PROJECT "IDENTIFICATION, CHARACTERISATION AND MAPPING OF THE FLIGHT PATHS OF BIRDS THAT INTERACT WITH HIGH-VOLTAGE POWER LINES"

SUMMARY

Red Eléctrica de España carried out, between 2010 and 2016, the Project for the 'Identification, Characterisation and Mapping of the Flight paths of Birds that Interact with High-Voltage Power Lines'. This project was approached in the context of the study and search for solutions to the problems arising from the interactions between birds and overhead power transmission lines, and mainly from accidents occurring as a result of birds colliding into the grounding cables, and that impact, to a greater or lesser degree, diverse species – among them several classified as 'threatened'.

The goal of the project is to map the flight paths of the bird species which are most prone to collisions with power lines; identifying the areas and routes most frequented and used by the birds in their regular movements, which are the ones most associated with situations of potential risk of collision with cables. The information about areas of presence and flight paths is particularly useful in the decision-making process regarding new projects (design of power line corridors with the least possible impact) and to prioritize mitigation actions (mainly the marking of cables with flight-diverter devices) in those areas that are considered a priority due to the greater presence of sensitive species.

The scope of the project covered the entire Spanish territory, therefore in 2016 it was possible to complete the development of different tools that would enable the ultimate goals of the Project to be achieved; a set of tools which was prepared for each of the 17 Spanish autonomous communities. These tools, which constitute the main results and deliverables of the project, are of three types:

1 Geographic information systems prepared for each territory, with the most complete and up-to-date information on the areas of presence and flight routes of a total of 46 species of birds considered prone or sensitive to collision with power line cables (focal species: see annex);
2 Sensitivity maps, which allow the identification of areas that are more or less sensitive to overhead electricity lines based on the intra- and interspecific aggregation pattern of the focal species, and which are therefore especially useful for the planning of new of power line corridors;
3 Risk maps, which in addition to considering the distribution pattern of the species, take into account the presence of factors that influence the probability of occurrence of collision accidents. These maps are the main tool for the planning of mitigation measures, prioritizing actions in those line sections with the greatest potential impact on bird life.

Geographic Information System (GIS)

The project enabled a geographic information system to be built for the territory of each autonomous community, and subsequently the 17 territorial GISs were integrated into a single global GIS covering the entire national territory.

Each GIS brings together the territorial and environmental data collected for each autonomous community and the relevant information on the focal species present in each territory (prepared from raw data available regarding their areas of presence and flight paths). These focal species, for which geographic data was collected and analysed to incorporate it into the GIS, were selected based on criteria related to the objectives of the project: proneness to collision accidents and other negative effects associated with transmission lines, degree of threat, flight behaviour and predictability of movement patterns.

The information about bird life contained in the GIS is not the raw information collected, it is the result of the interpretation of the same following different guidelines and criteria. Once the data for each species was completed and included in the GIS, the information is presented at three different levels of precision or work scales ('grain size'): areas of presence (context level), areas of caution (caution level) and detailed information (detail level); additionally, the main flight routes and paths known for each species can be displayed.

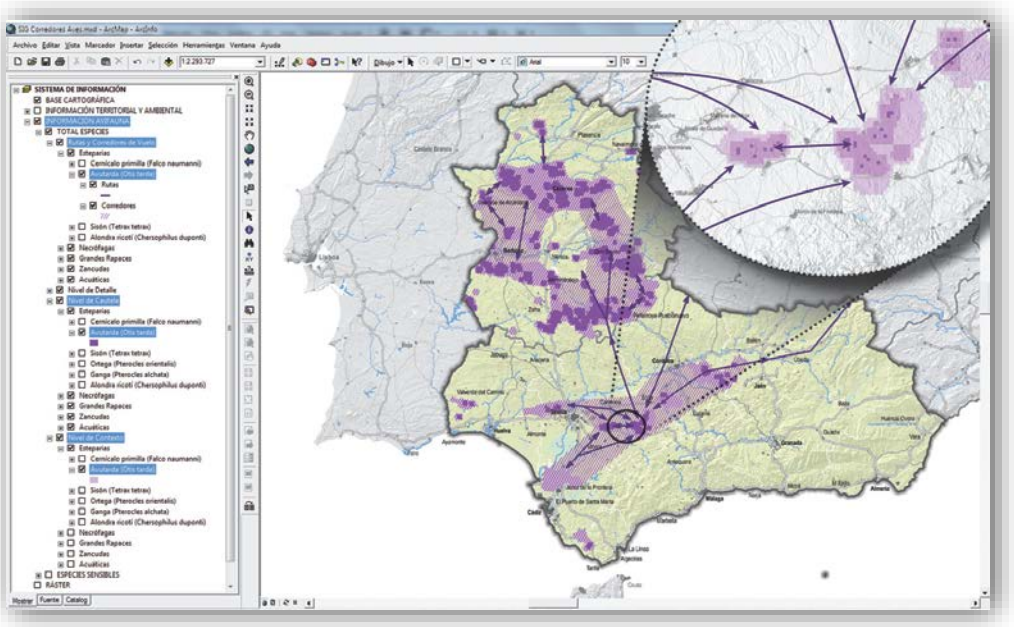
- Context level: The "areas of presence" of each species are collected from the different sources consulted (breeding areas, wintering areas, etc.), This information, which is of a 'thick grain size', is best considered in the initial planning stages for new facilities, in order to place power line projects in their bird life context and to generate graphic output on a regional scale.

- Caution level: the areas potentially most sensitive to power transmission lines, or 'caution areas', are identified (in 1 x 1 km UTM grids). This 'medium-sized grain' information is generated for each focal bird species, based on specific criteria defined for each one, principally on their vulnerability to power transmission lines but also with the precision of the data available. It is most useful that this type of information be taken into account during the definition stage of corridors or layouts for new projects, as well as in identifying potentially problematic areas for bird collisions with lines.

- Detail level: the most precise data for each species is collected (in 1 x 1 km UTM grids). This 'fine grain-sized' information is useful for the detailed analysis of projects and for the assessment of problems associated with specific spans or sections of existing lines, due to their proximity to points of particular importance (for example, nests of sensitive species, communal roosting sites, areas showing increased intensity of use by birds, etc.).

- Flight routes and paths: this level integrates the information collected for some species from different sources (locations of radio-marked birds, sighting of groups of birds in flight, indirect evidences of movements between areas, migratory routes, etc.). The information is in some cases precise (for example, flight paths generated from exhaustive monitoring of radio-marked birds) and in others, they basically reflect flows between areas without seeking to provide precision details (routes). They identify the areas of the territory that are considered to be overflown regularly by each species in their movements between areas of presence, allowing the presence of long-distance migrating species to be detected, often in high altitude flights, so usually the risk of occurrence of collision accidents with overhead lines is reduced.

GIS image generated by the project

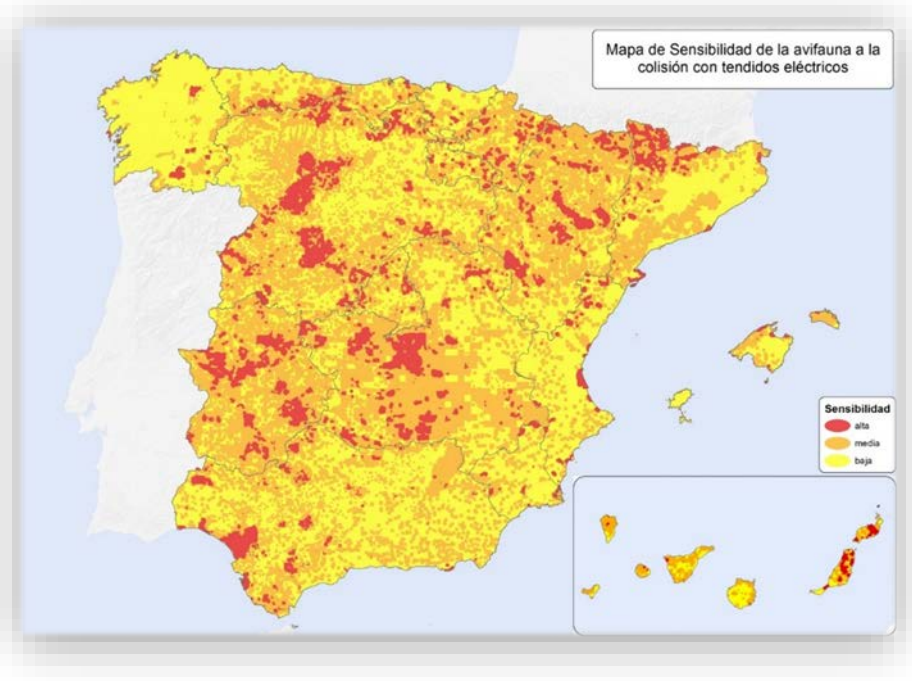


Sensitivity maps

A bird sensitivity map has been prepared for each territory showing their sensitivity to electricity transmission lines based on the spatial distribution and density pattern of sensitive bird species. The data used as the starting point to prepare the sensitivity map corresponds to the 'caution level' for each of the 46 selected focal species, assigning each species a specific weight or a different weighting coefficient.

It is known that there are species more prone than others to collision accidents, and species more vulnerable than others to species population effects, regarding the accident rate associated with these factors; this is taken into account in the drafting of sensitivity maps by assigning to each focal species a weighting coefficient that depends on its proneness to accidents and its vulnerability to this type of impact, and which is calculated as the result of the consideration and weighting of different aspects of its anatomy, behaviour, state of conservation and spatial distribution.

Sensitivity maps are constructed using a sequence of numerical data processes and geometric analyses of the original information, the areas of caution delimited for each species. These processes include kernel analysis, numerical data processes of population censuses and cluster type analysis of aggregated values. Thus, areas of different sensitivity (high, medium or low) are identified, depending on the species present and their density patterns in the territory; areas of high sensitivity are those in which significant high density aggregate values regarding the presence of focal species are detected; areas of medium sensitivity are those with the presence of species but where a significant high density aggregate values is not detected; and finally, areas of low sensitivity are those without the presence of focal species. The map of sensitivity of each territory results from the graphical representation of these areas on the mapping system.



Risk maps

Collision risk maps are intended to serve as the basis for a corrective or mitigating action plan for overhead lines that, with objective criteria, identifies those spans or sections of transmission lines belonging to Red Eléctrica de España in which to prioritise the implementation of corrective measures to prevent birds from colliding with electricity lines. The purpose of this prioritisation is, whenever necessary, to proactively channel available economic resources to those line sections of the grid where corrective actions will result in a reduction of the accident rate and therefore have a positive impact on bird communities. As a result of the analysis, areas of greater risk are identified for birds prone to collisions and, consequently, the sections of lines where it would be a priority to act on to significantly minimise the number of birds colliding with lines (risk map).

Risk maps can be prepared for a specific line, for a set of lines within a specific area or for an individual territorial area in which an analysis of the power line collision risk to birds is desired. Red Eléctrica has drafted risk maps of the meshed transmission grid lines located in each autonomous community and has therefore been able to assess the risk that each overhead line section of the national transmission grid may pose to birds.

The starting point for the drawing up of these maps are sensitivity maps, which map out the presence and spatial concurrence of different factors that increase the risk of collision. Taken into account among these are locations which attract birds (such as municipal solid waste landfills, carrion feeding sites, water points, wetlands, etc.), the topography (and more specifically the landforms that can act as channels that may condition the flight paths of birds to heights that coincide with that of cables, such as valleys, hills, watercourses, etc.), the frequency of fog (as it limits visibility and increases the frequency of collisions), the presence of other facilities that pose a risk (crossings or parallelisms between existing lines, wind farms …) and the characteristics of the habitat. The existence of collision records on existing lines is also considered as an indicator of the risk to birds. The mapping is carried out to provide a level of resolution of 1 x 1 km UTM grids.

It is therefore possible to determine an estimated risk coefficient value for each UTM grid of a given territory based on the concurrence of the different factors analysed. The combination of the sensitivity level and the risk coefficient allows a combined level of sensitivity and risk to be assigned to each area of the territory.

Finally, by superimposing the corridor layout of a line or set of lines within a territory on the map drafted in this way, we can generate and obtain the corresponding risk map, which assigns the sensitivity and risk coefficient to each span or section of line corresponding to the UTM grid in the which it is located. The final risk map is drawn up for each line or set of lines, from which it is possible to identify the spans or sections of line with the greatest risk to birds and therefore those that should be considered a priority for the implementation of corrective or mitigation measures.

ANNEX - FOCAL BIRD SPECIES

The focal bird species, on which the information has been collected and analysed for its subsequent incorporation into the system, have been selected based on criteria related to the objectives of the project:

- Interaction with overhead power transmission installations: bird species prone to collide with cables, usually registered as collision victims or registered with a frequency exceeding that which is expected due to their numbers. These include species for which there are no accident records, but which are regarded as prone to collision due to their biometric characteristics, flight behaviour and similarity to other species that are prone to and species considered less prone to these accidents but sensitive to other effects such as disturbances and alteration of habitat.

- Gregarious behaviour: species with a conspicuous gregarious behaviour, which tend to form large concentrations of specimens and to move in groups, at least at some point during the annual period or their vital-life cycle, given that this type of behaviour is related, on the one hand, with a greater susceptibility to collision accidents and on the other, to a greater availability of information about their density patterns and movements, since they are more easily detectable.

- Predictability of movements: species with regular and predictable movement patterns.

- Degree of threat: bird species regarded as endangered, included in the categories of "endangered" or "vulnerable" in the Spanish Catalogue of endangered species.

GROUP	SPECIES
STEPPE BIRDS	**Great Bustard** (*Otis tarda*)
	Houbara Bustard (*Chlamydotis undulata*)
	Little Bustard (*Tetrax tetrax*)
	Black-bellied Sandgrouse (*Pterocles orientalis*)
	Pin-tailed Sandgrouse (*Pterocles alchata*)
	Lesser Kestrel (*Falco naumanni*)
	Dupont's Lark *(Chersophilus duponti*)
	Stone Curlew (*Burhinus oedicnemus* sbspp.*)*
	Cream-coloured Courser (*Cursorius cursor*)
NECROPHAGOUS BIRDS	**Griffon Vulture** (*Gyps fulvus*)
	Cinereous Vulture (*Aegypius monachus*)
	Egyptian Vulture (*Neophron percnopterus* sbspp.)
	Bearded Vulture (*Gypaetus barbatus*)
	Red Kite (*Milvus milvus*)
RAPTORS	**Spanish ImENrial Eagle** (*Aquila adalberti*)
	Bonelli's Eagle (*Hieraaetus fasciatus*)
	Golden Eagle (*Aquila chrysaetos*)
	Osprey (*Pandion haliaetus*)
	Barbary Falcon *(Falco ENlegrinoides*)
WADING BIRDS (WADERS)	**Black Stork** (*Ciconia nigra*)
	White Stork (*Ciconia ciconia*)
	Common Crane (*Grus grus*)
	Common Flamingo (*Phoenicopterus roseus*)

	Eurasian Spoonbill (*Platalea leucorodia*)
	Glossy Ibis (*Plegadis falcinellus*)
	Northern Bald Ibis (*Geronticus eremita*)
	Eurasian Bittern (*Botaurus stellaris*)
	Squacco Heron (*Ardeola ralloides*)
AQUATIC BIRDS	**Red-knobbed Coot** *(Fulica cristata)*
	White-headed Duck (*Oxyura leucocephala*)
	Marbled Duck (*Marmaronetta angustirostris*)
	Ferruginous Duck (*Aythya nyroca*)
	Greylag Goose *(Anser anser)*
	Gulf-billed Tern (*Sterna nilotica*)
	Ruddy Shelduck (T*adorna ferruginea)*
	Common Shelduck (*Tadorna tadorna)*
OTHER SPECIES	**Wood Grouse** *(Tetrao urogallus)*
	Bollé's Pigeon (*Columba bollii*)
	White-tailed Laurel Pigeon (*Columba junioniae*)
	Blue Chaffinch (*Fringilla teydea subspp*.)
	Canary Islands Raven *(Corvus corax canariensis)*
	Collared Pratincole (*Glareola pratincola*)
	Grey Partridge (*ENrDix ENrdix*)
	Rock Ptarmigan (*Lagopus mutus*)
	White-backed Woodpecker (*Dendrocopos leucotos*)