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Small wildlife of fields and meadows in Europe

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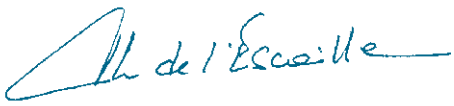
Acknowledgments

Thierry de l'Escaille
Secretary General ELO



It is my pleasure to thank the authors of this study, which is made in the framework of the reform of the Common Agricultural Policy and other major strategies such as the «Green Pact for Europe» to fight against climate change and environmental degradation and the EU Biodiversity Strategy 2030 aiming to restore biodiversity.

This ambitious project required the coordination of a multinational and multisectoral team under the leadership of Jurgen Tack. The work done initiated already constructive debates in many policy-oriented meetings in various EU Member States on the valuable contribution the small fauna of the plains could have for biodiversity and related management practices.

This work would probably not have seen the light of day if it had not been initiated in particular by friends such as Éric Jolly or Tony de Kettenis. Aware of the problem of the state of biodiversity and climate change, they called for the idea of a study offering both a scientific inventory and recommendations. In the same way, this work could not have been carried out without the support of major private (in particular the 'Fondation Sommer) or public bodies (including the French Office for Biodiversity OFB in partnership with the AGPB) as well as the Wildlife Label network. The recommendations in this study are based on experience and have already demonstrated their added value towards ambitious and sustainable objectives.

I would like to thank all of them very warmly.

I dedicate this study to all the actors of the European plains and estate managers without whom nothing will become reality in the future: farmers, foresters, hunters, fishermen, nature lovers and their partners in public institutions. May it also be a source of realistic inspiration for those who will have to take decisions in the future.

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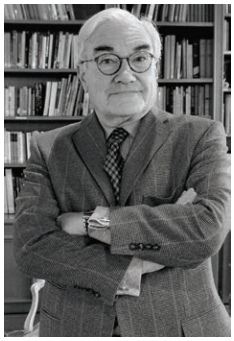
Preface



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Philippe DULAC
President of the François SOMMER Foundation

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The recovery of the «small wild fauna of the fields and meadows» is a major challenge for the restoration of biodiversity and for the sustainability of hunting.

Biodiversity has become, as much as global warming, one of the major concerns of our time. The sixth extinction of species is certainly not a new phenomenon in the history of planet Earth, but its scale is cause for concern. Too many species became extinct or are threatened with extinction. The small fauna of the fields and meadows is not escaping this phenomenon, far from it.

This decrease has been and is still experienced as a major concern by the hunting world. For people of my generation who started hunting after the war, the evolution observed over the last 50 years has been brutal. At that time, big game was rare and when hunting «in the woods», one had to be content with modest hunting bags. But hunting «on the plains» offered a considerable number of hunters - in France more than twice their current numbers - happy and inexpensive hunting days. But the plain has been largely depopulated. North of the Loire (France), the grey partridge has practically disappeared during the last twenty years. The use of pesticides, resulting in the disappearance of a large part of the young birds' diet, has made reproduction very difficult. Farming practices extending over long periods of the year leave little shelter for the small fauna hunted by predators.

In recent years, studies have been carried out on methodologies to reverse this evolution. They show that solutions do exist. It is fairly well known what should be done. But the owners and farmers who manage these areas still need to get involved. Most of them are having a hard time and are concentrating on the profitability of their activity. Hunting - which they still do sometimes, but not always - does not generate income. They are therefore not necessarily motivated.

The current reform of the CAP may provide an opportunity to overcome this problem. It would be a pity not to make use of it. Certainly, technical discussions will have to be held to define the content of the measures to be adopted. But the general orientation of the reform, in a direction favourable to biodiversity, and consequently to hunting, must be imposed. This is in everyone's best interest.

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Pierre DUBREUIL,
General director of 'Office Français de la Biodiversité' (OFB)

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It is alarming to find out that biodiversity is collapsing from insect populations up to bird and small mammal populations, all representatives of the small wildlife in France and elsewhere in Europe. This is not disputed by anyone. The reasons for the decline of species that are often emblematic for our territories (grey or red partridge, wheat quail, skylark) are numerous and well known: the change in agricultural practices since the «Glorious Thirties» (land consolidation, hedge clearance, mechanisation), the use of phytosanitary products (for example, researchers from public bodies have been able to demonstrate the impact of imidacloprid on grey partridges), not forgetting the urban sprawl and the transformation of agricultural land due to unlimited urbanisation

(housing estates, motorways, gradual disappearance of wetlands, etc.).

A major player in the biodiversity sphere is the public body formerly known as the National Hunting and Wildlife Office and today as the French Biodiversity Office. It has for many years been conducting studies with its partners, including the 'Fondation Sommer' and ELO, on how to halt the loss of biodiversity by promoting practices that are favourable to biodiversity and enable those who adopt them to reconcile a viable economic model with a thriving small plains fauna.

The 'Agrifaune' programme, now deployed throughout France, is a very good example of this. By promoting grass strips, remembering the role of hedges and offering agricultural equipment (such as tractor equipment to keep animals away when mowing), this programme clearly indicates that alternatives exist.

Certification and communication are also important instruments and should be further developed. The present study, which is the result of long discussions between the European Landowners Organization, the Sommer Foundation and public bodies, demonstrates this. The attribution of the Wildlife Estate label to estates where men and women, farmers, hunters, managers and researchers can testify to the results obtained after the use of good practices is an important leverage.

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Konstantin KOSTOPOULOS,

General director of the Wildlife Estates Label (WE)

It is widely recognized that Nature is important for our society's ability to cope with global change, health threats and disasters. Protecting and restoring biodiversity and well-functioning ecosystems is key to boost our resilience and prevent the emergence and spread of future diseases. Nature is also a vital ally in the fight against climate change.

It is however also true that nature is in a state of crisis. The five main direct drivers of biodiversity loss – changes in land and sea use, over exploitation, climate change, pollution, and invasive alien species – are often quoted as responsible for the crisis.

The EU has demonstrated its ambition to reverse biodiversity loss building on the objective to ensure that by 2050 all of the world's ecosystems are restored and protected. As a milestone, it aims to ensure that Europe's biodiversity will be on the path to recovery by 2030, in line with the commitments set out in the European Green Deal.

The EU had established legal frameworks, strategies and action plans to protect nature and restore habitats and species. However, up to now, these measures proved to be inadequate to reverse the negative trend in biodiversity loss. To put biodiversity on the path to recovery by 2030, the recommendations and commitments of the Green Deal relevant to nature restoration aim at improving and widening the network of protected areas and developing an ambitious EU Nature Restoration Plan. In addition, the revised Common Agricultural Policy (CAP) includes enhanced "green architecture" provisions that provide the means and the legal framework in support of nature and biodiversity restoration in combination with the Green Deal recommendations.

The present study uses small wildlife of fields, "the best-known biodiversity component for people living

and working in the countryside", as a point of reference for an analysis of the above interlinked legal frameworks, measures and strategies, as well as their relevance to landowners, farmers and hunters. It takes the reader through the causes for the loss of biodiversity and the existing EU legal provisions as well as the management and restoration of small wildlife population, the CAP and the tools for private land conservation and concludes with some case studies. The reader will also find useful information on a set of typical mammals and birds on Europe's fields to help understand the decline in populations and on the measures on species protection adopted by national governments.

In very concrete terms, the study also includes policy recommendations on a number of issues very vividly debated in the European Institutions and in various stakeholder fora following the publication of the European Commission proposals on the CAP and of the Green Deal recommendations. Amongst them are the proposals to increase protected areas by 30% of which 10% should be under strict protection, reduction of chemical pesticides, payments for ecosystem services, organic farming, etc.

The role of all stakeholders in the process of EU policy formulation and implementation has been recognized and integrated into the new CAP and the Green Deal.

This study, with its policy or practical recommendations, should be therefore useful to all actors involved or having a responsibility in the management of rural territories. It fully illustrates the constant spirit of ELO over the years in researching and facilitating common understanding among the political, public or private sectors towards sustainable results in favour of, among others, the environment, biodiversity and natural resources through rural development. Ensuring that all stakeholders are involved is more than ever crucial in the on-going debate on future policies to protect and restore biodiversity.

These recommendations also come at a time when the EU member states are called upon to draw up their national policies for the implementation of the new CAP. They can be used to assist them in the formulation of these policies, in particular with regard to environmental and biodiversity conditions, taking into account ambitious but realistic objectives, with appropriate support and rewarded ownership.

In this context, current initiatives going to the right direction as an asset from the private sector in rural areas, showing already ambition and concrete added value, should be fully recognized and encouraged. While this should be the case for many of the above-mentioned recommendations, this is also typically relevant for the well-recognized Wildlife Estates (WE) project. The project has been already developed in 19 European countries by ELO over a number of years, with a view to encourage and enhance private landowners and land managers in their efforts to protect biodiversity in their lands in using the most outstanding tools and instruments. The project now covers about 420 estates, nearly 2 million hectares and is rapidly expanding. This is a good example of how a fair acknowledgement and reward for the efforts of these private actors to promote biodiversity could make a big difference in the conservation of nature.

Any reforms in the future, including that of the WE project, while safeguarding economic sustainability, will benefit from taking into account the new direction of the EU policy on biodiversity as well as the recommendations in the present small wildlife study which constitute a valuable reference.

Abstract

For several decades, the agricultural plains have seen a dramatic decline in the number of small wildlife in fields and meadows.

This report describes the declining biodiversity of fields and meadows in Europe and how the European Union has acted on this by adopting nature legislation and by developing biodiversity strategies. Even though not have always successful.

The decline in small wildlife populations is caused by multiple practices including crop intensification, agricultural land consolidation, use of pesticides, urbanisation etc. This study will have a closer look at agricultural production techniques, study the effect of grazing and the use of fertilisers and pesticides. It will also discuss the role of hunting and study the increasing populations of predators and their effects on the small wildlife of fields and meadows.

Once the causes of the decline of these small wildlife species of fields and meadows are known we have a look at the most important management practices to protect the small wildlife in the fields and meadows. This includes habitat related management: hedges, grassed strips and wildlife fallow strips by providing refuge areas and additional food resources to generate small wildlife recovery. Although these developments have demonstrated a positive impact on the fields' and meadows' wildlife and, more specifically, on its avifauna, it has also been found that their effectiveness depends on the consistency with which they are established, as well as on the size of their siting areas. Next to habitat management this report describes management practices at the species level, including the regulation of predators and artificial feeding. But we also have a look at more innovative practices such as nature-based agriculture. We question if organic farming is really having a positive impact on biodiversity and we have a look at the potential cooperation between stakeholders in the countryside. We also have a look at the importance of guardianship and how the "Wildlife Estates" label can play a role in the much-needed public recognition towards private landowners.

In order to encourage the implementation of voluntary actions in favour of the environment in agricultural areas, the CAP has launched the programme of Agri-Environmental Measures (AEM) based on multi-annual contracts. These allow for the implementation of developments on the edges and within the crops that increase the carrying capacity of the plains, e.g., the capacity of a territory (and its habitats) to accommodate a certain density of individuals for each species. This report looks forward to the new CAP under development and the role it could play in the protection of small wildlife. Next to CAP-funding, the LIFE-programme can also play a role in supporting small wildlife, be it more specifically in Natura 2000 areas.

We conclude this study with several case studies which successfully used one of the instruments or methods described in the study, as the proof is in the pudding.

Policy recommendations

Towards the EU Biodiversity Strategy 2030:

- Successive EU Biodiversity strategies have not succeeded to halt the loss of biodiversity within the European Union. The biodiversity of fields and meadows has shown a steady decline and is not slowing down.
- There is a need for more coherence between different successive and parallel strategies related to biodiversity and agriculture.
- The new EU Biodiversity strategy proposes to increase protected areas by 30%. This can only be realised with the support of private landowners. Private landowners must be made real partners in this process. This can be achieved by including them in every step of the decision process. As voluntary measures have proven to be very successful among private landowners, we ask for a broad set of voluntary private land conservation tools. Several Life+ projects have listed such tools and have shown the interest of private landowners. By developing and providing payments for ecosystem services in line with market practice nature conservation can even become a thriving part of the rural economy.
- The EU Biodiversity Strategy 2030 also suggests that 1/3 of protected areas should be under strict protection (10% land and 10% sea). The proposed concept of strict protection is not taking into account environmental and climatic change and could even have a negative impact on biodiversity.
- The proposed reduction of chemical pesticides should go hand-in-hand with the development of more environmentally friendly alternatives enabling farmers to ensure Europe's and the world's food security. This requires actions to enable faster deployment of biological control methods and products by revising the regulatory approval process for such products. To review the regulatory provisions affecting efforts to internalising plant protection in crop genotypes the best technologies that modern biotechnology can offer should be used.
- An increasing set of tools for private land conservation, include payments for ecosystem services, tax benefits, labels for nature conservation management and sustainable produced natural products which are being explored and should be implemented to enable private landowners to fully participate and contribute to the conservation of nature.

Towards the CAP

- Agro-environmental measures (hedges and wooded banks, grassy headlands and field margins, woodland edge land, fallow land for wildlife, beetle banks, hay meadows, flower strips, over-wintered stubbles, and scrubs) have proven to contribute significantly to the diversity of small wildlife populations.
- The impact of modern harvesting and mowing technology is largely negative. However sometimes small adaptations in the use of this technology have a significantly positive effect. Simply adjusting the speed of mowing machines can already give significant results. Mowing and harvesting times also have a major impact on the survival rate and reproduction success of small wildlife.
- Organic farming, in contrast to nature-based agriculture, is not making a significant contribution to biodiversity at the farm or regional level.
- Crop choice plays an important role in the success of small wildlife.
- Low intensity grazing is the most attractive grassland production method for most small fauna (mammals, birds, insects, small reptiles, microorganisms), providing cover combined with higher abundancy of insects. Although some species, like Lapwing and Grey Partridge, benefit from more intense grazing. Use of vermicides and antibiotics however should be discouraged until their working on dung biotics resides. The effect leads to reduction of an important amount of insect food and slows down the composting of dung.
- High nature value farming, nature-based farming and circular farming are new farming methodologies which are currently being studied, with promising results towards as well circular economy as to small wildlife populations. While it is often stated that the greening of the CAP as currently implemented is not enhancing environmental and climate performance, it remains unclear if this really is the case. The period of implementation remains too short to lead to conclusive results. During many decades however, we have been subsidising nature conservation while we not being able to halt the loss of biodiversity.
- Within the new CAP, payments for ecosystems are a promising instrument on the condition that the

delivered results and not the size of land of an individual farmer will be the basis of the payment.

- Eco-schemes could significantly contribute to the delivery of public goods. It will, however, be difficult to determine the value of e.g., biodiversity to society. Another problem related to the payment for public goods is the need for extensive reporting and verification. To guarantee an equal treatment of all farmers, a binding share of the national direct payment envelope for eco-schemes is a necessity.

Towards sustainable hunting

- Hunters are one of the beneficiaries of increasing wildlife populations, which relates to increasing game populations even though shooting has a direct impact on individuals. Hunting conservation is a form of nature conservation which implements specific measures to increase biodiversity, not at least on farmland.

- Sustainable hunting is an activity that provides significant social, cultural, economic, and environmental benefits in different regions of the European Union. The hunting practice has been adapted over the last decades, with higher emphasis on preservation and sustainability resulting in bag statistics that have dropped in line with the decline of small game and wildlife populations. Compared with agriculture shooting equipment and methods have evolved little to nothing in efficiency over the past centuries.

- Decreasing populations are the result of the interaction of many different drivers including agriculture, urbanisation, nature conservation practices and hunting practices. There is no sound scientific evidence that hunting is a major driver of decreasing small wildlife populations.

- Predator control has in general a positive impact on small wildlife populations and should be part of larger management or restoration plans to increase results. Obviously, this should be done in function of the population and ecological context.

- Nature conservation in fields and meadows is most efficiently organised when including farmers and hunters. The use of agricultural land and hunting are inseparable. A symbiotic partnership between farmers and hunters on the management of natural resources could result in a balanced agricultural and environmental development. Preserving the biodiversity present in fields and meadows and could conserve the benefits provided by ecosystems such as reduced soil erosion, better water quality and improved agricultural yields through insect pollination.

- Species management including predator control, hunting and the use of wildlife crops have a positive impact on small wildlife populations.

- Predators take advantage of the longitudinal arrangements (e.g., field margins, woodland edge land etc) to hunt on small wildlife. Such agro-environmental measures should preferably be combined with predator control at the appropriate level.

- Artificial feeding is an often-debated technique. While priority should be given to habitat restoration, artificial feeding could be effective in conserving small wildlife populations depending on the local situation.

- The use of educated private game wardens with a good local knowledge has a significant positive effect on small game populations in fields and meadows. It is however difficult to find professionals to manage small game in a territory. A dedicated school at EU level could deliver highly skilled game wardens to deal with the present shortages.

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Why this study?

Small wildlife populations (mammals, birds, insects, small reptiles, microorganisms) are under pressure all over Europe. While the decreasing numbers are caused by many factors the general public often refers to hunting as the main cause of the decline of small fauna in Europe. This review study brings together scientific studies, legislation, hunting practices, management, and restoration of small wildlife populations and their habitats. It provides recommendations to wildlife and nature managers, as well as to the policy makers tackling environmental issues.

It is not a coincidence that the European Landowners' Organization has chosen Mid 2020 to publish a study on small wildlife of fields and meadows. The European Commission just published several important strategical documents: the farm to fork strategy and the EU Biodiversity Strategy. Later this year the European Forestry Strategy should follow. The European institutions have also committed to adopt a new reform of the Common Agricultural Policy (CAP) by considering the multiannual financial framework from 2021-2027. This will be done before the end of 2020.

All these strategies are interlinked and for private landowners, farmers, and hunters as they interact at the level of the biodiversity of the fields and meadows. The best-known biodiversity components for people living and working in the countryside are the birds and small mammals of the fields and meadows. By bringing together the scientific information on the small wildlife of fields and meadows ELO is and will be able to integrate this knowledge in its recommendations, policy papers and opinion documents on the different strategies mentioned. For farmers, landowners and other stakeholders including EU institutions, this document can guide them when discussing and negotiating the CAP and the agro-environmental measures within pillar 2 which are now the responsibility of the individual member states.

The declining biodiversity of fields and meadows

Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems (United Nations, 1992).

Biodiversity is not static but changes from one location to the other and changes over time. It refers to the basic building blocks of the ecosystems, as well natural as those managed by humans. Biodiversity is also at the base of natural benefits provided by nature or ecosystem services, including water recycling, clean air, carbon storage, pollination, climate regulation, pest control etc.

Worldwide biodiversity is declining. Agricultural biodiversity is not an exemption to this general trend. Agricultural biodiversity refers to all ecosystems and biodiversity related to farming, including animal breeds and seed varieties, but also the many natural organisms (wild biodiversity) in fields, meadows, and other farmland.

Agriculture is often seen as an important driver of biodiversity loss (Dudley & Alexander, 2017). While this is certainly the case, the interaction between the historical expansion of farming, present day agricultural practices and environmental change (land use change, habitat fragmentation, climate change, invasive alien species, climate change, …) (Slingenberg *et al.*, 2009) is so complicated that often scientific results can be interpreted in different ways depending on the point of view of the individual stakeholder.

There is no doubt that the intensity of farming has a direct effect on biodiversity. The intensification often results in an increased use of chemicals and machinery (EEA, 2015). The negative impact of the intensification of livestock farming on biodiversity is estimated by the European Commission's Joint Research Centre (JRC) to account for 78% of species loss

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(Leip *et al.*, 2015). The detrimental impact of livestock farming is mainly caused by eutrophication due to the surplus of nitrogen and phosphorous pollution (UN (FAO), 2006).

The declining biodiversity on farmland becomes very visible in fields and meadows where multiple stakeholders (farmers, hunters, recreationists, ...) are sharing the ecosystem services delivered by those valuable ecosystems, which include food production and environmental services such as carbon storage, pollination, etc.

The biodiversity of fields and meadows consists of many components. One of the least known to the public is the soil biodiversity. Under the farmland's surface you can find microorganisms such as bacteria and fungi, insects, earthworms, and moles which are all interacting and providing healthy farmland. They represent over 25% of all living species (European Landowners' Organization, 2010). Important ecosystem services provided by the soil biodiversity include water purification, carbon storage, preventing erosion and mitigating climate change. Even today the knowledge on soil biodiversity is limited but soils are unquestionable under pressure because of erosion, contamination, salinization and sealing (Joint Research Centre European Soil Data Centre (ESDAC), 2019).

Besides soil biodiversity, insect biodiversity is equally important to fields and meadows but is not so well known. Sánchez-Bayo & Wyckhuys (2019) reviewed 73 historical reports of insects and revealed dramatic rates of decline that may lead to the extinction of 40% of the world's insect species over the next few decades. In this study, the intensification of agriculture is also seen as a main driver. One of the best-known insect groups are butterflies. They are considered as excellent barometers of overall biodiversity. They are omnipresent and sensitive to environmental change making them excellent indicator species. The grassland butterfly population decreased by 50% in the period from 1990-2011 indicating an overall loss of grassland biodiversity.

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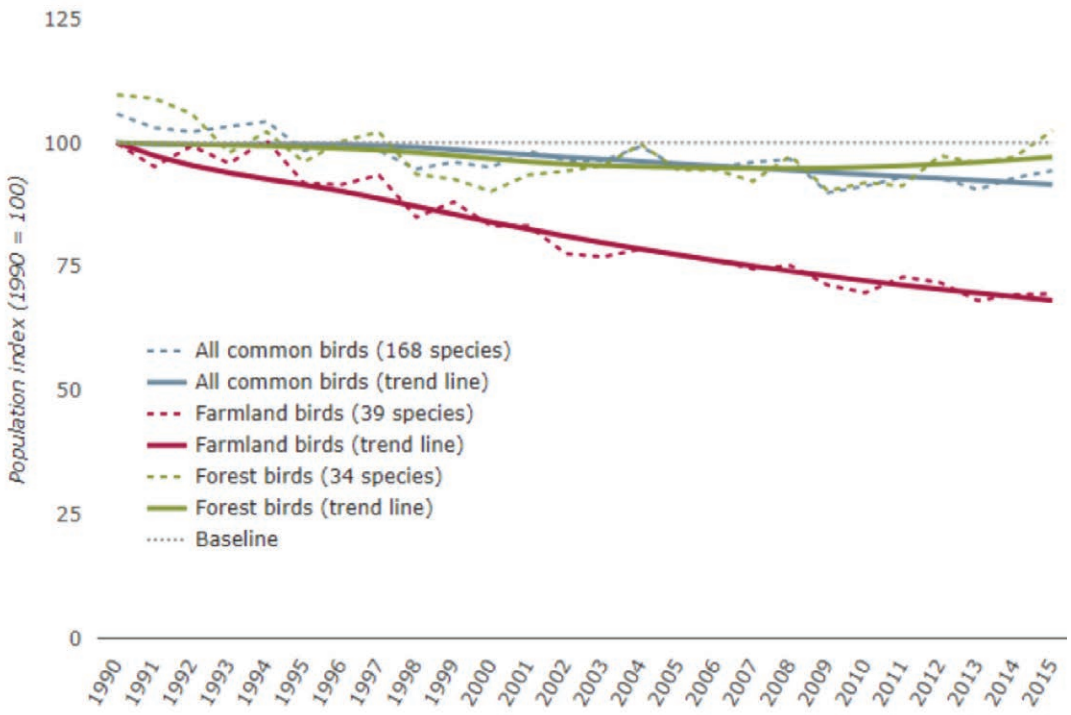
People living and working in the countryside have a much better knowledge of birds and mammals compared with the above-mentioned groups of insects. For this reason, the present report is focusing mainly on those two species groups.

The European Commission often uses the EU Farmland Bird Index as an indicator to measure European farmland biodiversity. The European Commission admits this method has limitations but considers it as the best available methodology (European Commission, 2018). The EU Farmland Bird Index shows a decreasing population of almost 30% since 1990. There has been a 39% decrease in the cropland bird populations, a 12% of the bird species are under threat and 20% are near threatened, declining or are extinct (European Environment Agency, 2016).



EU Common Birds – population index (source: EEA)

Finding reliable information on trends for small mammal species is much more difficult than for birds. While recent monitoring efforts are filling in the gap on the short term (10-15 years), long term population trends are missing for non-huntable species (Meinig *et al.*, 2009). Population trends of hunted species are often based on hunting bags. In annex 2 of this report, you will find an overview of well-known field and meadow birds and small mammals including their ecology and demography.

A policy framework to halt the loss of biodiversity

Declining biodiversity, including small wildlife populations of fields and meadows, triggered governments all over the world to act. As a first step, legislation was developed to protect species and habitats. Within the EU the European Commission set up a legislative framework as the basis for all species protection legislation.

Legal framework in Europe

Small wildlife species and habitats are part of the more general nature protection legislation in Europe, compromising of three main Legal Instruments, which are the cornerstones of Europe's nature conservation policy today:

- The Convention on the Conservation of European Wildlife and Natural Habitats or the Bern Convention (1979).
- Council Directive 79/409/EEC on the conservation of wild birds or the Birds Directive (1979, amended in 2009).
- Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora or the Habitat Directive (1992).

Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention)

The Bern Convention is a binding international legal instrument in the field of EU nature conservation. It entered into force in 1982, administered by the Council of Europe. Both the European Union and its Member States are parties as well as non-European countries.

The convention recognizes that wild fauna and flora constitutes a natural heritage of aesthetic, scientific, cultural, recreational, economic and intrinsic value that needs to be preserved and handed on to future generations and aims to achieve a greater conservation unity between its members.

Council Directive 79/409/EEC on the conservation of wild birds or Birds Directive (1979, amended in 2009)

EU Member States unanimously adopted Directive 79/409/EEC in April 1979 based on the provisions of the Bern convention but pertaining only to wild birds. Amended in 2009, it became the Directive 2009/147/EC. The Birds Directive aims to protect all the 500 wild bird species naturally occurring in the European Union[1]. It provides a common framework for the conservation of wild birds and their habitats.

Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (Habitats Directive)

The Council Directive 92/43/EEC of 21 May 1992, or the European Habitat Directive, was also enacted to implement the Bern Convention in the EU. But unlike the convention, the Habitats Directive does not have trans-border cooperation as a goal. Instead, it contains legal obligations for all EU member states to safeguard a 'favourable conservation status' (FCS)[2] for selected species and habitat types (European Commission, 2007). This central concept is coordinated by the European Commission as a central authority.

The full aim of the Habitat Directive is laid down in Article 2.

Article 2 (Directive 92/43/EEC)

- The aim of this Directive shall be to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States to which the Treaty applies.
- Measures taken pursuant to this Directive shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest.
- Measures taken pursuant to this Directive shall take account of economic, social and cultural requirements and regional and local characteristics.

Member States must aim to maintain or restore, at favourable conservation status, the natural habitats and species of wild fauna and flora listed in Annex II, IV and V of the Directive. The provisions aim is thus more than just avoiding extinction of the species under consideration (European Commission, 2007).

- **Annex II species** (about 900): core areas of their habitat are designated as sites of Community importance (SCIs) and included in the Natura 2000 network. These sites must be managed in accordance with the ecological needs of the species.
- **Annex IV species** (over 400, including many annex II species): a strict protection regime must be applied across their entire natural range within the EU, both within and outside Natura 2000 sites.
- **Annex V species** (over 90): Member States must ensure that their exploitation and taking in the wild is compatible with maintaining them in a favourable conservation status.

The Habitat Directive must be seen in the context of the Bern Convention and the Birds Directive. The Habitats directive shares not only common objectives with the Birds Directive, it also has a similar conceptual structure and describes common provisions in relation to the network of protected sites (Natura 2000) (European Commission, 2007).

The EU Nature Directives and hunting regulations

The Bird directive recognizes sustainable hunting as a tool to help achieve conservation objectives. Annex II species of the Birds Directive[3] may be hunted, although such hunting must comply with certain rules[4]. The directive recognizes that the management of hunting is the responsibility of the Member States, including their role in determining hunting seasons within their territory in accordance with the requirements of the Directive (EC, 2008). Hunting is thus carried out under national legislation; the listing of a species in Annex II does not oblige a Member State to allow for it to be hunted. It is merely an option of which the Member States may or may not avail themselves. However, Member States must outlaw all

1 *https://ec.europa.eu/environment/nature/legislation/birdsdirective/index_en.htm*

2 *A favourable conservation status of a species as described in Directive 92/43/EEC Art.1(i):*
(1) population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
(2) the natural range of the species is neither being reduced nor is likely to be reduced in the foreseeable future, and
(3) there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis

3 *Directive 2009/147/EC Art. 7(1): Owing to their population level, geographical distribution and reproductive rate throughout the Community, the species listed in Annex II may be hunted under national legislation. Member States shall ensure that the hunting of these species does not jeopardise conservation efforts in their distribution area. 7(2) The species referred to in Annex II, Part A, may be hunted in the geographical sea and land area where this Directive applies. 7(3) The species referred to in Annex II, Part B, may be hunted only in the member states in respect of which they are indicated.*

4 *Directive 2009/147/EC Art. 7-9*

forms of non-selective and large-scale killings, listed in Annex IV to the Directive and clearly set out the principles of ecologically balanced control and wise use to be respected regarding hunting, and hunting seasons[5].

In order to restore and maintain the populations of huntable bird species to a favourable conservation status in the EU, Delegates of the Member States in the ORNIS committee together with NGOs agree on management plans identifying short-term (3 years) objectives to halt the decline of these species that are at that moment in an unfavourable conservation status. Existing plans (2019): Black Tailed Godwit (*Limosa limosa*), Velvet Scoter (*Melanitta fusca*), Curlew species, Pintail (*Anas acuta*), Red Crested Pochard (*Netta rufina*), Eurasian skylark (*Alauda arvensis*), Turtle Dove (*Streptopelia turtur*).

The EU Nature Directives implementation in the EU Member States

The practical implementation of the EU Nature Directives is left to the Member States. It can be done through legal protection, but just as much through adequate land use planning or management agreements.

Leaving the implementation of the EU Nature Directives results in as many approaches to nature conservation as there are EU Member States. To follow up the progress of the implementation of the EU Nature Directives the EU Member States have to make six-yearly a report on the conservation status of habitats and species.

Reporting

The Habitats Directive require Member States to report every six years on the conservation status of habitats and species and the implementation of the measures[6] taken under the Directive. Monitoring of conservation status is an obligation[7] for all habitats (as listed in Annex I) and species (as listed in Annex II, IV and V) (European Commission, 2007).

Under the Birds directive Member States forward every three years a report on the implementation of national provisions taken[8] under the Directive to the commission. The monitoring provisions are thus not restricted to Natura 2000 sites and data need to be collected both inside and outside the Natura 2000 network to achieve a full appreciation of conservation status (European Commission, 2007).

EU Biodiversity Strategy

Despite the EU Nature Directives biodiversity kept declining. This was also the case outside Europe. To tackle the worldwide loss of species and habitats the United Nations took the initiative to set up a Convention on Biological Diversity (1992) which was ratified by the EU and each of its individual Member States in 1993.

In order to fulfil its obligations under the Convention on Biological Diversity the European Commission adopted in 1998 a Communication on a European Biodiversity Strategy. Additionally, the EC adopted an EU Biodiversity Action Plan in implementation of the Gothenburg Agenda in sustainable development. The objective was to halt the loss of biodiversity by 2010, a target which was never met. In 2011 a new EU Biodiversity Strategy was adopted aiming to halt the loss of biodiversity and ecosystem services in the EU. It set out six targets and 20 actions. With 6 more months to go we can be sure that the targets will not be met again.

In the first part of 2020 the European Commission presented its EU Biodiversity Strategy for 2030 'Bringing Nature back in our lives'[9].

[5] *Directive 2009/147/EC Art. 7(4)*
[6] *Directive 92 /43 /EEC, Article 6 (1)*
[7] *Directive 92 /43 /EEC, Article 11*
[8] *Directive 2009/147/EC Art. 12*
[9] *https://ec.europa.eu/info/sites/info/files/communication-annex-eu-biodiversity-strategy-2030_en.pdf*

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Key commitments by 2030 are as follows:

1. Legally binding EU nature restoration targets to be proposed in 2021, subject to an impact assessment. By 2030, significant areas of degraded and carbon-rich ecosystems will be restored; habitats and species show no deterioration in conservation trends and status; and at least 30% reach favourable conservation status or at least show a positive trend.
2. The decline in pollinators is reversed.
3. The risk and use of chemical pesticides are reduced by 50% and the use of more hazardous pesticides is also reduced by 50%.
4. At least 10% of the agricultural area is under high-diversity landscape features.
5. At least 25% of the agricultural land is under organic farming management, and the uptake of agro-ecological practices is significantly increased.
6. Three billion new trees are planted in the EU, in full respect of ecological principles.
7. Significant progress has been made in the remediation of contaminated soil sites.
8. At least 25,000 km of free-flowing rivers are restored.
9. There is a 50% reduction in the number of Red List species threatened by invasive alien species.
10. The losses of nutrients from fertilizers are reduced by 50%, resulting in the reduction of the use of fertilizers by at least 20%.
11. Cities with at least 20,000 inhabitants have an ambitious Urban Greening Plan.
12. No chemical pesticides are used in sensitive areas such as EU urban green areas.
13. The negative impacts on sensitive species and habitats, including on the seabed through fishing and extraction activities, are substantially reduced to achieve good environmental status.
14. The by-catch of species is eliminated or reduced to a level that allows species recovery and conservation.

While many of the above-mentioned commitments most certainly can have a positive impact on small wildlife in fields and meadows it is remarkable how again quantity prevails on quality making it most probable that even in 2030 biodiversity loss will not be halted.

Causes of the loss of biodiversity in fields and meadows

Before legislation and strategies can become effective, we need to have a good view on the causes of biodiversity loss in fields and meadows. As the title of this report indicates, we are focussing on small wildlife, more specifically on farmland birds and small mammals.

Agriculture: production techniques

Less variation in crop structure

Some species prefer crops with high cover, others prefer low cover or even open bare spaces. Some need crops that attract insects to feed their chicks in the breeding season and/or have seeds available all year round. Other species need edible crops. Variety though, is a key aspect for successful population conservation: the cultural and landscape mosaic. Indeed, we must be able to offer biodiversity a diversity of refuges. The cultural mosaic is of interest because it makes it possible to think about practices on a larger territorial scale than the farm. It is therefore necessary to have a global approach to the territory by associating farmers.

Agricultural crop land consists typically of grasses (e.g., forage grasses and cereal crops), broad-leaved crops and, on unenclosed grazing land, mixes of grasses with woody shrubs. Intensification has had three general effects on these swards. It has increased their density (e.g., mass of vegetation per unit area prior to any grazing or harvesting impacts) and it has simplified and homogenized sward structure and architecture, both directly and by reduction in the species diversity of swards. Mechanized, uniform sowing, agrochemical use, drainage, efficient harvesting and seed cleaning, re-seeding and increases in grazing and cutting intensity on grasslands and rolling of tillage crops have all contributed.

The mosaic provides varied resources (food, cover, nesting sites) for wildlife in the area (Bro *et al.*, 2007.). Alternating crops combined with long and narrow plots are key elements in the preservation of entomofauna and avifauna (Alignier *et al.*, 2020). Indeed, these factors make it possible to increase the number of interfaces between the different environments (Bro E., 2016). A positive consequence of the measure is the limited disturbance linked to field work. This action can be combined with other management activities.

During the year, different crops provide a different type of cover necessary for small wildlife. The edges of winter cereal plots provide very good cover for ground-nesting birds (e.g., Grey Partridge (Reitz F., 1997) or Skylark (Eraud C., 2002)). They are frequented by these species from March (mating period) to harvest (breeding period). Afterwards, industrial spring crops (sugar beet, potatoes, vegetables, etc.) or maize provide shelter for the young broods after the cereal harvest until they are harvested in the autumn. Once all the crops have been harvested it is the turn of the intermediate crops to take over. After the green manure has been ploughed in, it is the turn of the rapeseed to take over during the winter period (January to March).

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Intensification creates simpler, more homogeneous, and denser swards in both tillage crops and grassland. This influences predation risk, exposure to weather extremes and the diversity, abundance, and accessibility of food. The more uniform and denser the vegetation, the fewer the number of birds and range of species that can nest and forage successfully. Reversing recent trends towards dense, simplified and homogeneous swards will improve nesting and foraging habitat conditions for a wide range of species across farming systems, and may represent a cost-effective mechanism for the further improvement of agri-environment scheme options designed to assist the recovery of farmland bird populations (Wilson *et al.*, 2005).

In France, in the region of the Sologne for example, there was a high density of small wild fauna (grey partridge, pheasant, hare...). There was also a diversified agriculture with cereal production, sheep, cattle and vines. Today, the diversity of biotopes in

this region has gradually decreased with a negative effect on the small wildlife populations having difficulties to sustain themselves. In 1997, 1 ha out of 5 in the region of Sologne was fallow land because this was more profitable than production. Today the forest represents more than 50% of the territory. This decline in diversified agricultural land has favoured the development of wild boar and other large game populations, increasing the pressure on the remaining agricultural plots. (See also the study: «Wild boar populations in Europe» (Tack, 2018)).

The same applies to the abandonment of livestock farming in mountain areas caused by economic reasons and/or the return of the wolf, resulting in the closure of open spaces in the mountain pastures (to the benefit of the forests). The open or semi-open areas that are essential for maintaining the black grouse and capercaillie populations are therefore strongly reduced.

Meadow harvesting and mowing techniques

Meadows require regular harvesting (cutting) to avoid vegetation and habitat succession, and hence avoid high plant diversity. The impacts of the harvesting process on animal, and particularly invertebrate, abundance and diversity is, however, not well known, but is expected to be largely negative (Humbert, 2010).

Humbert (2010) assesses the direct impacts of the grass harvesting process on field invertebrates. The meadow harvesting process, often referred to as "cutting" or "mowing" when used in a broad sense, includes several stages:

1. Mowing the grass
2. Conditioning (crushing) the grass
3. Drying by tedding the grass
4. Windrowing (raking) the grass
5. Removing (baling or loading) the grass from the field

Not all these stages are necessarily present during the process, depending on the environment and type of meadow.

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Hand bar mowers are slightly less damaging than rotary mowers and adding a conditioner to a rotary mower increases impacts two to three folds. Conditioning (stage two) is a recent practice that is used to accelerate the drying of the grass by crushing it after mowing.

Furthermore, post-mowing harvesting interventions (e.g., tedding, raking, and baling) also have considerable impacts, especially on less mobile species such as *Orthoptera* where about 60% of the individuals that survived mowing are subsequently killed. Indeed, any benefits gained in terms of reduced grasshopper mortality by using a tractor-powered bar mower over a rotary mower are mostly lost by the cumulative impact of the subsequent harvesting stages. Reducing the number of harvests per year to the strict minimum required to maintain the plant community (one or two) is recommended. For field vertebrates, such as amphibians, a cutting height of 10 cm is recommended.

To prevent nest destruction and chick mortality, changes in mowing techniques should be considered. Nest destruction and chick mortality was recorded at 60%. The mortality decreased when the fields were mown from the centre towards the edge (Tyler *et al.*, 1998). The distance to cover is also important (Green *et al.*, 1997). The proportion of chicks killed was significantly lower in fields that were mowed from the inside outwards compared to outside-in or strip methods. Chicks in fields mowed from the outside inwards had a 57% killing rate and would have been killed without intervention, compared with 17% in fields mowed from inside-out. Also, the mowing date is a main factor affecting ground nesting bird vulnerability, especially at nesting stage before chicks hatch (Green *et al.*, 1997).

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Leaving uncut grass refuges is a simple yet effective measure to mitigate the direct negative impact of the harvesting process. Leaving 10% of the area uncut

when mowing with a maximum of 30 m distance between two refuges is recommended for invertebrates.

(Tyler *et al*., 1998) also showed that chick mortality was also lower (32%) when mowing from the centre to the side (Inside-Outside I-O) of the field during compared with the opposite direction (O-I) when the grass bordering the plot being mown had already been cut. In these circumstances the proportion of chicks that escaped was highest for the older chicks especially when the width of the mowed strip was narrow for the birds to escape. Chicks were less likely to be killed by I-O than O-I mowing even when the width of open ground to be crossed was similar for both methods. It is estimated that leaving refuge strips of unmown grass would reduce the chick mortality when there is little natural escape cover at the edges of meadows being mown I-O.

Besides the direction (I-O, O-I) also the speed of the mowing machine plays a significant role in the survival rate of small wildlife. Slower machinery allows the small wildlife species to escape towards the borders. Another reason to apply border management is to increase the survival rate of small wildlife.

Well planned mowing dates, followed by simply applying an inside-out harvesting route, will improve the population of ground nesting birds significantly, without impacting farm economical value. Education and awareness should suffice for this measure. The measure would however be put to action surely by adding a combined incentive for leaving the necessary amount of escape cover at the edges.

In a French study (Bro & Millot, 2013), the brooding failure of first nests was related to predation of grey partridge in 54% of cases, 9% to agricultural practices and 7% to maintenance of linear elements. In case of a second nest, failure was due to predation in 41% of nests, agricultural practices in 36% of nests and maintenance of linear elements only 2%. Hence, it is mostly on the second nest that agricultural practices have a greater impact, from the end of June to mid-July. This was mostly due to mowing grass, harvesting lucerne (mid-May to July) and harvesting of winter peas and cereals from beginning of July.

A recent study done in France showed a decrease of 20% in the small wildlife population each time the grass is mowed (Guitton J-S. *et al*., 2017).

The most frequent prescription regarding mowing date is that mowing should not take place before the 1st of August. This usually results in an average mowing date after the 10th of August. Average mowing dates within fields where Corncrake is present in Britain and Ireland are mostly from mid-July to early August. Hence, according to the simulated modelling results, this prescription should result in an increase in productivity sufficient to stop the population decline, especially when combined with mowing from the centre of the meadow outwards (Green *et al*., 1997).

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To increase the probability of escaping mowing machines (for invertebrates), mowing should not occur before 9:00 or 10:00 am depending on site temperatures. Where possible and adequate for the plant community, a late summer cut is a safe measure regarding many invertebrate communities (Humbert, 2010).

Verhulst *et al*. (2007) studied in the Netherlands the effects of postponed mowing combined with per-clutch payments (where farmers are being payed per wader clutch without being restricted in their farming practices) as agri-environmental measures. The tests were done on 12,5-ha plots (1,6 ha postponed mowing and 10,9 ha per clutch payment). Conventionally managed grasslands served as controls. On plots operating a combination of postponed mowing and per-clutch payment, more territories of all bird species were found and more Redshanks *Tringa totanus* were observed. The same pattern occurred on fields with per-clutch payment alone. On fields with postponed mowing alone, we found more territories of the most abundant wader species but on conventional fields we observed more Lapwings *Vanellus vanellus*. The positive effects of postponed mowing on wader territories were probably caused by small differences in soil moisture and groundwater level between the two field types, as inclusion of these factors in a general linear model rendered all scheme effects insignificant.

Postponed mowing affected the form and amount of fertilizer applied to the fields as well as available nitrogen, but none of the other environmental factors that were measured. Additional analyses identified groundwater depth, penetration resistance and prey density (earthworms, Lumbricidae, and leatherjackets, Tipulidae larvae) as the main factors determining

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wader density. The results show that conservation measures consisting of postponed mowing and per-clutch payment implemented by agri-environment collectives do not support a higher abundance of waders but do support marginally higher breeding densities of waders compared to conventional farms. These results are probably due to differences in soil moisture and groundwater depth. The effectiveness of agri-environment schemes directed towards conservation of waders might be enhanced by including raised groundwater levels into scheme prescriptions (Verhulst *et al.*, 2007).

A literature review from 2000 (Aebischer *et al.*, 2000) found that the UK population of Corncrakes Crex crex increased from 480 to 589 males between 1993 and 1998 (an average rise of 3.5% per year) following schemes to get farmers to delay mowing dates and to leave unmown 'corridors' to allow chicks to escape to field edges which are thought to increase chick survival.[10]

Along with mowing techniques, depending on targeted species, mowing dates should be shifted approximately to the 1st of August. However, legal effects of allowed fertilizer timing, preparing for winter crops must be considered too to create efficient measures. Mowing in the early morning or evening is not easy to control, but could be stimulated by sensibilisation actions among farmers, although the effect of time on small wildlife would be greatest on their favoured crops like wheat, potatoes, sugar beet, grassland etc. rather than harvesting maize or sowing on bare land.

Hunters or game keepers could be brought in the planning to drive small fauna out of the fields one or two days before activities. Indeed, wheat mowing is an important period for farmers and more specifically for cereal farmers. The dates of sowing - and therefore of harvesting - are first of all linked to the growing cycle specific to each crop. They also depend on the weather conditions encountered (rain, drought, temperature...). It is therefore advisable to involve all stakeholders to enable a concerted territorial approach.

Some of above-mentioned points could appear negative at first glance, whereas their analysis and practice show that agriculture itself carries many solutions and methods to restore sustainable agriculture and biodiversity.

[10] *https://www.conservationevidence.com/individual-study/2441*

Sustainable and efficient agriculture: a solution for biodiversity

As important stakeholder, farmers are well aware of the decline in biodiversity and have started to take action to preserve it (cf. AGPB - OFB Compendium, see Annex 1). Farmers have, for example, created ecological corridors and used numerous biological control techniques. Experts have demonstrated that biodiversity offers ecosystem services improving the resilience of farms. In this respect, farmers have an interest in protecting biodiversity including ground beetles, pollinating insects, birds eating harmful insects, ... In other words, biodiversity becomes an essential production factor integrated into the farm project: from the choice of species to be produced or farmed, right up to the level of valorisation of the products. In the same way, certain species are dependent on agricultural areas that require special attention from the farmers.

Since the 1990s there has been a desire to find real synergies between agriculture and biodiversity (Le Roux *et al.*, 2008). This study shows that although agriculture impacts biodiversity, there are ways to reduce its effects. Two levels at which a farmer can interfere are identified: agricultural practices applied at plot level and the diversity of natural agrosystems and ecosystems at landscape level. In other words, it is possible to have a plot-based approach, e.g., at farm level, complemented by a territorial approach at the scale of the landscape.

With regard to agricultural practices at the plot level, it is possible to identify a series of practices to reduce the effects of agriculture on biodiversity in terms of the use of plant protection products, tillage and fertilisation. Precision farming enables the farmer to optimise farming systems while reducing the impact on biodiversity. However, these practices must involve all local stakeholders and should be as close as possible to economic and social realities.

Farmers hold the keys to maintaining biodiversity in the agricultural environment. Biodiversity could be a tool for as well economically efficient and as environmentally friendly agriculture. However, practices underpinning this are not widely enough known and should be more active communicated. Some practices also require investment and paradigm shifts that will need financial support.

However, the economic situation of farmers and the increase in the level of ambition leave little room for manoeuvre, especially with an uncertain CAP budget. Remuneration for farmers' commitments on biodiversity therefore appears to be a necessity. To do so, commitments must first be recognised by developing clear indicators.

Climate change

Scientific studies on the effects of climate change on small wildlife populations are rare (bibliographic review of French studies, not including overseas territories: Massu & Landmann, 2011). Farmers, landowners, and hunters however indicate there is a serious impact due to extreme weather events such as droughts, heavy thunderstorms, etc.

For example, 2016 was undoubtedly the year having the largest effect on the demography of the Grey Partridge in France. In any case, it was the year in which the worst breeding index was recorded since monitoring began almost 40 years ago.

This is not a major surprise given the weather conditions at the heart of the species' range, with record rainfall during the months of May and June.

The weather was only slightly milder later in June, with further heavy rainfall towards the middle of the month on land that was still very wet, combined with lower-than-normal maximum temperatures during the first two decades, reflecting a lack of sunshine. (Source: ONCFS -DRE- Unité Faune de Plaine, 2016, Lettre du Réseau perdrix faisan).

For more information:
http://www.oncfs.gouv.fr/IMG/pdf/lettre-infos-reseau-perdrix-faisan-Numero25-fevrier-2017.pdf

Grazing

Generally speaking, lowland and mountain meadows naturally refer to different contexts in terms of ecology, land management and agricultural practices.

The risk of a snipe nest being destroyed by trampling is related to the number of cows per hectare. The figure below shows Mayfield estimates of the risk of a nest being trampled, based on the data of fifty-two nests in sixteen fields with cattle present, divided into four categories according to the number of cattle per hectare. The effect was greater on replacement nests, as the season progressed, when more cows were introduced on the field (Green, 1988).

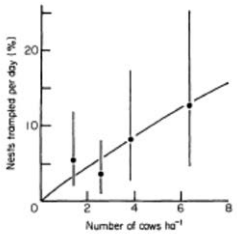


FIG. 3. Proportion of snipe nests trampled by cattle per day in relation to the density of cattle on the field. Points are proportions with 95% exact binomial confidence limits. The curve represents the expected relationship if the daily probability of a nest being trampled was given by; $1-0{\cdot}9787^{d}$ where d is the number of cattle ha^{-1}.

A study by Baines *et al.* (2002) addresses the issue of overgrazing by sheep in relation to heather regeneration by reducing sheep. Lapwing was 10-fold fewer and Grey Partridge 60% fewer on fields where grazing had been reduced. Black and Red Grouse tended to be more numerous on plots with grazing reduction, but not significant. No effect was found on Pheasant, Curlew, Redshank, and Snipe.

Breeding densities and nesting success of Black Grouse are higher on lightly compared with heavily grazed moors. Moors with higher intensities of grazing had vegetation on average 3,2% shorter and had 36% less vertical vegetation cover. This probably reflects protection from predation by vegetative cover, and higher abundances of preferred insects in the more complex vegetation structure of moors with lower numbers of larger grazing mammals. Heavily grazed moors supported 41% fewer invertebrates and threefold fewer Lepidoptera larvae and half as many Araneae and Hemiptera. (Baines, 1996).

Low intensity grazing is most attractive to small fauna, providing cover and higher abundancy of insects. Although Lapwing and Grey Partridge benefit from more intense grazing.

Fertilizers

Fertilizing techniques can also cause a significant difference in breeding success of farmland birds. Onrust (2017) examined the effect of slurry and moreover the effect of this fertilizer technique on earthworms. Intensification techniques caused farmers to shift from putting rough manure on their fields to injecting slurry. This reduces Red Worms (*Lumbricus rubellus*) especially those which pull organic matter like dung and litter into the soil, and are an important prey. (The Red Worms live of the fungi that grow on it. Later, bacteria take over from the fungi, serving as food for the Grey Worms in a second phase). The use of injecting slurry causes the disappearance of Red Worms, which are an important prey for meadow birds and even predators like Foxes and Badgers. This causes the soil to dry out faster. Heightening the water table usually isn't effective, and a dry crust covers the soil, prohibiting birds to penetrate in their search for worms (Onrust, 2017; Onrust *et al.*, 2019). Attention should be given to the use of certain organic fertilizers as they can be carriers of diseases when not properly disinfected (e.g., Coccidiose).

A study by Onrust *et al.* (2019) also shows a positive impact of Red Worms on plant productivity, when less slurry and more dead rough organic material is provided on the field. Earth worm's presence results in an increase of 25% of crop yield and 23% of biomass. The positive effects of earthworms become larger when more residue is returned to the soil but disappear when soil nitrogen availability is higher. This suggests that earthworms stimulate plant growth predominantly through releasing nitrogen locked away in residue and soil organic matter.

For worm eating species like the Black-tailed Godwit, Eurasian Curlew or Lapwing, fertilizing techniques prove to be an important measure for population restauration (Dainese *et al.*, 2019).

In the same way, fertilizers certainly play a role on the soil fauna, but the impact of tillage seems to much more pronounced (Onrust *et al.*, 2019).

Meanwhile, the effect of fertilizers can also be negative as fertilising the soil often results in a decrease of the floral diversity which is having a negative impact on the insect biodiversity.

Pesticides

The impact of increased pesticide use on arable land has been an important factor of decline of farmland species.

Chick survival of Grey Partridge is determined mostly by the abundance of their insect food, and by the fact that the quality of the chick's diet has been progressively reduced by the use of pesticides and by other modern farming techniques. (Potts, 1980).

In 1989 a major change in agricultural practice was the start of large-scale use of summer insecticide. Chick survival rates averaged a third lower where insecticide was used intensively compared with areas where little or no insecticide was used (22% vs 34%) (Aebischer & Potts, 1998). Chick survival rates of Grey Partridge averaged 49% before the introduction of herbicides and 32% once their use became widespread (Potts & Aebischer, 1995).

Red-legged Partridges (*Alectoris rufa*) are known to be susceptible to at least three pesticides (imidacloprid, thiram and difenoconazole), with birds experiencing sub-lethal and lethal effects when fed wheat seed dressed in those substances (Lopez-Antia *et al.*, 2013). It has been calculated that a Grey Partridge (*Perdix perdix*) would have to feed on just six beet seeds treated with 0.9 mg of imidacloprid to have a 50% chance of being killed by the dose (Gibbons *et al.*, 2015).

There is no direct evidence to suggest that pesticides have been responsible for declines in Turtle Dove, but Feral Pigeons (*Columba livia*) are also known to be susceptible to the pesticide Imidacloprid (Gibbons *et al.*, 2015).

Equilibrium between yield and low use of chemicals is not an easy study to make. It is very depending on individual species. Low use of pesticides during chick season is of primary importance. When applying pesticides, the effect on the crops and the food availability for the small wildlife species should be taken into account. Alternatives that show no or less effect on small fauna should be encouraged.

Hunting

Next to intensified agriculture, some say hunting is a major driver of decreasing wildlife, but there is no sound scientific evidence for this. Hunting, like agriculture, has almost always existed. Although, shooting equipment and methods have evolved little to nothing in efficiency. However, we see hunting practice has been adapted over the last decades, with higher emphasis on the conservation of habitats, wild fauna and their sustainability. For small game, bag statistics have dropped in line with the decline of small game and wildlife populations. For big game, like deer and wild boar, an adverse effect is observed, which is on the contrary not seen as driven by hunting practices... These population dynamics are the result of the interaction of many different drivers, including agriculture, urbanization, nature conservation practices and hunting practices (e.g., by developing hunting management plans).

Reimoser & Reimoser (2016) studied hunting bags and wildlife population of 19 wildlife species in nine countries in Central Europe (Germany, Poland, Czech Republic, Slovakia, Austria, Switzerland, South Tirol, Slovenia and Hungary). The tables below show the hunting bags over the nine countries and respectively per country per small game. The declining populations are indicated in a coloured box.

Table 2 Total hunting bags of Central Europe (9 countries) in the years 1970, 1980, 1990, 2000, 2010 and 2014 for 19 wildlife species, and bag differences 2014–1970 (trends)

	Hunting bag per year (number of animals)						Difference
Species	1970	1980	1990	2000	2010	2014	2014–1970
Red deer *(Cervus elaphus)*	106,429	153,220	241,912	201,129	263,868	324,317	217,888
Roe deer *(Capreolus capreolus)*	907,066	1,217,972	1,528,596	1,709,543	1,842,035	1,879,313	972,247
Chamois *(Rupicapra rupicapra)*	26,377	42,074	50,098	45,293	38,216	36,655	10,278
Ibex *(Capra ibex)*	0	549	1,283	1,358	1,471	1,629	1,629
Mouflon *(Ovis orientalis)*	4,091	8,097	20,701	19,954	26,678	28,807	24,716
Wild boar *(Sus scrofa)*	105,244	254,197	565,133	625,009	1,146,365	1,199,380	1,094,136
Brown hare *(Lepus europaeus)*	3,155,274	1,551,461	1,388,048	915,112	649,649	507,954	-2,647,320
Partridge *(Perdix perdix)*	979,871	242,629	264,676	44,716	18,398	14,746	-965,125
Pheasant *(Phasianus colchicus)*	2,992,075	2,274,026	2,093,670	1,704,942	1,315,510	1,270,824	-1,721,251
Wild pigeons *(Columbidae)*	582,486	627,332	818,232	813,229	869,666	604,913	22,427
Wild Ducks *(Anatidae)*	653,924	929,808	1,326,943	1,338,709	1,024,041	938,863	284,939
Capercaillie *(Tetrao urogallus)*	1,309	411	607	420	383	316	-993
Black grouse *(Tetrao tetrix)*	4,558	3,121	4,004	2,567	1,901	2071	-2,487
Red Fox *(Vulpes vulpes)*	287,434	350,744	556,041	921,676	900,760	861,658	574,224
Badger *(Meles meles)*	14,172	12,114	23,401	51,468	85,758	93,019	78,847
Raccoon dog *(Nyctereutes procyonoides)*	18	289	548	7,365	27,924	41,689	41,671
Raccoon *(Procyon lotor)*	0	0	1,936	9,075	68,141	117,297	117,297
Brown bear *(Ursus arctos)*	15	21	53	31	47	20	5
Wolf *(Canis lupus)*	56	87	225	118	150	56	0
Moose *(Alces alces)*	350	600	1,490	300	200	0	-350

Table 3b Number of small game culled in the years 1970, 1980, 1990, 2000, 2010 and 2014 in the 9 countries

	Year	SLO	ST (I)	CH	A	D	PL	CZ	SK	H
European hare	1970	29833	6006	20097	342870	1264587	284000	808299	246309	189112
	1980	9072	5259	14651	265520	740925	178000	225023	76565	50777
	1990	9388	3069	5681	180067	607834	217000	189785	63836	123845
	2000	2135	2718	2584	194019	442127	65000	94108	32051	85223
	2010	2452	2802	2409	106101	367321	18000	62483	14525	78810
	2014	2156	2797	1755	116135	236106	15000	39591	14890	84477
Partridge	1970	7971	58	1485	105203	445564	270000	32919	49694	75006
	1980	1361	9	299	37640	46403	158000	37	10	240
	1990	1585	0	0	8265	29328	223000	38	0	4045
	2000	2479	0	0	9109	11092	23000	0	269	1246
	2010	1507	0	0	7132	5543	3100	0	419	2204
	2014	1445	0	0	4098	2322	2500	0	2624	3202
Pheasant	1970	69669	2166	6268	409767	983375	56000	1019370	93133	424162
	1980	29013	1936	2903	353051	369378	233000	486112	87318	742264
	1990	37820	1916	2292	206283	367154	118000	527537	60165	812239
	2000	39658	101	155	190601	336908	95000	561637	90257	430384
	2010	20890	13	23	82138	204541	104000	526545	91811	306452
	2014	13925	5	31	70444	113914	129000	478808	79275	399352
Pigeons	1970	14037	2695	13909	36619	421727	*no data*	104921	5310	*no data*
	1980	4448	1081	6522	23677	559225	3000	33331	1577	*no data*
	1990	4748	748	2948	20942	773296	6000	15154	892	*no data*
	2000	0	608	9121	20180	749729	11000	21393	1806	*no data*
	2010	0	200	6092	17915	812028	11100	20925	1606	*no data*
	2014	0	125	4854	14650	552340	12100	18374	2595	*no data*
Ducks	1970	6680	*no data*	19520	41123	386907	*no data*	102233	26613	77528
	1980	8207	552	23346	70418	424424	128000	115967	25254	142399
	1990	11196	780	15348	77674	571240	123000	273973	22498	243210
	2000	6164	790	8109	85000	516868	130000	336013	18385	244334
	2010	3775	1044	6364	80497	418331	105000	272267	18276	123306
	2014	2820	781	6588	57663	394842	105900	262345	16529	95037
Capercaillie	1970	89	206	11	1036	145	*no data*	23	94	0
	1980	42	0	0	365	0	10	0	36	0
	1990	0	0	0	599	0	9	0	0	0
	2000	0	0	0	420	0	0	0	0	0
	2010	0	0	0	383	0	0	0	0	0
	2014	0	0	0	316	0	0	0	0	0
Black grouse	1970	148	506	1397	2026	465	*no data*	632	38	0
	1980	119	0	532	2094	0	405	72	18	0
	1990	138	0	1294	2555	0	144	11	0	0
	2000	0	274	508	2059	0	0	0	0	0
	2010	0	300	390	1511	0	0	0	0	0
	2014	0	351	542	1529	0	0	0	0	0

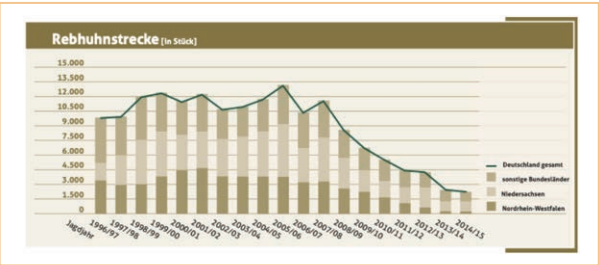
For small game there is a decline since 1970 for Brown Hare, Partridge, Pheasant, Capercaillie and Black Grouse. There is an increase for Wild Pigeon and Wild Duck. While the small game is often showing a decrease in populations, we see for many of the big game species growing populations. At the same time, we see an enormous increase for the Red Fox (typical small game predator).

In Germany, Czechia, Slovakia, Austria and Hungary hunting rights are connected to the landowner. In Switzerland, Slovenia, South Tyrol and Poland game belongs to the public. In all of these countries, hunters must take special courses and pass an exam.

In Germany we have seen a decline of 36% in the statistics for European hare between 2010 and 2014 while spring population show a stable to slightly declining trend (figure below) (Jagdverband, 2018). This suggests other factors play a major role on the population than shooting, or an increase of population could have been expected.

Total population density of hare in spring /100 ha in all German reference areas between 2008 and 2018.

For partridge we see a similar trend between the monitored areas of Partridge and the bag statistics, dropping by half (Jagdverband, 2015). This could suggest that hunters automatically reduce their impact when there is a decline in the population but also indicates other factors could play a far more pronounced role. In the case of a fast and sudden population drop, hunters should take immediate action to lower their bag statistics. For this, yearly monitoring, access to data and inter sector communication play an important role.



Partridge: total hunting bag in Germany

Partridge: population density (number of pairs/100ha) in Schleswig-Holstein between 2006 and 2015 (Jagdverband, 2018).

Smith *et al.* (2005) summarized the results of 77 research papers, published between 1952 and 2003, from 12 European countries (Austria, Bulgaria, Denmark, France, Germany, Hungary, Italy, Poland, Slovakia, Sweden, Switzerland, United Kingdom). Investigating the relationship of hare abundancy, farmland characteristics and the effect of hunting, they concluded hunting had no effect on hare density throughout Europe.

Generally speaking, maintaining a reasonable hunting activity, rather than prohibiting it, remains more profitable for the conservation of a species and its habitat. Hunters can implement a set of actions favouring the management of territories, species and their habitat, e.g., through implementing hunting plans, even when those are having a limited scope.

Studies on the effect of hunting on rabbit populations in Spain, suggest that hunting in late spring instead of autumn optimizes hunting extraction while conserving rabbit population. Half the hunters would agree to policy changes (Angulo & Villafuerte, 2004). To conserve the population, hunting during winter should be avoided when females increase their activity outside the warrens. Hence, summer should be retrieved as the main hunting season for populations with high turnover levels or in case of population control (Calvete *et al.*, 2005).

Watson *et al.* (2007) found that intensive shooting of Red-legged Partridges could lead to reductions of 68–85% in equilibrium density of Grey Partridge pairs. It is however well recognised that harvest rates should be kept below 20% when populations are present at low densities. This shows an urgent need for awareness raising and education among hunters.

They also indicate that removing Grey Partridge from the UK quarry list would be counterproductive, as most actions to boost wild Grey Partridge densities is carried out by enthusiasts with hunting as the incentive. Indeed, Havet & Biadi (1990) already showed that although hunting pression in fragile populations isn't always adapted fast enough, a hunting moratorium on the species hasn't prevented its downfall.

Aebischer & Ewald (2010) went even further and showed that, with appropriate precautions, it was possible to shoot over 60% of Red-legged Partridges *Alectoris rufa* while maintaining Grey Partridge losses below 5%.

For European Turtle Dove, a migratory species there is a definite effect of shooting. Next to habitat loss in breeding and wintering areas, illegal killing, trapping and unsustainable hunting levels are a major threat. For this species a European Action Plan was made in 2018 (Fisher *et al.*, 2018). Turtle Dove is huntable in 10 European countries in compliance with the Birds directive: Austria, Bulgaria, Cyprus, France, Greece, Italy, Malta, Portugal, Romania and Spain. However, the hunting season overlaps with the breeding season in Austria and, to a less extent, in France and Spain.

On the contrary, in Africa, hunting is not in alignment with the EU Bird Directive. The Turtle Dove is subject to hunting in both the wintering grounds and in the migration period (Barlow *et al.*, 1997), and the combined effect of direct mortality and disturbance at roosts during the crucial pre-migration period when the birds must substantially increase their body mass is likely to affect survival (Zwarts *et al.*, 2009).

Hunting tourism also remains an unquantified problem. Agencies offer Turtle Dove hunting during the summer in some parts of Europe, such as in Bulgaria and the former Yugoslav Republic of Macedonia (no quota, with a hunting season from mid-August to the end of September).

Increasing populations of predators

Nearly all studies on the impact of small fauna point fingers to predation as an important cause of death (European Landowners' Organization, 2013). Depending on ecological and social contexts, habitat restauration alone is not enough to restore populations,

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and if not combined with predator control leads to higher costs and even the risks of extinction. The effect is more profound as populations are low and hence more vulnerable.

Studies show an increase of generalist predators (Fox, Crow, Magpie, Badger, Marten, even Wild Boar) while the numbers of their prey decline. Fox is the predator that has most effect on small fauna. Predator control is thus to be seen as a major management technique to increase the populations of small fauna. Consequently, hunters and game keepers should be encouraged/incentivised to play a more profound role in taking generalist predators to a lower population for small fauna to build up strong populations.

The impact of Feral Cats has not been studied much, but recent studies suggest a significant impact on wild fauna, which is not surprising seeing their preys and behaviour is very similar to Fox.

Due to foxes being the main predator, avian predators are mostly seen as a secondary effect. The effect of low densities of avian predators is relatively small. However, larger populations of avian predators can have significant effects on the prey populations and should be considered when measures are implemented to increase predator populations like Hen Harrier.

Results from a review on predation as limiting factor for bird population (Roos *et al.*, 2018) confirm that the generalist predators Red Fox (*Vulpes vulpes*) and Crow (*Corvus corone* and *C. cornix*) occur in high densities in the United Kingdom compared with other European countries. In addition, some avian and mammalian predators have increased dramatically in the United Kingdom during recent decades. Despite these high and increasing densities of predators, we found little evidence that predation limits populations of Pigeons, Woodpeckers and Passerines, whereas evidence suggests that ground-nesting seabirds, waders and gamebirds can be limited by predation. Using life-history characteristics of prey species, we found that mainly long-lived species with high adult survival and late onset of breeding were limited by predation. Single-brooded species were also more likely to be limited by predation than multi-brooded species. Predators that depredate prey species during all life stages (e.g., from nest to adult stages) limited prey numbers more than predators that depredated only specific life stages (e.g., solely during the nesting phase). The Red Fox and non-native mammals (e.g., the American Mink *Neovison vison*) were frequently identified as numerically limiting their prey species.

In the short term, traditional predator-management techniques (e.g., lethal control or fencing to reduce predation by a small number of predator species) could be used to protect these vulnerable species. However, as these techniques are costly and time-consuming, we advocate that future research should identify land-use practices and landscape

configurations that would reduce predator numbers and predation rates (Roos *et al.*, 2018). Corridors are assumed to be an efficient conservation tool for reducing changes in local biodiversity induced by fragmentation and loss of natural habitats.

A Czech study investigated the preferences for carnivore mammals in corridors versus hayfields. Species detected during the scent station survey included the Domestic Cat (*Felis catus*), Red Fox (*V. vulpes*), Polecat (*M. putorius*, *M. eversmanni*), Ermine (*M. erminea*), Lesser Weasel (*M. nivalis*), and Marten (*Martes spp.*). Carnivores predominated in corridors (35 visits), compared to hayfields (1 visit) (Šálek *et al.*, 2009).

Corvids

Madden *et al.* (2015) made a review of the impact of corvids on bird productivity and abundance. Combining 42 studies, in 81% of the cases no negative influence of corvids on either abundance or productivity of prey species was found. Negative impacts were significantly more likely in cases examining productivity rather than abundance (46 vs. 10%). Experimental studies that removed only corvid species were significantly less likely to show a positive impact on productivity than those removing corvids alongside other predators (16 vs. 60%). This suggests that the impact of corvids is smaller than that of other predators, or that compensatory predation occurs. Crows were found to be significantly more likely to have a negative impact on prey species productivity than were Magpies (62 vs. 12%), but no differences were found in relation to prey abundance. We conclude that while Corvids can have a negative impact on bird species, their impact is small overall, and nearly five times more frequent for productivity than for abundance. These results suggest that in most cases bird populations are unlikely to be limited by corvid predation and that conservation measures may generally be better targeted at other limiting factors.

A United Kingdom study by Dunn *et al.* (2016) tested whether songbirds select nest sites according to structural features of hedgerows (including nest visibility and accessibility), and whether these features influence nest predation risk. Songbirds selected nesting sites affording higher vegetation cover above the nest, increased visibility on the nest-side of the hedgerow and reduced visibility on the far side of the hedge. Nest survival was unrelated to Corvid abundance and only weakly related (at the egg stage) to Corvid nest proximity. Nest survival at the chick stage was higher where vegetation structure restricted access to corvid-sized predators (averaging 0.78 vs. 0.53), and at nests close to potential vantage points. Overall nest survival was sensitive to hedgerow structure (accessibility) particularly at low exposure to Corvid predation, while the overall impact of Corvid exposure was dependent on the relationship involving proximity to vantage points. Nest survival over the chick stage was much higher (0.67) in stock-proof, trimmed and mechanically cut hedgerows, (which tended to provide lower side visibility and accessibility) compared to recently laid, remnant or leggy hedgerows (0.18). Long-term reductions in the management of British hedgerows may therefore be exposing nesting songbirds to increased predation risk. The authors recommend regular rotational cutting of hedgerows to maintain a dense woody structure and this thereby reduces songbird nest predation (Dunn *et al.*, 2016).

Corvids are also well-known predators of hares and rabbits.

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Fox

Red Foxes respond very well to changing human landscape alteration as well as changes in landscape productivity (Walton *et al.*, 2017). Foxes and cats are the most abundant medium-sized urban carnivores. Foxes exhibit larger ranges than cats, while non castrated cats showed larger home ranges than castrated cats. Diet diversity obtained for both predators confirmed their trophic plasticity within urban habitats. Both predators consumed fewer mammals and invertebrates in highly disturbed habitats compared to medium ones (Castañeda *et al.*, 2019). Red Fox and Stone Marten had relatively wide trophic niches, reflecting their consumption of mammals, birds, plants, arthropods, reptiles, amphibians and manmade items are consistent with their reputations as opportunistic generalists. Both species have a high dietary overlap, ranging from 49,5% in summer up to 82,3% in spring and also consume manmade foods (Papakosta *et al.*, 2010).

Feral / domestic cats

Knol (2015) studied the effect of feral cats on Dutch fauna. Based on local studies and foreign literature. the number of casualties in fauna due to feral cats is estimated over 141 million preys of wild fauna. 38% of the population of summer birds is killed by feral cats. Besides predation, feral cats form a reservoir for toxoplasmosis with negative effects on fauna. Also, they could play a part in the distribution of Echinococcosis (*Echinococcus multilocularis*). They can also cross with wild cats and hence cause greater effects on nature.

Woods *et al.* (2003) conducted a questionnaire which showed a total of 14 370 prey items that were brought home by 986 cats living in 618 households. Mammals made up 69% of the items, birds 24%, amphibians 4%, reptiles 1%, fish < 1%, invertebrates 1% and unidentified items 1%. A minimum of 44 species of wild bird, 20 species of wild mammal, 4 species of reptile and 3 species of amphibian were recorded.

Liberg (1984) related natural prey of Domestic Cat (*Felis catus*) in the Revinge area in southern Sweden during 1974–79 was to prey abundance, annual production, and availability. Of 1,437 scats collected, 996 contained remains of vertebrate prey. Most cats (80–85%) were house-based and obtained 15 to 90% of their food from natural prey, depending on abundance and availability of the latter. Wild Rabbit (*Oryctolagus cuniculus*) was the most important prey, and cats responded functionally to changes in abundance and availability of this prey. Prolonged snow cover made rabbits vulnerable to cats irrespective of abundance. Small rodents were the second most important cat prey, while Brown Hare (*Lepus europeus*) and birds were less important. In a period with high rabbit abundance, cat predation corresponded to 4% of annual production of rabbits and to about 20% of annual production of FieldVole (*Microtus agrestis*) and Wood Mouse (*Apodemus silvaticus*). The feral cats prey choice was similar to that of house-based cats, but as the former subsisted almost completely on natural prey, their absolute intake (294 g/day during years with high rabbit abundance) was four times that of an average house-based cat (66 g/day).

Hen Harrier

A Scottish study by Redpath & Thirgood (1999) found that 15% of harrier prey consisted of Red Grouse, of which 96% were chicks. Meadow Pipit was the most popular pray, followed by Red Grouse. Both males and females tended to have higher delivery rates of specific prey when this prey was more common. The functional response curve of the model suggested that harriers took the highest proportion of grouse chicks at densities of 67 chicks per km^2. At high harrier densities, the curve suggests that over 60% of available grouse chicks may be taken over the 6-week nestling period of harrier chicks. During the study, the mean grouse brood size in early June was estimated at 5,5 chicks per pair. A density of 67chicks per km^2 therefore is equivalent to roughly 12 grouse broods per km^2.

But predation of grouse chicks continues beyond the nestling stage. Further data suggest that the percentage of grouse in the diet of harriers stayed broadly the same from hatch stage to dispersal stage. Following that harriers share the same habitat as grouse and due to possible polygamy and not being strongly territorial, harriers have the potential to limit grouse populations in low density. There is density dependence in harrier predation on grouse chicks.

The breeding densities of these generalist predators were related to the abundance of alternative prey, so their impact on grouse numbers varied between moors. On moors with abundant small prey and no raptor persecution, breeding densities of harriers were likely to be high. If these grouse populations were to fall to densities <12 pairs/km^2, data suggest that harrier predation might hold them there during the breeding season.

Earlier radio-tracking data showed that mortality because of raptors was high before egg-laying commences (Redpath & Thirgood, 1997).

A study by Redpath *et al.* (2001) tested if supplementary feeding of Hen Harrier would reduce predation on Red Grouse. A minimum of 78% of the radio-tagged grouse that were killed during spring were killed by raptors. The mortality was not affected by supplementary feeding, indicating that other raptors were responsible for much of the predation of adult grouse.

Both male and female harriers at nests where supplementary food was available caught grouse chicks at a lower rate (0,5 grouse chicks per 100 h) than harriers at nests not provided with food (3,7 grouse chicks per 100 h). Supplementary feeding may provide a useful tool in reducing the number of grouse chicks taken by harriers.

Peregrines

A Scottish study by Redpath & Thirgood (1999) found that prey items in peregrine pellets, came from four main prey groups: gamebirds (*Galliformes*), pigeons (*Columbiformes*), waders (*Charadriiformes*) and passerines (*Passeriformes*). The bulk of collection of prey during breeding season consisted of racing and feral pigeons (48%), with red grouse the second most abundant. Of the grouse collected, most were adult (92%), but 10 chicks were noted. Because peregrine is not strictly bound to moorland, where grouse reside, there was a significant linear relationship between grouse availability and the proportion of grouse in the diet. Calculations show a low predation at grouse densities >20 per km^2, but increasing predation as density declined. There is no density dependence in peregrine predation on the adult grouse.

Our data suggested that predation by peregrines hunting in the absence of other predators would not limit grouse numbers. However, peregrine predation in addition to harrier predation is likely to reduce the ability of low-density grouse populations to increase.

Populations effected by predators

European Brown Hare

Smith *et al.* (2005) carried out a review of 77 research papers, published between 1952 and 2003, from 12 European countries (Austria, Bulgaria, Denmark, France, Germany, Hungary, Italy, Poland, Slovakia, Sweden, Switzerland, United Kingdom). The paper investigated the relationships between hare abundancy and farmland habitat characteristic throughout Europe. Climate and predator numbers were also considered, as changes in these have also frequently been used as explanations for the decline in hare numbers. The study results show that the effects of climate and predator numbers are magnified by the loss of high quality year-round forage and cover (Smith *et al.*, 2005).

The homogenisation of the landscape possibly improved the accessibility for generalist predators in the landscape, with an increased impact on prey populations (Schneider, 2001; Smith *et al.*, 2005; Gorini *et al.*, 2012). Additionally, predator numbers have increased in north-western Europe in the last decades (e.g., birds of prey: Parlevliet, 2003; Red Fox: Tapper, 1992; Knauer *et al.*, 2010), while also expanding their distribution (e.g., birds of prey: Boele *et al.*, 2008; Hustings & Vergeer, 2002; Red Fox: Davidson *et al.*, 2012).

The effects of predation risk, for example, depend on the hunting mode of predators (Creel, 2011), group size and body mass of prey species, or the ability of prey to make use of a refuge for escape (Lima & Dill, 1990). The population sizes of smaller prey species and solitary prey species are expected to be strongly affected by predation, whereas the larger prey species or prey species that live in groups are expected to be strongly affected by food availability (Sinclair *et al.*, 2003; Hopcraft *et al.*, 2010; Creel, 2011).

In European Hare, risk effects are thought to be particularly strong, because they are solitary, free-ranging and do not make use of a burrow for escape (Creel, 2011). Additionally, European hares have developed a very strong anti-predator strategy, as they are built for flight, while at the same time they can be immobile, vigilant, and cryptic (Focardi & Rizzotto, 1999).

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Various species of predators prey on the European Hare (Huber, 2004; Tapper & Yalden, 2010), belong mainly to four different types, namely (a) birds of prey (e.g., Northern Goshawk, Eurasian Sparrow Hawk, Short-eared Owl, Long-eared Owl, Little owl, Eurasian Buzzard, Western Marsh Harrier, Hen Harrier, Montagu's Harrier, Tawny Owl, and Barn Owl), (b) omnivorous birds (e.g., Great Egret, Grey Heron, Purple Heron, and White Stork), (c) carnivorous mammals (e.g., Domestic or Feral Cat, Stoat, European Mink, Lesser Weasel, European Polecat, and American Mink), and (d) omnivorous mammals (e.g., Domestic Dog, Beech Marten, European Pine Marten, and Red Fox).

Weterings (2018) studied the effects of predation on adult European Hare. During increased activity of predators, hares spent a higher proportion of time in low-risk vegetation types that had tall vegetation, or a low food quality or quantity. The distance covered between resting and foraging grounds was negatively affected by elevated predation risk, while use of less risky (often low-quality) vegetation during resting and foraging was favoured. A correlation between fellow prey was tested. The study showed that predator absence possibly led to avoidance behaviour between Hare and Rabbit, while predator presence promoted coexistence between the two species. Comparing habitat characteristics, predator abundancy and fellow prey abundancy, the study shows that habitat characteristics (i.e., forage quality, vegetation height and edible biomass) more strongly affected hare foraging time than the activity of predators, and the activity of competitors was least important. High fox activity negatively affected the proportion of time that hares spent in short vegetation. The reason that hares do not spend more time in short vegetation during times of high risk is probably because that hares cannot detect foxes early enough or escape from these foxes if patches of short vegetation are smaller than their minimum flight distance.

Remarkably, the proportion of time spent foraging in a vegetation type not only increased in low-risk, low-quality vegetation types, it also increased when foxes were more active. This implies that hares not only perceived a predation risk that was nonuniformly spread over the landscape (i.e., low and high risk vegetation types) (Kotler & Blaustein, 1995) but hares also perceived a predation risk that was uniformly spread over the landscape. Prey increase their time spent foraging if they have no safe refuges from predators (i.e., free-ranging herbivores), especially if "predator and prey are of similar body size and locomotion" (Eccard *et al.,* 2008, p.726), like the European Hare and the Red Fox.

Predation might be less strong than the effect of resource acquisition, probably because the relative size difference between our prey species and its predator was small (Sinclair *et al*., 2003).

Grey Partridge

In a 2004 study Watson (2004) researched the effects of raptor predation on Grey Partridge in England. This study therefore aimed to determine if predation risk was sufficient to limit Grey Partridge populations, and if so, how the effects might be mitigated.

Partridge mortality to raptors was linearly density dependent and a simulation model suggested that raptor predation was only likely to cause a significant proportion of mortality below a very low density of 5 birds per km^2. Partridge mortality to raptors occurred mainly in the late winter, suggesting that the investigation of raptor predation effects on habitat use and anti-predator behaviour should focus on the change in size of social unit from broods to pairs that occurred in late January.

Contour density region maps showed that there was a negative relationship between areas of raptor activity and areas containing grey partridges, however, the relationship was not statistically significant.

Woodpigeons, pheasants, and red-legged partridges were the most prominent prey species constituting 93.6% for raptors and 95.2% for foxes. Note that woodpigeons were taken by raptors in proportion to their abundance, whilst red-legged partridges had a much higher vulnerability index than grey partridges. Only nine dead grey partridges were found, but grey partridge density was low relative to the more frequent species in the sample: grey partridges were taken slightly more frequently by raptors than expected given their occurrence in the population. Overall it appeared that grey partridges were simply too rare to form a large part of the diet of generalists, constituting only 6.3% of the raptor diet and 4.7% of the fox diet (Watson, 2004).

European Rabbit

Trout & Tittensor (1989) reviewed the predation on wild rabbit. Rabbit populations have been shown to increase very rapidly when predator density has suddenly been reduced. It has been suggested that predators affect the spread and dispersion of rabbits both at the geographical and local levels. Predation has not, however, been shown to have an important influence at high Rabbit densities. Thus, its role can be that of a limiting factor rather than a density-dependent regulatory mortality factor.

Red-backed Shrike

Roos (2002) studied the functional response, seasonal decline, and landscape differences in nest predation risk. For the experiment he places artificial nests within the natural range of nest densities in dry semi-natural shrub-rich grasslands in Sweden. The artificial shrub-nests contains two quail eggs and a plasticine egg. The results form nest predation on artificial nests were compared to real nests of red-backed shrikes.

Corvids were the major nest predators on artificial shrub nests as revealed by marks in plasticine eggs. Within the natural variation in densities of simultaneously active shrub nests, corvids increased their rates of predation with increasing densities of artificial nests, indicating a functional response. Nest predation risk decreased with time in the season and differed between grassland plots in farmland-dominated (high risk), farmland-forest mosaic (low risk), and forest-dominated (low risk) landscape surroundings. Furthermore, predation risk on artificial nests increased with decreasing distance to nests of at least one corvid species. Breeding red-backed shrikes selected grasslands with a low nest predation risk on artificial nests and reproductive success of shrikes was positively related to success of artificial nests. Moreover, the probability of success for both artificial and real red-backed shrike nests increased with increasing distance from the nearest corvid nest. Thus, results from the artificial nest experiment were validated by the results from the Red-backed Shrike population study (Roos, 2002).

Simulation modelling showed that a reduction in chick survival rate from 49% to 32% had little effect on spring stocks as long as nest predation was controlled but that stocks collapsed when nest predation control was relaxed (Potts & Aebischer, 1995).

In a study in Germany, mortality of hens was highest during breeding (50%). Mortality was lowest in autumn. During winter, mortality was below the annual average in periods without snow cover. Days with snow cover the predation risk was fivefold higher than at snow-free days. Mammalian predators were the cause for 82% of hen population decrease. From 71 nests, 30% of the clutches hatched, 41% was disturbed without the hen dying and in 22% the hen died; 7% remained unclear. About one fifth of these lost nests was due to predation. Predation of breeding hens and predation of the clutch only had similar impacts on the reproduction of the population. Due to high nest predation rates, chick mortality contributed less to the losses (20%), while chick survival was 38%. Nest predation was twofold higher in linear structures compared with broad or spacious structures (Gottschalk & Beeke, 2014).

Common Quail

Purger *et al.* (2008) conducted a study on nest predation survival of ground nesting birds (Common Pheasant and Common Quail) in grass and wheat fields in Hungary. There were no agricultural activities in the studied fields. Tests were done using artificial ground-nests containing one chicken egg, one quail egg and one plasticine egg.

The major predators in wheat were birds (16%) and mammals (84%), whereas in energy grass all predation (100%) was caused by mammals. There was no significant difference between types of predators in the two habitats. On-spot observations, traces and marks left on plasticine eggs, several droppings and the patterns of nest predation all suggested that most nests were destroyed by Red Foxes. A significantly higher proportion of plasticine eggs were damaged in wheat (80%) than in energy grass (48%). Based on marks left on plasticine eggs, small mammal abundance was higher in wheat (80%) than in energy grass (33%), the latter habitat not yielding any small mammal captures at all. Traps in the wheat field caught significantly more small mammals with plasticine eggs (14) than with quail eggs (5). Plasticine eggs had a greater attraction effect on small mammals, thus could negatively influence experiments with artificial ground nests.

Based on these marks, however, it was not possible to identify the bird predator. One or two individuals of Western Marsh-Harrier were seen flying low above both study areas continuously (Purger *et al.*, 2008).

Lapwing

Predation was the main proximate cause of mortality for radio-marked chicks and accounted for 52% of all losses. Predation was a significant mortality factor until chicks were at least 20 days old, whereas poor body condition (31% of all radio-marked chick losses) and ditch entrapment (17% of all losses) only killed very young chicks. Fledging success, not hatching success, was thought to be the main limit on productivity.

At the surface living chick prey was abundant throughout the season in arable fields and late-hatched chicks suffered higher mortality than those that hatched earlier mainly due to an increase in predation late in the season (Linsley, 1999).

Black-tailed Godwit

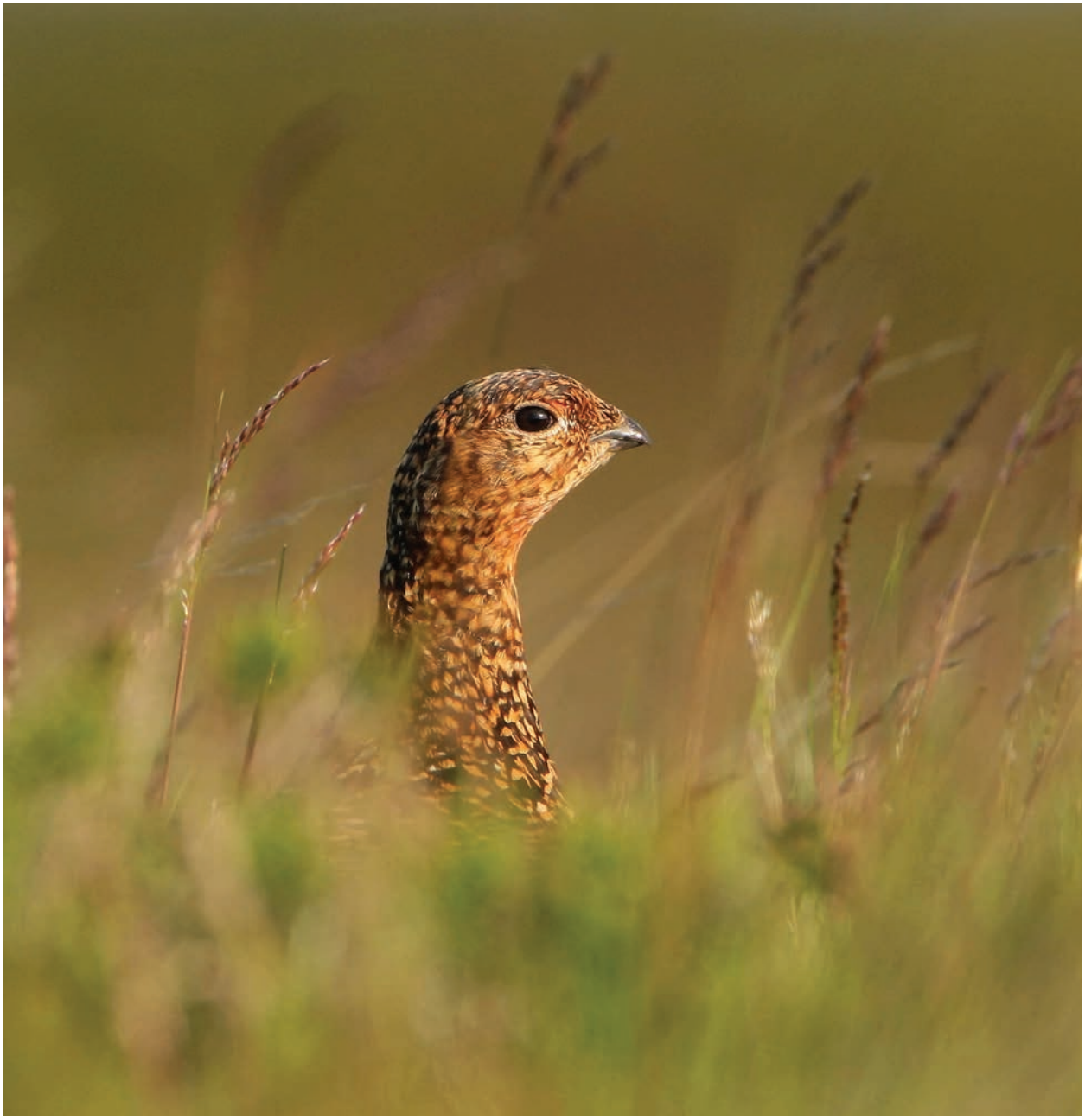
An overall reduction of predation pressure from 73% to 30% will restore the Godwit population (now, in 2019, estimated at 23.500) within 10 years at the level of 33.000 breeding pairs by 2030. Lowering the predation pressure from 73% into 25% results in a larger surplus of young birds and 40.000 breeding pairs in 2030. Investment only in habitat management without predation control will result in more loss of money and Black-tailed Godwits. It leads almost to extinction of the Black-tailed Godwit within several decades. A calculated breeding population of 1997 breeding pairs in 2050 (Knol, 2019).

Grouse

Kauhala *et al.* (2000) studied the effect of predator removal (Red Fox, Raccoon Dog, Pine Marten and Stoat) on grouse in Finland. The breeding success of grouse in northern Finland, indicated by the young/adults ratio, did not decline in an area where predators were removed despite a decline in the overall population. The mean nest size during the experiment was significantly higher in the areas where predators were removed than in the protected areas (where predators where not removed) both in southern and northern Finland. Predator removal/protection thus affected the reproductive success of grouse, but the impact of control on adult grouse populations was not as evident (Kauhala *et al.*, 2000).

Skylark

For his doctoral thesis, Weibel (1999) researched the effects of wildflower strips in intensively used arable area in Swiss on skylarks. Predation caused 72% of all nest failures (n = 193) and was more frequent during the nestling stage than during incubation. Of the total of 1493 nests which were predated, 14% of the losses could be attributed to corvids and 12% to small rodents. A further 14% were taken by larger mammals, which were probably also responsible for the 60% of eggs which were removed without a trace.



Management and restoration of small wildlife populations

Habitat Management

Fields and meadows avifauna have specific needs depending on the habitat they live in and the period of the year. For these reasons, a mix of different cultures and environments is necessary for the development and maintenance of all species.

Hedges and wooded banks

Originally, hedges and wooded strips were planted to define the boundaries of a territory or provide natural barriers for livestock. During the last decades, the consolidation of agricultural land promoted the uprooting of hedges and wooded strips that were subject to CAP-funded subsidies (Demeter *et al.,* 2010). It is only since 1995 that these structures have been protected and are now part of the small "natural" elements of the landscape. Today, the establishment of hedgerows and wooded strips with indigenous species, as well as the management of these are subsidized as agro-environmental measures, in order to preserve this natural heritage, which is beneficial to farmers and the environment.

Planting techniques consist of 1, 2 or 3 strips made up of several species of shrubs. Shrubs should be planted at a spacing of about 60-80 cm while the trunks should be protected with a trunk guard.

Implementation of a double row hedge at the headland (Roworth, 2009).

Usually in the form of isolated strips or groups, these structural elements in the landscape can be divided into three different categories, each with its advantages and disadvantages.

The first category is the low trimmed hedge, probably the most common. With a height of between 1 and 2 m, the management of this type of hedge consists of frequent pruning to encourage the development of new branches. This requires regular annual work. This type of hedge is advantageous from the point of view of agriculture as it reduces soil erosion and acts as a windbreak that protects crops from the weather, while taking up little space. From an environmental point of view, the low hedge is an excellent refuge for passerines and small mammals, but its management prevents the production of spring flowers and winter fruits, thus limiting the presence of invertebrates, a source of food for birds in particular. Nevertheless, when they are joined to a grassed strip, their impact on the fauna and flora is significant.

The second category is the wooded bank, made up of the same species as the low trimmed hedge, but requires less regular management. This allows the shrubs to develop better and to follow the cycle of the seasons. Although this type of hedge provides more agricultural benefits than low hedges (reduced erosion, wind breaker and pollinating insects), they are not very popular with farmers. They take up more space and it is more time consuming to maintain the bushy hedges and to avoid encroachment on the surrounding land, occasional side pruning and re-growing. It is unfortunate that the agricultural world appreciates them less, as their environmental contribution is considerably greater. Indeed, wooded banks are home to a significant number of both animal and plant species that are entirely dependent on this habitat for survival (Hinsley & Bellamy, 2000).

Finally, the third category is that of isolated trees, bushes and groves, which has little impact on agricultural practices, but are important benchmarks for small wildlife. Indeed, birds such as grey partridges define their territory according to these landscape structure elements (Ory *et al.,* 2011).



Different categories of hedges and wooded banks: on the left are low hedges that have been trimmed (Smith, 2009), in the centre are wooded-banks (Adams, 2010) and on the right are isolated trees, bushes and groves (Jorjorian, 2010).

Subsidies granted for the conservation of a hedge amount to 5€/m per year (depending on the EU Member State). Pruning the hedges once per year is planned for low hedges, as well as occasional lateral pruning for open hedges. These operations cannot be carried out during the breeding period, i.e. from 15 April to 1 July in Wallonia (Belgium) or to 31 July in France. For wooded banks the subsidy can go up to more than 80€/100m^2. In 2019 the Walloon Government agreed to plant 4000 km additional hedges in a period of 5 years.

It would be interesting to establish a management that would increase both agricultural yield and environmental benefits. England has been experimenting with so-called improved hedge management, which is limited to one hedge trimming every 3 years. This reduces the amount of farming operations, while maintaining the advantages of a crop hedge. On the environmental side, this tri-annual period allows shrubs to flower and attract pollinating insects, as well as to form fruits that provide a food supplement for wildlife during the winter period. Finally, the optimization of the environmental performance of this management includes a rotating management system. This consists of dividing the territory into three parts, and applying hedge pruning to only one of the parts each year. This rotating system ensures for food resources all year round (Defra 2010).

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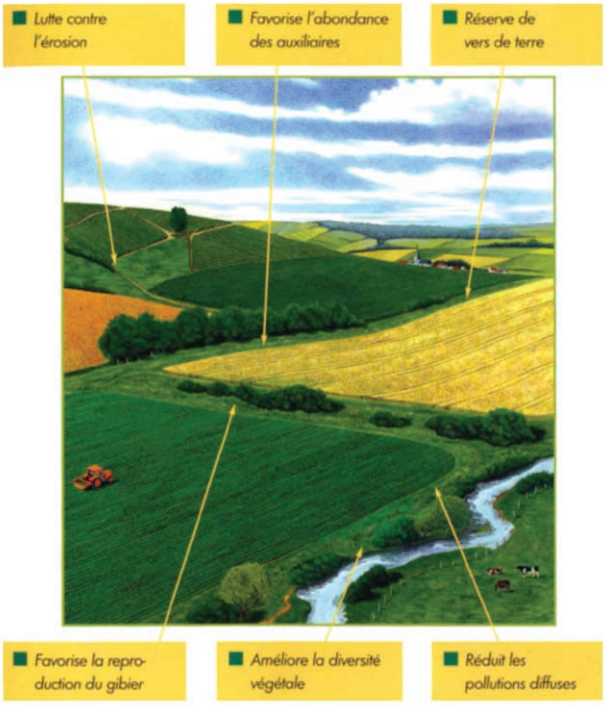
Grassy headlands and field margins

Grassy headlands and field margins are the most common conservation measures in agriculture. This is due to the easy establishment and management of grassy headlands and field borders, while providing a wide range of benefits for both agriculture and the environment. Usually in the form of strips and placed at the edge of the field, they can be seeded naturally or artificially, depending on the fertility of the soil. If the strip of land converted to a headland is very fertile a seed mixture of grasses and broadleaf weeds to prevent weed contamination can be used. On the other hand, if the land dedicated to the grassy headland or field border is unproductive on well-drained soil you could allow the vegetation to regenerate naturally, so that a greater variety of species can establish themselves. The width of these belts varies according to the agricultural machines used on the field.

Studies carried out in the United Kingdom have shown that a field border must be a minimum of 6 meter along the edge of a field. Together with appropriate management, this can significantly impact the environmental and agricultural functioning of the field. In this case, the presence of field borders reduces the risk of erosion, which leads to considerable losses of organic matter and significant damage to crops. In addition, the creation of these buffer zones, between crops and adjacent habitats, helps to reduce pollution caused by the runoff of plant protection products (Marshall & Moonen, 2002). Furthermore, not ploughing on these plots allows the development of a diversified flora that shelters arthropod species (beetles, diptera, etc.) acting on the control of arthropod pests such as aphids in the case of beet. When composed of flowering plants, the field border can also host a wide range of pollinating insects, increases agricultural yield (Ythier & Bernard, 2003). Finally, grassy headlands also benefit small wildlife, which use this habitat as a refuge and transition zone between crops. These bands are particularly favourable to the typical avifauna of agricultural fields, which benefit both from the cover during the nesting season and from the invertebrates found there, which are an important source of food for them during the summer (Ory *et al.*, 2011).

A schematic diagram of the benefits of grassy headlands and field borders in agricultural settings (Gall, 2009).



The grassy headlands and field margins described can still be improved to provide more agricultural and environmental benefits. To enable this, headlands and field margins should allow for habitat diversification within the same strip. This can be realised by dividing the strip into two distinct parts which are mowed at specific (different) periods, while exporting the mowing. The inner side of the plot is mowed several times a year to create a short grassy area, while the outer side of the plot should only be mowed once every 3-5 years to allow the development of a tall grassy area with young bushes. As with the management of hedges, the adoption of a rotating system (over 3 to 5 years), applied to the outer part of the headlands, makes it possible to preserve refuge areas on part of the territory each year (Defra, 2010).

Nevertheless, if only one intervention is carried out per year, it is important to avoid any intervention after 15 April and before 15 July, in order to allow the fauna to reproduce. If weeds are present in the area, it is possible to maintain only the infested areas as well as keeping them high (+30 cm).

Grassy headlands managed annually on the inner edge of the cropped plot, and every 3-5 years on the outer edge of the hedgerow (Carr 2012).

Grassy headlands and field margins must have a suitable location. Apart from the mineral properties of the soil, sunny exposure will allow better development of the flora, and therefore of the invertebrates which, in turn, benefit the avifauna. In addition, to limit access to indiscriminate walkers and motorized vehicles, it is preferable not to place these strips along the edges or at junctions with public roads (Bataille *et al.*, 2009).

High topping of field margins instead of ploughing will favour multi-annual plants suppressing weeds. Those multi-annual plants also have a positive effect on insect biodiversity creating an additional food source for birds and other small wildlife.

Woodland edge management

An edge is a transitional zone between two different habitats. In the case of agricultural areas, the edge refers to the boundary between the farmed area and the adjacent environment, e.g., between a field and a forest. These transition zones attract a large number of plant and animal species and are generally richer in biodiversity than either environment taken in isolation. This phenomenon is usually described as the "edge effect" or "border effect" and can have a negative impact on biodiversity if managed inappropriately. The high density of species in these restricted areas increase considerably due to the exposure to

predation and intensive management. For example, if a field is cultivated as far as the edge of the forest, the first few metres (5 to 10 metres on either side) of the strip bordering the forest will be exposed to mechanical agricultural management (mowing, ploughing, phytosanitary products, etc.). Thus, the species found there will be negatively impacted. Only highly mobile species will be able to find refuge in their native environment. This hybrid zone may attract certain species, but if intensively managed, will lead to their destruction. Its function as a shelter will only be temporary and will not be of long-term interest for the development of the target species.

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Thus, if no transitional zone is planned between two "natural" spaces, for example between a forest and a crop, the abrupt transition from one environment to the other disturbs the balance of each environment and has a negative impact on both habitats (Schneider *et al.*, 2012). Therefore, in order to preserve this area of high ecological value, it is important to adopt a management that acts not only as a buffer zone between two habitats, but also as a refuge area for a group of species.

Edge management must be carried out on a strip of land approximately 10 to 20 metres width, located between a woodland and a farmed area, to allow for the development of grassy and scrubby plants that benefit the small fauna of the plains as well as invertebrates. It is a necessity that these strips are protected from agricultural activities and from applications of plant protection products such as insecticides or broad-spectrum weed killers. Edge maintenance will therefore consist of a regime consisting of gyrogrinding and coppicing every 5 to 10 years. Ideally, this maintenance is carried out during the winter period, but no intervention should be carried out during the nesting period (1st of March – 1st of August). Wherever possible, maintenance should be carried out in a partial manner to allow wildlife to find a refuge area during the period following the intervention (Defra, 2010).

Two examples of biodiversity-friendly woodland edges (Wakley, 2010).

Although proper edge maintenance results in a significant increase in biodiversity and acts as an ecological corridor for species in adjacent environments, the density of species and the narrow configuration of these edge strips also accentuate the presence of predators. As far as the objective is to re-establish the small fauna of the plains, habitat development must be accompanied by predator management.

Fallow land for wildlife

Under the CAP, agricultural set-aside was first introduced as an economic measure to limit overproduction of certain crops (particularly cereals). These consisted of the cessation of all agricultural activities on part of the land, known as "set-aside", in exchange for financial compensation. This support system has been divided into two pillars dealing on the one hand with market measures through conditionalities (Pillar I) and on the other hand with rural development such as voluntary environmental programmes (Pillar II). The term set-aside is no longer associated with "set-aside", and farmers can use their set-aside land for environmental purposes, with continued financial compensation.

Wildlife fallows consist of small plots of cultivated land with mixtures of unharvested arable plants, which provide a valuable source of food for the small wildlife of plains and meadows, both in summer and in the off-season. These plots are located in the least productive areas but are particularly interesting from an environmental point of view. They can be in the form of strips or on the field edges. However, in this case, an additional uncultivated area should be juxtaposed to optimize the slash effect. Although there are some similarities between the grassed strip and the wildlife fallow, the management of these two measures are fundamentally different from each other. The wildlife fallow is cultivated annually, while the grassed strip is established mechanically or naturally in the first year and then subjected to an annual mowing regime.

Wildlife fallow between a forest and a crop, thereby promoting the transition from one natural habitat to another (Cardner, 2010).

The effectiveness of fallows in supporting the needs of small animals depends on the types of crops grown and the management adopted. Firstly, the choice of the mix of plant species making up the wildlife plots is made according to the target bird species, the soil type, and the exposure of the plot. No single species should account for more than 2/3 of the mixture by weight, and a varied composition of leguminous and cereal plants helps to minimize the impact of pests and diseases on the productivity of those plots (Defra, 2010). Secondly, the management of the establishment, maintenance and re-cultivation of these plots must be coordinated with the needs of small wildlife. These interventions must be carried out either in spring (February-April) or late summer-early autumn (August-September). This management maximizes food resources, which become increasingly scarce as winter extends and promotes a flowering canopy during the summer, attracting the pollinating insects that form the basis of the young birds' diet. With exception to certain mixtures based on biannual plants such as cabbage, the fallow crop must be renewed each year. Therefore, to avoid the proliferation of weeds, it is preferable to change the location of the plots on an annual rotation basis. The choice of fallow crop is extremely important with a preference of melliferous flowering plants (for summer season) and grain (for winter).

Finally, wildlife fallows may also consist of extensive unharvested strips. This measure consists of the establishment of a strip of grain with a wider plant spacing than the rest of the crop. This practice allows the development of arable plants that are favourable to invertebrates, as well as additional seed production. The birdlife during the winter months will therefore have an additional food source. The management of these strips does not differ from the adjacent crop, except that the application of pesticides and fertilizers is prohibited from the 15th of March until the next harvest. With high environmental performance, this option is very popular among English farmers, as it requires very little maintenance and represents an interesting financial compensation (€500/ha) (Defra, 2010). However, the more open structure of these strips tends to promote weed proliferation. To avoid crop contamination, regular changing of the belt is also recommended. If the belt is placed in an area prone to weeds, it is also preferable to increase the sowing rate.

A strip of grain left standing as a feeding cover for overwintering birds at the crop edge (RSPB, 2011).

Flower strips

By establishing flower strips in agricultural fields, you can create continuous supply of pollen and seeds when the strip is well managed using a good mix of flowering plants encouraging late flowering.

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Flower strips often must be re-established after three or four years. By using perennial flower-rich margins made up of fine grasses and flowering plants such as Knapweed, Scabious, Bird's-foot Trefoil and Yarrow you can avoid the need to seed again after some years.

Flowering strips are beneficial for many animals including birds and insects. As many pollinating insects are attracted by the flower strip this can have a positive impact on the yield of the crops on the field. Depending on the choice of seed mixture you use the flower strips become of more of interest for insects, birds or other animals.

A flower strip can target two distinct groups of birds: birds wintering near hedges, and birds wintering feeding on the ground. In function of the group you want to conserve the composition of feeder plants and the planting structure is different. Indeed, depending on the chosen location, and the group of birds targeted, the standard pattern of these bands is largely adaptable. If, for example, a "fauna" strip is located near a hedge, the strip should be with a mixture of flax or wheat-based food plants, supplemented with other varieties (triticale, forage radish), should allow food to be maintained until late winter.

On the other hand, the "wildlife" strips developed for ground-feeding species are generally located in the middle of a crop, or far from any landscape features. These strips, are mainly composed of wheat, are subdivided into two parts and separated by a grassy strip. This structure of about 12 meters allows the implementation of an alternating management of implantation, to always keep a cover on foot. This type of management is particularly favourable to the grey partridge, whose density is directly related to availability and quantity of food (especially in winter).

It is also recommended to stop the strip at a sprayer distance (10 to 20 metres) from the edge of the cultivated field. This recommendation facilitates the farmer's work and avoids a direct continuity between the strip and the main mesh, thus breaking predation corridors and reducing the accessibility of the strip to predators. Moreover, this precaution limits the access of these gangs to unscrupulous pro-leaders and motorized vehicles.

Overwintering bird management strips, in all their variants, are considered the most effective measures for meeting the needs of wintering avifauna. Nevertheless, the implementation and integration of these measures into the system of an agricultural territory can be problematic. In the ideal case, the farmer is also the owner as the implementation and annual maintenance of these measures require a considerable amount of time and specific mechanisation. Indeed, the alternate management of these strips does not allow for a rotating system as described in the section on wildlife fallows.

While a restriction on pesticides and weed control is entirely justified, depending on the location of the development, a ban on fertilizer can be a problem in terms of the proper establishment of the canopy, and more specifically the amount of seed produced to ensure an effective winter food resource.

Hay meadows

Today the flower-rich hay meadow is a rare and important habitat. When the hay meadow is the result of traditional, low intensity farming they contribute significantly to nature conservation. The bright and varied colours of hay meadows in June and July are often a touristic attraction. While not as supportive to biodiversity the hay meadows with few species of plants can provide food for seed-eating birds and nesting habitat for ground-nesting birds.

But silage is often cut too early and too frequently to produce seed or allow birds to complete nesting. The time of cutting is critical to ground-nesting birds. The use of high levels of fertilizer can severely reduce the variety of species and habitats.

Plants and other wildlife associated with traditional hay meadows need long-established management practices to continue.

Over-wintered stubbles

At the time of crop harvest seed food availability for birds is very high. Afterwards, seed food becomes increasingly scarce until new seed sources become available in the spring.

Cereal stubbles are an essential environment for the reproduction of certain species native to the agricultural plains: skylarks, quails, grey partridge, etc... With the increasingly early harvests, the birds no longer have time to finish nesting before the harvest. If the stubble is kept high after the harvest, the impact is limited.

If you have spring crops in your rotation, then over-wintered stubbles are an easy way to provide seed food for birds through the winter. The later you leave stubbles in the field, the better. Preferably leave the cereal stubbles uncultivated and unsprayed to provide seed food for birds.

Short stubbles enable seed-eating birds to see approaching danger and fly off. Tall stubbles will act as cover for gamebirds. Many birds, such as, skylarks and yellowhammers benefit from the presence of stubbles.

Farmers also have to plant inter-crop cover during the winter period. These canopies have the advantage of capturing nitrate ions, capturing and storing carbon, limiting erosion and protecting the soil from bad winter weather. These canopies also have the advantage to offer winter refuges for small fauna. Very often to establish these inter-crop canopies, farmers quickly remove the stubble after harvest to sow them (to ensure good development of the canopy before winter). However, early stubble ploughing after harvest prevents the species from completing their reproductive cycle.

There are two types of alternatives that make it possible to reconcile the two issues (see Annex 1/Action 6):
1. Direct sowing in between stubbles
2. Manuel sowing

Use of corn ear stripper/stripper header

In the Netherlands, a corn ear stripper was introduced to avoid geese landing on certain areas near airports. The harvester only harvests the corn ears, leaving the straw standing in the field, making it unattractive for geese to land (Visser *et al.*, 2016). This technique has been used in 2019 in Belgium to harvest wheat while keeping the stubble as cover for European hamster (*Cricetus cricetus*)[11]. If the straw cannot be sold, this would be an average net cost of € 360. Also there is a supplementary problem that the straw needs to remain in this case until fertilizing is no longer possible due to legislation, translating in an additional loss of profit for the farmer. (Visser *et al.*, 2016).

Use of an ear stripper or leaving stubble could be a low-cost measure for farmers allowing cover to remain until other sheltering crops can grow. These should hence be combined in a whole-field approach for maximum effectiveness.

Scrub

Scrub is a common part of many habitats, such as grassland and woodland. Using a diversity of shrub species, age and structure is essential to attract a variety of small wildlife.

Crop choice

Stoate *et al.* (2004) studied crop management related to farmland birds. Game crops were used more than other farmland habitats by a wide range of bird species. Kale and Quinoa were used by many species, whereas maize was used by very few. Cereals such as Triticale and Millet were used by many species, including several not associated with brassicas such as Kale. Crop species differed in the rate of seed shedding, and therefore in the amount of seed food that they provided through the winter. Crop location influenced the use by some bird species, with crops close to hedges or other cover generally being favoured. The use of nitrogen fertilizer influenced seed yield, and therefore crop value as a source of food for birds. Our results suggest that, if managed and sited correctly, a combination of two or three crop species can provide a valuable winter food resource for many nationally declining farmland bird species, but further attention needs to be given to their agronomy. This form of management is now incorporated as an option within agro-environment schemes in England, Scotland, and Wales. It enables farmers to apply existing skills to conservation and is compatible with their cultural values.

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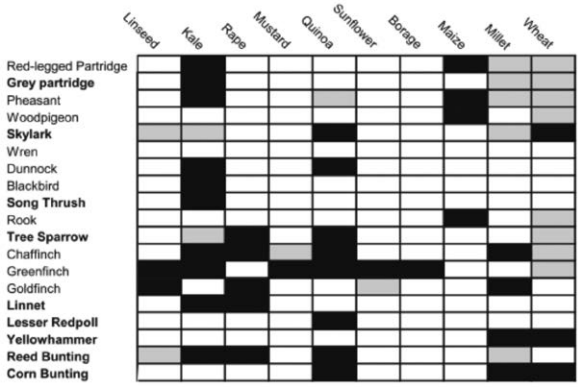
[11] *https://www.natuurenbos.be/pers-nieuws/nieuws/uniek-voor-vlaanderen-haspengouw-wordt-er-tarwe-geoogst-met-een-arenstripper*

The figure below gives an overview of the studied crops and preferences of birds.



Given that different crops can often require different management, whether in terms of weed control or fertilizer application, the crop mixtures prescribed under set-aside and agri-environment regulations are also a constraint on successful crop management. For example, current Countryside Stewardship prescriptions require the planting of a mixture of Kale, Quinoa and Triticale, even though drilling dates differ between these crops by more than a month. However, the results presented in this paper suggest that at least two crops are required to provide seed food for a range of bird species through the winter. We suggest that it should be permissible to plant seed-bearing crop combinations, in separate single-species strips. This permits seedbed preparation, timing of drilling, pest and weed control, and fertilizer application to be managed according to each crop's needs. As farmers are often frustrated by not being able to grow seed-producing crops effectively, because of legislative constraints, the option to plant combinations of single-species strips could increase farmer commitment to achieving the conservation objectives of seed-bearing crops. Single- species strips may require use of narrower drills than are routinely available on arable farms, but the increasing adoption of seed-bearing crops for gamebirds. Agri-environment schemes are already encouraging greater adoption of narrow drills by farmers and contractors.

Flexibility is also required to enable farmers to select crop species that are appropriate to their local conditions. For example, suitability of millet varies between regions, with this crop being best suited to light soils and southern regions, but soil type and aspect can also influence decisions on crop choice within regions, and even within farms.

Recommendations for best practice therefore might include:

- Decision on spring- or autumn-sown species according to farming system (e.g., seasonal labour availability) and soil type.
- Concentration on species that have been shown to provide food for a range of bird species (e.g., Kale, Quinoa, Millet and Triticale).
- Rotating crops around the farm in order to reduce soil nutrient depletion and weed seedbank, or
- Application of at least 90 kg N/ha after 2 years and
- Application of herbicides when necessary to control competing weeds.
- Planting of combinations of single-species crops in order to facilitate appropriate agronomy.

Parish & Sotherton (2004) showed that counts of songbirds during the breeding season on 21 farms across eastern Scotland, United Kingdom, resulted in up to 80 times as many birds were recorded from game crops than nearby conventional crops. At the same time, butterflies and bumblebees were, respectively, up to 15 and 40 times more abundant in the game crops than conventional crops. In a survey of weeds in smaller game crop plots where sowing conditions were controlled, 90% more species were found than in nearby conventional crops (180% more broad-leaved weeds). Weeds from important bird-food groups were nearly three times as abundant in game crops as conventional crops. Game crops therefore provide a very attractive habitat for many forms of wildlife that in turn provide valuable resources for songbirds, many of which are currently declining on modern farmland.

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Moorcroft *et al.* (2002) examined correlations of use by eight farm birds of different types of intensively managed wheat and barley stubble fields, organic wheat fields and set-aside fields on mixed lowland farmland in central England. Higher seed abundance was associated with greater occupancy by Grey Partridge (*Perdix perdix*). Larger areas of bare earth within stubble fields were associated with lower occupancy by Woodpigeon (*Columba palumbus*). Field occupancy was significantly greater on intensive barley stubbles for all these species except woodpigeon, which was significantly greater on under sown organic wheat

stubbles. No species was most strongly associated with intensive wheat stubbles.

On conventional intensively farmed sites, seed abundance and area of bare earth were significantly greater on barley stubbles than on wheat stubbles. Seed numbers fell throughout the winter in all stubble types, although reductions were greatest on intensive barley stubbles, intermediate on intensive wheat stubble and lowest on undersown organic wheat stubbles. In autumn, grey partridges rarely fed on fields where cereal grain density was below 50 per m2. However, in spring, both species fed on these fields irrespective of grain density, perhaps indicating a switch to other food sources.

This suggests that land managers wishing to maximize the value of overwinter stubble fields for granivorous birds locate such fields where there is a substantial natural regeneration of weed flora and where previous cropping (e.g., barley) is likely to offer a sparse stubble with substantial areas of bare ground.

Game crops are the most attractive crops to farmland birds. Kale, quinoa, triticale and millet are used by many species, whereas maize is used by few. As seed yield is important, use of fertilizer (at least 90kg N/ha after 2 years) also has a positive influence. To provide seed-bearing through the winter hungry-gap at least two seed-providing crops are required. Planting in single-species strips permits seedbed preparation, timing of drilling, pest and weed control and fertilizer application to be managed according to each crop's need.

Use of crops by small fauna: crop rotation (See annex n°1/Action n°2):

A mosaic of cultures each with its own management distributed over the entire territory enables biodiversity to be conserved at each period of the year (Sirami *et al.,* 2019). In line with the specific features of the farm, it may be worth rethinking the distribution and alternation of crops in the area without necessarily losing productive surface area (Hendrickx *et al*., 2007).

For flying insects (ladybirds, bees...), the diversity of the environment (crops and facilities) will provide them with a food resource spread throughout the year. For example, in February it is the hazelnut trees that will provide food; in March the plum trees, in April the rapeseed and in July/August the sunflowers. A diversity of flowers throughout the year favours a great diversity of insect species (Perovic *et al*., 2015) and pollinators, as well as the insect eating ladybirds and hoverflies. The latter require nectar and pollen (Villenave-Chasset, 2017) to lay eggs and regulate pest populations. For entomofauna crawling on the ground (such as ground beetles), the immediate proximity of these different crops is necessary as they cannot move more than 80-90m from the edge (Collins *et al*., 2002).

Species Management

Predator management

The preceding sections highlight the importance of land use planning to provide different types of habitat for the small wildlife of the fields and meadows, and for the avifauna, to provide shelter, food and breeding habitat. However, the linear structure of these developments, as well as the increased connectivity of the plot, also encourages predation by species adjacent to these developments. Indeed, predators take advantage of these longitudinal arrangements to patrol the plain in search of prey. Although natural, this phenomenon is accentuated by a disproportionate increase in predator populations relative to the availability of prey, as well as by the concentration of prey in restricted areas (edge effect). This imbalance is linked to the absence or scarcity of large, or direct predators, but above all to the surprising ability of small predators to adapt quickly to changing habitats, as well as to take advantage of the additional food resources provided by urbanisation. These opportunistic species then gain the upper hand over other species with less adaptive capacity, and whose habitat is greatly reduced. Numerous French and English studies have demonstrated that predation is often the greatest mortality factor for the plains' wildlife and that good predator management allows for a significant increase in small wildlife (Potts 2012, Reynolds *et al*., 2010, ONCFS, 2007, Mayot *et al*., 1998). In addition, these studies have also shown that the effectiveness of these linear developments in supporting the plains wildlife (including a refuge area from predation) can be greatly enhanced if associated with predator management.

The impact of predation was described earlier in this study.

Predator control

If the presence of predators is indispensable on the territories to limit the populations of crop pests, their development can be limited as provided for in the texts. Thus, although the Black Crow (*Corvus corone*) and the chattering Magpie (*Pica pica*) are protected in Europe by the Birds Directive (EEC/79/409), it is still possible to regulate their populations using firearms, traps and live decoys (not mutilated) by means of special derogations.

Regulation of predators can often take place all year round, day and night. Regulations to control predators are however different within each of the EU Member States.

According to a major synthesis by the ONCFS (Office National de la Chasse et de la Faune Sauvage, France - Mayot *et al.,* 2006) covering many studies and species, and in different countries, it seems that a significant limitation of predators has a positive effect on fauna, provided that it is distributed in space and sustained over time (Mayot *et al.*,2006). Hunters and game wardens are probably the most important regulators of predators. The dynamics of hunting and thus of the hunting management of the fields and meadows play a key role in the recovery of the small wildlife of those habitats.

Hunting as a management tool

Hunting small wildlife in fields and meadows has been a long-standing activity. This is defined by the taking of huntable species such as Grey Partridge (*Perdix perdix*), Colchid Hheasant (*Phasianus colchicus*), European Hare (*Lepus europaeus*) and Wild Rabbit (*Oryctolagus cuniculus*) at specified periods. These withdrawals are estimated on an annual basis according to the populations, to preserve these species on a territory. Hunting is the result of a complex year-round management of habitats in favour of hunted species. The success of a hunting season is therefore intimately linked to long-term management efforts. Thus, most plains hunters set up wildlife facilities serving as refuges and food sources for small game. These developments are generally accompanied by appropriate management of predators through trapping and shooting. In practice, these game management operations require a considerable amount of time in the field and knowledge of the species and are carried out by trained game wardens. Therefore, if we consider the financial cost of such management and the salary of a full-time employee, it represents a significant local economic investment.

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For several decades now, the popularity of big game has grown considerably in the world of hunting. This trend is explained by several factors. Firstly, the sharp decline in small game discourages many hunters whose efforts yield only meagre results. Secondly, the increase in big game populations and the cheaper maintenance of their habitats make this hunt more attractive than that of small game. Finally, in addition to the financial cost, the disaffection for the game warden profession is making it increasingly difficult to find a qualified professional to manage small game on a territory.

Game releasing

Priority should always be given to habitat restoration in function of small fauna. The release of game can have certain advantages but remains a delicate issue. Several studies show that caution must be taken with regard to the release of game and the consequences it has on wild populations.

In certain situations, especially when hunters do not have the means to seriously tackle the environmental aspects for a higher carrying wildlife capacity, game releasing could be a justified means to increase populations. Game released after hunting season helps restock the reproductive population. Game released before hunting season allows an increase in bag statistics (Havet & Biadi, 1990; Bro & Mayot, 2006).

Partridges are also released to limit removal of the natural population of Grey partridge, whilst satisfying the shooting demand (Bro & Mayot, 2006).

For Mallard, a migratory species, game releasing to artificially augment game numbers, had as a side effect on the areas where the species had disappeared and have now become repopulated by Mallard (Havet & Biadi, 1990).

In general, however, the impact on other induced effects, for example pathogenic or genetic types on wild populations, should not be underestimated (Champagnon *et al.*, 2013 ; Bech *et al.*, 2017).

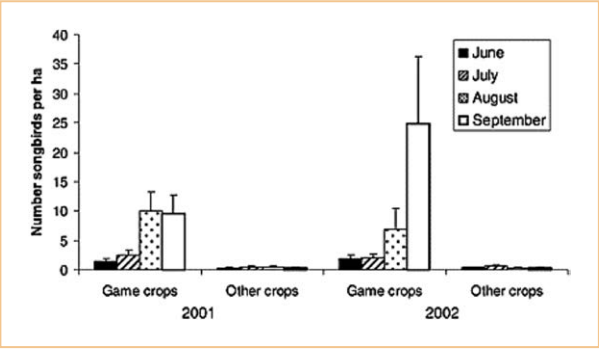
A study by Neumann *et al.* (2015) shows pheasant release resulted in significant changes in the species composition of Carabidae, with shifts towards species typical of arable fields and grassland. There was an overall increase in the abundance of detritivores, including *Diplopoda*, *Oniscoidea*, *Gastropoda* (snails), at higher release densities. Mean release density in our study was from 1489 ± 126 birds/ha (range 174–3409, n = 37 pens) and they suggest that detrimental effects on specialist woodland invertebrates would be minimized if releasing was conducted at the recommended density of 700 birds/ha.

Buner & Schaub (2008) tested the effect of three release techniques on the survival rate of Grey partridge in Switserland. Survival tended to be highest in wild-hatched partridges of the founder population (mean ± SE; 0.90 ± 0.03), followed by that of fostered chicks (0.86 ± 0.03) and translocated adult wild birds (0.82 ± 0.06). While survival of these groups was not statistically different from each other, survival of captive-reared adults was significantly lower (0.70 ± 0.06).

Gortazar *et al.* (2000) analysed the success of release management of Red-legged Partridge in northeast Spain and concluded that traditional restocking is not an effective management tool to enhance wild population, although the technique may be improved by scattering the release sites, with (after the first 72 hours) 37.4 ± 1.8 % survival compared to only 5.8 ± 1.1 % in the grouped releases.

Restoring small fauna populations in hunting areas using wildlife crops

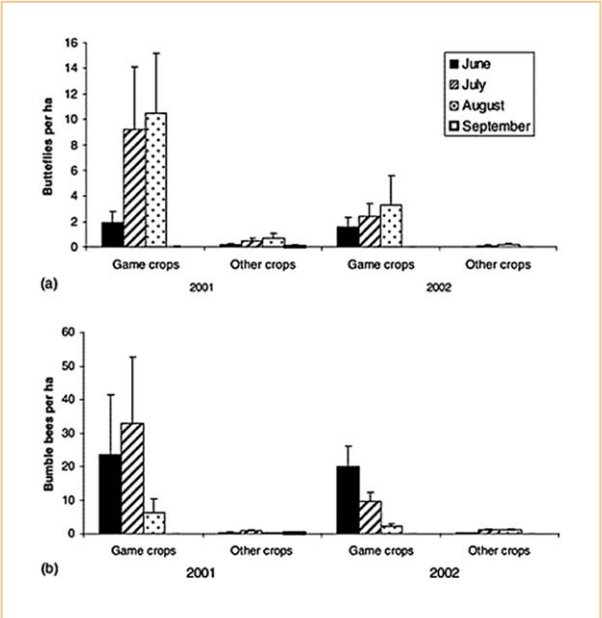
Wildlife crops are plots of land developed with cereals, cruciferous plants and leguminous plants to favour small wildlife within a hunting territory and represent between 5 and 10% of the cultivated land of the territory. Depending on local conditions and target species, the management of these crops can take the form of wildlife fallows, extensive unharvested strips or managed strips as described earlier. Although the primary objectives are to provide nesting shelter and food-producing vegetation for small wildlife, this type of culture is particularly beneficial to the avifauna of the fields. Indeed, a study on the impact of hunting developments on the fields' avifauna shows that wildlife cultures have up to 80 times more songbirds than conventional cultures (see figure below) (Parish & Sotherton, 2004). According to research carried out by the Game and Wildlife Conservation Trust (2003), the abundance of avifauna can be up to 100 times greater on arable hunting crops and up to 325 times greater on pasture hunting crops (GWCT, 2013) than on conventional crops.



A comparison of the presence of songbirds on game crops and conventional crops (other crops) during June, July, August and September 2001 and 2002 (Parish & Sotherton, 2004).

The abundance of songbirds on hunting crops was also noted by Sage *et al.* (2005) in a study of the decline of avifauna within agricultural plots in England and Europe. The study concludes that, despite the significant reduction in plains avifauna, the presence of songbirds in hunting cultures remains higher than conventional cultures during the breeding season, as well as during the winter period (Sage *et al.*, 2005).

In addition, Parish *et al.* (2004) also observed that some insects such as butterflies and bumble bees were up to 15 and 40 times more abundant in hunting crops than in conventional crops, respectively. Indeed, sown at low densities, hunting facilities give way to spontaneous vegetation rich in species (90% more species than in conventional crops) that attract pollinating insects (Parish & Sotherton, 2004).



Insects present on hunting and conventional crops.

Wildlife crops provide a very attractive habitat for many wildlife species, which in turn provide valuable resources for songbirds, many of which are currently in decline on modern agricultural land.

Artificial feeding

This practice is usually part of a game management plan to maintain game in a defined area. In the context of small wildlife of fields and meadows, particularly the bird population, the previous sections of this report highlight the importance of food availability during the winter period as one of the essential elements for bird survival. However, the abundance of seeds present in wildlife facilities naturally declines sharply during the winter period, leaving the avifauna with a nutritional deficiency before the resources are available again in the spring. This decrease in seed

availability during the late winter period was a major cause of the decline of many granivorous species. In addition, the lack of food at the end of the winter season weakens them and thus affects their ability to reproduce during the nesting period, thus reducing the quantity of eggs and the success of the broods.

In England, you can get subsidies for artificial feeding as nature management under the CAP, on condition that it is composed of a mixture based on wheat or rapeseed (minimum 75%), combined with the management of wintering avifauna (MAE) (Defra, 2010). To avoid looting by opportunistic species such as badger or wild boar, the feeders should also be protected by a coarse-meshed and/or rigid wire mesh.

A wooden structure equipped with a feeder against looting by opportunistic species (FDC 2012), and a classic feeder visited by a grey partridge (right) (Kubrak, 2008).

In France, many studies have also noted that the presence of feeders on hunting territories favoured the recovery of avifauna, particularly grey partridges (Mérieau & Bro ,2009; Connor & Draycott, 2010). Indeed, these studies highlight the territorial behaviour of grey partridges and recommend one feeder per pair.

Ideally, the feeders are placed on the edges of fields or, better still, on strips of land within the crops, but always on bare soil (without vegetation). To reduce predation, feeders should also be placed where birds have an unobstructed view, and without trees in the direct neighbourhood that can be used as perches for raptors. Nevertheless, the provision of food at a fixed point tends to bring birds together in a more restricted area, thus favouring predation on these species. Once again, it is therefore essential to accompany this hunting management with predator management, so as not to increase predation pressure on the avifauna.

Finally, the establishment and management of hunting cultures, as well as the installation and supply of feeders, all accompanied by daily predator control, requires considerable time in the field. As the owners or tenants of the hunting territory do not always have the time to carry out these tasks, they often call upon a specific sworn gamekeeper.

In a study carried out in 2008, the GWCT demonstrated that the additional supply of cereals through the installation of feeders at a rate of 1 feeder every 8 to 10 ha enables the birds to compensate for this food deficit, and to assist them during the nesting period. Although this method is generally used for hunting purposes, the results of this study show that the feeders also benefit the rest of the avifauna (Szczur, In press).

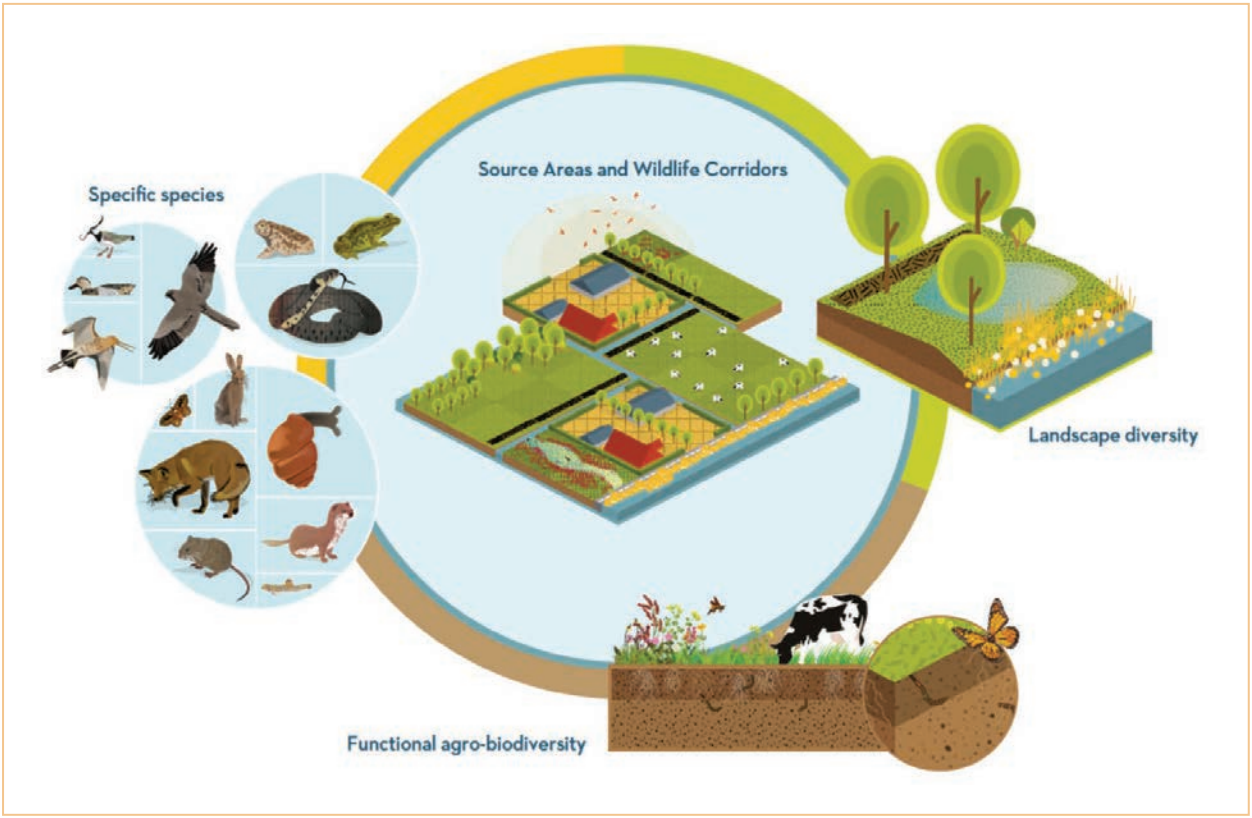
Nature-based agriculture

Nature-based agriculture is a form of sustainable agriculture based on a resilient food and ecosystem. Ecological processes are integrated maximally into farming practice. Nature-inclusive agriculture provides food within the boundaries set by the environment and having a positive impact on biodiversity. Van Doorn *et al.* (2016) described nature-inclusive agriculture using the following three dimensions:

Maximal use of biodiversity making essential contributions to a resilient agriculture. Nature based solutions such as prevention of disease and pests, pollination, the supply and treatment of water, natural soil fertility and good soil structure are essential parts of a functional agro-biodiversity.

Circular agriculture closing nutrient cycles aiming at zero-emissions and more efficient use of natural resources. Negative effects of farming practices are brought back to the absolute minimum resulting in positive consequences for specific species on the farm and in the surrounding countryside.

Landscape management and the conservation of species on the farm. Realising a green infrastructure at farms has a positive impact on as well as the functional agro-biodiversity as on the survival of meadow and farmland birds and other farmland species.



The four elements of biodiversity in dairy farming (Erisman et al., 2014).

1. Functional agro-biodiversity (aimed primarily at soil quality, mineral cycles, and plants).
2. Landscape diversity (landscape elements on the farm itself are of benefit to functional agro-biodiversity).
3. Source areas and wildlife corridors (in particular, measures at landscape scale, coordination between Nature Network Netherlands, management, exchanges between areas, etc.).
4. Specific species (additional measures for species conservation and support).

Soil

A crucial aspect of nature-based agriculture is a healthy soil capable of holding and delivering water. This contributes to the supply and management of nutrients and sequesters carbon and uses it to maintain soil life. A healthy soil, in combination with landscape elements, also supports a functional agro-biodiversity including ecosystem services such as pollination and pest control.

Biodiversity

Many species, including farmland and meadow birds, are depending on habitats present in a healthy agricultural landscape. To protect specific species additional measures can be necessary, e.g., postponed mowing dates. The combination of nature-based agriculture and the current practice of agricultural nature conservations could result in a reduced pressure on the environment.

Nature-based agriculture is not simply a matter of agriculture serving nature, but an agricultural practice which uses ecological processes optimally, reducing pressure on the environment (Erisman *et al.*, 2017).

Circular agriculture

Closing nutrient levels at the farm level will lead to more mixed farms or landscapes with mixed agricultural practices where dairy farms and arable farms are working closely together resulting in a more resilient system and ecosystem making a more efficient use of existing natural resources.

Climate change

Adaptation and mitigation of climate change requires an integrated approach. Nature-based agriculture can play an important role as it is creating a farming system less susceptible to drought and excessive

rainfall, sequestrating larger amounts of carbon, and reinforcing agriculture's capacity to adapt. Improving soil quality in terms of structure, composition (minerals, dry matter and compost) and soil life play an important role to make the soil more resilient making farms less susceptible to drought, excessive rainfall, diseases and pests and can therefore enabling them to adapt to climate change. Carbon sequestration in soil also plays a key role in soil management in relation to food and water quality and quantity.

Organic Farming

Often organic farming is linked to positive effects towards biodiversity. Most of the time those studies are conducted at the field level while very little is known about its effect on the farm and regional level.

Schneider *et al.* (2014) studies the effects of organic farming on species diversity at the field, farm and regional levels by sampling plants, earthworms, spiders and bees in 1470 fields of 205 randomly selected organic and nonorganic farms in twelve European and African regions. While species richness was on average 10,5% higher in organic than non-organic fields there was no significant difference between organic and non-organic farms and at the regional level.

Species richness at the farm level is a combination of farming effects at the field level and the composition of farmland habitats on each farm. This indicates that agro-environmental measures such as beetle banks, hay meadows, flower strips over-wintered stubbles and scrub could easily compensate for the non-organic agricultural techniques.

Cooperation between farmers and hunters

Biodiversity of fields and meadows is directly related to agriculture and hunting. If we want to install a successful nature conservation in those areas, we should incentivise the primary land users in those habitats. Often farmers and hunters are blamed for decreasing numbers of small wildlife. While certain practices in today's countryside certainly contribute to this decline, farmers and hunters remain an important part of the solution. Often their interests are intertwined as hunters regulate game species eating farm crops: e.g., Corvid, Pigeon, and Wild Boar.

Hunters are willing to pay more for hunting on estates that have better ecological characteristics, which may be indicative of good conservation status. This suggests that identifying and promoting such estates could lead to systems that are both ecologically and economically sustainable. (Delibes-Mateos *et al.*, 2014). Also farmers' motivation for successful crop establishment is often influenced by their shooting interests (Stoate *et al.*, 2004). (see also game crops in chapter on Agriculture).

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Shooting revenue, combined with the income generated from the agri–environment payments, helps offset the cost of management. This balances out investment of landowners in grey partridge conservation (Ewald *et al.*, 2012). Hunting organisations also carry out activities that are beneficial to Turtle Dove, such as restoring hedges and woodland, clearing springs, providing food directly, planting set-aside crops, voluntarily policing hunting activity, and limiting birds taken (Fisher *et al.*, 2018). Research by Rocha & Quillfeldt (2015) shows that hunting estates in south-west Spain, where food supplementation takes place, have higher young/adult ratios than control ones (estimated in the second half of August, prior to the opening of the hunting season).

Partridges also benefit from game conservation techniques such as predator control and restocking (Potts, 1980). Hoodless et al. (1999) showed that supplementary feeding wheat to pheasants results in a significantly higher mean percentage of cocks that were territorial. There was also a significant increase in territory density, although it did not affect hens. Also, average passerine densities in southwest Scotland were two orders of magnitude greater in game cover crops than conventional crops. (Parish & Sotherton, 2008).

Hunters websites often provide information on how to improve nature for game species.

The private game warden

The private game warden is responsible for guarding the game within the limits of the territory for which he is responsible. As defined in articles 9 to 16 of the Code of Criminal Investigation of 17 November 1808 of Belgian law, "the country guard is empowered to establish offences, to question persons for this purpose and to draw up the lease reports himself" (Dewael 2006). Its limited police jurisdiction makes it possible to control the disturbance of species by unscrupulous walkers, as well as to limit poaching or the dumping of waste on the land. In addition to his or her function as a gamekeeper, the private gamekeeper is also a field manager, and is hired by private individuals to ensure game management on their territory.

The role of the private game warden in the hunting management of a territory

Because of his daily presence on the territory and his observation skills, the game warden is generally the person who knows the territory and the species that inhabit it best. Not underestimating the complexity of the problem of degraded ecosystems, his knowledge of the territory enables him to quickly detect imbalances between populations, or even within the population of a single species. Thus, its role with regard to the hunting management of the territory is to guide the decisions of the owners, or tenants, of the territory towards the integration of management measures (grazing and predation control), as well as towards the implementation of wildlife management measures (wildlife fallows, flower strips, forest edges,...) including annual game harvesting.

When hunting small game, the game warden works in close collaboration with the farmer who owns or leases the farmland within the territory, to set up wildlife facilities to improve small game cover, feeding and nesting. A good cooperation between these two actors is a key element in the success and effectiveness of the measures taken. Indeed, the agricultural experience of the farmer combined with the game warden's knowledge of the needs of the game, can results in a clear improvement in living conditions, and therefore an increase in the area's capacity to accommodate game. In most cases, financial compensation or an interest in hunting encourages the farmer to take an active part in such management.

Another key role in the management of small wildlife is the integration of appropriate predator control in the territory. It consists mainly of regular trapping and shooting on the lookout. The authorized traps are limited to:

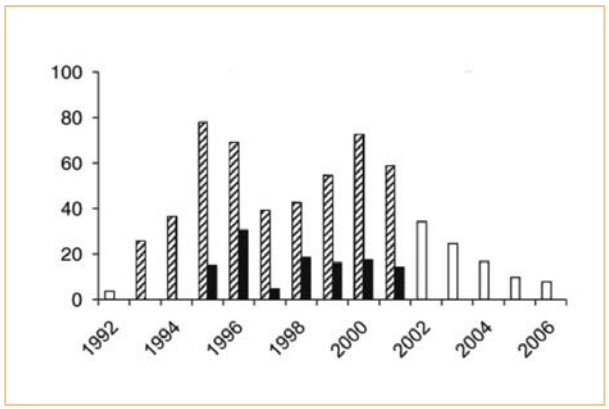
- Boxes or traps.
- Non-poisoned, non-living bait.
- Traps with laces triggered by pressure on a paddle or any other trigger system, the purpose of which is to capture the animal by one of its limbs without injuring it.
- Collars fitted with a stop.

Finally, the game warden's role is also to determine the annual hunting withdrawals of the game species present on the territory. These samples are limited quantitatively and qualitatively according to the morphological characteristics, behaviour, sensitivity to disturbance, status (migratory or sedentary) and population dynamics of the species concerned (ONCFS, 2007). In fact, the number of animals that may be taken during the hunting season on a territory is set by quotas, which are themselves based on the reproductive capacity and the demographic situation of the hunted species. In addition, restrictions on hunting periods (the number of effective hunting days) and the hunting methods used (selective shooting and methods of hunting) make it possible to limit the taking and disturbance of species in space and time.

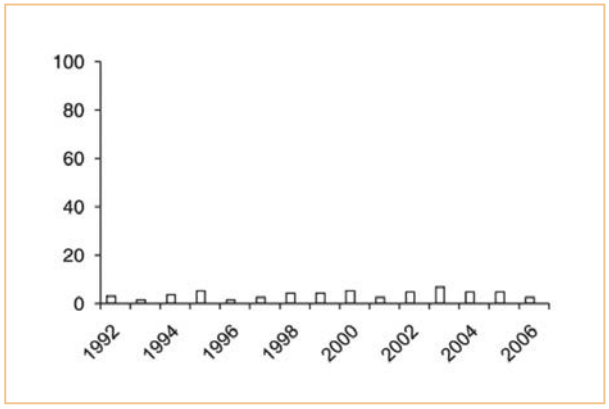
Therefore, a relevant estimate of the hunting harvest allows the sustainability of hunting within a territory, as well as ensuring a positive demographic curve of the hunted species.

The impact of guardianship on small game populations

Of the game warden functions cited above, predator management appears to be the most effective measure towards small game populations. Indeed, according to many studies, wildlife development on its own has little impact on the dynamics of small game populations if it is not accompanied by appropriate predator management. For example, a study on hare populations compared the number of hares present per km^2 on two English territories that benefited from wildlife management with and without predation control (Reynolds *et al.*, 2010).



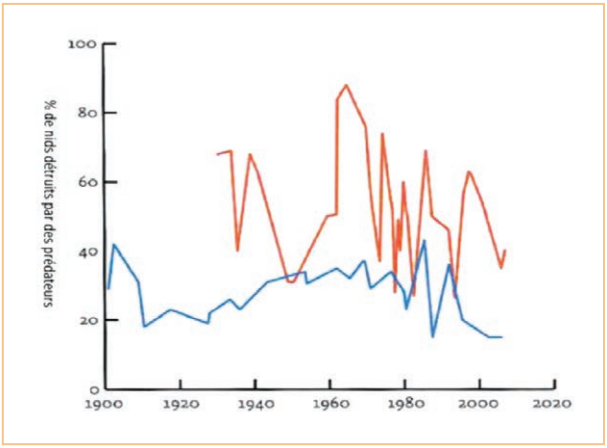
With control



With no control

A graphical comparison of hare numbers per km^2 between two territories with predator management until 2001 (left) and without predator management (right). The two territories benefited from wildlife development throughout the entire specified period (1992-2006). Hatched bars: hare populations during predation control; empty bars: hare populations without predation control; full bars: hare samples (Reynolds J.C. et al., 2010).

Another study on the predation of grey partridge nests gathered data from 74 field studies showing the percentages of nests destroyed by predators on territories with and without game wardens (Potts, 2012).



The percentage of grey partridge (Perdix perdix) nests destroyed by predators in the presence of a gamekeeper (in blue) and without a gamekeeper (in red) during the 20th century (Potts, 2012).

The two comparative studies above clearly show that predator management by game wardens has a significant impact on small game populations. However, this popular profession at the end of the 19th century generates fewer and fewer vocations today and the number of active game wardens is constantly decreasing. In England, the number of game wardens fell from 23,000 in 1914 to less than 5,000 in 1970 (Potts, 2012).

In 2013, the National Gamekeepers' Organisation in England still had 3,000 full-time gamekeepers. This phenomenon is also observed in France (Fédération Nationale des Gardes Champêtres de France), where the number of guards has decreased from about 28,589 in 1884 to 1,500 in 2013. This decline in the number of game wardens across Europe also means a significant reduction in predator control over a large number of territories. As described above, it is therefore not surprising to observe an increase in predator populations and a consequent decrease in small wildlife populations. Therefore, to halt the decline of the Plains' small wildlife, it is also essential to dust off the image of the game warden, and to promote this profession in specialized schools and cycles. It plays a key role in the balance of species and the recovery of the plains' small wildlife.

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Public recognition: the Wildlife Estates Label

Getting public recognition for their efforts in nature conservation is important for farmers, landowners, and hunters. The Wildlife Estates Label is a voluntary private land conservation instrument acknowledging the work done by private landowners in the field of biodiversity and nature conservation while maintaining socio-economic activities.

While its focus is on biodiversity conservation it is not excluding hunting practices on the labelled territory. Such an approach enables, especially in fields and meadows, the collaboration between hunters, farmers and private landowners resulting in successful restoring populations of small wildlife.

Indeed, the appreciation of the importance of biodiversity preservation was the fundamental reason for establishing the WE Label. The Label knows that European habitats are threatened by a variety of factors such as fragmentation, degradation, and destruction. This is due to changes in land-use, intensification and conversion of production systems, abandonment of traditional practices which are often biodiversity-friendly, infrastructure developments, urbanization, and lack of funds to support rural communities. Other key pressures include pollution and the spread of invasive alien species. Climate change may potentially add to the existing stress on the ecosystems that are vital for society. It is absolutely essential to halt biodiversity loss in order to restore the ability of ecosystems to adapt to climate change. In the face of these challenges, the Wildlife Estate Label succeeded in creating and improving habitats in favour of biodiversity, as well as in restoring natural conditions where wildlife can thrive. They were only able to achieve that due to enormous collaboration from Europe's farmers, foresters, hunters, and anglers, who all are indirect producers of wild flora and fauna. They are the key stakeholders in achieving sustainable rural development.

The concept of "conservation through wise use" embraces not only sustainable exploitation of wildlife via rural activities, but also the spiritual value of wildlife to society as a whole. This concept recognizes the role of active and positive management. It is based on the ability to deploy a package of legitimate measures designed to manage wildlife. These activities are either targeted at enhancement of the survival and productivity of certain species so as to expand their population, or to manage their abundance in order to reduce their impact on other species or ecosystem services.

Rural estates are crucial in supporting rural economies, which in turn play a significant role in overcoming the world's food, energy, and environmental challenges. Therefore, even if financial support to the rural sector is retreating, complementary private initiatives and private financing instruments of rural development are called for in order to enhance sustainable rural development.

As environmental degradation accelerates, the role of private land managers becomes increasingly important in preserving nature and landscapes through good management practices. This is why the WE Label has sought to facilitate collaboration between private and public actors. It has done so, in order to illustrate that the work undertaken by landowners who received the label is very much in line with the fundamental philosophy of bio- diversity conservation.

The Wildlife Estates (WE) Label was established in 2005, when key actors from national authorities and private organisations active in nature conservation and land management took the opportunity to develop a philosophy entwining the concepts of wildlife management and sustainable land use. Since then, the project has expanded progressively to promote biodiversity conservation in the face of emerging political, economic and social concerns at both the EU and local levels.

The network of labelled estates started with Spain, Belgium, France (Territoire de faune sauvage), Portugal and the Netherlands, and has been continuously growing ever since. Currently, Western countries such as Spain, Portugal, Sweden, France, Belgium and the region of Scotland have the most representatives. As the project grew, the establishment of National Delegations became necessary, which in turn resulted in even further increased recognition and publicity of the initiative in each participating country. Growth of the initiative was paralleled with the development of evaluation grids for each biogeographic region (Mediterranean, Boreal, Alpine and Continental).

Today, the WE Label is represented in 19 countries with more than 360 labelled estates covering over 1.700.000 hectares in various biogeographic regions. The sizes of labelled estates range from small holdings of a few tens of hectares to large, sometimes well-known estates covering tens of thousands of hectares. Nevertheless, they are all fundamentally united in their goals to preserve and enhance their natural, cultural and social environment.

www.wildlife-estates.eu

European policy instruments

In order to support the EU biodiversity, the European Commission has developed a number of (financial) instruments to support initiatives aiming to save biodiversity.

LIFE and Natura 2000

The activities of the Directorate-General for Environment (DG ENV) are financed mainly through the LIFE programme, the European Union's programme supporting environment, biodiversity and nature throughout the Union.[12]

The LIFE multiannual work programme for 2018-2020 details the current funding priorities. It clarifies budgets by specifying what kind of projects can receive support within the sub-programmes for environment and climate action. In total, €1 243.81 million are earmarked for work on nature conservation and environmental protection, and a further €413.25 million for climate action.

The current LIFE programme has four objectives:

1. Help move towards resource-efficient, low carbon and climate resilient economy, improve the quality of the environment and halt and reverse biodiversity loss.
2. Improve the development, implementation and enforcement of EU environmental and climate policy and legislation, and act as a catalyst for, and promote, the mainstreaming of environmental and climate objectives into other policies and practices.
3. Support better environmental and climate governance at all levels, including better involvement of civil society, NGOs and local actors.
4. Support the implementation of the 7th environmental action plan.[13]

In Germany farmland accounts for 34% of total Natura 2000 land area. While agricultural land has been declining, the percentage of forests inside Natura 2000 sites has increased from 1990–2012. Because extensive livestock management and other low-intensity farming practices required by Natura 2000 have become unprofitable, key farmland habitats and species of community interest are under pressure. Rental prices of grassland and arable land, are affected negatively by Natura 2000 (Koemle, Lakner, & Yu, 2019).

Agricultural landscapes comprise 28,6% of the Natura 2000 surface, with the lowest values being recorded in Nordic countries (under 5%), and the highest in Mediterranean countries or in those regions containing a high percentage of plains and low hills (Hungary, Romania, Denmark, and Poland) (Table 2) (Ioja, Rozylowicz, Patroescu, Niţă, & Onose, 2011). EEA (2004) estimates that between 5% and 65% of Important Birds Areas are threatened by the abandonment of agricultural fields, principally by the transformation of pastures and grasslands into shrubs and forests.

	Area N2000 terrestirial (HA)	agricultu re	% agri	forestry	grass	% grass	heat hs	wetl ands	coast	rocks	PAF for restauration and measures for species and habitats (2021-2027) annual costs	annual cost/ha	one-off costs	one-off cost/ha	
Estonia	806.900		0		15.000	2	900	###	500		14.480.000	18	19.380.343	24	
Sweden (for	5.789.800		0	2.200.000	429.100	7			5.000	####	132.068.000	23	41.550.000	7	
Ireland	952.900	105.667	11	83.873	45.679	5		###	#####			0		0	
BE-Wal	220.990		0			0					17.095.565	77	8.741.428	40	
BE-FL	166.187	83.094	50	49.058		0		###				0		0	
Poland	6.115.600	190.000	3		58.000	1					780.000.000	128	220.000.000	36	
Hungary	1.993.900	752.099	38	833.051	203.976	10		###	0		111.194.320	56	27.185.000	14	
Greece	3.602.900	547.641	15	2.709.381		0		###			59.553.000	17	174.200.000	48	14_20
Slovenia	767.560		0			0					31.858.500	42	11.536.000	15	
Denmark	353.628	143.500	41	77.635	51.153	14		###							14_20

Evaluating the effectiveness of conservation funding for two decades showed flagship (Otis tarda, Tetrax tetrax and Falco naumanni) and specialized fallow field species were more favorable (i.e., increased more or declined less) inside the Natura 2000 Protection Area than in a nearby control area. However, the reverse was found for total bird species, farmland, ground-nesting and steppe species, species associated to ploughed fields, and species of European conservation concern (Santana et al., 2014)which during two decades benefited from protection regulations, conservation projects, and agri-environment schemes. Variation between 1995-1997 and 2010-2012 in richness and abundance of flagship (Otis tarda, Tetrax tetrax, and Falco naumanni.

[12] *https://ec.europa.eu/environment/funding/intro_en.htm*
[13] *https://ec.europa.eu/easme/en/section/life/life-legal-basis*

The common agricultural policy (CAP)

A short history

When the Treaty of Rome established the common market in 1958, state intervention was a major feature of agriculture in the six founding Member States. If the principle of the free movement of goods was to apply to agricultural produce, ongoing state intervention notwithstanding, national intervention mechanisms which were incompatible with the common market had to be transferred to Community level: this is the basic rationale behind the establishment of the CAP.

The CAP was established in 1962 by the six founding member states of the Treaty of Rome (Belgium, France, West Germany, Italy, Luxembourg, and the Netherlands). The initial objectives of a self-sufficient European agricultural sector have gradually become obsolete due to Europe's integration in diversified global food markets, a diversification of food sources guarantying a reliable food supply and changing food preferences including substantial amounts of food types not produced in Europe (Boulanger & Messerlin, 2010). Today's CAP's objectives are to increase productivity and efficiency in the farming sector, ensure a fair standard of living for farmers, stabilize markets, ensure the availability of supplies, and ensuring this supply is provided for EU citizens at reasonable prices (Burrell, 2009; European Commission, 2012).

Originally the CAP had to control commodity prices through price support including export subsidies. This approach resulted in mismatches in demand and supply with excess supply of for example milk and butter, resulting in a growing resistance and increasing demands for reform. The CAP was incompatible with the principle of free trade resulting in many disagreements at the level of the World Trade Organisation's General Agreement on Tariffs and Trade (GATT) (Weyerbrock, 1998).

The CAP was revised several times. The most important revisions were:

- The MacSharry reform (1992): integrating the European internal market for food production into the global market, including measures such as the abolishment of tariffs on import, the cutting of price support, and the phasing out of quotas for suppliers. The focus of the CAP shifted to direct payments to compensate farmers for income losses. The MacSharry reform broadened the CAP's scope introducing rural development.

- Agenda 2000 (introduced in 1999) further expanded the focus on rural development.
- The Fishler reform (2003) took effect in 2003 (Ackrill 2000; Burrell 2009; Greer 2013; OECD, 2011) and almost completely ceased product support while installing a decoupled system of direct payments as income support for farmers no longer considering the type and amount of commodity farmed.

The CAP today

Today the CAP is facing new challenges including its contribution to climate change, its impact on reducing biodiversity, and increasing societal sensitivities related to animal welfare. At the same time the demand for agricultural products is increasing due to the growing world population while uncertainties on the impact of climate change on agriculture remain.

At present, the CAP consists of two pillars. Pilar one is dedicated to decoupled direct payments for farmers. Since the last change in the CAP in 2013 30% of direct payments have been dedicated for the so-called "greening" of the CAP. Intention of this budget shift was to pay for the realisation of environmental efforts. Two policies have been implemented: cross compliance rules foreseeing transfer cuts for farmers not complying with good agricultural and environmental practices, and greening payments. In pillar two (rural development) farmers get additional rewards for services benefiting the environment and contributing to climate change mitigation. Pillar two is making use of a contract approach in which farmers are compensated for additional costs they incur when implementing environmental and climate related measures. Pillar two focusses on rural development and, unlike pillar one, is co-financed by the EU member states.

In the past years, a fierce discussion developed on pillar one especially. On one side the pure income support from Europe is questioned: are farmers, compared to other professionals, so needy that direct income support on top of the usual welfare state income support is needed, and if so, is there a need that such an income support must be financed by the EU budget. On the others side the greening in the CAP is questioned. As it became more difficult to legitimize direct payments to farmers from the EU budget, the focus of pillar one shifted more and more to the delivery of public goods. The greening approach incentivizes farmers to produce public goods that market incentives alone would not provide. Within the greening component of pillar one farmers are

eligible for green payments if the fulfil several conditions such as crop diversification, maintenance of permanent grassland, and ecological areas in support of biodiversity. Small farms and organic farmers are considered green by definition. This is questionable as those smaller farms have fewer financial opportunities to invest in ecosystem services next to their main farming activities. But also, the impact of the 30% greening share is questioned by especially nature conservation organisations such as BirdLife Europe and NABU. A meta-analysis conducted by independent researchers (Pe'er *et al.*, 2017), including 450 scientific studies, concluded the greening's conditionality is insufficient to reverse negative trends in biodiversity and climate change. The European Court of Auditors (2017) came to a similar insight: "greening, as currently implemented, is unlikely to significantly enhance the CAP's environmental and climate performance". Their report also concluded that only around 5% of all EU farmland underwent changes because of the greening component of CAP. None of the studies mentioned questioned the short period of time between the start of the greening measures and the evaluation made. More than 50 years of nature conservation efforts within the EU have not led to halting the loss of biodiversity and has not been able to conserve vulnerable species, so a period of 3 years to make an evaluation of greening measures in agriculture can hardly be seen as a sufficient time period for a valid evaluation.

CAP beyond 2020

After the publication of a first communication (European Commission, 2017) the European Commission (EC) published its proposals for CAP beyond 2020 (European Commission, 2018). Proposals made by the EC as a basis for negotiations included: the two-pillar structure of direct payments and rural development remains, a seven-year budget of €365 billion of which €265 billion is reserved for direct payments to farmers, a five percent cut in current prices (12 percent in constant prices accounting for inflation). The new European Commission (starting 1st of December 2020) revealed additional elements including its Farm to Fork Strategy.

While the budget allocated to CAP remains by far higher than other urgent challenges such as migration and border security with a 11:1 budgetary ratio, or security and defence with a 14:1 ratio. Even with a relative mild proposed cut in the CAP budget the ongoing discussions at the level of the European Council and the European Parliament remain fierce with some countries fighting for every Euro.

What initially was announced as a revolution became an evolution where comprehensive reforms including the phasing out of direct payments and the introduction of a national co-financing share (European Commission 2017) are off the table. In the end the new CAP model resembles the current one with more flexibility for member states and incentives for higher ambitions on environmental and climate action.

Direct payments and European public goods

In order to improve the delivery of public goods within the new CAP the European Commission has proposed several levers to improve the link between direct payments and European public goods. Basic principles of those instruments relate to instruments, verifiable conditions with adequate pricing and binding budgetary shares. If the delivery of public goods is becoming the main aim of pillar 1 it is important not to discriminate farmers by the size of their lands. Payments for ecosystems should be based on the goods delivered and not on the size of land of an individual farmer.

Eco-schemes

Within the broader toolkit developed by the European Commission the eco-schemes could significantly contribute to the delivery of public goods. Eco-schemes are voluntary instruments defined by the EU Member States. Eco-schemes are instruments compensating farmers for services they provide to society. Only services above the mandatory requirements will be compensated. To realise this, prices should be defined for well-defined public good provision. It will, however, be difficult to determine the value of e.g., biodiversity to society. Another problem related to the payment for public goods is the need for extensive reporting and verification.

It will be the EU Member States taking responsibility of developing eco-schemes. To guaranty an equal treatment of all farmers a binding share of the national direct payment envelope for eco-schemes is a necessity.

Rural Development measures

The common agricultural policy (CAP) supports the vibrancy and economic viability of rural communities through rural development measures (the so-called second pillar).

The rural development measures reinforce the market measures and income supports of the CAP with strategies and funding to strengthen

the EU's agri-food and forestry sectors, environmental sustainability, and the wellbeing of rural areas in general.

The three long-term rural development objectives for the 2014-20 period include: (1) fostering the competitiveness of agriculture; (2) ensuring the sustainable management of natural resources, and climate action; and (3) achieving a balanced territorial development of rural economies and communities including the creation and maintenance of employment.

European agricultural fund for rural development

The European agricultural fund for rural development (EAFRD) is the funding instrument of the CAP that supports rural development strategies and projects. It also forms part of the European structural investment funds (ESIF).

The EAFRD budget for the 2014-20 period amounts to around €100 billion. The budget will be spent over the course of this period, through the implementation of rural development programmes which run until the end of 2023.

It is distributed according to six priorities: (1) fostering knowledge transfer and innovation in agriculture, forestry and rural areas; (2) enhancing the viability and competitiveness of all types of agriculture, and promoting innovative farm technologies and sustainable forest management; (3) promoting food chain organisation, animal welfare and risk management in agriculture;(4) promoting resource efficiency and supporting the shift toward a low-carbon and climate resilient economy in the agriculture, food and forestry sectors; (5) restoring, preserving and enhancing ecosystems related to agriculture and forestry; and (6) promoting social inclusion, poverty reduction and economic development in rural areas.

Each of these priorities shall contribute to the cross-cutting objectives of innovation, environment and climate change mitigation and adaptation.

Rural development programmes

In order to address these priorities, EU countries are implementing rural development programmes (RDPs) tailored to fit their own unique challenges and capabilities. These are funded through the EAFRD.

These programmes can be prepared on a national or regional basis and must work towards at least four of the six priorities of the EAFRD. Countries must set targets according to specific focus areas, identifying the measures they will use and the funding they will need in order to achieve these targets.

Thus, while the European Commission, approves, and monitors RDPs, decisions regarding the selection of projects and the granting of payments are handled at national or regional levels.

Examples of projects funded by the EAFRD and implemented through RDPs include: (1) providing investment funds for a small family pepper growing business in Hungary using exclusively renewable energy; (2) setting up a house location system in Formentera, Spain that has helped emergency services to respond quickly to people in need; and (3) restoring the damaged forests of Nizna Boca, Slovakia, through funding the clearing, afforestation and preservation of young forest stands.

The projects database of the European network for rural development (ENRD) contains a comprehensive list of projects.

At least 30% of funding for each RDP must be dedicated to measures relevant for the environment and climate change, much of which is channelled through grants and annual payments to farmers who switch towards more environmentally friendly practices.

At least 5% of RDP funding must go to actions based on the LEADER method. LEADER is a "bottom up" approach, bringing together farmers, rural businesses, local organisations, public authorities, and individuals from different sectors to form a local action group (LAGs). LAGs prepare their own local development strategies, based on managing their own respective budgets.

Rural development programmes can also support smart villages. This initiative aims at providing a versatile toolbox to foster, enable and help scale up innovation in rural areas around Europe, addressing the common challenges faced by citizens living in rural territories.

Furthermore, through financial instruments, the EAFRD acts as a source for loans, microcredits, guarantees and equities, available to recipients in agriculture, forestry and rural areas who are undertaking financially viable projects that support the priorities of the EAFRD.

European network for rural development

The European network for rural development (ENRD) acts as a hub of information on how rural development policy, programmes, projects, and other initiatives are working in practice and how they can be improved to achieve more. Its aims to engage and reach anyone with an interest in and commitment to rural development in Europe.

The ENRD supports the effective implementation of EU countries' rural development programmes by generating and sharing knowledge, as well as through facilitating information exchange and cooperation across rural Europe.

These activities are facilitated by two support units: the ENRD contact point and the European evaluation helpdesk for rural development.

European innovation partnership for agriculture

The European innovation partnership for agricultural productivity and sustainability (EIP-Agri) also supports the goals of rural development by encouraging innovation in agriculture and rural communities.

The EIP-Agri was created to bridge the gap between the innovative solutions created by researchers and the uptake of new technologies by those living and working in rural areas. By creating partnerships between those who will eventually use new technology and those that create them, EIP-Agri aims to accelerate the uptake of change.

Source: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development_en#overview

The Commission has established three overarching priorities for rural development policy:

1. Fostering agricultural competitiveness.
2. Ensuring sustainable management of natural resources and climate action.
3. Achieving balanced territorial development of rural economies and communities, including the creation and maintenance of employment.

Those main objectives translate into the following six EU priorities for rural development policy:

1. Fostering knowledge transfer in agriculture, forestry, and rural areas.
2. Enhancing the competitiveness of all types of agriculture and enhancing farm viability.
3. Promoting food chain organisation and risk management in agriculture.
4. Restoring, preserving, and enhancing ecosystems dependent on agriculture and forestry.
5. Promoting resource efficiency and supporting the shift toward a low-carbon and climate-resilient economy in the agriculture, food, and forestry sectors.
6. Promoting social inclusion, poverty reduction and economic development in rural areas.

Rural development policy is implemented through rural development programmes designed by Member States (or Member State regions). These multiannual programmes apply a personalised strategy that meets the specific needs of Member States (or regions) and relates to at least four of the six abovementioned priorities. (Schmidt et al., 2004).

The programmes are based on a combination of measures selected from a 'menu' of European measures detailed in the Rural Development Regulation (Reg-

ulation (EU) No 1305/2013) and co-financed by the EAFRD. The co-financing rates vary according to the region and measure concerned. [14]

For this study we extract priorities: 4 (Restoring, preserving and enhancing ecosystems dependent on agriculture and forestry) and 5 (Promoting resource efficiency and supporting the shift toward a low-carbon and climate-resilient economy in the agriculture, food and forestry sectors); and measures: 8. Forest, 10. Agro-environment Climate, 11. Organic farming, 12. Natura 2000 and Water framework and 13. Areas with specific constraints[15].

08. Investments in the development of forest areas and improving forest viability (Art. 21-26)

1. Afforestation and creation of woodland:

   Support shall be granted to public (only if the managing body is a private body or a municipality) and private landholders of agricultural or non-agricultural land, and shall cover the costs of establishment and an annual premium per hectare to cover the costs of agricultural income foregone and maintenance, including early and late cleanings, for a maximum period of **twelve years**. Species planted shall be adapted to the environment and climate of the area (if necessary other woody perennials such as shrubs or bushes are allowed) and comply with minimum environmental requirements. No support shall be granted for short rotation coppicing, Christmas trees or fast-growing trees for energy production.

2. Establishment of agroforestry systems:

   Support shall be granted to private landholders and municipalities to cover costs of establishment and an annual premium per hectare for maintenance for a maximum period of **five years**.

3. Prevention and restoration of damage to forests from forest fires, natural disasters and catastrophic events, including pest and disease outbreaks, and climate related threats:

   Support shall be granted to private and public forest-holders and other private public bodies and cover costs for (a) the establishment of protective infrastructure, (b) local, small scale prevention activities against fire or other natural hazards, including use of grazing animals, (c) establishing and improving forest fire, pest and disease monitoring facilities and communication equipment, (d) restoring forest potential damage from fires and other natural disasters including pests, diseases and catastrophic events and climate change related events. No support shall be granted for loss of income resulting from the natural disaster.

4. Investments improving the resilience and environmental value as well as the mitigation potential of forest ecosystems:

   Support shall be granted to natural persons, private and public forest-holders for the achievement of commitments for environmental aims, for the provision of ecosystem services and/or for the enhancement of the public amenity value of forest and wooded land in the area concerned or the improvement of the climate change mitigation potential of ecosystems, without excluding economic benefits in the long term.

10. Agri-environment-climate (Art. 28)

Support is available in accordance with Member states' national, regional, or local specific needs and priorities. This measure aims to preserve and promote the necessary changes to agricultural practices that make a positive contribution to the environment and climate, going beyond the mandatory standards. The payment shall be granted to farmers and other land-managers who voluntarily carry out operations consisting of one or more agri-environment climate commitments on agricultural land. Commitments shall be undertaken for a period of five to seven years and shall compensate for all or part of the additional costs and income foregone, it may be granted at a flat-rate or as a one-off payment.

No support under this measure may be granted for commitments that are covered under the organic farming measure.

11. Organic farming (Art. 29)

Support can be granted per hectare of agricultural area to farmers who voluntary convert or maintain organic farming practices and methods beyond the relevant mandatory standards. Commitments shall be made for five to seven years. Payments shall compensate for additional costs and income forgone.

12. Natura 2000 and Water Framework Directive payments (Art. 30)

Support can be granted annually per hectare of agricultural area or forest in order to compensate beneficiaries (farmers and private forest holders or other land managers, be it individuals or groups) for additional costs and income foregone related to the implementation of mentioned directives.

[14] *https://www.europarl.europa.eu/factsheets/en/sheet/110/second-pillar-of-the-cap-rural-development-policy*
[15] *https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R1305*

13. Payments to areas facing natural or other specific constraints & Designation of areas facing natural and other specific constraints (Art. 32-33)

Payments to farmers in mountain areas and other areas facing natural or other specific constraints shall be granted annually per hectare of agricultural area in order to compensate farmers for additional costs and income foregone to the constraints for agricultural production in the area concerned.

Payments shall be granted to active farmers in mountain or other specific affected areas characterised by a considerable limitation of the possibilities for using the land and by an appreciable increase in production costs due to (a) difficult climate conditions due to altitude, (b) at a lower altitude the presence of too deep slopes for use of machinery or requiring expensive machinery.

We notice that almost every country or state spends most of their rural development funds on Priority 4. Hence, we would expect high amounts of agricultural land put under some kind of management contract for environmental purposes.

A vital role for nature

The CAP has considerable influence on how land in the EU Member States is managed – perhaps to be expected considering the money involved - more than €50bn every year, entirely paid for by the public through their taxes.

To encourage the implementation of voluntary actions in favour of the environment in agricultural areas, the CAP has launched the programme of Agri-Environmental Measures (AEM) based on multiannual contracts. These allow for the implementation of developments on the edges and within the crops that increase the carrying capacity of the Plains, e.g., the capacity of a territory (and its habitats) to accommodate a certain density of individuals for each species. A considerable amount of the budget of agri-environment schemes is used to protect small wildlife in fields and meadows.

There have been some successes with schemes targeted at specific species. However, despite these efforts many farmland bird species such as the skylark, corn bunting, grey partridge and turtle dove continue to decline.

Tools for private land conservation

The Life+ project "Land Is For Ever" prepared policy recommendations towards the European Commission concerning a set of tools to be used to promote private land conservation. A large majority of those tools are very useful to protect small wildlife of fields and meadows and could generate collaboration between the countryside's main stakeholders: farmers, private landowners, and hunters.

The following core issues should be taken care of when further developing those private land conservation tools:

- The set of tools offered should respect the variety of private landowners.
- Application and monitoring requirements should be equal and feasible for individual owners and NGO's.
- Tools should respect the economic value of the land.
- Tools and their compensation mechanisms should be organized in a framework which the landowner can trust on the long term.
- Two-way knowledge exchange in agreeing on a contract is critical to encourage trust and cooperation.
- Tools should offer a flexibility in case of threats undermining the values of the land e.g. climate extremity or diseases or aspects that are not under the control of the landowner.
- Support in insurance and liability of the private owner when opening the land for public is required.

Conservation easement

A voluntary but legally binding agreement between a landowner and an organisation (NGO or Government agency). The landowner (temporary) relinquishes certain rights over the land to protect the natural landscape while maintaining the ownership and the use of the land in ways that do not conflict with the terms of the easement. The landowner retains the rights to use the land, produce on the land, sell it, and pass it on to their heirs. By donating conservation rights, the owner can allow land to be retained in the family while securing priority areas for conservation. Easement contracts are binding for present and future owners of the land, permanently or for the term agreed on in the contract. The easement contract also describes the compensation for the landowner if a significant economic loss is expected. E.g., Agreement on maintaining a certain habitat type, with or without specifying the management activities; Agreement on not developing the land.

Land Stewardship

The landowner keeps the management of the land but commits to a set of conservation-oriented actions with a recognized NGO or governmental agency. Both parties agree and commit, on equal level, to the terms and conditions of the agreement. The agreement can be either set in a form regulated by law (e.g., lease) or in a document only regulated by the autonomy of will. Doing so, anywhere in Europe, even the smallest non-profit organisation can write an agreement when a landowner is willing to sign. Agreements are flexible to fit the land and management situation. The stewardship organization must recognize the economic value and activities of the land or (support to) provide a financial compensation. A legally binding agreement is advised when the agreement involves costs and efforts for the parties and interests worth to be protected, e.g., a lesser profit for the landowner due to certain restrictions. Not having a formal legal framework for land stewardship makes it difficult to enforce stewardship agreements in case of disagreement. However, this is a flexible strategy that offers different tools which can be adapted easily to respond to local and economical contexts. E.g., Support to reach habitat requirements, financial support or grant guidance, monitoring support, corridor creation, nest area protection.

Private reserves designation

Private reserves are defined as land under private ownership that has been set aside for the protection of nature and its components through legal or other effective means for personal or public benefits e.g., natural water filter, game management,... The landowner voluntary submits (part of) the land as a private reserve and agrees on a long-term commitment to manage the land in a way to maintain the nature values and benefits under this legal or administrative framework. This tool has a significant potential to promote conservation on private land when landowners' benefits are directly linked to conservation or maintenance of wildlife habitats. Ex. Private wild-

life reserves for the protection of biodiversity as well as private game reserves or ranches, where game or trophy hunting, wildlife viewing, eco-tourism etc, within predefined sustainable limits, can generate extra income. Government entities must be able to guarantee the long-term recognition and support and allow flexibility to the land manager if needed due to external factors. They may implement monitoring actions to ensure the protection of environmental values and long-term commitment for conservation. On the other hand, it is important to maintain a certain independency of the land manager to reduce influence and preserve objectivity from NGO's and governmental agencies. The significant advantage of private reserves is the potential speed of response to conservation challenges, compared to governmental agencies or bigger NGO's, if the manager has sufficient management freedom.

Conservation contracts

The landowner enters a voluntary contract (for a limited period) with an organization or governmental agency to ensure that the property is used or managed for conservation purposes. This contract has a clear end and clearly state no further consequences for the landowner after this date. The owner is permitted to make changes to the property and the management plan by submitting an amendment to the contract if needed to cover for internal or external threats. E.g., Agri-Environmental schemes (CAP), Forest certification contracts.

Safe Harbor Agreement

Landowners receive a formal 'no penalty' assurance from the government in exchange for fulfilling the specific conditions of a biodiversity value agreement that contributes to the recovery of endangered species. Landowners voluntarily propose the implementation of restorative and habitat management measures to conserve/protect a threatened species. In return the owner is provided with a guarantee ensuring no additional conservation measures will be imposed if the number of listed species is increasing because of the actions. This agreement can also protect the landowner against a penalty when the goal could not be reached despite the implementation of the agreed management strategy. Under safe harbor agreements, participants are guaranteed a reduction in liability and are ensured that they will be exempt from any future regulations not included in

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their agreement. E.g., today landowners often prevent natural succession to avoid colonization by protected species because of fear for restrictions. The conservation law is creating here the perverse effect. E.g., temporary nature (NL).

Strategic partnerships between companies and private landowners / Biodiversity mitigation and offset

Conservation actions by private landowners to compensate for biodiversity losses elsewhere (Polluter-pays principle). This would involve private landowners in a created market for the trade of biodiversity. Polluter-pays principle has been implemented by several Community legislations and various additional laws in EU Member States, but currently only focuses on conservation organizations. In general, under liability regimes, organisations must pay when they cause environmental damage. In this example of a financial scheme, the impacting entity might be able to purchase offset credits from a mitigation bank operated by a third party that has already carried out advance mitigation by eg. private land managers. These land managers are then financially compensated by the impacting entity, through the mitigation bank. E.g. actions to restore, enhance, create, or protect biodiversity values prior to any negative impacts from development.

Land Exchange for conservation

The landowner agrees to an exchange of land that is ecologically valuable for one that is less ecologically valuable but may retain other values (economic). Both parties agree the exchange. The deal is decided between a landowner and a conservation or governmental organization.

Funding land acquisition for conservation purposes

Financial support for land purchase for conservation purpose (in perpetuity). Both individual landowners and conservation organizations are subject to equal requirements to guarantee their experience and knowledge in managing highly valuable nature. E.g. Flanders Nature Conservation Legislation.

Incentives and compensation mechanisms for private landowner

Each tool should offer the possibility to cover for potential financial or land value loss by financial support or economic opportunities. Financial compensation mechanisms.

- Direct payments from government (based on result/based on implemented measures, cost compensation/economic loss compensation.
- Direct payment from NGO (grant, funds).
- Tax benefits (income tax, property tax, inheritance tax).
- Label or certification for market access.

Case studies

Elmley (UK) – agri-environmental schemes

Elmley is a 3,300-acre estate based on an island in the Thames, situated away from the bustle of North Kent, just an hour from London.

Elmley is an internationally important fresh water grazing marsh wetland renowned for significant populations of over-wintering and breeding birds, and also hare, waterholes, rare invertebrates and flora. Elmley's vast amount of freshwater habitat alongside the equally vast expanses of salt marsh and mudflats of the Swale (a channel of the sea separating Sheppey from the mainland) make the area a gigantic feeding table for waders and wildfowl throughout the year. Peak number of waders and wildfowl come between January to March, especially when there is a cold spell in NW Europe. The grazing marsh is also interspersed with wide fleets, reed beds, rough grassland strips, hay meadows and 9 km of sea walls – all of which provide habitats for a variety of terrestrial and aquatic species.

The conservation efforts across the Reserve are focused on breeding waders and particularly Lapwing (*Vanellus Vanellus*) and Redshank (*Tringa Totanus*). To ensure the grazing marsh is as good as it possibly can be for their fledging success, the estate undertakes intensive management throughout the year focusing on livestock grazing, water control, micro-topography (digging out rills and scrapes to create gentle undulations in which water can collect), grass management and predator management. With a small team and some great volunteers, a huge amount is achieved.

At Elmley conservation and farming go hand in hand. The cattle do the heavy lifting of maintaining the sward (grasses) at the right height and density over the year with excellent results for breeding waders and fantastic beef extensively reared in a sustainable way. To do this on such a large site the estate needs a lot of livestock and so they partner with several local farmers to run a combined herd of up to 900 native and continental breed cows and 1000 Romney sheep.

Elmley is a seasonally drying wetland and only receives water from rainfall. To make the most of this water the estate has a network of ditches and rills connected by pipe controls which enables them to hold onto water and manage levels to within centimetres across 9 square kilometres! In dry years they supplement the water levels by abstracting water from nearby ditches and reservoirs to provide high winter levels favoured by vast flocks of wildfowl without flooding the marsh and harming the invertebrates upon which many species depend. As levels recede each spring muddy edges along the rills provide invertebrate rich and easily accessible feeding areas for waders and their chicks each Spring. To provide accurate measures of this work and to ensure the wildlife is doing well the estate has a team of voluntary surveyors who spend numerous hours counting wetland birds throughout the year and wader chicks each Spring. Their results are published monthly in a newsletter/blog.

In addition to grazing the estate tops (or cuts) the grasses, sedges and rushes in mid-late summer (which takes around six weeks!) to promote regrowth which intern attracts returning winter migrant birds to the marshes. Around this time, the estate also creates and improves areas across the marsh, digging new scrapes and rills, desilting ditches and repairs infrastructure.

All conservation work is funded by EU and UK Government agri-environment schemes and follows best practice and Natural England guidelines. The estate is actively involved in developing new techniques and ideas for conservation minded land management and contribute to conservation policy and rural affairs regularly.

Source: https://www.elmleynaturereserve.co.uk

Weeberg Estate Leefdaal (Belgium) - Private Land Stewewardship

The estate is located on the plateau of Duisburg, and forms a beautiful agricultural area with large isolated forest massifs, solitary trees and typical vegetation along hollow roads and embankments. For centuries, Leefdaal has been the home of the de Liedekerke family, which guarantees the preservation of a solid rural tradition in this region, south of Leuven, between Bertem and Neerijse.

This estate obtained the Wildlife Estate Label in 2018 and became the winner of the prestigious Baillet-Latour Prize for the Environment in 2019.

The aim of the Wildlife Estate label is to confirm and further promote good management of biodiversity, which has often been applied in discretion by private

actors for generations, as being of great social importance. In this way, other parties (governments, local actors, etc.) can (re) discover the reality and practice of caring stewardship as a contribution to nature conservation.

The estate owns several hundred hectares, of which just under half are forests and the other half consists of agricultural land. The forests (mainly deciduous trees such as beech and combined beech and oak forests) are managed on the basis of a traditional forest management plan. The estate applies innovative agricultural techniques that benefit biodiversity as much as possible, such as direct sowing, non-inversion tillage, mechanical weed control, no-till (only the strip is worked where sowing is done) and agroforestry. In addition to arable farming (fields), more than 20 ha of meadows are managed in function of biodiversity.

The estate does not have important water features except 2 large pools, which are important for the protected Common midwife toad.

For 10 years now, the domain has been committed to agricultural management that benefits biodiversity. Assisted by agricultural company Agriland, which is active all over Flanders, and the Flemish Land Agency (VLM), the domain makes maximum use of rural development funds (agri-environment-climate measures) including 6.3 ha of grassland fauna management, 1.5 ha of food crops for field birds and 1.3 ha of hedges. The VLM works with different management packages that sometimes vary from year to year. The domain tries to optimize the packages offered for field birds, small landscape elements, water quality (crops with a low risk profile of contamination by nitrates), erosion control and field edge management.

To implement agri-environment-climate measures the manager receives an appropriate annual compensation. For example, the fees for the construction and maintenance of mixed strips of grass targeting field birds (in species protection areas) or the maintenance of food crops are around 2,000 € / ha in Flanders (Belgium).

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Over the years, more than 5 km of hedges, hedges and wood edges have been laid with the assistance of "Regional Landscape Dijleland (RLD)", a nature conservation organisation. The wood edges are planted with different types of native scrub.

The wood edges and the grass strips also influence erosion. These plantings keep the soil together better, so run-off material from higher parcels is collected or slowed down. The planting also ensures that the water penetrates better into the ground and does not run off too quickly during heavy rain. They are therefore strategically laid out on sloping plots. The grass strips protect the forest edges or edges of the agricultural activity. On the one hand, one cannot get too far when ploughing, on the other hand, the forest or hedge is not adversely affected by spraying work that is carried out.

The domain likes to work with mixed grass strips and duo or trio edge management with winter stubble, grain edges or fauna edges, good for wildlife and field birds.

The financial conditions linked to the agri-environment-climate measures vary depending on the type of management agreement that is chosen (under supervision of VLM consultants). E.g., the management agreements for field birds or for field borders do not allow the use of fertilizers or soil improvers on the strips. However, the agri-environment-climate measure for erosion control does not have this restriction. It is therefore important to find the most suitable formula for what you want to achieve and to do it in the right place.

Source: https://landelijk.vlaanderen/wpcontent/uploads/2018/06/LE_78_2018_01_v5.pdf

Soil conservation agriculture, a 3rd route between conventional agriculture and organic farming (France)

This technique was imported in France more than 20 years ago. After a slow start, the technique has recently observed a rapid increase due to the fact that this regenerative agriculture meets economic and environmental challenges linked to present day agriculture. Currently nearly 7% of the French useful agricultural area is under this type of management.

This form of agriculture is based on 3 fundamental pillars:

Reduced tillage:
Tillage is costly because the need for heavy equipment and the use of fossil fuel. It impacts the miner-

alization of organic matter and results in the reduction of organic matter. The decrease in the amount of organic matter combined with tillage leads to erosion. To eliminate erosion and reduce the costs related to mechanical processes, farmers gradually replace mechanical work with ecological processes. The final objective is to increase soil life by limiting the destruction of its habitat.

Soil life is composed of macrofauna like earthworms which have a role of bioturbation by ingesting the organic matter bringing it into the soil while bringing up clays which tend to descend in the soil. They create a reserve of soil nutrients. In this soil we also find the mesofauna (fragmenters) like the springtails which have a role of degrading the organic matter on the surface. Microfauna (regulators) such as nematodes have a regulatory role of the microflora. The microflora (soil chemical engineers) such as fungi, bacteria and yeasts have a role in maintaining biogeochemical cycles. Thanks to the concerted action of all these individuals the soil gets a high fertility including a higher water retention and becomes more nutritious. Direct seeding becomes effective once the soil life is dynamic and well developed. To protect the soil it is covered with plants. By limiting interventions and maintaining a permanent cover this type of agriculture is very favourable to the conservation of habitats for small fauna.

Permanent ground cover:
A soil should never be bare! This rule emanates from an observation of nature where the soil is always covered either by living or by dead plants. Without cover, plants will settle quickly to fill the «void». However, this spontaneous flora consists often of pioneer plants which are very often considered weeds for crops.

Permanent ground cover therefore has an important role in weed management. It protects the soil against sun, frost, and heat. This cover is also a food resource for life in the soil.

Those covers are also excellent habitats for small wildlife supplying it with large quantities of insects.

Diversified crop succession:
Crop succession should be as diverse as possible both spatially and temporally. Monocultures should always be avoided as it results in insect pests and crop diseases. Those problems lead to costly interventions for the farmer (chemical or mechanical).

This diversity makes it possible to exploit the advantages of each crop family (e.g. legumes capture nitrogen from the air, crucifers with their taproots perforate the ground in depth ...). Spatial diversity of crops makes the system more complex resulting in a more resilient agricultural system.

Soil conservation agriculture favours the biodiversity of the soil ecosystem.
The 3 pillars mentioned are completely interdependent from each other in order for the system to be efficient and functional. This regenerative agriculture promotes carbon sequestration through permanent ground cover and reduced labour. “It replaces steel with roots, diesel with photosynthesis, urea with diversity and phytosanitary products by diversity” says Frédéric Thomas who if a founding father of this technique in France.

So, with the maintenance of residues on the surface, a soil always covered and undisturbed, and a spatial and temporal diversity of crops, this innovative agriculture promotes biodiversity within agricultural plots:
- By increasing the number of insects (nutrition for bird chicks, pollination).
- By increasing natural soil fertility resulting in a reduced use of phytosanitary products.
- By creating a covered refuge at all times of the year for small wildlife.

Source: http://www.petitgibier.fr

References / bibliography

Aebischer, N.J., and G.R. Potts. 1998. "Spatial Changes in Grey Partridge Distribution in Relation to 25 Years of Changing Agriculture in Sussex."

Aebischer, N, and Julie A. Ewald. 2010. "Grey Partridge Perdix Perdix in the UK: Recovery Status, Set-aside and Shooting." *Ibis* 152(3): 212–13.

Aebischer, N J, R E Green, and a D Evans. 2000. "From Science to Recovery: Four Case Studies of How Research Has Been Translated into Conservation Action in the UK." *Ecology and Conservation of Lowland Farmland Birds*: 43–54.

Alignier, Audrey, Xavier O. Sole-Senan, Irene Robleño, Barbara Baraibar, Lenore Fahrig, David Giralt, Nicolas Gross, Jean-Louis Martin, Jordi Guinjuan, Clélia Sirami, Gavin Siriwardena, Aliette Bosem Baillod, Colette Bertrand, Romain Carrié, Annika Hass, Laura Henckel, Paul Miguet, Isabelle Badenhausser, Jacques Baudry, Peter Batary.. 2020. Configurational crop heterogeneity increases within-field plant diversity. J Appl Ecol. 57:654–663.

Allister Slingenberg *et al.* 2009. "Study on Understanding the Causes of Biodiversity Loss and the Policy Assessment Framework (Financed by the European Commission - Directorate-General for Environment in the Context of the Framework Contract No. DG ENV/G.1/FRA/2006/0073)."

Angulo, Elena, and Rafael Villafuerte. 2004. "Modelling Hunting Strategies for the Conservation of Wild Rabbit Populations." *Biological Conservation* 115(2): 291–301.

Baines, D, P K Warren, and J R Calladine. 2002. "Spatial and Temporal Differences in the Abundance of Black Grouse and Other Moorland Birds in Relation to Reductions in Sheep Grazing." *Aspects of Applied Biology* 67: 245–52.

Baines, David. 1996. "The Implications of Grazing and Predator Management on the Habitats and Breeding Success of Black Grouse Tetrao Tetrix." *The Journal of Applied Ecology* 33(1): 54.

Bech, Nicolas, Jérôme Boissier, Jean-François Allienne, Clause Novoa & Elisabeth Bro. 2017. Existe-t-il une différence génétique entre les perdrix grises d'élevages et les perdrix sauvages des plaines de grande culture? Faune Sauvage 317: 97-101.

Bro E. ; 2016. La Perdrix grise. Biologie, écologie, gestion et conservation. Biotope, Mèze, 304p.

E. (coord). 2007. La faune sauvage en milieux cultivés, Comment gérer le petit gibier et ses habitats, Office National de la Chasse et de la Faune Sauvage, 79p.

Bro, Elisabeth, and Florian Millot. 2013. "Bilan de l'étude PeGASE Sur La Perdrix Grise." *Faune Sauvage* (298): 17–48.

Calvete, Carlos, Elena Angulo, and Rosa Estrada. 2005. "Conservation of European Wild Rabbit Populations When Hunting Is Age and Sex Selective." *Biological Conservation* 121(4): 623–34.

Castañeda, I. *et al.* 2019. "Trophic Patterns and Home-Range Size of Two Generalist Urban Carnivores: A Review." *Journal of Zoology* 307(2): 79–92.

Champagnon, Jocelyn, Michel Gauthier-Clerc, Jean-Dominique Lebreton, Jean-Baptiste Mouronval & Mathhieu Guillemain. 2013. Les canards colverts lâchés pur la chasse interagissent-ils avec les populations suvages? Faune Sauvage 298: 4-9.

Collins K.L., N.D Boatman, A Wilcox, J.M Holland, K Chaney. 2002. Influence of beetle banks on cereal aphid predation in winter wheat , Agriculture, Ecosystems and Environment n°93, p 337–350.

Creel, Scott. 2011. "Toward a Predictive Theory of Risk Effects: Hypotheses for Prey Attributes and Compensatory Mortality." *Ecology* 92(12): 2190–95.

Dainese, Matteo & Poppenborg Martin, Emily & Aizen, Marcelo & Albrecht, Matthias & Bartomeus, Ignasi & Bommarco, Riccardo & Carvalheiro, Luísa & Chaplin-Kramer, Rebecca & Gagic, Vesna & Garibaldi, Lucas & Ghazoul, Jaboury & Grab, Heather & Jonsson, Mattias & Karp, Daniel & Kennedy, Christina & Kleijn, David & Kremen, Claire & Landis, Doug & Letourneau, Deborah & Ramos, Davi. (2019). A global synthesis reveals biodiversity-mediated benefits for crop production. Science Advances. 5. eaax0121. 10.1126/sciadv.aax0121

Delibes-Mateos, Miguel *et al.* 2014. "Does Hunters' Willingness to Pay Match the Best Hunting Options for Biodiversity Conservation? A Choice Expriment Application for Small-Game Hunting in Spain." *Biological Conservation* 177 (September 2014): 36–42.

Dudley, N., Alexander, S. 2017. "Agriculture and Biodiversity: A Review." *Biodiversity* 18: 45–49.

Dunn, Jenny C. *et al.* 2016. "Can Hedgerow Management Mitigate the Impacts of Predation on Songbird Nest Survival?" *Journal of Chemical Information and Modeling* 53(9): 1689–99.

EEA. 2004. 1/2004 Office for Official Publications of the European Communities *High Nature Value Farmland - Characteristics, Trends and Policy Challenges*. http://scholar.google.com/scholar?hl=en&btnG=-Search&q=intitle:High+nature+value+farmland+Characteristics+,+trends+and#0.

———. 2015. "SOER 2015 Briefing: Agriculture."

European Commission. 2017. "The Future of Food and Farming."

———. 2018a. "EU Budget: The Common Agricultural Policy beyond 2020, Fact Sheet."

European Commission, Directorate-General for Agriculture and Rural Development. 2018. "Annual Activity Report 2017." (Ares(2018)2205365).

European Environment Agency. 2016. "Mapping and Assessing the Condition of Europe's Ecosystems: Progress and Challenges and EEA Contribution to the Implementation of the EU Biodiversity Strategy to 2020." : 66.

European Landowners' Organization. 2010. "Agriculture and Biodiversity." : 47.

European Landowners' Organization. 2010. "Le rétablissement de la petite faune des plaines". ELO, Bruxelles, 51pp.

Ewald, J. A., G. R. Potts, and N. J. Aebischer. 2012. "Restoration of a Wild Grey Partridge Shoot: A Major Development in the Sussex Study, UK." *Animal Biodiversity and Conservation* 35(2): 363–69.

Fisher, Ian *et al.* 2018. *International Single Species Action Plan for the Conservation of the European Turtle-Dove Streptopelia Turtur (2018 to 2028)*. https://ec.europa.eu/environment/nature/conservation/wildbirds/hunting/docs/20181002 Final_draft_European Turtle-Dove.pdf.

Eraud C. 2002. Ecologie de l'Alouette des Champs Alauda arvensis en Milieux Cultivés, Caractéristiques Ecologiques de l'Habitat et Perspectives de Conservation,Thése de l'Ecole Pratique des Hautes Etudes, ONCFS, Ministère de l'Education Nationale, de la Recherche et de la Technologie, p168.

Gibbons, David, Christy Morrissey, and Pierre Mineau. 2015. "A Review of the Direct and Indirect Effects of Neonicotinoids and Fipronil on Vertebrate Wildlife." *Environmental Science and Pollution Research* 22(1): 103–18.

Gottschalk, Eckhard, and Werner Beeke. 2014. "Wie Ist Der Drastische Rückgang Des Rebhuhns (Perdix Perdix) Aufzuhalten? Erfahrungen Aus Zehn Jahren Mit Dem Rebhuhnschutzprojekt Im Landkreis Göttingen." *Berichte zum Vogelschutz* 51(Wild 2011): 95–116.

Green, R. E. 1988. "Effects of Environmental Factors on the Timing and Success of Breeding of Common Snipe Gallinago Gallinago (Aves: Scolopacidae)." *The Journal of Applied Ecology* 25(1): 79.

Green, R. E., G. A. Tyler, T. J. Stowe, and A. V. Newton. 1997. "A Simulation Model of the Effect of Mowing of Agricultural Grassland on the Breeding Success of the Corncrake (Crex Crex)." *Journal of Zoology* 243(1): 81–115.

Guitton, Jean-Sébastien, Franck Drouyer, Florian Marquet, and François Omnès. 2017. "Comment réduire l'impact de la fauche mécanique des prairies sur le petit gibier de plaine. ?" Faune sauvage 317, 83-88.

Hendrickx, Frederik, Jean-Pierre Maelfait, Walter Wingerden, Oliver Schweiger, Marjan Speelmans, Isabel Augenstein, Regula Billeter, Debra Bailey, Roman Bukacek, Françoise Burel, Tim Diekötter, Jolanda Dirksen, Felix Herzog, Jaan Liira, Martina Roubalova, Viki Vandomme, R.J.F. Bugter. 2007. How landscape structure, land-use intensity and habitat diversity affect components of total arthropod diversity in agricultural landscapes, Journal of Applied Ecology, n°44, p340–351.

Hoodless, A. N., R. A.H. Draycott, M. N. Ludiman, and P. A. Robertson. 1999. "Effects of Supplementary Feeding on Territoriality, Breeding Success and Survival of Pheasants." *Journal of Applied Ecology* 36(1): 147–56.

Humbert, Jean-Yves. 2010. "Meadow Harvesting Process and Its Impacts on Field Invertebrates."

Ioja, Cristian *et al.* 2011. "Agriculture and Conservation in the Natura 2000 Network: A Sustainable Development Approach of the European Union." *Agricultural and Environmental Informatics, Governance and Management: Emerging Research Applications* (November 2018): 339–58.

Jagdverband. 2015. 15 www.jagdverband.be *Jahresbericht 2015 - Wildtier-Informationssystem Der Länder Deutschlands*.

———. 2018. "Jahresbericht 2018 - Wildtier-Informationssytem Der Länder Deutschlands." www.feuerwehr-aschaffenburg.de.

Joint Research Centre European Soil Data Centre (ESDAC). 2019. "Soil Biodiversity." https://esdac.jrc.ec.europa.eu/themes/soil-biodiversity.

Kauhala, Kaarina, Pekka Helle, and Eero Helle. 2000. "Predator Control and the Density and Reproductive Success of Grouse Populations in Finland." *Ecography* 23(2): 161–68.

Knol, W. 2015. *Verwilderde Huiskatten : Effecten Op de Natuur in Nederland*.

———. 2019. *Vermindering van Predatiedruk Bij Weidevogels*.

Koemle, Dieter, Sebastian Lakner, and Xiaohua Yu. 2019. "The Impact of Natura 2000 Designation on Agricultural Land Rents in Germany." *Land Use Policy* 87(November 2018).

Kotler, B. P., and L. Blaustein. 1995. "Titrating Food and Safety in a Heterogeneous Environment: When Are the Risky and Safe Patches of Equal Value?" *Oikos* 74(2): 251.

Leip *et al*. 2015. "Impacts of European Livestock Production: Nitrogen, Sulphur, Phosphorus and Greenhouse Gas Emissions, Land-Use, Water Eutrophication and Biodiversity." *Environmental Research Letters*.

X. Le Roux, R. Barbault, J. Baudry, F. Burel, I. Doussan, E. Garnier, F. Herzog, S. Lavorel, R. Lifran, J. Roger-Estrade, J.P. Sarthou, M. Trommetter (éditeurs), 2008. Agriculture et biodiversité. Valoriser les synergies. Expertise scientifique collective, synthèse du rapport, INRA (France).

Liberg, Olof. 1984. 65 *Food Habits and Prey Impact by Feral and House-Based Domestic Cats in a Rural Area in Southern Sweden*.

Lima, S. L., and L. M. Dill. 1990. "Behavioral Decisions Made under the Risk of Predation: A Review and Prospectus." *Canadian Journal of Zoology* 68(4): 619–40.

Linsley, Mark David. 1999. "The Effects of Intensive Agriculture on the Breeding Ecology of the Lapwing (Vanellus Vanellus L.)."

Lopez-Antia, Ana, Manuel E. Ortiz-Santaliestra, François Mougeot, and Rafael Mateo. 2013. "Experimental Exposure of Red-Legged Partridges (Alectoris Rufa) to Seeds Coated with Imidacloprid, Thiram and Difenoconazole." *Ecotoxicology* 22(1): 125–38.

Madden, Christine F., Beatriz Arroyo, and Arjun Amar. 2015. "A Review of the Impacts of Corvids on Bird Productivity and Abundance." Ibis 157(1): 1–16.

Massu, Natacha, and Guy Landmann, coord., 2011. Connaissance des impacts du changement climatique sur la biodiversité en France métropolitaine, synthèse de la bibliographie. Mars 2011. eCoFor. 180 p.

Meinig, H., Boye, P. & Hutterer, R. 2009. "Rote Liste Und Gesamtartenliste Der Säugetiere (Mammalia) Deutschlands, Stand Oktober 2008. Band 1: Wirbeltiere. In: Rote Liste Gefährdeter Tiere, Pflanzen Und Pilze Deutschlands." *Bundesamt für Naturschutz (Hrsg.) Naturschutz und Biologische Vielfalt* 70: 115–53.

Moorcroft, D., M. J. Whittingham, R. B. Bradbury, and J. D. Wilson. 2002. "The Selection of Stubble Fields by Wintering Granivorous Birds Reflects Vegetation Cover and Food Abundance." *Journal of Applied Ecology* 39(3): 535–47.

OECD. 2011. "Evaluation of Agricultural Policy Reforms in the European Union. Paris: OECD."

Onrust, Jeroen. 2017. *Earth, Worms and Birds*.

Onrust, Jeroen, Eddy Wymenga, and Theunis Piersma. 2019. "Rode Regenwormen : Sleutelspelers Voor Boerenlandbiodiversiteit." *Levende Natuur* 120(4): 144–48.

Papakosta, Malamati *et al*. 2010. "Dietary Overlap among Seasons and Habitats of Red Fox and Stone Marten in Central Greece." *European Journal of Scientific Research* 45(1): 122–27.

Parish, David M.B., and Nicolas W. Sotherton. 2004. "Game Crops as Summer Habitat for Farmland Songbirds in Scotland." *Agriculture, Ecosystems and Environment* 104(3): 429–38.

———. 2008. "Landscape-Dependent Use of a Seed-Rich Habitat by Farmland Passerines: Relative Importance of Game Cover Crops in a Grassland versus an Arable Region of Scotland." *Bird Study* 55(1): 118–23.

Pe'er, Guy, Sebastian Lakner, Robert Müller, Giole Passoni, Vasileios Bontzorlos, Dagmar Clough, Francisco Moreira, Clémentine Azam, Jurij Berger, Peter Bezak, Aletta Bonn, Bernd Hansjürgens, Lars Hartmann, Janina Kleemann, Angela Lomba, Amanda Sahrbacher, and Yves Zinngrebe. 2017. "Is the CAP Fit for Purpose? An Evidence Based Seite 17 | The EU Budget and Common Agricultural Policy Beyond 2020: Seven More Years of Money for Nothing? Fitness-Check Assessment." *Leipzig: German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig*.

Perovic, David, Sagrario Gámez-Virués, Carmen Börschig, Alexandra Klein, Jochen Krauss, Juliana Steckel, Christoph Rothenwöhrer, Stefan Erasmi, Teja Tscharntke, Catrin Westphal, Catrin. 2015. Configurational landscape heterogeneity shapes functional community composition of grassland butterflies. J. Appl. Ecol. 52, 505–513.

Potts, G. R. 1980. "The Effects of Modern Agriculture, Nest Predation and Game Management on the Population Ecology of Partridges (Perdix Perdix and Alectoris Rufa)." *Advances in Ecological Research* 11(C): 1–79.

Potts, G. R., and N. J. Aebischer. 1995. "Population Dynamics of the Grey Partridge." *Ibis* 137(1): 29–37.

Purger, Jeno J., Szilvia Csuka, and Kornélia Kurucz. 2008. "Predation Survival of Ground Nesting Birds in Grass and Wheat Fields: Experiment with Plasticine Eggs and Artificial Nests." *Polish Journal of Ecology* 56(3): 481–86.

Redpath, S.M., and S.J. Thirgood. 1997. HM Station *Birds of Prey and Red Grouse*.

Redpath, Stephen M., and Simon J. Thirgood. 1999. "Numerical and Functional Responses in Generalist Predators: Hen Harriers and Peregrines on Scottish Grouse Moors." *Journal of Animal Ecology* 68(5): 879–92.

Redpath, Stephen M., Simon J. Thirgood, and Fiona M. Leckie. 2001. "Does Supplementary Feeding Reduce Predation of Red Grouse by Hen Harriers?" *Journal of Applied Ecology* 38(6): 1157–68.

Reimoser, F, and S Reimoser. 2016. "Long-Term Trends of Hunting Bags and Wildlife Populations in Central Europe." *Beiträge zur Jagd&Wildforschung* 41(December 2016): 29–43.

Reitz F. and Mayot P. ; 1997. Etude nationale perdrix grise : premier bilan.Bull. Mens. ONC n°228 : 4-13.

Rocha, Gregorio, and Petra Quillfeldt. 2015. "Effect of Supplementary Food on Age Ratios of European Turtle Doves (Streptopelia Turtur L.)." *Animal Biodiversity and Conservation* 38(1): 11–22.

Roos, Staffan. 2002. "Functional Response, Seasonal Decline and Landscape Differences in Nest Predation Risk." *Oecologia* 133(4): 608–15.

Roos, Staffan, Jennifer Smart, David W. Gibbons, and Jeremy D. Wilson. 2018. "A Review of Predation as a Limiting Factor for Bird Populations in Mesopredator-Rich Landscapes: A Case Study of the UK." *Biological Reviews* 93(4): 1915–37.

Šálek, Martin, Jakub Kreisinger, František Sedláček, and Tomáš Albrecht. 2009. "Corridor vs. Hayfield Matrix Use by Mammalian Predators in an Agricultural Landscape." *Agriculture, Ecosystems and Environment* 134(1–2): 8–13.

Sánchez-Bayo, Francisco & Wyckhuys, Kris A.G. 2019. "Worldwide Decline of Entomofauna: A Review of Its Drivers." *Biological Conservation* 232: 8–27.

Santana, Joana *et al.* 2014. "Mixed Effects of Long-Term Conservation Investment in Natura 2000 Farmland." *Conservation Letters* 7(5): 467–77.

Schmidt, Niels M., Tommy Asferg, and Mads C. Forchhammer. 2004. "Long-Term Patterns in European Brown Hare Population Dynamics in Denmark: Effects of Agriculture, Predation and Climate." *BMC Ecology* 4: 1–7.

Sirami, Clélia, Nicolas Gross, Aliette Bosem Baillod, Colette Bertrand, Romain Carrié, Annika Hass, Laura Henckel, Paul Miguet, Carole Vuillot, Audrey Alignier, Jude Girard, Peter Batary, Yann Clough, Cyrille Violle, David Giralt, Gerard Bota, I. Badenhausser, Gaëtan Lefebvre, Bertrand Gauffre, Lenore Fahrig, Lenore. 2019. Increasing crop heterogeneity enhances multitrophic diversity across agricultural regions, Proceedings of the National Academy of Sciences, INRA.

Smith, Rebecca K., Nancy Vaughan Jennings, and Stephen Harris. 2005. "A Quantitative Analysis of the Abundance and Demography of European Hares Lepus Europaeus in Relation to Habitat Type, Intensity of Agriculture and Climate." *Mammal Review* 35(1): 1–24.

Stoate, Chris, Ian G. Henderson, and David M B Parish. 2004. "Development of an Agri-Environment Scheme Option: Seed-Bearing Crops for Farmland Birds." *Ibis* 146(SUPPL. 2): 203–9.

Tack, J. 2018. "Les populations de sangliers (*Sus scrofa*) en Europe : examen scientifique de l'évolution des populations et des conséquences sur leur gestion. European Landowners' Organization, Bruxelles, 56 pp.

Trout, R. C., and A. M. Tittensor. 1989. "Can Predators Regulate Wild Rabbit Oryctolagus Cuniculus Population Density in England and Wales?" *Mammal Review* 19(4): 153–73.

Tucker, G. M. 1992. "Effects of Agricultural Practices on Field Use by Invertebrate- Feeding Birds in Winter." *Journal of Applied Ecology* 29(3): 779–90.

Tyler, Glen A., Rhys E. Green, and Catherine Casey. 1998. "Survival and Behaviour of Corncrake Crex Crex Chicks during the Mowing of Agricultural Grassland." *Bird Study* 45(1): 35–50.

UN (FAO). 2006. "Livestock's Long Shadow: Environmental Issues and Options." *FAO*.

United Nations. 1992. "Convention on Biological Diversity."

Verhulst, Jort, David Kleijn, and Frank Berendse. 2007. "Direct and Indirect Effects of the Most Widely Implemented Dutch Agri-Environment Schemes on Breeding Waders." *Journal of Applied Ecology* 44(1): 70–80.

Villenave-Chasset ; 2017. Biodiversité fonctionnelle, Protection des cultures et auxiliaires sauvage, La France Agricole, 148p.

Visser, A J *et al.* 2016. "Evaluatie Tijdelijke Regeling Bijdragen Onderwerken Graanresten Onderdeel Onderzoek Naar Alternatieven." www.wageningenUR.nl/ppo.

Walton, Zea, Gustaf Samelius, Morten Odden, and Tomas Willebrand. 2017. "Variation in Home Range Size of Red Foxes Vulpes Vulpes along a Gradient of Productivity and Human Landscape Alteration." *PLoS ONE* 12(4): 1–14. http://dx.doi.org/10.1371/journal.pone.0175291.

Watson, M., N. J. Aebischer, G. R. Potts, and J. A. Ewald. 2007. "The Relative Effects of Raptor Predation and Shooting on Overwinter Mortality of Grey Partridges in the United Kingdom." *Journal of Applied Ecology* 44(5): 972–82.

Watson, M. 2004. "The Effects of Raptor Predation on Grey Partridges _Perdix Perdix_." : 1–236. http://intranet/research/library/Documents/2004/2004WatsonMThesis.pdf.

Weibel, Urs Matthias. 1999. "Effects of Wildflower Strips in an Intensively Used Arable Area on Skylarks (Alauda Arvensis)."

Weterings, Martijn. 2018. *Effects of Predation Risk and Habitat Characteristics on European Hare 2018*.

Wilson, Jeremy D., Mark J. Whittingham, and Richard B. Bradbury. 2005. "The Management of Crop Structure: A General Approach to Reversing the Impacts of Agricultural Intensification on Birds?" *Ibis* 147(3): 453–63.

Woods, Michael, Robbie A. McDonald, and Stephen Harris. 2003. "Predation of Wildlife by Domestic Cats Felis Catus in Great Britain." *Mammal Review* 33(2): 174–88.

ANNEX 1:
Actions – fact sheets

The actions described in this appendix are the result of research developed in France under the aegis of the Association Générale des Producteurs de Blé et autres céréales (AGBP) and Office français de la biodiversité (OFB). They also have been published in the form of fact sheets to be distributed to encourage farmers and private landowners to support and develop biodiversity on their land, in fields and meadows.

The actions described are applicable throughout the European Union. However, they have been developed to support French farmers, landowners and hunters. For this reason, the different actions refer to French legislation and indicate the French contact persons. If you would like more information on the applicability of these actions in other EU Member States, you can always contact the organisations responsible for this publication. You can find their contact details below.

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Action 1: Field borders

A field border is the area of vegetation between a crop and the adjacent environment: path, road, etc.

Source: People and Territories/Agrifauna

Objectives of the measure

The outer edges of fields in good agro-ecological condition, constitute refuge areas for all the small fauna of the plain (insects, birds...) and are essential during the breeding period. These semi-natural elements provide many ecosystem services when managed and protected sustainably[16,17]: 90% of beneficiaries require a semi-natural habitat at some point in their life cycle.

Expected benefits

A functional outer field border allows the development of auxiliary reservoirs favourable to crops[18]. A well-preserved field border is not composed of weeds and therefore does not require mandatory annual maintenance. The risk of soiling the adjacent cultivated plot is greatly reduced[19].

Did you know that
What is a functional border?

It is composed of perennial, diversified and nectariferous species while being free of weeds. It must be at least 1 metre wide. It must be protected from mechanical and chemical disturbances. Thus, a functional and diversified border does not require maintenance during the summer period.

What experts have to say

«On a 120-hectare farm, the average surface area of the field borders is about 2 hectares. These lines are essential to the biodiversity of the cultivated plains. In order to reconcile all the issues, it is important to manage them in an appropriate and sustainable way».

David Granger, in charge of agriculture, wildlife and game damage at the French Biodiversity Office (Office Français de la Biodiversité).

Source: Agrifaune/Homme et Territoire (Agrifaune/Human and Territory)

[16] *Keller S., Häni F., 2000. Ansprüche von Nützlingen und Schädlingen an den Lebensraum. In: Nentwig W (ed) Streifenförmige ökologische Ausgleichsflächen in der Kulturlandschaft: Ackerkrautstreifen, Buntbrache, Feldränder. Verlag Agrarökologie, Bern, pp 199–217.*
[17] *Boller E. F., Häni F., Poehling H. M., 2004. Ecological Infrastructures: Ideabook on Functional Biodiversity at the Farm Level. IOBC-OILB. 212pp*
[18] *Le bris C. et al., 2011. Gestion des bords de champs et biodiversité en plaine céréalière, Faune sauvage n°291, p64-70.*
[19] *Le bris C. et al., 2014. Comment concilier agronomie et biodiversité des bordures de champs en plaine céréalière ? - Bilan des expérimentations Agrifaune Loiret et Eure-et-Loir. Faune Sauvage. n°305, p38-44.*

Methodology

The Agrifaune programme has set up diagnostic tools to determine the functionality of field borders in arable farming areas via:

- the *Ecobordure* tool validated for the southern Paris and Armorican Massif basins (currently being validated for the other regions of France)
- the typology of field borders in cereal plains.

These two tools determine the ecological state of the borders. A management plan is co-constructed with the farmer following this diagnosis to improve the quality of the border.

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Reseeded field borders with an adapted canopy, making it favourable to all wildlife and the auxiliaries of these borders[20].

A border in a state of "average degradation" means that there is the presence of a moderately diverse flora and weeds. It is therefore recommended that this border be managed in such a way as to destroy weeds before they go to seed (about 20 cm), thus limiting weed competition with wild plants. After a few years, the composition stabilises and optimises.

Conversely, a border in "poor condition" means that it is made up of a majority of so-called nitrophilous and pioneer plants (weeds). Field borders that are generally less than one metre wide favour these species. These borders are also not very favourable to biodiversity because their floristic diversity is very low. If the edges are too degraded, replanting with a mixture adapted to the pedoclimatic and cultural conditions of the region is envisaged.

The Agrifaune programme has developed a mix of perennial plants for re-sowing field borders. It is composed of plants from different families: Red Fescue, Common Bluegrass, Yarrow, Yarrow, Centaury, Great Daisy, Perforated St. John's Wort, Plantain, Alfalfa lupulin...

Advice:

In order to maintain a good biological condition of the border, any disturbance of the border must be avoided: soil drift, fertilisation or plant protection products are detrimental to the structure and composition of the border.

Reseeding cost: about 18 € for 100m².
See seed paragraph below.

How do I implement this practice on my farm?

In order to work on the agro-ecological quality of field borders, it is possible to work at the farm level or at the territorial level (commune or community of communes scale). In the second case, it is interesting for the project leader to involve the local authority, the departmental hunting federation, the chamber of agriculture or the departmental hikers' association...

Regulatory limit (orders of 9 April 2018 and 17 April 2020)

This type of field border can be considered effective from as little as 1 metre wide and most often it is between 1 and 2 metres, which is the limit of acceptability for farmers. However, since the decree of 9 April 2018, the minimum width for the eligibility of field borders in EIS is 5m. This French over-transposition is the main obstacle to their implementation.

Ecobordure diagnostic tool and typology of the outer edges of the field

Training for farmers, O.S. or C.A. or F.D.C. volunteer technicians:
Formation typology of the outer edges of the field.
Ecobordure training.

Training contact: Chloé Swiderski, Agroecology researcher at the Association Hommes et Territoires - email: c.swiderski@hommes-et-territoires.asso.fr

Reseeding

A specific 1.50m seed drill has been developed for the resowing of field edges. This seed drill is made available on request by the partners of the Agrifaune programme.

Contact: Bruno Heckenbenner, Biodiversity Officer at the Meuse Departmental Chamber of Agriculture and national representative of the WGNA Machinisme.
bruno.heckenbenner@meuse.chambagri.fr

[20] *Le bris C. et al., 2019. Bordures extérieures de champs, semer pour valoriser les espaces non fonctionnels. Hommes et Territoire. Agrifaune*

Seeds

The Agrifaune field-edge seed mix costs around 18€ per 100m²: highly effective, very favourable to biodiversity as a whole and with a reasonable impact on production.

This mixture has been validated for the southern Parisian basin and the chalky Champagne region. It is in the process of being validated for the other regions of France.

Composition of the Agrifaune mixture:
http://www.agrifaune.fr/fileadmin/user_upload/National/004_eve-agrifaune/Publications_GTNA_BDC/plaquetteBORDUREweb.2019.pdf

To go further:

A local labelled plant cover (https://www.vegetal-local.fr/) will ensure that the plants are adapted to the biogeographical region's auxiliaries. The cost of sowing (Agrifaune Bords de Champ) may vary depending on the type of seed and the date of planting:

Type of seed	Sowing in autumn (25kg/ha)	Sowing in spring (20kg/ha
Normal: 75€/kg	18€ for 100m².	15€ for 100m².
Local: 90€/kg	22,5€ for 100m².	18€ for 100m².

Action 2: The mosaic of cultures

A mosaic of cultures combined with a diversity of developments spread throughout the territory enables biodiversity to be preserved at each period of the year[21]. In line with the specific features of the farm, it may be worth rethinking the distribution and alternation of crops in the area without necessarily losing productive surface area[22].

Objectives of the measure

The mosaic brings a variety of resources (food, cover, nesting sites) to the wildlife on the territory[23]. Alternating crops combined with long and narrow plots are key elements in the preservation of entomofauna and avifauna[24]. Indeed, these factors make it possible to increase the number of interfaces between the different environments[25]. One of the interests of the measure is to limit the disturbances linked to field work. This lever can be combined with the addition of other amenities. (Action aménagement).

What experts have to say

"Diversification of the crop mosaic is an essential element in restoring biodiversity in cultivated agricultural areas. Not only does it make it possible to safeguard many species, but it also ensures the production of ecosystem services for both farmers and society. »

François Omnès, Deputy Director of the Department of Actors and Citizens at the French Biodiversity Office.

Expected benefits

Throughout the year, each crop provides a different type of cover necessary for small wildlife. The edges of winter cereal plots will provide very good cover for ground-nesting birds (e.g., Grey Partridge[26] or Skylark[27]). They are frequented by these species from March (mating period) to harvest (breeding period). Afterwards, industrial spring crops (sugar beet, potatoes, vegetables, etc.) or maize provide shelter for the young broods after the cereal harvest until they are harvested in the autumn. Then it is the turn of the intermediate crops to take over once all the crops have been harvested. Once the green manure has been destroyed, it is the turn of the rapeseed to take over during the winter (January to March).

For flying insects (ladybirds, bees...), the diversity of the environment (crops and facilities) will provide them with a diversified food resource spread throughout the year. For example, in February it is the hazelnut trees that will provide this resource; in March the plum trees, in April the rapeseed and in July/August the sunflowers. A diversity of flowering spread throughout the year favours a great diversity of insect species[28] and pollinators, but also auxiliaries such as ladybirds or hoverflies. The latter require nectar and pollen[29] to lay eggs and regulate pest populations. For entomofauna crawling on the ground (such as ground beetles), the immediate proximity of these different crops is necessary as they cannot move more than 80-90m from the edge[30].

What experts have to say

"Each crop will favour its own procession of insects, so the more diverse the checkerboard, the more diverse the insect populations will be. As with birds, insects move from crop to crop over the seasons, each time to the crop where there is the most food resource".

Véronique Tosser, Biodiversity Officer at Arvalis Institut du Végétale.

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21 *Sirami C. et al., 2019, Increasing crop heterogeneity enhances multitrophic diversity across agricultural regions, Proceedings of the National Academy of Sciences, INRA.*

22 *Hendrickx F. et al., 2007. How landscape structure, land-use intensity and habitat diversity affect components of total arthropod diversity in agricultural landscapes, Journal of Applied Ecology, n°44, p340–351.*

23 *Bro E. et al., 2007. La faune sauvage en milieux cultivés, Comment gérer le petit gibier et ses habitats, Office National de la Chasse et de la Faune Sauvage, 79p.*

24 *Alignier A., Solé-Senan X.O., Robleño I., et al., 2020 Configurational crop heterogeneity increases within-field plant diversity. J Appl Ecol. 57:654–663.*

25 *Bro E., 2016. La Perdrix grise. Biologie, écologie, gestion et conservation. Biotope, Mèze, 304p.*

26 *Reitz F. & Mayot P., 1997. Etude nationale perdrix grise: premier bilan.Bull. Mens. ONC n°228: 4-13.*

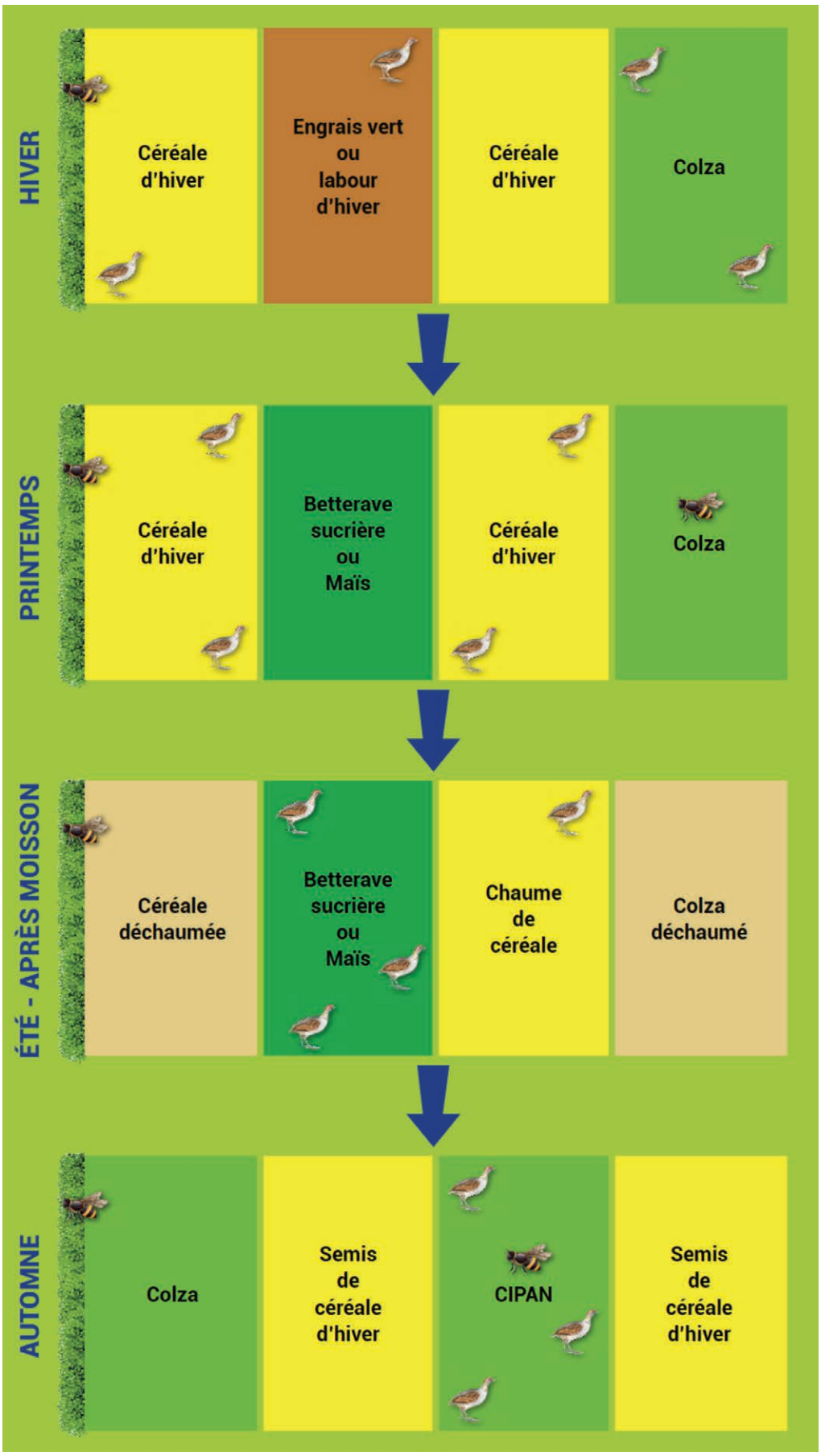
27 *Eraud C., 2002. Ecologie de l'Alouette des Champs Alauda arvensis en Milieux Cultivés, Caractéristiques Ecologiques de l'Habitat et Perspectives de Conservation,Thése de l'Ecole Pratique des Hautes Etudes, ONCFS, Ministère de l'Education Nationale, de la Recherche et de la Technologie, p168.*

28 *Perovic D. et al., 2015. Configurational landscape heterogeneity shapes functional community composition of grassland butterflies. J. Appl. Ecol. 52, 505–513.*

29 *Villenave-Chasset, 2017. Biodiversité fonctionnelle, Protection des cultures et auxiliaires sauvage, La France Agricole, 148p.*

30 *Collins K.L. et al., 2002. Influence of beetle banks on cereal aphid predation in winter wheat , Agriculture, Ecosystems and Environment n°93, p 337–350.*

DIAGRAM with the different alternations



How do I implement this practice on my farm?

Alternate a winter cereal with another crop grown on the farm, avoiding the formation of too large blocks of the same crop.

For a grouped plot, it is recommended to divide up the plots by taking a multiple of the widest tool present on the farm in order to create islands between 150 and 200m wide.

The implementation of crop rotation on large plots is relevant and effective, as is the reduction in plot size.

Did you know?

Feedback from the AGRIFAUNE network - The cultural mosaic in the County area.

The plateaus of the upper Doubs are characterised by large expanses of meadows. This ultra-grassy context is explained by the AOC Comté specifications, which do not want silage maize or immature cereals in the feed for dairy cows. This grass monoculture favours the cyclical swarming of vole populations, which has an economic impact on farms. In order to limit the populations, livestock farmers have resorted to cultivating old, over-infested meadows. They then planted cereal mixtures for two years in a row in order to diversify the environment and disturb the voles. Cereal mixtures are used as a concentrate in the feed of dairy cows. These plots of land also favoured the small fauna present in these sectors. (Agrifaune 25)

Limit

The potential costs are 10% overtime from the time spent on the field ends[31].

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Alternating between different wheats with a future spring crop.

Advice:

This practice is recommended for grouped or single plots.

In the case of scattered parcels of land, we recommend starting a dialogue with neighbouring farmers in order to exchange ideas on how to set up the system on a territorial scale.

When implementing crop rotation, care must be taken to ensure that the return times of the same crop on the plot correspond to the times of crop succession.

To go further:

It is possible to add arrangements between the different cultures. This increases the interfaces between the different environments. (see the layout and plot organisation sheets).

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Complementarity between cultures: on the left is the refuge culture for nesting and on the right is the refuge culture for rearing youngsters.

[31] *Omnès F. et al., 2011, Gestion de territoire, concilier sur l'exploitation agricole production de qualité, environnement, biodiversité et paysage. 4p*

Action 3: Facilities

Action 3A: Ancillary and biodiversity-friendly developments

Biodiversity-friendly developments are essential reference points for crop helpers and small lowland fauna.

There is no such thing as an ideal layout. The important thing is to give priority to a diversity of developments spread throughout the territory. A mosaic of refuges is the most favourable for the conservation of numerous species such as butterflies and birds.

Advice:

"There is no such thing as bad management, the farmer must choose the one best suited to his system and his motivations".

Objectives of the measure

These facilities will make it possible to shelter and feed a diversity of species during transition periods (harvesting, tillage, latency between two flowering periods, etc.). They also constitute a breeding ground for some of them. There are several types of possible arrangements such as herbaceous cover, fallow land for wildlife, honey crops, crops for energy purposes, hedges and bushes or stone piles.

Expected benefits

The positive effects of the developments are multiplied when they are spread over the entire plot. They can be diverse:
Contribute to the beauty of the landscape.
Create a multitude of landmarks, refuges and food resources for all biodiversity[32]: birds, insects, reptiles, small mammals, etc.
To increase the natural regulating potential of pests[33].
Limit transfers of active ingredients.

What experts say

"90% of beneficials need at some point in their biological cycle an uncultivated environment: field borders, bushes, hedges, flowering strips, etc... Against 1 out of 2 pests".
Jean Pierre Sarthou, Agro Toulouse INP, INRAE AGIR.

Methodology: types of facilities

For operational implementation, there are two types of development: the strip and the island.

Type of layout	Band	Island or plot
Advantages	Increase of the reception capacity of the territory by the border effect. Easy to set up via GPS.	Create areas with more peace of mind. Increase the functionality of fixed or heterogeneous elements already present on the plot.
Disadvantages	Possible frequentation by local residents, due to confusion with paths.	Problem of access for the farmer when crops are high.
Tips	Leave the width of a sprayer pass between the edge of the field and the strip. Laying out the facilities on a slope break will stop erosion.	Install the installations in the corners of the plots, around electric pylons or any fixed element of the plot.

[32] *Sirami C. et al., 2019. Increasing crop heterogeneity enhances multitrophic diversity across agricultural regions, Proceedings of the National Academy of Sciences, INRA.*
[33] *Boller E.F., Häni F., Poehling H. M., 2004. Ecological Infrastructures: Ideabook on Functional Biodiversity at the Farm Level. IOBC-OILB. 212pp.*

How do I implement this practice on my farm?

The location of the future development should be considered in relation to the width of the widest tool present on the farm (e.g., the width of the sprayer). The optimum width is the width that will facilitate the farmer's work. The aim is to obtain a number of sprayer roundabouts so that there is no additional headland to be made.

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Strip or island: to be defined according to the context of the operation and your expectations.

To limit the transfer of diffuse pollutants and the phenomena of soil erosion or the creation of gullies, it may be possible to locate specific developments in these areas:

- On transfer and waterways,
- At the foot of slopes with a gradient of more than 5%,
- In corners of fields sensitive to erosion,
- At right angles to the run-off axis,
- In sensitive areas to protect houses or roads.

Did you know?

For crawling insects, it is estimated that the maximum distance they can travel from a curb or fixed element is approximately 75m to 80m[34].

For anti-erosion management, grasses have been determined to be the most effective (so-called strong plants): Meadow Fescue (*Festuca pratensis* Huds.), Orchard Grass (*Dactylis glomerata* L.) or Miscanthus (*Miscanthus (x) giganteus*) provided it is not harvested. However, it is possible to associate them with flowering plants (low retention capacity) such as Yarrow (*Achillea ptarmica* L.) without altering the retention capacity. In fact, in order to stop a 20cm swath of water, a minimum of 30cm of above-ground biomass must be maintained. High maintenance (30cm from the ground) is necessary. For a perfect efficiency, it is not recommended to drive with material. (Source: AREA-asso.fr)

Advice:

In order to identify the appropriate locations and types of development, a farm-wide diagnosis can be carried out:

- Determine the areas of the plot that are the least productive and the least efficient to cultivate: veins of pebbles, strong soil, false plot corners, etc.
- To identify the talweg axes to stem erosion and runoff phenomena.
- To locate areas with high ecological stakes, such as wetlands.

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Layout in a corner of the plot: right of way but gain in productivity.

[34] *Collins K.L. et al., 2002. Influence of beetle banks on cereal aphid predation in winter wheat , Agriculture, Ecosystems and Environment n°93, p 337–350.*

Methodology: the different possible compositions

There are different types of cover for the facilities: herbaceous cover, shrub cover or biomass cover. For more information, click on the photo of the type of cover you are interested in.

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Herbaceous cover, hedge or biomass production strip.

Regulatory limit:

New developments should not be "put under a bell". There must be flexibility in the location and relocation of infrastructure. Indeed, with the evolution of equipment, an adaptation can become a handicap for the farmer's work. He will then have to be able to move it a few metres to limit the inconvenience caused, while making sure to respect the current regulations in force on the subject.

Concerning hedges, it is strongly advised to ensure the maintenance and conservation of old hedges with high ecological and landscape value, such as thick multi-layer hedges with a diversified composition, hedges composed of remarkable species (elm, linden etc) or hedges on slopes.

For more information:
https://www.telepac.agriculture.gouv.fr/telepac/pdf/conditionnalite/2017/technique/Conditionnalite-2017_fiche-technique_BCAE7_particularites-topographiques.pdf

Advice:

When planting on the edge of a property, it is advisable to check the boundaries and not to plant on the neighbouring property. In this way, possible future inconvenience can be avoided.

To go further

These facilities also have a role in limiting diffuse pollution towards the aquatic environment.

For further information:
http://www.genieecologique.fr/reference-biblio/guide-daide-limplantation-des-zones-tampons-pour-lattenuation-des-transferts-de

Action 3B: Herbaceous and floristic cover

Also known as "beetle banks", grassed strips are veritable reservoirs for beetles and pollinators[35]. It is possible to maximise their presence by choosing a composition of herbaceous and floristic cover adapted to the pedo-climatic and economic context of each farm. However, the composition must be diversified and based mainly on dicotyledonous plants of various families[36]. ***This mix of flowering plants is interesting because it will allow a spread out flowering as long as possible***[37]. During the breeding period (May-June), the herbaceous cover provides a great diversity of insects which are fundamental for the success of the broods[38,39].

Did you know?

Grasses protect crawling insects from the carabean-type soil thanks to their hold on the ground (upright tuft form). Legumes favour diptera such as hoverflies and hymenoptera (wild and domestic bees). Apiaceae (e.g. carvis) or asteraceae (e.g. common dandelion) favour a diverse family of insects such as parasitoid micro-wasps (predator of many pests: flea beetles, aphids, etc.)[40].

What experts say:

"In the auxiliaries, it is mainly the larvae that consume or parasitize the pests. The adults need pollen and nectar to lay their eggs. Flowers are therefore essential to promote the natural regulation of pests".

		Perennial mix	Annual/biennial mix
Sustainability		5-7 years minimum to more.	1 to 3 years.
Advantages	Economic	Only 1 sowing to be carried out for several years. No particular intervention except in the case of brushwood. (once every 2 to 5 years)	Inexpensive and readily available seed.
	Biodiversity	A lasting marker over time Lodging and roofed at every period of the year. Production of nectar and spread pollen.	Locates quickly installed. Shelter and cover quickly in function. Nectar and pollen production in summer and seed supply in winter.
Disadvantages	Economic	Expensive seed that can be difficult to find.	Obligation to reseed more often, every 1 to 3 years.
	Biodiversity	Covered long to install (2 to 3 years to be fully effective)	Period of void (between the periods of destruction of the old canopy and sowing of the new one). Difficult to obtain a spread out flowering.
Example of species		Agglomerated cocksfoot, cultivated Alfalfa, Tall Fescue, Yarrow, Petiole Ally, Tall Oats, Sphondy Hogweed, Variegated Coronilla, Lady's Julienne, Daisy and Red Clover, Sweet Clover	Phacelia, cabbage, Alexandria Clover, Buckwheat, Millet, Sunflower, Sorghum, Oats, Moha, Clover, Vetch, Kitty, Rye, Triticale ...
Point of interest		Sowing in the autumn promotes canopy establishment.	Do not hesitate to seed late in the spring to limit competition with weeds and pests.
Remark		These 2 types of mixtures are quite complementary on a territorial scale.	

35 *Thomas M.B., Wratten S.D., Sotherton N.W., 1991. Creation of 'island' habitats in farmland to manipulate populations of beneficial arthropods: predator densities and emigration. Journal of Applied Ecology, 28, 906-917.*

36 *Wäckers F.L., van Rijn P.C.J., 2012. Pick and mix: Selecting flowering plants to meet the requirements of target biological control insects. In: Biodiversity and Insect Pests: Key Issues for Sustainable Management (Eds. G.M. Gurr et al.). John Wiley & Sons, Ltd, Chichester, 139–165.*

37 *Tschumi et al., 2016. Les bandes fleuries pour auxiliaires limitent les ravageurs dans les grandes cultures*

38 *Aebischer N.J., Green R.E., Evans A.D., 2000. From science to recovery: four case studies of how research has been translated into conservation action in the UK. Pages 140-150 in: J.A. Vickery, P.V. Grice, A.D. Evans & N.J. Aebischer (eds.) The Ecology and Conservation of Lowland Farmland Birds. British Ornithologists' Union, Tring.*

39 *Bro E., 2016. La Perdrix grise. Biologie, écologie, gestion et conservation. Biotope, Mèze, 304p.*

40 *Casdar Muscari, 2015-2018. Ministère de l'Agriculture et l'Alimentation.*

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Biannual or permanent coverage?

Which mix to choose?

Certain species are to be banned in seed production basins such as wild carrots, wild chicory and wild parsnip. For perennial mixes, it is advisable to choose seeds with the local plant designation, which guarantees that the plant is of regional origin. These plants will therefore be better able to adapt to the pedoclimatic conditions of the farm. It is also the assurance that the flora is well adapted to the populations of auxiliary insects known as indigenous or autochthonous.

Advice:

To make it easier to choose the composition of a herbaceous area to favour crop helpers, you can refer to this resource:
https://arena-auximore.fr/wp-content/uploads/2014/10/Annexes.pdf

To go further

It can be interesting to:
Mix the types and shapes of cover on the same line: alternate grassy strips, flowering fallow land, miscanthus, etc.

Combine bushes or a hedge with herbaceous cover,
Adding seeders to help field birds survive,
Add wood or branch piles on the layouts. These elements will be very favourable to the overwintering of insects. In addition, these small mounds are popular with male birds in territorial fields.

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Perennial cover enriched with flowering plants.

Action 3C: Hedges and bushes

A hedge favourable to biodiversity is a ***hedge that is heterogeneous*** in its ***composition and structure***. The composition favourable to biodiversity depends on its ***floristic*** (flowering spread over the whole year) and ***fruiting*** (winter food resource for birds) ***richness as well as on the diversity of its strata***: trees, shrubs, lianas and its grassy bank at the foot of the hedge[41]. The latter is fundamental to the survival of amphibians and reptiles in cultivated fields[42]. The structure is also important because the diversity of strata provides nesting sites for all birds that depend on hedges (warblers, thrushes...). It is preferable to plant ***hedges that are wide enough*** (double or triple rows) to provide an effective refuge for terrestrial fauna. Maintaining a grassy strip at the foot of the hedge also makes sense to add to the attraction for the helpers, but also to facilitate access to the hedge for the farmer.

Did you know?

The various successive regroupings since the 1950s have encouraged a massive uprooting of hedges. This is true in the bocage area. However, in the arable or open field areas, hedges were scarcely or not at all present. In these areas, it is mainly the edges that have been reduced. These edges are essential for the biodiversity of the plains[43].

What experts have to say

"The diversity of strata is very favourable for beneficials because there are multiple food resources and refuges for insects". ***Véronique Tosser***, Arvalis Institut du Végétal.

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Wide hedge young and low or old and high but always accompanied by its hedge foot.

For a new hedge or bush plantation, it is advisable to take inspiration from the composition of old hedges already present in the area to select the species adapted to your farm. Here is a non-exhaustive indicative list of species that can be used for a new plantation:

Common Name	Latin name	Growth habit	Interests
Blood Dogwood	*Cornus sanguinea L.*	Bushy shrub	Nectar producing and bay
Privet	*Ligustrum vulgare L.*	Bushy shrub	Bay
Common Charm	*Carpinus betulus L.*	Tree that can be managed as a bush	Winter shelter in the foliage.
Elderberry Black	*Sambucus nigra L.*	Bushy shrub	Nectar producing and bay
Robinier-Faux accacia	*Robinia pseudoacacia L.*	Tree that can be managed as a bush	Nectar producing
Holly	*Ilex aquifolium L.*	Bushes	Evergreen foliage and berry
Sea Buckthorn	*Hippophae rhamnoides L.*	Bushes	Nectar producing and bay
Hawthorn	*Crataegus spp.*	Bushy shrub	Nectar producing and bay
Wild Apple tree	*Malus sylvestris L.*	Tree	Nectar producing and fruit bearing
Wild Pear tree	*Pyrus pyraster L.*	Tree	Nectar producing and fruit bearing
Bird's-eye Rowan	*Sorbus aucuparia L.*	Tree	Nectar producing and bay
Pedunculate Oak	*Quercus robur L.*	High jet shaft	Houses many helpers: spiders, bedbugs...

41 *Pasquet G., 2014. La chasse verte, Montbel, 296p.*
42 *Boissinot A. et al., 2013. Influence de la structure du bocage sur les amphibiens et les reptiles, Une approche multi-échelles, Faune sauvage, n°301, p41-48.*
43 *Omnès F., 2017. Parcellaire et faune sauvage: vers un aménagement foncier agro-écologique?, Faune sauvage, p 66-73.*

Conversely, certain species should be avoided in field crops:

- Conifers because they are less interesting for crop helpers and some are even host plants to a family of pest moths: *Agrotis*.
- *Prunus* (Cherry, Plum) and *Prunus Pradus* (Choke-cherry) because they harbour the cluster Cherry Aphid (*Rhopalsiphum padi*). This aphid can attack straw cereals and maize.
- The Plum tree as it is the primary host of the Peach Aphid (*Myzus persicae*) and can attack rape-seed.

To be accompanied in a planting project, it is possible to get in touch with a specialised local structure.

Planting advice:

To allow optimal development of the young plants, it is important:

To protect them from wildlife, such as deer or rabbits. Install mulching to limit competition with the flora of the planting site.

To go further:

In order to choose the most suitable species for the use of auxiliaries, the AuxilHaie tool can be used: https://chambres-agriculture.fr/recherche-innovation/agroecologie/agroforesterie/auxilhaie/

Maintenance of the hedge or bushes:

- Maintain hedges between December and April[44].
- Do not maintain all hedges at the same height and in the same years. Some bird species prefer low, dense hedges such as the Black-headed Warbler. The species nests about 1m above the ground. Other species prefer higher hedges with a clear foot (umbrella-type hedge) such as the American Goldfinch. The latter nests in the forks of trees between 2 and 10m high.
- Develop wide hedges as they are home to a richer and more abundant bird and entomofauna[45].
- Maintain a grassy hem at the foot.

[44] *Aubinneau J. et al., 2007. Bocage, haie et faune sauvage, Gestion pratique. ONCFS.*
[45] *Chevallier N. et al., 2013. L'entretien des haies a-t-il un impact sur la communauté d'oiseaux du bocage de l'Avesnois? Faune Sauvage, N° 299.*

Action 3D: Planning for industrial biomass production

Miscanthus/TCR, willow/switchgrass strips are harvested at the end of the winter so the impact of the harvest on small wildlife is minimal. These are interesting for the lowland fauna when they are planted in the form of strips. Indeed, they create ecological corridors (green screen) which are essential for the circulation of insects. The interest is to provide a protective cover in winter for the fauna of the plain[46]. In most situations, these strips should not exceed 6m in width.

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What cover is used?

	Miscanthus[47]	TCR Willow[48]	Switchgrass[49]
Pedo-climatic needs	Temperate climate	600 to 1000mm of water per year. Plot not wet.	Sow in warm soil. European climate.
Foot density	10,000 plants/ha	15,000 plants/ha	20 kg/ha
Set-up cost/ha	3500€/ha	2500€/ha	1600€/ha
Harvesting periodicity	1 /year	1/3 years	1/year
Average yield	10 to 13t/ha	6 to 12 t/ha	15 t/ha
Lower calorific value (kWh/kg)	4,2 à 4,4	3,6	4,3
Means of harvesting	Classic Kemper	Specific harvesting head: about 85 000€.	Ordinary mower
Service life	20 years old	20 years old	10 years

What are the possible outlets?

Currently, these crops are mainly used as industrial or collective biomass when the sectors are structured. Biomass can also be used as mulch for market garden crops or for livestock.

Advice:

In areas with a high density of large game, these strips may favour their confinement in the plain, leading to a possible increase in crop damage. It is not recommended to carry out this type of development.

46 *FDC76, 2017. Intérêt des bandes ligno-cellulosiques en milieu agricole pour la petite faune du sol, OAB, 48p.*
47 *https://www.aile.asso.fr/wp-content/uploads/2008/04/panneauttcrmiscanthus.pdf*
48 *https://www.aile.asso.fr/wp-content/uploads/2008/01/wilwater-guidetechnique.pdf*
49 *https://www.biomasse-territoire.info/wp content/uploads/2018/02/Comparaison_des_differents_agrocombustibles.pdf*

Action 4: Maintenance of herbaceous areas

An herbaceous area in good ecological condition is an area composed of several families of non-weedy flowering plants for cultivation. In order to maintain the optimal composition, any disturbance to this area (drift from tillage, fertilisation or phytosanitary products) that could lead to the germination and development of weedy plants must be avoided.

In this case, it is then possible not to maintain the grassy areas which are essential for the small fauna of the plain.

However, after several years, it can happen that a grassy strip or fallow land etc. gets dirty and becomes a reservoir for weeds (e.g., Canada Thistle). Mechanical maintenance is a solution to limit soiling if the edges are composed of weeds.

Objectives of the measure and expected benefits

These grassy borders are a popular nesting and rearing area for young birds[50].

In the case of a qualitative approach, it is possible to leave the choice to the farmers to maintain by whatever means they wish, before going to seed.

The ultimate aim is to have heterogeneous management of herbaceous areas at landscape level[51],[52].

Did you know?

Mechanical maintenance can lead to a decrease of 30-50% in the arthropod population, 50% in the spider population, 30% in the staphylin population and 36% in the ground beetle population[53].

Methodology

SELECTIVE MAINTENANCE OF PROBLEM AREAS AND CUTTING HEIGHT.

The aim is to maintain a minimum shelter cover for wildlife during the breeding period. If the cover is maintained only in weedy problem areas and between 30cm and 40cm then the objective is achieved.

The advantage is also to maintain a herbaceous cover that is fundamental for the protection of beneficials[54]. This results in a non-homogeneous cover with crushed areas and others intact.

What experts have to say

"Selection of problem areas: Best compromise between beneficials and agriculture in the case of occasional infestations of problematic weeds.

Maintenance high 30 to 40 cm: Be careful, shredding in the spring only spares 10% of the insects."

Jean Pierre Sarthou, Agro Toulouse INP, INRAE AGIR.

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Grassed strip with an interlayer maintained at more than 40cm: a ridge that combines keeping the adjacent plots clean and biodiversity!

MAINTENANCE IN WINTER IN CASE OF MUDDY CONDITIONS.

If the composition allows it, it is possible to maintain the herbaceous areas only in winter without the risk of promoting soiling in the plots. This practice reduces maintenance costs and reduces the risk of soiling the adjacent cultivated plot[55] (idem Action bordure de champs).

Advice

The maintenance method that has the least impact on the auxiliaries and is the most economical is mowing.

What experts have to say

A maintenance in winter (during January) and high (30 to 40 cm) allows to save 80% of insects. Beware, autumn (which is a small spring) is a period of reproduction for certain auxiliary insects.

Jean Pierre Sarthou, Agro Toulouse INP, INRAE AGIR.

[50] *Bro E., 2016. La Perdrix grise. Biologie, écologie, gestion et conservation. Biotope, Mèze, 304p.*
[51] *Kruess A., 2002. Grazing Intensity and the Diversity of Grasshoppers, Butterflies, and Trap-Nesting Bees and Wasps, Society for conservation Biology, Volume 16, Issue 6, p1570-1580.*
[52] *Cizek O. et al., 2012. Diversification of mowing regime increases arthropods diversity in species-poor cultural hay meadows, Journal of insect conservation, n°16, p215-226.*
[53] *Thorbek P. et al., 2004. Reduced numbers of generalist arthropod predators after crop management British Ecological Society, Journal of Applied Ecology, 41, p526–538*
[54] *Le bris C., 2011. Gestion des bords de champs et biodiversité en plaine céréalière, Faune sauvage n°291, p64-70.*
[55] *Le bris C. et al., 2014. Comment concilier agronomie et biodiversité des bordures de champs en plaine céréalière ? - Bilan des expérimentations Agrifaune Loiret et Eure-et-Loir. Faune Sauvage. n°305, p38-44.*

© Charles Boutour

Grassy strip made up of perennial, non-weedy species that allows mechanical maintenance only every 2 to 3 years.

Regulatory limit

At present, the regulations impose a period of no maintenance of field borders or fallow land generally spread over May/June. This period corresponds to the nesting period of the insects and birds nesting on the ground but also to the period when weeds such as ryegrass, vulpine, Canada thistle, etc. come to seed. Because of this regulation, there is an increase in the number of shredders in the plots the day before and the day after the prohibition date. In this situation, the herbaceous areas lose all their interest as shelters for wildlife and as reservoirs for auxiliaries.

How do I implement these practices on my farm?

As with field borders (link to field borders), it may be appropriate to carry out a survey or floristic inventory of herbaceous areas: fallow land or grassy strips. Depending on the weed flora present, its location and the type of cover, the appropriate method of maintenance can be chosen.
In case of weed problems*:

Type of layout	Problematic weed (vulpine, ryegrass...)	Volatile weed (thistles...)	Material
Field edges (0.5 and 1.5 m wide)	Localized regular pollarding	Localized pruning at flowering	Mower
Grassed belt type GAEC (min 5m wide)	Localized regular pollarding Maintenance of the first metre of the edge of the crop at 30 or 40 cm from the ground Watch out for nests!!		
Fallow land			

*If the problem of soiling at the edge of the crop continues, a more comprehensive diagnosis and measurement will be required. (See action sheet: Field margins).

Did you know

During the maintenance of these areas, it is possible to discover a pheasant or partridge nest. It will then be abandoned by the mother as it will be put in view of predators.
It is then possible to contact the technical department of your local hunters' federation which will be able to take care of the eggs.

Advice:

In the case of invasive species (Japanese Knotweed, Giant Hogweed, Sagebrush, etc.), chemical control remains the most effective, rapid and appropriate technique for eliminating them while complying with current regulations. Indeed, a rapid elimination of these species is necessary to limit the nuisance to the agro-ecosystem.
For more information on invasive alien species and how to manage them:
http://especes-exotiques-envahissantes.fr/categorie-espece/flore/

To go further:

The most interesting maintenance method to maintain optimal ecological diversity for beneficials is mowing with export[56].

[56] *Noordijk J. et al.,2010. Effects of vegetation management by mowing on ground-dwelling arthropods, Ecological Engineering, Volume 36, Issue 5, Science Direct, p740-750*

Action 5: Protection of biodiversity in agricultural work

The size of the agricultural machinery has increased to increase the throughput of the worksite. This expansion, combined with an increase in the speed of the equipment, has a significant effect on small wildlife during harvesting[57] or maintenance work in herbaceous areas.

Objectives of the measure

Several techniques can be used to reduce the pressure on the medium, including the use of scare bars or centrifugal work during mowing and harvesting.

Expected benefits

For small fauna populations (hare and pheasant), it has been estimated that mowing causes the death of 15 to 20% of the individuals present in the plot[58].

Methodology

The fodder harvest (May-June) is the most critical. To limit the impact of agricultural work (mowing, harvesting, stubble ploughing, etc.) it is recommended that certain measures be put in place:

- Use of scare bars either with combs or chains. Ideally it will be necessary to alternate the type of bar according to the periods[59] (see characteristics table). These tools will disturb the canopy before the passage of the tool allowing the movement of the animals present.

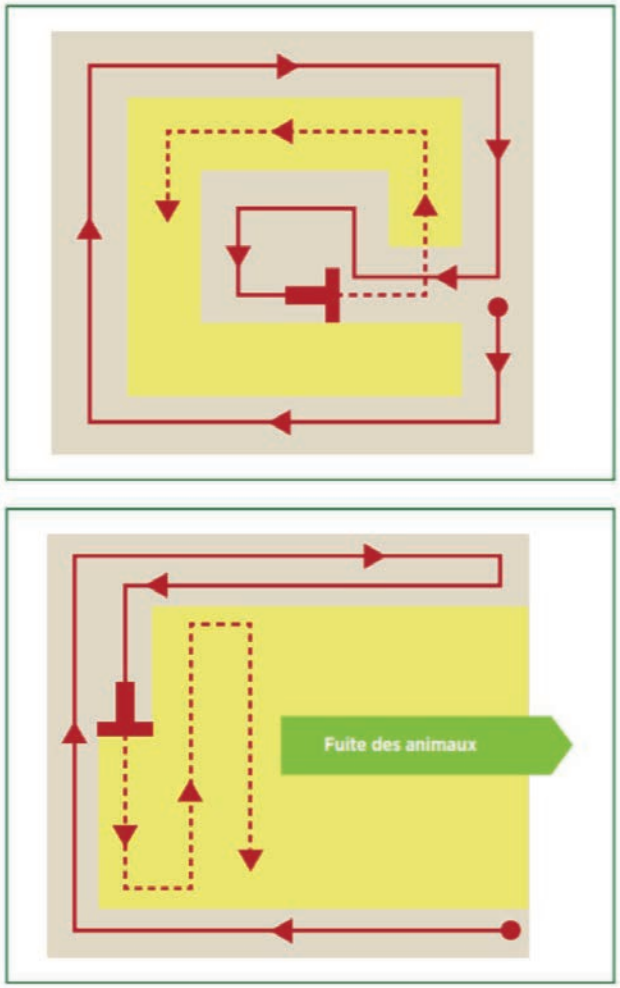
Photo source: FDC 58

FDC 41

Spreader bar with chains or combs.

[57] *Barbier L., 1979. Incidence des coupes de luzerne à déshydrater sur la faune locale, Bulletin Mensuel ONC, n°26, p18-21.*
[58] *Guitton J-S. et al., 2017. Comment réduire l'impact de la fauche mécanique des prairies sur le petit gibier de plaine, Faune sauvage, n°317, p83-88.*
[59] *Drouyer F., Heckenbenner B., 2018. Plaquette: La barre d'effarouchement, travaux du GTNA Machinisme, Programme Agrifaune.*

- Centrifugal work[60]. The so-called centripetal work favours the concentration of animals in the last worked bands, creating a deadly trap for the fauna present. Centrifugal work encourages the animals to flee to the outside of the plot.



Deux exemples d'itinéraires de travail respectueux de la faune sauvage

Source : revue *Faune Sauvage*, n° 291, 2e trimestre 2011 – Inspiré de *Agriculture et biodiversité*, J. Bertrand, 2001.

Source : plaquette Agrifaune ONCFS 2009.

Maintain a reasonable machine speed.

What experts have to say

"During the first weeks of their lives, the survival technique for young mammals is immobility. When approaching a craft, the probability of spontaneous escape is low or even non-existent. The combination of these measures will make it possible to limit the impact of work during sensitive periods".

David Granger, in charge of agriculture, wildlife and game damage at the French Biodiversity Office (Office Français de la Biodiversité).

How do I implement this practice on my farm?

The cost of a scare bar is between 1500 and 2500€ HT (depending on the width) or 300 and 500€ minimum (for a home-made manufacture). Locally, some departmental hunters' federations or other hunters' associations acquire bars to make them available free of charge to volunteer farmers.

[60] *Broyer J., 1996. Les fenaisons centrifuges, une méthode pour réduire la mortalité des jeunes râles des genêts Crex Crex et cailles des blés Coturnix Coturnix, Revue d'écologie (Terre Vie), n°51, p269-276.*

Did you know?

It is not uncommon for departmental hunters' federations or municipal companies to acquire bars and make them available free of charge to farmers who request them.

To do so, contact the Federation's technical department.

Technical characteristics of a scare bar:

	Comb bar	Chain bar
Period of use	From April to August	From September to March
Type of cover	Meadow or alfalfa mowing (Hatching) Maintenance of grassed strips	Maintenance of grassed strips Destruction of green manure
Principle	The combs touching the ground push the animals to force them out of their hiding place.	Chains slipping on the floor or cover make noise and jostle the cover to disturb the animals.
Spacing	30 cm between each comb	30 cm between each chain
Technical characteristics	A comb must be at least 45 cm long	A chain should be 45 cm long and heavy enough not to wrap around the axle.
To be installed on the tractor's front linkage or to be adapted to the weight.		

To go further:

In the case of fodder harvesting, it can be interesting to leave a strip of unharvested fodder on the edges. This can be frequented by nesting birds. If the fodder has flowers, leaving a strip will also be favourable to flying insects (pollinators and beneficials).

Action 6: Conservation of cereal stubble during interculture

Cereal plots are prime habitats for field crop species such as grey partridges, wheat quails, skylarks and sparrows. Cereal stubble is a preferred wintering site for a good number of avian species[61].

Objectives of the measure

In recent years, early stubble tillage for ICNAF implementation has resulted in significant habitat loss for birds, preventing them from completing their reproductive cycle[62]. To remedy this, the conservation of straight stubble when sowing green manures seems to be an appropriate solution[63]. Green manures (ICNAF) are essential to meet the objectives of capturing soil nutrients, storing carbon, improving soil structure, increasing soil organic matter[64] and also providing shelter and food for wildlife in the autumn.

Expected benefits

Field birds can be considered as beneficials with a potential impact on the seed stock present on the soil surface[65].

Intercropping canopies also have a role in storing nutrients and protecting the soil surface against erosion or climatic excesses.

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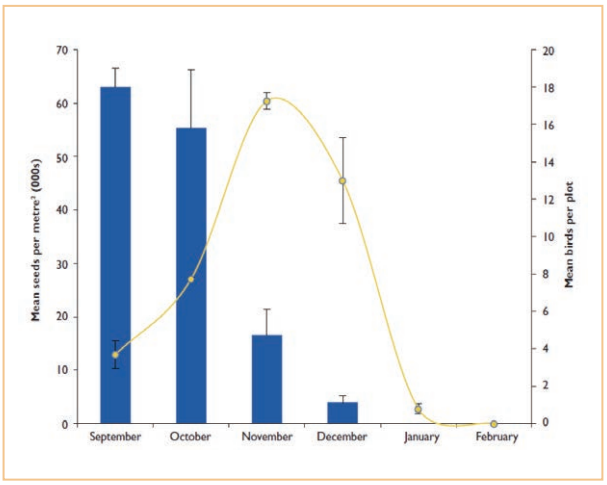
61 *Donald P.F., Evans A.D., 1994. Habitat selection by Corn buntings Milaria calandra in winter. Bird Study, 41: 199-210.*

62 *Millot F. et al., 2017. Mauvaise reproductions des perdrix grises ces dernières années Quel rôle des moissons des céréales? Faune Sauvage n°317, p89-92.*

63 *Eraud C., 2002. Ecologie de l'Alouette des Champs Alauda arvensis en Milieux Cultivés, Caractéristiques Ecologiques de l'Habitat et Perspectives de Conservation, Thése de l'Ecole Pratique des Hautes Etudes, ONCFS, Ministère de l'Education Nationale, de la Recherche et de la Technologie, p168.*

64 *Labreuche J. et al., 2011. Cultures intermédiaires Impacts et conduites, Arvalis institut du végétal, p231*

65 *Stoate C. et al., 2017. Field of the future, 25 years of Allerton project – A winning blueprint for farming, wildlife and the environnement, GWCT Allerton Project, 36p.*



Relationship between the number of Yellow Bunting and the surface seed stock (GWCT Allerton project).

Did you know?

An adult skylark consumes an average of 6g of seeds per day. Over a year, a couple of skylarks can consume about 3.2 kg of weed seeds for 9 months in France. However, if cereals are stubble ploughed too early, the time of presence of the skylarks will be almost halved and the consumption of weed seeds will also be reduced[66].

What experts have say

"The harvest induces a rapid modification of the habitat for the small wildlife that lives there. The maintenance of cereal stubble limits the impact of this phenomenon by maintaining a place favourable to the life cycle of many species".

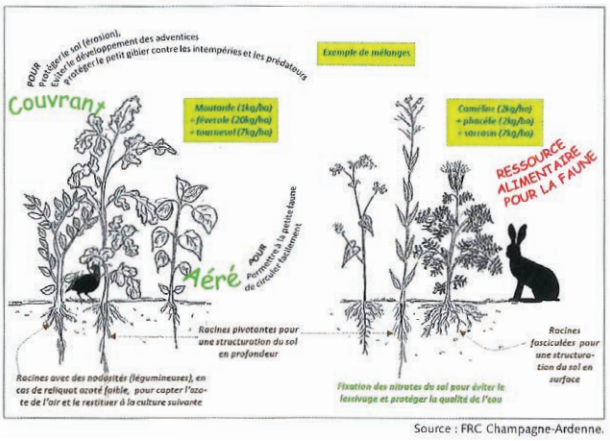
David Granger, in charge of agriculture, wildlife and game damage at the French Biodiversity Office (Office Français de la Biodiversité).

Methodology and how do I implement this practice on my farm?

To reconcile these different objectives, there are alternatives to sowing after stubble ploughing: sowing in the cereal before harvest and direct sowing in the stubble fields. Green manures composed of several species are recommended because one species alone cannot meet all the objectives.

Complex diversified green manures are generally more productive than simple mixtures. In a complex mix, there will always be a few species that will manage to grow in any weather conditions. There must be sufficient cover that is favourable to biodiversity:

- Covering to create shelter in winter and compete with weeds ;
- Circulating so that small wildlife can move around easily[67].



Source : FRC Champagne-Ardenne.

Did you know?

The Agrifaune programme has tested and validated a certain number of covers that make it possible to reconcile agronomy, economics and wildlife. http://www.agrifaune.fr/fileadmin/user_upload/National/004_eve-agrifaune/Publications_GTNA_Intercultures/melanges2.pdf

SOWING ON THE FLY BEFORE HARVESTING

There are two possible sowing periods for sowing green manure in the air.

At the end of the winter, before the cereal starts up again.

Flying sowing can be carried out with the fertiliser seed drill or slug pellet spreader. To ensure a good emergence, a harrow can be used in addition. Clovers are the most suitable for this type of seeding. Sown at 10kg/ha, they will germinate at the end of winter and will be "smothered" by the wheat until harvest. After the harvest, the installed clover will take advantage of the light and residual humidity to grow and develop. This technique makes it possible to obtain cover regardless of the level of precipitation in the summer period.

Figure 2: Clover cover well established in cereal stalls after harvest (Source: FDC 32/Agrifaune).

66 *Thibaut Powolny, 2012. Faire face à l'hiver - Quelles réponses à l'hétérogénéité de la ressource en agroécosystème ? L'exemple de l'alouette des champs (Alauda arvensis). Sciences de l'environnement. Université de Poitiers.*

67 *Heckenbenner B. et al., 2011. CIPAN: quand l'outil règlementaire devient un atout agronomique et faunistique, Faune sauvage, n°291, p11-19.*

Cost of the clover sown in the air at 10kg/ha: about 60 €/ha.

Advice:

This practice is not recommended in plots with a problem of weedy dicotyledons such as thistle. Indeed, the weedkiller would destroy the canopy before the harvest.

In the last month before the harvest, either a few days before the harvest or during a rainfall in the previous weeks.

Pre-harvest broadcast sowing must be carried out with a fertiliser seeder using the sprayer passes. The advantage is to take advantage of the last rainfall obtained before harvesting and the residual moisture present on the surface to place the seeds in optimal conditions for emergence. In certain pedoclimatic contexts, the soil surface is too dry at harvest time, making sowing ineffective. It is then preferable to anticipate sowing and take advantage of the last rainfall during the months of May/June.

Advice:

Beware of the remanence of products used in cereal vegetation, this could handicap the development of the canopy.

Did you know?

It is recommended to sow small seeds that can germinate easily such as oats, buckwheat, millet or rape. For more information on plants that can easily be broadcast seeded under the harvester's header:
http://www.fiches.arvalis-infos.fr/liste_fiches.php?-fiche=ci&type=pures
or https://gieemagellan.wixsite.com/magellan/acacia

The complex aspect of this practice will be the homogeneous distribution of seeds on the surface of the soil, especially for small seeds such as clover. The seed drill will have no difficulty in distributing the large seeds but the lighter ones on the other hand will have difficulty in being projected over the whole of the desired distance. To compensate for these physical constraints, it is recommended to "glue" the small seeds to the large ones with a mixture of flour and glucose powder.

Advice:
Recipe for seed sticking for 1 ha for a mixture sown at 110kg/ha:
Using a concrete mixer to mix.

- 100kg large seeds / 2 litres of water / 10 kg of glucose
  Mix
- 6 litres of water to create the glue
  Mix
- 10 kg of small seeds
  Mix
- 14 kg of flours to dry the mixture and prevent it from setting.

Source: GIEE Magellan.
https://www.youtube.com/watch?v=mq-hJ8gvoY-g&list=LLHc3GYA197CkppL3tzaa1lQ&index=6&t=0s

This technique has the advantage of having a very high work rate (10ha/hour) with a very low cost. Moreover, the work is carried out during a calm period. However, this technique requires rain after spreading to obtain a good levelling.

DIRECT SOWING IN THE HEADLANDS

To successfully establish green manure in the uplands, direct sowing with a tine seeder gives very good results. The small tines of the seed drill (about 1 cm wide) will open a well-cleared furrow to promote soil-seed contact. For this type of sowing, the disc seeder is not recommended as it tends to accumulate residues at the bottom of the furrow. These residues will dry it out, greatly limiting germination potential. To reduce drying, it is recommended to leave high straws (40cm). This will improve sowing success.

© Charles Boutour

Interculture cover crop planted with a direct drill in the stubble in mid-July.

It is recommended to sow it as soon as the threshing machine passes by and no later than three days after harvesting. This sowing technique is advantageous because it allows the residual moisture still present at harvest to be retained while ensuring optimum seed placement. It is also economical in terms of running costs, provided that you have a suitable seed drill. Moreover, this method allows a greater diversity of species to be sown than broadcast sowing.

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Interculture covered in extremes in December.

Advice:

The destruction of green manure:

The method of destruction that has the least impact on wildlife is freezing. However, as periods of frost become increasingly rare, it is difficult to rely on this method. Interculture grazing is an interesting option but it is not applicable everywhere because the presence of a ruminant herd is necessary on or near the farm.

For shallow stubble cultivation and mechanical destruction methods, the implementation of scaring techniques (see biodiversity protection) should be considered as these canopies could become death traps for small fauna. Finally, if no other alternative is possible, chemical weeding remains authorised.

Did you know:

To optimise carbon sequestration in the soil, it is recommended that fertilisers be kept in vegetation for 6 to 8 months. The result of maintaining these canopies for this long is the sequestration of 126 kg of C/ha/year[68]. This also makes it possible to create areas of shelter and cover during the winter period for both sedentary (grey partridge, hare, etc.) and migratory species (skylark, wheat quail, etc.).

In the composition of the chosen mixture, care must be taken to favour rather late plants, as early plants lignify more quickly. Lignin can cause nitrogen to be lost in the next crop.

Limitations:

When the plots have been harvested in difficult conditions during the previous harvest (compaction and rutting), stubble ploughing is then used to level the plot.

In plots heavily impacted by weeds, false sowings can contribute to limiting seed stock. However, tillage will limit the available useful reserve: evaporation of 4 mm of water per day, thus compromising the success of green manure sowing[69].

In the case of burying organic matter, these practices are limited.

To go further:

You can consult the report of the GIEE Magellan explaining the techniques.
https://a8f8f996-9048-4137-99ce-13f063da3466.filesusr.com/ugd/a22602_b6888c7b4c2d-4d85ab446367767712d9.pdf

You can use the tool to choose the cover:
http://www.fiches.arvalis-infos.fr/liste_fiches.php?-fiche=ci&type=pures
https://gieemagellan.wixsite.com/magellan/acacia

[68] *Pellerin S. et al., 2019. Stocker du carbone dans les sols français, quel potentiel au regard de l'objectif 4 pour 1000 et à quel coût? Synthèse du rapport d'étude, INRA, 114P.*

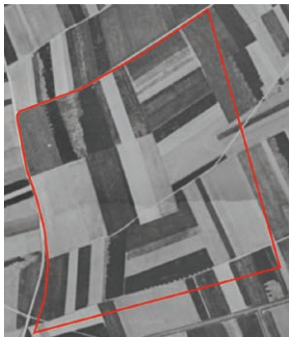
[69] *Hatfield L. et al., 2001. Managing Soils t Managing Soils to Achie o Achieve Greater W eater Water Use Efficiency: A Re ater Use Efficiency: A Review, Publications from USDA-ARS / UNL Faculty. 1341.*

Action 7: Parcel organisation: increasing the edge effect

In open fields, crop edges are essential components for the reproduction of entomofauna[70] and lowland avifauna[71].

Objectives and expected benefits

Edges are necessary for the development of populations of about 90% of beneficials[72], compared to 50% of pests. For crawling insects, it is estimated that the distance surveyed from an edge is about 75m to 80m[73].



Evolution of the lowland landscape on the same 36.4 ha island between 1950 and 2000.

In addition to the number of plots which has decreased, the quantity of available edge has decreased (7.2 km of field edge (180m edge/ha) in 1950 against 3.2 km of available edge (80m edge) in 2000).

Did you know?

The various regroupings since the 1950s have encouraged the uprooting of hedges. However, in the lowland areas, hedges were scarce or not present at all: it is the quantity of available edge that has decreased[74].

Birds that nest on the ground in crops locate their nests in the first 25 metres of the border: 85% of Grey Partridge nests[75] and 70% of Skylark nests[76]. The amount of available edge reflects the carrying capacity of the plot.

What experts say

"This factor is very important; the plots should not be too large. Due to the generally limited daily movements, it is considered that a plot is no longer sufficiently protected beyond 80 m from a refuge area. The width offering the best compromise is therefore about 150 m. Limiting the width of a plot of land is all the more effective when a refuge area (grassy strip, bushes, woods...) separates it from its neighbour. Moreover, it is very important to connect these refuge areas to each other".

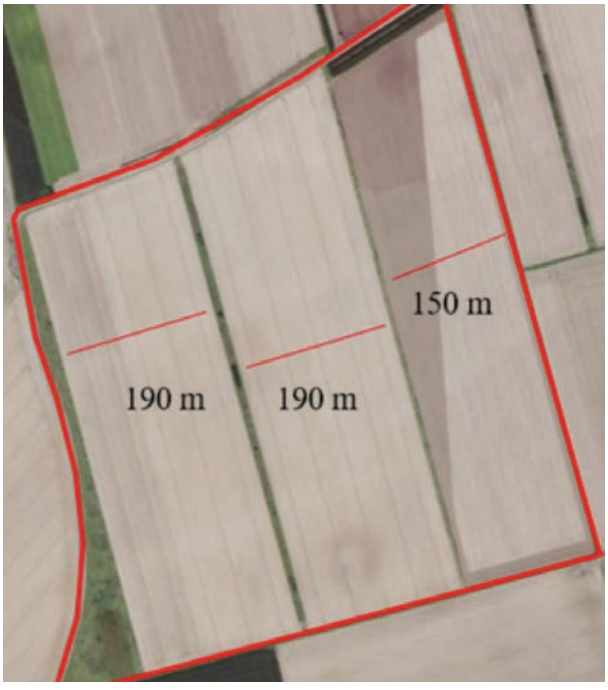
Jean Pierre Sarthou, Agro Toulouse INP, INRAE AGIR.

Did you know?

It is possible to cut the plots into a multiple of the widest tool used on the farm: sprayer, boom, or irrigation reel. With the precision equipment, it is now possible to be accurate to the cm.

Methodology

Encouraging farmers to return to the situation of 1950 would be utopian and counterproductive. However, it is possible to increase the proportion of selvage while making the farmer's work easier. Each interface between two environments favours the amount of edge available. In order to combine workflow and biodiversity, rectangular plots are preferable. Few farms have only rectangular plots.



70 *Keller S., Häni F., 2000. Ansprüche von Nützlingen und Schädlingen an den Lebensraum. Streifenförmige ökologische Ausgleichsflächen in der Kulturlandschaft: Ackerkrautstreifen, Buntbrache, Feldränder. Verlag Agraröökologie, Bern, 199-217.*

71 *Eraud C., 2002. Ecologie de l'Alouette des Champs Alauda arvensis en Milieux Cultivés, Caractéristiques Ecologiques de l'Habitat et Perspectives de Conservation,Thése de l'Ecole Pratique des Hautes Etudes, ONCFS, Ministère de l'Education Nationale, de la Recherche et de la Technologie, p168*

72 *Boller E. F., Häni F., Poehling H. M., 2004. Ecological Infrastructures: Ideabook on Functional Biodiversity at the Farm Level. IOBC-OILB. 212pp*

73 *Collins K.L. et al., 2002. Influence of beetle banks on cereal aphid predation in winter wheat, Agriculture, Ecosystems and Environment n°93, p 337–350.*

74 *Omnès F., 2017. Parcellaire et faune sauvage: vers un aménagement foncier agro-écologique?, Faune sauvage, p 66-73.*

75 *Bro E., 2016. La Perdrix grise. Biologie, écologie, gestion et conservation. Biotope, Mèze, 304p.*

76 *Eraud C., 2002. Ecologie de l'Alouette des Champs Alauda arvensis en Milieux Cultivés, Caractéristiques Ecologiques de l'Habitat et Perspectives de Conservation, Thése de l'Ecole Pratique des Hautes Etudes, ONCFS, Ministère de l'Education Nationale, de la Recherche et de la Technologie, p168.*

The same islet as in figure 1 to date, e.g., 6km of edge (150m edge/ha) and 3 easily cultivable plots.

This organisation of the plot combined with crop rotation are key elements in the preservation of the entomofauna, the avifauna of the cultivated plains and biodiversity as a whole[77]. These factors make it possible to increase the number of interfaces between the different environments[78].

Advice

An efficient plot width for biodiversity and agricultural work is a multiple of the widest tool between 150 and 200m wide.

What experts say

"In problem areas with large game, the narrow plots offer the advantage of facilitating the roaming abilities of the animals".

David Granger, in charge of agriculture, wildlife and game damage at the French Biodiversity Office (Office Français de la Biodiversité).

How can I implement this practice on my farm?

At the farm level, the plot is rarely homogeneous in terms of soil quality, shape and size.

For tortuous plots, it is possible to cut them into islands of optimal shape. In this way, work in plots with unattractive shapes is optimised. The advantage is that no more time is wasted on maneuvering in short sprayer turns, false angles or sharp curves.

Did you know?

Cutting into a round number of sprayer passes improves efficiency, limits maneuvers, and avoids double dosing.

Tower courtyards decrease the performance of the plot: higher time load for more or less equal production compared to the rest of the plot.

These spaces are areas that can be developed as a priority.

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Tower courtyards: slight loss of surface area but gain in productivity.

It is also possible to develop areas of land with very low agronomic potential: pebble veins, woodland edges, wetlands, etc. These cultivated areas also reduce the performance of the plot: low production for the same or higher operating costs compared to the rest of the plot.

Limitations:

The implementation of this practice is more difficult for small or landlocked plots.

To go further:

Adding a strip between the plots will increase the number of available edges and therefore the carrying capacity of the area.

[77] *Alignier A., Solé-Senan X.O., Robleño I., et al., 2020 Configurational crop heterogeneity increases within-field plant diversity. J Appl Ecol. 57:654–663.*
[78] *Bro E., 2016. La Perdrix grise. Biologie, écologie, gestion et conservation. Biotope, Mèze, 304p.*

Action 8: Soil cover

Covered soil implies the maintenance of living or dead vegetation on its surface.

Objectives of the measure

This method captures soil nutrients, stores carbon, improves soil structure, increases soil organic matter[79] and protects the soil surface against erosion and climate excesses.

Expected benefits

Covered soil reduces erosion considerably. The difference between annual soil formation and natural erosion is on average less than 0.2 mm per year[80]. It therefore takes at least 50 years to create 1cm of soil. However, uncovered soil can erode more than 1mm per year, resulting in a sharp decline in soil fertility. A permanently covered soil, combined with specific arrangements to limit mud transfer, would considerably reduce the gully phenomena during strong periods of erosion.

Permanent soil cover also increases surface organic matter[81]. This increase is amplified if the soil is worked very little, or not at all[82]. Maintaining a living cover over a period of 6 to 8 months during intercropping could allow the sequestration of 126 kg of C/ha/year[83].

What experts say

"Diversifying crops in time and space, with plant cover during intercropping, will limit periods of bare soil (thus limiting erosion), and improve carbon sequestration, rainwater infiltration and soil structure. Consequently, improved soil fertility will give the soil a higher productivity potential".

Jean Pierre Sarthou, Agro Toulouse INP, INRAE AGIR.

Did you know?

Tersilochinae are parasitic micro-wasps of the larvae of meligèthes. These insects spend the winter in underground galleries. They usually emerge from rapeseed wheat in mid-February. The two important factors for these species are the availability of flowers when they emerge and shallow tillage.

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Soil covered by a diversified mix.

The organic matter on the surface maintains a good level of moisture but also provides shelter and food for the entire life of the soil. This fauna increases the mesoporosity (0.2 to 50µm) of the soil at depth[84], which facilitates deep root exploration and water infiltration during violent thunderstorms. It will also increase the useful soil reserve and reduce surface runoff. Humus has a water retention capacity of 5 to 6 times its weight.

For all these reasons, crops can be more resilient to climate change.

79 *Labreuche J. et al., 2011. Cultures intermédiaires Impacts et conduites, Arvalis institut du végétal, p231.*
80 *Montgomery D. R., 2007. Soil erosion and agricultural sustainability, USDA, U.S. Department of Agriculture., PNAS Direct Submission, Vol 104, n°33*
81 *Thomas F. et al., 2016. Les couverts végétaux gestion pratique de l'interculture, Edition La France Agricole, 302p.*
82 *Dimassi et al., 2016. Long-term effect of contrasted tillage and crop management on soil carbon dynamics during 41 years, Agriculture, Ecosystems & Environment, Volume 188, Pages 134-146.*
83 *Dimassi et al., 2016. Long-term effect of contrasted tillage and crop management on soil carbon dynamics during 41 years, Agriculture, Ecosystems & Environment, Volume 188, Pages 134-146.*
84 *Gicheru et al., 1994. Effects of residue mulch and tillage on soil moisture conservation, Soil Technology Volume 7, Issue 3, Pages 209-220.*

Did you know?

Humus has a water retention capacity of 5 to 6 times its weight.

Crop residues or green manure left on the surface of the soil have the advantage of limiting the physical aggression of the climate: too much heat or heavy rain during the transition before a new sowing. Cover crops also play a role in weed management. Finally, these canopies provide shelter and cover for all wildlife in winter, both sedentary (grey partridge, hares, etc.) and migratory[85] species (Skylark, Wheat Quail, etc.).

Some wild bees (e.g., the panty bee) are known as ground bees. This means that they lay their eggs and spend the winter in the soil in agricultural plots. They can dig galleries of up to 30 cm. Deep tillage is not without consequences for these species.

How can I implement this practice on my farm?

Green manures composed of several species are recommended because a monospecific plot cannot meet all the objectives. Complex diversified green manures are generally more productive than simple mixtures. In addition, a diversified cover will allow a diversity of plant actions on the soil: shrubs, bushes, vines, ground level or perforators.

Complex diversified green manures are generally more productive than simple mixtures. In a complex mix, there will always be a few species that will manage to grow in any weather conditions. There must be sufficient cover that is favourable to biodiversity:

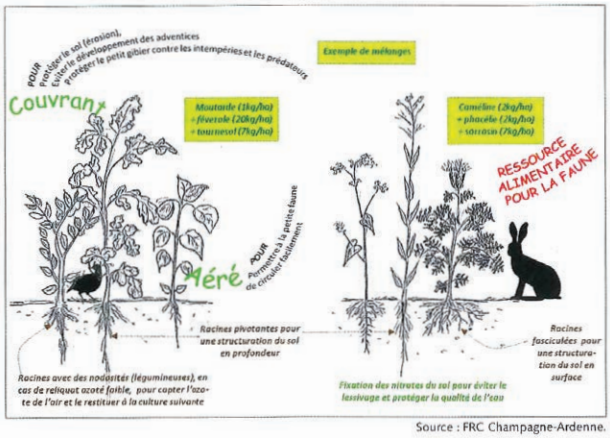
Covering to provide shelter in winter and compete with weeds.

Circulating so that small wildlife can move around easily[86] .

Did you know?

The Agrifaune programme has tested and validated a certain number of covers that make it possible to reconcile agronomy, economics and wildlife.

http://www.agrifaune.fr/fileadmin/user_upload/National/004_eve-agrifaune/Publications_GTNA_Intercultures/melanges2.pdf



Source : FRC Champagne-Ardenne.

For more information, see the stubble conservation action.

To go further:

Soil cover combined with a limitation of deep tillage are important levers to favour soil life such as earthworms, mycorrhizae or soil insects.

[85] *Barré K. et al., 2018. Weed control method drives conservation tillage efficiency on farmland breeding birdsAgriculture, Ecosystems and Environment, Elsevier Masson, 2018, 256, pp.74-81.*

[86] *Heckenbenner B. et al., 2011. CIPAN: quand l'outil règlementaire devient un atout agronomique et faunistique, Faune sauvage, n°291, p11-19.*

Action 9: Fitting out of farm buildings

Agricultural buildings such as granaries, barns or the tops of silos are home to useful bird species, especially on cereal plains.

Objectives of the measure and expected benefits

It is possible to increase the presence of certain species such as swallows, kestrels, barn owls, chickadees or bats by creating specific facilities. It is recommended to install nesting boxes in buildings or in the trees on the farm's premises. Indeed, the installation of well-positioned nesting boxes will facilitate the presence of a couple in the long term. Like auxiliary insects, these species provide ecosystem services that are favourable to the entire agricultural ecosystem. Favouring these species is a means of preventive control against crop pests.

What experts say

Hedges, bushes or groves of trees provide natural nesting sites for passerines and perches for birds of prey. The need for artificial facilities will depend mainly on the landscape of the farm.

David Granger, in charge of agriculture, wildlife and game damage at the French Biodiversity Office (Office Français de la Biodiversité).

Did you know?

A couple of frightened owls consume about 4000 prey (mice, lizards...) each year. A bat consumes up to 600 mosquitoes per night, which represents 60,000 individuals over the 3 summer months.

Methodology and how do I implement this practice on my farm?

Naturally, these species settle in farm buildings. Before installing new nesting boxes, it is more relevant to maintain and improve the existing ones. That is to say, to keep entrances to the buildings so that these species can continue to breed there.

Exposure is the essential element to be taken into account when installing a nesting box. Relatively easy to place, the entrances to the nesting boxes should be positioned away from the prevailing wind and bad weather. It is therefore preferable to install them towards the east or south.

Spooky owl: inside a fertilizer or material storage building with an open side, at least 5m high. The nest box should have an inner wall so that the eggs can be placed in total darkness. It is a nocturnal bird.

Athena's Owl: on an isolated tree between 4 and 5 m high. As with the Barn Owl, the nest box should have a system to cut off the entrance of direct light to the chicks.

© Charles Boutour

The kestrel: the nest box should preferably be installed outside on a high point (5 to 6 m minimum). It is possible to install it on the outside cladding of a building, on an IPN post, or on the roof of a storage silo if it is properly watertight.

Advice:

Action "Operation nesting boxes on the farm" of the Association Hommes et Territoires - link to the action sheets: http://www.hommes-et-territoires.asso.fr/site-content/15-nichoirs-a-la-ferme/9-nichoirs-a-la-ferme ;
Methodology for the installation of the Nest Boxes for the Barn Owl carried out by the League for the Protection of Birds (LPO). Link to the sheet: https://www.lpo.fr/images/rapaces/cahiers_techniques/CT_effraie.pdf ;
Methodology for the installation of nesting boxes for the Athena Owl bell tower carried out by the League for the Protection of Birds (LPO). Link to the file: https://www.lpo.fr/images/rapaces/cahiers_techniques/ctcheveche.pdf

To go further:

The installation of perches on areas infested with small mammals in addition to the nesting boxes can facilitate the work of these birds of prey.

For the passerines:

Species	Diameter of the flight hole	Inner bottom	Interior height	Distance between the flight hole and the base of the nesting box	Height of installation
Black Tit	25-27	10 x 10 cm	17 cm	11 cm	2 to 4 m
Blue Tit	26-28	13 x 13 cm	23 cm	17 cm	2 to 5 m
Coal tit	32	14 x 14 cm	23 cm	17 cm	2 to 6 m
Redstart with white forehead	Oval 32 mm wide and 46 mm high	14 x 14 cm	23 cm	17 cm	1.5 to 4 m
Nuthatch torchpot	46-50	18 x 18 cm	28 cm	21 cm	4 to 12m

Advice:
Methodology proposed by the League for the Protection of Birds (LPO) concerning the creation of nesting boxes for passerines. Link to the sheet:
http://www.lpo-auvergne.org/sites/default/files/documents-telecharger/nichoirs_passereaux_-_fiche_refuge.pdf

For wild pollinators:

To build a nest box for wild bees, it is possible to use a 1 litre plastic bottle (minimum length 17-18 cm) on which the neck has been removed and in which 32 cardboard tubes are placed. This nest box is then placed 1 m high on a wooden post. It will then be very easy to determine the presence/absence of pollinator in the nesting box. If the cardboard tubes, which are 7 mm in diameter, are blocked, it means that a female has laid her eggs there for the winter.

Advice

For more information: http://www.vigienature.fr/fr/agriculteurs and
http://www.vigienature.fr/fr/actualites/oab-abeilles-sauvages-s-observent-plein-tube-3469

Limitations:

It is necessary to carry out a precise observation of the species frequenting the farm and then identify the places favourable for the installation of the nesting boxes. It would not necessarily be appropriate to install 5 nesting boxes for the different species presented above. In the event of a year of high pressure, these species could find themselves submerged by the explosion in the number of their prey. In this case, human intervention will be necessary to restore the balance.

To go further:

It is possible to contact the LPO in your region to exchange and identify the places where to place the nesting boxes.

Link to regional LPO references:
https://www.lpo.fr/la-vie-associative/le-reseau-lpo

ANNEX 2:
Ecology and demography of small wildlife species

While small wildlife includes a broad set of taxonomic groups this study focuses on small mammals and birds of fields and meadows in Europe. We have limited this study to those well-known taxonomic groups because they can be used as indicator species for the presence of a much larger group of animals including insects, amphibians, ...

Without aiming to be complete we list in this chapter a set of typical small mammals and birds of Europe's fields and meadows with some basic information on their ecology and demography. A good knowledge of those elements is a basic requirement to understand why those species showed a dramatic decline in the size of their populations in the last decades.

Mammals

Badger, Eurasian *(Meles meles)*

Characteristics

The Eurasian Badger is our largest representative of the family *Mustelidae*. It weighs usually 10 to 20 kg. Most in the autumn when it creates fat reserves. Measures up to 75 cm. We can easily recognize it for its characteristic white head with two black stripes over the lights (eyes). Boar typically has broader head, thicker neck and narrower tail than sow, which is sleeker, has narrower, less domed head and fluffier tail. The coat is gray-yellow with black and white ends, coarse and bristly. The abdomen and limbs are blackish. The figure is pudgy, the head pointed. Below its small tale and above its anus it has a paired scent gland with a yellow, semi-liquid, gooey fatty secretion. The whole body is adapted for raking with its low limbs and long strong claws. The badger is stepping on his entire feet, and therefore we call it plantigrade.

Habitat

Member of the family *Mustelidae*, is widespread to almost all of Europe including UK, with exception of Scandinavia, lives also at Crete and some parts of Asia from west to far east. It is classified as least concern on the IUCN Red List[87] as it has a wide range and a large stable population size. Several subspecies differentiating in colour and size are recognized. Within Europe we can recognize two major groups divided by the river Volga. West from the river the Badger is bigger dark silver-grey colour with distinctive face mask. They live in forests. East of the Volga river until Ural Mountains the badger is smaller with sandy colour small face mask. They are steppe inhabitants, spending most of their lives below the ground.

It prefers deciduous woods with clearings, or open pastureland with small patches of woodland. It is also found in mixed and coniferous woodland, scrub, suburban areas and urban parks[88].

Diet

The Badger is not a picky boarder. It is an opportunistic forager with an omnivorous diet. Of the European predators, it has the least adapted teeth to catch and eat fleshy prey. Especially stools have wide crowns, which reveal that the teeth are adapted mainly to plant food, although it does not avoid the animal one. It comes out at night and seeks after the food with a gentle smell. With its paws it rakes the soil surface, crumbles rotten stumps, reverses stones, or digs out the dens of small underground vertebrates such as hedgehogs, moles, and rabbits. It also consumes a variety of invertebrates (especially earthworms), wasp and bee nests, including honeycombs, birds' eggs and carrion. He is also satisfied with various insects, collects slugs, frogs and this animal diet supplements with forest berries, roots, mushrooms or tubers, acorns, and cereal crops. He's a typical omnivore. Its hunting area is not large, usually only 2 km on average. In case of food "supply" it comes out to feed even during the day.

Social behaviour

The Badger lives the night way of life, but he sometimes enjoys the daylight and sun. In hidden places he digs up very complicated and intertwined corridors that lead up to 5 m deep and are about 10 m long. In the den, the badger keeps anxious cleanliness.

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87 *T. Kranz, A., Abramov, A.V., Herrero, J. & Maran, Meles Meles. The IUCN Red List of Threatened Species 2016: E.T29673A45203002, IUCN, 2016 <https://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T29673A45203002.en>.*

88 *M. Stubbe, The Atlas of European Mammals, Vulpes Vulpes (In: A.J. Mitchell-Jones, G. Amori, W. Bogdanowicz, B. Kryštufek, P.J.H. Reijnders, F. Spitzenberger, M. Stubbe, J.B.M. Thissen, V. Vohralík, J. Zima (eds), Academic Press, London.., 1999).*

He lines it with moss and ferns, which he transports moving backwards into the burrow, "stuffed" under his belly. Badger puts his droppings into the hole several steps (but also up to 100 m) from the burrow. The badger does not cover up this "toilet" but exchanges it for another if it is already full. Often, a Fox moves into the occupied den, but the cleanliness loving original tenant is evicted after some time by its disorder. The Badger lives very secretly and leaves his burrow only at night. However, it does not avoid human settlements.

In the northern parts of its range the species hibernates during the winter months (since October till February). It is not strict hibernation as they interrupt it with short period of activity. In more moderate climate conditions, the badgers do not even hibernate at all.

Contrary to the common opinion the badgers are not loners. There are quite often more families settled in one den setts, which are visiting frequently each other. The badgers make usually all-life lasting couples[89].

Reproduction

In Europe badgers mating take place usually in July, in case of young individuals and females not yet fertilized, until August and longer, however there are big differences across the badger's population across the Eurasian continent, where mating can take place since January till October. Males typically mate with only one female, whereas sows have been known to mate with more than one male. The badgers are usually sexually mature in the age of one year. Estrus in European badgers lasts up to six days and may occur throughout the year. Pregnancy is reported for 28 - 32 weeks, but may vary up to 55-60 weeks, if we include the period of max. 5 months of embryonic latency, meaning the suspension of fetal development so that the pups are born into more favourable climatic conditions. The female breeds 1 - 5 pups, which are bare and about a month blind. They can see after 28 to 35 days. Since July, the young can usually hunt alone. They stay with their mother long enough and we can meet whole badger families even in autumn. After a year they mature. The Badger lives up to 15 years.

Demography

The IUCN Red list suggests that the Eurasian Badger has a stable population in Europe, with several countries reporting an increase in numbers. The European badger has become more abundant in Central Europe as the number of rabies cases reduced over the last two decades. In western Europe and particularly the UK, there have been increases in numbers. In western Ukraine the population has increased. In Russia, 30,000 individuals were estimated in 1990. In the United Kingdom (1980s-1990s) there was a 77% increase in the total population size[90]. Overall the general population of badgers in Europe has been kept at bay by agricultural intensification.

Densities have increased in Europe during recent decades, also as a result of the reduction in rabies cases[91]. Density varies drastically with their large range across Europe. At its most northern limit, in Finland, density is as low as 2 to 2.5 individuals per each km^2. In higher densely populated areas such as south west England, it can increase to between 17 and 58 individuals per km^2 [92].

In France badgers are present throughout the county although less common in areas such as Paris, Orleans and Artois. From the early 1990's there were estimations of the badger population in France being approximately 80,000, however it was argued that there is probably a much larger population as the estimation would give a national density of only 0.15 badgers/km^2.

The badger population has the potential to increase by around 70% each year, with 50% of that figure subject to natural mortality. According to this estimation, it would therefore leave a 20% residual margin for overall population growth. The causes of natural mortality were identified in an autopsy of 1,206 badgers by the British MAFF. Included in the autopsy were reports of starvation in both very young and very old badgers, infected bites, raspatory infections, lymphosarcoma. It is estimated that among mammals the badger has a relatively high infant mortality rate, with reports suggesting that 37.5% of badger cubs die before emerging from their sett[93].

Fox, Red *(Vulpes vulpes)*

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89 Zdenek Berger Dobroruka, Ludek j., *Mammals* (Aventinum, 2004).
90 Jacques Hausser and Markus Graf, 'Meles Meles', *Säugetiere Der Schweiz / Mammifères de La Suisse / Mammiferi Della Svizzera*, 8235 (1995), 395–99 <https://doi.org/10.1007/978-3-0348-7753-4_76>
91 *Hausser and Graf.*
92 H I Griffiths and D H Thomas, *The Conservation and Management of the European Badger (Meles Meles)*, 1997.
93 *Griffiths and Thomas.*

Description

One of the most common European carnivores. It reaches medium size, has a long bushy tail (over 50% of the body length) an elongated muzzle and large pointed ears, worn upright. The colour is mostly rusty, only the throat, abdomen and tail end are white, and the back of the ears and paws are black. However, there are also individuals significantly lighter or darker.

Body length 50 - 80cm, tail length 30 - 45 cm, height at withers 35 - 40 cm, length of hind paw 13 - 17 cm, ear length 8 - 10 cm, weight 3 - 10 kg[94].

Habitat

In Europe it is found in a very wide variety of habitats including all types of forest and open landscapes. It is well adapted to many anthropogenic habitats including farmland and suburban and urban areas[95,96]. The wide range of habitats includes forested areas and calamitous clearings, groves, shrubs, shores of stagnant and flowing waters, field landscape, quarries, reclamation, as well as the surroundings of human settlements. There are also purely urban populations living permanently in big cities. It occurs mainly in the range of 200 - 800 m, but sometimes also at altitudes above 1400 m[97].

The Red Fox has an extremely large range. It is distributed throughout the northern hemisphere, from the Arctic Circle to North Africa, Central America, and the Asiatic steppes. It occurs throughout the whole of Europe, with the exception of Iceland, Svalbard, Crete, and some of the smaller Mediterranean and North Sea islands[98,99,100,101,102,103]. European subspecies were introduced to the eastern states of the US (e.g., Virginia) in the 17th Century, mixed with local subspecies, and then moved southwards with forest clearance. The species was also introduced to Australia in 1800s. Elsewhere introduced to the Falkland Islands (Malvinas) and to the Isle of Man (UK), although it may subsequently have disappeared there[104]. It occurs from sea level to 3,000 m[105].

Diet

Red foxes are adaptable and opportunistic omnivores, with a diet ranging from invertebrates (e.g. earthworms and beetles) to mammals and birds (including game birds), and fruit. They also scavenge in rural areas (e.g. in Europe and Canada on deer and sheep carcasses which may be the major food source in upland areas in winter), and in urban areas (on bird tables, compost heaps and refuse)[106].

Food varies greatly according to season and local conditions. The main food ingredients are rodents and other smaller vertebrates. They feed on insects, molluscs, but also forest berries and other plant food. In winter and in the period of care for youngsters hunt more hare, roe dear pups, pheasants, ducks and domestic poultry. It normally feeds on prey of lynx, or on the carrion of large mammals. It also consumes human rubbish in landfills and from garbage bins in cities[107].

Social Behaviour

The Fox is extremely adaptable and changes the way of life (activity, behaviour, food, home districts, ...) according to environmental conditions. In addition to the mating season and care of the chicks lives solitary. He leaves the hiding places only at dusk and at night, but in quiet places it can be reached during the day. Resting in thickets, rock cavities, pipes, or burrows (especially badgers). In the short term, it has been operating in an area of tens to hundreds of hectares, in the long term its territory reaches 2.5 to 10 km^2. The home districts of foxes normally overlap. Known are also nomadic cases, which during the year turns several districts. In places of high population density, foxes live in groups (urban environment) where only the leading females reproduce[108].

Reproduction

The rut takes place from January to March and after 52-53 days of gestation females usually give birth to 4-5 (3-10) pups in March-May. They become independent after 3 months, sexually mature at the age of 10 months and looking for new territory most often within 6-14 km from the place of birth. In nature they live to the age of 8 years, but individuals older than 6 years represent only 1 - 4% of the population[109].

94 Miloš Anděra and Jiří Gaisler, *Savci České Republiky*, 2019.
95 M. Larivière, S. and Pasitschniak-Arts, 'Vulpes Vulpes', *Mammalian Species*, 537 (1996), 1–11.
96 *Stubbe.*
97 *Anděra and Gaisler.*
98 *E. R. Hall, The Mammals of North America. (New York: John Wiley and Sons, 1981).*
99 *D.W. Ginsberg, J.R. and Macdonald, Foxes, Wolves, Jackals, and Dogs: An Action Plan for the Conservation of Canids. (Gland, Switzerland, 1990).*
100 *H. (ed.). Abe, 'A Pictorial Guide to the Mammals of Japan', Tokai University Press.., 1994.*
101 *Stubbe.*
102 *S. Wilson, D.E. and Ruff, The Smithsonian Book of North American Mammals (Washington D.C.: Smithsonian Institution Press.., 1999).*
103 *M. Abe, H., Ishii, N., Ito, T., Kaneko, Y., Maeda, K., Miura, S. and Yoneda, A Guide to the Mammals of Japan (Tokyo, Japan..: Tokai University, 2005).*
104 *M. and Macdonald D.W. (eds). Sillero-Zubiri, C., Hoffmann, Canids: Foxes, Wolves, Jackals and Dogs. Status Survey and Conservation Action Plan., 2004.*
105 *Stubbe.*
106 *Sillero-Zubiri, C., Hoffmann.*
107 *Anděra and Gaisler.*
108 *Anděra and Gaisler.*
109 *Anděra and Gaisler.*

Demography

According to the IUCN, the Red Fox's current population trend is stable in Europe . Fox populations are not static however, with seasonal patterns of dispersal. The number of dispersals depends on population density, home range and level of human activity and control. Dispersal distances are also extremely variable, ranging from 0 to more than 300 km, with a mean of about 40 km estimated in Sweden[110].

The red fox is usually monogamous, and the home range of each family group is relatively stable[111]. As Foxes are common in both urban and rural areas in parts of Europe there is differentiation in certain demographic values. For example, the home ranges in urban or suburban areas vary between 40 to 700 ha whereas it can reach up to 1500 ha in forests.

The red fox no longer has natural population checks from larger carnivores such as wolves since they were eradicated in some parts of Europe including the UK and Ireland. Therefore, due to this and their adaptation to farmland and suburban area, the fox population has potential to grow rapidly in some regions. However, their predation on game birds and domestic livestock such as duck or chickens means that they are subject to number regulation either from traditional hunting or, more often, shot.

Hare, European *(Lepus europaeus)*

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Characteristics

Hare belongs to a special order of Rabbits (*Leporidae*). It has an elongated body, an oval head with remarkably long ear lobes (12-14 cm) and hind legs considerably longer and stronger than the front legs. Some subspecies have smaller ears giving them the evolutionary advantage of being less visible. Yellow-brown to brown-grey colour with short black tail with white tip and long ears. Huge earlobes allow him to hear very well. Outside of hearing it has very good touch and smell. It is a bit worse with sight but can see still very well. Especially in the dark. Eyes located on the sides of the head allow an almost circular field of view.

As if frayed hair on the feet facilitates movement on smooth surfaces. The colour of the back is cinnamon brown, the sides are light-brown and the belly is almost white. The earlobes are terminated on the outside by a black tip, dark is also the upper side of the short tail. Seasonal differences in colour are not reflected, but winter hair is up to a third denser than in summer. He's a very good runner and jumper.

The pups are born with thin hair and open eyes - so they are much more developed than a rabbit. A reliable feature to distinguish hare from rabbit is that the ear ends are always black.

Measures: Head with body 55 to 70 cm, tail 7,5 to 10 cm, height 11.5 to 15 cm, weight 2,5-7 kg.

Habitat

Widespread almost all over the world. The original area extends from southern Finland and the coasts of western Europe through north-west Africa across Europe to the Near East, the Middle East and the Transcaucasus up to central Siberia, where the incidence is slowly moving eastwards.

It was artificially introduced in southern Sweden, Great Britain and most recently in Ireland. In England, the brown hare was introduced on many islands, but with little success. It also occurs in Ireland, but only in some places. Apparently, this is related to the fact that it is more sensitive to moisture and has greater demands on sheltering than the white hare.

The hare is an indigenous inhabitant of the steppes and forest steppes and seeks a rugged cultural landscape in which agricultural crops alternate with grassy areas, forests and shrubbery. The optimum combination of environmental conditions includes annual rainfall of 450-750 mm, snow cover duration of 40-60 days, and average annual air temperatures above 10 ° C. It resides on fields, meadows, boundaries, hillsides and windbreaks, in orchards, or in areas to various degrees of devastation (dumps of surface mines, abandoned quarries,...). It is commonly found

[110] *Bianca Zecchin and others, 'Genetic and Spatial Characterization of the Red Fox (Vulpes Vulpes) Population in the Area Stretching between the Eastern and Dinaric Alps and Its Relationship with Rabies and Canine Distemper Dynamics', PLoS ONE, 14.3 (2019), 1–21 <https://doi.org/10.1371/journal.pone.0213515>.*

[111] *Zecchin and others.*

on the periphery or in the garden districts of larger cities. It is also present along the edges of forests. It is found in the mountains on calamitous meadows and meadows above the upper limit of the forest[112].

The highest occurrence density of brown hare is at lower altitudes, on limestone and clayey soils cultivated relatively intensively.

Diet

The composition of exclusively vegetable food varies according to supply during the year. Overall, it is dominated by the green parts of wild herbs and crops, and at the time of the year usually consists of 2-3 ingredients, which may be one of the causes of digestive problems of hare in large-scale farming (intestinal bacteria cannot quickly adapt to new food after harvest) . In winter, with high snow cover the hare nibbles the shoots and bark of deciduous trees, and occasionally consumes various pulpy fruits and seeds. It does not search for water to drink; it usually suffices with water contained in the food[113].

Grasses, grain shoots, juicy herbs, in winter also buds and tree bark. In the diet of hares, herbs growing in the fields seem to be of great importance because, where they are lacking due to intensive cultivation, the number of field hare also decreases. At the same time, it was agriculture, which by its nature of cultural steppe made this steppe animal available to Europe.

Social Behaviour

Long ears, large eyes, sensitive olfactory organs and long legs characterize hare as an animal whose only defence is escape. If he feels threatened, he usually ducks into the recess in the terrain and folds his ears. When grazing at dusk, it moves remarkably slowly and closes to the ground.

They usually stay in one place. Marking experiments have shown, however, that they travel over more or less long distances.

The hare leads a solitary life, only at the time of mating it is possible to see several individuals together. Not only his colour, but also his natural timidity protects him from predators. In contrast, the hare is a cheerful and clever creature.

It usually rests during the day and only comes out of hiding at dusk; but the specific form of activity rhythm varies according to the season, weather, type of environment and population density.

The same largely applies to the size of home districts, which ranges from 4 to 76 ha (average around 30 ha). The vast majority of the pups settle within a radius of 3 km from the place of birth (mostly up to 500m)[114].

The body structure allows him to run at speeds of up to 75 km / h, while also jumping well into the distance (2-4 m) and height (up to 1 m).

Reproduction

The length of the breeding period is determined by weather conditions, optimally lasts from 8 to 9 months from January to September, most of the pups are born from April to July. The female usually has 2-3 litters with 2-5 pups, which about half an hour after birth are already moving well. The young are born outside, not in underground burrows like rabbits. That is why the hare chicks are capable of independent movement immediately after birth. They stay with their mother for 2-3 days, then they break up and only come to breastfeeding once a day for 3 weeks. A special feature of the hare is re-fertilization during pregnancy (so-called superfetation), which shortens the intervals between two litters (mostly by 3 to 7 days). This peculiarity occurs more in captive hares than in wild. The highest age ranges from 8 to 12 years, but in intensive hunting, only 6% of the population survives the third year of life. Typical population density ranges from 0.1 to 3.4 ex./ha[115].

Demography

In Europe, European Hare populations have experienced declines across much of its geographic range and throughout many regions. Despite this, its conservation status remains least concern worldwide on the IUCN red list[116]. It is regarded as threatened and near threatened with various other European conservation bodies however, due to noticeable declines in hunting bags and population densities over in the 20th century. In particular, the 1970's saw significant declines in hare populations with a wider range of their population decline occurring in the following two decades[117].

There are multiple studies which have investigated the causes of the decline in hare populations. Agricultural intensification is usually identified as the main threat for European hares with a certain unison of research bodies holding this view. The intensification of agricultural production has caused significant reduction in habitat heterogeneity whereby a loss of cover and lack of quality food has made the hare

112 *Anděra and Gaisler*
113 *Anděra and Gaisler*
114 *Anděra and Gaisler*
115 *Anděra and Gaisler*
116 *S. Hacklander, K. & Schai-Braun, IUCN Red List, 'Lepus Europaeus, Hare European', 8235 (2019).*
117 *Jan Cukor and others, 'First Findings of Brown Hare (Lepus Europaeus) Reintroduction in Relation to Seasonal Impact', PLoS ONE, 13.10 (2018), 1–16 <https://doi.org/10.1371/journal.pone.0205078>.*

vulnerable to predators, diseases and unfavourable weather conditions[118]. Not removing stubbles after harvesting seems to be an efficient way to decrease the decline in hare populations.

Natural population densities are around 2/100 ha but can reach up to 275/100 ha in more suitable habitats[119]. A study conducted in the Czech Republic found mean hare densities were highest in habitat with the following characteristics[120]: elevation (sea level up to 200 m); annual snow cover duration (40-60 days); mean annual precipitation (450-700 mm); annual sunshine duration (1801-2000 hrs); mean annual air temperature (>10˚C).

Population dynamics are mainly affected by juvenile mortality due to annual differences in weather conditions, mechanical activities in agricultural land, diseases, and predation[121]. Variation in climate and weather can significantly influence vital rate parameters and consequently determine changes in population density. For instance, weather effects such as variation in temperature and precipitation influence body condition, survival, and reproduction in various mammals.

Brown hares usually stick to a territory however they do not actively defend it from conspecifics and home ranges often overlap substantially. Dispersal is mostly restricted to young males with distances varying from between several hundred meters to several kilometres.

Marten, Beech *(Martes foina)*

Characteristics

Medium-sized weasel beast (the size of a domestic cat), whose movement silhouette is characterized by hunched back of the body. The bushy tail is approximately half the length of the body (45-55%), short legs are terminated by paws with strong claws and hairs between them. Basic colour is grey-brown with whitish undercoat, legs and tail darker than back. Usually, a pure white spot on the throat extends deep to the forelimbs, sometimes visible on the sides of the neck. The pink tip of the muzzle is lined with long tactile hair, other tactile hairs grow at the throat and above the eyes. The light hem is less pronounced, and the tail is less hairy and the hair is thinner than the European pine marten (*Martes martes*)[122].

Dimensions: body length 37 - 52 c, tail length 21 - 31 cm, hind paw length 7 - 9 cm, ear length 4 - 5 cm, weight 0,9 - 2,1 kg.

Habitat

It is a typical inhabitant of an open cultural landscape, the primary range of habitats includes mainly habitats of ecotone character at the edge of forests, rocky terrain, abandoned and active quarries, as well as settlements (individual settlements and villages). Over the past two decades, it has been increasingly occurring in the midst of large forests previously inhabited exclusively by European Pine Marten. In the mountains, it commonly inhabits calamitous clearings, peat bogs and sometimes appear even above the forest border. With a recent population explosion, it has increased its abundance in suburban and urban habitats, where it permanently occurs in peripheral parts and in the city centres. It avoids undeveloped areas with no buildings. The altitude range of the sites is 140 - 1600 meters above sea level. The average value is 404 meters above sea level[123].

Beech Marten's habitat preferences vary in different parts of its range. It is typically found in deciduous forest, forest edge, and open rocky hillsides (sometimes above the tree line). However, in Switzerland, northeast France, Luxembourg and southern Germany, it is very common in suburban and urban areas, often building its nest in house attics, outhouses, barns, garages, or even in motor-car engine spaces. In some areas it is common in towns and rare in woods. Commensal Beech Martens may cause damage to roofs, insulation, and electrical wiring and pipes in houses and motorcars. In some parts of its range, it seems to avoid urban areas: in Israel, it is more associated with woodland than with urban or cultivated areas, a pattern apparently typical in Mediterranean ecosystems[124].

Beech Marten occurs through much of Europe and central Asia south-east to northern Myanmar. It is found from Spain to western Portugal[125], through central and southern Europe (Mitchell-Jones et al. 1999), the Middle East (south-west to Israel, from where Werner[126] traced no records from the southern portion), and central Asia, extending as far east

118 *Stéphanie C. Schai-Braun and others, 'Estimating Sustainable Harvest Rates for European Hare (Lepus Europaeus) Populations', Sustainability (Switzerland), 11.10 (2019), 1–20 <https://doi.org/10.3390/su11102837>.*
119 *Hacklander, K. & Schai-Braun.*
120 *Hacklander, K. & Schai-Braun.*
121 *Hacklander, K. & Schai-Braun.*
122 *Anděra and Gaisler.*
123 *Anděra and Gaisler.*
124 *N.Y. Werner, 'Small Carnivores, Big Database – Inferring Possible Small Carnivore Distribution and Population Trends in Israel from over 30 Years of Recorded Sightings.', Small Carnivore Conservation, 47 (2012), 17-25.*
125 *J.C.B. Muñoz, L.J.P., Gisbert, J. and Gutiérrez, Atlas y Libro Rojo de Los Mamíferos Terrestres de España (Organismo autónomo parques nacionales, Dirección general para la biodiversidad., 2007).*
126 *Werner.*

as the Tuva (Russia) and Tien Shan mountains and north-west China[127]. In Europe, it is absent from Ireland, Great Britain, the Scandinavian peninsula, Finland, the northern Baltic and northern European Russia. At the end of 20th century, the species extended in European Russia as far as Moscow province in the north and across the Volga River in the east[128]. Along the Himalaya it occurs in Afghanistan, Pakistan, India, Nepal and Bhutan; it was recently found in northern Myanmar[129]. The species was introduced to Ibiza, Balearic Islands (Spain) but it failed. It was also introduced to Wisconsin, U.S.A.[130].

The species has been recorded from sea level to 2,000 m in Israel[131] from the lowlands to 3,400 m in Kazakhstan, and to 4,200 m in Nepal. In India, it has been found above 1,300 m (Choudhury 2013) up to 3,950 m [132].

Diet

It is highly adaptable in the diet. The main prey is small mammals and other vertebrates, which complements the eggs of birds and various fruits. It also catches insects and digs out bumble bees and wasps. It does not despise even small pets and eggs, in cities it focuses on synanthropic mammals (especially rats) and birds[133].

Social Behaviour

She lives solitary with mostly night activity with two peaks, after sunset and before sunrise, often she is caught in the gloom. He skilfully climbs the rocks and perpendicular walls of buildings, as well as beams, roof ridges and ledges of houses. He regularly alternates places of daily rest and galleries, he often seeks a place of rest in piles of brushwood, cracks and stone debris, or in barns, sheds, woodsheds, on the attics and in the cellars of buildings. A relatively new phenomenon in cities is hidden in the engine compartment or other places of cars. Adaptation to the urban environment, subject to sufficient food resources (pigeons, rodents, garbage cans), is accompanied by other eco-ethical changes, such as the shrinking of the home district from several hundred hectares to several tens of hectares. The districts are relatively stable, changing seasonally (larger in summer than winter) and gender (male three times larger than females). In nature, when hunting for food, it is rather on the ground and shrub floors. They usually don't hunt in the trees[134].

Reproduction

The mating period falls into the summer, between July and August. Unfertilized females can still mate in January-February. Of the long gestation period (maximum length of 8 to 9.5 months), about three-quarters of it is a latent stage (secret pregnancy). The young are born feathered, sucking the milk for 7 to 8 weeks and become independent during autumn. Sexually mature a year later. They live to the highest age of 8 - 10 years, but individuals over two years make up at most one sixth of the population. In the wild the population density is between 0.7 - 2 ex./km^2, in urban environment it increases up to threefold (4.7 to 5.8 ex./km^2)[135].

Demography

The population of the Beech Marten in Europe is considered stable[136]. The beech marten is widely distributed, with a range in Europe spanning from the Mediterranean to the Baltic sea[137]. There is much dispute in regards the northernmost limit of their distribution, although it is often considered to be Denmark. The species is not present in the UK, most of Scandinavia and Ireland. Its population suffered great decline in the 1900's due to over hunting and trapping, however numbers rose again between the 1950's and 1970's in countries including Germany, Denmark and Switzerland. The species also returned to regions where it had previously been eradicated such as the Netherlands[138].

Within its European range, the Beech Marten shares much of its geographical range with its more common European relative, the Pine Marten[139]. The home range of male beech martens is between 12 to 211 ha, and largest during the mating season in the summer.

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127 *Y.X. Wang, A Complete Checklist of Mammal Species and Subspecies in China (A Taxonomic and Geographic Reference). (Beijing, China: China Forestry Publishing House, 2003).*

128 *A. A. Abramov, A. V., Kruskop, S. V. and Lissovsky, 'Distribution of the Stone Marten Martes Foina (Carnivora, Mustelidae) in the European Part of Russia.', Russian Journal of Theriology, 5(1) (2006), 37–41*

129 *S. Rabinowitz, A. and Tun Khaing, 'Status of Selected Mammal Species in North Myanmar.', Oryx, 32.(2): (1998), 201–8.*

130 *C. A. Long, 'Stone Marten (Martes Foina) in Southeast Wisconsin, U.S.A.', Small Carnivore Conservation, 13 (1995), 14.*

131 *Werner.*

132 *Anděra and Gaisler*

133 *Anděra and Gaisler*

134 *Anděra and Gaisler*

135 *Anděra and Gaisler*

136 *IUCN, 'Martes Foina, Assessment by: Abramov, A.V., Kranz, A., Herrero, J., Choudhury, A. & Maran, T. View', The IUCN Red List of Threatened Species 2016, 8235 (2016), e.T29672A45202514 <http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T29672A45202514.en>.*

137 *A.V. Abramov, S.V. Kruskop, and A.A. Lissovsky, 'Distribution of the Stone Marten Martes Foina (Carnivora, Mustelidae) in the European Part of Russia', Russian Journal of Theriology, 5.1 (2006), 35–39 <https://doi.org/10.15298/rusjtheriol.05.1.05>.*

138 *Jan Herr, 'Ecology and Behaviour of Urban Stone Martens (Martes Foina) in Luxembourg', Life Sciences, 2008, 226 <https://doi.org/10.13140/2.1.3635.9047>.*

139 *Herr.*

Marten, European Pine *(Martes martes)*

Description

Medium-sized weasel beast (the size of a domestic cat), whose movement silhouette is characterized by hunched back of the body. The bushy tail is approximately half the length of the body (45-55%), short legs are terminated by paws with strong claws and hairs between them. Basic colour is dark- brown, on tail and paws almost black-brown, undercoat is grey or yellow-brown. A striking yellowish to orange spot on the throat tapering to the throat and does not reach the forelimbs. The ear lobe is lined with a narrow strip. The tip of the nose is black. Winter coat is longer, denser and softer than summer coat[140].

Dimensions: body length 40 - 53 cm, tail length 23 - 28 cm, hind paw length 8 - 10 cm, ear length 4 - 5 cm, weight 0,8 – 1,6 kg.

Habitat

Pine Marten inhabits deciduous, mixed and coniferous woodlands, as well as scrub. It does not seek out Human dwellings and avoids civilization. Optimal habitat appears to be woodlands with an incomplete canopy and dense understorey vegetation. 80% of the sites are in the range of 200 - 600 meters above sea level. The annual home district has a size of 5 - 25 km^2, in females significantly smaller than in males[141].

Pine Marten has a wide distribution in the west and central Palaearctic, across most of Europe, Asia Minor, northern Iran, the Caucasus, and in westernmost parts of Asian Russia (western Siberia). In Russia, it is expanding to the east in the southern taiga subzone: in Omsk province and Altaiski Krai, in the western districts of Novosibirsk and Tomsk provinces. It is widespread in continental Europe, with the exceptions of most of Iberia[142] and of Greece, and of parts of Belgium and the Netherlands. It is found on the Mediterranean islands of Corsica, Sardinia, and Sicily. It was introduced historically to the Balearics. It was formerly widespread in the British Isles but is now restricted to Ireland and northern Britain[143],[144],[145].

In Kazakhstan Pine Marten has been recorded along the northern border from Bolshoi Uzen' river in the west to Semey city in the east and along Ural (Jaik) river from middle reaches (Uralsk city) to the delta (Atyrau city). Inland, martens were recorded in the north part of Western-Kazakhstan province and Aktobe province, in the centre of Kostanai province, in Northern-Kazakhstan province (Petropavlovsk City), and in the north part of Akmola province (Astana city).

In 2012 the species was recorded in Temirtau city in the south. In Iran there are very few records, all those with accurate and precise locality coming from the country's north[146].

The known occupied altitude ranges from sea-level to the timber line (2,300 m in the Pyrenees).

Diet

They hunt in crowns and tree trunks. Smaller catches eat on the spot, the larger drags to the shelter or to the trees. He is a food opportunist; the composition of food varies according to seasonal and local offerings. Predominant forest rodents (Mink, Squirrel), not second place are different birds up to the size of Capercaillie. They hunt bats in the hollows of trees, insects (beetles, beetles, longhorn beetles, ...) a large part of the food is also forest berries. She also eats forest honey. Especially in winter, she looks for carrion, sometimes swallows needles and pieces of wood to help her digest[147].

Social Behaviour

They live solitary, except during the mating season. Usually hunting in the evening and during the night. During the day resting in tree cavities, or abandoned nests of predators, squirrels, crows. It is solitary, but not highly territorial. They have been using permanent trails for many years and are marking them with a stinking secretion of anal glands that it rubs against stones and branches. The home ranges often overlap partly or even totally.

Pine Marten can utilise a variety of den sites, which are used for breeding. Den sites can include rock crevices, tree cavities, subterranean burrows, buildings (abandoned or occupied), old bird nests, squirrel nests and log piles. These sites provide cover from weather extremes and safety from potential predators. Den sites are normally only occupied during the breeding season. Outside of this period, Pine Marten use what are termed refuge sites. Refuge sites can be very varied although normally they are located several metres off the ground in forest canopy. Upturned or blown over tress are often used as refuge sites, but

140 *Anděra and Gaisler.*
141 *Anděra and Gaisler.*
142 *Muñoz, L.J.P., Gisbert, J. and Gutiérrez.*
143 *J. Birks, J.D.S. and Messenger, Evidence of Pine Martens in England and Wales 1996-2007 (The Vincent Wildlife Trust, Herefordshire, UK., 2010).*
144 *P. O'Mahony, D., O'Reilly, C. and Turner, 'Pine Marten (Martes Martes) Distribution and Abundance in Ireland: A Cross-Jurisdictional Analysis Using Non-Invasive Genetic Survey Techniques.', Mammalian Biology, 77 (2012), 351–357.*
145 *C. Croose, E., Birks, J.D.S., Schofield, H.W. and O'Reilly, Distribution of the Pine Marten (Martes Martes) in Southern Scotland in 2013., 2014.*
146 *E.M. Baradarani, K. and Moqanaki, 'A Recent Record of Pine Marten Martes Martes from the Caspian Region of Iran.', Small Carnivore Conservation, 51 (2014), 82–84.*
147 *Anděra and Gaisler.*

the species can exploit any habitat feature that provides cover and safety. Pine Marten will tend to have refuge and den sites that are used repeatedly in a forest and they can have a high fidelity to these sites[148].

Reproduction

The mating period falls into the summer, between July and August. A female may mate with several males while on heat. Unfertilized females can still mate in January-February. Of the long gestation period (maximum length of 8 to 9.5 months), about three-quarters of it is a latent stage (secret pregnancy). Mostly 3 to 5 kits are born, but it can be less or more. The kits themselves are born totally infirm. They weigh about 3 decagrams, they are blind and almost bare, sucking the milk for 7 to 8 weeks and become independent during autumn. Sexually mature a year later. They live to the highest age up to 11 years, but individuals over three years are rare as most of them is hunted before the age of three. In the wild the population density is between 0.5 – 0,6 ex./km^2, exceptionally up to 0,9 ex./km^2 [149].

Demography

The IUCN reports that the current population status of the Pine Marten in Europe is stable. It has a large range through the boreal regions of Europe, and it remains widespread particularly in the northern and eastern parts of its range[150].

Overall, there have been declines in the population throughout Europe in the 20th Century, with some significant ones including an estimation of an 80% decline in Russia from the 1920's until the 1980's. The Russian pine marten population is reported to have been steadily increasing since the 1990's with figures suggesting a population of 187,000 between 2011–2013[151].

Similar to the Russian trend of pine marten populations, northern and central European countries experienced decline until the 1980's. Once abundant throughout the British Isles, its territory is now scarce and limited to Scotland with range suspected to be extending southwards once more[152]. Their functional extinction in Wales and England was mostly as a result of fur trapping and deforestation particularly[153].

Pine Marten populations are often dependant on that of the Wood Mouse, which in turn is depending on an abundance of common oak. As the main prey of the Pine Marten, there has been significant correlation between an abundance of wood mouse and larger Pine Marten litters[154].

According to the 2013 -2018 report from Article 17, the pine marten has a range in most bioregions, particularly in Alpine and Boreal, but also Pannonian where its range is part of 86.14% of Hungary's surface area. Its range extends to Mediterranean, Steppic and Atlantic bioregions as well. The highest maximum populations occur in the Slovakia with a maximum 50,000 individuals. Estonia shares the same maximum number of individuals, whilst the Czech Republic has a maximum of 45,000 individuals and Austria 42,000.

Rabbit, European *(Oryctolagus cuniculus)*

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Description

The European Rabbit (*Oryctolagus cuniculus*) is an endangered mammal originating from southwestern Europe (Spain, Portugal and France) and possibly northwest Africa[155]. They're lagomorphs with short tails and relatively large ears. While size and weights may vary depending on food and the habitat quality, the European rabbit usually measures around 40 centimetres and weights 1,2-2 kilograms[156].

148 *D. O' Mahony, Socio-Spatial Ecology and Habitat Selection of Pine Marten (Martes Martes) in Upland Coniferous Plantations, Ireland., 2009.*
149 *Anděra and Gaisler.*
150 *J. Herrero and others, 'Martes Martes', The IUCN Red List of Threatened Species 2016, 8235 (2016), e.T12848A45199169. <http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T12848A45199169.en>.*
151 *Herrero and others.*
152 *Herrero and others.*
153 *Alexander A. Grabham, Gareth Ventress, and Matt W. Hayward, 'The Diet of Denning Female European Pine Martens (Martes Martes) in Galloway Forest District, South West Scotland, Great Britain', Mammal Research, 64.1 (2019), 87–97 <https://doi.org/10.1007/s13364-018-0398-5>.*
154 *Hans Kleef and HJ Wijsman, 'Mast, Mice and Pine Marten (Martes Martes): The Pine Marten's Reproductive Response to Wood Mouse (Apodemus Sylvaticus) Fluctuations in The Netherlands', Lutra, 58.1 (2015), 23–33.*
155 *R. Villafuerte and M. Delibes-Mateos, 'Oryctolagus Cuniculus - European Rabbit', Animal Diversity Web, 8235 (2019) <https://doi.org/https://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T41291A45189779.en>.*
156 *Michael Hutchins and others, Grzimek's Animal Life Encyclopedia, Second Edi (Gale Group, 2003).*

Rabbits are fast runners, with long legs and large hind feet. The foot posture is plantigrade during slow movements, but digitigrade while running. Their body is covered in soft rather long, normally reddish to grey-brown fur. The dentition is similar to rodents', with ever growing incisors and absent canines[157].

Habitat

The European Rabbit usually lives in open grassland, with loosely compacted and well-drained soils, where they can build warrens. Even though the rabbits can usually be found living in warrens, there are also non-typical situations of living environments, as they are highly adaptable animals. They can be found in farmland areas, Mediterranean oak savannas or scrub-forests[158].

Extensive human economic activities, such as agriculture, was often a factor making rabbits colonize new areas. As a result, this species has learned how to coexist with humans. They can sometimes be found in cities, living in gardens, lawns, parks and even cemeteries[159].

Social Behaviour

Oryctolagus cuniculus is extremely social, living in family burrow systems that function as family territory. The area they occupy is usually small (around 1 ha) and made up of interconnected maze of burrows (a "warren"), where 6 to 12 adults live[160], ensuring greater breeding success[161].

Dung hills mark their territories[162] within females does tend to be more territorial than bucks, though the areas frequented mostly by females are usually not defended[163]. The European Rabbit usually stays close to its burrow, moving no more than 25-50 meters from it. However, when sudden and important changes happen, such as harvest, they can move even 500 meters. The same behaviour can also be a form of protection from predators[164].

Being gregarious animals, rabbits establish parallel dominance hierarchies within the colony, both for males and females. For bucks, access to does and therefore siring most offspring is what determines the status. When it comes to does, status is translated in access to the best nesting sites, with subordinate does usually using breeding spots far from the main warren, which puts them in greater danger of predation[165].

Diet

Rabbits are, with rare exception, herbivores, with a diet consisting mainly of herbs and grasses, but also seeds, fruits, leaves, roots, bark of trees and buds[166]. In areas with mixed crops, rabbits prefer winter wheat over maize[167]. There have also been cases of rabbits eating snails[168]. As a result, they have caused important damage to crops at various times, being considered a primary agricultural pest[169].

Reproduction

Rabbits are reflex or induced ovulators, meaning that does come into heat and become attractive to bucks, but the act of mating needs to take place in order for the ovulation to be stimulated (which will occur around 12 hours after copulation)[170]. It takes 3.5 months for the females to reach sexual maturity and 4 months for the males, with a maximum life span of around 9 years[171].

The mating system is based on the dominance hierarchy within the warren[172]. It's generally polygynandrous, but dominant males will try to monopolize particular females[173]. Lower status bucks will however form rather monogamous breeding relationships[174].

157 *Hutchins and others.*
158 *Hutchins and others.*
159 *Ati Tislerics, 'Oryctolagus Cuniculus European Rabbit', Animal Diversity Web, 2000 <https://animaldiversity.org/site/accounts/information/Oryctolagus_cuniculus.html#8a6b6ca7e04c187e316405f56f4336aa> [accessed 12 February 2020].*
160 *Hutchins and others.*
161 *Joanne C Daly, 'Effects of Social Organization and Environmental', 35.4 (1981), 689–706.*
162 *R. Mykytowycz and M. L. Dudzinski, 'Aggressive and Protective Behaviour of Adult Rabbits Oryctolagus Cuniculus (L.) Towards Juveniles', Behaviour, 43.3–4 (1973), 97–120.*
163 *Françoise M Vastrade, 'Spacing Behaviour of Free-Ranging Domestic Rabbits, Oryctolagus Cuniculus L.', Applied Animal Behaviour Science, 18.2 (1987), 185–95.*
164 *Stephan Harris and Derek William Yalden, Mammals of the British Isles: Handbook, ed. by Stephan Harris and Derek William Yalden, 4th editio (Mammal Society, 2008).*
165 *Harris and Yalden.*
166 *Hutchins and others.*
167 *Harris and Yalden.*
168 *G E H Barrett-Hamilton, M A C Hinton, and E A Wilson, A History of British Mammals, A History of British Mammals (Gurney and Jackson, 1910) <https://books.google.be/books?id=ivEbtAEACAAJ>.*
169 *Terry A. Vaughan, James M. Ryan, and Nicholas J. Czaplewski, Mammalogy, Sixth edit (Jones & Bartlett Learning, 2015).*
170 *Hutchins and others.*
171 *D Macdonald and D W Macdonald, The Encyclopaedia of Mammals, An Equinox Book (Allen & Unwin, 1984) <https://books.google.be/books?id=U6DTAQAACAAJ>.*
172 *Hutchins and others.*
173 *Tisleris.*
174 *Gabriela González-Mariscal and others, 'Transitory Inhibition of Scent Marking by Copulation in Male and Female Rabbits', Animal Behaviour, 53.2 (1997), 323–33.*

Rabbits can reproduce all year round. However, the breeding period usually takes place during the first half of the year[175]. The gestation period for rabbits is about 30 days, the average litter contains 5 to 6 young, born without any fur and with their eyes closed, which makes them altricial[176]. In overpopulated colonies does may experience intrauterine resorption and lose their embryos[177].

Before giving births, they will construct a "stab", which is a separate burrow away from the warren, typically in open field, that will function as a nest. Breeding burrows are made out of moss, grass and fur from the belly of the doe, serving also as shelter from predators[178]. The kittens will stay in this nest, where their mom will come and visit once a day for a few minutes in order to nurse them[179]. This apparent lack of parental care is however compensated by the richness of lagomorph milk[180].

Demography

According to the IUCN, the European Rabbit population is decreasing, with this trend escalating in recent years. Previously there had been population declines recorded, for example in Portugal between 1995 – 2002 which saw a 24% reduction in the population however this decline was much more pronounced previously as a consequence of myxomatosis and RHD outbreaks in the 1950's and 1980's. As of 2005, rabbit populations in the Iberian Peninsula had declined to as little as 5-10% of the number from 1950, based on the decrease in Doñana National Park, a protected area.

Decline has been uneven across the range, due to varying degrees of threat. Most recently, beginning in 2011-2012, a new wave of disease (a new variant of Rabbit Hemorrhagic Disease virus – GI.2/RHDV2/b) has swept through many rabbit populations causing massive declines.

Density of rabbits has been recorded at a maximum of 40 per hectare in prime habitat, though the abundance has declined significantly since the arrival of new threats such as viral diseases like myxomatosis and RHD[181].

Rabbit density in the proximity to Yeguas River in Andújar and Cardeña National parks in southern Spain, declined from more than 3.5 rabbits/ha in 2010 to less than 1 rabbit/ha in 2013 (a decline of approximately 75%). Hunters have similarly noted the decreased abundance of rabbits based on declines of 70-80% in the hunter bags in some estates compared with recent years[182]. Also, rabbit abundance decreased by 57% between 2010 and 2014 in 26 localities surveyed in the Córdoba province (southern Spain), only 11% of these populations experienced a positive trend during the study period[183]. The recent overall estimated 60-70% decline in populations of European Rabbits has been followed by decreases of 65.7% in Iberian Lynx and 45.5% in Spanish Imperial Eagle fecundities[184].

The concentration of the wild rabbit population is estimated at between 0.5 and 10 rabbits per kilometre across Europe, representing a decline in population of approximately 30% over the last 10 years.

Estimates of rabbit mortality resulting from myxomatosis approaching 100% were common in several European countries. Empirical information shows that the disease became endemic and, although rabbit mortality in the field fell progressively over the following decades, populations have never returned to their former levels[185].

Birds

Bustard, Great *(Otis tarda)*

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[175] *Walker's Mammals of the World, ed. by Ronald M. Nowak, 6th editio (Johns Hopkins University Press, 1999).*
[176] *Hutchins and others; Nowak.*
[177] *Harris and Yalden.*
[178] *Barrett-Hamilton, Hinton, and Wilson.*
[179] *Vaughan, Ryan, and Czaplewski; Hutchins and others.*
[180] *Hutchins and others.*
[181] *Villafuerte and Delibes-Mateos.*
[182] *Delibes-Mateos.*
[183] Guerrero-Casado J., Carpio A.J., and F.S. Tortosa, 'Recent Negative Trends of Wild Rabbit Populations in Southern Spain after the Arrival of the New Variant of the Rabbit Hemorrhagic Disease Virus RHDV2.', *Mamm. Biol*, 81 (2016), 361–64.
[184] P. C. Monterroso, P. , Garrote, G. , Serronha, A. , Santos, E. , Delibes-Mateos, M. , Abrantes, J. , ... Alves, 'Disease-mediated Bottom-up Regulation: An Emergent Virus Affects a Keystone Prey, and Alters the Dynamics of Trophic Webs.', *Scientific Reports*, 6.36072 (2016).
[185] *JM Rosell, 'Current Health Problems in Rabbit Production.', 2000.*

Characteristics

Bird larger than Turkey, reddish brown (copper like) colour with thick striations. Bottom side white. Strong, light grey neck, powerful running legs. The male has feathers forming a beard at the base of the beak, the female is smaller and without a beard. The pups are matt coloured, have a rusty upper side of the head. Dust feather is creamy in colour with black spots and stripes[186].

Male - body length 105cm, weight 5-18 kg (one of the heaviest flying birds). Females - length 75 cm, weight 3,0-5,5 kg[187].

Large, grey-and-brown bustard. Grey head and neck, brown barred black above. White underparts with reddish-brown breast-band, developing with age in males. Males significantly larger than females and develop a gular pouch and long white whiskers during the breeding season. Upright stance and deliberate walk. In flight, powerful regular wing beats resemble an eagle, but does not glide. Voice Displaying males make hollow "umb" sound. Alarm call is a short, nasal bark. Young birds have a soft, trilling call[188].

Habitat

The main occurrence areas are steppe areas, with the cultural steppe spread more to the north[189].

Originally a species of the Eurasian steppe, this species has acclimated to agricultural landscapes[190]. It occurs in open, flat or somewhat rolling landscapes, usually with a mixture of crops (cereals, vineyards, fodder plants, in some countries also with steppic grassland[191]. The eastern subspecies inhabits both open steppe and forest steppe, including small forest openings[192]. Areas with little or no disturbance and abundant supply of insects are required for successful breeding. Nest sites are selected in grassland, fallow or cereal fields[193] (primarily alfalfa in Central Europe and wheat in Russia, Mongolia and Kazakhstan[194] in areas of low patch-type diversity, far from human infrastructure and with good horizontal visibility[195]. The eastern subspecies nests in agricultural mosaics, open steppe, and adjacent to forest edge[196]. It exhibits highly variable migratory behaviour across populations, including obligate winter migrants (Asia, Russia), facultative migrants (central European populations) and partial winter and summer migrants with differential migratory pattern by sex (Iberian populations)[197],[198],[199].

The great bustard is traditionally a dry grassland/steppic species but in Europe it is now found almost exclusively in flat open agricultural land, especially traditional extensive farmland. Birds in Iberia inhabit mixed forms of pasture, arable and fallow land, while those in Hungary live in steppic grasslands, pastures and semi-natural grasslands (puszta) intermixed with agricultural land. A certain amount of fallow land (e.g., fallow plots, set-aside plots, field margins, etc) is necessary to provide food and cover. Wintering habitat consists mostly of large fallow plains of leguminous crops such as alfalfa, clover, rape or other types of crucifers. Studies have shown that Great Bustard will preferentially select stubble fields, but will avoid ploughed or uncultivated areas, or any areas with roads, power lines or other human artefacts. Great Bustards show strong fidelity to sites already used by other bustards (con-specific attraction), even if suitable habitat is available elsewhere. This may limit the re-colonisation of previously occupied or newly created sites[200].

Diet

Food is predominantly vegetable, to a lesser extent animal - from insects to small vertebrates. Great bustards are omnivorous and opportunistic feeders. They usually forage in cultivated areas and depend on leguminous crops such as clover, alfalfa, black mustard and turnip, which constitute their main food source in the winter along with seeds (of wheat and barley) found on the ground after harvesting. In summer the diet is more diverse, with 40% being made up

186 *Walter Černý, Ptáci (Aventinum, 1990).*
187 *K.a kol. Hudec, Fauna ČR Ptáci 2/1 (Academia Praha, 2005).*
188 *BirdLife International, 'IUCN Red List for Birds: Species Factsheet', 2020 <http://www.birdlife.org> [accessed 15 July 2020].*
189 *Hudec.*
190 *M. Kessler, 'Современный Статус Дрофы в Центральной Азии и Шаги к Ее Сохранению [Modern Status of the Great Bustard in Central Asia and the Steps for Its Preservation]', Степной Бюллетень [Steppe Bulletin], 46 (2016), 61–69.*
191 *J. c. Alonso, 'The Great Bustard: Past, Present and Future of a Globally Threatened Species.', Ornis Hungarica, 22(2) (2014), 1–13.*
192 *Kessler.*
193 *F. Rocha, P.; Morales, M. B.; Moreira, 'Nest Site Habitat Selection and Nesting Performance of the Great Bustard Otis Tarda in Southern Portugal: Implications for Conservation.', Bird Conservation International, 23.(3) (2013), 323–36.*
194 *Kessler.*
195 *B. Magaña, M.; Alonso, J. C.; Martín, C. A.; Bautista, L. M.; Martín, 'Nest-Site Selection by Great Bustards Otis Tarda Suggests a Trade-off between Concealment and Visibility.', Ibis, 152.(1) (2010), 77–89.*
196 *Kessler.*
197 *E. Morales, M. B., Alonso, J. C., Alonso, J. A. and Martín, 'Migration Patterns in Male Great Bustards (Otis Tarda).', Auk, 117 (2000), 493–98.*
198 *J.A. Alonso, J. C.; Morales, M. B.; Alonso, 'Partial Migration, and Lek and Nesting Area Fidelity in Female Great Bustards.', Condor, 102 (2000), 127–36.*
199 *B. Palacín, C., Alonso, J. C., Alonso, J. A., Martín, C. A., Magaña, M. and Martín, 'Differential Migration by Sex in the Great Bustard: Possible Consequences of an Extreme Sexual Size Dimorphism.', Ethology, 115 (2009), 617-626.*
200 *European Commission, 'Great Bustard Otis Tarda', 2019, pp. 1–9.*

of invertebrates[201]. It also eats rodents, the chicks of other species, earthworms, butterflies, large insects and larvae. Lizards and amphibians are also eaten, depending on the season[202].

Social behaviour

Steppe species live in polygamy, up to 4 females per male. These birds are diurnal, and, among vertebrates, have one of the greatest differences in size between the sexes. For this reason, males and females live in separate groups for almost the whole year, except during the mating season. This size difference also affects food requirements as well as breeding, dispersal and migratory behaviours. Females tend to flock together with individuals who are related. They are more philopatric and gregarious than males and will often remain at their natal area for their entire life. Bustards are not great flyers. Young males disperse some 5-65km from the site where they were born whilst females will usually only disperse 0,5-5 km from their natal nest[203].

In winter, males establish a group hierarchy, engaging in violent, prolonged fights, stabbing the head and neck of other males, sometimes causing serious injury, behaviour which is typical of bustards. Some populations of Great Bustard are migratory, gathering at pre-migratory sites in great numbers in order to collectively move to winter grounds[204].

Reproduction

It nests once a year; the nest is a simple depression on the ground. It lays 1-4 eggs, sits on them for 23-25 days.

These birds are polygynous, and one male may mate with as many as five females. The males perform spectacular courtship displays, competing in a lekking system, where they gather at a 'lek' or small display ground to try to impress the females.

The breeding season is in March with striking mating calls. It nests once a year; the nest is a dent on the bare ground. Nests are usually close to leks. The female lays 1-4 eggs in May-June depending on the region and on her own incubates them for about 25 days to a month. Chicks are precocial and can immediately leave the nest. Their mother raises them, and they fledge at around 30-35 days. They do not reach full size until 80 to 120 days old, and for about ten months are dependent on their mother[205].

Demography

The Great Bustard currently has a decreasing population trend in Europe. Globally, the population of the Great bustard is estimated to be in the region of 43,847 and 56,847 individuals.

Historically the great bustard is recorded to have suffered rapid population decline due to agricultural intensification which has caused severe habitat loss and fragmentation. Collisions with power lines and hunting have also contributed to their numerical demise. Their main populations are currently situated in Russia, China and Mongolia where accurate data is lacking. However, we know that declines have continued in certain ranges including eastern and central Europe. Despite this, EU member state countries including Hungary, Austria, Germany as well as the Iberian Peninsula have reported increasing number in recent decades and a supposedly stable population since the 1990's. The population in the Iberian Peninsula, however, has very recently started to decline. The bird is vulnerable to further decline in Europe with the threat of climate change and further agricultural expansion.

The Czech Republic has always been the centre of the occurrence of southern Moravia, especially the surroundings of Znojmo. A drastic population decline occurred in the 1970s and the population decreased until the 1990s. In 1996 the last nest was detected, and the species was recorded extinct according to the Red List.

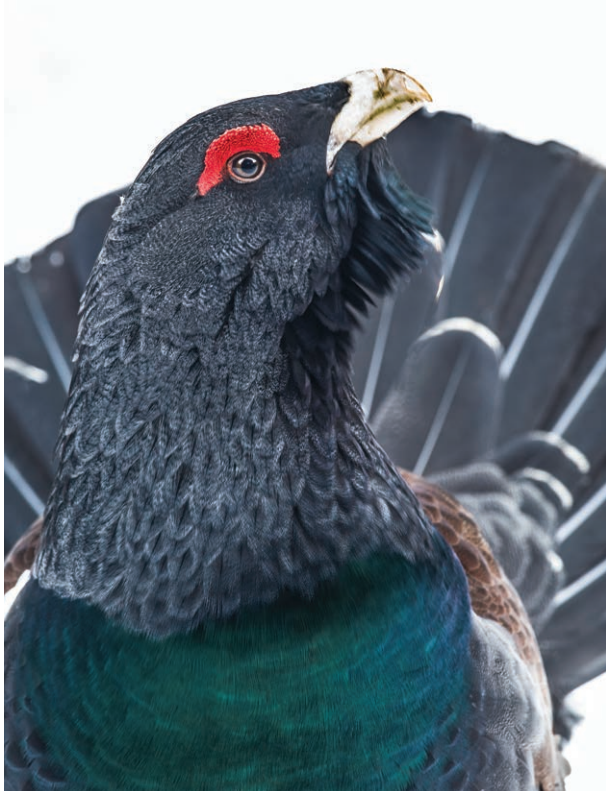
In 2006, however, the nesting in South Moravia was confirmed again, and the species is slowly returning. This is mainly the result of a very successful rescue program in Austria, where we managed to achieve an increase in population and bustards are more often found in former localities in the Czech Republic.

Reintroduction program of the Great Bustard has been running in Great Britain in recent years, otherwise the situation at the European level is not favourable ... catastrophic decline was recorded in Slovakia (almost disappearance of the population, which previously numbered up to 1000 pieces).

There are few successful experiments with artificial breeding. Strict protection and preservation of a suitable environment are required[206].

201 *European Commission.*
202 *Animalia, 'Great Bustard', 2018 <http://animalia.bio/great-bustard>.*
203 *European Commission.*
204 *Animalia*
205 *Animalia*
206 *Hudec.*

Capercaillie, Western *(Tetrao urogallus)*



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Characteristics

Nearly turkey-sized bird, dark, shiny blue-green chest. Longer rounded tail. The female is smaller, reddish-brown, has a rusty spot on her chest. Length Male: 87 cm – Female: 60 cm. Wingspan: 87-125 cm. Weight Male: 3900-4300 g (up to 6500 g) – Female: 1700-2000 g

The adult male has dark plumage, slate grey and narrowly vermiculated, mostly blackish on head and neck. Wings are dark brown with conspicuous white carpal patch. Upper and undertail-coverts and underparts are dark grey to blackish, with variable amount of white, forming spots or streaks. Underwing-coverts are white. Breast is dark glossy blue/green. The tail is long and rounded with white-tipped feathers and shaft-streaks on rectrices, forming light whitish patches. The strong bill is yellowish-white. The eyes are brown, with bright red comb above. Robust legs and feet are dark grey. Tarsi are feathered. The female is smaller than male. She has cryptic plumage overall, barred and mottled black, grey and buff. We can see a rusty breast patch. The tail is rounded and rufous[207].

The first winter the male is similar to adult but smaller. It has smaller and darker bill. In both sexes, tail feathers are narrower, and the outer pair of primaries is reddish-brown. The juvenile has pale fine streaks on mantle. The chick is mostly reddish-brown overall, with greyish wings. The bill is pink with blackish upper mandible. The eyes are dark brown to black. It has the typical V-marking on the forehead.

Habitat

The Capercaillie needs large, mostly coniferous forests, with scattered open areas to live. The species inhabits forest and woodland, mainly coniferous or mixed coniferous deciduous[208]. It prefers extensive areas of old, shady forest often with damp soil and interspersed with bogs, areas of peat or glades, and with a dense undergrowth of ericaceous plants (*Vaccinium*, *Calluna*) but with canopy neither too open nor closed. It may use more open forest in winter and denser forest with abundant fruit bushes in summer. Important are the stands of berry bushes and herbs, which provide food and shelter.

Tetrao urogallus occupies Europe in a fragmented area outside the Iberian Peninsula and the eastern and southern Carpathians (represented by ssp. *T. u. Taczanowskii* and *T. u. Rudolfi*). The area continues to northwest Siberia. Permanent species (from some areas spring and autumn overflights are known) more common among northern populations.

During winter, it can be seen in more open forest in the northern parts of the range, but during summer, it frequents dense forest with fruiting bushes where this species can breed and moult. In south of range, it is only found in mountain forest[209].

Diet

From autumn to spring, it feeds on needles and buds of trees. For the rest of the year it eats various berries and other fruits, as well as leaves and shoots of plants. Insects and small invertebrates form a minor part of the diet. Only the chicks of animal feed predominate. The food in the stomach is crushed by the ingested stones (max. 615 pieces and weight over 40 g).

In northern parts of its range, it feeds predominantly on pine needles during the winter. In southern parts of the range its winter diet is more varied. In summer its diet includes needles, leaves, stems and berries of a variety of plants. Insects are only important in the diet of small chicks. It is mainly sedentary with local movements in winter in response to feeding requirements[210].

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207 *Nicole Bouglouan, 'Western Capercaillie' <http://www.oiseaux-birds.com/card-western-capercaillie.html>. Bouglouan*

208 *D.A de Juana, E. and Kirwan, in del Hoyo, J., Elliott, A., & Sargatal, J., Christie, Western Capercaillie (Tetrao Urogallus). Handbook of the Birds of the World Alive. (Barcelona: Lynx Edicions, 2012).*

209 *Bouglouan.*

210 *de Juana, E. and Kirwan, in del Hoyo, J., Elliott, A., & Sargatal, J., Christie.*

Social Behaviour

The Western Capercaillie male can be very vocal during displays, producing series of knocking sounds, sometimes similar to sticks being taped together "plip-plip-plip-itit-t-t klop", the last note recalls the sound of a cork popping from a bottle! This series is followed by repeated harsh rasping wheezes. The male also produces loud guttural bubbling. The female often utters several calls when watching for displaying males, with one similar to the "crow" of pheasants

At the beginning of the breeding season, in spring, these shy and wary birds gather at traditional sites to display communally. These ritual displays are spectacular and used to attract females and keep other males at bay, and even other animals, including humans. They can become fairly aggressive, and an unpaired male may display to anything that moves!

Usually, the Western Capercaillie calls from tree branches before coming down to the ground with a noisy flight. Then, the ground displays can start. A male may display alone or with other males, and mainly at dawn for safety. During the ritual displays, the male cocks and fans widely its rounded tail. The wings are dropped in order to expose the white carpal patches. Such male challenges to rivals while uttering its peculiar "popping" song.

Females select males on visual factors such as beauty of plumage, song and vigour of displays, but also performances during confrontations.

Males often fight in territorial defence, adopting ritual postures like during displays. They call and bow facing each other, pecking out at rival's head but without true contact. However, disputes may turn into real fight with intensification of pecks and strong wing beats. Birds can be killed during such combats, or they die quickly due to injuries.

The Western Capercaillie is mainly sedentary in its range, only performing local movements in winter according to weather conditions and food resources. The Western Capercaillie is mainly terrestrial but if flushed, it rises with noisy strong wingbeats. Then, its flight is silent. It is able to twist with agility between trees within dense forest. Wings are large and rounded and allow powerful wingbeats[211].

Reproduction

Males form ill-defined leks[212]. The flow begins in March. Since April the female lays 5-10 eggs into the nest, which is usually shallow depression on the ground lined with plant material or feathers, most often at the base of the tree. They sit on them for 26-28 days, mostly the first day the chicks leave the nest and are taken to places with enough food. The females only rake their food, the cubs feed themselves from the beginning. They grow very fast; at the age of 14 days, they already fly a long distance. They are fully fledged at the age of 30-40 days, they remain with the female until autumn, and are divided into flocks by sex in winter. In nature, the highest age was 12 years, captive more than 18[213].

The main threat to this species is destruction or alteration of its woodland habitat. It is still commonly heavily hunted (even during breeding season), except in SW and C Europe. Other factors possibly involved in declines include disturbance (e.g., development of ski facilities and other winter recreation activities), collisions (especially of juveniles) with high-tension powerlines and in some areas fences, predation (e.g. by foxes), pollution (acid rain) and climatic changes, (e.g. in Scotland).

Demography

In Europe, there is estimated to be a Capercaillie population of between 660 000 – 1,000,000 males. In total this equates to between 1 330 000 and 2 000 000 mature individuals. The European population is increasing according to BirdLife international 2015 report; however, the overall population trend is that the species is decreasing[214].

Europe makes up roughly 40% of the Capercaillie' global range. Therefore, the global population is estimated to have between 3 000 000 and 5 500 000 mature individuals.

A globally decreasing population trend is as a result of habitat destruction and alteration. Significant range contraction has occurred both in the west and east of the species' range. The species has experienced local extinctions in some areas[215].

The Black Forest in south west Germany has had fluctuating population trends annually since 1970, however there has been a significant long-term decline. In 1971 there were 570 males counted whereas in 2018 only 167 were counted. Whilst there is no clear reason for the decline in this scenario, it is speculated that causes would include habitat deterioration from changes in forestry practices and management as well as pressure from increased predation and climate change[216].

[211] *Bouglouan.*
[212] *de Juana, E. and Kirwan, in del Hoyo, J., Elliott, A., & Sargatal, J., Christie..*
[213] *Hudec.*
[214] *BirdLife International, 'Tetrao Urogallus, Western Capercaillie', IUCN Red List, 8235 (2016).*
[215] *BirdLife International, 'Tetrao Urogallus, Western Capercaillie'.*
[216] *BirdLife International, 'Tetrao Urogallus, Western Capercaillie'.*

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Coot, Eurasian *(Fulica atra)*

Description

The Eurasian Coot (*Fulica atra*) is a water bird from the *Rallidae* Family nesting in almost all Europe. It is a sedentary species in temperate climate areas, but populations in the North and East of the continent migrate to the central, western and southern areas in winter. Some even reach North Africa. Departure to winter areas is in September, and the return trip begins in February[217].

The male and the female have a black head, a black body with grey wreaths, a white beak with a small white flash on the forehead, contrasting with their black body. The eyes are red, the legs are yellow-green, and the feet are partially palmate and grey, with scaly skin and long fingers. The clawed and robust legs help them swim and dive in the water. The body length is 36-39 cm, with a 70-80 cm wingspan, and an average body weight between 600-900 g. It can live up to 15 years. The male and the female look very much alike, although the female is slightly smaller[218].

Habitat

It lives in areas with small, quiet waters, lakes, ponds, irrigation canals, dams, marshes and ballast. It nests mostly on flooded pits and lakes, with overhanging branches or marginal vegetation. It winters on bigger lakes and more open shores[219].

The common coot usually avoids narrowly confined, closely overgrown and very shallow waters or those waters overshadowed by cliffs or trees[220]. When solitary, *Fulica atra* roosts at sunset on mudbanks, sandbanks, small islets, floating mats of vegetation or branches of trees over water, while more open waters and meadows are preferred when in flocks[221].

The nest is quite large, built disorderly from stems of aquatic plants and reed beds laid in layers, lined with moss, wet plants, reed and other surrounding plants. Usually, the nest has a height of 11-20 cm and a diameter of 26-38 cm, and after drying it is an extremely durable construction, so that it is not drained by the current. The male has a habit of building a second nest to spend his resting hours[222].

Social behaviour

When it is in danger, it sinks quickly, or hides in the reed bushes, being a timid and very cautious bird. Sometimes it has a habit of hitting water with its feet, hitting the enemy with splashes of water and flying fast so it won't get caught.

During the nesting season, males are the first to reach the breeding places. Often, they occupy a small territory and fight each other for its defence, as the species have a highly developed territorial sense. They swell their feathers, push each other into the water until they manage to chase away any rival from the bounded territory. The male attracts the female by swimming on the surface of the water, holding his elongated neck up. The female and the male build a nest together in the reed hatches, on the bent or dead stems, mostly the nest floats on the water[223],[224].

The species nests in loose colonies[225] of dispersed solitary pairs[226]. During winter, the Common Coot is highly gregarious and can be found in large flocks up to several thousand individuals[227].

217 *BirdLife International, 'Fulica Atra', The IUCN Red List of Threatened Species 2019: E.T22692913A154269531., 2019 <http://www.iucnredlist.org/>; The Book of British Birds, ed. by Marion Paull and Caroline Boucher (The Reader's Digest Association Limited, 2009), p. 197.*

218 *Rob Hume, RSPB Complete Birds of Britain and Europe (Dorling Kindersley, 2002), p. 159; Mark Beaman and Steve Madge, The Handbook of Bird Identification for Europe and the Western Palearctic (London: Cristopher Helm Publishers, 1998), p. 272; Paull and Boucher, p. 197.*

219 *Paull and Boucher.*

220 *BirdLife International, 'Fulica Atra'.*

221 *BirdLife International, 'Fulica Atra'.*

222 *Jerome A. Jackson, J. Walter Bock, and Donna Olendorf, Grzimek's Animal Life Encyclopedia. Volume 9. Birds II (Gale Group, 2002), p. 50; BirdLife International, 'Fulica Atra'.*

223 *Paull and Boucher.*

224 *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 9. Birds II.*

225 *Paull and Boucher.*

226 *BirdLife International, 'Fulica Atra'.*

227 *BirdLife International, 'Fulica Atra'.*

Diet

Fulica atra is characteristically omnivorous, but its diet consists largely of vegetal intake[228]. It feeds, mainly, with aquatic plants, but does not refuse invertebrates, birds' eggs, amphibians, fish or small mammals. It obtains its food by easily diving under water and bouncing back up like a cork or by collecting it on the ground. Its diet includes shoot of reeds, roots of water plants, corn and seeds, some small fish, newts, tadpoles, dragonfly nymphs and other water insects[229].

Reproduction

The Eurasian Coot reaches sexual maturity at the age of two years. It's a monogamous species, extremely territorial in the mating season, aggressive both towards its own species and towards other species. In terms of sexual display, coots share similar components with moorhens. The mating ritual includes a bowing-and-nibbling ceremony, a greeting and passing ceremony, and a courtship chase[230].

The female lays 4-12 eggs which are hatched for 22-30 days by both parents, who take turns. The female and the male protect their chicks and eggs, hiding them as best they can in the reed bushes, so they are not observed by predators, especially by crows. The chicks grow fast, and when they reach half the weight of the adults they start to fly. The juveniles are fully independent 55-60 days after hatching. The species usually have 2 brooms per year[231].

Demography

The European population of the Common Coot is estimated at 945,000 – 1,550,000 pairs and therefore around 2,000,000 – 3,090,000 mature individuals. The global population has increased by 19% since 1980, and the population trend is currently increasing as well. There is estimated to be between 8,000,000 and 9,750,000 individuals. Of that number, it is likely that around 5,300,000 – 6,500,000 are mature individuals. Across the globe the population trends are inconsistent with some regions reporting increasing, decreasing and stable numbers as well as unknown trends. Whilst Europe's current trend is one of increase, it is projected that populations will decline and approach a rate of decline of 30% within the next three generations or 21 years[232].

France makes up 7% of the European population with between 234,200 – 294,000 individuals and this population has seen an increase of 29% since the year 2000[233].

The common coot is a widespread breeder across Europe. Its large European breeding range accounts, however, for less than half of its total global breeding range. The population in Europe underwent a significant increase between 1970 – 1990, although important populations in Central and Eastern European as well as Russian populations declined between 1990 – 2000 despite much of Europe maintaining a stable or increasing population during the same period[234].

Crake, Corn *(Crex crex)*

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Description

Sexes similar, but female has slightly warmer buff upperparts, narrower and duller grey streak over eye, and sometimes less grey on cheeks, neck and breast.

228 *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 9. Birds II.*
229 *Paull and Boucher.*
230 *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 9. Birds II, p. 50.*
231 *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 9. Birds II, p. 50.*
232 *IUCN, 'Fulica Atra', 8235 (2019).*
233 *Birdlife International, 'European Birds of Conservation Concern: Populations, Trends and National Responsibilities', BirdLife International, 2017, 1–172*
234 *Greater Short-toed Lark, 'European IUCN Red List Category –', Europe, 3 (2000), 1994.*

Non-breeding plumage similar to breeding, but upperparts more rufous-brown, less grey; male has less grey on side of head, and little or none on neck and breast. Immature very like adult but probably has limited barring on upperwing-coverts. Juvenile like adult but has narrower, more buff-yellow-tinged, brown feather fringes on upperparts; less barring on upperwing-coverts; grey of sides of head, fore neck and breast replaced with buff-brown, sometimes with white dots on breast; less contrastingly barred flanks; duller iris; dark grey legs and feet[235].

27–30 cm; male 129–210 g, female 138–158 g; wingspan 42–53 cm.

Habitat

The species breeds in open or semi-open habitats, mainly meadows with tall grass. The original breeding habitat would almost certainly have been riverine meadows of *Carex-Iris-Typhoides* and alpine, coastal and fire-created grasslands with few trees or bushes present[236]. The species is now strongly associated with agricultural grassland managed for the production of hay[237]. Suitable habitats include moist, unfertilised grassland and regularly cut meadows in areas of low-intensity agriculture where vegetation grows tall in summer. Across its European range, hay or silage fields in valleys liable to flooding seem of most importance, but birds also breed in hay and silage fields in subalpine areas. Wetlands and marsh edges may act as important refuges when drier habitats are unsuitable. Males are also found singing in clear-cuts in forest, pastures and young conifer plantations. Singing males can regularly be heard in fertilised meadows or fields sown with cereals, but successful reproduction here is thought to be infrequent[238].

It avoids very marshy areas, standing water, river and lake margins and open ground with rocks, stones and gravel[239], and also those areas with a thick layer of dead grass or very dense vegetation above 50 cm tall[240]. Adults move to areas of high herbage along ditches to moult after breeding[241]: embankments or fallow areas adjacent to the breeding habitat are very important as moulting sites[242].

During migration it occurs in a variety of habitats including wheat fields and on golf courses[243]. In the wintering grounds dry grassland and savanna are preferred with birds also occurring in rank grass near rivers, sewage ponds and pools and in relatively short grass in wetter areas, moist sedgebeds and reedbeds and in tall grass within young conifer plantations[244]. It also occurs in *Eragrostis* hayfields, old land and pastures, maize fields bounded by grass, fallow and abandoned cultivation uncut grass on airfields, and the edges of sugarcane[245]. It occurs where vegetation is between 30cm and 2m in height, and often in areas that are burnt during the dry season[246].

Diet

It feeds on a wide range of invertebrates, including taxa living on plants, on the soil surface and in the soil[247]. Earthworms, molluscs, *Isopoda*, *Diplopoda*, *Arachnida* and insects (including *Coleoptera*, *Diptera*, *Dermaptera*, *Orthoptera*, *Odonata*, *Dictyoptera* and *Hymenoptera*); also small frogs, small mammals and birds (in captivity), green parts of plants, and seeds (especially grasses and grain). Diet similar in wintering areas; in South Africa takes many ants, termites and dung beetles (*Scarabaeinae*). In wintering areas normally forages within cover, occasionally on open grassy tracks or dirt roads; takes food from ground, low-growing plants and interior of grass tussocks; shifts and probes litter with bill; runs to catch active prey. Most active at dawn and dusk, after rain and during drizzle[248].

Social Behaviour

The species is a long-distance migrant[249]. It breeds during the months of April-August, with nests generally well separated but sometimes only 20-55 m apart from one another[250]. It is sequentially polygy-

235 *G. M. Taylor, B.; Kirwan, 'Corn Crake (Crex Crex), Version 1.0. In Birds of the World (J. Del Hoyo, A. Elliott, J. Sargatal, D.A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.*
236 *N. Green, R. E.; Rocamora, G.; Schäffer, 'Population, Ecology and Threats to the Corncrake Crex Crex in Europe.', Vogelwelt, 1997, 117–34.*
237 *K. N. Barnes, The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. (Johannesburg: BirdLife South Africa, 2000).*
238 *U. Schäffer, N.; Mammen, 'Proceedings of the International Corncrake Workshop 1998.', in Proceedings of the International Corncrake Workshop 1998., 1999.*
239 *J. del Hoyo, J., Elliott, A., and Sargatal, Handbook of the Birds of the World, Vol. 3: Hoatzin to Auks. (Barcelona, Spain: Lynx Edicions, 1996).*
240 *K.E.L. Cramp, S.; Simmons, Handbook of the Birds of Europe, the Middle East and Africa. The Birds of the Western Palearctic, Volume II: Hawks to Bustards. (Oxford, U.K.: Oxford University Press, 1980).*
241 *B. Taylor, Rails: A Guide to the Rails, Crakes, Gallinules and Coots of the World. (Robertsbridge, UK.: Pica Press, 1998).*
242 *Taylor, Rails: A Guide to the Rails, Crakes, Gallinules and Coots of the World.*
243 *Taylor, Rails: A Guide to the Rails, Crakes, Gallinules and Coots of the World.*
244 *Barnes.*
245 *Barnes.*
246 *Taylor, Rails: A Guide to the Rails, Crakes, Gallinules and Coots of the World.*
247 *Green, R. E.; Rocamora, G.; Schäffer.*
248 *Taylor, B.; Kirwan.*
249 *del Hoyo, J., Elliott, A., and Sargatal.*
250 *Taylor, Rails: A Guide to the Rails, Crakes, Gallinules and Coots of the World.*

nous, with some males moving a considerable distance to new singing areas[251]. A male's territory may encompass several nests[252], and local concentrations of breeding birds therefore sometimes occur[253]. The species normally produces two broods per year. It begins to leave its breeding grounds in August, with a peak in September[254], and arrives on its African wintering grounds in November-December[255]. It migrates at night, travelling at low altitude[256]. During migration it sometimes travels in pairs[257], occasionally forming groups of around 20-40 individuals[258], and diurnally resting flocks may contain several hundred birds[259]. It occurs solitarily during the non-breeding season, individual birds holding territories of 4-9 ha[260]. The return migration begins in late February or March, and the breeding grounds are occupied from mid-April[261].

Advertising call of male a monotonous, rasping double call "krek-krek"; calls from ground or low perch; early in breeding season may call for hours, both day and night. Male also has "growling-mew" call, like grunting squeal of small pigs, used when aggressive and in sexual display. Also, various grunts, whistles, cheeps, clicks and quacking notes[262].

Reproduction

Mating season from April–August. Monogamous pair-bond of seasonal duration formerly assumed, but serial polygyny regularly occurs, males occupying shifting and overlapping home ranges, and mating with two or more females, remaining with a female only until second half of laying period. By means of acoustic identification of individual males it has been found that in Central Europe 50% of males change territories during the breeding season[263].

Nest-site in grassland; sometimes in safer sites along hedgerows, near isolated trees, or in bushy or weedgrown areas. Nest on ground, in dense continuous vegetation or in tussock; sometimes only a scrape but usually shallow cup of grass, weeds and brambles, lined with dead leaves; often with surrounding stems pulled over top in loose canopy; average external diameter 12–15 cm; depth 3–4 cm; probably built by female alone.

Usually 8–12 eggs (6–14), laid at daily intervals; clutches of up to 19 by two females; incubation 16–19 days, by female alone; hatching synchronous; chick has sooty brown-black down, tinged rufous-brown on upperparts, grey-brown iris, pale pink bill (soon becoming black-brown), and black legs and feet; chicks precocial, leave nest soon after hatching; cared for by female alone, sometimes by two adults (unclear if second is male or female); self-feeding after 3–4 days; independent at fledging or earlier; fledging 34–38 days, when capable of flight; post-juvenile moult then begins and is completed after circa 1 month. Age of first breeding one year. 1–2 broods, in western Europe two broods are normal, first hatching mid-June, second in late July; replacements laid after egg loss[264].

Demography

According to Birdlife International[265], in 2004 there was a population of approximately 1,300,000 to 2,000,000 breeding pairs in Europe. Previously there had been estimates that the population of breeding pairs was between 1,000,000 and 1,800,000 pairs in 1999 A further 500,000 – 1,250,000 pairs are estimated to be present in Eastern Asia bringing the total population to around 2,000,000 – 3,400,000 pairs and between 5,400,000 and 9,700,000 individuals.

According to the European Commission's list of threatened species in 2019, there has been steep decline in Corncrake numbers in Europe. It reports that despite being widespread throughout EU member states the corncrake has a population of just 2,800 – 4,500 pairs. The report justifies these figures through the habitat loss caused by mechanisation and the intensification of hay and silage making. This has resulted in the destruction of nests and young particularly but also adults. Collisions with powerlines and hunting are also reported to pose threats to the Corncrake.

Despite a stable current population trend. It is projected that the Corncrake will undergo a series of declines (between 1 – 20%) in parts of its range in the forthcoming three generations, an 11-year period. Whilst it's range in Russia and Kazakhstan are expected to remain relatively stable, its European popula-

251 *Green, R. E.; Rocamora, G.; Schäffer.*
252 *Taylor, Rails: A Guide to the Rails, Crakes, Gallinules and Coots of the World.*
253 *Taylor, Rails: A Guide to the Rails, Crakes, Gallinules and Coots of the World.*
254 *K.E.L. Cramp, S.; Simmons.*
255 *K.E.L. Cramp, S.; Simmons.*
256 *del Hoyo, J., Elliott, A., and Sargatal.*
257 *K.E.L. Cramp, S.; Simmons.*
258 *Taylor, Rails: A Guide to the Rails, Crakes, Gallinules and Coots of the World.*
259 *Taylor, Rails: A Guide to the Rails, Crakes, Gallinules and Coots of the World.*
260 *Taylor, Rails: A Guide to the Rails, Crakes, Gallinules and Coots of the World.*
261 *K.E.L. Cramp, S.; Simmons.*
262 *K.E.L. Cramp, S.; Simmons. Taylor, B.; Kirwan.*
263 *T.S. Budka, M.; Wojas, L.; Osiejuk, 'Is It Possible to Acoustically Identify Individuals within a Population?', Journal of Ornithology, 156.(2): (2015), 481–488.*
264 *Taylor, B.; Kirwan.*
265 *IUCN Redlist BirdLife International, 'Crex Crex, Crake Corn', 8235 (2015).*

tion has cause for concern with projections of land use changes causing a decline of between 1 – 20%.

Crow, Carrion *(Corvus corone)*

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Description

Corvus corone is a uniformly black bird, averaging 47 cm in length. It weighs between 300 - 450 grams as an adult. In certain light, its feathers appear glossy. The male and female look alike.

Crows' feet are anisodactyl, with three forward-facing toes, and one back-facing toe. The wingspan of an adult carrion crow is between 84 and 100 cm. It looks very similar to an immature rook, *Corvus frugilegus*, but can be distinguished by the carrion crow's larger beak. It is nearly identical to a raven, *Corvus corax*, except for the carrion crow's much smaller size and lighter bill[266],[267].

A rather compact archetypal crow with relatively flat crown running onto slightly arched culmen. Plumage is wholly black, greenish hue on head and wings becoming more purplish-red on rest of upperparts, the lower underparts dull black; in worn plumage, becomes very dull, unglossed black overall; iris dark brown; bill and legs black.

Juvenile has plumage duller and rather looser, sootier black, than adult, also greyer iris and pinkish-red interior of mandibles (grey in adults) and may show pale or fleshy gape-flanges into first autumn; birds with whitish patches on wings (on some forming a band along whole length of wing, at bases of primaries and secondaries) are not unusual and seem invariably to be first-years. Hybrids between present species and *C. cornix* vary from being almost wholly black with scattered grey feathers on mantle and breast to being *cornix*-like with blackish markings[268].

Habitat

Carrion crows live in a variety of habitats. Historically, they lived in marshlands, lightly cultivated areas with sparse tree cover, and on coasts. More recently, they have adapted to suburban and urban areas to an incredible degree. They use parks and buildings for nesting, and forage for food in landfills and dumpsters. Individuals in cities have very similar foraging success to those in non-urban environments. The only major detriment observed is a decrease in nutritional health. They are not limited by elevation, existing from sea level up into mountainous areas. Carrion crows tend to nest in trees or on cliffs[269],[270].

Inhabits a huge variety of open country, preferably with at least scattered trees. Favours mixed farmland, parks and gardens, also by forest clearings, and equally at home on moorland and on inshore islands, coastal cliffs and estuarine flats. Ascends to 2000 m in Swiss Alps.

Diet

Carrion crows are omnivores, consuming living invertebrates, and the seeds and nuts of plants. They have also been known to steal crops from humans, especially corn. There have been many reported instances, some with documented evidence, of *Corvus corone* engaging in extremely complicated foraging behaviours. They have been seen stealing fish from baited lines by pulling the line in with their beak and feet, as well as using cars to crack nuts too strong for their beak.

Diet varies according to local habitats, but consists basically of invertebrates, especially earthworms (*Lumbricidae*), small mammals, frogs, bird eggs and nestlings, as well as carrion; in addition, small amounts of grain and weed seeds taken. Feeds almost entirely on ground, turning over seaweed, dung or stones to get at insects and other invertebrates. Although not known for its agility in the air, will pursue other birds to make them drop or regurgitate food items. Surprising number of reports of attempting to catch birds in flight. Opens shellfish by flying high before pausing

266 *Hollom. Peterson, R., G. Mountfort, A Field Guide to the Birds of Britain and Europe. (Boston: The Riverside Press Cambridge: Houghton Mifflin Company Boston., 1954).*
267 *H. Richner, 'Habitat-Specific Growth and Fitness in Carrion Crows (Corvus Corone Corone).', Journal of Animal Ecology, 58.2: (1989), 427–40.*
268 *S. Madge, 'Carrion Crow (Corvus Corone), Version 1.0. In Birds of the World (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.*
269 *D. Canestrari. Baglione, V., J. Marcos, 'Cooperatively Breeding Groups of Carrion Crows (Corvus Corone Corone) in Northern Spain.', The Auk, 119.3: (2002), 790–99.*
270 *Peterson, R., G. Mountfort.*

and dropping them on to a hard surface, repeating the performance several times if necessary. Pairs patrol roadsides in early mornings for roadkill carrion, or forage along lakeshores, across intertidal mudflats and along seashores, searching for both dead and live food items. Exceptionally, recorded as picking dead and live fish from surface of lake, even hovering briefly while doing so, sometimes using feet, as well as by picking from surface with bill. Although forages among taller grass than do other corvids, prefers newly mown hayfields and fresh stubble following harvest, where considerable numbers may assemble. Several observations of food-hoarding, but this habit seems to be less widespread than it is among several other corvids[271].

Carrion crows are often seen caching food. When facing competition from other birds, they often harvest much more food than is needed at one time and hide it. Studies have shown they can remember hundreds or even thousands of locations, as well as remember individual items hidden there. It has been observed that they return to and eat perishable food items before items that will keep for longer times[272].

Social Behaviour

Carrion crows live in flocks known as murders until they mate. Murders often consist of members of a few separate families. These groups often roam a large area, using their numbers to compete for resources. Once they find a mate, they leave the flock and claim territory. After establishing their territory, mated pairs defend this territory year-round in most populations. In populations living in colder territories, the pair may migrate during the winter months, moving south to a warmer climate.

Corvus corone has shown extremely complicated patterns of behaviour. Individuals of the species have been shown using tools, such as sticks to reach food items in a laboratory setting. In the wild, they have been observed using cars to open nuts too hard for them to break with their beak. There is also evidence that carrion crows can become familiar with individuals of other species[273]. found that captive carrion crows performed better on tests when they had prior experience with the individual administering the test. This has also been observed in the wild with individual carrion crows interacting with humans who live near their territory.

Carrion crows are known to either defend a territory in pairs or to roam an area in flocks of five to twenty birds known as murders. In general, only breeding pairs defend a territory, while non-breeding crows travel looking for food and other resources[274,275,276,277,278].

Mated pairs of carrion crows defend areas of 200 - 500 square meters (average 475 square meters). Murders of younger birds move across a much wider area, which has not been quantified sufficiently in the literature[279,280,281].

Carrion crows have a highly sophisticated ability to track objects visually. As seen in a study by Hoffmann & Rüttler[282], they are able to track objects even when the object in question is out of sight. They were able to successfully learn to follow out-of-sight items during variations of the classic shell game, find hidden objects based on visual cues, as well as locate objects deceptively hidden. In all cases, carrion crows were able to discover the object within the perimeters of the test after minimal learning time.

Additionally, carrion crows have shown response to olfactory cues. When exposed to familiar scents, crows were more likely to respond than they did to unfamiliar smells. Evidence shows carrion crows react to odour clues involved with foraging, predator avoidance, and recognition of other birds, including partners and kin.

Finally, carrion crows have shown the ability to mimic sounds, including human speech. However, their typical wild call is characteristic of other crow species. It sounds like "crow!" with a harsh, sometime guttural, tone to it[283,284].

271 *Madge.*
272 *C. Perrins, The Princeton Encyclopedia of Birds. (Princeton, New Jersey: Princeton University Press., 2009).*
273 *K. Kotrschal. Cibulski, L., C. Wascher, B. Weiss, 'Familiarity with the Experimenter Influences the Performance of Common Ravens (Corvus Corax) and Carrion Crows (Corvus Corone Corone) in Cognitive Tasks.', Behavioural Processes, 2013, 129–37.*
274 *Baglione, V., J. Marcos.*
275 *Cibulski, L., C. Wascher, B. Weiss.*
276 *A. Nieder. Hoffmann, A., V. Rüttler, 'Ontogeny of Object Permanence and Object Tracking in the Carrion Crow, Corvus Corone.', Animal Behaviour, 2011, 359-367/2.*
277 *A. Moll, F.; Nieder, 'The Long and the Short of It: Rule-Based Relative Length Discrimination in Carrion Crows, Corvus Corone.', Behavioural Processes, 2014, 142–49.*
278 *D. Canestrari. Wascher, C., R. Heiss, V. Baglione, 'Behavioural Responses to Olfactory Cues in Carrion Crows.', Behavioural Processes, 2014, 1–5.*
279 *Baglione, V., J. Marcos.*
280 *R. Bossema, I.; Benus, 'Territorial Defence and Intra-Pair Cooperation in the Carrion Crow (Corvus Corone.', Behavioral Ecology and Sociobiology, 1985, 99–104.*
281 *Perrins.*
282 *Hoffmann, A., V. Rüttler.*
283 *Hoffmann, A., V. Rüttler.*
284 *Wascher, C., R. Heiss, V. Baglione.*

Carrion crows can significantly affect local populations of birds by preying on their eggs[285]. This indicates they likely perform a role in population control on their ecosystem by reducing brood sizes in other birds.

Often encountered in pairs or family parties, and assemblages of 50–100 can gather at favoured feeding sites such as rubbish dumps and tidal mudflats. Larger numbers, up to 5000, may roost in mixed flocks in stands of large trees. Often indulges in apparent "play" activities, including repeatedly sliding down sloping roof, or hanging upside-down and swinging by feet from washing line or telephone wires.

Reproduction

Carrion crows form monogamous pairs, which stay together for life. They breed in early spring, from March to April. In most cases, these pairs defend the same territory they live in year-round. Some populations may migrate to a mating site.

Season commences late Mars in Britain, peak egg-laying mid-April, and dates similar in W Europe overall; single-brooded.

In a shared breeding ground in Spain, carrion crows have been known to mate with hooded crows, *Corvus cornix*. These matings produce viable hybrids which show similar reproductive success to non-hybrid individuals.

Each nest consists of just one mated pair. However, around 3% of individuals engage in cooperative mating. Cooperative breeding has been discovered in a population in Northern Spain where c. 75% of the breeding territories are held by cohesive groups consisting of 3–9 birds[286]; groups comprise a breeding pair, its philopatric offspring, and/or immigrants (mainly males) closely related to the breeder of the same sex[287]; sexually mature immigrants may share reproduction with the dominant pair, whereas non-dispersing offspring do not, thus avoiding incest[288]; non-breeders contribute to defending the territory, building the nest, and feeding the chicks and the incubating female, although some group members refrain from helping in any task, five being the maximum number of caregivers found in a group[289]; breeding females carry out the vast majority of sanitation tasks (i.e. nest and chick cleaning and fluffing of the nest's inner layer), with the exception of fecal-sac removal which is done by any adult present at the nest during excretion[290].

Each spring, a pair of carrion crows lays one clutch of four to five eggs, incubation almost entirely by female, fed on or near nest by male for first 9–10 days, male sometimes taking over for short stints. These eggs take seventeen to twenty days to hatch. The nestlings mature for an additional twenty-eight to thirty days in the nest before they fledge. Both the male and female of the species take an average of three years to begin reproduction. In some cases, young carrion crows stay with their parents for up to two years to learn foraging behaviours, or to help raise future offspring of the parents[291,292,293].

Both individuals are involved in the nest-making process. Only the female incubates the eggs, while the male continues to defend the territory and provide provisions to the female as needed. After hatching, both parents defend and feed the nestlings[294,295,296] Able to breed when 15–17 months old.

About half of all carrion crows do not live past their first year. In captivity, they have been known to live as long as 29 years, with the oldest birds dying of mental deterioration, indicating this is a true maximum to their age[297].

Demography

In Europe, the Crow has a breeding population of between 9,000,000 and 16,000,000 pairs and therefore approximately 17,00,000 – 33,000,000 mature individuals. Europe makes up around 30% of the entire global range of Crow, and so the global population would be in the region of between 60,000,000 – 110,000,000 mature individuals[298].

285 *D. Baines. Fletcher, K., A. Hoodless, 'Impacts of Predator Abundance on Red Grouse Lagopus Lagopus Scotica during a Period of Experimental Predator Control.', Wildlife Biology, 19.3: (2013), 248–56.*
286 *Baglione, V., J. Marcos.*
287 *J. Baglione, V., Canestrari, D., Marcos, J.M. and Ekman, 'Kin Selection in Cooperative Alliances of Carrion Crows. Science. 300: 1947–1949.', 2003.*
288 *J. Baglione, V., Marcos, J.M., Canestrari, D. and Ekman, 'Direct Fitness Benefits of Group Living in a Complex Cooperative Society of Carrion Crows, Corvus Corone Corone.', Animal Behaviour, 64.(6): (2002), 887–893.*
289 *V. Canestrari, D., Marcos, J.M. and Baglione, 'Effect of Parentage and Relatedness on the Individual Contribution to Cooperative Chick Care in Carrion Crows Corvus Corone Corone.', Behavioral Ecology and Sociobiology, 57.(5): (2005), 422–428.*
290 *V. Bolopo, D., Canestrari, D., Marcos, J.M. and Baglione, 'Nest Sanitation in Cooperatively Breeding Carrion Crows.', Auk., 132.(3): (2015), 604–612*
291 *Baglione, V., J. Marcos.*
292 *Perrins.*
293 *C. Randler, 'Habitat Use by Carrion Crowns Corvus Corone Corone and Hooded Crows C. c. Cornix and Their Hybrids in Eastern Germany.', Acta Ornithologica, 42.2: (2007), 191–94.*
294 *Baglione, V., J. Marcos.*
295 *Perrins.*
296 *Randler.*
297 *Perrins.*
298 *IUCN, 'Corvus Corone', 8235 (2017).*

The population in Europe has grown 20% since 1980, and in the period of 1980 – 2013 it saw a moderate increase. Overall, the global population trend is increasing. The Crow is experiencing short term and long-term breeding population growth in several European countries including Italy, Latvia and the UK. Ireland, Hungary and Austria also have increasing short term projections for breeding populations. In France and Finland, the breeding population is not expected to rise however it is likely that their ranges will increase in the countries. Finland's population will in fact decrease along with Estonia's and Bulgaria's populations.

Cuckoo *(Cuculus canorus)*

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Description

Adult male dark ashy-grey above, tail blackish brown, spotted and tipped with white, unevenly barred black. Chin to breast ashy grey, rest of underparts white with black bars. Eye-ring yellow, iris light brown to orange, bill black with yellow base, feet yellow. Female similar but has rufous-tinged upper breast; female (race *canorus* only) also occurs in a rufous ("hepatic") morph, with upperparts barred chestnut and blackish brown, rump and uppertail-coverts plain rufous, underparts white barred pale chestnut and blackish, lower breast tinged rufous. Juvenile has white nape spot, white tips to crown and back feathers[299]. Size 32–34 cm; male 114–133 g, female 106–112 g.

Habitat

The species inhabits forests and woodlands, both coniferous and deciduous, second growth, open wooded areas, wooded steppe, scrub, heathland, also meadows, reedbeds. Lowlands and moorlands and hill country to 2000 m, in Nepal up to 3800 m [300].

Social Behaviour

Migratory in North of range, arriving in South West Britain mainly April–May, when occasionally recorded in small parties, and even in one flock of 50+ birds. Resident in tropical lowland areas of South Asia. Winter resident in sub-Saharan Africa and in Sri Lanka. Palearctic populations migrate to Africa, where a Dutch-ringed juvenile was found in Togo in October and a British-ringed juvenile found in Cameroon in January. Migrants appear in N Senegal as early as late July through October; in West Africa nearly all records are in autumn (September–December), birds apparently continuing on to Central and South Africa. Satellite-tracking of individuals from UK revealed that most of those tagged in England and Scotland ended up on Téké Plateau, in SE PR Congo, in mixed habitat of gallery forest and savanna. The two surviving Welsh individuals wintering much further East of the five tagged in England in 2011, three moved South East to Italy, crossed Mediterranean and headed to the South across the Sahara to Central Africa, while the two others flew South West to Spain and then down W Africa (skirting Sahara), before moving inland to PR Congo. In 2012 a third route was taken, cuckoos from both Scotland and Wales migrating via Germany and Austria through Greece before crossing Mediterranean and heading South into the African hinterland[301]. It is a brood parasite; host species include many insectivorous songbirds such as flycatchers, chats, warblers, pipits, wagtails and buntings. Over 100 host species have been recorded.

Diet

Insects, mainly caterpillars, less often dragonflies, damselflies, mayflies, crickets, cicadas; beetles in cold weather upon spring arrival on northern breeding grounds. It eats also spiders, snails, rarely fruit. Preys on eggs and nestlings of small birds. Female may forage 2–3 km from laying sites male feeds at up to 4 km from singing site[302].

Reproduction

In North-West Europe it breeds between May and June. Some species only occasionally parasitized, but still raise young cuckoo. Often mobbed by real or potential hosts near their nests. Eggs polymorphic in colour (blue, pink, whitish) and pattern (spotted

[299] *D.A. Payne, R. and Christie, Common Cuckoo (Cuculus Canorus), Handbook of the Birds of the World Alive, Lynx Edicions, Barcelona., 2013.*
[300] *Payne, R. and Christie.*
[301] *A. Pitches, "'BB" Does the Congo', British Birds, 106.1 (2013), 5.*
[302] *Payne, R. and Christie.*

or unmarked). In the Palearctic region, 15 distinct types were recognized, and circa 77% of eggs closely match those of their host in colour and pattern. Eggs are also polymorphic in East India. Mean 23 mm × 17 mm; incubation 11,5–12,5 days[303]. Egg mimicry to different host species can be explained by the existence of female-specific lineages of cuckoos, called gentes (singular gens)[304]. Egg mimicry includes not only background and spot colours, but also egg size[305]. Nestling period 17–18 days. Evicts host's eggs and chicks. Fledges at 80 g, then fed by foster parents for another 2–3 weeks. Chicks, when threatened, expel dark foul-smelling liquid from their cloaca, its repellent effect being especially intensive on mammalian predators[306]. Both observational and experimental studies in S Spain (Sierra Nevada Mountains) revealed that, whereas most potential host species exhibited high rejection rates of both mimetic and non-mimetic eggs, European Robin (*Erithacus rubecula*), the only species regularly parasitized, had low rejection rate. Analysis of published information on rejection rates of non-mimetic models on Europe-wide scale, as well as South Spain data, indicated that interspecific variation in rejection rate apparently is a result of nest-site choice and habitat. Ground-nesting species having lower rejection rates than species breeding in trees or bushes, while the effect of tree abundance in habitat (previously shown to increase parasitism by cuckoo) was evident only from analyses of continental-scale data and not from observations in Sierra Nevada[307].

Demography

Not globally threatened (Least Concern). Generally, a common and vocally conspicuous species throughout its range. Densities include 1–2 males/km² in suitable habitats in NorthEurope. Population of Britain and Ireland estimated at 16,000–32,000 pairs, and that of France at 100,000–1,000,000 pairs. Numbers have been decreasing in West Europe during the 20th century. This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion. Despite the fact that the population trend appears to be decreasing, the decline is not believed to be sufficiently rapid to approach the thresholds for Vulnerable under the population trend criterion. The European population is estimated at 5,960,000-10,800,000 calling or lekking males, which equates to 11,900,000-21,500,000 mature individuals. Europe forms circa 30% of the global range, so a very preliminary estimate of the global population size is 40,000,000-72,000,000 mature individuals, although further validation of this estimate is needed. The population is therefore placed in the band 40,000,000-75,000,000 mature individuals. Declines in northern Europe have been attributed to the intensification of agriculture, resulting in fewer insects and hosts. Climate change is also an important factor where short-distance migrating host species have advanced their arrival more than the cuckoos resulting in a mismatch of nesting times[308].

Dove, Collared *(Streptopelia decaocto)*

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Description

The Eurasian Collared Dove (*Streptopelia decaocto*) is a non-migrant *Columbiforme* from the *Columbidae* family, resembling the Turtle Dove, the Feral Pigeon or the Kestrel[309]. This fairly large dove is a common sight in Europe, in farms and suburbs[310]. It's a plain-coloured pigeon with a thin black collar on the back of its neck, with red legs, dark eyes, a pale, grey-brown body with a subtle pink head and breast. The tail is long, with a whitish tip, while the wings are dark at the tips

303 *Payne, R. and Christie.*
304 *H. Gibbs, H.L., Sorenson, M.D., Marchetti, K., Brooke, M.deL., Davies, N.B. and Nakamura, 'Genetic Evidence for Female Host-Specific Races of the Common Cuckoo.', Nature, 407 (2000), 183–186.*
305 *J.A. Antonov, A., Stokke, B.G., Vikan, J.R., Fossøy, F., Ranke, P.S., Røskaft, E., Moksnes, A., Møller, A.P. and Shykoff, 'Egg Phenotype Differentiation in Sympatric Cuckoo Cuculus Canorus Gentes.', Journal of Evolutionary Biology, 23 (2010), 1170–1182.*
306 *M. Trnka, A., Požgayová, M., Procházka, P., Capek, M. and Honza, 'Chemical Defence in Avian Brood Parasites: Production and Function of Repulsive Secretions in Common Cuckoo Chicks', Journal of Avian Biology, 47.2: (2016), 288–293.*
307 *M. Martín-Vivaldi, M., Soler, J. J., Møller, A. P., Pérez-Contreras, T. and Soler, 'The Importance of Nest-Site and Habitat in Egg Recognition Ability of Potential Hosts of the Common Cuckoo Cuculus Canorus', Ibis, 155.1: (2013), 140–155.*
308 *R.A. Erritzøe, J., Mann, C.F., Brammer, F.P., and Fuller, Cuckoos of the World (Bloomsbury (Christopher Helm), 2012).*
309 *Hume, p. 235; C Harrison and A Greensmith, Birds of the World, Smithsonian Handbooks (Dorling Kindersley, 2002), p. 161 <https://books.google.be/books?id=kZ0LPwAACAAJ>.*
310 *Hume, p. 235; Beaman and Madge, p. 476.*

and grey on the upper area. Juveniles lack the black neck collar and have a sandy buff body[311]. The sexes are virtually identical, but the female has a browner crown and nape[312].

The species is usually 31-33 cm long, with a wingspan of 47-55 cm, a weight between 150 and 220 g, living up to 10 years[313]. In flight, it looks broader winged and longer tailed than, for example, the European Turtle Dove[314].

Habitat

It's an arboreal species[315], often roosting and nesting in tall, dense coniferous trees, usually in parks or gardens[316]. In the last century, it has widened its range northwards and westwards and can now be found in most range, associated with man-altered habitats: farmyards, groves, oases, orchards, gardens, grain stores, docks etc[317].

The nest is a rather simple platform, consisting of twigs and rubbish, usually in a tree, preferably a conifer[318]. Both sexes build the nest, in 2-4 days. The male will select the location and will bring the necessary materials, while the female will assemble the nest platform[319].

Social behaviour

Streptopelia decaocto is most often seen in pairs, but it can also form small flocks during the winter at good roosting and foraging sites. While flocks of thousands have been recorded in Central Europe, older birds prefer to remain in pairs throughout the winter as well, seldom if at all joining feeding flocks[320].

Doves display 3 kinds of songs, corresponding to territorial or sexual drives: the advertising (the perch-coo), the one delivered at the nest or the potential nest site (the nest-coo) and the one where the male displays at the female (the bow-coo). Although songs are typically associated with males, some female doves also sing[321]. In a common courtship display, vocalizations are in line with other actions by the male, such as struts around the female, puffing and blowing the breast and neck feathers[322].

Diet

The Eurasian Collared Dove is a forager, looking for food almost exclusively on the ground, waking at a high speed with head bobbing[323]. It relies partially on food provided incidentally by people or the food put specifically for smaller birds[324]. Its diet includes cultivated grains, grass seeds, weed seeds, bread, fruits, berries, buds, shoots[325].

Reproduction

The species is a monogamous bird that breeds 2 or 3 times throughout the whole year[326]. The female lays clutch of 2 oval and white eggs, that are hatched together with the male for 14-18 days[327]. The female preferentially incubates from afternoon until morning, while the male will hatch during the morning[328].

Within a few hours of hatching, the young are being fed with "crop milk", that is rich in fat and protein[329]. The juveniles open their eyes in 3-5 days and fledge after 15-19 days, becoming independent a week later[330].

Demography

The European Eurasian Collared Dove population is estimated at around 7,000,000 – 14,000,000 pairs and therefore between 15,000,000 – 28,600,000 mature individuals. Europe males up roughly 40% of the entire global range which means a relative estimate for the global population would be in the region of 60,000,000 to 111,000,000 individuals, and of that number, 40,000,000 – 75,000,000 are estimated to be mature individuals. The population is undergoing an increasing population trend and in Europe the population has increased by 67% since 1980, with only a modest increase between 1980 and 2013[331].

311 *Hume, p. 235; Harrison and Greensmith, p. 161; David Gibbs, Eustace Barnes, and John Cox, Pigeons and Doves. A Guide to the Pigeons and Doves of the World (London: Christopher Helm, 2010), p. 259.*
312 *Beaman and Madge, p. 476.*
313 *Hume, p. 235.*
314 *Beaman and Madge, p. 476.*
315 *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 9. Birds II, p. 248.*
316 *Hume, p. 235.*
317 *Beaman and Madge, p. 476; Gibbs, Barnes, and Cox, p. 259.*
318 *Hume, p. 235; Harrison and Greensmith, p. 161.*
319 *SARA R. Morris, The Sibley Guide To Bird Life and Behavior, ed. by Chris Elphick, John B. Dunning Jr, and David Allen Sibley, 1st editio (New York, 2001), p. 222.*
320 *Gibbs, Barnes, and Cox, p. 259.*
321 *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 9. Birds II, p. 249.*
322 *Morris, p. 321.*
323 *Gibbs, Barnes, and Cox, p. 259.*
324 *Hume, p. 235.*
325 *Gibbs, Barnes, and Cox, p. 259.*
326 *Hume, p. 235; Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 9. Birds II, p. 250; Morris, p. 321.*
327 *Hume, p. 235; Gibbs, Barnes, and Cox, p. 259.*
328 *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 9. Birds II, p. 250.*
329 *Morris, p. 322.*
330 *Gibbs, Barnes, and Cox, p. 259.*
331 *IUCN, 'Streptopelia Decaocto', 8235 (2019).*

Whilst the species is not migratory, their rate of dispersal is extremely high. Originally from India, they have become permanent residents in Europe and North America since the early 20th century. Despite its natural habitat being subject to loss and degradation, the Eurasian collared dove has managed to live in abundance in human modified habitat such as towns and cities. They now typically breed in these areas, where there is an abundance of food and trees for nesting.

Dove, Rock *(Columba livia)*

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Description

The Rock Dove is medium-sized pigeon. Total length (North American ferals): males 30–36 cm, females 29–35 cm. Average mass: breeding males 369 g, breeding females 340 g. Bill dark grey; underwing coverts white; tail with blue-black subterminal band; outer rectrix white on proximal 2/3 of outer vane; rump gray or white. Wings usually with two dark bars on greater coverts and inner secondaries; underwing white. Basic colour bluish grey in most, darkest on head and rump, palest on wing-coverts; colour bluish black in some, rusty red in a few, and a fraction mostly white or grizzled; many with albinotic feathers almost anywhere. Neck and upper breast suffused with purple and green iridescence, with each feather bifurcated. Iris varies from golden orange to orange to red-orange; orbital skin blue-grey; bill black, cere white; legs red or purplish red. Female slightly duller grey with less neck iridescence. Juvenile duller still, with dull eyes and feet; some iridescence on each side of neck in male but not female[332].

In 126 trapped birds at Lawrence, Kansas[333], mean gross body weight was 346.9 g (s = 38.0). Of those, 78 were breeding adults weighing 355.1 g (s = 32.0), significantly more than 48 nonbreeding birds (333.5 g [s = 32.0]; most presumably subadults). Thirsty-seven breeding females weighed 340.1 g (s = 34.7), significantly less than 41 breeding males (368.7 g [s = 38.6]).

Habitat

Wild Rock Doves roost and nest in crevices, caves in rocky seaside cliffs or interior uplands, especially near open scrub vegetation or human agriculture. Studies in Scotland found species inhabiting ledges in caves and sea cliffs; some populations have invaded ruined buildings. In Algerian Sahara can be found at sites where rocks, some vegetation and a source of water occur together; in Tunisia, inhabits deep wells; in Israel, found on steep rocky slopes and in canyons. Avoids areas of tall and dense vegetation. North American ferals are also found in such habitats, but most are human commensals, using farm buildings and small-town 19th-century architecture; many are found in canters of high-density human cities, where skyscrapers are cliff-substitutes. The species increasingly uses highway infrastructures (e.g., overpasses, bridges), facilitating its spread to more remote areas, given adequate food[334].

Studies in northern Poland found pigeons in 19 of 33 towns censused, with numbers correlated with town area and significantly greater in towns within agricultural landscapes than in towns surrounded by forests[335]. In Poznan, Poland, pigeon density was highest in plots with tall buildings, human-related food resources, schools and green space and lowest in areas of high street density and further from the city centre[336].

Diet

Rock doves feed in the early morning and in the mid-afternoon on the open ground. They eat mainly seeds. Studies of pigeons in a semi-rural part of Kansas found that their diet includes the following: 92% corn, 3.2% oats, 3.7% cherry, along with small amounts of knotweed, elm, poison ivy, and barley. Rock doves are also granivorous. In cities, feral pigeons also eat

[332] *R. F. Lowther, P. E.; Johnston, 'Rock Pigeon (Columba Livia), Version 1.0. In Birds of the World (S. M. Billerman, Editor).', Cornell Lab of Ornithology, Ithaca, NY, USA., 2020 <https://doi.org/10.2173/bow.rocpig.01>.*

[333] *S. Johnston, R.; Johnson, 'Reproductive Ecology of Feral Pigeons.' In Granivorous Birds in the Ecological Landscape., Edited by J. Pinowski and D. Summers-Smith, (Warszaw: Polish Ecological Publ., 1990).*

[334] *Faulkner Doug, Birds of Wyoming, (Greenwood Village, Colo.: Roberts and Co., 2010).*

[335] *P. Hetmanski, T.; Bochenski, M.; Tryjanowski, P. ; Skórka, 'The Effect of Habitat and Number of Inhabitants on the Population Sizes of Feral Pigeons around Towns in Northern Poland.', European Journal of Wildlife Research, 57.(3): (2011), 421–28.*

[336] *T. Mizera and P. Skórka. Przybylska, K., A. Haidt, L. Myczko, A. Ekner-Grzyb, Z. M. Rosin, Z. Kwiecinski, P. Tryjanowski, J. Suchodolska, V. Takacs, L. Jankowiak, M. Tobólka, O. Wasielewski, A. Graclik, A. J. Krawczyk, A. Kasprzak, P. Szwajkowski, P. Wylegala, A. W. Malecha, 'Local and Landscape-Level Factors Affecting the Density and Distribution of the Feral Pigeon Columba Livia Var. Domestica in an Urban Environment.', Acta Ornithologica, 47.(1): (2012), 37–45.*

popcorn, cake, peanuts, bread, and currants. Female rock doves need to eat a diet somewhat higher in protein and calcium in order to have the nutritional resources to lay eggs[337].

Forages chiefly in early morning or mid-afternoon, on open ground; less commonly on trees and shrubs, were clumsy. There birds perch, stretch, and peck; very rarely hover at tips of outer branches. May feed near breeding territory, but also may fly several kilometres. Feed opportunistically; may show producer-scrounger effects in groups[338].

Seeds, fruits, rarely invertebrates[339]. In the U.S., a "semi-rural" study of 144 feral pigeon crop contents showed Corn (*Zea mays*, 92% of total volume), Oat (*Avena*, 3.2%), Knotweed (*Polygonum*), Cherry (*Prunus*; 3.7%), Wheat (*Triticum*, 0.4%), Barley (*Hordeum*, 0.5%), plant debris, Millet (*Setaria*), Goosegrass (*Eleusine*), Pokeberry (*Phytolaca*), Crabgrass (*Digitaria*), Black Locust (*Robinia*), Sorghum (*Sorghum*), Elm (*Ulmus americana*), Poison Ivy (*Rhus radicans*), Pigweed (*Amaranthus*), and Acorn (*Quercus*)[340]. Around humans, bread, popcorn, peanuts, cake, and currants are eaten[341].

Studies in Europe reveal that birds feed typically on grains, such as *Triticum*, *Hordeum* and *Avena*; legumes like *Pisum*, *Vicia*, *Phaseolus* and *Melilotus*, and various weeds including *Rumex*, *Polygonum*, *Chenopodium*, *Atriplex*, *Stellaria* and *Ranunculus*. Some invertebrates also taken, including moth larvae and pupae, snails and slugs. In Algerian Sahara, birds depend on Desert Melon (*Coloquintus vulgaris*) as a source of food and moisture.

Some birds live for extended periods on just one foodstuff, such as corn or barley. Experimental studies on preferences with a wide range of seeds show all consumed, but individuals idiosyncratic. Peas (*Pisum*; 20% protein) preferred in some studies, corn (9% protein) in others[342].

Social Behaviour

Rock doves peck food off the ground and drink with their bill directly in water, to use it like a straw. A dove may bow and coo when threatening a rival, inflating its throat and walking around in a circle. These birds feed early in the morning and during the mid-afternoon, individually or in flocks. They roost together on walls or statues or in buildings. They flock while feeding, roosting, or sunning. Rock doves generally run or walk while bobbing their heads backward and forward. Their flight is a direct and steady path. This species is most often seen during the daylight - especially perched on buildings or in urban parks. They seek cover during the day when it is hot, and at night. When disturbed in a group, the Rock Dove takes off with a noisy sound like clapping. Doves, especially carrier or homing breeds, can find their way home over long distances. Despite this ability, a wild Rock Dove is sedentary and rarely leaves its local area[343].

Pigeons generally walk or run while bobbing their heads forward and backward. They fly with a steady and direct path. Pigeons are most often seen during daylight, seeking cover at night and in during the heat of the day, according to the climate. They flock while roosting, sunning, and feeding, but no play has been observed. In the nesting territory, both sexes are aggressive, pecking intruders on the head.

Both sexes aggressive in nest territory; males commonly supplant, flying down from nest and taking place of intruder. May then display by crouching and shifting position of wing, perhaps raising one or both, intending to peck or strike with wing. Naive intruders are sometimes smartly pecked on the head. Adults usually fly off, if male; sometimes remain if female. Males "drive" mated females, a characteristic columbid behaviour[344],[345]. Driving, a pushy kind of chasing, occurs when other birds crowd the pair when the female is sexually receptive; aim probably is to remove the female from the proximity of other males[346].

Reproduction

Bond established by extensive display[347],[348]. Begins with bowing and cooing, in which male stands tall, inflates crop, fans tail, struts in circle, bows head and neck while giving display coo. This is repeated many times while circling and moving around the female. Hetero-preening ("nibbling") follows, male first, female later. Female ultimately solicits feeding; male appears to regurgitate seed or liquid. Female may repeat, followed by a crouch with wings half raised; male then mounts, balances with flapping wings while vents are opposed 1–2 s for sperm transfer.

337 *Richard F. Johnston, 'Birds of North America No. 13, 1992.', The American Ornithologists' Union., 1992.*
338 *L. Giraldeau, L.; Lefebvre, 'Exchangeable Producer-Scrounger Roles in a Captive Flock of Feral Pigeons: A Case for the Skill-Pool Effect.', Animal Behaviour, 34: (1986), 797–803.*
339 *N. Murton, R.; Westwood, 'The Foods of the Rock Dove and Feral Pigeon.', Bird Study, 1966, 130-146.*
340 *P. F. Pierson, T. A., R. G. Cobb ; Scanlon, 'Crop Contents of Rock Doves in Virginia.', Wilson Bulletin, 1976, 489–90.*
341 *Murton, R.; Westwood.*
342 *P. Griminger, 'Digestive System and Nutrition.' In Physiology and Behaviour of the Pigeon., Edited by M. Abs (London: Academic Press, London, UK., 1983).*
343 *'Rock Dove - Animalia', Animalia <http://animalia.bio/rock-dove>.*
344 *H. A. Carr, Posthumous Works of Charles Otis Whitman, III. The Behavior of Pigeons., Carnegie Inst. Wash. Publ., 1919.*
345 *D. Haag, Ethogramm Der Taube. (Basel: Medizinische Biologie, 1991).*
346 *D. Goodwin, 'Behaviour.' In Physiology and Behaviour of the Pigeon., Edited by M. Abs, (London: Academic Press., 1983).*
347 *Goodwin.*
348 *Haag.*

Mode of 1st nests mid-February, hatch at day 18, squabs fledge at day 48, earliest in early Mars.

Known to breed all year round in Britain and Ireland with peak breeding in April and minimum in July. Season varies from region to region, in the Mediterranean Mars–July, in Cyprus from Mars–May.

Incubation usually begins with laying of a 2nd egg. Incubation patch situated in ventral apterium (± 10 x 2 cm), bare of feathers year-round[349]. Incubation period about 18.5 d, with a range of 16-19 days.

Both sexes incubate, male from mid-morning to late afternoon, female from late afternoon to mid-morning, both spending about same amount of daylight time on the nest[350]. Male roosts off nest. Eggs covered > 99% of the time, rarely exposed to temperature stress. Parents return to the nest quickly if disturbed, and egg mortality in winter is the same as in summer[351].

Rock doves are monogamous and pairs mate for life. Pairs may form any time during the year. Males and females work cooperatively for most aspects of parenting. The male supplies the nesting material, and the female constructs the nest, being a platform of grass and twigs. Nest sites are used again and again, with nesting material added for each subsequent brood. In suburban and urban areas, doves will nest on a range of flat covered surfaces, such as ledges and beams on buildings and bridges. In natural areas, they use sheltered cliff-ledges. One pair may produce 5 or more broods per year. Both parents also feeding 'pigeon milk to their young, a fat and protein-rich liquid that they produce in their crops. The chicks leave the nest at around 4 weeks of age[352].

Average age at sexual or reproductive maturity (female and male) 140 days. Average lifespan in wild 6.0 years, in captivity 35 years[353].

Demography

The current population trend of the Rock Dove is that the species is decreasing. This population decline is reported to be as a result of the wild species interbreeding with the domestic form. In Europe it is estimated that there are between 11,000,000 and 22,000,000 pairs and therefore equating to between 22,100,000 and 45,000,000 mature individuals[354].

The rock dove has a very large range and is native to the majority of EU member states however it was introduced to the Netherlands, Denmark and Lichtenstein. Similarly, to the Common Woodpigeon, the Rock Dove has thrived in human modified habitat and is now abundant in town in cities all over Europe[355].

The Rock Dove breeds all year round in Ireland and the UK with a peak breeding period in April. In southern regions such as the Mediterranean, it breeds between March and July[356].

Dove, Wood *(Columba palumbus)*

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Description

General colour bluish grey, duller on wings; primaries black with pale edges; breast mauve-pink merging to creamy on belly; flanks grey; feathers along edge of wing white, forming a band on open wing; iridescent purple-pink and green feathers beside a white patch on each side of neck; rectrices grey with broad black terminal band; pale greyish white central band evident on underside of tail, but less conspicuous on upper side; iris greenish white to pale golden; orbital skin grey; bill purplish pink basally, golden distally, cere white; legs reddish purple. Female tends to have smaller white neck patches; breast less pink. Juvenile

349 *R. H. Drent, 'Incubation.' In Avian Biology, Edited by D. S. Farner and J. R. King, (New York: Academic Press., 1975).*
350 *Goodwin.*
351 *S. Johnston, R.; Johnson, 'Reproductive Ecology of Feral Pigeons.' In Granivorous Birds in the Ecological Landscape., Edited by J. Pinowski and D. Summers-Smith, (Warszaw: Polish Ecological Publ., 1990).*
352 *'Rock Dove - Animalia'.*
353 *F. Mosca, '"Pigeons and Pigeon Genetics for Everyone" (On-Line). Accessed May 8, 2001 at Http://Www.Angelfire.Com/Ga3/Pigeongenetics/.', 2001 <http://www.angelfire.com/ga3/pigeongenetics/.>.*
354 *Birdlife International, IUCN Redlist, Rock Dove, 'Columba Livia', 8235 (2019).*
355 *Animalia Chordata and Aves Columbiformes, 'Introduced : Native ':, 2015.*
356 *Chordata and Columbiformes.*

duller and paler, feathers edged with conspicuous or faintly indicated fawn or rust; breast rusty fawn; white and iridescence on neck lacking[357].

Measurements – length 41–45 cm; weight 284–690 g.

Habitat

The species is found in a mosaic of woodland and open ground, notably farmland, parks and suburban gardens[358]. It is typically a species of ecotone in deciduous or coniferous woodland. It occurs at 1500–1600 m, and even up to the treeline in the Alps. The original breeding habitat in central Europe was the edges of old mixed pine and oak forests. In the higher woods in Britain found in ash (*Fraxinus*) forests up to 370 m, and in beech, oak and ash woods in lowland; also inhabits plantations of exotics notably Sitka spruce (*Picea sitchensis*) and Douglas fir (*Pseudotsuga menziesii*). This species was not adversely affected by the fragmentation of forests due to agricultural practices. On the contrary it frequents open country, especially fields of crops, when foraging. Colonization of parks and gardens in towns was first reported in central Europe in the early 19th century and is still continuing. In the east urban breeding populations early in the 21st century extended to the western borders of Lithuania, Belarus and Ukraine[359]. In the west urban breeding was first noted in the Iberian Peninsula in the 1940s but was still not widespread in 2015[360].

Diet

It takes food from the ground and also feeds in trees. Most of diet made up of plant matter, including green leaves, buds, flowers, seeds, berries and root crops; grain taken includes wheat (*Triticum*), barley (*Hordeum*), oats (*Avena*), maize (*Zea*) and rape (*Brassica*); fruits and seeds consumed include those of oak, beech, elder (*Sambucus*), olive (*Olea*)[361]; leaves eaten include those of clover (*Trifolium*), rape and cabbage (*Brassica*). Various invertebrates are also occasionally eaten, including earthworms, gall wasps, beetles, pupae of lepidoptera, spiders, slugs and snails. As many as 107 different crop species have been identified as winter food in Sweden. Foraging flocks on farmland may number many thousands, sufficient to cause significant crop damage – notably to oilseed rape plants[362] – and to require deterrence measures.

The diet is overall very varied and shows marked seasonal and regional variation. In Ireland, cereal grains comprise the largest proportion of the diet in summer and autumn, whereas the diet is dominated by the fruit and seeds of trees in spring and winter. This varied diet allows Woodpigeons to feed on seasonally abundant food sources, that have a high calorific content and that are ignored by most other seed-eating birds[363]. Woodpigeon crops sampled in southern Spain contained remains of 20 plant and five snail species. However, in Spain acorns of *Quercus sp.* were the most consumed item in winter, cereals dominated the summer diet and tree fruits predominated in spring and autumn[364].

Social Behaviour

Northern and Eastern European birds are mostly migratory, as are West Siberian populations. The species is partially migratory or resident in Western, Central & Southern Europe. Large numbers of northern birds winter in the northern Mediterranean countries. For example, millions enter the Iberian Peninsula via the western Pyrenean passes, where they are traditionally hunted, between mid-September and November, returning in February and March; the wintering birds concentrate in the open oak woodlands (dehesas) of Extremadura and eastern Portugal; very few continue beyond the Peninsula to North Africa[365]. Populations living in the middle Atlas Mountains of Morocco fly daily to plains to feed, although some individuals may forage only 15 m from the nest. Elsewhere flocks often fly considerable distances to feed on farmland, returning to woods and forests to roost.

Quite vocal. Advertising call: a repeated rhythmic phrase involving four or five cooing notes with only short pauses between phrases, thus often sounding like a continuous series. Apparently little vocal difference between races. In display flight, reaches some height and makes clapping sounds with wings before gliding downwards on stiff wings.

357 *E.F.J. Baptista, L.F., P.W. Trail, H.M. Horblit, P. F. D. Boesman, Garcia, 'Common Wood-Pigeon (Columba Palumbus), Version 1.0. In Birds of the World (J. Del Hoyo, A. Elliott, J. Sargatal, D.A. Christie, and E. de Juana, Editors).', Cornell Lab of Ornithology, Ithaca, NY, USA., 2020 <https://doi.org/10.2173/bow.cowpig1.01>.*

358 *M.F. Tucker, G.M. and Heath, Birds in Europe: Their Conservation Status. (Cambridge, U.K.: BirdLife International, 1994).*

359 *A. Bea, A., Svazas, S., Grishanov, G., Kozulin, A., Stanevicius, V., Astafieva, T., Olano, I., Raudonikis, L., Butkauskas, D. and Sruoga, 'Woodland and Urban Populations of the Woodpigeon Columba Palumbus in the Eastern Baltic Region.', Ardeola, 58.(2): (2011), 315–321.*

360 *E. de Juana, E. and Garcia, The Birds of the Iberian Peninsula. (London: Bloomsbury, 2015).*

361 *A. Perea, R. and Gutiérrez-Galán, 'Introducing Cultivated Trees into the Wild: Wood Pigeons as Dispersers of Domestic Olive Seeds.', Acta Oecologica, 71.(1): (2016), 73–79.*

362 *I. Newton, Farming and Birds. New Naturalist Library. (London: Collins, 2017).*

363 *J. Ó Huallachain, D. and Dunne, 'Seasonal Variation in the Diet and Food Preference of the Woodpigeon Columba Palumbus in Ireland.', Bird Study, 2013, 417–422.*

364 *J. Gutiérrez-Galán, A., Alonso González, C. and Maroto De Mercado, 'Woodpigeon Columba Palumbus Diet Composition in Mediterranean Southern Spain.', Ardeola, 64.(1): (2017), 17–30.*

365 *de Juana, E. and Garcia.*

Reproduction

Its breeding season varies between regions, ranging from late February to early September. It normally lays two eggs. The nest is built of twigs and lined with more twigs, grasses and leaves usually 1.5-2.5 m above ground in trees and on building ledges or occasionally in thick vegetation or under a hedge.

Season varies with zone, ranging from late February to early September. Nest 17–23 cm in diameter, consists of twigs up to 20 cm long; lined with finer twigs, grasses and leaves; nests become bulkier with repeated use; placed 1·5–2·5 m above ground in fork of tree or on branch, in a creeper in tree, or rarely on ground in thick vegetation or under a hedge, or even on ledge of a building. Normally 2 white eggs (1–3); incubation 16–17 days, beginning with first egg; fledging 28–29 days, although exceptionally squabs may stay in the nest until 34 days old[366].

Demography

The Common Woodpigeon is a very common bird in Europe with a population estimated to be between 20,500,000 and 29,000,000 pairs and therefore amounting to 50,000,000 to 60,000,000 mature individuals. Europe forms approximately 80% of the entire global range. This means that a global population size would be estimated to be in the region of 55,000,000 to 75,000,000 mature individuals.

Due to its ability to thrive in urban areas and exploit habitat which has been modified by humans, its population is increasing. Its range has expanded northwards to the Faroe Islands and Fenno Scandia.

The population in Europe has increased by 84% since 1980 up until 2016 according to ESIT.

Flycatcher, Spotted *(Muscicapa striata)*

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Characteristics

Spotted Flycatcher is mousey grey-brown above, paler from forehead to forecrown; forehead to nape streaked brown-black. Its lores are whitish, ear-coverts and neck side grey-brown. The upperwing is dark brown, scapulars and median and lesser upperwing-coverts narrowly edged pale grey-brown, inner greater coverts narrowly edged pale brown-grey on outer webs, tertials and inner secondaries edged whitish on outer web. The uppertail-coverts with pale grey edges, tail dark brown with narrow whitish feather tips; dull white below, pale grey-buff wash on breast, flanks and thighs, with chin and throat sides, breast and upper flanks streaked mousey grey-brown; axillaries pale brownish-buff, underwing-coverts grey-brown, broadly fringed pale buff; iris dark olive-brown; bill brown-black, base of lower mandible pinkish to horn-coloured; legs brown-black. Sexes alike. Juvenile is blackish-brown with dense ochre-buff spotting and scaling above, upperwing-coverts grey-brown, tipped rufous-buff, remiges edged pale rusty and ochre-buff, rectrices narrowly fringed rusty-buff, underparts washed pale buff, breast, flanks and upper belly densely scalloped blackish-brown, pinkish base of lower mandible. Immature as adult, but uppertail-coverts tipped rufous-buff, greater upperwing-coverts with whitish spot at tip[367].

Size 13,5–14,5 cm; weight 11,2–21,9 g.

366 *Baptista, L.F., P.W. Trail, H.M. Horblit, P. F. D. Boesman, Garcia.*

367 *B. Taylor, 'Spotted Flycatcher (Muscicapa Striata).', in Del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. and de Juana, E. (Eds), Handbook of the Birds of the World Alive (Barcelona: Lynx Edicions, 2015).*

Habitat

This species inhabits almost any open woodland or timbered area with raised perches providing an open view. During the breeding season it favours well-spaced mature trees to younger trees and bushes, and thus has adapted well to avenues, parks, gardens, orchards and other man-made habitats, as well as occupying many types of deciduous or coniferous woodland. It is also found at woodland edges, in forest glades, clearings and burnt patches, and in trees along streams, rivers and edges of standing water. The breeding season in Europe is from mid-May to mid-August, mainly May-June farther east and April-July in north-west Africa. The nest is a bulky cup of loosely piled fine twigs, rootlets, dead leaves, pieces of decaying bark, moss, dry grass, lichens and fibres, bound with hair and lined with hair, feathers and finer material. It is sited above the ground on a natural or artificial ledge, in a niche, at the base of a basket-shaped tuft of twigs against a tree trunk, in a hole in a tree, branch or stump, in creeper against a tree or wall, or on top of a flat branch[368].

Diet

Polyphagous species, where the animal component is dominant. However, the plant component, especially pulpy fruits, is common in the diet of adults and youngsters. Flycatcher eats mainly flying insects, especially Hymenopterans (including bees, wasps and winged ants), up to 64% of their diet for adults, compare to young birds who prefer Dipterans, making up to 75% of their diet[369]. Its diet also consists of Lepidopterans (adults and larvae, mainly moths) helping to deal with their occasional outbrakes in forests, mayflies (Ephemeroptera), dragonflies and damselflies (Odonata), stoneflies (Plecoptera), grasshoppers (Orthoptera), earwigs (Dermaptera), bugs (Hemiptera), lacewings (Neuroptera), caddis flies (Trichoptera), beetles (Coleoptera), mantids (Mantodea) and scorpion flies (Mecoptera). It also takes spiders (Araneae), harvestmen (Opiliones), centipedes (Chilopoda) and millipedes (Diplopoda), woodlice (Isopoda), snails (Gastropoda) and earthworms (Oligochaeta). From small fruits, it prefers those of genera Berberis, Rhamnus, Cornus, Sorbus, Lonicera, Prunus, Morus, Rubus and Trema. Hunts mainly by sallying from perch, usually low branch or fence 1–2 m above ground; catches prey in flight and usually returns to perch to eat it. Most forays made outside tree canopy, with most prey hawked in continuous movement from one perch to the next. Catches some prey on ground, and some items gleaned from leaves and tree trunks; also hovers in front of bushes to pluck berries, and hovers to look for prey on ground. Rubs and beats bees and wasps against perch to remove stings[370].

Social behaviour

Migratory; all populations winter in sub-Saharan Africa. Birds progress gradually, rather than in long non-stop flights, apparently moving in relation to rains. In West Palearctic, autumn migration begins in August, birds entering Africa from mid-August to mid-November and most moving gradually south; passage continues in West Africa in October to November; most reach East Africa in October and South Africa in December. Return passage starts late February, departure date influenced mainly by day length. Areas in extreme south vacated by early April; passage through North Africa and Mediterranean region mostly mid-April to end of May, and arrival on West Palearctic breeding grounds mainly second half of May, continuing to end June[371].

Reproduction

Happening mid-May to mid-August, two broods regular in Europe. Typically, monogamous, polygamy is unique[372]. Solitary, territorial. Clutch 2–7 eggs, mainly 4–6, laid at daily intervals; will re-lay if clutch lost; incubation by female only, begins when clutch complete, period 10–17 days. Hatching usually synchronous, chicks fed by both parents, nestling period 12–17 days. Fledged young fed by parents for a further 12–32 days. In Britain, 77·9% of 1052 eggs in 267 clutches hatched, 81·3% of 749 hatchlings (in 197 broods) fledged, 10% of eggs lost to predators, 9% infertile and 4% lost to human interference; in Switzerland, 73% of 103 eggs produced fledged young, 7% deserted, 11% preyed on (as eggs or chicks) and 5% of eggs infertile, over 18-year period 66% of first broods and 88% of second broods produced fledged young. Production rate in Germany over 14 years was 2,67 young per pair. Longevity of ringed birds 5 years for female and 8–9 years for male; mean annual mortality 0,45 for females, 0,65 for males[373].

Demography

Not globally threatened. The commonest and most widespread flycatcher in West Palearctic; estimated European population c. 7,750,000 pairs. Since mid-1960s has declined in Britain, Ireland, Norway, Sweden, Finland, Lithuania, Germany, Netherlands, Belgium, Czech Republic, Spain and Ukraine; long-term migrant-ringing programmes, however, suggest a

368 *Taylor, 'Spotted Flycatcher (Muscicapa Striata).'*
369 *Karel Šťastný and Karel Hudec, Fauna ČR Ptáci III/1, 2nd edn (Praha: Academia, 2011).*
370 *Taylor, 'Spotted Flycatcher (Muscicapa Striata).'*
371 *Taylor, 'Spotted Flycatcher (Muscicapa Striata).'*
372 *Šťastný and Hudec.*
373 *Taylor, 'Spotted Flycatcher (Muscicapa Striata).'*

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marked decline only in North and Central European populations. Decline in North West Europe may reflect a long sequence of generally cooler summers, or may be due to adverse factors such as biocide-induced reductions or contamination of insect populations, removal of old trees and general habitat deterioration. In African non-breeding quarters widespread and uncommon to locally common, with no evidence of significant recent declines; probably benefits locally from increased habitat availability in arid areas, such as watered ornamental gardens and alien-tree plantations. This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion. Despite the fact that the population trend appears to be decreasing, the decline is not believed to be sufficiently rapid to approach the thresholds for Vulnerable under the population trend criterion. The population size is extremely large, and hence does not approach the thresholds for Vulnerable under the population size criterion. For these reasons, the specie is evaluated as Least Concern. In Europe, the breeding population is estimated to number 14,900,000-22,700,000 pairs, which equates to 29,700,000-45,500,000 mature individuals. Europe forms c. 55% of the global range, so a very preliminary estimate of the global population size is 54,000,000-83,000,000 mature individuals, although further validation of this estimate is needed[374].

Goose, Greater White-fronted *(Anser albifrons)*

Description

The Greater White-fronted Goose (*Anser albifrons)* is a migratory bird from the *Antidae* family. It looks very similar to the Lesser White-fronted Goose (*Anser erytropus*) but distinguishes itself from the other "grey geese" due to it's the irregular, large, black abdominal patches and the extensive white patch surrounding base of bill[375]. Goslings have less noticeable white markings on the flanks and lack the black ventral markings[376], with orange legs and a pink bill with dark tip[377].

The length of the Greater White-fronted Goose ranges from 65 to 78 cm, while the wingspan is 1.3-1.65 m. It weights 1.9-2.5 kg and usually lives for 15-20 years[378].

Habitat

Anser albifrons breeds on lowland tundra, usually close to marshes, lakes or rivers and winters in open country, in steppes, farmlands, upland bogs, stubble fields[379]. It is a "waterside goose", meaning that they prefer estuaries, floods and broad rivers because they provide both drinking water and a safe shelter overnight[380].

374 *BirdLife International, IUCN Red List for Birds: Species Factsheet, 2020 <http://www.birdlife.org>.*
375 *Beaman and Madge.*
376 *Frank Bellrose and Paul A. Johnsgard, 'Ducks, Geese, and Swans of the World', The Journal of Wildlife Management, 43.4 (1979), 1011 (p. 55) <https://doi.org/10.2307/3808295>.*
377 *Hume.*
378 *Hume.*
379 *Beaman and Madge, p. 121; Derek A Scott and others, 'Atlas of Anatidae Populations in Africa and Western Eurasia Based on a Project Initiated by Directorate for Nature Management Ministry of Agriculture, Nature Management and Fisheries, The Netherlands', Wetlands International Publication, 1996, p. 67.*
380 *Hume.*

The nest is a down-filled construction on the ground[381] consisting of plant matter and is placed amongst vegetation, often on slopes or raised hummocks to protect from flooding[382] and provide excellent visibility of the surrounding area[383]. Nesting pairs almost never use the same nesting site two years in a row[384].

Social behaviour

It is a gregarious bird that lives in flocks[385] of various dimensions, up to 30 000 individuals[386]. As winter begins, flocks usually break into smaller units of families and pairs that will also gradually spread and become less conspicuous[387].

In the breeding season, hostile encounters and triumph ceremonies are common and also beneficial to pair formation and maintaining family bonds. Before copulation, both sexes display head-dipping behaviour, while intercourse is followed by mutual calling and wing lifting[388].

The European White-fronted Goose is a migratory species that breeds in northern Russia and Siberia east to the Kolima River and winters in warmer climates, such as in England, along the coast of the North Sea, in the Mediterranean countries and south of the Caspian and Black seas[389]. The migration process starts in autumn, in September, with geese reaching Germany in early October, and the main winter quarters in November or December; the return passage to the breeding sites begins in March and ends in May[390]. *Anser albifrons* are also highly mobile during winter, when they usually move between roosting and feeding sites[391], while the regular winter locations tend to remain the same year after year[392].

Diet

This species of geese are vegetarians foraging on firm ground while steadily walking forward[393], covering an area from 4 to 20 km from the rooting site[394]. During summer, they usually feed with grasses, herbs or even fruits, such as horsetails or cotton grass[395], while in the autumn and winter geese will concentrate on sedges and grasses, including agricultural grains (Corn, Oat, Barley, Wheat, rRce) and root-stalks of cattails and bulrushes[396].

Reproduction

White-fronted geese are monogamous birds that start breeding around the age of three, after having formed permanent pairs a year before. The birds arrive at the breeding areas soon after they become snow-free and they prepare the nests, usually scattered from other pairs. Each pair is also accompanied by the goslings from the previous year and sometimes also the two-year olds. The latter however don't become territorial and will soon leave the nesting area of their family, while the younger will remain close to their families and will be in charge of defending the nest against predators and even human intruders[397].

The breeding period begins in late May, with the birds laying their eggs at a one per day rate. A clutch usually includes 3 to 7 eggs that are incubated for 21 to 18 days. Goslings remain with their parents for a whole year, sometimes even for two[398].

Shortly after the young have hatched, adults gather in small flocks (up to 30 individuals) near the breeding areas to moult for 25[399] and up to 35 days[400]. During this time, the birds are unable to fly, and they attain it back around the same time the juveniles do.

Demography

In Europe, the Greater White-fronted Goose is estimated to have a population of between 260,000 and 310,000 pairs. The total number of individuals in Europe is therefore in the region of 520,000 to 620,000. Globally the population is estimated at 3 000 000 – 3 600 000 individuals although the current population trend in unknown. This uncertainty on the overall trend is due to different trends in different populations, with some populations decreasing, increasing

381 *Hume.*
382 *BirdLife International, 'Anser Albifrons', The IUCN Red List of Threatened Species 2016: E.T22679881A85980652, 2016 <http://www.iucnredlist.org/>.*
383 *Bellrose and Johnsgard.*
384 *Bellrose and Johnsgard.*
385 *Hume.*
386 *Sam Schellinger, 'Anser Albifrons Greater White-Fronted Goose', Animal Diversity Web, 2014 <https://animaldiversity.org/accounts/Anser_albifrons/#B25EDF80-0853-11E3-9673-002500F14F28> [accessed 24 February 2020].*
387 *Bellrose and Johnsgard.*
388 *Bellrose and Johnsgard.*
389 *Bellrose and Johnsgard; Hume; Scott and others; Beaman and Madge.*
390 *Scott and others*
391 *Scott and others*
392 *Hume.*
393 *Hume.*
394 *BirdLife International, 'Anser Albifrons'.*
395 *Bellrose and Johnsgard.*
396 *Bellrose and Johnsgard.*
397 *Bellrose and Johnsgard.*
398 *Schellinger; Bellrose and Johnsgard.*
399 *BirdLife International, 'Anser Albifrons'; Scott and others*
400 *Bellrose and Johnsgard*

or remaining stable. In Europe the population is reported to be stable and the North American population is said to have increased dramatically over the last 40 years for example[401].

The greater white fronted goose has wintering populations in four regions of Europe. These include Northwest Europe throughout Germany, Britain and France, with higher densities and numbers in the Netherlands. A population is also present in Central Europe, Turkey, and in the Caspian region[402]. Greenland has a population which spends the winter in the UK and Ireland. From late September until February, 50% of this population calls Ireland home.

Goose, Greylag *(Anser anser)*

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Description

The Greylag Goose (*Anser anser*) is a species of large goose from *Anatidae* Family, that resembles most the domestic goose. The plume is mostly grey-brown with the upper parts defined by the white edges of the flight feathers. The chest and abdomen are lighter and relatively evenly coloured. The legs are pink in colour. The young (first year) resemble adults but are less strongly patterned dorsally and miss the spotting on the lower breast[403]. The body length is 74-84 cm and has an average weight of 2070-4560 g, with a wingspan between 149 and 168 cm. The lifespan is usually 15-20 years[404].

Habitat

In Eastern and Central Europe, the Greylag Goose can usually be found in extensive marshes[405], while in the Western parts, in areas such as the British Isles, they breed on small islets surrounded by sedge and heather covered moorlands[406]. During the nesting period, it prefers large wetlands, associated with the large rivers in the plains. During the winter period, it prefers a lowland area, rich in agricultural crops or an area with natural grassy vegetation.

The nest is lined with leaves and consists of a shallow, natural depression in the ground, with an inner cup of feather down[407]. It can also be constructed at the base of trees, in sheltered hollows or under bushes. Despite the species semi-colonial character, nests are usually set within a small area[408].

Social Behaviour

Geese live in flocks that often travel in V formation[409]. They are gregarious birds, which helps them function as a group, where some individuals will look out for predators and the others will be able to feed properly, without being in a constant state of alert[410]. When alarmed, geese make loud, harsh calls[411].

Typical for the Greylag Goose are highly ritualized behaviours, such as the so-called "triumph ceremony"[412]. It serves for maintaining the social structure within the flock, advertising territories in the breeding season, and keeping families together[413].

Anser anser is a fully migratory species, except for some sedentary or locally dispersive populations living in temperate regions (e.g., the birds breeding the Black Sea region)[414]. Most birds traditionally fly to lower latitudes during winter. For example, birds breeding in Denmark, Norway or Sweden will migrate to Spain during winter, while the geese from Iceland

401 *BirdLife International, 'Anser Albifrons'.*
402 *Szabolcs Nagy, Stephan Flink, and Tom Langendoen, 'Report on the Conservation Status of Migratory Waterbirds in the Agreement Area. Sixth Edition.', 2015.*
403 *Bellrose and Johnsgard; Hume; Harrison and Greensmith.*
404 *Hume.*
405 *Hume.*
406 *Bellrose and Johnsgard*
407 *Harrison and Greensmith*
408 *Bellrose and Johnsgard.*
409 *Harrison and Greensmith; Hume.*
410 *The Social Life of Greylag Geese: Patterns, Mechanisms and Evolutionary Function in an Avian Model System, ed. by I. Scheiber and others (Cambridge: Cambridge University Press, 2013) <https://doi.org/DOI: 10.1017/CBO9781139049955>.*
411 *Harrison and Greensmith.*
412 *Jerome A. Jackson, J. Walter Bock, and Donna Olendorf, Grzimek's Animal Life Encyclopedia. Volume 8. Birds I, 2nd editio (Gale Group, 2002).*
413 *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 8. Birds I; Bellrose and Johnsgard.*
414 *Scott and others.*

will move to Scotland for the cold season. In the last decade, migration distances in Central Europe were reduced due to the increasing winter temperatures[415].

Diet

The Greylag Goose is an herbivorous species that feeds with grass, leaves, roots, shoots, fruits or stems. In winter, its diet consists of mostly agricultural grain and potatoes[416]. The Greylag geese have a horizontal, head-down posture while feeding, showing striking white rear[417]. They can be found grazing in pastures, together with cows or sheep, as there the grass is more nutritious.

Reproduction

The Greylag Goose is a monogamous bird, forming long-term, probably life-long partnerships, with only a small percentage (5-8%) re-mating during a lifespan[418]. Pairing occurs most often by the time the geese are 1.5 years old, while successful breeding usually happens by the age of 3.

The breeding period begins in late March / early April. The female usually lays 4-6 eggs, which she hatches alone, while the male defends the territory. Incubation lasts 27-28 days, but the females may leave their nests to defecate and sometimes even forage some at night. Fledging takes 8-9 weeks, until the chicks are able to fly, with longer periods for the arctic-nesting geese. The pairs nest in isolation or in lax colonies which they begin to occupy several weeks before laying eggs[419].

Young geese form a family group together with their parents and migrate with them in the larger flock. The family disperse only when the young are driven away by the adults the following year[420].

Demography

The mature population in Europe is estimated to be in the vicinity of 650,000 individuals, with 300,000 pairs. This gives a population trend where the greylag goose is subject to increasing numbers[421].

Over the last four decades the goose population has been increasing gradually. From 1980 and 2009 the estimated annual growth rate was 8.5%, and wintering numbers have also increased within their ranges between Sweden, Germany, France and the Netherlands. Prior to this, Spain had the largest wintering population of 82%, however, recurring drought in Spanish wetlands caused by climate change forced the goose to redistribute its majority wintering population in Europe[422].

The Wetlands atlas records six discrete population in Europe. This includes a wintering and breeding population in Iceland. A population breeding in Southern Scandinavia and west Germany which winters from the Netherlands down to parts of Spain. The UK has a small population which breeds in northwest Scotland and has a small rate of dispersal. The Baltic states and central Europe have a breeding population which winters in north Africa. An eastern European population exists in the south in Turkey and the black sea region, as well as a western Siberian population further north.

Grouse, Black *(Tetrao tetrix)*

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Description

Males or 'blackcocks' are very distinctive, with glossy blue-black plumage and red wattles (the bright red patches over each eye), white bars on the wings (seen only in flight) and curved black tail feathers. When displaying, these feathers are fanned, giving the tail a

415 *Michal Podhrázský and others, 'Central European Greylag Geese Anser Anser Show a Shortening of Migration Distance and Earlier Spring Arrival over 60 Years', Ibis, 159.2 (2017), 352–65 <https://doi.org/10.1111/ibi.12440>.*
416 *Bellrose and Johnsgard.*
417 *Hume.*
418 *Bruce. Bagemihl, Biological Exuberance : Animal Homosexuality and Natural Diversity (New York: St. Martin's Press, 1999).*
419 *Bellrose and Johnsgard.*
420 *Bellrose and Johnsgard.*
421 *Birdlife Internationa, IUCN Redlist, Greylag Goose, 'Anser Anser', 8235 (2018).*
422 *AEWA, 'International Single Species Management Plan for the Greylag Goose', 2018.*

lyre shape and exposing the striking white under-tail coverts.

Females or 'greyhens' are much more cryptic (well-camouflaged), to reduce the chance of being seen when nesting or feeding on the ground. Their reddish-brown plumage has dark bars, the tail is slightly notched and the white wing bars are narrower than on males, so less obvious.

Males are about 55 cm (21") from beak to tail, have a wingspan of 80 cm (31") and weigh in around 1.25 kg (2.75 lbs). Females are smaller, at 40 cm (16"), with a wingspan of 65 cm (26") and weigh about 950g (2.1 lbs, about the same size as a stocky mallard duck)[423]. Black grouse can live up to five years in the wild.

Habitat

The species occupies mosaics of different habitats requiring open, sparsely vegetated land for display, good shelter for roosting and sometimes shrubs or trees for feeding above the snow in winter[424]. In northern Europe it prefers deciduous or mixed forests to coniferous forest and spare, young stands to older denser ones. In southern European mountains such as the Alps it mainly uses moderately dense forest of spruce and fir, or larch[425]. It uses logged clearings in boreal forest, but such successional stages are ephemeral, necessitating local shifts in distribution. In western and central Europe, the species uses heathland and meadows and in the central European mountains it uses areas around the treeline[426]. It is also known to use bogs and areas of marginal cultivation. It searches for an open landscape with a mosaic of peat bogs, forest stands of various ages and open areas such as meadows, pastures or pastures.

Black grouse is most commonly associated with habitats of early succession stages with prevalence of cranberries (*Vacciniaceae*) and / or heather (*Calluna vulgaris*) on the herb floor because they provide sufficient food supply and at the same time shelter from predators[427,428,429,430]. In the fragmented landscape of Western and Central Europe however, it also uses other types of environments such as meadows, pastures[431,432], deciduous, coniferous and mixed forests permeated with pastures[433,434,435].

Diet

In many places it feeds on birch catkins and buds, shoots, needles, cones and male flowers of conifers in winter. In areas with less snow cover it uses more shrubs and grasses. In spring it switches to berries, stems and shoots of shrubs. It is largely sedentary although eruptive in some northern areas, with flocks moving hundreds of kilometres[436].

Cranberry and heather form an important ingredient in the grouse's food almost throughout year due to its high energy content and protein[437],[438]. During summer prevail seeds and vegetative parts of grass[439]. During the first two weeks of life chickens feed mostly on various invertebrates, with the most ants (*Formicidae*), caterpillars (*Lepidoptera*) and larvaes (*Symphyta*, *Tenthredinidae*)[440],[441].

The size of the grouse's home districts fluctuates between and within stocks in the range of 4–800 ha depending on many factors. Using telemetry was found that the size of the precinct was changing in relation to the age of the individual[442,443], human activities at the site[444], offering a suitable environment[445] and the season[446].

423 *Game and Wildlife Conservation Trust, 'Black Grouse', 2020 <https://www.gwct.org.uk/game/research/species/black-grouse/>.*
424 *Tucker, G.M. and Heath.*
425 *P. de Juana, E. and Boesman, Black Grouse (Lyrurus Tetrix). In: Del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. and de Juana, E. (Eds), Handbook of the Birds of the World Alive (Barcelona: Lynx Edicions, 2013).*
426 *Tucker, G.M. and Heath.*
427 *Børset, E., 'Black Grouse Lyrurus Tetrix and Capercaillie Tetrao Urogallus Brood Habitats in Norwegian Spruce Forest.', Oikos, 1973, 1–7.*
428 *Brittas R; Willebrand T, 'Nesting Habitats and Egg Predation in Swedish Black Grouse.', Ornis Scand., 1991, 261–263.*
429 *Baines D., 'Seasonal Differences in Habitat Selection by Black Grouse Tetrao Tetrix in the Northern Pennines, England.', Ibis, 1994, 39–43.*
430 *Caizergues A.; Ellison L. N., 'Natal Dispersal and Its Consequences in Black Grouse Tetrao Tetrix.', Ibis, 2002, 478–487.*
431 *Baines D., 'Seasonal Differences in Habitat Selection by Black Grouse Tetrao Tetrix in the Northern Pennines, England.', Ibis, 1994, 39–43.*
432 *Starling-Westerberg A., 'The Habitat Use and Diet of Black Grouse Tetrao Tetrix in the Pennine Hills of Northern England.', Bird Study, 2001, 76–89.*
433 *E.; Glutz von Blotzheim, U. N.; Bauer, K. M.; Bezzel, Handbuch Der Vögel Mitteleuropas. Bd. 5, Galliformes Und Gruiformes. (Wiesbaden: Akad. Verlagsgesellschaft, 1981).*
434 *Storaas T. & Wegge P., 'Nesting Habitats and Nest Predation in Sympatric Populations of Capercaillie and Black Grouse.', J. Wildl. Manage., 1987, 167–172.*
435 *Vitovič A. O. & Wiesner J. Klaus S., Bergmann H.–H., Marti C., Müller F., Die Birkhühner. (Wittenberg Lutherstadt: Ziemsen, 1990).*
436 *de Juana, E. and Boesman.*
437 *Ponce F. M. J., 'Le Régime Alimentaire Du Tétras–Lyre.', Gibier Faune Sauvage, 1987, 429–448.*
438 *Baines D.*
439 *Picozzi N. & Hepburn L. V., 'A Study of Black Grouse in North–East Scotland.', in Proc. 3 Int. Symp. Grouse.World Pheasant Association, Reading & CIC, Paris:, 1984, pp. 462–480.*
440 Starling-Westerberg A., 'The Habitat Use and Diet of Black Grouse Tetrao Tetrix in the Pennine Hills of Northern England.', *Bird Study*, 2001, 76–89.
441 *Picozzi N. & Hepburn L. V.*
442 *Robel R. J., 'Movements and Flock Stratification within a Population Blocks in Scotland.', J. Anim. Ecol., 1969, 755–763.*
443 *de Francechi P. F. & Mattedi S., 'Home Range of Male Black Grouse Tetrao Tetrix from Summer to Winter in the Eastern Alps (Friuli, Italy). In: Jenkins D. (Ed.)':, in Proc. 6 Int. Grouse Symp. World Pheasant Association. Italy, 1995, pp. 59–62.*
444 *M. Houard, T.; Mure, 'Les Tétras–Lyres Des Vallons de Salèse et Molières, Parc National Du Mercantour. Domaine Vital et Influence Du Tourisme.', Rev. Ecol. (Terre Vie), 1987, 165–171.*
445 *de Francechi P. F. & Mattedi S.*
446 *Svobodová J., 'Topické Nároky Tetřívka Obecného (Tetrao Tetrix) ve Vybraných Oblastech České Republiky.' (ČZU, Praha, 2005).*

Social Behaviour

Black Grouse are renowned for their spectacular communal breeding displays. At dawn in spring, dozens of males (blackcock) congregate on traditional display grounds (referred to as a lek). Here they stake out small patches of ground on to which they entice females (greyhens) for mating, which they do by fanning out their feathers and strutting around, making a distinctive mating call[447].

Compared to other Capercaillie the Black Grouse is very high dispersion rate[448]. While the average distance settlement (natural dispersion – distance from the place of birth to the place of first breeding) of hens shall be 10-20 km, for in the male, this distance is almost zero, which means that the roosters do not move away from their birthplace at all[449,450,451]. Explaining hypothesis evolution of higher dispersion of females in birds is built on male territoriality[452,453].

Reproduction

In April and May, during the early morning, the roosters in the wedding gown gather for traditional token areas (forest's halls, arenas), where they present themselves in an effort to win favour female. Here they present themselves at small territories that contain no obvious resources except the males themselves. Females are coming at the middling stage of mating time, three or four consecutive mornings, with the only target - choose a suitable male for mating. They mate only once, with most mating taking place in a short time within one to two weeks[454]. After that, the hens assume all further responsibility for incubating the clutch and taking care of the young while roosters stay on token areas and try to get more hens. So it means that females cannot get direct benefits such as good territory or caring male of their choice during mating. The primary gains resulting from the election of the best male may therefore be considered rather indirect, when good male genes will be inherited by his descendants. Only a few males have the possibility of copulation on the token, while most of them do not mate at all[455]. However, the hens may also copulate with those males who defend their territories near the most attractive male[456].

Equally interesting is that two years old and older females keep mating with the same male as in previous years if it is still alive[457]. This fact[458] was interpreted as a possible mechanism to prevent kinship pairing, and it cannot be ruled out that the long-term active presence of a male in a token area is a reliable feature of quality of its genes for females[459].

The nest is a shallow scrape usually lined with some plant material and feathers. The female builds a nest on the ground as a small basin lined with dry plant material, most often located under the branches of trees[460],[461]. Hens have been nesting in almost the same places for several consecutive years[462]. However, if the clutch is depredated, the hen chooses the next nesting site at much greater distance from the previous nest[463].

A full clutch has an average of 7.9 eggs[464], while one-year-old females are laying eggs later in the season and have smaller clumps than older hens and their chickens also have lower survival[465]. Black grouse have one brood of young each year. The eggs hatch during mid to late June[466].

The hens incubate the clutch on average 23–25 days[467]. The chicks grow very quickly and already at the age of two weeks are able long-distance flight. In families are staying until early winter when they

447 *Game and Wildlife Conservation Trust, 'Black Grouse'.*
448 *Caizergues A.; Ellison L. N.*
449 *Willebrand T., 'Demography and Ecology of Black Grouse Populations.' (Univ. Uppsala, Sweden., 1988).*
450 *Caizergues A.; Ellison L. N.*
451 *Warren P. K. & Baines D., 'Dispersal, Survival and Causes of Mortality in Black Grouse Tetrao Tetrix in Northern England.', Wildl. Biol., 2002, 91–97.*
452 *Greenwood P. J., 'Mating Systems, Philopatry and Dispersal in Birds and Mammals.', Anim. Behav., 1980, 1140–1162.*
453 *Dale S., 'Female-Biased Dispersal, Low Female Recruitment, Unpaired Males, and the Extinction of Small and Isolated Bird Populations.', Oikos, 2001, 344–356.*
454 *Alatalo R. V.; Höglund J.; Lundberg A.; Sutherland W. J., 'Evolution of Black Grouse Leks. Females Preferences Benefit Males in Larger Leks.', Behav. Ecol., 1992, 53–59.*
455 *Höglund J.; Alatalo R. V., Leks. (Princeton, New Jersey: Princeton Univ. Press, 1995).*
456 *Lundberg A. Rintamäki P. T., Alatalo R. V., Höglund J., 'Male Territoriality and Female Choice on Black Grouse Leks.', Anim. Behav., 1995, 759–767.*
457 *Rintamäki P. T., Alatalo R. V., Höglund J.*
458 *Rintamäki P. T. Höglund J., Piertney S. B., Alatalo R. V., Lindell J., Lundberg A., 'Inbreeding Depression and Male Fitness in Black Grouse.', in Proc. R. Soc. Lond. B 269:, 2002, pp. 711–715.*
459 *Lundberg A. Kokko H., Rintamäki P. T., Alatalo R. V., Höglund J., Karvonen E., 'Female Choice Selects for Lifetime Lekking Performance in Black Grouse Males.', in Proc. R. Soc. Lond. B 266:, 1999, pp. 2109–2115.*
460 *Glutz von Blotzheim, U. N.; Bauer, K. M.; Bezzel.*
461 *Storaas T., 'A Comparison of Losses in Artificial and Naturally Occurring Capercaillie Nests.', J. Wildl. Manage., 1988, 123–126.*
462 *Angelstam, P. K.; Jaarola, M.; Nordh.*
463 *L. Marjakangas, A.; Törmälä, 'Female Age and Breeding Performance in Cyclic Population of Black Grouse Tetrao Tetrix.', Wildl. Biol., 1997, 195–203.*
464 *K. E. L. (eds) Cramp, S.; Simmons, Handbook of the Birds of Europe, the Middle East and North Africa. Vol. 2. (Oxford: Oxford University Press, 1980).*
465 *Caizergues A.; Ellison L. N.*
466 *'Black Grouse, UK Biodiversity Action Plan', 2007 <http://www.blackgrouse.info/about/identification.htm>.*
467 *G. Baines, D.; Wilson, I. A.; Beeley, 'Timing of Breeding in Black Grouse Tetrao Tetrix and Capercaillie Tetro Urogallus and Distribution of Insect Food for the Chicks.', Ibis, 1996, 181–187.*

regroup into flocks[468]. Only males belonging to the same winter flock are close relatives, which could be a consequence different dispersion of both sexes with strong male loyalty to birth filopathy[469].

Demography

The Black Grouse population has decreased by 40% from between 1996 and 2016 according to ESIT. The IUCN also reports a current population trend which sees number decreasing. There is estimated to be between 1,200,000 and 2,000,000 calling or lekking males. This would suggest an overall mature population of around 2,500,000 to 4,000,000 in Europe. However, Europe only makes up about 30% of the global range and so the global population would be in the region of 11,00,000 individuals[470].

The habitat of black grouse has reduced significantly in recent decades and has led to the major declines in the species' range and in turn their population has suffered. Commercial afforestation of coniferous monocultures has increased, and this intensive cultivation has taken great swathes of prime heathland which is the natural habitat of the black grouse[471].

There is evidence that the pressure of hunting has an impact on the sex ratios of black grouse. The high hunting pressure leads to lower numbers of cocks and in turn smaller leks. Male black grouse chicks have a higher rate of mortality than female chicks when rearing conditions are poor[472].

Magpie *(Pica pica)*

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Description

46–50 cm; 200–270 g, male 185–247 g, female 161–240 g (nominate), male 214–268 g, female 208–232 g (*leucoptera*); wingspan 52–60 cm. Very distinctive magpie, mainly black and white, with long, graduated tail, mid-sized bill relatively wide at base, culmen downcurved distally.

Nominate race has head to breast and most of upperparts black with inconspicuous purple and green sheen; scapulars white, narrow greyish band across rump; upperwing black, highly glossed green or greenish blue on secondaries and tertials, inner webs of primaries white with black tips and bases, white usually concealed when bird at rest (but forms huge band on open wing); tail black, highly glossed with green and reddish purple, becoming almost matt black at very tip; flanks and central underparts white, lower belly, tibia feathering and undertail-coverts black; iris dark brown; bill and legs black.

[468] *Hudec K. (ed.), Fauna ČSSR. Ptáci – Aves, Vol. III/2. (Praha.: Academia, 1983).*
[469] *J. Höglund, J.; Alatalo, R. V.; Lundberg, A.; Rintamäki, P. T.; Lindell, 'Microsatellite Markers Reveal the Potential for Kin Selection on Black Grouse Leks.', in Proc. R. Soc. Lond. B 266:, 1999, pp. 813–816.*
[470] *BirdLife International, 'Lyrurus Tetrix', The IUCN Red List of Threatened Species 2016: E.T22679480A85944601, 2012 <http://www.iucnredlist.org/>.*
[471] *BirdLife International, 'Lyrurus Tetrix'.*
[472] *Niklaus Zbinden and others, 'Evidence for an Additive Effect of Hunting Mortality in an Alpine Black Grouse Lyrurus Tetrix Population', Wildlife Biology, 2018.1 (2018) <https://doi.org/10.2981/wlb.00418>.*

Sexes similar. Juvenile is similar to adult but duller, with black areas of plumage unglossed and sooty black, white areas tinged buffy, when recently fledged has patches of bare grey or grey-blue skin around eye and on malar, becoming much as adult by late summer. Races differ mainly in intensity of gloss in black areas of plumage, extent of white in wing, prominence or absence of white in rump, comparative tail length and size: fennorum is larger and has more extensive white on rump than nominate[473].

Habitat

Inhabits a tremendous variety of open country, preferably with at least scattered trees. Avoids both tracts of treeless country and extensive woodland or forests. In man-modified landscapes, favours mixed farmland, parks and gardens, with overgrown hedges and small stands of trees. In recent decades increasingly common in urban areas, especially in places with avenues of trees; can reach very high densities in parts of urbanized Europe. Observed to at least 4800 m in Tibet (where nests were recorded as high as 4400 m)[474].

Diet

Omnivorous, but mainly a carnivorous scavenger. Diet varies according to local habitats, basically of invertebrates, especially beetles (Coleoptera), and small mammals and lizards, frogs, bird eggs and nestlings, as well as carrion and rarely even adult birds, with surprising prey, such as Common Swifts (*Apus apus*), occasionally reported.

Comparative study of diet of nestlings in urban and rural areas in Czech Republic reported differences between the different environments, but that invertebrates, especially *Coleoptera*, were the most frequent prey in both, and that *Annelida* and *Lepidoptera* were preferentially selected versus *Isopoda*, *Diplopoda*, *Orthoptera* and *Hymenoptera*[475].

In rural Spain, during breeding season, arthropods and cereal seeds were the most frequently consumed food groups (> 60%), whereas eggs and birds were consumed only occasionally (< 6% and 17%)[476]. Pairs patrol roadsides in the early mornings, exploiting overnight roadkills. In addition, various seeds, berries and fruits are taken seasonally. Takes a variety of food scraps, and where unmolested can become cautiously confiding around picnic sites and in city parks, regularly visiting refuse bins. Feeds almost entirely on ground, walking with bold, strutting gait, carrying tail upwards as it searches for insects; side-hops to catch prey. Perches on cattle and sheep to feed on ectoparasites, such actions sometimes resulting in aggravated sores for the host animal. Freely stores food, but usually retrieves items within a few days. Although not known for its agility in the air, will pursue other birds to force them to drop or regurgitate food items; exceptionally, recorded as capturing small birds in flight, including a House Sparrow (*Passer domesticus*).

Social Behaviour

Essentially resident; few ringing recoveries exceed 30 km. Those in North Scandinavia move South following adverse weather conditions, in some years flocks gathering in South Sweden and attempting a sea crossing to Denmark (apparently relatively few succeed, the majority turning back). Finnish birds, presumably from far the North, may move further than assumed, as indicated by several ringing recoveries of more than 100 km, including one of 450 km. In Siberia, populations in extreme North of range shift South during severe weather, joining gatherings of magpies which are attracted towards towns and settlements from the open countryside. Being in general remarkably sedentary, the species is not prone to vagrancy, but vagrants reported from Singapore, Israel, Lebanon, and Scilly Is (off extreme SW England).

Normally utilizes lowest air-space, flying between trees with undulating flight action, sweeping up to perch just inside canopy. Although often encountered in pairs or family parties, larger groups are not uncommon, and assemblages of 20 or more gather for communal roosts. In Turkmenistan as many as 2000 have been estimated at one winter gathering, and in the Tibetan region of Asia ten magpies were counted as they left a single roosting nest; it seems that Tibetan individuals build several roosting nests, very close to or contiguous with one another, for added warmth. Biggest known urban roost is in L'viv (Lwow), in West Ukraine, where 1700 individuals recorded. Roosts in towns tend to be larger than those in farmland[477].

Reproduction

Season commences with nestbuilding as early as December in Britain, mid April being peak time for first egg-laying; dates similar elsewhere in Europe and, surprisingly, in Turkmenistan, but later, with laying chiefly last week April, in Central Siberia; single-brooded. Monogamous long-term pair-bond, partners keeping together throughout year, even when flocking. Solitary nester. Nest construction undertaken by both sexes, female doing bulk of building, male

[473] *Kirwan G. M. Madge, S.; Christie, D.A., 'Eurasian Magpie (Pica Pica), Version 1.0. In Birds of the World (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. Https://Doi.Org/10.2173/Bow.Eurmag1.01', 2020 <https://doi.org/10.2173/bow.eurmag1.01>.*

[474] *T. Lu, X.; Ke, D.; Ma, X.; Gong, G.; Yu, 'Nesting Records of 258 Bird Species in Lhasa Region, Tibet.', Chinese Birds, 1.(3): (2010), 167–174.*

[475] *A. Kryštofková, M.; Fousová, P.; Exnerová, 'Nestling Diet of the Common Magpie (Pica Pica) in Urban and Agricultural Areas.', Orn. Fenn., 88.(2): (2011), 138–146.*

[476] *P. Díaz-Ruiz, F., Zarca, J.C., Delibes-Mateos, M. and Ferreras, 'Feeding Habits of Black-Billed Magpie during the Breeding Season in Mediterranean Iberia: The Role of Birds and Eggs.', Bird Study, 62.(4): (2005), 516–522.*

[477] *Madge, S.; Christie, D.A.*

supplying most of materials, work takes 1–8 weeks (depending on experience of builders and availability of materials); nest a rather large, distinctively domed structure (occasionally undomed, especially in urban areas, where up to 32% of nests may be open), made from sticks and twigs, with side entrance protected by thorny twigs (in areas where twigs hard to come by, nest occasionally made entirely from wire), deep cup thickly lined with soft materials such as wool, animal fur, soft grasses and feathers, usually placed at variable height in crown of tall tree; normally a fresh nest built each year, although in some cases (e.g. where availability of nest-sites limited) an old nest may be repaired; in more open habitats electricity pylons also used as nest-site (nests on pylons in Khabarovsk region of Amurland/Ussuriland reach massive proportions, as fresh nest built each year on top of previous), and in habitats with few trees a stunted shrub may be used, or nest built on antenna mast or old building or even on ground, sheltered by heather (*Ericaceae*), stone wall or rocks, but may occasionally nest on buildings, even when suitable natural sites appear plentiful[478].

Clutch 2–8 eggs, chiefly 5–7, usually pale blue or greenish blue spotted or speckled olive or buff, sometimes with markings concentrated at one end, mean size 34·7 mm × 24 mm; incubation entirely by female, fed at nest by male, period 21–22 days; chicks fed by both sexes, mainly by male, leave nest after 24–30 days, dependent on adults for several weeks further; in autumn, young join up with flocks of non-breeders. Nests regularly parasitized by Great Spotted Cuckoo (*Clamator glandarius*) in parts of range; in Spain, on average just 0·6 young magpies fledge from nests parasitized by cuckoos[479]. Able to breed for first time when 15–17 months old.

Demography

The breeding population of Eurasian Magpie in Europe is estimated to number 7,500,000 – 19,000,000 pairs, and therefore between 22,550,00 – 57,000,000 individuals. Their population trend has been stable globally, and in Europe it has been stable with 1% population increase since 1980[480]. The population in France numbers at between 400,000 and 800,000 couples. Its short-term trend is stable however it has a declining long-term trend. It's distribution across France covers 549,400 km^2.

The Magpie has a large range which extends from Ireland to continental Europe as south as Spain, as north as Finland and as East as the Kamchatka peninsula in Russia. It has also been introduced further East in Japan. They are relatively versatile and well adapted to live in built up human modified areas. They have particularly high densities in suburban areas where there are scattered trees in parks and gardens.

Mallard *(Anas platyrhynchos)*

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Description

The Mallard (*Anas platyrhynchos*) is a species of large duck, from the *Anatidae* family. As with all species of ducks, sexual dimorphism is accentuated. The female has general brown, marbled colour, which is perfect for camouflage during egg hatching. The male is brightly coloured, with metallic green head and neck, a white ring at the base of the neck, and chestnut coloured chest. The body is coloured in shades of grey which is dorsally darker and the feathers around the tail are black. The body length is 50-60 cm and has an average weight of 735-1800 g. The wingspan is between 81-95 cm[481].

The many breeds of farmyard duck are the domestic forms of Mallard[482]. The first domestications took place in Southeast Asia in the Neolithic. Often, mating occurs between wild populations and domestic specimens, so there is a continuous genetic flow between the two categories.

Habitat

Anas platyrhynchos can be found in many areas, in several climates and habitats, from subtropical marshes to the Arctic tundra. The main requirement is a com-

478 *P.S. Redman, 'Magpie Nest on Church Spire.', British Birds, 106.(5): (2013), 290.*
479 *E. Yang, C., Liang, W., Antonov, A., Cai, Y., Stokke, B.G., Fossøy, F., Moksnes, A. and Røskaft, 'Diversity of Parasitic Cuckoos and Their Hosts in China.', Chinese Birds, 3.(1): (2012), 9–32.*
480 *IUCN, Red List species, 'Pica Pica', 8235 (2017).*
481 *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 8. Birds I; Hume; Harrison and Greensmith; Bellrose and Johnsgard.*
482 *Harrison and Greensmith; Hume.*

bination of shallow low-water areas and appropriate nesting cover, which can be grassy or herbaceous vegetation and even trees or shrubs[483]. They inhabit almost every type of wetland, including brackish, fresh or saline waters, if they provide some vegetative cover and are relatively shallow. Nevertheless, mallards tend to avoid oligotrophic and fast-slowing waters[484].

During wintertime, mallards may prefer saline habitats along the coast, in brackish estuaries or bays because of the shallow and fairly sheltered water[485].

Social behaviour

They are social animals that form flocks of various sizes. During the nesting period the population is widely dispersed, while in autumn and winter they gather in groups on non-freezing aquatic surfaces[486].

The Common Mallard usually displays social behaviour for several months, beginning with the last part of autumn, until late winter or the beginning of spring. Pairing activity happens on mostly water, but courtship flights are also common and even rape chases, especially by the end of the season when most females are already mated[487].

The central aquatic exhibits of males are head-up-tail-up, down-up, grunt-whistle, and nod-swimming. Females will stimulate courtship by performing nod-swimming to male display and making inciting calls[488].

The species is partially migratory, with northern breeding mallards usually wintering much further south and the ones breeding in temperate regions being sedentary or dispersive. For example, birds from Finland, Sweden, northwest Russia or the Baltic states usually migrate and spend the winter in areas ranging from Denmark to northern France or Great Britain. Birds breeding in central Europe are part sedentary and part migratory, wintering in the area of the Mediterranean or the Black Sea. Mallards from southwest Europe are mainly sedentary[489].

Diet

The mallard is flexible when it comes to food. It is an omnivorous and opportunistic bird that feeds both on the surface of the water, foraging for aquatic plants or invertebrates (insects, molluscs, crustaceans and occasionally small fish) in swampy areas or shallow water, as well as on land searching for the vegetal or invertebrate material that it can catch[490].

In order to feed, Anas platyrhynchos will swim with its bill dabbling, straining out food items with a comb-like arrangement of plates. The bird may also up-end itself to reach down to weeds or mud for food[491].

Reproduction

Mallards become sexually mature at the age of 1 year and are seasonally monogamous[492]. The breeding period can start early, even in February, with egg laying taking place starting in the second part of March or the beginning of April. The female usually lays 9-13 eggs, which she hatches alone, while the male may sometimes defend the territory. However, males usually gather in small flocks during this period and migrate to moulting areas[493].

The birds nest in isolation and sometimes in loose groups nesting a few meters away. The nests are located near the water, directly on the ground, hidden in vegetation. Sometimes the nest can be found in the stands or on buildings. The incubation period lasts 26-28 and the chicks fly 50-60 days after hatching[494].

Demography

According to ESIT, the population of mallard in Europe has increased by 43% from between 1980 and 2016. The current global population trend suggests numbers are increasing, however the IUCN red list estimates that the European population is stable, with a population of between 3,000,000 and 4,000,000 pairs and therefore around 6,000,000 to 9,000,000 mature individuals[495].

There are said to be five recognised populations in Europe/west Eurasia. These include a west Mediterranean group, black sea/east Mediterranean group, southwest Asian group, northwest European group and a detached population in Greenland. The population size in Greenland is estimated to be in the region of 15,000 – 30,000 with a breeding population of 5,000 – 10,000 pairs. Whilst the northwest popula-

[483] *Bellrose and Johnsgard.*
[484] *Scott and others.*
[485] *BirdLife International, 'Anas Platyrhynchos', The IUCN Red List of Threatened Species 2017: E.T22680186A119275821, 2017 <http://www.iucnredlist.org/>.*
[486] *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 8. Birds I.*
[487] *Bellrose and Johnsgard.*
[488] *Bellrose and Johnsgard; Jackson, Bock, and Olendorf*
[489] *Scott and others.*
[490] *BirdLife International, 'Anas Platyrhynchos'; Bellrose and Johnsgard; Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 8. Birds I.*
[491] *Harrison and Greensmith.*
[492] *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 8. Birds I; Bellrose and Johnsgard.*
[493] *BirdLife International, 'Anas Platyrhynchos'.*
[494] *Bellrose and Johnsgard; Hume.*
[495] *BirdLife International, 'Anas Platyrhynchos (Amended Version of 2017 Assessment)', The IUCN Red List of Threatened Species 2019: E.T22680186A155457360., 8235 (2019) <http://www.iucnredlist.org/>.*

tion is estimated to be 5,000,000, it is very dispersed and could therefore be as much as double this size. Meanwhile the northern Europe/western Mediterranean population is lower at around 1,000,000 individuals[496].

Some of Europe's largest breeding populations have seen an increasing population. These countries include the Netherlands, Ukraine, Sweden, and Britain, however, populations in Spain, Romania and the Czech Republic went down[497].

The Mallard is the most common and familiar duck in Europe with a widespread and generally numerous populations across Europe. Between the EU, UK, Switzerland and Norway, 4.5 million individual mallards are shot every year. Mallard numbers during winter in the UK and the Netherlands have shown signs of long-term declines between 1980 and 2010. Climate warming has a role in this fact as warmer and milder winters cause mallard to spend winter further north in Scandinavian and Baltic regions[498].

The Mallard has a widespread distribution throughout Europe; however, some densities are bigger than other. For example, there is a smaller density of wintering birds in the Alpine regions of Italy and the Balkans, whereas the density in areas such as the Rhine Valley, French/German border and Mediterranean regions of Spain and France have larger densities[499].

Partridge, Grey *(Perdix perdix)*

Description

The Partridge is a widespread farmland bird in Europe and Western Asia, which was also introduced in North America around two centuries ago. It's a bird in the *Phasianidae* family, smaller than the pheasant and larger than the quail. It lives mostly on the ground. It's among the commonest gamebirds from its range[500].

The male and the female have approximately the same colour, except for the brown spot on the chest which is obviously larger in the male. The predominant colour of the feather is brown-grey, with a rusty tail, visible when birds rise into the air. The head is rust-coloured, on the sides showing brown streaks[501]. Appearance may however vary in terms of plumage, with races in the West being more rufous brown and races in the East generally greyer and paler[502].

The body length is 29-31 cm, and the wingspan is 40-50 cm, with a body mass of 300-450 g. The maximum longevity achieved in the wild is 10-11 years, but the usual lifespan is around 5 years[503].

Habitat

In Europe, partridges can be found in steppes and open arable lands, generally in the temperate zone[504].

496 *S Delany and others, 'Report on the Conservation Status of Migratory Waterbirds in the Agreement Area', 2007, 110.*
497 *Delany and others.*
498 *Lars Dalby and others, 'The Status of the Nordic Populations of the Mallard (Anas Platyrhynchos) in a Changing World', Ornis Fennica, 90.1 (2013), 2–15.*
499 *Delany and others.*
500 *Harrison and Greensmith.*
501 *Harrison and Greensmith; Hume.*
502 *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 8. Birds I.*
503 *Hume.*
504 *BirdLife International, 'Perdix Perdix', The IUCN Red List of Threatened Species 2016: E.T22678911A85929015., 2016 <http://www.iucnredlist.org/>; Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 8. Birds I.*

They prefer traditional farmland which is open and mixed, with fields of meadow, arable crops and hedges on grassy banks However, they can also be observed in sand dunes areas, peat bogs, and swampy areas[505].

The Partridge likes to wander in the open spaces and has adapted to the changes of expanding agriculture. It is a predominantly sedentary bird and does not migrate, but in areas where the weather is unfavourable, it can go to warmer places, especially in Eastern Europe[506]. They can now mainly be found in less intensively managed croplands, in Spain and Caucasus, usually up to 2,600 m[507].

Social Behaviour

Perdix perdix possesses unique behavioural characteristics, has territorial instincts and lives in large groups, consisting of one or more families. In the breeding period, the males become aggressive with each other, in the fight to win the females. They attract females by stretching the wings, raising the tail and inflating the feathers. Unmated male partridges will seek to pair with already mated hens[508].

The nesting season starts in April-May and lasts until September-October of the year[509]. The nest is arranged at the ground level in the depths or at the base of dense vegetation. The female lines it with fluff and grass or twigs. If the nest or the eggs are destroyed, the female may deposit a new tip, but naturally the species has only one generation of chicks per year[510].

At the end of the nesting season, both females and males group into flocks of up to 10-15 individuals, called coveys[511]. Pairs live in more exclusive areas in Spring[512].

When alarmed, they crouch and hide in the grass, passing for a piece of dry turf or a clod of earth. When partridges are approached directly, they burst out of hiding and rapidly fly low over the ground, while making a sharply audible whistle with their wings[513].

Diet

The mature *Perdix perdix* feeds while walking on the ground, taking leaves, seeds and shoots, while the chicks' diet consists mainly of insects. For the young, insects are an essential protein supply and also the only thing they can yet digest[514].

Studies in many countries reveal that, in autumn, food consists mainly of green leaves of grasses (*Gramineae*), cereals and clover (e.g. *Trifolium*) and grain and weed seeds (especially *Polygonum*), e.g., in Polish study, diet at this season comprised cereal leaves (58.2% in total of all items), broadleaved plant species leaves (21.8%), seed cases of weeds (13.3%), cereal grains (3.5%), husks of grasses (1.2%) and other plant material (2%)[515].

In spring and summer, seed heads of chickweed (*Stellaria*) and unripe grass seeds are preferred in Britain. Proportion of weed seeds in autumn diet declined from 31% (by dry weight) in 1933–1936 to 4% in 1968–1977, attributed to use of herbicides and change in stubble removal practices.

Chicks dependent on insects in first 2 weeks of life; proportion in diet varies between studies, but at least half volume of intake. In Great Britain, plant bugs (*Miridae*), sawfly larvae (*Hymenoptera*; *Dolerus spp.*), *Lepidoptera* larvae, *Carabidae*, *Staphylinidae* preferred, but cereal aphids (*Aphidae*) also important sometimes[516],[517].

Reproduction

The partridge is a monogamous bird that will form a pair four months before the mating season. Females lay 14-16 olive-coloured eggs in March-April and incubation lasts 18-21 days, while the male protects the nest[518]. The chicks develop juvenile plumage about 40-55 days after hatching but begin to feed themselves 10-14 within days. They reach adult weight in three months' time[519].

After the chicks have hatched, the male returns to the nest, where he takes care of the chicks together with the female and stays with them until the chicks begin

505 *Hume.*
506 *BirdLife International, 'Perdix Perdix'.*
507 *Jackson, Bock, and Olendorf.*
508 *David Jenkins, 'Social Behaviour in the Partridge Perdix Perdix', Ibis, 103.2 (1961), 155–88.*
509 *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 9. Birds II.*
510 *Ahti Putaala and Raimo Hissa, 'Breeding Dispersal and Demography of Wild and Hand-Reared Grey Partridges Perdix Perdix in Finland', Wildlife Biology, 4.2 (1998), 137–45 <https://doi.org/10.2981/wlb.1998.016>.*
511 *Harrison and Greensmith; Hume.*
512 *Jackson, Bock, and Olendorf.*
513 *Harrison and Greensmith.*
514 *Hume; Jackson, Bock, and Olendorf.*
515 *M. Orłowski, G., Czarnecka, J. and Panek, 'Autumn–Winter Diet of Grey Partridges Perdix Perdix in Winter Crops, Stubble Fields and Fallows.', Bird Study, 58.(4): (2011), 473–486.*
516 *G. R. Potts, 'Recent Changes in the Farmland Fauna with Special Reference to the Decline of the Grey Partridge.', Bird Study, 17: (1970), 145–66.*
517 *R. E. Green, 'The Feeding Ecology and Survival of Partridge Chicks (Alectoris Rufa and Perdix Perdix) on Arable Farmland in East Anglia.', Journal of Applied Ecology, 1984, 817–30.*
518 *Hume; Harrison and Greensmith.*
519 *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 8. Birds I.*

to feed on their own and are capable of short flights. Pairs have only one tip per year[520].

The birds become active for reproduction in the second year of life. As a result, at the age of one year, the young partridges are left by the parents in the middle of the field to handle themselves[521].

Demography

ESIT reports that the Grey Partridge population in Europe has declined by 89% between 1980 and 2016. From 2000 to 2015 the decline has been at a rate of 20-30%[522]. It is estimated that a population of between 1,380,000 – 2,670,000 pairs exist in Europe which would equate to 2,750,000 – 5,340.000 mature individuals. The global population is in the region of 4,000,000 – 8,000,000 individuals which means that Europe makes up 70% of their global range[523]. France holds 46% of the European population with fluctuating population trends since 2000[524].

Reasons for its decline in Europe have been due to habitat loss and sharp declines in its prey, insects. Agricultural intensification has been accredited to this food shortage, with pesticides being in use throughout the partridge' range in Europe[525]. Much of the Partridge's staple diet, including insects, chickweed, knotweed, brittle-stem hemp-nettle and black bindweed saw significant declines as a result of pesticide and herbicide use. At the being of the 20th century it is reported that eight species of weed were present in cereal fields within each square metre. This number reduced to three by the 1980's. Hunting bags have seen fewer and fewer partridges since 1950 where chick survival rate was just 33% between 1955 and 1990 across Europe[526].

In 1950, 15% of cereal fields in the UK were being sprayed with herbicides. This percentage increased to 70% in less than ten years, and in 1965, over 90% of fields were being sprayed. Continental Europe saw a similar trend, but its intensifying of spraying started roughly 10 years late, nonetheless chick survival rate has direct correlation with the increased pesticide use across Europe since the 1950's[527].

Poor habitat quality is another reason for the Partridge's declining population in Europe. Agricultural intensification also caused the disappearance of hedgerows and other suitable forms of nesting sites. The upscaling and expansion of agricultural land meant there was a dire shortage of cover and chick rearing habitat. Exposure to predation from raptors such as the marsh harrier contributed to their decline and is an important morality factor. Game estates where predators are controlled have been beneficial to partridges, however the coexistence with other game birds such as the pheasant has been a cause of further decline for partridges. The two species share a common parasite which effects the partridge more severely than the pheasant or being caught up in the driven shoots[528].

Partridge, Red-legged *(Alectoris rufa)*

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Description

Best distinguished from other *Alectoris* by black mottling on breast and sides of neck forming necklace of spots and streaks, as well as more earth-brown upperparts. White forehead also distinctive. Might also be confused with *Perdix perd*ix, but note black-bordered white throat, unmarked upperparts, bold flanks barring and whitish supercilium of present species. Many introduced birds are in fact hybrids with *A. chukar* and these often appear greyer above, with much less streaking below the black gorget. Female slightly smaller than male, with duller head and throat and no tarsal spur. Juvenile smaller and much duller

520 *Jenkins.*
521 BirdLife International, '*Perdix Perdix*'.
522 BirdLife International, '*Perdix Perdix*'.
523 BirdLife International, '*Perdix Perdix*'.
524 BirdLife International, '*Perdix Perdix*'.
525 BirdLife International, '*Perdix Perdix*'.
526 *Dries Pieter Jan Kuijper, Ernst Oosterveld, and Eddy Wymenga, 'Decline and Potential Recovery of the European Grey Partridge (Perdix Perdix) Population-a Review', European Journal of Wildlife Research, 55.5 (2009), 455–63 <https://doi.org/10.1007/s10344-009-0311-2>.*
527 *Kuijper, Oosterveld, and Wymenga.*
528 *Kuijper, Oosterveld, and Wymenga.*

with crown and nape dark olive-brown, upperparts, breast-sides and flanks grey-brown, the latter tract with whitish subterminal bars and central streaks to each feather, breast blue-grey, throat whitish with dusky-mottled border, and rest of underparts yellowish buff, while bill and legs are dull reddish or horn-brown. However, soon attains traces of black collar and flanks pattern, and is essentially adult-like at age circa 4 months. Races very similar, differing mainly in tone of plumage colour: hispanica is darker, brighter and more richly coloured than nominate, with a stouter bill, while intercedens is much paler above than the preceding race, with a greyer rump, brighter underparts and a heavier bill than nominate race[529].

Size 34–38 cm; male 480–547 g, female 391–540 g; wingspan 47–50 cm.

Habitat

Apparently less specialized than other *Alectoris*. The species is found in open habitats ranging from Mediterranean to humid temperate zones, but not in boreal, oceanic or arid zones[530],[531]. It prefers lowland areas and generally is found in drier habitats than *Perdix perdix*. Avoids forest and wet areas if possible; uses habitats with a wide variety of soils and land uses, again more varied than congeners. Dry, hilly land with scattered small bushes up to c. 1300 m in montane foothills, but apparently on rare occasions as high as 2000 m, especially in S. Range from inhospitable dry terrain on lower mountain slopes to marginal cultivation, cropland, orchards, woodland[532], etc. Over most of its range it is associated with arable farming, using low intensity cropping with a mixture of cultivated, fallow and uncultivated ground[533].

Social Behaviour

Mostly sedentary, but some descent to lower ground noted in winter months[534]. Mainly recorded in small coveys of up to ten individuals, but aggregations of up to 70 are not infrequent during post-breeding season, with gatherings of up to 300 noted during cold winter weather and single-sex coveys of up to 40 birds reported in USA (introduced) during late winter; non-breeders remain in flocks throughout nesting period. In spring the male's loud cry may be heard before dawn. In winter, flocks of these partridges descend into the valleys to seek places free from snow[535].

Diet

Diet very similar to those of *A. chukar* and *Perdix perdix*, though takes some larger items than latter. Seeds, leaves and roots, grasses and legumes especially important in winter. In Spain, predominantly wild and cultivated grasses and forage legumes, mainly vetches, *Vicia*, and other seeds and fruits on occasion. Eat also ants, grasshoppers and other insects, with animal diet especially important to young birds. In Portugal, various seeds and roots, grass foliage (mainly *Poa*) and legumes; roots such as *Poa*, *Ranunculus* and *Leontodon* in August–October. From October grass leaves and legumes enter diet and become main components during winter. Insects form 3% by volume on average, but 10% in summer. Often visits drinking site in early morning, prior to feeding[536]. It has been less susceptible than the grey partridge to the reduction in cereal insects since the 1950s because its chicks consume considerably more seeds and vegetable matter, even shortly after hatching[537].

Reproduction

Lays eggs late April to early May in Portugal but starts as early as late January in Spain[538]. Late April to May in England, May to mid-June in France. Monogamous, with long-term bonds, occasionally bigamous. Winter coveys typically start to disband in Feb and Mar. Nest-site chosen by female. Nest, constructed by male, is scrape in ground lined with a few scraps of vegetation, usually in shade of grass tuft, bush or boulder, but occasionally up to circa 1 m above ground in holes in trees[539] . Mean 11,2–12,7 white or pale yellow-buff eggs speckled reddish brown and grey (range 7–20, exceptionally up to 28), laid at intervals of up to 36 hours, mean size 41,4 mm × 31,1 mm[540].

529 *P. McGowan, P.J.K., Kirwan, G.M. and Boesman, 'Red-Legged Partridge (Alectoris Rufa).', in J. Del Hoyo, A. Elliott, J. Sargatal, D.A. Christie and E. de Juana (Eds), Handbook of the Birds of the World Alive (Barcelona: Lynx Edicions, 2013).*
530 *McGowan, P.J.K., Kirwan, G.M. and Boesman.*
531 *Tucker, G.M. and Heath.*
532 *McGowan, P.J.K., Kirwan, G.M. and Boesman.*
533 *Tucker, G.M. and Heath.*
534 *McGowan, P.J.K., Kirwan, G.M. and Boesman.*
535 *'Birds Info: Red-Legged Partridge' <https://www.birdsinfo.org/red-legged-partridge/>.*
536 *McGowan, P.J.K., Kirwan, G.M. and Boesman.*
537 *Game and Wildlife Conservation Trust, 'Red-Legged Partridge', 2020 <https://www.gwct.org.uk/game/research/species/red-legged-partridge/>.*
538 *J.E. Vargas, J.M., Duarte, J., Farfan, M.A., Villafuerte, R. and Fa, 'Are Reclamo Hunting Seasons for the Spanish Red-Legged Partridge off the Mark?', Journal of Wildlife Management, 76.(4): (2012), 714–720.*
539 *J.M. Duarte, J. and Vargas, 'Nesting of the Red-Legged Partridge (Alectoris Rufa) upon Olive Tree Trunks in the South of Spain.', Alauda, 66.(4): (1998), 317–319 P.*
540 *Castell Harrison, C. J. O., Bird Nests, Eggs and Nestlings of Britain and Europe with North Africa and the Middle East. Second Revised Edition. (London: HarperCollins, 2002).*

Mass circa 12–19 g [541] (variation in egg colour is only between clutches, not within them)[542]. Male will incubate if female absent, but usually female alone incubates; double-brooding reported, with second clutch started shortly after first and adults incubating one clutch each, but incidence of this varies strongly between years being positively influenced by rainfall[543]. Incubation 23–25 days, probably starting with final egg[544]. Chicks have rich brown and cream down above, paler below. Young tended by both parents if only one clutch, each clutch by one parent if two. Chicks brooded when small. Precocial flight at circa 10 days. Full adult size at 50–60 days. Remain with adults through first winter. As females age, they tend to produce marginally lighter eggs but larger clutches, while younger females tend to start laying later than older females[545]. In addition, clutch size decreases with later laying date[546]. Nest and egg losses of c. 50% have been reported in Spain[547], with probability of clutch loss to predation differing between sexes, being much higher for nests incubated by females[548], while in Central Italy mean brood size decreased from circa 10 on hatching to circa 6 after 60 days old[549]. Sometimes parasitized by *Coturnix coturnix*[550], while the present species has been recorded egg-dumping in nests of Montagu's Harrier (*Circus pygargus*)[551]. Sexual maturity in first year. Survival in South Spain consistently > 90% for both sexes in natural habitats, but in two areas managed intensively for hunting and agriculture, survival was low during hunting period (72% for females and 79% for males), high during breeding season for males (99%) and intermediate for females (89%) due mainly to diseases, with hunting the main cause of mortality in both hunting areas[552]. Regular prey of Bonelli's Eagle (*Aquila fasciata*) in some areas[553], while predators of eggs and chicks include red foxes (*Vulpes vulpes*) and various corvids[554].

Demography:

Not globally threatened (Least Concern). The breeding population, which is confined to Europe, is estimated at 5,060,000-7,080,000 pairs, which equates to 10,100,000-14,200,000 mature individuals[555]. The disappearance of uncultivated land due to changes in agricultural practice has resulted in the loss of nesting cover and chick food. In pastoral areas, pastures have been agriculturally improved, and areas of low, herb-rich scrub converted to grassland and further habitat loss has occurred through the loss of arable farming from open hill areas, if livestock is removed (leading to encroachment of tall scrub and forest)[556]. Habitat fragmentation due to urbanization and agricultural expansion is also a problem.

Believed to have declined considerably in its native range, with extirpations reported in North Brittany (France), West & South Switzerland and Germany's Rhineland, while attempted reintroductions in the last-named country have since failed[557]. Following decline in Liguria, Piemonte and adjacent regions in North-West Italy, now stable at circa 1000–2000 coveys. Species is being reintroduced in parts of Central Italy where it became extinct in early 20th century, with predator controls being used to secure breeding success[558]. In the Iberian Peninsula, hunting has led to steep declines. In Portugal, declining and now scarce towards coastal regions. 6,200,000–7,400,000 birds may be shot each year, amounting to > 60% of estimated potential population[559].

541 *E. Cabezas-Díaz, S. and Virgós, 'Adaptive and Non-Adaptive Explanations for Hatching Failure in Eggs of the Red-Legged Partridge Alectoris Rufa.', Ardea, 95.(1): (2007), 55–63.*

542 *D. Castilla, A.M., Dhondt, A.A., Díaz-Uriarte, R. and Westmoreland, 'Predation in Ground-Nesting Birds: An Experimental Study Using Natural Egg-Color Variation.', Avian Conserv. & Ecol., 2.(1): (2007), 2.*

543 *J. Casas, F., Mougeot, F. and Viñuela, 'Double-Nesting Behaviour and Sexual Differences in Breeding Success in Wild Red-Legged Partridges Alectoris Rufa.', Ibis, 151.(4): (2009), 743–751.*

544 *Harrison, C. J. O.*

545 *R. Cabezas-Díaz, S., Virgós, E. and Villafuerte, 'Reproductive Performance Changes with Age and Laying Experience in the Red-Legged Partridge Alectoris Rufa.', Ibis, 147.(2): (2005), 316–323.*

546 *Casas, F., Mougeot, F. and Viñuela, 'Double-Nesting Behaviour and Sexual Differences in Breeding Success in Wild Red-Legged Partridges Alectoris Rufa.'*

547 *Duarte, J. and Vargas.*

548 *Casas, F., Mougeot, F. and Viñuela, 'Double-Nesting Behaviour and Sexual Differences in Breeding Success in Wild Red-Legged Partridges Alectoris Rufa.'*

549 *R. Meriggi, A. and Mazzoni della Stella, 'Dynamics of a Reintroduced Population of Red-Legged Partridges Alectoris Rufa in Central Italy.', Wildl. Biol., 9: (2004), 1–9.*

550 *J. Casas, F., Mougeot, F. and Viñuela, 'Occurrence of Common Quail Coturnix Coturnix Eggs in Red-Legged Partridge Alectoris Rufa Nests.', Bird Study, 57.(4): (2010), 560–562.*

551 *B. Talabante, C., Gómez, J., Aparicio, A. and Arroyo, 'Mixed Clutches in Montagu's Harrier Circus Pygargus Nests: A Maladaptive Brood Parasitism by Galliform Birds.', Bird Study, 60.(3): (2013), 414–416.*

552 *R. Buenestado, F.J., Ferreras, P., Blanco-Aguiar, J.A., Tortosa, F.S. and Villafuerte, 'Survival and Causes of Mortality among Wild Red-Legged Partridges Alectoris Rufa in Southern Spain: Implications for Conservation.', Ibis, 151.(4): (2009), 720–730.*

553 *J.M. Ontiveros, D. and Pleguezuelos, 'Influence of Prey Densities in the Distribution and Breeding Success of Bonelli's Eagle (Hieraaetus Fasciatus): Management Implications.', Biological Conservation, 93 (2000), 19–25.*

554 *Meriggi, A. and Mazzoni della Stella.*

555 *BirdLife International, IUCN Red List for Birds: Species Factsheet.*

556 *Tucker, G.M. and Heath.*

557 *K. Gedeon, K., Grüneberg, C., Mitschke, A., Sudfeldt, C., Eikhorst, W., Fischer, S., Flade, M., Frick, S., Geiersberger, I., Koop, B., Kramer, M., Krüger, T., Roth, N., Ryslavy, T., Stübing, S., Sudmann, S.R., Steffens, S., Vökler, F. and Witt, Atlas Deutscher Brutvogelarten [Atlas of German Breeding Birds]. (Münster: Stiftung Vogelmonitoring Deutschland und Dachverband Deutscher Avifaunisten, 2014).*

558 *Meriggi, A. and Mazzoni della Stella.*

559 *McGowan, P.J.K., Kirwan, G.M. and Boesman.*

Illegal importations of *A. graeca* and *A. chukar* may also be causing problems through hybridization and competition[560]. Most valuable gamebird in Spain, where widely distributed, with densities sometimes reaching in excess of 20 pairs per 100 ha[561]. Fairly common to common in areas of suitable habitat where not overhunted. Restocking with captive-bred birds frequent in hunting areas, but the population is overall considered to be in decline[562].

Wild stocks in Britain, where introduced, are currently estimated to number between 72,000 and 200,000 pairs, versus c. 90,000 in the late 1980s, with up to c. 6,500,000 released annually by the hunting fraternity, of which c. 2,600,000 are shot[563],[564]. Release into the field of individuals bred in farms with no control of their genetic identity and geographic origin appears to have already eroded the genetic diversity. Out of concern for the Wild Red-legged Partridge, the releasing of Chukars and Chukar/red-leg hybrids were prohibited in 1992 in UK[565].

A mean of 800,000 partridges were released annually in the province of Ciudad Real, Central Spain, in 2006–2012[566]. Nort-West Spain might represent the only area where *A. r. hispanica* would still occur[567]. In addition, farm-reared partridge releases appear to increase hunting pressure on wild breeding partridges[568].

Pheasant, Common *(Phasianus colchicus)*

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Description

The Common Pheasant (*Phasianus colchicus*) is a non-miratory species from the *Phasianidae* family[569], also known as the ring-necked pheasant[570]. It is widespread in Europe, where it has been introduced from Asia, and is a very popular gamebird[571].

560 *E. Barilani, M., Bernard-Laurent, A., Mucci, N., Tabarroni, C., Kark, S., Perez Garrido, J.A. and Randi, 'Hybridisation with Introduced Chukars (Alectoris Chukar) Threatens the Gene Pool Integrity of Native Rock (A. Graeca) and Red-Legged (A. Rufa) Partridge Populations.', Biological Conservation, 137 (2007), 57–69.*

561 *J. Gortázar, C., Villafuerte, R., Escudero, M.A. and Marco, 'Post-Breeding Densities of the Red-Legged Partridge (Alectoris Rufa) in Agrosystems: A Large-Scale Study in Aragón, Northeastern Spain', European Journal of Wildlife Research, 48.2 (2002), 94–101.*

562 *B. Díaz-Fernández, S., Viñuela, J. and Arroyo, 'Harvest of Red-Legged Partridge in Central Spain', Journal of Wildlife Management, 76.(7): (2012), 1354–1363.*

563 *M. and the Rare Breeding Birds Panel Ogilvie, 'Non-Native Birds Breeding in the United Kingdom in 1996.', British Birds, 92.(4): (1999), 176–182*

564 *M. and the Rare Breeding Birds Panel Holling, 'Non-Native Breeding Birds in the United Kingdom in 2006, 2007 and 2008.', British Birds, 104.(3): (2011), 114–138.*

565 *Game and Wildlife Conservation Trust, 'Red-Legged Partridge'.*

566 *B. Caro, J., Delibes-Mateos, M., Vicente, J. and Arroyo, 'A Quantitative Assessment of the Release of Farm-Reared Red-Legged Partridges (Alectoris Rufa) for Shooting in Central Spain', European Journal of Wildlife Research, 60.(6): (2014), 919–926.*

567 *J. Rodríguez García, M.J. and Galián, 'Lack of Mitochondrial Genetic Structure in the Red-Legged Partridge Alectoris Rufa (Phasianidae).', Journal of Zoological Systematics and Evolutionary Research, 52.1 (2014), 59–64.*

568 *F. Casas, F., Arroyo, B., Viñuela, J., Guzmán, J.L. and Mougeot, 'Are Farm-Reared Red-Legged Partridge Releases Increasing Hunting Pressure on Wild Breeding Partridges in Central Spain?', European Journal of Wildlife Research, 62.1 (2016), 79–84.*

569 *Harrison and Greensmith.*

570 *The Encyclopedia of Birds, ed. by Laurie E. Likoff (New York: Facts on File, 2007), p. 238.*

571 *Paull and Boucher, p. 61.*

It has a round body and a long tail, with visible differences between sexes. The male's head is usually green or metallic blue, while the copper-coloured body feathers are highlighted with a white ring around the neck and dark breast markings. The females tend to blend with grassy surroundings, as they have a less colourful plumage. Both sexes have long tails, but the male's is longer and trailing, while the female's is shorter and pointed. The bill is short, but sharp and downward curved, in order to be able to pluck food from the ground[572].

The length varies from 66-89 cm for males and 53-63 cm for females, with a wingspan of 70-90 cm [573] and a weight of 0.9-1.4 kg for the mature birds[574]. The average lifespan is 10-20 months[575], but it can live up to 7 years[576].

Several subspecies are identified based on their colors: red pheasant, green pheasant, blue pheasant, ...

Habitat

The Common Pheasant prefers open, lightly wooded areas, such as parks and farmlands[577]. It's a very local species in Spain, Portugal, and the South of Scandinavia, while also being widespread through Mid- and Western Europe[578]. It can be found varied habitats, especially in mixed temperate scrub, riverine and woodland edge[579], reedbeds, open woodland[580], arable fields, heaths, and moorland edges[581].

The nest is a lined with grass hollow on the ground along river and lake banks. The bird prefers to have a protective cover while nesting, usually consisting of dense, low vegetation (brambles, reedbeds, riverside thickets)[582]. Coarse grass seems to be favoured when it comes to nest building[583].

Social behaviour

Phasianus colchicus is a gregarious species, forming small flocks outside the nesting period[584] and in pairs made of one male and several females during breeding season[585].

They are active both at day and night and begin to call well before sunrise. They feed in the early morning and late afternoon, when they leave the roosting sites to forage for 2-3 hours. The warmest part of the day is spent dustbathing (to remove oil from its feathers), relaxing in the shade or sleeping. They return to the roost (a dense ground cover or a former squirrels' nests) after dusk, in groups of 2 to 24 birds[586].

Diet

It's an omnivore, feeding on a wide variety of animal and vegetable food, from weed seeds, berries, and grains, to grasshoppers, wireworms, caterpillars, and other insects[587]. Occasionally, the species eats lizards, field voles or small birds[588].

Pheasants are versatile foragers, that use the bill like a shovel, throwing the soil aside while looking for food (seeds, worms etc.). Their sharp bill makes it easier to take the buried food out of the ground. Jumps are also possible when the bird tries to reach high branches in search for berries, while flight is most common during spring, when the food is scarce, and the bird needs to feed with leaves[589].

Reproduction

The common pheasant is a polygamous bird, with a breeding system based on dominance. The dominant male will attract several females by performing a complex courtship ritual of sounds and movements, meant to impress the opposite sex[590].

The breeding season for the common pheasant is April-July, with one brood per year[591]. Following mating, the female lays 1-2 eggs per day[592] until she

572 *Likoff; Hume; S Madge, P J K McGowan, and G M Kirwan, Pheasants, Partridges and Grouse: A Guide to the Pheasants, Partridges, Quails, Grouse, Guineafowl, Buttonquails and Sandgrouse of the World, Helm Identification Guides (Christopher Helm, 2002), p. 322.*
573 *Beaman and Madge, p. 264.*
574 *Hume.*
575 *Likoff.*
576 *Hume.*
577 *Likoff.*
578 *Hume.*
579 *Jackson, Bock, and Olendorf, Grzimek's Animal Life Encyclopedia. Volume 8. Birds I, p. 451.*
580 *Beaman and Madge.*
581 *Hume.*
582 *Harrison and Greensmith; Hume Likoff.*
583 *Madge, McGowan, and Kirwan.*
584 *Harrison and Greensmith; Hume.*
585 *Madge, McGowan, and Kirwan.*
586 *Likoff, Madge, McGowan, and Kirwan.*
587 *Harrison and Greensmith.*
588 *Paull and Boucher.*
589 *Likoff.*
590 *Likoff.*
591 *Hume.*
592 *Likoff*

reaches a clutch of 8-14 pale olive eggs on average[593]. The male will defend the harem of 2 or more females (harems of 5 have been reported) while they're nesting for 22-25 days[594].

Chicks are able to leave the nest and to feed a few hours after hatching, they however remain near the hen for a few more weeks. The responsibility of taking care of the juveniles falls into the female's activity, while the male doesn't have a role. The young can fly at around 12 days and the brood leaves its mother after 10 weeks[595].

Demography

The pheasant population in Europe is currently increasing. It is estimated there are between 4,140,000 and 5,370,000 pairs and therefore around 8,290,000 or 10,700,00 mature individuals. As Europe makes up only 5% of the global range, the global population would be in the region of around 180,000,000 mature individuals. Within its large global range, the pheasant is very common, but its population is in decline due to habitat loss and over hunting. Europe however seems to buck this trend[596]. According to ESIT, the population has increased 49% since 1980.

Introduced to many of the EU member states as a game bird, it is now present in almost all of them. According to the invasive species index, the highest populations of pheasants are in the Central and North West of Europe. The UK has the highest number of pairs with a population estimated at 2,000,000 in 2015. Compared with the UK, other high numbers in Europe seem relatively low. In Germany, the total number of pairs is estimated to be between 200,000 and 300,000 pairs, whilst in France the numbers are suspected to be lower at around 175,000 - 275,000 pairs. There are numbers of similar sizes in the Czech Republic, Poland and Ireland, and the lowest numbers occurring in Baltic regions including Latvia and Lithuania.

Pochard, Common *(Aythya ferina)*

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Characteristics

42-49 cm, wingspan 72-82 cm [597]. Breeding male has rufous-chestnut head, blackish breast, upper mantle, undertail-coverts, rump and tail, silver-grey flight feathers and almost white underwing, grey body, dark grey bill with black tip and bright orange-red eyes[598]. Eclipse plumage similar to adult female. Female has dull brown head with pale grey eye stripe, throat, lores and cheeks. Body greyish-brown, darker above. Wings generally browner than those of male. Bill dull grey/black with black tip and eyes brown. Juvenile resembles adult female[599].

Male generally silent but makes wheezy whistles in display, female makes mainly monosyllabic calls[600].

Habitat

This species requires well-vegetated eutrophic to neutral swamps, marshes, lakes and slow-flowing rivers with areas of open water and abundant emergent fringing vegetation. It also breeds on saline, brackish and soda lakes and occasionally even in sheltered coastal bays[601]. The breeding grounds are reoccupied from early March (in the south) to early May (in Sibe-

593 *Madge, McGowan, and Kirwan.*
594 *Madge, McGowan, and Kirwan.*
595 *Likoff.*
596 *Birdlife International, IUCN Redlist, Common Pheasant, 'Phasianus Colchicus', 8235 (2016).*
597 *C.M. Snow, D.W. and Perrins, The Birds of the Western Palearctic Volume 1: Non-Passerines. (Oxford: Oxford University Press, 1998).*
598 *G.M. Carboneras, C. and Kirwan, 'Common Pochard In: J. Del Hoyo, A. Elliott, J. Sargatal, D.A. Christie and E. de Juana (Eds)', in Handbook of the Birds of the World Alive (Barcelona: Lynx Edicions, 2014).*
599 *K. Šťastný and K. Hudec, Fauna ČR Ptáci I– Aves (3rd Edition) (Praha: Academia, 2016).*
600 *Carboneras, C. and Kirwan.*
601 *J. Kear, Ducks, Geese and Swans Volume 1: General Chapters; Species Accounts (Anhima to Salvadorina). (Oxford, U.K.: Oxford University Press, 2005).*

ria)[602] with breeding starting from April-May. During the winter the species frequents similar habitats to those it breeds in, including large lakes, slow-flowing rivers, reservoirs, brackish waters, marshes, weirs (Africa) and flooded gravel pits[603,604,605,606,607]. The nest is a depression or shallow cup in a thick heap of vegetation positioned on the ground in shallow water[608,609,610,611,612]. As in the breeding season, the species will shift to coastal habitats such as brackish lagoons, tidal estuaries and inshore waters (where it may associate with sewage outfalls[613] when driven by frost or other compelling factors[614,615,616,617].

Diet

The species is omnivorous, its diet consisting of seeds, roots, rhizomes, the vegetative parts of grasses, sedges and aquatic plants as well as aquatic insects and larvae, molluscs, crustaceans, worms, amphibians and small fish[618,619,620,621,622].

The food consists mainly of young shoots of plants, buds and other vegetation parts and seeds of aquatic plants. Among the animals are mostly molluscs, aquatic insects and its larvae, caddisflies, midges, crustaceans, worms, occasionally some amphibians and their tadpoles, small fish. He collects food mainly in water by diving to a depth of 1 - 2 meters at short intervals[623].

Social behaviour

Northern populations of this species are highly migratory[624,625]. Those breeding in the milder parts of western or southern Europe are sedentary or only make short-distance movements, often in response to harsh weather conditions[626,627,628], although individuals from some areas, such as France may utilise multiple localities up to 200 km apart in one winter[629,630].

The population on the British Isles is stable or flying-over, only in cold winters a part of the pochards is moving to southern and south-western France. Similarly, the French and Dutch populations move more distances only in cold winters. Breeding populations from Scandinavia, Poland, the Baltic countries and Russia winter in Germany, Switzerland, the Netherlands, Great Britain and France[631].

Reproduction

Mating takes place in the spring months, but most couples are already created during winter. The nest is located in dense coastal stands, close to the water. nest placement also affects future predation. On the banks of the rivers, it is significantly higher than on islands in the middle of water bodies. Pochard nests in loose colonies, neighbouring nests are only a few meters apart. They are often inside seagull colonies that provide protection against predators. There are 5 - 18 eggs in the clutch, often 3-5, but even more than 20. From 15 eggs in the nest are mixed clutches, which are in the nest eggs from more females. Breeding parasitism is relatively frequent even in smaller clutches. Of the average number of 10 eggs in the clutch, only 6 are from one female. mixed clusters also work interspecifically, creating mixed families

602 *Scott and others.*
603 *K. Brown, L.H.; Urban, E.K.; Newman, The Birds of Africa, Volume I. (London: Academic Press, 1982).*
604 *H. Madge, S.; Burn, Wildfowl. (London: Christopher Helm, 1988).*
605 *J. del Hoyo, J.; Elliot, A.; Sargatal, Handbook of the Birds of the World, Vol. 1: Ostrich to Ducks. (Barcelona, Spain.: Lynx Edicions, 1992).*
606 *A. D. Q. Fox, A. D.; Jones, T. A.; Singleton, R.; Agnew, 'Food Supply and the Effects of Recreational Disturbance on the Abundance and Distribution of Wintering Pochard on a Gravel Pit Complex in Southern Britain', Hydrobiologia, 279/280 (1994), 253–62.*
607 *Scott and others.*
608 *P.A. Johnsgard, Ducks, Geese and Swans of the World. (Lincoln and London: University of Nebraska Press, 1978).*
609 *Madge, S.; Burn.*
610 *del Hoyo, J.; Elliot, A.; Sargatal.*
611 *C.M. Snow, D.W. and Perrins.*
612 *Kear.*
613 *Kear.*
614 *Madge, S.; Burn.*
615 *del Hoyo, J.; Elliot, A.; Sargatal.*
616 *Scott and others.*
617 *C.M. Snow, D.W. and Perrins.*
618 *P.A. Johnsgard.*
619 *Brown, L.H.; Urban, E.K.; Newman.*
620 *del Hoyo, J.; Elliot, A.; Sargatal.*
621 *S. J. Marsden, 'Impact of Disturbance on Waterfowl Wintering in a UK Dockland Redevelopment Area.', Environmental Management, 26.(2): (2000), 207–13.*
622 *Kear.*
623 *Šťastný and Hudec.*
624 *Scott and others.*
625 *C.M. Snow, D.W. and Perrins.*
626 *del Hoyo, J.; Elliot, A.; Sargatal.*
627 *Scott and others.*
628 *C.M. Snow, D.W. and Perrins.*
629 *L. Keller, I.; Korner-Nievergelt, F.; Jenni, 'Within-Winter Movements: A Common Phenomenon in the Common Pochard Aythya Ferina.', J. Ornithol., 150: (2009), 483-494.*
630 *A. Gourlay-Larour, M.-L.; Schricke, V.; Sorin, C.; L'Hotis, M.; Caizergues, 'Movements of Wintering Diving Ducks: New Insights from Nasal Saddled Individuals.', Bird Study, 59: (2012), 266–78.*
631 *Šťastný and Hudec.*

from different types of pochards. Incubation lasts 24 - 28 days. Only the female sits on the eggs. The young are leaving the nest after hatching and following the mother. They swim greatly and dive from day one. Weight approx. 42 grams. They are able to fly after 7 - 8 weeks[632].

Demography

The Common Pochard has a decreasing current population trend globally. Some populations are stable however in Europe the population is decreasing. Over three generations or 23 years, the population in Europe has declined by between 30 – 50%. Europe makes up 35% of the entire global breeding population and 40% of the global wintering population. Both populations are experiencing rates of decline between 30 and 50%. Globally the population is estimated number between 2,000,000 and 2,250,000 individuals, with some populations outside of Europe reported to be stable[633].

France holds 11% of the European population, with a fluctuating population trend since 2000 leaving a current population of between 64,000 and 95,000 individuals[634]. The Common Pochard has adapted well to man-made habitats such as fishponds. A study in France reported the density of pochard has been positively influenced by artificial carp feeding, however high fish biomass density has had a negative impact in poorly managed fishponds[635].

Quail *(Coturnix coturnix)*

Description

The Common Quail (*Coturnix coturnix*) from the *Phasianidae* family is the smallest gamebird in Europe[636] and among the smallest in the world[637]. It weights between 70 and 135 g, has a 16-18 cm body length and lives up to 8 years[638]. In flight they are surprisingly long winged and may be confused with young partridges, having a 32-35 cm wingspan[639].

The body is small and rotund, with a small bill, bold cream stripes on the brown back and dark stripes on flanks. They have slender legs and feet, with sharp claws that help them scratch the soil for seeds and insects. The female has a paler throat than the one of the male and lacks the neck bands[640].

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632 *Šťastný and Hudec.*
633 *Birdlife International, IUCN Redlist, Common Pochard, 'Aythya Ferina', 8235 (2019).*
634 *Birdlife International, Common Pochard, 'Aythya Ferina'*
635 *Joël Broyer and François Bourguemestre, 'Common Pochard Aythya Ferina Breeding Density and Fishpond Management in Central France', Wildlife Biology, 2020.1 (2020) <https://doi.org/10.2981/wlb.00592>.*
636 *Beaman and Madge, p. 262; Likoff, p. 244.*
637 *Harrison and Greensmith, p. 113.*
638 *Hume, p. 152.*
639 *Beaman and Madge, p. 262.*
640 *Likoff, p. 244; Hume, p. 152.*

Quails are secretive gamebirds living hidden in dense vegetation, which makes it difficult for birdwatchers to see them[641].

Habitat

Coturnix coturnix can be found in many areas, on level or fairly sloping terrain, from the sea level to altitudes over 3 000'. They're birds of open country that prefer dense vegetation, where they can hide from predators. Dense vegetation is also a popular choice for the breeding sites. They usually avoid shrub and woodland habitats or bare ground, favouring sunny areas with well drained soils. As the bird has also adapted to extensive agriculture. It can be found in crop fields, with a preference for wheat and clover, but barley, oats, rape, rye, flax, lucerne or meadow grasses are also popular[642]. The species prefer the center of fields rather than the edges[643].

The nest is a shallow hollow in the ground which the birds make by scratching with the feet and that us shaped using body pressure[644]. It is lined with grassy material[645] and situated in a difficult to spot environment, usually vertical structures (crops or grass), as eggs protection from aerial predators is essential[646].

Social behaviour

It is a shy bird that hides most of its life in dense cover and is reluctant to fly even when in danger[647]. When flushed from hiding, the quail will suddenly spring into the air with a low trilling call. When it flies, it is low and fast and only in order to drop down into cover again running to a safe distance[648].

In spite of its hesitancy towards flight, the common quail makes long annual migrations, from the breeding quarters in Europe to the wintering grounds in Africa[649]. It is a nocturnal migrator, travelling for distances up to 160 km per night[650].

In terms of mating rituals, the male will first cry out for the opposite sex's attention with far-carrying calls. Once a female is in his proximity, the male will display courting behaviours, such as drooping a wing toward her or trailing it along the ground. Offering food or running side-on are also displays of courtship[651].

Diet

Coturnix coturnix is an omnivorous bird whose diet consists of both of plants (over 100 species such as seeds, grasses, cereals, weeds) and small invertebrates (such as bugs, beetles, earwigs, ants, grasshoppers, spiders, snails or worms)[652]. There are seasonal variations in the choice of food, with both usually opting for animal food during spring and early summer, when the breeding period starts[653]. Outside the nesting season, the species will 88-100% of the times opt for vegetal intake, especially crops and seeds[654].

Reproduction

The Common Quail practises successive monogamy, but there are also cases of sequential polygamy or sequential polyandry[655]. In order to attract the female, the male utters a loud, staccato call, especially at dawn and dusk, and is generally silent once mated[656]. After the reproductive tie has been established, males leave the communal place and become difficult to detect in the field[657].

The breeding season usually begins in May in northern Europe and in March in southern Europe, with an average clutch size of 8-13 eggs[658] incubated by the female only for up to 3 weeks[659]. The chicks are well developed shortly after hatching and can even leave the nest within a few hours. They are able to feed themselves soon after hatching and can fly when they are 19 days old. The sexual maturity is achieved at the age of 1 [660].

Demography

Europe makes up 40% of the Quail's global range and has a population of between 3,300,000 and 6,720,000 calling or lekking males and therefor an overall

641 *Likoff, p. 242.*
642 *Likoff, p. 242.*
643 *C. Perennou, European Union Management Plan 2009–2011. Common Quail, Coturnix Coturnix., 2009, p. 18 <https://doi.org/10.1139/z74-036>.*
644 *Harrison and Greensmith, p. 113.*
645 *BirdLife International, 'Coturnix Coturnix', The IUCN Red List of Threatened Species 2016: E.T22678944A85846515., 2016 <http://www.iucnredlist.org/>; Hume, p. 152.*
646 *Perennou, p. 18.*
647 *Hume, p. 152; Harrison and Greensmith, p. 113.*
648 *Likoff, p. 242.*
649 *Likoff, p. 242.*
650 *Perennou, p. 15.*
651 *Likoff, p. 243.*
652 *Likoff, p. 243.*
653 *Likoff, p. 242; Perennou, pp. 15–16.*
654 *Perennou, p. 15.*
655 *Perennou, pp. 15–16.*
656 *Likoff, p. 243.*
657 *Perennou, p. 15.*
658 BirdLife International, '*Coturnix Coturnix*'.
659 *Likoff, p. 243.*
660 *Likoff, pp. 243–44.*

population estimated to be between 7,000,000 and 13,000,000 mature individuals. The global population is approximately in the region of the 20,000,000 – 35,000,000 individuals. This number is suggested to be decreasing, however, in Europe the population size is fluctuating[661].

Its overall decline is due to the intensification of agricultural practices and the use of pesticides. There is also the threat of netting the migrating birds[662].

France holds 4% of the European population which is an increase of 6-34% since 2000 [663]. The biggest populations are in Belarus, Bulgaria, Romania, Ukraine and Turkey with 47% of the European population breeding in Russia[664].

The nesting area in Europe ranges from Portugal and Ireland in the West to the Urals in the East. The Quail breeds in all EU member states[665].

Redstart, Common *(Phoenicurus phoenicurus)*

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Description

Male is bluish-grey from mid-crown to back and wings, with black face and throat, white band above forehead extending as short supercilium; orange-rufous rump and outer tail, blackish central tail feathers; orange-rufous breast and flanks, shading to buffier belly; bill and legs blackish. Female is plain mid-brown above, with narrow whitish eyeline, orange-tinged buffy-white below, tail as male. Juvenile is brown with buff spotting above and below, tail like adult[666]. Size 13–14·5 cm; 11–23 g.

Habitat

This species inhabits open forest and woodland, including old parkland and park-like gardens, forest clearings and margins, preferably with semi-open undergrowth or herbage. It is missing in dense forests with richly developed shrub and dense herbaceous layer[667]. In northern Europe, it occupies subarctic mountain birch and barren pine forests and in central and southern Europe it uses broadleaf forest, as well as many intermediate habitats such as heaths and commons with scattered mature trees, pollard willows (Salix) along streams and ditches, open hilly country with old stone walls and buildings. In Russia, it generally prefers broadleaf and mixed forest, less often pinewoods. In North Africa breeds in old oak (*Quercus*) and/or conifer (fir and cedar) forest at 1500–2200 m. Throughout range thinned oak woodland greatly favoured, but thinned woodland much less attractive after five years' regrowth. Old gardens, parks and cemeteries mimic thinned woodland, and in suburban Berlin (Germany) breeding densities up to 14 times that in closed forest. Usually winters mainly in semi-arid thorn steppe, thickets, dry open woodland, riverine acacia and gardens, to 2000 m. In winter in Sahel, commonest in areas with high overall tree density; in North Ethiopia woodland above 600 m. Often in more scrubby areas on passage. In Saudi Arabia, passage and winter, in palm groves and tamarisks[668].

Social Behaviour

Migratory species. In autumn, populations from West, Central and North of Europe move through Iberia over extended period from mid-August to early November and West Mediterranean and enter North West Africa, some remaining North of Sahara (regular January – February North Morocco and North Algeria, rarely eastern to Egypt). Eastern populations

661 BirdLife International, '*Coturnix Coturnix*'.
662 BirdLife International, '*Coturnix Coturnix*'.
663 BirdLife International, '*Coturnix Coturnix*'.
664 *Perennou.*
665 *Perennou.*
666 *D.A. Collar, N. and Christie, 'Common Redstart (Phoenicurus Phoenicurus)', in Del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. and de Juana, E. (Eds), Handbook of the Birds of the World Alive (Barcelona: Lynx Edicions, 2015).*
667 *Šťastný and Hudec.*
668 *Collar, N. and Christie.*

move through East Mediterranean, very common autumn passage migrant in Israel, mainly mid-August to mid-November, common in Jordan mid-September to mid-November, but relatively weak passage in Bahrain September–November. Great majority cross Sahara on broad front to winter in savanna belt (S of Sahel) E to Ethiopia and Lake Victoria. Main autumn passage in Algeria mid-September to mid-October, Senegal from mid-September, Chad and North Sudan late September to October, arriving in winter quarters October and November. Individuals of nominate birds wintering in North East Africa are probably all from Russia. Spring departure from March to early April, with strong passage through North Africa and Jordan mid-March to mid-May, males somewhat earlier than females, and greater numbers using more eastern routes involving Tunisia and Libya. In Israel main passage March–April, strong passage in United Arab Emirates mid-March to early May. Protracted passage March–June, with peak late April/early May, in E Saudi Arabia. Spring migrants appear in Spain from late March[669].

Diet

Invertebrates and berries. Animal food includes adult and larval beetles of at least 13 families, adult flies of at least ten families, adult and larval hymenopterans (ants, bees, wasps, sawflies and ichneumons), adult and larval lepidopterans of at least ten families, adult orthopterans of at least four families, hemipteran bugs of at least five families, earwigs, caddis flies, mayflies, damselflies, spiders, harvestmen, mites, woodlice, millipedes, molluscs and earthworms.

Plant food includes berries and fruits of Juniper (*Juniperus*), Yew (*Taxus*), Rowan (*Sorbus*), Bramble (*Rubus*), Currant (*Ribes*), Crowberry (*Empetrum*), Elder (*Sambucus*), Buckthorn (*Rhamnus*), Alder Buckthorn (*Frangula*), Dogwood (*Cornus*), Privet (*Ligustrum*), Strawberry-tree (*Arbutus*), Juneberry (*Amelanchier*), Cherry (*Prunus*) and Pear (*Pyrus*).

In summer, East Germany, 52% by number of 601 items in adult diet were hymenopterans, 23% beetles, 7% bugs, 7% flies and 11% others; stomachs of 16 spring and autumn birds, held 44% hymenopterans (mostly ants), 38% beetles, 8% bugs and 10% others. In study in Moldova, plant material only 7·4% of total food intake and appeared in diet only July–September/October, and seen to feed on berries of *Salvadora persica* prior to North migration in March (berries may be used to build pre-migratory fat reserves). Food brought to nestlings, Italy, 38% coleopterans, 31% dipterans, 26% lepidopterans, 2% spiders and 2% crustacea; in Germany, 27% adult and larval lepidopterans, 22% spiders (falling as young grew), 20% beetles (rising as young grew), 11% hymenopterans, 8% flies, 6% grasshoppers and 6% others in one study, in another study 20% beetles, 19% lepidopterans, 18% spiders, 17% flies, 11% bugs, 7% hymenopterans and 8% others, and in a third study 59% lepidopterans, 12% beetles, 8% spiders, 6% flies and 15% others.

Forages from bushes or lower branches of trees, flying out to catch prey on ground, usually returning to eat it; makes short sallies after flying insects, and flies or flutters to pick items from trunks, branches and leaves, sometimes hovering briefly. In boreal birch forest in summer, foraging divided fairly equally (25–30% each) among flights to ground, gleaning in tree foliage and aerial sallying, with 12% in herb layer and 8% from trunks and branches; male tends to make aerial sallies more than does female, which tends to do more foliage-gleaning than male. Shivers tail following body movement[670].

Reproduction

End April to mid-July in West Europe, up to 2 weeks earlier in South Europe; late May to late June in North Finland. Usually double-brooded in South Europe. Findings reveal low rates of extrapair paternity compared with other passerine birds, suggesting only a minor role of sperm competition in this sexually dichromatic species[671]. Territory size in generally good habitat in Europe 0,1–1 ha. Nest a cup of grass, roots and moss, lined with hair and feathers, usually placed 1–6 m up in hole in tree, wall or old stump, or nest box. In general, in a habitat with on one side open terrain, often facing South or South East.

Eggs 5–7 (increasing with latitude but declining through season, and older birds laying more eggs than younger), plain pale blue to greenish-blue, occasionally with fine dark reddish speckling. Incubation period 12–14 days, nestling period 12–15 days. Post-fledging dependence 10–14 days. Brood parasitism by Common Cuckoo (*Cuculus canorus*) fairly common (20% in one area of Finland). In a population breeding in nestboxes in Northern Finland up to 31% nests were found to hold cuckoo eggs, although most eggs were outside the nest cup and the effective parasitism rate was only 12·8%. The cavity nesting strategy of the redstart may make it a challenging host for the cuckoo to parasitize[672]. Of 479 eggs in 76 nests in Finland, 81% hatched and 92% of hatchlings fledged, giving 75% overall success, with mean 4,7

669 *Collar, N. and Christie.*
670 *Collar, N. and Christie.*
671 *B.E. et al. Kleven, O., Øigarden, T., Foyn, 'Low Frequency of Extrapair Paternity in the Common Redstart (Phoenicurus Phoenicurus).', Journal of Ornithology, 148.3 (2007), 373–378 <https://doi.org/10.1007/s10336-007-0139-z>.*
672 *J.T. Thomson, R.L., Tolvanen, J. and Forsman, 'Cuckoo Parasitism in a Cavity Nesting Host: Near Absent Egg-Rejection in a Northern Redstart Population under Heavy Apparent (but Low Effective) Brood Parasitism.', Journal of Avian Biology, 2016.*

young fledged per nest; in another study in extreme N Finland (in a "marginal" breeding area), hatching success and fledging success were, respectively, 0,91 and 0,89, and only heavy rainfall decreased nestling survival. Nest loss to Eurasian Wryneck (*Jynx torquilla*) and Common Starling (*Sturnus vulgaris*) sometimes frequent. Annual first-year mortality 79%, annual adult mortality 62%, annual overall mortality (Finland) 51%. Causes of mortality among ringed birds in NW Europe are domestic predator 18%, human-related (accidental) 24%, human-related (deliberate) 49%, other 9%. Age of first breeding variable, in one study 59% of individuals (75% males, 42% females) bred at 1 year. Oldest recorded individual 9 years 6 months.

Demography

Not globally threatened (Least Concern). In mid 1990s, European population estimated at 1,962,000–3,370,000 pairs (most in Finland, France, Germany and Romania), while 100,000–1,000,000 pairs in Russia and 10,000–100,000 pairs in Turkey; at that time Spain estimated to hold 75,000–94,000 pairs, and species listed there as nationally "Vulnerable" following steady declines attributed to events in winter quarters. By 2000 total European population (including European Russia and Turkey) revised to 6,800,000–16,000,000 pairs and considered generally stable. Uncommon local breeder in N Morocco and N Algeria, apparently extinct Tunisia.

In Oakwoods in Wales 67 territories/km², in broadleaf woodland in South & North England 58 and 26 territories/km² respectively, and in mixed oak-hazel and oak-birch coppice in West Scotland 49 pairs/km²; but as many as 266 pairs/km² at one site in East Germany, and up to 120 pairs/km² in parks and gardens in Switzerland.

Marked decline in northern half of Europe since 1960s, particularly severe in Central Europe since 1968, attributed to rainfall patterns in Sahel combined with intensified modern forestry practices (reducing availability of nest holes) and interspecific nest-site competition. However, the evidence for these is not strong and a partial recovery in Britain cannot be explained by changes in these factors[673]. The species may be subject to habitat degradation from pollution effects on forests in this region[674]. There is also evidence that in north-west Europe the species is subject to deliberate killing[675].

Snipe, Common *(Gallinago gallinago)*

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Description

Small to medium-sized snipe, with rather long bill and white belly. Plumage is variable and melanistic morph occurs (e.g., in Ireland). It flights generally faster and more erratic than other snipes of similar size. Differs from very similar but wholly allopatric *G. paraguaiae* normally by neck, breast and flanks more heavily marked, and, in flight, wings more pointed. Has prominent white trailing edge to wing, and supercilium narrower than eye-stripe at base of bill. Separation from very similar, and formerly conspecific, *G. delicata* is potentially very difficult and will require prolonged and detailed views to establish a vagrant of either species within the range of the other.

Sexes alike, differing only in measurements of body and feathers, especially total length of outer tail feather. No significant seasonal variation. Juvenile is very similar to adult, but wing-coverts more neatly but narrowly fringed pale buff (versus more prominent oval spots, separated by a dark shaft-streak in adults), rectrices lack dark shaft-streak distally, secondaries and tertials have narrower white tips, edges to outer edge of scapulars also white (yellowish and broader in adults) and primaries worn (fresh in adults). Ageing impossible following post-juvenile moult[676].

Size 25–27 cm; 72–181 g; wingspan 44–47 cm.

673 *Collar, N. and Christie.*
674 *M.J. Hagemeijer, E.J.M.; Blair, The EBCC Atlas of European Breeding Birds: Their Distribution and Abundance. (London: T. and A. D. Poyser, 1997).*
675 *Collar, N. and Christie.*
676 *M. Schmitz, 'Ageing Common Snipe by Field Marks.', Alula, 13.3 (2007), 134–141.*

Habitat

The species breeds in open fresh or brackish marshland with rich or tussocky vegetation, grassy or marshy edges of lakes and rivers, wet hay fields, swampy meadows and marshy tundra, in forest tundra and northernmost taiga zones. In general, it is found in areas providing combination of grassy cover and moist soils, rich in organic matter, and prefers relatively heterogeneous vegetation structure at breeding sites[677]. On Yamal Peninsula, North Russia, snipes reach highest densities in lowland flooded tundra[678], while in South Iceland, wetlands are the most important habitat type during the breeding season[679]. Outside breeding season, generally occupies similar habitats, with more use of anthropogenic habitats, e.g., sewage farms and rice fields, also upper reaches of estuaries, sometimes on coastal meadows.

Social Behaviour

Mostly migratory, wintering South to North. tropics. Some populations are sedentary or partially migratory, e.g., British Is (which also receives visitors from further North & East in winter, as well as race *faeroeensis*)[680], with small numbers also wintering as far North of Iceland, Faeroes, West Norway, Denmark and West Germany[681]. Race faeroeensis moves South to Ireland and westernmost Britain, South to Sicilly, in winter (with passage of Icelandic birds through Orkney, Shetland and Outer Hebrides also suspected)[682]. Analysis of snipe ringed in Poland revealed that birds migrating along Baltic coast tend to be in winter further North than those that pass through South Poland on migration, while snipe moving through the country at the beginning of autumn migration (originating from near breeding areas) overwinter further North than later migrants (from more northern areas), i.e. a leap-frog migration pattern[683]. Moves quickly from breeding grounds to moulting areas, and after few weeks quickly migrates to wintering grounds. High degree of site fidelity at staging sites and at least some evidence that individuals re-use same wintering areas[684]. Birds wintering in Afrotropics presumably from Russia, crossing Sahara on broad front. European and Atlantic birds move to South & West Europe. Species seems to have shifted main moulting grounds from continental (particularly Netherlands) to Britain since late 1950s. Autumn passage from late Jul to Nov, with arrival in N Africa mainly late Sept to early Oct, S of Sahara mainly Oct to early Nov; most birds leave Africa in Mar; crosses Europe Mar to early May, males typically arriving on breeding grounds 10–14 days earlier than females. Detailed study of spring migration across N Poland found that numbers at five sites peaked in first and second weeks of April[685], while investigation of autumn passage through C Europe has found that it has become later over the last c. 40 years, presumably in response to climate change[686].

Diet

Its diet includes larval insects (10–80%), adult insects, earthworms, small crustaceans, small gastropods and spiders. Plant fibres and seeds consumed in smaller quantities, once of teasel (*Dipsacus fulonum*)[687], whose seeds are rarely exploited by birds. I England, diet during Apr–Jun consisted mainly of earthworms and *tipulid* larvae, which accounted for 61 ± 7% and 24 ± 6% of dry weight of prey items ingested, respectively, but a wide variety of surface-active and aquatic prey were also taken, especially in April[688]. Feeds by vertical, rhythmic probing in substrate, often without removing bill from soil. Feeds typically in small groups, although may exhibit antagonistic behaviour towards conspecifics[689]. Essentially crepuscular.

Reproduction

Laying eggs from April to June (later at higher latitudes), exceptionally March[690]. Monogamous, but both sexes show high degree of promiscuity. Pairs occasionally form on passage, but generally males arrive

677 *M.C. Pearce-Higgins, J.W. and Grant, 'Relationships between Bird Abundance and the Composition and Structure of Moorland Vegetation.', Bird Study, 53.2 (2006), 112–125.*

678 *N. Sokolov, V., Ehrich, D., Yoccoz, N.G., Sokolov, A. and Lecomte, 'Bird Communities of the Arctic Shrub Tundra of Yamal: Habitat Specialists and Generalists.', PLoS ONE, 7.12 (2012), e50335.*

679 *T.G. Jóhannesdóttir, L., Arnalds, Ó., Brink, S. and Gunnarsson, 'Identifying Important Bird Habitats in a Sub-Arctic Area Undergoing Rapid Land-Use Change.', Bird Study, 61.4 (2014), 544–552.*

680 *J.H. Marchant, 'Wader Migration in Britain & Ireland: Continuing Studies in a Changing Environment.', British Birds, 95.12 (2002), 640–647.*

681 *C.M. eds. Snow, D.W. and Perrins, The Birds of the Western Palearctic. Concise Edition. Vol. 1. Non-Passerines. (Oxford & New York.: Oxford University Press, 1998).*

682 *Marchant.*

683 *T. Minias, P., Włodarczyk, R., Meissner, W., Remisiewicz, M., Kaczmarek, K., Czapulak, A., Chylarecki, P., Wojciechowski, A. and Janiszewski, ' The Migration System of Common Snipe Gallinago Gallinago on Autumn Passage through Central Europe.', Ardea, 98.1 (2010), 13–19.*

684 *S. Sauvage, A., Rumsey, S. and Rodwell, 'Recurrence of Palaearctic Birds in the Lower Senegal River Valley.', Malimbus, 20.1 (1998), 33–53.*

685 *W. Meissner, 'Spring Migration of Common Snipe Gallinago Gallinago, in the Gulf of Gdansk Area (Poland) Census Results and Notes on the Methodology.', Alauda, 69.3 (2001), 429–434.*

686 *J. Adamík, P. and Pietruszková, 'Advances in Spring but Variable Autumnal Trends in Timing of Inland Wader Migration.', Acta Ornithologica, 43.2 (2008), 119–128.*

687 *B. Forristal, 'Snipe Feeding on Teasel.', British Birds, 84.5 (1991), 194–195.*

688 *D. Hoodless, A.N., Ewald, J.A. and Baines, 'Habitat Use and Diet of Common Snipe Gallinago Gallinago Breeding on Moorland in Northern England.', Bird Study, 54.2 (2007), 182–191.*

689 *R. Plummer, 'Antagonistic Behaviour of Feeding Common Snipe.', British Birds, 89.4 (1996), 175–176.*

690 *Harrison, C. J. O.*

on breeding grounds 10–14 days before females[691]. Territorial, densities up to 10–38 (even 110) pairs/km². Nest, constructed by female[692], usually on dry spot, covered by grasses, rushes, sedges or sphagnum, lined with fine grasses, scrape 10–15 cm wide and 2–5 cm deep (8). Typically, single-brooded[693], exceptionally double-brooded[694]. Four eggs (2–5), with laying interval one day. Pale green to olive or darker buff, blotched blackish to red-brown, violet or grey, mean size 39,3 mm × 28,6 mm [695]. Lays replacement clutches. Incubation 17–21 days[696], by female alone, starting with third or fourth egg[697]. Chicks are mahogany red, more hazel-brown or tawny on sides of head and underparts, with black and white bands on head. Both parents care for young, but male entices oldest 1–2 from nest to tend. Young initially fed bill-to-bill. Fledging 19–20 days. Success 2,2 hatchlings per nest, 3,5 per successful nest. High proportion of eggs may be predated or trampled by cattle[698]. Mean annual mortality 52%.

Demography:

Not globally threatened (Least Concern). Global population recently estimated at more than 4,000,000 birds[699], but that in Europe numbers 2,670,000–5,060,000 pairs (2000–2014), with 2,000,000–4,000,000 pairs (77%) in West Russia alone, where breeding range is reportedly extending N in recent decades[700],[701]. Possibly more than 1,000,000 birds winter in South West & South Central Asia, and 100,000s in East & South East Asia. Elsewhere, in Europe, some 92,000–180,000 pairs nest in Finland, 72,000–197,000 in Sweden, 70,000–90,000 in Belarus, and 80,000 pairs in UK[702]. Westernmost outpost are the Azores, where seven islands support breeding populations and densities of up to 6,8–8,5 breeding pairs per km² have been reported. Despite reasonably common presence of *G. delicata* in non-breeding season[703], there is no evidence to date that the latter breeds in the archipelago[704]. Total of 180,000 pairs (faroeensis) breed in Iceland, with perhaps c. 105,000 individuals in S of island (versus 200,000–300,000 pairs in late 1980s), with another 800–2000 pairs in Faeroes[705]. Common to very abundant on African wintering grounds (c. 1,500,000 in Sudan).

Decline noted in many breeding populations of Europe (e.g. 30% decrease in Northern Ireland between 1987 and 1999[706], and French population most recently estimated at just 37–62 pairs)[707] and West Siberia (though has apparently colonized Slovenia[708] and numbers reportedly stable in Norway, Estonia, Hungary, Spain, Croatia and Russia)[709], probably chiefly due to habitat changes, especially drainage. In Schleswig-Holstein, N Germany, decline from 13,000 pairs in 1970 to 1500 in 1992, and total population in Germany most recently estimated at 5500–8500 pairs[710]. 99–100% decline after improvement of marginal grasslands in North England, where mean breeding density on moorlands was 2,28 ± 0,25 birds/km² during surveys in early part of present century[711], and overall decline of 67% across the British Isles during final quarter of 20th century, despite significant local increases[712]. Beyond the South edge of breeding range, formerly nested in Armenia and Bulgaria[713], probably breeds in parts of Turkey[714], and there are summer records from Azerbaijan[715].

Low water levels shorten period of food availability in pastures, due to lower penetrability of soil, and thereby strongly influence length of breeding sea-

691 *C.M. eds. Snow, D.W. and Perrins.*
692 *Harrison, C. J. O.*
693 *C.M. eds. Snow, D.W. and Perrins.*
694 *Harrison, C. J. O.*
695 *Harrison, C. J. O.*
696 *C.M. eds. Snow, D.W. and Perrins.*
697 *Harrison, C. J. O.*
698 *C.J. Van Gils, J., Wiersma, P., Kirwan, G.M. and Sharpe, 'Common Snipe (Gallinago Gallinago).', in Del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. and de Juana, E. (Eds), Handbook of the Birds of the World Alive (Barcelona: Lynx Edicions, 2015).*
699 *'Wetlands International Waterbird Population Estimates.', 2015 <http://wpe.wetlands.org/>.*
700 *Snow and Perrins.*
701 *BirdLife International, IUCN Red List, Bécassine des marais (Gallinago gallinago),2015*
702 *BirdLife International, Bécassine des marais (Gallinago gallinago)*
703 *D. Rodrigues, T.M. and Gonçalves, 'The Occurrence of Two Allopatric Snipe Gallinago Spp. in the Azores Islands.', Ardeola, 60.1 (2013), 113–121.*
704 *M. Hering, J. and Päckert, 'DNA Analysis of a Juvenile Common Snipe on Corvo, Azores.', British Birds, 103.3 (2010), 184–185.*
705 *Snow and Perrins.*
706 *J.A. Henderson, I.G., Wilson, A.M., Steele, D. and Vickery, 'Population Estimates, Trends and Habitat Associations of Breeding Lapwing Vanellus Vanellus, Curlew Numenius Arquata and Snipe Gallinago Gallinago in Northern Ireland in 1999.', Bird Study, 49.1 (2002), 17–25.*
707 *G. Quaintenne, 'Les Oiseaux Nicheurs Rares et Menacés En France En 2012.', Ornithos, 20.6 (2013), 297–332.*
708 *M. Vogrin, 'Breeding Waders in Slovenia.', Ornis Svecica, 10 (2000), 141–148.*
709 *C.M. eds. Snow, D.W. and Perrins.*
710 *Gedeon, K., Grüneberg, C., Mitschke, A., Sudfeldt, C., Eikhorst, W., Fischer, S., Flade, M., Frick, S., Geiersberger, I., Koop, B., Kramer, M., Krüger, T., Roth, N., Ryslavy, T., Stübing, S., Sudmann, S.R., Steffens, S., Vökler, F. and Witt.*
711 *Hoodless, A.N., Ewald, J.A. and Baines.*
712 *K. Smart, J., Amar, A., O'Brien, M., Grice, P. and Smith, 'Changing Land Management of Lowland Wet Grasslands of the UK: Impacts on Snipe Abundance and Habitat Quality.', Animal Conservation, 11 (2008), 339–351.*
713 *Snow and Perrins.*
714 *B. Marlow, T., Kirwan, G.M. and Günes, 'Does Common Snipe Gallinago Gallinago Breed in Turkey?', Sandgrouse, 23.2 (2001), 147.*
715 *Snow and Perrins.*

son. Careful manipulation of water levels may allow improvement of breeding success, but general habitat management designed to improve conditions for grassland-breeding waders often leads to only short-term gains for present species[716] and it is now generally believed that declines are probably not exclusively driven by changes in habitat conditions[717], although increases have been registered on former grouse moors after management was discontinued[718]. Changes in habitat structure and food abundance, which already negatively affect this (and many other) species might also lead to increased predation risks for nestlings[719]. Estimated 1,500,000 birds hunted annually in Europe (notably France)[720].

Wagtail, Western Yellow *(Motacilla flava)*

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Description

Male in breeding plumage has blue-grey forehead to nape and hindneck, often somewhat darker ear-coverts, long narrow white supercilium from bill base to nape-side, dark stripe through eye, thin whitish submoustachial stripe. Upperparts greenish-tinged olive-brown; remiges blackish, tertials fringed yellow or buffy white, wing-coverts blackish, fringed and tipped greenish yellow (two wingbars); tail brownish black, fringed olive, outer two feather pairs wholly or largely white. Chin, throat and underparts bright yellow, some green on breast-side and flanks, sometimes an indistinct olive or greenish necklace; underwing-coverts white; iris dark brown; bill greyish to black; legs slate-grey to black. Male non-breeding plumage is similar to breeding female, browner above, yellower rump, wingbars less contrasting, dark necklace more obvious. Female in breeding plumage has duller, less contrasting head pattern, greyish or grey-brown crown, brownish cheeks, upperparts browner, less yellow; paler and less uniformly yellow below, especially throat, breast buffish and variably spotted dark brown, often forming necklace. Non-breeding female is duller than male, paler below, often with more obvious necklace. Immature resembles non-breeding female, may be greener above[721].

Size 16,5 cm; male 12,3–26,4 g, female 11,2–22,6 g, much variation with season, time of day and locality.

Habitat

Variety of damp or wet habitats with low vegetation, from damp meadows, marshes, waterside pastures, sewage farms and bogs to damp steppe and grassy tundra, also large clearings in forest in N of range. In non-breeding season uses similar habitats, especially pasture and damp grassland, also cultivations; roosts in reedbeds and similar tall vegetation.

The nest is located on the ground, hidden in vegetation, in waterlogged habitats on elevated places (about half of the nests near the water). A female accompanied by a male chooses the nesting site[722].

Most races forage primarily in damp grassland or on relatively bare open ground at edges of rivers, lakes and other wetlands, but also in dry grassland and cereal crops. Often feeds around herds of cattle and other large mammals, especially when on migration and in non-breeding season, and in African winter quarters associates with herds of game in rather open acacia (Acacia) savanna. Mainly lowlands to c. 1000 m, but in Caucasus locally up to 2500 m; breeds at 3600–4500 m in Ladakh[723].

716 *G.J.M. Ausden, M. and Hirons, 'Grassland Nature Reserves for Breeding Wading Birds in England and the Implications for the ESA Agri-Environment Scheme.', Biological Conservation, 106 (2002), 279–291.*
717 *Smart and others.*
718 *S. Baines, D., Redpath, S., Richardson, M. and Thirgood, 'The Direct and Indirect Effects of Predation by Hen Harriers Circus Cyaneus on Trends in Breeding Birds on a Scottish Grouse Moor.', Ibis, 150.1 (2008), 27–36.*
719 *K.L. Whittingham, M.J. and Evans, 'The Effects of Habitat Structure on Predation Risk of Birds in Agricultural Landscapes.', Ibis, 146.2 (2004), 210–220.*
720 *Van Gils, J., Wiersma, P., Kirwan, G.M. and Sharpe.*
721 *D.A. Tyler, S. and Christie, 'Yellow Wagtail (Motacilla Flava)', in Del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. and de Juana, E. (Eds), Handbook of the Birds of the World Alive (Barcelona: Lynx Edicions, 2016).*
722 *Šťastný and Hudec.*
723 *Tyler, S. and Christie.*

Social Behaviour

Almost wholly migratory. Resident in Egypt (pygmaea), probably at least partially so also in NW & W Africa (Iberiae). W populations winter throughout sub-Saharan Africa. Departure from breeding grounds mainly August–October, from July to North, reaching winter quarters mostly in October. Return begins February, some not leaving until end April, arrival in breeding areas March–May, in North sometimes not until early June. Migrates diurnally, in flocks; adults and offspring may migrate together, although males reported as leaving wintering grounds earlier than females, and males were earlier migrants than females on four Italian islands; adult males may arrive before yearling males[724]. A scientifically significant species with its great variability, resulting in a large number of subspecies, often evaluated as separate species, but mixing in numerous hybrid zones[725].

Diet

Diet includes wide variety of terrestrial and aquatic invertebrates; also, some plant material, especially seeds. Invertebrates range from small flies (Diptera), bugs (Hemiptera), beetles (Coleoptera), grasshoppers (Orthoptera), butterflies (Lepidoptera), cockroaches (Blattodea), termites (Isoptera) and ants (Hymenoptera) to crustaceans. Dragonflies (Odonata) sometimes important by mass. In African winter quarters, sample of stomach contents dominated in terms of bulk by adult beetles 3–5 mm long, and larvae of beetles and lepidopterans present in small numbers. Bugs, beetles, ants and grasshoppers were numerically the most important prey in another study. Small flies were found to be most important elsewhere, as at Lake Chad and Lake Victoria. Some berries, e.g., from saltbush (Salvadora persica), and other plant material also taken. Forages by picking items from the ground or from water while walking; also runpicks and makes short flights to catch insects in the air, over water or from vegetation. Occasionally hovers over vegetation to take prey. Frequently associates with domestic stock, especially cattle, both in summer and in winter, also with wild game in winter quarters; takes advantage of insects attracted by the animals and their dung and disturbed by their grazing activity. Often in small to large or very large flocks outside breeding season; single individuals often defend a feeding territory throughout winter, and small flocks may also do so[726].

Reproduction

Season April–August, varying with latitude. 1–2 broods. Monogamous; solitary, territorial breeder. Nest built mainly by female, a grass cup lined with hair, placed on or close to ground in shallow scrape. Clutch 4–6 eggs (rarely seven), pale grey/grey-buff to rather dark olive-brown, and unmarked or with irregular darker spots/blotches, mean size 19 mm × 14·1 mm. Incubation by both sexes, female taking greater share, starts with final egg, period 11–14 days; chicks fed by both parents. Nestling period 10–14 days. Fledglings remain with parents for several weeks. Nests sometimes parasitized by Common Cuckoo (Cuculus canorus). Adult seen to feed Crested Lark (Galerida cristata) fledgling in S France.

Demography

Not globally threatened (Least Concern). Locally common to very common. Uncommon in some regions, and status of some races uncertain. In Europe, the breeding population is estimated to number 9,630,000-16,000,000 pairs, which equates to 19,300,000-32,100,000 mature individuals. Europe forms c.30% of the global range, so a very preliminary estimate of the global population size is 64,000,000-107,000,000 mature individuals, although further validation of this estimate is needed[727]. Very large roosts in winter quarters, e.g., one in Nigeria estimated to contain 50,000 individuals. Declines reported between 1970 and 1990 in 13 countries in Europe. In Britain, marked decline (9,4%) noted between breeding survey in 1968–72 and that in 1998–1991. Declines have been linked with agricultural intensification, especially drainage of wetlands in floodplains and replacement of grassland with cereals; in some areas, as in E Britain, this species does breed in root crops and cereals, but at lower densities than in prime floodplain habitats. Drainage, use of pesticides and dumping of manure may have caused declines in Continental Europe. Few comparable data from other parts of range[728].

[724] *Tyler, S. and Christie.*
[725] *Šťastný and Hudec.*
[726] *Tyler, S. and Christie.*
[727] *BirdLife International, 'IUCN Red List for Birds', Species Factsheet, 2020 <http://datazone.birdlife.org/species/factsheet/western-yellow-wagtail-motacilla-flava>.*
[728] *Tyler, S. and Christie.*

Woodcock *(Scolopax rusticola)*

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Description

Woodcock is a medium to small (nearly a size Partridge), elusive wader adapted for a life in woodland and fields found in temperate and subarctic Eurasia. It is the most numerous of eight species of Woodcocks globally[729].

Its cryptic camouflage with reddish brown upperparts and buff coloured underparts suits it to hide in its woodland habitat, most often visible in flight[730].

The head is barred with black stripes. The eyes are set far back on the head giving it 360-degree vision. Its long, sensitive bill it allows it to probe in the ground for food, which makes it vulnerable in wintertime when the ground is frozen.

The wings are rounded, and the base of the bill is flesh coloured with a dark tip. The legs vary from grey to pink. The species is sexually dimorphic, with the male much larger than the female.

Adults are 33–38 cm in length, including the 6–8 cm long straight bill, and have a 55–65 cm wingspan[731].

Habitat

The distribution of earthworms is an important habitat characteristic for the species throughout the year[732]. For breeding the species requires extensive unfragmented areas[733,734] of broadleaved deciduous or mixed broadleaved/coniferous forest[735] containing a dense undergrowth of shrubs and ground cover[736] (e.g. of brambles *Rubus spp.*, holly *Ilex aquifolium*, hazel *Corylus avellana*, gorse *Ulex spp.*, bracken *Pteridium spp.* or bilberry Vaccinium myrtillus)[737,738] and with a mosaic[739] of dry, warm resting places, moist areas for foraging[740] (e.g. streams, springs or damp, swampy patches)[741], [742], and clearings or other open areas as flight paths[743],[744]. The species may also nest in swampy forests with mossy ground, brooks and other watercourses or alternatively in coniferous forest with moist leaf litter and an undergrowth of broadleaved shrubs and ferns[745].

The species' habitats requirements during the daylight hours of the non-breeding season are similar to its breeding habitat requirements but are less restricted[746]. As well as extensive broadleaved or mixed broadleaved/coniferous forest[747] the species will also occupy young conifer plantations[748], hedges with high densities of trees and shrubs[749], smaller woods, areas of scrub[750] and coppiced habitats with coppice of between 7 and 20 years old[751]. It still shows a strong preference for woodlands with rich (e.g., mull) humus types that have high earthworm biomasses[752]. At night during this season the species gathers to roost and feed in damp, earthworm-rich, permanent grass-

729 *Game and Wildlife Conservation Trust, 'Woodcock, Rusticola, Scolopax', 2020 <https://www.gwct.org.uk/game/research/species/woodcock/>.*
730 *Černý.*
731 *Peter Mullarney, Killian; Svensson, Lars; Zetterstrom, Dan; Grant, Collins Bird Guide (London: HarperCollins, 1999).*
732 *P.A. Johnsgard, The Plovers, Sandpipers and Snipes of the World (Lincoln, U.S.A. and London: University of Nebraska Press, 1981).*
733 *A. J. Hayman, P.; Marchant, J.; Prater, Shorebirds (London: Croom Helm, 1986).*
734 *del Hoyo, J., Elliott, A., and Sargatal.*
735 *P.A. Johnsgard.*
736 *F. Lutz, M.; Pagh Jensen, In Prep. European Management Plan for Woodcock Scolopax Rusticola 2006-2009 (Draft).*
737 *del Hoyo and others*
738 *Lutz, M.; Pagh Jensen.*
739 *del Hoyo and others*
740 *P.A. Johnsgard.*
741 *del Hoyo and others*
742 *Hayman, P.; Marchant, J.; Prater.*
743 *P.A. Johnsgard.*
744 *P Hayman, P.; Marchant, J.; Prater.*
745 *P.A. Johnsgard.*
746 *del Hoyo, J., Elliott, A., and Sargatal.*
747 *P.A. Johnsgard.*
748 *del Hoyo and others.*
749 *Y. Duriez, O.; Eraud, C.; Barbraud, C.; Ferrand, 'Factors Affecting Population Dynamics of Eurasian Woodcocks Wintering in France: Assessing the Efficiency of a Hunting-Free Reserve.', Biological Conservation, 122.(1): (2005), 89–97.*
750 *Hayman, P.; Marchant, J.; Prater.*
751 *del Hoyo, J., Elliott, A., and Sargatal.*
752 *Duriez, O.; Eraud, C.; Barbraud, C.; Ferrand.*

lands[753,754,755] sometimes 3-4 km away from woodland areas used for cover during the day[756], showing a preference for grazed meadows compared to cultivated fields (as the latter contain higher earthworm biomasses)[757]. The species may also feed on intertidal mud during freezing weather[758].

Diet

Its diet consists predominantly of earthworms, especially during the non-breeding season, but the species may also take adult and larval insects (e.g., beetles, earwigs and millipedes), spiders, slugs, leaches, ribbon worms[759] and plant material such as seeds, fruit, agricultural grain (e.g., oats and maize), and grass roots and leaves. Small freshwater bivalve molluscs and crustaceans are also taken by migrating birds[760]. The composition of the diet may differ between the sexes[761].

Social Behaviour

The northern and eastern populations are strongly migratory and must travel south and west in autumn to escape the winter freeze on their breeding sites. Owing to their diet of invertebrates and the manner in which they probe the soil to feed, woodcocks are unable to tolerate long periods of permanent frost. Between December and March, the bulk of the European population is concentrated in Britain, Ireland, France, Spain, Italy and Greece, where conditions are comparatively mild[762].

The species is sedentary on Atlantic islands[763],[764] and in some areas in south-western maritime countries[765] but is otherwise strongly migratory[766],[767]. The spring migration starts at the end of February[768] (the timing of this movement being closely related to temperature), with the species arriving on the breeding grounds between March and mid-May. In Europe, the species breeds from the end of February to July[769]. The autumn migration to the wintering grounds is largely governed by the timing of the first winter frosts (e.g., from October to November)[770]. The species is typically solitary and usually migrates singly or in groups of 5-6 [771]. Individuals may also become aggregated by topography or weather conditions, especially when migrating overland or where food and shelter are restricted[772]. It typically forages nocturnally during the winter[773].

Reproduction

Male Woodcock may begin displaying as early as the end of February and continue throughout the breeding season. The 'roding' display involves a repeated two-part call that is uttered in flight and consists of a high nasal whistle interspersed with a series of low grunts.

Until the late 1970s, it was believed that the roding calls were territorial warnings to other males, but Game Conservancy Trust research, conducted by Dr Graham Hirons during the late 1970s and 1980s, proved that this is not the case. Radio-tracking of male Woodcock showed that they were not territorial but that roding circuits often overlapped. The roding circuits and calls are akin to a lekking system, with males competing for airspace. The research revealed a polygynous mating system, whereby a dominant male may mate with up to four females in a breeding season, something that was previously unknown prior to the radio-tracking. Dr. Hiron's work was also able to dispel the myth that males assist with the incubation and upbringing of young and showed that in fact the female woodcock is solely responsible for her offspring. The tendency to encounter 'pairs' of Woodcock during the breeding season arises because male birds will shadow females after mating and during laying but following this period will leave her in order to attempt to mate again.

753 *Hayman, P.; Marchant, J.; Prater.*
754 *del Hoyo, J., Elliott, A., and Sargatal.*
755 *Duriez, O.; Eraud, C.; Barbraud, C.; Ferrand.*
756 *Hayman, P.; Marchant, J.; Prater.*
757 *Duriez, O.; Eraud, C.; Barbraud, C.; Ferrand.*
758 *Hayman, P.; Marchant, J.; Prater.*
759 *del Hoyo, J., Elliott, A., and Sargatal.*
760 *P. A. Johnsgard.*
761 *del Hoyo, J., Elliott, A., and Sargatal.*
762 *Game and Wildlife Conservation Trust, 'Woodcock, Rusticola, Scolopax'.*
763 *Hayman, P.; Marchant, J.; Prater.*
764 *del Hoyo, J., Elliott, A., and Sargatal.*
765 *C.M. Snow, D.W. and Perrins.*
766 *Hayman, P.; Marchant, J.; Prater.*
767 *del Hoyo, J., Elliott, A., and Sargatal.*
768 *Ferrand Y.; Aubry P.; Landry P.; Priol P., 'In Prep. Behavioural Responses of Human Disturbance on Wintering European Woodcock.'*
769 *del Hoyo, J., Elliott, A., and Sargatal.*
770 *del Hoyo, J., Elliott, A., and Sargatal.*
771 *C.M. Snow, D.W. and Perrins.*
772 *C.M. Snow, D.W. and Perrins.*
773 *del Hoyo, J., Elliott, A., and Sargatal.*

The nest is a shallow depression in the ground concealed by shrubs[774] in open wooded sites[775], often at the base of a tree or near a dead fallen branch or log[776].

The female nests on the ground and the clutch of typically four eggs is incubated for 21 to 24 days. She will lead her offspring away from the nest within a few hours of hatching, but they will be dependent on her for the next 15-20 days. The woodcock is renowned for its habit of carrying its young to safety between its feet when threatened. Some may consider this to be folklore and it is certainly hard to authenticate as it so rarely observed, but there are many documented examples of this behaviour. To our knowledge no photographic evidence exists to date.

It breeds throughout Europe as far south as northern Spain and Italy and as far west as Britain and Ireland. There are even small resident populations on the Azores and the Canary Islands.

Information on the size of breeding woodcock populations is relatively poor and the accuracy of estimates varies from country to country. By far the largest numbers, however, are known to breed in the Baltic States, Finland, Scandinavia and Russia. Indeed, the woodcock breeds across Russia between approximately 50°N and 70°N[777].

In the UK, woodcock breed from early March until July, with egg-laying peaking between mid-March and mid-April. A wide range of woodland types may be used, but there appears to be some preference towards more mature woodland with a diverse range of tree species. Certain ground flora species seem to be preferred when selecting nest sites, particularly bramble (*Rubus fruticosus*) and dog's mercury (*Mercurialis perennis*)[778] .

Demography

In Europe, the Woodcock is estimated to have a population of 13,800,000 – 17,000,000 mature individuals. Of this figure, the estimated population of calling or lekking males is between 7,000,000 and 9,000,000.

Globally they have a population estimated to be between 14,000,000 and 25,000,000 with one third of their population breeding in Europe. Russia and Fennoscandia have the greatest breeding population. 90% of the European population breeds in these two regions, but their breeding range extends down to the Mediterranean Sea, Canary Islands and western Europe.

Generally, the Woodcock has a large range of approximately 10 million square kilometres. Due to this and the relatively large and stable population, the IUCN evaluates the species as 'least concern'. The Woodcock does experience threats from increased fragmentation of woodland areas which is prime habitat for the woodcock. Intensified farming practices and expansion also pose a threat, as well as a vulnerability to avian influenza.

In certain regions of Europe there have been noticeable declines. The population in Britain for example is estimated to have declined from 78,346 males in 2003 to 55,241 males in 2007 giving an overall reduction of 29%. This decline is fragmented between regions of Britain, with Northern Scotland recording a decline of just 1% whereas in Southern Scotland the decline was as much as 59%[779].

The woodcock population density varies between different woodland. Males are more present in mixed woodland than coniferous or deciduous woodland[780].

774 *del Hoyo, J., Elliott, A., and Sargatal.*
775 *P. A. Johnsgard.*
776 *P. A. Johnsgard.*
777 *Game and Wildlife Conservation Trust, 'Woodcock, Rusticola, Scolopax'.*
778 *Game and Wildlife Conservation Trust, 'Woodcock, Rusticola, Scolopax'.*
779 *Christopher J. Heward and others, 'Current Status and Recent Trend of the Eurasian Woodcock Scolopax Rusticola as a Breeding Bird in Britain', Bird Study, 62.4 (2015), 535–51 <https://doi.org/10.1080/00063657.2015.1092497>.*
780 *Andrew N. Hoodless and others, 'Densities and Population Estimates of Breeding Eurasian Woodcock Sco/Opax Rusticola in Britain in 2003', Bird Study, 56.1 (2009), 15–25 <https://doi.org/10.1080/00063650802674768>.*

ANNEX 3:
Species Protection in EU Member States

Austria

Nature conservation and species protection efforts are coordinated by the Federal States based on different State Laws. Agri-environmental schemes exist under the national «ÖPUL", the Austrian programme for an environmentally appropriate, extensive and natural habitat friendly agriculture. Lower Austria offers four nature conservation measures under the framework of its 5-year agri-environment plan ÖPUL 2000, all of which were taken up for Great Bustard protection.

Belgium

In addition to the specific protection measures prescribed by the European directives, species protection in Flanders is regulated by the "Species Decree" (Soortenbesluit, 2019)[781] . The Species Decree provides for the possibility of drawing up specific species protection programs. Such programs include measures with the aim of ensuring that a species (or several species) are in a favourable state within Flanders[782] (e.g. *Crex crex*). The Flemish Land Agency also offers specific management agreements for the protection of field and meadow birds ((Skylark (*Alauda arvensis*), Partridge (*Perdix perdix*), Redshank (*Tringa totanus*), Common Snipe (*Gallinago gallinago*), Garganey (*Anas querquedula*), Black-tailed Godwit (*Limosa limosa*), Eurasian Curlew (*Numenius arquata*), Shoveler (*Anas clypeata*), Northern Lapwing (*Vanellus vanellus*), Eurasian Oystercatcher (*Haematopus ostralegus*), Meadow Pipit (*Anthus pratensis*), Eurasian Skylark (*Alauda arvensis*), Yellow Wagtail (*Motacilla flava*)).

Both in Flanders and Wallonia farmers can, in exchange for an annual fee, implement a package of Agri-Environmental measures and regulations on a voluntary basis aimed at maintaining or improving the quality of the environment, nature or landscape for these species[783]. Examples of measures for field and meadow species are delaying mowing date, controlled grazing, natural field borders, or mixing of seed-producing crops. The Walloon Government implemented the decree on agri-environmental and climatic aid, modified in 2017, without mentioning specific species supported per package of measures. Species categorized under "Game species" are excluded from the Flemish Species Decree and managed according to the Flemish "Hunting Decree" (24/07/1991).

Bulgaria

The Biological Diversity Act (2002)[784] regulates the conservation of the protected plant and animal species of wild flora and fauna by introducing protective measures. The Act contains appendices with a list of species for whose preservation a priority conservation of the habitats is required like the Corncrake (*Crex crex*), Great Bustard (*Otis tarda*), European Roller (*Coracias garrulus*), Red-backed Shrike (*Lanius collurio*), Grey Shrike (*Lanius minor*), Rock Partridge (*Alectoric graeca*), and species declared to be strictly protected in the territory of the whole country like Little Bustard (*Tetrax tetrax*), Northern Lapwing (*Vanellus vanellus*), Great Bustard, Corncrake, Black-tailed Godwit (*Limosa limosa*), Great Snipe (*Gallinago media*), Eurasian Hoopoe (*Upupa epops*), European Roller, Eurasian Green Woodpecker (*Picus viridis*), Red-backed Shrike (*Lanius collurio*), Grey Shrike (*Lanius minor*) or Common Moorhen (*Gallinula chloropus*). The Act also lists species open for regulatory use, including game species like Common Quail (*Coturnix coturnix*), European Turtle Dove (*Streptopelia turtur*), Eurasian Collared Dove (*Streptopelia decaocto*), Eurasian Wryneck (*Jynx torquilla*), Common Snipe (*Gallinago gallinago*), Mallard (*Anas platyrynchos*) and Grey Partridge (*Perdix perdix*).

Croatia

The Croatian Nature Protection Act (Official Gazette no. 70/05) compromises 331 protected species taxa and is today the fundamental regulation governing the area of nature protection in the Republic of Croatia. Via implementing acts (ordinances and regulations) the Nature Protection Act is continually aligned with the relevant directives and regulations in the area of the environment to pertain to the protection of birds and wild fauna. Apart from the Agri-Environmental measures supporting the creation of an attractive habitat for meadow and field fauna in agricultural areas, the Rural Development programme (2014-2020) also includes a specific pilot measure for the protection of the Corncrake (*Crex crex*).

781 *https://codex.vlaanderen.be*
782 *https://www.natuurenbos.be/sbp*
783 *http://vacvzw.be/vlm-beheerovereenkomsten/*
784 *State Gazette No. 77, 9 August 2002 http://www.fao.org/faolex/results/details/en/c/LEX-FAOC040293*

Cyprus

The Nature and wildlife protection and management Law (N. 153(I)2003, amended by No. 131(I)2006), harmonises the current Cypriot legislation with the European Nature protection standards. Cyprus is one of the few countries without specific measures included in the Rural Development Program concerning the management of grass and semi-natural forage area for field birds[785].

Czech Republic

Following on the Birds and Habitat Council Directives the Nature and Landscape protection Act (no. 114/1992 Coll.), supported by several decrees, defines general protection of all plant and animal species, and separately the protection of wild birds (Government Regulation 51/2004). Action Plans are implemented for species threatened by extinction in the form of comprehensive packages of measures to eliminate or reduce known threatening factors and improve the living conditions. Management Plans have been prepared for less severely endangered species[786]. The list of protected species covers among others Grey Partridge (*Perdix perdix*), Raven (*Corvus corax*), Common Quail (*Coturnix coturnix*), Eurasian Woodcock (*Scolopax rusticola*), Capercaillie (*Tetrao urogallus*), Black Grouse (*Lyrurus tetrix*). The agri-environmental scheme (2015) was launched with promising benefits for field birds consisting of non-managed ploughed stripes during the whole breeding season[787].

Denmark

In Denmark, nature and species protection is regulated by the Ministry of Environment and Food within three legislations, such as the Nature Conservation Act (no. 749/2007), the Forestry Act (no. 793/2007) and the Hunting and Game Administration Act (no. 747/2007). These statutes implement both the Habitat Directive and the Birds Directive. The Danish government has launched several initiatives to meet the 20 Aichi Targets (targets set by the Convention Biological Diversity – CBD), including the Agreement on the Nature Package (2016). The package includes schemes to incentive the establishment of green covers with mixtures of seed- and nectar-producing plant species to benefit insects, birds and wildlife. It also allocates funding to continue collaboration with the Danish Hunters' Association on a project to restore wildlife on farmland, «Markvildtprojektet». This project includes a targeted effort directed at selected species in the open countryside, and this will help establish more habitats for hares, partridges, larks, etc[788]. National management plans for a number of individual species were issued for, among others, hare, partridge, corncrake and meadow birds primarily the dunlin, the black-tailed godwit and the ruff[789]

Estonia

The Estonian Nature Conservation Act (RT I, 22.02.2019, 21) together with the Forest Act implements the EU Directives by also aiming to protect wild species by preserving their diversity and ensuring their favourable status[790], taking over the definition of "Favourable conservation Status" from the Habitats Directive.

Finland

A species in Finland may be protected by the Nature Conservation Act, declared as a threatened species, or placed under a strict protection order or a specific conservation programme by the Ministry of Environment. The Turtle Dove (*Sreptopelia turtur*) is included in the list of field and meadow protected species[791]. The threat status of Finnish species is evaluated every ten years; most recently in 2019 and based on the IUCN criteria.

France

In France, species protection in general is included in article L411-1 of the environment code and by various ministerial orders fixing, by taxonomic groups, the list of protected species and the terms of their protection. Agri-environmental schemes exist with commitments that could have a positive impact on the field and meadow species. The new hunting law of 2012 updated the French legislation by giving hunting federations a role in terms of biodiversity management and wildlife preservation. Since the 1st of January 2020, the French Association for biodiversity and the National Office for hunting and wildlife conservation joined within the new French Office of Biodiversity.

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785 *Rural Development Program Cyprus 2014-2020*
786 *Ministry of the Environment of the Czech Republic https://www.mzp.cz/en*
787 *Vojtěch Kubelka and others, 'Threats and Conservation of Meadow-Breeding Shorebirds in the Czech*
788 *Danish Ministry of Environment and Food, 'Sixth Danish Country Report Convention on Biological Diversity', 2019*
789 *Danish Ministry of the Environment, '5 Th Danish Country Report To the Convention on Biological Diversity', 2014 <https://www.cbd.int/doc/world/dk/dk-nr-05-en.pdf>.*
790 *Estonian Nature Conservation Act RT I, 22.02.2019, 21: https://www.riigiteataja.ee/akt/122022019021*
791 *Nature Conservation Decree 1997/160: https://www.finlex.fi/fi/laki/ajantasa/1997/19970160*

Germany

The Federal Ministry for the Environment shall give notice of the specially protected and strictly protected species in the Federal Gazette[792]. The primary source of nature conservation law in Germany is the Federal Nature Conservation Act (BNatSchG), which implements the Habitats Directive and the Birds Directive in national law. In addition, each of the 16 states within the Federal Republic has their own national nature conservation laws, therefore the State legislation may vary in detail. Germany has work programmes to protect the Great Bustard in both federal states of Brandenburg and Saxony-Anhalt. Agri-environmental schemes are implemented in several states on a voluntary basis to support habitat management measures of meadow and field birds.

Hungary

Species protection in Hungary is covered by the Nature Conservation Act No. LIII. of 1996 (last version entered into force 2013). This Act is completed by other laws regulating forestry and the Protection and Management of Game Species and Hunting (Law 55/1996) and implemented by different regulations. Agri-environmental schemes can be implemented on a voluntary basis to support habitat management measures of meadow and field birds. The Hungarian administration disposes a financial compensation for farmers who report the presence of breeding scarce bird species on their land. The most relevant species for the payments are birds such as the Corncrake (*Crex crex*), and Collared Pratincole (*Glareola pratincole*). European Roller (*Coracias garrulus*), and Great Bustard (*Otis tarda*) are strictly protected species in Hungary. The Accessible Sky Agreement is a unique national initiative signed in 2008, which brings together the ministry responsible for environment (Ministry of Rural Development) and electricity distribution companies and NGOs with the overall goal to contribute to the conservation of natural assets of Hungary by reducing bird casualties caused by power lines[793].

Italy

Act No. 157/1992 translates the EU Bird directive to the Italian legislation implemented by several regional Acts. It provides provisions for the protection of wildlife, restrictions on hunting and includes a list of protected species (mammals and birds) threatened with extinction including Bustard (*Otis tarda*), Little Bustard (*Tetrax tetrax*).

Ireland

The Wildlife Act (1976) is the principal national legislation providing for the protection of wildlife in Ireland. The first Wildlife Act of 1976 provided a good legislative base for species conservation with provisions, including those regulating hunting, quite similar to the EU Birds and Habitats Directives. This Act was substantially enlarged and improved by different Wildlife (Amendment) Acts and European communities Regulations[794], transposing the Habitats Directive and the Birds Directive into the Irish Legislation.

Currently all bird species are afforded a protected status by the Wildlife Act. Species Action Plans have been implemented for the Hare (*Lepus timidus hibernicus*) and Corncrake (*Crex crex*)[795]. A voluntary agri-environment scheme, the Rural Environment Protection Scheme (REPS) is available to make an impact on the habitat maintenance of field and meadow species. The scheme includes a supplementary payment for the implementation of a 'Corncrake friendly management'. Landowners receive a grant/payment if they agree to delayed mowing of meadows, carry out Corncrake friendly mowing when cutting the meadow and leave an unmown strip of meadow along the side of the plot if required[796]. A Curlew Conservation Programme was established in 2017 to pioneer Curlew conservation efforts in Ireland[797].

Latvia

The system of nature protection in Latvia is regulated by 2 laws, namely, the Law on Species and Habitats Protection and the Law on Specially Protected Nature Territories. Based on these laws, the Cabinet of Ministers has adopted several supporting regulations and established the lists of specially protected species. Additional specific nature protection requirements are included in sectoral (e.g., forestry, agriculture, spatial planning, building) legislation.

Lithuania

The purpose of the Lithuanian Law on Environmental Protection (1992 No I-2223) was to implement at the legal acts of the European Union. It defines that damage has been caused to the environment where there is a direct or indirect effect on the favourable conservation status of a species aimed at conservation (Art. 32), without defining the term "favourable conservation status". The Lithuanian Rural Development Programme (2014-2020) includes payments for commitments in the management of specific grass-

792 *Formulated by the Conservation of Nature and of Landscapes Act; 1998, Federal Law Gazette I p. 2994: https://germanlawarchive.iuscomp.org/?p=319*
793 *Government of Hungary, 'Fifth National Report to the Convention on Biological Diversity', 2014, 2009–13 <https://www.cbd.int/doc/world/za/za-nr-05-en.pdf>.*
794 *S. I. No. 477 of 2011*
795 *National Parks and Wildlife Service, 'All Ireland Species Action Plans', 2005, 16–22 <https://www.npws.ie/sites/default/files/publications/pdf/2005_Group_SAP.pdf>.*
796 *National Parks & Wildlife Service, 2020, https://www.npws.ie/farmers-and-landowners/schemes/corncrake-grant-scheme*
797 *Department of Culture Heritage and the Gaeltacht, 'Curlew Conservation Programme', 2018, 1–23.*

land, preservation of rare bird habitats, strips or fields of melliferous plants on arable land and the preservation of endangered Lithuanian ancient domestic bird breeds.

Luxembourg

In 2004 a new amended Law concerning the protection of nature and natural resources was implemented. A first National Strategy Plan on the Protection of Nature (as for which the implementation was provided by the Act Art. 51 and 52 of the Law) was approved by the Governmental Council in 2007. Strategy plans include the targets set out in the EU "Biodiversity 2020 Strategy" and must be reviewed every 5 years. The current plan runs from 2017 to 2021. This strategy continues the approach of the first National Plan (2007) which identified several species and habitats for which 40 action plans have been developed including Grey Partridge (*Perdix perdix*), Northern Lapwing (*Vanellus vanellus*) and Common Quail (*Coturnix coturnix*)[798]. Most of the species programmes were initiated in 2010. The fox, skunk and badger are protected predator species resulting in a negative effect on small wildlife species.

Malta

All species of naturally occurring wild birds are protected through the Conservation of Wild Birds Regulations, 2006 (S.L. 549.42)[799], which in turn, transposes obligations of the EC Birds Directive 2009/147/EC. The Environment Protection Act came into force in 2016, amended in 2018. From species present in Malta, the Corncrake (*Crex crex*), Great Snipe (*Gallinago media*), European Roller (*Coracias garrulus*), Lesser Grey Shrike (*Lanius minor*), Eurasian Collared Dove (*Streptopelia decaocto*), Alpine Swift (*Tachymarptis melba*), Eurasian Wryneck (*Jynx torquilla*), Black-tailed Godwit (*Limosa limosa*), Hoopoo (*Upupa epops*), and Red-backed Shrike (*Lanius collurio*) shall be the subject of field and meadow bird conservation measures. However, wild bird species which occur on the islands are migratory, none are resident or breed on a regular basis in the wild. As such, no further specific national or regional programmes are available.

Netherlands

Protection of vulnerable species in the Netherlands has been regulated by the new Nature Conservation Act (Natuurbeschermingswet) since January 2017. The act implements the European Habitats and Bird Directives describing national species protection, hunting, protected species damage, habitat protection and population management in one act. The granting of exemptions and derogations to this Act lies with the provinces. The prohibitions and derogation criteria for birds and Habitats Directive species are closely aligned with the provisions of the European Directives. The basic principle of the Act is that no damage may be done to protected animals unless this is explicitly permitted, without specifying specific activities that are not permitted.

The prohibitions and species lists for birds and other European protected species included in the Nature Conservation Act are taken from the Birds Directive and the Habitat Directive respectively. For other, 'nationally' protected species the prohibitions are inspired by the Habitat Directive but became in some respects less strict. The list of 'nationally protected' species includes Hare (*Lepus europaeus*) and Rabbit (*Oryctolagus cuniculus*), and Fox (*Vulpes vulpes*) as a predator resulting in a decrease of ground breeding birds.

Farmers can enter several kinds of meadow-bird contracts with the Province under a subsidy scheme for nature and landscape conservation which offers financial compensation for their management activities. The management activity for meadow bird protection is restricted to target areas, meadow bird areas. There are several packages farmers can choose like nest protection and delayed management[800].

Poland

The latest regulation on animal protection was published by the Ministry of Environment in 2016. Agri-environment-climate measures under the Polish Rural Development Program for 2014-2020 include packages for the protection of farmland and meadow bird breeding habitats, designed for the Warbler species, Common Snipe (*Gallinago gallinago*), Red-backed Shrike (*Lanius collurio*), Black-tailed Godwit (*Limosa limosa*), Common Redshank (*Tringa totanus*), Northern Lapwing (*Vanellus vanellus*), Great Snipe (*Gallinago media*) and Cornkrake (*Crex crex*). Also, since 2004 a national law was put into place forbidding to burn grass to protect (breeding) species (OJ 2004 No. 92 item 880).

Portugal

Species protection in Portugal is described in the 'Legal Regime for the Conservation of Nature and Biodiversity[801], including national initiative schemes

[798] *Gouvernement du Grand-Duché de Luxembourg, Plan National concernant la Protection de la Nature 2017-2021, 2017, https://environnement.public.lu/dam-assets/documents/natur/general/pnpn2.pdf*
[799] *Environment Protection Act, Chapter 549: http://www.justiceservices.gov.mt/DownloadDocument.aspx?app=lom&itemid=11548&l=1*
[800] *Katrin Prager, 'The Use of Indicators in Agri-Environmental Management in the Netherlands', 2012.*
[801] *DL No. 142/2008, of 24 July 2008, (IV) http://www.pgdlisboa.pt/leis/lei_print_articulado.php?tabela=leis&artigo_id=&nid=1369&nversao=&tabela=leis*

and regimes arising from international legal instruments. The adoption of the Birds Directive and the Habitats Directive is set out in a separate diploma[802], including a list of protected species and species that can be traded (e.g., Grey partridge). Agri-environmental schemes are available to be implemented on a voluntary basis to support habitat management measures of meadow and field birds.

Romania

Romania has a complex legislative framework for the conservation, management and sustainable use of biodiversity. In order to harmonize the national legislation with global and European objectives regarding species protection, changes have been made in all major laws and regulations, including the Environmental Protection Act, Biological Diversity Act, Protected Areas Act, Law on Hunting and Game Protection, etc[803]. In the National Plan for Rural Development 2014-2020 under the Measure 10 action packages are available for the Red-breasted Goose (*Branta ruficollis*) on arable land and the Great Bustard (*Otis tarda*) on arable land and pastures and includes measures for common bird species associated with agricultural land in general. These measures are combined with a compensatory 5 year payment offered to the farmer[804].

Slovenia

In addition to the Nature Conservation Act, regulations on the protection of endangered wild fauna were adopted in 2004 in order to transpose the EU's Birds and Habitats Directives in Slovenia's legal system and have regularly been amended. According to these Directives, species found in Slovenia, including all native bird species, must be maintained in the favourable conservation status. Agri-environment payments include subsidies for maintaining extensive grasslands, conservation of meadows outgrown with birch/fern communities and bird conservation in extensive humid meadows at Natura 2000 sites.

Spain

The List of Wild Species under a Special Protection Regime is established through the Law on Natural Heritage and Biodiversity 42/2007 and developed by Royal Decree 139/2011. The Decree covers the development of a list of Wild Species under special protection (Art. 53, Art. 55), making a distinction between species 'endangered' and 'vulnerable'. The Spanish Catalogue of Threatened Species is established from this list and includes: European Roller (*Coracias garrulus*), Eurasian Green Woodpecker (*Picus viridis*), Red-backed Shrike (*Lanius collurio*), Lesser Grey Shrike (*Lanius minor*), Eurasian Wryneck (*Jynx torquilla*), Corncrake (*Crex crex*), Hoopoo (*Upupa epops*) and Black-tailed Godwit (*Limosa limosa*) as threatened species, Little Bustard (*Tetrax tetrax*) as vulnerable and the Great Bustard (*Otis tarda*) as Endangered.

The Wild Flora and Fauna Committee is responsible for the implementation of specific measures to manage populations of species included in the Catalogue through conservation strategies and action plans. These strategies establish guidance criteria or guidelines for action plans, specifying minimum content and structure for these documents. Action plans currently exist among others for the Pyrenean Capercaillie (*Tertao urogallus*)[805] and Red-knobbed Coot (*Fulica cristata*)[806]. The Autonomous Communities and cities are required to develop recovery plans for endangered species and conservation plans for species categorized as vulnerable[807].

Sweden

In 1909, the Swedish Parliament enacted the first Nature Protection Act including the fundamental environmental rules, detailed provisions are laid down in ordinances made by the Government. The Swedish Species Protection Ordinance sets forth the rules that specify which species are protected by law. All wild bird species are protected. In addition to the protection Act, all wild birds and mammals, are also protected under the Hunting Act (SFS 1987:259) and Hunting Ordinance (SFS 1987:905). There are exceptions on the protection during hunting seasons on some fifty species like Common Quail (*Coturnix coturnix*), European Turtle Dove (*Streptopelia turtur*), Eurasian Collared Dove (*Streptopelia decaocto*), Northern Lapwing (*Vanellus vanellus*), Eurasian Wryneck (*Jynx torquilla*), Corncrake (*Crex crex*), Black-tailed Godwit (*Limosa limosa*), Great Snipe (*Gallinago media*), Common Snipe (*Gallinago gallinago*), Hoopoo (*Upupa epops*) or Eurasian Green Woodpecker (*Picus viridis*).

802 *Decree-Law No. 140/99 on biodiversity protection: http://extwprlegs1.fao.org/docs/texts/por22472.doc*
803 *Department of Culture Heritage and the Gaeltacht, 'Curlew Conservation Programme', 2018, 1–23*
804 *Agricultural Payments and Intervention Agency: http://www.apia.org.ro/ro/masura-10-agro-mediu-si-clima*
805 *Estrategia Para, L A Conservaci, and E N Espa, Urogallo Pirenaico, 2005*
806 *Department of Culture Heritage and the Gaeltacht, 'Curlew Conservation Programme', 2018, 1–23*
807 *José María de la Cuesta Sáenz José María Caballero Lozano, Código de Caza, Boletin Oficial Del Estado, 2020 <https://www.boe.es/legislacion/codigos/codigo.php?id=095_Codigo_de_Caza&modo=2>*

UK *(Before Brexit)*

The Wildlife and Countryside Act 1981 was enacted in Great Britain to implement the Birds and habitat Directives. Decreasing wildlife populations resulted in changes to the 1981 Act in each country and regulations in Scotland differ now from those in England and Wales. The UK has overall responsibility for the environment and biodiversity but to allow conservation approaches to be tailored to the different environments each country has developed national biodiversity strategies with its own list of protected species.

The Wildlife and Countryside Act 1981 affords protections to all wild birds. Game birds are an exception under the Game Act, but a few game species whose populations are not viable to shoot have additional protection and ways to encourage landowners to protect and enhance their habitat e.g. Black Grouse (*Lyrurus tetrix*) and Capercaillie (*Tetrao urogallus*). These species are Biodiversity Action Plan priority species and are included in the Scottish Biodiversity List. Conservation efforts are put in place to boost grey partridge numbers as they are UK red list species under the Birds of Conservation Concern and as a priority species in the UK Biodiversity Action Plan.

Curlew (*Numenius arquata*), Black Grouse (*Lyrurus tetrix*), Lapwing (*Vanellus vanellus*), Redshank (*Tringa totanus*), Snipe (*Gallinago gallinago*), Oystercatcher (*Haematopus ostralegus*), are defined as vulnerable priority species in Scotland. Wading birds, including Curlew (*Numenius arquata*) and Snipe (*Gallinago gallinago*), are priority species for conservation in Scotland. Common Quail (*Coturnix coturnix*), Corncrake (*Crex crex*), Lapwing (*Vanellus vanellus*), Black-tailed Godwit (*Limosa limosa*) and Turtle Dove (*Streptopelia turtur*) are priority species in Northern Ireland.

Five local goose management schemes exist in Scotland which focus on migratory species and operate during winter and spring and two schemes focuses on resident populations of greylag geese during summer[808]. Agri-Environment Scheme funding has been available to support wildlife by including the creation of wader scrapes, sowing seed-rich crops, managing hedgerows for wildlife and planting wildlife-friendly field margins and predator control efforts are stimulated to benefit Black Grouse and Capercaillie populations[809]

[808] *Scottish Government, 'Rural Payments and Services' <https://www.ruralpayments.org/topics/all-schemes/>.*
[809] *Scottish Government, 'Wildlife Management' <https://www.gov.scot/policies/wildlife-management/species-management>.*

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