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Radiotracking of Pheasants (*Phasianus colchicus* L.): To Test Captive Rearing Technologies

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1. Introduction

The common pheasant is a species that comes from Asia: its natural geographical distribution includes the central western and eastern areas of Asia, from Caucaso to Formosa island. It has been largely introduced in Europe: in Italy since Roman age, in most of central western and eastern Europe between 500 and 800 B.C.; much later it has been introduced also in North America, Hawaii islands, New Zealand and in many other countries (Cramp & Simmons, 1980; Hill & Robertson, 1988; Johnsgard, 1986). In Italy the populations of pheasant are composed of hybrids coming from subspecies of "*Phasianus colchius*" part of "*colchius*" group, "*mongolicus*" and "*torquatus*" and from the two subspecieses of "*Phasianus versicolor*" (Brichetti, 1984). At the present, the nominal subspecies can be considered extinct in Italy: the last stocks, probably extinct or genetically contaminated by captive reared pheasants released for hunting purposes, survived until the end of last century in Tuscany, Basilicata, Calabria and some other small areas of the north Italy. It is difficult to establish the consistency of the Italian population of this species, because its distribution is not known and because generally data density are missing. The Italian population is constituted by more or less isolated sub-populations, preserved in Protected Areas (PA) and in few hunting areas. The groups of animals, which are in free hunting territories, cannot be considered real populations because these groups are not self-sustaining, but they are artificially re-constituted year after year by regular restocking with new pheasants, breeders or young ones, captive reared or wild ones captured in no hunting areas during the winter months (Santilli & Bagliacca, 2008).

1.1 Rearing technique of breeders

The breeders are selected by the farmers within the same hatching group on vivacity of temperament, origin, health, body development, size and feather condition. The weight and growing speed are so very important. The restocking, which is carried out by the farmers during January and February, is the formation of harems constituted by one male and 5-6 females, or colonies of breeders constituted by 8-10 males and 40-50 females. The breeders are raised in outside little ground pens (1 or more pheasant/sq.m) or in cages. The wild females lay approximately 15-20 eggs and the best farmed hens up to 80-100 eggs. The top of the output of the wild animals is recorded between the second and the third year of activity.

At the end of the reproductive season, the farmer who uses farm pheasants adapted to the breeding, eliminate his own breeders selling them as subjects "ready to be hunted". The farmer who uses breeding pheasants coming from the wild keeps them for 2-3 years. For this purpose the farmer chooses the most prolific and strong subjects and moves them into different and big aviaries, where they will recover their strength in view of the following reproductive season. The eggs of the pheasant, that have an average weight of 33 g., have a smooth shell and a changeable plain color from the light brown to the grayish - green. The reproduction is usually between March and July. The eggs are picked once - twice a day, and after the discarding of the defective ones, are preserved in special drawers or in simple bowls containing fine sand, at a temperature below 18°C - 20°C no longer than 7-10 days, in rooms, with or without air changing. Before being incubated the eggs are disinfected by formaline fumigation, ozone, UV rays, washing or nebulization of disinfectant. The incubation period lasts for 23-25 days and can be natural or artificial. In the natural incubation the eggs are hatched in varying numbers from 6 to 24, rarely by the pheasants, most of the times by hens. The artificial incubation is the most widespread and it is carried out in the same incubators used for poultry. The hatching takes average 24 hours and it is obtained in specific machines where the eggs are moved for the last 3 days of incubation. The pheasant chicks, hatched from the egg, remain 8-24 hours into the hatching machines, to totally dry up and to take a rest.

1.2 Rearing technique of growing pheasants

The breeding of the growing pheasants starts with the so called warm stage that takes about 3/5 weeks. The chicks are kept in well ventilated areas with a decreasing temperature from 37,6°C during the first 3 days, to approximately 21°C at the end of the third/fourth week.

In natural incubation the warm stage is carried out, by maternal warmth and in artificial incubation by artificial heaters, all over the shed or localized, the so called substitutes of the mother. For this purpose different equipment can be used: hot batteries (multi shelves heating cages in which 50 - 60 chicks can stay per shelf) or radiant heaters suspended on the top of simple control circles (circular box in wood, plastic net or other, till the capacity of 500-600 little pheasants, equipped with gas heater, electric heater or infrared rays lamps put to the right height to guarantee the correct temperature at the pheasant level). In this first stage, the animals are submitted to the most of the vaccinations and treatments. Around day 21, the chicks raised for the repopulating operations are submitted to a transition stage. The animals from internal rooms, where the temperature never goes down 21°C, start to go to external grass parks, shaded and sheltered from winds. After 30 days, the so called cold stage starts and the chicks are placed in big breeding aviaries (between some hundreds sq.m to a few hectares) in which they have to get used to the external environment. These aviaries are localized in flat pieces of land or with little slope, loose with good drainage and totally enclosed by wire mesh supported by chestnut cement poles. The complete feed, pellets or crumbles, are replaced, partially or totally by rations containing cereal grains, but also vegetables (e.g. salad, nettle, alfalfa and so on) to ensure proper fiber intake. When the pheasants are 60-70 days old can reach the territory of release. These pheasants, however, must stay, for a period of acclimatization (there they will prepare and exercise the functions required by free-living) in special aviaries with grass shrub and tree vegetation. These special aviaries must be prepared in the releasing areas.

1.3 Problems related to traditional rearing

The major problems associated with traditional methods of farming have arisen with the uncritical application of criteria of domestic poultry production to the rearing of game. This approach has favored the most domestic characteristics, the productivity in captivity is therefore greatly increased, both for direct selection and for the natural, often unconscious, breeding selection. Another effect was to reduce pheasant genetic variability that the original group of subjects had. In addition, the reproducers, have been identified among pheasants producing the best performance in captivity and, consequently, has increased exponentially the selection of subjects suitable for captive breeding. The genotype of the pheasants that were most productive in the rearing has thus spread rapidly in all breeders and from them into the wild. The farms became more intensive over time, as a result of increased demand for captive birds. Stocking density was greatly increased, especially through the use of devices that limited the aggressiveness, and the extensive phase, represented by the finisher period spent in the aviaries that replicate the wild environment, has worsened, reducing time and going to a progressive degradation of the environment. The arboreal vegetation, as required by pheasants roost for the night, was eliminated from nearly all the farms, because his presence made more difficult to manage the aviaries and did not allow to achieve low and cheaper structures. The herbaceous vegetation, suitable for the pheasants and planted inside the aviaries for food and mimicry, has been reduced since plant cultivation inside the aviaries is difficult and expensive; seeds suitable for pheasants has been almost completely abandoned and remained only the species useful for camouflage and natural weed of reduced interest for pheasant nutrition (Bagliacca et al., 1994). At the same time the high density and the constant use of farm breeders , with the culling of the subjects with imperfect plumage (pecked), determined the increase of the aggressiveness in the farm pheasants. Discarding the pheasants which were injured not only chooses the most aggressive animals, but also chooses those with the most beautiful plumage (bright and intense colors) (Bagliacca et al., 1996). Since it is known that the characteristics of the plumage are secondary sexual characteristics associated with the level of sex hormones, with this choice, preference was given automatically to animals more aggressive, which occupy the highest positions in the scale of the pecking order and which are the subjects with the greater performances (higher ovarian efficiency and deposition rates). The use of mechanical devices to control aggression has become so indispensable in almost all farms. The application of various models of antipecking devices (such as beak guards, blinkers, or ring-beak bite) completely alters the behavior during captivity. These systems in fact hamper the functionality of the bill, preventing contact with the object of the same pecking, counter the complete closing, or block the direct frontal view needed to catch or flight. Diets normally used in rearing, rich in energy, protein and low in fiber, differ from those that the pheasants can find into the wild. In captive rearing concentrate diets also allow the weaker subject to reach the reproductive age. Concentrate diets thus contribute to the selection of domestication or captive rearing, with clear negative consequences on the genetics of animals whose aim is the wildlife. Concentrate diets also do not allow a proper development of the caeca, necessary for the use of poor food in nature. The adaptation of the digestive system to the diluted diets (poor in nutrients and rich in fiber), typical of pheasants living in the wild, needs at least 30 days (Bagliacca et al. 1994, 1996).

1.4 Considerations on restocking of wild pheasants

The term restocking is defined as the release of individuals of a species still existing in the habitat, but with a reduced population levels. This type of intervention, using farm subjects,

is widespread in many areas of the Hunting Italian Districts (HTD) and in most of them is the only technique used for management. As summarized by Meriggi (1998), the use of captive animals have a wide range of negative effects:

- prevent the formation of proper management and conservative mentality of the hunters;
- require large investments of money, which could be used for the improvement of the environment;
- create high concentrations of individuals who may cause damage to the habitat, the predators attraction, consequent to the high concentration of pheasants can also affect natural populations and epidemics outbreaks can involve the releasing places;
- can cause the lost of the local populations which are genetically replaced by the captive reared animals.

Regarding in particular the captive pheasants, several studies have shown that these animals have a poor attitude to settle in the wild (Cocchi et al., 1998). In particular, a study conducted in a protected area in the province of Florence, with radio collared pheasants (Papeschi & Petrini, 1993), showed that the captive pheasants had a significantly lower survival rates than the wild translocated (from another PA), especially during the first month after release, while the wild translocated showed surprising survivals of about 80% even after 10 months from release.

1.5 The attempt to reduce the problems of restocking with captive pheasants

In Italy the first attempt to reduce the problem related to the release of farm pheasants was done by the Regional Agency for Development and Innovation in Tuscany Agriculture (ARSIA). Together with leading experts in the field, the Agency produced a "Guideline for the breeding of galliformes fitted for restocking and reintroduction" (Dessi Fulgheri et al., 1998). This work analyzed the different breeding techniques showing that the quality of the animal produced is deeply influenced by the different choices and technologies adopted by the farmers. Almost simultaneously data on an experimental trial conducted in Province of Siena, on the farm of Casabianca were published by Santilli & Mazzoni Della Stella (1998). These data demonstrated the possibility to use pheasants captured inside the PA as reproducers in the farm, although with some objective difficulties. Behavioral tests (Santilli et al., 2004) were also made on the progeny of these animals. The different origin of the pheasants subjected to behavioral tests showed differences attributable to the different genetic origin of the animals. Both experimental groups were in fact kept in the same rearing conditions from hatch. It appeared that natural selection, which acted on wild pheasant reproducers, was able to select a population of pheasants characterized by a different behavior than the population obtained from captive pheasant reproducers in which acted the farm selection. Although the behavior is a character modulated by the experiences (influenced by training) and received with the imprinting, the offspring of the farm pheasants reacted differently from the offspring of the pheasants catch into the PA. Another interesting study (Bagliacca et al., 2007), in some ways preparatory to the use of the wild pheasants as reproducers in the farms, showed that there are genetic differences between pheasants from different wild origin (PA) and different breeding farms. This latest study brings to the indication to use wild pheasants reproducers captured from no far areas to those where the offspring will be released. The experience of Siena at the end of 90 years has been replicated and implemented, on an ongoing basis over time, from the farm of Casentino (Province of Arezzo), in collaboration with the Florence HTD (Fronte et al., 2005).

The data from this experience confirmed that farm reproducers show significantly higher production than those of wild captured. It is therefore evident that the use of wild pheasants as reproducers in intensive farms is not a quantitatively convenient choice, despite the improvement observed in the subsequent years of captivity. A proposed good compromise in terms of productivity was the use of the offspring of the wild captured pheasants as the a farm pheasant reproducers. These subjects, while retaining most of the genetic traits of wildness that distinguishes the parental generation, did not show production significantly different compared to those of the farm pheasants. Finally, in 2003, ARSIA produced the disciplinary for the production of "Quality Pheasants". The main elements shown were to restore conditions more similar to those observed in the wild in the farm growing. In particular, the following traits were considered essentials:

- to supply diets with low protein and energy content and high fiber content with the aim to promote a "functional exercise" of the digestive system of birds, at least during the final stage of rearing (finisher period);
- to guarantee a minimum height of the aviaries which is essential to promote bird flight learning;
- to guarantee the presence of trees or perching facilities for the pheasants;
- to decrease the density to a level which allows the presence of feeding vegetation species and refuge vegetation species;
- to forbid the use devices or drugs with the aim to control pecking;
- to reduce temporally the so called warm phase which is a totally artificial period;

Experiments on the survival of pheasants produced following this disciplinary, have been carried out by two different research groups. Improved survivals were observed by Ciuffreda et al. (2007) in respect to the traditional farm pheasants and different dispersion behaviors were observed by Bagliacca et al. (2008). The use of quality pheasants improves significantly the restocking results, but gives problems for the structure of the wild populations that game manager want to preserve. Paradoxically, while the poor quality of pheasants, which are produced by intensive farming, guarantee a low genetic risk (they are unable to survive for long time), the quality pheasants, if genetically different from the local ones, may represent a real risk for the self-reproducing wild local populations. These last are in fact able to survive in large number until the next breeding season and can alter the genotype of the local pheasants, even in surrounding areas (secondary irradiation). Until now the breeding techniques suggested to the game producers has obliged them to reduce the so called warm phase, not considering the effect of this artificial period on the imprinting on pheasants. The use of hens for the hatching of pheasant eggs, or only for the adoption of the pheasant chicks, has been defined a technique that improves the ability to adapt to the natural life of the offspring out from the farm (Game Conservancy 1994). It remains to prove the feasibility of using this technique for producing pheasants in contexts other than amateur or incidental, that is, with a project that is "economical. "

2. The case study example

Studies have repeatedly emphasized the limited survival of pheasants reared using traditional methods compared to the wild one, mainly in relation to the inefficient behavior versus the predators and the reduced capacity utilization of natural foods. These inefficient behavior do not happen in pheasants reared by parents who show the typical attitude of defense. The need for technical improvement of the animals, immediately after hatching

(imprinting phase, during the so called warm phase), has been poorly evaluated, especially for the production of pheasants for the restocking of wild populations.

The purpose of this study was therefore to measure the effects related to the use of brooding hens after the hatch for the growing of pheasants, compared to the artificial rearing of the growing pheasants under gas heater after hatch (during the warm phase). The real effect of the proposed new technology must be consequently evaluated measuring the comparative survival rates in nature, as well as the habitat use and the characteristics of the home range of the pheasants after their release into the wild.

2.1 Materials and methods

At the end of March 2008, 32 wild pheasants were transferred to the State Forestry Corps breeding division of Bieri (Province of Lucca) from various PA of the Florence HTD. To capture the pheasants, "falling baskets" (cages) were placed at random throughout the entire PA territories: the birds were attracted by grain nearby and below the baskets. When the birds went to peck at the feed, they triggered the release mechanism, making the basket fall. The captured pheasants, 7 males and 25 females, were used to produce eggs for artificial hatching.

2.1.1 Experimental pheasant production

The pheasant reproducers caught in the PA were placed in an aviary (5x8 x h 3 meters). It had an almost full outer wooden screen to disturb the birds as little as possible. Inside, there was a plastic net (h 1.5 meter) below the roof to protect the birds from injuring themselves in a potential attempt to escape through the roof. Wooden screens were also provided to guarantee pheasant to hide when workers entered to collect the laid eggs. In the first few days, 2 males and 1 female died for trauma, bringing the total number of birds down to 6 males and 24 females. The collected eggs were incubated in accordance with standard methods. Near to the aviary for the captured pheasants, another aviary was constructed for hens to be forced into brooding (Game Conservancy 1994). The pheasants chicks hatchd in the incubator were then forcedly adopted by the hens and raised for 60 days, 6-15 pheasants/hen.

2.1.2 Release zones

The experiment was conducted in two small PA where reared pheasants can be released ("Zone di Rispetto Venatorio" - ZRV) in the Province of Florence. The first, "Leccio Poneta" in Strada in Chianti, had an area of 176 hectares; the second, "Le Bartaline," in Panzano in Chianti, had an area of 184 hectares (Figure n. 2).
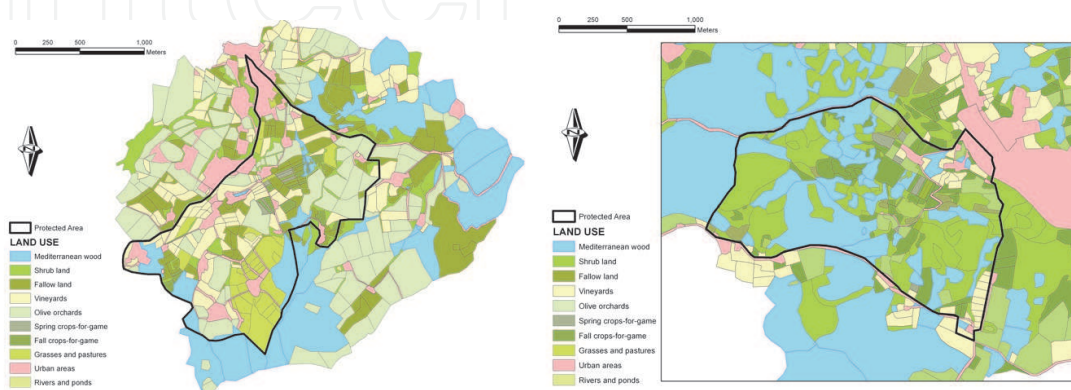

Fig. 1. Land uses in the ZRV "Le Bartaline" and "Leccio Poneta".

Both ZRV have a very similar assortment of environmental characteristics, natural vegetation, as well as trees and shrubs, mainly of the Mediterranean variety. The former zone is characterized by the presence of common broom (*Cytisus scoparius*), wild blackberry (*Rubus ulmifolius*), bay laurel (*Laurus nobilis*), heather (*Erica arborea*) and blackthorn (*Prunus spinosa*) growing at the edges of roads and fields. The latter zone consists of small stone pine forests (*Pinus pinea*), downy oak (*Quercus pubescens*), turkey oak (*Quercus cerris*), holm oak (*Quercus ilex*), wild cherry (*Prunus avium*) and black alder (*Alnus glutinosa*). Small farmers practicing "traditional" or organic agriculture are the only farms present in the ZRC, most of them characterized by small fields. The major crops are grapes (*Vitis vinifera*) and olives (*Olea europea*), while herbaceous plants are very often left uncultivated. Both ZRC are also characterized by natural boundaries separating the different plots of land. Rather than fences, there are borders of uncultivated land, farm roads, hedges, and trees, widely exploited by small game for shelter and feeding (Simonetta, 1975). Fruit trees including common fig (*Ficus carica*), wild cherry (*Prunus avium*), white and black mulberry (*Morus alba* and *Morus nigra*) and common hazel (*Corylus avellana*) are randomly widespread in the ZRC. There is no artificial irrigation equipment in the ZRC but there are abundant small rivers, streams and lakes. Each year; the HTD of Florence, which manage the public wildlife institutions on behalf of the Province of Florence; and the ZRV Management Committee, through cooperation landowners, seed the so-called "crops to be lost for game" (plots of no-harvested food crops) on special strips of land. In the Spring, a mixture of sorghum (*Sorghum vulgare*), rapeseed (*Brassica napus*) and sunflower (*Helianthus annuus*) are sown. In the Fall, a combination of broad bean (*Vicia faba*), hard and common wheat (*Triticum durum* and *Triticum aestivum*) are sown. This makes the area more suitable to both sedentary and migrating wild birds. In these ZRC, the hunting guards and landowners of the HTD perform constant monitoring of the game population in addition to predator activity (censuses and, if necessary, capture and slaughter). In both ZRV there are fenced areas fitted for pheasants acclimatization and equipped with anti-cat device on the outside fence. The fenced area in ZRV "Leccio Poneta," has an area of 3 hectares, and in "Le Bartaline" has an area of 9 hectares. Within the fenced areas there are also two acclimatization aviaries where the pheasants can be placed before being released. In both the ZRV there are also artificial feeding points which are regularly inspected and refilled (mainly troughs) inside and outside the fenced areas, 6 in "Leccio Poneta" and 3 in "Le Bartaline".

2.1.3 Pheasants under study

A total of 117 pheasants were evaluated for about 100 days, regarding their survival and behavior in nature: 57 of which were traditionally bred (29 males and 28 females) **Control**, and the remaining 60 were adopted and raised by hens (30 males and 30 females), **Hen**. Before being placed in the acclimatization aviaries in either ZRV, the following parameters were measured in the pheasants :

- **Live weight:** a technical balance (±1g) with a box, the weight of which was known, was used for weighing each bird;
- **Tarsus length:** a Vernier caliper (0.2 mm error) was used to measure the length of the tarsus (the measurement was carried out externally, from the talocrural joint (ankle) to the distal trochlea of the tarsometatarsus.
- **Tarsus Diameters:** the measurement, always taken with the Vernier caliper, was taken at the midpoint of the right tarsometatarsus, noting the longitudinal diameter - **minimum diameter** and the transverse diameter (just before the spur with males) **maximum diameter**;

- **Spur Length:** the transverse diameter or tarsus including the spur was taken by the Vernier caliper in the males;
- **Remiges Length:** a metal tape measure was used to externally measure the distance between the bird hand and the longest primary flight feather.

Radio collars (TW3 Biotrack + ½AA cell) were supplied to 40 pheasants (20 from the Hen group and 20 from the Control group) while the remaining 77 (40 from the Hen group and 37 from the Control group) were provided with numbered and differently colored ponchos (Figure 2). The frequencies of all tags ranged between 151,045 and 151,975 MHz. (crystal modulation radios, maximum instability ±4.2 MHz).

Fig. 2. Pheasants with mounted radio collar (left) and poncho + radio collar (right).

The radiotags did not affect the animals' survival as the weight of the radio (with cell, antenna and collar) was well below 3% of the animals' own weight (Perez et al., 2004). The radio was always attached to the neck (Bardi et al., 1983), eliminating the potential risk of diseases and/or injury caused by the other types of fixing. Once all the measurements had been taken and the radio transmitters had been fixed on all the pheasants, they were placed in the acclimatization aviary: a tunnel-shaped, 30*3 m, entirely constructed of soft plastic square mesh netting to prevent head injuries during attempts to escape. The pheasants remained in the aviaries for 24 hours in order to test the proper working of their tags, and to ensure that the attached collar did not create problems for the pheasants. Only 114 pheasants were released due to damage occurred during handling for collar supplying or measuring.

2.1.4 Localization techniques

The radio tagged pheasants were monitored through radio-tracking (Godfrey & Bryant, 2003), the poncho equipped pheasants were monitored by direct sighting through the aid of binoculars and then by telescope. A portable radio receiver with a modulation ranging from 151,000 to 151,999 MHz was used to localize the radio signals (Biotrack Sica-receiver). The operator could select the desired frequency on the receiver and then identify and locate each pheasant. A Yaghi, four element, manual antenna (a characteristically directional antenna) was used to locate the signal's direction of the tag. Having a small number of birds, most of the radio localization were made via direct sighting; triangulation was rarely used. All locations were made from late September to early April, 2 or 3 times a week, and always from the early morning until early afternoon. A GPS (Global Positioning System) on a handheld device (Garmin eTrex Legend navigator) was used to record the direct sighting

localization. The data were then transferred on a geo-referencing program (ArcGIS ®-ESRI), which had been previously loaded with the maps of the ZRV through a specific software (GPS-Utility ltd. 1998-2006). The geographical coordinates of points on the earth's surface obtained by satellites orbiting the earth (Betti et al., 2001), in our study were saved as Northeast Cartesian coordinates (Gauss-Boaga), referring to the reference system ROMA 1940 (Galetto & Spalla, 1995). when the pheasants was not clear to the observer (did not succeed in direct observation of the pheasant) a triangulation obtained with a single worker was used to obtain the fix. The observer, made the first detection, quickly moved to a second point of listening in order to minimize the possible pheasant movement, and then to calculate the pheasant triangulation as precise as possible (Hessler et al. 1970; Warner & Etter, 1983). The two identified directions were manually reported on the regional technical maps (1:10,000) using a still rule and a pencil. If an animal was not seen or triangulated more than twice in the same place, direct sighting was always used the next time, to verify the conditions of the subject (death or not). All locations were analyzed for survival, dispersion, home range and land use. The locations obtained through triangulation were manually entered into the geo-referencing program, in the same file where the direct locations were automatically transferred. Cards were also used, together with the GPS devices to complete the daily data collection; frequency of tag or poncho number, time, habitat where the pheasant was observed, weather conditions and other features were recorded for each pheasant in the cards.

2.1.5 Data processing

The two groups, **Hen** and **Control**, were studied in many ways over time from late September to early April. Data on biometrics measurement (live weight, tarsus length, diameters, spur length, and remiges length), recorded before release, were submitted to variance analysis in relation to the two groups and different sex (SAS 2002). Survival rates were analyzed using the Kaplan-Meier method, which allows to follow the survival pattern over time and probabilistically classify the missing animals in relation to tag, group, sex and within the different ZRV of release (Efron 1988, Lee 1980, Petrini 1995, Pollock et al. 1989a, Pollock et al. 1989b, SAS 2002). In particular, when the animal was checked alive or changed its position in two consecutive sightings, it was coded as alive, whereas if the poncho or the radiotag was found, with the remains or not, the birds was coded as dead. Animals sighted up to a certain period and then no longer detected, were consequently considered "missing" (probabilistically live/dead), and considered alive only up until the last time they were seen. The causes of death of the animals were only recorded and not submitted to statistical analysis, due to the little number of necroscopies. The maximum distances reached from the point of release calculated on GIS (ArcGIS ®- ESRI) were submitted to variance analysis in relation to tag, group and sex within the different release ZRV (nested model; SAS, 2002). The home range of each subject was determined using the Hawth's Tool GIS (ArcGIS ®- ESRI), evaluating the Minimum Convex Polygon or maximum area (MCP) obtained by joining the outermost points where each subject had been detected. The MCP was determined only for pheasants with a radio collar that had been observed at least 5 different times. The MCP areas were then subjected, as in the previous cases, to variance analysis (SAS 2002). The land use maps, in digitized format, were produced by a preliminary process of photo-interpretation, then verified by a location scout view into the field to identify the crops that were not identifiable through aerial photos or were changed, and to correctly define the polygon vectors. The ten environmental types summarized and categorized were: woods, shrub area, uncultivated

fields, vineyards, olive orchards, Spring crops for game, winter crops for game, grassland and pastures, urban areas (such as cities and construction sites) and river and ponds. The environmental composition of each home range, and the type of environment assigned to each location were obtained using Hawth's Tool GIS (ArcGIS ®- ESRI). The environmental availability was calculated from random points used like centers of circles with an area equal to the average pheasant home range, calculated for each ZRV (Fearer & Stauffer 2004). Two criteria were used to evaluate the use of available habitat through the Composition Analysis (Aebisher et al. 1993; Manly et al. 2002; Pendleton et al. 1998):

1. The home range choice = home range composition in relation to the composition of the available habitat, equal to:

$$\frac{\dfrac{\text{Surface area of a single type of environment in the home range}}{\text{Home range (MCP) surface area}}}{\dfrac{\text{Surface area of a single type of environment in the study area}}{\text{Study surface area}}}$$

2. The choice in the home range = the number of fixes in a particular habitat relative to how often that habitat appears in the home range, equal to:

$$\frac{\dfrac{\text{Total number of localization of a subject in a single type of environment}}{\text{Total number of localization of a subject}}}{\dfrac{\text{Surface area of a single type of environment in the home range}}{\text{Home range surface area}}}$$

The environmental choices (log transformed) were then submitted, as in the previous case, to variance analysis for more categorical factors (Pendleton et al. 1998; SAS 2002). If there was an available habitat in the home range not being used by the animal, zero values were converted to 0.01% before the log transformation. (Aebisher et al. 1993).

2.2 Results and discussion

The morphological characteristics, survival rates, use of the fenced acclimatization area, pheasant home range surfaces and dispersion (distances from the releasing points) and pheasant land uses, were opportunely summarized in tables and figures and separately discussed.

2.2.1 Morphological characteristics

The live weights, the tarsus length and diameter, the remiges length, the tarsus diameter and the spur + tarsus diameter, for each thesis, mean ± standard deviation, are shown in the Table n. 1 and Table n. 2.

group:		Control – n. 29		Hen - n. 30	
Live weight mean	g	1,235 ± 23.2	**A**	960 ± 21.7	**B**
Tarsus length	cm	8.53 ± 0.083	ns	8.50 ± 0.078	ns
Remiges length	cm	23.8 ± 0.170	**A**	22.7 ± 0.159	**B**
Tarsus diameter min	mm	6.93 ± 0.101	a	6.59 ± 0.095	b
Tarsus diameter max	mm	10.2 ± 0.169	**A**	8.84 ± 0.158	**B**
Spur + tarsus diameter	mm	18.6 ± 0.290	**A**	14.6± 0.269	**B**

Table 1. Male morphologic characteristics (means ± st.dev), different letters show differences per p<0.05 if cursive or p<0.01 if capital.

group:			Control – n. 28		Hen - n. 30	
Live weight	g		945 ± 16.9	**A**	749 ± 17.2	**B**
Tarsus length	cm		7.44 ± 0.174	ns	7.43 ± 0.177	ns
Remiges length	cm		21.7 ± 0.118	ns	21.3 ± 0.131	ns
Tarsus diameter min	mm		5.92 ± 0.092	ns	5.69 ± 0.094	ns
Tarsus diameter max	mm		8.42 ± 0.112	**A**	7.68 ± 0.114	**B**

Table 2. Female morphologic characteristics (means ± st.dev); different letters show differences per p<0.01.

From the observation of the tables, we can see great differences in the live weights, remiges length, tarsus diameters and spur length between the males bearing to the two groups. However, also in the females, the average larger sizes were measured in the Control group, even if only the differences between the body weights reached the minimum significant level. these results show that the maximum pheasant growth rate can be obtained only with the totally controlled rearing conditions used by the standard technology while the use of natural brooding does not allow the pheasant chicks to reach their maximum potential growth.

2.2.2 Survival rates

The results of the survival rates (Table n. 3) showed difference survivals in relationship to the different rearing technique; the pheasants of the group Hen showing an improvement of their survival rates, either with poncho or radio tags (90.0% *vs.* 57.1% and 35.0% *vs.* 21.1%, respectively).

			Poncho tag	Chi square Tests	Radio tag	Chi square Tests	Both tags	Tests
Control	Released/Dead	n	35/15	Log-rank=5.50* P=0.02 / Wilkoxson=4,07* P=0.04	19/15	Log-rank=1,34 P=0.24 / Wilkoxson=1,80 P=0.18	54/30	Log-rank=5.50* P=0.02 / Wilkoxso5,48* P=0.02
	Survived	%	**57.1**		**21.1**		**44.4**	
Hen	Released/Dead	n	40/4		20/13		60/17	
	Survived	%	**90.0**		**35.0**		**71.7**	
Both	Released/Dead		75/19		39/28		114/47	
	Survived		**74.4**		**28.2**		**58.8**	
	Chi square Test		Log-rank 1.14* P= 0.02 Wilkoxson 0.23 P= 0.63					

Table 3. Survival rates of the reared pheasants: effect of different rearing and tag (* show significant differences between percentages).

Survival rates of the pheasants bearing a poncho was higher than the survival rates of the radio tagged pheasants. Surely the survival rates of the poncho tagged pheasants were deeply overestimated (not every dead pheasant can be found). For this reason ponchos can be used only for the comparison between different groups with equivalent subjects and cannot be used to evaluated absolute survival rates. However, also the survival rates estimated with the radio-tagged pheasants were very high, either in the Control or in the Hen group. Several factors hardly influences the survival rates of the captive reared pheasants (e.g. the use of nasal blinders or not, the age of the access to the flying pens and so on) and both our groups of pheasants were reared expressly with the aim of their future wild release. The Graphic n. 1 shows very well how the mortality of the Control group was higher than the Hen group after the release and how this phenomenon increased differently during the observation period.
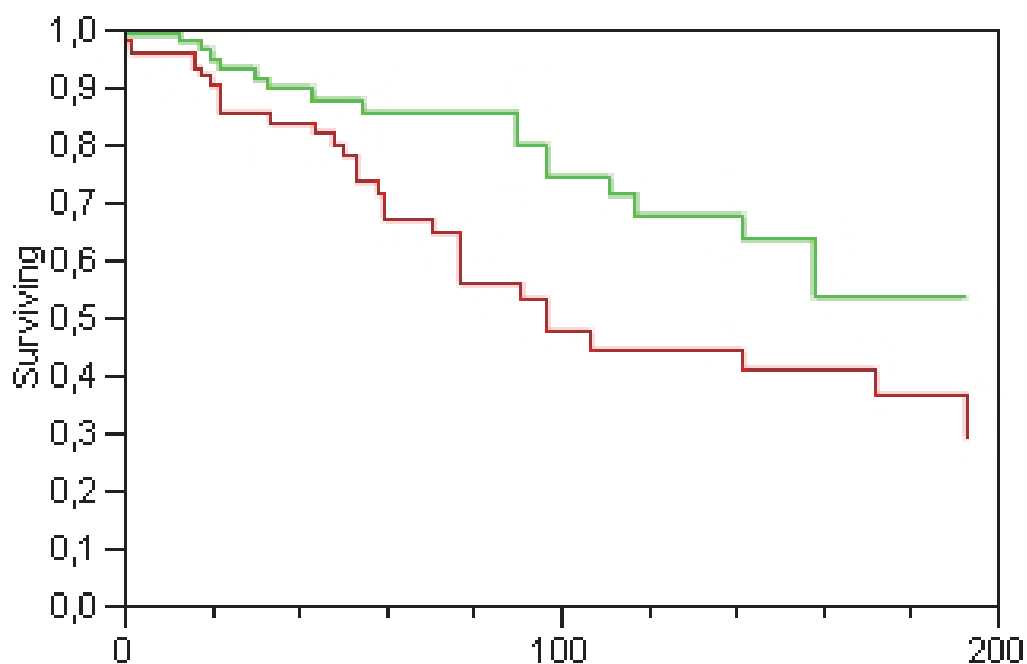

Fig. 3. Survival rates of the two groups with the Kaplan-Meier method (SAS 2002)

2.2.3 Effect of the fenced acclimatization area

The position of the pheasants were arbitrary studied in two periods (the month of release and the 5th mouth after release), see Table 4a. Differences were evidenced in relation to sex and group, as well as by ZRV. In the "Le Bartaline" ZRV during the month after their release, the females of the Control group remained inside the fenced acclimatization area more than the Hen group, the same trend was shown by the males but differences did not reach the statistic significance. In the "Leccio Poneta" ZRV, on the contrary, during the month after their release the dispersion did not differ between thesis.

The month of release			Males	Test	Females	Test	Both	Test
ZRV Leccio Poneta - pheasant fixes within the fenced areas								
Control	outside/total	n	11/37		20/53		31/90	
Control	fence use	%	**70.27**	Log-rank=1.89 P=0.17 / Wilkoxson=1.87 P=0.17	**62.26**	Log-rank=0.01 P=0.98 / Wilkoxson=0.01 P=0.98	**65.56**	Log-rank=0.84 P=0.36 / Wilkoxson=0.84 P=0.36
Hen	outside/total	n	20/45		15/40		35/85	
Hen	fence use	%	**55.56**		**62.50**		**58.82**	
ZRV Le Bartaline								
Control	outside/total	n	10/48		5/31		15/79	
Control	fence use	%	**79.17**	Log-rank=3.10 P=0.08 / Wilkoxson=2.92 P=0.08	**83.87**	Log-rank=8.48 P<0.01 / Wilkoxson=6.61 P<0.01	**81.81**	Log-rank=9.43 P<0.01 / Wilkoxson=8.70 P<0.01
Hen	outside/total	n	3/39		0/38		3/77	
Hen	fence use	%	**92.31**		**100.00**		**96.10**	

Table 4a. Contingency tables of the use of the acclimatization fenced area in the two ZRV the month after release.

During the 5th month, see Table 4b, in the "Le Bartaline" ZRV the trend changed: the pheasants of the Control group remained more in the fenced area than the Hen group (the comparison within female was not possible due to a lack of fixes for Control females). The same trend was shown in the "Leccio Poneta" ZRV but, again the differences did not reach the significant level. This can be explained by the smaller size of the acclimatization fenced area of the Leccio Poneta ZRV and the generally better environment of the acclimatization fenced area in Le Bartaline ZRV (olive orchards, crops for game, shrubs land and little woods).

The results of the use of the fenced acclimatization areas of both ZRV are summarized in Table 5. As expected the fenced acclimatization areas is less used after 5 months than during the month following the pheasant release (high significant differences are shown for the Hen group, while the differences within the males of the Control group did not reach the statistical significance). The clear effect of dispersion which characterizes the 5th month (significant for both the group, but more evident in the Hen group than in the Control group and more clear for females than for males) show that with the approaching of the reproductive season the fenced area is abandoned by most females (the fenced area can be a good nesting only for few females) but the presence of pheasants in the fenced areas remains high in both sexes, probably for the presence of the strips of crops for game and of the supplementary feed feeders.

the 5th months after release			Males	Test	Females	Test	Both	Test
ZRV Leccio Poneta								
Control	outside/total	n	8/18		19/33		27/51	
Control	fence use	%	**55.56**		**42.42**		**47.06**	
Hen	outside/total	n	12/18		19/27		31/45	
Hen	fence use	%	**33.33**		**29.6**3		**39.58**	
				Log-rank=1.81 P=0.18 / Wilkoxson=1.80 P=0.18		Log-rank=1.06 P=0.30 / Wilkoxson=1.05 P=0.31		Log-rank=2.56 P=0.11 / Wilkoxson=2.54 P=0.11
ZRV le Bartaline								
Control	outside/total	n	6/21		-		6/21	
Control	fence use	%	**71.43**		**-**		**71.43**	
Hen	outside/total	n	15/20		8/16		23/36	
Hen	fence use	%	**25.00**		**50.00**		**36.11**	
				Log-rank=9.19** P<0.01 / Wilkoxson=8.84**P<0.01				Log-rank=6.78** P<0.01 / Wilkoxson=6.62*P<0.01

Table 4b. Contingency tables of the use of the acclimatization fenced area in the two ZRC the 5th month after release.

Control group			Males	Test	Females	Test	Both	Test
The month of release	outside/total	n	21/85		25/84		46/169	
The month of release	fence use	%	**75.29**		**70.24**		**72.78**	
the 5th month	outside/total	n	14/39		19/33		33/72	
the 5th month	fence use	%	**64.10**		**42.42**		**54.17**	
				Log-rank=1.61 P=0.20 / Wilkoxson=1.65 P=0.20		Log-rank=7.66** P<0.01 / Wilkoxson=7.81** P<0.01		Log-rank=7.73** P<0.01 / Wilkoxson=7.94** P<0.01

Table 5a. Contingency tables of the use of the acclimatization fenced areas in the Control group.

the different behavior shown by the Hen group and the Control group can be explained by the imprinting needed to find food, received by the Hen group but not received by the Control group and the greater antipredator capacity of the Hen group than the Control group.

	Hen group		Males	Test	Females	Test	Both	Test
The month of release	outside/total	n	61/84	Log-rank=20.7** P<0.01 / Wilkoxson=20.6**P<0.01	63/78	Log-rank=23.1** P<0.01 / Wilkoxson=23.2**P<0.01	38/162	Log-rank=42.8** P<0.01 / Wilkoxson=42.9**P<0.01
	fence use	%	**72.62**		**80.77**		**76.54**	
5 month later	outside/total	n	5/41		57/73		54/81	
	fence use	%	**46.75**		37.21		**43.14**	

Table 5b. Contingency tables of the use of the acclimatization fenced areas in the Hen group.

2.2.4 Pheasant Home range surfaces and dispersion

There were not differences between the home range surfaces and dispersion (distances from the releasing points) of the two groups (Table 6 and 7). The similarity between the home-range sizes of the two groups can be well appreciated in Figure 4 and 5. This result is very interesting for the pheasants gamekeeper choices. In similar environments these parameters can be used as reference parameter to plan releasing points or for the creation of a new correctly dimensioned PA or to establish efficient networks of supplementary artificial feeders.
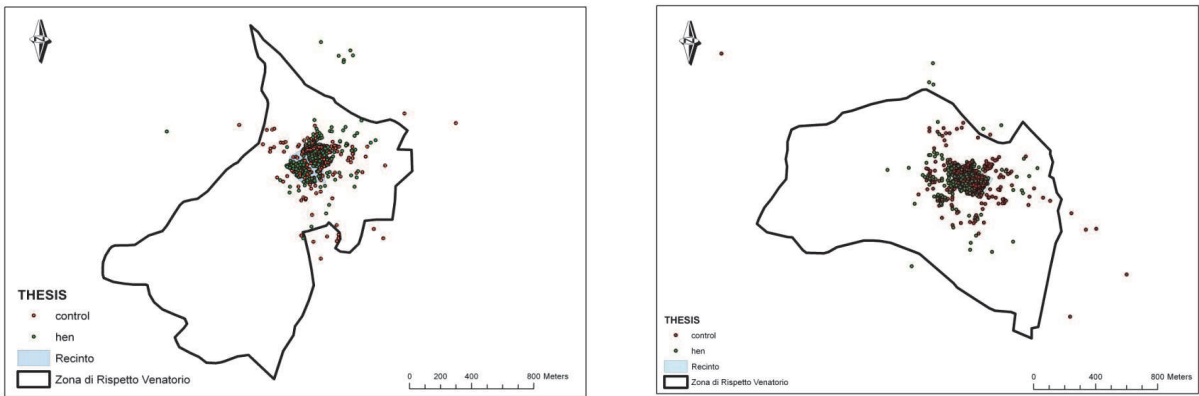

Fig. 4. Animals observations (fixes) by different groups within the two ZRV

ZRV	group Hen		group Control	
	pheasants	avg - st.dev	pheasants	avg - st.dev
Le Bartaline	9	369 ± 191.5	9	401 ± 196.7
Leccio Poneta	10	408 ± 157.9	11	447 ± 279.8

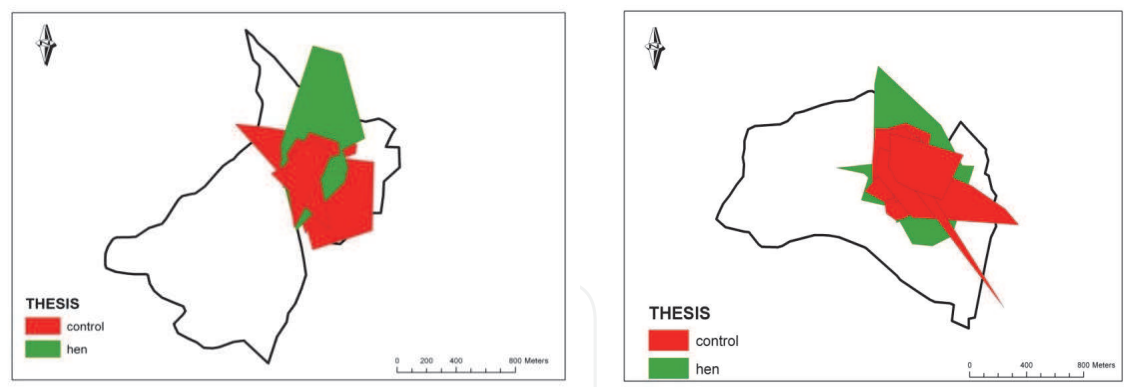Table 6. Average Max distances from the release sites (meters ± std.dev).

Fig. 5. Animals home ranges (MCP) by thesis inside the two Protected Areas

ZRV	group Hen		group Control	
	pheasants	avg - st.dev	pheasants	avg - st.dev
Le Bartaline	9	11.1 ± 8.26	9	10.1 ± 8.06
Leccio Poneta	10	12.9 ± 11.92	11	12.9 ± 7.59

Table 7. Average Home Range areas (MCP) (hectare ± std.dev).

2.2.5 Pheasant land use

The data concerning the pheasant land uses (considering both the ZRV), referring to both sexes, are shown in Table 8.

"Le Bartaline" & ZRV "Leccio Poneta"	Hen	Control	Overall values
	home range uses		
Woods	0.945[abc]	0.883[abc]	0.917[ab]
Shrubs area	0.881[abc]	0.777[abc]	0.833[bc]
Uncultivated fields	2.010[a]	1.920[ab]	1.970[ab]
Vineyards	0.397[cd]	0.399[cd]	0.397[cd]
Olive orchards	0.805[abc]	0.705[bcd]	0.760[bc]
Spring crops for game	1.620[ab]	2.630[ab]	2.130[ab]
Winter crops for game	2.900[a]	3.810[a]	3.370[a]
Grasses and pastures	0.484[bcd]	0.314[cd]	0.406[cd]
Urban areas	0.073	0.273[cd]	0.164[d]
River and ponds	0.015[d]	0.019[d]	0.017[d]
Standard error of means	0.0938	0.0899	0.0646

note: Least square means > 1 show larger incidences of the land use in the home range than in the study area; Least square means < 1 show smaller incidences of the land use in the home range than in the study area; Land uses bearing different superscripts differ within the same column per p<0.05;

Table 8. Land uses in the pheasant home range (MCP) in respect to the overall land uses (analysis carried out on log-values, Aebischer et al., 1993).

The winter crops-for-game, the spring crops-for-game, the fallow lands and the wood were more represented within the home ranges of both group of pheasants. However the home ranges of the Hen group were characterized by a greater presence of shrub land and olive orchards. The home ranges of the Control group were characterized by a greater presence of shrub land. In general these results confirmed the great importance of crops for game. Winter crops for game in this experiment represented old crops, since they were seeded the year before the release of the pheasants (wheat, broad beans and oats). In this phenological state these crops are able to provide feeding but also good protection and hiding places for the pheasants. There were not evident differences between the different crops for game. We note, however, that the Hen group preferred a greater number of types.

The presence of pheasants fixes in the different land uses, referring to both sexes, are shown in Table 9.

ZRV Le Bartaline & ZRV Leccio Poneta	Hen	Control	Overall values
	choices in the home range		
Woods	5.356[ab]	5.628[a]	5.497[a]
Shrubs area	1.456[abc]	1.738[abc]	1.597[bcd]
Uncultivated fields	6.226[a]	5.388[ab]	5.797[a]
Vineyards	0.830[c]	0.597[cd]	0707[d]
Olive orchards	0.945[bc]	1.098[bc]	0.981[bcd]
Spring crops for game	3.916[abc]	4.208[ab]	4.067[ab]
Winter crops for game	2.176[abc]	3.858[ab]	3.047[ab]
Grasses and pastures	0.937[bc]	1.008[bc]	0.970[cd]
Urban areas (biased)	0.016[de]	0.015[de]	0.015[de]
River and ponds (biased)	0.016[de]	0.015[de]	0.015[de]
Standard error of means	0.1067	0.0988	0.0720

note: Least square means > 1 show greater number of fix in the land use than the incidence of the land use in the home range; Least square means < 1 show smaller number of fix in the land use than the incidence of the land use in the home range; Land uses bearing different superscripts differ within the same column per $p<0.05$;

Table 9. Land use location of the pheasant fixes in respect to the land use incidence in the MCP (analysis on log-values, Aebischer et al., 1993).

The fix locations of the pheasants within their home range showed that wood, uncultivated fields and crops for-game were the most frequented within the home range. No fix was observed during the trial in the artificial areas (extractive, construction sites and urban areas) or river and ponds. Considering only the Control group the shrubs area, the olive orchards and the grasses and pastures acquire greater importance while in the Hen group the majority of fix were found in the uncultivated fields; followed by both types of crops for game and the shrubs area. Also in this case the importance of the uncultivated fields and the crops for game were confirmed by the pheasant fixes. The preference for the woods was

explained by their reduced dimensions (several small woods) which allowed the pheasants to find perches for the night and refuges for the day.

2.3 Conclusion

The high survival rates of the pheasants, reared according to the disciplinary rules set forth for the production of pheasants to be released in the wild as part of game repopulating programs, can be further increased with the adoption of the technique of mother fostering applied to the artificially hatched pheasants chicks. With the aim to estimate the future survival of the pheasants to be released, the simple evaluation of the morphological traits is of reduced or none interest; in our case, the brooded pheasants were worse than the artificially heated one. Radio tracking is not the only methodology to check the survival rates of the pheasants after release. The efficiency of radio tracking pheasants can be greatly increased by the simple use of ponchos which did not cause any increase of the research costs, on condition to tests groups with similar numbers. The increase of the production costs of hen brooded pheasants, mainly space and man working time, however, must be evaluated on the positive effect on survivals linked with the use of this technology. The same problem concerns the positive results obtained with the adaptation of pheasants to be released in fenced areas located in the releasing sites with the presence of artificial feeding and crops-for-game.

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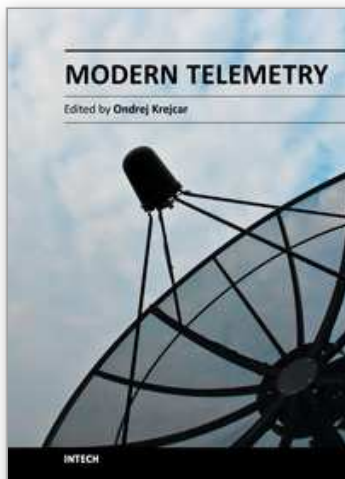
Modern Telemetry

Edited by Dr. Ondrej Krejcar

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