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PROGRESS IN THE DEVELOPMENT OF AN EURASIAN-AFRICAN BIRD MIGRATION ATLAS

*(Submitted by the European Union of Bird Ringing (EURING)
and the Institute of Avian Research)*

Summary:

The African-Eurasian Bird Migration Atlas is being developed under the auspices of CMS in the framework of a Global Animal Migration Atlas, of which it constitutes a module.

The African-Eurasian Bird Migration Atlas is being developed and compiled by the European Union of Bird Ringing (EURING) under a Project Cooperation Agreement (PCA) between the CMS Secretariat and the Institute of Avian Research, acting on behalf of EURING.

The development of the African-Eurasian Bird Migration Atlas is funded with the contribution granted by the Government of Italy under the Migratory Species Champion Programme.

This information document includes a progress report on the development of the various components of the project. The project is expected to be completed in 2021.

Eurasian-African Bird Migration Atlas progress report

February 2020

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**A report to the Convention on Migratory Species
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Wilhelmshaven, Germany**

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Table of Contents

- 1. Abstract**
- 2. Ring recovery data management**
- 3. Tracking data management**
- 4. Species accounts**
- 5. Development of web tools and solutions**
- 6. Migration seasons of hunted species**
- 7. Killing of birds by man**
- 8. Connectivity analysis**
- 9. Historical changes in migration patterns**
- 10. Annex 1 – Provisional species list**

1. Abstract

- 1.1 The data management process is largely complete. New submissions have been received from 26 Ringing Centres and the EURING databank now contains 24.8 million encounter records. All data have been checked and contributing schemes have made corrections where possible.
- 1.2 Tracking datasets suitable for use in the Atlas have been identified and software for transmitting data from Movebank to the Atlas web application is nearing completion. Access to a range of tracking datasets has been established and discussions concerning access to further datasets are ongoing.
- 1.3 The set of maps and figures to be used for the species accounts has been defined and implemented in the widely used statistical software package R. There will be four core maps for each species: Overall connectivity by ringing region, connectivity by month and by region, annual movements (animated map) and recoveries by condition. Instructions for writing the species accounts have been developed and agreed and the species list has been established. Writing of the species accounts has now started.
- 1.4 The main components of the web application that will deliver the atlas have been designed and tested. Mockups have been produced for a range of electronic devices from mobile phones to desktop computers, and have generally been well received. Several streams of work to build the live web application (database structure, web application, core website and user interface) are ongoing.
- 1.5 Most of the analyses of the migration seasons of hunted species have been completed and an interim report has been prepared. Work on the second phase of analysis on modelling of the spatial-temporal onset of spring migration is ongoing.
- 1.6 Work on the killing of birds by man, with particular reference to illegal killing (IKB) has been planned and the main analyses will start shortly.
- 1.7 Methods of connectivity analysis have been implemented and applied to four sample species, cormorant *Phalacrocorax carbo*, teal *Anas crecca*, barn swallow *Hirundo rustica* and European robin *Erithacus rubecula*. The analytical methods worked well and showed varying levels of connectivity for all species. Work to extend these analyses to a much wider range of species is ongoing.
- 1.8 Work on historical changes in migration patterns has commenced. Some of the data analysis programs have been written and others are under development. The analyses are initially focussing on 10 example species with high quality datasets. They will be extended to a wider range of species based on these initial analyses.

2. Ring recovery data management

The EURING databank (EDB) is the primary dataset on which the Atlas is based. It contains ring recovery data from all bird ringing schemes accross Europe (du Feu et al 2016) and is managed by the BTO on behalf of EURING. Many schemes only submit updates to the EDB every few years, so an immediate priority has been to request additional submissions so that the data used for this project are as up-to-date as possible. This process has been very successful and a large number of new data submissions have been received and processed (Table 1.1), ensuring that the Atlas will be based on the most comprehensive dataset yet assembled. This has involved a very substantial amount of work by the contributing schemes, by the EDB Manager Dorian Moss and by the Atlas team at the BTO. Full details of the contents of the EURING databank are available on the EURING website. Further information on the species that we plan to include in the Atlas and the volumes of data available is provided in section 4 below.

All ringing schemes undertake their own data validation processes but due to variations in software and staff availability data checking standards are not uniform. Therefore the second stage of the data preparation process was to run a large series of systematic checks on all data. Flags were added to each record to indicate whether or not they had passed or failed each check. Schemes were then provided with lists of potentially erroneous records and asked to check and correct them. Many have done so, allowing the check flags to be updated so that the data can be used for the Atlas. Where we have detected errors but Ringing Schemes have been unable to resolve them they will not be used in relevant Atlas analyses.

The EURING databank has long been based on the principle that all ring recovery data remain the property of the contributing Ringing Schemes, and may only be supplied to analysts for defined purposes and with the agreement of the relevent contributing schemes. Procedures for managing this process for small and moderate data requests (usually for data from one or a few species) are operated online via the EURING website. However because the Atlas involves a high proportion of the recovery data owned by every member scheme special data access arrangements are needed. Procedures have been agreed with CMS whereby EURING has provided CMS with a fixed term license to use the EDB recovery data in the Atlas. This license will initially be for a period of six years and will be renewable by mutual agreement. EURING then requires member schemes to sign an agreement that allows the use of their data in the Atlas. This agreement has been prepared and was discussed with member schemes at the EURING General Meeting in September 2019. The agreement is now being finalized and member schemes will be invited to sign it shortly, well in advance of the publication of the Atlas. EURING member schemes are highly supportive of the Atlas project.

Table 2.1 New submissions to the EURING databank during the Atlas project

Ringling Scheme	Date	Note or action	Records held in EDB	Most recent data
Belgium - Bruxelles (BLB)	07/08/2018	New dataset loaded	1465731	2018
Belgium - Bruxelles (BLB)	13/01/2020	New dataset, corrected after error reports	1608348	2019
Bulgaria - Sofia (BGS)	31/10/2019	New data submission received, checked and loaded	16451	2015
Channel Islands - Jersey (CIJ)	03/11/2019	New data submission, comprising entire database. Extracted recoveries, corrected errors and loaded	102571	2019
Croatia- Zagreb (HRZ)	04/12/2019	2017-19 data plus corrections following error checks received, combined with existing data, duplicates removed and checks made. Data loaded after further corrections	40122	2019
Czech Republic - Praha (CZP)	04/06/2019	Dataset corrected following error reports, and recent data added	488866	2019
Denmark - Copenhagen (DKC)	14/12/2018	Loaded new dataset including known problem records	391998	2018
Denmark - Copenhagen (DKC)	06/01/2020	New dataset received, following error reports. Scheme unable to make further corrections now, so deleted errors and loaded data	366014	2018
Estonia – Matsalu (ETM)	07/01/2019	New dataset received, including corrections as well as latest data.	63406	2018
Finland – Helsinki (SFH)	17/04/2019	Loaded new dataset	2105035	2019
France – Paris (FRP)	10/07/2018	Replacement dataset received, checked and loaded. Error logs sent to FRP		
France – Paris (FRP)	28/02/2019	New dataset with all movements of 5km or more and all dead recoveries loaded	172266	2019
Germany – Hiddensee (DEH)	08/06/2019	Completely updated dataset received and loaded after several corrections made to interim subsets	1152087	2019
Germany – Hiddensee (DEH)	11/11/2019	Dataset corrected by scheme following error reports, new version with updates received, checked and loaded after further corrections by scheme	1167360	2019
Germany – Radolfzell (DER)	08/06/2019	New dataset with a large increase in the number of records loaded after resolution of errors	1188562	2019
Hungary – Budapest (HGB)	06/03/2019	New dataset received, errors corrected	124466	2019
Iceland – Reykjavik (ISR)	06/12/2019	Reworked previous data, removed duplicates but no new data received	14619	2016
Italy – Bologna (IAB)	28/02/2019	Revised dataset loaded, earlier errors had been removed by scheme	800301	2018
Lithuania – Kaunas (LIK)	30/05/2019	New dataset with corrections to errors which had been notified to scheme	144287	2019
Lithuania – Kaunas (LIK)	04/11/2019	New dataset received with further updates	147155	2019

Netherlands – Arnhem (NLA)	27/11/2019	All ringing records sent but only recoveries loaded. Errors deleted and remainder loaded	2668412	2019
North America (USA/Canada) – Washington (NAW)	04/10/2018	Data up to 2017 received and converted to EURING 2000+ format	614	2017
Norway – Stavanger (NOS)	28/06/2019	New dataset with corrections to errors and substantial amount of new data	966973	2019
Norway – Stavanger (NOS)	06/11/2019	Revised dataset with reduced coordinate accuracy for sensitive species	975366	2019
Poland – Gdansk (PLG)	31/08/2018	New dataset loaded, error reports sent to scheme	984977	2017
Poland – Gdansk (PLG)	05/12/2019	New dataset received, including updates and correction	1175250	2019
Slovakia – Bratislava (SKB)	06/01/2020	New dataset received, corrections made	107805	2019
Slovenia – Ljubljana (SLL)	14/11/2019	New dataset received, birds ringed in Slovenia and recovered abroad. Corrected data loaded	6979	2019
Spain - Madrid (ESS)	10/12/2019	New dataset including corrections made following error reports	777141	2019
Spain - San Sebastian (ESA)	06/03/2019	Loaded revised data following receipt of further corrections	162972	2019
Spain - San Sebastian (ESA)	05/12/2019	New enlarged dataset received and checked, loaded following receipt of corrections	194719	2019
Sweden – Stockholm (SVS)	11/03/2019	New dataset loaded after corrections made by scheme	367991	2019
Sweden – Stockholm (SVS)	05/11/2019	New dataset loaded after Atlas error checks corrected by scheme	370741	2019
Switzerland – Sempach (HES)	10/12/2018	New dataset received and loaded	279074	2018
Switzerland – Sempach (HES)	21/11/2019	New dataset loaded after Atlas error checks corrected by scheme	288221	2019
United Kingdom and Ireland – BTO (GBT)	20/03/2019	New dataset loaded	8429412	2019

3. Tracking data management

Wolfgang Fiedler, Max Planck Institute of Animal Behavior

3.1 Search for existing tracking data

The search for published data containing movement information that has been revealed through GPS tracking, solar geolocation or by related electronic devices has been completed by Graham Geen with a few additions by Wolfgang Fiedler. 504 papers referring to 119 species have been identified and are currently collected to be sent to the species authors.

The online tracking databank Movebank and other known internet resources are currently queried to identify tracking data with information about migrations of the bird species included in the atlas that are not necessarily published in a classical paper yet. 133 studies have been identified so far, but this part of the work is currently ongoing. Information about the existing data is also currently collected to be sent to species account authors.

In addition Movebank has been queried to identify studies that qualify for a live link into the online atlas tool. More than 100 studies have already been identified. It turned out that a large proportion of these studies have the same person, group or institution as data owners and first contacts with these groups

have been made. It is intended to regulate the data usage of these studies in the online atlas tool through bilateral agreements of which a draft version has been completed.

Except for some of the agreements this part is expected to be finished in March.

3.2 Movebank link

For all species with existing sufficient data in Movebank for which we are able to obtain appropriate permissions links to the online component of the atlas will be provided. The best data link between Movebank and the Online Atlas Tool has been identified and is currently being tested by the IT / Atlas website team.

Two problems have been identified: (1) the temporal data resolution in many studies is much higher than needed for the Migration Atlas (for example tracking data partially gathered with 1 Hz) while the data volume creates unnecessary capacity problems. (2) Tracking datasets revealed through some of the methods not using GPS localisation have high rates of outliers resulting from large inaccuracies. The data needs to be filtered through filters that are principally available but currently not yet applicable in the automated data link as it will be established between Movebank and the Online Atlas Tool.

Solutions to both problems have been identified and are currently being developed and implemented by Movebank programmers. According to the contract the work shall be finished by end of March.

To ensure rapid responses to web queries it has been decided that a cached copy of the data will be maintained at the BTO end but Movebank will be responsible for determining the content of this component of the dataset. This has been agreed with the Movebank core team and it has been confirmed that this procedure will be legal for all datasets that are already published in Movebank under a creative commons license as well as those who will be used on the basis of bilateral agreements.

4. Species accounts

A mapping structure for the species accounts has been developed. Each species account will comprise a set of four standard maps and accompanying interpretive text. The four map types are:

1. Overall connectivity patterns by ringing region
2. Connectivity by month and by region
3. Annual movements
4. Recoveries by condition

Each of these map types is described below using example text for the Barn Swallow. We outline the options associated with each interactive map type and highlight key points that the authors of the accompanying text are asked to address.

All maps for the online Atlas will be interactive, with click, zoom and pan functionality. Users will be able to select layers, and will probably also be able to query points using either click or hover, which then shows a pop-up text box giving some additional information about a point (e.g. scheme, date, country, recovery circumstances, possibly age/sex information).

For some species maps of movements shown by tracking data will also be provided, based on the data collation process described in section 2 of this report. Mapping of these data is still under development and is not described here.

4.1 Overall connectivity patterns, by ringing region

This interactive map will be the main landing map for most species accounts. It shows the connectivity patterns between ringing and recovery locations, coloured according to 8 different European regions of origin, denoting the region where a bird was originally ringed. Ringing and recovery locations are given as points, connected by a line. Users will be able to click and select/de-select different layers, according to regions.

09920 *Hirundo rustica* | Ringing-recovery connectivity patterns, by European region of origin



Expected text content (maximum 800 characters)

Authors will focus on describing the **main patterns of migratory connectivity** between ringing regions and re-encounter locations.

Text will give priority to identifying any notable caveats about interpreting the maps. Possible content includes:

- Differences between regions (direction, distance)
- Migratory divides / overall strategies (e.g. leapfrog migration)
- Overall directions of movements patterns (e.g. southwest - northeast for Curlew)
- Reference to any differences between subspecies and/or populations in the above
- Any notable caveats about interpreting the data
 - e.g. mapped data are only distant (≥ 50 km) recoveries, but a species is predominantly resident, or a partial migrant in certain regions e.g. Blue Tit

Interpretation considerations & caveats about the data

- Any notable connectivity patterns which are likely biased, or missing, based on expert knowledge or the literature
 - E.g. for hunted species, there may be a bias showing connectivity to countries where the species is huntable, and a lack of connectivity to countries where it is not huntable
 - E.g. biases in the season in which ringing activity most often takes place for a particular species in a particular country

4.2. Connectivity by month and by region

This interactive map is the most complicated of all the map visualisations, and will be the most difficult to interpret clearly and succinctly. It shows connectivity patterns by month, for each region separately, for individuals encountered (regardless of whether it is a ringing or recovery event) in the focal selected region, in the focal selected month. For example, using *Hirundo rustica* below, if a user selects the Central region, and selects the month of June, they will see:

09920 *Hirundo rustica* | Connectivity patterns by month, for encounters in the Central region of Europe

	N individuals	N encounters
Mapped data*	2035	4450
Total available data	22009	81130

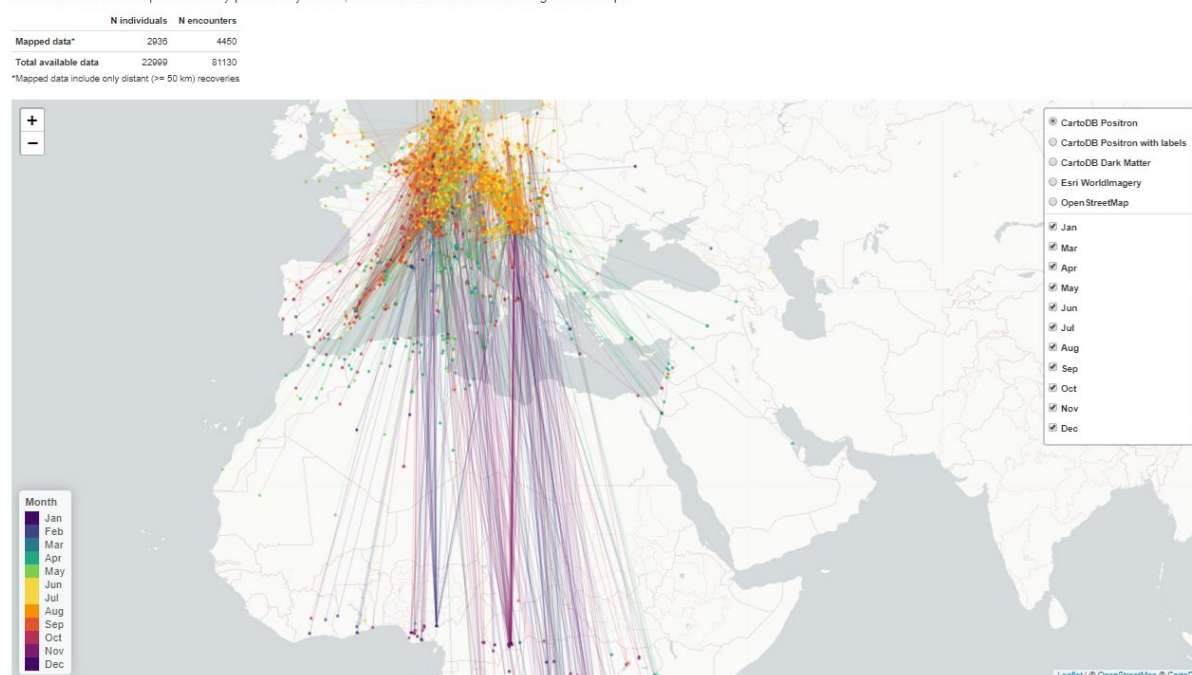
*Mapped data include only distant (≥ 50 km) recoveries



1. **The focal encounter:** points of all encounters (irrespective of whether the encounter is a ringing or recovery event) in the Central region, in June, with these focal encounter points coloured according to the colour for June in the map legend (yellow in this case);
2. **The destination encounter:** points of all of the individuals above where they were encountered at any other time of year, with a line connecting the focal encounter to the destination encounter. The colour of the destination point and line is the colour of the month in which the destination encounter occurred (according to the colours in the map legend). So in the example above, swallows encountered in the Central region of Europe in June are encountered during the winter in Africa (purple points and lines), in North Africa and southern Europe in spring (green points and lines), and also in Iberia and the Mediterranean in autumn (reddish points and lines).

If a user selects all of the months, they will see the main times of year when birds encountered in a particular region are encountered elsewhere. Using the example of *Hirundo rustica* again, birds encountered in the Central region of Europe are also encountered in various parts of Africa from Nov-Feb, in North Africa, southern Europe and a few in the eastern Mediterranean in Mar-Apr, in the Central region countries (and some in Scandinavia) in May-Aug, and again in southern Europe (but rarely North Africa) in Aug-Oct.

09920 *Hirundo rustica* | Connectivity patterns by month, for encounters in the Central region of Europe



Users will be able to select different regions to load for the map. On devices with sufficient screen space, they will probably be able to compare a set number of different regions at the same time. As for the overall connectivity map, users will probably also be able to query points using either click or hover, which then shows a pop-up text box giving some additional information about a point (e.g. scheme, date, country, recovery circumstances, possibly age/sex information).

4.2.1. Expected content (maximum 800 characters)

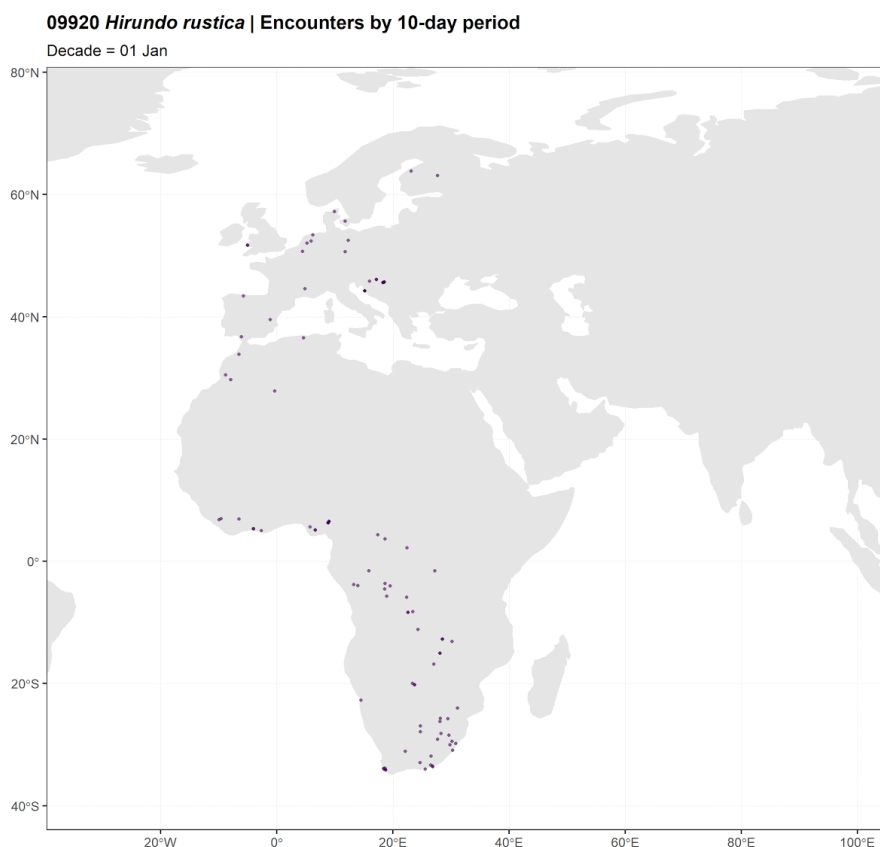
Authors will focus on interpreting the main, **seasonal** patterns of **connectivity**. The text for this map should be distinguished from the 'annual movements' animated map by focusing on **connectivity** patterns, rather than timings of arrivals and departures.

4.2.2. Interpretation considerations & caveats about the data

- Any notable connectivity patterns which are likely biased, or missing, based on expert knowledge or the literature
 - E.g. for hunted species, there may be a bias showing connectivity to countries where the species is huntable, and a lack of connectivity to countries where it is not huntable
 - E.g. biases in the season in which ringing activity most often takes place for a particular species in a particular country

4.3 Annual movements

These interactive and animated maps will show the annual occurrence of encounters (either ringing or recovery), in 10-day and/or monthly time steps, depending on the number of records available for a species. Data-rich species will have both 10-day and monthly time step animations, while more data-poor species will have only monthly time step animations. The colour key will be the same as for the previous map. Users will be able to control play/pause, the animation speed, and will be able to manually step through time steps. Users will be able to select different regions to load for the map. On devices with sufficient screen space, they will probably be able to compare a set number of different regions at the same time.



4.3.1. Expected content (maximum 800 characters)

Authors will focus on describing the **main timings of patterns of movement**, and any differences in timing between the main regions with the most data. Avoid referring to connectivity patterns which will be dealt with in the first two maps.

4.3.2. Interpretation considerations & caveats about the data

Authors are expected to provide some interpretation for recoveries which occur during times of year outside a species 'normal' range for that time of year (e.g. Afro-Palearctic migrants recorded in Scandinavia in December). These are more likely to be recoveries that are due to a bird being found at that time of year as dead for some time, rather than cases of vagrancy.

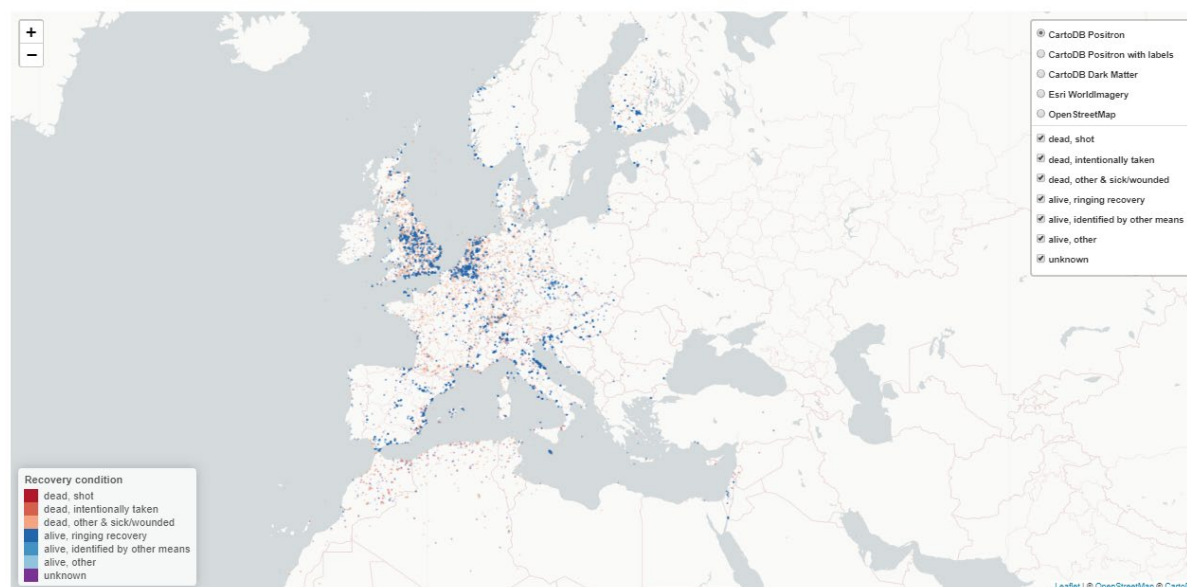
4.4. Recoveries by condition

This interactive map will show the distribution of recoveries of different conditions, where recovery condition and circumstance codes are grouped into a small number of major categories described in 'plain English'. Users will be able to select different regions to load for the map. On devices with sufficient screen space, they will probably be able to compare a set number of different regions at the same time.

09920 *Hirundo rustica* | Recoveries according to condition

	N records	N individuals	N recoveries
Mapped data*	32309	16024	16285
Total available data	219319	99280	120039

*Mapped data include only distant (≥ 50 km) recoveries



4.4.1. Expected content (maximum 800 characters)

For huntable species, authors will focus on comparing the 'dead, other causes' category to the 'dead, shot or intentionally taken' category.

For non-huntable species, authors will compare patterns of dead recoveries that are mainly reported by the public with those of recaptures and resightings that are largely generated by ornithologists.

4.5 Production of species accounts

Writing of the species accounts has now started. As outlined above the species accounts will be written as four discrete sections, each appearing alongside the relevant map type.

4.6 Selection of species

The funded Atlas project will produce accounts for 300 species. This corresponds to the number of species for which good data on movements are available. We have excluded species that are essentially resident and most cases of introduced species. Some species with very few recoveries but good tracking data are included. This list is now largely fixed but there may be a very small number of changes for species with limited data, as we will only know whether the data are adequate when the maps have been examined in detail. There are a small number of reserve species that could be added to meet the 300 total if necessary. The current species list is presented in Annex 1.

5. Development of web tools and solutions

There are a number of key stages in the development of the Migration Atlas website which we list briefly here. Much of the work involved is highly technical but it is critical for the effective delivery of the Atlas project.

5.1 Database development

All data will be stored in an on-line Oracle database hosted by the BTO. Additional database tables are being developed to hold the frozen Atlas recovery dataset and to hold the tracking data that will be automatically downloaded from Movebank via a web service. All of this work is well advanced.

5.2 Basic website infrastructure

A Drupal database will be implemented to store and present all outputs from the Atlas. Much of the material will be static content, including information on methods and interpretation, results of the research modules and key conservation related findings. We will also provide bespoke pages with Ringing Schemes can use to thank contributors from particular countries and to direct them to relevant parts of the Atlas content. The main website is currently at the planning stage. Implementation should be straightforward as most will be based on standard Drupal modules where the BTO team already have experience from their own website.

5.3 Dynamic presentation of maps and tables

Much of the core Atlas content including maps of recoveries and tracking data, together with various tables and graphs, will be presented dynamically via a web application. This application will query the database and generate maps and graphs in real time. This web application will be written primarily in Java and SQL, technologies where the BTO IT team have strong expertise. The specification has been completed and programming work is now in progress.

5.4 Website design

This has been the emphasis of much of the website development work so far. Special design tools have been used to produce mockup of the website that are sufficiently dynamic as to allow testing of the main functionality, although at this stage they are actually using static outputs. Design work has focussed primarily on mobile phones and tablets, as these are the devices where complex visual applications are most challenging to implement. Screenshots of some key aspects of the proposed design are presented below, based on the account for Greater White-fronted Goose. A typical map page shows the annual pattern of movements (as an animated map in the live version) (Figure 5.1). The arrow on the right of the screen opens base map options (Figure 5.2) while that on the left allows users to choose between the four different types of recovery maps (Figure 5.3). An arrow at the bottom allows the map key to be displayed (Figure 5.4). By scrolling down the screen users can display relevant parts of the species text (Figure 5.5) and a range of graphs summarizing different aspects of the dataset (Figure 5.6). We are now confident that we have developed an effective and workable design for the main components of the web application. Work on implementation of the website is ongoing.

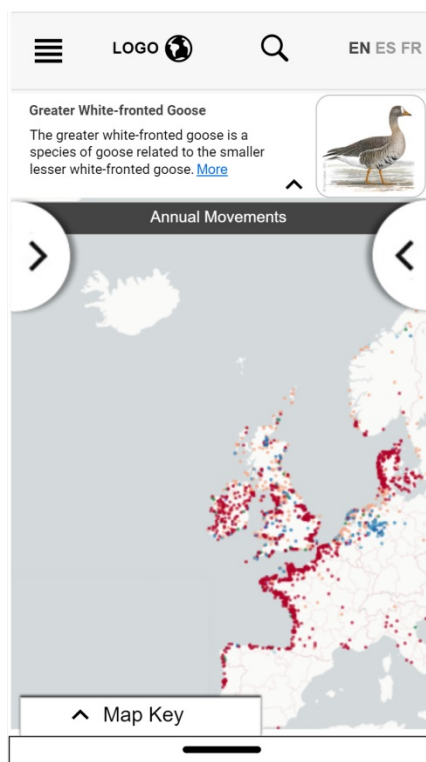


Figure 5.1 Mobile screen image showing annual movements map for Greater Whitefronted Goose

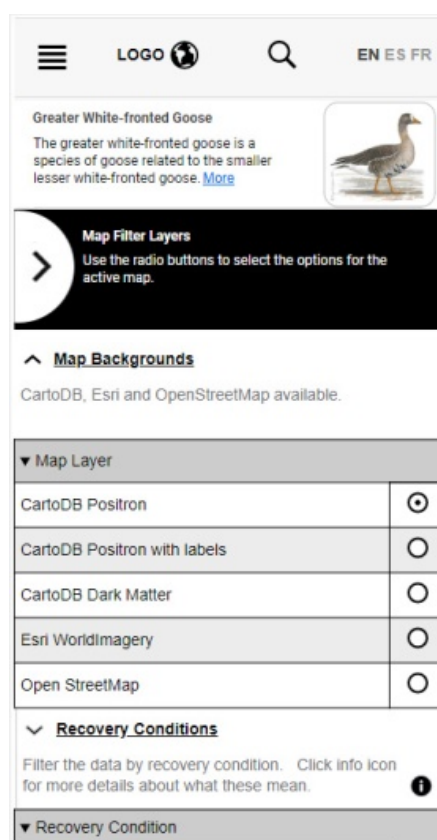


Figure 5.2 Mobile screen image showing base map selection options

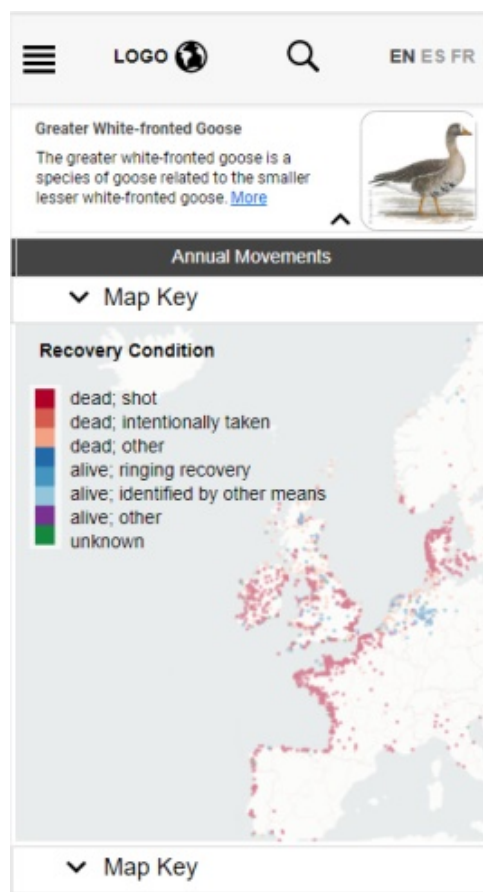


Figure 5.3 Mobile screen image of Annual Movements map for Greater Whitefronted Goose with map key selected.

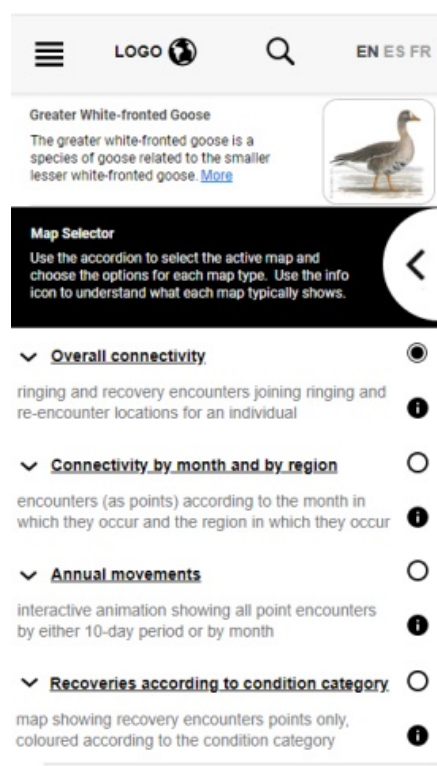


Figure 5.4 Mobile screen image for selection of different map options

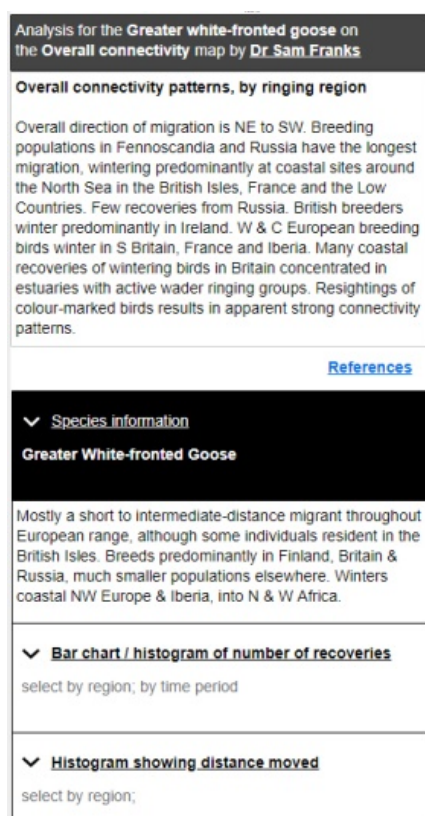


Figure 5.5 Mobile screen image for Greater Whitefronted Goose showing part of the species account

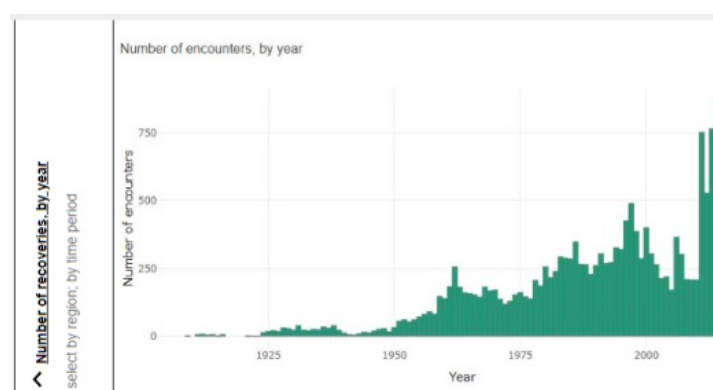


Figure 5.6 Mobile screen image for Greater Whitefronted Goose showing graph of number of encounters by year

6. Analysis of the current migration seasons of hunted species

Prof. Dr. Franz Bairlein, Institute of Avian Research, Wilhelmshaven, Germany
in collaboration with
Dr. Roberto Ambrosini, University of Milan, Milan, Italy

6.1 Background

The Key Concept of Article 7(4) of the Birds Directive 79/409/EEC is to ensure that hunting of species listed in Annex II of the Birds Directive does not jeopardize conservation efforts. 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. This resulted in pronounced differences in e.g. the onset of prenuptial (return) migration between even neighbouring Member States (countries).

6.2 Objective of current analysis

6.2.1 Overall objectives

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 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.

6.2.2 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. Further, we defined each bird as “migrating” if the mean distance between ringing place in the South and the place of northbound recovery exceeded 100 km. 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.

To evaluate the seasonal course 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.

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 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) (Fig. 1).

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.

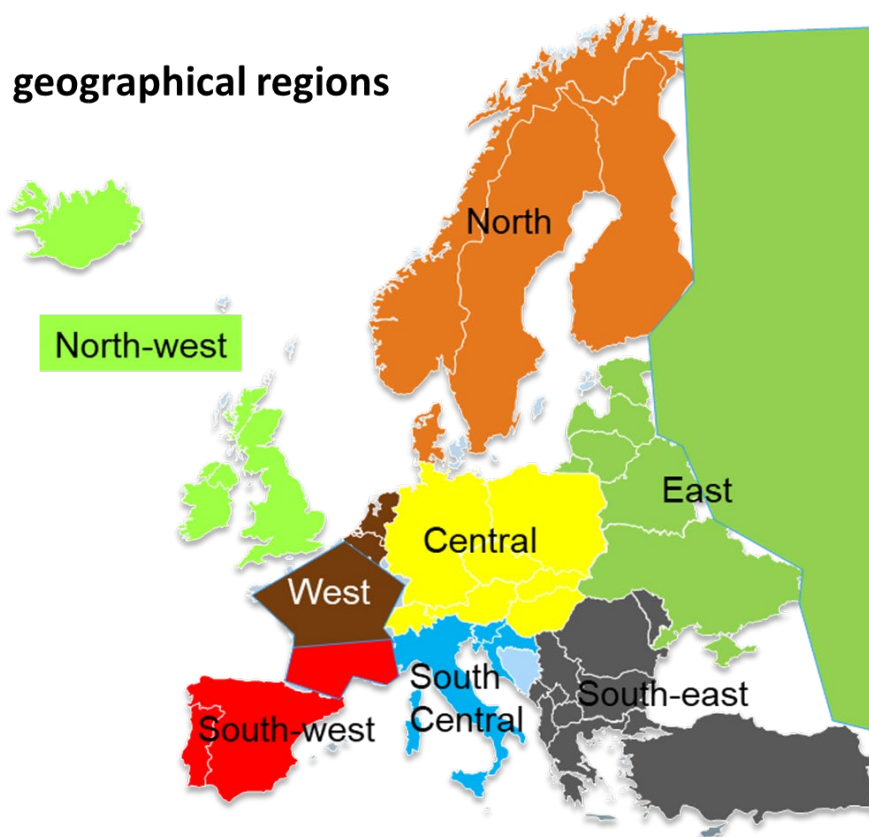


Fig. 1: Geographical regions as used in this analysis (after: The World Factbook; <https://www.cia.gov/library/publications/the-world-factbook/>; extended)

6.2.3 Modelling of movement probabilities

(conducted by Roberto Ambrosini, University of Milan, Italy)

In contrast to using a single recovery, temporal-spatial movement can be modelled by using any encounter of birds within a given geographical area unit. This approach follows the basic model of Ambrosini et al. (2014) but extended to account for partial migrants as well as spatial autocorrelation between neighbouring grid cells.

6.3 Examples of the analyses

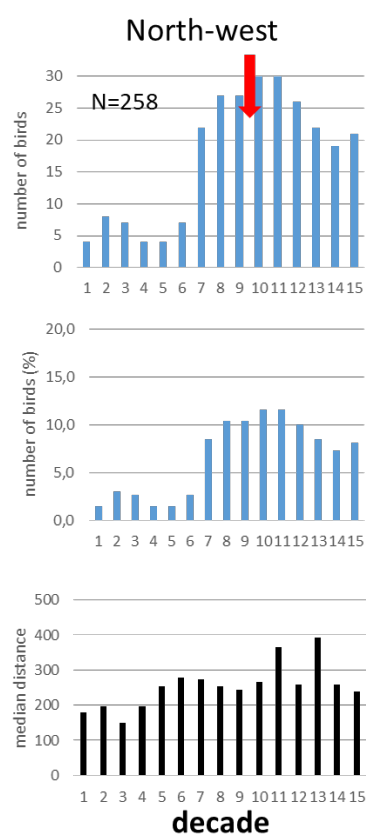
6.3.1 Recovery analysis

Of the in total 80 species listed in Annex II of the Bird Directive as huntable in Member States 79 have entries in the EDB but only 26 provide more than 500 recoveries of ringed birds (Table 6.1).

Species		number of records
Mute Swan	<i>Cygnus olor</i>	7,385
Bean Goose	<i>Anser fabalis</i>	2,217
Pink-footed Goose	<i>Anser brachyrhynchus</i>	1,284
Greater White-fronted Goose	<i>Anser albifrons</i>	5,281
Greylag Goose	<i>Anser anser</i>	914
Eurasian Wigeon	<i>Anas penelope</i>	1,381
Eurasian Teal	<i>Anas crecca</i>	2,228
Mallard	<i>Anas platyrhynchos</i>	2,263
Northern Pintail	<i>Anas acuta</i>	1,098
Common Pochard	<i>Aythya ferina</i>	1,036
Tufted Duck	<i>Aythya fuligula</i>	2,047
Eurasian Coot	<i>Fulica atra</i>	764
Eurasian Oystercatcher	<i>Haematopus ostralegus</i>	2,179
Red Knot	<i>Calidris canutus</i>	658
Eurasian Woodcock	<i>Scolopax rusticola</i>	1,563
Common Black-headed Gull	<i>Larus ridibundus</i>	16,060
Mew Gull	<i>Larus canus</i>	2,817
Lesser Black-backed Gull	<i>Larus fuscus</i>	5,262
Herring Gull	<i>Larus argentatus</i>	9,784
Great Black-backed Gull	<i>Larus marinus</i>	558
Common Blackbird	<i>Turdus merula</i>	4,312
Fieldfare	<i>Turdus pilaris</i>	517
Song Thrush	<i>Turdus philomelos</i>	630
Rook	<i>Corvus frugilegus</i>	1,193
Carrion Crow	<i>Corvus corone</i>	1,001
Common Starling	<i>Sturnus vulgaris</i>	6,508

Table 6.1 Species with sufficient data for hunting seasons analysis. Number of records of northbound movements greater than 100 km during decades 1-15.

An example is given in Figure 2 for the Song Thrush (*Turdus philomelos*):



North

no data

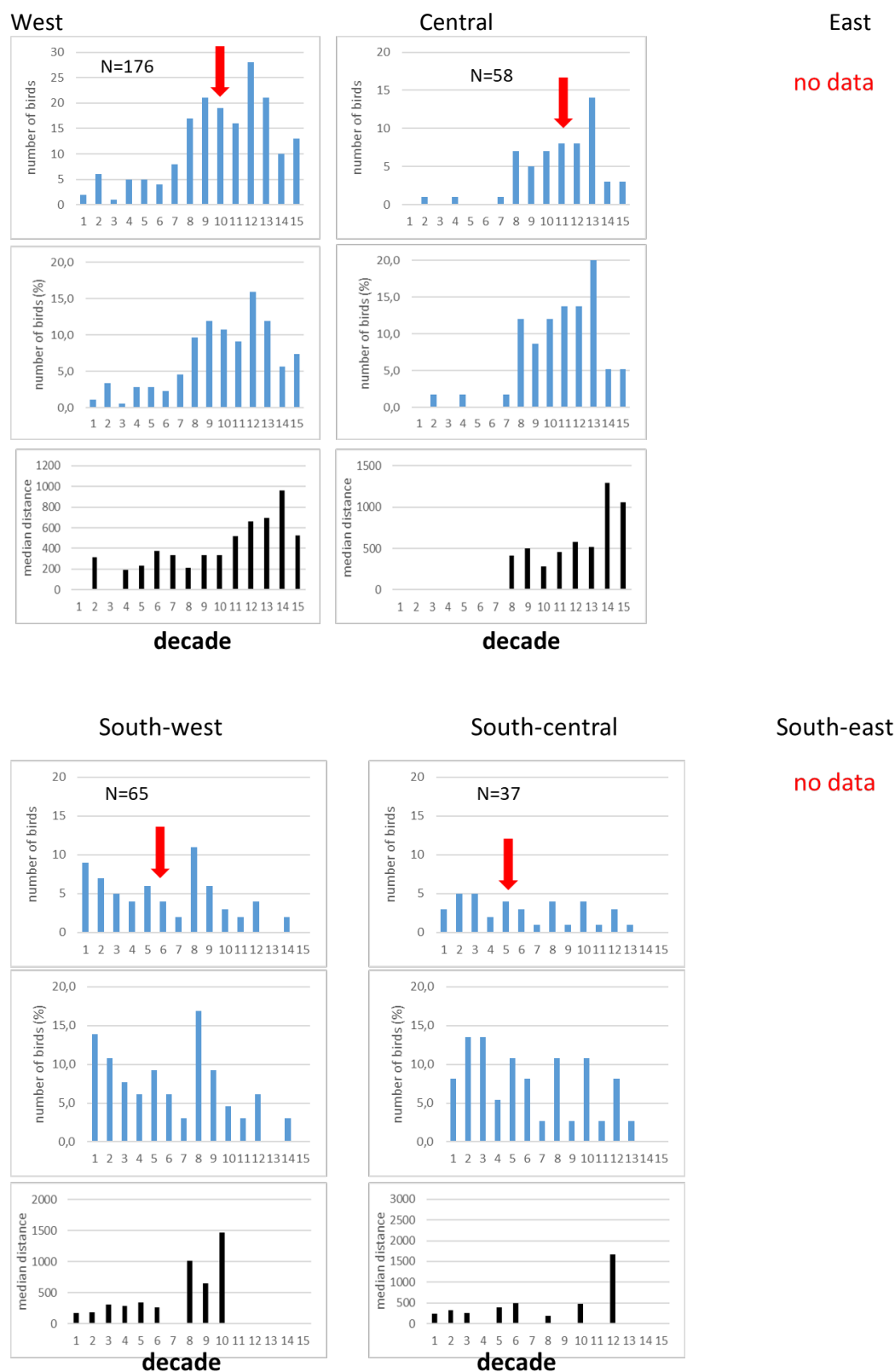


Fig. 2: Onset of prenuptial (return) migration of Song Thrush by geographical region and decade. The arrows show the median date of onset of return migration.

The results of Spatial modelling for the Song Thrush is shown in Figure 3.

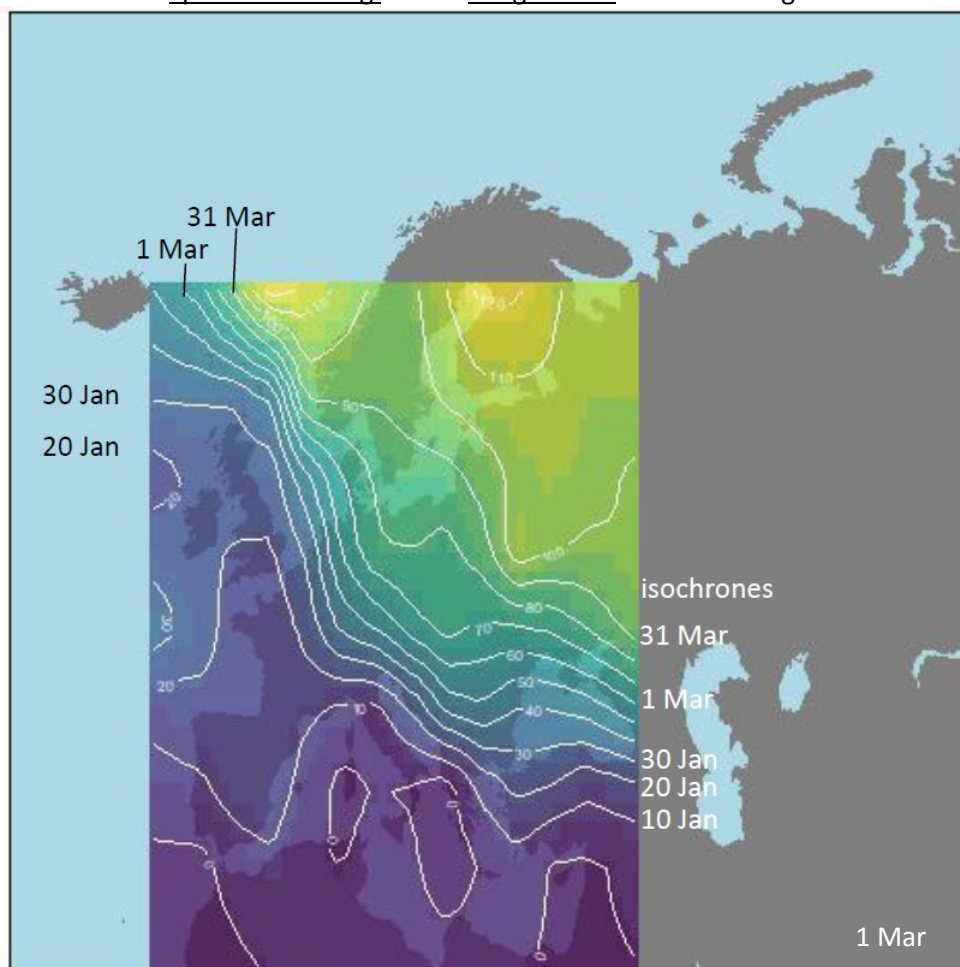


Fig. 3: Onset of return migration in Song Thrush as revealed by modelling. The contour-lines (isochrones) as well as colour-codes are connecting equal onset of return migration. Only encounters with accuracy of date of 3 days (either side of the true date) or recoveries of birds freshly dead were considered (N = 45,617; analysis and map provided by R. Ambrosini).

6.3.2 Comparison of recovery and model data

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 January, and both methods show the median date of return migration in decade 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.

6.3 Progress as of 31 January 2020

The analysis of the single recoveries are completed.

The modelling of the spatial-temporal onset of spring migration is still in progress because of unexpected difficulties in recruiting skilled personnel.

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- European Commission (1979) Directive on the conservation of wild birds (79/409/EEC). Brussels.
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7. Killing of birds by man, with particular reference to illegal killing IKB

Fernando Spina

This module considers the different sources of mortality on birds as derived from intentional taking and killing by man. Also based on the strong interest and active initiatives taken by CMS on the illegal aspects of taking and trade, a special attention will be devoted to illegal actions which remove birds from wild populations, the latter included in the general definition of IKB. The module is under the responsibility of ISPRA (Istituto Superiore Protezione e Ricerca Ambientale, Bird Migration Research Branch, Italy), with the coordination of Fernando Spina. ISPRA has direct experience on this specific issue, given the active role the Institute plays within the Italian National Action Plan on illegal actions against wild birds. At the moment ISPRA is to advertise the process of recruiting an analyst who will be fully involved in the module developments. The data-sets to be analysed will be arranged based on EURING code values of conditions and circumstances at recovery of a ringed bird. This will allow to select all data where the recovery of a dead ringed bird derives from an intentional action by man, i.e. excluding bird mortality events caused by e.g. human infrastructures, like wind turbines etc. Thanks to the long historical coverage of EURING data, analyses of these data will improve existing knowledge on causes of intentional mortality by man, based on a geographical, historical and seasonal basis, as well as with reference to the different taxonomic groups of species affected. The results on seasonal distribution of mortality intentionally caused by man will be important to evaluate the relative demographic impact of taking on natural populations along the annual cycle. The historical period covered by EURING data is a unique feature of these analyses and will allow to consider possible trends/changes in intentional taking by man for same species and flyways, but along the decades. Fig. 1 refers to a pilot analysis produced by EURING and shows how shooting of migrating Black Kites *Milvus migrans* has been significantly decreasing across Europe during the last decades, yet shows signs of increase in North-west African countries, in connection to a possible local increase in the possession of shotguns and cartridges. Similar results will also contribute to better understand historical and geographical cultural changes in the relationship between Man and birds across the huge geographical area encompassed by data stored at the EURING Data Bank. As an example, the relative frequency of Ospreys ringed abroad and intentionally shot in Italy significantly decreases when compared to other sources of mortality (Fig. 2).

A special attention will be devoted to IKB; from this respect, a questionnaire is being drafted to be circulated across EURING Member Schemes in order to collect information on historical changes in hunting legislation in the various countries. This will allow selecting periods where a given species was huntable or protected in the different countries, in order to improve our knowledge of the conservation effect of legislation, as well as on possible historical and geographical trends in compliance with legislation. A general analysis will be carried on from this respect with reference to the entry into force of the EU Wild Birds Directive. Once confirmed IKB events will be selected, a detailed analysis will aim to improve existing knowledge on geographical distribution of “black-spots” (i.e. sites/areas of particularly intense IKB activities), as well as possible historical changes in the relative importance of single sites. Further aspects which will be considered in general and with a special attention to IKB are methods used to catch/kill wild birds. In general, this module will offer a first-ever large-scale, long-term multi-species analyses of relationships between man and birds along the Eurasian-African flyway.

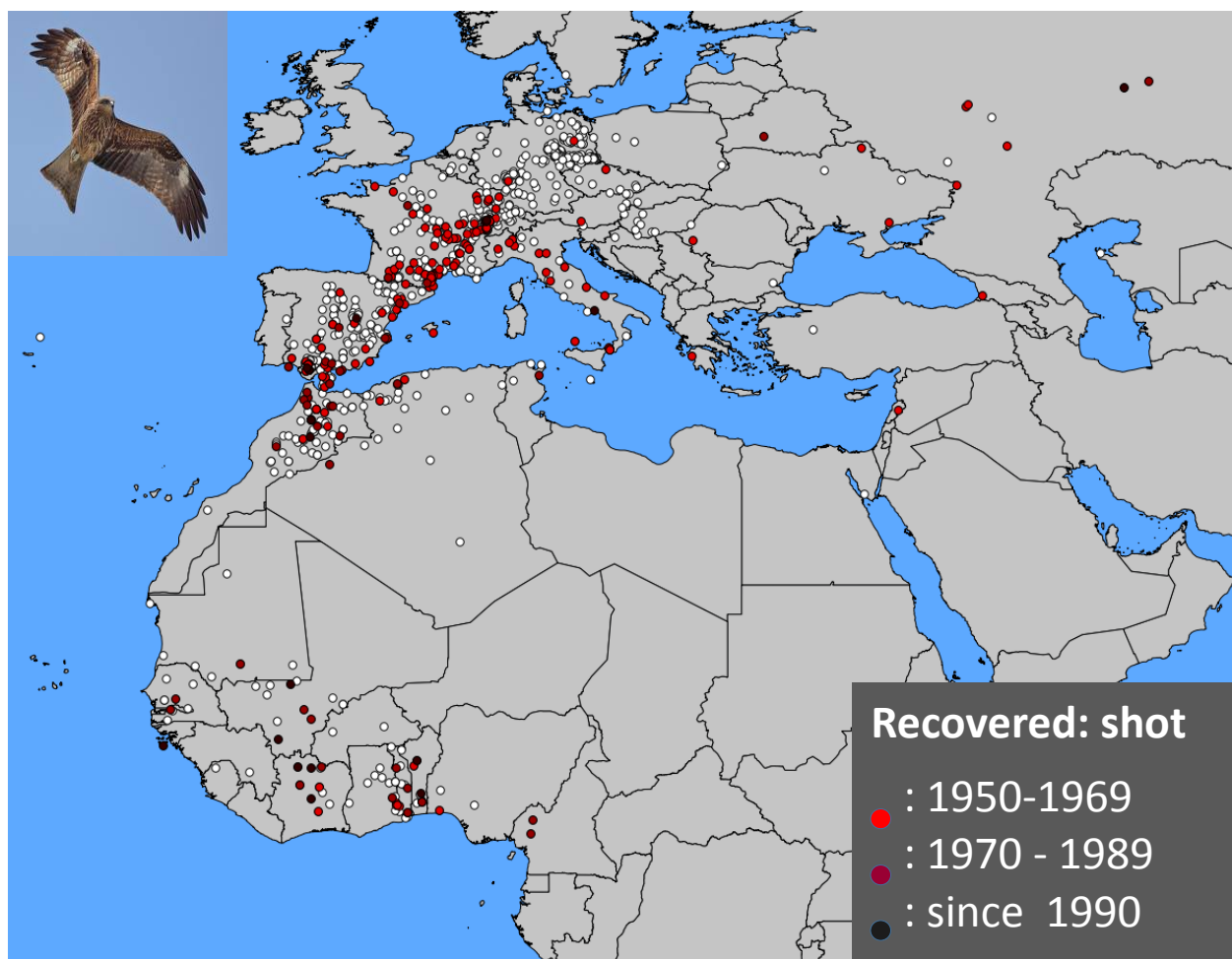


Fig. 7.1 The need for a flyway approach to IKB issues. Historical and geographical distribution of events of intentional shooting of ringed Black Kites (EURING, unpubl.). White dots show recoveries from other causes.

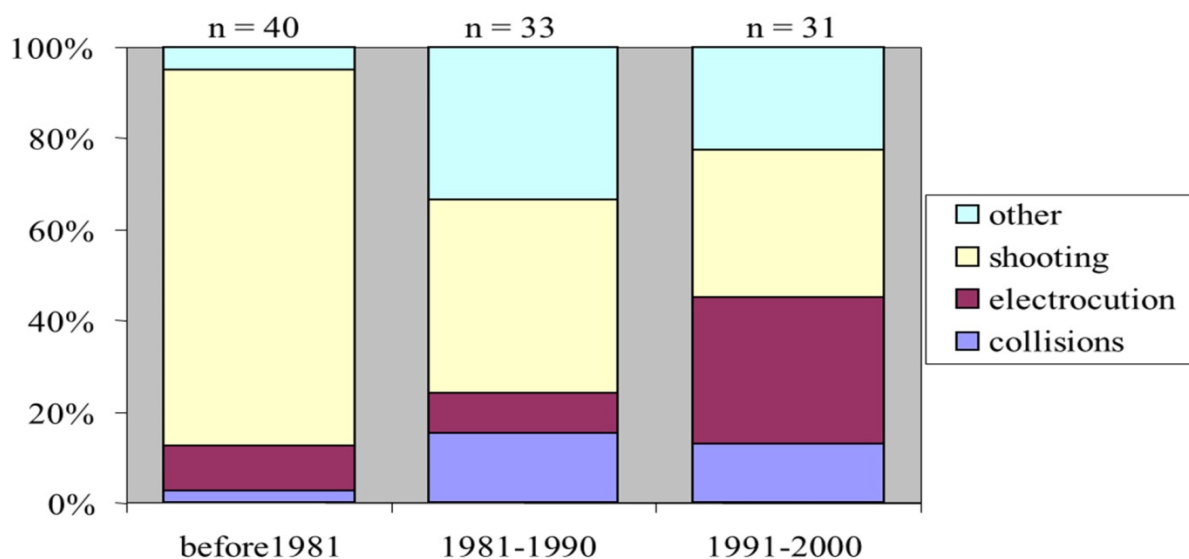


Fig. 7.2 Historical trend of recovery conditions of dead ringed Ospreys in Italy

8. Connectivity analysis

Roberto Ambrosini and Niccolò Fattorini

Department of Environmental Science and Policy, University of Milan, Milan, Italy

8.1 Introduction and methods

In this first part of the work, we focussed on developing a robust procedure for selecting data suitable for migratory connectivity analyses according to the method proposed by Ambrosini, Møller and Saino (2009). So far, we focussed on four species with different migration ecology and number of re-encounters: the cormorant *Phalacrocorax carbo*, the teal *Anas crecca*, the barn swallow *Hirundo rustica* and the European robin *Erithacus rubecula*.

The procedure we used goes through the following steps:

1. We retained records for which "use for atlas" is TRUE.
2. We discarded records whose:
 - a. "condition" is 3, 4, 5 or 6 (birds that were not found freshly dead or birds that were in poor condition or had an accident when ringed or alive and probably healthy but taken into captivity);
 - b. "manipulated" is C, F, T, M or H (birds that were kept for more than 13 h during ringing or birds that have been moved or held extensively during ringing or those hand reared);
 - c. "moved" is 2, 4 or 6 (birds that were moved unintentionally by man or other agency, or intentionally by man, or moved by water e.g. found on shoreline);
 - d. "date.acc" is 4, 5, 6, 7, 8 (birds for which the dates of ringing and/or recovery were not recorded accurately to the nearest 1 week for both the ringing and the finding date);
 - e. "coord.acc" is 6, 7, 8 or 9 (birds for which the place of ringing and/or recovery were not recorded accurately to the nearest 100 Km for both the ringing and the finding date).
3. Temporal masking. Following Cramp (1998), for cormorant, teal and European robin and Ambrosini et al. (2009), for Barn Swallow, we identified three species-specific periods corresponding to an "extended" breeding period (EB), a "focal" breeding period (FB) and a focal non-breeding period (NB) (i.e. wintering). We then retained only records in the FB period or in the NB period. We also retained records in the EB period if individuals were caught at nest (catching method = "N") or if they were aged as "pullus, unable to fledge" (age.byscheme = 1) . Thus we retained all records in the focal breeding and non-breeding periods, which should correspond to individuals recorded during stationary periods, or individuals recorded at nest, and therefore at their breeding grounds.
4. Geographical masking. We used distribution maps provided by BirdLife International and Handbook of the Birds of the World (2019) for discarding records in the FB and EB periods falling outside the species-specific breeding range or outside the range where a species is classified as "resident" (i.e. present all year round) and for discarding records in the NB period falling outside the species-specific non-breeding ("wintering") range or outside the range where a species is classified as resident.

5. After the above steps, we retained only records of individuals with a record in both the breeding and the on-breeding period. If an individual still had more than one observation during breeding or non-breeding periods, we retained the earliest record only.
6. We performed the migratory connectivity analysis according to the procedure described in Ambrosini *et al.* (2009). Briefly, the steps of the analyses were as follows:
 - a. We calculated two matrices of great-circle distances, one between the positions of the individuals in the breeding grounds and one between the positions of individuals in the non-breeding grounds.
 - b. We calculated the Mantel correlation coefficient between the two matrices and tested for its significance by permutation (999 times).
 - c. If the Mantel test was significant (i.e. there is significant migratory connectivity), we performed a series of k-means cluster analyses setting the pre-defined number of clusters from 2 to 9 and recorded the overall average silhouette width (oasw) values (Rousseeuw, 1987) of each analysis.
 - d. We selected the number of clusters that maximized the oasw value and if it was > 0.5 (corresponding to substantial clustering) we partitioned the records into the corresponding number of clusters.
 - e. We repeated steps a-d for each cluster identified in point d, if it includes at least 20 individuals, to identify sub-clusters of each cluster. We proceed up to the fourth level of sub-clusters.

All the steps are implemented in a script in R 3.6.2 statistical software.

8.2 Results and discussion

The main results obtained on the four above-mentioned species are summarized in Table 1 and in maps showing the geographical clusters of individuals identified by the migratory connectivity analysis. For brevity, we report here maps showing first-level clusters for each species (Figures 1-4). We found a significant migratory connectivity for all species. The barn swallow and the European robin showed a considerable clustering. In contrast, the cormorant and the teal did not show substantial clustering, thus migratory connectivity for these species seem mainly due to pattern transference (Ambrosini *et al.*, 2009).

Overall, the procedure identified clusters generally consistent with those identified in previous analyses on the barn swallow (Ambrosini *et al.*, 2009), which is not surprising because the same general procedure was applied to ringing data extracted from the EURING data bank both in these analyses and in those included in past works. However, the degree of migratory connectivity identified for the barn swallow is higher than that identified in (Ambrosini *et al.*, 2009) probably due to the slightly larger sample available. The present analyses also allowed identifying a cluster of individuals wintering in the Iberian Peninsula, which were excluded from previous elaborations. This indicates that the data selection procedure currently implemented and based on both a geographical and temporal masking allows a better selection of input data.

Comparison of results of the present analyses on the European robin with those from a previous study (Ambrosini *et al.*, 2016) is more difficult, as the previous work considered individuals found dead in winter only. However, the degree of migratory connectivity is similar in both studies.

Interestingly, the two non-passerine species showed significant connectivity due to pattern transference. Future extension of the analyses will reveal how much this mechanism generating connectivity is widespread among passerine and non-passerine species.

These results therefore confirm that the procedure developed so far is robust and versatile and can be extended to further species. The next step will be an assessment of the minimum sample size necessary for the analyses. This analysis will be performed by progressively rarefying some large datasets to assess the minimum sample size that still allows identifying the level and pattern of migratory connectivity assessed on the whole dataset.

Table 1. Summary of the results of the analyses. The total number of records (N.tot) is reported in the first column under the species name. The number of individuals used for the migratory connectivity analysis (N) is reported in the second column with the results of the analyses on the whole dataset (r_M is the Mantel correlation coefficient and p its associated p-value. Oasw is the overall average silhouette width). The following columns report results of the analyses at first to fourth level of clustering. Results are reported in details up to the second level of clustering, and summarized for third and fourth level.

Species	global range	Level of clustering			
		1 st	2 nd	3 rd	4 th
Cormorant <i>Phalacrocorax carbo</i> N.Tot= 85823	N=2881 $r_M=0.43$ (p<0.001) 3 clusters (oasw=0.47)	-	-	-	-
Teal <i>Anas crecca</i> N.Tot= 101493	N=229 $r_M=0.20$ (p<0.001) 5 clusters (oasw=0.44)	-	-	-	-
Barn Swallow <i>Hirundo rustica</i> N.Tot= 259750	N=237 $r_M=0.48$ (p<0.001) 3 clusters (oasw=0.65)	1.1 N=91 $r_M=0.10$ (p=0.055) 1.2 N=112 $r_M=0.13$ (p=0.017) 2 clusters (oasw=0.52) 1.3 N=34 $r_M=0.15$ (p=0.001) 2 clusters (oasw=0.84)	1.2.1 N=82 $r_M=0.03$ (p=0.292) 1.2.2 N=30 $r_M=-0.18$ (p=0.531) 1.3.1 N=3 1.3.2 N=31 $r_M=1$ (p<0.001) 3 clusters (oasw=0.84)	3 third level clusters, none of which can be further divided	-
European Robin <i>Erithacus rubecula</i> N.Tot= 853216	N= 5993 $r_M=0.94$ (p<0.001) 2 clusters (oasw=0.75)	1.1 N=5693 $r_M=0.94$ (p<0.001) 8 clusters (oasw=0.43) 1.2 N=300 $r_M=0.71$ (p<0.001) 7 clusters (oasw=0.76)	1.2.1 N=21 $r_M=0.034$ (p<0.001) 3 clusters (oasw=0.33) 1.2.2 N=27 $r_M=0.86$ (p<0.001) 7 clusters (oasw=0.81) 1.2.3 N=69 $r_M=0.91$ (p<0.001) 2 clusters (oasw=0.82) 1.2.4 N=77 $r_M=1$ (p<0.001) 8 clusters (oasw=0.91) 1.2.5 N=36 $r_M=1$ (p<0.001) 5 clusters (oasw=0.92) 1.2.6 N=4 1.2.7 N=66 $r_M=1$ (p<0.001) 9 clusters (oasw=0.93)	31 third level clusters, 5 of which can be further divided	9 fourth level clusters

Figure 1. Left: distribution map of the encounters used for migratory connectivity analysis of the cormorant. Lines connect positions where the same individual was encountered. Right: 95% kernel density of individuals in the breeding (solid line) and non-breeding (dashed line) grounds. Maps show the breeding (yellow) and non-breeding (light blue) range of the species and the range where the species occur all year round (green) according to BirdLife International and Handbook of the Birds of the World (2019).

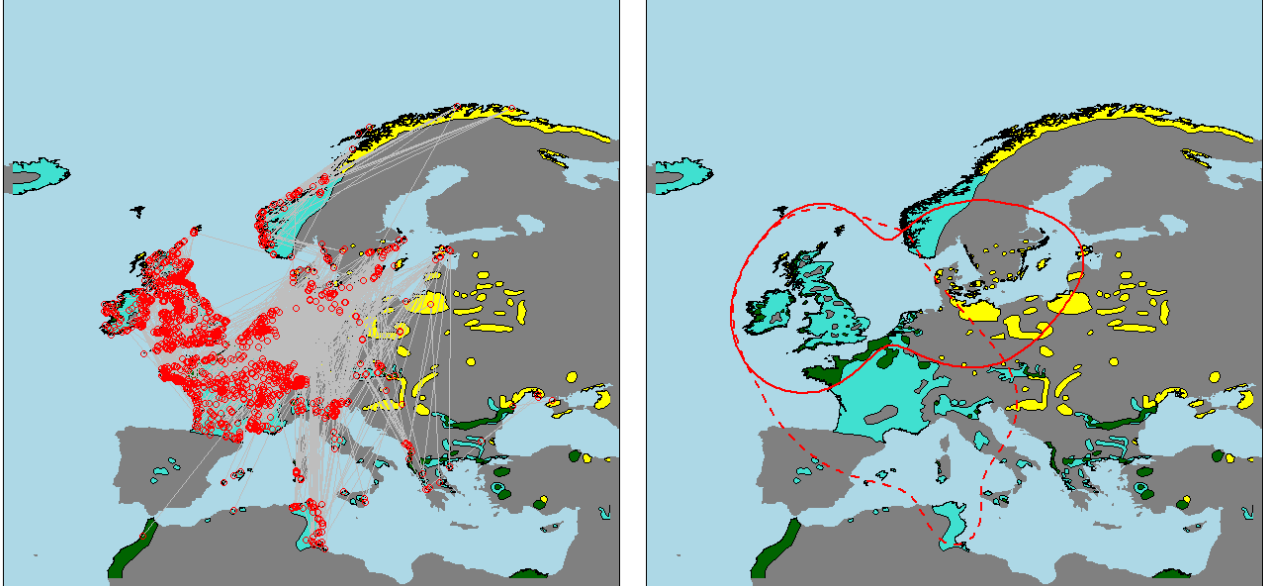


Figure 2. Left: distribution map of the encounters used for migratory connectivity analysis of the teal. Lines connect positions where the same individual was encountered. Right: 95% kernel density of individuals in the breeding (solid line) and non-breeding (dashed line) grounds. Maps show the breeding (yellow) and non-breeding (light blue) range of the species and the range where the species occur all year round (green) according to BirdLife International and Handbook of the Birds of the World (2019).

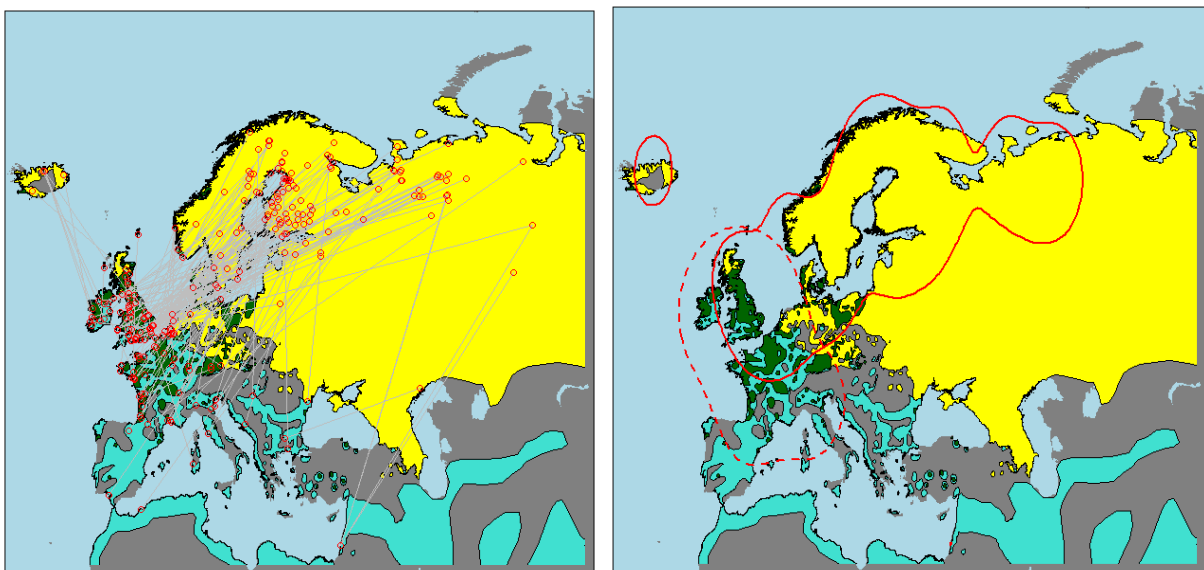


Figure 3. Left: distribution map of the encounters used for migratory connectivity analysis of the barn swallow. Lines connect positions where the same individual was encountered. Different colours indicate different first-level clusters. Right: 95% kernel density of individuals in the breeding (solid line) and non-breeding (dashed line) grounds of each cluster. Maps show the breeding (yellow) and non-breeding (light blue) range of the species and the range where the species occur all year round (green) according to BirdLife International and Handbook of the Birds of the World (2019).

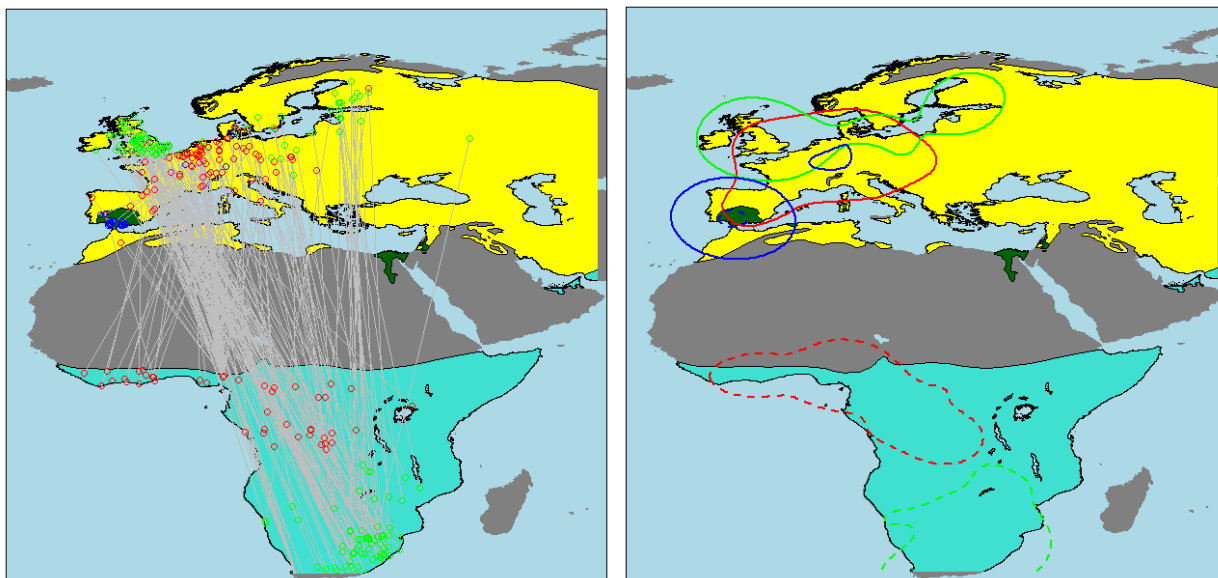
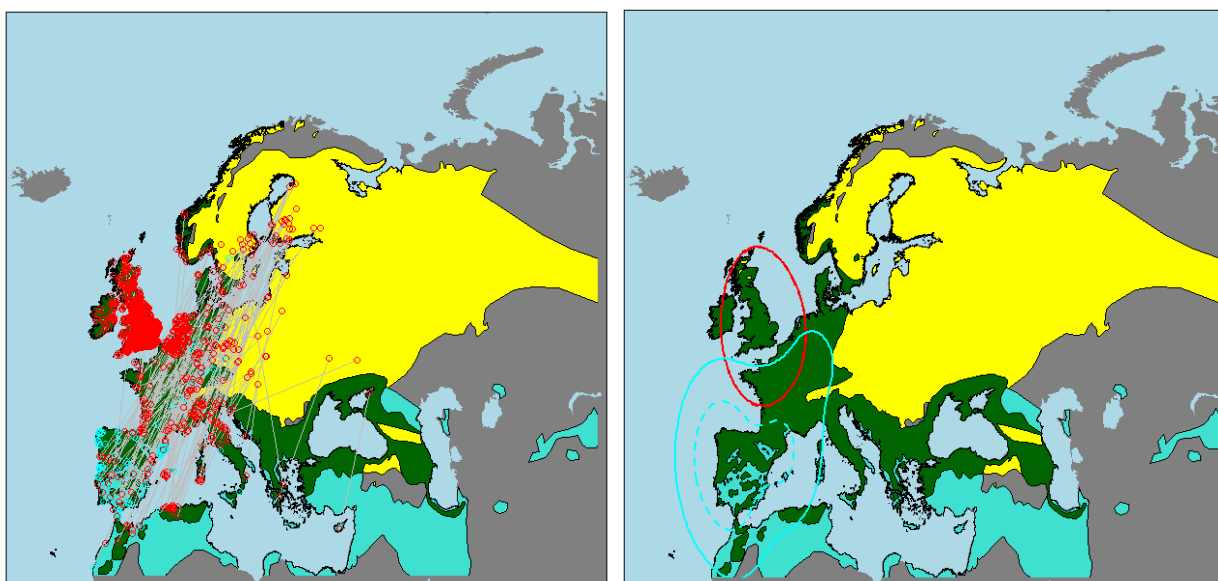


Figure 4. Left: distribution map of the encounters used for migratory connectivity analysis of the European robin. Lines connect positions where the same individual was encountered. Different colours indicate different first-level clusters. Right: 95% kernel density of individuals in the breeding (solid line) and non-breeding (dashed line) grounds of each cluster (note that breeding and non-breeding kernels of the red cluster overlap). Maps show the breeding (yellow) and non-breeding (light blue) range of the species and the range where the species occur all year round (green) according to BirdLife International and Handbook of the Birds of the World (2019).



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9. Historical changes in migration patterns

Kasper Thorup, Copenhagen Bird Ringing Centre, Natural History Museum of Denmark, University of Copenhagen

We are working on a moderate number of species with good spatial and temporal coverage. The main results will be descriptive graphs and maps allowing for description and interpretation of spatiotemporal changes in migration patterns. The work will provide a basis for future research on relating changes in migration patterns to climate and land use changes. In addition to the direct analyses of recoveries, we will assess potential biases in these analyses visually from graphs of changes in recovery and reporting probabilities over time. We only focus on birds recovered dead to avoid the substantial geographical variation in recapture and resighting probabilities. Breeding periods will be based on the breeding season as defined in the literature, whereas we will define the wintering period as December-February for all species. Analyses will be performed for species with more than 50 accurate spatiotemporal data from the season in question. Overall, our analyses follow the data selection and analyses guidelines in Fiedler W, Bairlein F, Köppen U (2004; Using Large-Scale Data from Ringed Birds for the Investigation of Effects of Climate Change on Migrating Birds: Pitfalls and Prospects. *Advances in Ecological Research* 35: 49-67).

Our analyses of changes in migration patterns will result in tables of summarizing figures, trend graphs (see example Fig. 1), decadal geographical maps (Fig. 2) as well as figures detailing potential changes in recovery reasons separated into hunted/known/unknown recovery causes (Fig. 3). Based on these tables, graphs and maps, we will write species-by-species summaries and interpretations taking into account potential biases and linking to environmental conditions. Lastly, we will provide an overall summary across species linked to climate and land use change and potential future changes. The work components are primarily a limited and short literature review, followed by data acquisition/curation and analyses, writing species-by-species comments and lastly writing an overall summary.

Current status: We have received data from EURING DATA BANK for ten species. Filtering scripts have been written according to the criteria defined above (Table 1). Programming for creation of tables, figures and maps has started but are not finalized.

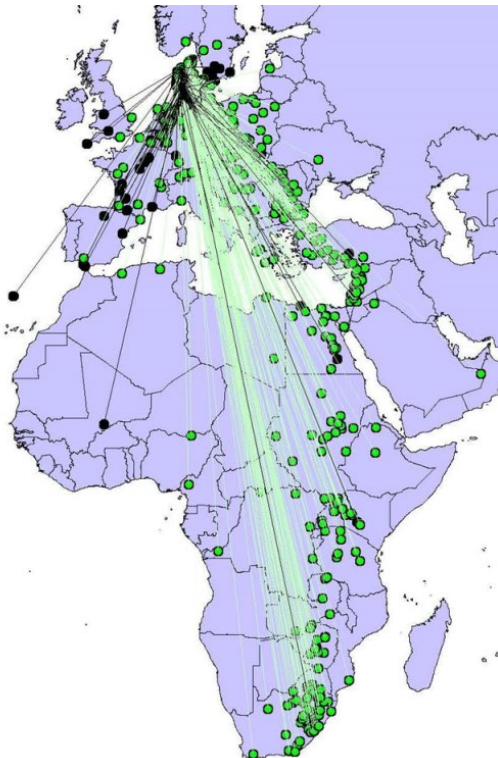


Fig. 1. Ring recoveries of white storks ringed in Denmark during two time periods showing a change in wintering grounds

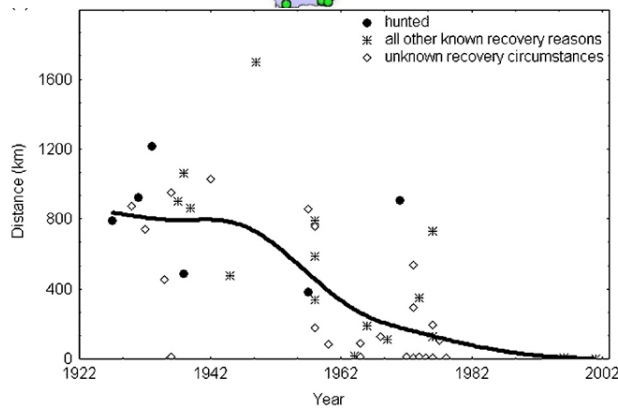


Fig. 2. Greenfinch ringed during breeding in Germany showing a decrease in migration distance (From Fiedler et al. 2004).

Raptors

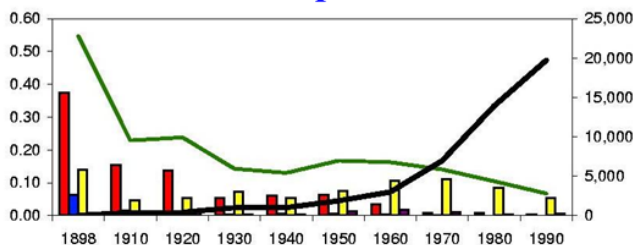


Fig. 3. Recoveries rates of raptors ringed in Denmark (red: shot; blue: otherwise caused by human; yellow: not hunted; purple: controlled. Green line: all recoveries; black line: numbers ringed). In the early 1900s more than 10 % of ringed raptors were shot.

Species	Original number of records	Number of records after selection	Number of birds
02380_Milvus-migrans	4118	1992	996
01890_Anas-acuta	18312	2180	1090
01840_Anas-crecca	101493	3054	1527
01610_Anser-anser	175282	14362	7181
12000_Turdus-philomelos	139464	9782	4891
13490_Ficedula-hypoleuca	185036	17098	8549
09920_Hirundo-rustica	259750	12556	6278
15820_Sturnus-vulgaris	294818	26462	13231
10990_Erithacus-rubecula	853219	5158	2579
01340_Ciconia-ciconia	268342	31026	15513

Table 1. Species and number of records processed until now.

Annex 1 Provisional list of species to be included in the Atlas

Scientific name	English name
Tetrao urogallus	Western Capercaillie
Coturnix coturnix	Common Quail
Branta bernicla	Brent Goose
Branta ruficollis	Red-breasted Goose
Branta canadensis	Canada Goose
Branta leucopsis	Barnacle Goose
Anser anser	Greylag Goose
Anser brachyrhynchus	Pink-footed Goose
Anser albifrons	Greater White-fronted Goose
Anser erythropus	Lesser White-fronted Goose
Anser fabalis/serrirostris	Taiga/Tundra Bean Goose
Cygnus olor	Mute Swan
Cygnus columbianus	Tundra Swan
Cygnus cygnus	Whooper Swan
Alopochen aegyptiaca	Egyptian Goose
Tadorna tadorna	Common Shelduck
Aix galericulata	Mandarin Duck
Spatula querquedula	Garganey
Spatula clypeata	Northern Shoveler
Mareca strepera	Gadwall
Mareca penelope	Eurasian Wigeon
Anas platyrhynchos	Mallard
Anas acuta	Northern Pintail
Anas crecca	Eurasian Teal
Netta rufina	Red-crested Pochard
Aythya ferina	Common Pochard
Aythya nyroca	Ferruginous Duck
Aythya fuligula	Tufted Duck
Aythya marila	Greater Scaup
Somateria mollissima	Common Eider
Melanitta fusca	Velvet Scoter
Melanitta nigra	Common Scoter
Clangula hyemalis	Long-tailed Duck
Bucephala clangula	Common Goldeneye
Mergellus albellus	Smew
Mergus merganser	Common Merganser
Mergus serrator	Red-breasted Merganser
Caprimulgus ruficollis	Red-necked Nightjar
Caprimulgus europaeus	European Nightjar
Tachymarptis melba	Alpine Swift
Apus apus	Common Swift
Otis tarda	Great Bustard
Cuculus canorus	Common Cuckoo
Columba oenas	Stock Dove

<i>Columba palumbus</i>	Common Wood Pigeon
<i>Streptopelia turtur</i>	European Turtle Dove
<i>Streptopelia decaocto</i>	Eurasian Collared Dove
<i>Rallus aquaticus</i>	Water Rail
<i>Crex crex</i>	Corn Crake
<i>Porzana porzana</i>	Spotted Crake
<i>Gallinula chloropus</i>	Common Moorhen
<i>Fulica atra</i>	Eurasian Coot
<i>Grus virgo</i>	Demoiselle Crane
<i>Grus grus</i>	Common Crane
<i>Tachybaptus ruficollis</i>	Little Grebe
<i>Podiceps cristatus</i>	Great Crested Grebe
<i>Podiceps auritus</i>	Slavonian Grebe
<i>Podiceps nigricollis</i>	Black-necked Grebe
<i>Phoenicopterus roseus</i>	Greater Flamingo
<i>Burhinus oedicephalus</i>	Eurasian Stone-curlew
<i>Haematopus ostralegus</i>	Eurasian Oystercatcher
<i>Himantopus himantopus</i>	Black-winged Stilt
<i>Recurvirostra avosetta</i>	Pied Avocet
<i>Vanellus vanellus</i>	Northern Lapwing
<i>Pluvialis apricaria</i>	European Golden Plover
<i>Pluvialis squatarola</i>	Grey Plover
<i>Charadrius hiaticula</i>	Common Ringed Plover
<i>Charadrius dubius</i>	Little Ringed Plover
<i>Charadrius alexandrinus</i>	Kentish Plover
<i>Charadrius morinellus</i>	Eurasian Dotterel
<i>Numenius phaeopus</i>	Whimbrel
<i>Numenius arquata</i>	Eurasian Curlew
<i>Limosa lapponica</i>	Bar-tailed Godwit
<i>Limosa limosa</i>	Black-tailed Godwit
<i>Arenaria interpres</i>	Ruddy Turnstone
<i>Calidris canutus</i>	Red Knot
<i>Calidris pugnax</i>	Ruff
<i>Calidris ferruginea</i>	Curlew Sandpiper
<i>Calidris temminckii</i>	Temminck's Stint
<i>Calidris alba</i>	Sanderling
<i>Calidris alpina</i>	Dunlin
<i>Calidris maritima</i>	Purple Sandpiper
<i>Calidris minuta</i>	Little Stint
<i>Scolopax rusticola</i>	Eurasian Woodcock
<i>Lymnocyrtus minimus</i>	Jack Snipe
<i>Gallinago media</i>	Great Snipe
<i>Gallinago gallinago</i>	Common Snipe
<i>Phalaropus lobatus</i>	Red-necked Phalarope
<i>Actitis hypoleucos</i>	Common Sandpiper
<i>Tringa ochropus</i>	Green Sandpiper
<i>Tringa totanus</i>	Common Redshank
<i>Tringa glareola</i>	Wood Sandpiper

<i>Tringa erythropus</i>	Spotted Redshank
<i>Tringa nebularia</i>	Common Greenshank
<i>Rissa tridactyla</i>	Black-legged Kittiwake
<i>Pagophila eburnea</i>	Ivory Gull
<i>Chroicocephalus genei</i>	Slender-billed Gull
<i>Chroicocephalus ridibundus</i>	Black-headed Gull
<i>Hydrocoloeus minutus</i>	Little Gull
<i>Ichthyaetus audouinii</i>	Audouin's Gull
<i>Ichthyaetus melanocephalus</i>	Mediterranean Gull
<i>Ichthyaetus ichthyaetus</i>	Pallas's Gull
<i>Larus canus</i>	Common Gull
<i>Larus marinus</i>	Great Black-backed Gull
<i>Larus hyperboreus</i>	Glaucous Gull
<i>Larus argentatus</i>	European Herring Gull
<i>Larus fuscus</i>	Lesser Black-backed Gull
<i>Gelochelidon nilotica</i>	Gull-billed Tern
<i>Hydroprogne caspia</i>	Caspian Tern
<i>Thalasseus sandvicensis</i>	Sandwich Tern
<i>Sternula albifrons</i>	Little Tern
<i>Sterna dougallii</i>	Roseate Tern
<i>Sterna hirundo</i>	Common Tern
<i>Sterna paradisaea</i>	Arctic Tern
<i>Chlidonias hybrida</i>	Whiskered Tern
<i>Chlidonias niger</i>	Black Tern
<i>Stercorarius skua</i>	Great Skua
<i>Stercorarius parasiticus</i>	Arctic Skua
<i>Stercorarius longicaudus</i>	Long-tailed Skua
<i>Alle alle</i>	Little Auk
<i>Uria lomvia</i>	Brünnich's Guillemot
<i>Uria aalge</i>	Guillemot
<i>Alca torda</i>	Razorbill
<i>Cepphus grylle</i>	Black Guillemot
<i>Fratercula arctica</i>	Atlantic Puffin
<i>Gavia stellata</i>	Red-throated Diver
<i>Gavia arctica</i>	Black-throated Diver
<i>Hydrobates pelagicus</i>	European Storm Petrel
<i>Oceanodroma leucorhoa</i>	Leach's Storm Petrel
<i>Fulmarus glacialis</i>	Northern Fulmar
<i>Calonectris borealis</i>	Cory's Shearwater
<i>Puffinus puffinus</i>	Manx Shearwater
<i>Ciconia nigra</i>	Black Stork
<i>Ciconia ciconia</i>	White Stork
<i>Morus bassanus</i>	Northern Gannet
<i>Microcarbo pygmaeus</i>	Pygmy Cormorant
<i>Phalacrocorax aristotelis</i>	European Shag
<i>Phalacrocorax carbo</i>	Great Cormorant
<i>Geronticus eremita</i>	Northern Bald Ibis
<i>Plegadis falcinellus</i>	Glossy Ibis

<i>Platalea leucorodia</i>	Eurasian Spoonbill
<i>Botaurus stellaris</i>	Eurasian Bittern
<i>Ixobrychus minutus</i>	Little Bittern
<i>Nycticorax nycticorax</i>	Black-crowned Night Heron
<i>Ardeola ralloides</i>	Squacco Heron
<i>Bubulcus ibis</i>	Western Cattle Egret
<i>Ardea cinerea</i>	Grey Heron
<i>Ardea purpurea</i>	Purple Heron
<i>Ardea alba</i>	Great Egret
<i>Egretta garzetta</i>	Little Egret
<i>Pelecanus onocrotalus</i>	Great White Pelican
<i>Pandion haliaetus</i>	Western Osprey
<i>Gypaetus barbatus</i>	Bearded Vulture
<i>Neophron percnopterus</i>	Egyptian Vulture
<i>Pernis apivorus</i>	European Honey Buzzard
<i>Gyps fulvus</i>	Griffon Vulture
<i>Aegypius monachus</i>	Cinereous Vulture
<i>Circaetus gallicus</i>	Short-toed Snake Eagle
<i>Clanga pomarina</i>	Lesser Spotted Eagle
<i>Clanga clanga</i>	Greater Spotted Eagle
<i>Hieraaetus pennatus</i>	Booted Eagle
<i>Aquila heliaca</i>	Eastern Imperial Eagle
<i>Aquila chrysaetos</i>	Golden Eagle
<i>Aquila fasciata</i>	Bonelli's Eagle
<i>Accipiter nisus</i>	Eurasian Sparrowhawk
<i>Accipiter gentilis</i>	Northern Goshawk
<i>Circus aeruginosus</i>	Western Marsh Harrier
<i>Circus cyaneus</i>	Hen Harrier
<i>Circus pygargus</i>	Montagu's Harrier
<i>Milvus milvus</i>	Red Kite
<i>Milvus migrans</i>	Black Kite
<i>Haliaeetus albicilla</i>	White-tailed Eagle
<i>Buteo lagopus</i>	Rough-legged Buzzard
<i>Buteo buteo</i>	Common Buzzard
<i>Tyto alba</i>	Western Barn Owl
<i>Otus scops</i>	Eurasian Scops Owl
<i>Strix aluco</i>	Tawny Owl
<i>Strix nebulosa</i>	Great Grey Owl
<i>Surnia ulula</i>	Northern Hawk-Owl
<i>Glaucidium passerinum</i>	Eurasian Pygmy Owl
<i>Athene noctua</i>	Little Owl
<i>Aegolius funereus</i>	Tengmalm's Owl
<i>Asio otus</i>	Long-eared Owl
<i>Asio flammeus</i>	Short-eared Owl
<i>Upupa epops</i>	Eurasian Hoopoe
<i>Coracias garrulus</i>	European Roller
<i>Alcedo atthis</i>	Common Kingfisher
<i>Merops apiaster</i>	European Bee-eater

<i>Jynx torquilla</i>	Eurasian Wryneck
<i>Dendrocopos major</i>	Great Spotted Woodpecker
<i>Falco naumanni</i>	Lesser Kestrel
<i>Falco tinnunculus</i>	Common Kestrel
<i>Falco vespertinus</i>	Red-footed Falcon
<i>Falco eleonora</i>	Eleonora's Falcon
<i>Falco columbarius</i>	Merlin
<i>Falco subbuteo</i>	Eurasian Hobby
<i>Falco cherrug</i>	Saker Falcon
<i>Falco peregrinus</i>	Peregrine Falcon
<i>Lanius collurio</i>	Red-backed Shrike
<i>Lanius excubitor</i>	Great Grey Shrike
<i>Lanius senator</i>	Woodchat Shrike
<i>Oriolus oriolus</i>	Eurasian Golden Oriole
<i>Garrulus glandarius</i>	Eurasian Jay
<i>Nucifraga caryocatactes</i>	Spotted Nutcracker
<i>Coloeus monedula</i>	Western Jackdaw
<i>Corvus frugilegus</i>	Rook
<i>Corvus corax</i>	Northern Raven
<i>Corvus corone/cornix</i>	Carrion/Hooded Crow
<i>Bombycilla garrulus</i>	Bohemian Waxwing
<i>Periparus ater</i>	Coal Tit
<i>Poecile montanus</i>	Willow Tit
<i>Cyanistes caeruleus</i>	Eurasian Blue Tit
<i>Parus major</i>	Great Tit
<i>Remiz pendulinus</i>	Eurasian Penduline Tit
<i>Panurus biarmicus</i>	Bearded Tit
<i>Lullula arborea</i>	Woodlark
<i>Alauda arvensis</i>	Eurasian Skylark
<i>Riparia riparia</i>	Sand Martin
<i>Hirundo rustica</i>	Barn Swallow
<i>Delichon urbicum</i>	Common House Martin
<i>Cettia cetti</i>	Cetti's Warbler
<i>Aegithalos caudatus</i>	Long-tailed Tit
<i>Phylloscopus sibilatrix</i>	Wood Warbler
<i>Phylloscopus trochilus</i>	Willow Warbler
<i>Phylloscopus collybita</i>	Common Chiffchaff
<i>Acrocephalus arundinaceus</i>	Great Reed Warbler
<i>Acrocephalus melanopogon</i>	Moustached Warbler
<i>Acrocephalus paludicola</i>	Aquatic Warbler
<i>Acrocephalus schoenobaenus</i>	Sedge Warbler
<i>Acrocephalus dumetorum</i>	Blyth's Reed Warbler
<i>Acrocephalus scirpaceus</i>	Eurasian Reed Warbler
<i>Acrocephalus palustris</i>	Marsh Warbler
<i>Iduna pallida</i>	Eastern Olivaceous Warbler
<i>Hippolais polyglotta</i>	Melodious Warbler
<i>Hippolais icterina</i>	Icterine Warbler
<i>Locustella naevia</i>	Common Grasshopper Warbler

<i>Locustella luscinioides</i>	Savi's Warbler
<i>Sylvia atricapilla</i>	Eurasian Blackcap
<i>Sylvia borin</i>	Garden Warbler
<i>Sylvia nisoria</i>	Barred Warbler
<i>Sylvia curruca</i>	Lesser Whitethroat
<i>Sylvia communis</i>	Common Whitethroat
<i>Sylvia cantillans</i>	Subalpine Warbler
<i>Sylvia melanocephala</i>	Sardinian Warbler
<i>Regulus ignicapilla</i>	Common Firecrest
<i>Regulus regulus</i>	Goldcrest
<i>Troglodytes troglodytes</i>	Eurasian Wren
<i>Sitta europaea</i>	Eurasian Nuthatch
<i>Certhia familiaris</i>	Eurasian Treecreeper
<i>Certhia brachydactyla</i>	Short-toed Treecreeper
<i>Sturnus vulgaris</i>	Common Starling
<i>Turdus torquatus</i>	Ring Ouzel
<i>Turdus merula</i>	Common Blackbird
<i>Turdus pilaris</i>	Fieldfare
<i>Turdus iliacus</i>	Redwing
<i>Turdus philomelos</i>	Song Thrush
<i>Turdus viscivorus</i>	Mistle Thrush
<i>Muscicapa striata</i>	Spotted Flycatcher
<i>Erithacus rubecula</i>	European Robin
<i>Luscinia svecica</i>	Bluethroat
<i>Luscinia luscinia</i>	Thrush Nightingale
<i>Luscinia megarhynchos</i>	Common Nightingale
<i>Ficedula hypoleuca</i>	European Pied Flycatcher
<i>Ficedula albicollis</i>	Collared Flycatcher
<i>Phoenicurus ochruros</i>	Black Redstart
<i>Phoenicurus phoenicurus</i>	Common Redstart
<i>Saxicola rubetra</i>	Whinchat
<i>Saxicola rubicola</i>	European Stonechat
<i>Oenanthe oenanthe</i>	Northern Wheatear
<i>Cinclus cinclus</i>	White-throated Dipper
<i>Passer hispaniolensis</i>	Spanish Sparrow
<i>Passer montanus</i>	Eurasian Tree Sparrow
<i>Prunella modularis</i>	Dunnock
<i>Motacilla flava</i>	Western Yellow Wagtail
<i>Motacilla cinerea</i>	Grey Wagtail
<i>Motacilla alba</i>	White Wagtail
<i>Anthus pratensis</i>	Meadow Pipit
<i>Anthus trivialis</i>	Tree Pipit
<i>Anthus petrosus/spinoletta</i>	Rock/Water Pipit
<i>Fringilla coelebs</i>	Common Chaffinch
<i>Fringilla montifringilla</i>	Brambling
<i>Coccothraustes coccothraustes</i>	Hawfinch
<i>Pinicola enucleator</i>	Pine Grosbeak
<i>Pyrrhula pyrrhula</i>	Eurasian Bullfinch

Carpodacus erythrinus	Common Rosefinch
Chloris chloris	European Greenfinch
Linaria flavirostris	Twite
Linaria cannabina	Common Linnet
Acanthis hornemanni	Arctic Redpoll
Acanthis flammea/cabaret	Common/Lesser Redpoll
Loxia curvirostra	Common Crossbill
Carduelis carduelis	European Goldfinch
Carduelis citrinella	Citril Finch
Serinus serinus	European Serin
Spinus spinus	Eurasian Siskin
Plectrophenax nivalis	Snow Bunting
Emberiza calandra	Corn Bunting
Emberiza citrinella	Yellowhammer
Emberiza hortulana	Ortolan Bunting
Emberiza schoeniclus	Common Reed Bunting