FACTORS AFFECTING DIFFERENTIAL UNDERESTIMATES OF BIRD COLLISION FATALITIES AT ELECTRIC LINES: A CASE STUDY IN THE CANARY ISLANDS

FACTORES QUE AFECTAN A LA SUBESTIMACIÓN DIFERENCIAL DE LAS COLISIONES DE AVES CON LÍNEAS ELÉCTRICAS: UN CASO DE ESTUDIO EN LAS ISLAS CANARIAS

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APPENDIX 1. A

Description of the zig-zag pattern during the search surveys under electric lines

[Descripción del patrón de zigzageo seguido durante la prospección de las líneas eléctricas.]

The mean zigzagging coefficient was 1.678, a ratio between the length of the zig-zag transect and the length of the power line (sd = 0.430; weighted mean of 152 randomly selected sections obtained in the three study periods), very close to that of x1.6 suggested by Red Eléctrica de España in the Metodología y protocolos para la recogida y análisis de datos de siniestralidad de aves por colisión en líneas de transporte de electricidad. Figure A1-A illustrates an "average" case of how the power lines were prospected. The average walking speed (including the time in movement and the time dedicated to recording the data of the carcasses and the characteristics of the power lines and their surroundings) was 2.46km/h (s.d. = 0.987; range: 1, 1-3.3 km/h). The percentage of time in movement was tremendously variable, mainly due to whether or not carcasses were found: 72% (s.d. = 31.1%; range: 40-92%). The average speed during movement was 3.39km/h (s.d. = 0.429). The average maximum separation of the researchers to the axis of the power line, the “knee” of the zigzag, was 40.6m (s.d. = 9.2m; estimate made on 400 randomly chosen points from six different observers). Although researchers, on average, walked up to 40.6m from the axis of the power line, they could look for carcasses further from that point in the “knee” of the zigzag, as shown in Figure A1-A.

Zigzag survey is a sampling protocol that uniformly covers the study area. It is easily demonstrated by considering how any parallel line to the power line axis crosses the zigzag trail the same number of times irrespective of the perpendicular distance to the axis (see lines A, B and C in the upper part of Figure A2). Detection probability of a carcass is a matter of the distance to the observer, irrespective of the distance to the power line axis. Thus locations 1 in the lower part of Figure A2 (being very close or far away from the power line axis) are covered “more intensively” than 3, considering the curves of probability of detection in Figure 3 in the main document. Nevertheless, locations 2, at the same level as 1 with respect to the axis are “less intensively” covered than both 1 and 3. Averaging over a very large sample of transects and carcass locations,
the average distance of any location 1, 2, 3… to the zigzag is the same. Thus, some locations are over-covered near the legs, or knees, of the zigzag (locations 1), but there are also other locations (2) that are under-covered. By means of Monte Carlo simulations it is demonstrated that the average distance of any location to the zigzag line is the same irrespective of the distance to the power line axis, although the variance is higher near the knees of the zigzags. On the other hand, the average angle of the knee in the zigzags (74°) was broad enough to minimise the apparent problem of higher detections in locations near the “knees” of the zigzag.
Figure A1. Scheme of the zig-zag pattern followed during the prospection of electric lines. (A) Mean characteristics of the zig-zag transects. The linear distance (red), zig-zag distance (blue), angle (pink) and the maximum distance from the axis of the electric line (green), are shown. (B) Scheme of the tracks (blue) followed by two observers prospecting a high-voltage line in parallel. (C) Scheme of the track (green) followed by one observer prospecting a medium-voltage or telephone line.

Figure A1. Esquema del patrón de zigzageo seguido durante la prospección de las líneas eléctricas. (A) Características medias de los transectos en zig-zag. Se representa la distancia lineal (rojo), la distancia en zig-zag (azul), el ángulo (rosa) y la distancia máxima desde el eje de la línea eléctrica (verde). (B) Esquema de los transectos (azul) seguidos por dos observadores que prospectaron en paralelo una línea de alta tensión. (C) Esquema de un transecto (verde) seguido por un observador prospectando una línea de media tensión o telefónica.
**Figure A2.** Scheme of the zig-zag pattern followed during the prospection of electric lines. At the top, the figure illustrates the uniform survey of the sampling area under the zig-zag pattern. At the bottom, the graph shows the potential location of carcasses with respect of the axis and the zig-zag transect (*i.e.* the observer), exposing contrasting scenarios where locations are over-sampled or under-sampled.

**Figura A2.** Esquema del patrón de zig-zageo seguido durante la prospección de las líneas eléctricas. En la parte superior, la figura representa el muestreo uniforme del área muestreada bajo un patrón de zig-zageo. En la parte inferior, el gráfico representa la localización potencial de los cadáveres con respecto al eje y al transecto en zig-zag (*i.e.* el observador), representando diferentes escenarios donde las localizaciones son sobre muestreadas o infra muestreadas.
APPENDIX 1. B.

Description and photographs of the decomposition states of carcasses. [Descripción y fotografías de los estados de descomposición de los cadáveres.]

State 1 or fresh is characterised by the presence of soft tissues, covering from time of death to body inflammation due to bacterial fermentation (Fig. B1).

![Carcass of Rock Pigeon Columba livia in decomposition state 1 or fresh.](image)

**Figure B1.** Carcass of Rock Pigeon *Columba livia* in decomposition state 1 or fresh. [Cadáver de una paloma bravía *Columba livia* en estado de descomposición 1 o fresco.]

State 2 or *emphysematous* included from the beginning of inflammation caused by bacterial fermentation until body rupture due to pressure and superficial tissue decomposition (Fig. B2).
**Figure B2.** Carcass of Domestic Chicken *Gallus gallus domesticus* in decomposition state 2 or *emphysematous*.

[Cadáver de una gallina doméstica *Gallus gallus domesticus* en estado de descomposición 2 o enfisematoso.]

State 3 or *colicuative* encompassing from gas release until decomposition and disappearance of soft tissues (Fig. B3).

**Figure B3.** Carcass of Domestic Chicken *Gallus gallus domesticus* in decomposition state 3 or *colicuative*

[Cadáver de una gallina doméstica *Gallus gallus domesticus* en estado de descomposición 3 o colicuativo.]
State 4 or post-colicuative only dried tissues, cartilages and bones remain (Fig. B4).

**Figure B4.** Carcass of Domestic Chicken *Gallus gallus domesticus* in decomposition state 4 or post-colicuative.

[Cadáver de una gallina doméstica *Gallus gallus domesticus* en estado de descomposición 4 o post-colicuativo.]
State 5 or *skeletal reduction* occurred when only bone remains are distinguishable (Fig. B5).

**Figure B5.** Carcass of Domestic Chicken *Gallus gallus domesticus* in decomposition state 5 or *skeletal reduction*

[Cadáver de una gallina doméstica Gallus gallus domesticus en estado de descomposición 5 o reducción esquelética.]