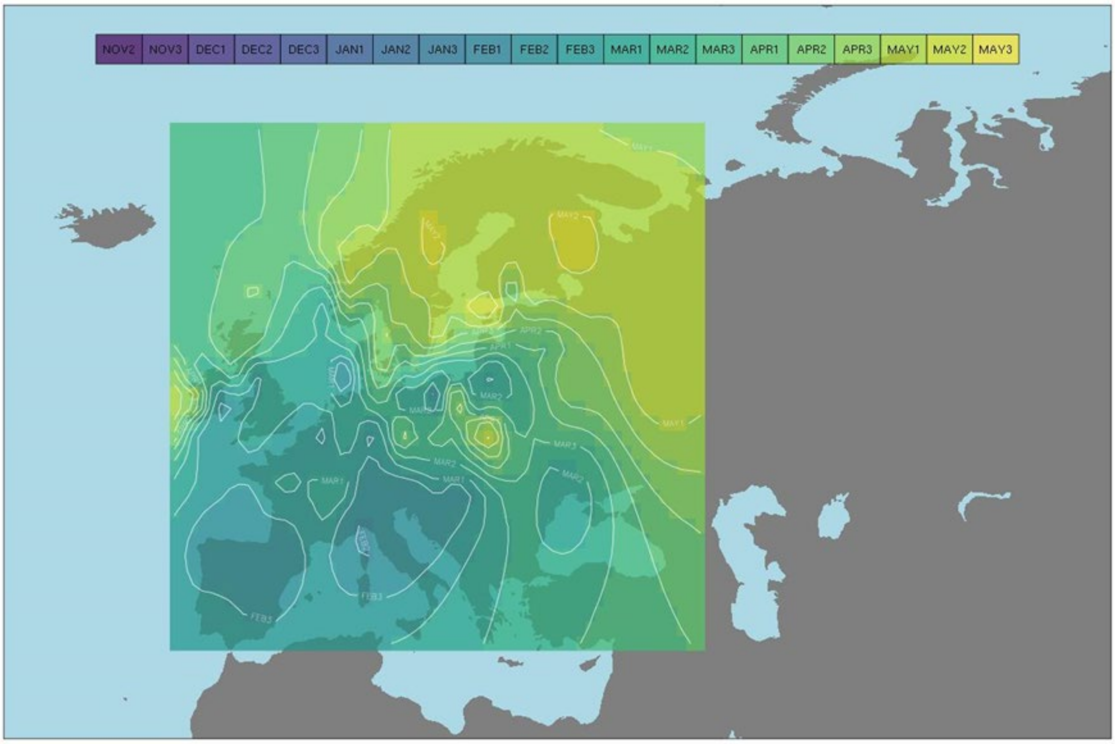
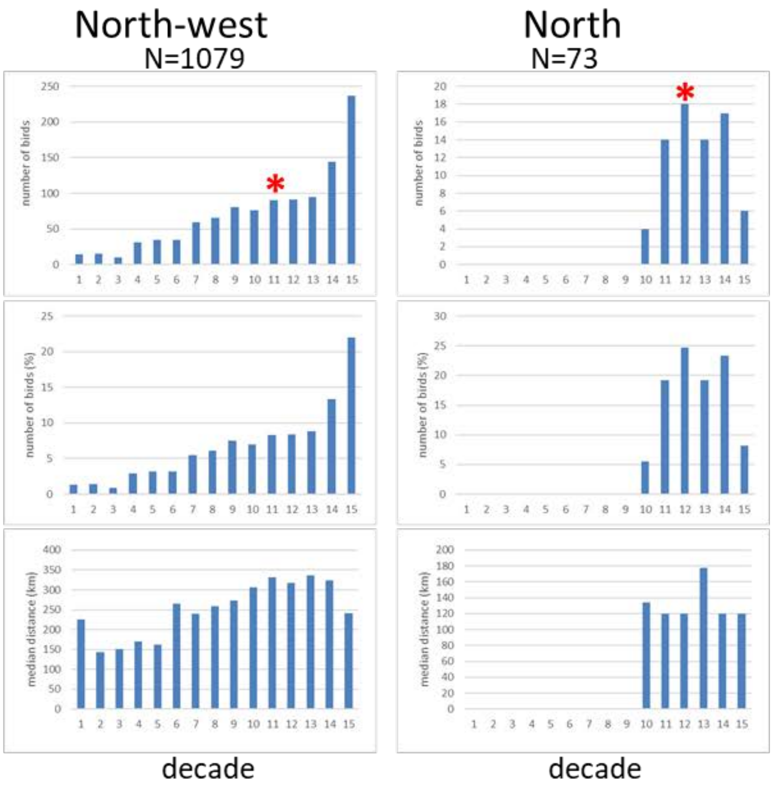
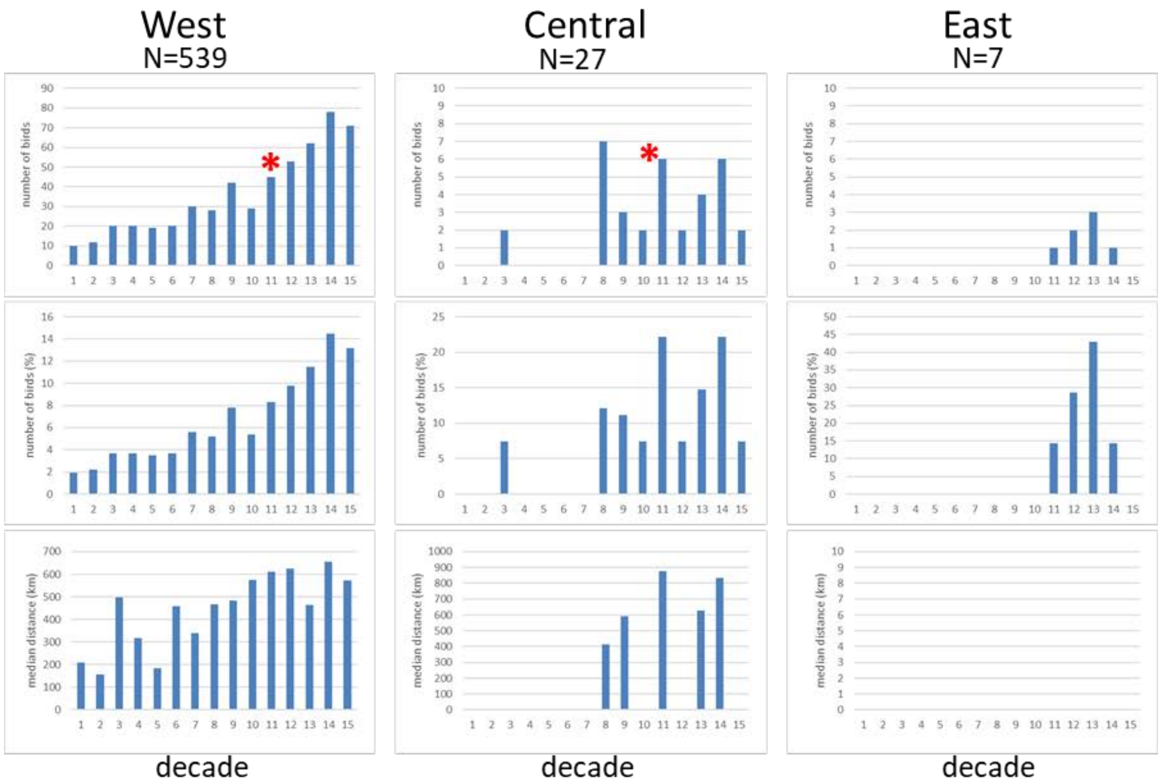


Fig. 4: Median migration date of pre-nuptial migration of Mew Gull. The map shows the date when 50% of individuals are on migration.

05910 Lesser Black-backed Gull *Larus fuscus*

Recovery analysis





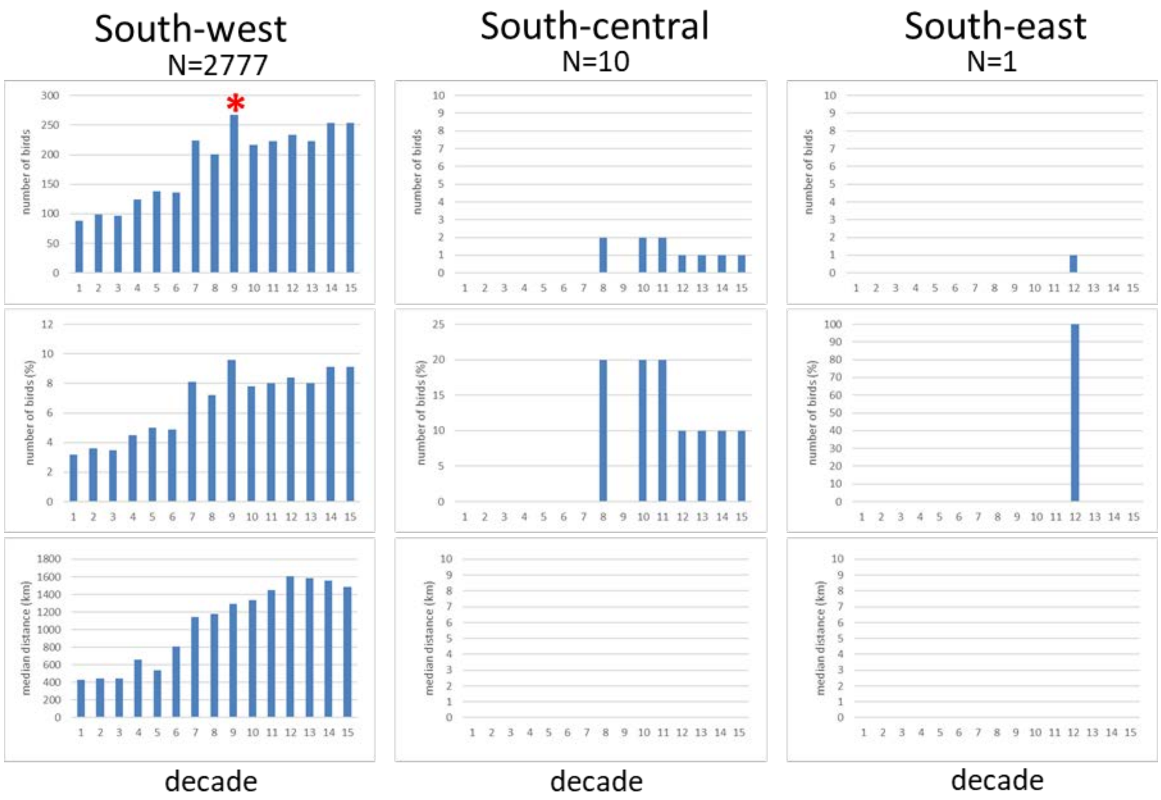


Fig. 1: Onset of prenuptial (return) migration of Lesser Black-backed Gull by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

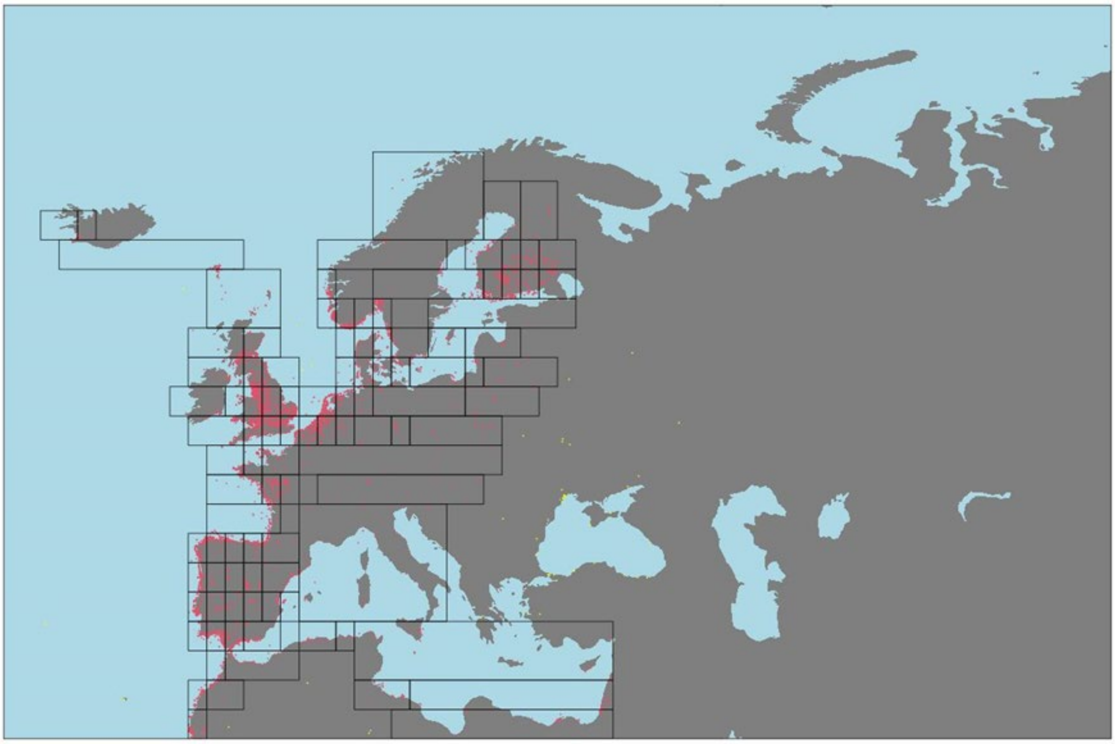


Fig. 2: Data availability for the analyses of Lesser Black-backed Gull pre-nuptial migration. Red dots: encounters used (116,842), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

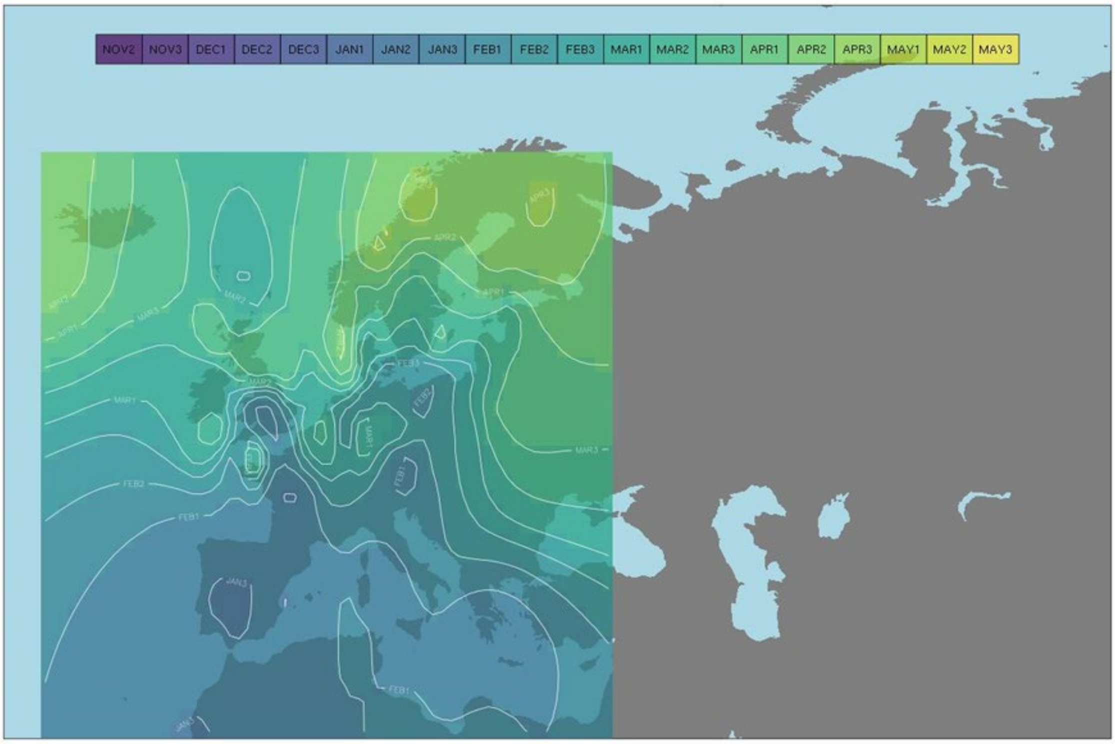


Fig. 3: Onset of pre-nuptial migration of Lesser Black-backed Gull. The map shows the date when 5% of individuals are on migration.

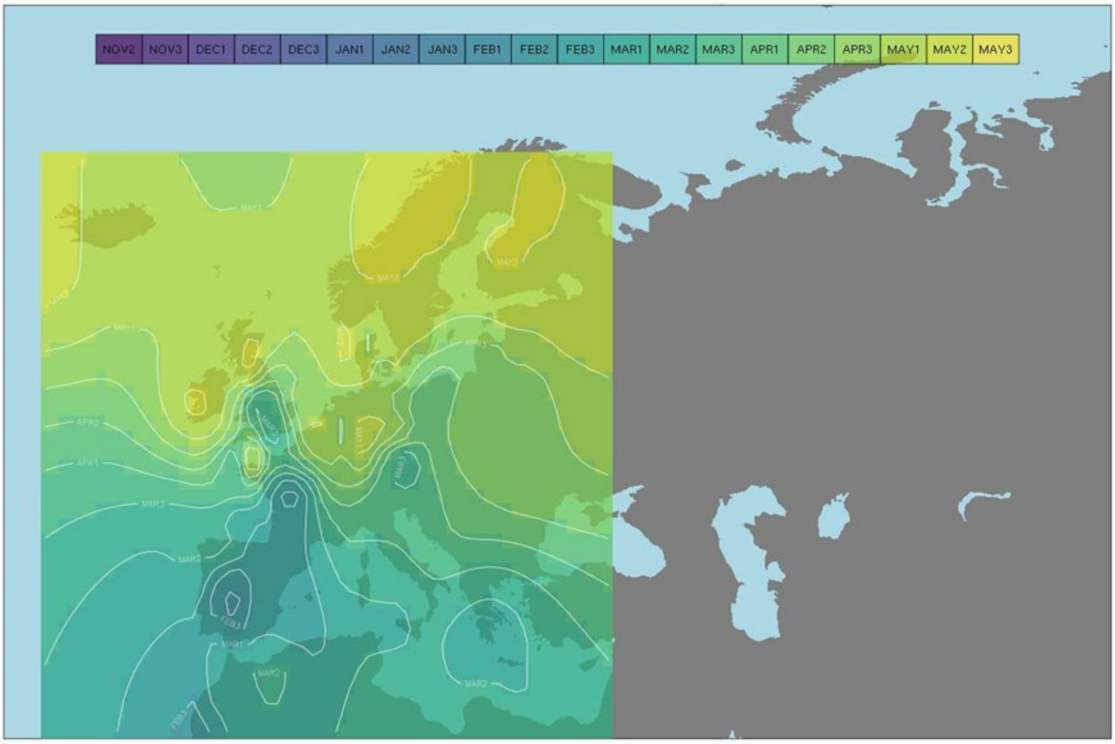
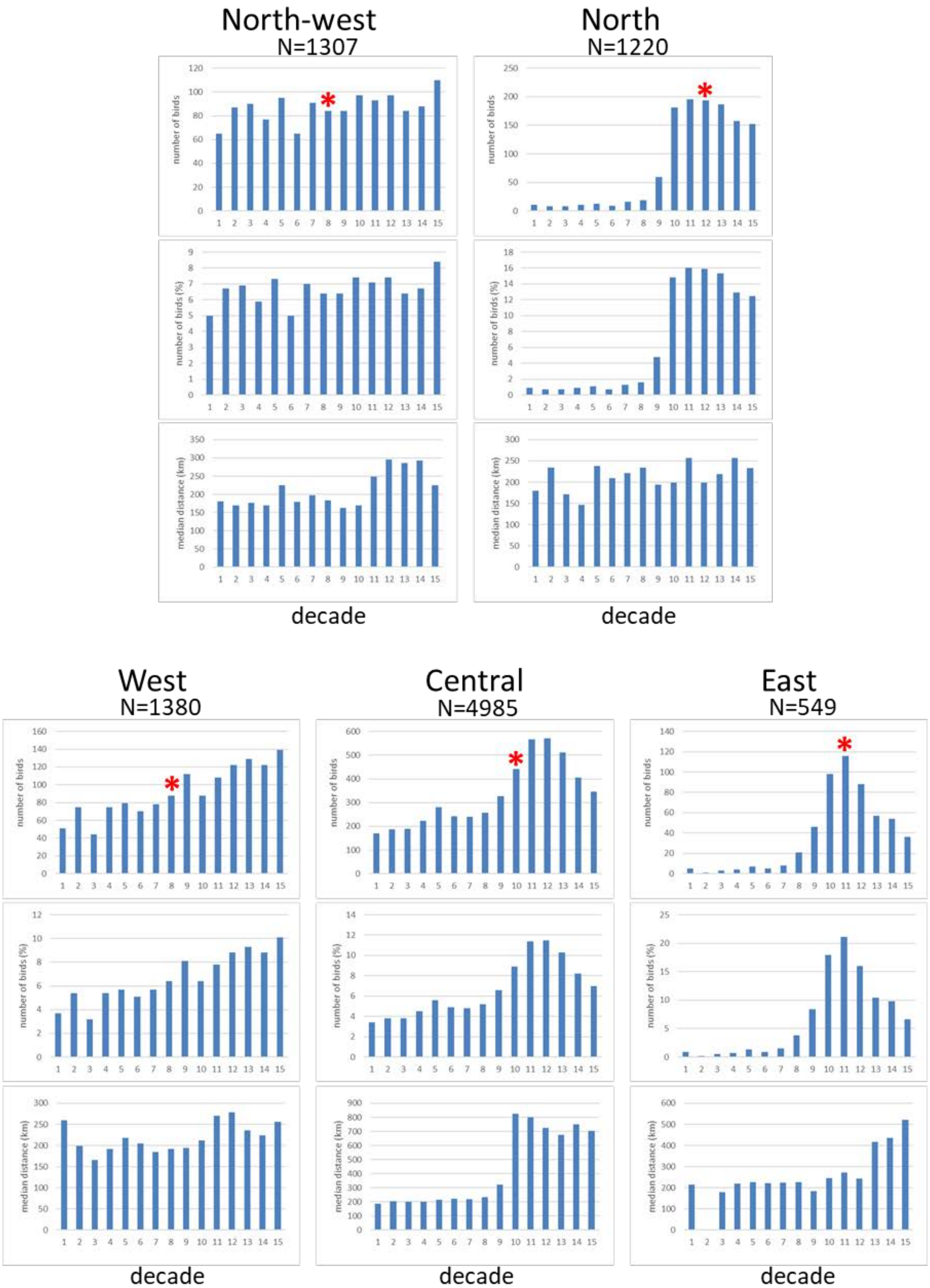


Fig. 4: Median migration date of pre-nuptial migration of Lesser Black-backed Gull. The map shows the date when 50% of individuals are on migration.

05920 Herring Gull *Larus argentatus*

Recovery analysis



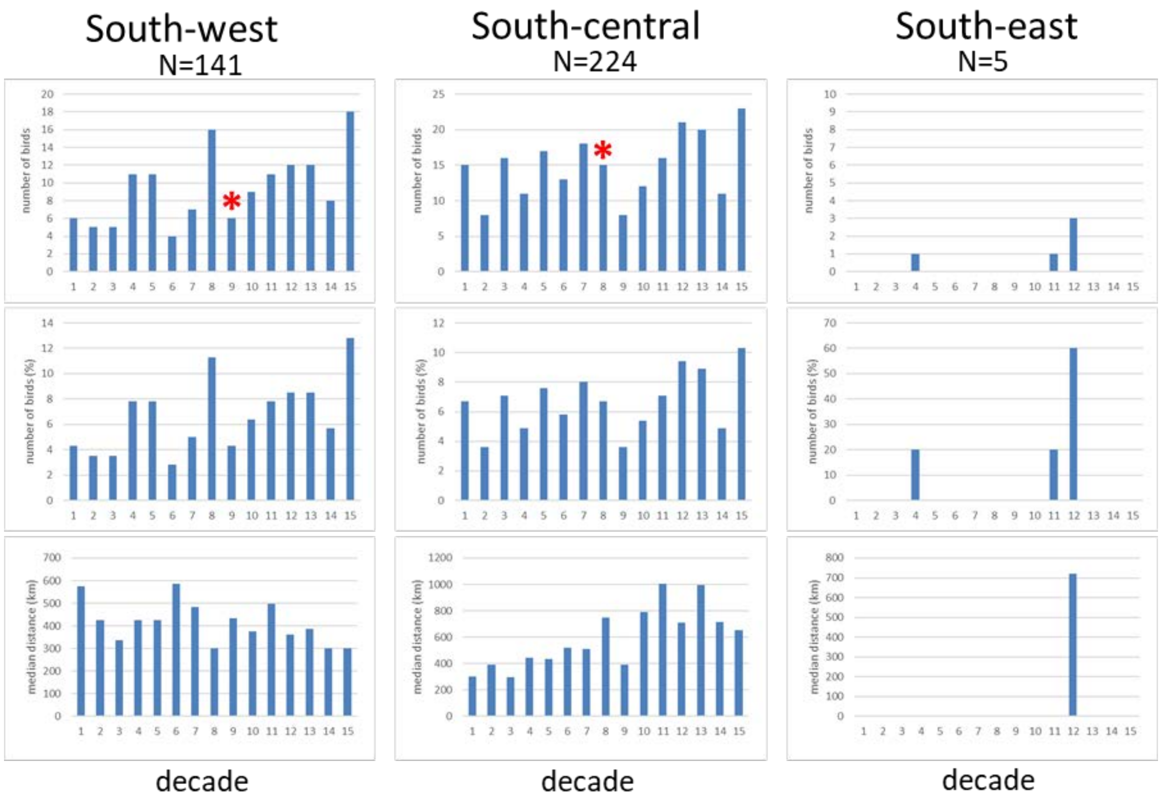


Fig. 1: Onset of prenuptial (return) migration of Herring Gull by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

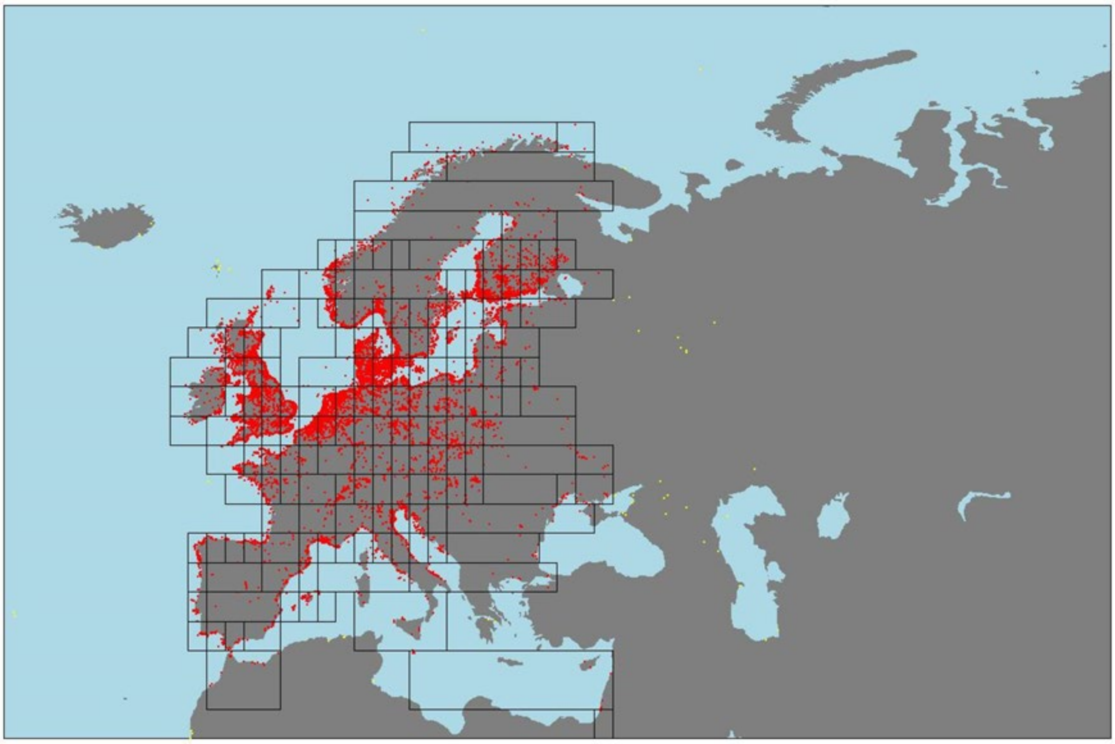


Fig. 2: Data availability for the analyses of Herring Gull pre-nuptial migration. Red dots: encounters used (285,135), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

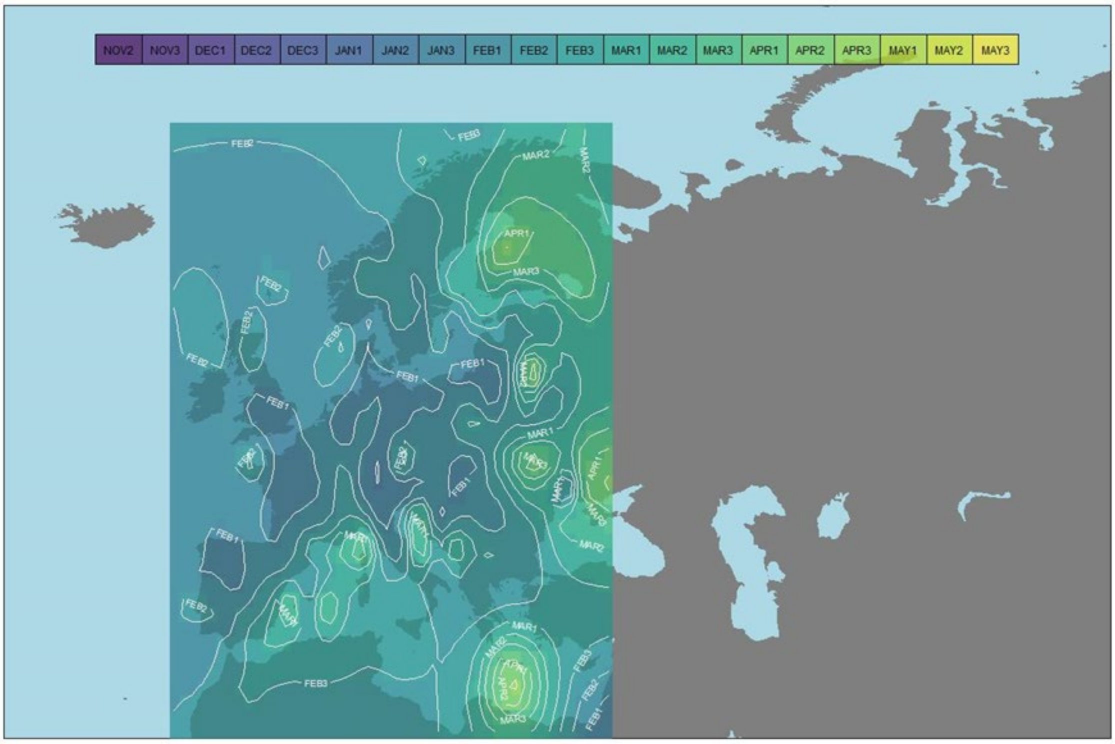


Fig. 3: Onset of pre-nuptial migration of Herring Gull. The map shows the date when 5% of individuals are on migration.

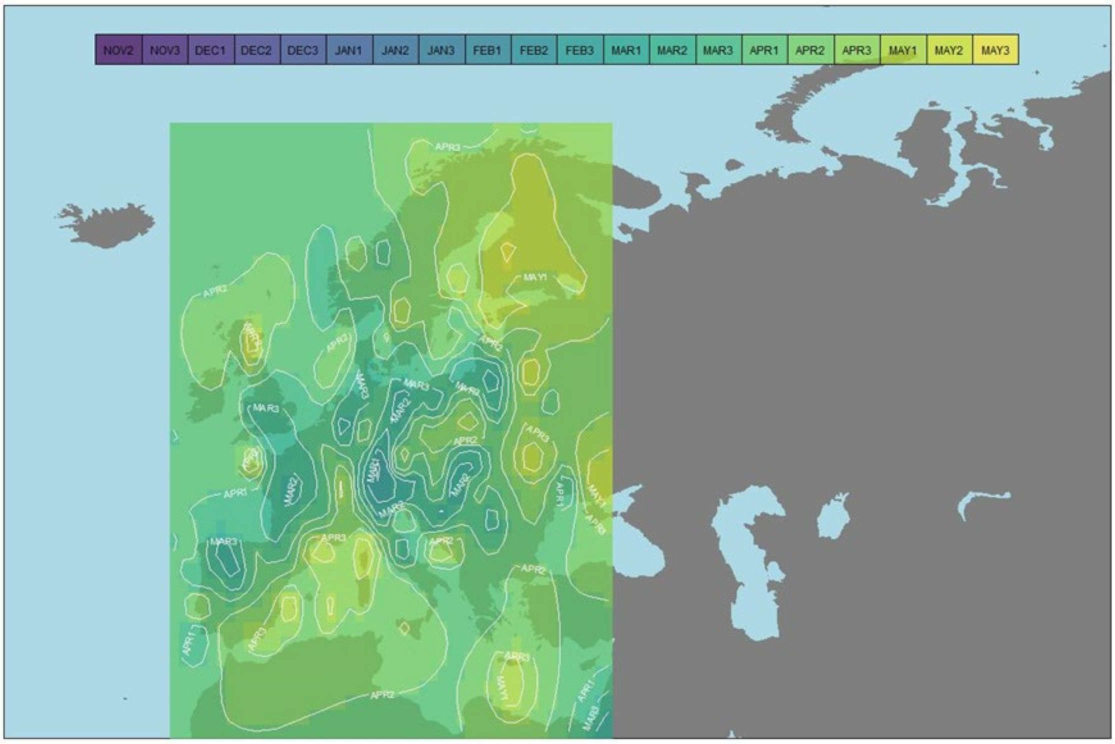
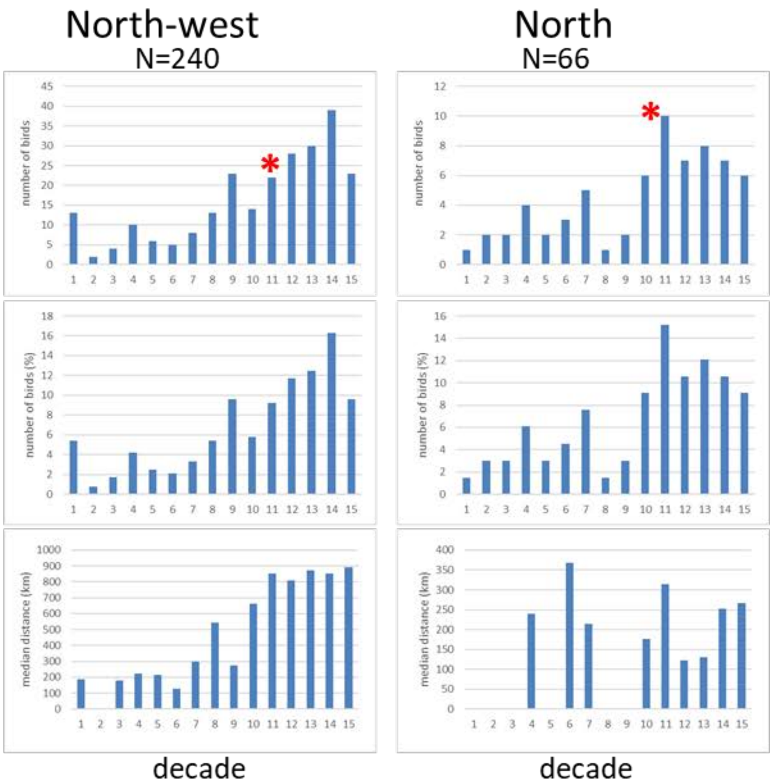
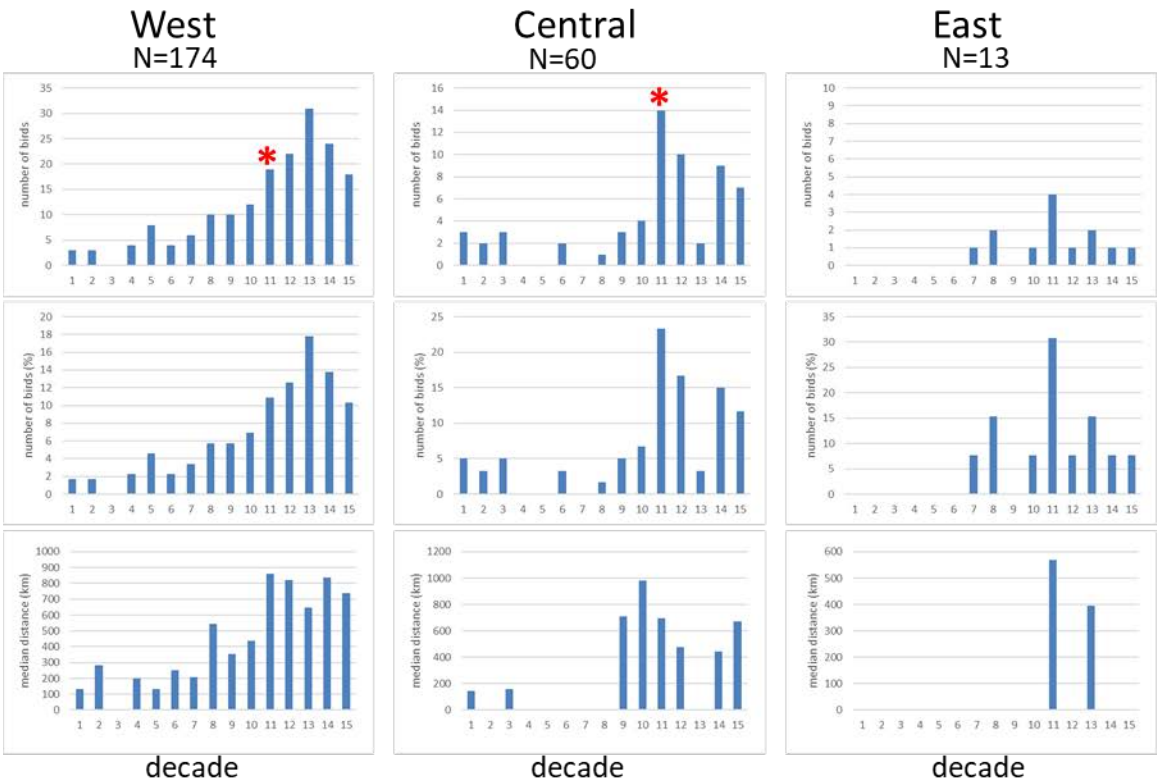


Fig. 4: Median migration date of pre-nuptial migration of Herring Gull. The map shows the date when 50% of individuals are on migration.

06000 Great Black-backed Gull *Larus marinus*

Recovery analysis





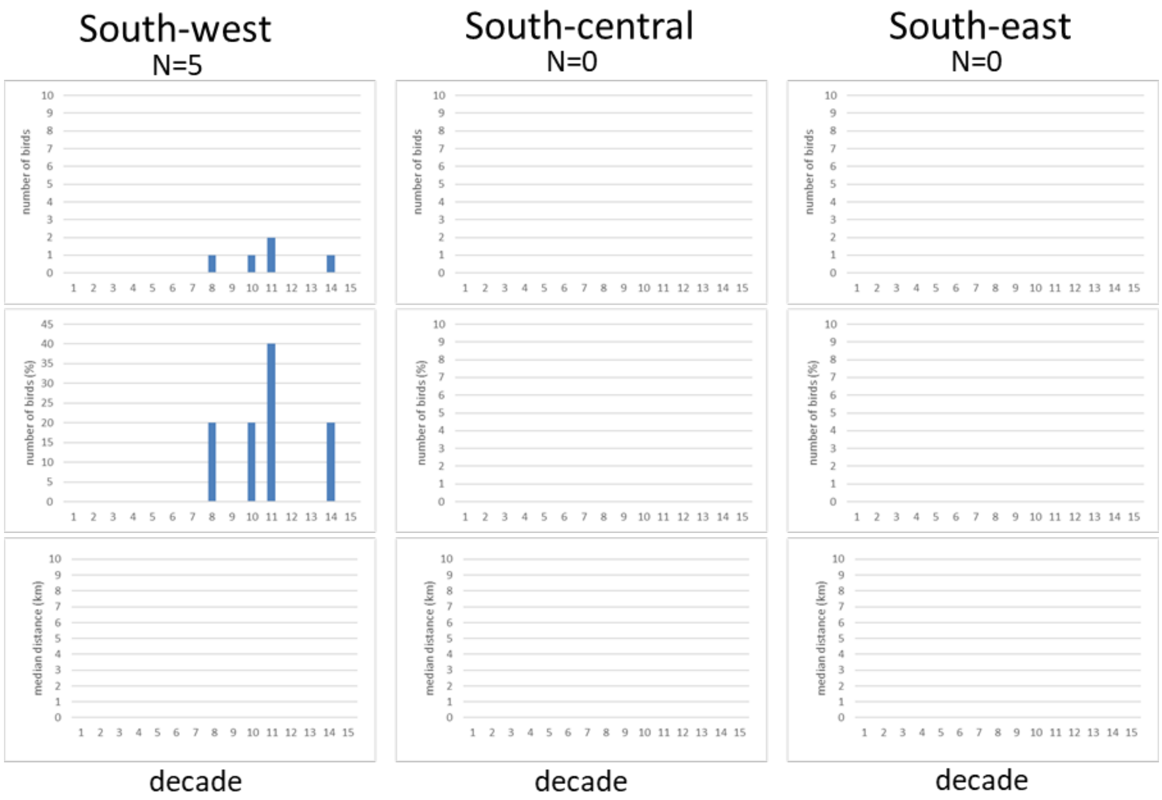


Fig. 1: Onset of prenuptial (return) migration of Great Black-backed Gull by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

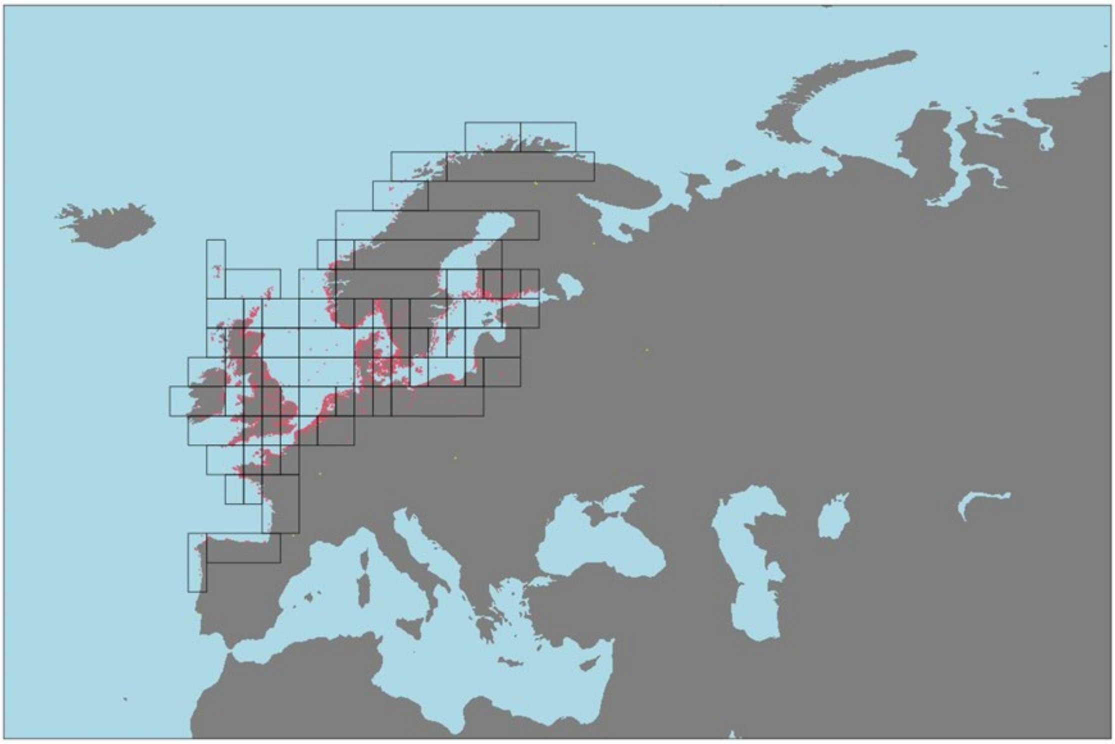


Fig. 2: Data availability for the analyses of Great Black-backed Gull pre-nuptial migration. Red dots: encounters used (23,382), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

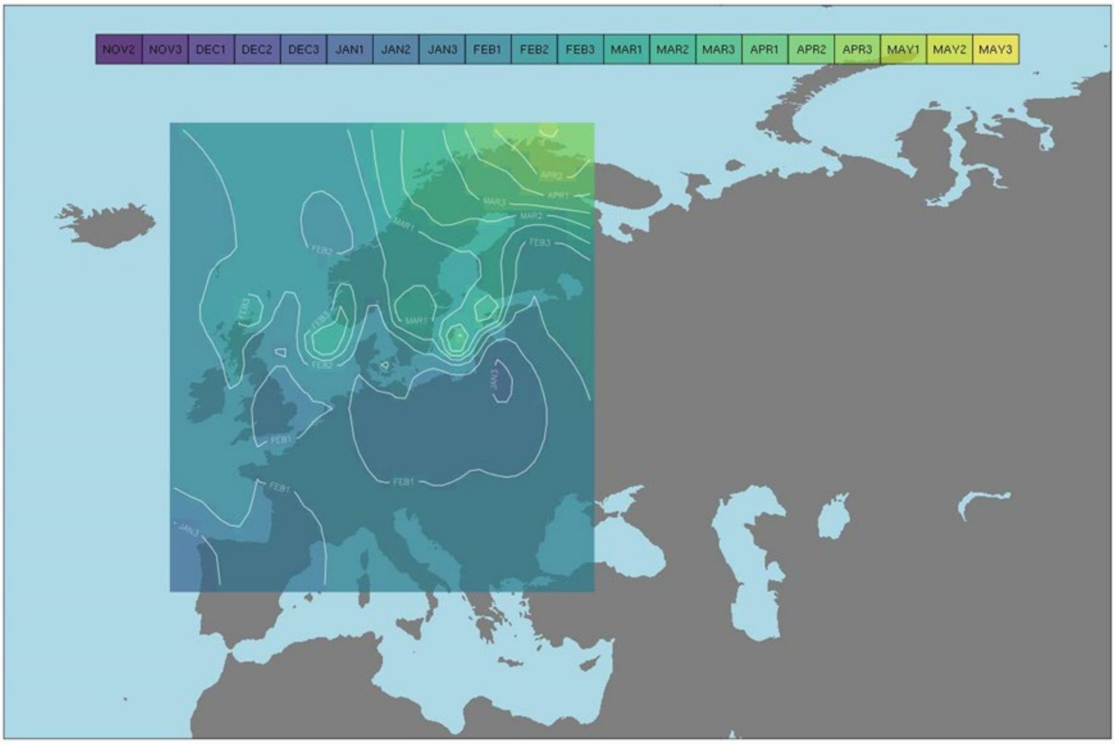


Fig. 3: Onset of pre-nuptial migration of Great Black-backed Gull. The map shows the date when 5% of individuals are on migration.

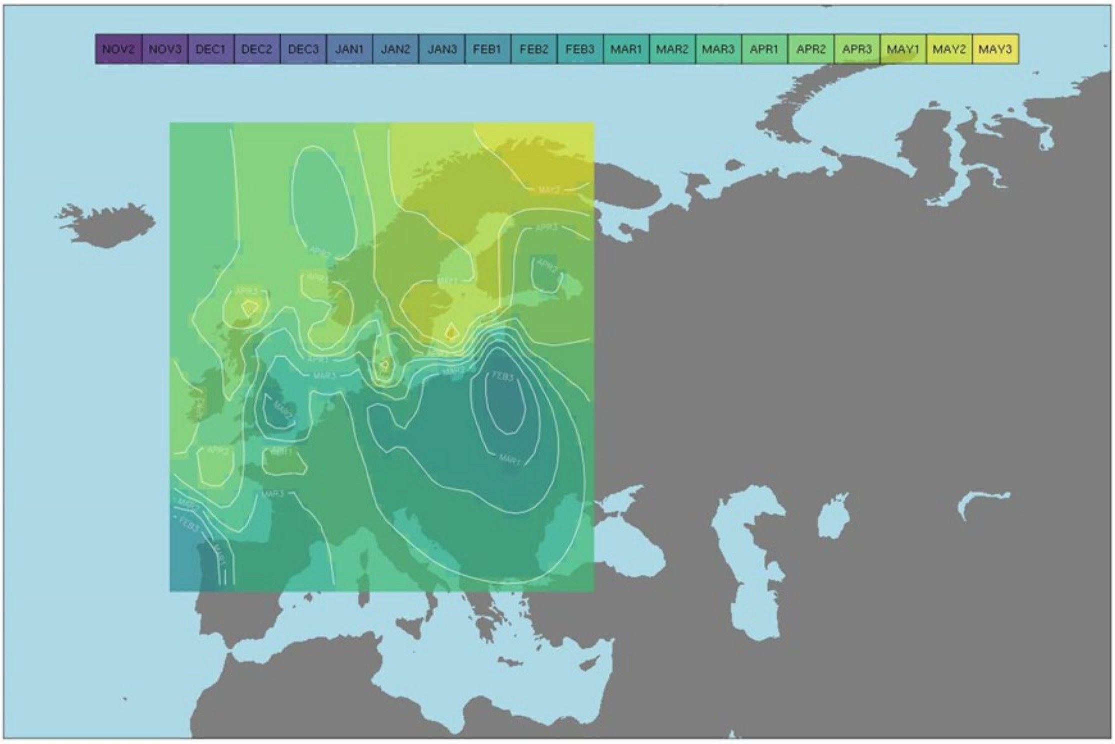


Fig. 4: Median migration date of pre-nuptial migration of Great Black-backed Gull. The map shows the date when 50% of individuals are on migration.

06680 Stock Dove *Columba oenas*

Recovery analysis

No data for recovery analysis.

Mapping analysis

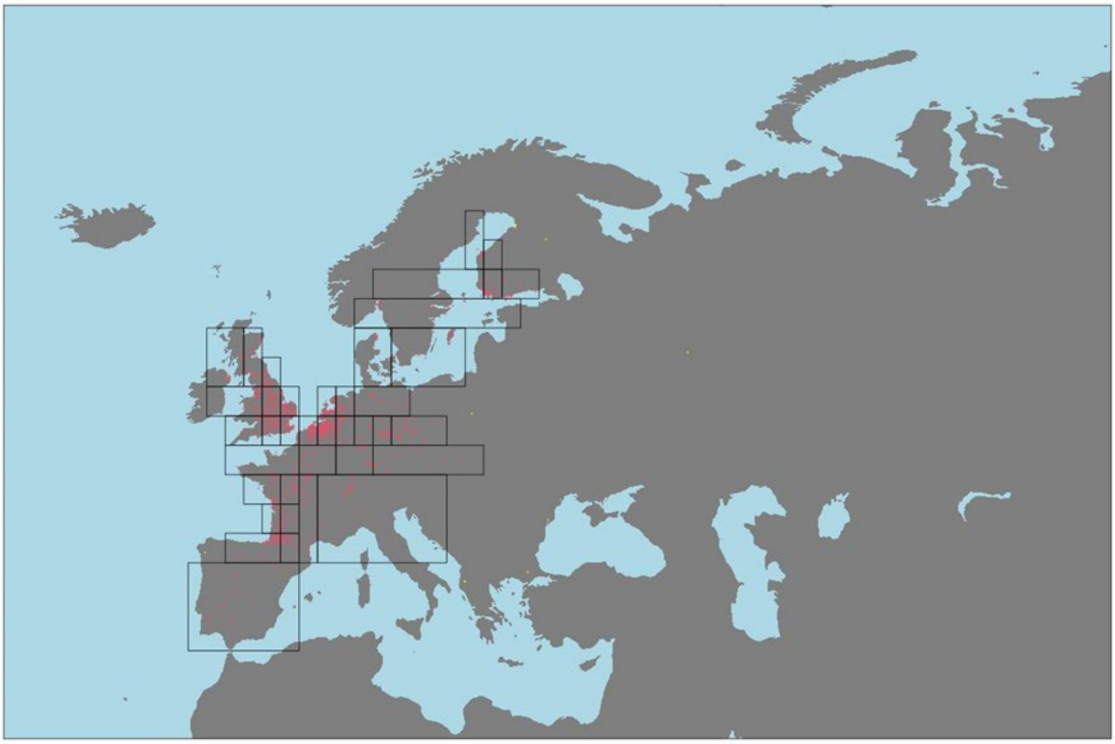


Fig. 2: Data availability for the analyses of Stock Dove pre-nuptial migration. Red dots: encounters used (4072), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

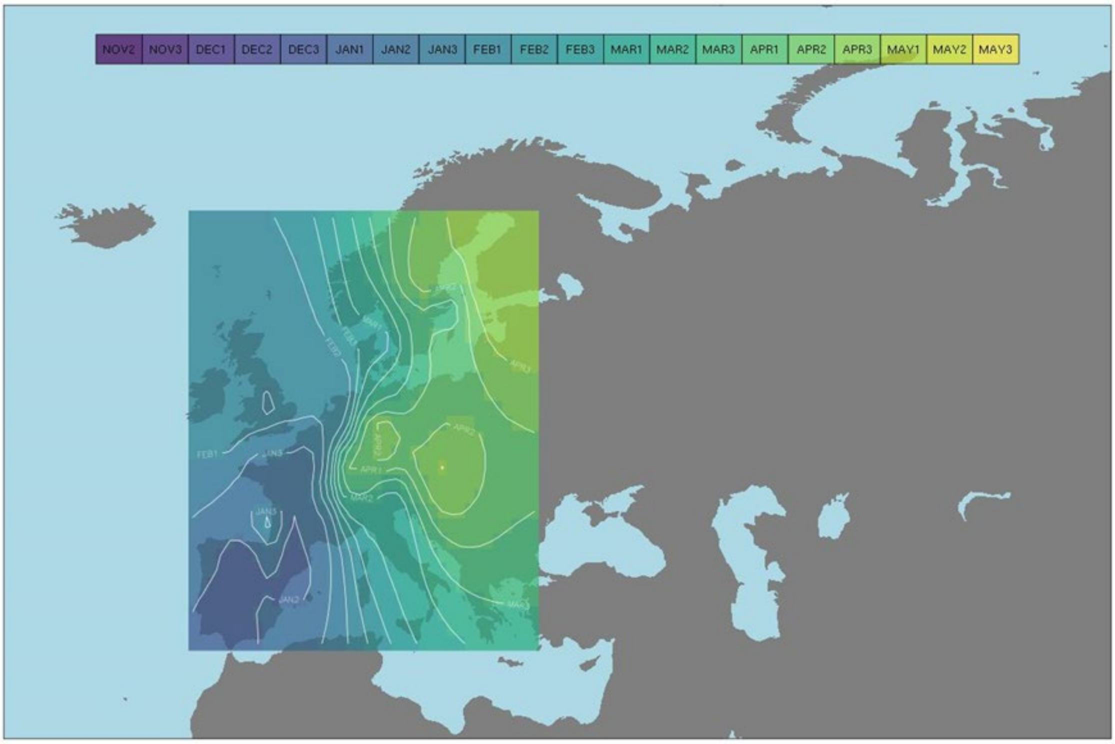


Fig. 3: Onset of pre-nuptial migration of Stock Dove. The map shows the date when 5% of individuals are on migration.

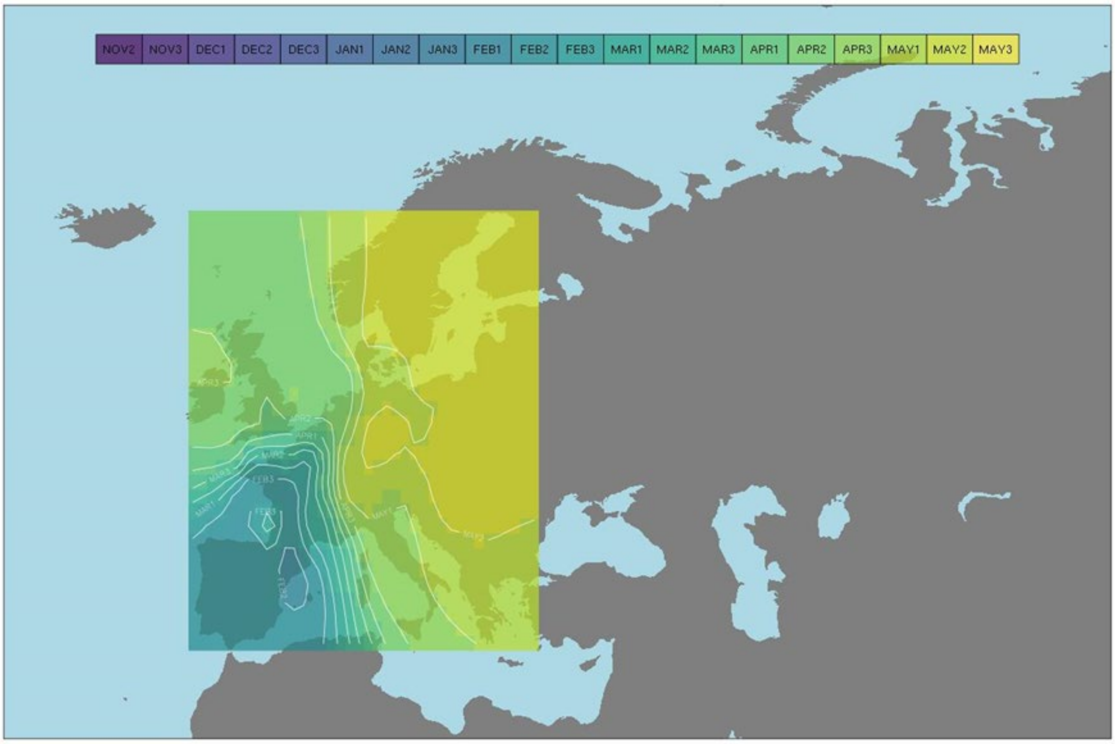
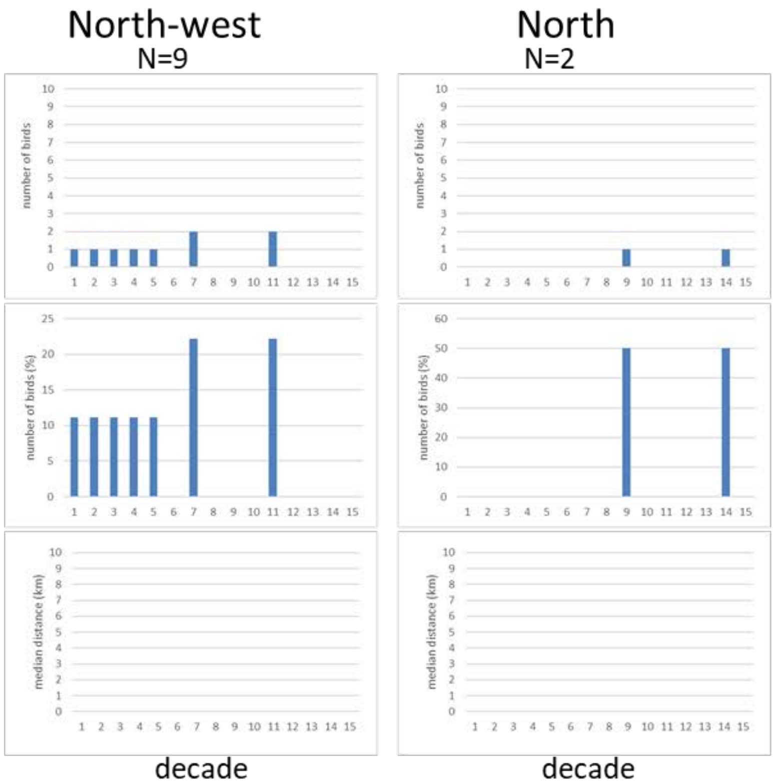
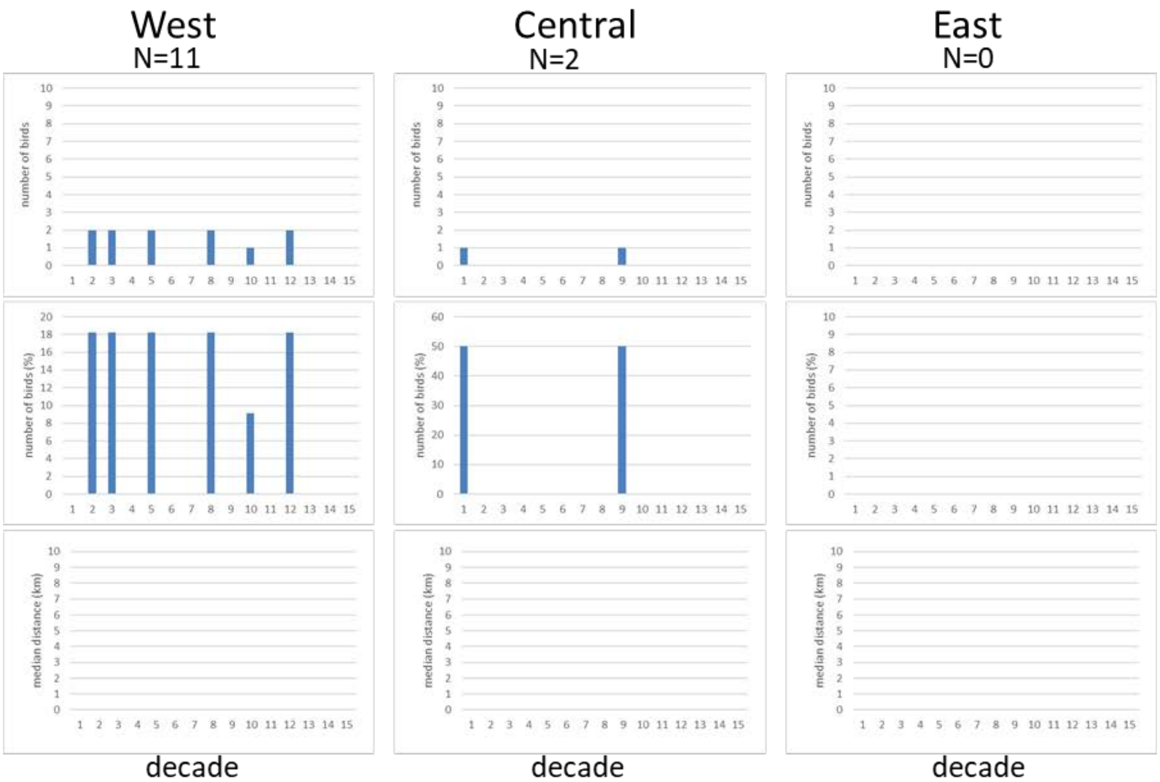


Fig. 4: Median migration date of pre-nuptial migration of Stock Dove. The map shows the date when 50% of individuals are on migration.

06700 Common Wood Pigeon *Columba palumbus*

Recovery analysis





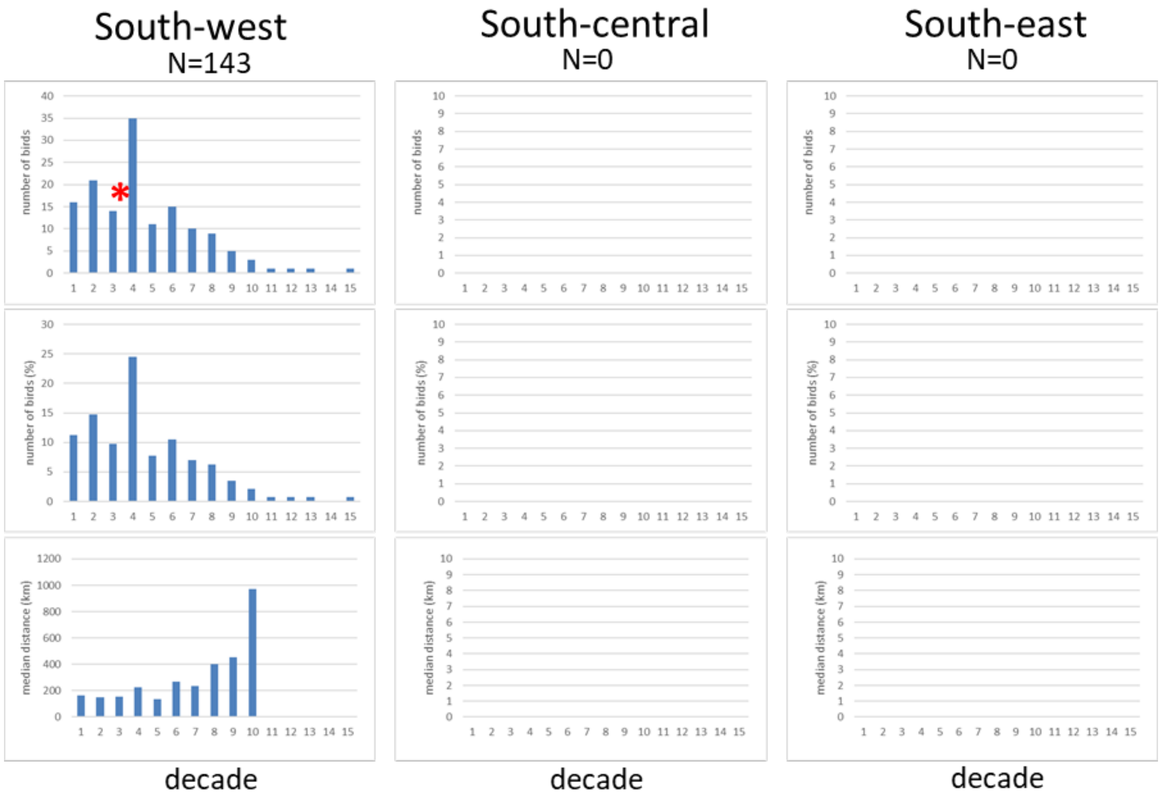


Fig. 1: Onset of prenuptial (return) migration of Common Wood Pigeon by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

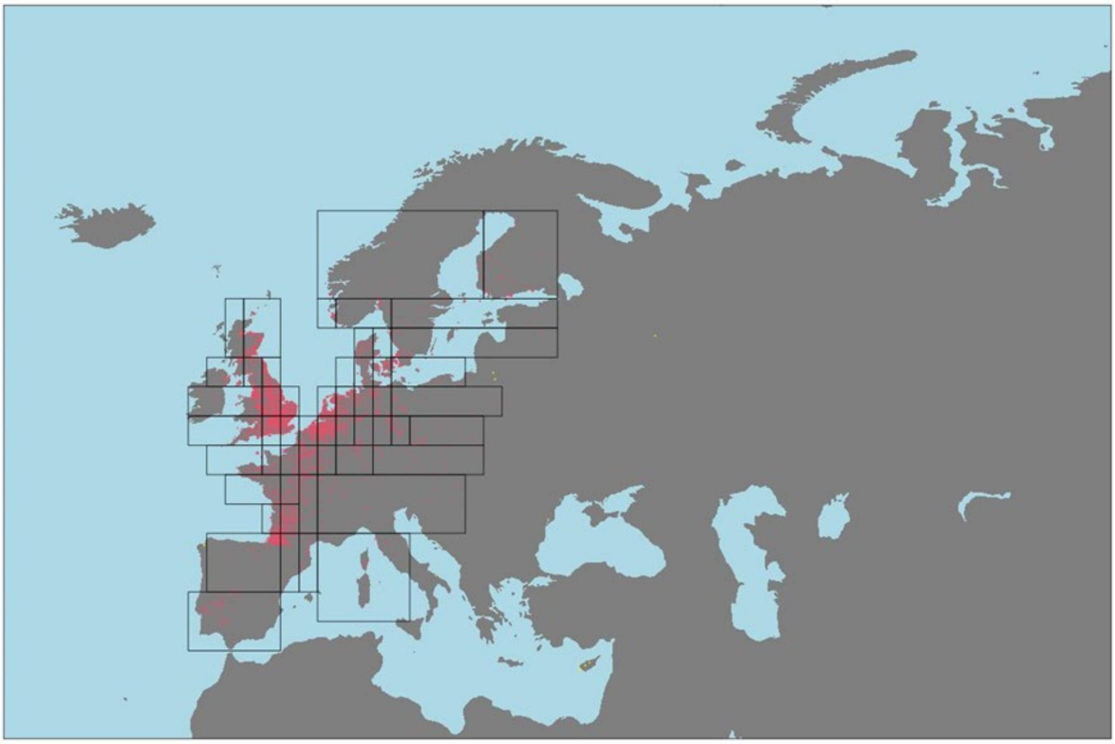


Fig. 2: Data availability for the analyses of Common Wood Pigeon pre-nuptial migration. Red dots: encounters used (9363), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

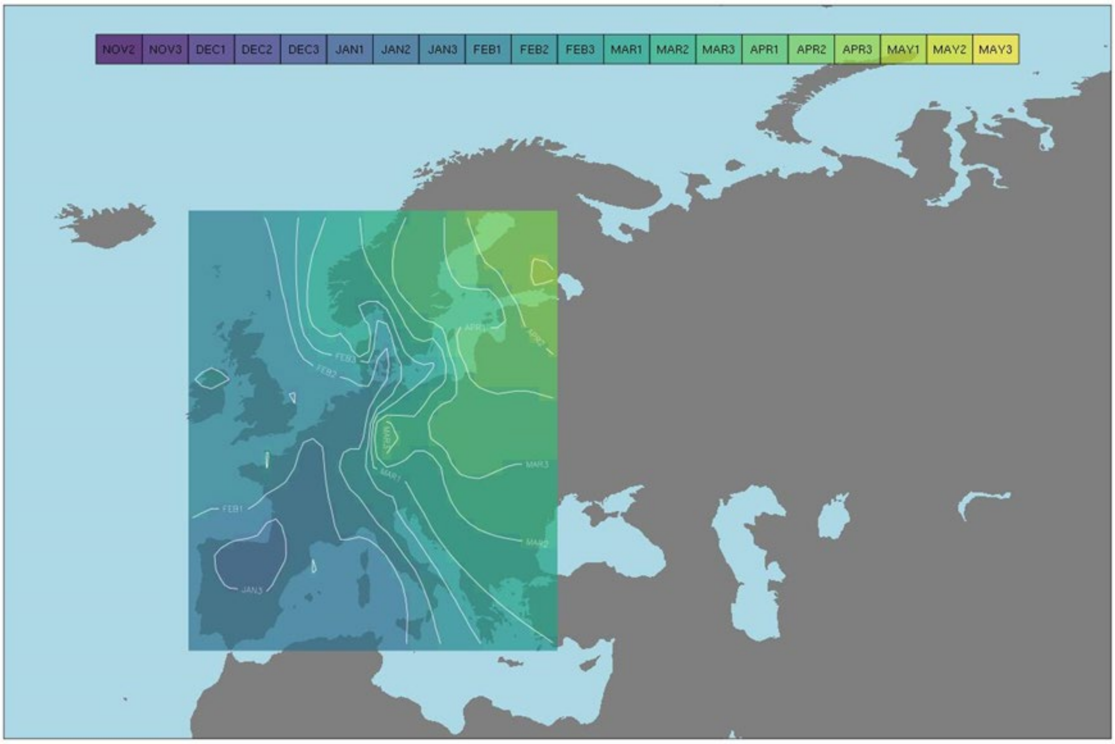


Fig. 3: Onset of pre-nuptial migration of Common Wood Pigeon. The map shows the date when 5% of individuals are on migration.

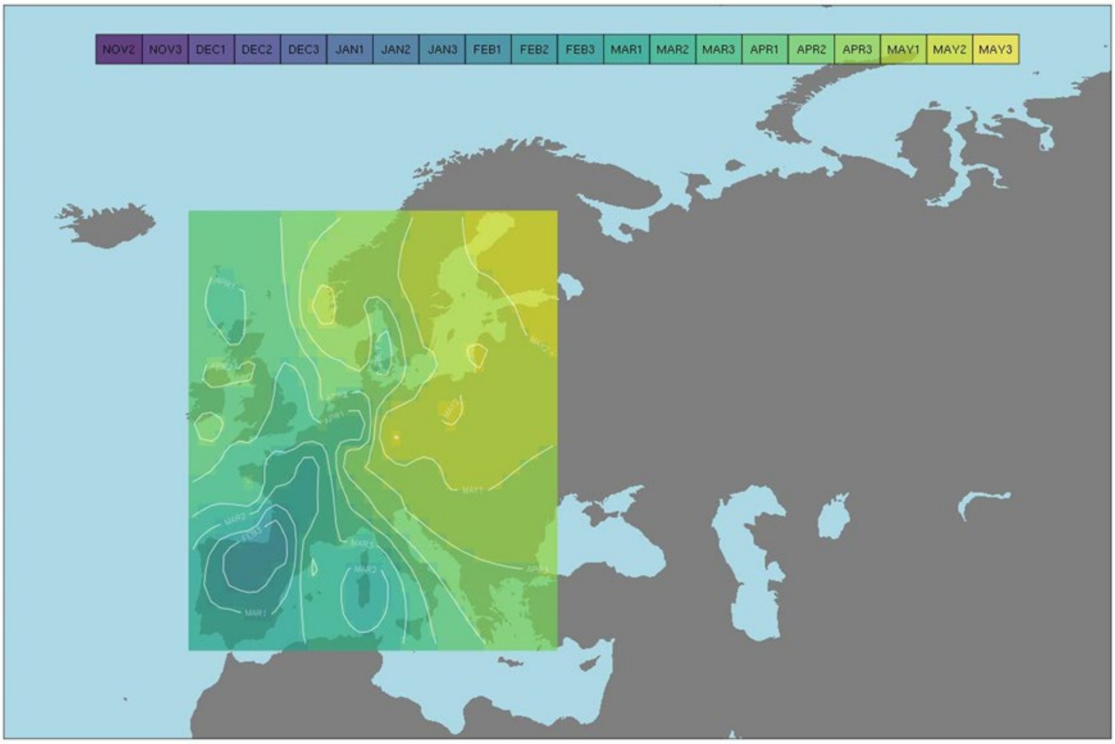


Fig. 4: Median migration date of pre-nuptial migration of Common Wood Pigeon. The map shows the date when 50% of individuals are on migration.

06840 Eurasian Collared Dove *Streptopelia decaocto*

Recovery analysis

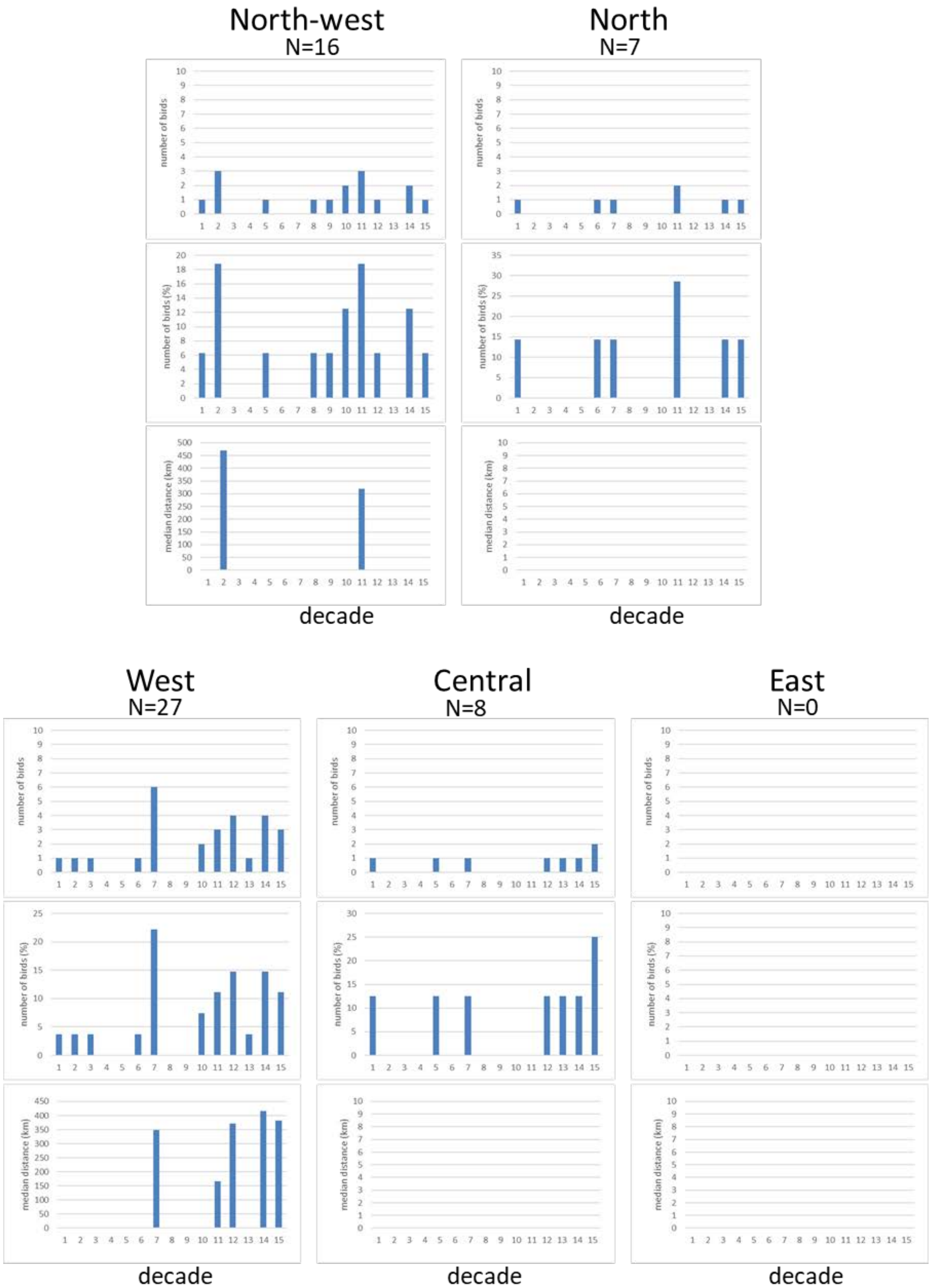


Fig. 1: Onset of prenuptial (return) migration of Eurasian Collared Dove by geographical region and decade. No data for South-west, South-central, South-east.

Mapping analysis

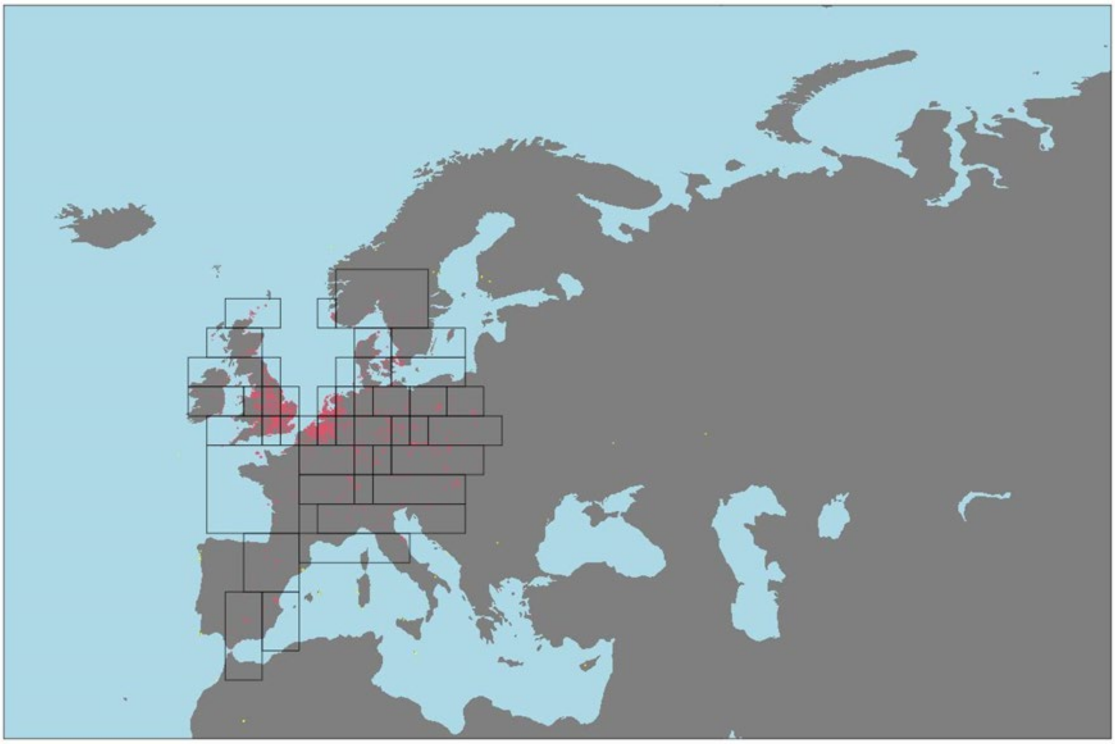


Fig. 2: Data availability for the analyses of Eurasian Collared Dove pre-nuptial migration. Red dots: encounters used (8981), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

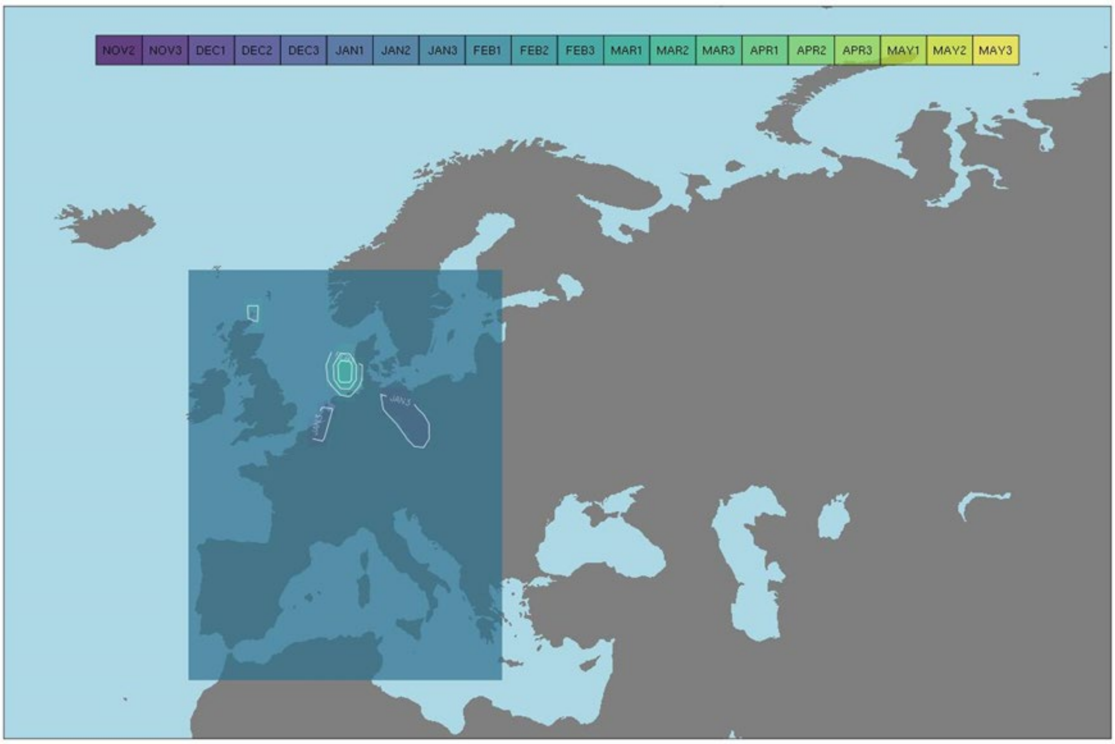


Fig. 3: Onset of pre-nuptial migration of Eurasian Collared Dove. The map shows the date when 5% of individuals are on migration.

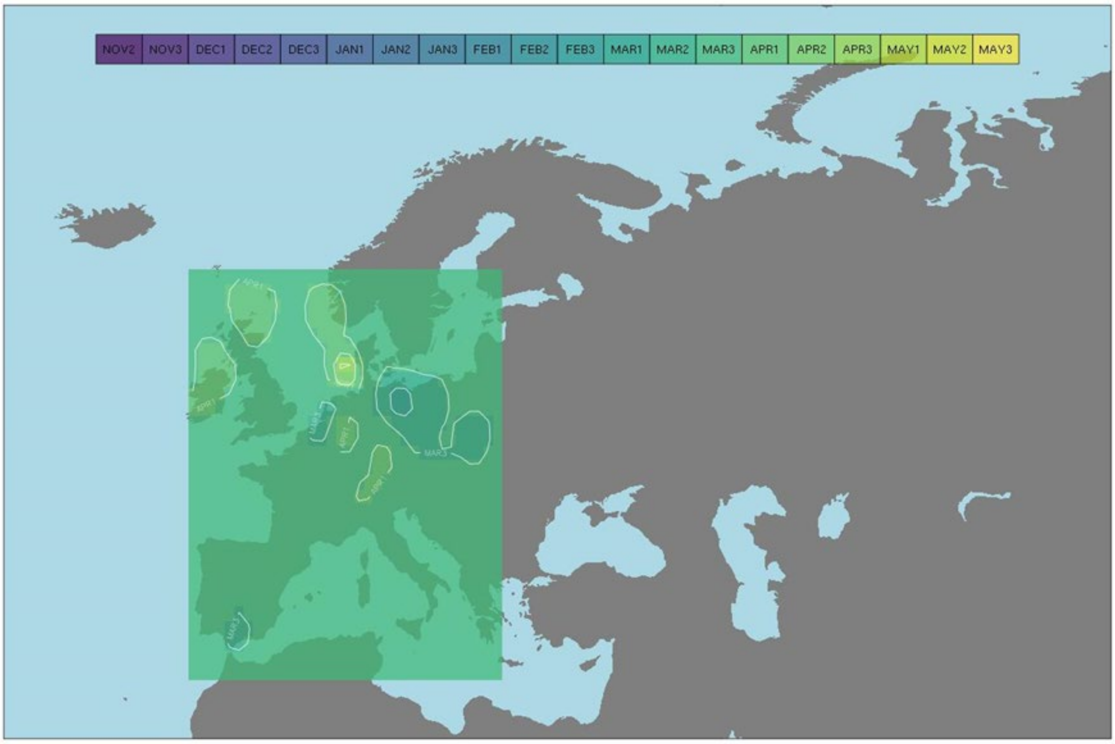


Fig. 4: Median migration date of pre-nuptial migration of Eurasian Collared Dove. The map shows the date when 50% of individuals are on migration.

06870 European Turtle Dove *Columba turtur*

Recovery analysis

No data for recovery analysis.

Mapping analysis

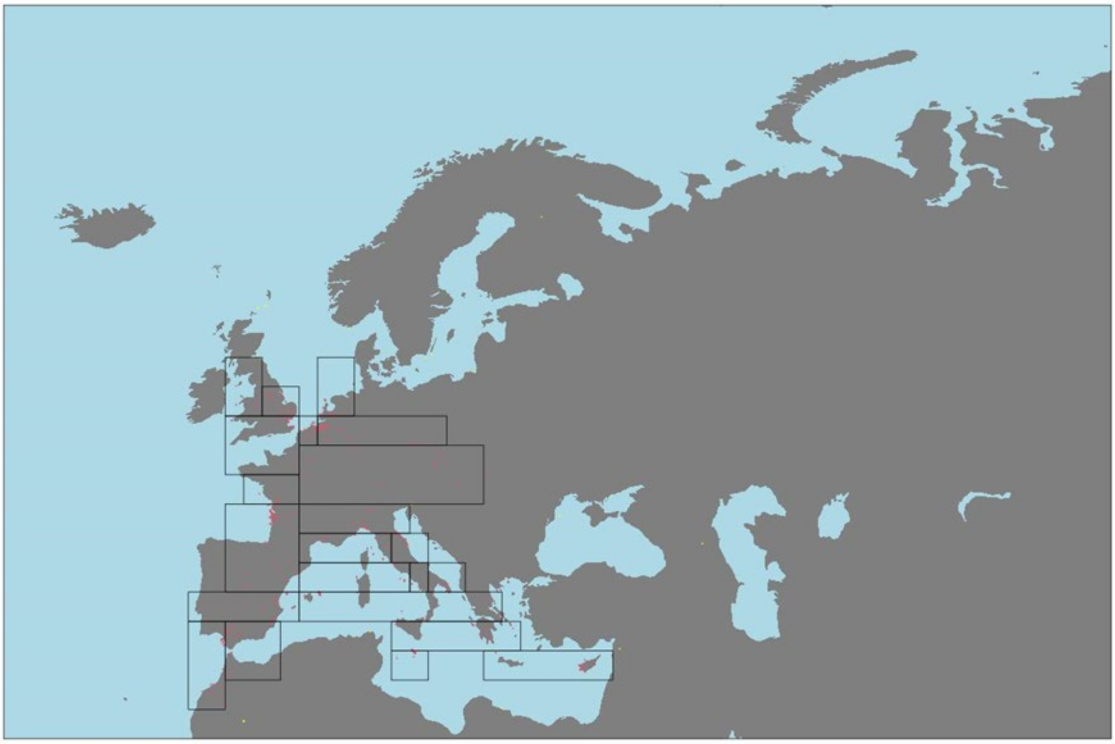


Fig. 2: Data availability for the analyses of European Turtle Dove pre-nuptial migration. Red dots: encounters used (1125), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

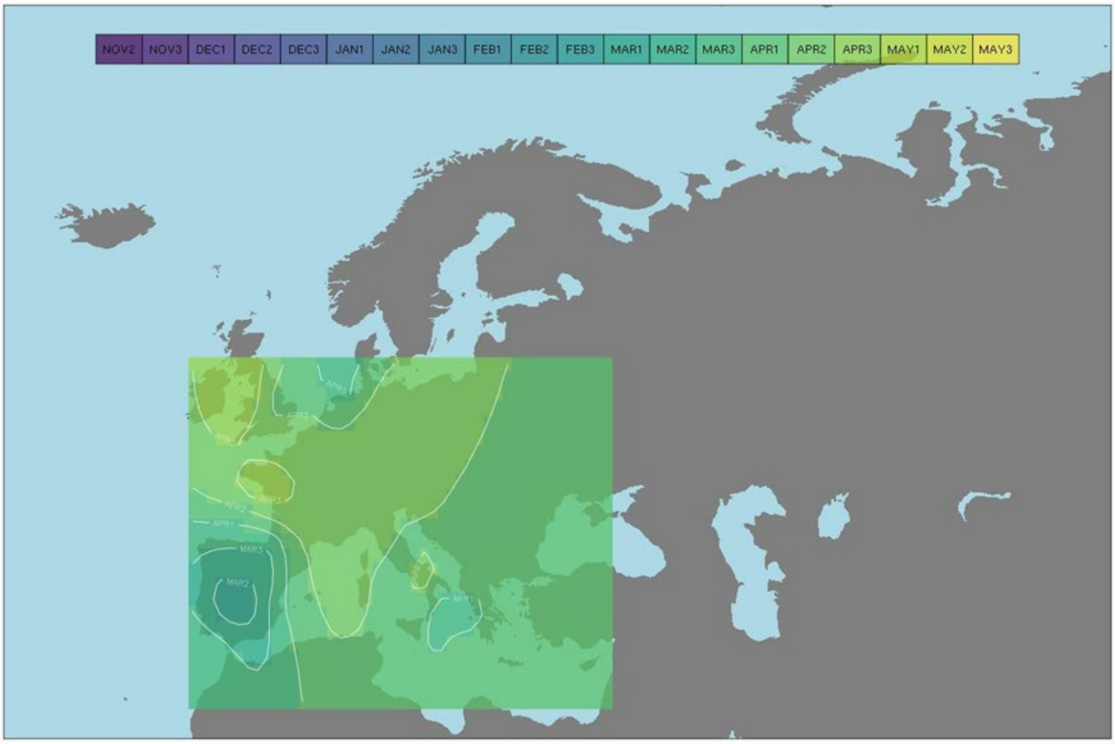


Fig. 3: Onset of pre-nuptial migration of European Turtle Dove. The map shows the date when 5% of individuals are on migration.

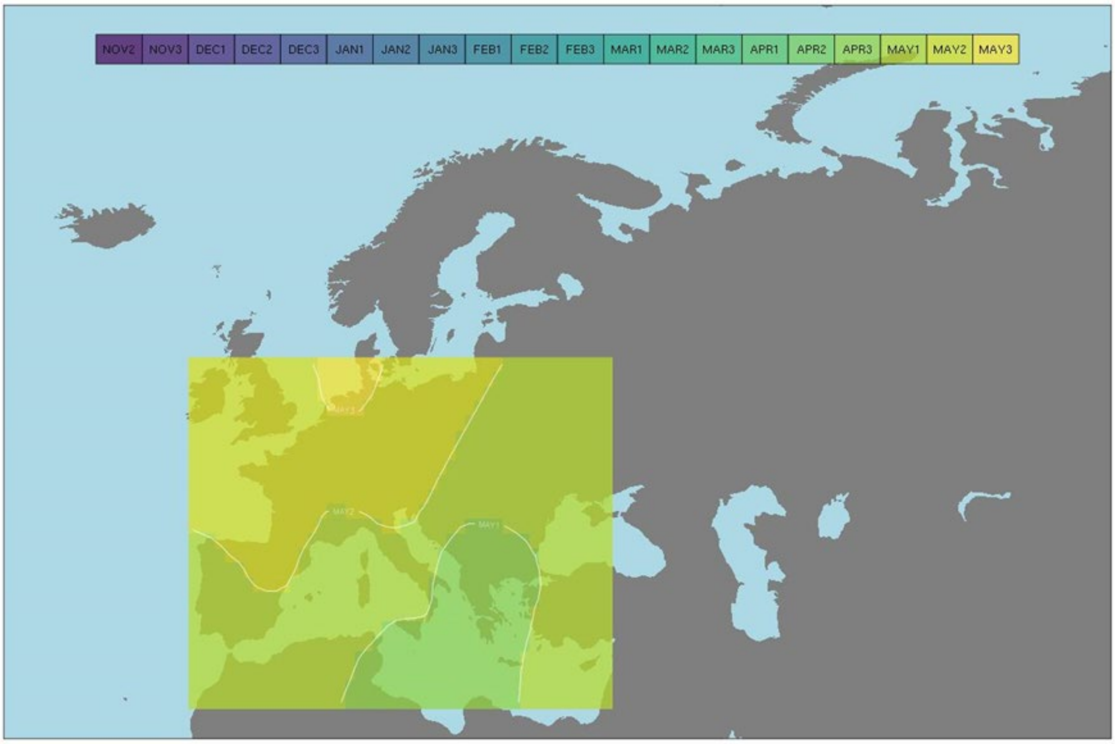
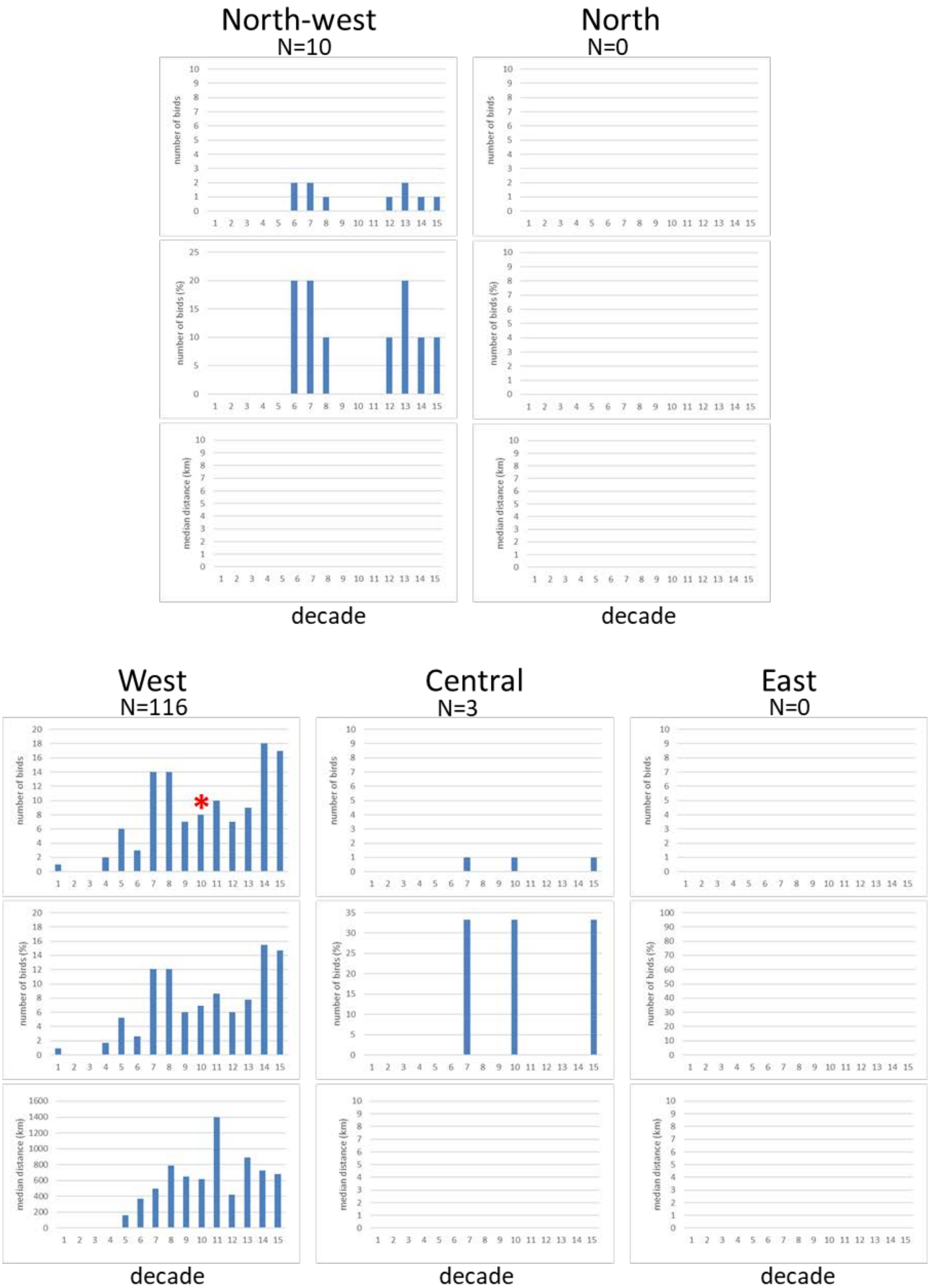


Fig. 4: Median migration date of pre-nuptial migration of European Turtle Dove. The map shows the date when 50% of individuals are on migration.

09760 Eurasian Skylark *Alauda arvensis*

Recovery analysis



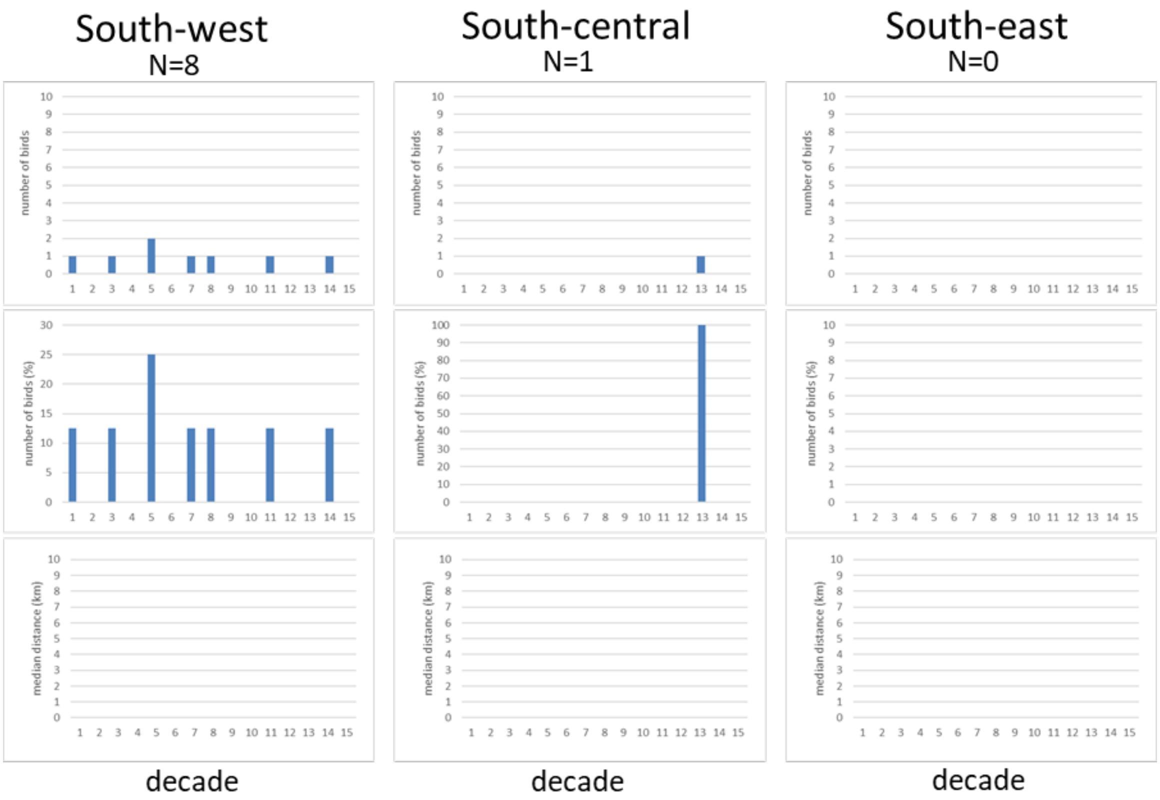


Fig. 1: Onset of prenuptial (return) migration of Eurasian Skylark by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

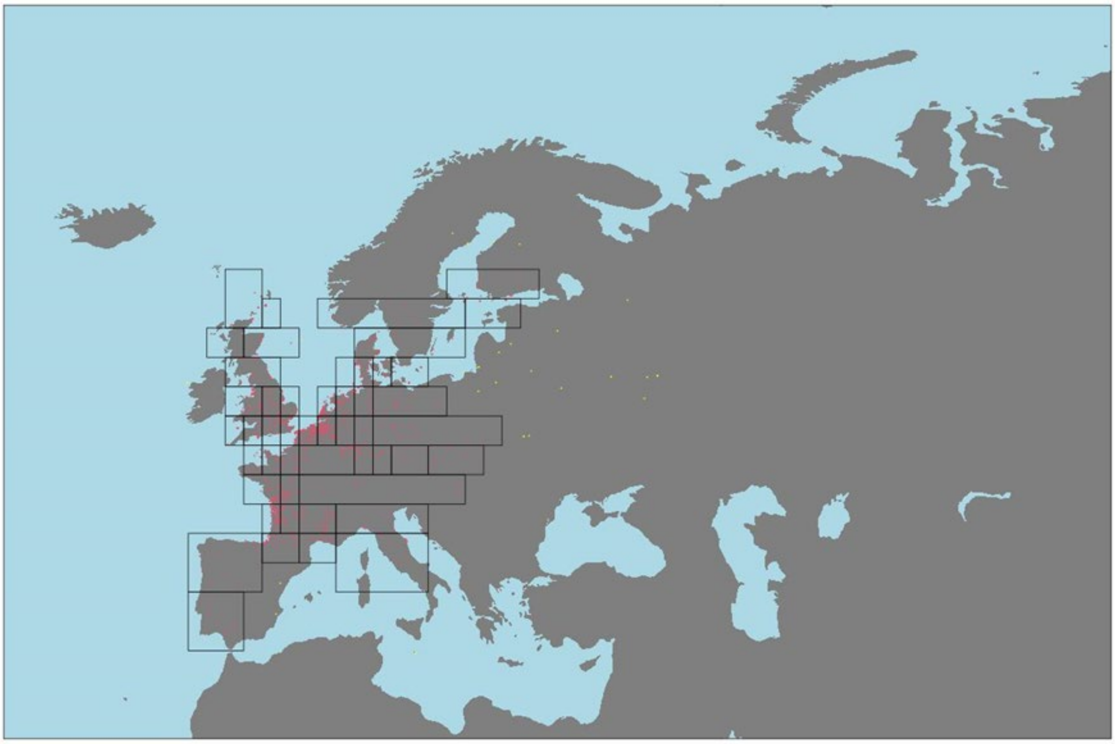


Fig. 2: Data availability for the analyses of Eurasian Skylark pre-nuptial migration. Red dots: encounters used (3526), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

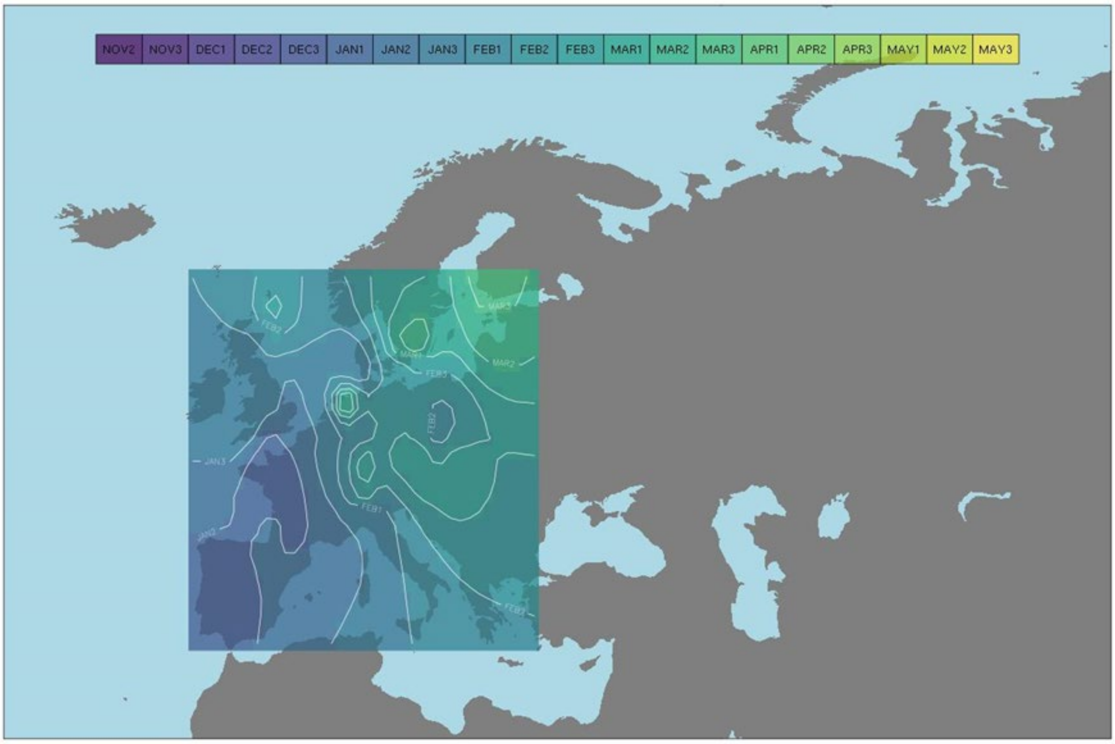


Fig. 3: Onset of pre-nuptial migration of Eurasian Skylark. The map shows the date when 5% of individuals are on migration.

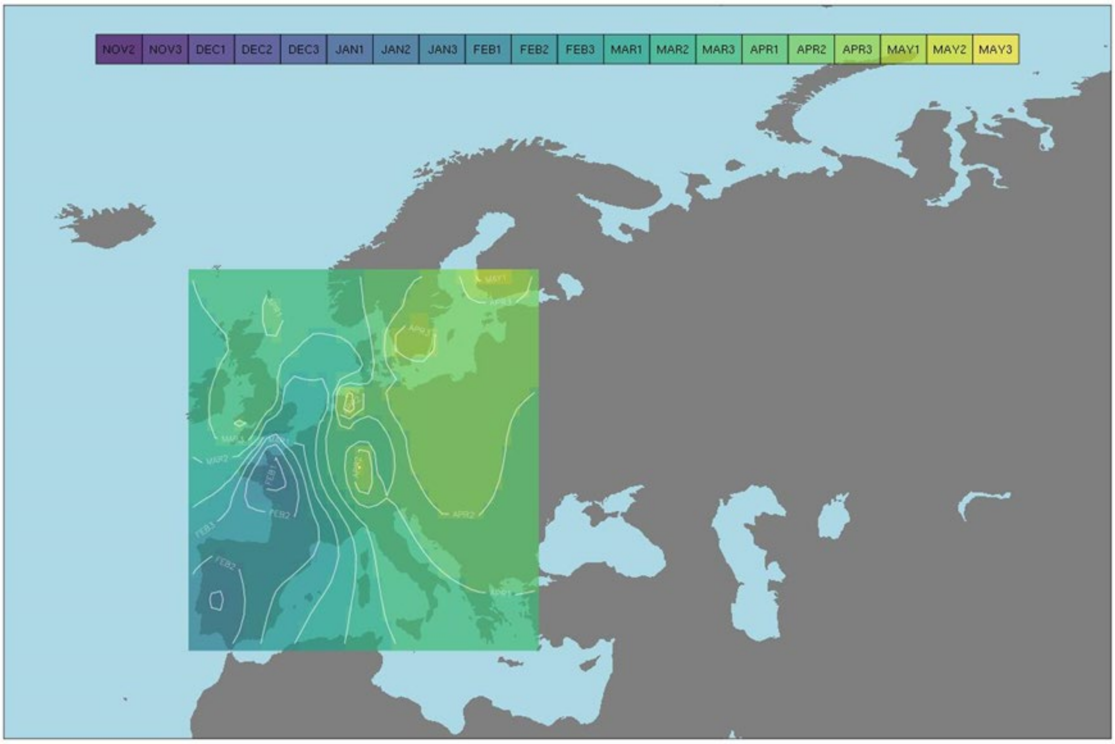
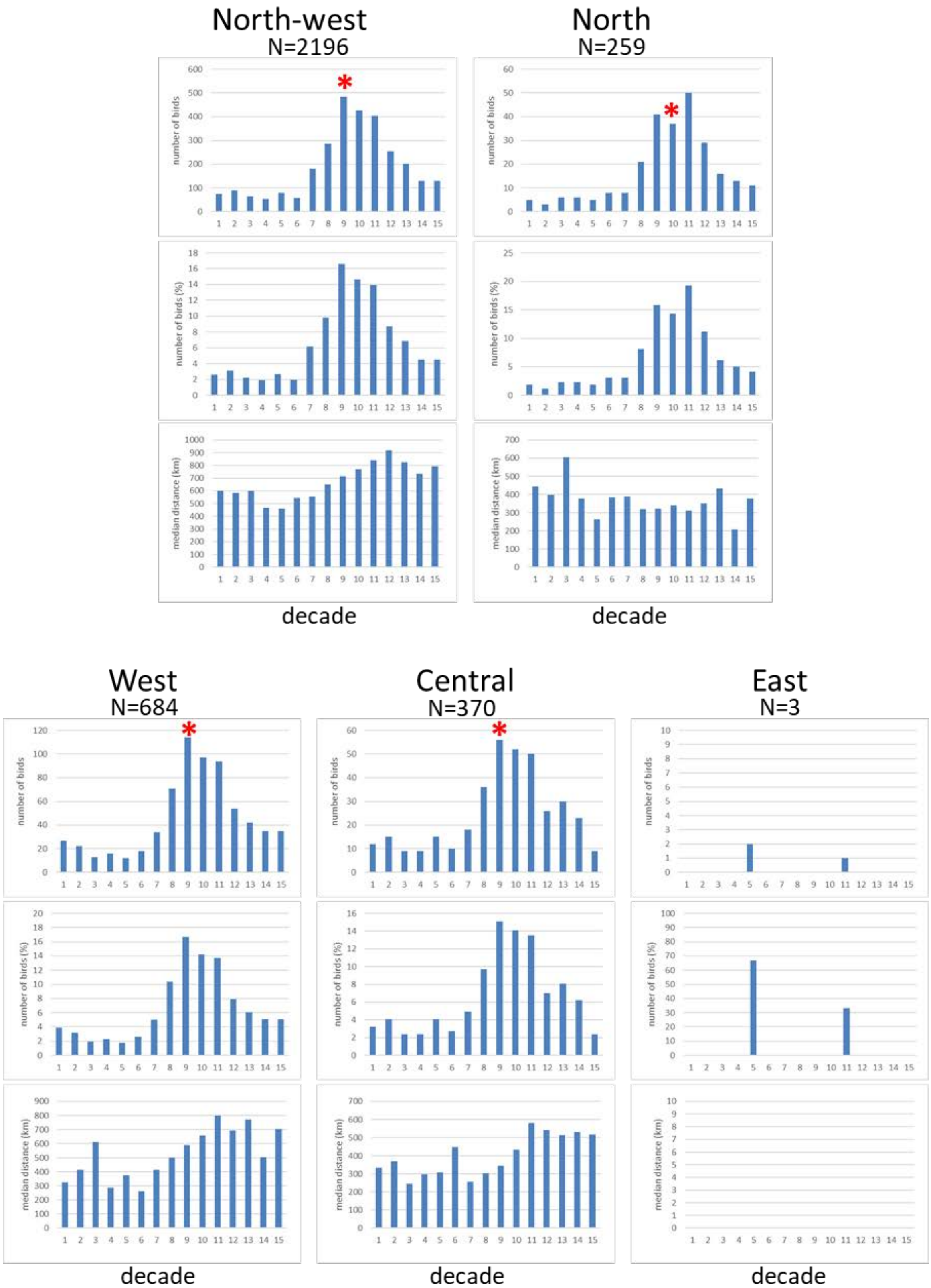


Fig. 4: Median migration date of pre-nuptial migration of Eurasian Skylark. The map shows the date when 50% of individuals are on migration.

11870 Common Blackbird *Turdus merula*

Recovery analysis



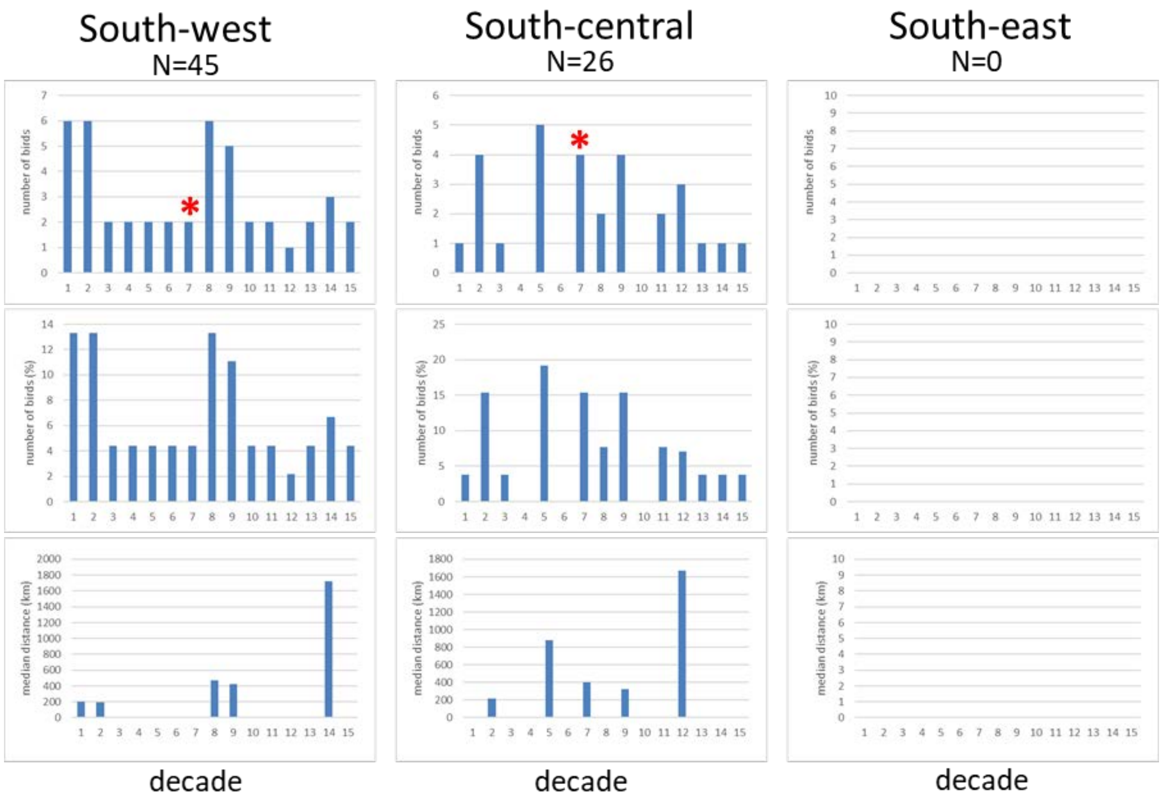


Fig. 1: Onset of prenuptial (return) migration of Common Blackbird by geographical region and decade. The asterisk denotes the median date of onset of return migration.

Mapping analysis

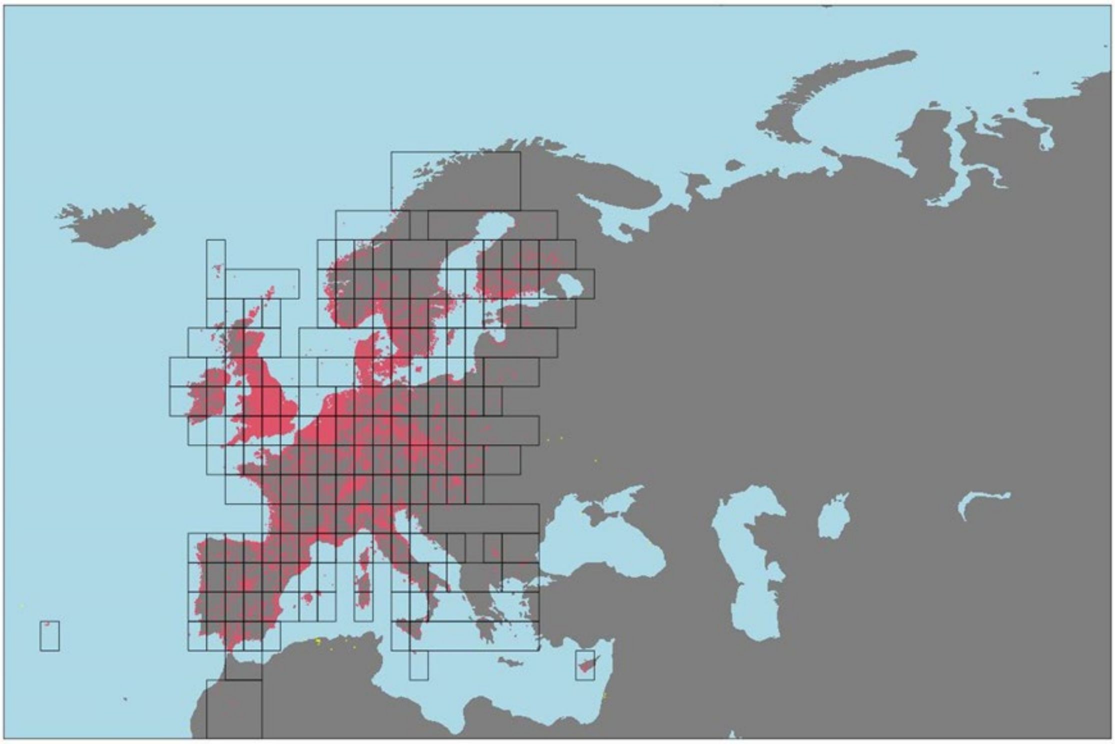


Fig. 2: Data availability for the analyses of Common Blackbird pre-nuptial migration. Red dots: encounters used (306,674), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

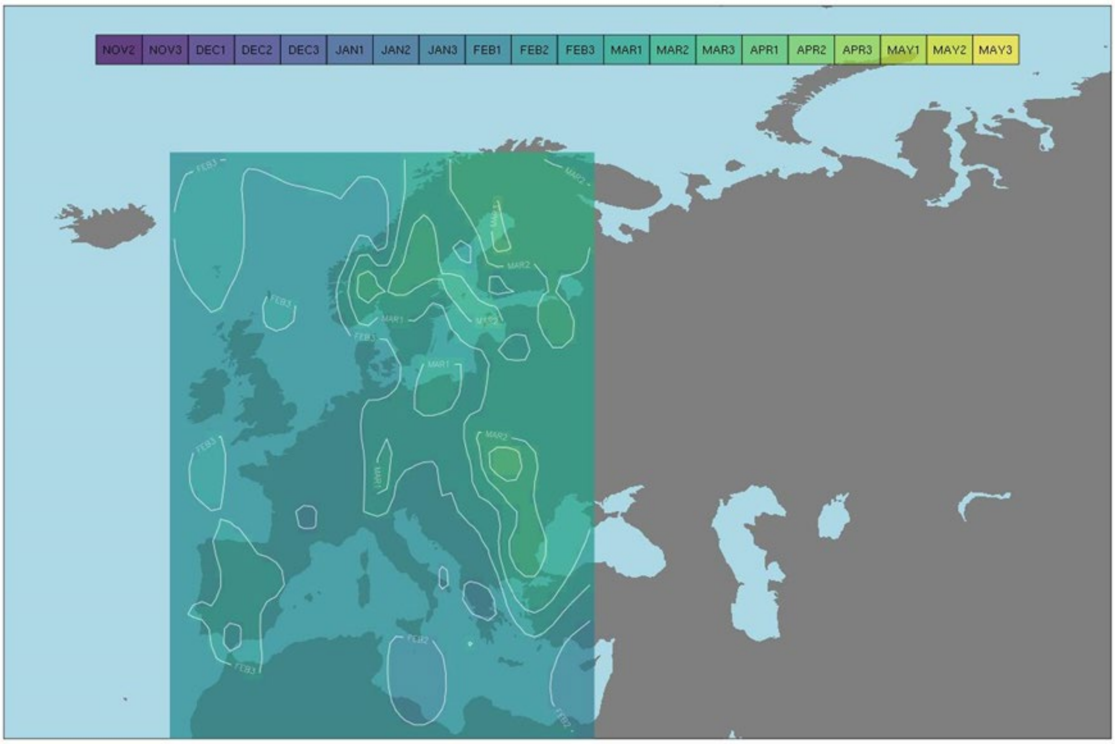


Fig. 3: Onset of pre-nuptial migration of Common Blackbird. The map shows the date when 5% of individuals are on migration.

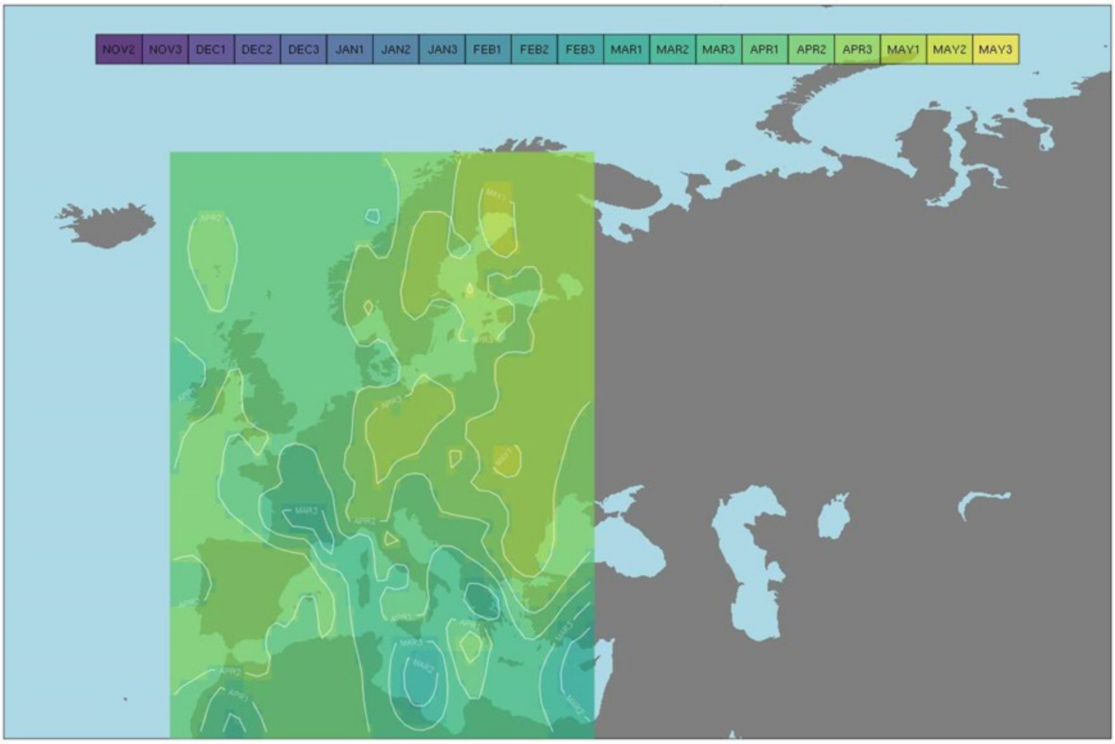
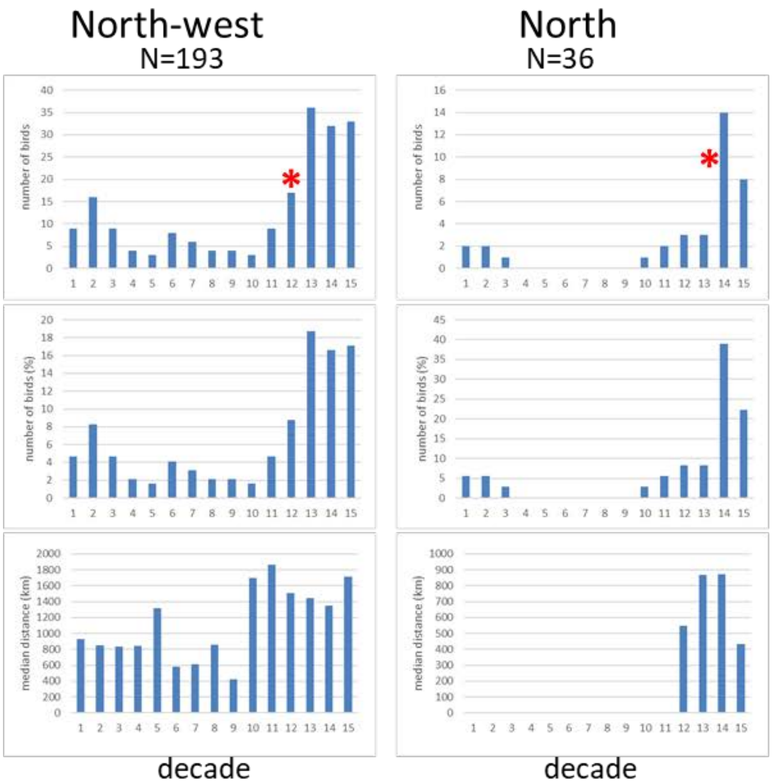
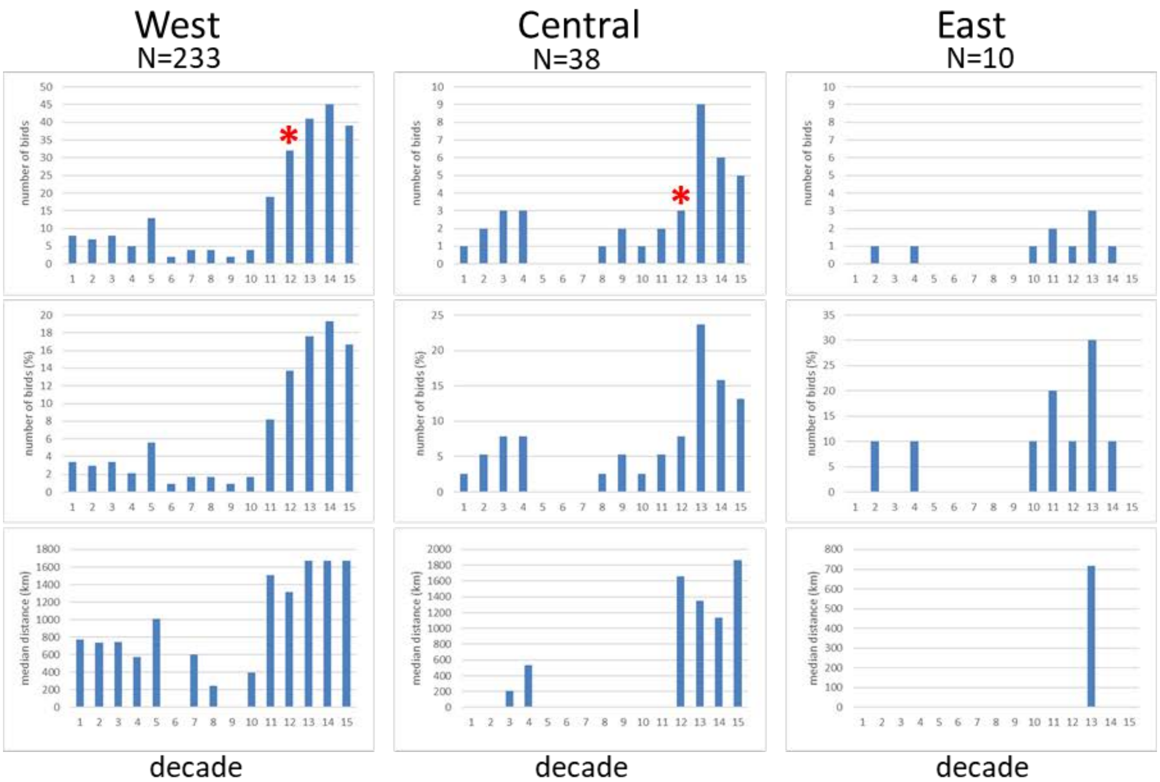


Fig. 4: Median migration date of pre-nuptial migration of Common Blackbird. The map shows the date when 50% of individuals are on migration.

11980 Fieldfare *Turdus pilaris*

Recovery analysis





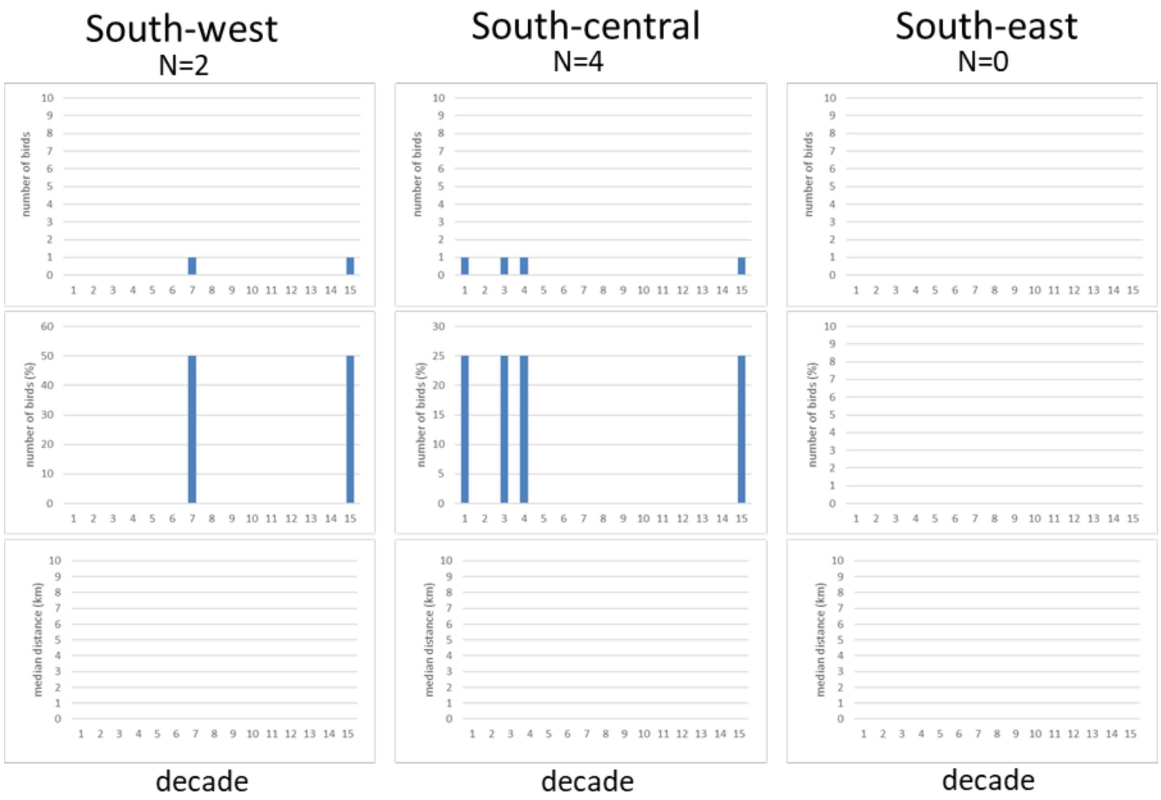


Fig. 1: Onset of prenuptial (return) migration of Fieldfare by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

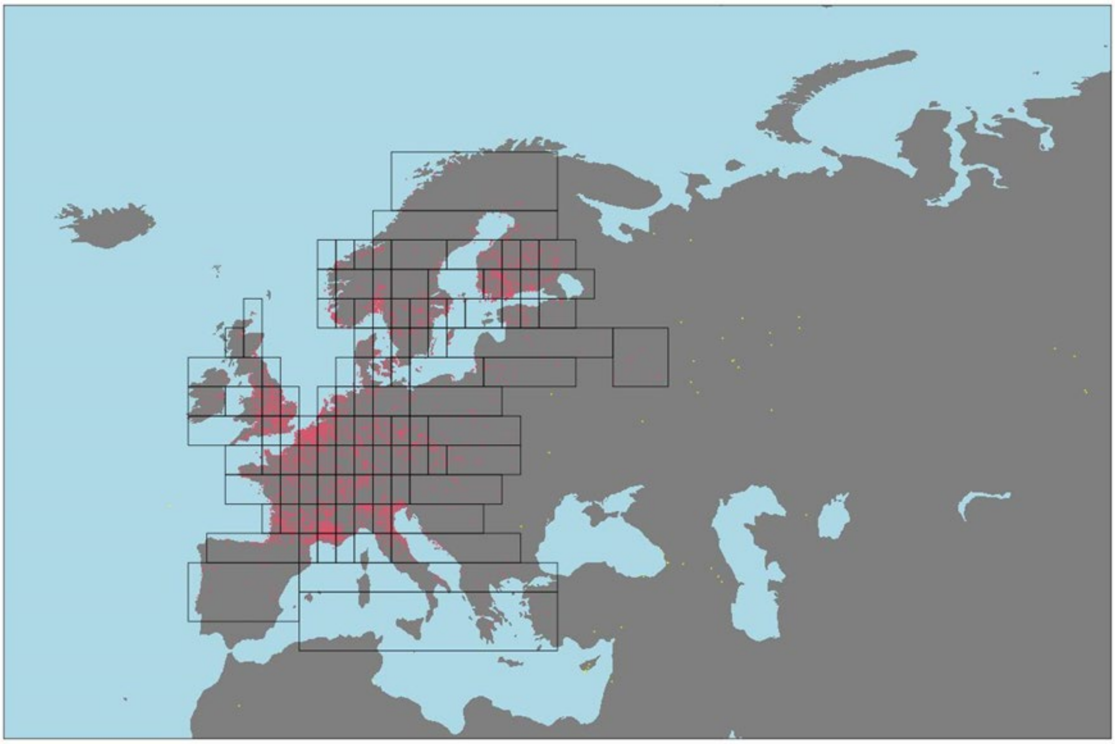


Fig. 2: Data availability for the analyses of Fieldfare pre-nuptial migration. Red dots: encounters used (12,517), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

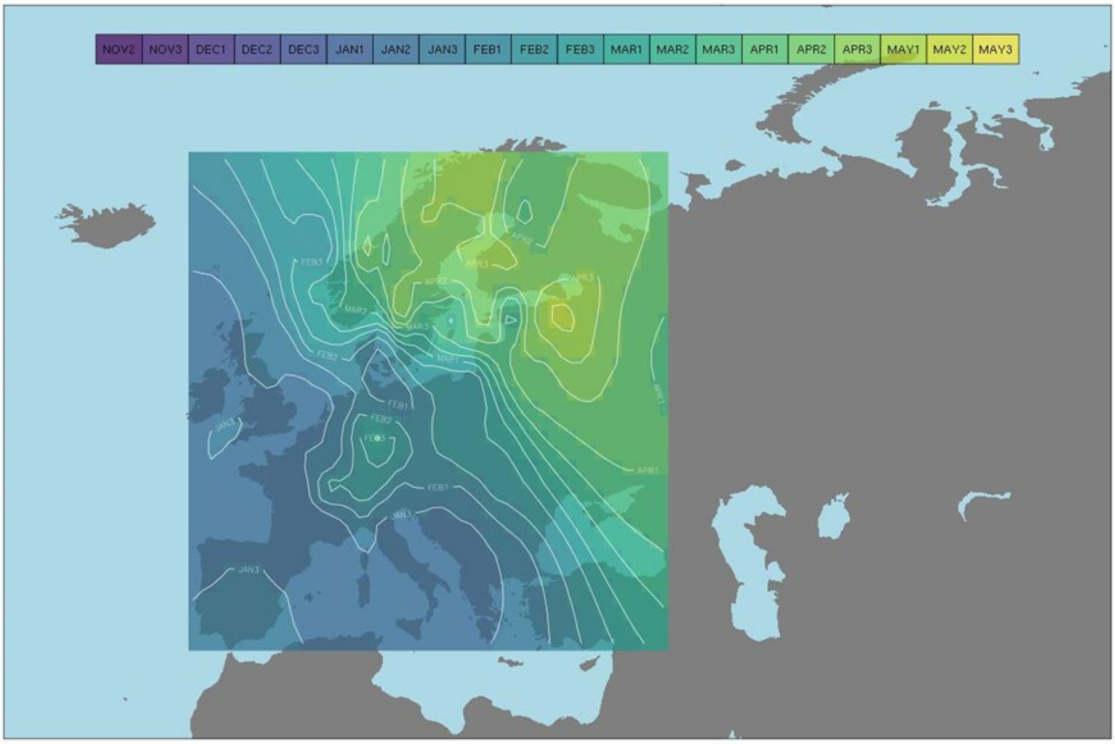


Fig. 3: Onset of pre-nuptial migration of Fieldfare. The map shows the date when 5% of individuals are on migration.

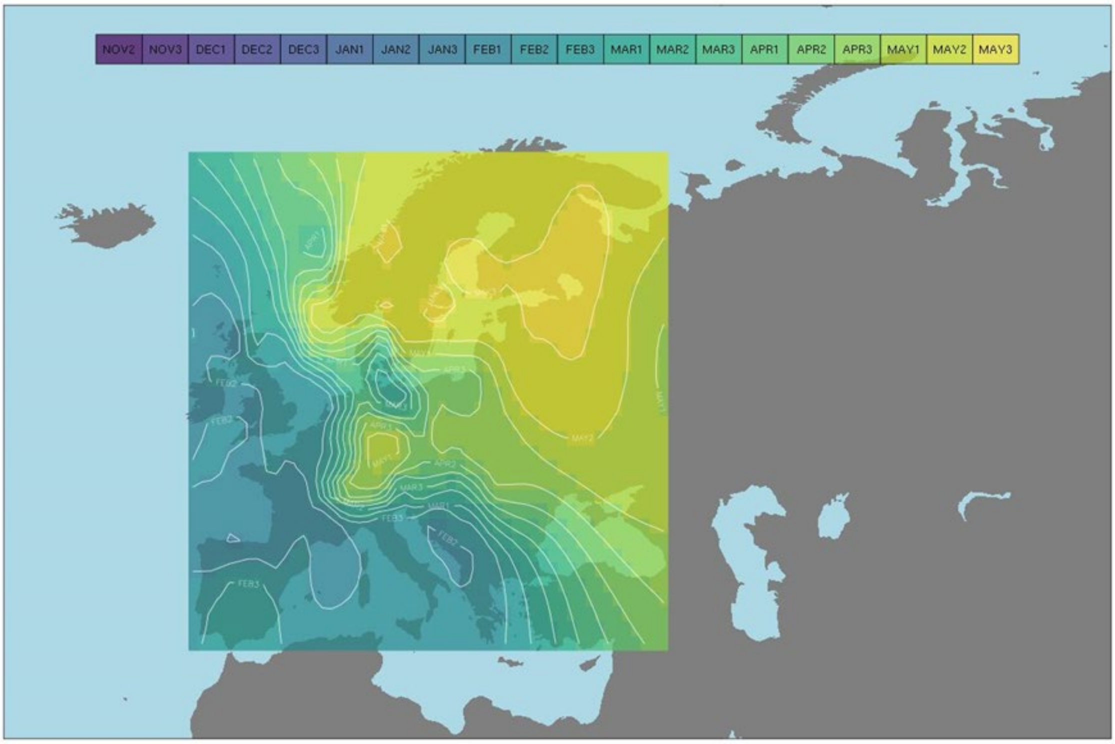
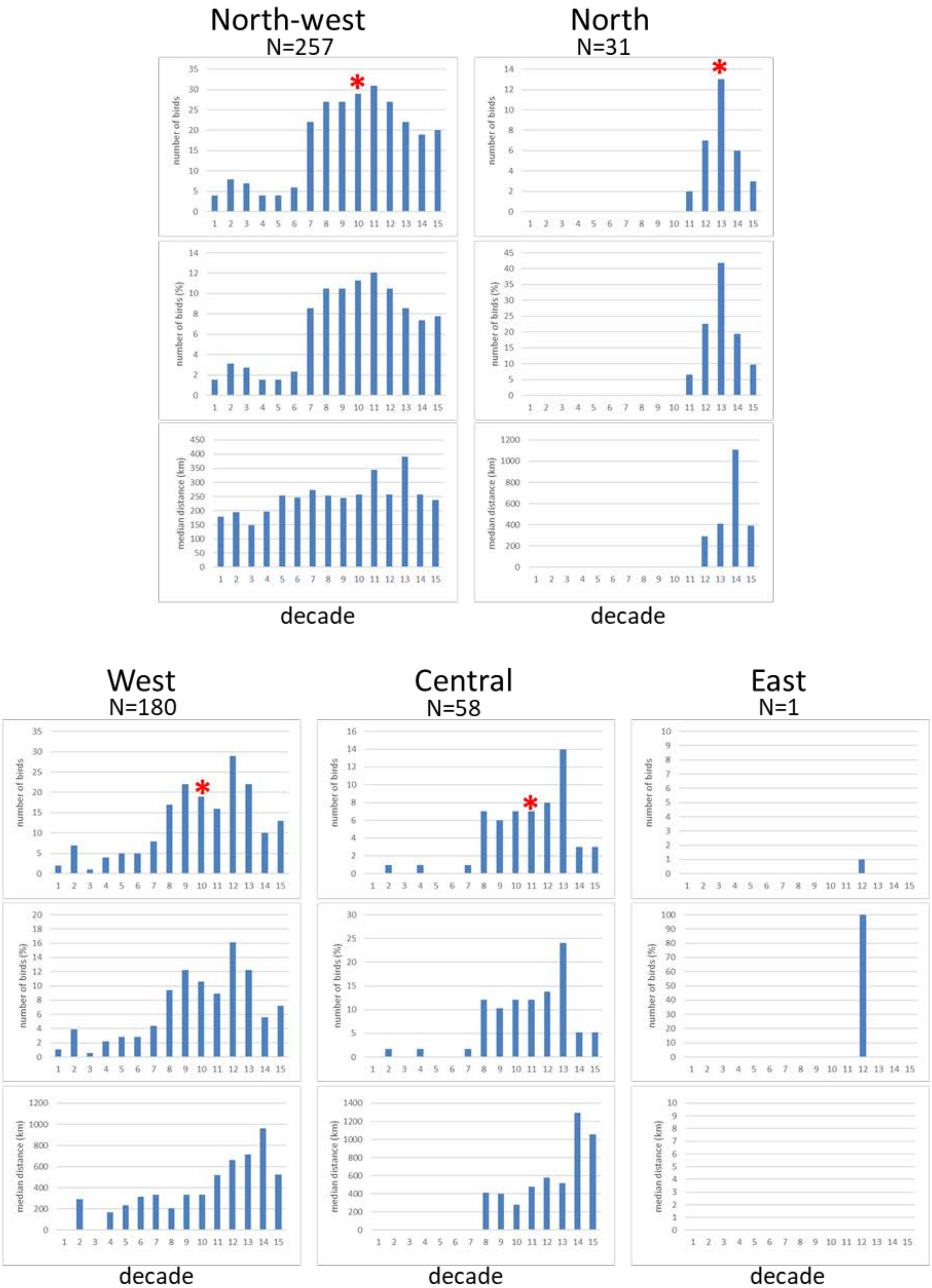


Fig. 4: Median migration date of pre-nuptial migration of Fieldfare. The map shows the date when 50% of individuals are on migration.

12000 Song Thrush *Turdus philomelos*

Recovery analysis



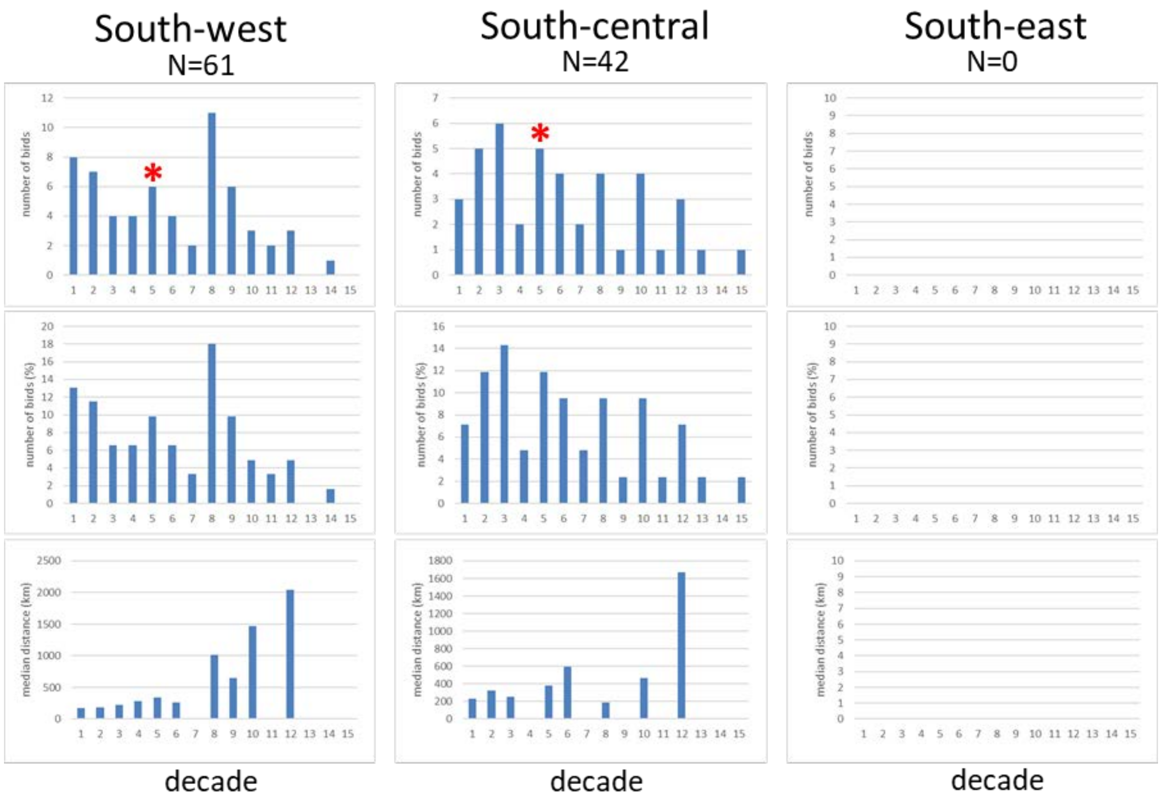


Fig. 1: Onset of prenuptial (return) migration of Song Thrush by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

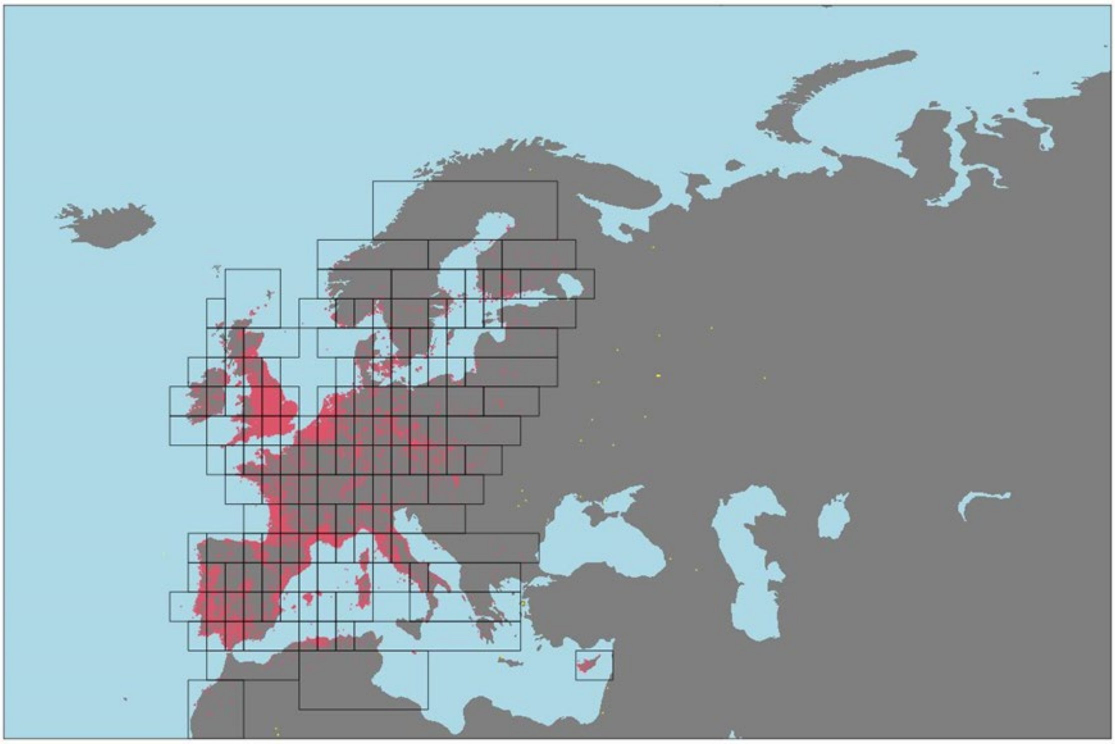


Fig. 2: Data availability for the analyses of Song Thrush pre-nuptial migration. Red dots: encounters used (54,448), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 25, minimum number of different encounter dates in a cell = 15.

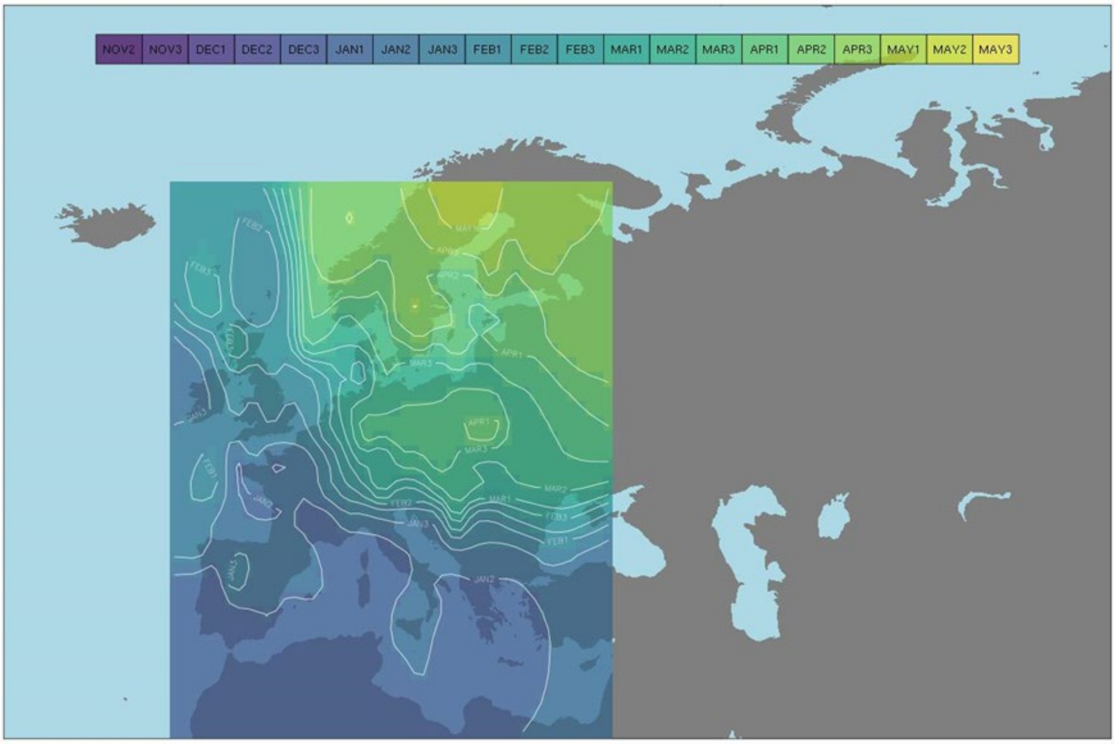


Fig. 3: Onset of pre-nuptial migration of Song Thrush. The map shows the date when 5% of individuals are on migration.

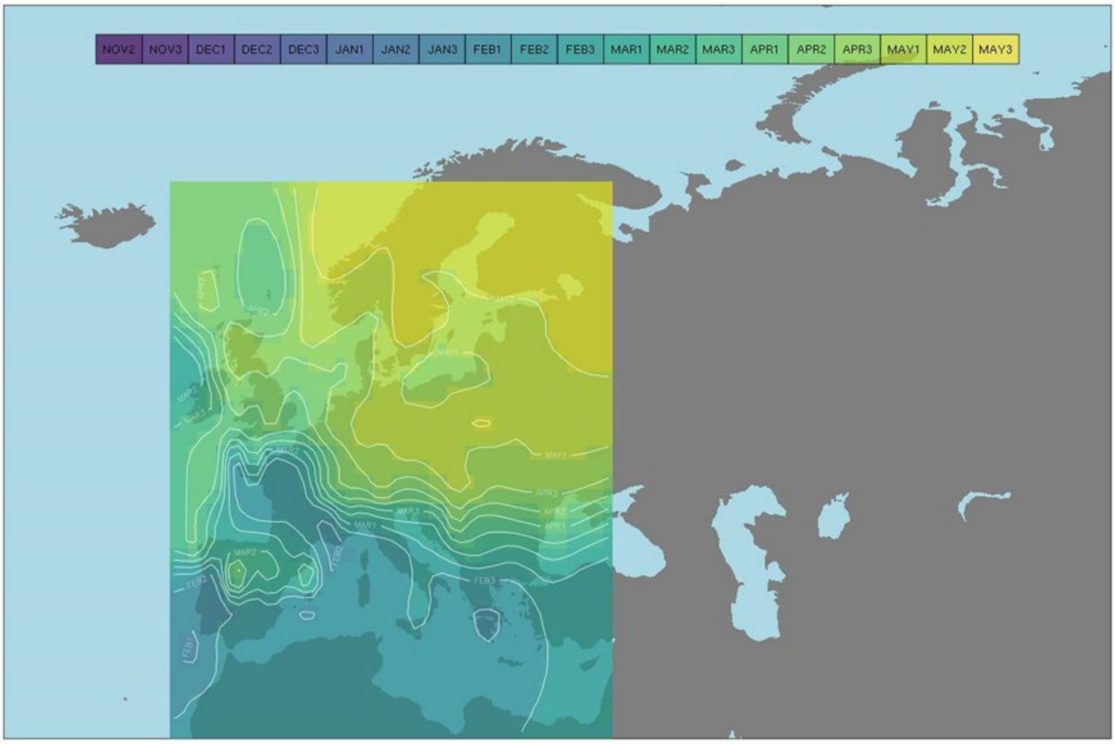
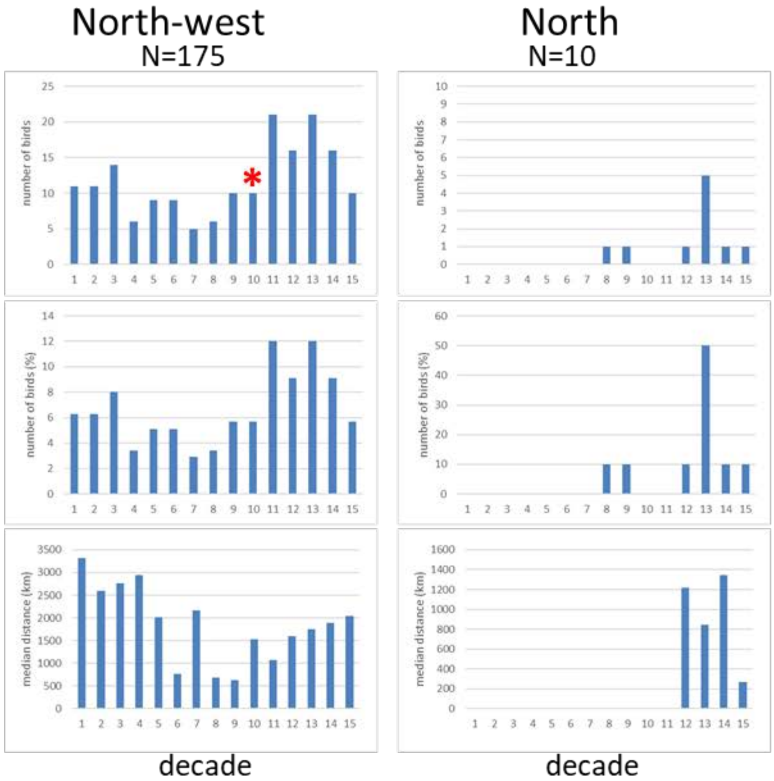
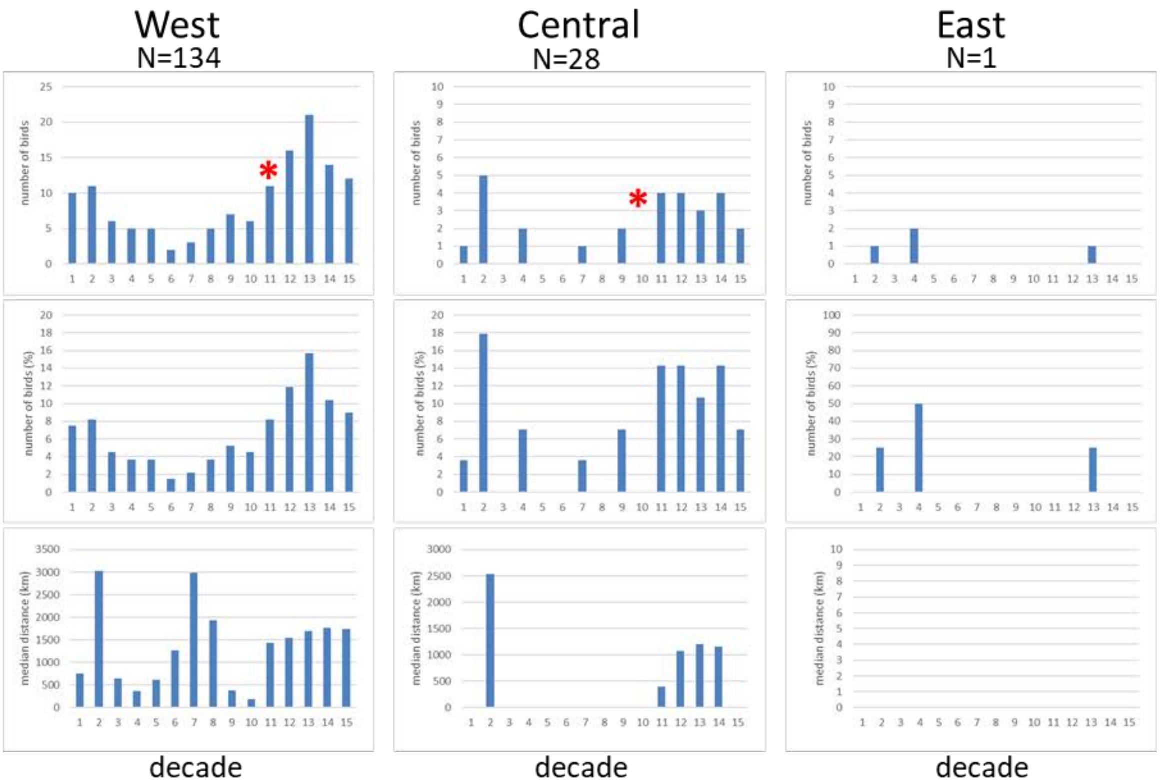


Fig. 4: Median migration date of pre-nuptial migration of Song Thrush. The map shows the date when 50% of individuals are on migration.

12010 Red-winged Thrush *Turdus iliacus*

Recovery analysis





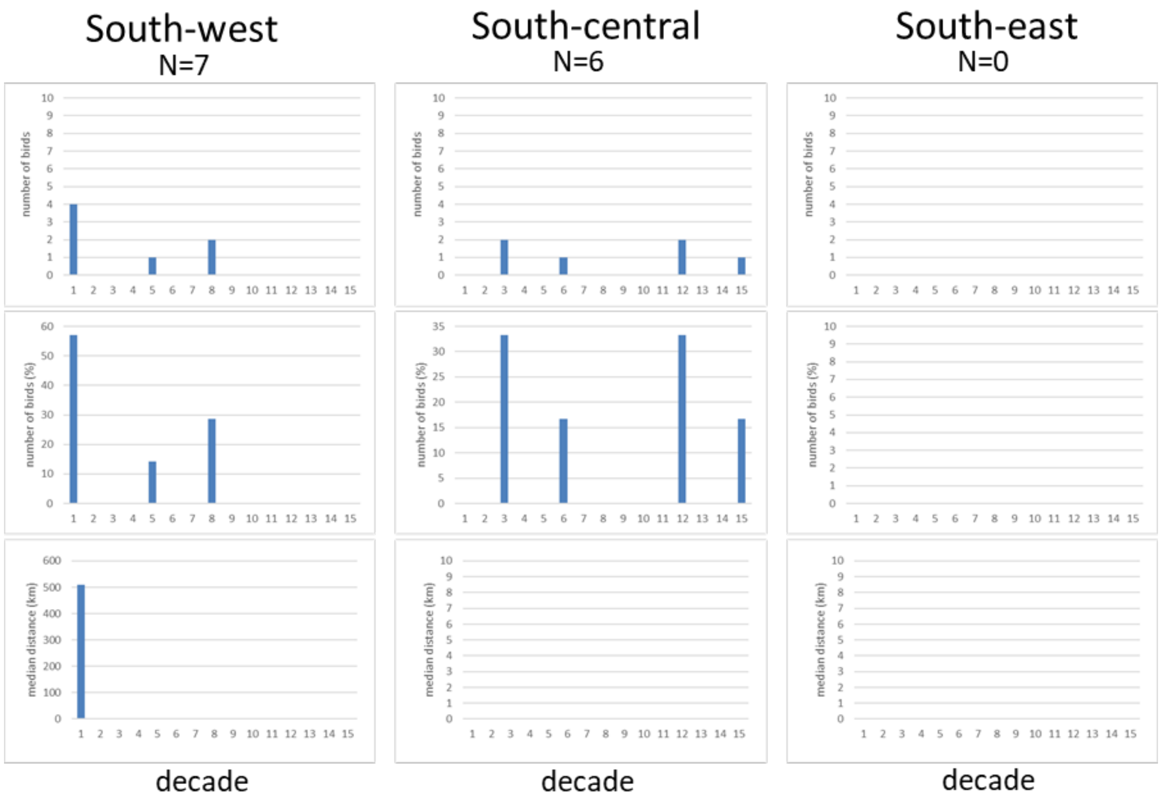


Fig. 1: Onset of prenuptial (return) migration of Red-winged Thrush by geographical region and decade. The asterix denotes the median date of onset of return migration.

Mapping analysis

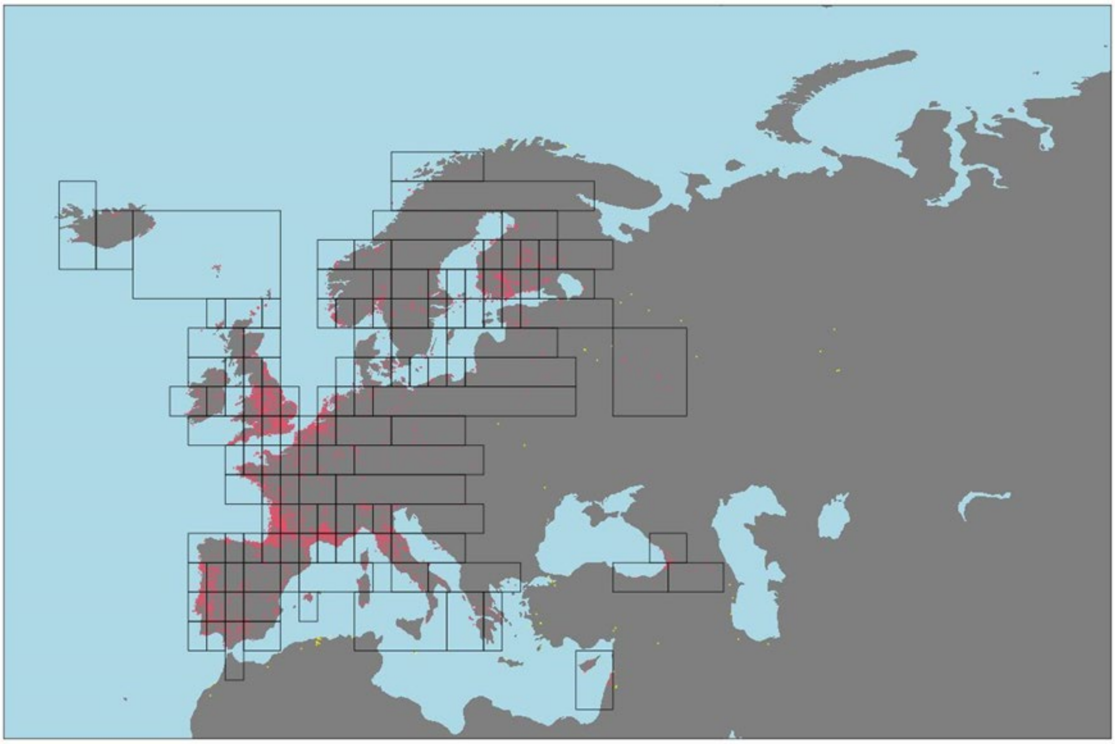


Fig. 2: Data availability for the analyses of Red-winged Thrush pre-nuptial migration. Red dots: encounters used (11,615), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

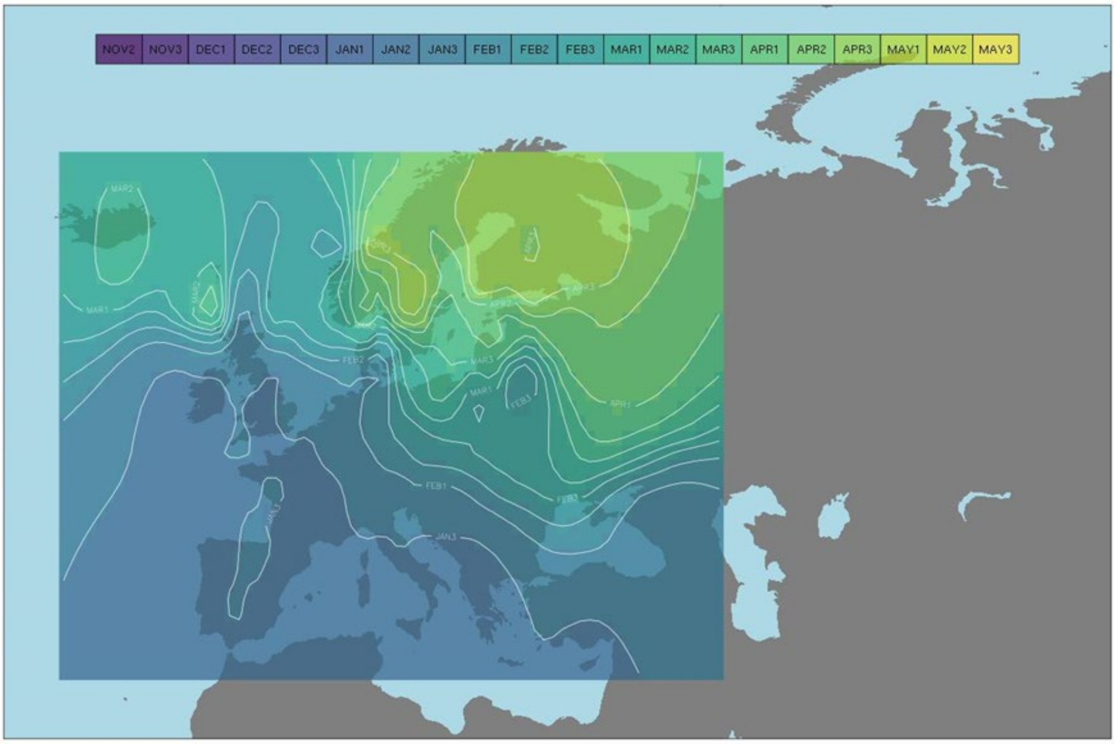


Fig. 3: Onset of pre-nuptial migration of Red-winged Thrush. The map shows the date when 5% of individuals are on migration.

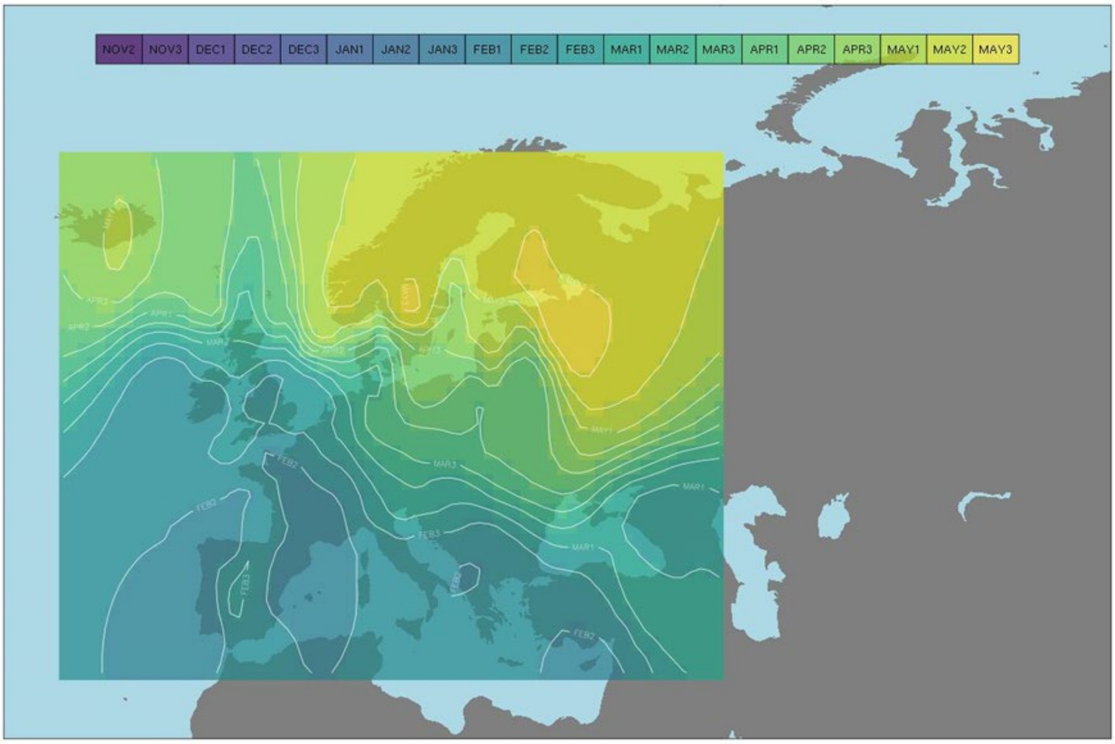


Fig. 4: Median migration date of pre-nuptial migration of Red-winged Thrush. The map shows the date when 50% of individuals are on migration.

12020 Mistle Thrush *Turdus viscivorus*

Recovery analysis

No data for recovery analysis.

Mapping analysis

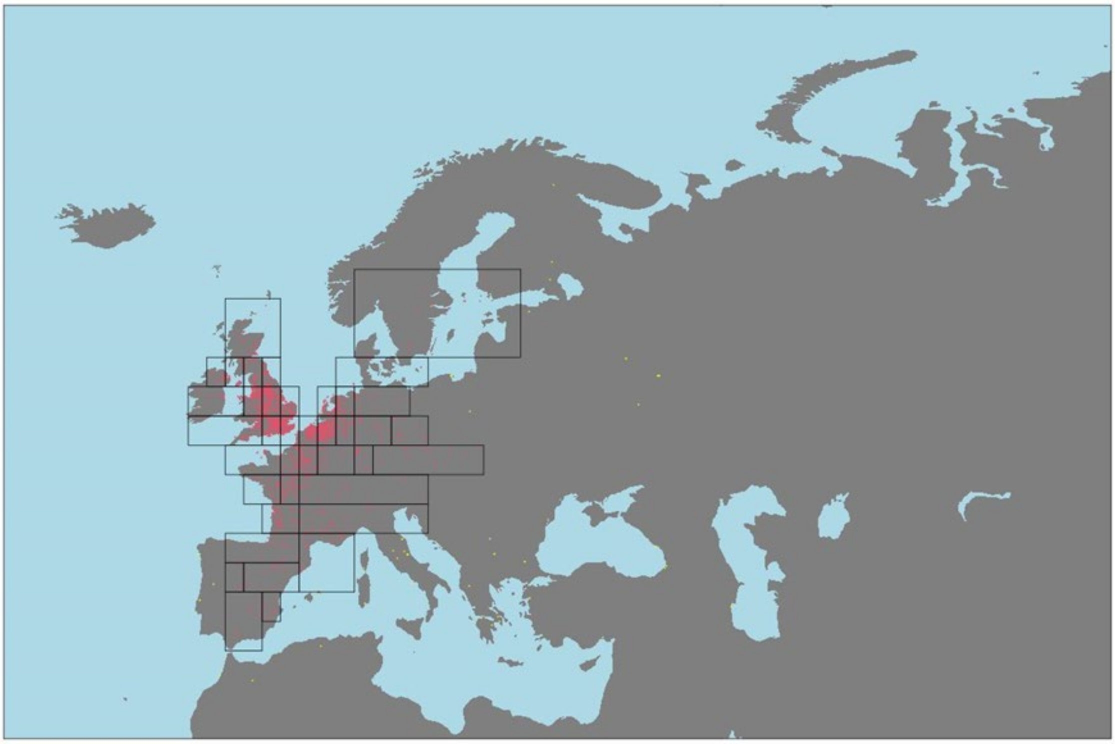


Fig. 2: Data availability for the analyses of Mistle Thrush pre-nuptial migration. Red dots: encounters used (4058), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

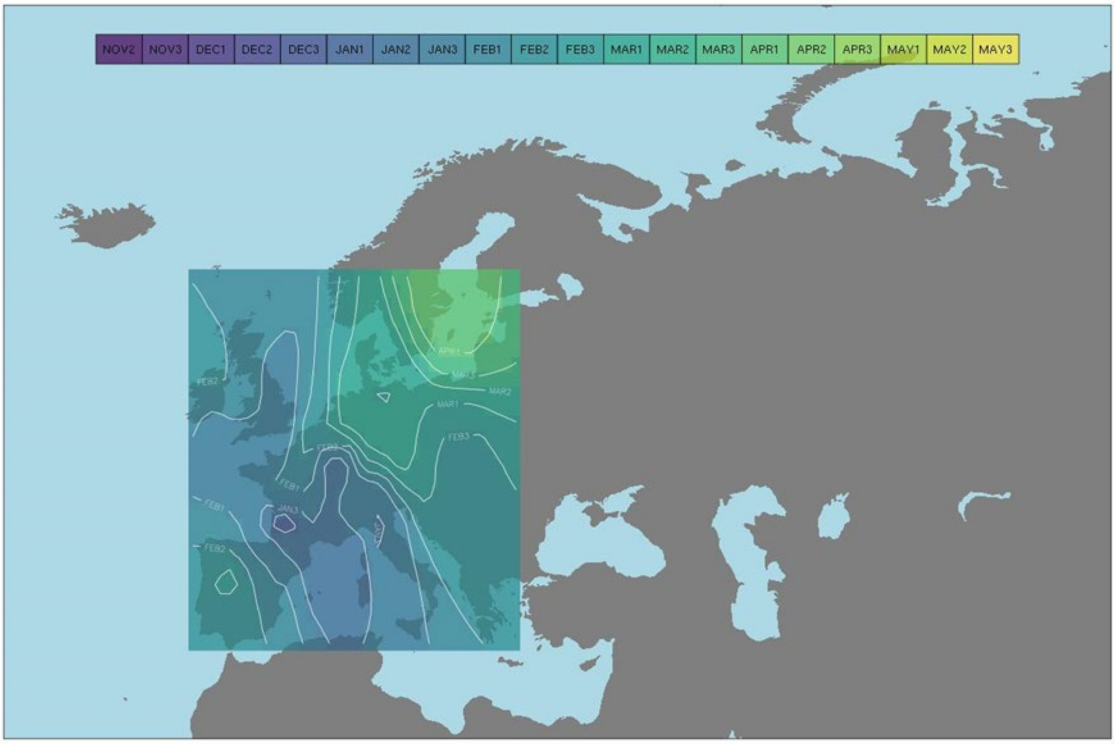


Fig. 3: Onset of pre-nuptial migration of Mistle Thrush. The map shows the date when 5% of individuals are on migration.

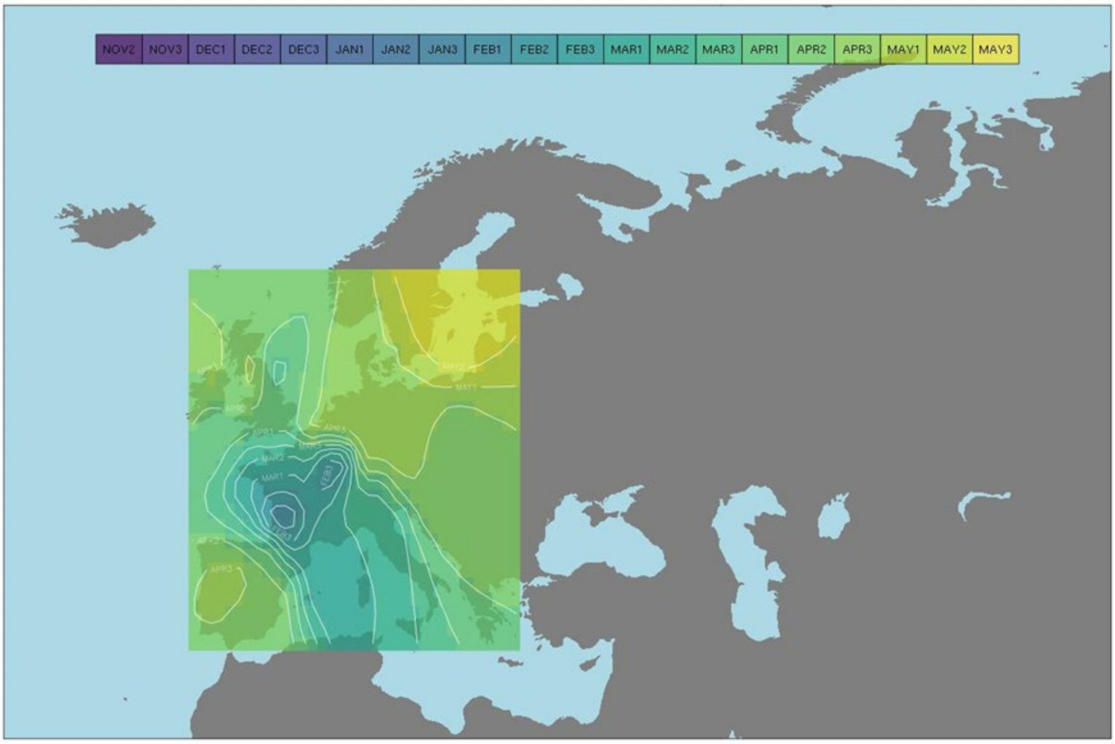


Fig. 4: Median migration date of pre-nuptial migration of Mistle Thrush. The map shows the date when 50% of individuals are on migration.

15390 European Roller *Garrulus glandarius*

Recovery analysis

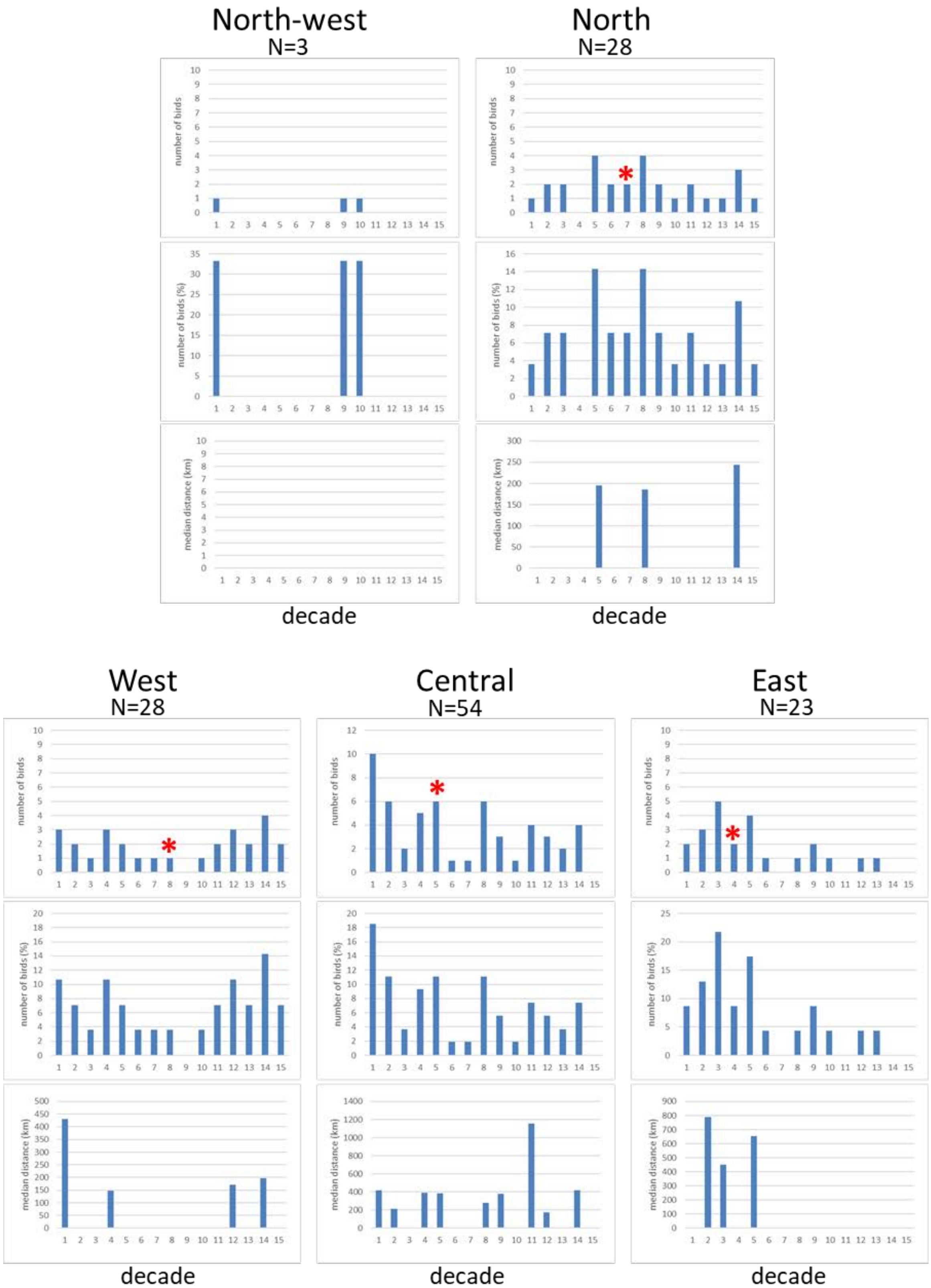


Fig. 1: Onset of prenuptial (return) migration of European Roller by geographical region and decade. The asterix denotes the median date of onset of return migration. No data from South-west, South-central, South-east.

Mapping analysis

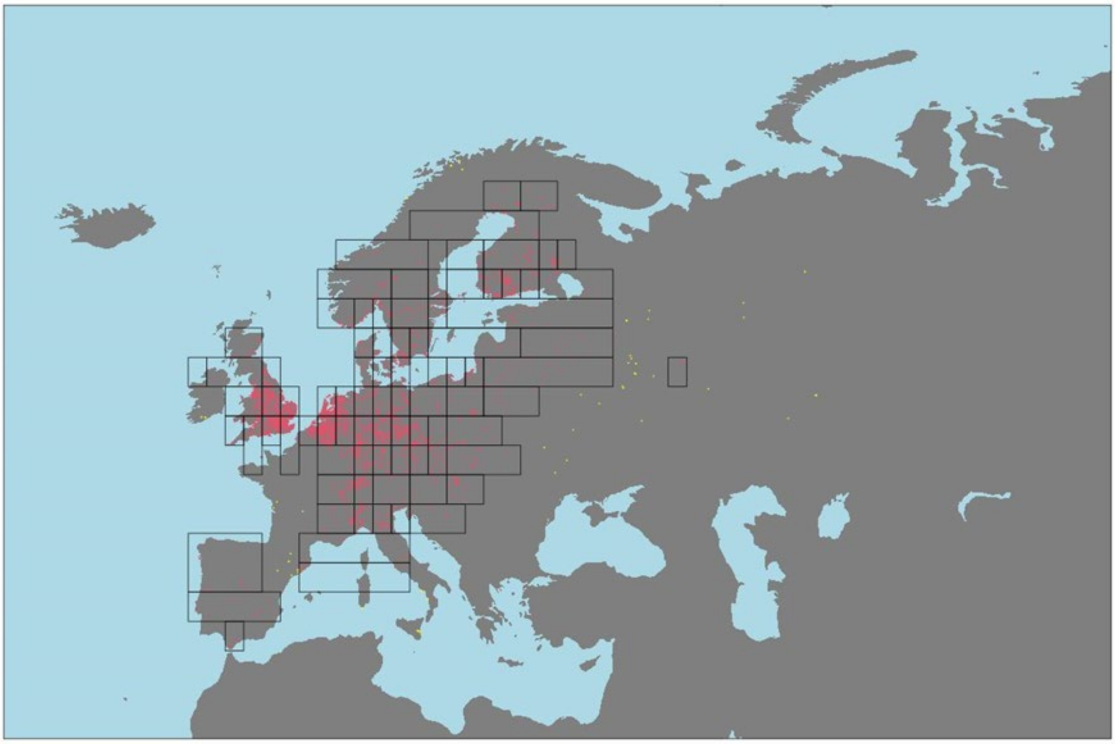


Fig. 2: Data availability for the analyses of European Roller pre-nuptial migration. Red dots: encounters used (9631), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

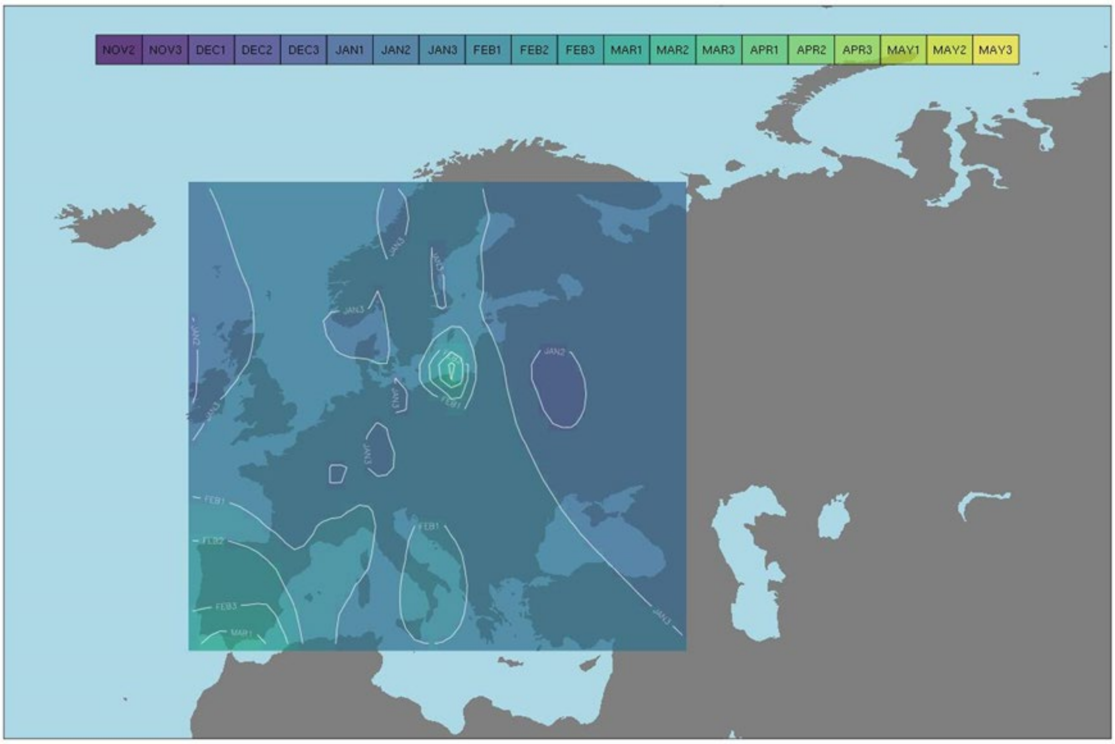


Fig. 3: Onset of pre-nuptial migration of European Roller. The map shows the date when 5% of individuals are on migration.

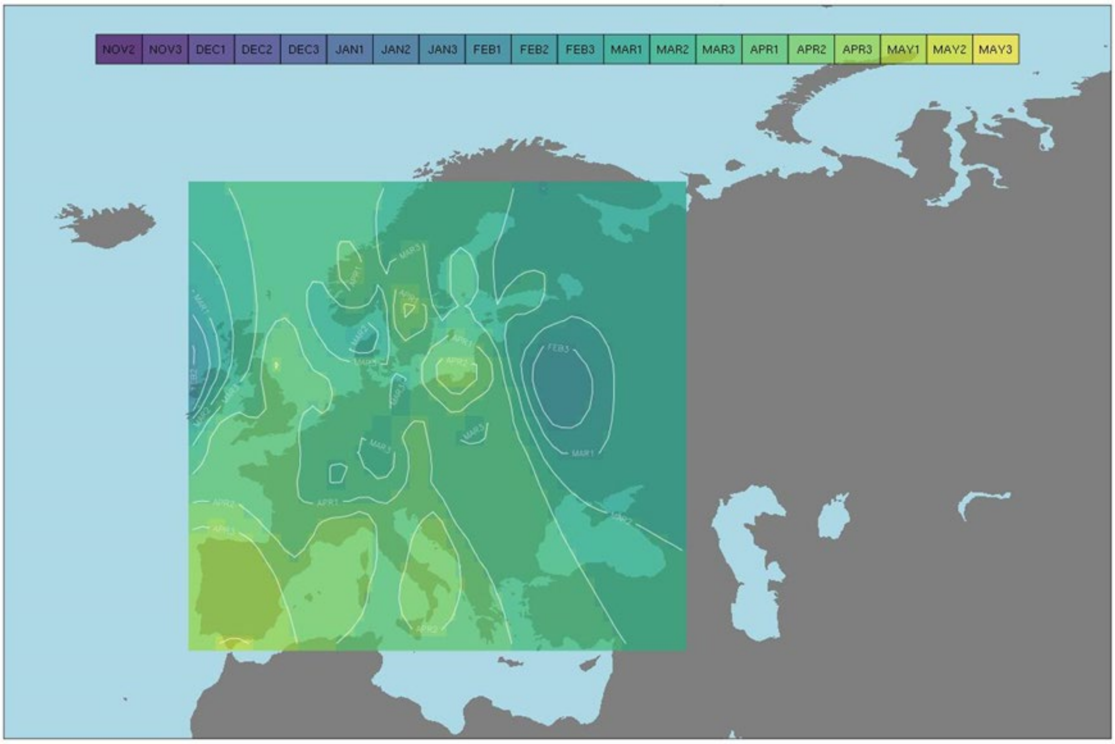


Fig. 4: Median migration date of pre-nuptial migration of European Roller. The map shows the date when 50% of individuals are on migration.

15490 Eurasian Magpie *Pica pica*

Recovery analysis

No data for recovery analysis.

Mapping analysis

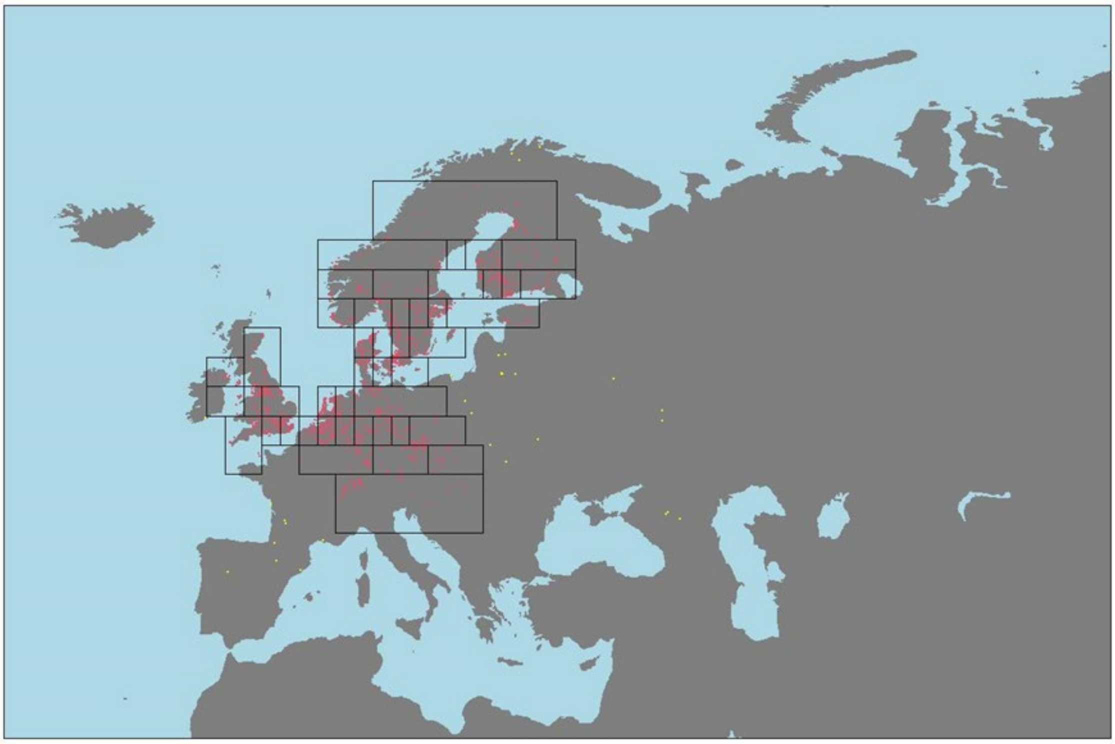


Fig. 2: Data availability for the analyses of Eurasian Magpie pre-nuptial migration. Red dots: encounters used (2688), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

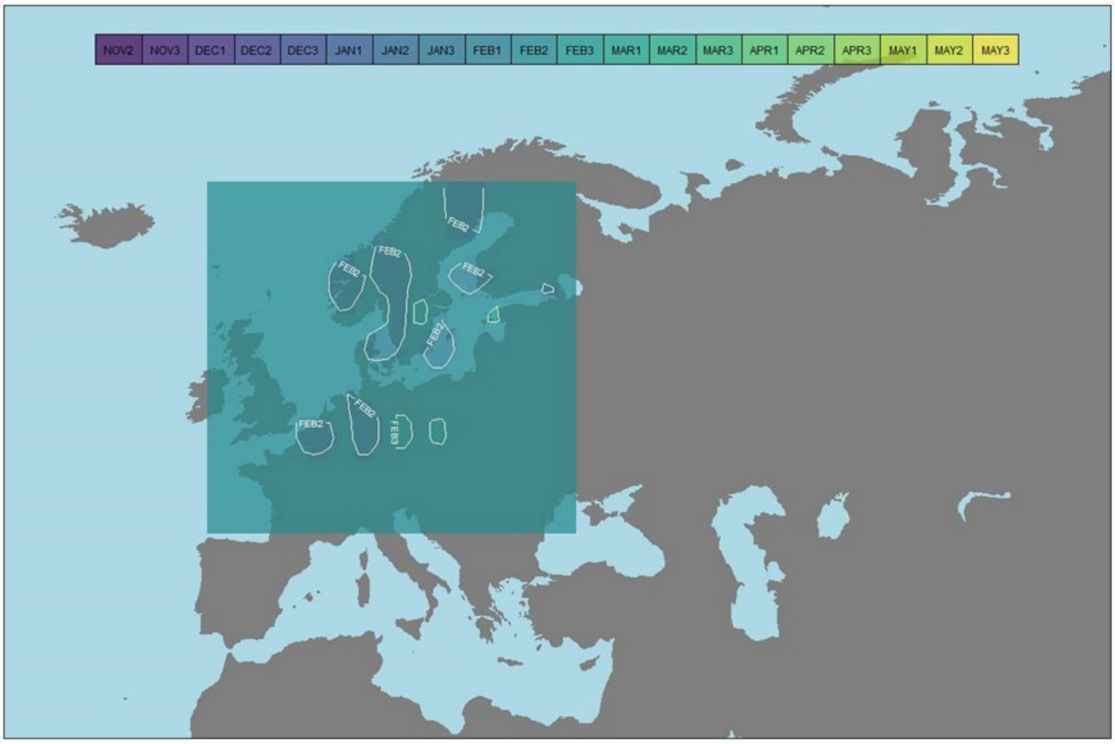


Fig. 3: Onset of pre-nuptial migration of Eurasian Magpie. The map shows the date when 5% of individuals are on migration.

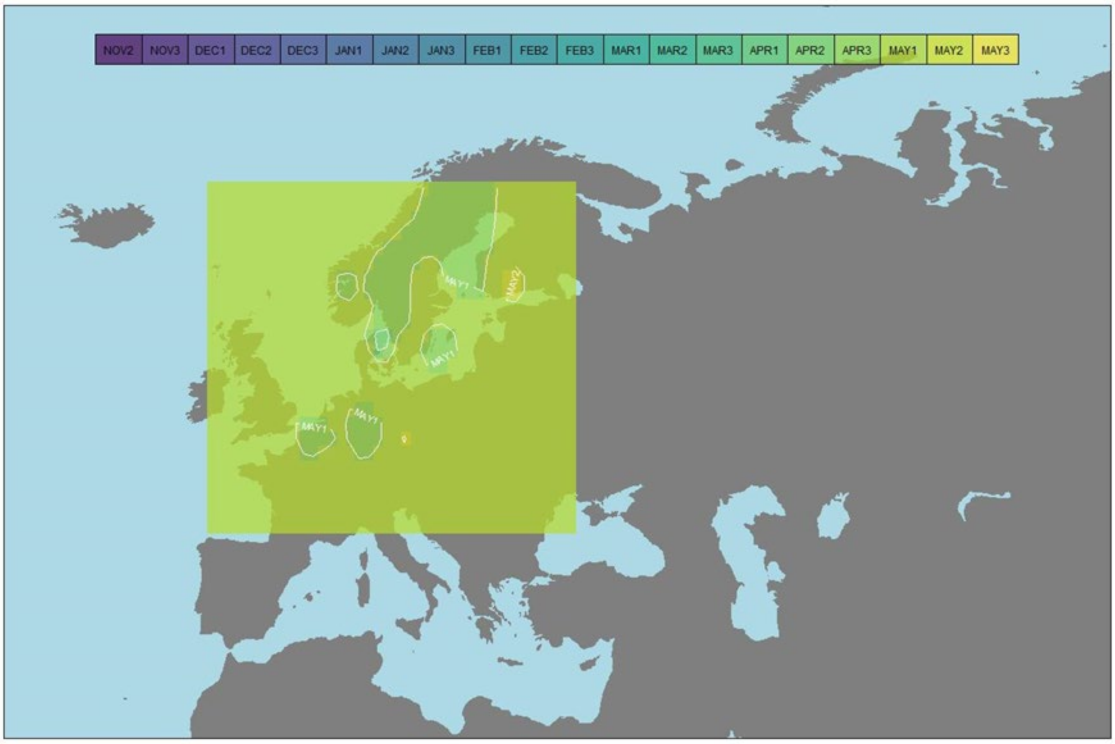


Fig. 4: Median migration date of pre-nuptial migration of Eurasian Magpie. The map shows the date when 50% of individuals are on migration.

15600 Western Jackdaw *Corvus monedula*

Recovery analysis

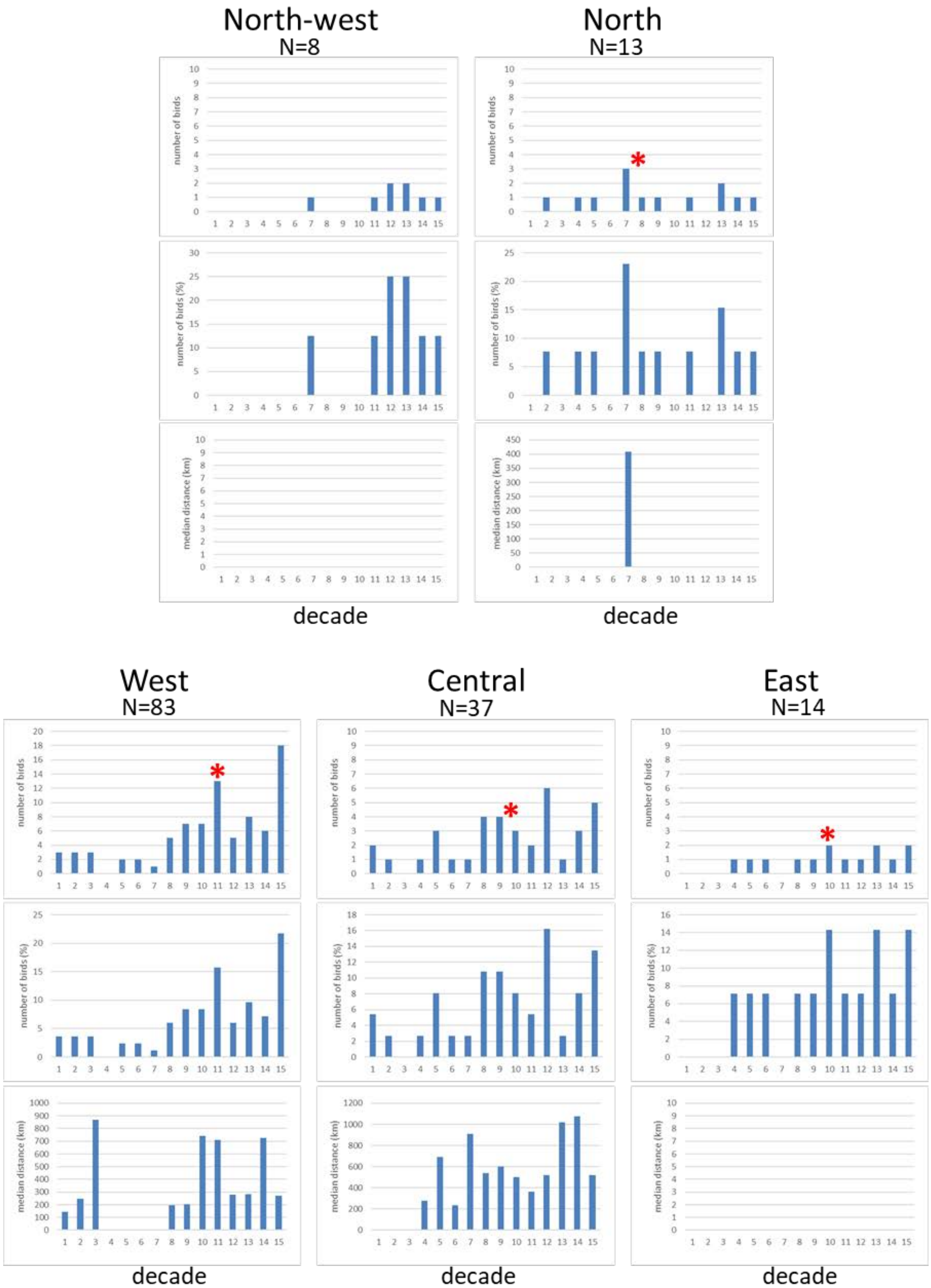


Fig. 1: Onset of prenuptial (return) migration of Western Jackdaw by geographical region and decade. The asterix denotes the median date of onset of return migration. No data from South-west, South-central, South-east.

Mapping analysis

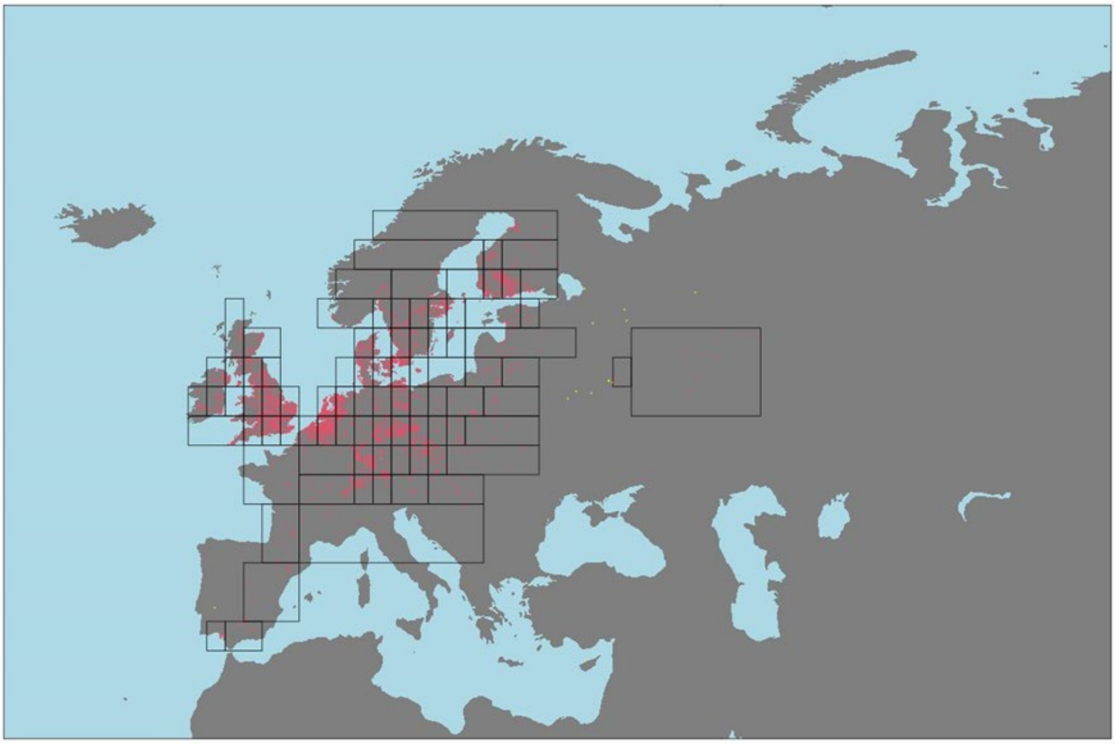


Fig. 2: Data availability for the analyses of Western Jackdaw pre-nuptial migration. Red dots: encounters used (39,212), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

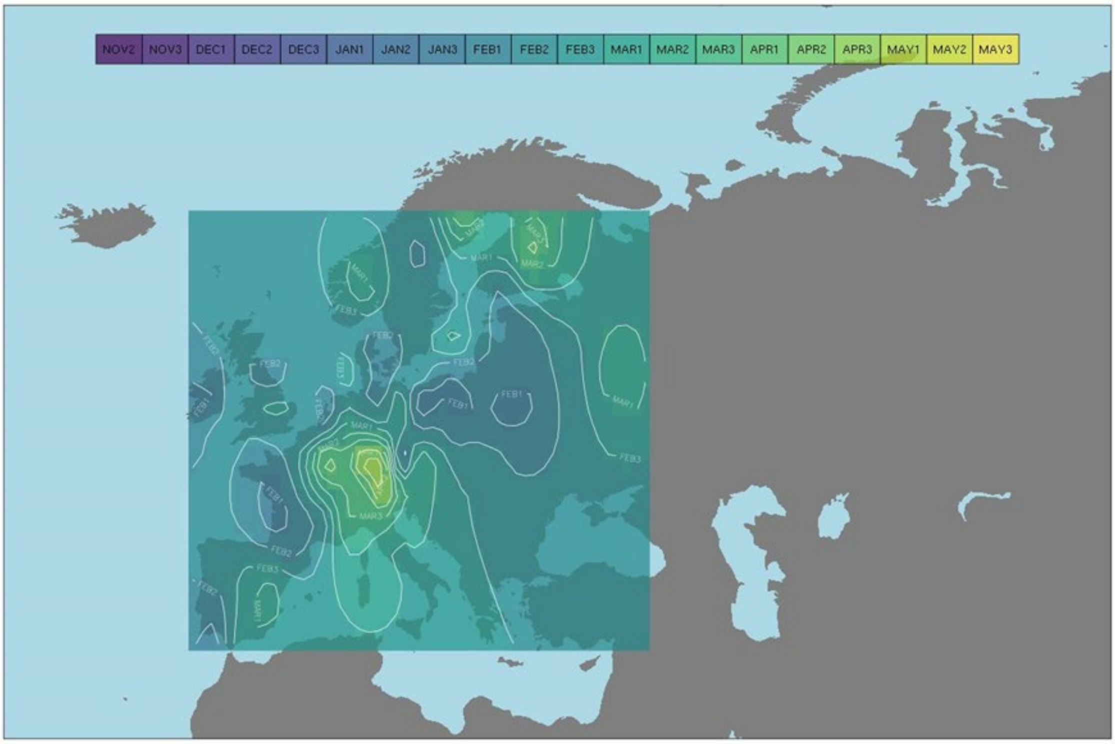


Fig. 3: Onset of pre-nuptial migration of Western Jackdaw. The map shows the date when 5% of individuals are on migration.

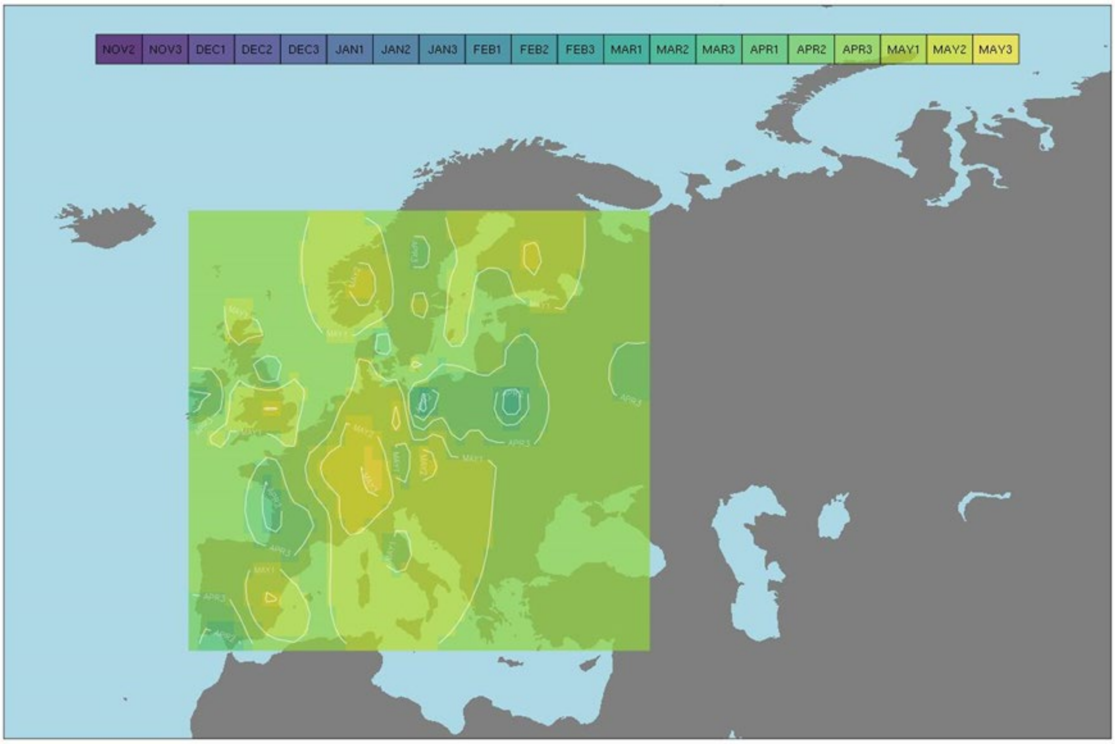


Fig. 4: Median migration date of pre-nuptial migration of Western Jackdaw. The map shows the date when 50% of individuals are on migration.

15630 Rook *Corvus frugilegus*

Recovery analysis

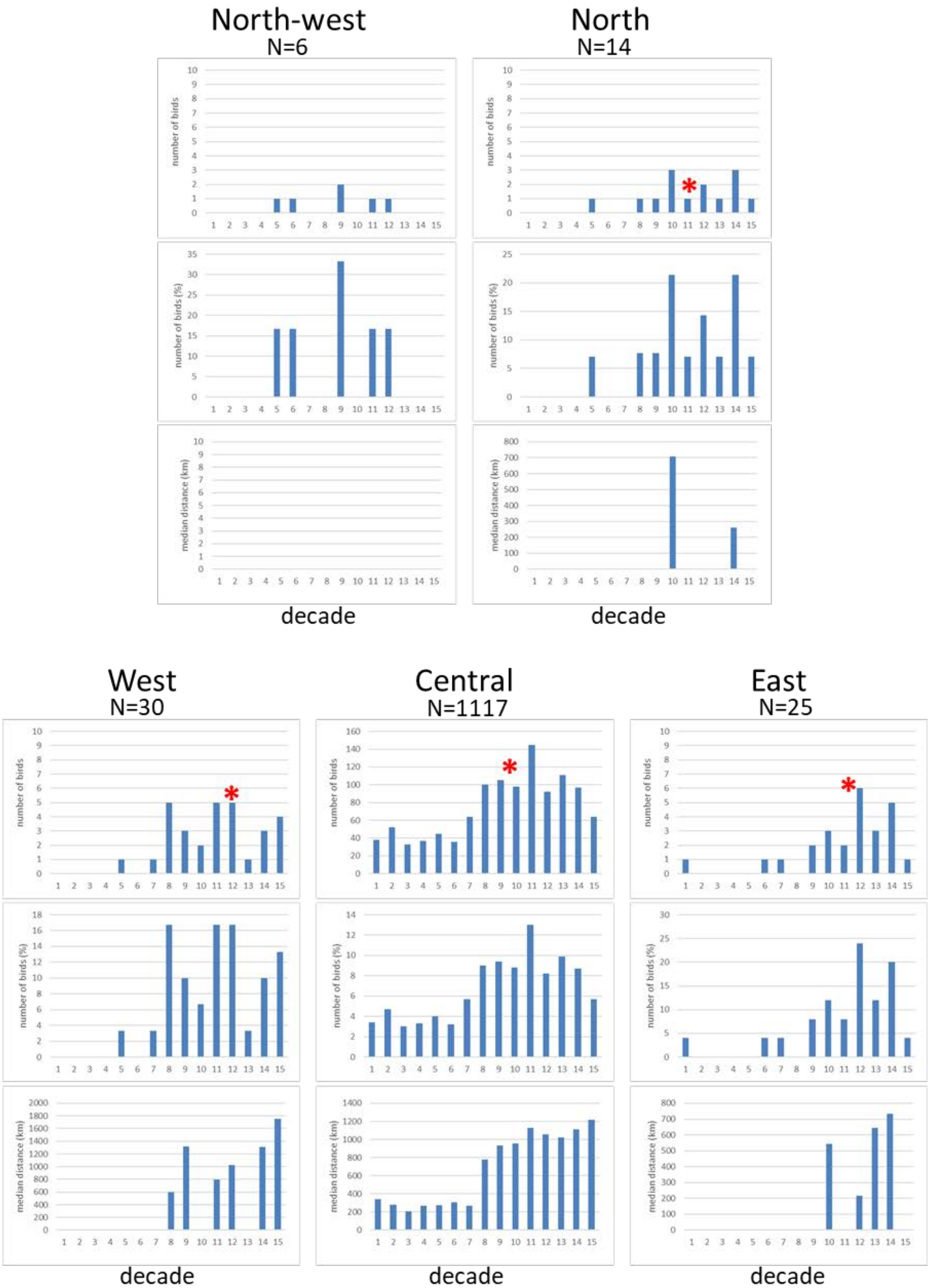


Fig. 1: Onset of prenuptial (return) migration of Rook by geographical region and decade. The asterix denotes the median date of onset of return migration. No data from South-west, South-central, South-east.

Mapping analysis

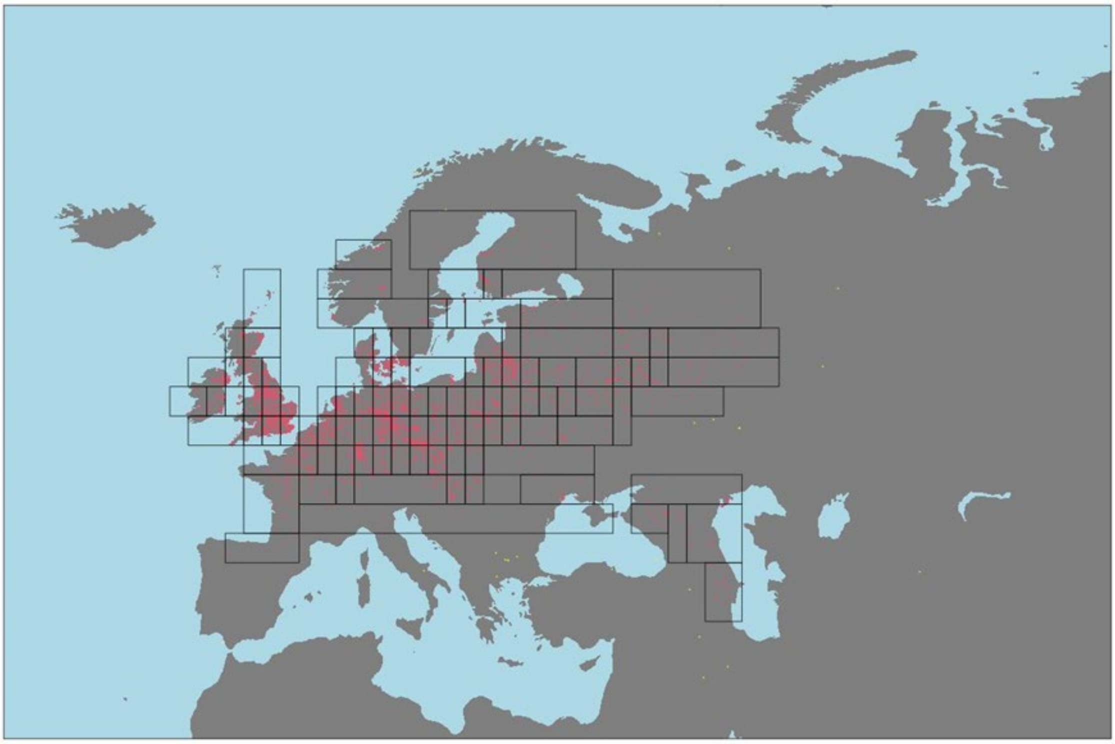


Fig. 2: Data availability for the analyses of Rook pre-nuptial migration. Red dots: encounters used (14,098), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

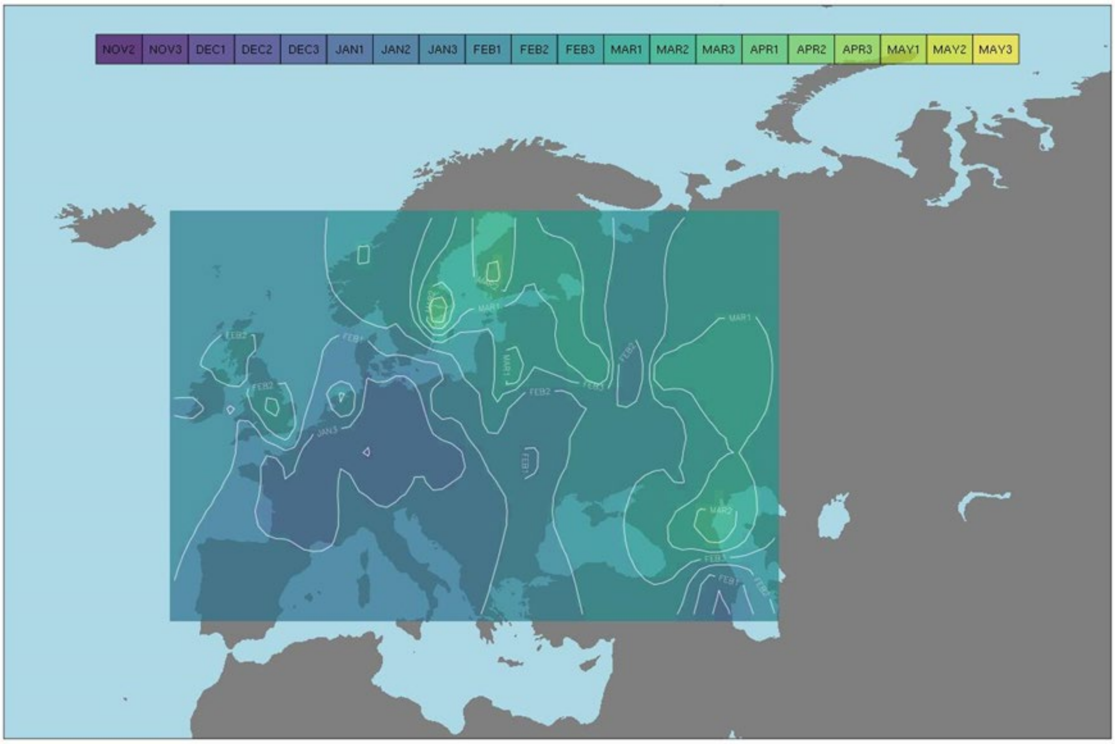


Fig. 3: Onset of pre-nuptial migration of Rook. The map shows the date when 5% of individuals are on migration.

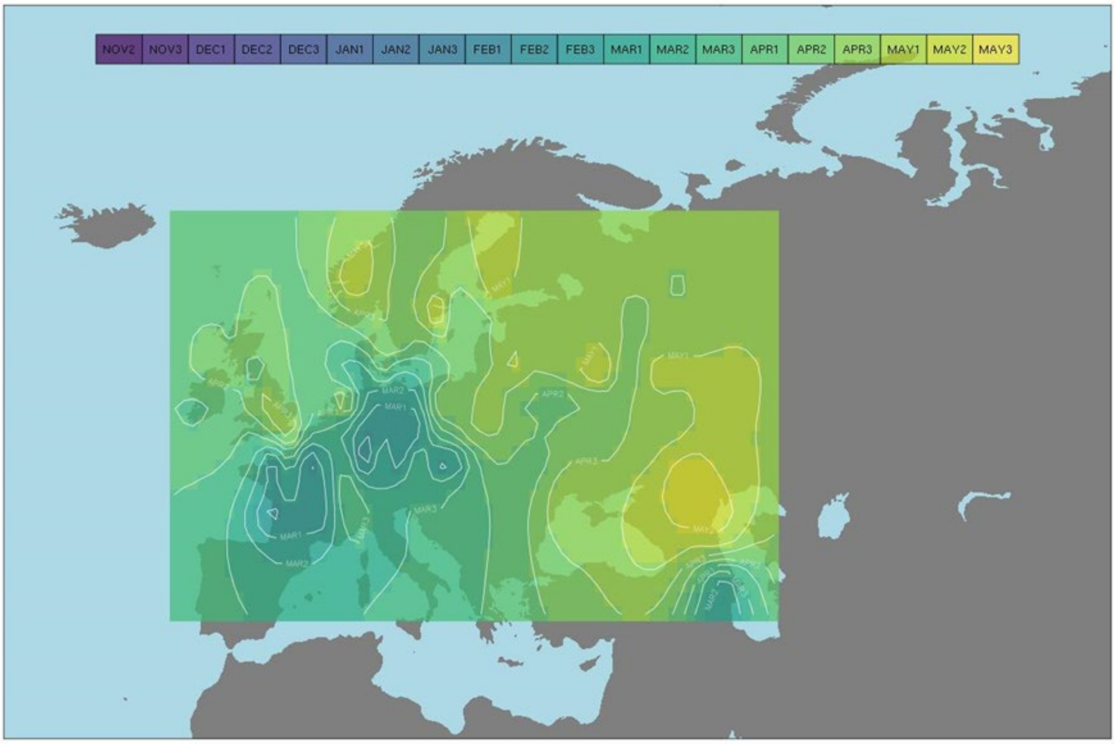


Fig. 4: Median migration date of pre-nuptial migration of Rook. The map shows the date when 50% of individuals are on migration.

15670 Carrion Crow *Corvus corone*

Recovery analysis

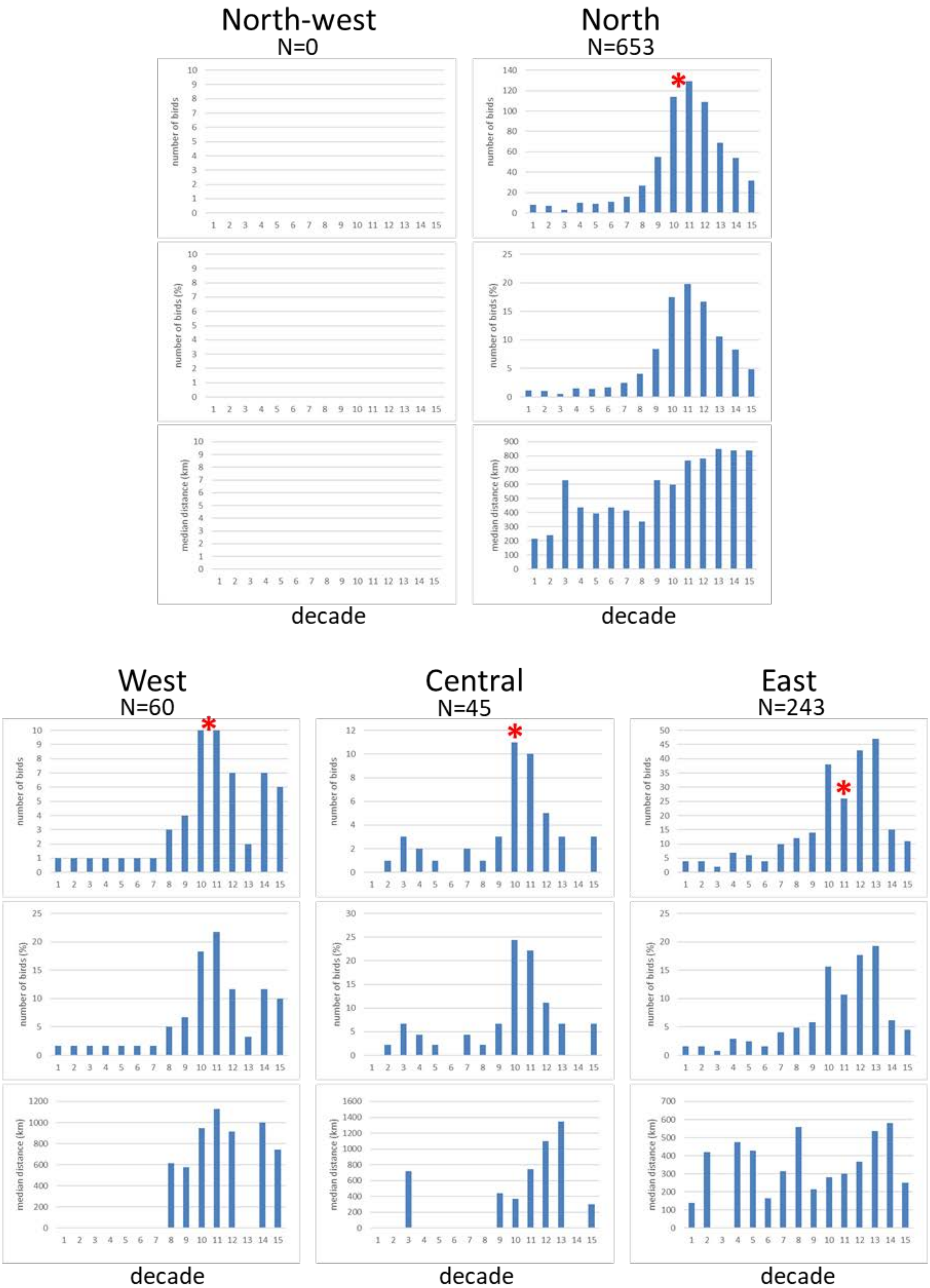


Fig. 1: Onset of prenuptial (return) migration of Carrion Crow by geographical region and decade. The asterix denotes the median date of onset of return migration. No data from South-west, South-central, South-east.

Mapping analysis

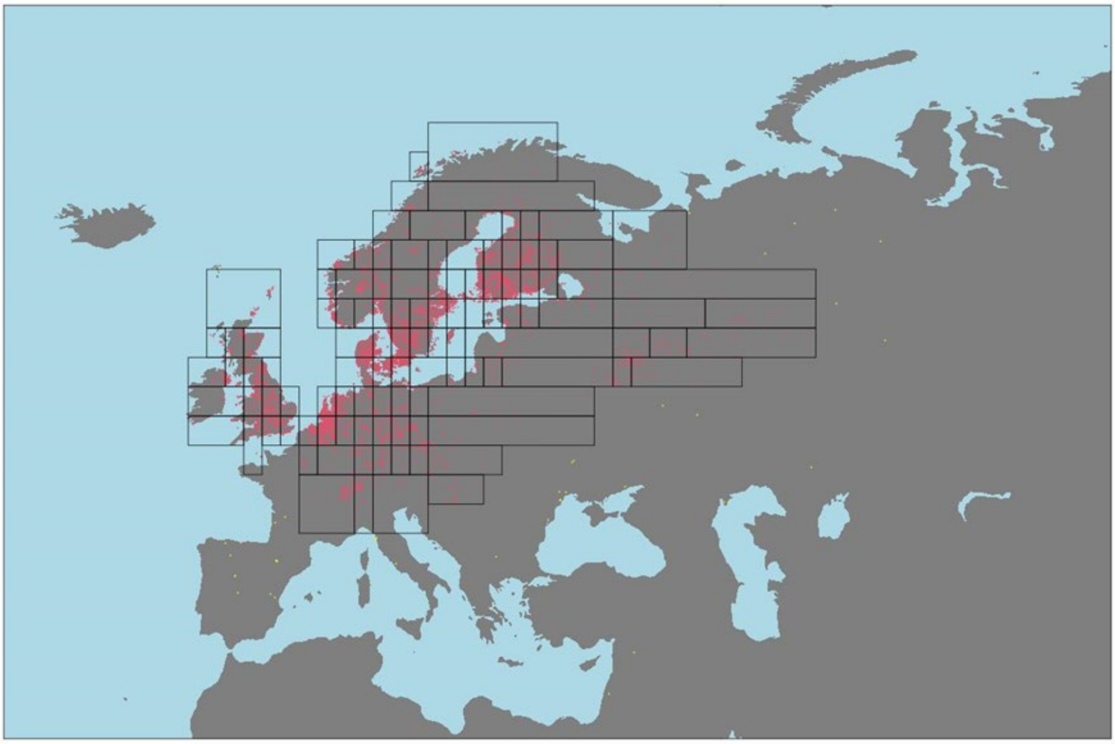


Fig. 2: Data availability for the analyses of Carrion Crow pre-nuptial migration. Red dots: encounters used (27,567), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 20, minimum number of different encounter dates in a cell = 10.

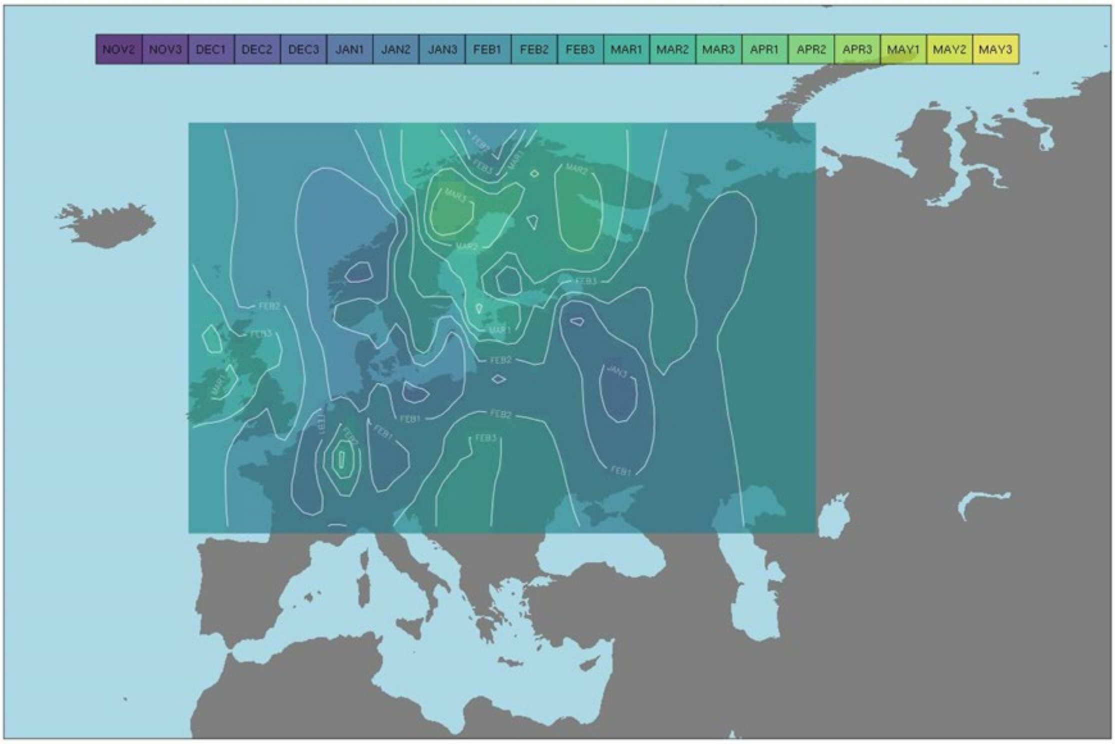


Fig. 3: Onset of pre-nuptial migration of Carrion Crow. The map shows the date when 5% of individuals are on migration.

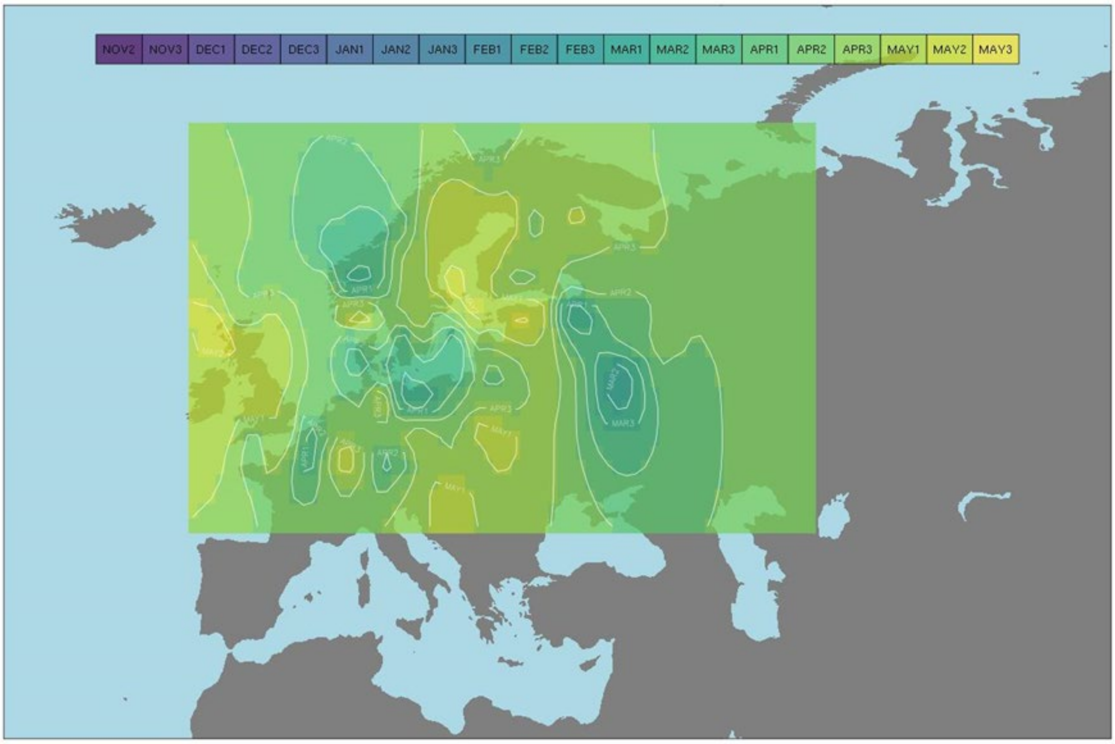
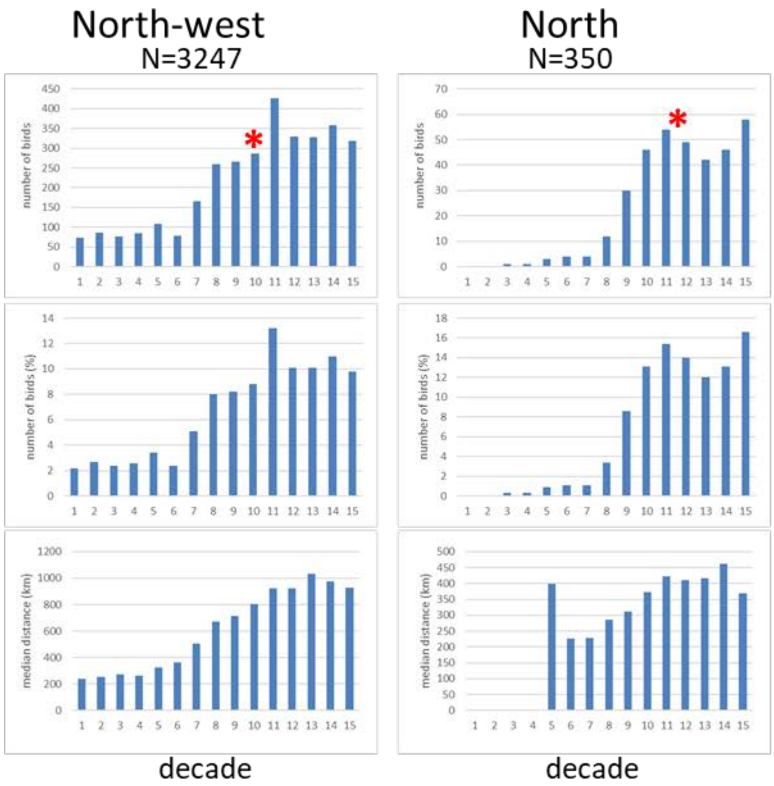
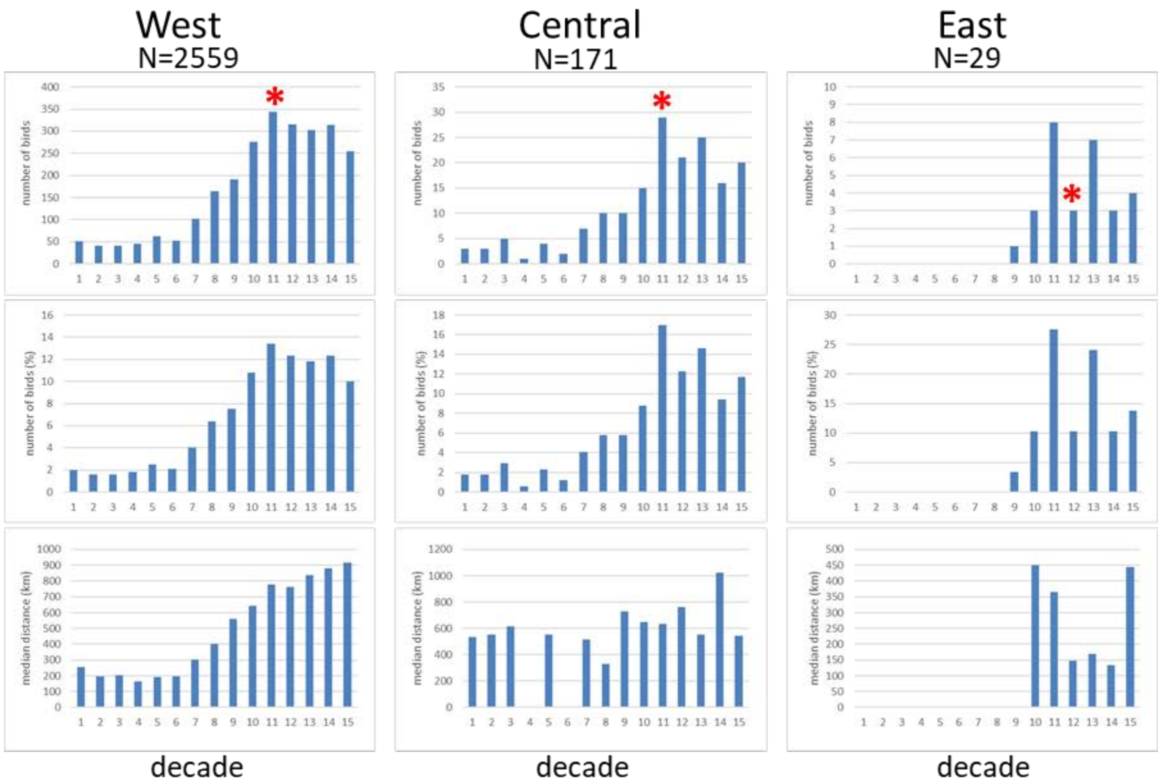


Fig. 4: Median migration date of pre-nuptial migration of Carrion Crow. The map shows the date when 50% of individuals are on migration.

15820 Common Starling *Sturnus vulgaris*

Recovery analysis





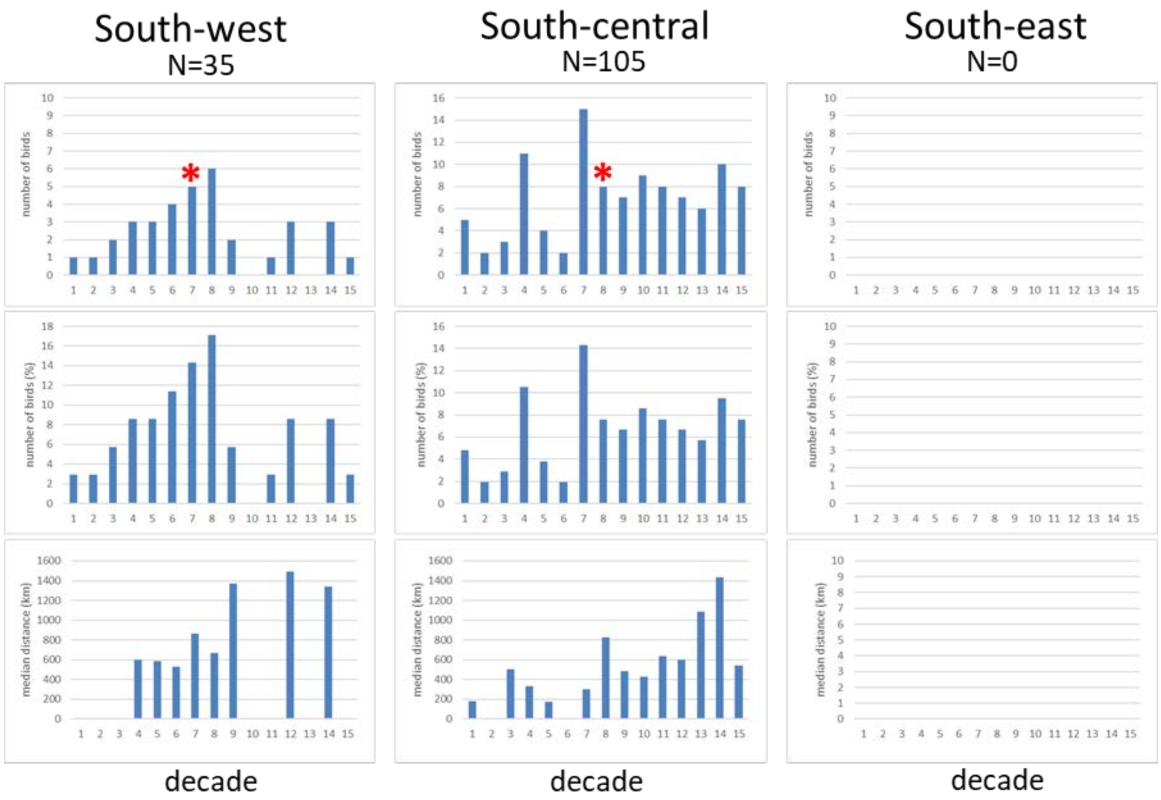


Fig. 1: Onset of prenuptial (return) migration of Common Starling by geographical region and decade. The asterix denotes the median date of onset of return migration. No data from South-west, South-central, South-east.

Mapping analysis

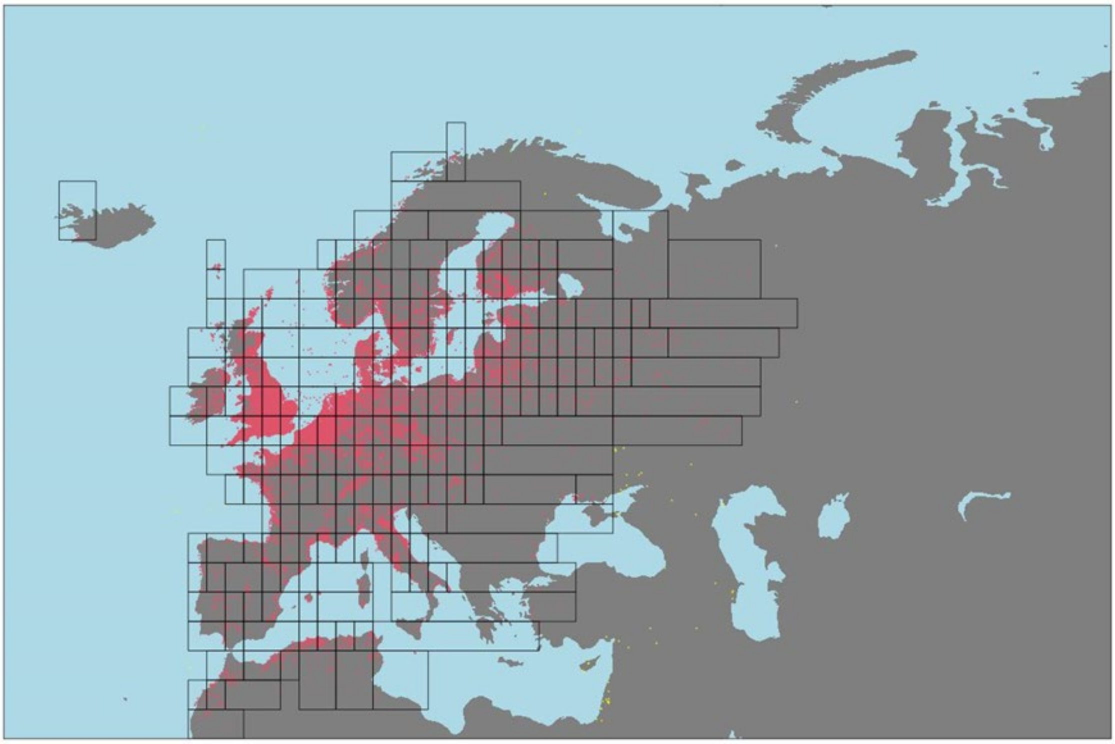


Fig. 2: Data availability for the analyses of Common Starling pre-nuptial migration. Red dots: encounters used (157,062), yellow dots: encounters discarded because they were isolated. Minimum number of encounters in a cell = 15, minimum number of different encounter dates in a cell = 7.

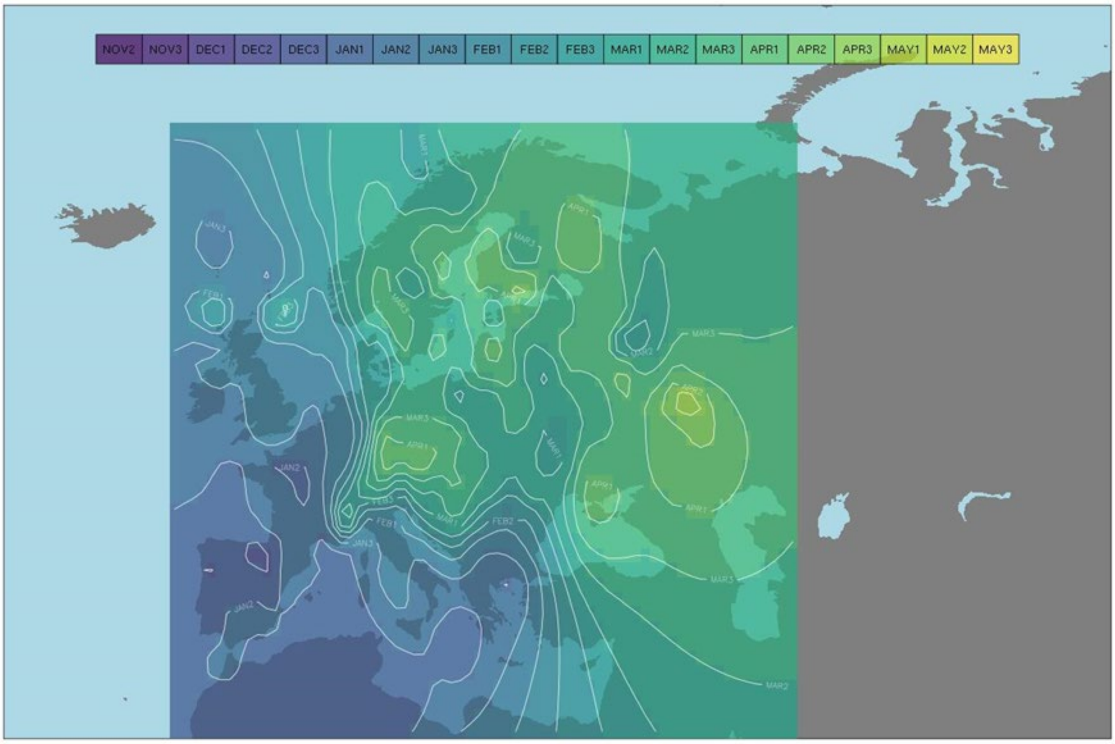


Fig. 3: Onset of pre-nuptial migration of Common Starling. The map shows the date when 5% of individuals are on migration.

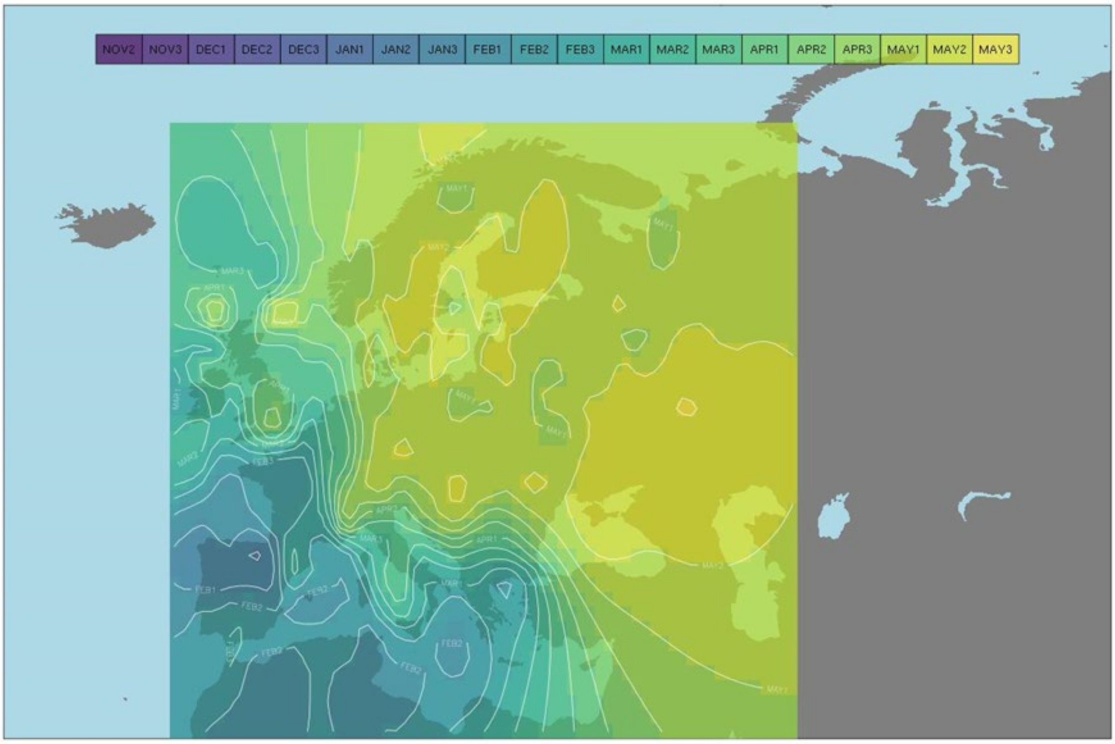


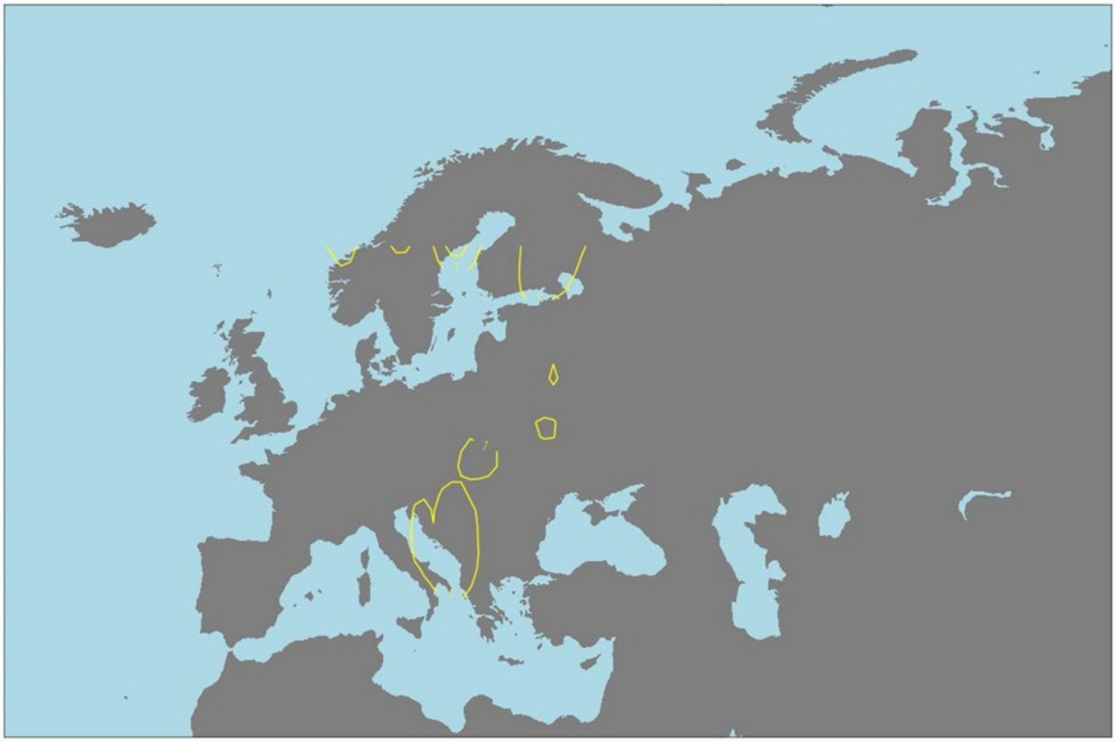
Fig. 4: Median migration date of pre-nuptial migration of Common Starling. The map shows the date when 50% of individuals are on migration.

Appendix 1

Pre-nuptial Migration Phenology

Maps of the standard error of the date of onset of pre-nuptial migration progression from the 27 models produced by the analyses with different combinations of parameter values. Lines include areas with similar values of standard error of onset date (in days).

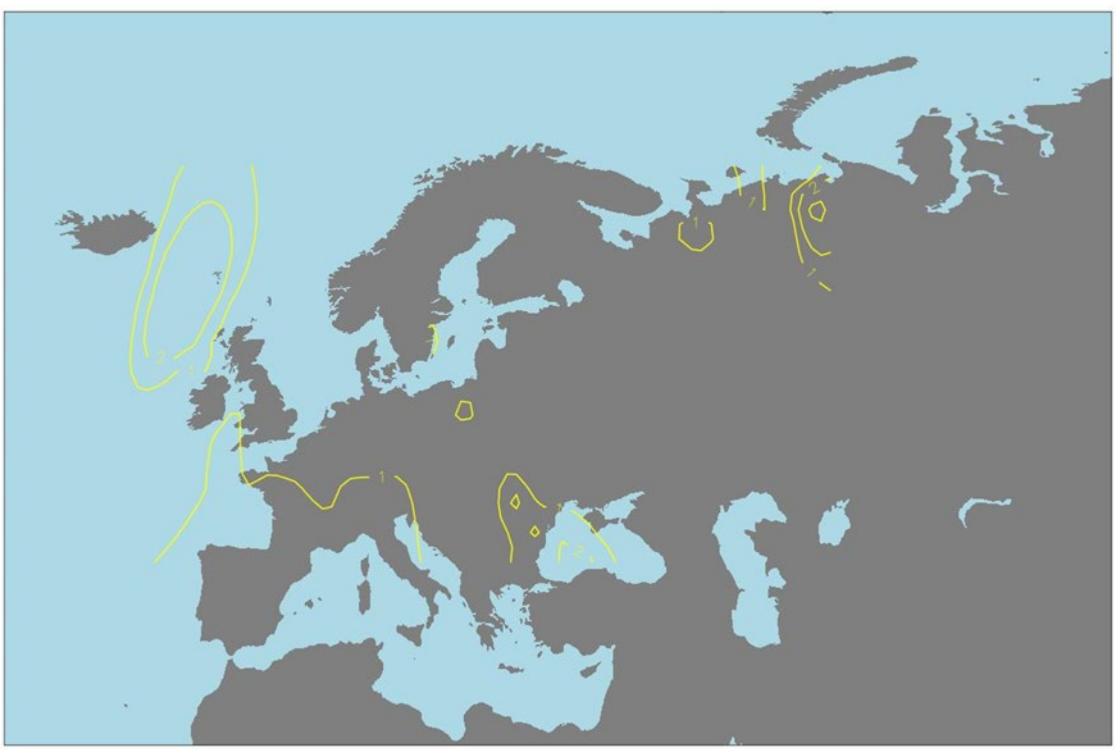
01520 ***Cygnus olor***



01570 ***Anser fabalis***

01580 *Anser brachyrhynchus*

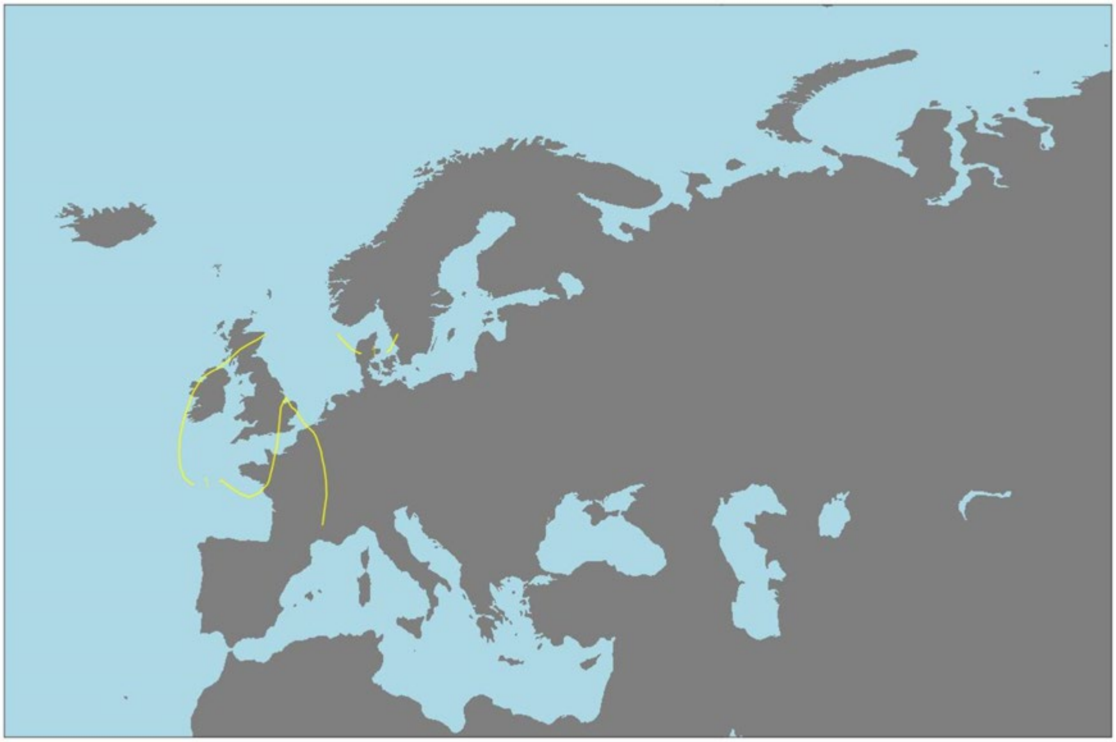
01590 *Anser albifrons*



01610 ***Anser anser***

01660 ***Branta canadensis***

01680 *Branta bernicla*



01790 *Anas penelope*

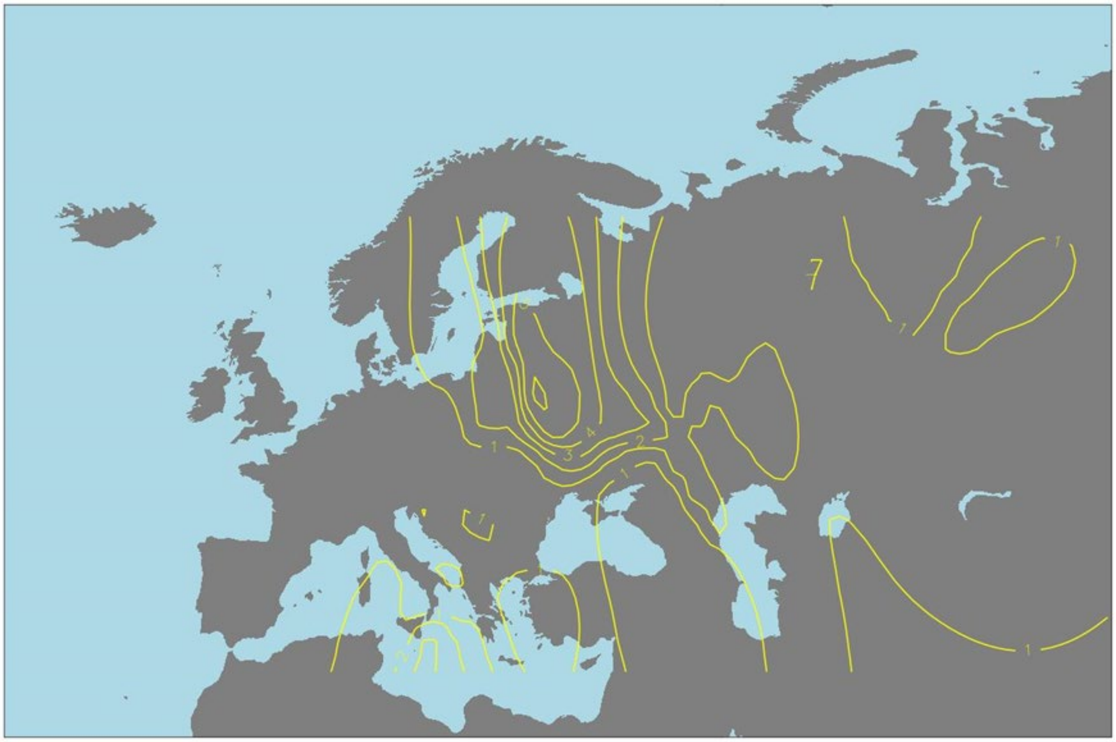
01820 ***Anas strepera***

01840 ***Anas crecca***

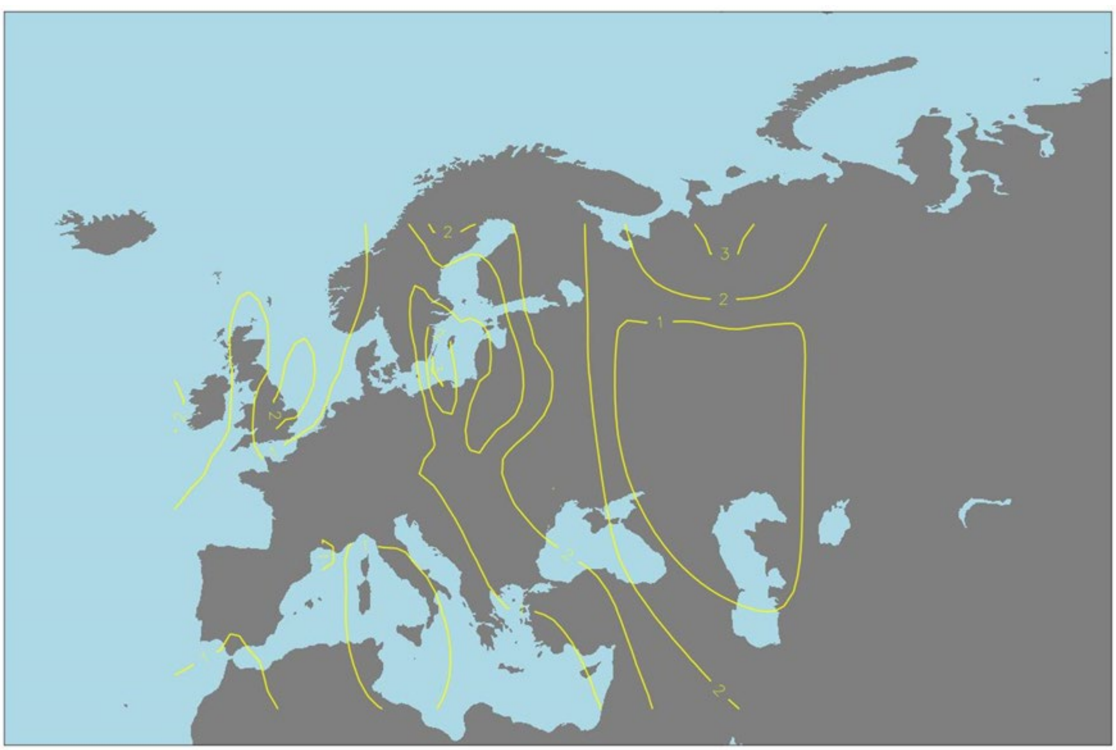
01860 ***Anas platyrhynchos***

01890 ***Anas acuta***

01910 ***Anas querquedula***



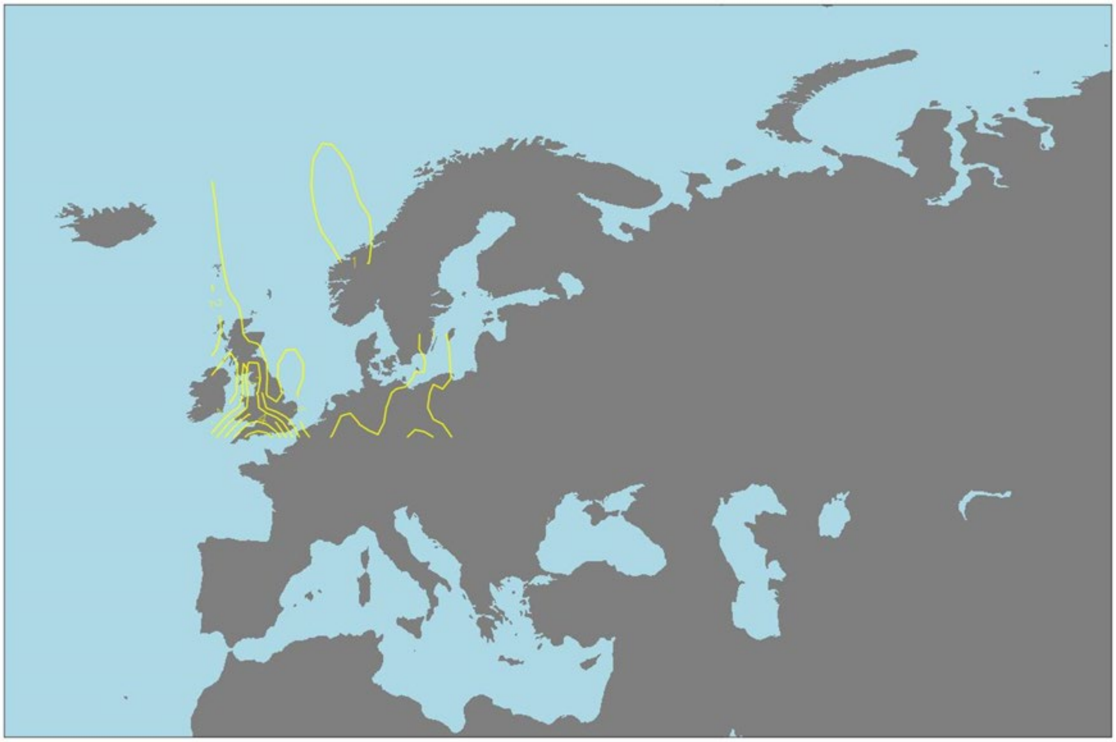
01940 ***Anas clypeata***



01980 ***Aythya ferina***

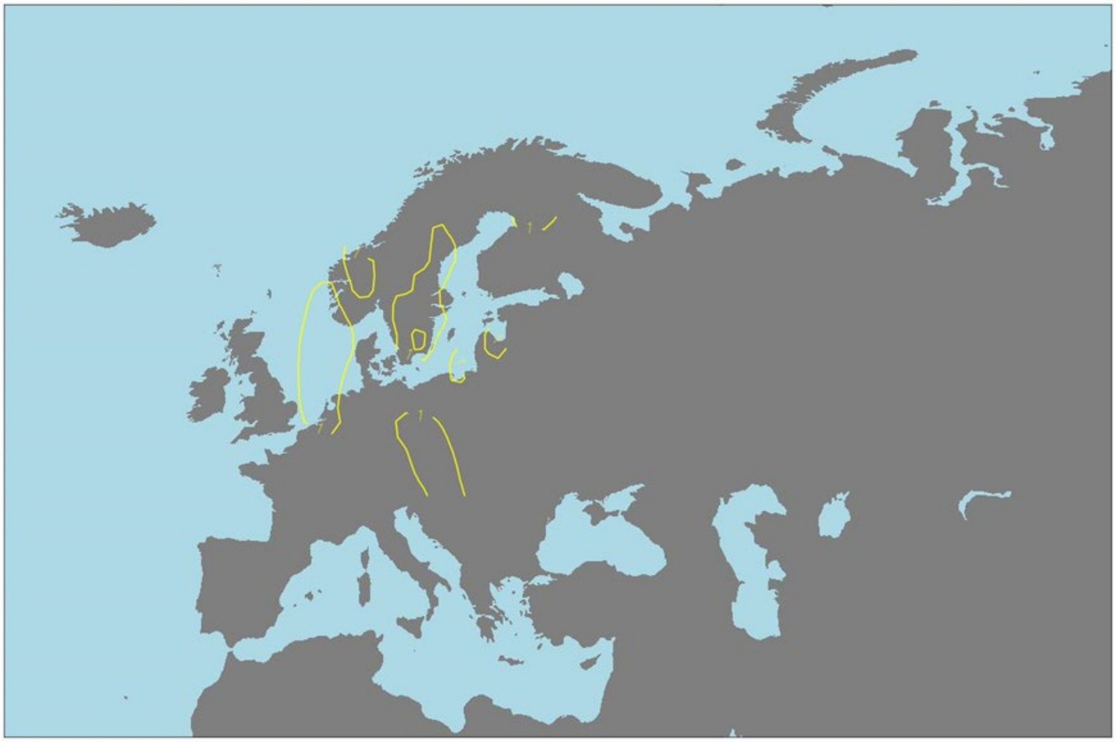
02030 ***Aythya fuligula***

02060 *Somateria mollissima*



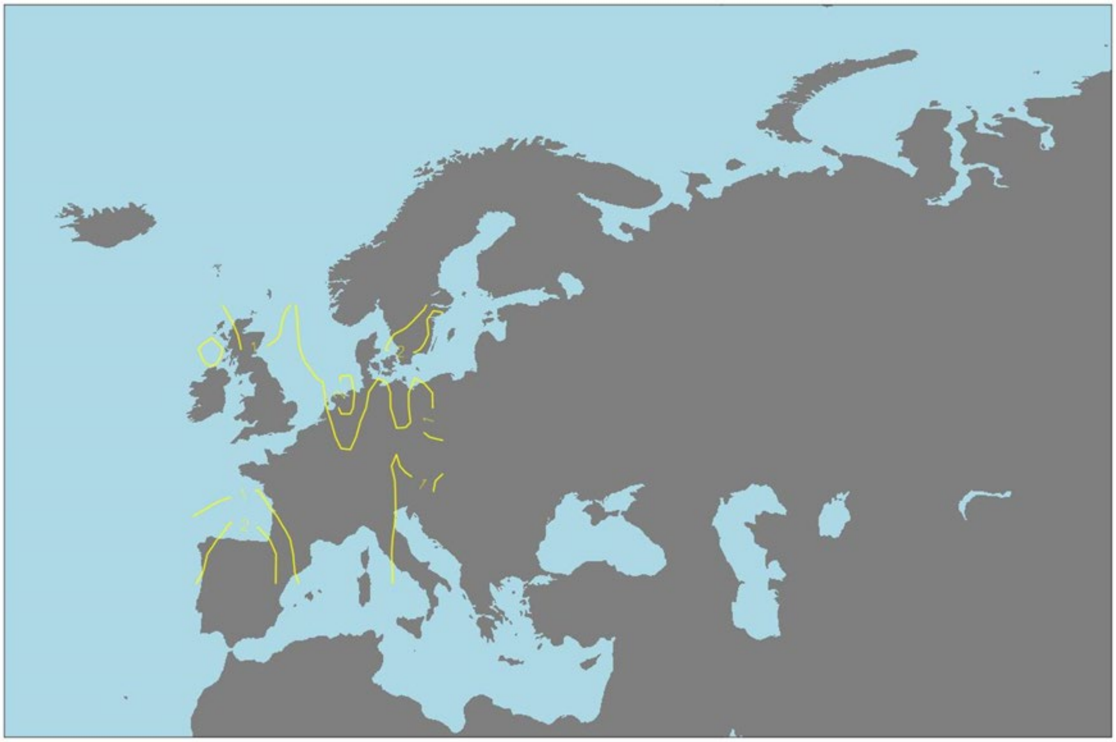
02180 *Bucephala clangula*

02230 *Mergus merganser*

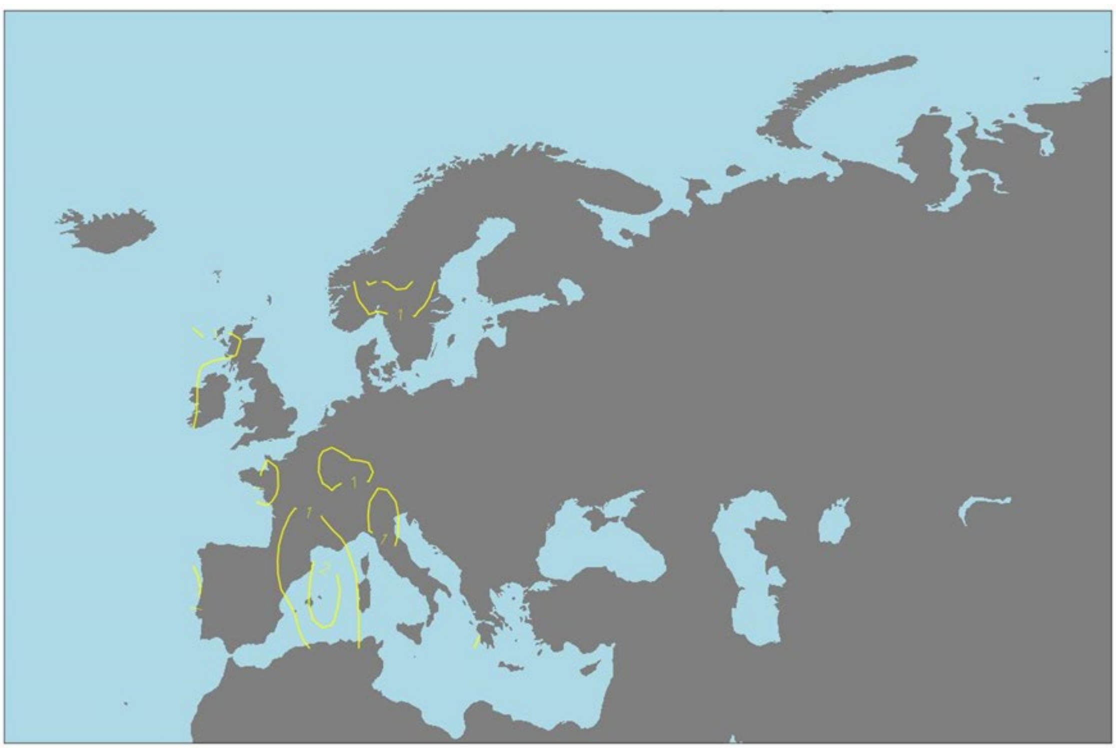


03700 *Coturnix coturnix*

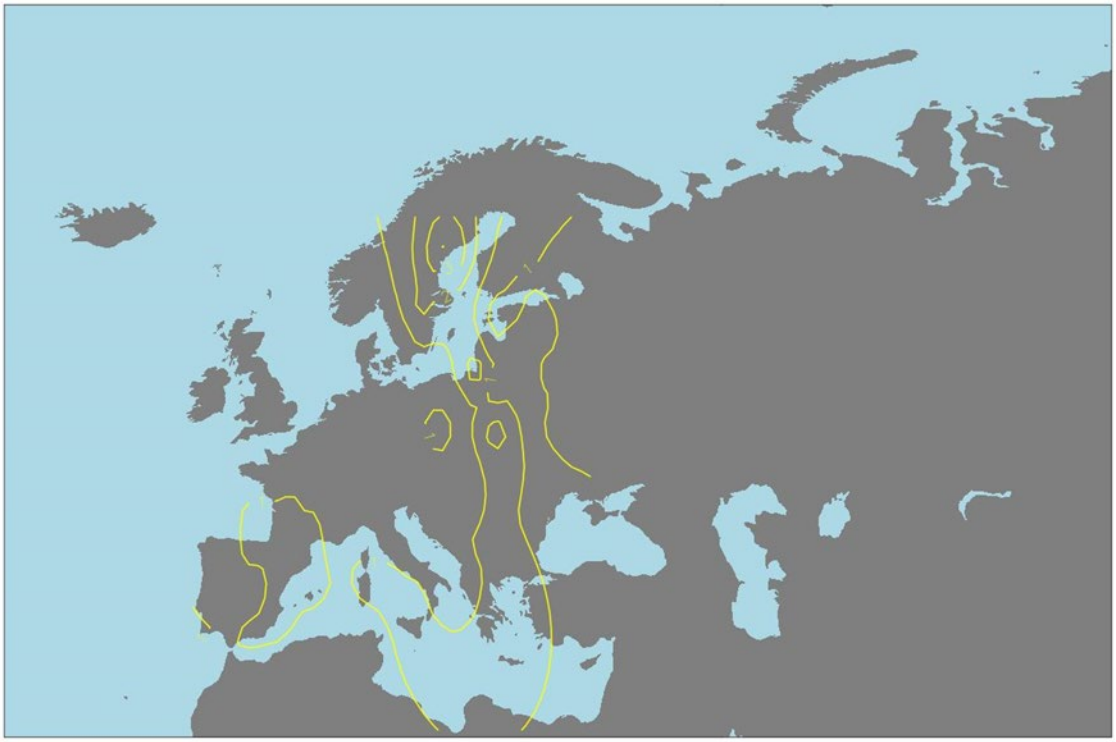
04070 *Rallus aquaticus*



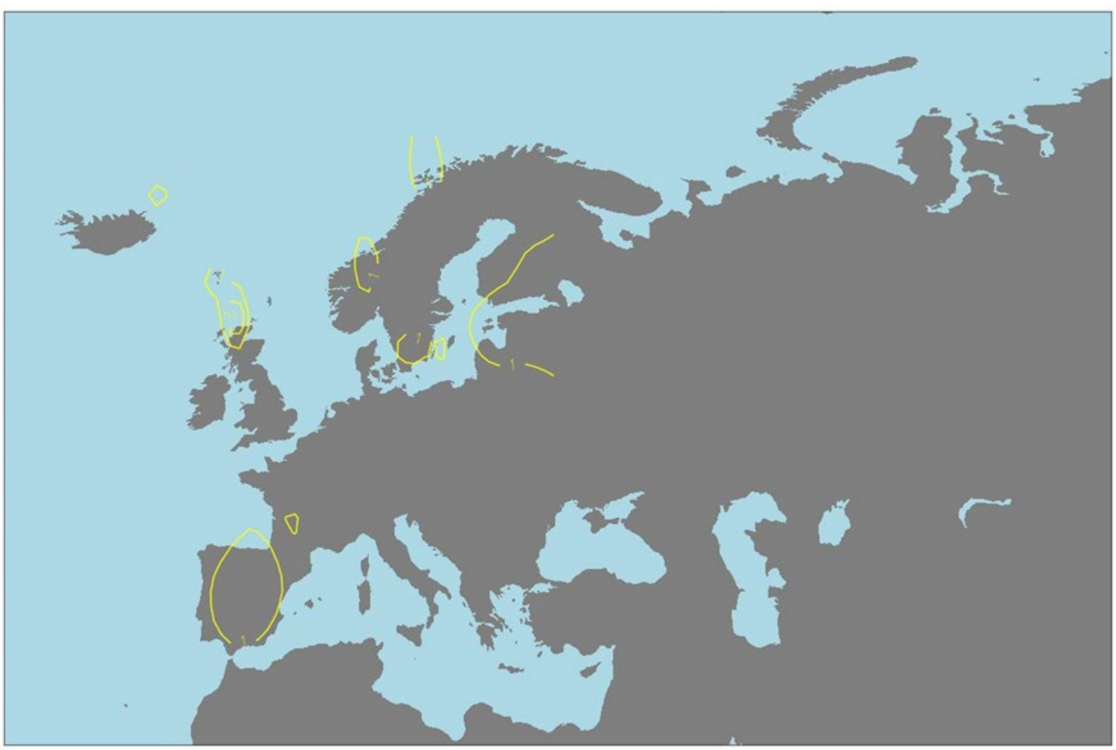
04240 *Gallinula chloropus*



04290 ***Fulica atra***

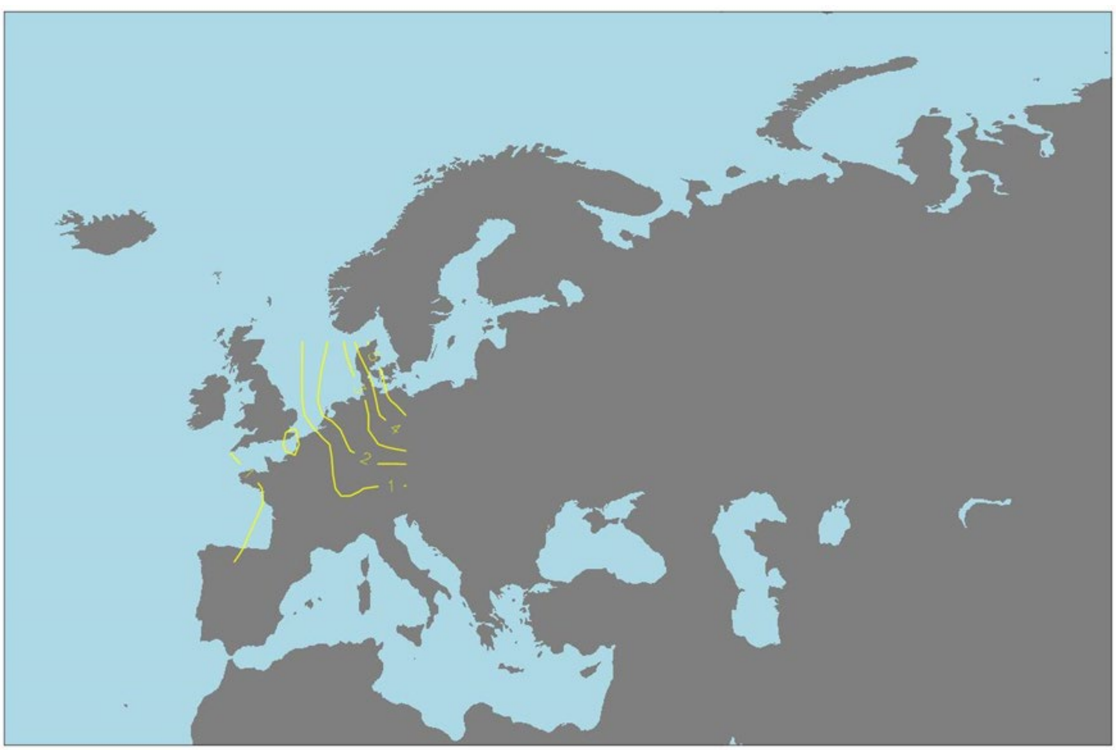


04500 ***Haematopus ostralegus***



04850 *Pluvialis apricaria*

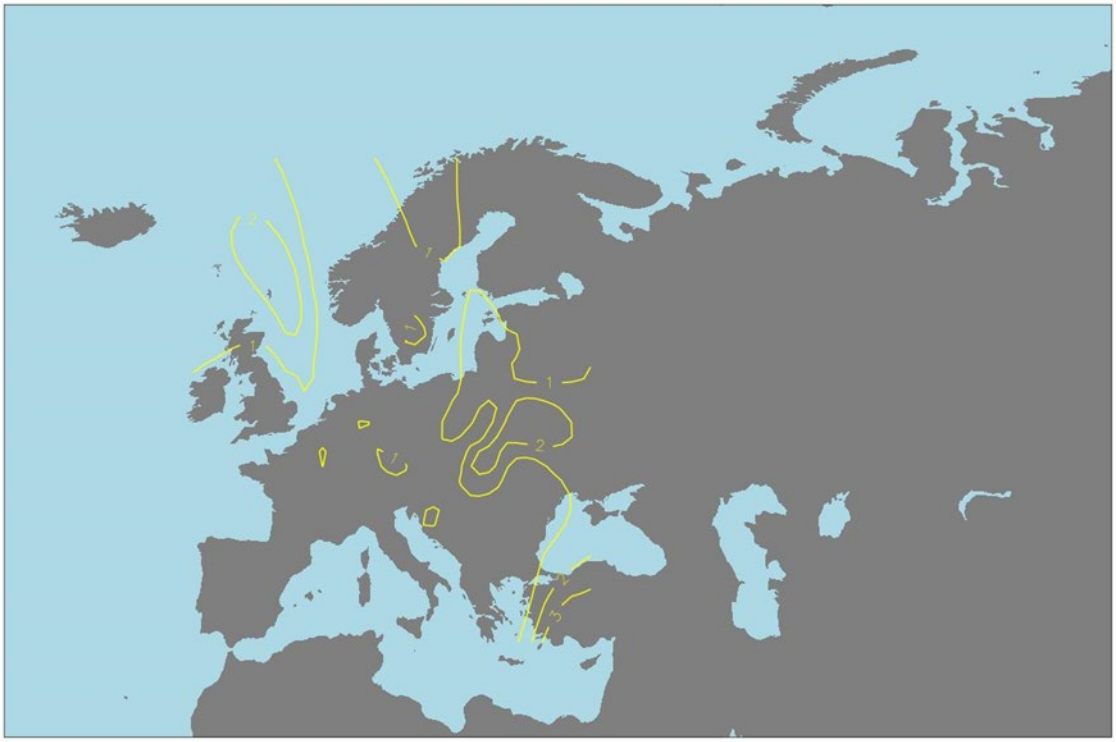
04860 *Pluvialis squatarola*



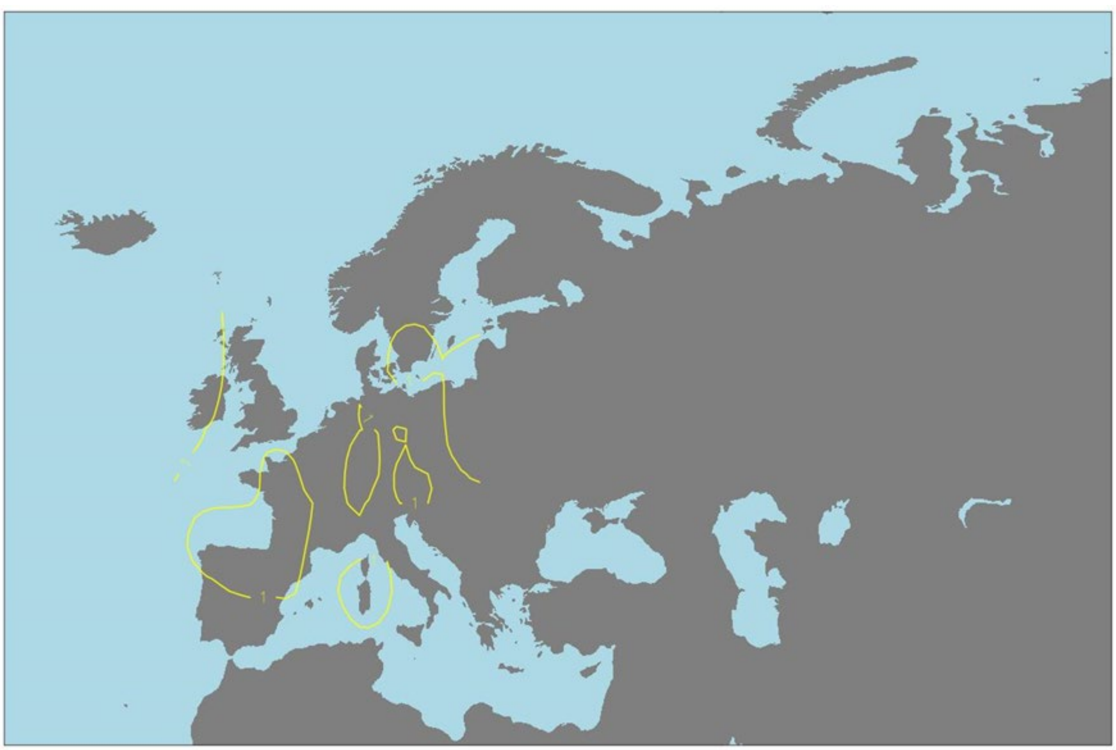
04930 ***Vanellus vanellus***

04960 ***Calidris canutus***

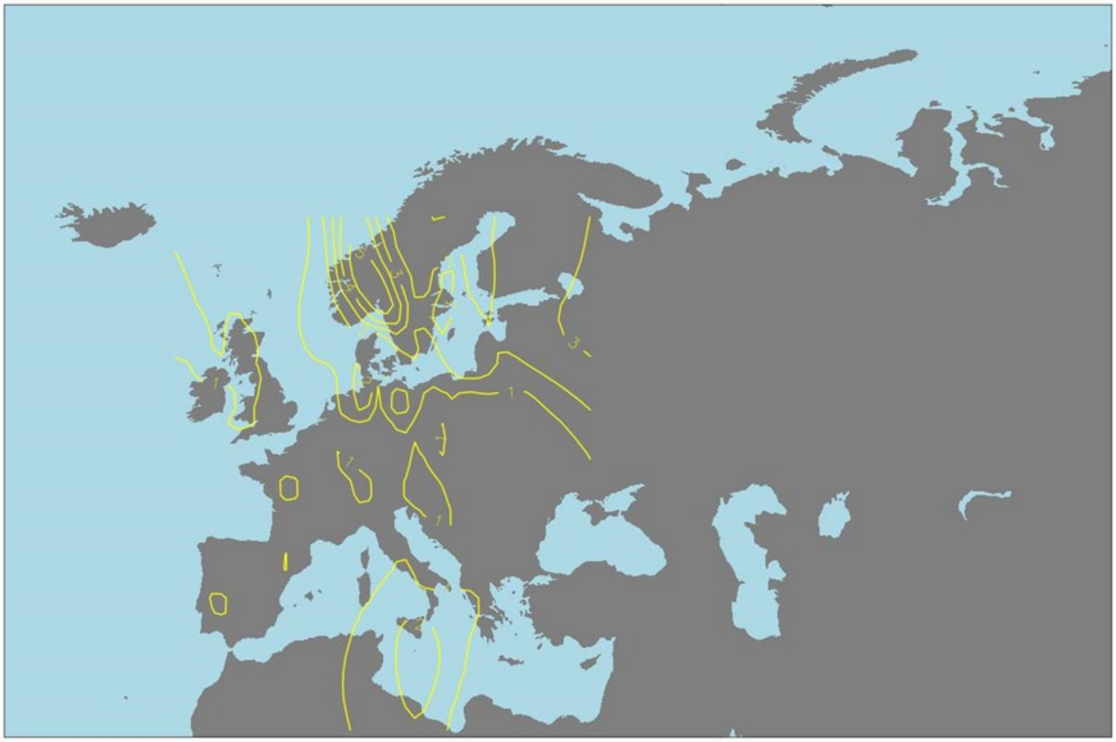
05170 ***Philomachus pugnax***



05180 ***Lymnocryptes minimus***

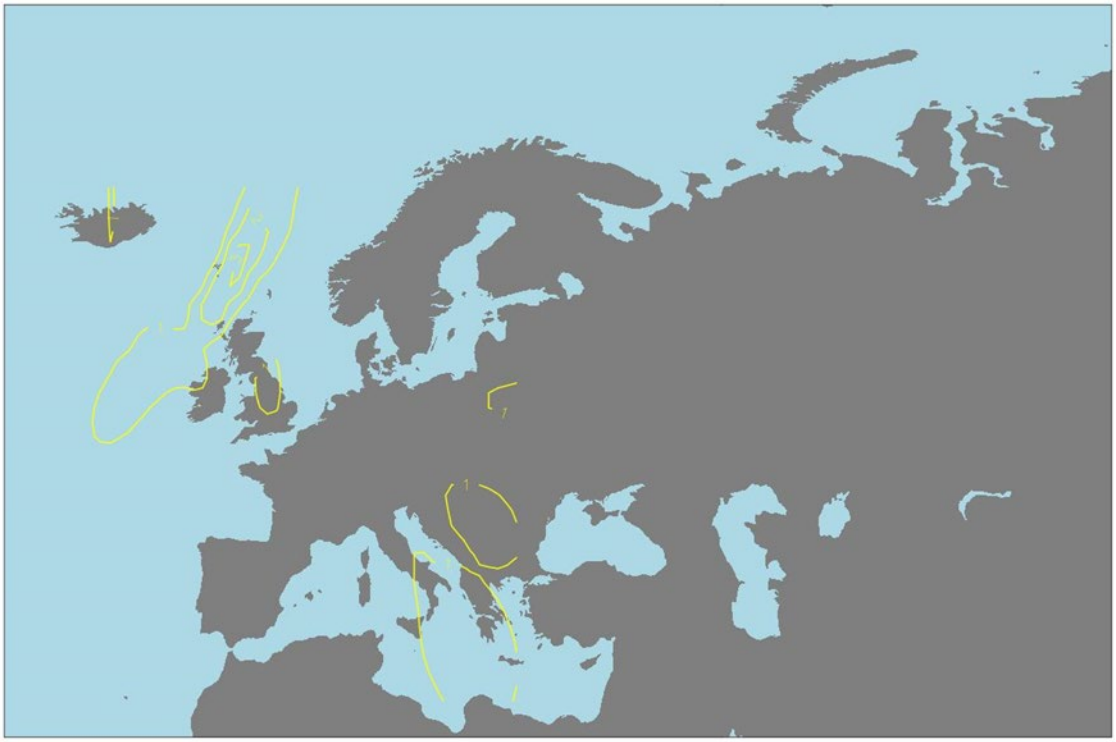


05190 *Gallinago gallinago*

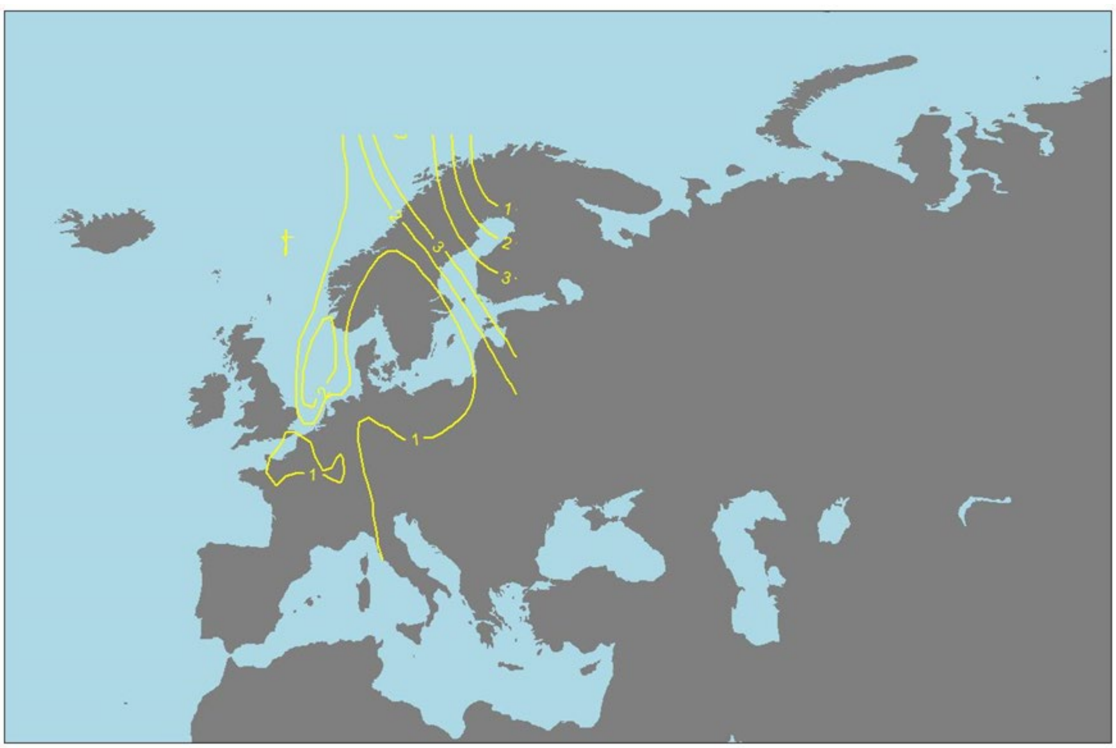


05290 *Scolopax rusticola*

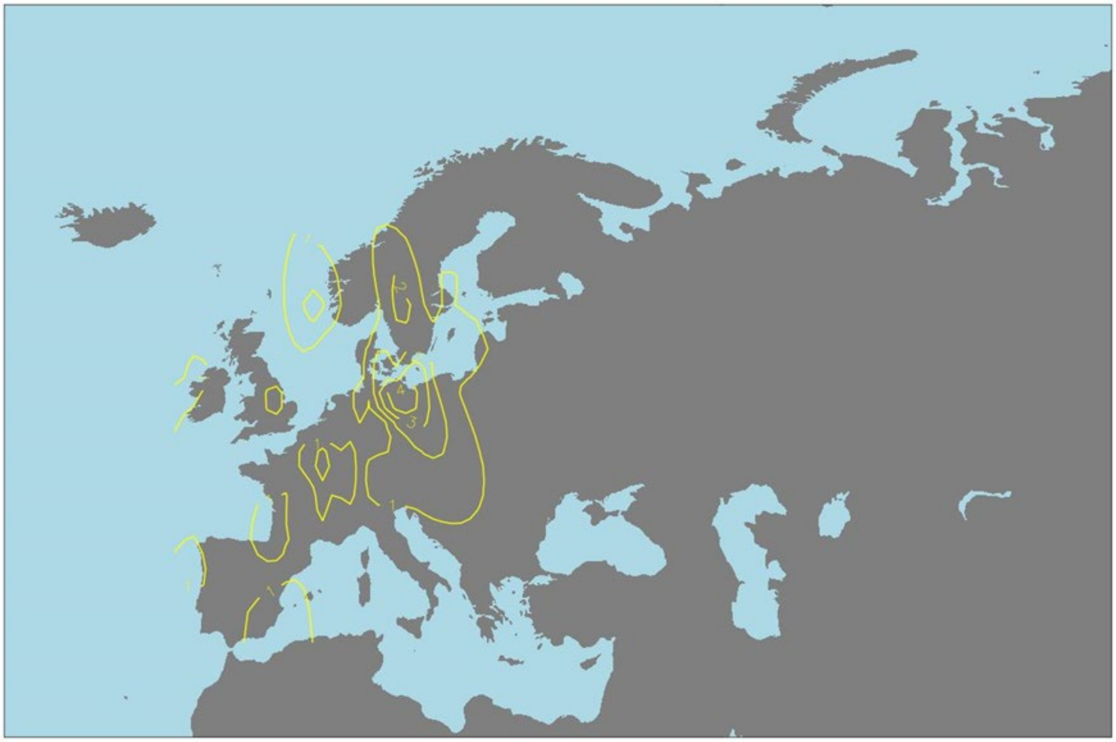
05320 ***Limosa limosa***



05340 ***Limosa lapponica***

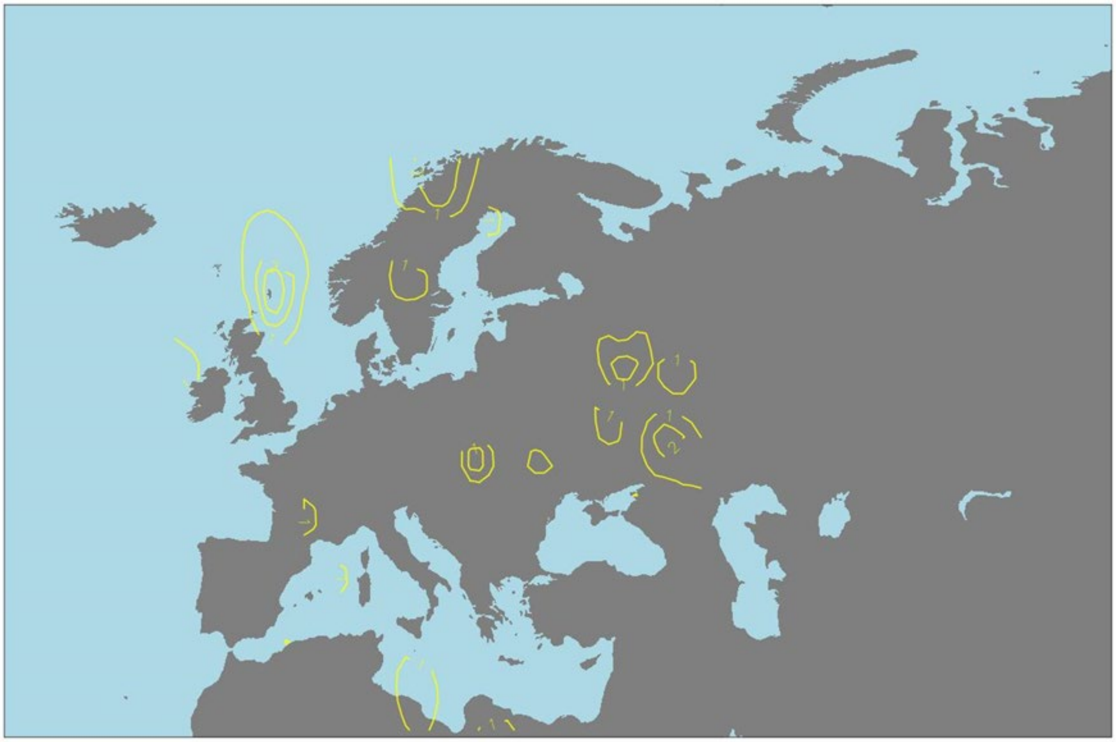


05410 ***Numenius arquata***

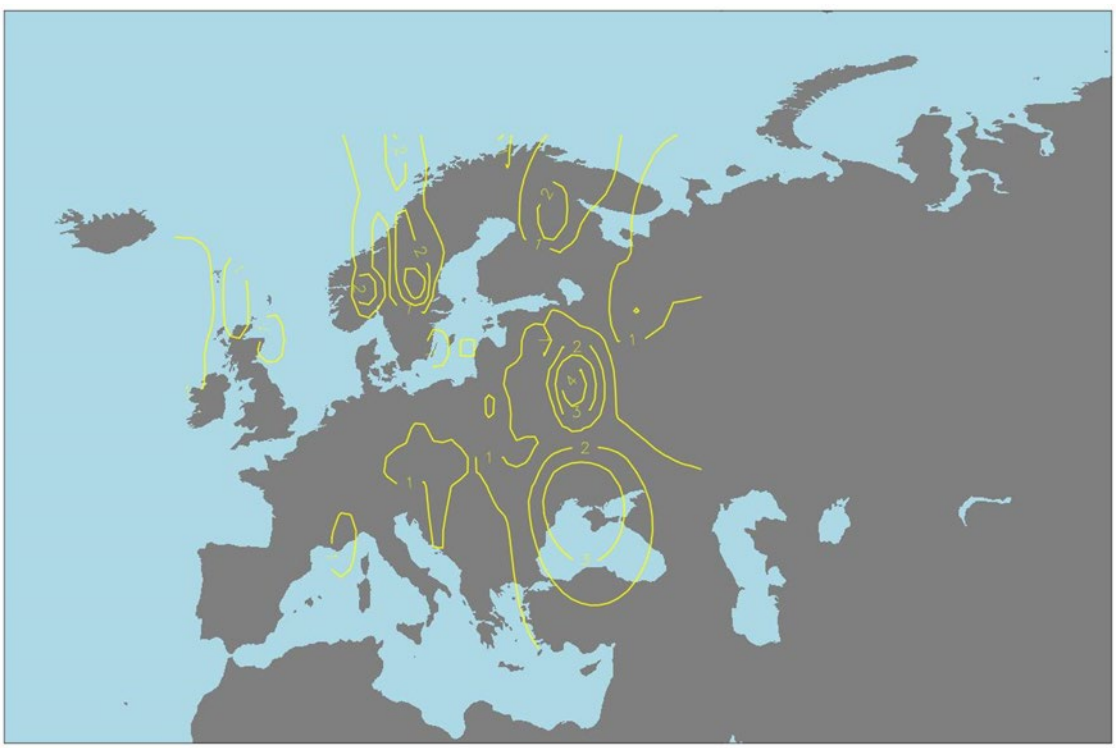


05460 ***Tringa totanus***

05820 *Larus ridibundus*

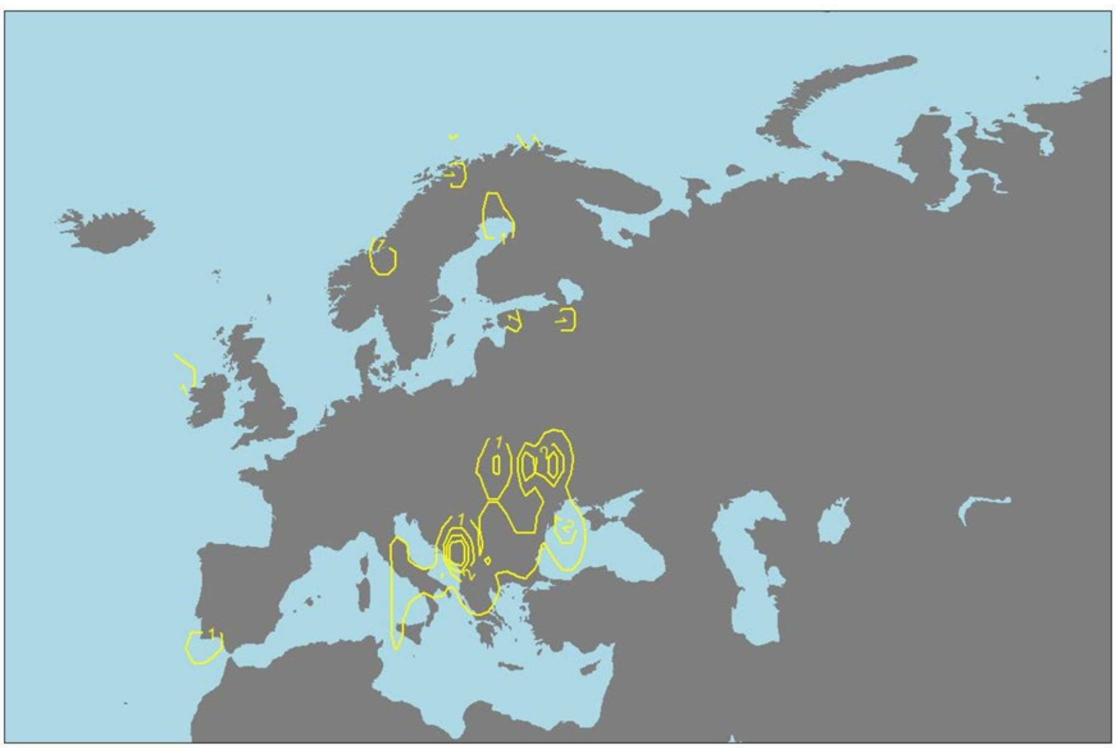


05900 *Larus canus*



05910 *Larus fuscus*

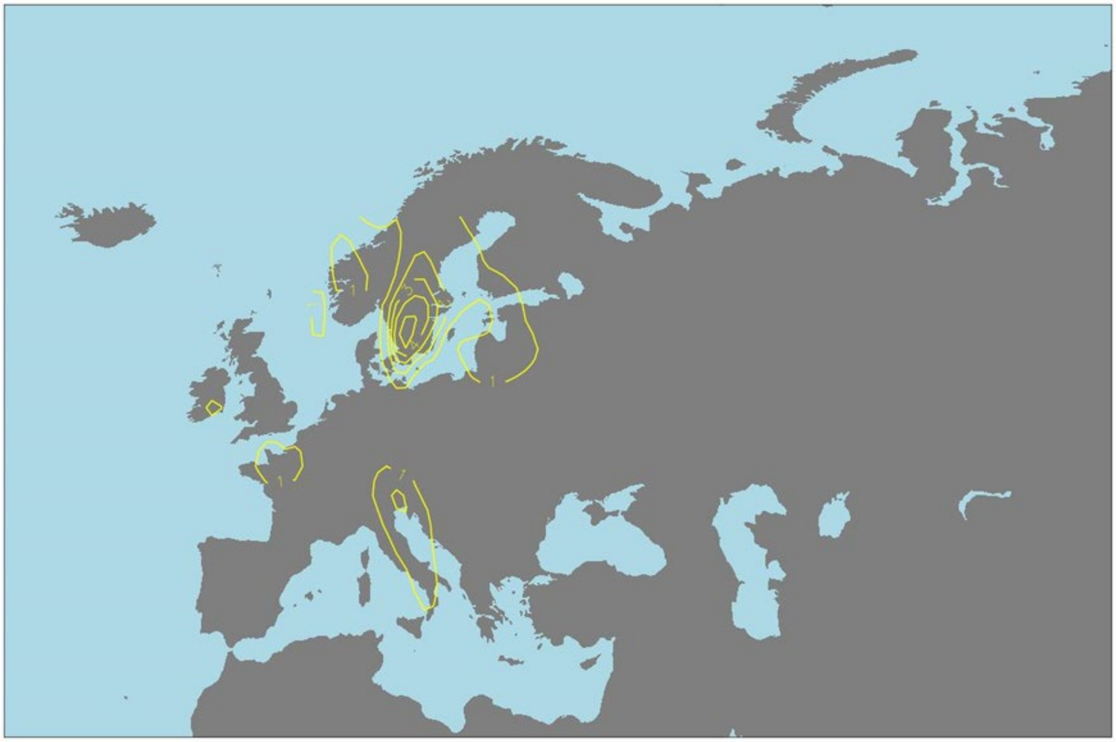
05920 *Larus argentatus*



06000 *Larus marinus*

06680 *Columba oenas*

06700 *Columba palumbus*



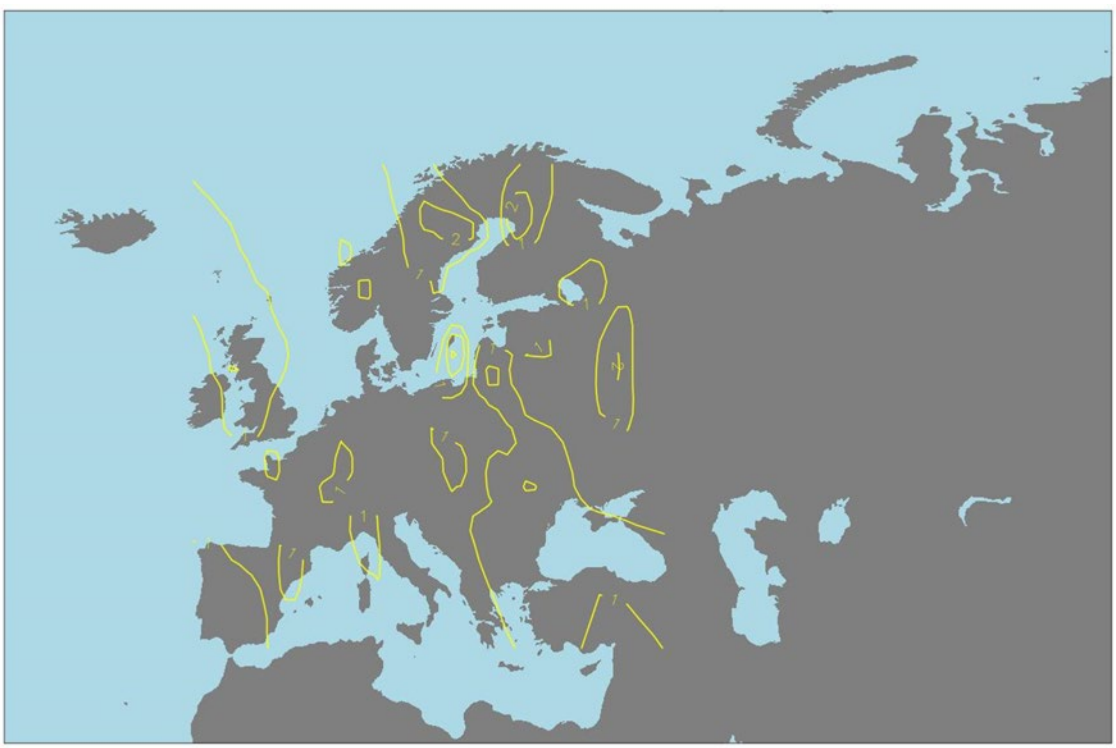
06840 *Streptopelia decaocto*

06870 *Streptopelia turtur*

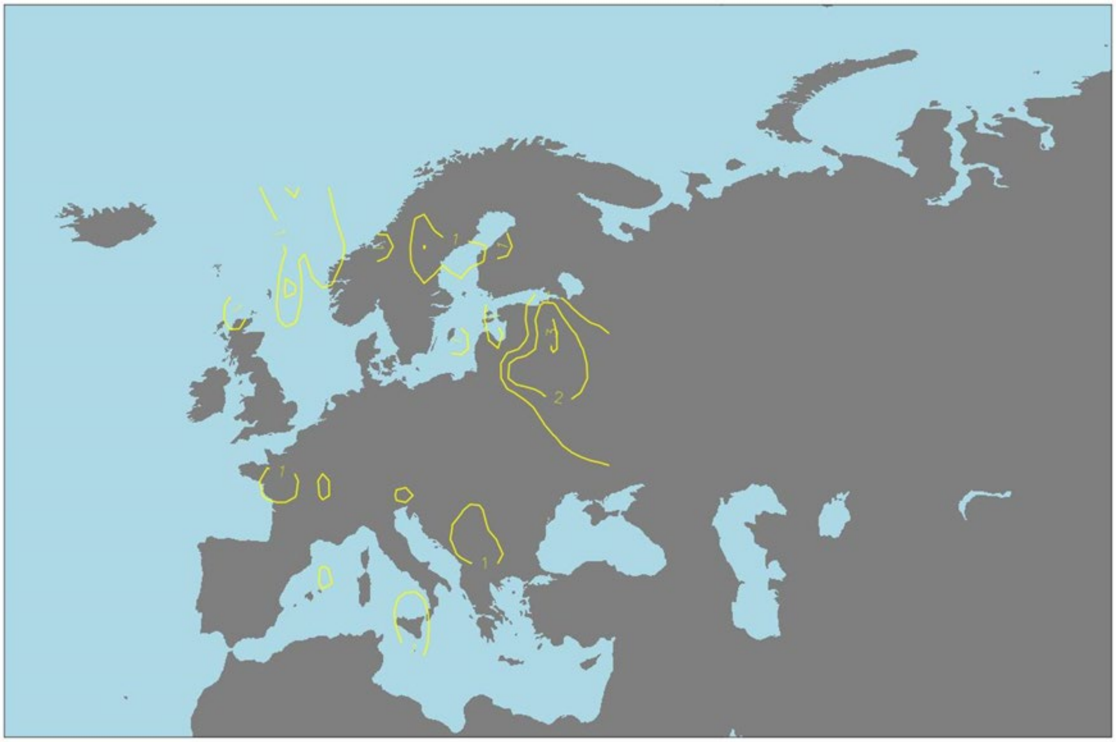
09760 *Alauda arvensis*

11870 *Turdus merula*

11980 *Turdus pilaris*



12000 *Turdus philomelos*



12010 *Turdus iliacus*

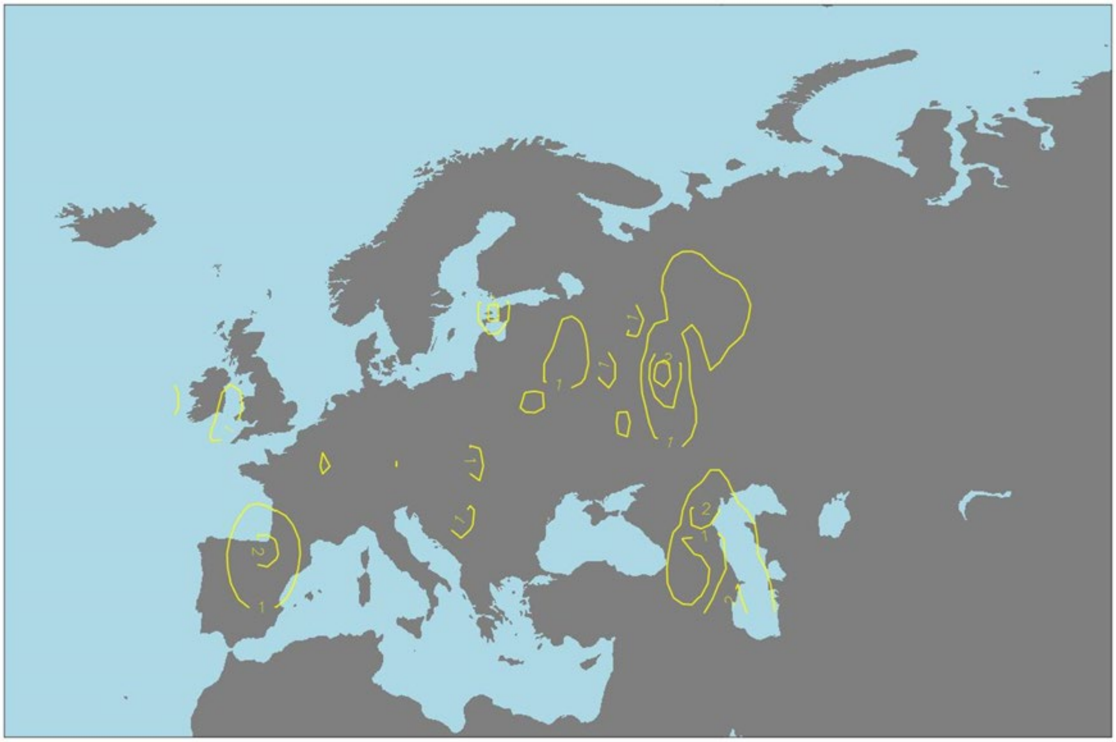
12020 ***Turdus viscivorus***

15390 ***Garrulus glandarius***

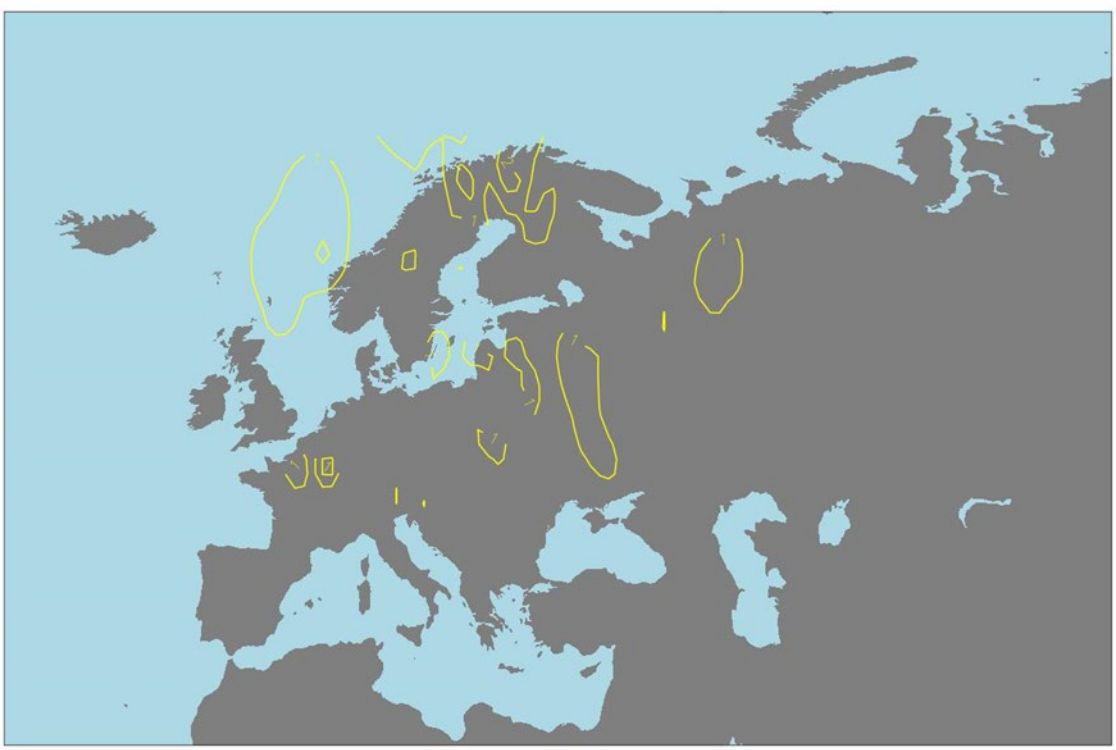
15490 *Pica pica*

15600 *Corvus monedula*

15630 *Corvus frugilegus*



15670 *Corvus corone*



15820 *Sturnus vulgaris*