Good practice monitoring methods to analyse key factors of the human pressure on the raptor population of a region

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1. Introduction

Aim of the visit:
Collation of the practice of the host organisation with our practice on raptor monitoring as regards analysing human pressure in the study area and to monitor the effectiveness of mitigation activities.

Human pressure on raptor populations are very similar reaching across boundaries of countries and even continents, threatening the globally endangered raptor species and populations. During the visit we investigated raptor losses in Madrid Community, Spain.

Host organisation:
GREFA (Native Fauna and its Habitat Rehabilitation Group) is a non-government, non-profit organization, created in 1981 as an association for the study and conservation of nature, especially raptors. Since its foundation GREFA started varied conservation projects in increasing numbers and on larger scale. It works with a limited number of permanent staff, but as awareness raising and education is considered as an important mission of the organisation, many volunteers (students, biologists, veterinaries, etc.) are involved in these projects and in the work of the rehabilitation centre. They co-operate with several universities and institutes in Spain (Madrid, Zaragoza, Valladolid, etc.), and also with some of Portugal.

Location/visit location:
The host organisation (GREFA)'s Wild Fauna Hospital and Centre is based in el Monte del Pilar in Majadahonda in Community of Madrid. Our stay during the visit was based in GREFA's Center in Majadahonda with field visits on the project areas in Madrid Community, Castilia-La Mancha Community, Castillia y Leon Community, also including a shorter stay in Valladolid to study the biological control project on the experimental site.

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2. Methods

2.1. Study area

GREFA's Wild Fauna Hospital and Centre works in Central Spain (Community of Madrid) and provides veterinary attention to injured wild animals. After having received treatment and being rehabilitated, birds are released back into the wild and monitored. Wild animal admission to the centre provides GREFA with the ability to study the main threats for the native fauna, most of them coming from human activities. GREFA runs special raptor conservation and monitoring projects, like bird breeding in captivity and its later release back into the wild programme for Lesser Kestrel, Golden Eagle, Griffon Vulture, Eurasian Black Vulture, and Montagu's Harrier preservation programme.

Protection of endangered birds of prey is a principal task of GREFA. This work covers from one hand the collection and veterinary treatment and follow-up care of injured raptors, and if the condition of the bird allows, its release to the wild after rehabilitation. If the bird suffered permanent injury and its condition does not allow to be released to the wild again, in that case the bird will be kept for interpretation, education, awareness raising purposes and for breeding in captivity. Number of injured animals admitted to GREFA's hospital was between *2000 and 4265* in the period of 2006-2011. The ratio of the different animal groups: *85% bird*, 9% reptile, 5% mammal 1% amphibian. According to the regional conservation status, 9% of these species is considered as threatened with extinction, 1 % as vulnerable, 4% having special significance.

GREFA runs several conservation programme for raptors and participates in national and international conservation programmes. Monitoring is essential part of all of these projects. Young birds born in captivity breeding programmes, and those individuals cured to health will be repatriated in habitats considered to be optimal for the release. The reintroduction and local population conservation projects always focus on those species being native in the region, but suffering severe population decline or became extinct due to human impacts. These projects also include habitat protection and enhancement, and the elimination of the threatening factors (e.g. insulation of dangerous overhead power lines).

2.2. Methods

Date of the visit: 09.11.2012 – 23.11.2012.
Participants: Szilvia Gőri and Miklós Dudás.
Method: discussions with experts and field visits.

Experts interviewed:

Ernesto Álvarez Xusto, director of GREFA
Manuel Galán Crespo
Alfonso Paz Luna
Juan José Iglesias Lebrija
Juan Martinez
Pablo Izquierdo Cezón

3. Results

3.1. Key factors of human pressure on the raptor population of the region identified in the working area of GREFA (Madrid Community and surroundings)

3.1.1. The limiting factors on raptors identified in the region can be regarded as universal:

- electrocution on the pylons of the middle voltage power lines (20 kV) while perching or resting on them,
- collision with high voltage (220, 400, 750 kV, etc.) power lines,
- car accidents on highways and roads, affecting mainly owls,
- poisoning:

-- primer toxicity, when the food (carcass placed out) is prepared with poison and cause death directly and

-- secondary toxicity, when the chemicals (rodenticides) used to control the prey population (common vole, hamster) accumulates in the body of the raptor and causes death of the top predator,

- illegal shooting by hunters,
- transformation and loss of their natural habitats, disturbance of the breeding habitats (agricultural works, tourism), forest fires (in 2012 in the Sierra de Guadarrama mountains in Madrid Community thousands of hectares of pine forest was burned down and in the fire 6 nests of Black Vulture were destroyed, fortunately only one nest had chick yet; or in the other case also this year 4 nests of Black Vulture nests were burned down in a forest fire in Extremadura, unfortunately all with chicks),
- (illegal international trade of rare birds of prey is raising year by year, but our study did not deal with this question).

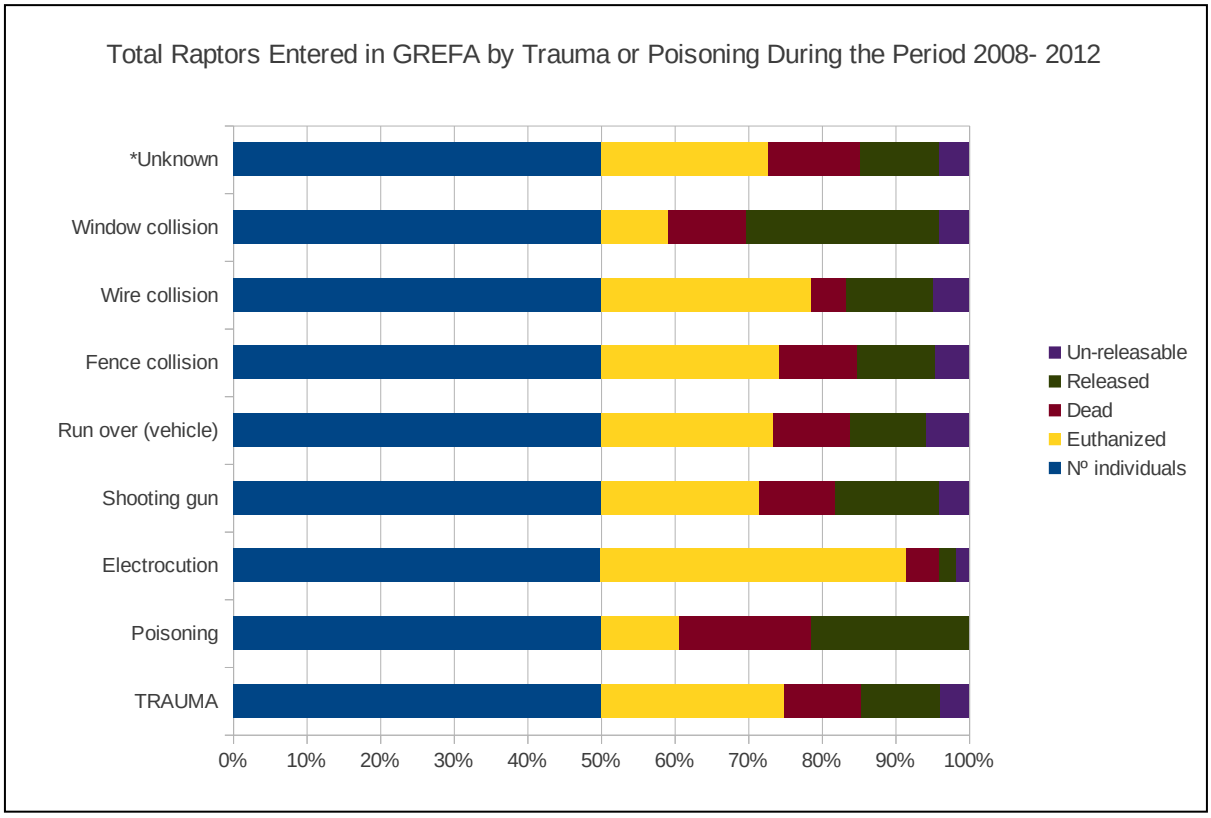
The high number of injured raptors admitted at GREFA's Wildlife Hospital allows an evaluation of the degree of the different factors of human pressure (first five factors of the list above) in the region. GREFA is considered as a national and international reference on the veterinary treatment of wildlife because of the high number of diagnosed animals, the hospital management model, the educational and training programmes and the involvement in scientific investigation at the service of conservation. In 2011, 4265 injured animals have been treated here. Therefore, the data analysis of the injured raptors, which have been entering the centre, gives a good overview on the most critical factors of human pressure on the raptor population of the region. A five years period was investigated from 2008 until 2012.

Table. 1. TOTAL Number of RAPTORS ENTERED IN GREFA BY TRAUMA OR POISONING DURING THE PERIOD 2008-2012 (by Manuel Galán, GREFA)

CAUSE	Nº individuals	%	Euthanized	%	Dead	%	Released	%	Un-releasable	%
TRAUMA	**802**	**100%**	**400**	**50%**	**168**	**21%**	**173**	**22%**	**61**	**8%**
Poisoning	**14**	**2%**	**3**	**21%**	**5**	**36%**	**6**	**43%**	**0**	**0%**
Electrocution	**123**	**15%**	**102**	**83%**	**11**	**9%**	**6**	**5%**	**4**	**3%**
Shooting gun	**88**	**11%**	**38**	**43%**	**18**	**20%**	**25**	**28%**	**7**	**8%**
Run over (vehicle)	96	12%	45	47%	20	21%	20	21%	11	11%
Fence collision	33	4%	16	48%	7	21%	7	21%	3	9%
Wire collision	21	3%	12	57%	2	10%	5	24%	2	10%
Window collision	38	5%	7	18%	8	21%	20	53%	3	8%
*Unknown	389	49%	177	46%	97	25%	84	22%	31	8%
Nº total species	**29**									

**Unknown trauma. The animal enters in GREFA with signs of trauma but unknown.*
Euthanized; in the opinion of the vets of GREFA, there aren't therapy to recover the animal. This is euthanized.
Dead; when animal dies in the hospital admission or during the treatment.
Released; animal released after veterinary treatment.
Un-releasable; animal not recovered for wildlife but for their injuries can live in captivity (education, breeding…)

Figure 1. RAPTORS ENTERED IN GREFA BY TRAUMA OR POISONING DURING THE PERIOD 2008-2012



- Data of ***Table 1.*** indicates, that in the four year period of 2008-2012, a total number of 802 individuals of 29 raptor species were admitted at GREFA's wildlife hospital. In the case of 49% of the injured birds (389 individuals) the case of the injury could not be identified. Many young (first year) birds were found in debilitated condition by GREFA's specialists, found after public call to GREFA. Based on the several decades experience of the specialists and the statistical data, it can be clearly stated, that the mortality of the youngs in the first year is very high for raptors. This might be a result of the situation, that several individuals didn't learn yet the perfect hunting technique when leaving the parents; or in the case of scavengers it often happens, that the young get drifted away from the colony and alone without the more experienced individuals of the colony he is not able to find the carcasses. Thus the starved birds soon get weakened and loose their ability to move.
- 15% of the injured birds received at GREFA get electrocution on the pylons of the middle voltage power lines. This factor of human pressure caused the highest mortality during the investigated period, resulting in the loss of 123 individuals. It can be seen, that this type of trauma leads almost surely to death, the ratio of those birds which can later be released is in this case the lowest. 92% of the admitted birds died (dead or euthanized), only 5% (6) of the birds could be released to the wild again.
- The second human induced factor causing high mortality is the collision with cars. It results death in 68% of the cases, but the chance for the successful veterinary treatment is much higher compared to the electrocution, 21% of the cured birds can be released.
- The number of birds shot illegally is also high,11% of all cases, meaning the third cause of death for raptors in the study area.
- Collision with the glass window surfaces of large office buildings also represent considerable extent of injury to raptors, but this type of trauma leads to the lowest rate of mortality compared to the other types, as 53% of the injured birds can be released to the wild again.
- Wire fences between private lands cause injury mostly to harriers. 4% of the raptors received at GREFA have injury because of getting caught by fences, and unfortunately the majority, 70% of them die.
- Large eagles and vultures often suffer injury and death because of collision with wires of the high voltage power lines. This case of trauma represents 3% of all cases.
- In the last four years 2 % of the birds arrived to GREFA suffered illegal poisoning. Compared to the other ones, this type of trauma can be healed with a relative good chance. Thanks to the good veterinary treatment, 43% of the injured birds could be released to the wild again, representing the highest percentage of all traumas. This underlines the importance of the early discover of the poisoned birds.
- Regarding all the injured raptors admitted at GREFA, only 22% of them can be healed and released to the wild, 8% suffers lasting injury and can survive only in captivity serving for education or captivity breeding programmes.

These data highlight, that human induced factors mean serious pressure on the raptor population of a region. Therefore, in the conservation of the endangered raptors it is a task of essential importance to reduce or eliminate the negative factors causing direct losses, among others the insulation of structures of power lines, to lay underground the most critical middle voltage power lines or to use anti-collision devices and to repress illegal poisoning and shooting.

3.1.2. Mitigation activities

Table 1. suggests electrocution to be highest pressure on raptors in the study area, while car accidents and poisoning being also severe factors causing high mortality. In this chapter the study focuses on the realised mitigation activities. In 3.2. the problem with electrocution and collision will be discussed in details.

- Human pressure: car accidents
  Mitigation activities for raptors as compensatory measures due to the duplication of the M-501 highway

Habitat loss due to road constructions and car accidents are serious conservation problems in the study area. For the 4th consecutive year, GREFA has been undertaking compensatory measures due to the duplication of the M-501 highway such as programs involving some of the most emblematic and threatened species of Madrid community: Spanish Imperial Eagle, Black Vulture, Bonelli's Eagle, Lesser Kestrel and Red Kite. Within the obtained results in 2011, they underlined the replenishment of the Lesser Kestrel population in an area where it had disappeared decades ago, and the reintroduction of four captive-bred Bonelli's Eagle.

(1) Conservation of the Black Vulture (*Aegypius monachus*)

The Black Vulture is considered as a species threatened by extinction in Madrid Community. GREFA has been working for the conservation of the species since 20 years in this region. In the frame of the compensatory measures the following actions have been taken:

- census and control of the breeding pairs
- watching of the nests
- supplementary feeding
- marking of the youngs and the adults with GPS transmitters to study the dispersal and feeding areas.

(2) Reinforcement of the program for constructing specific buildings for Lesser Kestrel (*Falco naumanni*)

In 2008-2011 four new buildings were built or existing buildings (water tower, silo) equipped with nest boxes for the breeding for the species (in Navas del Rey, Quijorna, Sevilla la Nueva, Navalcarnero). In 2011 there were 362 chicks liberated in these buildings, all born at GREFA center. Moreover, 300 hatchlings were ringed. In 2011, 21 pairs were monitored in these buildings, from which 13 were successfully breeding. Please find details in 3.4.

(3) Reinforcement of the conservation program for the Bonelli's Eagle (*Hieraaetus fasciatus*)

This is a pioneer program in Europe for the conservation of Bonelli's Eagle, which has been started in 2010 with the first release of two youngs. In 2011 four youngs were released (2 males and 2 females) in Madrid Community, where only 2 pairs remained. All the released birds were marked with GPS transmitters. Only one the two birds released in 2010 provided information continuously, this individual settled nearby in Toledo province. In 2011, 3 foreign individuals were observed, which were certainly attracted to the region by the released birds.

(4) Census of Red Kite (*Milvus milvus*) breeding pairs in Madrid Community.

The census has been realised since 2010. The population of the species suffered decline, which is caused mainly by poisoning and electrocution. In 2011 4-6 breeding pairs were

localised (proved-probable), demonstrating that this number is far from being a viable population. Furthermore, 3 individuals were marked with GPS transmitter for observation.

(5) Surveillance of Imperial Eagle (*Aquila adalberti*) in Madrid Community

The Imperial Eagle is an emblematic endangered species of Madrid Community, but thanks to the efforts slowly recovering. In the frame of the compensatory measures the following actions have been taken:

- census of the breeding pairs and those of keeping territory
- watching of the nests
- supplementary feeding
- marking with GPS transmitters.

Until now 3 pairs are monitored continuously, and 4 individuals (2 youngs and 2 adults) are marked with GPS.

- Human pressure: disturbance of the breeding habitat and mitigation
  Montagu's Harrier conservation.

For the last 15 years, GREFA has been working with the Iberian harriers, mainly with Montagu's harrier (*Circus pygargus*) in Madrid Community to locate their nests on the ground in the cereal crops. During these years, actions to raise awareness among farmers have been essential too, and hundreds of nests were saved from combine harvesters. The area selected for the project host a population of 30-40 breeding pairs. In the localisation of the nests many volunteers and other organisations also have been involved.

Monitoring activity: nest localising, ringing of youngs, census and control.

Output of monitoring data:

- feeding studies, conservation plan for the species,
- practical conservation actions: nest marking, chick rescue and release.

This ground breeding species often choose intensively cultivated fields for nesting. Montagu's Harrier often builds his nest in cereal crop fields and alfalfa fields. The breeding period (including egg laying and chick raising) is in coincidence with the harvesting time of these crops, which resulted in the destruction of many nests – with eggs or chicks – in the previous years. Before starting the conservation programme, a campaign was held to raise awareness and calling the attention of the farmers to the protection problems of the species and to convince them for co-operating. In the beginning of the project, the crop was not cut in a patch around the localised nest. This method failed, because predators (fox, dog, even people) did find the nest more often and the clutch was destroyed. In order to eliminate this loss, a new method was applied by GREFA. The farmer who find the nest during the harvest calls the experts, who collect the chicks and take to GREFA Centre. The youngs are raised here until the age of 4-5 weeks, and after full fledging, when they already can feed by themselves, but before being able to fly the specialists start the process of their release to the wild. They used to be released on the places where they were collected, with a method called "hacking". In this method a 2.5 m high fence is built from hay or straw bale of little size on a room size surface. This structure will be rounded by a wire fence for protection purposes. The youngs will be put on to the ground in this structure and they will be fed here, without seeing man. The youngs will leave the place after a few weeks of follow-up care.

In the period of 2007-2011 the average number of rescued clutches was between 25 and 35, meaning 4-5 youngs per nest. In 2012 a very high percentage, 80% of the localised nests had to be rescued because the drought resulted shortage of food. Usually 50% of the localised nests has to be rescued.

- Human pressure: illegal hunting

Hunting pressure can be mitigated by informing the hunting associations and consulting with them, for this purpose GREFA organise regularly symposiums and consultations in the Centre.

3.2. Raptor losses on power lines and mitigation methods

3.2.1. Causes of raptor losses

Ever since power supply exist on our continent, bird accidents – mostly with raptors – are known due to electrocution when approaching or touching the electrical structures, and due to collisions.

For a long time, safety and conservational aspects to avoid or reduce bird accidents were not taken into consideration in the design of the electrical structures (pylons, transformers, etc.). With the expansion of the electric power lines bird accidents occurred more frequently.

Most dangerous are those power lines situated in open landscapes, grasslands and pastures, where there is no other possibility (line of trees, woods) for raptors for perching. On cultivated lands, especially on alfalfa fields and stubble-fields Kestrels, Buzzards and Red Kites hunting for common vole are threatened by power lines.

Bird losses occur in highest densities in mid-summer and early autumn. Partly because of the high casualties of young birds, as they are not skilled enough yet to land safe on a pylon, partly due to the foggy weather in autumn mornings, when also the adults fall victim.

When approaching the power lines and poles, and when flying at low altitudes in the open landscape, birds may suffer fatal injuries, because of both electrocution and collision:

- Short circuit: The bird suffers electrocution, when touching two wires while approaching the structures. Mostly large birds are (e.g. eagles) are affected, as their wing span is wide enough to touch both wire.
- Short circuit to earth: The bird while approaching the structure touches the wire and some conductive part of the power pole. It can affect birds of any size, this is the most frequent type of electrocution. This type of electrocution is the main cause of death of the Bonelli's Eagle in the study area.
- Collision: Large birds like eagles (e.g. *Aquila adalberti*) and vultures (*Gyps fulvus*), also Great Bustard (*Otis tarda*) are often victims of collision, especially when visibility is poor (autumn and winter, in fog and snow). Waders and waterfowl are also considerably affected by collision as migrating during the night, when flying in flocks. The critical power line sections can often be localised, as high casualties occur usually on wires crossing main migrational routes or local flyways between feeding and roosting grounds.

It is not always easy to identify the most dangerous medium voltage power line sections, as the carcasses are often taken away by scavengers (fox, dog, beech marten, etc.), making the exact data collection impossible. The carcasses which can be found give only a severe underestimation of the real losses. According to some authors, 60 % of the carcasses disappear within the first 4 days (fox, beech marten, domestic cat, dog, etc.).

According to the monitoring data of GREFA, Bonelli's Eagle (*Hieraaetus fasciatus*) is one of those species highest susceptible of suffer from electrocution, because the hunting strategy of this species is to hide relatively low to attack the prey, which means that in open landscapes the bird tries to get hidden, so attempts to perch between the wires of the pylons of the middle voltage power lines resulting electrocution. Golden Eagle (*Aquila chrysaetus*) and Spanish Imperial Eagle (*Aquila adalberti*) used to perch on the highest point of these pylons, where the risk of electrocution is much lower.

Results of the long term monitoring revealed, that 50% of youngs of Bonelli's Eagle dies because of electrocution in their first year. The specialists of GREFA survey the home range of the birds equipped with GPS transmitter on the feeding area, and according to their movement they identify the dangerous sections of the power lines and determine which sections have to be insulated or transformed to bird safe structures. Insulation of these lines of pylons is one of the most important nature conservation tasks, but unfortunately it takes also in Spain a long time until execution is implemented.

A new act was enacted in 2009, stating that the dangerous power lines have to be transformed within a 5 year period on the SPA-s. But this process slowed down because of the economical crisis. Those pylons already insulated are safe for the large eagles (Golden Eagle, Spanish Imperial Eagle) and experts think that the population increase (from 140 pairs in 2000 until 350-400 pairs) of the Spanish Imperial Eagle might be also due to these actions.

3.2.2. Mitigation of raptor losses

Investigations of the last decades pointed out, that middle voltage power lines represent one of the main limiting factors for populations of protected raptor species. Therefore, several types of bird protecting structures have been developed internationally. These technical solutions significantly mitigate the bird losses on power lines.

(1) Methods used to prevent electrocution

- Laying the most critical overhead cables underground. Underground cables provide 100% bird protection once and for all, but to bury above-ground cables is very expensive, therefore it can be applied only on the most critical, protected habitats. In Hungary in the Hortobágy National Park a long term project has been started to replace the selected critical overhead power lines to underground cables, between 2006-2015 more, that 115 km power line will be buried (92 km is already done). In the buffer zones of the national park area and in other SPA-s other means of avoiding bird losses due to collision and electrocution also had to be considered and used.
- Transformation of the particularly dangerous pylons (transmission poles, switches, connections, tension towers, etc.) and insulation of them to avoid bird accidents. This is also an expensive solution.

- Installation of devices to inhibit birds to land on the pole. Electric companies developed several types; they are usually effective and cheap.
- Installation of insulations to prevent short circuit. In Hungary an insulation device was developed in 1991, but it has got the disadvantage that it fits only some types of poles. There are some good international developments of insulation devices, which fit to the wires and to the porcelain structures as well, they are universal. As good example the device developed by the American RAICHEM company can be mentioned. These insulation devices might be regarded as the best ones, they are of resistant (against acids and lyes) material and they are long lasting. Similarly good is the Finnish ERNSTO insulation device, both types are used in Hungary.
- Equipments to ensure safe perching for birds also can be installed. The installation of these sitting poles is relatively easy and cheap. They provide protection for the large raptors.
- Using insulated wire also ensures safety in the case of some pylon types.
- In 1999 a new technology was tested in Hungary on a 1.5 km long power line, aiming at the protection of a Red-footed Falcon (*Falco vespertinus*) colony breeding nearby, because birds suffered electrocution in high numbers here. Special star-shaped protecting units of 25 cm diameter were installed on the cross-pieces of the pylons, directly touching the wire and the porcelain insulator. Due to their large size, these units provide also mechanical protection, because they narrow down the space on the iron cross-pieces, reducing the chance for birds to sit here. In addition, they create a mini electric field locally, therefore those birds trying to perch here will get some electric shock, which is not lethal, but divert the bird and it will not try to sit on these dangerous parts. This technology was successfully applied in the USA, mainly to protect squirrels. This bird protection method has not been widely used yet in Europe.

(2) Methods used to prevent collision

Several types of anti-collision devices are used on middle voltage power lines to makes wires visible to birds and avoid bird collisions.

- In Spain the installation of black plastic bands on the dangerous wires is widespread.
- Other type of bird diverter used to avoid bird collision is “Firefly”. This equipment swivels in the wind, the rotational speed of the Firefly increases effectiveness. Firefly use fluorescent colours designed specifically for bird vision and it can be seen even in relatively bad visibility conditions. On middle voltage power lines it can be installed under voltage, which makes the implementation cheaper. It can easily be fixed from the ground with an installation tool. It is easy to move when bird activity changes with the season. On high voltage power lines it can be installed only on switched off wire. We didn’t see this equipment to be used in Spain, in Hungary it is used in several bird habitats, also by Hortobagy National Park Directorate and the experiences are good.
- In Spain on high voltage power lines (750 kV, 400 kV, etc.), besides coloured balls, special spirals (with 55-60 cm diameter) are installed to make wires visible for birds, in order to reduce the frequent collisions of large birds like Golden Eagle, White-tailed Eagle, Griffon Vulture, Black Vulture, and also Great Bustard and Common Crane.

In the frame of the monitoring activity, those areas supporting concentrations of raptors (feeding areas, resting and over-night habitats, migration flyways, etc.) have to be

thematically surveyed and the dangerous sections of middle voltage power lines have to be identified and mapped. GREFA has mapped the critical power line sections with GPS tracking of Bonelli's Eagle. Based on the results of the survey, the critical pylons causing bird losses were insulated. In 2012 two Bonelli's Eagles died here from the 6 released individuals. This work was financed as a compensatory measure due to highway constructions in the region. Unfortunately the technical solution was not appropriate, as the life time of the insulation is 12 year according to the technical parameters, but it get ruined after 2 years. The cost of the insulation of one pylon was 20,000 Euro.

(3) Alternative methods

Usually it takes a long time (several month) from the decision until a "killer" pylon will be insulated, maintaining permanently the loss of the species occurring on the area. In Hungary an alternative method was tested in the Hortobágy National Park, which could be used as a "first aid" mitigation method until the problem is solved with the insulation of the pylon. The method is used on agriculture fields, where 1,5-2 m high T-sticks are placed to the feeding area of the raptors, 20-25 has to be used per hectare, on the spots holding the most dense common vole populations. According to our experiences, raptors favour these shorter perching places, from where they start to hunt and after they return to eat the prey. They were preferred mostly by common raptor species like Kestrel (*Falco tinnunculus*), Common Buzzard (*Buteo buteo*), Long-eared Owl (*Asio otus*), but occasionally Merlin (*Falco columbarius*), Rough-legged Buzzard (*Buteo lagopus*), Great Grey Shrike (*Lanius excubitor*) also used these T-sticks. Frequency of the perching on the "killer" pylons significantly decreased during the investigation period. It is important, that the T-sticks have to be replaced after 8-10 days to other spots inhabited by voles.

3.3. Secondary toxicity and mitigation methods

Secondary toxicity is also a very serious and universal problem of human pressure on raptor populations. Parallel with the world-wide spreading of the intensive chemicalization, always new and new agents considered being harmless appear which after all turns out to have undesirable side-effects. In many cases, it takes decades until the withdrawal of the authority permission for use of those chemicals.

Because of the wide range of groups of chemicals used, it is impossible to give a general overview of the subject in this short paper. We briefly discuss the rodenticides in use and interpret a pioneer project of GREFA, which is a proven alternative to use of chemicals.

In the previous decades the detection of the agents of the chemicals (pesticides) used in agriculture (e.g. organic phosphoric acid ester, carbamat-type compound, organic mercury compounds) was very difficult in many cases because of the inexactness of the laboratory analysis methods, and due to the advanced status of the natural detoxification processes of the living organisms. Fortunately, nowadays the special laboratories are brought up to date regarding the available instruments, and if the sample to be used for the analysis can be taken shortly after the carcass have been collected (if deep frozen it can be kept for longer), the used chemical can be detected with much higher certainty than previously.

Wildlife of the natural habitats and the agricultural ecosystems indicates the unwanted side-effects of the pesticides, but the long-term effect of these chemicals on population level might

be detected only after decades, following a population collapse (since a few years similar tendency can be noticed studying the populations of Red Kite, Common Buzzard and Kestrel).

Concerning plant protection, agriculturists already partly admit, that those chemicals which are efficient to control common vole, hamster, brown rat are mostly harmful to other wildlife as well. Therefore, toxicological analysis of the chemicals used in agriculture practice and the assessment of their hazardous quality has to receive more and more importance.

In the list below those agents are selected, where the possibility of secondary toxicity can not be excluded, or in the case of some of them it was proved by laboratory testing. These chemicals are anticoagulants; their toxic effect cumulates in the living organs (e.g. the coumarin types).

Table 2. Agents may cause or proved to cause secondary toxicity

Agent	Used on arable lands	Used in residential buildings, stables, rubbish-heaps
Chlorophacinon	+	+
Diphacinon	+	+
Cumaclor	+	+
Coumatetralyl	+	-
Warfarin	+	+
Pindone	+	-
Brodifacoum	?*	?*
Bromadiolone	*	*
Diphenacum	*	-
Difethialone	*	*
Flocumaphen	*	*

+ Causing death after repeated consumption
∗ Causing death after one consumption
? Chemicals in trade in Hungary, under withdrawal
- Use allowed only in large-scale farming

Table 3. Lethal doses of the different anticoagulants for rat

Anticoagulant	**LD50 mg/kg albino brown rat**	**Usual bait concentration %**	**LD50 (bait g) for rat of 250 g weight**
Brodifakum	0.25	0.0075	0.9
Bromadiolon	1.125	0.0050	5.6
Ifendakum	1.80	0.0050	9.0
Kumatetrail	16.50	0.0375	11.0
Diphacinon	3.00	0.0050	15
Pindone	50.00	0.0250	50.0
Chlorophacinon	20.50	0.0050	102.5
Warfarin	186.00	0.0250	186.0
Kumaklór	900.00	0.0250	900.0

Table 4. Lethal doses of the different anticoagulants for mouse

Anticoagulant	LD50 mg/kg albino house mouse	Usual bait concentration %	LD50 (bait g) for house mouse of 25 g weight
Brodifakum	0.40	0.0075	0.1
Difenakum	0.80	0.0050	0.4
Bromadiolon	1.75	0.0050	0.9
Warfarin	374.00	0.0250	37.0
Diphacinon	141.00	0.0050	70.5

As the toxic effect of these anticoagulants accumulates, the bait can cause death taken even in very small amount but repeated.

In Spain these problems emerged most apparently in the population changes of the Red Kite (*Milvus milvus*). The centre of the dispersal area of the species is concentrated in West-Europe. The species was widespread and common in previous centuries, but in the early 20th century its population decreased considerably on several locations or became extinct. Germany, France and Spain support the most significant populations. The United Kingdom holds a population which was reintroduced (in a 15 years long programme) after the species became extinct from here, this population is residential. In the early 1990ies the total breeding population was estimated between 3500-4000 pairs in Spain. In wintertime the majority of the European population stays in Spain, previously with a number of 55000-60000 individuals. In the last 10 years the breeding and the wintering population have been drastically fallen. From other hand this is due to the illegal shootings, because there was a strong decline also in the populations of the small game caused by habitat losses. Hunters made Red Kite responsible for the population decline of the Rabbit (*Oryctolagus cuniculus*) and the Red-legged Partridge (*Alectoris rufa*). The other factor, which is even more important was the rodent pest control in agriculture organised on the level of the autonomous communities, when several types of rodenticide (Bromadiolone, Brodifakum, Chlorophacinon etc.) have been used, which caused poisoning for hundreds of raptors. According to the population data of the previous years, the population fall still continues. The breeding population in the region of Segovia between 1994 and 2001 fall by 50%. This trend of decrease is detected in other regions, like Andalusia, Madrid and Valladolid. The status of the species is instable also in other parts of the country, so the population decrease can be regarded as general in most of the areas.

Now the procedure to obtain permit for the use of the chemicals in trade seems internationally to be only a formal, administrative action. These chemicals are not subjected to exact, internationally accredited laboratory testing (GOOD LABORATORY PRACTICE - ecotoxicology), but the parameters given by the producer or the distributor are automatically accepted. The supplementary control of these chemicals focused on not more than the primer toxicity, under laboratory and field conditions. However, it is impossible to correctly assess the influence what pesticides have on the living environment without exactly knowing the mechanism they are acting, and without control it is also not possible to identify any methods, how to avoid the accidental negative side-effects.

Chemicalization of the industrial agriculture reached such an extent worldwide, that we might say that almost week by week new "wonder chemicals" are put on the market. In order to moderate this unfavourable process, it is necessary to re-examine those pesticides being already on the market, and the new ones have to be put under more exact laboratory tests, and also field test, if necessary.

Nowadays in Hungary, similarly to other countries, pesticides have to obtain authority permission before marketing. The authorisation procedure is usually similar to the method used in the EU. This method includes full series of toxicological investigations, results of which give the basis for the competent authority to take decision, whether the chemical can get permission or not. (One remark: in Hungary there was working only one accredited ecotoxicological laboratory, but it was closed few years ago.)

On the other hand, environmental friendly farming and bio farming are getting more and more popular, because people started to recognize, that most pesticides brought into our environment might cause severe problems to human health.

Environmental friendly pest control: an experimental program in Castilla y León

As an alternative way to manage these serious environmental and conservational problems, since 4 years GREFA has started to run an environmental friendly pest control experimental program in Castilla y León community. Previously, during the last peak registered in north-western Spain in 2007, the regional government provided € 24 million for chemical control for common vole (*Microtus arvalis*) with large-scale use of rodenticides (particularly anticoagulants such as chlorophacinone and bromadiolone) and compensations to farmers. Chemical control using rodenticides can cause secondary poisoning of non-target raptors, and resulted big losses of Red Kite, Common Buzzard, Kestrel and Barn Owl. On some parts of the region, the population of the Red Kite fall by 50% because of secondary poisoning.

In the frame of the biological control experiment, 3 study areas have been selected on agriculture fields in Castilla y León in the provinces of Valladolid, Zamora and Palencia, where common vole populations reached high densities during the last vole outbreak of 2007. The study areas are partly staying under protection. Each study area is 2000 ha, and a control plot of the same size was also selected, at least 4 km far from the study area but in similar habitat. This distance is enough to have no influence of the nest boxes on the control plots. **The use of chemicals is forbidden on the experimental areas.** These tree experimental areas are located in a distance of 50-60 km from each other. A total of 300 nest boxes were installed on the 3 experimental plots. In each experimental plot 100 nest boxes were erected on wooden pillars, 50 for Kestrel (*Falco tinnunculus*) and 50 for Barn Owl (*Tyto alba*). The nest boxes for Barn Owls are erected on lower elevations, while those of for Kestrels on higher elevations, on the top of the hills. When a new nest box is installed, Kestrel or Barn Own pellets are placed around the pillars acting as key stimulus and attracting Kestrels and Barn Owls from other locations. The experts found, that the nest boxes manipulated this way were occupied more frequently. As a strong competition was found from Kestrels, on each study area distinct “kestrel areas” and “owl areas” were selected (they differ in the location and type of nest box). Kestrel also occupy the Barn Owl nest boxes, therefore an internal partition wall was built in the owl boxes, because owls prefer the darker interior spaces, and this box type was more often occupied by them. The wall also protects the owls from Kestrels. After the first experiences, the owl nest boxes were modified with the installation of a wide board in front of the hole of the box. In years of high vole densities Barn Owls might have big clutches with 7-9 chicks and also two clutches per year, therefore the youngs with different age and size have not got enough space in the box, and the youngs start to creep away, which is a typical behaviour. As a result of this, many youngs fall out the box and die, resulting very high mortality of youngs. Bigger nest boxes might solve the problem, but under the local climatic conditions the frequent strong wind would fell down the bigger size boxes.

Therefore, the problem was solved with an entrance board to protect the youngs from falling out and the same size of box. It was also observed, that these wooden pillars are used as perching places by other raptors (e.g. Red Kite, Common Buzzard) in these treeless plain landscapes. Researchers observed, that mainly Common Buzzard get accustomed to prey the newly fledged Kestrel youngs and in the dusk the Barn Owl youngs.

In the beginning very strong conflicts had arisen with the hunting associations of the experimental areas, because the sites very rich in prey (*Microtus arvalis, Apodemus sylvaticus, Mus musculus domesticus*) attracted also other raptors (Spanish Imperial Eagle, Booted Eagle, Red Kite, Common Buzzard) in higher numbers. The more frequent occurrence of these raptors resulted higher predation pressure on the small game species like rabbit (*Oryctolagus cuniculus*) and the Red-legged Partridge (*Alectoris rufa*).

In order to solve the conflict, co-operation agreements were signed with the local hunting associations and suitable hiding places have been planted for small games. Small woods, willow-groves, shrubs were introduced on the edge of the agriculture fields, along watercourses, channels, and the improved habitat conditions provided better chances for survival and reproduction for the game species. Even more important aim of the habitat enhancement is to abandon some cultivated fields and to ensure refugees for wildlife covered by natural vegetation, which is suitable not only for the games species, but also other preys like insects, amphibians and reptiles. Abandonment of plough lands on the long term has a positive impact to heighten biodiversity. This management of the conflict can be accepted by both stakeholders, as majority of the farmers are hunters as well.

Practical results of the biological control experiment have convinced step by step the local farmers, showing a more economic way of farming. One significant factor in reducing costs is to eliminate the expensive rodenticides from the production technology. **Monitoring data has proved, that one Kestrel pair raising a usual size of 4 youngs eat 500-800 common vole during the breeding season.**

Monitoring with raptors: a method used in the experiment to asses vole densities

The study areas (experimental and control areas) are continuously monitored, including analysis of owl pellets (in owl pellets the sculls and jaws of small mammals remains completely intact after digestion) in order to have an estimation on the actual densities of the prey species. Data analysis results give indication about the population trends of the Common vole (*Microtus arvalis*), which is the most dominant prey. The population trends of the vole can be best followed by the breeding success of the Barn Owl, as this species is rather feed specialist, therefore if the vole population significantly fall on the hunting area it can be seen in the number of the raised youngs. In this case the second breeding often fails. In the case of the Kestrel this phenomena can not be detected, as this species is rather feed generalist, and in periods with low vole densities Kestrel change his diet to other preys like insects, lizards, other small mammals, etc. Kestrel has got more flexible hunting strategy compared to Barn Owl.

Short-eared Owl (*Asio flammeus*) is also considered to be a good indicator of the prey. The appearance of the species in higher numbers in a crop field, especially in winter time, indicates high densities of Common vole in the crop (e.g. alfalfa).

Marking of Kestrel and Barn Owl youngs with colour rings on the project area to monitor their expansion is integral part of the research.

The 100% nest boxes on the experimental plots is in general occupied in 40% by Kestrel and 10% by Barn Owl, in a place even 70 pairs of Kestrel occupy the nest boxes. It is planned for the future to expand the erection of the nest boxes along water courses and alfalfa fields with more 50 nest boxes, as these places are very good vole habitats. The cost of producing one nest box and installing it on the site is € 100.

Investigation data supports, that vole gradation is interrelated with the irrigation practice of agriculture, as soils with optimum moisture condition promote the spreading of the species and shorten the gradation periods. In this region vole outbreaks occur generally in every two years, while in Hungary only in 4 years.

In the environmentally friendly agricultural technology it is very important to integrate different methods. Agro technological methods can be used not only for mechanical control (disk harrowing, shallow deep-ploughing, flooding the plot for a short period) of voles, but destroying their tunnels they became more easily victims of predators. The soil cultivation forces them to migrate, which results significantly higher mortality. Investigations have proved, that a single disk-harrowing of the stubble-field results the death of 50-60% of the local vole population.

Local farmers are getting more and more convinced of the efficiency of the biological control. When the experimental project has been started in 2007, it was financed by biodiversity projects of the Ministry for Environment in order to protect the endangered raptor species. In the future, the continuation of the project will be financed by the local Ministry for Agriculture focusing on the biological control. This is thanks to the success of the project verified by monitoring data, which also were used to convince the community.

Monitoring data also revealed that the Red Kite population has increased by 20% on the experimental area.

Observing the success of the project, GREFA decided to introduce the biological control to new areas in the future. Previously the local government has provided subsidies to farmers for the chemical control of common vole, but more and more farmers intend to turn to the biological control. In Palencia, under a more wet local climatic condition vole outbreak appears in every second year, and a large amount of money has been paid for chemical control. In this region the local ministry for agriculture plans to try the biological control. On the pilot project area the local mayor was largely suspicious about the project in the beginning, but later, based on the experiences and the success of the project he became one of the biggest supporters of it. He participates the awareness raising events organised about the biological control and attempts to convince farmers and hunting associations.

It is also planned by GREFA to introduce the biological control in other autonomous communities.

Please find details on the experiment and on the monitoring methodology used in the referred paper *Paz et.al.* (2012).

3.4. Birds breeding in captivity: role in the conservation of endangered raptor species

The objective of the birds captivity breeding programs run by GREFA in its wildlife rehabilitation centre is the protection of those raptors endangered due to human impacts and the stabilization or increase of their populations.

3.4.1. Monitoring methods

All conservation programs involve monitoring.

High-quality monitoring is essential part of recent re-introduction programs. Experts at GREFA apply a few methods to gain appropriate information on the released birds. This information allows evaluating, how successful was the preparation of the bird for the release to the wild, and give indication of the necessary modifications in the implementation of the conservation projects.

Colour foot-rings, and marking of the wings with painting or small plastic sheets with numbers are some of the simplest marking methods used.

Other method used is the application of radio-telemetry transmitter to the back or tail of the bird. The transmission distance of these devices are not wide (20-100 km), but with tuning to the appropriate frequency they allow to follow individually the released birds.

The most up-date and efficient method is the application of the GPS transmitters. These devices usually work with solar energy, so theoretically their lifetime is unlimited. The actual location of the birds is provided with the highest accuracy with GPS coordinates.

Transmitters of different weights are used for different raptors: 20 g for falcons, 30-45 g for eagles, 70 g for vultures. In order to minimise the sources of errors in this work, it is always the same expert having all the skills, who fix the transmitters to the birds.

The price of these transmitters are around 3000 €, and the data can be gained even from the mobile telephone network with the newest development of **GSM/GPS transmitters**. This is a completely new technology, which was used only as a prototype in 2012 and GREFA's experts used it to mark Black Vultures. Exact bird localization data can be received from the mobile telephone network daily or each second day. The monthly cost of receiving the data is around 20-30 €, which is much lower compared to the data providing of the traditional satellite method.

"Groupe Spécial Mobile", a telecommunications standard set for digital cellular networks. The GSM system is now used in over 220 countries. The GSM/GPS transmitters are also capable of transmitting more data than an Argos/GPS PTT (traditional) and, ultimately, are much more cost effective per unit of data transmitted. User fiendly data access: data are transfered from the unit to our server from anywhere in the world where there is GSM coverage. Normally within 10 minutes of receiving the data the server will automatically parse the data and email three output files directly to the customer.

Data Flow from Transmitter to User (source: **http://microwavetelemetry.com**):

3.4.2. Conservation programme of endangered raptors with captivity breeding

(1) Bonelli's Eagle (*Hieraaetus fasciatus*)

Conservation status: endangered, unfavourable conservation status in Europe, on IUCN Red List.

The project aims at the reinforcement and reintroduction of the species for the recuperation of its Spanish population. In 2010 Bonelli's net was established, a group for the recuperation of Bonelli's populations in Madrid, Navarra and Mallorca, three of communities where the number of individuals of this species is decreasing. Even though these projects are realised in local activities, their aim is to restore the whole Mediterranean Bonelli's Eagle population. The project is a pioneer one; nobody has tried before the reintroduction of this species in large scale, involving several autonomous communities.

There was 16-17 pairs recorded in Madrid Community in the 1990ies, today there are only 2 known nests. Annually only one of the 2 pairs used to have successful breeding. According to the monitoring data the survival rate of youngs in the first year is 50%. Similar trend was recorded in Navarra, the breeding population fell to 2 pairs. The species has been extinct from Mallorca since 40 years. The stronghold of the European population is estimated to be 100 pairs in Andalusia; this population is the basis of the reintroduction programme. Bonelli's Eagle usually lays 2 eggs from which only one is raised. Cannibalism ("Cainism") of the chicks is a typical phenomenon for this species, and shortly after hatching the stronger chick (hatched 1-2 days sooner) will dominate the other, resulting his weakening and death. Therefore, GREFA takes the weaker chick from the natural nest and raise them in captivity until 3-4 weeks age, later on he get taken back into the nest. There is no more aggression between the chicks in this age and both youngs will successfully leave the nest. In Hungary the same method was used to save Lesser Spotted Eagles (*Aquila pomarina*) youngs.

It is often found during the check of the natural nests, that chicks suffer from different diseases (e g. *Trichomonas*). After it will get successfully cured at GREFA centre, the young will be replaced into the natural nest or kept for captivity breeding. Recently the forming of 7 breeding pairs is attempted, now there is 3 breeding pairs in the centre. Bonelli's Eagle captivity breeding is complicated, as the species is very sensitive to any noise and moving. Therefore, they are kept in completely closed aviaries, when all the necessary keeping activities can be provided with minimal disturbance.

Madrid
The project has been started here in 2010, one year before the implementation on national level. Since the beginning 6 individuals have been released, all equipped with GPS transmitter for their monitoring.

There have been 6 youngs released in 2012 with the so called hacking method. Hacking: artificial nest is created in a suitable habitat and the 45-55 days youngs are placed here in pairs. The birds are fed, but in a way that they can not see any human. After they left the nest they regularly return to it, where living prey is provided for them (partridge, pigeon, rat, etc.), ensuring in this way to exercise their hunting technique.

The GPS following of the released birds provided surprising information on all the the first phase of the dispersal, with movements to the limits of the Iberian peninsula, covering the coastline at Castellon until Gibraltar, the coastline at a Coruna until the Portuguese coast at Algarve, passing also the central highlands and Extremadura.

In 2010-2011 from the released 6 individuals 3 have survived until today and keep hunting in the surroundings (Toledo and Badajoz). Regrettably, 3 birds died during the first 6 month of their life, they were killed by electrocution in different parts of the country. In this year (2012), 2 individuals of those ones released this year were killed by electrocution.

These monitoring data proved, that the main cause of death of the youngs of this species is electrocution.

Navarra
One young born at GREFA Wildlife Centre and another from France were released in a nature reserve (Reserva de Caparreta).

Mallorca
Altogether 6 individuals have been released in 2011 in the mountains of the northern part of the island. 4 chicks were born in captivity (3 at GREFA) and 2 youngs born in wild (they were released with acclimatization cage method). All the 6 keep moving on the island, using the plain territories as a hunting area for rabbit and partridge. The monitoring detected difference in their diet: the released two youngs are specialised for wood pigeons and see gulls along the coastline, where they stay since their liberation.

Monitoring method: GPS tracking/Satellite

(2) Golden Eagle (*Aquila crysaetos*)

Conservation status: rare, unfavourable conservation status in Europe.

The reintroduction program has been started in 2001 in Galicia. During the last decade GREFA has released 18 chicks (raised in the centre) of Golden Eagle in the Natural Park Baixa Limia do Xurés, Ourense. Recently they work with 2 breeding pairs and since this year 2 other pairs is planned to form. In the design of the aviary it is important, that eagles could have good outlook to identify all external stimulus. The pair generally lays 4-8 eggs per year. The first clutch will be taken from the nest after 10 days and will be artificially incubated, therefore the pair starts a second breeding, but with less eggs (1-2) this time. There were 3 youngs and one adult birds released in the frame of the project in 2012.

The monitoring of these eagles is performed by GPS satellites. In the beginning the birds were marked with radio transmitters VHF terrestrial, but this equipment required in situ following with radio receptor. Since 2008 the monitoring is performed by GPS, which method is more expensive but more effective in providing data. There have been 7 individuals marked with GPS since 2008, from which 4 is still providing data. This tracking provides very interesting data about home ranges and juvenile dispersal areas, the threatening factors and allows the surveillance of each of them throughout their development. The reintroduction project also includes conservation actions to mitigate the identified threatening factors, like transformation of the dangerous electric power lines and combating the use of poisons, which is the main cause of death of the species in Spain. In order to complete the information about the species in Ourense province, in 2012 one wild individual was also marked.

Thanks to the project the number of territories of the species in the province of Ourense has increased in recent years, reaching today 6 pairs.

Monitoring method: GPS tracking/Satellite

(3) Black Vulture (*Aegypius monachus*)

Conservation status: rare, globally threatened, on IUCN Red List. SPEC 1: Species of global conservation concern.

The European population significantly decreased by the middle of the last century, the species became extinct from several countries. In this time the Spanish population was around 200 pairs. Due to the active conservation efforts, recently the breeding population is around 2000 pairs. Several reintroduction and population strengthening programmes have been implemented, in Catalonia in the Pyrenees, in Portugal and in the Massive Central. Despite the conservation status of the species is still instable. Extinct from large part of the Balkan (Albania, Serbia, Macedonia, Croatia, Romania). In Bulgaria and Greece only a few breeding pairs survived. In South-Eastern Europe the survival of the species is uncertain. The highly fragmented, small populations located far from each other and their status is totally unstable. In Ukraine 2-5 pairs, in Russia 20-40 pairs, in the Caucasus (Armenia, Georgia, Azerbaijan) 80-110 pairs can be found. Asia Minor (Turkey) holds a population of app. 100 pairs.

GREFA runs a reintroduction project of the Black Vulture to the Pyrenees. The project began to show results in 2010 with the birth of the first chick of this species in the region after their extinction since more, than hundred years.

In the Wildlife Centre of the GREFA 4 pairs are kept in captivity for breeding. The pair lay only 1 egg, the incubation period is 55-56 days long. In 2012 only two pairs had successful breeding, the youngs were separated after 80-85 days and after getting accustomed to the new

habitat conditions they were released in the Pyrenees (Sierra de Boumort) near a feeding station, where they can join other individuals and learn the necessary behaviour patterns for the survival from the adults.

More information: www.blackvultur-pyrenees.org

(4) Lesser Kestrel (*Falco naumanni*)

Conservation status: depleted in Europe, globally threatened, vulnerable on IUCN Red List. SPEC 1: Species of global conservation concern.

The Spanish population was 100,000 individuals in the 1950ies, which declined to 30,000 by the 1970ies. The intensive chemicalization of the agriculture is thought to be the main cause of the population decline. On the first place, the rapid spreading of the use of insecticides is responsible for the decline, and also the drastic diminishing of the potential nesting places. This species breeds in buildings (silos, church towers, castle ruins, barns, dove-cots, etc.). During the renovation of these type of buildings the suitable and previously actively used nesting places (edges, corners, etc.) disappeared. Nowadays it is very rare in Spain to see it nesting in decaying tree or in loess ridges in the hole of Bee-eater. Other problem is presented by the negative human impacts on the wintering area in Africa, but there are only assumptions about these factors yet. According to the data of the colour-ringing monitoring programme of the species carried out since several years, it is only the 20% of the youngs, which returns to the breeding area in the following spring.

(a) Corridors for the Lesser Kestrel - setting of nest boxes on buildings

This is a long term project to stabilize the population of the species, or possibly to increase it. This project aims at restoring Lesser Kestrel colonies by reformulating old structures and setting nest boxes in local buildings (silos, electric poles, old buildings, etc.) and by constructing specific structures - "Primillares" - in order to reintroduce the species and to help it's re-expansion. GREFA has worked in regions of Madrid, Cuenca, Guadalajara, Cáceres, Badajoz, Ciudad Real and Córdoba, making up more than 60 places and more than 2000 nest boxes. The result of the project is 30 new colonies and 50 % occupation.

GREFA has started to set nest boxes on buildings in the 1990ies. Special tiles, wooden nest boxes and nest "holes" from concrete were built and installed to several renewed buildings, even on restored castle ruins. Practical experiences induced some structural modifications to do on the nest boxes. For example the concrete nest boxes facing south did get overheated and as the chicks could not bear it jumped out from the nest. In other cases the nest boxes had to be made safe from the predation of Magpie with a separation panel at the entrance, and the problem with the predation by (*Genetta genetta*) in the "Primillares" is still need to be solved.

(b) Building of "Primillares"

Lesser Kestrel was considered as a species threatened with extinction in Madrid region. GREFA has constructed specific buildings in the region to make possible the breeding of the Lesser Kestrel, in order to recover the populations by means of the reintroduction of individuals bred in captivity. Due to this project, the 22 % of the Lesser Kestrel population of Madrid is localised in these specific buildings, which also fit to the landscape. The

reintroduction project has been started in 2002, and from 6 pairs reached 81 breeding pairs in these buildings.

40-45 pairs are involved in the captivity breeding programme. Female and male adults are kept separated until the start of the breeding season (March). When the displaying behaviour begins, the breeding couples are formed with regard to combine the previous pairs (based on the ring numbers). This is because better breeding success can be expected in this way. If the adult does not accept the pair in the first few days, changes are made to find another pair. One couple lays generally 7-8 eggs. This number can be reached if the eggs of the first clutch (4-5) are taken from the nest after 10 days, stimulating the birds to lay a second clutch of 2-3 eggs. The chicks of the second clutch are raised by the adults. The eggs of the first clutch are incubated artificially and raised by man until 4-5 weeks. After this, when the youngs are already able to feed alone but before full fledging (can not fly yet), the experts start with the procedure to prepare them for the release. Generally 75% of the total egg number will be successfully hatched, the young raised and released to the wild.

Table 5. Captivity breeding data of Lesser Kestrel (*Falco naumanni*) at GREFA, 2009-2012

Year	**Number of youngs (db)**
2009	164
2010	247
2011	297
2012	320

Those chicks raised in the wildlife centre, but unable to fly yet, will be taken into special buildings of artificial colonies in an area of 24 km diameter.

In these buildings GREFA's specialists feed the youngs, and they are continuously controlled and monitored until they live the nest boxes. The continuous monitoring means not only field observations, but all activity is followed by permanent video control in each building.

The youngs can not see man in these artificial colony buildings. Generally 40 young are taken into one building. In the breeding season in March the whole process starts with taking some adults from the wildlife centre into the colony tower and they are kept in a big outside volier. In this volier the birds have direct contact with their environment, and in this way they attract birds with displaying behaviour those birds returning from the last year's youngs of this tower, to settle here and breed. Youngs are usually returning to the place where they left the nest in the previous year (they are philopatric), but from the second year they join other colonies. Colour ringing monitoring data also revealed that some individuals join natural colonies to breed. The appropriate distance of the different colonies makes the continuous connection and interchange possible between the artificial and natural colonies, which are one of the most important aims of the project.

22% (86 pairs) of the breeding Lesser Kestrel population of Madrid Community breeds in 8 artificial towers built by GREFA. In 2012 600 young birds were colour ringed 300 from captivity breeding and 300 hatched wild in the towers. In the vicinity of the releasing areas experts inform farmers about the protection of the species and about their role in the biological control through feeding on voles and insects. They try to convince farmers not to use chemicals in this region. They also co-operate with local governments in the programme.

Monitoring: marking, banding, video control.

3.5. Poisoning and mitigation: artificial feeding of raptors

3.5.1. Raptors as indicator: chemical load on environment

The industrial and social development of the last 200 years provided more and more chemicals for the service of mankind, including also biologically active ones in increasing numbers. Several synthetic organic compounds have been applied, which does not occur in the natural environment, and when they get in the biological processes, it takes very long time until they get degraded.

Unfortunately, the use of biologically active compounds grew to so considerable size nowadays, that chemicalization of our environment, especially in agriculture became a characteristic feature of our modern life. Consequently, wildlife became overloaded by new, biologically active substances.

In the last decades it was proved in the case of many pesticides, that their agents get accumulated in the living organisms (bioaccumulation). Environmental analytics proved, that for example the half-period of the DDT can be measured in decades. These substances are the so called persistent compounds, which decays very slowly or their metabolites have even stronger negative biological influence. Most common types: DDT (dichlorodiphenyltrichloroethane), DDE (dichlorodiphenyldichloroethylene), lindane (HCH - Hexachlorocyclohexane) – banned in 2000, heavy metals (mercury, lead).

In conservation researches raptors have been investigated as indicators of these environmental loads. It was also suspected, that those pesticides responsible for population declines of raptors, which were already withdrawn from the market, still keeps influencing the population size of raptors until nowadays. Pesticides from the environment are taken by the prey (doves, pigeons, rodents, etc.) into the organism of raptors.

In Hungary the national conservation programme for the Saker Falcon (*Falco cherrug*) has been started in the early 1980ies, when some not hatched eggs and died embryo were collected for analysis. The scale of the investigation (number of samples) was limited by finance; it was carried out by colleagues of the Hortobágy National Park Directorate. Independently from the Hungarian research, similar investigations of eggs have been carried out parallel in Bohemia and Slovakia, giving good possibility for comparison. Czech colleagues carried out the analytical investigation of the collected eggs (19) in the period of **1978-1996** (Dr. Vojtěch Mirlik, Ústav ekologie krajiny AV ČR. Květná 8, 603 65 Brno. Czech Republik). Investigations revealed that a metabolite of the DDT (DDE) was still present in significant amount in the eggs.

Table 6. Amount of chlorinated hydrocarbon type pesticides in the egg of Saker Falcon (*Falco cherrug*), mg/kg dry material (1978-1996), Czech Republic

Sample/piece egg	**HCB mg/kg**	**αHCH mg/kg**	**μHCH mg/kg**	**DDT mg/kg**	**PCB mg/kg**	**DDE mg/kg**
A	9.4	-	-	-	-	**18.8**
A	2.180	-	-	-	2.231	**7.370**
A	1.364	D	0.118	-	D	-
A	5.990	-	-	-	2.289	**18.42**
A	0.292	-	-	-	0.782	**9.784**
A	1.740	0.016	0.063	D	-	**2.510**
A	0.520	D	0.016	D	-	**1.390**
A	0.04	-	-	0.03	-	**3.10**
A	0.05	-	-	0.12	-	**1.59**
A	0.18	-	-	0.12	-	**1.37**
A1	0.02	0.00	-	-	0.10	-
A	0.94	-	0.01	-	2.16	-
A2	-	-	-	4.44	8.42	-
A	-	-	-	-	0.24	-
A	-	-	-	-	0.48	-

D (in traces, amount unmeasurable)
A (1 egg in one clutch)
A1 (4 eggs from one clutch, mixed sample)
A2 (3 eggs from one clutch, mixed sample)

In Hungary in the breeding season of 1984 unfertile eggs or eggs with dead embryos were analysed for heavy metals (mainly for mercury and lead) and chlorinated hydrocarbon type pesticides, using gas chromatography, the most update analysis method of that time. Unsuccessful eggs were collected from the continuously watched nests and used for the analysis.

Table 7. Inorganic mercury amount and total mercury amount in the egg and embryo of Saker Falcon (*Falco cherrug*), mg/kg dry material (1984), Hungary

Sample	Inorganic mercury	Total mercury
Eggshell (Bükk National Park - Bánvölgy)	**0,210**	**0,275**
Eggshell (Tarnalelesz 1)	**0,105**	**0,138**
Eggshell (Tarnalelesz 2)	**0,072**	**0,692**
Complete egg (Tarnalelesz 1)	**0,139**	**0,275**
Complete egg (Tarnalelesz 2)	0,000	**0,692**
Embryo (Bükk National Park - Gerennavár)	0,000	**0,413**

Table 8. Amount of chlorinated hydrocarbon type pesticides in the egg and embryo of Saker Falcon (*Falco cherrug*), mg/kg dry material (**1984**), Hungary

Component	Egg	Embryo
alpha-HCH	0,000	**0,014**
gamma-HCH	0,000	**0,052**
beta-HCH	**0,035**	**0,164**
delta-HCH	0,000	0,000
Heptachlor	0,000	0,000
Aldrin	0,000	0,000
Dieldrin	0,000	0,000
P, p' DDE	**12,800**	**19,700**
O, p' TDE	0,000	0,000
P, p' TDE	0,000	**1,260**
P p' DDT	0,000	0,000

Similarly to the results of the Czech investigation, the metabolite of the DDT (DDE) was present in high amount in the eggs and embryo in the Hungarian samples also.

These results are remarkable, because the investigations were carried out nearly in the same time and in relatively big distance. It means, that the pesticide load of the environment was significant in that time, according to the measurable amounts these regions were generally polluted.

After 25 years this small scale research was repeated by the Hortobágy National Park Directorate. As Saker Falcon moved from the hills to the plain to nest, eggs were collected from the plains. The following eggs were collected at the end of the breeding period in 2008 and 2009, from Hortobágy, South-Nyírség and Bihar, altogether 11 eggs from 8 nests. Clutches with several eggs were taken as one sample in the investigation.

Table 9. Amount of chlorinated hydrocarbon type pesticides and heavy metals in the egg and embryo of Saker Falcon (*Falco cherrug*), mg/kg dry material (**2008-2009**), Hungary

No sample Component	**1. (mg/kg) eggshell**	**2. (mg/kg) eggshell**	**3. (mg/kg) egg**	**4. (mg/kg) egg**	**5. (mg/kg) egg+ embr.**	**6. (mg/kg) egg+ embr.**	**7. (mg/kg) egg**	**8. (mg/kg) egg**
A-HCH	<0,001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachlor	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Δ-HCH	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachlor-epoxid	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
P,p-DDE	**0,01**	**0,07**	**0,1**	**0.17**	**0.06**	**0.09**	**0.2**	**0.009**
Dieldrin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
P,p-DDD	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.005**	<0.001
B-endosulfan	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
P,p-DDT	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury	**<0.10**	**<0.10**	**0.13**	**0.11**	**<0.10**	**0.17**	**0.16**	**0.28**
Lead	**<2.0**	**<2.0**	**<2.0**	**<2.0**	**<2.0**	**<2.0**	**<2.0**	**<2.0**

Compared these data to those ones from 1984 it is remarkable, that DDE was present in much smaller amount.

Of course, these data are only for information, because the small number of samples does not allow taking solid final conclusions, but it is enough to keep the attention focused on this general problem.

The use of seed-dressings (fungicides) containing organic mercury was banned in the late 1970ies, despite it was in measurable amount in the samples. They are characterised by strong persistence, they are decaying very slowly in the environment. It gets accumulated in the living organisms and towards the top of the food pyramid the toxic effect gets more concentrated (bio magnification). The use of these chemicals was restricted to seed-dressing (maize, wheat) only. Saker Falcons take these chemicals through preys: pigeons and doves feeding on agricultural lands.

The situation is very similar in the case of the lead, exhaust gas of cars, accumulators, lead shots pollute the environment with lead. In 1984 in the Bükk National Park, Hungary in the liver of a dead Saker Falcon embryo 0,68 mg/kg lead pollution was detected..

Other group of chemicals causing problems is the chlorinated hydrocarbons (insecticides), they are also very persistent and the decaying very slowly, during decades. They get accumulated int he food chain and get stored in the fatty tissue. Since 1968 in Hungary it is prohibited to use chemicals containing DDT, technical HCH, aldrin, dieldrin, etc. These insecticides are decaying very slowly and get accumulated in the living organisms, even in nowadays can get into the organism of Saker Falcons from insectivorous birds (Starling, Thrushes, Larks, etc.). Therefore, raptors might suffer not only lethal poisoning but also sub lethal poisoning. This kind of problem was revealed by Hickey and Anderson when they found, that the chlorinated hydrocarbons produce errors in the calcium metabolism in the organisms of birds, resulting weaker eggshell and the egg get more easily broken.

Toxic substances deposited in fatty tissue start to have an effect, when during longer hard weather conditions the bird can not catch prey and the fat deposits of the body will get mobilised. We do not know the mechanism, how these residuals reduce the self-protecting ability of the immunity system of the falcons, and a normally harmless micro-organism how can turn to be pathogenic.

Repeat of these investigations would serve more information on the actual level of these pesticides in the organism of the falcons, as these substances are still present after 20-25 years to some extent and the changes could be monitored.

In spite of the use of the DDT is banned since 1968, pesticides containing chlorinated hydrocarbons are still used (Thionex 50WP, Thiodan 35EC, Thionex 35EC etc.), although they have endosulfan agent.

Pesticides traded nowadays are less persistent; they cumulate and accumulate in the food chain to less extent.

GREFA did not carry out this type of investigations in the years past.

3.5.2. Primer poisoning of raptors

In spite of their legal protection, since the 1990ies the illegal poisoning of raptors has increased all over in Europe. The detected cases are probably only a small portion of all illegal poisonings occurred.

Poisoning of raptors seem to be animated by two main motives, one of them is the population increase and expansion of red fox, wolf and golden jackal, raising the possible conflicts with farmers. The other reason is the aversion to raptors, which is always present in the attitude of some hunting associations. In several cases it was proven, that the poisonned bait was placed out to such an open area, where not only fox, wolf, golden jackal could easily find, but also raptors. In many instances the poisoned bait was put near the nest of Imperial Eagle or White-tailed Eagle, and the poisoning of the adults resulted the death of the youngs as well. The illegal use of pesticides for poisoning is increasing among animal keepers and hunters.

These pesticides are very strong poisons, categorised in the first danger class as particularly dangerous chemicals. The **Chinufur 40 FW 40 %** has **carbofuran** agent, used for soil disinfection and seed treating (liquid). The **Furadan 10G 10 %** has **carbofuran** agent, insecticide, used for soil disinfection. The **Furadan 4F 40 %** has **carbofuran** agent, insecticide, used for seed treating (liquid). The **Marshal 25BC 25 %** has **carbosulfan** agent, insecticide, used for soil disinfection. The **Thimet 10G 10 % phorate** agent, insecticide, used for soil disinfection. Physiological impact: it inhibits acetylcholinesterase, acetylcholin will be accumulated, and the impulse will stay permanent leading to spasm of the muscles. The death is due to the spasm of myocardium and respiratory muscles.

Majority of the poisoned birds is found too late, when they can't be saved. But if the birds are found in time, they can be successfully treated with injecting 10 % magnesium sulphate and Atropin sulfuricum into the crop continuously until the symptoms will be stopped.

3.5.3. Artificial feeding of raptors

Poisoning cases found out until now and handled by legal means almost did not entail any sanctions to prevent further poisonings. Therefore, nature conservation organisations have to elaborate proposals for the solution on global level, which can be applied everywhere in Europe.

In Spain there are big differences in the occurrence of poisonings between the autonomous communities, also the regional legislations are different. For example in Toledo region poisoning occurs frequently (causing big problems for Spanish Imperial Eagle, to less extent for Golden Eagle), in Madrid region poisoning is less frequent. There was established a national working group to examine the cases of poisoning, members of which includes national WWF and BirdLife organisations and GREFA.

On the working area of GREFA poisoning relatively frequently occurs, several individuals (Griffon Vulture, Black Vulture, Spanish Imperial Eagle, Bonelli's Eagle, Red Kite, etc.) are admitted to the wildlife centre because of poisoning (see point 3.). In the last years an expert team was established which was specialised to examine the poisoning cases, working with specially trained dogs to find poisoned bait carcasses. For example in Extremadura the hunting right of some hunting associations were suspended during the period of the

investigation. Regrettably, these initiatives had been finally stopped referring to financial reasons.

At present the establishment of legally controlled feeding stations seems to be the only solution for mitigation against poisoning. The all year round maintained feeding stations attract raptors because of the easily available food, and the survival chances of those birds regularly feeding on these places are much better compared to those birds feeding on uncontrolled areas.

Similar feeding project is maintained in several European countries for example for the protection of the White-tailed Eagle (*Haliaeetus albicilla*), e.g. in Finland, Norway, Hungary. In the frame of the vulture conservation projects, feeding stations have been established in Macedonia, Croatia, and Serbia. In Austria and Switzerland winter feeding of Bearded Vulture (*Gypaetus barbatus*) and Red Kite (*Milvus milvus*) is carried out.

From the EU member sates permitted feeding stations are maintained on protected areas of Bulgaria, Greece, Spain, France, Italy, Portugal, Cyprus basically for the protection of the scavenger vultures, but other raptor species (Imperial Eagle, Golden Eagle, White-tailed Eagle, Black Kite, Red Kite) also often visit these places.

In Spain recently there exist about 150 permitted feeding stations, and some 60 more along both sides of the border to France in the Pyrenees. In two national parks (Monfragüe and Cabaneros) there is no need to feed vultures as they have enough natural food supply (red dear, wild boar, etc.) In Madrid region (Cordillera Central) there is not feeding yet, the intestines from hunting and the carcasses from animal keeping provides food for vultures. In the last years GREFA's experts found that the natural food supply is decreasing, as several weakened young vultures were found (20-25). Another unfavourable phenomenon gets strengthened in the last years; vultures visit in increasing numbers the rubbish heaps because of the shortage of food. Several cases were detected, when some indigestible objects (plastic, metal pieces, broken glass, etc.) get into the crop of the vultures causing death in increasing numbers. GREFA decided to establish feeding stations nearby those rubbish heaps considered to be especially dangerous. The authorisation process is recently going on; the feeding stations will hopefully attract vultures from the rubbish heaps.

Protection of vulture species is a priority programme of GREFA (VULTURNET). Spain is the only country in Europe, where all the four vulture species occurs in high numbers; therefore it can be called as the "genetical reserve of vultures". As a result of the active protection on global level of the last decades, a migration wave has been started among European vulture populations, especially Griffon Vultures. Some individuals wander larger and larger distances and use those migrational routes, which were known only in the last century. In the last decades mainly the young, subadult individuals have increased tendency for wandering. Remarkable, that more and more vulture observations are reported from north-western, south-western and east European countries lately. According to the 2012 autumn census, 5 thousand young Griffon Vultures passed at Gibraltar to Africa. GREFA coordinates or participates several national and international programmes for vulture reintroduction to the traditional breeding areas. Since 2007 GREFA runs a Black Vulture reintroduction programme in the Pyrenees, and already in 2010 one pair was successfully breeding in an artificial nest. There is another Black Vulture reintroduction programme in Portugal. In France (Massif Central-Grands Causses) Black Vulture and Griffon Vulture reintroduction programmes are implemented. In Italy in Pollino and Abruzzi regions for the reintroduction of

Griffon Vulture, in Bulgaria in the mountains of Pirin and Rodope for the strengthening of the reduced and stagnant populations 70 Griffon Vultures were released in 2011 (in the two countries totally). The tried and tested method of the reintroduction is to install a big acclimatization cage in a good breeding habitat nearby a feeding station and the vultures are kept here for a longer period before releasing. Usually these are adult birds and may form pairs already in the cage during the acclimatization period, where they spend usually 6-12 months. The birds are released only after this time, and it is very important, that they have to be released during/near the mating season. In this case it might happen that some of them they will successfully breed already in the first year of the release to their new habitat.

There is under elaboration a vulture conservation programme for the Carpathian Basin region with the help of the GREFA. The first step of it might be a Slovakian-Hungarian-Romanian co-operation aiming at the reintroduction of the Griffon Vulture to the former traditional breeding areas in the Carpathian Mountains. The most important precondition of this programme is to establish and maintain a feeding station network in the competent regions. The network would support the summer visitors as well, visiting more and more often these countries, ensuring that the visitors could return to the breeding colony they left. GREFA intends to open a migrational route between the West-European and the East-European countries („corridor").

4. Conclusions

In our report we focused on the use of the monitoring data in the protection and conservation of raptor species.

- Investigation of main factors of human pressure on raptors in Madrid region revealed, that electrocution on the pylons of the middle voltage power lines caused the highest mortality on the investigated area.
- The pioneer project of the biological control system proved a new alternative way to control common vole population with an avian predator population instead of using chemicals. Sound monitoring data of the project helped to convince stakeholders, and to introduce the application of the method from local scale to larger scale in several autonomous communities in Spain.
- Monitoring data revealed the important role of captivity breeding programmes in the conservation of endangered raptor species which aim at the compensation of population decline caused by different types of human pressure.
- It has basic importance, that information resulted form monitoring was directly be used in the conservation of the species, allowing an adaptive management to be implemented through modifying conservation programmes according to the monitoring results.

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