An assessment of the potential effect of oil-and-gas 6–10 kV overhead power lines on bird mortality in the western Orenburg Region steppe

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Abstract. This paper calculates a possible damage to avifauna during the oil and gas production in the western Orenburg Region steppe. Based on field data on bird mortality by electrocution at 6–10 kV overhead power lines in the study area (3.22 individuals/km), we calculated possible values of bird mortality within the model site of oil and gas fields with a broad road and electrical network. The total estimated number of dead birds reached 432.64 individuals at the power lines of the model site with a total length of 134.36 km, and the estimated amount of damage was 991 560 rubles. Birds pertaining to the Corvids, Accipitrids, and Falcons perished most frequently at unsafe power lines. When oil and gas fields are located near specially protected natural areas or in the Russian-Kazakh border zone, the estimates of bird deaths at unsafe power lines are supposed to be closer to actual values.

1. Introduction

Oil and gas production is a necessary condition for the existence of a modern society, but during the development of oil and gas fields, a variety of specialized infrastructure of oil and gas fields is introduced into the natural landscapes: drilling rigs, compressors, generators, flare installations, pipelines, power lines, etc. In the steppe grasslands of Russia, bird mortality at overhead power lines is a proved factor limiting the steppe avifauna population, including rare and endangered species [1, 2, 3, 4, 5, 6, 7, 8]. Electrocution of birds occurs at low-voltage 6–10 kV power lines mainly in treeless areas within steppe and semi-desert landscapes.

The Orenburg Cis-Urals was chosen as the study area. It is a part of the Volga-Ural Oil and Gas Province, where about 23% of the entire Russian oil volume is extracted [9]. The Orenburg Cis-Urals covers the central and north-western oil and gas-bearing sections of the Orenburg Region, where oil and gas exploration and production began in the early 40s of the 20th century. The development of natural and anthropogenic complexes within the boundaries of oil and gas fields has a complex dynamics and for a long time occurred without the necessary assessment of geoecological consequences. At the beginning of 2017, the recoverable oil reserves of the Orenburg Cis-Urals are concentrated in 198 fields, covering 25 administrative districts of the Orenburg Region with a total area of more than 90 sq. km. These aspects prove the research representativeness of this region for analyzing the impact of oil and gas production on the abundance of some steppe and forest-steppe species fauna, which can be considered as an indicator of the general state of steppe ecosystems [10]. This work attempts to estimate possible potential wildlife damage caused by such oil and gas clusters
with a branched infrastructure, particularly avifauna damage. As a model site for damage analysis, an oil and gas field section in the Pervomaisky administrative district of the Orenburg Region was selected, which is characterized by a significant amount of accumulated anthropogenic load – the oil and gas field within the key site has been developed for more than 20 years.

2. Material and Methods

The study area is located in the steppe southwest of the Orenburg Region with a temperate climate, in an arid humidification zone. The average temperature in July is +22°C and -15°C in January. Annual precipitation totals 300–350 mm. In areas with the remaining natural vegetation cover, bunchgrass fescue feather grass steppes on chestnut saline and chernozem soils are common. Such rare red-listed species as the Wild cat (*Felis lybica*), Steppe eagle (*Aquila nipalensis*), Imperial eagle (*Aquila heliaca*), Demoiselle crane (*Anthropoides virgo*), Bustard (*Otis tarda*) occur in the study area. Several medium-sized oil and gas fields are being developed here.

The background data for the presented analysis are based on the field survey of 6–10 kV overhead power lines that were unsafe for birds. The surveys were done in the spring-summer period of 2012 in the Pervomayskiy, Kurmanaevskiy, Ilekskiy, and Tashlinskiy administrative districts of the Orenburg Region. This work was part of a large-scale project to identify the most unsafe 6–10 kV overhead power lines, which was implemented in 2011–2012 in various administrative districts of the Orenburg Region (figure 1).

![Figure 1. Administrative districts of the Orenburg Region (highlighted in gray) surveyed in 2011–2012 to estimate mortality of birds killed by electrocution at 6–10 kV power lines.](image)

The 2020 model site with oil and gas field facilities and a developed network of overhead power lines was selected considering its location in steppe landscapes surrounded by previously surveyed power lines: small segments of power lines were selectively surveyed (on average 4 km each). All the finds of dead birds were mapped using a GPS navigator. In the oil and gas-bearing western part of the region, the total kilometrage of such a sample survey was about 60 km. Then, the total number of bird remains found was extrapolated to a similar 6–10 kV overhead power line network of the selected model site, having previously estimated the total length of the power lines based on satellite images.
This method was used to assess possible potential damage to wildlife associated with the activities of a particular oil and gas facility in the steppe area of the region.

Figure 2. The model site with facilities and 6–10 kV power lines supporting the oil and gas field in the Pervomaisky District of the Orenburg Region, 2020.

The possible damage was calculated based on the minimum amount paid for the dead individual in the following amount: the families Accipitridae and Falconidae – 5000 rubles, the family Corvidae and other families – 1000 rubles (the rates for calculating the damage are valid for 2020).

3. Results and Discussion

In the study area, the most frequent electrocution victims were species pertaining to the Corvids (the Rook, Jackdaw, Magpie) – 2.01 individuals/km, Falcons (the Kestrel, Red-footed falcon, Eurasian hobby) – 0.78 individuals/km and Accipitrids (the Common buzzard, Imperial eagle, Steppe eagle, Black kite) – 0.26 individuals/km. The average bird mortality at power lines in the study area was 3.22 individuals/km (table 1).

With an average bird mortality of 3.22 birds per 1 km of power lines in the study area, the estimated possible number of bird deaths was 432.64 individuals for the entire power line grid with a length of 134.36 km in the model site (table 1). The perished Corvids were 270.06 individuals, the Falcons – 104.8 individuals, and the Accipitrids – 34.93 individuals (table 1).

The total estimated damage that can be caused to wildlife resulting from one oil and gas cluster activities was, therefore, not less than 991560 rubles (table 1).

It should be taken into account that the calculated numbers of bird deaths for the model site are close to the maximum values and are not always applicable to the specific operating conditions of a particular enterprise. Nevertheless, when oil and gas production facilities are located near protected areas or in the border zone with Kazakhstan, where biodiversity are thought to be higher for a number of reasons – the minimum disturbance, best food supply, availability of breeding biotopes [11], the estimated figures will approach real values.

When analyzing empirical and statistical data on the death of birds of prey, we must consider their significance for agricultural production. Many bird species affect the land productivity, representing a form of biological method of agricultural pest control. The economic effect of their activity on agricultural lands could not be underestimated: each family of predatory mouse-eaters destroys 500–1000 murine rodents per season, saving about half a ton of grain harvest [12].
Table 1. Total length of power lines, species composition, number of electrocuted individuals and possible amount of damage caused to avifauna as a result of electrocution.

|                      | Background data | Calculated data | Calculated minimal damage, rubles |
|----------------------|-----------------|-----------------|----------------------------------|
| The total length of power lines surveyed, km | 57.72           | The total length of power lines in the model site, km | 134.36                          |
| The total number of birds, individuals including: | 186             | The total number of birds, individuals including: | 432.64 991560                   |
| family Accipitridae  | 15              | family Accipitridae                                    | 34.93 174650                      |
| family Falconidae    | 45              | family Falconida                                       | 104.80 524000                     |
| family Corvidae      | 116             | family Corvidae                                        | 270.06 270060                     |
| Individuals per km of lines including: | 3.22            | Individuals per km of lines including: | -                            |
| family Accipitridae  | 0.26            | family Accipitridae                                    | -                                |
| family Falconida     | 0.78            | family Falconida                                       | -                                |
| family Corvidae      | 2.01            | family Corvidae                                        | -                                |

These figures need to be supplemented by extermination of ground squirrels, acridoid grasshoppers, snap bag (wireworm), sunn pest, sugar-beet weevil, cereal chafer larvae, and other pests of agricultural fields. There are examples of targeted use of birds of prey in agricultural sectors. In some areas of Hungary, some birds of prey species are used as guards of garden plantations and vineyards. This method of protection against starlings or sparrows was found to be better than any modern acoustic analogues (shooting, noise effects, danger cry tape recording, etc.). Other proposals deserve attention such as the use of large falcons to protect fish ponds and fish farms from fish-eating birds, and natural regulation of pigeon numbers in cities [12].

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