Characterisation of hunting management in red-legged partridge (*Alectoris rufa*) estates in Central Spain

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ABSTRACT

In Spain, hunting is spatially organized for administrative purposes in hunting estates. There are a variety of hunting estates depending on their creation aim, hunting rights ownership or conservation figures in the area, but private and social hunting estates are two frequent types of them and the selected ones for the work we are going to present here. Two controversial techniques to achieve harvest maximization (predator control and release of farm-raised partridges) and other management techniques barely known are studied here in relation to harvest. As a first step in the evaluation of the economic efficiency and ecological impact of various hunting management techniques, we evaluate whether red-legged partridge bags are related to management variables, or to other traits of the hunting estates. We studied 66120 ha distributed between 30 Hunting Management Units located in Central Spain. We found a large influence of having “intensive estate licence” (estates where releases and hunting are authorized all year long, without restriction on numbers released) on harvest. On non-intensive estates, the only significant independent variable related to partridge harvest was summer partridge density. Interestingly, we found that non-intensive hunting estates with occasional or regular autumn releases had lower summer densities than the ones without releases. Finally, on intensive estates the only significant variable related with harvest was the number of farm partridges restocked. It appears that the most efficient (ecologically) management techniques would be those destined to maximise the summer densities (i.e, protect wild stocks). The negative relationship between restocking and summer densities may be non-causal (more restocking is performed in those estates with lower densities), but it may be causal (releases having negative impacts on wild stocks), as has been suggested by other research. In relation to intensive estates, looking at the importance of releases, it would be interesting to evaluate costs in relation to benefits of releases.

In Spain, hunting is spatially organized for administrative purposes in hunting estates. These estates are areas where hunting rights belong, during a variable period, to a private individual or a legal entity, and where the owner of the hunting rights (private or public owner) is responsible of observing the laws. There are a variety of hunting estates depending on their creation aim, hunting rights ownership or conservation figures in the area, but private and social hunting estates are two frequent types of them and the selected ones for the work we are going to present here.

Two of the most controversial techniques in Spain to achieve harvest maximization are predator control and restocking (release of farm-raised partridges), practices that could negatively affect wild populations of game or non-game species, but for which the effects at large scale, in terms of management (effect on hunting bags) or ecological effect (on wild stocks), have not been evaluated with reliable data. The frequency or effects of other management techniques and the economical flows in hunting estates are barely known too.

The ultimate goal of our research is to evaluate the economic efficiency and ecological impact of various hunting management techniques. As a first step, we evaluate whether red-legged partridge bags are related to management variables, or to other characteristics of the hunting estates.

MATERIAL AND METHODS

As study unit we defined the Hunting Management Unit (HMU from now on) as a continuous territory with two traits: (1) it was allowed to hunt in the whole territory, and (2) it was managed as a unit (i.e., same management goals, coordinated management execution, same economical or otherwise profit evaluation by HMU manager), regardless of the administrative situation. The latter implies that one HMU may have two or more administratively different hunting estates.

We studied 30 HMUs located in Central Spain, mainly in Castilla La Mancha. Municipalities where they are located appear in figure 1. Whole study area takes up 66120 ha, with a heterogeneous distribution between HMUs (figure 2).

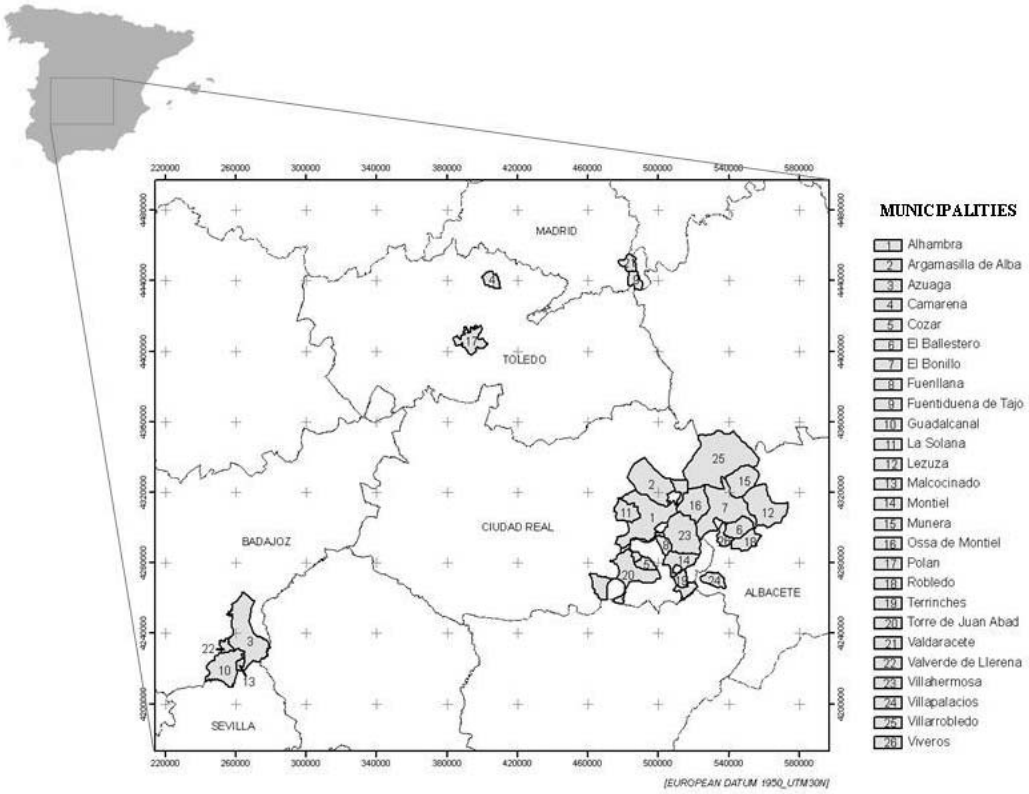

Figure 1: Municipalities where study area is located.

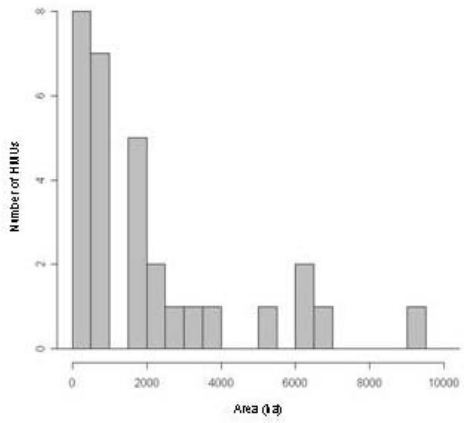

Figure 2: HMUs area histogram.

PARTRIDGE ABUNDANCE DATA

We calculated a summer partridge density index conducting one survey across each HMU. Surveys were carried out when most of the cereal had been harvested (in order to maximise visibility), but before farm-reared partridge releases were widespread (in estates with releases). HMUs were surveyed from June to August, 21 of them in 2006 and the other 9 in 2008.

We used point counts method (Tellería, 1986) and designed transects through whole estate, selecting good visibility points with a distance between each other of 750m. Partridge number and location was recorded on each point during 5-10 minutes by an experimented observer.

The density index was calculated as (1)

$$D_j = \frac{A_j}{B_j} \qquad (1)$$

Were:

D_j : Summer partridge density index for each HMU.

A_j : Sum of recorded partridges within a radius of 250m at each observation point.

B_j : Number of observation points used for each HMU.

HABITAT DATA

Habitat data were recorded during surveys as habitat type percentage within a radius of 100 m at each observation point. Habitat categories were defined with functional and management meaning for red-legged partridge.

To summarize habitat information we analysed structure of data variability using principal components analysis (Pearson, 1901; Hotelling, 1933).

The problem of using principal component analysis as independent variables in statistical models is their interpretation. To avoid mistakes because of a bad habitat characterization, we used principal components and original (raw data) variables, both in two different starting saturated models.

MANAGEMENT DATA

Management data were collected conducting a face-to-face questionnaire to each hunting manager, agreeing appointments by previous telephone calls. We obtained data of partridge harvest, predator control, farm partridge releases, hunting pressure, and possession of “intensive” hunting estate licence. Hunting estates administratively defined as “intensive” have no restrictions in relation to number or timing of farm-reared partridge releases. Non-intensive estates may or may not release farm-reared partridges, but if they do they have to do so within certain regulations (timing,

numbers). The overall number and frequency of partridges released is always smaller than in intensive estates.

All variables finally studied in this work (14 variables) and their mean value and standard deviation appear in table 1. We specify the results for intensive and non-intensive hunting estates separately.

Table 1: Mean value of every independent variable, for intensive and no intensive hunting estates.

VARIABLE	NON-INTENSIVE		INTENSIVE	
	MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION
Partride Density	2,288	3,180	1,598	1,284
% Woodland	31,282	21,304	25,881	33,926
Ratio Cereal_Stubble	1,941	3,744	0,027	0,041
Shannon diversity index	-1,661	0,404	-1,852	0,615
PC1	-20,024	23,470	-14,217	35,481
PC2	-14,626	12,407	-11,541	17,534
PC3	-6,616	10,160	8,987	12,761
Harvest (partridge/ha)	0,499	0,647	17,272	10,057
Foxes controlled/ha	0,190	0,513	0,321	0,273
Magpies controlled/ha	1,999	1,930	2,125	1,838
Hunting Pressure	0,168	0,157	0,212	0,091
Area (ha)	2010,920	2511,633	3169,400	1452,308
Partridges Released/ha	0,222	0,414	30,575	20,015

RESULTS

When we analyse partridge harvest using the whole sample, the final model obtained (AIC = 52,911) has tree significant independent variables: possession or not of intensive hunting estate licence (p = 0,0001), partridge summer density (p = 0,002) and number of farm partridges restocked (p = 0,049). Given the large influence of "intensive estate licence" found, we subsequently studied separately intensive and non-intensive estates.

$$\log(Harvest + 0{,}1) = \beta_0 + \beta_1 Density + \beta_2 releases + \beta_3 Intensive + \varepsilon$$

		P valor
β_0	-1,112	0,000
β_1	0,124	0,002
β_2	0,029	0,046
β_3	2,729	0,000

AIC	52,911

NON-INTENSIVE HUNTING ESTATES

On non-intensive estates, the only significant independent variable related to partridge harvest was summer density (p = 0,005), and the relation was a positive one. Secondarily, we found a weak significant effect of habitat on bags, with harvest being larger in estates with a higher proportion of woodland. There was no effect of any management variable on partridge bags (other than the effect that these may have on increasing summer density).

$$\log(Harvest + 0{,}1) = \beta_0 + \beta_1 Density + \varepsilon$$

		P valor
β_0	-1,053	0,000
β_1	0,117	0,005
AIC		48,052

$$\log(Harvest + 0{,}1) = \beta_0 + \beta_1 Woodland + \beta_2 Density + \varepsilon$$

		P valor
β_0	-1,349	0,000
β_1	0,010	0,078
β_2	0,110	0,007
AIC		46,435

Interestingly, we found that non-intensive hunting estates with occasional or regular autumn releases had lower summer partridge densities than the ones without releases (Fig. 3).

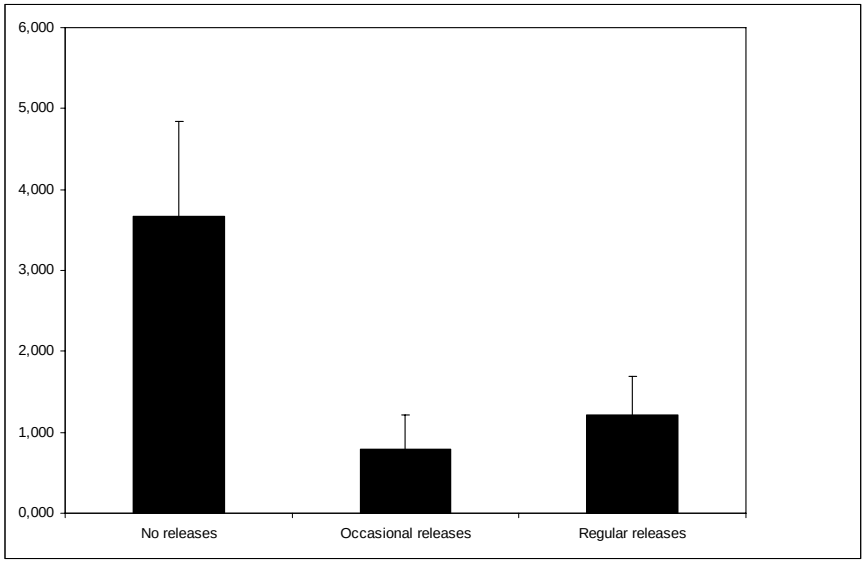

Figure 3: Mean (± SD) partridge density (partridges per observation point) in non-intensive hunting estates according to the frequency of farm-reared partridge releases.

INTENSIVE ESTATES

On intensive estates, the only significant variable related with harvest was the number of farm partridges restocked (p = 0,016), with a positive relation.

$$\log(Harvest + 0{,}1) = \beta_0 + \beta_1 releases + \varepsilon$$

		P valor
β_0	1,849	0,003
β_1	0,028	0,016

AIC	2,948

QUALITATIVE RESULTS

Figure 4 shows a qualitative summary of the results. We found two clear levels of management characteristics that influence on harvest. First level corresponds with intensive hunting estate licence, which defines two very different kinds of management and depends on human decision. On intensive estates, second level is composed by releases, which depends on human decision again. On non-intensive estates, second level is composed by summer density. It thus appears that the most efficient (ecologically) management techniques would be those destined to maximise the summer densities (i.e, protect wild stocks). The negative relationship between restocking and

summer densities may be non-causal (more restocking is performed in those estates with lower densities), but it may be causal (releases having negative impacts on wild stocks), as has been suggested by other research. It would be important to evaluate next which management techniques maximise the density and reproduction of wild stocks, as those would be the most efficient in terms of maximising bags in non-intensive estates. In relation to intensive estates, it would be interesting to evaluate an economic evaluation of the various techniques (harvest is much higher, but economic input in terms of birds released and trappers paid to maintain the fox populations down is also much higher).

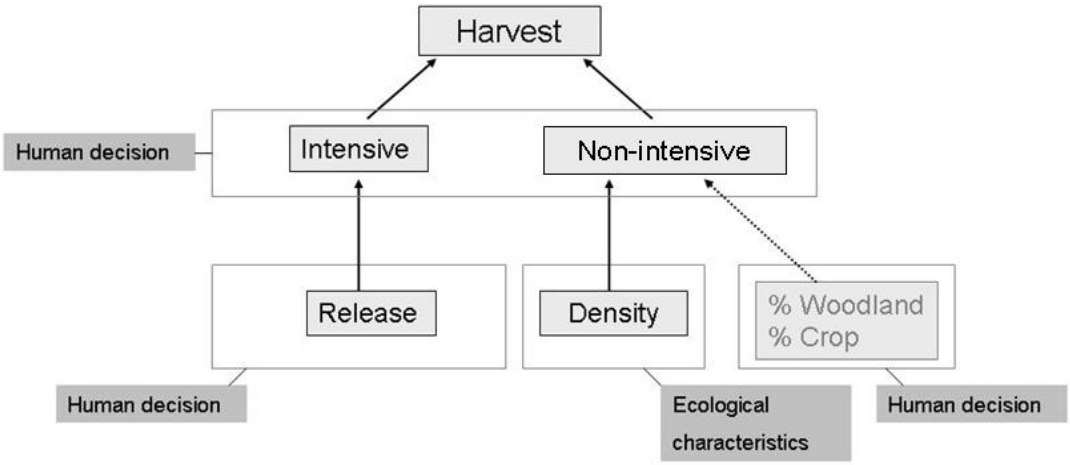

Figure 4: Qualitative summary of the results.

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