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Infrastructure & Ecology Network Europe

Harmonizing Transportation and Nature



ABSTRACT BOOK

The Value of Nature in Resilient Infrastructure

IENE 2026 INTERNATIONAL CONFERENCE
IN PARTNERSHIP WITH

rebuilding nature

MORE INFORMATION

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The IENE 2026 International Conference "The Value of Nature in Resilient Infrastructure": Abstract Book, 21–25 September 2026, Bristol, United Kingdom

EDITOR

Julie Maillard

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Welcome

Dear colleagues and friends,

I cannot believe the time has come. I have only been involved with IENE for just over 2 years after attending my first IENE conference in Prague 2024. I was quite shocked by the length of the conference... 5 days! But after attending I understood why spending this time together after 2 years apart is so important, to get the most from the range of expertise and experience in the room. But also, to make new connections, to catch up with old friends and to share challenges. This community feels really big when you attend these events, but can be quite a lonely space when you are the only person in your country pushing for these types of changes. So, I urge you to embrace this time and make the most of our 5 days together!

This year marks a special milestone, the 30th anniversary of IENE, and we are honoured to celebrate it in Bristol, a city internationally recognised for environmental leadership, innovation and community-driven sustainability.

Our theme “The Value of Nature in Resilient Infrastructure” reflects a growing global recognition that infrastructure systems must evolve. As climate pressures intensify, infrastructure must not only minimise harm but actively contribute to ecological recovery, connectivity and resilience. This year's programme brings together leading practitioners, researchers, policymakers and industry partners to explore new approaches, share evidence and strengthen the cross-sector partnerships essential for delivery.

The Organising Committee would like to thank our conference partner Rebuilding Nature for their unwavering dedication bringing this conference to life. We are deeply grateful to our Organising Committee members for their commitment and leadership in bringing IENE to the UK and our host UWE Bristol.

With delegates from more than 30 countries, IENE 2026 promises to be a vibrant, inspiring and impactful event. We hope you enjoy your time in Bristol, reconnect with colleagues, forge new partnerships, and leave energised for the work ahead.

Louise McGowan
Chair, IENE 2026 Organising Committee
Natural England

About IENE & the Conference

IENE is a network of experts working with various aspects of transportation, linear infrastructure and ecology. The network was initiated in 1996 to provide an independent, international and interdisciplinary arena for the exchange and development of expert knowledge, and with the aim to promote a safe and ecologically sustainable pan-European transport infrastructure.

Every two years, IENE hosts an international conference bringing together scientists, engineers, planners, policymakers, NGOs and industry leaders. The conference provides a platform for sharing best practice, presenting new research, strengthening partnerships and advancing solutions to habitat fragmentation, wildlife mortality, ecological connectivity and nature-positive infrastructure.

MAIN THEME OF IENE 2026

The Value of Nature in Resilient Infrastructure

The conference programme is built around four strategic themes designed to spark genuinely cross-disciplinary conversation:

1

The Value of Nature

Placing ecological and social value at the heart of infrastructure decision-making, and critically assessing investment, valuation and nature-based approaches.

2

Resilience through Nature

Strengthening climate resilience by working with ecosystem processes, while recognising ecological limits and the risks of maladaptation.

3

Pace over Perfection

Scaling proven solutions to reduce fragmentation and severance at landscape and network scales, balancing urgency with ecological integrity.

4

Creating Actionable Knowledge

Turning foundational knowledge into action on ecological severance, supporting connected habitats and informed restoration planning.

The Team Behind IENE 2026

IENE GOVERNANCE BOARD

As the decision-making body of IENE between General Assemblies, the Governance Board provided strategic guidance and oversight for IENE 2026, ensuring that the conference reflects the mission and priorities of the network, and supported the organisers throughout its preparation.

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Jonathan Hess, French Ministry for the Ecological Transition
Louise McGowan, Natural England

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Ivo Dostál, Transport Research Centre (CDV)
Martin Strnad, Ministry of the Environment of the Czech Republic

Keynote Speakers

IENE 2026 welcomed international experts across ecology, engineering, climate resilience, transport planning and nature-positive infrastructure to its plenary sessions.

Tony Juniper CBE
Chair, Natural England

Steve Elderkin OBE
Director of Environmental Sustainability, National Highways; Co-Founder, Rebuilding Nature

Johan Rydlöv
President, IENE

Erik Gómez-Baggethun
Professor of Environmental Governance (NMBU) and Senior Research Associate (Oxford)

Oliver Harmar
Chief Officer, Natural England

Kunle Barker
Property Expert, Broadcaster and Sustainability Advocate

Sara Santos
Researcher, University of Évora (MED & CHANGE)

Sara Santos is an Invited Researcher at the University of Évora (MED & CHANGE). With 16 years of expertise in conservation biology and road ecology, her research explores how infrastructure impacts wildlife movement and functional connectivity. She investigates the barrier effects of roads on population persistence and the role of roadside management as a provider of ecosystem services. Recently, she expanded into disease ecology, focusing on pathogen transmission at the wildlife-domestic interface. Her work translates long-term ecological data into actionable knowledge, promoting nature-based solutions for resilient infrastructure and sustainable development at the intersection of transport and biodiversity.

Jo Bradley
Director of Operations UK, Stormwater Shepherds

Jo Bradley is one of the UK's leading specialists in highway runoff pollution, sustainable drainage (SuDS), and stormwater management. She is the Director of Operations (UK) at Stormwater Shepherds UK, an environmental charity focused on achieving zero pollution from urban runoff and improving the health of rivers, streams and coastal waters. Before joining Stormwater Shepherds in 2020, Jo spent 28 years at the Environment Agency, where she worked across a broad range of pollution prevention and water quality issues.

Manuela Panzacchi
Senior Researcher, Norwegian Institute for Nature Research (NINA)

Manuela Panzacchi is one of Europe's leading researchers in landscape connectivity, movement ecology and ecological networks, and is widely recognised within the IENE community. She is a Senior Research Scientist at the Norwegian Institute for Nature Research (NINA) in Trondheim, Norway, where she and her team developed methods and decision-support tools to understand how the cumulative impact of infrastructure and other human activities, including climate change, affect wildlife movement and habitat connectivity, and to concretely guide sustainable land planning. The tools allow scenario analyses to simulate the effect of new infrastructure, mitigation or restoration measures, and sensitivity analyses to identify vulnerable key areas and corridors to be prioritised for conservation or restoration.

Edgar van der Grift
Senior Research Ecologist, Wageningen Environmental Research

Jonathan Hess
French Ministry for Ecological Transition

Jonathan Hess is a biodiversity, transport and energy project officer at the French Ministry for the Ecological Transition. In particular, he is in charge of the French research programme on transport and energy infrastructure, territories, ecosystems and landscapes, ITTECOP (Infrastructures, territoires, transports, énergies, écosystèmes et paysages). This research programme, created in 2008, contributes to a strong reflection on the integration of ecosystem and landscape issues in the development and implementation of infrastructure projects or the adaptation of existing facilities. The core of the programme is based on funding research projects through calls for proposals. Jonathan Hess is also the French representative within the Governing Board of IENE.



Bridging in different centuries in Greece · © Lazaros Georgiadis

01
Plenary Sessions

Panel discussions and invited plenary contributions

2 CONTRIBUTIONS

Green is Cheaper than Grey: Barriers and Solutions to Mainstreaming Nature into the Built Environment

Tuesday 22 September · 09:30–10:30 · Queen Square

Green is cheaper than grey – barriers and solutions to mainstreaming nature into the built environment

Oliver Harmar[1], Kunle Barker[2], Jerry Tate[3], Lisa Palframan[4], Selina Mason[5], Louise Clarke[6]

[1] Natural England, United Kingdom

[2] Natural Places, United Kingdom

[3] Tate + Co Architects, United Kingdom

[4] Homes England, United Kingdom

[5] Lendlease, United Kingdom

[6] Berkley Group, United Kingdom

KEYWORDS
ecological economics, evidence-based mitigation, long-term resilience, nature-based solutions, spatial planning

There is a strong evidence base supporting the value and benefit of incorporating nature into housing development – and yet nature is still all too often absent in new developments.

Natural England has been convening roundtable discussions with government agencies, developers, architects and volume housebuilders to get to the heart of what the barriers to incorporating nature are in a UK context, and how we might develop solutions that reach across the sector. The following themes have emerged from these discussions:

- Inclusion of nature in projects starts strong but fades away. Often at the start of projects, there are a lot of pro-nature initiatives. However, these are then eroded as the project develops due to economic pressures. Are Business Cases treating nature as they would other socio-economic benefits, e.g health and social cohesion, or is the burden of proof higher?
- The lack of a mobilised evidence base on the benefits of nature hinders economic arguments to keep nature central to projects. The evidence is out there, but is it assembled and collated in the right way to make the economic case? Costs are as important as value - green is cheaper than grey.
- Stewardship and maintenance are crucial to unlocking value. Current issues with covering the costs of service charges and maintenance are holding back unlocking the value of nature in development. Volunteering is not a reliable way of conducting maintenance, promoting questions about who is valued to do this.
- It is imperative to quantify who pays, receives the value and owns the benefits. Many of the benefits of nature will be felt those who are not paying for these benefits (e.g. health benefits to NHS England) – how do we align these? As well as the robust economic statistics on the value of nature, there also more intangible benefits such as sense of place that should also be owned.
- A shortfall of naturalist skills in the development sector. Does the development sector have enough people who understand nature at strategic level? There also skills issues at the ground-level in industries such as horticulture.
- How do we win the argument for nature when we are not in the room? Who has the influence, who has the money, who has the will and who has the need for increasing nature in development – and how do we bring these 4 groups of people together?
- We can build nature into the commercial world, as well as the residential – there is a whole new generation of office buildings incorporating ecology within buildings. Therefore, we also need to also consider clients for leasing buildings when thinking about the benefits of nature.

This panel session will introduce these findings through a 10-15 minute opening statement from Natural England's Chief Strategy Officer, prompting both the audience and panel to reflect on them. Natural England will also give an example of a legislative system change that they are leading – the move to the Nature Restoration Fund (NRF)) and a more strategic approach to ensuring development does not just limit damage but actively increases nature.

In a 30-45 minute session, the panel will then discuss the barriers the roundtables have identified, and what potential solutions may be (including inspirational examples from around the world). This will involve interactive discussions with the audience, where attendees are invited to share their perspectives on how similar challenges have been approached in other parts of the world.

Natural capital is critical infrastructure

Tuesday 22 September · 16:15–17:00 · Queen Square

PLENARY SESSION | NATURAL CAPITAL IS CRITICAL INFRASTRUCTURE

Natural capital is critical infrastructure: evidence, implications and actions

Jonathan Nichols[1],
Oliver Seville[1],
Lesley Wilson[2]

[1] Jacobs, United Kingdom

[2] ISEP, United Kingdom

KEYWORDS
ecological economics, ecological and social values, natural capital (critical perspectives), decision-making frameworks, governance architecture

Natural capital already meets national and international definitions of critical infrastructure, but investment in nature is still falling short. Our natural capital assets, such as forests, rivers, soils and wetlands, provide the essential ecosystem services that underpin our economy and our lives. These natural assets regulate our climate, filter our water, protect our built infrastructure, feed our supply chains, and support our health. Evidence shows that biodiversity loss and ecosystem collapse pose national security risks and dire economic consequences, while the transition to a nature positive economy presents an opportunity for growth. But these assets can't act alone: they need to be part of functioning ecological networks, be more effectively integrated into our other infrastructure systems, and supported by policy frameworks that steer infrastructure planning.

This session will present the 'evidence behind the catchphrase' and six recommendations for government on why natural capital should be formally classified as critical infrastructure. The presentation will build on the findings of a recent policy paper by the Institute of Sustainability and Environmental Professionals (ISEP) and Jacobs: https://www.isepglobal.org/resources/news/2026/january/report-calls-for-uk-to-designate-natural-capital-as-critical-national-infrastructure-to-strengthen-growth-and-resilience/

The presentation will be followed by a panel discussion focused on lessons learned from infrastructure operators who are already taking practical steps to value nature and rebuild ecological networks. The panel will explore the opportunities and challenges that other infrastructure organisations may face, and the importance of scaling from assets to networks. Discussion will aim to conclude by reflecting on what nature recovery programmes can learn from the infrastructure sector for delivering at scale.



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02

Oral Presentations

Parallel sessions, Tuesday, Thursday and Friday

96 CONTRIBUTIONS

Embedding Nature into Infrastructure Planning

Tuesday 22 September · 11:00–13:00 · Eastville Park

ORAL PRESENTATION | EMBEDDING NATURE INTO INFRASTRUCTURE PLANNING

Transforming linear infrastructure through nature-positive policy: Colombia's Green Road Infrastructure Guidelines

Mario Orlando Lopez Castro[1], Magda Contanza Buitrago Ríos[2], Ximena Barrera Rey[2], Rodrigo Botero[3], Maryi Adriana Serrano[3], Beltsy Barrera[3], Tremaine Gregory[4], Daniela Nieto Lopez[2], Kate Newman[4]

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KEYWORDS
biodiversity loss, decision-making frameworks, ecological resilience, avoidance, institutional reform

Global road expansion is accelerating, with nearly 90% of new infrastructure development expected in developing nations. In biodiversity-rich countries such as Colombia, road development has become a major driver of biodiversity loss, particularly in environmentally sensitive regions such as the Amazon rainforest. In these contexts, infrastructure decisions can irreversibly undermine ecosystem services and ecological resilience, upon which planetary water regulation, food supply, and carbon sequestration depend. Failure to recognize the value of nature within transport planning not only degrades ecosystems but also weakens the foundations of long-term social and economic development.

Colombia's diverse geography—spanning the Pacific coast, the Andes, the Amazon, and the Caribbean—illustrates how transport infrastructure intersects landscapes of exceptional ecological and social value. Roads influence watershed integrity, habitat connectivity, and the provision of ecosystem services at local, national, and global scales. This complexity highlights the urgent need to integrate nature's value into decision-making frameworks in transport infrastructure development, particularly in countries where development pressures overlap with globally significant ecosystems.

Recognizing these challenges, Colombia adopted an innovative governance and policy approach in 2013, mandating interministerial coordination between the Ministries of Transportation and Environment for infrastructure planning. With technical and strategic support from the Foundation for Conservation and Sustainable Development of Colombia and the World Wildlife Fund, this collaboration led to the development of the Green Road Infrastructure Guidelines (GRI) (Lineamientos de Infraestructura Verde Vial). The GRI were formally adopted as national policy in April 2024, marking a significant shift in how biodiversity and ecosystem services are addressed within the transport sector.

The GRI frame biodiversity and ecosystem services as strategic assets rather than constraints to development. Central to the guidelines is an upstream, avoidance-focused approach that prioritizes early-stage planning, landscape- and watershed-scale analysis, and informed route selection to prevent impacts on critical ecosystems before they occur. By emphasizing impact prevention over downstream mitigation, the GRI seek to reduce biodiversity loss while improving the environmental performance and long-term viability of road infrastructure.

Where impacts cannot be fully avoided, the guidelines provide tailored mitigation, restoration, and monitoring measures, supported by detailed technical guidance. This integrated approach ensures that environmental considerations are embedded throughout the entire project lifecycle, rather than addressed as an afterthought.

By embedding the value of nature into transport planning and policy, the GRI contribute to strengthening ecological resilience, reducing long-term environmental and financial risk, and supporting nature-positive infrastructure outcomes. Aligned with Target 14 of the Kunming–Montreal Global Biodiversity Framework, Colombia's experience demonstrates how policy innovation and cross-sector collaboration can drive transformational change. The GRI offer a replicable model for countries seeking to reconcile infrastructure development with the conservation of natural capital, positioning the value of nature as a foundation for sustainable and resilient transport systems.

ORAL PRESENTATION | EMBEDDING NATURE INTO INFRASTRUCTURE PLANNING

Nature as Enabler: Embedding Natural Value in London's Transport Infrastructure

Christoph Brintrup

Transport for London (TfL), United Kingdom

Principal Engineering Lead – Green Infrastructure & Biodiversity, United Kingdom

KEYWORDS
ecosystem function, nature-based solutions, landscape connectivity, ecological integrity at scale, decision-making frameworks

This presentation explores how nature-led design and ecosystem thinking can act as powerful enablers in the design, planning, delivery and long-term management of complex linear transport infrastructure. Drawing on Transport for London's (TfL) experience as one of the UK's largest infrastructure operators, it demonstrates how treating nature as an asset can unlock ecological, social and economic value across a densely urbanised environment.

The session will outline TfL's evolving approach to green infrastructure, biodiversity and landscape design, guided by principles that place ecosystem function and natural resilience at the centre of decision-making. It will provide insights into how TfL is embedding nature into design, planning and operational processes and how this supports climate resilience, improves ecological connectivity and enhances the everyday urban experience of the city's residents and visitors.

The presentation will also discuss TfL's development of its natural capital accounting system to better quantify environmental benefits and support decision making. Furthermore, the presentation will touch on the organisation's feasibility work related to TfL's habitat bank, an innovative step that could help meet statutory biodiversity requirements and stringent corporate environmental commitments. Finally, the session will examine how strategic, large-scale land use decision making can create networks of habitats that deliver multiple benefits, including improved wellbeing, customer experience, local regeneration, commercial and long-term economic value.

The presentation aims to demonstrate how investment in nature can shape a transport system that protects, enhances and transforms urban environments and which delivers multiple benefits for nature, people and the wider planet.

ORAL PRESENTATION | EMBEDDING NATURE INTO INFRASTRUCTURE PLANNING

Mapping Priority Areas for Canopy Bridge Installation within Road Infrastructure to Enhance Habitat Connectivity for Arboreal Mammals in the Brazilian Amazon

Fernanda Abra[1,2], **Luan Goebel**[3], **Artur Lupinetti-Cunha**[4], **Tremaine Gregory**[5], **Alfonso Alonso**[6]

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KEYWORDS
spatial planning, strategic defragmentation, scaling pathways

Road expansion in the Brazilian Amazon poses a major threat to arboreal mammals by disrupting canopy connectivity and increasing mortality risk. However, spatially explicit tools to guide large-scale mitigation planning remain limited. To address this gap, we developed a spatial prioritization framework to identify optimal locations for implementing artificial canopy bridges across the Amazonian road network. We integrated federal road data, MapBiomas land-use rasters (30 m resolution), and range maps developed by arboreal mammal researchers. For each road segment, we extracted ecological and land-use variables, including overlap with strictly protected areas, sustainable-use protected areas, and Indigenous Lands, as well as the richness of threatened and non-threatened arboreal mammal species. A weighted multi-criteria analysis (MCA), with weights assigned based on ecological relevance and conservation priorities, was applied to generate a prioritization score (0–1) for all federal and state roads in the Amazon biome, subdivided into segments of 100 m in length. Priority areas were unevenly distributed and strongly clustered in regions of high arboreal mammal richness, particularly within and surrounding protected areas and Indigenous Lands. These clusters were concentrated along major highways in the central and northeastern Amazon, including BR-230 in Paraíba, Ceará, Piauí, Maranhão, Tocantins, Pará, and Amazonas states, and BR-364 in São Paulo, Minas Gerais, Goiás, Mato Grosso, Rondônia, and Acre states. Of the 37,750 km of roads analyzed, only 137.18 km (0.36%) reached the highest prioritization threshold (MCA ≥ 0.9), highlighting a small but critical subset of locations where targeted interventions could be most effective. This study provides a spatially explicit and scalable framework to guide ecological connectivity interventions, supporting more strategic allocation of resources and evidence-based, biodiversity-friendly infrastructure planning in the Brazilian Amazon.

ORAL PRESENTATION | EMBEDDING NATURE INTO INFRASTRUCTURE PLANNING

Does connectivity count? Valuing the role of habitat connectivity in infrastructure planning

Helen Dunn[1],
Robert Spencer[2],
Dean Kerwick-Chrisp[3],
Rhona Lochhead[1]

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[2] AECOM, Spain

[3] National Highways, United Kingdom

KEYWORDS
internalisation of externalities, decision-making frameworks, landscape connectivity, ecological and social values, natural capital (critical perspectives)

Does connectivity count? Valuing the role of habitat connectivity in infrastructure planning

The State of Nature 2025 report highlights continued and significant biodiversity decline across the UK, reinforcing the urgency to halt and reverse nature loss. At the same time, there is growing recognition of nature as critical infrastructure, delivering essential services such as carbon sequestration, flood mitigation, air quality regulation and pollination. For infrastructure owners and operators, this creates a practical challenge: how to integrate biodiversity, natural capital and connectivity considerations meaningfully into early-stage planning and investment decisions, rather than addressing them late as residual mitigation.

This paper explores a central valuation question increasingly faced by infrastructure decision-makers: does ecological connectivity count, and if so, what is the value of “bridging the gap”? While the ecological importance of connectivity is well established, its treatment within appraisal, optioneering and portfolio-level decision frameworks remains inconsistent and under-developed.

The presentation draws on recent experience applying natural capital valuation, biodiversity assessment and habitat connectivity modelling in an infrastructure context. It reflects on how these approaches inform early stages of scheme development and schematic design, and how rapid, cost-efficient assessment can enable connectivity to be configured proactively as an opportunity asset , rather than addressed reactively through mitigation.

Insights are drawn from the application of EcoUplift , a rapid natural capital and biodiversity assessment platform that blends national datasets with client-owned survey data to support portfolio- and site-scale analysis across large, multi-asset estates. The tool enables comparison of future land-use scenarios, supports emerging regulatory requirements such as biodiversity net gain, and provides an evidence base for strategic land-based planning and reporting.

Since early 2023, AECOM has worked with NatureScot, the Scottish Wildlife Trust and Scottish local authorities to develop approaches for modelling habitat connectivity and nature corridors in support of national Nature Network and Nature-based Solutions planning. This paper offers a joint practitioner–client reflection on how such methods influence infrastructure decision-making in practice, where connectivity delivers measurable value, and where current valuation and appraisal frameworks continue to fall short when applied to complex, linear infrastructure systems.

ORAL PRESENTATION | EMBEDDING NATURE INTO INFRASTRUCTURE PLANNING

Designing and constructing the UK's first heathland green bridge.

Victoria Gilbey

AtkinsRéalis, United Kingdom

KEYWORDS
landscape connectivity, nature-based solutions, ecological resilience, monitoring

Cockcrow green bridge will provide vast benefits for nature. It will provide habitat connectivity for a European designated site vulnerable to climate change impacts and facilitate genetic mixing and population expansions for rare heathland species. It's the first green bridge in the UK to support heathland habitats and the flagship of National Highway's M25 junction 10 Nationally Significant Infrastructure Scheme.

Winner of National Highways Good Road Design Award 2023 and recently published in the Institute Civil Engineers Native Positive special edition. It will be recognised on a global platform as delivering habitat connectivity at a landscape scale.

The scheme has a dedicated ecological monitoring strategy covering multiple target species, and delivered with partners inlcuding NGOs, and the data will be shared widely to inform future green bridge projects.

ORAL PRESENTATION | EMBEDDING NATURE INTO INFRASTRUCTURE PLANNING

Integrating expert knowledge to reveal nature-based value of roadside ecosystems

Ziadany Mayoral Solis, Brunelle Marche, Brice Corrigeux, Mauricio Camargo

Université de Lorraine, ERPI, France

KEYWORDS
ecosystem function, nature-based solutions, social–ecological systems, trade-off analysis, adaptive management

Roadside environments are increasingly recognised as multifunctional socio-ecological systems that contribute to biodiversity conservation, ecological connectivity, and the regulation of key ecosystem processes within transport infrastructures (Forman & Alexander, 1998; Coffin, 2007). However, their capacity to deliver ecosystem services remains insufficiently characterised, particularly in relation to maintenance practices that strongly shape vegetation structure and ecological dynamics. This gap limits the ability of infrastructure managers to design nature-positive strategies grounded in robust and actionable knowledge.

This study proposes an integrated methodological framework to assess and model the contribution of roadside management practices to ecosystem service delivery, combining two complementary expert-based methods. First, a Delphi-based process is used to identify and characterise the main ecosystem services provided by roadside ecosystems, including biodiversity support, water and soil regulation, invasive species control, and fire risk mitigation, enabling the construction of a structured and shared representation of roadside socio-ecosystem functions (Mukherjee et al., 2015; Martin et al., 2012). Second, a structured expert elicitation framework is implemented to evaluate the effects of different maintenance practices on these ecosystem services. By systematically assessing practice–service relationships, this method generates a comparative understanding of how management choices influence ecological outcomes, in line with growing efforts to mobilise expert knowledge in environmental assessment where empirical data remain limited or fragmented (Sutherland et al., 2013).

The originality of the framework lies in its capacity to move beyond static descriptions of ecosystem services towards a more dynamic understanding of roadside socio-ecosystems, where management practices actively shape ecological functions and associated benefits. By explicitly linking practices and ecosystem services, the approach enables the identification of trade-offs, synergies, and leverage points for more nature-positive management strategies (Cord et al., 2017). Positioned at the intersection of ecological knowledge and operational decision-making, this work contributes to advancing decision-oriented approaches for infrastructure management, demonstrating how systematically structured expert knowledge can inform practical decisions and support the transition towards more adaptive and multifunctional roadside management strategies.

Taking the ecosystem service of biodiversity conservation as an example, two functions were explored through expert workshops: the pollination function and the habitat function. To analyse the influence matrix, we identified the most central variables — those with the highest number of incoming and outgoing connections. For the pollination function, these are food source, flora richness, invasive alien species, and flora abundance; for the habitat function, they are flora abundance, flora richness, soil pH, and soil humidity. This highlights the central role of the flora compartment in biodiversity conservation, as well as the interconnections between soil, flora, and fauna compartments.

The influence matrix further revealed which management practices exert the greatest influence on biodiversity conservation across both functions: the management of species with conservation interest, herbaceous vegetation maintenance frequency, full-width mowing period, and herbaceous vegetation maintenance height. This clarifies how management practices propagate their influence through the system and how they interconnect with ecological variables. The expert elicitation results complement this picture by showing how different practices and their alternatives affect the potential ecosystem service that roadsides may deliver, confirming the management of species with conservation interest and herbaceous vegetation maintenance frequency as the practices with the highest biodiversity gain, followed by management of invasive alien species, full-width mowing period, herbaceous vegetation maintenance technique, and herbaceous vegetation maintenance height.

Taken together, both methods consistently identify the management of species with conservation interest and herbaceous vegetation maintenance frequency as the most influential practices, and more broadly highlight the central role of herbaceous vegetation management, across its different parameters, in determining the potential of roadsides for biodiversity conservation.

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Making the Economic Case for Nature

Tuesday 22 September · 11:00–13:00 · Greville Smyth Park

ORAL PRESENTATION | MAKING THE ECONOMIC CASE FOR NATURE

How taking into account biodiversity in the value chain as a company

Cora Cremezi-Charlet, Marie Hochberg

SNCF, France

KEYWORDS
decision-making frameworks, evaluation, long-term resilience, scaling pathways, ecological limits

Every economic sector has impacts on biodiversity and companies need to evaluate their impacts and dependencies on biodiversity to establish appropriate action plans allowing them to develop their activities within the planetary boundaries. Different kinds of tools and methodologies exist to assess impacts and dependencies and establish action plans. The experimentation of these tools and methods have raised interrogations regarding data availability, the appropriate scale of analysis and to what extent these methodologies can apply to linear transport infrastructures.

In order to assess its impacts and dependencies and build its biodiversity strategy, SNCF has first tested the Global Biodiversity Score tool (GBS) to assess its biodiversity footprint across its value chain. The GBS was developed by CDC Biodiversité. This tool integrates the same three scopes as the carbon footprint. It relies on financial data, environmental pressure data, ... at corporate level to calculate impacts and evaluate dependencies on biodiversity (complemented by the tool ENCORE). The GBS assesses the impacts resulting from one year of activity (referred to as "dynamic impacts") as well as the impacts resulting from past activities (referred to as "static impacts"). This study helped us understand to what extent our environmental policies are connected and can contribute to our biodiversity strategy. It seems possible to evaluate the impact and related costs of major policies, such as GHG emissions reductions or use of recycled materials instead of new ones, by developing scenarios. However, the GBS does not fully capture the impact of local measures.

In order to go further, SNCF is now exploring science-based targets for nature methodology (developed by SBTN) to assess and prioritize its impacts on biodiversity, across its value chain and define science based targets to mitigate them. The Science Based Targets Network is a civil society and scientific initiative founded in 2019 by a group of global NGOs. It developed methodology inspired by Science Based Target Initiative SBTi which applies to GHG emissions. These organizations came together to collectively define what is needed to ensure that businesses and cities can operate within planetary boundaries while meeting the society's needs. SBTN provides guidance to companies to help them measure and mitigate their impacts on biodiversity. Compared to the GBS tool, SBTN's methodology integrates the spatial dimension of the business activities by considering the location of operational sites and the origin and nature of upstream commodities, in order to identify areas with the highest biodiversity impacts (by crossing the pressure data of the activities and the state of nature at these locations).

Although this approach can be applied to industrial sites, it appears to be poorly suited to linear infrastructures. How the impacts of 28 000 km of railway lines can be analyzed? Neither SBTN, nor the GBS, account for these specific impacts such as fragmentation. Neither considers the role of longitudinal ecological corridors. At the current stage of the development of the methodology, train circulation is a missing point in SBTn methodology. Indeed, train circulation is considered as an activity of service and thus excluded from the analysis.

Considering these limits, SNCF Group has decided to experiment the SBTN methodology and to conduct an assessment of the impacts of the business unit of SNCF Voyageurs across its value chains. For its direct operations, the analysis focused on its maintenance centers. Aligned with pressures for which SBTN targets have been developed, the methodology requires the most accurate characterization of the following pressures: water use, land use, soil and water pollutions. Gathering those data across numerous maintenance centers was a first challenge. The site characterization is now completed with an assessment of the state of nature at each site location. The WWF Risk Filter Tool was used to estimate the state of nature. The indicators of this tool have different scales and their accuracy can vary. It raised interrogations regarding their representativeness compared to the reality observed on the sites, which are generally located in urban or suburban areas.

It appears that, in order to establish a biodiversity pathway/strategy, a company must combine a global approach, developing a systemic view of its environmental policies (water, circular economy, ...), with an accurate understanding of its impacts and state of nature at the local scale.

ORAL PRESENTATION | MAKING THE ECONOMIC CASE FOR NATURE

Evaluating the Socio-Economic Impacts of Animal–Vehicle Collisions

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KEYWORDS
ecological economics, decision-making frameworks, financing mechanisms, biodiversity loss

Few countries have conducted comprehensive assessments of the total costs associated with animal–vehicle collisions. On behalf of the Norwegian Agriculture Agency, we carried out a socio-economic analysis of animal–vehicle collisions in Norway, complemented by a corresponding analysis for the Swedish Transport Administration. Together, these analyses provide an overview of the consequences and costs associated with collisions involving wild-living animals, free-ranging livestock, semi-domesticated reindeer and pets.

Our study identifies the key components required for a comprehensive valuation. Costs are categorized into direct, indirect, and long-term costs. Some can be readily quantified, whereas others are more difficult to express in monetary terms. All relevant cost components have been allocated across affected stakeholders, including car drivers, vehicle owners, railway operators and rolling-stock owners, insurance companies, the healthcare sector, municipalities, police, emergency services, and owners of livestock, pets, reindeer and hunting areas. Key parameters include human fatalities, severe injuries, vehicle damage, and other health-related costs. Additional cost elements encompass search and retrieval of injured animals, carcass handling, loss of hunting value, infrastructure repair, traffic delays, and administrative processes. Ecological impacts include loss of biodiversity, loss of animal production, animal welfare implications and suffering. Together, these elements form important evidence base for evaluating mitigation measures and conducting cost–benefit assessments aimed at reducing animal–vehicle collisions.

ORAL PRESENTATION | MAKING THE ECONOMIC CASE FOR NATURE

Economic evaluation of ecosystem services across the lifecycle of sustainable railway infrastructures

Carlo Prislei,
Alessandra Altobello,
Francesco Valerio Catania,
Chiara Ravagnan,
Martina Busti,
Gloria Dajelli,
Flavia Demarinis,
Luca Colacillo

FS Engineering - FS Group, Italy

KEYWORDS
nature-based solutions, decision-making frameworks, ecosystem function, social–ecological systems, trade-off analysis

Economic evaluation of ecosystem services across the lifecycle of sustainable railway infrastructures

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Abstract

The growing research demand for innovation towards sustainable railway infrastructures calls for the development and application of effective decision-making models capable of addressing key environmental and socio-economic factors. Within this context, the paper aims to advance the debate on sustainable infrastructure design by illustrating the potential of integrating environmental and economic assessments, focusing on the role of ecosystems services. Ecosystem services provide a valuable framework, enabling a comprehensive understanding of the trade-offs associated with infrastructure projects across their lifecycle, particularly when explicitly identified and evaluated in economic terms. Indeed, integrating economic assessments of ecosystem services into design processes, enables stakeholders to account for environmental costs and benefits, thereby supporting the adoption of nature-based solutions and orienting infrastructural development toward ecological and socio-economic resilience in the long-term. In this context, the paper presents a methodology that embeds ecosystem services evaluations within lifecycle-based design, demonstrating how railway infrastructure projects can better align with biodiversity strategies and wider sustainability goals, such as the EU Green Infrastructure Strategy and the EU Biodiversity Strategy for 2030. The methodology is based on an in-depth literature review that synthesises different evaluation approaches, focusing on selected ecosystem services, such as carbon sequestration. Additionally, the paper examines cross-sectoral transferability challenges, demonstrating how integration into decision-making processes, including cost–benefit analysis, can enhance transparency and investments in biodiversity protection. To this end, the paper reviews the current state of the art, supports with concrete evidence the proposed methodology and concludes by discussing the results alongside further potential development and applications.

ORAL PRESENTATION | MAKING THE ECONOMIC CASE FOR NATURE

Accelerating nature-positive action: overcoming gaps by implementing a proportionate TNFD approach

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KEYWORDS
accelerated implementation, vision-led delivery, trade-off analysis, decision-making frameworks

"Pace over perfection" is a defining principle for infrastructure organisations responding to the nature crisis. While expectations around nature-positive delivery and frameworks such as the Taskforce for Nature-related Financial Disclosures (TNFD) are rising fast, in practice, nature-positive action at a strategic level remains emergent, fragmented and constrained by data, governance and capability gaps. Waiting for perfect information or certainty on future legislation mandating nature's inclusion in decision-making exposes businesses to future inefficiencies whilst delaying the urgent action needed to secure long-term ecological integrity and infrastructure resilience.

Identifying and managing nature-related risks and opportunities through frameworks such as the TNFD are key to building not only a nature-neutral future, but a nature-positive one and for minimising risks at a business level. However, data limitations, experience and skills challenges within infrastructure organisations limits the pace at which this can be done. This paper uses practical experience from working with infrastructure bodies to demonstrate that using the TNFD guidance to integrate nature into business strategy should begin immediately, and take a phased, iterative approach over time.

This paper presents an innovative, proportionate and vision-led delivery approach developed with a UK water company, demonstrating how organisations can accelerate progress by focusing on the most material nature interactions, while building institutional capability for continuous improvement. Beginning with TNFD-aligned sustainability reporting, this work prioritised capacity-building and strategic alignment across the business, raising the profile of nature and embedding shared ownership of nature-related risks and opportunities beyond traditional sustainability functions.

The paper draws on recent work applying the TNFD's LEAP approach illustrating how participatory foresight and exploratory analysis can generate practical insight without overburdening organisations early in their adoption journey. By mapping priority impact drivers, dependencies and location-specific pathways, the water company has strengthened its governance architecture and created a foundation for improved nature risk management and investment in nature.

Crucially, these insights are already informing real-world action – from procurement and materials sourcing strategies, to biodiversity strategy and land use planning. The approach supports strategic defragmentation by harmonising reporting, strategy and delivery to unlock scaling pathways. While the experience underlying this paper is rooted in the water sector, the insights are directly transferable to other forms of infrastructure including transport and energy, where infrastructure coherence and accelerated implementation are essential to achieving a nature-positive future.

ORAL PRESENTATION | MAKING THE ECONOMIC CASE FOR NATURE

Circular Thinking to Unlock Nature Outcomes and Create Value for a UK Ports Authority

Valerie Robertson, Richard Jones

Jacobs, United Kingdom

KEYWORDS
ecological economics, ecological and social values, circular economy, nature markets, adaptive management

Infrastructure and nature can function not as competing systems, but as an integrated system capable of delivering climate-resilient, long-term economic and environmental value. Drawing on ecological economics and circular economy principles, this session challenges the conventional framing of infrastructure's environmental impacts as unavoidable externalities to be mitigated. Instead, it reframes nature as an asset, providing opportunities to deliver sustainable outcomes whilst simultaneously reducing cost and risk. This is illustrated by sharing the recent case study of the Harwich Haven Authority's Beneficial Use of Dredged Sediment (BUDS) programme, which provides a practical, real-world example of how routine infrastructure operations can be redesigned to align with ecological function.

Ports, estuaries, and other coastal assets sit at the interface between economic activity and highly dynamic natural systems. Their long-term viability depends as much on sediment flows, habitats, and ecosystem services as on engineered structures. Yet infrastructure projects' traditional appraisal, investment and regulatory frameworks often treat these dependencies as constraints rather than assets.

Maintenance dredging illustrates this tension clearly. It is essential for safe navigation and the continued operation of ports that are central to national and regional economies, yet it is frequently perceived primarily through the lens of environmental risk. The disposal of dredged material is commonly treated as compliance and cost issues with limited consideration of the wider opportunities it presents. The approach taken by Harwich Haven Authority's BUDS programme fundamentally reframes this challenge by treating the dredged sediment not as waste, but as a valuable resource within a circular system.

Through the strategic placement of the dredged sediment to create and restore valuable intertidal habitats in the estuary, such as saltmarsh, BUDS demonstrates how engineering and ecological objectives can be deliberately aligned. These valuable habitats deliver multiple, interlinked benefits: they sequester and store carbon, contribute to flood risk management by attenuating wave energy and accommodating rising sea levels, improve water quality, and enhance biodiversity and ecological connectivity across fragmented coastal landscapes that are experiencing increasing pressures. At the same time, this approach not only supports the continued operation and viability of the port by maintaining navigable channels, but it also reduces its longer-term exposure to climate-related risks due to the restored coastal habitats.

Critically, this approach moves beyond narrow notions of environmental mitigation. Rather than compensating for damage elsewhere, "beneficial use" embeds ecological enhancement within the core functioning of infrastructure systems. From an ecological economics perspective, this reflects a shift away from treating nature as an external input and towards recognising certain ecosystems as forms of critical natural capital. These assets perform functions that are difficult or costly to replace through engineered means alone, particularly under conditions of accelerating climate change and biodiversity loss.

The session also explores the economic opportunities associated with this reframing. Emerging nature markets, such as Biodiversity Net Gain and blue carbon credits, offer potential routes to capture financial value and generate revenue. The session shares how the BUDS case also highlights how value is also generated through avoided costs, reduced future liabilities, increased asset resilience, and improved regulatory and stakeholder relationships. For infrastructure operators more generally, this includes lower exposure to flood and erosion risk, greater flexibility under tightening environmental regulation, and enhanced social licence to operate in sensitive environments.

At the same time, the session takes a critical stance on the limitations of market-based mechanisms. Nature markets remain uneven in maturity, geographically constrained, and dependent on robust governance, monitoring, and verification frameworks, which can limit their viability. There is also a risk that over-reliance on tradable units can narrow attention to what is easily measured, at the expense of wider system functions and long-term ecological integrity. The BUDS experience underscores the importance of decision-making frameworks that recognise

plural values, ecological limits, and cumulative benefits, rather than relying solely on price signals.

Many of these lessons are transferable from the ports sector – as other infrastructure sectors generate material flows, such as sediment, spoil, water, and biomass, that are currently treated as liabilities. Applying circular, nature-focused thinking to these flows opens up opportunities to enhance resilience, restore ecosystems, and create long-term value across landscapes, particularly when coordinated at scale.

Overall, the session aims to demonstrate how investing in innovative, nature-focused circular thinking can reframe infrastructure from a source of environmental pressure into a driver of nature-positive resilience with multiple sustainability benefits. By working with natural systems rather than against them, infrastructure can play a central role in addressing climate risk, reversing ecological decline, and supporting enduring economic and social prosperity.

ORAL PRESENTATION | MAKING THE ECONOMIC CASE FOR NATURE

Developing a Biodiversity Metric for Linear Infrastructure: The Transport Infrastructure Ireland Approach

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KEYWORDS
decision-making frameworks, biodiversity loss, internalisation of externalities, ecological and social values, ecological integrity at scale

Ireland is facing a well-documented biodiversity crisis, with 85% of EU protected habitats and 18% of protected species assessed as being in unfavourable conservation condition[1]. Linear infrastructure projects such as roads, greenways and light rail contribute to pressures on biodiversity through land take, fragmentation, hydrological change and long-term alteration of ecological processes. While established environmental assessment processes such as Environmental Impact Assessment (EIA) and Appropriate Assessment (AA) provide essential qualitative evaluation of these effects, TII identified a gap in the ability to quantify biodiversity impacts and outcomes consistently, across projects and at programme scale. This gap also limits the ability to demonstrate, account for and ultimately assign value to biodiversity outcomes, which is increasingly recognised as a requirement for credible nature markets.

Ireland currently has no nationally recognised biodiversity accounting framework. Existing ecological assessments rely heavily on professional judgement and habitat mapping, but lack a standardised method for comparing options, tracking losses and gains, or evidencing biodiversity outcomes through the project life cycle. In response, TII initiated the development of a bespoke biodiversity metric tailored to Irish habitats, datasets, legislative context and the spatial realities of linear infrastructure planning. By establishing a transparent and repeatable approach to measuring biodiversity change, the TII Biodiversity Metric provides an enabling step towards future nature-based investment mechanisms, where quantified biodiversity outcomes underpin valuation, accountability and market confidence.

The TII Biodiversity Metric adapts the core principles of established biodiversity accounting approaches, while introducing targeted modifications to reflect Irish ecological priorities. It is structured around three integrated components:

- An early-stage Options Appraisal Tool applies spatial analysis to compare route corridors against national land-cover mapping, designated sites and irreplaceable habitats. It supports the first step of the mitigation hierarchy by identifying irreplaceable and protected habitats during route selection, enabling avoidance before design progresses. The tool presents biodiversity risks visually, facilitating communication and collaboration across disciplines.
- Habitat Condition Assessments provide structured field verification using tailored Irish condition sheets aligned with Ireland's national habitat classification system, Fossitt. These assessments record habitat structure, ecological integrity, species composition and management indicators through pass/fail questions completed by qualified ecologists. This ground-truthing helps ensure biodiversity values are recorded consistently, while retaining professional judgement.
- The Full Biodiversity Metric consolidates spatial and field data within a transparent calculation framework that converts habitat information into biodiversity units. This enables comparison of baseline and post-construction scenarios, identification of losses and gains, and assessment of enhancement opportunities. Time-to-target condition and difficulty multipliers are applied to support realistic evaluation of habitat creation and restoration. Irreplaceable habitats identified within the TII Biodiversity Metric tool (active raised bog, blanket bog, machair, turloughs and ancient woodland) are treated as irreplaceable features, reflecting their conservation importance and limited capacity for compensation.

Together, these components provide a consistent, evidence-based approach for integrating biodiversity considerations into linear infrastructure planning in Ireland. The presentation will outline the rationale, structure and application of the TII Biodiversity Metric, highlight key differences from UK approaches, and reflect on early lessons for embedding biodiversity value into transport decision-making. The approach offers transferable insights for other infrastructure authorities operating in jurisdictions without statutory biodiversity net gain requirements. It also demonstrates how robust biodiversity accounting can support the emerging recognition of nature as an asset, providing a technical foundation for future nature markets linked to infrastructure delivery and land management.

Assessing Ecological Risk in Infrastructure Planning

Tuesday 22 September · 11:00–13:00 · Victoria Park

ORAL PRESENTATION | ASSESSING ECOLOGICAL RISK IN INFRASTRUCTURE PLANNING

Using local knowledge surveys to inform the impact assessment of a mine access road for primates in West Africa

Fraser WIlkinson

SLR Consulting, United Kingdom

KEYWORDS
ecological and social values, biodiversity loss, landscape connectivity, artificial intelligence applications, evidence-based mitigation

This project aimed to develop a primate baseline and management plan for a mine and associated facilities and access road in West Africa.

Collecting effective and relevant baseline data is a common challenge when trying to determine the potential impacts of projects on biodiversity. We were working in an area that has not been well studied, and other methods had provided limited information. We had originally conducted transect and camera trapping studies, but results were limited and indicated that the primate populations may in fact occur where we previously hadn't expected them to.

When discussing the camera trapping, I will also briefly discuss SLR's in-house video analysis software that is driven by machine learning and helped to significantly reduce the manual work required to identify the species present in the videos collected.

We decided that an effective way to close this knowledge gap would be to conduct local knowledge surveys. Several members of the local communities engaged in farming and hunting and so were frequently seeing or hearing certain primates. This information was invaluable. We also conducted additional camera trapping studies following the LKS in areas we had previously not surveyed but were reported to have chimpanzees present.

Based on the combined results of transects, camera traps, and local knowledge surveys, we had a much better understanding of the primates' presence across the whole landscape, including confirmed chimpanzee habitat. This included which habitats they use and how they interact with humans. From this, we were able to build a better impact assessment and therefore more effective mitigation.

The proposed mitigation follows the mitigation hierarchy, but restoration and offsetting will be required to achieve a net gain. This is complicated given the ecological and socio-economic context. A key concern for the project is the development of the access road and the improved access this provides, as well as people migrating to the town in search of work, either on the mine site or in supporting services as the town grows. This will undoubtedly put additional pressures on an already delicate ecosystem.

Whilst the finer details of any offsetting are still in progress, the baseline data collected have meant we have been able to develop a far more robust approach than would have otherwise been possible. For example, we have confirmed areas of habitat close to a forest reserve that house monkeys and chimpanzees but are becoming isolated from other core habitat. We have recommended focussing offsetting measures on this area and improving connectivity through a habitat corridor.

Broadly speaking, the approach to offsetting can be split into two streams. Firstly, there is the direct restoration of degraded habitat that has been lost to logging or agriculture. Secondly, there are socially-orientated approaches that aim to reduce pressures on habitat by bringing benefits to local people. This could include alternative fuels and proteins, improved agricultural techniques, or measures to reduce tension with chimpanzees. Such initiatives are hard to implement, but, with our robust baseline data and community-focussed approach, we are confident that benefits can be achieved for people and wildlife.

ORAL PRESENTATION | ASSESSING ECOLOGICAL RISK IN INFRASTRUCTURE PLANNING

A decision-oriented method for improving wildfire prioritization along road networks

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Université de Lorraine, ERPI, France

KEYWORDS
decision-making frameworks, decision-support modelling, climate adaptation, spatial planning, monitoring

Wildfires are increasingly recognised as systemic socio-ecological risks, with road networks acting both as ignition corridors and as critical infrastructures for fire suppression and emergency response (Narayanaraj & Wimberly, 2012; Syphard et al., 2007; Kwon et al., 2025). In this context, prioritizing roadside interventions has become a key challenge for infrastructure managers, who must allocate limited resources under increasing climatic and anthropogenic pressures (Calkin et al., 2014, 2015).

Current wildfire risk assessments commonly rely on Geographic Information Systems (GIS) combined with Multi-Criteria Decision Analysis (MCDA) to integrate heterogeneous drivers such as topography, vegetation, climate, and human proximity (Pourtaghi et al., 2016; Khan et al., 2024). Among these methods, the Analytic Hierarchy Process (AHP) is widely used to structure expert knowledge and derive weighting schemes (Saaty, 2004). However, most applications adopt compensatory aggregation, allowing critical vulnerabilities to be offset by favourable conditions. In infrastructure risk management, such compensation may lead to the under-prioritization of segments exhibiting non-substitutable risk factors, particularly along anthropogenic interfaces (Cinelli et al., 2014; Banihabib et al., 2017).

To address this limitation, this study proposes a hybrid decision-support framework combining AHP with the non-compensatory FlowSort method (Nemery & Lamboray, 2008). The approach separates epistemic structuring (criteria weighting) from normative classification (risk assignment), enabling the identification of critical configurations without excessive trade-offs. A Wildfire Roadside Risk Index (WRRI) is constructed to assign road segments into discrete operational categories ranging from very low to very high risk. The index integrates four criteria — topography (elevation, slope, aspect, topographic wetness index), anthropogenic pressure (distance to roads and settlements), climate (precipitation, land surface temperature, wind), and vegetation (NDVI, land cover) — selected for their established influence on fire ignition and spread.

The framework is applied to two contrasted French territories (Mediterranean Hérault and oceanic Côtes d'Armor) using multi-source geospatial datasets and 25 years of satellite-derived fire occurrence data. Results show that anthropogenic factors (proximity to roads and settlements) and climatic variables dominate the weighting structure, jointly accounting for more than 65% of total importance. Validation against historical fire data indicates that 76% of fire events in Hérault and 81% in Côtes d'Armor occur within segments classified as high or very high risk. In comparison to a standard additive model, the non-compensatory approach reclassifies approximately 12–18% of segments, reducing the underestimation of structurally critical areas.

These results demonstrate that non-compensatory MCDA provides a more robust basis for infrastructure decision-making by aligning risk assessment with operational logics based on thresholds and prioritization categories. Beyond wildfire applications, the proposed framework contributes to advancing decision-oriented methodologies for managing multifunctional roadside infrastructures under increasing environmental uncertainty.

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ORAL PRESENTATION | ASSESSING ECOLOGICAL RISK IN INFRASTRUCTURE PLANNING

From Expertise to Deployment: A Capacity-Building Framework for Mainstreaming Biodiversity in the Transport Sector of the Danube Region

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KEYWORDS
decision-making frameworks, landscape connectivity, social–ecological systems, institutional reform, vision-led delivery

Mainstreaming biodiversity into transport infrastructure planning remains a persistent challenge across Europe, particularly in the Danube Region where accelerated infrastructure development coincides with high biodiversity value. While initiatives such as the BISON and SaveGREEN projects have consolidated expertise — its transfer into practice remains largely ineffective. The HARMON 2 project (Interreg Danube Region Programme, 2024–2025) addresses this by identifying structural gaps and proposing actionable solutions.

Building on a systematic assessment of capacity-building needs HARMON 2 developed a comprehensive framework mapping the process of change "from expertise to deployment" through five interlinked stages — knowledge repository, dissemination of information, outreach and awareness, transdisciplinary training, and consultations for decision-makers and implementors. A readiness assessment proved that no stage currently operates at an adequate level, with the knowledge repository rated as deficient and all others as low.

The analysis revealed key missing links both between and within stages: the absence of a dedicated forum and exchange platform, the lack of tailored and easily accessible content, insufficient train-the-trainers programs and certification systems, and a shortage of data-based modelling and visualization tools for transparent decision-making. To bridge these systemic gaps, HARMON 2 proposes the establishment of a Regional Excellence Centre (REC) — a non-profit entity with a commercial arm — designed to act as a capacity integrator, sustaining initiatives through four pillars: networking and facilitation, formal education and capacity building, deployment integration, and innovative decision-making support.

ORAL PRESENTATION | ASSESSING ECOLOGICAL RISK IN INFRASTRUCTURE PLANNING

Staying Connected: protecting our critical infrastructure in the South West using nature based solutions

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KEYWORDS
landscape-scale restoration, infrastructure coherence, nature-based solutions, nature markets, climate adaptation

Theme/ key message: Harnessing nature for growth, resilience and security, to improve the resilience of our critical infrastructure in the South West against climate change and reduce access loss to the region

Introduction

Nature South West (NSW) and the South West Infrastructure Partnership (SWIP) are collaborating, to drive and deliver resilience actions (via nature based solutions), that help tackle the climate change impacts facing the South West, which are exacerbating damages to critical infrastructure (especially from flooding). Losing connection to the rest of the country has significant, far-reaching impacts for businesses, growth and communities.

Traditional 'grey' engineering solutions can't address the pressures of increasingly significant weather events and climate change alone. Coupling them with nature based solutions at a systems level is a more sustainable and long term opportunity to increase resilience, whilst also delivering wider benefits to a broader area beyond the point of risk.

Drivers

- We are moving quickly in response to the palpable demand from buyers, investors and funders for aggregated, costed delivery at scale nature based solution projects, as well as listening to suppliers (farm clusters and delivery projects) in order to support them in becoming 'shovel ready' and meeting the needs of the market
- The Infrastructure Client Group (ICE) is undertaking a risk based analysis of their assets, highlighting resilience actions required- and we intend to add value to this piece of work/ dovetail with it
- New policies and strategies will help drive this activity, including the Land Use Framework, revised Flood and Coastal Risk Erosion Risk Management (FCERM) funding policy, the government's growth agenda and joined up transport strategies (managing risk)

Objectives

- We have instigated a Geographic Information Systems (GIS) evidence gathering and analysis exercise, using the Environment Agency National Receptor Dataset, to identify those critical infrastructure assets most at risk- focussing initially on flood impacts, across six infrastructure categories (including the strategic transport network)
- We will then depict the points/ assets that have a catchment area upstream of them, where nature based solutions could help provide significant resilience gains
- We already have well developed case studies highlighting this synergy, including Home - Connecting the Culm and will develop more

Expected outcomes

- Nature-based solutions at scale provide a highly significant opportunity to build resilience, to enable the South West to stay connected , whilst providing a range of measurable co-benefits including for biodiversity, carbon storage and people
- A cross-sector regional partnership committed to accelerating large-scale nature recovery across South West England
- Attract and showcase funding for nature recovery that delivers for the region's economic, environmental and social needs

Economic benefits

- Avoiding costly damages to critical infrastructure as well as to reputation
- Accessibility to the South West opens up economic opportunity including the huge tourism industry in the region

Nature benefits

- Significant co-benefits including Water Environment Regulation, biodiversity (BNG), carbon storage in soils, drought resilience

Community benefits

- Nature based solutions build resilience for communities at risk from flooding and allows them to better adapt for future prosperity

Co-creating solutions and delivering at scale

Via an interactive workshop, we invite critical infrastructure providers, businesses, investors, and stakeholders to act as 'critical friends' and help target effort. Together, we can grow investment in nature-based solutions and make the South West a powerhouse of innovation and resilience, and a model for the rest of the UK.

Designing Resilient Landscapes: Evidence, Tools and Approaches for Nature-Positive Infrastructure

Tuesday 22 September · 14:00–16:00 · Greville Smyth Park

ORAL PRESENTATION | DESIGNING RESILIENT LANDSCAPES: EVIDENCE, TOOLS AND APPROACHES FOR NATURE-POSITIVE INFRASTRUCTURE

Identifying Climate-Smart Ecological Corridors at Landscape Scale: Digital Twins and Integrated Tools for Resilient Infrastructure Planning

Cristian-Remus Papp[1,2], **Gabriele Retez**[3], **Cristian Malos**[2], **Nada Tosheva**[4], **Tanya Schnell**[4], **Zoltán Szabó**[1], **Hildegard Meyer**[5]

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KEYWORDS
climate adaptation, landscape connectivity, decision-support modelling, nature-based solutions, spatial planning

Maintaining functional ecological connectivity is a critical component of resilience in human-dominated landscapes, particularly under accelerating climate change and expanding grey infrastructure. Large mammals require extensive, connected forest landscapes to sustain viable populations, yet these landscapes are increasingly fragmented by transport infrastructure, land-use intensification and emerging transboundary barriers, including fences. Identifying and conserving climate-smart ecological corridors at the landscape scale is therefore essential not only for biodiversity conservation, but also for reducing human-wildlife conflicts and preventing future conflicts between green and grey infrastructure.

This presentation highlights key outcomes from the ForestConnect project (Interreg Danube Region), which developed and tested a suite of integrated tools and methodologies to support climate-resilient connectivity planning for large carnivores across the Carpathian–Dinaric–Balkan region. ForestConnect combines (i) a harmonised, transnational GIS-based monitoring framework for large carnivore occurrence, habitats and movement barriers, with (ii) an innovative Digital Twin modelling approach that integrates habitat suitability modelling, resistance-based connectivity analysis and future climate scenarios.

A shared GIS database was compiled from systematic and opportunistic monitoring data collected across multiple pilot sites in Romania, Slovakia, Ukraine, Bulgaria, Serbia and Montenegro. Harmonised datasets on species occurrence (brown bear, grey wolf and Eurasian lynx), land cover, human pressures and physical barriers were standardised and integrated into a common spatial framework. This database provided the empirical foundation for connectivity modelling while explicitly accounting for uneven sampling effort and methodological constraints.

Building on this foundation, the Digital Twin methodology was implemented to explore how connectivity patterns may shift under future climatic conditions. Habitat suitability was modelled using presence-only species distribution models, integrating land cover, topography, human modification indices and climatic variables. Suitability outputs were transformed into resistance surfaces and analysed using circuit-theory connectivity modelling. Present-day and future (SSP5–8.5) connectivity surfaces were overlaid to identify areas of stable connectivity , connectivity loss and potential future connectivity , providing a scenario-based, climate-informed representation of landscape permeability.

Results across pilot sites consistently highlight forests as the dominant element supporting large carnivore movement, while open land, intensive agriculture, settlements and infrastructure reduce permeability. Climate change effects on connectivity were context-dependent, acting indirectly through changes in vegetation structure and landscape configuration rather than as direct physiological constraints. In several landscapes, future connectivity contracted into fewer areas that may function as climate refugia, while transboundary analyses revealed the importance of large, cross-border forest systems for maintaining resilient connectivity.

While not delineating fixed corridors, the ForestConnect approach demonstrates how climate-smart, landscape-scale connectivity assessments can inform early-stage infrastructure and spatial planning, helping to avoid conflict hotspots, reduce wildlife-vehicle collisions and minimise costly late-stage mitigation. Crucially, the results illustrates the need for interdisciplinary collaboration among ecologists, GIS specialists, climate scientists, infrastructure planners and decision-makers, supported by shared digital tools.

We argue that integrating climate-informed connectivity modelling and digital twin concepts into planning frameworks offers a scalable pathway to operationalise resilience through nature, reconciling biodiversity conservation with infrastructure development in a rapidly changing climate.

In conclusion, our work demonstrates that forest integrity is the primary driver of large carnivore connectivity and landscape resilience, while fragmentation from infrastructure and intensive land use represents the dominant constraint across regions. Climate change reshapes connectivity indirectly, often concentrating movement into fewer, more stable areas rather than simply shifting corridors, highlighting the importance of climate-robust refugia. Meaningful connectivity assessment for wide-ranging species requires landscape-scale and transboundary approaches, as analyses confined to protected or administrative boundaries risk misrepresenting functional connectivity. Digital Twin and GIS-based tools are most effective as iterative, scenario-based decision-support instruments that inform early infrastructure planning and conflict avoidance rather than delineating fixed corridors.

ORAL PRESENTATION | DESIGNING RESILIENT LANDSCAPES: EVIDENCE, TOOLS AND APPROACHES FOR NATURE-POSITIVE INFRASTRUCTURE

OptiBioNum - Optimising the biodiversity capacity of infrastructure related buidlings through the use of standardised ecological indicators incorporated into digital models.

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KEYWORDS
technology expansion futures, systems innovation, decision-support modelling, retrofitting infrastructure, infrastructure coherence

OptiBioNum aims to incorporate standardised indicators into digital models of buildings, structures and infrastructure, enabling their design or retrofitting to be optimised in terms of their capacity to support biodiversity. The use of such indicators within digital models will enable a more detailed assessment of the biodiversity-supporting capacity of buildings or infrastructure and optimise the environmental quality of these projects from the earliest stages.

Introduction

In a context where the integration of biodiversity into the design and adaptation of regions, cities and their infrastructure is becoming increasingly important, there is a growing need for comparability between project variants and between projects. To meet this need, a number of certification schemes have been developed, but they struggle to effectively account for aspects relating to the ecological connectivity of the areas concerned. OptiBioNum aims to use digital simulation to develop robust, reproducible and comparable indicators of the functioning of ecological networks across different variants within a digital infrastructure model. The use of such indicators will enable a more detailed assessment of the biodiversity-hosting capacity of buildings or infrastructure and optimise the environmental quality of these projects from the earliest stages.

Numerical simulation approaches offer the opportunity to produce standardised assessments of how ecological networks function, which can be utilised at a very early stage in project design, whether for new projects or developments involving existing infrastructure. They also enable different project variants to be modelled so that they can be compared in a standardised manner. Thus, since 2022, TerrOïko has been conducting exploratory work on the development of standardised indicators at national level, derived from the results of numerical simulations, enabling an objective comparison of performance in terms of supporting biodiversity at the level of local authorities or neighbourhoods. The indicators produced reflect the role of a neighbourhood or a sub-set of developed or developable plots in the functioning of green corridors. ‘Hosting potential’ indicators, for example, are designed to assess, outside of a landscape context, a project’s capacity to host a diversity of species. Other indicators, such as those relating to a site’s ‘responsibility’, highlight the site’s importance to the functioning of the ecological network, regardless of the presence or absence of anthropogenic pressures such as lighting or noise pollution.

In addition to the need to adapt indicators to the building scale or to the linear structure of transport networks, the OptiBioNum project had to address the requirement to use hybrid GIS and BIM digital models, enabling, on the one hand, the explicit integration of 3D elements into the assessment of indicators at the building scale and, on the other, work on the role of fine-scale elements (BIM) within a large-scale ecological network (GIS). With this in mind, OptiBioNum’s target have consisted of automating and embedding the processing required to evaluate the indicators within operative workflows for representing and manipulating GIS and BIM objects with standardized approaches.

Methodology

Indicator refinment: To date, indicators have been developped deriving umbrella species metapopulation simulation results. To strengthen the approach and reinforce the comparability between sites, the project perfomed an extensive litterature review and collect life-history traits for 806 species representative of the main metropolitan ecological networks. We then perfomed clustering analysis to create ‘virtual species’ representative of functionnal guilds for further simulations. Thus we designed 70 standardised ecotypes that can be applied to any construction project.

Building design scenarios: To develop the workflow integrating biodiversity into BIM process, we use 2 existing stations, 1 existing technical centre and 1 under design phase. We therefore con-

duct workshop with architects, civil engineers and ecologists to develop 2-3 scenarios of ecologicaly and technicaly relevant design alternatives.

Scenario's biodiversity related performance assessment: For each scenario, we ran 40 of the 70 standardised ecotypes simulations and derived the related indicators to assess scenarios performances.

Building the bridge between SIG and BIM: All along the project duration, processes to build the bridges between SIG-based and BIM-based activities have been reported with BPMN (Business Process Model and Note).

Results

The scenario analysis showed that most buildings under study present sub-optimal design in regards to their ability to preserve biodiversity. In addition, workshop performed also highlighted the fact that the main limitation for choosing a better option for biodiversity was the lack of BIM-embedded quantitative and comparable information on biodiversity performance.

Thus, OptiBioNum provided three key results

A batch of 70 standardized ecotypes that can be use to assess relative biodiversity performances of any construction project in western Europe.

A comprehensive BPMN modelling the performance assessment process and its integration into BIM-based processes.

Highlights the ability of such approach to support decision making at the early stage of project design.

ORAL PRESENTATION | DESIGNING RESILIENT LANDSCAPES: EVIDENCE, TOOLS AND APPROACHES FOR NATURE-POSITIVE INFRASTRUCTURE

Landscape-scale restoration – improving the habitat connectivity on the strategic road network whilst achieving good design

Andrew Linfoot

Jacobs, United Kingdom

KEYWORDS
landscape connectivity, spatial planning, wildlife mortality assessment, landscape-scale restoration, fauna passage design

Part of the global nature crisis is the urgency of addressing fragmentation, but it is best for actions to be strategic, using evidence-based solutions, and to operate at a variety of scales/

The Atkins Jacobs Joint Venture is providing environmental services to National Highways to help them deliver their vision set out in the environmental and sustainability strategy through evidence-based mitigation.

The team is working with National Highways to explore ways to reduce landscape scale severance and improve connectivity across the strategic road network for people, place and nature.

This work includes identifying opportunities for new green bridges, retrofitting infrastructure such as existing crossings, and improving connectivity parallel with the road network.

Different methods are being explored include wildlife mortality assessment, analysis of barrier permeability, and fauna passage design that considers species behavioural response. Together, these approaches aim to identify interventions that deliver measurable benefits at a landscape scale while addressing local needs.

The study examines how connectivity, mitigation and restoration can be delivered beyond individual sites to landscapes and infrastructure networks through strategic planning and working with partners and stakeholders.

The study examines how connectivity, mitigation and landscape-scale restoration can be achieved beyond individual sites, through strategic planning and cross-boundary coordination with partners and stakeholders. It considers how interventions contribute to wider ecological resilience, including population viability and long-term genomic connectivity.

The presentation will share the knowledge gained from developing new methods and using decision-support modelling and evidence-based mitigation for identifying locations suitable for landscape-scale interventions that tackle habitat fragmentation. This includes the use of data sets through to the practicalities of delivering solutions on the ground.

It will also share how the methodology identified the need to consider and balance a range of environmental, sustainability and social issues. Key understandings used in the study included:

- the proposed intervention's relationship to strategic plans,
- the need to think beyond connecting designated nature conservation sites both sides of linear infrastructure,
- how the benefits of connectivity into the wider landscape are achieved,
- policy issues in relation to designated sites,
- balancing the benefits vs. potential impacts, and
- the ability to retrofit infrastructure as complementary interventions to larger scale green bridges in achieving fauna passage.

The presentation will conclude by sharing how the study also examines the role of good design in achieving the connectivity, whilst achieving integration of crossings into the landscape.

ORAL PRESENTATION | DESIGNING RESILIENT LANDSCAPES: EVIDENCE, TOOLS AND APPROACHES FOR NATURE-POSITIVE INFRASTRUCTURE

Natural Asset Platform piloted on regional infrastructure network - making nature metrics accessible for evidence-based decisions

Harry Catharell-Hargreaves[1], Sally Fraser[2], Eliza Eakin[2], Kirsteen Allan[1], Jonathan Nichols[1], Abigail Urquhart[1], Richard Jones[1], Steven Bosher[1], Justin Clowes[1], Matt Grove[1], Katie Born[1], Kylie Jones[3], Calum Crockart[3]

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KEYWORDS
ecological economics, ecological and social values, natural capital (critical perspectives), biodiversity loss, nature markets

Scottish and Southern Electricity Networks (Distribution) (SSEN) deliver power to over 3.9 million homes and business across the diverse and unique geographies in two regions: the north of Scotland and central southern England. Their infrastructure network includes over 128,000km of overhead lines and 460km of subsea cables powering island communities. As part of their regulatory Environmental Action Plan (2023-2028) they have a commitment to achieve these goals using innovative and analytical systems based on foundational knowledge. This includes developing a tool to baseline and monitor their biodiversity at an estate level and support the cultural change required to enhance biodiversity with a reliable evidence base. They also want to assess net changes in natural capital and impacts on nature and society from different options for new connections and network projects, adopting an appropriate tool to monitor the provision of ecosystem services from network sites and commit to reporting on this annually.

Similarly, many of Jacobs' major clients across the public and private sectors have increasing statutory and business needs to understand the value of their biodiversity and natural assets across their estate, in an effort to tackle habitat fragmentation and landscape-scale severance due to transportation. They require actionable intelligence to support Biodiversity Net Gain, delivery of ESG (Environmental, Social and Governance) goals and to support a greater understanding of their own assets, in order to measure and deliver sustainability outcomes. There is a wealth of information and data available to support these assessments but often this is siloed, with inconsistent formats and a lack of co-ordination across industry.

As part of the Natural Asset Platform, Jacobs has developed custom geospatial models that combine mapping and information to assign habitat types to land parcels and linear features across their regional, linear infrastructure. This includes hedgerows and watercourses. It uses a holistic combination of ecological and economic data. Biodiversity value is quantified as standard using Defra's Statutory Biodiversity Metric for England and an SSE version of the Biodiversity Metric modified for the Scottish context. Automated models are also developed to create natural capital valuations for the different ecosystem services, aligned with UK government and international guidance. For example, the approaches for modelling Carbon Sequestration and Carbon Storage estimate the quantity of carbon removed from the atmosphere in tons of CO2e, the amount of carbon currently stored by the land and calculates the economic value of those benefits in £.

The Natural Asset Platform enables SSEN-Distribution to map their natural assets (habitats), quantify and value the biodiversity assets, natural capital assets and ecosystem service benefits they provide. Ecosystem service modelling is provided for including Air Pollutant Removal, Carbon Sequestration, Carbon Storage, Flood Regulation, Food Production, Wood Production (Timber), Recreation and Pollination. .

This is applicable to their land estates, project boundaries and wider water catchments that they operate in. It enables SSEN to account for the benefits that their natural assets provide to their business, customers and local communities. It helps them to strategically plan optimised use of their land resources to meet their business needs, statutory obligations, offset carbon, build climate resilience and maximise social value.

The platform is a web-based geospatial tool with a client interface, web maps and dashboards. This allows SSEN staff and contractors to directly interrogate, analyse and report on these datasets for individual projects, regional performance areas and across their entire estate.

ORAL PRESENTATION | DESIGNING RESILIENT LANDSCAPES: EVIDENCE, TOOLS AND APPROACHES FOR NATURE-POSITIVE INFRASTRUCTURE

Fish migration - mapping of barriers as a mean to support the National Strategy for River Restoration 2021–2030 by strengthening the evidence base for restoring longitudinal connectivity, improving targeting of investments, and facilitating cross-agency learning on effective fish-passage solutions.

Nlna Mari Jørgensen[1],
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KEYWORDS
ecological economics, fauna passage design, evidence-based mitigation, ecosystem function, biodiversity loss

Fish migration is essential for healthy river ecosystems and viable fish populations in Norwegian watercourses. Road infrastructure can disrupt longitudinal connectivity where roads cross rivers and streams, particularly when culverts and small drainage structures are undersized, perched, or otherwise poorly designed. Such structures may partially or completely block access to upstream spawning and rearing habitats, reducing population resilience and undermining river restoration objectives.

The Norwegian Public Roads Administration (Statens vegvesen) is developing a systematic approach to identify, verify and prioritise measures that restore fish passage at road crossings. The work is built on a large-scale screening of registrations in the Norwegian Road Database (NVDB): approximately 570,000 culverts and drainage structures have been reviewed, and around 10,000 locations have been flagged as potential fish-migration barriers requiring field verification. These candidate barriers are highlighted and searchable in a dedicated database and visualised in a mapping solution together with an updated survey form that supports consistent assessment and documentation.

Road owners and relevant authorities are encouraged to record whether a given structure constitutes a confirmed barrier and therefore should be upgraded, enabling coordinated prioritisation across actors (e.g., county authorities, municipalities, Nye Veier and Statens vegvesen) and across water regions. The mapping solution was launched on 19 June and was developed in collaboration with the Norwegian Environment Agency (Miljødirektoratet). Collected data are made available for broader use in water management, including through Vann-Nett (Norway's Water Information System), to support transparent decision-making and alignment with river basin planning.

The initiative supports the National Strategy for River Restoration 2021–2030, which highlights the transport sector as an actor that can affect watercourses through physical interventions and calls for mapping barriers and re-establishing free fish passage using effective solutions. This contribution to IENE presents the workflow from national screening to local verification, and discusses how a shared, standardised data foundation can accelerate implementation of connectivity measures, improve targeting of investments, and facilitate reporting and learning across agencies and regions.

ORAL PRESENTATION | DESIGNING RESILIENT LANDSCAPES: EVIDENCE, TOOLS AND APPROACHES FOR NATURE-POSITIVE INFRASTRUCTURE

Publication of green crossings by the Austrian Federal Highway Administration

Brigitte Sladek

ASFINAG, Austria

KEYWORDS
decision-making frameworks, spatial planning, landscape connectivity, barrier permeability, strategic defragmentation

The Austrian motorway and expressway network's wildlife (green) crossings are publicly available on the map at https://www.lebensraumvernetzung.at/de/map. By publishing this data, ASFINAG enhances transparency for external stakeholders—interested citizens, municipalities and planning offices, nature conservation organisations, and hunting associations.

Planning departments and municipalities can quickly locate crossings and better integrate them into spatial plans. Conservation agencies and NGOs gain early, reliable information to protect and secure green corridors ahead of new crossings, strengthening biodiversity. Future requests under the Environmental Information Act and the Freedom of Information Act can be directed to the platform, streamlining responses and reducing administrative effort. External institutions also benefit from access to key geodata for research, studies, and long-term monitoring.

The session will present the published crossing data and discuss data protection considerations and data management practices.

Nature Based Solutions

Tuesday 22 September · 14:00–16:00 · Victoria Park

ORAL PRESENTATION | NATURE BASED SOLUTIONS

Nature-based Solutions for Transport Resilience: Emerging Insights for Practical Application

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KEYWORDS
climate adaptation, landscape connectivity, nature-based solutions, uncertainty, accelerated implementation

Nature-based Solutions (NbS) are increasingly referenced as a means of enhancing the climate resilience of transport infrastructure while delivering biodiversity and wider environmental and societal benefits. However, their current application across transport modes remains uneven, and the evidence base underpinning their use is often fragmented and inconsistently interpreted.

This poster outlines the scope and high-level findings of an evidence-led study on NbS for transport resilience in the UK. The work synthesises existing literature and transport-relevant case studies. It examines the strength and limitations of the evidence base for NbS benefits in climate-adapted transport infrastructure, how those benefits are measured and evidenced, and the common implementation barriers that constrain wider adoption of NbS across infrastructure for different transport modes (road, rail, aviation and ports). The study focuses on three practitioner-relevant questions: (i) what evidence exists for effective climate resilience and wider benefits of NbS in transport contexts, and where significant gaps remain; (ii) how NbS benefits are currently measured and communicated; and (iii) what barriers limit adoption of NbS, and what practical changes are needed to support wider implementation in transport infrastructure. The work aims to supports more consistent, implementable and nature-positive use of NbS in climate-adapted transport systems. The poster contributes to IENE discussions on actionable knowledge that strengthens the connection between the interdisciplinary evidence base for NbS and delivery of more resilient, viable transport infrastructure.

ORAL PRESENTATION | NATURE BASED SOLUTIONS

From design to post-construction evaluation : multi-taxa outcomes of ecological integration in the reconstruction of the Charmaix Viaduct (French Alps)

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KEYWORDS
ecological resilience, retrofitting infrastructure, monitoring, species behavioural response, ecosystem function

The reconstruction of transport infrastructures in mountain environments raises acute challenges for biodiversity conservation, particularly where protected species depend on long-standing structures. The Charmaix Viaduct (French Alps) hosted a wide range of protected taxa prior to reconstruction, including bats (Plecotus auritus), breeding Western House Martins (Delichon urbicum), reptiles, protected flora (Gagea villosa, Allium scorodoprasum), and habitats suitable for the Apollo butterfly (Parnassius apollo).

This contribution presents the results of an integrated ecological programme spanning six years of monitoring during construction (2019–2024) and the first year of post-construction monitoring (2025). Ecological measures were embedded into the project design and implementation, including bat roosts integrated into new bridge piers, hypogean bat shelters created from former structural elements, artificial nesting sites for Western House Martins, reptile hibernacula built using recycled construction materials, and strict protection of sensitive habitats throughout the works.

Post-construction monitoring in 2025 provides the first assessment of ecological functionality beyond compliance. Results show a clear positive response from avifauna, with 16 occupied Western House Martin nests in 2025, exceeding pre-work conditions (12 breeding pairs), and the use of bridge structures as communal roosts. Bat activity monitoring confirmed continued use of the site as a foraging corridor by Plecotus auritus , with evidence of transit and hunting beneath the deck, while early signs of roost use were detected inside one newly constructed pier during autumn. Reptile hibernacula showed early signs of functionality, with Podarcis muralis detected on multiple structures. Floral monitoring highlighted contrasting dynamics, with the persistence of Allium scorodoprasum populations, while Gagea villosa was no longer observed, likely reflecting long-term habitat closure rather than construction impacts. Notably, one Apollo butterfly individual was observed in 2025, despite significant habitat disturbance following a major flood event.

This case study illustrates how long-term ecological integration, adaptive management, and post-construction monitoring are essential to assess the real ecological performance of infrastructure projects. It contributes to the IENE 2026 themes “Resilience Through Nature” and “Pace Over Perfection” by demonstrating how nature-inclusive infrastructure can deliver measurable biodiversity outcomes while operating under strong engineering, regulatory and climatic constraints.

ORAL PRESENTATION | NATURE BASED SOLUTIONS

NaturQuartier - The success story of an ecological compensation area.

Brigitte Sladek

ASFINAG, Austria

KEYWORDS
monitoring, landscape connectivity, ecological and social values, nature-based solutions, ecosystem function

Large-scale infrastructure projects require effective and transparent biodiversity compensation strategies. For the eastern section of the S7 Fürstenfeld expressway (Austria), the Environmental Impact Assessment mandated the creation of 15 hectares of compensatory habitat for open-land bird species. This was implemented on a single restored gravel extraction site in Großwilfersdorf (Austria-Styria), ensuring timely mitigation of ecological impacts in close alignment with the construction schedule.

By consolidating habitat measures in a contiguous area, the project maximises ecological effectiveness, land-use efficiency, and administrative governance. Within a short time, the site became a biodiversity hotspot, with over 190 bird species recorded, including rare and protected taxa.

Since 2022, a multi-year, evidence-based biodiversity monitoring programme has provided robust data on flora and fauna, guiding adaptive management. From 2025, adaptive, nature-based management through extensive year-round grazing will enhance structural diversity and ecological resilience.

Structured public engagement—including a visitor platform and ornithological observation platform—fosters regional acceptance, without promoting recreational or tourism use. By combining innovative ecological design, rigorous monitoring, and participatory governance, the project delivers a transferable best-practice model for biodiversity compensation, supporting sustainable infrastructure development, regulatory compliance, and informed public-sector decision-making

The session examines the development of this ecological compensation area from the perspectives of land revenue, nature conservation, and landscape management. It provides insight into the management options considered—both with and without grazing livestock—and explains why some were rejected. It also highlights the practical challenges of balancing the interests of ornithologists, hunters, passersby, and the wider community.

ORAL PRESENTATION | NATURE BASED SOLUTIONS

Beyond Mitigation: Integrating Ecological Functionality into Civil Infrastructure Systems

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KEYWORDS
social–ecological systems, ecological and social values, cross-boundary coordination, long-term resilience, ecosystem function

Civil infrastructure is undergoing a profound transformation in the context of global environmental change, biodiversity loss, and increasing social-ecological uncertainties. Within this context, these infrastructures are increasingly recognized as components of complex social-ecological systems, where maintaining ecosystem functioning and biodiversity is essential for long-term adaptive capacity. This latter is crucial for building resilience of coupled social ecological systems across spatial, temporal, and institutional scales. While emerging paradigms (including ecosystem-based management, bioengineering, ecological engineering and nature-based solutions), seek to embed infrastructure development within ecological processes, their operationalization within the rigid constraints of the built environment remains a significant challenge.

Drawing on a systematic review and qualitative meta-synthesis of 153 peer-reviewed articles spanning 25 years of scientific literature (2001–2025) at the intersection of civil engineering and ecology, this study examines the empirical mechanisms and dimensions driving the integration of ecological processes into civil infrastructure planning and management.

By adopting a Social-Ecological Systems (SES) framework, this meta-synthesis offers a new analytical lens that redefines how civil infrastructure, territorial dynamics, and ecological processes interlock. Synthesizing these review findings, the analysis demonstrates that operationalizing socio-ecological resilience within infrastructure practices requires a structural triple shift in scale. Spatially , civil engineering must transcend traditional site-bounded parcel constraints to embrace landscape-matrix dynamics, ensuring functional connectivity and continuous ecosystem flows across multi-scalar spatial domains. Temporally , design paradigms must transition from deterministic, static structural frameworks toward adaptive management models capable of accommodating non-linear ecological trajectories, biological succession, and deep environmental uncertainty. And institutionally , infrastructure delivery must move away from rigid, top-down linear execution models toward territorialized governance structures, wherein engineering processes co-evolve with dynamic socio-ecological systems, local socio-ecological knowledge, and community sense of place. To navigate these systemic transformations, robust decision-making must rely on interdisciplinary integration, leveraging spatial planning as a primary driver to align civil infrastructure with landscape-scale ecological processes and dynamics. This shift reframes infrastructure development away from localized, aesthetic greening toward long-term, adaptive investments in territorial socio-ecological resilience.

ORAL PRESENTATION | NATURE BASED SOLUTIONS

Thrift shopping biodiversity? Translocating biodiverse topsoil from a road construction site to an urban area

Martine Alexandra Andersen Hennig[1], **Bente Jessen Graae**[1], **Susanne Eich-Greatorex**[2], **Marie Digre**[1], **Katrin Knoth**[3], **Rolf André Bohne**[1], **Martijn Lodewijk Vandegehuchte**[1]

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KEYWORDS
cross-boundary coordination, biodiversity loss, nature markets, monitoring, evidence-based mitigation

Road construction fragments ecosystems and contributes to global biodiversity loss, creating a strong need for evidence-based mitigation and restoration measures that can deliver tangible ecological results beyond the construction footprint. As the pressure on the infrastructure sector to achieve nature neutrality increases, there is growing interest in approaches that can restore ecosystems in both quality and extent. Although on-site revegetation using local soils is widely used, off-site compensation is often necessary when habitat loss cannot be avoided. An under-explored approach is the translocation of topsoil from construction to degraded areas, with the potential to conserve plant species through the transfer of seed banks, propagules, and soil properties. This study evaluated the effectiveness of off-site topsoil translocation from forest and grassland ecosystems at a planned road construction site. In 2022, the topsoil was transferred either as intact vegetation turfs or as mixed bulk soil to a species-poor urban park. Parallel treatments of turf, bulk soil and undisturbed reference plots were established at the road site and the urban receptor site to provide a comparison with the conditions in the original habitat. Vegetation monitoring was conducted in 2022 and 2024 to assess the composition of the vascular plant community and ecological indicator values. The soil properties were analyzed after one year to evaluate whether the translocated material retained key soil characteristics. A total of 76 species were successfully translocated from the road site, effectively doubling the diversity of native plants in the urban park. The abundance of original road site plant species in translocated treatments spanned from 74% in forest bulk soils, 75% in the grassland bulk soils, 80% in forest turfs and 85% in grassland turfs. For both habitats, turfs that remained at the road site consistently resembled the reference communities. While the translocated grassland turfs did not differ from the reference plant community, the forest turfs closely resembled the reference communities. In contrast, bulk soil translocated to the park shifted toward park-like vegetation dominated by soil disturbance-tolerant species, suggesting that receptor conditions and management strongly influence restoration results. The bulk soils of the translocated forest were slightly more resistant to colonization by nontarget species due to effective shading that restricted light-dependent species to dominate. The soil properties in the translocated bulk soils and turfs did not differ from the undisturbed reference levels of nutrients, pH, and bulk density, indicating that the translocation retained key soil characteristics. The translocated grassland topsoil had a faster turnover of species and overlapped more with the park species communities, but also were more prone to nontarget species colonization, whereas shade application likely prevented this in forest bulk soils. These findings suggest that turf translocation is a reliable method of preserving and restoring plant communities, especially for woody species and those sensitive to soil disturbance. Bulk soil translocation offers a lower-cost but less predictable alternative and may risk promoting non-target species. Overall, topsoil translocation can contribute to biodiversity conservation in degraded urban areas and provide actionable guidance for infrastructure mitigation, but it should complement - not justify - ecosystem destruction. More research is needed to evaluate long-term outcomes and broader applicability in different donor and receptor contexts.

ORAL PRESENTATION | NATURE BASED SOLUTIONS

Unlocking the potential of transport corridors to support regional ecological connectivity

Nick Cork[1,2],
Neil Strong[3],
Emma Ferranti[1,2],
Daniel Donaldson[1],
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KEYWORDS
ecological economics, ecological and social values, natural capital (critical perspectives), biodiversity loss, decision-making frameworks, evaluation, climate adaptation, ecological resilience, nature-based solutions, landscape connectivity, ecological integrity at scale, trade-off analysis, evidence-based mitigation, barrier permeability, landscape-scale restoration, cross-boundary coordination, wildlife mortality assessment, fauna passage design, decision-support modelling

Linear transport infrastructure is a major driver of habitat fragmentation, creating barriers to species movement and reducing landscape connectivity. However, transport corridors often contain extensive areas of semi-natural habitat, particularly vegetated verges, which studies suggest can contribute to regional ecological connectivity when managed strategically. This is especially beneficial in urban settings where alternative pathways are limited. This research investigates how existing transport infrastructure can be reframed from a source of ecological fragmentation into a potential contributor to landscape-scale connectivity, and a facilitator for dispersal under our changing climatic conditions. By locating hotspots where ecological networks coincide with transport corridors, resources can be optimised to maximum effect to conserve and enhance connectivity pathways and to identify potential wildlife-vehicle collision hotspots.

We developed and applied an asset-focussed methodology to identify locations where connectivity pathways converge on transport corridors by integrating infrastructure information with spatial ecological modelling. The approach combines structural and functional connectivity analyses, incorporating habitat distribution, vegetation characteristics and transport corridor proximity effects. Transport verges were separated into left and right buffers and subdivided into 10m segment lengths, enabling ecological connectivity metrics to be associated with infrastructure assets locally, indicating likely crossing points and verge movement potential. This provides a practical mechanism for translating landscape-scale ecological analysis into operational decision-making.

The methodology was applied to a railway network case study in the West Midlands, UK, integrating regional land cover with detailed woody vegetation and rail infrastructure datasets. The analysis identified sections of railway corridor where existing woody vegetation contributes significantly to wider ecological connectivity increasing effective permeability of the conurbation for movement of woodland species, and where targeted management interventions could maintain and enhance habitat network functionality. Potential wildlife-vehicle collision locations were identified by comparing flow in opposite verge buffers. Results demonstrate that appropriately managed railway verges can function as strategically important components of regional ecological networks, particularly within highly modified landscapes where opportunities for habitat creation and restoration are constrained.

The findings highlight the value of moving beyond traditional approaches that consider transport infrastructure solely as a constraint to ecological connectivity. Instead, the research demonstrates the potential for infrastructure assets to be incorporated into wider nature recovery strategies through evidence-based vegetation management. By identifying where interventions are likely to deliver the greatest connectivity benefits, the approach supports more efficient allocation of resources and enables collaboration between infrastructure managers, ecological practitioners and regional planning authorities.

This research contributes to the development of nature-positive transport systems by providing a scalable decision-support approach for embedding ecological connectivity within infrastructure management processes. It demonstrates how asset-level information and landscape-scale ecological analysis can be combined to deliver actionable knowledge, supporting resilient landscapes and improved biodiversity outcomes while recognising the operational requirements of transport networks.

Bridging the Canopy Gap

Tuesday 22 September · 14:00–16:00 · Eastville Park

ORAL PRESENTATION | BRIDGING THE CANOPY GAP

Bridging the Canopy Gap: Research and Mitigation for Arboreal Mammals

Tremaine Gregory[1,2], Fernanda Abra[2,3,4], Steve Bega[5], Pascal Peterman[6], Edgar van der Grift[7], Lucie Yrles[8], Alfonso Alonso[2], Hugh Jansman[7], Nina Villing[7], Margareet Laar[7], Maëlle Kermabon[8], Cyril Assenat[9], Ian White[10], Hazel Ryan[11], Fernanda Teixeira[12], Birthe Linden[13], Kylie Soanes[14], Anna Nekaris[15,16], Ines Azofeifa Rojas[17], Farah Carrasco Rueda[18,2], Gabriella da Costa Pereira[19], Pamela Cunneyworth[20], Thais Queiroz Morcatti[21]

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KEYWORDS
retrofitting infrastructure, barrier permeability, evidence-based mitigation, fauna passage design, species behavioural response

The transport ecology literature is dominated by studies of terrestrial species. However, there is a growing body of work on the impacts of transport infrastructure on arboreal fauna and mitigation solutions. Due to their preference for branches for safe passage over transport infrastructure and a potential aversion to crossing on the ground, transport infrastructure can be an absolute barrier to arboreal mammals, preventing movement, gene flow, resource acquisition, and impacting the important services this group provides to ecosystems such as pollination and seed dispersal. On the other hand, there are many semi-arboreal species that have the behavioral plasticity to cross linear infrastructure on the ground, but traditional infrastructure barriers designed to keep terrestrial wildlife out of the roadway for collision prevention are not effective, due to the animals' advanced climbing capacity. This session will explore examples of work on the impacts of transport infrastructure on arboreal mammals and research into mitigation solutions from around the world. The session will open with a global overview of mitigation research and then delve deeper into case studies from across Europe to the Amazon. We will describe the most recent findings in canopy bridge and arboreal mammal barrier research, touching on everything from an in-depth literature review that is revealing where bridge studies are being performed and what patterns are surfacing, to canopy bridge placement and design research and policy to innovations in barrier design.

For this session, we propose a 90-minute symposium, with six 15-minute presentations.

ORAL PRESENTATION | BRIDGING THE CANOPY GAP

Reconnecting the Canopies: Protecting Endangered Primates in the Brazilian Amazon Arc of Deforestation

Fernanda Abra[1,2], **Luan Goebel**[3], **Maelle Freitas**[4], **Tremaine Gregory**[5], **Alfonso Alonso**[6]

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KEYWORDS
evidence-based mitigation, landscape connectivity, fauna passage design

Arboreal species are disproportionately negatively impacted by roads and traffic, as canopy discontinuity limits movement and access to critical resources, underscoring the need for targeted mitigation measures such as artificial canopy bridges. In this study, we evaluated arboreal mammal use of seven artificial canopy bridges in urban areas of the municipality of Alta Floresta, situated within a highly fragmented Amazonian landscape. Each bridge was monitored using a paired camera-trap system: one camera oriented toward the bridge to record crossing events and a second camera positioned toward the adjacent forest to capture approach and rejection responses by arboreal species. The monitoring was carried out over 12 months (October 2024 to October 2025), totaling 215,319 camera-trap days. Each canopy bridge integrated three structural design components within a single bridge to accommodate different locomotor strategies: (1) a lower two-dimensional bridge, (2) a middle one-dimensional bridge, and (3) an upper one-dimensional bridge. We recorded 9,894 crossing events involving 10 mammal species, representing four orders and eight families, including four threatened primate species. The central one-dimensional bridge accounted for 60% of the crossings. The mammals Alouatta puruensis, Aotus azarae, Ateles chamek, Caluromys philander, Coendou prehensilis, Mico schneideri, Plecturocebus grovesi, and Sapajus apella were more frequently recorded on the central bridge, whereas Didelphis marsupialis was more often detected on the lower bridge. Our findings demonstrate the effectiveness of artificial canopy bridges in facilitating safe crossings and highlight the importance of incorporating diverse structural designs to accommodate the ecological and behavioral variability of arboreal mammal species.

Designing Infrastructure for Ecological Connectivity

Tuesday 22 September · 14:00–16:00 · Castle Park B

ORAL PRESENTATION | DESIGNING INFRASTRUCTURE FOR ECOLOGICAL CONNECTIVITY

Road Infrastructure and Traffic Are Barriers to Wildlife Movement Across Highways

Lorna Haworth, Benjamin Hodgson, Fraser Shilling

UC Davis, United States

KEYWORDS
landscape connectivity, wildlife mortality assessment, cumulative impacts, barrier permeability, species behavioural response

One of the most direct impacts of roads on connectivity is through individual animal mortality caused by collisions with vehicles. Wildlife-vehicle collisions (WVC) are frequently used as a proxy for wildlife movement. In some cases, road design decisions that reduce human risk may inadvertently exacerbate negative effects of roads on connectivity. Median barriers (longitudinal barriers placed between opposing lanes of traffic) are installed to prevent collisions and improve human safety, yet little is known about their impacts on wildlife connectivity, or WVC at large extents. Medians vary in their permeability, where concrete barriers are the least permeable and no median is the most permeable to wildlife movement, therefore it should be expected that median characteristics and structure should have different effects on WVC rates. Medians present a tradeoff for wildlife movement; a more permeable median could be more conducive for wildlife travel across highways; however increased travel could lead to increased mortality from WVCs. Alternatively, a less permeable median could result in less mortality, but create a barrier effect that limits connectivity across populations if not properly mitigated.

WVC data from the California Roadkill Observation System (CROS) paired with simulated random points, median attributes collected from Google Street View, and other covariates (traffic volume, topography, predicted habitat, season, and distance to landcover) were used in generalized linear models (GLMs) to determine which factors increase WVC probability. Four median type groups were identified based upon permeability and built infrastructure; 1) no median, 2) vegetation and gravel, 3) guardrails comprised of cable, or metal beam guardrail, and 4) concrete. Three mammal species were evaluated ranging across a large spatial extent within California and body size: mule (or black-tailed) deer (Odocoileus hemionus), coyote (Canis latrans), and western gray squirrel (Sciurus griseus ; WGS). Body size allows species to visually interpret the view across roads; deer may be able to see over median structures whereas WGS may not.

For deer there was a consistently significant decreasing effect of WVC rates with the presence of any of the median barriers (cable, metal beam, and concrete). Coyote WVC was not significantly affected by median type, while WGS had negative significant effects for concrete and vegetated types, while guardrail had no significant effect. Other covariates of significance differed depending on the species, with similarities between mule deer and coyote as roadside fence barriers decreased WVC probability and elevation increased WVC probability. For mule deer season had an increasing effect during the fall and decreasing during the winter when compared to summer. For coyote season had a decreasing effect during the spring when compared to summer. WGS WVC probability had an increasing effect with slope steepness and predicted habitat suitability. Distances to landcover classes were different for each species, perhaps highlighting that species-specific ecology is important in understanding WVC probability.

The strongest covariate that significantly related to WVC across all three species was traffic volume. Mule deer and coyote exhibited a positively increasing relationship between increasing traffic volume and WVC probability. WGS WVC probability increased to about 30,105 vehicles/day before declining. To evaluate the additional barrier effect of traffic, we used average maximum animal travel speeds from scientific literature and calculated the percentage of the California State Highway System (SHS) that is a barrier to wildlife movement due to traffic. Of the approximate 48,527 km in the CA SHS, traffic volume and median barriers (in combination or separately) created a barrier effect on 32% of roads for mule deer, 48% for coyotes, and 56% for arboreal squirrels. This combination of median barrier presence and traffic volume presents a significant barrier to wildlife movement, varying in degree with animal type.

ORAL PRESENTATION | DESIGNING INFRASTRUCTURE FOR ECOLOGICAL CONNECTIVITY

Assessing multifunctionality of drainage culverts as biological passages for medium-sized mammals in Sweden

Rune Sørås, Jan-Olof Helldin

Swedish University of Agricultural Sciences, Swedish Biodiversity Centre, Sweden

KEYWORDS
retrofitting infrastructure, barrier permeability, species behavioural response, fauna passage design, monitoring

We will present the result of an empirical study that assesses the multifunctionality of drainage culverts (diameter < 2000 mm), and the extent to which they are utilized by animals as wildlife passages. Our work highlights how this type of mitigation can fit more then one purpose, as they can support reduced mortality and barrier effects, in addition to the intended drainage effect. We believe our work will further aid in the planning, implementation and retrofitting of culverts as a combined approach to fit usage as both wildlife passages and seasonal drainage culverts.

ORAL PRESENTATION | DESIGNING INFRASTRUCTURE FOR ECOLOGICAL CONNECTIVITY

What is the optimal length for wildlife fencing?

Michele Deis,
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KEYWORDS
retrofitting infrastructure, spatial planning, governance architecture, decision-making frameworks

Wildlife fencing can effectively reduce wildlife-vehicle collisions (WVC) on roads when properly installed. However, short fence sections may lead to mobile wildlife following the fence to its end, where they could cross, potentially creating new WVC hotspots. In contrast, fences extending for several kilometers lower the risk of wildlife following the fence to the end. Therefore, the IENE Handbook also recommends that wildlife fences are as sufficiently long as needed and seamlessly connected.

We examined suitable fence lengths for German national roads to prevent the displacement of WVC hotspots caused by insufficient fence sections. The following recommendations are made:

A: The wildlife fence should be extended seamlessly to a road overpass or underpass if the building is located within 300 meters of the immediate fence ends. If there is a road intersection within this radius, the wildlife fence should be extended 100 meters along it.

B: If no such building is within 300 meters, the fence lengths should take linear landscape features or forest-field boundaries into account which wildlife use when approaching the road. The wildlife fence should be extended at least 100 meters beyond the start of these feature.

C: If no building or landscape features exist within the 300-meter radius, the fence should be extended by an additional 200 meters at each end.

The appropriate fence length ultimately depends on local conditions along the WVC hotspot, and deviations from these recommendations should be considered on a case-by-case basis.

ORAL PRESENTATION | DESIGNING INFRASTRUCTURE FOR ECOLOGICAL CONNECTIVITY

From mitigation to nature-led infrastructure: lessons from HS2's Colne Valley Western Slopes

Matthew Hobbs, Chris Cantle

Align JV, United Kingdom

KEYWORDS
circular economy, ecological resilience, adaptive management, vision-led delivery, landscape-scale restoration

Major infrastructure projects are often judged by how effectively they mitigate ecological impacts. HS2's Colne Valley Western Slopes offers a wider proposition: that large construction projects can also create resilient, multifunctional landscapes that support nature recovery, climate adaptation, circular economy outcomes and social value.

This paper will present the design and delivery of the Colne Valley Western Slopes, a 127 ha landscape-scale habitat creation scheme being delivered by Align as part of the HS2 rail project. The scheme will create a mosaic of chalk grassland, wood pasture and wetland habitats by reusing site-won soils, substrates and construction materials from within one of the UK's largest construction sites. The project is well advanced and is expected to be largely complete by the end of 2026.

The paper will focus on how ecological ambition has been translated into practical infrastructure delivery. The project has been shaped by an integrated team of ecologists, landscape architects, soil specialists and engineers, working to a shared design vision and assurance process. This collaborative model has enabled design decisions to balance engineering requirements with long-term ecological function, landscape character, carbon reduction, access to nature and future management.

A central theme will be the use of evidence-led design to de-risk nature-based delivery at scale. The Western Slopes approach has been informed by foundational soils research, including a two-year chalk grassland research initiative with Cranfield University and Tim O'Hare Associates, laboratory and field trials of different soil profiles, dedicated on-site habitat creation trials, and wetland creation trials using chalk liners formed from tunnel arisings. The paper will explain how this research has informed construction methods for chalk grassland, wetland and woodland/scrub establishment, including the use of recycled concrete, construction aggregates and sub-optimal arable soils to create habitat-supporting substrates.

The project also demonstrates the role of circular economy thinking in resilient infrastructure. By retaining and reusing materials on site, the scheme reduces road haulage, waste treatment and imported material demand, while creating soil profiles designed to support target habitats over the long term. Replacing arable land and a former quarry with semi-natural habitats also creates opportunities for increased carbon sequestration and climate adaptation.

The Western Slopes has been designed not only as a habitat creation project, but as a long-term functioning landscape. Management will be based on adaptive techniques and natural processes, including free-roaming grazing animals and delivery by experienced conservation managers. Monitoring is already tracking the establishment of newly created habitats and the colonisation of notable plant, bird and invertebrate species. From 2026, grazing trials and expanded monitoring of soils and invertebrates are expected to further inform adaptive management and future restoration practice.

The paper will draw out transferable lessons for infrastructure planners, designers, contractors, clients and land managers. It will consider how the project has influenced wider HS2 delivery and infrastructure decision-making in the UK, and how similar approaches could be applied across future transport projects to deliver ecological connectivity, cost efficiencies, carbon benefits and more resilient landscapes.

By presenting the Western Slopes as an example of landscape-scale, evidence-led and collaboratively delivered habitat creation, the paper will contribute directly to IENE 2026's discussion of how nature can be embedded at the heart of resilient infrastructure — not as an afterthought or constraint, but as a core measure of infrastructure value.

ORAL PRESENTATION | DESIGNING INFRASTRUCTURE FOR ECOLOGICAL CONNECTIVITY

Pioneering Wildlife Impact Mitigation on a Federal Highway in the Pantanal, Brazil

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KEYWORDS
biodiversity loss, decision-making frameworks, monitoring, wildlife mortality assessment, before-after evaluation

The number of wildlife vehicle collision (WVC) studies has increased significantly worldwide. However, few studies provide effective mitigation plans. Here, we fill the knowledge gap by evaluating the seasonal spatiotemporal distribution of roadkill and the efficiency of 15 wildlife underpasses and associated fencing on wildlife mortality. Roadkill data were collected over six years along BR-262 highway (280 km) in the Pantanal–Cerrado ecotone in Mato Grosso do Sul, Brazil, supporting the development of a mitigation plan for wildlife–vehicle collisions, which can be scaled to other regions. Results identified 9,157 roadkilled individuals from 238 vertebrate species, including 17 species listed as threatened. Reptiles and mammals were the most frequent roadkill records, with Caiman yacare, followed by Dasypus novemcinctus and Cerdocyon thous, showing the highest numbers. Using a BACI design, roadkill of Caiman yacare was reduced by 70.4% in segments with long fences (≥ 3 km), while no significant results were observed for Cerdocyon thous and Hydrochoerus hydrochaeris. Aggregation analyses revealed 589 overlapping roadkill clusters. Our results support the implementation of 18 fenced sections, totaling 170 km of fencing when both sides of the highway are considered. The fenced segments will encompass 44 existing bridges and 22 underpasses (box and drainage culverts), 10 new wildlife underpasses, seven artificial canopy bridges, six speed traps, eight jump-outs, and 36 rumble strips. The mitigation plan represents a pioneering model for addressing WVC on highways in Pantanal and is expected to guide and inspire similar efforts in transport infrastructure planning.

ORAL PRESENTATION | DESIGNING INFRASTRUCTURE FOR ECOLOGICAL CONNECTIVITY

Landscape connectivity for rare mammals - Pine marten underpass and culvert use in the New Forest National Park.

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KEYWORDS
monitoring, before-after evaluation, retrofitting infrastructure, landscape connectivity, ecosystem function

Since 1999, 14 pine marten road traffic accidents have been found and recorded in the New Forest National Park, with an increase in frequency in the last 10 years. Particular areas along the A35 and A337, that have suitable habitat on either side of the road, have been identified as hotspots for road traffic accidents. Thus, a Before After Control Intervention (BACI) study was initiated by Forestry England and Wild New Forest Guided Tours in partnership with Animex International. Six locations (two underpasses, two culverts and two bridges) were selected for the study. To identify and monitor individual species activity inside and outside each structure, they had Browning Recon Force Elite HP4 trail cameras deployed; four cameras per structure, two at each entrance, one directed inside and one outside. Cameras were deployed on the 01/01/2026, set to record 20 second videos, with a one minute delay time and are in situ continuously. All wild species were recorded for this study. Animal detections were classified into four categories of crossing type - visit, full crossing, exploration and unknown passage. Similarly, to determine whether water depth impacted an individual's ability to use said structure, is has been classified into four categories - dry, dry patches, wet and inundated.

After several months of initial data collection to trial particular crossing points, official monitoring and data recording started in January of 2026. Within the first six months of camera deployment over 1,000 videos have been captured of a multitude of species. A total of nineteen pine marten records have been analysed, with only 26% of individuals successfully using the structure to safely cross under the road network. Furthermore, these data show that the martens will only cross under the road when water levels are low and dry areas are available for crossing. A further six months of data collection is necessary to better understand the ability of pine martens using these structures to cross the road network, yet these preliminary results indicate intervention is needed in certain hotspots across the New Forest. In the latter part of the year, Forestry England and Wild New Forest Guided Tours will be working with Animex International to undertake site surveys and make contact with planning authorities. If permissions are granted, there are hopes to install interventions, most likely mammal shelves, at three sites in spring 2027, to then repeat our trial camera deployment. This will then help us determine whether these interventions are more or less beneficial for pine marten connectivity across this unique landscape in the South of England.

Cumulative Impact Assessment in Pairing Transport Infrastructure: SYMBIOSIS Project Workshop

Tuesday 22 September · 14:00–16:00 · Ashton Court

ORAL PRESENTATION | CUMULATIVE IMPACT ASSESSMENT IN PAIRING TRANSPORT INFRASTRUCTURE: SYMBIOSIS PROJECT WORKSHOP

Towards defining biodiversity challenges and solutions in cumulative impact assessment in pairing linear transportation infrastructure in the framework of the EU-Rail SYMBIOSIS Project

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KEYWORDS
landscape connectivity, strategic defragmentation, irreversibility, ecological integrity at scale, barrier permeability

The expansion and increasing complexity of transportation networks represent a significant threat to ecological connectivity and, consequently, biodiversity at large spatial scales. Therefore, ensuring the functionality of ecological corridors and landscape connectivity in the face of this expansion is a critical priority for global biodiversity conservation. The challenges of cumulative impact assessment (CIA) in the context of paired or bundled linear transport infrastructure (LTI), is one focus of the EU-Funded Systemic Mobilisation for Joint Biodiversity and Infrastructure (SYMBIOSIS) project, a pioneering interdisciplinary initiative at the intersection of transport and biodiversity. CIA is challenging because the ecological effects of multiple, closely associated infrastructure corridors can interact across space and time in non-linear ways, making it difficult to disentangle individual impacts, identify thresholds, and predict their combined consequences for biodiversity.. Within this context, we propose an interactive session to explore the main challenges and solutions for CIA in cases of paired or bundled LTI in biodiversity-sensitive landscapes.

The session will consist of two 45-minute parts.

1. The first part will include a 20 minute presentation of SYMBIOSIS activities related to CIA and biodiversity. A draft framework of the project's results on CIA will be presented, based on: (a) a desk literature review on CIA in relation to biodiversity loss and ecological connectivity; and (b) a targeted questionnaire distributed to stakeholders from multiple sectors (including transport, environment, policymaking, economics, NGOs, etc.).

To support the interactive nature of the session and facilitate productive brainstorming, a summary of challenges and potential solutions will be presented across four categories identified during the project:

A. Ecological and Biological Challenges: issues related to understanding, measuring, and predicting ecological impacts.

B. Conceptual and Methodological Challenges: issues concerning underlying assumptions, analytical frameworks, and data limitations.

C. Spatial and Technical Planning Challenges: issues related to infrastructure design, spatial configuration, and assessment methods.

D. Governance and Stakeholder Challenges: issues involving management, coordination, and participation.

2. After the presentation, the first part will be completed with an open Q&A session, discussion, and brainstorming on CIA and LTI, as well as with practical instructions for the group work of the second part.The second part will involve group work, during which participants will identify key biodiversity challenges and propose practical solutions to improve CIA approaches in transportation infrastructure contexts. An interactive exercise will be conducted to explore specific challenges within the four categories above, focusing on different combinations of linear transport infrastructure (LTI), such as:

- Road - Railway
- Road – Road (e.g., Motorway – parallel regional road)
- Road - Powerlines

- Railway – Powerlines
- Bundling more than two LTI.

This part of the session will include the formation of small working groups, each focusing on a specific pair of LTIs in which the participants have experience. Each group will discuss and identify the challenges encountered in each of the four categories during the implementation of the project. The discussions and teamwork will be guided by a structured questionnaire on CIA and LTI. Participants at the workshop will benefit from the shared knowledge generated by the discussions and the questionnaire, hopefully inspiring ideas that can be taken back to their organisations. The data generated by the questionnaire and the discussions of the interactive session will be used as complementary and important input in the final SYMBIOSIS project deliverable with the title “Recommendations on environmental impact assessment of the cumulative effects of pairing infrastructure development”.

Planning Connected Landscapes

Thursday 24 September · 11:00–13:00 · Greville Smyth Park

ORAL PRESENTATION | PLANNING CONNECTED LANDSCAPES

The Revised Austrian Directive on Wildlife Habitat Connectivity – General public interest as the driving force for habitat connectivity until 2040

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KEYWORDS
ecological and social values, biodiversity loss, landscape connectivity, infrastructure coherence, strategic defragmentation

Background and Achievements

The original Austrian directive on "Wildlife Habitat Connectivity" (BMVIT, 2006) came into effect with the ambitious goal of mitigating progressive habitat fragmentation caused by the construction and expansion of major transport infrastructure. A central pillar of this strategy was the mandatory construction of 18 strategically placed green bridges (wildlife crossings) to secure essential wildlife corridors. However, the historical track record after more than two decades is underwhelming: to date, only five of the twenty proposed green bridges have been realized . The main causes for this implementation deficit lie in massive competition for land use, a lack of legal enforcement instruments, and persistent conflicts of use with local landowners.

Root Cause Analysis and Spatial Planning Deficits

The faltering implementation highlights a systemic problem: The issue of habitat connectivity is still insufficiently considered and legally underweighted in both regional and local spatial planning . Over the past 20 years, massive and dramatic landscape interventions have occurred at many of the sites originally designated for green bridges. Sprawling settlement development, the large-scale zoning of open spaces for alternative energy infrastructure (such as photovoltaics and wind power), as well as new commercial and industrial sites, have established a significant disturbance regime along the historically planned corridors. These developments have drastically increased the barrier effect within the landscape and illustrate the spatial planning failures of recent decades.

The New Directive: Public Interest at the Core

To counteract the impending loss of ecological permeability in Austria, the outlook envisions a comprehensive revision of the Directive with an implementation horizon extending to 2040. The conceptual core and absolute guiding principle of this new edition is a radical paradigm shift: The plan is to declare the functional connectivity of habitats a matter of paramount public interest. The protection of biodiversity and intact ecosystems must evolve from a minor compromise into a fundamental societal imperative. Based on this guiding principle, a critical re-evaluation of the 13 pending locations regarding their feasibility is being conducted. This will be accompanied by specific measures that are to be incorporated into federal and state spatial planning laws as well as into sector-specific legislation on a mandatory basis in the future

Legal Safeguarding and the Instrument of Expropriation Because the public interest in an intact natural landscape will take center stage in the future, it must also be consistently enforceable by law. The new Directive therefore does not shy away from drastically tightening the legal leverage: It explicitly anchors the possibility of an expropriation title (compulsory purchase) for land parcels that are strictly necessary for the construction of green bridges and their guiding structures. Until now, projects have often failed due to the veto of individual landowners. The legal anchoring of the expropriation option corrects this imbalance in favor of the common good. Primarily, this title serves to significantly strengthen the negotiating position of project developers to reach viable compromises with landowners more quickly. However, should the negotiation process be blocked, the execution of expropriation represents the consistent ultima ratio to ensure that the overriding public interest in habitat connectivity is no longer jeopardized by individual interests. Nevertheless, past experience has shown that many conflicts of interest can be prevented from the outset by transparently sharing information and proactively engaging the local population , municipal mayors , and the hunting community. Ultimately, ensuring a high level of public acceptance is a vital success factor for the efficient and sustainable long-term functionality of constructed green bridges."

The text also discusses measures to protect the corridor routes around the green bridges. The Austrian Guidelines RVS 04.03.12 'Wildlife Protection' (FSV, 2007) provides one approach. It identifies specific land uses near green bridges that cause high disturbance and reduce their functionality . Furthermore, the ministry commissioned a guideline to assess the ecological permeability of these corridors (Applying this guideline would ensure the green bridges work as intended.) This guideline serves as a crucial instrument and has already been successfully utilized in several federal states to define minimum standards, such as the minimum widths for local, regional, and supra-regional wildlife corridors. However, neither document is legally binding at present (except the guideline ‘Wildlife Protection’ for the motorway operator Asfinag). Within the revision procedure of Austrian directive on "Wildlife Habitat Connectivity" the ministry is currently evaluating whether and how to make these guidelines (or their specific content) legally binding.

Case studies

Drawing on illustrative case studies , the diverse land-use conflicts and the immense spatial pressure at various proposed green bridge locations are demonstrated . Furthermore, the text outlines the new established cooperative planning processes at sites where both high-capacity road networks and high-speed railway lines necessitate structural mitigation measures to safeguard corridor functionality. These collaborative efforts were facilitated and underpinned by a Memorandum of Understanding on securing habitat corridors, established between the Austrian federal railway and the Austrian motorway operator, as well as the ministry.

Conclusion

To address the practical effectiveness of these measures, it should be noted that the revised guideline builds upon 20 years of comprehensive experience gained from green bridge retrofitting projects. Additionally, the focus on legal frameworks is supported by a detailed legal evaluation , which confirmed the feasibility of applying the expropriation clause specifically to green bridge infrastructure.

The revised Austrian Directive on "Wildlife Habitat Connectivity" thus marks a historical turning point: Through the clear prioritization of the general public interest and the accompanying provision of strict legal instruments —up to and including expropriation—wildlife protection transforms from a toothless declaration of intent into a robust, enforceable pillar of Austrian infrastructure and landscape planning up to 2040. Ultimately, the clear and proactive communication of this guideline will be a major determinant of its success . Ensuring that all involved parties fully understand its goals and practical implications is key to fostering widespread acceptance and seamless implementation.

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ORAL PRESENTATION | PLANNING CONNECTED LANDSCAPES

Ecological network modelling: a method to identify structures that support improvements in ecological connectivity. The case study of the Nantes–Le Mans railway line, France.

Laura Clevenot[1,2], **Emma Drancourt**[1,3], **Hippolyte Pouchelle**[4]

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KEYWORDS
decision-support modelling, barrier permeability, landscape connectivity, before-after evaluation, fauna passage design

On the French rail network, collisions between trains and wildlife have increased significantly in recent years. For SNCF Réseau, the national infrastructure manager, there is therefore an urgent need to reduce these incidents while ensuring an acceptable level of ecological connectivity across the network. This study addresses this challenge.

SNCF Réseau aims to improve the functionality of existing structures on the national rail network and has therefore developed a method to identify existing engineering structures that were not originally designed for wildlife but are located in areas with a high potential need for animal crossings. The first step is to identify structurally functional infrastructures - those offering sufficient clearance for animals to pass through- with selection criteria adapted to target special species such as deer, wild boar, fox and hedgehog. The study then evaluates the ecological connectivity of the surrounding landscape using landscape graph-based modeling (Graphab software), assigning each structure a connectivity value to determine its suitability for wildlife. To prioritise landscaping adaptation works, the study again uses ecological graphs to assess how structural improvements affect overall connectivity. Selected structures are monitored using video surveillance at different stages: before and after the section is fenced off, and then following any adaptation works, in order to assess changes in wildlife use.

Based on the thesis work of Tess Heydorff-Decaux, which draws on ecological network modelling, this approach aims to prioritise the structures most suitable for wildlife-friendly adaptation. The aim is to evaluate whether ecological network modelling can serve as an effective prioritisation tool for selecting structures to be adapted. The presentation will focus on the Nantes–Angers–Le Mans railway line where a project to fully fence the line required maintaining an acceptable level of ecological connectivity. As part of this project, all modelling stages have been conducted and camera monitoring has been ongoing on the selected structures for the past year.

ORAL PRESENTATION | PLANNING CONNECTED LANDSCAPES

Restoring ecological continuities on regional transportation infrastructures in France : Complementarity between the Cerema's GIS expertise, the transportation networks operators knowledge and the Government priority given to biodiversity.

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Cerema Centre-Est, France

KEYWORDS
biodiversity loss, decision-support modelling, wildlife mortality assessment, retrofitting infrastructure, landscape-scale restoration

In France, State action to restore ecological connectivity is set by National Biodiversity Strategy 2030. Consequently, a specific government measure on ecological connectivity is titled "reinforcement of the actions towards ecological continuities and the erasing of obstacles."

Thanks to its experts in biodiversity, transport infrastructures, geomatics and data, Cerema was tasked by State services to identify breaks in ecological connectivity, called priority "black spots," at the regional scale using the national methodology also developed by Cerema.

In the national work, the methodology was designed and deployed on motorway-type infrastructures.

In our regional study, we included roads with an Average Annual Daily Traffic greater than 7,500 (seven thousand five hundred) vehicles, where traffic impacts on wildlife are already highly significant.

This regional work was only possible thanks to the mobilization of an unprecedented national database of annual average daily traffic that we constructed in another context to meet the objectives of the European Environmental Noise Directive.

By adapting the national black-spot methodology to our regional network, we were also able to address local service roads, departmental and regional roads. We then exploited our mapping of road sections that are particularly prone to wildlife–vehicle collisions, derived from our interoperable regional killroad database to which all infrastructure managers and nature protection associations contribute. This novel regional approach allowed us to supplement the national method with an approach centered on wildlife collisions.

The road sections that are most impermeable to wildlife movement were crossed with data on biodiversity reservoirs and ecological corridors to identify black spots at the regional scale.

The Cerema is in charge of implementing this action to the regional level through a participatory approach including a wide range of stakeholders : transportation network operators, environmental NGOs, hunting associations, State and local authorities (mainly "departments"). The objectives of these workshops are to identify the spots where terrestrial ecological continuity is interrupted and to prioritize the places where infrastructures are to be built in order to restore the ecological corridors

Moreover, the flagship species Lynx lynx, which represents very high conservation stakes and is particularly vulnerable to roadkills, was also considered in the workshops. Strategic black spots for this species did not appear from the national or regional geomatic analysis alone, and were therefore elevated to the forefront of priorities.

Our results can be used in three complementary ways

To steer State funding toward high-added-value operations for restoring ecological connectivity,

To inform infrastructure managers about the stakes on their network so that they undertake defragmentation works, potentially co-funded by the State,

To support State services in identifying sensitive areas for ecological connectivity in authorization procedures for new projects, plans and programs, so as not to degrade existing or already restored ecological connectivity.

Our work is deployed across two French administrative regions that present high ecological connectivity stakes: Auvergne-Rhône-Alpes and Bourgogne-Franche-Comté, representing 22% of France's territory. This study is financially supported by the State and by the two Regions concerned.

ORAL PRESENTATION | PLANNING CONNECTED LANDSCAPES

Motorway fringes under ecological transition policies: integration into spatial planning

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KEYWORDS
social–ecological systems, ecological resilience, spatial planning, governance architecture, long-term resilience

Long considered as purely technical spaces, motorway surroundings are now emerging as strategic areas in the context of public policies for ecological transition.

Motorway dependencies, whether vegetated or not, belong to the infrastructural system and are defined by specific regimes of ownership and management. Supporting the primary function of highways as mobility corridors, they fulfil technical roles such as soil stabilization, water management, noise mitigation, and safety, and typically extend 10 to 15 meters on either side of the roadway. At their intersection with surrounding territories, these spaces form intermediate zones between high-speed infrastructure and the urban fabric, referred to as infrastructural fringes or edges (Bonin et al., 2015).

In the context of ecological transition policies, motorways are no longer viewed solely as transport infrastructures but increasingly as potential supports for territorial resilience, integrating objectives such as greening, de-artificialization, and energy production (notably through solarization).The research describes this evolution as a process of diversification, whereby infrastructures originally designed to ensure the movement of people and goods are progressively expected to support additional functions.

At the same time, despite their significant presence and their role in shaping such fringes, these spaces remain largely marginal to spatial planning (Mayeur, 2024). They fall under two distinct spheres of action: the “road sector” and the “planning sector.” The first tends to operate relatively autonomously, more in parallel than in synergy with territorial dynamics, often justified by safety considerations (Espinasse, 2026). This shift raises questions about the concrete modalities of transformation of these spaces and their integration into territorial strategies.

Empirical observations conducted in the Bordeaux metropolitan area and the Ile-de-France region (France) reveal overlapping intervention perimeters and difficulties in articulating infrastructural and territorial logics. More broadly, they highlight a limited integration between road management strategies and spatial planning policies, particularly regarding ecological continuity. Actions remain largely focused on the roadway and its immediate surroundings, with no systematic articulation with planning documents or ecological strategies, although these interactions vary depending on local contexts. The criteria guiding the allocation of parcels located along motorways remain poorly defined. They appear to combine opportunistic logics with more stabilized criteria (economic profitability, technical constraints, land surface, ecological quality, soil characteristics and pollution). Moreover, competing uses are emerging among road actors regarding the future of these spaces (Espinasse, 2026).

This research aims to characterise motorway fringes through their ecological dimension and to examine how this dimension is understood, framed, and incorporated by different stakeholders. Particular attention is paid to the interactions between road infrastructure managers, territorial planning authorities, and researchers, and to the ways in which ecological considerations influence the governance of these spaces. The research investigates the criteria guiding land-use decisions along motorways and the conditions under which infrastructural and territorial perspectives converge or diverge in the implementation of ecological transition policies.

Building on these objectives, the paper provides a structured review of the existing literature and practical initiatives concerning the ecological functions of motorway fringes and their integration into public policies. By bringing together contributions from the fields of transport infrastructure, spatial planning, and ecological governance, it identifies the main conceptual approaches, institutional frameworks, and operational practices that have emerged. In doing so, the paper highlights current knowledge gaps and discusses the governance challenges associated with the articulation of road infrastructure management and broader territorial and ecological planning strategies.

This research is a postdoctoral research (2026–2027) is part of the TransNat project (“Transforming transport infrastructures in dense urban contexts: rethinking renaturation?”), conducted within the ITTECOP programme. It is based on the hypothesis that ecological transition policies do not necessarily lead to the disappearance of highways, but rather to their func-

tional and ecological reconfiguration. At the European scale, it investigates whether models of management and integration of motorway fringes can be identified, and whether converging trends emerge across practices and representations. The European perspective is particularly relevant for analysing the circulation of urban and environmental policy models(Kennedy, 2016), which contribute to redefining the functions and meanings of these spaces.

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ORAL PRESENTATION | PLANNING CONNECTED LANDSCAPES

From Fragmentation to Function: Mobilising Evidence to Retrofit Transport Networks for Landscape-Scale Wildlife Connectivity.

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KEYWORDS
landscape connectivity, retrofitting infrastructure, ecological integrity at scale, strategic defragmentation, cross-boundary coordination

Transport infrastructure is one of the most pervasive drivers of habitat fragmentation in the UK, acting cumulatively across landscapes to restrict movement, increase mortality, degrade habitat quality and undermine long-term population viability. While the urgency of restoring ecological connectivity is widely acknowledged, responses often remain site-specific, opportunistic, or insufficiently evidence led. The Mobilising Nature – Tackling Transport Severance programme led by the West of England Nature Partnership addresses this challenge by shifting focus from individual mitigation structures installed on an ad-hoc basis to a strategic, region-wide approach that combines empirical monitoring, spatial analysis, and governance innovation to deliver connectivity at scale.

This contribution presents findings from a multi-year programme (still ongoing) assessing transport severance and nature connectivity infrastructure (NCI) across South Gloucestershire and the wider West of England. Covering nearly 1,000 miles of road, including motorways, and local highways, the work integrates desk-based GIS assessment with field surveys, rapid appraisal tools, and targeted camera trapping to evaluate existing crossing structures and their effectiveness for wildlife movement. To date, 100s of human-designed crossing points (bridges, subways, culverts and tunnels) and 25 purpose-built wildlife structures have been mapped and categorised according to their likelihood of use by different taxa.

Empirical monitoring demonstrates that not all crossing structures deliver connectivity. Results show marked differences in wildlife use between fully aquatic culverts, mixed-use structures, and unlit, low-disturbance bridges, with dry ledges, vegetation context and human disturbance emerging as key determinants of effectiveness. Camera trapping evidence confirms use of adapted infrastructure by a range of species including deer, fox, badger, small mammals and birds, while also identifying widespread underperformance of drainage-led culverts commonly assumed to provide permeability. These findings reinforce the need for species-appropriate design and long-term monitoring rather than reliance on assumed functionality.

Crucially, the programme translates evidence into action through a prioritisation framework that identifies high-, medium- and low-likelihood opportunities for retrofitting existing infrastructure. Ninety-three high-likelihood retrofitting sites have already been identified, forming a pipeline of deliverable projects aligned with the Local Nature Recovery Strategy. This approach should enable rapid but evidence-guided intervention, avoiding piecemeal delivery while responding to funding and policy windows.

The work also demonstrates how connectivity planning can operate beyond site boundaries, linking transport mitigation to invasive species management, road verge design, drainage upgrades, lighting strategies and biodiversity net gain delivery. By embedding nature connectivity into highways governance, maintenance regimes and future design standards, the programme will reframe mitigation from a compensatory afterthought to a core infrastructure function.

This case study shows how actionable knowledge can be generated through integrated monitoring, cross-sector collaboration and spatial prioritisation, providing a replicable model for regions seeking to restore ecological function across fragmented landscapes. As climate change intensifies pressures on both infrastructure and wildlife, evidence-led retrofitting of existing networks represents one of the most immediate and scalable routes to reconnect nature at landscape scale.

Monitoring, Mapping & Predicting Wildlife Risk

Thursday 24 September · 11:00–13:00 · Eastville Park

ORAL PRESENTATION | MONITORING, MAPPING & PREDICTING WILDLIFE RISK

Wildlife Step Counters: Accuracy and Limits of Dead Reckoning in Simulated Ungulate Movement Near Transportation Infrastructure

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CDV Transport Research Centre, Czechia

KEYWORDS
monitoring, evidence-based mitigation, wildlife mortality assessment, decision-support modelling, species behavioural response

While GPS telemetry remains the standard for tracking ungulates, battery constraints limit GPS frequency and reduce the accuracy of reconstructed trajectories. Dead reckoning, integrating an inertial measurement unit, offers a promising methodological advancement, yet its performance in ungulate tracking remains insufficiently quantified.

We present a simulation-based framework to assess the accuracy and limitations of dead reckoning for reconstructing ungulate movement near transportation infrastructure, evaluating the influence of GPS frequency and accelerometer error on the reconstruction error and, subsequently, the road crossing localization error. Our three-stage approach combined (1) generating ungulate trajectories using an animal movement model, (2) controlled subsampling of GPS fixes at varying intervals to simulate varying GPS frequency, and (3) reconstructing ungulate trajectories using dead reckoning. As a benchmark, the trajectory reconstruction was also performed using a linear interpolation between GPS fixes. Reconstruction accuracy was evaluated using the Euclidean distance between the original and reconstructed trajectories.

Our results demonstrate that dead reckoning consistently improves trajectory reconstruction when compared to the linear interpolation. Its performance is strongly influenced by GPS sampling frequency and error propagation of the accelerometer measurements. These findings highlight bot the potential and constraints of integrating inertial data into ungulate monitoring.

Reconstructing ungulate trajectories at finer spatial detail enables better understanding of behavioural response to infrastructure, particularly for evaluating the effectiveness of wildlife-vehicle-collision mitigation measures. While dead reckoning shows clear promise, its practical application requires careful consideration of its limitations. Future research should focus on validating our results with field-based data from real-world conditions.

ORAL PRESENTATION | MONITORING, MAPPING & PREDICTING WILDLIFE RISK

From silent roads to risk maps: A predictive screening framework for wildlife-vehicle interactions in Romania

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KEYWORDS
biodiversity loss, landscape connectivity, monitoring, wildlife mortality assessment, species behavioural response

Roadkill data are widely used to identify collision hotspots and guide mitigation. In Romania, however, such data are largely opportunistic and spatially biased toward accessible and populated areas, creating a “silent road” problem in which absence of records may be misinterpreted as absence of impact.

This study presents a bias-aware predictive framework that shifts the focus from carcass mapping to the identification of potential animal–road interaction zones. Using a national dataset of over 3,000 opportunistic records, a used-versus-available design is implemented through logistic regression modelling, comparing observed locations with randomly sampled road segments. The model relates the probability of recorded wildlife–vehicle events to landscape and infrastructure variables—including proximity to forests, rivers and ecological corridors, terrain characteristics, and road class—while explicitly incorporating proxies for reporting bias (e.g. settlement proximity and accessibility).

Rather than estimating mortality rates directly, the approach derives a landscape–infrastructure signature associated with wildlife movement intersecting roads under uneven detection conditions. This signature is projected across the national road network to generate continuous risk surfaces, including in areas with limited or no observational data.

The resulting maps provide a screening-level tool to support targeted monitoring, prioritisation of mitigation measures, and the integration of collision risk into transport planning and environmental impact assessment in data-poor contexts.

ORAL PRESENTATION | MONITORING, MAPPING & PREDICTING WILDLIFE RISK

Estimating Annual Large Mammal Roadkill at Large Extents

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KEYWORDS
evaluation, monitoring, wildlife mortality assessment, cumulative impacts, uncertainty

Wildlife-vehicle collisions (WVC) represent the most taxonomically and spatially pervasive source of direct mortality for ground-dwelling vertebrates, yet population-level consequences remain poorly quantified at regional and national scales. WVC rates generally increase as traffic volumes increase to moderate levels, after which rates plateau or decline. Despite the well-documented prevalence of WVC, there are no published quantitative estimates of total annual mortality over large areas that could inform population management as hunting, disease, depredation, and WVC all impact demography. This gap may limit transportation agencies' effective evaluation of the effects caused by roads on populations leading to inadequate mitigation.

We describe and apply a detection-corrected estimation framework for total annual WVC in California for four large mammal species: mule (or black-tailed) deer (Odocoileus hemionus), puma (Puma concolor), black bear (Ursus americanus), and elk (Cervus canadensis). Using systematically recorded WVC data from 2016-2024 (n=30,370 incidents for all four species), we adapted the USGS GenEst binomial modelling framework (Dalthorp et al. 2018) to account for imperfect detection of WVC carcasses and provide estimated total annual WVC mortality for each species. Model parameters consisted of two detection components: the probability of observing a carcass given search effort and searcher efficiency, and the probability of carcass presence at the time of observation given carcass persistence rates and post-collision displacement. Search effort was derived from California Highway Patrol WVC records, which provided systematic coverage of the California State Highway System at a frequency of at least once per day. Remaining parameters were determined from other datasets and published literature, and sensitivity analyses using conservative bounds were conducted to evaluate uncertainty and the effect on model output.

Based upon the 2016-2024 data, we estimated that 44,355 (+/-5,617) mule deer, 470 (+/-299) pumas, 1,761 (+/-581) black bears, and 298 (+/-92) elk were killed per year on paved roads – representing at least 9.5%, 17.1%, 2.9%, and 2.3% of the current official California Department of Fish and Wildlife statewide population estimates, respectively. These population-level impacts suggest WVC apply potentially unsustainable pressure on large mammal species persistence. Quantified human-induced mortality for species could be useful to incorporate into future analyses, as mortality is just one element in species demography. This method to estimate total WVC mortality can be applied to other regions where systematic WVC reporting exists, especially as quantitative estimates aid in prioritizing policy, conservation, and mitigation efforts.

ORAL PRESENTATION | MONITORING, MAPPING & PREDICTING WILDLIFE RISK

Bridging the Gap: Four Years of Spatial-Temporal Roadkill Data Guiding Infrastructure Mitigation in Southern Brazil

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KEYWORDS
spatial planning, strategic defragmentation, wildlife mortality assessment, monitoring, landscape connectivity

Road networks in managed landscapes reduce functional connectivity and increase wildlife mortality. Implementing effective mitigation requires robust, longitudinal empirical data. This study presents the outcomes of a comprehensive four-year systematic roadkill monitoring program covering approximately 2,000 kilometres of roads within a fragmented forestry and agricultural matrix in southern Brazil. The primary objective of this extensive longitudinal assessment is to inform targeted infrastructure interventions and roadkill mitigation. Based on over 5,500 vertebrate fatalities (over 48-month period), we applied Spatial-Temporal Kernel Density Estimation (STKDE+) to pinpoint persistent mortality hotspots. Concurrently, high-resolution landscape metrics were utilized to determine the environmental drivers of wildlife-vehicle collisions. The spatial-temporal modelling identified high-risk zones that remained stable throughout the four years, providing a technical baseline for deploying terrestrial underpasses and wildlife fencing for different animal groups. To restore canopy connectivity, we conducted a specialized analysis focused on the brown howler monkey (Alouatta guariba clamitans), a species strictly dependent on connected forests and listed as "Vulnerable" on the IUCN Red List. By evaluating forest fragments adjacent to the road network, we systematically prioritized structural gaps under 30 meters that separate large, ecologically significant forest patches. This data-driven approach supports the strategic placement of artificial canopy bridges and terrestrial mitigation structures where they can most effectively reconnect isolated habitats. Ultimately, this four-year scientific assessment demonstrates how continuous monitoring and spatial intelligence are essential to optimize resources, reduce road mortality, restore landscape permeability in human-modified environments and ensure biodiversity conservation.

ORAL PRESENTATION | MONITORING, MAPPING & PREDICTING WILDLIFE RISK

Operationalising biodiversity monitoring on railway networks through passive acoustics, earth observation and integrated data workflows

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KEYWORDS
artificial intelligence applications, scaling pathways, landscape connectivity, adaptive management, monitoring

Railway networks extend for thousands of kilometres across diverse ecological habitats in Europe, with significant expansion expected as the transport sector moves towards net-zero carbon. While the impacts of railways on wildlife can be highly detrimental for many species through habitat fragmentation and the risk of collisions with trains, the ecological role of railway verges as habitats and corridors for plants, invertebrates and vertebrates remains poorly understood. These linear features can support diverse communities and, in some landscapes, are among the last remaining areas providing semi-natural habitats and functional corridors for biodiversity. Yet the contribution of these linear structures to biodiversity is rarely quantified or systematically monitored, hindering their valuation and integrated management to deliver nature-positive outcomes.

Biodiversity monitoring is increasingly expected of transport infrastructure operators, yet it remains inconsistently implemented in practice. A survey of European railway operators conducted under the EU-funded SYMBIOSIS project found that only about half undertake formal monitoring of habitat (58%) or biodiversity (50%). Monitoring is mainly constrained by limited internal expertise and cost, and driven largely by regulatory compliance rather than by operational needs such as infrastructure resilience, safety and planning. These barriers mean monitoring programmes and their data are poorly integrated into planning and day-to-day asset management. Addressing them requires standardised, resource-efficient methods that lower the expertise threshold and can be seamlessly integrated into existing management systems. To this end, this work demonstrates a monitoring framework that combines landscape-scale remote sensing of habitats with automated in situ sensors, principally passive acoustics, to monitor and measure species-level biodiversity. Both streams are brought together through an integrated field-management system and a cloud-based data-processing pipeline that is readily transferable to local infrastructure where required.

At the landscape scale, earth observation (EO), including high-resolution optical imagery, multispectral data and airborne LiDAR, provides scalable, repeatable habitat mapping across extensive linear networks at a fraction of the cost of traditional field surveys. When processed through rigorous, scientifically robust workflows that incorporate AI-assisted classification, these data streamline the detection of habitat change and invasive species, as well as the characterisation of vegetation structure, above-ground biomass (carbon stocks) and landscape connectivity. Designed for interoperability, this approach integrates data across scales within a unified system and reuses the substantial EO and survey datasets that many operators and third parties already hold for planning and engineering but rarely exploit for ecological analysis.

At the site level, ground-based automated monitoring provides biodiversity surveillance that EO cannot deliver, resolving the species-level detail behind the habitat map. In situ sensors such as passive acoustics enable non-invasive, year-round detection of vocalising wildlife, focusing on birds and bats as tractable, well-characterised indicator groups, at substantially lower person-hour cost than traditional field surveys. Operationalising such monitoring at network scale depends less on the sensors themselves than on how they are deployed and how the resulting data are processed, validated and used. An integrated field-management system and a dedicated data-processing pipeline take recordings from deployment through to validated species-level classification, embedding acoustic classifiers within a workflow that standardises collection, processing and quality control across sites. Beyond automating detection, a rigorous and fully integrated framework allows biodiversity monitoring to be organised, managed and overseen from a single centralised system. The framework centralises specialist expertise through validated classifiers and auditable quality-control procedures, rather than requiring equivalent expertise at every deployment site. This retains scientific oversight while making monitoring practical at scale. Looking ahead, such a centralised system offers a foundation for prioritising effort and distributing available resources across a network where they are most needed.

Translating this potential into operational practice requires rigorous field testing in real railway environments. Ongoing pilots in the UK, Spain and Portugal, running since May 2026 across diverse railway settings, are evaluating the integrated framework: landscape-scale earth observation and in situ automated sensors, brought together within a management system and data-

processing pipeline. The pilots use a bespoke GIS platform for field data capture, monitoring and dissemination linked to centralised storage, computing and classification, while retaining the option of local deployment where operational or data-governance constraints require it. Rather than testing each technology in isolation, the pilots assess their full integration across three countries, deliberately stress-testing the framework against diverse habitats, species pools and operating conditions, even though operational deployment would most likely sit at the national scale within a single operator's network. Alongside technical feasibility, the pilots are documenting the real-world costs of deployment and operation and surfacing the logistical, organisational and data-management challenges that must be resolved before large-scale deployment across national networks.

The transformative opportunity lies in extending the integration demonstrated in these pilots further into asset management systems. The same integrated field-management and data-processing pipeline that delivers validated, species-level data for the target groups can feed directly into the Geographic Information Systems (GIS) and Building Information Modelling (BIM) environments operators already use, where, combined with ecological models, it can inform maintenance scheduling, identify wildlife corridors, flag collision-risk hotspots, guide habitat restoration and support climate-resilience planning. Crucially, a standardised pipeline also enables standardised outputs: multispecies biodiversity indicators, built from consistent species-level data, that can be tracked over time and compared across sites, operators and sectors. The sector's existing reliance on centralised data storage and cross-departmental sharing offers a solid foundation to build on.

Realised at scale, standardised indicators of this kind would enable operators to report against biodiversity policy frameworks and targets using direct, repeatable measurements rather than unstandardised surveys, and to track progress over time. Technology and data alone, however, will not deliver this. It requires a genuine shift in institutional ambition from compliance-driven monitoring to evidence-based stewardship: embedding biodiversity as a core operational function, building in-house capacity, and adopting shared standards and accessible tools. This shift depends on sustained collaboration between ecological experts, engineers, asset managers and operators to co-design procedures that are scientifically robust, practically deployable and embedded in existing workflows. An integrated framework that couples standardised field protocols, automated classification and centralised data management within the systems operators already run makes this shift achievable and turns biodiversity data into a fully integrated, decision-ready output, enabling the sector to act as an active steward of biodiversity and to demonstrate tangible progress in protecting nature to regulators, investors and the public.

ORAL PRESENTATION | MONITORING, MAPPING & PREDICTING WILDLIFE RISK

Global effects of roadkill on carnivore persistence over the next 50 Years

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KEYWORDS
population viability analysis

Roads expose carnivores to vehicle collisions, yet the long-term demographic consequences of this mortality remain poorly understood. A global systematic review of road monitoring studies shows that carnivore species are consistently affected by roadkill, but few studies have evaluated whether observed mortality rates are sufficient to influence population persistence.

Here, we used the spatially explicit population model mortalityRISK to predict the effects of empirically observed roadkill rates on carnivore populations over the next 50 years. We compiled a global dataset from 163 systematic road surveys conducted between 2000 and 2024, documenting carnivore–vehicle collisions across 115 species. Roadkill rates were standardized by survey effort, and species-level demographic parameters were primarily obtained from open-access trait databases, including PanTHERIA, TetraDENSITY, Amniote, and Animal Diversity Web. Simulations were conducted across species' IUCN distribution ranges at 50x50km resolution, while explicitly accounting for the current global road network.

Most carnivore species were predicted to experience only limited population declines due to road mortality alone, generally below 1% over 50 years. However, two felids showed substantially greater sensitivity: the leopard (Panthera pardus) and the European wildcat (Felis silvestris) were predicted to decline by approximately 25% and 6%, respectively. We further identified mortality thresholds above which roadkill accelerates population decline. For the most sensitive species, these thresholds corresponded to road-related mortality affecting fewer than 15% of the total population. Although currently observed roadkill rates generally remain below these thresholds, caution is warranted. Our models consider road mortality alone and do not incorporate other sources of mortality, such as human persecution, habitat loss, or additional anthropogenic pressures. When combined, these threats are likely to interact synergistically, potentially amplifying population declines and increasing long-term extinction risk beyond the effects of road mortality alone.

Evaluating Ecological Impacts of Infrastructure

Thursday 24 September · 11:00–13:00 · Castle Park B

ORAL PRESENTATION | EVALUATING ECOLOGICAL IMPACTS OF INFRASTRUCTURE

Lack of a statistically significant effect of a new road and bridge on woodland birds

Rodney van der Ree

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KEYWORDS
ecological and social values, biodiversity loss, evaluation, before-after evaluation, evidence-based mitigation

The new road and bridges for the Echuca-Moama Bridge Project which spans the Murray River in south-east Australia passed through habitat of the threatened Victorian Temperate Woodland Bird Community (VTWBC). The population-level goal was for no reduction of >25% in detection rate (>80% confidence) of VTWBC species >100 m from the Project. To assess this, a sampling grid comprising 79 fixed monitoring points spaced approximately 200 m apart were established at the Project (impact) site and at two control sites (1.5 and 8 km away). All birds seen within a 5-minute period within a 50-m radius of each monitoring point were recorded. Bird surveys were undertaken in autumn/winter and spring/summer in 2019 (baseline), 2020 and 2021 (during construction), and 2022, 2023 and 2024 (post construction). Between 3,223 and 4,004 birds were observed annually at the 79 monitoring points over the six-year period, with the average of 11.9 and 12.0 birds seen at each monitoring point in 2019 and 2024. There was a 16% increase in the total number of detections of core VTWBC species at the Impact Site in 2024 compared to 2019, which equated to a relative decline of 57% once the increase at control sites were taken into account. However, the statistical significance of this result is less than the 80% threshold set for the Project, which means that there is insufficient certainty to attribute this result to the Project. The implications of these results for the Project and monitoring programs in general will be discussed.

ORAL PRESENTATION | EVALUATING ECOLOGICAL IMPACTS OF INFRASTRUCTURE

Development of an indicator for plant biodiversity monitoring under powerlines

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KEYWORDS
evaluation, participatory foresight, monitoring

Powerlines are linear transportation infrastructures essential worldwide to provide electricity to populations. Transmission grids cover over seven million of kilometers in the world, and they thus represent an important aspect of landscape management. Vegetation beneath high voltage powerlines must be managed due to safety and operating constraints and are the responsibility of the Transmission System Operator (TSO). Vegetation management in powerline corridors traditionally includes tree felling and rotary grinding which maintain clear cuts and cause direct habitat destruction and fragmentation, which are among the major causes of biodiversity loss. However, its negative impacts on biodiversity could be diminished by less disruptive management practices that could create high-quality open habitats and refugees within forest landscape. To favor biodiversity, the French TSO has developed less disruptive management practices such as pasture, mowing, and selective tree cutting, as part of the development of integrated vegetation management in Europe, in partnership with stakeholders under convention. To guide management politics, effects of management practices on biodiversity need to be assessed and, biodiversity potential of powerline corridors quantified.

A first large-scale experiment investigating management type effects on plant biodiversity did not give conclusive results on taxonomic diversity but revealed that alternative management practices could enabled phylogenetic diversity to be maintained despite forest fragmentation. We probably do not have enough perspective to detect strong effects of management practices on vegetation taxonomic diversity, as past management could have a stronger footprint than current management on plant communities. In order to guide management politics and follow plant biodiversity potential over time in powerline corridors, especially linked to vegetation management practices, a composite indicator easy to record by non-expert Transmission System Operator agents, called Flor'Elec, was developed. It derives from RENATU and IBP, two indicators of biodiversity potential based on protocols that can be implemented by non-specialists and already in place in France. Such indicator leans on the notion that a habitat characteristic, reflecting for instance the presence of micro-habitats, reflect the potential that a habitat has to host diverse species. It does not replace vegetation survey done by specialists, but it is a synthetic tool to evaluate the biodiversity potential of the habitat and to communicate.

Flor'Elec combines up to ten variables deemed to favor biodiversity easy to observe in the field. With a large-scaled experiment in metropolitan France, we investigated the relationships between empirical plant biodiversity indices and these variables composing Flor'Elec. In a follow-up experiment, we quantified observation bias with a large panel of observers and contrasting sites. Based on these results and on field observations when applying the protocol, we discuss what Flor'Elec can or cannot tell us, our recommendations to its use, and more generally what this case of study teach us about the methodological choices and scientific validation of such indicator.

ORAL PRESENTATION | EVALUATING ECOLOGICAL IMPACTS OF INFRASTRUCTURE

A decade of applied research and knowledge transfer on bird-power line interactions through a successful TSO-Academia partnership in Portugal

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KEYWORDS
natural capital (critical perspectives), monitoring, evaluation, biodiversity loss, evidence-based mitigation

The partnership between REN – the Portuguese Transmission System Operator (TSO) – and BIOPOLIS/CIBIO – a Research Centre specialized in biodiversity – started in 2015 with two main objectives: developing scientific research on bird-power line (PL) interactions and promoting knowledge transfer to REN and other stakeholders.

On the scientific domain, more than 20 papers were published to date covering three main thematic lines: (i) improving the understanding of the negative impacts of PL on bird populations; (ii) assessing and advancing monitoring methods and mitigation practices; and (iii) analysing the risks and opportunities posed by nesting behaviour on transmission pylons. Bellow, some content of the most illustrative studies is provided.

Within the first thematic line, we highlight a global review of the current knowledge on bird collision with power lines, describing the main driving factors, namely those related with species (e.g. vision, morphology), site (e.g. topography, light and weather conditions, disturbance) and type of power line (pylon configuration, height and wire diameter). Other examples, focusing on farmland species, include a study showing that power lines with vertical configuration (taller pylons and more levels of wires) pose higher collision risk for bustards (Otididae) and another one demonstrating displacement effects of transmission lines on breeding calandra larks (Melanocorypha calandra) and little bustards (Tetrax tetrax).

From the second thematic line, the main focus is given to a global meta-analysis on the effectiveness of wire-marking to mitigate bird collisions with power lines, concluding that installation of anti-collision devices is responsible for overall reduction of ca. 50% of mortality rates. Other highlighted research paper describes the response of different groups of vertebrate scavengers to the right-of-way of power lines and its implications for bird fatality estimates usually done in monitoring programs to assess negative impacts of these infrastructures.

Regarding the third thematic line, the highlight goes for papers showing the strong increase observed in the last decades in the number of white stork (Ciconia Ciconia) nests on pylons of transmission lines in Portugal, and the success of REN's long-term management practices to significantly reduce bird-related electrical faults. Finally, a study focusing on other species (besides the white stork) breeding on REN pylons is reported, reported 14 additional species, including raptors, corvids and other (smaller) passeriforms, from which 5 are threatened in the country.

Besides the development of this significant research at the international level, a key feature of this partnership relies on a direct and active application of the existing scientific knowledge to REN's operations. This is achieved mainly through technical/scientific advice typically provided by BIOPOLIS/CIBIO for specific projects, particularly during Environmental Impact Assessment (EIA) for new transmission PL.

REN's operations, as well as those from their consultants, have also been enhanced by the new national best-practice guidelines for monitoring and mitigating the impacts of transmission lines on birds, including the evaluation of wire-marking effectiveness to reduce bird collisions. As one of the most important non-scientific outputs of the partnership, these guidelines were developed in close collaboration and validated by the national nature conservation authority and are now recognized as a key reference document in the field. Although developed for the Portuguese context, it contains several practical recommendations applicable to other regions of the world (e.g. Asia or Africa).

Beyond EIA context, many other knowledge transfer activities were carried out, from which we highlight the creation of REN's Strategy for Biodiversity, contributing to CIGRE's Technical brochure "Interactions between Electrical Infrastructure and Wildlife", participating in training sessions on Biodiversity for REN employes, as well as consistently engaging in national and international outreach events.

Overall, this long-term academia-TSO partnership underscores the tangible benefits of aligning scientific research with real-world needs to support more sustainable energy infrastructure.

ORAL PRESENTATION | EVALUATING ECOLOGICAL IMPACTS OF INFRASTRUCTURE

Monitoring wildlife in airport environments through bioacoustics: a case study at Barcelona Airport

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KEYWORDS
technology expansion futures, artificial intelligence applications, monitoring, evidence-based mitigation, adaptive management

Acquiring robust knowledge of wildlife at airports is essential for the design and implementation of measures aimed at reducing bird strike risk while protecting biodiversity. Bird censuses are routinely conducted by experts using direct observation techniques to identify species present within airfields and surrounding areas. However, these methods show limitations in particular conditions, such as nighttime. To assess the potential of bioacoustics monitoring for collecting wildlife data and improving knowledge of nocturnal bird activity within the airfield, a pilot study was conducted at the Barcelona-El Prat international airport, which is surrounded by agricultural land, wetlands, and the sea. From April 2024 to April 2025, three autonomous recording units were deployed in manoeuvring areas within the airfield. Devices were operated during nighttime (from 30 minutes after sunset to 30 minutes before sunrise), accumulating a total of 6,382 recording hours. Audio data were analysed for species identification using Chirpity software, followed by validation from expert ornithologists. A total of 120,000 detections corresponding to 66 bird species were analysed. Phenology and abundance of target species were assessed, along with their temporal distribution and spatial occurrence patterns. This provided a comprehensive dataset characterising nocturnal bird activity over the airport flight area, revealing interspecific differences in spatial and temporal movement patterns. We conclude that passive acoustic monitoring is an effective tool for standardized nighttime bird monitoring on airfields, supporting evidence-based decision-making to reduce wildlife hazards to aviation safety and enhance biodiversity conservation. The study was developed in cooperation with AENA, Josep Tarradellas Barcelona-El Prat airport.

ORAL PRESENTATION | EVALUATING ECOLOGICAL IMPACTS OF INFRASTRUCTURE

From solar farms to transport infrastructure: how BIODIVoltaïque bridges the gap between private data and national biodiversity monitoring.

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KEYWORDS
monitoring, before-after evaluation, evidence-based mitigation, biodiversity loss, adaptive management

Private companies generate large amount of biodiversity data as part of environmental impact assessments (EIA). Although the deposit of raw data is obligatory in France since 2016, the data remain largely unexploited beyond the scale of each project. The main challenge lies in the multitude of protocols used to collect the data, making them incomparable. In collaboration with trade unions representing the solar energy sector (SER and ENERPLAN), the French Biodiversity Agency, the Agency for Ecological Transition and the consultancy Crexeco have led BIODIVoltaïque, a project dedicated to harmonising the sampling and monitoring protocols deployed within the framework of EIAs.

Building on previous works, analysing current EIA practices, and taking into account the advice of a scientific expert, BIODIVoltaïque's methodology was based on an iterative process comprising two main phases of consultation with the many stakeholders involved in the implementation of EIAs: solar farm developers, ecological engineering consultancies, public authorities, NGOs, regional and national committees for nature protection.

The consultation resulted in six key principles related to the harmonisation of sampling protocols. Building on the principles, BIODIVoltaïque has developed, in collaboration with the consulted stakeholders, a toolkit containing harmonised protocols for the ecological entities most commonly concerned by ground-mounted solar photovoltaic farms. The toolkit is accompanied by an analytical framework providing guidance for future data analysis. It is important to note that BIODIVoltaïque's toolkit offers representative but not exhaustive protocols. The protocols are well-adapted for ordinary biodiversity but must be adjusted or supplemented to address specific issues such as remarkable biodiversity in the context of EIAs. Although the entities are very common across mainland France, they are not necessarily appropriate to all projects and BIODIVoltaïque has also developed a transparent multi-criteria selection process to help identify relevant entities.

BIODIVoltaïque also put emphasis on the applicability of the toolkit. Given current EIA practices, there is a good match between the entities currently being monitored and those listed in the toolkit, suggesting that using the toolkit will not entail significant additional costs. BIODIVoltaïque will test this hypothesis applying its approach to a representative subset of existing solar farms (up to ten) and comparing the resulting practices with what was outlined in the initial EIA.

On top of facilitating EIAs through the harmonisation of protocols, BIODIVoltaïque's toolkit will also enable data generated by private companies to be directly integrated into the French program of biodiversity monitoring. In a near future, the comparable data coming from EIAs will contribute to better understand the effect of solar photovoltaic farms on biodiversity, responding to the initial need of the solar energy sector. To our knowledge, BIODIVoltaïque is the first project of its kind at the European level and could be inspiring and be easily adapted to other Member States and to the sector of transportation.

ORAL PRESENTATION | EVALUATING ECOLOGICAL IMPACTS OF INFRASTRUCTURE

Promoting biodiversity on traffic verges – from research to action

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KEYWORDS
biodiversity loss, decision-making frameworks, accelerated implementation, landscape connectivity, institutional reform

Traffic verges, vegetated areas adjacent to roads, railways and waterways, comprise at least 3% of Germany's land area. They are not subject to any production-oriented development pressure, reflect a variety of site conditions, and like transport routes themselves exhibit a linear and connecting structure. Previous studies by the Federal Ministry of Transport (BMV) research network highlight the importance of traffic verges for biodiversity and habitat connectivity. Particularly in agricultural areas traffic verges provide vital habitat for flora and fauna. Appropriate management is crucial for maintaining and promoting biodiversity on these areas. Based on a research project by BASt (Federal Highway and Transport Research Institute) the FGSV (German Road and Transportation Research Association) has revised its standard regulations for the maintenance of roadside verges. These regulations provide instruction and guidance on all areas relevant to vegetation maintenance such as the management of open land and woody vegetation along federal roads. Traditionally roadside maintenance was strongly driven by economy with little consideration of ecological issues. The new edition takes both into account. For example, mowing in sections and leaving refuge areas for arthropods and other small organisms will become the new standard. This technique provides great benefit for biodiversity without generating additional costs. Preventing the introduction and spread of problematic (invasive) plants on roadside verges is essential not only for protecting biodiversity but also for reducing effort and costs associated with vegetation management. A guidance document on dealing with problematic plants published by BASt lists prevention and control measures for the most common problematic plants found along transport routes. Recent amendments in regulations and guidance documents represent an important step towards a biodiversity-promoting road maintenance.

Preventing Wildlife Collisions: From Prediction to Practice

Thursday 24 September · 11:00–13:00 · Victoria Park

ORAL PRESENTATION | PREVENTING WILDLIFE COLLISIONS: FROM PREDICTION TO PRACTICE

From Habitat Suitability to Operational Rail-Risk Forecasting: Multitemporal AI Models for Predicting Wild Boar Collisions on the French Railway Network

Adrian F. Meyer[1,2], **Theo Reibel**[1], **Stefan Pretali**[1], **Kevin Morelle**[3,4], **Mathias Kneubühler**[2], **Denis Jordan**[1]

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KEYWORDS
decision-support modelling, remote sensing, artificial intelligence applications, evidence-based mitigation, wildlife mortality assessment

Wild boar (Sus scrofa) incidents along the SNCF railway network have increased markedly, causing operational disruptions, infrastructure damage, and broader wildlife-management conflicts. Traditional ecological models typically provide static descriptions that lack operational relevance. Addressing this gap, we present a multiyear PhD research project that integrates ecological habitat modelling with operational railway collision prediction, explicitly designed to generate actionable knowledge.

First, we developed national-scale, multitemporal habitat suitability models by integrating diverse datasets: SNCF rail collision records, national roadkill data (RRN), and GBIF species observations. Critically, we addressed inherent spatial sampling biases through rigorous bias-correction methods. Dynamic predictors encompassed climatic and remotely sensed variables, alongside annually updated, nation-wide, high-resolution (30 m) land-cover classifications generated by fine-tuning a Vision Transformer model on Harmonized Landsat-Sentinel imagery. The resulting ecological suitability layers accurately reflect seasonal dynamics relevant to wild boar habitat preferences, capturing critical resource areas such as forest-agriculture interfaces, mast-producing habitats, and peri-urban greenbelts.

Second, we translated this detailed ecological understanding into an operational collision-risk prediction framework. Railway lines were segmented into standardized 1-km units, for which we derived monthly collision-risk surfaces using historic collision data. Ecological predictors were supplemented with detailed railway-specific data, including train frequency, velocity profiles, curvature, passability of infrastructure, hunting intensity proxies, and proximity to biologically significant vegetation classes. We systematically compared diverse machine-learning modelling approaches: spatial generalized additive models (GAM), decision-tree ensembles (Random Forest, XGBoost, Gradient Boosted Machines), and exploratory recurrent neural networks (LSTM). Concurrently, AI-assisted camera-trap data were employed as complementary ground-truth validation, clarifying that presence alone insufficiently predicts collision risk - highlighting the necessity of integrated predictive modelling.

Crucially, our modelling outputs are implemented within a novel interactive web-based dashboard. This online platform empowers SNCF stakeholders with specific tools for proactive risk management - facilitating immediate visualization of collision hotspots, seasonal forecasting of risk dynamics, and prioritization of targeted mitigation strategies, including strategic fencing, monitoring initiatives, deterrence measures, and adaptive habitat management.

This research moves decisively beyond passive ecological description, synthesizing ecological monitoring, advanced remote sensing, cutting-edge machine-learning methods, and railway operational data into a unified actionable knowledge system. The final outcome directly supports strategic infrastructure decisions, ultimately fostering safer, more ecologically resilient railway networks across France.

ORAL PRESENTATION | PREVENTING WILDLIFE COLLISIONS: FROM PREDICTION TO PRACTICE

Safe Tracks: a scalable acoustic deterrent to reduce wildlife-train collisions without increasing barrier effects

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KEYWORDS
monitoring, evidence-based mitigation, species behavioural response, wildlife mortality assessment, biodiversity loss

Between 2023 and 2025, more than 2,500 animals were killed along a 750 km railway in central-western Brazil, with mammals accounting for 91% of records, including the threatened lowland tapir (Tapirus terrestris). Mitigation measures implemented along a 20 km section in the Cerrado biome included wildlife underpasses, fencing and community engagement. However, fence theft and vandalism reduced effectiveness, while fencing may also contribute to barrier effects by restricting animal movement.

To address these challenges, Rumo S.A., in partnership with Brazil's National Land Transport Agency (ANTT), developed the first railway wildlife deterrent system in the country based on acoustic signals. The system emits sounds prior to train passage, temporarily repelling animals from the track area without imposing permanent physical barriers. Ex situ trials identified three sounds with deterrent potential for tapirs: ambulance sirens, dog barks and train horns.

Preliminary field results from camera monitoring indicate consistent behavioural responses across multiple species, suggesting avoidance of the track area during system activation. Notably, between September 2025 and April 2026, no wildlife collisions were recorded within the experimental section.

These findings provide preliminary evidence that simple, adaptable and rapidly deployable solutions may contribute to reducing wildlife mortality while maintaining functional connectivity. Although results are still initial, observed behavioural responses and the absence of recorded collisions during the monitoring period suggest promising potential. Acoustic deterrents may represent a scalable and cost-effective alternative or complement to traditional mitigation measures, particularly in contexts where infrastructure integrity and long-term maintenance are limiting factors.

ORAL PRESENTATION | PREVENTING WILDLIFE COLLISIONS: FROM PREDICTION TO PRACTICE

Acoustic stimuli vs blue light: Which one is efficient to deter wild ungulates?

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KEYWORDS
avoidance, nature-based solutions, evidence-based mitigation, species behavioural response, landscape connectivity

While the French National Railway Company (SNCF) faces significant challenges from wildlife-train collisions, with incidents rising from 1200 to 2500 over the past decade, acoustic deterrent solutions appear promising. Previous studies suggested that "super-signals", based on specific acoustic features from the natural vocal repertoire of species, could be a promising way to deter wildlife. Here, drawing on prior playback experiments on captive ungulates and existing literature, we developed fully synthetic 'superstimuli' and compared their effectiveness in deterring wild ungulates with flashing blue light and human voice. While our playback experiment is mainly based on one hundred and thirty-one wild boar reactions, we recorded seventy-eight flight responses to sounds, compared with only four responses to flashes. Our 'superstimuli' and human voice seem promising as acoustic deterrent signals to manage wildlife-train collisions.

ORAL PRESENTATION | PREVENTING WILDLIFE COLLISIONS: FROM PREDICTION TO PRACTICE

Reducing wildlife–train collisions in France: First results from trackside and onboard acoustic deterrent devices

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KEYWORDS
landscape connectivity, nature-based solutions, systems innovation, avoidance, before-after evaluation

In France, in 2024, SNCF had to deal with more than 2,500 collisions with wild animals, and this number continues to rise as ungulate populations grow alongside the increase in rail traffic. Faced with this immense problem for wildlife and transportation, SNCF has developed deterrent sounds that have been tested and validated on animals in captivity and in the wild. The promising results led to the development of two devices designed to emit these sounds in a railway environment. The first system, deployed by SNCF Réseau, is based on fixed beacons deployed along the track that detect the train and emit a deterrent signal to alert the animals. The efficiency is evaluated by comparing the number of collisions in the deployment area before and after the device is installed. The second system, tested by SNCF Voyageurs, is a device installed on two regional trains. The trains have been equipped with speakers to emit sounds in areas with a high risk of collisions. Cameras were also installed on the trains to observe the animal's reactions to the sounds. Both solutions were implemented in 2024 in various regions of France, with promising results. With the track-side system in place, collisions dropped by 90%, and equipped trains have remained collision-free since the trial started.

ORAL PRESENTATION | PREVENTING WILDLIFE COLLISIONS: FROM PREDICTION TO PRACTICE

Deterrent Sounds on Maintenance Trains to Reduce Collisions with Domestic Reindeer and Wildlife and train: An Ongoing Experiment

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KEYWORDS
landscape connectivity, ecological resilience, technology expansion futures, barrier permeability, wildlife mortality assessment

In an ongoing experiment (since January 2025), deterrent sounds are deployed on maintenance trains to reduce collisions between trains and domestic reindeer and other wildlife along the Nordlandsbanen. Two maintenance trains are equipped with ruggedized long-range loudspeakers designed for harsh environmental conditions. The system can deliver sound pressure levels of up to 133 dB at the source. Controlled measurements show average sound levels of 75 dB at 100 m and 65 dB at 200 m from the loudspeaker. Only within approximately 20 m from the train, does train noise mask the emitted sound. When animals are observed on or near the track, the driver activates a predefined warning sound via a single-button trigger. A camera system simultaneously records and stores video from 10 seconds before to 10 seconds after activation, enabling analysis of animal behaviour before and during sound exposure. So far, we have analyzed 48 videos (n = 22 moose and n = 26 domestic reindeer) of ungulate behavior when a maintenance train is passing. Preliminary results may indicate that moose (n = 12) show a somewhat increased escape response (NS) when the deterrent sound is played, compared to when no sound is played (n = 10; control). Domestic reindeer (n = 18) also show increased attention when the sound is played (n = 8; control). Due to the herd instinct of domestic reindeer, they often cross the railway in front of the train to reach the rest of the herd, even though this can increase collision risk.

From Grey to Blue and Green Infrastructure: Upscaling Nature-based Solutions (NbS) in Railway Networks (SYMBIOSIS)

Thursday 24 September · 11:00–13:00 · Ashton Court

ORAL PRESENTATION | FROM GREY TO BLUE AND GREEN INFRASTRUCTURE: UPSCALING NATURE-BASED SOLUTIONS (NBS) IN RAILWAY NETWORKS (SYMBIOSIS)

From Grey to Blue and Green Infrastructure: Upscaling Nature-based Solutions (NbS) in Railway Networks

Luis M. Fernández[1,2], **Carme Rosell**[1,2], **Joan Marull**[1], **Reto Schmucki**[3], **Neil Strong**[4], **Jeff Ollerton**[5], **Lorenzo Franzoni**[6], **Pinar Yilmazer**[7]

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KEYWORDS
climate adaptation, landscape connectivity, nature-based solutions, adaptive management, long-term resilience

Climate change poses increasing risks to railway networks, causing infrastructure damage and economic losses that require the implementation of adaptation plans to enhance infrastructure resilience. Mitigation actions are often undertaken without considering Nature-based Solutions (NbS), despite their potential to deliver multiple co-benefits for infrastructure performance, society, and biodiversity, including climate change adaptation and habitat connectivity. Within the framework of the EU-RAIL SYMBIOSIS project, the state of the art of ecological asset design and management across European railways has been assessed. European railway networks encompass extensive publicly owned land, including aquatic and terrestrial ecosystems, which can be strategically managed to strengthen Blue and Green Infrastructure. Flooding and extreme heat have been identified as the main climate-related hazards affecting railway resilience in Europe, requiring adaptation measures that are still predominantly focused on grey infrastructure, relying on artificial elements such as concrete or metal. This workshop will present a catalogue of key NbS suitable for implementation within railway rights-of-way, supported by selected case studies. Presentations will be followed by facilitated discussions to examine feasibility, costs, and benefits of each solution, as well as key considerations for their design, implementation, and maintenance. The session will evaluate the potential of NbS to reinforce Blue and Green Infrastructure and enhance the resilience of European railway networks. The outcomes will contribute to the development of guidelines to support decision-making, promoting solutions that enhance biodiversity while reducing climate-related risks through the application of NbS on land owned by railway operators.

Powering Nature Recovery: Reducing Biodiversity Impacts of Energy Infrastructure

Thursday 24 September · 14:00–16:00 · Greville Smyth Park

ORAL PRESENTATION | POWERING NATURE RECOVERY: REDUCING BIODIVERSITY IMPACTS OF ENERGY INFRASTRUCTURE

How to prevent Dangerous Liaisons: how habitat and pylon characteristics drive the use of pylons by nesting white storks

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KEYWORDS
social–ecological systems, spatial planning, species behavioural response, evidence-based mitigation, decision-support modelling

Although electrical infrastructures can be dangerous for avifauna, they are also used as nesting sites by several bird species. This is the case for the White Stork (Ciconia ciconia), whose populations are spatially and numerically expanding in France (population increase +694.6% between 2001 and 2019). This situation affects both the birds and Transmission System Operator (TSO) because it simultaneously puts at risk their populations and electricity quality. There is then a need to be able to predict which pylons are likely to be occupied (and therefore problematic for birds and power transmission) in the near future.

Here, we aimed to understand the drivers of high-voltage pylon use for nesting by white storks in France by contrasting the surrounding habitats and characteristics of occupied vs. non-occupied pylons, using machine learning algorithms.

We first demonstrated that storks preferred pylons surrounded by an important stream network, but also pylons closer to marshes, pastures and large streams and secondly that pylon silhouette with horizontal open lattice tower are preferentially chosen.

A refined analysis within suitable pylons revealed that other pylon characteristics contrasted occupied and non-occupied pylons. These included the length of horizontal space available for nesting and the number of nests on surrounding pylons (rather than the total number of nests regardless of nesting support), suggesting social effects that could amplify pylon nesting behaviour in regions where storks already nest on this type of supports.

Overall, our results provide guidelines for spatially prioritising mitigation measures and planning future power lines.

ORAL PRESENTATION | POWERING NATURE RECOVERY: REDUCING BIODIVERSITY IMPACTS OF ENERGY INFRASTRUCTURE

Detecting High-Risk Bird and Bat Flight Crossings Using Structural Landscape Features

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KEYWORDS
landscape connectivity, spatial planning, remote sensing, artificial intelligence applications

Identifying high-risk locations where transport infrastructure intersects bird and bat flight corridors is essential for targeted mitigation. Many models use mortality records as a proxy for flight frequency, but these data are scarce and spatially biased, and in our tests explained little variation.

We therefore developed an expert-informed model based on structural landscape connectivity, assuming flights concentrate where infrastructure intersects biocorridors, especially forest edges and linear vegetation. Although the mechanisms differ (bats use acoustic cues; small passerines seek cover from predation), both groups rely on vegetated corridors for movement.

From high-resolution biennial aerial imagery, we delineated tree crowns, derived a skeletal network of linear vegetation, and added a forest-edge layer. Intersections with the transport network were scored in a regular hexagonal grid to map potentially critical sites. Zoologists then validated outputs to remove false positives (e.g., forest interiors, longitudinal vegetation, and complex junctions).

This structural approach identified high-risk locations and correlated well with observed flight activity, including species abundance and diversity. Ongoing analyses of environmental characteristics will further specify drivers of risk and support a practical tool to mitigate biodiversity impacts of transport infrastructure.

ORAL PRESENTATION | POWERING NATURE RECOVERY: REDUCING BIODIVERSITY IMPACTS OF ENERGY INFRASTRUCTURE

Video-based monitoring to assess bird crossings and collision risk at transmission power lines: Advantages and challenges of a novel technology

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KEYWORDS
technology expansion futures, systems innovation, wildlife mortality assessment, species behavioural response, monitoring

Power lines are expected to continue expanding significantly worldwide. One of their key environmental impacts is direct bird mortality due to collisions with overhead wires. This impact has traditionally been assessed through on-foot carcass searches along power line rights-of-way. However, carcass detection is strongly affected by several sources of bias, including carcass removal by scavengers and searcher efficiency. Additionally, carcass searches can be severely compromised in some types of habitats, such as flooded areas, highly rugged terrain or areas with very dense vegetation.

To overcome these constraints, video-based monitoring systems have been proposed as an alternative to traditional ground surveys. Over the past 15 years, several companies have developed and deployed 24/7 video monitoring solutions for wind farms to track bird and bat activity and detect potential collisions. These systems are often combined with AI algorithms that detect and identify target species in video footage, sometimes in real time, enabling the triggering of mitigation measures such as turbine shutdown-on-demand. However, comparable ready-to-use services have not yet been developed or widely deployed for overhead power lines.

As part of the LIFE SafeLines4Birds project, a completely new camera-based system was developed to monitor bird crossings and potential collisions with wires on transmission power lines. Developed by APREX Solutions with the support of RTE, Elia, LPO France, and Natuurpunt, each unit consists of a diurnal camera and a thermal camera mounted on pylons, combined with solar panels, batteries, and a box unit containing the hard drives and other system components.

The novel system was first implemented during the winter of 2024/2025 and spring 2025 on four different sites, through the installation of a total of eight units (two units per site): one site was selected in a wetland in France, two sites in meadows habitat in Belgium, and one site in a forest in Belgium. Each video system operated 24/7, monitoring at least one power line span in front of the pylon where it was deployed (corresponding 370-495 m of length). During these periods, each system was remotely checked every 2-3 days to promptly detect and address any issues affecting data collection, such as power supply failures or other technical malfunctions. Further testing is planned for 2026–2027, involving additional units and sites.

To process the large volume of footage collected, an algorithm is being developed to automatically detect birds in flight based on machine learning. For this purpose, a training dataset was created with almost 3,000 “bird events” under different conditions (e.g. target size, light conditions, background complexity) to train the model to reliably detect birds crossing between or near power line wires. This algorithm is being validated using independent analysis of selected video recordings, cross-validating algorithm-detected events with those identified by human observers in the footage to quantify false positive and false negative rates across a range of environmental and operational conditions.

In this presentation, we summarise the main advantages and limitations of using these emerging technologies in the context of power lines, while also providing an overview of the most recurrent issues and challenges encountered during footage collection and proposing strategies to mitigate them. We further present the progress of the algorithm developed for detecting birds in flight in the recorded footage. These key learnings and advances aim to strongly contribute to the development of reliable, ready-to-use video-based systems that will enable 24/7 monitoring of general bird activity, risky fights and potential collisions with power lines, offering a true alternative to traditional survey methods and providing valuable additional data to improve current knowledge of these interactions.

ORAL PRESENTATION | POWERING NATURE RECOVERY: REDUCING BIODIVERSITY IMPACTS OF ENERGY INFRASTRUCTURE

Joint Efforts for Safer Power Lines: Protecting Birds along the Danube River

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KEYWORDS
wildlife mortality assessment, cross-boundary coordination, retrofitting infrastructure, monitoring, evidence-based mitigation

One of the biggest threats to wild bird species is electrocution and collisions with power lines that cause thousands of avoidable deaths and injuries. The LIFE Danube Free Sky project addresses these threats and represents a unique example of wide transnational cooperation along with one of the most important migration corridors, stopover sites, and wintering places for many bird species in Europe - the Danube River. This initiative brings together 15 partners from seven countries with the aim of protecting bird populations across 25 Special Protection Areas and 9 Important Bird Areas along the Danube River. 82 trained field assistants carried out a field survey (01/2021-10/2022) that covered 1,580 km of 8 types of aboveground power lines and electric railway lines, and 12,535 utility poles. During the field surveys, 2,098 bird carcasses and bird remains representing 103 bird species were identified under the power lines. For 1,833 individuals belonging to 93 species, it was possible to determine the exact cause of death. Electrocutions accounted for 55% (1,009 individuals), belonging to 35 bird species; collisions accounted for 45% (824 individuals), involving 78 bird species. The Eurasian Magpie (Pica pica) was the most detected and was associated with 27% (n=193) of all electrocutions. The second highest mortality was observed for the Eurasian Buzzard (Buteo buteo) with 22% (157 ind.). The Mute Swan (Cygnus olor) was the most common bird detected accounted for 20% (155 ind.) of all identified collisions. The second highest mortality was observed for the Mallard (Anas platyrhynchos) with 9.1% (71 ind.). Thanks to close cooperation with power grid operators along the Danube River, both electrocution (4,637 poles were identified for anti-electrocution measures) and collision (276.5 km of power lines were identified as a top-priority for increasing their visibility) risks have been systematically addressed, leading to the successful implementation of effective, state-of-the-art mitigation solutions. The measures implemented were tested, and their effectiveness in protecting birds from electrocution and collisions was monitored. Several modern technologies were used for monitoring, such as GPS transmitters on young individuals of Dalmatian Pelicans, Imperial Eagles, and Saker Falcons, to determine their mortality and identify high-risk "hotspots" on power lines. A dog-assisted carcass searches were carried out along railways in Austria to assess the effectiveness of retrofitting power supply pylons with bird protection devices. Special drones and new experimental bird diverters were tested and evaluated in preventing collisions. This abstract was prepared under the project LIFE Danube Free Sky – Transnational conservation of birds along the Danube river (LIFE19 NAT/ SK/001023) co-funded by the European Union and the Ministry of Environment of the Slovak Republic.

ORAL PRESENTATION | POWERING NATURE RECOVERY: REDUCING BIODIVERSITY IMPACTS OF ENERGY INFRASTRUCTURE

Evidence-Based Mitigation of Bird Collision and Wildlife Electrocution along Power Line Infrastructure

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KEYWORDS
wildlife mortality assessment, evidence-based mitigation, species behavioural response, retrofitting infrastructure, landscape connectivity

The continued expansion and densification of power transmission and distribution networks has intensified interactions between linear energy infrastructure and wildlife. Across many regions, two impact mechanisms remain particularly persistent and widespread: bird collisions with overhead conductors and wildlife electrocution associated with hazardous infrastructure configurations . These impacts contribute directly to wildlife mortality and can undermine ecological connectivity, particularly where power lines intersect migratory routes, open landscapes, and areas of regular wildlife movement.

While mitigation measures are widely applied, their effectiveness is not uniform across species, habitats, infrastructure types, or environmental conditions. Recent studies and meta-analyses indicate that bird flight diverters can significantly reduce collision mortality; however, performance varies according to diverter design, visibility mechanisms, deployment density, and site-specific factors. Similarly, electrocution mitigation effectiveness depends on infrastructure configuration, species behaviour, and the suitability of protective measures applied to hazardous assets.

This presentation examines Wildlife & Asset Protection (WAP) mitigation solutions through an evidence-based perspective, focusing on two complementary mitigation categories: bird collision prevention and wildlife electrocution protection. Bird collision mitigation is explored through the selection and deployment of visibility-enhancement technologies, including the role of diverter design and visual performance in supporting line detectability. Electrocution mitigation is examined through insulation systems, protective covering technologies, and configuration adaptations designed to reduce contact risk for birds and other wildlife.

Drawing on published research and operational experience, the presentation discusses how species behaviour, site characteristics, infrastructure constraints, and risk assessment influence mitigation performance. Particular emphasis is placed on selecting solutions that are appropriate to the ecological and operational context rather than applying a single mitigation approach across all situations.

Aligned with the IENE 2026 theme of Creating Actionable Knowledge , this contribution demonstrates how evidence-based mitigation can support reductions in wildlife mortality, maintain functional ecological connectivity, and contribute to more nature-compatible management of existing power line infrastructure.

Objectives of the Presentation

- To examine the two principal wildlife impacts associated with power lines: bird collision and wildlife electrocution.
- To review current evidence on the effectiveness of mitigation measures used to address these impacts.
- To explore how species behaviour, infrastructure characteristics, and environmental conditions influence mitigation performance.
- To discuss risk-based approaches for selecting and prioritising mitigation measures on existing infrastructure.
- To support knowledge exchange between infrastructure operators, practitioners, and ecologists.

Expected Outcomes

Participants will gain

- An improved understanding of the factors driving bird collision and wildlife electrocution risk along power line infrastructure.
- Insight into current evidence regarding the effectiveness of collision and electrocution mitigation measures.
- A clearer appreciation of why mitigation performance varies across species, locations, and infrastructure types.
- Practical guidance for selecting and prioritising mitigation solutions based on ecological and operational context.
- Actionable knowledge that can support biodiversity commitments and wildlife-friendly infrastructure management.

ORAL PRESENTATION | POWERING NATURE RECOVERY: REDUCING BIODIVERSITY IMPACTS OF ENERGY INFRASTRUCTURE

Strategies for Mitigating Wildlife Mortality on Power Lines while Improving Grid Reliability

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KEYWORDS
evidence-based mitigation, long-term resilience, retrofitting infrastructure, before-after evaluation, infrastructure coherence

Avian electrocution on power lines remains a significant cause of wildlife mortality and a recurring source of power outages and fire risk across electricity networks. While effective technical solutions exist, their impact is often limited by fragmented, site-based implementation rather than coordinated action at network scales. This presentation focuses on how evidence-based knowledge can be translated into actionable mitigation strategies that reduce bird mortality while strengthening grid reliability. Beginning with identifying the risk areas and danger posed by power lines and substations to wildlife, we dive into the impact caused by electrocution, emphasizing the need for proactive measures.

The presentation emphasises the importance of interaction and cooperation between utilities, wildlife organisations, regulators, and technical experts to achieve effective and scalable mitigation outcomes. Using data analysis and case studies from the Mediterranean region, it demonstrates how targeted mitigation can significantly reduce bird mortality while also decreasing power outages.

Various avian electrocution mitigation options are discussed, including design approaches, material specifications, and installation techniques, with particular attention to retrofitting existing infrastructure. By integrating practical solutions with monitoring and coordinated implementation, the presentation shows how electrocution risk mitigation can be effectively scaled across infrastructure networks, delivering lasting benefits for both wildlife and grid reliability.

Finally, the presentation draws on practical experience from industry-developed solutions to illustrate how technical design and manufacturing expertise can contribute to reducing power outages and fire risk on power lines, while supporting the protection of endangered wildlife.

Scaling Nature-Positive Action

Friday 25 September · 09:30–10:30 · Eastville Park
Friday 25 September · 11:00–12:00 · Eastville Park

ORAL PRESENTATION | SCALING NATURE-POSITIVE ACTION

Twenty-five years of moving the needle: how a long-term cooperative taskforce is accelerating habitat defragmentation across Spain's transport network

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KEYWORDS
biodiversity loss, decision-making frameworks, spatial planning, strategic defragmentation, governance architecture

Transport infrastructure remains one of the leading drivers of habitat fragmentation across Europe, yet the pathway from scientific evidence to systematic defragmentation action is rarely straightforward. Institutional inertia, fragmented governance, and the persistent gap between research communities and infrastructure operators continue to slow progress, even where proven solutions exist.

This presentation draws on twenty-five years of experience from Spain's National Working Group on Habitat Fragmentation (Grupo de Trabajo sobre Fragmentación de Hábitats causada por Infraestructuras de Transporte), established in 1999 in the framework of COST Action 341 and coordinated by MITECO under the State Commission for Natural Heritage and Biodiversity. The Working Group brings together representatives from transport, environmental and impact assessment administrations at both national and regional level spanning all 17 autonomous communities, around a shared agenda of defragmentation at network scale. It has been recognised with the IENE Project Award.

Over two and a half decades, the Working Group has produced a suite of strategic and technical instruments. The Technical Prescriptions for the Design of Wildlife Passages, Perimeter Fencing and Other Measures to Support Biodiversity in Transport Infrastructure now in its third edition (2026), co-developed with national experts and aligned with the IENE Biodiversity and Infrastructure handbook, have provided the technical backbone for the construction of thousands of wildlife crossings across Spain's road and rail networks. Each successive edition has incorporated not only new ecological evidence and monitoring results, but direct practitioner feedback, creating a deliberate iterative loop between knowledge production and field implementation.

In 2024, the National Defragmentation Strategy for Habitats Affected by Linear Transport Infrastructure was formally approved by Spain's Sectoral Environment Conference. Structured around eight strategic axes and thirty-seven specific actions, covering priority area identification, permeability improvements to existing infrastructure, road kill reduction, and nature-based solutions in infrastructure management, it provides a ten-year policy framework binding on all administrations. The Strategy is accompanied by an Action Programme that includes many actions, such as the development of a national inventory of fauna passages, offering for the first time a systematic baseline for monitoring progress at network scale.

We also present the Stop Fauna Collisions project as a case study of cooperative applied science mobilising citizen science, road managers and researchers around the shared challenge of wildlife mortality on transport infrastructure.

Drawing on this body of experience, the presentation critically examines what has enabled progress including the institutional design of the Working Group, the role of guidelines tailored to infrastructure professionals, and the value of sustained cross-sector trust and what has stalled it, notably the persistent under-resourcing of monitoring and the risk of applying innovative measures without adequate evaluation frameworks.

We argue that long-term, trust-based cooperative governance structures are as critical to successful defragmentation as the technical solutions they produce and that the Spanish model offers transferable lessons for other EU member states now facing implementation obligations for example under the Nature Restoration Law.

ORAL PRESENTATION | SCALING NATURE-POSITIVE ACTION

Durable ecological maintenance of linear transport infrastructure rights-of-way through the creation of local partnerships with training institutes for nature-related professions

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KEYWORDS
ecological and social values, social–ecological systems, adaptive management, landscape connectivity, monitoring

Partnerships between operators of linear transport infrastructure (LTI), landowners of LTI rights-of-way (ROW) and local stakeholders with skills in the management of natural environments can be a smart solution for the efficient ecological management of ROW. However, such partnerships frequently encounter viability problems. Interdisciplinary research analysed the problem and led to elaborating a generic process for setting viable local partnerships, applicable to four types of LTI (roads, railways, waterways, powerlines) and adaptable to the specificities of each situation. The current step of our research process is to assess the proposal through experimentation at operational level: support provided to partnership setup, then steering. Through the creation of new partnerships from scratch, the objective is to strengthen the methodological proposal and to use these collaborations as demonstrators of feasibility over the coming years. In this view, our research action cross-referenced landowners and operator sites with the potential interest of numerous local stakeholders. Training institutes for nature-related professions proved interested by partnership opportunities: they allow training projects spanning several years, serving as educational tool for students of all levels, from middle school to high school and higher education. Such local partners are able to implement maintenance techniques respectful of biodiversity and are able to monitor the ecological benefits of their actions. They can demonstrate the value of techniques for which other stakeholders are neither competent nor convinced. This is illustrated by partnership created for the management of a motorway ROW in favor of pollinating insects.

ORAL PRESENTATION | SCALING NATURE-POSITIVE ACTION

New activities addressing bird protection on power lines in the Czech Republic

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Nature Conservation Agency of the Czech Republic, Czechia

KEYWORDS
wildlife mortality assessment, biodiversity loss, evaluation, monitoring

Bird mortality on power lines began to be addressed from the 1970s, when the first mitigation measures were introduced. Since the 1990s, the Nature Conservation Agency of the Czech Republic (NCA) has been actively involved, establishing long-term cooperation between ornithologists, nature conservation authorities, and electricity distribution companies.

A large-scale monitoring project conducted in 2015–2016 significantly advanced understanding of the issue. During this period, approximately 76,000 power poles and 6,400 km of power lines (around 10% of the national network) were inspected. The study aimed to identify hazardous pole types and constructions, as well as to quantify bird mortality associated with specific infrastructure. Based on these data, it was estimated that more than 100,000 birds die annually on power lines in the Czech Republic. The monitoring not only identified the most dangerous structures but also evaluated the effectiveness of previously implemented mitigation measures, thereby initiating the development of new, more effective solutions (i.e. claw-type bracket with perch on a pole).

Current legislation requires the exclusive use of bird-safe designs during construction and reconstruction of power lines, based on recommendations issued by the NCA. Furthermore, a national target has been set to retrofit all existing hazardous poles by 2035. In addition to electrocution, bird collisions with power lines are increasingly addressed. Recent guidelines define high-risk areas where bird flight diverters must be installed during the construction or upgrading of power lines.

In 2026, a new Swiss-Czech cooperation project "A Comprehensive Solution to Landscape Fragmentation in the Czech Republic" focusing not only on bird protection on energy infrastructure has been launched.

The main objective of the project is to provide a comprehensive solution to landscape fragmentation in the Czech Republic, focusing on three key areas: ensuring landscape connectivity for large mammals, addressing the fragmentation of the river network and proposing measures for its ecological restoration, and addressing landscape fragmentation in relation to power lines.

An update of the “Habitat of Selected Specially Protected Species of Large Mammals” map layer (a spatial analysis GIS map for land-use planning) will be carried out, along with monitoring of critical sites for migration (including a feasibility study of defragmentation measures for 10 of them). Additionally, there will be monitoring of the fish species composition and monitoring of artificial barriers in watercourses, as well as an analysis of the impacts of small hydropower plants and residual flows. A feasibility study will be prepared for the removal of three migration barriers on the Želivka watercourse.

Building on existing knowledge, it also responds to emerging challenges associated with the expansion of energy networks driven by renewable energy development. The project part dedicated to bird protection includes: (i) development of a nationwide electrocution risk map; (ii) installation of bird diverters on 12 km of existing power lines in high-risk areas; (iii) monitoring of the effectiveness of anti-electrocution measures along 2,000 km of power lines; (iv) evaluation of selected diverters using camera systems; (v) development of a guideline for managing nesting of White Storks (Ciconia ciconia) on low- and medium-voltage poles; (vi) design of mitigation measures to prevent stork injuries at transformer stations; and (vii) preparation of a methodology for the ecological management of power line corridors.

The project builds upon previous efforts while addressing previously underexplored aspects, with the aim of achieving a comprehensive and systematic approach to bird protection across the Czech Republic.

ORAL PRESENTATION | SCALING NATURE-POSITIVE ACTION

Infrastructure for people, wildlife and the planet: Award winning community engagement for biodiversity.

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The Tree Council, United Kingdom

KEYWORDS
ecological and social values, vision-led delivery, biodiversity loss, uncertainty, cross-boundary coordination

The railway estate is Britains biggest neighbour, with a third of the population living within 500 metres. In recognition of exemplifying 'what can be achieved when stakeholders are brought together in a meaningful way' the Tree Council and Network Rail were recognised at the Big Biodiversity Challenge Awards in 2024. How did the Tree Council and Network Rail bring together 180 communities to plant over 350,000 trees and hedgerows in their neighbourhoods, in just a few years? And, has the community engagement programme continued to grow?

In this session Network Rail, The Tree Council and partners will get practical and show how railway teams and local communities across Britain have worked together to plant, grow and care for trees, creating green corridors and growing community pride. The presentation will show how social value and biodiversity have come together to drive tree planting at scale to provide nature recovery, flood prevention, social cohesion and much more.

We'll also share how we are boosting the impact of the work by learning about tree establishment and survival.

ORAL PRESENTATION | SCALING NATURE-POSITIVE ACTION

Protecting a Rewilding Landscape Through Infrastructure Planning: Multi-Stakeholder Collaboration for Ecological Connectivity in the Filiasi–Caransebes Corridor

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KEYWORDS
ecological economics, ecological and social values, biodiversity loss, decision-making frameworks, landscape connectivity

In the Armenis area of the South-Western Carpathians (Romania), the narrow Timis River valley represents a critical ecological connectivity bottleneck linking seven national and natural parks. The valley is already crossed by a national road with high wildlife impermeability and by a railway line currently undergoing modernization. At the same time, a new express road project is under preparation, creating a significant risk of additional habitat fragmentation within one of the most important rewilding landscapes in Eastern Europe.

Over the last decade, more than 100 European bison (Bison bonasus) have been reintroduced into the area, establishing a free-ranging and expanding population with increasing ecological and socio-economic importance. During the planning process for the express road, several route alternatives were initially assessed by the national road authority, while tunnel solutions were excluded at an early stage due to perceived excessive construction costs.

In early 2025, WeWilder initiated an extensive stakeholder engagement process involving local communities, civil society organizations, ecological experts and public authorities. Local stakeholders expressed strong concerns regarding the potential impacts of the proposed infrastructure on traditional farming systems, landscape integrity, biodiversity, and the growing ecotourism potential associated with the rewilding area. Supported by the technical expertise of EPC Environmental Consultancy, stakeholders collaboratively developed an alternative route option designed to minimize additional fragmentation of the ecological corridor.

The proposed alternative was subsequently discussed with the national road company, design consultants and the Ministry of Transport. A revised cost-benefit assessment demonstrated that the long-term ecological, social and economic losses associated with corridor fragmentation would likely exceed the additional costs required for tunnel-based infrastructure solutions. The quality of the technical arguments, combined with sustained stakeholder engagement, ultimately led the road authority to develop a new route alternative inspired by the community proposal.

The resulting solution significantly reduces additional fragmentation pressures and creates opportunities for future landscape defragmentation measures in the Timis corridor. This case study highlights the importance of participatory planning, cross-sector collaboration and evidence-based decision-making in reconciling transport infrastructure development with ecological connectivity conservation in rewilding landscapes.

ORAL PRESENTATION | SCALING NATURE-POSITIVE ACTION

Towards a Responsibility Framework for Sufficiency-Oriented Transport Infrastructure

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KEYWORDS
demand reduction, sufficiency, degrowth, ecological economics, governance architecture

For more than half a century, transport infrastructure planning has followed a consistent logic: forecast demand, provide capacity, and mitigate the impacts of resulting projects. Three decades of infrastructure ecology research have demonstrated that this sequence cannot prevent cumulative biodiversity loss, habitat fragmentation, and connectivity decline — not because mitigation is inadequate, but because ecological and social objectives enter the planning process too late. The problem is structural, not technical. This paper reframes infrastructure ecology: from a science primarily concerned with mitigating the impacts of decisions already made, to one concerned with shaping the strategic decisions that determine whether, where, and how infrastructure is developed. The ethical foundation of this reorientation is responsibility: those who build infrastructure build the backbone of landscapes and shape living systems for generations to come. We introduce responsibility-led infrastructure planning as the conceptual framework through which ecological and social objectives become the starting point of strategic decision-making rather than constraints applied after projects have been conceived. Its logical space is bounded above by ecological limits of what living landscapes can sustain and below by a social foundation guaranteeing sufficient accessibility for all. Four operational principles give the paradigm planning content: sufficiency, ecological primacy, reversibility, and living-network management. A necessity test, applied at plan and programme level before any corridor is designated, determines whether infrastructure is required at all. Grey and green infrastructure are not two separate systems to be traded off: they are parts of the same landscape backbone, and planning must treat them as such.

From Policy to Practice

Friday 25 September · 09:30–10:30 · Greville Smyth Park
Friday 25 September · 11:00–12:00 · Greville Smyth Park

ORAL PRESENTATION | FROM POLICY TO PRACTICE

Nature-Positive Procurement: Mainstreaming Biodiversity in Transport Infrastructure Procurement

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KEYWORDS
institutional reform, landscape connectivity, scaling pathways, long-term resilience

Despite growing awareness about the biodiversity impacts caused by transport infrastructure, a critical bottleneck to addressing them persists: infrastructure procurement strategies and processes remain ill-equipped to avoid and mitigate biodiversity impacts and generate benefits for nature. As a result, governments miss the opportunity to deliver resilient, ecologically sound transport infrastructure at scale.

The International Institute for Sustainable Development (IISD) is working with multilateral development banks, national ministries, procurement agencies and other stakeholders to mainstream biodiversity considerations into transport infrastructure procurement, as part of the Global Environment Facility-funded Greening Transportation Infrastructure Development Integrated Program (GRID IP), led by WWF. The initiative focuses on building the evidence base and practical capacity in Malaysia, the Philippines, Nepal, Ukraine, and Suriname.

This presentation outlines key barriers and enabling conditions for nature-positive procurement and aims to raise awareness on the important function public procurement has in the delivery of sustainable transport infrastructure. It will also introduce findings from IISD's research on how to embed biodiversity considerations across the procurement lifecycle. The presentation will conclude with recommendations for governments, procuring authorities and multilateral development banks to accelerate the uptake of nature-positive procurement approaches for infrastructure procurement.

ORAL PRESENTATION | FROM POLICY TO PRACTICE

Introducing practical tools for assessing and developing WVC mitigation options

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KEYWORDS
decision-support modelling, decision-making frameworks, technology expansion futures, evaluation, evidence-based mitigation

Wildlife-vehicle collisions (WVCs) pose threats to wildlife populations and human safety worldwide. Approaches to reducing WVC are numerous, diverse, and evolving, especially with recent advancements in technological solutions, including machine learning, artificial intelligence, and animal detection systems. There is a need to evaluate which mitigation measures are most valuable for development, investment, and implementation in a wide variety of contexts.

We synthesised information and learnings from a global literature review, as well as a symposium titled 'Using technology to reduce wildlife-vehicle collisions' and a subsequent one-day writing workshop, involving professionals from ecology, technology, industry and government fields held in Sydney and online in May 2024. From this synthesis we created two novel tools to assist with development and assessment of the array of WVC mitigation measures.

The first tool is a schema that is used to sort WVC solutions into functional categories. The three levels of categorisation are: intended target of behaviour change (wildlife or vehicle-operator), approach type (physical, signal-based, or detection-assisted), and positioning (wayside, in-vehicle, or non-road-based). Any WVC mitigation measure, including those not yet developed, can be applied to the schema. These categorisation allow users across multiple disciplines and levels of expertise to see the similarities and differences between the suite of mitigation options, reducing overwhelm and increasing understanding and confidence.

The second tool is an assessment framework that provides a comprehensive methodology for assessing and comparing all mitigation options. The framework guides users through steps from identifying the options and context, through assessing components of each option using the available literature, comparing options, and finally deciding future directions for development and implementation. The framework emphasises the need to assess not only the technological readiness of options, but also the robustness of scientific theory and evidence to which they are related.

Use of the tools introduced in this presentation can guide future development and implementation of WVC solutions. They can be used by ecologists, technology experts, developers, and government and private investors, and highlight the importance of each field and collaboration between them to the overall process. Both tools can be applied to any context, including varied locations, goals, budgets, and target species. They have been successfully applied in New South Wales, Australia, where investment and implementation were directed towards the most suitable options, which were targeted enhanced signage systems and improved detection systems for Australian species, in this context.

The tools introduced identify and bridge gaps within and between technological and ecological fields, avoid common past issues, increase efficiency of implementation, and conceptualise, categorise, visualise, and guide the advancement of WVC mitigation and a suite of other infrastructure solutions

ORAL PRESENTATION | FROM POLICY TO PRACTICE

Rethinking traffic thresholds in wildlife-vehicle collision risk

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KEYWORDS
wildlife mortality assessment, barrier permeability, spatial planning, adaptive management, species behavioural response

Wildlife–vehicle collisions (WVC) occur when animal movement coincides with vehicle presence on roads. Traditionally in road ecology, coarse metrics such as annual average daily traffic volume or road categories have been used as a proxy of vehicle presence on roads. However, such coarse measures ignore the influence of temporal activity patterns (both commuter and wildlife activity) on the risk of collisions, and miss true fine-scale (i.e., hourly) fluctuations in traffic volume and wildlife crossing activity. While human activity is structured around 'clock-time', wildlife are predominately active in accordance to 'sun-time' and seasonal cycles. By the nature of these two different scales, there are times of the day and year where commuter activity and wildlife activity patterns synchronize and desynchronize. As a result, the risk of collisions are roads are not static, rather temporally dynamic, yet these patterns have yet to be described in the literature. Using WVC data combined with hourly resolved traffic curves, we demonstrate how WVC risk fluctuates through the day, and that local threats of WVC occurrence are better explained by relative hourly traffic intensity, rather than absolute traffic volume. Furthermore, using periods of daylight-saving time shifts as a natural experiment, we demonstrate that sudden shifts in commuter traffic towards crepuscular hours increases the risk of WVC with crepuscular-active species such as roe deer. Together, these findings suggest that there are no uniform absolute traffic volumes at which a road can be deemed to be of high or low WVC risk. Rather the local risk of WVC change over the day and year, and are predominately representative of when, and where, human activity and local wildlife activity overlap. Our results highlight the importance of considering fine-scale temporal traffic dynamics and the synchronization with high wildlife activity when assessing WVC risk and designing mitigation strategies.

ORAL PRESENTATION | FROM POLICY TO PRACTICE

Advancing Sustainable Transport in the Tropics: Brazil's National Guidelines for Wildlife Mitigation on Federal Highways

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KEYWORDS
decision-making frameworks, landscape connectivity, spatial planning, fauna passage design, retrofitting infrastructure

The expansion of transport infrastructure across tropical regions poses significant challenges for biodiversity conservation, particularly in megadiverse countries where road networks intersect critical habitats. In this context, Brazil has taken a decisive step toward integrating ecological principles into infrastructure planning through the publication of the technical volume Road Safety and Wildlife Conservation: Mitigation Measures to Reduce Impacts on Wild Animals on Brazilian Federal Highways, developed by the Ministry of Transportation (DNIT). This book represents the first nationally standardized framework in Brazil dedicated to mitigating wildlife–vehicle collisions and enhancing landscape connectivity across federal highways. It compiles scientific evidence, technical guidelines, and operational procedures for the planning, design, and implementation of mitigation measures, including wildlife crossings, canopy bridges, fencing systems, and traffic-calming strategies. The publication also incorporates lessons learned from large-scale case studies, such as the highway BR-262 mitigation program in the Pantanal biome and canopy bridge initiatives in the Amazon, demonstrating the feasibility of applying evidence-based solutions. By institutionalizing best practices and aligning engineering with ecological knowledge, the publication framework supports Brazil in transitioning toward a more sustainable model of road infrastructure, one that simultaneously enhances road safety and safeguards biodiversity. This work underscores the critical role of science-based policy and cross-sectoral coordination in reconciling infrastructure development with the conservation of tropical biodiversity.

ORAL PRESENTATION | FROM POLICY TO PRACTICE

Liability for Wildlife–Vehicle Collisions in Europe: What Legal Responsibility Means for Reporting and Management

Michal Bíl

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KEYWORDS
decision-making frameworks, monitoring, wildlife mortality assessment, cross-boundary coordination

Wildlife–vehicle collisions are a persistent challenge for transport systems and wildlife conservation, raising questions not only about prevention but also about responsibility when accidents occur. Because wild animals are not controlled by a single owner and collisions are influenced by road design, traffic, and wildlife management, assigning liability is often contested and can shape how different actors respond. This contribution presents results of an international study involving representatives from almost all parts of Europe, synthesizing current approaches to liability for wildlife–vehicle collisions and considering how legal frameworks may affect the willingness to report incidents and the quality of available data. We compiled information through a structured questionnaire completed by national experts, complemented by follow-up clarification, to capture both formal rules and practical procedures applied after a collision. The review highlights substantial diversity among countries and, in several cases, within countries depending on context (e.g., road type, mitigation measures, driver behaviour, or the species involved). Liability may rest with drivers, road authorities or operators, hunting or wildlife-management organisations, or may be absent altogether. We show how these arrangements can create incentives to transfer responsibility, discourage reporting, or shift recording duties between institutions. We argue that understanding liability frameworks is essential for interpreting cross-country differences in collision statistics and for designing reporting systems that support evidence-based mitigation. Finally, we outline pragmatic directions for improving coordination among stakeholders and aligning liability and reporting practices with the shared goals of road safety, animal welfare, and effective targeting of mitigation measures.

ORAL PRESENTATION | FROM POLICY TO PRACTICE

Seasonal peaks in water deer roadkill associated with reproductive cycles: implications for mitigation strategies

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Roadkill is a major source of wildlife mortality, yet its temporal dynamics are often overlooked in mitigation planning. This study shows that roadkill risk in water deer (Hydropotes inermis) is not constant throughout the year but is concentrated during specific periods associated with reproductive cycles.

Using nationwide roadkill data collected through the Korea Roadkill Observation System from 2023 to 2024, we identified clear seasonal peaks in April–June and November–December. These periods correspond to key reproductive phases, including late pregnancy, parturition, fawn-rearing, and the rutting season. Camera trap data from wildlife crossing structures further supported this pattern, documenting presumed pregnant females and females with fawns during expected reproductive periods.

Although individual reproductive status was not directly verified, the consistency between temporal patterns, field observations, and ecological literature suggests that increased movement associated with reproductive behavior contributes to elevated roadkill risk.

Our findings demonstrate that roadkill risk is not uniform throughout the year and highlight the importance of incorporating seasonal dynamics into mitigation planning. These results support a shift toward seasonally targeted mitigation strategies, including seasonal speed reduction, enhanced warning systems, and targeted monitoring during high-risk periods.

Digital Innovation for Faster Decisions

Friday 25 September · 09:30–10:30 · Victoria Park
Friday 25 September · 11:00–12:00 · Victoria Park

ORAL PRESENTATION | DIGITAL INNOVATION FOR FASTER DECISIONS

Combined Wildlife Detection & AI Analysis. Combining wildlife detection with integrated data analysis options.

Gert Hamberg

Prowild, Netherlands

KEYWORDS
monitoring, systems innovation, fauna passage design, artificial intelligence applications, evaluation

Wildlife-vehicle collisions pose a significant challenge for both road safety and biodiversity conservation. At the same time, ecological monitoring often relies on fragmented, labour-intensive data collection methods that limit scalability and long-term insight generation. This study presents an integrated system that combines real-time wildlife detection with advanced data analysis capabilities, bridging the gap between infrastructure safety and ecological research.

The system operates through a multi-stage detection and verification pipeline. Radar sensors continuously monitor roadside environments and detect moving objects approaching or crossing the roadway. Upon detection, a camera system is automatically directed to the target location, where visual data is captured and processed. A generative AI engine then classifies the detected object, distinguishing between human and non-human entities and supporting species-level identification when conditions allow. When a relevant risk is identified, dynamic warning systems—such as LED signage—are activated in real time to alert drivers and reduce collision risk.

Beyond its safety function, the system generates structured, timestamped datasets that support long-term ecological monitoring. These datasets enable analysis of movement patterns, habitat use, and behavioural events, providing valuable input for scientific research and evidence-based policy development. The integration of generative AI further enhances the system by enabling natural language-based querying of recorded data, significantly reducing manual review effort and improving accessibility of large datasets.

The platform is designed for real-world deployment and can be integrated with existing infrastructure, including IP camera systems and external signalling devices. It supports real-time alerts, scalable multi-location deployment, and automated data export for further analysis. Importantly, the system focuses on detecting and classifying animals of sufficient size to ensure reliable performance under operational conditions.

By combining real-time intervention capabilities with robust data collection and analysis, the proposed system offers a dual-purpose solution: improving road safety while simultaneously advancing ecological knowledge. This integrated approach provides a foundation for smarter infrastructure, supporting both immediate risk mitigation and long-term conservation and policy objectives.

ORAL PRESENTATION | DIGITAL INNOVATION FOR FASTER DECISIONS

A new tool for effective planning of more landscape adapted solutions promoting a nature-neutral future

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KEYWORDS
landscape connectivity, decision-support modelling, spatial planning, landscape-scale restoration, retrofitting infrastructure

We have developed a new framework to quantitative analyses of how well infrastructure of different kinds are adapted to landscape regarding habitat connectivity and ecological functionality. As a proof of concept, we will present a case study where the method is applied on 11 species and organism groups that are known to be affected by transport infrastructure in different ways, including amphibians, several insects, bats, moose and roedeer. The multispecies approach enables indications on which species or groups of species that suffers most by mortality risks, noise, pollution imposed by the traffic and barrier effects caused by the infrastructure itself. This makes the model very precise about which mitigations measures that are needed to make the infrastructure more adapted to the landscape, which is not the case with similar methods suggested earlier. The method also identifies specific parts of the infrastructure that have the most severe impact on the affected biodiversity and thereby indicating where further mitigations will be most required. Our findings suggest that the new method can be a very effective tool for planners to achieve more landscape adapted infrastructure regarding both new roads and railway as improvements of the existing infrastructure. We see this as a very important part of achieving a nature-neutral future. Furthermore, the effect-based approach can be applied, not only to biodiversity, but also to other environmental aspects, such as e.g. socio-economy and people's health.

ORAL PRESENTATION | DIGITAL INNOVATION FOR FASTER DECISIONS

Artificial Intelligence for Smarter Wildlife–Vehicle Collision Mitigation Planning

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KEYWORDS
artificial intelligence applications, evidence-based mitigation, systems innovation, ecological economics, spatial planning

Wildlife–vehicle collisions represent a major road-safety and ecological challenge, particularly in regions with extensive road networks and high biological diversity. Although road authorities have implemented a broad range of mitigation measures, their effectiveness and cost vary substantially depending on traffic conditions, landscape context, and the species involved. In practice, mitigation is still often selected without a systematic procedure linking local collision patterns to the most suitable intervention. This study proposes an artificial intelligence-based framework to support strategic and cost-effective decision-making for wildlife–vehicle collision mitigation at the regional scale.

The workflow begins with a georeferenced accident database derived from the ARENA system. Collision hotspots were identified using Kernel Density Estimation (KDE), and the training dataset was expanded beyond the regional road network to include state and provincial roads in order to increase sample size and variability, resulting in 2,368 hotspot sections and 22,284 wildlife–vehicle collisions derived from 51,819 accident records for 2019–2024, excluding 2020.

Each hotspot section was then characterised through a GIS-based procedure using a 500 m buffer around the road segment. Variables were selected according to their relevance for mitigation planning and included traffic characteristics, surrounding landscape, and biological-temporal descriptors. Specifically, the analysis considered average daily traffic and mean speed; the proportion of forest, shrubland, maize crops, anthropised land, and terrain slope; and biological-temporal variables such as the proportion of collisions involving wild boar and collision seasonality. These variables were derived from traffic maps, digital terrain models, land-cover sources, crop layers, and accident records.

To identify recurrent collision contexts, a Self-Organizing Map (SOM) neural network was trained in R using a 9 × 9 structure, generating 81 initial patterns from a matrix of 2,368 hotspot sections and 9 explanatory variables. These patterns represented road sections sharing similar traffic, landscape, temporal, and species-related conditions. To reduce complexity and improve interpretability for management purposes, the 81 SOM cells were subsequently reclassified by expert judgement into 38 broader pattern groups, each representing a distinctive mitigation context.

A set of mitigation measures was then aligned with each of the 38 pattern groups on the basis of evidence regarding effectiveness and applicability. The measures considered included fencing, wildlife crossing structures, olfactory repellents, ultrasonic devices, roadside reflectors, conventional and thermal cameras, animal-detection systems, fibre optics, habitat management, roadside vegetation clearing, traffic calming, intelligent warning signs, and conventional signage. Finally, a cost-benefit analysis was performed by combining mitigation costs and effectiveness with the estimated economic losses associated with collisions by species, allowing return-on-investment periods to be calculated for each road section–measure combination. This makes it possible to rank interventions according to expected efficiency and to guide more rational public investment.

ORAL PRESENTATION | DIGITAL INNOVATION FOR FASTER DECISIONS

Preserving Permeability Through Machine Learning – Connectivity and Suitability Through the Eyes of a Bat

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KEYWORDS
ecological resilience, landscape connectivity, evidence-based mitigation, decision-support modelling, artificial intelligence applications

Accelerating climate change and continued landscape fragmentation are placing unprecedented pressure on the UK's ecological networks. With the UK Government's emerging rhetoric and the introduction of the Planning and Infrastructure Act 2025, an emphasis that environmental surveys and mitigation design should be proportionate and appropriate. Therefore, survey and mitigation strategies for major infrastructure schemes need to evolve and be more strategic and innovated in their approach to understand the impacts of a scheme on the environment. Translating these requirements into practice calls for decision-making frameworks that are evidence-driven, spatially coherent and capable of operating at the scale of nationally significant infrastructure.

Mott MacDonald has delivered a pioneering, cross-disciplinary approach to bat habitat suitability modelling (HSM) for a major UK railway scheme, marking a significant advancement in ecological practice. The project integrated ecology, geospatial analysis and data science to establish a rigorous, efficient and repeatable framework for biodiversity assessment on large-scale infrastructure projects, ensuring a robust and defensible baseline for bats.

A central challenge in ecological assessment for major infrastructure is the persistent barrier of land access, which often constrains survey design and undermines the representativeness of ecological baselines. A central innovation was the adoption of Local Pivotal Method (LPM) sampling to design a spatially balanced network of static bat detectors. Whilst widely used in advanced statistical applications, LPM is rarely applied in UK ecological survey design. Its integration ensured even spatial coverage across the landscape, reduced spatial autocorrelation and produced a high-quality, representative dataset. By enabling targeted static detector placement and avoiding unnecessary survey effort, LPM delivered immediate benefits, including greater survey efficiency and stronger evidential confidence, and set a new precedent for scientifically robust survey design across the industry.

Building on this, we applied Integrated Nested Laplace Approximation (INLA) to develop predictive habitat suitability models that explicitly accounted for spatial dependency and uncertainty. These elements are often overlooked in traditional ecological assessments. Through a domain-driven variable selection process, our models were both statistically sound and ecologically meaningful. The resulting suite of habitat suitability maps offered a clear, defensible understanding of species distributions, directly informing design development, environmental impact assessment and targeted survey strategies.

Crucially, the framework is designed to work with citizen-science and Environmental Records Centre datasets, which are often spatially biased. Our spatial thinning and weighting algorithms correct for uneven sampling effort, enabling robust habitat suitability modelling even where field survey budgets are limited. This democratises access to advanced ecological modelling, allowing charities, local authorities and community groups to adopt techniques traditionally restricted to research institutions or major engineering consultancies.

To complement these outputs, we incorporated Circuitscape (a free, open-source ecological modelling tool that uses electrical circuit theory to predict how wildlife moves through the landscape) to model landscape permeability and functional connectivity. This cutting-edge technique enabled us to identify the most probable movement routes, highlight critical pinch points and understand how bat species might navigate a landscape undergoing substantial change by looking at conductors (habitats that allow movement) and resistors (barriers to movement). Integrating connectivity modelling at this stage and scale provided genuinely actionable insight, guiding the prioritisation of mitigation through design where it could deliver the highest ecological value and long-term biodiversity gains.

Taken together, this workflow (LPM sampling, INLA modelling, Circuitscape connectivity) represented a step-change in ecological assessment for linear infrastructure projects. It demonstrates how open-source analytical tools, when paired with ecological expertise, can transform decision-making, reduce uncertainty and support proportionate, evidence-led survey strategies and scheme design.

The integrated workflow resulted in targeted and proportionate surveys, reducing the number of surveys and effort required, whilst improving the reliability of the evidence base. In turn, this enabled estimated cost savings of millions of pounds across the lifetime of the scheme, demonstrating that innovation in ecological modelling can deliver both environmental and economic benefits.

The refined evidence base also supported more defensible impact assessments, more strategic mitigation design, and better alignment with ecological resilience objectives post-development. The combination of LPM, INLA and Circuitscape produced outputs that informed real-time design decisions, validated during ongoing project monitoring and peer review.

Together, these innovations demonstrate how advanced modelling can actively strengthen resilience through nature by enabling infrastructure design that respects ecological limits, maintains landscape permeability and avoids maladaptive outcomes. By revealing functional connectivity, identifying thresholds of ecological vulnerability and guiding mitigation toward areas of highest value, the workflow supports infrastructure that can adapt and reorganise alongside changing environmental conditions. It shows how data-driven, ecologically grounded approaches can help major projects work with natural processes rather than against them, embedding resilience, reducing cumulative impacts and ensuring that long-term infrastructure viability is underpinned by the integrity of the ecosystems it intersects.

ORAL PRESENTATION | DIGITAL INNOVATION FOR FASTER DECISIONS

Roads with digitalBio - A Biodiversity Management Platform

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Ascendi, Portugal

KEYWORDS
wildlife mortality assessment, artificial intelligence applications, decision-making frameworks, nature-based solutions, monitoring

Managing biodiversity alongside linear infrastructure requires practical tools that convert ecological knowledge into operational action. At Ascendi, we developed a GIS-based Biodiversity Management Tool, derived from our Biodiversity Action Plan, to embed biodiversity into routine infrastructure management and support evidence-based decision-making across the network.

The strategy is structured around three pillars: systematic monitoring and data analysis, communication and awareness-raising, and the implementation of mitigation and biodiversity enhancement actions across the network. The core of the system is a GIS-based platform that supports collaboration between field operatives, patrol teams, engineering managers, and biodiversity specialists. Through dedicated field applications, some featuring a gamified interface to encourage staff engagement, users can collect, georeference, and record data on species, habitats, and ecosystems. In parallel, AI models such as Fast R-CNN are integrated into the GIS to detect invasive flora, including Cortaderia selloana, in UAV-derived orthophoto maps, improving early detection and control planning while complementing data collection. The sampling framework depends on the descriptor and defined objectives; however, mobile applications enables the expansion of its scope across the network.

The system provides real-time access to spatially referenced natural values and Biological Constraints mapping, ensuring biodiversity is considered in planning and operational decisions and supporting the mitigation hierarchy across projects and maintenance activities. Aggregated data are used to generate biodiversity richness maps and ecological models that guide the prioritisation of protected areas and the design of targeted measures, including vegetation management, invasive species control, ecological restoration, and nature-based solutions for slope stabilisation and climate resilience.

Data flow framework supports the structured collection, validation, management, and dissemination of biodiversity data within Ascendi. Field data are acquired through dedicated mobile applications, enabling real-time recording of georeferenced observations and environmental parameters. All records are uploaded to internal servers for secure storage and centralized management, with a validation step in which the biodiversity team reviews submissions from non-certified users to ensure data reliability. Validated data are then integrated into internal dashboards and GIS viewers to support visualization, analysis, and decision-making. Currently restricted to internal environment, the framework is designed to evolve toward active data sharing with external stakeholders, promoting broader collaboration and knowledge exchange.

The tool also integrates animal-vehicle collision records and ecological corridor permeability assessments. Collision data collected by patrol staff are analysed using Kernel Density Estimation to identify spatial and temporal hotspots. To improve data capture and reduce human error, we are developing an automated image-based system for detecting and identifying small animals; the first phase has been successfully completed, achieving 95.5% precision. A long-term camera-trap programme has also enabled the development of a YOLOv11 model capable of identifying species and recognising animal crossings in images, with 90.8% precision and 88.3% recall. This method processes hundreds of thousands of photographs in less than an hour, reducing weeks of manual work and significantly improving monitoring efficiency.

By combining GIS, artificial intelligence, and field-based workflows, Ascendi has created an operational biodiversity framework that strengthens mitigation and supports the sustainable management of transport infrastructure.

ORAL PRESENTATION | DIGITAL INNOVATION FOR FASTER DECISIONS

Maintaining Integrity at Speed: Using AI-Powered Satellite Mapping and Scenario Modelling to Reduce Habitat Fragmentation at the Pace of Infrastructure Delivery

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KEYWORDS
artificial intelligence applications, ecological integrity at scale, evidence-based mitigation, landscape-scale restoration, remote sensing

Framework

Linear infrastructure is a primary driver of habitat fragmentation. Identifying critical severance points and establishing ecological baselines traditionally relies on slow, manual field surveys. This "perfection-seeking" approach often results in outdated data that delays infrastructure delivery and vital ecological mitigation.

Objectives

This study evaluates a hybrid digital workflow designed to accelerate ecological baselining and quantitative biodiversity scenario modelling (including BNG and regional net benefit frameworks) without compromising data integrity.

Methods

We deployed a three-stage hybrid workflow combining AI satellite analytics, mobile field validation, and automated BNG compliance engines:

Automated Remote Baselining: Satellite imagery is processed via Gentian's AI model to generate preliminary habitat classifications and landscape connectivity metrics.

Ecologist Field Validation: AI outputs are imported into Coreo for targeted, ecologist-led ground-truthing ("human-in-the-loop" validation).

Real-Time Scenario Testing: Validated baselines are evaluated in a Post-Intervention Tool to model design variants, calculate habitat unit shifts, and run automated compliance checks against statutory policy rules.

Results & Case Study Application

The framework is evaluated via a UK linear infrastructure pilot assessing: (1) baseline generation speed, (2) spatial accuracy of AI boundaries pre- and post-field verification, and (3) processing efficiency of automated ecological metric calculations versus traditional workflows. Preliminary testing indicates combining remote classification with targeted mobile ground-truthing significantly compresses timelines from spatial input to statutory reporting.

Significance & Conclusions

This workflow offers a scalable path balancing speed with scientific integrity for major infrastructure compliance. Combining remote sensing with ecologist validation shifts teams from slow, perfection-seeking baselining to dynamic, evidence-led decision-making.

Learning from Practice

Friday 25 September · 09:30–10:30 · Castle Park A
Friday 25 September · 11:00–12:00 · Castle Park A

ORAL PRESENTATION | LEARNING FROM PRACTICE

Motorway Fencing: Effectiveness, Displacement, and the Spatiotemporal "Leakage" Effect

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KEYWORDS
wildlife mortality assessment, evidence-based mitigation, monitoring, before-after evaluation, longitudinal monitoring

Continuous fencing combined with wildlife overpasses/underpasses is a primary strategy for mitigating wildlife–vehicle collisions (WVC) on motorways. Besides expected reductions in WVC on fenced motorways, two concerns remain: whether fencing displaces collision risk onto adjacent unfenced roads and if localized failures, such as fence ends or gaps, create new WVC hotspots. Here, we evaluate the effectiveness of continuous fencing and test for spatial displacement of WVC using several case studies from Czechia and Canada, while interpreting the results in the context of known “fence-end/gap” mechanisms and the value of monitoring collision patterns through time.

Across all case studies, continuous motorway fencing led to both statistically and practically significant reductions in WVC, consistent with previously reported mitigation effectiveness. Importantly, we detected no evidence of WVC displacement to adjacent lower-class roads at any spatial scale; in one case study, WVC decreased on nearby roads, likely reflecting concurrent land-use changes. Taken together, these findings support continuous fencing as an effective measure that reduces WVC without shifting risk to the surrounding roads.

However, the overall success of fencing can be undermined by spatiotemporal “leakage”. Using the STKDE+ (Spatiotemporal KDE+) method, we identified that remaining WVC on fenced road sections are often nonrandomly concentrated near fence defects, access gates, maintenance-related breaches, and fence ends. Therefore, evaluating fencing should move beyond simple counts to spatiotemporal screening. This approach allows practitioners to distinguish between successful WVC hotspot mitigation and the emergence of new risks, guiding targeted maintenance and more resilient infrastructure design.

ORAL PRESENTATION | LEARNING FROM PRACTICE

APPR Motorways - Evaluating the effectiveness of wildlife overpasses at network scale : early results from one of Europe's largest faunal monitoring programmes

Hippolyte Pouchelle[1], **François Pich**[2], **Emmanuel Millet-Delpech**[1], **Ivan Beltran**[3]

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KEYWORDS
landscape connectivity, fauna passage design, monitoring, retrofitting infrastructure, longitudinal monitoring

Habitat fragmentation caused by linear transport infrastructure remains a major driver of biodiversity loss at the landscape scale. In response, a large national programme led by motorway operators APRR and AREA has delivered 19 wildlife overpasses (ecoponts) along major French motorways, representing a total investment of approximately €80 million. Within this programme, an in-depth ecological monitoring scheme has been implemented on 10 ecoponts, forming one of the most extensive faunal monitoring programmes for wildlife overpasses currently initiated in Europe.

A key strength of this programme lies in its highly developed preparatory phase, during which the monitoring objectives, indicators and protocols were defined through an expert-led ecological design process. The monitoring framework was established by an experienced ecologist to ensure methodological consistency, multi-taxa relevance and long-term interpretability prior to field deployment. Monitoring began in 2024, was actively conducted in 2025, and will be continued in 2026 to capture temporal dynamics in ecopont use and ecological connectivity.

To deepen the assessment of ecopont functionality, the analytical approach relies on statistical comparisons between ecoponts and carefully selected reference (control) sites located in comparable landscape contexts. This comparative framework, inspired by BACI-type principles, allows the interpretation of species diversity, relative abundance and, where detectable, effective crossings while controlling for landscape structure, anthropogenic pressure and monitoring conditions.

The study focuses on ecoponts along the A6, A36 and A71 motorways in central-eastern France and targets terrestrial mammals, bats, amphibians and reptiles. Complementary protocols combine camera trapping, amphibian transects, environmental DNA, reptile surveys, acoustic monitoring of bats and 3D bat flight-path reconstruction using acoustic trajectography. Given the very large volume of data generated by camera traps (50), artificial intelligence tools were used to pre-classify images, significantly improving data processing efficiency, before expert validation and ecological analysis. Camera-trap monitoring has also documented the presence of the Eurasian lynx (Lynx lynx), highlighting the role of these ecoponts within functional corridors used by large, conservation-sensitive carnivores.

Preliminary results reveal strong inter-site variability driven by landscape context and species ecology. While diversity and abundance indicators are often higher on reference sites, ecoponts show clear evidence of use by multiple taxa, including large mammals, bats and amphibians. These early findings demonstrate both the ecological potential of wildlife overpasses and the necessity of long-term, large-scale monitoring coupled with reference-site comparisons to robustly evaluate functional connectivity outcomes.

This contribution aligns with the IENE 2026 themes "Pace Over Perfection" and "Creating Actionable Knowledge", illustrating how advanced monitoring tools can inform adaptive management and future wildlife crossing design at infrastructure network scale.

ORAL PRESENTATION | LEARNING FROM PRACTICE

AIoT VS traditionnal camera trap monitoring system to assess fauna passages' efficiency : a GHG perspective.

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KEYWORDS
landscape connectivity, longitudinal monitoring, artificial intelligence applications, fauna passage design, evidence-based mitigation

Introduction

Following the recent recommendations to assess mitigation measure efficiency, more and more camera-trap-based monitoring systems are deployed over large landscapes leading to massive transport needs of field operators as well as large image storage infrastructures.

Based on the current 3 years (2025-2027) survey of 15 overpasses conducted by the French motorway manager APRR, we compared the relative performances between traditionnal and AIoT (connected cameras with AI embedded systems) camera trap surveys in terms of GHG production.

Methods

The analytical framework consists in the deployment of about 100 cameras to monitor 15 sites along the 1900km of the motorway network following a control impact design. Images are therefore analyzed with deep learning algorithms. Finally, relative abundance and species diversity of control sites and fauna passages are used to assess the overpasses efficiency.

Within this analytical framework, the traditionnal system uses classical camera traps and the images must be collected on the fied by operators and are therefore analyzed with large deep learning models. The AIoT system considers the replacement of classical camera traps by AIoT ones embedding lighter specialized deep learning models and communication system which sends the image analysis thanks to its connected functionnalities (GSM, Lora, etc.).

As AIoT cameras are still prototypes, only 8 have been deployed on a single site exactly at the same place as classical ones. On this site, selected for it's species diversity and intense animal activity, we compared the detection and recognition ability of the AIoT camera with those provided by the traditionnal system (classical cameras with large deep learning algortithm). Autonomy performances obtained on this single site of high activity was then applied to the comprehensive monitoring deployment to assess field operator travels requirement for the whole system maintenance.

The methods proposed by the French energy agency (ADEME) to estimate GHG emission of transport and digital systems were used to assess the emission produced by both the system. As this exploratory work occurred the second year of the survey, we performed our GHG emission estimation based on the actual distances travelled by field operators and the actual image production during the two first years.

Results

Results show that ecological performances estimators are equivalent for both the systems while traditionnal system provides more detailed informations. The AIoT cameras allows a drastic GHG emission reduction. Indeed, the GHG emission related to field work transport reduces by 65 % and the data storage emission are divided by 10 8 .

Discussion

Both the systems have benefits and drawbacks in terms of balance between ecological targets and GHG emission produced by ecological surveys. Classical systems, allows for more detailed analysis and missed less species (especially rare ones) than the AIoT one. However, it is much more time consuming and emits much more GHG.

Finally, we explore further deployment opportunities which may combine the advantages of both the systems in the short to medium term.

ORAL PRESENTATION | LEARNING FROM PRACTICE

What makes wildlife crossing structures work? Structural and environmental determinants of mammal use at overpasses across South Korea

Jiyun Kim

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Road infrastructure is a leading driver of habitat fragmentation, yet empirical evidence on which structural and environmental factors govern wildlife crossing structures effectiveness remains sparse, particularly for national-scale assessments across East Asia.

We monitored mammal use of overpass-type wildlife crossing structures across four provinces of South Korea using camera traps operated between April and November 2024. Nine target species were surveyed spanning large and medium body sizes — including three nationally threatened species (leopard cat Prionailurus bengalensis, yellow-throated marten Martes flavigula, and Eurasian otter Lutra lutra). Wildlife use was quantified using the Relative Abundance Index (RAI) and species richness (mean: 7 species per crossing, range: 4–13).

Multiple linear regression identified crossing length, entrance slope gradient, and daily average vehicle speed as significant predictors of mammal use. Species richness increased with crossing length (β=0.034) and decreased with steeper entrance gradients (β=–0.051). Higher vehicle speeds were positively correlated with species richness — a counterintuitive result likely reflecting road-barrier pressure channelling animals toward crossing structures (adj. R^2=0.479, $p<0.001$).

These findings demonstrate that simple, measurable structural and environmental attributes can reliably predict wildlife crossing structures effectiveness at a national scale. Notably, entrance slope gradient emerged as a critical determinant of mammal use, providing empirical support for slope criteria recently incorporated into South Korean design guidelines.

ORAL PRESENTATION | LEARNING FROM PRACTICE

Assessing Landscape Fragmentation Dynamics using IDFK method: Time series 1990 – 2033 for the Czech Republic

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KEYWORDS
landscape connectivity, ecosystem function, decision-making frameworks, spatial planning, strategic defragmentation

Introduction

Landscape fragmentation is a critical anthropogenic threat to biodiversity, primarily driven by linear transport infrastructure. Traditional quantification methods, such as Unfragmented Areas by Traffic (UAT) and effective mesh size (meff), exhibit methodological limitations by treating all infrastructure elements as absolute, impermeable barriers. This binary approach ignores real-world barrier permeability influenced by traffic volume and the presence of technical mitigation measures.

Methodology

The Landscape Fragmentation Dynamics Indicator (IDFK - Indikátor Dynamiky Fragmentace Krajiny from the Czech language) introduces a functional approach by modelling partial permeability of barriers on a gradient from 0.0 (impermeable) to 1.0 (fully permeable). The core of the calculation is the Migration Potential (MP), determined for each technical object (bridges, tunnels, underpasses) as a product of its technical potential (MPT – dimensions and openness) and ecological potential (MPE – quality of surrounding land-use). Unlike older metrics, IDFK integrates Annual Average Daily Traffic (AADTI) to adjust barrier effects of non-motorway roads, acknowledging that lower traffic allows for spontaneous permeability.

Data and Scenarios

The methodology was applied to the Czech Republic through retrospective scenarios (1990, 2000, 2010, 2020) and a predictive model for 2033. Data sources included Corine Land Cover (CLC), ZABAGED®, and official traffic census data. The 2033 scenario incorporates planned highway completions (aiming for 2,000 km in total) and new high-speed rail (VRT) corridors.

Results and Discussion

The analysis confirms a progressive trend of increasing fragmentation. In 1990, 78% of the territory was classified as having low or very low fragmentation; by 2020, this dropped to 52%, meaning a quarter of the national territory suffered significant connectivity degradation in three decades. The average IDFK value decreased from 247 km² in 1990 to 116 km² in 2020, with a further decline to 101 km² predicted by 2033. Comparative analysis shows that IDFK consistently yields higher connectivity values than because it recognizes the functional impact of implemented migration objects, proving that barrier effects can be partially mitigated through strategic investments.

Conclusion and Policy Implications

The IDFK has potential to become GIS-based tool for spatial planning and strategic decision-making and supports Strategic Environmental Assessments (SEA/EIA), enabling multi-temporal evaluation and feedback-based verification of ecological investments on a macro-scale. By transcending binary barrier models, this approach offers a refined representation of landscape connectivity essential for sustainable infrastructure development.

Wildlife Connectivity Across Linear Infrastructure

Friday 25 September · 09:30–10:30 · Ashton Court

ORAL PRESENTATION | WILDLIFE CONNECTIVITY ACROSS LINEAR INFRASTRUCTURE

Rail networks and ecological corridors: Between conflicts and opportunities for crossing.

Tess Heydorff-Decaux[1,2], **Céline Clauzel**[1,2], **Laura Clévenot**[1,3], **Anne Petit**[3]

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KEYWORDS
wildlife mortality assessment, landscape connectivity, species behavioural response, evidence-based mitigation, barrier permeability

This study, conducted as part of a PhD research project, investigates the interactions between movement networks of wild ungulates (roe deer, red deer, and wild boar) and the railway system, focusing on a railway section in southern Brittany, France. The study aims to identify (i) the factors driving conflict zones between these two networks, as reflected by wildlife–train collisions, and (ii) the conditions that promote safe crossings of railway infrastructure. Particular attention is given to non-wildlife-specific structures (e.g., underpasses and overpasses originally designed for roads, paths, or waterways), which may serve as crossing opportunities for animals.

Wildlife activity around forty such structures was monitored using camera traps over a one-year period. Data on structure use, combined with collision records collected by railway operators, were analyzed both spatially and temporally. These data were then related to a range of explanatory variables operating at multiple spatial scales, including landscape composition, structural and anthropogenic factors, as well as functional connectivity.

The results highlight the key role of landscape composition, particularly the proportion of forested and agricultural areas, and railway traffic at dawn in explaining both the location and intensity of collisions. Regarding non-dedicated crossing structures, successful crossings were mainly observed in roe deer, while wild boar crossings were infrequent and no red deer crossings were recorded. Roe deer tended to use structures located in less forested, more heterogeneous landscapes and with low road traffic disturbance. In contrast, wild boar were primarily detected near these structures for foraging purposes, and could prefer crossing railway tracks directly rather than using non-dedicated structures when no physical barriers are present.

These interspecific differences underline the need for species-specific management strategies. More broadly, this study contributes to a better understanding of how railway networks affect ecological connectivity by jointly considering the drivers of both safe crossings and collision risks. In particular, it emphasizes the functional role of certain non-dedicated structures in facilitating roe deer movements. These findings have practical implications, notably for identifying existing structures that could effectively channel ungulate crossings in fenced sections, and for improving the spatial targeting of collision mitigation measures.

ORAL PRESENTATION | WILDLIFE CONNECTIVITY ACROSS LINEAR INFRASTRUCTURE

Developing Guidance for Wildlife-Friendly Linear Infrastructure: Lessons from Asian Elephant and Snow Leopard Landscapes

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KEYWORDS
cross-boundary coordination, fauna passage design, evidence-based mitigation, spatial planning, avoidance

Linear transport infrastructure poses significant and growing threats to wide-ranging species, particularly in regions where roads and railways increasingly intersect critical habitats. Among the most affected are Asian elephants and snow leopards, species whose large spatial requirements and sensitivity to fragmentation make them especially vulnerable to infrastructure development. In response, two international, multi-stakeholder initiatives have produced comprehensive guidance to support more wildlife-friendly infrastructure planning and design: The Handbook to Mitigate the Impacts of Roads and Railways on Asian Elephants , developed by the Asian Elephant Transport Working Group (AsETWG), and Guiding the Future of Linear Infrastructure Development in Snow Leopard Landscapes , developed for the Global Snow Leopard and Ecosystem Protection Program (GSLEP).

Despite differences in ecological and socio-political contexts, the two initiatives converge on common principles: the need for standardized guidance, evidence-based decision-making, and adaptive management grounded in monitoring. They also underscore persistent challenges, including data gaps, limited technical capacity, and inconsistent policy implementation.

This presentation will cover the history of engagement with the AsETWG and the GSLEP on the issue of sustainable infrastructure that led to the development of the guidelines and the power of such institutions to convene unlikely partners and governments. We will also discuss how both documents have catalyzed deeper conversations and workshops with governments toward policy on sustainable infrastructure, with elephants and snow leopards serving as highly effective ambassadors for the topic. We will demonstrate how a guidance document, with capacity building and support for implementation, can engage important new regions and stakeholders on sustainable infrastructure.

ORAL PRESENTATION | WILDLIFE CONNECTIVITY ACROSS LINEAR INFRASTRUCTURE

Mapping microhabitat refuges along railway verges using connectivity, microclimate and vegetation structure

Adriana Príncipe[1], Josep Serra Gallego[2], Reto Schmucki[2], Jeff Ollerton[3,4], Fernando Ascensão[1]

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KEYWORDS
decision-making frameworks, landscape connectivity, spatial planning, landscape-scale restoration, remote sensing

As railway networks expand worldwide and urban connectivity increases, there is renewed attention to the contribution of railway verges in supporting biodiversity. Although railways, like other linear infrastructures, contribute to the fragmentation of natural and semi-natural ecosystems, railway verges can also function as important ecological corridors and habitat refuges for several species. Identifying priority verges for conservation and microhabitat creation can therefore support targeted ecological restoration actions, with the potential to enhance biodiversity at both local and regional scales.

However, mapping existing and potential microhabitats along railway verges remains challenging. High-resolution spatial data offer new opportunities to overcome this limitation. In this study, we use spatial and ecological connectivity metrics to assess verge connectivity, alongside microclimatic conditions driven by topography and vegetation structure, as key variables for identifying microhabitats within railway verges.

Ten study sites were selected along ten major railway lines in Portugal, spanning a macroclimatic gradient. Our objectives are to identify: (1) microhabitats of high ecological importance across different surrounding land-use matrices; (2) topographically driven microclimatic conditions associated with vegetation structure on railway verges; and (3) vegetation structure that can create additional microclimatic conditions and macrohabitats that enhance local biodiversity.

For that, we will use high-resolution topographic variables (<50cm 2) and vegetation structure indices derived from remote sensing data (e.g., LiDAR and orthophotos) to calculate microclimatic conditions and the diversity of vegetation structure over railway verges. Biodiversity will be assessed using passive acoustic devices to estimate bird diversity, and vegetation surveys using quadrats to evaluate plant diversity in microhabitats with contrasting microclimatic and vegetation structure conditions.

Preliminary results show that the vegetation structure of herbaceous and shrub species is affected by microclimatic conditions derived from topography, but that does not apply to adult trees. This study contributes to establishing a framework for mapping potential microhabitats using connectivity and microclimatic conditions, which can direct ecological restoration actions on railway verges and other linear infrastructures to increase connectivity and support biodiversity by facilitating species dispersal across fragmented landscapes.

Interactive Platform for Collaborating on Nature Connectivity with Various Partners

Friday 25 September · 13:00–14:00 · Castle Park A

ORAL PRESENTATION | INTERACTIVE PLATFORM FOR COLLABORATING ON NATURE CONNECTIVITY WITH VARIOUS PARTNERS

Interactive platform for collaborating on nature connectivity with various partners.

Thomas Impens[1],
Jan Mampaey[1],
Sara Maes[2],
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KEYWORDS
landscape connectivity, decision-making frameworks, decision-support modelling, spatial planning, strategic defragmentation

Flanders has a very high fragmentation rate, due to a highly developed transportation network of railways, artificial waterways and roads. Nature is spread thin, with only a few larger reserves and even fewer connecting routes. Creating new ecological corridors is a challenge, because they cross a large number of different land uses and functions within the landscape.

It is therefore important to easily involve potential partners in the creation of ecological corridors. However, policies and actions towards defragmentation are spread over different levels of competent authorities: federal, regional, provincial and municipal authorities need a way to work together to achieve a stronger nature connectedness over the Flemish territory.

Together with various partners (provincial and Flemish), we developed a method to identify opportunities for ecological connectivity within the landscape. The output consists of map layers which, based on ecological data, identify the best ecological corridors for four major habitat groups representing four groups of animal species. These layers take into account both established spatial policy and the ecological characteristics of the species groups. The species groups represent a collection of both European protected species and regional priority species.

The method therefore contributes to both European and more local biodiversity targets. It provides a basis for linking ecological corridors in Flanders to the Trans-European Nature Network.

The map layers can be easily accessed via an online tool in a GIS environment. In the next phase, we aim to integrate the tool into an interactive platform. This platform provides the available spatial information on potential ecological corridors, but also serves as a space where partners can add comments, additions, opportunities and priorities to the map layers. The interactive platform communicates the shared vision on ecological corridors held by the Flemish and provincial authorities and enables potential partners active in the open space sector to engage in dialogue.

In this workshop, we aim to explain the method we have developed and demonstrate the capabilities of the online tool. Through dialogue with participants, we want to learn about the networks of ecological corridors that exist in other European countries and how these are communicated. We also want to further test how participants experience the various features of the interactive platform. Lastly we want the participants to take home some new insights as well, shared during the workshop.

Translating Knowledge into Practice: Identifying Skills Gaps, Delivery Modes, Opportunities and Challenges

Friday 25 September · 13:00–14:00 · Ashton Court

Translating Knowledge into Practice: Identifying skills gaps, delivery modes, opportunities and challenges

Heather Rumble, Danielle Sinnett

University of the West of England (UWE), Bristol, United Kingdom

KEYWORDS
nature-based solutions, ecological resilience, social–ecological systems, ecological and social values, decision-making frameworks

Draft session plan: This can be tailored to conference session length, but would ideally be of 60 minutes or more

Participants: Infrastructure planners, engineers, ecologists, consultants, policymakers, researchers and educators

1. Framing and Context (10 minutes)

Session leads introduce the challenge of translating evidence into delivery at scale, briefly outlining lessons from the 10-day WECA green infrastructure CPD programme. This includes:

- Where practitioners engaged most strongly with evidence
- Where practitioners felt implementation barriers persisted
- The value of integrated learning across ecology, design, delivery and governance

This sets a shared baseline and positions training as a strategic intervention for connectivity, mitigation and restoration across infrastructure systems. We would seek testimonials from our network of other CPD/training providers (CIEEM, RTPI, WENP) ahead of the session to share in our presentation. The session would be open to all, with a sign-up sheet available to gauge numbers on the day/cap participation based on room size.

2. Structured Small-Group Discussion (30 minutes)

Participants break into small, facilitated groups, guided by prompt questions focused on:

- Critical intervention points: Where in infrastructure lifecycles training has the greatest leverage
- Knowledge formats and narratives: What types of evidence, tools and stories resonate with different professional audiences
- Skills gaps: Priority gaps limiting nature-positive outcomes (e.g. ecological literacy, long-term performance monitoring)
- Delivery models: What has worked (and not worked) in existing CPD, in-house training, regulatory guidance or informal learning

Groups will be encouraged to link discussion back to real projects, networks and cross-boundary contexts.

3. Synthesis and Collective Prioritisation (20 minutes) + opportunity to develop further after the conference

Groups report back key insights. The facilitators lead a live synthesis, clustering ideas into shared principles and prioritising those with the greatest potential to accelerate evidence-led implementation.

Expected Outputs

The session and follow-on work will generate

- A practitioner-focused framework identifying when, how and for whom nature-positive infrastructure training is most effective
- A prioritised list of sector-wide skills gaps constraining connectivity, mitigation and restoration at scale
- A set of actionable principles for training and capacity-building, applicable across infrastructure types and governance contexts

These outputs aim to support the conference theme by moving beyond evidence presentation to practical mechanisms for embedding long-term ecological performance into infrastructure systems, which we would aim to publish as a collaborative peer-reviewed article or trade journal article.

Scaling up Action for the Climate and Ecological Emergencies in the West of England

Friday 25 September · 13:00–14:00 · Greville Smyth Park

ORAL PRESENTATION | SCALING UP ACTION FOR THE CLIMATE AND ECOLOGICAL EMERGENCIES IN THE WEST OF ENGLAND

Scaling up action for the climate and ecological emergencies in the West of England

Mia Ridler, Charlie McGuin, Louise Clancy

West of England Combined Authority, United Kingdom

KEYWORDS
decision-making frameworks, climate adaptation, nature-based solutions, cross-boundary coordination, retrofitting infrastructure

Who will be on the panel?

This is to be decided depending on the required seniority of other panellists.

Assuming it is not an Executive Director Panel, it will possibly be Louise Clancy, Senior Environment Manager Sustainable Transport or Chris Salmon Head of Transport Directorate Planning & Interim

Head of Transport Programmes.

Examples of work and outputs being developed and delivered by the MCA and Partners.

Nature Recovery and Biodiversity

The MCA's Nature Recovery proposals enable MCA-funded transport projects to support nature recovery and placemaking - benefiting local communities, as well as mitigating against the detrimental impacts to nature the highway network has in terms of habitat severance.

It is proposed that major corridor schemes under permitted development will be subject to minimum 10% BNG (currently there is no requirement), with an aspirational target score of 20%. This will help to ensure that all major transport corridor projects make a positive contribution to nature recovery, enabling consistency and delivery at scale. Schemes will have the flexibility in how they deliver effectively for nature and within project budgets, for example with regards to project boundaries or through achieving their BNG in Local Nature Recovery Strategy (LNRS) focus areas– those pinpointed as the areas in the region where nature recovery will be most impactful. The West of England has a rich nature heritage, and this will demonstrate how we embed the LRNS into our work.

We also recognise the importance of providing for nature within our urban areas, which is reflected in the proposals for all urban transport schemes to deliver an uplift in Urban Greening Factor Score, with an aspirational, but not mandatory target score of 0.25. BNG was not deemed to be the most effective measure to incorporate into particularly urban schemes, so UGF was seen as an appropriate alternative to achieve maximum benefits for nature recovery. This approach is new for transport schemes. We will collect data on UGF scores achieved and lessons learned to help inform a potentially mandatory UGF score for future schemes to ensure that we are remaining as ambitious and impactful as possible with regards to embedding nature recovery into our urban realm through our transport infrastructure projects. Alongside helping to enhance nature recovery in the region's urban environment, this requirement will also provide multiple benefits, such as enhanced climate resilience, green spaces, improved resident health & wellbeing, and better placemaking.

Talking points for the panel discussion could include

- Recognition that transport schemes provide important public sector funding that helps to address market failures – such as the case for the ecological and climate emergencies. That it can be an important catalyst for other sectors (e.g. housing). But the transport schemes must still deliver their objectives, so policy proposals need to be designed reasonably and proportionately.
- The challenging context for embedding climate and ecological proposals into transport infrastructure, such as the scrutiny of costs and the lack of cost data for rolling out at scale.
- The benefits for being ahead of legislation – designing a process that works best for the region and enables flexibility in delivery.

- This is the start – solid foundations, but now it's time to develop a delivery model that will look at how we can test, trial and roll out sustainable solutions such as SUDS.

Nature Engagement Pilot

Nature engagement provides an opportunity to encourage people to become more aware of different transport options. As well as understand the nature benefits of the schemes we deliver on their doorsteps. It helps to boost connections with local habitats, fostering a sense of stewardship, and providing health and wellbeing benefits.

We are using the Bristol to Bath Railway Path (BBRP), an active travel route running between Bristol and Bath, as a pilot for nature engagement. Interventions include interpretation boards highlighting the interesting and ecologically important species along the corridor – for example, there are 4 rare, nationally important bat species and glow-worms. We are also planning on going into local schools to construct insect hotels which will be installed along the corridor, with a nature-based educational element built into these workshops, and are looking to commission a local artist to work with community groups to produce some artwork depicting local nature along the path. These interventions, along with other local and national examples, will form the basis of the toolkit for project managers can use to incorporate nature engagement into their projects.

SuDS

Many transport schemes involve retrofitting into existing highway / area boundaries. For example – creating a cycle or bus lane, improving walking routes, new bus stops, bringing an existing rail line back in to use. These projects create challenges when looking to deliver sustainable drainage or any form of biodiversity enhancements, with limited space and other utilities and other infrastructure present. Not only is space as issue, but fully understanding the benefits (cost and wider) of including sustainable drainage in comparison to traditional drainage and the long term costs of implementing them. The MCA working in partnership with the Resilience Frome project, which brings together stakeholders including Wessex Water, Network Rail, National Highways, with key staff in the local authorities – maintenance, highways, parks for a workshop.

We hosted a joint workshop to interrogate barriers to sustainable drainage and the solutions and how the region could improve delivery of SuDs. The findings from this workshop are informing a tool that the MCA is developing on whole life costing of SUDS. This will allow projects to compare different design options for drainage (grey and green) and include the delivery costs, maintenance costs, and natural capital benefits. The tool will also include the ability to show where costs and benefits are distributed and which budgets sustainable drainage will support.

Mobilising Nature

The West of England Nature Partnership has priority programmes for the region, one of which is 'mobilising nature' and tacking transport severance. The MCA has begun support this programme by convening key partners in Network Rail and National Highways to discuss the opportunities to work together with UAs to explore locations where all partners can contribute to connecting habitats and enabling the mobilisation of nature.

Environment Reference Guide and Environment Engagement Series

The MCA created a best practice guide that supports sustainable infrastructure. This guide details questions to ask during project lifecycle stages, case studies and best practice examples where enhanced benefits have been delivered. This guide has a specific nature and biodiversity theme where projects can view examples of where others have gone over and above their statutory duties to deliver for nature. This guide is shared with all partners and for new transport projects will be an essential step to review and explore if those examples can be integrated into their project. To make this guide more meaningful, the MCA developed a series of in person events where guest speakers from those case studies in the guide and other examples come and speak to key stakeholders about their experiences and successes when delivering enhanced environmental benefits and outcomes. Bringing our key stakeholders together to explore different opportunities it an essential part of delivering at scale.

Planning with Nature: Decision-Support Tools and Approaches for Sustainable Infrastructure

Friday 25 September · 13:00–14:00 · Victoria Park

ORAL PRESENTATION | PLANNING WITH NATURE: DECISION-SUPPORT TOOLS AND APPROACHES FOR SUSTAINABLE INFRASTRUCTURE

Planning with Nature: Decision-Support Tools and Approaches for Sustainable Infrastructure

Hamza Butt

UNEP-WCMC, United Kingdom

KEYWORDS
evidence-based mitigation, decision-making frameworks, biodiversity loss, systems innovation, decision-support modelling

Infrastructure decisions are often made before biodiversity risks, ecological connectivity, and cumulative impacts are adequately understood. This panel brings together practitioners demonstrating decision-support tools that can bring biodiversity considerations upstream, so nature becomes a core input into infrastructure planning, siting, design, and investment rather than an afterthought.

Rationale

There is no shortage of tools that claim to support sustainable infrastructure development. The more difficult task is ensuring that these tools are used early in the planning (and pre-planning) and embedded deeply within planning and decision-making processes to influence outcomes. Across roads, railways, transmission lines, energy, and other infrastructure, biodiversity considerations still too often enter the process late, when options have narrowed, and harmful impacts are harder and more costly to avoid.

This panel responds to that challenge by focusing on decision-support tools that can improve both the quality and timing of infrastructure decisions. It brings together practitioners working with tools that serve distinct functions across the infrastructure cycle: MESA for spatial screening and environmental sensitivity analysis; IBAT for biodiversity data, screening, and due diligence; and ENCORE and the WWF Risk Filter for nature-related risk assessment. Together, these help identify sensitivities, compare alternatives, support strategic planning, and strengthen implementation of the mitigation hierarchy. The aim is not only to showcase tools, but to discuss how they can be used in ways that are credible, accessible, and genuinely decision-relevant.

Session format

Panel presentations, followed by discussion. Each panelist presents and demonstrates one tool alongside its real-world application, followed by a facilitated discussion on barriers to uptake and factors that make tools influential in practice.

Session objectives

- Showcase practical tools and approaches that improve sustainable infrastructure planning and delivery.
- Demonstrate how MESA, IBAT, ENCORE, and the WWF Risk Filter can support screening, siting, spatial prioritisation, due diligence, and risk and mitigation planning.
- Explore barriers to uptake, including data gaps, institutional constraints, poor interoperability, and weak links to formal decision processes.
- Generate actionable recommendations for improving the use of evidence in infrastructure policy, planning, and investment decisions.

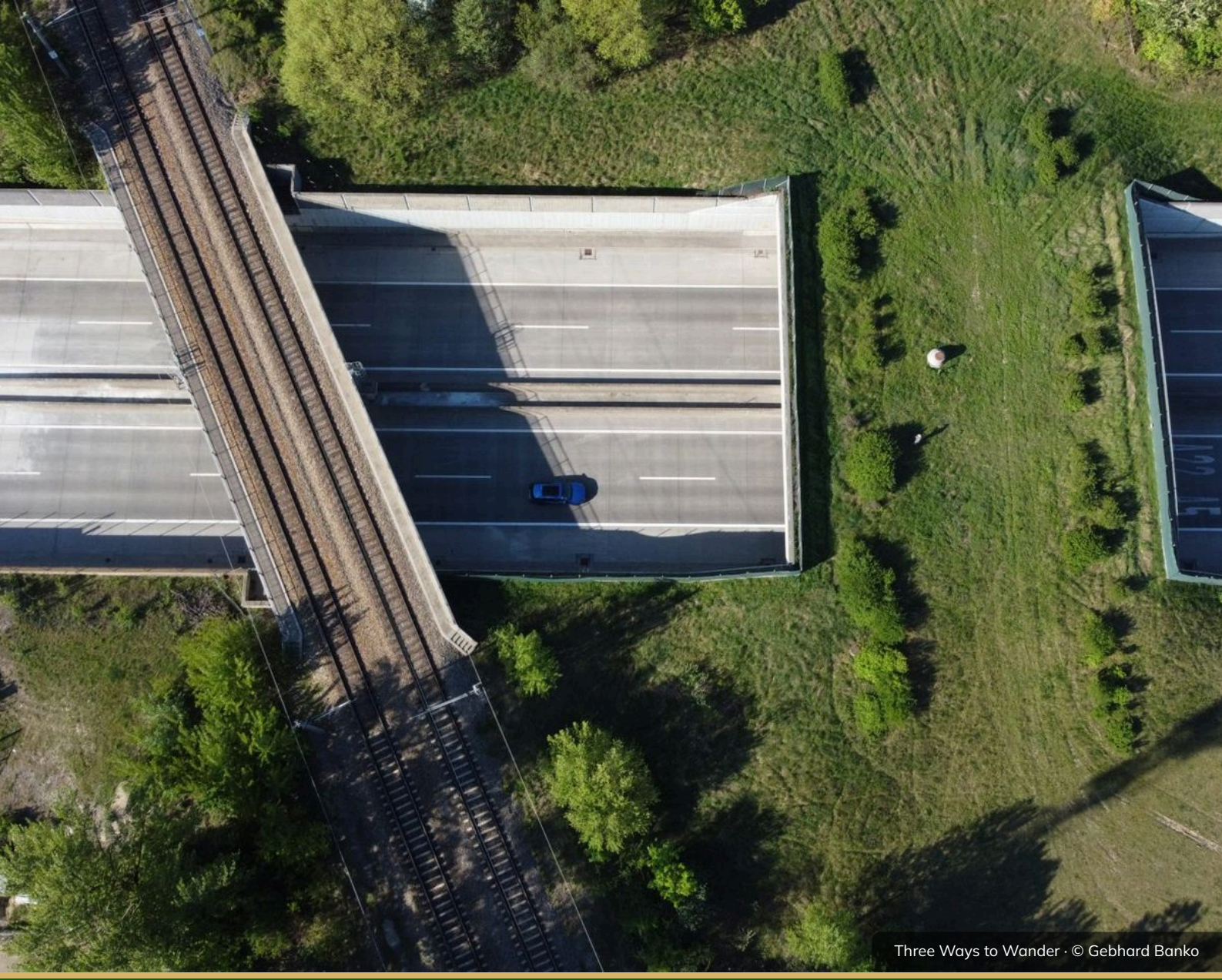
Suggested scope of contributions

- applications of MESA or other sensitivity-mapping approaches to infrastructure planning and route selection
- IBAT-enabled screening, biodiversity due diligence, or critical habitat assessments
- use of ENCORE or similar frameworks to understand nature-related dependencies, impacts, and risks in infrastructure portfolios

- application of the WWF Risk Filter to assess and prioritise biodiversity and water-related risk across sites and portfolios
- digital environmental data systems that improve access to baseline, monitoring, and cumulative impact information
- lessons on governance, data sharing, institutional uptake, and scaling tool use in practice

Expected value of the session

The panel will create a stronger shared understanding of how different decision-support tools can be used across the infrastructure cycle, what their limitations are, and what conditions improve uptake. It will also help bridge the gap between technical innovation and institutional application by drawing out practical lessons for planners, regulators, financiers, consultants, researchers, and infrastructure operators.



Three Ways to Wander · © Gebhard Banko

03

Lightning Talks

Short-format presentations, Tuesday 22 September

6 CONTRIBUTIONS

Lightning Talks

Tuesday 22 September · 16:00–17:00 · Greville Smyth Park

LIGHTNING TALK | LIGHTNING TALKS

From edge to hedge: boundary establishment techniques and the Hadley Wood hedge trials

Jon Stokes, Jackie Shallcross

The Tree Council, United Kingdom

KEYWORDS
biodiversity loss, landscape connectivity, infrastructure coherence, adaptive management, barrier permeability

The Tree Council, the UK's national charity bringing people together for the love of trees, acts as a critical friend to Network Rail in the UK to help them balance the value of nature with their operational needs. In response to local community needs and the Varley report in 2018, we supported Network Rail to test an 'innovative' old idea – the railway hedge!

Hedgerow establishment techniques including natural regeneration, seeding (the historical method) and planting whips yielded varying results but have all resulted in a manageable line-side buzzing with nature.

We will discuss how the community engagement and the proof of concept have come together to influence ongoing vegetation management at scale.

Predicting Priority Areas for Wildlife Crossings: A Connectivity Modeling Approach for Railway Infrastructure

Leonardo Rodrigues, Jéssica Souza, Isadora Oliveira

Rumo S.A, Brazil

KEYWORDS
remote sensing, decision-support modelling, landscape connectivity, decision-making frameworks, fauna passage design

Introduction

Rail transport in Brazil, although less extensive than road transport, comprises approximately 31,000 kilometers of network (ANTF) and presents significant potential for impacts on wildlife.

Due to the country's continental scale and the presence of six distinct biomes, the railway network intersects diverse ecosystems, exposing multiple faunal groups to interactions with railway infrastructure. In this context, the implementation of effective mitigation measures becomes essential to reduce impacts inherent to land transport systems, such as direct mortality, habitat loss, barrier effects, and degradation of environmental quality in surrounding areas (ABRA, 2020). Among these measures, wildlife crossings stand out, as they reduce fatalities by enabling safe animal movement and contribute to maintaining ecological connectivity, minimizing the barrier effect that railways can impose on populations.

Traditionally, the definition of such mitigation measures relies on historical monitoring data of wildlife roadkill from existing railways or highways, allowing the identification of mortality hotspots. However, in greenfield projects, where no prior collision records exist, there is a need to develop predictive approaches capable of identifying areas with a higher probability of wildlife movement along the proposed railway alignment, avoiding the need to accumulate fatalities before implementing mitigation actions.

Objectives

The implementation and operation of railways can result in habitat fragmentation and wildlife mortality due to collisions with animals. Therefore, projects have been developed to mitigate these impacts across intersected biomes, incorporating sustainable practices that go beyond regulatory compliance.

This study aims to develop a methodology capable of identifying areas with a higher probability of wildlife collisions, providing technical support for defining priority locations for wildlife crossings along future railway segments. The proposal is based on the development of a Wildlife Connectivity Model that integrates environmental variables related to ecological sensitivity and habitat connectivity, focusing on reducing biodiversity impacts and increasing landscape permeability.

Proposed Methodology

Habitat fragmentation and loss of ecological connectivity are critical drivers of biodiversity decline, as they directly affect species movement and ecosystem integrity. Studies indicate that areas with higher functional connectivity may coincide with regions of increased collision risk, as they concentrate wildlife movement flows (Pither, 2023).

In this context, connectivity models have been widely used to represent the capacity of landscapes to facilitate or restrict wildlife movement, enabling the identification of priority areas for conservation and impact mitigation. Due to limited data on species movement within the study area, the model does not consider specific species groups but instead focuses on environmental characteristics as the primary predictive factor.

The methodology was structured using tools available in ArcGIS Pro (developed by ESRI), integrating spatial variables such as land use, proximity to water bodies, and, where applicable, protected areas. This approach follows established methodologies in the literature, in which landscape metrics are used to explain and predict wildlife collisions in linear infrastructure projects.

The model was built using secondary data from recognized sources, including protected areas obtained from the National System of Conservation Units (SNUC), hydrography data from the Brazilian Forest Service, and land use and land cover information from the Living Atlas (ESRI), based on satellite imagery classified at 10-meter spatial resolution. It is important to note that input data quality directly influences model results, and field validation or the use of higher-accuracy datasets is recommended whenever possible.

Step 1 consists of generating continuous surfaces using the Distance Accumulation tool applied to hydrography and protected areas vector layers. This step is essential, as connectivity models perform better when based on continuous variables, allowing a more realistic representation of spatial influences on wildlife movement. At this stage, the barrier feature is also defined, referred to in the literature as the cost surface, which in this case corresponds to the railway alignment.

In Step 2, land use data are reclassified by assigning values according to their importance for ecological connectivity. Native vegetation areas are considered most favorable, agricultural and pasture areas are assigned intermediate values, and urbanized zones are classified as least permeable, using a relevance scale from 10 to 1.

In Step 3, accumulated distance surfaces (hydrography and protected areas) are normalized using the Rescale by Function tool, which adjusts the influence of distance for each variable. Different functions were tested, and the one that best represented local ecological characteristics was selected.

In Step 5, variables are integrated using the Weighted Sum tool, allowing weighted combination of input layers. The assigned weights are based on the ecological relevance of each variable and sensitivity testing. Hydrography and land use exerted the greatest influence on the model, while protected areas contributed as habitat core areas, although not always connected.

Finally, in Step 6, the Wildlife Connectivity Model is generated, and priority areas are identified using the Local Regions tool, highlighting regions with higher connectivity potential.

Expected Results

The proposed connectivity model demonstrates strong potential for replication across different infrastructure projects, such as highways, ports, airports, and energy sector developments. The integration of environmental variables with spatial modeling techniques enables more efficient decision-making, contributing to the reduction of environmental impacts and promoting more sustainable development.

PITHER, Richard; O'BRIEN, Paul; BRENNAN, Angela; HIRSH-PEARSON, Kristen; BOWMAN, Jeff. Predicting areas important for ecological connectivity throughout Canada. PLOS ONE, [S.l.], v. 18, n. 2, e0281980, 2023. Disponível em: https://doi.org/10.1371/journal.pone.0281980. Acesso em: 9 abr. 2026.

ABRA, Fernanda Delborgo et al. Use of unfenced highway underpasses by lowland tapirs and other medium and large mammals in central-western Brazil. Perspectives in Ecology and Conservation, v. 18, n. 4, p. 247-256, 2020.

LIGHTNING TALK | LIGHTNING TALKS

Monitoring serval use of drainage underpass culverts and estimating population abundance in two serval roadkill hotspot areas along the N3 Toll Route, South Africa

Thabo Innocent Hlatshwayo[1], Erin Adams[1], Lourens Leeuwner[1], Wendy Collinson-Jonker[2], Colleen Downs[3]

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[3] University of KwaZulu-Natal, South Africa

KEYWORDS
landscape connectivity, wildlife mortality assessment, retrofitting infrastructure, monitoring, species behavioural response

The fragmentation of natural habitats by transport corridors has influenced the abundance and movement patterns of wildlife. As such, numerous species and wildlife populations have become isolated, with limited dispersal routes and increased wildlife roadkill risks. The present study relied on data collected daily by the N3 route patrol staff from 2011 to 2025 to analyse the spatiotemporal patterns of serval (Leptailurus serval) roadkill on the N3 Toll Route. In addition, drainage culverts that are located along two sections of the N3 toll route that were identified sensitive for serval roadkill incidents were identified and erected with a 2km roadside fencing that funnels serval towards the closest underpass culvert for crossing. Each of the two hotspot sections comprised of four drainage culverts that were located less than 2km apart. One camera trap was installed on each culvert's entrance at a height of less than 0.5m to record serval visitations. Camera traps were first installed in April 2023, with data downloaded quarterly. All Serval data were downloaded from TrapTagger and individuals assigned with a specific IDs. To verify if same serval individuals repeatedly used the culverts to cross the highway or if, an existing serval population that has been fragmented by the N3 highway used the drainage culverts, serval coat patterns (skin spotting) reflecting the identities of individuals using the drainage culverts was analysed using a specialised software, WildBook. The results of the roadkill surveys have showed that a total of 369 serval roadkill incidents were reported, with sections 4 and 10 of the N3 highway identified as serval roadkill sensitive road-stretches. The camera trap data has indicated that a total of 115 Serval photos were recorded on eight drainage culverts located along the two identified serval hotspots on the N3 route over 929 trap nights. Serval visitations on the monitored drainage culverts have indicated that at least 18 individual servals have used the culverts during the survey period. Servals were captured on 48 occasions in KwaZulu-Natal, with 6 unique individuals identified. In Mpumalanga, Servals were captured 67 times, and 12 unique individuals were identified. These findings show that servals have potentially maintained a home range on either side of the highway and the presence of the highway considerably impact their daily movement patterns. Overall, roadside fencing has proven to be effective in reducing serval roadkill incidents along the fenced sections of the N3 toll route, indicating an opportunity for low-income countries to harness cost effective measures for connecting road-fragmented natural landscapes.

LIGHTNING TALK | LIGHTNING TALKS

Hedgerow suitability assessment to define survey effort for bats and linear infrastructure schemes

Sarah Proctor, David Chatterton

WSP UK Ltd, United Kingdom

KEYWORDS
decision-making frameworks, decision-support modelling, ecological integrity at scale, evaluation, monitoring

Linear infrastructure has been shown to have negative impacts on bats. Therefore, DEFRA and the University of Leeds conducted research in this realm, with an aim to standardise a cost-effective survey method to assess the effects of linear transport infrastructure on bats and the effectiveness of mitigation such as crossing structures. Local scale surveys were designed to assess mitigation design; though a baseline of the original commuting feature is required to assess if mitigation is required and to measure its efficacy against baseline. The baseline survey includes visual observations, noting flight height, direction and distance from commuting feature. However, it is difficult to be cost-effective when pairing the crossing point survey effort with Bat Conservation Trust Guidelines.

Since the release of DEFRA's linear infrastructure survey guidelines, questions have been raised regarding a proportionate survey effort for bat crossing point surveys. Surveying every suitable bat crossing feature on large scale schemes is often financially and commercially unachievable and disproportionate. With large-scale impact how does this survey effort relate to mitigation implementation? The designed protocol details a new proportionate assessment for selecting hedgerows to survey for commuting bats, based on assessment of key habitat features.

In 2022, the impact assessment of a Carbon Capture and Storage (CCS) project, part of the wider 'HyNet North West' scheme commenced. This Nationally Significant Infrastructure Project seeks to reduce carbon dioxide emissions from industry, homes, and transport, capturing emissions and transporting and storing them within old gas fields. The CCS pipeline includes the construction and installation of approximately 36km of pipeline and associated Above Ground Infrastructure, resulting in short term, temporary impacts to bats over the construction period. Approximately 400 hedgerows were identified as intersected. These hedgerows form a complex of networks providing ecological connectivity across the wider landscape and their temporary fragmentation may have a temporary adverse effect on bats. Fragmentation of hedgerows providing connectivity between maternity sites and foraging areas or mating sites may have the potential to impact the favourable conservation status of a species.

Using the DEFRA methods to survey all suitable commuting features does not lend itself easily a proportionate survey approach over such an extensive area. Therefore, novel survey methods and effort, building on existing survey guidance, were considered to provide a pragmatic, robust and repeatable approach. As a result, the assessment aim was to identify hedgerows important for bat movement within a 100m corridor and determine the level of this impact to inform mitigation design. Using this novel approach survey effort was reduced from over 400 hedgerows to just 193 hedgerows. Reducing both scope and costs for the client. This stepwise approach was successful as planning permission was gained through a development consent order application and accepted by statutory stakeholders.

LIGHTNING TALK | LIGHTNING TALKS

Towards a Comprehensive Assessment of Wildlife–Vehicle Collisions: Integrating Police and Hunting Data

Falko Brieger,
Johanna Heeres

Forest Research Institute, Germany

KEYWORDS
monitoring, adaptive management, biodiversity loss, decision-support modelling, wildlife mortality assessment

In order to effectively address the enormous number of wildlife-vehicle collisions (WVC) through mitigation measures, it is essential to understand the spatial occurrence and distribution of such collisions. However, WVC in Germany are still not recorded comprehensively nationwide or according to a standardized system. To date, these collisions are reported through various reporting systems and only by those individuals directly involved in WVC.

On the one hand, these include drivers seeking reimbursement for vehicle damage from their vehicle insurance and the police who are called to the scene of the accident; on the other hand, hunters document WVC in their hunting statistics. Until now, there is a lack of central portals where combined WVC occurrences can be documented and stored with coordinates. Consequently, only a fraction of WVC are recorded.

In the state of Baden-Württemberg, online portals have been introduced that, for the first time, enable improved recording of WVC. Since 2021, the police record all WVC with coordinates in own system. Hunters also record their known WVC with coordinates in the new state hunting statistics portal. Comparisons between the two systems indicate that WVC data reported by the police and hunters differ significantly from each other by number, location, date, time and species.

Our goal is to merge both databases to obtain a comprehensive picture of the WVC situation in Baden-Württemberg. With these detailed WVC data, analyses of spatial and temporal patterns are now possible, allowing for the identification of hotspots and the targeted implementation of mitigation measures.

LIGHTNING TALK | LIGHTNING TALKS

Using traffic-flow theory to guide fencing decisions by identifying critical thresholds for unsuccessful road crossings

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KEYWORDS
decision-making frameworks, adaptive management, spatial planning, accelerated implementation

The traffic-flow theory provides a quantitative framework for assessing wildlife crossing success under varying traffic conditions, as originally proposed by van Langevelde & Jaarsma (2004). By translating principles of vehicle flow into an ecological context, the approach estimates the probability that animals can safely cross a road based on traffic intensity, road width, and species-specific movement characteristics.

A key insight of this method is that with increasing traffic volume, the availability of sufficiently large gaps in traffic declines rapidly. Beyond a critical threshold, successful crossings of wildlife become highly unlikely, meaning that any crossing attempt is increasingly likely to result in a collision.

This approach is particularly relevant for prioritizing road sections where wildlife crossings, if they occur, will most likely not be successful and can have severe consequences for human safety. On highways, wildlife-vehicle collisions are comparatively rare. However, high driven speeds and high daily traffic volumes can carry a disproportionate risk of serious or fatal outcomes for vehicle drivers. The traffic-flow theory enables the identification of such high-risk segments even in the absence of clustered wildlife-vehicle collision data, supporting a precautionary strategy for the implementation of mitigation measures such as fencing.



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04

Workshops & Interactive Sessions

Hands-on sessions, workshops and wellbeing activities

8 CONTRIBUTIONS

Connecting Technical Disciplines for Nature-Positive Infrastructure

Tuesday 22 September · 11:00–13:00 · Castle Park B
Thursday 24 September · 14:00–16:00 · Victoria Park

Connecting Technical Disciplines for Nature-Positive Infrastructure

Kate Newman[1], Rodney Van der Ree[2], Basma Hahn[3], Elke Hahn[4], Tremaine Gregory[1]

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KEYWORDS
biodiversity loss, decision-making frameworks, institutional reform, systems innovation, long-term resilience

How can we design, build, and manage the transport infrastructure society needs - while restoring biodiversity, strengthening climate resilience, and sustaining the ecosystems that support life?

This highly interactive, two-part session brings together transport ecologists and the planners, engineers, and consultants shaping our transport systems - to spark fresh connections and co-create solutions to one of the defining challenges of our time.

Governments and the private sector around the world are increasingly being called upon to place nature at the heart of infrastructure decision-making. Recent global agreements under the United Nations Conventions on Migratory Species and Biological Diversity have raised expectations for how projects must avoid harm, restore ecosystems, and maintain ecological connectivity. At the same time, the private sector is being pressured to disclose - and ultimately reduce - its impacts on biodiversity and climate through regulations such as the European Union's Corporate Sustainability Reporting Directive and voluntary initiatives including the Science Based Targets Network and the Taskforce on Nature-related Financial Disclosures. Translating these ambitious commitments into day-to-day planning, design, construction, and operations remains one of the sector's greatest challenges.

The session begins with a one-hour interdisciplinary panel discussion, setting the stage for the interactive workshop to follow. The panel will feature five to seven leaders from ecology, consulting engineering, advocacy, and road and rail development. Panelists will share perspectives and experiences and engage with the audience to frame key themes for the workshop that follows.

In the second hour, participants will take part in a facilitated, hands-on workshop. Attendees will be divided into interdisciplinary table groups, each working on a transport infrastructure challenge. Drawing on diverse viewpoints, groups will develop recommendations for integrated practical solutions and innovative approaches. Table leaders, supported by the panelists, will help keep discussions focused and productive. The conclusions and recommendations from each group will be consolidated into a brief workshop report to be shared with the wider IENE 2026 community.

Why attend?

- Hear provocative perspectives from leading voices in the transport ecology community and infrastructure practitioner associations such as the International Federation of Consulting Engineers (FIDIC) and the International Road Federation (IRF) as they explore and discuss practical opportunities and stubborn barriers to achieving positive outcomes for biodiversity in linear infrastructure development.
- Discuss innovative approaches to practices increasingly called for in global policy agreements, such as cumulative impact assessment, adaptive management, and biodiversity mainstreaming—practices that will reshape infrastructure projects worldwide as they become the norm.
- Co-create practical solutions for streamlining interdisciplinary collaboration across the ecology and engineering communities, accelerating innovation, and aligning professional practice with global biodiversity goals.

What makes this session different?

Rather than focusing on a single discipline or tool, this workshop explores infrastructure across its full lifecycle—from early landscape-scale ecological assessments to on-the-ground delivery and operations—highlighting how ecological and built systems can work in harmony. It builds

directly on emerging global initiatives such as the Greening Transportation Infrastructure Development (GRID) Program funded by the Global Environment Facility, and the growing movement toward communities of practice, such as the Community of Practice on Nature and Infrastructure (CoPNI) and the Sustainable Infrastructure Community of Learners (SI-CoL) that connect knowledge, tools, and people across sectors to design and deliver ecologically sustainable infrastructure services.

What will you walk away with?

- A clearer understanding of how conservation science and engineering practice can align to deliver better outcomes for people, nature, and climate.
- New professional connections across disciplines and regions.
- A set of participant-generated recommendations for collaborative action, to be captured in a workshop report and shared with the wider IENE community.

If you are passionate about contributing to infrastructure systems that support wildlife, strengthen ecosystems, and meet human needs and aspirations, join this session to collaborate across disciplines and help shape the next generation of sustainable, nature-positive infrastructure.

Integrating Biodiversity into Climate-Resilient Infrastructure: Insights from the EU SYMBIOSIS Project

Tuesday 22 September · 11:00–13:00 · Ashton Court

Integrating Biodiversity into Climate-Resilient Infrastructure: Insights from the EU SYMBIOSIS Project

Fruzsina Csala[1], Savina Carluccio[1], Gemma Cowan[1], Lorenzo Franzoni[2], Pınar Yılmazer[2], Carme Rosell[3,4], Luis M. Fernández[3,4], Reto Schmucki[5], Jeff Ollerton[5,6], Matina Loukea[7], Lazaros Georgiadis[7,8]

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KEYWORDS
ecological and social values, decision-making frameworks, nature-based solutions, long-term resilience, monitoring

This 90-minute interactive workshop showcases emerging results from SYMBIOSIS, an EU-RAIL-funded initiative developing practical approaches to integrating biodiversity into climate-resilient transport infrastructure. Bringing together expertise from the transport, energy and biodiversity sectors, SYMBIOSIS is developing decision-support methodologies, harmonised biodiversity monitoring approaches and governance recommendations that support biodiversity throughout the infrastructure lifecycle. The workshop combines short presentations with interactive discussions, giving participants the opportunity to explore these emerging approaches, share practical experience and contribute to the refinement of the project's tools and recommendations.

It begins with a brief introduction to SYMBIOSIS, followed by three focused thematic segments addressing key challenges and innovations, each combining a presentation with an interactive element to be completed in small groups. The workshop follows the lifecycle of biodiversity integration in infrastructure planning, and the three segments are designed as a connected sequence reflecting the SYMBIOSIS ambition to integrate biodiversity considerations from planning and implementation to monitoring and long-term governance.

The first segment asks how we choose the right intervention, focusing on the prioritisation of climate-resilient NbS: project partners will present recent work on mapping railway resilience to climate change and identifying priority areas for nature-based solutions that strengthen infrastructure while enhancing biodiversity and ecosystem services, before participants take part in a scenario-based activity exploring how to select the most appropriate interventions to improve climate resilience and biodiversity.

The second segment asks how we measure and integrate biodiversity, focusing on biodiversity monitoring strategy and data integration: this segment will explore current biodiversity monitoring and reporting practices, highlighting gaps as well as opportunities enabled by emerging technologies and integrated workflow tools, before participants take part in a tabletop exercise, in small groups, to imagine and reflect on how best to address the challenges of standardising and upscaling biodiversity monitoring and integrate data and their insights into decision-making processes.

The third segment asks how we embed biodiversity in decision-making, focusing on governance, participation, cumulative impacts and reporting: it will address societal and governance challenges in sustainable transport development, including stakeholder engagement, integration of biodiversity into infrastructure planning, cumulative impact assessment and corporate sustainability reporting, before participants draw on their own experience in a challenge-based exercise exploring aspects of governance, stakeholder engagement and sustainability reporting to manage trade-offs and support better decision-making throughout the infrastructure lifecycle.

By the end of the workshop, participants will better understand how different technical, environmental and operational criteria influence the selection of nature-based solutions for climate-resilient infrastructure; evaluate the suitability of different biodiversity monitoring approaches for specific management objectives and organisational contexts; identify practical actions to strengthen biodiversity integration in infrastructure planning, stakeholder engagement and sustainability reporting; exchange experience and learn from peers across the transport and biodiversity sectors; and contribute to advancing best practice in transport ecology through collaborative discussion on practical approaches to biodiversity-positive infrastructure.

Towards Defining Key Performance Indicators for Mainstreaming Biodiversity in Corporate Sustainability Reporting (EU-Rail SYMBIOSIS)

Thursday 24 September · 14:00–16:00 · Ashton Court

Towards defining Key Performance Indicators for mainstreaming biodiversity in Corporate Sustainability Reporting in the framework of the EU-Rail SYMBIOSIS Project

Lazaros Georgiadis[1,2,3], **Matina Loukea**[1], **Almona Tani**[4], **Martina Busti**[4], **Carlo Prislei**[4], **Eduardo Prieto**[5], **Manuel Luis Campos Molina**[5], **Lorenzo Franzoni**[6]

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KEYWORDS
ecological economics, ecological and social values, institutional reform, financing mechanisms, governance architecture

Environmental, Social, and Governance (ESG) reporting is rapidly evolving in response to increasing demands for socially and environmentally responsible corporate behaviour. At the European Union level, the Corporate Sustainability Reporting Directive (CSRD) entered into force in 2024 (Directive 2024/1760), establishing a comprehensive regulatory framework for companies to disclose information on risks and opportunities arising from social and environmental issues. Focusing, among other aspects, on the challenges of mainstreaming biodiversity into ESG reporting, the Systemic Mobilisation for Joint Biodiversity and Infrastructure (SYMBIOSIS) project represents a pioneering interdisciplinary initiative at the intersection of biodiversity and ESG management studies, applied to the transport sector. By identifying key gaps, barriers, and opportunities for alignment with evolving international regulations and strategies on green and sustainable infrastructure, and by integrating ecosystem and biodiversity considerations throughout the lifecycle of transport infrastructure development, SYMBIOSIS provides an in-depth analysis of operational biodiversity-related definitions and actions in the transport sector. Within this context, we propose an interactive session on defining Key Performance Indicators (KPIs) applicable to Corporate Social Responsibility (CSR) frameworks at both European and international levels. including national reporting efforts aligned with the Kunming–Montreal Global Biodiversity Framework under the Convention on Biological Diversity.

The session will consist of two 45-minute parts.

1. The first part will include a presentation of SYMBIOSIS activities related to CSR and biodiversity, followed by an open discussion. A draft framework of the project's results on CSR will be presented, based on: (a) a desk literature review on CSR in relation to biodiversity loss and ecological connectivity; and (b) a targeted questionnaire distributed to stakeholders from multiple sectors (including transport, environment, policymaking, economics, NGOs, etc.).

To support the interactive nature of the session and facilitate productive brainstorming, a summary of challenges and potential solutions will be presented across four categories identified during the project:

A. Frameworks, standards, and policy alignment: These issues refer to using established reporting frameworks and aligning with international and regulatory commitments to ensure strategic coherence .

B. Measurement tools, indicators, and data standardization: issues focused on quantitative tools, KPIs, metrics, benchmarks, and the need for standardized data collection and monitoring to support the operational effectiveness and traceability of the reporting framework.

C. Innovative and responsible risk management and impact reduction: issues and solutions on emphasizing the treatment of biodiversity as a risk factor and implementing concrete measures to reduce impacts.

D. Communication, collaboration, and capacity building: issues and directions of actions towards better communication and understanding of biodiversity matters between sectors, collaboration with experts, NGOs, and stakeholders, and investing on capacity building.

Also, based on the case studies identified and described shortly in the main deliverable of the task a specific framework of biodiversity KPIs used in CSR will be presented.

2. The second part will involve group work, during which participants will identify key biodiversity challenges and propose practical solutions to improve CSR approaches in transportation infrastructure contexts. A specific interactive exercise will be conducted to focus on the definition of existing or new possible biodiversity KPIs to be proposed in both corporate sustainability reporting and national reporting, aligning national transportation strategies within the Kunming–Montreal Global Biodiversity Framework. The overall work will include the formation of four working groups, each focusing on one of the four categories of KPIs identified during the implementation of the project. Each group will discuss and assess the importance of the KPIs within its assigned category. The discussions will be guided and facilitated using printed KPI sheets, which participants will score according to the importance they assign to each indicator. Subject to the time available, participants may rotate between groups to work on a different KPI category.

Applying Ecosystem Services to Linear Infrastructure: Overcoming Common Challenges

Thursday 24 September · 14:00–16:00 · Castle Park B

WORKSHOP / INTERACTIVE SESSION | APPLYING ECOSYSTEM SERVICES TO LINEAR INFRASTRUCTURE: OVERCOMING COMMON CHALLENGES

Applying Ecosystem Services to Linear Infrastructure: Using the Ecosystem Valuation for Railways (ECOV4R) Framework.

Michael Image[1],
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KEYWORDS
internalisation of externalities, decision-making frameworks, evidence-based mitigation, before-after evaluation, ecological and social values

There is growing recognition of the dependence that businesses, communities and economies have on natural assets and the ecosystem services they provide. Biodiversity loss and ecosystem collapse rank among the top five global risks. Railway land and adjacent ecosystems provide vital services, including flood management, erosion control, and cooling, that benefit both society and rail infrastructure. Existing and proposed railway corridors often traverse ecologically and culturally sensitive areas. Simultaneously, climate change is intensifying risks such as extreme rainfall, heatwaves and wildfires, increasing pressures on rail networks. These intersecting challenges present opportunities to enhance rail infrastructure resilience through the integration of an ecosystem services approach within railway planning and asset management.

Until now, no railway-specific framework exists to assess and value ecosystem services across multiple geographies. To address this, the International Union of Railways (UIC), together with AtkinsRéalis and eftec, developed the Ecosystem Valuation for Railways (ECOV4R) Framework. Launched in March 2026, the Framework supports decision making, Environmental Impact Assessments, sustainability reporting and nature disclosures. Developed collaboratively with railway infrastructure managers across multiple regions, the Framework integrates best practice guidance and geospatial habitat analysis to provide the first 'how-to' guidance on ecosystem services for the international rail sector.

We piloted ECOV4R on two projects. The first applied the Framework prospectively to explore how natural flood management (NFM) could enhance the resilience of railway assets in the UK, using the Cotswold Line in Oxfordshire as a case study. We estimated the benefits of NFM measures on a range of ecosystem services including flood risk, food production, biodiversity, and carbon sequestration. Our results illustrate that investment in NFM at a catchment scale contributes materially to national climate mitigation and biodiversity goals, whilst also delivering resilience dividends for infrastructure performance.

The second applied the ECOV4R Framework retrospectively to the Palencia–León high-speed line upgrade in northern Spain. Alongside the requisite mitigation, additional ecological restoration measures were implemented alongside the main works, including the creation of wetlands and the planting of broadleaved trees. Embankments and surrounding areas were later covered with grassland. Our ecosystem service valuation highlights the important contribution of these features to regulating and cultural services beyond the primary purpose of environmental mitigation.

The development of the Framework and its pilot applications have revealed key insights. Firstly, the most valuable elements of NFM interventions often extend beyond the primary flood risk alleviation objective, with important implications for co-funding models. Secondly, the pilots demonstrate that ECOV4R can be readily integrated into existing planning and assessment processes such as Environmental Impact Assessment. Thirdly, the benefits of new habitats depend on sustained maintenance, whilst collaboration with landowners is essential to realise the full potential of catchment-scale interventions. Without these enabling conditions and associated governance, projected ecosystem service gains may not be fully realised. Looking forward, further applications beyond Europe would be valuable to test ECOV4R in different ecological, institutional, and socioeconomic settings.

From Roadkill Counts to Population Risk: A Framework to Assess the Demographic Impact of Roadkill

Thursday 24 September · 14:00–16:00 · Castle Park A

From roadkill counts to population risk: a framework to assess the demographic impact of roadkill

Clara Grilo,
Tomé Neves

CIBIO | BIOPOLIS, Portugal

KEYWORDS
population viability analysis, wildlife mortality assessment, long-term resilience, monitoring, biodiversity loss

Workshop - Understanding whether road mortality poses a real threat to wildlife populations remains one of the central challenges in road ecology. While roadkill surveys generate valuable information on species occurrence and spatial patterns, translating these data into meaningful population-level insights is still difficult. This workshop introduces a practical, accessible framework to bridge that gap by turning field observations into actionable knowledge for conservation and infrastructure planning.

Participants will be guided through a step-by-step workflow that combines roadkill data, species traits, and simplified population modelling. The workshop will demonstrate how to:

- Estimate mortality rates from standardized roadkill surveys while accounting for detection and carcass persistence biases;
- Incorporate species-specific demographic parameters from global databases;
- Evaluate the impact of observed roadkill on populations by using a user-friendly mortalityRISK population model.

Participants will explore how road mortality affects population growth and extinction risk under different scenarios and identify the roadkill thresholds above which population starts to decline. This hands-on approach allows users to test realistic management options and better understand thresholds of concern.

Using pre-prepared datasets and reproducible workflows, the workshop emphasizes practical application and immediate usability. By the end of the session, participants will be equipped to move beyond descriptive roadkill metrics and evaluate when, where, and for which species mortality from collisions with vehicles represent a significant demographic risk.

This framework under the scope of the RISKY project provides a powerful yet accessible tool to support evidence-based decision-making, helping researchers, practitioners, and infrastructure managers prioritize mitigation actions where they are most needed.

Biodiversity Net Gain in Practice

Thursday 24 September · 16:30–17:15 · Queen Square

WORKSHOP / INTERACTIVE SESSION | BIODIVERSITY NET GAIN IN PRACTICE

Biodiversity Net Gain in Practice: Regulator, Landowner, Consultant and Engineer Perspectives on England's Evolving Framework

Eric Heath[1], **Nick White**[2], **Richard Gowing**[3], **Victoria Newlove**[4]

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[3] WSP, United Kingdom

[4] ARUP, United Kingdom

KEYWORDS
ecological economics, nature markets, financing mechanisms, governance architecture, biodiversity loss

Biodiversity Net Gain (BNG) represents one of the most significant shifts in how England values nature within the planning system. Since becoming mandatory for most developments in February 2024 following the adoption of the Environment Act 2021, the policy has begun to reshape how developers, landowners, consultants and regulators think about ecological value — moving biodiversity from a residual concern to a quantified, tradeable and legally binding outcome. With mandatory BNG for Nationally Significant Infrastructure Projects coming into force in May 2026, the policy is now directly relevant to the transport and linear infrastructure sector at the heart of IENE.

Yet for all its ambition, BNG raises as many questions as it answers. Does the statutory metric meaningfully capture ecological value, or does it risk reducing nature to a number? How are landowners engaging with the habitat market, and what is the experience on the ground? How are consultancies integrating BNG into infrastructure appraisal and design? And how does the regulator view early implementation — where is the policy working, and where are the gaps?

This panel brings together four speakers from distinct professional positions to offer a frank, multi-perspective account of BNG's development and early delivery. Rather than presenting a single narrative, the session is designed to surface productive tensions: between policy intent and practice, between market mechanisms and ecological integrity, between the pace of infrastructure delivery and the 30-year horizons BNG demands.

Nick White (Natural England) will offer the regulatory perspective — including how Natural England has approached the design of the statutory metric, the Biodiversity Gain Site Register, and the challenges of oversight and enforcement as the regime scales.

Eric Heath (Belmont Estate) will speak from the landowner's perspective — exploring the realities of entering the biodiversity unit market, the opportunities and risks for rural estates, and what genuine, long-term habitat management looks like beyond the spreadsheet.

Richard Gowing (WSP) will draw on experience from major infrastructure projects to examine how BNG is being integrated into transport planning and environmental impact assessment — including the particular challenges posed by linear infrastructure, where habitat fragmentation and connectivity are central concerns.

Victoria Newlove (Arup) will address the design and engineering dimension — how BNG is influencing project design, where nature-based solutions are being embedded into infrastructure from the outset, and what the profession still needs to learn to deliver genuinely nature-positive outcomes.

Together, the panel will assess whether BNG is beginning to shift the value placed on nature within infrastructure decision-making, or whether structural limitations — in the metric, the market, and monitoring — risk undermining its potential. Audience questions will be invited following the four short presentations.

Session Objectives

- To present the development of England's BNG framework from distinct professional perspectives
- To critically assess early implementation experience across regulation, land management, consultancy and engineering design
- To identify practical lessons relevant to the transport and infrastructure sector as NSIP BNG comes into force
- To stimulate discussion on how BNG can be strengthened to deliver genuine, lasting ecological value rather than compliance on paper

Using Social Media and Blogs to Share Your Research and Case Studies to the Widest Possible Audience

Thursday 24 September · 16:30–17:30 · Castle Park A

WORKSHOP / INTERACTIVE SESSION | USING SOCIAL MEDIA AND BLOGS TO SHARE YOUR RESEARCH AND CASE STUDIES TO THE WIDEST POSSIBLE AUDIENCE

Using social media and blogs to share your research and case studies to the widest possible audience

Rodney van der Ree[1], **Steve Bega**[2]

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[2] Animex International, United Kingdom

KEYWORDS
biodiversity loss, nature-based solutions, participatory foresight, institutional reform, evidence-based mitigation

It is predicted that 25-million lane-km of new roads will be built by 2050, and 90% of this will be in non-OECD countries. Many countries and regions lack the expertise, resources and political will to implement ecologically-friendly infrastructure development. An important key step in improving the uptake of ecologically sound advice and designs is ensuring that everyone has a better understanding of the impacts and solutions. Global efforts to communicate and disseminate information must be (1) Accessible – can it be found and accessed? (2) Relevant to the audience – does each audience get the information they need? (3) Understandable – can the information presented be understood by each user group? (4) Usable – Does the information fill an information gap or need? (5) Is it aesthetically appealing and does it invite your audience to read more?

In this workshop, we will give practical advice, instruction, hints and tips to enable you to write a blog-style summary or produce a short social-media clip of your research or project for a relevant audience. We will guide you through the process, including (1) Identifying your 'story'. (2) Defining your audience. (3) Crafting your message. (4) Revising and editing your story. (5) Disseminating and promoting your story.

It is critical that we engage with a much wider audience than we typically do with our research, projects and environmental approvals. Unless we build support from a broader audience – including local communities, politicians, neighbours, transport agencies, engineers, etc, we will not make the necessary changes to transportation to

The session will include a participatory session where participants review a peer-reviewed scientific paper within the transport ecology discipline and prepare a title and 2 sentence 'hook' to engage their audience. Together we will review each others ideas and learn from each other. The workshop and the practical exercise can be completed by those participating virtually as well as those physically in the room.

You are invited to use the tips you learn today to prepare a short article or blog for www.TransportEcology.info or a short video or visual content for social media. www.TransportEcology.info is a freely accessible resource for planners, designers, ecologists, engineers, funders, and the community to implement best practise.

Wellbeing Breakout Sessions

Tuesday to Friday · various times · Wellbeing Room

WORKSHOP / INTERACTIVE SESSION | WELLBEING BREAKOUT SESSIONS

Event Break Session (Quiet Space for Rest and Reflection)

Lizzie Hall

AtkinsRéalis, United Kingdom

AtkinsRéalis's Wellbeing Program aims to create an environment where employees can thrive, flourish and achieve their full potential. With Wellbeing high on our agenda, we were excited to see the event break session description as part of the IENE agenda. We would be very happy to explore whether we can help shape a break session, focusing on providing a quiet space for rest and reflection, promoting wellbeing, accessibility and inclusive participation.



The Pyrenean Contrast · © Alejandra Franco Saldarriaga

05

Poster Communications

Poster exhibition in the central atrium of EP1

28 CONTRIBUTIONS

THEME

Resilience Through Nature

POSTER 14 | RESILIENCE THROUGH NATURE

Wildlife passages as anthropogenic habitats

Maris Kruuse

The Centre of Estonian Rural Research and Knowledge, Estonia

Estonian Naturalists` Society, Estonia

KEYWORDS
landscape connectivity, species behavioural response, fauna passage design, monitoring, nature-based solutions

Wildlife passages, in particular overpasses, are anthropogenic structures designed to reconnect habitats fragmented by roads, railways or water ways. These green bridges imitate natural environments using soil, vegetation, and diverse zones to encourage movement for various animal species, there by reducing roadkill and restoring ecological corridors.

Wildlife passages are not intended to replace habitats lost to the construction of the highway, nor is that their aim; however, monitoring data indicate that several wild ungulates use ecoducts once in a while not only for crossing movements, but also for foraging and resting, indicating that to some extent crossing structure may be considered part of their habitat. Territorial marking behavior has been observed in male roe deer.

We analyzed camera trap data from Estonia's first wildlife overpass (built in2013) during two periods: initial monitoring (March 12, 2015 – October 31, 2016),and follow-up monitoring (November 6, 2020 – October 25, 2022), focusing on the observed behaviour of the Cervidae species moose (Alces alces) and roe deer (Capreolus capreolus) .

There were no moose sightings on the Kolu overpass during I period, but in II period we registered 23 moose crossings, out of which 9% were feeding events. In 13% of the cases the behaviour of moose was described as "calm". 78% of the cases were not specified, indicating routine crossings.

For roe deer, we registered 144 and 728 crossing events during I and II monitoring periods, respectively. In period I, 68% of crossings were described as "slow walk", 18% as "standing still", and 11% running. 3% of the cases were unspecified. No feeding events were recorded. In period II, 8% of recorded events were described as "feeding", 19% "slow walk", 4% "running" and 1% "standing still". For 69% of crossing events there we no specific notes as these were regular undisturbed movements.

The undisturbed behaviour of the animals was likely influenced by vegetation growth, including deciduous trees and shrubs providing food and cover. The minimal human presence also likely supports greater wildlife use.

POSTER 119 | RESILIENCE THROUGH NATURE

Predicting long-term estuarine habitat change with limited data: an example from the southwest coast

Nigel Pontee, Beth Cooper

Jacobs, United Kingdom

KEYWORDS
climate adaptation, social–ecological systems, adaptive management, long-term resilience, uncertainty

Resilience through nature depends on understanding how ecosystems and infrastructure systems will co-evolve under long-term environmental change. In estuarine settings, accelerating sea-level rise increases the need to anticipate future habitat dynamics, yet many systems lack the long-term, spatially consistent datasets required for detailed numerical modelling. This evidence gap presents a challenge for adaptive planning, particularly where habitats play a role in flood risk management, shoreline stability and the functioning of critical infrastructure.

This study presents a transferable approach for predicting long-term habitat change in data-limited estuaries. The method emphasises conceptual understanding over precise prediction, combining expert-led interpretation of geomorphological processes, extrapolation of historical trends where evidence exists, explicit assumptions about where habitats may persist or transition, and simple spatial calculations aligned with projected sea-level rise. By making uncertainties and assumptions explicit, the approach supports transparent decision-making under conditions of incomplete information.

The Tamar–Plymouth Sound system is used as an illustrative example. Like many UK estuaries, it has been extensively modified over centuries and supports nationally important infrastructure alongside designated habitats and valued ecosystem services. Despite these complexities, data availability remains uneven across habitat types, requiring a structured, assumption-based approach to explore future change.

Application of the framework indicates a substantial rebalancing of habitats over the coming century. Results suggest pronounced losses of hard-substrate intertidal habitats, including rock and boulder features, which are particularly sensitive to rising sea levels and limited capacity for landward adjustment. In contrast, vegetated intertidal habitats such as saltmarsh and reedbed are projected to expand in many parts of the system, supported by accommodation space and sediment supply, while subtidal areas increase as lower intertidal zones are progressively inundated. Other habitats are projected to remain broadly stable at the system scale, though localised variation highlights the influence of geomorphological setting and sediment dynamics.

The study does not quantify impacts on infrastructure, flood risk or socio-economic value. However, the predicted changes underline strong functional links between habitats and infrastructure performance. Loss of structurally complex intertidal habitats may increase exposure and alter sediment pathways, while expansion of vegetated habitats may enhance natural attenuation processes in some locations. Such interactions illustrate how habitat change can influence resilience outcomes, reinforcing the need to consider ecological trajectories within long-term infrastructure and coastal management planning.

Overall, the study demonstrates that meaningful insight into future habitat change can be generated even where empirical data are limited. By prioritising transparency, scalability and conceptual consistency, the approach supports resilience through nature by enabling proactive, adaptive decision-making while acknowledging ecological limits and uncertainty.

POSTER 129 | RESILIENCE THROUGH NATURE

What drives wildlife underpass use in tropical railways? Insights from two long-term monitoring programmes in Brazil

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KEYWORDS
monitoring, landscape connectivity, fauna passage design, species behavioural response, long-term resilience

As ferrovias são cruciais para o desenvolvimento econômico, mas representam desafios significativos para a vida selvagem, aumentando a fragmentação do habitat e reduzindo a conectividade da paisagem. Em regiões tropicais, as evidências empíricas sobre a eficácia de medidas de mitigação, como passagens subterrâneas para animais selvagens, ainda são limitadas. Este estudo apresenta resultados do monitoramento de longo prazo de passagens subterrâneas ao longo de duas importantes ferrovias brasileiras, Malha Norte e Malha Central, localizadas em paisagens altamente biodiversas e modificadas pela ação humana no Cerrado e na Mata Atlântica, ambos considerados hotspots mundiais de biodiversidade. Utilizando armadilhas fotográficas e modelos lineares mistos generalizados, avaliamos os padrões de uso da fauna e a eficácia das passagens subterrâneas em diversos grupos funcionais de mamíferos. Ao longo de ambas as ferrovias, o monitoramento registrou mais de 4.000 registros independentes e dezenas de espécies de mamíferos, incluindo táxons ameaçados como a anta (Tapirus terrestris), o tamanduá-bandeira (Myrmecophaga tridactyla), o tatu-canastra (Priodontes maximus) e a onça-pintada (Panthera onca). As passagens subterrâneas foram consistentemente utilizadas pela fauna silvestre, com altas proporções de travessias completas ou potenciais na maioria dos grupos. Os resultados mostraram que o contexto da paisagem foi mais importante para explicar o uso das passagens subterrâneas do que a própria eficácia da travessia. A cobertura vegetal nativa foi um importante preditor de uso em Malha Central, particularmente para herbívoros, enquanto a proximidade com a água foi o preditor mais forte em Malha Norte. Efeitos sazonais também foram detectados, especialmente em Malha Norte, onde o uso das passagens subterrâneas foi geralmente maior durante a estação seca. Em contraste, a probabilidade de um animal completar uma travessia foi frequentemente pouco explicada pelas variáveis ambientais medidas, sugerindo que características estruturais das passagens ou o comportamento das espécies podem desempenhar um papel mais importante na determinação da eficácia. Essas descobertas mostram que as passagens subterrâneas podem apoiar a conectividade funcional em paisagens tropicais fragmentadas, mas seu desempenho depende fortemente de onde são construídas, especialmente se as estruturas forem cercadas, caso o objetivo seja reduzir colisões com trens. A localização estratégica próxima a habitats adequados e corredores de movimento natural pode aumentar substancialmente o uso, fornecendo orientações práticas para um planejamento ferroviário mais favorável à natureza.

THEME

Creating Actionable Knowledge

POSTER 11 | CREATING ACTIONABLE KNOWLEDGE

Structural integrity governs fence effectiveness: how fence discontinuities determine wildlife–vehicle collision risk

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KEYWORDS
evaluation, wildlife mortality assessment, evidence-based mitigation, before-after evaluation, retrofitting infrastructure

Wildlife exclusion fencing is widely used to reduce ungulate–vehicle collisions (UVC), yet large-scale evaluations of how fence design influences mitigation performance remain scarce. We assessed the effectiveness of wildlife fencing installed between 2016 and 2021 on 30 Swedish road sections using a Before-After-Control-Impact design. Fencing reduced wildlife-vehicle collision (WVC) rates by 66.8% relative to concurrent background trends on unfenced control roads. Newly constructed bypass alignments outperformed retrofitted roads (73.2% vs. 62.4%), primarily because they had fewer structural discontinuities. To explain variation in mitigation performance among roads, we modelled log response ratios using inverse-variance weighted OLS regression with AICc-based model selection. Open road connections were the dominant predictor of reduced effectiveness across all ungulate species; each additional open connection per kilometre was equivalent to losing approximately 500 m of functionally intact fencing. Gated connections were associated with improved outcomes overall, but the spatial analysis revealed that WVC remained clustered near gate structures (observed/expected distance ratio = 0.82), indicating residual permeability. Cattle grids used to secure road connections proved ambiguous. Monte Carlo simulations confirmed that collisions were significantly concentrated near open connections, open fence ends, and isolators, but not near gated or grade-separated wildlife passages. Together, the regression and spatial analyses converge on a consistent mechanism: fence discontinuities act as critical nodes of system failure, and their density governs overall mitigation efficacy. These findings call for a shift in fence appraisal from barrier length to system integrity, with particular attention to the management of road connections and fence terminations.

POSTER 13 | CREATING ACTIONABLE KNOWLEDGE

Increased human visitation causes habituation in endangered Amami rabbits on Amami-Oshima Island, Japan

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KEYWORDS
species behavioural response, adaptive management, biodiversity loss

Introduction Amami rabbits (Pentalagus furnessi) are an endangered species distributed only on Amami-Oshima Island and Tokunoshima Island in southwestern Japan. In recent years, the population of Amami rabbits has been recovering due to the eradication of invasive mongooses on Amami-Oshima Island. However, along with this recovery, roadkill on this species have increased.

Amami-Oshima Island attracts many visitors interested in its culture and natural environment. Visitors can easily observe Amami rabbits at night because they are frequently active on roads, engaging in behaviors such as foraging and defecating. As a result, people tend to visit specific areas where rabbits are easier to observe. Frequent human presence may lead to habituation of Amami rabbits to cars.

The aim of this study is to clarify differences in rabbit responses to cars between two areas (Area A and Area B) with different levels of visitor activity.

Methods

Area A included sites that were frequently visited by tourists and tour guides throughout the year. In contrast, cars rarely passed through Area B at night. Both areas consisted of evergreen broadleaf forests dominated by Castanopsis sieboldii .

Rabbits were surveyed by car at a speed of 10 km/h after sunset in both areas from March 2024 to March 2025. When a rabbit was detected ahead, the car approached it while maintaining the same speed. The distance between the car and the rabbit at the moment it fled was measured using a laser rangefinder.

Escape behavior was defined as a change from stillness or foraging at the same location to movement in another direction, either by walking or running. The age of each rabbit (adult or juvenile) was recorded based on body size.

Results and Discussion

A total of 74 samples were collected (Area A: 23 samples; Area B: 51 samples). The distance at which rabbits fled from approaching cars differed significantly between the two areas (Mann–Whitney U test: $z = -2.80$, $P = 0.005$). The mean escape distance was 8.37 m (±13.55 m, range: 0–63 m) in Area A and 7.1 m (±14.39 m, range: 0–51 m) in Area B.

Cars were able to approach rabbits more closely in Area A, where human visitation was more frequent. This suggests that repeated exposure to humans and vehicles may have led to habituation in Amami rabbits.

Observation of wildlife is essential for understanding their biology and for environmental education of visitors; however, guidelines for observation should be established to prevent habituation.

Visitors should also be aware of the presence of Amami rabbits and reduce their speed, as close approaches may increase the risk of roadkill.

POSTER 17 | CREATING ACTIONABLE KNOWLEDGE

Do animals read the railway time table?

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KEYWORDS
monitoring, evidence-based mitigation, fauna passage design

Railways pose significant threats for wildlife, both as barriers, particularly in busy and high-speed railways, and as a source of mortality, where collision frequencies may exceed those reported for roads. In contrast to roads, traffic on railways is less frequent, follow a predictable timetable with distinct events separated by long periods where animals are undisturbed. Thus one might expect that animal could learn the spatial-temporal pattern and adjust to the recurring train disturbance by avoiding being near the track. However, it remains unclear to what degree wildlife can perceive and respond to trains, let alone whether they can exploit the temporal regularity of railway schedules.

This ongoing study addresses this question by evaluating the presence of animals on tracks in relation to train traffic. We present camera trap data that has been collected during November 2023 to May 2025 along two railroad sections of 500 m in southern Sweden, one of the major hotspots for wildlife-train collisions in Sweden. The analysis focuses on large ungulates, mainly fallow deer, but also roe deer, moose and wild boar, as well as medium-sized mammals such as fox, badger and hare. Whenever animals or trains were detected, one to three pictures were taken to verify the ocurrences and time. Over 6000 observations of animals were recorded, some 3000 of trains but only 14 where animals and trains were captured in the same picture and thus the risk of collision was high. However, no collision was detected. Analyses are currently ongoing and numbers may change.

POSTER 23 | CREATING ACTIONABLE KNOWLEDGE

From Fragments to Frameworks: Mapping Power Line Impacts on Nature

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KEYWORDS
decision-making frameworks, ecosystem function, evidence-based mitigation, cumulative impacts, spatial planning

The rapid expansion of electricity transmission networks is essential to the energy transition. At the same time, overhead high-voltage power lines can affect biodiversity through habitat alteration, fragmentation, and barrier effects, making ecological considerations increasingly important in early planning and routing decisions. Although a substantial body of research exists, the evidence is scattered across disciplines, taxa, and ecological scales. As a result, it is often applied selectively in environmental impact assessments, typically focusing on a narrow set of taxa and a limited range of ecological responses.

This poster presents preliminary results from a systematic map that consolidates this fragmented evidence base. The map synthesizes empirical studies on biodiversity impacts of overhead high-voltage power lines (≥60 kV) in temperate and boreal terrestrial ecosystems. Using established systematic mapping methods, studies are catalogued by taxonomic group, ecosystem type, impact pathway, and ecological response. Evidence is structured using the Essential Biodiversity Variables (EBV) framework alongside selected ecosystem service classes, allowing comparison across ecological levels and planning contexts.

The mapping reveals pronounced imbalances in the evidence base. Research is strongly skewed towards birds and direct mortality close to power lines, while ecosystem-level processes, cumulative effects, and functional responses across landscapes are far less represented. At the same time, the map brings visibility to a substantial body of evidence on corridor-related ecological responses, including the maintenance of open habitats, edge-associated species assemblages, and early successional vegetation. These responses are highly context- and taxon-dependent and have rarely been systematically incorporated into planning practice or environmental assessments.

A core objective of the work is to demonstrate how systematic evidence mapping can support more consistent, transparent, and ecologically grounded use of knowledge in infrastructure planning. We explore how mapped evidence can be used to test and improve results from emerging, project-based nature accounting systems. By linking model-based indicators to empirically documented impact pathways and response patterns, the map helps clarify where accounting results are well supported by evidence, where responses differ across taxa or ecological levels, and where uncertainty remains. Combined with spatial land-use indices and information on restoration potential and restorable nature, this approach enables a more nuanced assessment of ecological risks, trade-offs, and opportunities in route selection and vegetation management.

POSTER 24 | CREATING ACTIONABLE KNOWLEDGE

Train drivers' insights and experiences with wildlife-train collisions

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KEYWORDS
wildlife mortality assessment, monitoring, evidence-based mitigation, barrier permeability, landscape connectivity

Linear infrastructure, such as roads and railways, fragments the landscape, thereby negatively affecting ecological connectivity and leading to collisions between vehicles and wildlife. In rail transport, a collision between multi-ton locomotives and animals usually cause little or no damage to the rolling stock, and therefore many incidents remain unreported. In addition, some collisions may go unnoticed by train drivers, especially under poor visibility conditions or when small animals are involved. To gain insights from the direct participants in these collisions – train drivers – we developed a questionnaire comprising 15 basic questions addressing collision frequency, time of occurrence, species involved, vehicle damage, or train delays.

We obtained responses from a total of 64 train drivers from different railway operators and varying levels of professional experience. Their insights suggest that wildlife–train collisions occur relatively frequently, although this is not clearly captured in official data. The survey further confirmed that such incidents rarely result in damage or train delays, as very large mammals (e.g. moose) are almost absent in Czechia. Train drivers were given the opportunity to identify locations they considered hazardous. The findings complement existing data on wildlife-train collisions and provide unique insights from the perspective of train drivers, which can be used to better protect railways and wildlife.

POSTER 25 | CREATING ACTIONABLE KNOWLEDGE

Spatial and temporal patterns of wildlife–train collisions in Czechia

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KEYWORDS
wildlife mortality assessment, spatial planning, monitoring, evidence-based mitigation, cumulative impacts

Wildlife-train collisions (WTCs) in Czechia represent a complex issue that has historically received less research attention than incidents on roads. Because very large mammals are not present in sufficiently high concentrations to cause severe vehicle damage, available datasets are relatively limited compared with those from roads. Information regarding these incidents is primarily sourced from infrastructure managers, who receive information from train operators. In addition, WTC data are supplemented by the Srazenazver.cz application, which integrates records from volunteers and hunters.

The Czech rail network is characterized by a significant lack of systematic WTC mitigation measures, as railway lines remain largely unfenced and dedicated protection is missing. Reports from hunting area administrators indicate that WTCs involving multiple individuals at once also occur, particularly in the case of wild boars. To effectively identify hazardous areas, this study utilized the KDE+ method , a specialized statistical tool designed to identify statistically significant spatial clusters (hotspots) along linear infrastructure. This methodology allowed for the creation of comprehensive maps pinpointing where these collisions concentrate and defining high-risk periods throughout the year. The findings were subsequently compared with the situation on roads, where more extensive databases provide a broader context for understanding spatial and temporal patterns of wildlife mortality in the landscape.

POSTER 36 | CREATING ACTIONABLE KNOWLEDGE

Evaluating combined deterrents for safer wildlife road crossings

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KEYWORDS
wildlife mortality assessment, before-after evaluation, evaluation, monitoring

Various measures designed to prevent or at least reduce the risk of collisions between wildlife and vehicles have been tested on lower class roads. Odour deterrents proved to be ineffective; several studies reported a short-term reduction in mortality in tens of percent. The aim of our study was to assess the effectiveness of two types of combined deterrents (the optical-acoustic Deer Deter and the optical-olfactory Hagopur Kombiset), which were installed along road sections, using animal vehicle collision (AVC) data and applying the BACI design.

Starting in March 2022, as part of the project "Transport infrastructure permeability for fauna as a prerequisite for safe and sustainable transport", regular weekly monitoring of AVC began on 7 sections of Class I and II roads in the Vysočina Region (central part of the Czech Republic). In December 2023, two types of combined deterrents were installed on those sections, spanning 18.6 km: optical-acoustic (10 km) and optical-olfactory (8.6 km). Data were continuously collected until the end of May 2025.

AVC data in the monitored sections were collected from 3 sources: own monitoring with a frequency 1x / week, Police AVC database and data from local hunters. AVC was also monitored on 7 control sections 88 km long. Here, data collection was conducted 1x / week (own monitoring), and data from the police were also available (no data from hunters).

The results show that in the control sections was detected the statistically significant reduction in mortality (-45.5%, 95% CI: -69.8 to -21.3). Although the sections treated with Kombiset showed a reduction (-22.0%), the effect wasn´t statistically significant at $\alpha = 0.05$. For sections treated with Deer Deter, the average change was small (-7.2%). Although a wide range of other statistical methods were used, the conclusion was similar - the effectiveness of deterrents was not statistically proven.

We tested two specific combined animal detterents: the Deer Deter and the Hagopur Kombiset (see above). There are very few published results in the scientific literature regarding the effectiveness of both devices (theoretically, their ineffectiveness is discussed); therefore, our main goal was to rigorously test them in the field using the BACI method over an exceptionally long period of time. Our study was published in the journal Nature Conservation 63: 173–198 (2026) and thus provides evidence based results on experimental design rather than mere speculation.

POSTER 37 | CREATING ACTIONABLE KNOWLEDGE

Road infrastructure factors associated with wildlife incidents on the State Road Network in Spain

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KEYWORDS
wildlife mortality assessment, infrastructure coherence, evaluation, longitudinal monitoring, decision-support modelling

Road Sections with a High Frequency of Wildlife-Related Traffic Incidents (known in Spanish as TEFIVA) are segments of the Spanish State Road Network identified by the Directorate-General for Roads. They are defined as road sections at least 1 km long in which a minimum of 10 traffic incidents involving animals the size of a fox or larger were recorded between 2017 and 2021. These incidents include both collisions resulting in property damage and other traffic events involving wildlife, provided that at least one of them resulted in casualties.

This study presents preliminary results from an ongoing research project aimed at characterizing these road sections, identifying the most relevant factors associated with incident frequency, and providing criteria for the definition of mitigation measures designed to improve road safety while reducing habitat fragmentation and wildlife mortality.

A total of 77 TEFIVA sections were surveyed in the field, considering variables related to the integration of road infrastructure with the surrounding terrain, including vertical alignment changes, embankments, cuttings, trenches, and slopes, among others. The presence and condition of roadside fencing were also assessed, together with the presence and functional adequacy of transverse structures, such as wildlife crossings and drainage structures, in accordance with current sector-specific technical guidelines. In addition, the Average Annual Daily Traffic corresponding to each section was incorporated into the analysis.

To examine the relationship between infrastructure characteristics and the frequency of incidents recorded between 2017 and 2021, variables with zero or near-zero variance and those exhibiting high correlation were first removed. Highly correlated variables were identified using Cramér's V coefficient in order to reduce redundancy and collinearity issues. A baseline model was subsequently fitted using negative binomial regression, which was selected over a Poisson model due to the observed overdispersion. Furthermore, a model-selection procedure based on the Akaike Information Criterion corrected for small sample sizes (AICc) was applied to identify the predictors with the strongest statistical support. The robustness of the results was evaluated through residual diagnostics, influential observation analyses, and sensitivity analyses. Results were expressed as Incidence Rate Ratios (IRR).

Of the 77 surveyed road sections, 15 were equipped with roadside fencing, whereas 62 lacked this measure. Of the 15 fenced sections, 14 were located on high-capacity roads, where continuous fencing along the entire route is mandatory. By contrast, the 62 unfenced sections corresponded to conventional roads, where such a regulatory requirement does not apply. Defects such as holes, subsidence, and/or excavations were identified in ten fenced sections. Moreover, only seven of the 173 transverse structures inspected complied with the technical specifications for wildlife crossing and roadside fencing design.

Both the baseline model and the models selected through the AICc procedure identified the presence of fencing and the dimensions of transverse structures, particularly modified culverts, as the most relevant infrastructure-related factors associated with incident frequency. The presence of fencing was associated with a 42% reduction in the expected frequency of incidents (IRR = 0.58; 95% CI: 0.41-0.81; $p = 0.001$), whereas modified culverts with dimensions of at least 2 × 2 m were associated with a higher frequency of incidents (IRR = 1.80; 95% CI: 1.40-2.32; $p < 0.001$). However, this result should be interpreted with caution, as most of the identified modified culverts did not comply with the technical specifications required to function effectively as wildlife crossings.

Model diagnostics revealed no evidence of multicollinearity, residual overdispersion, zero inflation, or relevant outliers. Sensitivity analyses confirmed the stability of the effects associated with fencing and transverse structure dimensions, whereas other variables showed less robust associations.

These findings suggest that roadside fencing and certain characteristics of transverse structures are among the infrastructure features most closely associated with incident frequency in the TEFIVA sections analyzed, providing a basis for prioritizing and guiding mitigation measures. Furthermore, they highlight that the mere presence of transverse structures does not guarantee adequate ecological permeability of road infrastructure. Their design and adaptation in accordance with technical standards should therefore be considered a priority for simultaneously improving road safety and reducing wildlife mortality.

The future incorporation of environmental variables and wildlife distribution data could enhance the explanatory power of the models and facilitate the development of more targeted mitigation measures for individual road sections.

POSTER 38 | CREATING ACTIONABLE KNOWLEDGE

Lineside vegetation management is biodiversity management: getting practical to enhance trackside biodiversity in the UK

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KEYWORDS
biodiversity loss, landscape connectivity, infrastructure coherence, vision-led delivery, before-after evaluation

Trees line Britain's railways and Network Rail manage about 1000 hectares of woodland each year for safety. The woodland is of variable condition and can be improved to enhance biodiversity. Taking a pragmatic approach and using the Woodland Condition Assessment scoring mechanism as a base, we have established a set of principles and practical guidance for enhancing the condition of woodland along the UK's rail network easily and during routine vegetation management. Pilot testing has demonstrated a proof of concept and, with other research partners, we have received government funding to progress the idea through engagement with linear feature managers and increased data gathering via remote sensing. Our poster will include visual representations of the principles in practice, which could be adapted by other audiences.

The Tree Council is a national charity and acts as a critical friend to Network Rail (NR) to help them balance the value of nature with their operational needs. We work with multiple partners and research agencies as part of our science and research programme.

POSTER 56 | CREATING ACTIONABLE KNOWLEDGE

Immediate Changes in Vehicle Operating Speeds from Road-Surface Markings and Their Effectiveness as a Roadkill Mitigation Measure

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KEYWORDS
before-after evaluation, wildlife mortality assessment, monitoring, evaluation, evidence-based mitigation

Background: Deer-vehicle collisions (DVCs) involving Sika deer (Cervus nippon yesoensis) have become a critical road-safety concern in Hokkaido, Japan, reaching a record high of 6,705 cases in 2025. While exclusion fencing is a highly effective mitigation measure, its cost and installation time create a need for alternative low-cost, rapidly deployable countermeasures. This study evaluated the effectiveness of “Deer Caution” road-surface markings as a warning measure intended to influence driver behaviour and reduce vehicle speeds at DVC-prone sites.

Methods: Vehicle speeds were measured using traffic counters immediately before and after the markings at three representative road geometries—flat straight, post-curve, and crest sections—selected from 22 marked sites in eastern Hokkaido. A total of 41,796 vehicles were analysed and classified by size as small (<6 m) and large (≥6 m). Mean speed changes were evaluated statistically using paired t-tests and sign tests.

Results: The effects of the markings varied by road geometry and vehicle type. On flat straight sections, a significant mean speed reduction of -1.06 km/h was observed, with a stronger effect for large vehicles (-2.08 km/h). On crest sections, a small but significant overall reduction was observed (-0.48 km/h); however, large vehicles showed an increase in speed (+1.10 km/h). On post-curve sections, speeds increased slightly (+0.25 km/h), suggesting that the warning effect was offset by the natural acceleration behaviour associated with exiting a curve.

Conclusion: The 1.06 km/h reduction observed on flat straight sections corresponds to an approximate 2.4 m increase in available stopping distance, which may be important for collision avoidance. These findings suggest that road-surface markings can serve as a useful tool for DVC mitigation, but their effectiveness is highly site-specific. Strategic placement, particularly on flat straight approaches, is essential to maximise the speed-reduction effect and improve road safety.

POSTER 61 | CREATING ACTIONABLE KNOWLEDGE

What about the impact of underground utilities on wetlands ?

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KEYWORDS
social–ecological systems, ecological limits, ecological integrity at scale, evidence-based mitigation, barrier permeability

The installation of underground utilities, such as power lines and high-pressure gas transmission pipelines, poses significant environmental challenges to wetlands, which are vital ecosystems for biodiversity, water regulation, and climate resilience. During construction, activities like excavation and trenching can disrupt wetland hydrology, leading to altered moisture gradients, shorter hydroperiods, and changes in water flow, all of which can degrade habitat quality and ecological functions. Soil structure and properties are also affected, with compaction, risks of thermal alterations from buried cables, and potential contamination from construction materials or pollutants. These physical disturbances might result in long-term impacts on both flora and fauna, including loss of plant diversity, shifts in species composition, and negative effects on wildlife that depend on intact wetland habitats. While undergrounding utilities can reduce some visual and collision risks associated with overhead lines, it introduces new concerns, such as soil heating and persistent soil degradation. Mitigation strategie are essential to minimize harm. However, the long-term ecological consequences of underground utilities in wetlands remain understudied, highlighting the need for further research and careful planning to balance infrastructure development with wetland conservation. In this study, we are conducting a comprehensive review to identify key knowledge gaps and emerging trends regarding the impacts of these buried services on the biophysical characteristics and ecological functions of wetlands. By synthesizing existing research, we seek to offer new research perspectives, particularly in light of the growing challenges posed by climate change.

POSTER 71 | CREATING ACTIONABLE KNOWLEDGE

Evaluating Brown Bear (Ursus arctos) Habitat Availability and Infrastructure Permeability in the Pre-Construction Phase of the Sibiu–Făgăraș Motorway

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KEYWORDS
landscape connectivity, monitoring, evidence-based mitigation, infrastructure coherence, barrier permeability

The Sibiu–Făgăraș Motorway project intersects a critical ecological corridor of international significance, linking the core habitats of the Southern Carpathians with the Olt River basin. This landscape is vital for the long-term genetic flow and dispersal of the Brown Bear (Ursus arctos). This study presents the findings of an intensive one-year pre-construction monitoring program designed to generate robust, actionable baseline data to mitigate ecological severance.

Our methodology integrated multi-seasonal field surveys with high-resolution spatial analysis. We combined track identification and scat analysis with a systematic camera-trapping grid to capture temporal and spatial movement patterns. These field data were subsequently utilized to calibrate Habitat Suitability Models (HSM), identifying core areas and movement pathways. The findings demonstrate a high degree of habitat availability within the project's immediate footprint, characterized by a complex mosaic of deciduous forests, shrublands, and riparian corridors that facilitate regional connectivity. However, the analysis also identifies significant existing anthropogenic pressures, including intensive agriculture and the current national road network, which already restrict permeability.

Preliminary analytical results pinpoint specific "bottlenecks" along the planned alignment where seasonal bear movements are concentrated due to topographical and land-cover constraints. While these incipient data provide a crucial foundation for the current design of large mammal crossings, they serve as a baseline for a long-term longitudinal study. Continuous monitoring throughout the construction and operational phases is imperative to validate the effectiveness of the proposed mitigation measures. Ultimately, this comprehensive dataset will provide the empirical evidence needed to retrospectively evaluate whether the decision-making process—specifically the choice between viaducts and dedicated green bridges (ecoducts)—was ecologically sound or if additional adaptive management is required to prevent irreversible population fragmentation.

POSTER 80 | CREATING ACTIONABLE KNOWLEDGE

What drives ungulate-train collisions in Sweden: large-scale spatial patterns

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KEYWORDS
monitoring, wildlife mortality assessment, decision-support modelling

Wildlife–train collisions (WTC) are increasing across Europe as ungulate populations recover and rail traffic intensifies. Understanding the spatial factors that shape collision risk is essential for developing targeted and cost-effective mitigation strategies. We analysed 32,031 ungulate–train collisions reported by train operators across the Swedish railway network between 2015 and 2021, covering four ungulate groups: moose (Alces alces), roe deer (Capreolus capreolus), wild boar (Sus scrofa), and fallow/red deer combined. Using a Bayesian hurdle-gamma modelling framework applied to 2,089 railway sections, we tested the relative importance of animal abundance, landscape composition, train traffic volume, and infrastructure characteristics on collision frequencies. Local animal abundance, proxied by police-reported road accidents with ungulates on adjacent roads, was the strongest and most consistent predictor of WTC across all species. Train traffic volume (log-transformed) was the second-strongest predictor, but its effect was unimodal: collision risk peaked at intermediate traffic levels and declined on the busiest railways, suggesting behavioural avoidance near high-traffic lines. Environmental variables showed species-specific effects reflecting habitat preferences, while infrastructure variables alone explained little variance, indicating that existing Swedish rail infrastructure is poorly differentiated with respect to wildlife risk. Our results indicate that WTC risk is primarily determined by where animals occur and how intensively the railway is used, and we therefore recommend prioritizing interventions at sections with intermediate traffic that cut through important wildlife habitats. Non-structural measures such as biologically meaningful acoustic deterrents warrant field evaluation as a promising, cost-effective complement to fencing and wildlife passages, particularly on lower-traffic lines.

POSTER 81 | CREATING ACTIONABLE KNOWLEDGE

Responses of wildlife to acoustic stimuli at railways - implications for wildlife warning systems

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KEYWORDS
landscape connectivity, evidence-based mitigation, barrier permeability, before-after evaluation

Wildlife–train collisions are a persistent conservation and safety concern, yet evidence on effective acoustic deterrents remains scarce. We used Motion Activated Sound Systems (MASS) to expose free-ranging wildlife near railways to five acoustic stimuli: white noise, human voice, predator vocalisations, train horn, and railway bell, with silence as control. We quantified response intensity, flight probability, and flight direction across 561 video encounters at 25 sites in Sweden and Norway, involving seven species grouped as ungulates (roe deer, fallow deer, moose, wild boar) and medium-sized mammals (red fox, badger, hare).

Bayesian multilevel models showed all acoustic stimuli substantially increased flight probability above the near-zero silence baseline, confirming a stimulus-driven response. Response intensity ranked: white noise > predator vocalisations ≈ human voice > train horn ≈ railway bell, with the three top stimuli producing 0.66–0.83 predicted probability of immediate flight in ungulates versus 0.31–0.38 for horn and bell. All active stimuli approximately halved the probability of animals moving towards the railway relative to silence (~33% to ~14%), showing MASS redirects animals away from the collision-risk zone rather than merely startling them. An exploratory habituation analysis found declining response intensity with cumulative site exposure in medium-sized mammals but not in ungulates, traced mainly to one heavily-visited site rather than a population-wide trend, suggesting habituation is unlikely to compromise deployment where warnings are reinforced by genuine train arrivals.

White noise and biologically informed threat signals, in particular the human voice, emerge as the most effective and versatile stimuli for acoustic railway wildlife deterrence.

POSTER 84 | CREATING ACTIONABLE KNOWLEDGE

Innovative Thermal Imaging used to Field Test how Barbastelle Bats Cross Roads to Inform Cost Effective Proportionate Mitigation

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KEYWORDS
monitoring, evidence-based mitigation, species behavioural response, barrier permeability, wildlife mortality assessment

Mitigation to address the impacts of fragmentation and collision from transport infrastructure needs to be evidence-led and proportionate to the risk, yet uncertainty in bat road-crossing behaviour can drive disproportionate mitigation. We present an empirical survey technique applying new technology to build knowledge of how barbastelle (Barbastella barbastellus) responded behaviourally to infrastructure in a local context, informing proportionate mitigation design.

A 13 km hybrid online/offline bus scheme near the Eversden and Wimpole Special Area of Conservation (nearest maternity colony ~0.25 km) required effective severance mitigation. Radiotracking and activity surveys identified commuting routes. To address Statutory Nature Conservation Body (SNCB) concerns about the use of poorly evidenced hop-overs, we field-tested a thermal-imaging method (FLIR Research Studio) on existing roads (A1303, A428) where radiotracked bats were known to cross. Four locations were surveyed at least twice (June–August 2025), spanning 5-38 m canopy gaps across single/dual carriageway roads at-grade and in cuttings. Thermal-imaging with software-tracked flights was time-synchronised with manually verified barbastelle registrations from static detectors (±30 s). We observed 220 bats: one individual potentially flew at single-decker bus 'at-risk' height (3–6 m), while >99% crossed at safe heights (typically 4–20 m+), including across the widest gaps. This evidence informed: (1) cost-effective short hop-overs to be implemented to reduce fragmentation and barrier effects; (2) gave confidence to the SNCB to approve proportionate mitigation and confirm no adverse effect on the integrity of the SAC; and (3) embedded post-construction monitoring and refinement to continue to test mitigation effectiveness.

POSTER 88 | CREATING ACTIONABLE KNOWLEDGE

Advancing Wildlife–Infrastructure Risk Assessment Through Long-Term Collision Data: Evidence of Climate-Driven Shifts in Ungulate Behaviour

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KEYWORDS
wildlife mortality assessment, species behavioural response, longitudinal monitoring, evidence-based mitigation, monitoring

Long-term wildlife–vehicle collision (WVC) datasets offer a powerful but underused source of behavioural and ecological insight. Analysing 190,723 WVC records from the Czech Republic (1982–2019), we identify a significant climate-related shift in ungulate behaviour detectable only through collision time series. The spring peak of WVC—dominated by roe deer—now occurs almost one month earlier than at the start of the monitoring period. This shift is statistically robust and cannot be explained by changes in traffic volume or reporting practices. Instead, it aligns with long-term warming trends and earlier vegetation phenophases, which advance key behavioural periods such as territory establishment and spring dispersal.

Our findings demonstrate that WVC datasets can reveal subtle, population-level behavioural responses to climate change that are not captured by traditional ecological monitoring. This has direct implications for infrastructure planning, mitigation timing, and risk forecasting. By integrating long-term collision data into strategic planning frameworks, transport authorities can better anticipate seasonal risk windows, adapt mitigation measures to shifting phenology, and improve the long-term effectiveness of wildlife–infrastructure interventions.

This contribution highlights the value of WVC monitoring as an actionable evidence base for reducing wildlife mortality, improving road safety, and supporting adaptive management under accelerating climate change.

POSTER 91 | CREATING ACTIONABLE KNOWLEDGE

Using a wildlife warning system to avert ungulates from a level-crossing prior train arrival

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KEYWORDS
systems innovation, fauna passage design, species behavioural response, strategic defragmentation, evidence-based mitigation

Enhancing wildlife connectivity while reducing train collisions is a significant challenge for infrastructure authorities. Fences and fauna bridges yield positive results but are expensive, justifiable primarily on high-speed, high-volume lines. Along most of the railway network, more cost-efficient solutions are needed. The Swedish Transport Administration has adapted railway station safety technologies for wildlife protection at a fauna level-crossing. Detection relies on thermal cameras with image recognition, while animals are deterred by a human voice message. To minimize disturbance and habituation, the sound warning activates only when animals are detected while a train is approaching, allowing wildlife to use the fauna passage undisturbed at all other times. Approximately 100 trains traverse the site each day, operating at speeds up to 140 km/hr.

During the first three years since construction, wildlife was recorded on 1207 occasions, of which 200 (17%) triggered the warning system. Fallow deer accounted for most events (N=632), followed by roe deer (N=303), moose (N=42) and wild boar (N=18). Ungulate reactions to the warning sound could be analyzed on 167 occasions. Upon sound activation, the majority (64%) of ungulates stopped or moved away from the tracks without crossing. The overall passage crossing rate was approximately 51%. No accidents were reported at the site during the three-year period. These results suggest that acoustic warning systems can enhance safety at fauna level-crossings. Effective implementation requires naturalistic sound design and signal variation to prevent habituation, particularly at sites with high ungulate presence and frequent train traffic. Analyses are ongoing.

POSTER 128 | CREATING ACTIONABLE KNOWLEDGE

The Rapidly Evolving World of Wildlife Crossings: Case Studies of Successful Ecological Connectivity

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KEYWORDS
fauna passage design, barrier permeability, evidence-based mitigation, landscape-scale restoration, wildlife mortality assessment

Transportation infrastructure has long posed a barrier to terrestrial and aquatic connectivity, fragmenting habitats, altering hydrology, and increasing wildlife mortality. Addressing these impacts is increasingly recognised as critical for biodiversity conservation, ecosystem resilience, and road safety, particularly under climate change pressures. In response, transportation mitigation has evolved toward more evidence-based mitigation informed by ecological science, monitoring, and adaptive management.

A central strategy is the design and implementation of fish and wildlife crossings, supported by fencing and other measures to increase barrier permeability and reduce wildlife-vehicle collisions. Effective fauna passage design, including appropriately sized culverts and bridges, improves aquatic and terrestrial movement while restoring more natural hydrological processes. Increasingly, projects incorporate retrofitting infrastructure to improve passage at existing barriers, rather than focusing solely on new construction.

Best practices now emphasise landscape-scale restoration, integrating crossing structures into broader conservation and land-use planning. Tools such as ecological and movement modelling support wildlife mortality assessment, identify priority mitigation locations, and predict species behavioural response to infrastructure. Rigorous monitoring, including before-after evaluation, is increasingly used to assess performance and refine designs.

The regulatory landscape is also shifting toward stronger considerations of connectivity with effective implementation often depending on cross-boundary coordination among transportation agencies, land managers, and conservation groups.

This poster highlights international case studies demonstrating how integrated, data-driven approaches can reduce fragmentation, enhance biodiversity, and deliver safer, more sustainable transportation networks.

POSTER 132 | CREATING ACTIONABLE KNOWLEDGE

The West of England Wildlife Index

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KEYWORDS
biodiversity loss, evidence-based mitigation, ecological integrity at scale, ecological resilience, ecological limits

The Wildlife Index (WI) is an ecological monitoring project covering the West of England Combined Authority (WECA) that aims to understand how wildlife populations are changing in the region. It incorporates systematic abundance data from national monitoring schemes and additional surveys at 20 selected sites to create a robust evidence base for different species across a range of habitats in the region. Presently, the project uses over 30,000 observations of birds, fish, invertebrates, mammals, and other groups and will continue to include observations of additional species as they are collected from the monitoring sites.

Working in partnership with the University of Bristol, a Bayesian multilevel modelling approach was developed to estimate changes in species abundance. This model draws on recent work in quantitative ecology demonstrating that where and when species are observed should be considered for robust trend estimation (Johnson et al., 2024). By selecting the highest-quality data available and using a sophisticated modelling approach, the project seeks to understand how abundance—a key facet of biodiversity (Callaghan et al., 2024)—is changing at the regional scale.

Initial results from monitoring scheme data between 2000 and 2025 indicate that 15% of species within the WECA region are declining, 9% are stable, and 4% are increasing; the remainder of species have uncertain trends, primarily due to limited abundance data. Looking at species groups and habitat associations, results suggest that are 30% of grassland-associated butterfly species are declining; 47% of grassland-associated birds are declining; and 62% of fish species analysed are declining. Results also showed that some generalist and urban-adapted species, including red fox and robin, are increasing, while hedgehog populations appear to be stable within the WECA region. These results have been published in the West of England State of Nature Report (2026), which is already helping to garner attention and investment for large-scale nature restoration in the region.

The Wildlife Index will create actionable knowledge by generating insight into species populations at both the local and regional level. The first survey year of the Wildlife Index project aligns with the announcement of the West of England Growth Strategy, which over the next decade aims to transform the region, including its transport network and growth zones. Several of the WI sites are located within the West of England's growth zones, including three in 'Somer Valley' and two within the 'North Somerset Growth Gateway'. Long-term monitoring of these sites and comparisons with WI sites located outside of growth zones may help to improve our understanding of the wider impacts of infrastructure and development on species populations and habitats. Surveys in 2026 and 2027 will provide a baseline of pre-growth zone development, while future surveys in 5, 10, 15, and 20 years will capture changes in species abundances during and after growth zone development. Predicted impacts include increased pressure on public-access wildlife sites, increased light and noise pollution, and barrier and fragmentation effects; all of which have potential to impact local species populations. At the regional level, capturing widespread declines in species abundances could provide evidence for ambitious landscape-scale nature recovery and be used to inform conservation priorities.

This work presents a novel method for monitoring nature across a region, using established survey methods, citizen science contributions, and Bayesian modelling to estimate trends of individual species and species groups. We hope that in the future, the results of this long-term study will enable informed decision making for nature and effective mitigation for wildlife in future regional developments.

Refs

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POSTER 55 | CREATING ACTIONABLE KNOWLEDGE

Driver Awareness Approach to Reducing Sika Deer–Vehicle Collisions

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KEYWORDS
wildlife mortality assessment, evidence-based mitigation, species behavioural response, decision-making frameworks, governance architecture

Collisions between vehicles and large mammals are a growing concern worldwide, posing significant challenges for both human safety and wildlife management. In Hokkaido, Japan, vehicle collisions with sika deer (Cervus nippon yesoensis) have been increasing steadily, reaching 6,705 reported cases in 2025 and marking a record high for nine consecutive years. These incidents can result in severe injuries and fatalities, as well as substantial economic losses and psychological impacts on drivers.

To address this issue, we implemented a driver awareness initiative that combined outreach activities with participatory data collection. Educational articles were published over a one-year period in a widely distributed regional driving magazine to inform drivers about wildlife–vehicle collision risks and raise awareness. In parallel, drivers were invited to submit video footage of wildlife encounters, including sightings, near-misses, and collisions.

A total of 26 videos were collected and analysed. More than half of the incidents involved sika deer, while other species included foxes, raccoon dogs, cranes, brown bears, and raccoons. Notably, all collision and near-miss cases involved sika deer. Analysis of the footage revealed numerous high-risk situations, including sudden emergence from roadside vegetation, unpredictable crossing movements, activity under low-light conditions, and group behaviour.

Based on these findings, awareness-raising materials were developed, including short video clips for social media and a short explanatory video providing information on collision statistics, risk factors, and sika deer behaviour. In addition, a roadkill map showing collision hotspots at a 1-km resolution, together with a GPS-based location display, was developed to support drivers' situational awareness.

These materials were disseminated via a project website and social media platforms. The roadkill map is currently being used by road authorities, while the awareness-raising videos are under consideration for use by police organisations and educational institutions. The results indicate that participatory video collection provides a practical means of capturing real-world wildlife–vehicle interactions and identifying situations and behaviours associated with collision risk.

This case study illustrates the practical potential of using participatory video collection and communication tools to develop and deliver driver awareness initiatives aimed at reducing wildlife–vehicle collisions. The present study focused on the development and implementation of these awareness-raising activities rather than on formally evaluating their effectiveness. Future work will therefore include questionnaire-based research to assess changes in driver awareness and behaviour, alongside continued data collection and refinement of outreach strategies.

POSTER 69 | CREATING ACTIONABLE KNOWLEDGE

Integrated assessment of wildlife permeability, functional connectivity, and collision risk along the A-1 motorway in northern Madrid

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KEYWORDS
infrastructure coherence, barrier permeability, species behavioural response, monitoring, landscape connectivity

High-capacity roads are major drivers of habitat fragmentation and direct wildlife mortality. Although mitigation usually relies on fencing and wildlife crossing structures, integrated approaches that jointly assess functional connectivity, actual wildlife use, collision patterns, and the characteristics of existing crossing points remain limited.

This study addresses these gaps along the A-1 motorway in the Sierra Norte de Madrid, a 52.5-km section between El Molar and the Madrid–Castilla y León boundary. We combined functional connectivity modelling, field-based assessment of wildlife use, collision analysis, and structural characterization of existing crossing points. Functional connectivity was modelled for nine macro and mesomammal species using species-specific resistance surfaces derived from land cover and slope, together with core-area definition based on home-range requirements, and analysed through Linkage Pathways and Pinch Point Mapper to identify least-cost paths and connectivity bottlenecks.

In parallel, wildlife site occupancy was assessed by camera trapping with 116 camera-trap stations in total, combining 85 stations distributed across 18 UTM 5 × 5 km cells in natural and semi-natural habitats with 31 additional stations installed in transverse structures potentially usable as wildlife crossings. Cameras operated continuously for at least 30 days and were complemented by direct field observations and systematic recording of indirect evidence of wildlife use, including footprints, scats and other signs detected during inspections of all inventoried structures.

Roadkill records for 2013–2023 documented 229 collisions, mainly involving wild boar (103) and roe deer (78). These records were obtained from the traffic safety national authorities database, georeferenced in a GIS environment, and analysed to identify temporal trends and spatial clustering of collision hotspots along the motorway. Existing permeability structures were inventoried along 42.2 km, with 75 transverse structures recorded, each characterised in terms of dimensions, structural typology, surrounding land use, maintenance, obstacles, fencing, vegetation at entrances, and signs of fauna, but only 9.3% were suitable for large mammals.

The results reveal a clearly deficient level of permeability and show that collision hotspots are concentrated in sectors where functional connectivity persists but adequate crossing opportunities are lacking. This highlights the need to move beyond isolated mitigation measures and towards integrated, landscape-scale planning that aligns ecological connectivity, wildlife movement, and road safety objectives.

POSTER 87 | CREATING ACTIONABLE KNOWLEDGE

A new type of narrow green bridge for Geoffroy's bats (Myotis emarginatus)

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KEYWORDS
landscape connectivity, barrier permeability, infrastructure coherence, fauna passage design, financing mechanisms

Challenge

Highway A2 in the south of the Netherlands intersects Geoffroy's bat (Myotis emarginatus) flightpaths between roosts and feeding grounds. Radiotelemetry indicated that bats use tall trees to cross the road at seven locations in a 18-km trajectory, but these trees will be removed for a road expansion. Geoffroy's bats avoid open spaces or descend to ground-level, which would be detrimental. Three locations could be mitigated using existing bridges and a culvert. For the remaining four, international guidelines suggested 11—20 meters wide green bridges with tall screens, deep soil layers and multiple lines of vegetation, but our relatively high frequency of crossings required a cost-effective solution.

Methods

We compiled information from guidelines, overpass examples elsewhere, and broad international expert knowledge, to design a new type of narrow green bridge that met species' requirements at acceptable costs. Subsequently, our analysis and design were assessed by independent specialists. Finally, they were evaluated by competent authorities and funding ministry.

Design

Our design consists of narrow green bridges with a width of only 6 meters. Outward-flaring screens (1.4 meters tall) shield flightpaths from vehicle illumination, while providing dark flight width beyond the 6 meter bridge width. Bridges support a 2-meters wide area-specific soil layer of 60 centimetres deep, to sustain a continuous line of indigenous shrubs with an initial height of 1.5 meters. At both sides of the bridge, soil level decreases to 20 centimetres and accommodate herbal vegetation; these areas will also be used for maintenance. At both sides of the bridges, funnel-shaped vegetation will horizontally and vertically guide bats to the bridges. Shielded road illumination is placed on short poles to avoid scatter, for a modelled maximum illuminance of 0.5 lux in the flightpath.

Planning and monitoring

The four bridges will be built during the October 2026—April 2027 hibernation period, after which monitoring by automated radiotelemetry, automated ultrasonic recording and thermal imaging will take place until 2031.

POSTER 95 | CREATING ACTIONABLE KNOWLEDGE

Overview of a method to map the ecological permeability of linear transport infrastructures (LTIs) at national scale in France.

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KEYWORDS
evaluation, adaptive management, barrier permeability, longitudinal monitoring, scaling pathways

Introduction

The National Biodiversity Strategy 2030 (SNB 2030) aims to ensure that, by 2025, each region of France has identified the 'blackspots' (barriers to terrestrial ecological connectivity) to be restored by the end of the decade.

One of the objectives of the French Ministry for Ecological Transition was therefore to produce standardised homogeneous national maps, identifying linear infrastructure of transport, outside urban areas, so as to prioritise the identification of the most fragmenting sections requiring mitigation measures as a priority mitigations in first priority. Cerema carried out the study.

Methodology

The method was developed using the following process;

Data collection (limited to data available at national level in order to avoid any bias arising from data heterogeneity) and mapping of all structures crossing the LTIs, included viaducs and wildlife crossings. The LTIs were first ranked in order of increasing levels of raw ecological permeability, determined using several global primary parameters (number of lanes, traffic intensity, train speed, width of canal and presence or absence of fencing). Only fenced Level 1 LTIs (motorways, HS railways and the largest canals) with the lowest raw permeability, included in this nationalwide study. Crossing structures were taken into account in the next stage, in order to determine the refined ecological permeability rate at the scale of Level 1 LTI sections. Subsequently, all types of crossing structures types identified across all Level 1 LTIs were classified according to their 'Crossing Potential (CP) for wildlife (i.e. viaducts and fauna passages have the highest CP whilst road crossings have the lowest), whilst also taking into account the distance from the nearest crossing structures and the species' movement abilities.

All the most common species living in France were divided into three functional movement groups - groups 1, 2 and 3 - respectively capable of moving within a radius of 300 m (mainly amphibians, reptiles and small mammals), 300-1000 m (mainly leporids and mustelids) and 1000-3000 m (ungulates, foxes and badgers). Large carnivores, such as bears, were not included in the methodology, either because their populations are too small or, as in the case of wolves and lynx, because their range of movement exceeds the smaller scale of the crossing structures. Each LTI section is delineated by these three buffer zones around the crossing structures (radii of 300 m, 1000 m and 3000 as mentioned above). Where several buffer zones overlap, multiple permeability rates have been added to each section concerned.

In the case of « twinned » LTIs, the permeability rates of the LTI sections closer than 500 m were halved to account for the cumulative negative effects. LTI sections with a small number of crossing structures and long distances between them are therefore considered to be the least permeable to wildlife.

At last step, these least-permeable LTI sections identified through this process were overlaid onto all regional ecological connectivity networks (comprising all biodiversity hotspots areas linked by ecological corridors) in order to produce a map of the top priority blasckspot to be addressed first to Regions for analyses. A further list of less secondary blackspots, with lower priority was also drawn up, these sections serving to supplement the regional-scale analysis carried out subsequently.

Results

Priority and secondary "road" blackspots (132 in total) were identified across all regions, with the highest number of priority blackspots located in south-western and western France. There are only 7 "high-speed rail" blackspots nationwide. There are 41 priority "canal" blackspots spread across seven regions, particularly in northern France where canals are most numerous. Most of the blackspots have been confirmed by the six regions that carried out the analyses.

Discussion

This previous result which demonstrates reliability of the national methodology, is not contradicted by the fact that these regions included their own regional blackspots. In fact, all these regions used their own data and experts on the ecological network - which are essential for ensuring greater accuracy at their level – and did not draw on knowledge relating to the LTIs, which is particularly precise at national and regional levels. However, there are several limitations in the methodology. The animal-impermeability of Level 1 LTI fences is overestimated, small mammals such as mustelids can easily cross fences by climbing over them. Moreover, at national level, all the actual permeability of wildlife crossings cannot be assessed, as the classifications are nearly all based solely on expert opinion. Analyses are still not complete, at either several regions or national scale, to determine for example which landuse types and/or which LTI networks or any other covariable have the greatest influence on the site position of the 'potential least wildlife permeable LTI sections' compared with those of the blackspots, except that an ecological corridor crosses any blackspot. This study ultimately highlighted the need for a national database of crossing structures in order to implement a national defragmentation policy, as well as for the purpose of this methodology, particularly with regard to viaducts and hydraulic structures that are difficult to locate using automated GIS tools, as well as wildlife crossings, for the same reasons (and the 'SIPAF' database on wildlife crossings and viaducts in France was not yet complete at the time). This lack of comprehensive data necessitated time-consuming tasks such as the visual analysis of aerial photographs, specialised data collection and the involvement of local experts from Cerema.

POSTER 148 | CREATING ACTIONABLE KNOWLEDGE

Multifunctional green bridges as a measure to increase landscape permeability and support strategic landscape restoration within the context of European legislation and policy

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KEYWORDS
longitudinal monitoring, barrier permeability, spatial planning, landscape connectivity, strategic defragmentation

The rapid intensification of land use and the development of transportation infrastructure are among the main factors contributing to habitat fragmentation and an increase in collisions between vehicles and wildlife in Europe's cultural landscape. In Central Europe, which has long been significantly influenced by human activity, fragmentation is continuing to worsen and ecological connectivity is being disrupted.

This study monitored the effectiveness of multifunctional green bridges in Austria, which are designed for both animal migration and human use. Based on a year-long monitoring effort, it was found that these structures are used by a wide range of species typical of the cultural landscape. More than half of the recorded activity was attributed to the roe deer (Capreolus capreolus), followed by the European hare (Lepus europaeus), the red fox (Vulpes vulpes), martens (Martes sp.), and the European badger (Meles meles). At the same time, the bridges were heavily used by humans, particularly for driving, walking, transporting agricultural and forestry machinery, walking with dogs, and cycling. The width of the bridge (measured parallel to the crossed infrastructure) relative to its length was identified as a significant factor influencing mammal passage. The results highlight the importance of structural parameters for optimizing the ecological functionality of these structures.

Multifunctional green bridges are an effective tool for enhancing ecological connectivity in human-modified landscapes. At the same time, they can contribute to the implementation of European strategic documents and defragmentation policies, such as the EU Biodiversity Strategy to 2030 and the Nature Restoration Regulation, which emphasize landscape restoration and ecosystem connectivity. Strengthening connectivity at both the regional and supraregional levels will be key to restoring ecosystem functions, ensuring ecosystem services, and adapting to climate change. Well-designed and integrated green bridges can thus serve as a significant pillar for landscape restoration and enhancing its ecological stability.

THEME

Pace over Perfection

POSTER 18 | PACE OVER PERFECTION

Offsetting Nature – what does a good trade-off look like?

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KEYWORDS
ecological and social values, biodiversity loss, nature markets, trade-off analysis, landscape connectivity

Here, we focus on how nature-for-nature trade-offs can ensure biodiversity value, management, and protection. Based on new, concrete examples, we present a more dynamic approach to offsetting nature, where the value of nature restoration is given greater weight than, for example, the restoration of specific habitat types or geographical proximity to the nature that is being lost. The reasoning for this is that our primary goal is to protect and restore existing high quality habitats with threatened species.

Not all habitat types are equally easily restored. However, financing will always be a limiting factor and therefore we argue that investments should be allocated to sites with the highest return on biodiversity first – even if that is a different type of habitat.

By focusing on restoration of existing nature, we also avoid the uncertainty that is related to how new habitats will develop under a changing climate and related effects such as flooding or drought. By protecting and restoring existing ecosystems we enhance the resilience and reduce the vulnerability these areas are currently experiencing.

We apply a new biodiversity metric, with indicators focusing not solely on biotic integrity, but also on the lasting protection and completeness of ecological processes within an area. Additionally, by using this metric and looking at historical data, we are able to evaluate the effectiveness of historical offsetting projects. The evaluations rely on qualitative approaches for estimating biotic integrity using botanical surveys, as these has been conducted for decades, and allows comparisons between historically impacted areas and newer restored sites. However, we also synthesize the botanical complexity into a scale of 1-100 to calculate no net loss and biodiversity gains.

Although offsetting represents the final step in the mitigation hierarchy, in practice it is a solution that is often applied. This is partly because in many cases it is not possible to avoid impacts on nature—for example in connection with large infrastructure projects—and offsetting therefore appears unavoidable.

There is currently an extensive debate underway about the use of offsetting as a mitigation measure. The scientific literature highlights a number of significant pitfalls, including how nature quality is measured and compared across different habitat types, how long-lasting the positive effects are, and the degree of transparency in the methods used.

This presentation suits the theme of "Pace over Perfection" as it addresses the idea of "scaling up proven solutions to reduce fragmentation and severance across landscapes and infrastructure networks, balancing urgency with ecological integrity."

This is addressed, as we raise critical questions about current offsetting nature practices in Denmark: Is it the most cost-effective way to protect and restore nature, or can offsetting nature to a greater extent be used as a tool to shift investments from areas with low nature quality to areas with greater potential for biodiversity?

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