CEDR Transnational Road Research Programme
Call 2013: Roads and Wildlife – Cost efficient Road Management

Austria, Denmark, Germany, Ireland,
Norway, Sweden, Netherlands and UK

CEDR
Conférence Européenne des Directeurs des Routes
Conference of European Directors of Roads

Procedures for the Design of Roads in Harmony with Wildlife

Handbook on procurement and follow-up (incl. performance indicators)

Deliverable E – Part B
June 2016

Roughan O'Donovan Innovative Solutions (ROD-IS)

Bureau Waardenburg (BuWa)

Swedish National Road and Transport Research Institute (VTI)

MTA Centre for Ecological Research (MTA)

Harmony

CEDR Call 2013: Roads and Wildlife – Cost efficient Road Management
Harmony
Procedures for the Design of Roads in Harmony with Wildlife

Handbook on procurement and follow-up (incl. performance indicators)

Revision	Description	Made	Checked	Approved	Date
01	Draft final report	G Tschan, VTI E. Ó Catháin, ROD-IS C. Carey, ROD-IS B. Corrigan, ROD-IS	EOB, ROD-IS	MP, MTA	24/12/14
02	Draft final report	G Tschan, VTI C .Carey, ROD-IS	EOB, ROD-IS	AOC, ROD-IS	27/06/16
02	Draft final report	S. MacGearailt, ROD-IS	CC, ROD-IS	EOB, ROD-IS	14/12/16

Due date of deliverable: 31/10/2015
Actual submission date: 01/03/2016
Revised and resubmitted on: 27/06/2016
Revised and resubmitted on: 14/12/2016

Start date of project: 01/04/2014 End date of project: 31/03/2016

Author(s) this deliverable:
Georg Tschan, VTI, Sweden
Eoin Ó Catháin, ROD-IS, Ireland
Ciarán Carey, ROD-IS, Ireland
Barry Corrigan, ROD-IS, Ireland
Seamus Mac Gearailt, ROD-IS, Ireland

PEB Project Manager: Vincent O'Malley

Version 3, Dec 2016

Table of contents

1 Introduction

1.1 *Background*

Over the last 200 years, a great network of roads and railroads has grown all over the world. From the human perspective on the one hand, this means a considerable increase in individual mobility, but on the other hand it comes at the cost of a progressive fragmentation of the landscape surrounding us. Wildlife was until very recently not considered in the planning of infrastructure at all. However, transport infrastructure has an enormous effect on wildlife, causing the death of many thousands of animals each year, and contributing to a general decline of wildlife and natural habitats (Iuell et al., 2003). That wildlife populations in Europe did not crash, but instead showed a mild comeback from the mid-20th century, however, has to be attributed to species protection, an active, targeted conservation, and extended legal protection (Deinet et al., 2013). The discussion about mitigation efforts for the protection of wildlife in Europe has to be conducted In this context.

European countries are among those with the densest road networks in the world. Since the world network is likely to increase considerably in the near future – not least in developing countries (cf. Laurance et al., 2014) – it is important to lead with a good example in construction, maintenance and follow-up activities to create a sustainable infrastructure throughout the continent. However, today there are large differences between the individual countries in how the transportation infrastructure is procured, managed and maintained. For example, operation and maintenance can be delegated in part – or entirely – to private companies, and the amount of supervision by state or local governments varies considerably across Europe. In fact, most maintenance tasks for roads (and other transport routes) are nowadays given to one or more private companies. These in turn receive the respective assignments in a more or less standardised procurement process, which is commonly repeated after a specified time frame and which has to comply with the European rules for procurement of public contracts (European Commission, 2015).

The primary purpose of roads in Europe is to provide transportation corridors for human passengers and freight, but their design, operation and maintenance has to be done in harmony with wildlife. Actions that tackle the problem of landscape fragmentation and the conflict of interest between humans and wild animals will have an increasing importance in future. To this end, we will provide recommendations here for the procurement of project contracts that optimises the use of resources without compromising nature.

1.2 *Outline of this document*

This deliverable has been developed through a collaborative effort between ecologists and engineers. It is based on experience collected from the following nine EU Member states (in alphabetical order):

- Austria
- Belgium
- Greece
- Hungary
- The Republic of Ireland
- The Netherlands
- Norway
- Sweden
- The United Kingdom

Recommendations given here consider large motorway / trunk road construction and widening schemes. Additional studies would be required to establish if the findings of this study are applicable to other categories of project. The three major subjects covered in this report are:

(1) Procurement of contracts,
(2) Follow-up activities (i.e. post-construction, handover, and maintenance) and,
(3) Performance indicators.

For some forms of procurement of road works there were before now clear gaps in the chain of actions for wildlife protection that gave rise to risks of failure in wildlife protection measures. One of these shortcomings was a lack of continuity and consistency of wildlife protection regardless of the procurement process adopted.

An important approach to ensure proper implementation of wildlife-friendly measures is to include post-construction controls as an integral part of any project, which we refer to here as '*follow-up*'. *Follow-up* is thus defined as any activity that checks if a structure is fulfilling its purpose, in terms of quality and sustainability (here mainly applied to mitigation structures such as artificial wildlife crossings) and acts on the findings. In this sense, follow-up almost always comprises some form of biological monitoring. However, 'follow-up' is not to be confused with 'maintenance'. Maintenance activities have the purpose of keeping a structure functional, while a follow-up is checking the function of the structure following its initial construction. In contrast to maintenance, follow-up activities are usually performed only during a specified period after construction, however, this can vary depending on the specific site conditions. This will be further explained in the relevant sections of this document.

2 Procurement of Contracts

2.1 *General observations*

2.1.1 *Permissible Procurement Strategies*

The EU Procurement Directive 2014/24/EU permits five different types of procurement competition:

- Open;
- Restricted;
- Competitive Procedure with Negotiation;
- Competitive Dialogue;
- Innovation Partnership.

All of the above can include Suitability Assessments to establish the experience of the Contractor and Quality Assessments to measure the Contractor's proposed approach to the project, which can include specific measures for dealing with ecological protection and enhancement. The latter three options provide more scope for innovation by the contractor. However, the circumstances under which they can be used are more restrictive.

EU Procurement rules preclude – at present – consideration of past performance at the Tender Stage. That means that past performance may only be assessed at the Suitability Assessment Stage.

Studies have also shown that so-called *Green (Public) Procurement* (cf. European Commission, 2015a) with performance based objectives can achieve better environmental outcomes over standard environmental requirements incorporated into the EIA report/EIS. Some important observations that were made in the *Harmony* project:

- Increased focus on Quality in tender requirements leads to more robust tender submissions of higher quality.
- The importance of Quality Assessment increases where there are particular environmental sensitivities – e.g. proximity to a Natura 2000 site.
- Where there is an excessive focus on price, the quality of the completed project reduces. However, the use of Quality Assessment across the Study Area is limited and some jurisdictions require Contracts to be awarded on cost criteria only.
- There is frustration with the robustness of the procurement process in some jurisdictions. There need to be clear and specific evaluation criteria such that Contracting Authorities can resist procurement challenges. When a Contractor challenges high quality requirements, legal adjudicators often take a precautionary approach, frustrating the objectives of the Contracting Authority.

2.1.2 *Contracting Strategies*

The four different types of Contracting Strategies generally used for the construction and widening / improvement of large trunk road / motorway schemes across Europe are:

Contract Type/Name	Body responsible for project stage			
	Planning	***Design***	***Construction***	***Maintenance***
Traditional	Employer	Employer	Contractor	Employer
Design and Build (D&B)	Employer	Contractor	Contractor	Employer
Design, Build and Maintain (DBM)	Employer	Contractor	Contractor	Contractor
Early Contactor Involvement (ECI)	Contractor	Contractor	Contractor	Contractor/Employer

There are particular advantages and challenges associated with the contract types that are currently in use. In particular, we observed the following regarding each type:

Traditional Contracts (Employer Designed)

Traditional, employer-designed contracts offer the advantage that a certain continuity is ensured, because the same organisation is involved in the whole project life-cycle. Continuity is one of the cornerstones of a successful long-term project outcome but a failing of this form of contract is its vulnerability to a shortfall in resource commitment beyond construction.

Design & Build (D&B) Contracts

D&B contracts that lack suitably strong financial incentives (greater than the cost of measures) in regard to wildlife measures should be avoided from an ecological perspective. Here, there is the risk that the Contractor constructs the structure with a view to minimise costs only and without regard to the long term implications of the project performance or maintenance considerations.

Design, Build & Maintain (DBM) Contracts

DBM contracts should be preferred over pure D&B contracts as the Contractor is not only responsible for building the structure, but also for its maintenance. Thus, building a structure of good quality that will be functional for a long time is in the interest of the Contractor too, because it will incentivize the reduction of maintenance costs low will ideally render improvement works unnecessary.

A long maintenance period of several decades (e.g. in the Netherlands at present 20-30 years) can be achieved by setting the necessary money needed aside in the beginning. However, using DBM contracts can be either an advantage or a drawback, since their outcome depends on the performance of the contract holder on the one hand, but also on other, external factors (e.g. the state of scientific knowledge).

Early Contractor Involvement (ECI) Contracts

It is preferable to include the contractor in the project at an early stage. Often in these cases, the out-turn product is much closer to the planning scheme. This might also imply that the commitments of the Environmental Impact Statement will be much more effectively implemented. In addition, there are some obvious advantages when having all work, including advance surveys, undertaken by the same Contractor.

However, the Contracting Authority will have to work together with the Contractor from an early stage to design and achieve the objectives of the scheme. From the experience of several European countries that have employed this model over a number of years, the experience is that the Target Cost approach achieves co-operation and favourable outcomes.

Maintenance Contracts

In addition to the above construction contracts, maintenance contracts are increasingly common for mature networks that have accumulated over time. Maintenance Contracts are usually for fairly short periods of between 5 and 7 years so that poor performance can be addressed at reasonable intervals if necessary. Where a Contractor is undertaking maintenance and getting paid for it, it is necessary that the *Contracting Authority* must ensure that such works are being undertaken. From the viewpoint of international Best Practice it should therefore be favoured to procure maintenance works in *performance-based* contracts.

2.2 *Recommendations*

1) Ecological expertise in all parties involved in project delivery is essential for the successful implementation of environmental measures, from the preparation of contract documents through to the monitoring of road operations. The Contracting Authority requires access to suitable ecological expertise to enable it to fulfil its duties properly.
2) Formal arrangements for Maintenance are required, with provision for regular inspection and evaluation of mitigation measures to ensure that they continue to perform in line with the commitments made at the planning stage. This process requires suitable ecological expertise both for the Maintaining Organisation and in the Contracting Authority for suitable overall supervision of such activity across the full road network.
3) Increased use of Quality Assessment in the procurement process would be environmentally advantageous.
4) Engagement of specialist ecologists in both implementation and monitoring roles in the preparation and procurement of large Works and Maintenance Contracts is needed.

The key innovations that are possible within the legislative framework relate to the choice of contract rather than procurement strategy itself.

5) Options that provide an inherent performance monitoring function are best suited to achieve desired outcomes. The other forms of procurement require complementary actions by the Contracting Authority to achieve the same outcome for wildlife protection. Both DBM and ECI Contracts offer particular advantages.
6) To achieve ecological outcomes for the satisfactory management of existing infrastructure, Maintenance Only Contracts have potential to be particularly effective and may be used to improve the quality and functionality of wildlife measures.

Issues specific to particular types of contract are addressed in the following table:

Employer Designed	• Responsibility for wildlife protections rests with the Contracting Authority. • The full suite of expert ecological services for the design and monitoring of wildlife protections over the full life of the project is required.
Design & Build	• Contracting Authority determines performance requirements of the wildlife measures. • Appropriate ecologists design the wildlife measures. • Monitoring of the works may be undertaken by the Contractor for the initial performance period prior to handing it over to the Contracting Authority for maintenance and associated monitoring and remedial actions.
Design, Build & Maintain	• The wildlife measures are identified at the Employer Planning stage. • Appropriate ecological expertise needed for proper transfer to the next stages of Contractor Design / Contractor Construction / Contractor Maintenance. • The Contracting Authority has an ecological supervision role in monitoring the compliance at all stages including appropriate actions during the operational phase in response to Contractor monitoring.
Early Contractor Involvement	• Contractor Plans, Designs and Constructs with option to maintain/operate. • If contractor does not maintain then similar to D&B in terms of the role of the Contracting Authority in the Maintenance stage. • In instances where contractor maintains, this places the least demand on the Contracting Authority in terms of ecological expertise, since this responsibility is transferred to the contractor, although the Contracting Authority must ensure that targets are achieved. • An ECI Contract can operate on a target cost basis and include consideration of Maintenance arrangements from the outset. This “Engineering – Construction – Operation [ECO]” Contract may or may not include a financing element.
Maintenance Contract	• Wildlife measures maintained by a new Contractor with particular targets for management of the wildlife infrastructure amongst other duties. • Condition Assessment of the infrastructure is undertaken at the outset to identify defects and need for enhancements. Retrofit measures may be ordered, • The Contracting Authority is required to provide an ecological supervision role to monitor compliance at all stages including appropriate actions during the operational phase in response to Contractor monitoring. • This form of contract may have greatest application and value on a network management basis for cumulative ecological outcomes. It also provides a direct and effective means for management of the asset with suitable emphasis on the ecological functions. • The financial value of the ecological management tasks will be more significant in a relatively small value Maintenance Contract than in a much larger construction contract, and therefore the financial incentive to ensure suitable performance is more likely to be effective.

Where the design is undertaken or controlled by the Employer, there needs to be a Check process to ensure that the design is likely to result in the desired outcomes. This may be achieved through an independent checking process as is often applied for complex elements such as structures and earthworks. Another example is the Road Safety Audit procedure. A similar style Ecological Performance Audit process could potentially give greater confidence of a successful outcome. Such an audit could have 3 or 4 defined stages throughout the life of the project, with the final stage taking place after completion of construction and during the maintenance period.

In Contracts that involve design by the Contractor, there could be a Design Certification Process to ensure that the wildlife mitigation measures are designed by suitable competent persons. An auditing process could then provide independent verification of the design and construction to meet the required performance standards.

Sufficiently long performance periods of up to 5 years are necessary to enable the effectiveness of the mitigation measures to be monitored adequately and if necessary to allow for corrective action by the Contractor. This is often a requirement for the landscaping elements of major schemes, and may be extended to include the wildlife measures. Operational contracts are well suited in this respect, and it is desirable that construction-only contracts include an initial operational element in respect of these aspects to achieve consistent outcomes in all procurement scenarios.

For each of the 5 contract types mentioned above, the following table outlines the responsibilities for the various stages related to mitigation measures though the life a roads project.

Responsible Parties in each Procurement Process Type

	Activity	*Traditional Contract (Employer Designed)*	*Design & Build (D&B) Contract*	*Design, Build & Maintain (DBM) Contract*	*Early Contractor Involvement (ECI) Contract*	*Maintenance Contracts*
1	Environmental Assessment: Ecological, Hydro-Geological, Air Quality, etc		Employer		Employer & Contractor	Employer
2	Identify Mitigation Measures		Employer Designer		Contractor Designer	Employer
3	Design Mitigation Measures	Employer Designer	Contractor Designer	Contractor Designer	Contractor Designer	Employer Designer
4	Certify Designs - Check	Checker	Checker	Checker	Checker	Checker
5	Install Mitigation	Contractor	Contractor	Contractor	Contractor	n/a
6	Certify Installation	Employer Designer	Contractor Designer	Contractor Designer	Contractor Designer	n/a
7	Ecological Performance Audit - Annual for 5 Year Maintenance Period	Employer Designer	Contractor Designer	Contractor Designer	Contractor Designer	Contractor
8	Rectify Problems	Contractor	Contractor	Contractor	Contractor	Contractor
9	Supervision	Employer	Contractor Designer	Contractor Designer	Contractor Designer	Employer
10	Auditing	Independent	Independent	Independent	Independent	Independent
11	Management			Employer - Specialist Ecologist		

3 Follow-up: studies and activities

3.1 *General aspects of follow-up*

The meaning of the terms 'maintenance' and 'follow-up' should not be confused. *Maintenance* encompasses the technical activities to keep the structure in question working and has no time limit. *Follow-up*, on the other hand is usually the checking to determine if a structure is fulfilling its purpose and usually includes some biological monitoring. The latter does in most cases not have to be continued indefinitely, but only for a certain time after construction. *Monitoring* of biological activity should actually be considered an integral part of any follow-up study, but since it is often performed independently by researchers in scientific projects, opportunities for cooperation – e.g. between the National Road Authority and researchers at universities – should be used where possible to improve outcomes and understanding using up-to-date scientific methods and equipment.

Follow-up activities should be included as a standard feature in contract procurement – ideally as the appropriate kind of biological monitoring. This would enhance the efficacy of Environmental Impact Assessments (EIAs). Essentially, follow-up activities will also improve the effectiveness of mitigation measures, because they help to determine if the measures have achieved the desired effect (The Countryside Agency, 2006).

The absence of any commitment to follow-up activities in the contract is a cause for its neglect. Thus, it should *always be included* as an *integral part* when procuring a contract. However, there is also some evidence that inadequate follow-up of environmental requirements is due to the use of ambiguous language in contract documents.

Third-party control would ensure the implementation of adequate follow-up activities. It would be neither NRA personnel nor any of the contractors. Since the EIA Directive 2014/52/EU has recently included monitoring as a requirement of EIA, it is expected that such activities will be more commonplace in the near future. It would also be desirable to extend existing monitoring activities to more fully evaluate the functioning of mitigation structures.

3.2 *Approaches to follow-up*

Follow-up activities should already be considered during the planning stage. As an important tool for infrastructure development, the Environmental Impact Statement (EIS) already receives special attention during both the planning and the construction phases. Since the EIS provides predictions based on a number of previously available parameters, it is essential to compare the predicted with the actual impact of the road development during and after construction. An option is the use of performance indicators, which will be discussed further below.

The effectiveness of mitigation measures is usually tested by monitoring certain target species. The monitoring is mainly performed by visual inspections, often involving the use of cameras. Less common are methods of tracking, such as clay or sand beds. The method depends on the animal species to be surveyed and on the characteristics of the site where the study is to be performed. The increased use of methods that provide both qualitative and quantitative data allows the comparisons across sites and investigation of the influence of local conditions.

In the case where mitigation measures perform poorly, the structure in question may need improvement:

- Planting or landscaping are amongst a variety of improvement measures carried out in most European countries.
- The acquisition of agricultural land around an installed mitigation structure is another remedy but landowners themselves can also contribute to the improvement of quality.

It is not only necessary to check the function of a mitigation measure, but also its effectiveness at the population level. The performance of a mitigation structure has to be evaluated by using some kind of indicator or metrics that reflects its quality. This can be the quality and/or quantity of a species using the structure (i.e. for example species and number of animals per unit of time) or some other kind of performance indicators. In terms of follow-up, the use of measurable objectives and triggering thresholds would be the ideal situation (IEEM, 2006).

Qualitative and quantitative evaluations are carried out, with presence/absence or count data predominating in the activities undertaken. However, counting data only is not considered to be sufficient for a serious data evaluation. In fact, it is a gross simplification, and therefore widely criticised by researchers with ecological expertise. Hence:

- Supplement (simple) counting data with other kinds of measurements e.g., data from camera recordings in combination with data from GPS senders, trace traps, vegetation mapping or other, more sophisticated methods.

At present, data is often only collected *after* the construction of a mitigation measure for wildlife; thus, there is room for improvement.

- For a meaningful evaluation of the effectiveness, the monitoring should include *Before*, *After*, *Control* and *Impact* (BACI) measurements.

Follow-up actions, including supervision, should be undertaken by specialist personnel with the appropriate training to ensure that ecological measures are correctly implemented and maintained. While monitoring is a requirement of the EIA Directive, there is no corrective action procedure built in. Therefore, it is the responsibility of the Contracting Authority to include for this in the Works or Maintenance Contract. Where DBM Contracts are not used, maintenance otherwise typically falls to the Contracting Authority. Since there are opportunities for legacy wildlife problems to be addressed in maintenance contracts, the opportunity should be taken to improve the maintenance procedures alongside other works required for functional or operation reasons.

3.3 *Documentation and use of follow-up data*

Follow-up data should, in general, be available to the public since the so-called *Aarhus Convention* commits the public authorities in the member states of the European Union to publish all environmental information (European Commission, 2015b). So far the general policy with follow-up data is to keep it available, with release upon request. Creation of a unified database system would help to provide direct access for an external user via the internet, which is currently generally very limited. Easy access to data and an information policy developed for the long term would help maintain highly valuable experience and expertise.

Data should thus be collected and stored in a file format that later on will be compatible with standard database systems. Making data from specific projects/countries available will also create research opportunities that may generate insights into follow-up and good practice (Wessels et al., 2015). The creation of a unified, Europe-wide, database system for information retrieval would help raise public awareness on the issue of roads and wildlife. Public participation could also trigger a positive response and feedback, and will most probably result in more respect for the environment.

3.4 *Status and improvement possibilities regarding follow-up*

Follow-up studies are the only way to evaluate the effectiveness of mitigation measures. They provide the most effective way to gain knowledge and improve practice (Seiler & Folkeson, 2006). Follow-up studies have not received the attention that corresponds to their significance. Stakeholders are aware of the importance of follow-up but it is not prioritised. There is a lack of implementation and, when carried out, there is often poor or inconsistent practice. Follow-up activities are currently too dependent on personal convictions, i.e. they are only performed due to the personal commitment of an employee. A more systematic approach to maintenance and follow-up activities is needed, as well as an improvement of both. The methodology for survey and data collection in follow-up would be optimised if coordinated at an international level.

Follow-up activities, which have to be specified, should be standard in all contracts, and enforced if necessary.

The best outcomes in ensuring that environmental measures are correctly implemented and maintained are achieved when specialist personnel with the appropriate training undertake the follow-up actions.

It should be stated explicitly in the contracts (both construction and maintenance) that specialists with documented ecological/biological expertise are to be consulted from the early planning stage. Since Contractors will try to keep expenses to a minimum, there is a risk that the inclusion of ecological expertise will also be kept to a bare minimum. It should be made clear to the potential contractors that they do not run any competitive risk when all ecological aspects are included. Hence, price-only contracts make it difficult to achieve good outcomes.

One way to achieve these goals is the preferential use of DBFM contracts (see the section on "contracting strategies" above), when the Contractor will also be responsible for the functionality of his product. This, in turn, should provide sufficient incentive for him to keep it functional for a considerable amount of time. A further improvement could be a combination of DBFM and PPP (i.e. Public Private Partnerships) contracts where the contractor is given specific targets with financial incentives. This way of contracting would not only ensure that the measure is provided but also that the Contractor proves the use of the built structure (e.g. by ‘target species’).

3.5 *Follow-up: how to proceed in the future*

3.5.1 *Considerations*

There are no clear guidelines on follow-up. A solution to this problem is the design of a checklist or tool that provides guidance through the construction and/or maintenance processes, including follow-up (e.g. similar to the SUNRA tool; cf. Sowerby et al., 2014).

- Follow-up of the Environmental Impact Statement (EIS) should be compulsory.

- Ecological construction monitoring during the construction process would permit fast and professional response to unforeseen circumstances and provide the necessary background data for an evaluation of the mitigation measure's performance after construction.
- Traditional follow-up, the evaluation or checking if a structure is fulfilling its purpose, occurs throughout the operational life of the measure.

Incorporating all three of the above points would effectively lead to the aforementioned *Before*, *After*, *Control* and *Impact* (BACI) approach being adopted.

There is a need for clear and easy-to-measure parameters to evaluate the performance of mitigation measures. However, the performance of an ecosystem depends on many factors that are difficult to evaluate, much less to quantify – especially in the relatively short timeframe of a typical construction project. Many measurements are carried out to evaluate newly built mitigation structures, consisting for the most part of simple count data. Developing indicators (discussed in the following section) would greatly enhance the effectiveness of follow-up.

3.5.2 *Recommendations*

(1) Follow-up studies should be an integral part of procurement. More use should be made of Maintenance Contracts, in an attempt to lead to more efficient maintenance practice and better environmental outcomes.

(2) Clear guidelines should be developed, preferably as a standardised tool, to improve the implementation of standardised and regular follow-up.

(3) Creation of a unified database for information retrieval, which would simplify access to information and allow for easy comparisons across Europe.

(4) Both Maintenance Contractors and Contracting Authorities should have access to ecological expertise, either in-house or engaged, to ensure the environmental objectives of projects are achieved.

(5) Contracting Authorities need to be adequately resourced in order to undertake follow-up measures. Follow-up actions including supervision should be undertaken by specialist personnel with the appropriate training to ensure that ecological measures are correctly implemented and maintained.

(6) Inclusion of performance-based criteria in project contracts to focus the Contractor on environmental performance throughout the construction life of the project.

4 Indicators: metrics for evaluation

4.1 *Indicators as economic and ecological concepts*

Parameters that effectively and easily give a measure of a transportation-related environment's condition, is desirable, especially when examining the functionality of a mitigation structure or its effect on the surrounding environment. The development of suitable ecological/biological indicators would be beneficial to the implementation of most projects. 'Indicators' are here understood as parameters, which reliably should show the performance of wildlife mitigation measures.

Such indicators:

- have to be quantitative as well as qualitative,
- be measurable within reasonable limits of effort and,
- should constitute easily accessible, essential information on the functioning of an ecosystem.

The choice or design of indicators is dependent on local circumstances. Ecosystems are complex structures, and generalisation is inherently accompanied by a loss of information. The separation of *cause* from *effect* when dealing with an ecosystem is also important, and indicators for both are sometimes necessary. In most cases, human influence (e.g. constructing the road) will provide the cause, while the effect on the environment will have to be measured.

As well as this, ecosystems experience naturally qualitative and quantitative fluctuations. There is a danger that developed indicators will fail to document such fluctuations. This could prove disastrous when trying to evaluate the performance of an ecosystem using excessively simplified indicators. It needs to be kept in mind that possible, natural long-term fluctuations – for example of population sizes – have to be taken into account in such evaluations.

There is also a danger that "what gets measured gets done", with the possible implication that everything that remains unmeasured will also not be done (Barratt, 2011). Indicators, even those representing numeric 'target' values, can provide guidance, but they are only meaningful when used by individuals who entirely understand their meaning. Hence, communication on the same level or with an immediate supervisor is paramount. An ecosystem manager can have a few, but sometimes may have only a single indicator available to assess the system's condition but the use of such indicators must go hand in hand with experience and a deep, scientific and ecological understanding.

A good set of indicators provides unbiased guidance for the planning and operation of infrastructure and mitigation measures. The quality of any indicator is dependent on underlying data, which has to be collected beforehand. In turn, the availability of data will influence the choice of the indicators. The type of message conveyed by indicators is dependent on the type of indicator used (Gudmundsson, 2004). In general indicators should:

(1)	Provide a representative picture of the whole;
(2)	Be a reasonable simplification of complexity;
(3)	Be adaptable;
(4)	Have a sound scientific and technical foundation;
(5)	Be adopted in international standards;
(6)	Provide a regular update.

Depending on the user group – e.g. ecologists, decision-makers, the general public – the indicator should pass on only the information that is needed. A universal indicator that works on all levels does not exist. Indicators also have to be adapted anew for each project.

Care has to be taken that indicators will not be used solely as *performance* measures, e.g. by a subcontractor. This might otherwise lead to an incentive to fulfil certain ecologically relevant obligations irrespectively of the actual need, leading to so-called *unintended consequences* (in the sense of Merton, 1936). In the worst case, there is a risk that wrongly interpreted indicators – if they are designed mainly as *economic* incentives – can become so-called *perverse incentives*. These kinds of incentives result in undesirable outcomes, which are contrary to the original intention to establish such an incentive. The consequences of perverse incentives have been especially problematic in biodiversity conservation (Gordon et al., 2015), which is directly related to the topic of wildlife mitigation discussed here.

Indicators for wildlife mitigation projects should be aligned along the following points:

(1)	Indicators should be easy to measure, comparable and reproducible.
(2)	Indicators to be measured have to take the Environmental Impact Statement (EIS) into account.
(3)	It is important to establish a baseline beforehand, on which the indicator(s) will be modelled. This necessitates the availability of sufficient base data.
(4)	The indicators should already be considered during the procurement process.
(5)	Indicators should reliably show if a mitigation structure is functioning as planned.
(6)	In the specific case of mitigation structures such as wildlife bridges, the indicator(s) used should be able to document 'negative' outcomes as well, e.g. when a structure is *not* used by the target species.
(7)	The indicators used should include a 'positive' element, i.e. preferably include an incentive that reliably leads to the outcome planned. This could be, e.g. an economic benefit for the contractor when performing well rather than a penalty for poor performance.
(8)	Indicators have to consider that different species might be measures. This might necessitate the use of a different (kind of) indicator.

Indicators have to be adapted specifically for each project. However the following two indicators are recommended for use in mitigation of wildlife for road projects:

(1) Road kill (according to a pre-specified process of measurement); and
(2) Usage of crossings (using a pre-defined method of measurement and a pre-specified target species list/formula).

The use of indicators should not lead to the neglect of other crucial factors. Information flow – especially to sub-contractors and to the public – is vitally important, with the challenge of communicating complex matters through various levels a difficult one to overcome. The importance of follow-up for the successful implementation of all wildlife-related road projects cannot be discounted.

5 Conclusions

In conclusion, we provide the following, general recommendations:

(1)	Ecological expertise is essential for the successful implementation of environmental measures from the preparation of contract documents through to the monitoring of road operations.
(2)	The increased use of Quality Assessment, including ecological requirements, in procurement would provide environmental advantages.
(3)	Further advantages could be achieved if past performance of contractors were considered in procurement.
(4)	Construction and Operation Contracts that incorporate a Maintenance function with appropriate monitoring are preferred as this ensures that there is a process for problems to be resolved.
(5)	Contracts which engage the Contractor before the Planning Stage and that carry through to Operation and Maintenance are particularly successful for wildlife protection as they provide continuity and monitoring throughout the entire process.
(6)	Performance based mitigation measures of a DBFM (PPP) contract where the contractor is given specific targets with financial incentives may be a way of not only ensuring that the measure is provided but, by requiring the Contractor to prove the use of the measure by the target species, they are also incentivised to undertake extensive monitoring.
(7)	Follow-up studies need to be an integral part of all mitigation projects.
(8)	Follow-up studies should be performed or supervised by experienced ecologists, who ideally are permanently employed to ensure: a. a continuation of competence throughout the lifecycle of the project up to and including the maintenance phase; b. the build-up of local knowledge; c. development of performance indicators, which will be locally applicable.

With the involvement of ecological expertise and financial incentives we can ensure a long-term strategy, a continued personal commitment and the supervision of ecological performance, and not the least a considerable reduction of administrative expenses. A failure (i.e., not meeting the targets) through misunderstanding or misuse of Key Performance Indicators or other generalised indicators can thus be avoided.

References

Barratt P, 2011. KPIs have no place in the public sector. *"The Drum", Australian Broadcasting Corporation (ABC)*, 3 November 2011. URL: http://www.abc.net.au/news/2011-11-03/barratt---kpis-have-no-place-in-the-public-sector/3615966 (Accessed: 2015-11-19.)

Deinet S, Ieronymidou C, McRae L, Burfield IJ, Foppen RP, Collen B, & Böhm M, 2013. *Wildlife comeback in Europe: the recovery of selected mammal and bird species*. Final report to Rewilding Europe by ZSL, BirdLife International and the European Bird Census Council. London, UK: ZSL.

European Commission, 2015. *Public contracts: Rules & procedures*. URL: http://europa.eu/youreurope/business/public-tenders/rules-procedures/index_en.htm (Accessed: 2015-11-10.)

European Commission, 2015a. *Green Public Procurement*. URL: http://ec.europa.eu/environment/gpp/index_en.htm (Accessed: 2016-02-12.)

European Commission, 2015b. *The Aarhus Convention*. URL: http://ec.europa.eu/environment/aarhus/ (Accessed: 2015-11-09.)

Gordon A, Bull JW, Wilcox C, Maron M, 2015. Perverse incentives risk undermining biodiversity offset policies. *Journal of Applied Ecology*, **52**(2): 532-537.

Gudmundsson H, 2004. Sustainable transport and performance indicators. *Issues in Environmental Science and Technology*, **20**: 35-63.

IEEM, 2006. *Guidelines for ecological impact assessment in the United Kingdom*. Council of the Institute of Ecology and Environmental Management.

Iuell B, Bekker H, Cuperus R, Dufek J, Fry G, Hicks C, Hlaváč V, Keller V, Rosell C, Sangwine T, Tørsløv N, & Wandall B le Maire (Eds.), 2003. *Wildlife and traffic: a European handbook for identifying conflicts and designing solutions*. COST 341: Habitat fragmentation due to transportation infrastructure. Utrecht: KNNV Publishers.

Laurance WF, Clements GR, Sloan S, O'Connell CS, Mueller ND, Goosem M, Venter O, Edwards DP, Phalan B, Balmford A, Van Der Ree R, & Arrea IB, 2014. A global strategy for road building. *Nature*, **513**(7517): 229-232.

Merton RK, 1936. The unanticipated consequences of purposive social action. *American Sociological Review*, **1**(6): 894-904.

Seiler A, Folkeson L (eds.), 2006. Habitat fragmentation due to transportation infrastructure. COST 341 national state-of-the-art report Sweden. *VTI rapport* **530**A: 1-146.

Sowerby C, Langstraat J, Harmer C, Folkeson L, Gudmundsson H, 2014. SUNRA: a sustainability rating system framework for National Road Administrations. Paper presented at *Transport Research Arena 2014*, Paris, France.

The Countryside Agency, 2006. *Including landscape in road design, construction and mitigation: a good practice discussion note*. Cheltenham.

Wessels J-A, Retief F, Morrison-Saunders A, 2015. Appraising the value of independent EIA follow-up verifiers. *Environmental Impact Assessment Review*, **50**: 178–189.