FAUNA MONITORING STUDIES AND THE DEVELOPMENT OF WIND FARMS IN ROMANIA

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Abstract. Starting from the obvious diminution of fossil natural resources and the increase of the concerns regarding the diminution of carbon dioxide emissions in the context of the climate global changes, during the last decades, new energetic national strategies were proposed and the research programs were intensified on the energetic production using the renewable, "green" resources. Firstly, national legislation regarded just the technical aspects; during the last years, the environmental specialists began studies on the impact of wind farms on the environment – using the presence of birds and bats like criteria, but also, the assessment of the habitats and other environmental elements, generally. In Romania, this activity is just at the beginning and some investors try to take advantage of the absence of experience, but also of the legislation weakness, to ignore the necessity of one appropriate evaluation of this energetic infrastructure impact on the environment. Our paper is not focused on rendering the results of a biodiversity monitoring study but on presenting some methodological aspects related to this type of studies using our experience in one-year program of bird and bat diversity monitoring in four different future wind farms that will be developed within Vaslui County territory.

Keywords: fauna, methodology, monitoring, wind farms.

Rezumat. Studiile de monitorizare a faunei şi dezvoltarea parcurilor eoliene în România. Plecând de la diminuarea evidentă a stocurilor de resurse naturale fosile şi intensificarea preocupărilor legate de reducerea emisiilor de carbon în contextul modificărilor globale ale climatului, în ultimele decenii, au fost elaborate strategii naţionale energetice noi şi s-au diversificat programele de cercetare în domeniul producţiei de energie folosind surse regenerabile, „verzi". La început, legislaţiile naţionale au pritivit doar aspectele tehnice ale acestui domeniu; de-a lungul ultimilor ani, specialiştii au iniţiat studii privind impactul parcurilor eoliene asupra mediului, folosind prezenţa păsărilor şi a liliecilor ca indicatori, dar şi studii de evaluare a modificării habitatelor şi a celorlalte elemente componente ale mediului. În România, această activitate se află la început, iar unii investitori încearcă să exploateze absenţa experienţei, dar şi a legislaţiei corespunzătoare, ignorând necesitatea realizării unei evaluări adecvate a impactului acestui gen de infrastructură asupra mediului. În cele ce urmează, nu urmărim prezentarea rezultatelor unui studiu de monitorizare a biodiversităţii ci propunem câteva aspecte de metodologie a unor astfel de studii, valorificând experienţa acumulată în timpul derulării unui program de monitorizare a diversităţii avifaunei şi liliecilor pe durata unui an, în perimetrul a patru viitoare parcuri eoliene din judeţul Vaslui.

Cuvinte cheie: faună, metodologie, monitorizare, parcuri eoliene.

INTRODUCTION

In December 2008, the European Union adopted a new strategy regarding the climate change context and energy development following that the EU members will increase the "green" energy use to 20% of the total European energy production by 2020. In fact, during the last two decades especially, the research effort on the topic of energetic production using the renewable, "green" resources (wind, sun, geothermal and hydrothermal energy, hydropower, biogas, etc.) was intensified starting from the obvious diminution of some fossil natural resources (coal, oil, natural gas) and the parallel increase of the concerns regarding the diminution of carbon dioxide emissions in the context of the climate global changes.

At the beginning of this new energetic sector development, the national laws regarded just the technical aspects.

After the appearance of some large wind farms in different regions of North America and Europe, ornithologists and bat researchers began the studies on the impact of these infrastructures on the environment - especially, on the mentioned two flying vertebrates groups, but also, on the habitats and other biotic elements, generally.

The collision risk is influenced by very different factors like the seasonal activity, flying behaviour of each species, intensity of the daily movements of birds and bats feeding, hunting and migration behaviour, individual size, existing habitats and different environmental elements, the general aspects of the wind farm. In Spain, the bird collision annual rate is about 1.2-64.26 individuals / one wind turbine so, the specialists assess that, yearly, a number between 19,000 and one million birds are victims of the collision injuries at wind farms, while for bats, the rate is higher than this, 6.3-99 individuals/one wind turbine (ATIENZA et al., 2009). Recent studies done in northern UK assess the diminution of the breeding populations for some bird species with percentages of about 15-53% not only within the perimeter of the wind farm but also about 500m around it (PEARCE-HIGGINS et al., 2009).

There exists, also, evidence of barotraumas caused to the bats by rapid air-pressure reduction near moving turbine-blades and its major consequence on the bat mortality in the wind farms area (BAERWALD et al., 2008).

The initial starting point for the impact studies of the wind farms on the environmental elements was represented by the protocol BACI (Before / After Control Impact), done in the middle '90 years in the last century, in U.S.A. The methodology follows the status of the bird and bat populations before and after the settlement of one wind farm, permitting to obtain enough and relevant data to evaluate the collision risk and other threatening factors for these two vertebrates groups (RISSER et al., 2007).

In the European Union, an international teamwork, including specialists in ornithology and bat monitoring studies and working under one contract with the European Commission, prepared a guidance document in order to provide best practices in the wind farm development, especially for those proposed to reach the limits of Nature 2000 sites. The standardization of one monitoring methodology follows to obtain comparable data in different study areas, but also to elaborate monitoring rules, enough flexible to adapt in a specific investigated area and for specific technical parameters of the future wind farm (HŐTKER, 2006).

In Romania, the wind farm development, but also, the monitoring study of these infrastructures impact on the birds and bats are just in the beginning stage. Presently, there is no official methodology for this kind of studies and some investors try to ignore the necessity of one appropriate evaluation of the wind farm impact on biodiversity and environment using the legislation weakness but also the lack of experience in this field. For this reason, a documentation work was absolutely necessary in order to develop the best monitoring schedule and to give a theoretical evaluation of the collision risk for the birds and bats species recorded in the investigated sites, using the references similar studies done in sites with working wind farms.

CASE-STUDY PRESENTATION

During the period November 2008 - 31 October 2009, a regularly monitoring study was done focusing on the bird and bat populations present during all yearly phenological aspects, within and in the neighbourhood of the four sites located in Vaslui County, where four wind farms will be developed.

There were followed different aspects, in order to obtain relevant data necessary for the theoretical evaluation of the collision risk and other impact forms generated by the future wind farms to the bird and bat population present in the inside and neighbouring ecosystems:

- to evaluate the bird and bat diversity, during the wintering period, spring and autumn migration time and in the reproduction period;
- to estimate the bird and bat population present in the investigated areas during all periods of the yearly biological rhythms characteristic for both flying vertebrates groups;
- to identify the limits of the hunting and feeding territories for different bird groups (especially, raptors) and bats within and in the neighbourhood of the future wind farm areas;
- monitoring the bird and bat daily flyways between the breeding sites and feeding territories, respectively, the refuge and resting sites and feedings territories;
- to identify the bird and bat flyways during the migration time within and in the neighbourhood of the future wind farm territory;
- to identify the existing bat reproduction and maternity colonies;
- to identify the bats wintering sites in the areas.

On other hand, special attention was given to the identification of the main habitats within and in the neighbourhood of each site, to the evaluation of their present status, following their potential evolution not only due to the construction of the wind farms but also due to the local community activities in these territories.

After the systems for registering wind parameters were fixed in the future wind farms areas, a special monitoring activity began around these pillars in order to collect information on the passerine collision situations (despite the fact that we did not find this kind of data in the references). The wires that are used to fixing the pillar in the ground are thin and grey, so, seems to be, practically, invisible for the small birds that fly in the area. The main aim of this monitoring activity was to collect relevant information about this unexpected collision risk for passerine birds (involved species, habitats that increase the risk of collisions, etc.).

We must notice the fact that there is any available study on the bird and bat presence in the ecosystems within the perimeter and near the future wind farms, but only one ornithological study that give general information about the bird presence in different ecosystems from the territory of Vaslui County (PAPADOPOL, 1975).

RESULTS AND DISCUSSION

An appropriate monitoring study done before the wind farm's development in one area can avoid future greater loses for the investors. For example, in Spain there exist areas where parts of some wind farms were definitely closed due their high impact on some bird species. In Castellón (eastern Spain), 50 turbines - from a total of 260 - were shut down definitely in May 2008 after one monitoring study that provided enough information about the turbines impact on the Griffon Vulture – *Gyps fulvus* (MARTINEZ-ABRAIN et al., 2011).

In order to obtain real and valuable information about the bird and bat presence or activity in one area, it is very important to start from the fact that the annual biological rhythm of these two flying vertebrate groups presents some similarities but specific stages and parameters, too. During the winter period, the birds are active, being represented in our country by the sedentary species, wintering visitors and partial migratory species. The birds present a diurnal rhythm that depends on the meteorological conditions and can be seen searching for food in the natural ecosystems or in the agricultural lands, but also within the villages. The bats are inactive during the winter season, passing through the hibernating time in caves, hollow trees in old forests, isolated and abandoned houses, garrets and lofts, churches.

The birds group presents a large breeding season, beginning from February for some species groups (family Corvidae) or just in the first decade of May for most migratory passerines. In the same time, the majority bird species has one clutch, so only one juvenile generation/yearly, but there exist some species that have two or more clutches yearly, especially from the sedentary species group that begins earlier the breeding season, but there are some summer visitor species that present two juvenile generations in a year, the second one leaving the nest in the first part of the August. For this reason, generally speaking, when the ornithologists talk about the bird breeding season they analyze a large period, despite the fact that they present the bird activity around the nest during the aestival phenological aspect (15 May – 15 July).

The meteorological conditions from the beginning of the bat activity period are very important for this vertebrate group, so, the high weather turnovers during the spring time, with great differences of the diurnal and nocturnal temperatures, can delay the beginning of the bat activity period for some days to some weeks. Usually, these flying mammals form their maternity colonies in the middle of spring and they leave it in the middle of July. After a feeding time, in August the bats manifest a gathering behaviour, forming the mating colonies, and leave it in September, when they begin the autumn migration time, flying to the wintering shelters, where form the wintering colonies.

Starting from the beginning of our monitoring studies, the team received complete maps of the future wind farm territories, including the number and the future position of the turbines, which is very useful not only to identify the access roads but also to plan the fieldwork and to formulate the final conclusions and recommendations for the investor.

During the first visits in the area, there were established some transects for the transect methods, trying to cover all the present habitat types: open lands, bushes and shrub areas within the future wind farm perimeter and within and in the close vicinity of the forest and woodlands present in the investigated area. There were chosen also some potential fixed points of observation for the migration monitoring in spring / autumn time (especially, for the gliding birds and bats) and for the observation on the feeding / hunting territories used by both vertebrate groups within and near the future wind farm area, in order to obtain the better covering of the perimeter for our monitoring studies, following to collect relevant data for our study program.

We done a special model of observation notes used during our fieldwork, recording the presence of flying animals, the counted bird and bat effectives, data on the feeding and hunting territories, but also information about the habitats and human activities within and around the future wind farm area.

We identified the bird species and we estimated their effectives using the direct observation through binoculars and telescope, through visual recording and through males' sounds, too. We followed to identify and estimate the wintering bird population, but also the diversity and the effectives present during the migration time and breeding period within and in the neighbourhood of the future wind farm area. The forest birds were counted along transects and from fixed observation points, too. For the aquatic birds, we counted each bird for the small groups and used the quantitative evaluation in band for the larger groups or flocks larger than 200 individuals.

In the final report, the bird effectives were presented in tables giving the minimum and maximum values recorded during the breeding season, wintering time, spring and autumn migration time.

During the period May - June, we had done nocturnal monitoring too, visiting each site twice in May and June, using the same transects with stops about 5 minutes on each 500m, in order to identify the presence and the effectives of the Corncrake (*Crex crex* LINNAEUS 1758) and the nocturnal raptors (Strigiformes) in the investigated sites through the male's calling activity. We used audio recordings to stimulate the males' activity in order to increase the possibility to obtain real data on the presence of these bird species in the area.

During the migration time, in order to identify the bird species and to evaluate their effectives, we used especially the fixed point counting method, very useful for the monitoring of soaring birds (raptor birds – Accipitriformes and Falconiformes, respectively, storks - Ciconiidae). We stayed in field starting from 9 o'clock in the morning till 18 o'clock in the afternoon during one day-monitoring program. This method permits, also, to identify the existence of the flyways within or near the perimeter of each site and to establish the limits of the hunting or feeding territories used by the birds in the visited area.

During the winter and spring migration (March - May), we had done a mapping work of the most important elements for the future wind farm territory – the main habitats (after the spring agricultural works finished and, step by step, observing the germination and growing of the cultivated plants, we could identify the main crops, the natural habitats and the abandoned arable lands).

During our fieldwork, we followed the mapping of the bird and bat flyways, hunting and feeding territories along the different seasons of the year (especially, for the raptor bird group and bats), the local movements ways of different bird groups between the breeding areas and feeding territories, respectively, of the bats between the roosting and feeding territories. We focused our attention on the bird and bat flying height during their movements within the perimeters of the future wind farms, too.

During the winter period, taking benefits from the better visibility due the absence of the leaves, there were identified the number and the position of the large nests that could be occupied by the raptor birds or by the Raven (*Corvus corax* LINNAEUS 1758) in the forest areas along our observation transects and their vicinity. Till the middle part of April, especially in the meteorological conditions of the 2009 spring (March had a very low temperatures and a very high, unusual, rainfall level while the last frost was recorded in the first decade of April), using the benefit of the good visibility in the forests due the prolonged absence of the leaves, we continued the monitoring of the large nests in order to identify the bird species that occupied it (sedentary or summer visitor raptor species, respectively, the Raven - *C. corax*), within or in the neighbourhoods of the investigated sites.

During May and the first decade of June, around the pillar with wind measurement apparatus in one investigated site, we found some individuals of passerine birds died because of the impact with the wires that fixed the pillar on the ground. There were recorded seven died birds: three individuals of Skylark (*Alauda arvensis* LINNAEUS 1758), one female of Blackcap (*Sylvia atricapilla* LINNAEUS 1758), one female of Whitethroat (*S. communis* LATHAM 1787), one individual of Chiffchaff (*Phylloscopus collybita* VIEILLOT 1817) and one individual of Nightingale (*Luscinia megarhynchos* BREHM, 1931). Barley was cultivated on the land around the pillar. Another two passerine birds were found dead because of the impact with the fixing wires in the proximity of another pillar with wind measurement apparatus, raised by another company, at about 3 km from our investigation area: one individual of Chiffchaff (*Phylloscopus collybita*) and a male of Blackcap (*Sylvia atricapilla*). Around this pillar, there was cultivated sunflower and there were also some blackberry bushes (*Rubus idaeus* LINNAEUS 1758), while in the neighbourhood, on the other side of the local road it was present a young tree, the edge of Sihastrului Forest being at a distance of about 100 m. We can mention that all the birds were adults, belonging to summer visitor species in the area. Just one of these species - *Alauda arvensis* - breeds in the agricultural land where it search for food, too and the highest number of died birds because of the collision with the fixing wires was recorded for this species. The other passerine species are forest breeding species, but they can fly outside of the forest edge, searching food in the sectors with bushes and shrubs. Through the present gathered field data we can propose two hypothesis trying to explain the collision incidents recorded in May and during the first decade of June in this site:

1. the birds need an accommodation period after the construction of these pillars, which are new elements in their well-known landscape – all the dead passerine birds belonging to migratory bird species that, immediately after their arrival in the breeding area, begin to fly searching suitable breeding territories;
2. the birds were during the maximum behaviour excitability period, being in the initial part of the breeding season with all behaviour components (the territorial behaviour, pairs forming time and mating display performing are associated with a high energetic consumption and an excessive psychic manifestations), when the birds fly on long or short distances, limiting and defending its territories, trying to attract the opposite sex partner to form a breeding pair, including by catching and offering insects like gifts.

We thought, also, at a third hypothesis, respectively, the constant collecting of died passerine birds by the local community, frightened by the possibility that the wind farm construction could be stopped. Some questions of the members of the local community suggested this hypothesis as well. But the appearance of bird faeces on the pillars fixing wires and on the ground surrounding it, suggests that the passerines started to use these new high elements from the land like survey and resting points. More recently, during another monitoring study in a future wind farm area, in Dobrogea (south-eastern Romania), we recorded a similar collision situation but for bats.

Regarding the bat species study, during the winter period, the monitoring activity was focused on the identification of the wintering sites for the bats within and near the future wind farm territory, in order to establish the bats diversity and to evaluate wintering populations of this group in the area. We had done also some interviews with the people from each site in order to obtain available data on the presence of the bats the villages from the site and in their neighbourhood. In the same time, the suitable habitats for the bats were identified in the investigated area, too.

For the bat field study, our team used different types of bat-detectors in order to identify the bat species specific sounds during their activity period in fixed points and along some transects that were established during the later January field visiting in the area. Also from fixed points, we performed visual recording of the bat presence and activity in the area, using the artificial lighting systems. We used different bat/detector models (each bat-detector presents advantages and disadvantages): field detector *Heterodin* (model *Pettersson* D100), bat-detector with frequency division *Batbox Duet*, bat-detector with time expansion *Tranquility* model with recorder Edirol R-09HR and Minidisc Sony Mz-R 909 and model *Pettersson* D 240X with recorder Olympus, GPS (Garmin GPS 60), field parameters measure apparatus (clock, thermo-hygrometers (SK Sato Datalogger) – temperature and air humidity are recorded at the beginning and of each transect limits), lighting systems (electrical frontals).

The bat activity was recorded in fixed points and two types of transects - driven and *per pedes* or walked transects. The point counts were chosen near turbine location and in the areas with suitable habitats for bats (forests, woodlands, streetlamps in the nearest villages and along potential commuting routes, etc.), using recordings of maximum 20 minutes in each point.

In the driven transects method, the total length was about 25 – 50km/site that allowed us to cover and sample a larger area, while the recording activities started 30 minutes before the sunset and continued for about three - four hours after sunset, driving at a speed of no more than 25 km/h.

The bat-detector was fixed on the car right back window, being orientated under an angle of 45^0 with the ground but also with the car back part. The GPS was fixed on the windscreen, with it aerial parallel with the ground. For this type of transects we used the bat-detector with time expansion *Tranquility*. Even the driven transects represent one of the most used methods for the advantage of covering a larger area, the best method is to divide the road area into a series of walked transects and points count locations. Often, for one large site it is necessary to select a number of various routes in different areas of the site, following the habitats and general aspects in order to ensure a suitable level of sample coverage (RODRIGUES et al., 2008).

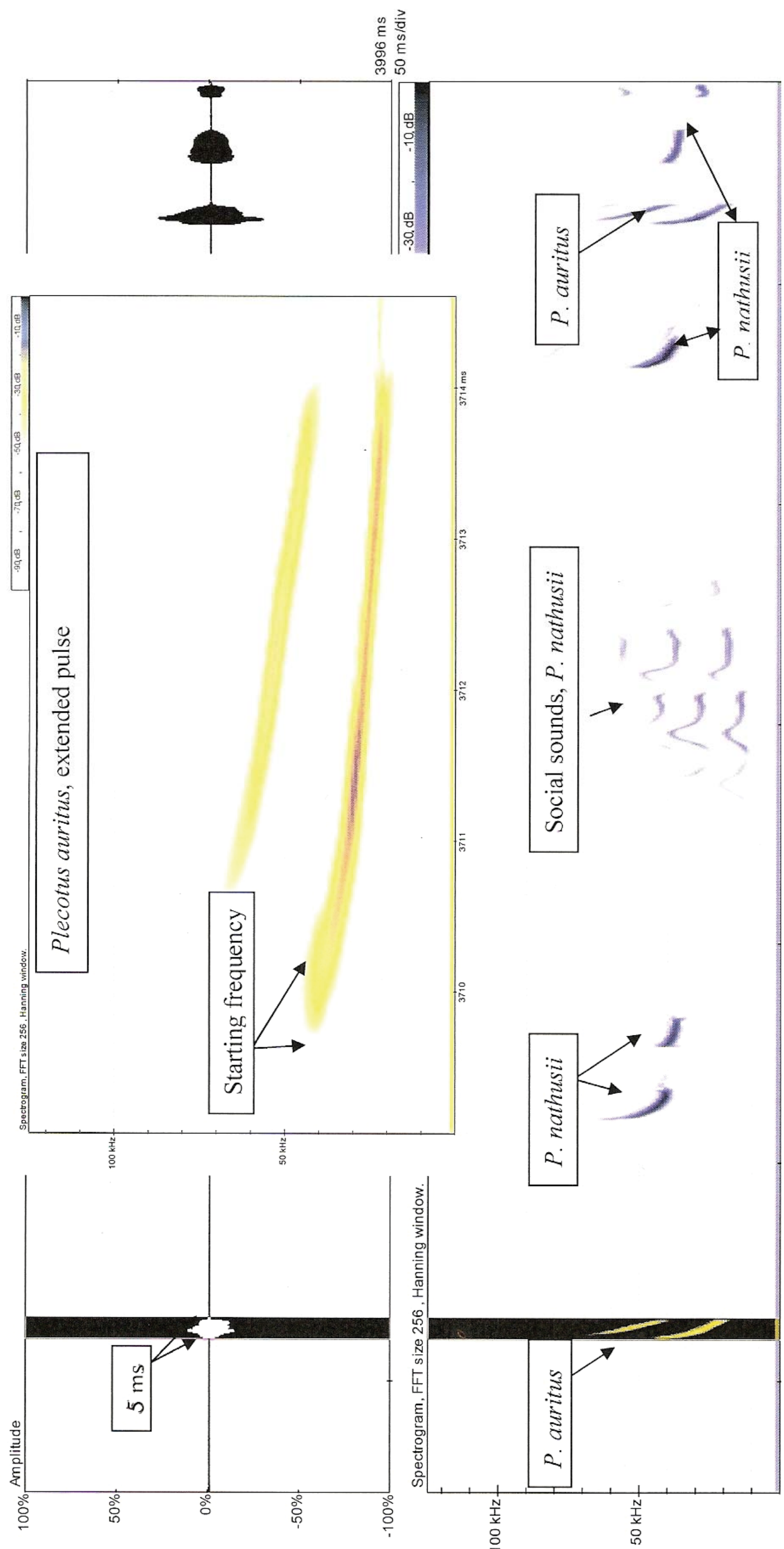

Figure 1. Model of bat sonogram analysed through BatSound 4 program: *Plecotus auritus* (LINNAEUS 1758) – echolocation, respectively, *Pipistrellus nathusii* (KEYSERLING & BALSIUS 1839) - social sounds and feeding behaviour (analysed by Georgiana Mărginean & Oana Chachula).

The bat activity can be, also, permanently recorded using the automatic static bat-detectors (for example, we used the model *SM2 bat-detector*) that can be installed in points covering the turbine future positions. These bat-detectors record bat activity during the whole night, starting 30 minutes before the sunset till 30 minutes after the sunrise time and can be fixed in the area for different periods of time, even about 9 months.

Finally, the recorders - *sonograms* - are analysed in laboratory with the computer, using special IT programmes as the specific ones like BatSound or any other analyse program like CoodEdith. This analysis permits to obtain data about the bat species identity and the bat activity during the recording period by analysing the sounds from the sonograms (Fig. 1), viewing one series of parameters (for example, minimum frequency, maximum frequency, etc.) correlated with different field parameters (temperature, habitat type, etc.), the recorder time and the general aspect of the recorded sounds.

For the bat recorded sounds, there are used cap letters to represent the main type of sounds – modulate frequency = FM, constant frequency = CF and quasi-constant frequency = QCF. The type of the used bat-detector can influence the correctness of the analysis. More than this we must keep in our attention the fact that one bat species can have different sounds from one to other habitat types, making possible the confusion between species – for example, the bat species of the genre *Nyctalus* present CF sound in open lands, QCF sounds near the forest edge and FM sounds within the forests or other closed habitats. In the presented sonogram the species *Plecotus auritus* (LINNAEUS 1758) presents a pulse with the following parameters: 5 ms time length, first pulse amplitude – 30.3 kHz, second pulse amplitude – 51.2 kHz, while the first pulse has a more explosive beginning. For the species *Pipistrellus nathusii* (KEYSERLING & BALSIUS 1839), the recorded sounds have quasi-constant frequency going to constant frequency, with the next parameters: 8.1 ms time length, amplitude – 37.6 kHz, maximum frequency – 40.5 kHz, minimum frequency – 34.1 kHz; the modulate quasi-constant sounds appear with 9.2 ms time length, amplitude – 64.6 kHz, maximum frequency – 34.3 kHz, minimum frequency – 41.7 kHz.

We underline that, during the whole study period, we monitored all bird and bat species not only those included in Annex 1 of Birds Directive (species that need special conservation measures) or in Annex 2 (species of community interest that need special protected areas) and Annex 4 (strictly protected species in the European Union) of Habitats Directive. The final study report contained information about the bird and bat diversity, breeding / reproductive populations, their distribution in the suitable habitats, daily and seasonal flyways, hunting and feeding territories in wintering, migration and breeding / reproductive time, wintering shelters, including mapping for the last three aspects for each future wind farm area.

CONCLUSION AND RECOMMENDATIONS

Our experience in monitoring bird and bat populations, as well as the estimation of habitat evolution in the area, permitted us to assess that it is possible to identify the best technical solutions (*good practices*) that could enable the development of a new "green" energy production way using a renewable resource (wind) and to conserve the territory biodiversity based on sustainable development principles.

First of all, the investors must be careful with the selection of the future wind farm location avoiding the vicinity of the Nature 2000 sites network and the main bird and bat migration flyways; they should also take into account that one of the most important requirements of the Birds Directive and Habitats Directive is to protect the species of community interest on the whole range of their habitats in the European Union.

The fieldwork monitoring study must cover at least one year in order to present all aspects of the annual biological rhythms of birds and bats populations from the investigated area.

The fieldwork on birds pointed out the fact that the diurnal birds can see the wind farm turbines from distances of about 300 - 500m, while the nocturnal birds observe the turbines presence at a distance of about 20m.

Like a rule, the birds avoid the turbines, flying on the wind farm limits; however, in case of some bird species that fly upper (rarely) or cross the wind farm, due to the diminution of their flight height, the collision risk increases, especially, when the distances between the turbines is smaller.

Generally, a wind farm perimeter with a straight-elongation form on the direction north-south (so, parallel line with the directions of the main birds migration flyways on Romania territory), with a lateral settlement of two – five turbines in a line, represent diminishing elements of the collision risk for the birds and bats populations.

All the present studies emphasize a greater collision risk in the wind farms situated on migration flyways, near important reproduction and feeding territories, for the large raptor birds and for bats, but also for the nocturnal migratory birds that use to fly at heights between 60-200 m.

Not only raptor birds but also passerines, including very good flying species like swallows and martins (Hirundinidae) or bat species were found dead through collision with the wind farm turbines during one recent study regarding the active wind farms impact in such areas with great conservation importance through their sheltered biodiversity in north-western India (PANDE et al., 2013). The authors notice the quite immediate disappearance of the killed animals in field due the scavengers activity. The collision risk increases during the rainfalls, fog conditions and strong winds, too. The temporarily shutting down of turbines can reduce significantly the percentage of the collision situation during the birds and bats migration time.

For the diurnal raptor birds (Accipitriformes and Falconiformes), the collision risk is bigger than for other groups due their hunting behaviour: these birds can use the turbine pillar like survey point in order to identify a potential prey, without keeping a safety distance to the moving elements; when the bird goes to attack the prey, it focuses all its attention on the prey, "forgetting" the propeller moving.

The collision risk is higher for bats because these mammals have not an avoiding behaviour, especially for the species that fly at great heights during the migration time (April - May, respectively, September - October); the most threatened species are the migratory ones like: *Eptesicus serotinus* (SCHREBER 1774), *Nyctalus noctula* (SCHREBER 1774), the *Pipistrellus* genre species, *Myotis dasycneme* (BOIE 1825) or *Myotis daubentonii* KUHL 1817 (HŐTKER et al., 2006).

High collision rates for bats were recorded in the wind farms located near forests or woodlands, but also near the watercourses used by bats like habitat corridors during their movements between the feeding, reproductive, roosting and wintering areas.

Anyway, in order to increase the security level for the raptor birds and bats during their feeding daily flights, we recommend fixing the nearest turbines at least 500m away from the forest edge, but also to avoid the linear vegetation systems (bushes, shrubs, etc.) used by bats as landmarks for orientation during their daily or seasonal movement flights.

Between other direct or indirect effects of wind farms on birds and bats populations, we must mention the fragmentation and loss of suitable habitat, change of the usual flyways, breeding/reproductive or wintering areas and barrier effects, diminution of the breeding passerine bird populations, increasing of electrocution risk through the development of energy transportation networks.

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