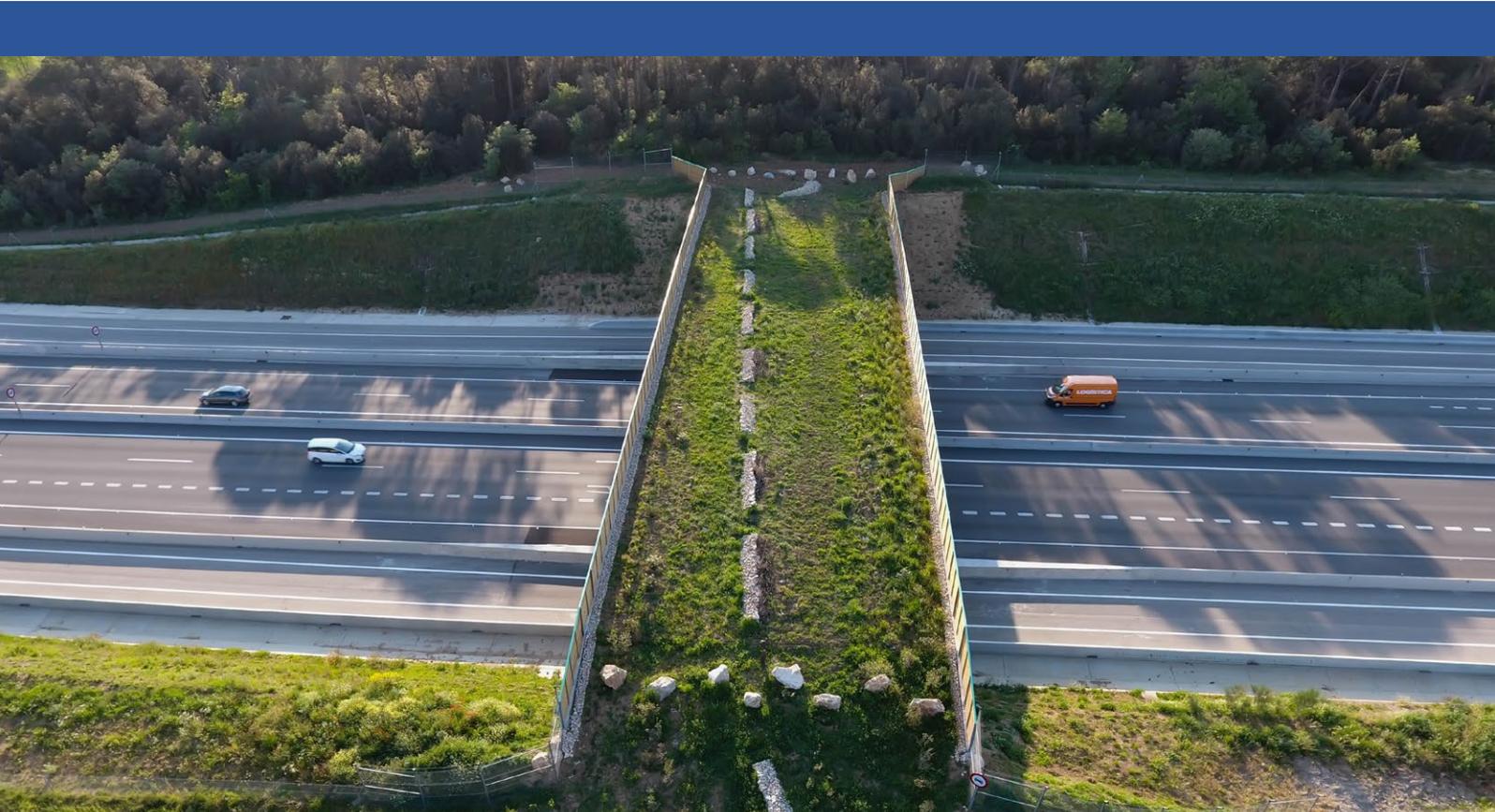




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Wildlife & Traffic

A European Handbook for Identifying Conflicts and Designing Solutions

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Maintenance of ecological assets on transport linear infrastructure

September 2020

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Authors: Carme Rosell¹, Marina Torrellas¹, Joana Colomer¹, Heinrich Reck², Ferran Navàs¹ & Michal Bil³

¹ MINUARTIA

² Institute for Natural Resource Conservation. Kiel University

³ CDV - Transport Research Centre.

CEDR Programme of Executive Board: Vincent O'Malley, Elke Hahn, Adam Hofland, Tony Sangwine & Anders Sjölund.

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Contributors: Jan Oloff Helldin, Albert Cama, Roser Campeny, Eugene O'Brien, E. Van der Grift contributed material and/or reviewed the text.

English editors: Paul O'Hare & Tony Sangwine.

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Summary

Ecological assets maintenance

This document deals with the critical issue of developing appropriate maintenance of ecological assets to guarantee the long-term performance of wildlife mitigation measures and provide appropriate management of habitats related to transport infrastructure such as verges, ponds, and other elements of drainage systems. The step-by-step guidelines are designed to be adopted and implemented by linear infrastructure operators and managers with the objective of optimizing traffic safety while at the same time enhancing benefits for biodiversity and its advantages to society.

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Appendix 1	Relevant environmental regulations and strategies to be considered at maintenance of ecological assets on transport linear infrastructure
Appendix 2	Fields to be included in the ecological asset database. Example of a wildlife crossing description form.

Acronyms

- ADS.** Animal Detection System
- AVC.** Animal Vehicle Collisions
- HTI.** Habitat related to Transport Infrastructure
- IAS.** Invasive Alien Species.
- KPI.** Key Performance Indicators
- PPP.** Public-Private Partnership

1. Introduction

1.1 Definition

The prevention of animal-vehicle collisions (AVCs) and complying with environmental legislation are central tenets in the design, construction and operation of the 6 million kilometres of roads and railways across Europe. Equally important is the goal to reduce biodiversity loss which can also have a substantial benefit to human welfare.

Ecological assets in transportation infrastructure comprise of all the elements aimed at reducing wildlife hazards including traffic safety, the mitigation of negative impacts on nature, and the enhancement of biodiversity in areas associated with transportation networks.

These guidelines provide recommendations for undertaking appropriate maintenance of ecological assets to allow for the preservation of the integrity, function, and long-term performance of these assets (see Table 1). Two main types can be identified:

- [Wildlife mitigation measures](#), to reduce AVC risk, to preserve ecological connectivity and to reduce disturbances caused by traffic to adjacent ecosystems. Main elements included are wildlife fences and screens, wildlife crossings and wildlife warning signs.
- [Habitats related to transportation infrastructure](#) (HTI) hosting wild flora and fauna. Main elements included are verges and other green areas, ponds, and other drainage elements (aquatic habitats).

Table 1. Main ecological asset functions preserved by applying appropriate maintenance.

	Wildlife fences and screens	Wildlife crossings	Wildlife warning signs	Verges and other green areas	Ponds and other drainage elements
Reduce AVC risk to traffic safety and wildlife mortality	●	●	●		
Reduce disturbance to wildlife and ecosystems	●				
Preserve ecological connectivity		●		●	●
Avoid the spread of invasive alien species				●	●
Reduce effects of climate-related risks and extreme events				●	●
Enhance habitats for wildlife and avoid creating ecological traps				●	●

1.2 Special requirements for ecological asset maintenance

Ecological asset maintenance places special requirements on road and railway maintenance approaches:

- Legal obligations exist in relation to infrastructure crossing Natura 2000 sites, (Sites of Community Importance (SCI), Special Areas of Conservation (SAC), and Special Protection Areas (SPA)) and other areas hosting species or habitats included in Bird and Habitats Directive (see [Appendix 1. Environmental regulations and strategies](#)).
- Diverse local site conditions and wildlife characteristics require that the general instructions provided in these guidelines are applied in a flexible way depending on the specific features of the area which may change over time.
- Specialists with skills in wildlife management should be part of the maintenance staff, and cooperation with stakeholders involved in biodiversity, water or land management is required - a structured multidisciplinary approach.
- Monitoring and evaluation of the effects from different maintenance practices/regimes is particularly important to expand our knowledge and understanding on this topic in order to adapt current practice to changing conditions.

1.3 Benefits

By undertaking appropriate maintenance of ecological assets, infrastructure operators optimise investment in traffic safety, which in turn contributes to enhanced benefits for biodiversity and human welfare.

The main benefits provided are:

- Improve traffic safety and reduce the high social and economic costs of road traffic accidents involving wild animals.
- Comply with the environmental legislation for biodiversity conservation and the conditions of the infrastructure planning approval process.
- Reduce wildlife mortality and disturbances to adjacent ecosystems due to traffic and infrastructure features.
- Maintain ecological connections across transport linear infrastructure.
- Avoid the spread of invasive alien species (IAS).
- Support the measures installed or constructed to enhance biodiversity on ponds, verges, and other green areas.
- Reduce the effects of climate-related risk and extreme events such as floods and forest fires.
- Play a part in improving future design, construction, and maintenance practice of ecological assets, by providing feedback on lessons learned.
- Ensure value for money invested in ecological mitigation.

1.4 Target users

These guidelines are primarily aimed at practitioners either responsible for or involved in the planning, construction, operation and maintenance of ecological infrastructure and those who oversee appointed maintenance contractors or personnel. They can also be used for educational purposes.

2. Developing an adaptive ecological asset maintenance plan

2.1 A process in the infrastructure life-cycle

Harmonising wildlife and transport infrastructure is a process that begins in the planning phase and must be delivered by the appropriate construction and maintenance of ecological assets. The necessary requirements for each ecological asset to facilitate maintenance through all life-cycle phases are listed in Table 2.

To neglect maintenance aspects in infrastructure design and construction may compromise the functionality of ecological mitigation during the operation phase and increase hazards to traffic safety. It may also lead to damage to protected species and sites.

Table 2. Maintenance needs to be attended along the whole infrastructure life-cycle.

INFRASTRUCTURE LIFE-CYCLE PHASE Requirements to facilitate appropriate maintenance and guarantee long-term performance of each ecological asset
PLANNING
<ul style="list-style-type: none">• Appropriately adapted to site conditions• Appropriately designed according to target species and habitat requirements• Duly inventoried and included in a database with description, location, standard conditions envisaged and key performance indicators• Provided with technical instructions for maintenance
CONSTRUCTION
<ul style="list-style-type: none">• Correctly constructed and installed according to the plan, or adapted to new constraints or site conditions• Made of durable, sustainable materials• Constructed and installed in a way that allows efficient maintenance at reasonable cost
OPERATION
<ul style="list-style-type: none">• Undertake inspection, maintenance and monitoring• Adapt maintenance to variation in conditions and recorded results• Disseminate knowledge and 'lessons learned' to improve future ecological asset design, construction and maintenance

2.2 Continuous improvement of maintenance practice

Successful maintenance strategies for ecological assets should be developed following a PDCA (Plan-Do-Check-Act) approach (see Figure 1).

To apply this adaptive strategy approach in ecological asset maintenance is particularly important due to temporal variation in species and ecosystems and increasing extreme events related to climate change.

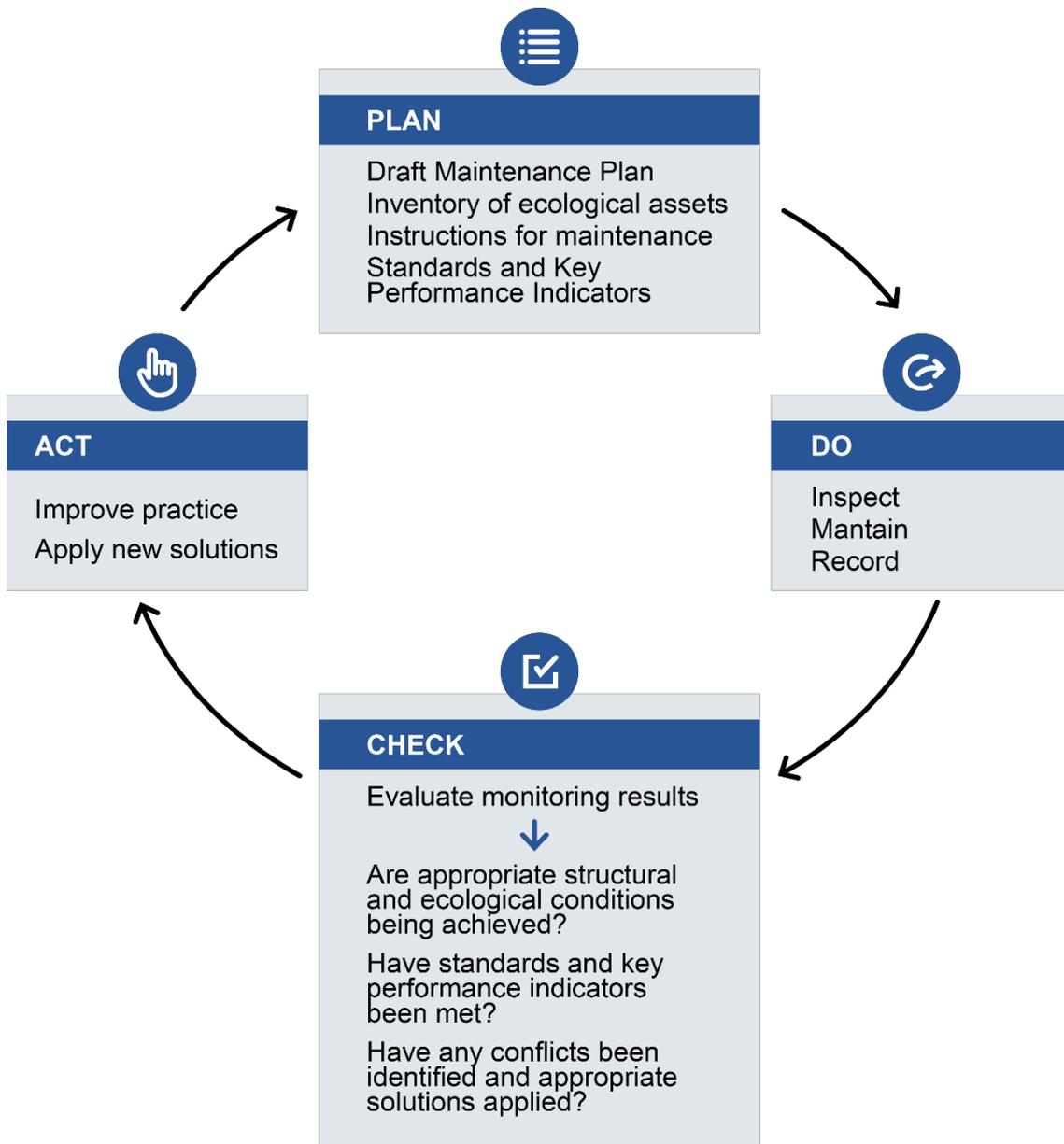


Figure 1. PDCA (Plan-Do-Check-Act) to be followed for the development of ecological asset maintenance during the operation phase.

2.3 Scope and aspects to be included in tenders and contracts

The scope of ecological asset maintenance plans depends on each situation and conditions. It could refer to:

- A whole regional or national transportation infrastructure network (it should be included in general maintenance guidelines).
- A single road or railway
- A single asset (such as a large landscape/green bridge, or a pond managed to enhance wildlife).

Operation and maintenance contracts are key tools to guarantee good practice. A detailed description of ecological asset maintenance SMART objectives (Specific, Measurable, Achievable, Relevant and Time-bound), standards and Key Performance Indicators (KPI) along with inclusion of suitable ecological capability within the maintenance team are requirements that should significantly improve practice. PPP (Public Private Partnership) operation and management contracts are particularly important because they are in force for long periods (decades). To establish objectives, standards and KPIs to be achieved are better than focusing on a description of tasks to be undertaken, because tasks may need to be adapted to potential new conditions.

2.4 Steps to develop the ecological asset maintenance plan

The maintenance plan should be developed following the steps shown in Figure 2.

Main steps to design and develop an ecological asset maintenance plan

Step
1

Define elements to be maintained

Identify the ecological assets that require maintenance guidelines

Step
2

Compile and organize information

Update infrastructure asset databases including information on Ecological assets to be inspected and maintained

Step
3

Draft maintenance plan

Draft maintenance plan in accordance with specific guidelines and standards including risk assessment and setting priorities

Step
4

Apply a cooperative approach

Identify mechanisms to engage and share information with stakeholders to improve maintenance and monitoring practice

Step
5

Implement training

Establish training programmes for technical staff and field crews about ecological asset maintenance

Step
6

Monitor, evaluate and report

Monitor the performance of ecological asset maintenance and produce progress reports which compile outcomes

Step
7

Adapt maintenance according to results

Modify maintenance guidelines according to evaluation results and lessons learned

Figure 2. Main steps to design and develop an ecological asset maintenance plan.

Step 1 – Define elements to be maintained

The first step to develop a maintenance plan is to identify the ecological assets that require specific maintenance guidelines. At minimum the following elements should be included:

- [Wildlife fences and screens \(see 3.2\)](#)
- [Wildlife crossing structures \(see 3.3\)](#)
- [Wildlife warning signs \(see 3.4\)](#)
- [Verges and other green areas \(see 3.5\)](#)
- [Ponds and other drainage elements \(see 3.6\)](#)
- [Animal-vehicle collision management \(see 3.7\)](#)

Step 2 – Compile and organize information

To correctly implement a maintenance plan, all information relating to ecological assets must be compiled and organised. Existing infrastructure databases should be updated to include ecological asset information.

Online databases will allow easy access to the information and give better notice about scheduled actions to be undertaken. Remote sensing and new technologies will allow easier checking and supervisor control. When a recorded parameter is not in line with the standard conditions or corrective measures are required, alerts could be provided. Contents to be included in inventories of ecological assets are shown in Table 3.

Table 3. Main ecological asset features to be included in infrastructure databases (it is recommended that online GIS databases are used).

TOPIC
Fields to be included in the ecological asset database
CODE, DESCRIPTION AND LOCATION
<ul style="list-style-type: none">• Location (accurate GPS coordinates).• Features to be recorded vary depending on the element. Consider including dimensions, shape, construction materials; features of the soil, vegetation, animal refuges, etc. (in case of verge management); features of slopes, water quality, etc. (in case of retention ponds). See Appendix 1 Example of a wildlife crossing description form .
GOALS, ECOLOGICAL FUNCTIONS AND STANDARDS
<ul style="list-style-type: none">• Identification of target species or habitats that will benefit from measures.• Ecological function to be achieved.• Technical specification and standards to be met.• Thresholds and deviations that will trigger corrective measures to be established
ACTIONS TO UNDERTAKE
<ul style="list-style-type: none">• Schedule for maintenance activities (including inspection tasks).• Instructions for actions to be undertaken.• Record of actions undertaken.

Step 3 – Draft maintenance plan

The maintenance plan is the basic document which describes objectives and actions to be undertaken. As mentioned in [section 1.2.2](#) the scope of the plan can vary largely, from the whole transportation network in a country or region, to a single ecological asset.

Main contents to be included in an 'Ecological asset maintenance plan' are listed in Table 4.

Table 4. Main contents to be included in an Ecological asset maintenance plan.

TOPIC Contents to be included in an ‘Ecological asset maintenance plan’
GENERAL INFORMATION ON ECOLOGICAL CONTEXT
<ul style="list-style-type: none"> • Description of landscape, ecosystems, and target species. • Natural Protected Areas. • Ecological connectivity. • Main constrains and ecological hazards (invasive alien species, forest fires, flooding, etc). • Main potential benefits for biodiversity.
GENERAL POLICY AND LEGAL OBLIGATIONS
<ul style="list-style-type: none"> • Legal obligations to be met. • Description of general policies. • General goals to be achieved.
ECOLOGICAL ASSET INVENTORY AND GUIDELINES FOR MAINTENANCE
<ul style="list-style-type: none"> • Inventory and description of all elements to be maintained (see Step 2). • Concise description and schedule for inspection and maintenance for each element according to local conditions. • Thresholds and procedures for identifying conflicts or deviations from standards with procedures to implement corrective measures.
ANIMAL-VEHICLE COLLISIONS MANAGEMENT
<ul style="list-style-type: none"> • Instructions to record and analyse data on AVC (methods for identifying ‘hot spots’). • Instructions for carcass recovery and management. • Thresholds and procedures to implement corrective measures.

Appropriate inspection and regular maintenance should guarantee the performance of the ecological assets and reduce the need for future ‘responsive maintenance’ (corrective measures) and investments required to restore ecological function. Tasks to be described include:

- Periodical inspections to check the appropriate state of the elements and managed areas and to test proper functioning of any device.
- Repair or replace damaged elements.
- Prepare soils, manage vegetation, guarantee appropriate water management on drainage elements, remove undesired materials, apply procedures to detect and remove invasive alien species (IAS), and other activities needed to maintain appropriate ecological conditions in green areas, ponds and other aquatic or terrestrial habitats.
- Collect and provide appropriate management of animal carcasses after traffic collisions, record and analyse data allowing the implementation of corrective measures to avoid future accidents.

- Monitor tasks to assess the functionality and effectiveness of measures and actions undertaken (evaluating the achievement of standards and KPI) and compliance monitoring.
- Detect deviations and conflicts (mortality of fauna observed in any section or element of the infrastructure, wildlife crossing not being used by target species, etc.) and develop procedures to apply corrective measures ('responsive maintenance').

Step 4 – Apply a cooperative approach

Road and railway authorities should provide platforms for cooperation with environment, water and land authorities, as well as regional and local stakeholders. Table 5. shows each stakeholder's main concerns. Contracts, agreements and regular stakeholder meetings are some tools to establish cooperation.

Table 5. Stakeholders who may be involved in maintenance of ecological assets in transport infrastructure.

STAKEHOLDERS

Topics of concern for cooperation

ENVIRONMENTAL ADMINISTRATIONS

- Target and priority species and habitats, Natural Protected Areas, ecological corridors, and other elements of the Green Infrastructure
- Biodiversity strategies plans and regulations that affect particular areas, habitats or species
- Cooperation in wildlife mitigation measures maintenance (such as wildlife crossings or restored habitats)

WATER ADMINISTRATIONS

- Extreme weather events that are expected to increase in the context of climate change and affect the infrastructure's resilience and particularly ecological asset management
- Drainage system (culverts, ditches and ponds) management according to the surrounding aquatic habitats
- Provision of valuable habitats for aquatics species (adapted ponds) and opportunities for wildlife crossing (drains adapted to use by wildlife)

LAND-PLANNING ADMINISTRATIONS

- Regulating land use in areas adjacent to wildlife crossings and other transport infrastructure habitats managed to enhance wildlife conservation.
- The maintenance of ecological corridors in the hinterland which are crucial to connect wildlife crossings to natural areas.

LOCAL ADMINISTRATIONS

- The possible engagement of local organisations and citizens in ecological asset maintenance and monitoring.

LANDOWNERS, FARMERS, HUNTERS AND RESEARCH, NATURE AND LAND STEWARDSHIP ORGANISATIONS

- Cooperation in wildlife mitigation measures maintenance (such as wildlife crossings or restored habitats).
- Cooperation in monitoring of ecological assets, target species or habitats around transport infrastructure.
- Help to collect information on animal-vehicle collisions and management of injured or dead fauna.

Step 5 – Implement training

An ecological asset maintenance training programme should provide essential information to technical staff and field crews which improves the daily practice of ecological asset maintenance operations (see [Box 1](#)).

BOX 1 Requirements to develop a training programme

- Define purpose, goals and target audience.
- Set a training curriculum suitable for each staff (technicians, field crews, etc.).
- Identify topics and staff needs.
- Schedule regular training seminars to update knowledge including field trips and practical training.
- Develop participative seminars to gather information from field crews and technical maintenance staff and learn from it.
- Provide specific training materials such as ‘toolbox’, sheets and field guides to identify species.
- Apps and websites could be envisaged as a useful tool allowing a continuous knowledge and procedures update.
- Choose trainers who combine teaching skills, expertise on wildlife and a good comprehensive knowledge of road and railways operations as required.

The main target audiences and contents to be provided are:

- To field crews and technical maintenance staff
 - Basic ecological concepts and goals for wildlife mitigation measures
 - Basic knowledge about target flora and fauna species
 - To understand importance of being alert for detecting and eradicating IAS
 - How to develop wildlife-related maintenance actions and provide appropriate conditions in green areas and aquatic habitats associated with drainage elements.
 - How to use devices and apply methods for recording wildlife information.
 - To learn about ecological traps and how to identify them.
- To transport authority staff
 - Increase ability to assess compliance with the standard required, according to the infrastructure’s ecological asset maintenance plan.
 - Understand the role of maintenance and traffic regulations in road traffic accidents involving wildlife, disturbance mitigation measures and data registration of these events.
- To transport infrastructure planners
 - Incorporate ecological assets and wildlife mitigation measures into new transport infrastructure, taking account of lessons learned from monitoring undertaking by the infrastructure operators.

Step 6 – Monitor, evaluate and report

Regular inspection tasks undertaken by maintenance teams aim to check that each mitigation measure is operating in accordance with the specified standards, legal or regulatory requirements established in the maintenance plan, and also to identify conflicts that require new corrective actions to restore appropriate performance.

The monitoring and evaluation described here is quite distinct from expert ecological monitoring to evaluate if ecological goals have been reached and maintained long term. This requires developing specific methodologies that should be designed and applied by experts. Such ecological monitoring is addressed in [WT Handbook Chapter 9](#).

Inspection actions to be undertaken by maintenance crews are described in factsheets (see 1.3 to 1.7). Some examples are:

- To inspect for damage in fencing, screens, signs, etc.
- To ensure materials are maintained in good condition
- To check that electronic devices are functioning correctly (e.g. sensors and signs activated by ADS)
- To detect any inappropriate material or use (e.g. debris or human uses) non-compatible with functions or performance of the ecological assets.
- To check if any animal is trapped or has died in any element of the infrastructure (e.g. fish in retention ponds, birds in the base of the screens, etc.)
- To check if the vegetation status is correct and no IAS are detected.
- To check water quality in ponds, verify that no animals are found dead or trapped and no IAS are detected.
- To identify hot spots of road mortality where animal carcasses are removed frequently.

All data must be recorded in a standardised way and integrated in databases established in the maintenance plan to allow proper analysis and assessment so should be readily accessible to all concerned parties (see Step 2).

Producing regular comprehensive internal reports (annually or more frequently) would play a crucial role in improving future maintenance practice and even bettering design and construction (see [Box 2](#)). Reports should identify conflicts and suitable corrective measures and would be useful to develop alternative good practice, to share relevant information with stakeholders and to encourage innovation.

At periodic intervals (e.g., 5 years), the ecological asset maintenance plan should be reviewed taking account of all improvements, new technologies and solutions identified. This wider perspective on performance and results will help guarantee continuous improvement of the practice.

BOX 2

Questions to be answered in maintenance reports

- What have we done?
- What is effective or even better than anticipated?
- What problems have we found in applying maintenance guidelines?
- What failures have we detected in wildlife mitigation measures?
- Which unforeseen conflicts with fauna occurred?
- Which solutions and innovative ideas can be provided to solve them?

Step 7 – Adapting maintenance according to results

Evaluation of ecological asset maintenance practice will optimise cost-effectiveness and lead to continuous improvement and identification of best maintenance practice.

Where deviations or conflicts are identified, corrective measures should modify current practices or apply innovative solutions. Appropriate assessment by wildlife experts will verify these modifications and solutions.

Examples of improvements are:

- If wildlife damage to fences or other wildlife mitigation measures and the species responsible for the problem are identified, reinforcements or solutions can be designed.
- Vandalism or theft of elements of ecological assets will lead to more resistant designs or materials that can be introduced along with other methods to avoid damage in the future.
- Impediments to maintenance of wildlife mitigation measures (e.g., designs that prevent access for maintenance; vegetation planted in a way that can potentially damage fences; ponds that cannot be cleaned with proper fauna rescue) will lead to solutions to avoid this in the future.

Handbooks on mitigation techniques and the cooperation of wildlife experts and other stakeholders can help to define solutions to recurring conflicts. On the other hand, disseminating information about failures and successful solutions could help to improve future practice in design, construction and maintenance of ecological assets

3. Maintenance requirements for ecological asset and wildlife management

3.1 General recommendations

Maintenance practice for each ecological asset should be based on guidelines included in maintenance plans (see [section 2.4](#)) and are summarised below.

- **Perform a detailed inventory** of elements to be inspected and maintained, including it a **GIS database**. Include data about geolocation, features (dimensions, materials, etc.) as well as targets, standards and goals to be met. All information recorded in the inspections and maintenance tasks should be comprehensively recorded in the database, which should also have scope to record any particular incident and/or modification to resolve problems or conflicts. All elements of each asset should be included in the inventory and the maintenance plan
- **Undertake the inspection and maintenance tasks** for each element according to the infrastructure plan and respective national guidelines and standards.
- **Schedule the inspection and maintenance tasks** appropriately to keep to specifications provided by designers and constructors, and according to weather events, biological events (e.g. seasonal migration or periods when target species movements are increased; seek wildlife expert assistance for schedules of target species) or any extraordinary event, such as infrastructure maintenance works.
- **Set the general qualitative or quantitative standards to be met**, according to target species, for all components of each ecological asset.
- **Establish and apply procedures for identifying conflicts or deviation from standards** and how to resolve them: repair, reinforce or replace.
- **Develop appropriate training** for maintenance staff and field crews.
- **Monitor, evaluate and report successes, needs and conflicts** experienced during maintenance, in order to correct deviations and include this information in future plans.
- **Modify the maintenance practice and plan** according to results, information gathered and any species creating conflicts or experiencing negative effects. Define and schedule additional actions if conflict increases or expands.

The overall guidelines for inspecting, preserving, and improving each asset are provided in the following sections and specific descriptive task sheets are included in [section 4](#).

3.2 Maintenance of wildlife fences and screens

Well designed, installed and maintained, fences prevent wildlife getting onto roads and railways, reducing roadkill and road traffic accident risks. Fences must also guide animal movements towards entrances of fauna passages or any transversal crossing structures.

Screens are installed to reduce disturbances from traffic (light or noise) at wildlife passages or on road stretches with sensitive adjacent habitats. They may also help funnel bird and bat flight to suitable crossing structures. In all cases they must be clearly visible to avoid bird collisions.

Wildlife fences and screens must be regularly inspected and maintained to ensure their long-term performance. Repeated damage by fauna or vandalism at particular locations could require a change of design.

All fencing components (mesh, wires, poles, escape devices and cattle grids, where applicable) and all type of screens (e.g. noise barriers, and screens to funnel bird and bat flight) should be included in the inventory and the maintenance plan.

The following descriptive maintenance task sheets are provided in [section 4](#).

[Maintenance of fencing: meshes and poles](#)

[Maintenance of fencing: escape devices](#)

[Maintenance of cattle grids](#)

[Maintenance of screens](#)

[Maintenance of amphibian/small fauna fences](#)

3.3 Maintenance of wildlife crossing structures

Wildlife crossings (also named fauna passages) are transversal structures located under or over the linear transport infrastructure constructed or modified to provide safe crossing points for animals and/or to connect habitats on both sides of the linear infrastructure. Main types of wildlife crossings are:

- Ecoducts (green/landscape bridges)
- Wildlife and multiuse overpasses
- Canopy bridges (tree-top overpasses)
- Viaducts
- Wildlife and multiuse underpasses
- Modified culverts
- Amphibian tunnels

Wildlife crossings must be regularly inspected and maintained to ensure their long-term performance. Structural points as well as ecological features related to soil, vegetation, wildlife refuges or human uses could have a major effect on fauna passage effectiveness and must be appropriately maintained. Land uses and environmental changes in adjacent areas may also radically modify their use by wildlife.

All types of wildlife crossing, including under and overpasses and culverts modified to enhance wildlife use should be included in the inventory and the maintenance plan. Maintenance tasks may vary widely according to the type of structure and must be based on standards provided in the project (see [Box 3](#)).

Some passages are specific for wildlife, while others are multiuse and combine wildlife crossing with drainage, cattle routes, pedestrian paths, or even low-intensity traffic roads. Cooperation with water, environmental and land planning authorities, as well as other local stakeholders, is crucial to guarantee their conservation and could assist in reducing maintenance costs.

Special structures, such as big landscape bridges (ecoducts), could require particular management involving local stakeholders. Those structures located in Natural Protected Areas, ecological corridors or with endangered target species should be prioritised and will require additional ecological monitoring by wildlife experts to verify the achievement of their goals.

The following descriptive maintenance task sheets are provided in [section 4](#).

[Maintenance of ecoducts, wildlife and multiuse overpasses](#)

[Maintenance of viaducts, wildlife and multiuse underpasses](#)

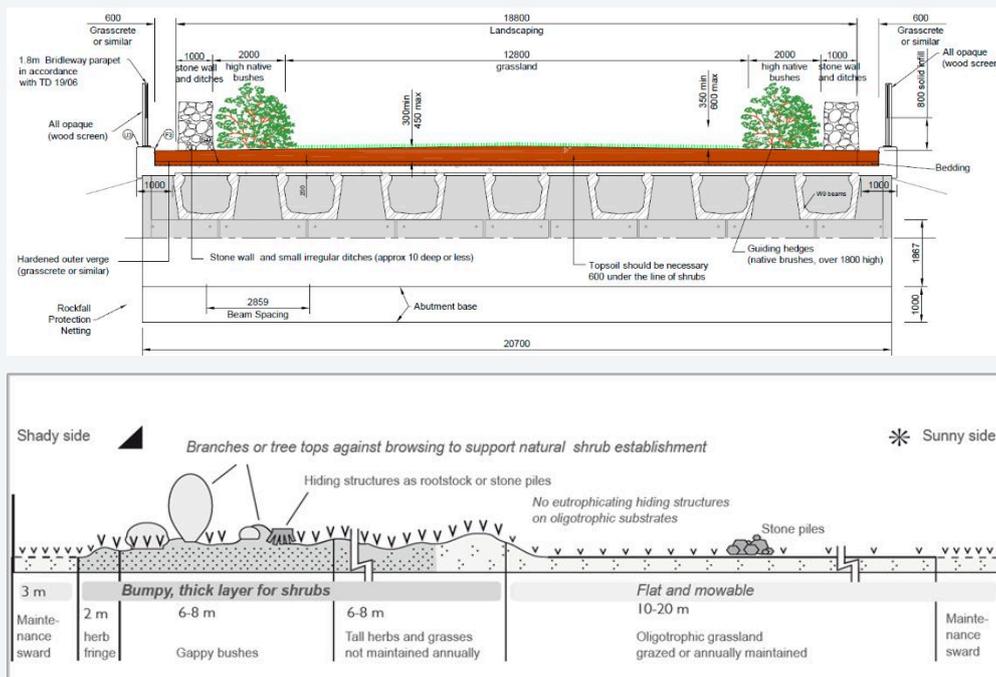
[Maintenance of modified culverts](#)

[Maintenance of amphibian tunnels](#)

BOX 3

Standards to be met must be provided in wildlife crossing projects

Maintenance tasks should be defined to achieve the standards and functions provided in wildlife crossing projects. This example shows a pair of structure plans that set the conditions to be achieved and guaranteed by good maintenance tasks.



Source: Ferrovial-Minuartia; Heinrich Reck.

3.4 Maintenance of wildlife warning signs

Wildlife warning signs aim to prevent AVC by influencing driver awareness and behaviour. The effectiveness of signs reduces if drivers become accustomed to them and don't heed the warning. This problem arises when wildlife warning signs are overused or are not adapted to hazardous road sections. To solve these problems, road operators use various types of awareness signs, and complement them with reinforced warning messages such as reflective or illuminated panels, temporary signs activated only during conflictive periods, or those activated by Animal Detection Systems (ADS).

Appropriate maintenance of all types of wildlife awareness signs (standard, reinforced, temporary or activated by ADS) to ensure they function correctly is crucial to maintain their effectiveness. The correct location of signs corresponding to conflictive road sections identified is also a key factor.

Activities must not only include inspecting, cleaning and repairing signs, but also the maintenance of electric and electronic components including sensor and energy supply elements. Relocating or even removing wildlife warning signs to adapt them to the AVC hotspots location is also part of the maintenance tasks.

Maintenance practice should be modified according to the results and information gathered. A periodic expert evaluation of AVC hotspots (see 3.7) is particularly important to determine if wildlife awareness signs are correctly placed or should be moved. Removal of signs should also be considered where there is no AVC risk in order to maintain the overall consistency of risk mitigation and to avoid drivers becoming desensitised to signs.

The effectiveness of wildlife awareness signs in announcing locations of risk may be enhanced by awareness campaigns organised to help drivers understand conflict and adapt their driving behaviour. The use of GPS apps which alert the location of wildlife awareness signs will also reinforce the understanding of the hazard and make drivers slow down.

The following descriptive maintenance task sheets are provided in [section 4](#).

[Maintenance of wildlife awareness signs](#)

[Maintenance of signs activated by Animal Detection Systems](#)

3.5 Maintenance of verges and other green areas

The main goal for road verges and medians management is to meet standards for road safety. However, most of these elements can also provide aesthetic landscape value and habitats for wildlife. These green areas, including resting areas and other landscaped zones, help enhance Green Infrastructure when they are managed to promote and sustain benefits to biodiversity. Two basic principles apply when enhancing habitats for wildlife:

- Legal obligations for wildlife conservation such as European Directives on Habitats and Birds, require that maintenance tasks do not injure, kill or disturb the breeding sites of endangered species ([see list](#)).
- Conflicts with traffic safety and the creation of 'ecological traps', attracting animals to areas with high mortality risk, must be avoided with expert help to carefully select the areas where biodiversity could be enhanced and those where wildlife access should be avoided.

Soil and vegetation management is key to attracting or deterring target species because wildlife habitats are defined by those elements. Landscaped green areas along transport linear infrastructure may have positive, neutral, or negative effects depending on how they are designed and managed.

Activities included in green areas maintenance are soil management, sowing, planting, mowing, pruning, replacement, removal and any other task needed to conserve or improve the green area habitats. Maintenance of structures that provide refuges to target species should also be included. A task schedule must be planned considering road safety, climate, soil and vegetation conditions and to provide a mosaic of habitats with different features where they are needed. The schedule must also be adapted to the life-cycles of wildlife target species to avoid any damage during breeding and hibernation periods.

Landscaped area maintenance should include the definition of sections to be managed according to different goals and functions (to reduce hazards to traffic, to enhance wildlife, etc.) identifying stretches that will require different conditions according to these (see [Box 4](#)). Conditions established by road and environment regulations must be considered.

Control of invasive alien species (IAS) is a key task to be developed and appropriate maintenance could also provide an essential ecological function in combatting the effects of climate change such as the risks of forest fire spread or flooding.

Site conditions such as weather, ecosystems and target species present in the area will have a strong influence on vegetation management. Cooperating with ecologists will help adapt guidelines in this document to local conditions.

Main aspects to be considered for verge and median biodiversity-friendly management are listed in [Box 5](#).

The following descriptive maintenance task sheets are provided in [section 4](#).

[Vegetation management](#)

[Maintenance of habitats for pollinators and other small fauna](#)

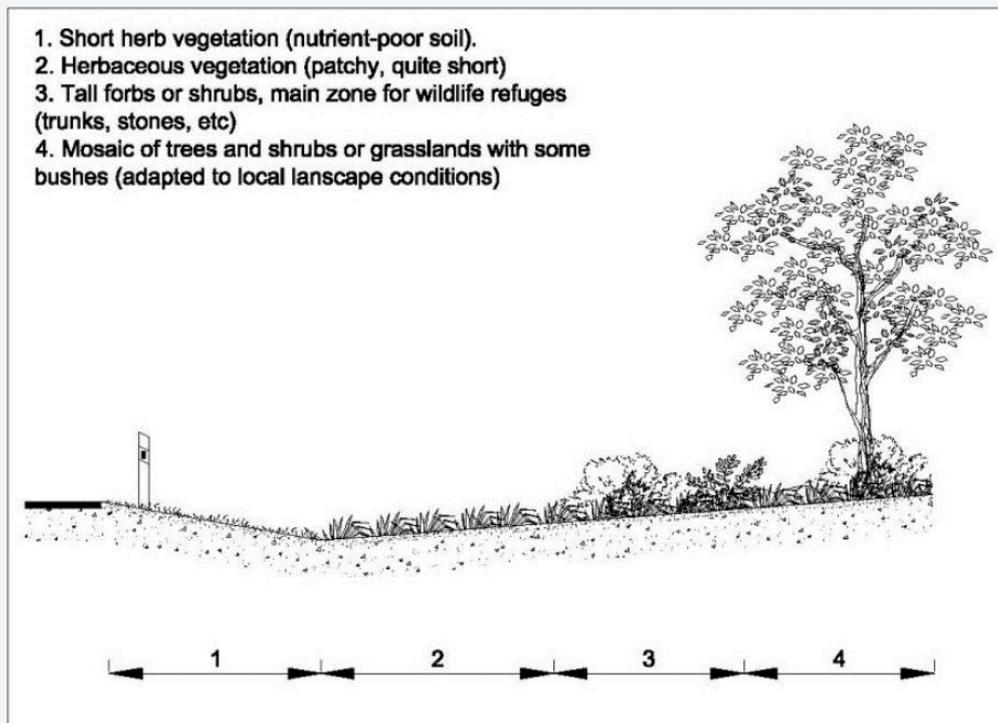
[Control of invasive alien species \(IAS\)](#)

[Reducing forest fire risk](#)

BOX 4

Sequence of road verge vegetation

A proposal for a sequence of verge vegetation management which takes into consideration traffic safety and wildlife habitat adaptation to reduce wildlife mortality risk. Recommendations must be adapted to local conditions and regulations.



Source: Heinrich Reck; Minuartia.

BOX 5

Best practice for verge and median maintenance

Basic principles

- Verges and medians play a basic role in road safety, which is always the priority factor. Benefits to biodiversity can be provided through an appropriate maintenance practice.
- Apply practice adapted to target species requirements at sections located in protected natural areas or others hosting priority habitats and species.
- Define procedures to detect and record threatened fauna and flora during the maintenance tasks.
- Apply early awareness measures to detect and eradicate invasive alien species. Do not introduce any invasive species in green area planting
- Avoid using pesticides and fertilisers. Apply biological control methods and consider soil replacement where vegetation overgrowth is presenting a potential conflict.
- Avoid creating 'ecological traps' where animals are attracted to places where they could become trapped with no possibility of exit, get injured or die.
- Consider providing habitats for small endangered fauna species avoiding attraction to hazardous areas where the risk of mortality may be higher.

Use suitable machinery

- Avoid machinery movement on verges as much as possible to avoid compacting and disrupting the soil.
- Provide mowing machines with digitalized maps indicating the location of sensitive road sections where specific maintenance tasks must be undertaken. GPS- and GIS- equipped mowing robots will improve nature friendly patch maintenance.
- At sensitive sites, use machinery suitable to reduce wildlife mortality or injury.
- Suction mowers are not recommended in sensitive sites and should be restricted to sites where grass could not be removed by other means.

Avoid attracting large animals

- Remove palatable vegetation such as trees and bushes producing large fruit and nutrient-rich grasses which attract deer, and avoid dense shrub vegetation that provide refuges for wild boar.
- Provide a large strip (approx. 3 to 5 m depending on the species, landscape and road speed limit) of poor soil with short grass, which widens the driver's field of vision and gives them opportunity to adapt their driving behaviour if an animal approaches.

Remove or modify any barrier that could increase wildlife mortality risk

- Replace or adapt any kerbs on roadsides and medians that create a barrier to small animals, stopping them getting off the road and causing an increase of mortality risk. Wildlife experts can advise about adaptation required according to target species.
- In critical road stretches with no perimeter fencing and high numbers of road casualties, consider replacing concrete safety barriers (New Jersey) which create difficulties for large animals to cross, by steel rope safety barriers.
- Modify gullies to avoid mortality of small animals where this has been recorded.

Apply gritting compatible with wildlife biodiversity

- Evaluate the use of calcium magnesium acetate as an alternative to sodium chloride to be applied in sensitive areas with endangered flora species.
- Gritting substances must be applied in a way that they do not spill over to immediately adjacent zone with grass.
- Prevent salty runoff from reaching retention ponds adapted to host wildlife or any other freshwater habitat.
- Prevent deer and other ungulates from accessing roadside salt depots.

3.6 Maintenance of ponds and other drainage elements

Drainage systems in roads and railways include perimeter ditches, retention ponds, culverts, and other transversal structures. Ensuring standards for water evacuation and road safety through drainage systems can be combined with enhancing biodiversity by providing habitats for wildlife. Ponds and ditches can host invertebrates and fish, attract amphibians to breed and provide shelter and food for insects, reptiles, mammals and birds. Two basic principles apply when enhancing aquatic habitats for wildlife:

- Legal obligations for wildlife conservation such as European Directives of Habitats and Bird, require that maintenance tasks do not injure, kill or disturb the breeding sites of endangered species ([see list](#)).
- Conflicts with traffic safety and the creation of 'ecological traps', attracting animals to areas with high mortality risk, must be avoided with expert help to carefully select the areas where biodiversity could be enhanced.

Drainage transversal structures such as culverts, open-span bridges and viaducts can also play a key role in ecological connectivity, providing links for wetlands, channels, rivers, and other aquatic elements of the Green Infrastructure. Drainage elements that can play a role as habitats for wildlife should be identified and specifications for management must be provided.

Maps of aquatic habitats in retention ponds, ditches and other elements of the drainage systems to be inspected and maintained, should be included in a GIS database. Management should be planned primarily to maintain the function of drainage and areas managed to enhance biodiversity should have particular specifications including standards to be met for all features in ponds and drainage elements (including water level variation, water quality, vegetation conditions, etc.).

Water, road and wildlife experts must work together to design successful drainage system maintenance practice.

Main aspects to be considered for drainage systems biodiversity-friendly maintenance are listed in [Box 6](#).

BOX 6

Best practice for drainage system maintenance

- Drainage plays a basic role in water evacuation and road safety which is always the priority factor.
- Modifying features of ponds or ditches to provide habitats for endangered aquatic and semi-aquatic species depends on the ability to provide adapted management which avoids any incidental damage or killing of protected species among invertebrates, fish, amphibians, reptiles and mammals such as otters and the critically endangered European mink (see Habitats Directive article 12.4).
- Avoid creating 'ecological traps' where animals are attracted to places where they could become trapped with no possibility of exit, get injured, poisoned or die.
- Define procedures to detect and record threatened fauna and flora during the maintenance tasks.
- Apply early awareness measures to detect and eradicate invasive alien species. Do not introduce any invasive species in ponds.
- Define procedures for pond's and drains cleaning adapted to target species requirements and planning fauna rescues beforehand if required.
- When ponds don't provide safe habitats for aquatic organisms due to pollutants, steep edges or very frequent cleaning requirements, prevent access for amphibians or other semiaquatic animals by installing appropriate fencing.

The following descriptive maintenance task sheets are provided in [section 4](#).

[Management of retention ponds to host wildlife](#)

See also

[Maintenance of viaducts, wildlife and multiuse underpasses](#)

[Maintenance of modified culverts.](#)

3.7 Animal-vehicle collisions (AVC) management

Road and railway traffic accidents involving large animals are increasing in many European regions. Removing carcasses is a significant task for maintenance crews, has health and safety implications and high economic costs. To appropriately record and analyse road traffic accidents involving animals is the basis for identifying hotspots of wildlife road mortality, factors increasing the risk, and the data thresholds at which action to reduce the AVC must be taken.

Investing in appropriate mitigation measures to avoid AVC is cost-effective practice in economic, social and environmental terms. A number of mitigation measures can be applied by road operators, such as improving or reinforcing fences, adapting existing transversal structures to be used by wildlife, and enhancing wildlife awareness signage based upon expert identification of conflict points and assessment of potential solutions.

AVC management should be based on the points listed below.

- **Develop practice based on instructions for the whole AVC management process** including searching, removing, recording data and undertaking regular expert analyses to determine conflictive road sections and take corrective action.
- **Define and apply procedures for removal and destruction of carcasses**, or any other treatment according to national legislation. Be aware that some animal health regulations could require specific management of carcasses, e.g. strict biosafety conditions exist for wild boar carcass management in regions affected by African Swine Fever.
- **Use a system to record roadkill data** which allows mitigation measures to be defined from the information (see [Box 7](#)). The data recorded from field crews collecting carcasses provides the key basic information. Periodic additional surveys conducted by wildlife experts are needed in sensitive areas crossing habitats with high risk of mortality of small animals (protected areas, river crossings, wetlands, etc.) which are not recorded during regular crew patrolling.
- **Provide field crews with procedures and appropriate devices for accurately recording carcasses collected.** Other stakeholders may also provide data such as police, traffic authorities, conservation organisations, hunters, etc.
- **Define and apply user friendly procedures for recording data about each animal carcass**, which include time (date and hour), location (road code, coordinates of the point) and details about the animal (species, sex and age class: adult or juvenile) if known. Local conditions related to the infrastructure or the landscape which help understand why the accidents occur should also be recorded.
- **Develop appropriate training** for maintenance staff and field crews on data collection and carcass management (see [section 2.4](#); step 5) including guides to identify the species.
- **Undertake regular analyses of the data collected to identify road mortality hotspots**, to be undertaken by experts (see [Box 8](#)).
 - Define the problem: numbers, most affected species, most conflictive periods, etc.)
 - Apply road accident clustering methods to identify sections where AVC are more frequent, e.g. KDE+ or any other which has the possibility to define a frequency threshold goal.
 - Identify where, when and why accidents cluster using location-specific data as a basis for the definition of appropriate solutions.

- **Set the general qualitative or quantitative standards to be met and thresholds of AVC frequency** which can vary widely depending on target species and their numbers in the area. This permits identification of priority road sections where thresholds are breached and appropriate mitigation measures must be taken.
- **Monitor, evaluate and report successes, needs and conflicts** experienced during the management of wildlife road mortality, in order to include this information in future plans.
- **Modify the maintenance plan and undertake corrective actions** according to results and information gathered and to target species most frequently road killed. Define and schedule additional actions to reduce conflicts (fencing combined with fauna passage, modification of verge and median conditions, etc.) if conflict increases or expands.

The following descriptive maintenance task sheets are provided in [section 4](#).

[Management of road killed animals](#)

[Management of animal-vehicle collisions \(AVC\) data](#)

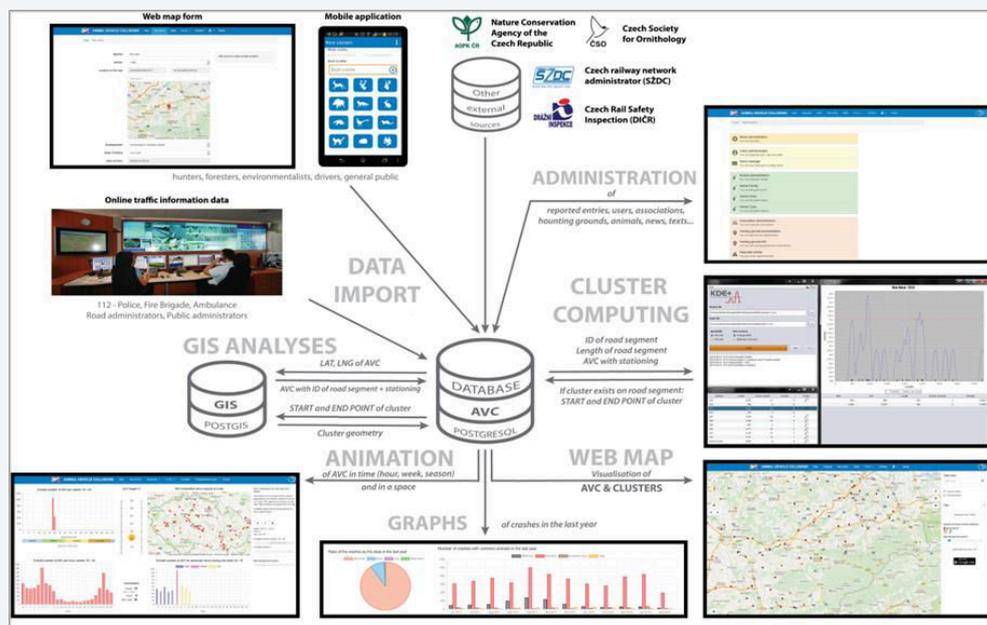
BOX 7 Animal-vehicle collision registration system

Elements to be included in the AVC registration system

- A spatial database.
- A website for data management.
- A mobile application for data capturing in the field.

Ad-hoc systems can be developed, or an existing one can be modified to suit. Off-the-shelf systems can be bought from developers.

An example of an AVC reporting system is shown below. Data enters the system from various sources. It is stored in a spatial database and analysed online using predefined scripts. Data can be viewed on a website together with AVC hotspots. The website is used by system administration and road operators.



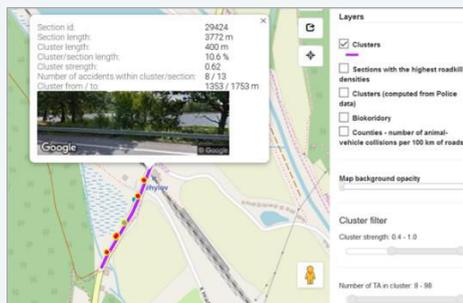
Source: CDV-Transport Research Centre. www.srazenazver.cz/en/

BOX 8

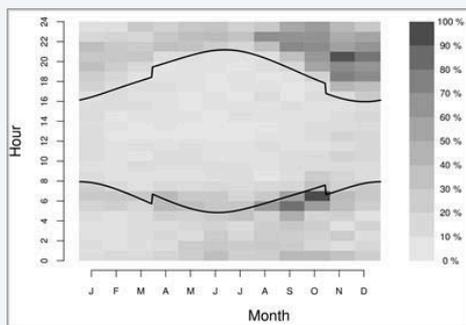
Data analyses to identify local factors which influence AVC hotspots and design mitigation measures

The following steps should be carried out to identify AVC hotspots, local factors causing roadkill clustering and appropriate mitigation measures:

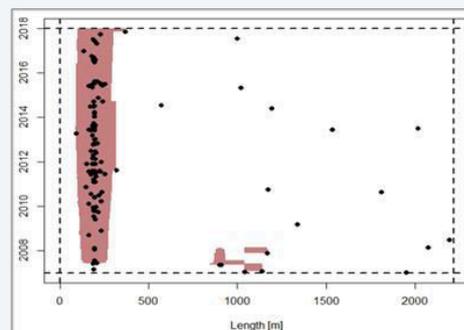
- 1) Prepare AVC roadkill database and link it to road maps.
- 2) Provide maps identifying single AVC events and AVC hotspots by using software which can define a frequency threshold goal and rank hotspots according to cluster strength, such as KDE+.
- 3) Determine factors influencing wildlife mortality clustering (generally and for target species or groups) by applying appropriate statistical analyses. Comparisons between environmental, road and other factors for both AVC hotspots and individual AVC events must be produced. The most hazardous hotspots could require inspection by experts to investigate causes.
- 4) Based on data analysis results, select the most suitable mitigation measures according to road type and species involved. Use expert advice and consider up-to-date scientific literature and technical guidelines to ensure that effective measures are implemented and monitored.



An example of a map with an AVC hotspots which can then be investigated.



An example of wild boar roadkill data. A high number of roadkill is recorded in the autumn before sunrise and after sunset.



An example of spatio-temporal analysis of AVC data which shows a hotspot stable over time, where mitigation measures should be applied.

Source: CDV-Transport Research Centre.

4. Maintenance tasks sheets

The ecological assets where specific maintenance guidelines apply are listed below with guidelines provided in the following sheets.

1. Wildlife fences and screens

1.1 Maintenance of fencing: meshes and poles

1.2 Maintenance of fencing: escape devices

1.3 Maintenance of cattle grids

1.4 Maintenance of screens installed to reduce disturbances

1.5 Maintenance of amphibian/small fauna fences

2. Wildlife crossing structures

2.1 Maintenance of ecoducts, wildlife and multiuse overpasses

2.2 Maintenance of viaducts wildlife and multiuse underpasses

2.3 Maintenance of modified culverts

2.4 Maintenance of amphibian tunnels

3. Wildlife warning awareness signs

3.1 Maintenance of wildlife awareness signs

3.2 Maintenance of signs activated by Animal Detection Systems (ADS)

4. Road verges and other green areas

4.1 Management of vegetation

4.2. Management of habitats for pollinators and other small fauna

4.3. Control of invasive alien species (IAS)

4.4. Management of verges to reduce forest fire risk in sensitive areas

5. Ponds and other elements of drainage systems

5.1 Management of retention ponds to host wildlife

6. Animal-vehicle collisions management

6.1 Management of road killed animals

6.2 Management of animal-vehicle collisions (AVC) data

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Maintenance of fencing: meshes and poles



INSPECTION TASKS To check

- Poles are well-fixed to the ground and stable.
- Mesh is not broken or deformed.
- Mesh is well-fixed to the ground or to the protection against digging.
- Mesh is well-fixed to the crossing structure walls or to screens.
- Reinforcing mesh is well-anchored to the main mesh.
- Intersections of fences with perimeter drainage ditches are well-protected to stop animals from entering.
- Branches or other vegetation elements are not damaging the fence.



SPECIFIC MAINTENANCE TASKS To do

- Change any pole that is broken or damaged and fix any unstable posts.
- Repair or replace broken or deformed meshes. Replace any anchorages to fix the mesh to the poles and/or to the ground that are corroded or broken.
- Install reinforcement meshes or protection against digging by wild boar, rabbits or other target species when required. Anchor reinforcing elements to main fence and bury their bottom section into the ground.
- Consider replacing the existing fence when its design or materials are inappropriate, and it requires considerable effort and cost to maintain.
- Restrict access and/or educate and inform local stakeholders in case of repeated damage caused by people.
- Regularly mow and prune bushes or tree branches to avoid fence damage. Maintaining a narrow corridor along the fence free of trees and bushes allows field crews to undertake maintenance tasks.



SCHEDULE

- Minimum: once a year, just before seasonal migrations or periods when target species movements are increased.
- Mowing and pruning vegetation should be scheduled according to local conditions.
- More frequent inspection may be required in sections that are repeatedly damaged.
- Additional inspections should be planned following floods, strong winds, snow or other adverse weather events.



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Maintenance of fencing: escape devices



INSPECTION TASKS To check

- Elements are not broken or deformed.
- Devices are not blocked by sand, rocks or vegetation.
- Gate closes tightly.



SPECIFIC MAINTENANCE TASKS To do

- Provide adequate maintenance of materials to ensure that escape gates close tightly. Apply anti-rust coatings and oil to the gate hinges.
- Remove rocks, sand or woody debris which could stop the gate from closing.
- Maintain vegetation or install additional components to guide animals through the exit from the inside. Maintain the exterior free of vegetation or any material that can obstruct the gate.
- Escape ramps require additional maintenance for wood, wire or any other material used in ramp construction.
- Consider removing escape devices if they cannot be maintained appropriately.



SCHEDULE

- Minimum: once a year, just before seasonal migrations or periods when target species movements are increased.
- More frequent inspection may be required in sections that are repeatedly damaged.
- Additional inspections should be planned following floods, strong winds, snow or other adverse weather events.



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Maintenance of cattle grids



INSPECTION TASKS To check

- Elements are not broken or deformed.
- Ditches underneath are not overfull of sand.
- Cattle grid completely bridge the gap between each end of the fence
- Escape ramps from ditches are free of obstacles.



SPECIFIC MAINTENANCE TASKS To do

- Regularly clean the ditch removing accumulations of rocks, sand or woody debris.
- Ensure grids are kept in good condition. Replace if needed.
- Remove any object placed on the ditch escape ramps that could prevent small fauna escaping if they fall into the ditch.



SCHEDULE

- Minimum: once a year, just before seasonal migrations or periods when target species movements are increased.
- More frequent inspection may be required in sections that are repeatedly damaged.
- Additional inspections should be planned following floods, strong winds, snow or other adverse weather events.



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Maintenance of screens installed to reduce disturbances



INSPECTION TASKS To check

- ❑ Components are not broken and have no gaps (different requirements for wood, concrete or polymer screens).
- ❑ Screens are correctly fixed to perimeter fences, maintaining continuity.
- ❑ For transparent screens, check appropriate marks have been installed to avoid bird collisions and that mortality is not apparent.
- ❑ If screens are designed to guide bat flight across the linear infrastructure, inspection should be provided according to the specific standards.



SPECIFIC MAINTENANCE TASKS To do

- Repair or replace any element that is broken or damaged.
- Install anti-vandal reinforcements to prevent wooden planks from being stolen.
- Consider replacing an existing screen when its design or materials are inappropriate, and maintenance costs rise.
- Reinforce the anchorage to the ground or to the perimeter fences when required.
- If any bird collisions are detected, mark transparent screens with coloured stripes according to the specific standards to ensure visibility to birds.
- Restrict access and/or educate and inform local stakeholders in case of repeated damage caused by people.



SCHEDULE

- Minimum: once a year, just before seasonal migrations or periods when target species movements are increased.
- More frequent inspection may be required in sections that are repeatedly damaged.
- Additional inspections should be planned following floods, strong winds, snow or other adverse weather events.



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Maintenance of amphibian/small fauna fences



INSPECTION TASKS To check

- Components of the guiding fences are not broken.
- Components are well-fixed to the ground.
- There is good continuity between the ends of the fence and entrances to amphibian passages.



SPECIFIC MAINTENANCE TASKS To do

- Maintain a corridor free of bushes, high grasses, rocks or sand along the fence.
- Replace inappropriate wire mesh with an opaque fence to ensure effectiveness and avoid trapping amphibians. Cover gullies and eliminate any other trap where small animals can fall.
- Repair any discontinuities between the fence and the entrances to the passage.
- Fences made of synthetic polymers, wood or similar materials require more frequent inspections than metal fences or concrete walls.



SCHEDULE

- Minimum: once a year, just before seasonal reproductive migrations or periods when target species movements are increased.
- More frequent inspection may be required in sections that are repeatedly damaged.
- Additional inspections should be planned following floods, strong winds, snow or other adverse weather events.



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Maintenance of ecoducts, wildlife and multiuse overpasses



INSPECTION TASKS To check

- Materials and drainage of the surface are appropriate.
- No human misuse of the structure is found.
- In multiuse overpasses, provisions to make human and wildlife uses compatible (guiding fences, informative panels, etc.) are appropriately maintained.
- Fences are continuous and anchored to wildlife crossing entrances or to lateral screens.
- Any components of the screen remain stable and have not been damaged or stolen, and that there is good continuity with fences.
- Vegetation height, composition and patch design is consistent with the standards.
- No Invasive Alien Species are found.
- No debris or other objects pose obstacles or prevent the appropriate use of the wildlife crossing.
- Any refuges for fauna such as stumps or stone rows are in good condition and in accordance with standards provided.



SPECIFIC MAINTENANCE TASKS To do

Structural features and uses

- Maintain or restore entrance areas to ensure these are free of obstacles to fauna movements and appropriately connected with the surrounding habitats.
- Replace any elements damaged by vandalism.
- In wildlife overpasses where no human use is planned, maintain appropriate state of the structures located at the entrances to avoid access of people and vehicles (large rocks, tree trunks or any other barrier).
- Periodically clean, fix, repair or replace any informative panels and no entry signs.

Fences and screens > see Sheet 1

- Replace broken or deformed meshes and repair any damage on screens.
- Reinforce the anchorage of the mesh to the ground and poles when needed. If a reinforced mesh is already present, ensure it is well attached to the lower part of the fence.



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Maintenance of ecoducts, wildlife and multiuse overpasses

SPECIFIC MAINTENANCE TASKS To do

Vegetation and fauna refuges > see Sheet 12

- Undertake mowing, pruning and other vegetation management according to standards provided.
- Prune bushes and trees beside fences and screens to avoid damage.
- Remove debris created by vegetation management (mowing, pruning, etc.) to avoid a fertilizing effect and excessive future plant growth.
- Remove any Invasive Alien Species found.
- Consider grazing to control vegetation growth in large wildlife overpasses.
- Maintain in appropriate condition any structure built to provide refuge for fauna (e.g. rows of stone or tree stumps).



SCHEDULE

- Minimum: once a year, just before seasonal migrations or periods when target species movements are increased.
- Mowing and pruning vegetation should be scheduled according to local conditions.
- Additional inspections should be planned following floods, strong winds, snow or other adverse weather events.

Maintenance of viaducts, wildlife and multiuse underpasses



INSPECTION TASKS To check

- Materials are in good condition.
- Appropriate drainage is provided to prevent permanent flooding or pooling.
- No human misuse is found such as storage of agricultural machinery or materials, livestock stabling, human settlements, etc.
- In multiuse underpasses, provisions to make human and wildlife uses compatible (guiding fences, informative panels, etc.) are appropriately maintained.
- Fences are correctly anchored to the underpass side walls and to the upper screen.
- Components of the upper screen to reduce disturbances remain in good condition and any perimeter fences maintain continuity with the screen.
- Vegetation height, composition and patch design is consistent with the standards.
- No Invasive Alien Species are found.
- No debris or other objects pose obstacles or prevent the appropriate use of the wildlife crossing.
- Any refuges for fauna such as stumps or stone rows are in good condition in accordance with standards provided.



SPECIFIC MAINTENANCE TASKS To do

Structural features and uses

- Maintain or restore entrance areas to ensure these are free of obstacles to fauna movements and appropriately connected with the surrounding habitats.
- Replace any elements damaged by vandalism.
- In wildlife underpasses where no human use is planned, maintain appropriate state of the structures located at the entrances to avoid access of people and vehicles (large rocks, tree trunks or any other barrier).
- Periodically clean, fix, repair or replace any informative panels and signs.

Fences and screens > see Sheet 1

- Replace broken or deformed meshes and any damage on screens.
- Reinforce the anchorage of the mesh to the ground and poles when needed. If a reinforced mesh is already present, ensure it is well attached to the lower part of the fence.



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Maintenance of viaducts, wildlife and multiuse underpasses

SPECIFIC MAINTENANCE TASKS To do

Vegetation and fauna refuges > see Sheet 12

- Undertake mowing, pruning and other vegetation management according to standards provided.
- Remove vegetation debris that could obstruct the passage.
- Remove any Invasive Alien Species found.
- Maintain in appropriate condition any structure to provide refuge to fauna (e.g. rows of stone or tree stumps).



SCHEDULE

- Minimum: once a year, just before seasonal migrations or periods when target species movements are increased.
- Mowing and pruning vegetation should be scheduled according to local conditions.
- Additional inspections should be planned following floods, strong winds, snow or other adverse weather events.



Maintenance of modified culverts



INSPECTION TASKS To check

- Dry ledges where they exist are in good condition.
- Appropriate drainage is provided to prevent permanent flooding or pooling while allowing the primary hydraulic function.
- In culverts adapted to allow the passage of fish, ensure the connectivity is maintained for the use of aquatic organisms.
- No human misuse of the structure is found.
- Fences are well-anchored to wildlife crossing entrances.
- Fences are appropriately fixed to the ground.
- Vegetation height, composition and patch design is consistent with the standards.
- No Invasive Alien Species are found.
- No debris or other objects pose obstacles or prevent the appropriate use of the wildlife crossing.



SPECIFIC MAINTENANCE TASKS To do

Structural features and uses

- Maintain or restore entrance areas to ensure these are free of obstacles to fauna movements and appropriately connected with the surrounding habitats.
- If the structure is flooded for long periods, install dry ledges at both sides of the culvert to increase it's use by fauna.
- Maintain dry ledges appropriate state, clear of obstacles.
- Substitute wooden ledges for concrete ones, if needed, to increase durability.
- Remove rocks and sand that could impede wildlife crossing or reduce the hydraulic capacity.

Fences and screens > see Sheet 1

- Replace broken or deformed meshes and any damage on screens.
- Reinforce the anchorage of the mesh to the ground and poles when needed. If a reinforced mesh is present, ensure it is well attached to the lower part of the fence.
- Modify any element of the drainage system close to the fauna passage to prevent animals having access to the road (e.g. junctions of fences with perimeter drains).





Maintenance of modified culverts

SPECIFIC MAINTENANCE TASKS To do

Vegetation > see Sheet 12

- Undertake mowing, pruning and other vegetation management according to standards provided.
- Remove vegetation debris that could obstruct the passage or reduce its hydraulic capacity.
- Remove any Invasive Alien Species found.



SCHEDULE

- Minimum: Once a year, just before periods of increased movements or migration periods.
- Mowing and pruning vegetation should be scheduled according to local conditions.
- Additional inspections should be planned following floods, strong winds, snow or other adverse weather events.

Maintenance of amphibian tunnels



INSPECTION TASKS To check

- Materials are in good condition.
- Appropriate drainage is provided to prevent flooding.
- Fences are correctly anchored to the entrances and the fence ends are L or U-shaped away from the road to prevent the amphibians from crossing on the road surface.
- Fences are appropriately fixed to the ground.
- Vegetation height, composition and patch design is consistent with the standards.
- No Invasive Alien Species are found.
- No debris or other objects pose obstacles or prevent the appropriate use of the wildlife crossing.



SPECIFIC MAINTENANCE TASKS To do

Structural features and uses

- Maintain or restore entrance areas to ensure these are free of obstacles to fauna movements and appropriately connected with the surrounding habitats.
- Replace any elements damaged by vandalism.
- Modify any element of the drainage system that could be a trap for small animals (e.g. gullies located close to fences and passages, if animals are falling into the pits, ensure these have escape ramps which are accessible for fauna and unobstructed).
- Remove rocks and sand that could obstruct the amphibian tunnel.

Fences and screens > see Sheet 5

- Replace broken or deformed parts of the fence.
- Reinforce the anchorage of the fence to the ground and amphibian tunnels when needed.

Vegetation > see Sheet 12

- Undertake mowing, pruning and other vegetation management according to standards provided.
- Remove vegetation debris that could obstruct the tunnel entrance.
- Remove any Invasive Alien Species found.
- Maintain any refuges near the fences and tunnels, according to the maintenance guidelines ensuring that they provide cover for the target species.
- If ponds are close to amphibian tunnels, ensure that water is not flooding the tunnel.



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Maintenance of amphibian tunnels



SCHEDULE

- Minimum: once a year, just before seasonal reproductive migrations or periods when target species movements are increased.
- Mowing and pruning vegetation should be scheduled according to local conditions.
- Additional inspections should be planned following floods, strong winds, snow or other adverse weather events.



Maintenance of wildlife awareness signs



INSPECTION TASKS To check

- ❑ Signs are clean and well fixed.
- ❑ Signs are installed at hazardous road sections according to information provided in the maintenance plan.
- ❑ Signs are in the correct location; the distance from the start of the hazardous stretch must be assessed according to the road features and speed limits, and as provided in the maintenance plan.



SPECIFIC MAINTENANCE TASKS To do

- Clean the signs. Repair or replace when damage is detected.
- Add relevant complementary information for drivers about the length of the hazard stretch. After reevaluation of AVC hazard risk, signs which no longer indicate the correct location of the hazardous stretch should be removed and/or relocated.
- To increase driver awareness, consider changing standard signs to temporal ones where AVC hazard shows a marked temporal variation, increasing during specific times of the year.
- When temporal warning signs have dynamic enhancing devices (e.g. sensors and flashing lights), ensure all these electronics function appropriately.
- Where wildlife awareness signs are painted on the tarmac to reinforce driver awareness, periodically repaint them.



SCHEDULE

- Minimum: once a year, check structural condition and clean.
- Corrections to the locations of signs must be planned every 5 years, after a re-evaluation of AVC risk and identification of any hotspot stretches.
- Temporal signs, when present, must be put into operation just before the critical period according to species involved. Adjust schedule plan in accordance to periodical analyses of AVC risks.



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3.2.

Maintenance of signs activated by Animal Detection Systems (ADS)



INSPECTION TASKS To check

- ❑ Signs are clean and well fixed.
- ❑ Signs are installed at hazardous road sections according to information provided in the maintenance plan.
- ❑ Signs are working correctly according to the below periodic tests:
 - Sensors to detect movement are in line with the target animal size.
 - Position and orientation of sensors is correct.
 - Sensors are not blocked by obstacles (e.g. rocks, vegetations or other objects) which impede the detection of the approaching animals.
 - Solar panels, batteries and connections function appropriately.
 - LED lights function appropriately when a detection event occurs.
 - The signs remain activated for the correct period depending on the target species' behaviour and crossing time.

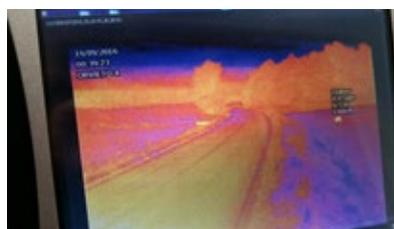


SPECIFIC MAINTENANCE TASKS To do

- Clean the signs. Repair or replace when damage is detected.
- Replace batteries, solar panels or any other elements damaged by vandalism or theft.
- Keep the detection area and zones between the sensors and sign receivers free from branches, bushes or tall grass vegetation. Accumulation of snow during winter requires additional maintenance tasks.
- To save time checking the correct system function, consider ADS systems which allow remote control and testing.
- Add panels to inform drivers how the ADS system functions, warning them when sign is active, indicates the immediate danger of collision with an animal close to or on the road.
- After re-evaluation of AVC hazard risk, signs which no longer indicate the correct location of the hazardous stretch should be removed and/or relocated.



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Maintenance of signs activated by Animal Detection Systems (ADS)



SCHEDULE

- Check appropriate operation of the ADS system at minimum once a month.
- Corrections to the locations of signs must be planned annually, after a re-evaluation of animal-vehicle collisions hazard risk and identification of any hotspot stretches.
- Temporal signs, when present, must be put into operation just before the critical period according to species involved. Adjust schedule plan in accordance to periodical analyses of AVC risks.

Management of vegetation



INSPECTION TASKS To check

- Appropriate state and condition is found according to standards provided in the maintenance plan.
- No vegetation obstructs driver's field of vision.
- No Invasive Alien Species are found.
- No dead bushes or trees are found.
- Frequency, periods and methods for mowing grass and pruning bushes and trees are adapted to reach the goals in each section according to standards provided in the maintenance plan, goals for target species and meeting legal regulations.



SPECIFIC MAINTENANCE TASKS To do

Move and prune vegetation according to maintenance plan

- Move after plant flowering, before winter, to ensure insects and other small fauna find refuges.
- Reduce the work and cost of frequent mowing by keeping patches or strips where plants can develop. Mow by sections applying alternate treatments over time allow to create a mosaic of different habitats.
- Remove vegetation debris within 10 days after mowing or cutting to avoid fertilization by decomposition.
- In sensitive areas, regularly prune vegetation instead of using cutting machines to avoid splitting branches or spreading tree diseases.
- In areas with high deer and wild boar density, manage road verges to reduce opportunities for food and cover which could attract these animals.
- Consider maintaining existing rows of trees which may funnel bat flight, provide refuges for insects or birds and other benefits to biodiversity, with appropriate maintenance to guarantee traffic safety.

Sow and plant well-adapted and not invasive vegetation

- Use only native and well-adapted vegetation species from the surrounding natural region.
- Do not use species which spread and grow fast, to avoid hindering growth of other species and enhance diversity.



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Management of vegetation

SPECIFIC MAINTENANCE TASKS To do

Use organic/non-toxic products and avoid fertilisers

- Apply biological control methods to avoid introducing toxic products into the environment. These techniques often take a long-term view that which will ultimately be more effective.
- If needed, use organic fertilizers instead of mineral ones.
- If chemicals are required in a well-justified specific case, choose target-specific products, with low toxicity, short permanence in the environment and always meeting regulations.

Consider grazing and local stakeholders involvement

- Establish cooperation agreements with local stakeholders to promote wildlife crossing vegetation maintenance by grazing and other practices that enhance the management of adjacent lands aiming to achieve the objectives of ecological assets.



SCHEDULE

- Schedule for mowing, pruning or other tasks must be adapted to the annual life cycles of wildlife and according to local conditions. A typical frequency could be:
 - In the median: twice to three times a year.
 - In the area beside platforms: twice to three times a year.
 - In green ditches (partially or completely flooded): once or twice a year where necessary. Maintenance tasks should be left until the breeding periods of insects and other small fauna in ditches are finished: end of summer/beginning of autumn.
- Avoid disturbance caused by vegetation management during breeding and hibernation periods of target species.

/4.2.

Management of habitats for pollinators and other small fauna



INSPECTION TASKS To check

- ❑ Appropriate state and condition of vegetation planted to feed pollinators is found and their habitats are suitable according to standards in the maintenance plan.
- ❑ No vegetation obstructs driver's field of vision.
- ❑ No Invasive Alien Species are found.
- ❑ Appropriate state of refuges for pollinators and other small fauna (trunks with holes, 'insects hotels', etc.) are maintained according to the standards provided.



SPECIFIC MAINTENANCE TASKS To do

Sow, plant and maintain herbaceous and flowering aromatic plants to feed pollinators

- Plant only native species that are already present in the natural ecosystems.
- Select a variety of plants that feed target pollinators species throughout the season.
- Choose plants that need a low mowing regime and adapt mowing activities according to the flowering period of each plant.

Create and maintain insect refuges

- Ensure the presence of breaks in the vegetation cover with small areas of sand and other areas with some dead wood.
- When required, install insect refuges ('bee-hotels' or posts with holes). The hole size and arrangement need to be adapted to the pollinator target species.
- Do not install beehives for honeybees because these could act as competitors for many other species of endangered pollinators.

Create and maintain habitats for small fauna

- Consider placing stumps and logs on parts of the verge furthest from traffic, to create habitats for endangered xylophage insects.
- Consider installing stone or wood rows, bat refuges, bird nesting-boxes or any other refuges for fauna in areas where they cannot be affected by vehicle collisions, such as within large wildlife crossings.
- Avoid creating 'ecological traps', which are habitats attracting animals to areas with high mortality risk. Seek wildlife/ecology experts to provide information adapted to the local ecological landscape.



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Management of habitats for pollinators and other small fauna



SCHEDULE

- Minimum: once a year, just before spring, the period of pollinators main activity or according to target species requirements.
- In areas where pollinator habitat creation is a target, maintenance tasks should be left until the flowering period of most plants has finished.
- Avoid disturbance caused by vegetation management during breeding and hibernation periods of target species.

/4.3.

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Control of Invasive Alien Species (IAS)



INSPECTION TASKS To check

- ❑ Identify bare soils and other areas IAS could potentially grow and programme periodic checks.
- ❑ Check for the presence of IAS periodically in ponds and particularly sensitive green areas.
- ❑ Report the detection of any IAS (plant or animal) found during maintenance works in green areas and drainages to allow quick removal.
- ❑ Record location and extension of any infestation as well as characteristics of the site.



SPECIFIC MAINTENANCE TASKS To do

Apply best practice to avoid IAS spreading

- Avoid sowing or planting any IAS that could spread and invade natural habitats beside roads.
- Do not leave areas with bare soil as it could easily be colonized by IAS.
- Where any IAS is found, clean vehicles and machinery after maintenance tasks to avoid transporting seeds and plants fragments.
- After applying IAS control methods, ensure remnants are carefully removed and do not represent a risk of further spread. Particular care should be applied near watercourses as they can rapidly disperse seeds.

Define an apply an 'Early Awareness Detection System'

- Provide field crews with lists and Field Guides of the most problematic IAS in the region and most sensitive areas (Lists for some countries are provided. See 'Control in Roads' project).
- Define a procedure to immediately report the detection of any IAS.

Apply control methods specific for each IAS

- Collect detailed data on plant or animal IAS present, scale of infestation and physical site conditions.
- Seek wildlife/ecology expert assistance to formulate and undertake appropriate control measures.
- Monitor post-control to ensure measures have been effective.

Maintain field crew awareness

- Keep crew engagement by updating knowledge on new IAS.



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Control of Invasive Alien Species (IAS)



SCHEDULE

- Perform IAS checking at least twice per year in the periods where they can be more easily identified and according to the frequency established by the risk assessment.

/4.4.

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Management of verges to reduce forest fire risk in sensitive areas



INSPECTION TASKS To check

- ❑ No dead vegetation, particularly shrubs or trees, is present at verges close to circulation platforms.
- ❑ No plants particularly well-adapted to fire (pyrophytes) or any vegetation that could contribute to initiation or propagation of fire are found close to circulation platforms.



SPECIFIC MAINTENANCE TASKS To do

- Keep verge vegetation tightly mowed in the strip close to circulation platforms to reduce risk of fire.
- Remove fallen trees, dried vegetation, debris and any other easily inflammable material from road verges.
- Relocate or remove existing individuals of particular problematic species, that burn easily or even can contribute to spread the fire such as pine trees, eucalyptus, or rock roses (*Cistus* sp).
- Work with forest fire authorities to identify potential firebreak sections of roads and railways where appropriate verge management, without trees, bushes or plants that burn fast, would assist in control of large forest fires.



SCHEDULE

- At least once a year, before periods of high risk of forest fire (usually end of spring).
- Additional inspections should be planned following weather conditions or events increasing forest fire risk.



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Management of retention ponds to wildlife



INSPECTION TASKS To check

- Water level variation is within limits provided in the maintenance plan.
- Water quality is appropriate and toxic elements for aquatic species are not detected in periodic biochemical analysis.
- Appropriate state and condition of vegetation growing at the pond margins and in the water is found, avoiding excessive growth.
- Margin slopes are smooth and allow the entry and exit of amphibians and other small fauna.
- No Invasive Alien Species are found.
- Check for the presence of aquatic fauna that would have to be rescued when ponds need drained.
- Record presence of flora and fauna target species and any evidence of breeding, and store the information in appropriate databases.



SPECIFIC MAINTENANCE TASKS To do

Prevent fauna access to hazardous ponds

- Install fencing or any other system to avoid access of animals to ponds which can pose a risk to fauna such as poor water quality and where animals may get trapped.
- Guide amphibian movements around the pond to adjacent habitats to stop them getting onto the roads.

Adapt retention ponds as amphibian breeding sites

- Guarantee appropriate water quality and physical conditions
- Avoid the colonization of fish predators.
- Maintain appropriate aquatic vegetation community

Enhance ponds as wildlife habitats

- Identify target species and their habitat requirements.
- Modify the slope gradient around the perimeter, water depth, flow velocity and other habitat features according to the requirements of target species.
- Manage vegetation to achieve a similar habitat to surrounding areas depending on the requirements of target species.



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Management of retention ponds to wildlife

SPECIFIC MAINTENANCE TASKS To do

- Consider managing ponds at the entrances of wildlife crossings to provide drinking points or breeding sites for animals.

Perform rescue of aquatic fauna before ponds are drained

- Seek wildlife/ecology expert assistance to identify species to be rescued, evaluate the population density and plan the best schedule and methods for rescue.
- Apply appropriate methods to rescue fauna living the pond and provide sites to keep them in good conditions while drainage is being undertaken.
- After drainage, restore conditions suitable for wildlife target species and return the animals to the pond, except any Invasive Alien Species.
- Monitor to ensure measures have been effective.



SCHEDULE

- Minimum: once a year, just before seasonal reproductive migrations or periods when target species movements are increased.
- Additional inspections should be planned following floods, strong winds, or other adverse weather events, and after road works, traffic accidents and other potential disturbances.
- The frequency and period of maintenance tasks should be adapted so that they do not affect fauna breeding in the retention ponds.



Management of road killed animals



INSPECTION TASKS To check

- ❑ A road survey for carcass recording and removal procedure is in place, to avoid attraction of scavengers, a risk of carcass-vehicle collision and to facilitate appropriate carcass disposal.
- ❑ Platforms and verges are explored when searching for carcasses, particularly in AVC hotspots.
- ❑ The procedure for data recording includes the identification of the species when possible, particularly for most relevant target species in each site.
- ❑ Periodic additional surveys of small fauna carcasses are planned where required, and undertaken by experts to obtain reliable data of small animals mortality.
- ❑ Coordination is established with traffic police, environmental authorities or any other organisation which record roadkill in the same area to compile all data gathered > See Sheet 18.



SPECIFIC MAINTENANCE TASKS To do

Apply best practice for collection and disposal

- Provide appropriate clothing and equipment to field crews to ensure hygienic conditions.
- Ensure large carcasses such as deer or wild boar, are more easily collected from platforms and verges by providing cranes, hoists or other special equipment on vehicles.
- Dispose of carcasses according to national regulations. Be aware of particular sanitary requirements, e.g. countries affected by African Swine Fever impose strict biosafety conditions for wild boar collection and disposal.

Register accurate data of all AVC and carcasses

- Record accurate data from carcasses and AVC to allow the identification of hotspots and application of mitigation measures to reduce risk > see Sheet 18.
- Provide field crews with devices to record data from AVC and carcasses, including accurate geographical position and photographs to allow further identification.

Maintain field crew awareness

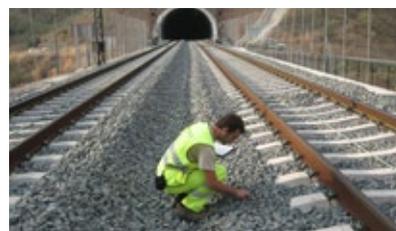
- Keep crew engagement by updating knowledge on animal road kill including the provision of user friendly field guides to help with species identification.



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Management of road killed animals



SCHEDULE

- Inspections should be undertaken earlier in the morning as roadkill frequently happens during the night.
- Define appropriate frequency according to target species' behaviour.
- Adapt seasonal and road section schedules according to analyses of available data on AVC occurrence.

Management of Animal-Vehicle Collisions (AVC) data



DATA COLLECTION To check

- Recording of the following data for any roadkill is undertaken, by providing field crews with suitable training and equipment
 - Collision date, and time if known.
 - Location: coordinates, road code and kilometer point.
 - Species involved, sex and age class, if known.
 - Any information which helps to explain AVC occurrence related to landscape (presence of rivers, nearby housing, etc.) or infrastructure features (fencing, road verges issues, garbage containers, etc.).
- A cooperative procedure with other organisations recording data related to AVC is established to develop a comprehensive database which will improve knowledge of AVC hotspots, helping to define solutions. Relevant organisations include:
 - Traffic police and insurance companies could provide information on injury and/or damage accidents involving large animals.
 - Research centres and NGOs, among others, could provide information on small road killed animals.



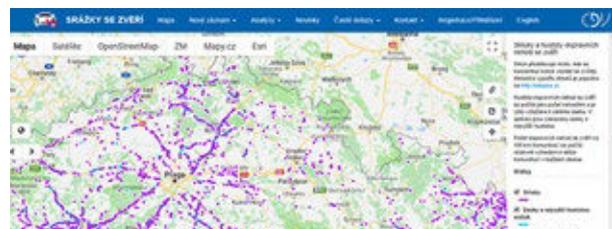
DATA MANAGEMENT AND AVC MITIGATION To do

Undertake analyses to identify where and when hotspots occur

- Provide statistical analyses of the data collected which outlines seasonal, annual and location variations in AVC numbers.
- Use a roadkill clustering method to identify hotspots where AVC occur in high frequency (e.g. KDE+ or any other which has the possibility to define a frequency threshold goal) and link it to an app/web-based system managing the AVC database.
- Perform analyses for particular target species or group of species (e.g. endangered species or large animals which pose a major risk to drivers).
- Use maps to visualize the location of AVC hotspots and provide data from different periods of the year.
- Identify where and when AVC hotspots are occurring along road sections over time.



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Management of Animal-Vehicle Collisions (AVC) data

SPECIFIC MAINTENANCE TASKS To do

Identify causes and provide solutions to reduce AVC risk

- Identify local factors related to landscape, infrastructure features or human activities which could influence AVC clustering involving different species, to assist in the investigation of why hotspots occur.
- Define the most effective mitigation measures to be applied in hotspot areas based on causes analysed. Factors which go beyond the routine maintenance of the road require ecology expert assessment.
- Undertake monitoring before and after mitigation to ensure measures have reduced AVC numbers.



SCHEDULE

- Periodic data analyses should be planned according to the frequency and variation of the AVC hotspot along road sections, at least once every 5 years.

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Appendix 1. Relevant environmental regulations and strategies to be considered at maintenance of ecological assets on transport linear infrastructure

- **Bern Convention** (EC, 1970) Council of Europe's Convention on the Conservation of European Wildlife and Natural Habitats
Art. 6.
Each Contracting Party shall take appropriate and necessary legislative and administrative measures to ensure the special protection of the wild fauna species specified in Appendix II. The following will in particular be prohibited for these species:
 - *all forms of deliberate capture and keeping and deliberate killing*
 - *the deliberate damage to or destruction of breeding or resting sites*
 - *the deliberate disturbance of wild fauna, particularly during the period of breeding, rearing and hibernation, insofar as disturbance would be significant in relation to the objectives of this Convention.*

- **Habitats Directive** (EC, 1992) Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora
Art. 12.
Member States shall take the requisite measures to establish a system of strict protection for the animal species listed in Annex IV (a) in their natural range, prohibiting:
 - *all forms of deliberate capture or killing of specimens of these species in the wild*
 - *deliberate disturbance of these species, particularly during the period of breeding,*
 - *rearing, hibernation and migration*
 - *deterioration or destruction of breeding sites or resting places.*

3. The prohibition referred to in paragraph 1 (a) and (b) and paragraph 2 shall apply to all stages of life of the animals to which this Article applies.

4. Member States shall establish a system to monitor the incidental capture and killing of the animal species listed in Annex IV (a). In the light of the information gathered, Member States shall take further research or conservation measures as required to ensure that incidental capture and killing does not have a significant negative impact on the species concerned.

- **EU Birds Directive** (EC, 2009) Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds
Art. 5
Without prejudice to Articles 7 and 9, Member States shall take the requisite measures to establish a general system of protection for all species of birds referred to in Article 1, prohibiting in particular:
 - *deliberate killing or capture by any method*
 - *deliberate disturbance of these birds particularly during the period of breeding and rearing, in so far as disturbance would be significant having regard to the objectives of this Directive.*

- **Aichi targets** (Biological Diversity Convention COP10, 2010)
Target 9. By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

Target 11. By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

Target 12. By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Target 15. By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

- **Green Infrastructure** (COM/2013/0249 final). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions. Green Infrastructure (GI). Enhancing Europe's Natural Capital.

- **EU Biodiversity Strategy for 2030.** (CE, 2020) COM 2020, 380 final. Bringing nature back into our lives. EU Nature Restoration Plan: key commitments by 2030
 1. *Legally binding EU nature restoration targets to be proposed in 2021, subject to an impact assessment. By 2030, significant areas of degraded and carbon-rich ecosystems are restored; habitats and species show no deterioration in conservation trends and status; and at least 30% reach favourable conservation status or at least show a positive trend.*
 2. *The decline in pollinators is reversed.*
 3. *The risk and use of chemical pesticides is reduced by 50% and the use of more hazardous pesticides is reduced by 50%.*
 6. *Three billion new trees are planted in the EU, in full respect of ecological principles.*
 10. *The losses of nutrients from fertilisers are reduced by 50%, resulting in the reduction of the use of fertilisers by at least 20%.*

- **Invasive Alien Species.** (CE, 2014) Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species
Art. 7
 1. *Invasive alien species of Union concern shall not be intentionally:*
 - (b) *kept, including in contained holding;*
 - (c) *bred, including in contained holding;*
 - (d) *transported to, from or within the Union, except for the transportation of species to facilities in the context of eradication;*
 - (g) *permitted to reproduce, grown or cultivated, including in contained holding; or*
 - (h) *released into the environment.*

Appendix 2. Fields to be included in the ecological asset database. Example of a wildlife crossing description form

Identification and location of the structure		STRUCTURE CODE: (TYPE_RoadCode_PK) e.g.: MUP_A2_55+100	
Road code: e.g.: A2	PK: (kilometre point; 000+000) e.g.: 55+100		
Road stretch: (town to town) e.g.: Brasov-Comarnic	Coordinates (X,Y): (If GPS location is not provided)		
Main structural features			
Type of non-wildlife crossing structures (With NO particular adaptations for wildlife) <input type="checkbox"/> Tunnel (TUN) <input type="checkbox"/> Overpass (OVP) <input type="checkbox"/> Viaduct (VIA) <input type="checkbox"/> Underpass (UNP) <input type="checkbox"/> Culvert / drainage (CUV) <input type="checkbox"/> Other: _____	Type of Wildlife crossing (Specific for wildlife or adapted to allow fauna use) <input type="checkbox"/> Ecoduct (ECO) <input type="checkbox"/> Wildlife Overpass (WOP) <input type="checkbox"/> Multi-use Overpass (MOP) <input type="checkbox"/> Wildlife Underpass (WUP) <input type="checkbox"/> Multi-use Underpass (MUP) <input type="checkbox"/> Modified culvert (WCU) <input type="checkbox"/> Amphibian tunnel (ATP)		
Road transversal section: <input type="checkbox"/> Flat <input type="checkbox"/> Embankment <input type="checkbox"/> Cutting <input type="checkbox"/> Slopes combination			
Structure section: <input type="checkbox"/> Circular <input type="checkbox"/> Rectangular <input type="checkbox"/> Vault <input type="checkbox"/> Other: _____	Composition of the structure: <input type="checkbox"/> Simple <input type="checkbox"/> Double <input type="checkbox"/> Triple <input type="checkbox"/> Other: _____		
Visibility of opposite entrance: <input type="checkbox"/> 0% <input type="checkbox"/> 25% <input type="checkbox"/> 50% <input type="checkbox"/> 100%			
Dimensions (m): Height (H): Width (W): Length (L): Openness Index (Section/L): Diameter (H): Length (L): Openness Index (Section/L): Multicellular Height (H): Width (W _{total} , W ₁ ; W ₂ ,...): Length (L): Openness Index (Section/L):			
Construction material: Structure <input type="checkbox"/> Concrete <input type="checkbox"/> Corrugated steel <input type="checkbox"/> Other: _____ Substratum material <input type="checkbox"/> Concrete <input type="checkbox"/> Corrugated steel <input type="checkbox"/> Natural substratum (%): _____ <input type="checkbox"/> Other: _____			
Presence of water: <input type="checkbox"/> No <input type="checkbox"/> Yes, permanent <input type="checkbox"/> Yes, temporal Water layer depth (cm): _____ Surface covered by water (%): _____			
Dry ledges: <input type="checkbox"/> <input type="checkbox"/> One side Material: _____ Width (m): _____ <input type="checkbox"/> <input type="checkbox"/> Both sides Material: _____ Width ₁ (m): _____ Width ₂ (m): _____			
Uses of the passages: <input type="checkbox"/> Cattle trail <input type="checkbox"/> Pedestrian trail <input type="checkbox"/> Forestry road (unpaved) <input type="checkbox"/> Paved road <input type="checkbox"/> Water channel <input type="checkbox"/> Stream crossing <input type="checkbox"/> Other: _____			
Other features:			
Inspected by:		Date inspection:	

STRUCTURE CODE: _____		
	Entrance 1 (orientation side; e.g.: NE:____)	Entrance 2 (orientation side; e.g.: SW:____)
Obstacles at the entrances		
Type of obstacle	<input type="checkbox"/> Stepped exit; num. of steps ____ height (cm): ____ <input type="checkbox"/> Stone or concrete ramp; slope (°): ____ <input type="checkbox"/> Pit <input type="checkbox"/> Riprap <input type="checkbox"/> Other: _____	<input type="checkbox"/> Stepped exit; num. of steps ____ height (cm): ____ <input type="checkbox"/> Stone or concrete ramp; slope (°): ____ <input type="checkbox"/> Pit <input type="checkbox"/> Riprap <input type="checkbox"/> Other: _____
Vegetation ²		
Dominant vegetation	<input type="checkbox"/> Trees <input type="checkbox"/> Bushes <input type="checkbox"/> Herbaceous	<input type="checkbox"/> Trees <input type="checkbox"/> Bushes <input type="checkbox"/> Herbaceous
Representative species		
% vegetation coverage	<input type="checkbox"/> 0-4 <input type="checkbox"/> 5-24 <input type="checkbox"/> 25-49 <input type="checkbox"/> 50-74 <input type="checkbox"/> 75-100	<input type="checkbox"/> 0-4 <input type="checkbox"/> 5-24 <input type="checkbox"/> 25-49 <input type="checkbox"/> 50-74 <input type="checkbox"/> 75-100
Surroundings ³		
Any activity causing disturbances at the vicinity? <input type="checkbox"/> No <input type="checkbox"/> Yes (which one?): _____		
Natural Habitat type/ Land use		
Distance to the entrance (m)		
Fences		
Typology	<input type="checkbox"/> Knotted wire mesh <input type="checkbox"/> Absent <input type="checkbox"/> Welded wire mesh <input type="checkbox"/> Other: _____ <input type="checkbox"/> Chain-link wire mesh Height (cm): ____ Mesh size (cm): ____	<input type="checkbox"/> Knotted wire mesh <input type="checkbox"/> Absent <input type="checkbox"/> Welded wire mesh <input type="checkbox"/> Other: _____ <input type="checkbox"/> Chain-link wire mesh Height (cm): ____ Mesh size (cm): ____
Safety barrier	<input type="checkbox"/> Metal <input type="checkbox"/> Wood <input type="checkbox"/> B-wave <input type="checkbox"/> New Jersey <input type="checkbox"/> Other: _____ Height (cm): ____	<input type="checkbox"/> Metal <input type="checkbox"/> Wood <input type="checkbox"/> B-wave <input type="checkbox"/> New Jersey <input type="checkbox"/> Other: _____ Height (cm): ____
Adjustment to the structure entrances	<input type="checkbox"/> Yes <input type="checkbox"/> No (openings or other)	<input type="checkbox"/> Yes <input type="checkbox"/> No (openings or other)
Presence of specific adaptations	<input type="checkbox"/> Base reinforcements <input type="checkbox"/> Outrigger <input type="checkbox"/> Other: _____	<input type="checkbox"/> Base reinforcements <input type="checkbox"/> Outrigger <input type="checkbox"/> Other: _____
Other features:		
Field photos: (number photo reference)		

² Observed at field approximately covering 2-3 m from the crossing structure entrances.

³ Analysed by GIS (buffer diameter distance according to the mean home range of target species)

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Conférence Européenne
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Conference of European
Directors of Roads

Conference of European Directors of Roads (CEDR)

Ave d'Auderghem 22-28

1040 Brussels, Belgium

Tel: +32 2771 2478

Email: information@cedr.eu

Website: <http://www.cedr.eu>



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