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Impact of Game Crops Intensification and Hunting Management on Red-Legged Partridge

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In the French Mediterranean region, large cultivated areas have been abandoned. Matorrals (shrublands) then woodland successional stages replace the mosaic of habitats, favourable to the red-legged Partridge *Alectoris rufa*. An agro-environmental operation, consisting of development of areas devoted to game crops, allowed the reopening of these landscapes on the studied site. This was followed by the development of a hunting plan and operation. We tested the impact of these managements on the dynamics of the red-legged partridge abundance. Our research showed that the limitation of hunting bag has a strong impact on the densities of partridge in spring, whereas habitat managements act favourably on the success of the reproduction and recruitment.

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Key words: *Alectoris rufa*, breeding success, brood size, game crop, habitat management, hunting management, French Mediterranean region, red-legged partridge, population dynamics, rural abandonment

Introduction

Agricultural declines have had a deep impact on the Mediterranean region of France: the progressive abandonment of vineyards and olives, pastures or gathering in scrubland, combined with rapid urbanization, has gradually transformed the Mediterranean landscape. This modern landscape, primarily comprised of mosaics - hills or plains, has resulted in matorrals, forests and fallow lands has extended, reducing habitats favourable to the species related to the open landscapes or edges for typically Mediterranean species, such as red-legged partridge. This important game species is representative of the Mediterranean landscape and is an important economic and conservation flagship of the region. These extensive modifications of its habitat constitute certainly one of the causes of its decline (Aebischer and Potts 1994, Ponce-Boutin et al. 2003b).

For the maintenance of partridge populations, various techniques of management have been developed, but more hill (Ponce-Boutin et al. 2003a) rather

than in plain landscaped (present study). The objective of this project was to test if management of abandoned vineyards could influence the population dynamics of red-legged partridge. In addition we tested the effects of a hunting management program.

Study Area

Located in the Mediterranean area of southern France, the commune of Pailhès (600 hectares) was almost exclusively a wine making area. From 1975, subsidies were distributed in order to decrease production of lower quality wines. In 1994, at the beginning of this study, the vineyard accounted only for 71% of the agricultural area. Much of the abandoned vineyard was in various stages of plant succession, including waste lands, matorral (15%) or wood (2%). Finally, 6% of the abandoned grounds remained cultivated, primarily with cereals.

Methods

The farmer's association of Herault, the Hunters Departmental Federation of Herault and the Na-

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tional Hunting and Wildlife Agency joined in 1994 to work on a project of agro-environmental measurements. The project was divided into contracts, helped over 5 years and suggested to farmers the creation of game crops (with sowing every 2 or 3 years), or the maintenance by crushing in some areas of 13 communes. For the commune used in this study, Pailhès, management was only applied to approximately 200 ha, the other part remained as test-control (363 hectares). The remaining area was occupied by the village and some private properties. Land use was controlled on its whole territory. 48 parcels thus were the subject of a contract, a total of 15.1 hectares, distributed on the managed portion. Four time periods created based on habitat managements in place: a first phase prior to the implementation of the measurement prior to 1994, a second phase of management implementation (1994 to 1998), a third phase of transition (1999-2000), where the majority of the game crops were converted into corn (Figure 1), and finally a fourth phase, since 2001, when no management was taking place.

In addition, as of the hunting season 1994-95, a hunting plan (limitation of the number of partridges to be hunted) was developed and where reductions of harvest were reduced to a take of 4 partridges per day. It was established in its final version from the autumn 1996. We distinguished 3 phases: no bag limit (hunting seasons 1992-93 and 1993-94), followed by the phase of the hunting plan set up (seasons 1994-95 and 1995-96), and finally implementation phase of hunting management starting in autumn 1996. A sector of 55 ha within the control area remained a hunting preserve throughout the period.

The number of partridges present in spring on each of the three zones was estimated annually during 1993-2006 (except 2000 and 2005) by using 9 drive counts. Reproductive success was estimated each year between 1994 and 2005 by the number of broods per adult and the average size of the broods on the managed and control area (except reserve) by means of the method of sampling of coveys (Office National de la Chasse et de la Faune Sauvage 2004).

We tested the impact of the various manage-

ment techniques, applied year N , on the density and the success of the partridge reproduction occurring the year $N+1$. The analyses consisted in successively testing the effects "hunting management" and "habitat management" by a univariate general linear model (two-way ANOVA) for each variable. In order to obtain the homoscedasticity, the variable density adjusted using a square root transformation.

In the experimental plan (figure 2), an observation represents a sector (managed area, control area out of reserve, reserve) $\times$ year. We used the measure of balance for one-way design $y = \tilde{n}/\bar{n} \leq 1$ where $\tilde{n}$ and $\bar{n}$ denote the arithmetic and harmonic means of the group sizes, respectively (Ahrens and Pincus 1981, Ahrens and Sanchez 2006). $y = 1$ if the design is balanced; the closer y is to 0, the more unbalanced is the design. We found that all the one-way designs are only slightly unbalanced ($y < 0.83$). Nevertheless, following Shaw and Mitchell-Olds (1993), when computing the two-way ANOVA with habitat management and hunting management as factors we used the so-called Type III sum of squares for performing the tests. ANOVA computations were done using SPSS 14.0 (SPSS Inc., Chicago IL).

Results

Spring density of red-legged partridges

The abundance estimates in spring of red-legged partridge populations revealed a total of 1245 birds during 1993 and 2006.

Intensification of game crops surfaces did not have a significant effect on the mean density in spring ($F = 0.526$, 2 df, $P = 0.60$), contrary to hunting management ($F = 5.968$, 3 df, $P = 0.003$). Indeed, following the installation of a bag limit, the partridge density doubled (increasing from 6.7 pairs/100 ha to 13.6 pairs/100 ha (Table 1). On the reserve, the average density appeared intermediate.

Number of broods per adult in summer

Surveys carried out during 1994-2005 outside of the hunting preserve revealed a total of 395 broods for 1198 adults.

It seems that neither the mode of hunting man-

agement ($F = 1.827$, 2 df, $P = 0.19$), nor the habitat managements carried out on the landscape ($F = 1.768$, 2 df, $P = 0.20$) influenced the average number of broods observed per adult (0.35 ± 0.13 SE).

Average brood size in summer

We recorded 412 broods throughout the study, representing a total of 2,499 chicks observed.

Bag limit did not seem to have a significant effect on the average size of the broods ($F = 1.345$, 2 df, $P = 0.28$). Conversely, a habitat management did have an impact on brood size ($F = 4.133$, 2 df, $P = 0.032$). Indeed, following the intensification of the game crops surfaces, average number of young partridges per brood increased by 30% (Table 2).

Discussion

The sowing of new game crops done within the framework of agro-environmental measurement does not appear to influence spring density of red-legged partridge. Conversely, as was shown by Ponce-Boutin et al. (2006), the development of a hunting plan on the commune, using bag limits, had a clearly positive impact on the abundance of the species.

It is possible that the influence of the cultures on this factor was hidden by the shooting carried out on partridges. Indeed, this one follows from the proposals calculated from the densities recorded in spring and from the success of the reproduction in the summer preceding the hunting season. The number of produced young increases all the more the bag suggested, what tends to level the number of birds next spring.

However, it appeared that the installation of cultures instead of closed landscape such as matorral, waste lands and woods, seemed to have a positive impact on the size of the broods. In order to confirm this study, the experiment was maintained on the same commune by reversing the role of each sector, i.e. by establishing game crops on the sector initially in control. Jointly, the hunting plan continues.

Additional studies undertaken on these populations suggest that the fecundity of hens is not in question, but rather the survival of the young par-

tridges in their first weeks of life (F. Ponce-Boutin, unpublished data). It should indeed be considered the fact that surveys done during summer to estimate the success of the reproduction are carried out 6 weeks after peak hatch, i.e. once the young birds underwent the most extremely of mortality rate. These game crops seem essential for chicks because they would offer to partridges, sufficient food as well as cover protecting them from predators, allowing a better survival.

Management Implications

Within sight of the results of the diet studies on red-legged partridges, the optimum seems to be a mixture including at least a cereal for the seed contribution in summer and of leguminous plants for the insects, nitrogen which they fix and the cover they offer in addition of food (Bro and Ponce-Boutin 2004, Green 1984, Ponce 1989). These sowing could also be laid out in inter-rows in orchards or vineyards (see Borralho et al. 1999) or being established on the set-aside lands, of which impact on the more effective in the countries with less-intensive agricultural practices and higher fractions of land removed from production (Buskirk and Willi 2004). It would be necessary to seek a uniformed distribution on the territory in order to make them available to a maximum of broods. It is not recommended crushing them or making them grazed in spring or in summer; on the other hand, maintaining a pasture of maintenance apart from these periods can only be favourable (nitrogen contribution by dejections, limitation of the progression towards waste lands, matorrals or woods). Finally, they will not make objects of any weed-killer treatment or pesticide.

Habitat management must be implemented jointly with limitations on the hunting bag so as to make it possible the partridge populations to reach their optimum level of density. The higher those will be, the more the effect of the increase of success of the reproduction will be noticeable.

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