

Understanding the land use dynamics in an endangered bird species' context: the case of the Ortolan bunting (*Hemberiza hortulana* L.) in South-Eastern France



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Abstract

Agricultural intensification and urbanization are commonly identified as the main causes for loss of biodiversity. The Drôme region in south-eastern France is an exemplary case, as it is converting from an historically heterogeneous landscape to a territory predominantly occupied by intensive agricultural and industrial land use. This study aims to assess the impact of this change on a particular endangered bird species, the Ortolan bunting (*Hemeberiza hortulana* L.), which is in decline all over Europe supposedly due to increase of monoculture. Current literature suggests, that this bird depends on diversified landscape elements such as meadows, semi-natural elements and winter cereals. Additionally, the study maps the local actors involved in shaping the landscape and how their priorities influence the presence of the Ortolan within their territory.

A literature review, a quantitative land-use comparison in a ten-year time frame (2007-2016) with qGIS, eight semi-structured interviews with different stakeholders and a landscape reading were conducted. The mapping and the interviews showed a trend for landscape homogenisation during the last thirty years due to land consolidations and a shift from polyculture to intensive cereal production. In this context, the main actor concerned about the protection of the Ortolan is the LPO (Ligue pour la Protection des Oiseaux). While other stakeholders such as the Agricultural chamber and the SCoT (Schéma de cohérence territoriale) are aware of this species' presence their priorities do not include its protection. The main obstacle for effective protection today is the lack of understanding of the bird's habitat requirements in the Drôme. Indeed, the Ortolan was discovered in the region only in 2009 and extensive studies are not yet available. More detailed information will help to implement more targeted agri-environmental schemes included in a more global approach to biodiversity conservation. This could encourage farmers to balance their economic productivity with preserving natural landscapes.

Introduction

Agricultural intensification is at the origin of important environmental issues, such as soil degradation, groundwater pollution and loss of biodiversity. Indeed, the incremental use of mechanization and consistent use of chemical pesticides in intensified agricultural systems can greatly impact food chains, through habitat loss or by causing a decrease of prey availability, such as arthropods (Potts 1986, in Stoate et al. 2001, Vepsäläinen et al. 2005).

A concrete example of how agricultural intensification has affected wildlife is the Ortolan bunting (*Hemeberiza hortulana L.*). This species is found throughout Europe and is rapidly decreasing due to habitat loss, mainly caused by expansion of agricultural land, homogenized crops and practices and removal of (semi-)natural, undisturbed elements (e.g. trees and hedgerows). The rapid decline of the European population of this particular bird has been worrying ecologists, who have mainly pointed the finger at industrial agriculture (i.e. large fields with monoculture cash crops) as the cause of this decline.

Ecology of the Ortolan

The Ortolan is a long distance migratory passerine species, which reproduces and nests in Europe and overwinters in Africa. The Ortolan requires a heterogeneous landscape, in which it can make use of different elements to forage, sing and nest (Vepsäläinen et al. 2005, Menz et al. 2009, Dale 2017). Trees and bushes are used as singing posts, and Oak trees (*Quercus spp.*) can also serve as foraging sources. In past studies, most of the bird populations were found in areas where the tree cover was around 20-30%, indicating that the Ortolan mainly favours open land (Menz and Arlettaz 2012). Indeed, as it is a ground foraging species, the foraging areas of the Ortolan are normally meadows, where high arthropod abundance is found, but also bare soil patches. Nesting also occurs on the ground, during the summer (Menz and Arlettaz 2012). The behaviour of the Ortolan has been shown to adapt to the change and intensification of the agricultural land use, as several Ortolan individuals were reported to forage in maize fields treated with herbicides, thus presenting bare

ground. Indeed, Menz et al. (2009) reported that although the treated maize fields contained less arthropods than adjacent meadows, preys were more available, indicating that prey availability, rather than abundance is more determining for the bird.

The French Ortolan population

In France, most of the populations of the Ortolan are found in the south and southwest regions, although some individuals have been detected in the northern part of the Drôme region (southeast France). The small isolated population found in this area is probably due to the frequent colonization and abandonment of habitats that the bird has shown, thus leading to sparse populations (Glitz 1967, Dale and Steifetten 2011, in Menz and Arlettaz 2012, Steifetten and Dale 2012). Despite the current literature about the Ortolan's ecology, little is known about the Drôme's population, as the first time the Ortolan has been seen in the area was in 2009. The Ortolan is expected to be present in the area between March and September, migrating to Africa for the winter. As shown by Fonderflick et al. (2005), it is possible that elements which are determinant for the Ortolan's presence in some areas (e.g. topography, aspect and climate, cultivated areas) may not be significant in other areas, even within the same country. Indeed, due to the lack of knowledge on the current Ortolan population and its ecological preferences, only assumptions can be made regarding its habitat requirements within the Drôme, and whether the landscape changes from the years prior to 2009 and now have affected the local population.

The Drôme

The Drôme region is located between the Vercors and the Provence; with a total area of 6,530 km² (15% of the Rhone-Alps), of which the area dedicated to agriculture equals to 204,342 ha.

The Drôme is characterized by a diversified landscape, which is the result of a constant adaptation to different climates over the years (for an overview of the zone of interest for the study, see fig. 1). Historically, the region was characterized by pasture (goats and cattle) and orchard areas (mainly cherries, peaches and apples). Today, annual crops occupy about 50% of the used agricultural surface (UAS),

although other crops such as fruits (22%), vineyards (15%) and mixed farming polyculture (15%) are also present. As for natural elements, forests occupy 43% of the Drôme area, and meadows occupy 27% (Drôme Agricultural Chamber, 2017).

Although, there has been a reported decline in agricultural land use of 11% between the years 2000 and 2010, accompanied by a decrease of small scale farms, increasing agricultural intensification, along with signs of urban expansion, represent a change in current and future land use of the region. These elements, along with the conversion from perennial crops to arable farming, are determining factors in the landscape dynamics and, hence, conservation of wildlife.

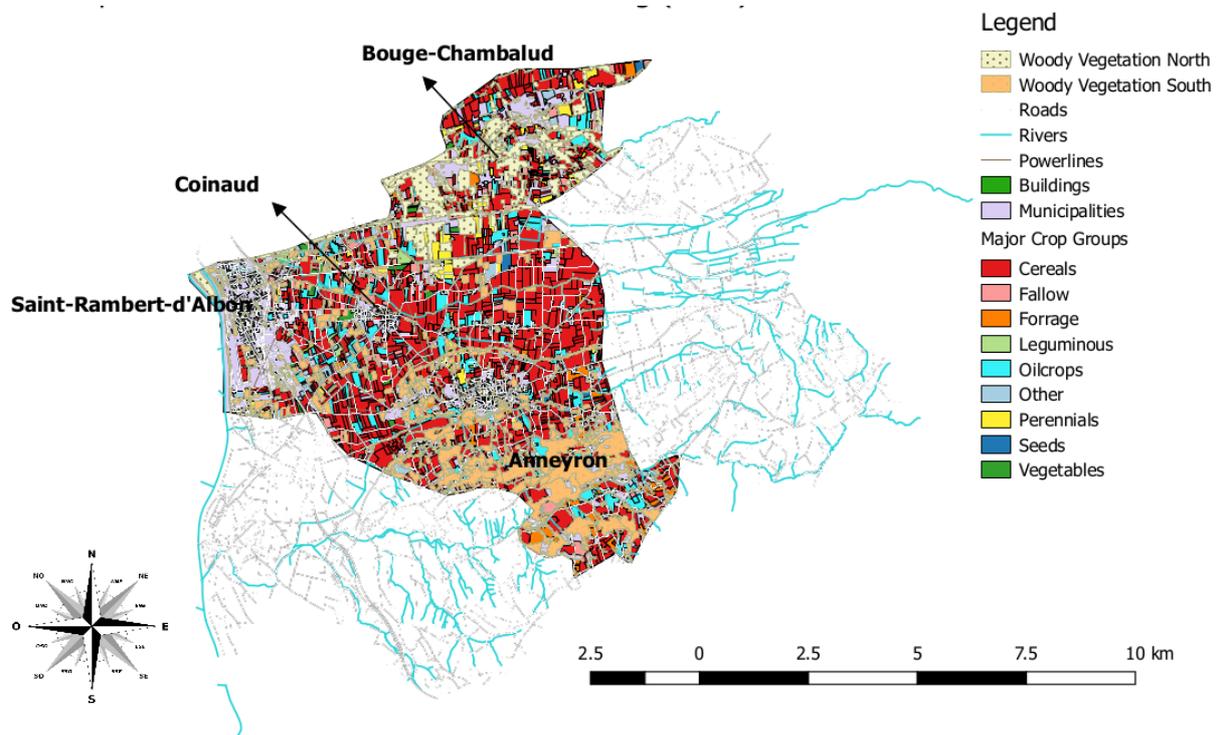


Figure 1 Anthropic and natural elements which characterize the municipalities of Saint-Rambert-d'Albon, Anneyron and Bouge-Chambalud, in which the zone of interest of the Ortolan bunting is found (Drôme, 2007)

Problem statement

Despite the reported adaptability of the Ortolan to predominantly agricultural landscapes due to the loss of ideal natural habitats (Fonderflick et al. 2005), agricultural intensification has been reported to cause negative effects on the bird's populations. In particular, the shift from winter to spring cereals and the increasing trend of industrial crops such as maize and sunflower are main threats to the maintenance of diverse foraging areas and suitable nesting grounds. Studies in other European countries have shown that the creation of larger fields has eliminated trees and hedges from the landscape, thus depriving the Ortolan of important foraging and mating elements (Stoate et al. 2001, Skokanová et al. 2016). Moreover, irrigation has been identified as another source of disruption, as the Ortolan prefers warm and well drained soils for foraging and nesting (Menz and Arlettaz 2012). Finally, urbanization poses an additional threat to the conservation of this species, as it disrupts in an even more prominent way the habitat of the Ortolan.

Hence, even though the reasons for the decline of Ortolan populations still need to be verified, "habitat loss and degradation, and related reduction in prey availability; climate change on the breeding grounds; [...] and environmental change in wintering areas" have been listed as the main causes for decline (Menz and Arlettaz 2012). Indeed, most of the proposed conservation measures are based on these causes, emphasizing the need to create patches of bare ground and increased heterogeneity in the landscape.

Other threats such as poaching have also greatly contributed to the rapid decline of the Ortolan populations, especially in the territories crossed during migration to Africa, where the birds overwinter. Indeed, during the migration period, around 30 000 birds are captured each year, and used to cook a traditional dish (*Dale 2017*).

Knowledge Gap

With respect to the Drôme population, it is unclear whether agricultural intensification is influencing the individuals in the same way as it has done with the other European populations. Furthermore, it is unclear why those individuals have settled in this specific area within the Drôme. Little is known about the Drôme individuals, and

recordings have started only recently (2009), so no data on the population is available prior to this year, to see the long-term population dynamics, especially in association with the evolution of the natural and agricultural landscape. Hence, the combination of a small population, the lack of knowledge of its past dynamics in the area and the lack of knowledge on its ecological needs complicate the conservation attempts of the Ortolan, making it difficult for biodiversity conservation programs to be financed.

Stakeholders

The conservation of the Ortolan bunting is prioritized by the LPO (“Ligue pour la Protection des Oiseaux”, a natural biodiversity association), but other identified stakeholders are: the agricultural chamber, the SCoT (“Schéma de cohérence territoriale”), local municipalities, the farmers. In order to understand the potential of the Drôme to conserve the Ortolan, and globally to preserve the natural and agricultural biodiversity of the area, it is important to assess the degree of collaboration between formal organizations, such as the agricultural chamber, the LPO and the SCoT, along with the determining how the communication with the farmers is done and by whom.

Indeed, the challenge in the area is to converge different priorities of the different stakeholders (e.g. conservation of biodiversity, agricultural practices or intensification, urbanization), thus making the communication between actors transparent and collaborative, which mainly enters within the responsibilities of the SCoT.

Aim of the study

The main aim of the study is to understand past and current land uses within the focal area of the study (the northern part of the Drôme region), relating the changes in the landscape to the presence of the Ortolan bunting. Agricultural intensification and urban expansion are taken into consideration to assess whether they could affect the local Ortolan bunting population. Particular attention is put on the impact of these land uses on landscape heterogeneity; indeed, as the literature suggests that the Ortolan prefers a fragmented landscape, this study uses landscape fragmentation as

a key indicator to determine the suitability of the area for the presence of the Ortolan. In addition, how the local stakeholders are communicating with each other with respect to the conservation of the Ortolan (and biodiversity in general) and what is the potential for change concerning the protection of this species are also important factors to consider. Focus will be put on how the land use has evolved in the past ten years, in order to see if the landscape within the interest zone of the Ortolan has significantly changed, if the changes might affect the presence of the Ortolan in the Drôme, and if they are coherent with the existing literature. By highlighting past and current land use trends, future scenarios for the area can be suggested, allowing to seek potential ways to address the conservation of this species and to advise the stakeholders.

Research questions and hypotheses

The following research questions are proposed: 1) To what extent do agricultural and urban intensification play a role in the modification of the landscape, thus affecting the presence of the Ortolan bunting in the area? 2) How are the different stakeholders involved in the conservation of the landscape, influencing its potential to conserve biodiversity and Ortolan in particular?

Consequently, we propose the following hypotheses: 1) Agricultural intensification and urban pressure reduce heterogeneous elements in the landscape such as hedgerows and small diverse fields. Thus, we expect a decline of the bird population if urbanization and agricultural intensification trends increase, progressively homogenizing the landscape and reducing the presence of (semi)-natural elements and diversified agricultural land, forcing the bird to seek other favourable habitats 2) We expect stakeholders which are not involved in wildlife conservation to not be concerned about the Ortolan and its importance in the Drôme area. We expect that projects in the area or changes in the landscape will be done without taking into consideration this species, thus increasing the chances for its disappearance from the Drôme.

Material and Methods

The report focuses on the northern area of the Drôme region, mainly within the municipalities of Anneyron and Saint-Rambert-d'Albon. The information is needed to understand how has the land use evolved and what is the potential for the conservation of the Ortolan within the area of interest. Information is obtained through interviews with the stakeholders, a landscape reading and by using qGIS (quantum Geographic Information System). The area of interest is characterized by the presence of the hearing points of the Ortolan, recorded by the LPO association in 2017. The hearing points serve as reference points to assess if landscape heterogeneity is indeed a determinant factor for the presence of the Ortolan in this case, or if the Drôme population has particularly adapted to open-field, homogeneous landscapes.

Data collection

Interviews

The nature of the interviews is semi-structured, thus allowing the interviewer and interviewee to freely communicate within a frame of premeditated questions (for interview questions, see Annex 1). This type of interview is more suited in cases in which there are no particular time constraints for both parties, allowing the interviewee to adequately answer to all of the interviewer's questions, and to open the conversation to other topics they think are also important. In case of time constraints, mainly, a structured interview type will be applied. This implies a stricter question-answer exchange, prior to which the questions will need to be finalized and organized in advance so to obtain concise and explicative answers and optimize the interviewee's and interviewer's time. Structured interviews will also be performed in case the interview must be done through phone-call.

Table 1 summarizes the interview type and what information we expect to obtain from each stakeholder. In total: 3 farmers, 1 LPO member, 2 SCoT members, 1 technician of the agricultural chamber and 1 municipality mayor were interviewed. The interviews mainly serve to understand which are the different stakeholders within the

area, their interactions, whether their decisions/actions are done taking into consideration the protection of the Ortolan and if how their decisions/actions which modify the local landscape might affect this particular species.

Table 1. Stakeholder, interview type and desired outcome of the interview.

Stakeholder	Interview Type	Desired Outcome
LPO	Semi-structured	Information on the biodiversity of the region, with focus on the Ortolan. Conservation projects and type of engagement with the other actors.
Agricultural Chamber	Structured	Evolution of the land-use with data on crop type and practices. History of the region and information on agricultural land management (acquisition, merging ...)
Farmers	Semi-structured	Cropping practices and management of their property (presence of natural elements), history of the region and issues linked to urbanization.
Municipalities	Semi-structured	Urban planning. Engagement in management of semi-natural elements, i.e. hedges and ditches.
SCoT	Semi-structured	Land use development and interaction with other stakeholders.

Landscape reading

The landscape reading is performed in a polygon which includes some of the areas of interest, circles of a 500m diameter, in which the Ortolan has been heard (See Annex 2). This step is important in order to familiarize with the area and understand the

context of the study. Both agricultural and (semi-)natural elements are considered. Since the harvest of all annual spring crops has already been performed, crop residues are used in order to distinguish the crop type, to a certain extent. The semi-natural elements considered are hedgerows, distinguished based on their density and composition (e.g. shrubby or trees), isolated trees, grass strips (if wider than 1m) and bank margins; isolated and abandoned houses within the fields are also noted.

Data processing

Interviews

The qualitative data from the interviews will be used to create a stakeholder network, a simplified representation which allows to visualize synergies and antagonisms between actors, along with the different objectives of the stakeholders. The qualitative data will also help understand past and current trends in the land use, see to which extent each stakeholder is involved in the conservation of the Ortolan and consequently assess the potential of the Drôme area to change in accordance to the conservation of this species. If possible, the interviews will also be used to determine future land use plans and suggest conservation measures for the Ortolan.

In order to do so, the answers of the stakeholders to the interview questions will be synthesized and grouped by category (e.g. land use, biodiversity) in order to give a clear overview of the situation.

Land use

Land use data from 2007 and data from 2016 (obtained from the French field register- geoportail.fr) are compared using qGIS (version 2.14.3), in order to see if and how the land use has changed in the past 10 years. From the municipalities of interest a polygon which encloses all the hearing points of the Ortolan from 2016 is chosen as the most interesting area for the study (figures 2 and 3). Particular attention is paid to how much the area has been homogenized with the evolution and type of the land use. Evolution of urbanization is also assessed and analysed in parallel with the evolution of the agricultural area, predominantly through interviews.

This allows to highlight land use trends and to possibly detect what might be the future situation in the area.

Total agricultural surfaces and major crop surfaces from 2007 and 2016 are compared using a two-sample t-test ($\alpha = 0.05$) to assess whether there are significant differences in the agricultural area between the two years. The area taken into consideration, for both years, includes only the sites in which the Ortolan has been heard, in order to maintain a degree of pertinence with the study. Additionally, field number count and major crop group are compared between the two years.

Results

The information gathered during the study is presented in the next paragraphs. For clarity, the results are divided under “land use” and “biodiversity”. Regarding land use, trends over the years of 2007 and 2016 can be observed through qGIS mapping. A further distinction of the land use change is represented in the data collected through interviews, representing the qualitative perception of the different stakeholders on the evolution of the land use and the relation between this and the presence of the Ortolan. Biodiversity is explained through the interviews. To finalize the results, a scheme with the interactions between all the involved stakeholders is placed to better understand the power relations in terms of conservation plans, urbanization and land use.

Land Use

qGIS

Changes in agricultural land use can be observed in figures 2 and 3. The hearing points refer to the year 2017, but were included in both maps to show what the areas looked like in the zones the Ortolan was heard one and 10 years before the recordings.

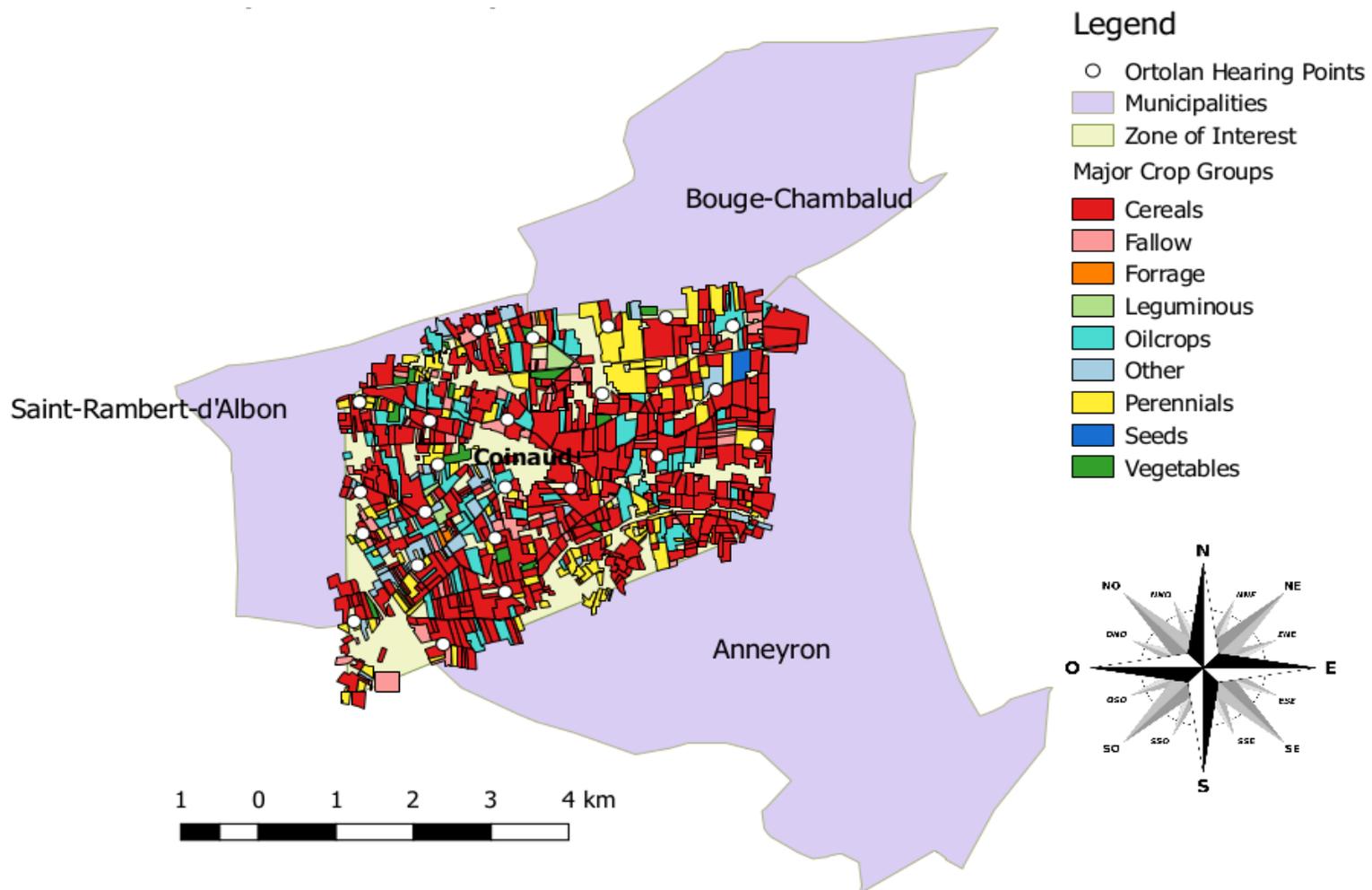


Figure 2 Agricultural land use in the area of interest of the Ortolan bunting (Drôme, 2007).

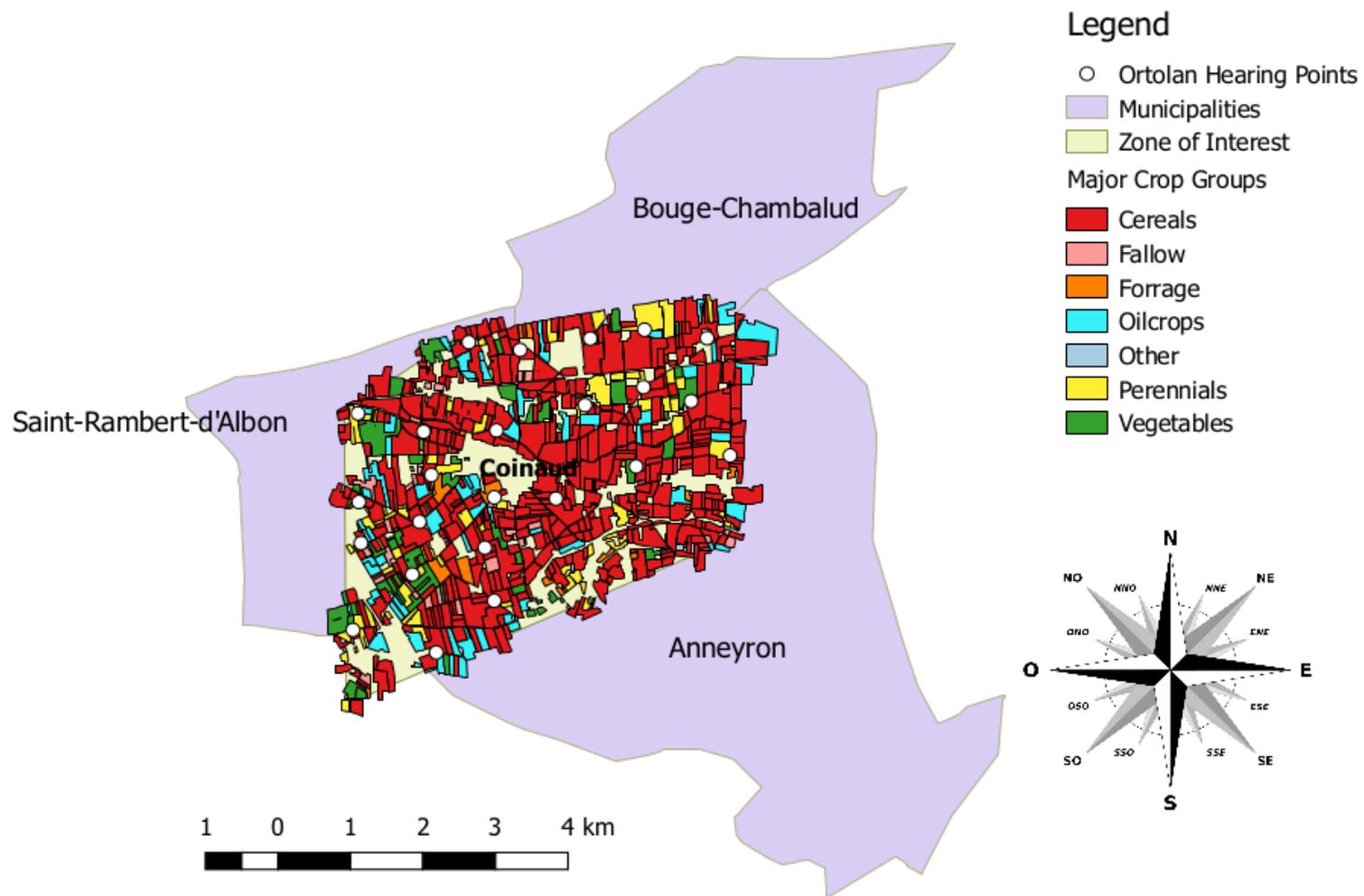


Figure 3 Agricultural land use in the area of interest of the Ortolan bunting (Drôme, 2016).

From a visual comparison, the cereal crops are predominant in both areas. A comparison of the total field surface occupied by the cereal groups in 2007 and 2016 shows that the cereal crops occupy a larger area in 2016 (two sample t-test, $\alpha=0.05$, fig. 4 and 5). Leguminous and seed crops have disappeared from 2007 to 2016. Average field surfaces are larger in 2016 (two sample t-test, $\alpha=0.05$), the number of fields decreases from the year 2007 to 2016, whereas the major crop group, cereals, remains consistent (Table 2).

Table 2 Comparison of field surface, field number and major crop between the years 2007 and 2016 in the zone of interest. Field surface and cereal surface are expressed as averages. The respective surfaces marked with ** are significantly different from each other ($\alpha=0.05$).

	2007	2016
Field Surface	2.27441**	2.46516**
Number of Fields	777	738
Major Crop Group	Cereals	Cereals
Cereal Surface	2.53634**	2.74971**

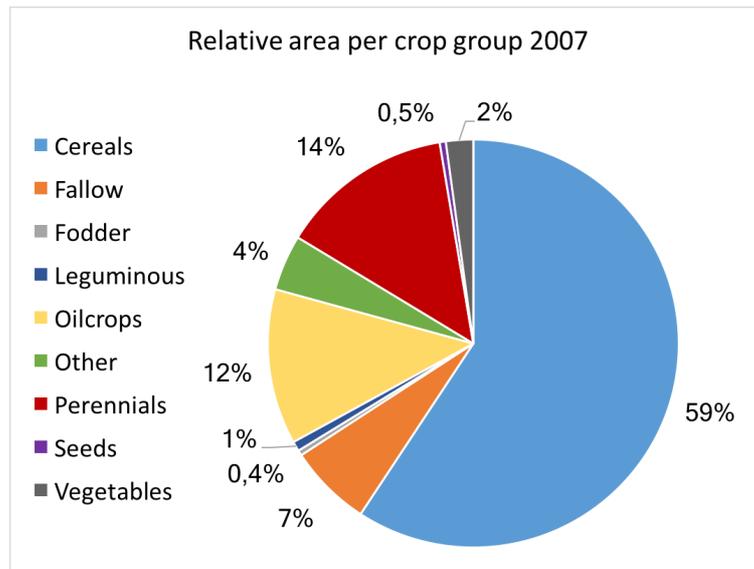


Figure 4 Percentage of area occupied by each crop group in the area of interest (2007).

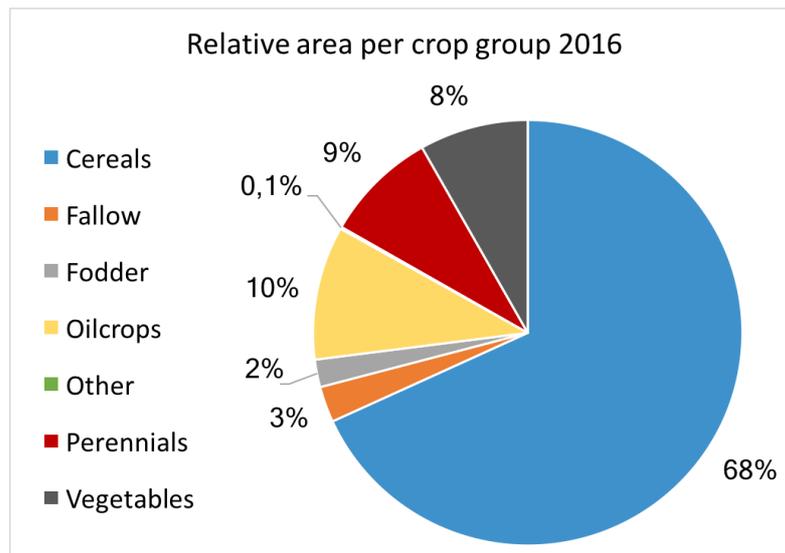


Figure 5 Percentage of area occupied by each crop group in the area of interest (2016).

Although the total number of fields has decreased in the zone of interest, the number of fields occupied by each crop group is consistent with the occupied area (fig. 6 and 7). The area occupied by cereals, fodder and vegetables has increased from 2007 to 2016, whereas for the other crop groups there has been a general decline over the decade.

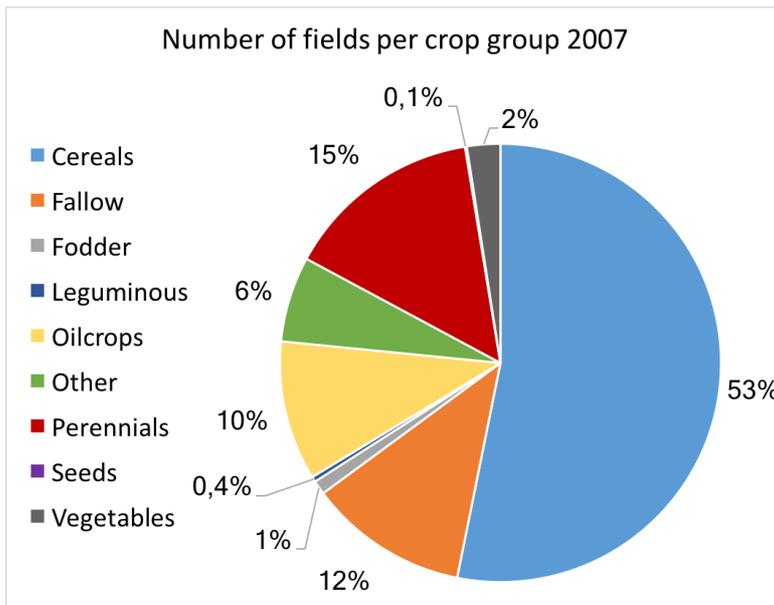


Figure 6 Percentage of number of fields occupied by each crop group in the area of interest (2007).

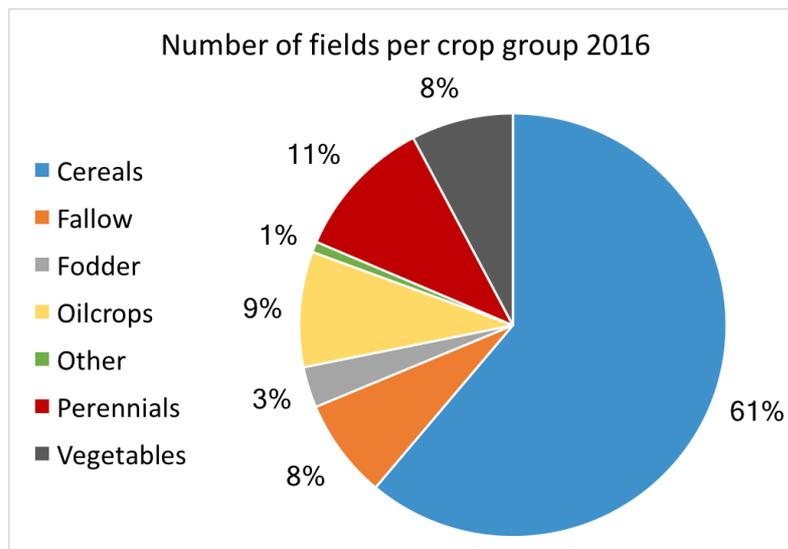


Figure 7 Percentage of number of fields occupied by each crop group in the area of interest (2016).

Interviews

In the 1970s polyculture (strawberry, peach, cherry, tobacco) and animal husbandry (goats and cows) were predominant in the northern part of the Drôme region. In the 1980s, the fields began to enlarge through informal consolidations within families due to the lack of succession and as the result of the increased availability of mechanization and chemical inputs that facilitated farming on larger areas (farmer 1, farmer 3, Anneyron representative).

During the 1990s, due to a repeated occurrence of late frosts and the appearance of the Sharka virus, many peach orchards were replaced with other perennial species (apricot and apples, between 1995 and 2000), or converted into arable land. The threshold for mandatory removal of the orchard was 10% of infested trees. Furthermore, the Spanish peaches were highly competitive. In this period the tobacco and animal husbandry also reduced (farmer 1). Nowadays there is an overproduction of apricot in the region (farmer 3). Strawberries are also an important agricultural product, although recently, due to the invasion of the *Drosophila suzukii* fly, the production is declining, or done in greenhouses (farmer 2).

In the area of interest of the study, two zones can be currently distinguished based on the land use: west from Coinaud in Saint-Rambert-d'Albon and east from Coinaud, in Anneyron (see fig. 1, 2, or 3). The two zones have known a similar evolution, yet the first zone is more oriented towards fruit production and the second one is dominated by cereal production.

In the former zone, agricultural land has gotten larger from an average of 30 ha per farm in the 1980s to more than 100 hectares per farm nowadays; in the second zone, farms have gone from 50 hectares to 300 hectares (farmer 1, farmer 2, farmer 3).

In terms of urbanization, the zone west from Coinaud (refer to fig. 1, 2 or 3) has had an urbanization tendency recently compared to the zone east from Coinaud (Anneyron representative). Nowadays, the SCoT set a limitation of the urbanization in the core of the towns rather than a spread distribution over the area.

Biodiversity

The farmers confirmed that formal (“*remembrements*”) and informal land consolidations in the region have led to increased field size and the removal of many hedgerows and field margins (farmer 1 and 2). *Remembrements* have been particularly important in the Anneyron area.

The main threat for biodiversity, and the Ortolan as seen by the LPO, is the homogenisation of the landscape and the reduction of diverse edges between different fields (LPO interview, 2017). According to observations, the LPO concluded that the Ortolan uses bare ground for feeding, strawberry fields for nesting and any available high place for singing. The Drôme Ortolans seem to favour telephone wires and poles (instead of trees) for singing (LPO, see fig. 8).

Finally, another threat, for the biodiversity in general but potentially also for the Ortolan, is the use of pesticides (LPO).

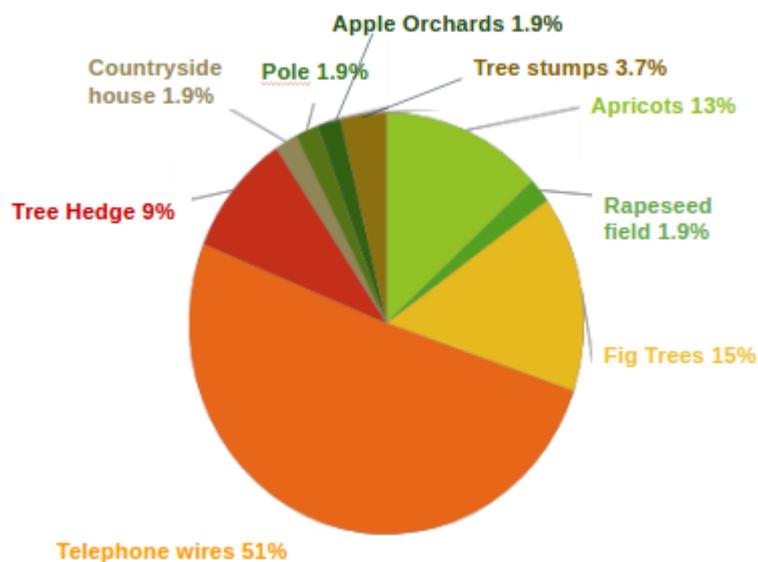


Figure 8 Singing post preferences of male Ortolans within the zone of interest (Modified from: LPO presentation, 2017).

Stakeholder relationships

The most important actors identified in the Drôme region, directly or indirectly involved in determining the future of the Ortolan within the area of interest, are: the **SCoT**, the **Agricultural Chamber**, the **LPO**, the **farmers**, the **DREAL** (*Direction Régionale de l'Environnement, de l'Aménagement et du Logement*), regional

hunters' associations, the **Communaute de communes**, the **town halls**. The actors are involved in different relationships (see Fig. 9), which are a consequence of the priorities of the different stakeholders. Promotion of the conservation of the Ortolan is advocated mainly by the LPO. The Agricultural Chambers prioritize agricultural production and the conservation of agricultural land. The Agricultural Chamber and the LPO are linked through an official collaboration agreement, but this is not respected by the Agricultural Chamber. A mediator is identified in the SCoT, which aims to converge protection of natural elements, and control urbanization and agricultural land use. The SCoT is in charge of maintaining a regional coherence of the landscape, the Communaute des communes decides where to address the economic development of the area, whereas the municipalities decide the use of the land (e.g. construction, agriculture).

The SCoT receives directives from the DREAL, but the relationship appears mostly conflicting, due to procedures concerning rare species' conservation. The hunters' associations have gained power in the Drôme region due to favouring by the regional right winged party, and finance farmers to sow winter crops in order to attract more wildlife to hunt. The attraction of wildlife in the area is of interest to the LPO, although the final objective is contrasting with the one of the hunters. There is an opportunity for collaboration, however the relationship between the two organizations remains prevalently conflicting at the moment.

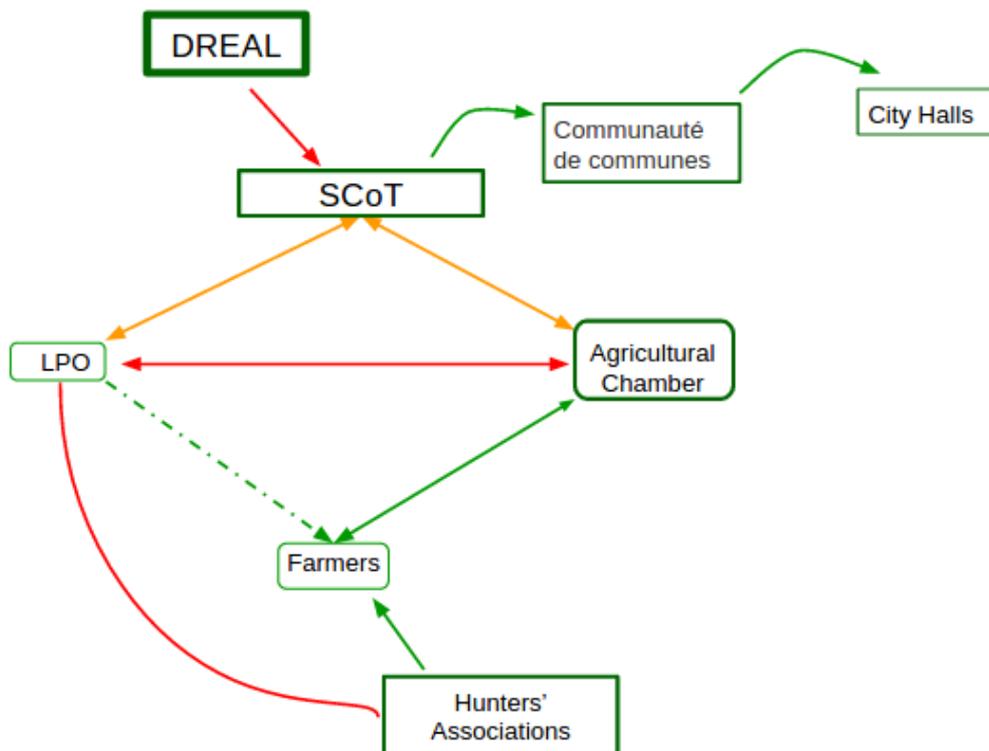


Figure 9 Schematic representation of the known actors involved in the zone of interest within the Drôme region. Color code of the arrows: red= antagonistic/uncollaborative relationship; green= synergistic relationship; orange= uncertain or possible. The borders of the actors' boxes determine the power they have in the decision making within the area: the DREAL has the most power, whereas the LPO and the farmers have the least power. The dashed line indicates an informal relationship, while the solid lines indicate formal relationships. Some relationships are identified as unidirectional, either for hierarchical reasons (Imposition of regulations from the DREAL to the SCoT) or because the relationship is mainly favoured or requested by one actor.

Discussion

To what extent do agricultural and urban intensification play a role in the modification of the landscape, thus affecting the presence of the Ortolan bunting in the area?

The agricultural landscape in the Drôme has known a general shift from small diversified fields, to large monocultures of cereals. The soil conditions were more suitable for fruit production west from Coinaud, favouring orchards and vegetable production; nowadays fields are also kept for speculation, to then sell them at a higher price for construction (Farmers, Anneyron representative). East from Coinaud, the transition to industrialized agriculture has been more prominent due to the land consolidations (“remembrements”), as a means to adapt to the intensifying agriculture and to manage land involved in heritage processes. These land mergings have been easier east from Coinaud as the orchards were less present, facilitating the exchange of fields of arable land.

Remembrements are a way to assure that each farmer has the same area of land after an installation of a natural element (e.g. hedges) or urban element (e.g. roads)- which occupies part of the farm property-, consequently reducing the fragmentation of the agricultural land use and creating a more homogenized agricultural landscape. Consolidations which were done through the municipalities have included the obligation for farmers to replant the semi-natural elements that had been taken away to merge two adjacent fields, although these have been often planted on roadsides, giving the hedgerow less ecological importance than if it were more embedded and connected to the surrounding natural landscape (Anneyron representative). Informal consolidations between families or family members did not consider this element, hence hedges have mostly not been re-planted in these cases.

A contribution to the landscape change has also been the 1992 PAC reform, which resulted in the massive transformation of grassland into cereal fields. The reform shifted the compensation from an intervention price strategy on cereals, i.e. the threshold price artificially maintained by the government, to compensatory payments per hectare (SENAT 1998) to large farms with cereals and oleaginous crops, for setting aside part of the land, therefore supporting large crop areas and cereal production (Agreste 2000).

The homogenization of the agricultural landscape and the reduction of semi-natural elements, had an impact on local biodiversity by reducing the connectivity within the landscape and enlarging the presence of unfavourable habitats, represented by substitution of meadows with intensively managed cereal fields. As for the Ortolan, it is possible that the elimination of hedgerows and natural elements caused by land merging may not represent a threat for this particular species. Although the positive effects of hedgerows on other wild species has been widely confirmed (Bond 2003). Male Ortolans have been found to prefer anthropic elements (e.g. telephone poles) to sing, as they can be heard from a greater distance due to the height of the posts (LPO).

The main threat derived from consolidations combined with the intensification of agriculture is thought to mostly derive from the disappearance of diverse edges between fields, implying the lack of diversity between cultures, thus limiting foraging and nesting habitats (Vickery and Arlettaz 2012). Moreover, the shift from winter cereals to spring cereals has also posed a threat to the Ortolan as the bird arrives in the area in spring, leading to scarce food sources as the crops- predominantly occupied by maize and sunflower- are not synchronized with its feeding needs.

The females in particular, need diverse sources of food in order to properly feed the chicks in the early summer. The Ortolans are highly mobile, but the males have been reported to forage relatively close to the females during the mating and nesting season (LPO), thus high heterogeneity during this time is important in order to not force the birds to cover more extended areas, with the risk of losing the control on the potential or established partner.

When considering agro-biodiversity, particularly important are the open-field strawberry fields within the landscape. According to Agreste, the total surface of strawberries was deemed to increase in the south east of France by 11% in five years in 2016, while in 2017 the surface change was expected to increase by 10% in five years (Agreste Conjoncture 2016, 2017). Nonetheless, these trends comprise the total surface of strawberries, without distinguishing between open field and greenhouse production, particularly important with respect to the needs of the Ortolan. In the area of interest within the Drôme, the current presence of strawberry fields within the agricultural land use could not be assessed using the qGIS tool. Through interviews with the LPO and farmers, it appears that if on one side open field

strawberries are particularly relevant for the Ortolan's nesting, on the other side they are disappearing or being grown in glass or plastic greenhouses, due to the aforementioned threat of the *Drosophila suzukii* fly and need to increase production to compete with foreign producers. The decrease in strawberry fields is deemed as the main threat to the presence of the Ortolan in the northern Drôme area, as the presence of bare ground between the strawberry rows represents an ideal habitat for nesting and ground foraging. Nesting in this habitat could represent an adaptability to lower habitat quality, as it was shown that other European Ortolan populations have shifted nesting from winter cereals or meadows to potato fields (e.g. Fonderflick et al. 2005, Deutsch and Südbeck 2007). With the expected decrease of open air strawberry production, the adverse habitats for the Ortolan will decrease, limiting its ability to adapt. Together with the scarce food sources and the intensive large scale agriculture, the future of the Ortolan within the agricultural landscape, although uncertain, is expected to follow the general decline trend observed in other European countries.

In regards to urbanization expansion, this greatly modifies the area by eliminating heterogeneous elements that are typical of more natural and agricultural landscapes and becoming more and more homogeneous. This is a threat for conserving biodiversity, however, between agricultural intensification and urbanization expansion, agricultural intensification has been reported to create "biodiversity deserts" (LPO) which along with not being suitable habitats for conserving biodiversity, cannot support the food chain of local biodiversity. Thereby, the "green" areas within the cities can sometimes host more biodiversity than large monoculture fields that represent food deserts for the Ortolan and biodiversity in general (SCoT, LPO).

An important factor that strongly threatens the disappearance of natural elements and the fragmentation of the area in the near future is the implementation of the PANDA (Parc d'Activité Nord Drôme Ardèche) project, a new highway exit that will make use of 300 ha and is intended to be an industrial zone in the west of Coinaud. While that is the trend in west of Coinaud, the east part has maintained a more conservative policy with respect to urbanization. The effects for biodiversity, and especially for the Ortolan, of the construction of the PANDA are very unexpected, since very little is known about it yet, however, even if any infrastructure project takes

into account biodiversity habitats, it cannot be denied that a project of this caliber could have consequences for the future of this bird in the study area and biodiversity in general.

As for urbanization development of the towns, the SCoT has put a limit to the urbanization projects, with the aim of concentrating private houses in the center of the towns, as opposed to more peripheral zones. This could be seen as a positive measure; however, this might cause the towns to expand from one point (the core of the towns) and leading to more homogenization, which is the main factor causing the disappearance of the Ortolan bird and biodiversity in general. These are clear examples of how the urban expansion will occur progressively more in the upcoming years, taking with it lands dedicated to other purposes.

Thus, the first hypothesis can be partly confirmed. Indeed, landscape homogenization is a potential threat, produced jointly by the action of the agricultural intensification and the growth of the urban areas. However, we cannot say to which magnitude is landscape homogenization affecting the conservation of the Ortolan population, but that it plays a crucial role on its presence in the area. Although, the loss of the (semi)-natural elements is not a threat *per se*, it should not be disregarded because there is other biodiversity in the area which needs to be protected. The major threat to the Ortolan is represented by the expansion of urban and industrial areas west from Coinaud, and by agricultural intensification and loss of agrobiodiversity east from Coinaud.

How are the different stakeholders involved in the conservation of the landscape, influencing its potential to conserve biodiversity and Ortolan in particular?

The LPO is the primary actor in the study and conservation of the Ortolan. Although other actors are aware of the presence of the bird in the area, (e.g. farmer 2, Anneryon representative, SCoT) it is not their priority to conserve this species.

The LPO has observed the Ortolan for the first time in the region in 2009 (during assessments for the French National Birds Atlas 2009-2013), the latest and only extensive hearing on the area of interest was conducted in 2017. Unfortunately, the LPO is unable to determine if the bird was present in the area prior to 2009, excluding

the possibility to determine population dynamics and assess if the population is at risk or not.

Given the uncertainty regarding the evolution of the population of the Ortolan over the last decades and the lack of information about the habitat preference, it is rather complex to assess if the bird is in danger and therefore needs protection/conservation efforts or if it is already well adapted to its environment.

This lack of knowledge is halting the cause of the LPO, which already struggles to involve the other local actors since it is a relatively small organisation (500 staff in France). Moreover, it receives “little” funding, compared to more powerful lobbies like the hunter associations (16 000 hunters in the Drôme only) who have an economic incentive from the region to apply their measures of interest, such as paying farmers to sow cover crops in the winter, which attracts more biodiversity for hunting purposes.

Therefore, the only means of protection of the Ortolan for the LPO is the sensibilisation to farmers based on voluntary action, dialogue and cooperation. Farmers are usually willing to participate if the measure they have to take is cheap and not time consuming like installing a nesting box, or waiting 1 or 2 more weeks before harvesting a parcel around a nest. Planting hedgerows can also be considered for the most motivated farmers, although it is not a priority measure for the conservation of the Ortolan. The actions of the LPO are not sufficient, as it's not a powerful enough actor to make the conservation of the Ortolan a primary objective in the area. The conservation of the Ortolan, among other species of interest in the area, is mainly determined by the involvement of each stakeholder in this project and how the stakeholders interact with each other in line with their objectives. The power relations between the different actors play an important role in determining how the landscape is changed and the effects of this on local biodiversity.

The agricultural chamber is supposed to support the LPO in this project but it is not providing any formal support, due to lack of interest in the LPO's work. The SCoT is more involved since they fund the LPO to carry out hearings of the Ortolan, as part of their legal obligation to take environmental studies in account, while supporting economic oriented projects, such as the PANDA. To support its environmental involvement, the SCoT intends to create a “Maison de la Biodiversité” to have permanently local technicians to assess biodiversity. Yet, its role is to give a coherence at a territorial scale, therefore it has to take in account every stakeholder

and in this discussion, farmers (through the agricultural chamber) and the local municipalities seem to have the most power since they will be directly affected by the economic development projects of the SCoT. A project of the caliber of the PANDA could be determining in shifting the power relations within the area, as it could occupy areas of interest for both the LPO and the Agricultural Chamber; thus, where it will be finally implemented will determine future relationships between the actors, possibly favouring the LPO and giving the association more power in the region.

Thus, the second hypothesis is partly confirmed, the LPO is the main actor involved in the Ortolan conservation. The Ortolan is known by important actors such as the SCoT, although it is too early to say if the projects in the area or changes in the landscape will be done taking into consideration the Ortolan due to ongoing discussion between the stakeholders. The greater voice of the agricultural chamber and the industrialization trend occurring in the Drôme, near the Rhône are likely to outweigh the Ortolan's protection concerns of the LPO, applying more broad non-targeted biodiversity conservation projects.

Conclusions

The landscape of the study area has suffered a shift from 2007 to present days, determined mostly by the homogenization of the agricultural land use, which could potentially affect the conservation of the Ortolan bird in the Drôme area. However, concerning this particular species, much information is still unknown, including its specific habitat requirements or if it is an endangered or threatened species. More means need to be deployed for studying the behaviour of the Drôme Ortolan in order to identify appropriate measures to protect the population and include it in a more comprehensive biodiversity conservation plan. Without more specific information about this bird, it is difficult to involve enough actors to effectively engage in the maintenance of a heterogeneous landscape for its conservation. Collaboration from important local actors is key in this sense, as they can financially support studies on the species and promote its conservation within the landscape to a larger audience. Agri-environmental schemes could be implemented by offering direct payments to the farmers who agree to apply specific measures to recover biodiversity. Some actions

could include diversifying the production favouring the open-air vegetable and small fruit production, setting aside land to be used as improved fallow (with specific sowing mixes to support spring and summer bird feeding) focussing especially on diversifying field margins. A more specific action would involve compensatory payments to the farmers for maintaining open-air strawberry fields, as reimbursement for the losses due to the possible *Drosophila suzukii* damage and lower yields compared to greenhouse production. Indeed, the difficulty of applying such measure lies in the specificity of its objectives, but if it introduced as part of a more holistic action plan to conserve wild and agricultural biodiversity, and promoted by important regional actors, (e.g. the DREAL) it could play an important role in maintaining the Ortolan within the region.

Collaboration can also be contemplated between the LPO and the regional hunters' association. As hunters are already paying farmers to sow cover crops in the winter to attract wildlife to hunt, they could extend the conservation of specific farmland areas even beyond the hunting season, favouring specific meadow habitats important for the Ortolan and other wildlife. Indeed, the collaboration seems unlikely, but for the purposes of conserving the Ortolan it would seem reasonable as the bird is not present in the area during hunting season and more wildlife might develop this way compared to what is present only during the hunting season, thus complying to the goals of the LPO of preservation of wild species.

An interesting reflection that can be applied to the urbanization expansion and agricultural intensification debate is that cities can sometimes host even more biodiversity than large monoculture fields when they remain unused. Indeed, agriculture is not the problem *per se*, it is the way that its management has progressed throughout the decades. As for now, convincing farmers to diversify their production without being clearly able to identify the local Ortolan birds' needs, does not seem like a very reliable measure. Although, a land sparing approach might be more feasible, allowing for intensive agricultural production and urbanization in some areas, and zones dedicated to host wildlife in others. On these lines, keeping the cities more concentrated with the creation of "green" areas could also be a reasonable measure until more research is done.

Multiple, parallel actions need to be implemented in order to maintain a landscape which allows for the balanced presence of agriculture, wildlife and economic development.

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Annex 1

Interview questions

Farmers

Current land use

How long have you been living / farming in this region?

How agriculture evolve so far? How will it be in the future?

What are you and your neighbours growing? (How diverse is the cropping system now?)

Why did you choose this type of agriculture / variety?

Are you organic or conventional?

Biodiversity

Do you have semi-natural elements on your property that you leave without management?

What were the changes in **agriculture** in the last 10, 20.. years? Perspective for the future?

=> did you observe an impact on local biodiversity?

What were the changes in **landscape** in the last 10, 20.. years? Perspective for the future?

Did some consolidation ("field merging") happen , or will happen in the future ?

=> did you observe an impact on local biodiversity?

Do you know the Ortolan bird? (show picture) Or about the conservation project?

Future land use

What crops did you have this year? Where they irrigated? Do you already know what possible crops you might put next year?

Do you plan changes in your farm? What are the future plans for your farm?

Did you hear about plans of urban expansion? Are there investors interested in this land?

Is the urban pressure is strong?

Natural Conservation Association

Biodiversity

Is there a high biodiversity in the area? How does it evolve last years? how does agriculture impact biodiversity?

What are the landscape elements necessary for the Ortolan habitat?

State of conservation

What legislation on conservation are in place for this area?

Is there a conservation plan for the Ortolan?

What could be issues of landscape change in the future?

Cooperation

Are you working with farmers to explain biodiversity issues? If yes, what are recommendations?

Are you working with Chambre d'Agriculture?

Are you working with other stakeholders? Which? What could others do to help conservation concerns?

If you were one of these other stakeholders what would you do / improve?

Chambre d'agriculture

Do you have data about the land use / change of land use? (especially about strawberries and orchards)

What are the trends in land use?

What are the biggest challenges for farmers in this region? pro and con?

Are you involved in the conservation of Ortolan? Are you in contact with the conservation association?

If yes, how do you work with farmers on conservation issues?

Do you see young farmers to install / take over farms here? What is the age structure of the farmers here?

Which zones are easier to improve on agroecological point of view?

Which initiatives for agroecology are already in place / implemented?

Municipality Saint-Rambert-d'Albon and Anneyron

How does the landscape and urbanisation evolve last decenies?

Do you participate into edge maintenance?

Do you observe increase in population? Are now companies installing here?

What are the development plans for your community?

Do you plan to transform agricultural land to building land?

Are you in contact with nature conservation associations? Are you aware of conservation efforts for the ortolan? If yes, in how far is the municipality involved?

Annex 2

Area in which the Preliminary landscape reading was performed. The area is found in the Saint-Rambert-d'Albon municipality, between the A7 highway and the city of Coinaud. One hearing point is found between the Rhone river and the highway.

