

Factors influencing pheasant *Phasianus colchicus* harvesting in Tuscany, Italy

Francesco Santilli & Marco Bagliacca

Santilli, F. & Bagliacca, M. 2008: Factors influencing pheasant *Phasianus colchicus* harvesting in Tuscany, Italy. - Wildl. Biol. 14: 281-287.

The common pheasant *Phasianus colchicus* is one of the most popular game bird species in Europe. In Italy their populations are commonly managed in order to increase the number of birds for the hunting season. For this reason we have analysed the effect of management strategies, such as hunting effort and land use and characteristics, on the number of pheasants harvested in 19 hunting districts (HDs) in Tuscany during 2001-2003 to detect the best strategies. Our results showed that, in addition to hunter density, protected area, number of wild pheasants relocated and year were selected in the final multivariate model which best explained the number of pheasants harvested. Restocking using wild pheasants captured in protected areas seemed to be of higher importance than releasing farm-reared pheasants. The key tool to sustaining the hunting pressure on pheasants seems to be correct management of the habitat combined with an adequate number of protected areas which can safeguard and produce wild pheasants which can then be captured and relocated or disperse naturally.

Key words: bag record, farm-rearing, game birds, land use, Phasianus colchicus, protected areas, wild population

Francesco Santilli & Marco Bagliacca, Department of Animal Production, University of Pisa, Via delle Piagge n. 2, I-56124 Pisa, Italy - e-mail addresses: fsantill@vet.unipi.it (Francesco Santilli); perdix@alice.it (Marco Bagliacca)

Corresponding author: Francesco Santilli

Received 10 August 2006, accepted 3 September 2007

Associate Editor: Kjell Einar Erikstad

The common pheasant *Phasianus colchicus* is the most important non-migratory game bird species in Italy, and consequently also in Tuscany. In 19 hunting districts (HDs) in Tuscany covering a total area

of 1,634,000 ha, 70,000-100,000 pheasants are shot each year by 120,000 Tuscan hunters. Furthermore, > 150,000 pheasants (estimated value) are harvested each year in private hunting areas within the same

districts. The private hunting areas cover a total area of 170,000 ha. Pheasant hunting is traditionally carried out using pointing dogs, whereas driving with beaters is uncommon, and only few private estates organise this kind of hunting.

In some HDs, pheasant management is based on protecting the species inside several hunting-free areas, each covering around 500-2,000 ha. In these areas, game birds are intensively managed by game-keepers using tools such as habitat improvement, supplemental feeding and predator control. After each hunting season part of the pheasant population in the hunting-free areas are captured and relocated to the hunting territories where the pheasant has disappeared or only occurs at very low density. Generally, pheasants are captured in cage traps baited with corn. Trammel nets are sometimes used, though less commonly, around small woodlands (Burrini et al. 1997). In the past, clap nets was the most commonly used method, but use of this method has declined because it is very labour intensive (Bub 1991). During 2001-2003, an average of 14,650 (SD = 2,424.9) wild pheasants were captured and released in the HDs of Tuscany each year.

In other HDs, releasing farm-reared birds is the prevalent method used to sustain hunting pressure. The birds are released in summer directly in the hunting territories or, in some cases, in small open top pens (100-300 ha) bordered by hunting-free areas where the pheasants are acclimatised. Releasing game birds after 31 August (three weeks before the hunting season starts) is not allowed. The birds spread outside the protected areas before and during the hunting season. In some cases, adult pen-reared pheasants are released in late winter, in order to enhance reproduction. An average of 125,140 (SD = 2,382.6) farm-reared pheasants were released in the HDs of Tuscany each year during 2001-2003.

Many HDs adopt both strategies (managing protected areas to produce wild birds and releasing farm-reared pheasants) combining them at different ratios.

The aim of our study was to evaluate the effect of the different strategies and of the land use and characteristics on the number of pheasants harvested per square kilometre corrected for hunting effort in the 19 HDs in Tuscany.

Bag records should be a good measure of game bird population abundance (Cattadori et al. 2003) and, thus, can be used to evaluate which management strategies and/or land characteristics are the best (Schmidt et al. 2004, Vargas et al. 2006).

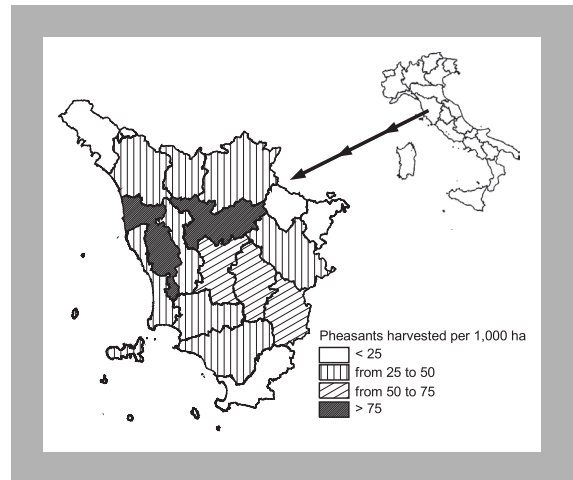


Figure 1. The 19 hunting districts in Tuscany.

Material and methods

The Tuscan Game and Wildlife Office compiled records of pheasants harvested in the 19 HDs in Tuscany during 2001-2003 by optically reading the hunters' personal game records (Fig. 1). The HDs have been active since 1996, and previous data were either not available or incomplete. HDs are very large game management units (average \pm SD: 108,300 \pm 54,500 ha) managed by a mixed committee consisting of public administrators, hunters, farmers and environmentalists, often supported by wildlife technicians.

The variables considered were (Table 1):

- Land use. The data were obtained by the Italian Institute of Statistics at the official web site of the Tuscan Regional Government (available at: <http://www.regione.toscana.it/cif/indicato/indsetto.htm#agr>). Land use was grouped into eight categories: woodlands, cereals, industrial crops, grass in rotation, grass and pastures, olive tree groves, vineyards and orchards. Surfaces covered by natural parks (national and regional (N = 4) located in wooded sites) and urban areas were excluded.
- The woodland edge ratio obtained by Corine Land Cover.
- The Shannon index as a measure of habitat diversity.
- The average farm surface (obtained by the Italian Institute of Statistics).
- The percentage of protected areas, i.e. every area located in the countryside where hunting is not allowed (protected for game management).

Table 1. Description of model variables used in the analysis of pheasant harvest record during 2001-2003.

Variable	Description
Woodlands	All kinds of woodlands
Cereals	Winter and spring cereals (wheat, barley, oat, maize and sorghum)
Industrial crops	Sunflower, sugar beet, soybean and colza
Grass in rotation	Grass and green fodder in rotation including grass, clover and lucerne
Grass and pastures	Grass areas permanently out of rotation and grazed pastures
Olive tree groves	Olive tree groves
Vineyards	Vineyards
Orchards	Orchards
Cattle	Cattle reared per square kilometre
Sheep and goats	Sheep and goats reared per square kilometre
Mountains	Territories > 700 m a.s.l.
Hills	Territories between 300 and 700 m a.s.l.
Plains	Territories < 300 m a.s.l.
Woodland edge ratio	Woodland edge ratio
Shannon index	Shannon index
Farm dimension	Average farm surface
Protected areas	Surface occupied by no-hunting areas managed for game species
Private hunting areas	Surface occupied by private game estates
Hunting effort	Number of hunters per square kilometre
Farm-reared pheasants	Farm-reared pheasants released per square kilometre
Wild pheasants	Wild pheasants captured in protected areas and released in hunting areas per square kilometre

- The percentage of private hunting areas (according to the Italian rules they can reach a maximum of 15% of the non-urban surfaces defined as 'agro-forestral surfaces'). The presence of private hunting areas is commonly believed to increase the bag records of the surrounding areas and include two types of estates: commercial estates, which can release pheasants also during the hunting season, and non-commercial estates, which are most common and which cannot release pheasants during the hunting season (after 31 August) and must respect a minimum game density index at the end of the hunting season (after 31 January). Since the private hunting areas are located inside the HDs, we wanted to verify if the presence of these areas, which are managed mainly by releasing farm-reared birds, had a real effect on the bag records of the surrounding areas (i.e. if pheasants dispersed outside their borders).
- The hunting effort expressed as number of hunters per square kilometre. These data represent the total density of hunters. Even though the pheasant is the most popular game species in Tuscany, we did not know how many hunters actually shot

pheasants or others species. For this reason, we preferred to use hunting effort as a variable rather than analysing catch per unit effort directly.

- The percentage of mountain (> 700 m a.s.l.), hill (300-700 m a.s.l.) and plain (< 300 m a.s.l.) territories (using the classification of Italian Institute of Statistics).
- The number of farm-reared pheasants released per year and the number of wild pheasants captured in protected areas and relocated in the hunting territories, released per square kilometre of HD. These data were obtained directly from each HD.

A multiple regression model was performed by stepwise selection in order to evaluate every possible effect of the variables on the pheasant bag records. We chose and entered regressor terms by forward steps (probability to enter 0.25) and then discarded them by backward steps (probability to remove 0.10). The hunting effort expressed as hunters per square kilometre was forced into the model. Variance Inflation Factors (VIF) were calculated for each predictor in order to detect multicollinearity. The VIF maximum value was 3.2 excluding serious multicollinearity risks (SAS 2002). Simple regressions between pheasant bags and the selected variables were also plotted.

Results

The multivariate model selected by the stepwise technique is shown in Table 2. In 2003, the number of pheasants harvested per square kilometre was significantly lower than in the two previous years.

No relationship between number of harvested pheasants and habitat traits was selected by the analysis. In addition to hunting effort, which was

Table 2. Regressors selected by stepwise analysis of the multiple regression model of pheasants harvested per square kilometre in the 19 hunting districts in Tuscany ($R^2=0.789$, $df=48$).

	Coefficient	SE	P
Intercept	-0.494	1.133	0.078
Regression terms			
Year (2001 and 2002 vs 2003)	0.487	0.185	0.011
Hunters per square kilometre*	0.419	0.053	<0.001
Protected areas	12.313	4.755	0.039
Wild pheasants released per square kilometre	0.636	0.319	0.055

* Entered into the model without forcing.

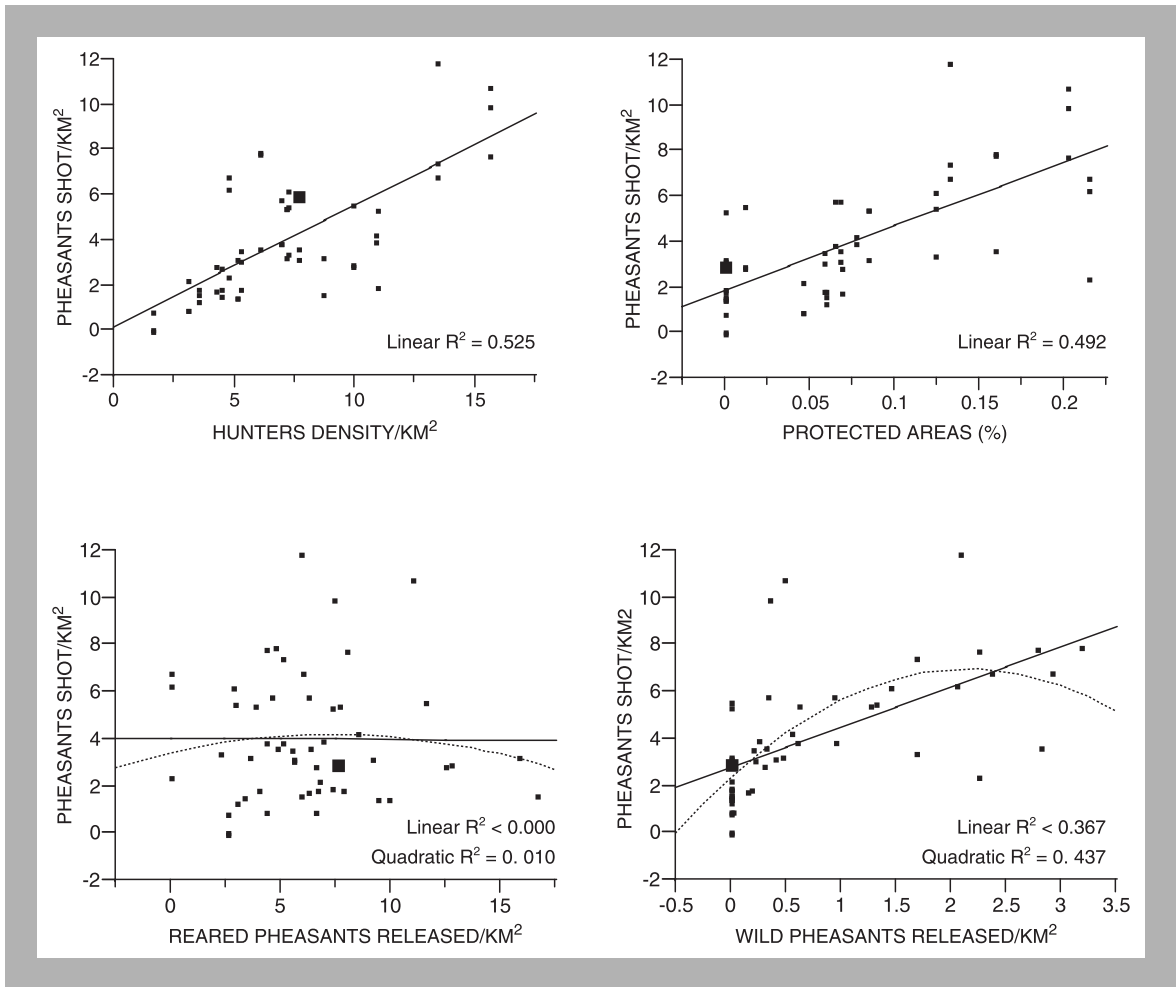


Figure 2. Regression functions of the density of pheasants harvested compared to hunter density and the other management variables. Unbroken lines show linear relationships and dotted lines show quadratic relationships.

selected by the final model without forcing, the only significant relationships (positive associations) selected were 'year' and 'protected areas managed for wildlife reproduction'. Although the number of wild pheasants captured in protected areas and relocated in the hunting territories per square kilometre was only of borderline significance ($P=0.055$), the model selected also this variable. Number of farm-reared birds and percentage of private game estates which regularly released hand-reared pheasants were both discarded by the model.

The relationship between hunting effort, protected areas, hand-reared pheasants released, wild pheasants relocated and pheasants harvested is shown in Figure 2. The relationship between wild pheasants relocated and pheasants harvested was fitted better by a square relationship than by a linear relationship.

Discussion

In Tuscany, spring and summer 2003 were exceptionally dry and hot which probably affected reproduction and chick survival negatively. In 2003, spring and summer mean temperatures were 1.9°C higher than the average temperatures during 1980-2002. Mean rainfall from May to August was 50% less than during 1986-2002 (Meneguzzo et al. 2003). Counting of the pheasants in the protected areas of the Siena Province showed that both covey density and dimension and, after reproduction, chick density was reduced during 2003 compared to 2001 and 2002. Covey density was reduced by 25.7% compared to 2001 and by 29.7% compared to 2002. Covey dimension was reduced by 7.9% compared to 2001 and by 23.7% compared to 2002. Chick density was reduced by 35.8% compared to 2001 and by

48.8% compared to 2002 (F. Santilli, pers. obs.). In 2003, pheasant density based on line transect counts conducted at the end of autumn was reduced by 9.4% compared to 2001 and by 25.2% compared to 2002. In addition, the pheasant density observed in the protected areas in the province of Pisa during 2003 (line transect counts conducted at the end of autumn), was the lowest observed during 1995-2003 (R. Mazzoni della Stella, unpubl. data). The observations carried out in a sample of the hunting-free areas (protected areas) perfectly agree with the reduction of the bag records observed all over Tuscany during that specific hunting season.

The lack of significant effect of the environmental variables is probably due to the fact that HDs in Tuscany are very large and are covered by various habitat types making it difficult to investigate habitat-species relationships. Therefore, the agricultural land use data obtained by the Italian Institute of Statistics are not very suitable for this kind of analysis as too many different kinds of crops are grouped together. Winter and spring cereals for example are included in the same category as well as sunflowers and sugar beets. The relationship of hunter density to hunting yield as shown in Figure 2 probably means that most of the Tuscan hunters are pheasant hunters.

At the larger scale of the HD, the positive effect of the presence of protected areas shows that pheasant hunting depends mainly on the wild populations protected inside the hunting-free areas. The farm-reared birds released each year have a small effect on pheasant harvesting and were discarded in the final model (see Fig. 2). The best pheasant yields are obtained by HDs that have a wider network of well-managed protected areas from which birds spread to non-protected areas outside their border and from which wild birds are routinely captured and relocated to the low-density hunting territories.

It is interesting to note that the relationship between the number of pheasants shot and the number of wild pheasants released (see Fig. 2) seems to be fitted better by a square relationship than a linear relationship, also with a reduced number of pheasant relocated. In fact, when pheasants are released in a habitat, they increase the population, and the 'limiting population factors' determined by the carrying capacity of their environment act according to the well-known non-linear (logistic) relationship.

The releasing of hand-reared pheasants, even if carried out using techniques to enhance acclimatisation (open top pen), probably has only a local effect

on harvest, and cannot compensate for the shortage of wild populations.

Pheasants that have been raised in a pen do not know how to avoid predators and consequently have very low survival rates in the wild, thus contributing only little to the harvest (Brittas et al. 1992, Hill & Robertson 1988b, Mayot & Biadi 1989). Anatomical, physiological and ethological differences, which are often observed between wild and captive-born galliforms (Dowell 1992, Anttila et al. 1995, Putaala & Hissa 1995, Bagliacca et al. 1998, Liukkonen-Anttila 2001, Millán et al. 2001, Santilli et al. 2002, Bagliacca et al. 2004, Santilli et al. 2004), lead to further reductions in survival and breeding success in captive-born pheasants when released in the wild. Finally, hand-reared birds are often more infested by intestinal parasites than the wild birds, reducing their fitness and consequently their survival (Woodburn 1995, Draycott et al. 2000, Millán et al. 2002, 2004). In a study, carried out in the province of Siena, pheasant droppings collected in areas where farm-reared birds were released, showed a higher prevalence of intestinal parasites compared to areas where only wild populations were present (Mani et al. 2001).

The missing effect of private hunting estates could have a similar explanation. Most of them tend to release large numbers of low-quality pen-reared pheasants that are shot by the hosts of the estates during the hunting season. The few birds that survive have poor reproductive success (Hill & Robertson 1988a) and so, the possibility that part of this population will spread outside the borders is much lower than that observed in the protected areas managed by the HDs.

The shortcomings of released hand-reared birds can be exacerbated by the fact that pheasant releasing often occurs in areas with poor breeding habitat (Sage & Robertson 2000), and the high densities of prey can be a functional and numerical response of predators to the high concentrations of birds at the release points (Kenward 1981, Robertson 1988, Gortázar et al. 2000). Poor performance may also be related to body condition in the nesting season. Robertson (1994) noted that released pheasants had lost 40% of their April body mass by the time they reached the brood rearing period.

Management implications

The strategy adopted by many Tuscan HDs (common in most of North Italy), consisting in creating

and managing a wide network of protected areas that provide pheasants by capture or by natural spreading, even if it reduces the hunting surfaces, seems the better choice to conserve the wild pheasant populations by reducing, in some cases, the request of hunters to release a great number of low-quality hand-reared birds. One HD in the province of Siena (which scored fourth place for number of harvested pheasants per square kilometre and first place for the number of protected areas) stopped releasing farm-reared birds in 2000. In this province the capture of wild pheasants in protected areas is a long tradition and has been documented since 1961 (Mazzoni della Stella 2000).

However, an important criticism of this strategy concerns the lack of a seasonal bag limit. Hunter behaviour remains insensitive to changes in population consistence and, in the long term, it should represent a threat for game bird conservation. A decrease in the number of wild populations due to habitat loss can be exacerbated by an uncontrolled hunting pressure as was the case for the grey partridge *Perdix perdix* in Italy during the 1970s (Matteucci & Toso 1992). In this case the 'creation' of protected areas was not sufficient to compensate for the losses caused by the combined effects of hunting and habitat change.

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