Railway Electrocution Monitoring

LIFE DANUBE FREE SKY (LIFE19 NAT/SK/001023)

Final Report

Co-funded by the European Union

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Contents

Abstract

Collision and electrocution on powerline infrastructure are significant yet preventable causes of mortality for wild birds in Europe, particularly for larger species, with several amongst them being globally threatened by extinction. The LIFE DANUBE FREE SKY project aimed to assess and mitigate those risks for avian species along the Danube River in Central and Southeastern Europe. Between 2021 and 2025, the first standardized monitoring of electrocutions on railway pylons in Austria has been conducted in Lower Austria and Burgenland province as part of the project. Parallel to the monitoring, 63 km of railway power lines were equipped with bird protection devices (1,263 pylons). By comparing monitoring results before and after the installation, we assessed the efficiency of the mitigation measures implemented within the framework of the LIFE project.

Dog-assisted carcass monitoring across three railway lines documented 202 wild bird carcasses, of which 24 individuals from at least eight taxa were categorized as electrocution victims. Corvids accounted for 79% of electrocution cases, highlighting their heightened vulnerability. Raptors represented the second most affected group (12.5 %). In the sections monitored for the comparative study, the number of electrocution events fell by 89% after the implementation of mitigation measures, with the only incident on an incompletely equipped pylon.

The report gives insights into this first study on railway electrocutions in Austria, discusses strengths and limitations of our approach towards carcass monitoring, addresses possible biases and pitfalls and analyses the effectiveness of the interventions taken, emphasizing the importance of targeted infrastructure modifications to achieve reductions in avian electrocution mortality. The findings provide guidance for conservationists, railway ecologists, and policymakers, demonstrating that interdisciplinary, well-coordinated planning of mitigation measures can deliver substantial improvements in wildlife protection while enhancing railway operation safety and reliability.

Zusammenfassung

Kollision und Elektrokution an Leitungsinfrastrukturen stellen jeweils bedeutende, aber zu guten Teilen vermeidbare Todesursachen für Vögel in Europa dar, wobei insbesondere größere Arten betroffen sind, von denen einige sogar weltweit in ihrem Bestand gefährdet sind. Das Projekt „LIFE DANUBE FREE SKY“ hat zum Ziel, Gefahren durch Leitungsinfrastrukturen entlang der Donau in Mittel- und Südosteuropa zu bewerten und entsprechende Minderungsmaßnahmen umzusetzen. Zwischen 2021 und 2025 wurde im Rahmen des Projekts in Niederösterreich und im Burgenland erstmals in Österreich ein standardisiertes Monitoring von Elektrokutionsopfern an Bahnstrommasten durchgeführt. Parallel dazu wurden 63 km Bahnstromleitungen bzw. 1.263 Masten mit Schutzeinrichtungen gegen Stromschlag ausgestattet. Der Vergleich der Ergebnisse des Totfundmonitorings vor und nach der Installation ermöglichte dabei eine Bewertung der Wirksamkeit der im Rahmen des LIFE-Projekts umgesetzten Schutzmaßnahmen.

Bei der mit Hunden durchgeführten Kadaversuche entlang dreier Bahnstrecken wurden 202 Wildvogelkadaver dokumentiert, von denen 24 Individuen aus mindestens acht Taxa als Opfer von Stromschlägen eingestuft wurden. Rabenvögel (Corvidae) machten 79 % der Elektrokutionsopfer aus, was ihre besondere Anfälligkeit unterstreicht. Greifvögel stellten die am zweithäufigsten betroffene Gruppe dar (12,5 %). In den für die Vergleichsstudie überwachten Abschnitten sank die Zahl der Elektrokutionen nach der Umsetzung der Schutzmaßnahmen um 89 %, wobei sich der einzige Vorfall im Zeitraum des Nachmonitorings an einem unvollständig ausgestatteten Mast ereignete.

Der Bericht gibt einen Einblick in diese erste Studie zu Elektrokution bei Vögeln im österreichischen Eisenbahnnetz, erörtert Stärken und Grenzen unseres Ansatzes des Totfundmonitorings auf Schienenverkehrswegen, geht auf mögliche Verzerrungen und Fallstricke ein und analysiert die Wirksamkeit der ergriffenen Maßnahmen. Er hebt dabei klar die Bedeutung gezielter Nachrüstungsmaßnahmen für die Verringerung der durch Stromschläge verursachten Sterblichkeit hervor. Die Ergebnisse stellen für Naturschützer:innen, Ökolog:innen und politische Entscheidungsträger:innen eine Orientierungshilfe dar und zeigen, dass eine interdisziplinäre, gut abgestimmte Maßnahmenplanung zu erheblichen Verbesserungen im Artenschutz führen und gleichzeitig die Sicherheit und Zuverlässigkeit des Eisenbahnbetriebs erhöhen kann.

1. Introduction

Bird mortality caused by linear infrastructure represents a significant conservation issue. Potential threats include collisions with trains, collisions with overhead wires and electrocution at power supply structures. Electrified railway lines expose birds to all three of these risks. They are therefore particularly relevant for mitigation of infrastructure-related mortality but also notoriously difficult to monitor (Borda-de-Água u. a. 2017). While the impacts of power lines on avian mortality have been widely studied, comparatively little empirical data is available on electrocution risks associated specifically with railway infrastructure, despite the extensive network of electrified railways in Austria and across Europe (Probst, Seaman, und Wrumnig 2017).

Electrocution occurs when birds bridge energized components of electrical installations, often while perching or taking off from pylons. Medium-sized to large birds are particularly vulnerable, and repeated mortality events may occur at specific high-risk structures (Raptor Protection of Slovakia 2023). In response, technical mitigation measures such as bird protection devices (BPD) have been developed and are increasingly installed on railway pylons (Schlüter u. a. 2025). However, systematic evaluations of their effectiveness under real operating conditions remain scarce, especially in the context of railway environments where accessibility, maintenance schedules, and carcass detectability pose additional challenges.

This report presents the results of a multi-year monitoring project assessing bird mortality along three electrified railway lines in eastern Austria (KMSYS91, KMSYS94, and KMSYS95). The primary objective was to document the occurrence and spatial distribution of bird electrocution and to evaluate the effectiveness of retrofitting measures using bird protection devices. To this end, standardized carcass searches — mostly dog-assisted surveys — were conducted before and after the installation of mitigation devices where possible. Particular emphasis was placed on distinguishing electrocution from other mortality events and on accounting for methodological biases inherent in carcass-based monitoring.

Due to a project change and already completed mitigation measures in parts of the rail network, a robust before–after comparison was only possible for selected sections of the KMSYS94 railway line between Parndorf and Kittsee. For these sections, electrocution rates were calculated using standardized exposure measures (pylon-days) to allow a quantitative assessment of mitigation efficacy. In addition to electrocution, the report also documents non-electrocution mortality, providing a broader overview of bird–railway interactions in the study areas.

Using a standardized, dog-assisted carcass monitoring scheme and a conservative and transparent analytical approach, we aim to contribute empirical evidence on the effectiveness of bird protection devices on railway pylons to support future mitigation planning, inform infrastructure management decisions, and highlight remaining knowledge gaps regarding avian electrocution risks along railways.

2. Methods

2.1. Protective measures

The goal of our study was to assess the effectiveness of protective measures against electrocution taken within the framework of the LIFE DANUBE FREE SKY project. Within the scope of the project, ÖBB Infrastruktur GmbH retrofitted 1,263 pylons, or 63,1 km of railway lines respectively, according to current standards (T. Schuh, pers. comm.). To this end, protective caps have been installed to the insulators on the pylon tops (Figure 1). These caps prevent birds and climbing animals from getting in contact with current-carrying parts of the line while sitting on top of the pylons or the insulators. Furthermore, the lower insulators at the bracket arms (supporting the contact and messenger wire) have been equipped with Animal Guards (see Figure 1b). These devices, mounted on the insulators, prevent animals from sitting on or crossing the insulator by administering small electric shocks, comparable to an electric fence.

Figure 1: *Installation of bird protection devices:* ***a)*** *mounting of protective caps on railway pylon top insulator (Photo: Renate Wunder);* ***b)*** *protective caps (center) and Animal Guards (bottom left) prepared for installation work (photo: ÖBB Infrastruktur GmbH)*

2.2. Survey methods

2.2.1. Recognition survey

Recognition surveys were planned as part of the project to familiarize with the study area, assess the spatial distribution of electrocuted birds along the railway track and plan the search sections for the baseline and post-refitting surveys accordingly. The carcass search was carried out visually as part of route inspections. To this end, the specified search sections were slowly walked along the track bed and adjacent areas of the railway embankment were checked for animal carcasses or parts thereof. Special attention was paid to the surroundings of the pylons to maximize the detection probability of electrocution victims. The search speed was accustomed to the characteristics of the search area and vegetation cover, averaging about two to three kilometres per hour.

2.2.2. Baseline survey and post-refitting survey

For the comparison of electrocution rates, surveys were carried out before (baseline survey) and after (post-refitting survey) the refitting of pylons with bird protection devices (BPD). These were planned to focus on dangerous sections of the railway line, based on the results of the recognition survey.

In contrast to the latter, baseline and post-refitting surveys were conducted with the help of certified carcass search dogs. Each section of approximately seven kilometres was searched by one dog and its handler once per run (the distance was determined on the basis of the dog handlers' experience in a practical trial, see also 2.4.1). The dog was directed along the side of the roadbed, where the pylons are situated. In the case of multiple parallel tracks (e.g. in train stations), the search team followed the main track and controlled the pylons adjacent to this track. The focus on electrocuted birds around the pylons must be taken into account when interpreting results for collision victims. All bird carcasses found (collision and electrocution victims) have been documented photographically, and a find protocol was filled in (see attachments).

Regarding the timing of the search runs, it was decided to cover the breeding season more intensely. A previous survey from Lower Austria suggests that the number of birds killed along railways is especially high during spring migration and breeding season (Hohenegger 2014). Furthermore, the number of car collision victims peaks during the months of April and May (random data from ornitho.at). However, it is unknown if these seasonal fluctuations are fully applicable when it comes to electrocution. Practically, searches in the second half of the breeding season proved to be especially exhausting for the search dogs and therefore most probably less effective, as high temperatures and dense vegetation complicated the search. After the finalization of the monitoring on railway line KMSYS91 and the inclusion of the lines KMSYS94 and KMSYS95 into the monitoring scheme the schedule had to be adjusted to the routine line closures of ÖBB Infrastruktur GmbH.

Although separated in the original project plan, there is no methodological difference between baseline and post-refitting surveys. In fact, the same monitoring method was used throughout all dog-assisted searches. Only afterwards, the recovered electrocution victims were assigned to the pre- and post-refitting period of the respective pylon.

2.3. Survey sections

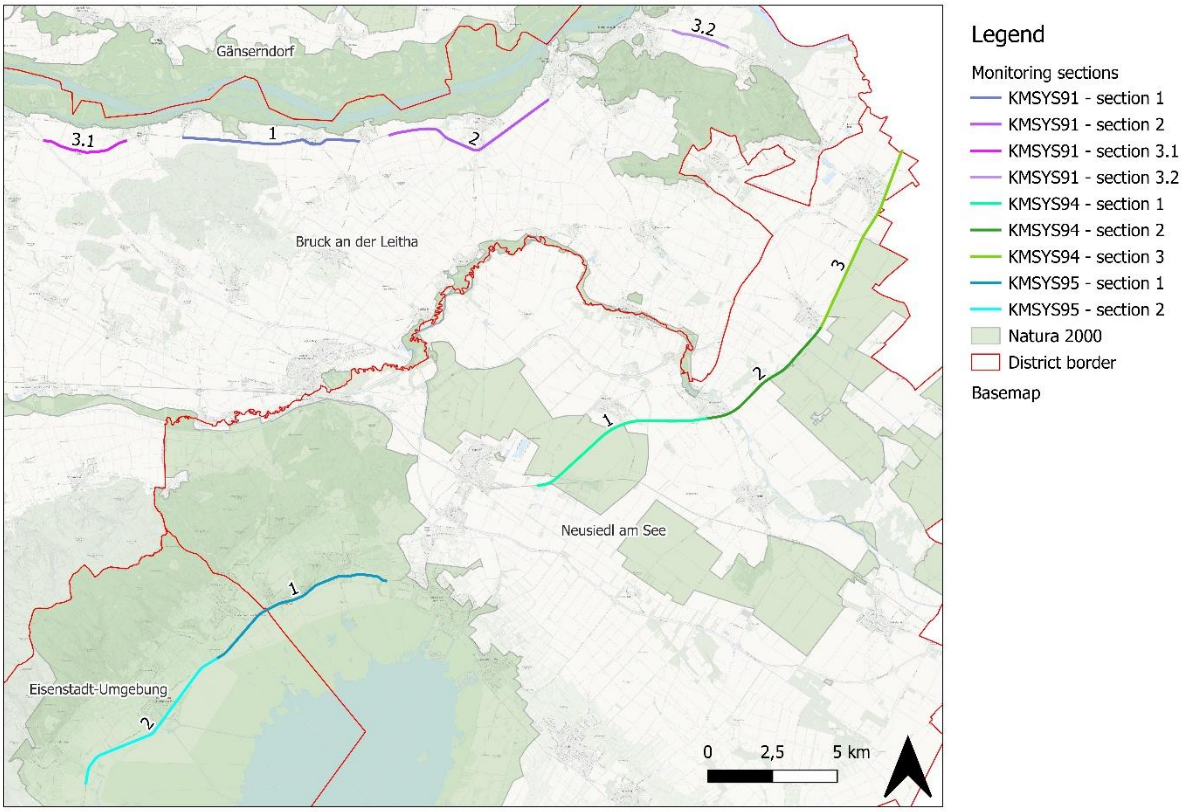

***Figure 2**: Survey sections*

All survey sections are situated along three railway lines in the far east of Austria, that run very near or through Special Protected Areas (SPAs, Natura 2000). In a preliminary assessment regarding electrocution risk on railway pylons, all three SPAs affected were ranked amongst the top seven with the highest priority (Probst, Seaman, und Wrumnig 2017).

2.3.1. KMSYS91

The railway line KMSYS91 corresponds to the S7 route between Fischamend and Wolfsthal, running south of the Danube and largely parallel to the river. While not directly cutting through the floodplain forest, the railway line lies very close to this area designated as a special protection area (SPA) under the birds directive (Donau-Auen östlich von Wien, AT1204000) and a national park (Nationalpark Donau-Auen). Therefore, several species of conservation concern in these protected areas are potentially affected by risk associated with the railway line.

Four separate monitoring sections were surveyed along this line (amounting to 3 search days per survey run): section 1, section 2, section 3.1, and section 3.2. More detailed descriptions of these sections can be found below.

2.3.1.1. KMSYS91 – section 1

Section 1 has a total length of 6.9 km. Starting at the level crossing Scharndorfer Straße, Wildungsmauer (48.107832 N, 16.802304 E), it ends at the stop in Haslau an der Donau on the B9 at km 20.0 (48.109611 N, 16.711903 E). The precise location of the section is shown in Figure 3.

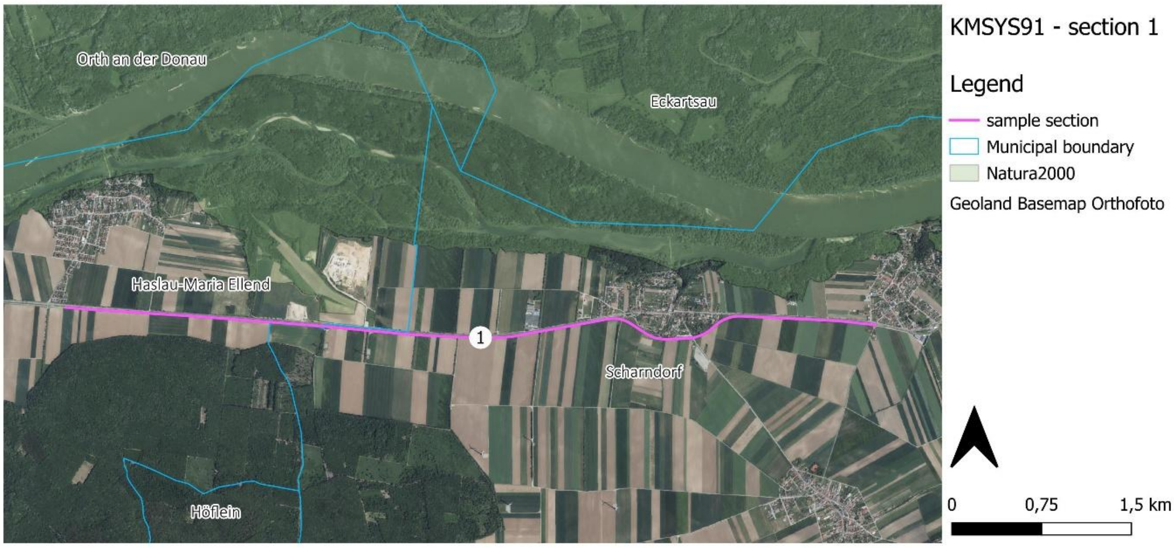

Figure 3: *KMSYS91 - monitoring section 1*

2.3.1.2. KMSYS91 – section 2

Section 2 covers a distance of 7 km. It begins at the first level crossing east of Wildungsmauer, located on the B9 at km 28.0 (48.110085 N, 16.818790 E), and extends eastwards to Deutsch-Altenburg, ending near B9 km 35.0 (48.121841 N, 16.900809 E). The exact alignment of this section is illustrated in Figure 4.

Figure 4: *KMSYS91 - monitoring section 2*

2.3.1.3. KMSYS91 - section 3.1

Section 3.1 has a length of 3.3 km. It starts at the motorway crossing near Fischamend (48.108613 N, 16.640542 E) and follows the railway corridor westwards until it reaches the area opposite the roundabout at Maria Ellend on the B9 at km 17.7 (48.108514 N, 16.681667 E). Figure 5 shows the exact location of the section.

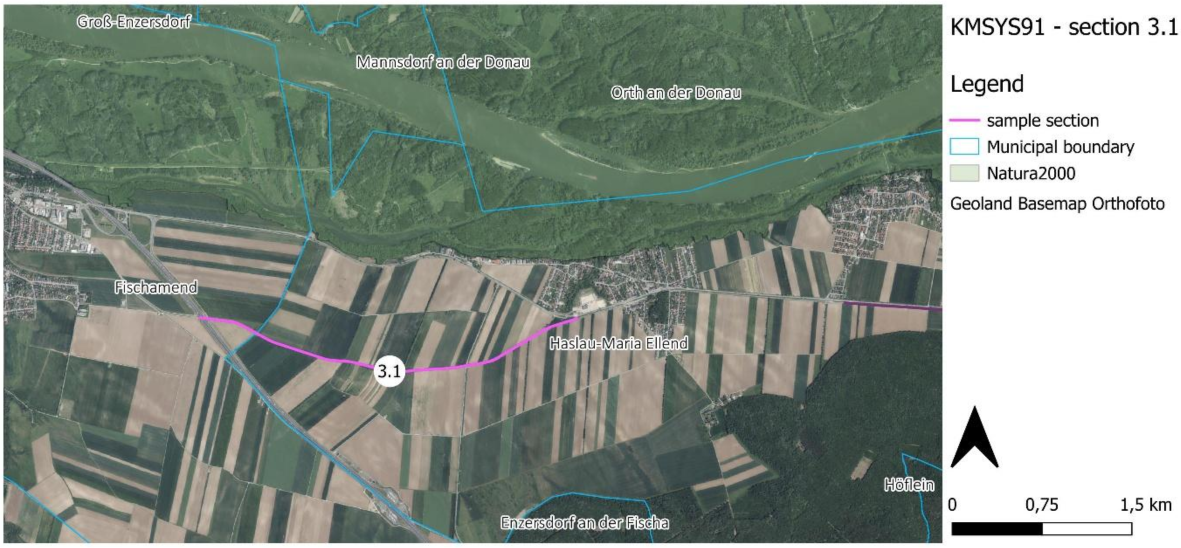

Figure 5: *KMSYS91 - monitoring section 3.1*

2.3.1.4. KMSYS91 - section 3.2

With a total length of 2.2 km, this section begins at the railway crossing east of Hainburg on the B9 at km 41.55 (48.145666 N, 16.966347 E). It continues southeast and ends at the B9 crossing at Galgenberg near Wolfsthal, around km 43.8 (48.139677 N, 16.994566 E). Its precise location is shown in Figure 6.

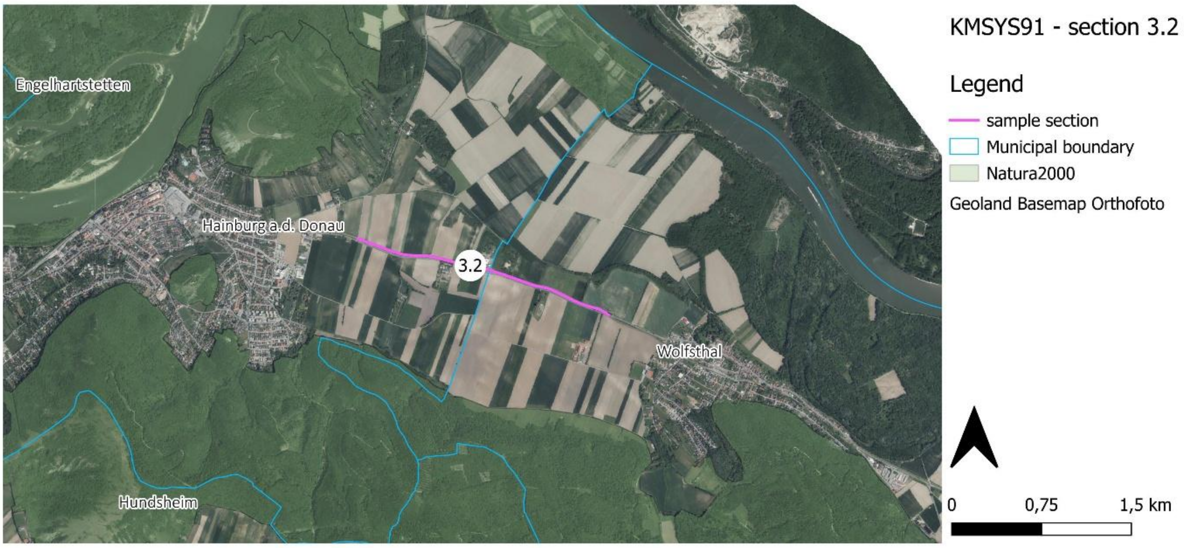

Figure 6: *KMSYS91 - monitoring section 3.2*

2.3.2. KMSYS94

The KMSYS94 railway line is the Parndorf–Bratislava branch of the Ostbahn. It runs through the northern part of the Burgenland region, connecting Parndorf with Kittsee before continuing towards the Slovakian border. Monitoring took place between Parndorf and Kittsee. In this area, the railway line partly cuts through the SPA "Parndorfer Platte – Heideboden" (AT1125129) or forms the SPA border. This railway line had been known for more or less regular train collisions of several endangered raptor species and Great Bustards.

Three monitoring sections were surveyed along this line: sections 1, 2 and 3. Detailed descriptions of these sections can be found in the following chapters.

2.3.2.1. KMSYS94 – section 1

Section 1 covers a total distance of approximately 7.3 km. It begins at the level crossing east of the Parndorf freight station (47.987951 N, 16.894321 E) and follows the line northeast until it reaches Gattendorf station (48.010677 N, 16.981446 E). The western half of the section lies within the SPA "Parndorfer Platte – Heideboden". The exact alignment of the section is shown in Figure 7.

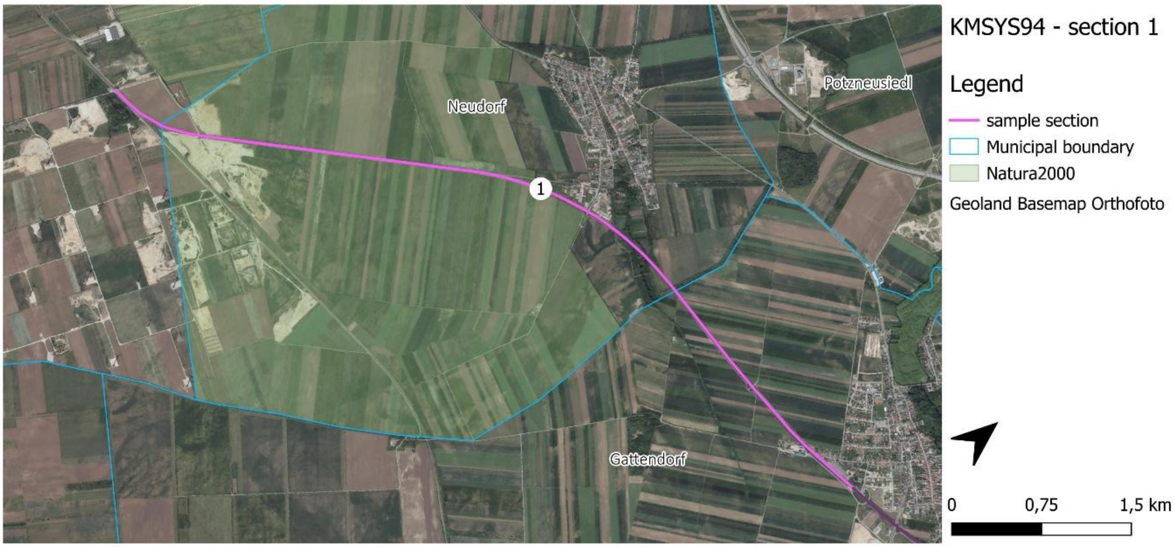

Figure 7: *KMSYS94 - monitoring section 1*

2.3.2.2. KMSYS94 – section 2

Section 2 has a length of around 5.9 km. It starts at Gattendorf station (48.010677 N, 16.981446 E) and continues eastwards to the L202 level crossing in Pama (48.042487 N, 17.041784 E). The northeastern half of the section borders the SPA "Parndorfer Platte – Heideboden". A detailed overview of this section is provided in Figure 8.

Figure 8: *KMSYS94 - monitoring section 2*

2.3.2.3. KMSYS94 – section 3

The third section extends over approximately 7.5 km. It begins at the L202 level crossing in Pama (48.042487 N, 17.041784 E) and stretches further northeast to the state border (48.102814 N, 17.084198 E). The southwestern half of the section borders the SPA "Parndorfer Platte – Heideboden". Its precise location is illustrated in Figure 9.

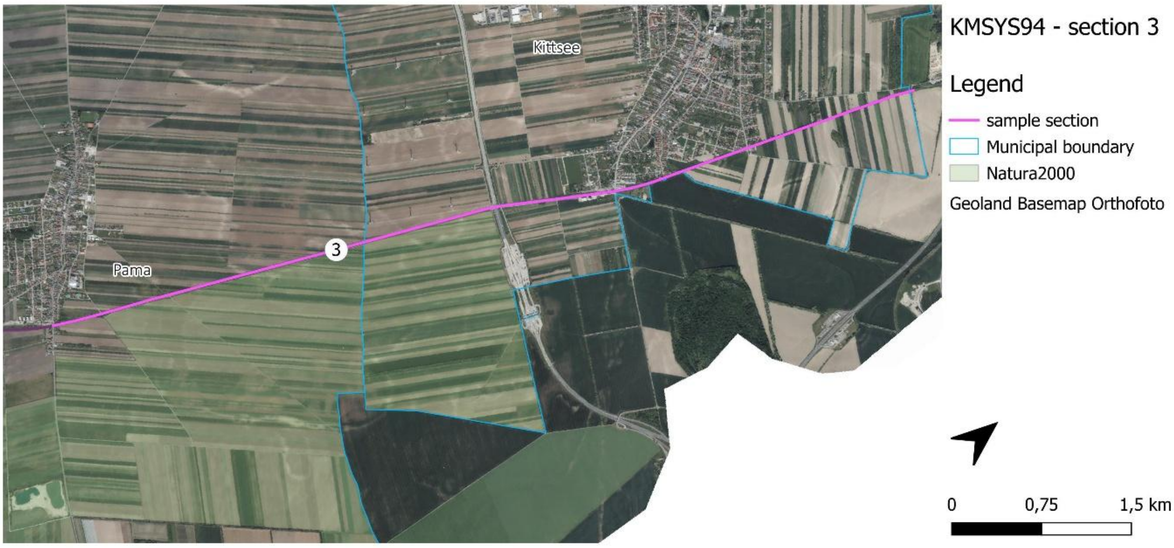

Figure 9: *KMSYS94 - monitoring section 3*

2.3.3. KMSYS95

The KMSYS95 railway line corresponds to the Pannonia Railway. It traverses the northern region of Burgenland, northwest of lake Neusiedl. The line is situated in open agricultural land along the massive reed belt of the lake. Monitoring was carried out along the stretch between Neusiedl am See and Donnerskirchen within the SPA "Neusiedler See - Nordöstliches Leithagebirge" (AT1110137). Two monitoring sections were surveyed along this line: section 1 and 2. Detailed descriptions of these sections can be found in the following chapters.

2.3.3.1. KMSYS95 – section 1

Section 1 covers approximately 7.7 km. It begins at the track junction west of Neusiedl station (47.955012 N, 16.815063 E) and follows the line southwards to the level crossing near the Breitenbrunn shooting club (47.928151 N, 16.727090 E). The precise alignment of this section is shown in Figure 10.

Figure 10: *KMSYS95 - monitoring section 1*

2.3.3.2. KMSYS95 – section 2

Section 2 covers 7.3 km and runs from the level crossing at the Breitenbrunn shooting club (47.928151 N, 16.727090 E) to the level crossing at Donnerskirchen Golf Club (47.885124 N, 16.659651 E). A detailed map of the route is provided in Figure 11.

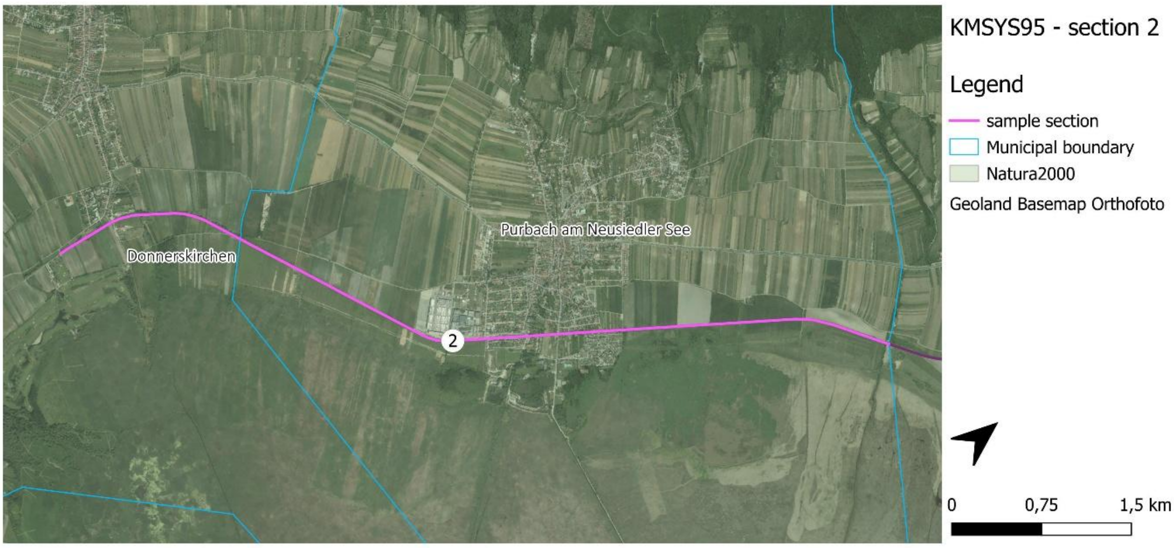

Figure 11: *KMSYS95 - monitoring section 2*

2.4. Survey procedure

2.4.1. KMSYS91

On the railway KMSYS91 we conducted a recognition survey in February 2021 (on the reasons for skipping this survey on KMSYS94 and KMSYS95 see 2.4.2). From the Fischamend to the Wolfsthal train station an experienced searcher together with ÖBB personal walked all safely accessible sections along the power supply line and controlled the surroundings of the pylons for bird corpses. As the railway personal had not been notified sufficiently in advance, we had no security protocol in place and could not access all areas of the track. We could carry out the monitoring around the pylons, but in some locations, it was not possible to search for or record collision victims directly on the track. Furthermore, a total stretch of 2 800 m or 8.8 % had to be skipped completely due to security concerns.

Based on the results of the recognition survey and an expert assessment of the electrocution risk along the railway track, we identified 17.4 km in three sections as suitable for baseline and post-refitting monitoring. Furthermore, we included a small section of 2.2 km, which had already been equipped with bird protection devices.

From March 2021 to March 2022, we conducted five monitoring runs (see Table 3, p. 37). During the first run, we searched the four sections within two days, as a preliminary inquiry of dog handlers had pointed to a maximum search distance of ten kilometres. In practice, we established a search distance of seven kilometres as a more reasonable approach, as the perseverance of the dogs seemed to significantly decrease after 3–4 hours, depending on environmental conditions. We therefore adjusted the monitoring schedule to cover the 19.2 km within three days per run.

After our fifth run in March 2022, the line was excluded from further retrofitting measures, as a full reconstruction of the track and pylons was planned for shortly after the project. In effect, the monitoring on KMSYS91 was discontinued.

2.4.2. KMSYS94

Due to operational and security reasons, monitoring on railway line KMSYS94 could only be conducted during maintenance closures. These are typically situated mid-spring (April–May) and late summer to early autumn (September–October). Therefore, we had to adjust our monitoring schedule accordingly. As results of the recognition survey are not fully comparable with those of dog-assisted monitoring, we decided to directly start with the baseline surveys – with the option of reducing the survey section extent afterwards – to collect sufficient data within the remaining time before the completion of refitting measures. We surveyed the whole railway from just east of Parndorf to the Austro-Slovak border near Kittsee for the first time in September 2022. Due to the big number of bird carcasses recovered during this first run and the high prevalence of endangered species in the surroundings, we continued to monitor the full segment for the rest of the project. In total, we conducted five monitoring runs (see Table 3, p. 37). Contrary to the initial project plan, the monitoring could not be separated clearly into baseline and post-refitting surveys, as refitting measures had been ongoing parallel to the monitoring in different segments of the surveyed railway. Rather, we identified segments with similar equipment dates and assessed each monitoring run accordingly, if it qualifies as pre- or post-refitting survey for the specific segment.

2.4.3. KMSYS95

Like KMSYS94, on railway line KMSYS95 the monitoring could only take place during maintenance closures. For the same reasons, we started directly with the baseline survey (dog-assisted). After the first run in September 2022, where we covered 15.2 km between Neusiedl am See and Donnerskirchen (sections 1 and 2 in Figure 2), we decided not to carry on with the survey on this railway. In the surveyed sections, the refitting measures had already been finished at the start of our monitoring. Furthermore, we only recovered a single carcass (of a likely collision victim) along the whole track. In effect, we had no data of any electrocution victims for a comparison.

2.5. Data collection

At project start, a standardised protocol for the examination of bird carcasses in the field and the recording of relevant parameters was established (see p. 38ff.). Upon discovery, carcasses were first photographically documented in situ without manipulation, including images of the original position, the immediate surroundings, and a broader location overview with reference to the nearest pylon. Basic metadata (date, time, unique ID, and location) were recorded for each individual. When multiple carcasses were found simultaneously, each bird was processed separately to ensure unambiguous assignment of images and data.

Geographic coordinates were determined using GPS-based applications and recorded in decimal degrees with high spatial precision. Subsequently, carcasses were examined for indicators relevant to cause-of-death assessment, including estimated time since death based on decomposition state, signs of electrocution (e.g. burns on toes or wing tips), external injuries, and noticeable internal injuries such as fractures. Palpation focused on key skeletal structures. Findings were documented in standardized forms and corresponding schematic illustrations. Examinations had to be conducted using disposable gloves, except for freshly deceased birds, and could be omitted in cases of advanced decomposition. Further photographic documentation included close-ups of visible injuries, standardized dorsal and ventral views with wings spread when possible, and images linking the carcass to its ID. Finally, each examined carcass had to be marked with a cotton thread on the leg or tarsus to prevent duplicate recording.

2.6. Data processing

2.6.1. Assignment of mortality reasons

Animals found dead along railway lines may have died from various causes. However, given the pronounced accumulation of carcasses in the vicinity of railway infrastructure, it must be concluded that most mortality events are related to the railway operation or infrastructure itself. On electrified lines, the principal causes include collisions with trains, collisions with overhead wires, and electric shock (electrocution). In some cases, animals found on the track may also have died from causes unrelated to railway operation.

Although one of the main railway-related causes (train or line collision, or electrocution) can be assumed in most cases, the assignment of a specific cause of death is often challenging. Carcasses are often already in a degraded condition when found, which limits the reliability of post hoc assessment. In addition, many carcasses – regardless of their initial condition – are subject to severe mechanical damage when run over by trains or displaced by air turbulence, further complicating interpretation. Distinguishing between injuries sustained ante mortem and post mortem is generally only possible in fresh carcasses, especially without professional histological examination.

During data collection, the presumed cause of death was therefore assigned based on carcass location and recognizable injuries wherever possible and noted on the data collection sheet. During data processing, the mortality reason was finally determined based on injury pattern, carcass location in relation to railway infrastructure and species-specific factors (typical behaviour and interaction with railway infrastructure) – as far as possible. We did not carry out any lab examinations of carcasses.

As the project focused on electrocution, we tried to identify relevant cases as confidently as possible and the examination focused on distinguishing between electrocution cases and all other causes of death (wire/train collisions, predation, illness etc.). We based our assessments on two main indications pointing to electrocution as cause of death, namely lack of skeletal trauma and finding location directly adjacent to pylon. Additionally, electricity marks are a very clear indication but are often missing in animals killed by railway pylons and are only observable in rather fresh carcasses. In addition, we took physiological characteristics and typical behaviour patterns into account, as many small species are incapable of causing short circuits or are extremely unlikely to do so, and some larger species do not settle on electricity pylons.

Individuals with severe skeletal trauma were treated as collision victims as were individuals with less severe injuries found far from the pylons. We did not assign the cause of death if we could not determine it with sufficient probability, especially if carcasses were severely decomposed and/or fragmented or birds were found next to pylons but with skeletal trauma.

Regarding collision victims, we used separate categories for overhead line and train collision victims in the field protocol, but a clear distinction proved impractical at large, as both may result in similar injury patterns. Moreover, birds that collide with overhead lines frequently fall into the track area and may subsequently be run over by trains. Consequently, most carcasses could not be assigned to one of these two causes confidently and both collision types were combined into a single category (“collision”) for data analysis.

2.6.2. Definition of the evaluation period

Originally, it was planned to survey similar time periods before and after the installation of BPD to quantify the efficacy of the measures. A recognition survey was planned at the start of the monitoring to identify especially dangerous stretches and produce “clean” circumstances for the subsequent monitoring. The recognition survey would therefore create a clear limit for the evaluation period, as animals killed before could be excluded from the comparative analysis.

As the schedule for the surveys had to be adapted after the project changes (see 2.4), we had less flexibility and time for carrying out the monitoring. At the start, some sections had already been equipped with BPD (see 2.6.4) and we could only finish two monitoring runs before the retrofitting started in the remaining sections. To include a sufficiently long pre-equipment period in the analysis, we therefore decided to incorporate data from the first monitoring run as well. However, in order to have a clearly defined evaluation period, we had to set a fictional start date and determine whether the animals found had died before this start date or during the evaluation period.

The fictional start date was set to 27th September, 2021, which is one year before the first monitoring run, due to several reasons:

- The monitoring schedule and periods for pre- and post-refitting monitoring on the relevant sections are nearly identical if the start date is set to September 2021.
- Our first monitoring run took place end of summer 2022, and the previous summer is most suitable to demarcate the evaluation period, as animals that died before or within the summer months differ greatly in condition from those that died after. Between November and March, however, decomposition processes (apart from consumption by wild animals) slow down considerably and the time of death is much more difficult to estimate.
- Detection probability decreases with time but is – in our opinion and suggested by repeated recoveries in our data – sufficiently high during the first year for mid- to large-sized birds.
- The congruence between pre- and post-refitting monitoring schedules ensures that biases (as detection probability) in the data are comparable and their influence on the result is therefore minimized.

In total, the evaluation period lasts 1 318 days from the fictional start date (27th September, 2021) to the second day of the last monitoring run (7th May, 2025). As one monitoring run took three days to complete, we always used the second search day as unified date for all calculations.

2.6.3. Estimation of mortality date

As we incorporated data from the first monitoring run into the comparative analysis and used a fictional start date, we had to determine if found animals had died in the respective evaluation period, or earlier and should therefore be excluded. For this purpose, we assessed the approximate time of death for all relevant carcasses through expert estimation. We calibrated our assessment by producing estimates for each detection of repeatedly found carcasses and compare the values to correct for potential systematic under- or overestimation.

2.6.4. Assessment of electrocution rate

For the comparative analysis regarding the efficacy of refitting measures, we identified the sections where the monitoring schedule allowed for a sound comparison of data collected before and after the refitting.

- On railway line KMSYS91, a small section had been equipped with bird protection devices (BPD) before our monitoring, but no further measures have been conducted during the project. Therefore, no data for the comparative analysis was available from this line.
- On railway line KMSYS94, some sections had been equipped with BPD prior to the start of the monitoring. The remaining pylons were equipped at the same time as the second and third monitoring run.
- On railway line KMSYS95, the refitting measures had already been finished before the start of our monitoring. Therefore, no data for the comparative analysis was available from this line.

In effect, the comparative analysis is restricted to data of the KMSYS94 railway line between Parndorf and Kittsee.

At the start of our monitoring in September 2022, two longer stretches of the survey sections (1.8 km at the southwestern end (within section 1) and 2.6 km at the northeastern end (within section 3)) had already been equipped with BPD. Furthermore, five and seven pylons were equipped during the modernisation of the railway stations Neudorf and Parndorf respectively. We excluded these four sections from the analysis, as no baseline data was available.

A further 17 single pylons between Gattendorf and Kittsee had been retrofitted prior to the first monitoring run, at least partly due to electrocution-induced damage to the insulators, and were therefore excluded likewise.

For the remaining 259 pylons along the main track, clustered into four sections (A, B, C and D, see Figure 12), we determined the number of days they remained unequipped and equipped within the evaluation period between the fictional start date on 27th September, 2021 (one year before the second day of the first monitoring run) and 7th May, 2025 (second day of the final monitoring run). These 259 pylons were equipped with BPD during the line closures in April and September 2023 (unified completion date 26th April and 20th September)[1].

The five survey runs corresponded to the progress of the installation as follows:

- two runs before the installation of the technical mitigation measures (with the later one coinciding with the starting of refitting measures),
- one run simultaneous with the completion of installation,
- two runs after the installation.

The electrocution victim records were assigned to the respective group (before vs. after installation of the mitigation equipment). We counted all carcasses as electrocution victims that had been categorised as such with at least moderate probability.

To calculate exposure measures ("pylon-days"), we first summed the number of days the pylons within each route section were unequipped and the number of days they were equipped. Each of these values was then multiplied by the number of pylons in the respective section. The resulting unequipped and equipped pylon-days were subsequently associated with the number of electrocution victims found in the corresponding phase to obtain two comparable detection rates per section.

Detection rates are standardised and reported as finds per 100 000 pylon-days, and the rates from the two phases (before vs. after installation) were compared.

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[1] The available data on equipment dates did not give exact dates for single pylons. It referred to long sections of the railway, did not specify the measures (e.g. installation of protective caps, installation of animal guards) and was – at least in part – erroneous. We clarified the equipment dates for the relevant sections using information from ÖBB personnel, our own photo documentation and Google Street View. However, a more precise documentation of any measures to be evaluated is crucial for a sound assessment and should be included in future projects.

Figure 12: *Evaluated sections (A-D) and pylons on KMSYS94 for the comparative analysis*

3. Results

During the monitoring on all three lines, 250 registrations of carcasses or parts of animals were made and reported. 13 registrations concerned other taxa than birds, captive birds (homing pigeons, Muscovy duck) or remains that could be not identified at all. The remaining 237 registrations concerned wild birds (including Feral Pigeons). Of these, 35 registrations were classified as recoveries of already known carcasses (double counts of disintegrated carcasses and subsequent registrations of older ones). Therefore, a total of 202 individual wild birds were found.

3.1. Electrocution

3.1.1. Electrocution victims

Of the total findings, 24 carcasses were identified as (very) probable or confirmed electrocution victims. The vast majority (79 %) of electrocution casualties were corvids (in Figure 13 all in reddish colours), comprising thirteen Carrion Crows (*Corvus corone/cornix*), one Jackdaw (*Coloeus monedula*), one Eurasian Magpie (*Pica pica*), and an additional three individuals that could be assigned only to the genus *Corvus*.
Further electrocution victims included two Common Kestrels (*Falco tinnunculus*), a Common Buzzard (*Buteo buteo*), a Great Cormorant (*Phalacrocorax carbo*), and a White Stork (*Ciconia ciconia*).

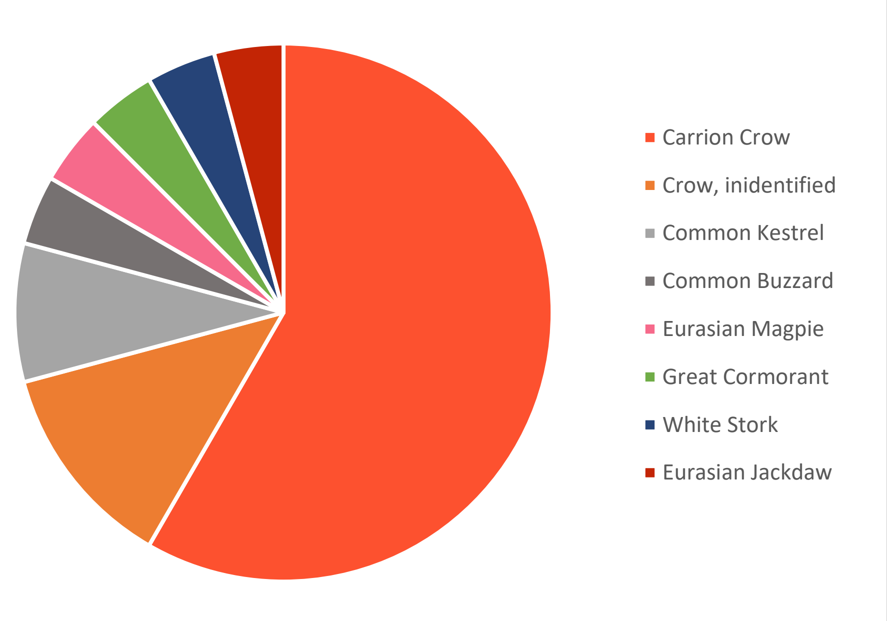

Figure 13: *Electrocution victims by species*

3.1.2. Geographical distribution of electrocution victims

Across the two monitoring sections KMSYS91 und KMSYS94, a total of 24 carcasses were recorded. Table 1 summarises the species recorded on each railway line. Section KMSYS91 yielded 7 findings, predominantly corvids and raptors (three unidentified crows, one Carrion Crow, two Common Kestrels and one Common Buzzard). Section KMSYS94 accounted for 17 findings, dominated by Carrion Crows (13), but also including a broader range of taxa (Eurasian Magpie, Great Cormorant, White Stork and Eurasian Jackdaw, each one finding).

Table 1: *Number of electrocution victims by species and railway line.*

	KMSYS91	KMSYS94	total
Carrion Crow	1	13	14
Crow, unidentified	3	0	3
Common Kestrel	2	0	2
Common Buzzard	1	0	1
Eurasian Magpie	0	1	1
Great Cormorant	0	1	1
White Stork	0	1	1
Eurasian Jackdaw	0	1	1
total	**7**	**17**	**24**

3.1.3. Detection rate comparison before/after equipping

In total, four evaluation sections (A-D, comprising 259 pylons) were suitable for the before–after equipment comparison. Across these 259 pylons, a total of eleven electrocution incidents were recorded during the monitoring period. Nine of these incidents occurred before the installation of the mitigation devices, and one occurred afterwards. One could not be clearly assigned to the before- or after-equipment period due to a very late recovery and heavy decomposition and was therefore excluded from the analysis. Figure 15 shows the temporal distribution of electrocution victims, the times of monitoring runs and the equipment progress of pylons on the relevant sections, which were retrofitted in two steps.

The detection rate across all evaluable sections combined was 5.27 finds per 100 000 pylon-days. This rate was considerably higher than the post-installation detection rate of 0.59 finds per 100 000 pylon-days. Figure 14 and Table 2 provide the detailed data of all four sub-sections.

In section A (Parndorf to Neudorf train station), the detection rate before equipping was 4.57 finds per 100 000 pylon-days (one victim). After equipping, no further electrocutions occurred, bringing the detection rate down to 0.

In section B of KMSYS94 (Neudorf train station to Gattendorf train station), the detection rate before equipping was 8.14 finds per 100 000 pylon-days (three victims). Following equipping, no additional electrocution victims were detected, resulting in a detection rate of 0.

In section C of KMSYS94 (Gattendorf train station to Pama train station), no electrocution victims were detected before equipping (detection rate 0). After equipping, one case was recorded, corresponding to a detection rate of 1.73 finds per 100 000 pylon-days.

In section D of KMSYS94 (Pama train station to Kittsee train station), the detection rate before equipping was 11.89 finds per 100 000 pylon-days (five victims). After equipping, no further electrocutions were recorded, resulting in a detection rate of 0.

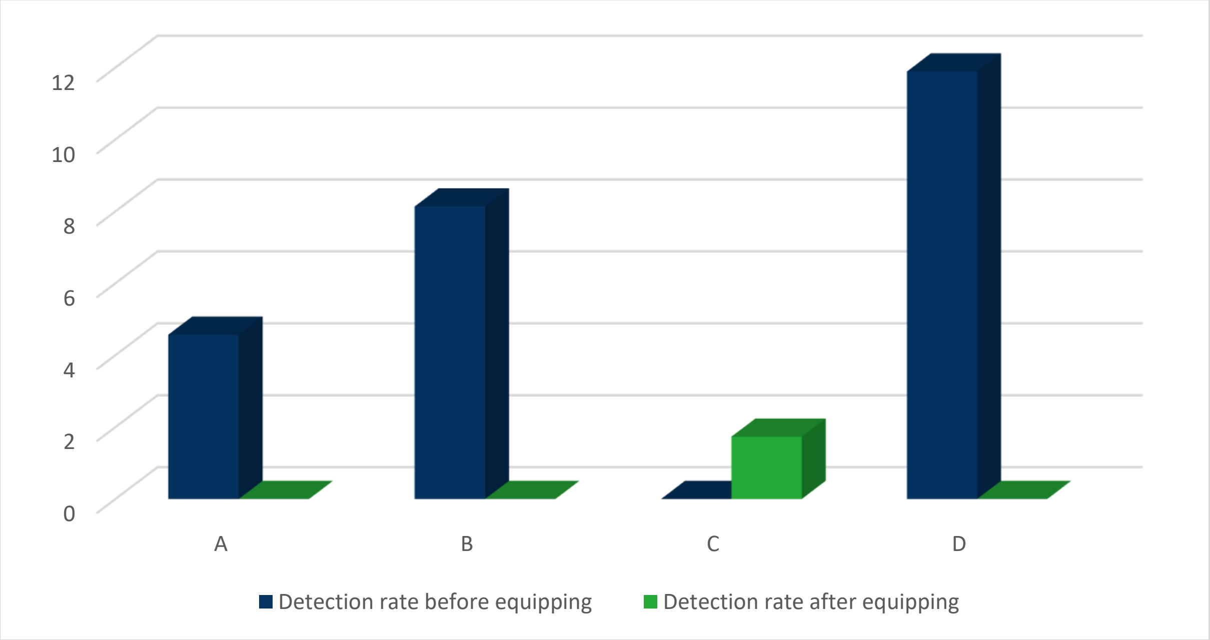

Figure 14: *Comparison of detection rates (findings per 100 000 pylon days) before and after equipment of BPD in the four subsections on KMSYS94*

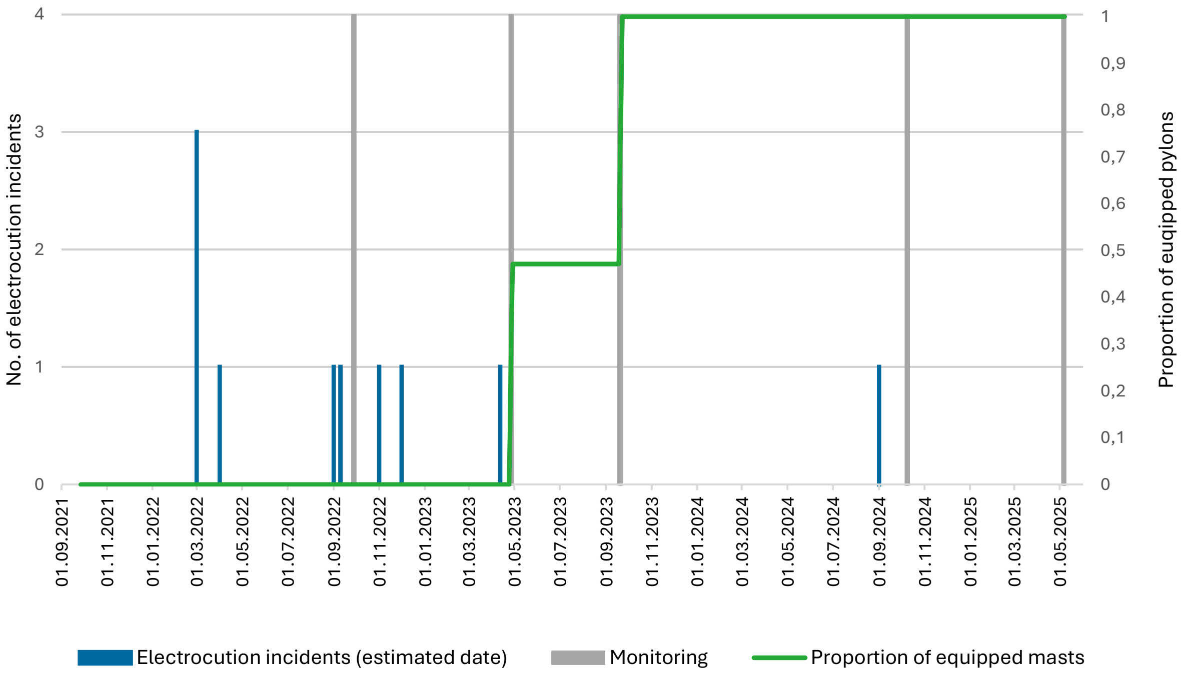

Figure 15: *Electrocution monitoring Parndorf-Kittsee before and after equipping the pylons.*

Table 2: *Electrocution rate before and after the installation of mitigation devices.*

Section	**Section length (km)**	**Days unequipped**	**Days equipped**	**Evaluable pylons**	**No. of electrocution victims before equipping**	**No. of electrocution victims after equipping**	**Pylon-days before equipping**	**Pylon-days after equipping**	**Detection rate (per 100 000 pylon-days) before equipping**	**Detection rate (per 100 000 pylon-days) after equipping**
Parndorf – Neudorf (A)	*2.2*	*576*	*742*	*38*	*1*	*0*	*21 888*	*28 196*	*4.57*	*0*
Neudorf – Gattendf. (B)	*2.6*	*723*	*595*	*51*	*3*	*0*	*36 873*	*30 345*	*8.14*	*0*
Gattendorf – Pama (C)	*5.7*	*723*	*595*	*97*	*0*	*1*	*70 131*	*57 715*	*0*	*1.73*
Pama – Kittsee (D)	*4.8*	*576*	*742*	*73*	*5*	*0*	*42 048*	*54 166*	*11.89*	*0*
total	***15.3***			***259***	***9***	***1***	***170 940***	***170 422***	***5.27***	***0.59***

3.2. Non-electrocution

A total of 178 bird carcasses were found that could not be attributed to electrocution with sufficient probability. 109 of these individuals died due to collisions with either trains or the overhead wire system. In 69 cases, the cause of death could not be determined.

Of the 178 bird carcasses in total, 158 individuals could be identified to the species or at least to the order. The majority of carcasses belonged to the order Galliformes (landfowl), which accounted for 60 individuals (38 %, see Figure 16). Other frequently represented orders included Accipitriformes (raptors) and Passeriformes (passerines), comprising 24 and 23 carcasses respectively (c. 15 % each). Additionally, Columbiformes (pigeons and doves) were recorded 21 times (13 %). Further findings included 18 Strigiformes (owls), representing 11 %, and 7 Falconiformes (falcons), making up 4 % of all carcasses, Anseriformes (waterfowl) with 3 individuals (2 %), and one each (1 %) from the orders Piciformes (woodpeckers) and Charadriiformes (waders and gulls).

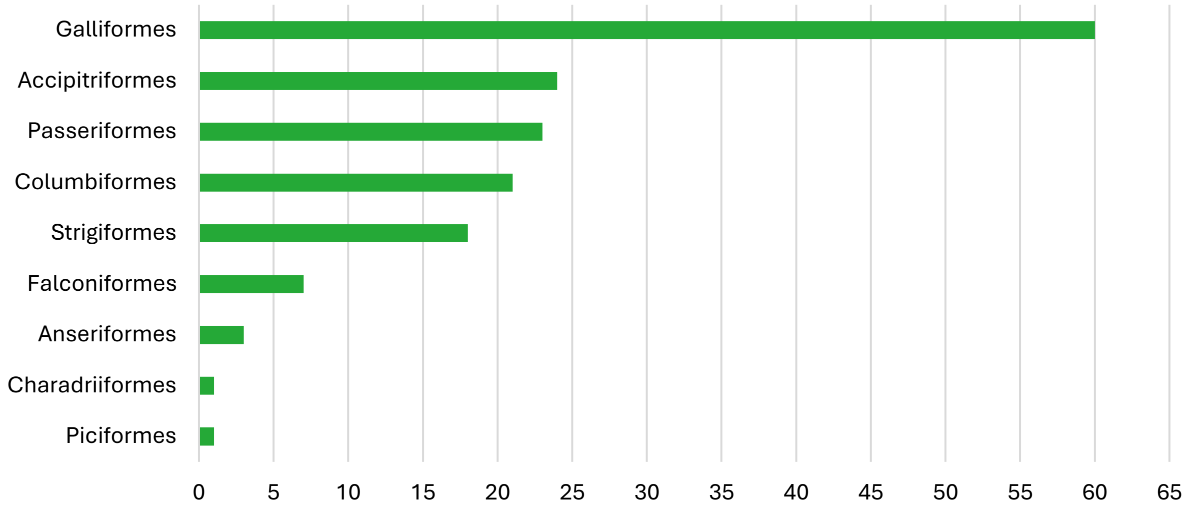

Figure 16: *Non-electrocution bird victims by order*

4. Discussion

4.1. Electrocution

4.1.1. Affected species

24 individuals of at least seven different species were found as electrocution victims during the monitoring runs on all three lines. While some only moderately common species have been registered (White Stork, Cormorant), the majority of individuals belonged to very common and widespread ones. Noticeably, corvids made up for 79 % of the carcasses assigned to electrocution. This number fits well into the broader picture: In the grid of the German "Deutsche Bahn", corvids made up for 76,4 % of short circuits between 2017 and 2020 (n= 12,005; Körner u. a. 2025). This emphasized dominance most probably reflects their frequent use of pylon and powerline structures as vantage points and their relatively large wingspan, which increases the likelihood of bridging energized elements. Social behaviour surely plays an additional role.

Contrary to the German data, we did not find any pigeons or doves that could be identified as electrocution victims. However, our data contains 14 finds of pigeons or doves without assigned cause of death and electrocution cannot be ruled out in most cases, although none of the carcasses were found under the pylons.

Predominantly due to the small sample size, the present study does only provide very limited insights into the range of species affected by electrocution after the installation of BPD. Only two birds died on evidently retrofitted pylons presumably through electrocution, both of them Carrion Crows (*Corvus corone/cornix*). If our assumptions are accurate and the protective caps on the pylon top insulators are more effective than the animal guards on lower ones (see also 4.1.2), this may lead to shifts in the species composition, as different species favour different perching locations on the pylons.

4.1.2. Efficacy of bird protection devices

Our data clearly shows reduced electrocution numbers after the retrofitting of railway pylons. In total, we found only two birds that had likely been electrocuted after the retrofitting work had been completed, although in one case the pylon in question had not been fully fitted out.

In our comparative analyses, the normalized "electrocution rate" (not corrected for detection probability) shows a drop from 5.27 incidents per 100 000 pylon-days before the installation to 0.59 incidents after, corresponding to an 89 % drop. Despite the small sample size of only ten evaluable electrocution victims in the evaluated sections, this reduction seems strong enough to demonstrate the value of the refitting measures for bird protection. With regard to assessing the effectiveness of the measures, it is particularly worth noting that the one putative electrocution victim after the retrofitting measures was discovered beneath a pylon with complex setup that had not been fully secured. At this pylon, at least one (dangerous) insulator had not been equipped with an Animal Guard.

For comparison, we also calculated the electrocution rate for all 106 pylons, that had already been refitted before the start of the monitoring. As the time of refitting measures on these pylons is unknown, we used only mortality events between first and last monitoring run (n= 1). For these 106 pylons, the normalized electrocution rate is 1.09 incidents per 100 000 pylon-days, which is higher than in the evaluated sections after refitting but, nevertheless, much lower than before. However, given the extremely small sample size, the calculated rate should be treated with caution.

In relation to this second putative electrocution case after retrofitting, it is noteworthy that the bird was found under a typical pylon with simple setup and we could not identify any structural deficiencies in the layout of the protective measures. Although we cannot definitively rule out a different cause of death, this likely electrocution points towards the possibility of (rare) electrocution events on pylons refitted according to current standards. As we don't have direct observations of electrocution events, we can only suggest possible mechanisms causing these incidents based on expert opinion. While protective caps on the pylon tops should prevent nearly all electrocutions, the animal guards used for the other insulators have a deterrent effect but could theoretically be bypassed by larger birds. Furthermore, an experimental study from Germany suggest that animal guards can pose a hazard under certain circumstances (Görlich u. a. 2021). Therefore, we want to encourage further research on the possibility of electrocutions on retrofitted pylons and emphasize the importance of meticulous documentation of suspected electrocution victims found under such pylons. Given the expectable rarity of such events, even incidental observations could be valuable in clarifying possible mechanisms.

4.2. Biases

4.2.1. Detection probability

The detection probability (searcher efficiency and carcass persistence) has a significant influence on the validity of mortality monitorings. Location-specific variations can distort the spatial distribution and species composition of the carcasses found, even within individual monitoring rounds or investigation periods: maintenance works at the track bed usually destroy carcasses, with, at best, only parts of large bones remaining. Railway personnel may remove larger animal carcasses found on the track bed. Vegetation management can make carcasses more visible under certain circumstance, on the other hand animal bodies can be destroyed during the procedure as well. In some areas, especially train stations, larger spaces are kept permanently free of vegetation, and carcasses are therefore easily visible for a longer time. In addition to location-specific factors, other short-term variable conditions such as weather or light can also influence the search efficiency. Furthermore, the overall detection probability for different species and species groups varies considerably, as underlined for example by the comparably low percentage of small passerines (5.6 %, 9 ind.) amongst non-electrocution victims (n= 158). Both the searcher efficiency and the carcass persistence, that could not be quantified within the present project, are correlated to species-specific characteristics. The interpretation of the results regarding species composition and absolute victim numbers must therefore be done cautiously. For electrocution victims, which are mostly medium sized to large birds, this bias is probably less pronounced but still existent. A systematic underestimation of smaller bodied birds compared to larger ones must be assumed, as the former are more likely to get carried away by scavengers, are less visible during the search runs and their remains survive for a shorter period of time. Also in our data, the presumably oldest bone remains belong to the largest bird found, a White Stork.

Therefore, we expect a stronger underestimation of smaller electrocution victims (e.g. pigeons) in absolute numbers, even in the comparative analysis. However, we assume that this does not substantially influence the relative changes observed by our study, as we consider the biases in the periods before and after the installation of BPD similar.

4.2.2. Mortality reason assessment

Our assessment of mortality reasons is subject to potential inaccuracy due to several factors. It is based on haptic and visual field examinations, which have limited informative value, as we could only evaluate more severe injuries (bone fractures, open wounds etc.). Due to the long intervals between monitoring runs, most carcasses were heavily decomposed, and injuries of soft tissue could not be assessed at all in many birds. Post-mortem displacement or destruction of carcasses by mechanic stress (e.g. train traffic) and consumption by wild animals can alter the apparent find situation and injury pattern and therefore influence the mortality reason assessment.

Apart from objective circumstances, personal biases of the executive staff could influence the assessment. To guarantee consistency, all mortality reason assignments were carried out or repeated by the project manager.

Taking these potential errors into account, we consider the identification of electrocution events as overall reliable but probably an underestimation. Electrocution primarily affects medium-sized to large birds and is often indicated by the carcass being located directly adjacent to pylons or other electrical infrastructure, normally without evidence of skeletal trauma. Additional indicators include typical electricity marks, particularly on the toes or wing tips. Consequently, for carcasses in typical circumstances without damage to bone structures the assessment as electrocution victims seems conclusive and robust, but displaced or damaged electrocution victims are likely to be overlooked.

For some suspected electrocutions, assignment remained uncertain and these cases were assessed carefully to prevent electrocution cases from being missed. In most cases, where the cause of death could not be established with at least moderate probability, it was due to the very bad condition of the carcass. Often, these birds had indeed been consumed by predators or were heavily decomposed.

For most cases without mortality reason assignment (n= 69), collision can be regarded as the most probable cause of death. In some cases, predation is a possible cause, but collision and following post-mortem consumption could not be excluded. Only eight carcasses without assessment have been found directly near pylons, four of them on the comparison sections of KMSYS94. All four of these birds have been killed before the equipment of pylons with BPD. Therefore, we conclude that – even if these four birds were killed by electrocution – our assignment of mortality causes would lead rather to an underestimation than an overestimation of the efficiency of the measures taken.

In conclusion, we suggest that our data only represents part of the electrocution victims present during the monitoring runs as some individuals could not be clearly assigned due to their condition. Apart from detection probability, this must be considered when deriving absolute electrocution numbers from the data. However, we consider our results regarding the reduction of electrocution events reliable, as the pre- and post-refitting monitoring have been carried out in very similar circumstances, and we tried to eliminate personal biases in the assessment of mortality reasons.

4.2.3. Mortality time estimates

The estimates for mortality dates are based on expert opinion and are therefore prone to errors. We tried to minimize the estimation error by different means. Assessment was made by experienced staff working on bird carcasses for multiple years. Furthermore, we carried out cross-checks on carcass photos with known approximate time of death (from repeated detections of the same carcasses, compare Figure 17). In this way, we could calibrate our assessment to the site-specific conditions and estimate our error. Based on these cross-checks, we are confident that the error for the timespan between death and finding does not exceed 20 to maximum 30 %. Even taking this potential margin of error into account, all data used for the comparative analysis clearly has to be assigned to the evaluation period. Conversely, all animals not assigned to our evaluation period unequivocably died well before September 2021. A single probable electrocution victim was excluded from the analyses, because it could not clearly be assigned to the respective period based on the estimated mortality date (this victim was furthermore found below a pylon that had at least one insulator without Animal Guard). In conclusion, we are sure that estimation errors of mortality dates did not influence the result of the comparative analysis regarding the effectiveness of the protection measures.

Figure 17a,b: *Decomposition progress of a Carrion Crow carcass between 26-09-2022 and 05-05-2025 (952 days)*

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Appendix 1: Monitoring sections

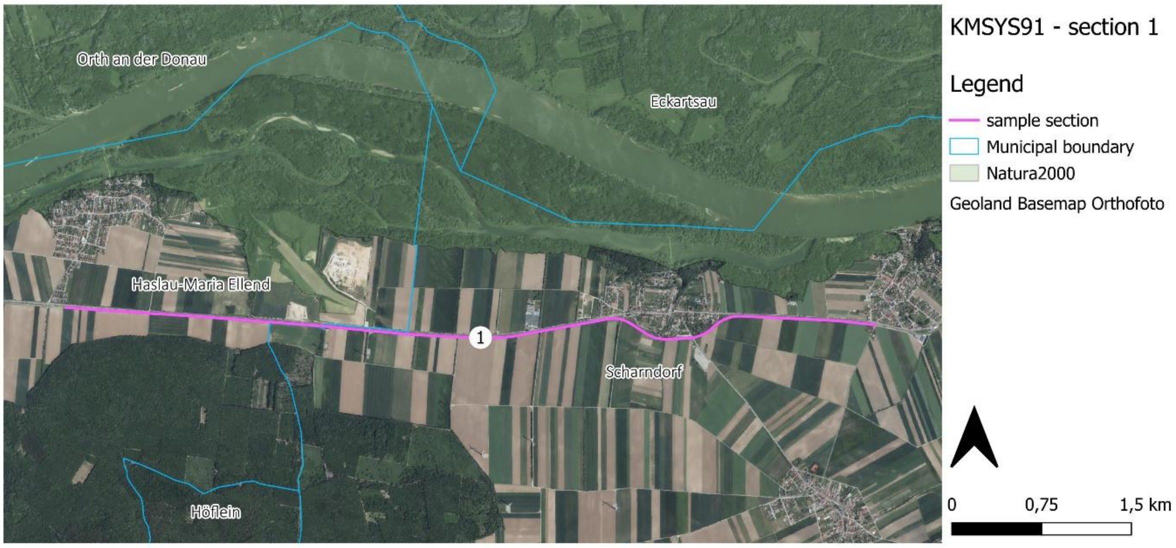


Figure 18: KMSYS91 - monitoring section 1

Figure 19: KMSYS91 - monitoring section 2

Figure 20: KMSYS91 - monitoring section 3.1

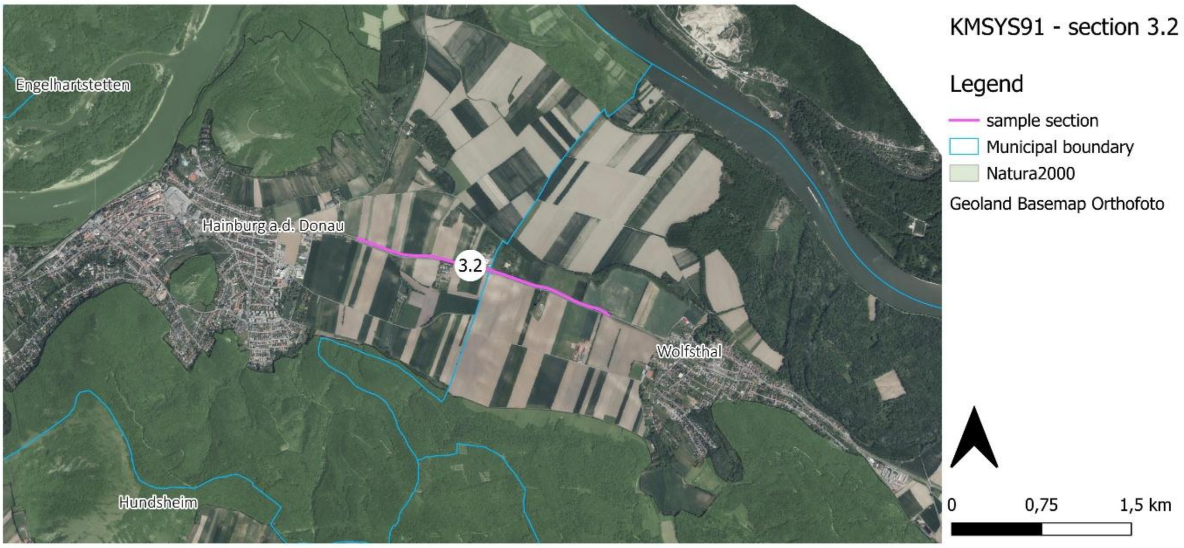


Figure 21: KMSYS91 - monitoring section 3.2

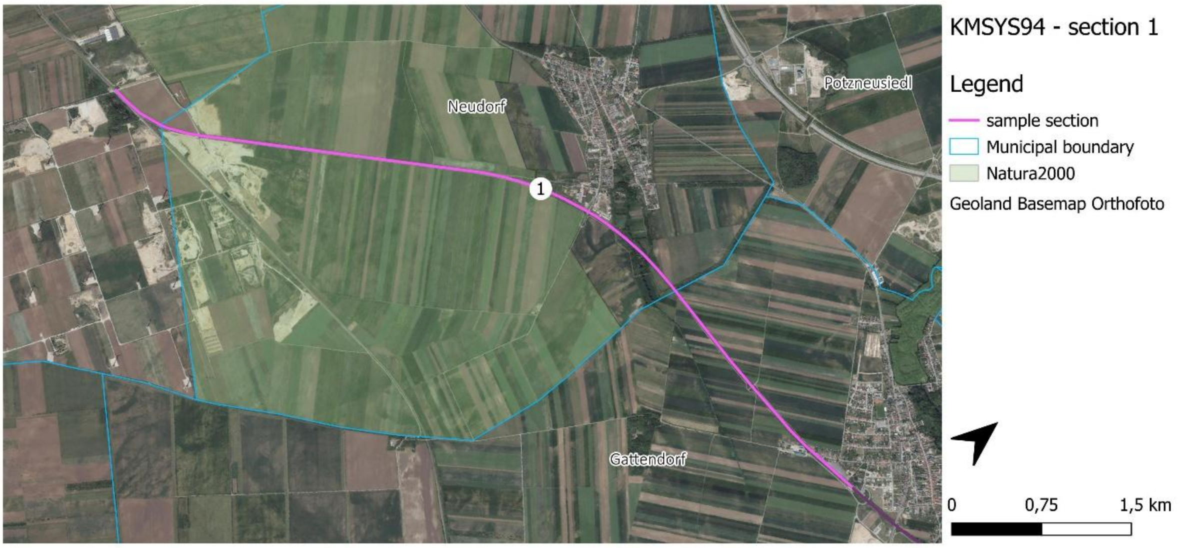


Figure 22: KMSYS94 - monitoring section 1

Figure 23: KMSYS94 - monitoring section 2

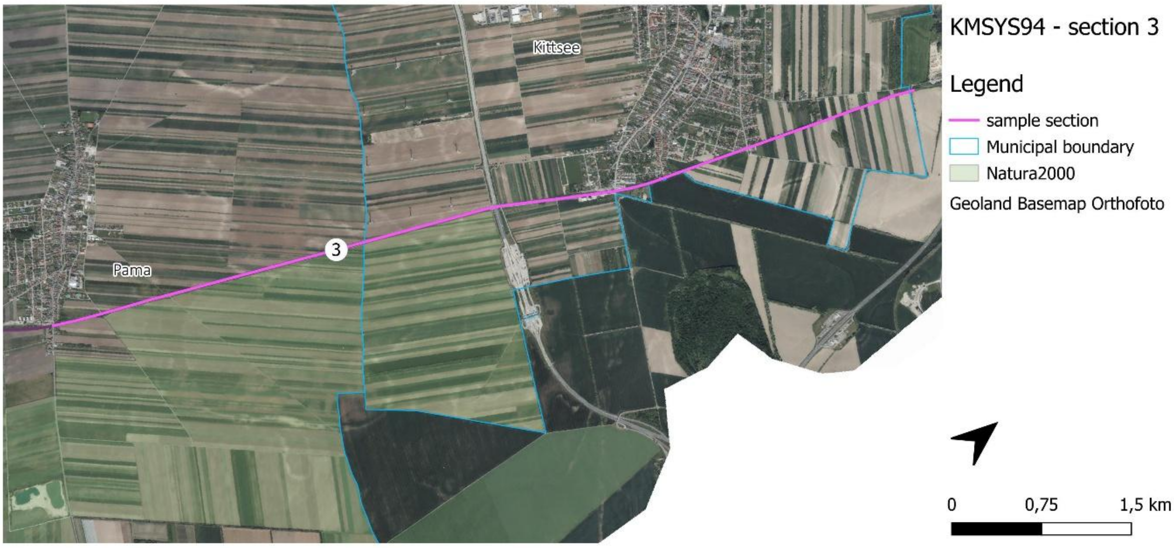


Figure 24: KMSYS94 - monitoring section 3

Figure 25: KMSYS95 - monitoring section 1

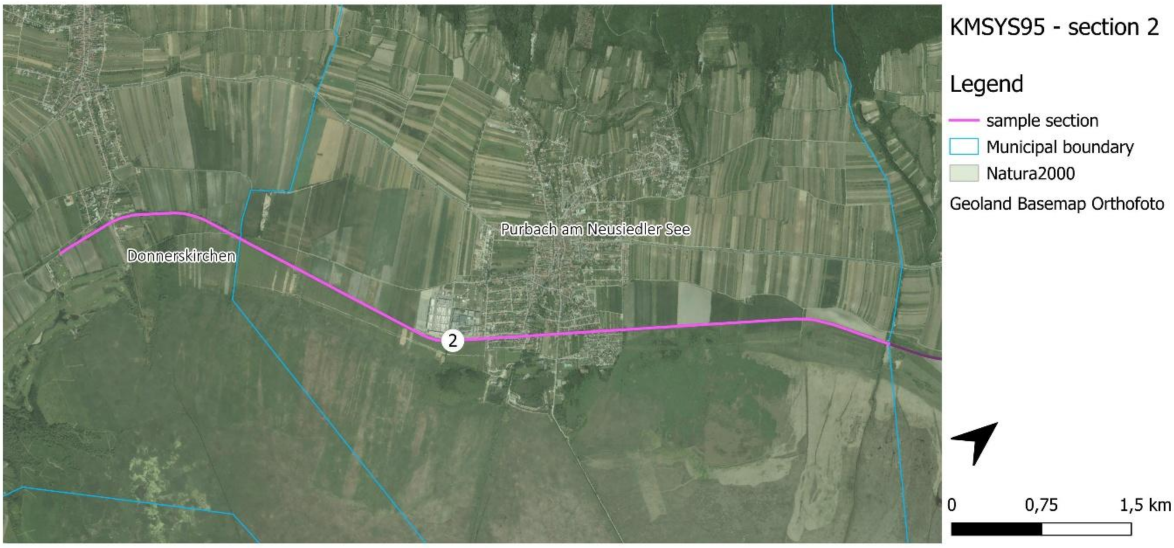


Figure 26: KMSYS95 - monitoring section 2

Appendix 2: Monitoring run overview

Table 3: *Overview of all monitoring runs during the project (searcher abbreviations: JHO… Johannes Hohenegger, SKN… Stefan Knöpfer, MSI… Marion Schindlauer, CWP… Christina Wolf-Petre)*

date	**railway line**	**section(s)**	**searcher**	**Searched distance**	**comments**
08.02.2021	KMSYS91		JHO	29,2	recognition survey between Fischamend and Wolfsthal
09.02.2021					
03.03.2021	KMSYS91	1 & 3.1	CWP	10,2	
04.03.2021	KMSYS91	2 & 3.2	MSI	9,2	
27.04.2021	KMSYS91	1	SKN	6,9	
28.04.2021	KMSYS91	2	CWP	7,0	
29.04.2021	KMSYS91	3.1 & 3.2	MSI	5,5	
09.06.2021	KMSYS91	1	SKN	6,9	
10.06.2021	KMSYS91	2	MSI	7,0	
11.06.2021	KMSYS91	3.1 & 3.2	CWP	5,5	
08.11.2021	KMSYS91	2	SKN	7,0	
09.11.2021	KMSYS91	1	CWP	6,9	
10.11.2021	KMSYS91	3.1 & 3.2	MSI	5,5	
28.02.2022	KMSYS91	2	CWP	7,0	
01.03.2022	KMSYS91	3.1 & 3.2	SKN	5,5	
02.03.2022	KMSYS91	1	CWP	6,9	
13.09.2022	KMSYS95	1	MSI	7,7	
14.09.2022	KMSYS95	2	CWP	7,3	
26.09.2022	KMSYS94	1	SKN	7,3	
28.09.2022	KMSYS94	2	CWP	5,9	
29.09.2022	KMSYS94	3	MSI	7,5	
25.04.2023	KMSYS94	3	SKN	7,5	
26.04.2023	KMSYS94	2	MSI	5,9	
28.04.2023	KMSYS94	1	MSI	7,3	
18.09.2023	KMSYS94	1	MSI	7,3	
20.09.2023	KMSYS94	3	MSI	7,5	
22.09.2023	KMSYS94	2	CWP	5,9	
07.10.2024	KMSYS94	2	CWP	5,9	
08.10.2024	KMSYS94	3	MSI	7,5	
10.10.2024	KMSYS94	1	CWP	7,3	
05.05.2025	KMSYS94	1	CWP	7,3	
07.05.2025	KMSYS94	2	CWP	5,9	
08.05.2025	KMSYS94	3	MSI	4,9	no search between Kittsee station and boarder (officially prohibited for disease control)

Appendix 3: Data recording protocols

Vorgangsweise bei Fund:

1. **Fotodokumentation (Vogel noch nicht berühren!)**
    a. Vogel in Fundlage
    b. Fundort (mit nächstgelegenem Masten)
    c. Umgebung
2. **Aufnahme der Grunddaten**
    a. Datum
    b. ID
    c. Uhrzeit
    } dient der eindeutigen Zuordnung der Bilder und Datensätze
    d. Lage (siehe Protokoll)
    bei simultan aufgefundenen Vögeln muss anhand der Uhrzeit im Protokoll und auf den Bildern klar sein, welcher Vogel zuerst bearbeitet wurde; daher immer jeden Vogel einzeln abarbeiten und nie bspw. Fotos von zwei Vögeln gleichzeitig machen und dann erst die Protokolle ausfüllen
3. **Bestimmung der Koordinaten und Eintragung (App GPS Logger oder Google Maps)**
    in Dezimalgrad, auf mind. 5 Kommastellen genau!
4. **Untersuchung des Kadavers** auf
    a. Liegedauer (Abschätzung anhand Verwesungszustand)
    b. Strommarken (insbesondere auf den Zehenballen, aber auch bspw. Flügelbug)
    c. äußerliche Verletzungen (Rupturen der Haut, Federverletzungen etc.)
    d. innere Verletzungen (insb. Brüche; Abtasten folgender Körperteile: Schädeldach, Halswirbelsäule, Arm- und Hand, Brustkorb, Brustbein, Becken, Beine)

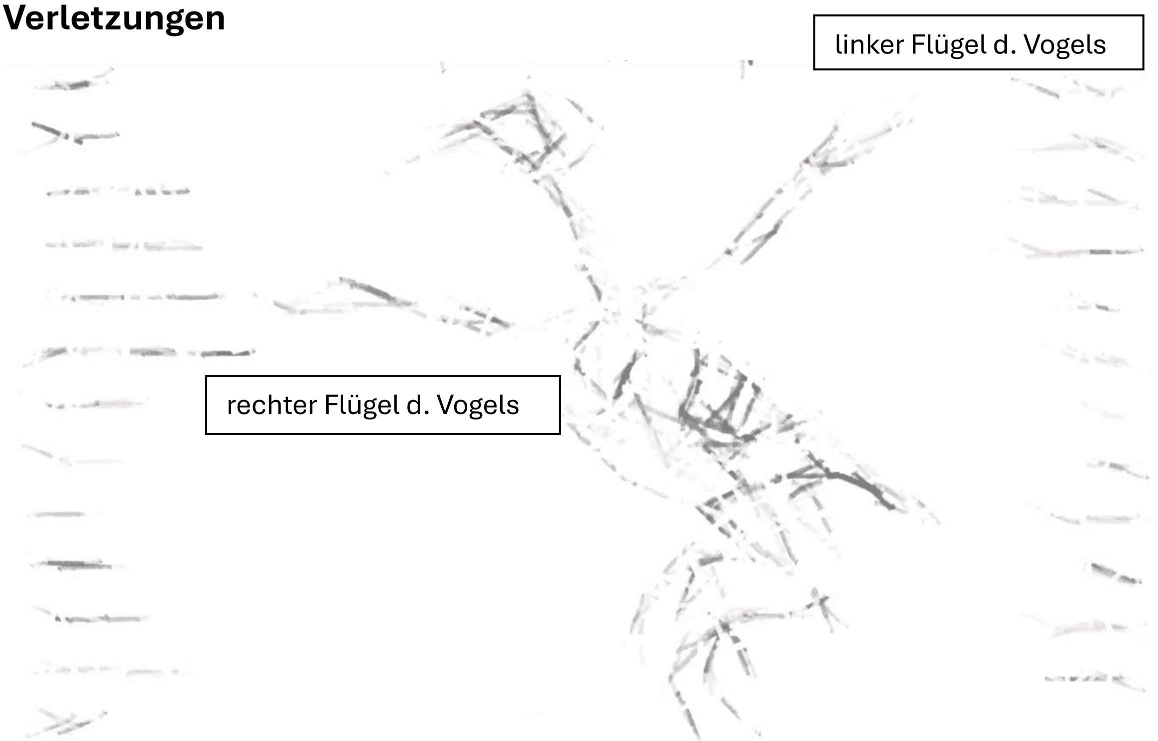
    und Eintragung in Formular und Abbildung (Brüche mit Strichen, Strommarken mit x, äußerliche Gewebsverletzungen mit Ringerl)

    Anm.: Die Untersuchung ist mit Einweghandschuhen durchzuführen, sofern der Vogel nicht frischtot ist. Die Untersuchung kann nach eigenem Ermessen unterbleiben, wenn der Vogel in einem Zustand der Verwesung ist, der eine erheblichen Beeinträchtigung des Wohlbefindens bei den Bearbeitenden verursachen würde

5. **Ausfüllen der Bemerkungen**, falls weitere Detailangaben gegeben werden können
6. **Fotodokumentation der sichtbaren Verletzungen sowie des Vogels von oben und unten mit ausgebreiteten Schwingen** (falls möglich)
7. **Fotodokumentation des Vogels mit Zettel/ID**
8. **Markierung des Vogels mittels Baumwollfadens am Bein/Tarsus**

Datum	DD . MM . YYYY	**ID**		**Uhrzeit**	HH:MM
Art		**Alter**		**Sex**	m f indet
Lage	Mast	Leitungsseite	Damm	leitungsabgewandt	
Koordinaten	, °	N	, °	E	
Strommarken	ja* ☐ nein ☐	*wenn ja, beschreiben und fotodokumentieren			
Liegedauer	frischtot	<1 Woche	<1 Monat	>1 Monat	

Verletzungen



Bemerkungen (Fundumstände, geschätzte Liegedauer, Verletzungen, sonst.)

BearbeiterIn

Nicht vergessen auf Fotodokumentation: 1) Vogel in Fundlage, 2) Fundort (inkl. nächstem Mast), 3) Umgebung, 4a & 4b) v. oben und unten mit ausge-breiteten Schwingen, 5) etwaige äußere Verletzungen, Strommarken etc. (entspricht mind. fünf Bildern pro Kadaver)

Appendix 4: Translation of data recording protocols

Procedure:

1. **Photographic documentation** (do not touch the bird yet!)
    a. Bird carcass in the position in which it was found
    b. Location overview (with nearest pylon)
    c. Surroundings
2. **Record basic data**
    a. Date
    b. ID
    c. Time
    d. Location (see protocol)

    (a–c) relevant for identification of images and data records

    If birds are found simultaneously, the time in the protocol and on the images must make it clear which bird was processed first; therefore, always process each bird individually and never, for example, take photos of two birds at the same time and then fill in the protocols

3. **Determine and record coordinates** (App GPS Logger or Google Maps)

    in decimal degrees, to at least 5 decimal places!

4. **Examination of the carcass** for
    a. Length of time lying (estimation based on state of decomposition)
    b. Electricity marks (especially on the toes, but also on the wing tip, for example)
    c. External injuries (ruptures of the skin, feather injuries, etc.)
    d. Internal injuries (especially fractures; palpation of the following body parts: skull, cervical spine, arm and hand, chest, sternum, pelvis, legs)

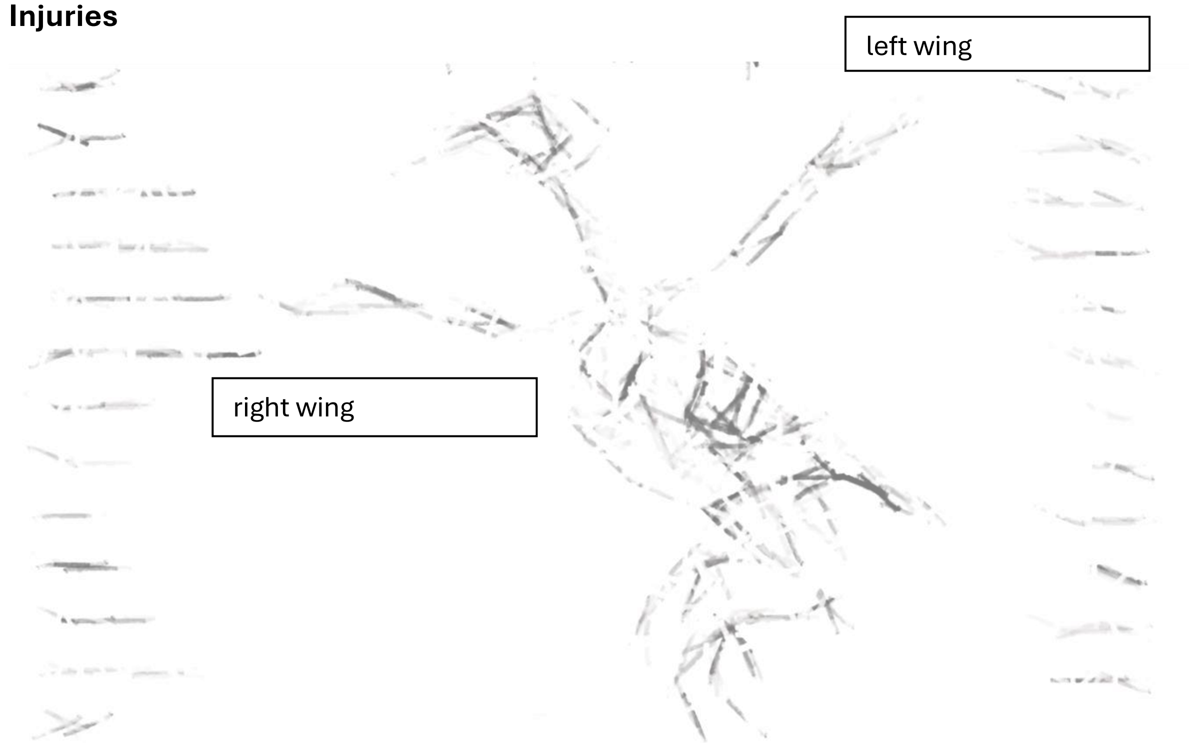
    and entry in the form and illustration (fractures with lines, electricity marks with x, external tissue injuries with circles)

Note: The examination must be carried out with disposable gloves unless the bird is freshly dead. The examination may be omitted at your discretion if the bird is in a state of decomposition that would cause significant discomfort to those handling it

5. **Fill in the comments** if further details can be provided
6. **Photographic documentation** of visible injuries and of the bird from above and below with wings spread (if possible)
7. **Photographic documentation** of the bird **with note sheet** or ID number
8. **Marking of the bird carcass** using cotton thread on the leg/tarsus

Date	DD . MM . YYYY	**ID**		**Time**	HH:MM
Species		**Age**		**Sex**	m f indet
Location	Next to pylon	side of line	embankment	opposite side	
coordinates	, °	N	, °	E	
electricity marks	yes* ☐ nein ☐	*if yes, please describe and document			
Age of carcass	fresh	<1 weed	<1 month	>1 month	

Injuries



Comments (circumstances, estimated age of carcass, injuries etc.)

Processed by

Do not forget photo documentation: 1) Bird in finding situation, 2) location (incl. nearest pylon), 3) surroundings, 4a & 4b) bird from above and below with wings spread 5) external injuries, electricity marks

(equals at least five pictures per finding)