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How to mitigate impacts of wind farms on bats? A review of potential conservation measures in the European context

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ABSTRACT

Wind energy is growing worldwide as a source of power generation. Bat assemblages may be negatively affected by wind farms due to the fatality of a significant number of individuals after colliding with the moving turbines or experiencing barotrauma. The implementation of wind farms should follow standard procedures to prevent such negative impacts: avoid, reduce and offset, in what is known as the mitigation hierarchy. According to this approach avoiding impacts is the priority, followed by the minimisation of the identified impacts, and finally, when residual negative impacts still remain, those must be offset or at least compensated. This paper presents a review on conservation measures for bats and presents some guidelines within the compensation scenario, focusing on negative impacts that remain after avoidance and minimisation measures. The conservation strategies presented aim at the improvement of the ecological conditions for the bat assemblage as a whole. While developed under the European context, the proposed measures are potentially applicable elsewhere, taking into consideration the specificity of each region in terms of bat assemblages present, landscape features and policy context regarding nature and biodiversity conservation and management. An analysis of potential opportunities and constraints arising from the implementation of offset/compensation programmes and gaps in the current knowledge is also considered.

1. Introduction

In the last 20 years, wind energy became the fastest growing source of power generation in the world and it is expected to continue growing in Europe, North America and in the developing markets of China and India. There is also a growing trend in Latin America, new Asian and Eastern European markets and in some African countries (Ledec et al., 2011; WWEA, 2013), though in the past three years, due to the global economic crisis, the rate of growth has slowed down (WWEA, 2013).

In Europe, during the last 30 years, wind energy has grown from 100 MW to over 100,000 MW (EWEA, 2012). Among European countries, Germany, Spain, Italy, France, UK and Portugal have shown an extraordinary growth in wind energy in the last decade (WWEA, 2013). In fact, energy produced from renewable sources is a priority in the European Union (EU) agenda, especially after the implementation of the Renewable Energy Directive in 2009 (2009/28/EC) and subsequent amending acts. This directive establishes mandatory targets for 2020, imposing a 20% share of energy from renewable sources by 2020 in all member states. As a consequence, several member states have seriously invested in the development of wind energy, as a crucial way to attain this goal.

This goal shift towards a more sustainable production of energy to reduce the emission of greenhouse gases is certainly desirable, but the development of wind energy facilities does not come free of risk of negative impacts on biodiversity (Voigt et al., 2012), as well as noise and visual impacts for local human communities (Leung and Yang, 2012).

Among vertebrates, bats are pointed out as one of the most affected groups (Arnett et al., 2011; Barclay et al., 2007; Johnson et al., 2003; Rydell et al., 2010). In the last few years, the concern about the negative impact of wind farms on bat assemblages has significantly increased

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among the scientific community. Since the implementation of the first wind farms in Europe and the USA, it was assumed that bats could be affected by collision with the moving turbines. However, this group only became a research focus when bat fatalities were documented as potentially higher than bird fatalities (Cryan and Barclay, 2009; Rodrigues et al., 2008; Rydell et al., 2010).

Bat fatalities result from direct collision or from barotrauma, i.e., experiencing rapid pressure changes that cause severe internal organ damage, especially in the lungs (Baerwald et al., 2008; Grodsky et al., 2011; Rollins et al., 2012). Bat fatality rates show significant variation among sites and years and although there are general recommendations from EUROBATS for the monitoring and estimation of fatalities (e.g. Rodrigues et al., 2008), the lack of standardised methods to estimate these rates hinders comparisons (EUROBATS, 2012). Nonetheless, significant fatality rates have been recorded in both the USA and Europe. In a review of the patterns of bat fatalities at wind energy facilities in North America (USA and Canada), Arnett et al. (2008) present as many as 69.6 bat fatalities per turbine per year. In Europe although a global study has not been done yet, it is known that fatality rates vary largely among sites and high numbers were also reported especially from Hohe Eck wind farm in southern Germany, where rates of 41.1 bat fatalities per turbine per year occurred (Rydell et al., 2010).

In the European Union all wind energy developments that are likely to have a significant impact on environment should be subjected to an environmental impact assessment (EIA) (Article 2, Directive 85/337/EEC). That is the formalised procedure that ensures that the likely effects of a new wind farm on the environment are fully understood (Jay et al., 2007) and taken into account before the proposed project is given development consent. For that reason they are a good decision-making tool on project viability (Rajvanshi, 2008; McKenney and Kiesecker, 2010) and should identify and, if possible, quantify impacts on biodiversity, confirm the need for mitigation and set out the mitigation required for the identified impacts (BBOP, 2009a; Marshall, 2001). The negative impacts are mitigated through the implementation of measures that aim at the reduction of those impacts to the point where they have no adverse effects (BBOP, 2012a). Within the EU there are regulations that consider population effects and also regulations focusing on individual specimens of species that are strictly protected. Ultimately, both focus on negative effects that will occur at the population level, though considering that, in threatened species, these effects are more severe, so even a reduced number of fatalities is of great concern.

Mitigation involves any process, activity or action designed to avoid, reduce or compensate those significant adverse impacts (Marshall, 2001). The mitigation measures are categorised according to their goals and following the mitigation hierarchy: (a) avoid, (b) reduce/moderate/minimise, (c) offset/compensate (Fig. 1) (BBOP, 2012d; Darbi et al., 2009; PricewaterhouseCoopers, 2010). This hierarchy implies that avoidance strategies have priority over remedial solutions (Marshall, 2001) and that those impacts that cannot be avoided or minimised must be addressed through biodiversity offsets or compensatory measures (BBOP, 2009a; PricewaterhouseCoopers, 2010). Strictly following the mitigation hierarchy, it is important to underline that offsets or compensatory measures are the “last resort” and must not provide a justification for proceeding with projects for which the residual impacts on biodiversity are unacceptable. This means that the “no go” option has to be considered seriously and applied in cases where the destruction of unique habitats, or irreversible loss would otherwise occur (BBOP, 2012c; Bishop, 2006).

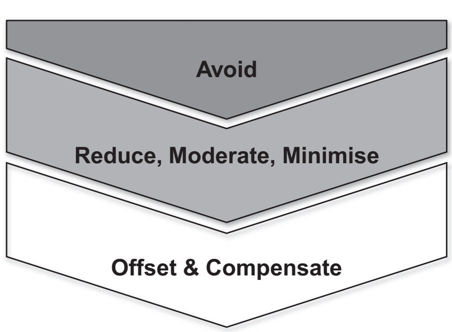

Fig. 1. Mitigation hierarchy (adapted from PricewaterhouseCoopers, 2010).

The last step of the mitigation hierarchy, the offset or compensation, has been acquiring importance and popularity among conservationists (McKenney and Kiesecker, 2010; Kiesecker et al., 2010). The clarification between those two concepts has been under discussion in recent years, and Biodiversity Offsets were defined by BBOP as “measurable conservation outcomes resulting from actions designed to compensate significant residual adverse impacts on biodiversity, after appropriate prevention and mitigation measures have been taken”. The offset measures should “achieve no net loss and preferably a net gain of biodiversity taking into account species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity” (BBOP, 2013; ten Kate et al., 2011). To demonstrate no net loss or a net gain, conservation action outcomes must demonstrate that biodiversity conserved is sufficient and of the same kind as the biodiversity lost or degraded due to the project's impacts, and that biodiversity persistence is not compromised, or if possible enhanced (BBOP, 2013; ten Kate et al., 2011). For compensation, there is no clear definition set by BBOP, and the edge between these two concepts is mainly related with the capacity of a project to demonstrate that the conservation outcomes are enough to guarantee “no net loss or a net gain” (BBOP, 2013; ten Kate et al., 2011).

Offsets are a relatively recent field of investigation (Hayes and Morrison-Saunders, 2007), and the Business and Biodiversity Offsets Programme has developed and introduced the Standards on Biodiversity Offsets. These standards are based on 10 principles that provide a framework for the design and implementation of biodiversity offsets and to verify its success (BBOP, 2009a): (1) adherence to mitigation hierarchy, (2) limits to what can be offset, (3) landscape context, (4) no net loss, (5) additional conservation outcomes, (6) stakeholder participation, (7) equity, (8) long-term outcomes, (9) transparency and (10) science and traditional knowledge.

The compliance with these principles helps to ensure that adequate offset programmes are created and implemented. However, there are several conservation programmes that, for a variety of reasons, are simply unable to follow all these principles, which is more evident in the case of principle 4 — no net loss/a net gain. For some projects it is not possible to prove no net loss because i) pre-impact data is lacking and it is impossible to know what was lost as a result of the project, and/or ii) gains achievable by the conservation actions are not easily quantified. If so, the programme in question should not be considered as an offset but as a compensation programme. Fig. 2 illustrates the continuum from a very basic form of compensation to the type of compensation that is a full offset and may realistically be expected to achieve no net loss or even a net gain.

Despite the recommendation to follow the mitigation hierarchy, monitoring programmes in several European wind farms have revealed that, in some situations, significant impact over bat populations may be occurring (EUROBATS, 2013). So, it is essential to guarantee that, for each wind energy facility, the mitigation hierarchy is followed from the beginning and that this sensitive group is taken into account in all steps. In that context, the implementation of the mitigation hierarchy should start during the planning and design phase, in order to avoid any important area, such as breeding, hibernating areas and/or foraging habitats of threatened bat species (EC, 2010). However, identifying potential impacts during the planning phase may be a difficult task, unless it is made in extreme circumstances with easily predictable impacts or in the predictable absence of impacts (e.g. near an important roost or at a hostile, windy and cold site). Furthermore, in some cases