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BIODIVERSITY AND INFRASTRUCTURE SYNERGIES AND OPPORTUNITIES FOR EUROPEAN TRANSPORT NETWORKS

DELIVERABLE 3.2

Report on identification of Best Practice and Gaps and Barriers to expand replicability and application of good and best practice to mainstream biodiversity and transport

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TABLE OF ABBREVIATIONS

Abbreviation	Meaning
BP	Best Practice
EIA	Environmental Impact Assessment
EU	European Union
GA	General Assembly
GP	Good Practice
IENE	Infra Eco Network Europe association
MS	Member States
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
SEA	Strategic Environmental Assessment
STRIA	Strategic Transport Research and Innovation Agenda
TEN-T	Trans-European Transport Network
TRA	Transport Research Arena
UN	United Nations
WP	Work Package

EXECUTIVE SUMMARY

The BISON project is led by a consortium of 39 European members and associated countries. It aims to tackle the integration of biodiversity with the development of transport infrastructure, including roads, railways, waterways, airports, ports, or energy transport networks.

Within the BISON project, WP3 has the overall objective to **identify and describe current good practices** and new technologies including nature-based solutions to be deployed to mainstream biodiversity in existing and future transport infrastructures. The identification of new emerging trends to be addressed in the present scenario of climate change and its effects on biodiversity and transport is also envisaged. The compilation of practices and recommendations to guarantee the user's safety and infrastructure resilience as well as contributing to achieve the UN Sustainable Development, the European Green Deal and the EU Biodiversity Strategy for 2030 Goals are the main focus of this WP. Moreover, its outputs will encourage the cooperation between European countries to design and operate transport infrastructures that will avoid or at least reduce impacts on biodiversity through e.g. traffic related mortality, habitat loss and fragmentation and environmental pollution, while enhancing infrastructure green areas to promote ecosystem functions such as creating suitable habitats for biodiversity and reconnecting populations. These relate to the effects of global warming but also to pathogen spread, technical innovations and socio-political and economic constraints that are expected to alter chances to maintain infrastructure efficiency and ecosystem services.

This Deliverable (D3.2): "Report on identification of Best Practice and Gaps and Barriers to expand replicability and application of good practice to mainstream biodiversity and transport" of the BISON project is the second deliverable produced in the context of this WP3 – Existing and future synergy between Infrastructure and Biodiversity. This report presents the methodology and the process used in the BISON project to compile and identify Best Practices among those currently implemented and to evaluate and weight all gaps and barriers to the expansion and replication of these practice.

The good practices analyses started first in the creation of 1) a questionnaire, to collect Good Practice to be analysed and also in a glossary dedicated to the main terms used in WP3 and Task 3.1 but also used for the needs of the whole BISON project, while the description of the methodology that is used in the context of this task for the identification of the good practices and 2 the criteria that are going to be applied for narrowing them down to the final 3 list of the best practices (Deliverable D 3.1). In this report, emphasis is given in a following step, to the method that have been defined and used to identify i) the gaps and ii) the barriers detected in the collection of all good practices extracted from the questionnaire (Sub-Task 3.1.1 deliverable) and from internal BISON experts, their evaluation process by internal and external experts and compared with gaps and barriers proposed in the S-T.3.1.1 questionnaire.

In the upcoming sections of this report, Section 1 is dedicated to the exploration of Best Practices. It encompasses the entire process of identifying and shortlisting the good practices, to the identification and assessment of the Best Practices using the MCA methodology, following a MAMCA approach, as described in D3.1. The section begins by providing an overview of the identification process, highlighting the rigorous criteria and selection process employed to compile the initial list of good practices. It then delves into the shortlisting phase, where specific selection criteria are applied to narrow down the extensive list. Following that, the methodology used to assess the Best Practices is presented, outlining the systematic approach and criteria utilized for assessment. Finally, the section concludes by presenting

the results of the evaluation, showcasing the ranked Best Practices and their notable attributes. This comprehensive section offers valuable insights into the entire process, from identification to evaluation, providing a solid foundation for subsequent sections of the report.

In Section 2, is exposed the method to identify gaps (Section 2.1) and barriers (Section 2.2) in the good and best practices collected from the questionnaire and external experts. The first results will expose for gaps (Section 3.1) and for barriers (Section 3.2), a preliminary global analysis has been conducted to merge both parameters, followed by a discussion on gaps (Section 4.1) and barriers (Section 4.2) to complete this gaps and barriers analyses ending this report. The next steps are finally described in Section 4.3.

In Section 3, are presented the methodology and results to evaluate stakeholder´s perception regarding gaps and barriers hindering the mainstream of biodiversity on transport infrastructure. These results have been obtained by participatory workshops where experts from both sectors discussed and ranked the initial list identified by the BISON Questionnaire and internal consultation.

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1. INTRODUCTION

Europe is connected by an extensive transport network of highways, roads, railroads, waterways, cycling paths, air and sea routes complemented with energy transportation infrastructures such as powerlines and pipelines. These transport networks compose a common feature of European landscapes, they connect people and provide access to essential services and resources. Transportation promotes economic activity and is often associated with economic development. Improving the connection of a city or a region to a large trade and transportation network can boost the local economy and create new jobs.

However, increasing economic activity is often observed in the main connected zones. It also often comes with the negative environmental impacts of human settlements. The transportation networks not only provide goods and services to people, but also shape and influence the surrounding environment. Usually, once a region achieves a certain level of connectivity, any additional transport infrastructure does not provide the same benefits (i.e. decreasing the economy of the small areas alongside the transport infrastructure and only benefiting to the main urban areas newly connected). But it may have a significant impact on the environment, especially biodiversity, by introducing for example invasive alien species into ecosystems, causing wildlife mortality, and creating barriers between natural habitats. Transport networks can also promote development of urban and other artificialized areas to relatively rural and less populated areas in Europe, putting pressure on natural habitats and biodiversity. The construction of large transport projects such as the Suez Canal can change the key characteristics of the entire ecosystem. Since the canal was built, more than 500 alien marine species have been introduced into the Mediterranean Sea (Zenetos et al., 2021).

All man-made infrastructure networks (roads, railroads, waterways, powerlines and pipelines) can create barriers and divide the natural landscape into smaller isolated areas. Multi-lane highways through natural areas provide physical barriers to flora and more particularly to fauna. In addition, it reduces habitats available to wildlife, mainly affecting the species with largest range territory, which combined with the lack of connectivity between different habitats, it makes these populations more vulnerable. Animals need to move to find food resources or breeding partners, and to adapt their ranges to new conditions created by climate change. They are at risk of being injured or killed when trying to cross roads or rails (the transport network is here considered as a filter and not a barrier to some species). Even fences bordering transport networks to prevent animal road kills, without fauna passages crossing the transport infrastructure, can fragment populations of certain species in ways that limit the gene pool, and eventually increasing their extinction probability.

Transport also generates pollutants that can extend beyond the scope of the transport network (e.g., concentrations of particulate matter, ozone, NOx or heavy metals that can affect humans, plants and animal health). Some areas, such as mountainous areas, coastal areas, wetlands and the sea, can be particularly vulnerable to traffic pollution. Similarly, oil spills and the release of harmful substances into the ocean can cause serious damage to marine life. Recognizing these risks, many measures have been taken at the European and international levels. Noise pollution from transport is another issue, and its impact is not limited to terrestrial ecosystems, ports and maritime circuits in the English Channel or in the Gulf if Genoa producing deep impacts on cetaceans (European Environment Agency, 2016).

Different initiatives regarding different phases of transport infrastructure development, such as better connections through tunnels or bridges, provision of appropriate fauna passages, measures to reduce

risk of collisions between wildlife and traffic, etc. should be promoted and undertaken to ease pressure on Europe's biodiversity and ecosystems. In fact, these initiatives can be planned on a much larger scale than a single infrastructure project involving different stakeholders (planners, investors, citizens, different government-level authorities...).

To this extent, European policies (such as the Green Infrastructure Strategy) and the Connecting Europe Facility (funding instrument to realise European transport infrastructure policy), promote the integration of biodiversity into the design, construction and operation phases of infrastructure. However, standards for infrastructure are difficult to achieve due to a deficit in knowledge about causal chains, lack of tools, involvement of relevant stakeholders and the broader understanding of infrastructure impacts on ecosystem changes, both national and international (Tinch et al., 2015).

According to the European Commission, the Green Infrastructure is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services such as water purification, air quality, space for recreation and climate mitigation and adaptation. For example, the application of Nature-based Solution instead of “grey” infrastructure to increase transport infrastructure resilience to climate change can provide numerous benefits. This network of green (terrestrial) and blue (aquatic) spaces can improve environmental conditions and therefore citizens' health and quality of life. It also enhances a green economy, opens job opportunities and supports biodiversity[1].

Moreover, in 2017, STRIA[2] recognised some of the main challenges concerning the biodiversity barriers, with proposed avenues to manage these, whilst Horizon Europe[3], through the development of research and innovation, aiming to contribute to the Green Deal[4] and the European Biodiversity Strategy[5].

Such recent EU transport policies have significantly increased consideration for nature and biodiversity in transport infrastructure development and operation. These concerns need to be taken into account in the planning phase as early as possible. Transportation infrastructure projects, including those related to the Trans-European Transport Network (TEN-T), help in improving the quality of life across Europe by providing services and public goods to remote areas. At the same time, EU legislation also covers the potential impacts of infrastructure projects taking place outside protected areas, but which can still affect them. This approach can be translated into a variety of actions in the field. For example, in the case of rail and road networks, there can be changes to the proposed routes to preserve a large area and avoid landscape fragmentation. Similarly, tunnels and viaducts can be designed and constructed to improve connectivity between protected areas and facilitate the movement of animal populations. EU funds may be withdrawn if the project does not comply with these rules.

National-level efforts and initiatives towards mainstreaming biodiversity in transport are just as important as the interest of people. In many cases, long-term strategies are developed at this level, funding decisions are made, and a place where scalability opportunities are available. Key factors to promote this mainstreaming and enable its implementation include (OECD, 2018):

[1] https://ec.europa.eu/environment/nature/ecosystems/index_en.htm
[2] https://ec.europa.eu/jrc/en/publication/strategic-transport-research-and-innovation-agenda-stria-roadmap-factsheets
[3] https://ec.europa.eu/info/sites/info/files/research_and_innovation/strategy_on_research_and_innovation/documents/ec_rtd_orientations-he-strategic-plan_122019.pdf
[4] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
[5] https://ec.europa.eu/environment/nature/biodiversity/strategy/index_en.htm

- mainstreaming biodiversity in relevant transport national plans and strategies;
- ensure coordination and consistency between the Biodiversity and the Transport relevant institutions and clearly define their roles;
- responsibility of the different actors;
- evidence-based generation required for sound decision-making;
- mainstreaming biodiversity in transport also in the national budget.

Although, there are still differences on the alignment level of the EU Member States (MS) to the EU policies, there are relevant developments also at the MS level and stricter environmental regulations, policies and practices already changing some projects' design. For example, an inland water transport project to deepen the Weser River in Germany was criticized due to its environmental impacts (change salt content, create stronger currents and threat river-dependent wildlife and riverbanks). The European Court of Justice has ruled that the project worsens the water quality of the Weser River and violates the EU Water Framework Directive. As a result, the project has been cancelled (European Environment Agency, 2016).

The BISON project aims to research and address such issues and relevant challenges, focusing on infrastructure development and preservation of biodiversity, respectively, in order to achieve social and economic well-being.

After the first step of defining the principles and criteria to identify and select best practices to mainstream biodiversity in transport infrastructure (see D3.1) this report presents the results of the application of these criteria on the good practices compiled and the Best Practices selected. At the same time, it describes the gaps and barriers hindering the application of these Best Practices identified in the process.

To do this, two methods are used: an indirect method showing gaps and barriers as a lack of good/best practices in main issues and in phases of life cycle of an infrastructure of transport project and a direct method analysing stakeholder´s perception of gaps and barriers.

2. BEST PRACTICES

2.1. IDENTIFICATION OF BEST PRACTICES

2.1.1. Starting with the Good Practices

The core activities of this Task 3.1 part (b) focuses on the identification of principles and criteria for recommended practice to support the co-existence of Green and Grey infrastructure and contribute to biodiversity restoration (see D3.1). To achieve this goal, information has been collected on good practices from two main sources:

1) by desk-based literature research and expert knowledge and practice provided by key stakeholders, and
2) assessing the data based on a number of criteria to achieve a final selection of best practices regarding the co-existence of Green and Grey infrastructure and biodiversity restoration.

The process of compiling the good practices guide for the BISON project involved an extensive review of various literature sources. These sources encompassed generic policy documents and regulations at the EU level, as well as specific information pertaining to individual EU Member States. By exploring these diverse materials, a comprehensive understanding of the subject matter was obtained.

However, in addition to the literature review, a significant emphasis was placed on engaging in active stakeholder consultation. This approach aimed to gather insights and perspectives directly from relevant stakeholders. To achieve this, a targeted online BISON questionnaire was conducted, reaching out to various stakeholders such as transport operators, authorities, environmental organizations, research institutes, user organizations, national enforcement bodies, and others.

The primary objective of this stakeholder consultation was twofold. Firstly, it served as a means to create awareness about the BISON project, ensuring that stakeholders were well-informed and knowledgeable about its goals and objectives. This awareness-building process was vital in generating interest and involvement from the stakeholder community. Secondly, the consultation aimed to benefit from the expertise and experiences of the diverse stakeholder groups. By actively seeking their opinions and insights through the online questionnaire, the project team could tap into the practical knowledge and specialized perspectives of those directly involved in or affected by the project. This collaborative approach not only enriched the best practices guide but also fostered a sense of ownership and engagement among the stakeholders.

In summary, the compilation of the good practices guide for the BISON project involved a thorough literature review, encompassing EU-level policies and regulations as well as information specific to individual Member States. Additionally, active stakeholder consultation, facilitated through the online BISON questionnaire, played a pivotal role in gathering valuable input, creating awareness, and incorporating diverse perspectives into the guide.

So, as part of the BISON project's initial survey, project partners, organizations, and experts were requested to propose cases of Good Practice. They were specifically directed towards key actors and were provided with a comprehensive BISON questionnaire to facilitate their submissions. The survey,

which spanned over four months, aimed to gather valuable examples of projects that could be considered as good practices and potentially replicated. To ensure a diverse range of perspectives and expertise, experts from the project partners, the Advisory Group, and Ministries were invited to participate in the survey. These individuals were well-positioned to provide insights into projects that demonstrated exemplary qualities and could serve as models for replication.

The intention behind soliciting examples of good practices was to identify successful initiatives that had achieved positive outcomes and demonstrated effective strategies or approaches. By gathering such cases, the BISON project aimed to highlight real-world experiences and showcase practical solutions that could be valuable in addressing similar challenges. The detailed BISON questionnaire provided a structured framework for collecting relevant information about these projects. It likely covered various aspects, such as project objectives, implementation methods, stakeholder involvement, achieved results, and lessons learned. This comprehensive questionnaire ensured that the proposed good practice examples were thoroughly documented, allowing for a detailed evaluation and subsequent replication if deemed suitable.

Overall, the initial BISON survey sought to tap into the expertise of project partners, organizations, and experts to identify and gather examples of good practices. By engaging a wide range of stakeholders and using a detailed questionnaire, the survey aimed to create a repository of successful projects that could inspire and guide future endeavours within the BISON project and beyond.

As various relevant initiatives have been developed, the selection of the examples to be included in the initial list of Good Practices concerning biodiversity and transport co-existence were mainly based on the following parameters (according to the information found in the literature):

- ***Compliance with regulation***, and possibly going beyond minimum compliance.
- ***Effectiveness***, or the degree to which the practice has a tangible positive impact on the green and grey infrastructure co-existence.
- ***Transferability***, or the ease of implementing the practice in other contexts (in terms of location as well as transport modes).

Additionally, as the Good Practices had to be described in a short summary BISON template in English, they had to be characterized by the following basic features:

- To **be grounded** with the mean to be supported by related documentation and evidence.
- To **be understandable** by experts of various fields.
- To **be understandable by international experts** as the members of the Advisory Group.

2.1.2. Identifying the Best Practices from the Good Practices list

After receiving a total of 143 proposals for Good Practices, the next step in the evaluation process was to narrow down this extensive list. The purpose was to identify the most promising practices that aligned with the desired criteria for inclusion in the final selection. To achieve this, an internal evaluation was conducted in two steps. These steps involved a screening exercise supported by specific selection criteria. The goal was to systematically assess and shortlist the practices based on their alignment with the desired criteria.

The first step of the evaluation process focused on applying initial selection criteria to the list of 143 proposed practices. These criteria were designed to filter out practices that did not meet the minimum requirements or did not align closely enough with the goals and objectives of the BISON project. During the BISON GA meeting in Paris in June 2022, the criteria for the evaluation and selection of Best Practices were decided upon. These criteria were designed to complement the initial baseline and ensure that the proposed practices were grounded in their potential impact and applicability. The following criteria were identified and agreed upon during the meeting:

- **Expected Impact on Biodiversity:** This criterion focuses on assessing the potential impact of the proposed practices on biodiversity. It aims to determine the extent to which the practices contribute to the conservation and enhancement of biodiversity in the transportation sector. Practices that demonstrate a significant positive impact on biodiversity are prioritized.
- **Modality Extendibility:** This criterion considers the extent to which the proposed practices can be extended or replicated in other modes. It evaluates the scalability and transferability of the practices, allowing for wider adoption and implementation beyond their initial application. Practices that have the potential to be extended and applied in various settings are given preference.
- **Geographical and Environmental Coverage:** This criterion examines the geographical and environmental coverage of the proposed practices. It assesses the extent to which the practices address diverse geographic regions and different environmental conditions. Practices that have a broad coverage and can be adapted to various environmental contexts are considered more favourable.

By incorporating these criteria into the evaluation process, the aim was to ensure that the selected Best Practices would have a positive impact on biodiversity, be extendable to different settings, and have a wide geographical and environmental coverage. This approach allowed for a more comprehensive assessment of the practices and facilitated the identification of practices that align closely with the goals and objectives of the BISON project.

The criteria decided during the BISON GA meeting in Paris in June 2022 were crucial in shaping the evaluation and selection process of Best Practices, providing a framework for assessing the practices based on their expected impact, extendibility, and coverage.

After evaluating each proposed practice based on these criteria a first selection of Good Practices was made. This rigorous evaluation process aimed to identify practices that demonstrated the most potential and promise in addressing the goals and objectives of the BISON project. As a result of this evaluation, the initial list of 143 proposed Good Practices was narrowed down to a refined selection of **87 Good Practices.** These 87 practices were selected based on their strong evidence base, indicating their effectiveness and alignment with the desired criteria.

After this preliminary evaluation, the shortlisted practices from the previous step undergo an in-depth evaluation. This stage involves a more detailed and comprehensive assessment of the practices to further narrow down the list. This assessment took place during an online meeting held in December 2022 with the Advisory Group members, with the aim of further refining and categorizing the practices. The analysis utilized a combination of two parameters to facilitate the screening process:

a) A Life Cycle Phase

The first parameter focused on the life cycle phase of each practice. The life cycle of a practice refers to the different stages it goes through, from strategic planning and design to operation and maintenance, and finally, decommissioning. Each proposed practice was assessed to determine which life cycle phase it primarily addressed. The available options for categorization based on life cycle phase included:

- **Strategic planning**: Practices that primarily focus on the strategic planning phase.
- **Design**: Practices that primarily pertain to the design phase.
- **Operation and Maintenance**: Practices that primarily relate to the operation and maintenance phase.
- **Decommissioning**: Practices that primarily address the decommissioning phase.
- **All life cycle phases**: Practices that are applicable across multiple life cycle phases.

b) A categorization type

The second parameter involved further categorizing the proposed practices based on their nature and characteristics. The available categories for this parameter included:

- **Established practice**: Practices that have been implemented and proven effective over time.
- **Pilot practice**: Practices that are in the pilot stage, being tested or implemented on a smaller scale.
- **Guidelines**: Practices that provide a set of guidelines or recommendations for specific actions or processes.
- **Recommendations**: Practices that offer recommendations for improvement or specific actions without providing a comprehensive guideline.

By combining these two parameters, the analysis aimed to create a framework for classifying the proposed practices more accurately. This categorization process enables a more detailed understanding of the nature, focus, and stage of development of each practice. It provides valuable insights for further evaluation and selection of the best practices to be included in the final compilation. Using the above screening approach from the "evidence based" 87 Good Practices the final **15 Best Practices** were selected to be included in the final evaluation with the experts.

2.2. VALIDATION OF BEST PRACTICES

2.2.1. Multi-Actor Multicriteria Analysis (MAMCA) methodology

The final selection of Best Practices was determined using the Multi-Actor Multicriteria Analysis (MAMCA) methodology. The methodology is explained with further detail in D3.1 but a summary is included in here to help understand the process and results. MAMCA is a methodology used to assess and rank different options or alternatives based on multiple criteria. MAMCA involves the participation of a group of experts or stakeholders, with expertise in various fields related to the topic under discussion, who collectively evaluate the options against a set of predefined criteria. The MAMCA process typically involves the following steps:

1) **Criteria Identification**: The relevant criteria for evaluating the options are identified and defined. These criteria can vary depending on the context and objectives of the analysis and in BISON, they were selected from the very beginning of the project and are the ones presented at Table 1.

2) **Weighting of Criteria**: The experts assign relative weights or importance to each criterion to reflect their relative significance in the evaluation process. This step helps ensure that the criteria are appropriately balanced.
3) **Option Assessment**: The experts evaluate each option or alternative against the identified criteria. This assessment can involve qualitative judgments, scoring, or rating of the options based on how well they meet each criterion.
4) **Aggregation of Scores**: The scores or ratings assigned to each option are aggregated to obtain an overall score for each option. This aggregation can be done using various methods, such as weighted sum, weighted product, or other mathematical approaches.
5) **Ranking of Options**: Based on the aggregated scores, the options are ranked in order of their performance. The option with the highest score is considered the most favourable or preferred choice.

MAMCA allows for the inclusion of multiple perspectives and stakeholder inputs in the decision-making process. By involving a group of experts or stakeholders and considering multiple criteria, it provides a more comprehensive and informed assessment of the options being evaluated.

In the context of the BISON project, MAMCA was utilized to assess and rank the proposed Best Practices. The methodology enabled the evaluation group to weigh the criteria, rate the practices against those criteria, and ultimately obtain a final ranked list of Best Practices based on their performance across the evaluation criteria. This approach involved a group of experts from both within and outside the BISON Consortium who participated in the evaluation process.

To successfully implement the MAMCA for mainstreaming transport and biodiversity, a diverse group of experts was considered necessary, each contributing their specialized knowledge and skills. The evaluation group included experts from relevant fields, such as **biodiversity**, **transportation** and **environmental assessment, impact evaluation, and sustainable development**. Biodiversity experts possess a deep understanding of ecological systems, species conservation, and the impacts of transportation infrastructure on biodiversity are essential. They provided valuable insights into the ecological aspects that need to be considered in the analysis. Also, transport experts who have expertise in different modes of transportation, infrastructure planning, and sustainable transport solutions participated. Their knowledge enabled a comprehensive evaluation of the transport-related factors affecting biodiversity. Additionally, experts in environmental assessment, impact evaluation, and sustainable development contributed their expertise to assess the environmental and social implications of different transport options.

The number of experts required in MAMCA analysis in general depends on the complexity and scale of the project, but a diverse team with representatives from these different disciplines is recommended to ensure a comprehensive and well-rounded analysis. The exact number of participants can vary, but having a diverse group of 5-10 experts is considered suitable to capture a range of perspectives and ensure a robust evaluation process.

In the evaluation process of Best Practices within the BISON project, the MAMCA approach was specifically utilized for road infrastructure, where a significant collective experience exists. This indicates that for road infrastructure practices, the evaluation followed a structured MAMCA methodology involving criteria weighting, expert ratings, and aggregation of scores to obtain a final ranking. Nevertheless, most of the Best Practices include evidence for other modes too. So no further assessment for other modes was considered necessary.

2.2.2. Limitation and assumptions of the survey

The MAMCA survey conducted within the BISON project for mainstreaming biodiversity and transport has some limitations and assumptions that should be taken into consideration. These include:

- Sample Size: The survey was conducted with a relatively small number of experts, with 7 participants involved. While efforts were made to ensure a diverse range of expertise and perspectives, the limited sample size may restrict the generalizability of the results.

- Expert Bias: The survey relied on the expertise and judgments of the participating experts. As with any subjective assessment, individual biases or preferences of the experts may have influenced their evaluations and rankings of the Best Practices.

- Data Availability: The evaluation of the Best Practices relied on the available data and information provided. If certain data or evidence were lacking for a particular practice, it could have impacted the assessment and ranking of that practice.

- Contextual Factors: The survey assumes that the evaluated Best Practices can be implemented across various contexts and locations. However, the effectiveness and applicability of these practices may vary depending on specific environmental, social, and regulatory factors in different regions or countries. Country-based practices may have unique considerations that were not fully captured in the survey.

- Language Barriers: The survey was conducted in English, which may have introduced language barriers for participants whose primary language is not English. This could potentially impact the accuracy and clarity of the responses and evaluations.

- Country-Based Practices: The survey focused on evaluating Best Practices across different countries and regions. However, country-specific practices or regulations have been also included, while their transferability and extendibility is an issue to be considered.

It is important to recognize these limitations and assumptions when interpreting the results of the MAMCA survey. While efforts were made to ensure a robust evaluation, further research and validation may be required to confirm the suitability and effectiveness of the identified Best Practices in different contexts.

2.2.3. Definition of principles and criteria for defining Best Practices

By conducting a thorough exploration of generic policy documents and regulations at the EU level, as well as desk-based literature research, this task has established a solid background for the BISON project. In addition, valuable insights and practical knowledge have been gathered through the active participation of key stakeholders in the BISON questionnaire. Building upon this extensive compilation of information and input, the next step (Step 2) involved defining a list of **main principles and criteria**. These principles and criteria serve as guiding factors to evaluate and select good practices from the collected data.

The purpose of establishing these principles and criteria is to ensure a systematic and objective approach to the selection process. By clearly defining the key factors to consider, the project team can effectively assess the identified practices against a set of predetermined standards. The main principles and criteria

could encompass various aspects, such as effectiveness, efficiency, sustainability, scalability, innovation, stakeholder engagement, and replicability. These principles reflect the desired qualities and characteristics that the BISON project aims to identify in good practices. By applying these principles and criteria, the project team can evaluate each practice based on its adherence to the defined standards. This evaluation process ensures that the selected good practices align with the project's objectives and have the potential to be replicated and implemented successfully.

Overall, by combining the background research, expert knowledge, and stakeholder input, the task has laid the groundwork for defining the main principles and criteria that will guide the selection of good practices within the BISON project. This systematic approach helps ensure the identification of practices that exhibit the desired qualities and have the potential to make a positive impact in the project's context.

To this aim, and after analysing the relevant literature and be taken into account the final selected and used criteria are described in the **Table 1**.

Table 1: Criteria for identification of Best Practices.

	Criterion	Description
1	Effectiveness	Reflects the extent to which a practice offers a solution to the problem it is supposed to address, namely the facilitation of co-existence of green and grey infrastructure and/or the restoration of biodiversity.
2	Relevance	Reflects the extent to which a practice is related to the recognized problem that the BISON project aims to address.
3	Functional diversity	Describes the extent to which a practice offers a holistic solution.
4	Efficiency	Describes the extent to which desired results are achieved at minimal costs (in terms of effort, energy, time and money).
5	Multimodality	Describes the extent to which a practice can address biodiversity problems typically related to multimodal transport (inspired by the central role multimodal transport plays in this project).
6	Maturity	Reflects the extent to which a practice has been tested and their outcomes and impact positively assessed.
7	Sustainability	Reflects the extent to which a practice is on a firm financial (availability of funding), legal (compliance with national and EU legislation) and social (culturally appropriate) basis, thus increasing the likelihood it will last.
8	Transformability	Reflects the extent to which a practice can be adapted to solve different (but relevant) problems.
9	Repeatability	Reflects the extent to which the methods used (in terms of scientific research or engineering) can be used in different but relevant problems/ cases, using clear protocol without “black box” and without high variations in the results due to hidden biases inherent to the method chosen.

	Criterion	Description
10	Transferability	Describes the extent to which a practice can be “scaled up” to other contexts (other locations, other modes of transport, etc.).
11	Innovation	Describes the innovative nature of a practice and the extent to which it can be a game changer
12	Co-benefits	Describes the positive spill-over effects of a practice, typically in terms of improving alignment in transport and biodiversity not belonging to the original target group or speeding up the service/reducing delays.

2.3. Results of Best Practices assessment

The MAMCA evaluation process for the Best Practices within the BISON project involved the participation of **7 experts**. These experts were selected from both within the Consortium and from the Advisory Group members, ensuring a diverse range of perspectives. The experts came from various countries including Greece, France, Turkey, Austria, and one with an international identity, bringing a global outlook to the evaluation process.

Furthermore, the experts possessed a broad range of expertise that covered all transport modes (Figure 1). Five out of the seven experts had knowledge and experience in both transport and biodiversity, allowing for a comprehensive understanding of the intersection between these two domains. One expert specialized solely in transport, one focused exclusively on biodiversity, and one had expertise in transport, biodiversity, and environmental legislation and policy making.

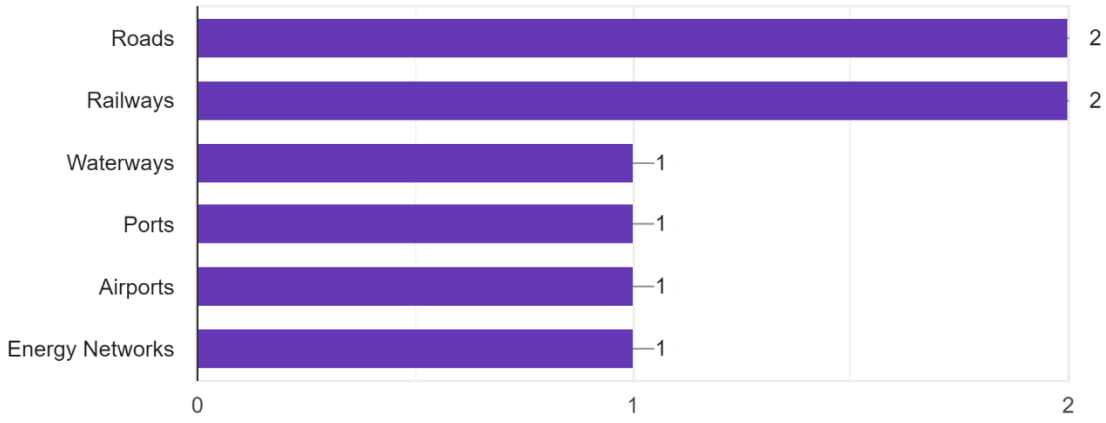


Figure 1: Expertise of MAMCA participant related to transport modes.

This composition of the expert group ensured that all relevant aspects related to transport, biodiversity, and environmental policy were taken into account during the evaluation process. The diversity of disciplines represented among the experts contributed to a comprehensive and well-rounded analysis of the Best Practices, considering multiple perspectives and ensuring a robust evaluation of their suitability and effectiveness.

The results of the MAMCA evaluation process for the Best Practices within the BISON project provided a ranked list of practices based on their performance against the defined criteria. The application of MAMCA allowed for a systematic and structured approach to compare and prioritize the practices according to their suitability and potential impact.

The ranking of the criteria based on the experts' responses is showed in Figure 2.

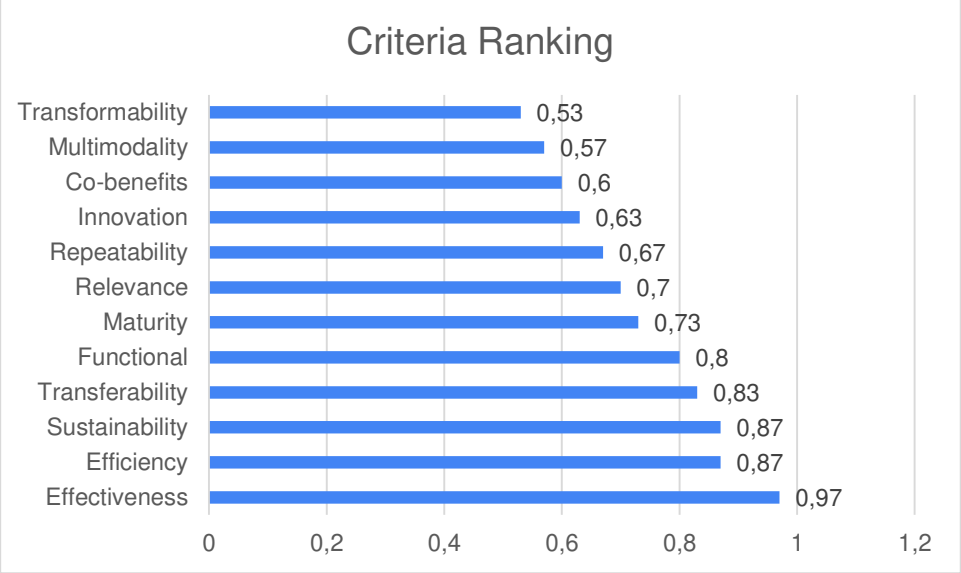


Figure 2: Overall ranking of the 12 criteria with its average scores.

The evaluation criteria used by the experts in the BISON project clearly indicate that the effectiveness of the Best Practices is considered the most important criterion. This highlights the emphasis placed on the practical impact and outcomes of the practices in achieving the project's goals and objectives. Effectiveness refers to the ability of the Best Practices to deliver the desired results and address the identified challenges effectively. The experts recognize that the practices should be able to make a significant positive difference in the realm of biodiversity conservation and sustainable transportation. Following effectiveness, the experts also prioritize the criterion of efficiency. This implies that the Best Practices are evaluated based on their ability to achieve the desired outcomes in a cost-effective and resource-efficient manner. Efficiency considerations include factors such as the optimal use of resources, time, and effort required for implementation. Additionally, sustainability is identified as an important criterion in the evaluation process. This indicates that the experts place value on practices that demonstrate long-term viability and resilience. Sustainability encompasses both environmental sustainability, ensuring that the practices minimize negative impacts on the environment, as well as socio-economic sustainability, considering the practices' ability to be maintained and supported by stakeholders over time.

Based on the weighted criteria and the feedback from the experts, a final ranking of the Best Practices has been established (Figure *3*). This ranking represents the culmination of the evaluation process and provides a clear indication of the practices that have emerged as the most exemplary and impactful within the BISON project. The weighted criteria, determined by considering the importance and relevance of each criterion, allowed for a systematic and objective assessment of the Best Practices. The experts' feedback and input further enriched the evaluation process, providing valuable insights and perspectives on the performance and potential of each practice. Taking into account the weighted criteria and the

expert feedback, the final ranking of the Best Practices reflects the collective judgment and consensus of the evaluation group. The practices that scored highest in terms of their effectiveness, efficiency, sustainability, and other relevant criteria have secured higher positions in the ranking.

Figure 3: Overall practices ranking according to MAMCA results.

The final ranked list of Best Practices reflects the combined expertise and judgments of the evaluation group, which consisted of both external and internal experts to the BISON Consortium. The group weighed the evaluation criteria and rated the practices based on their alignment with those criteria. The scores or ratings assigned to each practice were then aggregated to obtain an overall assessment.

The practices that received higher scores and ratings across the evaluation criteria were ranked more favourably in the final list. These practices demonstrated strong performance in terms of their positive

impact, feasibility of implementation, stakeholder involvement, sustainability, scalability, and adaptability. The ranking of practices allowed for the identification of the most promising and effective approaches in addressing the challenges and objectives of the BISON project. This ranked list provides valuable guidance for stakeholders and decision-makers involved in the transportation domain to understand and adopt practices that have proven to be successful and impactful.

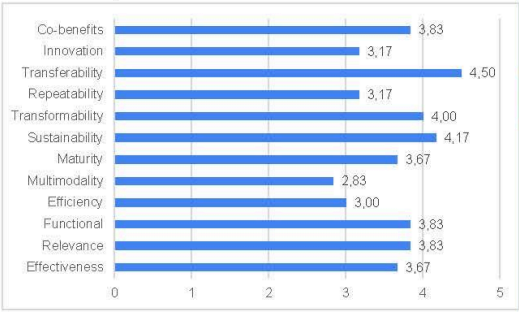
It is important to note that the MAMCA approach was specifically applied to road infrastructure practices, where collective experience existed. The results of the MAMCA evaluation process serve as a valuable resource for the BISON project and its stakeholders, providing insights into the practices that have demonstrated the highest potential for positive impact and effectiveness in the transportation sector.

The next figures present the Best Practices of BISON, following the template provided in D3.1. The MAMCA evaluation is also evident in each one.

GP1: International Action Plans of the Carpathian Convention for Sustainable Transport and Ensuring Ecological Connectivity

Measure rating (weighting factors)

Overall Weight:2.68



Category of the measure

Transport mode: All

Lifecycle phase:

- **Strategic Planning**
- **Design**
- **Operation & Maintenance**
- **Decommissioning**

Who and where

Name of organisation: Carpathian Convention
Location of measure: Carpathians
Available languages: English

Brief description of the practice

Under the umbrella of the Carpathian Convention two international Action Plan developed in the framework of two joined projects of the Interreg Danube Transational Programme (DTP):

1) The **Joint Strategic Action Plan 2021-2023 for the Implementation of the Protocol on Sustainable Transport** of the Carpathian Convention (Mikulov, 2014) to the Framework Convention on the Protection and Sustainable Development of the Carpathians (Kyiv, 2003).
2) The **International Action Plan on Conservation of Large Carnivores and Ensuring Ecological Connectivity in the Carpathians**

Impact

These two Action Plans have a strong potential impact on mainstreaming biodiversity and ecological connectivity in spatial planning and transport development in cross-border and international level. However, it requires national initiatives to implement concrete plans and activities in each country in local regional level.

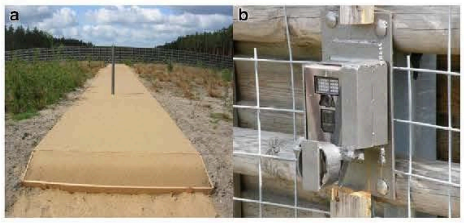
Transferability

Complete transferability to cross-sector and cross-border cooperation in large bio-regions scale as the Carpathian and Danube regions.

References (website link tested & functional)

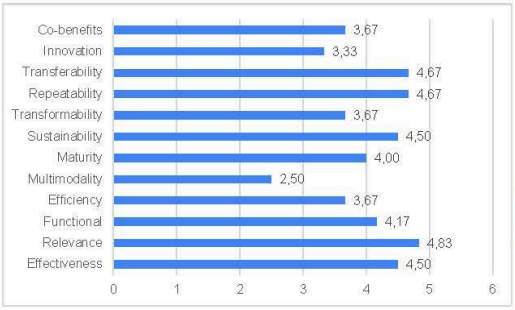
http://www.carpathianconvention.org/tl_files/carpathianconvention/Downloads/03%20Meetings%20and%20Events/Implementation%20Committee/CCIC2020/Sustainable%20Transport/Transport%20Strategic%20Action%20Plan.pdf
http://www.carpathianconvention.org/tl_files/carpathianconvention/Downloads/02%20Activities/Large%20carnivores/CC%20COP6_DOC9P_Int%20Action%20Plan%20Large%20Carnivores%20and%20Ecological%20Connectivity_ADOPTED.pdf
TRANSGREEN - Interreg Danube (interreg-danube.eu)
https://www.interreg-danube.eu/approved-projects/connectgreen
https://www.interreg-danube.eu/approved-projects/savegreen#!

GP2: Monitoring of mammal use of wildlife crossing structures along a new motorway in an area recently recolonized by wolves in Poland



Measure rating (weighting factors)

Overall weight: 2.98



Category of the measure

Transport mode:

Lifecycle phase:

- **Strategic Planning**
- Design
- **Operation & Maintenance**
- Decommissioning

Who and where

Name of organisation: **Department of Ecology, Institute of Functional Biology and Ecology, Faculty of Biology, University of Warsaw Poland & Association for Nature "Wolf"**
Location of measure: **Poland**
Available languages: **English**

Brief description of the practice

Towards understanding the role of wildlife crossing structures (WCSs) on enhancing connectivity between habitats of wild animals fragmented by fenced motorways, a special monitoring project implemented in the A4 motorway in the Lower Silesian Forest (western Poland). As the factors affecting their use by targeted species remain understudied, particularly in areas recently recolonized by large carnivores as wolves (Canis lupus), an investigation of the use of WCS (9 overpasses, 5 large underpasses and 4 small underpasses) implemented over 3 years (2010–2013). As a result, a conclusion extracted that overpasses, even with steep entrance slopes (25–26.5%), or integrated with moderately used gravel roads, maintain movement of wild terrestrial mammals much better than underpasses, and the presence of wolves does not hamper the movement of other wild species.

Impact

The implementation of such method and especially in a 3 year long duration has crucial impact on, a) understanding of use of WCS by wildlife and their effectiveness towards securing the permeability of highways or several species, and b) standardization of the structure and duration of the monitoring process of the effectiveness of WCS.

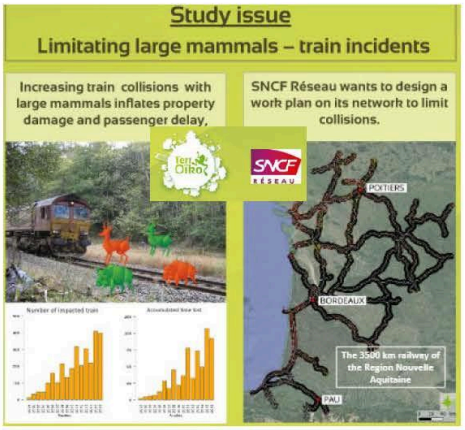
Transferability

The Transferability is high, especially on monitoring of other Linear Transport Infrastructure as railways, or in other areas with presence of large carnivores as key species for identification and management of ecological corridors especially when they are intersected by transport corridors.

References

Mysłajek R. W., Olkowska Emilia., Wronka-Tomulewicz M., & Nowak S., 2020. Mammal use of wildlife crossing structures along a new motorway in an area recently recolonized by wolves. European Journal of Wildlife Research 66: 79. https://doi.org/10.1007/s10344-020-01412-y

GP3: Animal Vehicle Collision (AVC) reduction strategy in French railways



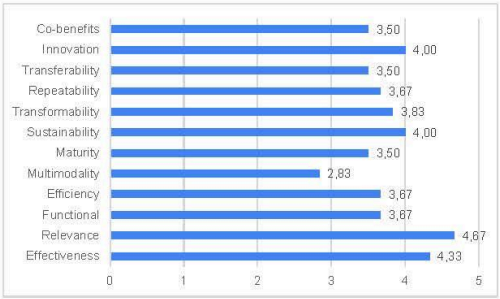
Nouvelle Aquitaine region, France
Available languages:
English

Brief description of the practice

SNCF reseau (French railway company) missioned TerrOïko to design a development program of New Aquitaine railways network to limit the number of animal-train-collision. The study aims to target hotspots with high potential for collisions, and TerrOïko has developed an analysis method consisting of crossing existing data on the location of the collisions with simulated demographic and displacement data of large mammals in order to map the hotspots and to prioritize them after complete statistical analyses.

Measure rating (weighting factors)

Overall weight: 2.77



Impact

Medium to strong: very good example of well-developed study with fine and reliable models for road (rail) kills management and help in decision-making.

Transferability

Partially complete: TerrOïko does not share the complete process of the animals' demographic and displacements models (Terroïko brevetted its processes and models). Only complete transferability when missioning TerrOïko. Method also for roads.

Category of the measure

Transport mode:

Lifecycle phase:

Strategic Planning
Design
Operation & Maintenance
Decommissioning

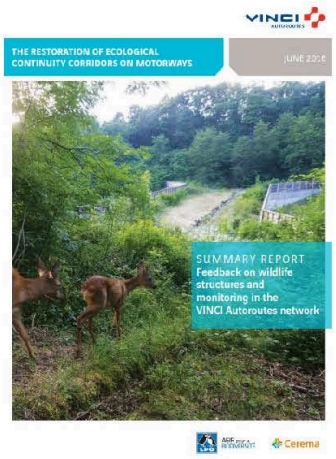
References (tested & functional!)

https://doi.org/10.13140/RG.2.2.20271.18087

Who and where

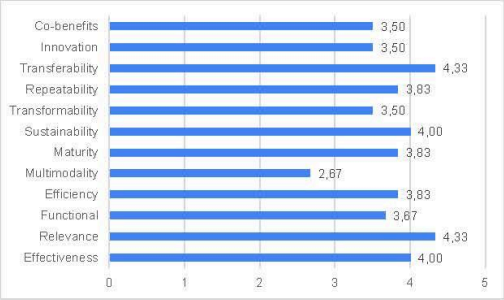
Name of organisation:
TerrOïko (study office in ecology)
Location of measure:

GP4: Feedback on wildlife structures and monitoring in the VINCI Autoroutes network



Measure rating (weighting factors)

Overall weight: 2.77



Category of the measure

Transport mode:

Lifecycle phase:

Strategic Planning

Design

Operation & Maintenance

Decommissioning

Who and where

Name of organisation: VINCI Autoroutes and partners
Location of measure: France
Available languages: English

Brief description of the practice

"The Restoration of ecological continuity corridors on motorways" is afeedback from the wildlife structures and monitoring in the "VINCI Autoroutes network" in French.
The feedback is presented in a summary report which does not claim to provide details on specific procedures, rather, it presents feedback from an operator and its partners. It was compiled based on monitoring that took place between 18 February 2011 and 29 April 2015. Because the monitoring techniques used were constantly developing, its content is subject to revision in the future (revised edition released in French and English on May 2023).

Impact

Medium to strong: a rare example of such reports from motorways stakeholders, with interesting lessons from their side. The next edition is as rich as the previous one, including for example detailed methodologies in fauna passages monitoring. This project team conducted by Vinci Autoroutes stakeholder include NGO, Study offices, Public institution (Cerema) and Research laboratory (CEFE/ CNRS), providing a strong reliability to these reports.

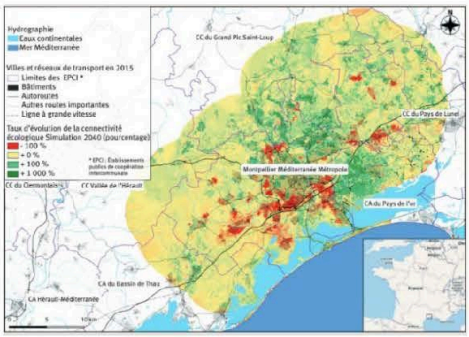
Transferability

Complete for all European countries. Concerning fauna passages construction and monitoring and many lessons provided are applicable to railways infrastructures.

References (tested and functional!)

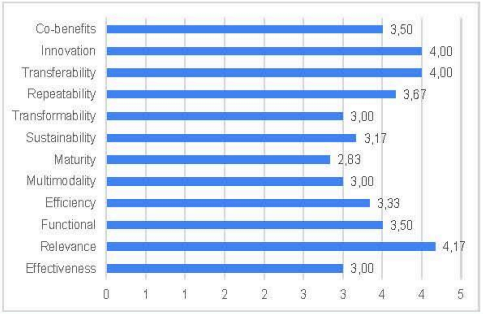
https://handbookwildlifetraffic.info/wp-content/uploads/2018/01/Cerema_2016_Restoration_ecological_corridors_motorways.pdf

GP5: Urban extension dynamic & impacts on biodiversity modelling



Measure rating (weighting factors)

Overall weight: 2.50



Category of the measure

Transport modes:

Lifecycle phase:

Strategic Planning

Design

Operation & Maintenance

Decommissioning

Who and where

Name of organisations: Centre d'économie de l'environnement Montpellier, Université Paris Est, TerrOïko

Location of measure: Occitanie region

Available languages: French

Brief description of the practice

The originality of this research project lies in the proposal of an iterative approach on a regional scale that combines two simulation models, urban and ecological, and an analysis according to different development scenarios for the year 2040. A three-stage approach:

- Modelling of land use change processes, particularly urban dynamics
- Assessment of their impact on biodiversity according to different land consumption scenario
- Identification of the consequences on the functioning of ecological dynamics

Impact

Medium impact: research project interesting research project using models and post-analysis of urban extension and their impacts on biodiversity to be developed and complete elsewhere (no enquiries about high employment areas, economic (for industries, peri-urban agriculture, local rural and urban districts population age and dynamic...). This study is not complete enough: need to make a link with infrastructures of transport network and their requalification planning to face the local population and the induced traffic volume increase.

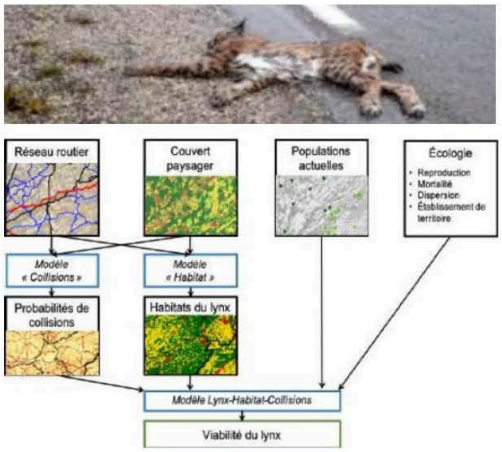
Transferability

Transferable but must be adapted among the regional or other local areas. But this method should be completed with other parameter (district function (trades/Industry/ living) and inhabitant age and retired/active rate, plot cost of each urban area district) that heavily influence urban dynamic...There is no link with traffic volume modelling on road network linking each urban area. Meanwhile, it is a good first step to investigate...

References (tested and functional!)

https://crerco.fr/IMG/pdf/revue-erc-modelisation-occitanie-.pdf

GP6: Roadkill data and statistical model for mitigation hierarchy



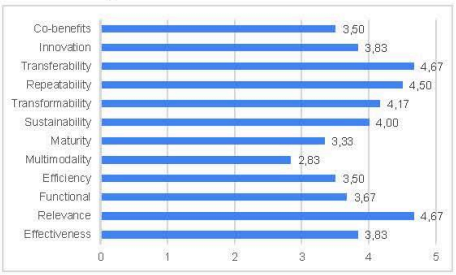
Location of measure: Distribution area of the Lynx (France, Switzerland, Germany)
Available languages: French and English (for abstracts, scientific publications)

Brief description of the practice

The ERC-Lynx project built upon previous works (modelling, ecological and technical diagnostics) to evaluate lynx viability regarding habitat preferences, the risk of collision when crossing roads and management actions. Main deliverable: 1st version of an operational tool for technical operators, helping them in their decision-making process for land use and road network planning.
The operationality of the tool is the result of close collaboration between scientists, managers and experts in transport infrastructures and those in lynx ecology and statistics.

Measure rating (weighting factors)

Overall weight: 2.84



Impact

This type of project has a strong potential impact on the protection of endangered species (mainly due to roadkill and poaching), integrating applied research, engineers and managers of transport infrastructures and natural areas, and experts on the species in question. However, it requires collaboration over a long period of time in order to see its effectiveness of the project which lasted only 3 years.

Transferability

Complete transferability from local to regional scales, taking into account of the local context and actors. Potentially applicable to railway infrastructures with adaptations (railways are low concerned with Lynx)

Category of the measure

Transport mode:

Lifecycle phase:

Strategic Planning
Design
Operation & Maintenance
Decommissioning

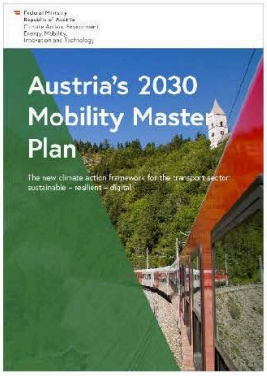
Who and where

Name of organisation: CEFE/ CNRS **(UMR 5175)**

References (website link tested & functional)

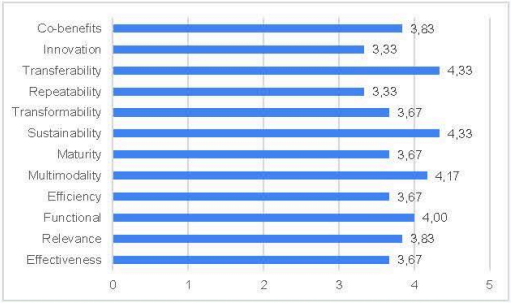
-Bauduin et al. (submitted). Eurasian lynx populations in Western Europe: What prospects for the next 50 years?
-Kramer-Schadt, S., Revilla, E., & Wiegand, T. (2005). Lynx reintroductions in fragmented landscapes of Germany: Projects with a future or misunderstood wildlife conservation? Biol. Conserv. 125, 169–182
-Final report to be found in: https://www.ittecop.fr/fr/content_page/item/239-erc-lynx

GP 7: Austria's 2030 Mobility Master Plan – Realigning the mobility sector



Measure rating (weighting factors)

Overall weight: 2.80



Category of the measure

Transport mode:

Lifecycle phase:

Strategic Planning
Design
Operation & Maintenance
Decommisioning

Who and where

Name of organisation: **Federal Ministry of Republic of Austria**
Location of measure:**Austria**
Available languages: **English**

Brief description of the practice

The 2030 Mobility Master Plan identifies ways to avoid, shift and improve traffic and transport and significantly increase the share of eco-mobility in total transport – foot and bicycle traffic, public modes of transport, and shared mobility.
Environmental objectives specifically will benefit from the Master Plan primarily from measures to avoid motorised transport. Regarding biodiversity, the Master Plan proposes promoting especially space-saving means of transport and getting around, such as walking, cycling and using public transport.

Impact

The Mobility Master Plan gives direction and makes clear, that environmental aspects such as land consumption and biodiversity have to be considered more strongly in mobility planning. It provides with a basis to give a higher priority to environmental aspects and biodiversity in plans, programmes and directives building on the Mobility Master Plan. E.g. the revision of the guideline for Strategic Environmental Assessment in terms of transport refers explicitly to the Mobility Master Plan and its environmental targets.

Transferability

A Mobility Master Plan is a very effective tool to give direction to future developments of mobility and related topics, such as biodiversity. It operates like a compass, but also offers concrete objectives. The Transferability is high, because basis are EU's ambitious climate targets, of course transposed into national targets.

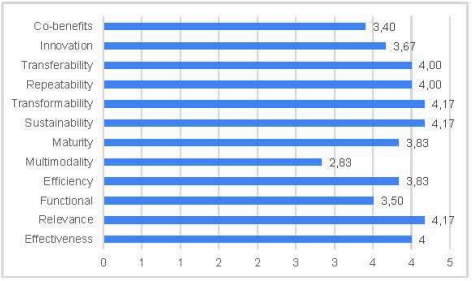
References

https://www.bmk.gv.at/en/topics/mobility/mobility masterplan2030.html

GP 8: Creation of attractive habitats for wildlife

Measure rating (weighting factors)

Overall weight: 2.79



Category of the measure

Transport mode:

Lifecycle phase:

Strategic Planning
Design
Construction
Operation & Maintenance
Decommissioning

Who and where

Name of organisation:
Barcelona Port Authority
Location of measure:
Llobregat River, Barcelona

Available languages:
English and Spanish

Brief description of the practice

Different artificial roosts for great cormorant (*Phalacrocorax carbo*) were created along the Llobregat river before the dismantlement of the main roost at the Llobregat delta due to the construction works for a new freight railway station at the Port of Barcelona.

The objectives were:

- To guarantee that the species remain at the Llobregat delta using these new alternative roosts.
- To avoid the creation of natural alternative roost by the species close to the Barcelona Airport which could cause hazards to aviation safety.

Since the creation of the artificial roosts a long-term monitoring is undertaken to validate the usefulness of the measure.

Impact

Both goals were achieved as most of the individuals in the previous main roost moved to the artificial roosts.

Transferability

The creation of attractive new habitats for wildlife is an effective measure to be applied in all type of infrastructure to avoid conflict with wildlife.
It also could be replicated to other locations.

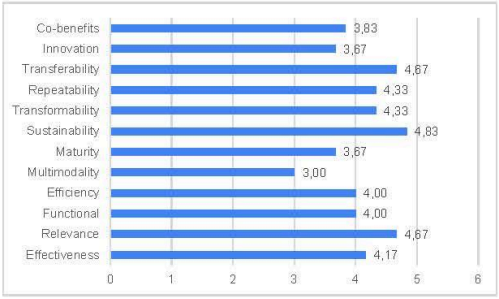
References

www.youtube.com/watch?v=MM_U28J67bQ

GP 9: Landscaping a new wildlife overpass in A2 Highway in Catalunya

Measure rating (weighting factors)

Overall weight: 3.02



Category of the measure

Transport mode:

Lifecycle phase:

Strategic Planning
Design
Construction
Operation & Maintenance
Decommissioning

Who and where

Name of organisation:
MITMA, ACESA
Location of measure:
Highway A2 – Girona (Catalunya, Spain)
Available languages:
English and Spanish

Brief description of the practice

A new wildlife overpass was built on the A2 highway to enhance the ecological connectivity in a strategic site. It was a defragmentation action developed as a compensatory measure of a highway enlargement in the vicinity. It was carried out without cutting the traffic on the highway (ca. 25.000 vehicles/day). It is one of the first overpasses in Spain in which the restoration has been specifically designed to create habitats for wildlife and particularly to benefit pollinators.

Grassland and shrub species were specifically selected to provide resources to wildlife (food, shelter, etc.) and to optimize the vegetation survival with a minimal maintenance. Refuges for small fauna, such as stone rows or wood piles were installed, along with specific measures to offer habitat for pollinators and other invertebrates (flowering plant species and nesting shelters).

Impact

Enhance of ecological connectivity providing habitat continuity of nearby natural habitat along the fauna passage, which have been specifically designed to attract wildlife species to promote its use.

Transferability

An example of success cooperation between different stakeholders (administration, road managers, engineers and environmental consultancies) to undertake defragmentation actions and restore ecological connectivity.

It provides an example on how wildlife overpasses landscaping could be designed not only to provide a passage for vertebrates but also to provide habitats to invertebrates.

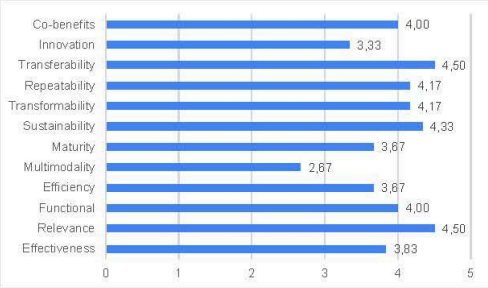
References

https://minuartia.com/wp-content/uploads/2020/04/icoet-2017-wildlife-overpass-rosell-et-al-2016.pdf

GP 10: Motorway Defragmentation Program in Austria

Measure rating (weighting factors)

Overall weight: 2.84



Category of the measure

Transport mode:

Lifecycle phase:

Strategic Planning

Design

Operation & Maintenance

Decommissioning

Who and where

Name of organisation:
Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)
Location of measure:
Austria
Available languages:
German

Brief description of the practice

The Directive "Habitat connectivity for Wildlife" (2006) of the BMK pledges the ASFINAG, the Austrian Motorway Company, to build 20 new crossing structures along existing motorways, at the crossing point with the most important migration corridors.

Impact

Large parts of the Austrian motorway network were build decades ago, long before the issue of wildlife migration was taken into account in road projects. As all motorways in Austria are fenced for safety reasons, they are impermeable barriers to migrating wildlife. The Directive aims to restore this barrier effect for the most important, supra regional migration corridors.

Therefore, ASFINAG needs to build new crossing structures at 20 locations along the existing motorway network, which were defined at the crossing points of the migration corridors and the fenced motorways.

Main challenges are the cooperation with other infrastructure types and land-use interests as well as the implementation into spatial planning.

Transferability

The concept can be easily transferred to other linear infrastructure modes, to other land use practices or to other locations.

The main question is where migration corridors are and if they still permeable.

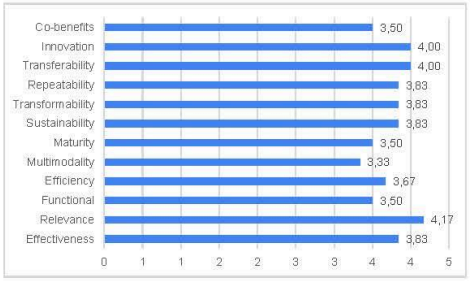
References

https://www.bmk.gv.at/themen/verkehr/strasse/umwelt/wildtiere.html

GP11: Interpretation and application aids for the maps of the habitat networks

Measure rating (weighting factors)

Overall weight: 2.75



Category of the measure

Transport mode:

Lifecycle phase:

Strategic Planning

Design

Operation & Maintenance

Decommissioning

Who and where

Name of organisation:
Federal Agency for Nature Conservation
Location of measure:
Germany
Available languages:
German

Brief description of the practice

The method and the results obtained with it form an essential technical basis for biotope network planning, for the avoidance or compensation of fragmentation through TI and the basis for the German defragmentation program via TI network.

Impact

The method has a very high impact on mainstreaming of biodiversity in the German Federal Transport Infrastructure Plan especially in order to define concrete potential and real conflict areas and points.

Transferability

Yes: The basic data are real biotope mappings. The various habitat networks are generated according to an algorithm that is universally applicable as long as the basic data are available.

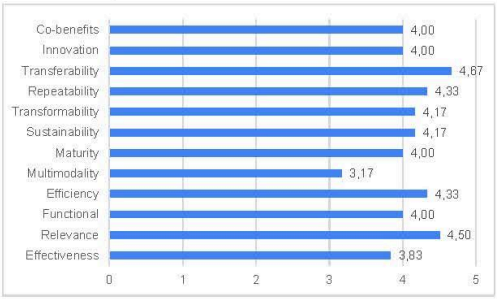
References

https://www.hs-osnabrueck.de/fileadmin/HSOS/Homepages/Personalhomepages/Personalhomepages-AuL/Haenel/pdf/Interpretationshilfe_Lebensraumnetzwerke.pdf

GP12: Dépôt-légal-biodiversité.naturefrance - DEPOBIO

Measure rating (weighting factors)

Overall weight: 3,01



Category of the measure

Transport mode:

Lifecycle phase:

Strategic Planning

Design

Operation & Maintenance

Decommissioning

Who and where

Name of organisation:
Ministry of Ecological Transition (MTE)
Location of measure:
France
Available languages:
French

Brief description of the practice

Pursuant to the law of August 8, 2016 (article L411-1A of the Environmental Code), project owners, public or private, must contribute to the inventory of natural heritage by entering or, failing that, by submission of raw biodiversity data. The objective of this system is to enrich knowledge with a view to better protecting the natural heritage of France.

Impact

Strong impact on biodiversity knowledge availability in a region or a country: all projects must legally provide all their row data of biodiversity collected during their EIA are centralized into a single national biodiversity database. These data (and metadata) (i.e. species presence) are now available for research studies, future projects design etc. And these data are far more available than in reports stocked in a small local administration room. Moreover, it does not imply a double data recording, all data once recorded on DEPOBIO website are immediately downloadable for reporting (EIA and other studies), avoiding then supplementary work.

Transferability

Complete, considering of the local context and for all transport modes.

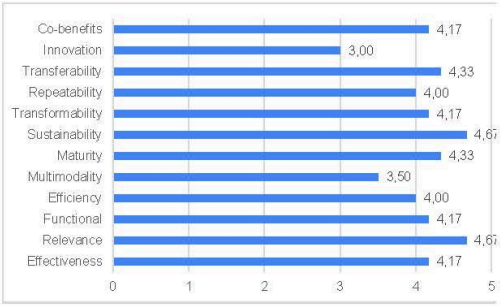
References (tested and functional!)

https://depot-legal-biodiversite.naturefrance.fr

GP13: Guidelines for Biodiversity Protection in transport infrastructure planning

Measure rating (weighting factors)

Overall weight: 3.02



Category of the measure

Transport mode:

Lifecycle phase:

- **Strategic Planning**
- **Design**
- **Operation & Maintenance**
- Decommissioning

Who and where

Name of organisation:
Austrian Research Association Roads, Railways and Transport
Location of measure:
Austria
Available languages:
German, some in English

Brief description of the practice

In Austria, the 'Austrian Research Association Roads, Railways, Transport' (RVS..?) deals with the development of the state of the art that may concern infrastructure projects. There are specialized committees in each relevant specialty, with experts from different disciplines working together on guidelines (RVS), in order to facilitate the practical implementation of the requirements. These guidelines are obligatory for the ASFINAG, the Austrian Motorway Company, but as they refer the state of the art in Austria (also by courts), many other infrastructure operators use them as well. They clearly explain the requirements in the different planning stages of a project, some even refer to the operation and maintenance phase. For the processing area 'Animals and Plants', several Guidelines have already been published.
RVS 04.01.11 Environmental Assessment
RVS 04.01.12 Environmental Measures
RVS 04.03.11 Amphibian Protection
RVS 04.30.12 Wildlife protection
RVS 04.03.13 Bird protection
RVS 04.03.14 Wild mammals (excluding bats) conservation
RVS 04.03.15 Species protection
RVS 04.03.16 Bats protection (to be published soon)

Impact

The RVS guidelines represent the state of the art, they define the methodology of environmental investigations, the evaluation of infrastructure impacts and the necessity of mitigation measures. By using these guidelines a high level of biodiversity protection is secured in infrastructure planning.

Transferability

Some parts, especially the methodology, could easily be transferred to other countries or regions. The biodiversity issues of course are related with the Austrian conditions, as well as the recommended measures. For implementation in other landscapes they would need to be adapted.

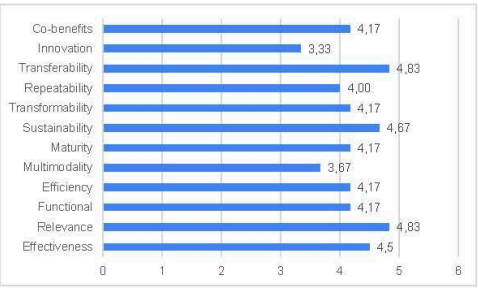
References

http://www.fsv.at/shop/produktlisteEN.aspx?ID=3197C858-15DE-4517-9EF2-F3B7E22175A4

GP14: Protected species habitat mapping in relation with the transport network in Czech Republic

Measure rating (weighting factors)

Overall weight: 3.12



Category of the measure

Transport mode:

Lifecycle phase:

Strategic Planning

Design

Operation & Maintenance

Decommissioning

Who and where

Name of organisation:
Nature Conservation Agency (NCA) of the Czech Republic
Location of measure:
Czech Republic
Available languages:
Czech

Brief description of the practice

Towards defining conflict points of the national transport infrastructure (TI) network in Czech Republic, a map (GIS layer) of delineating areas developed by NCA that are necessary to maintain minimum landscape connectivity for large mammals. This ecological connectivity national map includes areas categorized into three levels - (1) core areas with proven or potential ability to host target species; (2) migration corridors linking these areas; and (3) critical points where permeability is not currently ensured or is severely threatened.

Impact

This task has important impact of using official data for spatial planning at all levels and especially when the planned routes of TI should avoid the critical and conflict points for ecological connectivity (or at least to minimize the harm) or to solve the conflict with extra measures such as ecoduct or large underpass.
This map is also often used in EIA (migratory study) - indicating places where extra measures should be considered, especially when evaluating TI projects.

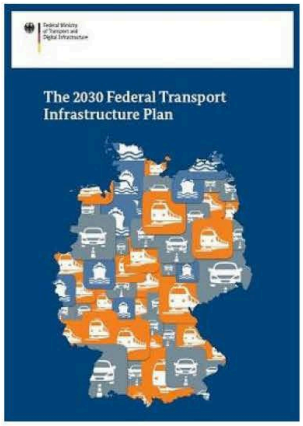
Transferability

The idea of defining such ecological maps and the method of delimitation of territories is widely transferable and assumed as necessary. The application to the actual process of protection of these territories is closely linked to the possibilities provided by the law system of each country.

References

https://arcg.is/z0Kaj is map server and than select the choice **"Biotop vybraných zvláště chráněných druhů"**
First published in: Romportl, D. (ed.), Zýka, V., Skokanová, H., Hlaváč, V., Krása, A., Kučera, Z., Sladová, M., Strnad, M., Větrovcová, J., Dostál, I., Havlíček, M., Jedlička, J., Pelikán, L., Svoboda, J., Anděl, P., Gorčicová, I., Petržilka, L., Poledníková, K., Poledník, L., Bartonička, T., Voříšek, P. *Atlas fragmentace a konektivity terestrických ekosystémů v České republice*. Praha: AOPK ČR, 2017, ISBN 978-80-88076-50-6.

GP 15: German Federal Transport Infrastructure Plan



Name of organisation:
Federal Ministry of Transport and Digital Infrastructure
Location of measure:
Germany
Available languages:
English, German

Brief description of the practice

The Federal Transport Infrastructure Plan (FTIP) 2030 in Germany focuses in particular replacement, upgrading and new construction of the three modes of transportation. The individual projects of the three modes are classified into priority categories.
Within the scope of its Sustainable Development Strategy and the National Biodiversity Strategy, the Federal Government is pursuing the objective of limiting land take for settlement and transport purposes in Germany to 30 hectares a day.

Impact

Moderate impact: The developed methodoloy (see 12.2 in the document) and the results are basic information for the planning process for the downstream planning process. It helps to justify the need for Green bridges, for example across motorways.

Transferability

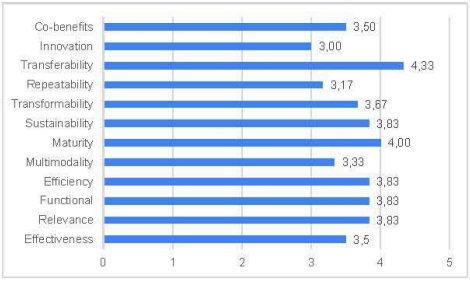
Some aspects of the Environmental and nature conservation appraisal (Module B, see p 62) Some of the criteria and their evaluation, e.g. the impairment of NATURA 2000 sites, are transferable to other states in Europe, other criteria, e.g. the fragmentation length of habitat networks, require the "habitat net" method.

References

https://bmdv.bund.de/SharedDocs/EN/publications/2030-federal-transport-infrastructure-plan.pdf?__blob=publicationFile

Measure rating (weighting factors)

Overall weight: 2.69



Category of the measure

Transport mode: motorway, railway, waterway

Lifecycle phase:

Strategic Planning
Design
Operation & Maintenance
Decommissioning

Who and where

3. GAPS AND BARRIERS ANALYSIS IN GOOD PRACTICES FROM THE QUESTIONNAIRE

3.1. AIM

This task (3.1.1) aims 'to identify the constraints and limitations that are slowing or hindering the application of best practice' to mainstream biodiversity on transport infrastructure. It is included in Task 3.1 which goal is 'to collect information about technologies, methods, processes, and tools currently applied in each country participating in the BISON project to mainstream biodiversity on transport'.

This chapter details the method used to detect the lacks - considered as gaps - of good practices (mainly coming from the results of the BISON questionnaire), in the successive phases of the life cycle of transport infrastructure projects and in the main issues generally considered in such projects. An initial analysis of the gaps and barriers, also provided by the stakeholders, is also described.

3.2. METHODOLOGY

As explained in section 1 within the scope of the BISON project and more specifically within WP3, the collection of information about relevant technologies, methods, processes, and tools currently applied in transport ecology have been collected through an online questionnaire. All Good Practice received were used as a first step to identify Best Practice (see Section 1), but also to detect the gaps[6] and barriers[7] in the replication of these practices. This process has also considered the work and the information processed in WP4 and WP5 to provide solutions based in research and transfer technology allowing to overcome obstacles and to make progress. Main works undertaken for this scope, as well as the previous steps are described in the Figure 4 and in the sections below. Finally, an analysis on the gaps[8] and barriers[9] that create difficulties for the application of these practices will be conducted, also in cooperation with

In the following chapters will be detailed the methods applied for 1) gaps and 2) barriers identifications.

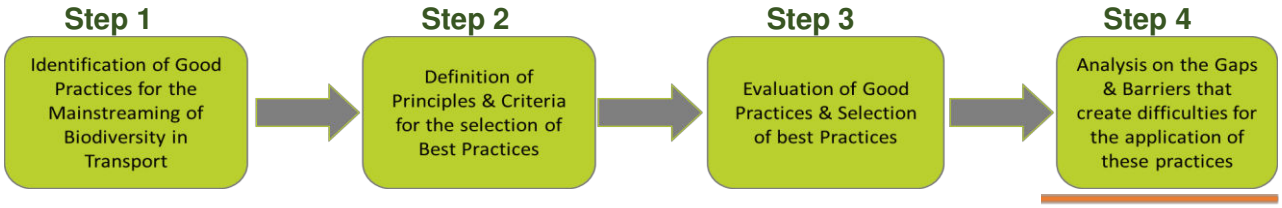


Figure 4: Main steps of Task 3.1 (underlined in orange: Gaps and Barriers identification).

6 "Gaps: Defined here as the absence or to small number of good practice.

7 "Barriers: Defined here as the elements that create difficulties for the application of the best practice. Any kind of impediment such as a rule, practice, law, policy, knowledge gaps) towards the effective application/implementation of dedicated tools for reducing the impact of various transport modes on the environment and its components (including ecosystem services).

3.2.1. Gaps identification methods

As the first step for the realisation of this work, partners of WP3 in cooperation with the whole BISON consortium have developed a dedicated questionnaire (see WP3 Sub-Task 3.1.1 internal report) in order to collect, good practices and gaps and barriers of dissemination (Figure *5*). This questionnaire was accompanied with a specific survey, asking internal BISON Consortium members to complement the collection of good practices (see good practice definition in Table 1 and Chapter 2.1.2 in D3.1 deliverable). Once these processes were completed, a descriptive statistical analysis was conducted on good practices categorisation tables.

Two complementary methods have been chosen to analyse gaps from survey data collection:

1. Analyse good practices per mode of transport, after their categorisation into main topics and transportation infrastructure project life cycle phases.
2. Analyse gaps description directly extracted from the questionnaire answers and categories among their primary questions asked during the survey.

A third method has been developed by the Task 5.4 in coordination with Task 3.1 to collect gaps, barriers and opportunities from experts which will not be presented in this report.

3.2.1.1. Good Practices categorisation for potential gaps identification

For this purpose, all good practices should be categorized according to two types of parameters:

i) phases of infrastructure of transport project life cycle
ii) topics commonly addressed at each phase of a project life cycle during EIA (Environmental Impact Assessment) or during a SEA (Strategic Environmental Assessment).

i. Phases of infrastructure of transport project life cycle:

The name and definition of each phase of the life cycle of a transport infrastructure project have been established by the members of the BISON project and is summarized in Figure 5 and Table *2* below:

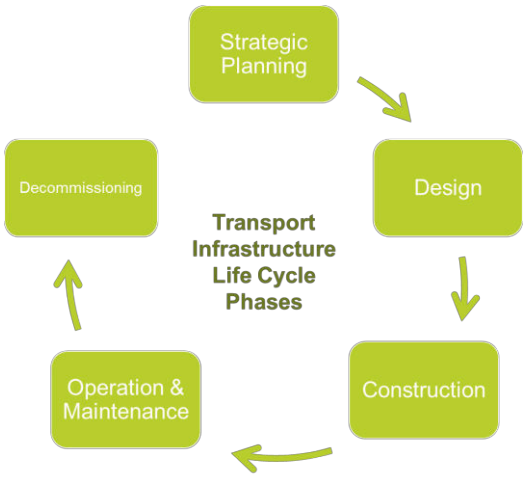


Figure 5: Transport infrastructure project life cycle phases.

BISON Consortium Members also suggested to add transversal items to the life cycle phases:
- Specific ARC item (avoidance, reduction (mitigation), compensation)
- Stakeholders engagements (education, publications, actions…)

Each good practice that concerns one or two phases of the life cycle of a transport infrastructure project has been included in both phases. In the same way, good practices applied for one transport mode that could be applied for others have been considered in both.

Table 2. Resume of main transport infrastructure life cycle phases and sub phases (Task 3.1)

Phase	Includes	Environmental process
1. Strategic Planning	**1.1. Transport policy** **1.2. Strategic transport plan** **1.3. Transport area or corridor delimitation** (also called 'Project planning')	SEA
2. Design	**2.1. Site or route selection** (also called 'Concept design' and 'Informative study') **2.2. Procurement** **2.3. Detailed design** (also called 'Constructive project')	EIA
3. Construction	**3.1. Construction**	Environmental Monitoring Programs
4. Operation, Maintenance & Upgrading	**4.1. Operation and maintenance** ***Upgrading****	Ecological asset maintenance Monitoring/Evaluation
5. Decommissioning	**5.1. Decommissioning** **5.2. Repurposing**	Restoration

(*) Upgrading was not included in "Operation & Maintenance" in the original report, but it is here included in "Operation & Maintenance" to ease the analysis. It was decided to be included as a different phase that require new design (sometimes even EIA) and construction.

ii. Topics commonly address during EIA / SEA

In addition, all good practices are categorised by main topics to be treated in all phases. These topics concern the SEA and EIA procedure (Figure 6 and Figure 7):

- baseline data collection, including habitats mapping;
- impacts (prediction and assessment);
- measures (avoidance, mitigation, compensation and complementary);
- evaluation and monitoring (Bond & Wathern, 1999).

Terminology and definitions:

Environmental processes, evaluation of potential harm or negative impacts of the certain stages from the life cycle of various transport modes (from planning to decommissioning) on the environment and its components (including on ecosystem services).

Environmental assessment is a process that ensures that the environmental implications of decisions are taken into account before the decisions are made.

SEA (Strategic Environmental Assessment) can be undertaken for public plans or programmes on the basis of Directive 2001/42/EC (known as 'Strategic Environmental Assessment' – SEA Directive) According to the Directive, its goal "is to provide for a high level of protection of the environment and contribute to the integration of environmental considerations into the preparation and adoption of plans and programs with a view to promoting sustainable development, by ensuring that, in accordance with this Directive, an environmental assessment is carried out of certain plans and programs which are likely to have significant effects on the environment".

EIA (Environmental Impact Assessment) is a process that focuses on assessing the environmental impacts of projects of a certain kind and scope. The Environmental Impact Assessment (EIA) Directive (2014/52/EU) applies to a wide range of defined public and private projects, which are defined in Annexes I and II. Mandatory EIA refers to all projects listed in Annex I, having been considered to have significant effects on the environment and require an EIA (e.g. for individual projects like long-distance railway lines, motorways and express roads, airports with a basic runway length ≥ 2100 m…). For projects listed in Annex II, the national authorities must decide whether an EIA is needed. EIA shall identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on the following factors: (a) population and human health; (b) biodiversity, with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC; (c) land, soil, water, air and climate; (d) material assets, cultural heritage and the landscape; (e) the interaction between the factors referred to in points (a) to (d).

When SEA is carried out beforehand, the EIA procedure is applied during design and following project life cycle phases. Both processes are very similar (https://ec.europa.eu/environment/eia/sea-legalcontext.htm) and element analysed during SEA can be considered during EIA as well. However, SEA are adapted to strategic programmes level at regional or national scales, including several modes of transportation infrastructures, and interaction between all infrastructures is a key item, as well as legislation and regulation. However, interactions between different modes of transportation infrastructures can occasionally concern EIA as well as legislation / regulation topic.

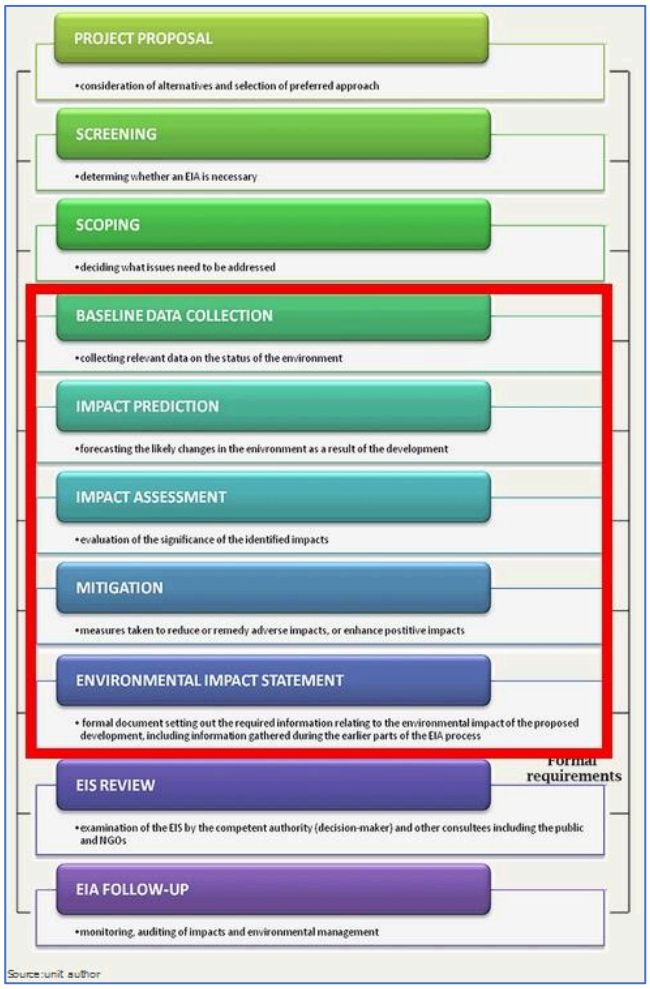


Figure 6: EIA Process stages in UK, and the stages in red square indicating some of the EIA topics use as Good Practices categorization.

Adaptation by the CEREMA of a figure in: https://www.soas.ac.uk/cedep-demos/000_P507_EA_K3736-Demo/unit1/page_14.htm

All good practices previously collected are distributed in a table among the life cycle phase(s) and the main topics for each transport mode of their concern (Figure 7). A cell includes only one good practice, and each item and phase life cycle can include one or several cells.

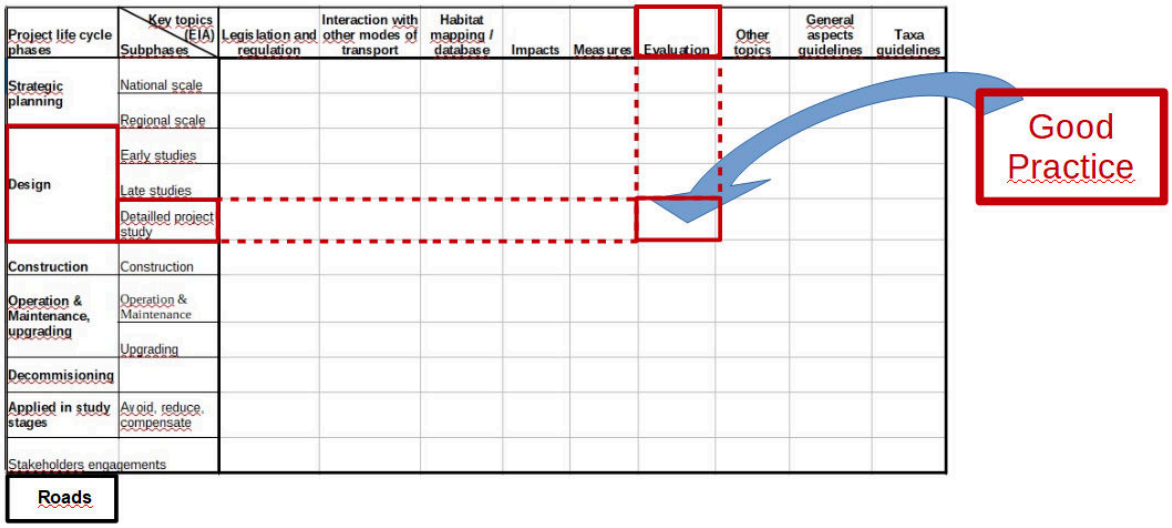


Figure 7: Good practices distribution in a double entry table concerning roads mode of transport.

Good practices are distributed in the table, the number of columns of an "EIA topic" varying from one to a maximum observed (i.e. from 1 to 11 columns; some of the phases of the life cycle of a project concentrate a big number of good practices. For the same "EIA topic" column, cells in another phase may not show up to any good practice (Figure 8).

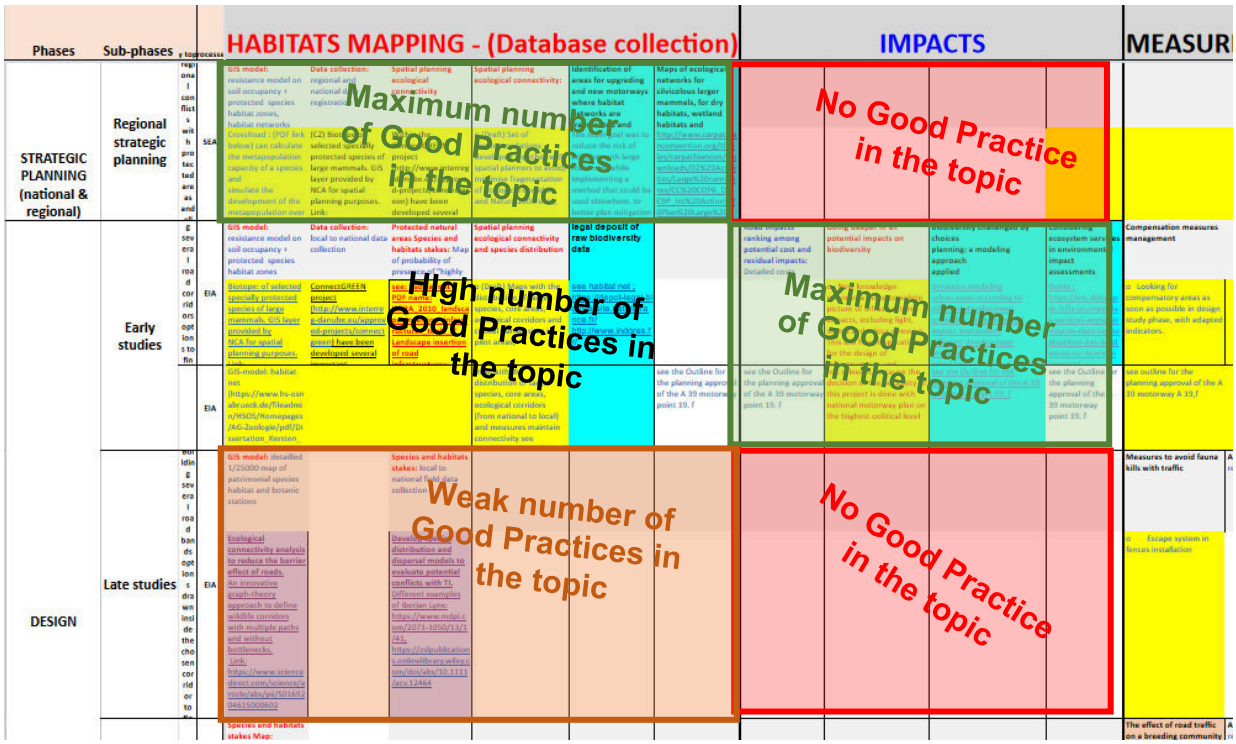


Figure 8: Spatial heterogeneity in good practices distribution in a part of the roads table.

This heterogeneity in good practices distribution in the table will provide to the next step of the method the information of which of EIA topic and which of life cycle phase has an important number of Good Practices and which of other parameters show a strong lack of Good Practices that will be considered in the last case as a **Potential Gap in Good Practices.**

These potential gaps will be determined with a descriptive statistical analysis method that is described in the following sub-chapter.

iii. Descriptive statistical analyses in detail

Data of good practices distributed in different life cycle phases and main EIA topics will be screened for abundance and absence. The main objective is to compare the number of Good Practices (N(GP)) collected with the total amount of cells available (N'(AllCells)) (Figure 9), considered for each life cycle phase and EIA topic as follows:

Abstract of the method:

The aim of this method is to see which items (i.e. impacts, evaluation) and which of life cycle phases of an infrastructure of transport project (i.e. strategic planning to decommissioning phases) show no or few good practices, considering that these "empty" items and phases show gaps in good practices. It is comparable as a footprint. To do so, we compare the ratio "number of good practices / number maximal potential number of good practices" in each items and phases to the one of all the items and phases, comparing a single case with a number of good practices to the global mean of number of good practices of the set of all cases. The cases below the global mean are considered as showing gaps in good practices.

1) $W_1 = N(GP)_{xy} / N'(AllCells)_{xy} = 1$; $N = N'$

with x corresponding to a Life cycle phase (row) and y corresponding to an EIA topic (column).

This is the optimal situation, with a maximum of Good Practices available for a Life cycle phase and an EIA topic.

2) $W_0 = N(GP)_{xy} / N'(AllCells)_{xy} = 0$; $N = 0$

with x corresponding to a Life cycle phase (row) and y corresponding to a EIA topic (column).

This is the situation without Good Practices available for a Life cycle phase and an EIA topic. Then, $W_0 \leq W_n \leq W_1$

3) $W_{total} = N_{total} / N'_{total}$

Where, for each mode of transport, W_{total} is the total number of GP N_{total} present in the table divided by the total number of cells available N'_{total}, W_{total} being considered as the median for comparison inside the table. W_n is compared to W_{total}:

If $Wn \geq W_{total}$, there is a number of GP sufficient for a Life cycle phase and an EIA topic.

If $Wn < W_{total}$, there is a lack of GP available and considering that these is a Potential Gap for a Life cycle phase and an EIA topic.

4) The index W_{total} by row ($W_{total-x}$) and by column ($W_{total-y}$ (respectively project life cycle phases and EIA Topics W index) are compared to the all table W_{total} index

and if: **$W_{total-x}$ or $W_{total-y} < W_{total}$ the project life cycle phases or the EIA Topic shows a Potential Gap in Good Practices.**

5) Finally, all three tables (Figure 9) per mode of transport are altogether compared to detect eventual common potential gaps to several modes of transport.

Then, internal BISON Consortium experts from CEREMA have checked, the gaps underlined in last table to detect some potential mistakes.

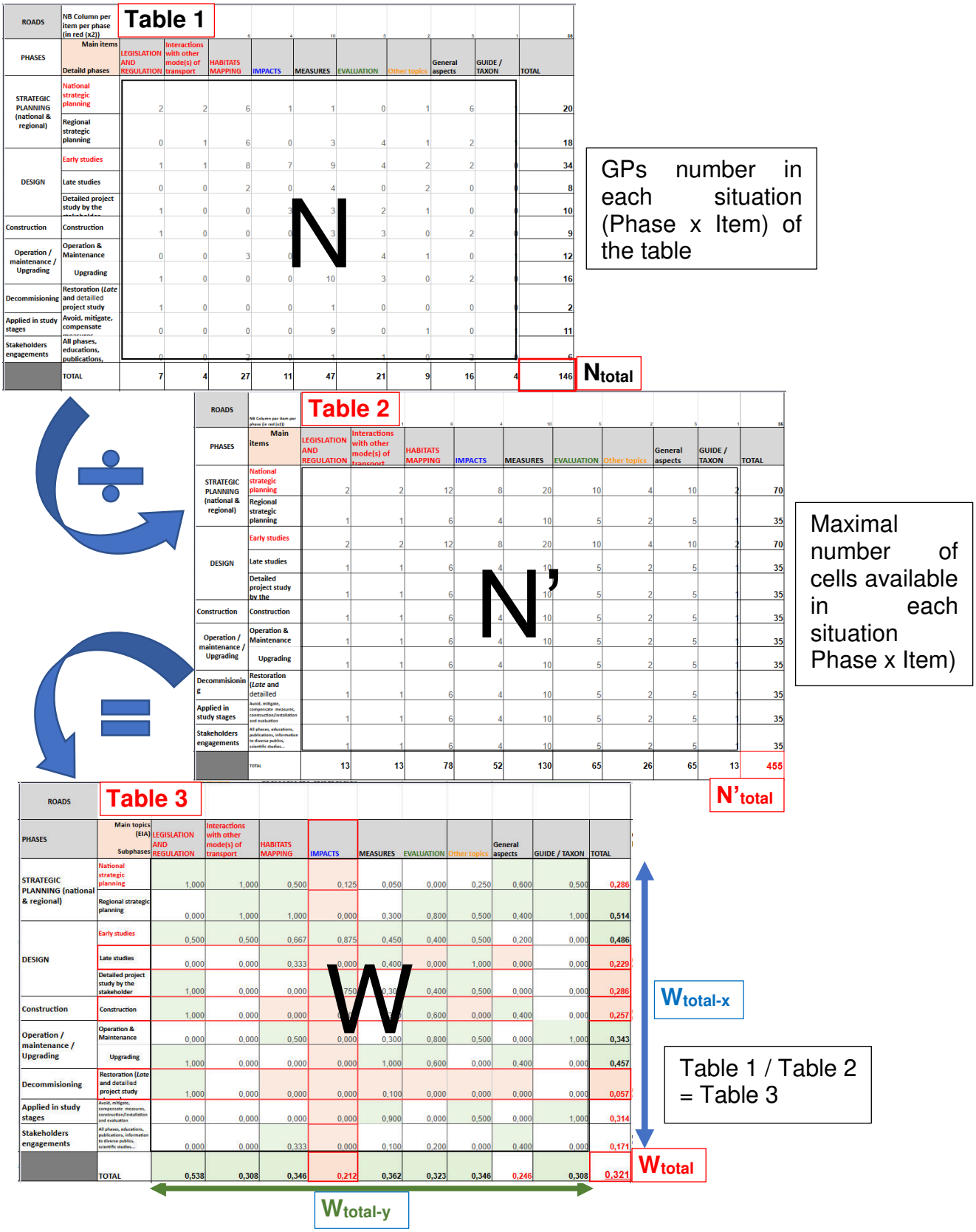


Figure 9: Successive steps of the Gaps statistical analysis
[(W = $N(GP)_{xy}$ / $N'(AllCells)_{xy}$ with N: number of Good Practices and N': number of all cells available].

3.2.2. Gaps and barriers extracted from the questionnaire

The other source of information about gaps and barriers comes directly from the stakeholders who have answered to the questionnaire. The questions are detailed in Figure *10* below.

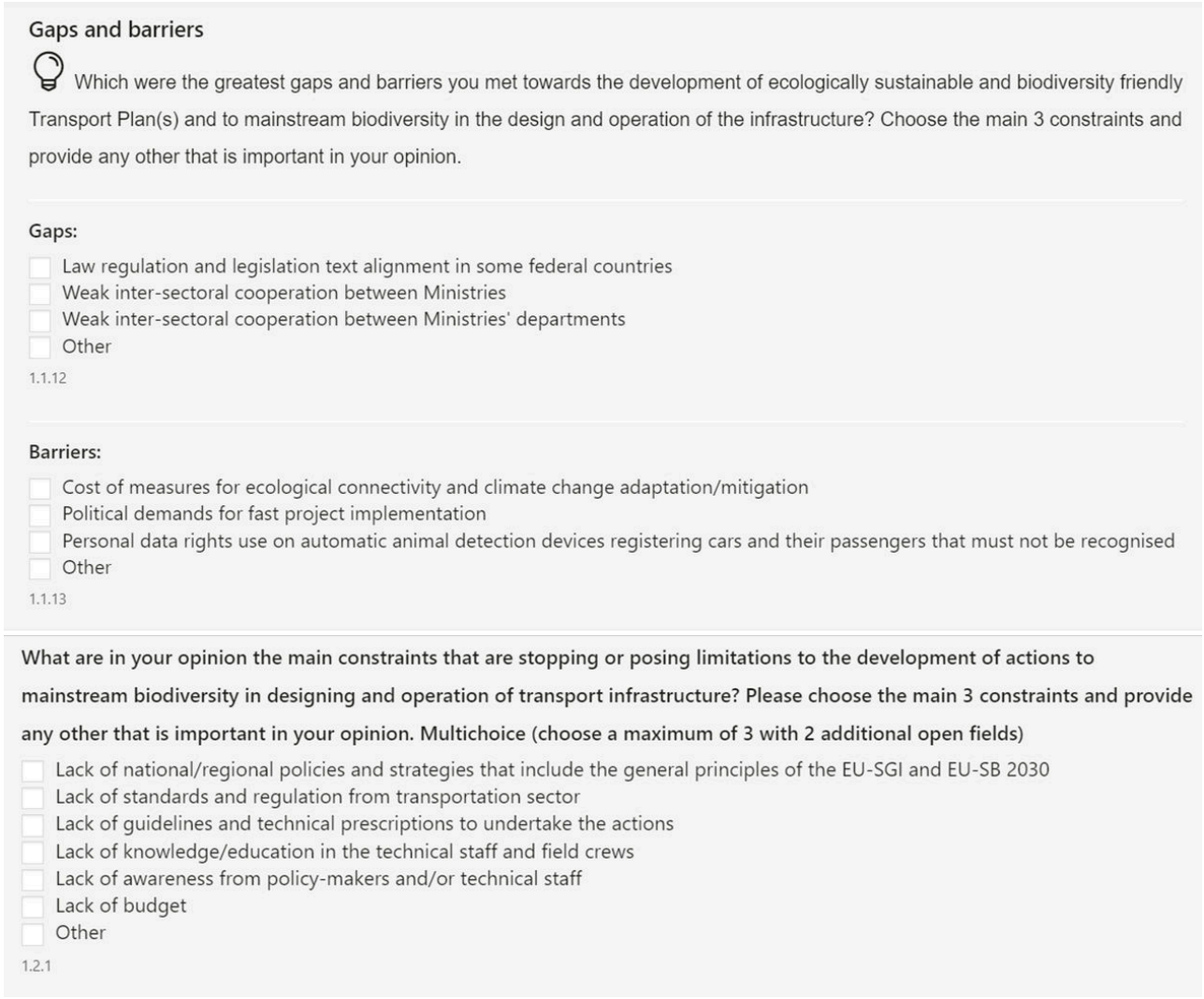


Figure 10: Example of questions regarding gaps, barriers and constraints in BISON questionnaire.

This questionnaire about gaps and barriers includes mainly questions about strategic and general aspects. Including more questions about technical items has not been done because it would have added too many questions to the questionnaire considered after construction as very (too) big, stakeholders would certainly not answer to all questions.

3.2.3. Gaps and Barriers identification methods

The aim of the work that is implemented within Sub-Task 3.1 is to gather gaps and barriers against good and best practices expansion. The main source of barriers, like gaps, has been collected with a questionnaire. Barriers have been completed with constraints[10] that will not be detailed in this report. The

10 Constraint definition: parameters that are stopping or posing limitations to the development of actions to mainstream biodiversity in planning, designing and operation of transport infrastructure (proposed in the Task 3.1 Questionnaire)

questionnaire proposed questions about gaps and barriers into several categories (see questions in Figure 10).

For the purpose of this document and to better understand the concepts, we have defined the main terms we are working with.

3.2.3.1. Method for Questionnaire Gaps analysis

All gaps proposed by diverse stakeholders have been first extracted from questionnaire answers, dispatched in several categories and numbered.

There are four categories concerning gaps detailed in Question Q1.1.12 (Figure 10):

- Law regulation and legislation text alignment in some federal countries.
- Weak inter-sectoral cooperation between Ministries.
- Weak inter-sectoral cooperation between Ministries' departments.
- Other.

3.2.3.2. Method for Questionnaire Barriers analysis

All barriers proposed by diverse stakeholders have been first extracted from questionnaire answers, dispatched in several categories and numbered.

These barriers have been distributed in 4 categories (see Figure 10):

- Cost of measures for ecological connectivity and climate change adaptation/mitigation.
- Political demands for last project implementation.
- Personal data rights use on automatic animal detection devices registering cars and their passengers that must not be recognised.
- Other.

Descriptive statistical analysis which has been applied for "barriers" was also used for "gaps" analysis.

3.3. RESULTS

3.3.1. Potential Gaps from Good Practices analysis

For all modes of transport grouped analysis, the results are shown in Table 11 A light expertise has been realised by internal BISON Consortium experts from Cerema to avoid any major mistake. In all following tables (Table 3 to Table 10), the green cells correspond to: $W \geq W_{total}$, the white cells to: $W < W_{total}$ and the red rows and red columns: project life cycle phase and EIA topic being considered with potential gap in good practices (GPs).

As a general result, few GPs are available for ports and airports. Furthermore, the number of stakeholders who responded to the questionnaire and who are involved in ports and powerlines, let alone pipelines, is low (Number (N) of experts interviewed [source: BISON Internal Report Questionnaire]: N_{ports} = 49, $N_{powerlines}$ = 41 and $N_{pipelines}$ = 22, compared to N_{roads} = 130, $N_{railways}$ = 109 and $N_{waterways}$ = 69))

Note: "Legislation and Regulation" and "Interactions with other mode(s) of transport" topics, concerning qualitative analyses, are considered differently than the other topics because they mainly concern the strategic planning.

3.3.1.1. Potential Gaps on Roads

Table 3; Good practices applied on roads projects, categorized and ranked among project life cycle and among EIA topics.

PHASES	Main topics (EIA) / Subphases	LEGISLATION AND REGULATION	Interactions with other mode(s)	HABITATS MAPPING	IMPACTS	MEASURES	EVALUAT	Other top	General aspects guides	GUIDE / TAXON	Wtotal (phases)
STRATEGIC PLANNING (national & regional)	National strategic planning										0,286
	Regional strategic planning										0,514
DESIGN	Early studies										0,486
	Late studies										0,229
	Detailed project study by the [illegible]										0,286
Construction	Construction										0,257
Operation / maintenance / Upgrading	Operation & Maintenance										0,343
	Upgrading										0,457
Decommisioning	Restoration (*Late* and detailled project study phases)										0,057
Applied in study stages	Avoid, mitigate, compensate measures, consultation/install-ation and realisation										0,314
Stakeholders engagements	All phases, education, publication, information to diverse publics, specific studies...										0,171
ROADS	Wtotal (topics)	0,538	0,308	0,346	0,212	0,362	0,323	0,346	0,246	0,308	0,321
	Legend:	Phase or topic with high number of good practices		Phase or topic with a medium number of good practices		Phase or topic with a lack of good practices		Phase or topic considered as a Gap			General Ratio (W_{total}) used as reference for comparison

The number of GPs is N_{total} = 146 and the total amount of available cells is N'_{total} = 455. Several phases are concerned by potential gaps. The Decommissioning phase shows the smallest $W_{total-x}$, followed by the "Stakeholders engagements" and by the construction phases.

"National strategic planning" subphase and "Applied in study" $W_{total-x}$ index being slightly smaller than W_{total}, they are not considered to have potential gap. "Late studies" and "Detailed project studies by

stakeholders" subphases $W_{total-x}$ index are smaller than W_{total} whereas "Early studies" subphase W index is higher than W_{total}. Design GPs have been mainly recorded for all modes of transport on only one studies subphase, but are usable for all Design phase. Then are merged all studies subphases, $W_{total-x} = N_x/N_x' = 52/140$ (see Tables 1 and 2 in Appendix 1), $W_{total-x.} = 0{,}371$, which is higher than W_{total}. Design phase is then not considered to have any potential gap of GP.

Concerning EIA topics, the Impacts and "General aspects guides" $W_{total-y}$ index are smaller than W_{total}, and are fully concerned by potential gaps. "Interaction with other modes of transport" $W_{total-y}$ index being nearly equal to W_{total} and "Legislation and Regulation" $W_{total-y}$ index being higher than W_{total} there are not concerned by potential gap.

3.3.1.2. Potential Gaps on Railways

Table 4. Good practices applied on railways projects categorized and ranked among project life cycle and among EIA topics.

PHASES	Main topics (EIA) / Subphases	TION AND REGULATION	ons with other mode(s) of	HABITATS MAPPING	IMPACTS	MEASURES	EVALUAT	Other top	General aspects guides	GUIDE / TAXON	Wtotal (phases)
STRATEGIC PLANNING (national & regional)	National strategic planning										0,594
	Regional strategic planning										0,688
DESIGN	Early studies										0,594
	Late studies										0,281
	Detailed project study by the										0,250
Construction	Construction										0,313
Operation / maintenance / Upgrading	Operation & Maintenance										0,656
	Upgrading										0,344
Decommisioning	Restoration (*Late* and detailled project study phases)										0,031
Applied in study stages	Avoid, mitigate, compensate measures, environmentalinclusion Ideas and exploring										0,375
Stakeholders engagements	Organize, coordinate, collaborate, information to diverse publics, sensibilis										0,250
RAILWAYS	Wtotal (topics)	0,182	0,182	0,364	0,182	0,496	0,424	0,500	0,394	0,545	0,398
	Legend:	Phase or topic with high number of good practices		Phase or topic with a medium number of good practices		Phase or topic with a lack of good practices		Phase or topic considered as a Gap			Global effectiveness (W_{total}) used as reference for comparison

The number of good practices is $N_{total} = 140$ and the total amount of available cells is $N'_{total} = 352$. Several phases are concerned by potential gaps. Decommissioning phase has the smallest $W_{total-x}$, followed by "Stakeholders engagements" and by Construction phases.

Upgrading subphase is below W_{total} and can be considered to have any potential gap. Late studies and "Detailed project studies by stakeholders" subphases $W_{total-x}$ are smaller than W_{total} and Early studies subphase $W_{total-x}$ is higher than $W_{total-x}$. When are merged all studies subphases, $W_{total-x} = N_x / N_x' = 36/96$

(see Tables 1 and 2 in Appendix 2), $W_{total\text{-}x}$. = 0,375, which is, as well as "Applied in studies stages", close to W_{total}. Design phase is then not considered to have any potential gap of GP.

Habitats mapping and "General aspects guides" W index, are close to W_{total}; these topics are not considered to have any potential gap of GP.

Concerning EIA topics, the Impacts topic shows potential gaps $W_{total\text{-}y}$ index being smaller than W_{total}. "Legislation and Regulation" and "Interactions with other mode(s) of transport" $W_{total\text{-}y}$ index are smaller than W_{total}, However, these topics concern mainly Strategic Planning Phase on which are recorded enough GPs. In this case, they are not considered to include any gap of GP.

3.3.1.3. Potential Gaps on Waterways

Table 5. Good practices applied on Waterways projects categorized and ranked among project life cycle and among EIA topics.

PHASES	Main topics (EIA) / Subphases	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	HABITATS MAPPING	IMPACTS	MEASURES	EVALUATION	Other topics	General aspects guides	GUIDE / TAXON	Wtotal (phases)
STRATEGIC PLANNING (national & regional)	National strategic planning										0,364
	Regional strategic planning										0,409
DESIGN	Early studies										0,591
	Late studies										0,318
	Detailed project study by the [illegible]										0,182
Construction	Construction										0,318
Operation / maintenance / Upgrading	Operation & Maintenance / Upgrading										0,682
Decommisioning	Restoration (*Late* and detailled project study										0,045
Applied in study stages	Avoid, mitigate, compensate measures, [illegible]										0,045
Stakeholders engagements	All phases, consultation, publication, information to diverse publics, [illegible]										0,091
WATERWAYS	Wtotal (topics)	0,200	0,100	0,325	0,233	0,333	0,400	0,300	0,350	0,200	0,305
	Legend:	Phase or topic with high number of good practices		Phase or topic with a medium number of good practices		Phase or topic with a lack of good practices		Phase or topic considered as a Gap			General Ratio (W_{total}) used as reference for comparison

The number of good practices is N_{total} = 67 and the total amount of available cells is N'_{total} = 220. Several phases and subphases are concerned by potential gaps. The subphases with the smallest $W_{total\text{-}x}$ are the Decommissioning and the "Applied in the study stages" phases, followed by the "Stakeholders engagements" phase.

Upgrading subphase is for this mode of transport merged into the "Operation / maintenance / upgrading" phase. "Detailed project studies by stakeholders" subphase is smaller $W_{total\text{-}x}$ than W_{total}, Early and Late studies subphases $W_{total\text{-}x}$ being higher than W_{total}. When are merged all studies subphases, $W_{total\text{-}x} = N_x/N_x' = 24/66$ (see Tables 1 and 2 in Appendix 3), $W_{total\text{-}x}$. = 0,364, which is higher than W_{total}. Design phase is then not considered to have a potential gap in GP.

Concerning EIA topics, the “Legislation and Regulation”, “Interactions with other modes of transport” W_y index show potential gaps (at regional scale) as well as “Other topics” and “Guide / Taxon” $W_{total\text{-}y}$ index being smaller than W_{total}.

3.3.1.4. *Gaps on Airports*

Table 6. Good practices applied on Airports projects categorized and ranked among project life cycle and among EIA topics (Yellow rows and columns are without good practice).

PHASES	Main topics (EIA) / Subphases	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	HABITATS MAPPING	IMPACTS	MEASURES	EVALUATION	Other topics	General aspects guides	GUIDE / TAXON	Wtotal (phases)
STRATEGIC PLANNING (national & regional)	National strategic planning										0,56
	Regional strategic planning										0,28
DESIGN	Early studies										0,44
	Late studies										0,17
	Detailed project study by the stakeholder										0,17
Construction	Construction										0,22
Operation / maintenance / Upgrading	Operation & Maintenance / Upgrading										0,56
Decommisioning	Restoration (*Late* and detailled project study phases)										0,00
Applied in study stages	[illegible]										0,17
Stakeholders engagements	[illegible]										0,11
AIRPORTS	Wtotal (topics)	0,10	0,10	0,27	0,00	0,32	0,45	0,10	0,45	0,00	0,267

Legend: Phase or topic with high number of good practices; Phase or topic with a medium number of good practices; Phase or topic with a lack of good practices; Phase or topic considered as a Gap; Phase or topic without good practice; General Ratio (W_{total}) used as reference for comparison

The number of good practices (N_{total} = 48) is low (nearly 10% of all good practices collected), the total amount of available cells being N'_{total} = 180, but the impacts of airports concerns mainly birds and the surface anthropised is not as important as roads or railways. We will then analyse the gaps concerning airports. Several phases are concerned by potential gaps.

It must be noticed that by the Decommissioning phase and the Impacts and “guides / taxon” EIA topics do not include any good practice.

Upgrading subphase is in this table merged to the “Operation / maintenance” phase. The “Detailed project studies by stakeholders” subphase $W_{total\text{-}x}$ is below W_{total}, Early and Late studies subphases being higher than $W_{total\text{-}x}$. When are merged all studies subphases into Design phase, $W_{total\text{-}x} = N_x / N_x' = 14/54$ (see Tables 1 and 2 for airports in Appendix 4), $W_{total\text{-}x}$. = 0,259, which is, as “ARC Applied in studies stages” $W_{total\text{-}x}$ index, very close to W_{total}. Design and “ARC Applied in studies stages“ phases are not considered to have any potential gap in good practice.

Concerning EIA topics, the “Legislation and regulation”, “Interactions with other modes of transport” show potential gaps (at regional scale) as well as “other topics”, their $W_{total\text{-}y}$ index being below W_{total}.

3.3.1.5. *Potential Gaps on Powerlines*

Table 7. Good practices applied on powerlines projects categorized and ranked among project life cycle and among EIA topics.

PHASES	Main topics (EIA) / Subphases	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	HABITATS MAPPING	IMPACTS	MEASURES	EVALUATION	Other topics	General aspects guides	GUIDE / TAXON	Wtotal (phases)
STRATEGIC PLANNING (national & regional)	National strategic planning										0,300
	Regional strategic planning										0,450
DESIGN	Early studies										0,700
	Late studies										0,050
	Detailed project study by the stakeholder										0,200
Construction	Construction										0,250
Operation / maintenance / Upgrading	Operation & Maintenance										0,250
	Upgrading										0,050
Decommisioning	Restoration (*Late* and detailled project study phases)										0,000
Applied in study stages	[illegible]										0,100
Stakeholders engagements	[illegible]										0,100
POWERLINES	Wtotal (topics)	0,182	0,091	0,242	0,09	0,234	0,333	0,00	0,364	0,00	0,223

Legend: Phase or topic with high number of good practices | Phase or topic with a medium number of good practices | Phase or topic with a lack of good practices | Phase or topic considered as a Gap | topic without good practice | General Ratio (Wtotal) used as reference for comparison

The number of good practices (N_{total} = 49) is low (nearly 10% of all good practices collected), the total amount of available cells being N'_{total} = 220) but the impacts of powerlines concern mainly birds and woodland habitats, limiting the number of possible of available good practices. We will then analyse the gaps in powerlines. Several phases are concerned by potential gaps: Upgrading phase has the smallest $W_{total\text{-}x}$ followed by the "Stakeholders engagements" and the "Applied in the study stages" project life cycle phases.

"Detailed project studies by stakeholder" $W_{total\text{-}x}$ is below the W_{total}, Early and Late studies subphases being higher than the $W_{total\text{-}x}$. When are merged all studies subphases altogether, $W_{total\text{-}x} = N_x/N_x' = 19/60$ (see Tables 1 and 2 in Appendix 5), $W_{total\text{-}x}$. = 0,317, which is close to W_{total}. Design phase is then not considered to have any potential gap in good practice.

Concerning EIA topics, the "Legislation and regulation" and especially "Interactions with other modes of transport" and Impacts $W_{total\text{-}y}$ index are smaller than W_{total}, and show potential gaps.

It must be noticed that by the Decommissioning phase and the "Other topics" and "guides / taxon EIA topics do not include any good practice.

3.3.1.6. *Potential Gaps on Ports and Pipelines*

The Table *8* and Table *9* illustrate the lack of good practices proposed for ports and pipelines.

Table 8. Good practices applied on ports projects categorized and ranked among project life cycle and among EIA topics.

PHASES	Main topics (EIA) / Subphases	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	HABITATS	IMPACTS	MEASURES	EVALUATION	Other topics	General aspects guides	GUIDE / TAXON	Wtotal (phases)
STRATEGIC PLANNING (national & regional)	National strategic planning										0,33
	Regional strategic planning										0,13
DESIGN	Early studies										0,53
	Late studies										0,07
	Detailed project study by the stakeholder										0,20
Construction	Construction										0,53
Operation / maintenance / Upgrading	Operation & Maintenance / Upgrading										0,47
Decommisioning	Restoration (*Late* and detailled project study phases)										0,00
Applied in study stages	Avoid, mitigate, compensate measures, consultation/finalisation, evaluation										0,07
Stakeholders engagements	All phases, education, publication, information to diverse publics,										0,07
PORTS	Wtotal (topics)	0,20	0,00	0,15	0,20	0,36	0,35	0,10	0,30	0,00	0,240

Legend:	Phase or topic with high number of good practices	Phase or topic with a medium number of good practices	Phase or topic with a lack of good practices	Phase or topic considered as a Gap	Phase or topic without good practice	General Ratio (W_{total}) used as reference for comparison

Table 9. Good practices applied on pipelines projects categorized and ranked among project life cycle and among EIA topics (Yellow rows and columns are empty of good practice).

PHASES	Main topics (EIA) / Subphases	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	HABITATS	IMPACTS	MEASURES	EVALUATION	Other topics	General aspects guides	GUIDE / TAXON	Wtotal (phases)
STRATEGIC PLANNING (national & regional)	National strategic planning										0,31
	Regional strategic planning										0,38
DESIGN	Early studies										0,62
	Late studies										0,08
	Detailed project study by the stakeholder										0,23
Construction	Construction										0,38
Operation / maintenance / Upgrading	Operation & Maintenance										0,08
	Upgrading										0,00
Decommisioning	Restoration (*Late* and detailled project study phases)										0,00
Applied in study stages	Avoid, mitigate, compensate measures, combination/install aline and evaluation										0,08
Stakeholders engagements	All phases, réunions, publications, information to diverse public, spécialiste réunions...										0,15
PIPELINES	Wtotal (topics)	0,09	0,09	0,27	0,00	0,39	0,27	0,00	0,27	0,00	0,210

Legend:	Phase or topic with high number of good practices	Phase or topic with a medium number of good practices	Phase or topic with a lack of good practices	Phase or topic considered as a Gap	Phase or topic without good practice	General Ratio (W_{total}) used as reference for comparison

3.3.1.7. Synthesis for all modes of transport

In this chapter, a comparison is carried out to detect common trends in all modes of transport. On the global analysis table (Table *10*) we pooled altogether all modes of transport, we find the same gap as found for Waterways, concerning EIA topics, the “Legislation and Regulation”, “Interactions with other modes of transport” W_y index show potential gaps (at regional scale) as well as “Other topics” and “Guide / Taxon” $W_{total\text{-}y}$ index being smaller than W_{total}. The topic concerning Taxon/guide is not exhaustive, there are many guides produced in Europe (see the website Transport Ecology Guidelines Portal: https://handbookwildlifetraffic.info/transport-ecology-guidelines-portal/).

Two phases with a gap are common to all transport modes: "Decommisioning" and "Stakeholders engagements", with a gap are with $W_{total\text{-}x} < 0.150$. “Applied in study stages” and more particularly upgrading phase are lower but close to $W_{total\text{-}x} = 0.300$, considering that there are gaps concerned need further examinations.

The only topic common to all modes of transport with potential gap is "Impacts".

Table 10. Good practices applied on “All modes of transport” projects categorized and ranked among project life cycle and among EIA topics (Yellow rows and columns are empty of good practice).

PHASES	Main topics (EIA) / Subphases	LEGISLATION AND REGULATION	with other mode(s) of transport	HABITATS MAPPING	IMPACTS	MEASURES	EVALUATION	Other topics	General aspects guides	GUIDE / TAXON	Wtotal (phases)
STRATEGIC PLANNING (national & regional)	National strategic planning										0,379
	Regional strategic planning										0,452
DESIGN	Early studies										0,547
	Late studies										0,194
	Detailed project study by the stakeholder										0,226
Construction	Construction										0,310
Operation / maintenance / Upgrading	Operation & Maintenance										0,458
	Upgrading										0,280
Decommisioning	Restoration (*Late* and detailled project study phases)										0,026
Applied in study stages	Avoid, mitigate, compensate measures, construction/installation and evaluation										0,200
Stakeholders engagements	All phases, education, publications, information to diverse public, scientific studies...										0,148
PIPELINES	Wtotal (topics)	0,218	0,132	0,308	0,172	0,367	0,359	0,250	0,326	0,158	0,300
	Legend:	Phase or topic with high number of good		Phase or topic with a medium number of		Phase or topic with a lack of good practices		**Phase or topic considered as a Gap**			General Ratio (W_{total}) used as reference for

Comparison between modes of transport

In Table 11, Roads and Railways GPs have altogether the half of all GPs, Inland waterways having only 13% of all GPs. Below 13% of all GPs collected, the number of topics/phases with a potential gap increases by 50%, which underlines the fact that the analyses carried out for airports and powerlines, which otherwise have a W < Wtotal index, are partly biased and potentially partial, thus requiring further validation. It strengthens also the conclusion to avoid GPs analysis for Ports and Pipelines, each one including below 7% of all GPs.

It should be noted that the percentage and total number of cells available for the GPs (Table *11*), compared by each transport mode to the number of GPs, allows the detection of the level of heterogeneity in the distribution by topics and by phases. Thus, for an equivalent number of GPs, roads have more available GPs than railways. This means that many GPs may have been positioned for particular topics and phases (such as Measures topic during the Maintenance phase) and that there may be more gaps than for railways which have a more regular distribution in the GP table and a proportionally more complete level of information than roads.

Table 11. Synthesis of good practices analysis for all modes of transport.

Modes of transport	ROAD 8	RAILWAY 8	WATERWAY 8	AIRPORT 8	POWERLINE 8	PORT 8	PIPELINE 8	TOTAL (all transport modes)
Total Number of GP* (N)	146	140	67	48	49	36	30	516
Total Number of available cells (N°)	455	352	220	180	220	150	143	1720
W total index	0,321	0,398	0,305	0,267	0,223	0,240	0,210	0,300
Comparison of transport modes Means with Total global mean	>	>	=	≤	<	<	<	-
% GP / each mode of transport	28,29%	27,13%	12,98%	9,30%	9,50%	6,98%	5,81%	100,00%
% "cells available" / each mode of transport	26,45%	20,47%	12,79%	10,47%	12,79%	8,72%	8,31%	100,00%
Gaps number in life cycle phas	3	3	3	4	4	-	-	Common phases gaps
list of gaps for project life cycle phases	- Construction - Decommisioning - Stakeholders engagemt	- Construction - Decommisioning - Stakeholders engagemt	- Decommisioning -Applied in studies - Stakeholders engagemt	- Construction - Decommisioning - Applied in studies - Stakeholders engagemt	- Upgrading - Decommisioning - Applied in studies - Stakeholder engagemt	-	-	- Decomminssioning - Stakeholders engagemt
Number of Gaps in EIA Topics	1	3	3	5	5	-	-	Common topics gaps
list of gaps for EIA Topics	- Impacts	- Impacts - Legislation - Interaction	- Impacts - Legislation - Interaction	- Impacts - Legislation - Interaction - Other topics - Guides/taxon	- Impacts - Legislation - Interaction - Other topics - Guides/taxon	-	-	- Impacts

(*) GP = Good Practice

3.4. GAPS FROM QUESTIONNAIRE RESULTS

A descriptive analysis applied on gaps extracted from the questionnaire answers provide the following results (Figure 11):

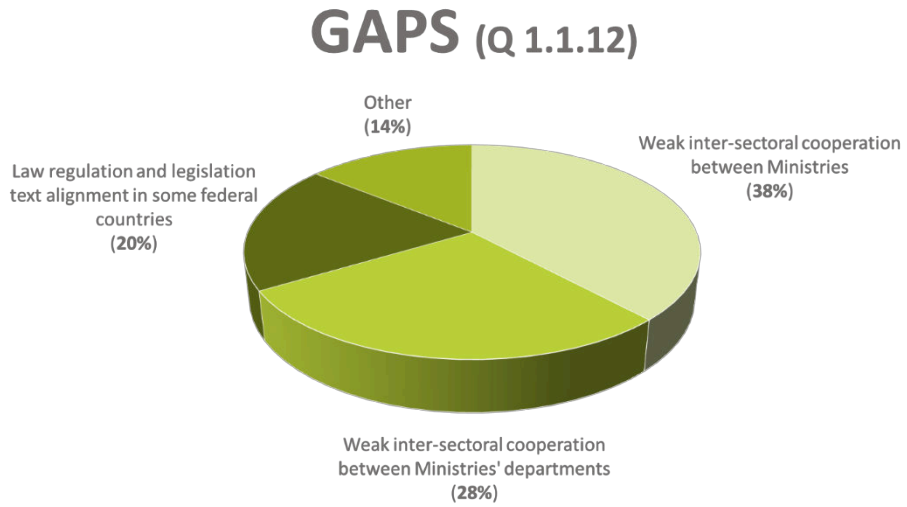


Figure 11: Gaps descriptive statistical analysis results.

The most identified gaps are within “inter-sectoral cooperation between Ministries” categories followed by “inter-sectoral cooperation between Ministries’ departments”, “Law regulation…” and finally “Other” categories.

A detailed list of answers provided under 'Other' is provided below and these other gaps in the Table 12 below can be categorised into 5 items.

Table 12.Gaps in Good Practice from the questionnaire and categorized into 5 items.

Gaps items	**Gaps extracted from the questionnaire**
Interest in effects of infrastructures of transport on biodiversity	- Lack of interest - Lack of political will
Lack of funding	- Lack of funding - Lack of channelling budgets for this matter - Economy has more priority than ecology (nature protection) - Many provisions on paper only
Transport economic sector lobbying	- Lobbying of industry - Policy on ecologically sustainable and biodiversity friendly Transport
Lack of coordination between administrations	- Lack of coordination among regional governments - Weak cooperation between ministries and local / regional state services Lack of coordination between authorities in charge of biodiversity management - Lack on the strategic level implementation - Gap between the objectives of the policy and the local political pressures not to implement them properly
Awareness and education	- Low level of knowledge across stakeholders - Lack of awareness at high political level, particularly from Transport Sector - Low level of awareness of employees of transport policy sector in EU-SGI, EU - SB issues

3.4.1. Results on Barriers

A descriptive analysis applied on barriers extracted from the questionnaire answers provide the following results (Figure 12):

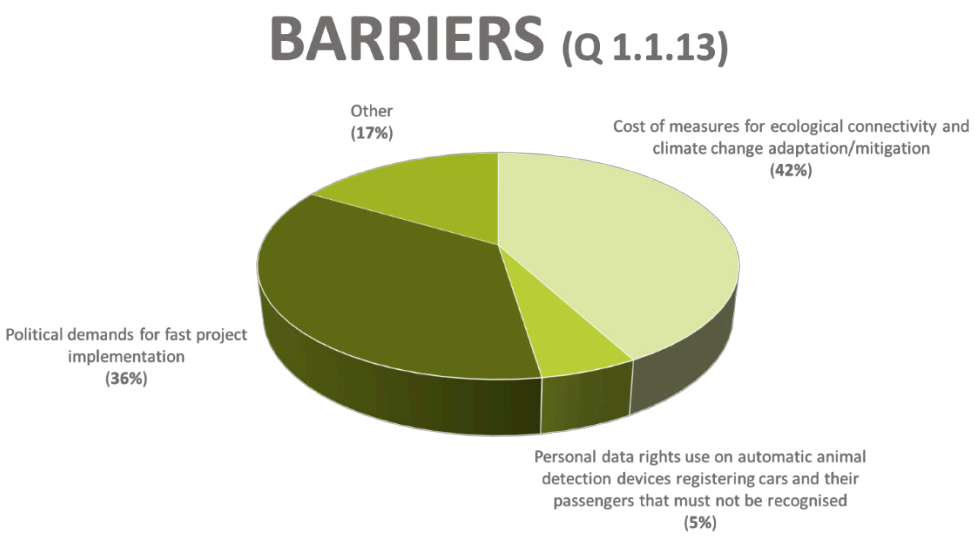


Figure 12: Barriers descriptive statistical analysis results.

The "cost of measures" barrier is the most cited one, the second most cited being the "political demand for fast project implementation, "personal data rights" being the less cited. A detailed list of answers provided under 'Other' is provided in Table 13. *"Other" barriers in Good Practices from the questionnaire and categorized into 5 items* below. Some of these items are close to the two main categories of barriers ("economical trends" with "cost of measures", and "will and enthusiasm of actors" with "political demand for fast project implementation").

Table 13. "Other" barriers in Good Practices from the questionnaire and categorized into 5 items.

Barriers items	**"Other" barriers extracted from the questionnaire**
Knowledge availability	• Lack of knowledge • Lack of clear guidelines about what measures to apply. • Lack of baseline data on biodiversity and connectivity
Will and enthusiasm of actors	• Unwillingness of actors for changing traditional solutions • Capacity and enthusiasm in developers. • Lack of political will
Administration organisation	• Environmental externalities are not sufficiently integrated into decision-making process. • Lack of specialists in key positions. • Regional services are pressured and don´t have enough resources (time notably) to do their job properly
Economical trends	• Private ownership of adjacent land • Economy has more priority than ecology (nature).
Awareness	• Understanding the importance of biodiversity protection and safeguarding ecological connectivity. • Lack of (ecological) awareness during the design phase.

3.5. DISCUSSION

This deliverable presents and describes the methodology used in the context of Task 3.1 for the identification of gaps and barriers in GPs currently applied to mainstream biodiversity in transport and their evaluation. This deliverable will help to establish interaction with WP4 and WP5 a SRDA about infrastructures of transport effects on biodiversity.

3.5.1. Potential Gaps of Good Practice and Gaps from questionnaire

The common assumption that tools and practices are more abundant for roads as it has been reported for number of publications for diverse studies in ecology such as the recent systematic reviews on potentiality of verges to constitute natural habitats (Villemey et al., 2019; Ouédraogo et al., 2020) is verified in this study. Railways have far fewer GPs than roads and GPs are even fewer in the context of waterways. Airports and ports provide only a few GPs because, as waterways, new constructions of this type of infrastructures are rare or non-existent in Europe and in the countries of the European Union (Eurostat and EGM, Table *14*). They represent only a small area (Table *14*) of built-up land compared to other modes of transport such as roads and railways, even though they indirectly generate a significant volume of traffic on the various linear transport infrastructure networks (roads, railways and waterways) and the impacts associated with this traffic. This limits the likelihood of acquiring a sufficient and usable number of GPs.

Table 14. Estimations of length and surface occupied in European Union by main roads, railways, waterways, ports and airports.
(Surface of roads, railways and waterways are based on a crude estimation of their width).

Infrastructures of transport in EU (year)	**Main Roads (2020)**	**Railways (2019)**	**Inland waterways (2019)**	**Ports (2021)**	**Airports (2018)**
Total Length (km) or number (ports - airports)	3 874 709	323 034	41 891	935	391
Total Surface (km²) (Infrastructure Width (m))	77 500 (20)	4 875 (15)	628 (15)	805	2725
***Sources** – (date of data)*	*Length and number of infrastructure (except Ports) Eurostat + diverse databases. Number of Ports: EGM - https://geoservices.ign.fr/egm (31/12/2021)*			*Surface for Ports and Airports: Corine Land Cover (2018)*	

Powerlines and pipelines have mainly permanent impacts on the forest habitats they cross as they require clearing (LIFE Elia RTE – ITTECOP (2015)) to prevent the tree canopy from touching the powerline cables and causing power outages or the root system of the tree vegetation from piercing and damaging the pipelines, which are usually buried in Europe. Impacts can sometime be positive for landscape and biodiversity (i.e. for some insect species that benefit of the open habitats inside woody areas) but are generally negative and are most significant during the construction phase, and remain significant during the commissioning of the powerlines for flying organism due to potential collisions with

power lines. The small variety of impacts on these two modes of transport, as for ports and airports (see Table *14*), implies a potentially small number of GPs compared to roads and railways.

3.5.1.1. Common Potential Gaps to all modes of transport

a. Impacts and other topics

The impacts of transport infrastructures are not well known for all taxa, especially on invertebrates (Jakobson et al., 2018), vegetation and soil (Ballantyne & Pickening, 2015). Disturbances such as noise (Sordello et al., 2019) and light impacts (Secondi et al., 2020; Sordello et al., 2022) that are deeply investigate still show important knowledge gaps. The gaps concern also the limits in accuracy of impacts evaluations, such as bird mortality evaluation due to collision with powerlines (Borner el al., 2017). Two important gaps, among many others, is the lack of consistent knowledge about the intensities of all impacts of each (type) project life cycle phase especially from construction to decommissioning on all taxa and habitats (Guinard et al., 2016) and how to improve cumulative impacts assessments (Mokany et al., 2019). However, this impacts (topics) GPs under-representation may be biased by the fact that impacts items are generally pooled with mitigation measures and even with their evaluation. So many Impacts GPs may be included into these two last topics.

“Legislation and regulation” as well as “Interaction between other transport modes” topics are, for all other modes of transport except roads, common topics revealing potential gaps of GPs. “Legislation and regulations” have for all transport modes the number of GPs N_y = 19 GPs and “Interaction between other transport modes” have the number of GPs N_y = 10 GPs. These topics concern mainly strategic planning phase and they are de facto under-represented compared to the other GPs’ topics (“legislation”: 3.68% and “Interaction”: 1.94%). “Interaction between other transport modes” GPs are particularly not frequently observed and show significant gap. During this phase, analyses of interactions conducting to the creation of a coordinated strategic planning between a project of new airport, railways and roads have been reported in Spain. A project of motorway circumventing Bordeaux (that has been stopped for now) used Mérignac airport more as a justification of construction of this motorway, arguing a strategic interest of connection of this motorway to the airport, than a real coordination with diverse urban modes of transport (bud, tramway…).

b. Transport infrastructure project life cycle phases

Decommissioning (phase) of infrastructure occurs rarely in Europe and even outside Europe, explaining why it shows potential gap in GPs, this point being confirm by CEREMA experts for airports and ports. Stakeholders engagements should be far more frequent but only 11 % of the persons who answered to the BISON questionnaire were from private companies involved in construction or are operators.

Based on internal waterways reports by CEREMA expert added examples to the list of GPs available of certain works of calibration, dredging and modernisation of docks. The low numbers of stakeholders contacted could also explain this deficit (see above). All concerning ARC “Applied in studies stages” are globally slightly below the W_{total} index of all modes of transport (Table *11*), $W_{total\text{-}x}$ is only higher to W_{total} for roads and railways. Upgrading shows potential GPs gap: it could be because upgrading is a recent item (except for Western Europe) and only roads and railways do not have gaps of GPs in the phase of upgrading. It could be linked with a low number of stakeholders for some modes of transport such as waterways: a waterway expert from CEREMA reports examples of GPs missed that need to be added

like certain works of calibration, dredging and modernization of docks and it needs to be deeply investigated in following steps.

Potential gaps of GPs concerns “Applied for studies stages”. It could be explained by the fact that phase can be another version of Design phase, and GPs has not been positioned in both “sister” phases.

c. Complementarity of potential gaps analysis with gaps from the questionnaire

The gaps from the questionnaire indicate the global context in the EU, the GPs detailing more the gaps in technical domains. But the first method results can bring supplemental information to the results observed in the questionnaire The most frequent gaps cited in the questionnaire (Figure 11) are about national and local administrations coordination and organisation, the second item being the lack of legislation gaps are also an important issue. These gaps are mainly controlled by the Political strategies in the Ministries of transportation and of environment, these two topics in some countries being pooled in the same Ministry (i.e. France). It is somehow in links with the lack of funding and of interest in effects of infrastructure s of transport in biodiversity that could be also linked to gaps in awareness and education. This last gap is confirmed by the potential gap in stakeholders’ engagements “phase” nearly observed in all modes of transport in the GPs distribution analysis (Table *10*). All these items are in direct interactions, and the motivation of all main actors is crucial.

Conversely, the potential gap observed on "interactions between several modes of transport" in the strategic planning phase would tend to indicate a lack of coordination between departments of the same ministry or even between several ministries involved in projects. It will be necessary in the further analysis process to determine which countries are more particularly impacted by this potential disorganisation of administrations, bearing in mind that France accounts for more than a quarter of all the responses to the questionnaire, thus biasing the analysis.

The gaps in scientific knowledge on infrastructures of transport on biodiversity, currently reported in the scientific literature do not appear clearly in our gap analyses, in part because it concerns all items and all phases to varying degrees. It concerns both the knowledge of impacts (i.e. cumulative impacts (Jaeger, 2015) and among many other items, the impacts on animal populations persistence (Barrientos et al., 2021), which is an obvious gap according to the results obtained. But these gaps in knowledge concern also the assessments of impacts and all types of measures, which despite the abundance of GPs, still require further study in terms of scientific knowledge (i.e. the sensitivity of the various animal and plant species to the various pollutions and nuisances at each phase of a transport infrastructure project and for each modes of transport (Guinard et al., 2016)). The WP4 and WP5 teams have the task of drawing up an assessment of the scientific knowledge gaps. Scientific knowledge was mainly perceived as a barrier by the interviewees (Table *12*).

d. Barriers on Good Practice

Comparing the results of the categorisation of barriers with those of the gaps, we find almost the same types of barrier categories but in different proportions (Figure 12), with political strategies remaining important but financial considerations being perceived as the most important barriers. The right to use personal data is a minor but noteworthy issue. We find the same types of categories as for the gaps in "other" barriers, except for lobbying of the economic sector of transport, which is not found in the barriers, which, in contrast to the gaps, mention the lack of available scientific knowledge.

The lack of funding, the will of politicians and administrations, which lack coordination in governance, and finally education & communication on the interactions between transport infrastructures and biodiversity are indeed unavoidable themes for both barriers and gaps. This situation is similar to the description of the main barriers by Tinch and his collaborators (2015), adding an "…insufficient capacity at the national level to implement laws and policies…".

These results provide the main gaps and barriers but there is a need of complementary analysis that is detailed in the following chapter.

4. STAKEHOLDER´S PERCEPTION ON GAPS AND BARRIERS

4.1. AIMS

The workshops explained in this section aimed to gather the perception and evaluate the consensus of stakeholders from both transport and biodiversity sectors on what are the most important 'Gaps and barriers' to mainstream biodiversity on transport infrastructure. These workshops included partners and other external stakeholders, including researchers and practitioners, working on ecology and transport sectors.

4.2. METHODOLOGY

Within the framework of the BISON Project, Task 3.1, 'Gaps' were defined as 'absence or too small number of good practice' and 'Barriers' as 'elements that create difficulties for the application of the best practice'.

The difference between these two concepts was not obvious for the partners as it was identified during the preparation of the first workshop. In order to facilitate the process and considering that the final aim is to use the information gathered to identify how to overcome obstacles and make progress in the goal of mainstreaming biodiversity on transport infrastructure both concepts, 'Gaps' and 'Barriers', were merged and discussed together.

The identification of 'Gaps and barriers' to mainstream biodiversity in transport infrastructure is an important part of the 'Identification of good practice per transport mode: 'State of Play'' (Task 3.1) that has been conducted in different stages: Compilation, Evaluation and Prioritisation. The process is detailed in the following sections.

4.2.1. Compilation

In a first stage, a compilation of 'Gaps and barriers' was conducted by different means:

- BISON questionnaire answers to the following questions:

  Q1.1.12 - *Which were the greatest gaps and barriers you met towards the development of ecologically sustainable and biodiversity friendly Transport Plan(s) and to mainstream biodiversity in the design and operation of the infrastructure?*

  Q1.2.1 - *What are in your opinion the main constraints that are stopping or posing limitations to the development of actions to mainstream biodiversity in designing and operation of transport infrastructure? Please choose the main 3 constraints and provide any other that is important in your opinion.*

- Internal review of Good Practices provided by stakeholders to identify the obstacles that hinder their effective replication and widespread implementation.

- 'Gaps and barriers' identified in Work Package 5 through internal workshop and expert consultation.

This initial list was reviewed to eliminate duplications, merge related entries and improve wording to ensure a general understanding. 'Gaps and barriers' compiled were organized in four categories to ease their assessment and evaluation in the second phase.

1. **Legislation and Funding:** including topics related to policies, strategies, plans, laws, and budget.
2. **Governance, Communication and Cooperation:** including topics related to awareness, training and stakeholder cooperation.
3. **Knowledge and Research:** including topics related to maps, data, technical solutions, research and innovation needs.
4. **Tools and Processes:** including topics related to guidelines, handbooks, standards, methods and databases.

4.2.2. Evaluation and prioritization

In the second phase, these thematic lists of 'Gaps and barriers' were evaluated by experts from both environmental and transport sectors in order to achieve the widest consensus possible about the most important 'Gaps and barriers' in transport ecology.

To do so three workshops were conducted in three events with the participation of partners and experts from ecology and transport (Figure 13):

- BISON mid-term seminar (June 2022; Paris, France). An initial workshop (see Section 1.1.2) was conducted with BISON partners to ensure consensus within project partners regarding category lists, improve and refine 'Gaps and barriers' wording to ease understanding and start their prioritization. Feedback provided by BISON partners was integrated and lists were reorganized accordingly to the votes received.

- IENE2022 Conference (September 2022; Cluj-Napoca, Romania). A second workshop was organized at IENE2022 Conference. Reorganized lists were presented to participants that provided inputs regarding their wording and rank them according to their importance.

- Transport Research Arena (November 2022; Lisbon, Portugal). To collect more input from transport sector a third round of consultation was conducted at TRA. In this case, the session included an introduction about the topic, the presentation of the list issued from IENE 2022 Conference and an online survey that was filled by participants accessing by a QR code. In this survey, participants ranked each 'Gaps and barrier' from 1 ('Not important') to 5 ('Really important').

Figure 13: Workshop conducted at IENE2022 Conference (top) and the session undertaken in TRA2022 (Bottom) (Photos by: Sylvain Moulherat; Yannick Autret).

4.2.2.1. Workshop methodology

The methodology followed for the workshops was the 'World Café' method (Figure 14), consisting in three parts:

1. **Introduction and framework.** A short presentation about the BISON Project and the methodology followed in producing the different lists was presented. The goals and the organization of the workshop were explained.

2. **Break-out groups.** Participants were divided in groups that rotated through the thematic tables where the different lists of 'Gaps and barriers' were presented. Each table had a facilitator to lead the conversation and enrich the discussion with the comments from previous groups and a person responsible to take notes.

3. **Common presentation and conclusions.** Final results obtained in each thematic table were presented to the participants and a final discussion was undertaken.

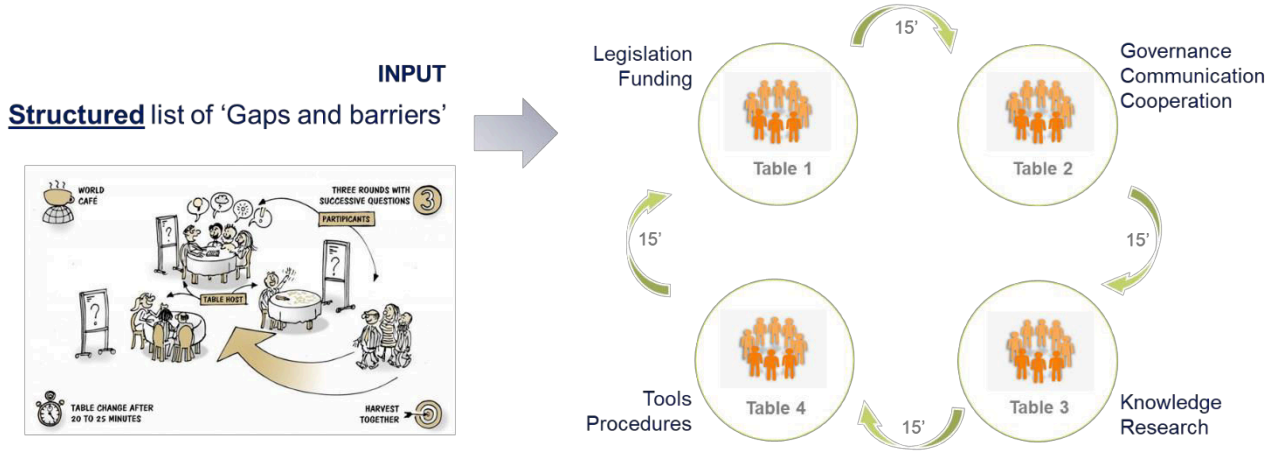


Figure 14: Schematic representation of the methodology followed to conduct the workshops for the identification of 'Gaps and barriers' to mainstream biodiversity in transport infrastructure.

A representation of the complete process followed is presented in Figure 15.

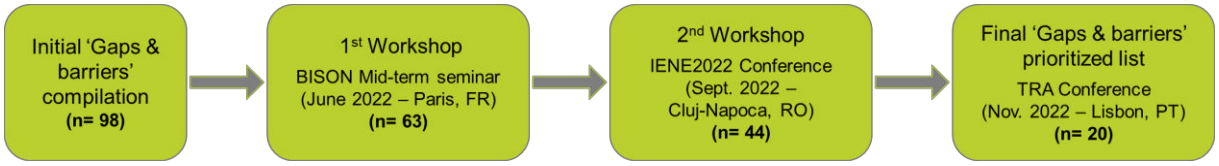


Figure 15: Schematic representation of the process followed to identify 'Gaps and Barriers'.

4.3. RESULTS

A total of 98 'Gaps and barriers' were identified in the initial compilation phase. The complete list is included in Appendix 6.

Once they were reviewed to eliminate duplicates, merge similar topics, and classified in four categories (Legislation and Funding; Governance, Communication and Cooperation; Knowledge and Research; Tools and Processes), 63 'Gaps and barriers' remained (Appendix 7). These four lists were presented at BISON mid-term seminar. Participants (ca. 40) provided feedback regarding their relevance and importance and about their classification among the different lists.

All feedback was collected and processed to refine and improve the lists. The results of this process were presented at IENE2022 Conference. In this workshop, although all 'Gaps and barriers' were presented, those identified as a priority in the previous step (n=44) were highlighted (Appendix 8). Ecology and transport experts (ca 30) participated in this workshop, where the process followed was the same than in the previous step.

After processing the feedback form this second workshop, the Top 5 'Gaps and barriers' were selected to be presented and evaluated at TRA Conference. 12 transport experts participated in the session and answered to the survey to rank these 'Gaps and barriers' according to their importance.

Final lists of 'Gaps and barriers' organized by categories are presented in Table 15 to Table 18 including average score for the Top 5 obtained at TRA Conference. These tables also include 'Gaps and barriers' ranked 6-10 after the first two workshop.

Table 15. Final list of 'Gaps and barriers' in Legislation and Funding identified in the workshops with project partners and participants of the IENE 2022 Conference. Top 5 are highlighted including the average scored obtained at TRA Conference.

'Gaps and barriers' in Legislation and Funding	
Top 5	**1.** Neglecting available knowledge about ecological corridors due to contradictions with transport/land planning (protected areas are considered but not other crucial areas for biodiversity) **(4.3)** **2.** Lack of policies, standards and regulations about sustainable and biodiversity friendly transport infrastructure requirements **(4.2)** **3.** Lack of funding (often -but not only- due to low priority of ecological topics on policies) **(4.1)** **4.** Incomplete integration of 'EU Strategy on Green Infrastructure' & 'EU Biodiversity Strategy for 2030' goals into Transport National policies (e.g. reduction of pesticides use; prevention AIS, implementation of Nature Based Solutions; etc.) **(3.8)** **5.** Lack of official guideline's (technical prescriptions approved by transport and environment authorities) related to mainstreaming biodiversity and transport infrastructure **(3.4)**
	6. Contradictory policies and standards to be applied for verges and other green and blue (drainage systems) areas associated to transport infrastructure (HTI) management (e.g., Safety vs. Biodiversity requirements). **7.** Lack of legal repositories/databases of biodiversity raw data. **8.** Lack of EU policies/guidelines to standardize ecological restoration and compensatory measures. **9.** Lack of alignment on legislation of federal administrations within countries. **10.** Lack of EU legislation on cross-cutting topics, such as soil artificialization, forest protection, and others.

Table 16. Final list of 'Gaps and barriers' in Governance, Communication and Cooperation identified in the workshops with project partners and participants of the IENE 2022 Conference. Top 5 are highlighted including the average scored obtained at TRA Conference.

'Gaps and barriers' in Governance, Communication and Cooperation	
Top 5	**1.** Lack of effective communication to decision-makers, engineers, field crews and other about potential solutions and actions to mainstream biodiversity **(4.4)** **2.** Unwillingness of stakeholders to change conventional design and management (due to i.e. 'fear of failure or legal consequences' or 'aversion to risk') which result in difficulties to implement innovative solutions **(4.4)** **3.** Lack of transport technical staff education and training about potential solutions to mainstream biodiversity (including not only effective measures and positive actions but also failures and ineffective measures to be avoided) **(4.3)** **4.** Lack of knowledge about consequences (including economics) of biodiversity and ecosystem services loss, limiting the application of ecological approaches on cost benefit evaluations **(4.3)** **5.** Lack of awareness/willingness to apply biodiversity conservation measures among policy-makers particularly from transport sector **(4.0)**
	6. Infrastructure 'industry' (engineering, construction, supplier companies) lobbying to keep 'business as usual'. **7.** Weak coordination/cooperation between authorities at different levels (country, regional and local) and dealing with different topics (biodiversity, transport and spatial planning). **8.** Policy and decision maker demands for fast project implementation which result in lack of resources (time notably) and pressure on biodiversity/technical staff involved infrastructure development. **9.** Lack of capacity for mutual understanding of knowledge and vocabulary between ecology and transport infrastructure stakeholders (capacity building is considered a crucial cross-sector issue. **10.** Lack of awareness and education of citizen -including children- needed to influence decision and policy makers.

Table 17. Final list of 'Gaps and barriers' in Knowledge, Research and Innovation identified in the workshops with project partners and participants of the IENE 2022 Conference. Top 5 are highlighted including the average scored obtained at TRA Conference.

'Gaps and barriers' in Knowledge, Research and Innovation	
Top 5	**1.** Lack/dissemination of knowledge on how to adapt transversal structures to increase ecological connectivity and resilience of infrastructure facing climate change at the same time **(4.4)** **2.** Deficits in the knowledge (or access to it) and baseline biodiversity data at large scale about wildlife populations, landscapes, ecosystem services, ecological connectivity, cumulative impacts, etc. and about mitigation measures (e.g. inventories and maintenance of wildlife passages) **(4.3)** **3.** Lack of research on cost-effectiveness analyses to improve communication with decision-makers **(4.3)** **4.** Lack of long-term monitoring and dissemination of the results about effectiveness of mitigation measures (including information about failures and ineffective measures) **(4.2)** **5.** Need for research specifically on effects of disturbance (noise, light, chemical pollution, etc.) and their cumulative effects on biodiversity **(4.0)**
	6. Lack of knowledge (or access to it) on areas where compensatory measures for defragmentation and ecological restoration could be undertaken (databases, maps…). **7.** Lack of appropriate impact indicators and methods for data gathering (considering small and non-endangered species; evaluating effectiveness vs use, etc.). **8.** Lack of Research, Development & Innovation programs to promote new technologies and efficient solutions for mainstreaming biodiversity and transport infrastructure in the scenario of climate change. **9.** Lack of criteria to identify 'biodiversity-friendly' transport infrastructure (by transport mode and including criteria for use of sustainable materials). **10.** Need for transversal research on climate change effects in transport infrastructure/biodiversity and solutions to face both (developed by expert from both sectors).

Table 18. Final list of 'Gaps and barriers' in Tools and Procedures identified in the workshops with project partners and participants of the IENE 2022 Conference. Top 5 are highlighted including the average scored obtained at TRA Conference.

'Gaps and barriers' in Tools and Procedures	
Top 5	**1.** Promote biodiversity positive actions and Nature based Solutions to be applied in transport infrastructure climate change adaptation plans, environmental evaluation, and other tools **(4.7)** **2.** Lack of integration of environmental externalities into decision-making process **(4.7)** **3.** Need for integrated platforms (digital tools) addressed to both sectors to improve communication about mainstreaming biodiversity and transport at different levels (from policy-making to infrastructure users) **(4.1)** **4.** Difficult access to biodiversity information and data about Defragmentation, compensation, road mortality, ecological corridors, ecological assets management and other **(3.9)** **5.** Need to improve Environmental Impact Assessment procedures to better evaluate transport infrastructure impacts on biodiversity (including fragmentation, ecosystem services, dynamic modelling, multispecies connectivity, cumulative impacts and other) **(3.7)**
	6. Lack of standardized methodologies (shared between both sectors) for gathering information and evaluating wildlife-vehicle collision, transport infrastructure impacts on biodiversity, mitigation measures effectiveness, identification of areas to defragment and climate change risk evaluation. **7.** Lack of inspection and maintenance plans of ecological assets in the operation phase (considering opportunities to develop positive actions for biodiversity). **8.** Lack of environmental monitoring programs included in national Transport Plans **9.** Neglecting the role of soil management for optimizing habitats and minimizing construction and maintenance costs. **10.** Lack of official standards and technical prescriptions to apply measures at different levels of mitigation hierarchy (i.e. about drainage adaptation to increase ecological connectivity and infrastructure resilience).

4.4. DISCUSSION

The identification of 'Gaps and barriers' that are slowing or hindering the mainstream application of best practice in transport ecology have been undertaken with a participatory approach including experts from biodiversity and transport sectors.

It is remarkable the high level of consensus reached between the experts of both sectors in the 20 main issues (5 per each topic: Legislation and Funding; Governance, Communication and Cooperation; Knowledge, Research and Innovation; Tools and Procedures). The average score for all 'Gaps and barriers' evaluated at TRA conference is 4.2 in a scale from 1 (Not important) to 5 (Really important). These scores ratify the importance of the 'Gaps and barriers' identified in the BISON Mid-term seminar and IENE2022 Conference.

The main 'Gaps and barriers' identified (with a rank of 4.7) are:

- 'Promote biodiversity positive actions and Nature based Solutions to be applied in transport infrastructure climate change adaptation plans, environmental evaluation, and other tools'.

- 'Lack of integration of environmental externalities into decision-making process'.

They reveal, in one hand, the shared interest between sectors of going beyond reducing the impacts that transport infrastructure cause in biodiversity and finding solutions that promote benefits for biodiversity and society altogether. Also, they show that the impacts (or 'environmental externalities') should be more considered by decision makers.

It is also important to highlight how the outputs of the BISON project can contribute to make progress and overcome the 'Gaps and barriers' identified.

- Some of the top-ranked 'Gaps and barriers' have highlighted the need of better communication between stakeholders at several levels. The first step of this process is to ensure all stakeholder involved are speaking a 'common language' and the Glossary developed in collaboration with IENE and PIARC is a first step in this direction.

- Others have mentioned the need of interdisciplinary education and training for technical staff. The development of a 'Learning Hub' could contribute to centralize training resources aiming to improve these interdisciplinary skills.

- Many of them include the lack of knowledge (or the difficulty to access to it) about different topics and at different phases of transport infrastructure life cycle. The development of an updated and user-friendly online handbook that facilitate user´s access to available information definitely contributes to eliminate this problem.

5. CONCLUSIONS

The current report represents the final version of the work conducted within Task 3.1 of the BISON project, focusing on the identification of Best Practices and the analysis of Gaps and Barriers in mainstreaming biodiversity and transport. The report summarizes the entire process undertaken since the project's inception, including the identification of Good Practices, research for extrapolation and validation of Best Practices, and the analysis of Gaps and Barriers based on the identified practices.

The initial list of 143 proposed Good Practices was carefully reviewed and narrowed down to a refined selection of 15 Best Practices, following specific identification criteria. These Best Practices underwent a detailed assessment using the MAMCA methodology, involving a total of 7 experts from diverse disciplines (transport, biodiversity, and environmental policies) and countries. The evaluation process considered 12 criteria in total, such as biodiversity impact, feasibility of implementation, sustainability, scalability, adaptability, etc. as they have been already defined in D3.1.

While the MAMCA evaluation has provided valuable insights and rankings of the Best Practices, it is important to acknowledge the limitations of the survey. These limitations include a small sample size, potential expert biases, data availability, contextual factors and language barriers. These limitations should be taken into account when interpreting the results and applying the Best Practices in different contexts.

Despite these limitations, the MAMCA evaluation has generated valuable guidance and a ranked list of Best Practices that can serve as a foundation for mainstreaming biodiversity in the transport sector. The results can inform decision-making, policy development, and implementation strategies to promote the coexistence of green and grey infrastructure and contribute to biodiversity restoration. Further research and adaptation of the identified Best Practices in specific regional and country contexts are recommended to ensure their effectiveness and applicability. Overall, the MAMCA evaluation has been a valuable tool in advancing the integration of biodiversity considerations into the transport sector.

The methods carried out for gaps and barriers analyses are complementary. The first method (see Chapter 1) provides more technical aspects about gaps and barriers and the second method (see Chapter 2) provides a more global overview about them. Both methods show common gaps and barriers that strengthen the reliability of their results, such as the lack of knowledge, with the first method providing more detail on the phases in which knowledge is lacking (i.e. construction and decommissioning) and on the issue of impacts. The second method, like the first, shows a lack of stakeholder involvement, but the second method gives more precise information (i.e. lack of instruction and training or lack of effective communication). Some results are found in one method and not in the other (the first method gives comparisons between each mode of transport (except ports and pipelines where too few good practices have been collected to give reliable results), the second method ranks the gaps and barriers in the 4 main themes. We can assume that this is the most complete analysis that could be obtained from all the data collected so far.

The various gaps and barriers are in fact interrelated and need to be addressed as a whole: the lack of tools and standards partly explains the lack of knowledge, large-scale research projects require a lot of data that is almost impossible to obtain in normal research projects, a European standardisation of fauna passage monitoring, for example, could potentially provide much more comparable data. These data need to be available in international databases that need to be built up. This is also a problem of lack of

knowledge dissemination. Linking the main gaps and barriers will indeed be crucial to finding efficient solutions and actions, and will help in building the SRDA.

In conclusion, the collection of good practices through the questionnaire and the complementary enquiries to a relatively small community of practitioners, and in spite of some other obstacles (Covid, ports and pipelines too poorly informed...), gave very fruitful first results of this kind. On the one hand, the analysis of the values of the good practices, which led to a list of best practices, made it possible to identify key practices as examples to be disseminated in Europe and on other continents. On the right hand, the analysis of the values of the good practices, leading to a list of best practices, makes it possible to obtain à first key practices list as successful examples to be disseminated throughout Europe and other continents. On the other hand, the analysis of their distribution on the main items questioned by the decision makers and practitioners during all the phases of the life cycle of all types of transport infrastructures, completed with Gaps and Barriers directly collected from the questionnaire spread in main general items, allowed to embrace a large field research from technical to general Gaps and Barriers. These complementary and essential "materials" have fed other BISON WP3 tasks, WP4 and WP5 tasks and can be a basis for a more coherent European Union policy of transport sector and biodiversity interests.

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APPENDICES

APPENDIX 1

Table 1 for the collection of Good Practices distributed among mains items and life cycle phases of road projects for gap analysis

PHASES	Main items / Detaild phases	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	HABITATS MAPPING	IMPACTS	MEASURES	EVALUATION	Other topics	General aspects	GUIDE / TAXON	TOTAL
STRATEGIC PLANNING (national & regional)	National strategic planning	2	2	6	1	1	0	1	6	1	20
	Regional strategic planning	0	1	6	0	3	4	1	2	1	18
DESIGN	Early studies	1	1	8	7	9	4	2	2	0	34
	Late studies	0	0	2	0	4	0	2	0	0	8
	Detailed project study by the stakeholder	1	0	0	3	3	2	1	0	0	10
Construction	Construction	1	0	0	0	3	3	0	2	0	9
Operation / maintenance / Upgrading	Operation & Maintenance	0	0	3	0	3	4	1	0	1	12
	Upgrading	1	0	0	0	10	3	0	2	0	16
Decommisioning	Restoration (*Late* and detailled project study	1	0	0	0	1	0	0	0	0	2
Applied in study stages	Avoid, mitigate, compensate	0	0	0	0	9	0	1	0	1	11
Stakeholders engagements	All phases, educations, publications,	0	0	2	0	1	1	0	2	0	6
ROADS	TOTAL	7	4	27	11	47	21	9	16	4	146

Table 2 for the number of cells available for collection of Good Practices distributed among mains items and life cycle phases of road projects for gap analysis

PHASES	Main items	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	HABITATS MAPPING	IMPACTS	MEASURES	EVALUATION	Other topics	General aspects	GUIDE / TAXON	TOTAL
STRATEGIC PLANNING (national & regional)	National strategic planning	2	2	12	8	20	10	4	10	2	70
	Regional strategic planning	1	1	6	4	10	5	2	5	1	35
DESIGN	Early studies	2	2	12	8	20	10	4	10	2	70
	Late studies	1	1	6	4	10	5	2	5	1	35
	Detailed project study by the	1	1	6	4	10	5	2	5	1	35
Construction	Construction	1	1	6	4	10	5	2	5	1	35
Operation / maintenance / Upgrading	Operation & Maintenance	1	1	6	4	10	5	2	5	1	35
	Upgrading	1	1	6	4	10	5	2	5	1	35
Decommisioning	Restoration (*Late* and detailled	1	1	6	4	10	5	2	5	1	35
Applied in study stages	Avoid, mitigate, compensate measures, construction/installation and evaluation	1	1	6	4	10	5	2	5	1	35
Stakeholders engagements	All phases, educations, publications, information to diverse publics, scientific studies...	1	1	6	4	10	5	2	5	1	35
	TOTAL	13	13	78	52	130	65	26	65	13	455

APPENDIX 2

Table 1 for the collection of Good Practices distributed among mains items and life cycle phases of railways projects for gap analysis

PHASES	Main items / Detaild phases	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	HABITATS MAPPING	IMPACTS	MEASURES	EVALUATION	Other topics	General aspects	GUIDE / TAXON	TOTAL
STRATEGIC PLANNING (national & regional)	National strategic planning	1	1	6	2	2	1	2	3	1	19
	Regional strategic planning	2	1	6	0	6	1	2	3	1	22
DESIGN	Early studies	0	0	5	1	7	3	1	1	1	19
	Late studies	0	0	2	0	2	2	1	1	1	9
	Detailed project study by the	0	0	0	0	5	2	1	0	0	8
Construction	Construction	0	0	0	0	5	3	0	2	0	10
Operation / maintenance / Upgrading	Operation & Maintenance	1	0	2	3	11	1	2	1	0	21
	Upgrading	0	0	1	0	8	1	0	0	1	11
Decommisioning	Restoration (*Late* and detailled project study	0	0	0	0	1	0	0	0	0	1
Applied in study stages	Avoid, mitigate, compensate	0	0	0	0	10	0	1	0	1	12
Stakeholders engagements	All phases, educations, publications	0	0	2	0	3	0	1	2	0	8
RAILWAYS	TOTAL	4	2	24	6	60	14	11	13	6	140

Table 2 for the number of cells available for collection of Good Practices distributed among mains items and life cycle phases of railways projects for gap analysis

PHASES	Main items	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	HABITATS MAPPING	IMPACTS	MEASURES	EVALUATION	Other topics	General aspects	GUIDE / TAXON	TOTAL
STRATEGIC PLANNING (national & regional)	National strategic planning	2	1	6	3	11	3	2	3	1	32
	Regional strategic planning	2	1	6	3	11	3	2	3	1	32
DESIGN	Early studies	2	1	6	3	11	3	2	3	1	32
	Late studies	2	1	6	3	11	3	2	3	1	32
	Detailed project study by the	2	1	6	3	11	3	2	3	1	32
Construction	Construction	2	1	6	3	11	3	2	3	1	32
Operation / maintenance / Upgrading	Operation & Maintenanc	2	1	6	3	11	3	2	3	1	32
	Upgrading	2	1	6	3	11	3	2	3	1	32
Decommisioning	Restoration (*Late* and detailled	2	1	6	3	11	3	2	3	1	32
Applied in study stages	Avoid, mitigate, compensate measures, construction/installa	2	1	6	3	11	3	2	3	1	32
Stakeholders engagements	All phases, educations, publications, information to	2	1	6	3	11	3	2	3	1	32
RAILWAYS	TOTAL	22	11	66	33	121	33	22	33	11	352

APPENDIX 3

Table 1 for the collection of Good Practices distributed among mains items and life cycle phases of waterways projects for gap analysis

PHASES	Main items	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	HABITATS MAPPING	IMPACTS	MEASURES	EVALUATION	Other topics	General aspects	GUIDE / TAXON	TOTAL
STRATEGIC PLANNING (national & regional)	National strategic planning	1	1	2	1	1	0	1	1	0	8
	Regional strategic planning	0	0	3	1	2	1	1	1	0	9
DESIGN	Early studies	0	0	4	1	4	2	1	1	0	13
	Late studies	0	0	2	0	2	1	0	1	1	7
	Detailed project study by the	0	0	0	0	1	2	0	0	1	4
Construction	Construction	0	0	0	0	3	3	0	1	0	7
Operation / maintenance / Upgrading	Operation & Maintenance / Upgrading	1	0	2	3	6	3	0	0	0	15
Decommisioning	Restoration (*Late* and detailled	0	0	0	1	0	0	0	0	0	1
Applied in study stages	Avoid, mitigate, compensate	0	0	0	0	1	0	0	0	0	1
Stakeholders engagements	All phases, educations, publications	0	0	0	0	0	0	0	2	0	2
WATERWAYS	TOTAL	2	1	13	7	20	12	3	7	2	67

Table 2 for the number of cells available for collection of Good Practices distributed among mains items and life cycle phases of waterways projects for gap analysis

PHASES	Main items	LEGISLATION AND REGULATION	Interactions with other mode(s) of	HABITATS MAPPING	IMPACTS	MEASURES	EVALUATION	Other topics	General aspects	GUIDE / TAXON	TOTAL
STRATEGIC PLANNING (national & regional)	National strategic planning	1	1	4	3	6	3	1	2	1	22
	Regional strategic planning	1	1	4	3	6	3	1	2	1	22
DESIGN	Early studies	1	1	4	3	6	3	1	2	1	22
	Late studies	1	1	4	3	6	3	1	2	1	22
	Detailed project study by the	1	1	4	3	6	3	1	2	1	22
Construction	Construction	1	1	4	3	6	3	1	2	1	22
Operation / maintenance / Upgrading	Operation & Maintenance / Upgrading	1	1	4	3	6	3	1	2	1	22
Decommisioning	Restoration (*Late* and detailled	1	1	4	3	6	3	1	2	1	22
Applied in study stages	Avoid, mitigate, compensate measures, construction/install	1	1	4	3	6	3	1	2	1	22
Stakeholders engagements	All phases, educations, publications, information to	1	1	4	3	6	3	1	2	1	22
WATERWAYS	TOTAL	10	10	40	30	60	30	10	20	10	220

APPENDIX 4

Table 1 for the collection of Good Practices distributed among mains items and life cycle phases of airports projects for gap analysis

PHASES	Main items / Detaild phases	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	HABITATS MAPPING	IMPACTS	MEASURES	EVALUATION	Other topics	Guides General aspects	Guides taxon	TOTAL
STRATEGIC PLANNING (national & regional)	National strategic	1	1	2	0	3	1	1	1	0	10
	Regional strategic	0	0	3	0	1	0	0	1	0	5
DESIGN	Early studies	0	0	0	0	4	2	0	2	0	8
	Late studies	0	0	0	0	1	1	0	1	0	3
	Detailed project	0	0	1	0	0	1	0	1	0	3
Construction	Constructio	0	0	0	0	2	2	0	0	0	4
Operation / maintenance / Upgrading	Maintenanc e	0	0	1	0	6	2	0	1	0	10
Decommisioning	Rehabilitatio n (Late and	0	0	0	0	0	0	0	0	0	0
Applied in study stages	Avoid, mitigate, compensate measures,	0	0	0	0	2	0	0	1	0	3
Stakeholders engagements	All phases, educations, publications , information	0	0	1	0	0	0	0	1	0	2
AIRPORTS	TOTAL	1	1	8	0	19	9	1	9	0	48

Table 2 for the number of cells available for collection of Good Practices distributed among mains items and life cycle phases of airports projects for gap analysis

PHASES	Main items / Detaild phases	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	Habitats mapping	IMPACTS	MEASURE	EVALUATIO	Other topics	Guides General aspects	Guides taxon	TOTAL
STRATEGIC PLANNING (national & regional)	National strategic	1	1	3	1	6	2	1	2	1	18
	Regional strategic	1	1	3	1	6	2	1	2	1	18
DESIGN	Early studies	1	1	3	1	6	2	1	2	1	18
	Late studies	1	1	3	1	6	2	1	2	1	18
	Detailed project study by the	1	1	3	1	6	2	1	2	1	18
Construction	Construction	1	1	3	1	6	2	1	2	1	18
Operation / maintenance / Upgrading	Maintenance	1	1	3	1	6	2	1	2	1	18
Decommisioning	Rehabilitation (Late and	1	1	3	1	6	2	1	2	1	18
Applied in study stages	Avoid, mitigate, compensate measures, construction/inst	1	1	3	1	6	2	1	2	1	18
Stakeholders engagements	All phases, educations, publications, information to	1	1	3	1	6	2	1	2	1	18
AIRPORTS	TOTAL	10	10	30	10	60	20	10	20	10	180

APPENDIX 5

Table 1 for the collection of Good Practices distributed among mains items and life cycle phases of powerlines projects for gap analysis

PHASES	Main items / Detaild phases	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	HABITATS MAPPING	IMPACTS	MEASURES	EVALUATION	Other topics	Guides General aspects	Guides / Taxon	TOTAL
STRATEGIC PLANNING (national & regional)	National strategic planning	1	0	1	0	2	0	0	2	0	6
	Regional strategic planning	0	0	3	0	3	1	0	2	0	9
DESIGN	Early studies	0	0	2	0	7	3	0	2	0	14
	Late studies	0	0	0	0	0	1	0	0	0	1
	Detailed project study by the stakeholder	0	0	1	0	1	2	0	0	0	4
Construction	Construction	1	0	0	0	2	2	0	0	0	5
Operation / maintenance / Upgrading	Operation & maintenance	0	0	0	0	2	2	0	1	0	5
	Upgrading	0	1	0	0	0	0	0	0	0	1
Decommisioning	Restoration (Late and detailled project study phases)	0	0	0	0	0	0	0	0	0	0
Applied in study stages	Avoid, mitigate, compensate measures & evaluation	0	0	0	1	1	0	0	0	0	2
Stakeholders engagements	All phases	0	0	1	0	0	0	0	1	0	2
POWERLINES	TOTAL	2	1	8	1	18	11	0	8	0	49

Table 2 for the number of cells available for collection of Good Practices distributed among mains items and life cycle phases of powerlines projects for gap analysis

PHASES	Main items / Detaild phases	LEGISLATION AND REGULATION	Interactions with other mode(s) of transport	HABITATS MAPPING	IMPACTS	MEASURES	EVALUATION	Other topics	Guides General aspects	Guides / Taxon	TOTAL
STRATEGIC PLANNING (national & regional)	National strategic planning	1	1	3	1	7	3	1	2	1	20
	Regional strategic planning	1	1	3	1	7	3	1	2	1	20
DESIGN	Early studies	1	1	3	1	7	3	1	2	1	20
	Late studies	1	1	3	1	7	3	1	2	1	20
	Detailed project study by the stakeholder	1	1	3	1	7	3	1	2	1	20
Construction	Construction	1	1	3	1	7	3	1	2	1	20
Operation / maintenance / Upgrading	Operation & maintenance	1	1	3	1	7	3	1	2	1	20
	Upgrading	1	1	3	1	7	3	1	2	1	20
Decommisioning	Restoration (Late and detailled project study phases)	1	1	3	1	7	3	1	2	1	20
Applied in study stages	Avoid, mitigate, compensate measures & evaluation	1	1	3	1	7	3	1	2	1	20
Stakeholders engagements	All phases	1	1	3	1	7	3	1	2	1	20
POWERLINES	TOTAL	11	11	33	11	77	33	11	22	11	220

APPENDIX 6

Initial list of 'Gaps and barriers' compiled through the different methods explained in Section 2.1.

1. Weak inter-sectoral cooperation between Ministries.
2. Weak inter-sectoral cooperation between Ministries´ departments.
3. Law regulation and legislation text alignment in some federal countries.
4. Lack of interest.
5. Lack of political will.
6. Gap between the objectives of the policy and the local political pressures not to implement them properly.
7. Lack of funding.
8. Lack of channeling budgets for this matter.
9. Low level of awareness of employees of transport policy sector in EU-SGI, EU-SB issues.
10. Lobbying of industry.
11. Policy on ecologically sustainable and biodiversity friendly Transport.
12. Lack of coordination among regional governments.
13. Weak cooperation between ministries and local / regional state services.
14. Economy has more priority than ecology (nature protection).
15. Many provisions on paper only.
16. Low level of knowledge across stakeholders.
17. Lack of awareness at high political level, particularly from Transport Sector.
18. Lack of coordination between authorities in charge of biodiversity management.
19. Lack on the strategic level implementation.
20. Lack of awareness from policy-makers and/or technical staff.
21. Lack of standards and regulation from transportation sector.
22. Lack of national/regional policies and strategies that include the general principles of the EU-SGI and EU-SB 2030.
23. Lack of guidelines and technical prescriptions to undertake the actions.
24. Deficits in the knowledge of the species or in the access to this knowledge.
25. Lack of real efficient evaluation of mitigation and compensation measures.
26. Lack of R+D and Innovation programs to promote and fund new technologies in the scenario of global change need (to be developed in coordination transport/biodiversity stakeholders).
27. Lack of monitoring and dissemination of the results about effectiveness of mitigation measures already applied (fauna passages, measures to increase traffic safety by reducing Animal-Vehicle Collisions, etc.). 'Learning by Doing' process.
28. Standardized process to identify AVC hotspots.
29. Accessible databases with information regarding roadkill, ecological corridors…
30. Systematic inventories of crossing structures.
31. Standardized process to identify areas to defragment, areas for compensation…

32. Accessible information regarding areas to defragment and/or for compensation (databases, maps…).
33. Consideration of climate change in the environmental evaluation of transportation plans and projects.
34. Climate change adaptation plan.
35. Spatial planning tools and integrative management of ecological corridors.
36. Effective communication of knowledge available to decision-makers, engineers, field crews…
37. Methodology for risk identification considering biodiversity, climate change…
38. Multidisciplinar committees and guidelines.
39. Species sensibility table to LTI impacts.
40. Landscape insertion of road infrastructures: methodological tools and good design practices.
41. Legal deposit of raw biodiversity data.
42. EIA dynamic modelling.
43. Consideration of ES in EIA.
44. Standardized approach to compensation.
45. Sharing lessons learnt wildlife passages building and monitoring.
46. Citizen involvement.
47. Species distribution and dispersal models and LTI.
48. Vegetation management and maintenance plans.
49. Criteria for fauna passages establishment.
50. Insect mark-capture-recapture surveys.
51. Stakeholder involvement.
52. Environmental assessment monitoring commission in TI projects.
53. Connectivity indicators.
54. Habitat fragmentation indicators.
55. Monitoring and evaluation of effectiveness of mitigation measures.
56. AVC Monitoring.
57. Post-construction fauna monitoring.
58. Road verges management and maintenance policy to enhance biodiversity.
59. Easily accessible information on biodiversity assets and management.
60. Habitat zoning.
61. Guidelines/policies for connectivity restoration after decommissioning.
62. Systematic drainage adaptation to provide connectivity.
63. Guidelines/policies for standardization of compensation measures.
64. Integration of EU-SGI and EU-BS2030 into national transport policies.
65. Lack of coordination and cooperation between transport and environmental sectors.
66. Lack of Environmental Monitoring Programs in National Transport Plans.
67. Lack of methodologies and tools to measure impacts correctly.
68. Lack of data (or access to it).
69. Lack of cross-cutting EU legislation on soil artificialization, forest protection…
70. Improve stakeholder involvement.
71. Improve cross sectoral cooperation.
72. Cost of measures for ecological connectivity and climate change adaptation/mitigation.
73. Political demands for fast project implementation.
74. Personal data rights use on automatic animal detection devices registering cars and their passengers that must be not recognized.
75. Lack of knowledge.
76. Lack of political will.

77. Economy has more priority than ecology (nature).
78. Environmental externalities are not sufficiently integrated into decision-making process.
79. Lack of (ecological) awareness during the design phase.
80. Capacity and enthusiasm in developers.
81. Lack of clear guidelines about what measures to apply.
82. Lack of specialists in key positions.
83. Lack of baseline data on biodiversity and connectivity.
84. Regional services are pressured and don´t have enough resources (time notably) to do their job properly.
85. Understanding the importance of biodiversity protection and safeguarding ecological connectivity.
86. Unwillingness of actors for changing traditional solutions.
87. Private ownership of adjacent land.
88. Lack of budget.
89. Lack of knowledge/education in the technical staff and field crews.
90. Lack of political interest.
91. Economy is considered as more important than ecology (nature protection).
92. Implementation of standards, guidelines, policies.
93. Opposing lobbying.
94. Nature Conservation and Spatial Planning are in competence of the federal states and the communities.
95. Lack of constraints on infrastructure managers in the operational phase.
96. Lack of guts to try new and or different things.
97. Lack of control.
98. In Romania, a comprehensive technical guidance has been developed in TRANSGREEN project, however, the documents has not been approved officially by the two relevant ministries (transport and environment) – despite the fact that it was developed with involvement of Ministry of Transport and Ministry of Environment (having the quality of Strategic Associated Partners in the project).

APPENDIX 7

Initial lists of 'Gaps and barriers' presented at BISON Mid-term seminar (June 2021 – Paris, France) organized by categories.

'Gaps and barriers' in Legislation and Funding

1. Incomplete integration of EU SGI and EU BS2030 into Transport National policies.
2. Legislation alignment within countries with federal administrations.
3. Lack of policy, standards and regulations on ecologically sustainable and biodiversity friendly Transport.
4. Lack of policies/guidelines to standardize compensation measures.
5. Lack of enough funding (often but not only due to low priority of ecology).
6. Personal data rights use on automatic animal detection devices registering cars and their passengers that must be not recognized.
7. Lack of official approvement for official guidelines even if they are agreed among the relevant ministries.
8. Lack of legal deposits (database/repository) of biodiversity raw data.
9. Lack of policies/guidelines for connectivity restoration after decommissioning.
10. Lack of EU legislation on cross-cutting topics, such as soil artificialization, forest protection…

‘Gaps and barriers’ in Governance, Communication and Cooperation

1. Weak coordination/cooperation between Ministries/regional governments.
2. Weak coordination/cooperation between biodiversity/transportation/spatial planning administrations.
3. Lobbying of industry/Opposing lobbying.
4. Lack of multistakeholder governance approach and stakeholder/citizen involvement.
5. Lack of effective communication of available knowledge to decision-makers, engineers, field crews…
6. No sharing lessons learnt regarding wildlife passages building and monitoring.
7. Gap between the objectives of the policy and the local political pressures not to implement them properly.
8. Lack of political interest/willingness.
9. Political demands for fast project implementation.
10. Pressures on biodiversity/transport services and lack of resources (time notably).
11. Lack of specialists in key positions.
12. Private ownership of adjacent land limits measures to apply.
13. Unwillingness of actors for changing traditional solutions.
14. Lack of capacity and enthusiasm in developers.
15. Many provisions on paper only (It could refer to: lack of accessibility or lack of application).
16. Lack on the strategic level implementation.
17. Low level of awareness of employees of transport policy sector in EU-SGI, EU-SB issues.
18. Lack of awareness at high political level and among policy-makers, particularly from Transport Sector.
19. Lack of awareness from technical staff, particularly but not only at the design phase.
20. Understanding the importance of biodiversity protection and safeguarding ecological connectivity.
21. Lack of opportunities to try and apply innovative solutions.

‘Gaps and barriers’ in Knowledge, Research and Innovation

1. Deficits in the knowledge of the species or in the access to this knowledge.
2. Lack of information regarding species sensibilities to TI Projects.
3. Lack of baseline data on biodiversity and connectivity.
4. Lack of monitoring and dissemination of the results about effectiveness of mitigation and compensation measures.
5. Lack of information regarding animal mortality due to TI, ecological corridors.
6. Appropriate zoning in HTI.
7. Lack of information (or access to it) regarding areas to defragment, for compensation, ecological corridors… (databases, maps…).
8. Lack of indicators (connectivity, habitat fragmentation...).
9. Comprehensive inventories of crossing structures (databases, maps).
10. Lack of criteria for fauna passages establishment.
11. Accurate knowledge on species distribution and dispersal versus TI.
12. Insect mark-capture-recapture surveys.
13. Knowledge on how to adapt transversal structures to face climate change and increase permeability at the same time.
14. Lack of R+D and Innovation programs to promote and fund new technologies in the scenario of global change need.

‘Gaps and barriers’ in Tools and Procedures

1. Need of improvement of EIA method to include, i.e.: ecosystem services and dynamic modelling.
2. Environmental externalities are not sufficiently integrated into decision-making process.
3. Lack of standardized methodology to apply compensation measures.
4. Lack of standard methodology to measure TI impacts on biodiversity.
5. Lack of standard methodology to evaluate mitigation measures effectiveness.
6. Lack of clear guidelines and technical prescriptions to apply measures.
7. Lack on Environmental Monitoring Programs in National Transport Plans.
8. Lack of control (on biodiversity issues) on infrastructure managers in the operational phase.
9. Lack of appropriate methodological tools to integrate TI into the landscape.
10. Difficult access to biodiversity information: defragmentation, compensation, road mortality, ecological corridors, ecological assets management.
11. Lack of environmental assessment monitoring commission in TI projects (T).
12. Lack of standard protocol to collect information on AVC and identify hotspots.
13. Lack of standard process to identify areas to defragment, for compensation measures…
14. Management and maintenance policies and plans to enhance biodiversity on verges and other HTI.
15. Consideration of climate change in environmental evaluation of transportation projects.
16. Absence of a Climate Change adaptation plan.
17. Standardized methodology for climate change risk evaluation.
18. Systematic adaptation of drainages to face climate change and improve connectivity.

APPENDIX 8

Lists of 'Gaps and barriers' presented at IENE2022 Conference (September 2022 – Cluj-Napoca, Romania) organized by categories. In the top half of the tables are included the 'Gaps and barriers' prioritised in the first workshop.

'Gaps and barriers' in Legislation and Funding

1. Lack of EU policies/guidelines to standardize compensation measures and connectivity restoration after decommissioning.
2. Lack of policy, standards and regulations on ecologically sustainable and biodiversity friendly Transport.
3. Lack of official approvement for official guidelines even if they are agreed among the relevant ministries.
4. Lack of legal repositories/databases of biodiversity raw data.
5. Incomplete integration of EU SGI and EU BS2030 into Transport National policies.
6. Lack of alignment on legislation within countries with federal administrations.
7. Lack of funding (often but not only due to low priority of ecology).
8. Personal data rights use on automatic animal detection devices registering cars and their passengers.
9. Lack of standard methodology to measure TI impacts on biodiversity.
10. Neglecting available knowledge regarding ecological corridors due to contradictions between different corridor approaches and/or planning levels.
11. Lack of EU legislation on cross-cutting topics, such as soil artificialization, forest protection…

'Gaps and barriers' in Governance, Communication and Cooperation

1. Lack of effective communication of available knowledge to decision-makers, engineers, field crews… Need to share both successes and failures.
2. Lack of capacity/understanding between TI developers and other stakeholders. Capacity building is considered a crucial cross-sector issue.
3. Lack of awareness/willingness about biodiversity Strategies among policy-makers particularly from transport sector.
4. Lack of awareness of citizens, including children education (needed to influence decision makers, policies etc.).
5. Weak coordination/cooperation between Ministries/regional/local governments. Within and among countries (trans-border cooperation).
6. Lobbying of infrastructure 'industry' (manufacturers and others) to keep business as usual'.
7. Unwillingness of actors for changing traditional solutions ('fear of failure', 'aversion to risk', 'fear of legal consequences').
8. Lack of education of transport technical staff about potential solutions and actions to mainstream biodiversity. Need for Training seminars, special courses, hybrid training.
9. Weak coordination/cooperation between biodiversity/transportation/ spatial planning administrations.
10. Political demands for fast project implementation in contrast with long-term required to develop infrastructure.
11. Lack of specialists in key positions with decision and cooperation capacity.
12. Lack of knowledge about cost of biodiversity loss, collisions with vehicles, etc. 'What is the cost of no action?', 'How a sustainable infrastructure should be?'

13. Lack of multistakeholder governance approach and stakeholder/citizen involvement.
14. Lack on the strategic level implementation.
15. Lack of awareness and knowledge from technical staff, particularly but not only at the design phase. Knowledge transfer to practitioners into practical guidelines.
16. Understanding the importance of biodiversity protection and safeguarding ecological connectivity.
17. Lack of continuation of EU Projects.
18. Gap between the objectives of the policy and the local actions.
19. Need for psychological science to help the collaboration.
20. Lack of resources (time notably) and pressures on biodiversity/technical staff.
21. Private ownership of adjacent land limits measures to apply.

22. Lack of opportunities to try and apply innovative solutions.

‘Gaps and barriers’ in Knowledge, Research and Innovation

1. Deficits in the knowledge and baseline data at large scale (populations, landscapes, ecosystem services, ecological connectivity, cumulative impacts…) or in the access to this knowledge.
2. Lack of long-term monitoring and dissemination of the results about effectiveness of mitigation and compensation measures (include also information about failures).
3. Inappropriate impact indicators or inappropriate methods for data gathering (neglecting small and non-endangered species; use vs effectiveness, etc).
4. Knowledge on how to adapt transversal structures to face climate change and increase permeability at the same time. Need to anticipate CC effects when designing mitigation measures and reassess over time due to changing conditions.
5. Lack of definitions and criteria for ‘biodiversity-friendly’ TI by transport mode. Including materials for new TI.
6. Lack of research on cost-effectiveness analyses to communicate better with decision-makers.
7. Comprehensive inventories of crossing structures (databases, maps) identifying their ecological role.
8. Need for research specifically on effects of disturbances (noise, light, chemical pollution, dust…) and their cumulative effects.
9. Lack of information (or access to it) regarding areas to defragment, for compensation, ecological corridors… (databases, maps…).
10. Lack of R+D and Innovation programs to promote and fund new technologies in the scenario of global change need.
11. Lack of information regarding animal mortality due to TI, ecological corridors…

12. Lack of criteria for fauna passages establishment.
13. Accurate knowledge on species distribution and dispersal versus TI.
14. Insect mark-capture-recapture surveys.
15. Special research is needed e. g. for the assessment of the impact of stepping stone biotope topology and for barrier impacts of different land use.
16. Guidelines for the delineation of impact areas of barrier effects and “parity GI concepts”.
17. Research on biodiversity reaction to artificial light in fauna passages.
18. Understand importance of secondary roads.
19. Transversal research and publications (not only transversal management teams).
20. Include urban areas to evaluate biodiversity.

21. Research on CC effects in TI/biodiversity: floods, fire…

'Gaps and barriers' in Tools and Procedures

1. Difficult access to biodiversity information and data: defragmentation, compensation, road mortality, ecological corridors, ecological assets management…
2. Lack of standardize methodologies: to collect information AVC, evaluate TI impacts, mitigation measures effectiveness, identification of areas to defragment; CC risk evaluation…
3. Need to improve EIA method to better evaluate TI impacts on biodiversity. Including: fragmentation, ecosystem services, dynamic modelling, multispecies connectivity, cumulative impacts…
4. Need of an integrated platform (formal and informal) addressed to both sector and at different levels (from policy-makers to TI users) for an effective communication among them (regarding impacts, solutions…).
5. Biodiversity should be more highlighted when talking about Climate Change.
6. Lack of clear guidelines and technical prescriptions to apply measures at different levels of mitigation hierarchy.
7. Lack of environmental monitoring programs in National Transport Plans.
8. Fragmentation and defragmentation concerns have to be better assessed and complementary avoided/mitigated.
9. Management and maintenance policies and plans to enhance biodiversity on verges and other HTI.
10. Environmental externalities are not sufficiently integrated into decision-making process.

11. Lack of control (about biodiversity issues) on infrastructure managers in the operational phase.
12. Lack of appropriate methodological tools to integrate TI into the landscape.
13. Neglecting available knowledge regarding ecological corridors due to difficult acquisition procedures for GIS-data for existing concepts.
14. For scales > 1:50.000: Special developed parity GI concepts should be part of any TI development.
15. Guidelines for plausibility checks of existent GI concepts and for TI-specific parity GI-concepts should be developed.
16. Inappropriate definition of the impact areas for fragmentation assessment (in scoping procedures).
17. Neglecting impact reduction by lower velocity standards. Their effects have always to be compared as an obligatory alternative in SEA and EIA.

18. Neglecting the role of soil management for optimizing habitats and minimizing maintenance (and construction) costs.
19. Consideration of climate change in environmental evaluation of transportation projects.
20. Absence of a Climate Change adaptation plan incorporating biodiversity concerns.
21. Lack of systematic adaptation of drainages to face climate change and improve ecological connectivity.