Monitoring wind energy projects in Spain
an analysis of environmental consents and impacts on wildlife

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Introduction

The analysis of **Environmental Impact Assessment** (EIA) documents is a complex process due to the large volume, structural diversity, varied content, and project-specific nature of each case. The main objective of this study is the **location, extraction, analysis and interpretation** of information related to the monitoring of **wind energy projects** and their **impacts on wildlife**. The study analyzes the resolutions of wind energy projects issued in Spain between 2020 and 2025 by the Ministry for the Ecological Transition and the Demographic Challenge (MITERD).

Materials and Methods

The methodology of this study is based on several key phases for the collection, analysis and structuring of data derived from EIAs. More than **3,000 documents** related to the **environmental permitting of renewable energy projects** have been analyzed, and data extraction is ongoing to continuously update the statistical model with new projects.

Regarding wind farms, approximately **800 environmental resolutions have been assessed**, of which **more than 300**, issued **between 2020 and 2025** by the MITERD in Spain, are graphically represented in this study. This study forms part of the development of a doctoral thesis.

The parameters were extracted using internally developed supervised **Generative Artificial Intelligence** (GAI) tools, combining intensive manual tagging by **specialized biodiversity staff** at Ideas Medioambientales and the continuous refinement of advanced AI models, including **Large Language Models** (LLMs) for semantic and syntactic text processing.

This hybrid approach has enabled the optimization of large-scale information processing, structuring non-standardized and dispersed data found in complex technical documents.

The methodological phases established are as follows:

- **Systematic access to and collection of documents** through official web portals using programmatic scraping techniques.
- **Filtering of documents** to ensure the relevance and quality of the sample.
- **Data extraction and analysis supported by advanced artificial intelligence processes**, especially Large Language Models trained to interpret technical and regulatory content.
- **Validation and qualitative review** of results by the expert technical team.
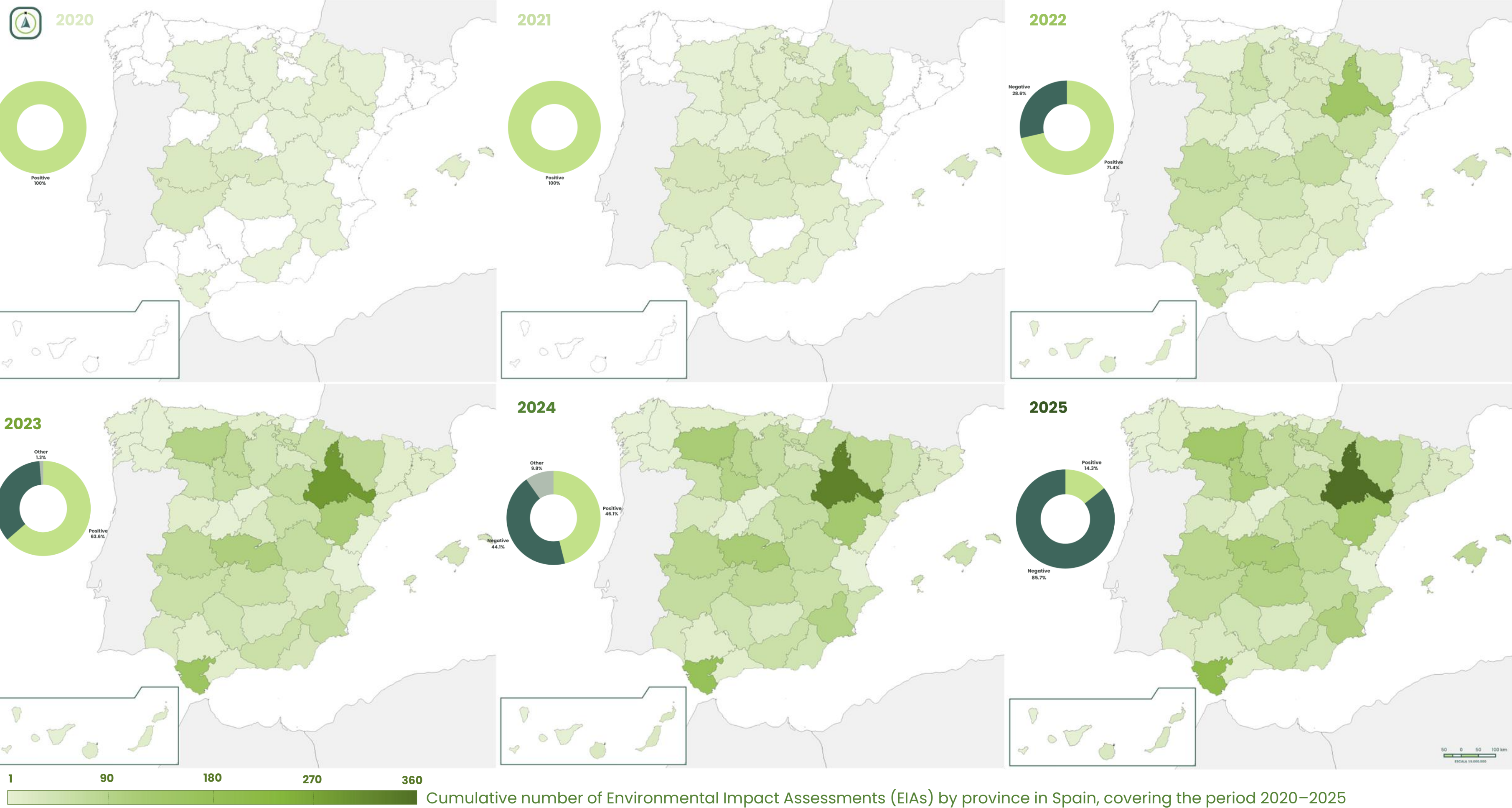- **Statistical analysis** of key parameters

Figure 1. Distribution map of Environmental Impact Assessments (EIAs) approved by the MITERD, as well as by the autonomous communities, across the different provinces of Spain between 2020 and 2025. The pie charts show the percentage of approved projects (light green), rejected projects (dark green), and other types of documents (gray) for each year.

Results

The analysis of Environmental Impact Assessment resolutions between 2020 and 2025 reveals a significant evolution in the processing of wind farm projects in Spain, based on the proportion of favorable and unfavorable outcomes. In the early years of the period, most projects received positive resolutions. In 2022, although 72.0% of the resolutions were favorable, unfavorable decisions began to appear (28.6%). In 2023, the proportion of favorable resolutions decreased to 63.6%, while unfavorable ones increased to 35.1%. A more pronounced shift is observed in 2024 and 2025, with a clear predominance of unfavorable resolutions: 75.0% in 2024 and 85.7% in 2025. Favorable outcomes, in contrast, dropped to 8.3% and 14.3%, respectively. These trends may reflect a change in environmental assessment criteria or increasing technical and environmental complexity in the projects submitted in recent years.

Wind farm projects in Spain have largely been managed by MITERD, with resolutions mainly published in the Official State Gazette (BOE), which compiled over 300 during the analyzed years. Several autonomous communities also stand out, such as Aragón, Castilla y León, and Castilla-La Mancha. Other regions report fewer publications, highlighting MITERD's central role in environmental management and the importance of analyzing this documentation to design more efficient and sustainable projects.
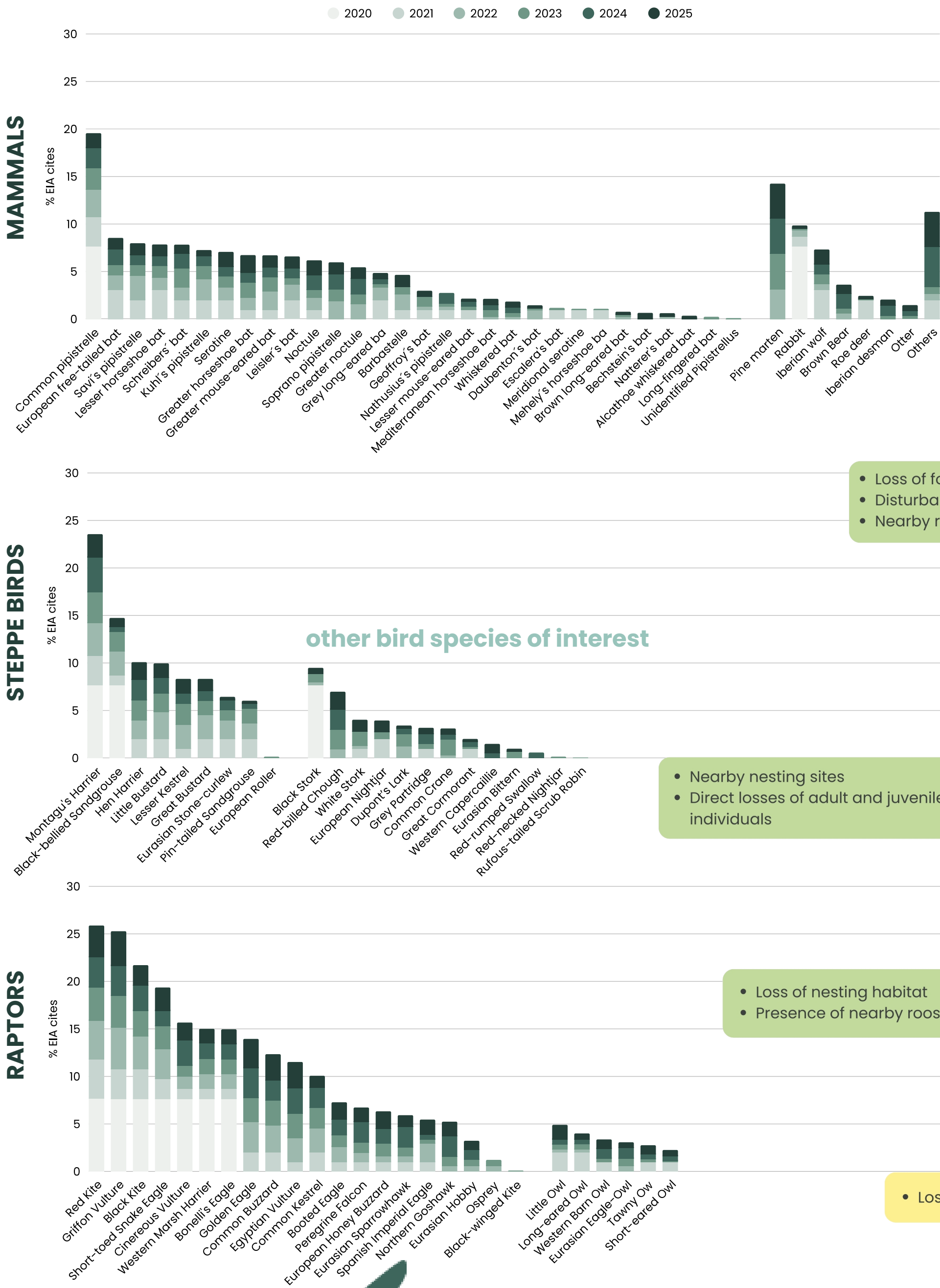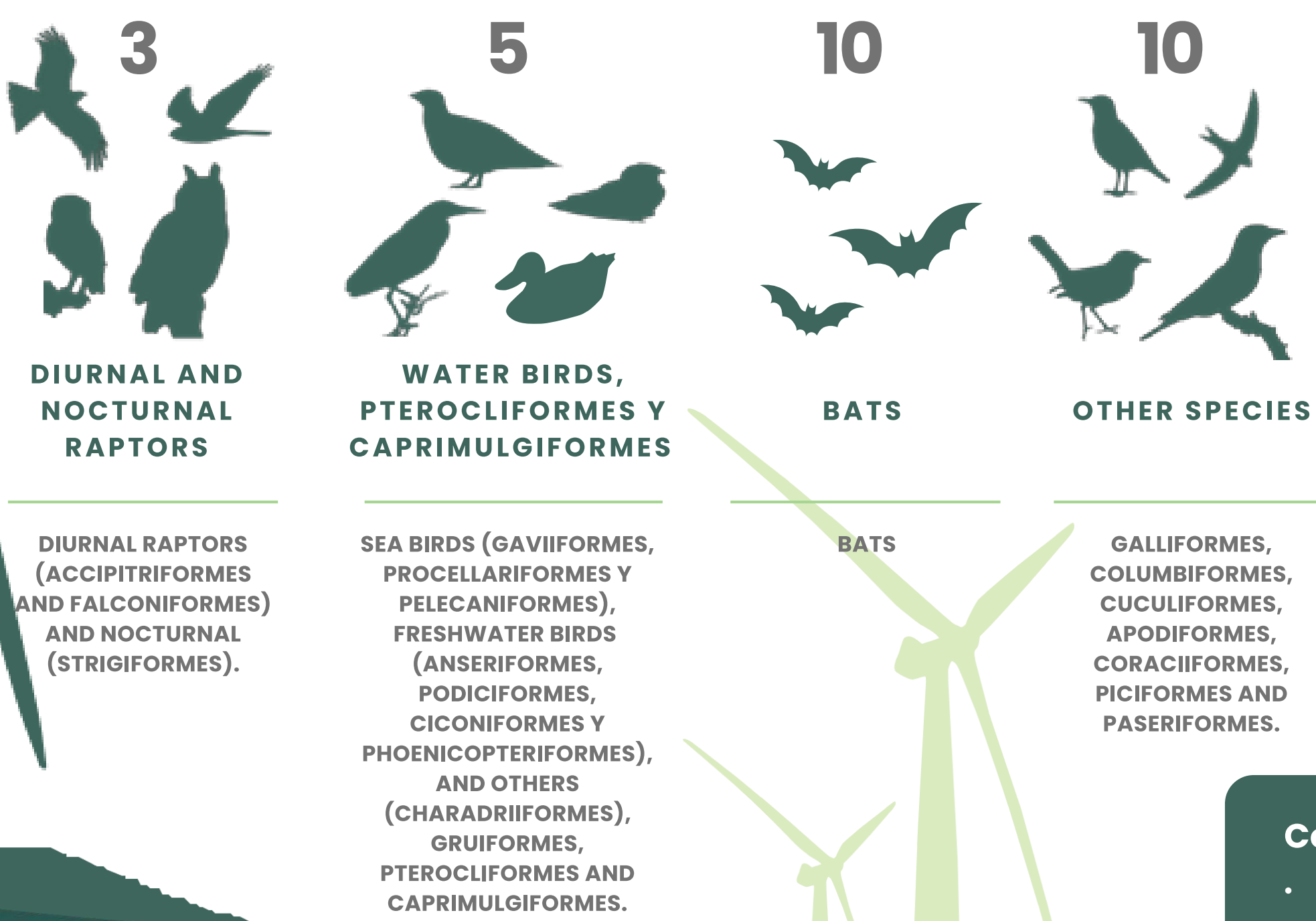
Most **species mentioned in EIAs** published in the Official State Gazette (BOE) hold a conservation status of "vulnerable" or higher. The most affected faunal groups are **raptors** (36.2%), **mammals** (40.5%, mainly **bats** 39.5%) and **steppe birds** (16.3%), all of which are associated with moderate to severe environmental impacts.

Among birds of prey, the species most frequently linked to negative EIA resolutions issued by MITERD include the **Egyptian vulture** (*Neophron percnopterus*), **Red kite** (*Milvus milvus*), **Golden eagle** (*Aquila chrysaetos*), and **Griffon vulture** (*Gyps fulvus*). For steppe birds, the **Lesser kestrel** (*Falco naumanni*), **Little bustard** (*Tetrax tetrax*), and **Black-bellied sandgrouse** (*Pterocles orientalis*) are among the most affected. The main causes of negative rulings include habitat loss, disturbance of breeding or nesting areas, and collision risks with wind turbines or overhead power lines.

Although **bats** are responsible for a relatively low percentage of projects classified as critically impacted, they appear frequently in EIAs due to their sensitivity to direct impacts from wind energy infrastructures. Other mammals, such as the **Brown bear** (*Ursus arctos*) and the **Iberian wolf** (*Canis lupus*), are also involved in negative rulings due to habitat fragmentation and reduced ecological connectivity.

Figure 2. Presence rates of raptors steppe birds, mammals, and other species of interest listed in the Environmental Impact Assessments by year.

Figure 3. Distribution of wildlife species identified in Environmental Impact Assessments (EIAs) as being subject to moderate or severe impacts. The figure also shows a secondary distribution of criticality percentages by species for projects that led to negative decisions by MITERD, as well as the main environmental impacts associated with each species.

REQUEST FOR THE OPERATIONAL PROTOCOL FOR MANAGING CONFLICTIVE WIND TURBINES ANNEX II

98,5 %

The **structure** of the Operational Protocol for Managing Conflictive Wind Turbines is very **consistent**, presenting similar characteristics across all authorized projects, and is included in Annex II of all **approved Environmental Impact Assessments**.

ANNUAL ACCEPTABLE COLLISION THRESHOLD

3 DIURNAL AND NOCTURNAL RAPTORS — DIURNAL RAPTORS (ACCIPITRIFORMES AND FALCONIFORMES) AND NOCTURNAL (STRIGIFORMES).

5 WATER BIRDS, PTEROCLIFORMES Y CAPRIMULGIFORMES — SEA BIRDS (GAVIIFORMES, PROCELLARIIFORMES Y PELECANIFORMES), FRESHWATER BIRDS (ANSERIFORMES, PODICIFORMES, CICONIIFORMES Y PHOENICOPTERIFORMES), AND OTHERS (CHARADRIIFORMES, GRUIFORMES, PTEROCLIFORMES AND CAPRIMULGIFORMES.

10 BATS — BATS

10 OTHER SPECIES — GALLIFORMES, COLUMBIFORMES, CUCULIFORMES, APODIFORMES, CORACIIFORMES, PICIFORMES AND PASERIFORMES.

98,5 % ENVIRONMENTAL MONITORING PLAN

95,7 % MORTALITY MONITORING

98,5 % WILDLIFE MONITORING

82,6 % MONITORING OF WIND TURBINE MORTALITY

91,3 % PRE-CONSTRUCTION WILDLIFE SURVEYS

58,2 % MORTALITY MONITORING ON HIGH-VOLTAGE POWER LINES

76,8 % PRE-CONSTRUCTION VEGETATION SURVEYS

21,7 % CARCASS DETECTION WITH DOGS

REQUEST FOR THE WIND TURBINE SHUTDOWN PROTOCOL FOR BATS

65,6%   **93,4 %**

The **protocols** included in the Environmental Impact Assessments exhibit considerable structural heterogeneity and significant variability in preventive measures, aiming to reduce bat mortality during periods of highest activity, defined by specific wind speeds, times, and dates.

PERIOD

JAN FEB MAR APR MAY JUN JUL AGO SEP OCT NOV DIC

STOPPING SPEED <6 m/s

TIMETABLE From one hour before sunset to three hours after sunset

CLIMATOLOGY Tº 8°C STOP

To minimize bat mortality, the start-up of wind turbines will be delayed until wind speeds exceed 5–6 m/s during the first hours of the night (from one hour before sunset to three hours after sunset), between July and October inclusive, coinciding with the wind speeds, times, and dates when bats are most active.

Figure 4. Percentage of wind energy projects approved by MITERD between 2020 and 2025 that incorporate the Operational Protocol for Managing Conflictive Wind Turbines and the Wind Turbine Shutdown Protocol for Bats in their EIAs. A summary of the Annual Acceptable Collision Threshold for birds and bats is included, which defines annual mortality limits that trigger mitigation measures, such as scheduled turbine shutdowns.

Conclusions

- **Birds of prey, bats, and steppe birds** are the species experiencing the **highest number of critical impacts** in wind energy projects.
- MITERD requires environmental monitoring plans in nearly all approved wind energy projects, including specific wildlife monitoring.
- **Mortality monitoring is explicitly mandated in 82.6% of projects for wind turbines**, but only in 58.2% for overhead power lines. Nonetheless, 95.7% of projects include some form of wildlife mortality monitoring, whether general or specific to turbines and/or power lines. The prescribed frequency for turbine inspections is typically weekly or biweekly, depending on regional guidelines set by each autonomous community. Notably, the use of detection dogs for carcass searches is specified in only 21.7% of projects.
- **98.5%** of projects are subject to the **Operational Protocol for Managing Conflictive Wind Turbines** (Annex II).
- **93.4%** of projects are subject to the **Wind Turbine Shutdown Protocol for Bats.**

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